

# EP series Optical Profile Projector

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## Operation Manual



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# Machine Descriptions

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## I. Applications of Profile Projector

EP series high precision optical profile projector provides accurate 2D measurement for all common geometric features such as circle, line angle and etc. All measured results can be printed or transferred to computer for further data processing.

EP series optical profile projector is designed for all critical dimensions measurement in mould & die making, form tool making, screw manufacturing, gear manufacturing and etc.

## II. Technical Specifications

### 2.1 Projector Screen

2.1.1 Screen size(mm) : effective size :  $\cong \Phi 300$ (mm) (with cross hair)

2.1.2 Screen rotation range : 0~360°

2.1.3 Screen rotation angular readout resolution : 1' or 0.01°

### 2.2 Lens

2.2.1 Magnification	10X	20X	50X
2.2.2 Viewing field (mm)	$\Phi 30$	$\Phi 15$	$\Phi 6$
2.2.3. Focal length (mm)	77.7	44.3	24.5

### 2.3 Table

2.3.1 Table size (mm) : 350 X 170

2.3.2 Table glass size (mm) : 225 X 120

2.3.3 X measurement Travel (mm) :  $\cong 200$ , readout resolution : 0.001

2.3.3 Y measurement Travel (mm) :  $\cong 100$ , readout resolution : 0.001

2.3.3 Z measurement Travel (mm) :  $\cong 85$ , (focusing use)

### 2.4 Illumination

2.4.1 24V, 150W halogen lamps are used in both transmission and reflection illumination system.

2.4.2 Cooling system: forced air cooling by 3 electrical fans

### 2.5 Power supply & Maximum power consumption

2.5.1 Rated power supply: 100-120V~200-240V~4A/2A, 50/60HZ

2.5.2 Operating temperature: 15°C-25°C

2.5.3 Storage temperature: -40°C - +55°C

2.5.4 Operating humidity: 40%-60%

2.5.5 Storage humidity(anti condensation)

### 2.6 Dimensions :

670 x 550 X 1030mm

### 2.7 Weights :

Net weight : 150 Kg ; Gross weight : 200 Kg.

# Machine Descriptions

## III. Operating principle :

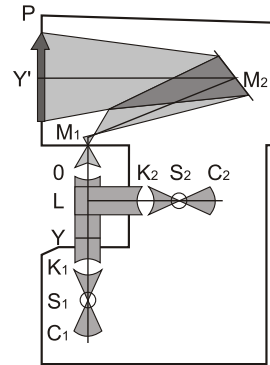
The operating principle of EP series profile projector are as follows :  
A work piece Y is placed on the table surface, there is an parallel ray illumination system S1 in below the work piece, the light from lamp S1 is made to be a parallel ray by the optical system K1 & C1, then the image of work piece Y is precisely projected to a precision magnification lens O, the image then reflects through two flat mirror M1 and M2, finally projected to the screen P and become a magnified image Y'.

Since the magnified image Y' is highly precise in dimensions, operator can measure the magnified image Y' by a glass grating scale to know the dimensions of the work piece Y.

EP series profile project equipped with a high precision digital readout system in the XY table which enable operator direct readout the dimension of the work piece with the assistance of magnified image.

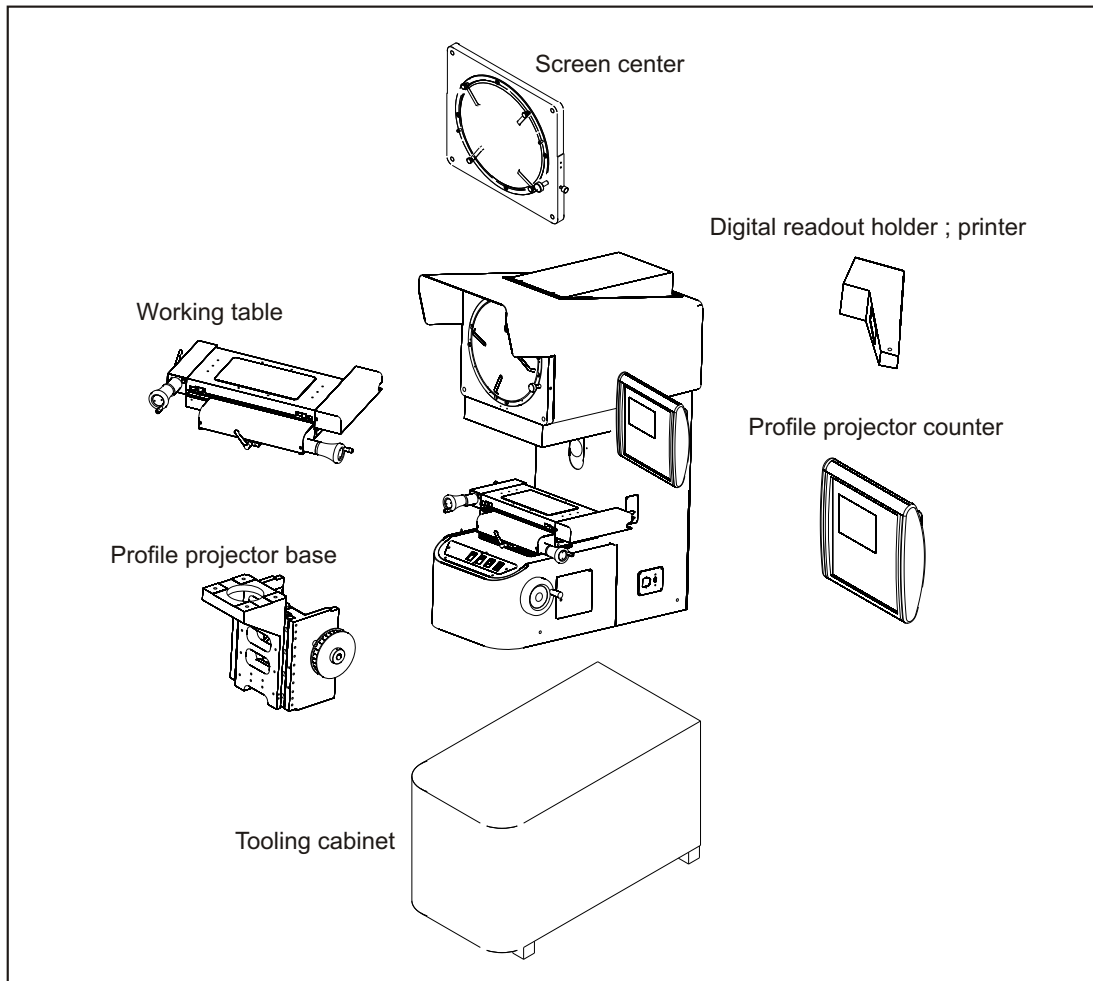
The projector screen P equipped with a high precision rotatory encoder digital readout system, which enable operator can direct make angular measurement on the work piece very precisely.

EP series projector have an reflective illumination system S2,K2&C2 built in as standard accessory for surface reflective measurements.



operating principle of EP series projector

### ■ Profile projector parts sketch map

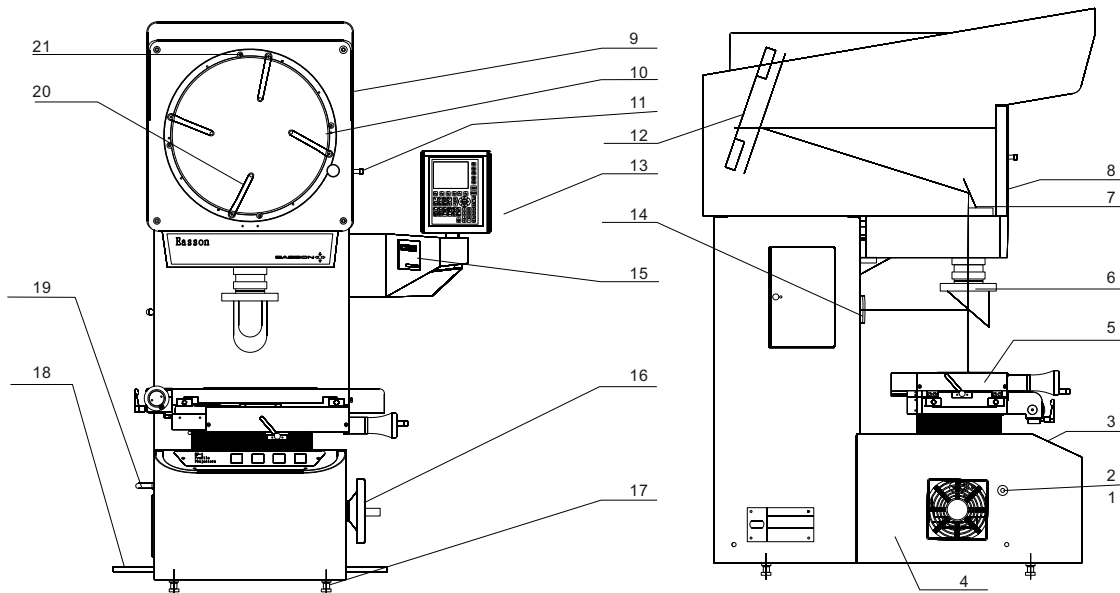


# Machine Descriptions

## IV. Structure & Parts Description :

### 4.1 Projector assembly & parts description

Projector are constructed by three sub-assemblies, they are projector box (9), body stand (4) and XY table (5)



**Parts Description :** 1. transmission illumination system 2. parallel ray focalizing unit 3. control panel 4. body stand  
 5. XY table 6. lens 7. front reflective mirror 8. screen rotation knob 9. projector box  
 10. projector screen 11. screen knocking screw 12. rear reflective mirror 13. digital readout counter  
 14. reflective illumination system 15. line printer 16. Z axis handwheel 17. level adjusting screws  
 18. handles for transportation 19. high magnification focalizing select 20. comparison film holders

#### 4.1.1 Projector box

Projector box consists of the lens(6), reflective mirror M1 and M2, projector screen(10), and the rotatory encoder

#### 4.1.2 Body stand

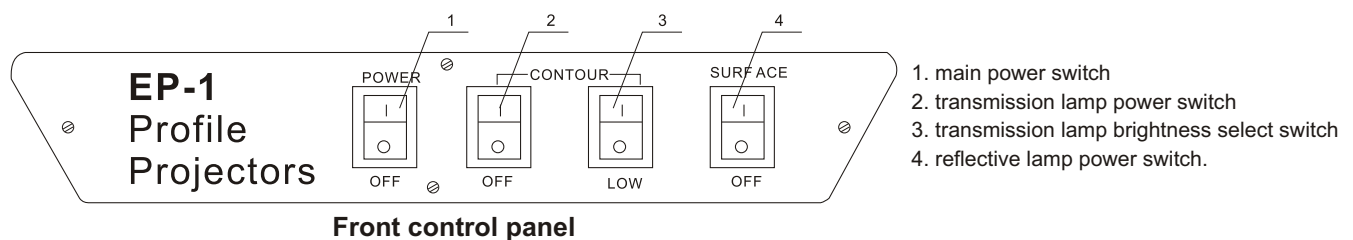
Body stand consists of the illumination systems, electrical control system and the air cooling system.

#### 4.1.3 XY table

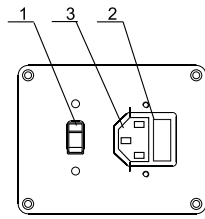
XY table consists of precision guideways for XY travels, linear scales and friction driving precision transmission system. Both the XY axes linear scales digital readout system have an readout resolution of 0.001mm

## 4.2 Control panels

There are four panels in EP series projector as follows

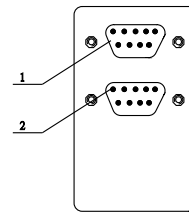


# Machine Descriptions



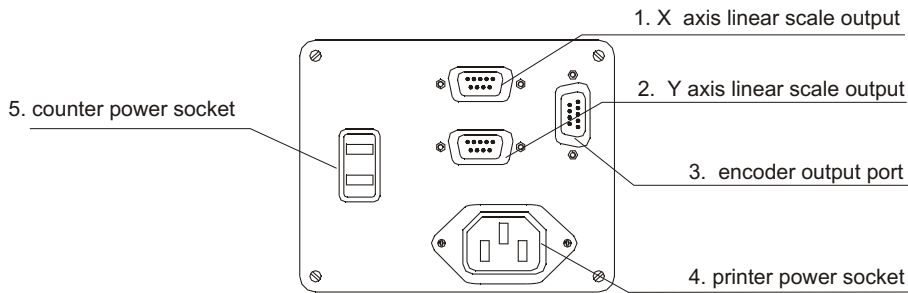
- 1. fuse holder
- 2. 220/110V select switch
- 3. power input socket

**Power panel**



- 1. X axis linear scale input port
- 2. Y axis linear scale input port

**Linear scale panel**

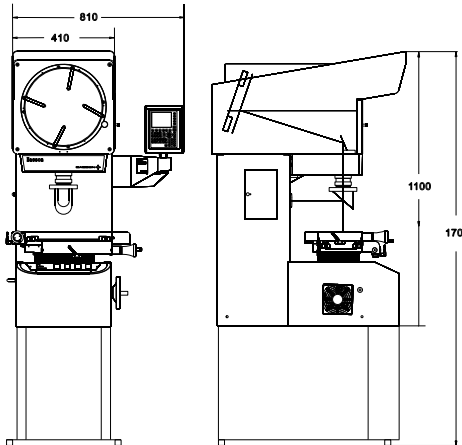
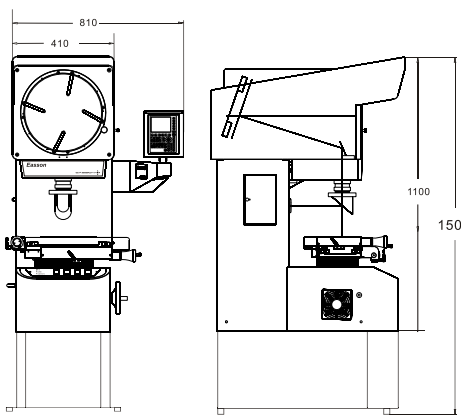


**Digital readout panel**

■ Operating of the machine:

There are two models of operating the machine: Vertical Model, Horizontal Model

In order to coordinate with our customer's different operating environment, two different machine base is provided for selection (shown as below), if customer prefer the Vertical Operating Model (for example, put the machine in the assembling line for many workers' use at the same time), then, he can choose the Vertical operating machine base. If on the other hand the customer likes the horizontal Operating Model (for example, the machine is put in the measurement department especially for large quantities of measurements of the QC staffs), then the Horizontal Operating Machine Base makes a perfect choice.

Dimensions of Vertical Operating Machine base	Dimensions of Horizontal Operating Machine base
	

# Installation & Operations

## V. Installation

- 5.1 Carefully unbox the wooden cases, remove all inner and outer packing material, take this manual out and read carefully before started to install the EP series projector.
- 5.2 Unscrew the four locking screws in the bottom of the projector, carefully place the projector onto machine bases stand.
- 5.3 Carefully adjust the level adjusting screw in the machine base stand until the projector table is leveled.
- 5.4 Carefully select the installation site of the projector, make sure the projector screen don't be placed towards a strong light source such as windows or lamp. This will reduce the projected image contrast and hence uncomfortable to measure.
- 5.5. Remove the guideway locking screws for X and Y axes in the XY table, check if the XY table can be moved freely and smoothly.
- 5.6 Check the power supply, make sure correct supply voltage selected, then plug-in the power.
- 5.7 Switch on the power, since the EP series projector's DRO ES-8P have non-linear error compensation, the very first thing to do is to let the XY table travel through the centre of the linear scale to find the scale's REF mark. ES-8P will request the operator move the X axis across the table centre to find the REF mark, then the same for Y axis. It is very important to travel from the negative side to positive side ( always move from negative end to positive end until display change or DRO's digits start run ). After X & Y axis REF found, then the DRO started count, operator can then start the measurements on the profile projector



Warning: The Machine is extremely heavy, transit it according to somatic anthropology, please note that four transit handles is provided.

## VI. Operations of profile projector



Warning: Take care of being hurt by high heat generated when replacing the lamp, it is well suggested to switch the power off and wait for 3 to 5 minutes (after the lamp base is completely cool down) before doing so.

### 6.1 Operation of illumination systems

Use of correct specifications of lamp is vital for projector operations, followings are the specifications of lamp that we recommend to user according to our experience

Manufacturer : OSRAM (Germany), <http://www.osram.com>

Specifications : XENOPHOT, long life Halogen photo optic lamp, 24V 150W

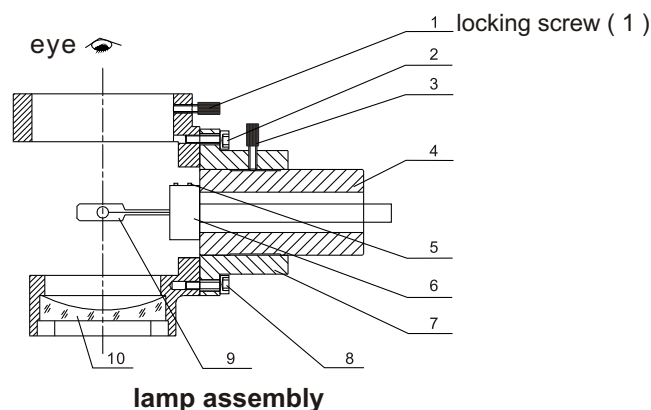
Regular inspection of lamp is necessary for assuring normal operation of profile projector. After the projector have been transported or moved, the lamp position may change and need to be re-adjusted. Or after the usable life of lamp over, replacement of lamp is necessary. The procedure of adjustment and replacement are as follows

#### 6.1.1 Adjustment of lamp

6.1.1.1 take off the lens, then switch on the lamp, if the image of the filament is not located at the centre of the projector screen, or the image is very blurred, then the lamp needed to be adjusted.

6.1.1.2 open the lower side door of the body stand, unscrew the locking screw (1) of the lamp unit, then the whole unit can be moved in up/down direction, you will see the image of filament changes between clear and blur.

6.1.1.3 adjust the lamp unit up and down until the image of filament becoming clear. lock the lamp unit by tightening the locking screw (1), then re-install the lens and adjustment of lamp completed.

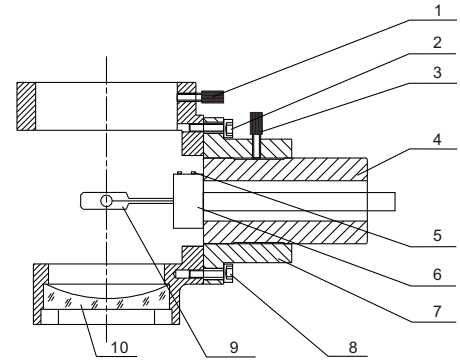


# Installation & Operations

## 6.1.2 Replacement of lamp

6.1.2.1 open the lower side door of the body stand, unscrew the lamp housing unit locking screw ( 3 ) to release the lamp housing unit ( 4 ). Take the lamp housing unit ( 4 ) out from the lamp assembly.

6.1.2.2 unscrew the lamp tightening screws ( 5 ), replace the lamp ( 9 ) with a new lamp. it is very important that to wear a hand glove during the replacement of lamp to avoid any finger touch to the lamp, it is because any dirt or oil on the lamp surface will great reduce the usable life of the lamp. after the replacement of lamp, fit the lamp housing unit ( 4 ) back to the lamp assembly.



**lamp assembly**

lamp housing unit locking screw ( 3 )  
lamp housing unit ( 4 )      lamp ( 9 )  
lamp tightening screw ( 5 )

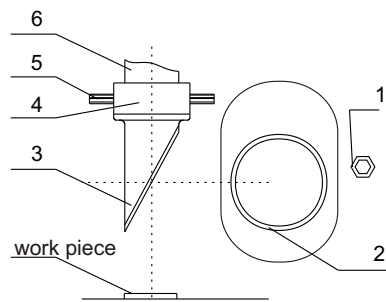
6.1.2.3 take off the lens, then switch on the lamp, rotate the lamp housing unit ( 4 ) until biggest filament can be seen in the projector screen, you will found that there are two blurred image of filament seen on the projector screen. then slide the lamp housing unit ( 4 ) forward and backward unit these two filament images overlap each other. Then tighten the lamp housing unit ( 4 ) by the locking screw ( 3 )

6.1.2.4. Carry out the procedure 6.1.1 to carry out the re-adjustment of lamp.

## 6.1.3 Adjustment of reflection illumination system

6.1.3.1 The lamp assembly unit of reflection image system is located on the middle of the body stand, the procedure for replacement of reflection lamp system are same as 6.1.2.

## 6.1.4 Surface reflection measurement



1 lamp unit locking screw  
2. reflection illumination assembly  
3. perspective mirror  
4. perspective mirror unit  
5. perspective mirror locking screw  
6. lens

**reflection image assembly**

6.1.4.1 attach the perspective mirror unit ( 4 ) to the lens ( 6 ), free the reflection illumination unit( 2 ) by loosen the lamp unit locking screw ( 1 ), posit the reflection illumination unit ( 2 ) right in front of the perspective mirror ( 3 ), then tighten the locking screw ( 1 ) to lock the reflection illumination unit ( 2 ) right in front of the perspective mirror ( 3 ), then switch on the surface illumination lamp.

6.1.4.2 put your work piece to be inspected onto the table surface, then you will see the surface reflection of your work piece, to adjust the brightness of the reflection image, you can rotate the reflective lens unit in reflection illumination assembly ( 2 ) to focus the light to achieve the correct brightness required.



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## Installation & Operations

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### 6.2 Use of lens and perspective mirror for surface reflection measurement

- 6.2.1 all lens ( 10X, 20X, 50X ) are having the same locking screw thread, and the same focal length, therefore, all lens are interchangeable in EP series projector. However, our lens cannot be used in other brandname projectors.
- 6.2.2 Higher magnification lens can give more accurate measurement, however, higher magnification lens have smaller view field, therefore more difficult and uncomfortable in measurement.
- 6.2.3 When high magnification lens ( 50X ) is used, make sure the to push out the high magnification focalizing select rod for a better and sharper image.
- 6.2.4 During the change of lens, please lower the table to make sure there is enough clearance for the lens change.
- 6.2.5 When the surface reflection measurement is not used, it is very important to detach the perspective mirror unit from the lens. The attach of perspective mirror unit without the reflection illumination system switched on will create image blur on project screen which make measurement becoming very difficult.

### 6.3 Operation of XY table

- 6.3.1 Since the EP series profile projector have non-linear error compensation built in the ES-8P digital readout system. The non-linear error compensation uses the linear scales' REF mark as the absolute reference position for the error compensation. Therefore, whenever the ES-8P DRO switched on, the very first thing to do is to let the table travel through the centre of the linear scale to find the scale's REF mark.
- 6.3.2 When switch on the ES-8P DRO, the ES-8P will request the operator move the X axis across the table centre to find the REF mark , then the same for Y axis. It is very important to travel from the negative side to positive side ( always move from negative end to positive end until display change or DRO's digits start run ). After X & Y axis REF found, then the DRO started count, operator can start the measurements on the profile projector.
- 6.3.3 Friction base rod transmission system are used in the XY table of EP series projector for backlash free transmission movement. The transmission system is a very smooth and precise system, but it is delicate too, therefore, during the measurement, please don't rough to rotate it too quickly, use it carefully and smoothly.
- 6.3.4 After the measurement or off from work, please move the XY table back to the centre position to balance the loading to the precision linear guideway in the XY table, this good practice can pro-long the work life of the projector, also this good practice can maintain the accuracy of the projector for a long time.

## 7. Measuring Methods in Profile Projector

Two measuring methods are common used in profile projector, they are contour comparison measurement and coordinates measurements using a DRO for data processing.

### 7.1 Contour comparison measurement method

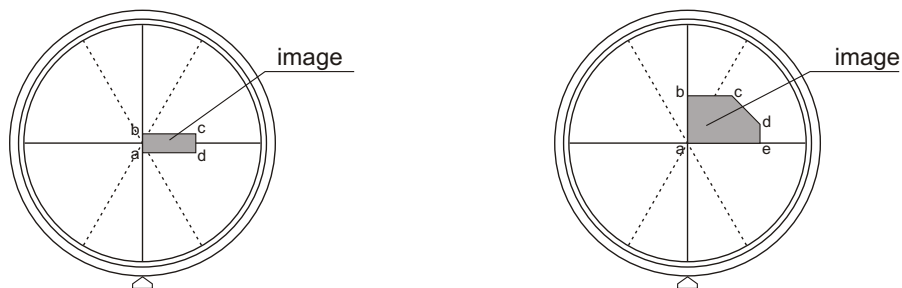
Contour comparison measurement is the most simple and the quickest way for measurement in profile projector, it is widely used in QC process for mass production in which the projector have to measure a big number of work piece in a very quick way, this method also widely used in measuring the work piece which is very complicate in sharpe & geometry such as screw, irregular profiles and etc., in which the work piece geometry is very complicated to be described by mathematical parameters.

Contour comparison measurement method make use of the very high accuracy / low distortion image magnification properties of profile projector. A high accuracy standard magnified contour film is needed to compare the projected image on the projector screen. The standard contour film are usually plastic transparent film that made by precision laser plotter on which the measured work piece's outlines is precisely plotted.

There are four comparison film holders built on the projector screen for contour comparison measurement.

During the comparison measurement, move the XY table until the projected image overlap the outlines in the standard comparison film, the error can be measured by using the cross hair of the projector screen and the digital readout system of the projector.

In the QC process for mass production, the tolerance band can be plotted on the comparison film for quick comparison of work piece ro decide if it in within or out of tolerance.



### 7.2. Coordinate measurement method using DRO for data processing

The Contour comparison measurement is simple and easy for profile projector measurement, however, it is not flexible. Not only it need a high accuracy pre-plotted standard comparison film for the measurement, when the image of the work piece is bigger than the projector screen, the contour comparison measurement method is not applicable.

Coordinate measurement method is using the cross hair of the projector screen as the edge find device, to pick up the edge points of the projected image, enter into the ES-8P DRO for data processing to measure the work piece geometric elements. For detail operation, please refer to second part of this manual - Digital Readout Functions.

Coordinate measurement method is flexible and accurate. But it is relatively more complicate to measure and need higher measurement skills from the operator.

# Maintenance

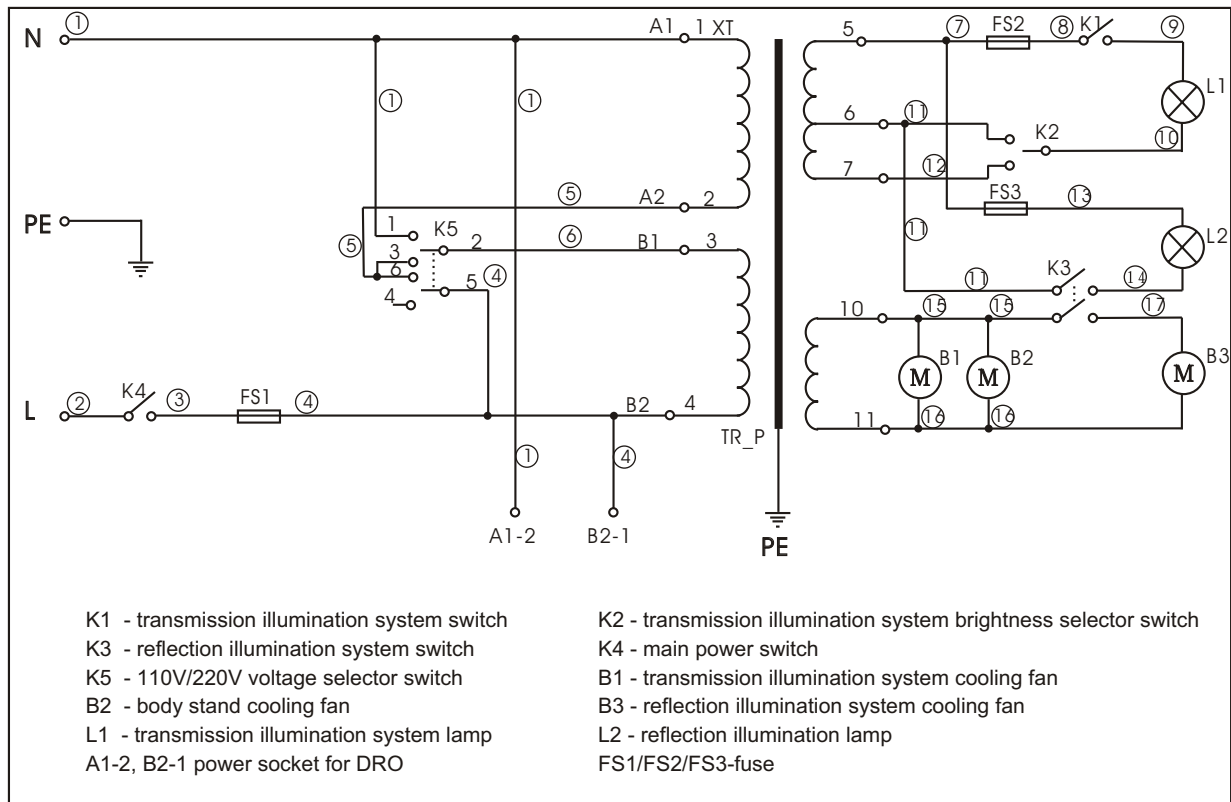
## 8. Maintenance

EP series profile projector is a precision measurement instrument, it consists of precision mechanism, optical system as well as delicate electronics. Good maintenance practice can effectively prolong the work life of projector and maintain the accuracy for long period of time.

- 8.1 The projector should be install in a dry & clean room ( room temperature  $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$ , relative humidity below 60% ) to avoid the optics getting modly, rusting of metallic part and etc. It is vital that the projector is installed in a clean environment because if dust deposited onto the precision guideway of the projector, it will destroy the measurement accuracy of the projector.
- 8.2 All optics may be handled with care, avoid any finger touch on the surface of optics. If there is any dust deposited on the surface of optics, blow the dust away by air or brush the dust away carefully. If any oil deposited on the surface of optics, clean it by degreased cotton with little alcohol.
- 8.3 Avoid finger touch to the projector screen. If any dust deposited onto the screen, brush it any or air the dust away carefully. If any oil deposited onto the screen surface, clean it by degreased cotton with little amount of alcohol.
- 8.4 The XY table is highly precision, it need a trained service engineer to calibrate and service it, also it needs precision instrument to re-adjust it. Please don't adjust any adjustment screws in the XY table by yourself.
- 8.5 The cooling fans are very important in pro-long the work life of lamps in projector, always regular check if all cooling fans work properly. If any cooling fans fail, please replace it immediately.
- 8.6 Please switch off the lamps which is not in used. The lamps have a defined work life. It is a waste of energy and shorten the work life of lamps if the lamps is switched on for a pro-long period of time. The lamps may become over-heated.

## 9. Electrical Circuit Diagram

The electrical circuit diagram of EP series profile projector



Warning: It is strongly suggested to cut off the power at first when switching the power between 110V/220V, omission of doing so may result in damage of the machine parts.

## Instruments and electronics' complete list

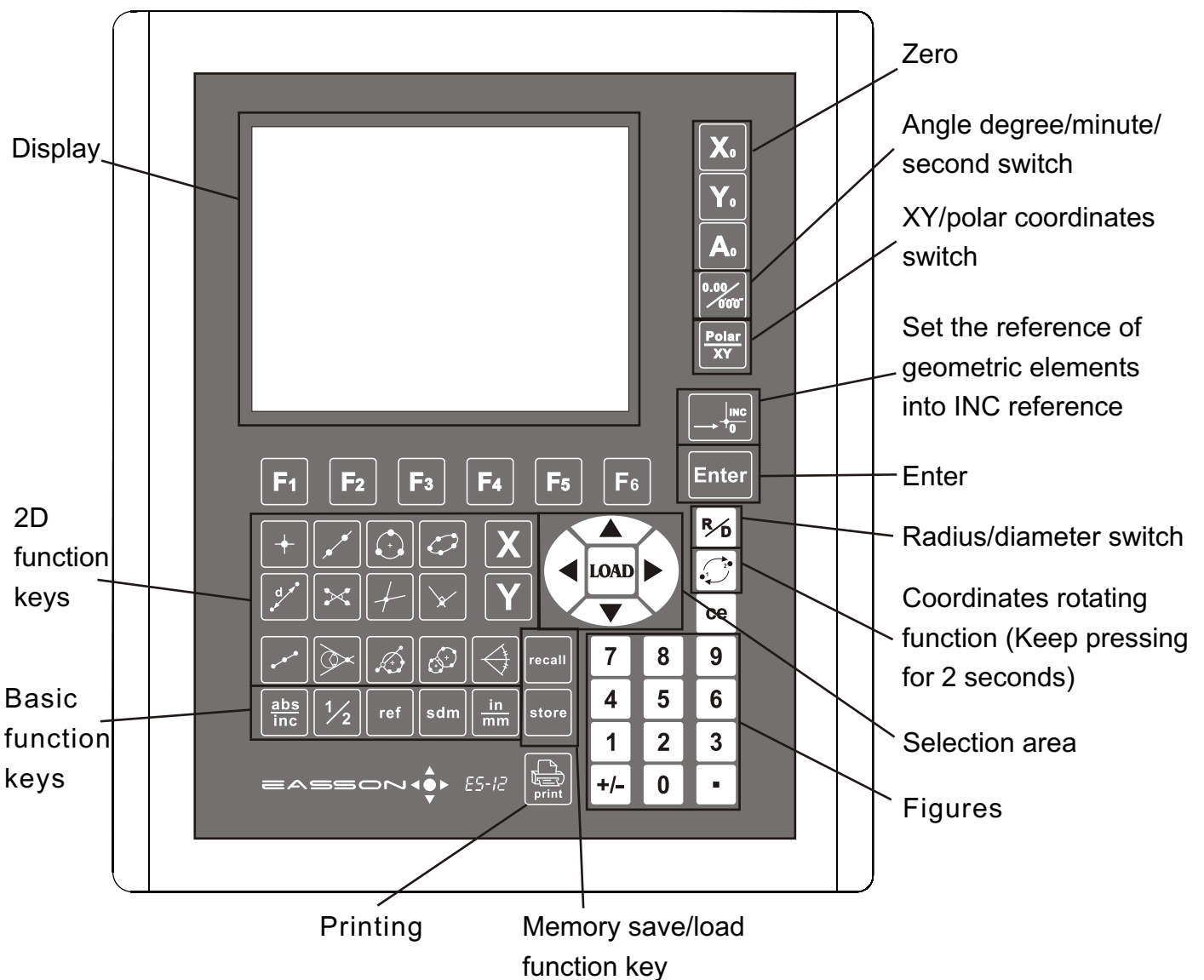
### 10. Instruments and electronics' complete list

Number	Name	Model	Specification
K1	Transmission lamp power switch	R5 T85	15A/250V~
K2	Transmission brightness select switch	R5 T85	15A/250V~
K3	Reflect lamp power switch	R5 T85	15A/250V~
K4	Main power switch	R5 T85	15A/250V~
K5	110V/220V, Voltage switch	L21	10A 125/250V~
B1	Transmission lamp cooling fan	SJ92025HA1	110V~/0.12A
B2	Machine body cooling fan	SJ1238LA1	110V~/0.12A
B3	Reflect lamp cooling fan	SJ90225HA1	110V~/0.12A
T1	Power transformer	R-320	400W
L1	Transmission lamp	HLX64642	24V~/150W
L2	Reflect lamp fuse	HGX64642	24V~/150W
FS1	Main power fuse		5A/250V
	Power socket		10A/250V
	Mini-printer transformer		Input:100-240V~ Output:5VDC 1500MA
FS2	Transmission fuse		10A/250V
FS3	Reflect lamp fuse		10A/250V

## Basic Function

ES-12 Digital Readout System is specially designed for 2D measuring, which can be used on profile projectors, 2D CCD measuring machines or microscopes etc...

### Keys description:

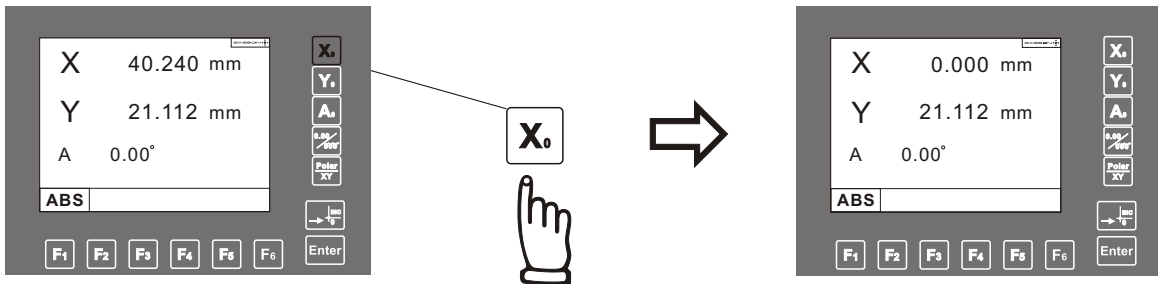


## Operation Instruction

- 1) Set the coordinates to ZERO **X<sub>0</sub>** **Y<sub>0</sub>** **A<sub>0</sub>**

Function: Set the coordinates to 0 in any position.

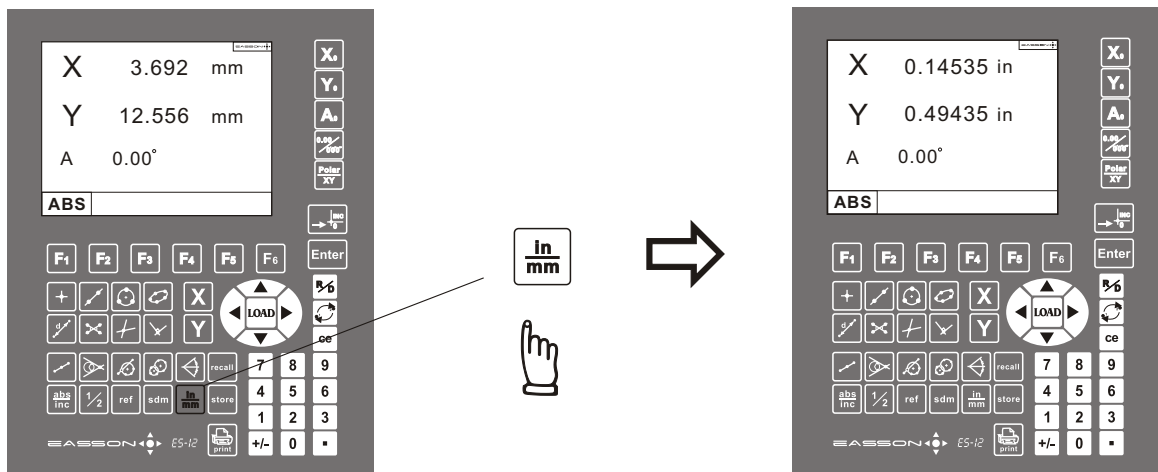
Example: Set the X coordinates to 0 in current position. (The same operation of the Y axis)



- 2) mm / Inch switch

Function: Switch between mm and Inch as the measuring unit.

Example: Switch current measuring unit mm to Inch.



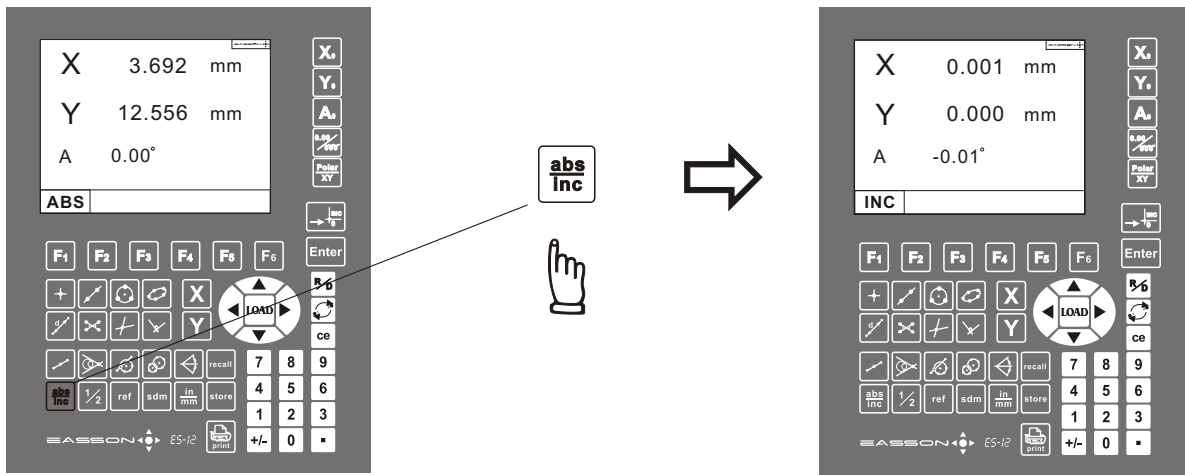
If switching back to mm is needed, press **in/mm** again.

- 3) ABS / INC coordinates display

Function: The DRO offers 2 standard coordinates display, ABS and INC.

Example: Switch from current ABS coordinates to INC.

## Center find

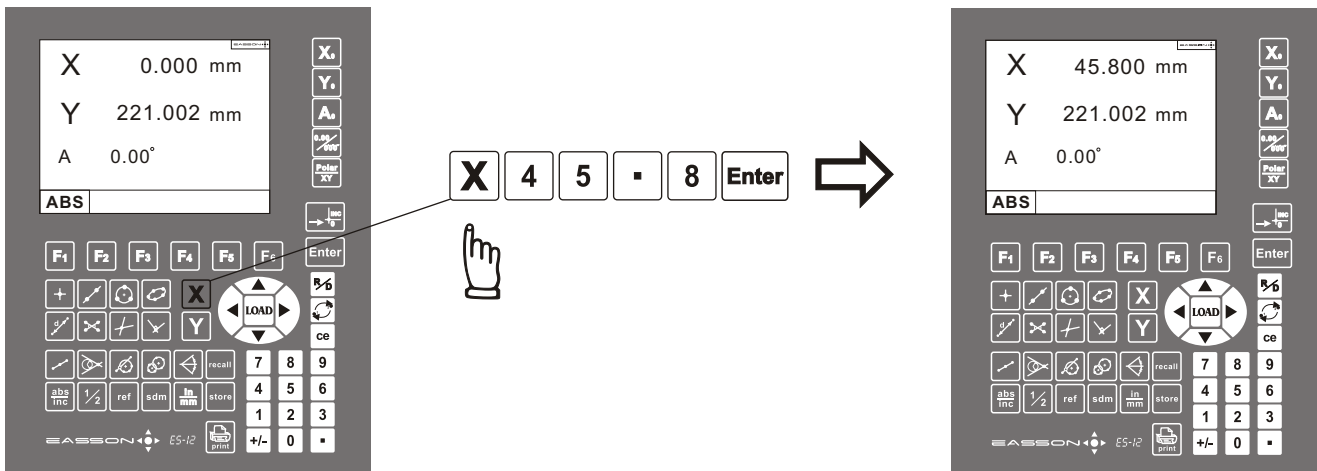


If switching back to ABS is needed, press **abs inc** again.

### 4) Input coordinates **X** **Y**

Function: Allows the operator to set the current position coordinates to any value.

Example: Set the current X position to 45.800mm.



### 5) Center find **1/2**

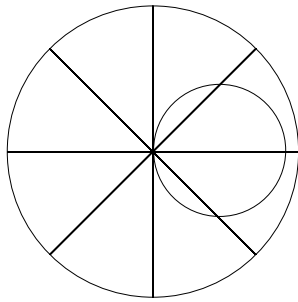
Function: The ES12 offers the center find function, which can divide the current display by 2, to set the reference in the center of the work piece.

Example: Set the X reference in the center of the work piece.

#### Operation:

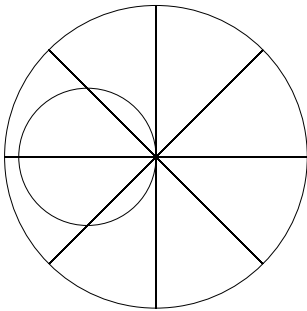
- Locate the center of the cross line of the projector screen at one end of the work piece, then set the coordinates to 0.

## Center find



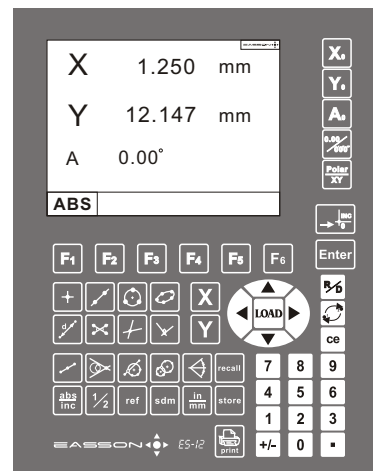
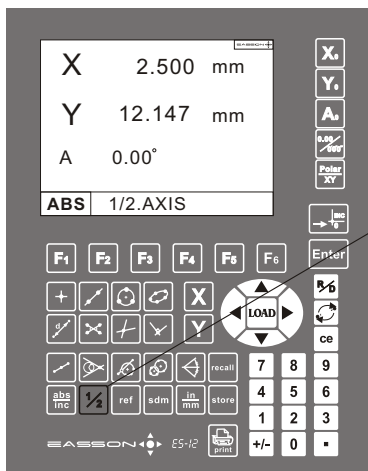
X	0.000	mm
Y	12.147	mm
A	0.00°	
ABS		

b) Locate the center of the cross line at the other end of the work piece.



X	2.500	mm
Y	12.147	mm
A	0.00°	
ABS		

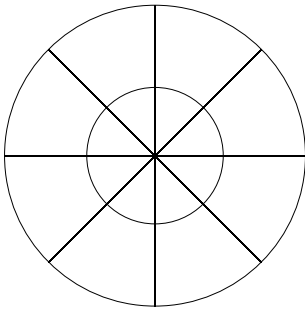
c) Press the center find function key, divide the current coordinates by 2.





## SDM function

d) The X reference coordinates is 0.000, move the linear transducer to 0.000, that is the X reference.





X	0.000 mm
Y	12.147 mm
A	0.00°
<b>ABS</b>	


### 6) SDM function

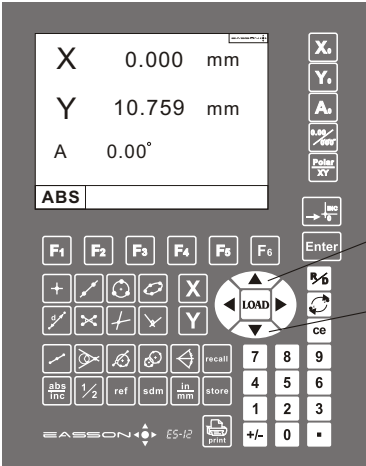
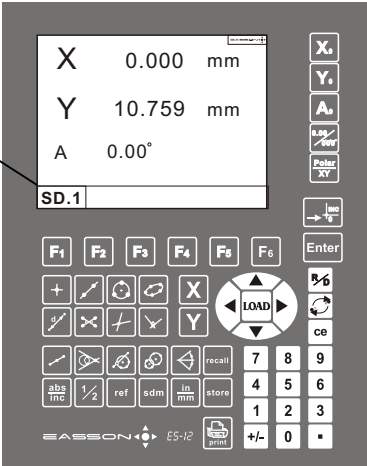
a) ES-12 offers 9 groups of the reference memories together with the ABS and INC.

Press Up, Down keys  
can change the current  
coordinates group, (From  
SD.1 to SD.9), which will  
be displayed.





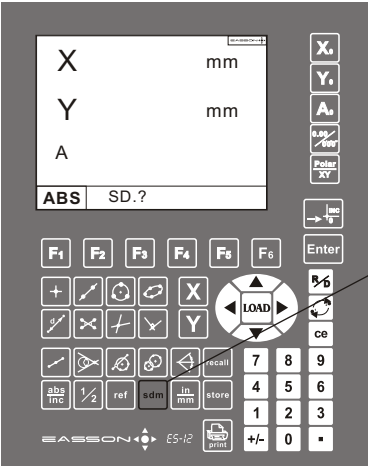
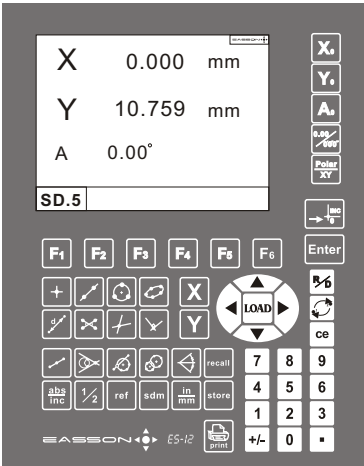


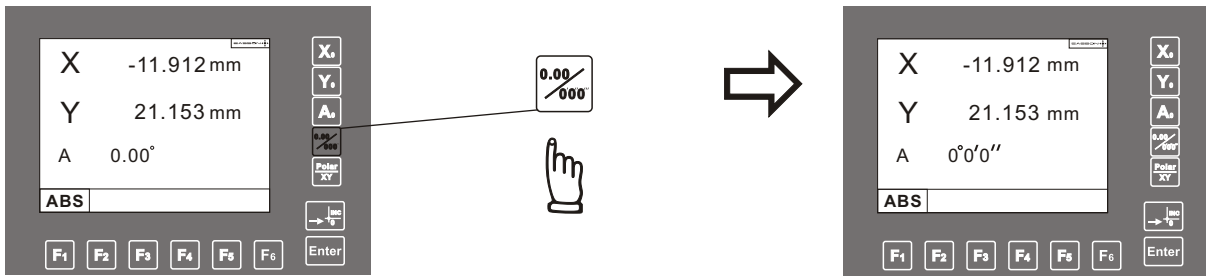
b) Users can also press sdm to enter the appointed coordinates group.

sdm
5
Enter

➔

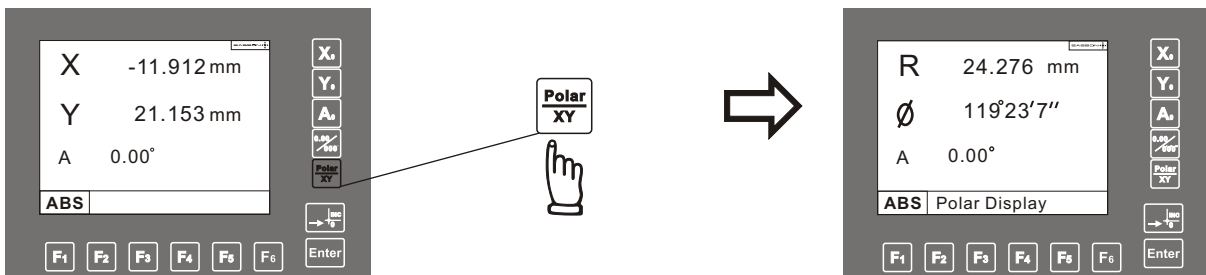



## 7) Degrees, minutes or seconds



Press the  $\frac{0.00}{000}$  again to exit from the degrees / minutes / seconds mode.

## 8) Polar coordinates display

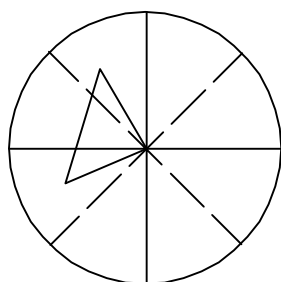
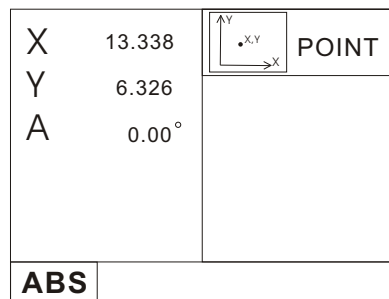
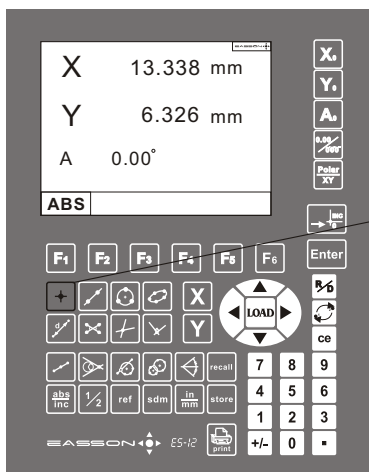


Press  $\frac{\text{Polar}}{\text{XY}}$  again to exit from the Polar coordinates display mode.

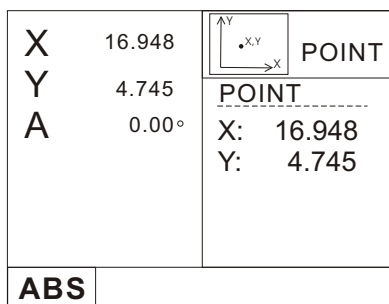
## Measuring function

### 9) Measuring function

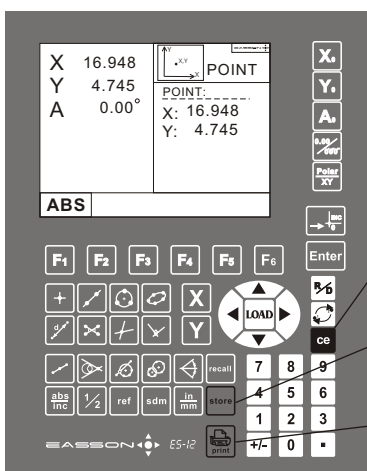
#### a) Points measuring



Enter



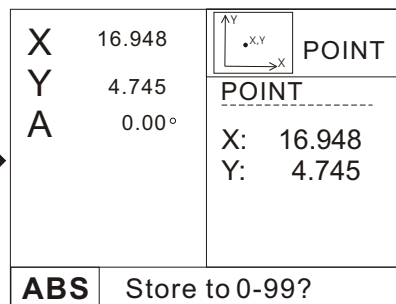
Move the work table to the required point, the coordinates of the point will be displayed.



Exit **ce**

Save **store**

Print



5

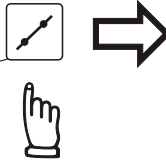
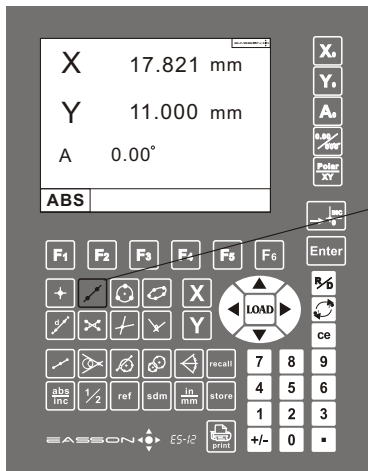
Enter


Users can select to save, print or exit.

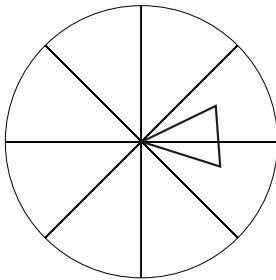
The memory position is NO. 0 to 99. For example the point needs to be saved in NO. 5 position, press **store** ⇒ **5** ⇒ **Enter**, the point information will be saved in memory position NO. 5.

## Measuring function

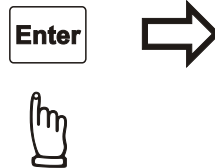
### b) Line measuring




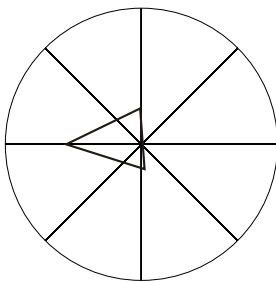
X	17.824		LINE
Y	11.000		
A	0.00°		
<b>ABS</b>	Enter Point. 1		



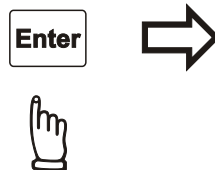
Move the work table to the required point, the coordinates will be displayed.




X	6.697		LINE
Y	12.594		Meas Point: 1
A	0.00°		X: 6.697
			Y: 12.594
<b>ABS</b>	Enter Point. 2		



Move the work table to the other point, the coordinates will be displayed.



X	8.727		LINE
Y	12.594		Meas Point: 1
A	0.00°		X: 6.697
			Y: 12.594
			Meas Point: 2
			X: 8.727
			Y: 12.594
<b>ABS</b>	Enter Point. 3		

**By different way to measure the line, will come out different measuring result.**

**First one is the measuring method as above, that is horizontal points selecting (or vertical selecting), the result display will be:**

## Measuring function

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved in NO. 5 position.

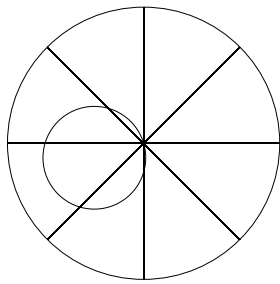
The second is the incline way of points selecting, the result will be:

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved in NO. 5 position.

### c) Circle measuring

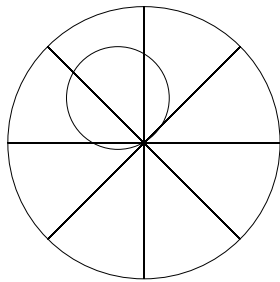
## Measuring function



Move the work table to the first point of the circle  
(At least select 3 points to fix a circle).



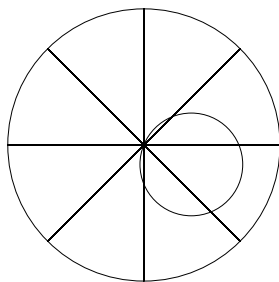
X	1.171	CIRCLE Meas Point: 1 X: 1.171 Y: 11.649
Y	11.649	
A	0.00°	
<b>ABS</b>		Enter Point. 2



Move the work table to the second point of the circle.



X	0.808	CIRCLE Meas Point: 1 X: 1.171 Y: 11.649 Meas Point: 2 X: 0.808 Y: 13.059
Y	13.059	
A	0.00°	
<b>ABS</b>		Enter Point. 3



Move the work table to the third point of the work table.



X	-1.166	CIRCLE Meas Point: 2 X: 0.808 Y: 13.059 Meas Point: 3 X: -1.166 Y: 11.656
Y	11.656	
A	0.00°	
<b>ABS</b>		Enter Point. 4

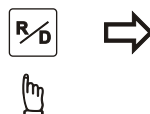
Users can select to save, print or exit.

X		CIRCLE CIRCLE:----- CENTRE X: 0.004 Y: 12.100 Rad: 1.251 Round: 0.000
Y		
A		
<b>ABS</b>		Store to 0-99?



The memory position is NO. 0 to 99.  
For example the line needs to be saved in NO. 5 position.

X		CIRCLE CIRCLE:----- CENTRE X: 0.004 Y: 12.100 Dia: 2.502 Round: 0.000
Y		
A		
<b>ABS</b>		Store to 0-99?



Press **R/D** to switch between Radius / Diameter display.

Operation of finding the center point of the circle:

X	-1.169 mm
Y	-0.444 mm
A	0.00°
<b>INC</b>	0 = CIR. CENTRE

Move the work table until the X, Y coordinates display are both 0, then this point is the center point of the circle.

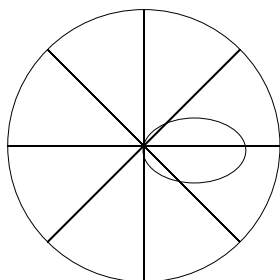


X	0.000 mm
Y	0.000 mm
A	0.00°
<b>INC</b>	0 = CIR. CENTRE

d) Ellipse measuring (5 points selecting)



X	19.456 mm
Y	-4.853 mm
A	0.00°
<b>ABS</b>	Enter Point. 1



Enter

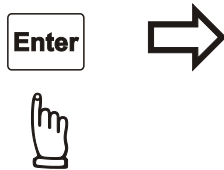


X	11.260
Y	21.528
A	0.00°
<b>ABS</b>	Enter Point. 1

Move the work table to the first point of the ellipse, the coordinates will be displayed. Select the other 4 points in the same way.

## Measuring function

- 
- 
- 
- 
- 



X	12.608		ELLIPSE
Y	27.148		Meas Point: 4
A	0.00°		X: 16.690 Y: 25.640
			Meas Point: 5 X: 12.608 Y: 27.148
<b>ABS</b>		Enter Point. 6	

At least select 5 points to fix an ellipse. Users can also select more than 6 points to fix an ellipse. If points selecting is finished, press **LOAD** and have the further process of the information.

( **NOTICE:** Selecting the points along the edge of the ellipse by uniform distance can make the measurement more precise. )

Users can select to save, print or exit.

The memory position is NO. 0 to 99. For example the line needs to be saved in NO. 5 position.

To find the center point of the ellipse, operate as below:

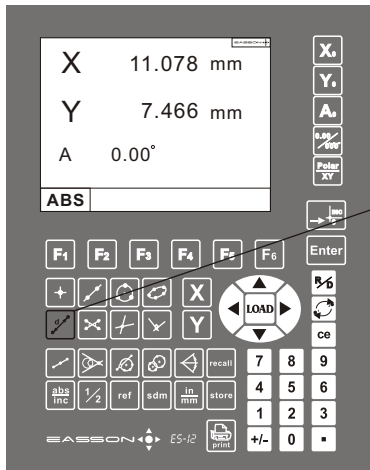
Move the work table until the X, Y coordinates display are both 0, then this point is the center point of the ellipse.


X	0.000 mm		
Y	0.000 mm		
A	0.00°		
<b>INC</b>		0 = EL. CENTRE	

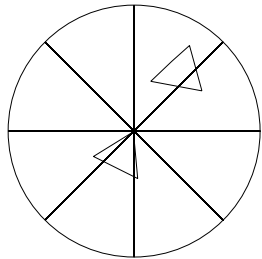


## Measuring function

### e) Length / distance




X	11.078	 DISTANCE
Y	7.466	
A	0.00°	
<b>ABS</b>	Select Point:1	

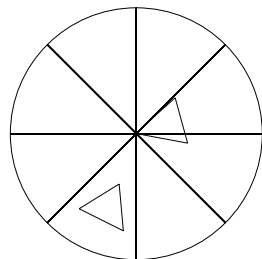


**Enter**




X	5.996	 DISTANCE
Y	11.744	
A	0.00°	
<b>ABS</b>	Select Point:2 Meas Point: 1 X: 5.996 Y: 11.744	

Move the work table to the first point of the line, the point coordinates will be displayed.



**Enter**

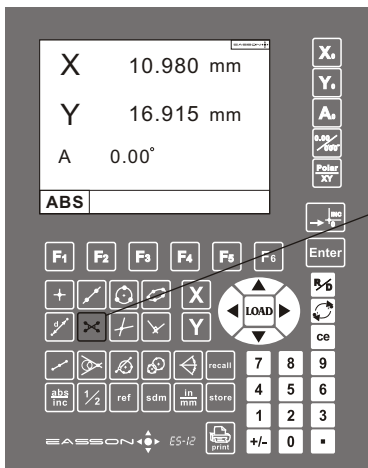



X		 DISTANCE
Y		
A		
<b>ABS</b>	Entry Done.. DISTANCE: ----- X1: 5.996 Y1: 11.774 X2: 9.197 Y2: 12.554 DIST: 3.302	

Move the work table to the second point of the line, the point coordinates will be displayed.

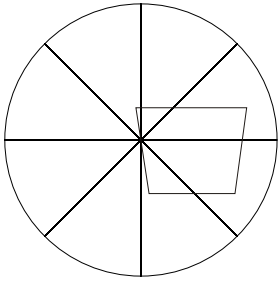
Users can select to save, print or exit.

### f) Point / point cross



X	10.980	 PT.INTC
Y	16.915	
A	0.00°	
<b>ABS</b>	PT. 1 of LINE 1	


## Measuring function

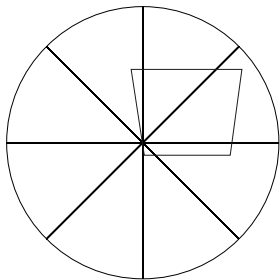


Move the work table to the first point of the first line.

Enter




X	5.948	 PT. INTC
Y	8.005	
A	0.00°	
		Meas Point: 1 X: 5.948 Y: 8.005
<b>ABS</b>	PT. 2 of LINE 1	

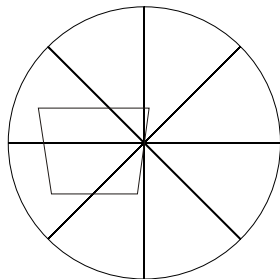


Move the work table to the second point of the first line.

Enter




X	5.934	 PT. INTC
Y	7.153	
A	0.00°	
		Meas Point: 1 X: 5.948 Y: 8.005 Meas Point: 2 X: 5.934 Y: 7.153
<b>ABS</b>	PT. 1 of LINE 2	

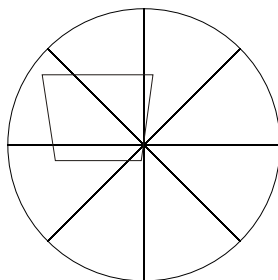


Move the work table to the first point of the second line.

Enter




X	6.577	 PT. INTC
Y	7.318	
A	0.00°	
		Meas Point: 2 X: 5.934 Y: 7.153 Meas Point: 3 X: 6.577 Y: 7.318
<b>ABS</b>	PT. 2 of LINE 2	



Move the work table to the second point of the second line.

Enter



X		 PT. INTC
Y		
A		
		INTERSEC.PT.: X: 5.931 Y: 6.957 ANG: 120.0811°
<b>ABS</b>		

Users can select to save, print or exit.

## Measuring function

Operate as below to find the line / line cross point:

The initial screen shows the 'PT. INTC' mode with the following data:

X	5.931
Y	6.957
A	120.081°

The 'INC' button is highlighted with a hand icon. An arrow points to the resulting screen:

X	2.248	mm
Y	1.252	mm
A	0.00°	
INC	0 = INTC. PT	

Move the work table until the X, Y coordinates display are both 0, then this point is the line / line cross point.

The resulting screen shows the intersection point coordinates:

X	0.000	mm
Y	0.000	mm
A	0.00°	
INC	0 = INTC. PT	

### g) Line / line cross point

The first condition of this function is to save 2 lines separately in 2 different memory position. For example:

Save the first line:

The initial screen shows the 'LINE' mode with the following data:

Y=M*X+C
M: 0.5577
C: 3.6474
INCL: 29.1500°
STG: 0.000

The 'ce' button is highlighted for 'Exit'. An arrow points to the 'store' button for 'Save'. Another arrow points to the '1' button followed by 'Enter' for 'Print'.

The resulting screen shows the line saved in memory position 1:

X		
Y		
A		
ABS	Store to 0-99?	

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved in NO. 1 position.

## Measuring function

Save the second line.

The diagram illustrates the steps to save a line. From the initial screen, the user presses the **ce** button to exit. Then, they press the **store** button to save the line. A prompt asks for a memory position from 0 to 99. The user selects **2** and presses **Enter**.

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved in NO. 2 position.

After saving the 2 lines separately the line / line cross point function can be operated.

The diagram shows the sequence for the line/line intersection function. It begins with a screen displaying the current coordinates: X = 15.868 mm, Y = 8.847 mm, and A = 0.00°. The user presses the intersection function button. The next screen prompts for the 'LINE 1 Feature NO.?' and the user presses **1** and **LOAD**. The following screen prompts for the 'LINE 2 Feature NO.?' and the user presses **2** and **LOAD**. The final screen displays 'Entry Done..'.

## Measuring function

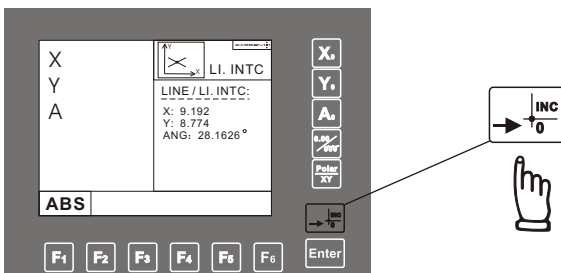
Enter



X	LI. INTC LINE / LI. INTC: X: 9.192 Y: 8.774 ANG: 28.1626°
Y	
A	
<b>ABS</b>	

Users can select to save, print or exit.

Operate as below to find the line / line cross point:



X	-0.652 mm
Y	-0.011 mm
A	0.00°
<b>INC</b>	

Move the work table until the X, Y coordinates display are both 0, then this point is the line / line cross point.

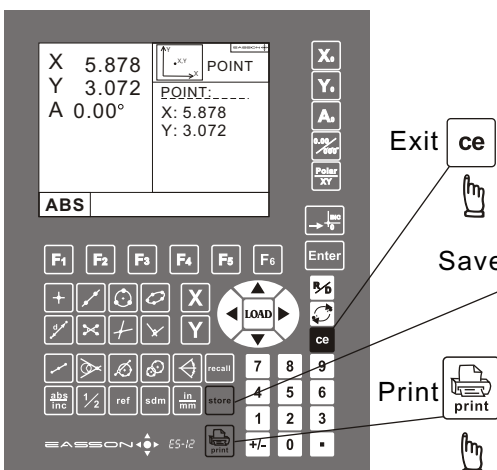


X	0.000 mm
Y	0.000 mm
A	0.00°
<b>INC</b>	

h) Point / line vertical point



Save the point.



Exit ce



Save store



Print



X	5.878	POINT POINT:----- X: 5.878 Y: 3.072
Y	3.072	
A	0.00°	
<b>ABS</b>		Store to 0-99?

1

Enter



The memory position is NO. 0 to 99.

For example the line needs to be saved in NO. 1 position.

Users can select to save, print or exit.

## Measuring function

Save the line.

Exit **ce**

Save **store**

Print **print**

**2** **Enter**

**ABS** Store to 0-99?

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved  
in NO. 2 position.

**ABS** LINE 1 FeatureNO.?

PEND. PT

**2** **LOAD**



**ABS** POINT 2 FeatureNO.?

PEND. PT

**1** **LOAD**



**ABS** Entry Done..

PEND. PT

## Measuring function

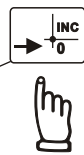
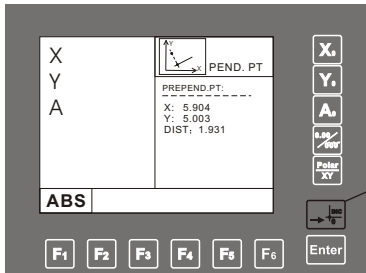
Enter



X Y A	<div style="text-align: right; font-size: small;">  PEND. PT                 </div> <hr style="border: 0; border-top: 1px dashed black;"/> PREPEND.PT: X: 5.904 Y: 5.003 DIST: 1.931
<b>ABS</b>	

Users can select to save, print or exit.

Operate as below to find the point / line vertical projecting point:



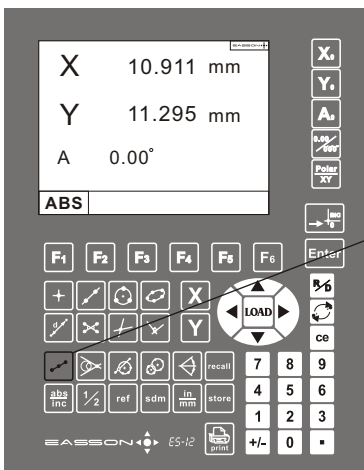
X	2.696 mm	
Y	-0.036 mm	
A	0.00°	
<b>INC</b>	0 = PREPEND. PT	

Move the work table until the X, Y coordinates display are both 0, then this point is the point / line vertical projecting point.



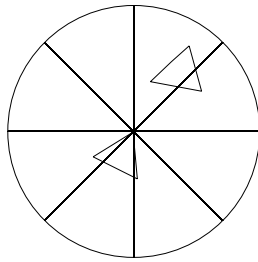
X	0.000 mm	
Y	0.000 mm	
A	0.00°	
<b>INC</b>	0 = PREPEND. PT	

l) Point / point center point



X	10.911	<div style="text-align: right; font-size: small;">  CENT.PT                 </div>
Y	11.295	
A	0.00°	
<b>ABS</b>	Select Point: 1	

## Measuring function

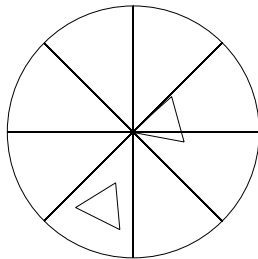


Move the work table to the first point, the coordinates will be displayed.

Enter



X	5.902	CENT.PT Meas Point: 1 X: 5.902 Y: 5.002
Y	5.002	
A	0.00°	
<b>ABS</b>	Select Point:2	



Move the work table to the second point, the coordinates will be displayed.

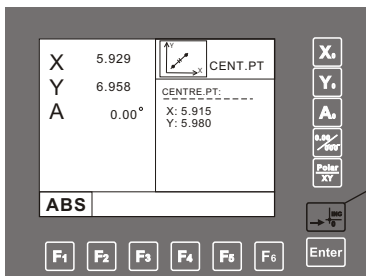
Enter



X	5.929	CENT.PT CENTRE.PT: ---- X: 5.915 Y: 5.980
Y	6.958	
A	0.00°	
<b>ABS</b>		

Users can select to save, print or exit.

Operate as below to find the point / point center point:



INC



X	0.014	mm
Y	0.978	mm
A	0.00°	
<b>INC</b>	0 = CENT. PT	

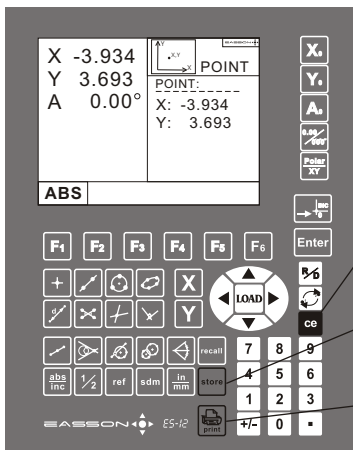
Move the work table until the X, Y coordinates display are both 0, then this point is point / point center point.



X	0.000	mm
Y	0.000	mm
A	0.00°	
<b>INC</b>	0 = CENT. PT	

j) Point / circle tangent point

Save the point.



Exit ce



Save store



Print print



X	-3.934	POINT POINT: X: -3.934 Y: 3.693
Y	3.693	
A	0.00°	
<b>ABS</b>	Store to 0-99?	

1 Enter



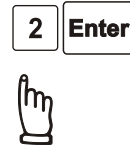
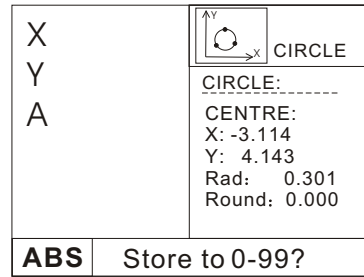
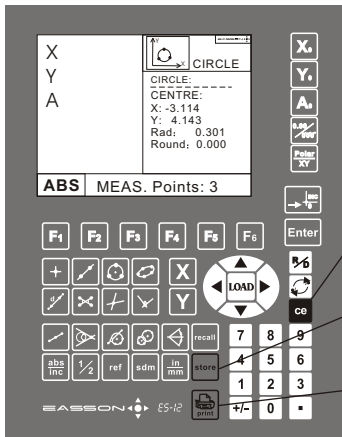
The memory position is NO. 0 to 99. For example the line needs to be saved in NO. 1 position.

Users can select to save, print or exit.



# Measuring function

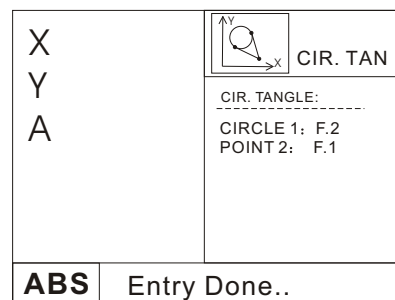
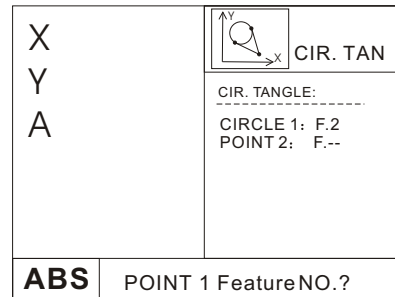
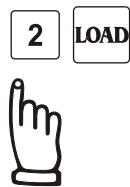
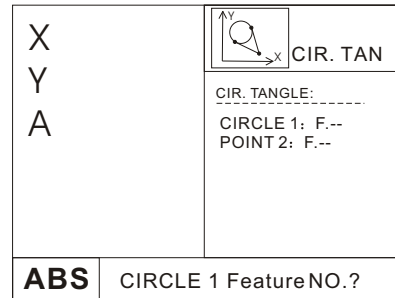
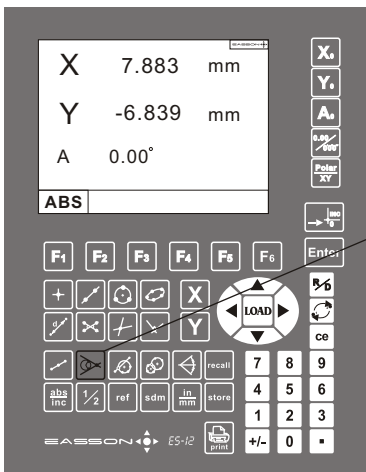
Save the circle.



The memory position is NO. 0 to 99.

For example the line needs to be saved in NO. 2 position.

Users can select to save, print or exit.



## Measuring function

Enter



X -3.062 Y 3.847 A 0.00°	<div style="border: 1px solid black; padding: 2px; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> CIR. TAN CIR. TANGLE: .. X: -3.062 Y: 3.847 X: -3.336 Y: 4.346
<b>ABS</b>	Circle Tangent: 1



X -3.336 Y 4.346 A 0.00°	<div style="border: 1px solid black; padding: 2px; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> CIR. TAN CIR. TANGLE: .. X: -3.062 Y: 3.847 X: -3.336 Y: 4.346
<b>ABS</b>	Circle Tangent: 2

Switch between 2 tangent points by press .

Operate as below to find the point / circle tangent point:

X -3.336 Y 4.346 A 0.00°	<div style="border: 1px solid black; padding: 2px; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> CIR. TAN CIR. TANGLE: .. X: -3.062 Y: 3.847 X: -3.336 Y: 4.346
<b>ABS</b>	Circle Tangent: 2
F1 F2 F3 F4 F5 F6	X <sub>0</sub> Y <sub>0</sub> A <sub>0</sub> Polar XY INC Enter



X 2.696 mm Y -0.036 mm A 0.00°	<div style="border: 1px solid black; padding: 2px; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> CIR. TAN CIR. TANGLE: .. X: -3.062 Y: 3.847 X: -3.336 Y: 4.346
<b>INC</b>	0 = TANGENT. PT 2

Move the work table until the X, Y coordinates display are both 0, then this point is the point / circle tangent point 2.

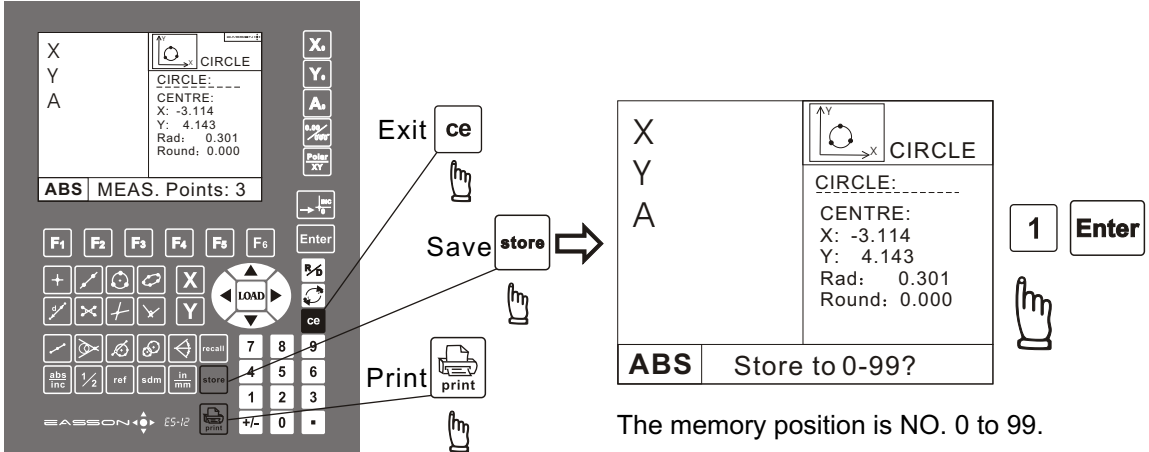


X 0.000 mm Y 0.000 mm A 0.00°	<div style="border: 1px solid black; padding: 2px; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> CIR. TAN CIR. TANGLE: .. X: -3.062 Y: 3.847 X: -3.336 Y: 4.346
<b>INC</b>	0 = TANGENT. PT 2

## Measuring function

### k) Line / circle tangent point

Save the circle.



The left panel shows the 'CIRCLE' screen with the following data:

X	
Y	
A	
CIRCLE: -----	
CENTRE:	
X:	-3.114
Y:	4.143
Rad:	0.301
Round:	0.000

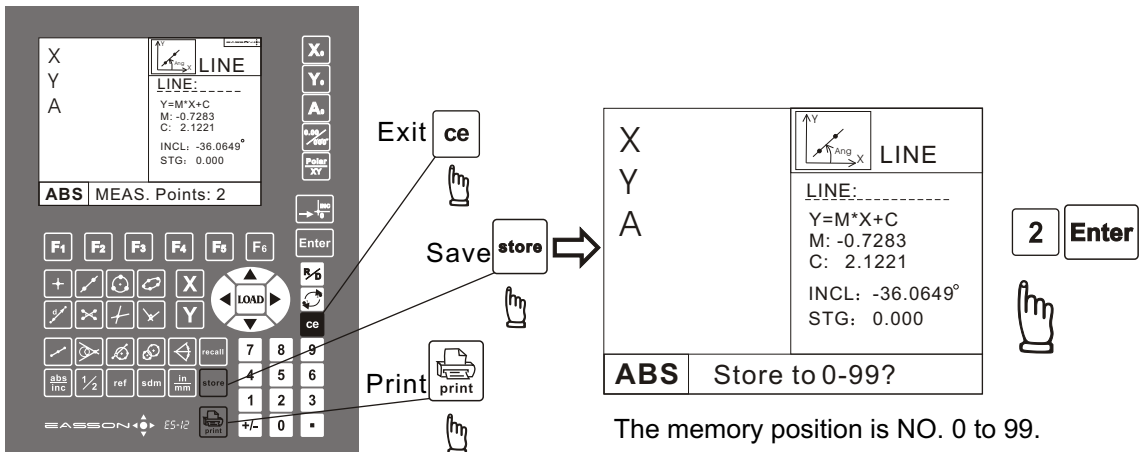
The right panel shows the 'Store to 0-99?' screen with the following data:

X	
Y	
A	
CIRCLE: -----	
CENTRE:	
X:	-3.114
Y:	4.143
Rad:	0.301
Round:	0.000
Store to 0-99?	

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved  
in NO.1 position.

Save the line.



The left panel shows the 'LINE' screen with the following data:

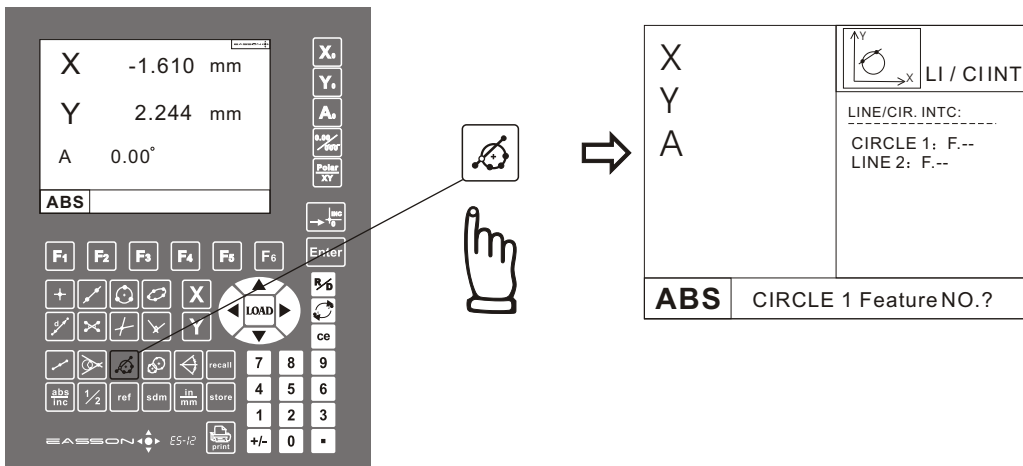
X	
Y	
A	
LINE: -----	
Y=M*X+C	
M:	-0.7283
C:	2.1221
INCL:	-36.0649°
STG:	0.000

The right panel shows the 'Store to 0-99?' screen with the following data:

X	
Y	
A	
LINE: -----	
Y=M*X+C	
M:	-0.7283
C:	2.1221
INCL:	-36.0649°
STG:	0.000
Store to 0-99?	

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved  
in NO.2 position.



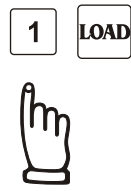
The left panel shows the 'LI / CI INT' screen with the following data:

X	-1.610 mm
Y	2.244 mm
A	0.00°

The right panel shows the 'CIRCLE 1 FeatureNO.?' screen with the following data:

X	
Y	
A	
LINE/CIR. INT: -----	
CIRCLE 1: F--	
LINE 2: F--	
CIRCLE 1 FeatureNO.?	

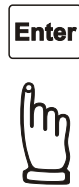
## Measuring function



X		LI / CI INT
Y		LINE/CIR. INTC: .....
A		CIRCLE 1: F.1 LINE 2: F.--
<b>ABS</b>	LINE 2 Feature NO.?	



X		LI / CI INT
Y		LINE/CIR. INTC: .....
A		CIRCLE 1: F.1 LINE 2: F.2
<b>ABS</b>	Entry Done..	



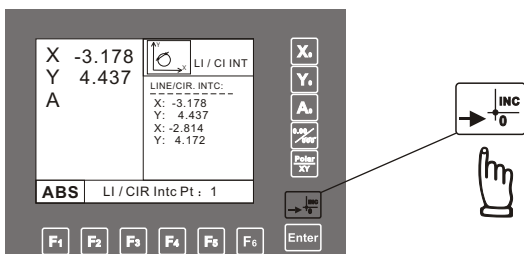
X	-2.814		LI / CI INT
Y	4.172		LINE/CIR. INTC: .....
A			X: -3.178 Y: 4.437 X: -2.814 Y: 4.172
<b>ABS</b>	LI / CIR Intc Pt : 2		



X	-3.178		LI / CI INT
Y	4.437		LINE/CIR. INTC: .....
A			X: -3.178 Y: 4.437 X: -2.814 Y: 4.172
<b>ABS</b>	LI / CIR Intc Pt : 1		

Press to switch between 2 cross points.

Operate as below to find the line / circle cross points:



X	0.084	mm
Y	0.007	mm
A	0.00°	
<b>INC</b>	0 = INTC. PT 1	

Move the work table until the X, Y coordinates display are both 0, then this point is the line / circle cross point 1.

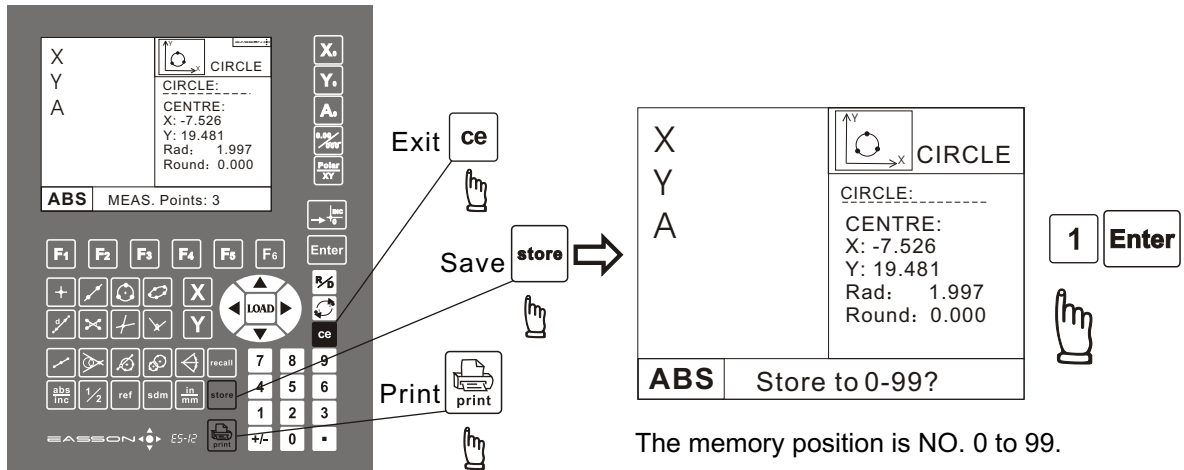


X	0.000	mm
Y	0.000	mm
A	0.00°	
<b>INC</b>	0 = INTC. PT 1	

# Measuring function

## l) Circle / circle cross points

Save the first circle.



Exit **ce**

Save **store**

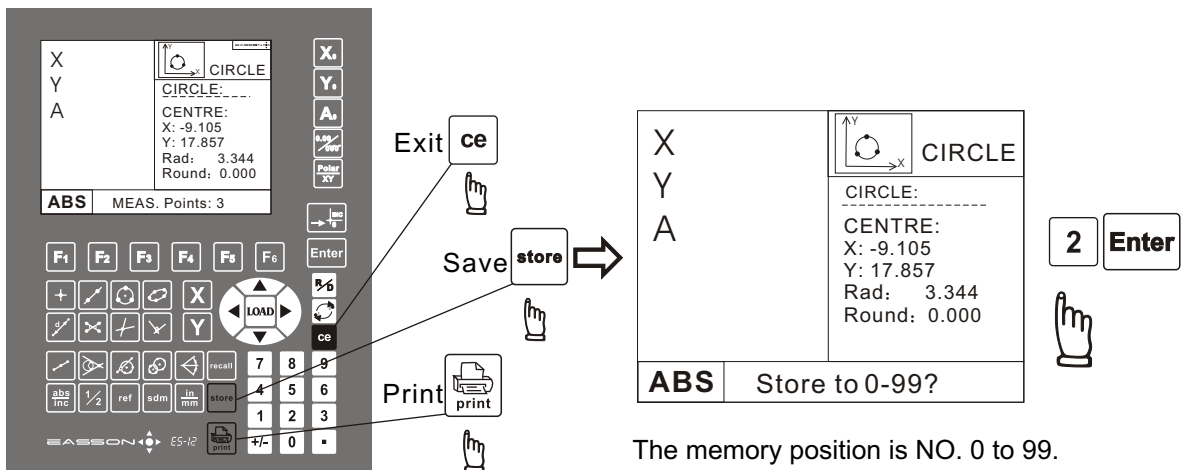
Print **print**

**1** **Enter**

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved in NO. 1 position.

Save the second circle.



Exit **ce**

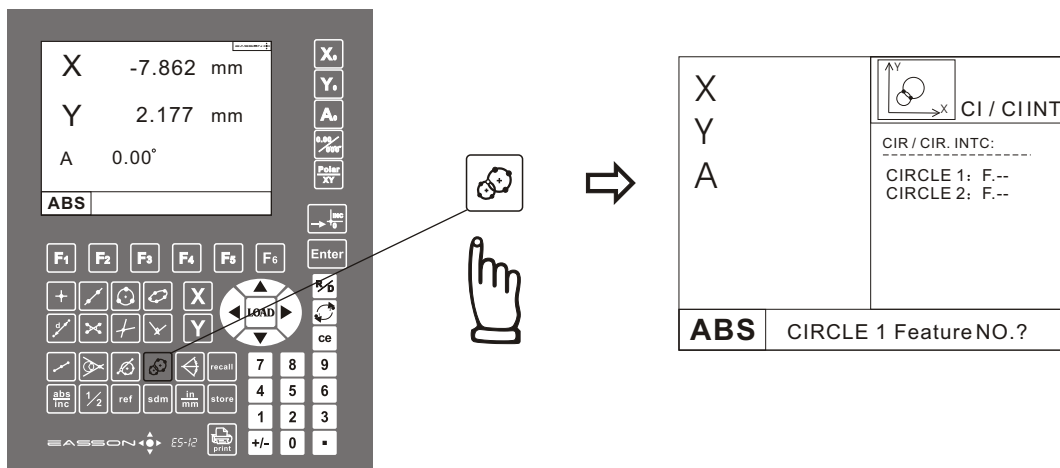
Save **store**

Print **print**

**2** **Enter**

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved in NO. 2 position.



**ABS** CIRCLE 1 FeatureNO.?

## Measuring function

1 LOAD



X		CI / CI INT CIR / CIR. INTC: --- CIRCLE 1: F.1 CIRCLE 2: F.--
Y		
A		
<b>ABS</b>		CIRCLE 2 FeatureNO.?

2 LOAD



X		CI / CI INT CIR / CIR. INTC: --- CIRCLE 1: F.1 CIRCLE 2: F.2
Y		
A		
<b>ABS</b>		Entry Done..

Enter



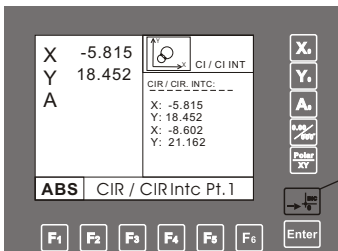
X	-8.602	CI / CI INT CIR / CIR. INTC: --- X: -5.815 Y: 18.452 X: -8.602 Y: 21.162
Y	21.162	
A		
<b>ABS</b>		CIR / CIR Intc Pt.2



X	-5.815	CI / CI INT CIR / CIR. INTC: --- X: -5.815 Y: 18.452 X: -8.602 Y: 21.162
Y	18.452	
A		
<b>ABS</b>		CIR / CIR Intc Pt.1

Press to switch between 2 cross points of the circles.

Operate as below to find the circle / circle cross points:



X	-1.429 mm
Y	-0.092 mm
A	0.00°
<b>INC</b>	0 = INTC. PT 1

Move the work table until the X, Y coordinates display are both 0, then this point is the circle / circle cross point 1.

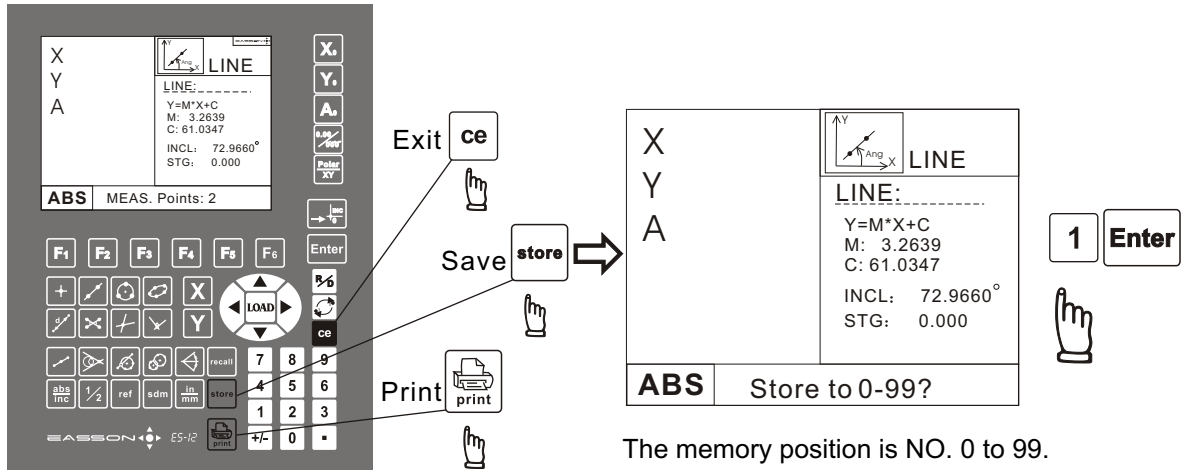


X	0.000 mm
Y	0.000 mm
A	0.00°
<b>INC</b>	0 = INTC. PT 1

## Measuring function

m) Line / line center line 

Save the first line.



Exit **ce**

Save **store**

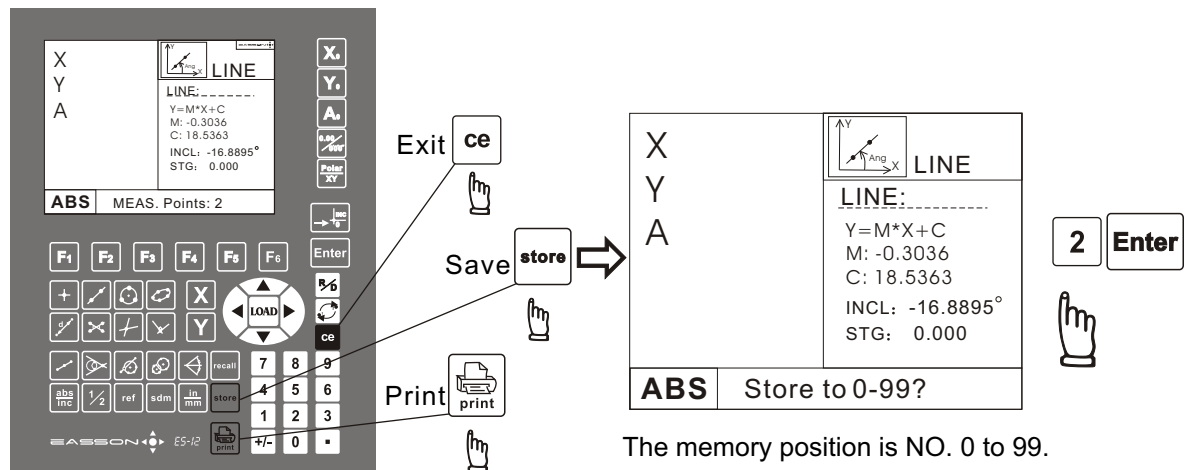
Print **print**

**1** **Enter**

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved  
in NO. 1 position.

Save the second line.



Exit **ce**

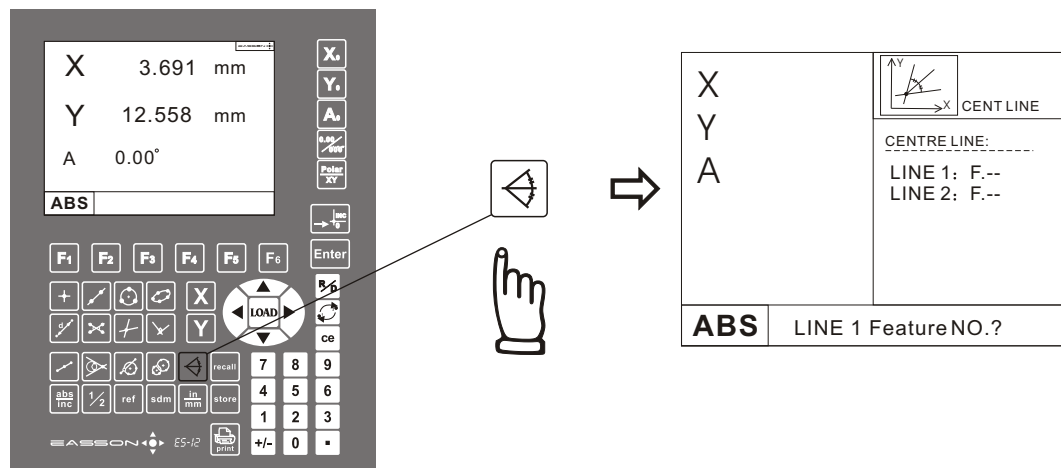
Save **store**

Print **print**

**2** **Enter**

Users can select to save, print or exit.

The memory position is NO. 0 to 99.  
For example the line needs to be saved  
in NO. 2 position.



**LINE 1 FeatureNO.?**

## Measuring function

1 **LOAD**



X Y A	CENT LINE CENTRE LINE:----- LINE 1: F.1 LINE 2: F.--
<b>ABS</b>	LINE 2 FeatureNO.?

2 **LOAD**



X Y A	CENT LINE CENTRE LINE:----- LINE 1: F.1 LINE 2: F.2
<b>ABS</b>	Entry Done..

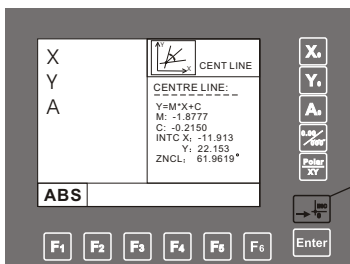
**Enter**



X Y A	CENT LINE CENTRE LINE:----- Y=M*X+C M: -1.8777 C: -0.2150 INTC X: -11.913 Y: 22.153 INCL: 61.9619°
<b>ABS</b>	

Users can select to save, print or exit.

Operate as below to find the cross point of the crossing lines:



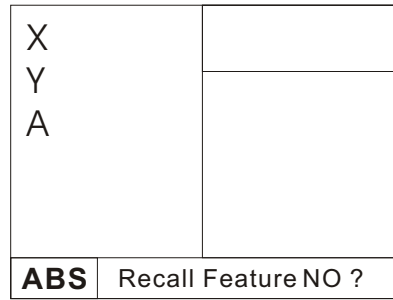
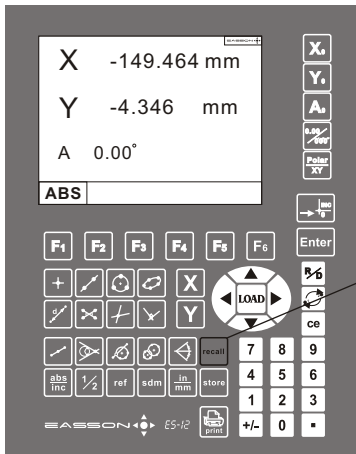
X Y A	2.016 mm -0.612 mm 0.00°
<b>INC</b>	0 = ZNTC. of C.LINE

Move the work table until the X, Y coordinates display are both 0, then this point is the cross point of the crossing lines.

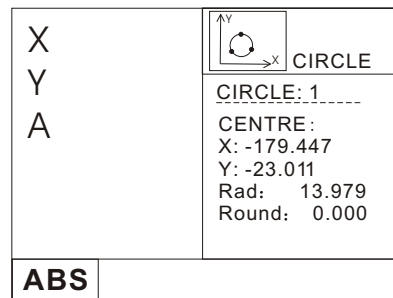
X Y A	0.000 mm 0.000 mm 0.00°
<b>INC</b>	0 = ZNTC. of C.LINE



n) Load the saved data. recall



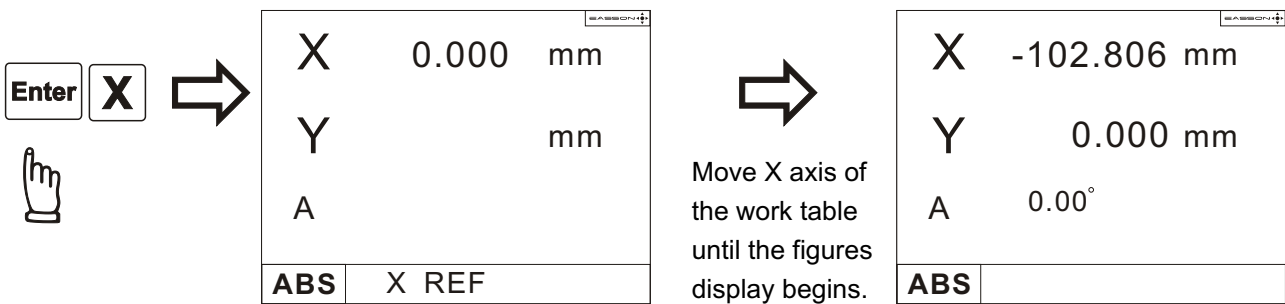
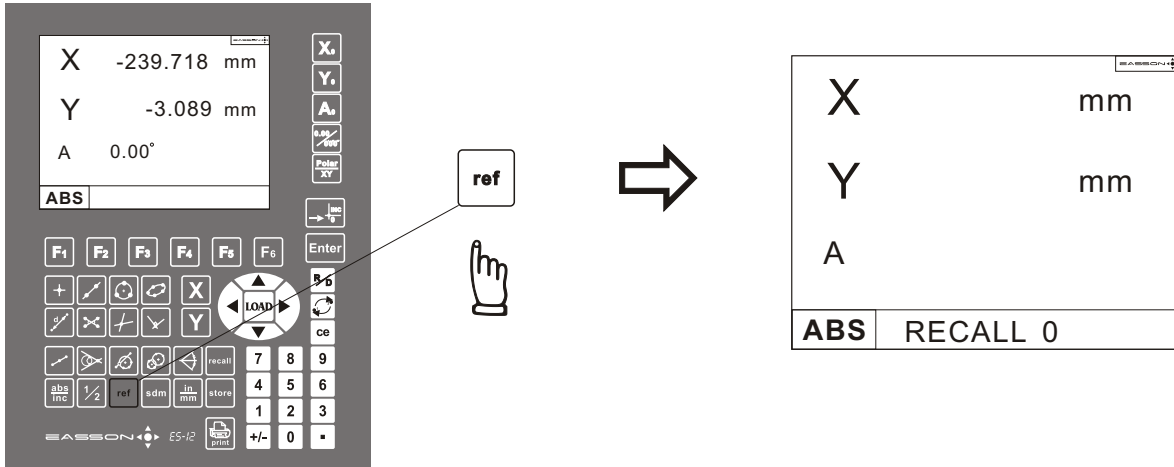
1 Enter



Press the figure keys to load the measured results.

## 10) Non-linear compensation

a) Find the reference in ABS coordinates.



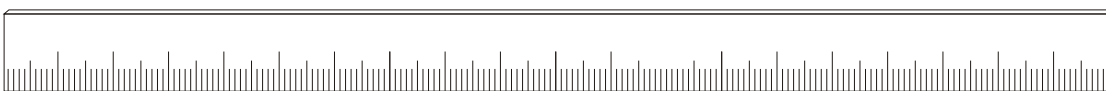
b) Find CP.START position.

The DRO non-linear compensation is calculated in the positive direction, so the CP.START should be at the negative point of the profile projector as the starting point.

**For example:** In this example we use the standard scale with 1 mm step distance as the measuring reference. Total compensation travel ( The maximum travel of the standard scale or the profile projector) is 200 mm, therefore,

$$CP.PITCH = 10\text{mm}$$

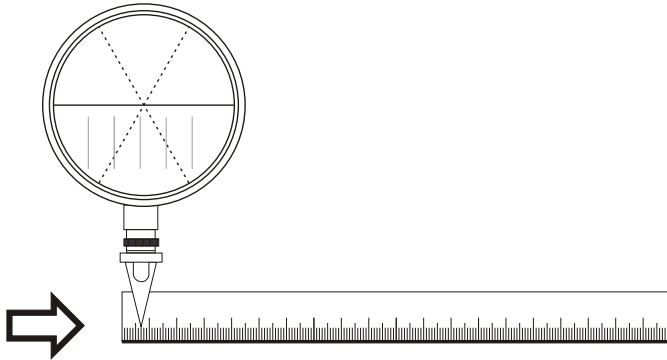
$$CP.STEP = (\text{Total compensation travel} = -200\text{mm}) / CP.PITCH = 20$$



Locate the starting point of the standard scale at the negative position of the profile projector, use the large magnification lens to focus this point as 0.

## Non-linear compensation

After focusing on this point, CP.START is the X axis display coordinates. Please notice, the DRO compensation direction is positive, so if the reference point of the linear transducer is at the center of the profile projector, CP.START value is negative.

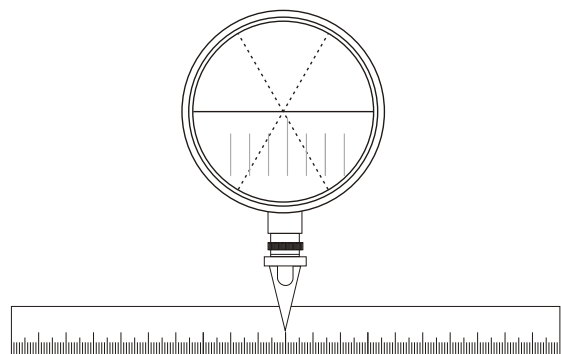
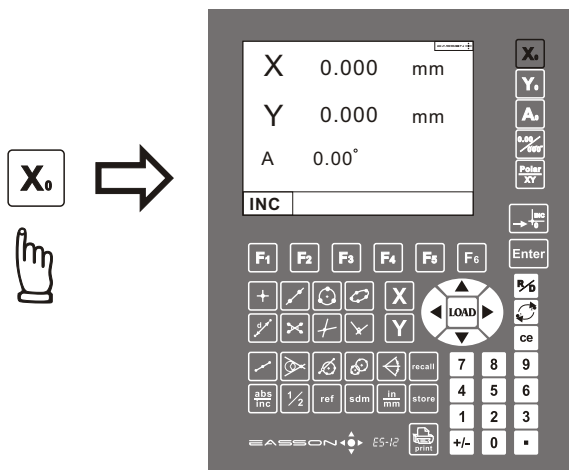


X	-102.806mm
Y	0.000mm
A	0.00°
<b>ABS</b>	

In this sample CP.START = -102.806, please note this number.

### c) Error measurement

For the convenience of measuring, INC coordinates display is advised. Set the coordinates to 0 at the first measuring point, then start measuring.



Start measuring, fill with the measuring result in the table as follow:

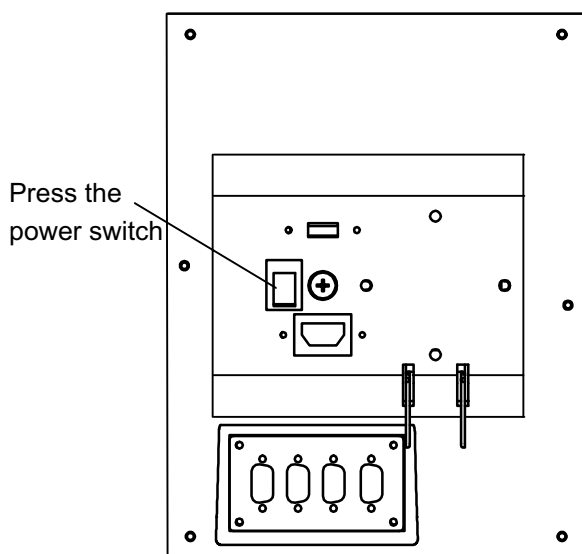
- \* We only need to input the measuring result during the non-linear compensation, but do not need to calculate the error, so the measuring result can be filled in a table as follow:

## Non-linear compensation

Standard position	Measuring result
10.000	9.994
20.000	19.989
30.000	29.987
40.000	39.983
50.000	49.981
.....	.....
.....	.....
.....	.....
190.000	189.934
200.000	199.930

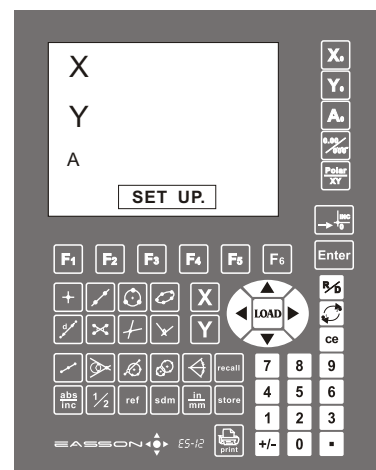
**CP.START=-102.806**  
**CP.PITCH=10**  
**CP.STEP=20**

d) Input the non-linear compensation data into the DRO:



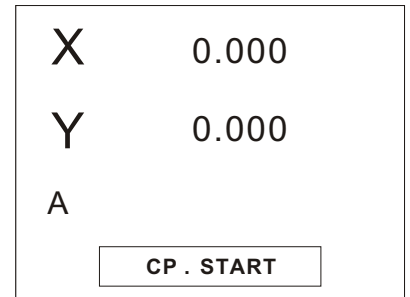
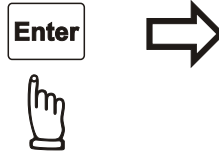
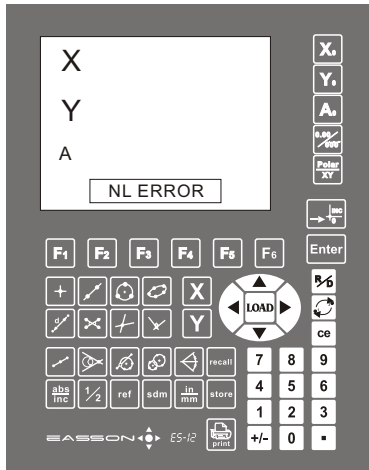
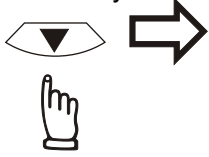
After the DRO power on and during the figures flashing, press **Enter** 3 times or above.

**Enter**

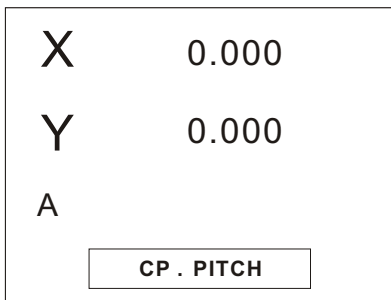
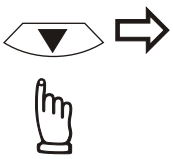
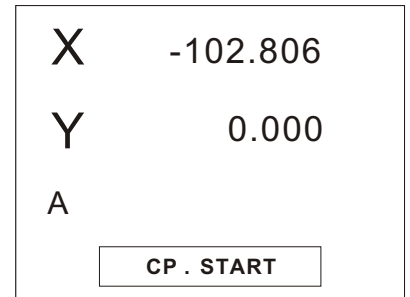
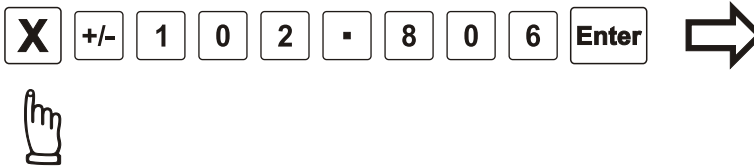


# Non-linear compensation

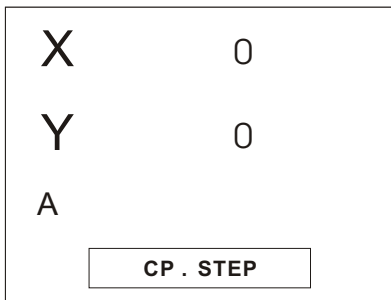
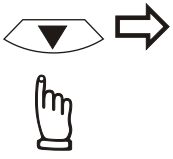
Press 6 times continually.



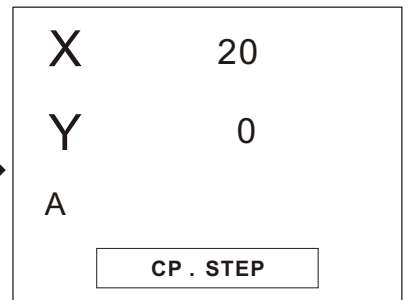
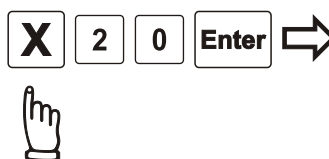
Input CP.START data.



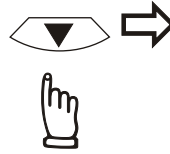
Input CP.PITCH data  
(Distance between each step).



Input CP.STEP data  
(Steps number).

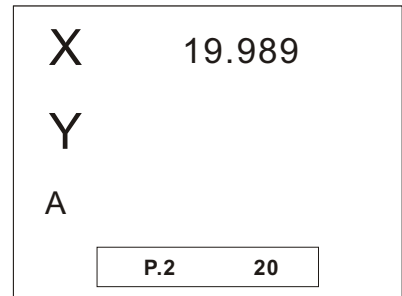
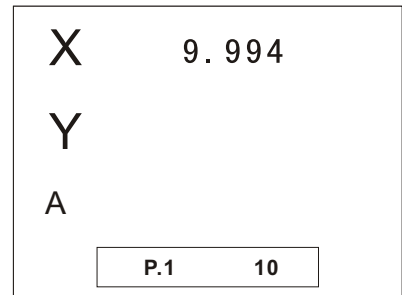



# Non-linear compensation

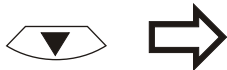


When the system enters into MEAS VAL mode press **X** to input the measuring result.

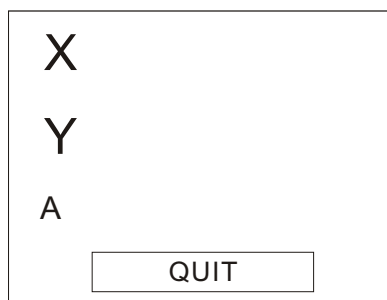
For example: Input the first measuring result.



Input all the measuring result one by one in order, press **Enter** **Enter**  after inputting all the results.



Press 3 times.



Press **Enter** to complete the process.

The Y axis non-linear compensation operation is the same as X axis.