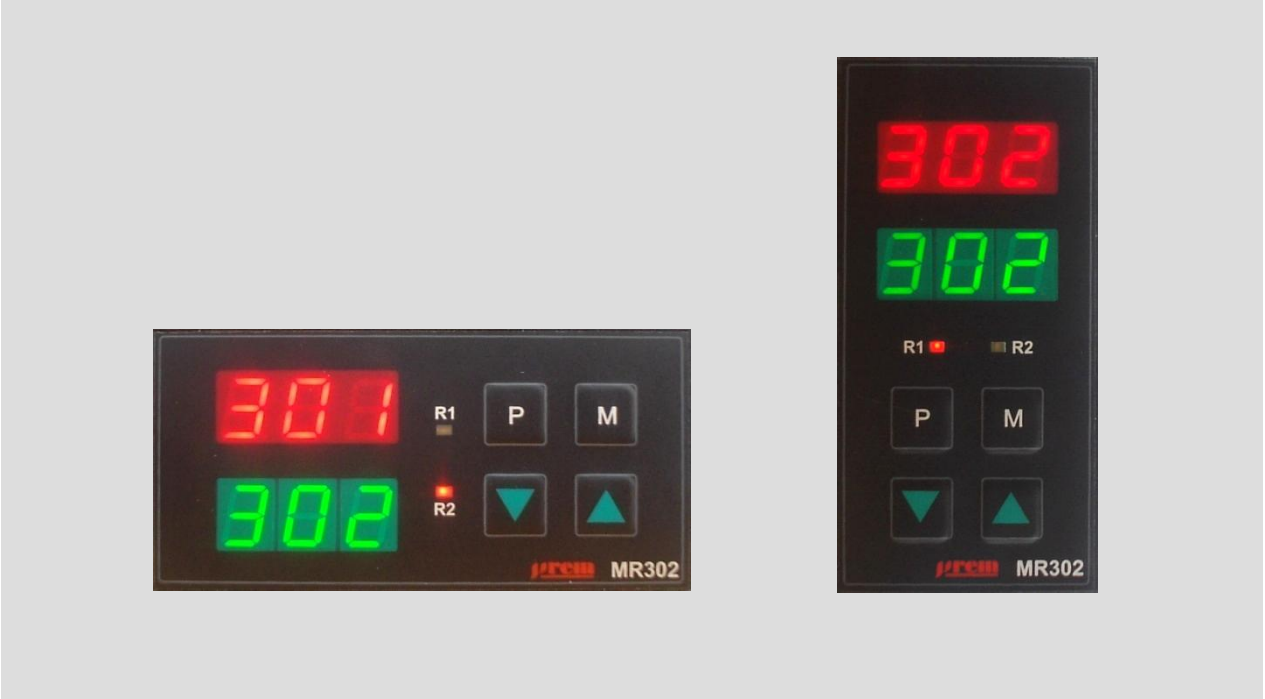
Digital Temperature Controllers
MR301/302



User's Manual

doc. 0488A-01/12

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1. Features

- Configurable analog input accepts Pt100, J, K and L probes
- Measurement accuracy better then 0.25%
- Display and setting resolution 0.1°C or 1°C
- Two independently configurable relay or solid-state outputs
- PID or ON/OFF transfer characteristics for output 1 (cooling or heating)
- ON/OFF transfer characteristics for output 2
- Parameter settings through menu system
- Parameters integrity control
- Configurable parameter access protection

2. Front-panel description and button functions

When the power is turned ON, all of the display lights flash a few times and after that basic view appears (Fig. 1). The upper display shows measured value and the lower display shows the set value. LED diodes R1 and R2 represent output 1 and output 2 states (respectfully). LED is lit when the corresponding output is ON.

By holding down the button (for more than approx. 1.5 seconds) entry into the main menu (list) is achieved.

A short press of the button is implemented to return to the previous list or leave the parameter setting without saving the new value.

This key is used to select menu elements or to save the new value of a parameter. The device responds with the release button.

Buttons "UP" and "DOWN" are for moving through the menu, or change the displayed value when setting parameters. A short press and release one of these buttons causes the transition to the next i.e. previous menu element, or increase/decrease the parameter value. Holding the button down for longer than 0.6 seconds causes further automatic change.

Figure 1

3. Access levels

Visibility of menus and parameters depends on the level with which the user has accessed the device. Application of these levels reduces long-term view and "hides" the important parameters of the less informed users. There are 3 levels of access.

Level 0 is accomplished by pressing "P" (for more than approx. 1.5 seconds), thus entering the main menu and it is not necessary for any prior notice (password).

For Level 1, it is necessary to pre-announce the device password. This is done as follows: Switching on the power supply, the device performs an initial test that takes about 6 seconds. If at any time during this test, press and release the "P" button, the device has received the password for Level 1. Entering the main menu can be done from then on as already described, the usual way, by pressing the "P" longer than 1.5 s. Permission to access Level 1 lasts until the power supply removal.

In order to gain access to menus and parameters from Level 2, button "M" should be pressed before switching on the power supply and hold it until "flashing" starts, and then release. When "flashing" stops, access menus and parameters may be performed in the same way as for level 0 or 1. Permission to access Level 2 applies to the first turn off the power supply.

4. Layout of menus and parameters

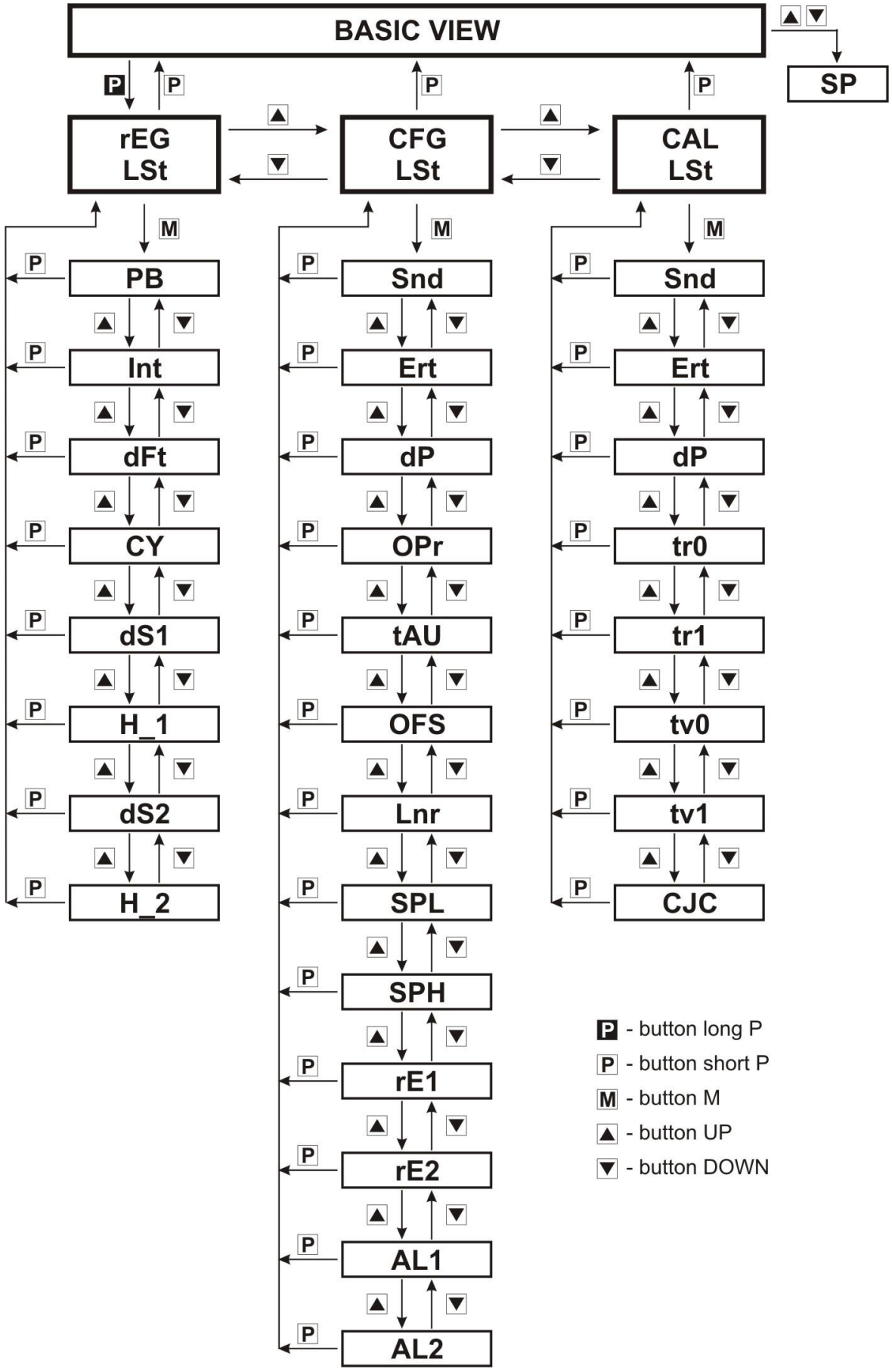

Figure 2

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5. Parameter setting

5.1. Setting the Set Point (SP parameter)

Adjusting the set temperature is approached directly from the main display by pressing the "UP" or "DOWN" button. The upper display is a written message SP, and on the lower display shows the current value of the set temperature. Diagram of the set temperature settings is given in Figure 3.

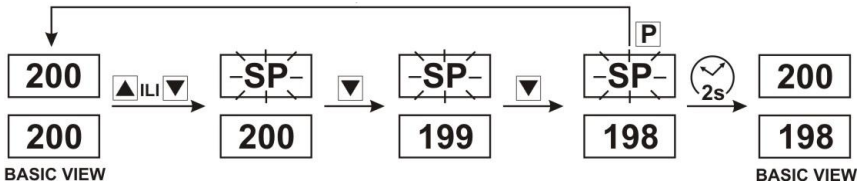

Figure 3

Since the adjustment starts, it is possible to call one of the four previously stored values for the SP by successive presses of the button "M". Thus, the selected value is still can be changed (see Figure 4).

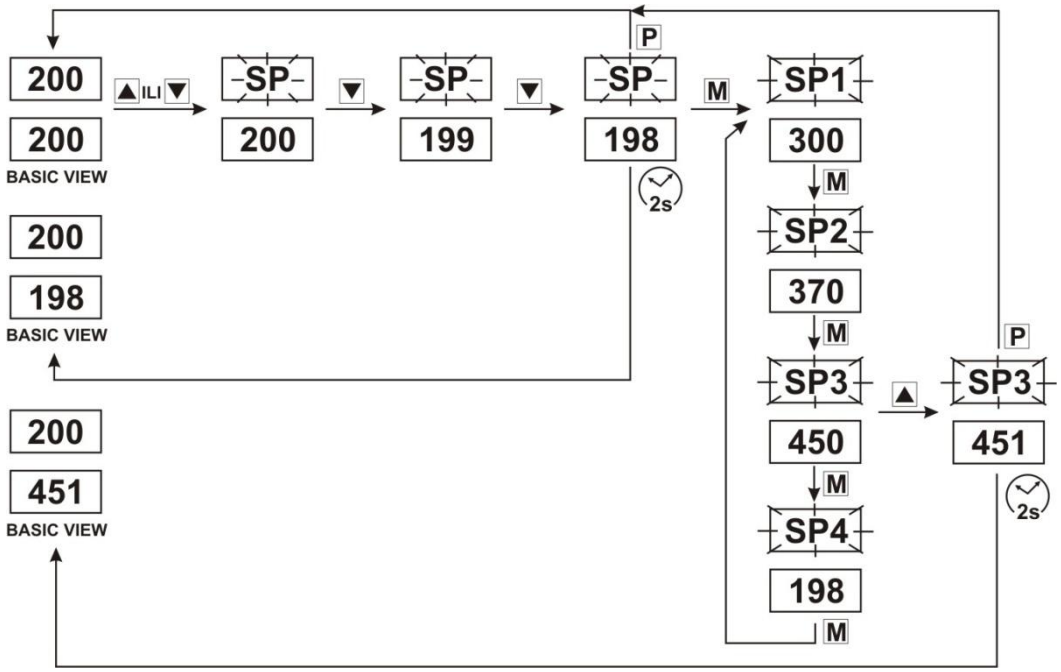

Figure 4

5.2. Setting other parameters

When the upper display shows the name of the desired parameter (the lower display shows the parameter value), press the "M" button to access its settings. An example of setting the value of parameter "Int" is given in Figure 5.

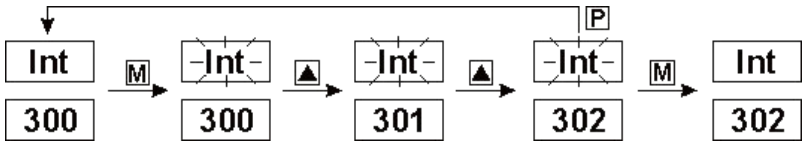

Figure 5

6. Overview of some important configuration parameters

Pressing the "M" button from the basic view starts the overview of some important configuration parameters. This allows the user to review the parameters defining the type of measuring probe, type of the output relay operation, behavior of relays in case of incorrect temperature measurements etc., without realizing the higher level passwords.

The upper display shows the parameter name while the lower shows parameter value. Keys "UP" and "DOWN" proceed to the next i.e. the previous parameter. Return to the basic view is achieved by briefly pressing the "P", or automatically 10 seconds after releasing the last pressed key.

7. Menus and parameters

MAIN MENU			
Name	**Level**	**Description**	**Note**
rEG LSt	0	Control parameter's menu	
CFG LSt	1	Configuration menu	
CAL LSt	2	Calibration menu	

CONTROL PARAMETER'S MENU (rEG LSt)				
Name	**Level**	**Range**	**Description**	**Note**
Pb	0	0.1 to 99.9 ºC	Proportional band	1
Int	0	60 to 999 s or OFF	Integral time	1
dFt	0	8 to 999 s	Derivative time	1
CY	0	1 to 999 s	Control period time for output 1	1
dS1	0	-199 to 999 ºC	Shift of control point 1	2, 4
H_1	0	0.1 to 99.9 ºC	Hysteresis for control output 1	2
dS2	0	-199 to 999 ºC	Shift of control point 2	3, 4
H_2	0	0.1 to 99.9 ºC	Hysteresis for control output 2	3

CONFIGURATION MENU (CFG LSt)				
Name	**Level**	**Range**	**Description**	**Note**
Snd	1	rtd, FEJ, nIC, FEL	Input probe	
Ert	1	0.0 to 99.9ºC or Int	Cold Junction Temperature	5
dP	1	OFF or On	Temperature unit 1ºC or 0.1ºC	
OPr	1	0 to 2	Operator level	
tAU	1	0 to 5	Digital filter coefficient	
OFS	1	-19.9 to 19.9 ºC	Temperature input shift	
Lnr	1	0.0 to 99.9 Ω	Resistance of connection leads (for Pt100 only)	6
SPL	1	-199 to 999 ºC	SP Lower Limit	4
SPH	1	-199 to 999 ºC	SP Upper Limit	4
rE1	1	PdH, PdC, Lr1 to Lr6	Output 1 operation type	
rE2	1	Lr1 to Lr6	Output 2 operation type	3
AL1	1	OFF or On	Alarm action for output 1	
AL2	1	OFF or On	Alarm action for output 2	3

CALIBRATION MENU (CAL LSt)				
Name	**Level**	**Range**	**Description**	**Note**
Snd	1	rtd, FEJ, nIC, FEL	Input probe	
Ert	1	0.0 to 99.9ºC or Int	Cold Junction Temperature	5
dP	1	OFF or On	Temperature unit 1ºC or 0.1ºC	
tr0	2	-19.9 to 19.9 ºC	Calibration offset 0 for Pt100	
tr1	2	-99 to 99 ºC	Calibration offset 1 for Pt100	
tv0	2	-19.9 to 19.9 ºC	Calibration offset 0 for FEJ	
tv1	2	-99 to 99 ºC	Calibration offset 1 for FEJ	
CJC	2	-9.9 to 9.9 ºC	Calibration offset for Cold Junction Temperature	

Nota 1: Visible if rE1 = PdH or PdC
Nota 2: Visible if rE1 = Lr1 to Lr6
Nota 3: In MR302 only
Nota 4: In 1°C or 0.1°C units depending on the parameter "dP"
Nota 5: Visible if Snd ≠ rtd
Nota 6: Visible if Snd = rtd

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7.1. **Control parameters**

Parameter: **Pb**

This parameter defines proportional band for PID control output.

In this band around the Set Point, the control output (Control Value) is proportional to the error signal (the difference between the Process Variable and the Set Point). Outside this range the output is on or off (depending on the control action and error signal).

Parameter: **Int**

The value of this parameter determines integral time constant (in seconds).

Integral action is most important factor governing control at set point. The integral term slowly shifts the output level as a result of an error between SP and measured value.

If the measured value e.g. is below SP the integral action gradually increases the output level in attempt to correct this error. Note that if you set a short integral time, the function will respond very quickly and may overshoot the SP. Setting a larger integral time value will cause a slower response. Integral time is sometimes called Reset.

Parameter: **dFt**

The dFt parameter determines derivative time constant (in seconds).

Derivative action provides a sudden shift in output level as a result of a rapid change in measured value in attempt to correct the perturbation before it goes too far.

Parameter: **CY**

This parameter set the minimum switching period for PID control output.

PID control output (in the proportional band) is alternatively switched on and off so the average value corresponds to the desired output level. Output period is exactly CY for 50% output value and becomes longer as the output value moving away this value. The minimum output OFF or ON time is CY/4.

Parameters: **dS1, dS2**

For ON/OFF output types marked Lr1 to Lr4, these parameters have the meaning as shown in Figure 6. Shift is relative to the SP, which means that a change in SP shifts the transition point itself. For output types Lr5 and Lr6, the value of this parameter is absolute i.e. gives the temperature at which the output changes the state regardless of the SP value.

Parameters: **H_1, H_2**

These parameters determine the hysteresis (difference between ON and OFF state) for the ON/OFF output types indicated by Lr1 and Lr6 (Figure 6). With ON/OFF control, hysteresis is used to stabilize operation when switching between ON and OFF.

7.2. **Configuration parameters**

Parameter: **Snd**

The Controller supports four types of input temperature sensor: platinum resistance thermometer and thermocouple of "J", "K" and "L" type. Set the value of Snd parameter to match the sensor that is used. See the paragraph 11.1.

Parameter: **Ert** (for thermocouple probes only)

If cold junction compensation is performed at the Controller (measuring the temperature of connecting terminals) i.e. thermocouple or extension cable is supplied to the Controller, this parameter should be set to "Int". If the cold junction is at some constant temperature maintained by an external device, the value of this parameter should be set to one that corresponds to a temperature that is maintained in the device.

Parameter: **dP**

If dP is set to "OFF", the temperature unit for the measured temperature and for parameters SP, SPL, SPH, dS1 and dS2 will be 1°C. If dP is set to ON they will be specified in units of 0.1°C.

Parameter: **OPr**

Parameter **OPr** defines the parameter modification level (with no password). If **OPr**=0, any parameter modification is disabled. If **OPr**=1, operator can modify the SP only (within the **SPL** and **SPH** limits). If **OPr**=2, operator can modify any parameter (in according to access level). That means it is not possible to enter main menu if **OPr**<2 (except with special password procedure).

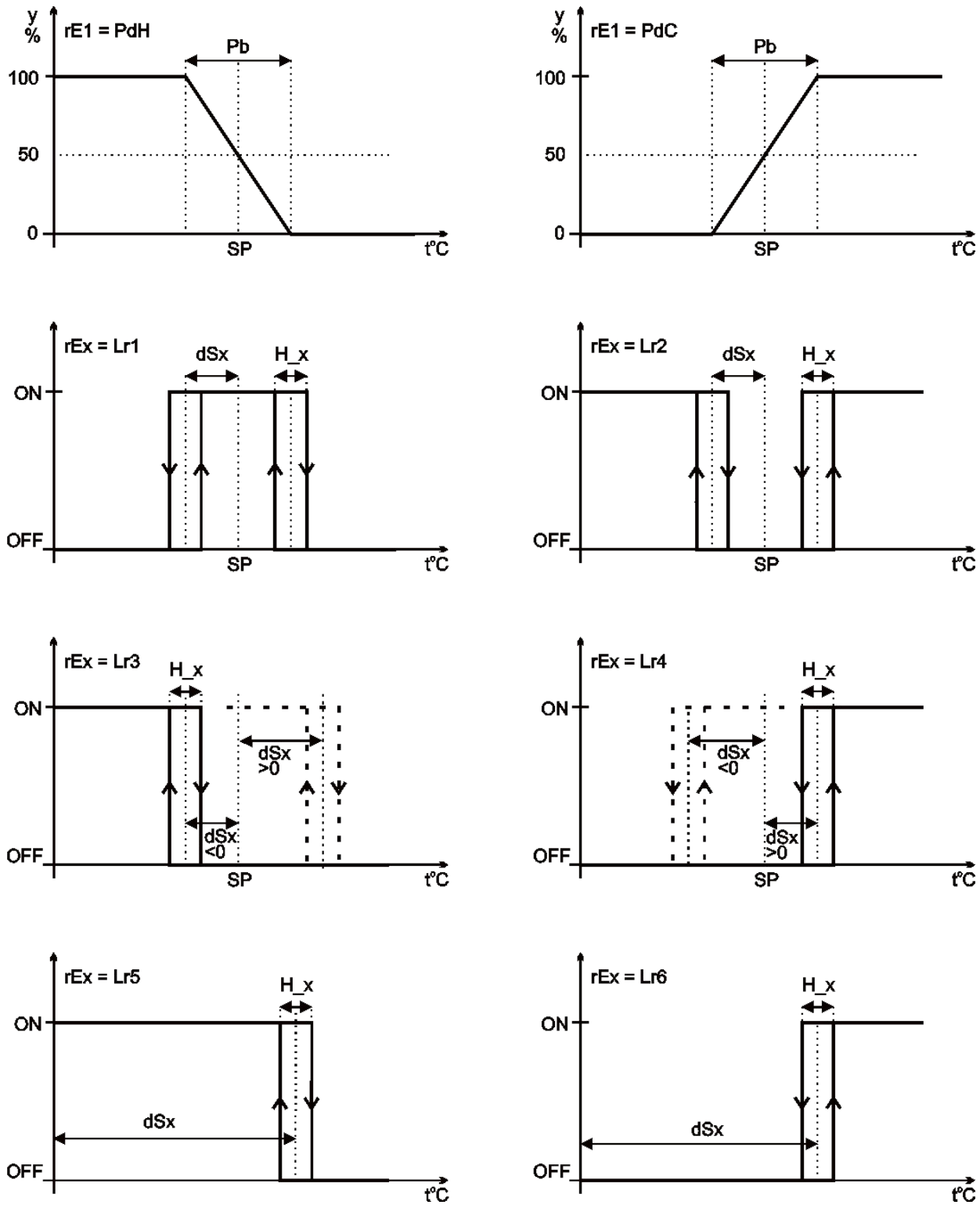

Figure 6

Parameter: **tAU**

The parameter determines intensity of input signal digital filtering. For **tAU**=0 there is no filtering. For **tAU**=5 filter time constant is approx. 8 seconds. Each decrement by 1 halves time constant. Suggested value is 2.

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Parameter: **OFS**

The value of **OFS** is added algebraically to the measured value. Possible reasons are:

a) Removal of input sensor zero error

b) Compensation of thermal gradient - temperature difference between the sensor location and the point of desired temperature measurement

Parameter: **Lnr** (for Pt100 probe only)

If 2-wire measurement is used for Pt100 probe, set Lnr to a value equal to lead resistance in Ohms.

Parameters: **SPL, SPH**

SPL is low limit while **SPH** is high limit for SP modification (regarding of **dP**).

Parameters: **rE1, rE2**

These parameters define the mode of output 1 and output 2. Output 1 can work in any way shown in Figure 6. Output 2 can function as a type of LR1 to LR6. Types marked with PdH (PID Heating) and PdC (PID Cooling) are for proportional control while other types are various types of ON/OFF control. In Figure 6, the SP indicates value of the set temperature.

Parameters: **AL1, AL2**

If thermocouple or Pt100 wires break or input signal is out of measurement limits, display shows appropriate blinking message explaining the problem. At the same time controller adjusts the outputs according to value of these two parameters.

7.3. **Calibration parameters**

Parameters: **tr0, tr1, tv0, tv1, CJC**

The meaning and use of these parameters is given in the measurement calibration paragraph.

8. Error messages

If thermocouple or Pt100 wires are broken or input signal is out of measurement limits, controller responds with a flashing error message from the next table:

Message	Meaning
o.o.o. + flash	Input signal underrange
b.b.b. + flash	Wire break or input signal overrange
∨ ∨ ∨ + flash	Measured value is below low limit for chosen sensor
∧ ∧ ∧ + flash	Measured value is above high limit for chosen sensor
– – –	The value to be displayed is lower than -199 or -19.9
E E E	The value to be displayed is higher than 999 or 99.9

- The appearance of the message "Err Par" informs the user that there is an unintentional change in the value of a parameter (excluding calibration parameters) - outside the user knowledge and actions, and due to equipment malfunction. During the presence of this message control outputs 1 and 2 are switched off. To remove this error the user need to check all the parameter values available on level 0 and 1, and then make any adjustment. First save the value of a parameter activates the process of protection of all parameters, eliminates error message and reactivates the control process.

- The appearance of the message "CAL Err" informs the user that there is a random change in the value of a calibration parameter - beyond user knowledge and action, and due to equipment malfunction. During the presence of this error, parameters AL1 and AL2 determine state of the control output 1 and 2. To remove this error you need to check all the calibration parameter values and then do one of the following three ways:

1) update the original factory calibration parameters, if you have them
2) contact the device manufacturer
3) perform the calibration as described in the section on device calibration

First storing the value of a calibration parameter activates protecting process of all calibration parameters, removes the error message and reactivates the control process.

- If a message "Err SPF" or "ILG Fun" appears, put the device out of function and send it to the service.

9. Device calibration

There are 5 calibration parameters to calibrate measuring. Parameters tr0 and tr1 are to calibrate Pt100 measuring, while the parameters tv0, tv1 and CJC calibrate thermocouple measurement. For calibration do the next steps:

1. Power up the device and leave it 15 minutes to warm up.
2. Set the parameter values for tr0, tr1, tv0, tv1, CJC, Ert, OFS and Lnr to zero
3. Set the parameters Snd=rtd, dP=On.
4. Connect a precision 100Ω resistor to terminals A1, A2 and A3. Wait for 30 seconds for the measurement to stabilize. Remember measured value for subsequent entry into the tr0.
5. Set the parameter dP = OFF.
6. Connect a precision 300Ω resistor to terminals A1, A2 and A3. Wait for 30 seconds for the measurement to stabilize. Subtract 558 from the measured value and remember result for subsequent entry into the tr1.
7. Set the parameters Snd=FEJ, dP=On.
8. Short connect A1 and A2 terminals. Wait for 30 seconds for the measurement to stabilize. Remember measured value for subsequent entry into the tv0.
9. Set the parameter dP=OFF.
10. Connect a 40.00mVdc signal to terminals A1(+), A2(-).Wait for 30 seconds for the measurement to stabilize. Subtract 714 from the measured value and remember result for subsequent entry into the tv1.
11. Set tr0, tr1, tv0 and tv1 to remembered values.
12. Set the parameters Ert= int, dP=On.
13. Short connect A1 and A2 terminals. Wait for 30 seconds for the measurement to stabilize. Measure the temperature of A1 terminal area. Set CJC value to the difference of the measured temperature and value shown on the lower display of the unit.
14. Set the parameters Snd, Ert, OFS, Lnr and dP as they were before calibration.

10. Connection scheme

* RE2 in MR302 only

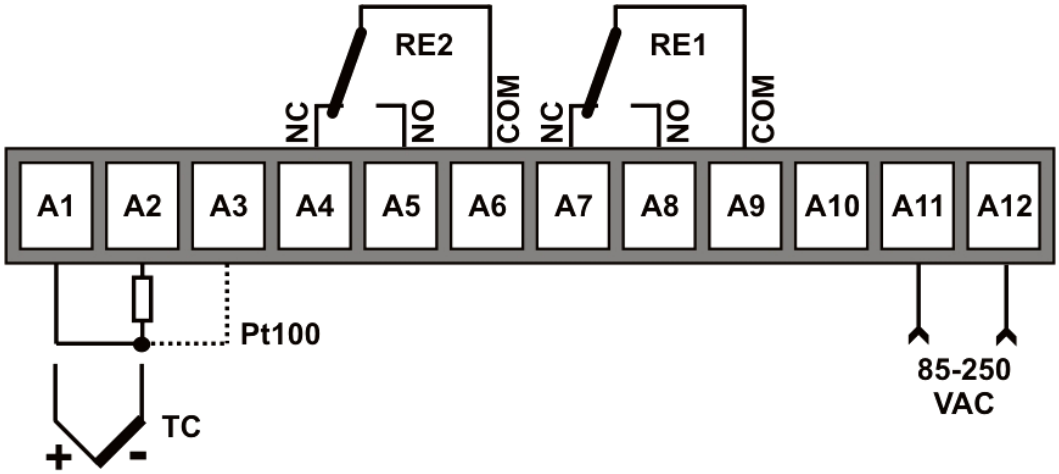

Figure 7

* If the 2-wire connection is used for Pt100 probe the terminal A3 should be left open.

The built-in protection scheme for relay contacts is given in Figure 8.

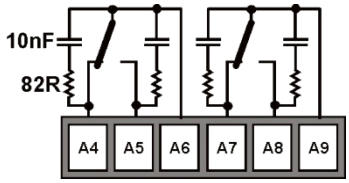

Figure 8

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11. Specifications

11.1. Possible sensors and measuring ranges

The following input sensors can be connected for temperature input:

Sensor type	Snd parameter	Standard	Indication range	FSR
Pt100	rtd	IEC 751	-199°C to 850°C	850°C
"J" Fe-CuNi	FEJ	IEC 584	-40°C to 750°C	750°C
"K" NiCr-Ni	nIC	IEC 584	-40°C to 999°C	999°C
"L" Fe-CuNi	FEL	DIN 43710	-40°C to 750°C	750°C

11.2. Electrical specifications

- Indication accuracy ≤ **0.25%** FSR ±1 LSD @ **25°C** ambient ±0.1% / 10°C
- Cold junction compensation accuracy ≤ 0.5°C @ **25**°C ambient ±0.2°C / 10°C
- Linearization error ≤ 0.1 °C
- Excitation current (for Pt100) < 150μA
- Input current (for thermocouple probes) < 1.5μA
- Sampling rate 3 - 5 per second
- Supply voltage 85 - 250VAC, 50/60Hz
- Operating temperature 0 to 60°C
- Power consumption 3VA
- Degree of protection IP54 front panel, IP20 rear case, IP00 terminals
- Terminals fast-on 6.3mm
- Output relay specification max. 250VAC, 3A (resistive load)
  electrical durability 1,000,000 operations

11.3. Dimensions

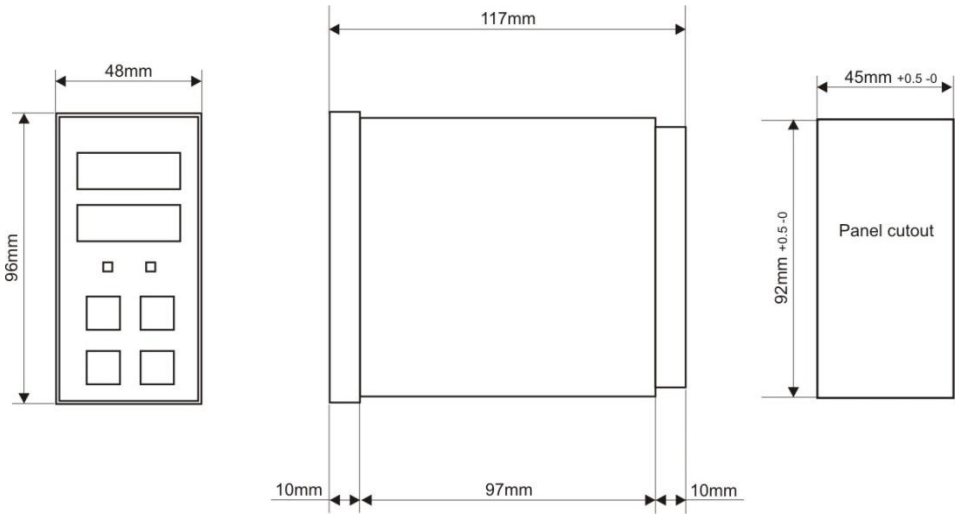

Figure 9

11.4. Ordering information

Unit type	Number of outputs	Dimensions
MR301 /H	1	DIN H48 x W96
MR301 /V	1	DIN H96 x W48
MR302 /H	2	DIN H48 x W96
MR302 /V	2	DIN H96 x W48

12. Notes

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