Meister

DIGITAL READOUT SYSTEM
Position Measuring Instrument and Precision Glass Scale

BC- 10M USER'S MANUAL
3 Axes Digital Readout for Mill
Rev C, 2007
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Automation Specialist

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Precautions

A. Earth the Digital ReadOut (DRO)

For safety and stability, we strongly request to the User to earth (⏚ the FG terminal behind the digital readout before using it.

- Do not use the digital readout under circumstances of high temperature or high humidity.
- Do not use the digital readout where there is a strong presence of magnetic field.
- Clean the display box using soft dry cloth.
- Do not try to clean the digital readout and the linear scales using spray gun.

B. AC Wiring Color Codes

Please check the power voltage setting of the DRO before plugging the unit to the power source.

Please connect the AC power according to this standard:

Conductor	US 115V AC	US 230V AC	Europe 240V AC
Ground	Green	Green	Green and yellow
Neutral	White	White	Light blue
Hot	Black	Black	Brown
Hot		Red	

C. Voltage Supply

The digital readout is using auto-switching power supply. The AC power supply is from 95 to 255 volts.

D. Linear Scale Shipping Brackets

Please remove the brackets used to hold the reading head securely during shipping.

Shipping brackets
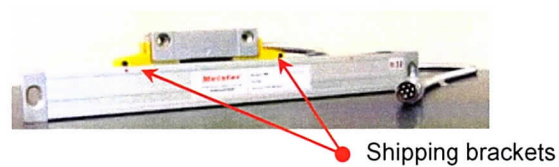
For sales and technical assistance, please contact us at: makuharik@gmail.com

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A.   Installation Guide

Do not install the BC-10M 10 DRO system where:

- The environment is full of chips, oil, water and/or dust without adequate protection.
- It is exposed to scorching sun or high temperature.
- Near equipment with high voltage or strong magnetic fields. If the condition cannot be avoided, be sure to use shielding or conduit to minimize the interference.
- The signal cable is near the power source cable.
- The digital readout box is subject to shocks or strong vibrations. Install the display box in an area where it cannot be damaged by metal chips or electric sparks, and is easy to see and operate. It's better to mount the display securely to a bracket or use the heavy duty-mounting arm. Use the dust cover to keep the DRO clean.

B.   Technical Specification of BC-10M

Number of axis: 2, 3

Resolution: 0.005mm /0.0002"

Calculating range: -9998.990 to +9998.990

LED: 7 digit and 1 more for "-" symbol

Response speed: 60 m/min (198 feet/min)

Error: ±1 count

Power source: AC 110 ~ 220V, Hz 50 ~ 60, 30VA

Temperature range:
        In Service – 0° ~ 40° C (32° F ~ 104° F)
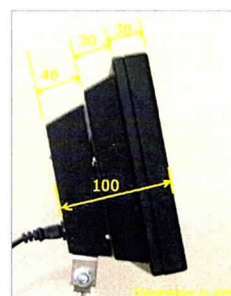
        In Storage -- 20° ~ 70° C

Relative Humidity: 95%, 25° C (77° F)
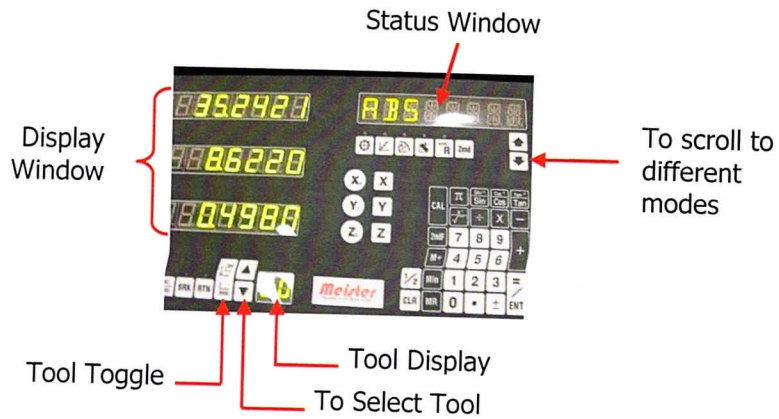
Pulse grating scale: DC 5Vdc/12Vdc
        A,B ortho square wave pulse signal

Net Weight: 1.5 Kg

Dimension: 227 breadth x 210 height x 100 depth (mm)

1.0 Parameters Set Up

Status Window
Display Window
To scroll to different modes
Tool Toggle
Tool Display
To Select Tool

1.2. Panel Instruction

Display window: Display for the X, Y and Z axis.

Status window: Display calculator and operation mode status.

1.3. Parameters Setup Mode

Upon power on, all the LED lights will be lighted up. The status window will display the model number "BC11 3M" and the display window will show the number "00000000" to "99999999" in running mode. Press the number '6' key when the DRO is doing a self test and the word "EXIT" will appear in the status window. You are now in the Parameter Setup Mode.

Using these 'UP' ⬆ or ⬇ 'DOWN' arrow key located below the status window, the following operation parameters can be changed:

EXIT, BEEP ON/OFF, DIRECTE, LIN COMP, R OR D, RESOLUTE, SRK OFF/ON, ALL CLR, Z DIAL, DIAL INC.

1.4. System Reset

To reset the system, select "ALL CLR" option. And press the 'ENT' key and all previous stored data would be erased when "CLR OK" is displayed in the status window. Press the up or down arrow key again to scroll to "EXIT". Confirm by pressing the 'ENT' key to return to the normal mode.

1.5. Shrink Function Setup

Enter parameters setup mode, and press the up or down arrow key to select "SRK OFF" or "SRK ON" option. Press the 'ENT' key to switch between "SRK OFF" and "SRK ON". To return to normal mode, press the up or down key to "EXIT" and press 'ENT' to confirm.

1.6. Enter Direction Setup

In the parameter setup mode press the up or down arrow key to select parameter, "DIRECTE". Press the 'ENT' key to confirm, and the status window will change to "SEL AXIS". Press X/Y/Z to select the axis and press. When done, press the up or down arrow key to select "EXIT". Press "ENT" to confirm and return to normal mode again.

+Y
[1]

+X
[1]

+Z
[1]
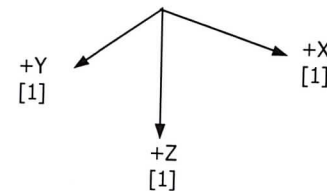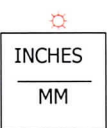
1.7 R or D (Radius or Diameter)

This function is used to set the axis as radius or diameter. Select the axis and then set '0' for Radius and '1' for diameter. For example to change for the X-axis, press the 'X' button to toggle between '0' and '1'. When the setting is changed to '1', any dimension keyed into the X-axis will be double. The factory's default is '0'.

2.0   Basic Functions

Function	Purpose	Operation	Display	Status Window
Set to zero	Reset the data to "0". Pressing the keys will delete the displayed data of the axis on the screen. The display becomes "0.000". ⓵ **In the ABS mode, this operation will delete the work piece zero.**	X axis $\quad X_0$ Y axis $\quad Y_0$ Z axis $\quad Z_0$	0.000 ABS 0.000 0.000	

Enter key	Keyboard enter key to input or store data	a. Input size: Input the machining size of a work piece into the memory of the digital readout.
		
		b. The "ENT" key is also used for confirmation in other operations:
		   - Calculate center, "1/2" function
		   - Recall, "RTN" function
		   - Preset dimension or Parameter setup
		   - Mechanical zero position function. ENT		

Axis selection key	Use the X Y Z keys to turn on the select axis so that data can be entered and store for use.	Take X axis as an example: Press X key followed by "**1**" and "**4**". Next press "ENT" to confirm and the data is stored to the **X-axis**. The same steps are used for Y and Z axis.	0.000 NEW BASE 14 14.000 ABS	
CLR	Clear data key	If the input data is wrong, press "**CLR**" key to cancel. CLR	0.000 ABS	
Preset dimension	To input dimension using the keypad. ⓵ **In ABS mode, preset dimensions function will impact the work piece zero position.**	For example: Select X-axis. X Then use the keypad to enter the value X = 126.850. And press "ENT" key to confirm.	0.000 ENTER DIM 126.850 ENTER DIM 126.850 INC	

Function	Purpose	Operation	Display	Status Window
Inch/ Metric Key	To switch from Inches to metric. When the LED is off, the dimension is in metric. Press the key again, the LED is lighted and the dimension is now in inches.	Inch display ☼ INCHES / MM Metric display	1.000 25.400	
Absolute/ Increment coordinate	Absolute/ Incremental mode selection During this process, the incremental coordinate and the absolute coordinate can be transformed at will. No manual calculation is needed and therefore efficiency is enhanced	When ABS/INC LED is off, the display is in Absolute Coordinate. ☼ INC ABS Press the "ABS/INC" key, the INC LED Is on, the display is in Incremental Mode.		ABS INC
Find Center (½)	Coordinate value divide by 2 ⓘ **In the ABS mode, the work piece zero position will be lost.**	Take X axis as an example: Locate the edge finder at one end of the work piece, and then zero the X axis value. Press X_0 Then align the other edge of the work piece. Press ½ and data will be divided by 2. Press X key to transfer value to this axis.	0.000 348.960 174.480	INC INC 1/2 AXIS INC
Recall "RTN" Key	Recall prior data in the register. ⓘ **Note:** It is only used under INC mode.	X-axis current display: 0.000 Select X axis Press RTN key. ☼ RTN Recall X axis data will be displayed. To confirm, press "ENT" key.	0.000 0 12.500 12.500	INC ENTER DIM RECALL INC

Function	Purpose	Operation	Display	Status Window
Mechanical Zero Point	Allow the user to find and memorize the scale's zero position before processing. There is a fixed mark on the glass scale. This function will find back the work piece zero position after a power failure. User can restore the position when needed.	1. To find mechanical zero position Press ⊠ X₀ X		

1. To find mechanical zero position

Press [⊠] (X₀) [X]

	0.000	FD. X REF

Then move the scale until the display stop counting. The Status Window display show "STOP" and a continuous beep sound can be heard.

	30.000	STOP

Press "ENT" to confirm. The coordinate index will be memorized.

	33.670	ABS

2. To search for work piece zero position. Press these keys

[⊠] [X] [RTN] [=/ENT]

and "ENT" to confirm

	30.000

Move the scale towards the mechanical zero position, and watch the display start counting. Keep moving the mill table until the DRO read zero, and this will be the work piece zero position.

	0.000

LIN COMP

To set Linear Error Compensation

Error due to wear of the machine may be compensated for by the S2000.
Measure the amount error by using the gage block and dial indicator. Then calculate the error in parts per million (ppm) as follows:

$$\frac{\text{Error Measured}}{\text{Distance Traveled}} = \text{ERROR ppm}$$

To compensate for error on the X-axis, press [X] followed by the amount of error to be compensated. Any number between −9999 and +9999 can be entered. Press "X" followed by "±100" for linear compensation of 1 micron or "±200" for 2 micron and so on.

To confirm, press the "ENT" key and exit this mode. To clear any mistake, press "CLR" key and re-enter the data.

Repeat the same steps for the Y-axis. Press "ENT" twice to exit this set up mode.

3.0 CALCULATOR FUNCTION | CAL |

The calculator of BC-10 not only provides normal mathematical calculations such as ADD, SUBSTRACT, MULTIPLY, DIVIDE, but also useful trigonometric calculation such as SIN, COS, TAN, SQR, SIN^{-1}, COS^{-1}, and TAN^{-1} that are frequently required during machining process.

Special **RESVLT TRANSFER** function not only can transfer all calculated result to the selected axis, but also can pick up selected axis's position counting value into calculator as an operator.

Calculator on/off key. LED light will be on when calculator is in used

Calculator Display Window

Keys to transfer calculated result to selected axis

Result Key

Keys to pick up selected axis position as an operator into calculator
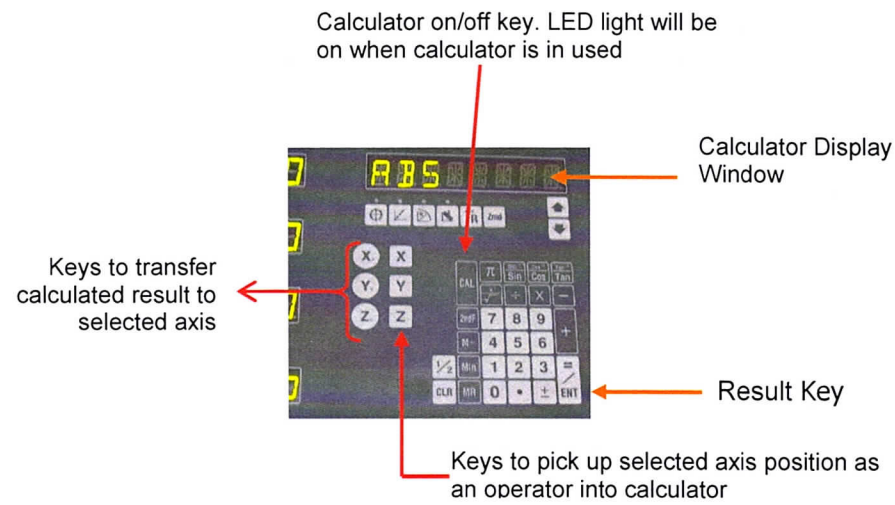
Set the BC-10 to calculator mode by pressing the "CAL" key. The LED light will be lighted when the DRO is set to calculator mode. All operations are the same as any other calculator.

Example of calculator functions:

3.1 Add/ Subtract: 78 + 9 – 11 = 76   DISPLAY

| 7 | 8 | + | 9 | - | 1 | 1 | = |

| 76 |

3.2 Multiple/Divide: 78 X 9 / 11 = 63.8173

| 7 | 8 | X | 9 | ÷ | 1 | 1 | = |

| 63.8173 |

3.3 Trigonometric function: 100 X COS30° = 86.60156

| 1 | 0 | 0 | X | 3 | 0 | COS | = |

| 86.60156 |

3.4 Inverse trigonometric function: Sin^{-1} 0.5 = 30°

| . | 5 | 2nF | Sin^{-1} | = |

| 30 |

3.5   Transfer Calculated Result to Selected Axis

Take an example: To transfer calculated result 76 to X axis:

a) Press [X] key and the value "76" will be displayed on the X-Axis immediately

b) Move X axis until display = 0.000, then the calculated position "76" is reached.

0,0

x = 76 mm
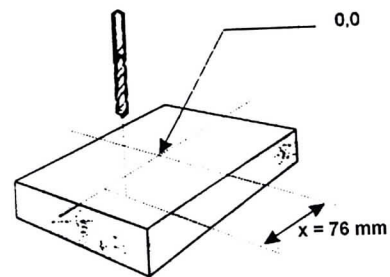
c) Pressing the CAL key [CAL] will end the calculator function and return to normal mode
again.

3.6   Transfer X or Y or Z position as an operator into the calculator

Take an example: To transfer X=108.670 to the calculator:

a) Switch to "CAL" function.

b) Press the [X] key and the value will display on the Calculator Display Window immediately.
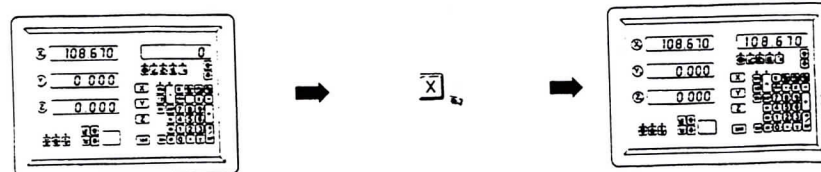
4.0   Shrink Function | SRK |

Plastic objects will shrink after it is injected into form. So the mold must be enlarged or shrink according to the shrinkage rate based on the finished product.

4.1   Set up shrinkage rate.

It is important to set up the shrinkage rate correctly because the calculated results is obtained by multiplying the input data by the shrinkage rate.

ie   if shrink rate = 1.005, then axis display = data input x 1.005

4.2   Instruction:

Operation		Display	Status Display
a) Select shrink function "SRK" key. | SRK | Note: LED will be lighted.	X Y	 1.000	SHRINK
b) Enter shrinkage rate | 1	.	0	0	5		X Y	 1.005	SHRINK
c) Press "ENT" key to confirm preset value	X Y	 1.005	SHRINK
d) End shrink function, press "SRK" key.		0.000 0.000	ABS

5.0 Bolt Holes Circle Machining (PCD)

Meister BC-10M DRO provides an easy method to machining bolt holes located on the pitch circle diameter. The user simply follows the step by step instruction on the STATUS DISPLAY WINDOW to key in these few parameters :

- Center of the circle [CENTER]
- Diameter [DIA]
- Number of holes [NO. HOLE]
- Start angle [ST. ANG]
- End angle [END. ANG]

The BC-10 DRO will calculate all the X and Y position of the center of every hole located on this pitch circle diameter. The holes are numbered in an anti-clockwise direction. The X and Y position for hole #1 is the absolute distance from the 0,0 position. When the user moves the mill table till the X-Y axes show 0.000 on the display, it means the drill bit is now at the center of the hole and you can start machining.
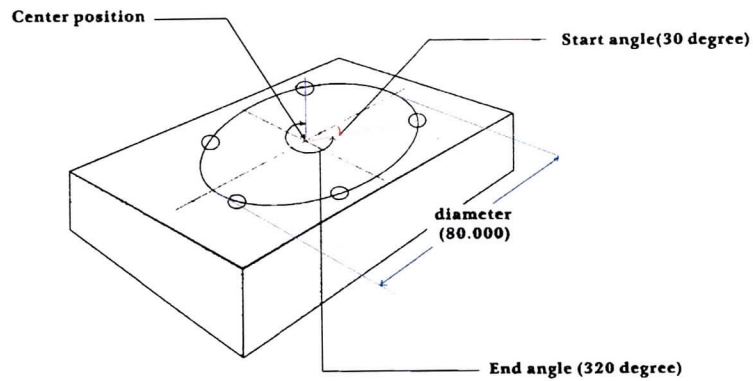
The user can also use the "UP" or "DOWN" arrow keys to select any one of the holes and move the mill table until the X and Y display show 0.000, the drill bit is now just above this hole center and you may start work.

The BHC or PCD function can also be used when the holes are equally spaced out within a section on the pitch as shown in the example below, the end angle is at 320 degree.

Example

Center Coordinate [CENTER] … X = 0.000,   Y = 0.000

Diameter [DIA] ………………….. 80.000 mm

Number of holes [NO. HOLES] … 5

Start Angle [ST. ANG] ………….. 30° (clockwise)

End Angle [END. ANG] ………… 320° (clockwise)

Before starting the Bolt Hole Circle function, User must set up work piece zero position!!

Operation		Display		Status Window

5.1 Set center of circle as the work piece zero

- Move work piece until the cutting tool points to the center of the circle.

X 0.000   ABS
Y 0.000

Press X and Z and keys

X 0.000   CENTER
Y 0.000

- To confirm the X and Y center coordinates, press the "ENT" key.

X 0.000   CENTER
Y 0.000

8

Operation		Display	Status Window
5.2 Next, press the "DOWN" arrow key.	X		DIA
And the next instruction would appear on the status window display.	Y	0.000	
Enter diameter = 80	X		DIA
To confirm, press "ENT" key	Y	80.000	
Next, press "Down" arrow key			
5.3 Enter number of holes	X		NO. HOLE
No. of holes is 5	Y	5	
To confirm, press "ENT" key	X		NO. HOLE
Next, press "Down" arrow key	Y	5	
5.4 Enter the Start Angle	X		ST ANG
	Y	0.000	
Start angle is 30 degree			
To confirm, press "ENT" key	X		ST ANG
Next, press "Down" arrow key	Y	30.000	
5.5 Enter the End Angle	X		END ANG
	Y	0.000	
End angle is 320 degree			
To confirm, press "ENT" key	X		END ANG
Next, press "Down" arrow key	Y	320.000	
5.6 Selecting the cutting holes			
Use the UP or DOWN arrow keys to select any of the holes.	X	- 34.640	HOLE 1
EXAMPLE: Hole #1	Y	- 19.995	
Move the work piece until the X and Y axes display shows "0.000".			
Now, the drill tool is over the hole location and the user can start machining.			

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The machining sequence is in an anti-clockwise direction as shown by the sketch below in:
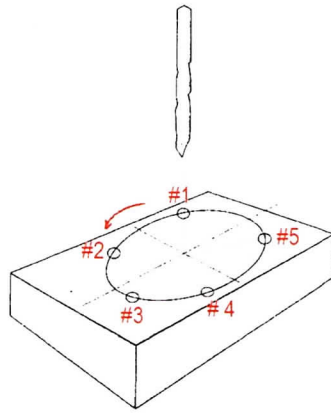
At anytime the user can return to normal ABS mode or temporarily exit the BOLT HOLE CIRCLE operation by pressing the "RTN" key:

Switch to normal display mode LED (RTN) Light On Normal Display

Return to Bolt Hole Circle mode LED (RTN) light off Bolt Hole circle display mode

Finish BHC cutting mode and return to ABS mode LED (BHC) light off Exit Bolt Hole Circle Mode

10
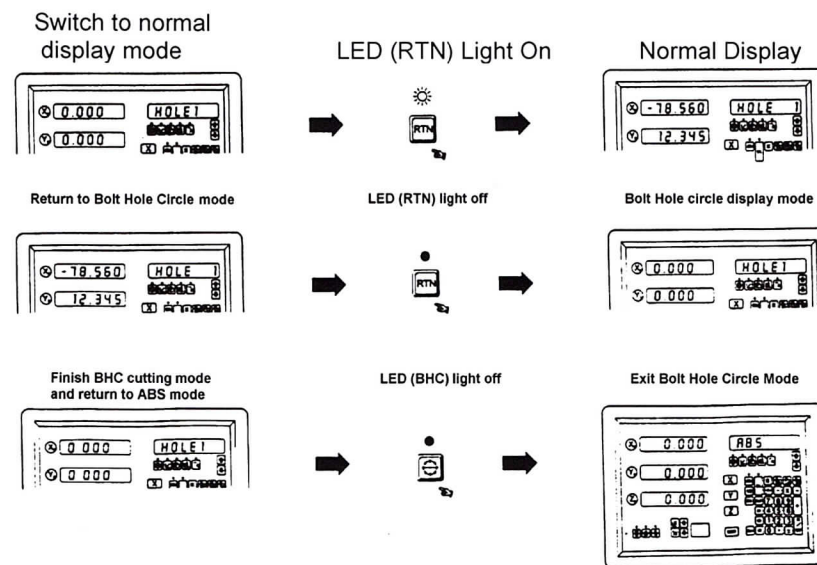
6.0 Holes on a Straight Line Function
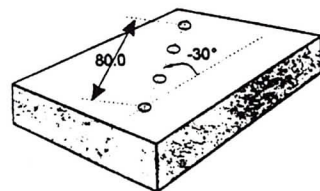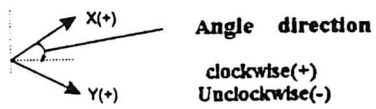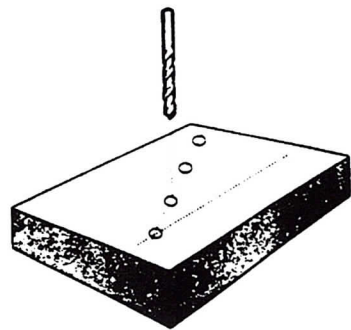
On the Meister BC- 10M DRO, drilling holes on a straight line is also a simple task using the SHL function. The user simply enters the cutting parameters following the step by step instruction indicated on the display window. And the BC- 10M DRO will calculate those holes and preset their temporary positions. Using them, the user need only to move the work piece until the selected axis display is "0.0000" which means the hole position has been reached and user can being to drill the hole. The parameters to be keyed in are:

- Length of the line [LIN DIST]
- Angle of the line [LIN ANG]
- Number of Holes [No. of HOLE]

The length of the line (LIN DIST) is defined as a distance between the center of the 1st hole to the center of the last hole on the straight line.

X(+)   Angle   direction

clockwise(+)
Y(+)   Unclockwise(-)

Example:

Length of the Line [LIN DIST] … 80.000 mm

Angle of the Line [LIN ANG] … -30 counter-clockwise

No. of Holes … 4

Operation	Display	Status Window

6.1 Move the work piece until cutting tool is positioned over the first hole. Set the first hole position as the work piece's zero position.

6.2 Press **X₀** and **Y₀** to set the zero position.

	Display	Status Window
X	0.000	ABS
Y	0.000	

6.3 Press this [icon] key to start using the SHL function.

6.4 Enter Length = 80.000 mm

8 **0**

	Display	Status Window
X		LIN DIST
Y	80.000	

To confirm, press "ENT" key

Next, key in the parameter, *LIN ANG*

	Display	Status Window
X		LIN ANG
Y	0.000	

Operation	Display	Status Window

6.5 Enter angle = - 30 degree

3	0	±

X | | LIN ANG
Y | - 30 |

To confirm, press "ENT" key

Next, key in the parameter Number of Hole

into the DRO

X | | NO. OF HOLE
Y | 0 |

6.6 Enter number of Holes = 4

X | | NO. OF HOLE
Y | 4 |

4

To confirm, press "ENT" key

6.7 Now, use the "UP" or "DOWN" arrow keys to scroll through all the parameters to ensure that you had entered the correct values. If the values are correct, we are ready to start drilling the holes. Use the "UP" or "DOWN" arrow keys to select any one of the holes. And move the work piece until the DRO display "0.0000" on the Status Window. It means that the drill bit is now over the hole's position you can start machining.

Any time if the user want to **RETURN TO NORMAL MODE** (ABS mode) OR temporarily exit SHL mode, please follows these steps:

12
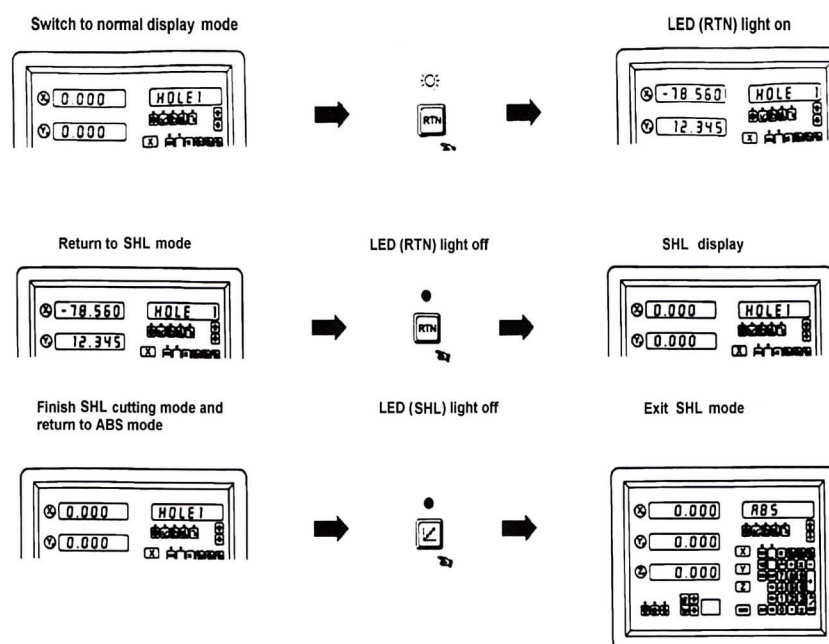
7.0   99 Sets Auxiliary Co-ordinates (SDM co-ordinates)

The BC-10 provides 99 sets of auxiliary co-ordinate memorized function (SDM). It is useful during batch machining of repeated work and work piece machining dimensions are from more than two co-ordinates.
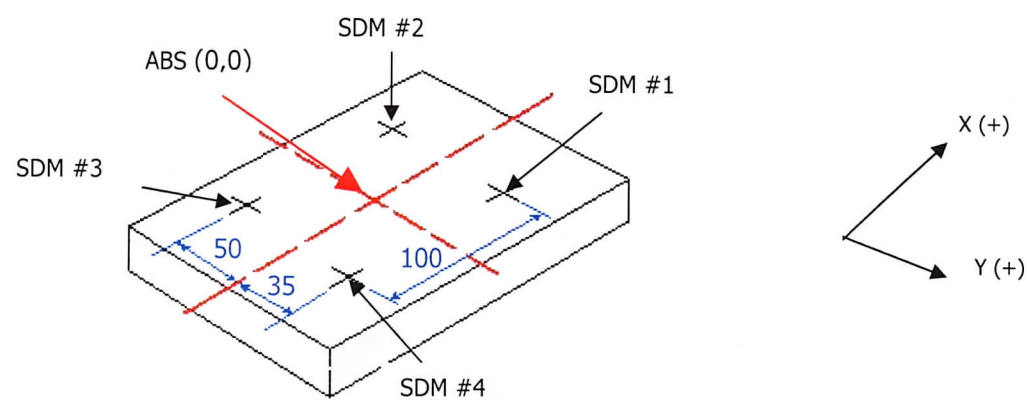
All 99 sets auxiliary co-ordinates are relative to ABS co-ordinates (base zero position). And all the 99 sets auxiliary co-ordinate positions will shift together with the ABS zero position as the zero position changes.

Example

To preset 4 sets of SDM co-ordinates (SDM1 to SDM4) of the above work piece, please follow these steps below.

Operation	Display	Status Window
7.1 Set work piece ABS zero position. Move work piece until cutting tool reaches ABS zero position and clear the display to zeros by pressing X_0 and Y_0 keys.	X 0.000 Y 0.000	ABS Tool Display: 0 0
7.2 Press Tool Toggle Key and enter to SDM mode.	X 0.000 Y 0.000	SDM MODE Tool Display: 0 1
7.3 Use the white color "UP" arrow key (next to the Tool Toggle Key) and the Tool display window will show "01". Now key these values of SDM#1 co-ordinates and press "ENT" to confirm.	X - 50.000 Y - 35.000	SDM MODE Tool Display: 0 1

X	5	0	ENT
Y	3	0	ENT

Operation	Display	Status Window

7.4 Next press the "UP" arrow key again and the Tool display window will show "02". Key these values of SDM #2 co-ordinates and press "ENT" to confirm.

X	5	0	ENT	
Y	5	0	±	ENT

X `0.000`   SDM MODE

Y `0.000`   Tool Display: `0 2`

X `- 50.000`   SDM MODE

Y `50.000`   Tool Display: `0 2`

7.5 Next press the "UP" arrow key again and the Tool display window will show "03". Key these values of SDM #3 co-ordinates and press "ENT" to confirm.

X	5	0	±	ENT
Y	5	0	±	ENT

X `0.000`   SDM MODE

Y `0.000`   Tool Display: `0 3`

X `- 50.000`   SDM MODE

Y `- 50.000`   Tool Display: `0 3`

7.6 Next press the "UP" arrow key again and the Tool display window will show "04". Key these values of SDM #4 co-ordinates and press "ENT" to confirm.

| X	5	0	±	ENT
Y	3	5	ENT	

X `0.000`   SDM MODE

Y `0.000`   Tool Display: `0 4`

X `- 50.000`   SDM MODE

Y `- 50.000`   Tool Display: `0 4`

After all SDM#1 to SDM#4 co-ordinates' positions have been preset, user can use "UP" or "DOWN" arrow keys to select them.

8.0   Introduction to Circular Arc Function (Concave and Convex Surface)

In the processing of moulds, the machining of circular arc (convex or concave) is un-avoidable. If only one piece of mould is required, it would not be productive to use a CNC for the job. However this could be easily done on a conventional mill with the help of any of the Meister mill digital readouts.

SIMPLE R

AUTO R
Note: the Led will be lighted when the function is in used.

UP / DOWN arrow keys
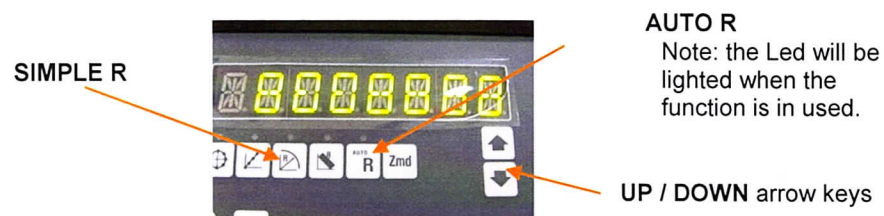
The advanced functions such as **AUTO R** and **Simple R** in the TOP10 and BC10M digital readouts makes it possible to make a single mould using a universal milling machine.

While it is simple to use Meister TOP10 or BC10M digital readout to machine complex circular arc surfaces, requiring just a few steps to enter all the necessary data, it requires the machinist to have a good understanding of the coordinate system, the XYZ working planes and the starting and end points.

The arc calculation function makes it possible to have control over the smoothness of the circular arc. The distance between two adjoining working points is kept uniform and thus the smoothness of the circular arc can be control by defining this distance which is called the maximum cut. The smaller the MAX CUT, the smoother the arc will be.

8.1   Working Planes and Co-ordinates

The circular arc function can be used on any of the working plane of a work piece – XY, XZ and YZ. The correct plane must be selected when using Meister BC10M DRO. Fig. 1 shows the various planes for a piece of work.

Fig 1

XY plane

+X direction

+Y direction

+Z direction

XZ plane   YZ plane

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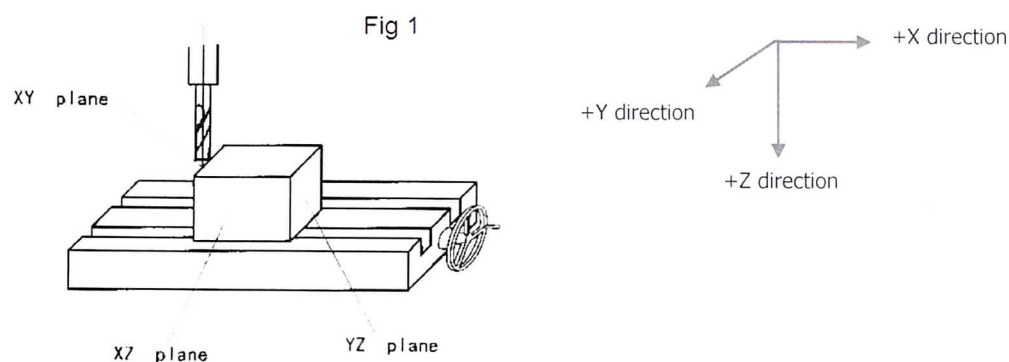
8.2 Center Point of Circular Arc

Fig 2 and Fig 3 illustrate what the co-ordinates of the center point of the circular arc should be with respect to the starting position of the cutting tool.
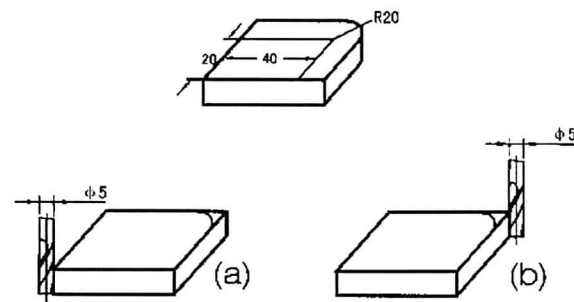

In Fig. 2 –

The cutting plane is XY.
Radius is 20 mm.
Tool diameter is 5 mm

Example I(a) -
The center of the circular arc is at (40, -20)

Example I(b) -
The center of the circular arc is at (-20, 20)

Fig. 2
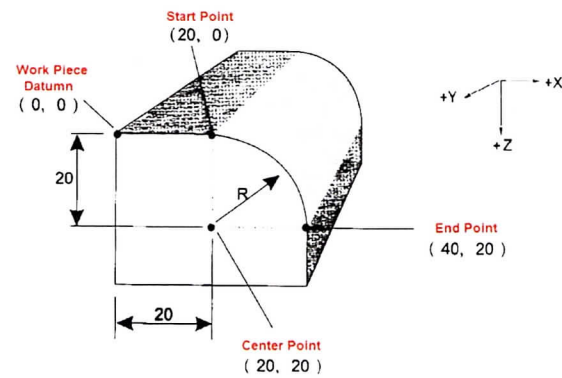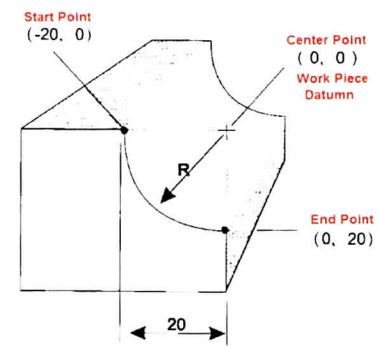
Fig. 2 and Fig 3 illustrate the concept of co-ordinates measurement system.

8.3 Maximum Cut / Z Step

a) **XY Plane** -- when milling a circular arc on the XY Plane, the maximum cut between two interpolated points is the machining step increment and it is the **MAX. CUT**.

| XY PLANE ARC PROCESSING	XY / YZ PLANE ARC PROCESSING	
		When using Smooth R, every incremental step of cut is called the MAX CUT.

b) **XZ/YZ Plane** -- in the XZ and YZ planes, maximum cut between two points is the **Z-Step.** This machining increment step is a fixed incremental value for processing the circular arc. When using the circular arc function on the XZ plane, the quality of smoothness may not be uniform across the whole surface but as shown in the sketch below.
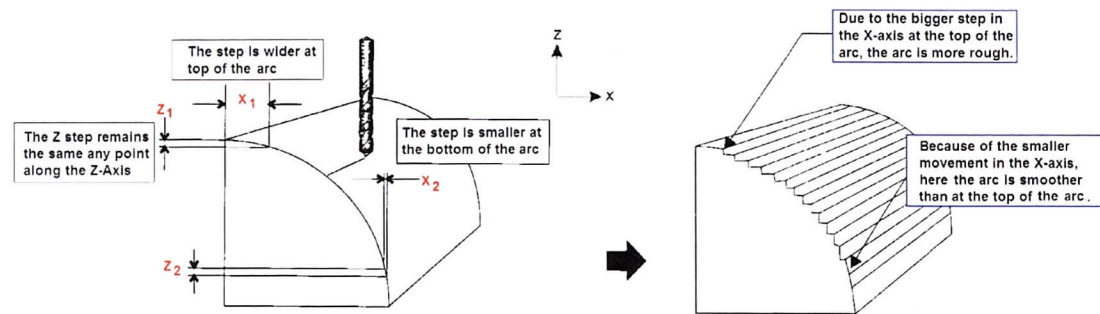
Such a symptom is unavoidable when working on the XZ and YZ planes.

8.4   Tool Compensation

The center position of the circular arc (or circle) is with respect to the position of the tool at the starting point.
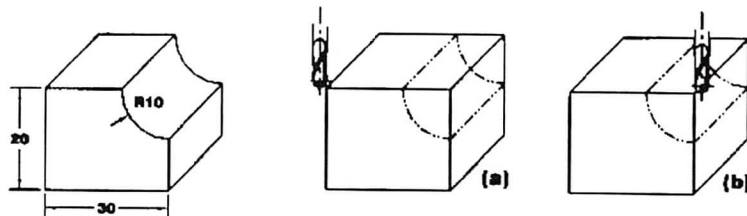
In Fig. (a), the processing of the circular arc in Plane XZ as shown using an end mill, the tool diameter must be set according to the diameter of the tool used.

In Fig. (b), the processing of the circular arc using an end mill, the tool diameter is set to zero.

In the following pages, we will learn how to use the AUTO R and Simple R functions for the Meister BC10M digital readout.
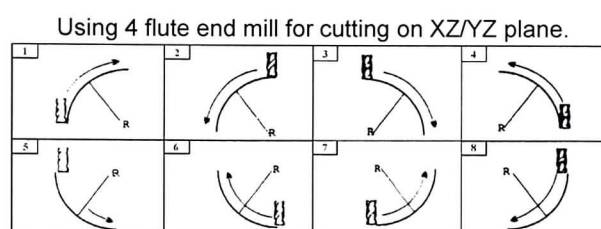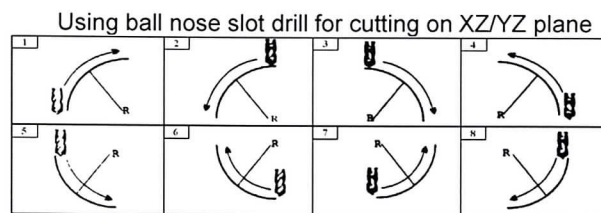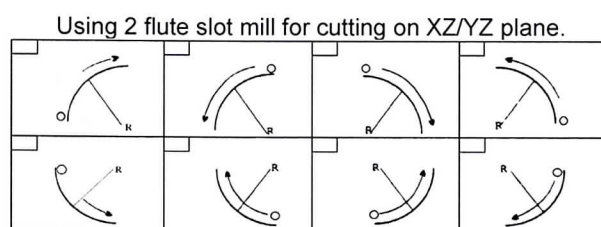
9.0   Simple R

Cutting a 90° radius is very simple if you have a CNC machine. If you do not have a CNC, you can still machine manage to process simple circular arc (convex or concave) using Meister TOP-10 or the BC10-M digital readouts. In this chapter, we will use the SIMPLE R function which is an easy method to perform 90° radius cuts using your conventional mill.

In general, the circular arc can be classified into the following 8 types as shown below using a ball nose end mill, a 4 flute end mill or 2 flute slot drill.

Simple-R: Type 1 - 8 Radius ARC for 90° radius cutting using different cutting tool

Using ball nose slot drill for cutting on XZ/YZ plane

Using 4 flute end mill for cutting on XZ/YZ plane.

Tool Diameter = 0

Using 2 flute slot mill for cutting on XZ/YZ plane.

For milling a 90 radius arc using **Simple-R** function, the following parameters are needed:

9.1   Cutting Plane

The user must determined on which plane is the radius arc to done and select the appropriate plane:

XY, YZ or XZ. The diagram below shows where the planes are on the work piece.

+X direction

+Y direction

+Z direction
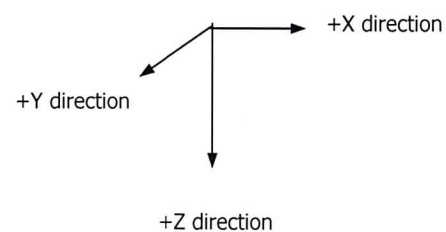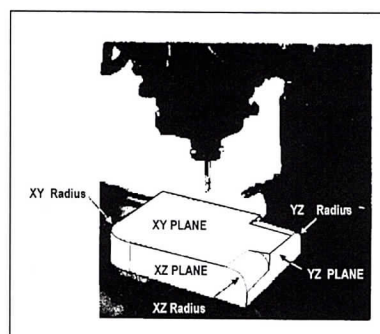
9.2   Type of Radius

Select one of the type of radius as shown in the chart on page 18. Types #1 to #4 are for milling of external radius and Type #5 - #8 are internal radius.
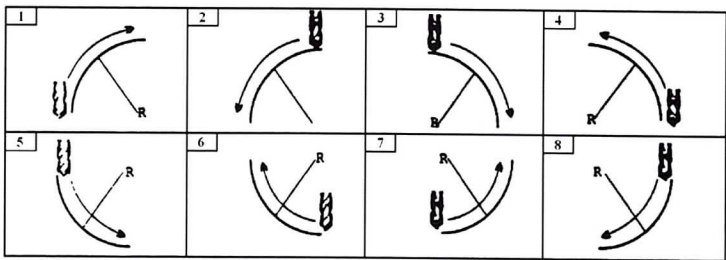
9.3   Radius, R
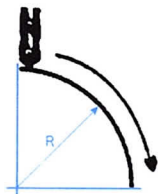
9.4   Tool Diameter
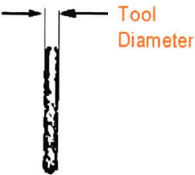
9.5   Tool compensation

	External: R + Tool Diameter	Internal: R -Tool Diameter
XZ/YZ Plane –		
XY Plane –		

9.6 **Max Cut or Z Step**

a) **XY Plane R**: -- when milling a R-radius on the XY Plane, the maximum cut between two interpolated points is the machining step increment and it is also the **MAX. CUT**.
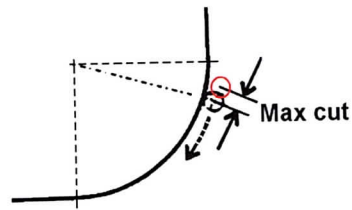
b) **XZ/YZ Plane R** -- under normal condition, the **Z Step** increment is fixed and to be specified as the machining step increment.
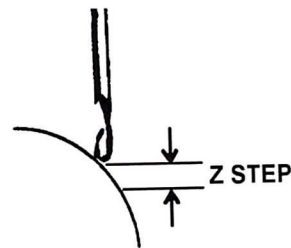
c) **XZ/YZ Plane R** – under Smooth-R option, the Z step or incremental step will be automatically calculated so that the maximum distance between each machining point is approximately the same.
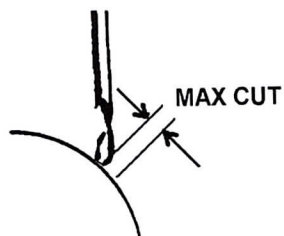
------ MAX CUT = max. distance between interpolated points

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<u>Example:</u>

Milling a radius of R=200 mm on the XZ plane of a work piece.
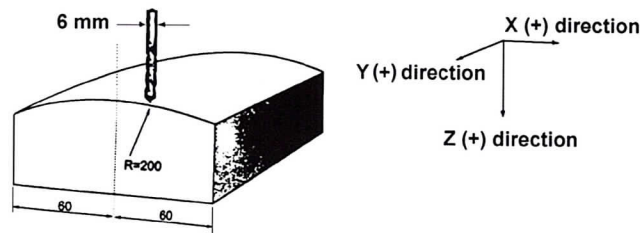
- Treat the work piece as if it is 2 parts by splitting it in the center. And use the 'Type 2' and 'Type 3' Simple-R pattern on half-side of the work piece as shown below.

Part #1:
Select 'Type 2' from the chart in the front panel of DRO.

Part #2:
Select 'Type 3' from the chart in the front panel of DRO

- Position the cutting tool at the center of the work piece, which is also the starting point of radius R. Set the Z-dial on the crank of the milling machine to zero.

Z axis dial set to "0'
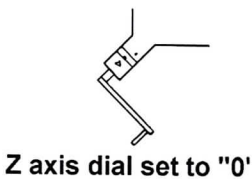
Once the cutter is in at the starting point of R and the mill machine Z-dial is set to zero, we can proceed to set up the DRO.

Operation		Display	Status Window
• With the cutter at the starting position of R, press the [X] and [Y] to set both the X and Y axes to zero.		X 0.000 Y 0.000	ABS
• Then, enter into Simple-R mode, press [⟋] and the LED lamp should light up. To scroll press the [⬇] key located below the **Status Window**.		X Y	SIM. R X Y
And after each data entry / selection, please press the "**ENT**" button to confirm.		X Y	SIM R X Z
• Scroll till the "**SIMPLE-R XZ**" option is displayed, press "**ENT**" to confirm.			

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Operation		Display	Status Window

- Then press the ⬇️ key again to go to the next parameter. For Part #1, we will use the 'Type 2' simple-R. Key in the number 2 and press "**ENT**"

X [ ]	TYPE 1 - 8
Y [2]	

- In the next parameter, enter radius, R=200

  Press "**ENT**" key to confirm.

X [ ]	R
Y [ ]	

- Next, the parameter is '**TOOL DIA**' or tool diameter. Set the tool diameter = 6.0 mm. Press '**ENT**' key to confirm.

X [ ]	TOOL DIA
Y [6]	

- Press the arrow down key ⬇️ to go to the next step. From here onwards, please take note of the different way the 2-axis and 3-axis BC10M DRO will shown the position for the z-axis which is incremental value of the amount of cut to take.

For BC10M 2-axis DRO, you will be prompted to enter the "Max Cut". Skip this step if you have the 3-axis DRO. Let set "Max Cut" = 5mm. To achieve a smoother surface finish use smaller incremental step.

- When prompted to set the "Max Cut", press "5" and press "ENT" to confirm.

X [ ]	Z STEP
Y [5]	

- Press the arrow down key ⬇️ and the BC10 2-axis display will show the following:

X [0.000]	[Z– 203.00]
Y [- 0 0.000]	

This is the starting point of the radius corner. The Status Window will display "**Z – 2 0 3. 00**".

X [4.995]	[Z– 202.940]
Y [0 0.060]	

Press the arrow down key and the co-ordinates for the 1st cut is display. Crank the z-axis handle to move the work piece along the Z-axis and move the job along the X-axis to make the cut. Stop when the X-axis display shows 0.000.

2nd point:

X [5.000]	[Z– 202.755]
Y [0 0.245]	

Press the arrow down key again and the co-ordinates for the 2nd cut will be shown. Repeat the same steps.

Last point:

X [000.00]	[Z– 0.000]
Y [81 0.500]	

The last point is reached when the Status Window shows "**Z – 0.000**".

Operation		Display	Status Window

BC10M 3-Axis Digital Readout

- For the *TOP10 3-axis* digital readout, the display box will show the coordinate positons for X and Z. The "**Z OU LI**" (Z out of limit) that is shown on the Status Window will disappear when the you crank the Z-axis handle.

	Display	Status Window
X	0.000	Z OU LI
Y	0.000	
Z	- 203.000	

- Crank the z-axis handle unitl the Z-axis display shows "− 2 0 0 . 0 0 0". Notice that at the same time, the X-axis display would change.

	Display	Status Window
X	34.740	AUTO X Z
Y	0.000	
Z	- 200.000	

- To make the 1st cut, move the job along the X-axis until the display shows "0.000". When this is done, press crank the z-axis handle until the Z-axis display shows "− 1 9 0 . 0 0 0". A new co-ordinate will be shown on the X-axis display. This is the co-ordinate for the 2nd cut on the job.

- Repeat the step until the Z-axis display reaches "0.000"

10.0 AUTO R

AUTO
R

The digital readout display box will prompt the machinist to enter all the parameters needed for processing a circular arc. This function provides a consistent incremental step (MAX CUT or Z STEP) in the processing of the circular arc so the smoothness of the circular arc is in the hands of the machinist. And it is easy to operate.

The following instruction will be displayed on the status window of the digital readout prompting you to input the necessary data and the cutting points will be shown on the X, Y and/or Z axis display screen.

No.	2X.R – XZ Plane	2X.R – YZ Plane	2X.R – XY Plane	Remarks
1	XZ CENT	YZ CENT	XY CENT	Cutting tool starts at this point which is the zero position
2	R	R	R	Key in the radius
3	XZ ST PT	YZ ST PT	XY ST PT	Key in the Start point of arc.
4	XZ END P	YZ END P	XY END P	Key in the End point of arc.
5	TOOL DIA	TOOL DIA	TOOL DIA	Key in the tool diameter.
6	R+TOOL / R–TOOL	R+TOOL / R–TOOL	R+TOOL / R–TOOL	Select according to convex or concave arc.
7	MAX CUT	MAX CUT	MAX CUT	Key in the maximum Z step.

Example A:

In the following example, we will be working on the XY plane of the work piece to machine the circular arc.

Working plane: **ARC - XY**
Center of arc, XY CENT:
        X=20.0   **Y=20.0 mm**
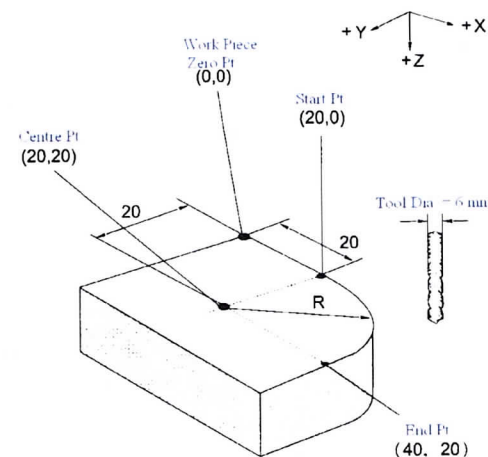Radius, R: **20.0 mm**
XY ST. PT: **X=20.0**   **Z=0.0 mm**
XY END P: **X=40.0**   **Z=20.0 mm**
TOOL DIA: **6.0 mm**
Tool Compensation: **R + TOOL**
Z STEP: **0.5 mm**

Before starting, please fixed the 4 flutes cutter to the tool holder and move the work piece to the START PT.

Clear all axes reading to zero by pressing the X_o and Y_o buttons.

To use AUTO R function, please follow the procedure outlined below.

Operation		Display	Status Window

A.1 Set the BC10M DRO to Smooth R function

by pressing the AUTO R button

| AUTO |
| R |

X	0.000
Y	0.000

Status Window: ABS

To proceed to the next step, press the DOWN arrow key just below the status display window.

A.2 In this step, we will select the working plane. We will use the XY plane for this work piece.

Press the DOWN arrow three times and you will see the following choices.

ARC – XY ⟶ Press 'ENT' to select XY plane.

2X.R – YZ

2X.R – XZ

X, Y — Status Window: ARC - XY

A.3 Next, press the DOWN arrow button and you will be prompted to key in the center of the circular arc.

Center of arc, XY CENT: **X=20.0   Y=20.0 mm.**

X	2	0	ENT
Y	2	0	ENT

X	20.000
Y	20.000

Status Window: XY   CENT

A.4 Next, press the DOWN arrow button and key in the radius, **R = 20 mm.**

2	0	ENT

X	
Y	20.000

Status Window: R

A.5 Next, press the DOWN arrow button and key in the Start Point of the circular arc.

X	2	0	ENT
Y	2		ENT

X	20.000
Y	0.000

Status Window: XY   ST   PT

A.6 Next, press the DOWN arrow button and key in the End Point of the circular arc.

X	2	0	ENT
Y	2	0	ENT

X	20.000
Y	20.000

Status Window: XY   END   PT

Press the DOWN arrow button to proceed to the next step to enter the tool diameter.

Operation		Display	Status Window

A.7 Key in tool diameter, TOOL DIA = 6 mm.

6	ENT

X [ ]   TOOL
Y [6.000]

In the next step, we will set the tool compensation for this job.

A.8 Press the DOWN arrow button two times, and you will see the following choice displayed on the status window:

R + TOOL $\rightarrow$ Press 'ENT button to set to R + TOOL.

R - TOOL

X [ ]   R + TOOL
Y [ ]

A.9 Next, press the DOWN arrow button and set the maximum cut increment in order to have a smooth circular arc. Set MAX CUT = 0.5 mm

·	5	ENT

X [ ]   MAX   CUT
Y [0.500]

A.10 Press the DOWN arrow key and the first cutting point would be displayed on the X and Y axis display window.

X [- 19.990]   PT   1
Y [3.000]

Now, move the work piece along the X and Y axis until the display shown 0.000 on the axis display window. You are ready to perform the 1st cut on the work piece. When this is done, press the DOWN arrow button and the Point #2 will be displayed on the status window.

X [0.000]   PT   1
Y [0.000]

A.11 Move the work piece along the X and Y axis until the display shown 0.000. You are ready to machine the 2nd cut on the work piece.

X [- 0.005]   PT   2
Y [- 0.010]

Repeat the process until the circular arc is done. There are a total of 74 points for this work piece.

At any time, when you may wish to pause or return to normal mode of operation, you can:

o Press the 'RTN' button to pause and press 'RTN' button again to continue from where you left off in AUTO R mode.

o Press the 'AUTO R' button to return to normal mode.
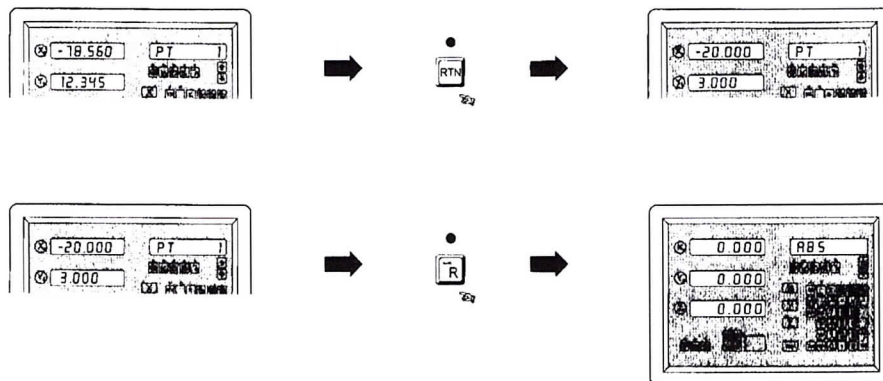
<u>Example B</u>:

In this example, we will be working on the XZ plane of the work piece to machine the circular arc.

Working plane: **2X.R - XZ**
Center of arc,   XZ CENT:
                          X=20.0 Y=20.0 mm
Radius, R: **20.0 mm**
XZ ST. PT: **X=20.0   Z=0.0 mm**
XZ END P: **X=40.0   Z=20.0 mm**
TOOL DIA: **6.0 mm**
Tool Compensation: **R + TOOL**
Z STEP: **0.5 mm**
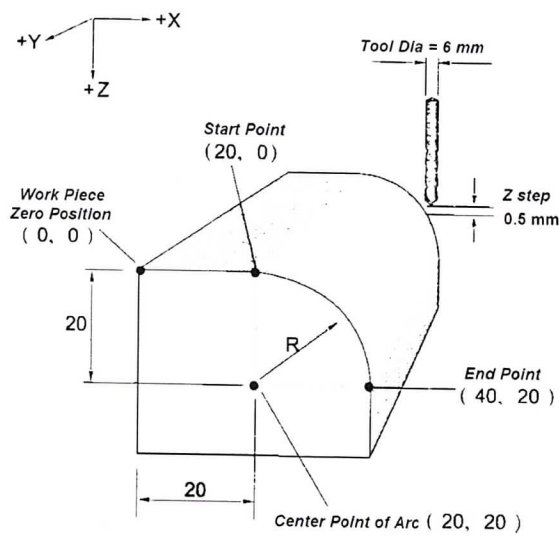
Before we start the AUTO R function, install the cutting tool into the tool chuck and move the cutting tool to the start point of the work piece. **Set all axes reading to zero** by pressing the X_o and Y_o buttons on the front panel.

Then press AUTO R button to set the digital readout to switch to Smooth R function.

Please follow the step by step procedure outlined below on how to use the AUTO R function.

Operation		Display	Status Window
B.1 Set the BC10M DRO to Smooth R function by pressing the AUTO R button		X 0.000 Y 0.000	ABS

In the next step, we will select the working plane.

B.2   Use the UP / DOWN arrow buttons located just below the status window to scroll backwards or forwards, and you will see the following choices:

ARC - XY

2X.R – YZ

2X.R - XZ → Press 'ENT' button to set 2X.R -XZ

X		2 X . R - XZ
Y		

We are using the 2.X.R - XZ plane for this work piece. Press the DOWN arrow button and proceed to the next step.

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Operation		Display	Status Window

B.3 Key in the center position of the circular arc:

X	2	0	ENT
Z	2	0	ENT

X   20.000   XZ CENT
Y   20.000

B.4 Press the DOWN arrow button and proceed to the next step, R.

X   R
Y   20.000

B.5 Key in the radius, R.

2	0	ENT

Press the DOWN arrow button and proceed to the next step, START POINT.

X   20.000   XZ ST PT
Y   0.000

B.6 Key in the START point of the circular arc.

XZ ST. PT: X=20.0   Y=0.0 mm

X	2	0	ENT
Y	0		ENT*

Press the DOWN arrow button and proceed to the next step, END POINT.

    * Since Y=0, you may skip this step.

B.7 Key in the END point of the circular arc.

XZ END P: X=40.0   Y=20.0 mm

X	4	0	ENT
Y	2	0	ENT

X   40.000   XZ END P
Y   20.000

Press the DOWN arrow button and to go to the next step, TOOL DIA.

B.8 Key in the tool diameter.

Tool DIA = 6 mm

6	ENT

X
Y   6.000   TOOL DIA

Press the DOWN arrow button to go to the next step.

B.9 Select the tool compensation.

Use the UP/DOWN arrow button to toggle between 'R + Tool' and 'R – Tool'.

To save the setting, just press the ENT button.

Press the DOWN arrow button and proceed to the next step to set the maximum cut or Z step.

X   R + TOOL
Y

| Operation		Display	Status Window
B.10 Key in the maximum cut which is kept consistent to get the desired smoothness. Set MAX CUT = 0.5mm. ┌─┬─┬─────┐ │ • │ 5 │ ENT │ └─┴─┴─────┘		X 0.500 Y	MAX CUT
Press the DOWN arrow button and the co-ordinates for the first milling point will be displayed.		X -19.995 Y - 0.000	Z 3.000
B.11 Move the mill table until the X-axis show '0.000' on the X-axis display window. Now, the cutting tool is over the first point and you may start milling along the X-axis.		X 0.000 Y - 0.000	Z 3.000
B.12 Next, press the DOWN arrow key and the 2nd milling will be displayed. Move the cutting tool until the X-axis display '0.000' on the axis display window. Now the tool is over the 2nd point and you may start milling. Repeat the step again until the last point is done.		X -0.005 Y - 0.005	Z 2.995

Since the BC10M 2 Axis DRO does not have a Z-axis display window, the amount of travel to for the Z axis (knee) of the mill is displayed on the status window. And the current position of the Z height is displayed in the Y-axis window as shown below:
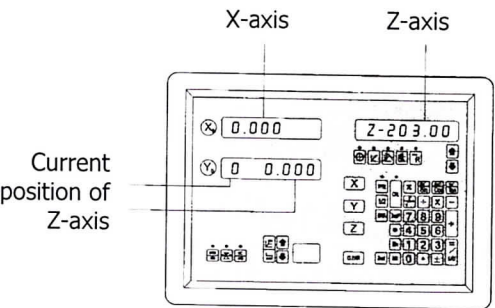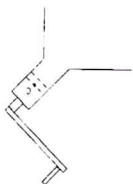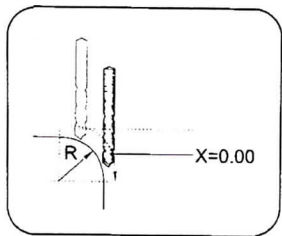
If the Z axis is out of range the error message "Z OU LI" or Z out of limit will be displayed on the status window. C

Meister

## *Precision Glass Scale*
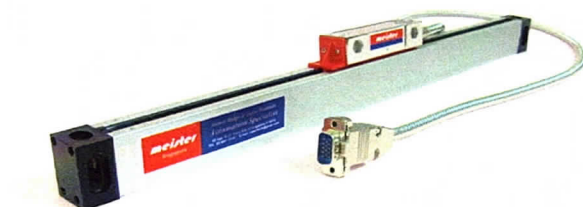
Rev G1, 2007

Automation Specialist

Meister Precision Glass Scale

Meister scales are high accuracy displacement transducers that connect to digital display unit to form digital measuring equipment.

Specifications

- a) Scale: Precision etched grating glass scales
- b) Grating pitch: 0.02mm (50LP/mm)
- c) Resolution: 5 μm
- d) Accuracy: ±0.005mm or ±0.0002 inches (at 20° C and within 1000mm)
- e) ABS reference marks   These marks are located near both ends of the scale.
- f) Measuring range: 100mm to 6000mm
- g) Operating temperature: 0° C ~ 40° C
- h) Response rate: 60 m/min or 198 ft/sec
- i) Input voltage: 5 Vdc
- j) Output signal: TTL signal output

  - Two orthogonal square wave signals with the amplitude of +5V (±5%)
  - Signal Output:
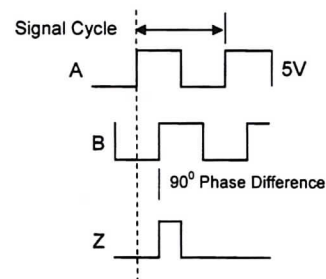
- k) Type of connector: Linear glass scale can be supplied with the following type of connectors upon request – DB7, DB9, HD15, 6 Pin Round, etc.
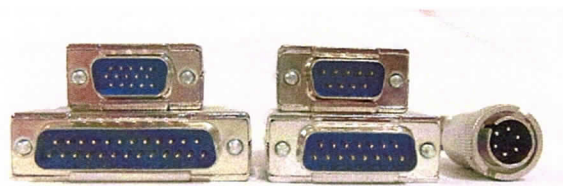

- l) The standard cable is 3 m (9.8 feet) long with stainless steel flexible armor sleeve. Linear scales with travel of 1.5 m long and above are provided with 5 m long cable. Extension cables are also available.

1.0 Installation

The following pictures show the right and wrong method of mounting the scales.

1.1 The read head is always mounted so that it is **not** directly in the path of the flow of the coolant.
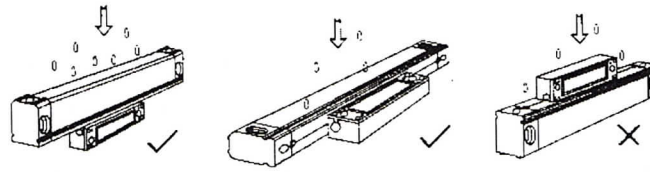
1.2 **Gap between the reader head and aluminium housing**: Maintain a small gap between the reader head and aluminun housing. Keep the gap consistent throughout the whole length of the glass scale to 1.2 ~ 1.5 mm. Use a feeler gage to check.
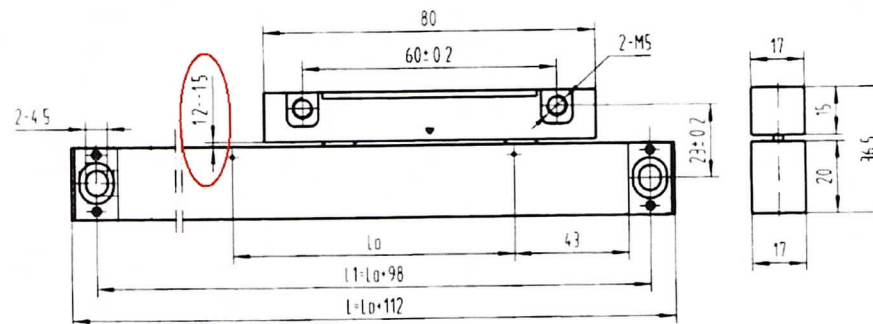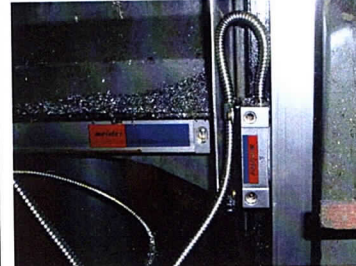

1.3 Provide coolant/chip cover for the scales.

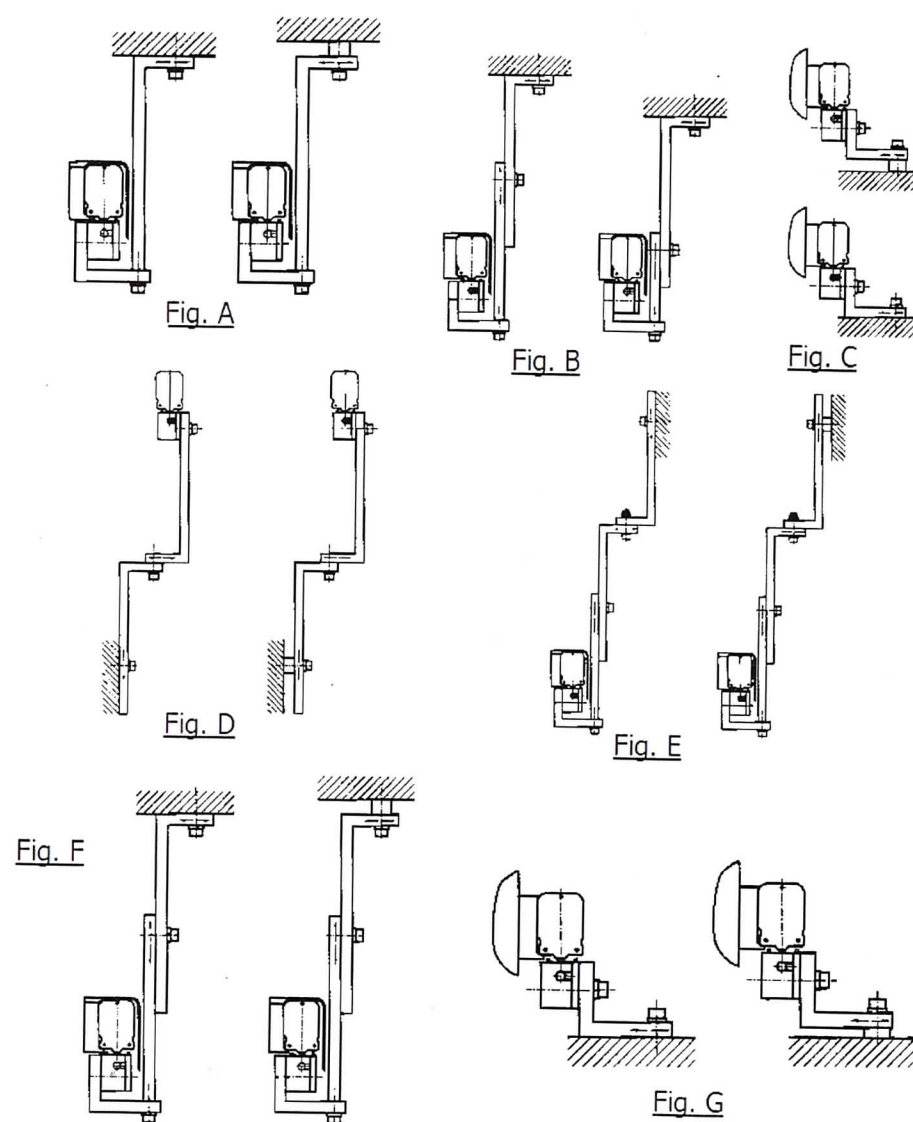1.3.1 Prolong the life of the linear glass scales by using chip/coolant covers.
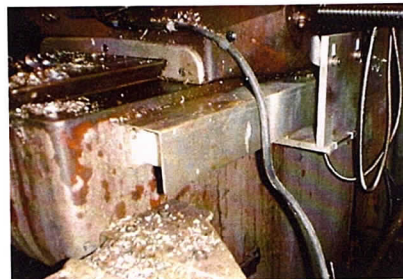
| **Right method:** Use chip/coolant covers as shown above. | **Wrong method:** The glass scales are exposed to chips! |

1.4   Mounting of the glass scale to the Y-axis.

Please refer to the examples shown below for ideas on mounting the Y-axis scale.

Fig. A

Fig. B

Fig. C

Fig. D

Fig. E

Fig. F

Fig. G

2.0   Maintenance

2.1   Always switch off the power when connecting or disconnecting the linear scale plug to the digital readout display box.

2.2   Ensure that the scale cable is able to move freely during machining.

2.3   Prevent the linear scale from being damaged by coolant or chip by installing a cover over the scale.

2.4   Clean the aluminum body of the linear scale daily.

2.5   Do not use the air or spray gun to clean the DRO and the linear scales.

Meister Precision Glass Scale

3.0 Meister MS Scale Series I
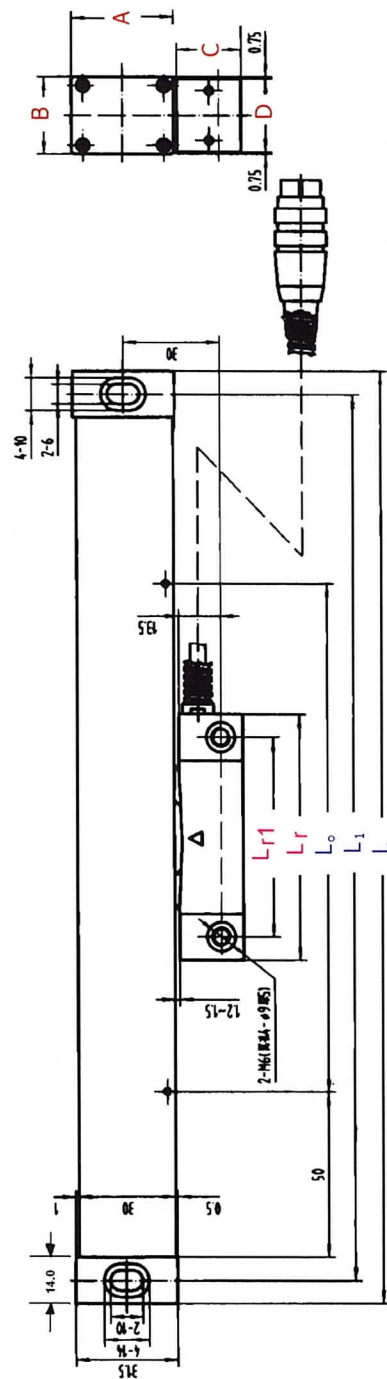
Model	A	B	C	D	Travel Length, L_o	Distance btw Mounting Holes, L_1	Overall Length, L	Distance btw Read Head Mounting Holes, L_{r1}	Length of Read head L_r
Standard MS 4	31.5	23.5	20.0	22.0	100, 150 ~ 1000 max Increment of 50mm	$L_1 = L_o + 114$	$L = L_o + 128$	60 ± 0.1	76.0
Compact MS 5A	30.5	18.0	20.0	18.0 ±0.5	250, 300, 350 and 400 mm	$L_1 = L_o + 114$	$L = L_o + 128$	80 ± 0.1	94.0
Micro MS 5	20	17	15	17	50 ~ 400 mm	$L_1 = L_o + 98$	$L = L_o + 112$	60 ± 0.2	80.0

Note: The read head, rubber seal, aluminum coolant/chip cover and connectors can be purchased separately.
The specification is subjected to change. All dimensions in mm unless specified.

4

4.0   MX Series Linear Glass Scale

Meister MX series Linear Glass Scale

MX6 Heavy   MX4 Standard   MX3 Small

Meister MX Model of Linear Scales

There are Meister MX3 Small, MX4 Standard and MX6 Heavy linear scales.

MX3 linear scale has a slim profile to fit into areas where space is a constraint such as the compound slide on a lathe.
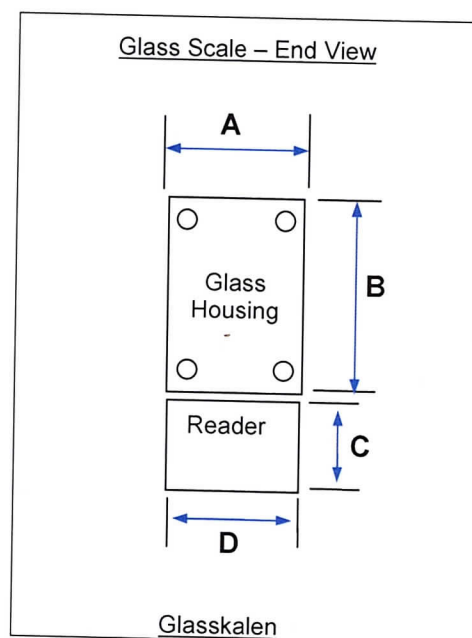
MX4 Standard is suitable for most applications.

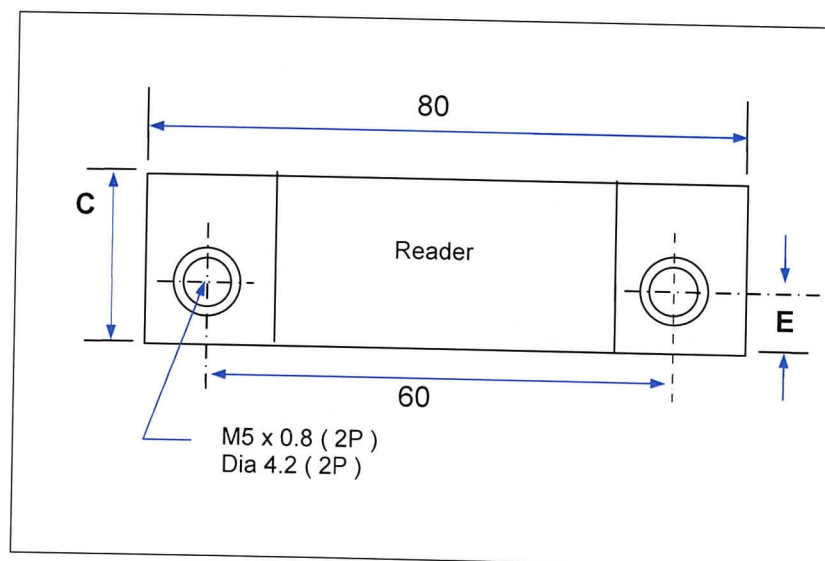MX6 Heavy is supplied for travel stroke of 1100 mm and above. It has a thicker aluminum body.

MX4 and MX6 have double sealing for better protection from chips and coolant.

4.1   MX Scale Dimension:

Model	A	B	C	D
MX3	20	29	18	20
MX4	22	34	19	22
MX6	30	47	19	30

Glass Scale – End View

Glasskalen

Model	E
MX3	6
MX4	7
MX6	8

M5 x 0.8 (2P)
Dia 4.2 (2P)
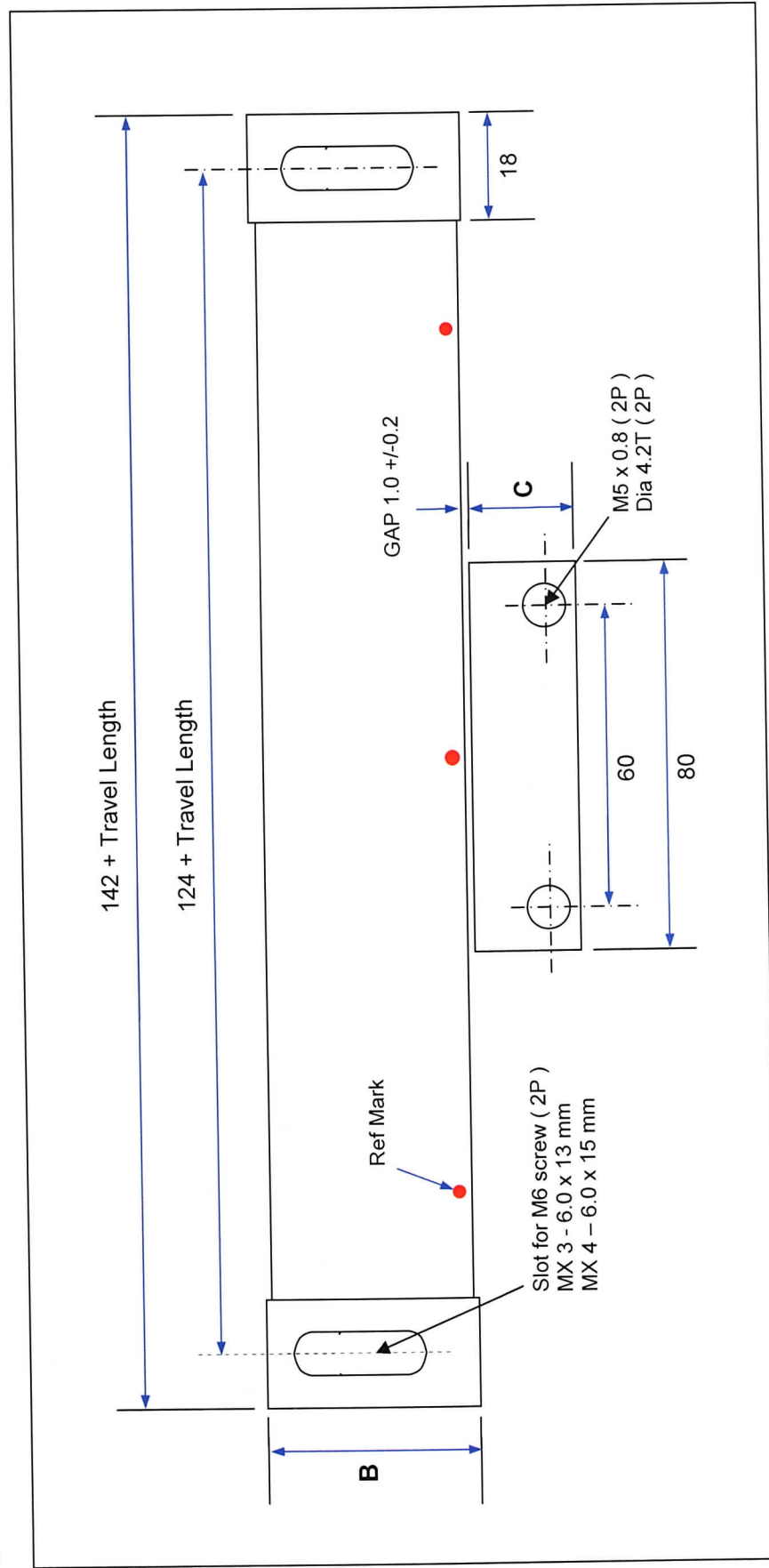
5

Meister Precision Glass Scale
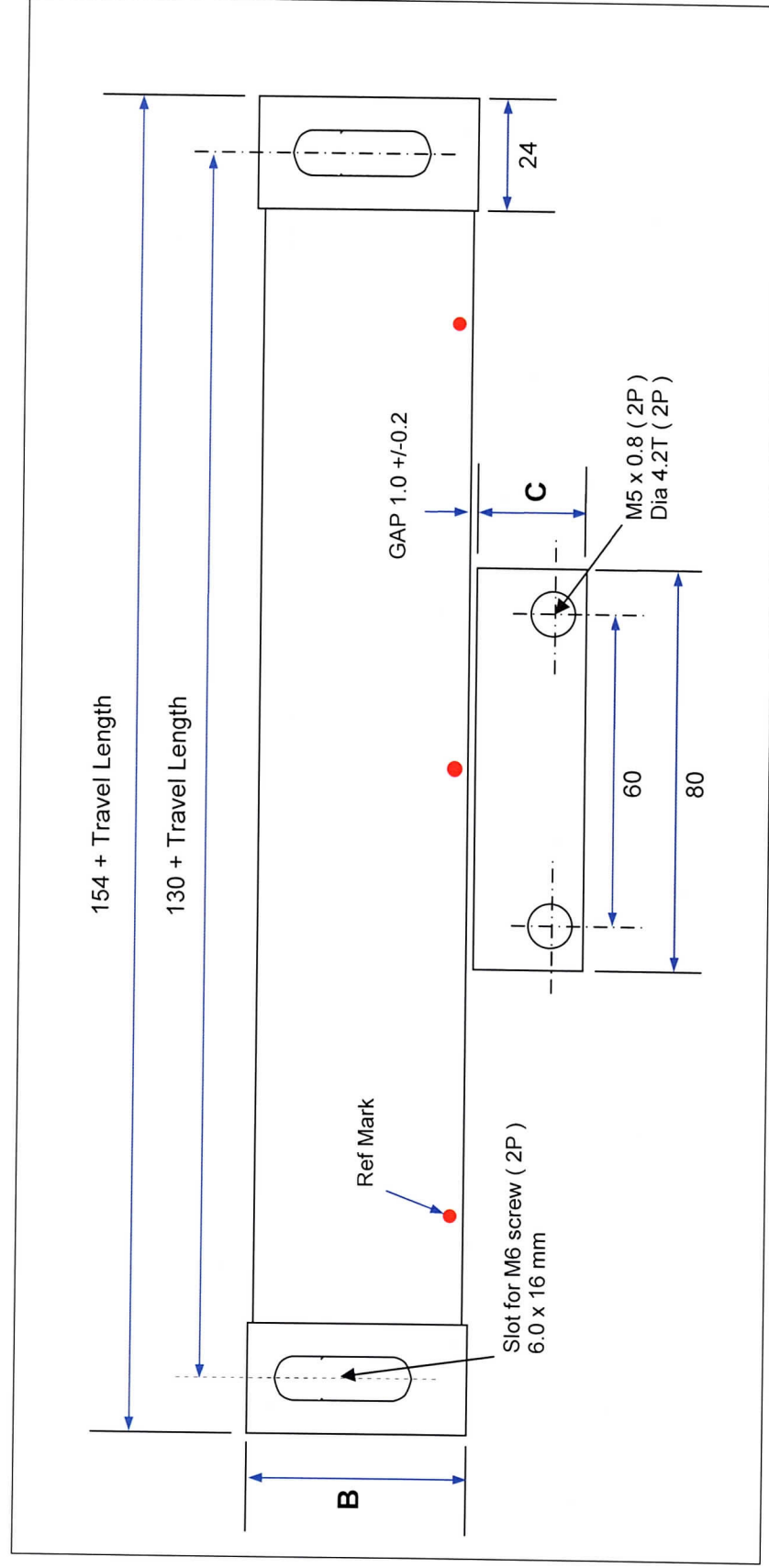
4.2   Meister MX3 and MX4 Scales

MX3 scales are available in travel length of 100, 120, 150, 170, 200, 220, 300, 350, 400, 450 and 500 mm.

MX4 scales are available in travel length of 100, 120, 150, 170, 200, 220, 250, 270, 300, 350, 400, 420, 450, 500, 520, 550, 570, 600, 620, 650, 700, 750, 770, 800, 850, 900, 950 and 1000 mm.

Meister Precision Glass Scale

4.3 Meister MX6 Scale

154 + Travel Length

130 + Travel Length

24

GAP 1.0 +/-0.2

C

M5 x 0.8 (2P)
Dia 4.2T (2P)

60

80

Ref Mark

Slot for M6 screw (2P)
6.0 x 16 mm

B

MX6 scales are available in standard travel length of 1100, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900, 2000, 2500 and 3000 mm.