Microprocessor temperature controller MR200

- Measurement accuracy better then 0.25%
- Configurable analog input accepts Pt100, J, K, S, R probes
- Multiple access level allowing parameter protection
- Display resolution 0.1°C or 1°C
- Optional DC analog output 0-20 or 4-20mA (non isolated from input)
- PID or ON/OFF transfer characteristics
- Two independently configurable relay or solid-state outputs
- Simple set point modifying by UP and DOWN buttons
- Optional asynchronous serial communication EIA-485 (MODBUS)
- Software calibration and offset adjustment

1. Front-panel description and button functions

- **Upper display functions**: *Measured value* when not in viewing the parameter list ("normal" display mode). *Parameter mnemonics* when in viewing the parameter list with the **P** button ("programming" display mode).
- **Lower display functions**: *Temperature set point* when in normal mode. *Parameter value* when in programming mode.
- **Output lights**: Each green LED (OP1 and OP2) is illuminated when the corresponding output channel (relay or solid-state) is ON.
- **Pushbuttons**:

  The **P**ARAMETER pushbutton (**P**) has 2 functions:

  - To enter and exit programming mode when depressed more then 1.5 seconds.
  - To advance to the next parameter when viewing parameter list

  The **UP** and **DOWN** arrows also have 2 functions:

  - Changing set point value when not in programming mode. The new value is automatically entered (memorized) 2 seconds after last button activity.
  - Increasing and decreasing (respectively) the value of the parameter currently displayed. Most parameters have continuously variable numeric values, for example set point, integral time constant etc. Others can be assigned only discrete values that are presented in a list of alphanumerical values; these are mainly the configuration parameters like display resolution, output configuration etc.

    For the numeric values, depressing the **UP** (**DOWN**) button once increases (decreases) the display value by 1. Holding a button down more than 0.6 seconds causes the value to increase or decrease automatically as long as the button is depressed.

  The **M** button is used to enter (memorize) any new parameter value. If you don't press this pushbutton after changing the parameter value, the memorized value will remain unchanged regardless of the shown value.

2. Modifying the set point

When in normal mode, use **UP** and **DOWN** buttons until desired value appears on the lower display. In programming mode there is a parameter **SP** (**S**et **P**oint) you can change like other parameters.

3. Modifying an adjustable parameter

Depressing **"P"** button more than 1.5s enters programming mode. Parameters are organized in a list thus allowing simple access, viewing and modifying. Each parameter is presented by mnemonic and value. Upper display shows parameter mnemonic while lower display shows its value. If any button is untouched for more than 15 seconds the display returns to normal mode.

To modify a certain parameter, continue short pressing **P** until its mnemonic appears in the upper display. Then modify the value with **UP** and **DOWN** pushbuttons. After desired value appears press **M** to enter new value.

To exit programming mode depress **"P"** button more than 1.5s.

4. Access levels

Access levels keep parameters protected from accidental modification. They also simplify everyday operation by suppressing infrequently modified parameters and shortening the parameter list. Special password procedure defines highest allowed access level.

With no password it is possible to access parameters with access level 0 and 1, in according to **OPEr** (see next paragraph). Entering any password overrides parameter modification level (except for the set point). Password is valid while the main supply lasts. There are two procedures to reach password for access level 2 and 3.

Procedure for password level 2: switch off the main supply first; wait for a while and then switch on the main supply; press and release button "**P**" while displays are flashing. After flashing finishes, it is possible to modify parameters with access level less or equal 2. This access license for level 2 is valid until the main supply lasts.

*Procedure for password level 3: s*witch off the main supply, press and hold "**M**" button, switch on the main supply, wait until flashing appears on the display and after that release "**M**" button. After flashing finishes, it is possible to modify parameters with access level less or equal 3. This access license for level 3 is valid until the main supply lasts.

5. Parameter list

Mnemonic	Level	Adjusting range	Explanation	
Sond	2	P100, FECJ, nICr, PrHS, PrHr	Sensor selection	
APr0	3	20.0 to 400.0 Ω	Resistance measurement calibration point 0	1
APr1	3	20.0 to 400.0 Ω	Resistance measurement calibration point 1	1
APv0	3	0.00 to 50.00 mV	Voltage measurement calibration point 0	2
APv1	3	0.00 to 50.00 mV	Voltage measurement calibration point 1	2
CJC	3	-9.9 to 9.9°C	Internal CJ temperature calibration	2
Ert	2	0.0 to 99.9°C or OFF	CJC reference selection	2
dP	2	OFF or ON	Display resolution 1°C or 0.1°C	
OPEr	2	0 to 2	Parameter modification level	
tAUF	2	0 to 5	Digital input filter constant	
OFSt	2	-99.9 to 99.9°C	Calibration offset	
Linr	2	0.0 to 30.0 Ω	Line resistance for 2-wire measurement	1
SPLL	2	-999 to 9999 °C	Set point low limit	3
SPHL	2	-999 to 9999 °C	Set point high limit	3
Intt	1	60 to 9999 sec.	Integral time constant	
dIFt	1	8 to 999 sec.	Derivative time constant	
CY	1	1 to 999 sec.	Cycle time	
tyP1	2(1)	PIdH, PIdC, Lr_1 to Lr_6	Output 1 configuration	
dSP1	1	-999 to 999°C	Displacement for output 1 (in respect to SP)	3
Pb1	1	0.1 to 999.9°C	Proportional band for output 1	4
HiS1	1	0.1 to 99.9°C	Hysteresis for output 1 (for Lr_1 to Lr_6 only)	4
AL_1	2(1)	0 to 100 %	Alarm power for output 1	
tyP2	2(1)	PIdH, PIdC, Lr_1 to Lr_6	Output 2 configuration	
dSP2	1	-999 to 999°C	Displacement for output 2 (in respect to SP)	3
Pb2	1	0.1 to 999.9°C	Proportional band for output 2	4
HiS2	1	0.1 to 99.9°C	Hysteresis for output 2 (for Lr_1 to Lr_6 only)	4
AL_2	2(1)	0 to 100 %	Alarm power for output 2	
SP	0	SPLL to SPHL °C	Set point	3

Note 1: Visible if Sond = P100
Note 2: Visible if Sond = FECJ, nICr, PrHS, PrHr
Note 3: Resolution 1°C or 0.1°C depends on dP
Note 4: Visibility depends on tyP1 (tyP2)

6. Parameter description

Parameter: **Sond**

Selecting a value in according to used sensor adjusts input circuit for voltage or resistance measurement.

Parameters: **APr0, APr1, APv0, APv1, CJC**

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

Parameter: **Ert (E*xternal* r*eference* t*emperature)**

If the internal temperature compensation is done within the unit itself, this parameter has to be set at OFF. If cold junction is at some external place, set this parameter to the value equal to this place temperature.

Parameter: **dP**

For **dP** = OFF display resolution is 1°C. For **dP** = On display resolution is 0.1°C. It also influences meaning of SP, SPLL, SPHL, dSP1 and dSP2 parameters.

Parameter: **OPEr** (Parameter modification level)

Parameter **OPEr** defines the parameter modification level (with no password). If **OPEr** = 0, any parameter modification is disabled. If **OPEr** = 1, operator can modify only set point in normal mode (within the **SPLL** and **SPHL** limits). If **OPEr** = 2, operator can modify any parameter (in according to access level) using normal and programming mode. That means it is not possible to enter programming mode with **OPEr** < 2 except with special password procedure.

Parameter : **tAUF**

The controller incorporates a digital input filter having an adjustable coefficient found under parameter. For **tAUF** = 0 there is no filtering. For **tAUF** = 5 filter time constant is aprox. 8 seconds. Each decrement by 1 halves time constant. Suggested value is 3.

Parameter: **OFSt**

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

a) Removal of thermocouple zero error

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

Parameter: **Linr**

If 2-wire measurement is employed (for Pt100 probe) set the **Linr** at value equal lead resistance in Ohms.

Parameters: **SPLL, SPHL**

SPLL is low limit while **SPHL** is high limit for SP modification (regarding of **dP**).

Parameter: **Intt (**Integral time constant)

Integral action is most important factor governing control at set point. The integral term slowly shifts the output level as a result of en error between set point and measured value. If the measured value is below set point the integral action gradually increases the output level in attempt to correct this error.

Parameter: **dIFt (**Derivative time constant)

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**

If an output is selected to be proportional (PidH or PIdC), output power is adjusted by regulation process. The output is switched on and off alternatively producing appropriate mean power. Parameter CY equals the switching cycle when duty cycle is 50 %. In all other instances the cycle is longer. The shortest switch on time (or switch off time) equals 1/4 CY. The value of this parameter is factory preset at 60 seconds. For higher regulation requirements this value has to be lowered. Especially for valve positioning controls, set this parameter at about 2 seconds.

Parameters: **tyP1, tyP2**

Each of the two outputs may function in any of the modes shown in the fig.1. Parameters **tyP1** and **tyP2** determine the function.

NOTE: For PID regulation, integral term is associated only to output 1.

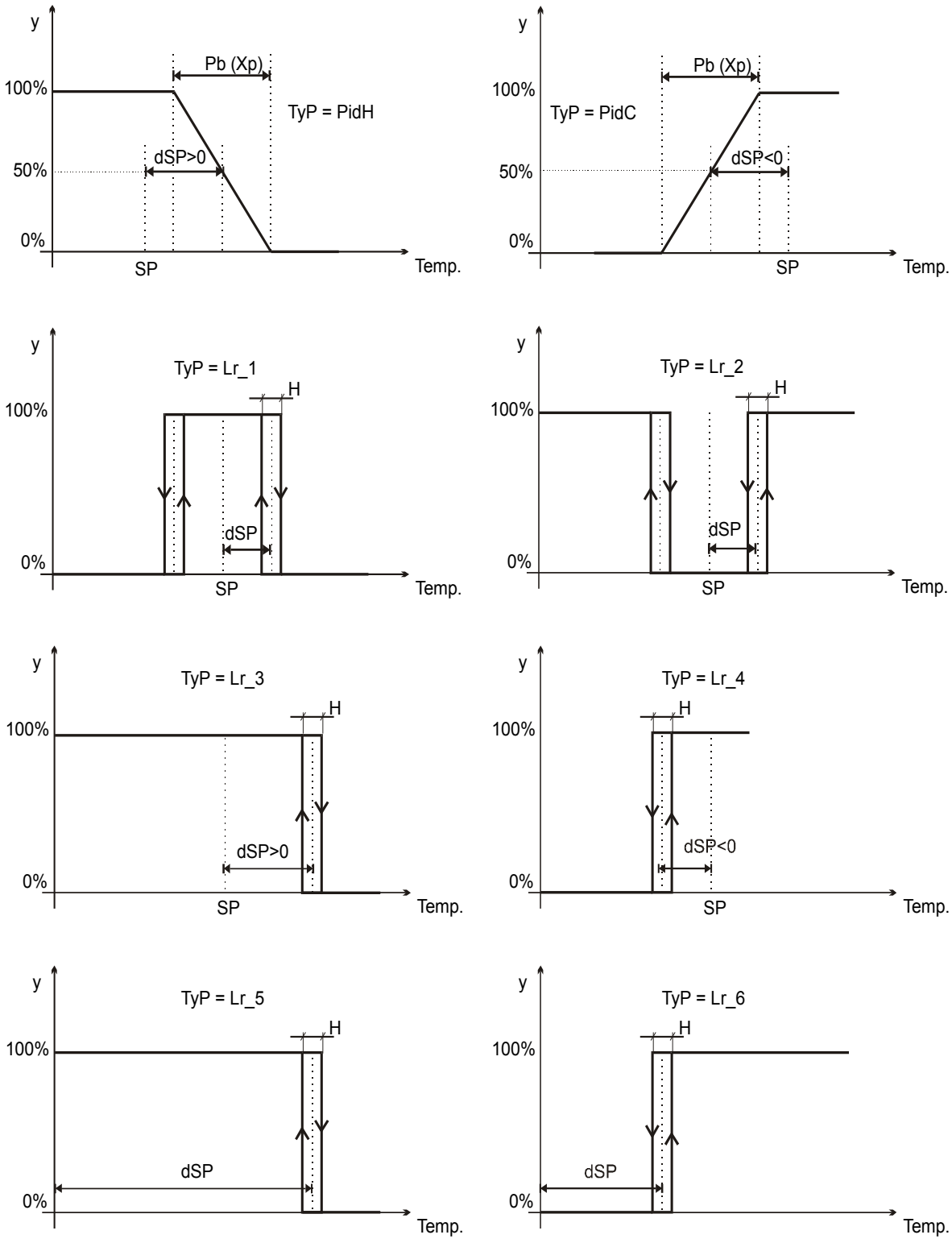

Figure 1.

Parameters: **dSP1, dSP2**

The value of these parameters is relative position (in respect to SP) of proportional band centers (50% of power) for characteristics defined with **PIdH** or **PIdC**. For ON/OFF output types defined with **Lr_1** to **Lr_4**, parameters value is relative position (in respect to SP) of hysteresis band centers. For types defined with **Lr_5** and **Lr_6**, parameters value defines position of hysteresis band centers in respect to 0°C.

Parameters: **Pb1, Pb2**

Proportional band (or gain) amplifies the error between set point and measured value to establish appropriate output power. Proportional band is the temperature range over which the output power level is continuously adjustable in a linear fashion from 0% to 100%. Outside the PB the output level is full ON or OFF.

If the PB is too narrow, the system oscillates being too sensitive. A wide PB could lead to wander control because of low responsiveness.

Parameters: **HiS1, HiS2**

Hysteresis band should be set as small as possible to minimize output excursions but large enough to reduce wear on devices such as mechanical contactors. For use with burners, the hysteresis should be as large as is needed by ventilation and ignition process.

Parameters: **AL_1, AL_2**

If thermocouple or Pt100 wires break or input signal is out of measurement limits, controller writes appropriate blinking message explaining the problem. At the same time it adjusts the outputs according to value of these two parameters. Duty cycle (%) of the outputs is appropriated to the given parameters as long as this problem exists (the switching cycle equals CY).

Parameter: **SP**

This is the Set point temperature.

7. Error messages

If thermocouple or Pt100 wires break or input signal is out of measurement limits, controller responds with an error message from the next table.

Message	Meanings
o.o.o.o. + Flash	Input signal underrange
b.b.b.b. + Flash	Break or input signal overrange
∨ ∨ ∨ ∨ + Flash	Measured value below low limit for chosen sensor
∧ ∧ ∧ ∧ + Flash	Measured value above high limit for chosen sensor
– – – –	The value is lower than -999 or -99.9
E E E E	The value is greater than 9999 or 999.9

8. Measurement calibration

There are 5 parameters used in calibration process. Parameters APv0, APv1 and CJC are used for calibration of thermocouple measurement, whereas APr0, APr1 are used for measurement by Pt100 sensor.

Calibration is done in two points, where the points are supposed to be as near to the ends of measurement range as possible. Measurement range for thermocouples is from -10.0mV to 55.0mV, while the range for Pt100 sensors is from 20Ω to 390Ω. We are going to show complete calibration procedure (if there is no need to calibrate some parameters simply go to the next step).

Apply power to the instrument and let it warm up for at least 15 minutes.

1. **Calibration for thermocouples**:
    a) First select **FECo** sensor by **Sond** parameter. This step is obligatory because it prepares input circuit for voltage measurement.
    b) Short connect with copper leads A1 with A2 terminal (0mV). Wait 20s for measurement stabilization and then set APv0 parameter at 0.00 (mV).
    c) Apply with copper leads an uncompensated 40.0mV voltage to input terminals A1 and A2 (A1(+), A2(-)) for the second adjusting point. Wait 20s for measurement stabilization and then set APv1 parameter at 40.00 (mV).

2. **Calibration for PT100 measurement**

   a) First select **PT100** sensor by **Sond** parameter. This step is obligatory because it prepares input circuit for resistance measurement.

   b) Connect the reference resistor (about 100Ω) to A1, A2 and A3 terminals. Wait 20s for measurement stabilization, and then set APr0 parameter at value that matches connected resistance.

   c) Connect the reference resistor (about 300Ω) to A1, A2 and A3 terminals. Wait 20s for measurement stabilization, and then set APr1 parameter at value that matches connected resistance.

3. **Calibration of temperature measurement at cold junction**

   First select **FECo** sensor by **Sond** parameter. This step is obligatory because it prepares input circuit for voltage measurement. Shorten A1 and A2 terminals. Wait 30s and then measure the temperature at A1 terminal using some precise thermometer. Then we calculate the difference between the temperature measured at thermometer and temperature shown at the upper display of the controller. Set the parameter CJC to equal the calculated difference.

9. Restoring the factory calibration

Instruments are calibrated in the factory. Two factory calibration sets are stored in two different areas in non-volatile memory. Only one is accessible to user through the calibration procedure.

If user calibration set is accidentally modified it is possible to recalibrate instrument through calibration procedure or restore factory calibration set by using following procedure:

First reach password for level 3. After flashing disappears depress and hold button **M**, depress and hold button **UP** and after that depress **DOWN**. Hold that button combination at least 1 second. Release buttons in reverse order.

10. Connection diagram

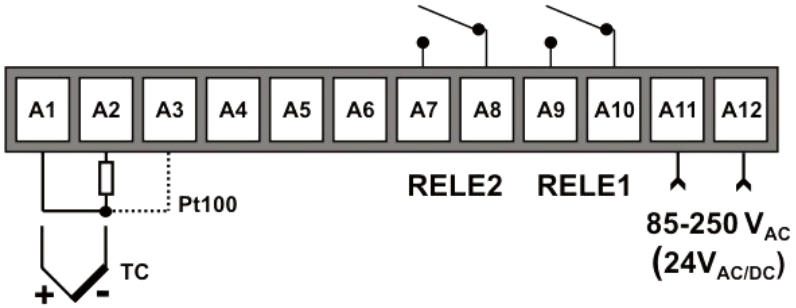

Figure 2.

Note: For two-wire connection with Pt100 sensor, leave A3 terminal unconnected.

11. Technical data:

- calibration accuracy	**≤ 0.25% FSR** @ **25°C** ±0.1% / 10°C
- CJC compensation accuracy	≤ 0.5°C @ **25**°C ±0.2°C / 10°C
- linearisation accuracy	≤ 0.1 °C (≤ 0.5°C for K, S and R)
- excitation current (for Pt100)	< 150μA
- input current for thermocouples	< 1.5μA
- sampling frequency	8 Hz
- power supply	220V/50Hz +10 -20 %
- power dissipation	3VA (typ.)
- operating temperature range	0 do 60°C
- relative humidity	5 - 95%, non-condensing
- climatic protection	IP54 for faceplate IP20 for the rest
- dimensions	96 x 48 x 117mm (H x W x D) or (W x H x D)
- cut-out	92 x 45mm -0 + 1mm
- electrical connections	terminals for fastons 6.3mm
- relay outputs	3A/250VAC
- Electrical life for relays	10^6 operations at nominal load

12. Accepted sensor types and measurement ranges

Type	Standard	Range
Pt100	IEC 751	-200°C do 850°C
"J" Fe-CuNi	IEC 584	-40°C do 750°C
"K" NiCr-Ni	IEC 584	-40°C do 1200°C
"S" Pt10Rh-Pt	IEC 584	0°C do 1700°C
"R" Pt13Rh-Pt	IEC 584	0°C do 1700°C

13. Ordering data

The controller is ordered by: MR200V for vertical and MR200H for horizontal mounting.

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