Chemische Institute der Universität Bonn
Abteilung Elektronik
2009

Peltier-Element-Kühlung

Bedienungsanleitung

Ausstattungsmerkmale :

- Liquid-to-Air Peltier-Element (ca. 70W)
- PID-Temperaturregler
- Drehzahlregelung der Umwälzpumpe
- Schlauchanschlüsse für $Ø_{innen}$ = 8mm

1 Allgemeine Sicherheitshinweise

Dieses Gerät ist gemäß VDE0411 Teil1, Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel, und Laborgeräte, gebaut. Es entspricht damit auch den Bestimmungen der europäischen Norm EN 61010-1 bzw. der internationalen Norm IEC 61010-1. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender die Hinweise und Warnvermerke, in der Bedienungsanleitung, beachten. Ergänzend zur Betriebsanleitung sind gesetzliche, allgemeingültige und sonstige verbindliche Regelungen der Unfallverhütung und zum Umweltschutz zu beachten.

Das Gerät entspricht den Bestimmungen der Schutzklasse 1.Entsprechend sind alle Gehäuse- und Chassisteile und Einschubmodule (19 Zoll) mit dem Netzschutzleiter verbunden. Das Gerät darf aus Sicherheitsgründen nur an vorschriftsmäßigen Schutzkontaktsteckdosen oder an Schutz-Trenntransformatoren der Schutzklasse 2 betrieben werden. Sind Zweifel an der Funktion oder Sicherheit der Netzsteckdosen aufgetreten, so sind die Steckdosen nach DIN VDE0100, Teil 610, zu prüfen. Das Auftrennen der Schutzkontaktverbindung innerhalb oder außerhalb des Gerätes ist unzulässig!

Das Gerät ist zum Gebrauch in sauberen, trockenen Räumen bestimmt. Es darf nicht bei besonders großem Staub- bzw. Feuchtigkeitsgehalt der Luft, bei Explosionsgefahr, sowie bei aggressiver chemischer Einwirkung betrieben werden.

Das Gerät muss aufrecht stehend betrieben werden, um eine ausreichende Luftzirkulation (Konvektionskühlung) zu gewährleisten. Lüftungslöcher dürfen nicht abgedeckt werden!

Der zulässige Umgebungstemperaturbereich während des Betriebes reicht von 0 °C... +40 °C. Während der Lagerung oder des Transports darf die Temperatur zwischen –20 °C und +70 °C betragen. Hat sich während des Transports oder der Lagerung Kondenswasser gebildet muss das Gerät ca. 2 Stunden akklimatisiert werden, bevor es in Betrieb genommen wird.

Das Öffnen des Gerätes darf nur von einer entsprechend ausgebildeten Fachkraft erfolgen. Vor dem Öffnen muss das Gerät ausgeschaltet und von allen Stromkreisen getrennt werden.

Wenn anzunehmen ist, dass ein gefahrloser Betrieb nicht mehr möglich ist, so ist das Gerät außer Betrieb zu setzen und gegen unabsichtlichen Betrieb zu sichern. Diese Annahme ist berechtigt,

- wenn das Gerät sichtbare Beschädigungen hat,
- wenn die Anschlussleitung beschädigt ist,
- wenn das Gerät lose Teile enthält,
- wenn das Gerät nicht mehr arbeitet,
- nach längerer Lagerung unter ungünstigen Verhältnissen (z.b. im Freien oder in feuchten Räumen),
- nach schweren Transportbeanspruchungen (z.b. mit einer Verpackung, die nicht den Mindestbedingungen von Post, Bahn oder Spedition entsprach.

Es ist sicher zu stellen, dass nur Sicherungen vom angegebenen Typ und der angegebenen Nennstromstärke als Ersatz verwendet werden. Die Verwendung geflickter Sicherungen oder Überbrücken des Sicherungshalters ist unzulässig. Zum Wechseln der Sicherungen trennen Sie das Netzgerät unbedingt vom Netz. Nach erfolgter Netztrennung öffnen Sie mit einem geeigneten Schraubendreher vorsichtig die Sicherungskappe mit der defekten Sicherung heraus, entnehmen die defekte Sicherung und ersetzen sie durch eine neue gleichen Typs. Nehmen Sie das Gerät erst dann wieder in Betrieb, wenn der Sicherungshalter sicher befestigt ist.

2 Einleitung

Die Kühlung ist dazu ausgelegt, die Kühlflüssigkeit in der Apparatur auf konstant niedrige Temperatur zu halten. Verwendet wird ein so genanntes Liquid-to-Air Peltier-Element mit ca. 70W. Die gewünschte Temperatur kann in Zehntel-Grad Schritten eingestellt werden, wobei stets nur eine Kühlung und keine Erwärmung stattfinden kann. Per Drehpotentiometer kann die Durchflussgeschwindigkeit eingestellt werden. Die Schlauchanschlüsse sind für Silikonschläuche mit 8mm Innendurchmesser dimensioniert.

3 Anschluss

Auf der Vorderseite des Gerätes befinden sich die Schlauchanschlüsse für die ab- und zulaufenden Schläuche. Zu verwenden sind optimalerweise Schläuche mit einem Innendurchmesser von 8mm. Zusätzlich sollten die Schläuche mit Schellen fixiert werden, um ein Austreten der Kühlflüssigkeit zu verhindern.

Abb. 1: Schlauchanschluss „ZUFLUSS“

Abb. 2: Schlauchanschluss „ABFLUSS“

Die Anordnung der Schläuche ist in den Abbildungen 1 und 2 zu ersehen.

Der Ausgleichsbehälter sollte nach Möglichkeit zwischen den Anschluss „ZUFLUSS“ und die weitere Apparatur eingebracht werden. Er dient zum einen dazu, die Inbetriebnahme der Anlage und das Einbringen der Kühlflüssigkeit zu vereinfachen und gleicht im Betrieb Volumen- und Druckunterschiede aus. Auch die Anschlüsse am Ausgleichsbehälter sind im Idealfall durch Schlauchschellen abzusichern.

Auf der Rückseite des Gerätes befindet sich der Netzanschluss, der mit Hilfe eines Kaltgerätekabels mit einer Schutzkontaktsteckdose verbunden wird.
Ist diese Verbindung hergestellt leuchtet die Glimmlampe des „Power“-Schalters.

4 Bedienung

Vor der Inbetriebnahme muss darauf geachtet werden, dass sämtliche Schlauchverbindungen gut gesichert sind und nach dem Einfüllen der Kühlflüssigkeit keine Undichtigkeiten auftreten.

4.1 Einschalten

Zum Einschalten des Gerätes wird der „Power“-Schalter betätigt und auf „Ein“ gestellt. Sofort setzt sich der oben befindliche Lüfter in Bewegung. Er lässt die Umgebungsluft nach unten durch die Kühlrippen des Peltier-Elementes strömen, die dann an den Seiten wieder austritt.

Der Temperaturregler beginnt nach dem Einschalter eine Startprozedur, bei der der Initialisierungscode angezeigt wird. Nach Abschluss dieser Prozedur werden die Ist- und die Soll-Temperatur der Kühlflüssigkeit angezeigt. Im Gerät befindet sich kurz vor dem Anschluss „ABFLUSS“ ein Temperatursensor, der dem Temperaturregler stets die tatsächliche Kühlflüssigkeitstemperatur mitteilt.

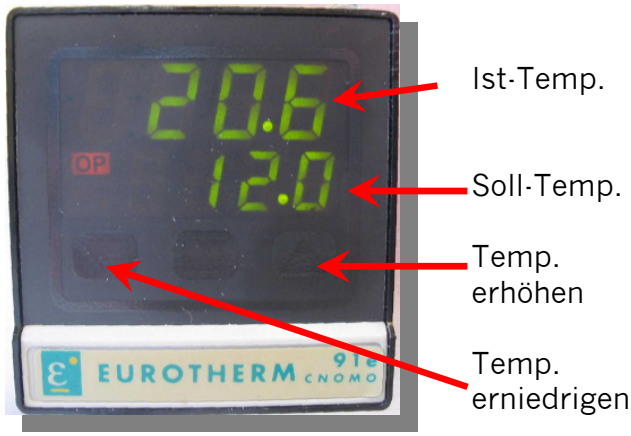


Abb. 3: Temperaturregler

Nach einer kurzen Verzögerung startet die Pumpe. Um einen sicheren Start der Pumpe zu gewährleisten, sollte der Drehzahlregler der Pumpe auf „MAX“ gestellt werden.

4.2 Temperaturregler

Die Haupteinstellung des Temperaturreglers, die Soll-Temperatur, wird über zwei Taster durchgeführt, die zunächst nach dem Gerätestart nicht unbedingt als solche erkannt werden. In der Anzeige- und Bedienoberfläche des Reglers sind vier Taster angebracht. Abbildung 3 zeigt, wo sich die Taster für die Solltemperaturerhöhung bzw. –Erniedrigung befinden.

Sobald eine Taste betätigt wird, werden die Tasten beleuchtet und sind gut sichtbar.

Abb. 4: Temperaturregler Tasten aktiviert

 Solltemperatur erniedrigen

 Setup-Menü

 Solltemperatur erhöhen

Die einmalige Betätigung einer Pfeiltaste erhöht oder erniedrigt die Solltemperatur um 0,1°C. Wird die Taste länger gedrückt gehalten, so wird die Änderung in $^{1}/_{10}$°C-Schritten über die nächsten ca. 2°C fortgesetzt. Anschließend wird die Temperatur bis zum nächsten Vielfachen von 10°C in 1°C-Schritten verändert. Ab diesem Punkt werden 10°C-Schritte durchgeführt. Sobald die

Tastenbetätigung beendet wird, wird direkt die eingestellte Temperatur vom Regler angefahren. Während der Regelung wird mit 

angezeigt, dass das Peltier-Element arbeitet.

Sollten weitere Einstellungen notwendig sein, so ist die Setup-Menü Taste zu betätigen. Weitere Informationen über die möglichen Einstellungen sind dem Datenblatt des Reglers im Anhang zu entnehmen.

4.3 Pumpe

Die Drehzahl der Umwälzpumpe kann stufenlos eingestellt werden. Dazu befindet sich auf der Gehäusefront ein Drehpotentiometer, dass zwischen den Werten „MIN“ und „MAX“ beweget werden kann.
Für einen optimalen Start der Kühlung sollte die Pumpe auf die maximale Drehzahl („MAX“) eingestellt werden. Nach dem Start kann dann auf die gewünschte oder notwendige Durchflussgeschwindigkeit herunter geregelt werden.

Abb. 5: Pumpendrehzahlregler

4.4 Ausschalten

Das Ausschalten des Gerätes kann jederzeit erfolgen und bedarf keiner bestimmten Ausschaltroutine. Zum Beenden der Kühl- und Pumpfunktion wird der „Power“-Schalter auf die Position „Aus“ gestellt. In diesem Fall stellen alle Teile des Gerätes (Temperaturregler, Pumpe und Peltier-Element mit Lüfter) sofort ihre Arbeit ein.

5 Technische Daten

Betriebsspannung	230 VAC +-10% / 50Hz
Leistungsaufnahme	max. ca. 190VA
Netzsicherung	Träge 1,25A / 250V
Temperaturcontroller	EUROTHERM 91e
Abmessungen (B x H x T)	250 x 150 x 200 mm
Max. Fördermenge der Pumpe	450 l/h
Kühlleistung des Peltier-Elementes	ca. 70W
Ausgänge	2 Schlauchanschlüsse (ZUFLUSS / ABFLUSS) für Silikon-Schlauch $Ø_{innen}$ = 8mm
Zubehör	Ausgleichsbehälter 300ml

6. Anhang

6.1 Datenblatt des Temperaturreglers

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

Seite 1 von 6

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 + (α_{25} + 12)/α_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	264$V_{ac\ rms}$
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

Seite 3 von 6

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 °C Min.	Display range °C Max.	Display range °F Min.	Display range °F Max.	Calibration accuracy specification Range °C Min.	Range °C Max.	Range °F Min.	Range °F Max.	Accuracy (see key at right)
Thermocouples									
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

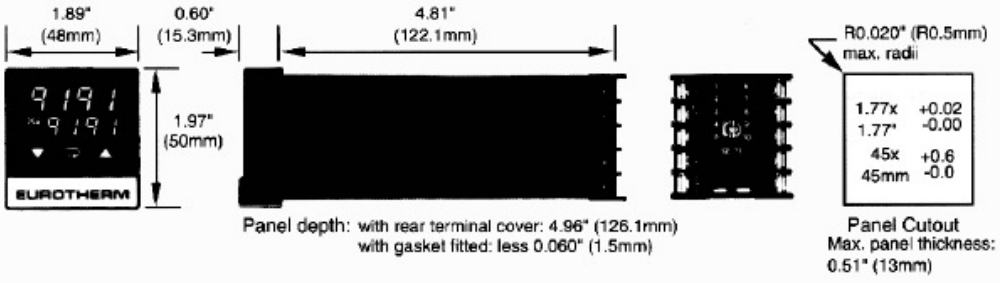
A = ±0.25% of reading ±1.5°C ±0.5 l.s.d.

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



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 ▼.

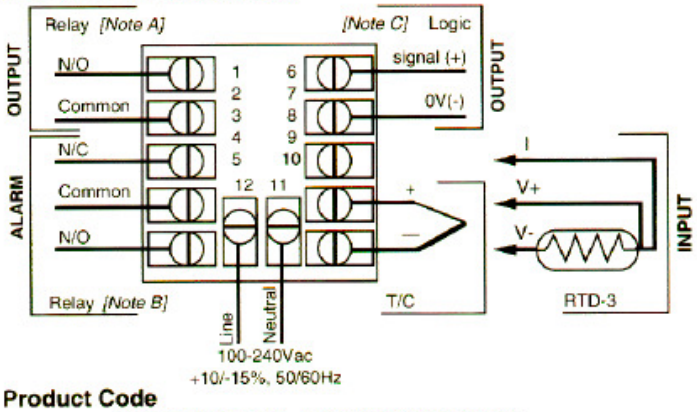
Pushing on the parameter button again reveals the alarm setpoint, **AL.SP**, which can be adjusted with ▲ and ▼. The display returns to the measured value if the operator depresses the parameter button or if left to time out for about 10s.

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.

Miniature PID - ON/OFF temperature controller — Model 91e

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] [4]	%
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
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6.2 Installations- und Bedienungsmanual des Temperaturreglers

EUROTHERM CONTROLS

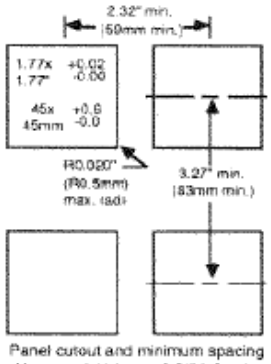
Installation and Operation Manual

Models 91 and 91e PID - ON/OFF temperature controllers

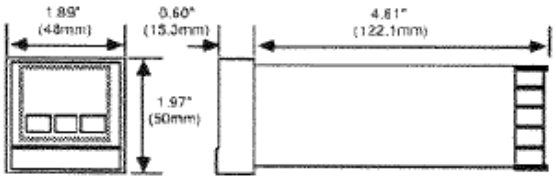
Features marked with an asterisk (*) are available only on units manufactured after January 1998 (Version 9.1).
Features marked with a double dagger (‡) are available only on units manufactured after May 1995 (Version 4.3).

1. Mechanical installation

- Prepare panel cutout
- Install the optional front panel gasket (part no. SO133297) if required. Remove the backing from the gasket and apply it around the panel cutout on the *outside of the panel*.
- Slide instrument sleeve into the cutout from the front of the panel.
- Position the mounting bracket on the rear of the instrument sleeve with the 2 clips facing the rear and positioned on the top and bottom of the sleeve.
- While holding the sleeve, slide the mounting bracket towards the panel until the clips engage on the ratchets. While still pulling back on the sleeve, press on the upper left and lower right hand corners of the bracket to seat the mounting bracket. Another push on the clips with a screwdriver might be necessary to secure the installation.



Panel cutout and minimum spacing
Max. panel thickness: 0.51" (13mm)



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

2. Electrical connections

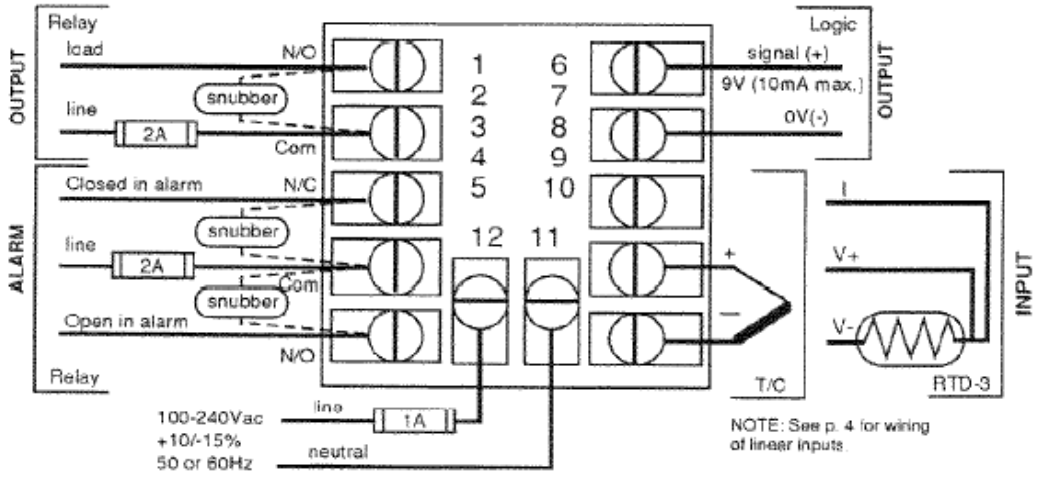
ELECTRICAL CONNECTIONS
WARNING! Ensure that the maximum voltage which is applied to the unit power supply, between any two isolated circuits, or between any isolated circuit and ground does not exceed 264Vac.

Power
Respect the polarity of the AC power supply: line wire must be connected to terminal 12, and the neutral must be connected to terminal 11.

Output
- Relay (terminals 1 and 2): Contact is closed during ON phase of output cycle (yellow "OP" lamp ON). Relay channel operative only when H.ct parameter (heat cycle time) is 5s or greater. A snubber may be required; see below.
- Logic (terminals 6 and 7): Signal goes high (current flows) during ON phase of output cycle (yellow "OP" lamp ON). Connect only to opto-isolated device loads, never connect to any grounded circuit. Keep wiring run shorter than 3' (1m) and well away from noise generating circuits.

Alarm relay (terminals 3, 4, and 5)
The alarm output is failsafe: the relay is de-energized during the alarm condition or power down. The attached alarm circuit should be designed for failsafe operation and fused appropriately. A snubber may be required; see below.

Snubbers
Connect snubbers CZ140398 (22nf + 100Ω) across the appropriate output or alarm relay contacts when driving AC inductive loads (mechanical contactors and solenoids). *Do not use snubbers when driving high impedance loads.* The snubber passes 1mA in 120Vac circuits, and 2mA in 240Vac circuits; this is sufficient to hold in certain relays with high impedance coils *and should not be used in such installations.*
WARNING! When an alarm contact is to be implemented as part of a systemwide failsafe alarm scheme, it is the user's responsibility to verify that the effect of the snubber does not interfere with the operation of the circuit. Certain high impedance circuits are not able to detect a contact opening when the snubber is placed across the contact. In these cases the snubber should not be installed across the relay contact.



NOTE: See p. 4 for wiring of linear inputs

Seite 1 von 5

Input

WARNING! The input sensor intended for use with this instrument is to be connected uniquely to the input terminals 9 and 10 and never looped to inputs of other instruments. The paralleled inputs of other instruments interfere with proper operation of the sensor break detection circuitry.

NOTE. The input circuit and the logic output are NOT isolated from one another.

Use of shielded, twisted pair is recommended. The shield must be connected to terminal 10 even when grounded elsewhere.

- Thermocouple: Use appropriate compensation cable. Keep loop resistance as low as possible (1kΩ maximum).
- RTD: Use 3 copper wires of same length and diameter. (20Ω/lead maximum resistance.)

Rear terminal cover

After wiring, attach rear terminal cover BD133125 with screw FY133264U001.

3. Configuration

CONFIGURATION PROCEDURE

1. Cycle power OFF and ON. Self test follows: **tESt** appears followed by **1111**, **8888**, then the 4-digit configuration code. Touch and hold secret key *only* after 4-digit configuration code appears to enter configuration mode.
2. See configuration code with left digit blinking.
3. Enter new code (refer to *Configuration code* table):
   ▼ = select digit position (1 through 4)
   ▲ = modify digit value.
4. To exit configuration mode do one of these:
   Secret key = accept new configuration; parameter value check follows.
   — = abort; return to previous configuration.

Configuration code

1st (left) digit
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

"Alarm function" assigns alarm type to alarm relay output. Sensor break and loop break alarms are always displayed even if not assigned to alarm relay.

2nd digit: Model 91 only

sensor type		*full specified range: Model 91* °F min	°F max	°C min	°C max
0	RTD (units' precision display)	-148	752	-100	400
1	RTD (tenths' precision display)	-99.9	752.0	-99.9	400.0
2	J—Fe/SAMA constantan	32	1472	0	800
3	K—Chromel™/Alumel™	32	2372	0	1300
4	L—Fe/Konstantan	32	1472	0	800
5	N—NiCroSil/NiSil	32	2372	0	1300
6	R—Pt-13%Rh/Pt	32	2912	0	1600
7	S—Pt-10%Rh/Pt	32	2912	0	1600

2nd digit: Model 91e only

sensor type		*full specified range: Model 91e* °F min	°F max	°C min	°C max
0	RTD (units' precision display)	-148	1112	-100	600
1	RTD (tenths' precision display)	-99.9	999.9	-99.9	600.0
2	J—Fe/SAMA constantan	-328	2192	-200	1200
3	K—Chromel™/Alumel™	-418	2502	-250	1372
4	L—Fe/Konstantan	-148	1652	-100	900
5	N—NiCroSil/NiSil	32	2372	0	1300
6	R—Pt-13%Rh/Pt	32	3213	0	1767
7	S—Pt-10%Rh/Pt	32	3213	0	1767
8	T—Cu/Adams constantan	-427	752	-255	400
9	Platinel II™	-418	2543	-250	1395
A	B—Pt-30%Rh/Pt-6%Rh *	1112	3308	600	1820
B	Linear a—2-point entry scaling ‡				
C	Linear b—point-and-span entry scaling ‡				

3rd digit

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

Lower range limit from tables, above

- *Prop band in % expressed as % of 400°C (or 752°F)*
- *Prop band in % expressed as % of 800°C (or 1472°F)*
- *Prop band in % expressed as % of full specified range*

4th (right) digit

	display	control type	output 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

Select "reverse" for heating applications and "direct" for cooling applications.

CONFIGURATION EXAMPLE

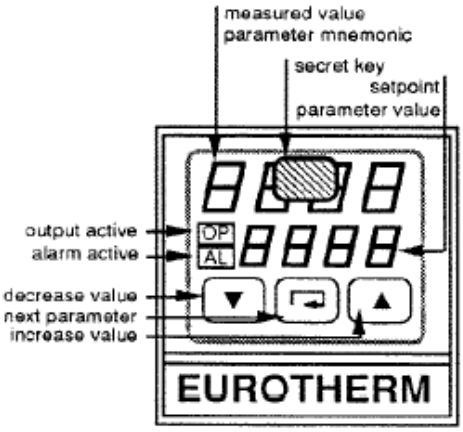
6253:

1st digit (**6**): full scale (absolute) alarm.
2nd digit (**2**): type J thermocouple input.
3rd digit (**5**): full specified range for input and proportional band display in degrees.
4th digit (**3**): display units in °F, reverse-acting PID control.

4. Operation

BASIC OPERATION

- To light up buttons: touch any button on front panel.
- To modify setpoint: ▲ and ▼.
- To enter protected list: use — until **AL.SP**, then "secret key". Continue with — to view parameters. [Model 91e only: It is possible to enter the protected list from the °C or °F display with the "secret key".]
- To modify a parameter value: with the parameter mnemonic in upper display, use ▲ and ▼.
- To return to measured value display when in protected list: "secret key".



ALARMS

Temperature alarms (configuration codes "1" through "4" and "6" for operation)
If the measured value enters the alarm condition as defined by the configuration code, the red "AL" lamp lights up and the alarm relay is de energized (failsafe operation). The alarm is non latching; the lamp goes out and the alarm relay is re-energized as soon as the measured value enters the "safe" condition.

Sensor break alarm (configuration code "5" for alarm relay output). If the controller has detected that the sensor circuit has failed, then the output power level is forced to 0% and **SnSr FAIL** is displayed.
A failed sensor is detected:

- if the input signal is out of the selected sensor's range,
- if the input is open circuit, or
- if the controller's operating temperature is outside of the 0-55°C operating range (thermocouple inputs only).

Upon reinstatement of the input sensor, the controller resumes controlling with the same output power level used at the moment of the break.

Loop break alarm (configuration code "7" for alarm relay output)
If the unit detects a break in the control loop, then **LP.Br** is displayed. The display (and optional relay operation) is latching. To reset, touch any key. The output level is determined by the control algorithm during the alarm condition.
To determine starting values for the **LP.br** parameter:
PID control: Set **LP.Br** equal to or slightly longer than **Int.t**.
ON/OFF control: Set **LP.Br** equal to one period of oscillation around setpoint (ON + OFF times).
For both types of control: increase **LP.Br** if spurious alarms occur; decrease for greater sensitivity.
NOTE: The above described operation of sensor break and loop break alarms always occurs irrespective of the configuration of the alarm relay.

Adjustable parameters

Mnemonic	Parameter	Adjustable range	Comments
OPEN LIST			
none	Setpoint	Upper limit: "SP.Hi" Lower limit: "SP.Lo"	Not adjustable during self tuning.
°C or °F	Display units	View only.	Display units selected in configuration.
tunE	Self tune on demand	Disable self tune: "OFF" Initiate self tune: "on"	Not displayed for ON/OFF control or if "SP.rr" enabled.
AL.SP	Alarm setpoint	Configured input sensor range for full scale (absolute temperature alarms 0 to upper range limit for deviation alarms	Alarm function selected in configuration. "AL.SP" operative only for temperature alarms; configuration codes "1" through "4" and "6". Due to hysteresis, deviation band alarm setting must be at least 2°C (or 4°F).
PROTECTED LIST			*Not accessible if self tuning in progress.*
ConF	Configuration code	View only in this list	Can be changed upon power up only.
Id	Instrument model ident.	View only: "91E"	Not included in Model 91 parameter list.
ProP	Proportional band	°C—2 to 400°C (°1 to 400°C) °F—4 to 720°F (°2 to 720°F) ‡ lin a— 1, 0.1, or 0.01 to "dSHI" - "dSLo" ‡ lin b— 1, 0.1, or 0.01 to "dSSn" or equivalent in percent.	Becomes hysteresis for ON/OFF control. Units (°C, °F or %) selected in configuration.
Int.t	Integral time constant	OFF plus 10 to 2000s	Valid for PID control only
dEr.t	Derivative time constant	OFF plus 1 to 200s	Valid for PID control only
OFSt	Calibration offset	-50.0 to 50.0°C (-90.0 to 90.0°F)	Display value = measured value + offset Appears for temperature inputs only.
SP.Hi	Setpoint high limit	Configured input sensor range	Must be greater than "SP.Lo"
SP.Lo	Setpoint low limit	Configured input sensor range	Must be less than "SP.Hi"
H PL ‡	Maximum power limit	0.0 to 100.0%	
H.et	Heat cycle time	Model 91: 1 to 20s Model 91e: 0.2 to 60.0s (5s or more for relay output)	Valid for PID control only, but for ON/OFF control disables relay output if set to 4s or less.
SP.rr	Setpoint ramp rate	OFF plus 0.1 to 50.0°C/min (0.2 to 90.0°F/min.)	Model 91e only. Self-tuning inhibited if ramping enabled.
LP.br	Loop break time constant	OFF plus 10 to 4000s	
LinE	Line frequency	50 Hertz: "50" 60 Hertz: "60"	Set to line frequency upon installation.

Display Messages

Message	Display condition	User action/comments
LOOP STATUS MESSAGES		
SnSr FAIL	Sensor fail. Input open or reversed; measured value outside of configured range.	Verify input sensor and connections. Message disappears when input signal is reinstated.
measured value LP.br	Loop break. Output at 0 or 100% and measured value moves less than 1/2 of "ProP" setting toward setpoint within time setting of "LP.br".	Verify output device, fuses, wiring and heater. Acknowledge by touching any key.
measured value SP.rr	Setpoint ramping in progress.	Model 91e only. Setpoint and "SP.rr" parameter still user-adjustable during ramping.
flashing value	Display overrange or out of specified accuracy range	Unit should not be used in this range.
SELF TUNE MESSAGES		
measured value tunE	Self tuning in progress. Message alternates with setpoint.	Annunciation only. Adjustment of setpoint and PID values inhibited during self tuning.
tunE FAIL	Self tuning operation has failed because controller cannot maintain setpoint.	Acknowledge by touching any key. Remove cause of failure: e.g. heater fuse blown, etc.
LinE FAIL	Loss of controller power during self-tuning operation renders sampled data questionable.	Acknowledge by touching any key. Verify power supply. Reinitiate self tuning procedure.

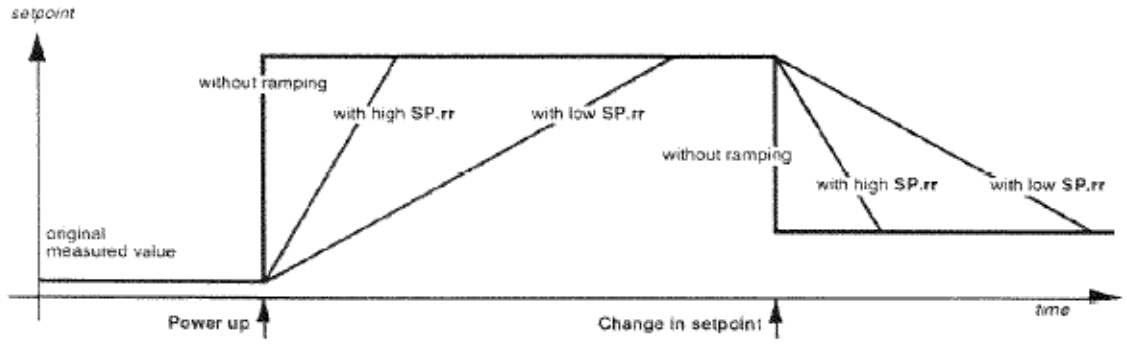
RAMP TO SETPOINT OPERATION (Model 91e only)
The setpoint ramping feature is enabled by setting **SP.rr** to any value except **OFF**. Ramping is initiated only by one of two conditions:

- power-up
- change in setpoint.

Upon power up, ramping always starts from the current measured value. The instantaneous setpoint follows a straight line to the target setpoint (the setpoint normally displayed along with the measured value). The speed at which the ramping progresses is selectable by **SP.rr** and remains constant for all ramps until **SP.rr** is changed. When the measured value follows a ramping setpoint through an alarm region, the alarm is detected, annunciated and output as follows:

- Full scale high and low alarms (configurations "4" and "6"). The alarm is non latching; crossing the alarm setpoint into the "safe" region ends the alarm condition.
- Deviation alarms (configurations "1", "2" and "3"). The deviation alarm follows the ramping setpoint. If the measured value cannot track the setpoint within the bounds of the deviation alarm, an alarm condition is generated.

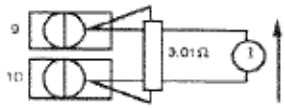
NOTE: Any value for **SP.rr** except **oFF** inhibits self tuning operation.

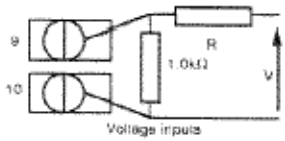


LINEAR INPUT SETUP
Electrical connections
For all inputs use a shielded twisted pair.

- Millivolt inputs (-10 to 70mV). Connect signal leads directly to input terminals 9 (+) and 10 (-).
- 0-20mA and 4-20mA inputs. Connect 3.01Ω shunt (part no. CA 9G3 R01) across input terminals 9 (+) and 10 (-).
- Higher voltage inputs. Voltage divider network is required (resistors supplied by user). Refer to table for suggested values. Resistor specifications: 1%, 0.125W minimum, ±100ppm metal or metal oxide film.

CAUTION: Use of the shunt or voltage divider inhibits operation of the sensor break detection feature.





Nominal range	R
-20 to 200mV	2.2kΩ
-0.1 to 1 V	15.0kΩ
-0.5 to 5V	75.0kΩ
-1 to 10V	150kΩ
-2.5 to 25V	392kΩ

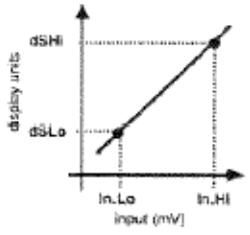
Scaling procedure
There are 2 methods for entering and scaling linear inputs:

- Linear a: 2-point scaling (configuration code "C").
- Linear b: point and span scaling (configuration code "D").

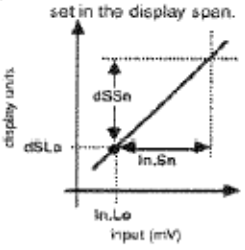
Linear a and Linear b
1. Set display decimal point position parameter, **dP**, to desired value.
2. If reading the input signal directly from the source, connect source (from signal generator or sensor) to input terminals. Apply a signal equal to a known low value for the first setup point.
3. Scroll through the protected list until **In.Lo**. Press and hold on ▲ or ▼ until **rEAd** appears, release, then push the button again. [Alternatively, if no input signal is required or the exact value is known, the input value in millivolts can be set in with ▲ or ▼.]
4. Scroll to **dSLo**. Then set in the corresponding display value with ▲ or ▼.

Linear a only
5. Again, if reading the input signal directly from the source, apply a signal equal to a known high value for the second setup point.
6. Scroll through the protects list until **In.Hi**. Press on ▲ or ▼ until **rEAd** appears, release, then push the button again. [Alternatively, if no input signal is required or the exact value is known, the input value in millivolts can be set in with ▲ or ▼.]
7. Access **dSHi**. Then set in the corresponding display value with ▲ or ▼.

Linear b only
8. Access **In.Sn**. With ▲ or ▼ set in the input signal span in millivolts.
9. Access **dSSn**. With ▲ or ▼ set in the display span.



Linear a: 2-point scaling



Linear b: point & span scaling

LINEAR INPUT SCALING (Replaces "OFSt" parameter in protected list)

In.Lo	input for low setup point	-9.99 to 70.00mV input signal range	Both linear a and b inputs. To read input signal value from rear terminals: Hold UP or DOWN until "rEAd" appears, release, then press the button again.
dSLo	Display value for low setup point	-999 to 9999, -99.9 to 999.9, or -9.99 to 99.99 process units	Both linear a and b inputs.
In.Hi	input for high setup point	-9.99 to 70.00mV input signal range	Linear a inputs only. To read input signal value from rear terminals: See procedure for "In.Lo", above.
dSHi	Display value for high setup point	-999 to 9999, -99.9 to 999.9, or -9.99 to 99.99 process units	Linear a inputs only.
In.Sn	input signal span	0.00 to 70.00mv	Linear b inputs only.
dSSn	Display span	-999 to 9999, -99.9 to 999.9, or -9.99 to 99.99 process units	Linear b inputs only.

TUNING AND ADJUSTMENTS

WARNING: The two PID tuning procedures presented here are based on perturbation response; the step changes involved may be detrimental to sensitive systems.

NOTE: Model 91e only: Set **SP.rr** to **oFF** before performing either of these tuning procedures.

PID self tuning procedure

1. Set appropriate values for all parameters except **ProP**, **Int.t**, and **dEr.t**.

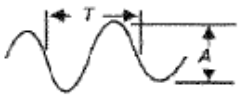
For PI control set **dEr.t = oFF**.
For PD control set **Int.t = oFF**.
For proportional only control set **Int.t = dEr.t = oFF**.
Model 91e only: The value for **LP.br** is also determined if the starting value is not set to **oFF**.

2. Initiate self tuning by setting **tunE** to **on**. The **tunE** message will flash in the lower display.
3. Wait for the tuning operation to finish: **tunE** will no longer be displayed.
4. The values for **ProP**, **Int.t**, and **dEr.t** can be viewed in the protected list (as well as **LP.br** for the Model 91e).
5. See the *Display messages* table for tuning messages.

PID manual tuning procedure

NOTE: Wait a sufficient period of time after each adjustment to see if the system will stabilize.

1. Set the setpoint to the normal operating temperature. **ProP** = minimum, **Int.t** = **oFF**, and **dEr.t** = **oFF**. Observe the peak-to-peak amplitude (*A*) and



period (*T*) of the oscillation of the measured value. This oscillation may not necessarily be centered about the setpoint.

2. Set **ProP** = 1.1 x *A*. If stable (probably not at setpoint) go to 3. If not, increase **ProP** until the temperature is stable.
3. Set **Int.t** = *T*. Wait at least 2 x *T*. If system becomes stable at setpoint, go to 4. If not, increase **Int.t** in small (<30%) steps until the temperature is stable at setpoint.
4. Set **dEr.t** = **Int.t**/6. If stable, go to 5. If not decrease **dEr.t** in small steps until temperature is stable. (**dEr.t** might have to be turned **oFF**.)
5. The loop should now be stable at setpoint. If not, try the following:
   - If **Int.t** is shorter than the period of oscillation, increase **Int.t** to be slightly longer than the period. If stability is not achieved after several small increases, then try:
   - Increase **ProP** in several small (<30%) steps. If oscillations continue, try:
   - Set **dEr.t** = **oFF**. If the temperature is still unstable, try:
   - Set **Int.t** = **oFF**. If stable, go to step 3 above and repeat. If not, increase **ProP** until temperature is stable, then go to step 3.

ON/OFF control adjustment

The hysteresis band (represented by **ProP**) should be set as small as possible to minimize ripple of the measured value, but large enough to reduce wear on devices such as mechanical contactors.

CAUTION!

Before installing, operating or servicing this unit supplied by Eurotherm, please read the following:

INSTRUCTIONS FOR SAFE USE OF EUROTHERM EQUIPMENT

(Note: These instructions represent good engineering principles and are applicable to all control equipment of the same type, whether from Eurotherm or any other supplier.)

ENCLOSURE OF LIVE PARTS

This unit should be installed inside a suitable grounded metal enclosure to prevent live parts being accessible to human hands and metal tools. It is recommended that rear terminal covers (available as an option) be fitted.

WIRING

It is important to connect the unit correctly in accordance with the installation data on this sheet. Wiring should conform to appropriate standards of good practice and local codes and regulations. Conductors should be commensurate with voltage and current ratings of the units.

OUT-OF-LIMITS ALARMS

In applications where excessive deviation of a controlled parameter due to equipment failure could cause damage to machinery or materials, or injury to personnel, it is strongly recommended that an additional separate unit with its own input sensor be used to give alarm indication or to shut down the process or both, as may be appropriate. (Note: The alarm function built into controllers may not give sufficient protection in these circumstances). When the controller alarm function or separate alarm units are used they should be checked for correct operation at regular intervals.

CONFIGURATION

Many instrument functions are user selectable from the front panel. It is the user's responsibility to verify that the instrument configuration is correct. Personal injury, property loss and equipment damage could result from an improperly configured instrument.

GROUNDING

This instrument has internal circuits which are isolated or "floating." This is necessary to prevent the occurrence of a "ground loop" in signal circuits. To avoid possible shock hazards in the event of an internal fault causing breakdown of insulation, it is recommended that all equipment connected to this unit be enclosed in a grounded metal enclosure. Sheaths of thermocouples (or other sensors) should be properly grounded by a separate conductor (instead of being dependent on grounding via the machine framework).

ESD PRECAUTIONS

This instrument contains static sensitive components. Care should be taken to avoid electrostatic discharge (ESD) and thus reduce incidents of damage to the instrument when removed from its sleeve. Any manipulation of the instrument printed circuit boards should be performed on a conductive surface with the personnel in contact with the surface by means of a grounded, metal or conductive plastic wrist strap with a 1MΩ series resistor.

SUPPLY ISOLATORS

Every electrical system should be provided with means for isolating the system from the AC supply to allow safe working during repair and maintenance. SCRs and triacs are not adequate means of isolating the supply, and should always be backed by a suitable mechanical disconnect switch.

HAZARDOUS ATMOSPHERES

This unit is not suitable for use in areas subject to hazardous atmospheres. No Eurotherm product should be connected to a circuit which passes into or through a hazardous area unless appropriate precautions are taken (even though the instrument itself may be located in a safe area). Such an installation should conform to the requirements of the relevant Authority. (In the USA: Factory Mutual Research Corporation and Underwriters' Laboratories, Inc.).

PROCEDURE IN THE EVENT OF TROUBLE

Before beginning any investigation of a fault, the electrical supplies to all equipment concerned should be switched off and isolated. Units suspected of being faulty should be disconnected and removed to a properly equipped workshop for testing. There are no user-serviceable parts inside this unit.

Doc. HA133329 Issue 5 9503