FAGOR

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DRO 400i TS
Installation / Operation Manual

INDEX

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

The intended use of the digital readout (DRO) display is to display the position measurement, both linear and angular, as well as other data obtained from the encoders connected to it. Perform operations such as those described in sections 2 and 3 of this manual.

1.1 Front Plate

Keys for axes

Keys for entering numeric values

7" color screen

Validate

Cursor keys

Power indicator LED

Keys to open the drop-down buttons of the FUNCTION BAR

Abort

Spindle keys
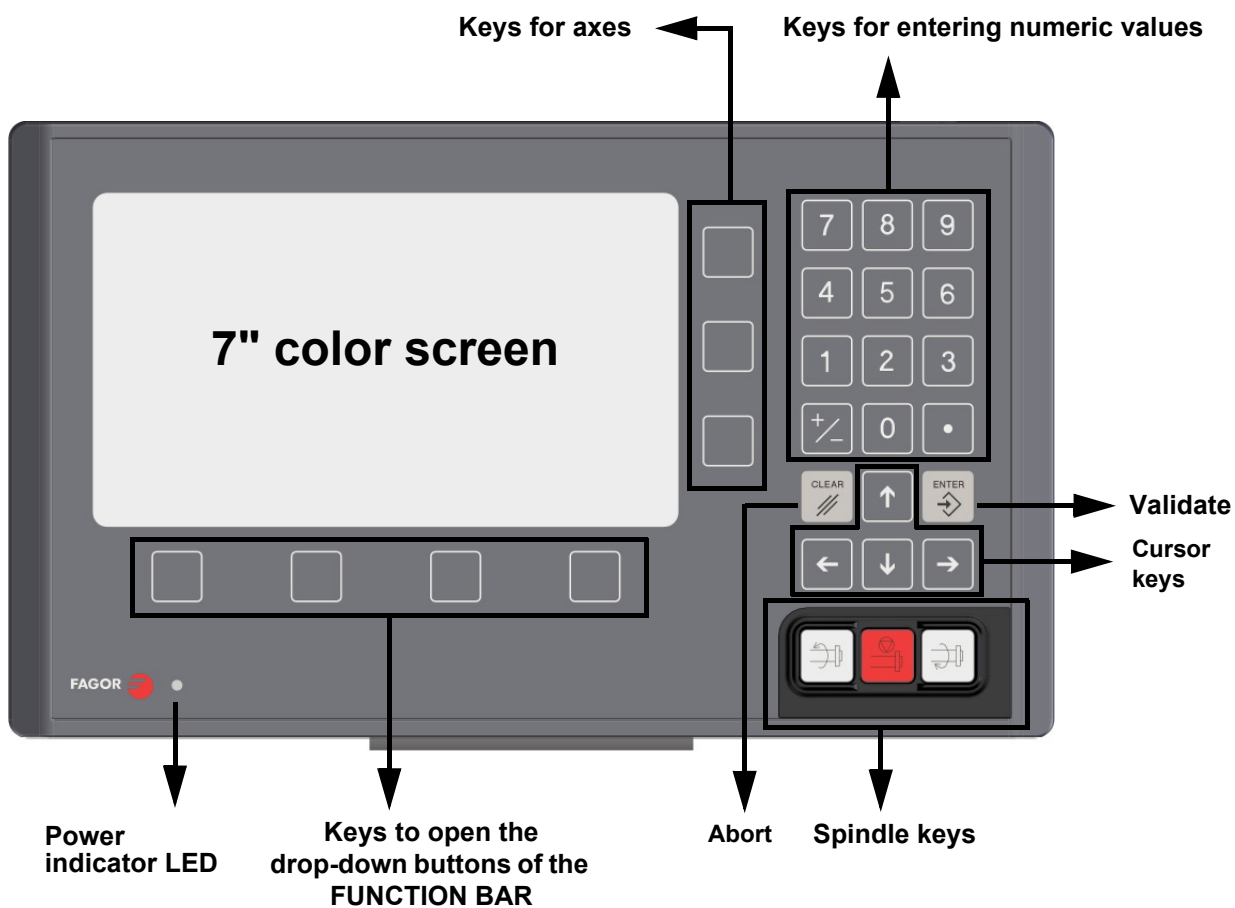
1.2 Turning the Unit On and Off

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.

ON/OFF Switch

X1
X2
X3
X4
X5
X6
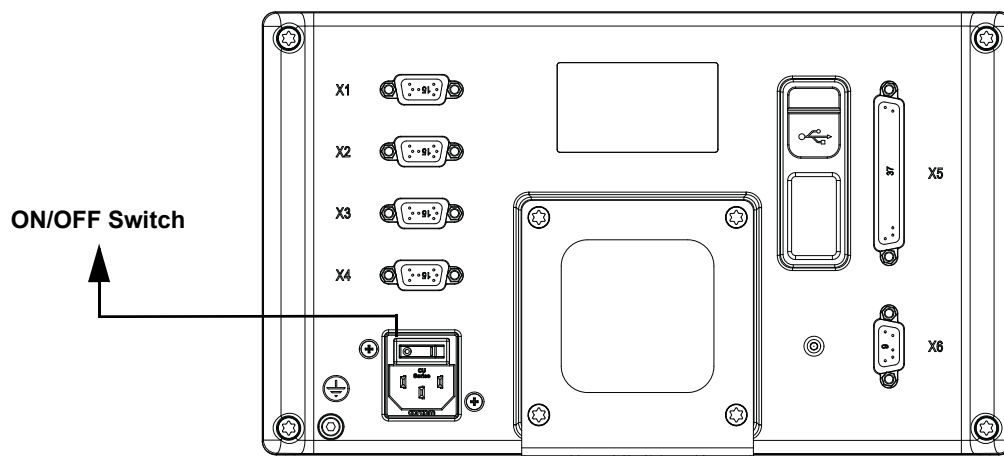
1.3 Main Screen Description

STATUS BAR   DISPLAY AREA

Set/Clear ——— Set

Active reference Nr ——— 2

Spindle orientation ———

X ⌀ 80.0000

Z 25.0000

Display units mm/inch ——— mm

Display mode: INC/ABS ——— ABS

Chronometer ——— 10:59

1 **2** 3 4   **RPM**   **CSS**

1000   30

Z / Z1 / Z2

FUNCTION BAR ———

Setup   Tool   Display   Function

Current range

Current / programmed RPM

CSS mode ON

Current / programmed CSS
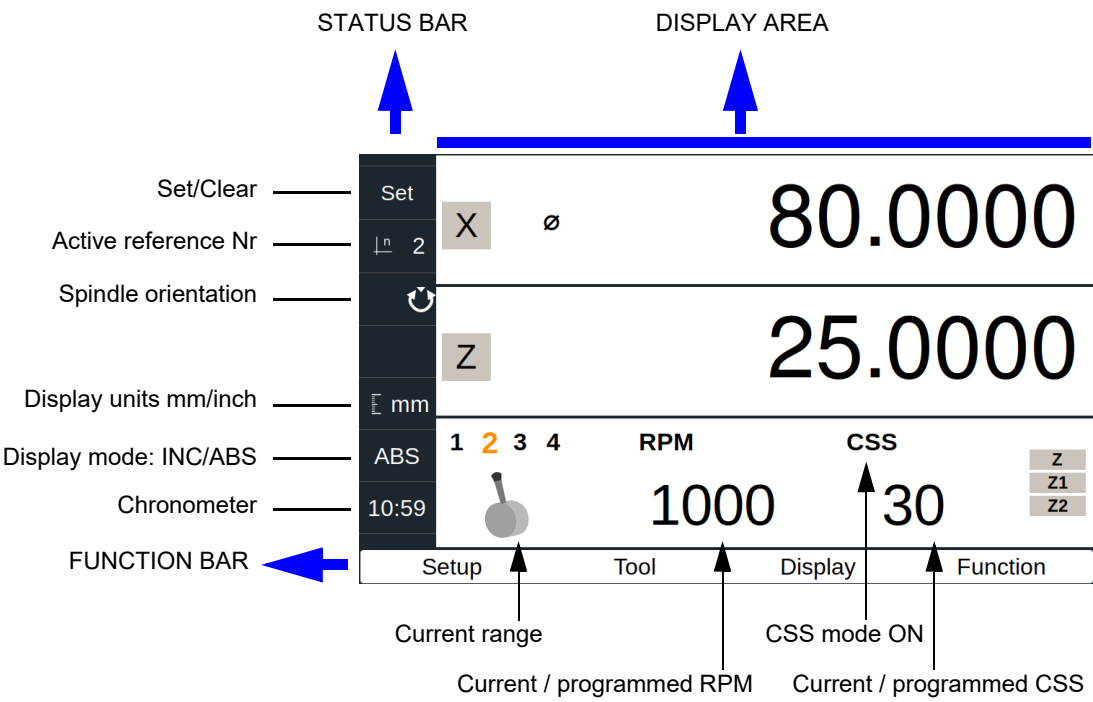
When the spindle is off, the RPM and CSS displays show the programmed values.

When the spindle is ON and there is an encoder on the spindle, the RPM and CSS displays will show the current value; but if there is no encoder, they will show their theoretical values.

1.4 Function Bar

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

1.4.1 Access to Functions

Setup	Tool	Display	Function
Home search	Set tool Nr	Inc/Abs	RPM
Configuration	Teach-in Tool table	mm/inch	CSS
		Rad/Diam	Angle measurement
		Set/Clear	Angle calculation
			Turning
			Calculator

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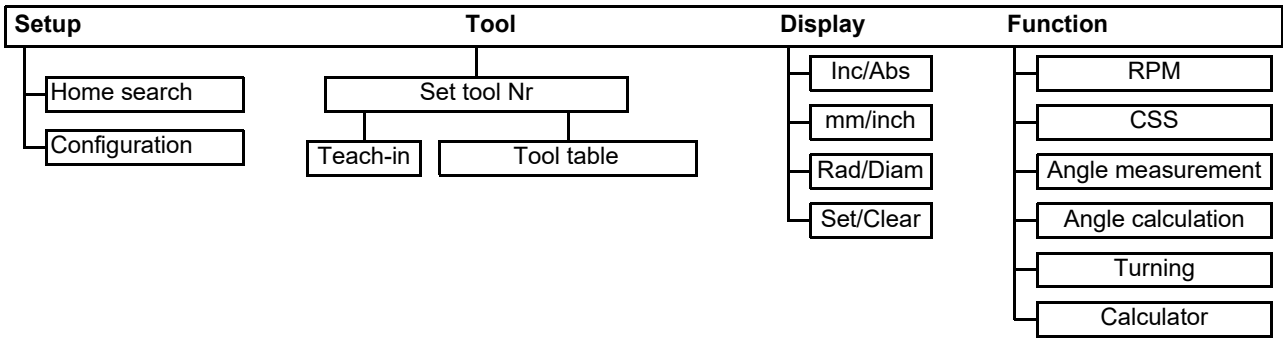
2 DRO Operation

2.1 Display Modes

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.

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 rad/diam

Display	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.

2.1.3 inc/abs

Display	inc/abs

Toggle between incremental and absolute feedback reading (counting).

The status bar shows the currently active feedback reading mode.

2.1.3.1 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.
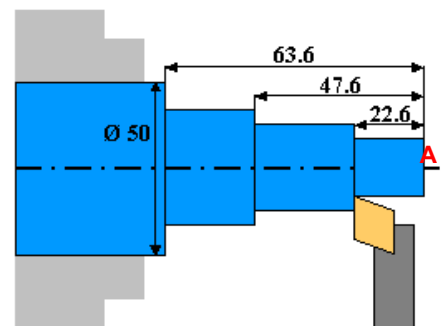
2.1.3.2 Incremental Mode

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.
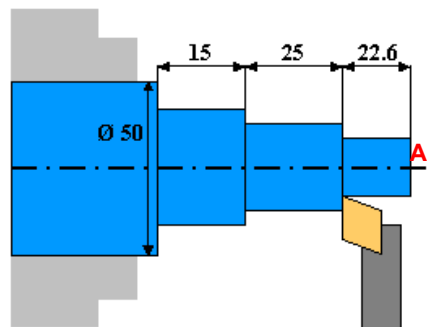
Clear Z axis.

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.

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   ENTER   To preset a value for an axis.

CLEAR   To zero the axis, either preset a 0 value using the previous keystroke sequence or use this other sequence (clear + axis).
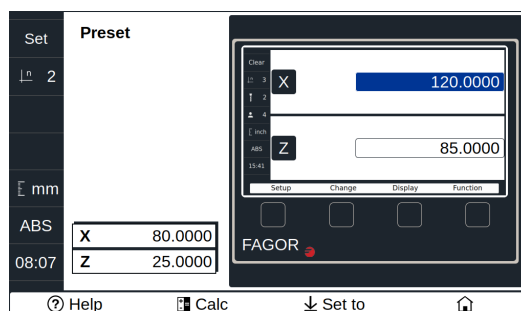
2.2.2 In "Clear" Mode

Set the display to zero.

To preset a value:

ENTER   Value   ENTER
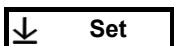
Set   And validate the data by pressing this key.

⌂   Or ignore it by pressing this key.

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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" on page 30).

Set		
	X	0.0000
⌐ 2		
	Z1	0.0000
	Z2	0.0000
Σ mm		
ABS		
	S	0.000
07:34		
⑦ Help		⌂

2.4 Tool

Each tool will remember the RPM and CSS values programmed by the user.

When the tool number is changed, the saved values will be set as current. If the spindle is turning, it will stop before setting the new values.

Set	**Tool**		
	Tool number		2
⌐ 2	Tool	X ø	Z
	0	0.0000	0.0000
	1	40.0000	10.0000
	2	80.0000	25.0000
Σ mm	3	120.0000	50.0000
ABS	4	240.0000	0.0000
	5	0.0000	0.0000
08:00	6	0.0000	0.0000
⑦ Help	⌃	⌄	⌂

2.4.1 Tool Setting

Tool	Teach

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

2.4.1.1 Setting the tool by touching a part of known diameter

ENTER 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. |

Set	**Teach tool**	
⌐ 2		Hold
		Hold
Σ mm		Tool: 2
ABS	X: 80.0000	X: 0.0000
08:11	Z: 25.0000	Z: 0.0000
⑦ Help	↓ Set to	⌂

2.4.1.2 Setting the tool by touching a part of unknown diameter

When the part must be removed to measure its dimensions, use the **HOLD** function.

ENTER
→
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 (Z1 + Z2) 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.

2.4.2 View Tool Table

Tool   **Tool table**

View tool offset table.

Tool	X ø	Z
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	0.0000	0.0000
6	0.0000	0.0000

Tool number: 2

Set · 2 · mm · ABS · 08:00 · ⑦ Help

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2.5 Machine Control

This unit offers the possibility to control the spindle as well as the inputs and outputs required for it.

2.5.1 Spindle Control

The Start Stop keys control the machine spindle.

Start spindle in m3.

Start spindle in m4.

Stop the spindle.

Note:

If the spindle is already turning, the m3 and m4 keys will speed up or slow down the spindle.

When starting or stopping the spindle, the machine will follow the programmed acceleration time.

The external JOG keys, M3 and M4, will work in the same way as the DRO keys.

2.5.1.1 Potentiometer Control

The spindle speed can be changed manually using an external potentiometer.

The potentiometer mode will turn on when the digital input called "Potentiometer on/off" is activated (the icon indicates that the potentiometer mode is active). Then, the analog input will be assumed as spindle velocity command. When exiting the potentiometer mode by deactivating the digital input "Potentiometer on/off" and after stopping the spindle, the DRO will return to its previous state, either RPM mode or CSS mode.

2.5.2 Range (Gear) Change

When selecting a work range other than the current one, the DRO waits for the user to change the indicated range (gear).

When using automatic range (gear) detection, the range cannot be edited at the DRO, just change the range and accept the confirmation of the change at the DRO.

The current range value will be read through inputs DM41, DM42, DM43, DM44. The exact combination of inputs DM41...DM44 for each range may be set by parameter.

If it detects that the gear has been changed while machining, the spindle stops immediately and it cannot be restarted until the range change is confirmed at the DRO.

The DRO generates digital outputs in order to be able use an automatic gear change.

Outputs M41, M42, M43 and M44 indicate the range (gear) to change to (M41 indicates Gear 1, M42 indicates Gear 2, etc.), then, the STROBE signal to command the gear changer to act. It is also possible to wait for the "M-done" signal as confirmation for the DRO that the gear change process is completed successfully.
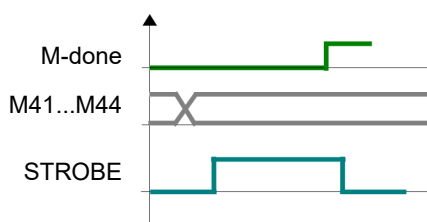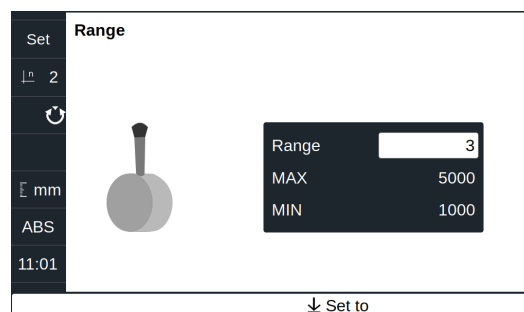
2.5.3 Control of Maximum Spindle Speed

Maximum spindle speed may be limited by an external device connected to inputs DT1, DT2, DT3 and DT4. A rotary selector switch may be used, binary, bcd, gray, etc. Or an intelligent device for safety.

It is possible to edit the RPM values for each combination of inputs DT1 to DT4.

The speed indicated by these inputs will be assumed as the maximum allowed at all times, even in potentiometer mode.

2.5.4 Spindle Orientation

For stopping the spindle in an angular position set by the user. It requires an encoder on the spindle.

How to preset the spindle orientation point.

While the spindle is stopped, access the following screen.

OFF   Turn spindle orientation off.

ON   Turn spindle orientation on.

⤓ Set   It takes the value of the current spindle position as the preset position to stop the spindle.

The icon shows that the spindle orientation mode is ON.

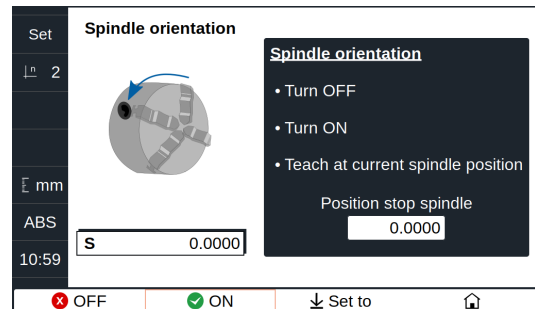**How to orient the spindle.**

While in spindle orientation mode, it will stop at the position preset earlier.

Force a stop.

Pressing STOP twice aborts spindle orientation and the spindle stops.

2.5.5 Emergency Input

The emergency input will stop the spindle immediately and disable all the digital outputs.

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2.6 Special Functions

| Function | It gives access to the specific lathe functions.

2.6.1 Set RPM

| Function | | RPM |
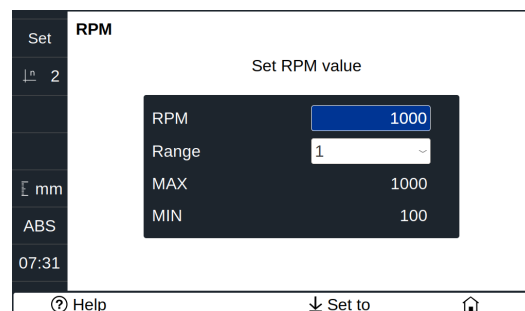
For setting the RPM value for the current tool.

RPM: Desired value in revolutions per minute.

Range: Gear range position.

| ↓ Set | Validate the programmed values.

| ⌂ | Exit without changing values.

RPM

Set RPM value

RPM	1000
Range	1
MAX	1000
MIN	100

Set / ⌐ 2 / ⊏ mm / ABS / 07:31

? Help   ↓ Set to   ⌂

Note:

The preset value must be between the minimum and the max. rpm for the selected range (gear).

Setting the RPM value turns the CSS mode OFF.

2.6.2 Set Constant Surface Speed, CSS

| Function | | VCC |

For setting the Constant Surface Speed value for the current tool.

VCC: Constant surface speed in m/min or ft/min.
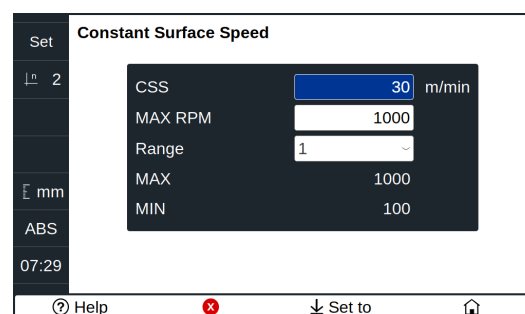
Max RPM: Maximum working RPM value.

Range: Gear range position.

| ✗ | Disable the CSS mode.

| ↓ Set | Validate the programmed values.

| ⌂ | Exit without changing values.

Constant Surface Speed

CSS	30	m/min
MAX RPM	1000	
Range	1	
MAX	1000	
MIN	100	

Set / ⌐ 2 / ⊏ mm / ABS / 07:29

? Help   ✗   ↓ Set to   ⌂

Note:

When CSS mode is ON, the CSS display of the main window will show a yellow light.

If the X axis value is changed by clearing it or by presetting a new value, the spindle will stop for safety.

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2.6.3 Angle Measurement

Function	Angle measurement

It may be used to calculate the angle or taper of a part by touching two points.

ENTER Touch the first point and press Enter.

ENTER Touch the second point and press Enter.

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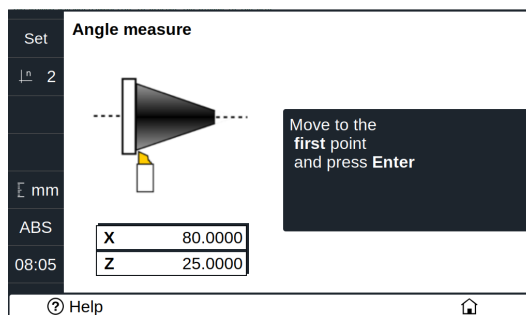
2.6.4 Angle Calculation

Function	Angle calculation

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

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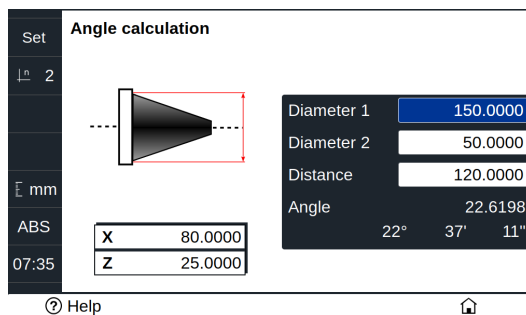
2.6.5 Turning Function

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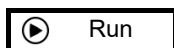
Execute turning cycle. Move the axes until both axis displays read zero.

⊘ Go on to the next execution step.

Total Nr of programmed passes

Current step Nr
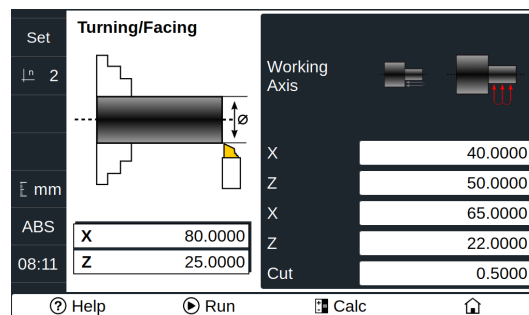
2.6.6 Calculator Function

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**, $\sqrt{\ }$.

⊥ 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.

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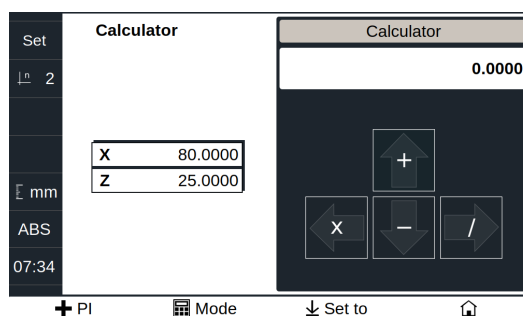
3 DRO Installation

There are two ways to mount the DRO 400i TS:

1- Mounted on the support arm.

Each support arm is available upon request and comes with its own specific assembly manual ·*man_dro_innova_support_arm*· for the horizontal arm and ·*man_dro_innova_support_arm _vertical* · for the vertical arm detailing the elements required for installation.

2- Built-in model.

3.1 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.

Mounting with support
ARM-300/500

Mounting with support
ARM-300/500

Mounting with rear stand

Mounting with support
ARM-V-500
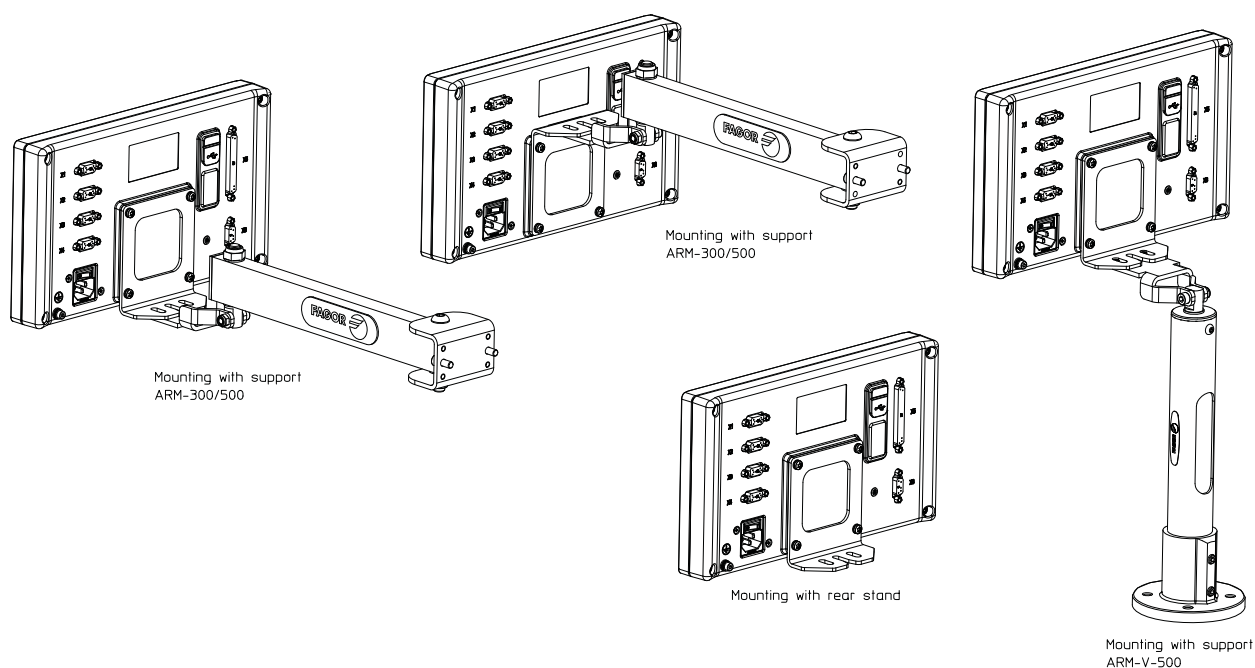
Note. Support arms are available on request.

3.2 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.

Mounting built-in
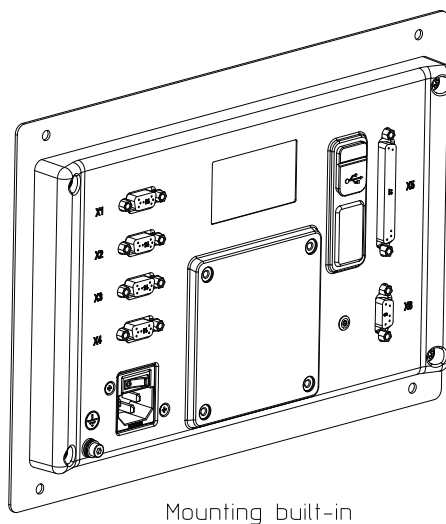
3.3   Dimensions of the Display, the Bracket and of the Window to Insert it Into

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
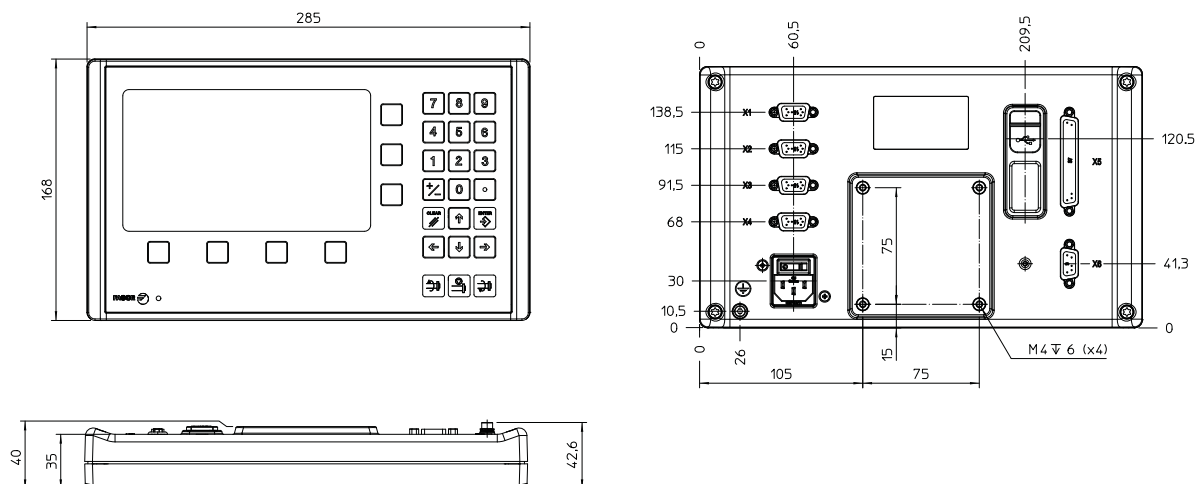
Dimensions of the window for recessed installation
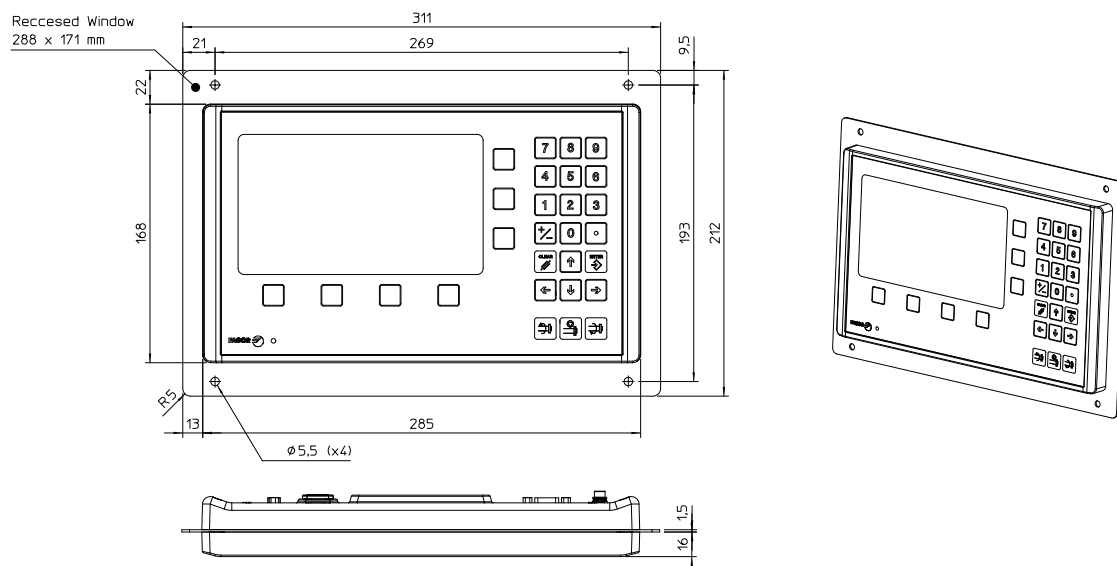
Dimensions of the arm bracket

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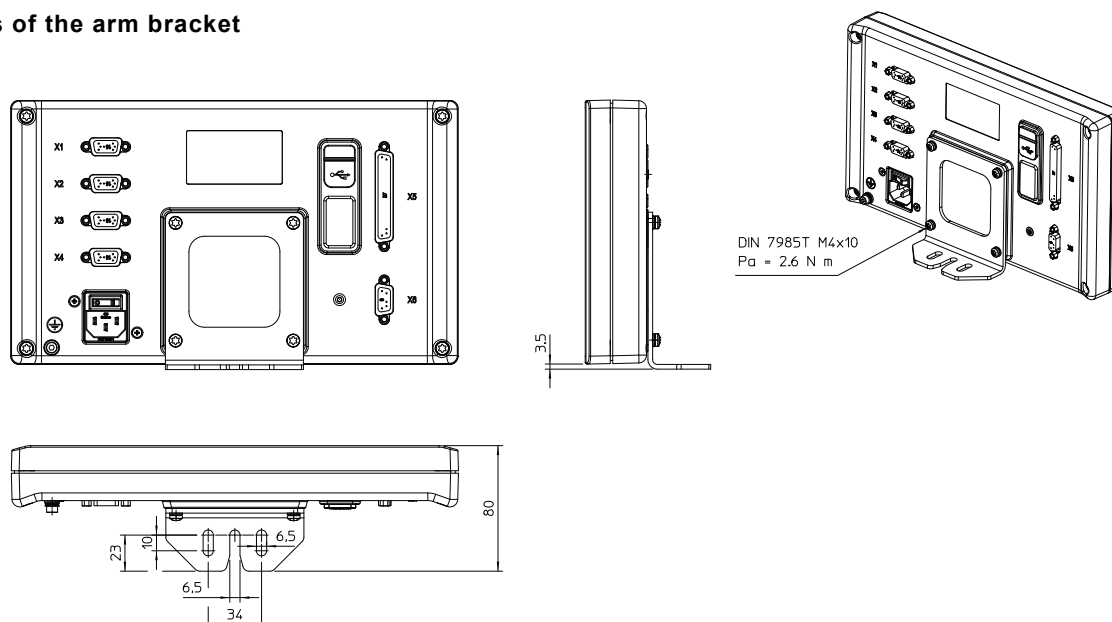
3.4 Rear Panel
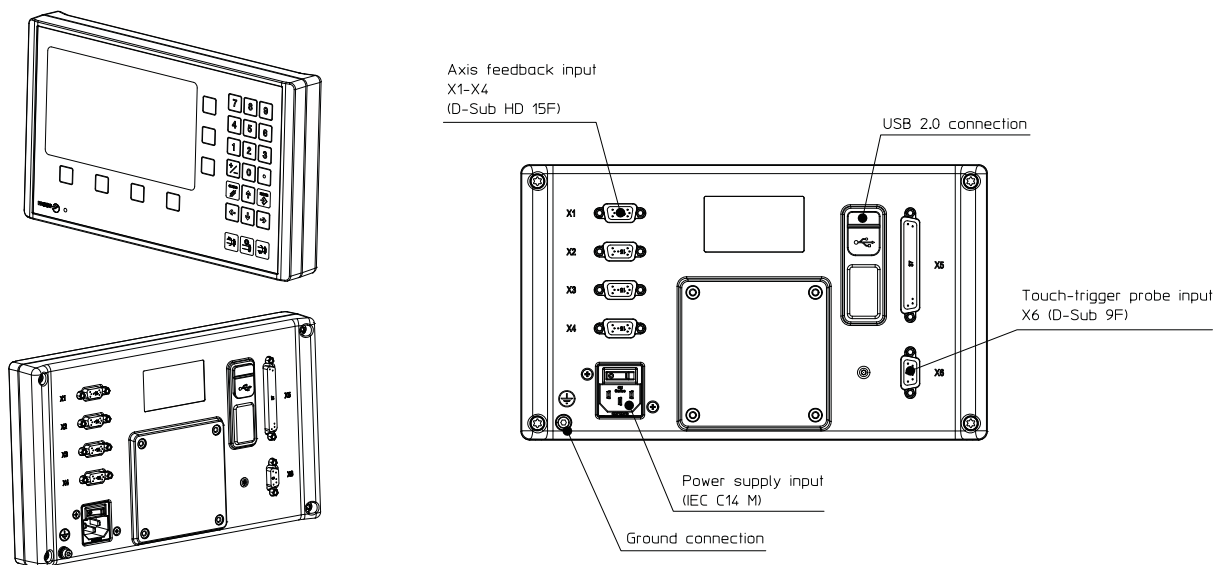
On the back of the unit the following items may be found:

- 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.- D-Sub HD type 15-pin female connector for 1st axis feedback device.

    X2.- D-Sub HD type 15-pin female connector for 2nd axis feedback device.

    X3.- D-Sub HD type 15-pin female connector for the third axis feedback device.

    X4.- D-Sub HD type 15-pin female connector for 4th axis (spindle) feedback device.

    X5.- 37-pin connector for inputs and outputs.

    X6.- D-Sub type 9-pin female connector for the probe.

3.4.1 UL/CSA Standard Marking

In order to comply with the **UL/CSA** standard, this equipment must be connected to the end application using an approved detachable cordset (ELBZ) consisting of SJT cables or equivalent for a minimum voltage of 300 Vac with a molded Nema 5-15 or Nema 6-15 plug and IEC C13 connector. Otherwise, FAGOR accepts no liability for any damage caused.

DO NOT REPLACE the removable power cord with one of inadequate capacity.

ETL file number:

Cert. to CSA
STD C22.2 # 61010-2-201

Conforms to
UL STD 61010-2-201

3168680

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.

3.5   General Technical Characteristics

- For indoor use.

- Universal power supply from 100 (1 - 10 %) Vac to 240 (1 + 10 %) Vac and mains frequencies between 50-60 Hz. Maximum power consumed 25 VA. Resistant to network outages of up to 10 ms.

- The machine parameters are stored for up to 10 years with the display turned off.

- Permissible ambient temperature during operation inside the display housing between 5 °C and 45 °C (41 °F and 113 °F).

- Permissible ambient temperature when NOT in operation inside the display housing between -40 °C and +70 °C (-40 °F and +158 °F)..

- Maximum **R**elative **H**umidity 95 % non condensing at 45 ºC (113 ºF).

- Degrees of protection provided by enclosures (according to DIN 40050): front panel IP 54, rear panel IP 4X, except for built-in models in which case is IP 20.

- Maximum altitude without loss of features: 2 000 m (6 561.6 ft) above mean sea level.

- Pollution Level: Degree 2.

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3.6 Connections

3.6.1 Connection of the Feedback Systems

The feedback systems (linear or rotary encoders) are connected via D-Sub HD type 15-pin female connectors: X1 through X4.

Characteristics of feedback inputs: X1, X2, X3 and X4
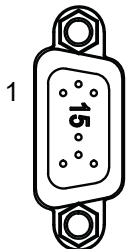
- Maximum feedback consumption: 250 mA at the +5 V input.

- It admits TTL square-wave signal.

- It admits voltage modulated 1 Vpp sinusoidal signal.

- It admits SSI communication for absolute encoders.

- Maximum frequency: 250 kHz, minimum gap between flanks: 950 ns.

- Phase difference: 90º ± 20º, hysteresis: 0.25 V, Vmax: 7 V, maximum input current: 3 mA.

- High threshold (logic state 1): 2.4 V < VIH < 5.0 V.

- Low threshold (logic state 0): 0.00 V < VIL < 0.55 V.

Feedback Connection. Connectors X1, X2, X3 and X4.

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

3.6.2 Input / Output Connection (X5 Connector). 37-Pin Connector

Characteristics of the analog input

Voltage range: ±10 V.

Impedance > 10 kΩ

Maximum unshielded cable length: 75 mm.

Characteristics of the analog output

Voltage range: ±10 V.

Minimum impedance of the input to which it is connected: 10 kΩ.

Maximum unshielded cable length: 75 mm.

We recommend using shielded cables joining the shield to the connector housing at each end.

Characteristics of the digital inputs

Rated voltage: +24 Vdc.

Maximum voltage: +30 Vdc.

Minimum voltage: +18 Vdc.

High threshold voltage (logic state 1): > +18 V.

Low threshold voltage (logic state 0): < +5 V.

Typical consumption of each input: 5 mA.

Maximum consumption of each input: 7 mA.

Characteristics of the digital outputs

Rated voltage: 24 Vac or Vdc.

Maximum voltage: 47 Vac or Vdc. Protection against over-voltage.

Maximum load current: 100 mA Protection against over-current.

Activation time: < 3 ms.

Deactivation time:< 3 ms.
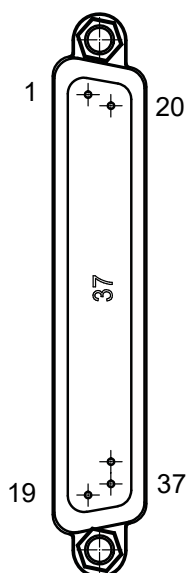
PIN	I/O	Signal	PIN	I/O	Signal
1		Chassis			
2	E	0 V external	20	E	0 V external
3	E	24 V external	21	E	24 V external
4	S	24 V user	22	S	24 V user
5	S	M3	23	E	Jog [-]
6	S	M41	24	S	M4
7	S	M43	25	S	M42
8	E	Jog [+]	26	S	M44
9	S		27	S	M STROBE
10	S		28	S	
11	E	Detect MAX RPM 1	29	S	
12	E	Detect MAX RPM 3	30	E	Detect MAX RPM 2
13	E	Emergency	31	E	Detect MAX RPM4
14	E	Jog - M3	32	E	M-done
15	E	Detect M41	33	E	Jog - M4
16	E	Detect M43	34	E	Detect M42
17		Chassis	35	E	Detect M44
18	E	Analog Potentiometer	36	E	Potentiometer ON/OFF
19	I/O	0 V analog	37	S	Spindle command

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3.6.2.1 Connection Diagram
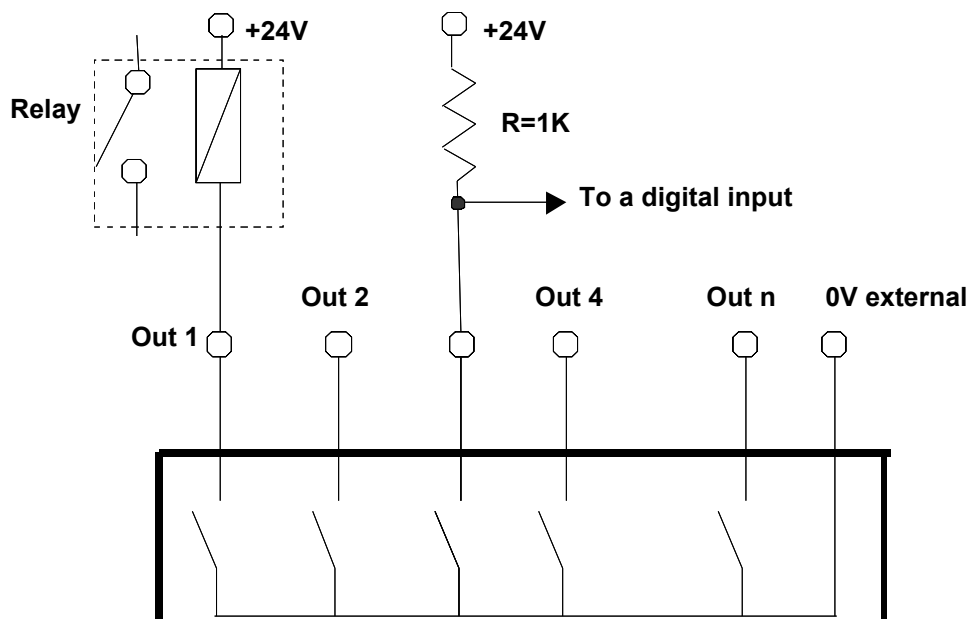
3.6.2.2 Connection Example
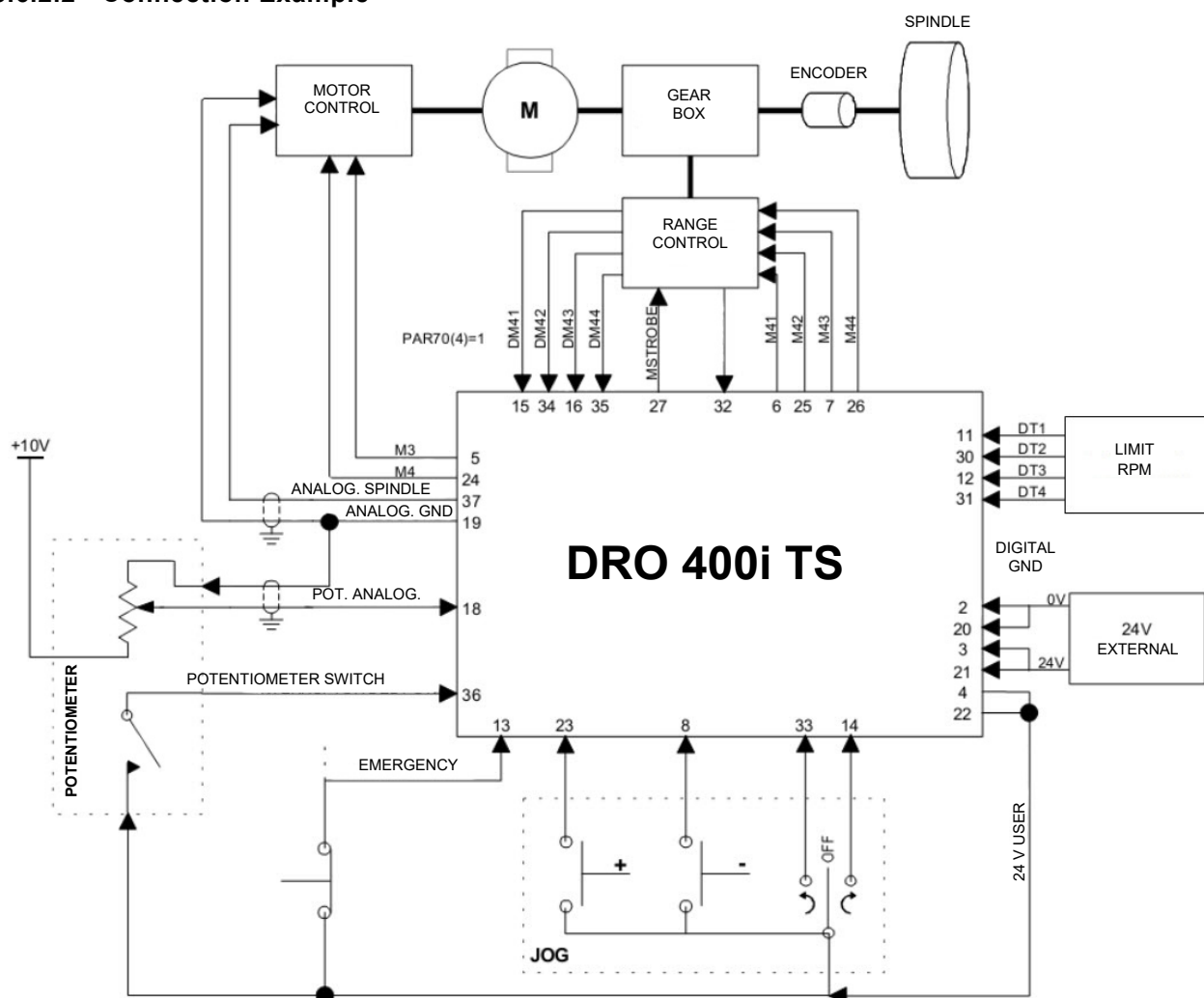
3.6.3 Probe Connection (Connector X6)

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

Characteristics of probe inputs X6
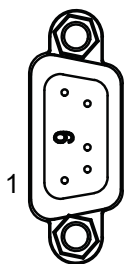
5 V Probe Input

Typical value 0.25 mA ➔ Vin = 5 V.

High threshold (logic level "1") VIH: From +2.4 Vdc on.

Low threshold (logic level "0") VIL: Below +0.9 Vdc.

Rated voltage Vimax = +15 Vdc.

24 V Probe Input

Typical value 0.30 mA ➔ Vin = 24 V.

High threshold (logic level "1") VIH: From +12.5 Vdc on.

Low threshold (logic level "0") VIL: Below +4 Vdc.

Rated voltage Vimax = +35 Vdc.

Probe Connection. Connector X6

PIN	SIGNAL	DESCRIPTION
1	CHASSIS	Ground Connection
2	+5 VOUT	+5 V Output
3	PROBE_5	+5 V Probe Input
4	PROBE_24	+24 V Probe Input
5	GNDVOUT	GND Output
6	5 VOUT	5 V Output
7	-	-
8	-	-
9	GNDVOUT	GND Output

The unit has two probe inputs (5 Vdc and 24 Vdc) 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.

Acts with the up-flank.

PIN3 Vcc=+5V TTL
PIN4 Vcc=+24Vcc
PIN5 0V
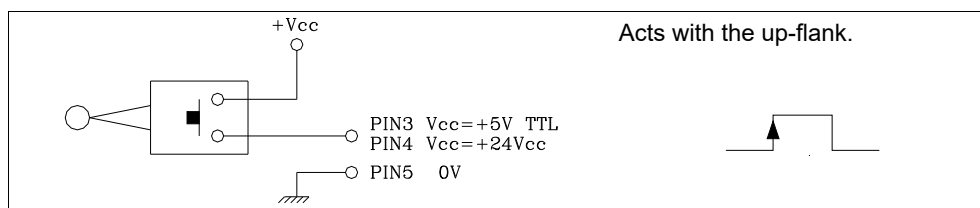
Probe with "normally closed contact" output.
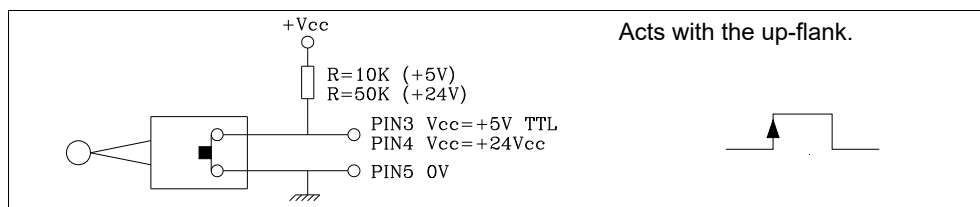
Acts with the up-flank.

R=10K (+5V)
R=50K (+24V)
PIN3 Vcc=+5V TTL
PIN4 Vcc=+24Vcc
PIN5 0V

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

Acts with a down flank.

PIN3 Vcc=+5V
PIN5 0V

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

+24V

12K
PIN4 Vcc=+24V
PIN5 0V

Acts with a down flank.
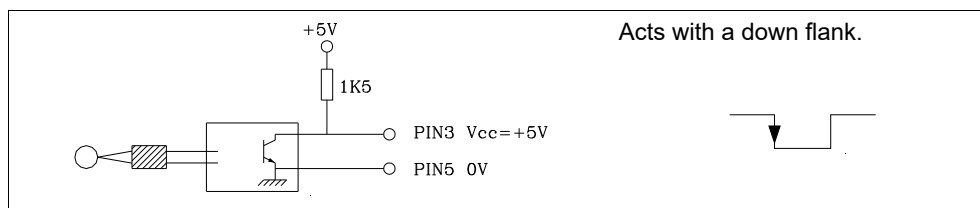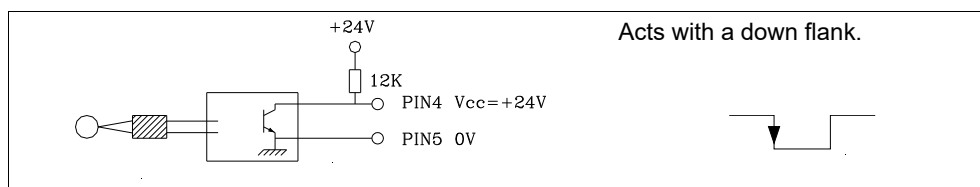
Interface with a PUSH-PULL output.

+Vcc

PIN3 Vcc=+5V TTL
PIN4 Vcc=+24Vcc
PIN5 0V)

The active flank depends on the interface used.
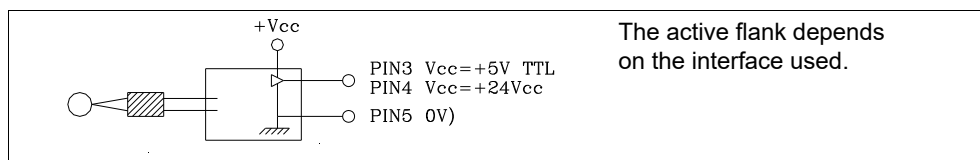
3.6.4 Power and Machine Connection

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 mm²) for this connection.

Connect the external earth terminal of the display to a **P**rotective **E**arth connection.

WARNING

To avoid the risk of electric shock, the equipment must only be connected to a supply mains with a **P**rotective **E**arth connection.

3.7 Installation Parameters

3.7.1 Accessing Installation Parameters

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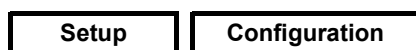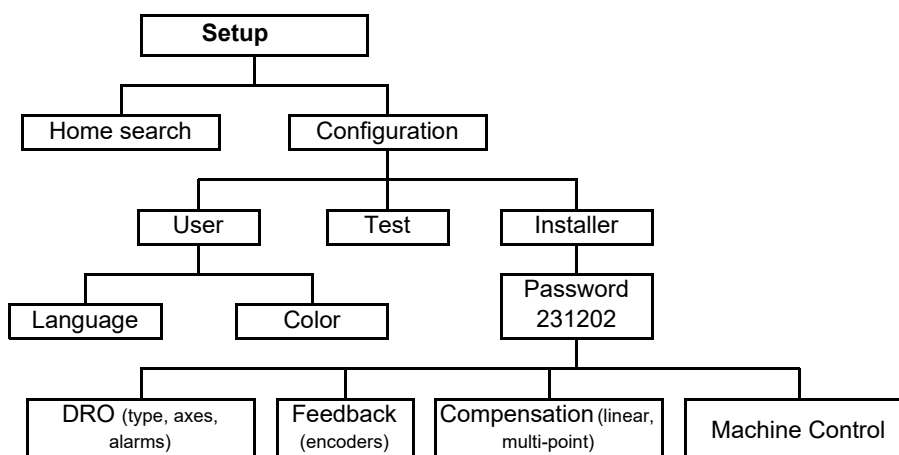
Gives access to setting installation and user parameters and to the test mode.

The parameter setup is divided into three parts:
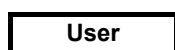
User

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

Install

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.
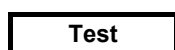
Test

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**
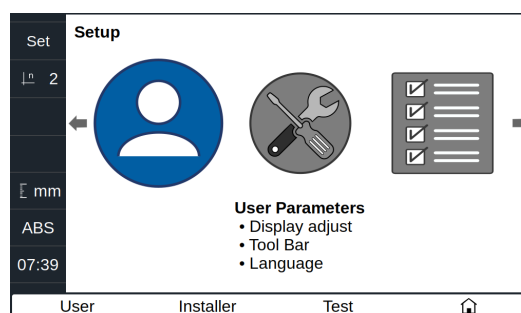
3.7.2 User Parameters
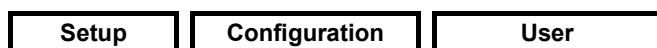
Setup	Configuration	User

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

3.7.2.1 Language
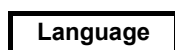
Language

Use the cursor keys to select the language.

 Press Enter.

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3.7.2.2 Screen Color

Color

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

3.7.3 Installer Parameters

Setup	Configuration	Installer

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**

This window offers the following options:

DRO, feedback, error compensation and machine control.
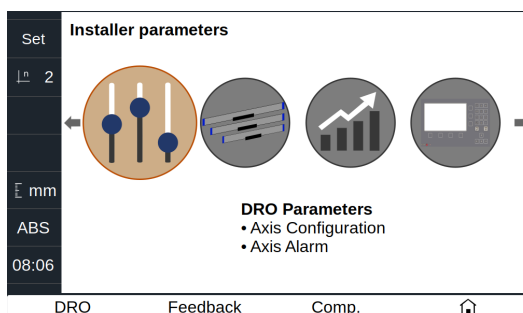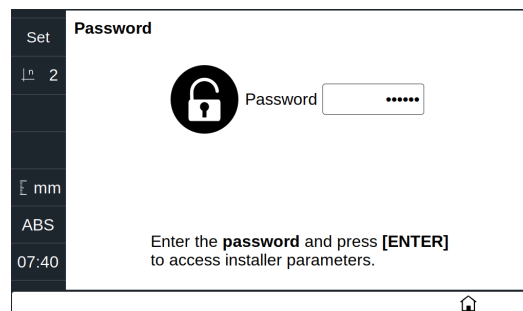
3.7.3.1 Parameter Backup into USB Memory

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

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

3.7.3.2 DRO

Setup	Configuration	Installer	DRO

It configures the DRO for each type of machine: Number of axes, default units, etc.

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

1- Type of Machine:
> In this case, it is set for lathe.

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

> This model sets 4 axes.
> The fourth one is the spindle.

3- Default units: mm or inch.

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.
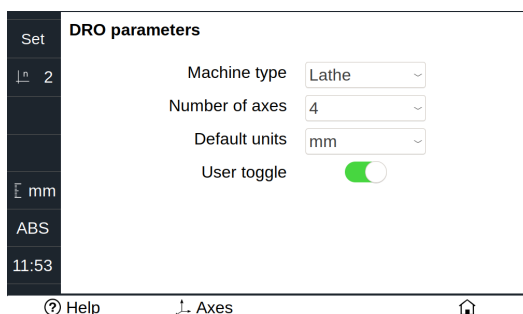
Axes Option

Setup	Configuration	Installer	DRO	Axes

These parameters must be set for each axis.

Note: To select the spindle axis (the 4th axis), press the 3rd axis key twice.

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.

5- Default value: Measurement in radius or diameter. Only available for the X 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.
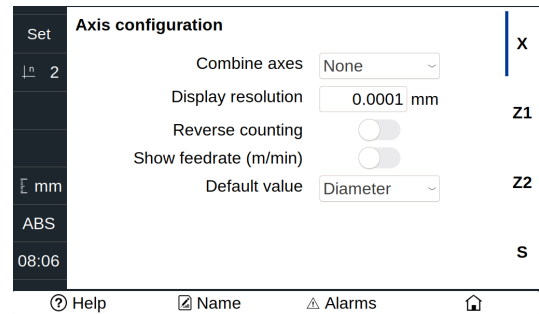
Alarms Option

Setup	Configuration	Installer	DRO	Alarms

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 0) or active high (TTL 1).
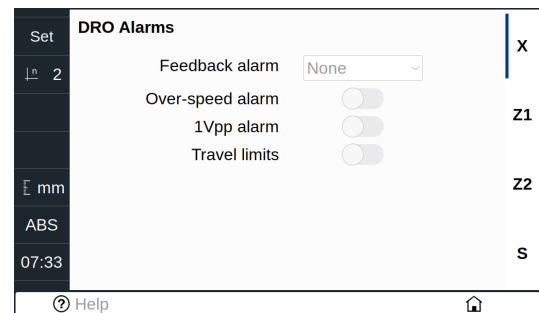
3- Feed rate overrun alarm: When set to YES, an alarm is issued over 200 kHz.

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.

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3.7.3.3 Feedback

Setup	Configuration	Installer	Feedback	FAGOR

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.

Set	**Fagor Feedback properties**		None	X
⌐ 2				
			None	Z1
	Series	S ·		
	Signals		None	Z2
Σ mm	RefMark			
ABS				
08:00			None	Z

ⓘ Help   ⊗ Clear   ↓ Set to   ⌂

Custom feedback selection

Setup	Configuration	Installer	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 leadscrew pitch in mm, inches or turns per inch.

Set	**Feedback properties**		X
⌐ 2	Axis type	Linear ⌄	
	Encoder signals	1 Vpp ⌄	Z1
	Resolution	0.0001	
	TTL multiply	4 ⌄	
Σ mm	SIN multiply	1 ⌄	Z2
ABS			
07:37			S

ⓘ Help   ⌐ Ref   ⤳ Fagor   ⌂

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- 1 Vpp: 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 **1 Vpp** 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:

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

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

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.

Axis type	Linear
Encoder signals	SSI
Resolution	0.0001
Number of bits	32

Reference

Setup	Configuration	Installer	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.

* 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, 2, 5, 10, 20, 25 or 50).

Reference marks

User Offset (mm)	0.0000
Homing on start up	
Inverted ref.	

🏠	Exit and save data.

3.7.3.4 Compensation

Setup	Configuration	Installer	Compensation

Choose the type of compensation to be used.

  1- NONE.

  2- LINEAR.

[ENTER →] 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 →] Enter the linear compensation value and press Enter.

  3- MULTI POINT.

[ENTER →] 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 max. amount of error that may be compensated corresponds to a slope of ±3 mm/m.

Error compensation

Select compensation type: Multi Point

Multi Point Error 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	-0.0300
6	0.0000	0.0000

(Set, X, Y, Z, W, mm, ABS, 13:05, Help, View)

[Edit] Pressing the Edit button displays a table with 108 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.

Error compensation

(Set, mm, ABS, 14:24)
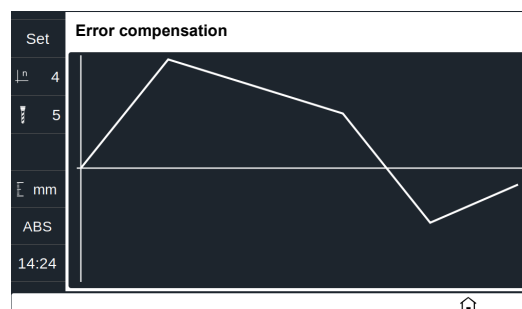
3.7.4 Test Mode

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, check-sum, 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**

3.7.5 Machine Control

| Setup | Configuration | Installer | Machine Control |

For setting the spindle control parameters, inputs and outputs.
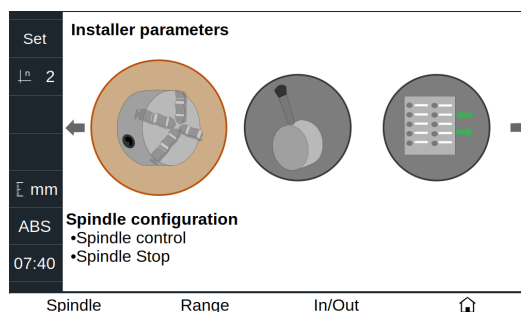
3.7.5.1 Spindle Configuration

| Setup | Configuration | Installer | Machine Control | Setup Spindle |

For setting the values for spindle control.

Spindle encoder: Defines whether the machine has an encoder connected to the spindle or not.

Spindle control: When selecting closed loop, the DRO will try to follow the programmed rpm.

Acceleration time: Time required by the analog signal to go from 0 V to 10 V. It is limited to 7 s.

Analog output: Depending on the drive, unipolar from 0 V to 10 V or bipolar from -10 V to +10 V.

M3 value: Analog command value for M3 rotation.

RPM inc: The value for RPM UP and DOWN keys.

External JOG only: Disables the M3 and M4 keys of the DRO, the external JOG can only be used to start the spindle.

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3.7.5.2 Spindle Orientation

Setup	Configuration	Installer	Machine Control	Setup Spindle	Stop

In order to be able to stop the spindle in a particular position, the system must have an encoder mounted on the spindle.
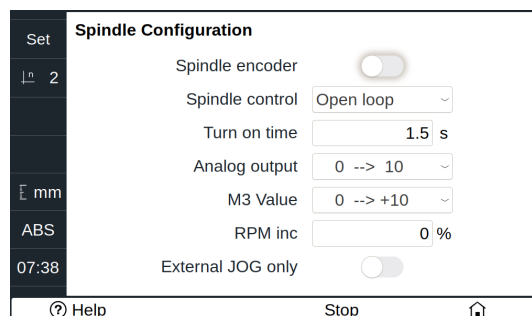
Spindle Orientation: It turns that option on or off.

RPM: RPM during spindle orientation.

Distance: Angular anticipation distance to stop the spindle.

Compensation: Of the analog output voltage of the spindle.

Cancel Oriented Stop: Maximum time to make the oriented stop. After this time the spindle will stop.

	Spindle Configuration	
Set	Spindle orientation	
└ⁿ 0	RPM	0
	Distance	0
	Compensation (v)	0.00
E mm	Cancel oriented stop	20 s
ABS		
12:15		
⑦ Help		⌂

3.7.5.3 Range Configuration

Setup	Configuration	Installer	Machine Control	Range
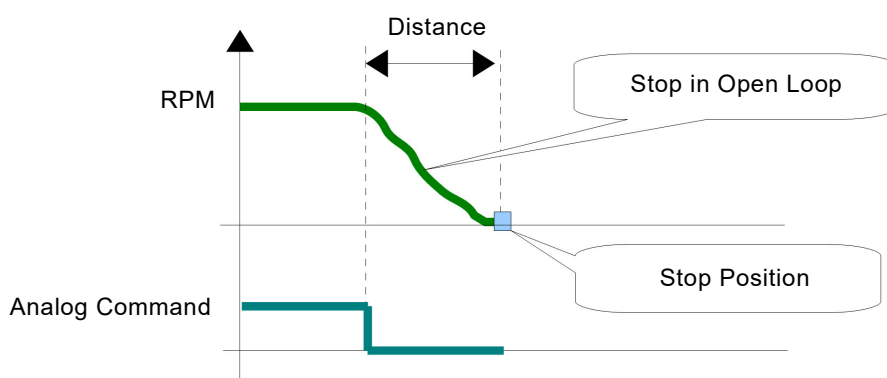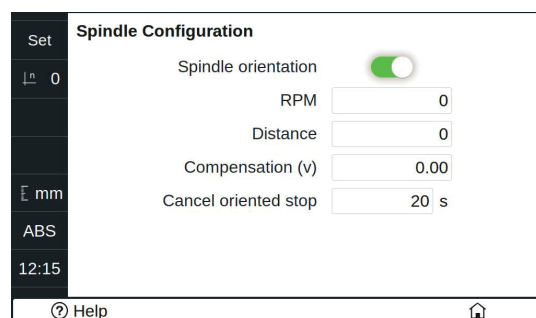
It sets the values for range control.

Automatic range (gear) detection: For safety, the DRO will control the current range by reading the digital inputs.

External speed box: For safety, an external box or selector that indicates to the DRO the maximum RPM allowed.

Automatic range (gear) change: The gear change can be done automatically.

M-done signal: For safety, wait for the M-done signal before considering that the gear change is completed and moving the spindle.

Reset Max RPM: For safety, reset max. RPM of the VCC (CSS) cycle on power up.

Confirm RPM: For safety, confirm if you really want to change the rpm.

Stop spindle (tool change): For safety, when changings the tool, the spindle must be stopped.

	Range configuration	
Set	Auto detect range	
└ⁿ 2	External speed box	
	Auto range change	
	Use M done signal	
E mm	Reset Max RPM	
ABS	Confirm RPM	
15:21	Stop spindle (tool change)	
⑦ Help	RPM Ext. Box	⌂
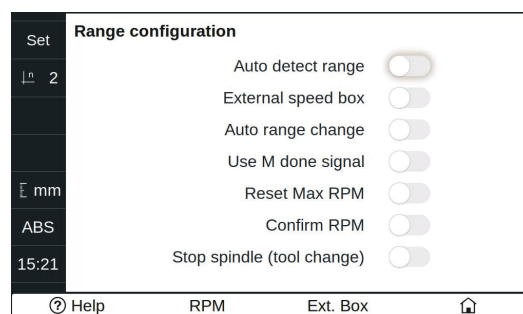
3.7.5.4 RPM Table for Each Range

Setup	Configuration	Installer	Machine Control	Range	RPM

For setting the gear range to control the spindle speed.

Automatic range (gear) configuration: It reads the correct position of the gear lever through its digital inputs.

Range: Gear range position

MIN: Minimum rpm value that may be preset for this range.

MAX: RPM value for an analog signal of 10 V.

COMP(%): Compensation for the analog signal. Useful to adjust the machine when working in open loop.

Stop spindle when bad range: The spindle stops when the actual speed exceeds the programmed speed by 25 %.

Range

Stop spindle when bad range ◯

Range	MIN	MAX	COMP (%)
1	100	1000	100
2	500	2000	100
3	1000	5000	100
4	5000	10000	100

Set
⌐ 2
⌐ mm
ABS
15:09
⑦ Help   Inputs   ⌂

3.7.5.5 Gear (Range) Detection Inputs

Setup	Configuration	Installer	Machine Control	Range	RPM	Inputs

To set the value of the inputs for each range.

Inputs

	InM44	InM43	InM42	InM41
Range 1	0	0	0	1
Range 2	0	0	1	0
Range 3	0	1	0	0
Range 4	1	0	0	0

Set
⌐ 2
⌐ mm
ABS
07:59
⌂

3.7.5.6 Active Level Configuration

Setup	Configuration	Installer	Machine Control	Inputs/Outputs

For setting the active level for the digital inputs.

Inputs

Pin	Name	Level
33	M4	0
14	M3	0
13	Emergency	0
23	Speed up	0
8	Slow down	0
36	Pot	0
15	Detect M41	0
34	Detect M42	0

Set
⌐ 2
⌐ mm
ABS
11:53
⑦ Help   Output   ⌄   ⌂

Setup	Configuration	Installer	Machine Control	Outputs

For setting the active level for the digital outputs.

Outputs

Pin	Name	Level
24	M4	0
5	M3	1
6	M41	0
25	M42	0
7	M43	0
26	M44	0
27	M Strobe	0

Set | ⌐ⁿ 2 | ⊢ mm | ABS | 07:59

? Help   Position   ⊗   ⌂

Setup	Configuration	Installer	Machine Control	Outputs	Position

To set the position on the selected axis.

Outputs

Pin	Axes	Position
9	X	0.0000
10	X	0.0000
28	X	0.0000
29	X	0.0000

Set | ⌐ⁿ 2 | ⊢ mm | ABS | 15:18

⌂

3.7.5.7 External Device or Box for Speed Limitation

Setup	Configuration	Installer	Machine Control	Range	External box

Inputs DT1, DT2, DT3 and DT4 may be used to set up to 16 different levels. Edit the table with the maximum RPM that indicate each level.

External speed box

DT 1,2,3,4	RPM
0	300
1	500
2	1000
3	1200
4	1400
5	1600
6	1800
7	2000

Set | ⌐ⁿ 2 | ⊢ mm | ABS | 07:59

⊙   ⊗   ⌂

4 Appendix

4.1 UL/CSA Seal

See 'UL/CSA Standard Marking' on page 19.

4.2 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.

4.2.1 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).

4.2.2 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.

Remember that if the appliance is used in a manner not specified by the manufacturer, the protection provided by the equipment may be compromised.

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 0.7 m (27.5 in) and 1.7 m (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 in).

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.

PROTECTIVE EARTH symbol.

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

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4.2.3 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.

4.2.4 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 in) 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.

4.3 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.

It is recommended to clean the device using a clean cloth soaked in 70 % isopropyl alcohol. **DO NOT USE** aggressive solvents, (benzol, acetones, etc.) which could damage the materials used to make the equipment.

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.