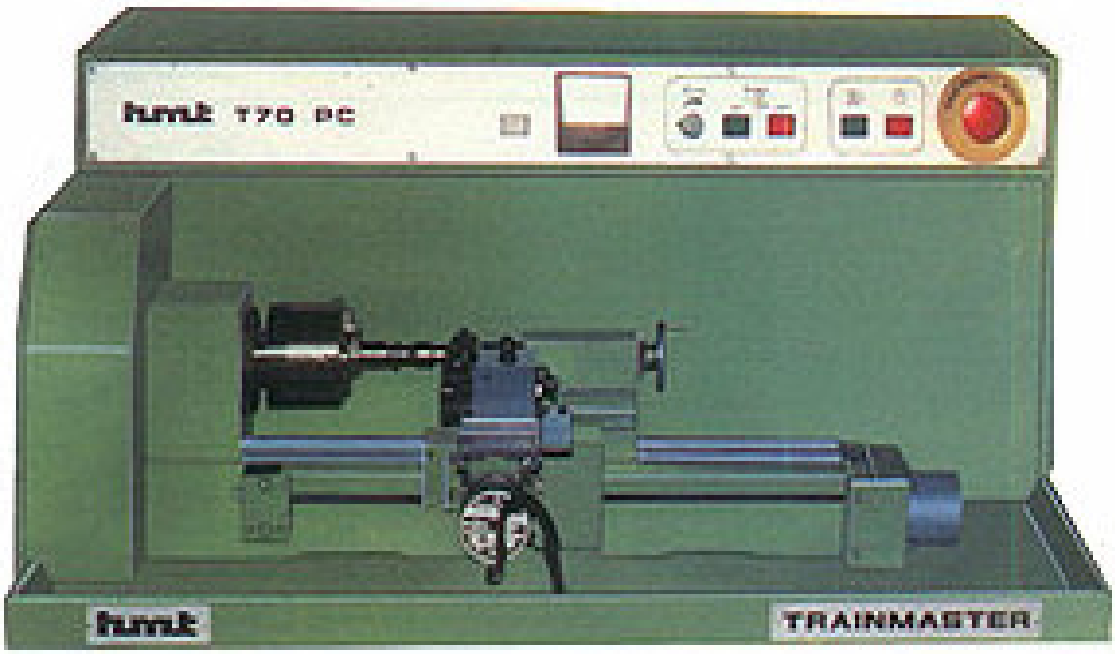
Microcontroller Based CNC Lathe System (MBCS) 1.0 User Manual



MAC Division

Unified Soft –Tech

.....Techies Tech Point

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Table of Contents

Chapter 0 Introduction

0.0 Product Description

MBCS 1.0 i.e. Microcontroller based CNC lathe system is a Numerical Control System that uses a dedicated 16-bit Microcontroller as an integrated part in its Main Control Unit (MCU) to execute the basic NC control functions. This product is the upgraded version for HMT CNC T-70, which uses 8085 microprocessor as a MCU. MBCS 1.0 uses 16-bit Microcontroller as an integrated part in its MCU, which enhances the system response. Also it gives the friendly User Interface and simple Editor to ease the programming.

0.1 Features

- ISO standard 15 G-codes and 6 M-codes
- Powerful software with self-diagnostic and security characteristics
- Precise control over tool movement
- Precise control over spindle rotation
- Axes control
  - 2 Axes Control (X and Z co-ordinate)
  - 2 axes X and Z are controlled by 2 separate stepper motors with 200 steps/rev
  - Feed rate 10 – 540 mm/min
  - Accuracy of +/- 20 of X-axis & +/- 50 of Z-axis
  - Precision 0.01 mm
  - Separate key to set the feedrate for tool movement
  - Four Jog Keys
- Spindle Control
  - Spindle driven by DC motor
  - 0 - 4000 RPM maximum
  - Operating range 60 - 2000 RPM
  - Accuracy of +/-1%
  - Precision 1 RPM
  - Key controlled spindle On/Off & speed increment/decrement
- Editor
  - User-friendly control panel
  - Part Program size from 000 to 999 blocks
  - Memory to store one program

- Continuous Execution of part program or Single Step Execution

- Job 0 positioning
  - Left side of the job or right side of the job
- Machine 0 positioning – provided at extremities of +Z and +X axes
- Different Beeps for warnings & Errors
- "DRY RUN" i.e. execution of the part program without movement of any of motors using "CONTROL KEY" (Refer Manual Mode control)
- Emergency stop for severe failure conditions

Chapter 1 Electrical Specification

1.0 Electrical Specifications

Operating Voltage:	230V AC
Supply voltage fluctuation:	+/- 5%
Supply frequency:	50-60Hz
Spindle Motor:	130V, 22A
Stepper Motors:	5V, 1A
LCD:	5V, 100mA
Environmental conditions:	Indoor use, Schools/Colleges training purpose

1.1 Getting Start with MBCS 1.0

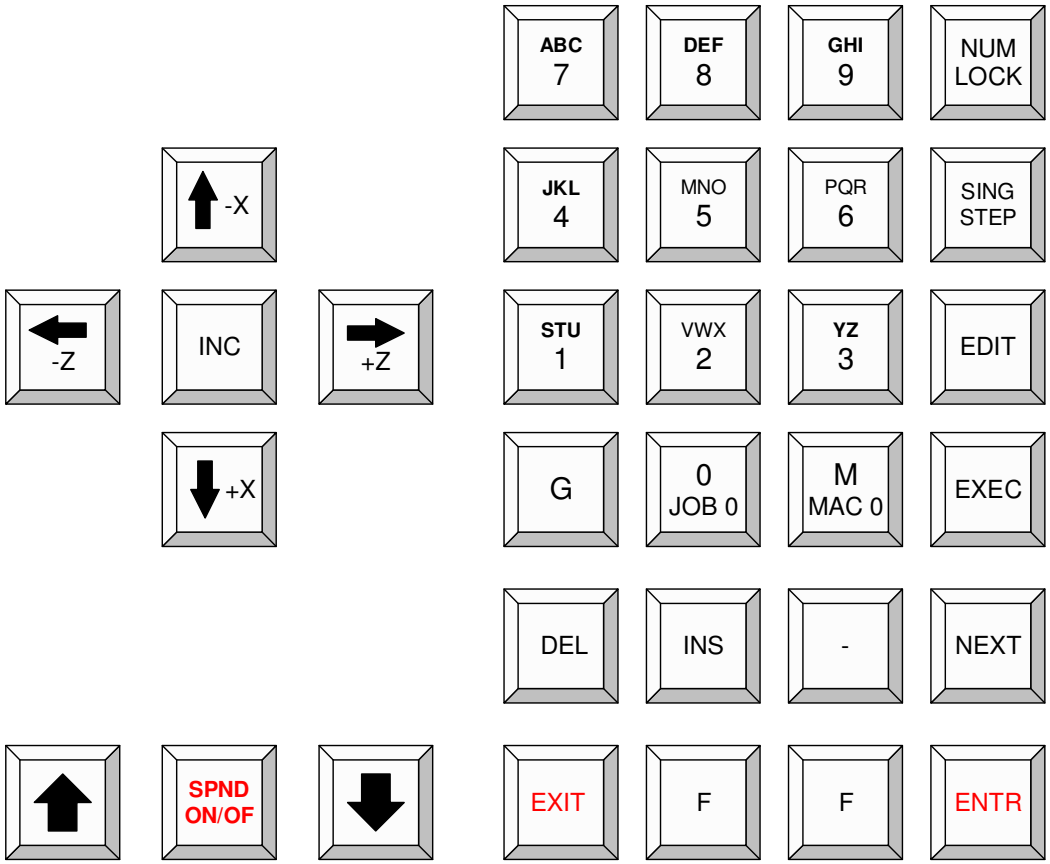
Before you switch on the system you should know about the two basic input/output entities of the system i.e. Keypad & LCD.

1.2 LCD

It is 20x4 output entity i.e. 4 rows or lines of each 20 columns or characters. This is used mainly to display all the messages & parameters that come across while operating the system. Example while editing the part program it displays the blocks, codes & parameters of part program & Error messages etc.

1.3 Keypad

MBCS 1.0 has a keypad input entity consisting of 32-keys as shown below.



1.3.0 Automatic Mode

- 0 to 9: Numerical keys for entering parameters & selecting option
- A to Z: Alpha numeric keys for Variable definition during part program
- G & M: Part program G & M code
- DEL: Delete the blocks in the part program
- INS: Insert the blocks in the part program
- -: Sign key, Indicates negative number in case of part program
- NUM LOCK is ON; 1 to 9 numerical keys will be available for use
- NUM LOCK is OFF; A to Z keys will be available for use
- EDIT: Edit the part program
- EXEC: for execution of program
- SING STEP: Block by block execution of the program.
- NEXT: To confirm the parameter edited

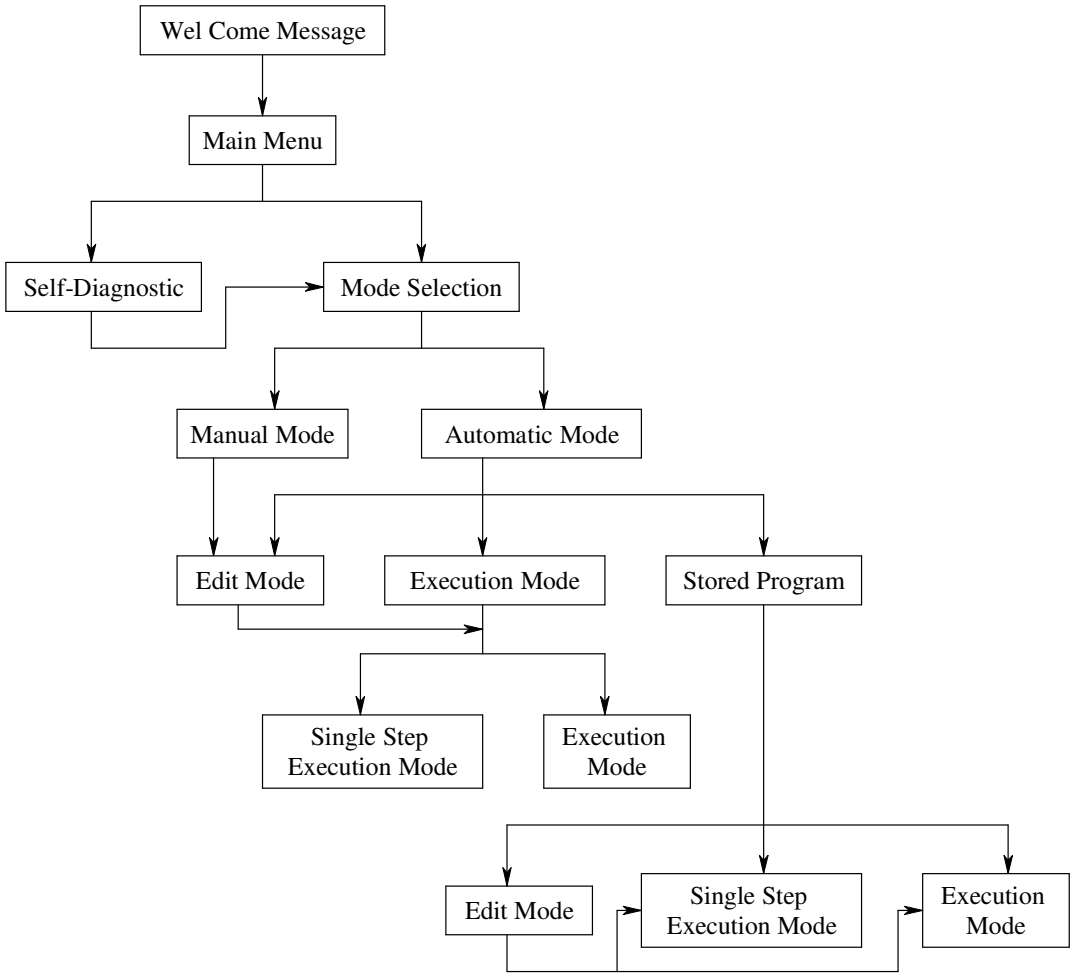
- ENTR: To process the operation
- EXIT: To go back to the previous menu
- Up(⬆), Down (⬇), Left (⬅) & Right (➡) arrow keys to view codes written

1.3.1 Manual Mode

- INC: to select the feed rate (mm/min) at which tool has to move in X & Z-axes (e.g. 1or 10 or 100 or 200).
- +Z & -Z: for Z-axis motor control
- +X & -X: for X-axis motor control
- SPND ON/OFF: for spindle ON/OFF
- ⬆ & ⬇: To increase/decrease spindle speed respectively.
- 0/ JOB 0: To set the Job zero positioning.
- M/ MAC 0: To set the Machine zero positioning.

1.4 (Software) Flow Diagram

The following shows the (Software) flow diagram for MBCS 1.0.



Once you power up the system, welcome message is displayed & waiting for a key press. After pressing a key a Main menu will be displayed with option either to select *Self-Diagnostic Mode*, where-in you can check the working conditions of all motors or *Mode Selection*.

In *Self-Diagnostic Mode* you need not do anything. Everything is checked automatically. Which takes around 1.5 seconds & finally gives result i.e. status of all the motors. It is a test for the external world (Spindle & Stepper motors).

In *Mode Selection* option of the operating modes is asked i.e. to select either Manual Mode or Automatic Mode.

In *Manual Mode* all the operations i.e. control of all the motors will be done manually. To start/stop the spindle, "SPND ON/OFF" key has to be pressed manually. Similarly for the tool movement jog keys has to be operated manually.

In *Automatic Mode* all the operations i.e. control of all the motors will be done through part program, user/operator writes a part program for the operations & with *execute* command operations can be performed. Even there is a provision to store the part program and *edit/execute* same stored part program.

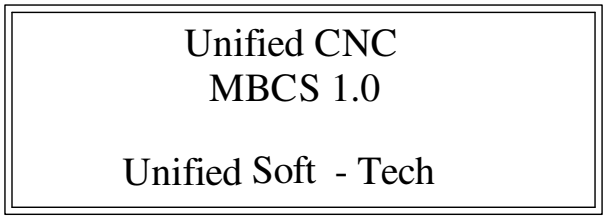
Edit Mode, user/operator can edit the part program for any lathe operation.

Execution Mode, executing the part program to perform lathe operation.

Single Step Execution Mode, same as Execution Mode but is performed block by block.

To Power up the System

1. Switch on the main supply switch (RED colour switch) at the back of the lathe.
2. You may Turn on the Control key to provide supply to the stepper motor.



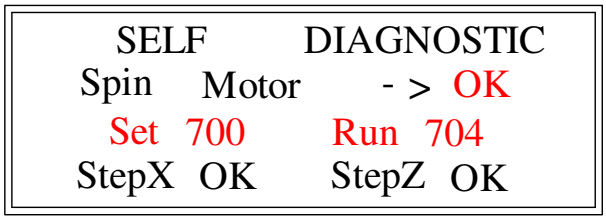
When you power on the system, Welcome message (as above) will be displayed on the LCD display, which confirms the working of software. Now it is waiting for you to press any key, when a key is pressed, Main menu will be displayed as below.

Chapter 2 Modes of Operation

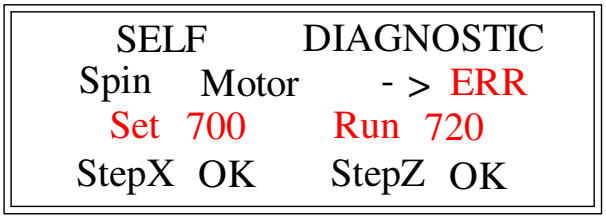
The MBCS 1.0 can operate in two modes either in Manual Mode or Automatic Mode. There is an option of Self-Diagnostic also; where–in user/operator can check the working conditions of all motors.

2.0 Self-Diagnostic Mode

In Self-Diagnostic, working conditions of all the motors can be checked. Initially spindle is rotated with predefined speed eg: 700 rpm & then from the feedback speed is measured & compared with set speed. If percentage of error is less than accuracy of the spindle then spindle motor is working fine & you can see the following display.

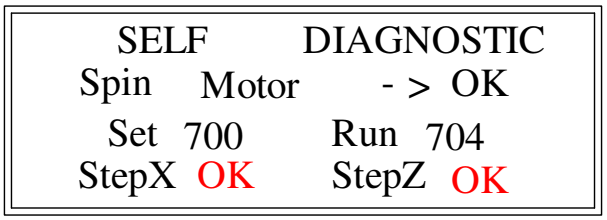


Otherwise problem in the spindle motor & following error message is displayed.

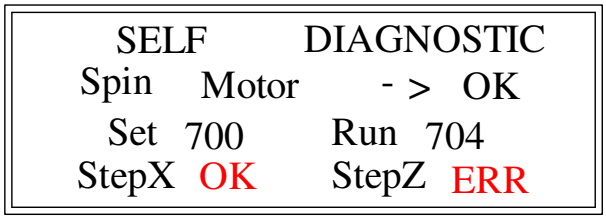


After spindle check, machine is positioned to Machine zero & stepper motors (x- & z-axes) are checked. From the following messages you can interpret that

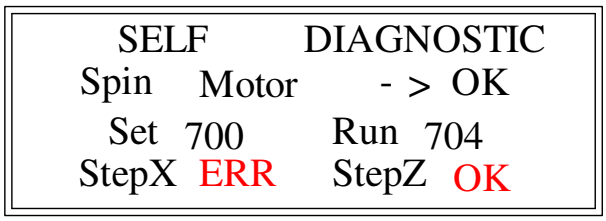
i. Both stepper motors are working fine.



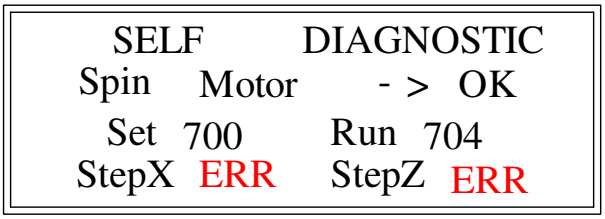
ii. X-axis Stepper motor Ok but Error in Z-axis Stepper motor.



iii. Z-axis Stepper motor Ok but Error in X-axis Stepper motor.

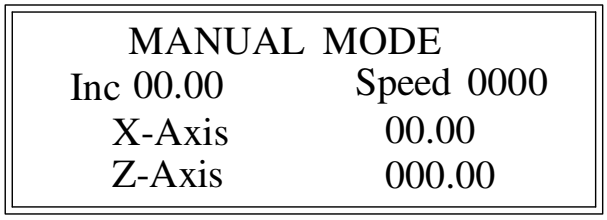


iv. Error in the both stepper motors.



2.1 Manual Mode Control

As the name indicates here user will be having the provision to move the tool manually. For the movement of tool 4 jog keys are provided in the keypad. Spindle can be switched On/Off and also its speed incremented/decremented manually. The following is the display format in case of manual mode.



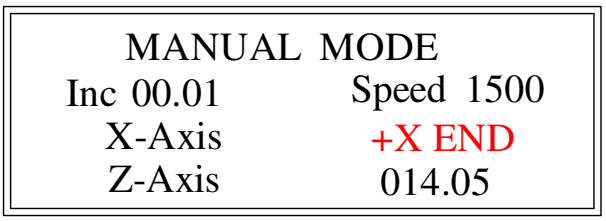
Features provided in manual mode are

2.1.0 Four Jog Keys

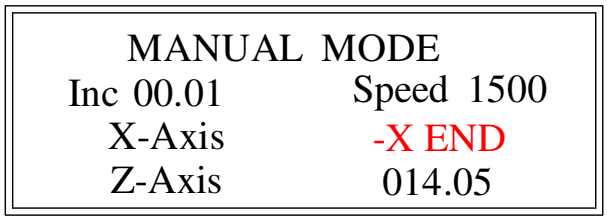
Four jog keys -X, +X, -Z and +Z are provided for the tool movement. User/Operator can move the tool in the desired direction by pressing the corresponding jog key.

The following Error messages such as –X END, +X END, –Z END and +Z END are displayed when respective limit switch is detected i.e. when you try to move the tool beyond its limit in the respective direction.

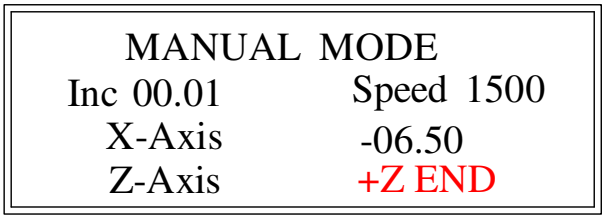
i. '+X' END
'+X' limit switch detected, tool can't be moved further in +X direction.



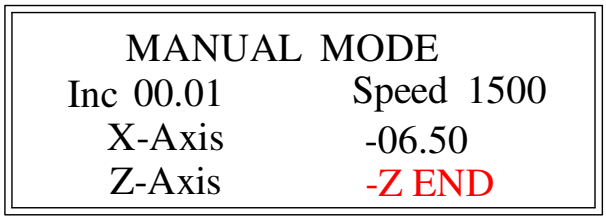
ii. '-X' END
'-X' limit switch detected, tool can't be moved further in -X direction.



iii. '+Z' END
'+Z' limit switch detected, tool can't be moved further in +Z direction.



iv. '-Z' END
'-Z' limit switch detected, tool can't be moved further in –Z direction.



2.1.1 Feedrate

"INC" key is provided to set the feedrate for tool movement. The feedrate is measured in terms of linear movement (or stepper motor steps) per each key press. Four ranges of feedrate are provided. They are

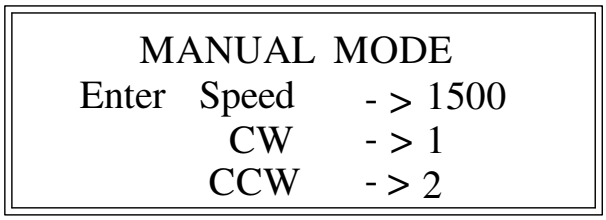
- 0.01 mm/keypress
- 0.1 mm/keypress
- 1.0 mm/keypress
- 2.0 mm/keypress

User can select one range out of above four. If you press 'INC' key once then 0.01mm/keypress, twice then 0.1/keypress, thrice then 1.0mm/keypress, fourth time then 2.0mm/keypress will be selected. If you press fifth time then again 0.01mm/keypress is selected and cycle repeats for further presses of 'INC' key.

2.1.2 Spindle On/Off

A single key "SPND ON/OFF" controls the On/Off of spindle. Initially the spindle will be off. When spindle is switched on by pressing the "SPND ON/OFF" key, the user will be prompted for spindle speed in RPM.

i. Numerical keys are used to set the speed.
ii. "ENTR" key is pressed to confirm the set speed.
iii. Then press "1" to rotate the spindle in Clockwise direction (CW)
iv. Or press "2" to rotate the spindle in Counter-Clockwise direction (CCW).

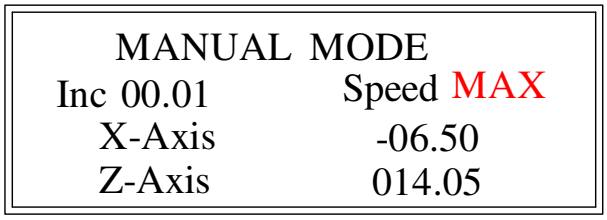


When spindle is rotating and "SPND ON/OFF" key is pressed then the spindle will be stopped.

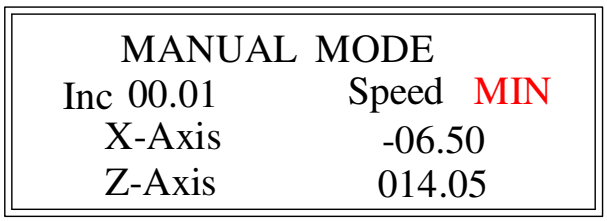
2.1.3 Spindle speed Increase/Decrease

Two keys "⬆" & "⬇" are provided to vary the spindle speed in manual mode. "⬆"key to increase & "⬇" to decrease the spindle speed. One key press will vary the spindle speed by 20 rpm.

The spindle speed range is 60 to 1600 rpm. If you try to increase the speed above 1600rpm then "MAX" is displayed, indicating that spindle is rotating at maximum rpm.



Similarly if you try to decrease the speed below 60rpm then "MIN" is displayed, indicating that spindle rotating at minimum rpm.



2.1.4 Machine Zero

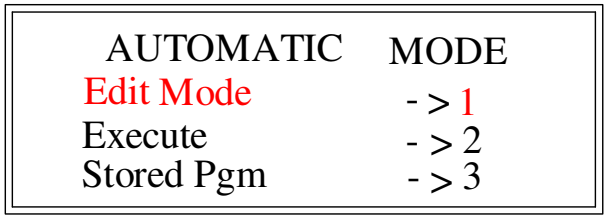
Tool can be set to machine zero by simply pressing "M/ MAC 0" key. The Machine zero positioning is provided at extremities of +Z and +X axes.

2.1.5 Job Zero

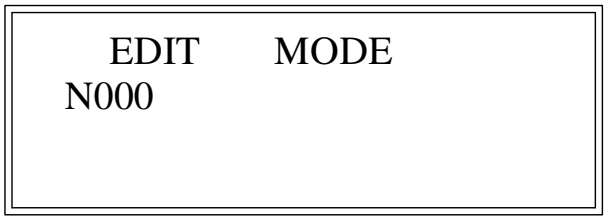
Machine can be set to job zero by simply pressing "0/ JOB 0" key.

2.2 Automatic Mode Control

In Automatic mode user/operator may edit new part program, execute the previously written part program or edit/execute the stored program. The display format in case of automatic mode is as follows.



If you press key "1" i.e. if you select editing new part program then block selection is displayed & you can start editing.



N100, Cursor will be at the last 0 position, you can select the any block from 000 to 999 depending your program size.

Once the starting block is selected and NEXT key is pressed display will wait for the type of code ("G" or "M") to be entered. After pressing "G" or "M", "00" is displayed in front. Now it is waiting for code to be entered. Depending upon the code entered the parameters corresponding to the code are displayed. The entry into parameters is just like fill in the blank format.

Example:

1. If G00 is entered the display will be
   N100 G00
   X 00.00 Z 00.00

   0s can be replaced by the different values.

2. If G33 code is entered the display will be
   N100 G33
   X 00.00 Z 00.00
   K 0.00 Q 00

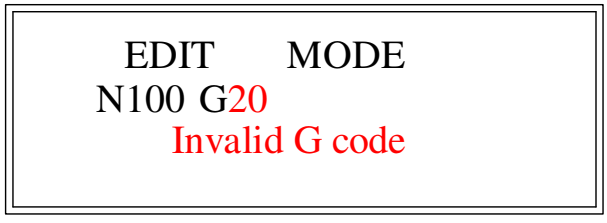
3. If M00 is entered the display will be
   N100 M00

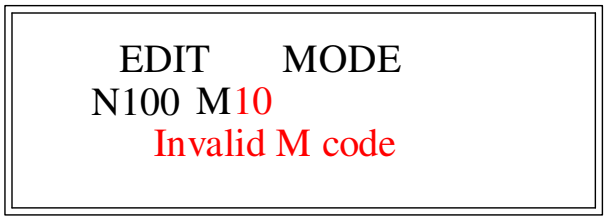
4. If M03 is entered the display will be
   N100 M03 SPEED 0000
   etc

In the above editing process you may get following error(s)

i. Invalid G/M code

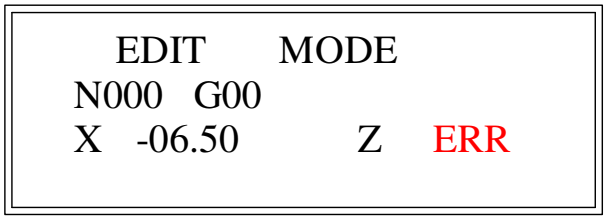
The entered code is not valid code. Please refer G& M code list provided the on the lathe machine or in the user manual. (LINK)?????





ii. X ERR or Z ERR

These messages are displayed when X/Z entered values are not in the range or range is exceeded i.e. X is crossed -/+60mm or Z is crossed -/+220mm.



iii. Similarly F ERR or SPEED ERR

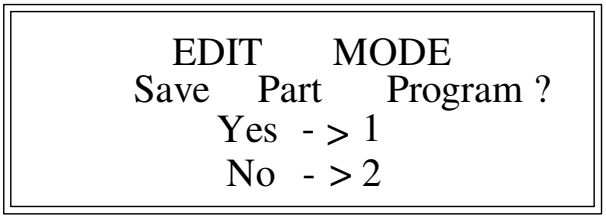
These messages are displayed when F/SPEED entered values are not in the range. F range 10 to 540 mm/min & SPEED range 60 to 2000 rpm.

You may use scroll keys i.e. "⬇/+X", "⬆/-X", "➡/-Z", & "⬅/+Z" to view the previously written codes.

To stop editing you may press any of the 3 keys mentioned below.

i. "EXIT" – To end the editing of program
ii. "EXE" – To execute the program.
iii. "SING STEP" – To execute the program in stepwise.

On pressing of any of these keys, the user will be prompted to save the part program as shown below.

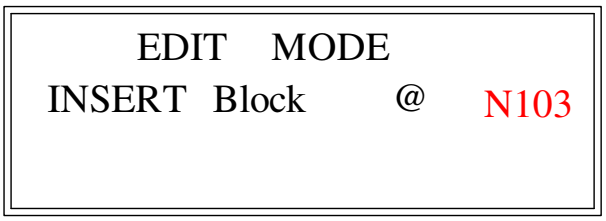


2.2.0 INSERT Codes

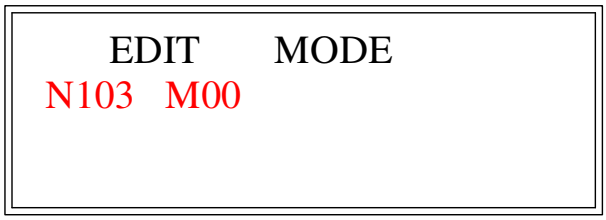
You may use “INS” key to insert the new block(s) of code in between the existing blocks.
Example:

N100 G71
N101 G91
N102 M03 SPEED 1200
N103 G00
X 01.00 Z 05.00
N104 G01
X 01.00 Z -05.00
N105 M02

Now if you think that one code is missing & should be placed at N103, then press “INS” key. Now the following display will be displayed with N000 & waiting for you enter the block number from where you want insert. In the considered example it is N103. After entering the block no., press “ENTER” key.



Now you can start inserting (same as editing). Once you finish inserting follow the same procedure as followed in terminating from editing.



After inserting block @ N103 the part program will be as follow

N100 G71
N101 G91
N102 M03 SPEED 1200
N103 M00
N104 G00
X 01.00 Z 05.00
N105 G01
X 01.00 Z -05.00
N106 M02

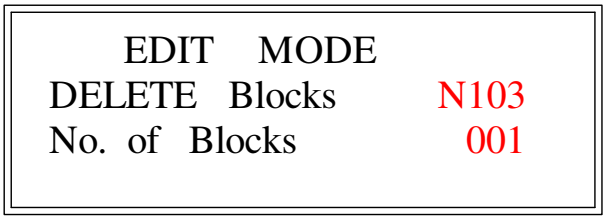
2.2.1 DELETE Codes

You may use "DEL" key to delete the block(s) of the part program.

Example:

N100 G71
N101 G91
N102 M03 SPEED 1200
N103 M00
N104 G00
X 01.00 Z 05.00
N105 G01
X 01.00 Z -05.00
N106 M02

Now if you think that one code is to be deleted, placed at N103, then press "DEL" key. Now the following display will be displayed with N000 & waiting for you enter the block number from where you want delete. In the considered example it is N103. After entering the block no., it is waiting for you enter no. of block(s) to be deleted. In the considered example it is only 1 block. Now press "ENTER" to process the delete operation.



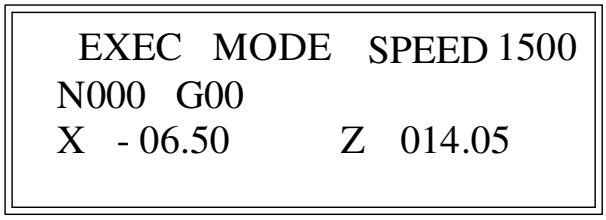
After the delete operation the part program will be as follow

N100 G71
N101 G91
N102 M03 SPEED 1200
N103 G00
X 01.00 Z 05.00
N104 G01
X 01.00 Z -05.00
N105 M02

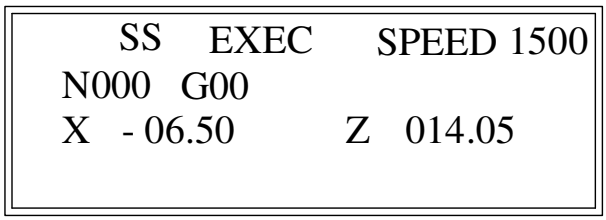
2.2.2 Execute or Single Step Execute

After editing the part program, to execute it simply press "Exec" key. Otherwise if u want to execute block-by-block, then simply press "Sing Step". In single step execution, after completing execution of a block, displays next code & controller waits for "Enter" key to be pressed. Once "ENTER" key is pressed it executes again the block displayed & cycle repeats.

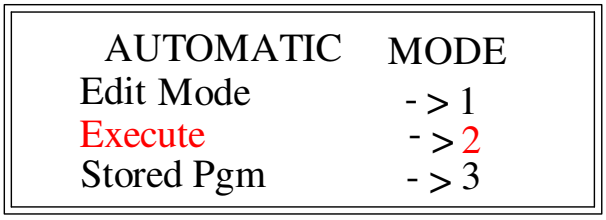
i.Display format while Executing.



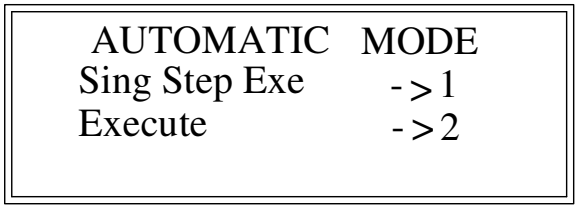
ii. Display format while Executing block wise (i.e. Sing Step Execution).



Or even you can go to "AUTOMATIC MODE" display (as shown below) & press "2".



Now you can either go with block wise execution (press "1") or continuous execution (press "2") of the part program.



In the above executing process you may get following error(s)

i. "–X" Limit switch detected.

ii. "+X" Limit switch detected.

iii. "–Z" Limit switch detected.

iv. "+Z" Limit switch detected.

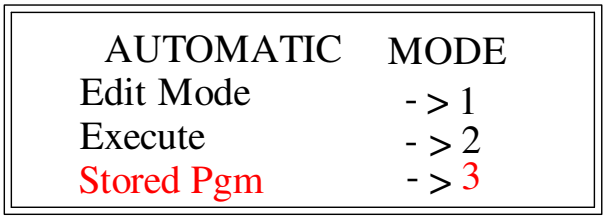
The editor takes care of the data validation of the X & Z parameters while editing i.e. to avoid length of 'X' parameter not to exceed -/+60mm & length of 'Z' parameter not to exceed -/+220mm. But if the start position is misplaced then such errors are bound to happen.

v. Spindle Overload

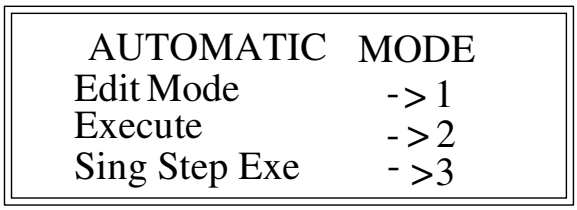
This error may occur, when you try to use heavy work piece or when the depth of cut is more than the specified value.

2.2.3 Stored Program

To edit or execute the stored program, first choose "Store Pgm" option (Press "3") in "AUTOMATIC MODE", as shown below.



Now you can edit (Press "1") or execute (Press "2") or execute block wise Press ("3") the previously stored program.



2.3 Emergency Stop

Emergency stop push button is provided in case severe failure(s). When Emergency stop push button pressed the following display will be prompted on LCD asking the options to quit or stop (press "EXIT") the current process or continue (press "ENTER") with same process.

Chapter 3 Mechanical Specification

3.0 Mechanical Specifications

	Metric	Inch
Capacities		
Height of the centres	70	27.55
Distance between centres	310	122.05
Swing over bed	100	39.37
Swing over cross-slide	60	23.62
Travel of cross-slide	55	21.65
Headstock		
Hole through main spindle	16	6.30
Spindle taper	MT2 (type)	MT2 (type)
Type of drive	DC motor	DC Motor
Speed range (step less)	50-3200 RPM	50-3200 RPM
Feed		
Type of Drive	Stepper Motor	Stepper Motor
No. of axes	2	2
Resolution	0.01	0.004
Rapid traverse rate	700 mm/min	275.59 inch/min
Feed rate	1-700 mm/min	0.39 - 275.59 inch/min
Accuracies		
Positioning X-axis	0.02	
Positioning Z-axis	0.06	
Repeatability X-axis	± 0.002	
Repeatability Z-axis	± 0.003	
General		
Floor space (L x W x H)	870 x 642 x 590	342.52 x 252.76 x 232.28
Machine weight	95 kg	

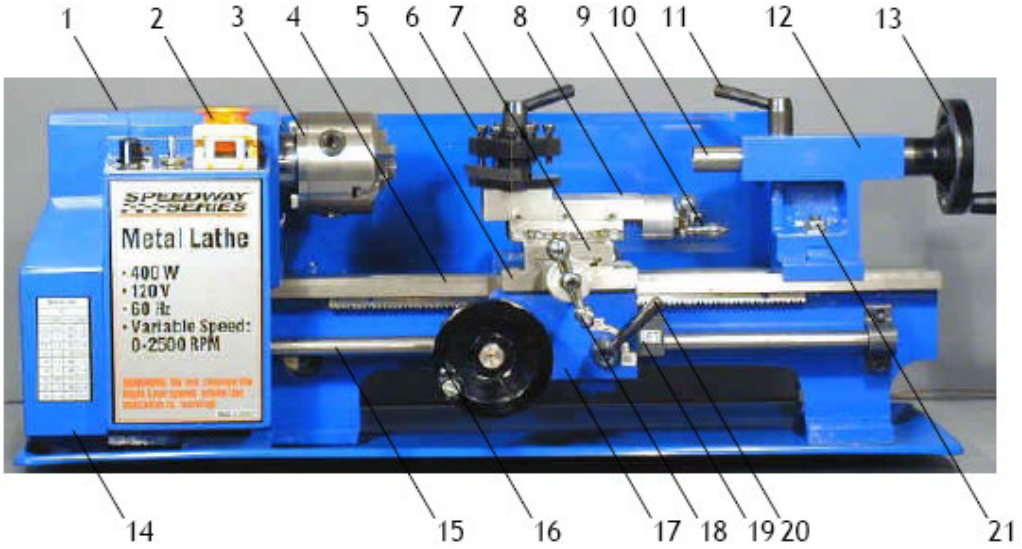
3.1 Safety Considerations

Review the safety instructions that came with your lathe. Besides the general safety rules for any power tool, the following are specific considerations for the trainer lathe.

- Your trainer lathe is just, a *mini*, or small lathe. Don't attempt jobs that are beyond its capacity.
- Check the work piece after you place it in the chuck or other work holding device. Be sure it is secure before turning on the lathe.
- Don't wear loose clothing or jewelry when operating the lathe.
- Better try the Dry Run and simulator (paper, pen and bed provided) first and then execute.

3.2 Lathe Parts

3.2.0 Front View



1. Headstock
2. 3-jaw chuck
3. Bed ways
4. Carriage
5. Lead screw
6. Tailstock quill
7. Tailstock quill locking screw
8. Tailstock
9. Tailstock quill hand wheel
10. Tailstock lock nut
11. Apron
12. Emergency Stop
13. Control On/Off
14. X-axis stepper motor
15. Z-axis stepper motor
16. Keypad
17. LCD Display

3.2.1 Rear View

1. Power ON/OFF
2. Power socket

3.3 Basic Accessories

The following accessories come with trainer lathes. Some trainer lathes come with additional accessories.

- Chuck key for the 3-jaw chuck
- Outside jaws for the 3-jaw chuck
- Hex wrenches: 3, 4, 5, and 6 mm
- Open end wrenches: 8 x 10 mm and 14 x 17 mm

3.4 Mechanical Arrangements

3.4.0 Mounting Your Lathe

All trainer lathes come with rubber feet that attach to the same holes used to secure the lathe for shipping. If you want your lathe to be portable, simply install these feet.

Note: If your lathe didn't come with them, adding chip tray braces spreads the feet by several inches and makes the lathe much steadier.

You can also bolt your lathe to your workbench. Mount the lathe to the workbench with 6 mm bolts. The bolts should be about 10 mm longer than the thickness of the workbench. Use fender washers on the underside of wooden benches to prevent the bolt heads from pulling through.

3.4.1 Cleaning

Your lathe will arrive coated with grease to protect it from corrosion during shipment. Follow this procedure to remove the grease:

1. Wipe most of the grease off with rags or paper towels.
2. Clean the surfaces with mineral spirits (paint thinner).
3. Coat the surfaces with oil.

See the *lubrication section* ????? for specific recommendations for lubricants.

3.4.2 Speed Shifter

The speed shifter is belt mechanism on the left side of the lathe. It selects the spindle speed range.

Speed Range	Belts engaged
50 – 358	BC1
75 – 498	BC2
113 – 758	BC3
217 – 1448	AC1
322 – 2152	AC2

NOTE: Never do this when the spindle is rotating.

To adjust the drive belt:

1. Cross check that Spindle is at rest position i.e. not rotating.
2. Remove the motor cover from the left side of the lathe.

3. Rotate the motor by hand adjust position the belt to the pulleys corresponding to speed, your are going to work (as given in the above table).
4. Replace the motor cover.

3.4.3 Compound Rest Rotation

The compound rest rotates on the cross slide and you can position it at any angle. Position the compound rest so it moves parallel to the guide ways to make precise turning.

To change the angle of the compound rest:

1. Loosen the head cap screw.
2. Turn the compound rest to the desired angle.
3. Tighten the head cap screw.

NOTE: Use a protractor between the compound rest and the cross slide. Don't depend on the die cast or plastic protractor that's on the side of the compound rest on some lathes.

3.4.4 Tailstock Lock Nut

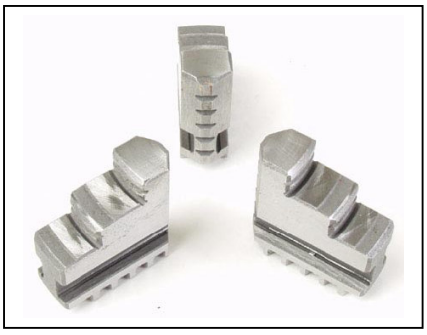
The tailstock is locked into position on the ways by the tailstock lock nut. Use a 55mm wrench to tighten the tailstock lock nut.

3.4.5 Tailstock Quill Hand Wheel

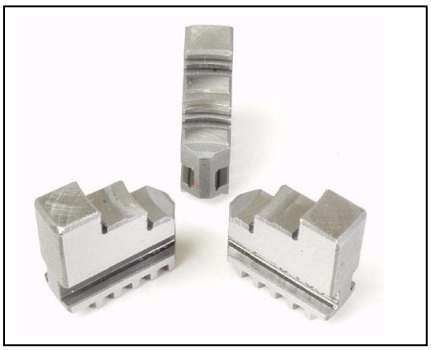
The tailstock quill hand wheel moves the tailstock quill in and out. Most trainer lathes have rather poor graduations on the top of the quill that show how far it is extended. Retract the tailstock quill all the way to remove tools from the taper in the tailstock quill.

3.4.6 Changing Chuck Jaws

3-Jaw lathe chucks come with two sets of jaws. The "normal" set is called the inside jaws, because the stepped side is designed to fit inside of hollow work pieces and hold by an outward force. In many cases, however, these jaws are used to clamp on the outside of smaller objects using the long straight side.



The second set of jaws is called the outside jaws because the stepped side of these jaws is designed to clamp on the outside of larger objects. Because of the construction of a 3-jaw chuck, each of the three jaws in a set is different. You will find a number in the groove in the side of each jaw that identifies its position in the set.



To install a set of chuck jaws:

1. Place the three jaws in numeric order on the bench.
2. Slide jaw number 1 into the slot in the chuck that has the serial number stamped in it.
3. Press the jaw into the slot with one hand, and with the other hand, turn the chuck key to open the chuck.
4. You will feel the jaw move out in the slot as you turn. Stop turning right after the jaw clicks inward in the slot.
5. Turn the chuck key to close the chuck about ¼ turn to engage jaw 1.
6. Slide jaw 2 into the next slot counterclockwise from jaw 1 when you are looking toward the headstock.
7. Slide jaw 3 into the open slot.
8. While pressing jaws 2 and 3 into the slots, turn the chuck key to close the chuck.

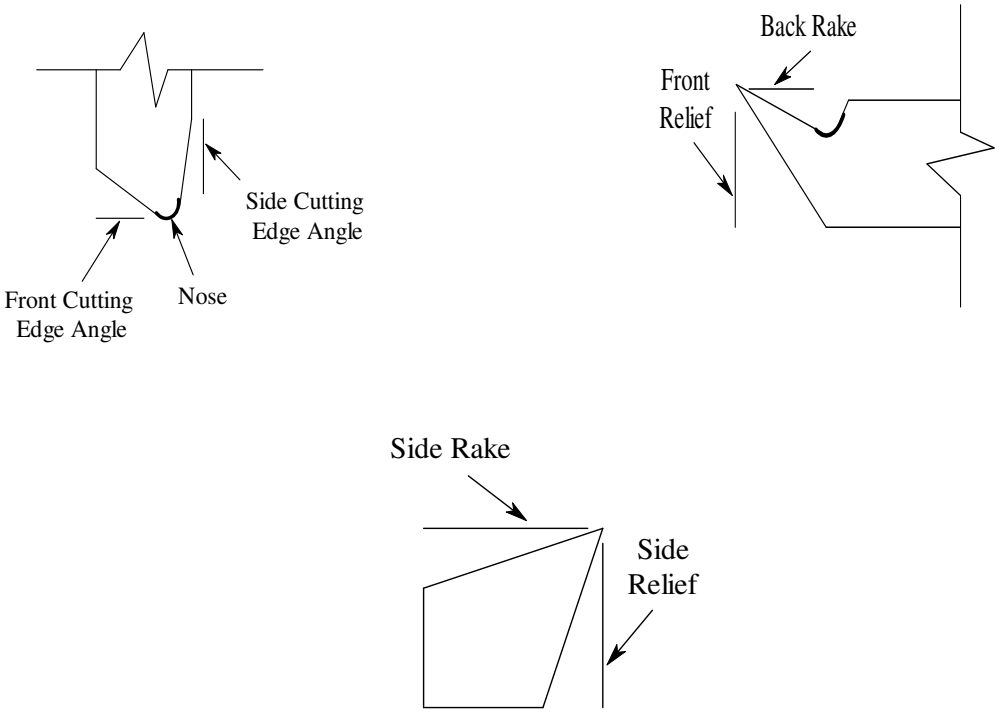
3.4.7 Grinding Tool Bits

When you purchase a new lathe tool bit, it might have an angle on the end, but it is not properly sharpened for turning. Grinding lathe tool bits is a bit of an art. It takes some practice to get good at it.

You need to create a cutting edge that is sharp, extends out so that the cutting edge and not the side of the tool contacts the work, but that still has enough support to maintain sufficient strength to cut metal.

Before diving in, there are some terms you need to understand. The illustration below shows these terms.

First, notice that there are two cutting edges on the tool bit. There is a cutting edge on the end of the tool bit called the front cutting edge. There is also a cutting edge on the side of the tool. Between these cutting edges is a rounded section of cutting edge called as “Nose”.



Side Cutting Edge: The side cutting edge does most of the cutting. As the too bit moves along the work piece the side cutting edge removes most of the material.
Front Cutting Edge: The front cutting edge cuts when the tool is advanced into the work.
Nose: The nose is a critical part of the cutting edge, because it produces the surface finish of the work piece.
Side Rake: The side rake produces the side cutting edge that cuts into the work piece.
Side Relief: Side relief provides clearance for the side cutting edge. Without side relief, the side of the tool bit would hit the work piece and not allow the cutting edge to penetrate the work piece.
Back Rake: The back rake produces the front cutting edge that cuts into the work piece.
Front Relief: Front relieve provides clearance for the front cutting edge. Without front relief, the front of the tool bit would hit the work piece and not allow the cutting edge to penetrate the work piece.

3.4.8 How to Grind Tool Bits

Use a bench grinder to sharpen your tool bits. Even an inexpensive bench grinder can do a good job grinding lathe tool bits. In some cases, you might want to purchase a higher quality fine grit wheel.

Keep a small cup of water near your grinder. Grinding generates heat, which can cause two problems. The tool bit will become too hot to hold.

Overheating can also affect the heat treatment of the tool bit, leaving the cutting edge soft.

Use a protractor to measure the angles. They are not super-critical, but you should try to stay within one degree of the recommendations.

i. Grind the Front Relief

The first step in creating a tool bit is to grind the front relief. For most work, a relief angle of 10° works well.

While you are grinding the front relief, you are also creating the front cutting edge angle. Make this angle about 10° also, so that the corner formed by the front cutting edge and the side cutting edge is less than 90°.

ii. Grind the Left Side Relief

Form the left side relief next. Again, create about a 10° angle. You don't need to form a side cutting angle. The side cutting edge can be parallel to the side of the tool blank.

iii. Grind the Top Rake

The top of the tool bit is ground at an angle that combines the back rake and the side rake. The side rake is most important, because the side cutting edge does most of the work. For cutting steel and aluminum, the side rake should be about 12° and the back rake should be about 8°. For cutting brass, the rake angles should be much less, or even 0°.

iv. Round the Nose

A small nose radius allows you to turn into tight corners. A large nose radius produces better surface finishes. Create a nose radius that is appropriate for the tool bit you are creating.

3.4.9 Adjusting Tool Bit Height

The cutting edge of the tool bit should almost always be set to the center height of the lathe spindle. There are several methods for checking the height of the tool bit. Perhaps the simplest way is to place a thin strip of metal, such as a steel rule or feeler gage, between the work piece and the point of the tool bit. If the height is correct, the strip of metal will be held vertical. If the top is leaning toward you, the tool bit is too low. If the top is leaning away from you, the tool bit is too high. Using the standard tool post, you adjust the tool bit height using shims under the tool bit. You can get an economical set of shims, about the right size, at any auto parts store. Purchase a set of feeler gages and remove the pivot pin. The easy way to adjust the tool bit height is to get a quick change tool post. Virtually all quick change tool posts incorporate a mechanism for easily adjusting the tool bit height.

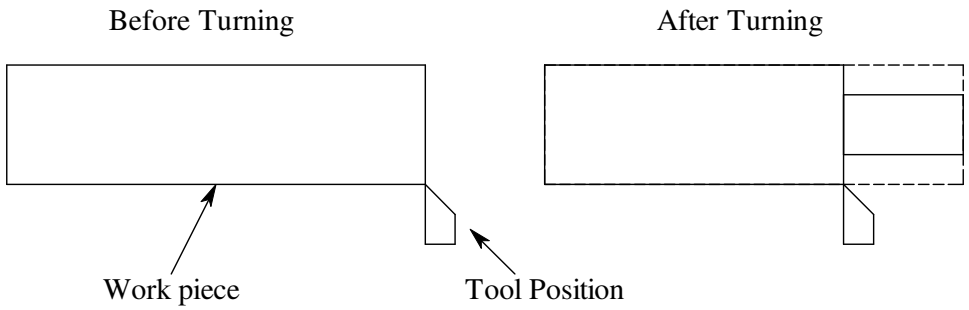
Chapter 4 Turning Operations

4.0 Manual Mode

4.0.0 Manual Turning

The most common use of a lathe is turning down the diameter of a work piece. Follow these steps to turn the outside diameter of a work piece.

1. Put a tool bit in the tool holder and adjust the cutting edge to center height.
2. Angle the tool so that the front cutting edge forms an acute angle with the axis of the work piece.
3. Move the carriage so that the tool bit is near the right end of the work piece.
4. Turn ON the system and go to the manual mode.
5. Turn ON the spindle motor and set the speed to an appropriately depending upon the material and diameter you are working on.
6. Using the –X jog key, advance the tool bit about 0.25mm (depending upon the material).
7. Using the –Z jog key, move the carriage slowly to the left. As the tool bit meets the work piece, it starts cutting.
8. When the desired length is reached take the tool back using +X jog key.
9. If you want further turning of the work piece, take home position using +Z jog key and repeat the above steps (from 7 to 9) else stop the spindle motor.

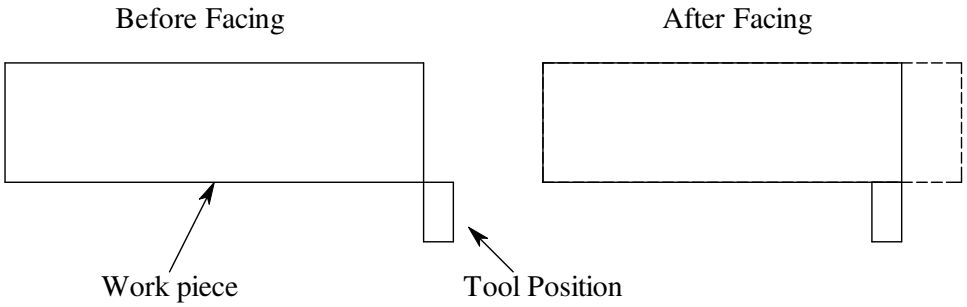


4.0.1 Manual Facing

Facing is cutting on the end (or face) of the work piece. Follow these steps for the facing

1. Put a tool bit in the tool holder and adjust the cutting edge to center height.
2. Angle the tool so that the side cutting edge forms an acute angle with the face of the work piece.
3. Turn ON the system and go to the manual mode.
4. Turn ON the spindle motor and set the speed to an appropriately depending upon the material and diameter you are working on.
5. Using the –Z jog key, move the tool bit about 0.20mm (depending upon the material) from the right end of the work piece.
6. Using the –X jog key, advance the tool bit slowly. As the tool bit meets the work piece, it starts cutting.

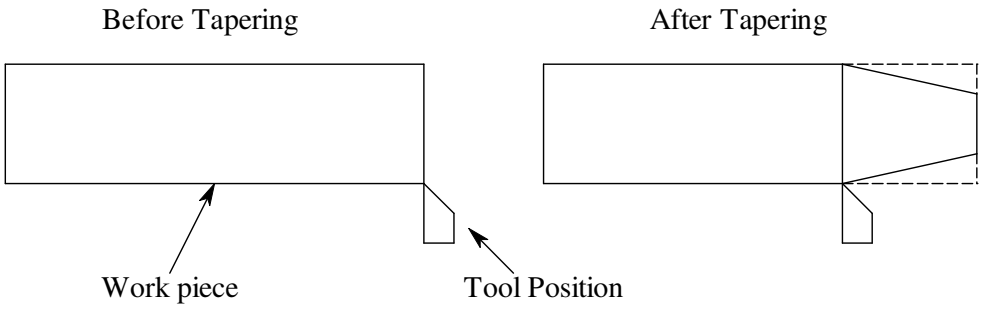
7. Continue advancing the cross slide until the tool bit reaches the center of the work piece.
8. Stop the spindle motor.



4.0.2 Manual Turning Angles

There are several methods of turning angles or tapers. Follow these steps to perform tapering for large angles of short length, such as a chamfer

1. Put a tool bit in the tool holder and adjust the cutting edge to center height.
2. Turn the compound rest to the angle you want.
3. Move the carriage so that the tool bit is near the right end of the work piece.
4. Turn ON the system and go to the manual mode.
5. Turn ON the spindle motor and set the speed to an appropriately depending upon the material and diameter you are working on.
6. Using the –X jog key, advance the tool bit about 0.25mm (depending upon the material).
7. Using the –Z jog key, move the carriage slowly to the left. As the tool bit meets the work piece, it starts cutting.
8. When the desired length is reached take the tool back using +X jog key.
9. If you want further turning of the work piece, take home position using +Z jog key and repeat the above steps (from 7 to 9) else stop the spindle motor.



Note: You can use the same method for small angles (usually called tapers) of a length less than the compound rest travel (X-axis travel).
For longer tapers, we suggest you perform in the Automatic Mode.

4.1 Automatic Mode

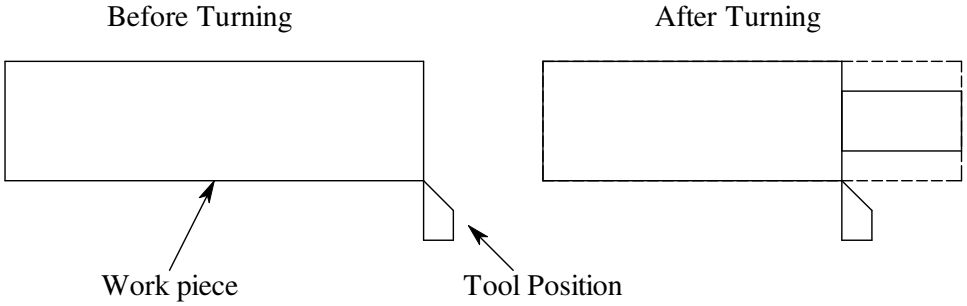
4.1.0 Automatic Turning

Facing is cutting on the end (or face) of the work piece. Follow these steps for the facing

1. Put a tool bit in the tool holder and adjust the cutting edge to center height.
2. Angle the tool so that the side cutting edge forms an acute angle with the face of the work piece.
3. Turn ON the system and go to the manual mode.
4. Turn ON the spindle motor and set the speed to an appropriately depending upon the material and diameter you are working on.
5. Go to Edit mode and edit the following example part program. You may vary the length of the turning depending upon material and work piece size.

```
G71                          ; To set the Metric mode
G91                          ; To set the Incremental programming mode
M03   SPEED 1200             ; To turn ON the Spindle motor @ 1200rpm
G81                          ; To turn, Canned diameter turning for 20mm length
X -00.25      Z -020.00        and 1mm diameter
Q04           F60
G00                          ; Take tool back from the work piece to avoid
groove
X 01.00       Z  000.00
M05                          ; Turn OFF the Spindle motor
M02                          ; End of the Part Program
```

6. Press “EXEC” or “SING STEP” to start the turning operation.



4.1.1 Automatic Facing

Facing is cutting on the end (or face) of the work piece. Follow these steps for the facing

1. Put a tool bit in the tool holder and adjust the cutting edge to center height.
2. Angle the tool so that the side cutting edge forms an acute angle with the face of the work piece.
3. Turn ON the system and go to the manual mode.

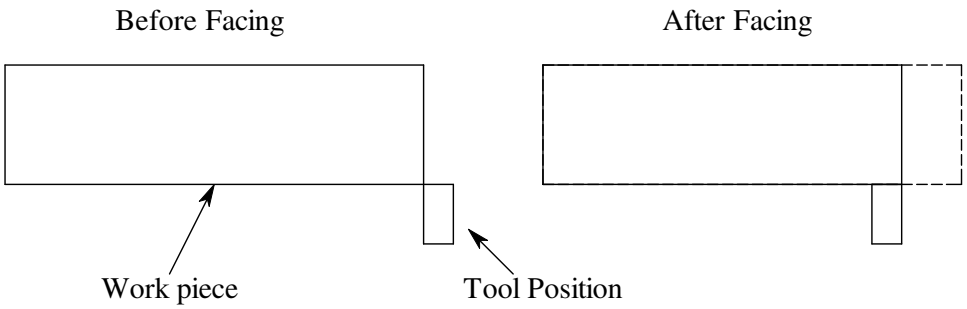
4. Turn ON the spindle motor and set the speed to an appropriately depending upon the material and diameter you are working on.
5. Go to Edit mode and edit the following example part program. You may vary the length of the turning depending upon material and work piece size.

```
G71                          ; To set the Metric mode
G91                          ; To set the Incremental programming mode
M03    SPEED 1200            ; To turn ON the Spindle motor @ 1200rpm
G82                          ; To Face, Canned diameter facing for 20mm length
X -00.25       Z -020.00       and 1mm diameter work piece
I  000.00      Q04    F60
G00                          ; Take tool back from the work piece to avoid
groove
X 01.00        Z  000.00
M05                          ; Turn OFF the Spindle motor
M02                          ; End of the Part Program

                             OR

G71                          ; To set the Metric mode
G91                          ; To set the Incremental programming mode
M03    SPEED 1200            ; To turn ON the Spindle motor @ 1200rpm
G82                          ; To Face, Canned diameter facing for 20mm length
X -10.00       Z -001.00       and 1mm diameter work piece
I -000.25      Q00    F60
G00                          ; Take tool back from the work piece to avoid
groove
X 01.00        Z  000.00
M05                          ; Turn OFF the Spindle motor
M02                          ; End of the Part Program
```

6. Press “EXEC” or “SING STEP” to start the turning operation.



4.1.2 Automatic Turning Angles

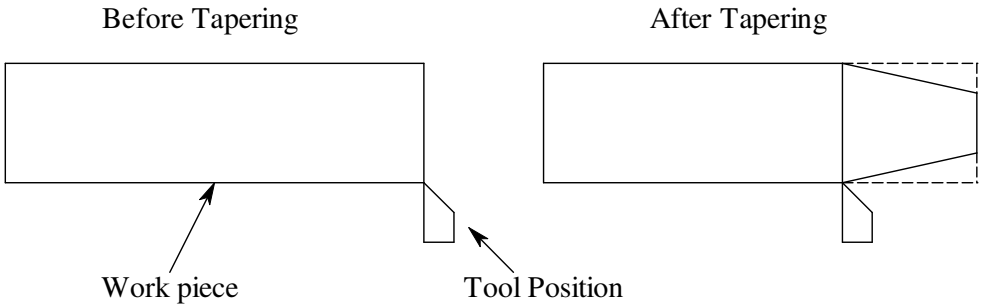
There are several methods of turning angles or tapers. Follow these steps to perform tapering

1. Put a tool bit in the tool holder and adjust the cutting edge to center height.
2. Turn the compound rest to the angle you want.

3. Turn ON the system and go to the manual mode.
4. Turn ON the spindle motor and set the speed to an appropriately depending upon the material and diameter you are working on.
5. Go to Edit mode and edit the following example part program. You may vary the length of the turning depending upon material and work piece size.

```
G71                             ; To set the Metric mode
G91                             ; To set the Incremental programming mode
M03    SPEED 1200               ; To turn ON the Spindle motor @ 1200rpm
G01                             ; To turn, angular turning for 20mm length
X -00.25        Z -020.00         and 00.25mm diameter
F60
G00                             ; Take tool back to start position
X 00.10         Z  020.00
G00                             ; Take tool back to start position
X -00.10        Z  000.00
G01                             ; To turn, angular turning for 20mm length
X -00.25        Z -020.00         and 00.25mm diameter
F60
G00                             ; Take tool back to start position
X 00.10         Z  020.00
G00                             ; Take tool back to start position
X -00.10        Z  000.00
G01                             ; To turn, angular turning for 20mm length
X -00.25        Z -020.00         and 00.25mm diameter
F60
G00                             ; Take tool back to start position
X 00.10         Z  020.00
G00                             ; Take tool back to start position
X -00.10        Z  000.00
G01                             ; To turn, angular turning for 20mm length
X -00.25        Z -020.00         and 00.25mm diameter
F60
G00                             ; Take tool back to start position
X 01.00         Z  000.00
G00                             ; Take tool back from the work piece to avoid
groove
X 01.00         Z  000.00
M05                             ; Turn OFF the Spindle motor
M02                             ; End of the Part Program
```

6. Press “EXEC” or “SING STEP” to start the turning operation.



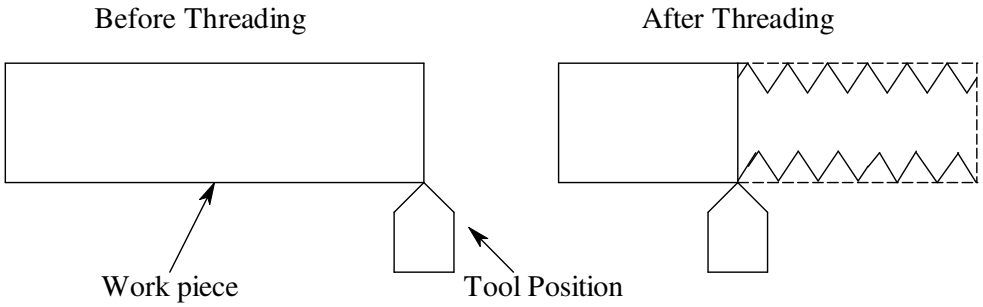
4.1.3 Automatic Threading

Threading is cutting on the end (or face) of the work piece. Follow these steps for the threading

1. Put a tool bit in the tool holder and adjust the cutting edge to center height.
2. Angle the tool so that the side cutting edge forms an acute angle with the face of the work piece.
3. Turn ON the system and go to the manual mode.
4. Turn ON the spindle motor and set the speed to an appropriately depending upon the material and diameter you are working on.
5. Go to Edit mode and edit the following example part program. You may vary the length of the turning depending upon material and work piece size.

```
G71                          ; To set the Metric mode
G91                          ; To set the Incremental programming mode
M03   SPEED 1200             ; To turn ON the Spindle motor @ 1200rpm
G81                          ; To turn, Canned diameter turning for 20mm length
X -00.25      Z -020.00        and 1mm diameter
Q04           F60
G00                          ; Take tool back from the work piece to avoid
groove
X 01.00       Z  000.00
M05                          ; Turn OFF the Spindle motor
M02                          ; End of the Part Program
```

6. Press “EXEC” or “SING STEP” to start the turning operation.



Appendix A ISO Standard G & M Codes List

A.0 G Codes List

G - CODES	DESRIPTION
G00	Rapid positioning
G01	Linear cutting
G02	Clockwise Circular cut
G03	Counter clockwise Circular cut
G04	Pause for the set period
G26	Conditional jump
G27	Unconditional jump
G28	Setting variable to a desired value
G33	Threading canned cycle
G70	Inch programming mode
G71	Metric programming
G81	Canned outside diameter turning cycle
G82	Canned cycle for facing
G90	Absolute programming mode
G91	Incremental programming mode
G92	Setting initial position

A.1 M Codes List

M – CODES	DESCRIPTION
M00	Temporary stop. Resume once ENTER key is pressed
M02	End of program. All operations terminated
M03	Spindle ON Clockwise (CW)
M04	Spindle ON Counterclockwise (CCW)
M05	Spindle OFF
M97	Halt until designated input is true
M99	Reset execution

Appendix B Common Accessories

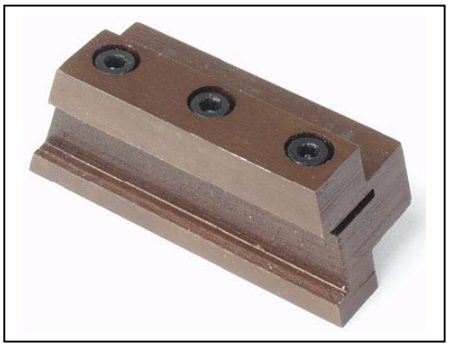
You will soon find that the purchase of a lathe is just an initial step. There are many tools and accessories that you will need to get full use from your lathe. Following are some common accessories used with the trainer lathe.

B.0 Cut-Off Tool Holder

Cutting-off, or parting, is a common procedure on a lathe. Once you have turned a piece on the end of a rod, you use a cut-off tool to part the work from the rod. Cut-off tools come in various widths, from about 0.040" wide, to much wider than can be used with a trainer lathe. But most cut-off blades are ½" tall. This means that they will not fit in the tool post that comes with the mini lathe.

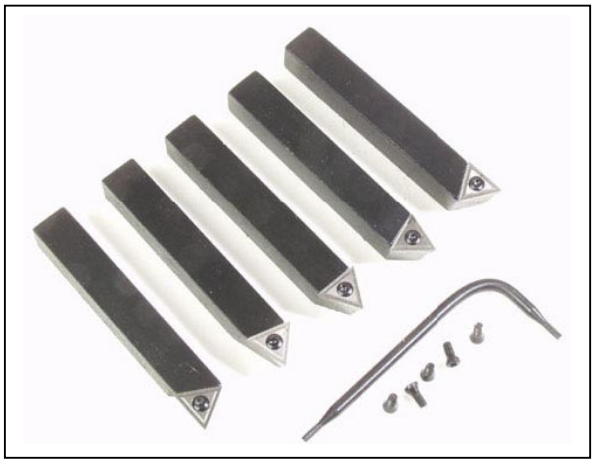
The cut-off tool holder shown fits in the standard tool post and holds a ½" tall cut-off blade.

This cut-off tool holder fits in the standard 4-way tool post (and most other tool posts) and holds 1/2" tall cut-off blades.

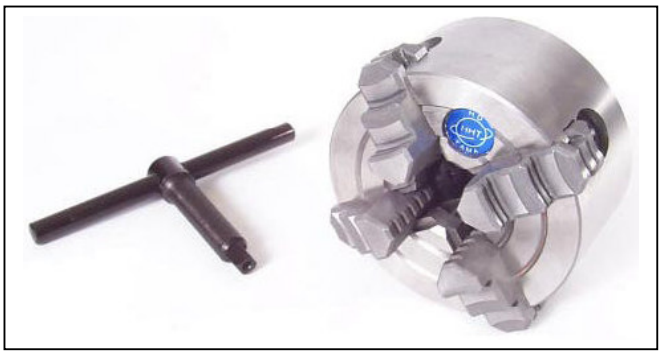


B.1 Indexable Turning Tools

Indexable turning tools usually come in a set of five tools, providing a range of cutting angles. These tools use indexable inserts, usually made from carbide, but sometimes from high-speed steel. They are called indexable because you can change an insert and the new insert will take the exact position of the insert it replaces. You can resume work with no further adjustments. Indexable inserts are pre-sharpened.



B.2 4-Jaw Chuck



The 3-jaw scroll chuck that comes with the trainer lathe provides a quick way to clamp round and hexagonal work fairly accurately.

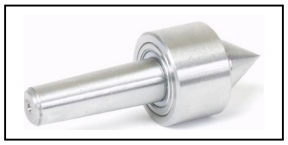
A 4-jaw independent chuck provides several advantages over a 3-jaw scroll chuck. It can hold square or rectangular work, as well as round. Work can be centered more accurately because you adjust each jaw independently. It can hold larger work than the same size 3-jaw chuck. You can offset work in a 4-jaw chuck by clamping it off center.

B.3 Faceplate

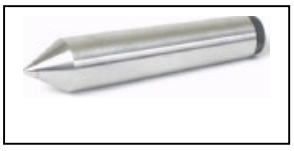
A faceplate allows you to mount work that can't be held in a chuck. You can bolt odd-shaped work pieces to the faceplate. The example faceplate shown is 6.25" in diameter and has 8 slots for mounting work.

B.4 Centers and Dogs

A live center goes in the tailstock and is used to support the end of a long work piece; it rotates with the work piece. A dead center goes in the spindle and supports work being turned between two centers. A lathe dog is used to drive work being turned between centers.



The live center has a 2 Morse taper shank. This center fits the tailstock of the trainer lathe.



The dead center has a 3 Morse taper shank. This center fits the headstock of the trainer lathe.

The center has a 60 degree included point angle. The lathe dog has a capacity of just over 3/8".

Appendix C Maintenance

Maintenance of the trainer lathe is simple, but important. Regular maintenance will keep your trainer lathe working like new for many years.

C.0 Cleaning

The maintenance you perform most often is cleaning. Keeping swarf (chips, shavings, and debris) off of wearing surfaces is the most important thing you can do to prolong the life of your lathe.

- Use a 1" paintbrush to remove swarf from the ways as you work.
- Clean the lead screw before each use.
- Clean swarf from the lathe, from top down after each use.

C.1 Lubrication

We recommend the use of two lubricants on your lathe.

- Where oil is required, we recommend Mobil 1 synthetic motor oil. Mobil 1 far exceeds the lubrication needs of the trainer lathe, and maintains a good surface film between applications.
- Where grease is required, we recommend Lubriplate 630-AA lithium (white) grease. Lithium grease is a plastic-friendly grease that is easy to find and easy to use

The following points on your lathe require lubrication.

Location	Lubricant	Frequency	Notes
Lathe ways	Oil	Daily	Apply oil to both the front and back ways on both sides of the carriage. Move the carriage back and forth to spread the oil.
Lead screw threads	Oil	Daily	Clean swarf (chips, shavings, and debris) daily.
Compound rest dovetail	Oil	Daily	Advance the compound rest to the extent of its normal travel. Apply oil to the end of the gib and the ends of the dovetails. Retract the compound rest.
Cross slide dovetail	Oil	Weekly	Advance the cross slide to the extent of its travel. Apply oil to the end of the gib and the ends of the dovetails. Retract the cross slide.
Lead screw bushings	Oil	Weekly	
Other Machined surfaces	Oil	Monthly	

Chuck	Oil	Monthly	Disassemble, clean and lubricate. Wrap with a paper towel, secure with an elastic band, and run lathe to sling out excess oil.
Lead screw	Grease	Yearly	Also lube change gears as you use them.
Cross slide feed screw	Grease	Yearly	
Tailstock quill and screw	Grease	Yearly	