English version

ULTIMHEAT® MUSEUM

Jacques Jumeau

Technology of components used in heating.

Chapter 45

Thermostats and humidistats, how to select the right knob

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Thermostats, humidistats, electronic controllers, how to select the right knob.

What a user sees of a control device is usually just the knob. The impression of general quality that it will have of the product will be based on the visual impression, the grip, the adaptation of this setting to the application, and the general feeling that it will withdraw from the handling of this controller.

We have the advantage of manufacturing our own knobs, and each of the existing models has been designed to best meet the requirements defined by customers and their applications. There is no universal knob. Here are the main points to define the most appropriate knob for the application.

1- Constraints linked to the thermostat or controller

1-1/ Shaft diameter and length

The shafts of the control devices exist in 4 main diameters: 6 and 8 mm in continental Europe, 4.75mm (3/16 ") in England, 6.35mm (1/4") in the USA. The diameters of 6 and 6.35 mm are the most common, the dia. 4.75mm having been used mainly in England for devices built during the second half of the 20th century, and the dia. 8 mm (5/16 ") especially used on control apparatus, valves and valves for gas cooking appliances.

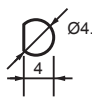
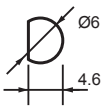
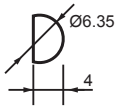
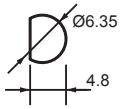
The length of the adjustment shafts is very variable, but in general will correspond to the type of application: For appliances, the shaft will be short, of about 10 to 12mm, because the knobs should not be used often, and for aesthetic reasons, they are not very thick. Longer adjustment shafts will be used when the unit is not attached directly to the faceplate, but on a backplate, to hide the mounting screws and use a small diameter knob. For professional devices, as the setting must be changed frequently, the handle will be thicker to allow a better grip, so the axis will be longer, of about 18 to 25mm.

Special attention must be given to the penetration length of the adjustment shaft in the knob, which must be between 70 and 100% of the depth of its receptacle.

1-2/ The dimension of the flat

The shafts can be cylindrical (in the case of most adjustable bimetallic thermostats) or have a flat surface (on the 6 mm axes of the bulb and capillary thermostats this flat dimension is universally standardized at 4.6mm, on the 6.35mm axes it can be 4 mm (humidistats) or 4.8mm (thermostats). In some particular devices there may be a second flat.

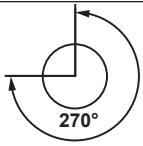
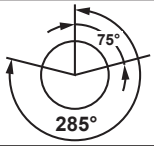
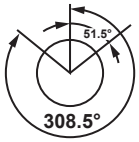
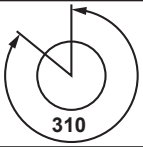
Usual flat dimensions :

Dia. 4.75mm, 4mm flat	Dia. 6mm, no flat	Dia. 6mm, 4.6mm flat	Dia. 6.35mm, no flat	Dia. 6.35mm, 4mm flat	Dia. 6.35mm, 4.8mm flat
					

1-3/ Mechanical angulation

The mechanical angulation is the angular rotation of the knob, between the maximum stop and the minimum stop.

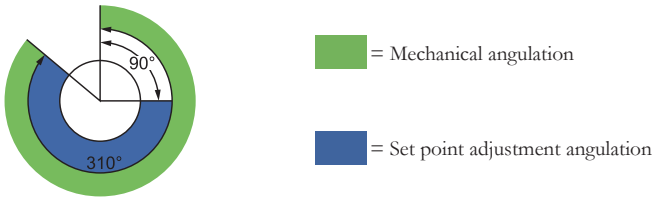
Usual mechanical angulations :

255°	270°	285°	308.5°	310°
				
Humidistats	Thermostat, European angulation	Energy regulators, English angulation	Energy regulators, European angulation	Thermostats, US angulation

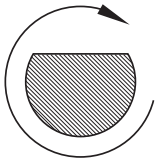
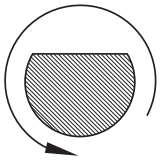
1-4/ Set point adjustment angulation

The set point adjustment angulation is the part of the mechanical angulation where a setpoint adjustment will be possible. In many devices, this adjustment angle will start from 20 to 60° angular from the minimum of mechanical angulation. This is due to the technical requirements of the devices.

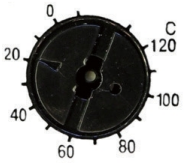
Example of set point angulation adjustment / mechanical angulation



1-5/ Direction of rotation

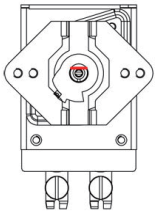
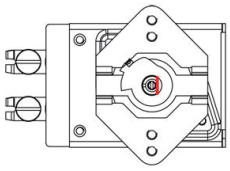
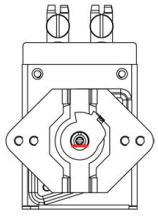
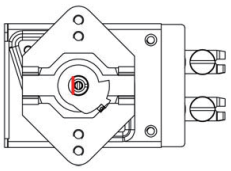
Clockwise	Anti-clockwise
	

In most cases, in Europe, the set point value is increased by turning the knob clockwise. In the USA and England, this direction of rotation can vary from one manufacturer to another. Special attention must be paid to this direction of rotation so that the graduation of the knob corresponds well to it. Confusion may appear when the knob has an arrow or mark and the graduation is printed on the fixed part.

Printed knob, fixed arrow,clockwise rotation	Printed knob, fixed arrow,anticlockwise rotation	Knob with arrow, printed mounting board, clockwise rotation	Knob with arrow, printed mounting board, anticlockwise rotation
			

1-6/ Thermostat or control position

Depending on the position of the thermostat or device, and therefore the position of its adjustment shaft, the position of the knob printing will be different. Most thermostats can be easily identified by the position of their electrical connection terminals.

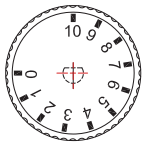
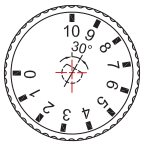
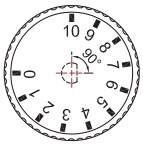
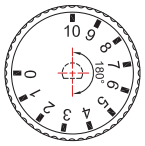
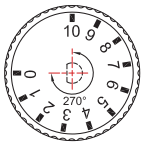
Most standard position Electric terminals downside (or facing the user if the thermostat is horizontal)	**Rotated 90° clockwise**	**Rotated 180° clockwise**	**Rotated 270° clockwise**
			

1-7/ Flat position on the knob

When the position of the thermostat has been defined, if it has an adjustment shaft with a flat, the position in which the flat will be when the thermostat is at maximum mechanical stop will determine the orientation of the printing of the knob, so that this print is in a readable position when the setting mark and the desired set point graduation coincide.

Most usual positions

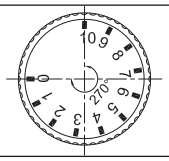
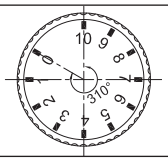
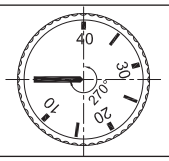
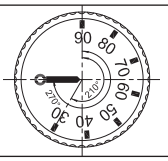
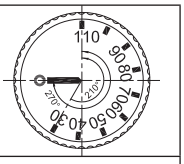
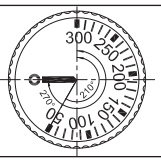
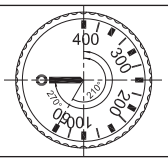
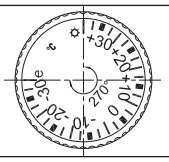
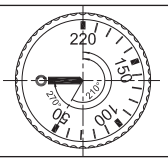
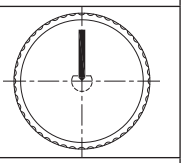
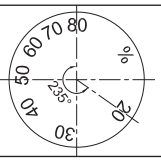
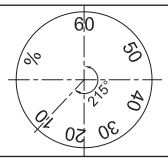
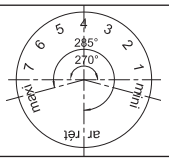
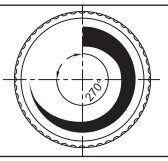
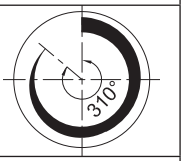
(The angle is given between the scale printing corresponding to the maximum position of the handle and the flat of the adjustment shaft)

0°	30°	90°	180°	270°
				

1-8/ Printed area

The printed area and its angular distribution must correspond to the values given for the thermostat or the device. These values and their angular position are usually given in the thermostat definition plan or in the catalog. If a printing with values is not desired, neutral zones or arrows may be used.

Usual scales printing

				
0-10 on 270°, clockwise direction	0-10 on 310°, clockwise direction	0-40 on 270°, clockwise direction	0-90 on 270°, clockwise direction, adjustment area 30-90° on 210° angular	0-110 on 270°, clockwise direction, adjustment area 30-110° on 210° angular
				
0-300 on 270°, clockwise direction, adjustment area 50-300° on 210° angular	0-400 on 270°, clockwise direction, adjustment area 50-400° on 210° angular	-35+35 on 270°, clockwise direction, adjustment area -35+35 on 270° angular	0-220 on 270°, clockwise direction, adjustment area 50-220° on 210° angular	Simple arrow
				
Adjustment area 20-80% on 235° angular, mechanical rotation 255°	Adjustment area 20-60% on 235° angular, mechanical rotation 255°	Adjustment area Min to Max on 210° angular, mechanical rotation 285° angular	Circular arrow on 270° clockwise direction	Circular arrow on 310° clockwise direction

2-Constraints linked to assembly

2-1/ Readability of the knob

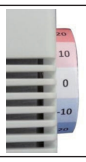
Depending on the assembly, the reading of the knob and the necessary accessories will be different. Particular attention must be paid to the fact that the graduation must be readable when it is in front of the mark. In the case of a fixed mark and a graduated knob, the position of the mark, on the top, below, or on the side, will influence the way of printing and the orientation of the print.

Examples of the influence of the position of mark on readability

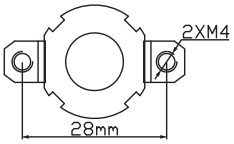
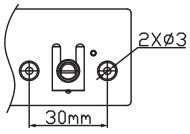
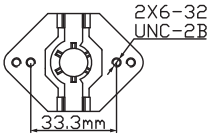
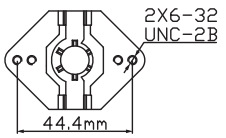
Mark on the left	Mark on the top	Knob printing on top	Knob printing on the left
			

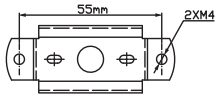
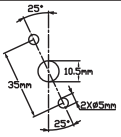
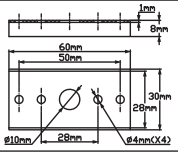
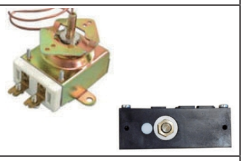
2-2/ Different types of mark and knobs couples

Screw driver shaft, printed dial	Arrow clips, printed dial	Printed knob, printed mark on mounting board	Printed knob
			
System that allows the smallest footprint. Generally used on devices where the setting is internal. dial can be printed directly or be an adhesive label	Small footprint. Generally used on devices where the setting is internal. dial can be printed directly or be an adhesive label	Printing of the knob on its flat side, printing of a mark on the mounting board	Printing of the knob on its flat face, and use a metal or plastic bezel with mark, held by the screws of the thermostat

Knob with mark and temperature printed dial	Knob with mark and temperature printed dial or temperature printed label	Side printed knob
		
Use of a knob with a printed or molded mark, and printing the graduation on a plastic or metal dial	Use of a knob with a mark (printed or molded), and printing the graduation on the mounting board or on a bezel or an adhesive label	sing a knob with a flat circular side, which allows printing or applying a printed adhesive. Fixed mark is printed or molded on mounting board

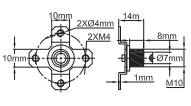
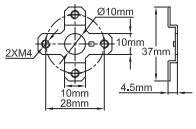
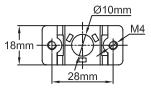
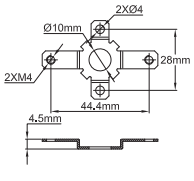
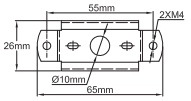
2-3/Board mounting style

Two M4 screws, 28mm distance	Two M3.5 screws or self-taping screws, 30mm distance	Two 6-32 UNC-2B screws, 33.3mm distance	Two 6-32 UNC-2B screws, 44.5mm distance
			
Standard in Europe	Standard for humidistats (USA, Europe, Asia)	Standard in USA	Standard in USA

Two M4 screws, 55mm distance	1/8 BSPP (or M10x1) single-hole bush fixing, with two locating spurts	Recessed mounting board	Mounting with backside screws
			
Used on some refrigerators thermostats	Standard in England, and also used on some refrigerators thermostats	Can be used with the 4 mounting types Makes invisible the screws and allows a mounting board crossing with possible seal	On some models, screws allow the fixing by the side or the back of the case of the thermostat

2-4/Mounting system conversion accessories :

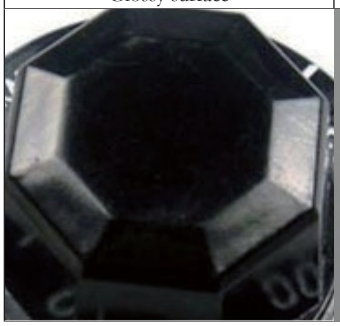
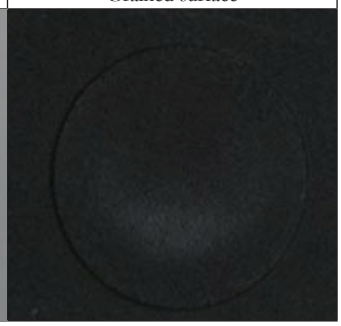
They allow you to switch from one mounting system to another and avoid having to re-drill the mounting bracket when replacing with a different device.

Conversion of the fixing by two M4 screws 28mm distance into a central threaded bush	90° rotation of a mounting by two M4 screws with 28mm distance	Conversion of a threaded central bush mounting into a 2 holes bracket for M4 screws, 28mm distance	Conversion of a threaded central bush mounting into a 2 holes bracket for M4 screws, 44.4mm distance	Conversion of a threaded central bush mounting into a 2 holes bracket for M4 screws, 55mm distance
				

2-5/Aesthetics

The aesthetic aspect involves the design, the surface finish (matte, glossy, satin), the color of the material, the color of the print. If a knob has to respond to a particular aesthetic requirement, all these parameters must be specified, but not everything is possible due to the constraints of molding, printing, mechanical and thermal resistance. Some plastics, especially if they have to withstand high temperatures, can only be made in black, and not all surface finishes are achievable with all materials.

Examples of differents surface finishes

Glossy surface	Matte surface	Grained surface
		

2-6/ Readability and visibility

To be visible and readable, the size of the printing must be sufficient. On knobs smaller than 30 mm, it becomes difficult to print readable graduations. The contrast must be maximum between the know material color and the graduation printing. For example: white knob with black print or white knob with black print. Embossed or debossed numbers are not correctly visible if they are not different in color

There are also knobs with a backlight: the graduations are illuminated by transparency, which allows reading day and night.

Knob with unprinted relief graduation	Knob with impressed graduation	Black knob, with white printing	White knob, with black printing	Backlighted knob
				

2-7/ Special case of adjustable devices with a manual reset button

Some devices have both a knob and a manual reset button. It must then be checked that the knob and any bezel or printing on the mounting board does not overlap the position of this manual reset.

Examples of devices with set point adjustment and manual reset

2-8/ Printing technology

There are several technologies for printing a knob. All do not give the same result, and their selection will depend on the usage parameters and the series envisaged. For household appliances, the resistance of this printing to the conditions of use as well as the test conditions are defined by standard IEC 730-1, and its European equivalent: EN60730-1 (annex A).

Printing technology	Thermal transfer	Silk screen	Pad printing	Embossing or debossing molding	Chemical engraving or anodization	Adhesive label	Laser printing
							
Abrasion resistance	Good (Excellent if printing on the back side of a transparent part)	Medium to low. (Excellent if printing on the back side of a transparent part)	Medium to low. (Excellent if printing on the back side of a transparent part)	Excellent	Excellent	Medium to good. (Excellent if printing on the back side of a transparent part)	Excellent
Solvents resistance	Medium	Poor	Poor	Excellent	Excellent	Medium to good	Excellent
Temperature resistance	Medium	Medium	Medium	Excellent	Excellent	Poor	Excellent
Printing quality	Medium	Good	Good	poor to Medium	Excellent	Excellent	Excellent
Tooling cost	Low	Low	Low	High (one injection mold for each temperature dia is needed)	Medium	Low	Very low
Printing cost	Low	Low	Medium	Expensive (One injection mold by type of dial is needed) No cost if debossed or embossed numbers High if color printing is different in recessed placed Low if printed by thermal transfer or pad printing	High	Low to Medium	Medium
Various	Difficult to achieve on high temperature melting plastics like PPS and thermosetting polyesters	Weak printing on PA66 and PA6	Weak printing on PA66 and PA6	The best solution for large quantities professional applications	Expensive knob with lots of parts, but maximum quality and durability	Especially used for knobs with printing on the cylindrical edge	Well suited to small and medium series, and marking on metal, but non-selectable color and technology is not compatible with some plastics

Other printing technologies are possible: machining, micro-percussion, but limited to samples, prototypes or small series.

2-9/ Units of the measured value

It is important to define the unit that will be used for the graduation to show it on the print if needed: Degrees Celsius (°C), degrees Fahrenheit (°F), percentage of relative humidity (% RH), or other.

3-Constraints linked to the conditions of use

3-1/ Hand grip

The handling conditions of the knob will be different for a product for household use, and for a product for industrial or professional use. In the case of a household product, aesthetics will be favored at the expense of handling. In the case of professional use, for a device that has to be regularly adjusted, for example in catering, users may have wet hands, greasy, or wear gloves, so the knob should be high and large enough, and have well defined facets to prevent the hand from slipping.

Poor hand grip	Medium hand grip	Good hand grip
		

3-2/Mechanical, thermal and chemical resistance of the knob

Unfortunately, there is no plastic material that can be used for the production of the joysticks, which satisfies all the conditions of use. A wise choice must therefore be made.

Main materials used for knobs

Material	ABS	PA66 or PA6	PC-ABS	PPS	Thermoset polyester ("Bakelite")	Polycarbonate (transparent)	Santoprene (elastomeric)
Resistance to temperature	Very poor	Good	Good	Excellent	Excellent	Good	Poor
Resistance to solvents and steam (cleaning)	Very poor	Medium	Medium	Excellent	Excellent	Medium	Medium
Mechanical strenght	Poor	Excellent	Good	Excellent	Good (Hard but brittle)	Excellent	Poor
Surface finish	Good	Good	Excellent	Medium	Good	Excellent	Soft material pleasant to the touch
Printing resistance	Excellent	Medium to bad. (Request a special surface treatment and special inks)	Excellent	Medium (thermal transfer printing almost impossible)	Medium to bad. Recessed printing recommended.	Excellent	Cannot be printed
Colors	All colors are possible	Many colors are possible	Many colors are possible	Black only	Black or grey only	Transparent or black	Cannot be printed
Various	The cheapest, but the worst temperature resistance	The best compromise price, temperature resistance, mechanical strength and printing resistance	The best surface finish	Very high temperature resistance (>200°C)	Very high temperature resistance (>200°C)	Used especially for transparent dials or knobs printed on the back side	Used in overmoulding in "soft grip" knobs

3-3/ Main Methods for clamping the knob to the adjustment shaft

Clamping techniques	Tightening by plastic elasticity of the knob	Tightening by the shaft elasticity	Tightening on the shaft outside diameter by a spring in the knob	Tightening on the shaft flat by a spring in the knob	Clamping by radial screw located on the handle	Clamping by axial jaws located on the handle	Gluing
							
Advantages	- The cheapest solution	- Simple knob - Knob can use hard plastics (Polyester, PPS)	- Excellent clamping on all shafts models with a flat. - No change in tightening characteristics over time. - The clamping force can be modified by changing the spring	- Good clamping on all shafts with a flat - Allows simple shafts. - Achievable on PPS and polyester knobs	- ightening on round shafts or shafts with a flat. - Usable on all materials	- Tightening on round shafts or shafts with a flat. - No visible screw	- Simple knob, easy to produce - Cheap solution

Clamping techniques	Tightening by plastic elasticity of the knob	Tightening by the shaft elasticity	Tightening on the shaft outside diameter by a spring in the knob	Tightening on the shaft flat by a spring in the knob	Clamping by radial screw located on the handle	Clamping by axial jaws located on the handle	Gluing
Disadvantages	- Tightening depends on the tolerances on the shaft diameter - The creep of the plastic as a function of the ambient temperature causes the reduction of the tightening in time. - Not possible on PPS and polyester knobs	- Costly thermostat shaft. Used mainly on US thermostats. Was developed at the beginning of the thermostats to avoid screw tightening on brittle thermoset plastics, before the arrival of more elastic thermoplastic knobs.	- Not achievable on PPS and polyester knobs	- The creep of the plastic as a function of the ambient temperature causes the reduction of the tightening in time.	- Costly - Tightening screw is visible	- Very expensive - Requires overmoulding of the plastic material on a brass core. - Only possible on high knobs with printing on the skirt	- Cannot be dismantled - Gluing plastic knobs on metal shafts is hazardous - Gluing is difficult or not compatible with some plastics - Practically achievable only between plastic knobs and plastic shafts

3-4/High end and low end mechanical stops

Some knobs may be equipped with a system for adjusting a mechanical stop at low end or high end of the scale, independently of the type of thermostat used. This allows, during installation, to reduce the possibilities of adjustment by the end user between certain limits.

Here is an invisible system that can be used on all devices using two M4 screws at 28mm distance. (Other systems exist)

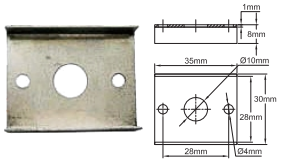
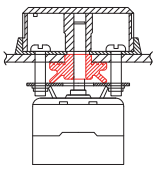
Internal notches on the handle: These notches lock the angular position of the internal movable stop	**The mobile stop:** It fits on the central part of the handle and has a wing that will serve as an angular stop	**The mobile stop in position:** the chosen position determines where the rotation will be limited	**The elevation washer:** It is mounted on one of the fastening screws. (Mounting board of the product was removed to facilitate shooting)	**Assembled device:** the movable stop blocks the rotation of the knob when it comes into contact with the raised fixing screw.
				

3-5/The tightness of the shaft as it passes through a wall

In certain applications in outdoor use, or in appliances washed with water jet, or even hot water jet under high pressure, it is necessary to avoid the water ingress inside the apparatus, where there are live electrical circuits. This water ingress is generally coming by the adjustment shaft or the fixing screws.

Several systems have been developed, providing different levels of resistance to water penetration. Here is an example of a simple and effective system.

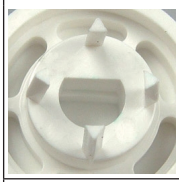
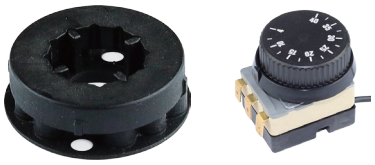
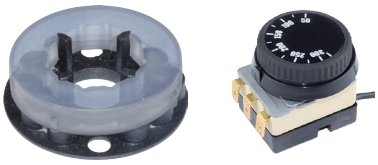
System that can be used on all devices, with a seal sandwiched between the mounting board, and a back plate using the 28 mm mounting holes distance

Stainless steel backplate	Silicone gasket	Installation
		

3-6/ Tactile feedback

More and more, in the electrical appliances, the use of the tactile feedback of the knobs is used. The user must feel a slight resistance every time he passes a setting.

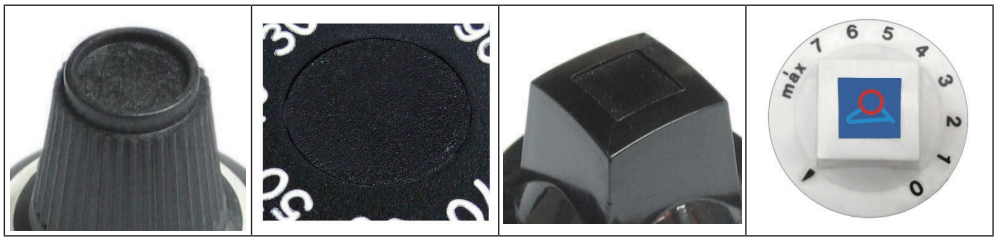
Examples of 3 technologies of tactile feedback

Tacticle feedback on enclosure and knob assembly (OEM products, development on customer specifications)	Tactile feedback accessory with 12 notches on 360 °, compatible with knobs designed to receive an adjustable internal stop, and thermostats with 2 screws at 28mm distance mounting. This accessory also allows to add one or two stops of mechanical rotation (every 30° angular)	Tactile feedback accessory with 12 notches on 360 °, compatible with the backlit "soft grip" knob, and thermostats with 2 screws at 28mm distance mounting. This accessory also makes it possible to add one or two stops of mechanical rotation (every 30° angular) and includes a recess for a dia. 6 mm backlight bulb
Knob:	Se monte dans la manette :	
		
Support :	Mounted under the knob, by the 28mm distance mounting holes of the thermostat	
		
Assembly:	Final assembly :	
		

3-7/Customization

Some knobs have been designed so that the end customer can customize the device himself by an adhesive label or printing. A recess is made in plastic molding. It allows the gluing the adhesive, while securing its location and making it more difficult to remove or to accidentally take it off.

Examples of recesses for customization:



4- Dials and bezels

These are the fixed parts, on the front of the product, and which, in correspondence with the knobs, define the set points. Their selection rules and characteristics of strength and print quality are identical to those of the knobs

Main types

Printed adhesive label	ABS bezel	Chrome plated ABS bezel	Plastic dial, pad printed or silk screen printed	Stainless steel or chrome plated brass bezel	Anodized aluminium dial	Chemical engraved aluminium dial