



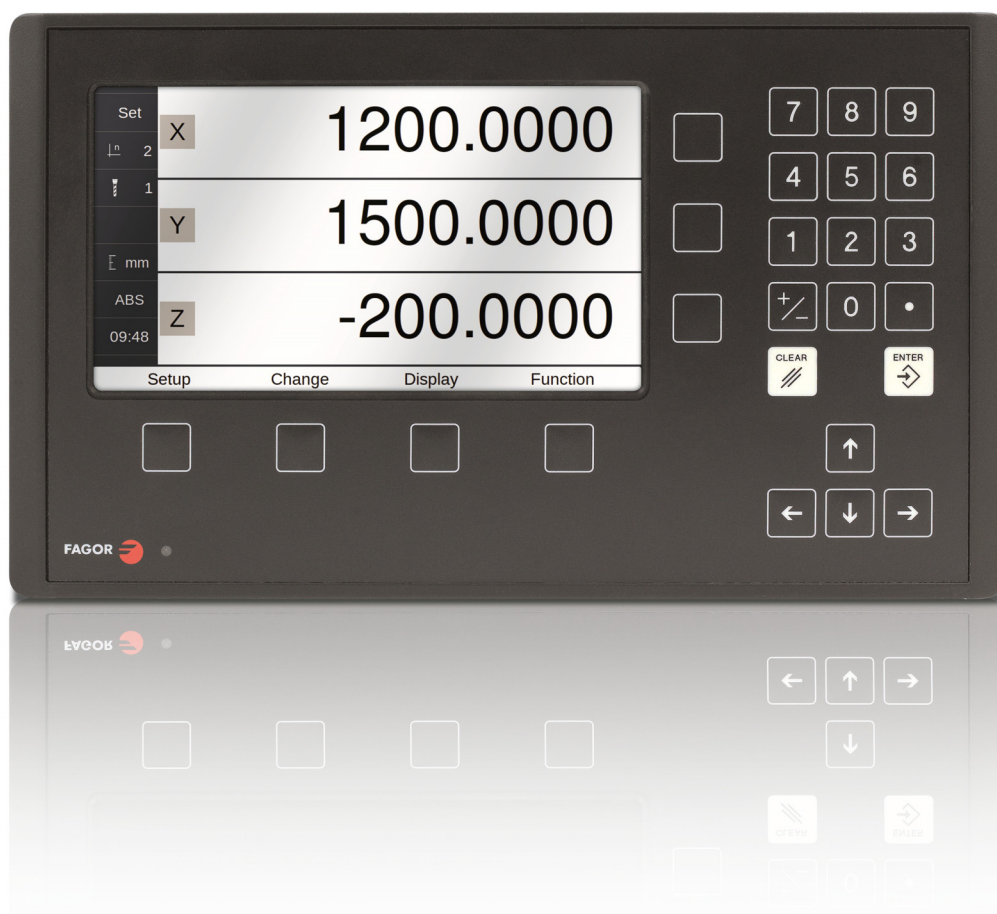
# DRO 400i

## Installation / Operation Manual

Manual code: 14460377

Manual version: 2310

Software version: v1.00





# INDEX

<b>1</b>	<b>DRO description .....</b>	<b>5</b>
<b>1.1</b>	<b>Front plate.....</b>	<b>5</b>
<b>1.2</b>	<b>Turning the unit on and off.....</b>	<b>5</b>
<b>1.3</b>	<b>Main screen description .....</b>	<b>6</b>
<b>1.4</b>	<b>Function bar.....</b>	<b>6</b>
1.4.1	Accessing functions in MILL mode .....	6
1.4.2	Accessing the functions in LATHE mode .....	6
<b>2</b>	<b>DRO operation in MILL mode .....</b>	<b>7</b>
<b>2.1</b>	<b>Display modes .....</b>	<b>7</b>
2.1.1	mm / inch .....	7
2.1.2	inc / abs .....	7
2.1.2.1	Absolute mode .....	7
2.1.2.2	Incremental mode .....	7
2.1.2.3	Degrees / Degrees-Minutes-Seconds .....	8
2.1.3	Rad / Diam .....	8
<b>2.2</b>	<b>Set/Clear.....</b>	<b>8</b>
2.2.1	In "Set" mode .....	8
2.2.2	In "Clear" mode .....	8
<b>2.3</b>	<b>Machine reference (home) search .....</b>	<b>9</b>
<b>2.4</b>	<b>Tools and references .....</b>	<b>9</b>
2.4.1	Tools .....	9
2.4.1.1	Tool change .....	9
2.4.1.2	Set a new tool in the table: .....	9
2.4.1.3	Tool compensation .....	10
2.4.2	Reference .....	10
2.4.2.1	Changing the reference .....	11
2.4.2.2	Setting part zero (datum) as instructed by the assistant: .....	11
2.4.2.3	Setting part zero (datum) without using the assistant .....	12
2.4.2.4	Searching the center of a part .....	12
<b>2.5</b>	<b>Special functions.....</b>	<b>13</b>
2.5.1	Bolt-hole drilling .....	13
2.5.2	Linear drilling .....	13
2.5.3	Grid pattern drilling .....	14
2.5.4	Go to .....	14
2.5.5	Calculator function .....	15
2.5.6	Simulation / execution special modes .....	15
2.5.6.1	Cycle simulation .....	15
2.5.6.2	Cycle execution .....	16
2.5.7	Probe .....	17
2.5.7.1	Turn the probe ON and OFF .....	17
<b>3</b>	<b>DRO operation in LATHE mode .....</b>	<b>19</b>
<b>3.1</b>	<b>Display modes .....</b>	<b>19</b>
3.1.1	2/3 axes .....	19
3.1.2	mm / inch .....	19
3.1.3	rad/diam .....	19
3.1.4	inc / abs .....	19
3.1.4.1	Absolute mode .....	19
3.1.4.2	Incremental mode .....	20
<b>3.2</b>	<b>Tool.....</b>	<b>20</b>
3.2.1	Tool setting .....	20
3.2.1.1	Setting the tool by touching a part of known diameter .....	21
3.2.1.2	Setting the tool by touching a part of unknown diameter .....	21
<b>3.3</b>	<b>Special functions.....</b>	<b>21</b>
3.3.1	Angle measurement .....	21
3.3.2	Angle calculation .....	22
3.3.3	Turning function .....	22
3.3.4	Calculator function .....	22
<b>4</b>	<b>DRO installation .....</b>	<b>23</b>
<b>4.1</b>	<b>Mounting on the support arm .....</b>	<b>23</b>
<b>4.2</b>	<b>Mounting of the built-in model.....</b>	<b>23</b>
<b>4.3</b>	<b>Dimensions of the display, the bracket and of the window to insert it into .....</b>	<b>24</b>
<b>4.4</b>	<b>Rear panel.....</b>	<b>25</b>
4.4.1	UL standard marking .....	25
<b>4.5</b>	<b>General technical characteristics .....</b>	<b>26</b>

<b>4.6</b>	<b>Connections .....</b>	<b>27</b>
4.6.1	Connection of the feedback systems .....	27
4.6.2	Probe connection (connector X6) .....	28
4.6.3	Power and machine connection .....	29
<b>4.7</b>	<b>Installation parameters .....</b>	<b>30</b>
4.7.1	Accessing installation parameters .....	30
4.7.2	User parameters .....	30
4.7.2.1	Language .....	30
4.7.2.2	Screen color .....	31
4.7.2.3	Chronometer .....	31
4.7.2.4	Sound .....	31
4.7.2.5	Screen brightness .....	31
4.7.3	Installer parameters .....	31
4.7.3.1	Parameter backup into USB memory .....	31
4.7.3.2	DRO .....	32
4.7.3.3	Feedback .....	33
4.7.3.4	Compensation .....	35
4.7.4	Test mode .....	36
<b>5</b>	<b>Appendix .....</b>	<b>37</b>
<b>5.1</b>	<b>UL seal .....</b>	<b>37</b>
<b>5.2</b>	<b>CE seal .....</b>	<b>37</b>
5.2.1	Declaration of conformity .....	37
5.2.2	Safety conditions .....	37
5.2.3	Warranty terms .....	39
5.2.4	Returning conditions .....	39
<b>5.3</b>	<b>Maintenance .....</b>	<b>39</b>

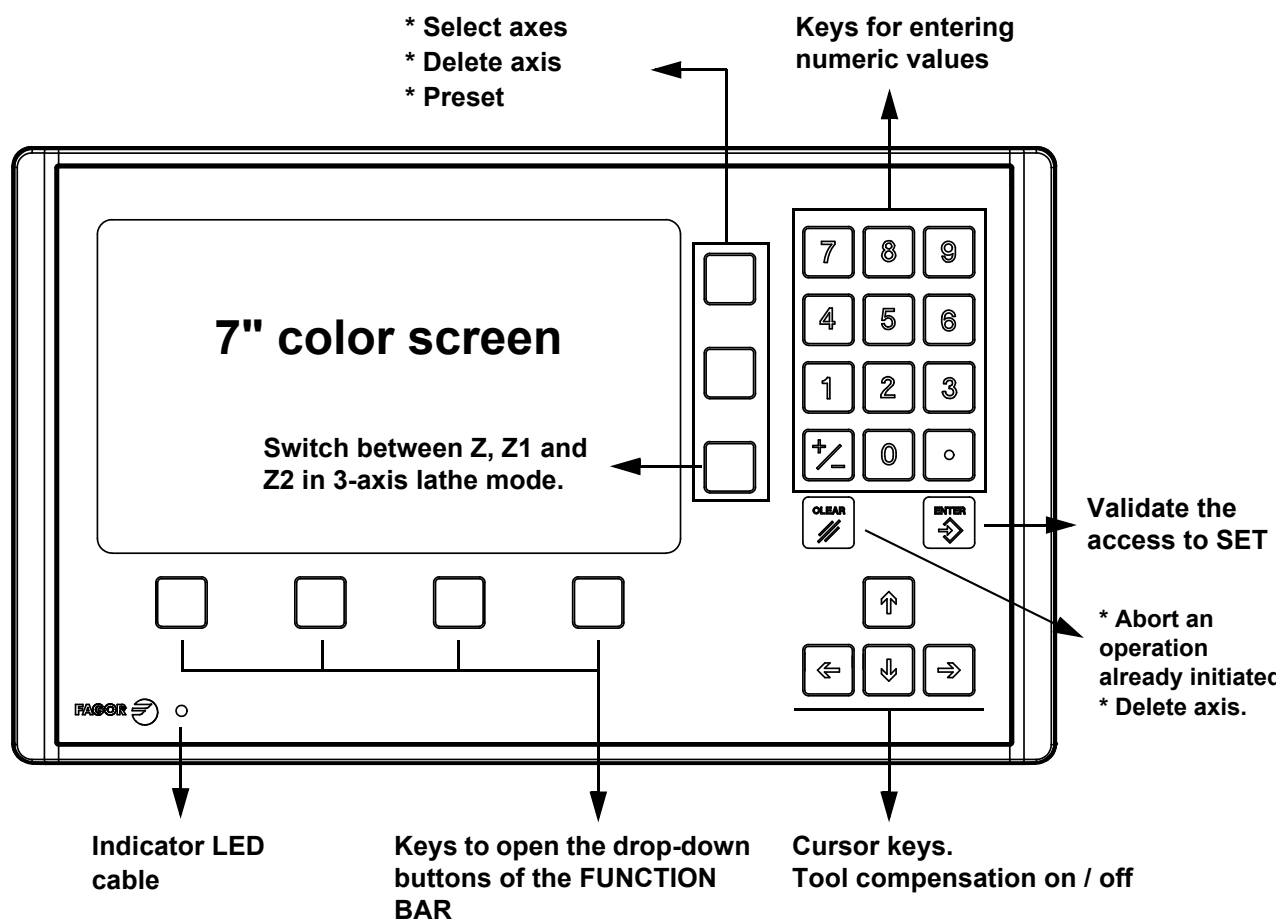
## IMPORTANT NOTE

**Some of the features described in this manual may not be available in this version.**

**Consult with the Fagor Automation branch office nearest you.**

# 1 DRO description

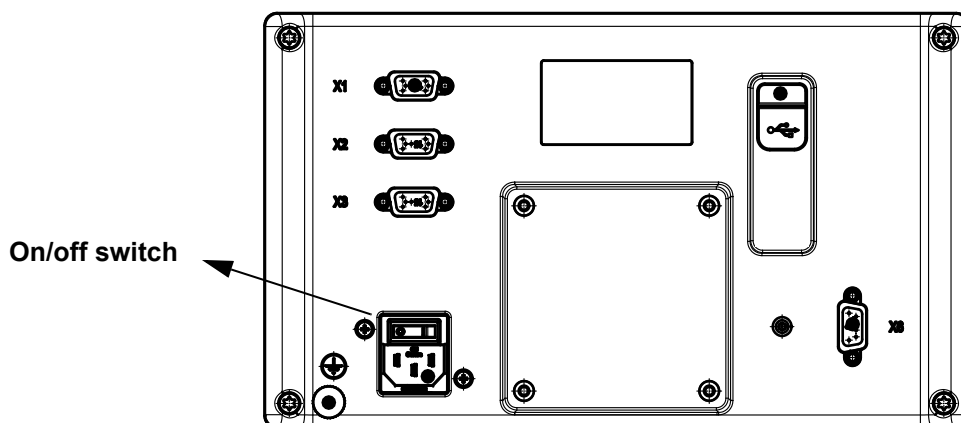
## 1.1 Front plate



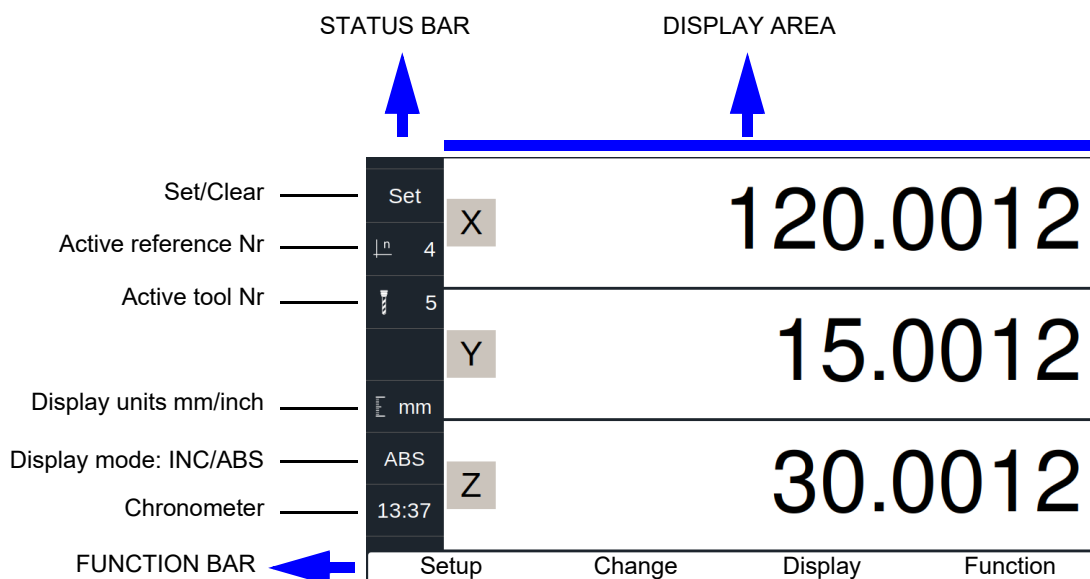
## 1.2 Turning the unit on and off

The Display is switched on and off by pressing the on/off switch at the back.

When the DRO is switched on, an initial screen appears, which disappears after a few seconds and opens the work screen.



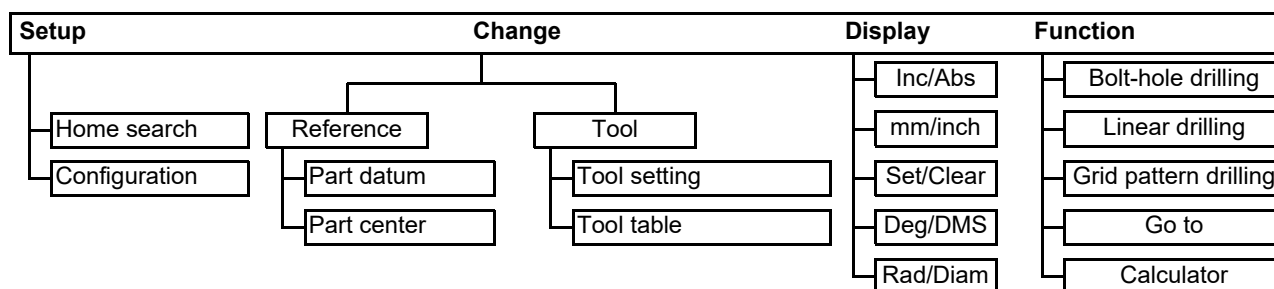
## 1.3 Main screen description



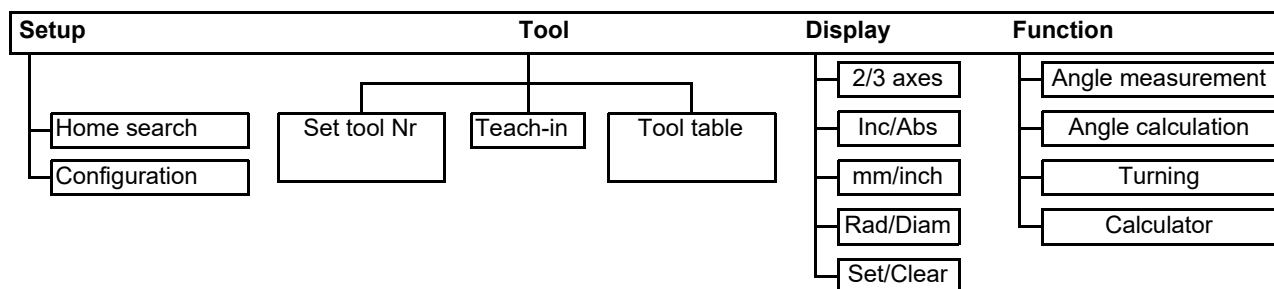
## 1.4 Function bar

The function bar gives access to the various functions offered by the DRO.

### 1.4.1 Accessing functions in MILL mode



### 1.4.2 Accessing the functions in LATHE mode



---

## 2 DRO operation in MILL mode

### 2.1 Display modes

Display

#### 2.1.1 mm / inch

Display

mm / inch

Toggle units between mm and inches.

This toggle is possible if the installer parameters have been set as toggle.

#### 2.1.2 inc / abs

Display

inc / abs

Toggle between incremental and absolute feedback reading (counting).

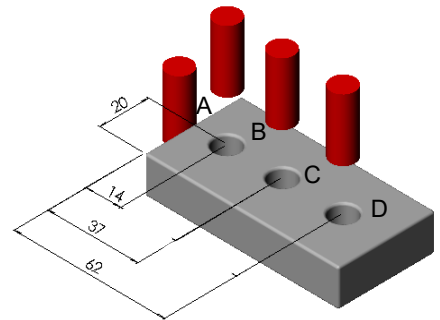
The status bar shows the currently active feedback reading mode.

##### 2.1.2.1 Absolute mode

The coordinates (position values) are referred to part zero.

The example on the right would be carried out as follows:

- (B) [14.000] Move the axis until the display reads [14.000] (B position) and drill the hole.
- (C) [37.000] Move the axis until the display reads [37.000] (C position) and drill the hole.
- (D) [62.000] Move the axis until the display reads [62.000] (D position) and drill the hole.

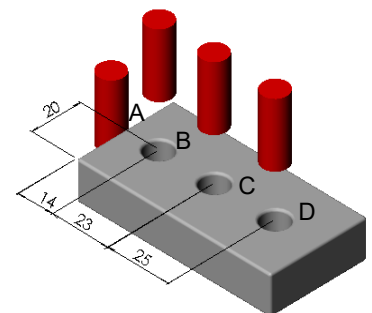


##### 2.1.2.2 Incremental mode

The coordinate is referred to the previous point where the axis display has been set to zero.

The example on the right would be carried out as follows starting at point A:

- (B) [14.000] Move the axis until the display reads [14.000] (B position) and drill the hole.  
Set the X axis to zero.
- (C) [23.000] Move the axis until the display reads [23.000] (C position) and drill the hole.  
Sets the X axis to zero.
- (D) [25.000] Move the axis until the display reads [25.000] (D position) and drill the hole.



### 2.1.2.3 Degrees / Degrees-Minutes-Seconds

Display

Deg / DMS



Toggles the axis display units between degrees and degrees, minutes, seconds.

### 2.1.3 Rad / Diam

Display

Rad / Diam

Toggles the X axis display between radius and diameter.

## 2.2 Set/Clear

Display

Set/Clear

There are two ways (modes) to set a value (Set) on the display or zero it (Clear).

### 2.2.1 In "Set" mode



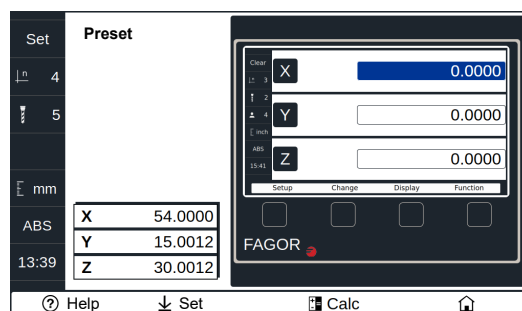
Value



To preset a value for an axis.



To zero the axis, either preset a 0 value using the previous keystroke sequence or use this other sequence (clear + axis).



### 2.2.2 In "Clear" mode

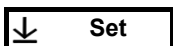


Set the display to zero.

To preset a value:



Value



And validate the data by pressing this key.



Or ignore it by pressing this key.



## 2.3 Machine reference (home) search

Setup

Home search



Select axis. A red bar appears on that axis display indicating that it is waiting for a reference pulse.

Move the selected axis until the DRO detects the reference mark.



A green checkmark appears next to the axis display when the reference mark is properly detected (homed) and the axis display will show the position value preset in parameter "user offset", (see [Reference](#)).

Set	X	0.0000
In 4		
5	Y	0.0000
mm		
ABS	Z	0.0000
13:40		
Help		



This icon indicates that the axis must be homed.

**Note:** When all the required axes are homed, the DRO automatically leaves the home search mode.

## 2.4 Tools and references

Change

### 2.4.1 Tools

Change

Tool

Change or define the tool (diameter and length).  
It offers a 20-tool table.

Set	Tool		
In 4	Tool Nr. 5		
5			
mm			
ABS			
13:41			
Help			

Tool	Diameter	Length
0	0.0000	0.0000
1	40.0000	10.0000
2	80.0000	25.0000
3	120.0000	50.0000
4	240.0000	0.0000
5	10.0000	0.0000
6	10.0000	0.0000

#### 2.4.1.1 Tool change

Tool Nr.



It becomes the current tool.

#### 2.4.1.2 Set a new tool in the table:



Select the tool number you wish to set.



Enter the diameter of the tool. Press Enter.



Enter the length of the tool. Press Enter.

2.4.1.3 Tool compensation

This DRO offers a function for compensating tool radius depending on the machining direction.

↑

ENTER

↔

Tool compensation on /off in this direction:

↓

ENTER

↔

Tool compensation on /off in this direction:

←

ENTER

↔

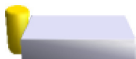
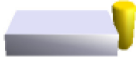

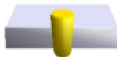
Tool compensation on /off in this direction:

→

ENTER

↔

Tool compensation on /off in this direction:



When machining pockets, tool radius compensation is activated in two axes at the same time.

→

↑

ENTER

↔

Tool compensation on /off for this corner of the pocket:

←

↑

ENTER

↔

Tool compensation on /off for this corner of the pocket:

←

↓

ENTER

↔

Tool compensation on /off for this corner of the pocket:





→

↓

ENTER

↔

Tool compensation on /off for this corner of the pocket:



2.4.2 Reference

Change

Reference

Change part reference (datum), set a new one or search the center of the part.

There are 100 references or datum points that may be set for the part when using absolute coordinates (0-99).

1/2

Assistant for searching the center of the part by touching on two sides.

Referencing

Assistant for setting the part zero (datum point).

Set

Number of Reference

4

mm

5

mm

ABS

14:55

Help

1/2

Referencing

Home

## 2.4.2.1 Changing the reference

Change

Reference

Changing from one reference to another.

Ref. no.



It changes to the selected reference.

## 2.4.2.2 Setting part zero (datum) as instructed by the assistant:

Change

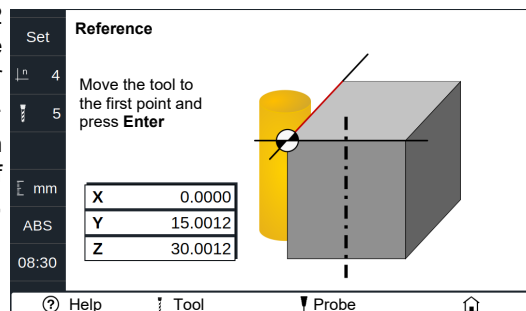
Reference

Origin

Setting part zero requires measuring at least 2 points. One point on each of the sides to be homed. The third point is optional and is used for setting the datum point (origin) of the vertical axis.

It activates the probe mode. If the probe has been set, it may be used to touch the desired sides of the part. Probe dimensions, length and diameter, must be entered as if they were those of a tool.

Probe



Tool

Set or change the tool. It will compensate for the radius of the tool being used.

[Z axis]

Activate Z axis homing.

**Optional:**

- Activate the probe mode if the probe has been configured and it is being used.
- Select the Z axis to set the datum point on the vertical axis.

**Sequence to follow:**

Tool

Set or change the tool.

Move the tool to the first side until it touches the part.



Press Enter.

Move the tool to the second side until it touches the part.



Press Enter.

If the vertical axis is activated, move the tool to the top side until it touches it.



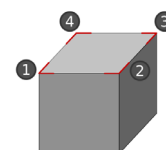
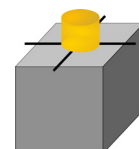
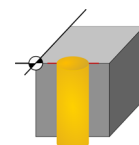
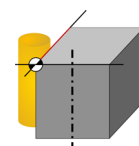
Press Enter.



Select the corner where the part zero (datum) will be set.

**Notes:** When using a probe, there is no need to press Enter, just touch a point on the desired side.

In order to ensure that tool or probe radius compensation is done correctly, the sides of the part to be referenced, must be aligned with the axes of the machine as much as possible.



### 2.4.2.3 Setting part zero (datum) without using the assistant

Change

Reference

Set a datum point at a corner other than the 3rd quadrant.

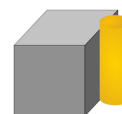


Compensate for tool radius on the X axis.

Touch with the tool on the side indicated in the figure.



Set the X axis to zero.

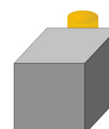


Compensate for tool radius on the Y axis.

Touch with the tool on the side indicated in the figure.



Set the Y axis to zero.



### 2.4.2.4 Searching the center of a part

Change

Reference

1/2

Tool

Set or change the tool.

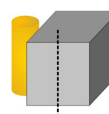
Probe

It activates the probe mode. If the probe has been set, it may be used to touch the desired sides of the part.

Move the tool to the first point.



Press ENTER.

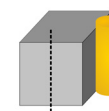


Move the tool to the second point.



Press the key of the axis whose center you're trying to find.

The display of the axis whose center you're searching shows a value that is half the distance moved in that axis. Move this axis to zero. The tool is now located at the center.



**Note:** This mode may be accessed directly by pressing this key.

## 2.5 Special functions

### Function

It gives access to the specific milling functions.

### 2.5.1 Bolt-hole drilling

#### Function

#### Bolt-hole drilling

It allows up to 99 holes to be drilled in a bolt-hole pattern in different planes (XY, XZ, YZ) without having to calculate the coordinates (X Y) of each hole, by simply keying in some basic data.



Select **Plane**.

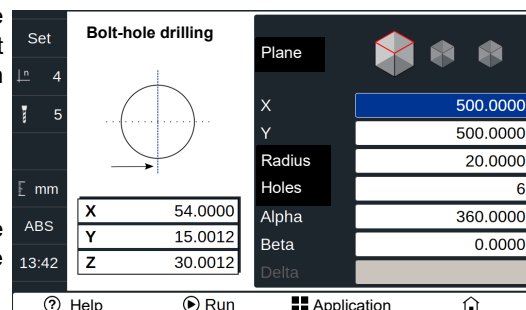
**X, Y:** Coordinates of the center of the circle where the holes will be drilled referred to the active reference zero.

**Radius** of the circle where the holes will be drilled.

**Number of Holes.**

**Alpha:** Total angle between the first and last hole of the circle.

**Beta:** Position of the first hole.



### 2.5.2 Linear drilling

#### Function

#### Linear drilling

It allows up to 99 holes to be drilled in line in different planes (XY, XZ, YZ) without having to calculate the coordinates (X Y) of each hole, by simply keying in some basic data.



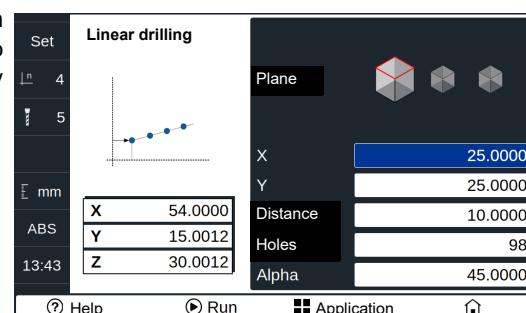
Select **Plane**.

**X, Y:** Position of the first hole.

**Distance** between holes.

**Number of Holes.**

**Alpha:** Inclination of the line of holes.



## 2.5.3 Grid pattern drilling

Function

Grid pattern

It allows up to 99 holes to be drilled in grid or frame pattern in different planes (XY, XZ, YZ) without having to calculate the coordinates (X Y) of each hole, by simply keying in some basic data.



Select **plane**.

**Type:** Grid (a matrix of holes) or frame (holes in the perimeter of a frame).

**X, Y:** Position of the first hole.

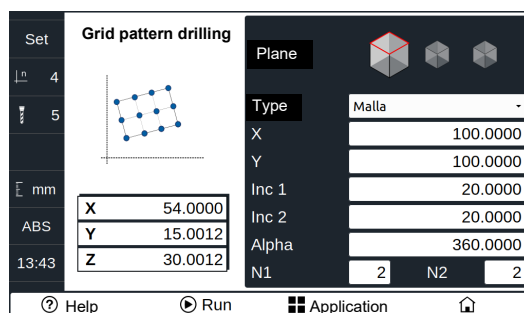
**Inc 1:** Gap between the holes of the grid along the X axis.

**Inc 2:** Gap between the holes of the grid along the Y axis.

**Alpha:** Inclination of the matrix of holes.

**N 1:** Nr of holes along the X axis.

**N 2:** Nr of holes along the Y axis.

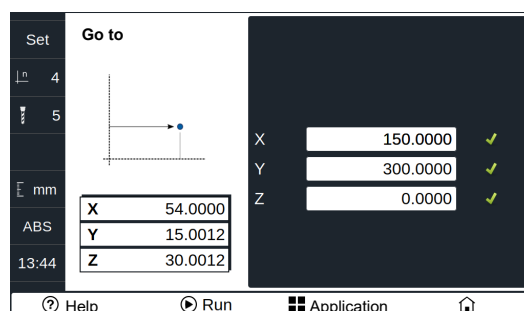


## 2.5.4 Go to

Function

Go to

This function is the alternative to the most commonly used positioning method consisting in presetting an incremental zero at a point and moving the axis until the display shows the desired coordinate. The **Go to** function may be used to do the same in the opposite direction, you enter the coordinates of the target point and the DRO screen shows these values with the negative sign. The operator must move the axes to zero. The advantage of using this method is that the operator does not have to memorize the target coordinates, he simply has to move the axes to zero.



When presetting a value on an axis, press **ENTER** to go on to the next axis and validate the data just entered.

## 2.5.5 Calculator function

Function

Calculator

It may be used to carry out mathematical and trigonometric operations as well as preset the desired axis with the result of the calculation or import the displayed coordinate values into the calculator to carry out math operations.

Different types of calculators may be selected at the function bar: Arithmetic, trigonometric and for square functions.

Numeric

Numeric calculator. Functions: + - x /

Trigonom

Trigonometric calculator. Functions: Sin, Cos, Tan.

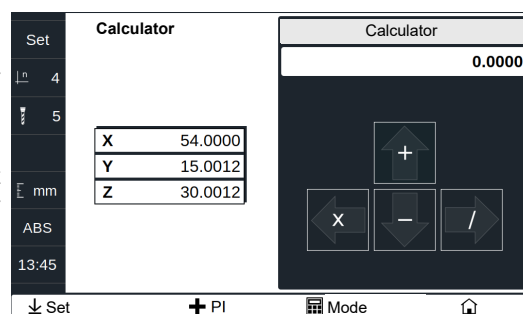
Square

Calculator with functions:  $x^2$ ,  $1/x$ ,  $\sqrt{\quad}$



Set

Set one of the axis with the result of the calculator. To do this, access the calculator by pressing the Calc button of the function bar on the Preset screen.



## 2.5.6 Simulation / execution special modes

After completing the data that define a drilling cycle, you can execute the cycle or simulate it to verify that data entered is correct.

### 2.5.6.1 Cycle simulation

Function

Bolt-hole drilling

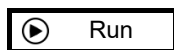
Application

Show Graph

Linear drilling

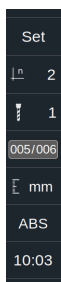
Grid pattern

## 2.5.6.2 Cycle execution

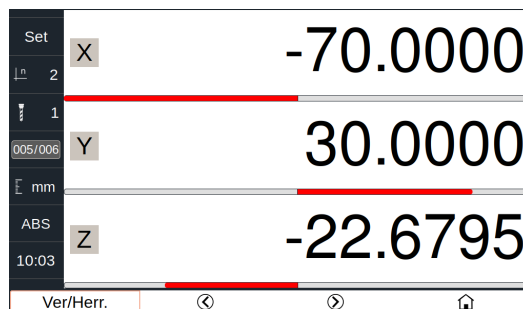


Pressing the **Run** key, the DRO shows the distance the axes must move to position at the first hole. Move the axes to zero.

The status bar indicates the number of the current hole and the total number of holes programmed in the cycle.



↓ Total number of holes programmed.  
↓ Current hole no.

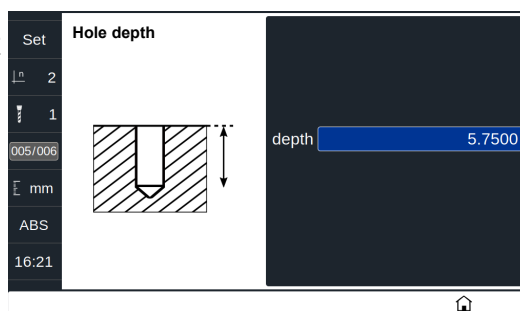


Once positioned at the drilling point, touch the surface with the tool. Press the Z axis key. The Z axis display reads zero.



Press Enter. A window opens for entering the hole depth. Press Enter to validate. The entered depth value is shown on the Z axis display.

Move the Z axis until its display reads zero. This way, the hole is drilled with the indicated depth.



Press this key to show the coordinates of the next drilling position (hole).

Repeat these steps until all the holes of the circle are drilled.

The following keys may also be used:



Go to the last hole.



Go to the first hole.



Select particular hole.



---

## 2.5.7 Probe

The probe stores the data about the probed points in a USB memory. The probing data may be read and processed at a PC.

The file containing the probed points is: **FAGOR/DRO/PROBE/probe.csv**

The format of the generated file is "**csv**" (comma separated values) and may be easily imported into a spreadsheet.

When using the USB-RS232 adapter, the probe data will be sent to the PC in the same format.

### RS232 communication parameters:

Baudrate:	9600 Baud
Number of bits:	8
Stop bits:	1
Parity:	none

From the left column to the right, the values correspond to the 1st, 2nd and 3rd axis respectively:

For example:

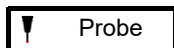
100.000	, 132.035	, 0.435
133.005	, 132.035	, 0.435
870.020	, 132.435	, 0.435
133.870	, 132.035	, 0.435
191.890	, 205.545	, 10.540

### 2.5.7.1 Turn the probe ON and OFF

Connect a USB memory to the DRO and wait for 4 seconds for the DRO to configure the memory.



To turn the probe mode ON.



The icon shows that the probe mode is ON. The data captured by the probe is saved in the file.

The probe **MUST** be turned OFF properly before extracting the USB memory so as not to lose any probing data.



To turn the probe mode OFF.

**Note:** Do not unplug the USB memory until the DRO completes the safe extraction sequence.



## 3 DRO operation in LATHE mode

### 3.1 Display modes

#### 3.1.1 2/3 axes



3rd



Toggle the reading of the second axis between Z (Z1 + Z2), Z1 or Z2, when the DRO has been set for 3-axis lathe.

When it has been set by parameter to only display the Z axis, this key toggles between displaying 2 axes (X, Z) and displaying 3 axes (X, Z1, Z2).

#### 3.1.2 mm / inch



Toggle units between mm and inches.

This toggle is possible if the installer parameters have been set as toggle.

#### 3.1.3 rad/diam



Toggle between radius mode and diameter mode. It only affects the X axis.

In **diameter mode**, the X axis display shows twice the actual distance traveled by the tool. When this mode is active, the X axis display shows the Ø sign.

In radius mode, the X axis display shows the actual distance traveled.

#### 3.1.4 inc / abs



Toggle between incremental and absolute feedback reading (counting).

The status bar shows the currently active feedback reading mode.

##### 3.1.4.1 Absolute mode

In this mode, the coordinates (position values) are referred to part zero.

Example on the right:

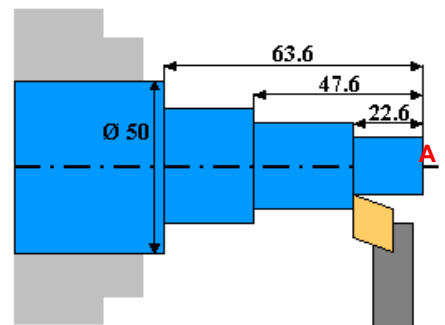
Set the DRO in absolute mode.

Set zero origin for the part.

Run several passes moving the Z axis from "0" to "63.6" until obtaining the desired diameter.

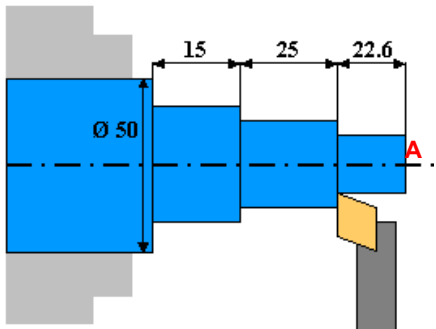
Run several passes moving the Z axis from "0" to "47.6" until obtaining the desired diameter.


Run several passes moving the Z axis from "0" to "22.6" until obtaining the desired diameter.




3.1.4.2 Incremental mode

The coordinate is referred to the previous point where the axis display has been set to zero.  
Set the dro in incremental mode.  
Set a floating zero (Z=0) at point A.  
Preset the value “22.6” for the Z axis. Run several passes moving the Z axis to zero until reducing it to the desired diameter.



 Clear Z axis.

Preset the value “25” for the Z axis. Run several passes moving the Z axis to zero until reducing it to the desired diameter.

 Clear Z axis.

Preset the value “15” for the Z axis. Run several passes moving the Z axis to zero until reducing it to the desired diameter.

3.2 Tool

**Change**      **Tool**

Set or change the tool.  
Up to 100 tool offsets may be defined at this DRO, from tool 0 to tool 99. The unit stores in its internal memory the relative offsets of all the tools with respect to that of tool "0". (master tool).  
Therefore, if tool 0 has been preset in ABS mode (on X and Z) and, then, the rest of the tools, it will suffice to just preset the master tool (tool 0) again (on Z) for the new part. The DRO will then automatically recalculate all the offsets of the rest of the tools without having to preset them for each part.

Set	Tool		
In	4	Tool Nr. 4	
mm			
ABS			
15:02			

**Teach**      Assistant for setting new tool offsets.

3.2.1 Tool setting

**Change**      **Tool**      **Teach**

When going into Teach mode, if the DRO was in INC mode, it switches to ABS mode.

### 3.2.1.1 Setting the tool by touching a part of known diameter



Enter tool number. Press Enter.

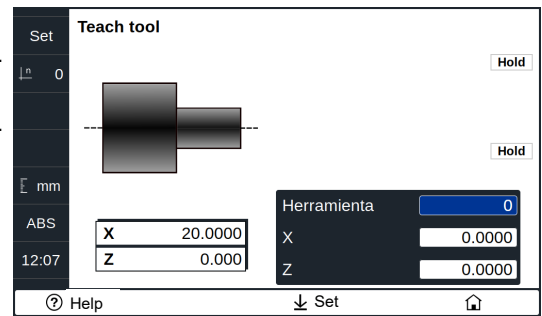
Move the X axis until the tool touches the part.  
Preset the part diameter.

Move the Z axis until the tool touches the part.  
Preset the value for the Z axis.



Set

Press button to validate.



### 3.2.1.2 Setting the tool by touching a part of unknown diameter



Enter tool number. Press Enter.

Move the X axis until the tool touches the part.

Move the Z axis until the tool touches the part.

Hold

Press **HOLD** for both axes.

Remove the part and measure it.

Preset the X axis with the measured diameter value.

Preset the value for the Z axis.



Set

Press button to validate.

These tool presets are kept in memory even when the unit is powered off up to a maximum of 10 years.

**Notes:** The presets done with any tool in incremental mode change the part zero for all the tools.

If a tool offset has been preset in  $Z_1$ ,  $Z_2$  or  $Z$  ( $Z_1 + Z_2$ ) mode, that tool must be used in the same mode ( $Z_1$ ,  $Z_2$  or  $Z$ ) when using it to machine the part.

The tool offsets are referred to the machine zero found at the time. When turning the DRO on, it is necessary to find the same reference mark.

## 3.3 Special functions

Function

It gives access to the specific lathe functions.

### 3.3.1 Angle measurement

Function

Angle measurement

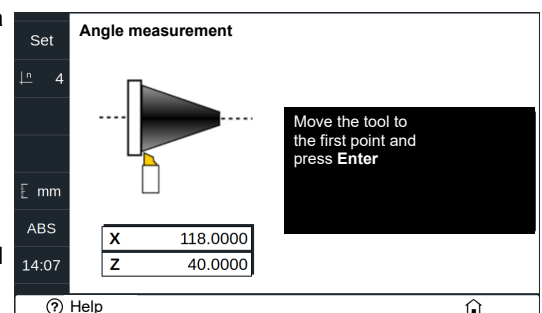


Touch the first point and press Enter.



Touch the second point and press Enter.

It shows the calculated angle in *degrees* and *degrees - minutes - seconds*.

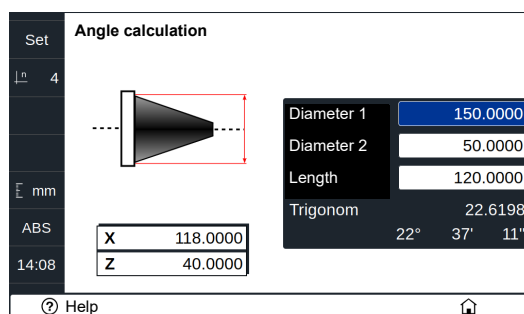


### 3.3.2 Angle calculation

Function

Angle calculation

Calculate the angle, knowing the diameters and the length between them.



### 3.3.3 Turning function

Function

Turning

Assistant for defining a turning cycle after having entered the following data:



**X:** Starting diameter. Move the X axis until the tool touches the part. Press X axis button to enter the position value on the X axis. If the part diameter is known, its value may be entered directly. Press Enter. The next field (box) is activated.



**Z:** Initial Z axis value. Place the tool touching the part on the Z axis. Preset a value and press the button for the Z axis to enter the value of the Z axis display. Press Enter. The next field (box) is activated.

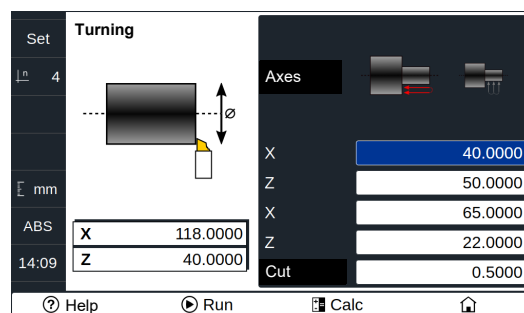


**X:** Enter **final diameter**. Press Enter.



**Z:** Enter Z axis final value. Press Enter. Press Enter.

**Cut:** Enter cutting pass in mm. The DRO will use this value also as the safety distance to withdraw after each pass.



Run

Execute turning cycle. Move the axes until both axis displays read zero.



Go on to the next execution step.



Total number of programmed passes.

Current step Nr

### 3.3.4 Calculator function

Function

Calculator

See section: [Calculator function](#).

## 4 DRO installation

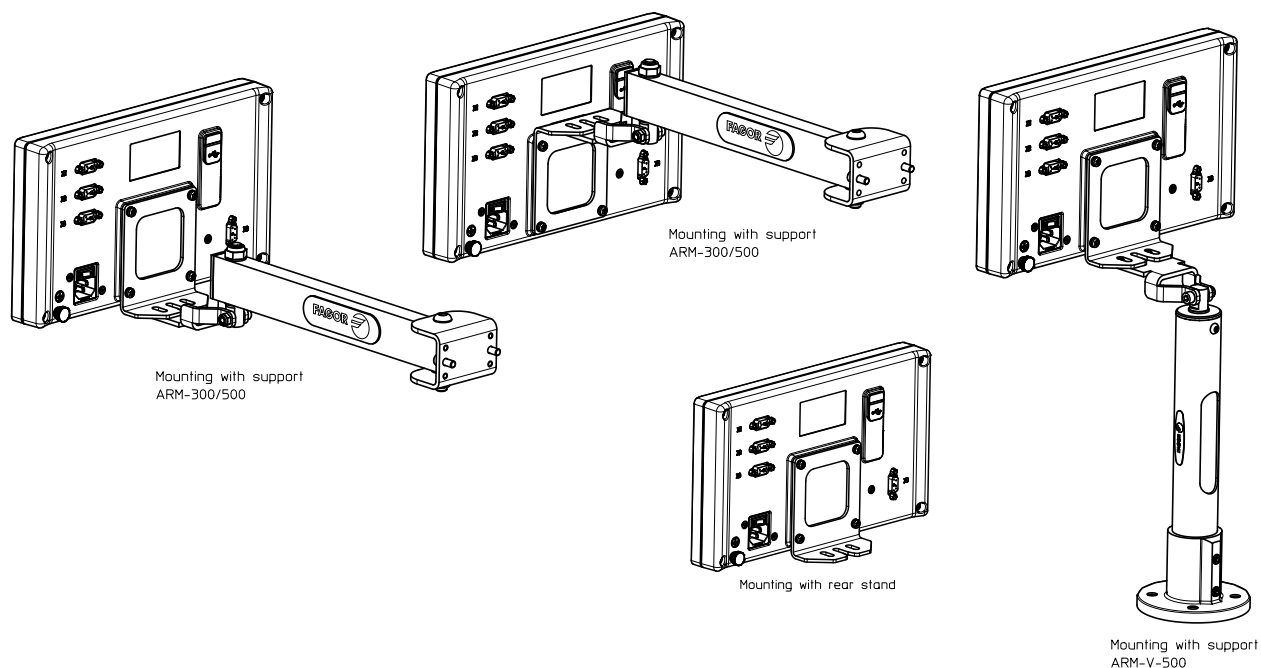
There are two ways to mount the DRO 400i:

- 1- Mounted on the support arm.
- 2- Built-in model.

### 4.1 Mounting on the support arm

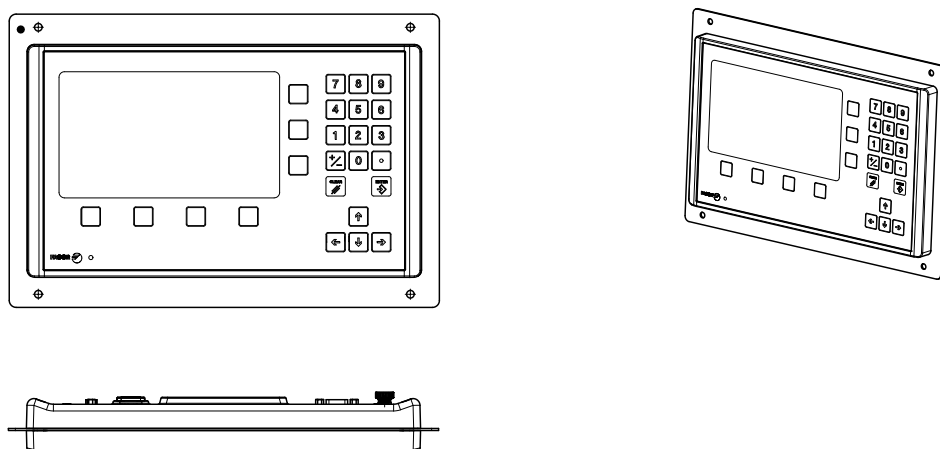
The DRO may be mounted at the desired height and may be oriented at will.

The DRO is mounted on to the support arm using two set-screws.



### 4.2 Mounting of the built-in model

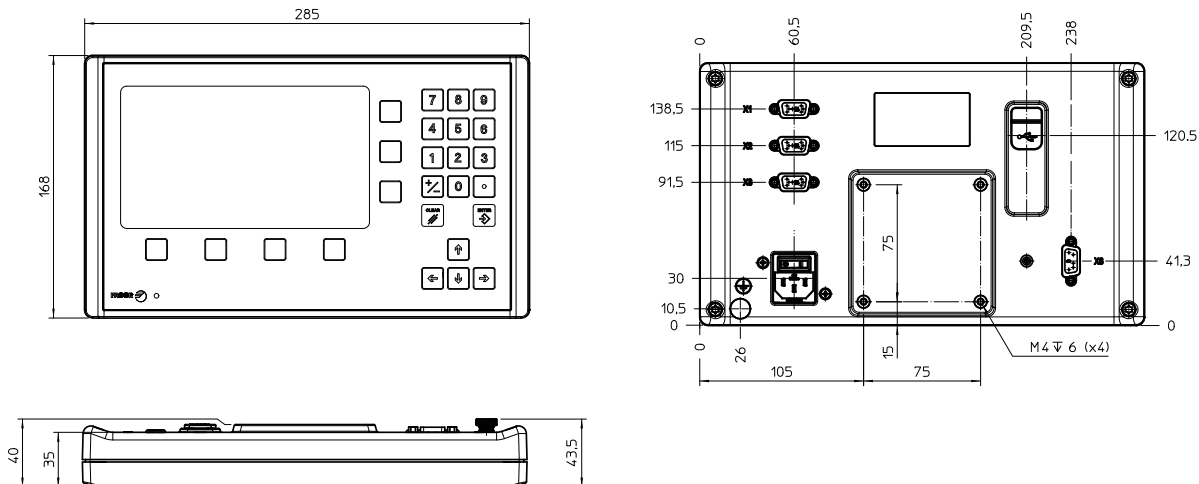
The DRO is ready to be built into an operator panel or pendant. The name of this model is special, a **B** has been added at the end of the product name.



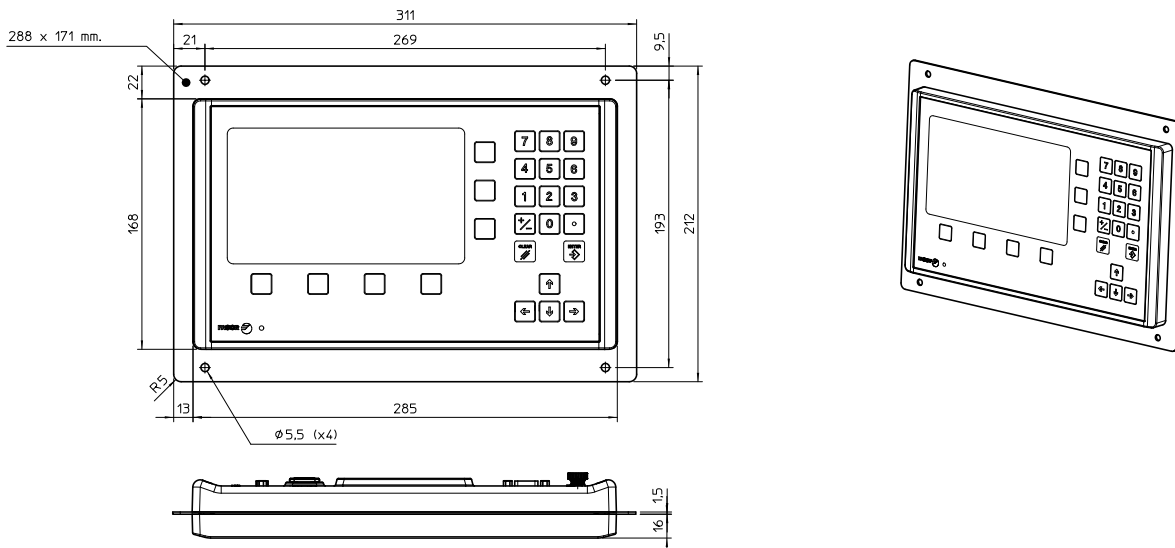
### 4.3 Dimensions of the display, the bracket and of the window to insert it into

The first figure shows the DRO dimensions. The second figure shows the dimensions of the hole needed in the enclosure of the machine to built this model into. The dimensions of the bracket where the arm is mounted are shown in the third figure.

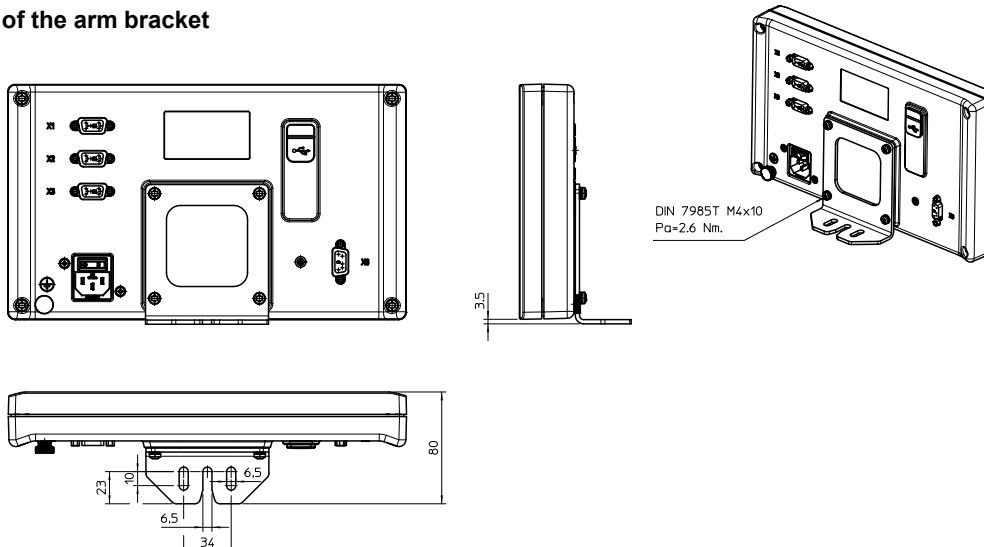
### Dimensions of the display



### Dimensions of the window for recessed installation

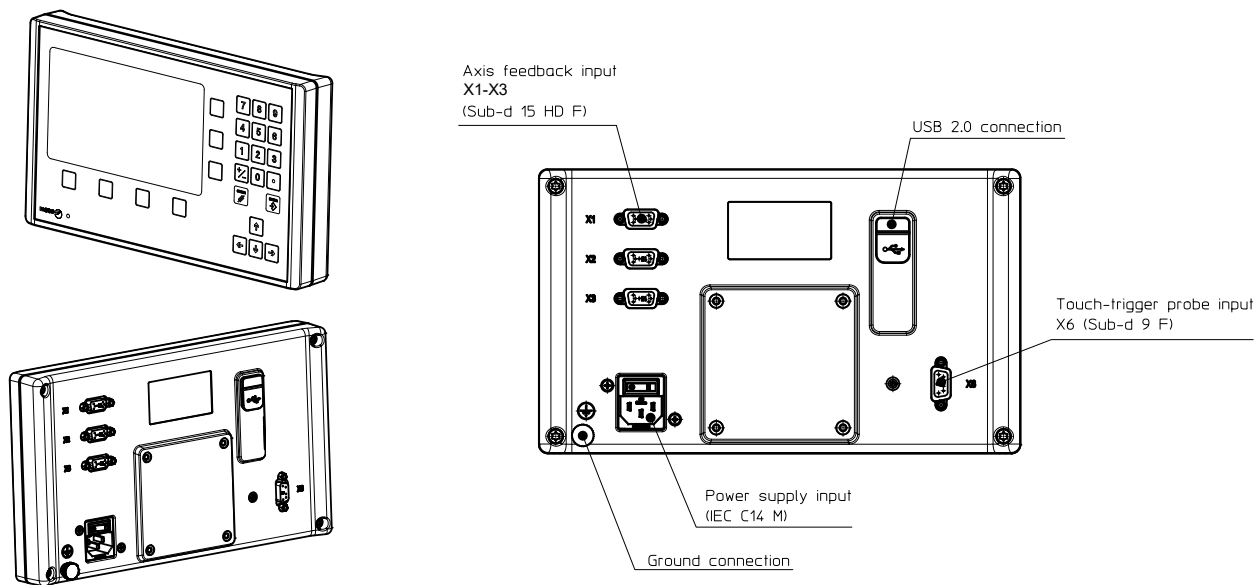


### Dimensions of the arm bracket





## 4.4 Rear panel



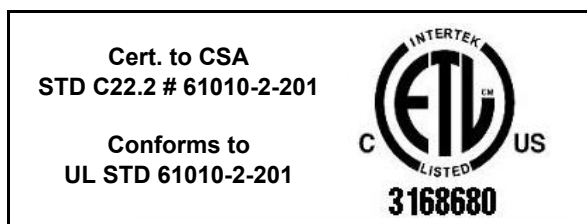
On the back of the unit the following items may be found:

- Three-prong power connector for AC and ground connection.
- On/off switch.
- M6 mm terminal, for general machine ground connection.
- Mounting bracket
- USB connector.
- Feedback connectors:
  - X1.-SUB-D HD type 15-pin female connector for 1st axis feedback device.
  - X2.-SUB-D HD type 15-pin female connector for 2nd axis feedback device.
  - X3.-SUB-D HD type 15-pin female connector for the third axis feedback device.
  - X6.-SUB-D type 9-pin female connector for the probe.

### 4.4.1 UL standard marking

In order to comply with "UL" standards, this unit must be connected in the final application using a listed detachable cord set (BLEZ) with a molded three-prong plug and a suitable fitting to be connected to the equipment, rated minimum 300 V AC. The cord type shall be SO, SJO or STO. Suitable Strain Relief means must be provided in the cord set to assure the connection of the plug and the fitting.

ETL file number:



#### **WARNING**

Do not handle the connectors while the unit is under power.

Before handling the connectors (mains, feedback, etc.) make sure that the unit is not under power. It is NOT enough to turn the display off by using the [on/off] key at the keyboard

---

## 4.5 General technical characteristics

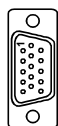
- Universal Power Supply between 100V AC and 240V AC  $\pm 10\%$  at a mains frequency between 50 Hz and 60 Hz, between 140 V DC and 340 V DC. Maximum power consumed 25 VA. It withstands power outages of up to 10 milliseconds.
- 10-year memory backup of installation parameters when the unit is off.
- The operating temperature inside the DRO enclosure must be between 5 °C and 45 °C (41 °F and 113 °F).
- The storage temperature inside the DRO enclosure must be -40 °C and +70 °C (-40 °F and 158 °F).
- Maximum relative humidity: 95% non condensing at 45 °C (113 °F).
- Front Panel Sealing: IP54 (DIN 40050), Rear panel: IP4X (DIN40050) except for built-in models in which case is: IP20.

## 4.6 Connections

### 4.6.1 Connection of the feedback systems

The feedback systems (linear or rotary encoders) are connected via SUB-D HD type 15-pin female connectors: X1 through X3.

#### Characteristics of feedback inputs: X1, X2 and X3:



- Maximum feedback consumption: 250 mA at the +5V input.
- Admits square-wave signal (TTL).
- It admits voltage modulated 1 Vpp sinusoidal signal.
- It admits SSI communication for absolute encoders
- Maximum frequency: 250 KHz, minimum gap between flanks: 950 nsec.
- Phase difference:  $90^\circ \pm 20^\circ$ , hysteresis: 0.25 V, Vmax: 7V, maximum input current: 3mA.
- High threshold (logic state 1):  $2.4\text{ V} < V_{IH} < 5\text{ V}$
- Low threshold (logic state 0):  $0.0\text{ V} < V_{IL} < 0.55\text{ V}$

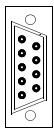
#### Feedback connection. Connectors X1, X2 and X3

Pin	Signal 1Vpp/T TL	Signal SSI	Function
1	A	-	Input for feedback signals
2	/A	-	
3	B	-	
4	/B	-	
5	I0	Data	
6	/I0	/Data	
7	Alarm	Clock	
8	/Alarm*	/Clock	
9	+5V		Power supply to feedback devices
10	Not connected		
11	0V		Power supply to feedback devices
12, 13, 14	Not connected		
15	Chassis		Shield

### 4.6.2 Probe connection (connector X6)

Either a 5 V or a 24 V probe may be connected.

#### Characteristics of probe inputs X6:



##### 5V probe input

Typical value 0,25 mA. → Vin = 5 V.  
High threshold (logic level "1") VIH: From +2.4 V DC on.  
Low threshold (logic level "0") VIL: Below +0.9 V DC.  
Rated voltage Vimax = +15 V DC.

##### 24 V probe input

Typical value 0,30 mA. → Vin = 24 V.  
High threshold (logic level "1") VIH: From +12.5 V DC on.  
Low threshold (logic level "0") VIL: Below +4 V DC.  
Rated voltage Vimax = +35 V DC.

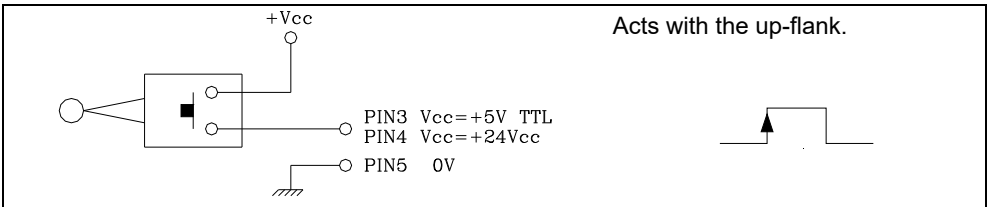
Probe connection. Connector X6

PIN	SIGNAL	DESCRIPTION.
1	CHASSIS	Ground connection
2	+5Vout	+5V output.
3	PROBE_5	+5V Probe input
4	PROBE_24	+24V Probe input
5	GNDVOUT	GND output.
6	5Vout	5V output.
7	---	---
8	---	---
9	GNDVOUT	GND output.

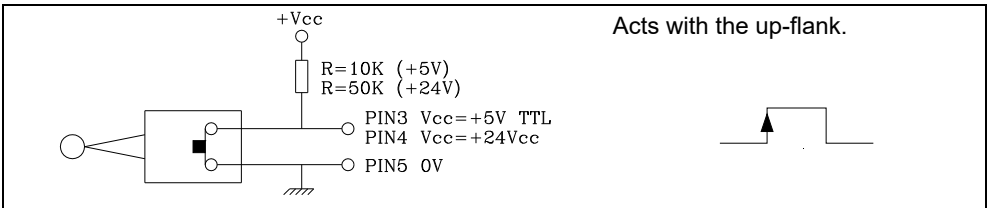
The unit has two probe inputs (5 V DC and 24 V DC) at connector X6.

Depending on the connection being used, it is possible to choose whether it is activated by the up flank or by the down flank of the probe (see section [DRO](#)).

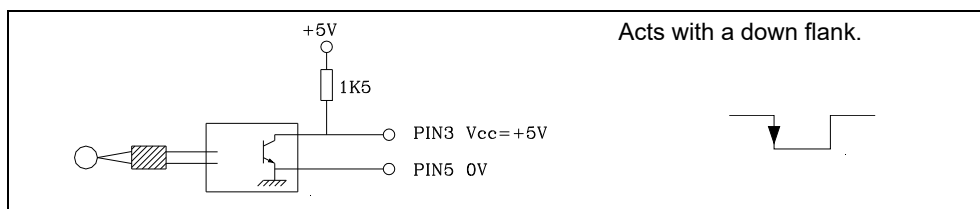
Probe with "normally open contact" output.



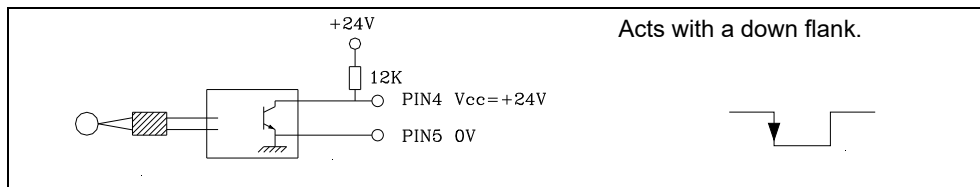
Probe with "normally closed contact" output.



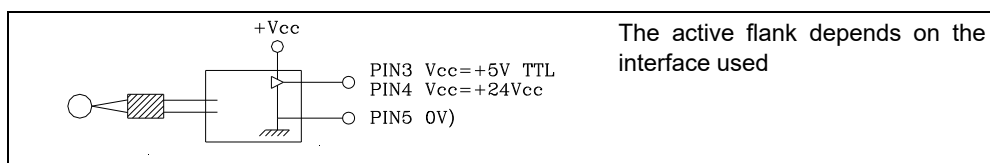
Interface with an open-collector output. Connection to +5 V.



Interface with an open-collector output. Connection to +24 V.



Interface with a PUSH-PULL output



### 4.6.3 Power and machine connection

Always mount it vertically so its keyboard is within operator's reach and its digits are easily visible (at operator's eye level).

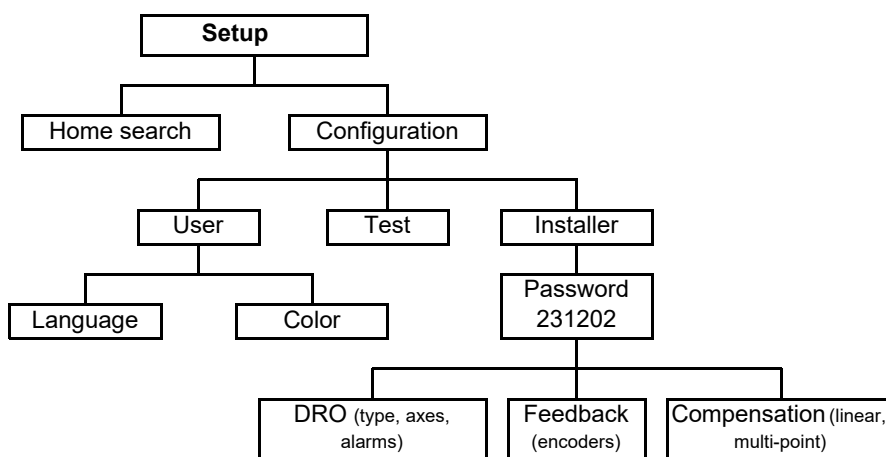
Do not connect or disconnect the DRO connectors while it is under power.

Connect all metallic parts to a common point on the machine tool and it to the general ground point.

Use cables of enough gage (no thinner than 8 mm<sup>2</sup>) for this connection.

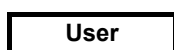
## 4.7 Installation parameters

### 4.7.1 Accessing installation parameters



Gives access to setting installation and user parameters and to the test mode.

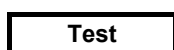
The parameter setup is divided into three parts:



**1- USER PARAMETERS:** Parameters that may be modified by the user: *change the language, set the chronometer and set the screen color.*



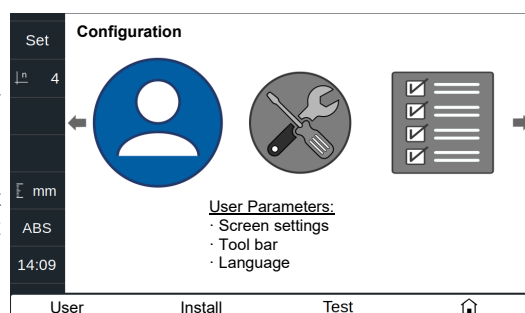
**2- INSTALLER PARAMETERS:** Parameters that must be set when installing the DRO for the first time, when replacing an encoder or when doing a repair. They are parameters related to the machine, feedback and to the DRO itself.



**3- TEST MODE:** To check the various status of different elements of the DRO, such as screen, keyboard, etc.

For the installer only. Accessing the test mode requires a password:

Password: **231202**

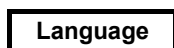


### 4.7.2 User parameters



Parameters that may be modified by the user: *change the language, set the chronometer and set the screen color.*

#### 4.7.2.1 Language



Use the cursor keys to select the language.



Press Enter.

---

### 4.7.2.2 Screen color

#### ColorSet

The colors of the background and numbers on the main screen can be changed. There is also the option to restore the original colors.

### 4.7.2.3 Chronometer

#### Chronometer

It is possible to turn the stopwatch on or off. As well as to restart your account or set a number.

### 4.7.2.4 Sound

#### Sound

It is possible to turn the keystroke sound on or off.

### 4.7.2.5 Screen brightness

#### Brightness

It is possible to adjust the brightness value of the screen by levels: Low, Medium, High.

## 4.7.3 Installer parameters

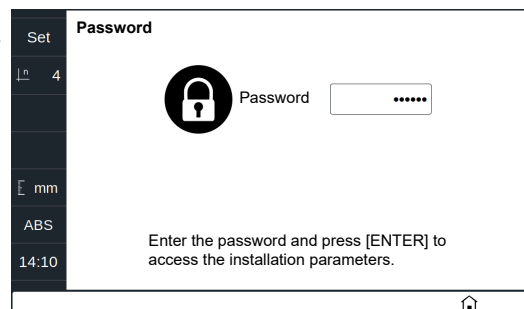
#### Setup

#### Configuration

#### Install

Parameters that must be set when installing the DRO for the first time, when replacing an encoder or when doing a repair. They are parameters related to the machine, feedback and to the DRO itself.

Enter the password: **231202**



### 4.7.3.1 Parameter backup into USB memory

If a USB memory is connected, it is possible to save and recover:

- DRO Parameters
- Multi-point compensation tables
- User programs

## 4.7.3.2 DRO

Setup

Configuration

Install

DRO

It configures the DRO for each type of machine: Number of axes, type of machine (mill, lathe, etc.).

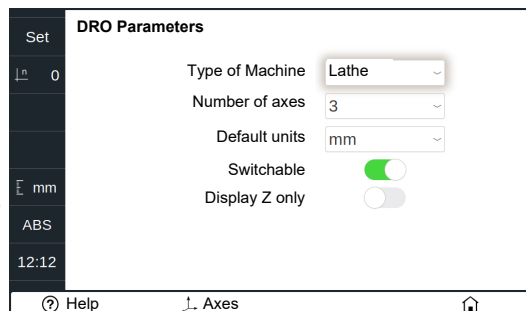
Pressing this button opens the window shown on the right. The following items are set in it:

**1- Type of Machine:** Mill or lathe.

**2- Number of axes to display:** 1, 2 or 3.

**3- Default units:** mm or inches.

**4- Toggled by the user:** Yes or NO. If set to "YES", to change the units, select the **mm/inch** option from the **Display** drop list while the DRO is showing the main screen.



**5- Configure the probe.** It may be configured as inactive, active low (0V) or active high (5V or 24V depending on type of connection).

3rd



**6- Display Z only.** The main window will only show the X and Z axes. Pressing the third axis selection key, the display will toggle between displaying 2 axes and displaying 3 axes.

### Axes option:

Setup

Configuration

Install

DRO

Axes

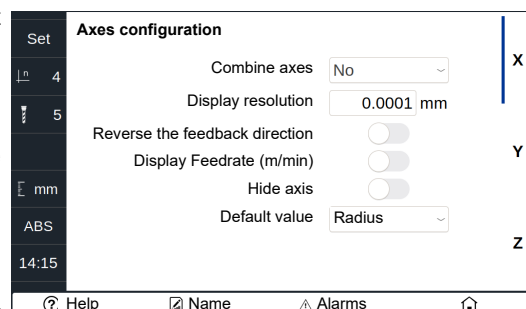
These parameters must be set for each axis.

**1- Combine axes:** It is possible to add/subtract any axis to/from another axis. The factory setting is NO.

Rotary axes cannot be combined.

**2- Display resolution:** It is the resolution of the DRO. It makes it possible to display the position with a coarser resolution than that of the feedback device, although the actual internal calculation is done with the finest resolution.

Factory setting: 0.0000. It means that the display resolution is the encoder resolution.



**3- Reverse the feedback reading (pulse counting) direction:** Yes or NO. Factory setting: NO.

**4-Display Feedrate:** Axis feed rate, both in mill and lathe modes. When activating this option ("YES"), the screens shows a window indicating the feed rate of each axis.

Name

The units will be m/min or inches/min depending on whether MM or INCH is active.

The names of the axes may also be changed instead of calling them X, Y or Z.



## Alarms option:

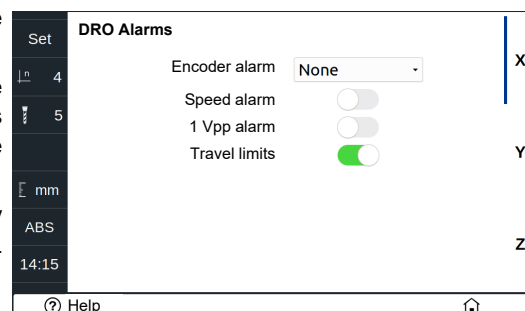


Turn on/off the various types of alarms.

These alarms must be set for each axis. The following screen is displayed:

**1- 1 Vpp alarm:** The DRO checks the amplitude and phase shift of 1 Vpp signals. An alarm is displayed when any of the signals gets out of the set limits.

**2- Feedback alarm.** Feedback alarm provided by TTL angular encoders. It may be active low (TTL O) or active high (TTL 1).



**3- Feed rate overrun alarm:** When set to YES, an alarm is issued over 200 kHz.

**4- Travel limits:** Setting it to YES activates two more fields (boxes) for entering the travel limits. A warning appears on the screen when overrunning these limits.

### 4.7.3.3 Feedback

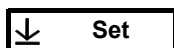


Selecting Fagor feedback knowing the name or model of the linear encoder.



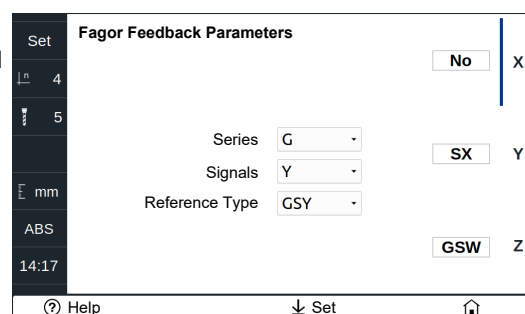
Select axis.

Select type of linear encoder, type of signal and type of reference pulse.



Set

To validate the data for that axis.



## Custom feedback selection:

Setup

Configuration

Install

Feedback

Use this screen to set the characteristics of the encoder.

They are parameters for each axis.

The sections to be set are:

**1- Type of axis:** Linear or rotary.

**1.1- LINEAR:** It requests the resolution of the linear encoder.

**1.2- ROTARY:** It requests the number of pulses/turn of the encoder and the number of turns the encoder must make for the machine to consider a 360° movement (mechanical gear ratio). For SSI, the number of bits per turn (maximum number of bits = 23).

**2- Type of encoder signal:** TTL, 1 Vpp or SSI.

**2.1- TTL:** It requests the resolution of the linear encoder or Nr of pulses of the encoder.

The following table shows the resolutions of FAGOR TTL linear encoders.

Model	Resolution
MT/MKT, MTD, CT & FT	0,005 mm
MX/MKX, CX, SX, GX, FX, LX, MOX, COX, SOX, GOX, FOX & LOX	0,001 mm
SY, SOY, SSY, GY, GOY & GSY	0.0005 mm
SW, SOW, SSW, GW, GOW & GSW	0.0001 mm

**2.2- 1Vpp:** The **TTL MULTIPLICATION** and **SINUSOIDAL MULTIPLICATION** boxes are activated.

\* **TTL multiplication.** Options: 0.5, 1, 2, 4. The factory setting is 4 and it is the one normally used with FAGOR linear encoders.

\* **Sinusoidal multiplication.** Options: 1, 5, 10, 20, 25, 50. One or the other is used depending on the resolution to be obtained if the feedback signal is **1Vpp** or **TTL** with **distance-coded** reference marks.

**Example:** We wish to install a FAGOR GP linear encoder (1 Vpp and 20-micron-pitch graduated glass) with **1 micron** resolution:

$$\text{Resolution} = \frac{\text{Graduation pitch (20, 40 or 100 } \mu\text{m)}}{\text{TTL multiplier * Sinusoidal multiplier}}$$

$$1 \mu\text{m} = \frac{20 \mu\text{m}}{4 * 5}$$

Therefore, a **1-micron resolution**, would require a **sinusoidal multiplying factor of 5**.

If the feedback signal is TTL with NO distance-coded reference marks, like GX, FT, SY etc. the value for this parameter will be "1".

**2.3- SSI:** It is the protocol used to communicate with absolute encoders. This protocol is configured with the following parameters:

\* **Resolution:** Only requested if the axis is linear. The resolution to be used with FAGOR absolute linear encoders is 0.0001 mm.

\* **Number of bits:** It sets the digital communication between the encoder and the DRO. The factory setting and the one used with absolute linear encoders are 32 bits.

## Reference

Setup

Configuration

Install

Feedback

Reference

This window sets the parameters related to home search and the type of reference mark of the encoder. This configuration must be set for each axis.

\* **User offset:** Offset of the reference point with respect to the reference zero of the feedback device, independent for each axis.

Usually, the machine reference zero (reference mark of the linear encoder) does not coincide with the absolute zero to be used. Therefore, this parameter must be assigned the value of the distance from the machine zero point to the feedback reference point.

Factory setting: 0.

This value will be in mm or inches depending on whether the DRO units have been set in "mm" or "INCH".

\* **Mandatory Home search.** When set to **YES**, every time the DRO is turned on, it forces a home search. It is recommended to set it to **YES** when the DRO uses positioning error compensation because if the compensated axis is not homed, the compensation will not be applied.

\* **Inverted Ref.** Reverses the polarity of the reference signal, required for models with FT, CT, MT and MKT encoders.

\* **Type:** It sets the homing system of the linear encoder: NONE, NORMAL (INCREMENTAL) or DISTANCE-CODED.

**When selecting DISTANCE-CODED, you must set the engraving pitch of the linear encoder (20 µm, 40 µm or 100 µm) and the external multiplying factor (1, 5, 10, 25 or 50).**



Exit and save data.

### 4.7.3.4 Compensation

Setup

Configuration

Install

Comp.

Choose the type of compensation to be used.

1- NONE.

2- LINEAR.



Choose LINEAR from the list, press Enter to validate it.

Edit

Press Edit to enter the compensation value. The following window is opened:

Even when working in inches, this value must always be in mm.



Enter the linear compensation value and press Enter.

3- MULTI POINT.



Choose MULTI-POINT from the list and press Enter to validate it.

**Important:** Before capturing data for an accuracy graph, a home search must be carried out because the compensation will not be applied until the home search is done. To use this compensation, it is recommended to force a home search on power-up.

The maximum amount of error that may be compensated corresponds to a slope of  $\pm 3\text{mm/m}$ .

Set	Error compensation			
In	2	Select compensation type		Multipoint
Out	1	Multipoint Compensation		
		Point	Position	Error
		1	0.0000	0.0000
		2	10.0000	0.0200
		3	30.0000	0.0100
		4	40.0000	-0.0100
		5	50.0000	-0.0030
		6	0.0000	0.0000
mm				
ABS				
16:33				
		Help		See /

**Edit**

Pressing the Edit button displays a table with 105 points and their corresponding error values.

**Error to be compensated = Master's actual position - displayed position**

There is no need to use all the points. The compensation point must have at least one point with no error (error 0).

Different options are offered when the Function button is pressed:

- Exit:

**Function**

**Exit**

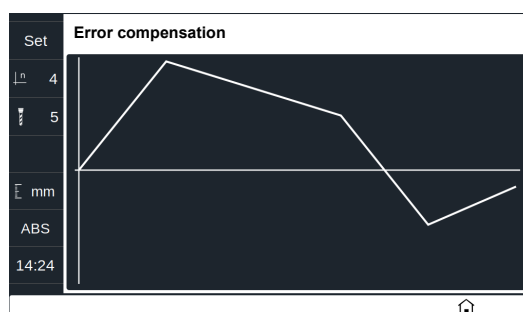
To exit the screen saving the data.

- Draw Graph:

**Function**

**Draw Graph**

Draws a graph with the points and errors entered. It is recommended to check the graph to detect possible mistakes made when entering data.



## 4.7.4 Test mode

**Test**

It may be used to know system information such as software version, hardware version, software burning date, etc.



Pressing the **Test** key displays the software and hardware versions, software recording date, checksum, error history, etc.

Pressing **Test** again offers the chance to run different tests that are very useful for troubleshooting the DRO itself or the encoder.

The Test mode is for the installer only and the access is protected with a password.

**Password: 231202**

---

## 5 Appendix

### 5.1 UL seal

See "UL standard marking" on page 25.

### 5.2 CE seal



---

#### **Warning**

Before starting up the DRO, carefully read the instructions of Chapter 2 in this manual. The DRO must not be powered-on until verifying that the machine complies with the "2006/42/EC" Directive.

---

#### 5.2.1 Declaration of conformity

The declaration of conformity for the DRO is available in the downloads section of FAGOR'S corporate website at <http://www.fagorautomation.com>. (Type of file: Declaration of conformity).

#### 5.2.2 Safety conditions

Read the following safety measures in order to prevent harming people or damage to this product and those products connected to it.

Fagor Automation shall not be held responsible of any physical or material damage originated from not complying with these basic safety rules.

##### **Do not manipulate the inside of the unit**



Only personnel authorized by Fagor Automation may access the interior of this unit.

##### **Do not handle the connectors with the unit connected to main AC power**



Before handling the connectors (mains, feedback, etc.) make sure that the unit is not under power.

##### **Use proper Mains AC power cables.**

To avoid risks, use only the Mains AC cables recommended for this unit.

##### **Avoid electric shocks.**

In order to avoid electrical discharges and fire hazards, do not apply electrical voltage outside the range indicated in chapter 2 of this manual

##### **Ground connection.**

In order to avoid electrical discharges, connect the ground terminals of all the modules to the main ground terminal. Also, before connecting the inputs and outputs of this product, make sure that the ground connection has been done.

##### **Before powering the unit up, make sure that it is connected to ground.**

In order to avoid electrical discharges, make sure that all the grounding connections are properly made.

##### **Ambient conditions.**

Respect the temperature and relative humidity ranges indicated in chapter.

---

**Do not work in explosive environments.**

In order to avoid risks, harm or damages, do not work in explosive environments.

**Working environment.**

This unit is ready to be used in Industrial Environments complying with the directives and regulations effective in the European Community.

**It is recommended to mount the DRO vertically,**

so its power switch of the back panel is at a distance between 0.7m (27.5 inches) and 1.7m (5.6 ft) off the floor and away from coolants, chemical products, blows etc that could damage it. Keep it away from direct sunlight, extremely hot air, high voltage and high current sources as well as from relays, or high electromagnetic fields (about 0.5 m or 20 inches).

This unit meets the European directives on electromagnetic compatibility. Nevertheless, it is recommended to keep it away from sources of electromagnetic disturbance, such as:

- Powerful loads connected to the same mains as the unit.
- Nearby portable transmitters (radio-telephones, Ham radio transmitters).
- Nearby radio / TC transmitters.
- Nearby arc welding machines.
- Nearby high voltage lines.
- Disturbance generating elements of the machine.
- Etc.

**Safety symbols.**

Symbols that may appear in the manual.



WARNING symbol

It has an associated text indicating those actions or operations may hurt people or damage products.

**Symbols that the product may carry.****WARNING symbol**

It has an associated text indicating those actions or operations may hurt people or damage products.

**"Electrical shock" symbol.**

It indicates that that point must be under voltage.

**"Ground Protection" symbol.**

It indicates that point must be connected to the main ground point of the machine as protection for people and units.

---

### 5.2.3 Warranty terms

The warranty conditions for the DRO are available in the downloads section of FAGOR's corporate website at <http://www.fagorautomation.com>. (Type of file: General sales-warranty conditions.

### 5.2.4 Returning conditions

When returning the DRO, pack it in its original package and with its original packaging material. If you do not have the original packaging material, pack it as follows:

Get a cardboard box whose 3 inside dimensions are at least 15 cm (6 inches) larger than those of the unit itself. The cardboard being used to make the box must have a resistance of 170 Kg (375 lb.).

When sending it to a Fagor Automation office for repair, attach a label indicating the owner of the unit, person to contact, type of unit, serial number, symptom and a brief description of the problem.

Protect the unit wrapping it up with a roll of polyethylene or with similar material.

Pad the unit inside the cardboard box with polyurethane foam on all sides.

Seal the cardboard box with packaging tape or with industrial staples.

## 5.3 Maintenance

#### **Cleaning:**

An accumulation of dirt in the equipment can act as a screen preventing proper dissipation of the heat generated by the internal electronic circuits with the consequent danger of overheating and DRO fault.

On the other hand, accumulated dirt can sometimes act as an electrical conductor and shortcircuit the internal circuitry, especially under high humidity conditions.

To clean the unit, we recommend to use non-abrasive dishwasher detergent (gel, never powder) or isotropic alcohol at 75% with a clean cloth. DO NOT USE aggressive solvents, (benzol, acetones, etc.) which could damage the materials the equipment is made with.

Never use air compressed at high pressure to clean the unit because it could cause the accumulation of electrostatic charges that could result in electrostatic shocks.

The plastics used in the front panel of the DRO stand up to: Grease and mineral oil, alkalis and bleaches, dissolved detergents and alcohol.

Avoid the effect of solvents such as Chlorohydrocarbons, Benzol, Esters and Ethers because these could damage the plastics with which the front of the equipment is made.

#### **Preventive Inspection.**

If the DRO does not come on press the rear switch for starting, make sure it is properly connected and being supplied with the proper mains voltage.

Fagor shall not be held responsible for any printing or transcribing errors in this manual and reserves the right to make any modifications to the characteristics of their products without prior notice.

**FAGOR AUTOMATION S. COOP.**

**B<sup>a</sup> San Andrés N° 19**

**Apdo de correos 144**

**20500 Arrasate/Mondragón**

**- Spain -**

**Web: [www.fagorautomation.com](http://www.fagorautomation.com)**

**Email: [contact@fagorautomation.es](mailto:contact@fagorautomation.es)**

**Tel.: (34) 943 039800**

**Fax: (34) 943 791712**

