ELECTRONICS
REGULATION
MEASUREMENT
AUTOMATION

Certified ISO 9001 : 2000 by

HRN EN ISO 9001:2002

Manual

Process PID controller

OMEGA 5k

type 4 – V1.3

Catalog numbers
- 0460.1x.xxx
- 0460.3x.xxx
- 0460.Ox.xxx

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Introduction:

- Control

- Three-state PID controller + two alarms (minimum and maximum)
- Few setpoint infliction options
- Control of motorized valves
- Manual mode
- Direct or reverse control
- Ratio control
- Auto-tuning

- Input

- Analog: 2 x universal (thermocouples by ITS-90 standard, Pt100 probes, standard current (0-4-20mA) and voltage signals (0-2-10V)) + 1 x potentiometer / current
- Digital measurement correction
- 4 x logic (digital) input (galvanic isolated, 24Vdc logic)

- Output

- 4 x relay 250V~/ 5A
- Analog (optional)
  - 0-10 V / 2-10 V
  - 0-20 mA / 4-20 mA
  - User selectable analog output signal (measured values, control values)
- RS-485 ModBUS communication

- Display

- LED display, 4 digits for measured value (PV)
- LED display, 4 digits for set value (SV)
- bar-graph for valve position or actual CV percentage (user selectable)

- Dimensions
  - 96x48, 48x96, 96x96, 144x72, 72x144 mm

- Power supply
  - 230 V~, 110 V~, 24V~, 24V=
  - on demand

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1 OPERATION

1.1 BASIC

OMEGA 5k controller have **dual analog input** able to support Pt100, all thermocouples covered by ITS-90 standard, standard current measuring signals (0-4-20mA) and standard voltage measuring signals (0-2-10V). Also, there is single **valve position feedback input** (potentiometer or 0-4-20mA current signal).

Process (measured) value (PV) and setpoint are displayed trough **two four digit displays**. Except permanent monitoring of process value and setpoint user has ability to change display to some other process variables (on demand for few seconds), like input1, input2, control value, participation of P-, I-, D-action, etc. Also, there is **bar-graph display** for current valve position or control value (CV) percentage.

Setpoint of PID control can be changed trough several ways: via keyboard on front panel of device, via logic inputs (selection between one of three predefined values) or via analog signal (standard current or voltage signal). NOTE: For setpoint change via logic inputs device must be shipped with additional logic inputs card!

Depends on user needs, and for simplification of use, this device can be shipped with some of six pre-configurations:

- type 1: signaling device with two alarms
- type 2: signaling device with four alarms
- type 3: signaling device with two alarms and second stage of PID cascade
- **type 4**: PID controller with two alarms (standard PID controller; PID controller for motorized valves; PID controller for motorized valves with valve position feedback)
- type 5: cascade PID controller (standard PID controller; PID controller for motorized valves; PID controller for motorized valves with valve position feedback)
- type 6: fully user configurable, contents all options of previous described types 1-5

Factory default for version of device shipped with this manual is **type 4** an can not be changed later by user!!!

As option, **OMEGA-5k** controller can be delivered with **continuous analog output** (0-4-20mA or 0-2-10V). Analog output could be driven by measured values or control values (user selectable).

Additional option also is **RS-485 ModBUS** communication module which enables OMEGA-5k to be connected on PC. Trough ModBUS network user can monitor the system, reconfigure the controller, or make archives of some process values.

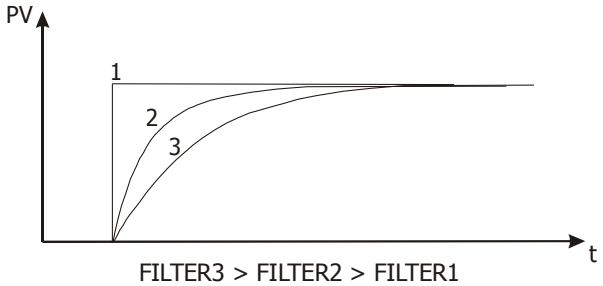
For PID control, device uses standard PID algorithm based on the following equation:

$$err(t) = SV - PV(t)$$

$$CV(t) = GAIN \cdot [err(t) + \frac{1}{Ti}\int_0^t err(t)dt + Td\frac{d}{dt}err(t)] + CV_{stat}$$

SV	-	setpoint value (SV; W)
PV	-	process value (PV; X)
CV	-	control value (CV; Y), [%]
CV_{stat}	-	static (constant) amount of control value (CV_{stat}, Y_{stat}), [%]
err	-	control error
GAIN	-	proportional gain
Ti	-	integral time, [s]
Td	-	derivative time, [s]

Also controller have built-in mean filter for elimination of EM disturbances in input signal. Larger filter value means more filtering, but slower measuring. Filter operation is displayed on the following figure:



FILTER3 > FILTER2 > FILTER1

1.2 PID CONTROLLER WITH TWO ALARMS

In this mode (type 4) relay 1 and relay 2 are under PID algorithm (see chapter *PID control*) in CV range from –100% to +100%. Relays 3 and 4 are under alarm function, relay 3 under alarm 3and relay 4 under alarm 4. Both alarms are fully configurable.

1.2.1 PID CONTROL

For PID control, device uses standard PID algorithm based on the following equation:

$$err(t) = SV - PV(t)$$

$$CV(t) = GAIN \cdot [err(t) + \frac{1}{Ti}\int_0^t err(t)dt + Td\frac{d}{dt}err(t)] + CV_{stat}$$

SV	-	setpoint value (SV; W)
PV	-	process value (PV; X)
CV	-	control value (CV; Y), [%]
CV_{stat}	-	static (constant) amount of control value (CV_{stat}, Y_{stat}), [%]
err	-	control error
GAIN	-	proportional gain
Ti	-	integral time, [s]
Td	-	derivative time, [s]

As PID controller, OMEGA-5k is able to perform all combinations of P-, I- and D-action (P, PI, PD, PID, etc). Control is three-state (for example, heating and cooling). Some PID action can be disabled by setting wanted action parameter to zero.

Hereafter all described is for reverse control (for direct is all the same only CV(t) changes the sign). Reverse control means that PV and CV works in opposite directions – when PV increase, CV decrease, and vice-versa – when PV decrease, CV increase (for example, control in heating systems).

1.2.2 PID CONTROLLER FOR MOTORIZED VALVES

In this mode of operation (parameter EMV in Menu II. set to YES) from control CV(t) function is eliminated I-action, because integral is already contained in mechanical position of the valve. On output relays (relay 1 and relay 2) now affects slightly changed control function $CV_{1,2}(t)$, as shown in following equation:

$$err(t) = SV - PV(t)$$

$$CV_{1,2}(t) = GAIN \cdot [err(t) + Td\frac{d}{dt}err(t)]$$

All other output actions (relay 3, relay 4. analog output) still acts according to complete control function CV(t).

1.2.3 PID CONTROLLER FOR MOTORIZED VALVES AND VALVE POSITION FEEDBACK

In this mode of operation (parameter EMV in Menu II. set to Fb) on output relays (relay 1 and relay 2) now affects control function $CV_{1,2}(t)$ in which final control error is difference between CV(t) and current valve position, as shown in following equations:

$$err(t) = SV - PV(t)$$

$$CV_{1,2}(t) = GAIN \cdot [err(t) + Td \frac{d}{dt} err(t)]$$

$$err(t) = SV - PV(t)$$

$$CV(t) = GAIN \cdot [err(t) + \frac{1}{Ti} \int_0^t err(t)dt + Td \frac{d}{dt} err(t)] + CV_{stat}$$

$$CV_{1,2}(t) = GAIN_{EMV} \cdot [CV(t) - EMV]$$

SV	-	setpoint value (SV; W)
PV	-	process value (PV; X)
CV	-	control value (CV; Y), [%]
CV_{stat}	-	static (constant) amount of control value (CV_{stat}, Y_{stat}), [%]
err	-	control error
GAIN	-	proportional gain
Ti	-	integral time, [s]
Td	-	derivative time, [s]
$GAIN_{EMV}$	-	proportional gain of valve position deviation
EMV	-	current valve position, [%]

All other output actions (relay 3, relay 4. analog output) still acts according to complete control function CV(t).

1.2.4 RATIO CONTROLLER

In case of ratio controller, setpoint SV and process value PV(t) for PID control function CV(t) are not taken directly as so far, but they receive slightly complex form: PV(t) is no more directly measured value, now it is combination of more measured values (*PV1, PV2,* …), each with is own weighting factor (*F1, F2,* …) and offset (*offset1, offset2,* …). Similar is with the setpoint. Ratio control is described trough following equations:

$$SV = F_0 \cdot [SV_{user} + offset_0] \qquad (1)$$

$$PV(t) = F_1 \cdot [PV_1(t) + offset_1] + F_2 \cdot [PV_2(t) + offset_2] + F_3 \cdot [PV_3(t) + offset_3] \qquad (2)$$

SV_{user}	-	user inflicted setpoint
F_0	-	setpoint weighting factor
$offset_0$	-	setpoint offset
F_1	-	weighting factor input 1 (PV1(t))
$offset_1$	-	offset input 1
F_2	-	weighting factor input 2 (PV2(t))
$offset_2$	-	offset input 2
F_3	-	weighting factor input 3 (PV3(t))
$offset_3$	-	offset input 3

Control error *err(t)* and control value *CV(t)* remains unchanged as in the previous occasions, they just receive new *SV* i *PV(t)* from previous equations:

$$err(t) = SV - PV(t)$$

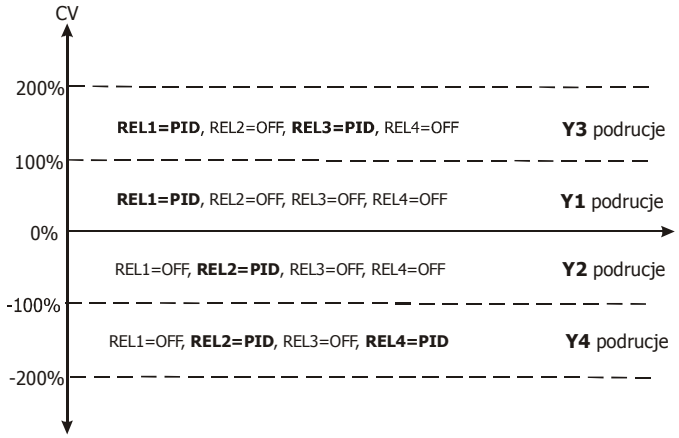
$$CV(t) = GAIN \cdot [err(t) + \frac{1}{Ti}\int_0^t err(t)dt + Td\frac{d}{dt}err(t)] + CV_{stat}$$

SV	-	setpoint value (SV; W)
PV	-	process value (PV; X)
CV	-	control value (CV; Y), [%]
CV_{stat}	-	static (constant) amount of control value (CV_{stat}, Y_{stat}), [%]
err	-	control error
GAIN	-	proportional gain
Ti	-	integral time, [s]
Td	-	derivative time, [s]

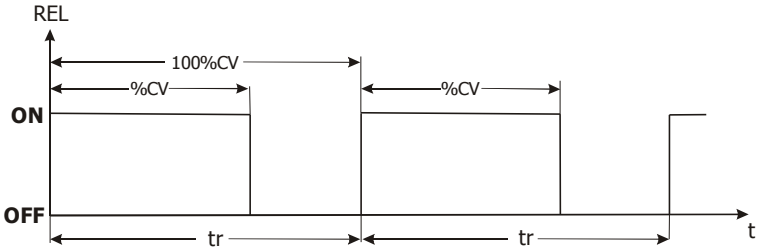
NOTE: For activation of ratio controller see parameter **PV** in Menu II. Setting this parameter to *rtIo*, ratio control is activated. Now in Menu I. appears new submenu, **rtIo**, in which can be adjusted described weighting factors and offsets. If some weighting factor is set to zero, this variable has no affect in control.

1.2.5 OUTPUT RELAY OPERATION

Output relays operation, depending on control value CV(t) amount and sign, is shown on the following figure:



By PID controller control relay operate with repetitive period named **tr**. Inside one period relay active time is directly proportional to control value CV, as shown on the following figure. CV=100% means permanently active relay, and CV=0% means relay permanently inactive.



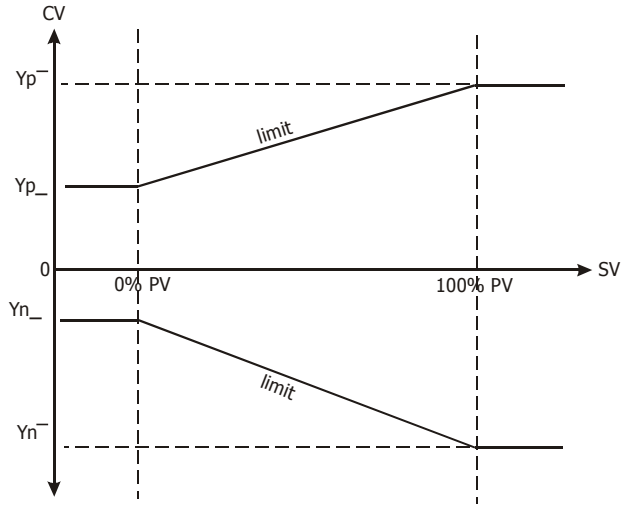
If **tr** is set to zero (tr=0), PID operation of related relay is deactivated and relay starts to operate according to **ON-OFF** control function with same setpoint SV as in case of PID control.

For direct control all works the same as for reverse, only output relays operate inverse considering the sign of control value CV.

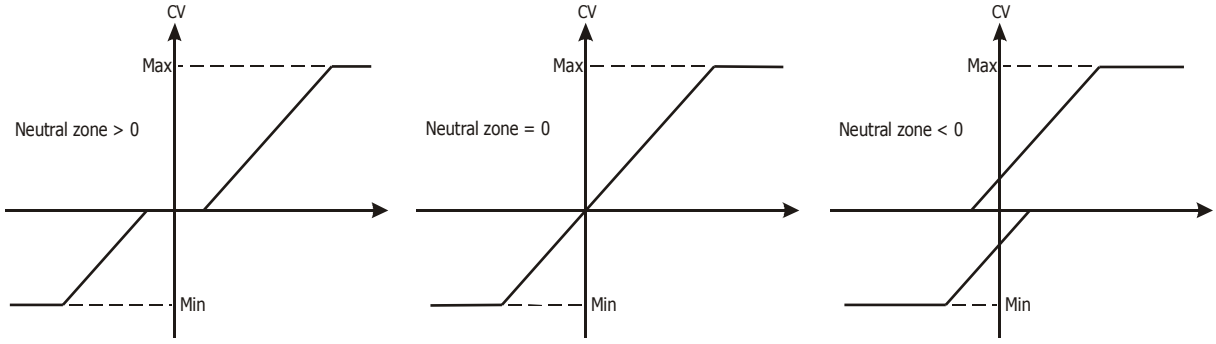
1.2.6 CONTROL VALUE LIMITING. NEUTRAL ZONE

Control value CV can be limited with limiting factors for minimum and maximum value of CV. Limiting factors can change dynamically according to current setpoint. Limiting CV automatically limits the maximum pulse duration at output relays 1 and 2. Except limitations of CV to some minimum / maximum value, user can also define a neutral zone of CV (in percentage of CV). Neutral zone has effect only in case of three-state control. In case of two-state control neutral zone is automatically forced to zero.

Operation CV min-max delimiter is shown on the following figure (CV can be anywhere between "limit" lines):



Operation of neutral zone is shown on the following figure (total wide of neutral zone is twice as neutral zone parameter value):



Beside CV, it is possible to limit I-action, in both directions, positive and negative. Limiting I-action directly affects on control loop dynamics. Amount of I-action must be enough to satisfy stationary system needs for energy.

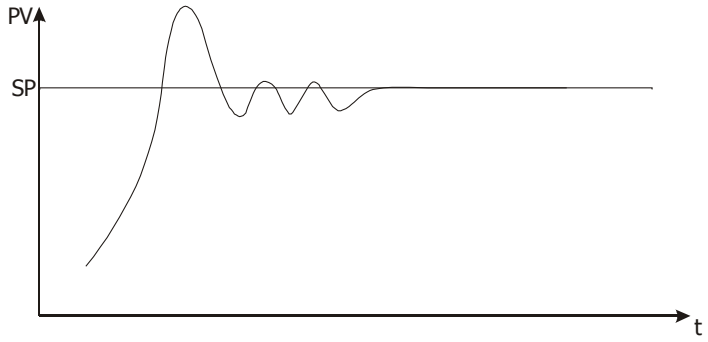
1.2.7 MANUAL OPERATION

Manual operation has two different modes of action. First case is when controller is in the mode for control motorized valve (parameter EMV is set to YES). Manual action in this case forces directly output relays trough belonging function keys.

Second case is when motorized valve control is deactivated (parameter EMV is set to oFF). Now manual action forces control value CV(t), and output relays operate in pulse mode (like in automatic mode) according to value of CV(t).

1.2.8 AUTO-TUNING

Auto-tuning (AT) function estimate PID parameters for current system based on system response monitoring. Principle of operation of AT function is shown on the following figure:



PID parameters estimated with AT function should be considered as first step in PID controller adjustment. Finally, **it's recommended for user to perform final adjustments and verification of PID parameters after AT function has ended**!

NOTE: AT function can't be used in systems with motorized valves without feedback!

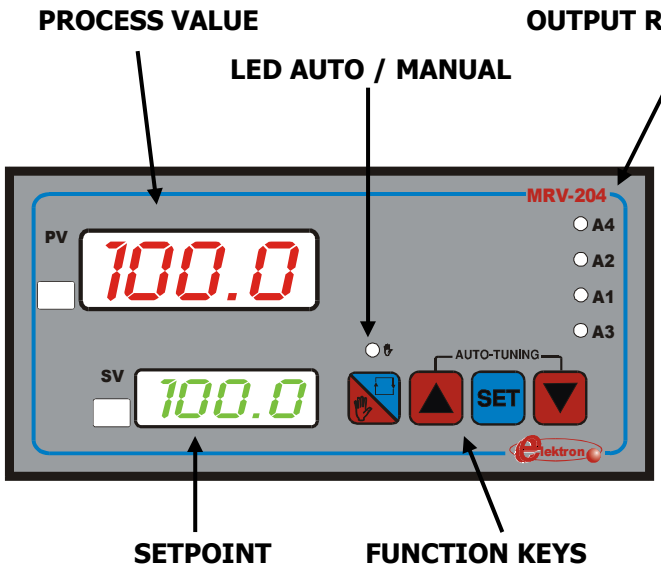
NOTE: User should be aware that AT function drives the system with 100% of available power! "Elektron – ERMA Strmec" don't take any responsibility for possible damages in system or goods caused with use of AT function!!!

2 TECHNICAL CHARACTERISTICS

2.1 TABLE

Front panel	foil with keyboard	
Mounting	panel cutout	
Case	96 x 96 x 119 mm	
	144 x 72 x 120 mm	
	72 x 144 x 120 mm	
Power supply	230 V~, 50 Hz	
Accuracy	0.3 + 2 digit	
Display	13mm red LED display, 4 digits for, measured (process) value	
	10mm green LED display, 4 digits, for setpoint value	
	25mm green LED BARGRAF (10 levels)	
Input	2x universal – user selectable	
	Current	0-20 mA/4-20 mA
	Voltage	0-10 V/2-10 V
	Thermocouples	K, L, N, E, S, R, T, B
	Resistance	Pt100, potentiometer
	Others	(PWM signal, frequency) on demand
	1x potentiometer	
	4x logic (galvanic isolated) (optional)	levels: "0" = 0-6 Vdc "1" = 12-24 Vdc
Output	4 relays, 250 V_{AC} / 5 A	
	0-4-20 mA analog output (optional)	
	0-2-10 V analog output (optional)	
	RS-485 ModBUS (optional)	
Control	Three-state (trough relays) + 2x alarm, relay contacts 5 A, 250 V~	
	Continuous (trough analog signal 0-4-20 mA or 0-2-10 V)	
Control function	ON/OFF, P, PI, PD, PID, selectable	
Parameters storage	Internal EEPROM memory	

2.2 DEVICE DESCRIPTION



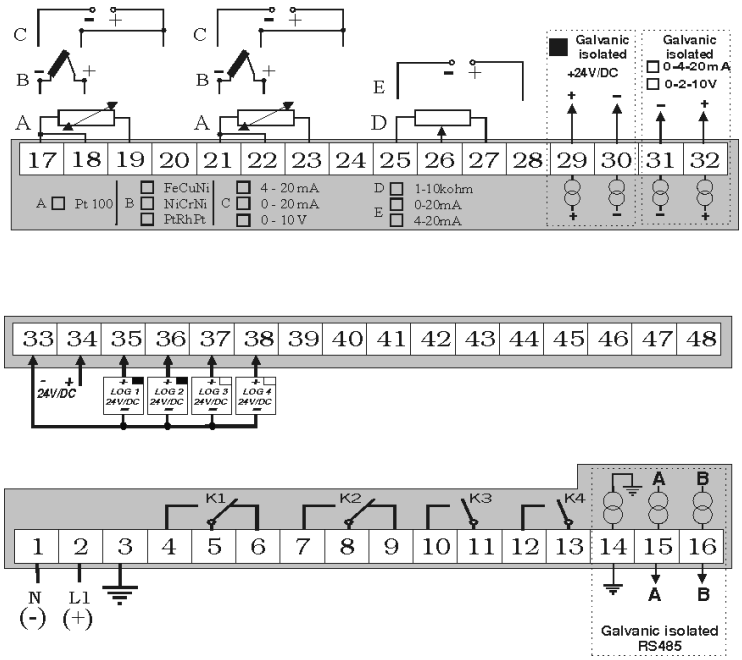
FUNCTION KEYS

- Keys up / down
- output relays activation in MANUAL mode

SET - displayed value selection
- Menu entry
- Validation

/ - AUTO / MANUAL mode

2.3 CONNECTION DIAGRAM



2.4 TERMINALS

1, 2	Power supply	
3	Power ground	
4, 5, 6	output relay **K1**	
7, 8, 9	output relay **K2**	
10, 11	output relay **K3**	
12, 13	output relay **K4**	
14, 15, 16	RS-485 ModBUS communication- **optional**	
17, 18, 19, 20	Analog input 1:	A. Pt100 probe connection
		B. Thermocouple connection
		A. Standard current signal connection
21, 22, 23, 24	Analog input 2:	A. Pt100 probe connection
		B. Thermocouple connection
		A. Standard current signal connection
25, 26, 27, 28	Analog input 3 – valve position feedback (potentiometer or current) or input 3 for ratio control (current only):	
		D D. potentiometer connection
		E E. current signal connection
29, 30	galvanic isolated voltage output +24Vdc/40mA (transmitter power supply)	
31, 32	analog output (0-4-20mA / 0-2-10V) – **optional**	
33, 34	external power supply for logic inputs card	
35, 36, 37, 38	logic input 1, 2, 3, 4	
39-40	unused!	

3 HANDLING INSTRUCTIONS

3.1 DISPLAYED VALUE

Standard display means process value (measured value) on **PV** (red) display and setpoint value on **SV** (green) display. Also, user can change display (for few second) to see current status of control value CV.

3.1.1 DISPLAYED VARIABLE CHANGE

Pressing **SET** key can perform change of displayed parameter. On SV display now stays label of displayed parameter and on PV display current amount of control value CV (in percentage):

- process value (PV)
- **In-1** – measured value at input 1
- **In-2** – measured value at input 2
- **Id** – device ID number
- **Y** – PID control value (CV)
- **Y12** – PID control value 0-100%; Y12 = 0-100% from Y
- **Y34** – PID control value 0-100%; Y34 = 100-200% from Y
- **YEXt** – valve position
- **P-cl** – current amount of P-action
- **I-cl** – current amount of I-action
- **D-cl** – current amount of D-action

After 25 seconds display automatically goes back to standard – process value on PV display and setpoint on SV display.

3.2 MENU I.

In menu I. user can change parameters meant for often change and adjusting (e.g. setpoint, PID parameters, …).

parameter		range	description
SP-L	**SP-U**	0.0 – 100.0	Setpoint (locked or unlocked).
GAIn		0.0 – 100.0	Proportional gain of PID control
tI		0.0 – 999.9	Integral time of PID regulation, [s]
td		0.0 – 999.9	Derivative time of PID control, [s]
YSt		-100.0 – 100.0	Static amount of control value CV (Y), [%]
ZonE		-100.0 – 100.0	Neutral zone of CV (Y) action, [%]
rAMP		0.0 – 999.9	Ramp increasing gradient, [*C/min]
tr-1		0.0 – 100.0	Repetition period of relay1 (mark **K1**), [s] **NOTE:** If tr-1=0 PID control is deactivated and switched to ON/OFF control!
tr-2		0.0 – 100.0	Repetition period of relay2 (mark **K2**), [s] **NOTE:** If tr-2=0 PID control is deactivated and switched to ON/OFF control!
ShIS		0.0 – 99.9	Setpoint hysteresis in case of ON/OFF control [in % of PV]; in use in case of ON/OFF control (tr-1=0, tr2=0 or both set to 0).
A-3		0.0 – 100.0	Alarm 3 setpoint
A-4		0.0 – 100.0	Alarm 4 setpoint

hIS3	0.0 – 100.0	Alarm 3 hysteresis
hIS4	0.0 – 100.0	Alarm 4 hysteresis
tP-3	0.0 – 100.0	Alarm 3 pause time, [s]
tP-4	0.0 – 100.0	Alarm 4 pause time, [s]
FILt	0.0 – 100.0	Measured value filter
LI.SP	-	Additional setpoint 1, 2 i 3 submenu (setpoint selection trough logic inputs). To access parameters hold **SET** key.
rtIo (1)	-	Ratio control parameters submenu (weighting factors and offsets); submenu activated when PV in Menu II. set to PV=rtIo. To access parameters hold **SET** key.
caL	-	**Menu II. access -** hold **SET** key
End1	-	**Menu I. exit**

(1) Active only when ratio control is activated (see parameter **PV** in Menu II.). In this submenu user can change weighting factors and offsets for ratio control (oFS.0 = setpoint offset, oFS.1 = input 1 offset, oFS.2 = input 2 offset, oFS.3 = input 3 offset, F.0 = setpoint weighting factor, F.1 = input 1 weighting factor, F.2 = input 2 weighting factor, F.3 = input 3 weighting factor)

3.2.1 MENU I. ACCESS

To access menu I. press the **SET** key and hold for cca 5 seconds. Into menu I. on display PV is label of currently selected parameter, while on display PV is parameters value.

3.2.2 PARAMETER CHANGING

With keys select parameter which need to be changed. Press the **SET** key – value on SV display begins to blink. Using keys set the new value. Confirm new value by pressing the **SET** key. Value on SV display stops to blink.

3.2.3 MENU EXIT

Using keys move to **End1** position. Press the **SET** key.

3.3 MENU II.

In menu II. are placed parameters which are intended to be configured only once or very rarely (limits, corrections, …).

parameter	range	description	
Lo-S	-999 – 9999	-	Setpoint lower limit (setpoint can't be entered below this value).
hI-S	-999 – 9999	-	Setpoint upper limit (setpoint can't be entered above this value).
In-1	0-10 2-10 0-20 4-20 Pt1 Pt0.1 tc-J tc-K tc-L	0-10V 2-10V 0-20 mA 4-20 mA Pt100 – resolution 1°C Pt100 – resolution 0.1°C Thermocouple tip J (Fe-CuNi) Thermocouple tip K (NiCr-Ni) Thermocouple tip L	Input signal at analog (measuring) input 1

	tc-N tc-E tc-S tc-R tc-t tc-B	Thermocouple tip N Thermocouple tip E Thermocouple tip S (PtRh-Pt) Thermocouple tip R Thermocouple tip T Thermocouple tip B	
Mod.1 (1)	**LIn** Sqrt X2 X3	linear (measuring direct) sqrt square cubic	Operation on standard current / voltage signal on input 1.
dP1 (1)	0.0.0.0	-	Number of decimal places (for scaling standard voltage and current measuring signals).
L-d1 (1)	-999 – 9999	-	Standard measuring signals scaling: value for 0% of input signal.
H-d1 (1)	-999 – 9999	-	Standard measuring signals scaling: value for 100% of input signal.
cMP1 (2)	**Intr** E-00 E-10 E-20 E-30 E-40 E-50	Internal compensation External compensation @ 0°C External compensation @ 10°C External compensation @ 20°C External compensation @ 30°C External compensation @ 40°C External compensation @ 50°C	Thermocouple cold junction compensation method for input 1.
In-1	0-10 2-10 0-20 4-20 Pt1 Pt0.1 tc-J tc-K tc-L tc-N tc-E tc-S tc-R tc-t tc-B	0-10V 2-10V 0-20 mA 4-20 mA Pt100 – resolution 1°C Pt100 – resolution 0.1°C Thermocouple tip J (Fe-CuNi) Thermocouple tip K (NiCr-Ni) Thermocouple tip L Thermocouple tip N Thermocouple tip E Thermocouple tip S (PtRh-Pt) Thermocouple tip R Thermocouple tip T Thermocouple tip B	Input signal at analog (measuring) input 2
Mod.2 (1)	**LIn** Sqrt X2 X3	linear (measuring direct) sqrt square cubic	Operation on standard current / voltage signal on input 2.
dP2 (1)	0.0.0.0	-	Number of decimal places (for scaling standard voltage and current measuring signals).
L-d2 (1)	-999 – 9999	-	Standard measuring signals scaling: value for 0% of input signal.
H-d2 (1)	-999 – 9999	-	Standard measuring signals scaling: value for 100% of input signal.
cMP2 (2)	**Intr** E-00 E-10 E-20 E-30 E-40 E-50	Internal compensation External compensation @ 0°C External compensation @ 10°C External compensation @ 20°C External compensation @ 30°C External compensation @ 40°C External compensation @ 50°C	Thermocouple cold junction compensation method for input 1.
cF-1	-25.0 – 25.0	-	input 1 correction factor
cF-2	-25.0 – 25.0	-	input 2 correction factor
out (3)	**In-1** In-2 Y1 Y2 Y3 Y4 YFSd	input 1 input 2 y1 0-100% y2 0-100% y3 0-100% y4 0-100% y from -100% to +100%	Value to proceed at analog output.

	YFSr	y from +100 to -100%	
out_ (3)	-999 – 9999	-	Analog output range: value for 0% of output.
out ¯ (3)	-999 –9999	-	Analog output range: value for 100% of output.
tIP (3)	0–20mA 0–10V 4–20mA 2–10V	-	Analog output type (label depends about current or voltage output).
cF-o (3)	-100.0 – 100.0	-	Analog output offset according to source signal.
Yn_	-200.0 – 0	-	Control value limit at 0% PV in negative direction, [%]
Yn ¯	-200.0 – 0	-	Control value limit at 100% PV in negative direction, [%]
Yp_	0 – 200.0		Control value limit at 0% PV in positive direction, [%]
Yp ¯	0 – 200.0	-	Control value limit at 100% PV in positive direction, [%]
In ¯	-200.0 - 0	-	I-action limit in negative direction, [%]
Ip ¯	0 – 200.0	-	I-action limit in positive direction, [%]
EMV	**no** YES Fb	standard control motorized valve control motor.valve with feedback	Control mode depending on actuator.
EM.Fb	**Pot** 0-20 4-20	potentiometer current 0-20mA current 4-20mA	Valve position feedback signal.
Fb_	-	-	Calibration of 0% valve feedback (EMV must be set to YES).
Fb¯	-	-	Calibration of 100% valve feedback (EMV must be set to YES).
IMP1 (4)	0.0 – 100.0		Relay 1 maximum impulse duration, [%]
IMP2 (4)	0.0 – 100.0		Relay 2 maximum impulse duration, [%]
rEG	**rEV** dIr	-	Direct or revere control (for example, heating or cooling).
PV	**In-1** In-2 rtIo	input 1 input 2 ratio control	Process value selection
SP.In	**Intr** In-1 In-2	parameter SP input 1 input 2	Setpont selection
bAr	**oFF** Fb Y12 Y1 Y2 Y34 Y3 Y4 In-1 In-2 In-3	disabled feedback signal PID y12 PID y1 PID y2 PID y34 PID y3 PID y4 input 1 input 2 input 3	Bar-graph display signal selection. Feedback = valve position. PID y = PID control cascade percentage. In case of Y12 and Y34 display automatically switch from one cascade to another – currently active relay give us also information about active cascade (Y1 = K1, Y2 =K2). Input 1, 2, 3 – percentage of measured signals at input 1, 2 or 3.
Atr	0.1 – 10.0	-	PV resolution by auto-tuning, [%]
ALt3	0-9999	-	Alarm 3 configuration word (see table under *Alarm configuration*)
ALt4	0-9999	-	Alarm 4 configuration word (see table under *Alarm configuration*)
Int	0-15	-	Display intensity

bKP	Load SaVE	load backup parameters backup parameters	Safety backup of user configuration.
cLr	-	-	**Restore factory defaults!**
End2	-	-	**Menu II. exit**

(1) Active only when input signal is one of standard current or voltage signals
(2) Active only when input signal is one of thermocouples
(3) Active only when analog output is active
(4) Active only when activated control of motorized valve with position feedback (EMV=Fb)

3.3.1 MENU II. ACCESS

For Menu II access move to **CAL** position in Menu I, press the **SET** key and hold for cca 5 seconds. Into Menu II on display PV is label of currently selected parameter, while on display SV is parameters value.

3.3.2 PARAMETER CHANGING

With keys select parameter which need to be changed. Press the **SET** key – value on SV display begins to blink. Using keys set the new value. Confirm new value by pressing the **SET** key. Value on SV display stops to blink.

3.3.3 ALARM CONFIGURATION

Alarm function must be configured depends on user needs. Configuration is performed trough four digit code (parameter for **ALt3** alarm 3 and parameter for **Alt4** alarm 4), as shown in following table:

1 0 0 1

SMJER	
0	reverse (minimum)
1	direct (maximum)
2	
3	
4	
5	
6	
7	
8	
9	

TIP	
0	alarm absolute
1	-
2	alarm relative with respect to SP
3	alarm relative in both directions (+/-)with respect to SP
4	
5	
6	
7	
8	
9	

ULAZ	
0	input 1
1	input 2
2	input 3
3	valve position
4	input 1 – input 2
5	input 2 – input 1
6	input 1 / input 2
7	input 2 / input 1
8	input 1 / input 3
9	input 3 / input 1

ON/OFF	
0	deactivated
1	activated
2	activated and locked
3	
4	
5	
6	
7	
8	
9	

Hereafter are few examples of alarm configuration, given for better understanding:

0 0 0 1 - minimum, inflicted absolute, monitoring input 1, alarm function activated
1 0 0 1 - maximum, inflicted absolute, monitoring input 1, alarm function activated
0 0 1 1 - minimum, inflicted absolute, monitoring input 2, alarm function activated
1 0 1 1 - maximum, inflicted absolute, monitoring input 2, alarm function activated

3.3.4 MENU EXIT

Using keys move to **End2** position. Press the **SET** key. Menu position is returned back to **CAL** in menu I.

3.4 MANUAL / AUTOMATIC MODE OF OPERATION

Automatic mode is characterized with automatic behavior of outputs depending on values on inputs according to PID algorithm.

In manual mode user affects on actuator (and process) by it self, monitoring and estimating situation in process.

3.4.1 AUTOMATIC → MANUAL

For transition from auto in manual mode hold ✋/🔄 key for cca 2-3 seconds, until LED with mark ✋ is activated. Device is now in manual mode. With keys user can affects on controler output.

3.4.2 MANUAL → AUTOMATIC

For transition from manual in auto mode hold ✋/🔄 key for cca 2-3 seconds, until LED with mark ✋ is deactivated. Device is now in automatic mode.

3.5 SETPOINT INFLICTION

Setpoint for PID control can be inflicted on several ways, depending on user needs:

- trough keyboard in menu I. only - so called "setpoint locked" option
- directly with keys on front panel (no need to access menu I.) or in menu I. - so called "setpoint unlocked" option
- trough logic inputs
- trough analog signal

3.5.1 SETPOINT INFLICTION MODE SELECTION

In menu I, beside parameter setpoint (mark SP) stays also and currently active setpoint infliction option:

- SP-L - "setpoint lock"
- SP-U - "setpoint unlock"

To change current setpoint infliction option (L→U ili U→L) go to parameter SP-X (X is currently active option) and hold **SET** key until option changes.

3.5.1.1 "setpoint lock"

When "setpoint locked" option is active (SP-L), setpoint can be changed only trough accessing menu I. (as described previously in *Parameter changing*).

3.5.1.2 "setpoint unlock"

If setpoint infliction mode is set to "setpoint unlocked" (SP-U), setpoint can be changed on two ways. First way is directly with keys, without accessing menu I. Just press (an hold a little) key or and setpoint value on display SV starts to blink. New setpoint value is validated after pressing the **SET** key or automatically 5-second after infliction of new value. After validation new setpoint value at SV display stops to blink.

Second way is actually same as by "setpoint locked" mode: setpoint can be changed in menu I. as all other parameters.

3.5.2 SETPOINT INFLICTION TROUGH LOGIC INPUTS

On demand, device can be shipped with additional galvanic isolated logic inputs card. In that case current setpoint value can be changed trough combination of digital signals on logic inputs. Selected setpoint 1, 2, or 3 from submenu **LI.SP** is copied in main setpoint, **SP-L / SP-U**, in Menu I. Relation between active (selected) setpoint and logic inputs is shown in following table:

SETPOINT		LOGIC INPUT	
		LOG.IN. 2	LOG.IN. 1
SP-L / SP-U	Location: Menu I.	0	0
SP.1	Location: Menu I. -> LI.SP submenu	0	1
SP.2		1	0
SP.3		1	1

Permitted states on logic inputs: "0" = 0-6Vdc, "1" = 12-24Vdc

3.5.3 SETPOINT INFLICTION TROUGH ANALOG INPUT

Setpoint of PID control can also be inflicted trough analog signal (on input 1 or input 2) if user (see SP.In parameter in Menu II.) activates that function. Also, in case of use setpoint from one of analog inputs, setpoints written in parameters trough keyboard are currently out of use. Now, setpoint is analog signal from selected input in range 0-100%.

3.6 AUTO-TUNING

Depending on regulation which want to be used (P, PI, PID, …), before running auto-tuning unused PID parameters need to be set to zero (gain, ti or td - e.g. for PI control parameter td needs to be set to zero). Zero value for certain parameter disables this parameter.

Before starting auto-tuning nature of process must be taken in consideration with the fact that auto-tuning can cause excessive overshot of process value above/below setpoint and cause high oscillations in system!!!

In processes which demands precise regulation auto-tuning is just first step in PID controller adjustment. Fine adjustments needs to be performed by user after auto-tuning finish his operation.

For decreasing EM disturbance influence on system response when performing auto-tuning, response monitoring is performed in discrete steps with specific resolution (defined in percentages of full scale for current input type). Auto-tuning resolution can be changed in range 0.1% - 10.0% (see parameter **Atr** in menu II.). Finest resolution also implies finest estimation of PID parameters, but also higher sensitivity to disturbances (if there are any).

3.6.1 AUTO-TUNING START

To start auto-tuning (AT) press and hold together keys and until LED with mark starts to blink. When auto-tuning is in progress display PV continuing blinking. When auto-tuning finishes, display PV stops to blink and new values for PID parameters are estimated and memorized.

3.6.2 AUTO-TUNING STOP

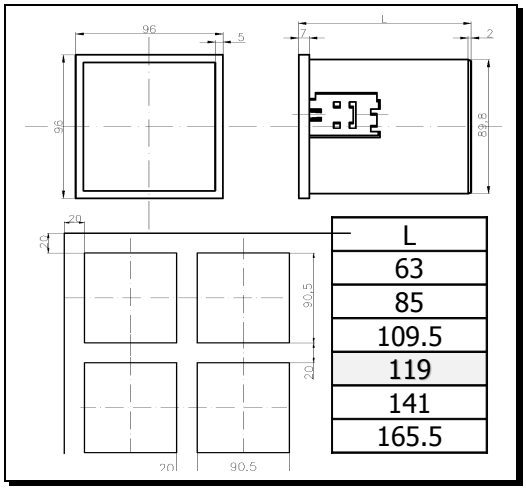
To abort auto-tuning currently in progress (before it finishes by itself) press and hold together keys and until LED with mark stops to blink. Values of PID parameters remain unchanged.

3.6.3 RECOMMENDED PROCEDURE

Before auto-tuning start it's recommended that difference between process value and setpoint is at least 10% or higher. Then auto-tuning can be started and performed with maximum efficiency.

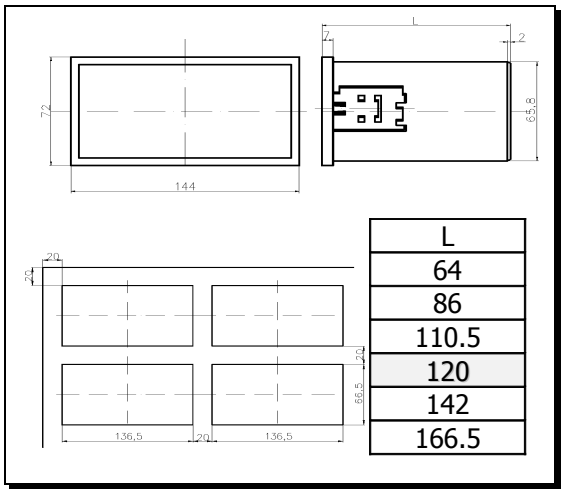
3.7 INSTALLATION

96 x 96 mm



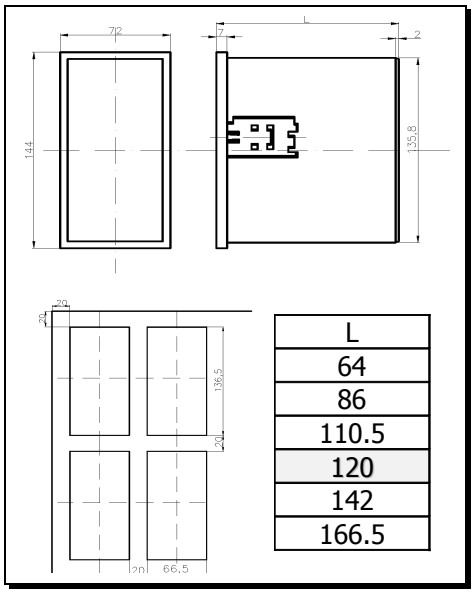
L
63
85
109.5
119
141
165.5

144 x 72 mm



L
64
86
110.5
120
142
166.5

72 x 144 mm



L
64
86
110.5
120
142
166.5

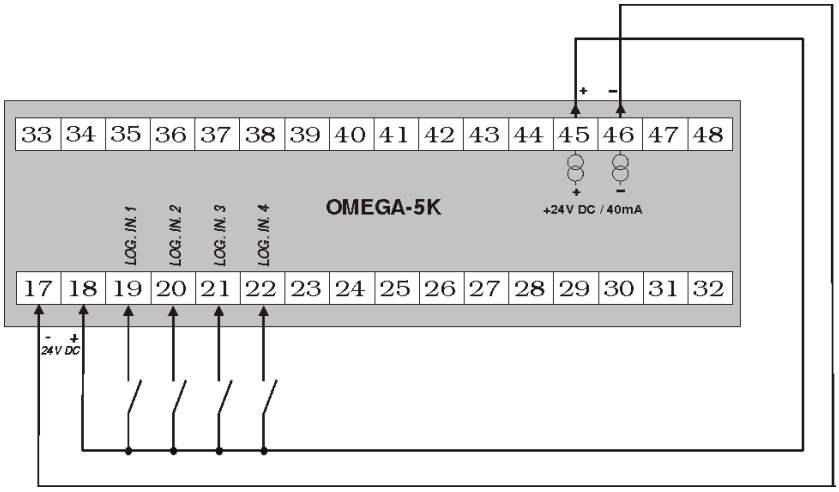
4 CATALOG NUMBERS

Process PID controller OMEGA-5k		0460.	x	x	x	x	x
Case		96x96	1				
		144x72	3				
		72x144	O				
Power supply		90-220 V_{AC}	0				
		220 V_{AC}	1				
		24 V_{DC}	3				
		24 V_{AC}	4				
Analog input		0-10 V	X				
		universal	U				
Output		relay	1				
		0-20 mA	5				
		4-20 mA	6				
		0-10 V	7				
		2-10 V	7				
Output algorithm		ON/OFF+PID+PI+P	3				

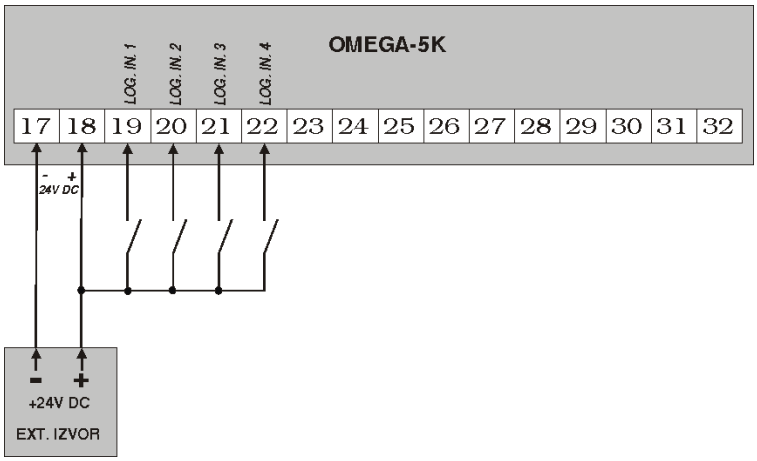
5 APPENDIX

5.1 LOGIC INPUTS CONNECTION EXAMPLES

5.1.1 OPTION A – USING INTERNAL +24VDC POWER SUPPLY FROM DEVICE



5.1.2 OPTION B – USING EXTERNAL +24VDC POWER SUPPLY



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