FANUC America Corporation
Robot Operations
Student Manual
MATGGROOP1114CE REV B

FANUC America Corporation
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FANUC

Customer Resource Center

1-888-FANUC-US, option 1 for Robotics

www.fanucamerica.com

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For best call results have: - F# or serial number information - Hour meter reading (if available) - Software type and edition - Any error messages and LED displays (if applicable)	**For best call results have:** - Part number & description (if known) - F# or serial number information - Method of payment (P.O., credit card, etc.) - Shipping & billing addresses - Repairs – problem description (any symptoms, error codes, or diagnostic LEDs that were identified) - Warranty – serial number or PO you placed original order with.	**For best call results have:** - Part number & description (if known) - F# or serial number information - Method of payment (P.O., credit card, etc.) - Shipping & billing addresses - Reason for repair (any symptoms, error codes, or diagnostic LEDs that were identified) - Requested Arrival Time	**For best call results have:** - Your billing address - Types of courses needed - Special requirements - F# or serial number information - Proposed schedules - Number of people attending - Student names (if available) - Method of payment (P.O., credit card, etc.)	**For best call results have:** - Description of your need

*NOTES:

A RETURN AUTHORIZATION ("RA") FROM THE SPARE PARTS DEPARTMENT IS **REQUIRED BEFORE** ANY MATERIAL IS SHIPPED BACK TO FANUC ROBOTICS. ITEMS RETURNED WITHOUT PROPER AUTHORIZATION WILL BE SUBJECT TO RETURN AT CUSTOMER EXPENSE.

ROBOT F# OR SERIAL NUMBER IS LOCATED ON THE ROBOT BASE OR OPERATIONAL PANEL. ROBODRILL SERIAL NUMBER IS LOCATED ON THE UPPER RIGHT CORNER OF RIGHT HAND DOOR OF REAR ELECTRICAL CABINET.

To register for free online services please visit: http://robot.fanucamerica.com/Contact-us/Contact-us.aspx

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The FANUC cRc Website provides *Web Chat Support* for all our registered customers found on https://crc.frc.com. Additionally, the website provides free access to all product datasheets. Features include the ability to submit parts orders or request parts returns for new, warranty and certified repair. With the assistance of the parts search engine, customers can access pricing and availability information. Another key feature is order tracking with automatic email notification capabilities for all parts orders. To take advantage of our Web Solutions, register at https://crc.frc.com then click on the link labeled "Not Registered?"

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cRc provides a multilingual, 24-hour telephone support group that possesses advanced troubleshooting skills to quickly resolve customers' technical robot issues or to simply assist with normal setup and maintenance questions. If required, we will assist with dispatching our highly-skilled service engineers to conduct onsite repairs or start-up installation support. Other routine services provided via our technical phone support include: parts identification, after-hours support, and email based support, FAQ's, error code lookup and remote diagnostics. The Technical Support Group can be reached by phone or email technicalsupport@fanucamerica.com

Training Solutions – cRc's Training Group provides 22,000+ square feet of laboratory space, current model robots, ROBODRILLS and 9 classrooms to provide you with the best "HANDS ON" training available. We also conduct classes at our regional offices or at your facility. We also offer computer-based eLearn training solutions. To register for a class or inquire about special training needs, please call or visit our website at www.fanucamerica.com/training where a complete product training schedule, course descriptions, online registration form and a wealth of other information is available.

Onsite Field Service Support – Service offerings include: local and regional dispatch, after-hours down production support, primary and resident site service engineers, installation support and programming, operation and performance audits, preventive maintenance, warranty tracking and repair, root cause analysis, and product reworks. **The Field Service Group can be reached by phone or email** fieldservice@fanucamerica.com

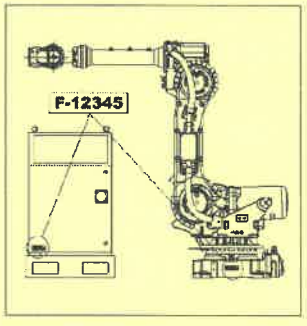
Parts – An inventory of over $52 million is available to meet spare part needs. Our staff of customer service representatives are available 24/7/365 and will promptly assist you with any parts orders or inquiries. Emergency orders can be processed at any time of the day. Spare Parts can be reached by phone or emailing spareparts@fanucamerica.com, or by sending a fax to 248-377-7832.

Certified Parts Solutions –Certified repair services are available for over 1,300 different components from multiple controller platforms. Our Rochester Hills facility performs authorized repair for North America using authentic FANUC parts. After the repair is completed, it is tested to original OEM specifications. Once the repair has passed our testing, it is certified, and the warranty plus repair data are posted on-line. OEM-specified updates and upgrades are also included during the repair process at no additional cost. Contact us to obtain a return authorization or log onto the cRc Site and use our easy three-step process. For additional cost savings, core credits are available on numerous parts.
Note: All certified repairs are backed by the same one-year warranty as a new FANUC America part.

Certified Robots for Reapplication – FANUC America supports your production Robot and/or ROBODRILL for its entire production life. The following is just a list of services offered to maximize life expectancy and minimize downtime.
- Robot Evaluations
- Recertification Process
- Upgrade Options – (additional auxiliary axes, adding vision hardware/software)

*All enhanced robots are backed by a limited one-year manufacturer's warranty.

When contacting cRc Services, please have your serial number available.
The F number tag locations are shown in this drawing.



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ROBOGUIDE®

FANUC Robotics

Robot Programming and Simulation

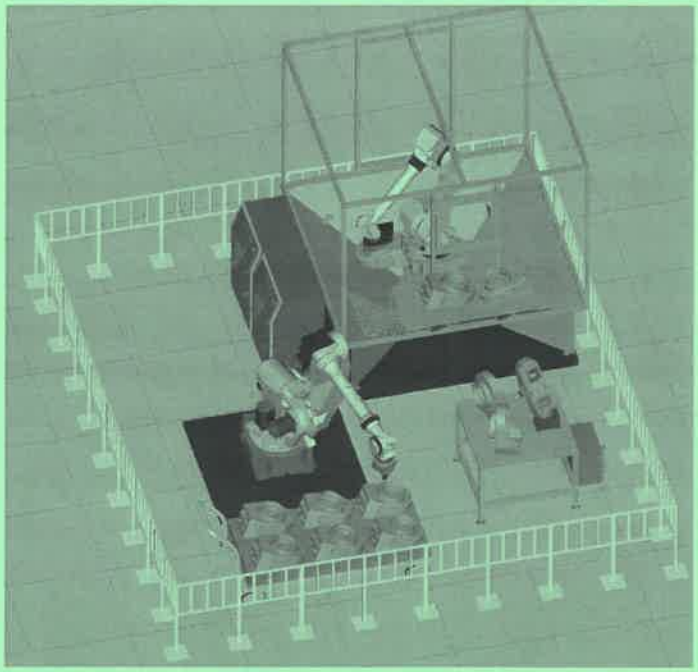
ROBOGUIDE is the leading offline programming product on the market for FANUC robots. The ROBOGUIDE family of process focused software packages allows users to create, program and simulate a robotic workcell in 3-D without the physical need and expense of a prototype workcell setup. With virtual robots and workcell models, offline programming with ROBOGUIDE reduces risk by enabling visualization of single and multi-robot workcell layouts before actual installation.

With ROBOGUIDE, sales, proposal and application engineers can import CAD models of parts, create a workcell including machines, part transfer devices and obstacles and teach robot paths to simulate the operation and performance of a multi-robot workcell. Reach verification, collision detection, accurate cycle time and robot trajectory and other system operations are provided in ROBOGUIDE's graphical virtual environment.

Virtual Robot Controller Software

True robot operation is provided using Virtual Robot Controllers which are a copy of the real software that runs on your robots. The Integrated Virtual Teach Pendant looks and operates like a real Teach Pendant. FANUC robots can be configured in many configurations with many axes. The virtual robot supports configurations including multiple arms, positioners and auxiliary axes.

The ability to create a virtual robot copy of your real robot makes it efficient to model already existing workcells. A backup of your real



robot can be used to duplicate the robot in ROBOGUIDE. This feature can be used for optimization and debug of production robots.

Cycle Time and Trajectory Profiling

Accurate cycle time reporting and trajectory plotting are essential when optimizing workcell parameters. ROBOGUIDE's cycle time profiler reports cycle time at the program, routine and motion instruction level. Robot motion trajectory tracing displays robot tool center point traces and can be plotted showing speed and accelerations along the trace.

Program Upload Download /Round Trip

Seamless data transfer between real and virtual robots. Programs can be uploaded and downloaded between real and virtual robots with no translation. Changes made in ROBOGUIDE can be directly loaded to a robot and changes on a real robot can be directly loaded to ROBOGUIDE.

Physical *i*Pendant™ Support

Operators can learn real Teach Pendant operations quickly with a physical *i*Pendant connection to ROBOGUIDE virtual robots. With optional interface hardware, a real *i*Pendant can be attached and used with ROBOGUIDE. Operator training can be performed without the need for a physical robot controller and robot arm.

Workcell Modeling and Machine Building

Complete workcell simulation can be obtained. Workcells contain more than robots as moving devices. Workcells can be constructed with multiple robots, positioners, conveyors and other moving and non-moving fixtures. ROBOGUIDE supports the modeling of essentially any robot configuration including multiple arm, robot with positioner and a robot on auxiliary axes.

CAD to Path

Drastically reduce programming time with comprehensive CAD to Path programming. Define a feature line on a CAD model and quickly generate programs using the feature line information. Hours of manual programming can be eliminated. CAD to Path supports generation of programs for coordinated motion, remote tool center point, multi-arm coordination and other configurations.

Motion Optimization

Optimize cycle time and motion for running production robot programs to reduce cycle time. ROBOGUIDE can connect to a robot, monitor robot motion and provide direction on improving cycle time. The visual feedback of a robot's performance and the easy-to-use interface allows the robot programmer to pinpoint performance bottlenecks and take corrective action.

Process Focused Software

ROBOGUIDE builds on FANUC Robotics application process focus. Process plug-ins customize the ROBOGUIDE interface with process specific capabilities.

ROBOGUIDE – WeldPRO™

WeldPRO simulates robotic arc welding process. WeldPRO CAD to Path programming capability supports auto generation of multiple robot group coordinated motion programs with defined torch angles and process parameters. Programs and settings from the virtual workcell can be transferred to the real robot to decrease installation time.

ROBOGUIDE – HandlingPRO™

HandlingPRO is used for material handling applications including load/unload, packaging, assembly and material removal. Features of HandlingPRO include CAD to Path programming, conveyor line tracking, machine modeling and programming.

ROBOGUIDE – PalletPRO™

PalletPRO simulation software can be used to completely build, debug and test a palletizing application offline. PalletPRO allows users to create a workcell layout, infeed and pallet stations, slip sheet and pallet dispensers. Hundreds of unit load pallet configurations can be created and visualized in 3-D using PalletPRO's built-in library of industry standard patterns. The data created in PalletPRO can be downloaded to a real robot controller containing PalletTool® software.

ROBOGUIDE – PickPRO

PickPRO lets you simulate and analyze high-speed picking processes. Visualize the operation of multi-robot systems interfaced to multiple conveyors and related equipment. It includes utilities to test the impact of various application parameters such as conveyor speed, product spacing and orientation, workload sharing among multiple robots, conveyor flow direction, robot model, equipment location, multi-tooled grippers and even exceptions such as surges and interruptions in product flow. PickPRO is an indispensable engineering and sales tool.

ROBOGUIDE – PaintPRO™

FANUC Robotics PaintPRO software is a graphical offline programming solution that simplifies robotic path, teach and paint process development. The operator automatically generates robot programs by graphically selecting the area of the part to be painted and chooses between several painting methods.

ROBOGUIDE – MotionPRO

MotionPRO is a revolutionary software which runs on a PC and when connected to a FANUC robot can provide expert assistance in optimizing robot motion. MotionPRO can potentially reduce 5-20% of cycle time and a significant amount of teaching and touch-up time.

Note: ROBOGUIDE® and PalletTool® are registered trademarks of FANUC LTD.

Intelligent Robot Solutions

FANUC Robotics

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1 COURSE OVERVIEW

This course covers the basic operations of FANUC robots, using the teach pendent as the main interface point.

(16 hours)

1.1 Course Goal:

Upon successful completion of this course, the student will be able to perform the following:

- Power up and jog the robot
- Understand Frames
- Execute production operations
- Modify, and execute a teach pendent program
- Backup programs and files

Recommended safety procedures are integrated into all training exercises.

The course consists of lectures, demonstrations, and a series of lab exercises designed to reinforce what the student has learned.

In addition to lab exercises, a pre-test and a post-test are used to measure mastery of objectives.

1.2 Audience:

This course is intended for the person who operates a FANUC robot

1.3 Prerequisites:

None

1.4 Course schedule

Session 1
- Administrative
- Introduction – Course Description
- Pre-Test
- Safety
- Robot System
- Teach Pendant Operations
- Operating Procedures
- Power Up the Robot System

Session 2
- Jogging in Joint
- Jogging in World
- Frame Overview

Session 3
- Run Production Operations
- Edit or Touchup a Program

Session 4
- Fault Diagnosis
- Other Functions

Session 5
- Program and file manipulation
- Post-Test
- Review Post Test
- Complete Evaluations & Issue Certificates

1.5 Task List

1. Turning on & Jogging the Robot	- Perform the power up procedure - Jog the robot in JOINT and WORLD - Change the Jog Speed of the robot - Perform the power down procedure
2. Frames	- Understand how frames impact programs
3. Execute Production Operations	- Test production programs - Step through a program - Test a program using SHIFT and FWD/BWD - Touchup program points
4. Recover from Common Faults	- Recover from Software Limits - Recover from E Stop condition - Display Alarm screen
5. Display I/O Screen	- Monitor I/O signals
6. Execute macros	- Execute a MACRO from manual functions screen - Execute a
7. Program & File Manipulation	- Setting the default device - Save programs/files to the default device - Backup teach pendant programs, application files, or system files

1.6 Objectives

Students successfully completing this course will be able to:

1. Safely power up the robot from a complete shutdown.	Identify all components of the cell that are part of the power-up sequence Recognize the main components of the robot Identify all safety considerations related to operating the cell Describe the correct sequence for powering up the cell Recognize and clear alarms that would inhibit cell operation
2. Recover from common programming and servo alarm conditions.	Clear servo alarm faults Correct programming faults
3. Safely and predictably jog the robot in specific manual jog systems.	Lab safety in a robot cell in our Plant setting Jog the robot in the Joint system Setup and use Cartesian Frames while jogging
4. Test a program.	Test a program using the three-step method
5. Select/Modify/Execute a teach pendant program.	Select a teach pendant program Edit the motion components of a program Execute the program
6. Use signals and specific cell and controller parameters.	Force, and monitor signals Add signals and I/O instructions to the program
7. Save/Load individual programs and files to/from a default device.	Set the default device Perform file maintenance

2 SAFETY

FANUC Robotics is not and does not represent itself as an expert in safety systems, safety equipment, or the specific safety aspects of your company and/or its work force. It is the responsibility of the owner, employer, or user to take all necessary steps to guarantee the safety of all personnel in the workplace

The appropriate level of safety for your application and installation can be best determined by safety system professionals. FANUC Robotics therefore, recommends that each customer consult with such professionals in order to provide a workplace that allows for the safe application, use, and operation of FANUC Robotics systems.

According to the industry standard ANSI/RIA R15-06, the owner or user is advised to consult the standards to ensure compliance with its requests for Robotics System design, usability, operation, maintenance, and service. Additionally, as the owner, employer, or user of a robotic system, it is your responsibility to arrange for the training of the operator of a robot system to recognize and respond to known hazards associated with your robotic system and to be aware of the recommended operating procedures for your particular application and robot installation.

Ensure that the robot being used is appropriate for the application. Robots used in classified (hazardous) locations must be certified for this use.

FANUC Robotics further, recommends that all personnel who intend to operate, program, repair, or otherwise use the robotics system be trained in an approved FANUC Robotics training course and become familiar with the proper operation of the system. Persons responsible for programming the system–including the design, implementation, and debugging of application programs–must be familiar with the recommended programming procedures for your application and robot installation.

The following guidelines are provided to emphasize the importance of safety in the workplace.

2.1 Considering Safety for Your Robot Installation

Safety is essential whenever robots are used. Keep in mind the following factors with regard to safety:

- The safety of people and equipment
- Use of safety enhancing devices
- Techniques for safe teaching and manual operation of the robot(s)
- Techniques for safe automatic operation of the robot(s)
- Regular scheduled inspection of the robot and workcell
- Proper maintenance of the robot

2.1.1 *Keeping People and Equipment Safe*

The safety of people is always of primary importance in any situation. However, equipment must be kept safe, too. When prioritizing how to apply safety to your robotic system, consider the following:

- People
- External devices
- Robot(s)
- Tooling
- Work piece

2.1.2 *Using Safety Enhancing Devices*

Always give appropriate attention to the work area that surrounds the robot. The safety of the work area can be enhanced by the installation of some or all of the following devices:

- Safety fences, barriers, or chains
- Light curtains
- Interlocks
- Pressure mats
- Floor markings
- Warning lights
- Mechanical stops
- EMERGENCY STOP buttons
- DEADMAN switches

2.1.3 *Setting Up a Safe Workcell*

A safe workcell is essential to protect people and equipment. Observe the following guidelines to ensure that the workcell is set up safely. These suggestions are intended to supplement and not replace existing federal, state, and local laws, regulations, and guidelines that pertain to safety.

- Sponsor your personnel for training in approved FANUC Robotics training course(s) related to your application. Never permit untrained personnel to operate the robots.
- Install a lockout device that uses an access code to prevent unauthorized persons from operating the robot.
- Use anti–tie–down logic to prevent the operator from bypassing safety measures.
- Arrange the workcell so the operator faces the workcell and can see what is going on inside the cell.
- Clearly identify the work envelope of each robot in the system with floor markings, signs, and special barriers. The work envelope is the area defined by the maximum motion range of the robot, including any tooling attached to the wrist flange that extend this range.
- Position all controllers outside the robot work envelope.
- Never rely on software as the primary safety element.

- Mount an adequate number of EMERGENCY STOP buttons or switches within easy reach of the operator and at critical points inside and around the outside of the workcell. Install flashing lights and/or audible warning devices that activate whenever the robot is operating, that is, whenever power is applied to the servo drive system. Audible warning devices shall exceed the ambient noise level at the end–use application.
- Wherever possible, install safety fences to protect against unauthorized entry by personnel into the work envelope.
- Install special guarding that prevents the operator from reaching into restricted areas of the work envelope.
- Use interlocks.
- Use presence or proximity sensing devices such as light curtains, mats, and capacitance and vision systems to enhance safety.
- Periodically check the safety joints or safety clutches that can be optionally installed between the robot wrist flange and tooling. If the tooling strikes an object, these devices dislodge, remove power from the system, and help to minimize damage to the tooling and robot.
- Make sure all external devices are properly filtered, grounded, shielded, and suppressed to prevent hazardous motion due to the effects of electro–magnetic interference (EMI), radio frequency interference (RFI), and electro–static discharge (ESD).
- Make provisions for power lockout/tagout at the controller.
- Eliminate pinch points. Pinch points are areas where personnel could get trapped between a moving robot and other equipment.
- Provide enough room inside the workcell to permit personnel to teach the robot and perform maintenance safely.
- Program the robot to load and unload material safely.
- If high voltage electrostatics are present, be sure to provide appropriate interlocks, warning, and beacons.
- If materials are being applied at dangerously high pressure, provide electrical interlocks for lockout of material flow and pressure.

2.1.4 *Staying Safe While Teaching or Manually Operating the Robot*

Advise all personnel who must teach the robot or otherwise manually operate the robot to observe the following rules:

- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Know whether or not you are using an intrinsically safe teach pendant if you are working in a hazardous environment.
- Before teaching, visually inspect the robot and work envelope to make sure that no potentially hazardous conditions exist. The work envelope is the area defined by the maximum motion range of the robot. These include tooling attached to the wrist flange that extends this range.
- The area near the robot must be clean and free of oil, water, or debris. Immediately report unsafe working conditions to the supervisor or safety department.

- FANUC America recommends that no one enter the work envelope of a robot that is on, except for robot teaching operations. However, if you must enter the work envelope, be sure all safeguards are in place, check the teach pendant DEADMAN switch for proper operation, and place the robot in T1 or T2 mode using the AUTO-T1-T2 mode select switch. Take the teach pendant with you, turn it on, and be prepared to release the DEADMAN switch. Only the person with the teach pendant should be in the work envelope.

> **⚠WARNING**
> **Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.**

- Know the path that can be used to escape from a moving robot; make sure the escape path is never blocked.
- Isolate the robot from all remote control signals that can cause motion while data is being taught.
- Test any program being run for the first time in the following manner:

> **⚠WARNING**
> **Stay outside the robot work envelope whenever a program is being run. Failure to do so can result in injury.**

- Using a low motion speed, single step the program for at least one full cycle.
- Using a low motion speed, test run the program continuously for at least one full cycle.
- Using the programmed speed, test run the program continuously for at least one full cycle.
- Make sure all personnel are outside the work envelope before running production.

2.1.5 *Staying Safe during Automatic Operation*

Advise all personnel who operate the robot during production to observe the following rules:

- Make sure all safety provisions are present and active.
- Know the entire workcell area. The workcell includes the robot and its work envelope, plus the area occupied by all external devices and other equipment with which the robot interacts.
- Understand the complete task the robot is programmed to perform before initiating automatic operation.
- Make sure all personnel are outside the work envelope before operating the robot.
- Never enter or allow others to enter the work envelope during automatic operation of the robot.
- Know the location and status of all switches, sensors, and control signals that could cause the robot to move.

- Know where the EMERGENCY STOP buttons are located on both the robot control and external control devices. Be prepared to press these buttons in an emergency.
- Never assume that a program is complete if the robot is not moving. The robot could be waiting for an input signal that will permit it to continue activity.
- If the robot is running in a pattern, do not assume it will continue to run in the same pattern.
- Never try to stop the robot, or break its motion, with your body. The only way to stop robot motion immediately is to press an EMERGENCY STOP button located on the controller panel, teach pendant, or emergency stop stations around the workcell.

2.1.6 *Staying Safe during Inspection*

When inspecting the robot, be sure to

- Turn off power at the controller.
- Lock out and tag out the power source at the controller according to the policies of your plant.
- Turn off the compressed air source and relieve the air pressure.
- If robot motion is not needed for inspecting the electrical circuits, press the EMERGENCY STOP button on the operator panel.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- If power is needed to check the robot motion or electrical circuits, be prepared to press the EMERGENCY STOP button, in an emergency.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

2.1.7 *Staying Safe during Maintenance*

When performing maintenance on your robot system, observe the following rules:

- Never enter the work envelope while the robot or a program is in operation.
- Before entering the work envelope, visually inspect the workcell to make sure no potentially hazardous conditions exist.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Consider all or any overlapping work envelopes of adjoining robots when standing in a work envelope.
- Test the teach pendant for proper operation before entering the work envelope.
- If it is necessary for you to enter the robot work envelope while power is turned on, you must be sure that you are in control of the robot. Be sure to take the teach pendant with you, press the DEADMAN switch, and turn the teach pendant on. Be prepared to release the DEADMAN switch to turn off servo power to the robot immediately.
- Whenever possible, perform maintenance with the power turned off. Before you open the controller front panel or enter the work envelope, turn off and lock out the 3–phase power source at the controller.

- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

> **⚠WARNING**
> **Lethal voltage is present in the controller WHENEVER IT IS CONNECTED to a power source. Be extremely careful to avoid electrical shock.**
> **HIGH VOLTAGE IS PRESENT at the input side whenever the controller is connected to a power source. Turning the main disconnect or circuit breaker to the OFF position removes power from the output side of the device only.**

- Release or block all stored energy. Before working on the pneumatic system, shut off the system air supply and purge the air lines.
- Isolate the robot from all remote control signals. If maintenance must be done when the power is on, make sure the person inside the work envelope has sole control of the robot. The teach pendant must be held by this person.
- Make sure personnel cannot get trapped between the moving robot and other equipment. Know the path that can be used to escape from a moving robot. Make sure the escape route is never blocked.
- Use blocks, mechanical stops, and pins to prevent hazardous movement by the robot. Make sure that such devices do not create pinch points that could trap personnel.

> **⚠WARNING**
> **Do not try to remove any mechanical component from the robot before thoroughly reading and understanding the procedures in the appropriate manual. Doing so can result in serious personal injury and component destruction.**

- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.
- When replacing or installing components, make sure dirt and debris do not enter the system.
- Use only specified parts for replacement. To avoid fires and damage to parts in the controller, never use nonspecified fuses.
- Before restarting a robot, make sure no one is inside the work envelope; be sure that the robot and all external devices are operating normally.

2.2 Keeping Machine Tools and External Devices Safe

Certain programming and mechanical measures are useful in keeping the machine tools and other external devices safe. Some of these measures are outlined below. Make sure you know all associated measures for safe use of such devices

2.2.1 *Programming Safety Precautions*

Implement the following programming safety measures to prevent damage to machine tools and other external devices.

- Back–check limit switches in the workcell to make sure they do not fail.
- Implement "failure routines" in programs that will provide appropriate robot actions if an external device or another robot in the workcell fails.
- Use handshaking protocol to synchronize robot and external device operations.
- Program the robot to check the condition of all external devices during an operating cycle.

2.2.2 *Mechanical Safety Precautions*

Implement the following mechanical safety measures to prevent damage to machine tools and other external devices.

- Make sure the workcell is clean and free of oil, water, and debris.
- Use software limits, limit switches, and mechanical hard stops to prevent undesired movement of the robot into the work area of machine tools and external devices.

2.3 Keeping the Robot Safe

Observe the following operating and programming guidelines to prevent damage to the robot.

2.3.1 *Operating Safety Precautions*

The following measures are designed to prevent damage to the robot during operation.

- Use a low override speed to increase your control over the robot when jogging the robot.
- Visualize the movement the robot will make before you press the jog keys on the teach pendant.
- Make sure the work envelope is clean and free of oil, water, or debris.
- Use circuit breakers to guard against electrical overload.

2.3.2 *Programming Safety Precautions*

The following safety measures are designed to prevent damage to the robot during programming:

- Establish interference zones to prevent collisions when two or more robots share a work area.
- Make sure that the program ends with the robot near or at the home position.
- Be aware of signals or other operations that could trigger operation of tooling resulting in personal injury or equipment damage.
- In dispensing applications, be aware of all safety guidelines with respect to the dispensing materials.

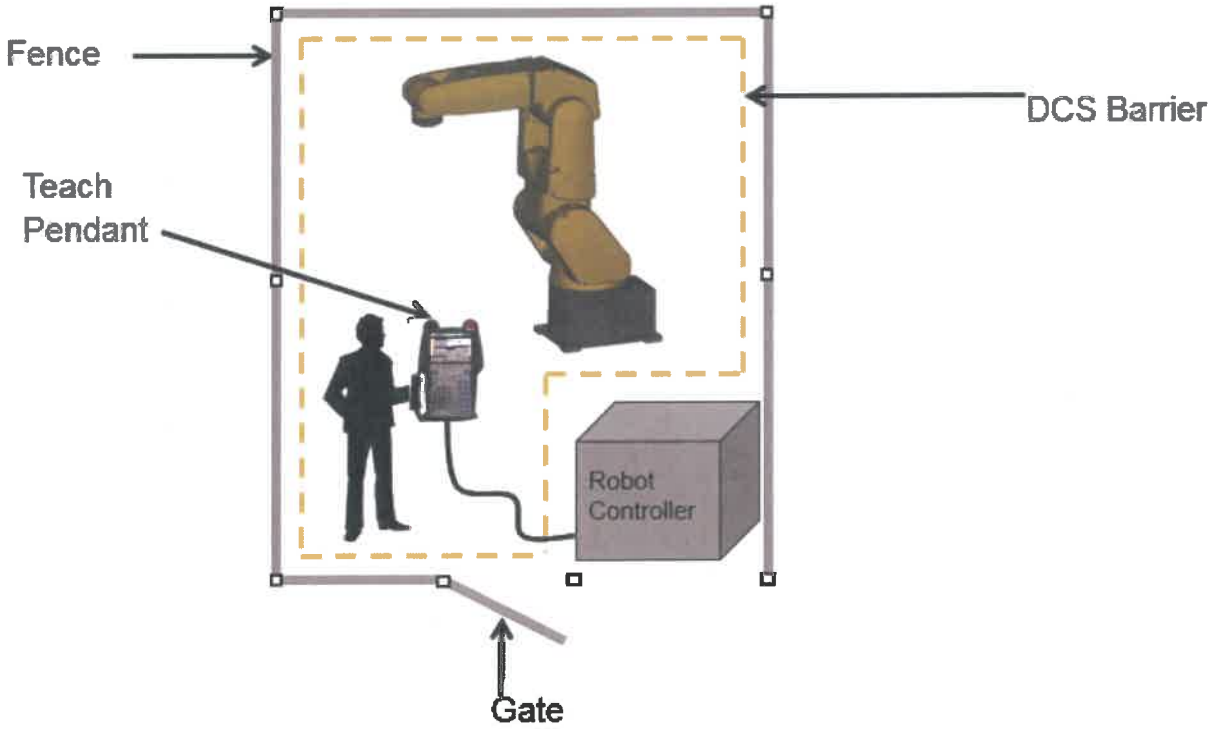
NOTE: Any deviation from the methods and safety practices described in this manual must conform to the approved standards of your company. If you have questions, see your supervisor.

2.4 FANUC Training Lab Safety

In the training lab…

- Do not work on any robot unless an instructor is present
- Keep controller doors closed and locked at all time
- Lock out robots and controllers
  - When not in lab
  - When on lunch break
- Keep hands clear of tooling
- Do not enter work cell without teach pendant
  - Teach pendant must be turned on whenever in cell with robot
  - Only one person in cell when robot and controller is powered up
  - Controller must be locked out if more than one person is in the work cell

Figure 2-1 Sample Robot Cell



2.5 Dual Check Safety

Dual Check Safety (DCS) Position/Speed Check features check the speed and position data of motors with two independent CPUs in the robot controller. These functions can detect position and speed errors immediately and shut down the motor power by two independent channels. Safety data and processes are cross-checked by two CPUs. Self-diagnosis of safety hardware and software is executed periodically to prevent potential failure accumulation.

DCS Position/Speed Check features do not need additional external sensors to monitor speed and position. Only the built-in servo motor sensors are used for this function. (To use the OPSFTY safety inputs, external electrical circuits are required.)

DCS functions are certified to meet the requirements of International Standard ISO13849-1 by a notarized body

Dual Check Safety (DCS) is a feature of the R-30iA and higher controllers that consists of the following safety functions:

- Emergency Stop Control (Standard)
- Position / Speed Check (Option)
- Joint Position Check
- Joint Speed Check
- Cartesian Position Check
- Cartesian Speed Check
- T1 Mode Speed Check

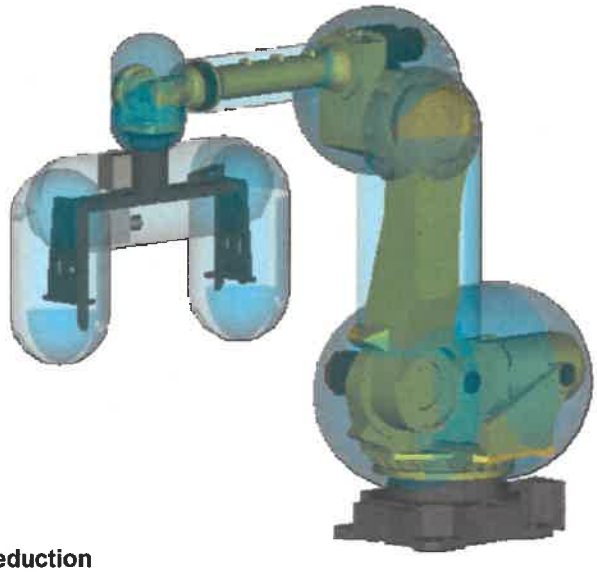
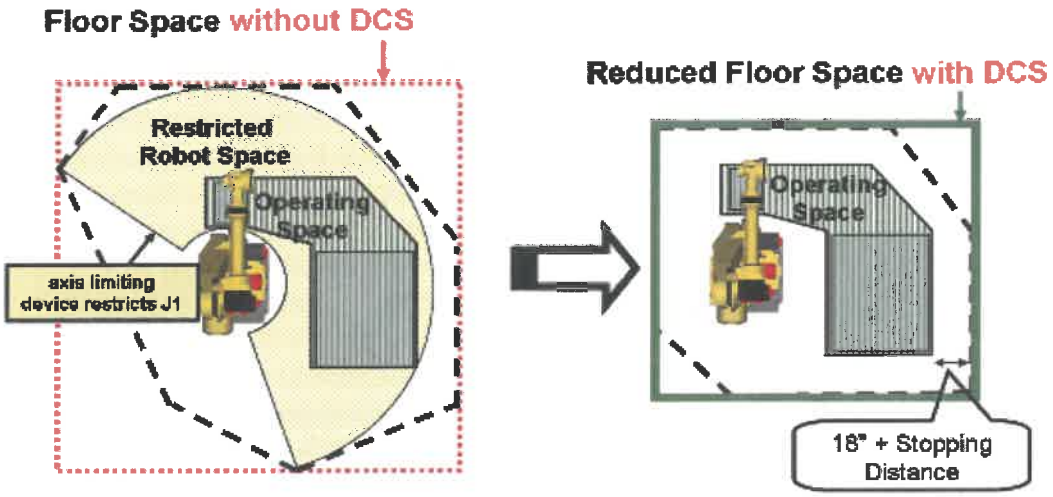


Figure 2-2 Floor Space Reduction



*Note - For Systems Using T1 Mode

3 PRE-TEST

Name_____ **Date** _____

This test is designed to evaluate your knowledge of FANUC robot operations prior to your taking this course. Each question has four possible answers and a place to indicate, *I don't know*. Choose the one that best answers the question. There is only one right answer. This test tells us a little about you and helps us to tailor the course to meet your needs. We appreciate you're taking the time to complete it.

Score _____**/10**

1. Turning the Teach Pendant ON:

A Activates the default program (MAIN)

B Enables communications with external devices

C Gives motion control solely to the operator via the Teach Pendant

D Energizes robotic arm

E I don't know

2. How many soft keys are on a FANUC teach pendant?

A 0

B 7

C 5

D All of them

E I don't know

3. Which direction does the TCP move in relation to the robot when the +X key is pressed while jogging in WORLD frame?

A Up

B Down

C To the right

D Straight out front

E I don't know

4. SHIFT and TOUCHUP are needed to do what?

A Change robot speed

B Request the positional screen to appear

C Record the current positional data of the robot

D Execute a MACRO program and return the robot to HOME

E I don't know

5. In the motion command "J P [2] 100% FINE", If you wanted to change the "FINE" component to a "CNT100" what buttons would you press?

A FCTN followed by ABORT ALL

B SHIFT and FWD

C SELECT followed by NEXT

D Select component, then press [CHOICE]

E I don't know

6. In step mode testing, to change the execution direction of the program, which hard key should you press while holding the shift key?

A Step Key

B FWD or BWD Keys

C +% or -% Keys

D Cursor (Arrow) Keys

E I don't know

7. Which of the following is a kind of I/O signal?

A UIP I/O

B SIP I/O

C Robot I/O

D Configuration I/O

E I don't know

8. To display stored programs on the controller which button should be pressed?

A FCTN

B FWD

C Select

D Hold

E I don't know

9. Which button is pressed to bring the robot to a controlled stop?

A Emergency Stop

B Hold

C Safe Stop

D Pause

E I don't know

10. Which of the following hard keys will bring the menu item "ABORT (ALL)" to the teach pendent display?

A I/O

B FCTN

C HOLD

D RESET

E I don't know

4 ROBOT SYSTEM

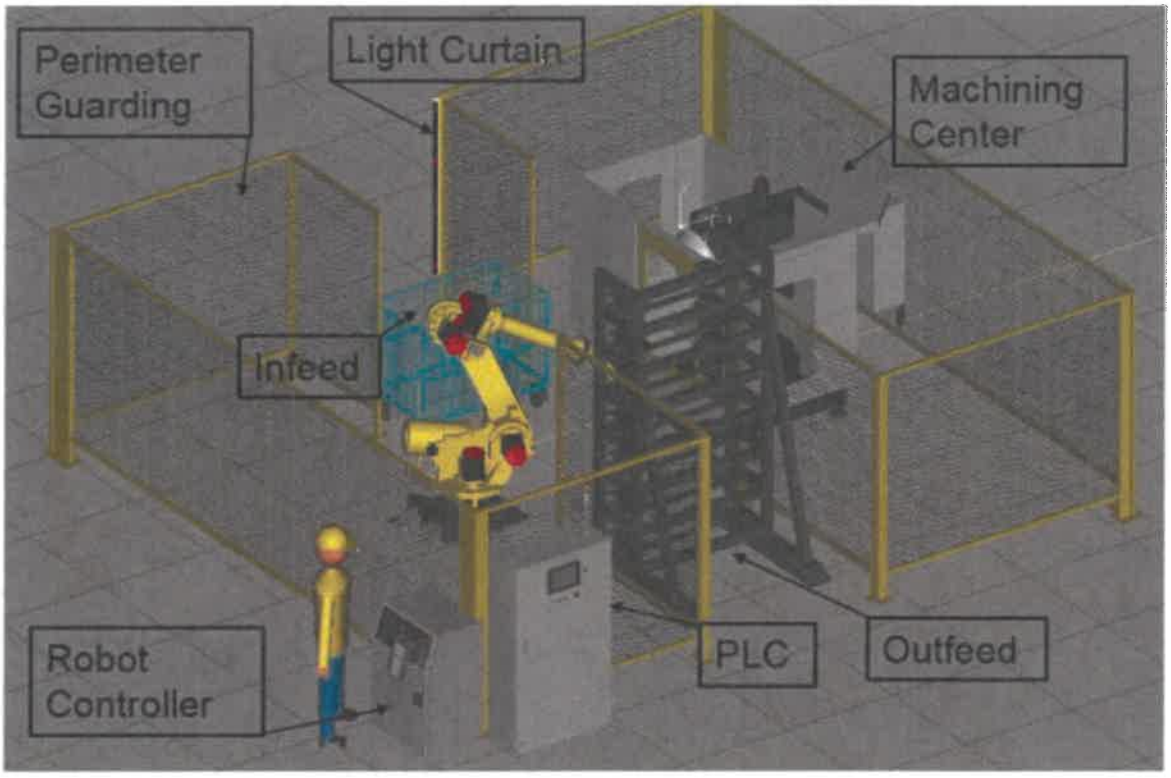
4.1 Chapter Objectives

- Understand the role of the FANUC robot in the overall Automation System
- Review different types of software
- Review types of FANUC controllers
  - Understand Standard Operator Panel functions
- Review types of FANUC Robots
  - Understand major axis and minor axis

4.2 Automation System

The Automation System makes it possible to speed up the production process and is often comprised of tasks that would be very time consuming or difficult for a human. Some of the components that make up an automation system are a Programmable Logic Controller (PLC), machining centers, robotic units, conveyors, tables, stands, perimeter guarding, and safety devices. This is not an all-encompassing list and your system may have more or less components. Essentially the items that create your automation system are all of the components that are required to accomplish the tasks of the system.

Figure 4-1 Example Automation System



In order for the system to function properly there must be a way to interpret and distribute data. Generally a PLC is tasked with this very important role. A PLC is an industrial computer that monitors a series of inputs and outputs and makes logic based decisions for the automated process. The robotic unit and other automated items within the system receive the signals from the PLC and execute their tasks accordingly.

The role of the robot within the system can vary greatly depending on the process in which it is executing. Usually the robot will be involved in either moving the parts within the system or moving End of Arm Tooling (EOAT) to a part to perform its programmed task. Because of this is vital to have an understanding of basic robot operations to understand how the robot operates and to manipulate the robot if necessary.

4.3 FANUC Robot System

There are four main components that make up a robot system; software, controller, mechanical unit, and peripheral equipment. The robot system requires all of these components to operate effectively.

FANUC also provides an F number which is a unique number for the robot's identification. The F number provides information such as controller type, robot model, installed options, and sales information. The number is located on the front of the controller cabinet (yellow robots and paint robots) and at the base of the robot (yellow robots only).

Figure 4-2 F Number Location

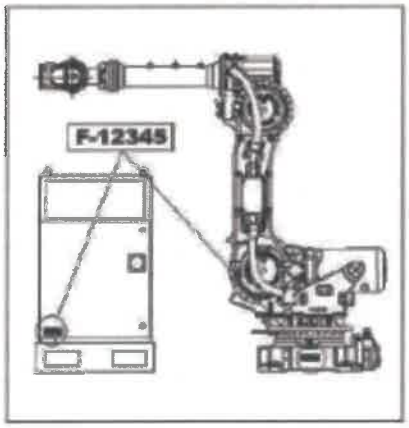
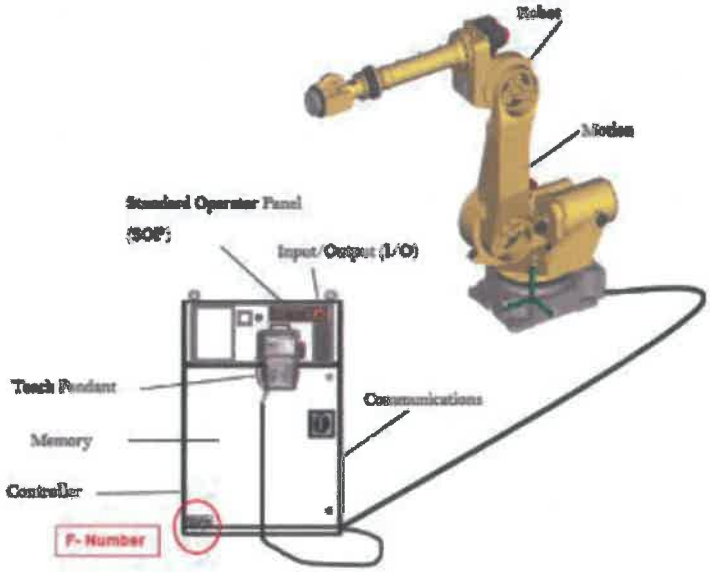


Figure 4-3 Robot System



4.3.1 *FANUC Robot Software*

FANUC Robots can handle a wide range of industrial applications providing process solutions for material handling, material joining, painting, dispensing and spot welding. The specific software loaded on the robotic unit defines the function of the robot. The software also contains specific fault isolation and diagnostics as well as communication protocols relative to the software and application. Each software is designated as a tool, refer to **Table 4-1** for examples of applications and applicable software.

Table 4-1 Software Applications

Application	Applicable Software
Material handling	HandlingTool LR HandlingTool
Material Removal	
Packing	
Palletizing	
Assembly	
Arc Welding	ArcTool LR ArcTool
Laser Cutting	
Automotive Painting	PaintTool LR PaintTool
General Industry Painting	
Sealing	DispenseTool LR DispenseTool
Dispensing	
Automotive Spot Welding	SpotTool+ LR SpotTool+
General Industry Spot Welding	

There are two version of software for each respective tool. The LR version of each Tool is a lighter version application of that software. The LR version of each type of software is for LR Mate robots only. Every other style of robot will utilize the non-LR designated software for the applicable process.

4.3.2 *Controller*

The controller contains the computer that operates the robot. It houses the application software, power supply, operator controls (like the teach pendant that is connected to the controller externally), control circuitry and memory that directs the operation and motion of the robot. The controller is also responsible for communication to external devices.

There are four common controllers;

- A-size Controller Cabinet
- B-size Controller Cabinet
- LR Mate Controller Cabinet
- Open-Air LR Mate Controller Cabinet

If your robot is an LR Mate robot you will have one of the Mate designated controllers. Otherwise the cabinet will either be an A-sized or B-sized depending on customer requirements.

Regardless of the style of cabinet the controller houses all of the necessary items to operate the standard six axis robot and communicate externally. In some cases there may

be an Auxiliary Control Panel (ACP) attached to the main controller. This houses any extra hardware that is required for the robot system to operate. An example would be an additional servo amplifier for an extended axis or additional motion group.

Figure 4-4 Common FANUC Controllers

4.3.2..1 Standard Operator Panel

The Standard Operator Panel (SOP) allows control of certain basic robot functions and provides indication concerning robot operation. Refer to **Figure 4-5** and **Table 4-2** for a description of each item.

Figure 4-5 Standard Operator Panel

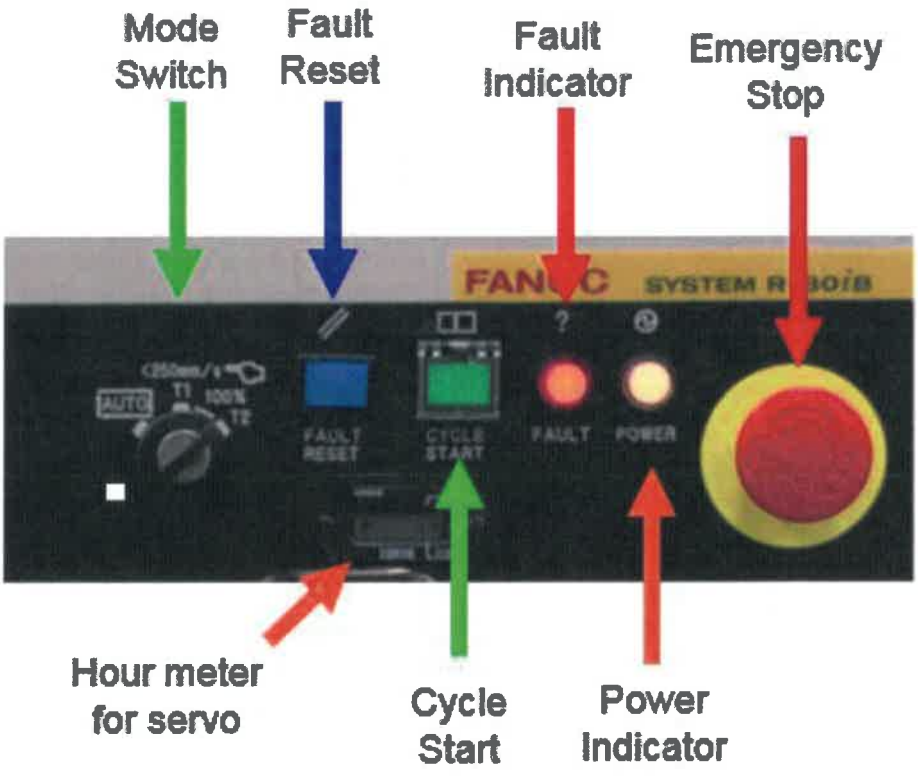


Table 4-2 Standard Operator Panel Functions

Item	Description
Emergency Stop	Applies Robot Brakes and Removes power from motors
Fault Indicator	Indicates that a fault has occurred
Fault Reset	Clears a fault message from the Teach Pendant Screen when it has been corrected
Mode Switch	Selects either Auto, T1, or T2 mode
Hour Meter	Tracks Servo On time
Cycle Start	Can start prgrams in Auto Mode. When lit indicates that a program is running.
Power Indicator	When lit indicats the controller is on.

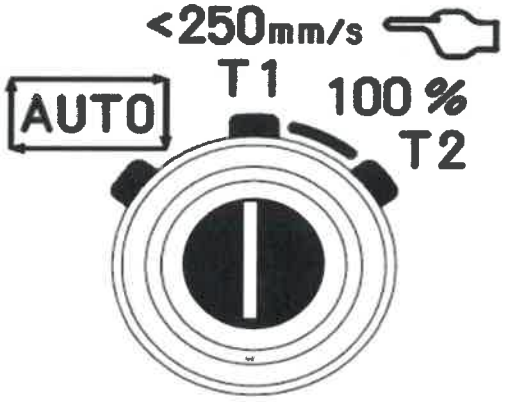
NOTE: Your SOP may have more items than shown here, in this case refer to the specific software manual for a description of these items.

4.3.2..2 Mode Select Switch

The Mode Select Switch is a keyed switch installed on the SOP that can be set to either Auto Mode, T1 Mode, or T2 Mode. You use the Mode Select Switch to select the most appropriate way to operate the robot, depending on the conditions and situation. You can lock the key switch in the AUTO or T1 modes by removing the key from the switch. However, you cannot remove the key from the key switch when the key is in the T2 position.

Figure 4-6 Mode Select Switch Settings

AUTO MODE – Robot operated at the specified maximum speed. Cannot start programs using the Teach Pendant.



T2 MODE (Test Mode 2) – Jog speed is restricted to 250 mm/sec or less. Program testing speeds are at full program speed.

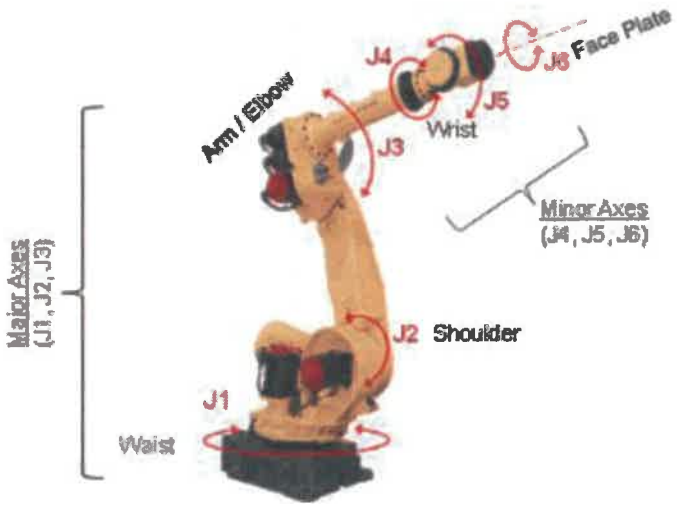
T1 MODE (Test Mode 1) – Jog and program testing speeds are restricted. Cartesian speed is less then 250 mm/sec and Joint speed is less than 10% of the maximum override speed.

NOTE: Some Controllers will not be equipped with T2 Mode

4.3.3 *Mechanical Unit*

A robot is a series of mechanical links driven by servomotors. A robot is classified by the number of linear and rotational axes. The axes are driven by the controller to move the tooling at the end of the robot arm.

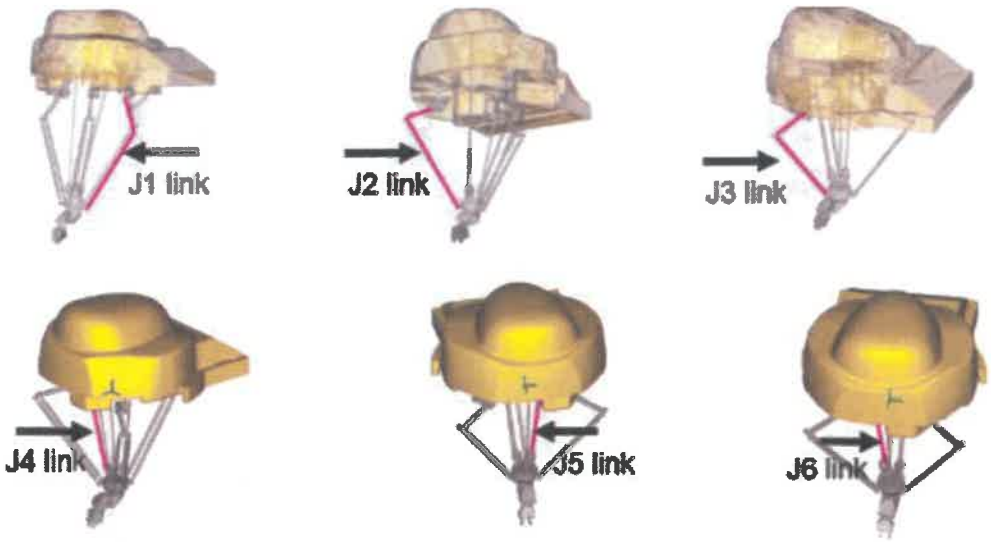
Figure 4-7 R2000iB Example Mechanical Unit



The area at each junction between the links is a joint, or axis. The major axes (1, 2, and 3) and minor axes (4, 5, and 6) move the tooling at the end of the robot arm. The movements are twisting, up-and-down, and side-to-side motions. The range of motion depends on the robot model and EOAT.

A Genkotsu Family robot (M1, M2, or M3) is a unique robot design that utilizes parallel links to enable quick motion. This style of robot appears to be different however it functions very similar to the six axis robot pictured above. Instead of axis each drive joint of this style robot is referred to as a link.

Figure 4-8 Genkotsu Family Robot



Each axis is driven by an electric Servo Motor.

- Uses Serial Pulse Encoder for positioning
- Motor brakes are applied mechanically released electrically
- Can be damaged from improper lubrication
- If the brake fails the motor must be replaced
- Motors are not customer serviceable

Figure 4-9 FANUC Servo Motor

NOTE: Motors can be rebuilt at a certified FANUC repair facility

The Serial Pulse Encoder:

- Sends Speed and Positional Information to the controller
- Stores encoder pulse counts when powered down, batteries retain the counts during the powered down period.

Figure 4-10 Serial Pulse Encoder

4.3.4 *Peripheral Equipment*

Peripheral equipment is any component that is not a part of the software, controller, or mechanical unit. These are items that aid the robot in accomplishing the process that it was designed for.

Some examples of peripheral Equipment are:

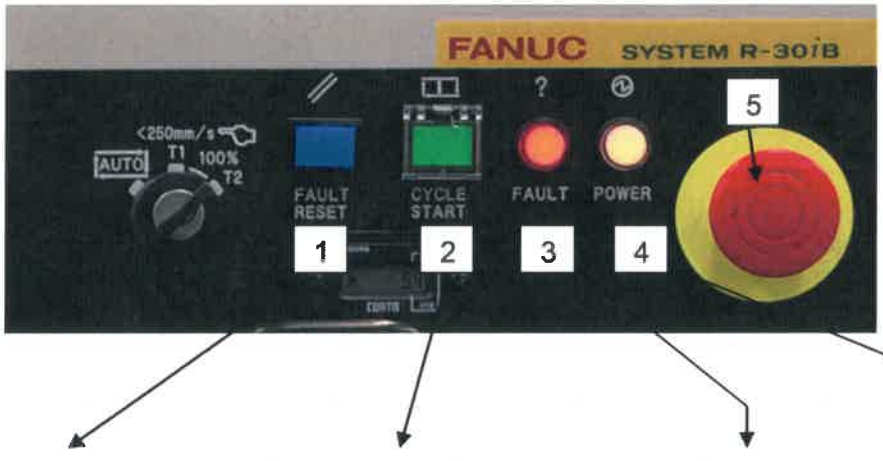
- PLC
- EOAT
- Proximity Switches
- Vision Systems
- Force Sensing Units
- Panel Views
- HMI
- Area Scanner
- Limit Switches

NOTE: This is not an all-inclusive list

NOTE: If adding any peripheral devices to your robot utilize the predesignated holes in the castings. DO NOT DRILL INTO THE ROBOT.

Chapter Review

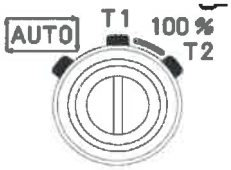
Identify each of the SOP components:



5_____

1_____ 2_____ 3_____ 4_____

Match the Mode Select Switches to the correct description:



Auto Mode

Both jog and program playback are at restricted speeds

T1

Jog speed is restricted but program playback is at full speed

T2

Robot operated at the specified maximum speed. Cannot start programs using the Teach Pendant

On a six axes robot list the Major Axes? _____ _____ _____

On a six axes robot list the Minor Axes? _____ _____ _____

5 TEACH PENDANT

5.1 Chapter Objective

- Identify different styles of teach pendants.
- Understand the different Deadman Switch positions.
- Differences between an Emergency Stop and Hold
- Become familiar with the teach pendant keys.
- Understand different teach pendant operations.

5.2 Teach Pendant Types

The Teach Pendant is hand-held operator interface device that gives motion control solely to the operator and displays the software menus. It is connected to the controller via a cable that plugs into either the MAIN CPU board inside the controller or, if the Teach Pendant cable can be disconnected then it will attach/detach via the operator panel.

5.2.1 *iPendant*

The iPendant is the standard teach pendant style. The iPendant provides teach pendant keys designed to make the FANUC America Corporation software easy to use.

The iPendant provides:

- A color graphics interface
- Pop-up menus
- Multiple windows
- Internet/Intranet access
- Integrated help and diagnostics
- Customized displays
- Touch Screen Capable

There are three styles of iPendant; RJ3iB, R30iA, and R30iB. Although the pendants are different their actual functions are largely unchanged across the three generations. As you approach the newer pendant there have only been capabilities added and optimized.

NOTE: RJ3iB and R30iA pendants are cross compatible

NOTE: R30iB is not cross compatible with any other controller.

Figure 5-1 RJ3iB/R30iA Teach Pendant (Old Style)

Figure 5-2 R30iA Teach Pendant (New Style)

Figure 5-3 R30iB Teach Pendant

5.3 ON/OFF Switch (ENABLE / DISABLE Switch)

The teach pendant can either be enabled or disabled utilizing the on/off switch that can be found either on the top left of the pendant or the middle right hand side depending on the style of pendant. The status of the pendant (enabled/disabled) dictates the functions that are available to the operator.

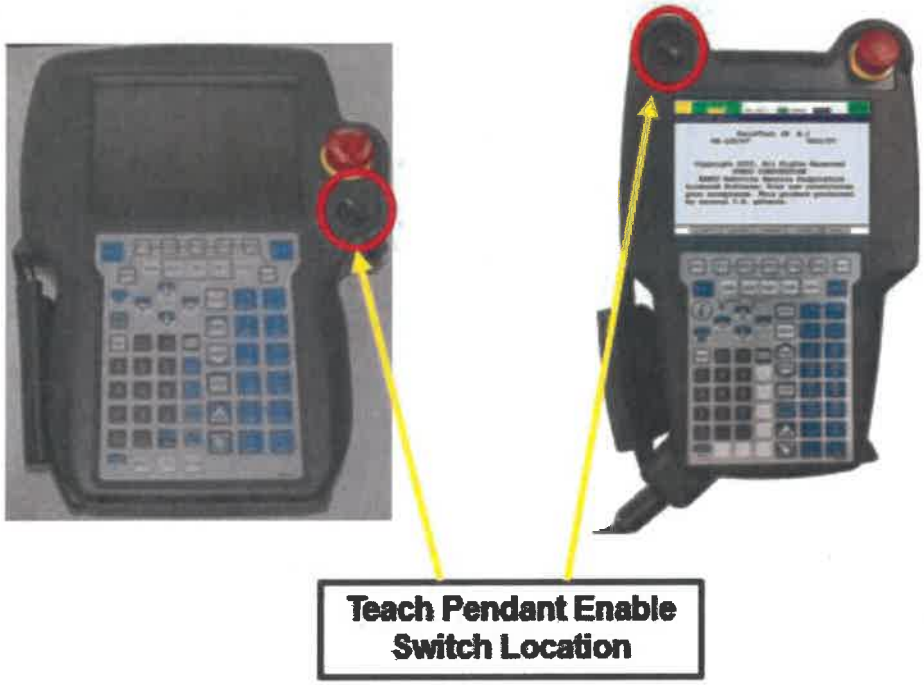
Teach Pendant On (Enabled):

- Gives motion control solely to the operator
- Ability to manually move the robot
- Create and edit programs
- Test / Run programs
- Perform manual functions

Teach Pendant Off (Disabled):

- Set up production operations
- Configure the application
- Edit programs (background edit only)
- Check Status
- Monitor Production

Figure 5-4 Enable Switch Location



5.4 DEADMAN Switch

The Teach Pendant DEADMAN Switch, which is located on the back of the Teach Pendant, is used to ensure personal safety when the Teach Pendant is enabled by interrupting robot motion in emergency situations.

If the Teach Pendant were in the ON position and an operator were to release their grasp of the DEADMAN switch, servo power is removed and robot brakes are immediately applied.

An operator must grip and hold one DEADMAN switch when jogging the robot.

When using R-J3iB and later teach pendants, the DEADMAN switch has **three positions**. In a three position teach pendant, releasing the DEADMAN switch or applying excessive force, when the Teach Pendant is ON will remove power from the servo motors and the brakes will be applied instantly.

Figure 5-5 DEADMAN Switch

R-J3iB and later teach pendants have three positions

In order to energize the robot the DEADMAN switch must be in, and held at, the center position for the duration of the robot motion. If this position is difficult to locate a good trick is to use your pinky finger to apply force. Apply pressure until you feel the slightest resistance, at this point locate and press the reset key, this should clear the fault.

5.5 EMERGENCY STOP Button

The red EMERGENCY STOP button is located on the front of the teach pendant. You can press the button to stop the robot immediately in case of accident or failure. The EMERGENCY STOP Button will function whether the teach pendant is on or off. The EMERGENCY STOP button should only be pressed in the event of an emergency.

Figure 5-6 Emergency Stop Button

CAUTION

Under certain load/speed conditions it could be possible to damage some mechanical units when E-stop button is pressed. In non-emergency situations the HOLD button is the preferred method of stopping the robot.

5.5.1 *EMERGENCY STOP vs HOLD*

Excessive emergency stops can add unnecessary wear and tear to the mechanical unit, thus increasing lost production due to down time. In a non-emergency situation it is in the best interest of the mechanical unit to utilize the Hold Button to stop the robots motion instead of the EMERGENCY STOP. While both options bring the robot to a stop the process is vastly different.

Figure 5-7 Hold Button Location

Emergency Stop Process

- Pauses program if one is running.
- Immediately stops the robot and applies the robot brakes.
- Shuts off power to the servo motors.

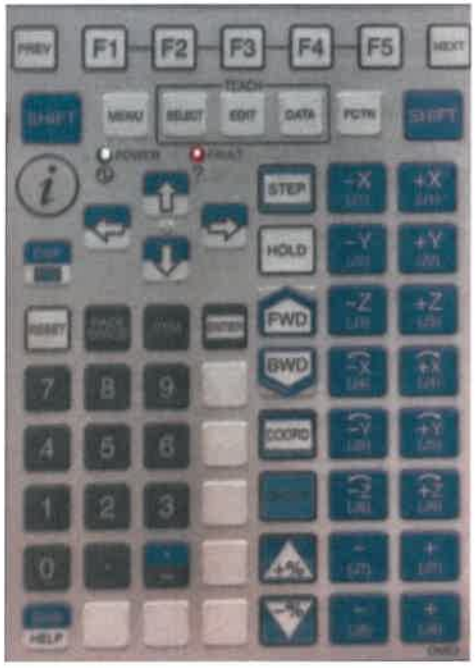
Hold Process

- Pause program execution.
- Slow motion to a controlled stop and hold.
- Optional Brake on Hold shuts off servo power after the robot stops.

NOTE: This above processes are solely to explain the difference between the two operations and in no way is insinuating that the operator cannot or should not utilize the EMERGENCY STOP.

5.6 Teach Pendant Keys

Figure 5-8 Teach Pendant Key Pad



The teach pendant key pad is comprised of a series of keys that are designed to make the pendant operations and navigation easier and more user friendly.

The teach pendant keys are divided into the following groups:

- Navigation and Data Entry Keys
- Robot Motion Keys
- Execution Keys
- Editing Keys
- Application-Specific Keys
- Help/Diagnostic Keys (iPendant only)

Refer to **Table 5-1** through **Table 5-7** for information about the teach pendant keys.

5.6.1 *Hard Keys and Soft Keys*

The teach pendant is also composed of a series of hard keys and soft keys. There are five soft keys on the teach pendant, they are keys labeled F1-F5 (function keys). Every other key on the pendant is designated as a hard key, as their functions do not change.

What makes a key a soft key is the functionality of the key. On the FANUC teach pendant depending on the screen displayed and in some cases the position of the cursor on the screen the function of the soft key will change. Therefore is vital as an operator that you are aware of function of the F1-F5 keys before pressing. The function of these keys are displayed along the bottom of the teach pendant above the function keys.

Figure 5-9 Soft Key Example

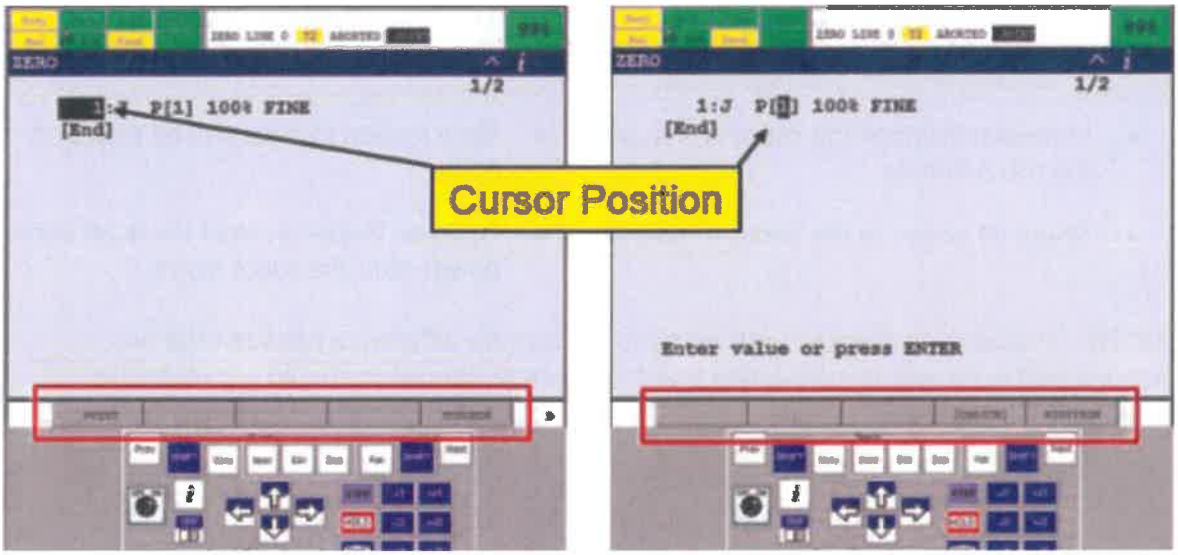


Table 5-1 Navigation and Data Entry Keys

*i*Pendant Key	Symbolic *i*Pendant Key (if available)	Function
		The F1 through F5 function keys are used to make choices based on the teach pendant display. Each function key has a unique label depending on the menu displayed on the teach pendant screen.
		The ⓘ key is a special key. When you press the ⓘ key together with other keys, the special screen is displayed. When you press and hold the ⓘ key, the Help for i key screen may be displayed. If not, you can press ⓘ + HELP to view the Help screen.
		The PREV key restores the most recent state. In some cases, the screen might not return to the immediately preceding status.
		The next page key is used to display the next set of function keys.
		The MENU key is used to display the screen menu.

Table 5-2 Navigation and Data Entry Keys (Cont'd)

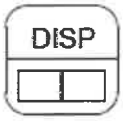
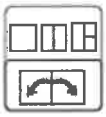
*i*Pendant Key	Symbolic *i*Pendant Key (if available)	Function
		The SELECT key is used to display the program selection screen. The EDIT key is used to display the program edit screen. The DATA key is used to display the program data screen.
		The DISP key is available only on the *i*Pendant and is used to activate the DISPLAY menu or change the focus. When you press SHIFT and the DISP key together, the DISPLAY menu appears. The DISPLAY menu allows you to change the number of windows displayed to be Single, Double, or Triple. The Status/Single choice displays status in addition to the single window. You can also use it to display help or diagnostics, set up user views and menu favorites, or to display a menu history.
		The FCTN key is used to display the function menu.

Table 5-3 Robot Motion Keys

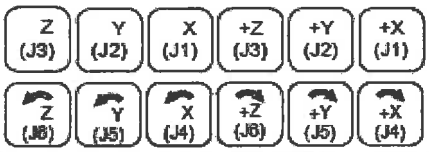
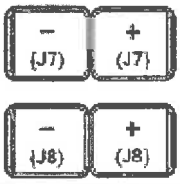
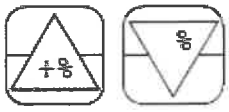
*i*Pendant Key	Symbolic *i* Pendant Key (if available)	Function
		The GROUP key is used to switch groups. Hold down the GROUP key and press the numeric key to switch to a specified group. Press the GROUP key and the 0 key together to toggle the sub group.
		The SHIFT key is used to jog the robot, teach the position data, and start a program. The right and left SHIFT keys have the same function.
		The jog keys are effective while a SHIFT key is pressed. They are used to jog the robot.
		These keys are used to jog extended axes or servo gun axes.
		The COORD key selects a jog coordinate system. Each time the COORD key is pressed, it selects the next jog type in the order: JOINT, JGFRM, World frame, TOOL, USER. When this key is pressed while a SHIFT key is pressed and held down, a jog menu for changing the coordinate system is displayed.
		The override key adjusts the feedrate override. Each time the override key is pressed, it selects the next override in the order: VFINE, FINE, 1%, 2% 3% 4% 5%, 10% 15% 20% and so forth in 5% increments to 100%. (Set $SHFTOV_ENB to alter the override settings.)

Table 5-4 Execution Keys

/Pendant Key	Symbolic /Pendant Key (if available)	Function
		The FWD key or BWD key (+ SHIFT key) starts a program. When the SHIFT key is released during regeneration, the program halts.
		The HOLD key causes a program to halt.
		The STEP key selects step or continuous test operation.
		The RESET key is used to clear an alarm.

Table 5-5 Editing Keys

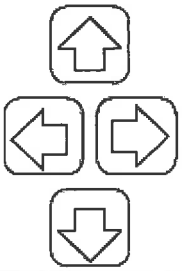
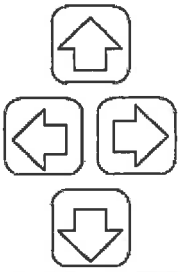
iPendant Key	Symbolic iPendant Key (if available)	Function
		The ENTER key is used to process and activate the current information set.
		The BACK SPACE key deletes the character or numeral immediately before the cursor.
		The arrow keys are used to highlight or select an item on the screen.
		The ITEM key moves the cursor to a line whose number is specified.

Table 5-6 HandlingTool Specific Keys

iPendant Key	Function
TOOL 1 TOOL 2	The TOOL 1 or 2 key displays the tool 1 or 2 screen.
MOVE MENU	The MOVE MENU key is not supported for HandlingTool.
SET UP	The SET UP key displays the SETUP screen.
STATUS	The STATUS key displays the STATUS screen.
POSN	The POSN key displays position data.
I/O	The I/O key displays the I/O screen.

Table 5-7 Help and Diagnostic Key

iPendant Key	Symbolic iPendant Key (if available)	Function
DIAG HELP		The HELP key displays help files that are available that describe the functions available for the active window. The SHIFT and DIAG keys together display diagnostic information for the currently active error or the selected error in the Alarm menu. This key is only available on the iPendant.

5.6.2 *Teach Pendant Status Indicators*

The teach pendant has several indicators to assist you in determining controller status. **Table 5-8** lists and describes the teach pendant status. The main indicators to be aware of from an operator perspective is Step, Hold, and Fault.

Table 5-8 Teach Pendant Status Indicators

Indicator	Description
FAULT	Indicates that a fault condition has occurred.
HOLD	Indicates that the robot is in a hold condition. HOLD is not on continuously during a hold condition.
STEP	Indicates that the robot is in step mode.
BUSY	Indicates that the controller is processing information.
RUN	Indicates that a program is being executed.
I/O	Indicates that the I/O is ENABLED
PROD	Indicates that the robot is in PRODUCTION MODE.
T CYC	Indicates that the robot is in the TEST CYCLE

Figure 5-10 Status Indicators

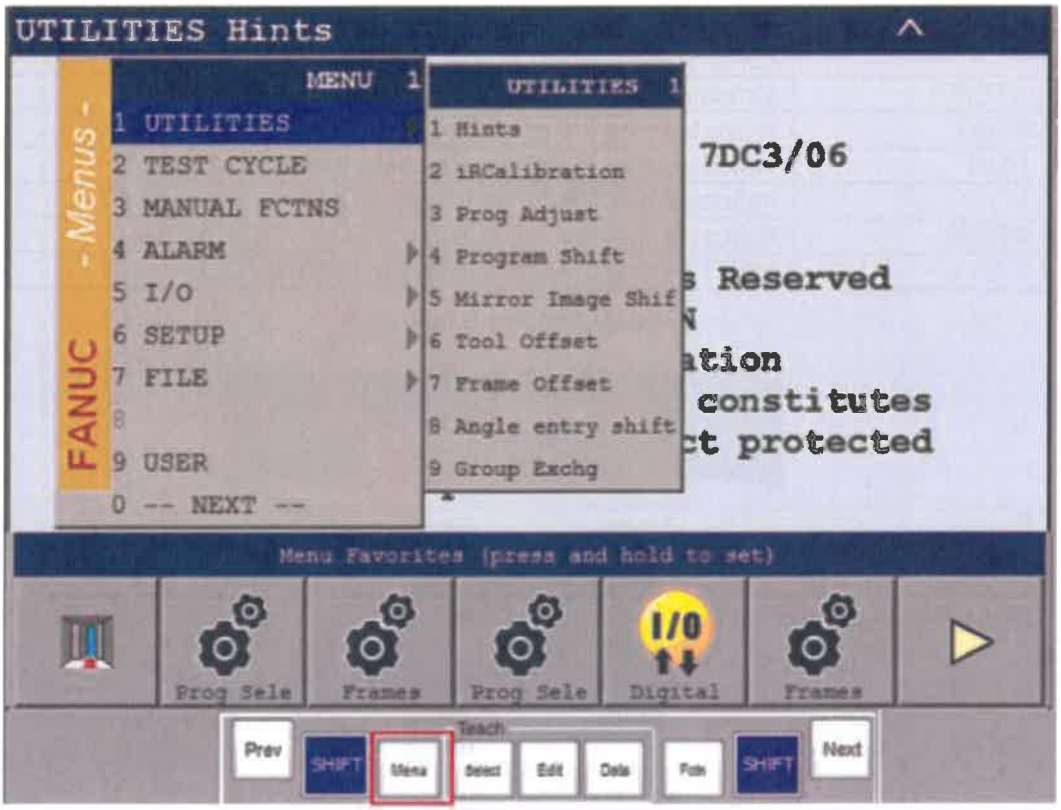
5.7 Teach Pendant Operations

As previously mentioned the teach pendant keys are designed to make the pendant easier to operate. Some of the items that are implemented within the teach pendant are the Popup Fly Out menu structure, split screen capabilities, and the diagnose/help key. As you become more familiar and proficient with the FANUC teach pendant these operations may prove to be very useful.

5.7.1 *Fly Out Menus*

To display the first level of Menus press the Menu key. You will see a screen similar to Figure 5-11. As you navigate the menu with the up and down arrow keys you will see the Fly Out Menu for each associated menu item. This capability enables you to navigate directly to the menu item you are searching for without having to navigate through multiple screens. A Fly Out menu exists for each menu item that has an arrow on the same line.

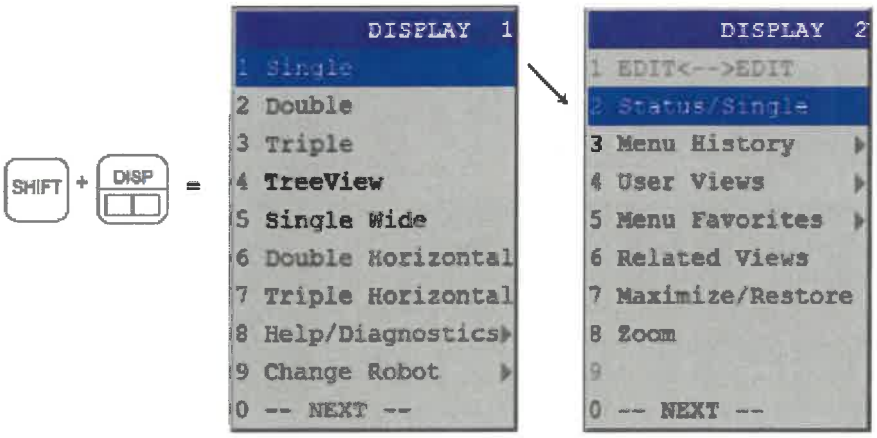
Figure 5-11 Popup Fly Out Menu Example



5.7.2 *Split Screen*

If you find it necessary to display multiple screens at the same time this can be accomplished with the split screen feature. To select multiple view press the Shift and Display key together. You will see a screen similar to **Figure 5-13**. Of the options the most commonly used are Single, Double, and Triple.

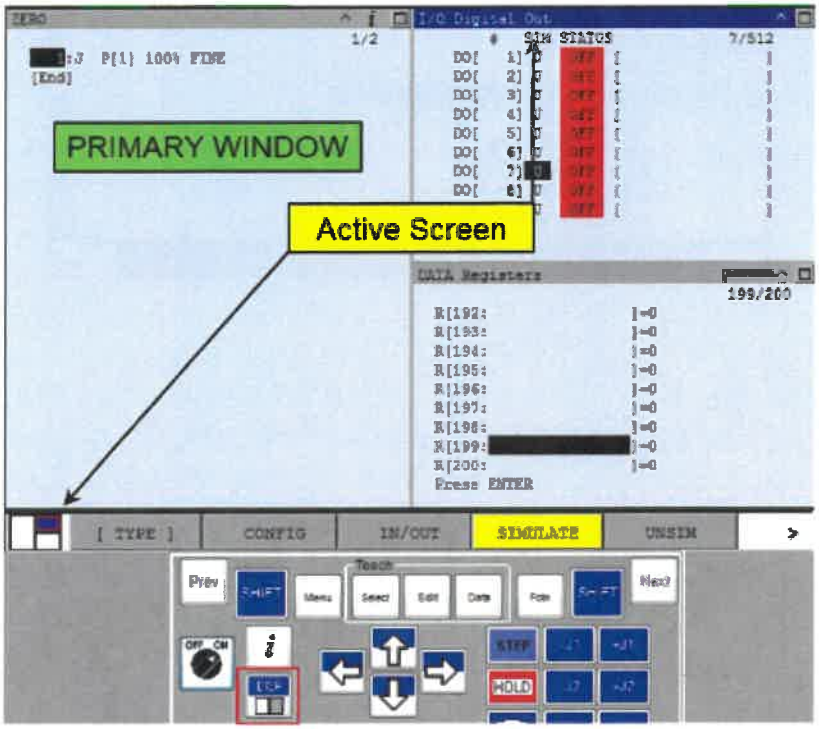
Figure 5-12 Split Screen Menu



To change the focus, or which screen is the active screen, either press the DISP key without holding Shift, or if the pendant is touch screen capable tap the screen that you want to be active. The active screen will have a blue title bar or you can check the bottom left corner of the pendant screen to see the active screen.

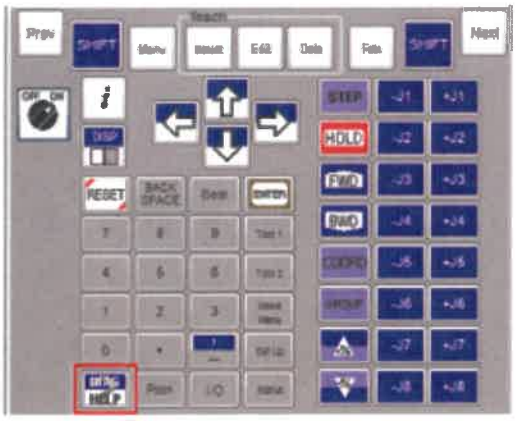
The screen on the left hand side is the Primary window. This is the only window that motion can take place. If testing or executing a program ensure it is displayed in this window.

Figure 5-13 Split Screen Example



5.7.3 *DIAGNOSE / HELP*

Figure 5-14 Diag / Help Key

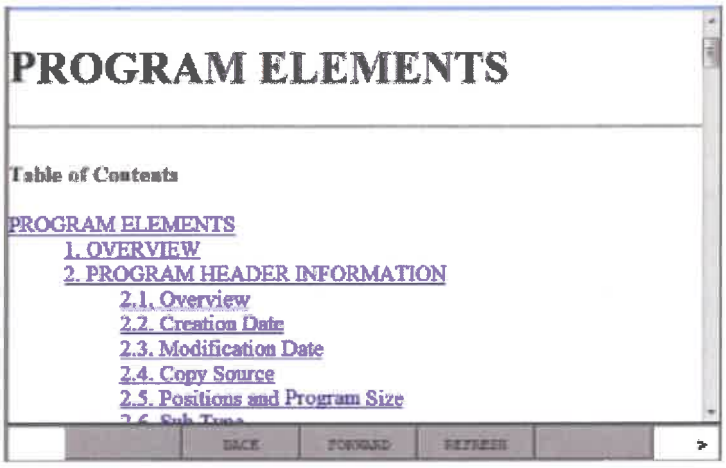


The Diagnose/Help key is a very useful tool to gain information about a current or past fault. To diagnose a fault press the Shift Key and Diag key together. Diagnosing Faults will be discussed in detail in Chapter 10.

In order to access Help, press the Help key without pressing Shift for whatever screen is being displayed. If help exists for the current screen a list of items displayed and descriptions of those items are shown. The help menu displays items that are very similar to those that are found in the Programming and Operations Manual's.

Figure 5-15 shows the items displayed when help is pressed from the Edit Screen. Each item can scrolled through and selected to display more detail.

Figure 5-15 Edit Screen Help Items



5.8 Chapter Review

Using a 3 position Deadman switch, which position allows you to jog the robot?

_____

Pressing the Emergency Stop brings the robot to a controlled stop and does not cause excessive wear and tear to the mechanical unit.

TRUE FALSE

The Teach Pendant must be on in order to access the menus.

TRUE FALSE

The R30iA and higher iPendant is able to have multiple windows and provide Internet/Intranet access.

TRUE FALSE

What is the key combination to access the slit screen menu?

_____

6 POWER UP AND JOGGING

6.1 Chapter Objectives

- Power up the Robot
- Cycle Power from the Pendant
- Power Down the Robot
- Jog the Robot in Joint and World
- View Positional Data

6.2 Powering Up the Robot

The most common method of powering up the robot is a Cold Start. To execute a Cold Start locate the main breaker on the controller and turn it to the on position. If you are working on an RJ3iB or older controller it is necessary to turn on the Main Breaker and then press the ON/OFF key on the SOP

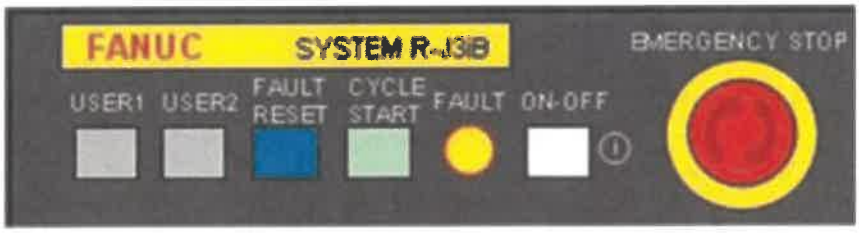
During a Cold start the controller:

- Initializes changes to system variables.
- Initializes changes to I/O Setup.
- Displays the UTILITIES Hints Screen upon successful completion.

> **WARNING**
>
> **DO NOT turn on the robot if you discover any problems or potential hazards. Report them immediately. Turning on a robot that does not pass inspection could result in serious injury.**

Figure 6-1 Main Breaker

Figure 6-2 SOP with ON / OFF Button



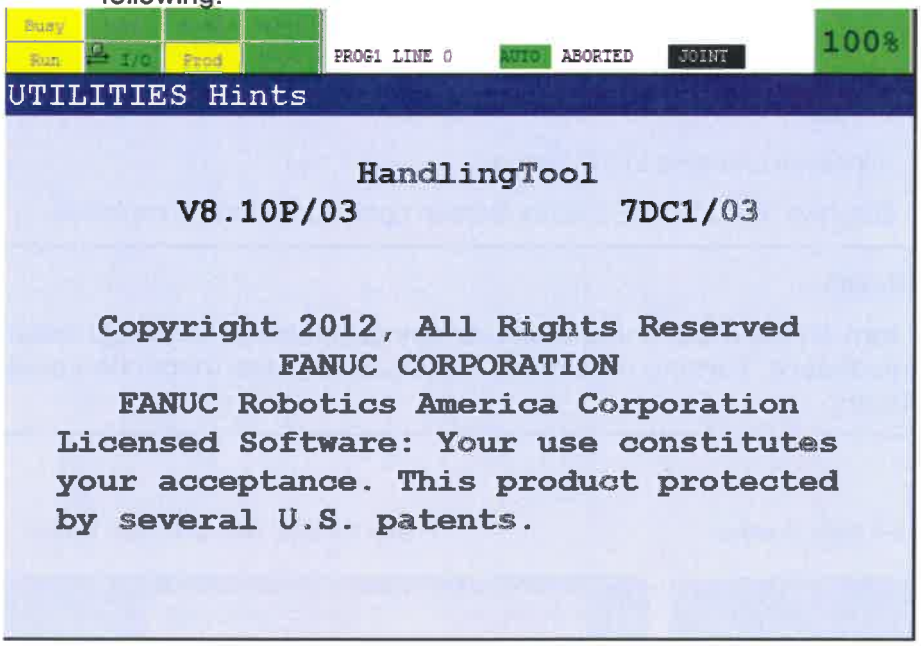
Procedure 6-1 Turning On the Robot

Condition

- All personnel and unnecessary equipment are out of the workcell.

Step

1. Visually inspect the robot, controller, workcell, and the surrounding area. During the inspection make sure all safeguards are in place and the work envelope is clear of personnel.
2. Turn the power disconnect circuit breaker or power switch on the operator panel to ON. **This completes turning on the robot for R-30iA, R-30iA Mate, R-30iB, and R30iB Mate controller.**
3. **For R-J3*i*B and earlier controllers,** press the ON/OFF button on the operator panel.
   - **On the operator panel**, the ON button will be illuminated, indicating robot power is on.
   - **On the teach pendant screen**, you will see a screen similar to the following.



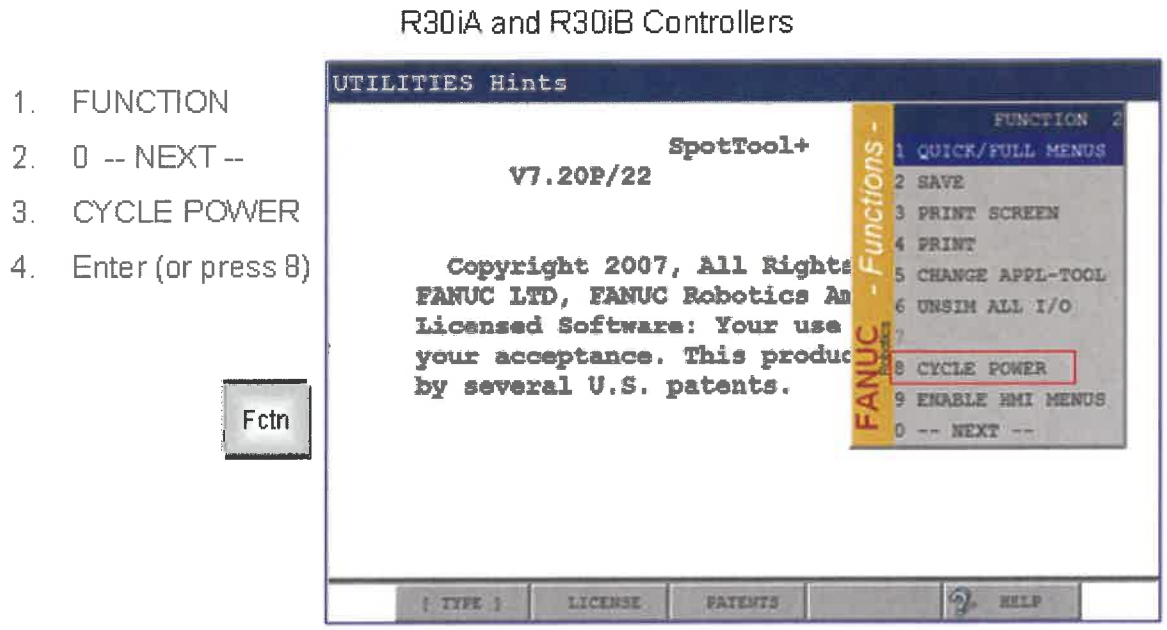
6.2.1 *Cycling Power from the Teach Pendant*

During operations it may become necessary to cycle power on the controller. This can be caused from a number reasons. For example it may be necessary to clear a fault or to initialize a setting.

There are two ways to cycle power on the controller; turn off the main breaker and turn it back on or cycle power from the Teach Pendant. The safer route is to utilize the teach pendant to cycle power. When the pendant executes the operations there is a built in delay to allow residual power to be released before reapplying power. This will minimize the likely hood of damaging any of the Printed Circuit Boards (PCB's) inside the controller.

Cycling power from the Teach Pendant is only available on R30iA and R30iB controllers only. Controllers older than these and **all Mate controllers** are not equipped with this function. In order to execute this task the teach pendant must be turned on (enabled).

Figure 6-3 Cycle Power



In the event you must utilize the Main Breaker to cycle power or the controller is not equipped with the capability to cycle power from the pendant;

- Pause any motion if executing
- Press the ON / OFF button (if applicable)
- Turn the breaker off
- Count to five
- Turn the breaker back on.

This will allow time for the power to dissipate before reapplying power.

6.2.1..1 Cycling Power on a Paint Robot

All of the considerations for cycling power from the teach pendant mentioned in the previous section apply to Paint Robots. However, unlike their yellow robot counterparts, all Paint Robot Controllers are equipped with an ON / OFF button.

In order to cycle power on a Paint Robot System without using the Function menu it is only necessary to press the ON / OFF button, you do not need to cycle the Main Breaker. Pressing the ON / OFF button only will maintain purge on the Mechanical Unit.

Procedure 6-2 Cycling Controller Power (R-30iA / R30iB only excluding Mate Controller)

Condition

- The teach pendant is enabled.
- You are not using an external robot connection. This is only available on the teach pendant.
- The controller is currently in a Cold start state.

Step

1. Press FCTN, press 0 –NEXT--
2. Select CYCLE POWER.
3. Press ENTER. You will see a screen similar to the following.

```
This will cycle power.
Are you sure?
     [NO]       YES
```

4. Use the teach pendant arrow keys to select YES, and press ENTER.

6.3 Powering Down the Robot

In order to power down the Robot System you only need to locate the Main Breaker and turn it to the off position for R30iA and R30iB. For RJ3iB and older controllers it is necessary to press the ON / OFF button on the SOP then turn the Main Breaker to the off position.

Regardless of the controller model prior to turning the system off ensure that the controller is not executing any motion. If necessary place the executing program in a Hold status, then power down the system. Failure to do this will result in an EMERGENCY STOP due to removing power from the Robot System.

⚠ WARNING

Lethal voltage is present in the controller WHENEVER IT IS CONNECTED to a power source. Be extremely careful to avoid electrical shock.

Turning the main disconnect or circuit breaker to the OFF position removes power from the output side of the device only. High voltage is always present at the input side whenever the controller is connected to a power source.

Procedure 6-3 Turning Off the Robot

Step **1** If a program is running or if the robot is moving, press the HOLD key on the teach pendant.

2 Perform any shutdown procedures specific to your installation. **For R-30iA and higher controllers, move to step 4.**

3 **For R-J3*i*B and earlier controllers,** press the ON/OFF button on the operator panel.

4 Turn the disconnect circuit breaker to OFF when performing maintenance on the robot or controller.

6.4 Jogging

Whenever you are manually moving the robot with the teach pendant the operation that you are performing is referred to as jogging. There are many reasons to jog the robot such as moving the robot to the home position, moving to a position to touch up a point, aligning the axis for mastering, and creating frames.

Regardless of the operation, as an operator it is very important to have an understanding how the robot moves. There are five ways to jog the robot; joint, world, tool, user, and jog frame. Each method is referred to as a coordinate system. This section will specifically focus on jogging the robot in joint and world.

Each coordinate system has the possibly to manipulate the mechanical unit in a different manner. Therefore, it is imperative to have an understanding of not only ***how fast*** the robot will move but also ***how*** the robot will move.

6.4.1 *Jog Speed (Override Speed)*

The jog speed keys on the teach pendant are used to increment or decrement the jog speed. The Shift key combined with a jog speed key causes the jog speed to be changed between 100, 50, 5, FINE, and VFINE. The jog speed is reflected in the upper right corner of the teach pendant screen in the green box, this is referred to as the general override. **Figure 6-4** shows the jog speed key location and location of the general override.

NOTE: When you use FINE and VFINE speed values, the robot moves one increment at a time. You must release the jog key and press it again to move the robot again.

Table 6-1 Jog Speed Values

	Speed Values	Joint	Cartesian
	100, 95, 90, 85, ... 20, 15, 10, 5, 4, 3, 2, 1	% of jog speed	% of jog speed
PULSE	FINE (incremental steps)	Approximately 0.001 degrees	Approximately 0.0009055 mm
PULSE	VFINE (incremental steps)	Approximately 0.0001 degrees	Approximately 0.00007874 mm

Figure 6-4 Jog Speed Keys

Jog Speed Adjustments

- **1%-100%**
- **FINE (0.001 degrees / 0.0009mm)**
- **VFINE (0.0001 degrees / 0.00007mm)**
  - Fraction of a degree or mm
  - Only one step at a time
  - Must release and re-press Jog key to keep moving the robot (for FINE and VFINE only)

Set the jog speed to a value that is appropriate for the conditions in the workcell, the kind of jogging the robot is doing, and your own experience in jogging a robot. Use a slow jog speed until you are familiar with the robot. The slower the jog speed, the more control you have over robot motion.

6.4.2 *Coordinate System*

The coordinate system sets how the robot will move. To toggle through the different systems press the COORD key on the pendant. You will see the coordinate system toggle on the teach pendant.

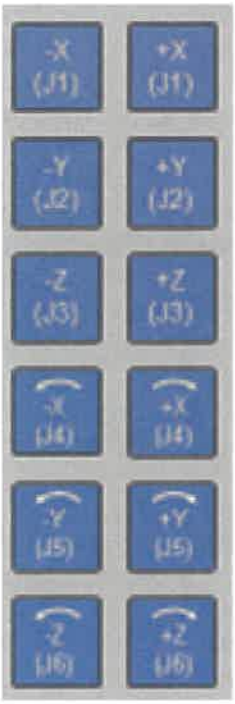
On newer R30iB controllers you can also press the Shift key and COORD together and the Jog Methods will appear along the bottom screen of the teach pendant. This way you can select the jog method directly without the need to toggle through the different methods.

When choosing the specific jog method note that the jog key will impact ho the robots moves depending on the method selected. If you are jogging in Joint pay particular attention to the keys with a "J" and the related "+" or "-" symbol, as these keys will move individual joints.

When jogging in any other method, you are manipulating a Cartesian coordinate system. For these other methods pay particular attention to the "X", "Y", and "Z" keys with the related "+" or "-" symbol.

Figure 6-5 COORD key

Figure 6-6 Jog Keys



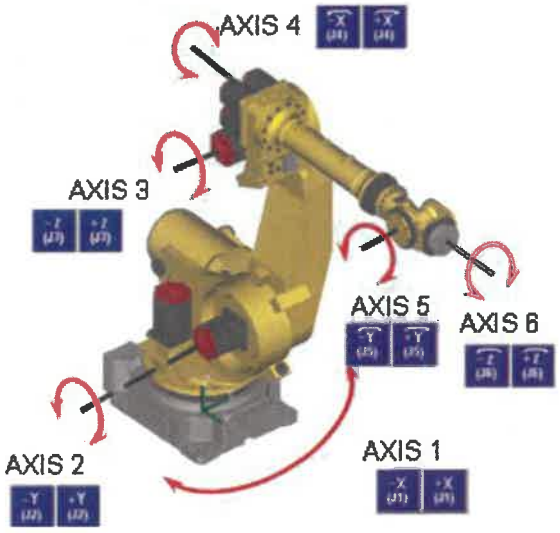
6.4.3 *JOINT Jogging*

The most efficient method of jogging is "JOINT" mode. This is the most efficient type motion because the processor does not have to calculate a linear path or maintain the tool center point in line with a plane.

Joint jogging refers to the movement of each individual axis of a robot, one at a time, in either a positive or negative direction. In order to assist operators, some robots have positive and negative directional markings located directly on the mechanical unit for reference.

The motion that takes place while in the JOINT jog mode has been compared to the motion seen when moving the human arm.

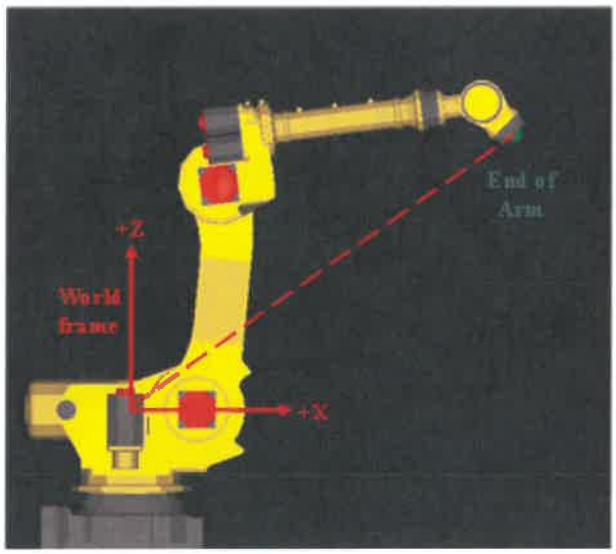
Figure 6-7 Joint Jogging



6.4.4 *World Jogging*

World frame allows you to move the robot tool center point in reference to a Cartesian Coordinate System. World is the default frame for the robot system and cannot be changed. World is also the default reference for other user-defined frames such as user and jog frame.

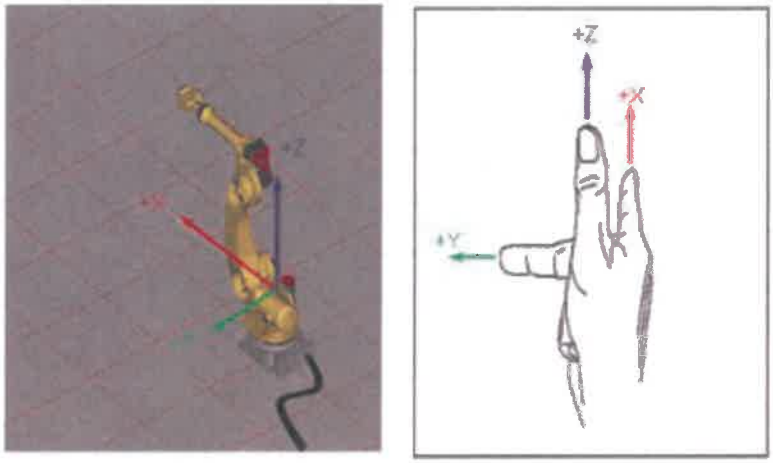
Figure 6-8 World Frame



World Frame is based on two reference points. One of these points is the intersection of a line perpendicular to the ground through Joint 1 and a line parallel to the ground through Joint 2. Where these lines cross identifies the origin of the frame. The origin point is the point on the robot that will never move.

The second point is the location of the Tool Center Point. By default the location of this point is the middle of the faceplate. We will discuss Tool Center points in the next chapter. When the robot moves in World Frame the controller moves the Tool Center Point in a linear manner relative to the frame.

Figure 6-9 Right Hand Rule



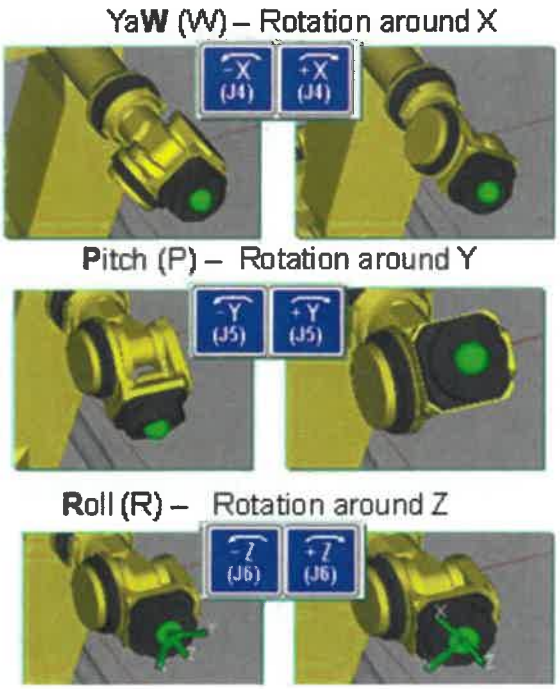
While moving in the World Coordinate System the motion is described using the right hand rule. With the right hand rule your index finger represents the "X" direction, your middle finger represents the "Y" direction, and your thumb represents the "Z" direction.

These directions are relative to the robots perspective as shown in **Figure 6-9**.

As mentioned previously, while jogging in a Cartesian Coordinate System such as World pay particular attention to the jog keys labeled with "X", "Y", and "Z". As these keys will move the robot in this selected Coordinate System along those planes. These are referred to as World Major Axes.

You can also move the robot rotationally about these planes. To jog the rotational axis utilize the "X", "Y", and "Z" keys with the arrows arcing over the top. These keys will rotate positive or negative around the specific plane. These keys are commonly referred to as Yaw (Rotation about "X"), Pitch (Rotation about "Y"), and Roll (Rotation about "Z") or World Minor Axes.

Figure 6-10 World Minor Axes



6.4.4..1 Singularity

Singularity occurs in an X-Y-Z/Cartesian coordinate only. For most six-axis industrial robots, wrist singularity occurs when the axes of Joints 4 and 6 are aligned. When axis 5 (J5) approaches 0 degrees, the robot encounters an infinite combination of axis 4 and axis 6 positions to achieve a location.

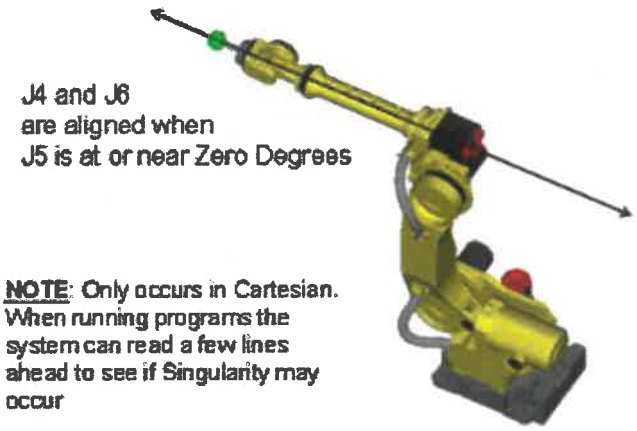
Said differently, singularity occurs when an infinite number of joint angels generate the same set of Cartesian data (J4, J5 and J6 on a 6 axis robot).

NOTE: Joint jogging is not effected by Singularity errors.

To recover from singularity:

- Press the COORD key to select Joint
- Move Joint 5 "+" or "-" 10 degrees
- Return to prior Cartesian Coordinate motion or continue to jog the robot.

Figure 6-11 Singularity



6.4.5 *Jogging the Robot*

Procedure 6-4 Jogging the Robot and Other Axes

Condition
- All personnel and unnecessary equipment are out of the workcell.
- All EMERGENCY STOP faults have been cleared.
- All other faults have been cleared and the fault light is not illuminated.
- The MODE SELECT switch is in the T1 or T2 position.

> **WARNING**
> **Make certain that all safety requirements for your workplace have been followed; otherwise, you could injure personnel or damage equipment.**

Step 1 Select a coordinate system by pressing the COORD key on the teach pendant until the coordinate system you want is displayed in the upper right hand corner of the teach pendant screen.

NOTE: The jog speed value will automatically be set to 10%, when the teach pendant is turned on, or when the controller is first powered up.

2 Turn the teach pendant ON/OFF switch to the ON position.

3 Hold the teach pendant and continuously hold the DEADMAN switch in the center position.

NOTE: If you compress the DEADMAN switch fully, robot motion will not be allowed and an error occurs. This is the same as when the DEADMAN switch is released. To clear the error, press the DEADMAN switch in the center position and press RESET.

4 Select a jog speed by pressing and releasing the appropriate jog speed key until the jog speed you want is displayed in the General Override.

a Set the jog speed to a low percentage (%) value if you are inexperienced in jogging the robot, or if you are uncertain how the robot will move.

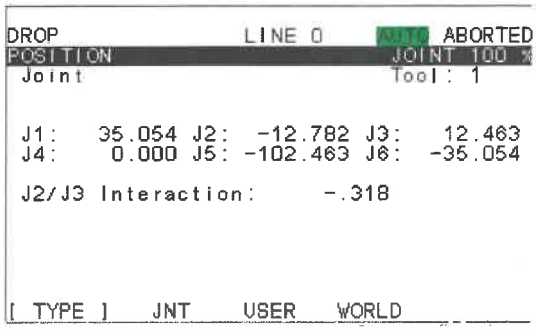
> **WARNING**
> **In the next step, the robot will move. To stop the robot immediately any time during jogging, release the DEADMAN switch or press the EMERGENCY STOP button.**

5 To jog, press and hold the SHIFT key and continuously press the jog key that corresponds to the direction in which you want to move the robot. To stop jogging, release the jog key

6 When you are finished jogging, turn the teach pendant ON/OFF switch to OFF, and release the DEADMAN switch

6.4.6 *Positional Status*

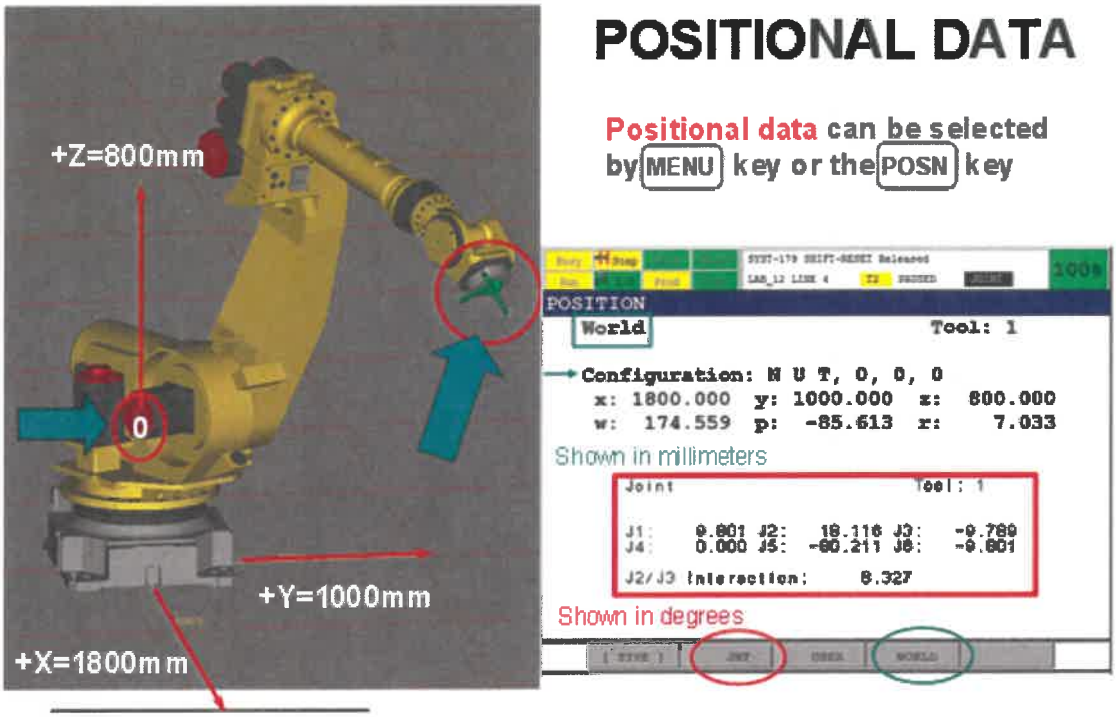
The POSITION screen displays positional information in joint angles or Cartesian coordinates. The positional information on this screen is updated continuously when the robot moves. The information displayed on these screens is for display only; you cannot change it.



There are two ways to access the position screen:

- Press the POSN key on the bottom row of the teach pendant.
- Press Menu, -0- Next, and one of the following:
  - R30iA: -4- Position
  - R30iB: Cursor to -4- 4D GRAPHICS, Select Position on the fly out menu.

Figure 6-12 Positional Data



The type of positional representation is selected based on the Function Soft Keys:

- **JOINT:** The joint screen displays positional information in degrees for each robot axis. Tool indicates the number of the active tool frame.
- **USER:** The user screen displays positional information in Cartesian coordinates based on the USER frame. Frame indicates the number of the active USER frame.
- **WORLD:** The world screen displays positional information in Cartesian coordinates based on the world frame.

6.5 Chapter Review

1) What key do you press to change the Coordinates to jog in JOINT mode?

_____

2) What direction does the robot move in the World Z+ if floor mounted?

_____

3) What are the different jog speed types? (Circle all the apply)
   - FINE
   - VFINE
   - COURSE
   - 100, 95, 90, 85……. %
   - 1 - 100 sec.

4) What key(s) can be depressed to access the Position screen?

_____

MATGGROOP1114CE REV B

Lab 1

Powering Up and Jogging the Robot in Joint

Student Name:

Assignment: The student will:
Power up the robot
Jog the robot using the JOINT COORD method

Condition: A FANUC robot and controller loaded with application software.

Step:

1 Power up the robot.

2 Change the robot's speed to a safe low speed

3 Carefully jog the robot around the workcell using JOINT jogging. Observe the motion of each axis.

Completed: ☐

Instructor: _____

Lab 2

Jog the robot in WORLD mode

Student Name:_____

Assignment: The student will:
Learn and practice jogging the robot in World mode
Familiarize with some of the Teach Pendant keys and functions normally used while jogging the robot.

Condition: A FANUC robot and controller loaded with HandlingTool application software. A table or cardboard box in the robot's work envelope.

Step:

1. Set the robot to jog in WORLD mode by hitting the COORD key until WORLD appears on the Teach Pendant screen.
2. What is the current selected jog/override speed?_____
3. What increments does the speed change when the +% key is pressed by itself?

   _____
4. In what increments does the speed change when the SHIFT key is pressed with the +% key?

   _____
5. Practice jogging in the WORLD frame with the pointer perpendicular to each side of the box or table to ensure you can successfully move the pointer along the X, Y and Z planes as well as rotate about the X,Y and Z axes.

Completed: ☐

Instructor: _____

Lab 3

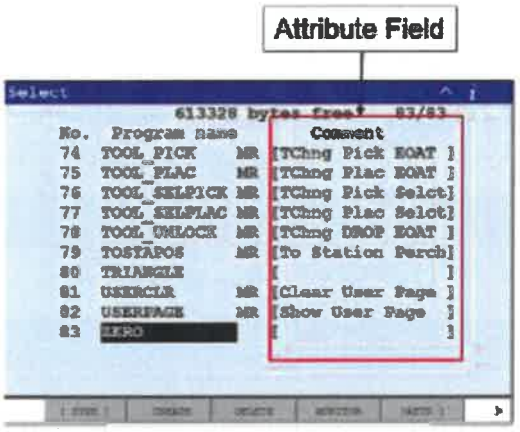
Teach Pendant Operations

Student Name:

Assignment : The student will:
Show Help data
Split the Screen
Identify Soft Keys

Condition: A FANUC robot and controller loaded with HandlingTool application.

Step: **7** Display the Select Screen by pressing the Select key. You will see a screen similar to below.



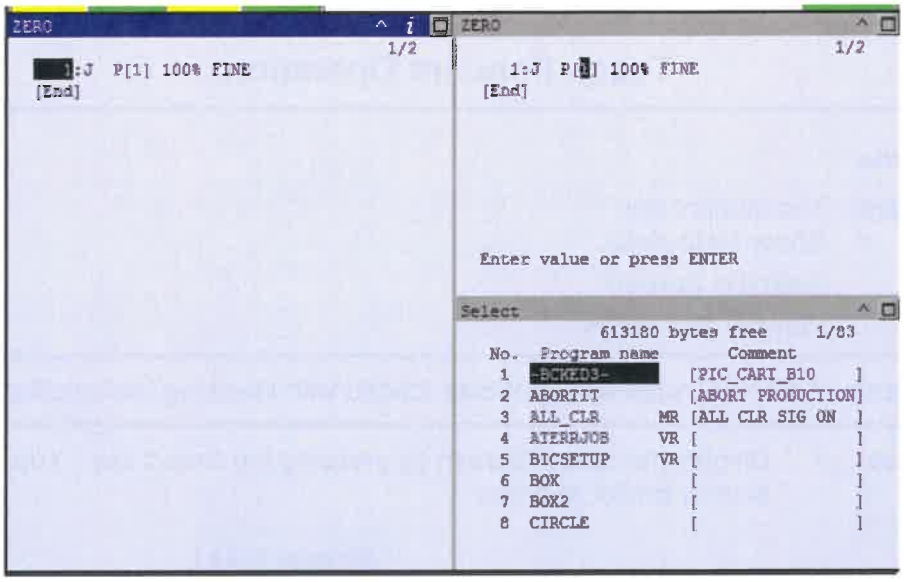
8 Use the Help Key to determine all the items that can be represented in the Attribute field, and write them in the space provided.

9 Split the screen to triple view and display the screens show below.

a Primary Window: Select key, Highlight ZERO, Press Enter

b Top Right Window: Same as above

c Bottom Right Window: Press Select Key



10 In each window place the cursor as shown above and in the space provided fill in the Soft Key descriptions.

Primary Window

Top Right

Bottom Right

11 Power down the robot

Completed: ☐

Instructor: _____

7 FRAMES

7.1 Chapter Objectives

- Understand the Cartesian Coordinate System
- Familiarize with WORLD Frame, TOOL Frame, USER Frame and JOG Frame
- Access the Position screen and how the location and orientation is measured
- Jog in the different Cartesian Coordinates

7.2 Cartesian Coordinate System

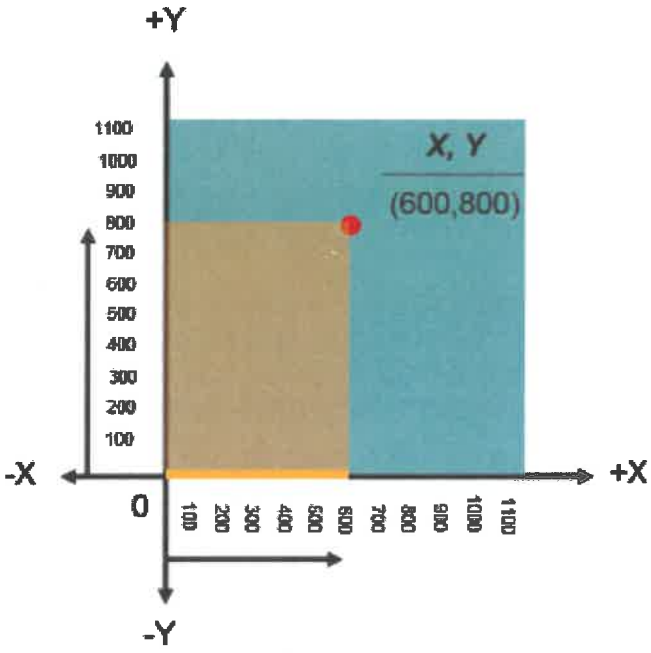
7.2.1 *Two Dimensional System*

A Cartesian Coordinate System is used to describe the **location** and **orientation** of a position. In a two dimensional Cartesian Coordinate System two axes are required to reach any point on a plane (X, Y). You have been indoctrinated into a two dimensional system in high school.

On the "X" and "Y" planes the point that they intersect make up the origin. That is the point on the system that everything is measured from.

In **Figure 7-1** to arrive at the point (600, 800) starting at the origin you move right on the X-plane 600, then up on the Y-plane 800.

Figure 7-1 Two Dimensional System

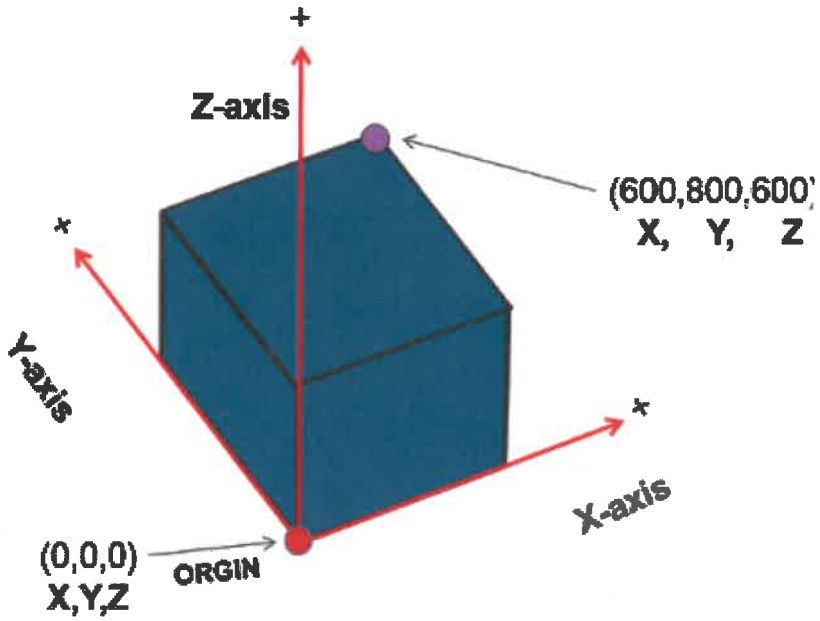


To relate this to the robot think of the origin in **Figure 7-1** as the origin of the robot and the red dot as the Tool Center Point. The Tool Center Point can be moved anywhere in relationship to the origin on the X-plane and Y-plane. The value of that point will always be the distance from the origin to the spot on the respective planes.

7.2.2 *Three Dimensional System*

The robot operates in a three dimensional Cartesian Coordinate System. In essence this means that we add the Z-plane and can now measure height or depth relative to the X and Y-planes.

Figure 7-2 Three Dimensional System



In **Figure 7-2** the execution is same to arrive at the point as discussed on the previous page. The only change is to account for the third value of 600. This moves the point up in the "Z+" direction to arrive at the point in the three dimensional system. The relationship between the point and origin are the same as discussed previously as well.

The **location** is the distance in the X, Y, and Z directions from the origin of the reference frame. The **orientation** is the rotation about the X, Y, and Z axes of the reference frame. When you record a position, its **location** and **orientation** is automatically recorded as X, Y, Z, W, P, and R relative to the origin of the frame it uses as a reference.

7.3 Frame Overview

A frame is an intersection of three planes at right angles to each other. The point where all three planes intersect is called the origin point, where X, Y & Z values are all zero. Any point can be located within a frame by providing three positive or negative numbers to represent the X, Y & Z distances from the origin. This kind of system is called a Cartesian coordinate system.

One of the benefits of defining frames is to establish reference points on a work piece such as a fixture or pallet. When the work piece moves, the program can be edited by adjusting the frame rather than adjusting all of the positional data in each program.

As discussed in the previous chapter there are five coordinate systems.

Default Coordinate Systems

- Joint (Non-Cartesian)
- World

User Defined Coordinate Systems

- Tool
- User
- Jog Frame

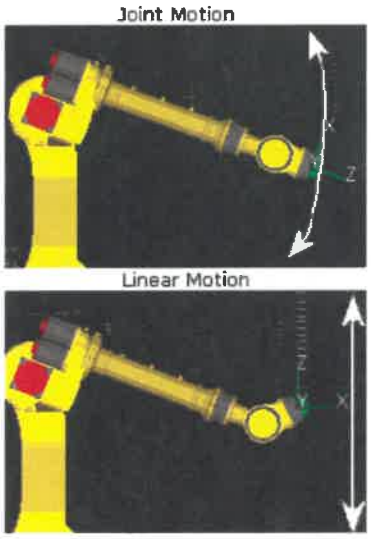
7.4 Types of Frames/Cartesian Coordinates

7.4.1 *WORLD Frame*

Starting with the WORLD Frame: Frames are used to describe the location and orientation of a position. When recording positional data for a program and no frames have been defined then WORLD Frame will be used.

WORLD is the default frame used to describe the location and orientation of the Tool Center Point (TCP). The default location of the TCP is the center of the faceplate. The TCP location can be changed once tooling has been added to the robot. When recording positional data for a program the robot measures from the WORLD origin to the tooling and is represented in X, Y, Z, W, P, R.

- The WORLD Frame is the **default** frame of the robot. It cannot be changed by the user.
- The **origin** of the world frame is located on the centerline of the J1-axis and at the height of the centerline of the J2-axis. This could be described as Machine Zero.
- The location of this origin never changes.
- The orientation of the WORLD frame never changes.
- When jogging in WORLD, the servo motors will maintain a linear (straight) movement with respect to the tool.



7.4.2 *Tool Frame*

An important reason to define a Tool Center Point (TCP) is simply to jog the TCP to the work piece which makes programming easier. Some software applications are based on a correctly defined TCP. Tool frames allow you to control the robot based on tooling. TOOL jog method allows the programmer to have greater control of the tooling.

When the robot is in auto, a correct TCP allows the end of the tool to follow a linear path.

By default, the TCP is located at the center of the robot's faceplate, this is the tool origin or tools zero location. When you define a Tool frame you move the TCP from the robot's

faceplate to a defined the point on the EOAT that the work is to be done. Once the Tool frame is taught it is commonly referred to as a UTool, UT, or TCP. In essence a TCP is just an offset from the robot faceplate to a defined point on the tool.

Figure 7-3 Tool Center Point Not Defined

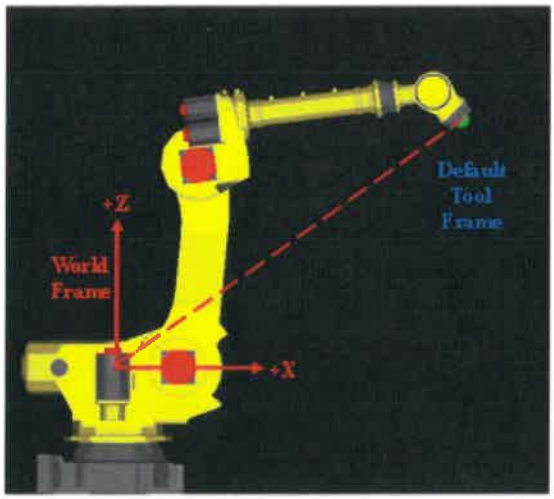


Figure 7-4 Tool Center Point Defined

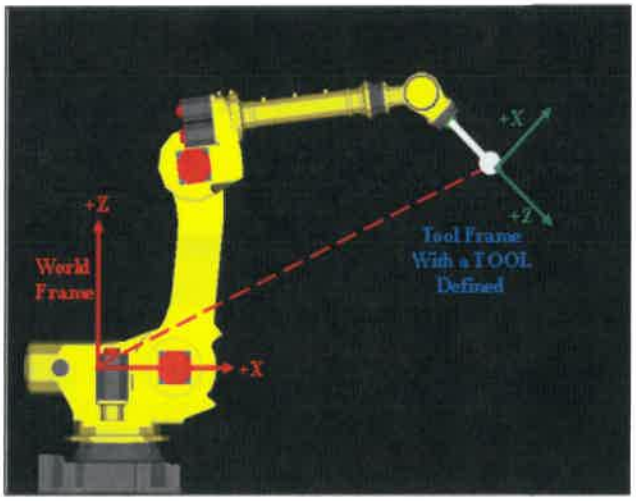
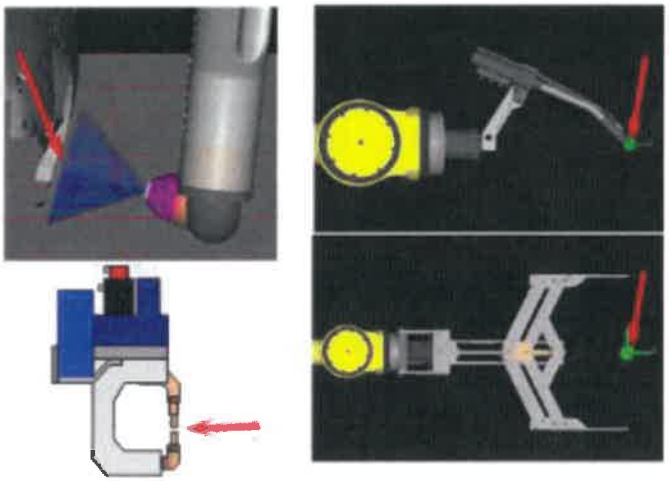


Figure 7-5 TCP Locations

Different software's define the TCP in a different location, as the point at which the work happens changes.

- PaintTool: Approx. 12" from the end of the applicator
- ArcTool: Tip of the wire
- SpotTool+: Point that the tips of the gun meet
- HandlingTool: Center of gripper or suction cups



7.4.3 *User Frame Overview*

A user frame is a frame that you can set up in any location, with any orientation. User frames are used so that positions in a program can be recorded relative to the origin of the frame.

All positions in a program are automatically recorded in user frame. If you do not set up the location and orientation of the user frame before you create a program, the user frame will be set by default to the world frame in the program and you cannot easily change it.

When jogging the robot in USER coordinate after you have defined the USER frame the robot will follow the X, Y, and Z direction of the new frame. You may like to think of USER frame as another "right hand rule" defined somewhere within the robot's work envelope. USER frames make teaching points and jogging easier.

A major benefit of USER Frames is the ability to record the program relative to a workpiece or fixture. This will allow for if the work piece moves to touch up the new location the frame and the program will follow.

Figure 7-6 Position Relative to World Frame

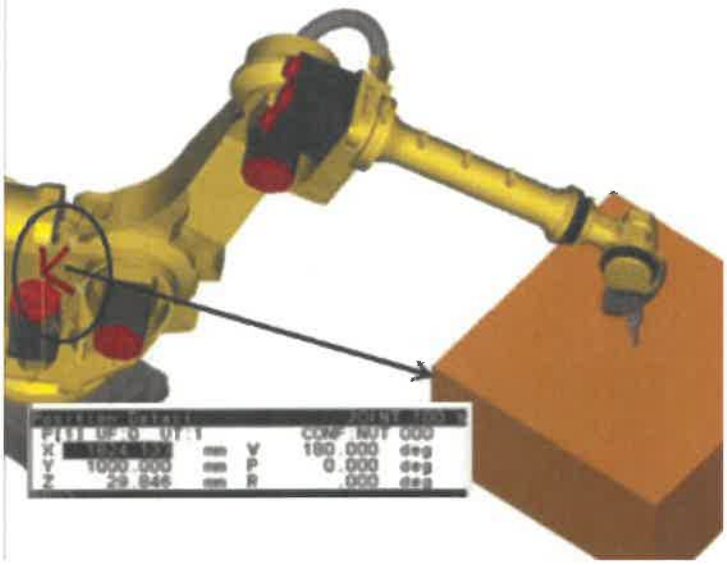
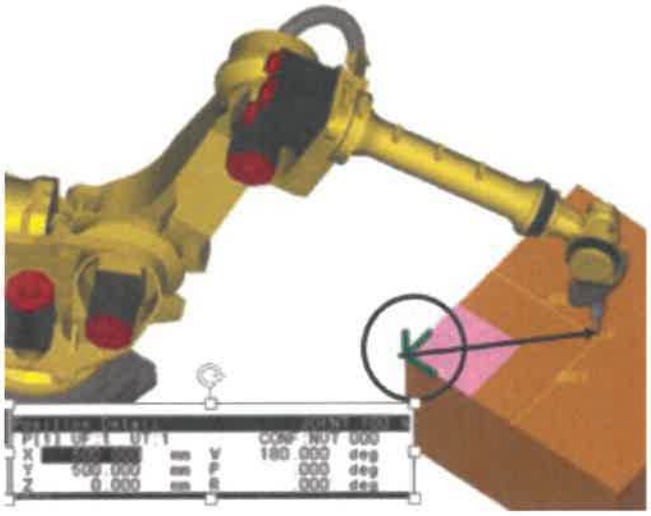


Figure 7-7 Position Relative to USER Frame



In Summary, the **Tool** Frame location tells the controller where the Tool frame is relative to the center of the faceplate (Tool Zero).

Positional data tells the controller where the Tool Frame is, relative to the **USER** Frame origin (Workpiece Zero/Datum). In the above example, there is a defined **USER Frame**.

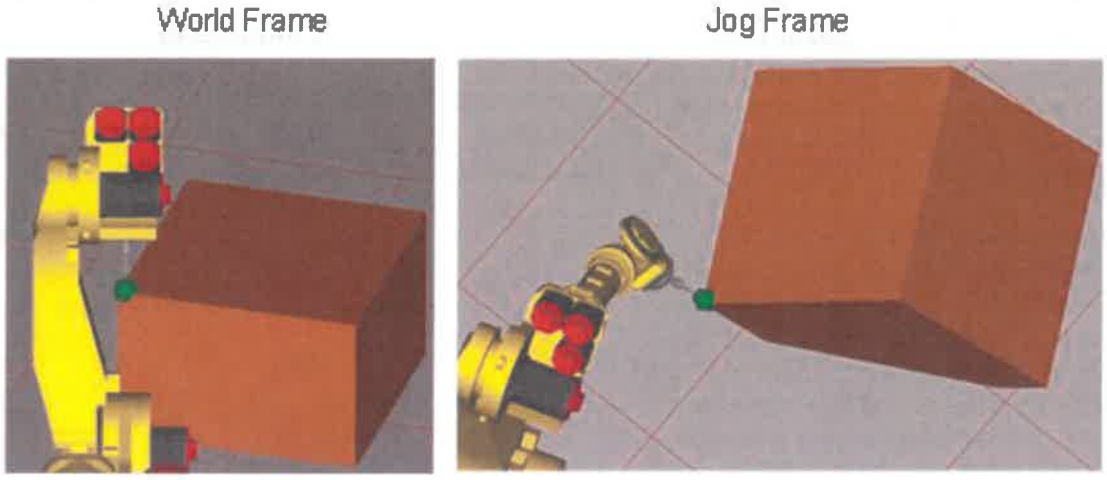
USER Frame offset data (UFRAME) tells the controller where the defined USER frame is relative to WORLD frame (Machine Zero).

7.4.4 *Jog Frame Overview*

Similar to using USER frame, the JOG Frame provides a convenient way to jog the robot relative to a particular workpiece. However, the big different between USER and JOG is that JOG frame has no effect on positional data when recording points. JOG Frame is just a convenient method of jogging the robot.

In this example, a JOG frame was defined to move along a part when the part is oriented differently from the WORLD frame or a detail on the part is oriented differently than a USER frame.

Figure 7-8 World Frame Jog Frame Comparison



The benefit of defining a jog frame is that it makes jogging easier when teaching points. It will remove the need to "tack" while jogging if a part is skewed in relation to the World frame. Remember that JOG frames can be taught anywhere inside the robot's workspace.

You might like to think of a Jog Frame as another right hand rule defined somewhere within the work envelope.

NOTE: A Jog Frame has no effect on program data.

Before you can use a JOG frame, you must set up its location and orientation. You can set up as many as five different JOG frames for each robot. You can select one JOG frame to be active at a time per motion group.

After the JOG Frame has been defined and is selected, the robot can be jogged in that frame when JGFRM is selected as the jog method.

7.5 Chapter Review

1) Where is the **default** TOOL center point?

_____

2) If you had to place an object at a 45 degree angle, what coordinate would assist in accomplishing jogging the robot along this angle? (circle all that apply)

WORLD JOINT JOG USER TOOL

Lab 6

Jog the robot with TOOL USER and JOG Frames

Student Name:_____

Assignment: The student will:

- Jog the robot in a TOOL Frame Coordinates
- Jog the robot in a USER Frame Coordinates
- Jog the robot in a JOG Frame Coordinates

Condition: A FANUC robot and controller loaded with HandlingTool application software.

Step:

1. Power up the robot in a safe fashion.
2. Jog the robot in TOOL.
   - **a** Press COORD to choose TOOL.
   - **b** Press Shift and COORD.
   - **c** In the Jog Menu (Yellow Box) enter a 1 on the Tool Line.
   - **d** Jog the Robot and notice how the tool is moving when you rotate Yaw, Pitch, and Roll.
   - **e** Press Shift and COORD.
   - **f** In the Jog Menu (Yellow Box) enter a 2 on the Tool Line.
   - **g** Jog the Robot and notice how the tool is pivoting about the tip of the tool when you rotate Yaw, Pitch, and Roll.

Why did the pivot point change?

_____

_____

3. Jog the robot in USER.
   - **a** Press COORD to choose USER.
   - **b** Press Shift and COORD.
   - **c** In the Jog Menu (Yellow Box) enter a 0 on the USER Line.
   - **d** Jog the Robot and notice the direction we move in "X", "Y", and "Z".
   - **e** Press Shift and COORD.
   - **f** In the Jog Menu (Yellow Box) enter a 1 on the USER Line.
   - **g** Jog the Robot and notice how the direction of "X", "Y", and "Z" changed.

h Display the position screen.

i Look at the positional data when represented in World.

j Look at the positional data when represented in User.

Why did the directions and Positional data change?

_____

_____

4 Jog the robot in the JOG Frame to verify proper orientation.

a Press COORD to choose JGFRM.

b Press Shift and COORD.

c In the Jog Menu (Yellow Box) enter a 1 on the JOG Line.

d Jog the Robot and notice the direction we move in "X", "Y", and "Z".

e Press Shift and COORD.

f In the Jog Menu (Yellow Box) enter a 2 on the JOG Line.

g Jog the Robot and notice how the direction of "X", "Y", and "Z" changed.

Why did the directions change?

_____

_____

5 Power down the robot.

Completed: ☐

Instructor: _____

- In general the USER Frame +Z direction should move away from the object. The "Right Hand Rule" can also be used to understand the X, Y, Z directions of the USER Frame.
- Use the **COORD** key to select the desired jogging method. Select USER or JOG Frame (JGFRM) to see the newly taught frame when jogging the robot.
- USER "0" is always the default WORLD Frame if no other USER Frame is selected in the Jog Menu.

8 PROGRAM OVERVIEW

8.1 Chapter Objectives

- Navigate the Select Screen
- Choose a Program
- Navigate the Edit Screen
- Test a Program
- Execute Production Operations

8.2 Select Screen

The Select Screen is the location that all of the stored programs are held. To access the Select Screen press the Select Key, you will see a screen similar to **Figure 8-1.**

From the Select Screen you can see all programs with applicable sub type and an attribute filed. In **Figure 8-1** the attribute filed currently shows comments that are attached to each program.

To sort the programs by sub type:

- Press F1 [TYPE]
- Select specific sub type from the pop up menu

To change the Attribute Field:

- Press F5 [ATTR]
- Select the Attribute from the list

Refer to **Table 8-1** for more information

Figure 8-1 Select Screen

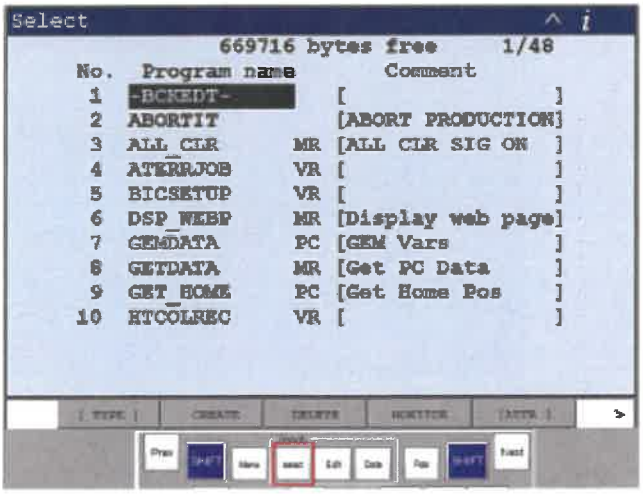
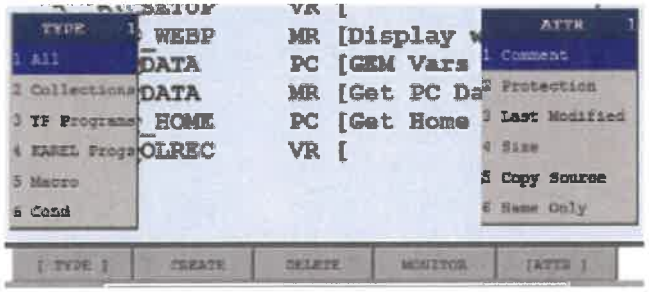


Figure 8-2 Type and Attribute Menu



NOTE: Sorting programs and choosing the attribute must be done individually, both menus cannot be displayed at the same time. **Figure 8-2** is for demonstration only.

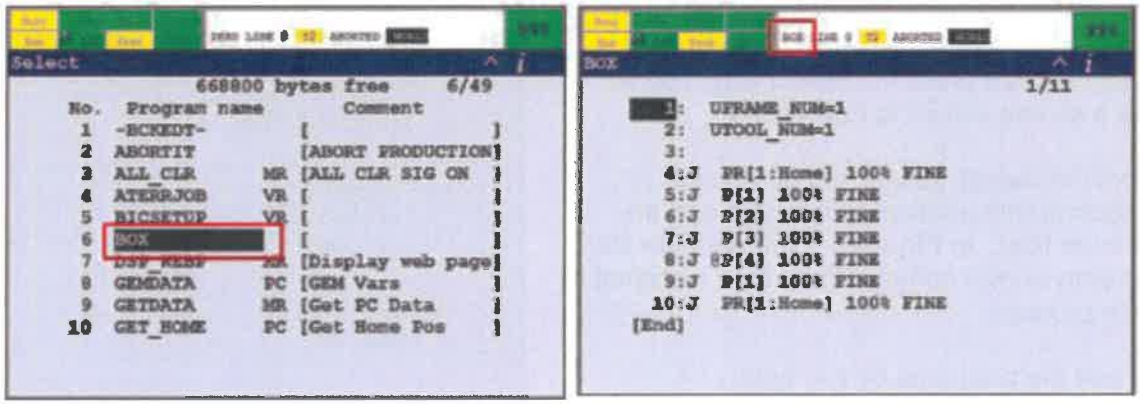
Table 8-1 Attribute Field Items

Item	Description
Comment	Displays comments defined in the Program Detail
Protection	Shows if Write Protect is enabled or disabled
Last Modified	Displays last date the program was changed
Size	Size of program
Copy source	Displays name of the program the program was copied form
Name Only	Displays nothing in the Attribute field, only program name is shown on the select screen.

8.2.1 *Selecting a Program*

From the Select Screen to choose a program for execution or testing simply highlight the target program and press enter. This will make the program the active program and you will see the program name populate the active program field along the top of the teach pendant.

Figure 8-3 Selecting a Program

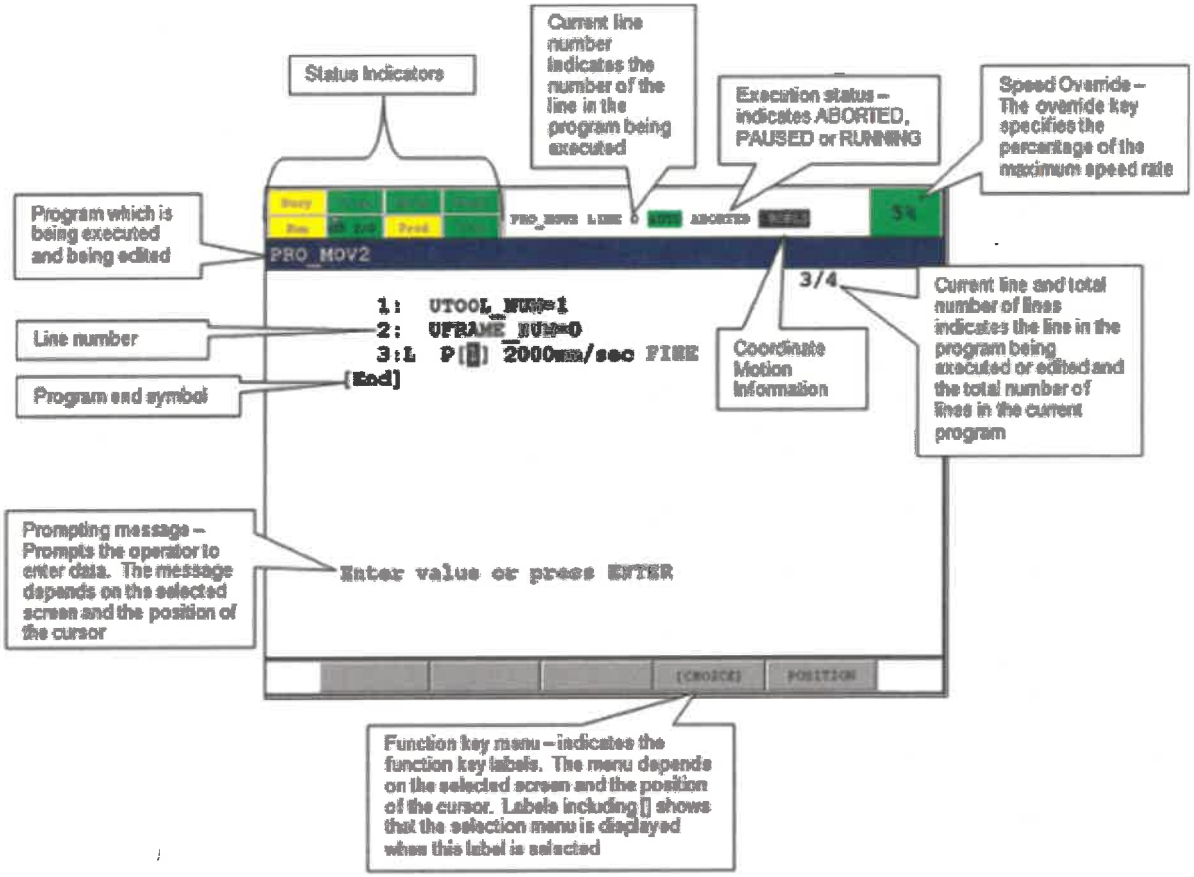


8.3 Edit Screen

The Edit Screen is the screen that displays your currently active program. The current active program is displayed across the top of the pendant at all times. From any menu within the software you can always access your active program by hitting the Edit key.

There is a wealth of information displayed across the teach pendant relating to the edit screen and the active program. Refer to **Figure 8-4** for details relating to the edit screen.

Figure 8-4 Edit Screen Detail



8.4 Testing a Program

Prior to executing any type of program in automatic mode they must be tested. FANUC offers two ways to test the program; STEP Test and Continuous Test. The benefit of testing the program allows the operator to verify the taught positions and paths, identify any interference points, and test the program logic.

While testing programs do not forget how the mode select switch impacts the motion:

T1

- Program playback at 250mm/sec or less

T2

- Program playback at programmed speed

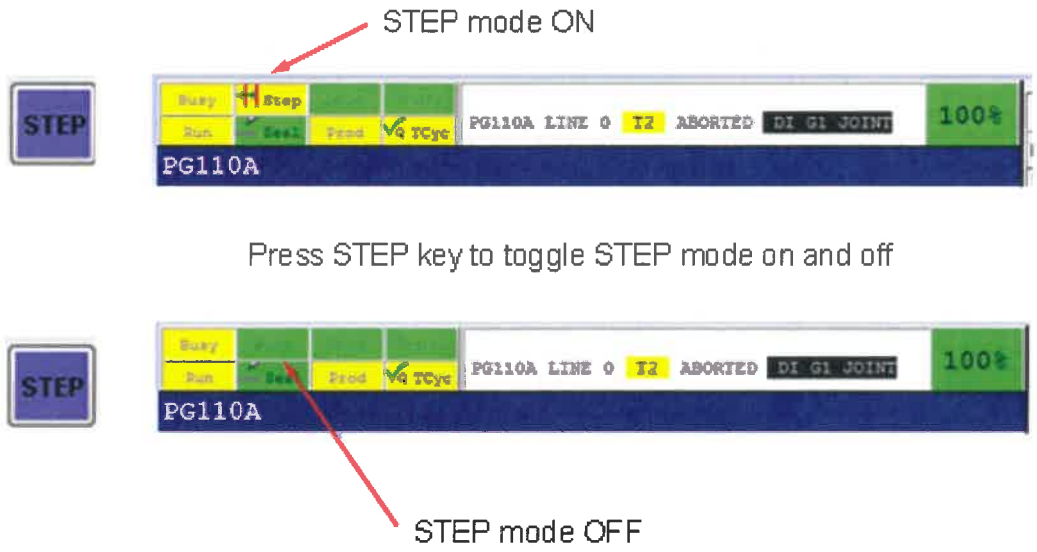
8.4.1 *Single STEP Testing a Program*

Single STEP testing a program is when you test the program only one line at a time. This allows the operator to proof the motion and the logic that makes up the program with more control. Each line is executed one at a time and does not continue execution until prompted from the teach pendant.

In order to enter STEP Testing mode you must locate and press the STEP key on the teach pendant. After pressing the STEP key you will see the STEP status indicator change from green to yellow (**Figure 8-5**).

While testing you can test forward or you can also test the program backward. To move forward through the program you press the FWD key, to execute backward in the program press the BWD key.

Figure 8-5 STEP Enabled / Disabled



To execute a STEP Test:

- Enable the Teach Pendant
- Select T1/T2 Mode
- Choose the program to be tested
- Place the cursor at the point to start testing
- Press the STEP key (ensure you are in STEP mode)
- Center the DEADMAN Switch
- Press and hold Shift and press FWD (will execute just selected line)

  NOTE: Shift must be held for the duration of motion, FWD should be pressed and released to execute the line.

- When ready press FWD again to execute the next line

NOTE: At any time during testing you can release the shift key to perform a controlled stop, or release the DEADMAN switch to perform an EMERGENCY STOP.

When the teach pendant FWD and BWD keys are disabled and the teach pendant is enabled, "FBD" (**F**orward/**B**ackward/**D**isabled) is displayed in the upper left hand corner of the teach pendant screen to indicate that you cannot use the teach pendant to run the program.

NOTE: DISABLE FWD/BWD allows you to disable the ability to execute program instructions when the SHIFT and FWD keys or SHIFT and BWD keys are pressed. To use DISABLE FWD/BWD, press FCTN and then select DISABLE FWD/BWD. The ability to use SHIFT FWD and SHIFT BWD will be disabled until you press FCTN and select DISABLE FWD/BWD again.

8.4.2 *Continuous Testing*

A continuous test gives the operator the ability to test the program without stopping. This can give the operator a better understand and more accurate representation of each motion path.

You may see the programmed paths execute differently from the STEP test to the Continuous test. This is because of how the controller interprets the termination type with each type of test. In a STEP test every termination is treated like a Fine termination. This means the robot moves to the programmed position and pauses. However, in a continuous test each motion statement is executed based on how it is programmed. We will discuss termination types in the next chapter.

To execute a Continuous Test:

- Enable the Teach Pendant
- Select T1/T2 Mode
- Choose the program to be tested
- Place the cursor at the point to start testing
- Check the STEP status indicator, ensure the controller is not in STEP mode
- Center the DEADMAN Switch
- Press and hold Shift and press FWD

  NOTE: Shift must be held for the duration of motion, FWD should be pressed and released to execute the program

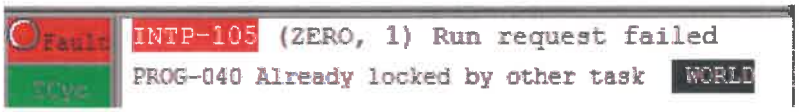
- When ready press FWD again to execute the next line

NOTE: At any time during testing you can release the Shift key to perform a controlled stop, or release the DEADMAN switch to perform an EMERGENCY STOP.

8.4.3 *Aborting a Program*

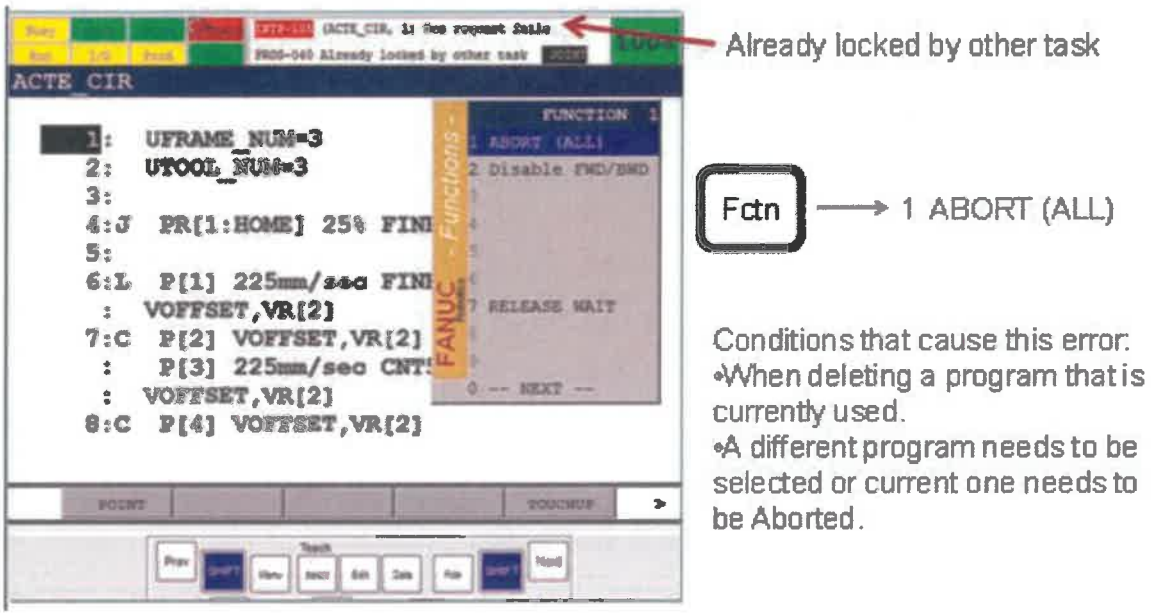
If a previous program was tested and the END statement of the program was not executed you may need to abort this program in order to execute a different program. You will see the fault in **Figure 8-6.**

Figure 8-6 Run Request Failed



All aborting a program does is end whatever the previously selected program and set the newly selected as the current active program. You will not erase any program data or delete any programs when aborting a program.

Figure 8-7 Abort a Program



If you find it necessary to abort a program:

- Press FCTN
- Select -1- ABORT (ALL).

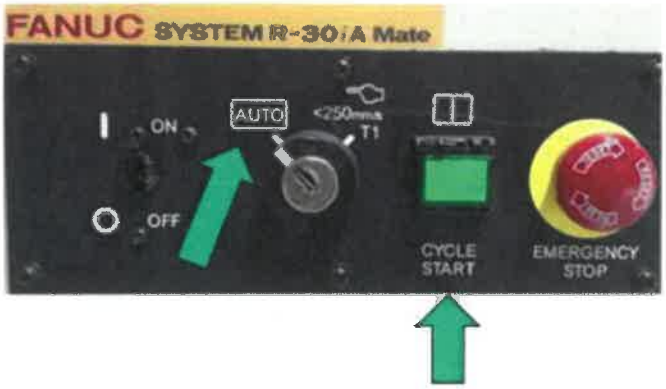
8.5 Running a Program in AUTO

After conducting the STEP Test and Continuous test on the program from the Teach Pendant, running a program using the CYCLE START button allows the robot to run solo without any assistance from the user.

To execute a program in AUTO:

- Disable the Teach Pendant
- Select AUTO Mode
- Choose the program to be tested
- Place the cursor at the point to start the program
- Check the STEP status indicator, ensure the controller is not in STEP mode
- Press Reset to clear any faults
- Press Cycle Start

Figure 8-8 Cycle Start



NOTE: When changing from T1/T2 to AUTO Mode there will always be a fault. Either; Teach Pendant Enabled in AUTO or Teach Pendant Disabled in T1/T2. This makes it necessary to press reset.

8.6 Chapter Review

1) What Teach Pendant key brings up the option Abort All?

   Menu Function Diag/Help STEP

2) What status indicator will turn green when the robot step mode is off?

   _____

3) To execute a program in Automatic Mode what button is pressed from the SOP

   User 2 User 1 Cycle Start Reset

MATGGROOP1114CE REV B

Lab 7

Execute a Program

Student Name:

Assignment: The student will:
Step Test a Handling Tool Program
Continuous Test a Handing Tool Program
Execute a Handling Tool Program in Automatic Mode

Condition: A FANUC robot and controller loaded with LR HandlingTool application software. The students will complete task individually.

Step:

1 Power up the controller

2 From the Select Screen locate the Program BOX and make it the active program.

3 On the Edit Screen the program should be similar to below.

```
BOX:
1: UFrame_Num=1
2: UTool_Num=1
3:
4: J PR [1:Home] 100% FINE
5: J P[1] 100% FINE
6: J P[2] 100% FINE
7: J P[3] 100% FINE
8: J P[4] 100% FINE
9: J P[5] 100% FINE
10: J P[2] 100% FINE
11: J P[1] 100% FINE
12: J PR [1:Home] 100% FINE
END
```

4 Step Test the BOX Program

5 Continuous Test the BOX Program

6 Execute the BOX Program in Automatic Mode

7 Power down the controller.

Completed: ☐

Instructor: _____

9 MOTION INSTRUCTIONS

9.1 Chapter Objectives

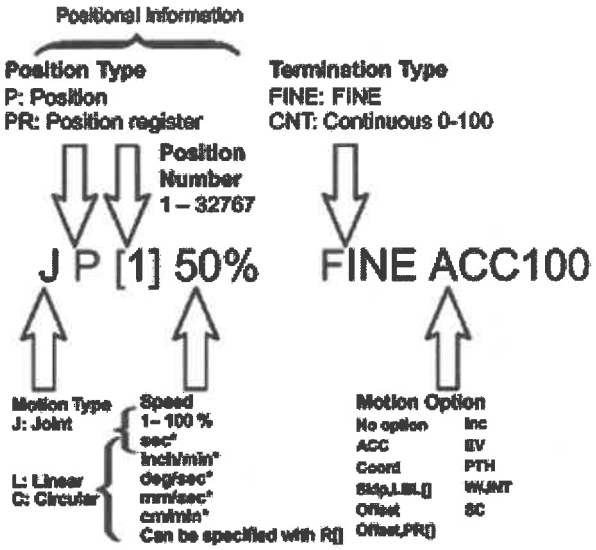
- Elements that describe a motion instruction
- Understand differences between Linear and Joint Motion
- Positon Information Overview
- Understand the difference between a Position and a Position Register
- Understand Robot Speed Values
- Learn the difference between FINE and Continuous Termination
- Understand what a Motion option is and does
- Understand the Difference between Recording a point and Touching Up a point

9.2 Motion Instruction Overview

A motion instruction directs the robot to move in a specified way to a specific location in the workcell using a specified speed. A motion instruction includes:

- Motion Type – How the robot moves to the position.
- Positional Information – Where the robot moves.
- Speed – How fast the robot moves to a position.
- Termination Type – What the robot does at the end of the move to the position.
- Motion Options – Additional commands that perform specific tasks during robot motion

Figure 9-1 Motion Instruction Description



NOTE: * denotes upper and lower limits based on robot model

9.3 Motion Types

The Motion Type defines how the robot will move to the destination position. It is specified in the program not by how the robot was jogged to the point, but the motion type specified on the motion instruction. Depending on the controller and software there may be as many as four motion types: Joint, Linear, Circular, and Circular Arc. For this course we will focus on Joint and Linear.

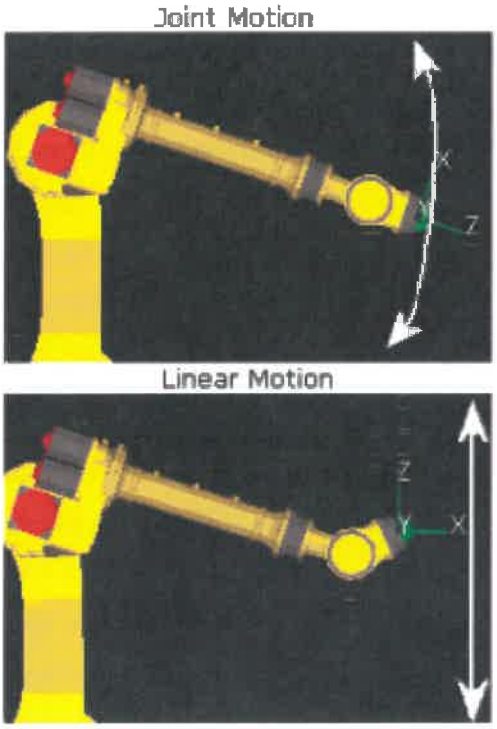
9.3.1 *Joint Motion*

- Causes the robot to move all required axes to the destination position simultaneously. The motion of each axis starts and stops at the same time
- Is programmed a the destination
- Speed is specified as a percentage of the total default speed, or timed; milliseconds or seconds. The actual speed of the move is pendant on the speed of the slowest axis

9.3.2 *Linear Motion*

- Causes the robot to move the TCP in a straight line from the start position to the destination position.
- Is programmed at the destination.
- Speed is specified in velocity; millimeters per second, centimeters per second, inches per minute, degrees per second. Or can be timed; milliseconds, seconds.

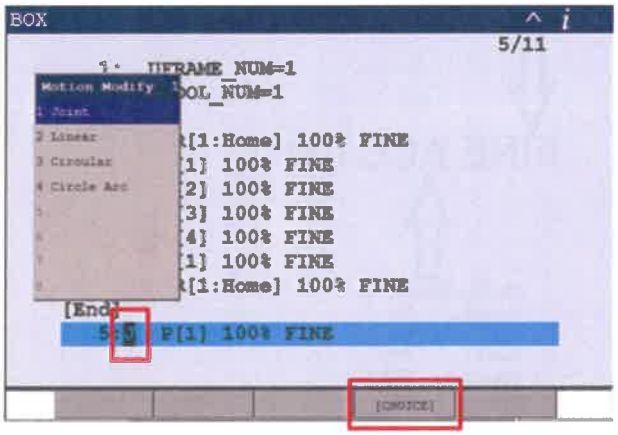
Figure 9-2 Motion Types



Changing Motion Types

The motion type for each motion statement can be changed individually

Figure 9-3 Changing Motion Type



- Highlight the motion type.
- Press the F4 [CHOICE] key.
- Choose Motion from popup menu.

9.4 Position Indicator Symbol

The position indicator symbol is an (@) sign and indicates that the robot is at the taught position. It is possible to be at multiple points within the same program depending on the positional data.

In the example below you can see in the program on the left the robot is at the taught position P[1]. However, on the right side the robot is also at the taught position P[1] and P[5]. This is because the actual data that makes up the position is the same. This will be an important factor to take into account if / when touching up points.

Figure 9-4 @ Indicator

9.5 Position Information

Positional information describes the location, orientation, and configuration of the tool center point when a motion instruction is executed within a program. All of the positional information is recorded when the motion instruction is added to the program.

It is important to understand that the positional information is recorded based on the active User Frame and Tool Frame. Positional data tells the controller where the Tool frame is relative to the USER frame. Refer to **Table 9-1** for more information.

Figure 9-5 Positional Information

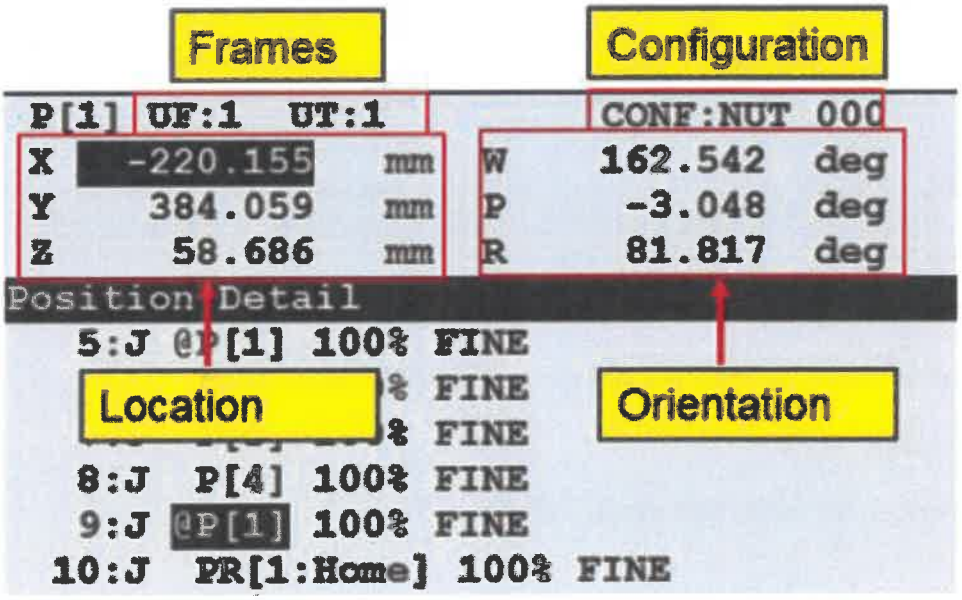


Table 9-1 Position Information

Item	Description
UF (User Frame)	References the User Frame the positon was recorded with respect to.
UT (Tool Frame)	References the Tool Frame the positon was recorded with respect to
Configuration	References the posture of the robot upon arrival at the position.
Location	Describes the three-dimensional location of the position.
Orientation	Describes rotation about X (Yaw), rotation about Y (Pitch), and rotation about Z (Roll).

Another key aspect of positional data is a position name. Positions that are deemed important or that should be identified can have a name attached to them.

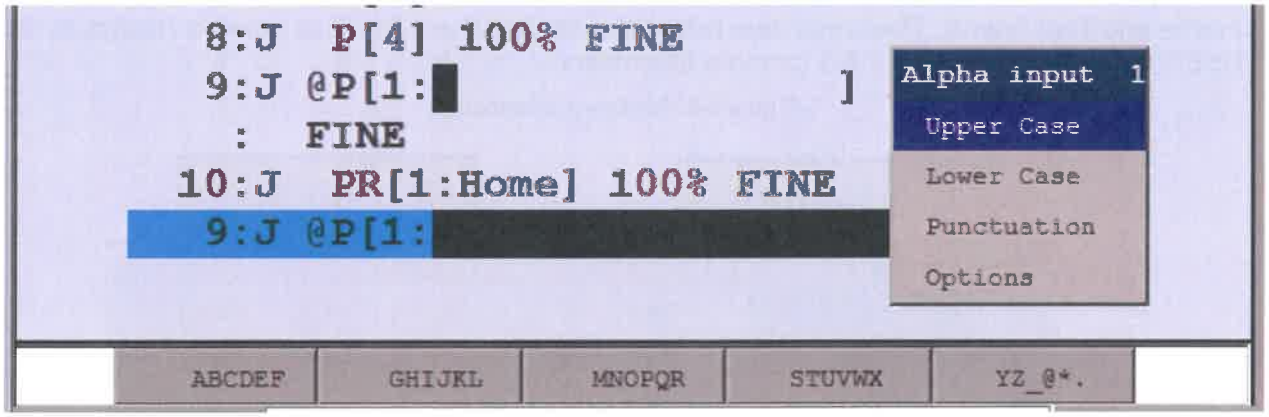
To name a Position:

- Highlight the Position ID Number
- Press Enter
- Use the Function Keys to name the positon
- Press Enter When Done

OR

- Cursor down to Options
- Press F[5] Keyboard
- Enter the name
- Press F[5] Exit

Figure 9-6 Naming a Position



9.6 Position Types

There are two types of positions that store the position information.

- Position: Local
- Position Register: Globally Accessible

9.6.1 *Position*

When a program point is recorded, by default, it is recorded as a position and identified with a "P" and an associated ID Number, it will show in the program as P[1] for example. A position is referred to as Local, meaning it is defined locally within the current program.

It is possible to have multiple positions identified within the same program by the same ID number. In this case all positions ***within*** the same program contain the ***exact same*** positional data.

It is also possible to have the same position ID across multiple programs. In this case the positional data will be different. This is because a position only exists within the program that it is recorded in (Local). There is no direct correlation between P [1] in one program and P [1] in a different program.

9.6.2 *Position Registers*

Position Registers can be used to store ***globally accessible*** positions. These positions are predefined on the Position Register Data Screen and can be shared for use in many programs. Generally a Positon Register is used for positions that will be used multiple times within a routine such as Home, Pick Positons, Drop positions, etc.

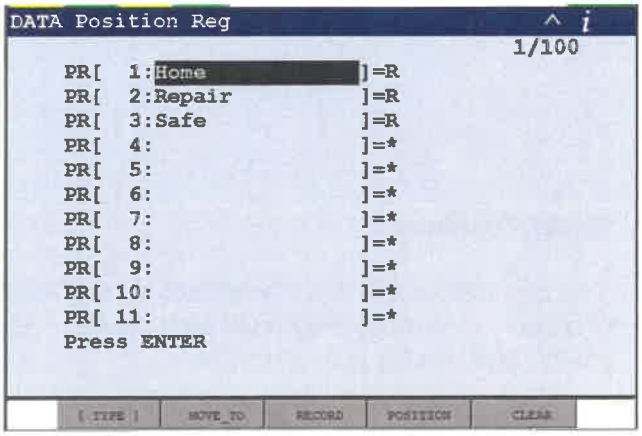
A Positon Register is identified within the program with a "PR" designation and an ID Number, it will appear as PR [1] for example. Position Register Data is globally accessible, this means that the positional information will be same anywhere that the same Position Register ID Number is seen within any program.

> **⚠ CAUTION**
> **Position registers are used in programs. Do not modify position register values unless you are sure how the position register is used in the system; otherwise, you could affect how programs are executed.**

To access Positon Register Data:

- Press Data
- F[1] TYPE
- Choose Position Register

Figure 9-7 Position Register Data

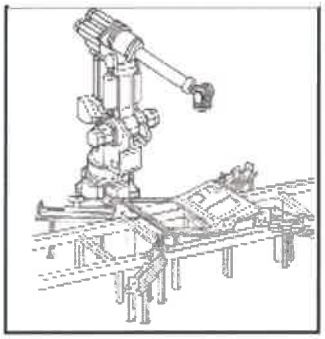


9.6.3 *Example of Position Registers*

HOME Position

The home position is a position away from the workpiece transfer area. Program the robot to move to home before the first position, between cycles, and any time the robot must be away from workcell activity.

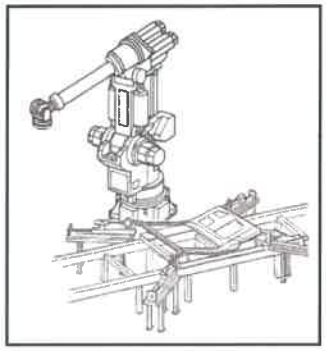
Figure 9-8 Home Position



Repair Position

The repair position is a position where robot repair operations are performed. Program the robot to move to the repair position any time repair operations must be performed. Record the repair position away from other equipment and the transfer area.

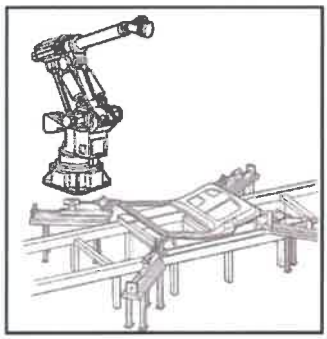
Figure 9-9 Repair Position



Safe Position

The safe position is away from fixtures and the workpiece transfer area. Program the robot to move to the safe position any time it is necessary to move the robot away from other workcell activities.

Figure 9-10 Safe Position



Other Positions

You can define any other positions to be predefined positions. Define any position that the program uses more than once as a predefined position. This minimizes the time it takes to create and modify your program.

9.6.4 *Creating Position Registers*

Position Registers are stored and recorded form the Position Register Data Screen. From this screen you can view existing Position Register data as well as create new Position Registers or Move To and existing Position Register.

To Create, View, or Move To Positon Register Data:

Create

- Move the Robot to the positon to record
- Highlight the PR to record
- Name the Position Register
- Press Shift and F[3] RECORD
- You will see an "R" on the PR line

NOTE: Ensure the correct frames are set prior to recording Position Registers.

Figure 9-11Creating a Position Register

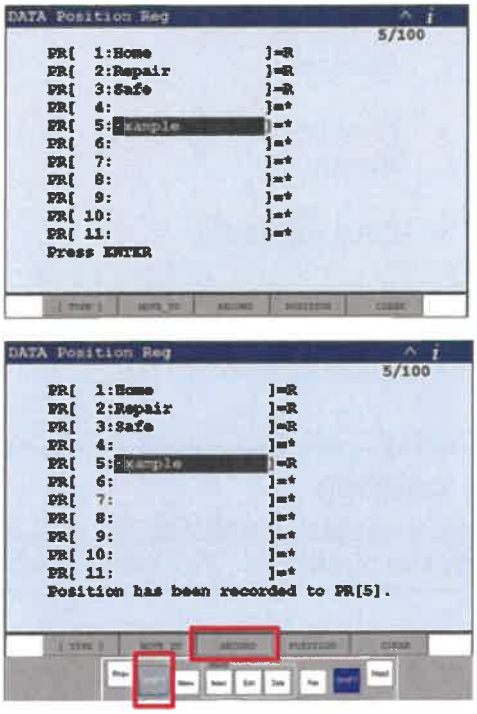
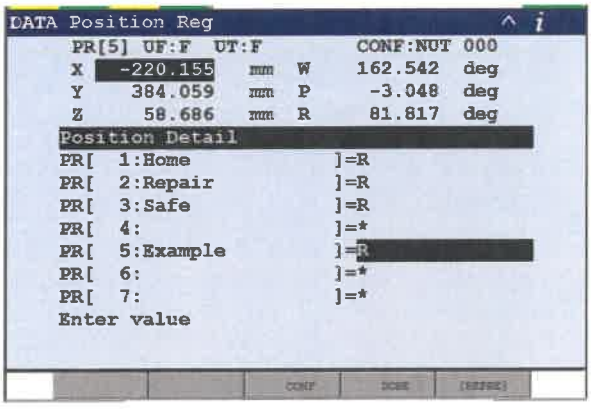


Figure 9-12 PR Positional Data



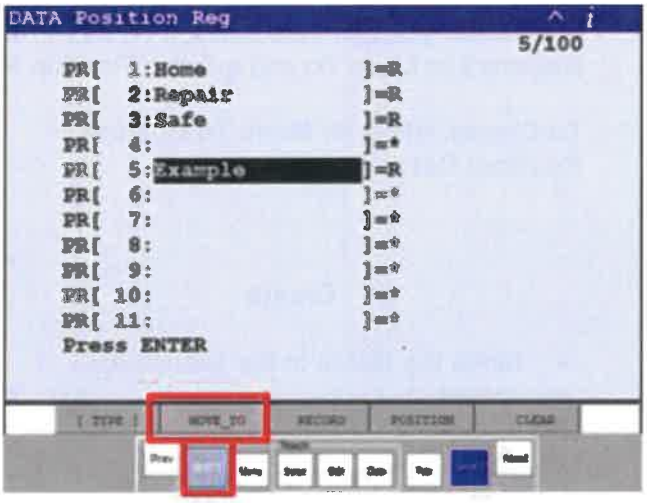
View

- Highlight the PR to be viewed
- Press F[4] POSITION

Move To

- Highlight the PR to move to.
- Set the Mode to T1
- Enable the Teach Pendant
- Center the DEADMAN Switch
- Clear any faults
- Press and Hold Shift
- Press F[2] MOVE TO

Figure 9-13 MOVE TO



CAUTION

Before executing a MOVE TO, and during the move, ensure the robot does not collide with any obstacles. The robot WILL take the most direct path to the recorded position.

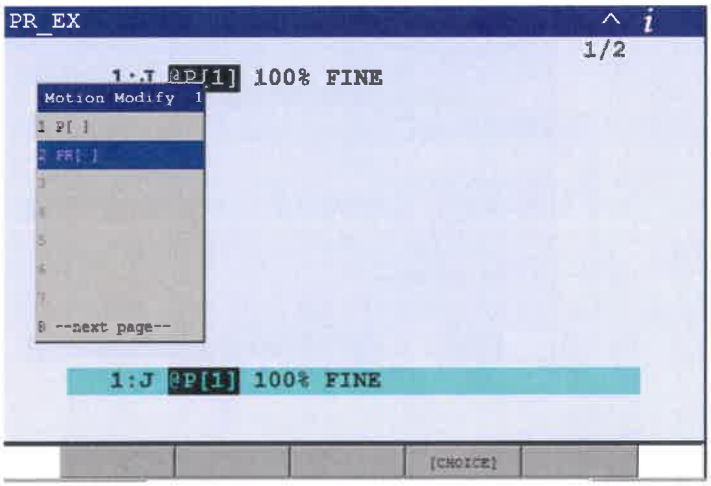
Adding a Position Register to a Program

When recording program points, the default recording is a position. If you want to add Position Registers to an existing program or a new program they must be manually added by altering the existing motion statement.

To add a Position Register to a Program:

- Record a bogus motion statement.
- Highlight the position field.
- Press F[4] CHOICE.
- Choose PR[ ] from the list.
- Manually enter the ID of the PR.

Figure 9-14 Adding a PR



9.6.5 *Positional Register Representation*

As previously discussed a Position Register is a globally accessible position. It is important to note the verbiage used to describe a position register, again globally accessible. This ***does not*** mean that the physical location of the Position Register for any given ID will always be in the same spot.

Figure 9-15 Position Register Frame Data

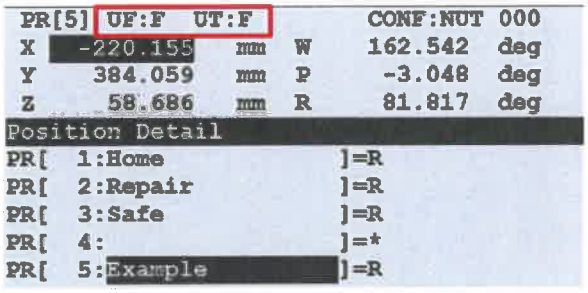
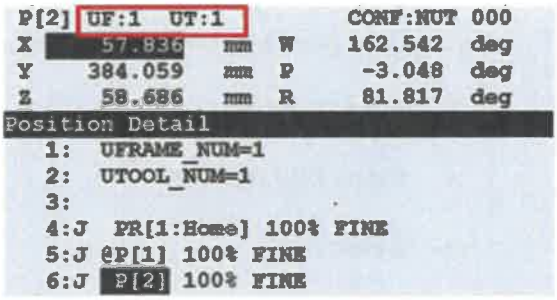


Figure 9-16 Position Frame Data

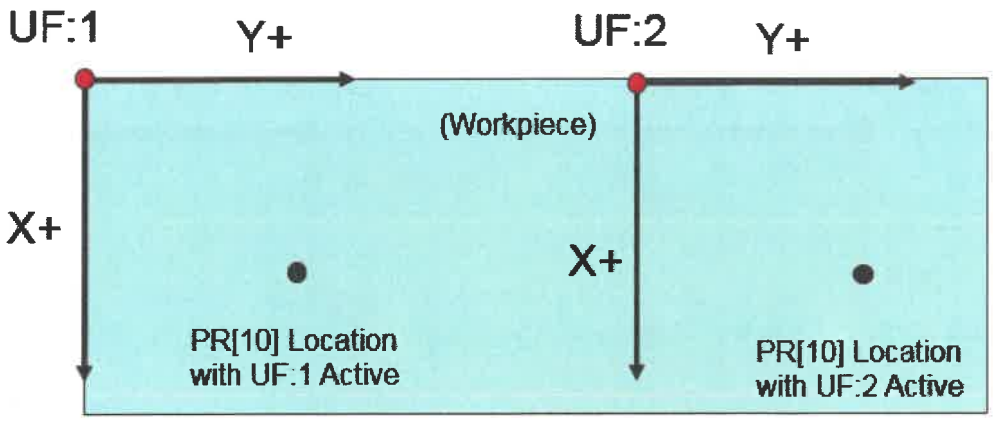


Notice above in, **Figure 9-15** the frames associated with PR [5] are UF: F and UT: F. However in **Figure 9-16,** the frames associated with P [2] are listed as UF: 1 and UT: 1. How frames are used with Position Registers allow them to become more versatile and globally accessible. It also explains why a Position Register may not always be in the same physical location all the time.

The USER frame, UF:F, and the TOOL frame, UT:F, will be set to 15 (FHex), which indicates that the currently active USER frame and TOOL frame will be used. What this means is that the controller will apply the position data of the Position Register to whatever frames are currently active and move to the stored position.

In essence Position Registers are not restricted by setting a specific frame in order to utilize them. This also means that if the incorrect frames are active utilizing a position register may result in a crash or undesirable outcomes.

Figure 9-17 UF: F / UT: F (Cartesian)



PR[10]	UF:F	UT:F		CONF:NUT	000
X	50.000	mm	W	162.542	deg
Y	50.000	mm	P	-3.048	deg
Z	0.000	mm	R	81.817	deg

Creating a Truly Global Position Register

If there is a requirement for a Posiiton Register to be in the same physical location all the time, regardles of active USER and/or TOOL Frame, this can be accomplished by changing the positonal representation. If the positonal data is represented in degrees this makes the position an absolute position. With this representation, regardless of the set USER and TOOL Frames the controller will send the Robot to the same location every time because the position is based on degrees at each joint.

To change positional representaiton:

- Access the Position Register positonal data
- Press F[5] REPRE
- Select Joint
- Select Continue from the prompt box

Figure 9-18 Joint Representation

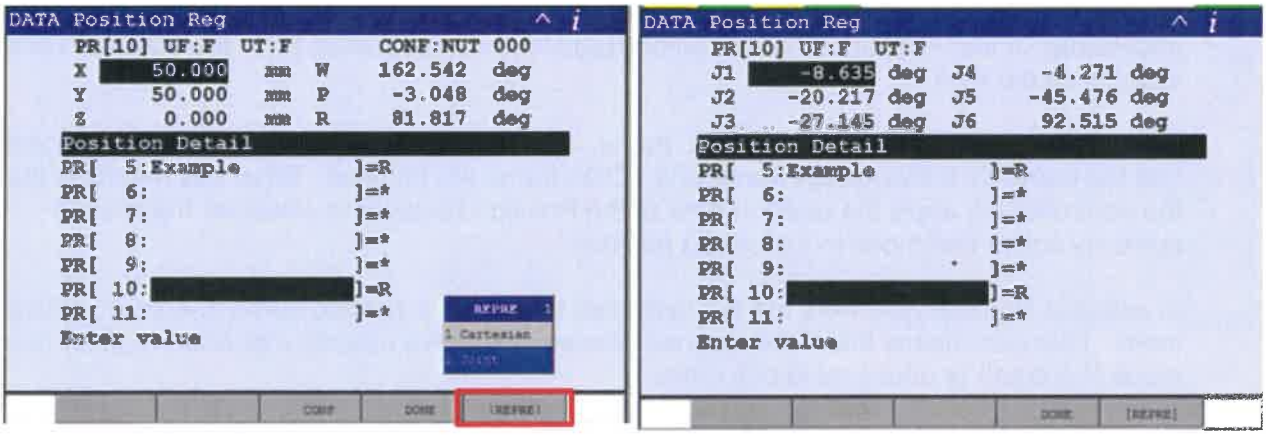
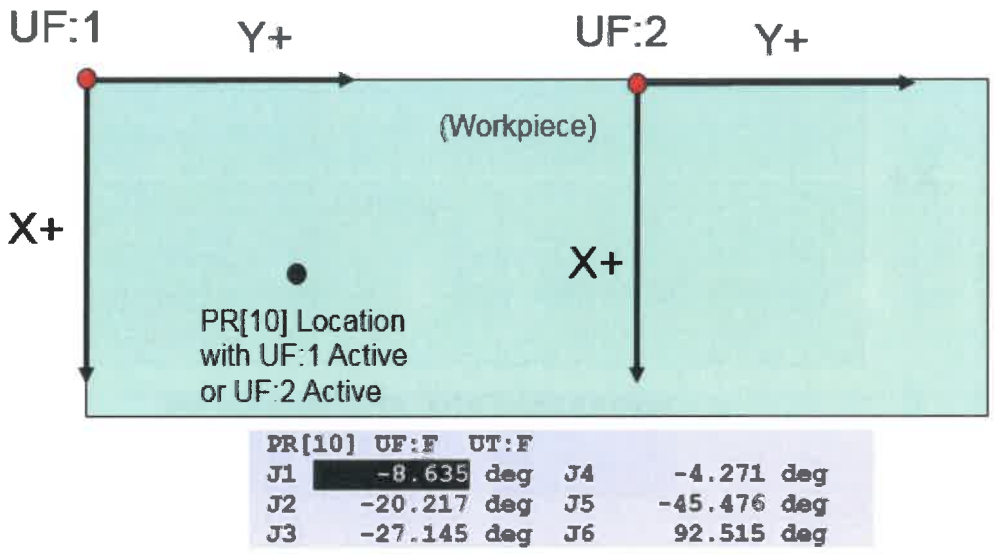


Figure 9-19 UF:F / UT:F (Joint)



9.7 Speed

Speed dictates how fast the robot will move while executing motion. Speed can be manipulated in two ways; as part of the motion statement or from the general override.

9.7.1 *Motion Statement Speed Values*

Speed must be specified as part of the motion statement. When assigning speed in the motion statement the available units are reflective of the motion type selected. **Figure 9-20** and **Figure 9-21**, show available speeds based on motion type.

Figure 9-20 Joint Motion

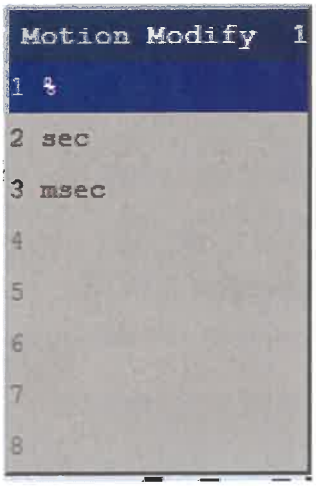
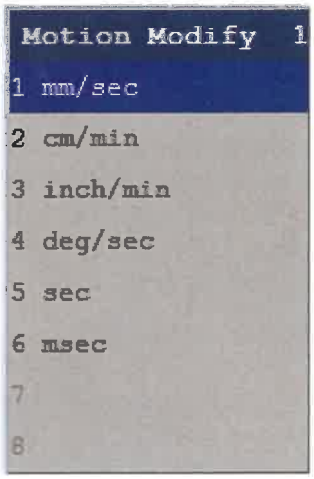


Figure 9-21 Linear Motion



To change speed values:

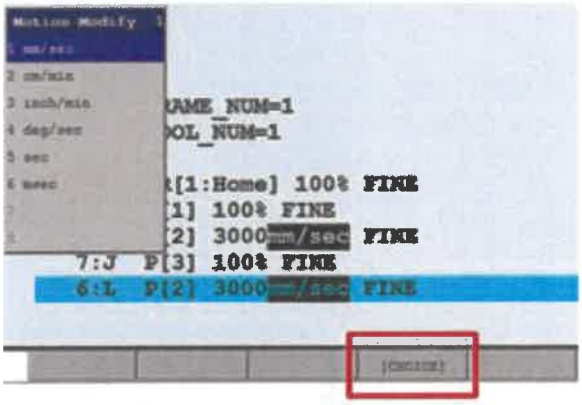
- Highlight the speed
- Type in the new value
- Press Enter

Figure 9-22 Changing Speed Value

To Change speed units:

- Highlight the speed
- Press F[4] CHOICE
- Choose the new unit from the list

Figure 9-23 Changing Speed Units



9.7.2 *General Override*

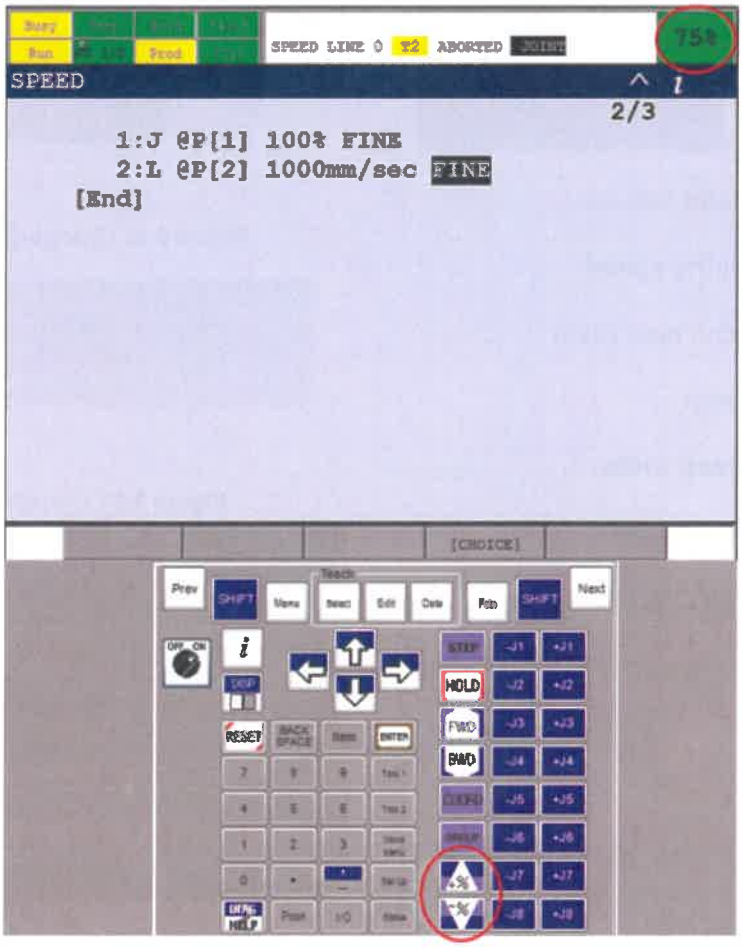
The general override is located at the top right corner of the teach pendant in the green box. The general override identifies the percentage of speed available for motion. To manipulate the general override utilize the "+%" and "-%" keys located on the bottom of the teach pendant.

The General Override:

- Can change speeds while running with the "+%" and "-%" keys, changes are 5% increments by default.
- Speeds range from .01% (VFine: Incremental) to 100%.
- Is a percentage of speed allowed.

An example of how the General Override impacts speeds is if the motion statement is programed to run at 100% and the general override is set to 75%, the robot will operate at 75% of the programmed 100%. For linear speeds, if the motion statement is programmed to execute at 1000 mm/sec and the override is set to 75%, the robot will operate a 750 mm/sec.

Figure 9-24 General Override

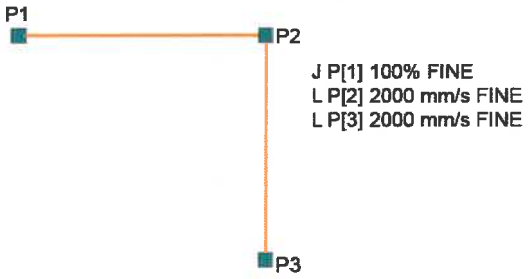


9.8 Termination Type

Termination type specifies the robots action as it approaches the end of the motion and is programmed at the destination. Termination type can be specified as Fine and Continuous.

9.8.1 *Fine Termination*

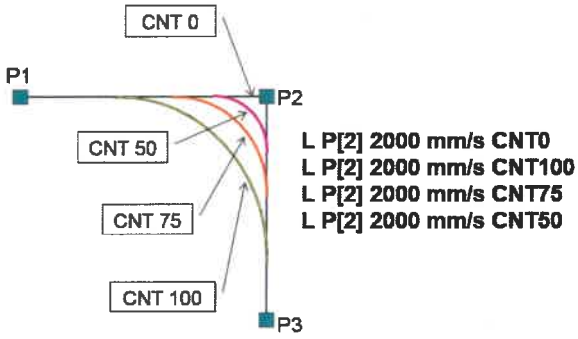
Figure 9-25



Fine termination type causes the robot to stop at the destination position before moving to the next position. The robot's tool tip accelerates to the defined speed, and then decelerates as it approaches the recorded position and comes to a complete stop, before continuing to the next recorded position.

9.8.2 *Continuous Termination*

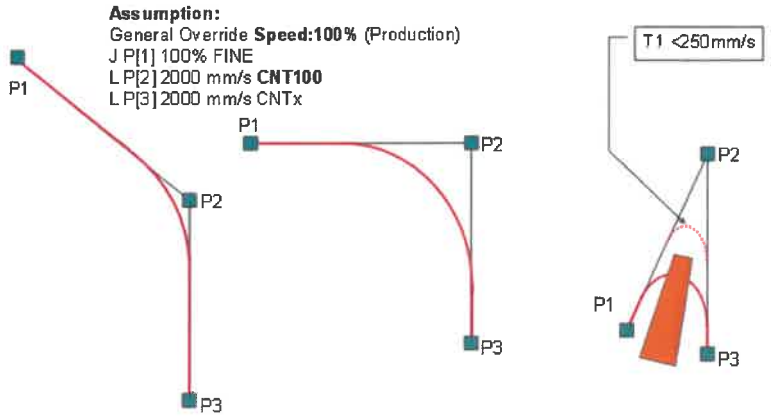
Figure 9-26



Continuous (CNT) termination type allows the robot to decelerate as it approaches the destination position but does not stop at the recorded position before it accelerates toward the next position. In the examples shown below, a value from 0 to 100 defines how close the robot comes to the destination position. At CNT0 the robot is closest, with maximum deceleration while at CNT100 the robot is farthest, with minimum deceleration.

The severity of the directional change at each taught position and the speed of the program determine how the Continuous rate will affect the path. As the angle increases the distance from the taught increases as well.

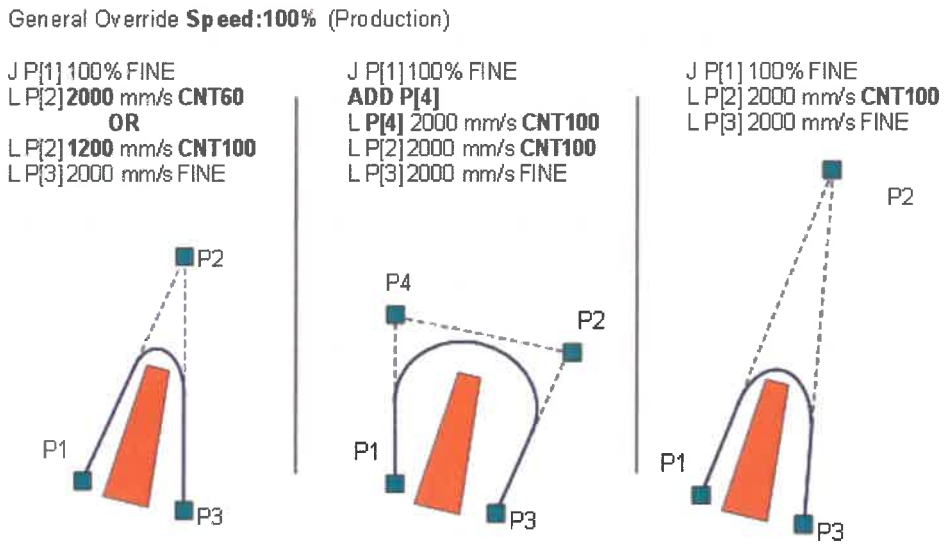
Figure 9-27 Directional Changes and CNT



NOTE: There may be inconsistencies between the T1 test and running in Auto. Run the programs in Auto at slow speeds at first to verify the path.

Refer to **Figure 9-28** for a guide to correct the path. If corrections are required for the path there are three main approaches for correction; lower the termination rate or the speed on the position (left), add a positon and touchup the old position (middle), or touchup the affected positon farther away from the current point (right).

Figure 9-28 CNT Path Corrections

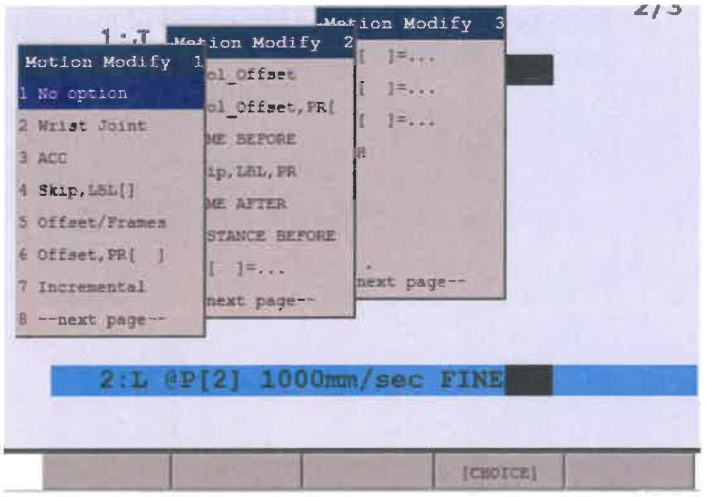


9.9 Motion Options

Motion option refers to additional instructions given to the robot to determine what the robot will do when it reaches its destination. These options are used to provide information to perform specific tasks during robot motion.

Figure 9-30 Motion Option

Figure 9-29 Adding Motion Options



To Add a Motion Option:

- Highlight the end of the motion statement.
- Press F[4] CHOICE.
- Choose option from the list.
- Selecting NO OPTION will remove an existing option from the statement or not add another motion option.

9.10 Touching Up a Point

While testing programs or running production it may be necessary to change positional data. This is referred to as touching up a point. When you touch up a point only the positional data is changed; the motion type, speed, and termination remains unchanged.

By changing only the positional data the path should remain largely unchanged. However, this does not preclude you from testing the change to ensure accuracy. Failure to properly test the change in the program may result in a crash or other undesirable outcomes.

In order to touch up a point:

- Select the program that requires the edit
- Place the cursor on the line that needs to be touched up
- Manually jog the robot to the new position
- Press and hold Shift and press F[5] TOUCH UP
- A successful touch up will display the @ symbol next to the position

Figure 9-31 Before Touch Up

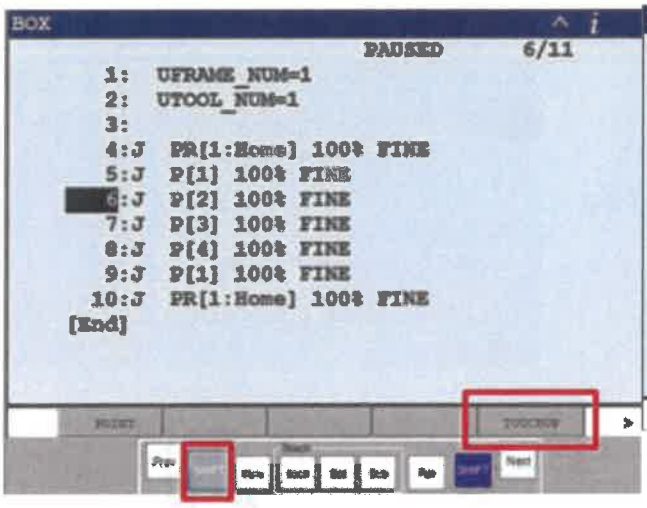
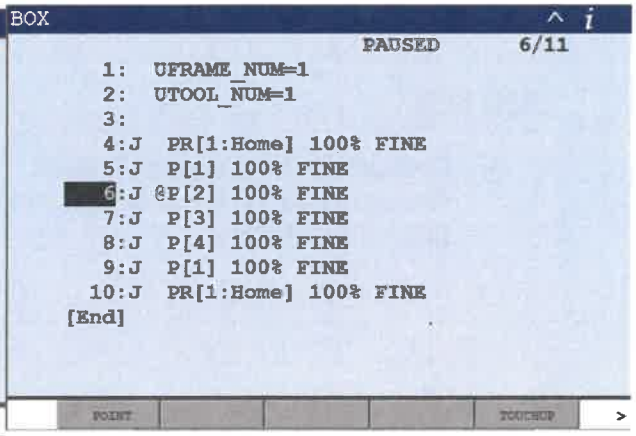


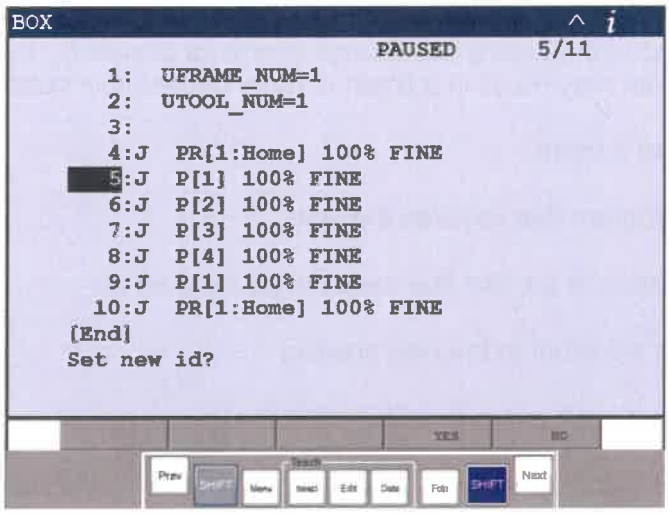
Figure 9-32 After Touch Up



9.10.1 *Set New ID*

If you see the message Set new ID along the bottom of the teach pendant when touching up a point this is the software alerting you that multiple instances of this position ID exist.

Figure 9-33 Set New ID

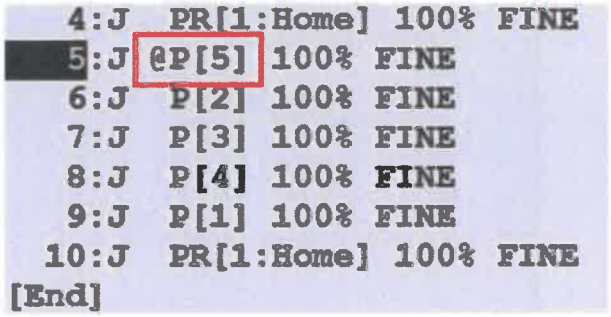


The options are:

F[4] YES:

- Positon ID of the current line will change to the next available ID and the point is touched up.

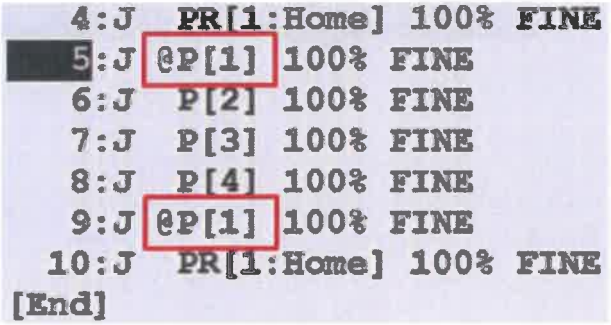
Figure 9-34 Set New ID? Yes



F[5] NO:

- Position ID of the current line will not change, all positon data with the same ID within the program will be touched up.

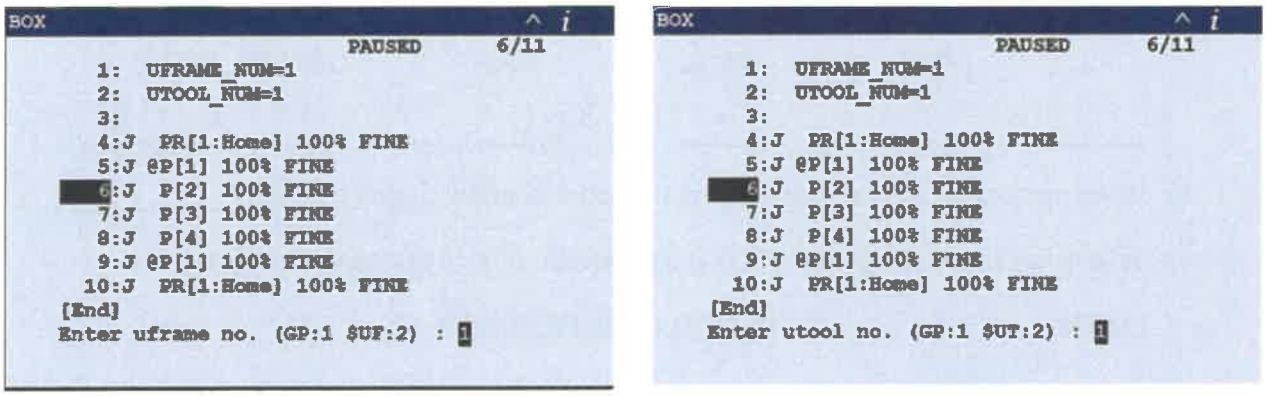
Figure 9-35 Set New ID? No



9.10.2 *Enter UTool / UFrame*

If the message "Enter UTool or Enter UFrame" appears along the bottom of the teach pendant when touching up a point, this is the software alerting you of a frame inconsistency. When touching up a point, the USER Frame and TOOL Frame numbers in the Jog Menu must match the frames numbers used inside the program (see step 1 and 2 on Fig. 8-36).

Figure 9-36 UTool / UFrame Inconsistency



To execute the touch up with a different frame:

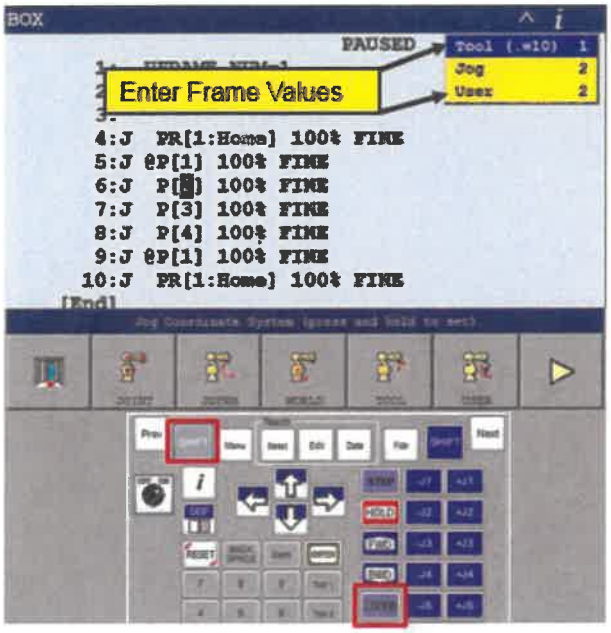
- Type the frame number (the one used in the program).
- Press Enter

Figure 9-37 Frame Change

To execute the touch up with the same frame:

- Press Previous
- Verify the correct frame that the position was recorded with
  - Highlight position ID
  - Press F[5] POSITION
- Set the frames active in the jog menu
  - Press Shift and COORD
  - Enter the frame number for either User or Tool
  - Repeat for other Frame if necessary
- Execute touch up again

Figure 9-38 Setting Frames



9.11 Chapter Review

1) What combination of keys are used to touch up a position?_____ _____

2) Fine termination type causes the robot to _____ at the destination position before moving to the next position.

3) Identify the motion instruction elements:

J	P[1]	100%	FINE	OFFSET, PR [2]
_____	_____	_____	_____	_____

4) What symbol is used to indicate that the robot is at the taught position? _____

5) Where is Position Register (PR [X]) data valid? (Circle the correct answer).

LOCAL or GLOBALLY ACCESSIBLE

MATGGROOP1114CE REV B

Lab 8

Name of Lab

Student Name: _____

Assignment: The student will:

- MOVE TO Three Position Registers
- Display Position Register Data

Condition: A FANUC robot and controller.

Step: **1** Display the Position Register Screen

2 Change the name of PR [1:Home] to PR [1: MY HOME]

3 Display the data for PR[1] and record it in the space below

J1:_____ J4:_____

J2:_____ J5:_____

J3:_____ J6:_____

Why is this Positon Register represented in Degrees instead of Cartesian?

_____

_____

_____

4 MOVE TO PR [1]

5 MOVE TO PR [2]

6 MOVE TO PR [3]

Completed: ☐

Instructor: _____

Lab 9

Motion Instructions

Student Name: _____

Assignment: The student will:

- Modify motion instruction components
- Observe affect that changes on motion instruction have on program
- Execute a program from the Standard Operators Panel

Condition: A FANUC robot and controller.

Step:

1 Modify the BOX program.

2 Change motion types, speed values, and termination type on some of the points and observe changes to the robot's path.

BOX:
1: UFrame_Num=1
2: UTool_Num=1
3:
4: J PR [1:Home] 100% FINE
5: J P[1] 100% CNT50
6: L P[2] 1200mm/sec CNT88
7: L P[3] 850mm/sec FINE
8: J P[4] 100% CNT5
9: L P[5] 1985mm/sec FINE
10: L P[2] 500 mm/sec CNT100
11: J P[1] 100% CNT90
12: J PR [1:Home] 100% FINE
[END]

8 Step Test the BOX Program

9 Continuous Test the BOX Program

10 Execute the BOX Program in Automatic Mode

Completed: ☐

Instructor: _____

MATGGROOP1114CE REV B

Lab 10
Touch Up Positions

Student Name: _____

Assignment: The student will:

- Modify Positional Data
- Observe affect that changes on Positional Data has on program
- Execute a program from the Standard Operators Panel

Condition: A FANUC robot and controller.

Step:

1. Power up the controller
2. Modify the BOX program
3. Touch up the positions of this program to make the box either larger or smaller
4. Step Test the BOX Program
5. Continuous Test the BOX Program
6. Execute the BOX Program in Automatic Mode

Completed: ☐

Instructor: _____

10 FAULT DIAGNOSIS AND RECOVERY

10.1 Chapter Objectives

- Diagnose Faults and Messages
- Recover from a Crash

10.2 Fault and Message Diagnosis

Errors occur because of:

- Hardware problems - a broken cable or tooling
- Software problems - incorrect program or data
- External problems - an open safety door or an over travel has occurred.

Most errors can be cleared by correcting the problem and pressing the Reset Key on the teach pendant or SOP. However, blindly pressing reset to clear an alarm may not actually solve the issue. It is best to gather an understanding of what the alarm means and recommended steps to correct the issue.

If troubleshooting it is usually best to view the Active alarms in the alarm log or history. This can aid in determining if there are any other active alarms as well and can aid in sorting out what is the actual problem.

Another useful tool to determine the cause and remedies of alarms is the diagnose tool. Diagnosing an alarm of message gives the user the possible cause and possible remedies to fix the issue. This can be useful for an operator to determine if they need to notify maintenance to correct the issue.

10.2.1 *Displaying the Alarm Log*

The alarm log is an invaluable tool for use in understanding active alarms. The teach pendant only displays the most recent alarm along the title bar of the pendant, if there are multiple alarms though they will not be displayed.

The alarm screen can be forced to display all of the active alarms whenever an alarm is triggered, however for troubleshooting purposes this may not be desirable.

A better alternative is to manually display the Alarm screen as needed.

Figure 10-1 Teach Pendant Recent Alarm

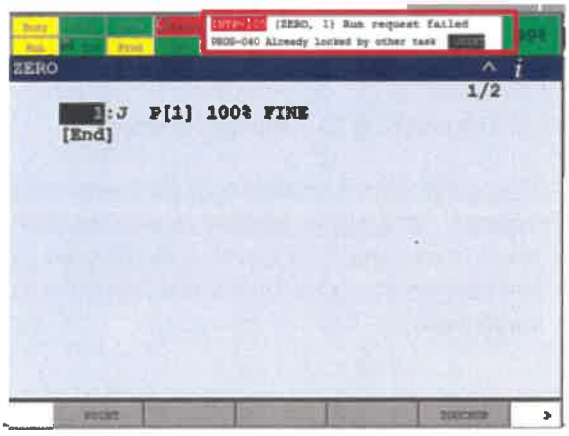
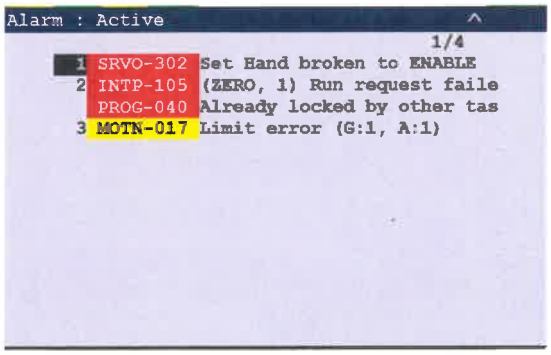


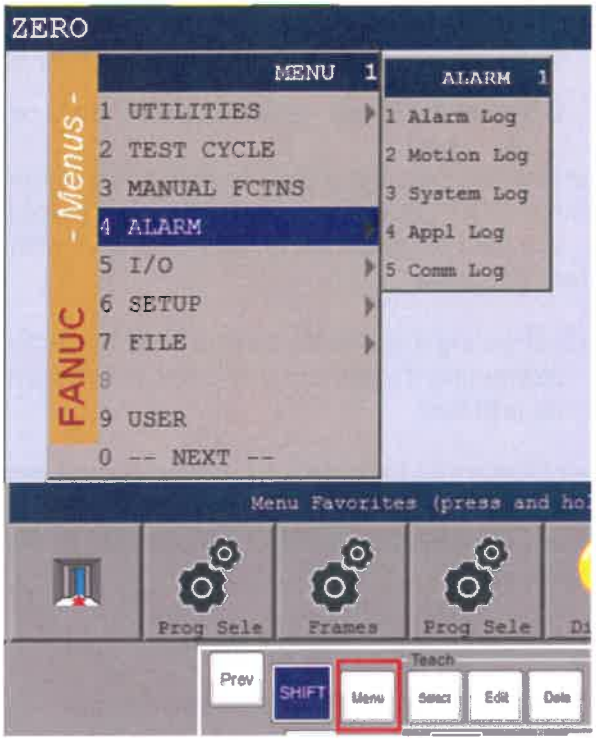
Figure 10-2 Alarm Screen



A benefit of displaying the Alarm screen is shown in **Figure 10-1** and **Figure 10-2**. In **Figure 10-1** (previous page), one alarm is shown along the top of the teach pendant, however **Figure 10-2** shows all of the alarms that are currently active.

By determining if there are any other alarms can aid in deciding which alarms needs to be corrected first. To identify how to fix the issues these alarms can be easily diagnosed.

Figure 10-3 Display the Alarm Screen



To display the Alarm Screen:

- Press Menu.
- Cursor down to -4- Alarms and press enter.

Or

- Press the number 4.

10.2.2 *Displaying the Alarm History*

From the Alarm screen you can view current alarms and also gain access to the alarm history. The alarm history stores the 100 most recent alarms. These can be used to determine what has been occurring on the robot system. The history of errors and messages can also be sorted based on alarm type and show the most recent 50 alarms of each type.

To Access Alarm History:

- Navigate to the Alarm Screen.
- Press F[3] HISTORY.

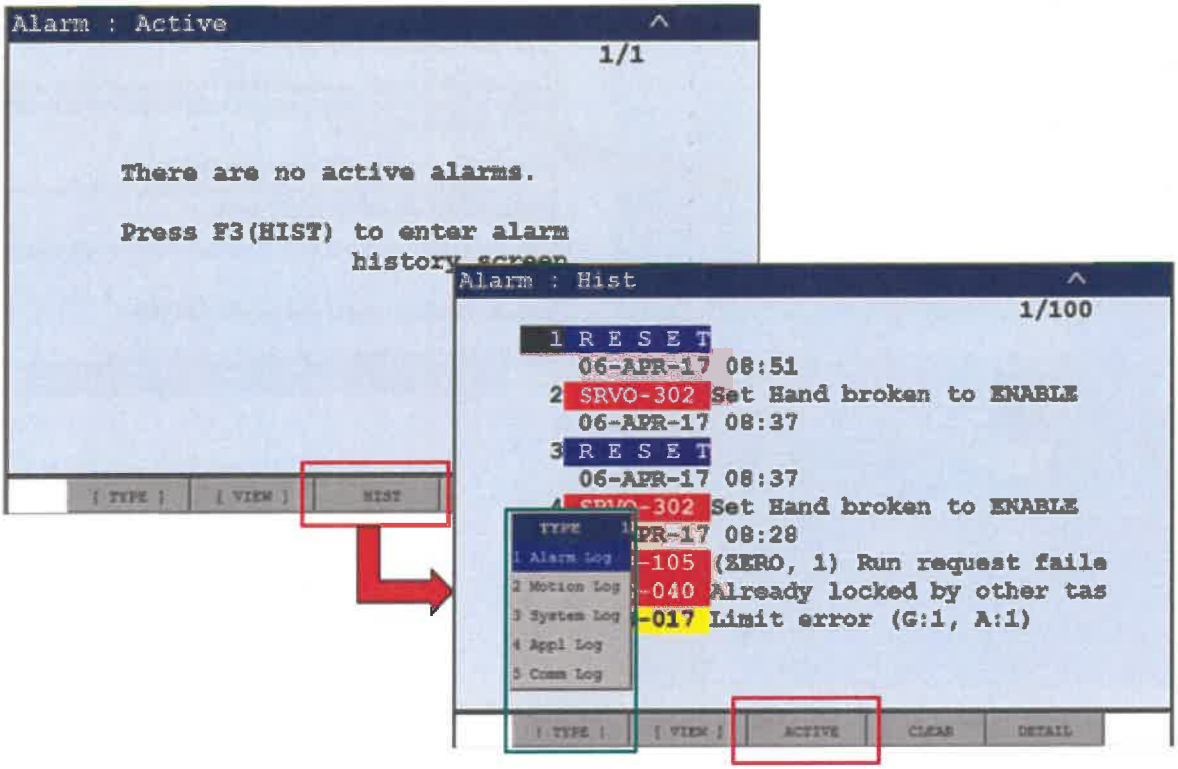
To Sort by Alarm Type:

- Navigate to the Alarm Screen.
- Press F[1] TYPE.
- Choose type from the list.

Return to Active Alarms:

- From a History Screen.
- Press F[3] ACTIVE.

Figure 10-4 Alarm History



10.2.3 *Diagnosing a Fault*

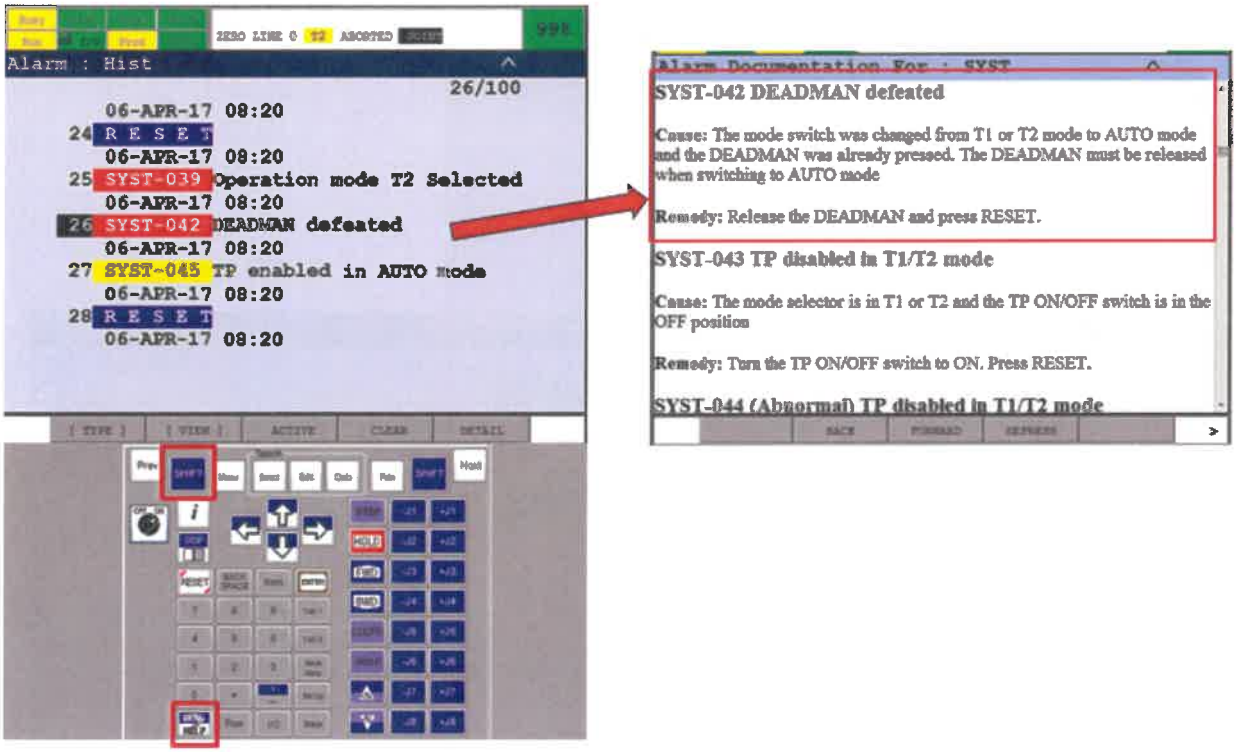
A fault can be diagnosed from multiple locations. If there is only one fault any time you press Shift and Diagnose it will diagnose the current fault. A better approach is to navigate to the Alarm and view the faults there. This will allow the operator to ensure they are aware of all faults and have the ability to diagnose a specific fault.

From the alarm screen a fault or message can be diagnosed from the active screen as well as any history screens.

To diagnose a fault or message:

- Navigate to the appropriate screen.
- Place the cursor next to the target fault or message.
- Press Shift and DIAG.
- To leave the diagnosis screen press PREV.

Figure 10-5 Diagnosing a Fault



10.3 Recovery

While executing production, or manually moving the robot via the teach pendant, the possibility of a crash will always be present. There are a number of reasons that could lead the robot to crashing. An operator should be able to identify why the robot crashed, and be able to recover the robot without causing any possible further damage.

Most programmers will identify possible areas where the robot may experience a collision and can account for this in the program. This can be done utilizing Skip Conditions and Automatic Recovery operations. Also, if initial setup is done properly Damage to the robot can be limited based on software sensitivity settings. The exact process for how to recover the robot from a crash will vary from plant to plant. However the methods to recover the robot are relatively common.

10.3.1 *Recovery methods*

Some of the common methods to recover the robot from a crash include:

- Manually Jogging the Robot from the crash.
- Executing a Recovery Macro program from a pushbutton on the HMI.
- Manually executing a Recovery program from the teach pendant.
- Executing Automatic Recovery (Software Option)

NOTE: Automatic Recovery requires no intervention from the operator

> **CAUTION**
> **If your recovery operation involves utilizing a Position Register and the MOVE TO feature the robot will take the most direct route to the recorded position. This may lead to a more catastrophic Collison and further damage to the robot.**

10.4 Common Errors

Common errors can be cleared by correcting the problem and using the RESET key

NOTE: If using the iPendant, press "SHIFT" and "DIAG" for diagnostic support. This provides fault code cause and remedy assistance.

SRVO – 001 SVAL 1 Operator's Panel E-Stop

Cause: Operator Panel Emergency Stop has been pressed

Remedy: Release the emergency stop button pressed on the operator's panel/operation box and press RESET

SRVO – 002 SVAL 1 Teach Pendant E – Stop

Cause: Teach Pendant Emergency Stop has been pressed

Remedy: Release the emergency stop button pressed on the Teach Pendant and press RESET

MOTN-017 Limit error (G:%d^2, A:%x^3 Hex)

Cause: One or more axis are in violation of the motion software limits. Refer to alarm text for specific group and axis.

Remedy: Move or re-teach the taught position. If this error occurred in auto mode, this robot may not be able to resume.

MOTN-018 Position not reachable

Cause: Position not reachable Or near by singularity

Remedy: Reteach the position that is not reachable. If this error occurred in auto mode, this robot may not be able to resume.

MOTN-019 In singularity

Cause: Position nearby singularity

Remedy: Reteach the position that is near a singularity point.

MOTN-310 Pos. Cfg. change 2 (G:%d^2)

Cause: Configuration mismatch Recovery

Remedy: Re-teach the destination position so that its configuration string matches the start position's configuration string.

PNT1-103 Configuration mismatch

Cause: This is a pause condition. The configuration (Flip/No-Flip) cannot change during a Cartesian (linear or circular) motion.

Remedy: Either reteach the motions using the same configuration (Flip or No-Flip), or use a joint motion to change configurations before proceeding with Cartesian motion.

SRVO-050 Collision Detection (Group: i Axis: j)

The disturbance torque estimated by the servomotor software is abnormally high.

Probable Causes:

1. Collision (Tip stick) / External force to the robot
2. Overload / Heavy acceleration
3. Increasing of the friction by low temperature
4. Insufficient torque by low voltage of power supply
5. Brake failure (includes mis-setting of brake number for auxiliary axis)
6. Aux. brake unit failure for aux. axis
7. Amplifier failure
8. Emergency stop unit failure
9. Motor failure
10. Motor power cable or brake cable failure
11. Reducer failure

Remedy:

1. Check whether the robot has collided with an object. To release this alarm, press and hold the SHIFT and RESET keys. Release only RESET key. Still pressing the SHIFT key, and press any jog key to the axis away from the collision.

2. Check whether the payload (mass, center of gravity, and inertia) are set correctly.

3. Check whether the applied load exceed the rating. If so, reduce the applied load. If you use the ACC override more than 100, please reduce the value of ACC override. Allowable disturbance threshold level can be changed from STATUS/Axis/Disturb screen.

4. If this alarm occurs when the robot is used after long time interval or when the temperature is very low, run the robot with low speed for a while before running with normal speed.

5. Check whether the motor power cable/connector and brake cable/connector are connected correctly. Especially, check whether the power cable/connector are not connected to other motors.

6. Measure the supplied voltage. Then, check whether the voltage is matched to the controller specification.

7. Check whether the motor brake is released properly when RESET is pressed or the robot moves. First of all, check whether the setting of brake number is correct when this alarm occurs on auxiliary axis.

8. When this alarm occurs on the auxiliary axis which brake is controlled by the aux. brake unit, check the fuse on the aux. brake unit.

9. There might be a failure with the following parts. Replace it or contact your FANUC technical Representative: Aux. brake unit (if it is used.), Servo amplifier, Servo Motor, Robot Connection Cables (power/brake line), Cable in mechanical unit (power/brake line), Reducer (Gearbox)

10.5 Chapter Review

1) Is it possible to have more than one Fault at a time?
   TRUE FALSE

2) What two Keys must be pressed to diagnose a FAULT?

   _____ _____

3) If you use the MOVE TO feature to send the robot home after a crash the robot will take the most _____ route to the recorded position.

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Lab 11
Diagnosing a Fault

Student Name: _____

Assignment: The student will:

- Navigate to the Alarm Screen
- Diagnose a Fault

Condition: A FANUC robot and controller.

Step: **1** Navigate to the Alarm Screen

2 Display the alarm history

3 Diagnose any fault listed on the Alarm Screen

a In the space provided write down the cause and remedy of this alarm

Cause:

_____

_____

_____

Remedy:

_____

_____

_____

Completed: ☐

Instructor: _____

Lab 12
Recovery

Student Name: _____

Assignment: The student will:

- Recover the Robot

Condition: A FANUC robot and controller.

Step: **1** The instructor has prepared a simulated crash

2 Utilizing manual intervention recover the robot to the home position without crashing.

Completed: ☐

Instructor: _____

11 OTHER FUNCTIONS

11.1 Chapter Objectives

- Edit Command Overview
  - Inserting blank lines into a Program
  - Deleting lines from a Program
- I/O Overview
  - Manipulate Robot Outputs
- Macro Overview
  - Execute a Manual Function MACRO

11.2 Edit Command Overview

The F[5] EDCMD soft key, within the programming menu, allows you make modifications to a program. Refer to **Table 11-1** for details of each item.

Table 11-1 Edit Command Items

Item	Description
Insert	Adds blank lines to the program. Must be used when adding positions or instructions to a program. Otherwise you will overwrite.
Delete	Removes line(s) from a program
Copy/Cut	Can copy a range of lines and paste them In the same or another program
Find	Allows searching for an instance of an instruction
Replace	Allows search and replace of instructions or variable items
Renumber	Renumbers positions (not PR's) sequentially from start to finish in a program
Comment	Hides or displays comments from other tables on the EDIT Screen
Undo	Allows an undo of the latest edit only
Remark	Masks out in instructions in a program
Color	Highlights remarks with a yellow background and I/O Status with Red (OFF) or Green (ON).
I/O Status	Displays or masks current status of I/O utilized in a program

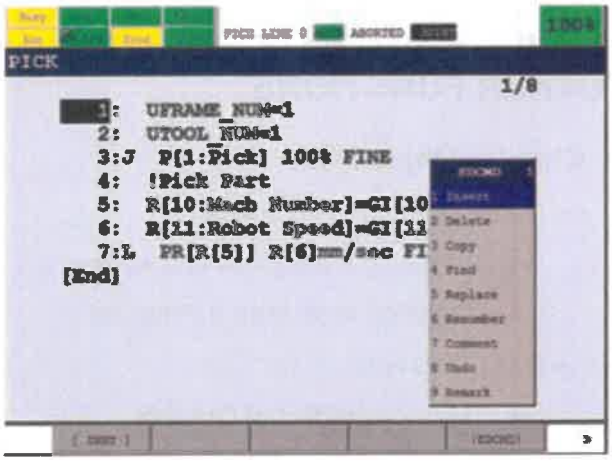
11.2.1 *Insert a Blank Line*

Adding blanks line to the program allows for the additional instructions to be added to the program. If blank lines are not added prior to adding instructions or additional motion statements whatever was on the line prior with be overwritten. Blank lines are also helpful for adding white space to the program. White space is no executed lines in a program that help break up the program code to offer eye relief to users.

To add blank lines:

- Place the cursor on the line below the spot to add the blank lines
- Press F[5] EDCMD
- Press Enter on line 1- Insert
- Enter the number of lines to insert
- Press enter

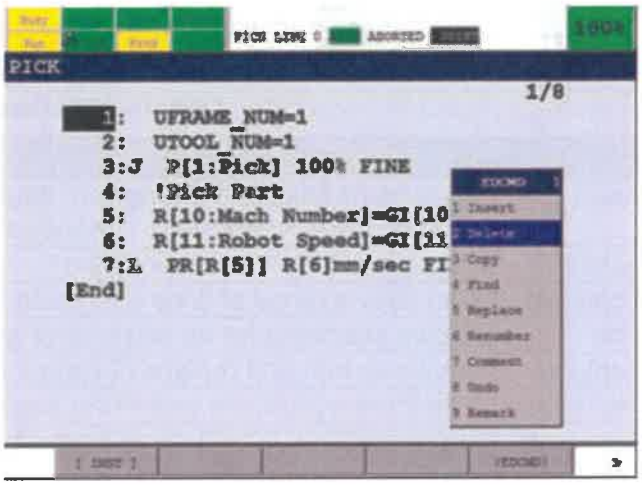
Figure 11-3 Insert



To delete lines:

- Place the cursor on the line, or the first line you want to delete.
- Press F[5] EDCMD
- Press Enter on line 2- Delete
- IF you only want to delete one line press F[4] YES
- If you want to delete more than one line, cursor up/down to select the range of lines desired, then press F[4] YES.

Figure 11-2 Delete



11.3 Inputs and Outputs Overview

Inputs and Outputs (I/O) are electrical signals that enable the controller to communicate with; Robot, EOAT, Sensors, Actuators, and Other pieces of Equipment. I/O can be hardware, signals, or other application specific functions.

The controller core software views I/O as signals. Outputs are signals sent by the controller. They can be turned on and off or set to a value by the controller or manipulated in the program. Inputs are signals that are received by the controller. Inputs are read, values can be stored, and decisions made.

I/O signals are identified by kind and number:

DI [1]= Digital Input 1 GO [2]= Group output 2 UI [1]= User Input 1

Table 11-2 I/O Types

Type	Description
User Operator Panel I/O (UI, UO)	Predefined signals into the robot that allow for control from remote devices.
Standard Operator Panel I/O (SI, SO)	SOP control.
Robot I/O (RI, RO)	Communication between the robot and the controller.
Digital I/O (DI, DO)	Signal sent to or from the controller, can only be ON or OFF.
Group I/O (GI, GO)	A sequence of Digital I/O interpreted as a binary integer.
Analog I/O (AI, AO)	I/O voltage within the range of the I/O board, converts external analog signals into numeric signals for use by the controller.

11.3.1 *Viewing an Manipulating I/O*

While running production I/O can be monitored from the I/O Screen and also forced ON or OFF if necessary. Forcing can only be done with an output since the controller controls those types of signals.

To View I/O:

- Press Menu
- Cursor to -5- I/O
- On the fly out menu choose the specific type of I/O to view.
- Signal type (input or output) can be toggled with F[3] IN / OUT
- Outputs can be forced with the F[4] ON and F[5] OFF soft keys.

Figure 11-4 I/O Menu

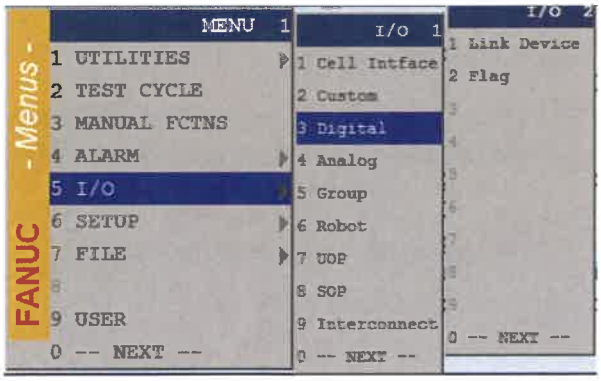
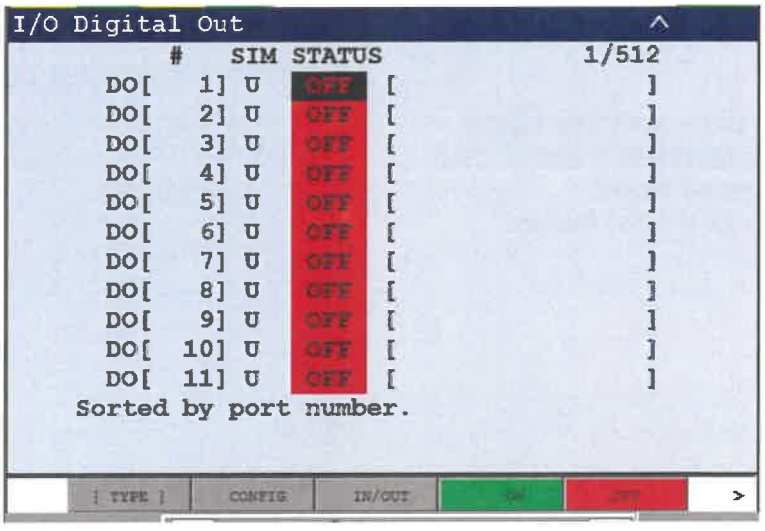


Figure 11-5 Digital I/O Screen



11.4 Macro Overview

A Macro is any program that is assigned a subtype of Macro at creation. A Macro, unlike ordinary programs, may be conveniently executed from the MANUAL FUNCTIONS screen or an external signal

Executing a Macro from the manual functions screens required the teach pendant to be enabled and the controller to be in T1 Mode, this is manually executing the Macro. Executing a Macro from an external signal requires the teach pendant to be disabled and the controller in AUTO Mode, this is executing a macro in AUTO.

There are two types of Macros: Predefined Macro and User Defined Macro.

A Predefined Macro is a Macro that performs a functions commonly associated with the application software. These programs some preloaded on the controller and cannot be changed.

A User Defined Macro is created to perform any number of repetitive tasks. These programs must be created, assigned a sub type of Macro and assigned to the Macro table. When you press a button on the cell HMI that manipulates the robot or the EOAT you are using a User Defined Macro to perform the task.

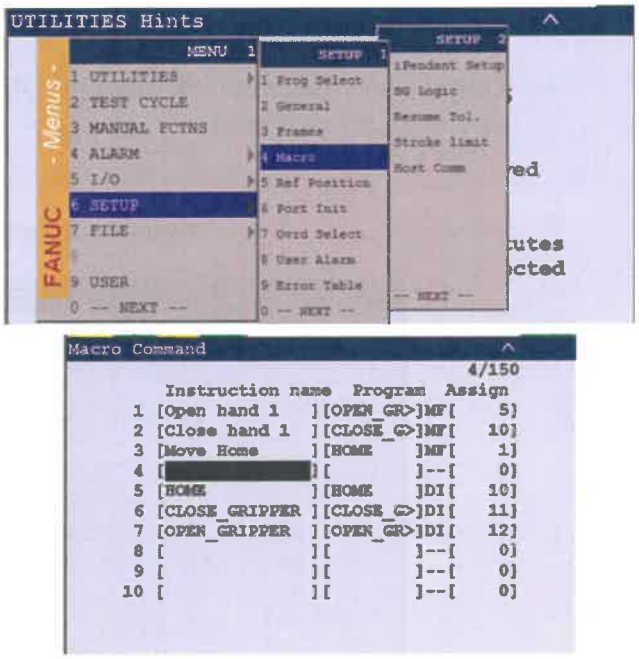
11.4.1 *Macro Table*

The Macro table is where the assignments are made for how each Macro is executed. The most common assignments are for MANUAL FUNCTIONS (MF) or an external signal (Digital Input [DI], User Input [UI]).

To navigate to the Macro Table:

- Press Menu
- Cursor down to -6- Setup
- On the fly out menu cursor to the right and down to Macro
- Press Enter

Figure 11-6 Macro Table



In **Figure 11-6**, there are three Macro assignments for MANUAL FUNCTIONS (T1 Mode) and three Macro assignments for DI (AUTO Mode).

11.4.2 *Executing a Macro*

With the Macro populated on the Macro Table it is possible to see how each Macro is assigned for execution.

Table 11-3 Macro Execution

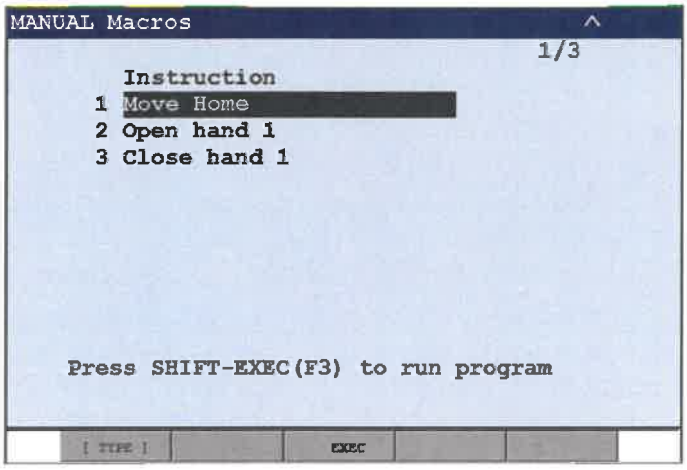
Item	Execution
Manual Mode (T1 / T2)	
User Key (UK)	Software Application Key
Shift user Key	Software application Key w/ Shift
MANUAL FUNCTIONS (MF)	Manual Function Screen
AUTO Mode	
Standard Operator Panel (SP)	USER 1 or USER 2 (RJ3iB and Older)
Digital Input (DI)	Activate Assigned DI
User Input (UI)	Activate Assigned UI
Robot Input (RI)	Activate Assigned RI

To execute a MANUAL FUNCTION Macro:

- Ensure the robot is in a manual mode.
- Press Menu.
- Select -3- MANUAL FUNCTIONS.
- Highlight Program from the list.
- Press Shift and F[3] EXEC.

NOTE: If another program is running is must be aborting before executing a MANUAL FUNCTION Macro.

Figure 11-7 Manual Function Macro



To execute a Macro from a Digital Input:

- Ensure the robot is in AUTO Mode
- Locate the assigned Digital Input
- Activate the assigned Digital Input

NOTE: If another program is running in AUTO Mode the Macro will not execute if the Motion Groups are the same. The software will post a Run Request Failed message.

11.5 **Chapter Review**

1) When inserting a blank line, place the cursor on the line _____ the spot to add the blank lines.

2) Outputs can be forced ON or OFF?

   TRUE FALSE

3) What are the two types of Macros?

   _____ _____

Lab 12
Edit Command

Student Name: _____

Assignment: The student will:

- Insert blank lines into a Program
- Delete Lines from a Program

Condition: A FANUC robot and controller.

Step:

1 Select the Program EDIT.

2 Utilize the Edit Command menu add white space to this program to make it easier to read.

3 Delete the motion statements with the comment "DELETE ME".

4 Step Test the EDIT Program.

5 Continuous Test the EDIT Program.

6 Execute the EDIT Program in Automatic Mode.

Completed: ☐

Instructor: _____

Lab 13
Manipulate I/O

Student Name: _____

Assignment: The student will:

- Open and Close the Gripper

Condition: A FANUC robot and controller.

Step: **1** Access the I/O Screen.

2 Display Robot Outputs.

3 Force the Robot Outputs ON and OFF that control the EOAT.

Completed: ☐

Instructor: _____

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Lab 14
Execute a Macro

Student Name: _____

Assignment: The student will:
1. **Execute a Macro in Manual Mode**
2. **Execute a Macro in AUTO Mode**

Condition: A FANUC robot and controller.

Step:
1 Display the Manual Functions Screen.
- **a** Execute any or all of the assigned Macros.

2 Display the Macro Table.
- **a** Identify the Digital Input Macro Assignments.
- **b** Execute these Macro Assignments in Automatic Mode.

3 Power down the controller.

Completed: ☐

Instructor: _____

12 FILE BACKUP

12.1 Chapter Objectives

- Identify the types of Backups
- Setting the default storage device
- Create a User Defined Directory
- Backup the SRAM data

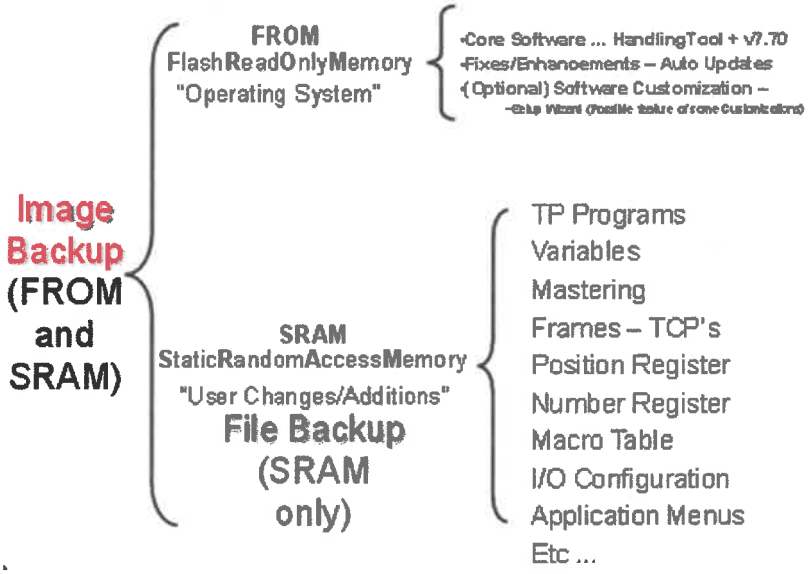
12.2 Types of Backups

There are two types of backups; file backup and image backup

A file backup contains all the user additions and changes to that robot. Items such as Frames, Variables, Menu Settings, Mastering, Position Registers, Registers, Macro Table, TP programs, I/O configurations, etc. are all saved when executing a file backup. You can pick and choose what items to save and what items to restore.

An image backup contains all of the above items plus the operating system, maintenance updates, and customizations software of the robot. An image is an exact copy of the robot memory. You cannot pick individual files to save or restore, it is all or nothing.

Figure 12-1 Back Up Data

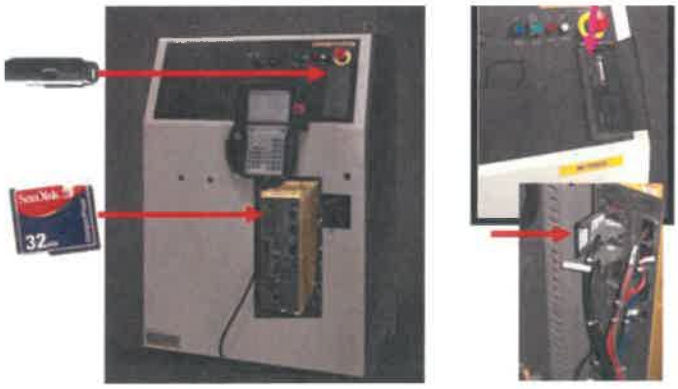


NOTE: We will only execute a File Back Up

12.2.1 *Setting the Default Storage Device*

Setting the default device means specifying which device to use when manipulating programs and files. You must set the default device before manipulating programs and files. Basically setting the device tells the controller the type of storage media you are using. After you set a default device it will remain the default until you change it.

Figure 12-2 Devices



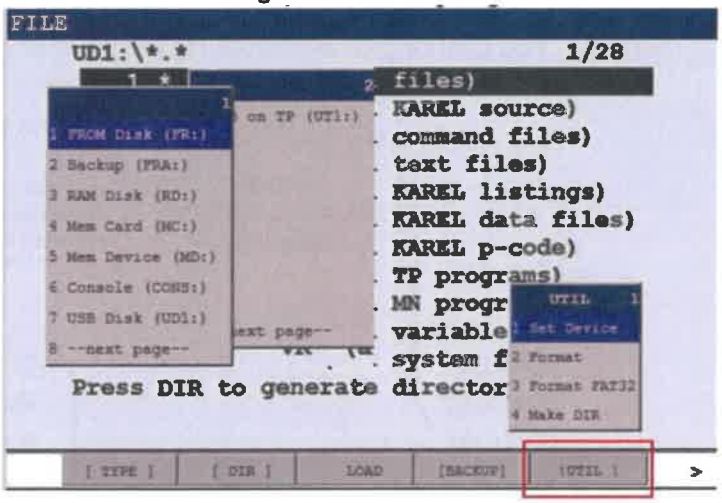
The most common default devices are:

- Memory Card (MC:)
- USB Memory Stick (UD1:) (Port on Controller)
- USB Memory Stick (UT1:) (Port on Teach Pendant)

To Set the Default Device:

- Insert the device into the correct port
- Press Menu
- Select -7- File
- From the File Screen Select F[5] UTIL
- Select Set Device
- Choose port from the list

Figure 12-3 Set Device



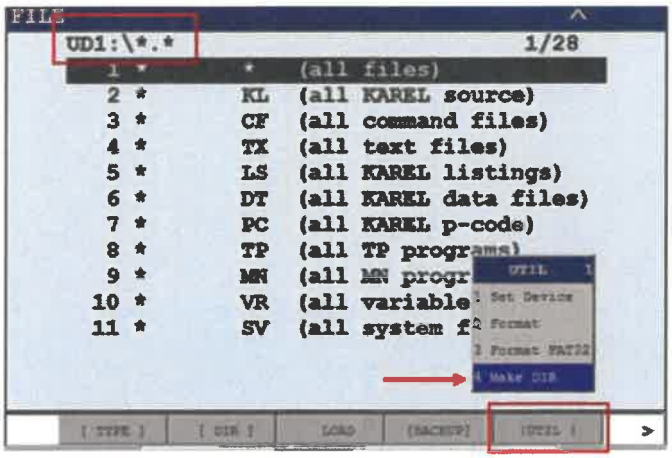
12.2.2 *Create User Defined Directory*

When saving a file back up the file names are the same time you execute the save. This requires the data to be stored in a different location for each occurrence of a backup. If this is not done each time a backup is executed the existing data will be overwritten. To maintain multiple occurrences of a backup or multiple robot backups on a single device it is necessary to create directories to separate the data. Essentially creating a directory is the same thing as adding a folder on your computer.

To create a directory:

- Set the device
- Ensure the top title of the screen displays your device and /*.* (Ex: UD1: /*.*)
- Press F[5] UTIL
- Select Make Dir
- Name the Directory
  - No Spaces
  - May Start with a Number

Figure 12-4 Make Directory



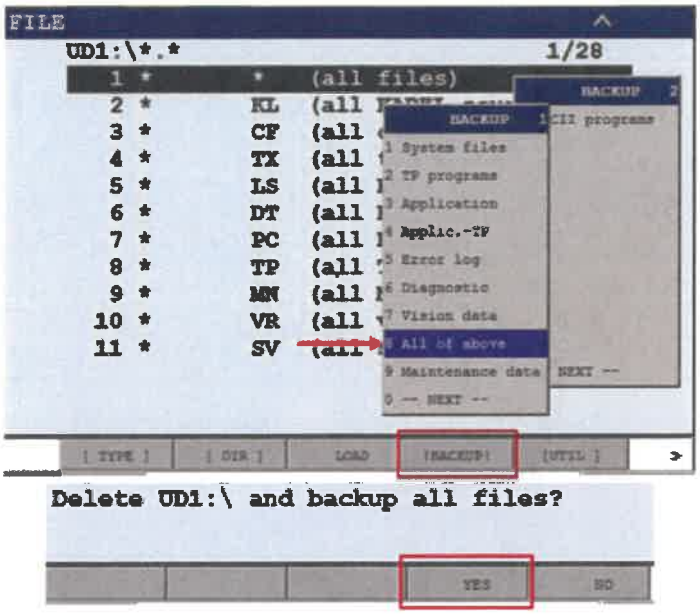
12.2.3 *File Backup*

When **backing up files**, you save them from controller's SRAM memory to the default device so that you have a second copy of the file. This is similar to backing up your personal photos, documents, music etc. File backup should be made anytime there is a change made to a program or file.

To execute the file backup:

- Navigate to the File Screen
- Set the device
- Create the User Directory
- Press F[4] BACKUP
- Choose All of the Above
- Press F[4] YES to complete backup

Figure 12-5 File Backup



12.3 Chapter Review

1) When should a file backup be made?

_____

MATGGROOP1114CE REV B

Lab 15
File Backup

Student Name: _____

Assignment: The student will:

- Create a File Backup

Condition: A FANUC robot and controller.

Step:

1. Run the program LOOP in Auto.
   - **a** This program will run continuously.
2. With the robot executing production.
   - **a** Set the device.
   - **b** Create a User Defined Directory.
   - **c** Execute a File Backup.
3. Safely stop production (Hint: **Do not** use the E-STOP)
4. Power down the Controller.

Completed: ☐

Instructor: _____

13 POST-TEST

Name_____ **Date** _____

This test is designed to evaluate your knowledge of FANUC robot operations upon completion of this course. Each question has four possible answers and a place to indicate, "I don't know." Choose the one that best answers the question. There is only one right answer. This test tells us a little about you and helps us to tailor the course to meet your needs. We appreciate your taking the time to complete it.

Score _____**/10**

1. Turning the Teach Pendant ON:

A Activates the default program (MAIN)

B Enables communications with external devices

C Gives motion control solely to the operator via the Teach Pendant

D Energizes robotic arm

E I don't know

2. 2. How many soft keys are on a FANUC teach pendant?

A 0

B 5

C 7

D All of them

E I don't know

3. Which direction does the TCP move in relation to the robot when the +X key is pressed while jogging in the WORLD frame?

A UP

B Down.

C To the right.

D Straight out front.

E I don't know

4. SHIFT and POINT are needed to do what?

A Change robot speed

B Request the positional screen to appear

C Record the current positional data of the robot

D Execute a MACRO program and return the robot to HOME

E I don't know

5. In the motion command "J P[2] 100% FINE", If you wanted to change the "FINE" component to a "CNT100" what buttons would you press?

A FCTN followed by ABORT ALL

B SHIFT and FWD

C SELECT followed by NEXT

D Select component, then press [CHOICE]

E I don't know

6. In STEP mode testing, to change the execution direction of the program, which hard key should you press while holding the shift key?

A Step key

B FWD or BWD keys

C +% or -% keys

D Cursor (Arrow) keys

E I don't know

7. Which of the following is a kind of I/O signal?

A UIP I/O

B SIP I/O

C Robot I/O

D Configuration I/O

E I don't know

8. To display stored programs on the controller which button should be pressed?

A FCTN

B FWD

C Select

D Hold

E I don't know

9. Which button is pressed to bring the robot to a controlled stop?

A Emergency Stop

B Hold

C Safe Stop

D Pause

E I don't know

10. Which of the following hard keys would bring the menu item ABORT ALL to the TP Screen?

A FCTN

B HOLD

C RESET

D E-STOP

E I Don't know