



innovative machine tools



GE FANUC 21 155/325II TC TRAINING GUIDE

9/11/03 Version 6
Made by EMCO
Authored by Chad Hawk

Training Index

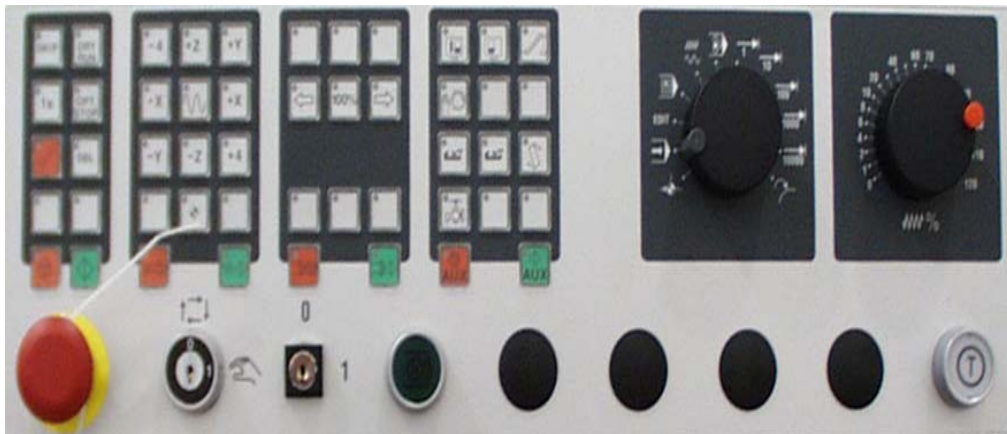
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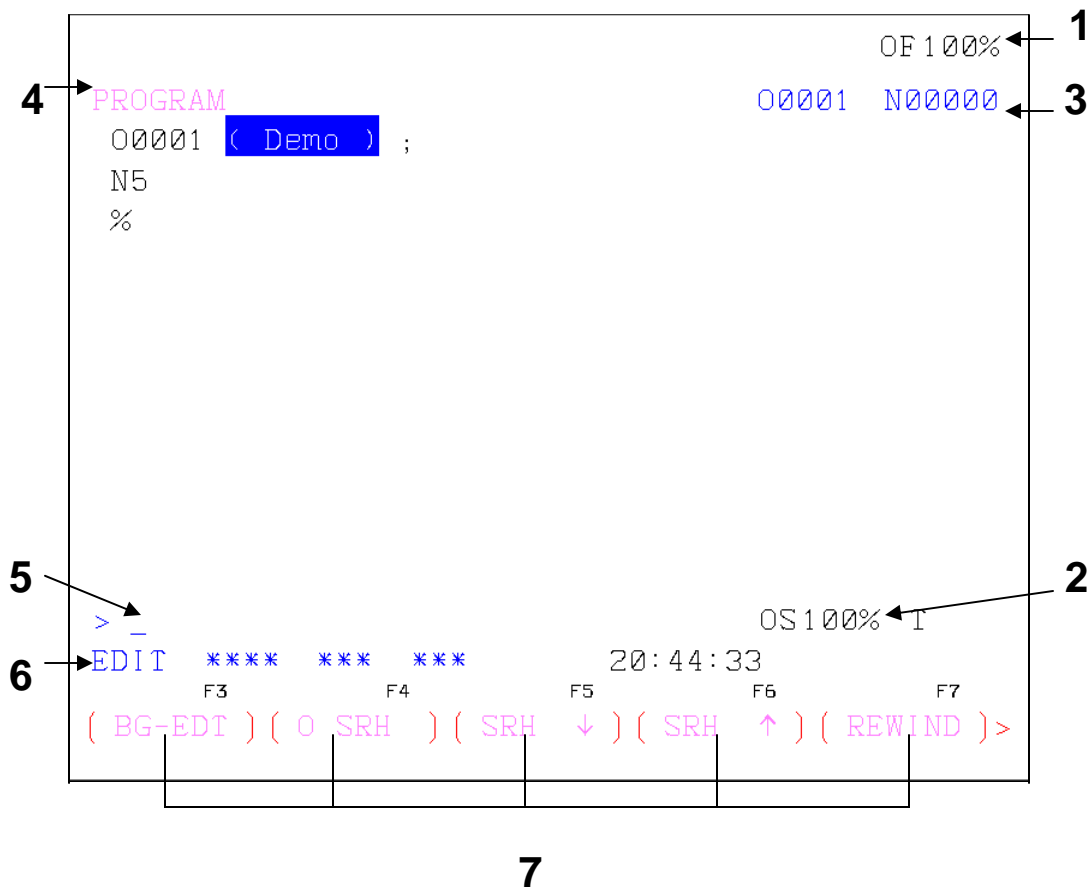
FANUC 21 CONTROL



MACHINE CONTROL



The Fanuc 21 Screen



1. **Displays of Feed**
2. **Spindle Speed override**
3. **Display of Program and Number block**
4. **Display of active Screen**
5. **Entry line**
6. **Display of active Mode**
7. **Display of Soft key Functions**

FANUC 21 KEYS



**RESET = cancels most alarms, resets program,
interrupts programs**

CURSOR MOVEMENT KEYS



CURSOR UP = moves cursor up



**CURSOR DOWN = moves cursor down, search
function, program call up**



PAGE UP = moves one page up



PAGE DOWN = moves one page down



CURSOR RIGHT = moves cursor right



CURSOR LEFT = moves cursor left

CHANGE KEYS



ALTER = alter word (replace word)



INSRT = insert word, create new program



DELET = deletes word / block or programs



EOB = end of block



CAN = deletes entries in the address one by one



INPUT = input offsets / words or numbers

DATA INPUT KEYS



Press a button for a letter / number needed. Use Shift for the second letter or symbol on that button.

FUNCTION KEYS (DISPLAY KEYS)



POS = displays actual, relative, machine positions



PROG = displays program, library page



OFFSET/ SETTINGS = displays wear, geometry, work shifts pages



SYSTEM = displays parameters, diagnostic pages

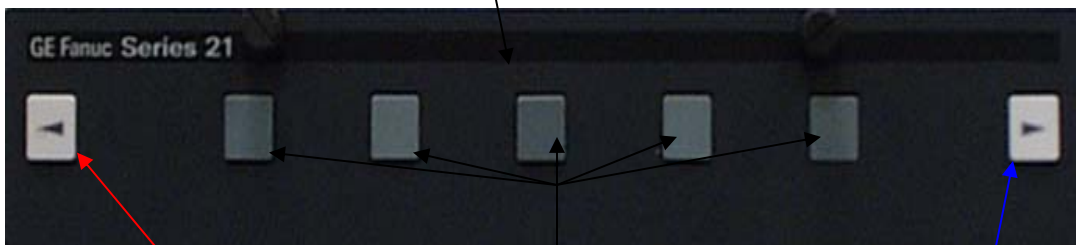


MESSAGE = displays operator & alarm messages



AUX / GRAPH = displays 2-d graph simulation

SOFT KEYS



SCROLL BACK

SOFT KEYS

PAGES OVER

MACHINE KEYS

MACHINE FUNCTION KEYS



= Press skip any block lines with (/ Slash) before block number will be skipped



= Test run without spindle on (remove raw material from chuck)



= (Single piece) for continuous mode active only on automatic material loading



= (Optional stop) for programs with (m1)



= (Reset) cancels most alarms, resets program, interrupts programs



= (Single block) reads one block line at a time



= (Cycle stop) program hold, feed hold



= (Cycle start) program start



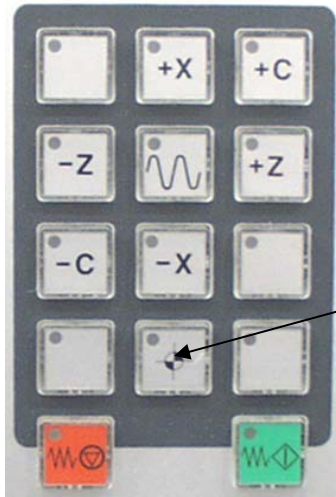
= (Agreement button) used for open/closing door or to jog axis with the door open



= (Mode Key) Automatic & Hand Mode
Hand Mode is for moving machine around with door open and works in conjunction with the (Agreement button)



=(Cycle start) program start



DIRECTION KEYS

These keys control axis directional movements

+4 & -4 = Additional axis

Reference all axis

Feed stop (Red) / Feed start (Green) works all modes but EDIT & ZRN



SPINDLE OVERRIDE KEYS

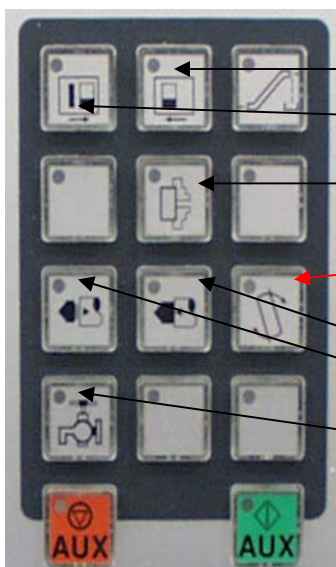
Arrow key pointing right increase the Spindle speed (120% high)

Arrow key pointing left decrease the Spindle speed (50% low)

100% key jumps speed to 100%

Spindle stop (Red) / Spindle start (Green)

Works all modes except EDIT & ZRN (Reference)



ACCESSORY FUCTIONS

Arrow right door closed

Arrow left door open

Press once chuck open

Press again chuck closed

Press turret index's one time clockwise
Each time pressed

Press tailstock moves backward

Press tailstock moves forward

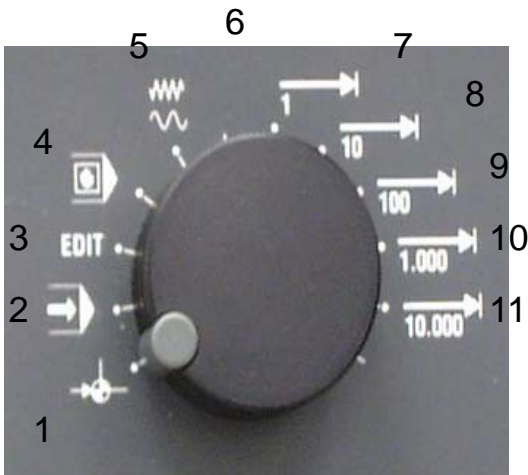
Press once coolant on

Press again coolant off

Press auxiliary drives on (Green)

Press auxiliary drives off (Red)

MODE DIAL



- (1) REF = Zero / Reference or Home mode
- (2) MEM = Automatic mode for running a program
- (3) EDIT = Edit mode for program changes or entering a new program
- (4) MDI = Manual Data Input mode for manually running the machine
- (5) JOG = Manual moving the axis in x or z
- (6) STEPS = Incremental feed movements
- (7) STEPS = .0001 or tenths
- (8) STEPS = .001 or thousands
- (9) STEPS = .010 or ten thousands
- (10) STEPS = .100 or hundred thousands
- (11) STEPS = .100 or hundred thousands

FEED OVERRIDE DIAL



Controls feed for jogging in the X Axis and the Z Axis. Overrides from 0% to 120% of the programmed feed rate or the rapid rate

Toggle Back										Over Toggle																																																																						
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Esc</td> <td>Mode</td> <td>Λ</td> <td>F3</td> <td>F4</td> <td>F5</td> <td>F6</td> <td>F7</td> <td>F8</td> <td>Output</td> <td>Input</td> <td>></td> <td>Display</td> </tr> </table>										Esc	Mode	Λ	F3	F4	F5	F6	F7	F8	Output	Input	>	Display	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td></td> <td></td> <td></td> </tr> </table>																																																									
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Reset		NC Stop	(cycle start)																																																																													



1. Any key with Gray highlight Press Ctrl + the key for that function
2. Some keys have two functions to them for 1st function just press the key
3. 2nd function will be Grey press Ctrl + the key for the function
4. Some automative keys when you press them 1 time this will close/tum off press them again will open/tum on
5. F1 is a toggle key for the modes: Zero, Auto, Edit, MDI, Jog and F11 then F11 give Increment Step
6. F12 is a toggle key for the Display screens: Position, Program, Offsets, Parameter, Alarm and F12 then F11 then F3 gives Graph
7. F12 then F11 then F3 then F11 then F3 gives you 3D view
8. Press enter 2 times this is the same as pressing EOB insert
9. Alt + F4 will exit the software back to the desktop
10. The Top right corner will allow the screen to be minimized, restored and close just like a standard windows screen

The machine functions are active only with NUM LOCK on

Keys are active they will move the axes if used as numbers. Use numbers on the keyboard.

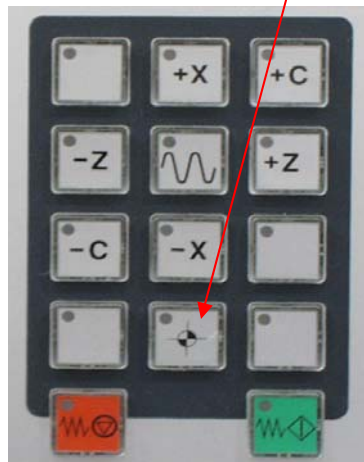
Turning the Machine On/Entering Fanuc Software

Referencing the Machine

1. Press the **AUX** button  (This turns on the Auxiliary Drives)
2. Press the **Agreement** button  and hold then **Open** door then **Shut** door (This Initialize the safety circuits on the Machine door)
3. Move the MODE dial to REF position also know as Reference make sure your feed rate is not on "0"

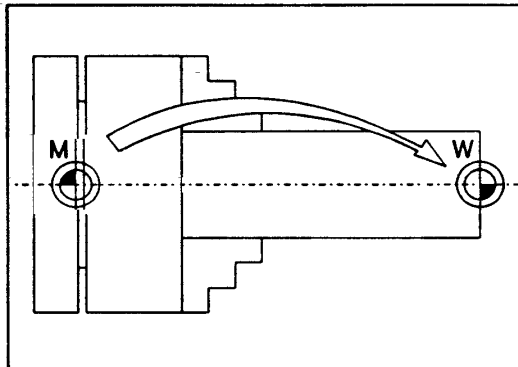


4. Press the X+ (arrow pointing up) this references the X axis.
5. Press the Z+ (arrow pointing left) this references the Z axis
6. For all axis press the Reference key



Note: Every time you enter Fanuc 21 Software or Turn the Machine On you must reference the axis

WORK SHIFT



Zero offset from machine zero point M to workpiece zero point W

With EMCO lathes the machine zero "M" lies on the rotating axis and on the end face of the spindle flange. This position is unsuitable as a starting point for dimensioning. With the so-called zero offset the coordinate system can be moved to a suitable point in the working area of the machine.

The offset register offers one adjustable zero offset.

When you define a value in the offset register, this value will be considered with program start and the coordinate zero point will be shifted from the machine zero M to the workpiece zero W.

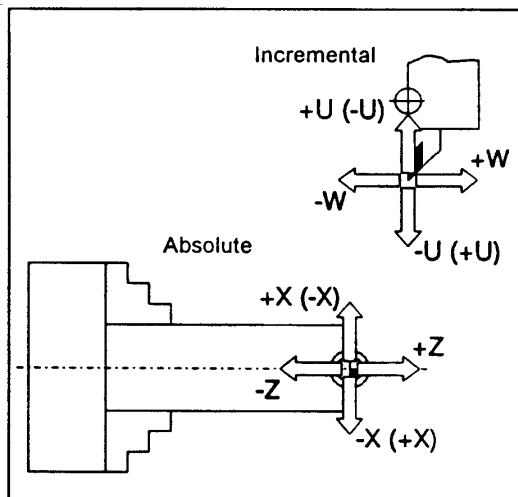
The workpiece zero point can be shifted within a program with "G92 - Coordinate system setting" in any number.

More informations see in the command description.

The Coordinate System

The X coordinate lies in the directions of the cross slide, the Z coordinate in the direction of the longitudinal slide.

Coordinate values in minus directions describe movements of the tool system towards the workpiece. Values in plus direction away from the workpiece,



Absolute coordinates refer to a fixed position, incremental coordinates to the tool position. The bracket values for X, -X, U, -U are valid for the PC TURN 50 because the tool is in front of the turning centre on this machine.

Coordinate System for Absolute Value Programming

The origin of the coordinate system lies at the machine zero "M" or at the workpiece zero "W" following a programmed zero offset.

All target points are described from the origin of the coordinate system by the indication of the respective X and Z distances.

X distances are indicated as the diameter (as dimensioned on the drawing).

Coordinate System for Incremental Value Programming

The origin of the coordinate system lies at the tool mount reference point "N" or at the cutting tip after a tool call-up.


The U coordinate lies in the direction of the cross slide, the W coordinate in the direction of the longitudinal slide. The plus and minus directions are the same as for absolute value programming.

With incremental value programming the actual paths of the tool (from point to point) are described. X distances are indicated as the diameter.

Work Shift:

1. Move the MODE dial to JOG position

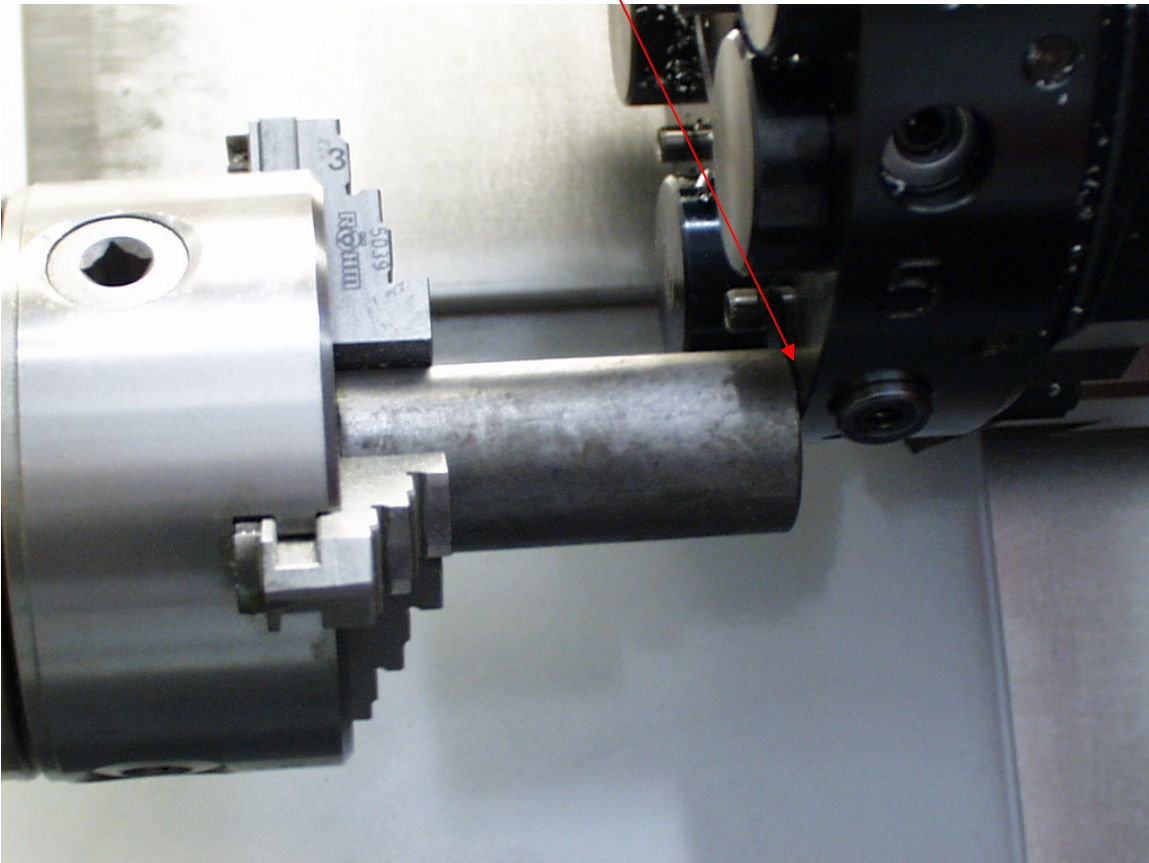
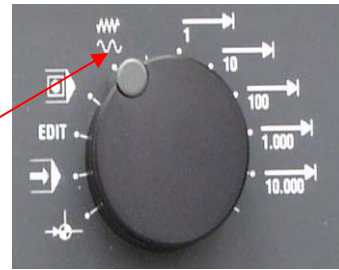
2. Index to a open tool holder position

Press  will index one tool position at a time

3. Jog the TURRET face to the face of the Work Piece & touch using the Direction keys.

(Use piece of paper between TURRET and Work Piece)

(Use the Feed override dial or Steps to approach at a slower feed)



4. Press the OFFSET/SETT button until Work Shift page appears
5. Make sure (Shift Value) Z is 0 if not highlight Z under (SHIFT VALUE) and type 0 and Input
6. The value that is in the ACTUAL POSITION (RELATIVE) Z type this value in (SHIFT VALUE) Z as a negative number
7. Then press INPUT button
8. Jog TURRET away from WORK PIECE using Z+

OFFSET
SETT.

This value is the distance from the Spindle Nose to the end of the Work Piece

OF 100%

WORK SHIFT
00000 N00000

(SHIFT VALUE)	(MEASUREMENT)
X 0.0000	X 0.0000
Z 0.0000	Z 0.0000

ACTUAL POSITION (RELATIVE)

X 0.0000

Z 0.0000

> z-4.94_

JOG **** **

F3

() ()

F4

() ()

F5

() ()

F6

(+INPUT) (INPUT)

F7

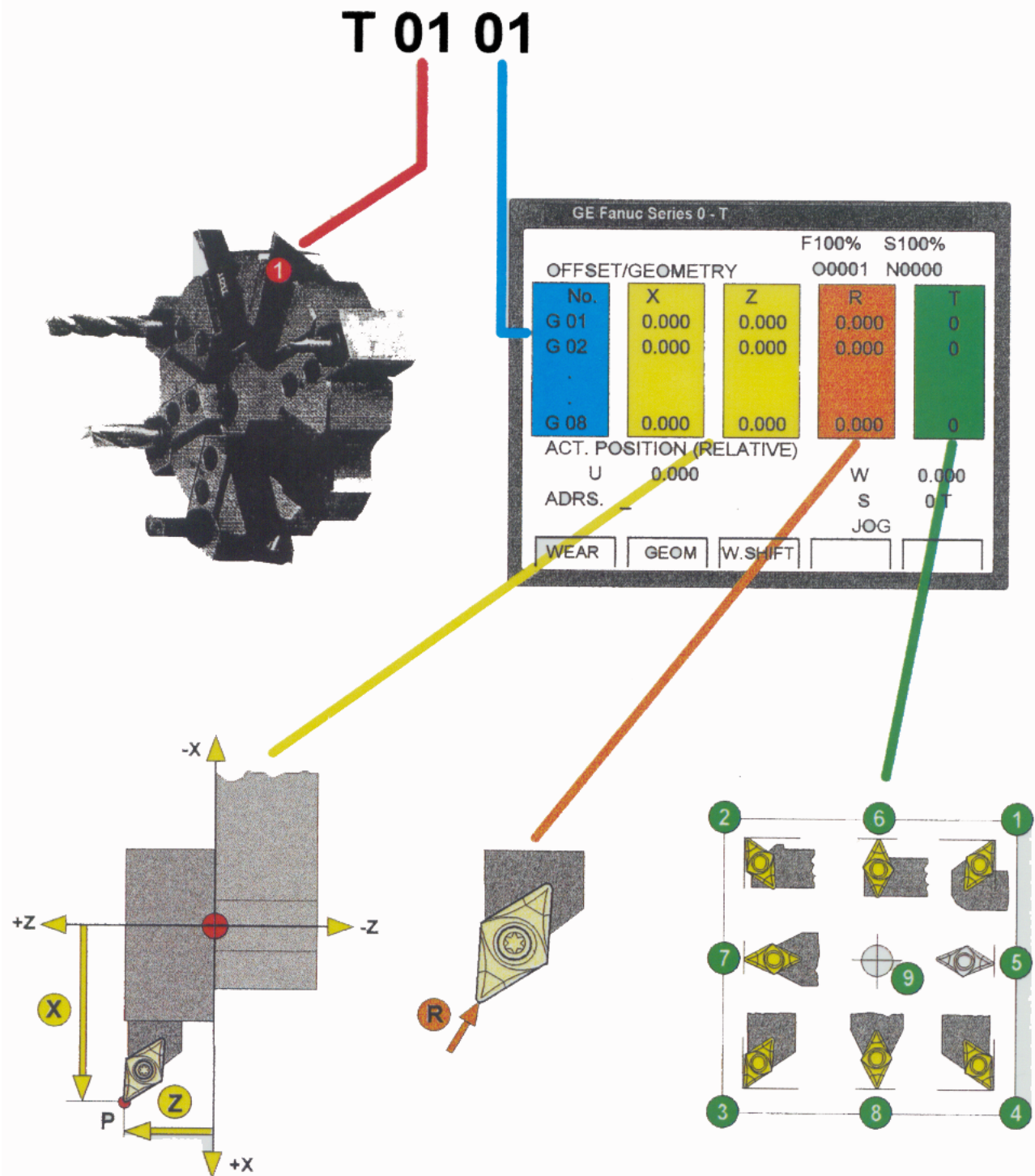
OS100% T

11:37:18

Note: Machine 0 is the turret face touching the spindle nose.

NEVER put a value in SHIFT VALUE X

TOOL OFFSETS



Tool Offsets

1. Index the TURRET to the tool being measured

- Move the MODE Dial to MDI position
- Press Program button

PROG

- Type tool number then press INPUT button

INPUT

Example: T0200

1. For scratching type S1000 then M04 press INPUT button

INPUT

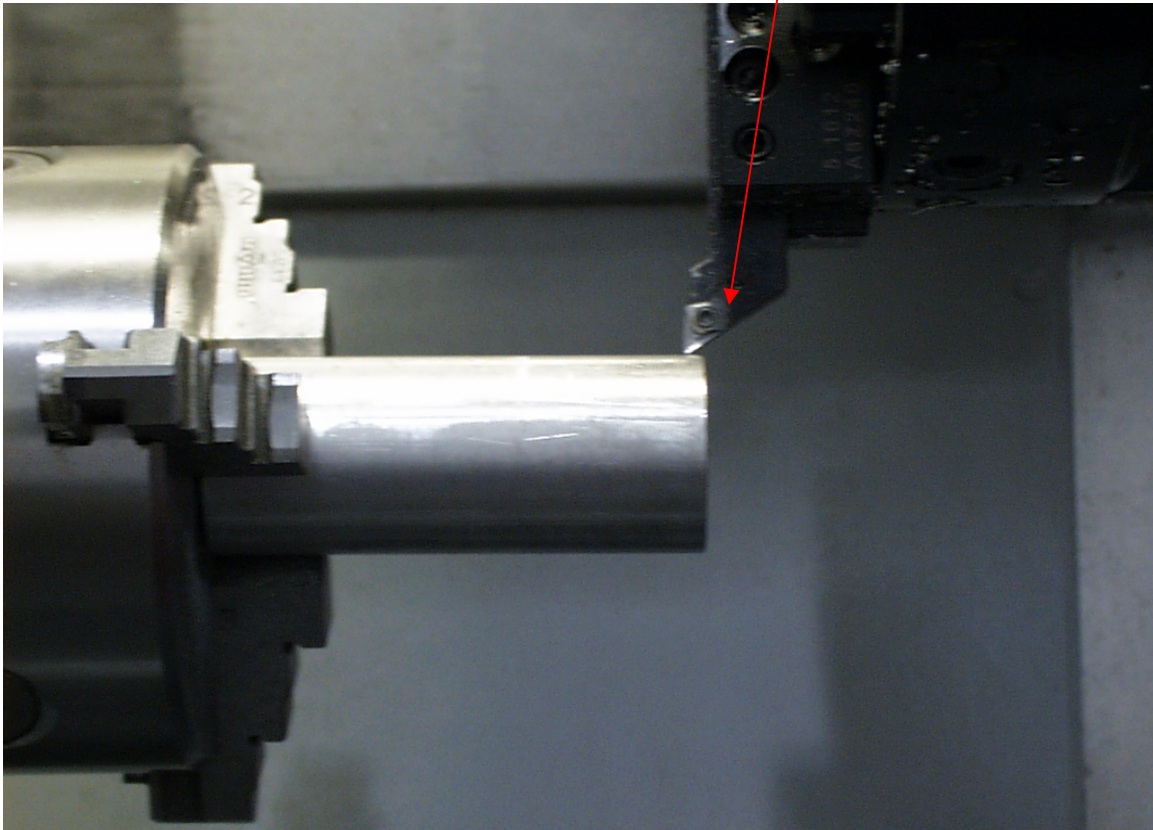
This is for Spindle speed & spindle on counter clockwise

- Press CYCLE START  (make sure door is closed)

2. Move the MODE Dial to JOG position

3. Jog TOOL TIP to the WORK PIECE & touch TOOL TIP to the DIAMETER of the WORK PIECE using the Direction keys.

(Use the Feed override dial or Steps to approach at a slower feed)



4. Press the OFFSET/SETT button until Geometry page appears



5. Take the value in Actual Position (Relative) X and subtract the Diameter of the Work Piece being scratched

6. Type value in G02 for X (If the tool being use is T0202)

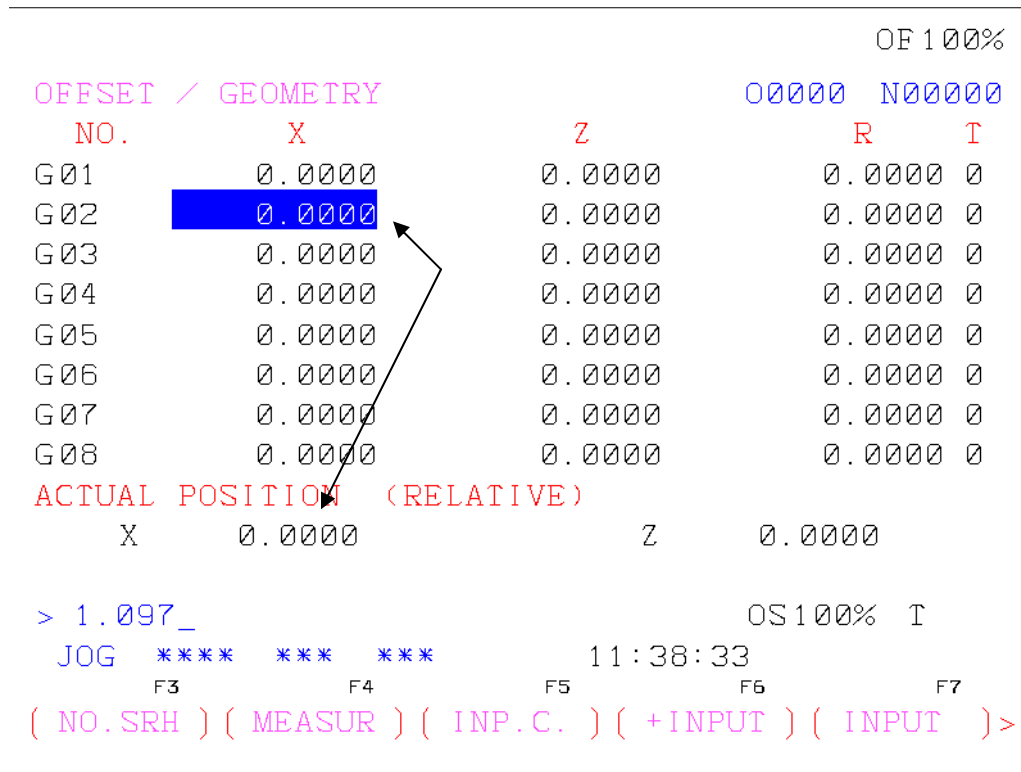
7. Then press INPUT



Example: X is 2.962 Type 1.962 (If stock is 1"dia.)

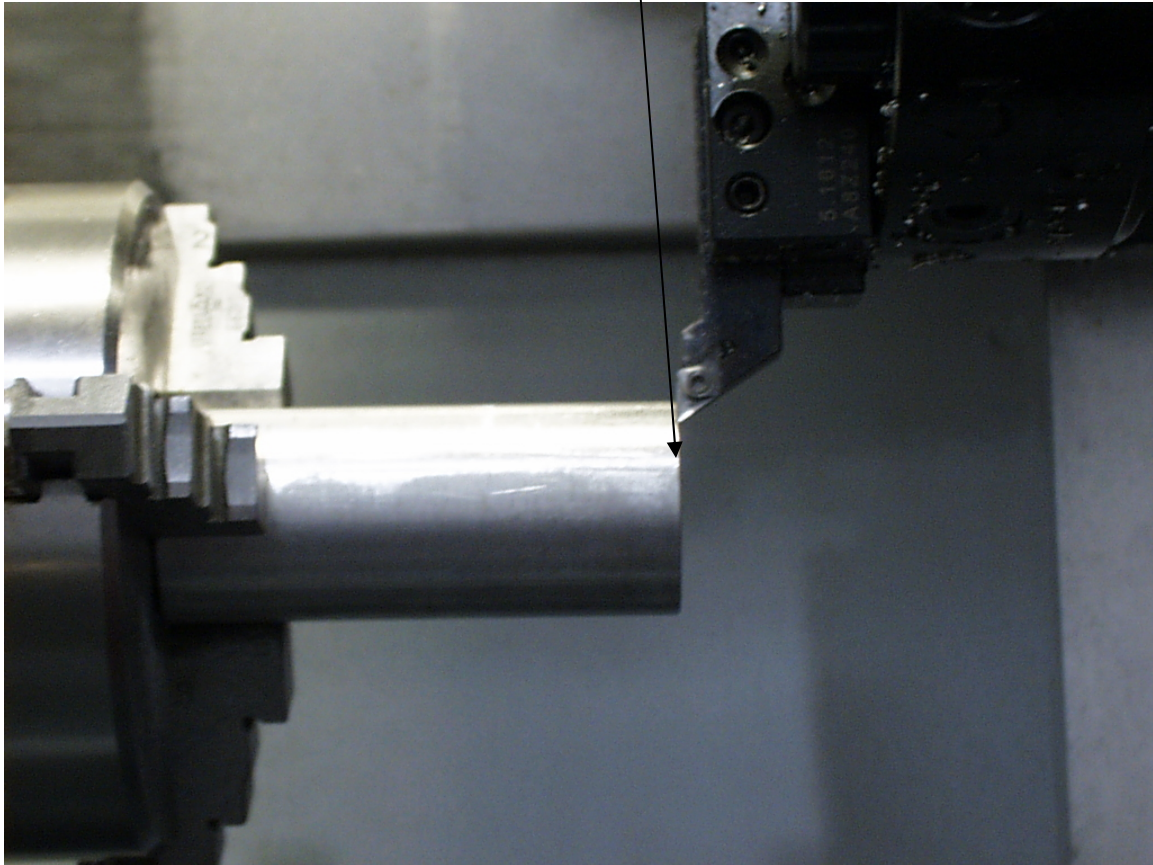
8. Jog TURRET away from WORK PIECE using X+

This value is the distance from an I.D. Tool Station to the Tool Tip



9. Jog TOOL TIP to the end of the WORK PIECE & touch TOOL TIP to the FACE of the WORK PIECE using the Direction keys.
10. Press the OFFSET/SETT button until Geometry page appears
(Use the Feed override dial or Steps to approach at a slower feed)

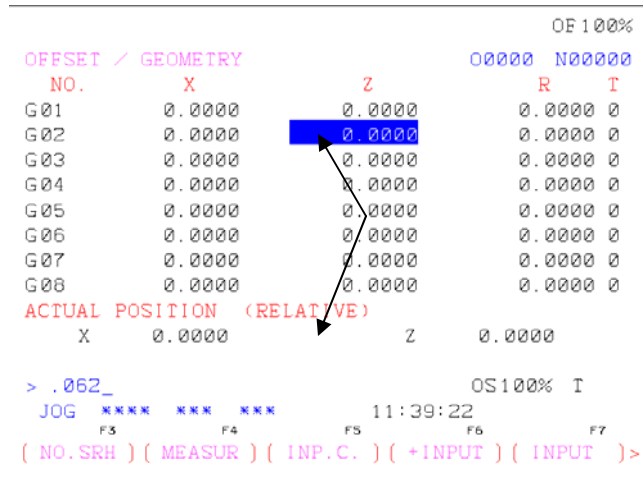
OFFSET
SETT.



11. The Value in the Actual Position (Relative) Z type this value in G02 for Z (If the tool being use is T0202)

12. Then press INPUT button 

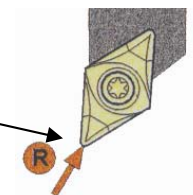
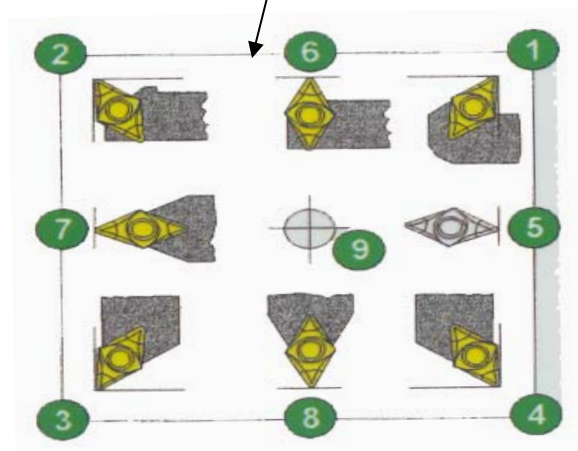
Example: Z is .062 Type .062



13. Jog TURRET away from WORK PIECE using Z+

14. The R will be Tool Tip Radius

15. The I is the Tool Direction or Tool Type

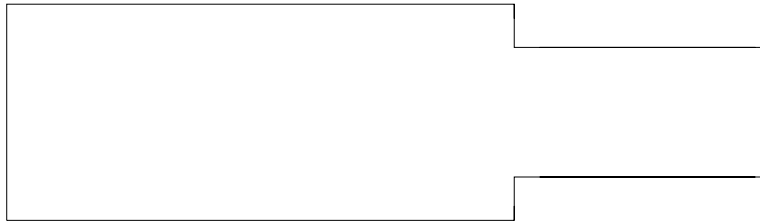


16. Repeat steps for all OD tools (STEPS 1-15)

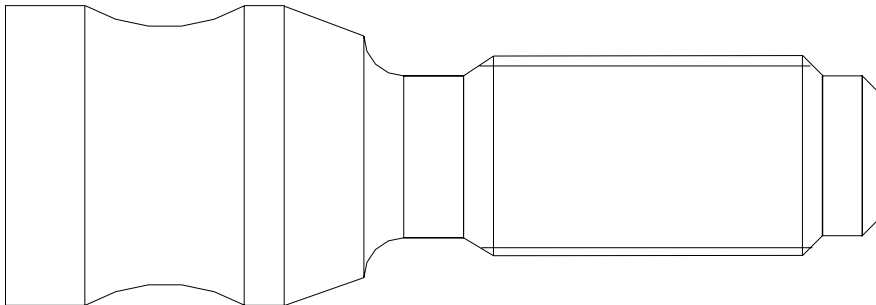
Note: The T is Direction that the Tool Points. Tool does not need to look like Tool in the Picture

Program Training

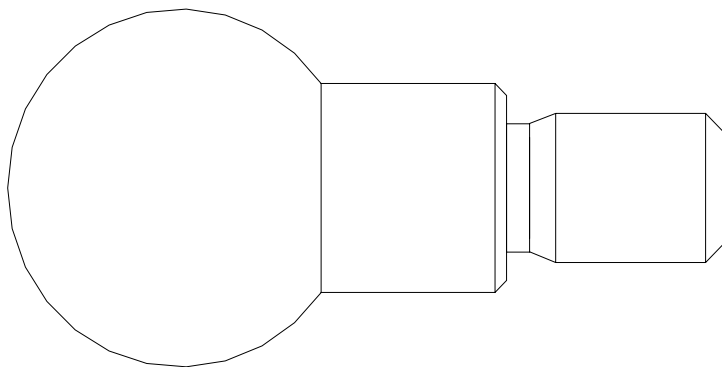
Program O0001



Program O0002




Program O0003




Change the Mode Dial to Edit & Press the  to do functions below
& on the next 2 Pages

- **INSERT A NEW PROGRAM**



1. Press letter o then program number
2. Press insert button 

Example: Q0001 OR Q1

- **CALL A EXISTING PROGRAM UP**

1. Press letter o then program number
2. Press cursor down button 




- **INSERT A WORD**

1. Press letter then number
2. Press insert button  or input 

HINT: When inserting a word to the left of the highlighted word the new word will be placed

Example: **N5** G01 X 0.25; G01 is the word being inserted

- **INSERT END OF BLOCK**

1. Press the (EOB) button 
2. Press insert button  or input 

HINT: at the end of each number line needs an End Of Block looks like a Semicolon (;)

Example: N5 G01 X1.00 F.003;

NOTE: IN EDIT & IN PROGRAM USE INSERT OR INPUT.

USE **INPUT** FOR ALL OTHER APPLICATIONS.

- **DELETE A PROGRAM**


1. Press letter o then program number

2. Press delete button 

Example: O0001 OR O1

- **DELETE ALL PROGRAMS**


1. Press letter o plus the – & 9999

2. Press delete button 

Example: O – 9999


- **DELETE A WORD**

1. Highlight the Word

2. Press delete button 

- **DELETE A BLOCK OR LINE NUMBER**

1. Type the number line and highlight the number line

2. Press delete button 

- **CANCEL MISTYPED WORD (Backspace)**


1. Press cancel button 

HINT: In the ADRS. (Address) at the lower left of the screen is the word & numbers that has been typed in. Before pressing insert or input check if what was typed in is correct. If not press cancel until error is erased and retype


- **ALTER A WORD**

1. Highlight the word needed altered type the change
2. Press alter button 


- **SEARCH FOR NUMBER BLOCK**

1. Press letter n and the number of the block
2. Press cursor down button 

- **SEARCH FOR WORD**

1. Type in word & number Example: (M30)
2. Press cursor down button 

- **SEARCH FOR LETTER**

1. Press letter
2. Press cursor down button 

HINT: This goes to the first (G). Follow steps 1 & 2 cursor goes to the next (G)

Survey of commands G-CODES (Group C): Mostly used

G00 Rapid traverse

- G01 Linear interpolation in working feed
- G02 Circular interpolation, clockwise
- G03 Circular interpolation, counter-clockwise
- G04 Dwell, active block by block
- G28 Approach reference point

G40 Deselect cutter radius compensation

- G41 Cutter radius compensation left
- G42 Cutter radius compensation right

G70 Dimensions in inch

- G71 Dimension in millimeter
- G72 Finishing cycle
- G73 Longitudinal turning cycle
- G78 Multiple Thread cutting cycle

G80 Deselect drilling cycles

- G83 Drilling cycle

G90 Absolute value programming

- G91 Incremental value programming
- G92 Set coordinates zero point / speed limitation
- G94 Feed in inch/min

G95 Feed in inch/rev

- G96 Constant cutting speed

G97 Constant speed

G98 Return to start plane

Bold print = is the Default codes that are on at all times until changed

Survey of commands M- CODES : Mostly used

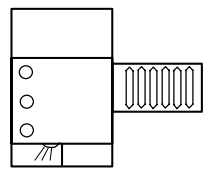
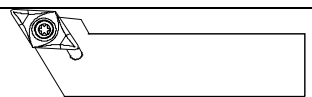

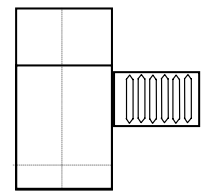
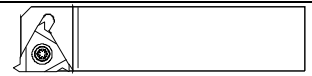

M00	Programmed stop unconditional
M03	Spindle ON clockwise
M04	Spindle ON counter clockwise
M05	Spindle OFF
M08	Coolant ON
M09	Coolant OFF
M20	Tailstock sleeve backward
M21	Tailstock sleeve forward
M25	Release clamping device
M26	Close clamping device
M30	Main program end with new start of program
M71	Blow-off ON (cleaning clamping device)
M72	Blow-off OFF
M98	Subroutine called up
M99	Subroutine end

Only one M-command for one Block authorized

Used Addresses

C	Chamfer
F	Feed rate, thread pitch
G	Path function
I, K	Circle parameter
M	Miscellaneous function
N	Block number 1 to 9999
O	Program number 1 to 9499
P	Dwell, subroutine, cycle parameter
Q	Cutting depth
R	Radius, retraction, cycle parameter
S	Spindle speed
T	Tool called out
X, Z	Position data in absolute
;	Block end

Need one of each tool and holder / collet's

Position	Part #	Discription	Picture
T0202	A8Z 240	Radial tool holder VDI 16, M4	
	271 050	Finishing tool left	
	271 056	Indexable inserts for aluminum	
T0404	A8Z 230	Radial tool holder VDI 16, M3	
	271 110	OD-threading tool right	
	271 115	Indexable inserts for OD-threading, right	

Program screen & Edit mode

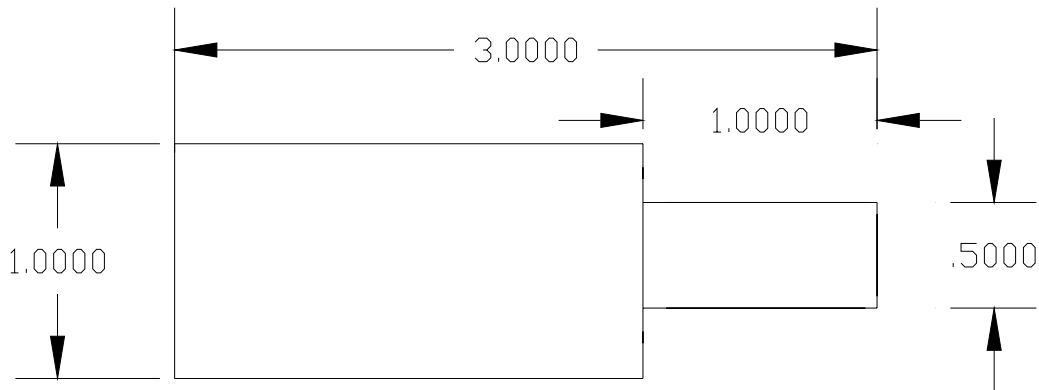
To edit / change a program / insert new programs & input or output excising programs & offsets

Program screen & MDI mode

To manually program the spindle speed / move the axis (X,Z) to a specified location and or Index to a certain tool

Note: Material is 2011-T3 Alum, All feeds & speeds are programmed for this type of Aluminum

Program Q0001



G73 U = Depth of Cut R = Retract Value

G73 P = First Block number of the Contour (Block number after the 2nd G73)

Q = Last Block number of the Contour F = Feed rate for cycle

(Facing in a cycle)

O0001 (Demo 1)

N5 (3.25 x 1 alum)

N10 G40 G70 G80 G90.....active codes

N15 G95 **G96** G98.....active codes

N20 G0 G28 U0 W0.....safe move

N25 T0202 S700 M4.....(Right Hand Finish Tool 55°)

N30 G0 X1.0 Z.1.....start point of cycle

N35 G73 U.06 R.02.....cycle parameters

N40 G73 **P45** **Q65** F.004.....cycle begin and end lines

N45 G0 X0.....first line of cycle

N50 G1 Z0.0.....movement to face of part

N55 X.5.....1st diameter of contour

N60 Z-1.0.....length of contour

N65 X1.0.....diameter of contour

N70 G0 G28 U0 W0.....safe move

N75 M30.....end of program

2D Simulation

1. Press **Graph** button on the Display Keys for the Graph screen to appear

[illegible]

Note: There are only 4 values you can change on this page the rest of them change by the values you will enter. This graph only works with an active program and runs only the current program selected

2. Work Length W = Overall length of stock in the Z direction this is a + value
3. Work Diameter D = Overall diameter of stock in the X direction + value
4. Graphic Center X = any area you wish to see past X0. Usually only if a Drill or a Tap is being used place a – value to see the tool movements for X pasted 0
Example -.100 is a common value entered
5. Graphic Center Z = this value is always a negative number and this is the area you wish to view. The longest Z- number in the program is normally used here

- **Changing I/O to floppy drive** (Only need to do this once stays default)

1. Move the Mode Dial to **EDIT**
2. Press **System** on the display keys
3. Page down until you see Parameter (Manual)
4. Cursor down to the I/O
5. Type A (for the Floppy Drive) press Input key

Other Drives useable: **B (Drive), C (Drive), P (Printer), 1, 2 (Com Ports)**

- **Output Program from Fanuc software to Drive unit**

1. Press the **Program** on the display key
2. Type program number to be send out
Example: letter O and program number
(O0002) or (O2)
3. Press the right Arrow key on the Soft keys
4. Press Punch then press Exec

- **Output Offsets from Fanuc software to Drive unit**

1. Press the **Offset/Sett** display key
2. Press (OPRT)
3. Press the right Arrow key on the Soft keys
4. Press Punch then press Exec

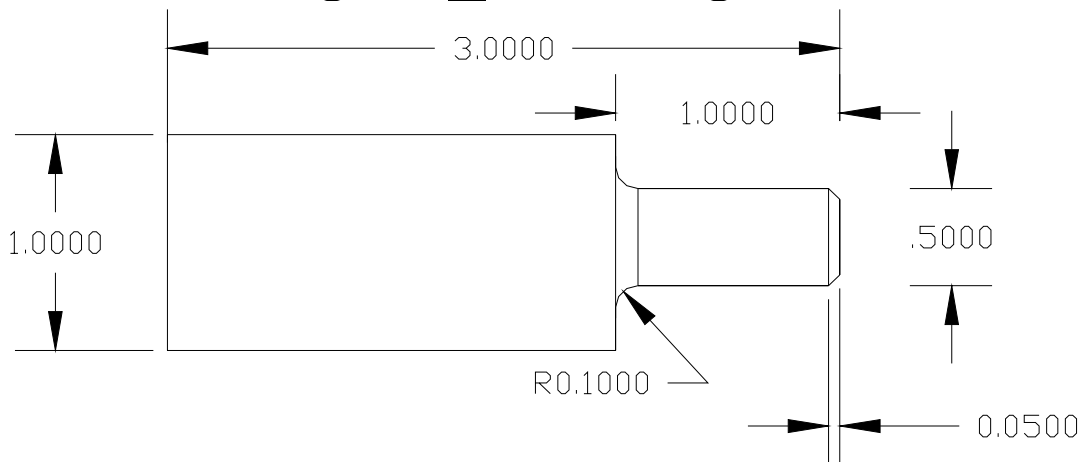
- **Input Program into Fanuc Software from Drive unit**

1. Press the **Program** display key
2. Type program number to be read
Example: letter O and program number
(O0002) or (O2)
3. Press the right Arrow key on the Soft keys
4. Press Read then press Exec

- **Input Offsets into Fanuc Software from Drive unit**

1. Press the **Offset/Sett** display key
2. Press (OPRT)
3. Press the right Arrow key on the Soft keys
4. Press Read then press Exec

Program Q0001 using C/R's



G73 U = Depth of Cut R = Retract Value

G73 P = First Block number of the Contour (Block number after the 2nd G73)

Q = Last Block number of the Contour F = Feed rate for cycle

(Facing in a cycle)

O0001 (Demo 1)

N5 (3.25 x 1 alum)

N10 **G40 G70 G80 G90**

N15 **G95 G96 G98**

N20 G0 G28 U0 W0.....safe move

N25 T0202 S700 M4 (Left Hand Finish Tool 55°)

N30 G0 X1.0 Z.1.....start point of cycle

N35 G73 U.06 R.02.....cycle parameters

N40 G73 **P45 Q65** F.004.....cycle begin and end lines

N**45** G0 X0.....first line of cycle

N50 G1 Z0.0.....movement to face of part

N55 X.5 **C.05**.....1st diameter of contour

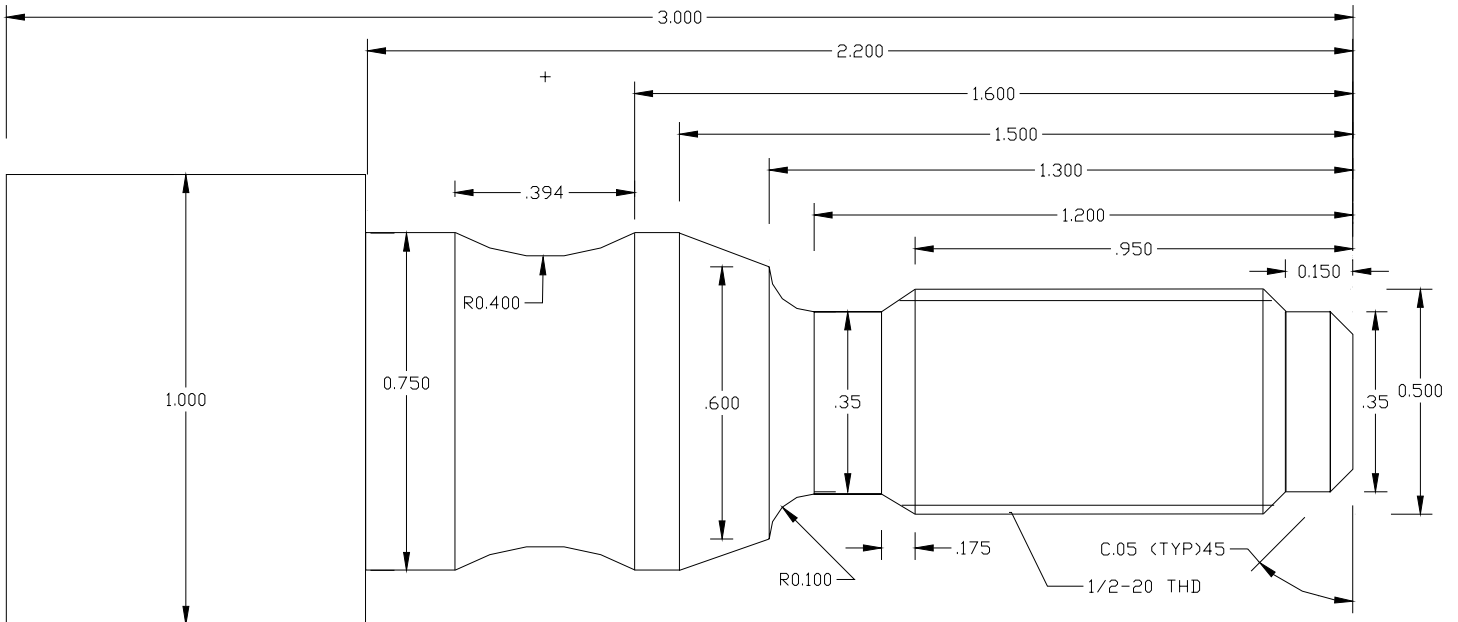
N60 Z-1.0 **R.1**.....length of contour

N**65** X1.0.....diameter of contour

N70 G0 G28 U0 W0.....safe move

N75 M30.....end of program

Program Q0002



G73 **U** = Depth of Cut **R** = Retract Value

G73 **P** = First Block number of the Contour (Block number after the 2nd G73)
Q = Last Block number of the Contour **U** = Allowance for Finish cut in X
W = Allowance for Finish cut in Z **F** = Feed rate for the cycle

HINT:

The X **BEFORE** G73 example (X 1.25) should be (=) to or (>) than X at the **END** of the Cycle. X at the end of the cycle determines stock size

G72 **P** = First Block number of the Contour (Block number after G73)
Q = Last Block number of the Contour

HINT:

BEFORE the G72 call a spindle **SPEED** higher and **FEED** rate lower
If possible change tool to a 55 degrees for FINISHING & 80 degree for
ROUGHING

G78 CYCLE MULTIPLE

Example for 1/2 20 thread

1ST G78

P = Is 6 Digits divided in 2 Digit groups

P = 1st two digits is number of FINISH PASSES 01

2ND two digits is PULL OUT ANGLE 00

3rd two digits is angle of the THREADS 60 degrees

Q = Minimum cutting DEPTH 0020 (Micro IN)

R = Finishing OFFSET .001

2nd G78

X = Minor DIA. X .434

Z = Length of THREAD from (0) call out Z -1.05

P = Depth of THREAD Radial 0330 (Micro IN)

Q = First cutting DEPTH 0120 (Micro IN)

F = Thread PITCH .050

Micro IN is the value without the decimal point

Example: .1000 is shown as 1000 (show all 4 place values)

HINT: Threading

$$\text{TPI} = \frac{1}{20} = \frac{1}{(F)} .05$$

$$\text{IPM} = \text{RPM} \times \text{PITCH}$$

$$\text{RPM} = \frac{\text{IPM}}{\text{PITCH}} = \frac{50}{.05} = 1000 \text{ RPM}$$

300 is max for a 155 machine
315 is max for a 325II Machine

Make sure the X value before the G78 is larger than the MAJOR Diameter and the Z is at least 2 times the PITCH before cutting threads

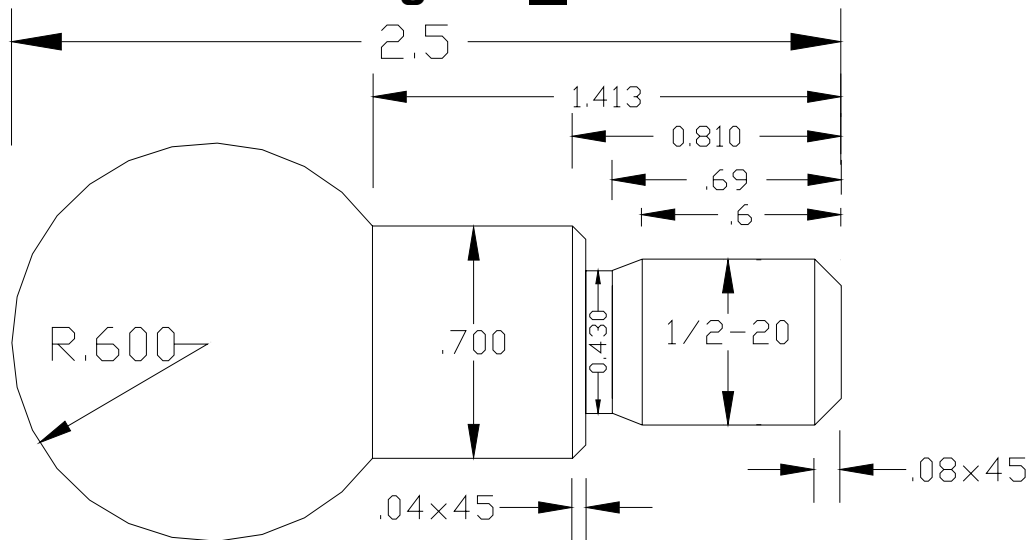
Example: N100 G0 X.55 Z.1 ; THIS IS THE START POINT FOR G78
N105 G78;

Program Q0002

O0002 (Demo 2)
N5 (Stock 3.25 x 1)
N10 G0 G28 U0 W0
N15 G96 T0202 S700 M4 (Left Hand Finish Tool 55°)
N20 G0 X1.1 Z.1.....Safe start for Facing
N25 Z0.....Face of part
N30 G1 X-.02 F.002.....Facing past Zero
N35 G0 X1.0 Z.1.....Start point of cycle
N40 G73 U.06 R.02.....Cycle parameters
N45 G73 P50 Q115 U.01 W.005 F.004.....Cycle finish offsets
N50 G0 G42 X.2.....Turning CRC on
N55 G1 Z0.....Face of part
N60 X.35 C.05
N65 Z-.15
N70 X.5 C.05
N75 Z-.950
N80 X.35 Z-1.125
N85 Z-1.3 R.1
N90 X.6
N95 X.75 Z-1.5
N100 Z-1.6
N105 G2 X.75 Z-1.994 R.4
N110 G1 Z-2.2
N115 G1 X1.0
N120 G0 G40 X1.1.....Cancel CRC
N125 S1000 F.002
N130 G72 P50 Q120
N135 G0 G28 U0 W0.....Safe Index Pos
N140 G97 S1000 M3Threading Speed in RPM
N145 T0404 (Threading Tool Right Hand)
N150 X.55 Z.1.....Start Pos. Thread Cycle
N155 G78 P010060 Q0020 R.001.....Threading cycle
N160 G78 X.434 Z-1.125 P0330 Q0120 F.05
N165 G0 G28 U0 W0.....Safe Return
N170 M30.....End of Program

1. To make a program tie together use M98 this calls out Sub programs or Sub routines.
Example: M98 P010001
2. After M98 P is identified with 6 digits.
 - The First 2 digits is the number of times program is to be repeated
 - The next 4 digits is the program number without the letter O
3. Programs that are being used as a Sub Programs must end with M99 instead of M30.
4. All programs can be used as Sub Programs or Main Programs
M99 means program is Sub, M30 means program is a Main
5. A main Program can also use M99 at the end.
 - Program is being used to repeat without cutting multiple parts.
 - This is mainly used for Demo's for just seeing Tool movements.

Program Q0003



O0003 (Ball Hitch)

N5 (Stock 2.5625 x 1.25)

N10 G0 G28 U0 W0

N15 G96 T0202 S700 M4 (Left Hand Finish Tool 55°)

N20 G0 Z.1

N25 Z0

N30 G1 X-.02 F.003

N35 G0 X1.25 Z.1

N40 G73 U.06 R.02

N45 G73 P50 Q95 U.01 W.005 F.004

N50 G0 G42 X.24

N55 G1 Z0

N60 X.5 C.08

N65 Z-.6

N70 X.43 Z-.69

N75 Z-.770

N80 X.7 C.04

N85 Z-1.413

N90 G3 X1.2 Z-1.92 R.6

N95 G1 X1.25

N100 G0 G40 X1.3

N105 S1000 F.002

N110 G72 P50 Q100

N115 G0 G28 U0 W0
N120 G97 S1000 M3
N125 T0404 (Threading tool Right hand)
N130 X.55 Z.1
N135 G78 P010060 Q0020 R.001
N140 G78 X.434 Z-.69 P0330 Q0100 F.05
N145 G0 G28 U0 W0
N150 M30 (Flip Part around) **Note: change M30 to M00 after touch off**

Then start back at line N150 to run the back side

N155 M98 P010004 (SUB PROGRAM FOR BACK SIDE)
N160 M30

Program Q0004

O0004 (Back side of Ball Hitch)

N5 G96

N10 G10 P0 Z- ←

Need to touch with turret to the face of stock to get the number for the (Z-) after you cut the first side. Now press Position and the number that is in Machine for (Z) place this number on line N10 for Z as (-).

N15 T0202 S700 M4 (Left Hand Finish Tool 55°)

N20 X1.25 Z.200

N25 G73 U.06 R.02

N30 G73 P35 Q55 U.01 W.005 F.004

N35 G0 G42 X0

N40 G1 Z0

N45 G3 X1.2 Z-.6 R.6

N50 G1 Z-.69

N55 X1.25

N60 G0 G40 X1.3

N65 S1000 F.002

N70 G72 P35 Q60

N75 G28 U0 W0

N80 G10 P0 Z- **(the original work shift)**

N85 M99

Might need to subtract from the Z- on line N10 at least .0625

This is the difference between the Stock size on the print and the Stock size recommended. This way the ball will blend together in the middle of the part. The other thing that can be done is to face .03125 on each side of the part as it is being machined