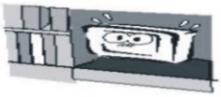
LCD Digital Readout

Operation Manual

Content

Notice: We will revise this manual's content according to the improvement of our products, so please refer to the product QR code. Thanks for your patronage and please pay attention to any change.

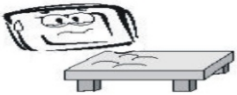
Warning and key points



Install the display with double-screw bolt and fix it on a stable position, or the display will decline and be damaged, even catch fire.

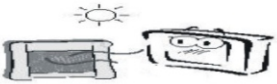
Do not put the display near water or oil etc, or it will be at the risk of catching fire.

Do not use damaged power patch plug and put the power cable near the heat sources, or it will evoke electric shock or fire.



Put the display on balanced plane, or it will decline even to be damaged.

Ensure the power plug is in good grounding before installation, or it may evoke electric shock or fire.



Do not use the display in the direct sunlight, and keep it away from heat source such as heater or baker, or the display may catch fire.

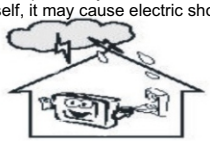
Do not use the display in rainstorm or thunder days, and pull out the power plug.

Do not parallel excessive slots and connect overfull plugs in a socket together, or it will catch fire due to overmuch power-dissipation.

Do not disassemble the display by yourself, if there is any fault, ask the professional for help to repair it. If you dismantle it by yourself, it may cause electric shock or fire.

Make sure the plug is in good electric contact, because the faulty contact will cause fire.

Pull out the power plug before washing with soft rag, do not use industrial chemical pharmaceuticals. And keep water outside of the display.



During rainstorm or thunder, please switch off the power, or it will evoke electric shock or fire.

Do not use the plug when your hands are wet, or it will cause electric shock.

If the plug or input cable is dirty, clean them immediately, or it will cause electric shock or fire when you use them.

If you don't use the display during a long period , please cut off the power, or it will cause electric shock or fire.

Switch off the power immediately and ask for repairing if there is awful odour or abnormal sound.

Do not use or store combustibles nearby the display, or it will evoke explosion or fire.

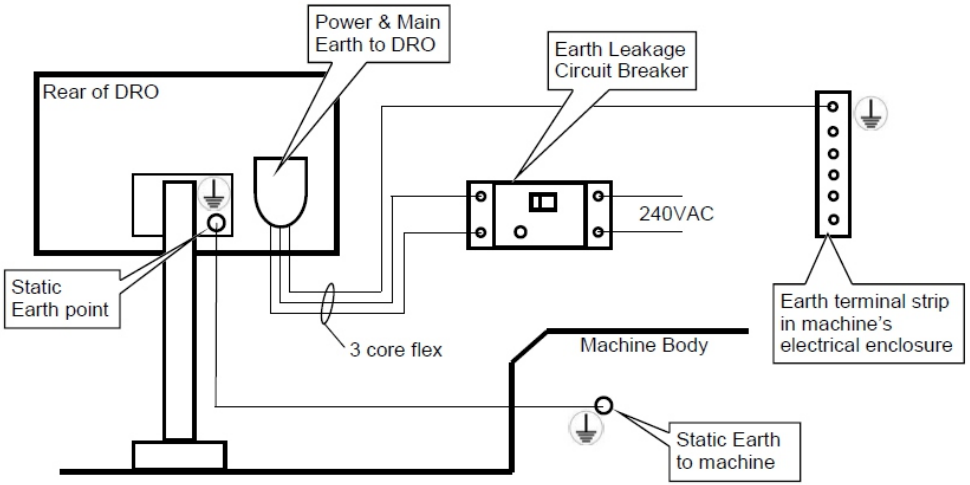
Read the notice above before installation. The product has to be installed by professionals.

** VERY IMPORTANT : SAFETY NOTICE **

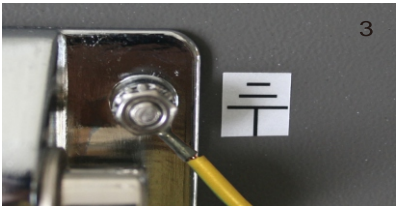
ATTENTION: To avoid possible Electrical Shock !!

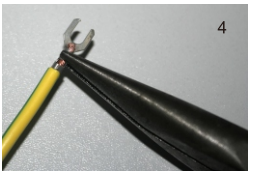
The DRO's Main Earth through the 3 core plug flex must be connected to Earth(ground), either directly through the plug supplied or through the machine it is fitted to. If hard wired, the power to the DRO must be protected by the Earth Leakage Circuit Breaker.

A speparate "Static" Earth also needs connecting from the Earth point on the rear of the DRO to the machine body(for measurement accuracy).



Fitting the Static Earth





1.1 SPECIFICATIONS :

Supply:	115V - 230V
Supply Voltage Fluctuation:	Not to exceed ±10% of the operating voltage
Max Power Consumption:	20 VA
Operating Temperature:	0 'C - 45 'C （32 'F - 113 'F ）
Operating Relative Humidity:	<=95% (45 'C ± 2 'C)
Storage Temperature:	-40 'C - 55 'C （-40 'F - 131 'F ）
Storage Relative Humidity:	<=95% (45 'C ± 2 'C)
Inputs:	Depend on model, 2, 3 or 4 Linear Transducers

**** we reserve the right to change the specifications as listed in above without any prior notice. ****

EMC Standard Specification (Anti-interference)

The DRO have been to conforms to relevant standards for electromagnetic compatibility (EMC) as detailed below.

IEC 61000-4-2 / GB / T 17799-2: Electrostatic discharge immunity (Contact discharge 6000V, Air discharge 8000V)
IEC 61000-4-4 / GB / T 17799-4: Electrical fast transient burst immunity (Pulse amplitude 2000V)
IEC 61000-4-5 / GB / T 17799-5: Lightning surge immunity (Superrimposed pulse voltage peak 2000V)

MOUNTING & INSTALLATION

2.1 MOUNTING

Select the location of the installation with due regard of safety and ease of operation. Keep the DRO away of moving parts and coolant spray. To ensure correct operation of the DRO , make sure that the DRO is correct grounding. Grounding diagram is as shown in SAFETY NOTICE.

The DRO can be mounted on 3 different arm stand brackets as per detailed on the Optional Accessories List. As shown in Figure 2.1:

Standard Single Joint
Arm Stand
(3.BR.05.0001)

Lathe Top Headstock
Arm Stand
(3.BR.05.0031)

Standard Lathe
Headstock Arm Stand
(3.BR.05.0026)

Figure 2.1 Mounting of the DRO

2.2 POWER SUPPLY CONNECTION

Before connecting the electrical supply to the DRO, please check the VOLTAGE SELECTOR switch to see if correctly main supply voltage selected or not. Check Figure below for the position of the switch.

The **PROTECTIVE EARTH CIRCUIT** of the mains supply **MUST BE CONNECTED** to the earth grounding terminal of the DRO through the supply cord **and** connected through an earth cable as per shown in Page 1.

The supply cord must be secured with cable ties to avoid from dropping into a hazardous position, for example the floor or coolant tray, when disconnected from the DRO.

The supply cord must be routed away from moving parts, swarf, coolant or sources of heat.

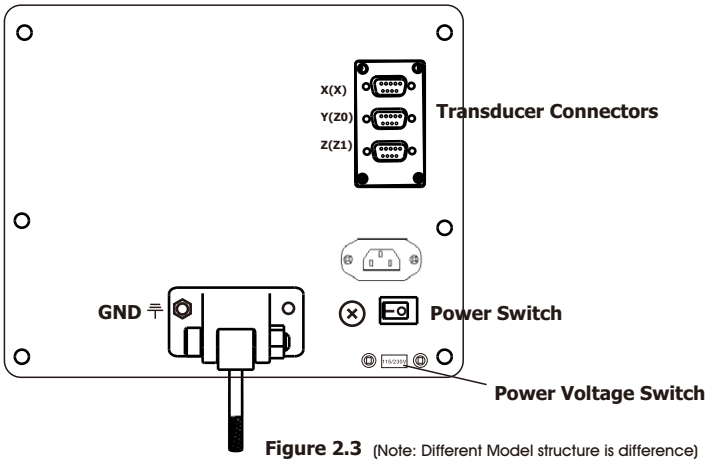


Figure 2.3 (Note: Different Model structure is difference)

If a mains plug is not already fitted to the supply cord or is of the wrong type, then a suitable EARTHED plug should be used which complies with the relevant specifications for plugs and socket-outlets.

The specification of the mains supply fuse is **T0.5A, 220V**. It can not be replaced by operator. If the fuse blows it is a possible indication of some significant problem with the power source.

Check the supply and wiring carefully. When replacing the fuse, the DRO must be first disconnected by removal of the IEC socket from the inlet. For this connector is the primary disconnect device, do not place the DRO in the place where is difficult to reach and make sure that the plug must be accessible all the time.

NOTE: 1. If the DRO is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

2. Non-professionals do NOT open the cover or repair

2.3 LINEAR TRANSDUCER CONNECTION

Connection sockets as shown in Figure 2.3. The transducers are connected to the DRO with 9-pin DB Type connectors.

Switch off the DRO before connecting or disconnecting the linear transducers. To fit the connectors into the appropriate socket on the back of the DRO, first align the connector and then push firmly in place. And secure with the screws. To remove the connectors, loosen the screws and pull the connector clear.

2.4 SWITCHING ON

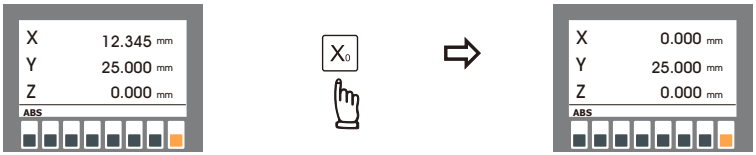
Find the power switch as shown in Figure 2.3.

When the operators switch on the DRO, the DRO will automatically go through a brief self diagnostic routine.

Basic Functions - Set display to ZERO

Purpose : Set the current position for that axis to ZERO

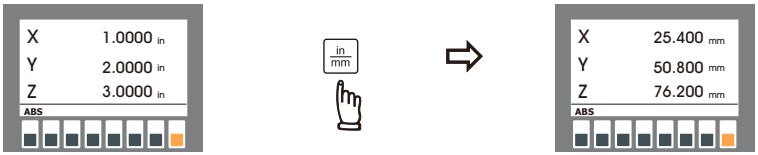
Example : To set the current X axis position to ZERO



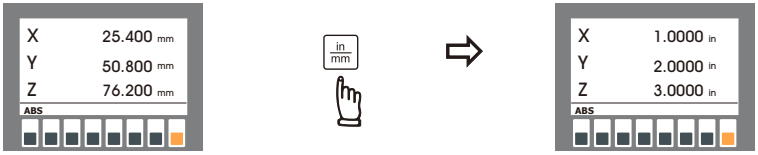
Inch / Metric display conversion

Purpose : Switches between Inch and Metric display

Example 1 : Currently in Inch display, to swap to Metric display



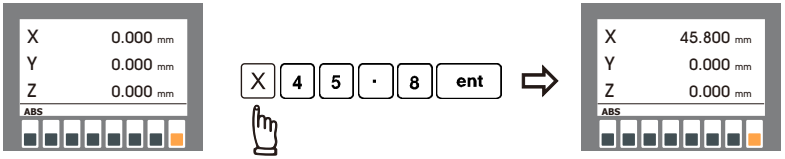
Example 2 : Currently in Metric display, to swap to Inch display



Enter Dimensions

Purpose : Set the current position for that axis to an entered dimension

Example : To set the current X axis poition to 45.800mm

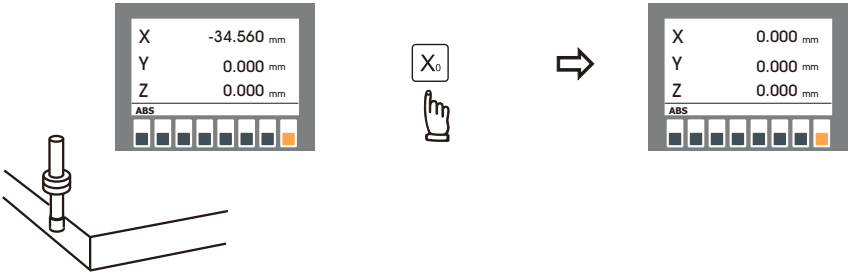


Basic Functions - Centre Find

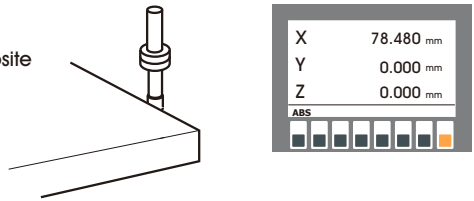
Purpose : DRO provides centre find function by halfing the current display coordinate, so that the zero position of the work piece is located at the centre of the work piece.

Example : To set the current X axis zero position at the centre of the work piece

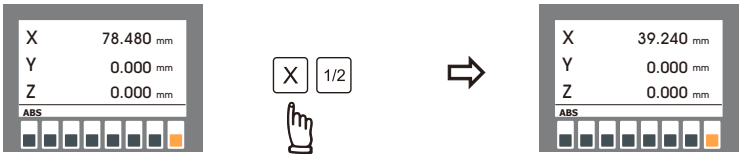
Step 1 : Locate the edge finder at one end of the work piece, then zero the X axis.



Step 2 : Located the edge finder at the opposite end of the work piece.



Step 3 : Then half the display coordinate using centre find function as per follows



Now the X axis zero position (0.000) is located right at the X centre of the work piece

Basic Functions - ABS/INC coordinate display

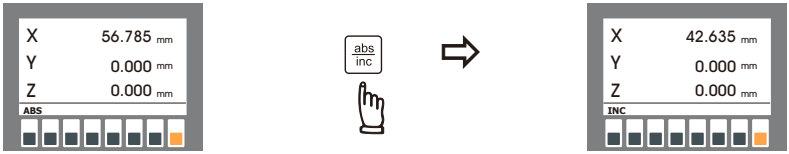
Purpose : DRO provides two sets of basic coordinate display, they are **ABS** (absolute) and **INC** (incremental) displays.

During machining operations, operator can store the work piece datum (ZERO position) in **ABS** coordinate, then switch to **INC** coordinate to continue machining operations

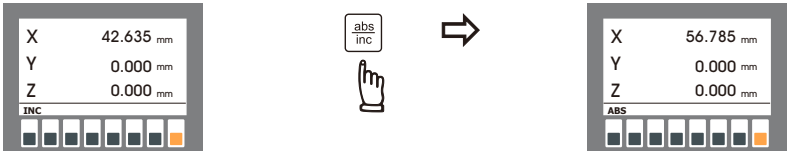
Then the operator is free to zero the axes or preset any dimensions into any axis in **INC** coordinate for any relative position machining. The work piece datum (work piece ZERO position) is still keep in ABS coordinate of the DRO.

Operator can switchs between **ABS** (absolute) and **INC** (incremental) coordinate without losing the work piece datum (work piece zero position).

Example 1 : Currently in **ABS** display coordinate, to switch to **INC** display coordinate



Example 2 : Currently in **INC** display coordinate, to switch to **ABS** display coordinate



Basic Functions - SPEED [axial cutting speed display]

Purpose : To make sure the machining surface finished is consistent, operator must know exactly how much the machine travel speed is for the machining (such as cutting, facing and etc..).

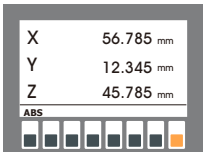
DRO provides the SPEED function to display the machine moving speed in **mm/min** in all selected axis. The SPEED display is filtered by an 0.25 sec display filter to provide stabilized speed display, to enable the operator to adjust the machine's power feed at a more easy and comfortable speed visualization.

The display resolution of the SPEED function is in **mm/min**, which is the most commonly used unit in machine feed rate in CNC machining or cutting tool feed calculations. SPEED function is very useful in monitoring many common machining process (such as cutting, facing and etc..) to achieve predictable surface finish or to achieve predictable cutting tool life.

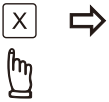
Example : To activate the SPEED display of X Axis, press [X] Axis button for more than 0.6 sec. Then the X moving speed display will be displayed in message window. Same operation for Y, Z and U axis.

XS - X SPEED display
YS - Y SPEED display
ZS - Z SPEED display
US - U SPEED display

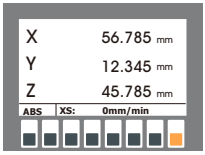
normal display mode



press for more than 0.6 sec.



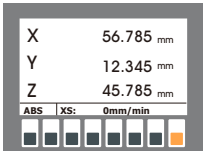
SPEED display mode

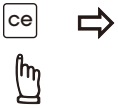


Please notice that during the SPEED display mode, all DRO functions are temporarily disable ! Operator have to exit the SPEED display mode to carry out any normal DRO functions

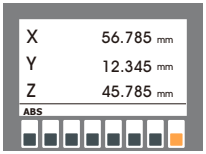
To exit the SPEED display mode and return to normal display mode, press [ce]

SPEED display mode





normal display mode



Basic Functions - YZ Axes Summing

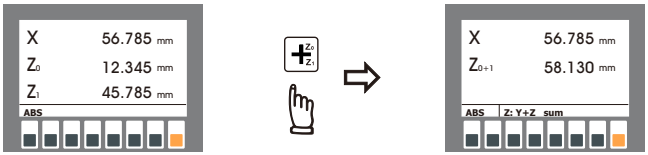
This function available only when the 3 Axes DRO configured to DRO TYPE = LATHE

Purpose : The Axes Summing function is a useful function for LATHE application.

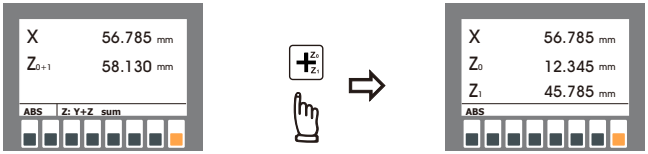
DRO provides the axes summing function for providing temporarily summing display of YZ axes, operator can swap back to the original displays (X/Y/Z individual display with no summing of axes) at any time they want.

The summing function is useful when two linear scales are installed on the cross slide of lathe. The summing function allow the operator to have direct combined reading of these two linear scales for the tool tip positioning, this make machining more easier and less mistake.

Example : To get the summing display of Y and Z axes



To exit from Axes summing display mode, return to normal X/Y/Z display, press



Please notice that when the display is in axes summing mode, all DRO functions are temporarily disabled to avoid confusion and mistaken operation !!

Built in Calculator

Function : Calculator is the most frequently use tool during the manual machining process.

DRO provides a built-in calculator which can perform normal mathematical calculations such as add, substract, multiply, division and etc., it also provides useful trigonometric calculations that are frequently used during machining process, such as SIN, COS, TAN, SQRT, and also their inverses, such as inv SIN, inv COS, inv TAN, SQUARE...

The built in calculator of this DRO also provides the "result transfer" function, all calculated result can "transfered" to any axis, the DRO temporarily preset the axis's zero position at the calculated result coordinate, operator simply move the machine to axis display = 0.000, then the tool is located at the calculated value. This preset is only temporarily, after the operator finished the machine operation at the calculated coordinate, he can simply press CE key, then the axis's zero position will be resumed to the original coordinate before the "result transfer", the operator can continue the remaining machining as normal.

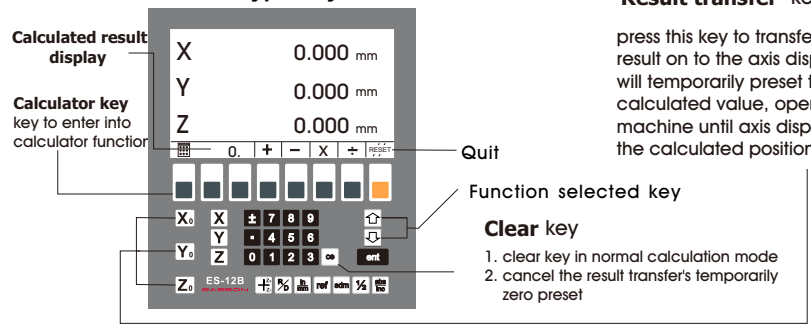
The built-in calculator offers following advantages :

1. Operations are same as normal commercially available calculators, easy to use and no need to learn.

2. Calculated result can be transfered to any axis directly, no need to mark down the calculated number on paper or etc., it is more convenience, time saving and less mistake.

3. No unnecessary down time in finding or sharing the calculators whenever you need one for mathematical calculation.

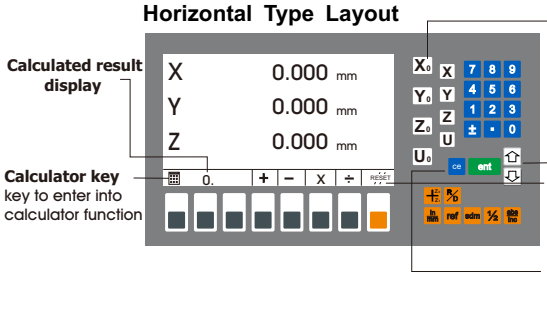
Vertical Type Layout



Result transfer key

press this key to transfer calculated result on to the axis display, then the DRO will temporarily preset the axis's zero at calculated value, operator just move the machine until axis display = 0.000, then the calculated position is reached.

Horizontal Type Layout

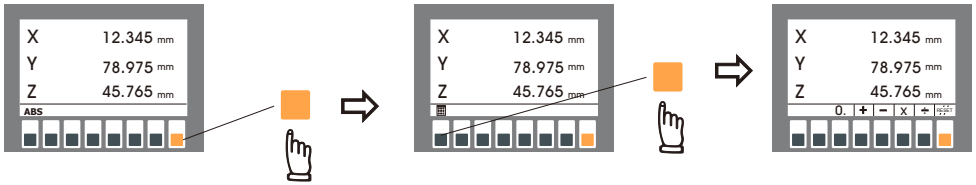


Result transfer

press this key to transfer calculated result on to the axis display, then the DRO will temporarily preset the axis's zero at calculated value, operator just move the machine until axis display = 0.000, then the calculated position is reached.

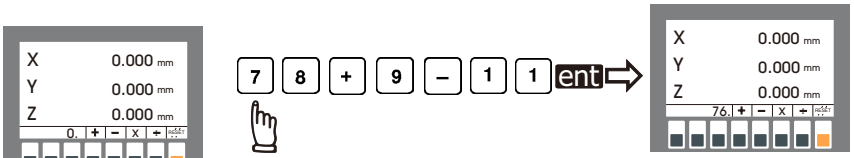
Built in Calculator

Example :

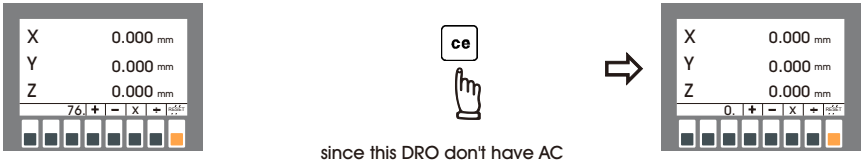


The operations of the DRO's built-in calculator is same as common commerically available calculator

i.e. Basic mathematics - **add** ; **substract** : 78 + 9 - 11 = 76



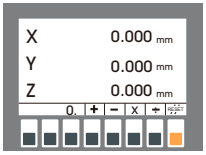
Clear & restart the calculation

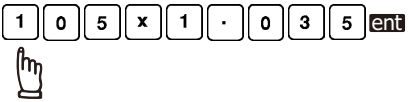


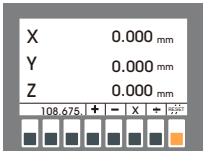
since this DRO don't have AC key as per normal calculator, therefore, CE key is used to act as the AC key in normal calculator

Result transfer

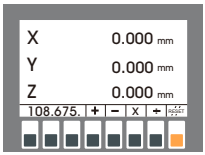
i.e. To move the tool at the X axis position : 105 X 1.035 = 108.675





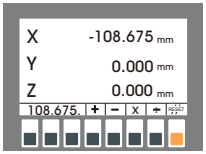


transfer the calculated result : 108.675
to X axis for tool positioning

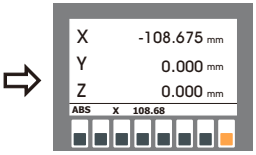


to transfer calculated result to X axis

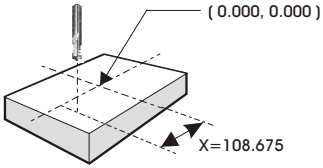
X axis zero position is now
temporarily preset at X = 108.675



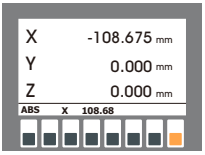
move the machine to X display = 0.000
then the tool is located at the position
of X = 108.675



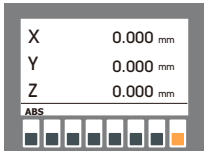
digit display shift left
to identify X axis is
at positioning mode



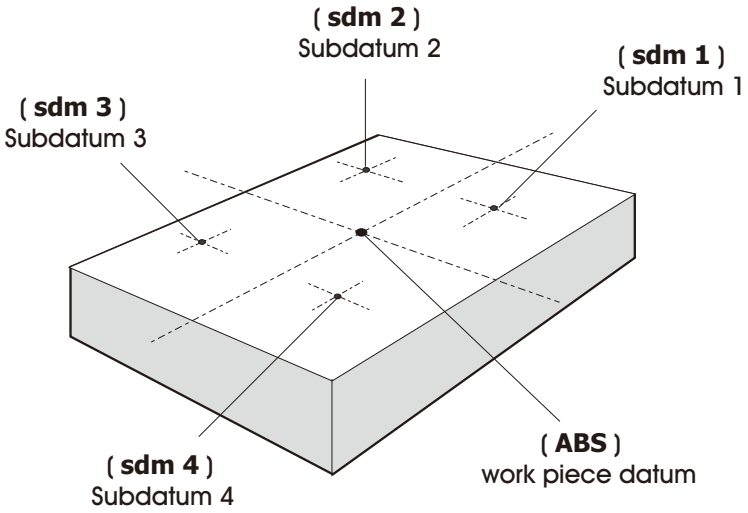
Tool is now at the position of calculated result,
(X = 108.675 in the above example)
press the CE key to return to the normal
display coordinate



return to normal display coordinate



199 Subdatum Function



199 Subdatum Function - working principal

Purpose : Most commonly available DROs in the market are just provide two set of work coordinates - ABS/INC, however, it was found that in case of a bit more complicated machining or in the small batch machining of repeative parts, only the ABS/INC coordinate are not adquate for providing efficient and convenience tool positioning for the machining.

Shortfalls of having only ABS/INC coordinates are as follows

- In many machining, the work piece machining demensions are come from more than two datums, therefore, operator have to switches between ABS and INC to set up extra machining datums times after times, this is time consuming and easily make unnecessary mistakes.

- In case of batch machining of repeative parts, operator have to set up and calcalates all machining positions repeatively, again, it is time consuming and not efficient !

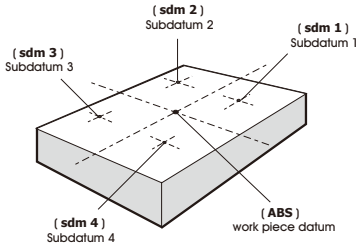
DRO provides extra 199 subdatums (sdm) memory to overcome the above shortfalls of having only the ABS/INC coordinates, sdm function not just simply provide 199 set of extra INC coordinates, it is specially designed to provide very useful and convenience operations to operator for repeative batch machining. *Followings are the difference between INC and SDMs.*

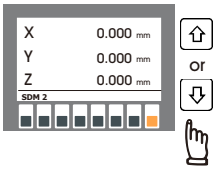
1. **INC is independent of ABS, it won't follows any change in ABS datum (zero point) . However, all sdm coordinates are relative to ABS coordinate, all sdms position are relative to ABS's zero, it will shift together with ABS zero position changes.**

2. **All sdms coordinate's relative distance to ABS can be enter directly into the DRO using the keypads. No need of any calculation or actual tool positionings inthe machine.**

sdm application in the work piece that have more than on datums

operator can store all work subdatums in the DRO's memory(as per) follows





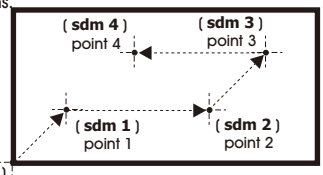
or

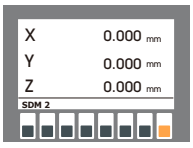
operator than can switches between the subdatums directly by press UP or DOWN keys, no need to refer back to ABS coordinate and set up the subdatums from their relative distance from ABS

sdm application in batch machining of repeative works

since all sdm subdatums (0.000) are relative to ABS zero, therefore, for any repeative works, the operator just need to set up the first work piece zero at ABS, store all the machining positions as the subdatum zero in one of the 199 subdatum memory.

For anymore repeative parts, just set up the 2nd, 3rd, 4th,.. etc.. work piece zero at ABS, then all the machining positions will repears in the subdatums zero positions.





press UP or DOWN keys to go to machining points

or

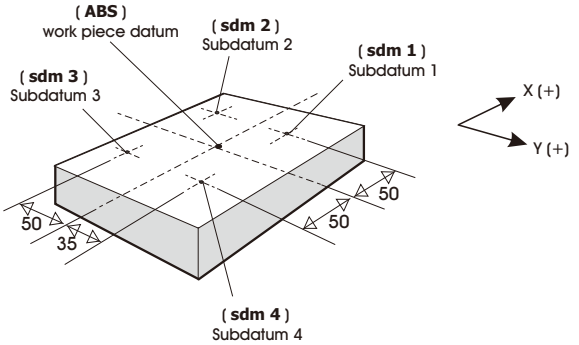
move the machine to display = 0.000, then tool is posited at the machining positions.

199 Subdatum Function

Application example :

To set up the following four subdatum zero (SdM 1 to SdM 4) as follows, followings two methods can be used.

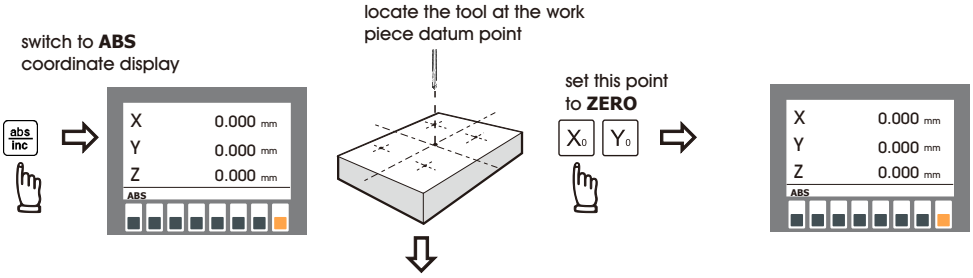
1. move the machine directly to required subdatum positions, then zero SdM display coordinate
2. directly key in the sdm zero position coordinate (coordinate relative to ABS zero)



Method 1 : move the machine to required subdatum position, then ZERO SdM display coordinate

Set up the work piece datum in ABS coordinate, then move the machine to required subdatum position, then ZERO SdM display coordinate accordingly

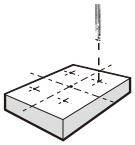
Step 1: setup the work piece datum in ABS coordinate



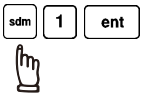
Step 2: setup the subdatum point 1 (**sdm 1**)

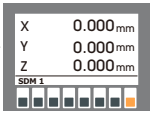
locate the tool at subdatum point 1 (**sdm 1**)
X=50.000 , Y=35.000

199 Subdatum Function

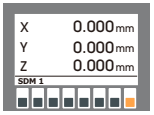


switch to **sdm 1**
coordiante display


sdm
1
ent



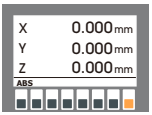
set this point
to **ZERO**



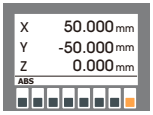
sdm 1 set up already

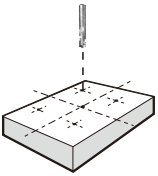
Step 3: setup the subdatum point 2 (**sdm 2**)

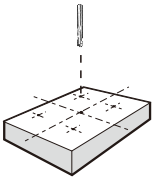
switch to **ABS**
coordinate display



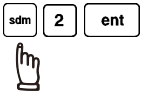
locate the tool at subdatum
point 2 (**sdm 2**)
X=50.000 , **Y=-50.000**



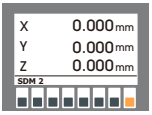




switch to **sdm 2**
coordiante display


sdm
2
ent

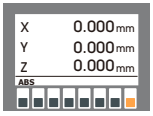
set this point
to **ZERO**



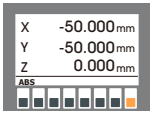
sdm 2 set up already

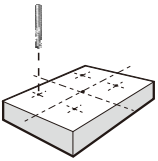
Step 4: setup the subdatum point 3 (**sdm 3**)

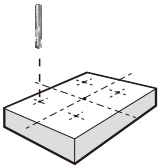
switch to **ABS**
coordinate display



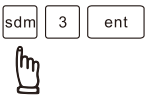
locate the tool at subdatum
point 3 (**sdm 3**)
X=-50.000 , **Y=-50.000**

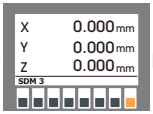




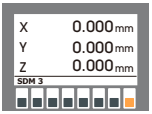


switch to **sdm 3**
coordiante display


sdm
3
ent



set this point
to **ZERO**



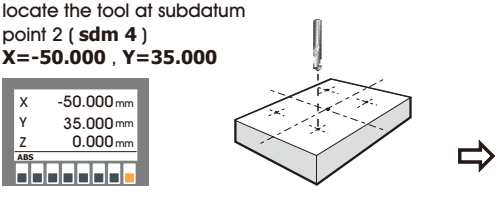
sdm 3 set up already

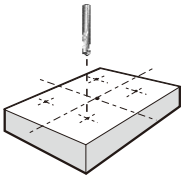
199 Subdatum Function

Step 5: setup the subdatum point 2 (**sdm 4**)

switch to **ABS**
coordinate display

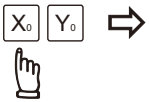
locate the tool at subdatum
point 2 (**sdm 4**)
X=-50.000 , **Y=35.000**

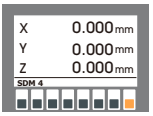




switch to **sdm 4**
coordiante display

set this point
to **ZERO**





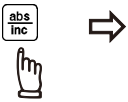
sdm 4 set up already

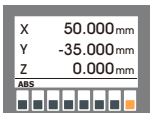
All the four subdatum points have already been set up

operator can press ⇧ or ⇩ to directly switch to the required subdatum (**sdm**) coordinate

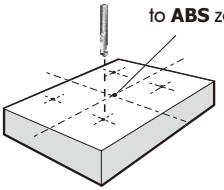
Example :

switch to **ABS**
coordinate display

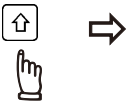


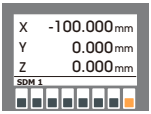


The DRO's XY displays is
now switched to refered
to **ABS** zeros

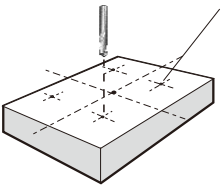


switch to next (**UP**)
sdm coordinate display



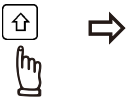


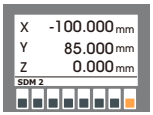
The DRO's XY displays is
now switched to refered
to **sdm 1** zeros



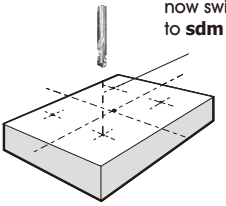
199 Subdatum Function

switch to next (**UP**)
sdm coordinate display

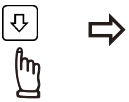


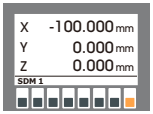


The DRO's XY displays is now switched to refered to **sdm 2** zeros

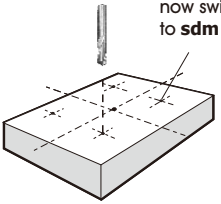


switch to next (**DOWN**)
sdm coordinate display





The DRO's XY displays is now switched to refered to **sdm 1** zeros



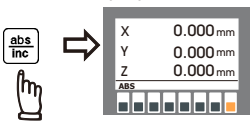
In case of many subdatum (sdm) points needed to be set up, operator will find that the method of direct keyin the sdm zero position coordinate (coordinate relative to ABS zero) is a much more quicker, more efficient and less mistake method.

Method 2 : direct keyin the sdm zero position coordinate (coordinate relative to ABS zero)

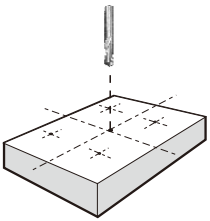
The subdatum ZERO positions can be keyed into the DRO directly, it is a much more easier, quicker and less mistaken method compared to the method 1.

Step 1: setup the work piece datum in **ABS** coordinate

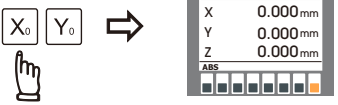
switch to **ABS**
coordinate display



locate the tool at the work piece datum point

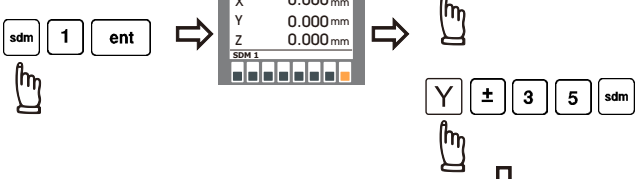


set this point to **ZERO**



Step 2: setup the subdatum point 1 (**sdm 1**)

switch to **sdm 1**
coordiante display



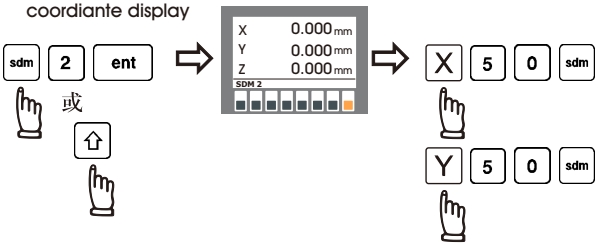
Notice :

when the coordinated is entered into the DRO, the displayed coordinate in the axis display shows a **negative sign** of your entered coordinate

It is correct because your tool is now loacted at the ABS zero coordinate, if you look from the sdm coordinate, it is right at the negative value of the sdm zero position coordinate

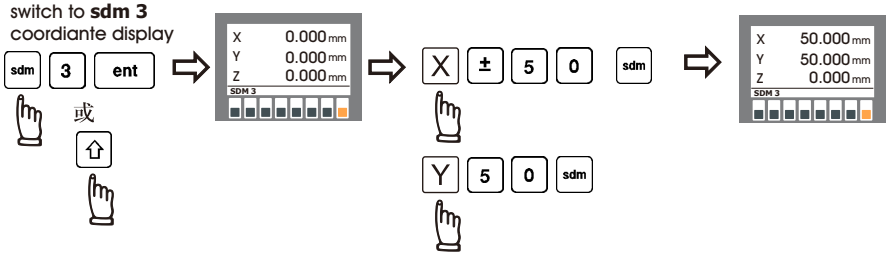
Step 3: setup the subdatum point 2 (**sdm 2**)

switch to **sdm 2**
coordiante display



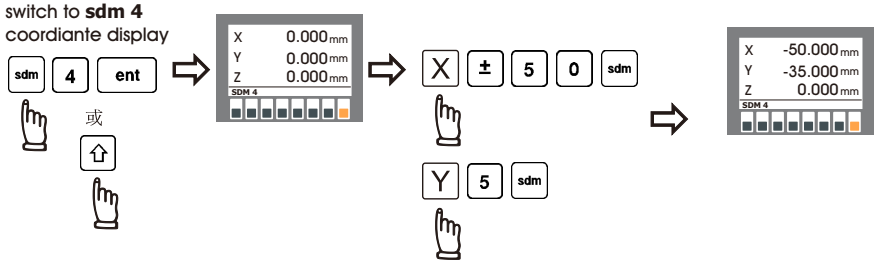
Step 4: setup the subdatum point 3 (**sdm 3**)

switch to **sdm 3**
coordiante display



Step 5: setup the subdatum point 4 (**sdm 4**)

switch to **sdm 4**
coordiante display

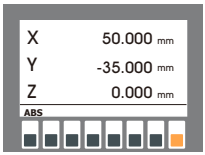


All the four subdatum points have already been set up

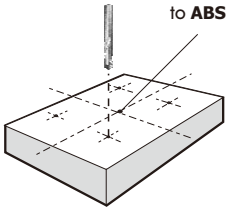
operator can press ⇧ or ⇩ to directly switch to the required subdatum (**sdm**) coordinate

Example :

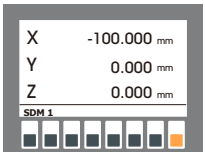
switch to **ABS** coordinate display



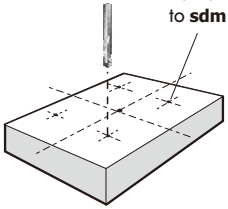
The DRO's XY displays is now switched to refered to **ABS** zeros



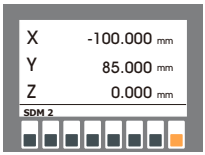
switch to next (**UP**) **sdm** coordinate display



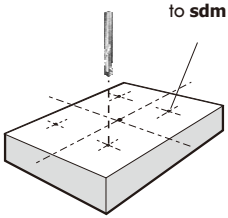
The DRO's XY displays is now switched to refered to **sdm 1** zeros



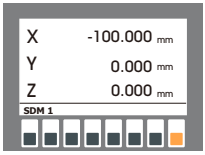
switch to next (**UP**) **sdm** coordinate display



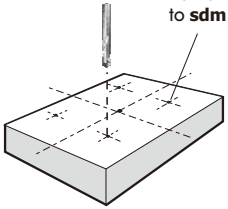
The DRO's XY displays is now switched to refered to **sdm 2** zeros



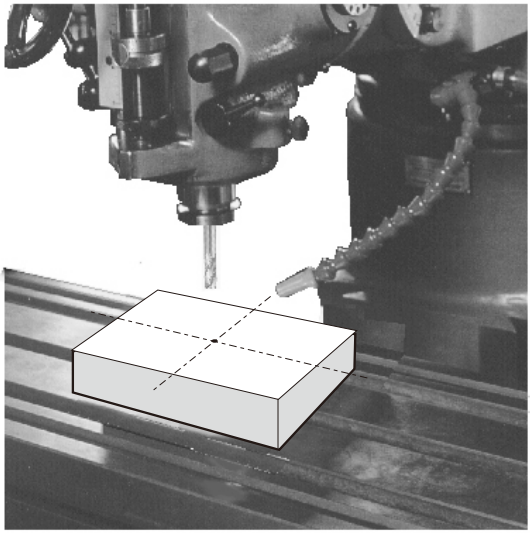
switch to next (**DOWN**) **sdm** coordinate display



The DRO's XY displays is now switched to refered to **sdm 1** zeros



REF datum memory



REF datum memory function - working principal

Function : In daily machining process, it is very common that the machining cannot be completed within one work shift, the DRO have to be switched off after work hours, or power failure happen during the machining process which inevitably lead to the lost of work piece datum (work piece's ABS zero position), the re-establishment of work piece datum using edge finder or other method is inevitably induce higher machining inaccuracy because it is not possible to re-establish the work piece datum at the exact position as per the previous datum.

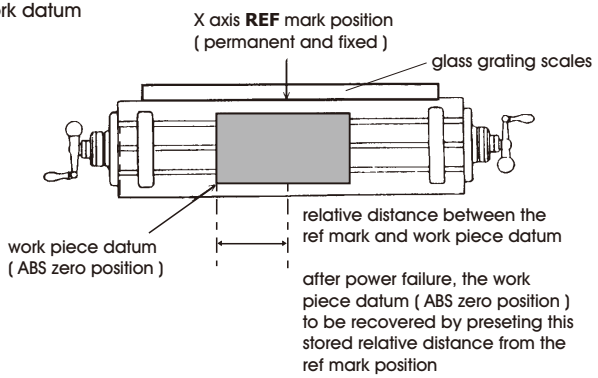
To allow the recovery of work piece datum very accurately, and no need to re-establish the work piece datum using edge finder or the other methods, every glass grating transducer have a **REF** mark which is a fixed position in the glass grating transducer. We can simply store the relative distance between the work piece datum and this **REF** mark into the DRO's memory, after recovered from a power failure, we can re-install the stored relative distance from the **REF** mark to re-establish the work piece datum.

Followings are the detail work principal of the **REF** datum memory :

- there are a permanent and fixed mark (position) in the center of every glass grating scale, normally it is called **REF** mark or **REF** point.

- since this **REF** point position is permanent and fixed, it will never change or disappear even when the DRO is switched off. Therefore, we can simply store the relative distance between this **REF** mark and the work piece datum (ABS zero position) in the DRO's memory. Then in case of power failure happen, after recovery from the power failure, we can use the **REF** datum memory function to re-install the store relative distance from the **REF** mark to re-establish the work piece datum (ABS zero position).

Example : to store the X axis work datum



Operation : DRO provides one of the best and most easy to use **REF** datum memory function in this industry.

There is no need to store the relative distance between the **REF** mark and your work piece datum, whenever you make any clear zsero, position preset or center find operating in ABS coordinate, this relative distance is automatically stored into the battery backup or ferrite core permantent memory, it will last so long as you don't change or update it, after you lost the work datum zero, you simply use the **recall 0** function to restore your work piece datum.

However, **you need to carry out the REF FIND function at least one time before you make any important machining**. This is to let the DRO know where the ref mark is located. **It is a very good practise to perform REF FIND function at least one time on every "power up" of the DRO (if possible),** If you plan to machine an important or serious job, **please remember to perform REF FIND at least one time before you start any important machining.** Only perform REF FIND one time is enough for every switch on of the DRO.

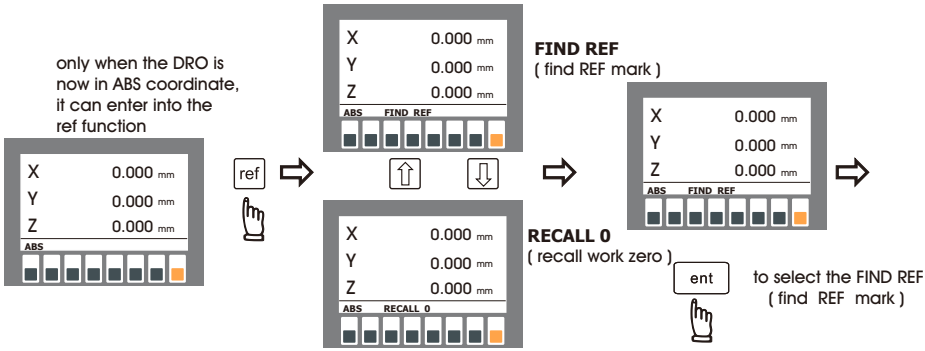
REF datum memory function - FIND REF

Function : In all basic functions of this DRO, such as dimension prset, zeroing, center find and etc., the DRO will automatically store the relative distance between the **REF** mark and the work piece datum (ABS Zero position), however, it is the most vital and basic that the DRO must know where the **REF** mark is located.

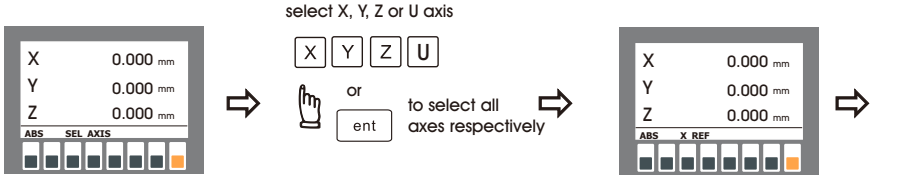
The REF FIND function is to let the DRO know where is the **REF** mark located. **If the operator do not perform this function at least one time after the power up of the DRO, then the DRO don't know where ther REF mark is located, and subsequently all the recall 0 function is totally useless and incorrect !**

Therefore, **it is a very good practise to <u>perform the REF FIND function at least one time on every power up</u> of the DRO, or before any important machining**, if you have perform the REF FIND once after the power up of the DRO, then you have no need to worry of losting your work piece datum no matter what power failure accident happen. You are for sure the work datum will never losted.

Step 1 : enter into the ref function, select the **FIND REF** (find **REF** mark)

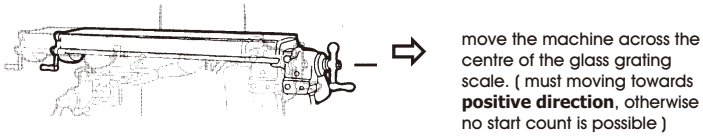


Step 2 : select the axis of which the REF mark needed to be found



Step 3 : move the machine across the center of the glass grating scale until the X axis digit display start run. (**please notice that the machine move must toward the positive direction**)

To improve the accuracy of the REF FIND, and avoid any backlash errors caused by old or inaccuracy machines, the REF FIND is designed to work on positive direction only

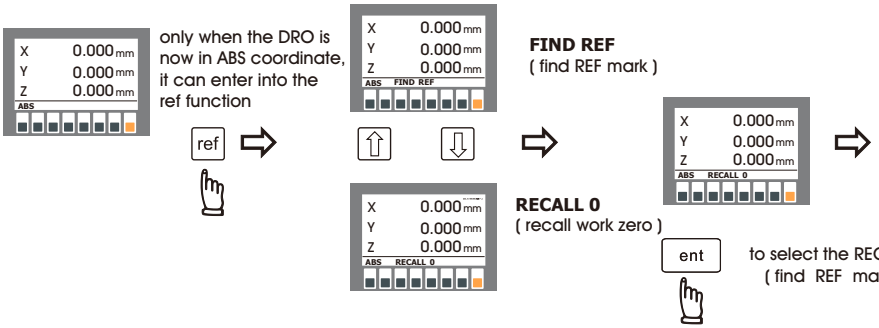


REF datum memory function - RECALL 0

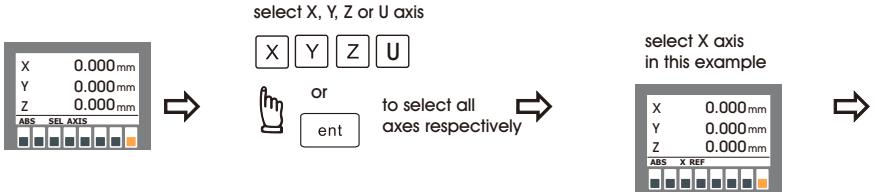
Function : after the lost of work piece datum due to power failure or switch off of the counter, the work piece datum can be recovered by **RECALL 0** function.

Please notice that if the operator do not perform the REF FIND at least one time before the establish of the work piece datum (ABS zero position), the RECALL 0 will give an error work datum position.

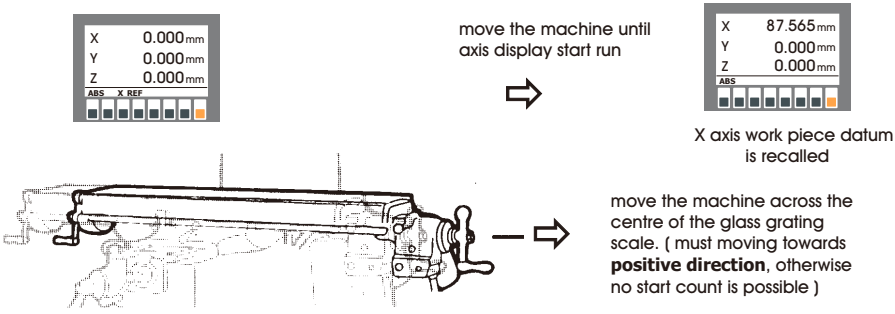
Step 1 : enter into the ref function, select the **RECALL 0** (recall work piece ZERO)



Step 2 : select the axis of which the axis of which the work piece datum needed to be recall



Step 3 : move the machine across the center of the glass grating scale until the X axis digit display start run. (**please notice that the machine move must toward the positive direction**)



To improve the accuracy of the RECALL 0, and avoid any backlash errors caused by old or inaccuracy machines, the RECALL 0 is designed to work on positive direction only

REF datum memory function - Power Failure Position

This Function is use in Absolute linear scale for the DRO ,after the lost of work piece datum due to power failure or switch off of the counter, the work piece datum can be recovered by **RECALL** function.

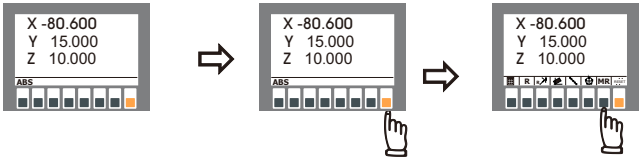
Please notice that if the operator do not perform the REF FIND before the establish of the work piece datum (ABS zero position), the RECALL 0 will give an error work datum position.

Step : Plug the VA series Absolute linear scale into the DRO connector , DRO will automatic load the Scale's Laser compensation data & show the scale serial number, ECF OK after finish loading then go to startup screen.

Find the REF first

Make a Movement about 10 mm to find the Absolute Zero point.

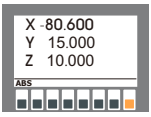
(Pay attention please All the axis of reference point must be found before you use this function, if you only want to find one axis REF first, you can press the ent key directly switch the axis that does not want to find the zero position into the incremental scale function, of course, we suggest you do not ignore to find the ABS zero position.)



Use X axis for example, after found the zero position

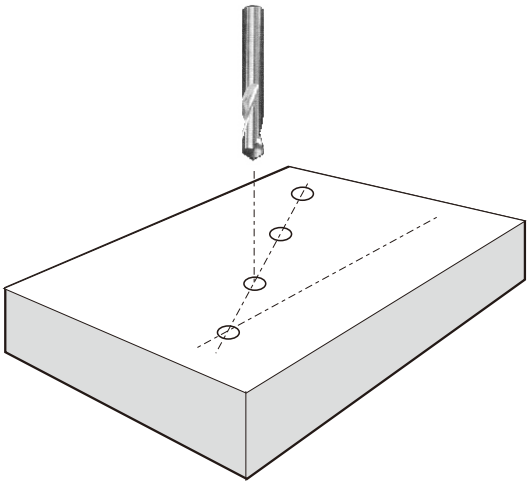
after the lost of work piece datum due to power failure or switch off of the counter, operator just only need to simple press " MR " button after find the REF, when show the message "PF. POINT", move the Axis reading to "0.000", then press enter, this position is the datum before power failure.

Notice: Before press the MR buttom Recall datum, operator must to find each axis of the REF,no need to worry about the position, DRO already save the position data during the power failure.



Now this position is power failure position

LHOLE - tool positioning for the Line Holes



LHOLE - tool positioning for Line Holes

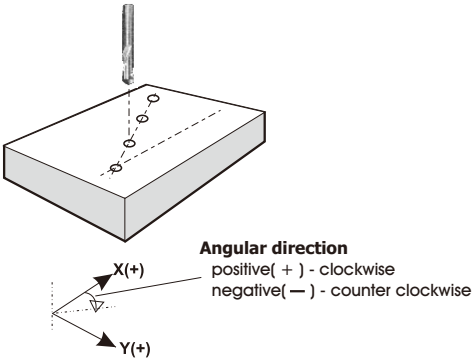
Function: DRO provides the LHOLE function for tool positioning for the holes drilling along a line, operator simply enter the machining parameters as per the step by step guide that shown on the DRO's message display, then the DRO will calculate all the holes position coordinate, and temporarily preset those holes' position to zero (0.000, 0.000). Operator simply move the machine until the X,Y axes displays = 0.000, 0.000, then the Line Holes' position are reached.

Machining parameters :

- Line angle (**LIN ANG**)
- Line distance (**LIN DIST**)
- No. of holes (**NO. HOLE**)

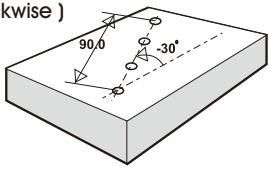
after the above machining parameters are entered into the DRO, the LHOLE function will temporarily preset all Line Holes' position = (0.000, 0.000)

operator can press ⇧ or ⇩ keys to select the Line Holes, and move the machine to display = (0.000, 0.000), then the Line Holes' position is reached.



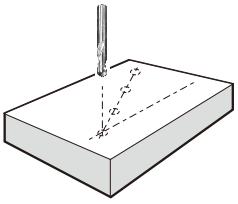
Example

Line angle (**LIN ANG**) ..... -30 degree (counter clockwise)
Line distance (**LIN DIST**) ..... 80.000 mm
No. of holes (**NO.HOLE**) 4



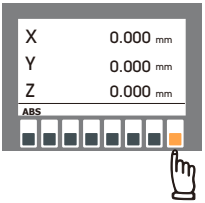
Step 1 : Posit the tool at the first Line Hole position.

The current tool position is used to be the first Line Hole position in the LHOLE function. Therefore, before entering into the LHOLE function, we must first posit the tool at the first Line Hole position.

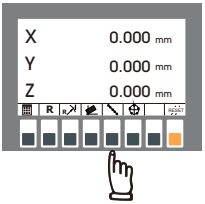


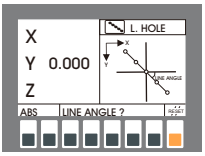
loacte the tool at the **first Line Hole** position

enter the **LHOLE** function



enter the Line angle (**LIN ANG**)

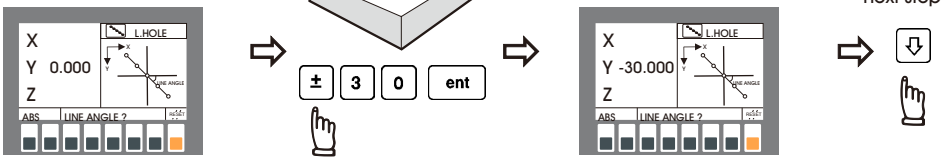




Step 2 : enter Line angle (**LIN ANG**)

Line angle (**LIN ANG**) = -30 degree

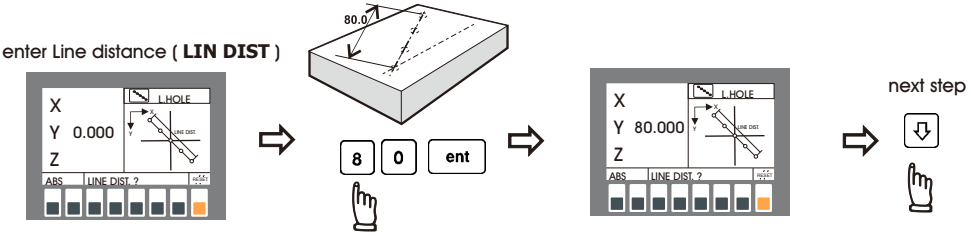
enter Line angle (**LIN ANG**)



Step 3 : enter Line distance (**LIN DIST**)

Line Distance（LIN DIST）=80 mm

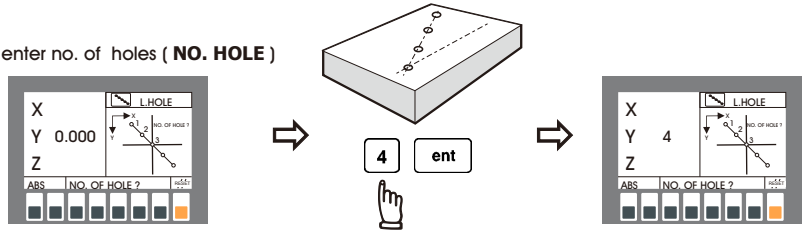
enter Line distance (**LIN DIST**)



Step 4 : enter no. of holes (**NO. HOLE**)

No. of holes (**NO. HOLE**) = 4

enter no. of holes (**NO. HOLE**)



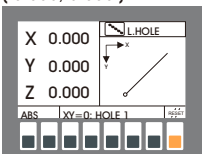
all LHOLE machining parameters already entered into the DRO ⇩ **to enter into the LHOLE machining mode**

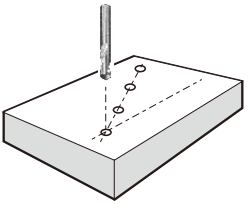
operator can press ⇧ or ⇩ to select the Line Hole's number, then move the machine to display = 0.000, then the Line Hole position are reached.

LHOLE - tool positioning for Line Holes

next Line Hole

move the machine to axes display
= (0.000, 0.000)

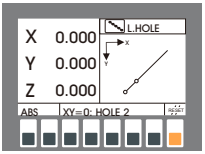


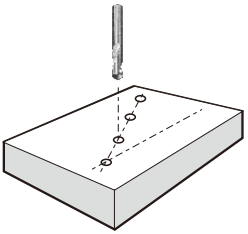


HOLE 2 = Line Hole no. 2

previous Line Hole

move the machine to axes display
= (0.000, 0.000)

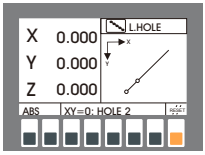




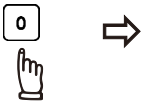
HOLE 1 = Line Hole no. 1

Anytime the operator want to check or verify if the DRO's LHOLE calculation correct or not, or want to temporarily exit the LHOLE function cycle (swap back to normal XYZ display), procedure are as follows :

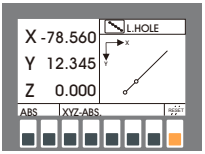
presently in **LHOLE** cycle



temporarily swap to normal
XYZ coordinate display

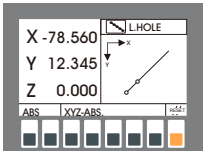


temporarily return to
XYZ coordinate display

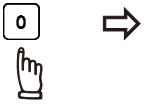


swap back to **LHOLE** function cycle to continue the Line Holes machining operation

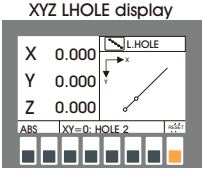
presently in the temporarily
XYZ coordinate display



swap back to **LHOLE**
function cycle

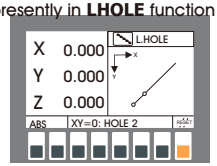


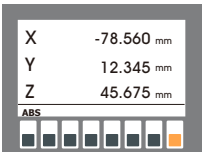
temporarily return to
XYZ LHOLE display



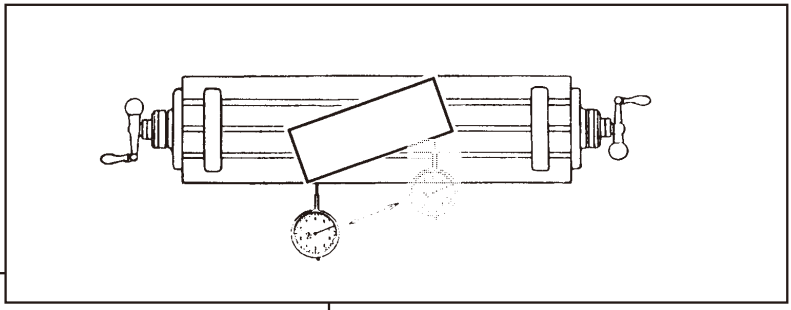
After the Line Holes machining operation completed, press RESET to exit from the LHOLE function cycle.

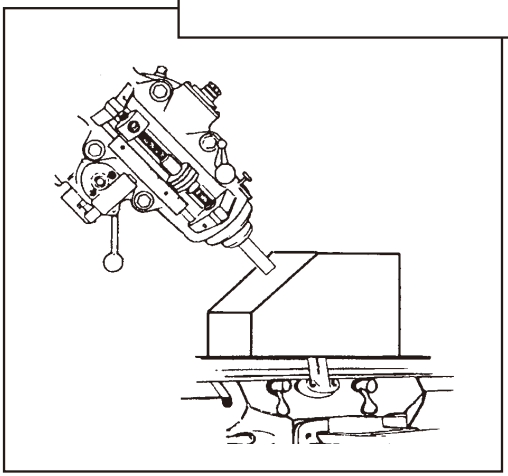
presently in **LHOLE** function cycle





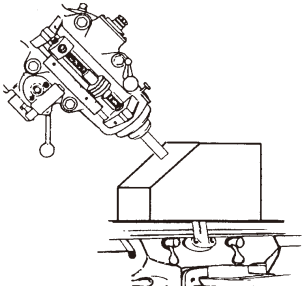
INCL - Inclined angle tool positioning





INCL - Inclined angle tool positioning

Function : In daily machining, it is quite common to machine an inclined surface, or datum the work piece at an inclined angle to X or Y axis.



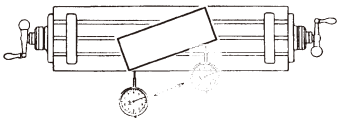
If the work piece is small or the accuracy requirement is low, operator can simply put the work directly onto an inclinded table or rotary table to machine the inclined work surface.

However, when the work piece is too big to be installed onto an inclined table or the accuracy requirement is high. The only solution is to calculate the machining positions using mathermatical method. It is very time consuming

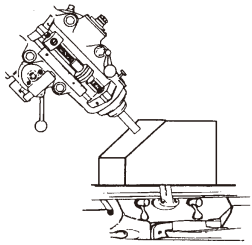
DRO provides an very easy to use INCL function to help the operator to posit the tool along an inclined angle.

application example of the INCL function :

A) XY plane - to accurately datum the work piece at an inclined angle



B) XZ/YZ plane - to machine an inclined surface (*only when 3 axis DRO is used*)

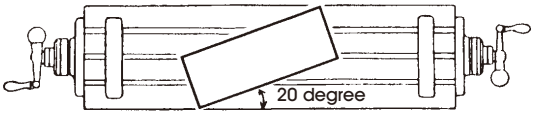


For lathe application, since the lathe have very different machine structure compared to milling machines, please refer to the chapter of "Supplement to Lathe application"

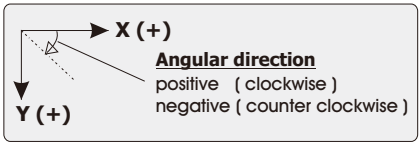
Example :

to accurately datum the work piece at 20 degress inclined from X axis

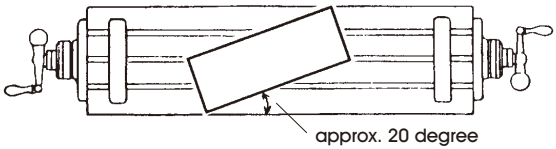
in this example, since the incline is counter clockwise, therefore, the angle is **-20 degree**



Angle convention

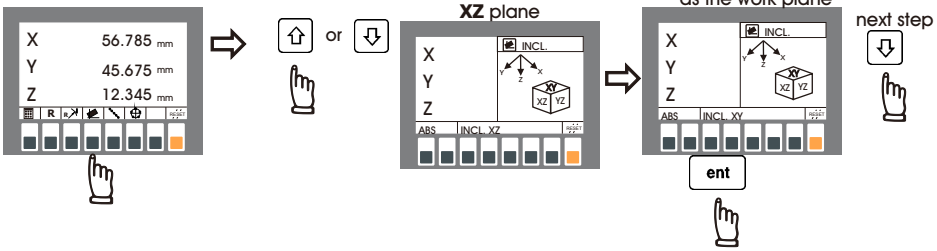


Operation procedure

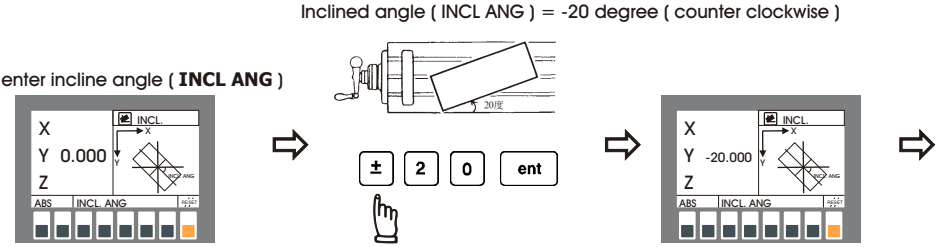


install the work piece onto an rotary table at approximately 20 degree as shown in the above diagram.

Step 1 : select the XY plane as the work plane (**INCL-XY**)



Step 2 : enter the incline angle (**INCL ANG**)



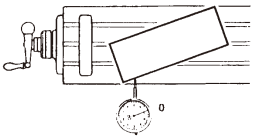
all the machining parameters already entered into the INCL function,

press to enter into the INCL machining function cycle

⇨ **The DRO is now entered into the INCL machining function cycle**

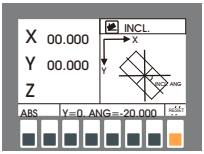
the datuming of the work piece at an inclined angle of 20 degrees is an iterative process, operations are as follows :

A) ZERO the dial imdicator at one end of the work piece



zero the X axis to redatum the X axis

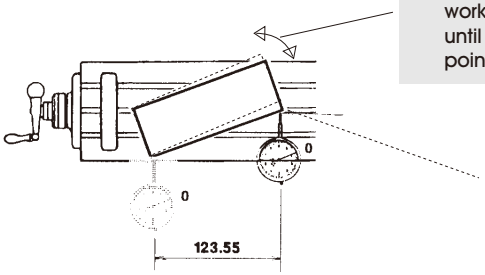
XY plane **INCL** machining mode display

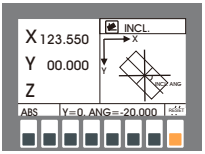


Y display is shifted left to remind the operator that the axis display zero position is preset to = **X** * TAN(**ANG**) operator simply move the machine to Y = 0.000, then the tool is accurately located at the inclined axis.

iterate between A) & B) until the alignment error is within the acceptable range

B) after move the machine to Y axis display = 0.000, then Y axis position is accuractely posited at the 20 degree, operator can fine tune the work piece's incline angle until the dial indicator pointing at ZERO



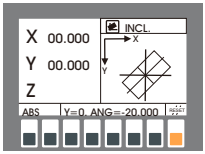


Since during the work piece's incline angle alignment, angular adjustment of any one end of the work piece will inevitably affect the position of the opposite end. Therefore, the above angular alignment fine tunning procedure A) & B) have to be carried oit iteratively until operator satify with the angular error of the alignment achieved.

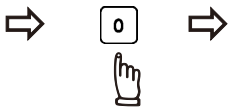
INCL - Inclined angle tool positioning

Anytime the operator want to check or verify if the DRO's INCL calculation correct or not, or want to temporarily exit the INCL machining mode display (swap back to normal XYZ display), procedure are as follows :

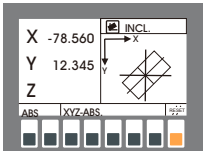
presently in **INCL** cycle



temporarily swap to normal XYZ coordinate display

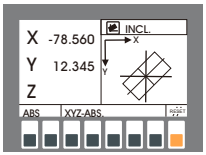


temporarily return to XYZ coordinate display

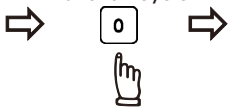


swap back to **INCL** machining mode display continue the INCL machining operation

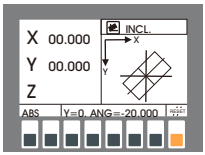
presently in the temporarily XYZ coordinate display



swap back to **INCL** function cycle

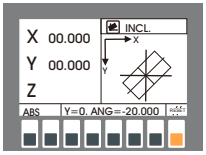


INCL machining mode display

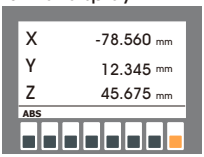


After the **INCL** machining operation completed, press RESET to exit from the INCL function cycle.

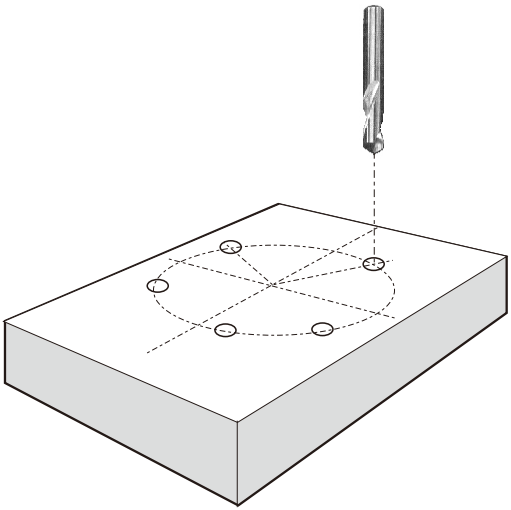
presently in **INCL** function cycle



exit **INCL** function, return to normal display



PCD - tool positioning for Pitch Circle Diameter

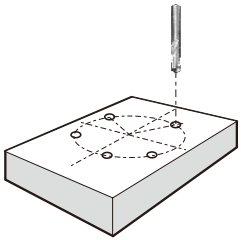


PCD - tool positioning for Pitch Circle Diameter

Function : DRO provides the PCD function for tool positioning for the drilling of the pitch holes along a Circle, operator simply enter the machining parameters as per the step by step guide that shown on the DRO's message display, then the DRO will calculate all the pitch holes position coordinate, and temporarily preset those holes' position to zero (0.000, 0.000).
Operator simply move the machine until the X,Y axes display = 0.000, 0.000,
then the Pitch Holes' position are reached.

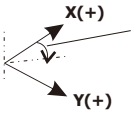
Machining parameters :

- Centre (**CENTRE**)
- Diameter (**DIA**)
- No. of holes (**NO. HOLE**)
- Start angle (**ST. ANG**)
- End angle (**End ANG**)



after the above machining parameters are entered into the DRO, the PCD function will temporarily preset all Pitch Holes' position = (0.000, 0.000)

operator can press ⇧ or ⇩ keys to select the Pitch Holes, and move the machine to display = (0.000, 0.000), then the Pitch Holes' position along a circle is reached.

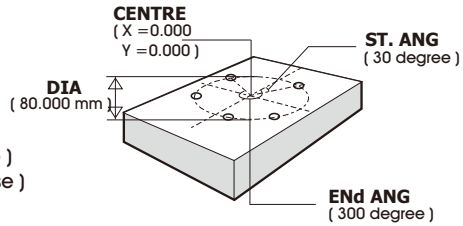


Angular direction
positive(+) - clockwise
negative(—) - counter clockwise

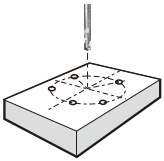
Example

Machining parameters :

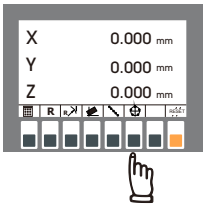
- Centre (**CENTRE**) ..... X=0.000, Y=0.000
- Diameter (**DIA**) ..... 80.000 mm
- No. of holes (**NO. HOLE**) ..... 5 holes
- Start angle (**ST. ANG**) ..... 30 degree (clockwise)
- End angle (**End ANG**) ..... 300 degree (clockwise)

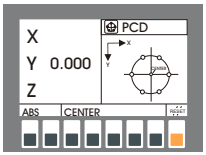


Step 1 : Setup the work piece datum (work piece zero), press ⊕ to enter into the **PCD** function



set up the work piece datum

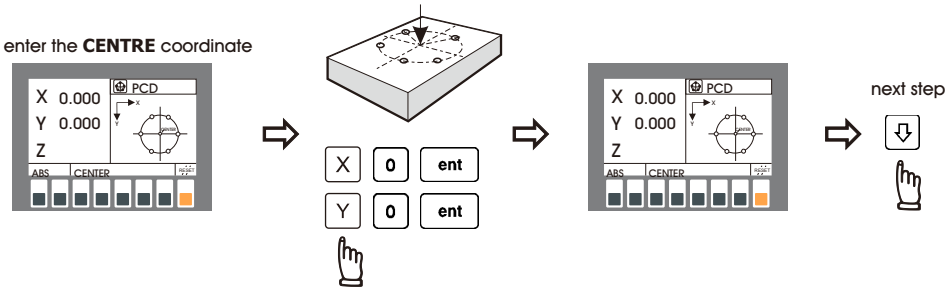




enter the **CENTRE** coordinate

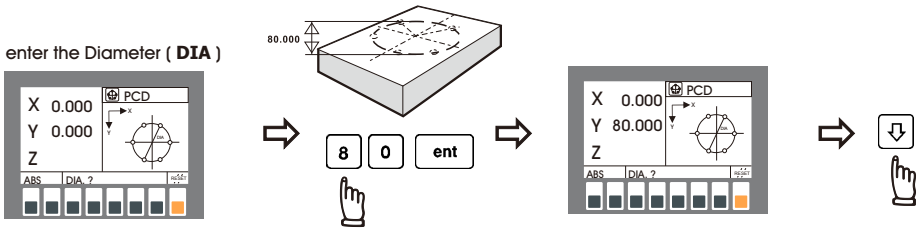
Step 2 : Enter the Centre coordinate (**CENTRE**)

centre coordinate (**CENTRE**) : X=0.000, Y=0.000



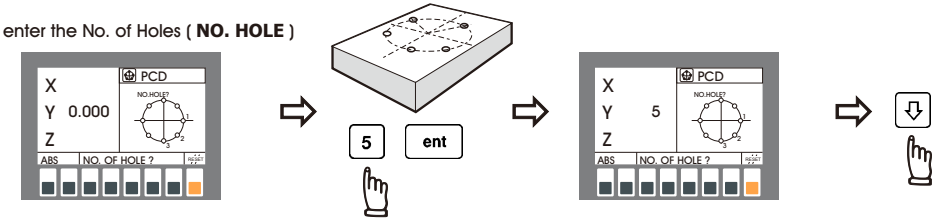
Step 3 : Enter Diameter (**DIA**)

Diameter (**DIA**) = 80.000mm



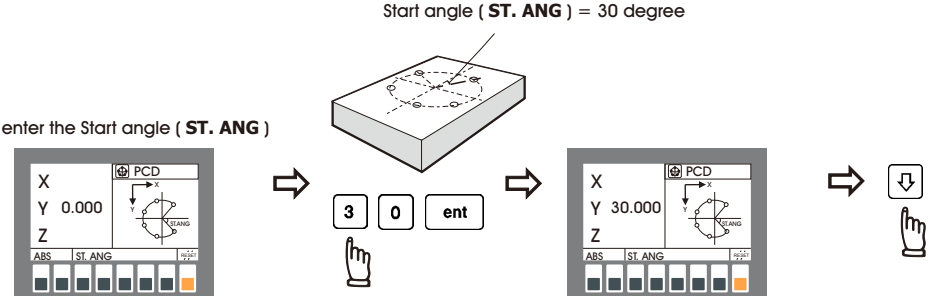
Step 4 : Enter No. of Holes (**NO. HOLE**)

No. of Holes (**NO. HOLE**) = 5



Step 5 : Enter the Start angle (**ST. ANG**)

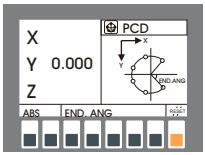
Start angle (**ST. ANG**) = 30 degree

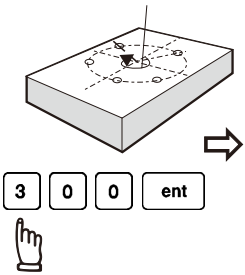


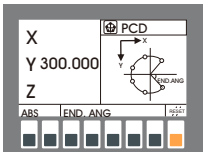
Step 6 : Enter the End Angle (**End. ANG**)

End angle (**ENd. ANG**) = 300 degree

enter the End angle (**ENd. ANG**)





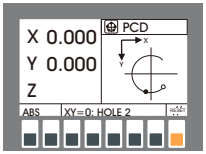


all PCD machining parameters already entered into the DRO ⇩ **to enter into the PCD machining mode**

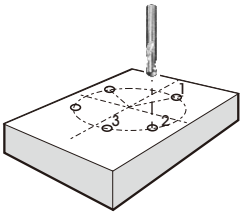
operator can press ⇧ or ⇩ to select the Pitch Hole's number, and move the machine to display = 0.000, then the Pitch Hole position is reached.

next Pitch Hole

move the machine to axes display = (0.000, 0.000)

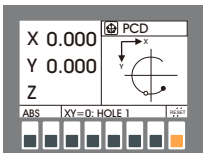


HOLE 2 = Pitch Hole no. 2

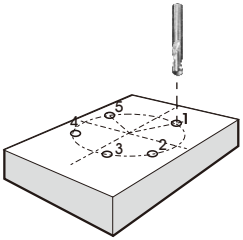


previous Pitch Hole

move the machine to axes display = (0.000, 0.000)



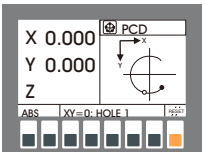
HOLE 1 = Pitch Hole no. 1



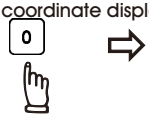
PCD - tool positioning for Pitch Circle Diameter

Anytime the operator want to check or verify if the DRO's PCD calculation correct or not, or want to temporarily exit the PCD function cycle (swap back to normal XYZ display), procedure are as follows :

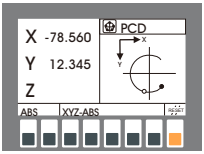
presently in **PCD** cycle



temporarily swap to normal XYZ coordinate display

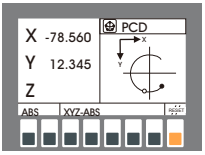


temporarily return to XYZ coordinate display

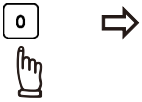


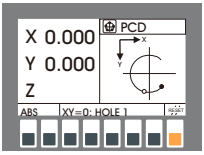
swap back to **PCD** function cycle to continue the PCD machining operation

presently in the temporarily XYZ coordinate display



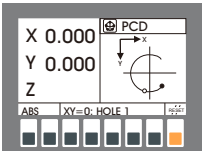
swap back to **PCD** function cycle



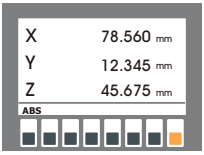


After all Pitch Holes machining operation completed, press RESET to exit from the PCD function cycle.

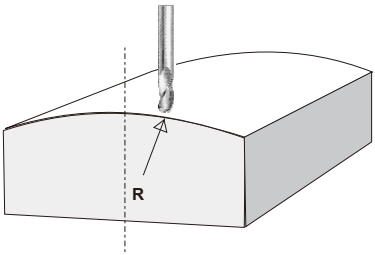
presently in **PCD** function cycle

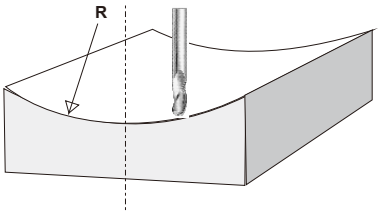


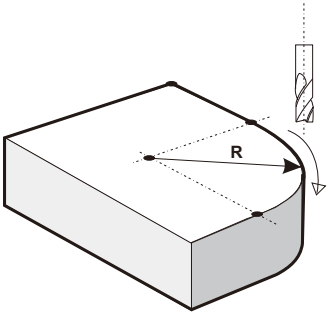
exit PCD function, return to normal display



Tool positioning for ARC machining







tool positioning for ARC machining

Function :

During daily machining, it is quite frequently to machine a round corner or arc surface, especially in mould making.

Of course, if the arc surface is complicated or quite a number of round corners have to be machined, or very precise arc or round corners needed to be machined, then CNC milling machine should be used.

But there is still a lot of the cases that only very simple arc surface or only one or two round corners needed to be machined. The pecision of those arc or round corners machining are not demanding at all (especially in mould making). If we do not have CNC machine in house, it is then more cost effective and time saving to carry out those relatively simple arc or round corners machining on your manual milling machine in house rather than sub-contract those CNC machining to an external sub-contractor.

In the past, many mould makers made their tool positioning calculation for ARC machining with a scientific calculator. But the process is time consuming and easily make mistake.

DRO features with a very easy to use tool positioning function for ARC machining which enable the operator to make simple ARC machining in shortest possible time. But be fore you make your decision to use the ARC function or to have your work piece to be machined in a CNC mcachine, please bear in mind that ARC function is only cost effective and time saving under following conditions.

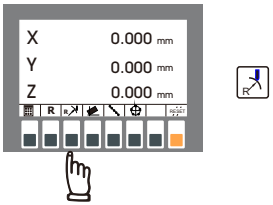
1) One Off Job

2) Only simple ARC surface or round corners to be machined.

ARC function groups

The ARC function of the ES-14 consists of only one program, this program have following two functions

R function



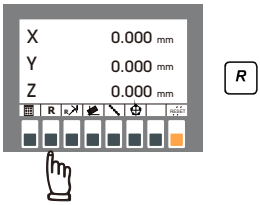
R function provides maximun flexibility in ARC machining, the ARC sector to be machined is defined by the coordinates of :

1) ARC centre ; 2) ARC Radius ; 3) ARC start point
4) ARC end point

Advantage :
- Very flexible, R function can machine virtually all kind of ARC, even the intersected ARCs

Limitation :
- Relatively a bit complicated to operate, operator need to calculate and enter the coordinate of ARC centre, start point and end point into the DRO.

Simplified R function



Since the ARC function of the DRO is aimed to machine only the very simple ARC or round corners, to make the operation really very simple to the operator, then DRO preset eight types of most frequently used ARC maching process, it make the operator virtually no need to make any calculation in the parameters entry.

Advantage :
- Very easy to use, operator just posit the tool at the ARC's start point, select the preset R type and ARC radius, then he can start machining the ARC right away.

Limitation :
- Restricted to only eight type of preseted ARC, cannot machine more complicated ARC such as interested ARC and etc..

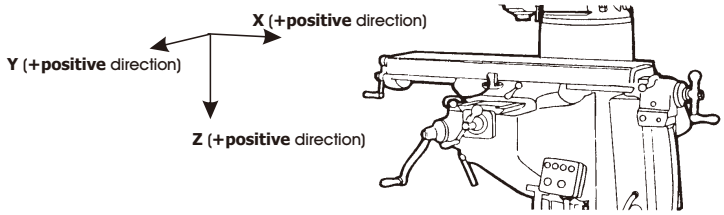
Understanding the Coordinate System :

For those operator whom don't have experience in CNC programming, or the first time user of the ES-14's R function, they may find that it is difficult to understand what is coordinate.

The coordinate is a pair of unmber which specify a position.

When using the ES-14's R function, it is necessary to enter the coordinates of ARC's center, start point, end point and etc.. to let the ES-14 knows the geometry of the ARC ro be machined.

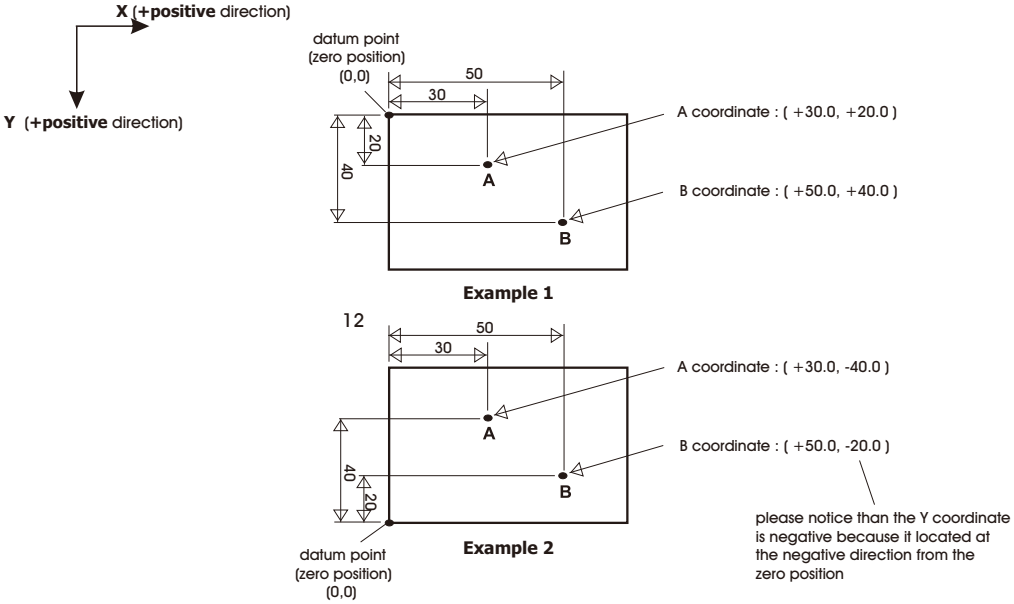
During installation of the ES-14, normally the service engineer will set the display direction same as the dial of the machine. For a typical knee type milling machine, the lead screw dial direction are as follows, therefore, DRO's display direction are also normally be set to the direction as per follows.

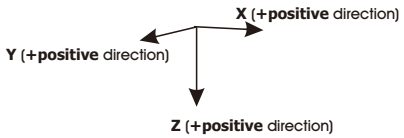


-- NOTICE --
Coordinate have signs to specify it's relative location from ZERO

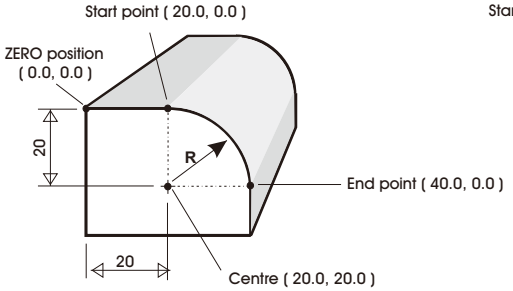
Coordinate Example

Coordinate is a pair of number which specify the distance from the datum point (ZERO position), the number can be either be positive or negative depend on it's relative direction from ZERO position.

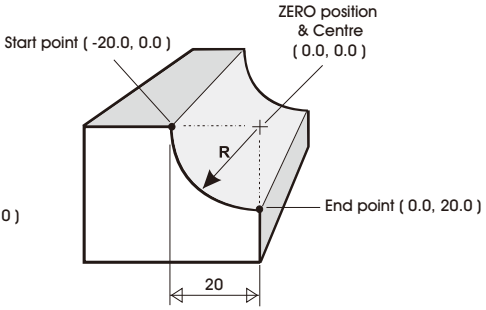




Example 3



Example 4

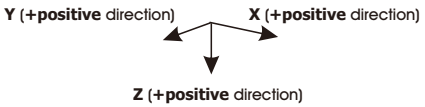


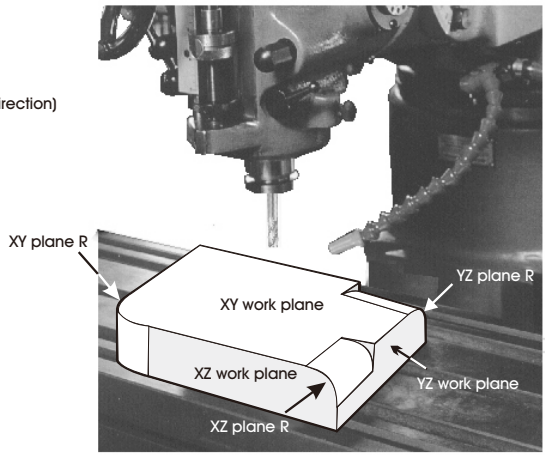
Work Plane :

The R function allows operator to machine R in XY, XZ and YZ plane as per following picture shows.

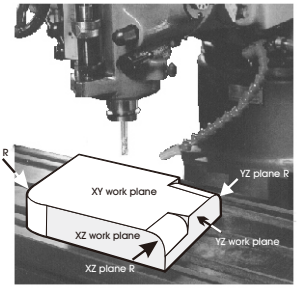
When only 2 axis DRO is used, it can calculate all the ARC tool positions on XZ & YZ work plane and assist the operator to posit the tool to the ARC machining points by a simulated Z position, the simulated Z position is showed on the message display of the DRO which shows the Z dial setting of the machine.

In the case of 3 axes DRO used, when the XZ or YZ plane ARC is to be machined, the X or Y axis machining positions along the ARC will follows the Z position of the machine automatically.

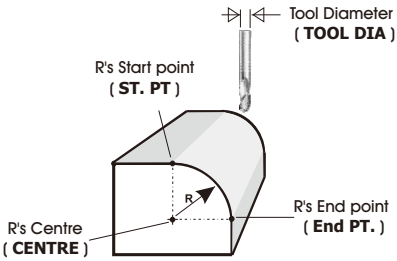




Following parameters needed to enter into the DRO for ARC machining.



1. Select the ARC work plane - **XY, XZ or YZ plane R**
2. R's Centre (**CENTRE**)
3. R's Radius (**R**)
4. R's Start point (**ST. PT.**)
5. R's End point (**End PT.**)
6. Tool Diameter (**TOOL DIA**)



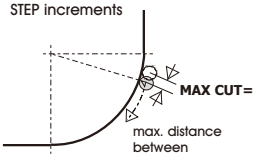
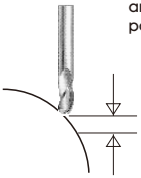
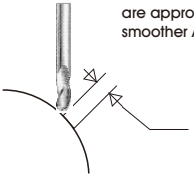
7. Select Tool Radius Compensation
(**R+TOOL**) or (**R-TOOL**)

	(**R+TOOL**)	(**R-TOOL**)
XZ / YZ plane **R**		
XY plane **R**		

8. Machining STEP increments (**Only when for 2 axes DRO is used or machining the XY plane R)**

Since in the 2 axes DRO, there is no Z axis available, in order to make the machining of XZ and YZ plane R possible, we need to simulate the Z axis position by mathematical method, also, we need to simulate the Z up/down increments by the UP or DOWN key press so that it can calculate the XZ / YZ arc machining position accordingly, this parameter is to specify how the Z position increment when UP or DOWN key is pressed.

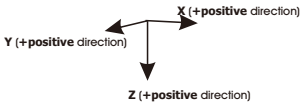
When machining the XZ and YZ plane R in 3 axes DRO, no need to enter this Machining STEP increments, it is because it calculate the X or Y machining positions and set those points to zero to guide theoperator to machine the ARC according to the current Z position. In case the Z position are out of the ARC's Z position range, an warning message [**r. OU LI**] - **R is outside the Z limit** is displaying on the Z axis of the DRO.

XY plane **R**	**XZ / YZ** plane **R** (**for 2 Axes DRO only, not for 3 Axes DRO**)	
For XY plane R, Max. distance between interoplated points is to be specified as the machining STEP increments  **MAX CUT=** max. distance between interpolated points	For XZ/YZ plane R, the Z STEP parameter is the Z step increments per UP or DOWN key press. The Z increment distance is fixed and specified by this parameter.  **Z STEP =** Fixed Z incremets per UP or DOWN pkey press	For XZ/YZ plane R, if the R MODE parameter of SETUP is selected to be MAX CUT, the DRO will calculate the Z step increments per UP or DOWN key press so that the Max. distances between each machining step are approximately the same for a smoother ARC machining.  **MAX CUT=** max. distance between interpolated points

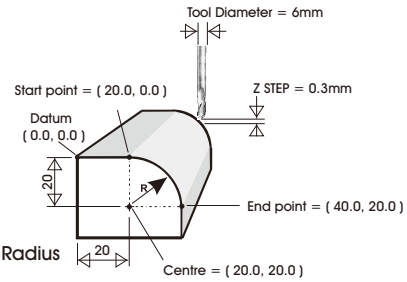
R function

Example :

To machine an XZ plane R as per shown in digram below



Following machining parameters have to enter into the DRO

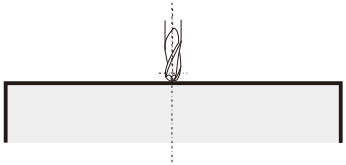


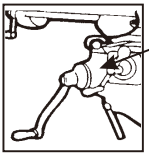
1. Select the XZ plane R ..... for 2 Axes DRO (**S.R - XZ**)
   ..... for 3 Axes DRO (**R -XZ**)
2. Centre (**XZ CENTR**) ..... X = 20.000 ; Z = 20.000
3. Radius (**R**) 20.000
4. Start point (**XZ ST. PT**) ..... X=20.000 ; Z = 0.000
5. End point (**XZ END P**) ..... X = 40.000 ; Z = 20.000
6. Tool diameter (**TOOL DIA**) 6.000
7. Tool Compensation - (**R+TOOL**) .... Actual ARC Radius = R + Tool Radius
8. Z increment per step (**Z STEP**) ..... 0.3mm (*for 2 Axes DRO only*)
   (*No Need for 3 Axes DRO*)

Operation Example

In case 2 Axes DRO is used, we must first reset the Z Dial to simulate the initial Z position at the ARC's start point

** Posit the Tool at start point of the ARC to be machined **



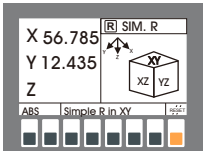


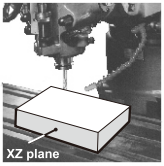
Set the Z axis Dial to ZERO (0.00)

**** **Only for 2 Axes DRO, not valid if a 3 Axes DRO is used** ***

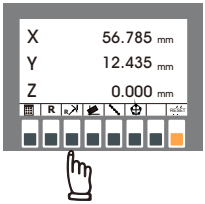
Step 1 : select work plane : XZ plane (**S.R - XZ**) for 2X DRO
(**R - XZ**) for 3X DRO

XY plane R

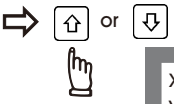




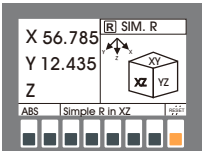
enter into R function



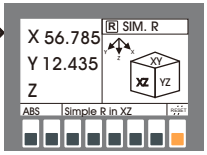
select work plane



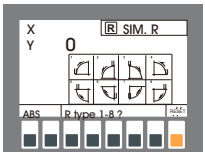
XZ plane R



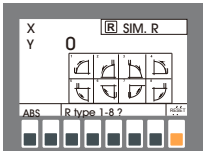
select XZ plane R

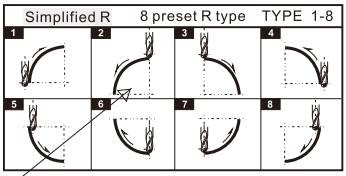


Step 2 : select preser R type (**TYPE 1 - 8**)

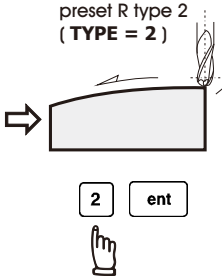


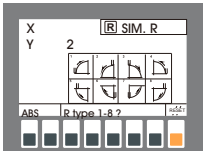
select **R** type (**TYPE 1-8**)





For the first part, select preset R type 2 (**TYPE = 2**)



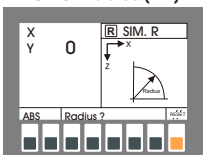


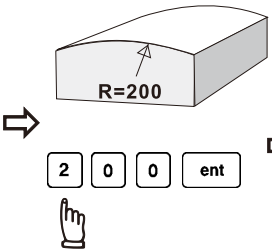
next step

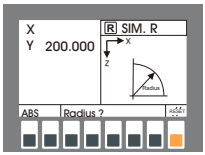
Step 3 : enter Radius(**R**)

Radius (R) = 200.000

enter Radius (**R**)





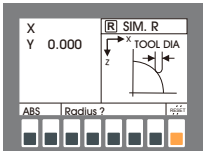


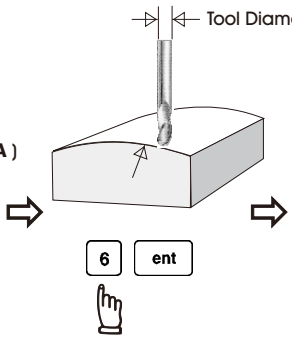
next step

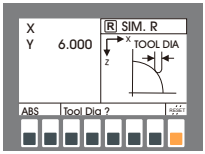
Step 4 : enter Tool Diameter (**TOOL DIA**)

Tool Diameter = 6.000

enter Tool diameter (**TOOL DIA**)







next step

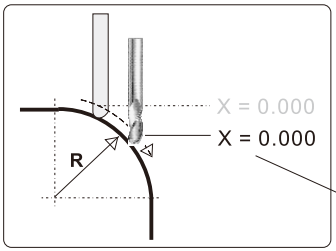
Simplified R Function - For 3 Axes DRO

If 2 axes DRO is used, please skip this page and go to the next two pages to continue the R parameters entry.

For 3 axes DRO, all the ARC parameter have been completely entered into the DRO, it will entered into the three axes ARC machining mode as per follows.

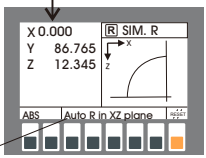
Three Axes ARC machining mode operation :

In the three axes ARC machining operation, the DRO will calculate the ARC profile according to the current Z axis position, and perset the X axis (in case XZ plane R) or Y axis (in case of YZ plane R) to 0.000 to guide the operator to machine the ARC profile.



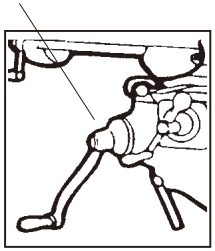
In this example, XZ plane R is selected, therefore, move the X axis until X display = 0.000 then the tool is posited on the ARC curve.

The display will **shift left** to signify it is not a normal coordinate display



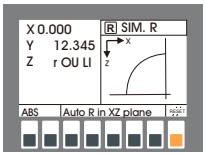
Since the X axis is preset automatically with the Z movement, therefore, we call it AUTO R - XZ plane

The operator can make Z axis increment to machine the ARC according to the surface finish they required.



In case the opeartor posit the Z axis outside the R curvature, the DRO will display " **r OU LI** " - [**R Outside Z Limits**] in the Z axis display

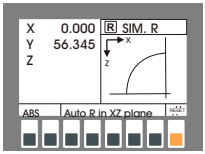
the Z position located out of the ARC range



Simplified R Function - For 3 Axes DRO

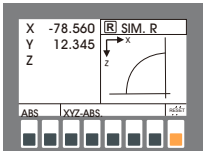
Anytime the operaor want to check or verify if the DRO's ARC calculation correct or not, or want to temporarily exit the ARC function cycle (swap to normal XYZ display). Operation proceduer are as follows :

presently in ARC cycle



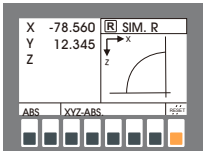
temporarily **swap** to normal XYZ coordinate display

temporarily return to XYZ coordinate display



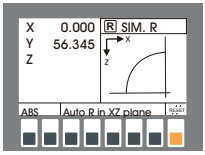
swap back to ARC machining cycle to continue the R machining process

Presently in the temporarily XYZ coordinate display



swap back to ARC machining cycle

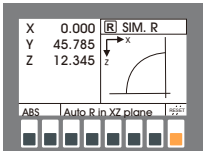
return to ARC function cycle

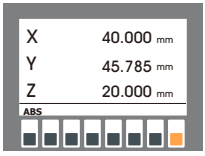


Quit from the ARC machining Cycle

Afte the ARC machining operation is completed , to quit from the ARC function cycle, press the ARC buttion key again.

presently in ARC function cycle



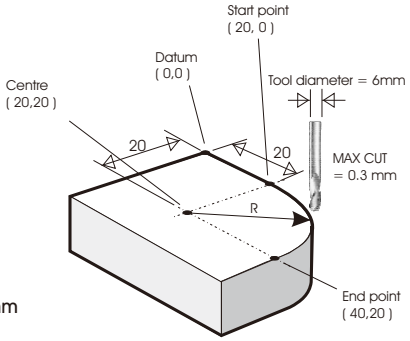


R function - XY plane ARC

Example :

To machine an XY plane R as per shown in digram below

Following machining parameters have to enter into the DRO



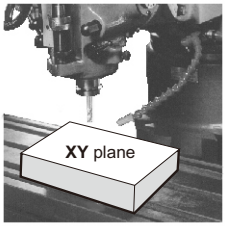
1. Select the XY plane R ..... (**R -XY**)
2. Centre (**XZ CENTR**) ..... X = 20.000 ; Y = 20.000
3. Radius (**R**) 20.000
4. Start point (**ST. PT**) ..... X = 20.000 ; Y = 0.000
5. End point (**ENd PT**) ..... X = 40.000 ; Y = 20.000
6. Tool diameter (**TOOL DIA**) ..... 6.000 mm

7. Tool Compensation - (**R+TOOL**) .... Actual ARC Radius
   = R + Tool Radius

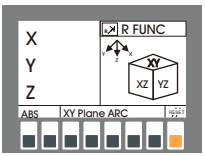
8. Max cut between interpolated points (**MAX CUT**) 0.3mm

Operation Example

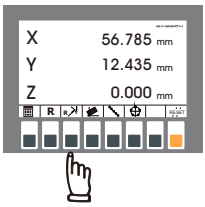
Step 1 : select work plane : XY plane R : (**R - XY**)



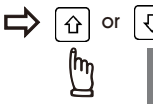
XY plane R



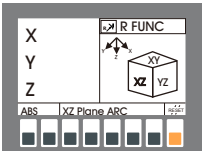
enter into R function



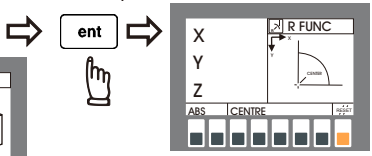
select work plane



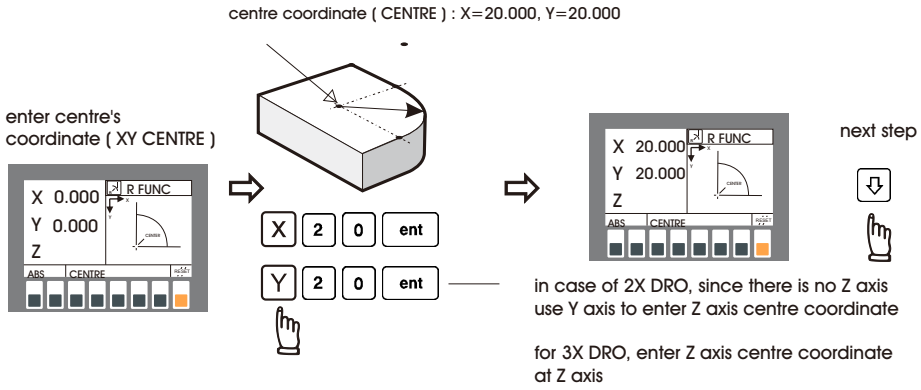
XZ plane R



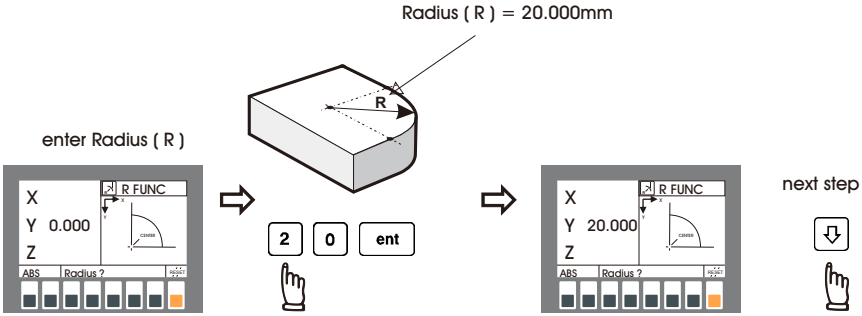
select XY plane R



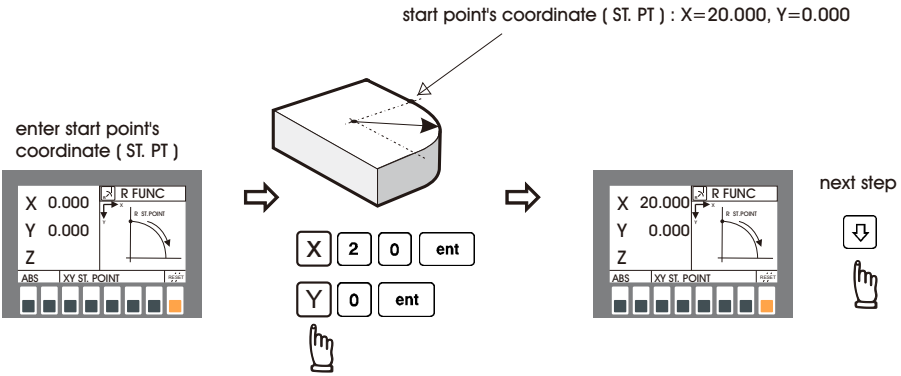
Step 2 : enter the Centre's coordinate (XY CENTR)



Step 3 : enter the Radius (R)



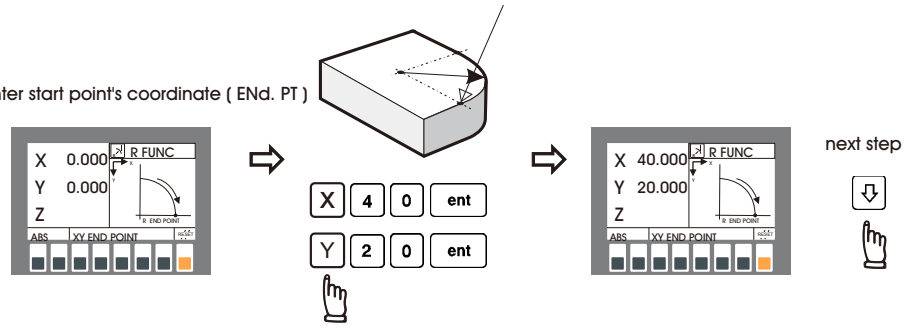
Step 4 : enter the Start point's coordinate (**ST. PT**)



Step 5 : enter the End point's coordinate (**ENd. PT**)

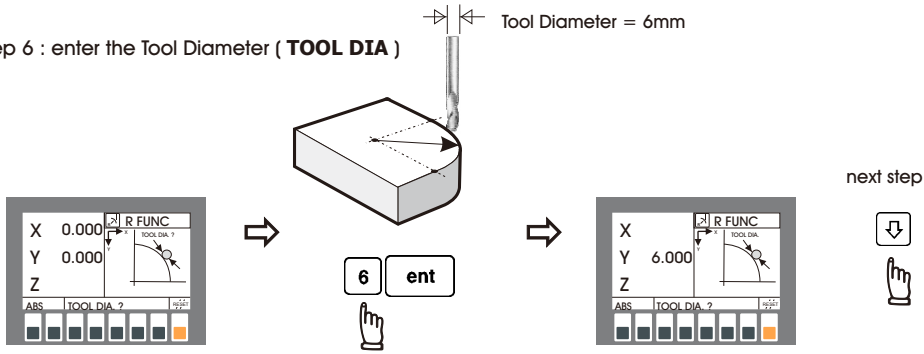
End point's coordinate (End. PT) : X=40.000, Y=20.000

enter start point's coordinate (ENd. PT)

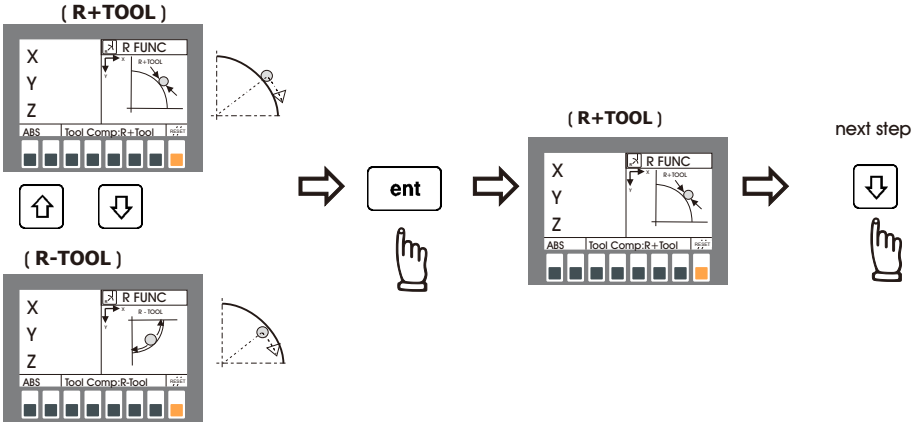


Step 6 : enter the Tool Diameter (**TOOL DIA**)

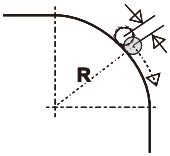
Tool Diameter = 6mm



Step 7 : select tool compensation direction (**R+TOOL**)

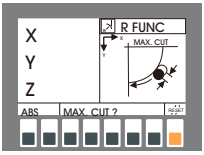


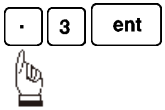
Step 8 : enter Max. Cut between interpolated points (**MAX CUT**)

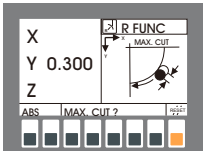


MAX CUT = 0.3mm

enter the Maximum Cut
(**MAX CUT**)





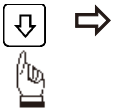


All R function machining parameters have already been entered into the DRO

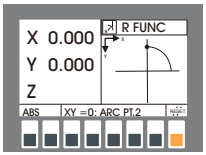
to enter into ARC machining mode

Operator can  or  to select the interpolated points along the ARC curvature, then move the machine to XY displays = 0.000, 0.000 to arrive at the curvature position.

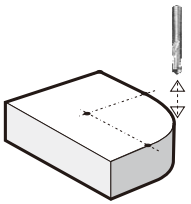
next **R** point



move the machine to XY displays
= (0.000, 0.000)

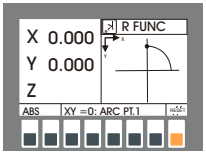


PT. 2 = interploated point No. 2

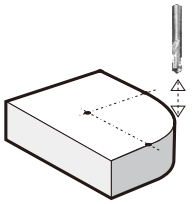


previous **R** point

move the machine to XY displays
= (0.000, 0.000)



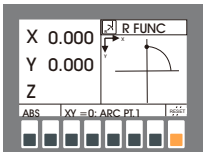
PT. 1 = interploated point No. 1



R function - XY plane ARC

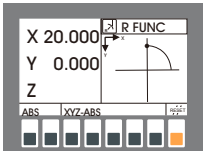
Anytime the operaor want to check or verify if the DRO's ARC calculation correct or not, or want to temporarily exit the ARC function cycle (swap to normal XYZ display). Operation proceduer are as follows :

presently in ARC cycle



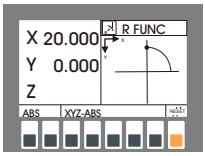
temporarily **swap** to normal XYZ coordinate display

temporarily return to XYZ coordinate display



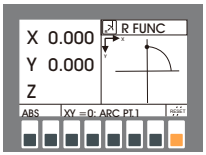
swap back to ARC machining cycle to continue the R machining process

Presently in the temporarily XYZ coordinate display



swap back to ARC machining cycle

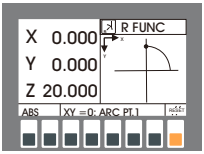
return to ARC function cycle

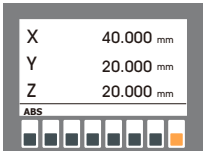


Quit from the ARC machining Cycle

After the ARC machining operation is completed , to quit from the ARC function cycle, press the RESET button key again.

presently in ARC function cycle



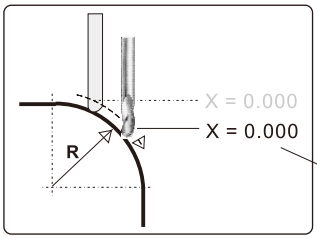


If 2 axes DRO is used, please skip this page and go to the next two pages to continue the R parameters entry.

For 3 axes DRO, all the ARC parameter have been completely entered into the DRO, it will entered into the three axes ARC machining mode as per follows.

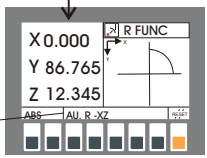
Three Axes ARC machining mode operation :

In the three axes ARC machining operation, the DRO will calculate the ARC profile according to the current Z axis position, and perset the X axis (in case XZ plane R) or Y axis (in case of YZ plane R) to 0.000 to guide the operator to machine the ARC profile.



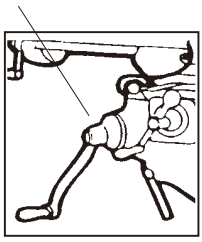
In this example, XZ plane R is selected, therefore, move the X axis until X display = 0.000 then the tool is posited on the ARC curve.

The display will **shift left** to signify it is not a normal coordinate display



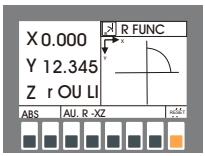
Since the X axis is preset automatically with the Z movement, therefore, we call it AUTO R - XZ plane

The operator can make Z axis increment to machine the ARC according to the surface finish they required.



In case the opeartor posit the Z axis outside the R curvature, the DRO will display " **r OU LI** " - [**R Outside Z Limits**] in the Z axis display

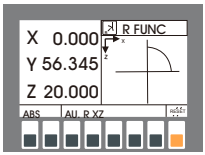
the Z position located out of the ARC range



R function - For 3 Axes DRO

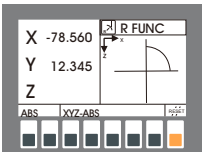
Anytime the operaor want to check or verify if the DRO's ARC calculation correct or not, or want to temporarily exit the ARC function cycle (swap to normal XYZ display). Operation proceduer are as follows :

presently in ARC cycle



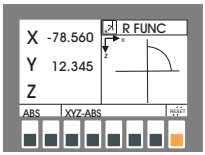
temporarily **swap** to normal XYZ coordinate display

temporarily return to XYZ coordinate display



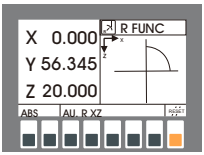
swap back to ARC machining cycle to continue the R machining process

Presently in the temporarily XYZ coordinate display



swap back to ARC machining cycle

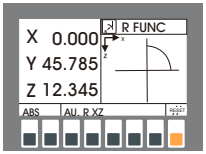
return to ARC function cycle

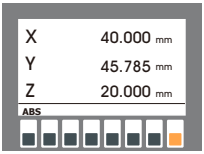


Quit from the ARC machining Cycle

After the ARC machining operation is completed , to quit from the ARC function cycle, press the RESET button key again.

presently in ARC function cycle





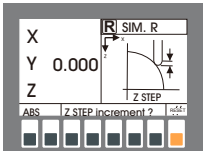
The following procedure are for 2 axes DRO, not valid for 3 axis DRO.

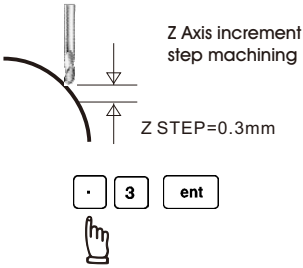
Step 8: enter the Z increment per step machining

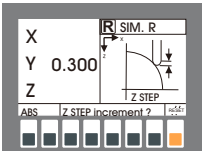
This DRO provides two options on the Z increment per UP or DOWN key press, Operator can enter their selection in the R. MODE menu of the DRO's SETUP procedure.

Option 1 : Fixed Z step (**Z STEP**)
under this option, the Z increment per step machining is fixed, since the ARC's curvature is vary with their Z position, operator have to use their experience to select different Z STEP increment during the ARC machining to get optimal and fastest machining.

enter Z step increment
(**Z STEP**)

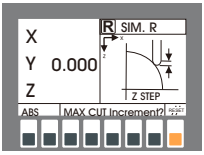


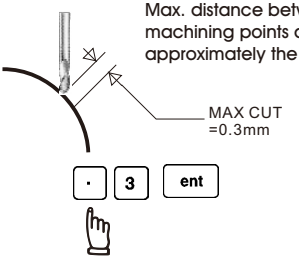


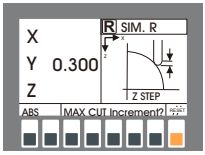


Option 2 : Maximum Cut (**MAX CUT**)
under this option, the DRO will calculate the best possible Z increment per step machining according to the curvature of the ARC, to make the interpolated point approximately equal to the MAX CUT entered

enter the Maximum Cut
(**MAX CUT**)







All R function machining parameters have already entered into the DRO, press the DOWN key to enter into two axis ARC machining mode

⇨ ⇩ to enter into two axes ARC machining mode

since two Axis DRO do not have Z Axis therefore, the DRI use UP / DOWN keys ⇧ and ⇩ to simulate the Z axis movement

⇧ - simulate Z axis move UP one step

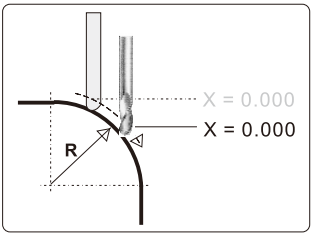
⇩ - simulate Z axis move DOWN on step

before starting the ARC machining in two axes ARC machining mode, please make sure the tool is posited at the ARC starting point and Z axis dial is set to ZERO (0.00)

Two Axes ARC machining mode operation :

During the XZ and YZ plane R machining, it is necessary to accurately posit the Z axis to obtain a precise Z position. However, there is no Z axis in two axis DRO. Therefore in order to guide the operator easily posit the Z axis during the ARC machining. DRO use the unused axis display to display the Z dial turn number and Z dial reading to guide the operator to posit the Z axis.

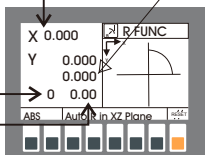
At the beginning of the ARC machining, the DRO will start and assume the Z axis dial at zero position with the tool posited at the starting point of the ARC, then press UP or DOWN key once to simulate Z axis move up or down the Z axis for one step, the corresponding Z dial turn number and Z dial reading will display on the unused axis. Operator just need to move the Z axis according to the dial reading display on this axis, then the correct Z axis height is reached.



Move the X axis until display = 0.000
then the tool is posited on the ARC curvature

The display will **shift left** to signify
it is not normal coordinate display

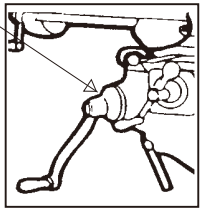
Z axis simulated height



move the Z axis
according to the dial
setting displayed
on Y axis

Z dial turn number

Z dial reading

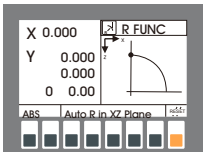


Display for 'Two axes ARC machining mode"

R function - For 2 Axes DRO

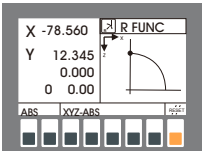
Anytime the operaor want to check or verify if the DRO's ARC calculation correct or not, or want to temporarily exit the ARC function cycle (swap to normal XYZ display). Operation proceduer are as follows :

presently in ARC cycle



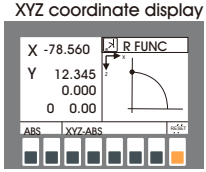
temporarily **swap** to normal XYZ coordinate display

temporarily return to XYZ coordinate display



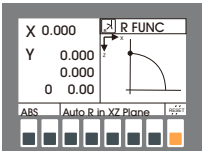
swap back to ARC machining cycle to continue the R machining process

Presently in the temporarily XYZ coordinate display



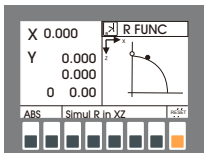
swap back to ARC machining cycle

return to ARC function cycle

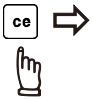


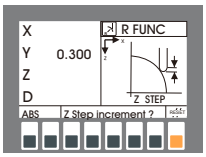
If fixed **Z STEP** option is choosed in the R MODE menu of SETUP , the **Z STEP** increment can be changed anytime during the ARC machining

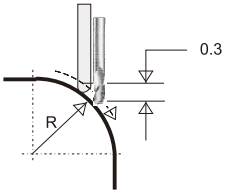
currently **Z STEP** increment = **0.3mm**



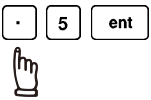
change the **Z STEP**



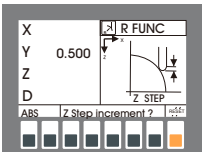


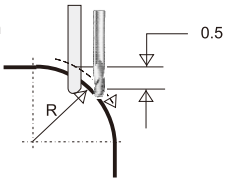


change **Z STEP** increment = **0.5mm**



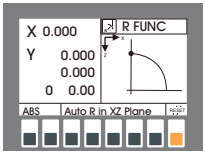
now the **Z STEP** increment = 0.5mm



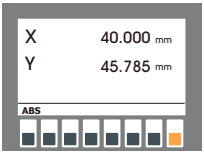


Quit from the ARC machining Cycle

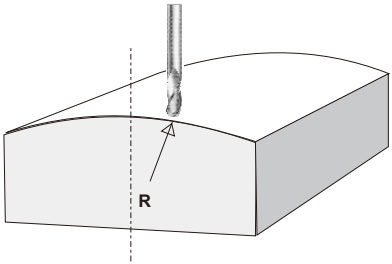
After the ARC machining operation is completed , to quit from the ARC function cycle, press the RESET button key again.

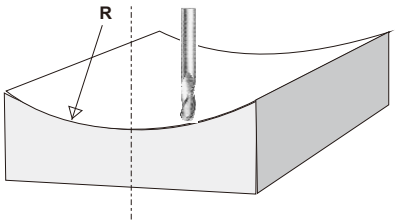


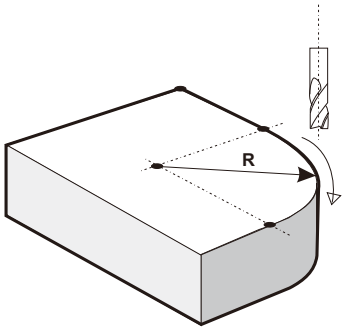
presently in ARC function cycle



Simplified R function





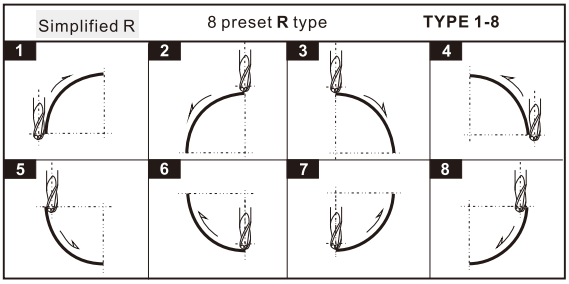


Simplified R Function

Function : The R function of the DRO is designed to machine simple ARC, in fact, after concluded from years of our experience, we found that over 95% of the case, most of our customers just use this DRO to machine very very simple ARC. Most of our customers found that the entry of machining parameters in the ARC function is quite complicated to them.

Therefore, it comes to an requirement that we must provide a very simple to use R function, so that the operator can handle it in a very very short time.

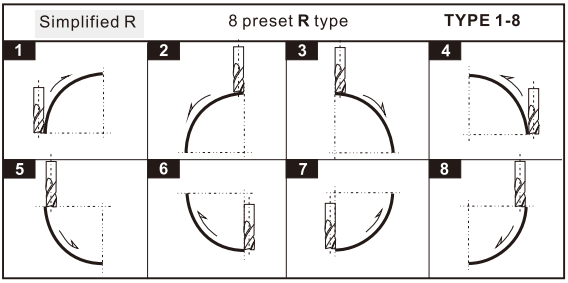
After a work survey, we found that in majority of cases, only eight type of simple ARC are normally used in the ARC machining. Therefore, this DRO have built in those 8 types of commonly used ARCs, operator just select the type of R they needed to machine, input the Radius, tool dia, and (for the 2 axes DRO, the Z axis increment per machining step), then they can start the R machining right away.

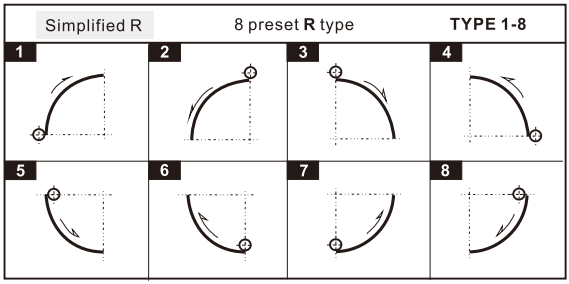


using ball nose mill cutter
to machine XZ/YZ plane R

using 4 flute End Mill
to machine XZ/YZ plane R

please notice that when using
flat end mill to machine R,
as we are actually using the
tool's sharp corner for cutting,
therefore the TOOL DIA must
be set to 0.000



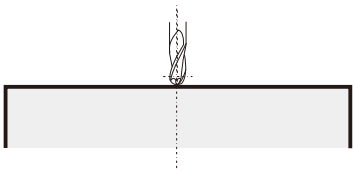


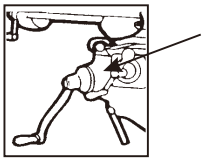
Using two flute (SLOT DRILL)
for XY plane R

Simplified R Function

In case 2 Axes DRO is used, we must first reset the Z Dial to simulate the initial Z position at the ARC's start point

** Posit the Tool at start point of the ARC to be machined **

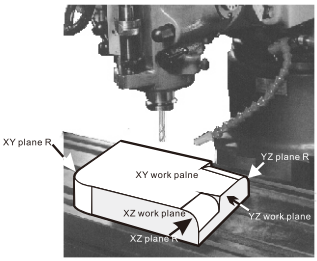




Set the Z axis Dial to ZERO (0.00)

****** Only for 2 Axes DRO, not valid if a 3 Axes DRO is used *****

Following parameters needed to enter into the DRO for simplified R machining

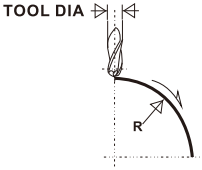


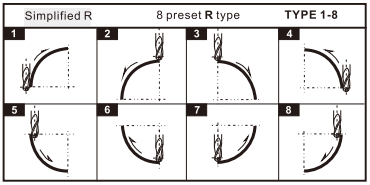
1. Select the work plane - XY, XZ or YZ plane R

2. Select the R type (**R type**) - Type 1 to 8

3 Input R's Radius (**R**)

4. Enter to Tool Diameter (**TOOL DIA**)

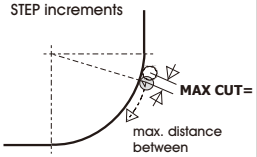
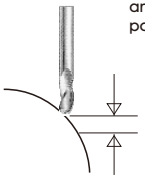
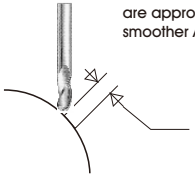




5. Machining STEP increments (**Only when for 2 axes DRO is used or machining the XY plane R)**

Since in the 2 axes DRO, there is no Z axis available, in order to make the machining of XZ and YZ plane R possible, we need to simulate the Z axis position by mathematical method, also, we need to simulate the Z up/down increments by the UP or DOWN key press so that the DRO can calculate the XZ / YZ arc machining position accordingly, this parameter is to specify how the Z position increment when UP or DOWN key is pressed.

When machining the XZ and YZ plane R in 3 axes DRO, no need to enter this Machining STEP increments, it is because the DRO can calculate the X or Y machining positions and set those points to zero to guide the operator to machine the ARC according to the current Z position. In case the Z position are out of the ARC's Z position range, an warning message [**r. OU LI**] - **R is outside the Z limit** is displaying on the Z axis of the DRO.

XY plane **R**	**XZ / YZ** plane **R** (**for 2 Axes DRO only, not for 3 Axes**)	
For XY plane R, Max. distance between interoplated points is to be specified as the machining STEP increments  **MAX CUT=** max. distance between interpolated points	For XZ/YZ plane R, the Z STEP parameter is the Z step increments per UP or DOWN key press. The Z increment distance is fixed and specified by this parameter.  **Z STEP =** Fixed Z incremets per UP or DOWN pkey press	For XZ/YZ plane R, if the R MODE parameter of SETUP is selected to be MAX CUT, the DRO will calculate the Z step increments per UP or DOWN key press so that the Max. distances between each machining step are approximately the same for a smoother ARC machining.  **MAX CUT=** max. distance between interpolated points

(Notice:Simple R function example please turn to page 41-44)

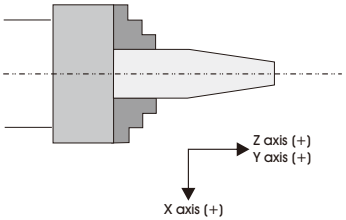
Application supplement for LATHE

This supplementary chapter of the manual is only valid for the setting of **DRO TYPE = LATHE** in the **SETUP** menu.

This is an supplementary chapter to the normal operation manual, it gives more realistic operational examples for the DRO operation for LATHE application.

Lathe application - Axes notation and common practise

Function : Since the structure of Lathe machine and also the machining process in lathe is very different from common vertical or horizontal machines like milling, boring or drilling machines.



The digram on the Left showing a very typical installation of DRO in lathe and showing the name of the axes.

It is a common practise (no technical reason, just commonly the people like to do it that way or they used to do it that way) that :

1. X axis display is installed in the cross axis of the lathe.

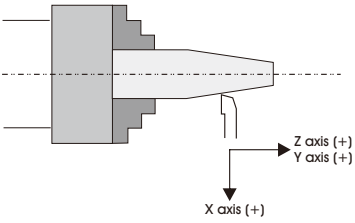
2. Y and/or Z axes displays are installed in the longitudinal axis of the lathe. In the case for a two axes DRO, the Y axis is normally used as the longitudinal axis display as per shown in the diagram.

It is very common that two scales are installed in the longitudinal axis direction of the lathe, let's say Y and Z axes of an 3 axes DRO's display, in such case, operator want to have the summing of these two axes when during the machining, but when during the setup of the work piece datum, he will natually prefer to have these two axes in their own position display seperately.

The difficult mission for us when we design the summing function of this DRO is different people have different practise, some of them want to put the longitudinal axis in the X axis display display, but some of them even want to put two scales in the cross axis, especially for the application in a big lathe !! So it make the axes display have to be summed very confused.

At the end, this DRO provides a flexible temporarily summing display for both the YZ or XZ axes display, so that the operator can choose the axes they want to have summing display.

For the INCL function, because of the machine structure, and the installation of scales is not very defined, therefore, it is useless to offer INCL function in XZ or YZ plane because the lathe machining process only a 2D process. Therefore INCL function in the XY plane is enough for the lathe application.



Also, the Y axis should be the main axis in the INCL function in Lathe.

Therefore, please notice that the INCL plane in Lathe have following difference compared to other application.

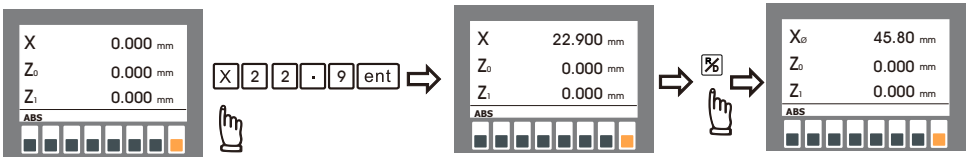
1) **No need to select INCL plane, the DRO assumes all INCL operation in XY plane only.**

2) **The Y axis is the main axis during the INCL machining mode, the X axis zero position display will be presetted by the DRO along an inclined angle wherever Y axis is posited.**

Basic Functions - Dimension Preset

Purpose : Set the current position for that axis to an entered dimension

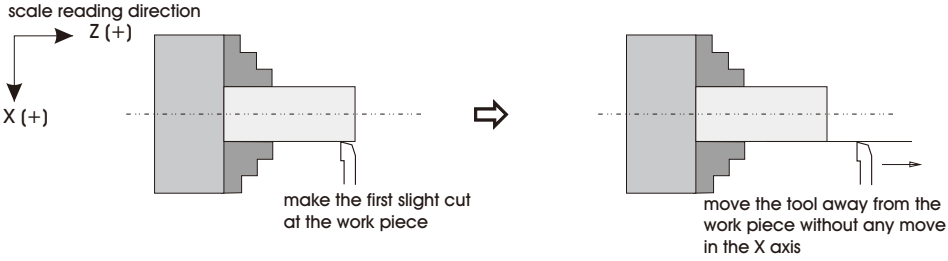
Example : To set the current X axis position to be 45.800mm



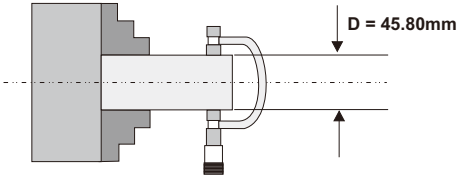
Application tips for lathe : The diemension preset function provides a very convenience way to monitor your cross feed in lathe maching. Let's assume the DRO's X axis is installed as per the diagram below.

a) Set the X axis display to be the DIA display in the SETUP mode

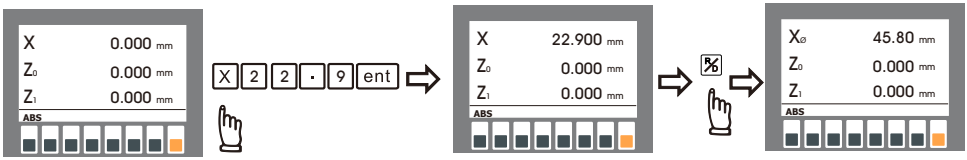
b) Make a slight first cut at the work piece along the Z axis, after finish this first cut, move the tool away from the work piece along the Z axis, it is important that don't move the X axis at all in order to keep the X axis position right at the cutting position of making this first slight cut.



c) Measure the work piece by a caliper. (i.e, The measured diameter of the work piece is 45.80mm)



d) Enter this measured diameter into the DRO by dimension preset function.

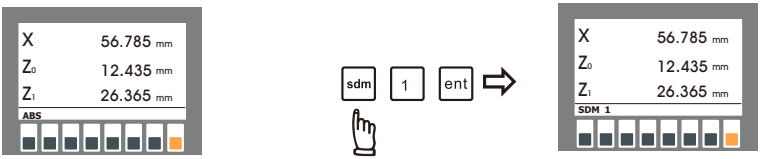


e) Since the X axis tool position is now at the position of making the first slight cut, and it is the measured diameteral reading of the work piece, if we preset this dimension into the DRO, then from now on, whatever dimension shown on the X axis display, it is the actual diameteral dimension of the work piece.

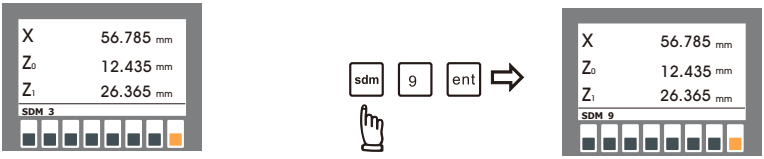
Basic Functions - 9 tools datum memory

Purpose : This DRO offer 9 tools memory, it is offered as a supplement of ABS/INC coordinates. For the lathe that have a high repeatability tool turret, this function provides a very quick ways to memory the tool tips offset, so that the operator don't have to datum the tool tips position whenever tool change is made.

Example 1 : Currently in INC display coordinate, to switch to TOOL 1 display coordinate



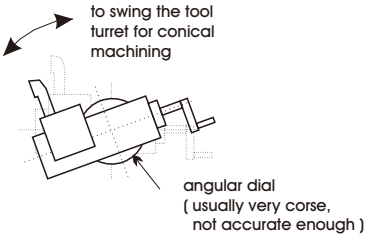
Example 2 : Currently in TOOL 3 display coordinate, to switch to TOOL 9 display coordinate

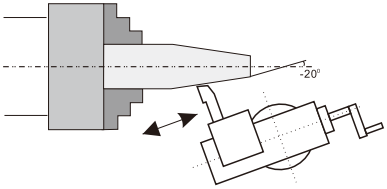


INCL function - To swing the tool turret on the cross slide for conical machining

To machine a conical work piece as per the diagram shown, it is the most basic that we have to swing the cross slide of the tool turret accurately at the incline angle that we have to machine.

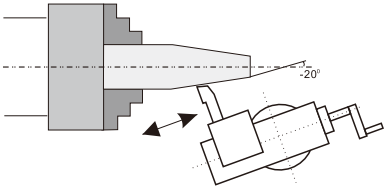
Most of the tool turret on the lathe have an angular dial allow the operator to swing the tool turret to the angle that required. However, this angular dial is usually very corse and not accurate enough.



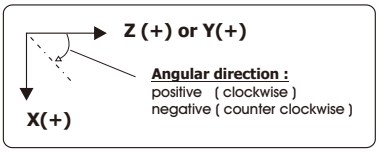


Conical Machining on Lathe

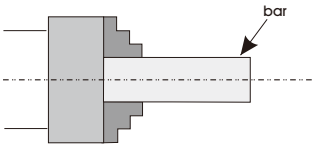
Example : To accuractely swing the tool turret on the cross slide by -20 degree, so that the operator can make to conical machining as per following diagram shown.



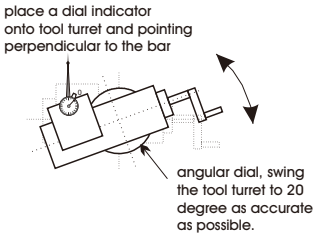
Directional Notations



Step 1 : Swing the tool turret to 20 degree accordining to the angular dial of the tool turret, swing it to the angle of 20 degree as accurate as possible, remove the cutting tool and put a dial indicator onto the tool turret, install a bar on the lathe as shown.

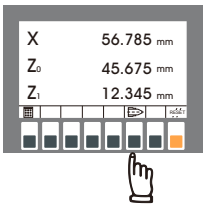


install a bar on the lathe

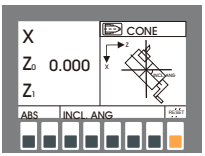


Step 2 : Enter into the INCL funcion

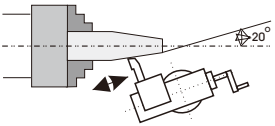
enter to the **INCL** function



enter incline angle (**INCL ANG**)

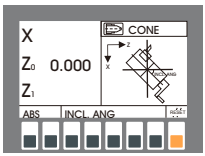


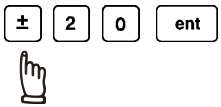
Step 3 : enter the incline angle (**INCL ANG**)

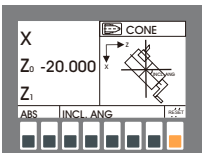


Inclined angle (INCL ANG)
= -20 degree (counter clockwise)

enter incline angle (**INCL ANG**)







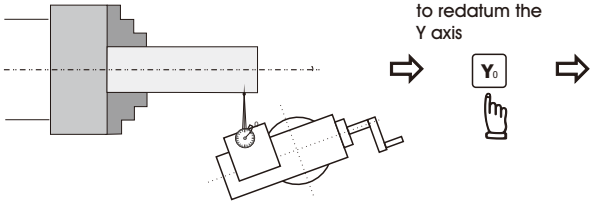
all the machining parameters already entered into the INCL function,

press ⇩ to enter into the INCL machining function cycle

The DRO is now entered into the INCL machining function cycle

The swinging of the lathe's tool turret on the cross slide to an inclined angle of 20 degrees accurately is an iterative process, operator have to repeat the steps (Step 4 to Step 8) below until he think he already achieved the accuracy required, operation are as follows.

Step 4 : place the dial indicator against the bar, and ZERO both the DROs and the dial indicator

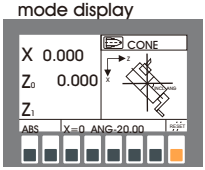


posit the dial at the work piece (bar),

1) ZERO the dial indicator

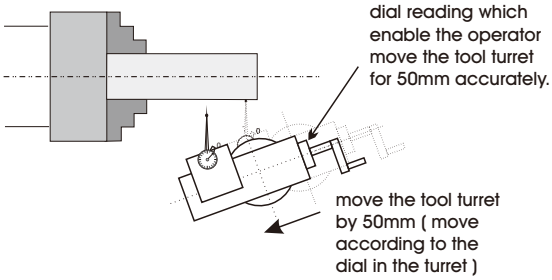
2) ZERO both X & Y axis by pressing Y0

XY plane **INCL** machining mode display



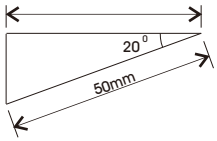
X display is shifted left to remind the operator that the axis display zero position is preset to = **Y** * TAN(**ANG**) operator simply move the machine to X = 0.000, then the tool is accurately located at the inclined axis.

Step 5 : move the tool turret to a distance (let's take an example of 50mm) as per shown in following digram, calculate the Y axis (Z axis) travel by the COS (angle) of the moved distance along the tool turret

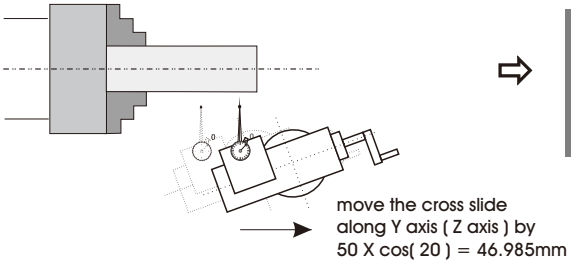


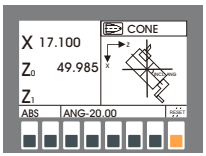
Y axis (Z axis) movement

50 X COS(20) = 46.985mm

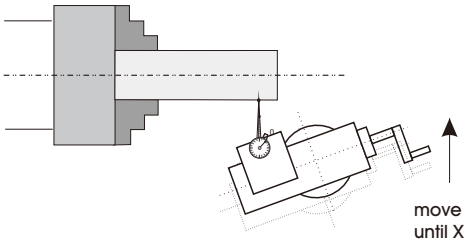


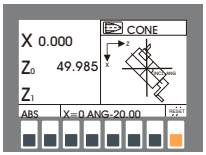
Step 6 : move the cross slide (Y axis or Z axis) to the COS distance of the tool turret movement as per diagram shown in below , (in this example = 50 X COS(20) = 46.985mm)



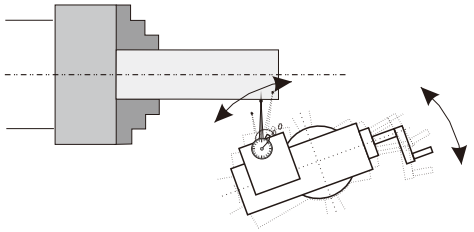


Step 7 : Move the lathe's cross slide along X axis until the X axis DRO display = 0.000





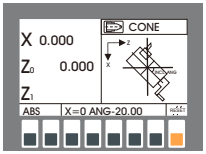
Step 8 : Swing the tool turret until the dial indicator pointing to ZERO



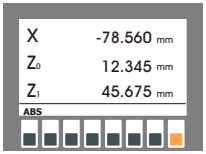
The angular alignment of the tool turret is an iteratively process, operator may have to repeat the Step 4 to Step 8 again to fine tune the incline angle, until there is no swinging of the tool turret is needed in the Step 8, which means the best possible alignment accuracy have been achieved.

Step 9 : The tool turret have been aligned to the inclined angle of 20 degree accurately, press RESET to exit the INCL function cycle, put off the dial indicator and replace with lathe cutter tool for conical machining.

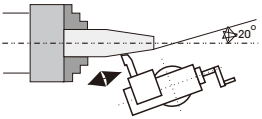
presently in **INCL** function cycle



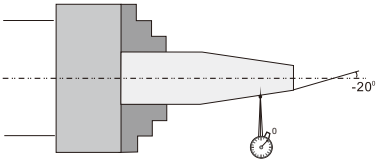
exit **INCL** function, return to normal display



replace the dial indicator with a lathe cutter tool for conical machining



Example : The INCL function of this DRO can be used in making the measurement of a conical work piece as per the diagram shown.

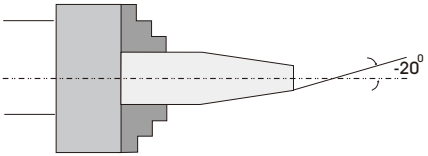


Cone measurement

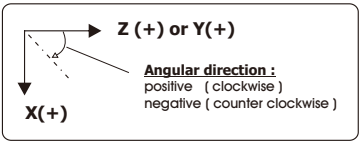
Normally, the tool turret of the cross slide of the lathe can be swing to a inclined angle for conical machining, the angular alignment of the tool turret have been demonstarted in the other chapter of this manual.

After the conical measurement, we can also use the INCL function to make measurement on the machined work piece. This DRO offers cone measuerment function for the ease of cone angle measuerment to help the operator to obtain a accurate and faster conical process.

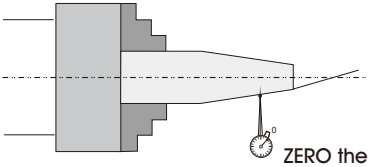
For example, to verify the conical work piece that have been machined at an inclined angle of 20 degree on the XZ plane as shown in the following diagram.



Directional Notations



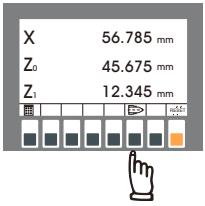
Step 1 : Place the dial indicator against the conical work piece as per following diagarm shown, and ZERO the dial indicator



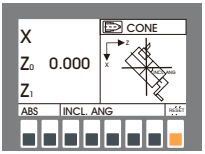
ZERO the dial indicator

Step 2 : Enter into the INCL funcion

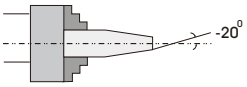
enter to the **INCL** function



enter incline angle (**INCL ANG**)

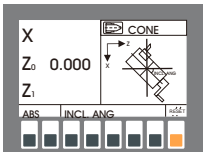


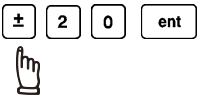
Step 3 : enter the incline angle (**INCL ANG**)

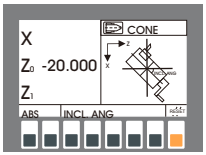


Conical angle (INCL ANG)
= -20 degree (counter clockwise)

enter incline angle (**INCL ANG**)





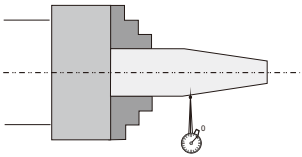


all the machining parameters already entered into the INCL function,

press ⇩ to enter into the INCL machining function cycle

The DRO is now entered into the INCL machining function cycle

Step 4 : ZERO the dial indicator at one end of the work piece, and also ZERO the DRO by pressing **Y0**

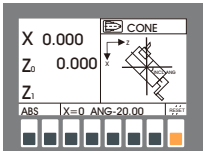


ZERO the dial Indicator

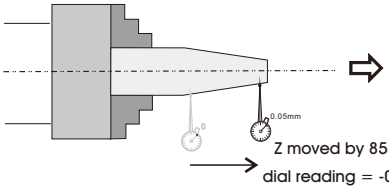
zero the Y axis to redatum the Y axis

Y0

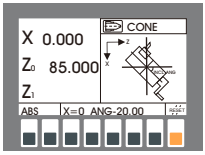
XY plane **INCL** machining mode display



X display is shifted left to remind the operator that the axis display zero position is preset to = **Y** * TAN(**ANG**) operator simply move the machine to X = 0.000, then the tool is accurately located at the inclined axis.



Z moved by 85.0mm
dial reading = -0.05mm



since the X axis zero position will follow the Z axis position at the incline angle of ANG (-20 degree in this example)operator just move the X axis display to = 0.000, it is then at a highly accurate -20 degree inclined to the Z axis.

The dial indicator shows -0.05mm
at Z axis display = 85.000mm,
when X axis is moved to X = 0.000mm.

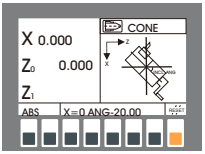
Then the **inclined angle error is -0.05mm**

Just mark down the reading in the dial indicator, it is the **inclined angle error**.

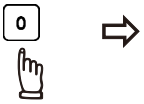
INCL function - cone measurement

Anytime the operator want to check or verify if the DRO's INCL calculation correct or not, or want to temporarily exit the INCL machining mode display (swap back to normal XYZ display), procedure are as follows :

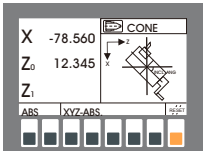
presently in **INCL** cycle



temporarily swap to normal XYZ coordinate display

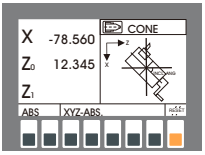


temporarily return to XYZ coordinate display

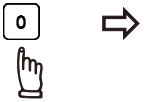


swap back to **INCL** machining mode display continue the cone measurement operation

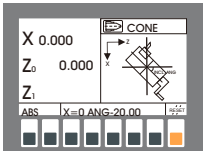
presently in the temporarily XYZ coordinate display



swap back to **INCL** function cycle

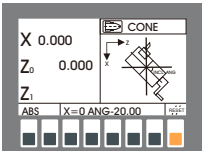


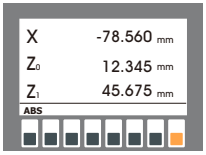
INCL machining mode display



After the **INCL** machining operation completed, press RESET to exit from the INCL function cycle.

presently in **INCL** function cycle





Diametral / Radius Display swap function (**In Lathe operation mode only**)

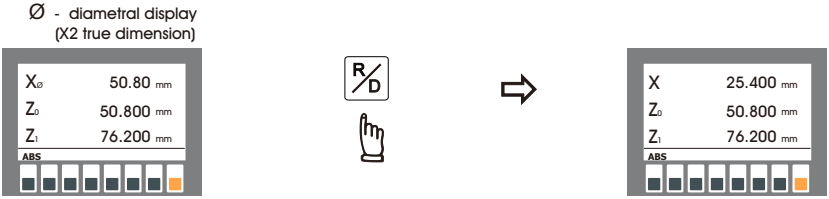
Purpose : Switches between Diametral and Radius (true dimension) display for X axis

In case the DRO is set in lathe operation mode, the X axis can be set to Diametral (X2 true dimension) or Radius (true dimension) display by simply press the R/D function button.

The mode of display will be store into the memory of the DRO. It will restore the current mode of display even the DRO have been switched off.

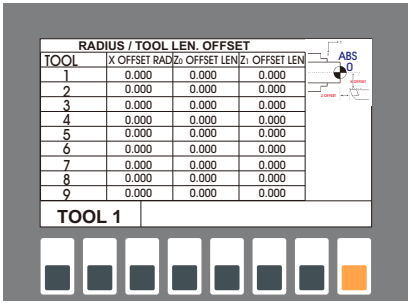
Example 1 : Currently in Radius display, to swap to Diametral display

Example 2 : Currently in Diametral display, to swap to Radius display

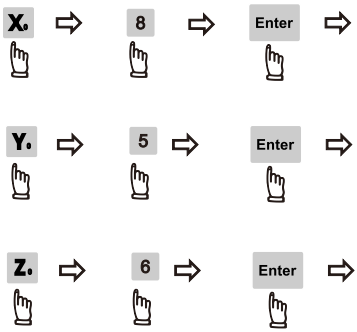


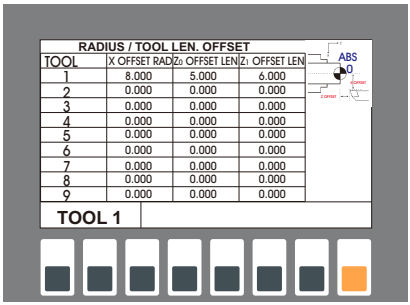
RADIUS / TOOL LEN. OFFSET menu is designed to allow user to swap the lathe tools convenient and efficient.

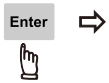
Press about 1 second

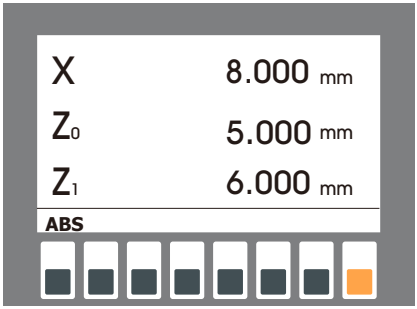


Example 1:









Operator can press  or  to select machine tool for machining.

A) Parameters Reset

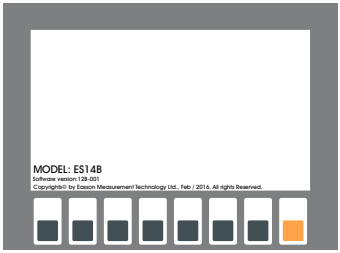
Each DRO is configured as it leaves the factory, and all parameters memory are backup by the RAM, so if customer need to reset all the parameters to the default when the parameters is wrong, operator can operate as per follow:

Operating Procedure :

1) Switch off the DRO

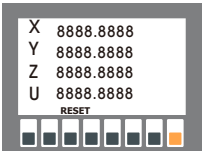
2) Switch on the DRO, after switching on, with the software version no " VER. X-? " showing in the message window, press the number "8" key to enter the parameter reset function.

DRO display LOGO
and software version
on the message window



press [8] to enter into the reset function

3) Reset completed, the DRO will proceed LED display test until switch off.



Reset completed and DRO enters into a endless LED test to let user know if there is any missing segment in the LEDs, you can switched off the DRO if you found no missing segment in the display LEDs

B) Parameters Setup

Each DRO is configured as it leaves the factory, however, in order to enable each DRO to be individually set up for particular machine and application, following SETUP procedure is used.

The SETUP procedure is written in a menu mode which enable you to using the pressing "UP" or "DOWN" keys to scroll through the top level selection options, simply press "enter" to come into the respective configuration mode, configure your choices and then exit the sub-functions as they arise.

The top level menu headers in orders are as follows :

DRO TYPE It is capable to provide professional DRO functions for following applications,
1) MILL - Milling machine application
2) LATHE - Lathe machine application
3) GRINDER - Grinding machine application
4) BORER -Boring machine application

LANGUAGE To make it more user friendly, the display message can be configured to one of the following languages:

1) ENGLISH	10) HINDI	19) TURKISH
2) Chinese	11) INDONESI	20) VIETNAM
3) GERMAN	12) JAPANESE	
4) SPANISH	13) KOREAN	
5) ITALIAN	14) PERSIAN	
6) PORTUGUE	15) ROMANIA	
7) ARABIC	16) RUSSIAN	
8) CZECH	17) SWEDEN	
9) FRENCH	18) THAI	

COLOR Specifies the color of display that the DRO have.

BRIGHT Specifies the brightness of display that the DRO (level 1-7).

AXIS NO Specifies the number of display axes that the DRO have.

DIRECTN Specifies the diection of count for each axis.

RESOLU Specifies the display resolution for each axis.

LIN COMP specifies the linear error compensation value (in PPM) for each axis..

NL ERROR Non linear error compensation is available in both X and Y axis of the DRO, this selection permit the non-linear error compensation value to be input. for details operation procedure, please refer to the "Non Linear Error Compensation" chapter.

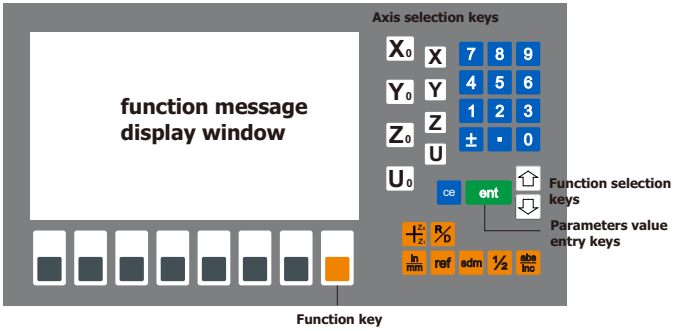
FLTR. PR specifies the filtering range of vibration for the vibration filtering function.

This version of software is offering vibration filtering as one of the standard function in this DRO.

This function is used primary for big or very old machine which the machine structure is not very rigid to resist the vibration when during machining or axis movement.

QUIT exit the SETUP function

Followings are the control keys that are used in the SETUP function.

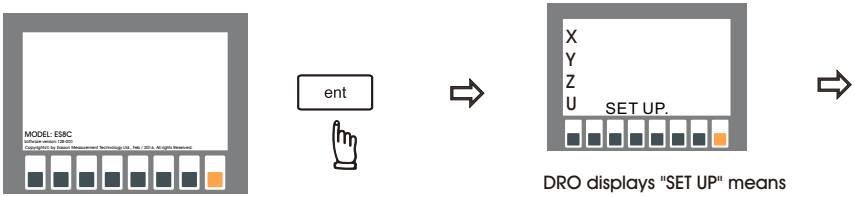


Operating Procedure of SETUP function :

To enter into the SETUP procedure, after the DRO is switching on with software version showing in the MESSAGE window, press the "ent" key to enter into the SETUP function.

1) **Switch off the DRO.**

2) **Switch on the DRO, after switching on with the software version no. "VER. X - ?" in the message window, press "ent" key to enter the parameter SETUP function.**



DRO displays "SET UP" means DRO have entered into the SETUP function

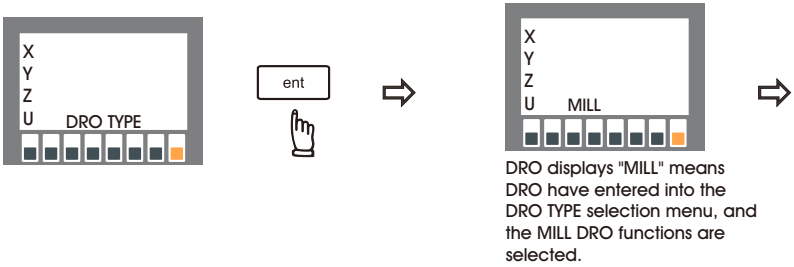
3) **Press** ⇩ **or** ⇧ **key to select next function in the menu, the next function after the SETUP is "DRO TYPE" which specifies the FUNCTION TYPE of the DRO.**

displays "DRO TYPE" means it is currently in FUNCTION TYPE selection entry function for user to specify the DRO Function type.

Parameters Setup Procedure - DRO TYPE

The DRO's software is all-in-one software which can config the DRO to provide professional DRO functions for one of the following applications, the talbe below listing out all the DRO functions available for different DRO TYPEs.

Press ent to select the "DRO TYPE" selection menu

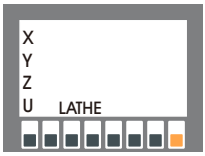


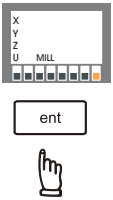
DRO displays "MILL" means DRO have entered into the DRO TYPE selection menu, and the MILL DRO functions are selected.

select the DRO TYPE functions

Functions \ DRO TYPE		mill	lathe	grinder	EDM	CS LATHE
Basic functions	- Clear zero - Centering (1/2) - in/mm display - Coorindate entry - abs/inc - power off memory - 199 subdatum - ref memory - 0.005 / 0.001mm - RAD / DIA display - speed display	•	•	•		
Built in Calculator		•	•	•		
PCD pitch circle diameter		•				
LHOLE line hole positioning		•				
INCL inclined machining		•	•			
SHRINK shrinkage calculation		•				
R function	*ARC positioning*	•				
	simple R	•				
Linear error compensation		•	•	•		
Non Linear error compensation		•	•	•		
Vibration filtering		•	•	•		
Axes summation			•			
EDM Z axis Relay Output						
Spindle Speed Control Output						

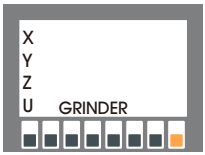
Select LATHE DRO functions





selection done, go to next menu

Select GRIND DRO functions

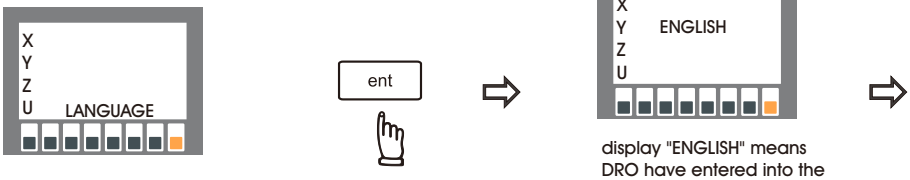


• function availiable in this DRO TYPE

Parameters Setup Procedure - LANGUAGE

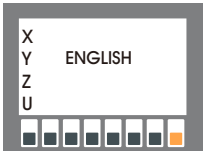
To make the DRO more user friendly to the operator in different countries in the world, the message display of this DRO can be configured to display messages in one of the following languages.

Press ent to select the "LANGUAGE" selection menu

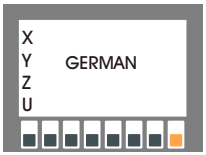


display "ENGLISH" means DRO have entered into the LANGUAGE selection menu, and the English message display is selected.

Select ENGLISH message display

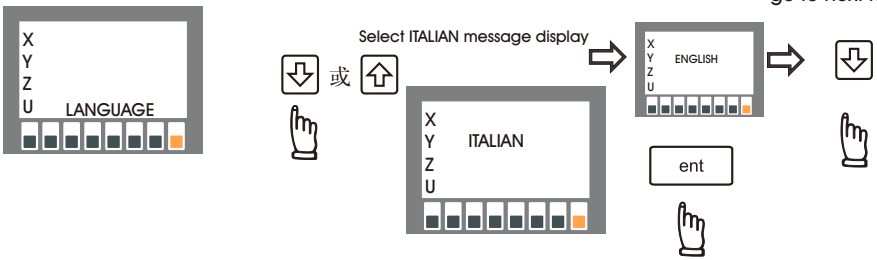


Select GERMAN message display

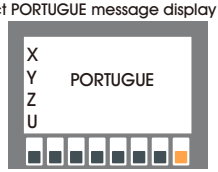


select the LANGUAGE displays

selection done, go to next menu



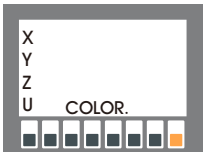
Select PORTUGUE message display

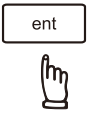


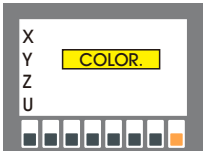
Parameters Setup Procedure - COLOR

To make the DRO more user friendly to the operator in different background color, the display of this DRO can be configured to display 14 kinds of background color.

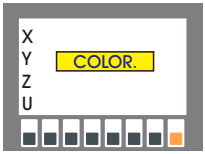
Press **ent** key into color setting



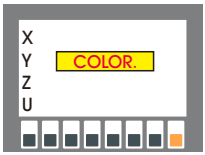




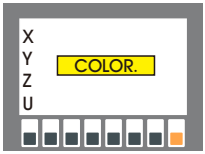
Black on yellow



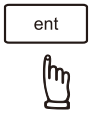
Blue on yellow

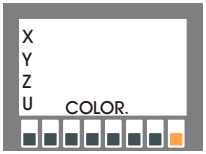


Red on yellow



Select Black on yellow



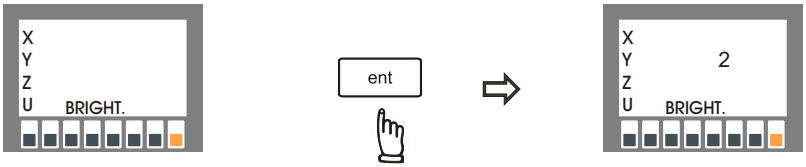


selection done,
go to next menu

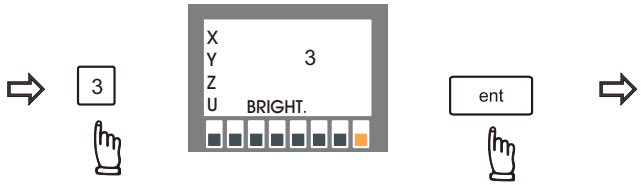
Parameters Setup Procedure - Brightness

DRO screen brightness provide level 1 to level 7 selection, level 1 is the lowest brightness, level 7 is the highest brightness.

Press **ent** key into bright setting



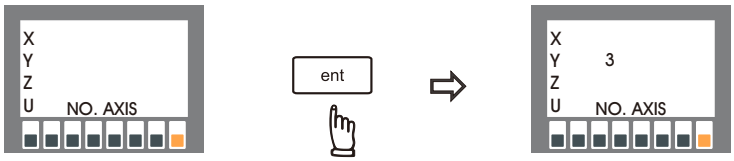
press the number key to select the brightness level



Parameters Setup Procedure - AXIS NO

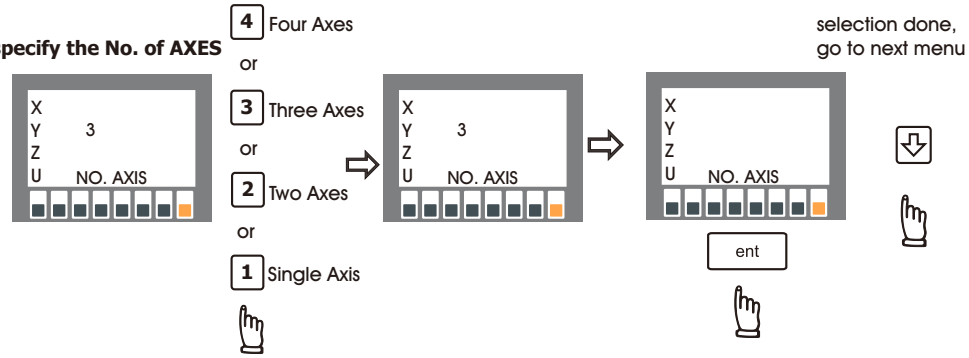
AXIS NO menu is allow operator user to specify how many axes are existing in the DRO. Operator can simply enter '1'- single axis, '2'- two axes, '3'-three axes or '4'-four axes. This parameter will affect the operations of all axis related functions such as ARC, R, ZX/ZY/UX/UY axes summation and INCL. If the operator do not specify the number of axes in the DRO correctly, he will find that the DRO's display axes are either the axis is not count (display) at all or the DRO functions not work properly.

Press [ent] to select the "AXIS NO" selection menu



display "AXIS NO" means DRO have entered into the AXIS NO. selection menu, user must specify the correct no. of axes exists in the DRO so that all realted functions can work properly.

specify the No. of AXES



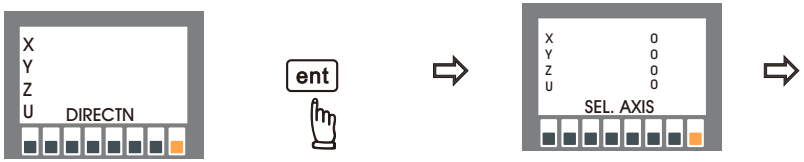
Parameters Setup Procedure - DIRECTN

DIRECTN menu is designed to allow user to swap the transducer (linear scale or encoder) counting direction.

The count direction of the transducer are specified by '0' or '1' :

'0' - DRO perform normal direct counting of the transducer. (POSITIVE)
'1' - DRO will reverse the natural counting of the transducer. (NEGATIVE)

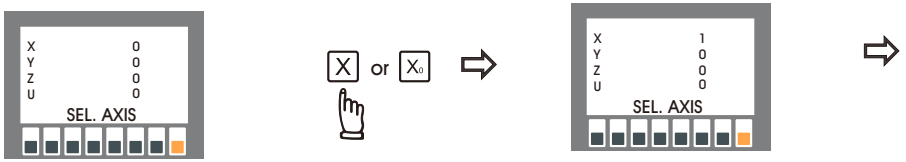
Press ent to select the "DIRECTN" selection menu



The count direction of each axis is represented by "0" or "1" in the axis digit display window

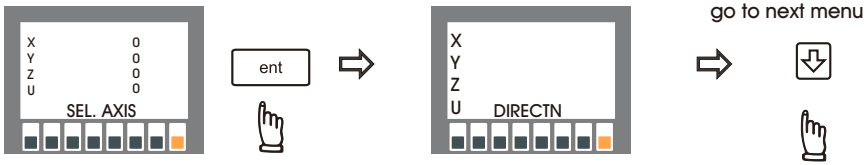
The '0' represent positive counting, '1' represent negative counting. Press the "ent" key to make your selection

For example, if you want to make a change to the current counting direction of X axis, procedure are as follows:



The X axis direction have been changed to '1' (negative)

Press X or X0 to specify the X axis, if the current count direction is '0', it will swap to '1' after the key press, and vice versa. The same procedure applied to Y , Z and U axis



selection done
go to next menu

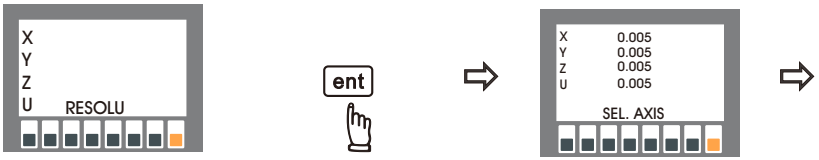
then press ent to exist from "DIRECTN" menu and return to the top level menu

Parameters Setup Procedure - RESOLU

RESOLU menu is designed to allow operator to specify the resolution display for each individual axis. The DRO is design to work with the linear scales of either 0.005mm or 0.001mm resolution. Mixed resolutions display (i.e. X axis in 0.005mm, Y axis in 0.001mm resolution is allowed in the DRO). All DRO functions can work properly under the mixed resolutions display.

The display resolution is either 0.005mm or 0.001mm, user can simply press the respective axis button to select the resolution display needed.

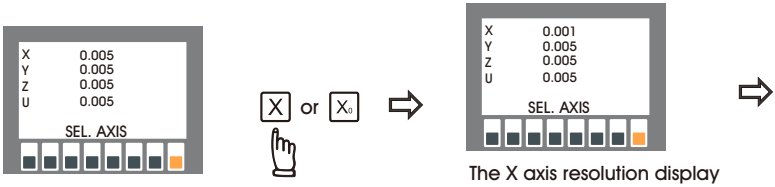
Press [ent] to select the "RESOLU" selection menu



The resolution display of each axis is displayed on the digit display window

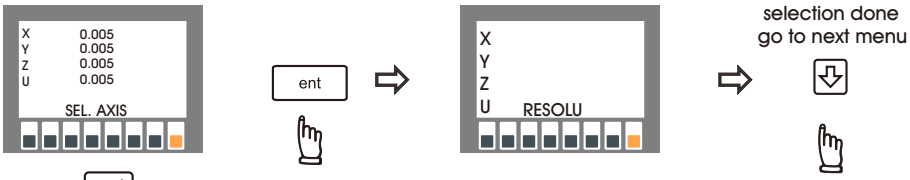
press the axis buttion to swap the resolution display, make your selection choice by pressing the "ent" key

For example, if you want to make a change to the current resolution (0.005mm) of X axis, to change it to 0.001mm resolution, procedure are as follows



The X axis resolution display have change from 0.005mm to 0.001mm

Press [X] or [X0] to specify the X axis, if the current resolution display is 0.005mm, it will swap to 0.001mm after the key press, and vice versa. The same procedure applied to Y , Z and U axis

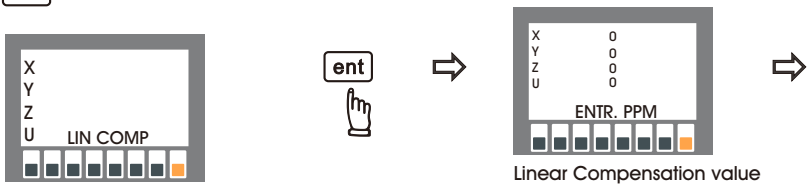


then press [ent] to exist from "RESOLU" menu and return to the top level menu

Parameters Setup Procedure - LIN COMP

LIN COMP menu is designed to allow user to enter the Linear Compensation value of each axis. The entered value must be in PPM (Parts Per Million). If the non-linear error compensation is in active, the Linear Compensation will not be effective any more.

Press [ent] to select the "LIN COMP" selection menu



Linear Compensation value of each axis is displayed on the axis display respectively

The linear compensation value is specified in PPM [**P**(arts) **P**(er) **M**(illion)], an example of calculating the PPM value are as follows.

1. Measure the error using s step gauge or any other device (e.g. guage block) of an accuracy level higher than the measuring resolution and the machine as a measuring standard. For example, if you are using an 0.005mm resolution linear scale and the machine is expected to have an accuracy of 0.02mm, the accuracy level of your measuring standard should be ideally at least one grade higher, such as 0.001mm resolution and 0.01mm in accuracy.

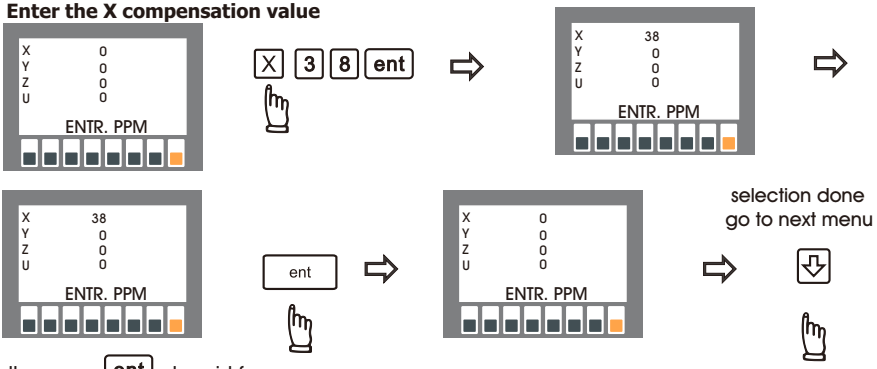
2. The error must be recoded in metric unit (um - micron - 0.001mm)
   (e.g. we measure the X axis and record an display error of 19um shorter over a length of 500mm)

3. Project the error to over the 1 meter (1000mm) in length
   (e.g. in the above example, if measurement is 1000mm, the error will be
   19um X (1000/500) = 38um)

4. Find the direction of error, if the DRO display longer than the measurement standard, then compensation value should be NEGATIVE, and vice versa. In this example, we find the DRO display is shorter then the standard, therefore compensation value should be an positive value, +38.

5. The PPM value is micron error extrapolated over a meter, the M(illion) referred to in calculation is 1 million microns to the meter.
   (e.g. in the above example, the entry compensation value should be +38)

Enter the X compensation value



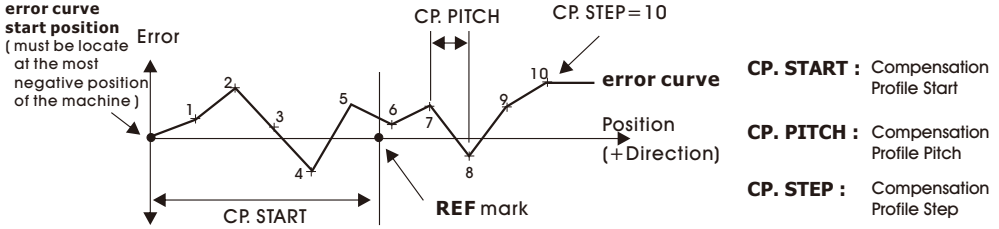
then press [ent] to exist from "LIN COMP" menu and return to the top level menu

Parameters Setup Procedure - NL ERROR

NL ERROR menu is designed to allow user to enter the Non Linear Error Compensation value into the DRO, so that the DRO can compensate virtually all type of error in the machine. With DRO's non linear error compensation function, as long as the position repeatability of the machine is good, it can greatly improve the machine accuracy. This feature is very useful in the application which demand very high machine accuracy. Such as Grinder application, Borer application amd etc..

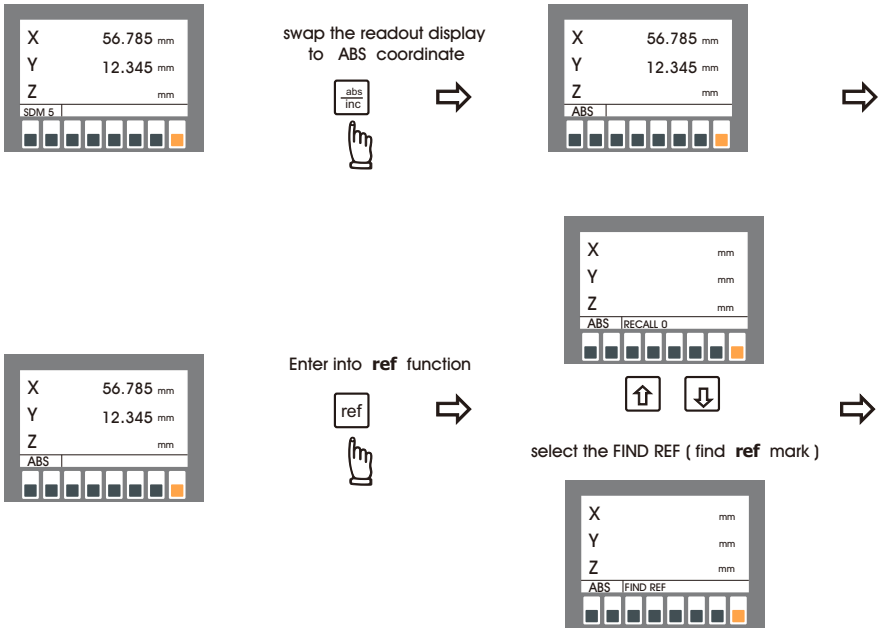
Principle of Operation.

Non Linear Error Compensation make use of the REF (reference mark) position of the linear scale to provide a fixed position as absolute zero of the machine. The DRO's CPU then compensat the readout readings according to the error table that built during this SETUP process. The compensation always started at the error curve start position as per the digram below. It is vital important to have the CP-START. position located at the most negative position of the machine, so that most of the machine travel range are covered by the non-linear error compensation. This DRO software offer non-linear error compensation in both X and Y axes, Maximum of 62 compensation steps is possible for each axis. Please notice that, after the non-linear compensation is in active, the linear compensation is not active any more.

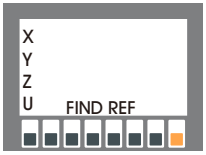


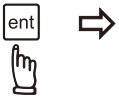
Operation Procedure

1) Locate the REF zeto at ABS coordinate :

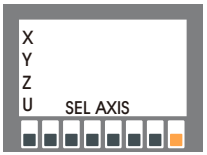


select the FIND REF (find ref mark)

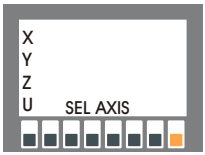




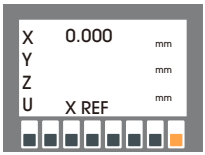
select the Axis



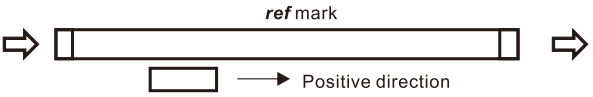
Let's take X as an example



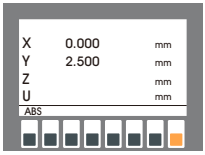
select the X axis



move the machine across the ref mark of the scale until the digits display start run. **Please remember that to move the scale towards the positive direction during finding REF mark.**



after the display digits start run, move the move to X = 0.000, it is the ref mark position of the scale.



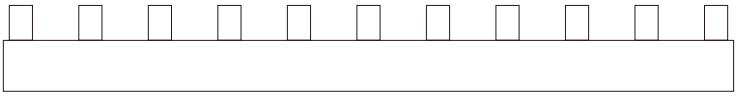
2) Locate the CP. START position

The CP. START position is the absolute reference for the internal error compensation calculation, it is the start point of the error curve, to make fast real time compensation calculation possible, the DRO assume all internal error compensation calculation are only in positive direction. Therefore, the CP. START position should be always located in the most negative position of the machine, so that all measured position in the error curve are located in positive direction.

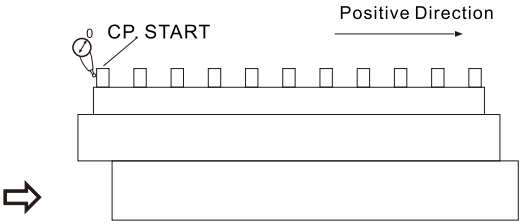
In the example below, we are using a step guage which have total measurement travel of 300mm as our our measurement standard. The step pitch of the step guage is 25.000mm
Our maximum machine travel is 265mm. Therefore,

CP. PITCH = 25.000mm

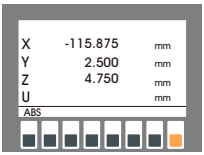
CP. STEP = 265/25 = 10.6 steps, since steps must be in integer, then round up to = 10 steps.



Using a dial indicator to locate the most negative position of the step guage, zero the dial indicator at this position, record down this position as the CP. START position.



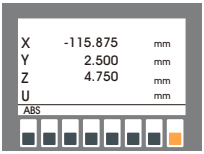
Because the CP. START position always at the most negative position of the machine, therefore, it should always a NEGATIVE value



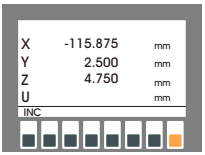
Please record down this position by pen, in this example, the CP. START position = - 115.875

3) START measure the error, to build up a error curve

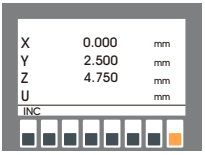
To mark the error measurement more easy, swap to INC coordinate and zero at the CP. START position



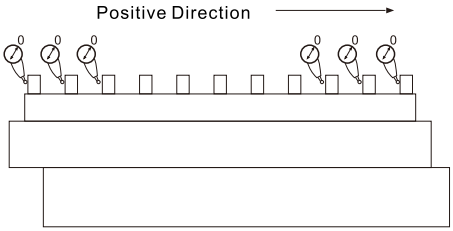
swap to INC coordinate



zero the INC coordinate at CP. START position



start measure the error by positioning the dial indicator on the step guage. Take down the display value that shown at the DRO axis display



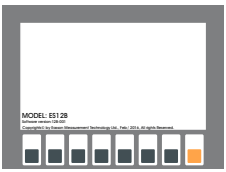
Record down the measured value from the readout and fill up following table

Standard position	Measured value
25.000	25.008
50.000	50.004
75.000	75.017
100.000	99.995
125.000	125.002
150.000	150.012
175.000	174.997
200.000	199.988
225.000	225.007
250.000	250.015

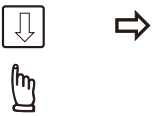
CP. START = -115.875
CP. PITCH = 25.000
CP. STEP = 10

4) Enter the error curve value into the DRO

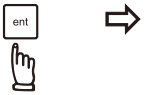
switch off the DRO and then switch it on again, press the "ent" to enter to SETUP function

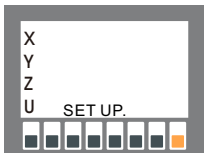


after entered into SETUP function, press the "DOWN" button until "NL ERROR" appear

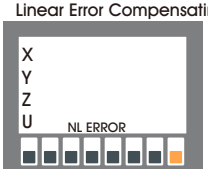


During the start up procedure when the DRO display the Version No. " VER. X-? " press "ent" once to enter to the SETUP function





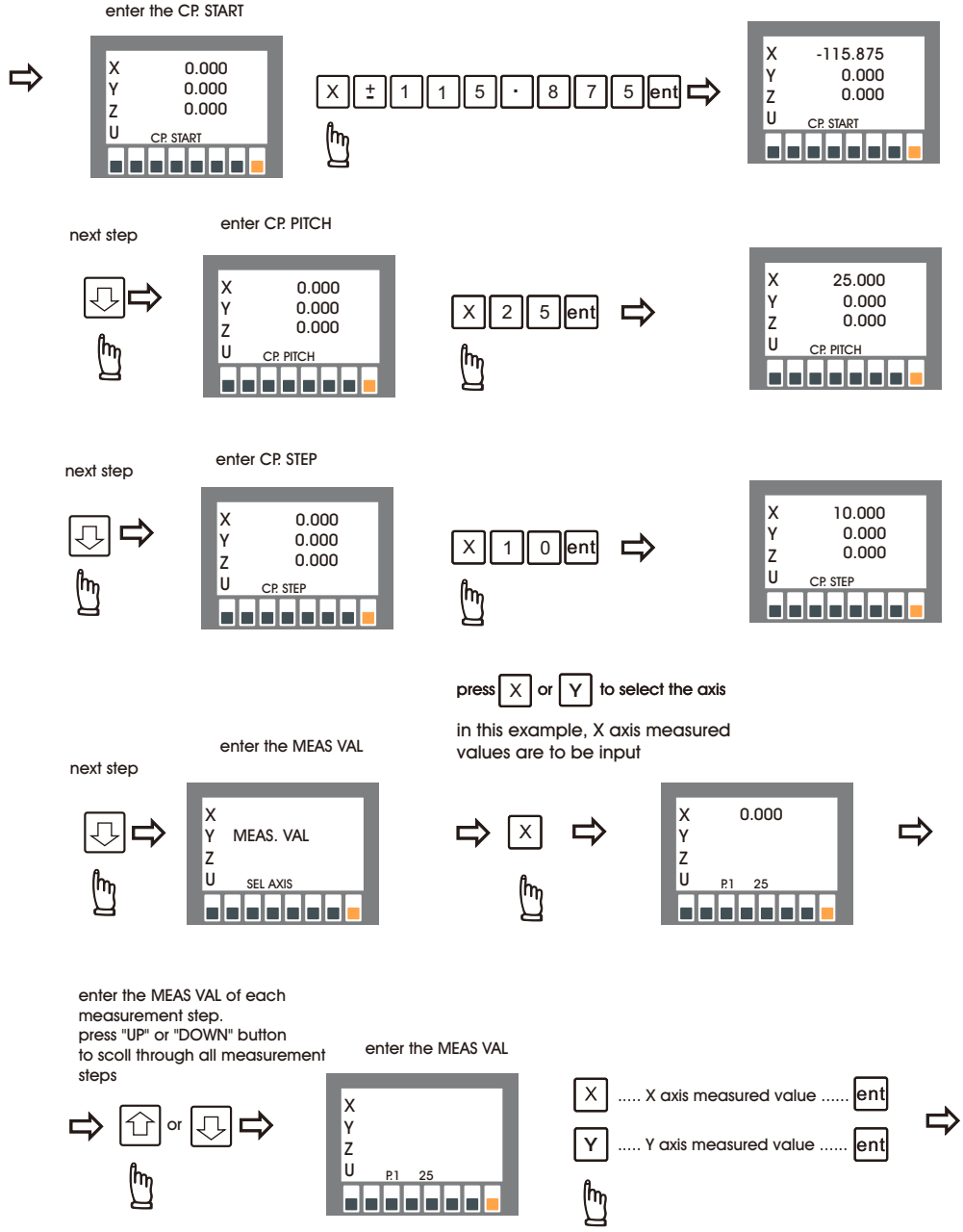
NL ERROR means Non Linear Error Compensatin



press 

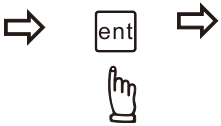
to enter into Non Linear Error Compensation Function

Parameters Setup Procedure - NL ERROR

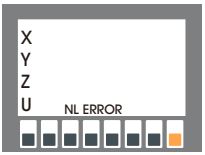


Parameters Setup Procedure - NL ERROR

after all measured values
entered into the DRO,
press "ent" to exit the
NL ERROR function.



Non Linear Error Compensation
Value input completed



selection done,
go to next menu

Parameters Setup Procedure - FLTR. PR & QUIT

FLTR. PR. menu is designed to allow user to specifies the filtering range of vibration for the vibration filtering function.

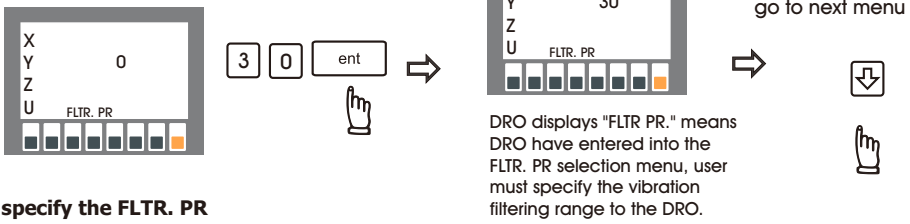
This version of software is offering vibration filtering as one of the standard function in the DRO.

This function is used prmary for big or very old machine which the machine structure is not very rigid to resist the vibration when during machining or axis movement.

The bigger the FLTR. PR, the bigger the filtering effect. Slower movement will be observed.

Please notice that the vibration filter won't affect the accuracy of the counting. The measurement accuracy is the same with or without the filter.

Press ent to select the "FLTR. PR" selection menu



specify the FLTR. PR

DRO displays "FLTR PR." means DRO have entered into the FLTR. PR selection menu, user must specify the vibration filtering range to the DRO.

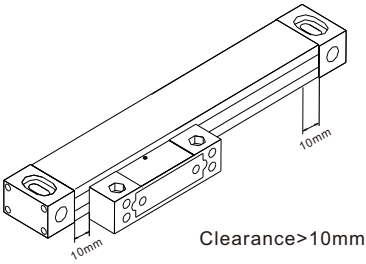
Press ent to select the "QUIT" selection menu

Please notice that the DRO must be switched off after quit from the SETUP function, otherwise, some of the new parameters may not be able to take effect

Installation Instructions

A. Precaution:

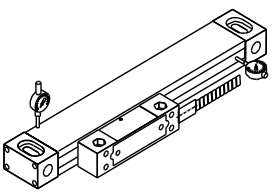
1. The travel length of the glass grating scale must be longer than the maximum travel of the machine, there should be at least 10mm clearance between the ends of the glass scale and the maximum travel of the machine as per the following figure shown.



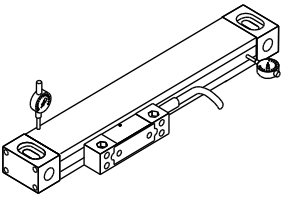
Clearance>10mm

2. To ensure the graduated glass scale to be installed is reliable, and to avoid any possibility of scale misalignment, the scale should be installed on machined flat surfaces of the machine wherever possible. In the case where there are no machined flat surfaces available on the machine, machined flat Blocks or the stainless steel fillers should be used. Wherever possible the scale ends and the reader head should be installed on a flat surface.

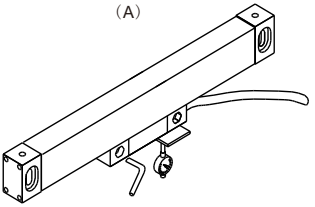
3. If a lever dial indicator is used to align the scale, it is important to ensure that the angle between the dial Indicator lever tip and the surface measured must be less than 30'to avoid a cosine measurement Error. If a vertical dial indicator is used as per the following figures shown, it is important to ensure that the dial indicator is perpendicular to the measured surface to also avoid the cosine measurement error.



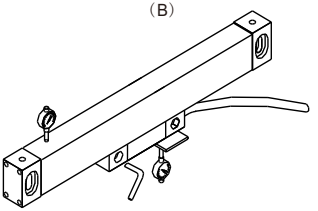
(A)



(B)

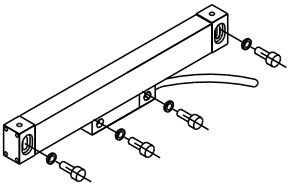


(C)

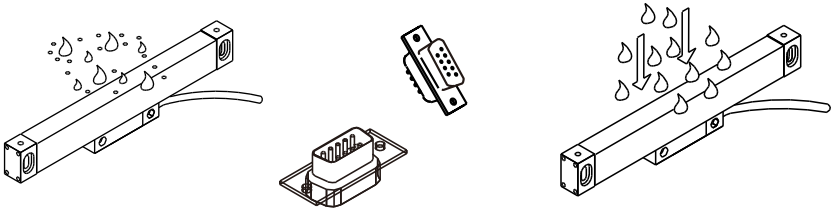


(D)

4. The following considerations must be taken to select the proper installation locations
(1) Scales should be installed on to a machined surface.

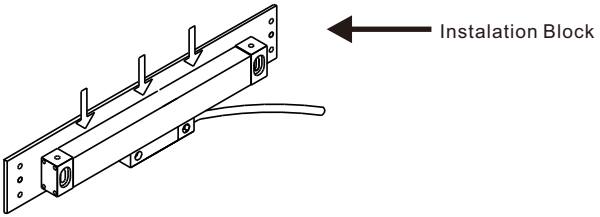


(2) The opening of the scale must not be installed as to be directly exposed to swarf, oil. Water .dust or other foreign products. Covers provided should be installed.

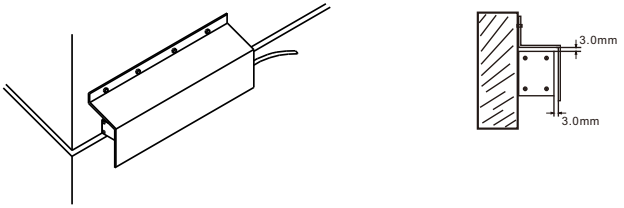


（A） （B） （C）

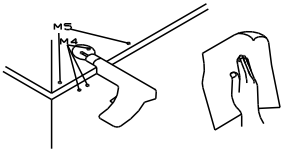
(3) In cases where machined flat surfaces are not available, an installation block or strip should be used to provide a flat datum for the installation. The installation strip must be as short as possible to provide a rigid datum.



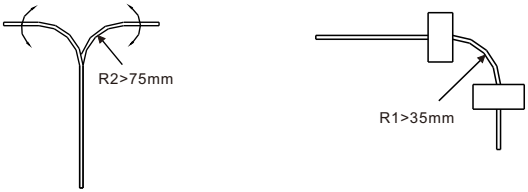
(4) A clearance of at least 3.0mm between the scale and scale cover.



5. All the tapped screw holes must have at least 6 threads to allow the screw to be firmly secured into the tapped holes. For the screw that is needed to secure a heavy load, the tapped holes must have at least 8 threads. After tapping the holes must be deburred and cleaned.

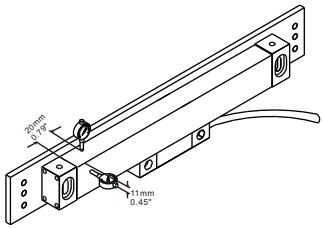


6. All cables must be fixed, but allow for the maximum machine travel movements. Below are diagrams, recommending the minium radius that should be used for bending the scale cable.



7. Grounding / Earthing is very important for the noise immunity, the grounding resistance must be less than 1.0 ohm.

8. The horizontal and Vertical alignment measurement are taken at 20mm away from the scale ends as per following figure shown.

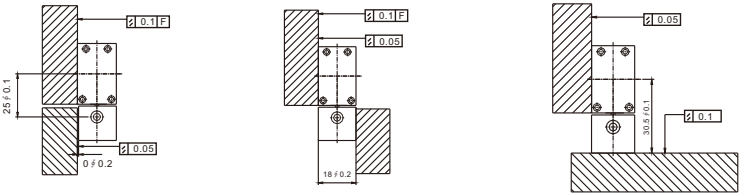


B. Installation standards & Requirements

1. Requirements for the mounting surface

a) If the scale mounting surfaces are not parallel to each other (i.e. As per shown in figure A and B), the parallelism of the two mounting surfaces must be less than 0.1mm.

b) If the mounting surfaces are perpendicular to each other. (I.e.As per shown in figure c), the squareness of these two mounting surfaces must be less than 0.1mm.



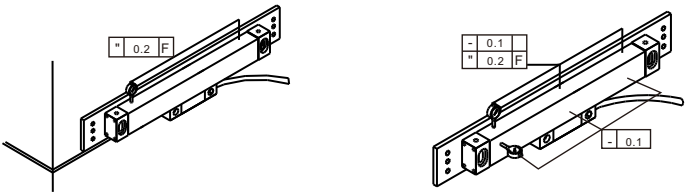
（A） （B） （C）

2. Scale Alignment

It is very important that the scale must be aligned parallel to the travel of the machine slide.

For scale travel less than 950mm, the maximum parallel error between the scale and the machine slide must be less than 0.1mm 0.15mm.

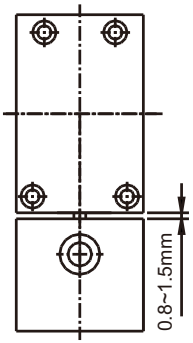
For scale travel longer than 950mm, the maximum alignment parallelism error must be less that 0.1mm.



L ＞950mm L ≤ 950mm

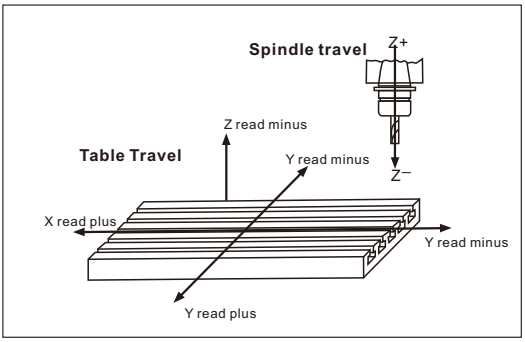
3. Clearances between the reader head and scale body:

(1) The clearance between the reader head and scale body must be kept between 0.8mm-1.5mm.
(2) The reader head must be less than 0.5mm parallel with the scale and can be set with feeler gauges to allow the reader head to move unrestricted along the scale.



Milling Machine Table Direction

The diagram below shows reading against table travel



Direction on Lathe Installation

When travelling towards the headstock the reading should be reduced. Cross slide towards the centre should be reduced.

Note!

At all times to give the best protection the scale should be mounted with the rubber seals facing down.
Where extreme exposure to swarf, coolant, dirt and compressed air, are present, sheet metal cover guards that are supplied should be placed over the scale for maximum protection. Between the scale and the reader head there is a blue strip which helps to maintain the correct distance between the reader head and the scale. This should be removed after installation

Scale Reading Direction

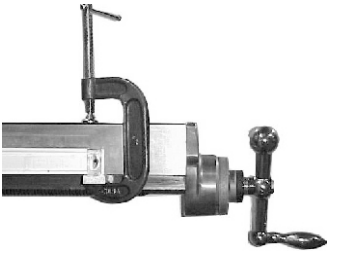
Before fitting the scale insure that the reading direction is correct. To change the direction of the reading of the scale, turn the scale over. Generally the scale is reading in the correct direction with the label of the scale exposed.

Lathe Scale Installation

Before fitting the scale connect the "x" axis to the cross slide to allow the Diameter function to work.

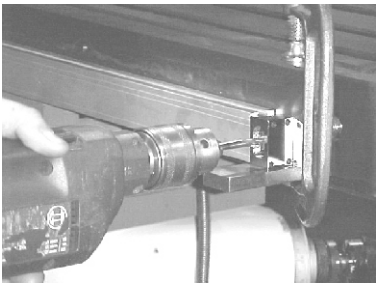
Fixing the "X" Scale on a Milling Machine

One of the easiest ways to set up an X scale on a milling machine, if the side of the table is machined, is to clamp two parallels to the flat table surface that the table travels on and sit the Scale on the parallels.

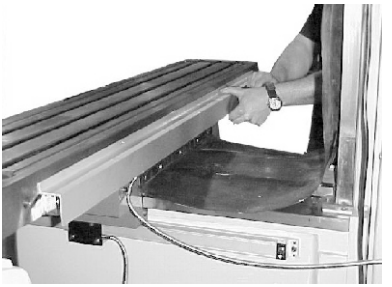


When the scale is mounted then fix the reader head to the saddle, if necessary packing the head to insure that it is parallel and in line with the scales. (The blue packing between the reader head and scale allows for the correct clearance and holds the reader head parallel to the scale.)

Carefully drill and tap the holes to take the screws provided

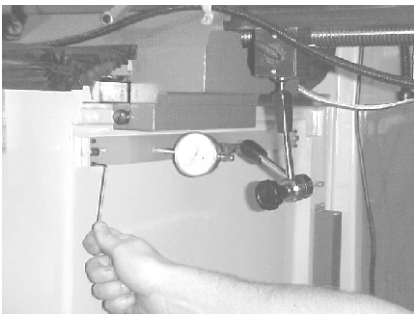


Mount the cover over the scale and drill and tap the holes to secure it to the table making sure that there is 3mm clearance between the cover and the scale.

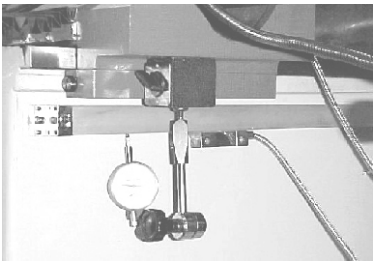


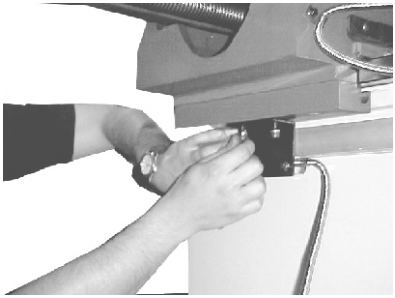
Attaching the "Y" Axis Scale.

If the surface is not machined mount the backing plate and use the grub screws to adjust the backing plate, checking with a dial indicator, until the scale is square and perpendicular to the machine slides.



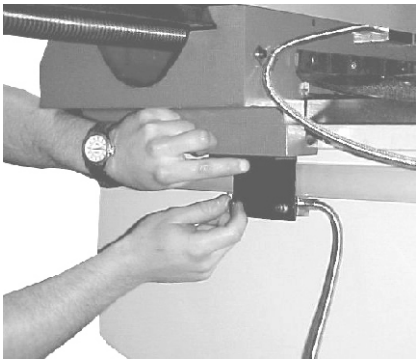
Mount the scale on the backing plate using the pre drilled holes, checking that the scale is parallel with the machine slide with a dial indicator .





Mount the bracket on the saddle to take the reader head making sure that the reader head is in line and parallel to the scale. Secure the cable making sure to leave enough free cable to allow for the travel of the slide.

After the scale is aligned to the axis, then drill and tap the scale to suit the bracket provided and mount the bracket insuring that the reader head is sitting correctly so that when the reader head is attached it will be square and parallel to the scale.



Fitting the "Z" Axis

Before mounting the scale insure that it will read"+"as you wind the table down, increasing the distance from the table to the cutter

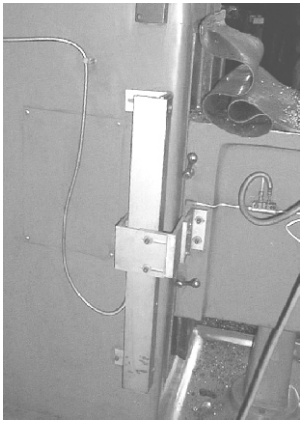


Fig.1

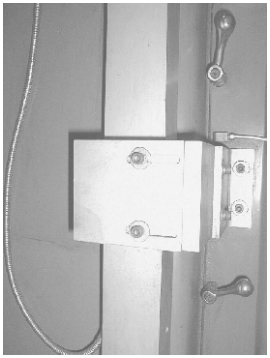


Fig.2

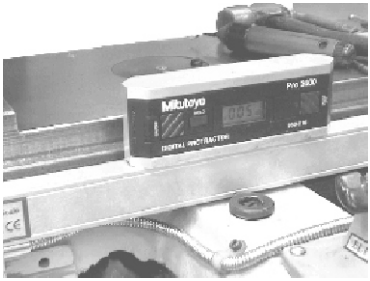
Fig.3

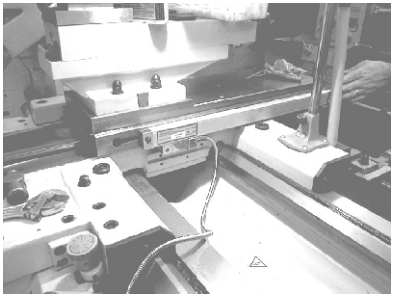
The"z" axis scale should be installed on the side of the column insuring that the open side of the scale is away from direct swarf and coolant and that the travel is in the right direction "-" towards the spindle and "+" away from the spindle. (Fig.1) The bracket is (Fig 2) mounted of the knee, and around the scale to allow for the cover (Fig .3) to protect the scale where excessive coolant & swart are present.

LATHE INSTALLATION

To install a readout on a lathe the following tips can be used. To mount the cross slide scale select a flat surface that is suitable and clear of the travelling parts of the lathe.

The scale should be mounted insuring that it is parallel and square to the slide.





Testing for parallel can be done by either a dial indicator or a precision level

When mounting the reader head if necessary pack the reader head so that it travels in line and square to the scale to avoid any damage to the scale.

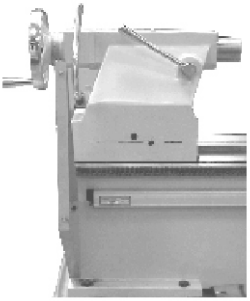


Fig .1

The longitudinal scale should be mounted on the back of the lathe (Fig 1)with the open side of the scale facing down and must be parallel to the bed. The reader head is mounted to the saddle (Fig .2 & 3)via the brackets provided. Some modification may be required for some lathes. Covers should be mounted over the slides as per Fig 4

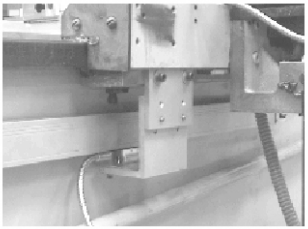


Fig .2

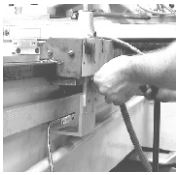


Fig .3

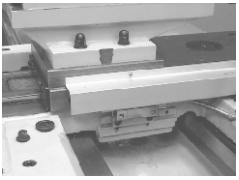


Fig .4