***S**ystémy **M**ěřicí, **A**nalytické a **R**egulační **T**echniky*

MR51D

PROGRAMMABLE TWO and THREE-STATE CONTROLLER

DESCRIPTION AND INSTRUCTIONS FOR USE

version 1.04

609

Development, manufacture and service:

SMART, spol. s r.o.
Purkyňova 45, 612 00 BRNO
Czech republic

tel.: 00420-541590639
fax: 00420-549246744
e-mail: smart@smartbrno.cz
www.smartbrno.cz

DESCRIPTION AND INSTRUCTIONS FOR USE OF MR51D

MR51D is two and three-state programmable controller by company SMART Brno. It is for the regulation of unit taken by resistance thermometers, thermoelectric cells or by sensors with current output.

Controller enables during the operation to switch over the display of the measured unit by means of the keyboard in such a way to show the size of resistance, voltage or power according to the used type of input.

Output part of the controller has three relays with switch-over contacts 230V/2A and voltage output for control of the semi-conducting relay (Solid State Relay - SSR), if required constantly changing output 0-10V or output +15V (floating) – for saturating the sensor with current output.

MR51D provides with its programme equipment a number of possibilities for quality regulation that can be obtained by the suitable setting of the constant regulation. In setting the controller it is possible to choose one or two types of regulations:

- simple discontinuous regulation
- continuous PID regulation

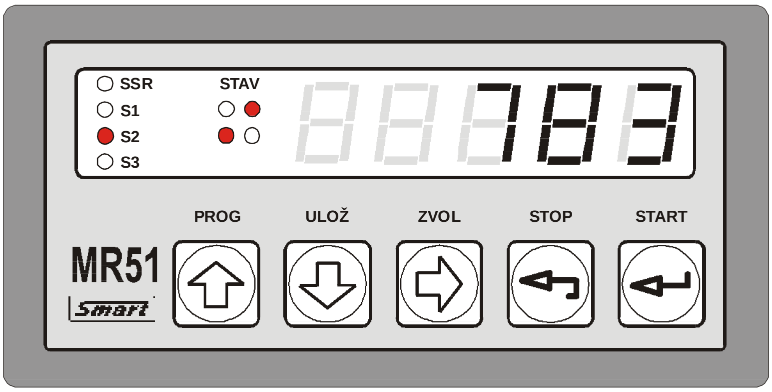


Figure 1 – front panel of the controller

The way of controlling the regulator, setting its parameters and its diagnostic functions are solved by means of well-arranged offers with display of objective text abbreviations on the seven-segment red LED display which lead the user in a simple dialogue regime in all possibilities of the controller without having to leaf through the manual.

Immediate information about the state of the regulated system are displayed on the left side of the display by means of LED diode which indicates the states of output relays and SSR, simple LED display gives information about the running of the regulation.

Five-key folio keyboard with touch response enables the quick setting of required parameters or recalling the required information about the state of the regulated system.

Modular conception of the controlling programme of the regulator makes it possible for the user to set it up according to his requirements.

The controller is also made in a version with real time clock circuit, which enables to programme several target values and times during which these values are to be kept for daily or weekly cycle. So it is not necessary to use several controllers with switching clocks. It is possible to order monitoring with printing or with transmission through the serial channel into PC.

I. BASIC PARAMETERS OF THE CONTROLLER

Input:

- Voltage - Thermocouple S, K, J, C, voltage measuring 0 to 25mV or 0 to 50mV
- Resistance
  - 0 to 300Ω (e.g.: Pt100 or measuring of resistance)
  - 0 to 3 000Ω (e.g.: Pt500, Pt1000, Ni1000 or resistance measuring)
  - 0 to 30 000Ω (e.g.: Ni10000 or resistance measuring)

  Resistance input is connected by two conductors, the resistance compensation is made by the software of the controller.
- Current - 0 to 20mA (it includes the span from 4 to 20mA)

The type of input (voltage, resistance 0-300Ω, resistance 0-3000Ω, resistance 0-30 000Ω or current) must be stated in the order.

Outputs:

- Switch contact relay S1 - 230V/2A
- Switch-over contact relay S2 - 230V/2A
- Switch-over contact relay S3 - 230V/2A
- Output 15V/10mA (on-off mode) for controlling semi-conducting relays (SSR)

Possibilities:

- Setting of desired value in the range
  - -200 to 500°C for Pt100
  - 0 to 900°C for thermocouple J
  - 0 to 1300°C for thermocouple K
  - 0 to 1600°C for thermocouple S
  - 0 to 2300°C for thermocouple C
  - -9999 to 9999 for current input
- Setting the signalling when measured variable is out of adjusted range
- Choice of one from two types of regulation
- Choice of one from three types of output variable control
- Setting the deviations – symmetrical and non-symmetrical
- Setting the regulation parameters
- All parameters remain unchanged after interruption of feeding
- Detection of failures of input sensor and errors in setting the controller

Detection:

- Input sensor break or disconnection
- Errors in target value setting
- Errors in setting the permissible deviations of target value
- Erroneous setting of input calibration
- Erroneous setting of the type of input sensor
- Signalling the abandoned range of measured variable by switching relay

Power Supply: 230V/0,04A, 50Hz

Dimensions: 96x48x130mm, mounting hole 92x43mm – built-in version
135x256x84mm – instrument for mounting in operation version

Coverage: IP50, if desired IP54 – built-in version
IP65 – instrument for mounting in operation version

Weight: 450g – built-in version
970g – instrument for mounting in operation version

II. THE CONTROLLER INSTALLATION

Mechanic mounting – instrument for mounting to operation version

MR51D has three mounting holes ϕ 5,2mm. Two mounting holes are in the bottom part of the housing, the last one is in the traversable central clamp. The first thing that should be done is to dismantle the bottom cover of the housing. MR51 housing is to be fastened into the operating position by the top traversable central clamp by means of a screw. By depressing down the clamp is engaged on the bottom of the housing. After that MR51D should be engaged in corners of the bottom part of the housing by means of two screws; and the mounting holes are sealed by attached metallic stoppers. Then we connect electrical parts of MR51D. The mounting is finished by fastening the bottom cover of the housing.

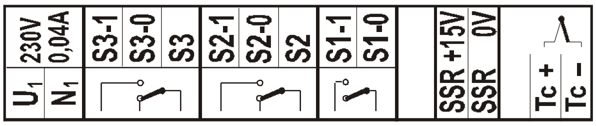
Mechanic mounting – switch board version

MR51D is mounted to the switch board panel by inserting it to prepared mounting hole of dimension 92x43mm and securing it by two conduit clamps which are to be moved by means of the screwdriver on two couples of fastening necks at the sides of MR51D.

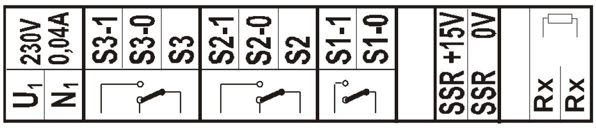
Electric connection

Feeding connection, controlling the connection of actuator, connection of sensing units or sensors is to be made by means of a screw connecting blocks in case of the instrument for mounting to the operation or by means of sockets, which are provided with screw clamps, in case of the switch board version. Description of clamps (figure II.1) is placed next to the connecting block of MR51D.

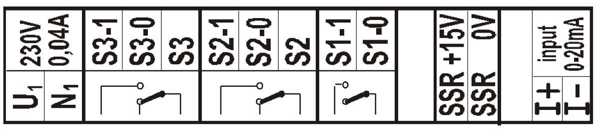
Connection of controller clamps in version for thermocouple



Connection of controller clamps in version thermometer Pt100



Connection of controller clamps in version for current input



Connection of controller clamps in version for current input with floating voltage output 15V DC

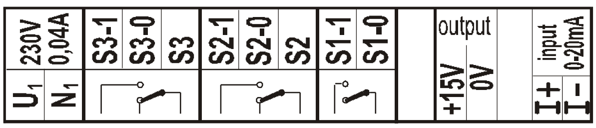


figure II.1 controller clamps

It is not admissible to concentrate wiring to the input block (thermocouple, resistive thermometer, etc.) with wiring of power conductors, which feed the controller, and wiring of conductors, which control regulated system. Input block connection is necessary to be led separately in order that the measured temperature would not be affected from outside. If it is not possible to lead this connection separately, it is necessary to make its braided shielding. The braided shielding is to be connected to the grounding point only on the controller side.

III. CONTROLLER OPERATION

The controller maintains the measured variable on the target value ±deviation. On the display it simultaneously shows the measured value for four seconds and for one seconds it displays adjusted target value by lowered brightness. On the graphic image-forming instrument (figure III.1) is shown in symbol the section in which the controlled variable occurs, in the vertical part there is displayed the state of particular controller outputs. If the output is switched on, its LED diode is illuminated.

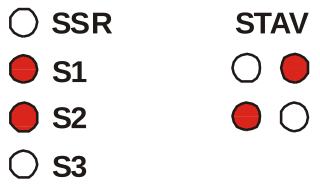


figure III.1 – graphic display

Symbol	Meaning
SSR	signalises the state of ouput for SSR relay (illuminated = switched on)
S1	signalises the state of relay S1 (illuminated = switched on)
S2	signalises the state of relay S2 (illuminated = switched on)
S3	signalises the state of relay S3 (illuminated = switched on)
STAV	displays the control state / increase, — persistence, \ decrease

Basic ideas used in this manual

Measured variable Variable which the controller measures and according to its value it controls
(controlled variable is also possible)

Target value Value at which the controller maintains the measured variable (value to which it is controlled)

Deviations of target value Permissible deviations of measured variable from the target value

Proportional band Band that is limited by deviations of target value

Signalling range Adjustable range (zone), if the measured variable is within the signalling span, the signalling relay is switched off, if measured variable is not within the signal span, the signalling relay is switched on

Measuring range Range in which the controller is able to measure, out of this range the controller is unable to measure so that it disconnects the protective and control relay

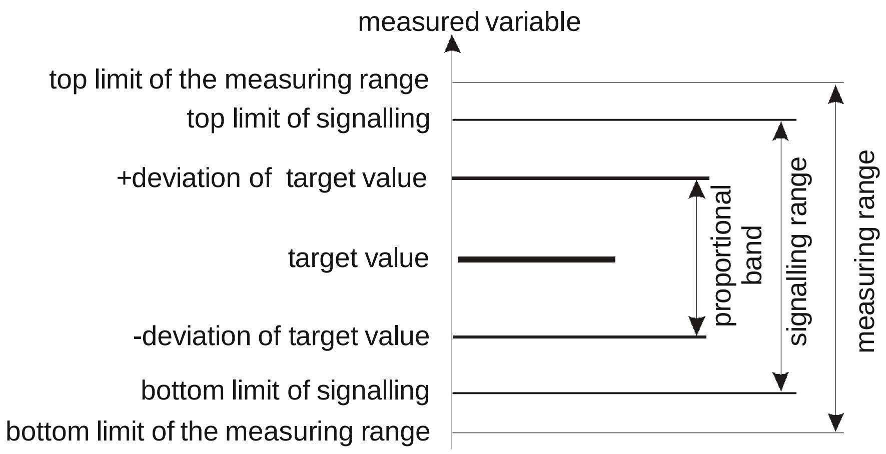


Figure III.2 – Basic ideas

Measuring range and signalling range

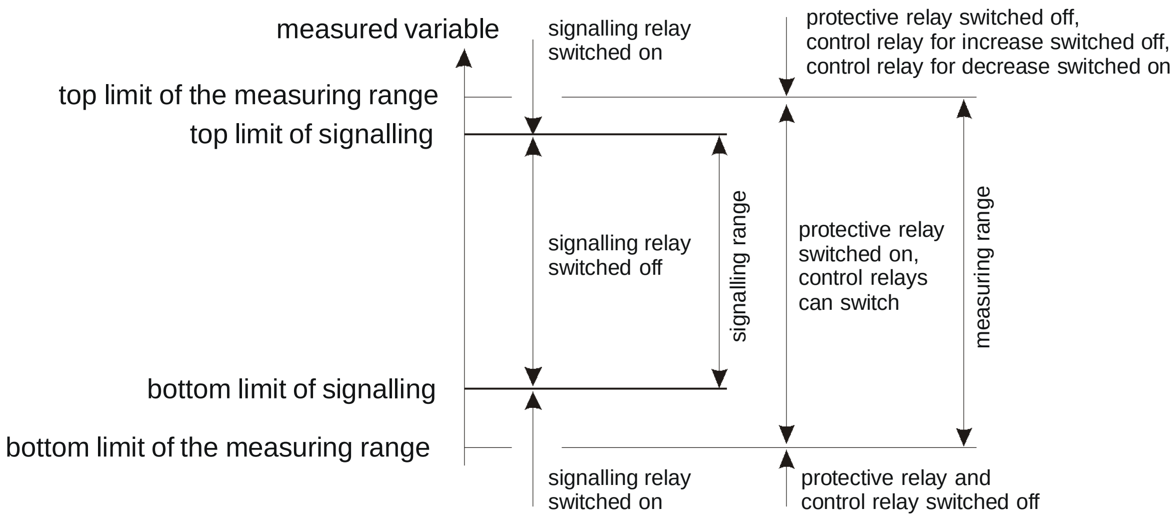


Figure III.3 – measuring range and signalling range

If the measured variable falls under the bottom limit of the measuring range, the controller disconnects the protective relay and control relay and it signalises an error until the measured variable returns back into the measuring range.
If the measured variable goes over the top limit of the measuring range, the controller disconnects protective relay and control relay for increases. Simultaneously it switches on the control relay for falls in order to get the measured variable back to the measuring range.
The state when the measured variable is out of the measuring range is said by the controller to be a state of input sensor failure.

Target value, permissible deviations, proportional band

A zone in the range target value ±deviations is called the proportional band or also the persistence section. The section under –deviation is called the increase section and the section above +deviation is called the decrease section, see figure III.4.

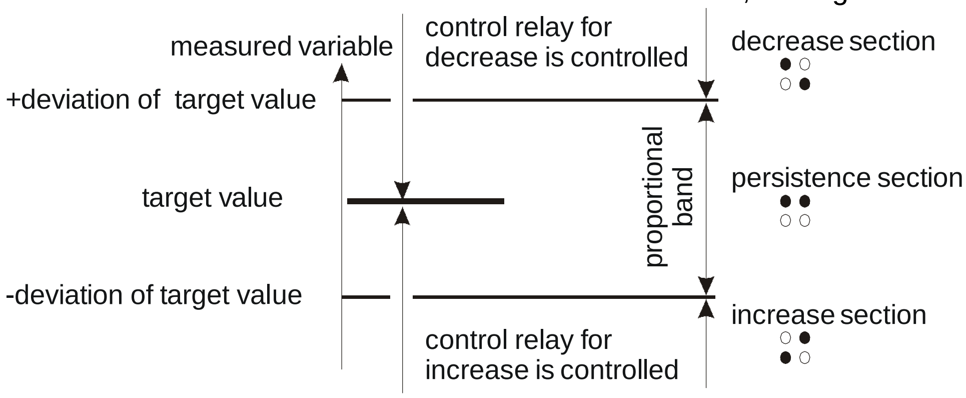


Figure III.4 –target value, permissible deviations and proportional band

Control of regulator output

The controller enables to choose which output components (relays) will be controlled and how. Following choices are possible:

Table III. 1

Type of control	Control relay for		Signalling relay	Protective relay
	increase	decrease		
SSR	SSR		S2	S1
R1	S1		S2	SSR
R2,3	S2	S3	S1	SSR

Operation of particular relays is described in the following table:

Control relay It carries out the control of the regulated system. We distinguish the relay for increase – e.g.: for heating, or opening a valve, and the relay for decrease – e.g.: closing a valve
These relays are controlled according to the chosen regulation algorithm.

Signalling relay Its function is to signalise the state when the measured variable leaves adjusted signalling range. It can be used as protective relay – then the signalling range is maximum allowed range in which the variable can move, see figure III: 3.

Protective relay Its function is to disconnect the regulated system in case of erroneous state or failure (see figure III. 3)

Caution:

If you use the controller in a version for current input with floating voltage output 15V, the controller has not the output for controlling the SSR relay on the connecting block so the SSR relay cannot be used.

Type of regulation

The controller enables to choose the type of regulation which is to be used for controlling the process. Each type of regulation uses several so called control constant which are described in the chapter about the setting of the controller.

Discontinuous regulation

It is the simplest type of regulation, it uses only the time constant. Its operating is following:
If the measured variable is in the persistence section, the controller does not perform any control activity.
If the measured variable is in the decrease section, the controller switches on the control relay for decrease. After a return of the measured variable in the persistence section, the relay is switched off.
If the measured variable is in the increase section, the controller switches on the control relay for increase. After a return of the measured variable in the persistence section the relay is switched off.

PID regulation

PID regulation is very precise regulation but it is also very sensitive to the right setting of control constants. Its operating is following:
The controller switches on the control relay for time which is assessed from a calculation from size of deviation of measured value from target value, and from relevant parameters of control - proportional, differentiation, time constant and constant of integration.

IV. USING THE CONTROLLER

Switching the controller

After the connecting the feeding to the controller, all display segments light up for several seconds and the initialisation is performed.

Controller operation

After the initialisation the controller displays on the display the value, which was measured on the input sensor, and carries on the control. This state, when the controller measures and controls, is called **the measuring state**, the state, when the operator manipulates with the controller by means of keyboard, is called **the manipulation state**.

Control of the regulator

The regulator is controlled by means of five keys keyboard. Particular keys of the keyboard have these functions:

In the measuring state

PROG	- target value setting
ULOŽ	- setting of the controller
ZVOL	- displaying the detected error and performance of the test of the controller
STOP	- not used
START	- setting the deviations from target value

In the manipulation state

ñ	- increasing in value/movement back in the menu
ò	- decreasing in value/movement forward in the menu
ð	- movement of the cursor to right
¬	- end without changes/leaving the menu
¿	- acknowledgement of the adjusted value and ending/ choice and acknowledgement of the entry in the menu

V. SETTING THE TARGET VALUE

Setting the target value

Setting the target value of controlled variable is carried out by depressing the **PROG** key in the measuring state. The controller displays this notice:

CIL

and waits for depressing the ¿ key. After depressing the ¿ key the controller displays current target value and enables its change by means of keyboard. After setting the target value we end setting by depressing the ¿ key and save changed value. Ending of setting without saving the changed value is made by depressing the ¬ key.
It is possible to set the target value only in range minimum – maximum value of the input sensor – see **setting/type of input sensor**. The controller does not allow setting of the target value which the controller would not be able to reach, because this value would be out of its measuring range.

Setting the permissible deviations of target value

Permissible deviations of controlled variable from target value can be set in two ways, see **setting/regime of deviation**.

- Symmetrical deviations – deviations which are the same from both sides to the target value
- Non-symmetrical – deviations are different

See figure III.2. Deviations can be set in range 1 to 99 for voltage or resistive input, for current input it is possible to set the deviation in range ± one half of adjusted measuring range.

Symmetrical deviation of target value

Permissible deviations of controlled variable are same on both sides (+ and -) from target value, only one value is set. We carry on the setting by depressing the **START** key in the measuring state. The controller displays this notice:

ODCHY

and waits for depressing the ¿ key**.** After depressing the ¿ key the controller displays adjusted deviation and enables its change by means of keyboard. After setting the deviation we end setting by depressing the ¿ key and save changed value. Ending of setting without saving the changed value is carried on by depressing the ¬ key**.**

Non-symmetrical deviations of target value:

Permissible deviations of controlled variable are different for increase (-) and for decrease (+), so it is necessary to set both values of deviations. Their setting is made by depressing the **START** key in the measuring state. The controller displays this notice:

ODCH+

and wait for depressing the ¿ key. After depressing the ¿ key the controller displays adjusted deviation and enables its change by means of the keyboard. After setting the deviation we end setting by depressing the ¿ key and save the changed value. Ending of setting without saving the changed value is carried on by depressing the ¬ key. The controller displays a challenge for change of –deviation:

ODCH-

Setting is made in the same way as the setting of +deviation.

VI. SETTING THE CONTROLLER

To the menu setting the controller we enter from the measuring state by depressing the **ULOŽ** key.

CAS-K	Time constant	1 to 250 seconds
PRO-K	Proportional constant	1 to 250
DER-K	Differentiation constant	1 to 250
INT-K	Constant of inegration	1 to 250
REZIM	Setting of deviation regime – symmetrical and non-symmetrical	
KONFI	Configuration of the controller – see **service level**	
VERZE	Number of version of controller software	
REGUL	Type of control	

Time, proportional, differentiation constant and constant of inegration influence directly the controlled process – constants of control. For reaching the highest possible quality of control it is necessary to know the parameters of controlled system, then we can determine right values of control constants. Because mostly we do not know these parameters exactly, we have to set them experimentally according to the specification stated in next paragraphs.
The controller enables to change all control parameters during the operation, but changes in setting of parameters are used during the next pass of control loop. Interval between two regulation actions is given by the time constant.

Time constant

It is used for all types of control and for all these types it has the same function. It determines the frequency with which the control and switching the heating are performed. Time constant is related to traffic delay of controlled system. It holds: the slower the system, the higher the time constant.

Proportional constant

For PID control type

It determines the influence of proportional band on the control. The lower the proportional constant, the shorter the time when the controller is active. Recommended value is 100; if adjusted value is closed to 1, the influence of proportional band is minimal. That means that the control is ID rather than PID. We do not recommend using only ID control because of its lowered stability.

Differentiation constant

Only for PID control type

It determines the influence of differentiation component of control, that is the influence of speed of changes in the measured variable. The higher the value of differentiation constant, the more important the speed of changes of controlled variable during the regulation. The controller will respond on the speed of changes faster and more. If the set value is closed to 1, the influence of the differentiation component is minimal. That means that the control is PI rather than PID.

Constant of integration

Only for PID control type

It determines the influence of control component of integration, that is long-term deviation from the target value. The component of integration makes long-term compensation of controlled system to the zero deviation. It is active only in the persistence phase. The higher the value of the constant of integration, the faster the compensation to the zero deviation, but there is larger danger that the system will oscillate. If the set value is closed to 1, the influence of the component of integration is minimal, that means that the control is PD rather then PID.

Recommended procedure of setting the control constants

We set the deviation of target value on desired value. Than we set the time constant, which we set for fast device with excess power on value ~1 to 3s, for slower device on value ~5 to 10s. We set the differentiation constant at 50 and the constant of integration on the lowest possible value 1.

We trace frequency of switching the control relays of the regulator and by a change of the time constant we try to get the controller to a state when it has the minimum of switching. At the same time we trace the deviation between desired value and real value. According to the size of the deviation we adjust the differentiation constant: if the controller responds to a decrease of the controlled variable slowly – we raise the differentiation constant, if the controller responds quickly and oscillates – we decrease the differentiation constant. The controller does not reach the target value for a long time – we raise the constant of integration.

Setting the deviation regime

SYMET	Symmetrical – we set the deviation ± target values (the deviation is same on both sides)
NESYM	Non-symmetrical – we set the deviation + and – target values

Version

It displays the number of version of controller software. Say, please, this number, to the producer in case of encountering a problem with your unit. Proceeding will be simpler and faster.

Type of control

The controller enables to choose following types of control:

NESPO	Simple discontinuous control Uses: time constant
PID	Continuous PID control Uses: time, proportional, differentiation constant and constant of integration

Detailed description of control type is in the chapter III Operation of controller, page 6.

Service level

It serves to mounting or service firm for setting the basic configuration of the controller. To the service level we can get from menu setting the level through the item **KONFI** and after inserting the right service password. At this level following settings are performed:

TYP C	Setting the type of input sensor
OVLAD	Setting the manner of control of controlled device
POSUN	Shift of the value
SIG D	Setting the bottom limit of the alarm
SIG H	Setting the top limit of the alarm
MEZ D	Setting the bottom limit of the range – for current input only
MEZ H	Setting the top limit of the range –for current input only
KOMPE	Setting the compensation of the sensor wiring –for resistive input only
RUCNI	Manual control of individual output elements of the controller
KALIB	Calibration of controller input

Type of input sensor

Choice of the type of input sensor. Each sensor has assigned maximal and minimal allowed value of measured variable at which the sensor can operate.

Voltage input sensor – thermocouple:

Maximal operating temperature of the thermocouple according to ČSN 25 8304 is stated in the name of the thermocouple.

J 700	Thermocouple J in the range 0 to 900°C
K1000	Thermocouple K in the range 0 to 1300°C
S1300	Thermocouple S in the range 0 to 1600°C
C2300	Thermocouple C in the range 0 to 2300°C
U0-50	Voltage input 0.00 to 50.00 mV in the range 0 to 50.00 mV
U0-25	Voltage input 0.00 to 25.00 mV in the range 0 to 25.00 mV

Resistive input sensor – resistive thermometer Pt100

Temperatures are read from the thermometer according to DIN 43760.

PT100	Resistive thermometer in the range –200 to 500°C
R 100	Resistive input 0 to 300 Ω

Current input sensor

The controller enables to choose input 0 to 20mA or 4-20mA, in the menu these variants are possible:

01.000 **010.00** **0100.0** **01000.**	Measuring the current in range 0 to 20mA, the position of the decimal point in the menu determines the position of the decimal point in the displayed number on the display. For these inputs it is necessary to set the measuring range by means of bottom and top limits.
P0-20	Measuring the current in the range 0 to 20mA, regardless of the setting of the limits
41.000 **410.00** **4100.0** **41000.**	Measuring the current in the range 4 to 20mA, the position of the decimal point in the menu determines the position of the decimal point in the displayed number on the display. For these inputs it is necessary to set the measuring range by means of bottom and top limits.
P4-20	Measuring the current in the range 4 to 20mA, regardless of the setting of the limits

Control component

The device can be controlled by either mechanical or semi-conducting relay. Mechanical relay is not suitable to use in case of quick switching (value of time constant is lower than 10). See table III. 1.

SSR	The regulator controls the relay S1, output for SSR is used for controlling the protective contactor
R1	The regulator controls SSR, the relay S1 is used for controlling the protective contactor
R2.3	Relay S2 controls the output when the variable increases; relay S3 controls the output when the variable decreases. Output for SSR is used for controlling the protective contactor.

Shift of measured variable

The shift of the value is possible to set in the range –25 to 50. During the production the shift of the measured value is set at 0. The importance of this item depends on the used type; and possible range of values is related to temperature sensors:

Resistive input sensor

The controller uses the software compensation of resistance of wiring; setting of the shift enables to put possible difference between real and measured temperature more precisely.

Voltage input sensor – thermocouple

The controller is equipped by compensation of cold side of thermocouple, setting of the shift enables to put possible difference between real and measured temperature more precisely.

Current input sensor

Setting enables the shift of the measured variable. We do not recommend setting other value than 0 in case of current inputs!

Setting the bottom and top signalling limit

Signalling limits are described in figure III. 3

Arbitrary number can be set as signalling limit. That enables to set a limit which is higher than measuring range in order that signalling is out of operating when signalling is not necessary for the controlled system.

Setting the bottom and top limit of the range –for current input only

Setting is to be used only for controllers with current input, for other controllers this setting is not performed and it is not displayed in the menu. Measuring range of current input is set by means of limits. Setting of the bottom and top limit determines operating conditions unambiguously.

Bottom limit

It sets the value of bottom part of the controller range (0 or 4mA). Adjusted number is unambiguously assigned to the current 0 or 4mA according to adjusted type of the sensor.

Top limit

It sets the value of top part of the controller range (20mA). Adjusted number is unambiguously assigned to current 20mA.

Limits are used for current types of input only without types P0-20 and P4-20, which are established only for measuring the current and their measuring range is given by the value 0 to 20 or 4 to 20.

Wiring compensation –for current input only

In a version with current input the controller uses two-wire connection. For securing precise measurement the software compensation of wiring resistance is used for the controller. The compensation is carried out by deducting the wiring resistance. The size of wiring resistance is possible either to measure by means of the controller or set by means of the keyboard. After setting the size of the wiring resistance it is possible to choose from following possibilities:

MER	Measuring the wiring resistance is made by means of the controller – see below
NASTA	Size of wiring resistance is set by means of the keyboard – see below

Measuring of wiring resistance by means of the controller

The controller displays the notice **ZKRAT.** The controller operator shorts clamps of resistive sensing unit as near to the sensing unit as it is possible. After short-circuiting the clamps and depressing the ¿ key the controller measures the wiring resistance and displays the notice **ULOZ?** Saving the new data into the memory is made by depressing the ¿ key. After recording the data into the memory the controller display the notice **OK**, which confirms that the operation has been successfully finished.

Setting the size of wiring resistance by means of the keyboard

The controller displays the adjusted value of wiring resistance, be means of the keyboard we set the value of wiring resistance. The adjusted value is confirmed by depressing the ¿ key, the controller displays the notice **ULOZ?** By depressing the ¿ key we save the new resistance value into the memory. After recording the value into the memory the controller displays the notice **OK**, which confirms that the operation has been successfully finished.

Manual control of the output element of the controllers

The controller enables to the service technician to examine the functionality of individual relays. During the manual control the controller does not regulate!
The controller displays selected control component and its states. Between components it is possible to move by means of the **ð** key, the state of the component is changed by the **ñ** key or the **ò** key.

R1-x	Relay R1; 0 – relay disabled, 1 – relay enabled
R2-x	Relay R2; 0 – relay disabled, 1 – relay enabled
R3-x	Relay R3; 0 – relay disabled, 1 – relay enabled
SSR-x	Relay SSR; 0 – relay disabled, 1 – relay enabled

Calibration of the controller input

Calibration is made by producer or authorised service firm. The accuracy of the calibration essentially influences the accuracy of the controller measuring.

Calibration of the controller in a version for the thermocouple

The controller must be calibrated for the input range 0 to 50 mV (**J 700, K1000, U0-50**) and for input range 0 to 25 mV (**S1300, U0-25**).
Calibration is to be made as follows:

1. We connect voltage supply with accurate voltmeter (with minimal measuring accuracy 0,01 mV) on input clamps
2. We entry to calibration by inserting the password.
3. The controller displays a challenge to setting the bottom limit of voltage (~0 mV) **S-MEZ**. After setting the voltage of the bottom limit we depress arbitrary key and on the display we set the voltage value in millivolts, set value is confirmed by depressing the key ¿.
4. The controller displays a challenge to setting the top limit of voltage (~50 mV for input 50 mV and ~25 mV for input 25mV) **H-MEZ**. After setting the voltage of the top limit we depress arbitrary key and on the display we set the voltage value in millivolts, set value is confirmed by depressing the key ¿.
5. The controller displays a question whether the setting is to be saved **ULOZ?**
6. After depressing the key ¿ the controller saves new setting and displays the notice **OK**, after depressing the other arbitrary key new values will not be saved and old setting remains unchanged.

Calibration of the controller in a version for the resistive thermometer Pt100

The controller must be calibrated for input range 0.0 to 300.0 Ω. Calibration is made as follows:

1. We connect the accurate resistor (the best is the resistive decade) with minimal accuracy 0.1 Ω on input clamps.
2. We entry to calibration by inserting the password.
3. The controller displays a challenge to the short-circuiting of the input clamps (setting the resistance 0Ω). After the short-circuiting of the input we depress the key ¿. The controller makes the measurement and calculates the shift of the input.
4. The controller displays a challenge to setting the top limit of the range (~300 Ω) **H-MEZ**. After setting the resistance of the top limit we depress arbitrary key and on the display we set the value of adjusted resistance, adjusted value is confirmed by depressing the key ¿.
5. The controller displays a question whether the setting is to be saved **ULOZ?**
6. After depressing the key ¿ the controller saves the new setting and displays the notice **OK**, after depressing the other arbitrary key new values will not be saved and the old setting remains unchanged.

Calibration of the controller in a version with current input

The controller must be calibrated for selected input range 0 to 20mA or 4 to 20mA. Calibration is made as follows:

1. We connect accurate power supply with the range 0 – 20 mA on input clamps.
2. We entry to calibration by inserting the right password.
3. The controller displays a challenge to setting the bottom limit of the range (~0 or 4 mA) **S-MEZ**. After setting the current of the bottom limit on the calibrating device we depress arbitrary key and on the display we set the value of the adjusted current in milliamperes, adjusted value is confirmed by depressing the key ¿.
4. The controller displays a challenge to setting the top limit of the range (~20 mA) **H-MEZ**. After setting the current of the top limit on the calibration device we depress arbitrary key and on the display we set the value of the adjusted current in milliamperes, adjusted value is confirmed by depressing the key ¿.
5. The controller displays a question whether the setting is to be saved **ULOZ?**
6. After depressing the key ¿ the controller saves the new setting and displays the notice **OK**, after depressing the other arbitrary key new values will not be saved and the old setting remains unchanged.

VII. DETECTED ERRONEOUS STATES

The controller performs the check of the state of the input sensor constantly; during reading the setting it performs the check of individual settings.

Indication of detected errors

If the controller detects an error, it starts to flash in points on the display until the error is eliminated. By depressing the **ZVOL** key the operator finds out the detected error, which he must eliminate, or he must inform of that error responsible person or service. Detected errors are of the form:

ZADNE	Device has no errors	
HOD □	Input sensor disabled	
HOD _	Input sensor overpoled or disabled	
E-VC	Error in the setting of the type of input sensor	
E-VST	Error in the setting of input calibration	
E-CIL	Error in the setting of target value	
E-ODC	Error in the setting of permissible deviations of target value	
E-C-K	Error in the setting of time constant	
E-P-K	Error in the setting of proportional constant	
E-D-K	Error in the setting of differentiation constant	
E-I-K	Error in the setting of constant of integration	
E-REZ	Error in the setting of regime of target value deviation	
E-OVL	Error in the setting of the manner of output variable control	
E-REG	Error in the setting of control type	– the controller itself set PID control
E-POS	Error in the setting of measured value shift	
E-SIG	Error in the setting of signalling limits	
E-MEZ	Error in the setting of span limits	– for current input only
E-V-T	Related temperature sensor error	– for voltage input only
E-KOM	Error in the setting of wiring compensation	– for resistive input only

Input sensor errors

The controller is able to detect disabled or overpoled input sensor. After detection of one from these errors the controller disconnects the protective and control relay – see figure III.3. After removal errors the controller engages the protective relay and enables switching the control relay

The controller displays the error if existing in the following manner:

Top horizontal primes illuminates on the whole display

The range of the controller measurement is exceeded.

The error can happen in these cases

- Measured variable is over-range of the controller measurement
- Because of disconnection or interruption of thermocouple
- Because of disconnection or interruption of resistive sensor

Bottom horizontal primes illuminates on the whole display

The range of the controller measurement is exceed – the bottom limit was under-gone.

The error can occur in these cases:

- By overpoling the thermocouple or the current sensor

Measured value is out of signalling range

If the measured variable is out of signalling range, the controller switches on the signalling relay and on the display next to the graphic delineator it displays a horizontal prime either on the top or on the bottom according to which limit is exceeded

Related temperature sensor error – for voltage input only

The controller uses the temperature sensor for compensation of cold end of thermocouple. The temperature sensor is the part of the controller. In case of failure in this sensor the controller displays vertical prime on the bottom part of the segment on the display next to the graphic delineator, in this case the controller uses temperature 25°C instead of the related temperature. The service assistance is necessary for this error removal.

VIII. GUARANTEE TERMS

The manufacturer guarantees the errorless function of the controller for the period of 12 months from the date of putting the controller into operation, however, at the latest 15 months from the date of selling the device to the customer. In the said period, the manufacturer is obliged to accomplish any repairs of failures, which were caused by material defects or by hidden manufacture defect, free of charge.
The guarantee does not include defects caused by mechanical damage of the controller, incorrect connection or use for another purpose than the product is designed for, breaching the working or storing conditions and not respecting the instructions given by the manufacturer.

Caution:

In case of failure in the sensor input circuit function (short-circuit at the sensor line, failure of input amplifier or converters), the controller may indicate incorrect value of the measured variable. The controller manufacturer is not liable for any secondary damages caused by the controller failure.
The manufacturer recommends that the regulated system be protected with another independent circuit that will disconnect the regulated system in case the maximum allowed value of measured variable is exceeded.

IX. OPERATING CONDITIONS

The controller must operate in an area protected against direct weather conditions, radiating heat, coarse impurities and aggressive vapours. The controller is calibrated for selected input sensor by the manufacturer.

Feeding:	230V/0,04A, 50Hz
Operating temperature:	0°C to 40°C
Storing temperature:	-40°C to 65°C
Relative air humidity:	max. 80% at 20°C
Dustiness:	max. 0,5 mg/m^3 of incombustible and non-conducting powder
Coverage:	IP50, if desired IP54 – built-in version
	IP65 – instrument for mounting to operation version
Protection:	Internal fusible cut-out T100 mA/250V

Production number: ______

The manufacturer address, orders, technical information:

SMART, Ltd.
Purkyňova 45
612 00 BRNO
Czech republic

tel: **00420 541 590 639**
fax: **00420 549 246 744**
e-mail: **smart@smartbrno.cz**
Internet: **www.smartbrno.cz**

Appendix A – Set of Characters for Seven-Segment Display

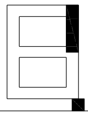
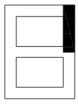
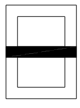
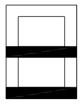
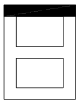
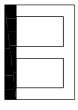
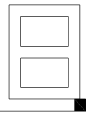
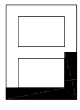
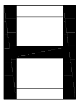
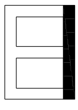
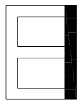
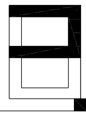
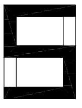
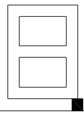
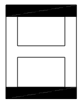
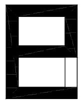
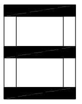
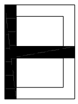
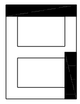
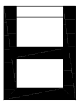
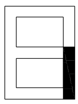
The display possibilities of the seven-segment display are limited. The character set is designed in such a way that the created characters correspond to the alphabet and generally used characters as much as possible. The table shows letters and digits and next to them the corresponding characters as displayed on the controller.

Letters and Digits

A		J		S		1	
b		k		t		2	
C		L		U		3	
d		M		v		4	
E		n		W		5	
F		O		X		6	
G		P		y		7	
H		q		z		8	
I		r		0		9	

Special Characters

Most of these characters is not used in the texts displayed on the controller.

! 	' 	- 	= 
" 	(	. 	> 
# 	) 	/ 	? 
$ 	* 	: 	@ 
% 	+ 	; 	
& 	\ 	<