

TRAK[®] EMX KNEE MILLS ProtoTRAK[®] EMX CNC

Safety, Programming, Operating and Care Manual

Document: P/N 26056 Version: 050611
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Covers Current Models:

- Ø **ProtoTRAK EMX Retrofits**
- Ø **TRAK K3EMX**

Non-Current Models

- Ø **TRAK K2 EMX**
- Ø **TRAK KEMX**
- Ø **TRAK K4 EMX**



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1.0 Introduction

Congratulations! Whether you bought the ProtoTRAK EMX CNC as a retrofit or as the CNC integrated into the TRAK Knee Mill, you have an excellent toolroom machine. The ProtoTRAK EMX has an easy-to-use interface features that make knee mill work faster and more productive.

Manual Machining is always available and made easier with features like power feed, 100 inch per minute rapids, and all the best features of sophisticated DRO's.

Two-Axis Machining is available at the touch of a button for the prototyping and moderately complex, low volume work that is typically done on knee mills.

The operation of the ProtoTRAK EMX CNC has been painstakingly refined to bring you the most useful CNC technology while retaining the ease of use that has made ProtoTRAK the top brand in controls for low volume production.

This manual will describe the operation of all basic and optional features in the appropriate context. Where optional features are discussed, a note will explain in which option the particular feature is found.

1.1 Models

The ProtoTRAK EMX CNC is featured in the following products:

Model	Description
Retrofits	
PTEMX	Two-axis CNC retrofit to your knee mill
Knee Mill	
TRAK-KEMX	Two-axis CNC, 33" x 15.5," 3 HP
Non-Current Knee Mills	
TRAK-K2 EMX	Two-axis CNC, 33" x 12," 3 HP
TRAK-K3 EMX	Two-axis CNC, 32" x 16," 3 HP
TRAK-K4 EMX	Two-axis CNC, 32" x 16.5," 5 HP

1.2 Manual Organization Notes

This manual covers the operation of the retrofit and TRAK K Mill products that use the ProtoTRAK EMX CNC.

Some Sections do not apply to all users. For example, if you own a ProtoTRAK retrofit, you should skip the sections that cover the description and operation of TRAK K Mills.

Sections that may not apply to all users contain a note to inform you of this fact.

Section 2 of this manual provides important safety information. It is highly recommended that all operators of this product review this safety information carefully.

2.0 Safety

The safe operation of your knee mill depends on its proper use and the precautions taken by each operator.

- Read and study this manual. Be certain every operator understands the operation and safety requirements of this machine *before* its use.
- Always wear safety glasses and safety shoes.
- Always stop the spindle and check to ensure the CNC control is in the stop mode before changing or adjusting the tool or workpiece.
- Never wear gloves, rings, watches, long sleeves, neckties, jewelry, or other loose items when operating or around the machine.
- Use adequate point of operation safeguarding. It is the responsibility of the employer to provide and ensure point of operation safeguarding per OSHA 1910.212 - Milling Machine.

2.1 Safety Publications

Refer to and study the following publications for assistance in enhancing the safe use of this machine.

Safety Requirements For The Construction, Care And Use of Drilling, Milling, and Boring Machines (ANSI B11.8-2001). Available from The American National Standards Institute, 1430 Broadway, New York, New York 10018.

Concepts And Techniques Of Machine Safeguarding (OSHA Publication Number 3067). Available from The Publication Office - O.S.H.A., U.S. Department of Labor, 200 Constitution Avenue, NW, Washington, DC 20210.

2.2 Danger, Warning, Caution, and Note Labels and Notices As Used In This Manual

DANGER - Immediate hazards that **will** result in severe personal injury or death. Danger labels on the machine are red in color.

WARNING - Hazards or unsafe practices that *could* result in severe personal injury and/or damage to the equipment. Warning labels on the machine are orange in color.

CAUTION - Hazards or unsafe practices that *could* result in minor personal injury or equipment/product damage. Caution labels on the machine are yellow in color.

NOTE - Call attention to specific issues requiring special attention or understanding.



SOUTH WESTERN INDUSTRIES
 2615 HOMESTEAD PLACE,
 RANCHO DOMINGUEZ, CA 90220

MODEL TRAK K3

S/N

ELECTRICAL RATINGS:

220 VOLTS 8.5 AMPS 3 PHASE
60 Hz

FLA OF LARGEST MOTOR 8.5 AMPS

SHORT CIRCUIT INTERRUPT 200K AMPS

ELECTRICAL DRAWING #: 20598-1

CNC CONTROL ELECTRICAL RATINGS:
 IF APPLICABLE

115 VOLTS 8 AMPS 1 PHASE
60 Hz

MACHINE (ONLY) MADE IN "XXXXXX"

i00902

Safety & Information Labels Used On The TRAK Knee Mills*

*It is forbidden by OSHA regulations and by law to deface, destroy or remove any
of these labels*

*Retrofit customers: please see the manual that came with your machine for information about safety and information labels.



**HIGH
VOLTAGE**

220/440 VOLTS

WARNING

IMPROPER INSTALLATION OR OPERATION OF THIS MOTOR MAY CAUSE INJURY TO PERSONNEL OR MOTOR FAILURE. READ OPERATING INSTRUCTIONS.

MOTOR MUST BE INSTALLED AND GROUNDED PER LOCAL AND NATIONAL ELECTRICAL CODES.

TO REDUCE POTENTIAL OF ELECTRICAL SHOCK DISCONNECT ALL POWER SOURCES BEFORE INITIATING ANY MAINTENANCE OR REPAIRS.

KEEP FINGERS AND FOREIGN OBJECTS AWAY FROM VENTILATION AND OTHER OPENINGS. KEEP AIR PASSAGES CLEAR.

EYEBOLTS OR LIFTING HOOKS, WHEN SUPPLIED, ARE INTENDED FOR LIFTING THE PRODUCT ONLY AND MUST NOT BE USED TO LIFT ADDITIONAL WEIGHT.

USE ONLY GRADE 5 SHOULDER EYEBOLTS WITH MINIMUM THREAD LENGTH OF 1 1/2 TIMES DIAMETER.

**Safety & Information Labels Used On The
ProtoTRAK EMX CNC**

*It is forbidden by OSHA regulations and by law to deface, destroy or remove any
of these labels*

2.3 Safety Precautions

1. Do not operate this machine before the **ProtoTRAK EMX CNC Safety, Installation, Maintenance, Service and Parts List Manual**, and the **Safety, Programming, Operating & Care Manual** have been studied and understood.
2. Do not run this machine without knowing the function of every control key, button, knob, or handle. Ask your supervisor or a qualified instructor for help when needed.
3. Protect your eyes. Wear approved safety glasses (with side shields) at all times.
4. Don't get caught in moving parts. Before operating this machine remove all jewelry including watches and rings, neckties, and any loose-fitting clothing.
5. Keep your hair away from moving parts. Wear adequate safety headgear.
6. Protect your feet. Wear safety shoes with oil-resistant, anti-skid soles, and steel toes.
7. Take off gloves before you start the machine. Gloves are easily caught in moving parts.
8. Remove all tools (wrenches, check keys, etc.) from the machine before you start. Loose items can become dangerous flying projectiles.
9. Never operate a milling machine after consuming alcoholic beverages, or taking strong medication, or while using non-prescription drugs.
10. Protect your hands. Stop the machine spindle and ensure that the CNC control is in the stop mode:
 - Before changing tools
 - Before changing parts
 - Before you clear away the chips, oil or coolant. Always use a chip scraper or brush
 - Before you make an adjustment to the part, fixture, coolant nozzle or take measurements
 - Before you open safeguards (protective shields, etc.). Never reach for the part, tool, or fixture around a safeguard.
11. Protect your eyes and the machine as well. Don't use a compressed air hose to remove the chips or clean the machine (oil, coolant, etc.).
12. Stop and disconnect the machine before you change belts, pulley, gears.
13. Keep work area well lighted. Ask for additional light if needed.
14. Do not lean on the machine while it is running.
15. Prevent slippage. Keep the work area dry and clean. Remove the chips, oil, coolant and obstacles of any kind around the machine.

16. Avoid getting pinched in places where the table, saddle or spindle head create "pinch points" while in motion.
17. Securely clamp and properly locate the workpiece in the vise, on the table, or in the fixture. Use stop blocks to prevent objects from flying loose. Use proper holding clamping attachments and position them clear of the tool path.
18. Use correct cutting parameters (speed, feed, depth, and width of cut) in order to prevent tool breakage.
19. Use proper cutting tools for the job. Pay attention to the rotation of the spindle: Left hand tool for counterclockwise rotation of spindle, and right hand tool for clockwise rotation of spindle.
20. Prevent damage to the workpiece or the cutting tool. Never start the machine (including the rotation of the spindle) if the tool is in contact with the part.
21. Check the direction (+ or -) of movement of the table when using the jog or power feed.
22. Don't use dull or damaged cutting tools. They break easily and become airborne. Inspect the sharpness of the edges, and the integrity of cutting tools and their holders. Use proper length for the tool.
23. Large overhang on cutting tools when not required result in accidents and damaged parts.
24. Prevent fires. When machining certain materials (magnesium, etc.) the chips and dust are highly flammable. Obtain special instruction from your supervisor before machining these materials.
25. Prevent fires. Keep flammable materials and fluids away from the machine and hot, flying chips.
26. When working in manual mode (not CNC) make sure the computer control is switched to DRO or OFF.
27. An optional interlocked guard is available from Southwestern Industries, Inc. for TRAK Knee Mills if the use of the table guard is deemed necessary by the user for his application.

3.0 Description

3.1 ProtoTRAK EMX CNC Specifications

The list below summarizes the features and specifications. Each feature is described in more detail in the appropriate section of the manual.

3.1.1 Basic System Specifications

Control Hardware

- Digital Servo Amplifiers – custom designed for ProtoTRAK operation
- D.C. Servo Motors – rated at 280 in-oz. continuous torque are twice that required
- Precision Ball Screws – in the table and saddle
- Modular Design – simplifies service and maximized uptime
- 115V/60HZ/8 amps
- Feedrate Override of programmed feedrate and rapid
- Polycarbonate Sealed Membrane Keypad to lock out contamination
- 7.0" Color LCD
- On board IDR flash memory storage for part programs
- USB port for interface with a storage device
- Rugged Industrial PC
- Glass Scale on quill for Z-axis readout

Software

- Diameter Cutter Compensation – allows programming of the part rather than the center of the tool path
- Circular Interpolation – makes arcs and any size hole easy to do with standard tools
- Linear Interpolation – to machine lines at any angle
- Conrad – provides automatic corner radius programming with one data input
- Incremental and Absolute – programming can even be mixed within an event
- Error Messages – to identify programming mistakes
- Fault Messages – for system self-diagnostics
- Parts Graphics display
- Look – a single button press to view graphics during programming
- Math Help – for finding points in a prompted format with graphical representation of prompts
- Machine Tool Error Compensation and Backlash Compensation custom set on mill after installation
- Selectable Inch/mm measurement readout
- Jog of X and Y from 1 to 100 inches per minute
- Continue Mill to eliminate repetitive data inputs while programming
- Context help information provides explanations of ProtoTRAK EMX operations

Programmed Canned Cycles

- Posn/Drill – single point
- Bolt Hole – series of points evenly spaced around a circle
- Mill – straight line in any direction
- Arc – any portion of a circle
- Pocket – a rectangle or circle and all the material inside, includes finish cut
- Frame – a perimeter of a rectangle or circle, includes finish cut
- Repeat – of programmed events with or without offset

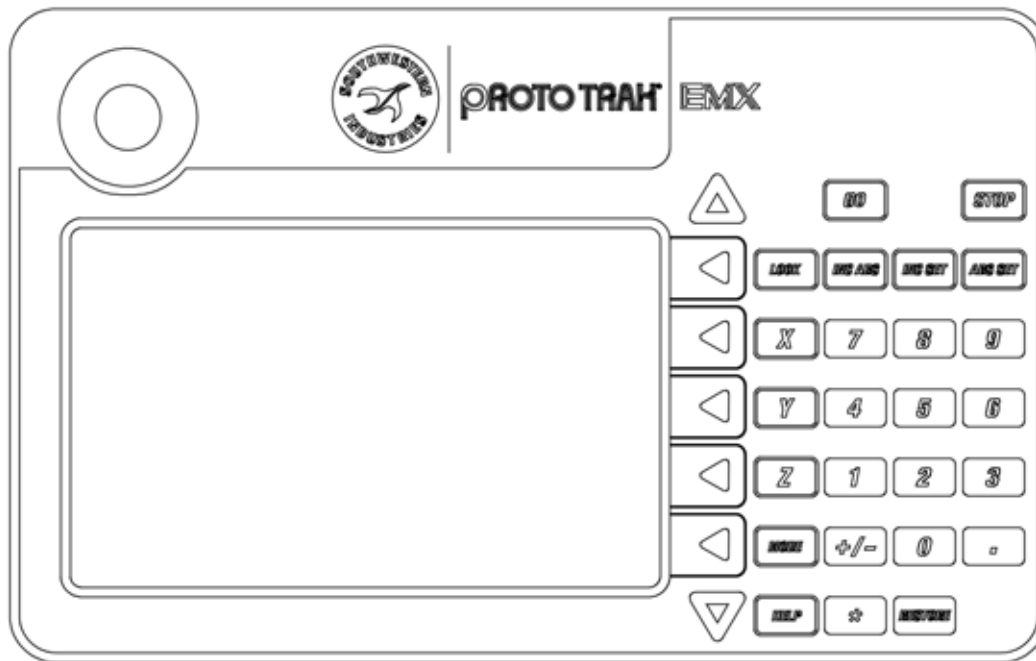
Options

- Remote Stop/Go (RSG) switch

- USB thumb drive for program storage and transfer. Includes a free offline EMX programming system.

3.2 Display Pendant

3.2.1 Front



i01276

Keyboard Hard Keys

GO: initiates motion in Run

STOP: halts motion during Run

LOOK: part graphics in Program mode

INC/ABS: switches all or one axis between incremental and absolute

INC SET: loads incremental dimensions and general data

ABS SET: loads absolute dimensions and general data

X, Y, Z: selects axis for subsequent commands

0-9, +/-, . : inputs numeric data with floating point format. Data is automatically + unless +/- key is pressed. All input data is automatically rounded to the system's resolution.

MODE: to change from one mode of operation to another

HELP: displays information about the operation of each mode.

RESTORE: clears an entry

Arrow Keys

Between the LCD Screen and the hard keys is a column of arrow keys.

Up key, down key: these are located at the top and bottom of the column, respectively. They have several uses:

- feedrate override in Run and DRO modes
- page forward, page back to move through events in a program
- data forward, data back to move through the data in an event

Middle five keys: These keys are called software programmable or soft keys. A description of the function or use of each of these keys will be shown on the LCD screen next to each key. If, at any time, there is no description above a key, that key will not operate.

Emergency Stop Switch

The emergency stop (E-stop) switch kills all power to the ProtoTRAK's servomotors. The computer and pendant remain powered.

The Liquid Crystal Display (LCD)

The display of the ProtoTRAK EMX is a 7" active-matrix color LCD.

The information displayed on the LCD screen is nearly always divided into 4 sections or areas.

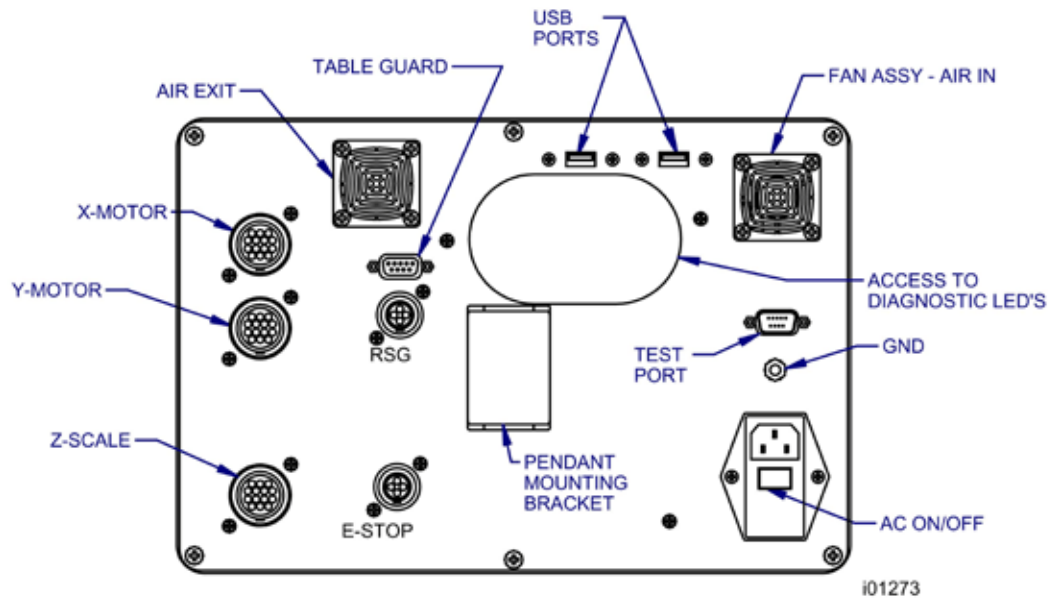
The top line, or status line, shows the system's current status. This includes the mode, inch or mm measurement and part numbers.

Beneath the status line, and filling most of the screen, is the information area. Position data, program data and graphics are shown here. In addition message windows will be here in the information area.

Beneath the information area is a single "conversation" line. When numeric data is required the conversation line will appear for you to see the numbers you enter before they are set into the system.

On the right side of the LCD are boxes describing the current function or use of each soft keys located next to them.

3.2.2 Pendant Back Panel



Motor

The X and Y motor cables are plugged in here.

Warning:

Never plug or unplug motor cables with the power on. This will destroy the computer!

Z Scale

Plug in the Z scale cable.

Table Guard

For plugging in the interlock switch that is part of the optional table guard. Not available with retrofits.

The USB Ports

There are two USB ports, use only one at a time for an optional thumb drive for program storage, transferring programs between ProtoTRAKs and computers and for program backup. Software updates will be through the USB port.

The ports are USB1.1 compliant.

The thumb drives listed below proved to be compatible with the ProtoTRAK EMX CNC at the time of this writing. We can't guarantee that the brands won't change in some way that makes them incompatible, but they work now.

PNY
Memorex
Lexar
Microadvantage
Delkin / E Film

The one we supply will definitely work – so the way to be sure is to order the USB MEM from us.

Test port

Used by the factory for testing only.

Grd (Ground)

We recommend that you ground the ProtoTRAK display to an earth ground such as a cold water pipe.

A/C Inlet

To plug in the incoming 110v power. The on/off switch is located directly below this inlet.

3.2.3 Servo Motors/Amplifiers

The ProtoTRAK EMX servomotor and amplifier have been combined into a single integrated package on each axis. The motors are rated 280 in-oz. maximum continuous torque that is sufficient for the heaviest cuts.

3.2.4 The Z Scale

In order to have the Z axis digital readout, it is necessary to have the optional Z-axis scale. The Z readout may be activated or deactivated with Special Code 15.

3.2.5 Ballscrews

Precision ballscrews are installed in the table and saddle to ensure smooth traverse and positive control for manual and CNC machining.

3.3 TRAK Knee Mill Specifications *(See Figures 3.3.1 and 3.3.2)*

This section describes the TRAK Knee Milling machines, it does not apply to ProtoTRAK EMX retrofits.

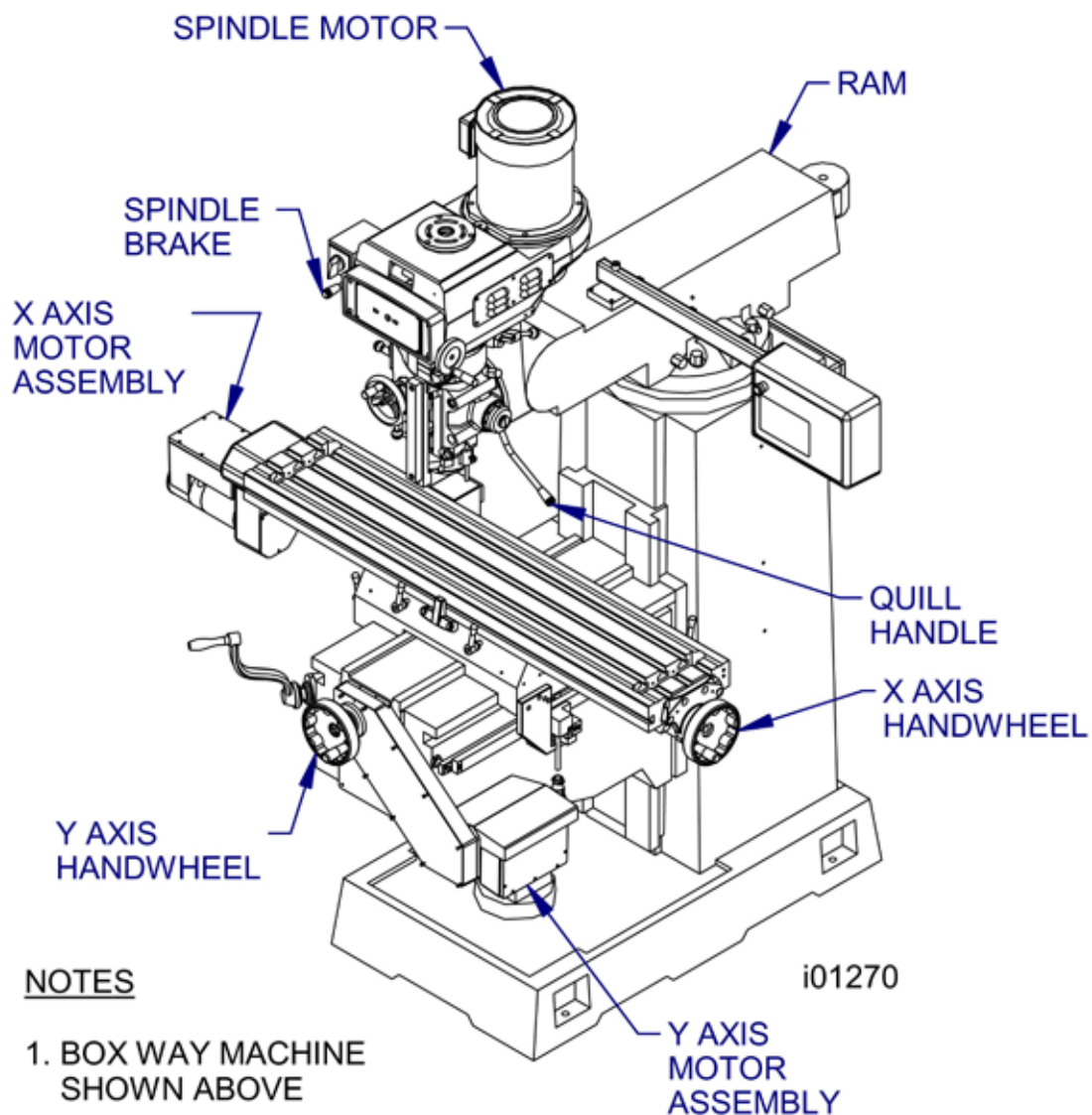


FIGURE 3.3.1 *The TRAK Knee Mill Machine Overview*

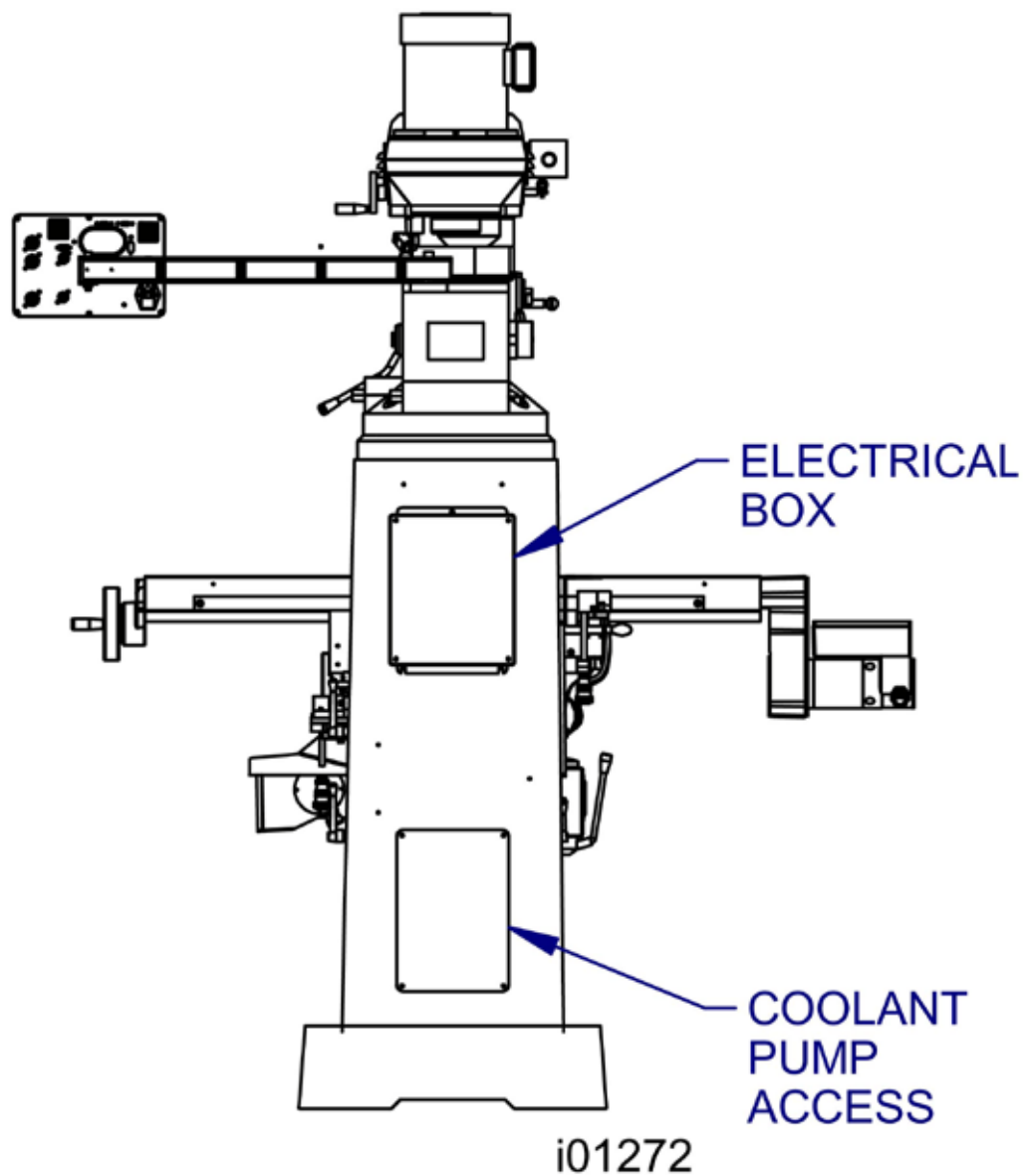


FIGURE 3.3.2 The TRAK Knee Mill back view

	TRAK KEMX	TRAK K2EMX	TRAK K3EMX	TRAK K4EMX
Table Size	50" X 10"	49" X 9"	50" X 10"	50" X 10"
Table Travel	31"	33"	32"	32"
Saddle Travel	15.5"	12"	16"	16 ½"
Knee Travel	15"	16"	16"	16 ½"
Ram Travel	21"	12"	15"	19"
Maximum Quill Travel	5"	5"	5"	5"
Quill Diameter	3.375"	3.375"	3.375"	3.938"
Spindle Taper	R8	R8	R8	NMTB 40
Spindle Speed Vari-speed head	70-4200 RPM	60-500, 600-4200 RPM	60-500, 600-4200 RPM	70-500, 600-3950 RPM
Spindle Speed – Opt E Head	N/A	Two Ranges: 40-600, 300-5000 RPM	Two Ranges: 40-600, 300-5000 RPM	Two Ranges: 40-600, 300-5000 RPM
Head Tilt	45° forward and back, 90° left and right	45° forward and back, 90° left and right	45° forward and back, 90° left and right	90° left and right
Quill Feeds per Rev	0.0015", 0.003", 0.006"	0.0015", 0.003", 0.006"	0.0015", 0.003", 0.006"	0.0015", 0.003", 0.006"
Spindle Motor Power – Vari-speed	3HP	3HP	3HP	5HP
Spindle Motor – Opt E Head	N/A	3HP	3HP	5HP
Power Requirement Control	110, 1P, 8A	110V, 1P, 10A	110V, 1P, 10A	110V, 1P, 10A
Power requirements, machine	220/440V, 3P, 8.5/4.25A	220/440V, 3P, 8.5/4.25A	220/440V, 3P, 8.5/4.25A	220/440V, 3P, 14/7A
Maximum Weight on Table	750	750 lbs.	750 lbs.	850 lbs.
Machine Weight	2820 lbs.	2200 lbs.	2816 lbs.	3630 lbs.
Machine dims: l, w, h	71" x 59" x 87"	70" x 57" x 83"	71" x 59" x 84"	71" x 59" x 91"
Max rapid feed X, Y	100IPM	100 IPM	100 IPM	100 IPM
Way surface type	Dovetail X, Y, Z	Dovetail X, Z, Y	Dovetail X, Z, Square Y	Dovetail X, Square Y, Z

- Precision 7207 CP4 spindle bearings
- Chrome hardened and ground quill
- Meehanite castings
- Slide ways are Turcite coated
- Wide way surfaces are hardened and ground

3.3.1 Manual Lubrication System

Ways and Ballscrew Lubrication

The TRAK Knee Mill X, Y, Z way surfaces and ball screws are lubricated manually with the lubrication pump located on the left side of the knee. Pull the handle fully and release 4 to 6 times at the beginning of each shift, and once every four hours of operation thereafter.

1. At the beginning of each day, check the oil level in the pump. If low, fill with SAE 30 or 30W oil.
2. Every six months of operation, apply a liberal coating of Mobile Grease-MP, or equivalent to the Z-Axis ACME screw.

CAUTION!

Failure to manually activate the pump at the beginning of each day may cause severe damage to the TRAK Knee Mill way surfaces and ball screws.

Head Lubrication

Once Each Week:

1. Fill the oil cup on the front of the head with SAE 30 or 30W oil. This oil lubricates the Hi/Lo range shifter.
2. Fill the ball oiler located in the front lower right corner of the speed changer housing. This oil lubricates the speed changer shaft.
3. Extend the quill fully and apply a coating of SAE 30 or 30W oil to the outside diameter of the quill.

Every Four Months:

Apply a good grade of general-purpose grease through the grease fittings on the back of the head and on the left side of the head. The grease lubricates the low range gear set and the feed change gears respectively.

3.3.2 Electrical Cabinet (TRAK Knee Mills Only)

TRAK Knee Mills use two electrical inputs. Spindle 220 or 440V power is wired into the cabinet. A cord is supplied from the cabinet to a 110V power source for running the ProtoTRAK EMX CNC.

3.4 Optional Equipment

3.4.1 Power Draw Bar

A manual draw bar comes standard with the machine. A power draw bar option may be ordered. For the TRAK K4 or other NMTB 40 machines, the draw bar included in the option may be CAT or NMTB/NST.

An NMTB/NST type of draw bar is the appropriate length to fit tool holders that have a threaded tang on the top. The CAT type is longer to thread into CNC tool holders that have the tool changer grip, or retention knob removed.

3.4.2 Remote Stop Go Switch

For the convenience of operation while running the program, a Remote Stop/Go switch may be purchased. This switch is on a ten-foot cable and operates like the FEED Stop and Go keys on the display.

3.4.3 Work Light (TRAK Knee Mills Only)

An optional halogen work light is available. It mounts to the left side (facing) of the column and plugs into a 110v outlet in the electrical cabinet.

3.4.4 Coolant Pump (TRAK Knee Mills Only)

The optional coolant pump is mounted in the back of the machine column. It is plugged into the electrical cabinet and may be configured to operate as commanded by the auxiliary functions, or with a separate switch.

3.4.5 Spray Coolant (TRAK Knee Mills Only)

The Fog Buster® spray coolant option consists of a one-gallon holding tank, nozzle, air lines and an air regulator for attaching compressed air. Coolant flow is adjusted by a needle valve at the sprayer head. Air flow is adjusted at the air pressure regulator with gage. Once flows are set, sprayer operation is controlled by an air toggle switch or by interface with the optional Auxiliary Functions.

3.4.6 Chip Pan (TRAK Knee Mills Only)

The Chip Pan option is available for TRAK Knee Mills only, not available for retrofits.

3.4.7 Table Guard (TRAK Knee Mills Only)

The Table guard option provides an enclosed workspace mounted on the table. The sliding door is switched to prevent operation of the CNC Run with the door open. While it will aid in the control of chips and coolant, it is not a full, waterproof enclosure. The Table Guard is available for TRAK Knee Mills only, it is not available for retrofits.

3.4.8 Auto Lubrication System (TRAK Knee Mills Only)

The way and ballscrew lubrication is wired to operate while the spindle is running.

Factory Default Values

Interval Time – 60 min

Discharge Time – 15 sec

Discharge Pressure – Approximately 100 – 150psi

To adjust the amount of Discharge Pressure displayed on the lube pump gauge, loosen the jam nut and turn the adjustment screw located on the top right side of the lube pump while the lube pump is activated. To activate the lube pump turn spindle on and press the Feed for continuous pumping and RST for a single programmed pump.

CAUTION!

Failure to properly lubricate the mill will result in the premature failure of bearings and sliding surfaces.

CAUTION!

Failure to manually activate the pump at the beginning of each day, or allowing the Auto Lube to run dry may cause severe damage to the mill's way surfaces and ballscrews.

3.4.9 USB Thumb Drive

The USB Thumb Drive option is a Delkin Devices 256MB thumb drive. It serves the following purposes:

- Save program files for backing up or additional storage
- Load program files
- Share program files between ProtoTRAKs or computers
- Save system configuration files, including backlash and calibration values
-

The thumb drive comes correctly configured for ProtoTRAK EMX interface and includes a copy to the PTEMX Offline Programming software for making part programs on a PC.

4.0 Basic Operation

Whether as a retrofit or as part of a TRAK Knee Mill, the ProtoTRAK EMX CNC combines the simplicity and flexibility of using a knee mill with the easy, natural user interface that makes the ProtoTRAK the top brand in CNCs for small lot machining.

4.1 ProtoTRAK EMX Basic Operation.

4.1.1 Switching the ProtoTRAK EMX CNC on and off

Turn the ProtoTRAK EMX System on by moving the on-off toggle switch located directly under the power cord.

When it is first turned on the system will display a series of boot-up screens while the ProtoTRAK EMX system loads.

To turn off the system, simply flip the toggle switch. It is not necessary to do a shutdown routine.

4.1.2 Screen saver

If the system is not used (either by a keystroke or by counting) for 20 continuous minutes, the LCD will turn itself off. Press any key to bring the screen back to its previous display. The key you press will be ignored except to turn the screen on.

4.1.3 Modes

The functions of the ProtoTRAK EMX are divided into Modes. Modes are groups of activities that belong together. Organizing the ProtoTRAK EMX this way makes it easy to use because you don't have to memorize how to do things. Simply select the Mode and then choose from the options.

The Modes of the ProtoTRAK EMX are:

- **DRO:** Contains the DRO features for working manually or setting up to run a program. This also contains the softkey for the Service Codes.
- **PROG (PROGRAM):** Where programs are written and edited, and part graphics displayed.
- **RUN:** Where programs are run to make parts.
- **MATH HELP:** Routines to help you quickly and easily calculate intersections, tangencies, centers and more.
- **PROG IN/OUT:** To store and retrieve part programs from the internal storage.



4.1.4 Emergency Stop

Press the button to shut off power to the axis motors. Power is also shut off to the spindle motor for TRAK Knee Mills. Rotate the switch to release.

4.2 Machine Operation

This section covers the operation of the TRAK Knee Mills. If you purchased your ProtoTRAK EMX CNC as a retrofit, please refer to the user manual that came with your machine.

4.2.1 Spindle On/Off, Forward/Reverse

The spindle switch is located on the left side of the milling head.

- Turn the Spindle switch to **left to 1** for forward (clockwise) spindle rotation if the Hi-Lo-Neutral lever is in the low position.
- Turn the Spindle switch **right to 2** for forward (clockwise) spindle rotation if the Hi-Lo-Neutral lever is in the high position.
- Turn the Spindle switch straight ahead for off.

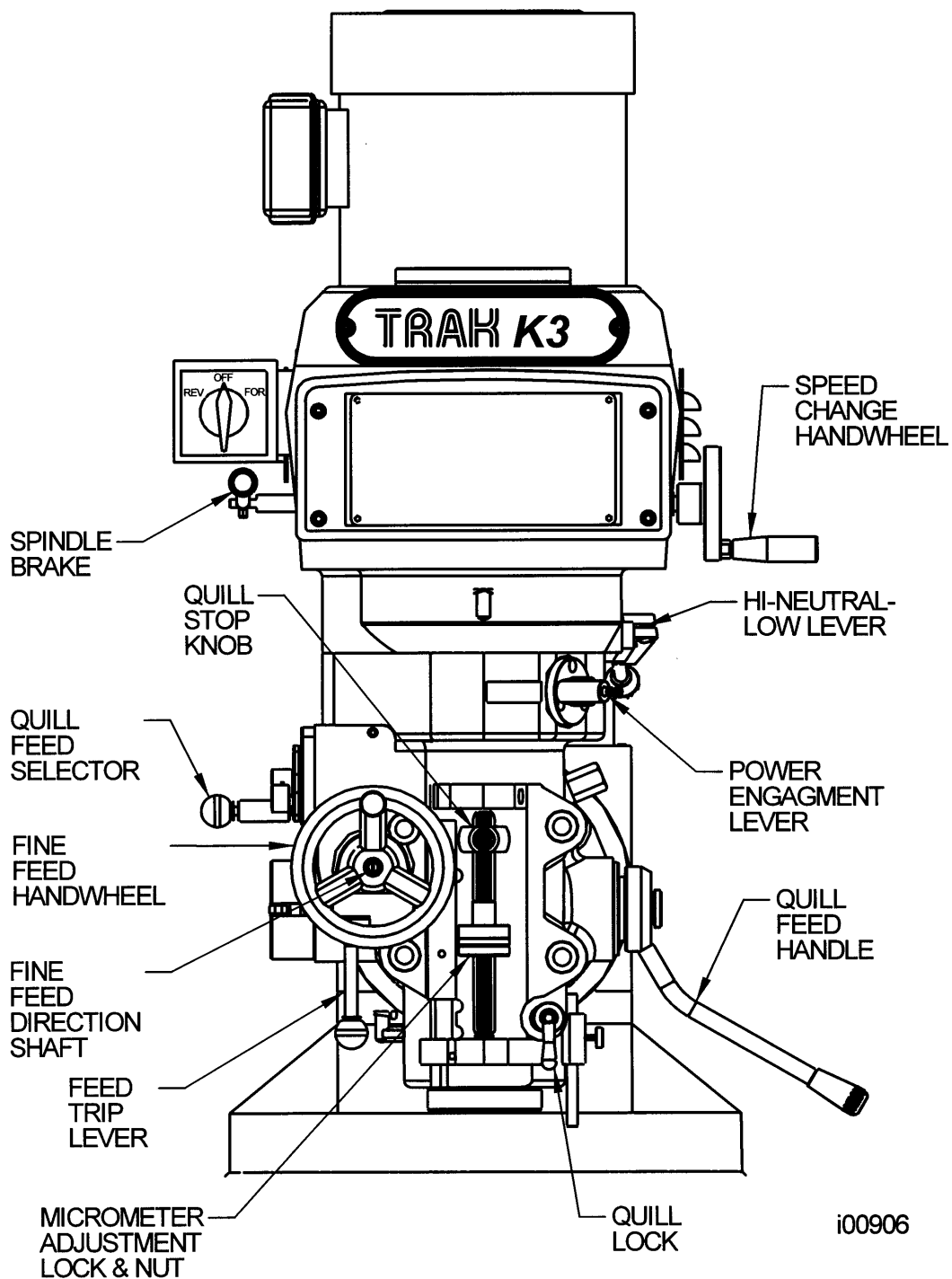


Figure 4.2.0 TRAK K3 Mill head front view. Shown without the standard quill glass scale.

4.2.2 Table, Saddle, Knee/Clamps

The table clamps are located on the front of the saddle. Rotate them clockwise until snug--overtightening is not necessary.

The saddle clamp is located on the left side of the saddle. Rotate clockwise to clamp the table until snug--overtightening is not necessary.

The knee clamps are located on the left side of the knee for the K2 and K3 mills, and on the right side for the K4.

CAUTION!

Do not run ProtoTRAK EMX program unless the table and saddle clamps are free .

4.2.3 Raising/Lowering the Knee

The knee is raised and lowered using the hand crank located on the left front of the knee. Clockwise rotation moves the knee up, while counterclockwise rotation moves the knee down.

Be sure the knee is unclamped before raising or lowering.

4.2.4 Spindle Brake

The mechanical spindle brake is activated pulling it down, or pushing it up. When the lever arm is in the horizontal position, the brake is off.

CAUTION!

Be certain that the spindle brake is released before starting the motor. Never attempt to activate the spindle brake when the motor is on.

4.2.5 Draw Bar

The draw bar holds the R8 or #40 NST tool holders into the spindle taper. The bar has a 5/8-11 right hand thread and should be tightened with a 23mm wrench from the top of the head. When tightening, it is necessary to activate the spindle brake (See 4.2.4 above). If the tool holder does not release from the spindle, lightly tap on the top of the bar to dislodge the tool.

4.2.6 High-Low-Neutral Level

The spindle RPM range selection is made through the High-Low-Neutral Lever.

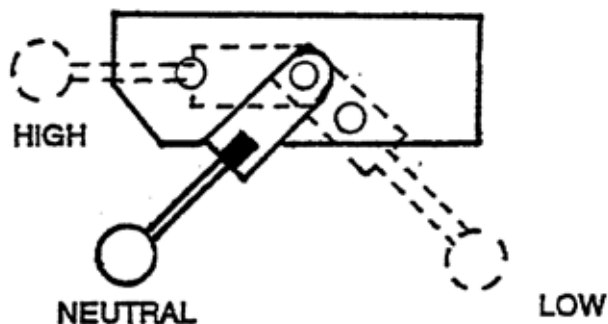


Figure 4.2.6

CAUTION!

Never attempt to change the range selection through the High-Low-Neutral lever when the spindle is rotating. Be certain the spindle ON/OFF switch is in the Off position.

Rotate the spindle by hand to help engage the lever into the high or low position.

Note: Shifting from the high to low range, or low to high range changes the direction of rotation for the On/Off switch (See Section 4.2.1).

4.2.7 Speed Changes

Spindle speed may be varied by rotating the variable speed crank.

CAUTION!

Do not rotate the variable speed crank when the spindle is stationary.

4.2.8 Operating the Quill

The quill may be moved up and down through its range with the quill feed handle. The quill may be locked into position by rotating the quill lock clockwise. Pull the handle out slightly to rotate it freely to a new position.

4.2.9 Adjusting the Quill Stop

The quill stop may be adjusted by rotating the micrometer dial nut. It is locked in place with the knurled nut.

4.2.10 Power Feed Engagement Lever

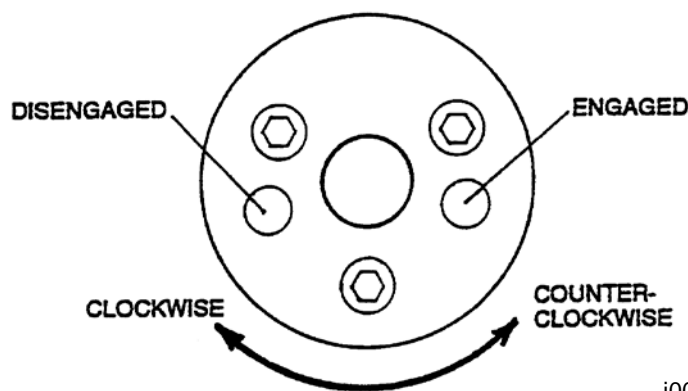


Figure 4.2.10

The power feed is engaged or disengaged with this selector. Pull out the knob and rotate it clockwise to disengage power feed. Rotate it counterclockwise to engage power feed.

CAUTION!

It is recommended that the selector be disengaged when the spindle is not running. Never have the feed engaged when the spindle RPM is over 3000. Always leave the selector in the disengaged position unless the feed function is being used.

4.2.11 Fine Feed Direction Shift

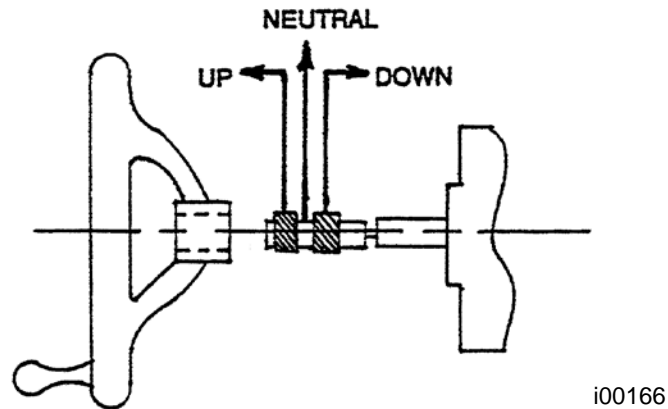
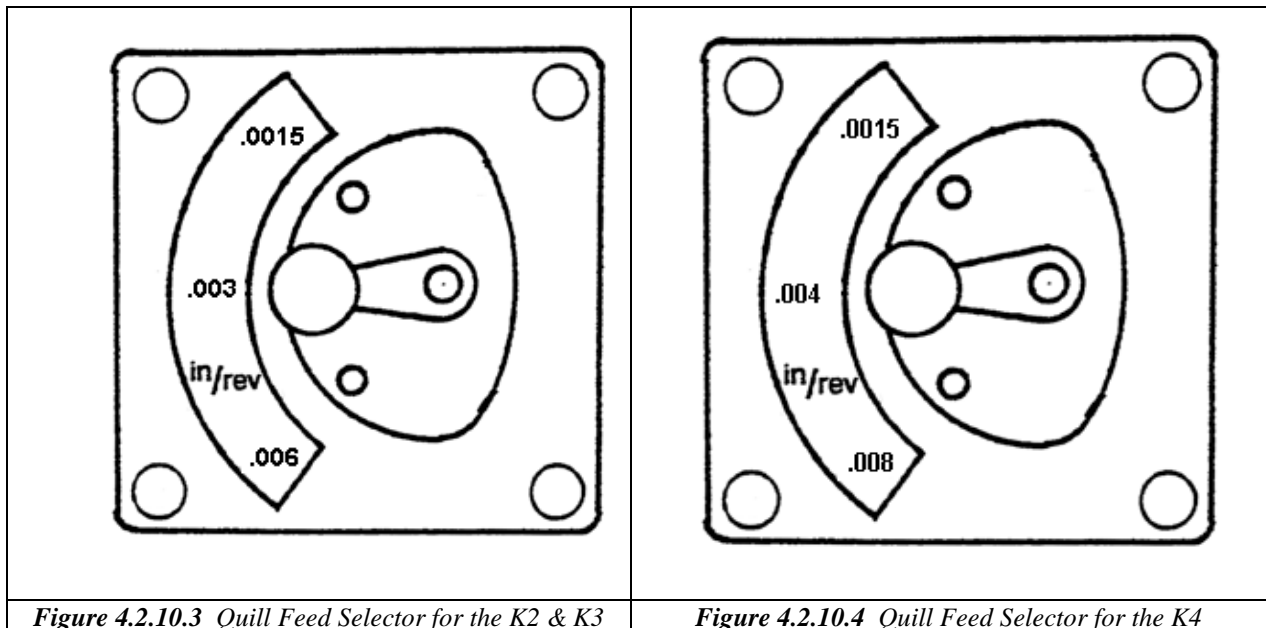


Figure 4.2.10.2

The direction of the fine feed is set by the position of the fine feed direction shaft. IN sets the direction down, OUT sets the direction up, and NEUTRAL in the middle.

4.2.12 Quill Feed Selector



This selector is used to set the quill feed speed.

To change speeds, pull the knob out and rotate the selector to the proper position. It is generally easier to change speeds with the spindle running or rotated by hand. Do not force the lever.

4.2.13 Feed Trip Lever

The Feed Trip Lever stops the quill feed motion when the quill stop knob reaches the quill micrometer dial.

Move the lever to the left to engage, or to the right to disengage.

4.2.14 Fine Hand Quill Feed

1. Disengage the Power Feed Engagement Lever.
2. Set the fine feed direction shaft to the neutral position.
3. Rotate the Fine Feed handwheel.

4.2.15 Fine Automatic Quill Feed

1. Be certain the quill lock is off.
2. Set the quill micrometer dial to the proper depth.
3. Engage the Power Feed Engagement lever when the motor is stopped.
4. Select proper quill feed (see above).

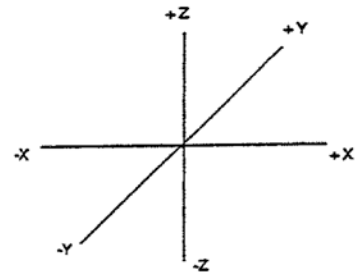
5.0 Definitions, Terms & Concepts

5.1 ProtoTRAK EMX Axis Conventions

X-axis: positive X-axis motion is defined as the table moving to the left when facing the mill. Consequently, measurement to the right is positive on the workpiece.

Y-axis: positive Y-axis motion is defined as the table moving toward you. Measurement toward the machine (away from you) is positive on the workpiece.

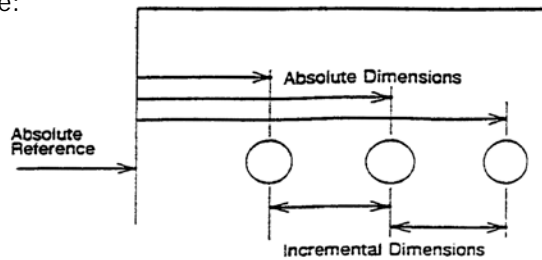
Z-axis: positive Z-axis motion is defined as moving the quill up. Measurement up is also positive on the workpiece.



5.2 Absolute & Incremental Reference

The ProtoTRAK EMX may be programmed and operated in either (or in a combination) of absolute or incremental dimensions. An absolute reference from which all absolute dimensions are measured (in DRO and program operation) can be set at any point on or even off the workpiece.

To help understand the difference between absolute and incremental position, consider the following example:



5.2.1 Some Rules for Incremental Reference Positions

In the section above, it was pretty clear what was meant by an incremental move. There are times that this is not completely clear. This occurs when you want to use incremental references for the first X and Y dimensioned data in a new event and the ending point of the previous event is not obvious. For example, with a circular pocket the ending point is not defined, what does the INC SET reference mean when programming the next event? Since this is not always completely clear, there are some sensible rules for what the ProtoTRAK EMX looks at in the previous event when the first dimensioned data is entered as an INC SET.*

** For events, such as Mill, that have an X,Y beginning and an X,Y end, the second set of data is always referenced from the first.*

If the event is a:

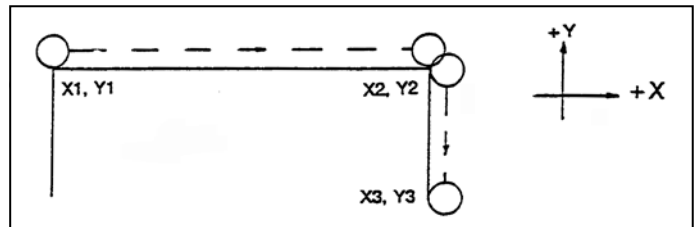
- **DRILL**, then an incremental move is from the X, Y programmed in that previous event.
- **BOLT HOLE**, then an incremental move is from the X CENTER, Y CENTER programmed in that event.
- **MILL**, then an incremental move is from the X END, Y END programmed in that event.
- **ARC**, then an incremental move is from the X END, Y END programmed in that event.
- **CIRCLE POCKET** or **FRAME**, then an incremental move is from the X CENTER, Y CENTER programmed in that event.
- **RECTANGLE POCKET** or **FRAME**, then an incremental move is from the first or X1, Y1 corner programmed in that event.
- **REPEAT**, then an incremental move is the same as for the event types shown above, but shifted by the programmed OFFSET.

5.3 Referenced and Non-Referenced Data

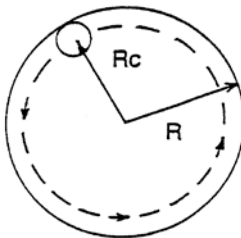
Data is always loaded into the ProtoTRAK EMX by using the INC SET or ABS SET key. X, Y, Z positions are referenced data. In entering any X, Y, or Z position data, you must note whether it is an incremental or absolute dimension and enter it accordingly. All other information (non-referenced data), such as tool diameter, feedrate, etc. is not a position and may, therefore, be loaded with either the INC SET or ABS SET key. This manual uses the term SET when either INC SET or ABS SET may be used interchangeably.

5.4 Tool Diameter Compensation

Tool diameter compensation allows the machined edges shown directly on the workpiece to be programmed instead of the center the tool. The ProtoTRAK EMX then automatically compensates for the programmed geometry so that the desired results are obtained.



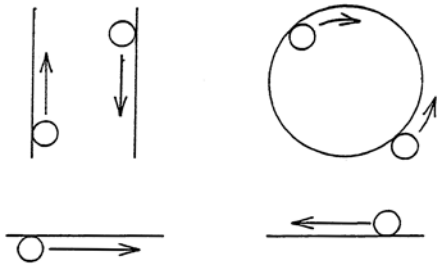
If the cutter in the sketch above is moving from left to right from point X1, Y1 to X2, Y2 and on to X3, Y3, these actual points can be programmed instead of the center of the cutter.



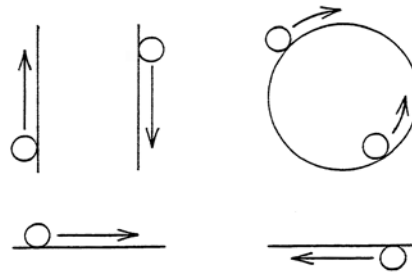
Or, the actual desired circle with radius R can be programmed instead of the radius of the center of the cutter Rc.

Tool cutter compensation is always specified as the tool either right or left of the workpiece while looking in the direction of the tool motion.

Examples of tool right are:



Examples of tool left are:



Tool center means no compensation either right or left. That is, the centerline of the tool will be moved to the programmed points.

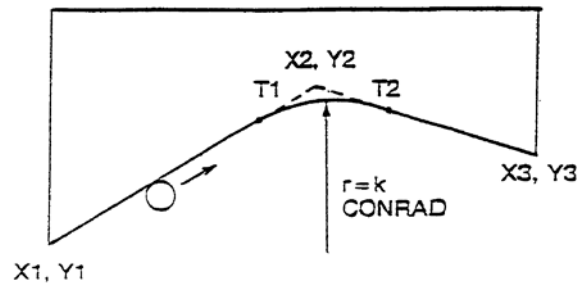
5.5 Connective Events

Connective events occur between two milling events (either Mill or Arc) when the X, Y, and Z ending points of the first event are in the same location as the X, Y, and Z starting points of the next event. In addition, the tool offset and tool number of both events must be the same.

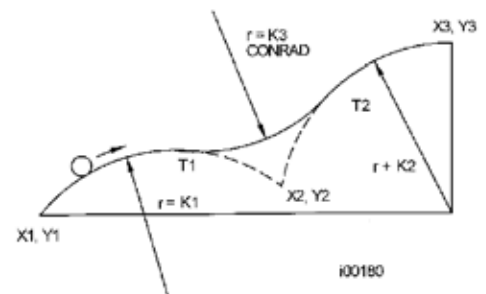
5.6 Conrad

Conrad allows you to program a tangentially connecting radius between connective events, or tangentially connecting radii for the corners of pockets and frames without the necessity of complex calculations.

For this figure, you simply program a Mill event from X1, Y1 to X2, Y2 with tool right offset, and another Mill event from X2, Y2 to X3, Y3 also with tool right offset. During the programming of the first Mill event, the system will prompt for Conrad at which time you input the numerical value of the tangentially connecting radius ($r=k$). The system will calculate the tangent points T1 and T2, and direct the tool cutter to move continuously from X1, Y1 through T1, $r=k$, T2 to X3, Y3.



For this figure, you program an Arc event from X1, Y1 to X2, Y2 with tool offset left, and another Arc event from X2, Y2 to X3, Y3 also with tool offset left. During the programming of the first Arc event, the system will prompt for Conrad at which time you input the numerical value of the tangentially connecting radius $r=K3$. The system will calculate the tangent points T1 and T2 and direct the tool cutter to move continuously from X1, Y1 through T1, $r=K3$, T2 to X3, Y3.



Note: Conrad must always be the same as or larger than the tool radius for inside corners.

If Conrad is less than the tool radius, and an inside corner is machined, the ProtoTRAK EMX will ignore the Conrad.

5.7 Memory and Storage

Computers can hold information in two ways. Information can be in **current memory** or in **storage**. Current memory (also known as RAM) is where the ProtoTRAK EMX holds the operating system and any part program that is ready to run.

In contrast, storage is where the programs are saved until they are erased deliberately. Programs are stored on the ProtoTRAK EMX on an internal flash drive that is capable of holding hundreds of typical programs.

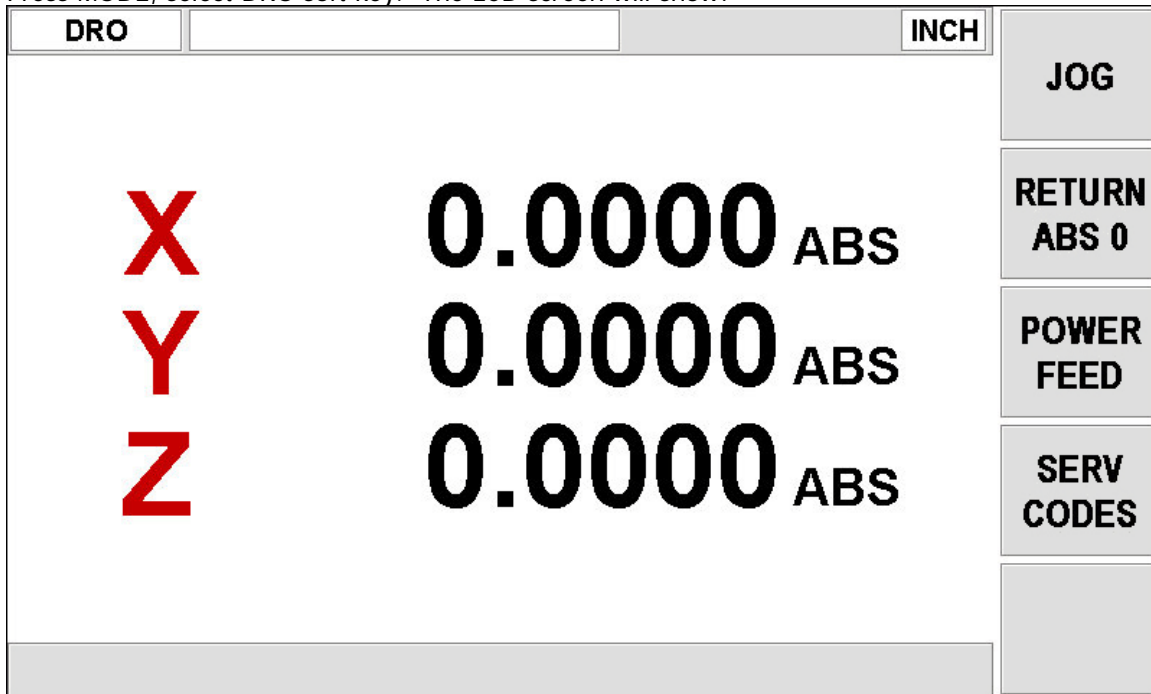
If power is lost or turned off, programs that are in current memory are lost, but programs stored on the internal drive are not.

6.0 Using the ProtoTRAK EMX as a DRO

The ProtoTRAK EMX operates in DRO Mode as a sophisticated digital readout with jog and power feed capability.

6.1 Enter DRO Mode

Press MODE, select DRO soft key. The LCD screen will show:



Note: the RETURN soft key is lit when in Jog.

6.2 DRO Functions

- **Clear Entry:** Press RSTR, then re-enter all keys.
- **Reset One Axis:** Press X or Y or Z, INC SET. This zeros the incremental position in the selected axis.
- **Preset:** Press X or Y or Z, numeric data, INC SET to preset selected axis.
- **Reset Absolute Reference:** Press X or Y or Z, ABS SET to set selected axis absolute to zero at the current position.
Note: This will also reset the incremental dimension if the absolute position is being displayed when it is reset.
- **Preset Absolute Reference:** Press X or Y or Z, numeric data, ABS SET to set the selected axis absolute to a preset location for the current machine position.
Note: This will also reset the incremental dimension if the absolute position is being displayed when it is preset.
- **Recall Absolute Position of All Axes:** Press INC/ABS. Note the dimension for each axis is labeled INC or ABS. Press INC/ABS again to revert to the original reading.
- **Recall Absolute Position of One Axis:** Press X or Y or Z, INC/ABS. Note the INC or ABS label for each axis. Repeat to get selected axis back to original reading.

6.3 Jog

The servo motors can be used to jog the table.

1. Press the JOG soft key.
2. The feedrate box will read 100 indicating the table will move in the X or Y positive direction at 100 inches per minute. A message will flash to warn you that JOG is activated.
3. Press +/- to reverse direction. The feedrate box will change to - 100" Press +/- again to go back to JOG + (the + is not shown).
4. Press the down arrow key (to the right of the LCD screen) to reduce the jog speed in 10 percent increments. The feedrate and override boxes will show these adjustments. Press the up arrow key to increase the speed. The range is between 10% and 150%.
5. Press and hold X or Y to jog that axis. Release the key to stop.
6. To jog at a given rate, for example, 25 inches per minute, simply press '25' while the jog message is flashing. This number will appear in the feedrate box. When you press X or Y you will jog at this rate. Press the up or down arrow keys to adjust. In metric this number represents the percent of the maximum, or 2540 mm/min.
7. Press RETURN soft key to return to manual DRO operation.

6.4 Return to Absolute Zero

At any time during manual DRO operation you may automatically move the table to your absolute zero location in X and Y by pressing the RETURN ABS 0 softkey. When you do, the conversation line will read "Ready to begin. Press Go when ready." Make sure your tool is clear and press the GO key. When you do, the servos will turn on, move the table at rapid speed to your X and Y absolute zero position, and then turn off. You will be at zero and in manual DRO operation.

6.5 Power Feed

The servomotors can be used as a power feed for the table or saddle or both.

1. Press the POWER FEED soft key.
2. A message box will appear that shows the power feed dimensions. All power feed moves are entered as incremental moves from the current position to the next position.
3. Enter a position by pressing the axis key, the distance to go and the +/- key (if needed). Input the entry by pressing INC SET. For example, if you wanted to make a power feed move of 2.00" of the table in the negative direction, you would enter: X, 2, +/-, INC SET.
4. Initiate the power feed move by pressing GO.
5. The feedrate is automatically set to 10 ipm (or 254 mm per min). Press the up or down arrow key to the right of the LCD screen to adjust the feedrate from 1 ipm to 100 ipm. (or 254 to 2540 mmpm)
6. Press STOP to halt power feed. Press GO to resume.
7. Repeat the process beginning at "3" above as often as you wish.
8. Press RETURN soft key to return to manual DRO operation.

6.6 Service Codes

Service codes are accessed from the DRO screen. Please see Section 10 for a detailed explanation of Service Codes.

6.7 Teach

Teach gives you the ability to enter X and Y dimensions into a program. It can be a useful way of entering a few manual moves for operations like clearing out excess material or remembering a few hole locations.

The process of using Teach is in two parts. The first part takes place in the DRO Mode. This is where you start the Teach program, establish the program events and enter the X and Y dimensions. The second part is in the Program Mode. This is where you complete the Teach events that you began in the DRO Mode by entering the rest of the data. Once the data is entered, the Teach events become just like the other events that make up a program.

6.7.1 Entering Teach Data

From the DRO screen, press Teach.

On the top of the screen, you will see the message "Teach" and an event counter. When you enter Teach, you are actually programming events. If there is already a program in current memory, Teaching will add events to the end of the program. If there is not already a program in current memory, Teaching will start a new program. For example, if you already had a program in current memory that had 10 events, when you press Teach, the event counter will say EVENT 11. If there is no program, the event counter will say EVENT 1.

The event counter shows the event for which data is being entered. You may teach in position, drill, and mill events only.

On the first Teach screen, the softkeys are:

POSN DRILL: a position / drill event.

MILL BEGIN: the beginning of a straight line or MILL event.

END TEACH: ends the teaching process and returns you to the main DRO screen.

If you press the POSN DRILL key, the event counter will go up by one and the screen remains the same. If you press the MILL BEGIN key, the event counter stays on the same number. That is because you have given the beginning point of the line but not yet the end. The softkey selections will change to:

MILL END: the last point of the Mill event. Press this to end the Mill event and select a POSN DRILL or new MILL event.

MILL CONT: the last point of the current Mill event, but the beginning of the next Mill event. You may enter successive Mill events by pressing the MILL CONT key.

Pressing either of the above softkeys will cause the event counter to increase by one.

At any time you may exit the Teach screen and return to the DRO screen. The events you have defined with their X and Y dimensions are finished in the Program Mode. See Section 7.3.6.

7.0 Programming

The ProtoTRAK EMX can be easily programmed to for a wide variety of parts in two axes.

A program is one or a series of **events**. It can either be a complete part, a set of operations on a side or only a small number of cuts. It is necessary to create a program when you want the CNC to machine the part for you.

7.1 Enter Program Mode and Assign a Program Name

To start programming, press MODE and select PROGRAM softkey. For a new program to be written, there cannot already be a program in the active or current program memory.

When you first enter Program Mode, you will encounter a screen that allows you to enter a program name or to enter the program at different events.

Event 0 is where you can enter the program name. You can also get to Event 0 by pressing Page Back from Event 1.

The program name is highlighted and you may enter a new program name at this point. Program names are made up of up to eight numbers.

Note: It is not necessary to enter a program name. If none is entered and the INC SET or ABS SET button is pushed, the system will assume the program name is 0.

The ProtoTRAK EMX automatically holds all of the completed events as you program in current memory.

Choices at the beginning of Program Mode:

GO TO BEGIN: puts Event 0 on the left side of the screen and the first event on the right side.

GO TO END: puts the last programmed event on the left side of the screen and the next event to be programmed on the right side.

GO TO #: enter the event number you wish to go to and then press SET. This puts the requested event number on the right side of the screen and the previous event number on the left.

Note: for a new program that has no Events, all the GO TO selections will take you to the beginning, with Event 0 on the left and the Select an Event options for Event 1 on the right.

7.2 Programming Strategy and Procedures

The ProtoTRAK EMX makes programming easy by allowing you to program the actual part geometry as defined by the print. The basic strategy is to select the softkey event type (geometry) and then follow all instructions in the conversation line. When an event is selected, all the prompts will be shown on the right side of the information area. The first prompt will be highlighted and also shown in the conversation line. Input the dimension or data requested and press INC SET or ABS SET. For X or Y dimension data it is very important to properly select INC SET or ABS SET. For all other data either SET will do.

As data is being entered it will show in the conversation line. If you make a mistake, for example, you press the wrong number key, you can clear the input by pressing RESTORE. When SET, the data will be transferred to the information area, and the next prompt will be shown in the conversation line.

From the event data screen you may press the up arrow key to the upper right of the LCD screen to go back to edit any data within an event.

Options within an event include:

PAGE FWD: moves forward through the programmed events.

PAGE BACK: moves backwards through the programmed events.

INSERT EVENT: use this to insert a new event into the program. This new event will take the place of the one that was on the right side of the screen when you pressed the INSERT EVENT key. That previous event, and all the events that follow, increase their event number by one. For example, if you started with a program of four events, if you were to press the INSERT EVENT key while Event 3 was on the right side of the screen, the previous Event 3 would become Event 4 and the previous Event 4 would become Event 5. If you insert a Repeat event, the event numbers will increase by one as when you insert another kind of event.

DELETE EVENT: this will delete the event on the right side of the screen.

When all data for an event has been entered, the entire event will be shifted to the left side of the screen and the conversation line will ask you to select the next event.

PROG		INCH	POSN DRILL MILL ARC POCKET FRAME REPEAT
EVENT 0	EVENT 1		
PROGRAM NAME			
<div style="border: 1px solid black; background-color: green; color: white; padding: 5px; display: inline-block;">Select an event.</div>			

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7.3 Programming Events

The following events are found in the ProtoTRAK EMX.

7.3.1 Posn Drill

This will position the table and saddle to the location you define. This event is used for drilling holes and other positioning moves.

When you press the POSN/DRILL key, you choose between:

- **One:** a single position.
- **Bolt Hole:** a series of positions spaced evenly around a circle.

When the program is run at a Posn/Drill Event, the ProtoTRAK EMX will servo at rapid (or as modified by you) to each location defined and will wait for you to finish the operation (e.g., drill the hole) and press the GO key before moving on.

7.3.2 Mill Event

Use this to machine a straight line in any direction. The prompts you answer in this event will allow the ProtoTRAK EMX to calculate the complete tool path, including the starting position and tool offsets. It is not necessary to program a rapid move to the beginning position of the Mill Event.

When the program is run at a Mill Event, the ProtoTRAK EMX will rapid to the beginning position, prompt you to set the quill Z depth, move through the Mill Event at the speed you program and end at the ending position. (See the discussion on **Continue** below for the variation in tool motion if the event is connective).

7.3.3 Arc Event

This is any part of a circle. Like the Mill Event, the prompts you answer will allow the ProtoTRAK EMX to calculate the complete tool path.

When the program is run at an Arc Event, the ProtoTRAK EMX will rapid to the beginning position, prompt you to set the quill Z depth, move through the Arc Event at the speed you program and end at the ending position. (See the discussion on Continue below for the variation in tool motion if the event is connective).

7.3.4 Pocket/Frame Event

Use this event to machine a pocket or frame with a minimal amount of programming. When you press the Pocket/Frame key, you choose between the following:

- **Circle pocket:** a circle and all the material in the center. Includes finish cut.
- **Rectangular pocket:** a rectangle and all the material in the middle. Includes finish cut.
- **Circle frame:** a circular circumference. Includes finish cut.
- **Rectangular frame:** a square or rectangular circumference. Includes finish cut.

When the program is run at a Frame Event, the ProtoTRAK EMX will rapid from wherever it is to 3 o'clock on circular pockets and frames and X1, Y1 on rectangular pockets and frames. After you set the cutter and press go, it will move through the first pass and then the finish cut at the programmed feedrate and then move the cutter away from the part by the amount of the programmed finish cut.

The Pocket Event will rapid to the center of the circle or rectangle. After you set the cutter and press GO, it will move in a logical path through the material (leaving the finish cut, if one is

programmed), using 70% of the cutter diameter. After the center is cleared, it will do the finish cut and ramp away from the part at the end by the amount of the programmed finish cut.

7.3.5 Repeat Events

This allows you to repeat an event or a group of events up to 99 times, with an offset in X or Y. This can be useful for drilling a series of evenly spaced holes, duplicating some machined shapes or even repeating an entire program with an offset for a second fixture. Another use is to repeat a programmed set of drill events (without offsets) so you can center drill, drill, and counterbore without reprogramming the second and third operations.

Repeat events may be "nested" up to five deep. That is, you can repeat a Repeat Event, of a Repeat Event, of a Repeat Event of some programmed event(s). One new tool number may be assigned for each Repeat Event.

7.3.6 Subroutine Events

The Subroutine Events are used for manipulating previously programmed geometry within the XY plane.

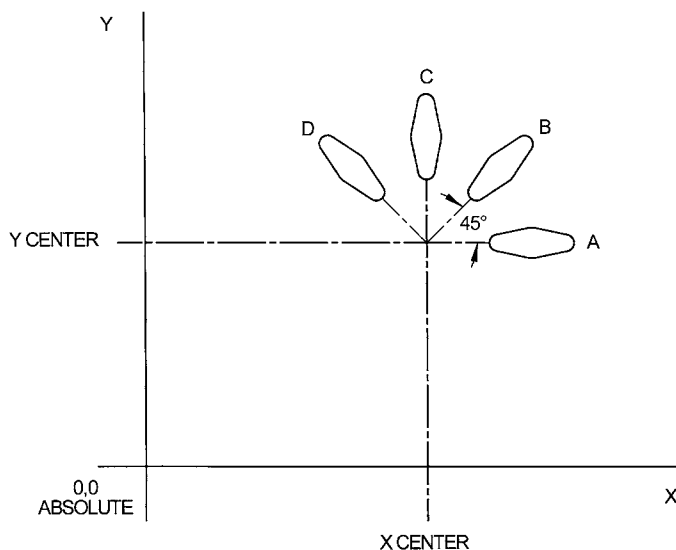
The Subroutine Event is divided into two options: Repeat and Rotate.

Repeat and Rotate may be connective. As long as the rules of connectivity are satisfied (see Section 5.5), the ProtoTRAK EMX will continue milling between preceding and subsequent events.

REPEAT allows you to repeat an event or a group of events up to 99 times with an offset in X and/or Y. This can be useful for drilling a series of evenly spaced holes, duplicating some machined shapes, or even repeating an entire program with an offset for a second fixture.

Repeat events may be "nested." That is, you can repeat a repeat event, of a repeat event, of some programmed event(s). One new tool number may be assigned for each Repeat Event.

ROTATE is used for polar rotation of parts that have a rotational symmetry around some point in the XY plane. In addition to specifying the events to be repeated, you must also indicate the absolute X and Y position of the center of rotation, the angle of rotation (measured counterclockwise as positive; and clockwise as negative), and the number of times the specified events are to be rotated and repeated. You may not rotate another rotate event. Consider the figure below:



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FIGURE 7.3 *Shape A programmed with 4 MILL events and Conrads. Using ROTATE, these 4 events are rotated through a 45 degree angle about a point offset from absolute zero by X Center and Y Center dimensions. A is rotated 3 times to produce shape B, C, and D.*

Press the **SUB** soft key to call up the Repeat and Rotate options.

7.3.7 Finishing Teach Events

Teach events are either POSN/DRILL or MILL events that are originated in the DRO Mode (see Section 6.7).

The Teach events that are started in the DRO Mode must be finished in the Program Mode before running. Teach events are of these different types:

TEACH POSN/DRILL - See Section 8.1 for a description of Position/Drill event prompts.

TEACH MILL - a straight line that specifies the beginning and the end. When TEACH MILL events are defined using the CONT MILL softkey, the prompts for information that cannot change will be suppressed. See Section 8.3 for a description of Mill event prompts.

When a Teach event is unfinished, the event header will appear in purple. Once all the prompts are completed, the word "Teach" will disappear. The event will become a normal POSN DRILL or MILL event.

7.4 Prompts Used to Define the Events

The following prompts are encountered in programming the events.

Holes - the number of holes in the bolt hole pattern.

Angle - the location of the first hole to be machined in a Bolt Hole event. It is the angle from the positive X axis (that is, 3 o'clock) to the hole. The positive angle is measured counterclockwise from 0.000 to 359.999 degrees.

Conrad - There are two meanings to Conrad:

1. The connecting radius between line or arc being programmed and the next line or arc event. Simply enter the radius value at this prompt and the ProtoTRAK EMX will figure the tool path to go from one event to the next with a connecting radius. If no radius is desired, or if you are programming the last event, enter 0 by pressing the INC SET or ABS SET key without a number value.
2. The corner radius in a rectangular pocket or frame. The radius is tangential.

Continue - to tell the ProtoTRAK EMX if the event is continuous to the next event(s) to be programmed. This saves inputs needed to define a profile. If the event is programmed with a Yes, for continue, then X begin, Y begin, Tool Offset, Feedrate and Tool # will not be prompted in the next one.

Direction - for an arc or circle, the direction is clockwise or counterclockwise.

Feedrate - the milling feedrate in in/min from .1 to 99.9 or in mm/min from 5 to 2500.

Fin cut - for a pocket or frame, the width of the finish cut. If 0 is input, there will be no finish cut.

Radius - the radius of the bolt hole pattern, arc or circle.

Tool # - the number you assign to identify the tool.

Tool Diameter - the diameter of the tool. See the note on finish cuts later in this section.

Tool offset - the selection of the tool offset, right, left or center relative to the programmed edge and tool movement.

X or Y - the X or Y dimension, may be defined in absolute or incremental reference.

X Begin or Y Begin - the X or Y beginning point of the line or arc.

X Center or Y Center - the X or Y dimension of the center of the bolt hole pattern, arc or circle.

X End or Y End - the X or Y ending point of the line or arc.

X1, Y1, and X3, Y3 - the X and Y dimensions for the opposite corners on a rectangular pocket or frame.

Prompts unique to the Repeat event:

First Event # - the first event to be repeated.

Last Event # - the last event to be repeated. If only one event is to be repeated, the First and Last events will be the same number.

X Offset - the incremental X offset from the event to be repeated.

Y Offset - the incremental Y offset from the event to be repeated.

Repeats - the number of times the events are to be repeated up to 99.

7.5 Continue

In MILL and ARC events the ProtoTRAK EMX will ask you to choose YES or NO to the continue prompt.

If you want the cutter to keep machining from the event you are programming to the next event without stopping, you should choose YES. If you want the cutter X/Y motion to stop so that you can adjust Z quill position, then choose NO.

If you choose YES, then the next event must be a connective event. Prompts for the X Beginning location, Y Beginning location, Tool Offset, Feedrate, and Tool # will not be asked because, if the events are connective, this data is already known. The programmed feedrate may be different for different events, even when the events are connective. To change the feedrate within a group of connective events, finish programming the event and then use the up arrow key to get access to the feedrate prompt in previous events.

7.6 Assumed Tool Offset, Feedrate, and Tool

When the INC SET key is pressed, the ProtoTRAK EMX will automatically program the following for these prompts:

TOOL OFFSET: for a Mill or Arc Event, same as the last event if that event was a Mill or Arc Event, otherwise, Tool Center.

FEEDRATE: same as last event if that event was a Mill, Arc, Pocket, or Frame.

TOOL #: same as last event, or Tool 1 in the first event.

You may change these assumed inputs by simply inputting the correct data when the event is programmed.

7.7 Incremental Reference Position

When X and Y data for the beginning position of any event are input as incremental data, this increment must be measured from some known point in the previous event. Following are the positions for each event type from which the incremental moves are made in the subsequent event:

POSITION/DRILL: X and Y programmed

BOLT HOLE: X CENTER and Y CENTER programmed

MILL: X END and Y END programmed

ARC: X END and Y END programmed

CIRCLE POCKET or FRAME: X CENTER and Y CENTER programmed

RECTANGLE POCKET or FRAME: X1 and Y1 corner programmed position

REPEAT: The appropriate reference position for the event prior to the first event that was repeated.

7.8 Finish Cuts

The Pocket and Frame events are designed with built-in finish cut routines because they are complete, stand-alone pieces of geometry. Shapes machined with a series of Mill or Arc events don't have an automatic routine for making finish cuts.

Instead, it is very easy to get a finish pass by overstating the size of the tool for the events in the initial pass, and then using a Repeat Event and programming a new tool with the actual size of the tool.

For the first pass, the cutter will be positioned away from the final cut half the amount of the difference between the actual size of the cutter and the diameter you put in. When the Repeat Events are run, the same cutter will be positioned correctly to do the final pass to size.

7.9 Look

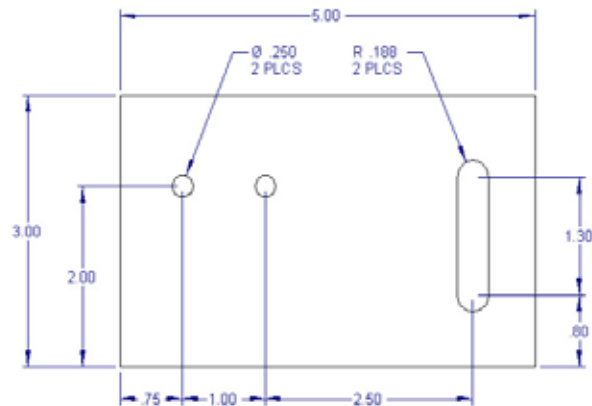
You can look at part graphics while in the Program Mode. At any time an event is finished programming and the Select Event prompt appears in the conversation line, simply press the LOOK hard key. The programmed events are automatically sized so that everything fits on the screen.

To return to the programming, press the RETURN softkey.

The part graphics are useful for checking what you have programmed so far. Certain kinds of programming mistakes are not caught by the graphics. These will surface when running the program.

7.10 A Sample Program

This simple part will be used to illustrate the process of programming.



Steps

1. Decide the order of machining. This part can be held in a vise. First we will drill the two holes and then we will mill the slot.
2. Decide the Absolute reference. In this case we will use the lower left corner as our 0 location for X and Y.
3. Enter the Program Mode. If there is already a program in the current memory, go into the Program In/Out Mode and press the CLEAR CURRENT softkey. (You may want to store the program in current memory first.)
4. Assign a part number. When there is no program in the current memory, the system will prompt for a program part number as soon as it goes into Program Mode. Enter a numeric part number (or not, if you don't want one) and press SET.
5. Program the first hole.

Event 1

Prompt	You push these keys
SELECT EVENT	POSN/DRILL
SELECT	ONE
X	.75 ABS SET
Y	2. ABS SET
Tool #	1 INC or ABS SET
Tool Dia	.1 INC or ABS SET

Notes:

- For the non-referenced data, either SET key will do.
- This first tool is a center drill. For the Position/Drill Event, the program will run without a tool diameter, but one may be entered as a reminder.

6. Program the second hole.

Event 2

Prompt	You push these keys
SELECT EVENT	POSN/DRILL
SELECT	ONE
X	1. INC SET
Y	INC SET
Tool #	INC SET
Tool Dia	INC SET

Notes:

- For the dimensions, it was handy to read these right off the print and put them in as incremental moves from the previous hole. We could have also programmed using $X = 1.75$ ABS SET and $Y = 2.0$ ABS SET.
- The INC SET entry for Y was taken as a 0 incremental move, you do not have to press 0.
- The INC SET for the Tool # and Tool Diameter were taken as "use the data from the previous event."

7. Repeat the holes to drill to size.

Event 3

Prompt	You push these keys
SELECT EVENT	REPEAT
First Event #	1 INC or ABS SET
Last event #	2 INC or ABS SET
X offset	INC SET
Y offset	INC SET
No. of Repeats	1 INC or ABS SET
Tool #	2 INC or ABS SET
Tool Dia	.25 INC or ABS SET

Note: We want to visit the same two holes, in the same place, with a different tool to do the final drilling.

8. Look at what you have programmed. Press the LOOK key. You will see two + marks on opposite sides of the screen to show where the holes have been programmed. Press RETURN to get back to the programming.

9. Program the slot.

Event 4

Prompt	You push these keys
SELECT EVENT	MILL
X Begin	4.25 ABS SET or 2.5 INC SET
Y Begin	.8 ABS SET
X End	INC SET
Y End	1.3, INC SET
Conrad	INC SET
Tool Offset	0, INC or ABS SET
Feedrate	7.5, INC or ABS SET
Continue	2, INC or ABS SET
Tool #	3, INC or ABS SET
Tool Dia	.375, INC or ABS SET

10. Look at the program again. If all went well, you should now see the two holes and slot tool path in the same proportion as they appear on the print. If not, check your inputs and try again.

When you machine the part, you will probably want to use a drill to open up a hole at the beginning of the slot for your milling tool. To do that, you can either:

- program a position event for the drill, or
- when the ProtoTRAK EMX positions at the beginning of the slot, center drill and drill first, then put in your mill.

If you have a lot of parts to do, it is worth your while to add the drill into the program, but probably not if you only have one or two. The great thing about the ProtoTRAK EMX is you don't *have* to make it part of the program. It still does the positioning for you and you have the flexibility to do the drill operations before you press the GO button for the milling.

8.0 Changing or Correcting Programs

In the Program Mode, you can easily correct mistakes or make changes to the program.

8.1 Deleting a Partially Programmed Event

If you wish to not program an event (or start over) after you have started to program, press the DELETE EVENT softkey and the screen will revert to the "Select Event" prompt.

8.2 Editing Data while Programming an Event

All data is entered by pressing the appropriate numeric keys and pressing INC SET or ABS SET. If you enter an incorrect number before you press INC SET or ABS SET you may clear the number by pressing RESTORE. Then, input the correct number and press SET.

If incorrect data has been entered and SET, you may correct it as you are still programming that same event by pressing the arrow up or arrow down keys to the right of the LCD screen until the incorrect data is highlighted and shown in the conversation line. Enter the correct number and SET. The ProtoTRAK EMX will not allow you to skip past prompts (by pressing an arrow key) that need to be entered to complete an event.

8.3 Editing Previously Programmed Events

From the Select Event screen you may press the arrow up key to the right of the LCD screen and the program will move back one event. From that point, you will have the following softkey options:

INSERT EVENT allows you to insert a new event between the two shown on the left and right side of the screen. When you press INSERT EVENT the screen will revert to the Select Event screen and you may program the new added event as you would any other. Subsequent events will be renumbered accordingly.

DELETE EVENT allows you to delete the event on the right side of the screen. Subsequent events will be renumbered accordingly.

PAGE FWD (Forward) indexes the event forward by one.

PAGE BACK indexes the event back by one.

8.4 Changing the Feedrate

If the feedrate is edited in any event it will automatically be edited in every subsequent and contiguous event with the same tool number and feedrate. For example, let's say events 5 through 10, and 13 through 16 were all programmed with tool number 2, and 5 inches per minute feedrate. If you edit the feedrate in Event 7 to 3 inches per minute, it will automatically change Events 8, 9, and 10 also. Events 5, 6, 13, 14, 15, and 16 will not be affected

8.5 Changing a Part Number (making a copy of a program)

You may want to rename a part program, or make a copy of a program using a different name. The latter may be useful if you have a new part to do that is similar to a part that you already have programmed. Make a copy of the program by saving it under a new part number and then make the changes.

You can rename a part program in three ways:

- Press the PAGE BACK key past the first event until you are at Event 0 and the prompt for Program Part Number. Enter the new part number and press SET.
- Exit the Program Mode by pressing Mode and then re-enter it. You will have an opportunity to rename it then.
- Rename it in the Program In/Out Mode. After pressing the PROG IN/OUT key, simply enter the new part number and press SAVE.

If the previous part program is already stored on the system internal storage it will remain in storage under the previous part number with the same information it had the last time it was stored.

8.6 Saving Changes to a Program

If a program is opened from storage and changes are made, the program must be stored again in Prog In/Out Mode for the changes to be preserved in the stored copy. Programs in current memory may be changed and run with the changes, but unless they are saved again, the changes made will be lost when the program is cleared from current memory. If you intend to keep the changes made to your program it is a good practice to store the program occasionally in case a power loss causes the program to be ejected from current memory.

8.7 Erasing an Entire Program

To erase an entire program from *current memory*, go to the Program In/Out Mode and press ERASE PROG. You will be prompted "Are you sure you want to erase this program?" You may want to store the program before you clear it from current memory. If it is not stored, pressing YES will permanently erase the program.

To erase an entire program from the internal *storage*, input the part number and then press DELETE. Programs in current memory will not be affected by this operation. You could erase a part number on the internal storage and the program in current memory will remain in current memory, even if it has the same part number as the one just erased.

Programs in current memory will automatically be erased when another program is retrieved from storage.

9.0 Making Parts with the CNC

9.1 Setting Up

Before you can run your program, you must set your absolute position in the DRO Mode. The CNC will use this absolute position as a reference for running your program.

9.2 Starting

After setting up in the DRO Mode, go into the Run Mode. You will see this screen:

The screenshot shows the CNC Run Mode interface. At the top, there are buttons for 'RUN' and 'INCH', and a text box for 'P/N 0'. Below these, there are fields for 'Event 1' and 'MILL', and 'Repeat 0'. The main display area shows the absolute positions for X, Y, and Z axes, all set to 0.0000. A green overlay box with white text provides instructions: 'LOAD TOOL #1, 0.2500 DIA. START SPINDLE PRESS GO FOR CNC RUN'. At the bottom, there are fields for 'Feed Rate 100.0' and 'Override 100'. The status line at the bottom right displays 'i01282'.

The part number appears in the status line.

To start the program, select between START and START EVENT#.

- START – starts running the program from the beginning.
- START EVENT # – starts running the program from an event in the middle. If you press this key you will be prompted to enter the event number for where to start.

9.3 Display Messages in Program Run

IN POSITION: appears in the status line when the program has come to a pause.

EVENT # and type: This is the current or next event to be run.

REPEAT: the number of the repeat for repeat events.

FEEDRATE: the actual table feedrate.

OVERRIDE: the feedrate override, controlled by pressing the up or down arrow keys above and below the soft keys.

9.4 Program Run Prompts

During Program Run, messages that direct you will appear in a green box. The ProtoTRAK EMX will wait until you press Go before moving the servo motors. What you need to do is obvious in most cases. Below is some supplemental information.

Check Z: Means to make sure the quill is properly retracted because the next move will be rapid. Press GO to continue.

Set Z: Means to drill and retract the quill for a drilling operation, or set and lock the quill to the proper depth for a milling cut. Press GO to continue.

Run Over: Means that the program run is complete. If you are running a second part that will be fixtured/clamped in the exact same position as the first part, you do not need to relocate the absolute 0 and restart. Instead, press the NEXT PART softkey when the conversation line states "Run Over" and the system will proceed directly to Event 1.

9.5 Stop

At any time, pressing the STOP key will halt the program. This freezes the program at that point. To continue, press the GO key.

9.6 Feedrate Override

The run feedrate may be changed at any time by pressing the up and down arrow keys to the right of the LCD screen. Each press changes the programmed feedrate (as well as the rapid feedrate) in 10% increments. The maximum overrides are from 10% to 150% of programmed feedrates.

9.7 Trial Run

Before cutting material, it is recommended that you do a trial run by keeping the quill up while the program runs through. Verify that the absolute reference is set correctly.

9.8 Data Errors

A program must make sense geometrically. For example, you can't machine a .250 inch diameter circular pocket using a .500 inch end mill. Data errors will nearly always be detected when the ProtoTRAK EMX runs through a program--either as a trial run or on an actual part run.

The Error message displays the error number (not necessarily important to you) and the event where the error was detected. This is not necessarily the event that is in error since the system often "looks ahead" to make sure there is compatibility from one event to another.

In addition, an explanation is given for each data error type as well as a suggested solution.

9.9 Fault Messages

The ProtoTRAK performs a number of automatic checks or self-diagnostics. If problems are found it will signal you through the display.

10.0 Math Help

Prints are, unfortunately, not always drawn and labeled in such a way as to provide all of the points necessary for programming. To minimize this problem, the ProtoTRAK EMX provides a graphic math help function which can be used to automatically calculate points of intersection, centers of arcs, trig functions, square roots, etc.

10.1 Procedure

To enter the Math Help Mode, press MODE and select the MATH HELP soft key. The screen will show:

MATH		INCH	A
A Line-Line Intersection B Line-Arc and Arc-Arc Intersection C Line-Arc Tangency D Centers, Points, Radius, Angles of Circles E Polar-Cartesian Transformation			B
			C
			D
			E

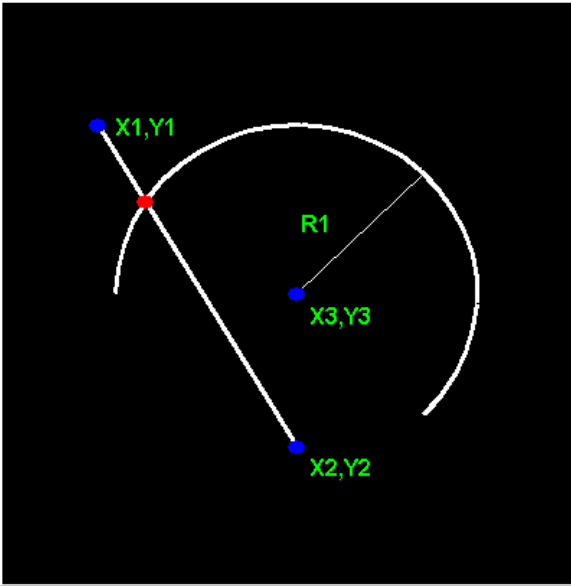
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If you already know the math help type you want (see Section 10.2) press the TYPE # softkey and enter the number and SET.

If you do not know the type, select from A through E using the softkeys.

If, for example, you wish to find the intersection of a straight line and an arc or circle, press the B softkey. The screen will show three choices for finding the intersection of a line with different information given.

If the information you know about the line and arc correspond to Type 13, then select the 13 softkey. The screen will then show:

MATH		INCH	
			
TYPE 13:			
X1	0.0000		
Y1	0.0000		
X2	2.0000		
Y2	0.0000		
X3	0.2500		
Y3	0.2500		
R1	0.0000		
		DATA UP	
		DATA DOWN	
		RETURN	
R1 :		0.0000	

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Input the known data in the same way you would program an event. When all of the data is entered, the solution (or solutions if there are more than one) will be shown on the left side of the information area.

There are often multiple solutions for geometry problems. For example, in the Type 13 example above, a line will often intersect an arc or circle in two places. In these cases all possible solutions will be calculated and displayed. In most cases a careful inspection of the print and some common sense will tell you which solution applies to your problem.

10.2 Math Help Types

Type #	What you need	What you know
10	Intersection of two lines	<ul style="list-style-type: none"> • 2 points on each line
11	Intersection of two lines	<ul style="list-style-type: none"> • 2 points on one line • 1 point on the other line • angle between the lines
12	Intersection of two lines	<ul style="list-style-type: none"> • 2 points on one line • 1 point on the other line • a radius tangent to both lines <i>when</i> one of the points on the two points known line is also on the radius
13	Intersection of a line and an arc	<ul style="list-style-type: none"> • 2 points on the line • arc center • arc radius
14	Intersection of a line and an arc	<ul style="list-style-type: none"> • 2 points on the line • 2 points on the arc • arc radius
15	Intersection of two arcs	<ul style="list-style-type: none"> • center of each arc • radius of each arc
16	Intersection of a line tangent to two arcs (line does not cross arc centers)	<ul style="list-style-type: none"> • center of each arc • radius of each arc
17	Intersection of a line tangent to an arc	<ul style="list-style-type: none"> • one point on the line • center of the arc • radius of the arc
18	Intersection of a line tangent to two arcs (line crosses arc centers)	<ul style="list-style-type: none"> • center of each arc • radius of each arc
19	Center and points of intersection of an arc tangent to two arcs	<ul style="list-style-type: none"> • 2 of the arc centers • all 3 radii
20	Center of an arc	<ul style="list-style-type: none"> • 2 points on the arc • radius of the arc
21	Point on an arc	<ul style="list-style-type: none"> • center of the arc • another point on the arc • angle between known and unknown points
22	Radius of an arc or circle	<ul style="list-style-type: none"> • 1 point on the arc • center of the arc
23	Center of an arc or circle	<ul style="list-style-type: none"> • 2 points on the arc • angle between the 2 points
24	Center and radius of an arc or circle	<ul style="list-style-type: none"> • 3 different points on the arc
25	Cartesian (X and Y) location	<ul style="list-style-type: none"> • polar (R and angle) coordinates
26	Angle in decimal	<ul style="list-style-type: none"> • angle degrees, minutes and seconds
27	Accurate X Y Center	<ul style="list-style-type: none"> • given X Y Center • 2 points on the arc
28	Sides and angles of a right triangle	<ul style="list-style-type: none"> • at least one side and another side or an angle

11.0 Program Memory & Storage

The ProtoTRAK EMX can only have one program at a time in current memory. This is the program you see when you enter the program mode and is the one that is available to run.

Programs may be stored for future use on the ProtoTRAK EMX internal storage.

Part programs are saved to storage or opened from storage in the Program In/Out Mode. When programs are transferred back and forth from current memory and storage, they stay in both locations unless erased or cleared. In other words, opening a program from internal storage into the current memory does not remove it from the internal storage. Only deleting the program will remove it.

11.1 Cautions About Opening and Deleting Programs

Care must be taken to keep from losing a program you wish to keep. This can happen two ways.

First, whenever a program is opened, it is loaded into the ProtoTRAK EMX's computer program memory. When this happens, your existing current program is erased. Therefore, if your current program is one you want to keep, be certain to store it before you retrieve another program.

Second, to store a program it must have a part number so that the ProtoTRAK EMX can find it when you want to open it. However, no two programs can have the same part number (how would the system decide which to retrieve?). Therefore, if you store a program with any particular part number, it will automatically erase any other program with that same part number.

In both cases above the ProtoTRAK EMX will give you a warning before erasing or overwriting your program.

11.2 Program Formats and Labeling

The ProtoTRAK family of products has its own unique programming system--one that organizes the program into events rather than codes and blocks. Programs written on a two-axis milling control (such as the ProtoTRAK EMX) will have the extension .MX2.

The .MX2 programs created by the ProtoTRAK EMX is compatible with those created on other ProtoTRAK two-axis CNCs, provided that the event types of the program are found in the control that is running the program.

11.3 Saving and Opening Programs from the ProtoTRAK EMX internal storage

Press MODE, and select the PROG IN/OUT softkey. The display will show:

PROG I/O		INCH	
0.MX2	115001.MX2	140014.MX2	OPEN
1.MX2	115002.MX2	140015.MX2	
10.MX2	115003.MX2	140016.MX2	
1009.MX2	123.MX2	140017.MX2	SAVE
105001.MX2	140001.MX2	140018.MX2	
105002.MX2	140002.MX2	140019.MX2	
105003.MX2	140003.MX2	140020.MX2	DELETE
105004.MX2	140004.MX2	18.MX2	
105005.MX2	140005.MX2	2.MX2	
105006.MX2	140006.MX2	22222.MX2	ERASE PROG
105007.MX2	140007.MX2	3051.MX2	
105008.MX2	140008.MX2	33.MX2	
105009.MX2	140009.MX2	333.MX2	PAGE FWD
11.MX2	140010.MX2	4.MX2	
111291.MX2	140011.MX2	4051.MX2	
111292.MX2	140013.MX2	45.MX2	
Program Name : 0			

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A view of Program In/Out Mode with a few programs saved.

- All part numbers in the ProtoTRAK EMX internal storage are listed in the Information Area.
- The part number of the current program (in current memory) is shown in the conversation line. You may change the part number at this screen by entering a new number and pressing SAVE.
- OPEN will write a program from the internal storage to current memory. First input the part number and then press the OPEN key. Then you will have the option of either opening as an MX2 or CAM file type. For more on CAM files and G-Code see section 11.5.
- SAVE will write the program in current memory to the internal storage. You will see the program added to the list in the information area after it is stored.
- DELETE will erase a program from the internal storage. First input the program number and then press the DELETE key.
- ERASE PROG will erase the program from current memory. You do this to clear current memory in order to write a new program.
- The PAGE FWD (Forward) softkey will continue the part number list if there are too many to be shown on the screen.

11.4 File Transfer and Backup

A USB port is provided and an optional USB Thumb drive offered as a convenient way to transfer and backup part programs.

If you buy the optional thumb drive from Southwestern Industries, it will already be configured correctly.

If you get your own thumb drive, please read the following:

- Please refer to page 12 for the list of thumb drives we have verified will work. Other brands, such as Sandisk, do not work at this time. This includes, unfortunately, Sandisk thumb drives that worked in previous ProtoTRAK models.
- Before you can transfer programs from the thumb drive to the ProtoTRAK EMX, you must put the files in a folder named "Programs".

To move files from the ProtoTRAK EMX internal storage to a thumb drive, do the following:

1. Plug the Thumb Drive into the ProtoTRAK EMX USB port.
2. Go to the DRO Mode.
3. Press Serv Codes.
4. Under group A, Software Service Codes, select code 340 "Copy Files from Control to USB Drive.
5. The ProtoTRAK EMX will place a folder on the thumb drive named "Programs" (if one doesn't exist already and write the programs saved in the internal storage of the ProtoTRAK EMX to the USB Thumb Drive. The programs will now be saved in both places.

To move files from a thumb drive to the ProtoTRAK EMX internal storage, do the following:

1. Plug the Thumb Drive into the ProtoTRAK EMX USB port.
2. Go to the DRO Mode.
3. Press Serv Codes.
4. Under group A, Software Service Codes, select code 341 "Copy Files from USB Drive to Control.
5. All the programs saved in the folder "Programs" on the thumb drive will also be saved on the ProtoTRAK EMX internal storage.

If there are programs with the same name in the destination location you will be asked by the ProtoTRAK EMX if you want to overwrite the existing file.

Programs of different names on the destination location will not be affected.

In keeping with our philosophy to make the ProtoTRAK EMX as simple as possible, we have elected the simplest possible program storage routines. File transfers between the ProtoTRAK EMX and thumb drive will move all programs between the two. This eliminates the complexity of adding file management to the ProtoTRAK EMX system. Files may be managed on the thumb drive with your offline computer.

11.5 CAM / G-Code files

The ProtoTRAK EMX allows you to open CAM / G-Code files and convert them into the Prototrak EMX programming format. First you must transfer the programs into the Prototrak's internal memory as described in section 11.4. The filename must be numeric, no more than 8 digits long, and have a .CAM file extension. The supported G-Code format is identical to that of any of our past 2 axis controls that had the CAM option.

11.5.1 G Codes Recognized by the ProtoTRAK EMX

G00	positioning (rapid)
G01	linear interpolation (feed)
G02	circular interpolation CW
G03	circular interpolation CCW
G20	input in inch
G21	input in mm
G40	cutter compensation cancel (for SWI it means center)
G41	cutter compensation left
G42	cutter compensation right
G80	cancel canned cycle
G81	drill canned cycle

11.5.2 M Codes Supported by the ProtoTRAK EMX

M00	program stop with prompt (press go to procd.)
M01	optional stop
M02	end of program (no rewind)
M06	tool change
M30	end program (rewind stop)

11.5.3 Valid Characters for Word/Address Sequences

G	Prepare to execute a G COMMAND
M	Prepare to execute a M COMMAND
N	Introduces a block number
T	Specifies the tool number to use
F	Specifies a feedrate
X	Specifies the X dimension
Y	Specifies the Y dimension
Z	Specifies the Z dimension
I	Specifies the incremental X dimension
J	Specifies the incremental Y dimension

12.0 Service Codes

Service codes are special codes used for set-up, installation or program file transfer.

12.1 Service Code Procedure

Go to the DRO Mode.

Press **SERVICE CODES**.

Input one of the codes from the list in section 12.2

Press **SET**.

For some of the codes, there are additional instructions.

12.2 Service Code Types

Code	Description	Notes
12	Determine feed forward constant	Runs a routine that determines the system friction for setting feed forward constant. Caution! Do not use this code unless you understand the consequences. For more details, see SWI Publication No. 26055 "ProtoTRAK EMX Installation and Service Manual."
13	Reset the default feed forward constant	In case you ignored the warning above, this resets the default set at the factory.
15	Activate or Deactivate Z readout	The Z-axis readout should be activated if you installed the optional Z-axis scale. This may be added to your system at any time and the Z readout activated by this code.
22	Turn on simulation	For demo purposes, the ProtoTRAK EMX may be run in simulation mode where the control operates normally but does not send commands to the motors. If you use this code, don't forget to restore your CNC to normal operation with Service Code 89! Simulation mode is also cancelled by turning the control on and off.
33	Software ID	Displays the version of software your ProtoTRAK EMX is using.
54	Continuous run mode	Keeps running the system through the program without stopping. It is used for testing.
66	Metric mode	To have the ProtoTRAK EMX power up in Metric measurement.
67	Inch mode	To have the ProtoTRAK EMX power up in Inch measurement.
79	Turn on beeper	Factory setting.
80	Turn off beeper	For stealthy machining.
81	Keyboard test	For testing the front panel buttons.
89	Cancel simulation	Cancel the Service Code 22 simulation.

Code	Description	Notes
97	Axis configuration	To orient the motor encoder. This should not need to be done except in a service situation.
100	Axis open loop test	Runs selected axis at rapid for one second and displays values. Caution! The machine will move. Be sure you understand the consequences before you use this code. See SWI Publication No 26055 "ProtoTRAK EMX Installation and Service Manual."
122	Calibration offset	Use this to modify your calibration factor. Cut part, measure, follow the instructions on the screen .
123	Calibration of each axis of measurement.	Detailed instructions are found in SWI Publication No. 26055 "ProtoTRAK EMX Installation and Service Manual."
125	Display calibration factors	See SWI Publication No. 26055 "ProtoTRAK EMX Installation and Service Manual."
127	Single encoder backlash calibration	Used to calculate a backlash value for entering in Code 128. See SWI Publication No. 26055 "ProtoTRAK EMX Installation and Service Manual."
128	Enter backlash value	Used to enter the backlash value calculated using Code 127. See SWI Publication No. 26055 "ProtoTRAK EMX Installation and Service Manual."
141	Load parameters	Will take parameters from USB thumb drive
142	Save control parameters	Save parameters to the USB thumb drive.
316	Update software	Used to update to the latest software version from the USB thumb drive.
340	Back up programs	Copy all the programs on the internal storage to the USB thumb drive.
341	Load programs	Copy all the programs on the USB thumb drive to the internal storage.

13.0 ProtoTRAK EMX Tutorial

The purpose of this tutorial is to help you to learn the operation and programming of the ProtoTRAK EMX. We've repeated some of the information found elsewhere in this manual so that you could go through this tutorial without flipping back and forth between pages. We will not cover all the operations of the ProtoTRAK EMX, just enough to get you comfortably started.

If you have been running a knee mill with a DRO, the ProtoTRAK EMX is about to make your life a lot easier. Just stay with this program for a couple of hours and you'll be making more parts with less effort in no time.

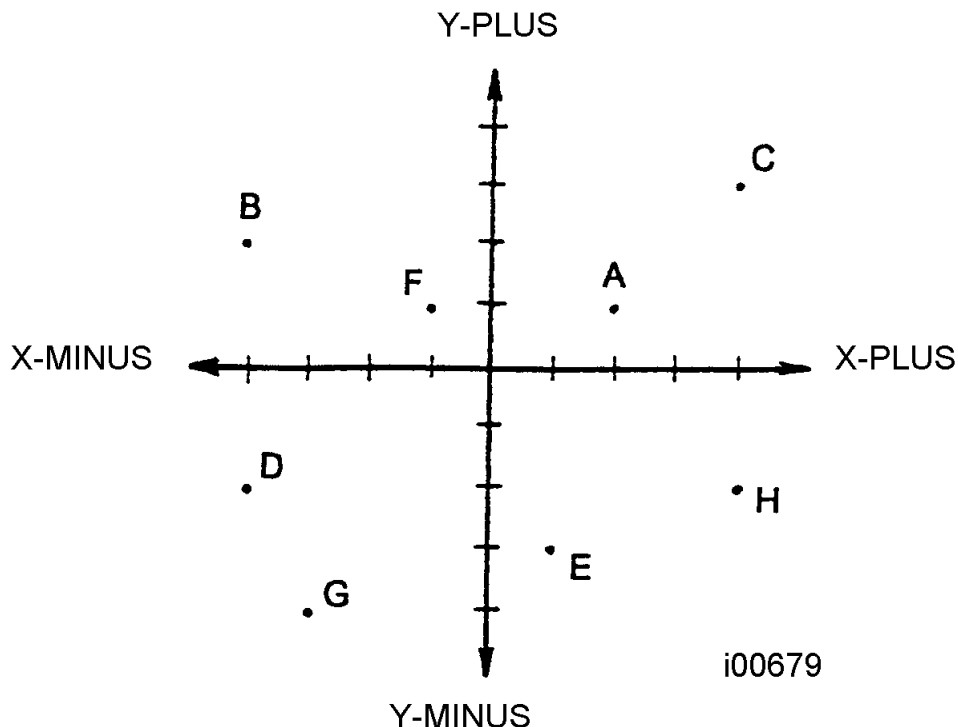
We assume you know how to run a knee mill, know how to read a blueprint, and have at least a little experience inputting information into a box like a digital readout or a computer. We told you this would be easy.

13.1 Working with Definitions, Terms, and Conventions

This first section contains some paper-and-pencil exercises to help get you warmed up and to clear up some stuff that may trip you up later. It isn't hard, to just take the twenty minutes or so you need to get through it.

X, Y, Plus (+), Minus (-)

The ProtoTRAK EMX works in the Cartesian Coordinate System. This is the common number line system that we can use to plot the location of a point in two dimensions, X and Y. Any given point may be located exactly by plotting its position on the X and Y axes. For example, the point A below is at point X = 2, Y = 1, or (2,1).



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The point where the X line and the Y line cross is the 0,0 point. This is known as Absolute 0.

To the right of the Absolute 0 is the X plus. To the left is X minus. That is true for points whether or not they are actually on the X line or not.

Above the Absolute 0 is Y plus, below is Y minus. Again, that is true whether the point is actually on the Y line or not.

Quiz 1

Answer these questions about what you've just read. Check your answers at the end of this section.

1. Absolute 0 is the point where _____.
2. Left of the Absolute 0 point is (X or Y) minus.
3. Above the Absolute 0 point is (X or Y) plus.
4. True or false. Any point in two dimensions can be plotted with the Cartesian Coordinate System.

Tip: if you have any problem with this part, take this manual out to your machine and put the drawing under the spindle so that the 0,0 point is lined up with the center of the spindle. Zero out the DRO on your display and crank the table different directions. Watch the DRO measurement count up and down, turning from positive to negative as you pass the 0,0 points.

Quiz 2

Write down the X and Y dimensions (including the + or - sign) of points A through H in the figure above:

	X	Y
A		
B		
C		
D		
E		
F		
G		
H		

Check your answers at the back of this section.

Absolute (ABS) and Incremental (INC)

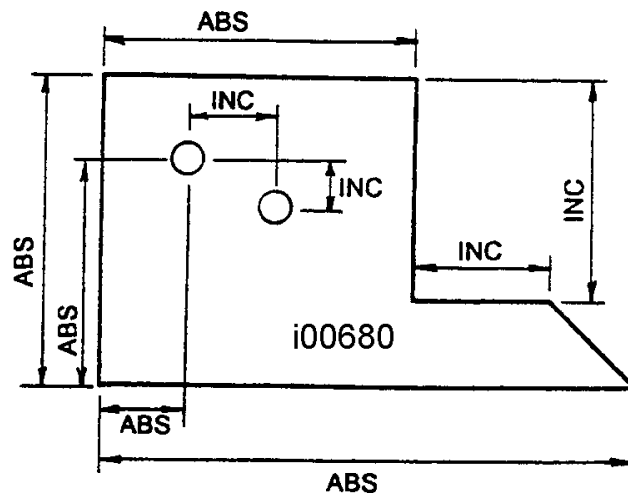
In the previous section we saw that the absolute dimension is the point at which both X and Y are 0. Every part we make with a ProtoTRAK EMX will have an absolute zero that you

give it. We want to put the Absolute 0 where it will make it easy to define the other points we need to machine, so a corner or the center of a circular pattern are usually the best.

When we program, we need to tell the ProtoTRAK EMX what the reference point is for the numbers we put in. When your reference point is the 0,0 we call that an Absolute Reference. That means that the number you put in is measured from 0,0. There is another way to define a point and that is with Incremental dimensions.

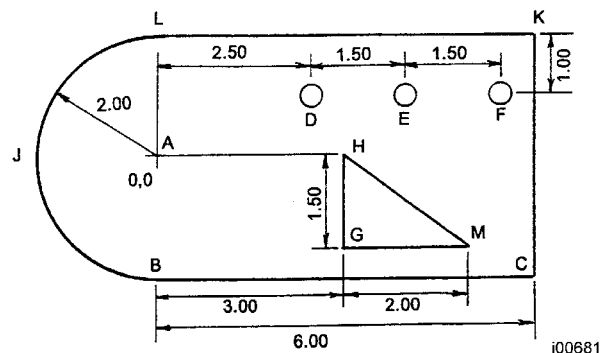
Incremental dimensions are simply dimensions measured from the previous point.

Consider the print below. If we say the bottom left corner is absolute zero (ABS 0) then the dimensions are absolute or incremental as shown.



Quiz 3

Absolute Zero at Point A.



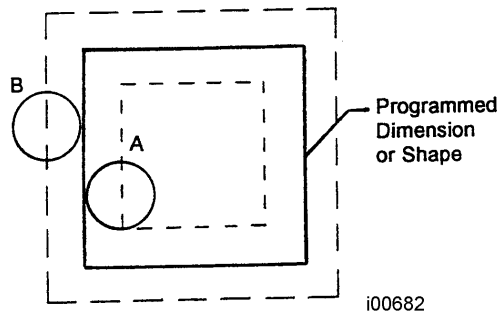
What are the incremental dimensions?

	X	Y
From D to E		
From E to F		
From D to F		
From L to B		
From G to M		
From H to M		
From M to H		
From K to K		

Check your answers at the back of this section.

Tool Compensation

One of the things that makes the ProtoTRAK EMX so easy to use is that you get to program the dimensions of the finished work piece that are right on the print, instead of the centerline of the tool. Let's say you programmed the square shape below shown as the solid line.

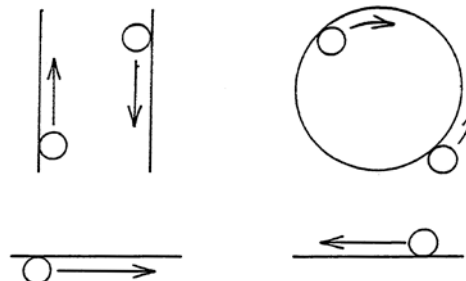


The ProtoTRAK has no way of knowing whether you want to cut a pocket out of the material, so you want your tool to follow Path A, or if you are squaring up a block so you want your tool to follow Path B. This is what tool cutter compensation (or cutter comp) is about.

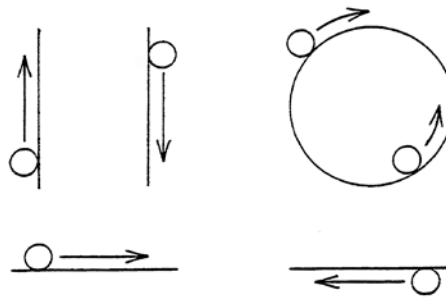
Once again, it is easier to think about these concepts when you imagine the tool is moving along a stationary point.

The rule is: Looking along the direction of tool motion (imagine yourself standing behind the tool as it moves away from you) is the tool to the right (tool right) of the work piece, or to the left (tool left) of the work piece.

Examples of tool right are:



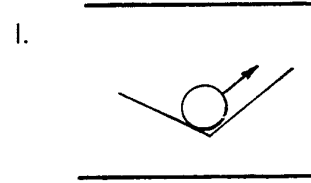
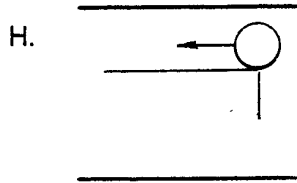
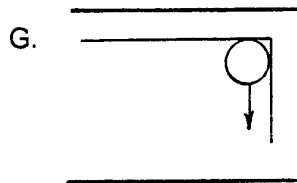
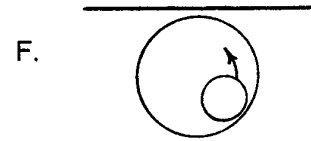
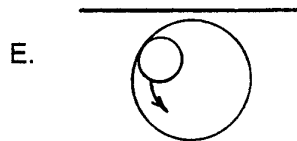
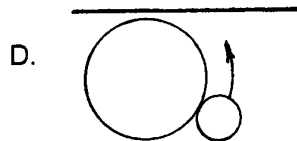
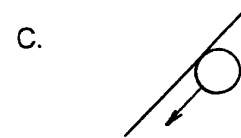
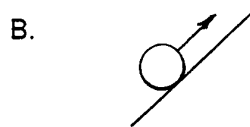
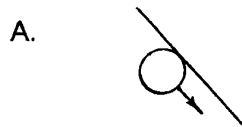
Examples of tool left are:



Tool center means no compensation either right or left. That is, the centerline of the tool will be moved directly over the points or line that is programmed.

Quiz 4

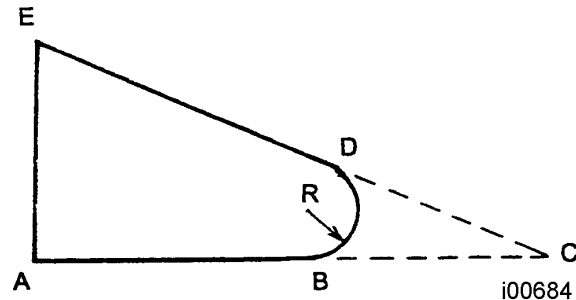
For the part, tool, and direction shown, indicate whether the compensation is Right, Left, or Center. Check your answers at the back of this manual.



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Conrad (Connecting or Corner Radius)

Conrad is another really nice feature of the ProtoTRAK EMX. In the example below you could machine a straight line from Point A to B, then an ARC with radius R from B to D, then another straight line from D to E.



The problem is that the arc is not easy to program because you often don't know where point D or B, or the center of R is located. However, you may know where Point C is, or you may be able to figure it out easily. In that case you can program the above part by programming a straight line from A to C, tell the control when it asks that you have a CONRAD equal to R, and then program another straight line from C to E. The ProtoTRAK will automatically blend the connecting radius (CONRAD R) between the two straight lines with no additional input.

For Rectangular Pockets or Frames, CONRAD stands for corner radius. You may input any value that makes sense considering the size of the pocket and the diameter of the tool.

Quiz Answers

Quiz 1

1. Absolute 0 is the point where the X and Y lines cross.
2. Left of the Absolute 0 point is X minus.
3. Above the Absolute 0 point is Y plus.
4. True. Any point in two dimensions CAN be plotted with the Cartesian Coordinate System.

Quiz 2

	X	Y
A	2	1
B	-4	2
C	4	3
D	-4	-2
E	1	-3
F	-1	1
G	-3	-4
H	4	-2

Quiz 3

	X	Y
A	0 abs	0 abs
B	0	-2.00
C	6.00	-2.00
D	2.50	1.00
E	4.00	1.00
F	5.50	1.00
G	3.00	-1.50
H	3.00	0
J	-2.00	0
K	6.00	2.00
L	0	2.00
M	5.00	-1.50

	X	Y
From D to E	1.50 inc	0 inc
From E to F	1.50	0
From D to F	3.00	0
From L to B	0	-4.00
From G to M	2.00	0
From H to M	2.00	-1.50
From M to H	-2.00	1.50
From K to K	0	0

Quiz 4

A	Right
B	Left
C	Left
D	Right
E	Left
F	Left
G	Right
H	Right
I	Left

13.2 Basic Operation

Now that we have that paper-and-pencil stuff finished, lets go to the machine.

Turn the ProtoTRAK EMX On

On the back of the control is an on/off toggle switch. Flip it up to turn the ProtoTRAK on.

Each time you turn the ProtoTRAK on, it must “boot up” or read its operating software off the built-in floppy disk drive. This takes about one minute, so we recommend turning on in the morning and off once at the end of the day.

If you don't use the ProtoTRAK for 20 minutes, its screen will go blank. This is the screen saver. Press any key or turn the X or Y handwheels and it will come on immediately.

Screen Organization

When the system has booted and a green box appears that says “select a mode”. Press DRO. This will get you into the Digital Readout Mode – the part of the control where you can work manually.

Before we get into that, there are a couple of things to notice about the screen.

The **STATUS** line is on the top. It tells you what mode of operation you are in, whether you're in inch or metric, if the servo motors are on, etc.

The **INFORMATION** area is below and is the largest part of the screen. It shows information or data depending on what you're doing. In DRO operation it shows the axis readout; in Programming it shows the program; when you press LOOK in programming it shows a picture of your part, etc.

The **CONVERSATION** line is below the information area. This is where you input all the data and this is where the ProtoTRAK will prompt you for the information or activity that it wants.

Keyboard Organization

The keyboard is made up of three sections: the soft keys, the data input keys, and the motion control keys.

The **SOFT KEYS** are the 5 unlabeled keys directly to the right of the screen. Their function is defined by the words the key is pointing to. If there is nothing written, then the key will not work.

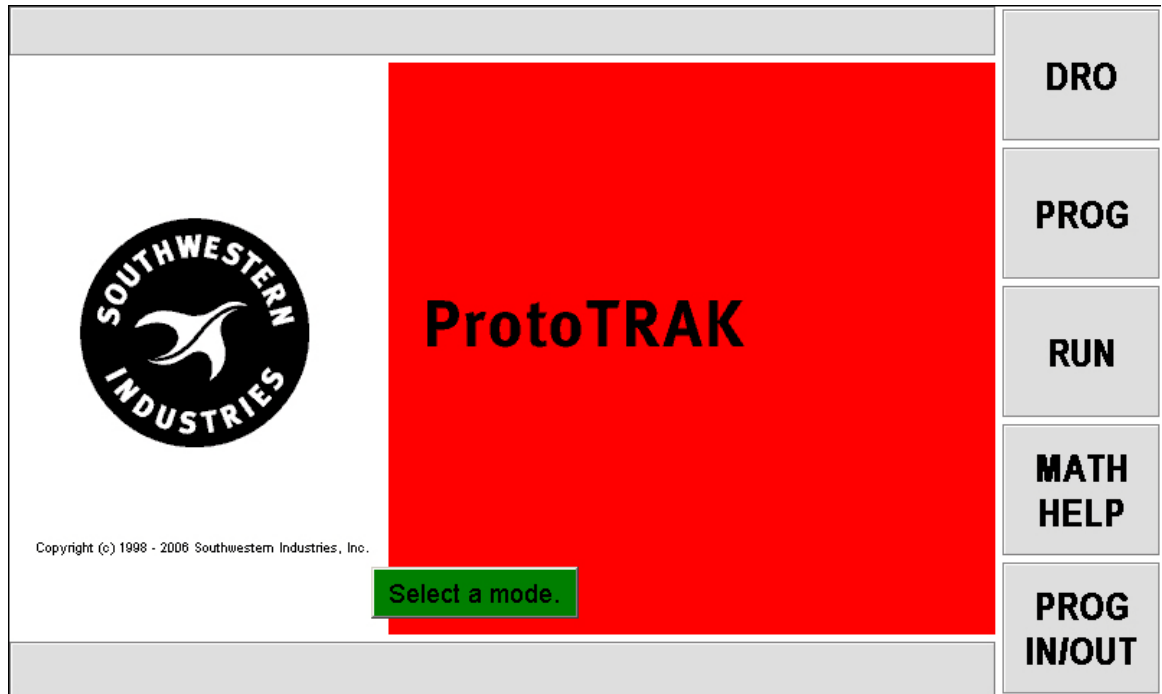
The **DATA INPUT** keys are the number keys and the other keys close to them. The operation of these keys is pretty obvious or will be explained in the next section. One thing to note at this point is the difference between the INC SET and the ABS SET keys directly above the number keys. If you are inputting an

X or Y dimension it is important to set or load this into the system with the correct key. If it is an absolute-referenced number, press ABS SET; if it is an incremental number, press INC SET. If you are inputting any value other than an X or Y, you may press either ABS SET or INC SET. In this case the manual will simply say SET.

The **MOTION CONTROL** keys are the GO and STOP on the upper part of the keyboard. In certain operations the ↓ and ↑ keys will change the feed rate of automatic motion.

Modes

Press the MODE function key. The screen will show:



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This is how you change from one mode of operation to another. If you ever get confused just press MODE to get back to this beginning screen.

Manual Operation

Now press the DRO soft key from the Select Mode screen above. The screen will once again show:

DRO		INCH	JOG
X	0.0000	ABS	RETURN ABS 0
Y	0.0000	ABS	POWER FEED
Z	0.0000	ABS	SERV CODES

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Do the following:

1. Press X, ABS SET, Y, ABS SET, X, INC SET, Y, INC SET. This will zero or reset the absolute and incremental readouts.
2. Press the INC/ABS key. Notice that the ABS on the screen changes to INC.
3. Manually crank the X handwheel so that the table moves left. Move the table so that the readout is X 1.0000 INC.
4. Manually crank the Y handwheel so that the saddle moves away from you. Move the saddle so that the readout is Y -1.0000 INC.
5. Press X, INC SET and Y, INC SET to reset the X and Y incremental readout to zero.
6. Move X another inch to 1.0000 INC and Y another inch to -1.0000 INC.
7. Press the INC/ABS function key to show your absolute position. That is, how far you have moved from Step 1 above where you set absolute. X should read 2.0000 ABS, and Y -2.0000 ABS.
8. Press X, ABS SET, Y, ABS SET to reset absolute to the position you're at now.

JOG

Do the following:

1. Fold up the X and Y handwheels (pull out, then fold up).

WARNING

Never operate the ProtoTRAK under servo motor control unless the handles are folded into their safety position.

2. Press the JOG soft key. A message in red will appear that says "CAUTION: JOG KEYS ARE ACTIVE". This means the ProtoTRAK is ready to jog in the plus X or Y direction at 100 inches per minute, so if you press X or Y, the machine will move.
3. Press and hold X. The table moves to the left at 100 ipm. Release the X key to stop.
4. Press and hold Y. The table moves towards you. Release.
5. Press the +/- key. Notice the number in the Feed Rate box on the lower left of the screen changes from "100" to "-100".
6. Press and hold X. The table now moves right. Release.
7. Press and hold Y. The saddle now moves away. Release.
8. Press the ↓ key. Notice the "JOG -100 ipm" changes to "JOG -90 ipm". Press the ↓ key several more times.
9. Press and hold X. Notice the table moves slower. Release.
10. Press the ↑ key several times until you are back to "JOG -100 ipm."
11. Press number key 9. Notice that the conversation line now says "FEED RATE 9"
12. Press either X or Y. The table or saddle now moves at 9 ipm. This is the way to get low feedrates for power feeding straight cuts in X or Y.
13. Press the RETN (Return) soft key to exit jog operation and go back to manual.

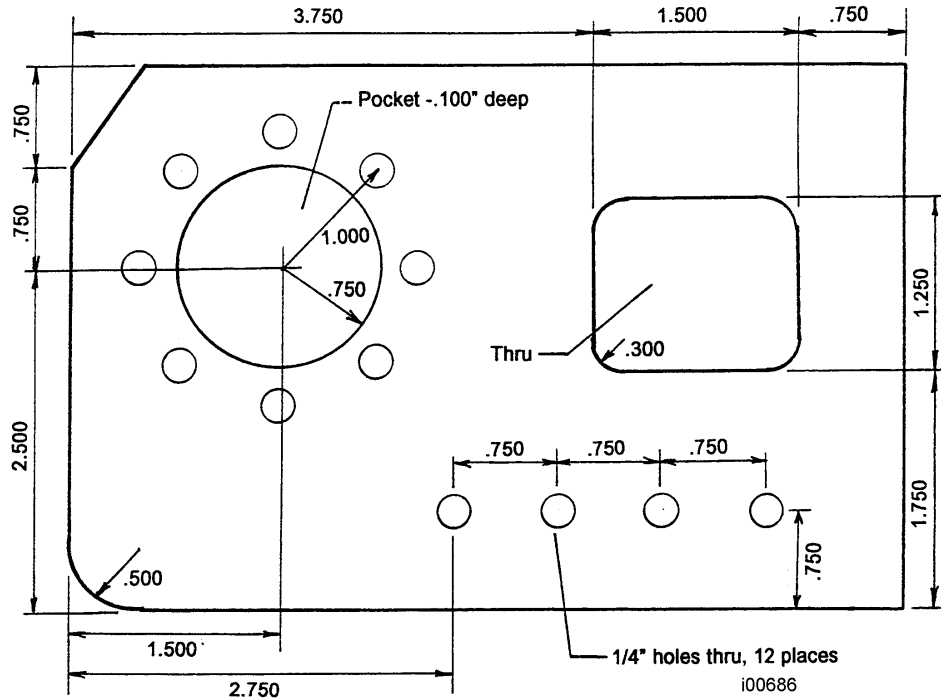
Return to Absolute Zero

Do the following:

1. Make sure the readout is displaying absolute (ABS). If not, press the INC/ABS key.
2. Move the handwheels to make sure you're **not** at zero.
3. Press the RETURN ABS 0 soft key.
4. Press GO. System prompts to "Check Z", press GO again. The table and saddle will automatically move to the absolute zero you set earlier.

13.3 Programming Sample Part 1

The purpose of this sample is to demonstrate most of the various event types or canned geometry's that can be programmed. Also to give you practice inputting data and running an actual part. If you don't want to machine the part, just follow along with the instructions for how to use the ProtoTRAK EMX.



Preparation

If you want to make this part, you will need the following.

1. A vise (if the vise does not have step jaws you will also need parallels).
2. A 1/4 drill.
3. A 3/8", 2 flute, bottom cutting end mill.
4. An edge finder or wiggler.
5. A piece of 6" x 4" x .250" aluminum.

Program Strategy

Before programming a part, take a moment to figure out what you want to do and what order you want to do it.

The strategy for programming a ProtoTRAK EMX is pretty straightforward:

- identify the geometry you want to machine from the print and the order you want to machine it, what to machine first, second, etc.
- select each geometry (event) on the control one at a time
- answer the questions that define the geometry

Our plan for this part is:

1. The lower left corner of the part will be our absolute zero, or absolute reference.
2. Drill the left most hole in the row using a Drill Event.
3. Drill the next 3 holes using a Repeat Event.
4. Drill the 8-hole bolt circle pattern using a Bolt Hole Event.
5. Mill the diagonal in the upper left corner using a Mill Event.
6. Mill the arc in the lower left corner using an Arc Event.
7. Mill the circular pocket with a Pocket Event.
8. Mill the through rectangle with a Frame Event.

Making and Inputting the Program

Press MODE and then press PROG soft key to enter the Program Mode.

The Program Part Number

- The conversation display says, "Program Name". You input 123, SET (INC SET or ABS SET).

Event 1 - The First Hole

- Conversation says, "Select Event". You press POSN/DRILL soft key. Now, press ONE to select the single hole.
- The right side of the information area shows that Event 1 is a Position/Drill and it lists what data is required. But keep your eye on the conversation line.
- Conversation says, "X". You press 2.75, ABS SET. Remember the lower left corner is our Absolute zero.
- "Y". You press .75, ABS SET.
- "TOOL #". Your press 1, SET.
- Tool number 1 is the 1/4 drill, so press .25, SET.

Event 2 - The Next 3 Holes

- "Select Event". You press the REPEAT soft key for Event 2 to make the next 3 holes in the row.
- Event 2 is a Repeat Event and the data needed is shown on the right of the information area. Notice Event 1 has shifted to the left.
- "First Event #". You press 1, SET because we want to repeat Event 1.
- "Last Event #". You press 1, SET because the only event we want to repeat is Event 1.

- "X Offset". You press .75, INC SET because that's the distance between the holes in the X direction.
- "Y Offset". You press 0, INC SET because the other holes are not shifted in the Y direction.
- "# Repeats". You press 3, SET because we want 3 more holes each offset by .75 inch.
- "Tool #". You press 1, SET because we're using the same tool.

Event 3 - The Bolt Hole Pattern

- "Select Event." You press POSN DRILL, then the BOLT HOLE soft key for Event 3.
- Event 2 has shifted to the left and the data you need to input is shown on the right.
- "# Holes". You press 8, SET because there are 8 holes.
- "X CENTER". You press 1.5, ABS SET.
- "Y CENTER". You press 2.5, ABS SET.
- "Radius". You press 1., SET because the radius of the bolt hole pattern is 1.000 inch.
- "Angle". You press 90., SET. This is the angle measured in the counterclockwise direction from 3:00 o'clock to the first hole you want to drill. We could have input 0 and then we would drill the right most hole first.
- "Tool #". You press SET. We're still using tool number 1, but notice we didn't press the 1. If you don't input a number, the ProtoTRAK assumes the last tool is used again.
- "Tool Dia". You press SET.

Event 4 - The Upper Left Diagonal

- "Select Event". You press MILL soft key for Event 4.
- "X Begin". You press 0, ABS SET to define the beginning of the milling cut at its lower left point on the diagonal.
- "Y Begin". You press 3.25, ABS SET to define the beginning of the milling cut.
- "X End". You press .5, ABS SET to define the end of the milling cut.
- "Y End". You press .75, INC SET to define the end of the milling cut. Notice we defined this as an incremental change of .75 inch from the beginning. We could have also input 4.0, ABS SET to also define the end point. Think about this and make sure you understand.
- "CONRAD". You press SET because we don't want to blend this mill cut into another cut.
- "Tool Offset". You press 2, SET because you're selecting that the tool is to the left of the work piece as it moves from beginning to end.

- "Feedrate". You press 5. , SET to mill at 5 inches per minute.
- "Tool #". You input 2, SET because we're calling the 3/8 end mill tool number 2.
- "Tool Dia." Your press .375 SET.
- "Continue". You input "No.", SET because this is not continuous path milling (wait to Sample Part 2).

Event 5 - The Lower Left Radius

- "Select Event". You input soft key ARC for Event 5.
- "X Begin". You input 0, ABS SET because we're going to start at the top and mill down and right.
- "Y Begin". You input .5, ABS SET.
- "X End". You input .5, ABS SET.
- "Y End". You input 0, ABS SET.
- "X Center". You input .5, ABS SET, or we could have input 0, INC SET since the X Center is the same as the X End.
- "Y Center". You input .5, ABS SET.
- "CONRAD". You input 0, SET.
- "Direction". You input 2, SET because we are milling in a counterclockwise direction.
- "Tool Offset". You input 1, SET because looking from beginning towards end (the direction of the tool cut) the tool is to the right of the work piece. Think about this to be sure you understand.
- "Feedrate". You input 5., SET.
- "Tool #". You input 2, SET because that's still our tool.
- "Tool Dia". You input .375 SET (or ONC SET).
- "Continue". You input "No", SET because this is not a continuous milling path.

Event 6 - The Circular Pocket

- "Select Event". You press POCKET FRAME soft key for Event 6.
- "Select". You press CIRCLE POCKET soft key because our pocket is circular.
- "X Center". You press 1.5, POCKET ABS SET.
- "Y Center". You press 2.5, ABS SET.

- "Radius". You press .75, SET defining the radius of the pocket.
- "Direction". You press 1, SET to select clockwise tool motion. We could have just as easily selected counterclockwise.
- "Fin Cut". You press .02, SET to select a finish cut of .020 inches. When machining, the program will hog out the pocket .020 undersized then make a finish cut pass to the proper size.
- "Feedrate". You press 8., SET.
- "Fin Feedrate". You press 5., SET.
- "Tool #". You press SET.
- "Tool Dia". You press SET.

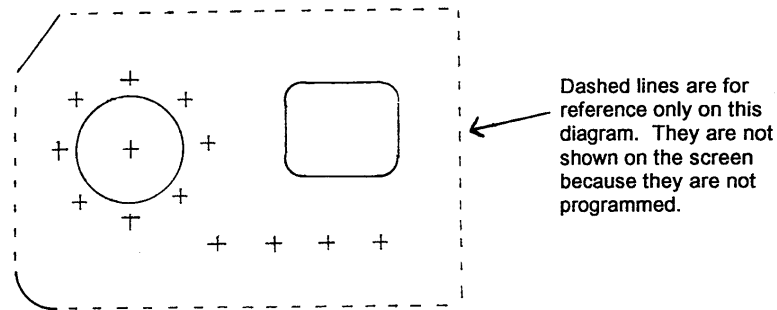
Event 7 - The Through Rectangle

- "Select Event". You press POCKET FRAME soft key for Event 7.
- "Select". You press RECT PROFILE soft key for the rectangular frame.
- "X1". You press 3.75, ABS SET which is the distance to corner number 1, which we will say is the lower left corner of the frame.
- "Y1". You press 1.75, ABS SET.
- "X 3". You press 1.5, INC SET because corner number 3 is the diagonal corner and it is 1.5 inches in the plus X direction from X1.
- "Y3". You press 1.25, INC SET.
- "CONRAD". You press .3, SET because the corner radius of the frame is .300 inch.
- "Direction". You press 2, SET to choose counterclockwise.
- "Tool Offset." You press 2, SET because when the tool moves counterclockwise around the inside of the rectangle frame, it is to the left of the work piece.
- "Fin Cut". You press .03, SET to select a .030 inch finish cut.
- "Feedrate." You press 5., SET.
- "Fin Feedrate". You press 2., SET.
- "Tool #". You press because we're still using tool number 2.
- "Tool Dia". You press SET.

Look at the Program

- Press the LOOK hard key to see what your program looks like. You don't have to finish the programming to see what you've done so far. Any time you see the SELECT EVENT prompt in the Program Mode, you can look at the part graphics.

The drawn part should look like this:



i00687

If your part draw doesn't look like this, don't panic. See if you can figure what piece of geometry, and therefore what event looks wrong. Go back to that part of your program and check your inputs against these instructions.

- Press RETURN. The program is complete

Program In/Out Mode

Now that we have a good program we want to save it. If you turn the ProtoTRAK off now the program will be lost. To prevent this, we will save it in the system's internal storage where it will stay (even without power) until you intentionally erase it.

Do the following:

1. Press MODE and select the PROG IN/OUT soft key.
2. The conversation line says, "Part Number 123". If you wanted to change the part number you could just put in a new one at this time. You press SAVE soft key and wait a few seconds until it's complete. Notice your new part number, 123, is now in the list.

Program Run Preparation

Set Up the Workpiece

If you want to make the part take a piece of 6"x4"x.25" aluminum and lock it into the vise as shown below. Use step jaws or parallels. Use step jaws or parallels. Make sure the material sticks out to the left of the vise by about 1 1/2 inch.

Set the part zero.

1. Press MODE and select DRO soft key.
2. Use your edge finder to position the spindle over the bottom left corner of the part. Remember this was our program absolute zero.
3. Press INC/ABS to be sure the display reads the absolute position (ABS).

4. Press X, ABS SET, Y, ABS SET to reset the ProtoTRAK absolute zero to the same position as the program absolute zero. This is how we tell the ProtoTRAK where the part is.

Program Run

This is where we make the part. Do the following:

Enter the Run Mode

- Press MODE and select RUN soft key.
- The conversation line says, "Select". Press START soft key.

Drill the Holes

- "Load Tool 1 Dia .250". Load the 1/4 drill in the spindle, then start the spindle, and adjust the RPM.

Note: You will probably want to center drill each hole first. You can run each event more than once by pressing Mode, Run, Start. To start at the middle of the program, press START EVENT #.

- X and Y readouts should read zero ABS. Beneath them the actual feedrate (now zero), and the feedrate override percent (now 100%) are shown.
- Press GO. The tool will move (actually the table moves) to the first hole in the row.
- "Set Z". You move the quill and drill the hole. After every drilling operation always make sure the tool is up to clear the work piece.
- Press GO and drill the remaining holes and holes in the bolt hole pattern each time the conversation line says "Set Z".

Mill the Upper Left Diagonal

- When the last hole is drilled the conversation line says, "Load Tool 2 Dia .375". You should stop the spindle, load the 3/8 end mill, start the spindle and adjust the RPM.
- Press GO. The tool will move to the upper left EMX of the part where the diagonal cut begins.
- "Set Z". You move the quill so the tool is slightly below the bottom of the plate to make the full depth cut. Lock the quill at this position.
- Press GO. The tool will move at 5 ipm and cut the diagonal.
- "Check Z". This is a warning to raise the quill because the next move will be at rapid speed (100 ipm). You should raise the tool.

Mill the Lower Left Radius

- Press GO. The tool will rapid to the beginning position for the Arc cut.
- "Set Z". Lower the tool to the correct depth and lock the quill.

- Press GO. The tool will move at 5 ipm and cut the arc.
- "Check Z". You should raise the tool.

Mill the Circular Pocket

- Press GO. The tool will rapid to about the center of the pocket.
- "Set Z." Bring the tool down (or the knee up) to .100 below the top of the part and lock the quill.
- Press GO. The tool will move at 8 ipm to machine the pocket. Press the ↑ and ↓ keys while cutting the pocket to see how you can adjust the speed while you're cutting. When the pocket is hogged out a little undersized, the cutter will automatically make the program .020 finish cut.
- "Check Z". You should raise the tool.

Mill the Through-Rectangle

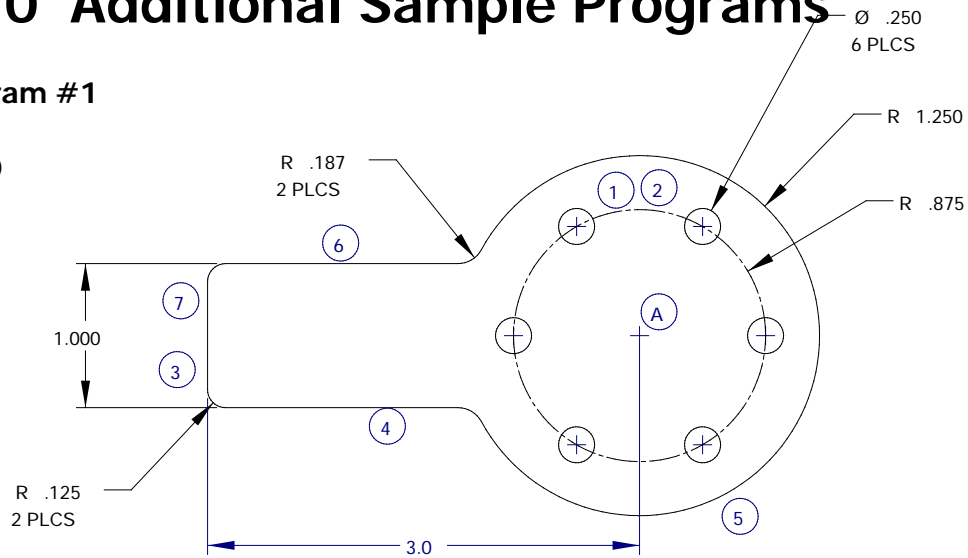
- Press GO. The tool will rapid to the beginning point to machine the rectangular frame thru.
- "Set Z". Move the quill down so that the tool is slightly below the bottom of the plate. Lock the quill.
- Press GO. The tool will move at 5 ipm (if you left the feedrate override at 100% when you adjusted ↑ and ↓) to machine the rectangle and make the finish pass.
- "Run Over". The part is finished. If you were making a second part and could locate it in the vise in the same place, you could now press the NEXT PART soft key and the whole program would be repeated.
- Press MODE to exit Run.

Congratulations. You've Made Your First Part.

14.0 Additional Sample Programs

Program #1

(I00376)



This sample part was programmed using the center of the bolt hole pattern (Point A) as the program absolute zero. The event numbers are shown in the circles.

• Programming Aspects Shown on This Part

- Bolt hole using 2 different tools.
- Profile milling.
- Math Help to calculate arc and line intersection points.

• Program Notes

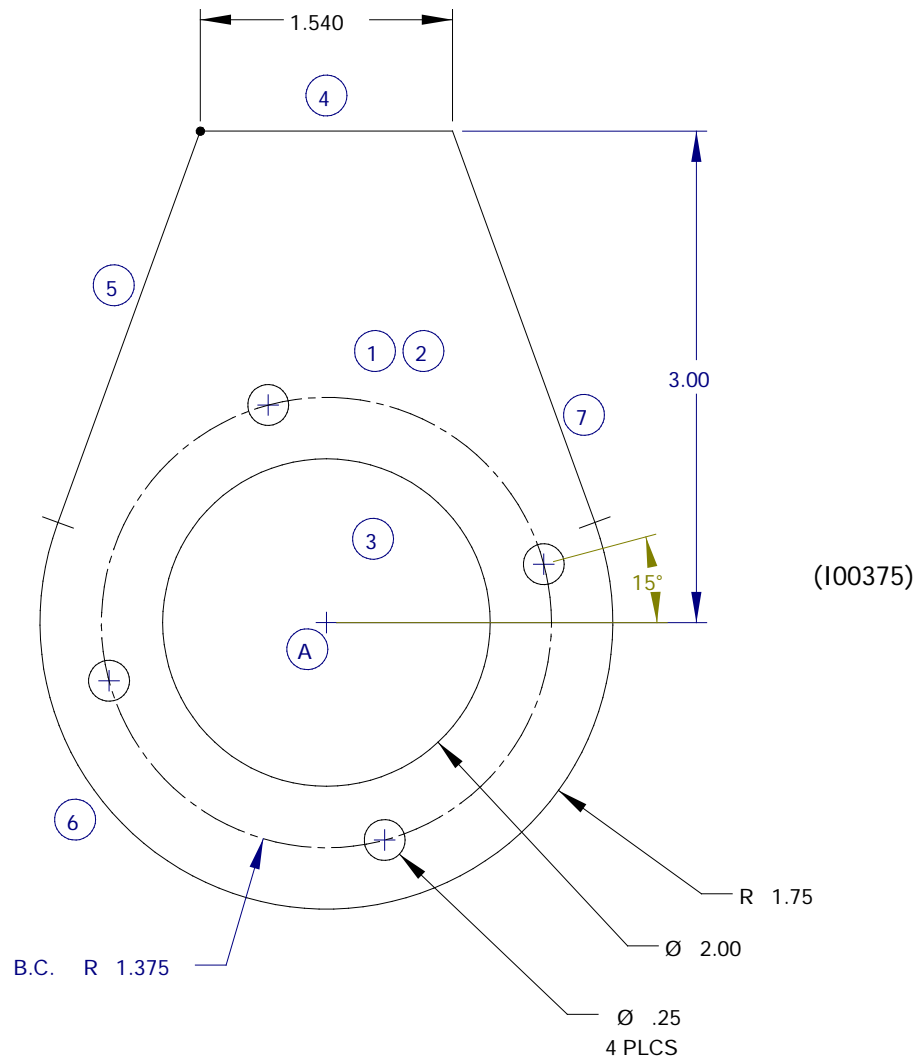
Event 1 spot drills the bolt hole pattern, and Event 2 drills the hole using Tool #2.

Event 1	Bolt Hole	
# Holes	6	<ul style="list-style-type: none"> Tool #1 is a spot drill; the diameter doesn't matter.
X Center	0 abs	
Y Center	0 abs	
Radius	0.875	
Angle	0	
Tool #	1	
Tool Dia	0	
Event 2	Repeat	
First Event #	1	<ul style="list-style-type: none"> Tool #2 is a 1/4" drill.
Last Event #	1	
X Offset	0 inc	
Y Offset	0 inc	
No. Of Repeats	1	
Tool #	2	

Events 3 through 7 mill the perimeter of the part.

Event 3	Mill	
X Begin Y Begin X End Y End Conrad Tool Offset Feed Rate Tool # Tool Dia Continue	-3.0 abs 0 abs 0 inc -0.5 abs 0.125 Right 10 3 .25 Yes	<ul style="list-style-type: none"> Tool #3 is a 1/4" end mill.
Event 4	Mill	
X End Y End Conrad Continue	-1.1456 abs 0 inc 0.187 Yes	<ul style="list-style-type: none"> Use Math Help Type 13 to find the intersection of the 2 parallel lines and the arc.
Event 5	Arc	
X End Y End X Center Y Center Conrad Direction Continue	0 inc 0.5 abs 0 abs 0 abs 0.187 CCW Yes	
Event 6	Mill	
X End Y End Conrad Continue	-3.0 abs 0 inc 0.125 Yes	
Event 7	Mill	
X End Y End Conrad Continue	0 inc 0 abs 0 inc No	<ul style="list-style-type: none"> Y End is programmed past the edge to ensure a good surface finish on the left side of the part.

Program # 2



This sample part was programmed using the center of the circular pocket (Point A) as the program absolute zero. The event numbers are shown in the circles.

• Programming Aspects Shown on This Part

- Bolt hole using 2 different tools.
- Circular Pocket.
- Profile milling.
- Math Help to calculate arc and line tangency points.

- **Program Notes**

Events 1 and 2 drill the bolt hole pattern using 2 different tools.

Event 1	Bolt Hole	
# Holes	4	• Tool #1 is a spot drill.
X Center	0 abs	
Y Center	0 abs	
Radius	1.375	
Angle	15.	
Tool #	1	
Event 2	Repeat	
First Event #	1	• Tool #2 is a 1/4" drill.
Last Event #	1	
X Offset	0 inc	
Y Offset	0 inc	
No. Of Repeats	1	
Tool #	2	

Event 3 mills the circular pocket.

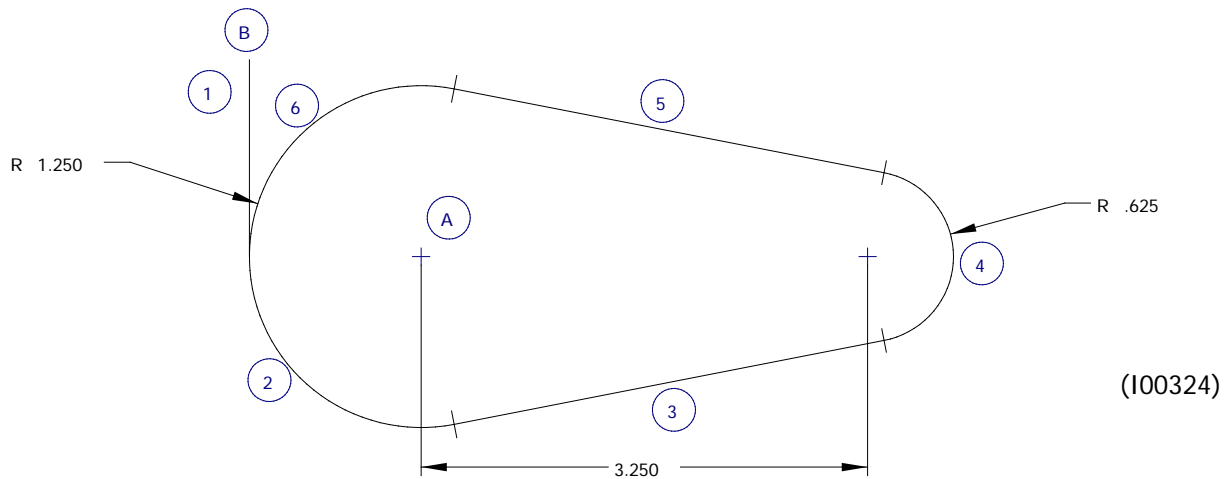
Event 3	Circle Pocket	
X Center	0 abs	• Tool #3 is a 1/2" end mill.
Y Center	0 abs	
Radius	1.	
Direction	CW	
Fin Cut	0.005	
Feed Rate	10.	
Fin Feed Rate	5.	
Tool #	3	
Tool Dia	.25	

Events 4 through 7 mill the profile of the part.

Event 4	Mill	
X Begin	0.77 abs	
Y Begin	3.0 abs	
X End	-0.77 abs	
Y End	3.0 abs	
Conrad	0	
Tool Offset	Right	
Feed Rate	10	
Tool #	3	
Tool Dia	Inc Set	
Continue	Yes	

Event 5	Mill	
X End Y End Conrad Continue	-1.6445 abs 0.5990 abs 0 Yes	<ul style="list-style-type: none"> Use Math Help Type 17 to find the tangency point of the line to the arc. See math help section.
Event 6	Arc	
X End Y End X Center Y Center Conrad Direction Continue	1.6445 abs 0 inc 0 abs 0 abs 0 CCW Yes	<ul style="list-style-type: none"> X End is the same value, but positive because of the part's symmetry about the center point.
Event 7	Mill	
X End Y End Conrad Continue	0.77 abs 3.0 abs 0 No	

Program # 3



This sample part was programmed using the center of the left arc (Point A) as the program absolute zero. The event numbers are shown in the circles.

• Programming Aspects Shown on This Part

- Profile milling.
- Math Help to calculate arc and line tangency points.

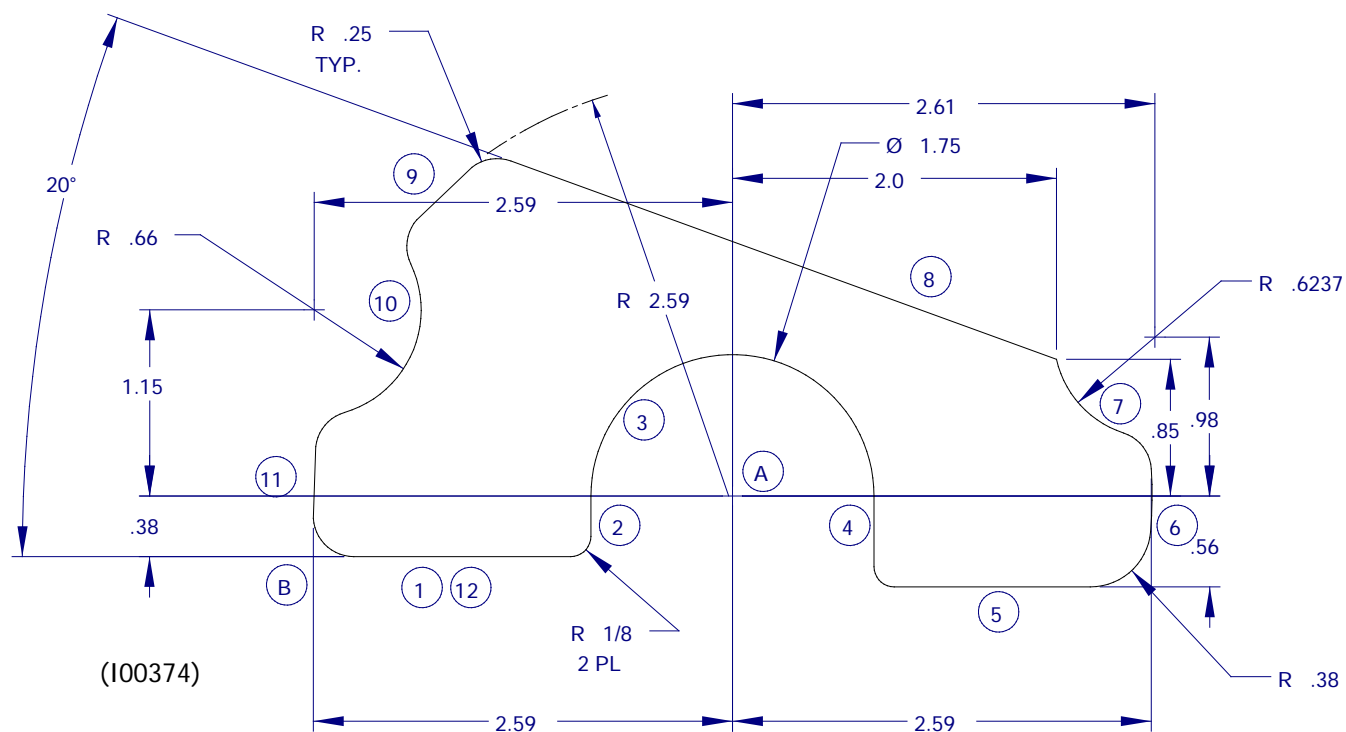
• Program Notes

Events 1 through 6 mill the profile of the part.

Event 1	Mill	
X Begin	-1.25 abs	<ul style="list-style-type: none"> The first mill event was used to ramp into the part starting at Point B. Tool #1 is a 1/2" end mill.
Y Begin	0.5 abs	
X End	0 inc	
Y End	0 abs	
Conrad	0	
Tool Offset	Right	
Feed Rate	10.	
Tool #	1	
Tool Dia	.5	
Continue	Yes	

Event 2	Arc	
X End Y End X Center Y Center Conrad Direction Continue	0.2404 abs -1.2267 abs 0 abs 0 abs 0 CCW Yes	<ul style="list-style-type: none"> • Use Math Help Type 16 to solve for intersection points. • See Math Help section.
Event 3	Mill	
X End Y End Conrad Continue	3.3702 abs -0.6133 abs 0 Yes	
Event 4	Arc	
X End Y End X Center Y Center Conrad Direction Continue	0 inc 0.6133 abs 3.25 abs 0 abs 0 CCW Yes	
Event 5	Mill	
X End Y End Conrad Continue	0.2404 abs 1.2267 abs 0 Yes	
Event 6	Arc	
X End Y End X Center Y Center Conrad Direction Continue	-1.25 abs 0 abs 0 abs 0 abs 0 CCW No	

Program # 4



This sample part was programmed using the center arc (Point A) as the program absolute zero. The event numbers are shown in the circles.

- **Programming Aspects Shown on This Part**

- Profile milling
- Math Help to calculate arc and line intersection points

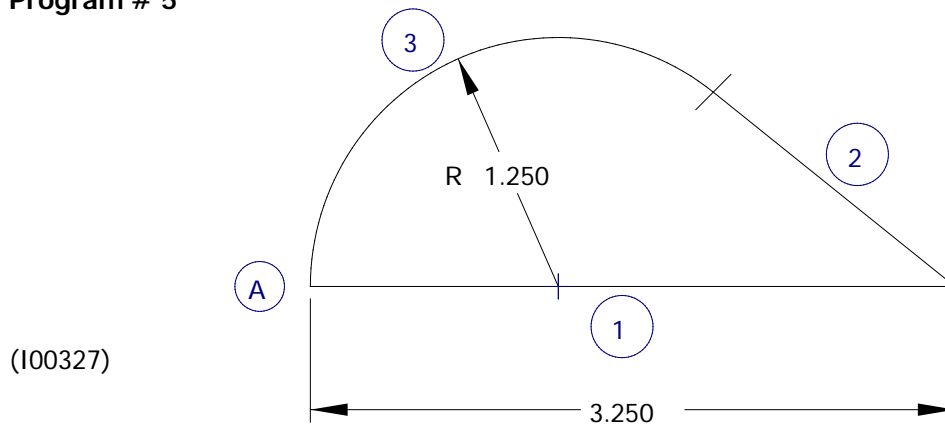
- **Program Notes**

Events 1 through 12 mill the profile of the part.

Event 1	Mill	
X Begin Y Begin X End Y End Conrad Tool Offset Feed Rate Continue Tool # Tool Dia	-2 abs -0.38 abs -0.875 abs 0 inc 0.125 Right 10. Yes 1 .5	<ul style="list-style-type: none"> • Tool #1 is a ½" end mill. • The first event starts at point B.
Event 2	Mill	
X End Y End Conrad Continue	0 inc 0 abs 0 Yes	
Event 3	Arc	
X End Y End X Center Y Center Conrad Direction Continue	0.875 abs 0 inc 0 abs 0 abs 0 CW Yes	
Event 4	Mill	
X End Y End Conrad Continue	0 inc -0.56 abs 0.125 Yes	
Event 5	Mill	
X End Y End Conrad Continue	2.59 abs 0 inc 0.38 Yes	
Event 6	Mill	
X End Y End Conrad Continue	0 inc 0.3566 abs 0.25 Yes	<ul style="list-style-type: none"> • Use Math Help Type 13 to find the intersection point of Events 6 and 7.

Event 7	Arc	
X End Y End X Center Y Center Conrad Direction Continue	2.0 abs 0.85 abs 2.61 abs 0.98 abs 0 CW Yes	
Event 8	Mill	
X End Y End Conrad Continue	-1.4884 abs 2.1196 abs 0.25 Yes	<ul style="list-style-type: none"> Use Math Help Type 13 to find intersection of Events 8 and 9. Find the second point on the line by using right triangle math help or math help type 25.
Event 9	Arc	
X End Y End X Center Y Center Conrad Direction Continue	-2.0701 abs 1.5566 abs 0 abs 0 abs 0.25 CCW Yes	<ul style="list-style-type: none"> Use Math Help Type 15 to find the intersection of arc's 9 and 10.
Event 10	Arc	
X End Y End X Center Y Center Conrad Direction Continue	-2.59 abs 0.49 abs -2.59 abs 1.15 abs 0.25 CW Yes	<ul style="list-style-type: none"> Use Math Help Type 13 to find the intersection of Events 10 and 11.
Event 11	Mill	
X End Y End Conrad Continue	0 inc -0.38 abs 0.25 Yes	
Event 12	Mill	
X End Y End Conrad Continue	-2 abs 0 inc 0 No	<ul style="list-style-type: none"> This mill event was added to allow a Conrad to be used at the end of Event 11.

Program # 5



This sample part was programmed using the lower left corner (Point A) as the program absolute zero. The event numbers are shown in the circles.

• Programming Aspects Shown on This Part

- Profile milling
- Math Help to calculate arc and line intersection points

• Program Notes

Events 1 through 3 mill the profile of the part.

Event 1	Mill	
X Begin	0 abs	<ul style="list-style-type: none"> Tool #1 is a ½" end mill.
Y Begin	0 abs	
X End	3.25 abs	
Y End	0 inc	
Conrad	0	
Tool Offset	Right	
Feed Rate	10.	
Tool #	1	
Tool Dia	.5	
Continue	Yes	
Event 2	Mill	
X End	2.0313 abs	<ul style="list-style-type: none"> Use Math Help Type 17 to find the intersection of Events 2 and 3.
Y End	0.9758 abs	
Conrad	0	
Continue	Yes	
Event 3	Arc	
X End	0 abs	
Y End	0 abs	
X Center	1.25 abs	
Y Center	0 abs	
Conrad	0	
Direction	CCW	
Continue	No	

Southwestern Industries, Inc

TRAK Warranty Policy

Warranty

TRAK products are warranted to the original purchaser to be free from defects in workmanship and materials for the following periods:

Product	Warranty Period	
	Materials	Factory Labor
New TRAK	1 Year	1 Year
Any EXCHANGE Unit	90 Days	90 Days

The warranty period starts on the date of the invoice to the original purchaser from Southwestern Industries, Inc. (SWI) or their authorized distributor.

If a unit under warranty fails, it will be repaired or exchanged at our option for a properly functioning unit in similar or better condition. Such repairs or exchanges will be made FOB Factory/Los Angeles or the location of our nearest factory representative or authorized distributor.

Disclaimers of Warranties

- This warranty is expressly in lieu of any other warranties, express or implied, including any implied warranty of merchantability or fitness for a particular purpose, and of any other obligations or liability on the part of SWI (or any producing entity, if different).
- Warranty repairs/exchanges do not cover incidental costs such as installation, labor, freight, etc.
- SWI is not responsible for consequential damages from use or misuse of any of its products.
- TRAK products are precision mechanical/electromechanical measurement systems and must be given the reasonable care that these types of instruments require:
- Replacement of chip scrapers and wipers is the responsibility of the customer. Consequently, the warranty does not apply if chips have been allowed to enter the mechanism.
- Accidental damage, beyond the control of SWI, is not covered by the warranty. Thus, the warranty does not apply if an instrument has been abused, dropped, hit, disassembled or opened.
- Improper installation by or at the direction of the customer in such a way that the product consequently fails, is considered to be beyond the control of the manufacturer and outside the scope of the warranty.

