EUROTHERM
CONTROLS

Model 91e

Miniature PID - ON/OFF temperature controller

CE

- **Compact—less than 2" square (fits 1/16 DIN cutout)**
- **Dual 4-digit LED displays for simultaneous viewing of setpoint and measured value**
- **For heating or cooling applications**
- **Simultaneous relay and logic control outputs**
- **All control and configuration parameters adjustable and securable from front panel without use of jumpers or links**
- **Self-tuning of PID terms for minimal overshoot**
- **Ramp-to-setpoint capability to minimize thermal shock to loads**
- Alarm channel with form C relay output
- Sensor break and loop break alarm indications
- PID or ON/OFF control
- Choice of type J, K, L, N, R, S, T or Platinel II™ thermocouple or RTD for input sensor
- Operation in °F or °C
- Integral mounting sleeve
- 3-button operation with protection of critical parameter values from accidental modification
- Designed for worldwide safety compliance
- Splash-proof NEMA 3 (IP-54) front panel wipes clean

The Model **91e** is an economical, general purpose temperature controller for applications where optimal control performance, product integrity, reliability, and sleek design are required. Eurotherm Controls' design and manufacturing of the Model **91e** combine the latest technology and exceptional engineering to produce a controller that satisfies a wide range of uses. A single universal version of the instrument enables the user to quickly set it up to one of over 2000 different configurations from the front panel. Even with this flexibility, the user interface remains clear and straightforward.

The technologies implemented by Eurotherm Controls offer significant benefits for the engineer and operator alike:

Wide viewing angle. Low reflectance touch screen front panel provides high visibility under bright and dim lighting conditions.

Long-life reliability. Surface-mount printed circuit boards are assembled and quality-checked in Eurotherm's own surface-mount facility.

Brownout immunity. Switchmode power supply handles line voltages between 100 and 240Vac (+10/–15%).

Increased shock and vibration resistance. Quality precious metal interconnection technology eliminates hand-soldered wiring.

The Model **91e** is completely engineered and manufactured in the United States by Eurotherm and is covered by a 2-year warranty.

Doc. No. HA133616 Issue 5 9605

Self tuning

The Model **91e** incorporates a self-tuning algorithm that automatically determines values for the PID parameters. The algorithm is operative at setpoint or upon startup. A unique feature of the algorithm minimizes overshoot when the tuning operation is launched from ambient.

The operator can simply select tuning from the front panel. The algorithm does not require that the operator load any initial PID parameter values to initialize the procedure. During the tuning operation, the message **tunE** is displayed alternately with the setpoint. When the algorithm has successfully finished tuning the loop, **tunE** is no longer displayed and the calculated parameter values are loaded into memory. These results can be inspected by the operator.

Controller configuration

Configuring the controller sets up the instrument for the intended application. The user can specify the alarm function, input type and range, display units, control type, etc. This information is presented in a 4-digit configuration code (the same as in the Product Code on the back page) viewable in the upper display for a few seconds after the instrument is powered up. The operator can modify the settings at this time if required. Configuring the Model **91e** takes less than a minute.

Mechanical features

Neat, clean-cut design throughout is the hallmark of the Model **91e**. The trim, uncluttered front panel design enhances control panel installations and is easy to keep clean.

Installation of the Model **91e** is a simple procedure. The panel mounting clip simply slides on from the rear. The rear terminal pressure plates rise up with the screw heads for fumble-free wire insertion in tight installations. Spade lugs are not required.

Process related safety features

Measured value alarm

The Model **91e** can be configured to act upon one of 5 input alarm conditions (see Specification). The form C relay output is failsafe (relay relaxed during an alarm condition) and non-latching.

A red annunciation LED on the front panel indicates whenever the measured value is in the alarm condition.

Sensor break alarm and shutdown

If the controller detects that the sensor circuit has failed, then the output power level is forced to 0% and the annunciation **SnSr FAIL** is displayed. Upon reinstatement of the input sensor, the controller resumes controlling with the same output power level used at the moment of the break. This has the advantage of making brief interruptions—those where the measured value has not significantly changed—relatively bumpless.

Loop break alarm

The Model **91e** can detect if there is a break in the control loop due to heater burn out, faulty output device or loose wiring. The operator is warned by the message **LP.br**. The message is latching, resettable by touching the front panel. During a loop break alarm condition, the controller output is determined by the control algorithm.

Built-in safety features

Eurotherm has designed and manufactured the Model **91e** to comply with North American and European fire and electrical safety standards. The plastic components are manufactured from flame retardant materials. The controller dissipates less than 5 watts, minimizing its contribution to enclosure temperature rise.

Robust connection system

The pressure plates on rear terminal screws protect against wire pullout and are vibration resistant. Two different diameter wires can be safely connected to one terminal screw without danger of one falling out. Wire sizes up to #12/AWG can be accommodated.

Foolproof user interface

In addition to being easy to use, the user interface minimizes button pushing while providing adequate protection for control parameter values and configuration. Each button push is accompanied by appropriate visual indication.

Parameter security

The controller configuration and parameter values are stored in non-volatile EEPROM. This memory provides data retention for the life of the controller with or without power applied. When the controller is powered up, it performs a self test to verify that all the memories and internal electronics are operating properly before controlling the temperature.

Specifications

1. INPUTS

All inputs

Sampling frequency	5Hz
Maximum common-mode voltage @ 50/60Hz	264$V_{ac\ rms}$ (with respect to supply terminals)
Common mode rejection @ 50/60 Hz	≥120dB (with respect to supply terminals)
Series mode rejection @ 50/60 Hz	≥60dB

Thermocouple inputs

Number of thermocouple types	9 (B, J, K, L, N, R, S, T and Platinel II™)
Calibration accuracy (maximum error)	
For temperatures >0°C	See Input Sensors Table
For temperatures <0°C	±0.25% of reading ± total offset error ± 0.5 l.s.d. where total offset error (°C) = 0.25°C + $(\alpha_{25} + 12)/\alpha_T$ and α_{25} (µV/°C) = Seebeck coefficient at 25°C α_T (µV/°C) = Seebeck coefficient at input temperature.
Thermocouple linearization accuracy	Better than ±0.25°C
Cold junction compensation rejection ratio	15:1 (with internal detector)
Maximum thermocouple loop resistance with no effect on reading	1000Ω

Resistance temperature detector input

Device	DIN 43760/BS 1904 (100Ω Pt), 3-wire connection
Resistance at 0°C	100Ω
Resistance at 100°C	138.5Ω
Calibration accuracy (maximum error)	±0.25% of reading ±1°C ±1/2 l.s.d.
Linearization accuracy	Better than 0.1°C
Maximum lead resistance	20Ω/lead
Excitation current	225µA (typical)

2. OUTPUT DEVICES

Logic (not isolated from thermocouple circuit)

Output	9V @ 10mA (900Ω load)
Short-circuit current	15mA (typical)

Relay (isolated from all other circuits)

Output channel	Form A, isolated (enabled when cycle time ≥5s)
Maximum load voltage	$264V_{ac\ rms}$
Maximum load current (resistive load)	$2A_{rms}$
Minimum load voltage	$10V_{peak}$

3. CONTROL CHARACTERISTICS

General

Offset adjustment range	-50.0 to +50.0°C (-90.0 to +90.0°F)
High and low setpoint limits	Limited to configured range

PID control configuration

Proportional band range	2-400°C (4-720°F) or equivalent in % of sensor range
Integral time constant range	OFF and 10-2000s
Derivative time constant range	OFF and 1-200s
Overshoot suppression	Eurotherm algorithm with high and low "cutback" points dependent on value of proportional band
Output signal type	Time proportioned
Output cycle time adjustment range	
Logic output	0.2 to 60.0s
Relay output	5.0 to 20s (relay output disabled for cycle times < 5s)
Minimum ON or OFF time	40ms

Self tuning

Self-tune initiation	By operator from front panel
Parameters determined	Proportional band, integral time constant (unless previously set to OFF), derivative time constant (unless previously set to OFF), and loop break time constant (unless previously set to OFF)
Tuning algorithm	Eurotherm self-tuning algorithm

ON/OFF control configuration

Control hysteresis adjustment range	2-400°C (4-720°F) or equivalent in % of sensor range

Setpoint ramping

Ramp rate adjustment range	0.1 to 50.0°C/min (0.2 to 90.0°F/min)

4. ALARMS

Alarm signal sources

Measured value

Number of independent selectable alarm input functions	5, ("Full-scale" high, "Full-scale" low, deviation high, deviation low, and deviation band)
Number of alarm functions assignable to alarm relay output	1

Hysteresis	1°C (1.8°F)
Annunciation during alarm condition	Red "AL" light
Alarm action	Non-latching
Control output level during alarm condition	Not affected by measured value alarm
Sensor break	
Alarm condition	Input open or measured value outside of configured range
Maximum reaction time (for $R_{in\ break} \geq 10K\Omega$)	5s
Annunciation during alarm condition	Flashing **Snsr FAIL** display
Alarm action	Non-latching
Control output level during alarm condition	0%

5. GENERAL

Overall dimensions	See below.
Power supply	Switchmode
Line voltage range	100-240$V_{ac\ rms}$ (+10/-15%)
Line frequency range	48-52Hz or 58-62Hz
Power dissipation	Less than 5W
Environmental considerations	
Operating temperature range	0-55°C
Ambient temperature coefficient	Better than150ppm of input span/°C
Calibration reference temperature	25°C
Relative humidity	5-95%, non-condensing
Fascia seal rating	NEMA 3 (IP-54) with optional front panel gasket

Input sensors

	Display range				Calibration accuracy specification				
					Range				Accuracy
	°C		°F		°C		°F		(see key
Thermocouples	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	at right)
B—Pt-30%Rh/Pt-6%Rh	600	1820	1112	3308	600	999	1112	1831	B
					1000	1820	1832	3308	A
J—Fe/SAMA constantan	-200	1200	-328	2192	-200	-1	-328	31	*
					0	1200	32	2192	A
K—Chromel™/Alumel™	-250	1372	-418	2502	-250	-1	-418	31	*
					0	1372	32	2502	A
L—Fe/Konstantan	-100	900	-148	1652	-100	-1	-148	31	*
					0	900	32	1652	A
N—NiCroSil/NiSil	0	1300	32	2372	0	1300	32	2372	B
Platinel II™	-250	1395	-418	2543	-250	-1	-418	31	*
					0	1395	32	2543	A
R—Pt-13%Rh/Pt	0	1767	32	3213	0	399	32	750	C
					400	1767	751	3213	B
S—Pt-10%Rh/Pt	0	1767	32	3213	0	399	32	750	C
					400	1767	751	3213	B
T—Cu/Adams constantan	-255	400	-427	752	-255	-1	-427	31	*
					0	400	32	752	A
RTD—100Ω Pt	-100	600	-148	1112	-100	600	-148	1112	*
DIN43760/BS1904	-99.9	600.0	-99.9	999.9	-99.9	600.0	-99.9	999.9	*

Key

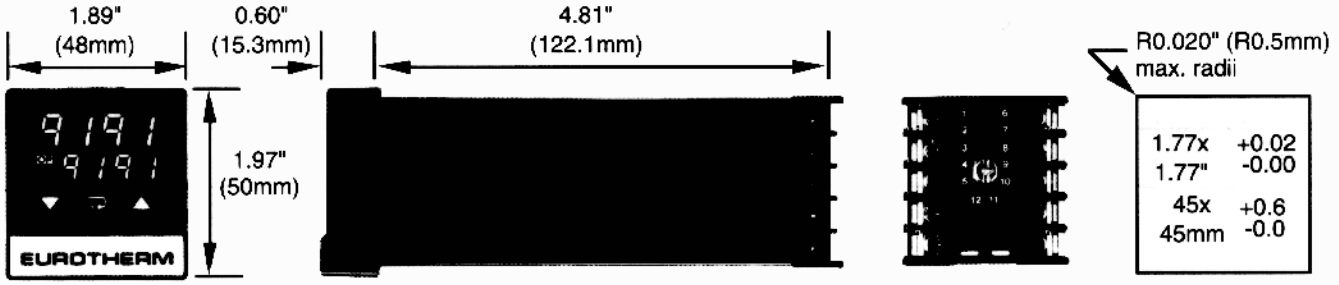
A = ±0.25% of reading ±1.5°C ±0.5 l.s.d.

B = ±0.25% of reading ±2.5°C ±0.5 l.s.d.

C = ±0.25% of reading ±3.5°C ±0.5 l.s.d.

* See Specification §1

Dimensions



Panel depth: with rear terminal cover: 4.96" (126.1mm)
with gasket fitted: less 0.060" (1.5mm)

Panel Cutout
Max. panel thickness:
0.51" (13mm)

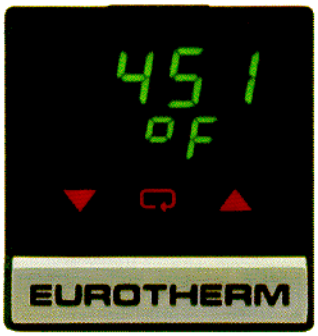
Operation

When the Model **91e** is unattended, the upper display indicates the measured value, and the lower, the setpoint. The icons behind the three pushbuttons are extinguished. When the control output is ON, the "OP" message lights up.

When the measured value alarm is active, the red "AL" light is illuminated. The alarm annunciation goes out when the temperature returns to the "safe" condition.

One touch on any button lights up the three pushbuttons: ▲ (increment), ▼ (decrement), and parameter button (next parameter). With ▲ and ▼, the setpoint can be freely adjusted within the limits imposed by the **SP.Hi** and **SP.Lo** parameters.

Touching the parameter button replaces the setpoint with the units of the measured value, either degrees Fahrenheit (shown) or Centigrade. The setpoint is restored after a few seconds if the parameter button is not touched again to advance to the next parameter.



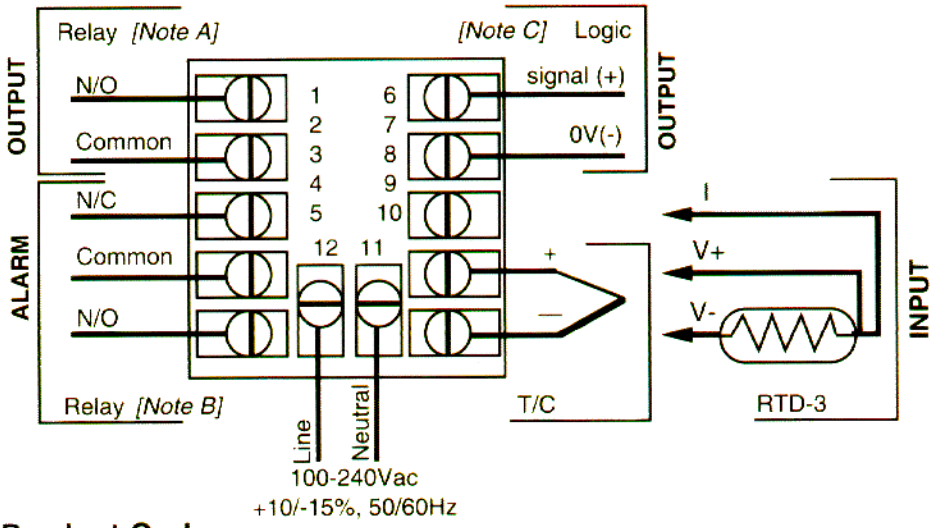
Another touch on the parameter button brings up the **tunE** parameter. Self tuning can be initiated with ▲ or disabled with ▼.

Pushing on the parameter button again reveals the alarm setpoint, **AL.SP**, which can be adjusted with ▲ and ▼. The display returns to the measured value if the operator depresses the parameter button or if left to time out for about 10s.

By touching a fourth unmarked, "secret" button on the front panel, the *protected* list can be accessed. This list is headed by the model identification and then the 4-digit instrument configuration code (for verification purposes only in this list). The next parameter—the proportional band—can be adjusted as all the others with ▲ and ▼.

The other protected list parameters can be accessed in turn with the parameter button and their values viewed and adjusted if desired.
These parameters are:
Int.t—Integral time constant
dEr.t—Derivative time constant
SP.rr—Setpoint ramp rate
SP.Hi—Setpoint high limit
SP.Lo—Setpoint low limit
H.ct—Output cycle time
LP.br—Loop break reaction time
Line—Line frequency.

Rear terminal connections



NOTES:

A. *Relay output operative only when the value of the cycle time parameter (**H.ct**) is greater than or equal to 5s.*
B. *N/C and N/O refer to the condition of the relay contacts when the relay is not energized; i.e. when the relay is in the alarm condition or when power is not applied to the controller.*
C. *Logic output not isolated from input circuit.*

Product Code

HARDWARE CODE [1] CONFIGURATION CODE [1]

Model	*3rd output*	*logo label*	*alarm function*	*sensor type*	*range and proportional band units*	*disp. units, control type & O/P act'n*	*country code*
91e /	**0** /		/(			/	)/

Coding:

HARDWARE CODE: *[1]*

third output

0	None

nameplate

0		Std. Eurotherm Logo
@...		Custom logo *[2]*
B		Blank

CONFIGURATION CODE: *[1]*

alarm function

0		Off (no alarm function)
1		Deviation low alarm
2		Deviation high alarm
3		Deviation band alarm
4		Full scale low alarm
6	*	Full scale high alarm
5		Sensor break alarm
7		Loop break alarm

sensor type

0		RTD (units' precision display)
1		RTD (tenths' precision display)
2	*	J—Fe/SAMA constantan
3		K—Chromel™/Alumel™
4		L—Fe/Konstantan
5		N—NiCroSil/NiSil
6		R—Pt-13%Rh/Pt
7		S—Pt-10%Rh/Pt
8		T—Cu/Adams constantan
9		Platinel II™
A		B—Pt-30%Rh/Pt-6%Rh

range & proportional band units

		upper range limit		prop. band
0		400°C (752°F)	*[3]*	%
1		400°C (752°F)		°C or °F
2		800°C (1472°F)	*[5]*	%
3		800°C (1472°F)		°C or °F
4		Full specified range	*[6]*	%
5	*	Full specified range		°C or °F

disp. units, control type, output action *[7]*

		disp.	control type	action
0		°F	ON/OFF	direct
1		°F	ON/OFF	reverse
2		°F	PID	direct
3	*	°F	PID	reverse
4		°C	ON/OFF	direct
5		°C	ON/OFF	reverse
6		°C	PID	direct
7		°C	PID	reverse

country code

AO	North America, 60Hz

ACCESSORIES:

CZ140398	RC snubber network *[8]*
BO133297	1/16 DIN frnt. pnl. gskt.
BD133125	Rear terminal cover *[9]*
FY133264U001	Rear term. cvr screw *[9]*
SUB90/ACCS-KIT/91E//	Accessory kit *[10]*

NOTES:

1. *The complete Product code consists of both the Hardware and the Configuration Codes. The standard Configuration Code (**6253**) is indicated in the tables by asterisks (*).*
2. *Custom logo nameplates are available. For quantity considerations, consult factory.*
3. *Range selection is for calculation of proportional band in percent and for restricting setpoint limits. Lower range limit is given for each sensor type in the Input sensors table inside this data bulletin.*
4. *Proportional band in % expressed as % of 400°C (or 752°F).*
5. *Proportional band in % expressed as % of 800°C (or 1472°F).*
6. *Proportional band in % expressed as % of full specified range.*
7. *Select "reverse acting" for heating applications, "direct acting" for cooling applications.*
8. *External RC snubber network required across relay contactors when driving AC inductive loads (mechanical contactors and solenoids). DO NOT USE SNUBBERS WHEN DRIVING HIGH IMPEDANCE LOADS!*
9. *Order rear terminal covers and screws in sets. One screw and cover required per unit.*
10. *Includes 2 snubbers and 1 each of the other accessories.*

EUROTHERM CONTROLS

EUROTHERM CONTROLS INC
11485 Sunset Hills Road, Reston, VA 20190-5286
TELEPHONE: 703-471-4870, FAX: 703-787-3437, BBS: 703-787-3444
WWW: http://www.eurotherm.com