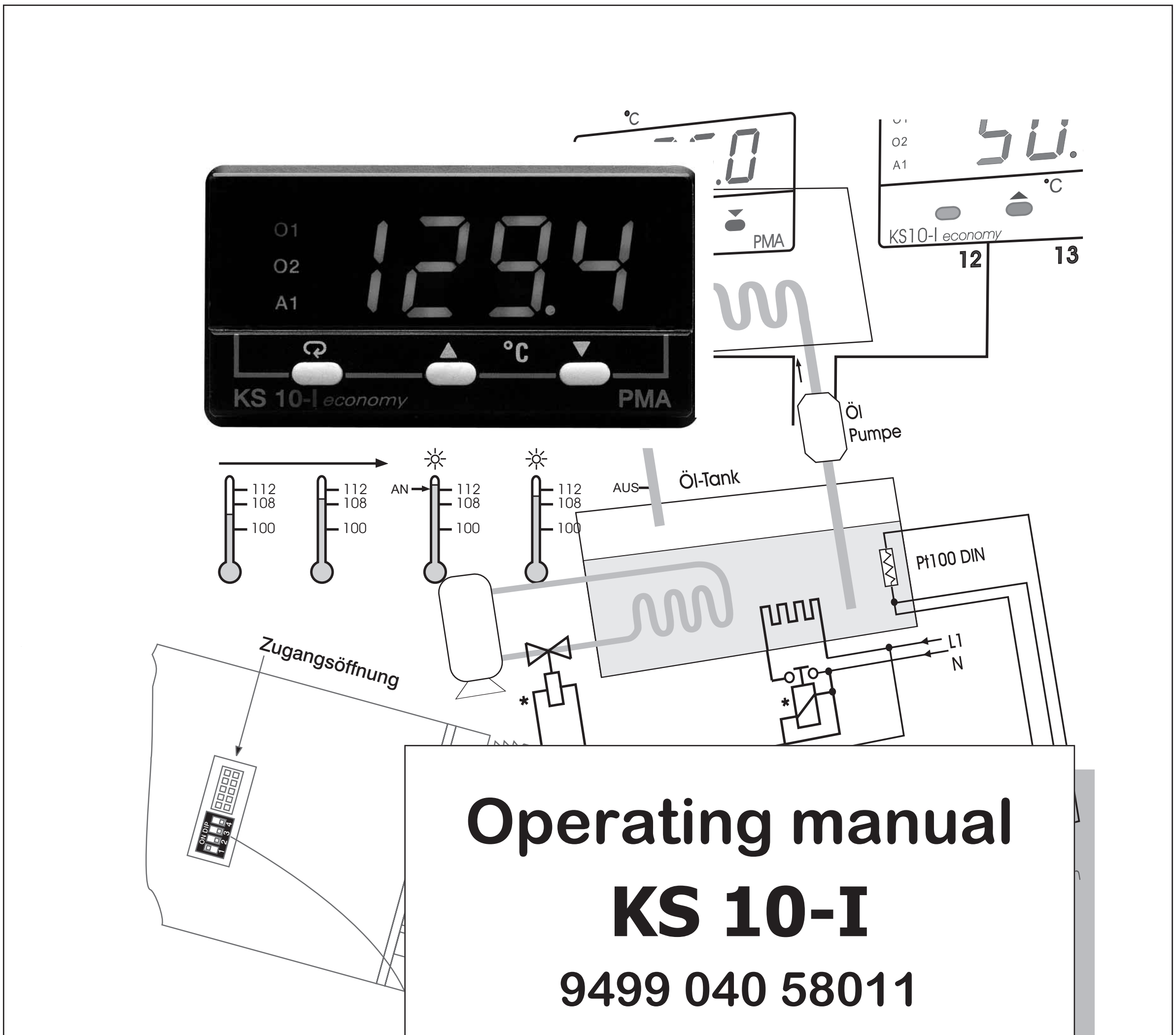
PMA Prozeß- und Maschinen-Automation GmbH

KS10-I



Operating manual

KS 10-I

9499 040 58011

Gültig ab: 8378

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1. Survey
1.1 Features

High accuracy 17-bit input AD
High accuracy 15-bit output DA
Fast input sample rate (10 times / second)
User menu configurable
Fuzzy + PID microprocessor control
Differential control
Auto-tune function
Self-tune function
Sleep mode function
" Soft-start " ramp and dwell timer
Programmable inputs (Thermocouple, RTD, mA, VDC)
Analog input for remote set point and CT
Event input for changing function & set point
Programmable digital filter
Hardware lockout protection
Loop break alarm
Heater break alarm
Sensor break alarm + Bumpless transfer
RS-485, communication
Front panel sealed to NEMA 4X & IP65

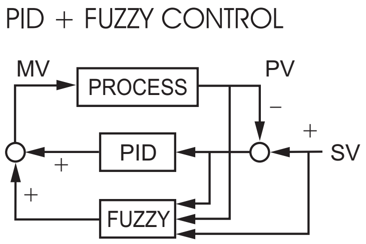
The KS10-I Fuzzy Logic plus PID microprocessor controller, incorporates a bright, easy to read 4-digit LED display, indicating process value. The Fuzzy Logic technology enables a process to reach a predetermined set point in the shortest time, with the minimum of overshoot during power-up or external load disturbance. The units are housed in a 1/16 DIN case, measuring 48 mm x 48 mm with 75 mm behind panel depth. The units features three touch keys to select the various control and input parameters. Using a unique function, you can put at most 5 parameters in front of user menu by using SEL1 to SEL5 contained in the setup menu. This is particularly useful to OEM's as it is easy to configure menu to suit the specific application.

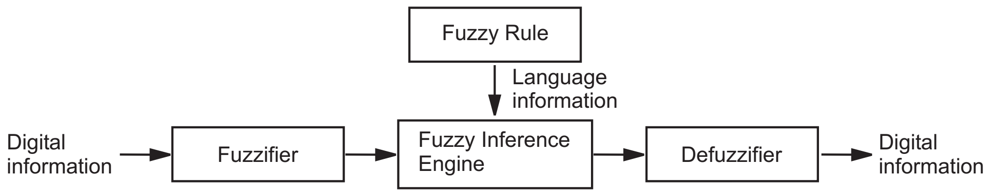
The KS10-I is powered by 11-26 or 90 - 264 VDC / AC supply, incorporating a 2 amp. control relay output and dual 2 amp. alarm relays output as standard which second alarm can be exceptionally configured into second output for cooling purpose or dwell timer. Alternative output options include SSR drive, 0/4...20 mA and 0 - 10 volts. The KS10-I is fully programmable for PT100, the thermocouple types J, K, T, E, B, R, S, N, L, 0 - 20mA, 4 -20mA and voltage signal input, with no need to modify the unit. The input signals are digitized by using a 17-bit A to D converter. Its fast sampling rate allows the KS10-I to control fast processes such as pressure and flow. Adaptive tune is incorporated. By using adaptive tune the control parameters can be optimized to accommodate changes in process dynamics and disturbances. You will find that this technique is specially useful for the processes with characteristics that were changing with time or with operating conditions.

Digital communications RS-485 or 0/4 - 20 mA retransmission are available as an additional option. These options allow the KS20-I to be integrated with supervisory control system and software, or alternatively drive remote display, chart recorders or data-loggers.

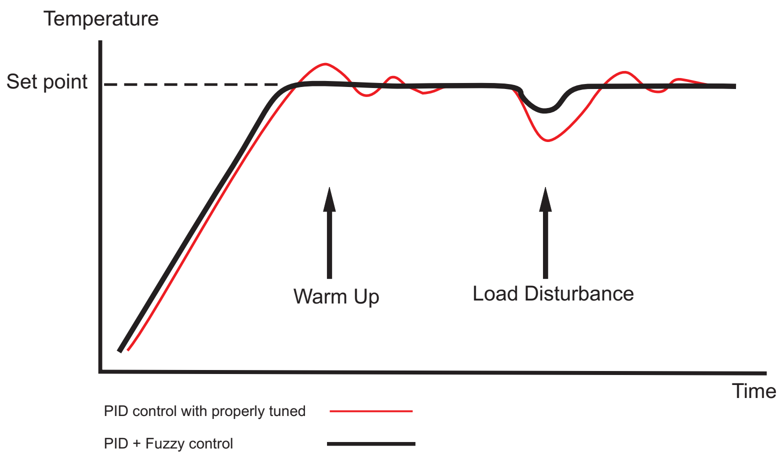
In last nearly a hundred years although PID control has been used and proved to be an efficient controlling method by many industries, yet the PID is difficult to deal with some sophisticated systems such as second and higher order systems, long time-lag systems, during set point change and/or load disturbance circumstance etc. The PID principle is based on a mathematic modeling which is obtained by tuning the process. Unfortunately , many systems are too complex to describe in numerical terms precisely. In addition, these systems may be variable from time to time. In order to overcome the imperfection of PID control, the Fuzzy Technology is introduced. What is the Fuzzy Control ? It looks like a good driver. Under different speeds and circumstances, he can control a car well with experiences he had before and does not require the knowledge of kinetic theory of motion. The Fuzzy Logic is a linguistic control which is different from the numerical PID control. It controls the system by experiences and does not need to simulate the system precisely as been controlled by PID.

Fuzzy PID System Block

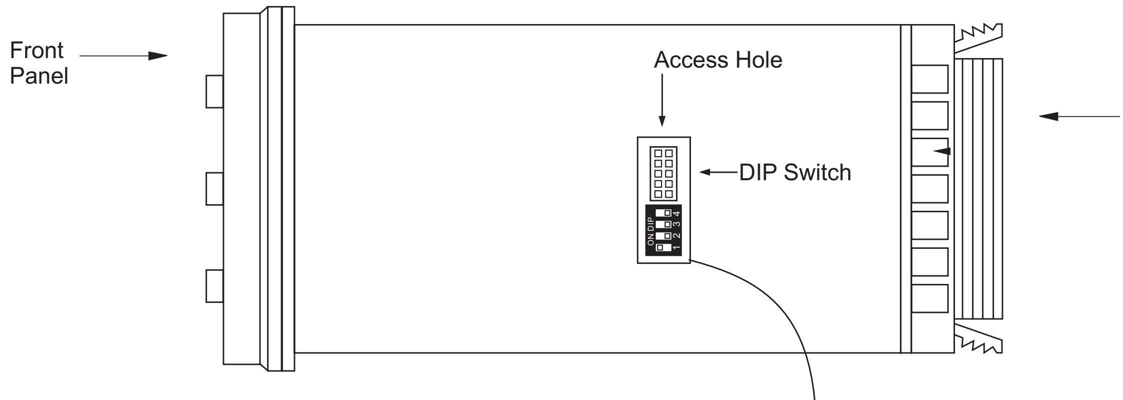




Fuzzy PID Enhances Control Stability



1.2 Mini jumper and DIP-switch



Control chassis - view below

DIP Switch Configuration

DIP Switch — ■ :ON □ :OFF

		1	2	3	4
Input 1 Select	TC, RTD, mV	■	□		
	0-1V, 0-5V, 1-5V, 0-10V	□	■		
	0-20 mA, 4-20 mA	■	■		
Lockout	All parameters are Unlocked			□	□
	Only SP1, SEL1–SEL5* are unlocked			■	□
	Only SP1 is unlocked			□	■
	All Parameters are locked			■	■
Factory Default Setting		■	□	□	□

When the unit leaves the factory, the DIP switch is set so that TC & RTD are selected for input 1 and all parameters are unlocked. Lockout function is used to disable the adjustment of parameters as well as operation of calibration mode.

However the menu can still be viewed even if under lockout condition.

* SEL1- SEL5 represent those parameters which are selected by using SEL1, SEL2,... SEL5 parameters contained in Setup menu. The selected parameters are then allocated at the beginning of the user menu.

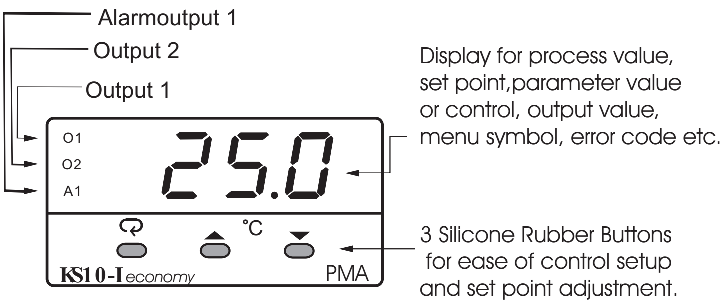
1.3 Keys and displays

The unit is programmed by using three keys on the front panel.
The available key functions are listed as following table.

Keypad Operation

TOUCHKEYS	FUNCTION	DESCRIPTION
[▲]	Up Key	Press and release quickly to increase the value of the displayed parameter. Press and hold to accelerate increment speed.
[▼]	Down Key	Press and release quickly to decrease the value of the displayed parameter. Press and hold to accelerate decrement speed.
[↻]	Scroll Key	Select the parameter in a direct sequence.
Press [↻] for at least 3 seconds	Enter Key	Allow access to more parameters in user menu, also used to Enter manual mode, auto-tune mode, default setting mode and save calibration data during calibration procedure.
Press [↻] for at least 6 seconds	Start Record Key	Reset historical values of PVHI and PVLO and start to record the peak process value.
Press [↻] [▲]	Reverse Scroll Key	Select the parameter in a reverse sequence during menu scrolling.
Press [↻] [▼]	Mode Key	Select the operation Mode in sequence.
Press [▲] [▼]	Reset Key	Reset the front panel display to a normal display mode, also used to leave the specific Mode execution and ending the auto-tune and manual control execution, and quit the sleep mode.
Press [▲] [▼] for at least 3 seconds	Sleep Key	The controller enters the sleep mode if the sleep function (SLEP) is enabled (select YES).
Press [↻] [▲] [▼]	Factory Key	By entering correct security code to allow execution of engineering programs. This function is used only in the factory to manage the diagnostic reports. The user should never attempt to operate this function.

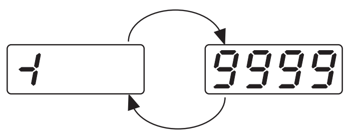
Front Panel Description



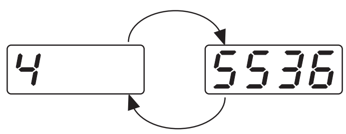
How to display a 5-digit number ?

For a number with decimal point the display will be shifted one digit right:
-199.99 will be displayed to -199.9
4553.6 will be displayed to 4553

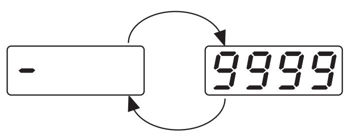
For a number without decimal point the display will be divided into two alternating phases:
-19999 will be displayed by:



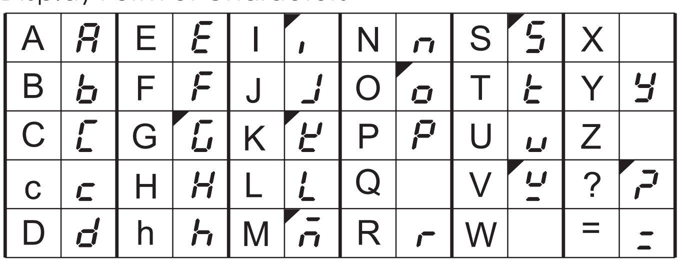
45536 will be displayed by:



-9999 will be displayed by:

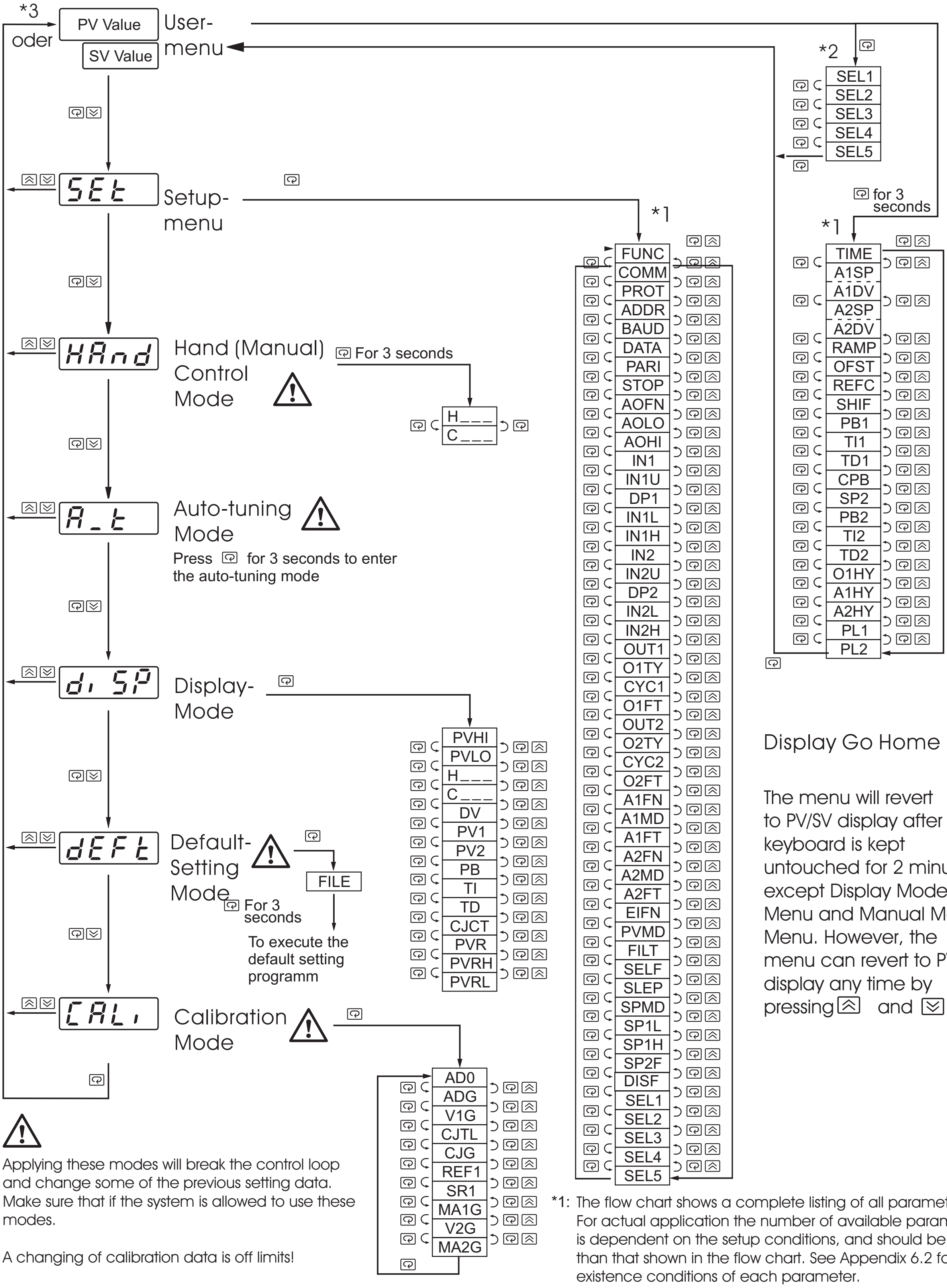


Display Form of Characters



◤: Confusing Character

1.4 Menu overview



Display Go Home

The menu will revert to PV/SV display after keyboard is kept untouched for 2 minutes except Display Mode Menu and Manual Mode Menu. However, the menu can revert to PV / SV display any time by pressing [▲] and [▼].

⚠ Applying these modes will break the control loop and change some of the previous setting data. Make sure that if the system is allowed to use these modes.

A changing of calibration data is off limits!

*1: The flow chart shows a complete listing of all parameters. For actual application the number of available parameters is dependent on the setup conditions, and should be less than that shown in the flow chart. See Appendix 6.2 for the existence conditions of each parameter.

*2: You can select at most 5 parameters put in front of the user menu by using SEL1 to SEL5 contained in the bottom of setup menu.

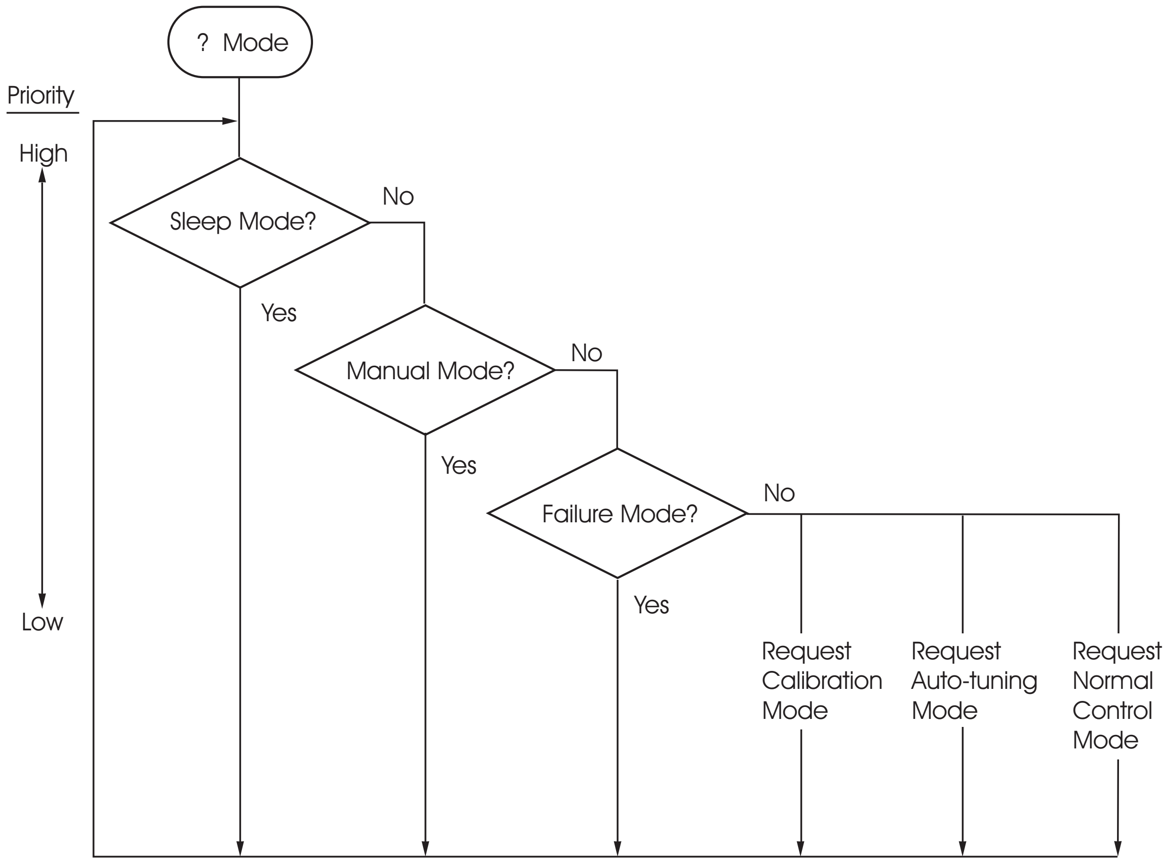
*3: The parameter DISF in the setup menu determinesif PV or SV Value is displayed.

1.5 System modes

The controller will maintain its control mode during you are operating user menu, setup menu or display mode, reloading default values or applying event input signal. Under certain conditions the normal control mode will transfer to an Exception Mode. The exception modes include : Sleep Mode, Manual Mode, Failure Mode, Calibration Mode and Auto-tuning Mode. All these modes are performing open loop control except the Auto-tuning Mode which is performing ON-OFF plus PID close loop control. The mode transfer is governed by the priority conditions. A lower priority mode can not alter a higher priority mode, as shown in Figure below.

System Modes
Sleep Mode :
See Section 4-11.
Manual Mode :
See Section 3-21.
Failure Mode :
See Section 3-15.
Auto-tuning Mode :
See Section 3-18.
Normal Control Mode :
See Section 3-22, 3-24, 4-1

System Mode Priority



The calibration mode, auto-tuning mode and normal control mode are at same priority level. The sleep mode is the highest priority.

1.6 Parameter Description

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
User Menu	✓	SP1		Set point 1	Low: SP1L High: SP1H	100.0°C (212.0°F)
	✓	TIME	tinE	Dwell Time	Low: 0 High: 6553.5 minutes	0.0
	✓	A1SP	A1SP	Alarm 1 Set point	See Table 1.5, 1.6	100.0°C (212.0°F)
	✓	A1DV	A1dv	Alarm 1 Deviation Value	Low: -200.0°C (-360.0°F) High: 200.0°C (360.0°F)	10.0°C (18.0°F)
	✓	A2SP	A2SP	Alarm 2 Set point	See Table 1.5, 1.7	100.0°C (212.0°F)
	✓	A2DV	A2dv	Alarm 2 Deviation Value	Low: -200.0°C (-360.0°F) High: 200.0°C (360.0°F)	10.0°C (18.0°F)
		RAMP	rAnP	Ramp Rate	Low: 0 High: 500.0°C (900.0°F)	0.0
	✓	OFST	oFSt	Offset Value for P control	Low: 0 High: 100.0 %	25.0
		REFC	rEFC	Reference Constant for Specific Function	Low: 0 High: 60	2
	✓	SHIF	SHiF	PV1 Shift (offset) Value	Low: -200.0°C (-360.0°F) High: 200.0°C (360.0°F)	0.0
	✓	PB1	Pb1	Proportional Band 1 Value	Low: 0 High: 500.0°C (900.0°F)	10.0°C (18.0°F)
	✓	TI1	ti1	Integral Time 1 Value	Low: 0 High: 1000 sec	100
	✓	TD1	td1	Derivative Time 1 Value	Low: 0 High: 360.0 sec	25.0
	✓	CPB	CPb	Cooling Proportional Band Value	Low: 1 High: 255 %	100
		SP2	SP2	Set point 2	See Table 1.5, 1.8	100.0°C (212.0°F)
		PB2	Pb2	Proportional Band 2 Value	Low: 0 High: 500.0°C (900.0°F)	10.0°C (18.0°F)
		TI2	ti2	Integral Time 2 Value	Low: 0 High: 1000 sec	100
		TD2	td2	Derivative Time 2 Value	Low: 0 High: 360.0 sec	25.0
	✓	O1HY	o1HY	Output 1 ON-OFF Control Hysteresis	Low: 0.1 High: 55.6°C (100.0°F)	0.1
	✓	A1HY	A1HY	Hysteresis Control of Alarm 1	Low: 0.1 High: 10.0°C (18.0°F)	0.1
	✓	A2HY	A2HY	Hysteresis Control of Alarm 2	Low: 0.1 High: 10.0°C (18.0°F)	0.1
		PL1	PL1	Output 1 Power Limit	Low: 0 High: 100 %	100
		PL2	PL2	Output 2 Power Limit	Low: 0 High: 100 %	100
Setup Menu	✓	FUNC	FunC	Function Complexity Level	0 bASC : Basic Function Mode 1 FuLL : Full Function Mode	1
		COMM	Conn	Communication Interface Type	0 nonE : No communication function 1 485 : RS-485 interface 2 232 : RS-232 interface 3 4-20 : 4 - 20 mA analog retransmission output 4 0-20 : 0 - 20 mA analog retransmission output 5 0-1v : 0 - 1V analog retransmission output 6 0-5v : 0 - 5V analog retransmission output 7 1-5v : 1 - 5V analog retransmission output 8 0-10 : 0 - 10V analog retransmission output	1
		PROT	Prot	COMM Protocol Selection	0 rtu : Modbus protocol RTU mode	0

Parameter Description 2/7

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
Setup Menu		ADDR	Addr	Address Assignment of Digital COMM	Low: 1 High: 255	—
		BAUD	bAud	Baud Rate of Digital COMM	0 0.3 : 0.3 Kbits/s baud rate 1 0.6 : 0.6 Kbits/s baud rate 2 1.2 : 1.2 Kbits/s baud rate 3 2.4 : 2.4 Kbits/s baud rate 4 4.8 : 4.8 Kbits/s baud rate 5 9.6 : 9.6 Kbits/s baud rate 6 14.4 : 14.4 Kbits/s baud rate 7 19.2 : 19.2 Kbits/s baud rate 8 28.8 : 28.8 Kbits/s baud rate 9 38.4 : 38.4 Kbits/s baud rate	5
		DATA	dAtA	Data Bit count of Digital COMM	0 7bit : 7 data bits 1 8bit : 8 data bits	1
		PARI	PAri	Parity Bit of Digital COMM	0 EvEn : Even parity 1 odd : Odd parity 2 nonE : No parity bit	0
		STOP	StoP	Stop Bit Count of Digital COMM	0 1bit : One stop bit 1 2bit : Two stop bits	0
		AOFN	Ao.Fn	Analog Output Function	0 Pv1 : Retransmit IN1 process value 1 Pv2 : Retransmit IN2 process value 2 P1-2 : Retransmit IN1 −IN2 difference process value 3 P2-1 : Retransmit IN2 −IN1 difference process value 4 Sv : Retransmit set point value 5 mv1 : Retransmit output 1 manipulation value 6 mv2 : Retransmit output 2 manipulation value 7 dv : Retransmit deviation(PV-SV) Value	0
		AOLO	Ao.Lo	Analog Output Low Scale Value	Low: -19999 High: 45536	0°C (32.0°F)
		AOHI	Ao.Hi	Analog Output High Scale Value	Low: -19999 High: 45536	100.0°C (212.0°F)
	✓	IN1	in1	IN1 Sensor Type Selection	0 J_tC : J type thermocouple 1 K_tC : K type thermocouple 2 t_tC : T type thermocouple 3 E_tC : E type thermocouple 4 b_tC : B type thermocouple 5 r_tC : R type thermocouple 6 S_tC : S type thermocouple	1 (0)

Parameter Description 3/7

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
Setup Menu	✓	IN1	in1	IN1 Sensor Type Selection	7 n_tC : N type thermocouple 8 L_tC : L type thermocouple 9 Pt.dn : PT 100 ohms DIN curve 10 Pt.JS : PT 100 ohms JIS curve 11 4-20 : 4 - 20 mA linear current input 12 0-20 : 0 - 20 mA linear current input 13 0-1V : 0 - 1V linear Voltage input 14 0-5V : 0 - 5V linear Voltage input 15 1-5V : 1 - 5V linear Voltage input 16 0-10 : 0 - 10V linear Voltage input 17 SPEC : Special defined sensor curve	1 (0)
	✓	IN1U	in1u	IN1 Unit Selection	0 oC : Degree C unit 1 oF : Degree F unit 2 Pu : Process unit	0 (1)
	✓	DP1	dP1	IN1 Decimal Point Selection	0 no.dP : No decimal point 1 1-dP : 1 decimal digit 2 2-dP : 2 decimal digits 3 3-dP : 3 decimal digits	1
	✓	IN1L	in1.L	IN1 Low Scale Value	Low: -19999 High: 45536	0
	✓	IN1H	in1.H	IN1 High Scale Value	Low: -19999 High: 45536	1000
		IN2	in2	IN2 Signal Type Selection	0 nonE : IN2 no function 1 Ct : Current transformer input 2 4-20 : 4 - 20 mA linear current input 3 0-20 : 0 - 20 mA linear current input 4 0-1V : 0 - 1V linear voltage input 5 0-5V : 0 - 5V linear voltage input 6 1-5V : 1 - 5V linear voltage input 7 0-10 : 0 - 10V linear voltage input	1
		IN2U	in2.u	IN2 Unit Selection	Same as IN1U	2
		DP2	dP2	IN2 Decimal Point Selection	Same as DP1	1
		IN2L	in2.L	IN2 Low Scale Value	Low: -19999 High: 45536	0
		IN2H	in2.H	IN2 High Scale Value	Low: -19999 High: 45536	1000
	✓	OUT1	out1	Output 1 Function	0 rEVr : Reverse (heating) control action 1 dirt : Direct (cooling) control action	0
	✓	O1TY	o1tY	Output 1 Signal Type	0 rELY : Relay output 1 SSrd : Solid state relay drive output 2 SSr : Solid state relay output 3 4-20 : 4 - 20 mA current module	0

Parameter Description 4/7

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
Setup Menu	✓	O1TY	o1tY	Output 1 Signal Type	4 0-20 : 0 - 20 mA current module 5 0-1V : 0 - 1V voltage module 6 0-5V : 0 - 5V voltage module 7 1-5V : 1 - 5V voltage module 8 0-10 : 0 - 10V voltage module	0
	✓	CYC1	CYC1	Output 1 Cycle Time	Low: 0.1 High: 100.0 sec	18.0
	✓	O1FT	o1Ft	Output 1 Failure Transfer Mode	Select BPLS (bumpless transfer) or 0.0 ~ 100.0 % to continue output 1 control function as the unit fails, power starts or manual mode starts.	BPLS
	✓	OUT2	out2	Output 2 Function	0 nonE : Output 2 no function 1 CooL : PID cooling control 2 =AL2 : Perform alarm 2 function 3 dCPS : DC power supply module installed	2
	✓	O2TY	o2tY	Output 2 Signal Type	Same as O1TY	0
	✓	CYC2	CYC2	Output 2 Cycle Time	Low: 0.1 High: 100.0 sec	18.0
	✓	O2FT	o2Ft	Output 2 Failure Transfer Mode	Select BPLS (bumpless transfer) or 0.0 ~ 100.0 % to continue output 2 control function as the unit fails, power starts or manual mode starts.	BPLS
	✓	A1FN	A1Fn	Alarm 1 Function	0 nonE : No alarm function 1 tinr : Dwell timer action 2 dEHi : Deviation high alarm 3 dELo : Deviation low alarm 4 dbHi : Deviation band out of band alarm 5 dbLo : Deviation band in band alarm 6 PV1H : IN1 process value high alarm 7 PV1L : IN1 process value low alarm 8 PV2H : IN2 process value high alarm 9 PV2L : IN2 process value low alarm 10 P12H : IN1 or IN2 process value high alarm 11 P12L : IN1 or IN2 process value low alarm 12 d12H : IN1 – IN2 difference process value high alarm 13 d12L : IN1 – IN2 difference process value low alarm 14 Lb : Loop break alarm 15 SEnb : Sensor break or A-D fails	2
	✓	A1MD	A1nd	Alarm 1 Operation Mode	0 norn : Normal alarm action 1 Ltch : Latching alarm action 2 HoLd : Hold alarm action 3 LtHo : Latching & Hold action	0

Parameter Description 5/7

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
Setup Menu	✓	A1FT	A 1.Ft	Alarm 1 Failure Transfer Mode	0 oFF : Alarm output OFF as unit fails 1 on : Alarm output ON as unit fails	1
	✓	A2FN	A2.Fn	Alarm 2 Function	Same as A1FN	2
	✓	A2MD	A2.nd	Alarm 2 Operation Mode	Same as A1MD	0
	✓	A2FT	A2.Ft	Alarm 2 Failure Transfer Mode	Same as A1FT	1
		EIFN	Ei.Fn	Event Input Function	0 nonE : Event input no function 1 SP2 : SP2 activated to replace SP1 2 Pi d2 : PB2, TI2, TD2 activated to replace PB1, TI1, TD1 3 SP.P2 : SP2, PB2, TI2, TD2 activated to replace SP1, PB1, TI1, TD1 4 r S.A 1 : Reset alarm 1 output 5 r S.A2 : Reset alarm 2 output 6 r.A 1.2 : Reset alarm 1 & alarm 2 7 d.o 1 : Disable Output 1 8 d.o2 : Disable Output 2 9 d.o 1.2 : Disable Output 1 & Output 2	1
		PVMD	PV.nd	PV Mode Selection	0 PV 1 : Use PV1 as process value 1 PV2 : Use PV2 as process value 2 P 1-2 : Use PV1 − PV2 (difference) as process value 3 P2- 1 : Use PV2 − PV1 (difference) as process value	0
		FILT	Fi Lt	Filter Damping Time Constant of PV	0 0 : 0 second time constant 1 0.2 : 0.2 second time constant 2 0.5 : 0.5 second time constant 3 1 : 1 second time constant 4 2 : 2 seconds time constant 5 5 : 5 seconds time constant 6 10 : 10 seconds time constant 7 20 : 20 seconds time constant 8 30 : 30 seconds time constant 9 60 : 60 seconds time constant	2
	✓	SELF	SELF	Self Turn Function Selection	0 nonE : Self tune function disabled 1 StAr : To restart a self tune 2 End : Self tune function finished	1
		SLEP	SLEP	Sleep mode Function Selection	0 nonE : Sleep mode function disabled 1 YES : Sleep mode function enabled	0

Parameter Description 6/7

Contained in	Basic Function	Parameter-notation	Display	Parameter-description	Range	Default-value
		SPMD	SP.md	Set point mode selection	0 SP 1.2 : Use SP1 or SP2 depends on EIFN) as set point 1 mi n.r : Use minute ramp rate as set point 2 Hr.r : Use hour ramp rate as set point 3 PV 1 : Use In1 process value as set point 4 PV2 : Use In2 process value as set point 5 PumP : Selected for pump control	0
	✓	SP1L	SP 1.L	Sp1 Low scale value	Low: -19999 High: 45536	0°C (32.0°F)
	✓	SP1H	SP 1.H	Sp1 High Scale Value	Low: -19999 High: 45536	1000.0°C (1832.0°F)
		SP2F	SP2F	Format of set point 2 Value	0 ACtu : Set point 2 (SP2) is an actual value 1 dEVi : Set point 2 (SP2) is a deviation value	0
	✓	DISF	di SF	Selection of display	0 PV : Process value 1 SV : Set point	0
Setup Menu	✓	SEL1	SEL 1	Select 1'st Parameter	0 nonE : No parameter 1 ti mE : First Parameter TIME 2 A 1.SP : First Parameter AISP 3 A 1.dV : First Parameter AIDV 4 A2.SP : First Parameter A2SP 5 A2.dV : First Parameter A2DV 6 rAmP : First Parameter RAMP 7 oFSt : First Parameter OFST 8 rEFC : First Parameter REFC 9 SHi F : First Parameter SHIF 10 Pb 1 : First Parameter PB 1 11 ti 1 : First Parameter TI 1 12 td 1 : First Parameter TD 1 13 C.Pb : First Parameter CPB 14 Reserved, not used 15 SP2 : First Parameter SP 2 16 Pb2 : First Parameter PB 2 17 ti 2 : First Parameter TI 2 18 td2 : First Parameter TD 2	0
	✓	SEL2	SEL 2	Select 2'nd Parameter	Same as SEL1	0
	✓	SEL3	SEL 3	Select 3'rd Parameter	Same as SEL1	0
	✓	SEL4	SEL 4	Select 4'th Parameter	Same as SEL1	0
	✓	SEL5	SEL 5	Select 5'th Parameter	Same as SEL1	0
Calibration Mode Menu	✓	AD0	Ad0	A to D Zero Calibration Coefficient	Low: -360 High: 360	—
	✓	ADG	AdG	A to D Gain Calibration Coefficient	Low: -199.9 High: 199.9	—
	✓	V1G	V 1.G	Voltage Input 1 Gain Calibration Coefficient	Low: -199.9 High: 199.9	—
	✓	CJTL	CJt.L	Cold Junction Low Temperature Calibration Coefficient	Low: -5.00 High: 40.00 °C	—

Parameter Description 7/7

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range				Default Value
Calibration Mode Menu	✓	CJG	CJ.G	Cold Junction Gain Calibration Coefficient	Low:	-199.9	High:	199.9	—
	✓	REF1	rEF. 1	Reference Voltage 1 Calibration Coefficient for RTD 1	Low:	-199.9	High:	199.9	—
	✓	SR1	Sr. 1	Serial Resistance 1 Calibration Coefficient for RTD 1	Low:	-199.9	High:	199.9	—
	✓	MA1G	MA 1.G	mA Input 1 Gain Calibration Coefficient	Low:	-199.9	High:	199.9	—
	✓	V2G	V2.G	Voltage Input 2 Gain Calibration Coefficient	Low:	-199.9	High:	199.9	—
	✓	MA2G	MA2.G	mA Input 2 Gain Calibration Coefficient	Low:	-199.9	High:	199.9	—
Display Mode Menu	✓	PVHI	PV.Hi	Historical Maximum Value of PV	Low:	-19999	High:	45536	—
	✓	PVLO	PV.Lo	Historical Minimum Value of PV	Low:	-19999	High:	45536	—
	✓	MV1	H_ _ _	Current Output 1 Value	Low:	0	High:	100.00 %	—
	✓	MV2	C_ _ _	Current Output 2 Value	Low:	0	High:	100.00 %	—
	✓	DV	dV	Current Deviation (PV-SV) Value	Low:	-12600	High:	12600	—
	✓	PV1	PV 1	IN1 Process Value	Low:	-19999	High:	45536	—
	✓	PV2	PV2	IN2 Process Value	Low:	-19999	High:	45536	—
	✓	PB	Pb	Current Proportional Band Value	Low:	0	High:	500.0 LC (900.0 LF)	—
	✓	TI	ti	Current Integral Time Value	Low:	0	High:	4000 sec	—
	✓	TD	td	Current Derivative Time Value	Low:	0	High:	1440 sec	—
	✓	CJCT	CJCt	Cold Junction Compensation Temperature	Low:	-40.00 LC	High:	90.00 LC	—
	✓	PVR	PVr	Current Process Rate Value	Low:	-16383	High:	16383	—
	✓	PVRH	PVr.H	Maximum Process Rate Value	Low:	-16383	High:	16383	—
	✓	PVRL	PVr.L	Minimum Process Rate Value	Low:	-16383	High:	16383	—

Input (IN1) Range

Input Type	J_TC	K_TC	T_TC	E_TC	B_TC	R_TC	S_TC
Range Low	-120 LC (-184 LF)	-200 LC (-328 LF)	-250 LC (-418 LF)	-100 LC (-148 LF)	0 LC (32 LF)	0 LC (32 LF)	0 LC (32 LF)
Range High	1000 LC (1832 LF)	1370 LC (2498 LF)	400 LC (752 LF)	900 LC (1652 LF)	1820 LC (3308 LF)	1767.8 LC (3214 LF)	1767.8 LC (3214 LF)

Input Type	N_TC	L_TC	PT.DN	PT.JS	CT	Linear (V, mA) or SPEC
Range Low	-250 LC (-418 LF)	-200 LC (-328 LF)	-210 LC (-346 LF)	-200 LC (-328 LF)	0 Amp	-19999
Range High	1300 LC (2372 LF)	900 LC (1652 LF)	700 LC (1292 LF)	600 LC (1112 LF)	90 Amp	45536

Range Determination for A1SP

If A1FN =	PV1.H, PV1.L	PV2.H,PV2.L	P1.2.H, P1.2.L D1.2.H, D1.2.L
Range of A1SP same as range of	IN1	IN2	IN1, IN2

Range Determination for A2SP

If A2FN =	PV1.H, PV1.L	PV2.H,PV2.L	P1.2.H, P1.2.L D1.2.H, D1.2.L
Range of A2SP same as range of	IN1	IN2	IN1, IN2

Range Determination for SP2

If PVMD =	PV1	PV2	P1− 2, P2−1
Range of SP2 same as range of	IN1	IN2	IN1, IN2

⚠ **Exception: If any of A1SP, A2SP or SP2 is configured with respect to CT input, its adjustment range is unlimited.**

2. Installation

⚠ Dangerous voltages capable of causing death are sometimes present in this instrument. Before installation or beginning any troubleshooting procedures the power to all equipment must be switched off and isolated. Units suspected of being faulty must be disconnected and removed to a properly equipped workshop for testing and repair. Component replacement and internal adjustments must be made by qualified maintenance personnel only.

⚠ To help minimize the possibility of fire or shock hazards, do not expose this instrument to rain or excessive moisture.

⚠ Do not use this instrument in areas subject to hazardous conditions such as excessive shock, vibration, dirt, moisture, corrosive gases or oil. The ambient temperature of the areas should not exceed the maximum rating specified in the datasheet..

2.1 Unpacking

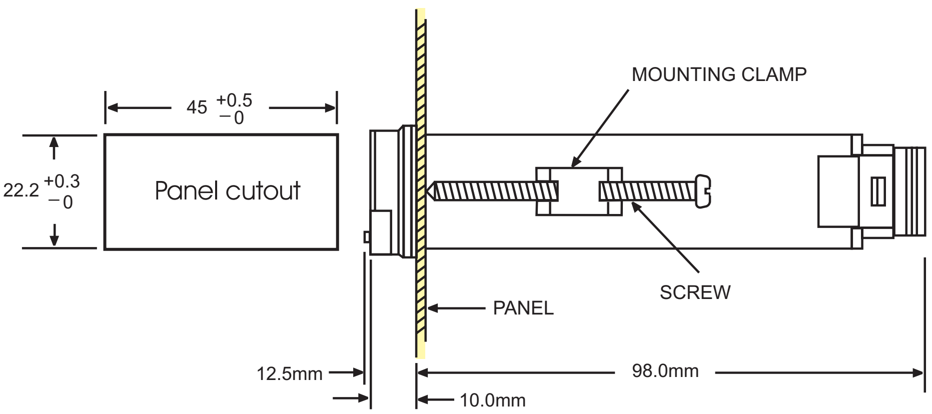
Upon receipt of the shipment remove the unit from the carton and inspect the unit for shipping damage.
If any damage due to transit is notices, report and file a claim with the carrier.
Write down the model number, serial number, and date code for future reference when corresponding with our service center. The serial number (S/N) and date code (D/C) are labeled on the box and housing of the control.

2.2 Mounting

Make panel cutout to dimension shown Figure 2.1.

Take both mounting clamps away and insert the controller into panel cutout. Install the mounting clamps back. Gently tighten the screws in the clamp till the controller front panels is fitted snugly in the cutout.

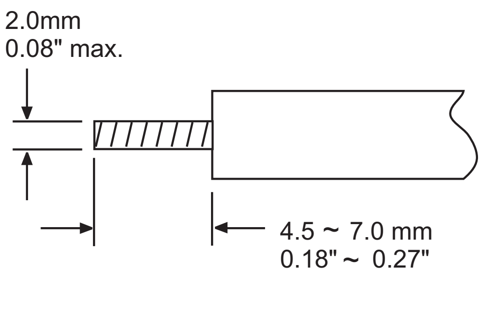
Mounting Dimensions



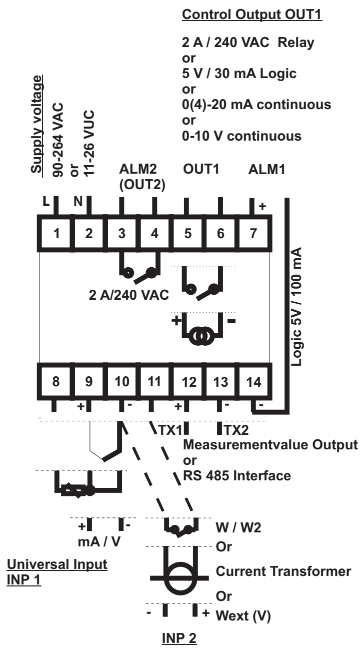
2.3 Wiring Precautions

- Before wiring, verify the label for correct model number and options. Switch off the power when checking.
- Care must be taken to ensure that maximum voltage ratings specified on the label are not exceeded.
- It is recommended that power to these units be protected by fuses or circuit breakers rated at the minimum value possible.
- All units should be installed inside a suitably grounded metal enclosure to prevent live parts being accessible to human hands and metal tools.
- All wiring must conform to appropriate standards of good practice and local codes and regulations. Wiring must be suitable for voltage, current, and temperature ratings of the system.
- The " stripped " leads are used for power and sensor connections.
- Take care not to over-tighten the terminal screws.
- Unused control terminals should not be used as jumper points as they may be internally connected, causing damage to the unit.
- Verify that the ratings of the output devices and the inputs as specified are not exceeded.
- Electric power in industrial environments contains a certain amount of noise in the form of transient voltage and spikes. This electrical noise can enter and adversely affect the operation of microprocessor-based controls. For this reason we strongly recommend the use of shielded thermocouple extension wire which connects from the sensor to the controller. This wire is a twisted-pair construction with foil wrap and drain wire. The drain wire is to be attached to ground at one end only.

Lead Termination



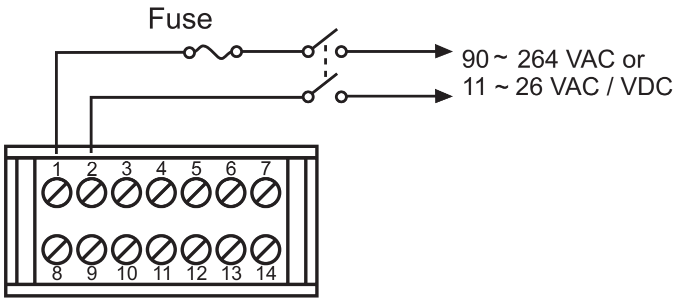
Connection Diagram



2.4 Power Wiring

The controller is supplied to operate on 11-26 VAC / VDC or 90-264VAC. Check that the installation mains voltage corresponds to that indicated on the product label before connecting power to the controllers.

Power supply Connections



⚠ This equipment is designed for installation in an enclosure which provides adequate protection against electric shock. The enclosure must be connected to earth ground.

Local requirements regarding electrical installation should be rigidly observed. Consideration should be given to the prevention of unauthorized personnel from gaining access to the power terminations.

2.5 Sensor Installation Guidelines

Proper sensor placement can eliminate many problems in a control system. The probe should be placed so that it can detect any temperature change with minimal thermal lag. In a process that requires fairly constant heat output, the probe should be placed close to the heater. In processes where the heat demand is variable, the probe should be closer to the work area. Some experimenting with probe location is often required to find this optimum position.

In a liquid process, addition of a stirrer will help to eliminate thermal lag. Since the thermocouple is basically a point measuring device, placing more than one thermocouple in parallel will provide an average temperature reading and produce better results in most air heated processes.

Proper sensor type is also a very important factor in obtaining precise measurements. The sensor must have the correct temperature range to meet the process requirements. In special processes the sensor might have to have different requirements such as leak-proof, anti-vibration, antiseptic, etc.

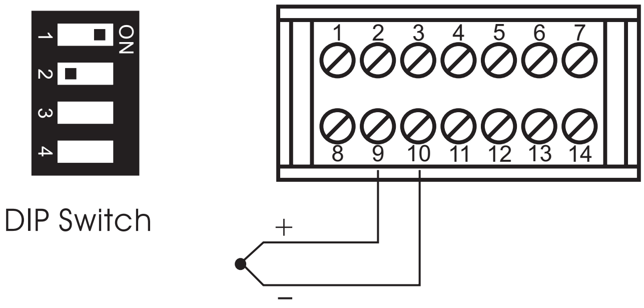
Standard sensor limits of error are ±4 degrees F (± 2degrees C) or 0.75% of sensed temperature (half that for special) plus drift caused by improper protection or an over-temperature occurrence. This error is far greater than controller error and cannot be corrected at the sensor except by proper selection and replacement.

2.6 Thermocouple Input Wiring

Thermocouple input connections are shown in the figure below. The correct type of thermocouple extension lead-wire or compensating cable must be used for the entire distance between the controller and the thermocouple, ensuring that the correct polarity is observed throughout. Joints in the cable should be avoided, if possible.

If the length of thermocouple plus the extension wire is too long, it may affect the temperature measurement. A 400 ohms K type or a 500 ohms J type thermocouple lead resistance will produce 1 degree C temperature error approximately.

Thermocouple Input Wiring



The colour codes used on the thermocouple extension leads are shown in the table below.

Thermocouple Cable Colour Codes

Thermocouple Type	Cable Material	British BS	American ASTM	German DIN	French NFE
T	Copper (Cu) Constantan (Cu-Ni)	+ white – blue * blue	+ blue – red * blue	+ red – brown * brown	+ yellow – blue * blue
J	Iron (Fe) Constantan (Cu- Ni)	+ yellow – blue * black	+ white – red * black	+ red – blue * blue	+ yellow – black * black
K	Nickel-Chromium (Ni-Cr) Nickel-Aluminum (Ni-Al)	+ brown – blue * red	+ yellow – red * yellow	+ red – green * green	+ yellow – purple * yellow
R S	Pt-13%Rh,Pt Pt-10%Rh,Pt	+ white – blue * green	+ black – red * green	+ red – white * white	+ yellow – green * green
B	Pt-30%Rh Pt-6%Rh	Use Copper Wire	+grey – red * grey	+red –grey * grey	Use Copper Wire

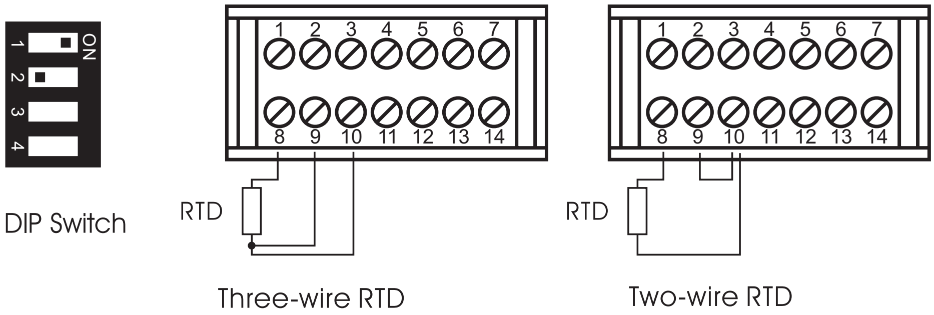
*** Colour of overall sheath**

2.7 RTD Input Wiring

RTD connection are shown in Figure 2.6, with the compensating lead connected to terminal 12. For two-wire RTD inputs, terminals 12 and 13 should be linked. The three-wire RTD offers the capability of lead resistance compensation provided that the three leads should be of same gauge and equal length.

Two-wire RTD should be avoided, if possible, for the purpose of accuracy. A 0.4 ohm lead resistance of a two-wire RTD will produce 1 degree C temperature error.

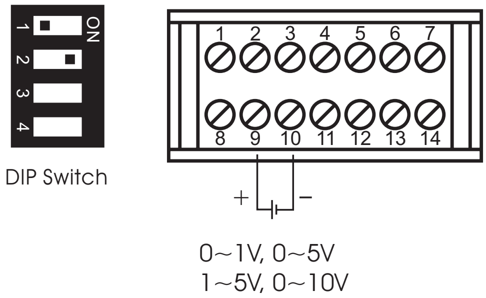
RTD Input Wiring



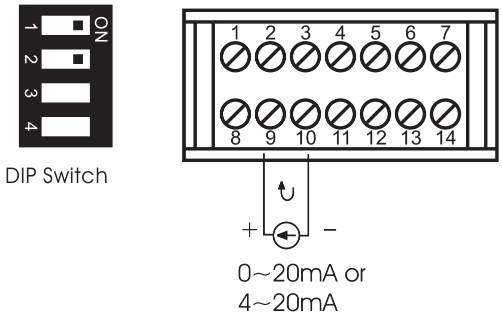
2.8 Linear DC Input Wiring

DC linear voltage and linear current connections for input 1 are shown in the two following figures.

Input 1 Linear Voltage Wiring

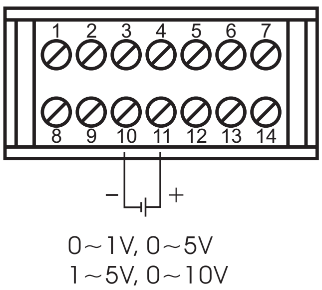


Input 1 Linear Current Wiring

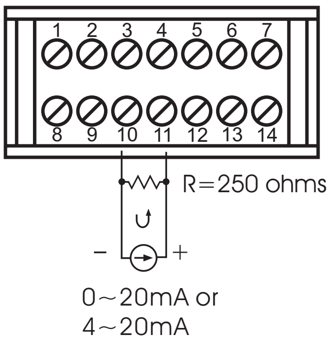


DC linear voltage and linear current connections for input 2 are shown in the two following figures.

Input 2 Linear Voltage Wiring



Input 2 Linear Current Wiring

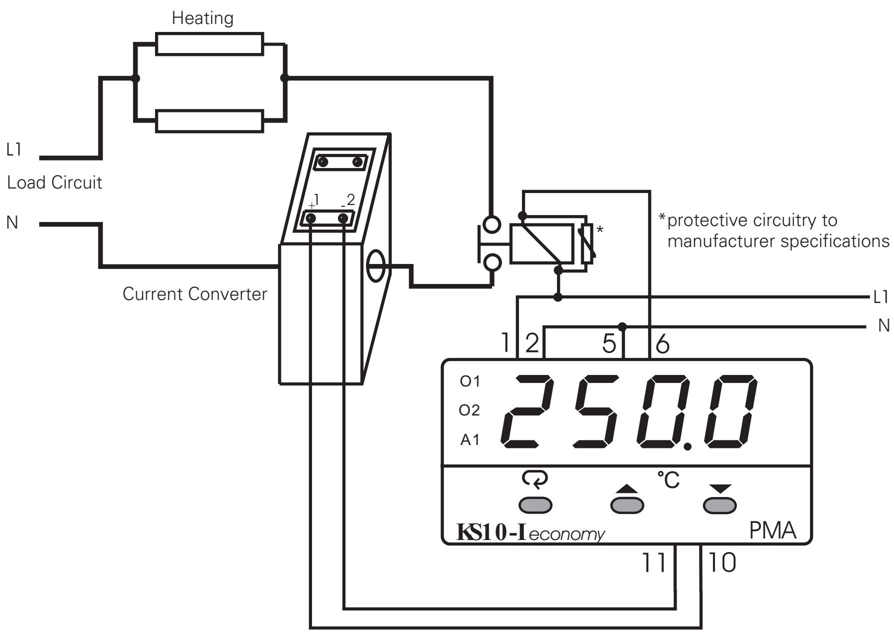


2.9 Connecting terminals for current converter/heating current

Note: If the heating to be measured is controlled by output 1, the setting should be 1 second or longer for CYC1, and RELY or SSR for O1TY.
If the heating is controlled by output 2, the setting should be 1 second or longer for CYC2, and RELY or SSR for O2TY. Since the current converter can measure only full-wave AC current, DC current or half-wave AC measurement is not possible.

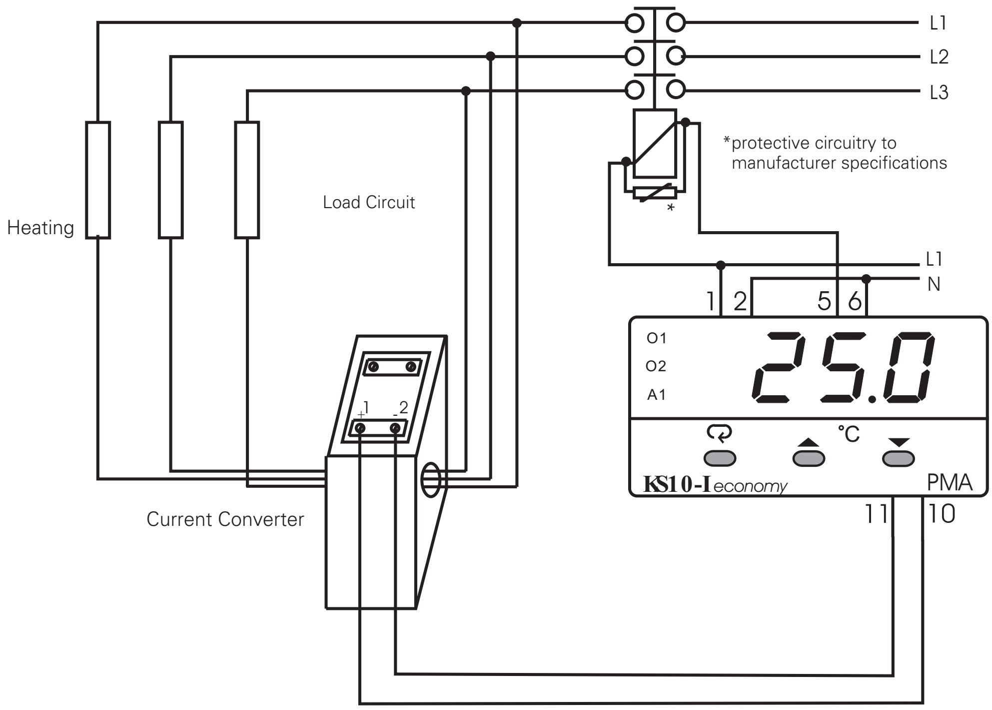
Example:
Two 2kW heatings are connected in parallel in an oven.
Mains supply is 230 V. The current rating for each heating is 8,7A.
For heating break monitoring, A1SP must be adjusted so that no alarm is still triggered at 230V-20% (8,7A+8,7A=17,4A -20% = 13,9A. In case of heating element break with overvoltage, however, the alarm must be triggered.
(8,7+20% =10,44A)
A1SP = 13,0A
A1HY = 0,1A switching hysteresis
A1FN = PV2.L input 2 min. alarm
A1MD = NORM normal alarm function

Restriction:
For reliable heating current measurement, CYC1 (CYC2) should be min.
1 second. Only full-wave AC current can be measured.



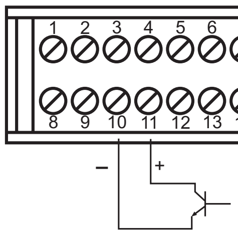
The following parameters must be set for this function:
FUNC = FULL accessible
IN2 = CT heating current input (current converter)
O1TY = RELY (SSR)
CYC1 = 1 sec. or higher

Heading 3-phase-connected

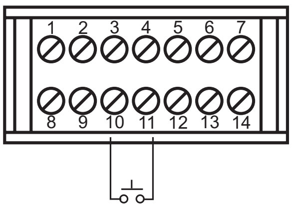


The following parameters must be set for this function:.
FUNC = FULL
IN2 = CT heating current input (Current Converter range 0 to50A)

2.10 Event Input Wiring



Open Collector Input

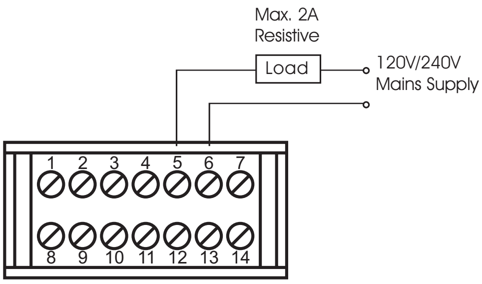


Switch Input

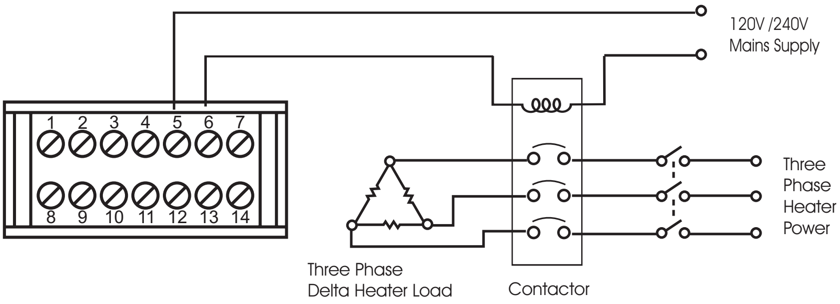
The event input can accept a switch signal as well as an open collector signal. The event input function (EIFN) is activated as the switch is closed or an open collector (or a logic signal) is pulled down.

2.11 Output 1 Wiring (Out1)

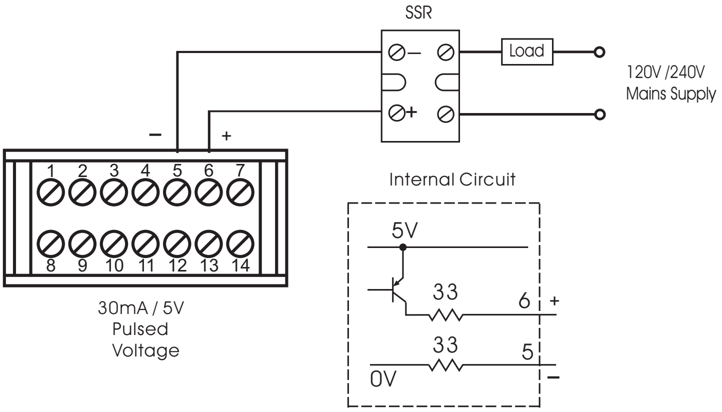
Relay Output Direct Drive



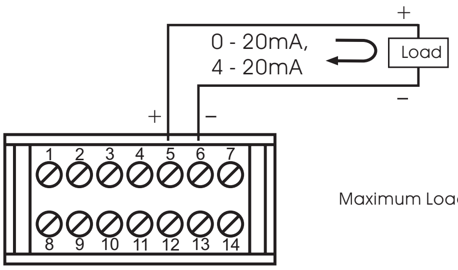
Relay Output to Drive Contactor



Logic Output to Drive SSR

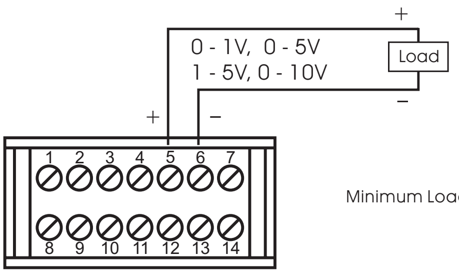


Linear Current



Maximum Load 500 Ω

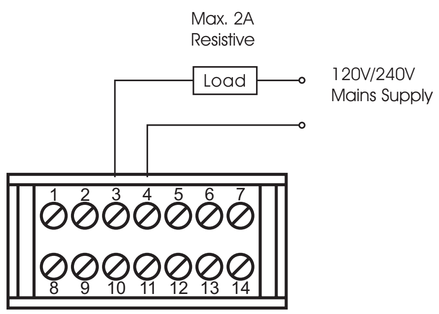
Linear Voltage



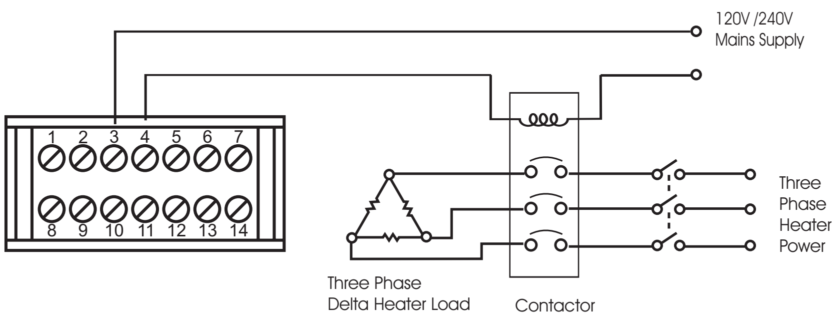
Minimum Load 10 K Ω

2.12 Output 2 Wiring (ALM2/OUT2)

Relay Output Direct Drive

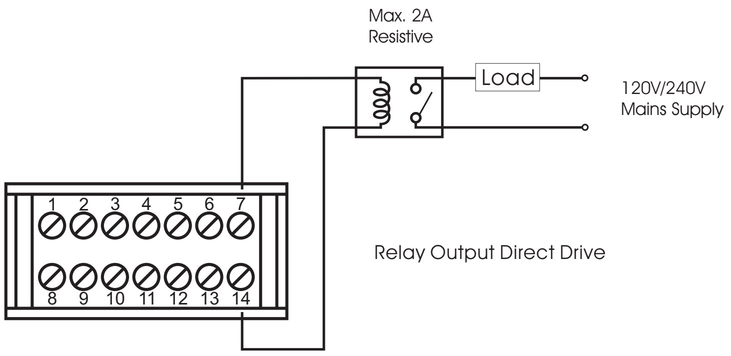


Relay Output to Drive Contactor

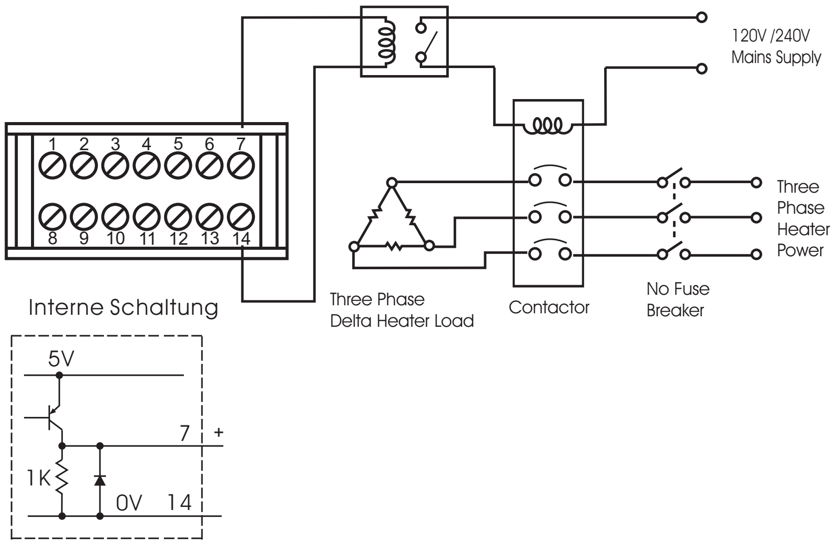


2.13 Alarm 1 Wiring (ALM1)

Alarm 1 Wiring

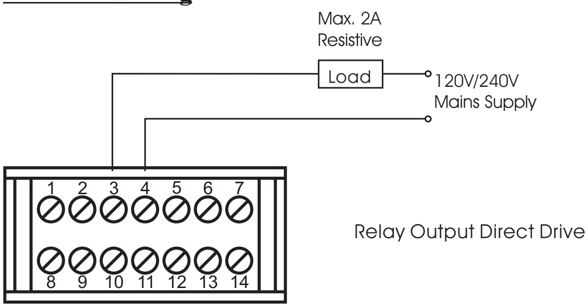


Relay Output to Drive Contactor

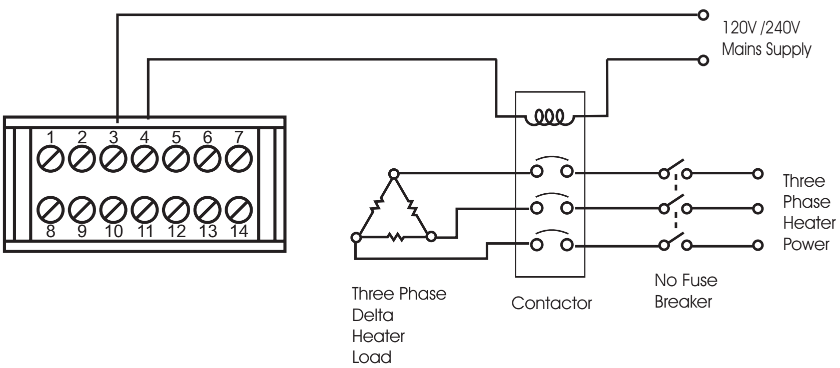


2.14 Alarm 2 Wiring (ALM2)

Alarm 2 Wiring

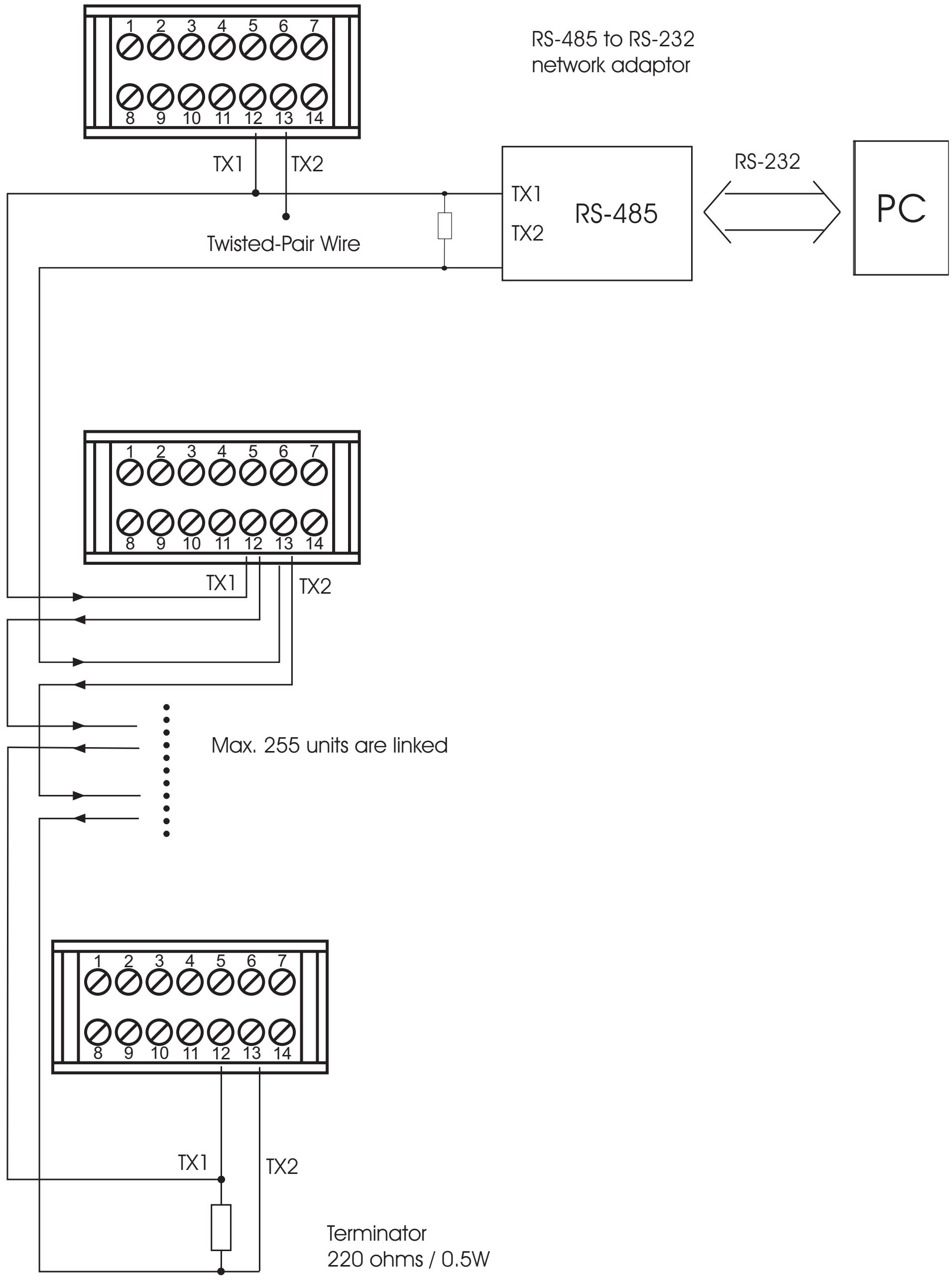


Relay Output to Drive Contactor



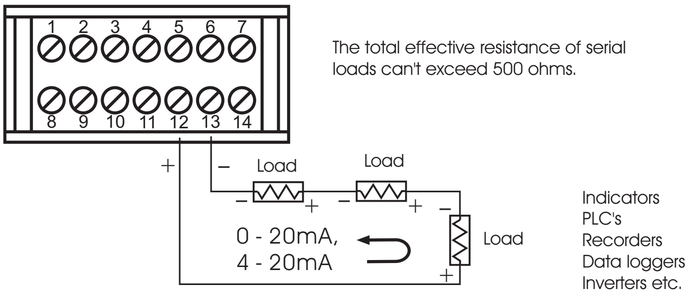
2.15 RS-485

RS-485 Wiring



2.16 Analog Retransmission Wiring

Retransmit Current



3. Programming the Basic Function

This unit provides the parameter " SET " which can be used to select the function complexity level before setup. If the Basic Mode (FUNC = BASC) is selected for a simple application, then the following functions are ignored and deleted from the full function menu:
RAMP, SP2, PB2, TI2, TD2, PL1, PL2, COMM, PROT, ADDR, BAUD, DATA, PARI, STOP, AOFN, AOLO, AOHI, IN2, IN2U, DP2, IN2L, IN2H, EIFN, PVMD, FILT, SLEP, SPMD. SP2F.

Basic Mode capabilities:

Input 1: Thermocouple, RTD, Volt, mA
Input 2: CT for heater break detection
Output 1: Heating or Cooling (Relay, SSR, Volt, mA)
Output 2: Cooling (Relay, SSR, Volt, mA), DC Power supply.
Alarm1: Relay for Deviation, Deviation Band, Process, Heater Break, Loop Break, Latch, Hold or Normal Alarm
Alarm 2: Relay for Deviation, Deviation Band, Process, Heater Break, Loop Break, Latch, Hold or Normal Alarm. .
Dwell Timer
Heater Break Alarm
Loop Break Alarm
Sensor Break Alarm
Failure Transfer
Bumpless Transfer
PV1 Shift
Programmable SP1 Range
Heat-Cool control
Hardware Lockout
Self-Tune
Auto-Tune
ON-OFF, P, PD, PI, PID Control
User Defined Menu (SEL)
Manual Control
Display Mode
Reload Default Values

If you don't need:

Second setpoint
Second PID
Event input
Soft start (RAMP)
Remote set point
Complex process value
Output power limit
Digital communication
Analog retransmission
Power shut off (Sleep Mode)
Digital filter

then you can use Basic Mode.

3.1 Input 1

Press [key] [key] to enter Setup Mode. Press [key] to select parameter. The upper display indicates the parameter symbol, and the lower display indicates the selection or the value for that parameter.

IN1 : Selects the sensor type and signal type for Input 1.
Range: (Thermocouple) J_TC, K_TC, T_TC, E_TC, B_TC, R_ TC, S_TC, N_TC, L_TC (RTD) PT.DN, PT.JS
(Linear) 4-20, 0-20, 0-1V, 0-5V, 1-5V, 0-10
Default: J_TC if °F is selected, K_TC if °C is selected.

IN1U: Selects the process unit for Input 1.
Range: °C, °F, PU (process unit) If the unit is neither °C nor °F, then selects PU.
Default: °C or °F.

DP1: : Selects the location of the decimal point for most (not all) process related parameters.
Range: (For T/C and RTD) NO.DP, 1-DP
(For Linear) NO.DP, 1-DP, 2-DP, 3-DP
Default: 1.DP

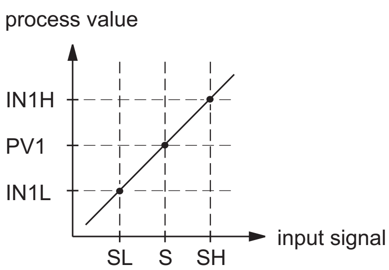
IN1L: Selects the low scale value for the Linear type input 1.
Hidden if : T/C or RTD type is selected for IN1.

IN1H: Selects the high scale value for the Linear type input 1.
Hidden if : T/C or RTD type is selected for IN1.

How to use IN1L and IN1H:

If 4 - 20 mA is selected for IN1, let SL specifies the input signal low (ie. 4 mA), SH specifies the input signal high (ie. 20 mA), S specifies the current input signal value, the conversion curve of process value is shown as following :

Conversion Curve for Linear Type Process Value



Formula : $PV1 = IN1L + (IN1H - IN1L) \frac{S - SL}{SH - SL}$

Example : A 4-20 mA current loop pressure transducer with range 0 - 15 kg/cm^2 is connected to input 1, then perform the following setup :

IN1 = 4 - 20 IN1L = 0.0
IN1U = PU IN1H = 15.0
DP1 = 1-DP

3.2 Out1 and Out2 Types

O1TY: Selects the signal type for Output 1.
The selection should be consistent with the output 1 module installed.
The available output 1 signal types are :

RELY:	Mechanical relay
SSRD:	Pulsed voltage output to drive SSR
4 - 20:	4 - 20 mA linear current output
0 - 20:	0 - 20 mA linear current output
0 - 1V:	0 - 1 V linear voltage output
0 - 5 V:	0 - 5 V linear voltage output
1 - 5 V:	1 - 5 V linear voltage output
0 - 10V:	0 - 10 V linear voltage output

O1TY

O2TY

O2TY: Selects the signal type for Output 2
The selection should be consistent with the output 2 module installed.
The available output 2 signal types are the same as for O1TY.

The range for linear current or voltage may not very accurate. For 0 % output, the value for 4 - 20 mA may be 3.8 mA to 4 mA, while for 100 % output, the value for 4 - 20 mA may be 20 mA to 21 mA. However, this deviation from ideal case will not affect the control performance at all.

3.3 Rearrange User Menu

The KS20-I has the flexibility to provide you to select those parameters which are most significant to you and put these parameters in the front of display sequence.

SEL1 : Selects the most significant parameter for view and change.
SEL2 : Selects the 2'nd significant parameter for view and change.
SEL3 : Selects the 3'rd significant parameter for view and change.
SEL4 : Selects the 4'th significant parameter for view and change.
SEL5 : Selects the 5'th significant parameter for view and change.

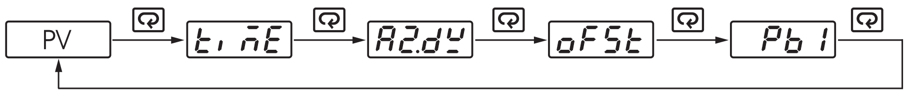
Range: NONE, TIME, A1.SP, A1.DV, A2.SP, A2.DV, RAMP, OFST, REFC, SHIF, PB1, TI1, TD1, C.PB, SP2, PB2, TI2, TD2

During you use the up-down key to select the parameters, you may not obtain all of the above parameters. The number of visible parameters is dependent on the setup condition. The hidden parameters for the specific application are also deleted from the SEL selection.

SEL1
SEL2
SEL3
SEL4
SEL5

Example:

A1FN selects TIMR
A2FN selects DE.HI
PB1 = 10
TI1 = 0
SEL1 selects TIME
SEL2 selects A2.DV
SEL3 selects OFST
SEL4 selects PB1
SEL5 selects NONE
Now, the upper display scrolling becomes :



3.3.1 Selecting the Display Process Value or Set Point

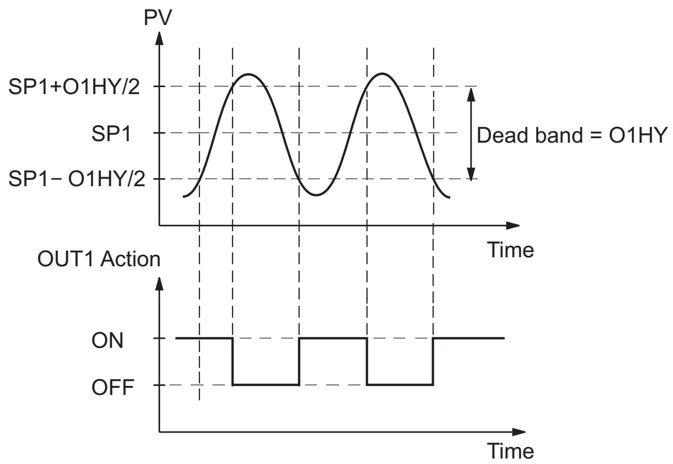
With some applications the set-point is more important than the process value. Using and you get to the setup menu. Press the key until parameter di SP appears. With the keys you can select PV for displaying the process value or SV for displaying the set-point.

3.4 Heat only control

Heat Only ON-OFF Control : Select REVR for OUT1, set PB1 to 0, SP1 is used to adjust set point value, O1HY is used to adjust dead band for ON-OFF control, TIME is used to adjust the dwell timer (enabled by selecting TIMR for A1FN or A2FN). The output 1 hysteresis (O1HY) is enabled in case of PB1 = 0 . The heat only on-off control function is shown in the following diagram :

Setup ON-OFF :
OUT1 = rEVr
PB1 = 0
Adjust: SP1, O1HY, TIME (if enabled)

Heat Only ON-OFF control



The ON-OFF control may introduce excessive process oscillation even if hysteresis is minimized to the smallest. If ON-OFF control is set (ie. PB1 = 0), TI1, TD1, CYC1, OFST, CPB will be hidden and have no function to the system. The manual mode, auto-tuning, self-tuning and bumpless transfer will be disabled too.

Setup P:
OUT1 = rEVr
TI1 = 0
CYC1 (if RELAY, SSR is selected for O1TY)

Adjust :
SP1, OFST, TIME (if enabled PB1 (≠ 0), TD1

Heat only P (or PD) control : Select REVR for OUT1, set TI1 to 0, SP1 is used to adjust set point value, TIME is used to adjust the dwell timer (enabled by selecting TIMR for A1FN or A2FN). OFST which is enabled in case of TI1 = 0 is used to adjust the control offset (manual reset). Adjust CYC1 according to the output1 type (O1TY).Generally, CYC1= 0.5 ~ 2 sec for SSR, CYC1=10 ~ 20 sec for relay output . CYC1 is inactive if linear output is selected for O1TY. O1TY is hidden if PB1 is not equal to 0.

OFST Function : OFST is measured in % with range 0 - 100.0 %. In the steady state (ie. process has been stabilized) if the process value is lower than the set point a definite value, say 5 ℃, while 20 ℃ is used for PB1, that is lower 25 %, then increase OFST 25 %, and vice versa.

After adjusting OFST value, the process value will be varied and eventually, coincide with set point. Using the P control (TI1 set to 0), the auto-tuning and self-tuning are disabled. Refer to section 3-19 " manual tuning " for the adjustment of PB1 and TD1. Manual reset (adjust OFST) is not practical because the load may change from time to time and often need to adjust OFST repeatedly. The PID control can avoid this situation.

Heat only PID control : Select REVR for OUT1, SP1 is used to adjust set point value, TIME is used to adjust the dwell timer (enabled by selecting TIMR for A1FN or A2FN). PB1 and TI1 should not be zero. Adjust CYC1 according to the output 1 type (O1TY). Generally, CYC1 = 0.5 ~ 2 sec for SSR, CYC1 = 10 ~ 20 sec for relay output. CYC1 is inactive if linear output is selected for O1TY.

In most cases the self-tuning can be used to substitute the auto-tuning. For critical process it is not recommended to use self-tuning. See section 3-17. If self-tuning is not used (select NONE for SELF), then use auto-tuning for the new process, or set PB1, TI1 and TD1 with historical values. See section 3-18 for auto-tuning operation. If the control result is still unsatisfactory, then use manual tuning to improve the control . See section 3-19 for manual tuning. The KS20-I contains a very clever PID and Fuzzy algorithm to achieve a very small overshoot and very quick response to the process if it is properly tuned.

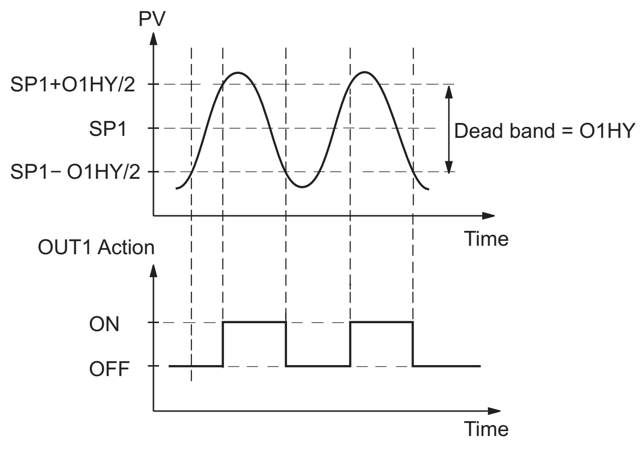
Setup PID :
OUT1 = rEVr
O1TY
CYC1 (if RELAY, SSRD or SSR is selected for O1TY)
SELF = NONE or STAR
Adjust:
SP1, TIME (if enabled), PB1 (≠ 0), TI1 (≠ 0), Td1.
Auto-tuning:
Used for new process.
Self-tuning:
Used for stable process.
Manual Tuning:
May be used if self-tuning and auto-tuning are inadequate.

3.5 Cool only control

ON-OFF control, P (PD) control and PID control can be used for cool control. Set OUT1 to DIRT (direct action). The other functions for cool only ON-OFF control, cool only P (PD) control and cool only PID control are same as descriptions in section 3-4 for heat only control except that the output variable (and action) for the cool control is inverse to the heat control, such as the following diagram shows:

Setup Cool Control :
OUT1 = dirt

ON-OFF control



Refer to section 3-4 in which similar descriptions for heat only control can be applied to cool only control.

3.6 Heat-Cool Control

The Heat-Cool Control can use one of 6 combinations of control modes.
Setup of parameters corresponding to each control mode are shown in the following table.

Hear-Cool control setup

Control Modes	Heat Uses	Cool Uses	Setup Values										
			OUT1	OUT2	O1HY	OFST	PB1	TI1	TD1	CPB	A2FN	A2MD	A2HY
Heat : ON-OFF Cool : ON-OFF	OUT1	OUT2	REVR	=AL2	☆	×	=0	×	×	×	DE.HI or PV1.H	NORM	☆
Heat : ON-OFF Cool : P (PD)	OUT2	OUT1	DIRT	=AL2	×	☆	≠0	=0	☆	×	DE.LO or PV1.L	NORM	☆
Heat : ON-OFF Cool : PID	OUT2	OUT1	DIRT	=AL2	×	×	≠0	≠0	☆	×	DE.LO or PV1.L	NORM	☆
Heat : P (PD) Cool : ON-OFF	OUT1	OUT2	REVR	=AL2	×	☆	≠0	=0	☆	×	DE.HI or PV1.H	NORM	☆
Heat : PID Cool : ON-OFF	OUT1	OUT2	REVR	=AL2	×	×	≠0	≠0	☆	×	DE.HI or PV1.H	NORM	☆
Heat : PID Cool : PID	OUT1	OUT2	REVR	COOL	×	×	≠0	≠0	☆	☆	×	×	×

× : Don't care
☆ : Adjust to meet process requirements

NOTE : The ON-OFF control may result excessive overshoot and undershoot problems in the process. The P (or PD)control will result a deviation process value from the set point. It is recommended to use PID control for the Heat-Cool control to produce a stable and zero offset process value.

Other Setup Required : O1TY, CYC1, O2TY, CYC2, A2SP, A2DV O1TY & O2TY are set in accordance with the types of OUT1 & OUT2 installed. CYC1 & CYC2 are selected according to the output1 type (O1TY) & output2 type (O2TY).
Generally, CYC1 selects 0.5 ~ 2 sec. if SSRD or SSR is used for O1TY, 10 ~ 20 sec. if relay is used for O1TY, and CYC1 is inactive if linear output is used. Similar condition is for CYC2 selection.
If OUT2 is configured for ON-OFF control (by selecting = AL2), the OUT2 acts as alarm output, and the process alarm as well as deviation alarm (see section 3-8 & 3-9) can be used. Adjust A2SP to change set point if process alarm is used, and adjust SP1 (with preset A2DV) to change set point if deviation alarm is used.

Examples:

Heat, PID+Cool ON-OFF : Set OUT1= REVR, OUT2= =AL2, A2FN= PV1.H, A2MD=NORM, A2HY=0.1, PB1=0, TI1=0,TD1=0, and set appropriate values for O1TY, CYC1, O2TY and CYC2.

Heat PID+Cool PID : set OUT1=REVR, OUT2=COOL, CPB=100, PB1=0, TI1=0 TD1=0, and set appropriate values for O1TY, CYC1, O2TY, CYC2. If the process is a stable system, you can select STAR for SELF to activate the self-tuning program. If the process is a critical system, then select NONE for SELF to disable the self-tuning program. See section 3-17 for self-tuning description. You can use the auto-tuning program for the new process or directly set the appropriate values for PB1, TI1 & TD1 according to the historical records for the repeated systems. If the control behavior is still inadequate, then use manual tuning to improve the control. See section 3-19 for manual tuning.

Adaptive Heat-Cool Dead Band : Conventional controllers use a fixed dead band which needs to be programmed by the user. The programming of dead band is difficult. If a positive value of dead band is used, the cooling action begins to operate until the process value exceeds the dead band. Because no cooling action within the dead band the process will result an excessive overshoot over the set point. On the other hand, if a negative value of dead band is used, the cooling action will continue to operate even if the process value is below the set point. Hence the energy is wasted because both the heating and cooling actions operate to the process simultaneously.

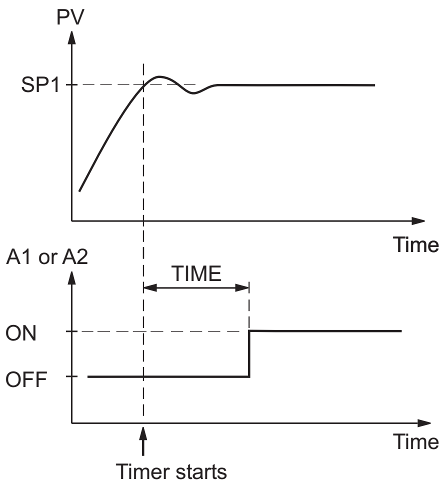
In order to prevent the above problems, The KS20-I contains a very clever algorithm. The user no longer needs to program the dead band. The dead band is implicitly contained in a program such that if the process value increases (not necessarily exceeds the set point), the cooling control will provide an optimal amount of cool to the process. If the process value decreases, the control will adjust its adaptive dead band to increase the heating action and decreases the cooling action immediately. While in the steady state the heating and cooling will not operate simultaneously to minimize the energy consumption.

CPB Programming : The cooling proportional band is measured in % of PB with range 1~255. Initially set 100% for CPB and examine the cooling effect. If cooling action should be enhanced then decrease CPB, if cooling action is too strong then increase CPB. The value of CPB is relative to PB and its value remains unchanged throughout the self-tuning and auto-tuning procedures.

3.7 Dwell Timer

Alarm1 or alarm 2 can be configured as dwell timer by selecting TIMR for A1FN or A2FN, but not both, otherwise Er07 will appear. As the dwell timer is configured, the TIME in user menu is used for dwell time adjustment. The dwell time is measured in minute ranging from 0 to 6553.5 minutes. Once the process reaches the set point the dwell timer starts to count from zero until time out. The timer relay will remain unchanged until time out. The dwell timer operation is shown as following diagram.

Dwell timer function



If alarm 1 is configured as dwell timer, A1SP, A1DV, A1HY and A1MD are hidden. Same case is for alarm 2.

Example :
Set A1FN=TIMR or A2FN=TIMR but not both.
Adjust TIME in minutes
A1MD (if A1FN=TIMR) or A2MD (if A2FN=TIMR) is inactive in this case.
If a form B relay is required for dwell timer, then order form B alarm 1 and configure A1FN. Form B relay is not available for alarm 2.

3.8 Process Alarms

There are at most two independent alarms available by adjusting OUT2. If =AL2 is selected for OUT2, then OUT2 will perform alarm 2 function. Now A2FN can't select NONE, otherwise Er06 will be displayed. A process alarm sets an absolute trigger level (or temperature). When the process (could be PV1, PV 2 or PV1-PV2) exceeds that absolute trigger level an alarm occurs. A process alarm is independent from set point.

Er06 Error Code

Adjust A1FN (Alarm 1 function) in setup menu. One of 8 functions can be selected for process alarm. These are : PV1.H, PV1.L, PV2.H, PV2.L, P1.2.H, P1.2.L, D1.2.H, D1.2.L. When the PV1.H or PV1.L is selected the alarm examines the PV1 value. When the PV2.H or PV2.L is selected the alarm examines the PV2 value. When the P1.2.H or P1.2.L is selected the alarm occurs if the PV1 or PV2 value exceed the trigger level. When the D1.2.H or D1.2.L is selected the alarm occurs if the PV1-PV2 (difference) value exceeds the trigger level.

8 Types of Process Alarms :
PV1.H, PV1.L, PV2.H, PV2.L, P1
P1.2.L, D1.2.H, D1.2.L

The trigger level is determined by A1SP (Alarm 1 set point) and A1HY (Alarm 1 hysteresis value) in User Menu for alarm 1. The hysteresis value is introduced to avoid interference action of alarm in a noisy environment.

Process Alarm 1
Setup : A1FN, A1MD
Adjust : A1SP, A1HY
Trigger level =
A1SP + 1/2 A1HY

Normally A1HY can be set with a minimum (0.1) value.
A1DV and/or A2DV are hidden if alarm 1 and/or alarm 2 select process alarm.

Process Alarm 2
Setup : OUT2, A2FN, A2MD
Adjust : A2SP, A2HY
Trigger level =
A2SP + 1/2 A2HY

Normal Alarm : A1MD = NORM
When a normal alarm is selected, the alarm output is de-energized in the non-alarm condition and energized in an alarm condition.

Latching Alarm : A1MD = LTCH
When a latching alarm is selected, once the alarm output is energized, it will remain unchanged even if the alarm condition has been cleared unless the power is shut off or apply event input in accordance with appropriate selection of EIFN.

Reset Latching alarm
1. Power off
2. Apply Event input in accordance with appropriate selection of EIFN

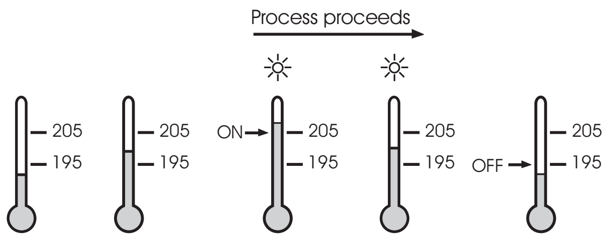
Holding Alarm : A1MD = HOLD
A holding alarm prevents an alarm on power up. The alarm is enabled only when the process reaches the set point value (may be SP1 or SP2, see selection 4-1 event input). Afterward, the alarm performs same function as normal alarm.

Latching / Holding Alarm : A1MD = LT.HO
A latching / holding alarm performs both holding and latching function.

Examples:

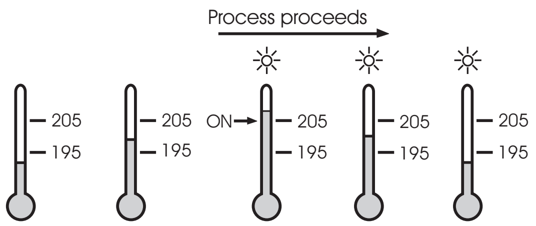
Normal Process Alarm

A1SP = 200 A1HY = 10.0
A1MD = NORM A1FN = PV1.H



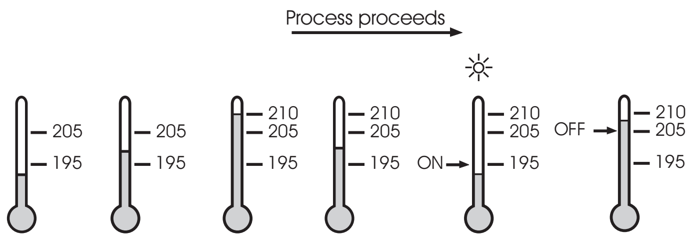
Latching Process Alarm

A1SP = 200 A1HY = 10.0
A1MD = LTCH A1FN = PV1.H



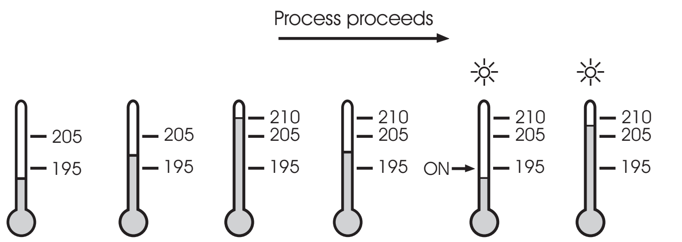
Holding Process Alarm

A1SP = 200 A1HY = 10.0 SP1 = 210
A1MD = HOLD A1FN = PV1.L



Latching / Holding Process Alarm

A1SP = 200 A1HY = 10.0 SP1 = 210
A1MD = LT.HO A1FN = PV1.L



Although the above descriptions are based on alarm 1, the same conditions can be applied to alarm 2.

3.9 Deviation Alarm

OUT2 can be configured as alarm 2 by selecting =AL2.
If OUT2 selects = AL2, then output2 will perform alarm 2 function.
Now A2FN can't select NONE, otherwise Er06 will appear.
A deviation alarm alerts the user when the process deviates too far from set point. The user can enter a positive or negative deviation value (A1DV, A2DV) for alarm1 and alarm 2. A hysteresis value (A1HY or A2HY) can be selected to avoid interference problem of alarm in a noisy environment. Normally, A1HY and A2HY can be set with a minimum (0.1) value. Trigger levels of alarm are moving with set point.
For alarm1, Trigger levels=SP1+A1DV±1/2 A1HY.
For alarm2, Trigger levels=SP1+A2DV±1/2 A2HY.
A1SP and/or A2SP are hidden if alarm1 and/or alarm 2 select deviation alarm. One of 4 kinds of alarm modes can be selected for alarm1 and alarm 2, these are: Normal alarm, Latching alarm, Holding alarm and Latching/Holding alarm.
See section 3-8 for the descriptions of these alarm modes.

Er06 Error Code

2 Types of Deviation Alarms :
DE.HI, DE.LO

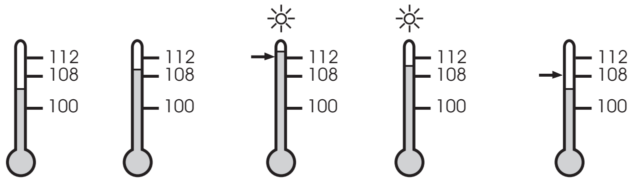
Deviation Alarm1
Setup : A1FN, A1MD
Adjust : SP1, A1DV, A1HY
Trigger levels=
SP1+A1DV+1/2A1HY

Deviation Alarm2 :
Setup : OUT2, A2FN, A2MD
Adjust : SP1, A2DV, A2HY
Trigger levels=
SP1+A2DV+1/2A2HY

Examples:

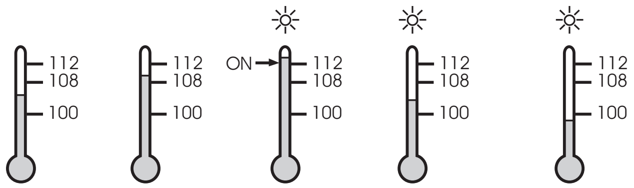
Normal Deviation Alarm

A1FN = DE.HI, A1MD = NORM, SP1 = 100, A1DV=10, A1HY=4



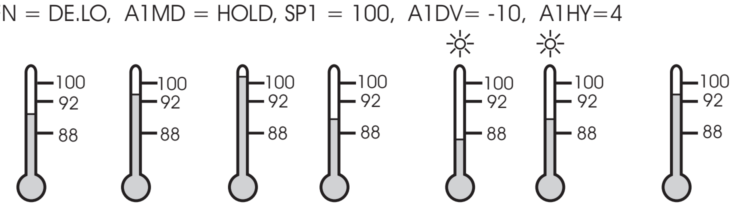
Latching Deviation Alarm

A1FN = DE.HI, A1MD = LTCH, SP1 = 100, A1DV=10, A1HY=4



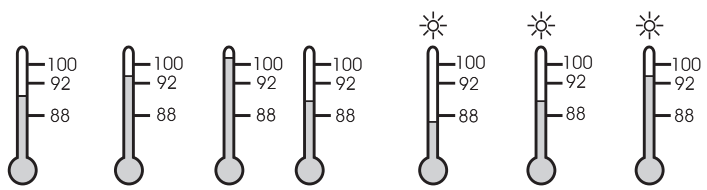
Holding Deviation Alarm

A1FN = DE.LO, A1MD = HOLD, SP1 = 100, A1DV= -10, A1HY=4



Latching /Holding Deviation Alarm

A1FN= DE.LO, A1MD = LT.HO, SP1 = 100, A1DV= -10, A1HY=4



3.10 Deviation Band Alarm

A deviation band alarm presets two reference levels relative to set point. Two types of deviation band alarm can be configured for alarm 1 and alarm 2. These are deviation band high alarm (A1FN or A2FN select DB.HI) and deviation band low alarm (A1FN or A2FN select DB.LO). If alarm 2 is required, then select =AL2 for OUT2. Now A2FN can't be selected with NONE, otherwise Er06 will appear. A1SP and A1HY are hidden if alarm 1 is selected with deviation band alarm. Similarly, A2SP and A2HY are hidden if alarm 2 is selected with deviation band alarm. Trigger levels of deviation band alarm are moving with set point. For alarm 1, trigger levels = SP1AA1DV.

For alarm 2, trigger levels = SP1AA2DV. One of 4 kinds of alarm modes can be selected for alarm 1 and alarm 2. These are : Normal alarm, Latching alarm, Holding alarm and Latching/Holding alarm. See Section 3-8 for descriptions of these alarm modes.

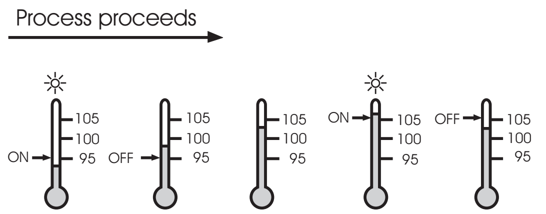
2 Types of Deviation Band Alarms:
DB.HI, DB.LO
Deviation Band Alarm 1 :
Setup: A1FN, A1MD
Adjust: SP1, A1DV
Trigger levels= SP1±A1DV
Deviation Band Alarm 2 :
Setup : OUT2, A2FN, A2MD
Adjust : SP1, A2DV
Trigger levels = SP1±A2DV

Er06 Error Code

Examples:

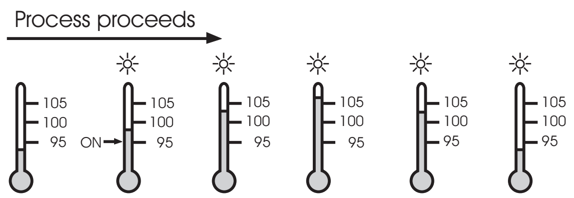
Normal Deviation Band Alarm

A1FN = DB.HI, A1MD = NORM, SP1 = 100, A1DV = 5



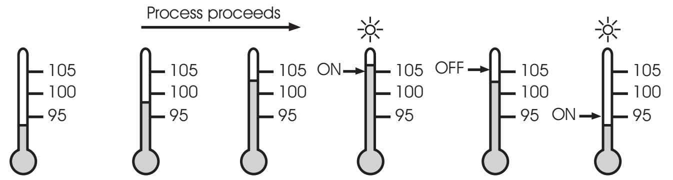
Latching Deviation Band Alarm

A1FN = DB.LO, A1MD = LTCH, SP1 = 100, A1DV = 5



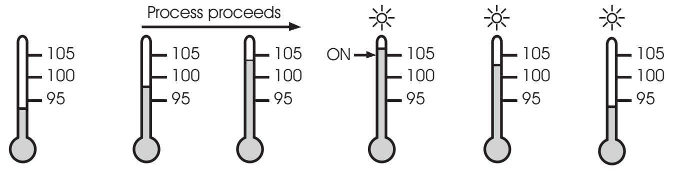
Holding Deviation Band Alarm

A1FN = DB.HI, A1MD = HOLD, SP1 = 100, A1DV = 5



Latching /Holding Deviation Band Alarm

A1FN = DB.HI, A1MD = LT.HO, SP1 = 100, A1DV = 5



3.11 Heater Break Alarm

A current transformer (order-no. 9407 998 00051) should be installed to detect the heater current if a heater break alarm is required.
The CT signal is sent to input 2, and the PV2 will indicate the heater current in 0.1 Amp. resolution. The range of current transformer is 0 to 50.0 Amp. For more detailed descriptions about heater current monitoring, please see Section 3-22.

Example:
A furnace uses two 2KW heaters connected in parallel to warm up the process. The line voltage is 220V and the rating current for each heater is 9.09A. If we want to detect any one heater break, set A1SP= 13.0A, A1HY=0.1A1FN=PV2.L, A1MD=NORM, then

Heater Break Alarm

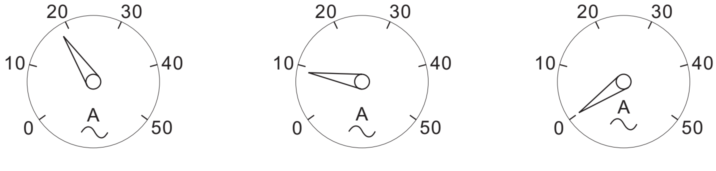
No heater breaks

1 heater breaks

Alarm !

2 heaters breaks

Alarm !



Heater Break Alarm 1
Setup : IN2 = CT
A1FN = PV2.L
A1MD = NORM
A1HY = 0.1
Adjust : A1SP
Trigger levels : A1SP A1/2 A1HY

Heater Break Alarm 2
Setup : IN2 = CT
A2FN = PV2.L
A2MD = NORM
A2HY = 0.1
Adjust : A2SP
Trigger levels : A2SP A1/2 A2HY

Limitations :
1. Linear output can't use heater break alarm.
2. CYC1 should use 1 second or longer to detect heater current reliably.

3.12 Loop Break Alarm

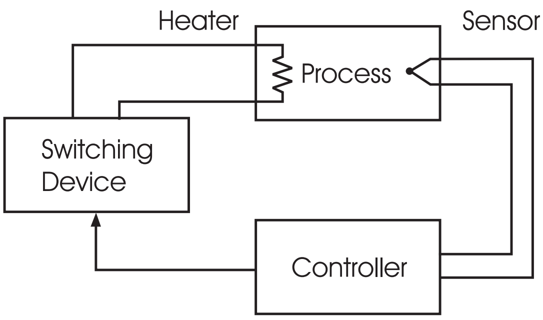
A1FN selects LB if alarm 1 is required to act as a loop break alarm. Similarly, if alarm 2 is required to act as loop break alarm, then OUT2 selects = AL2 and A1FN selects LB.
A1SP, A1DV and A1HY are hidden if alarm 1 is configured as a loop break alarm. Similarly, A2SP, A2DV and A2HY are hidden if alarm 2 is configured as a loop break alarm.
One of 4 kinds of alarm modes can be selected for alarm 1 and alarm 2, these are : Normal alarm, Latching alarm, Holding alarm and Latching/ Holding alarm. See section 3-8 for the descriptions of these alarm modes.

Loop Break Alarm 1
Setup : A1FN = LB
A1MD

Loop Break Alarm 2
Setup : OUT2 = =AL2
A2FN = LB
A2MD

Loop Break Conditions are detected during a time interval of 2TI1 (double of integral time, but 120 seconds maximum). Hence the loop break alarm doesn't respond quickly as it occurs. If the process value doesn't increase (or decrease) while the control variable MV1 has reached to its maximum (or minimum) value within the detecting time interval, a loop break alarm (if configured) will be actuated.

Loop Break Sources



Loop Break Sources : Sensor, Controller, Heater, Switching Device

Loop Break Alarm (if configured) may occur as one of the following conditions happens:
1. Input sensor is disconnected (or broken).
2. Input sensor is shorted.
3. Input sensor defective.
4. Input sensor is installed outside (isolated from) the process.
5. Controller fails (A-D converter damage).
6. Heater (or generally, chiller, valve, pump, motor etc.) breaks or fails or is uninstalled.
7. Switching device (used to drive heater) is open or shorted.

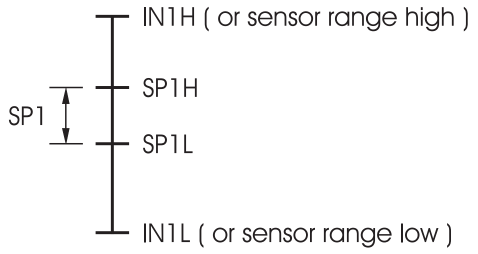
3.13 SP1 Range

Setup : SP1L, SP1H

SP1L (SP1 low limit value) and SP1H (SP1 high limit value) in setup menu are used to confine the adjustment range of SP1.

Example : A freezer is working in its normal temperature range -10 °C to -15 °C. In order to prevent an abnormal set point, SP1L and SP1H are set with the following values:
SP1L = -15 °C SP1H = -10 °C
Now SP1 can only be adjusted within the range from -10 °C to -15 °C.

SP1 Range



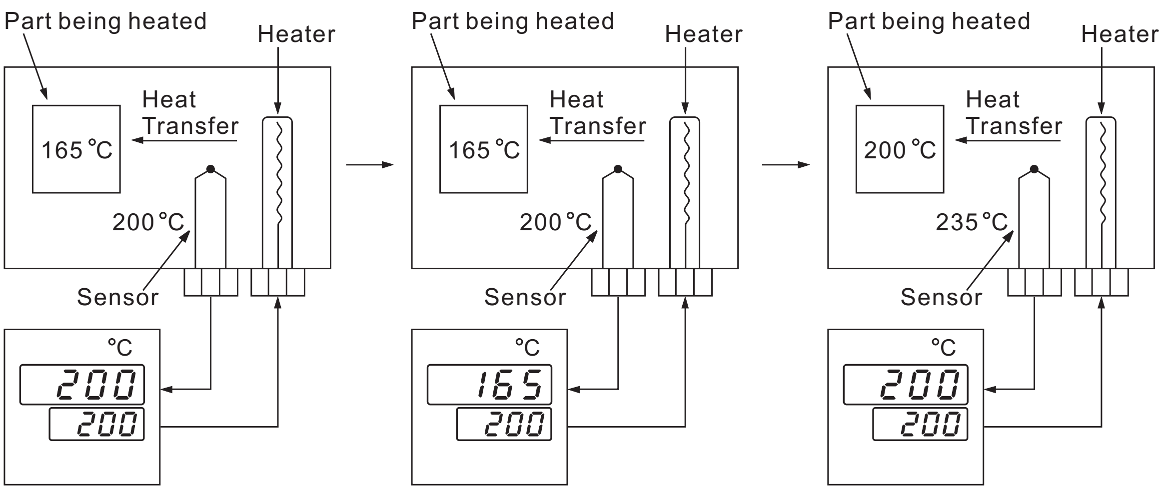
3.14 PV1 Shift

In certain applications it is desirable to shift the controller indicated value from its actual value. This can be easily accomplished with this control by using the PV1 shift function.

Cycle the control to the SHIF parameter by using the " Scroll " key. The number you adjust here, either positive or negative, will be added to the actual value. The SHIF function will alter PV1 only.

Here is an example. A process is equiped with a heater to warm the part and a thermocouple to sense the temperature. Due to the design and position of the components of the system, the sensor could not be placed any closer to the part. Thermal gradient (different temperature) is common and necessary to an extent in any thermal system for heat to be transferred from one point to another. If the difference between the sensor and the part is 35° C, and the desired temperature at the part to be heated is 200° C, the controlling value or the temperature at the sensor should be 235° C. You should input -35° C as to subtract 35° C from the actual process display. This in turn will cause the controller to energize the load and bring the process display up to the set point value.

PV1 Shift Application



35 °C temperature difference is observed
SHIF= 0

Adjust SHIF
SHIF= -35 °C
Supply more heat

Display is stable
SHIF= -35 °C
PV=SV

3.15 Failure Transfer

The controller will enter failure mode as one of the following conditions occurs:
1. SB1E occurs (due to the input 1 sensor break or input 1 current below 1mA if 4-20 mA is selected or input 1 voltage below 0.25V if 1-5 V is selected) if PV1, P1-2 or P2-1 is selected for PVMD.
2. SB2E occurs (due to the input 2 sensor break or input 2 current below 1mA if 4-20 mA is selected or input 2 voltage below 0.25V if 1-5 V is selected) if PV2, P1-2 or P2-1 is selected for PVMD.
3. ADER occurs due to the A-D converter of the controller fails.

The output 1 and output 2 will perform the failure transfer function as one of the following conditions occurs:
1. During power starts (within 2.5 seconds).
2. The controller enters the failure mode.
3. The controller enters the manual mode.
4. The controller enters the calibration mode.

Output 1 Failure Transfer, if activated, will perform :
1. If output 1 is configured as proportional control (PB1 ≠ 0), and BPLS is selected for O1FT, then output 1 will perform bumpless transfer. Thereafter the previous averaging value of MV1 will be used for controlling output 1.
2. If output 1 is configured as proportional control (PB1 ≠ 0), and a value of 0 to 100.0 % is set for O1FT, then output 1 will perform failure transfer. Thereafter the value of O1FT will be used for controlling output 1.
3. If output 1 is configured as ON-OFF control (PB1 = 0), then ' output 1 will be driven OFF if O1FN selects REVR and be driven ON if O1FN selects DIRT.

Output 2 Failure Transfer, if activated, will perform :
1. If OUT2 selects COOL, and BPLS is selected for O1FT, then output 2 will perform bumpless transfer. Thereafter the previous averaging value of MV2 will be used for controlling output 2.
2. If OUT2 selects COOL, and a value of 0 to 100.0 % is set for O2FT, then output 2 will perform failure transfer. Thereafter the value of O1FT will be used for controlling output 2.

Alarm 1 Failure Transfer is activated as the controller enters failure mode. Thereafter the alarm 1 will transfer to the ON or OFF state preset by A1FT.
Exception: If Loop Break (LB) alarm or sensor Break (SENB) alarm is configured for A1FN, the alarm 1 will be switched to ON state independent of the setting of A1FT. If Dwell Timer (TIMR) is configured for A1FN, the alarm 1will not perform failure transfer.

Alarm 2 Failure Transfer is activated as the controller enters failure mode. Thereafter the alarm 2 will transfer to the ON or OFF state preset by A2FT.
Exception: If Loop Break (LB) alarm or sensor Break (SENB) alarm is configured for A2FN, the alarm 2 will be switched to ON state independent of the setting of A2FT. If Dwell Timer (TIMR) is configured for A2FN, the alarm 2 will not perform failure transfer.

Failure Mode occurs as :
1. SB1E
2. SB2E
3. ADER

Failure Transfer of outout 1 and output 2 occurs as :
1. Power start (within 2.5 seconds)
2. Failure mode is activated
3. Manual mode is activated
4. Calibration mode is activated

Failure Transfer of alarm 1 and alarm 2 occurs as :
1. Failure mode is activated

Failure Transfer Setup :
1. O1FT
2. O2FT
3. A1FT
4. A2FT

3.16 Bumpless Transfer

The bumpless transfer function is available for output 1 and output 2 (provided that OUT2 is configured as COOL).

Bumpless Transfer is enabled by selecting BPLS for O1FT and/ or O2FT and activated as one of the following cases occurs :
1. Power starts (within 2.5 seconds).
2. The controller enters the failure mode. See section 3-15 for failure mode descriptions.
3. The controller enters the manual mode. See section 4-13 for manual mode descriptions.
4. The controller enters the calibration mode. See chapter 6 for calibration mode descriptions.

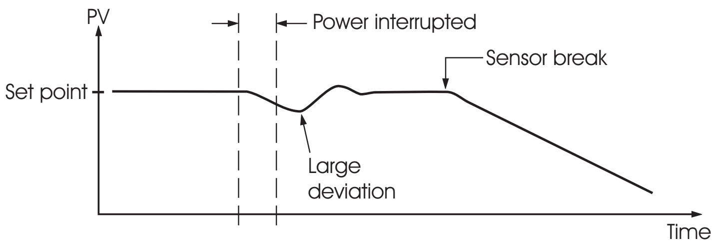
As the bumpless transfer is activated, the controller will transfer to open-loop control and uses the previous averaging value of MV1 and MV2 to continue control.

Bumpless Transfer Setup :
1. O1FT = BPLS
2. O2FT = BPLS

Bumpless Transfer occurs as :
1. Power Starts (within 2.5 seconds)
2. Failure mode is activated
3. Manual mode is activated
4. Calibration mode is activated

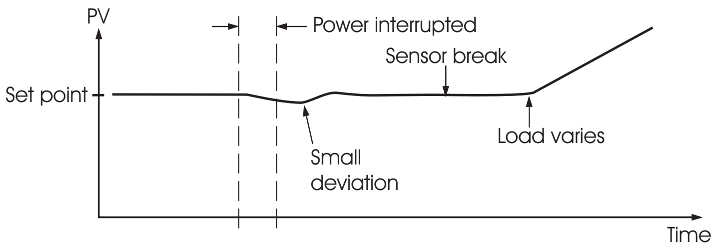
Benefits of bumpless transfer

Without Bumpless Transfer



Since the hardware and software need time to be initialized, the control is abnormal as the power is recovered and results a large disturbance to the process. During the sensor breaks, the process loses power.

With Bumpless Transfer



With bumpless transfer configured, the correct control variable is applied immediately as the power is recovered, the disturbance is small. During the sensor breaks, the controller continues to control by using its previous value. If the load doesn't change, the process will remain stable. Thereafter, once the load changes, the process may run away. Therefore, you should not rely on a bumpless transfer for a longer time. For fail safe reason, an additional alarm should be used to announce the operator when the system fails. For example, an independent alarm with High Alarm configured will switch to failure state and announces the operator to use manual control or take a proper security action when the system enters failure mode.

⚠ **Warning :As system fails, never depend on bumpless transfer for a long time, otherwise the run away problem will rise.**

3.17 Self-tuning

The Self-tuning (Adaptive tune) is available for tuning a process from time to time. For most stable process the Self-tuning will perform successfully without the need to apply an auto-tuning.

If the Self-tuning is not suitable for a critical process, you must select NONE for SELF (in the Setup menu) to disable the Self-tuning function.

If the self-tuning is desirable, you can select STAR for SELF to enable the self-tuning. The controller will change its control parameters and monitor the process behavior from time to time, and an optimal control factor is updated and stored in memory. If this happens, the self-tuning menu (SELF) will change to next state End to announce the user while the optimal condition is maintained. Afterward, if the set point has been changed or the load disturbance occurs such that the process behavior deviates from its optimal condition a significant factor, the SELF will revert to STAR state and restarts a new self tuning procedure.

If the self-tuning is enabled, the auto-tuning can still be used any time. The self-tuning will use the auto-tuning results for its initial values.

Self-tune Menu

SELF

↓ Selects

nonE Disable Self-tuning

or

StAr Enable Self-tuning

or

End Self-tuning complete

Exceptions:
Self-tuning does not function with:
1. SELF is set to NONE
2. Two-point control (ON-OFF control), PB=0
3. P / PD control, TI=0
4. Input circuit monitoring has responded.
5. Error monitoring has responded (e.g. sensor break)
6. Manual mode
7. "Sleep” mode
8. Calibration mode

During self-tuning, self-tuning at the set-point (auto-tune) can be started at any time. The PID parameters thus determined are used as start values for further self-tuning.

Self-tuning advantages
1. Process without major disturbances
2. The controller remains in automatic mode with PID behaviour.
3. During self-tuning, the set-point can be adjusted.
   Consequently, the method can be used also with the set-point ramp function and with external set-point.

3.18 Auto-tuning

⚠ The auto-tuning process is performed at set point.
The process will oscillate about the set point during tuning procedure. Set a set point to a lower value if overshoot beyond the normal process value is likely to cause damage.

The auto-tuning is applied in cases of :

* Initial setup for a new process
* The set point is changed substantially from the previous auto-tuning value
* The control result is unsatisfactory

Operation :

1. The system has been installed normally.
2. Use the default values for PID before tuning.
   The default values are : PB1=PB2=18.0 F.°
   TI1=TI2=100 sec, TD1=TD2=25.0 sec, of course, you can use other reasonable values for PID before tuning according to your previous experience. But don't use a zero value for PB1 and TI1 or PB2 and TI2, otherwise, the auto-tuning program will be disabled.
3. Set the set point to a normal operating value or a lower value if overshoot beyond the normal process value is likely to cause damage.
4. Press [⟲] [⋎] until [A_t] [----] appears on the display.
5. Press [⟲] for at least 3 seconds. The upper display will begin to flash and the auto-tuning procedure is beginning.

Applicable Conditions :
PB1≠0, TI1≠0 if PB1,TI1, TD1 assigned

PB2=0, TI2=0, if PB2, TI2, TD2 assigned

NOTE :
Any of the ramping function, remote set point or pump function, if used, will be disabled while auto-tuning is proceeding.

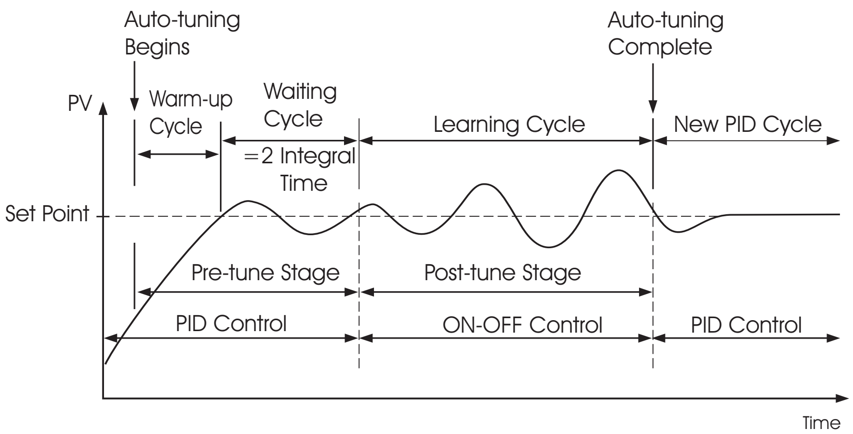
Procedures:
The auto-tuning can be applied either as the process is warming up (Cold Start) or as the process has been in steady state (Warm Start).

If the auto-tuning begins apart from the set point (Cold Start), the unit enters Warm-up cycle. As the process reaches the set point value, the unit enters waiting cycle. The waiting cycle elapses a double integral time (TI1 or TI2, dependent on the selection) then it enters a learning cycle. The double integral time is introduced to allow the process to reach a stable state. Before learning cycle, the unit performs pre-tune function with a PID control. While in learning cycle the unit performs post-tune function with an ON-OFF control. Learning cycle is used to test the characteristics of the process. The data are measured and used to determine the optimal PID values. At the end of the two successive ON-OFF cycles the PID values are obtained and automatically stored in the nonvolatile memory.
After the auto-tuning procedures are completed, the process display will cease to flash and the unit revert to PID control by using its new PID values.
During pre-tune stage the PID values will be modified if any unstable phenomenon which is caused by incorrect PID values is detected.
Without pre-tune stage, like other conventional controller, the tuning result will be strongly related to the time when the auto-tuning is applied. Hence different values will be obtained every time as auto-tuning is completed without pre-tune. It is particularly true when the auto-tuning are applied by using cold start and warm start.

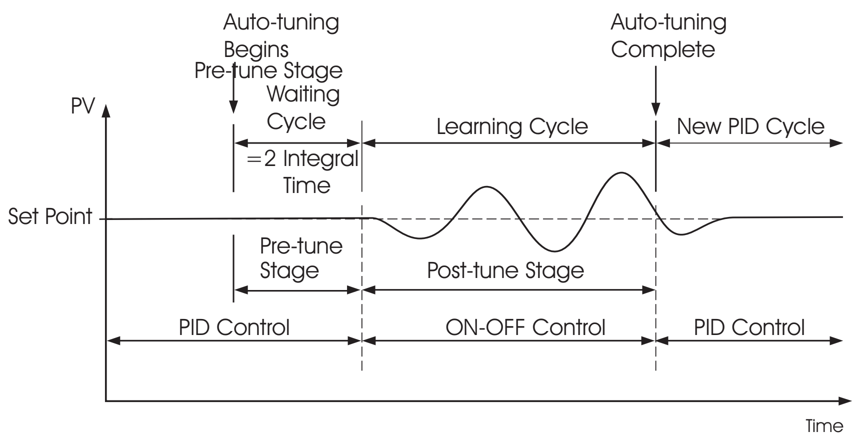
Pre-tune Function Advantage:
Consistent tuning results can be obtained

Auto-tuning Procedure

Cold Start



Warm Start



If the auto-tuning begins near the set point (warm start), the unit passes the warm-up cycle and enters the waiting cycle. Afterward the procedures are same as that described for cold start.

AtEr Auto-Tuning Error

AtEr Auto-Tuning Error

If auto-tuning fails an ATER message will appear on the upper display in cases of :

- If PB exceeds 9000 (9000 PU, 900.0 °F or 500.0 °C).
- or if TI exceeds 1000 seconds.
- or if set point is changed during auto-tuning procedure.
- or if event input state is changed such that set point value is changed.

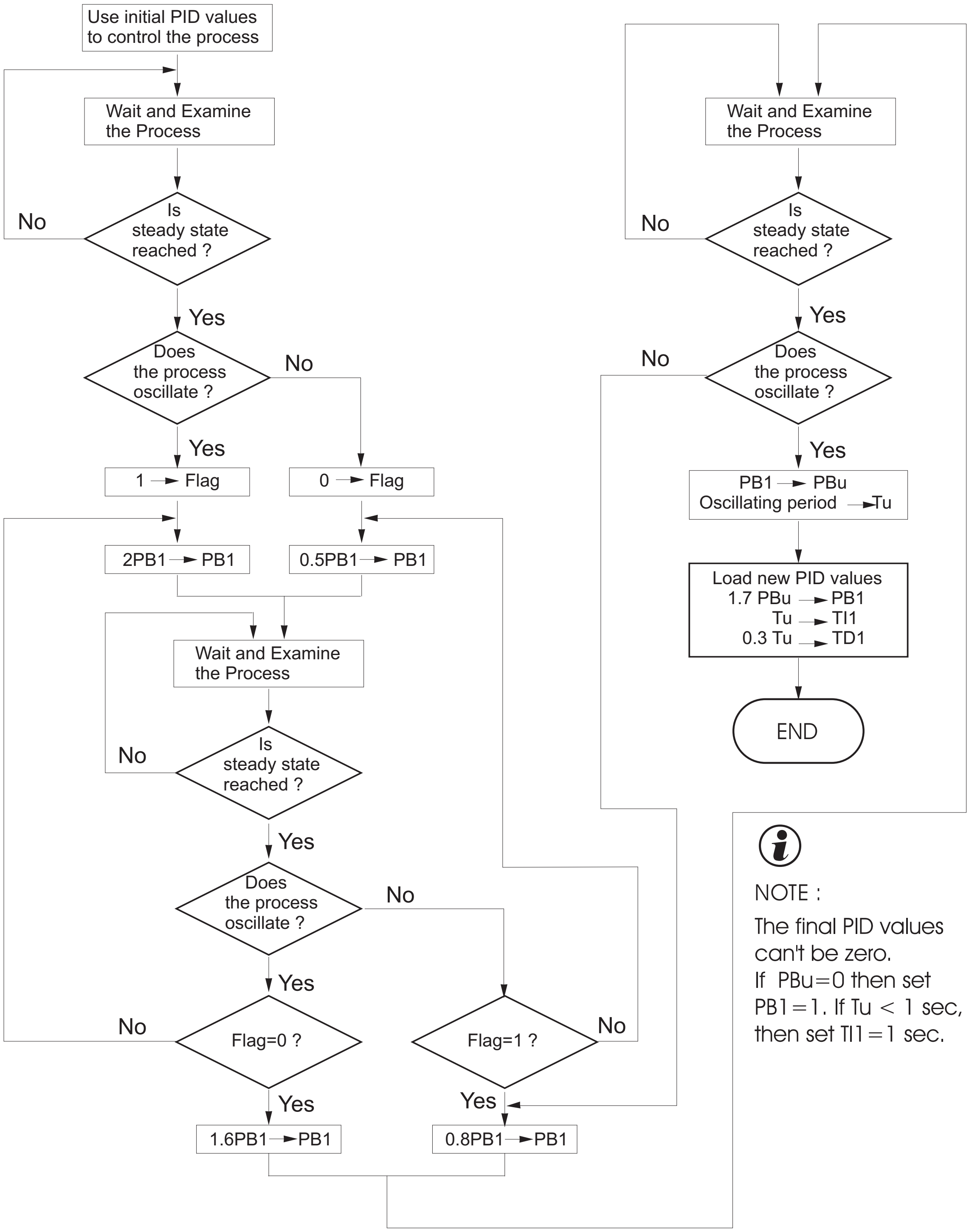
Solutions to AtEr

1. Try auto-tuning once again.
2. Don't change set point value during auto-tuning procedure.
3. Don't change event input state during auto-tuning procedure.
4. Use manual tuning instead of auto-tuning. (See section 3-19).
5. Touch any key to reset AtEr message.

3.19 Manual Tuning

In certain applications (very few) using both self-tuning and auto-tuning to tune a process may be inadequate for the control requirement, then you can try manual tuning. Connect the controller to the process and perform the procedures according to the flow chart shown in the following diagram.

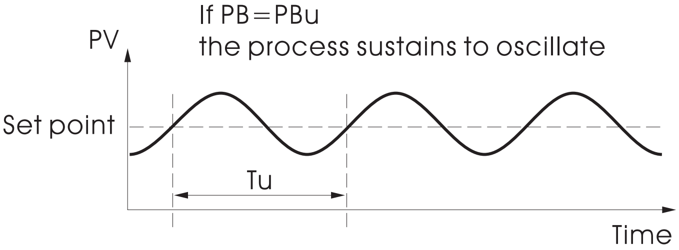
Manual Tuning Procedure



The above procedure may take a long time before reaching a new steady state since the P band was changed. This is particularly true for a slow process. So the above manual tuning procedures will take from minutes to hours to obtain optimal PID values.

The PBu is called the Ultimate P Band and the period of oscillation Tu is called the Ultimate Period in the flow chart of Figure 3.23 . The process during this occurs is called in a critical steady state. Figure 3.24 shows a critical steady state occasion.

Critical Steady State



If the control performance by using above tuning is still unsatisfactory, the following rules can be applied for further adjustment of PID values :

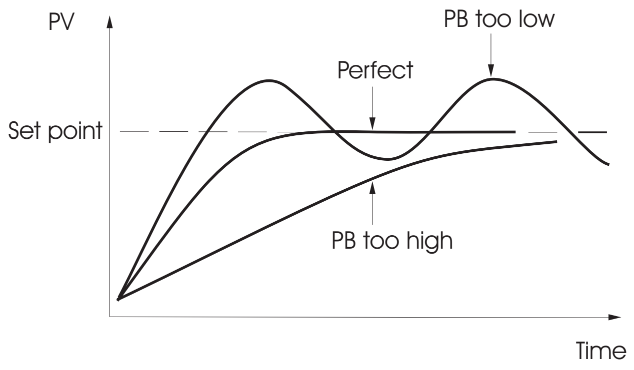
PID Adjustment Guide

ADJUSTMENT SEQUENCE	SYMPTION	SOLUTION
(1) Proportional Band (P) PB1 and/or PB2	Slow Response	Decrease PB1 or PB2
	High overshoot or Oscillations	Increase PB1 or PB2
(2) Integral Time (I) TI1 and/or TI2	Slow Response	Decrease TI1 or TI2
	Instability or Oscillations	Increase TI1 or TI2
(3) Derivative Time (D) TD1 and/or TD2	Slow Response or Oscillations	Decrease TD1 or TD2
	High Overshoot	Increase TD1 or TD2

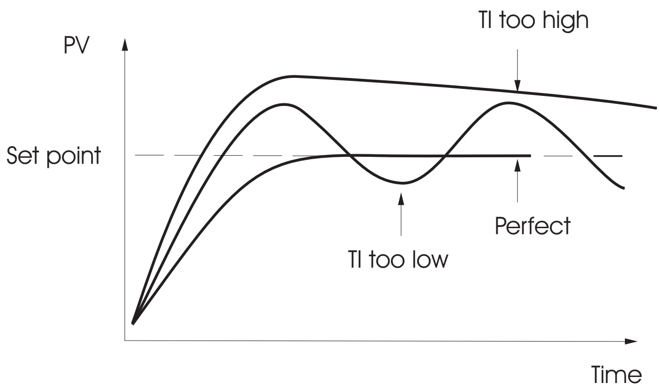
The following figures show the effects of PID adjustment on process response.

Effects of PID Adjustment

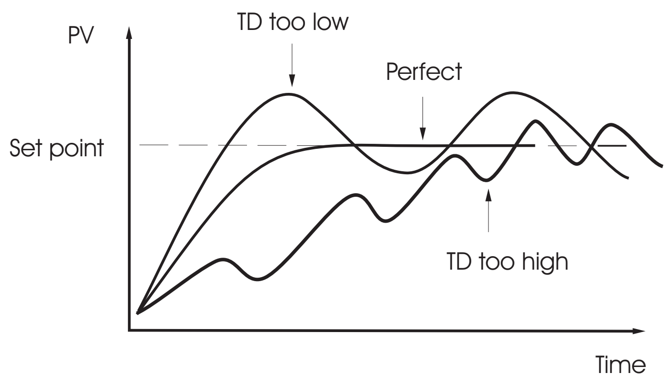
P action



I action



D action



3.20 Manual Control

The manual control may be used for the following purposes:

1. To test the process characteristics to obtain a step response as well as an impulse response and use these data for tuning a controller.
2. To use manual control instead of a close loop control as the sensor fails or the controller's A-D converter fails. NOTE that a bumpless transfer can not be used for a longer time. See section 3-16.
3. In certain applications it is desirable to supply a process with a constant demand.

Operation:

Press ↻ ▼ until HAnd Cont (Hand Control) appears on the display. Press ↻ for 3 seconds then the upper display will begin to flash and the lower display will show H _ _ _. The controller now enters the manual control mode. Pressing ↻ the lower display will show C _ _ _ and H _ _ _ alternately where H _ _ _ indicates output 1 (or heating) control variable value MV1 and C _ _ _ indicates output 2 (or cooling) control variable value MV2. Now you can use up-down key to adjust the percentage values for H or C.

H38.4 Means MV1=38.4 % for OUT1 (or Heating)

C7.63 Means MV2=7.63 % for OUT2 (or Cooling)

The controller performs open loop control as long as it stays in manual control mode. The H value is exported to output 1 (OUT1) and C value is exported to output 2 provided that OUT2 is performing cooling function (ie. OUT2 selects COOL).

Exception

If OUT1 is configured as ON-OFF control (ie. PB1=0 if PB1 is assigned or PB2=0 if PB2 is assigned by event input), the controller will never perform manual control mode.

Exit Manual Control

To press ▲ ▼ keys the controller will revert to its previous operating mode (may be a failure mode or normal control mode).

3.21 Display Mode

Operation

Press [⟲] [▼] several times until `dI5-` `PLAY` (Display) appears on the display. Then press [⟲] to enter the display mode. You can select more parameters to view by pressing [⟲] or pressing [⟲] [▲] in reverse sequence . The system mode of the controller and its operation will remain unchanged.
Entering the Display Mode, the upper display will show the parameter value and the lower display will show the parameter symbol except `H___` and `C___`. `H___` shows the percentage value for output 1 and `C___` shows the percentage value for output 2 in the lower display while the upper display shows the current process value.

PVHI/PVLO show the historical extreme (maximum or minimum) values of the process in the upper display. The historical extreme values are saved in a nonvolatile memory even if it is unpowered. Press [⟲] for at least 6 seconds to reset both the historical value of PVHI and PVLO and allow to record a new peak process value.

MV1/MV2 show the process value in the upper display and `H___` shows the percentage control value for the output 1, `C___` shows the percentage control value for the output 2.

DV shows the difference value between process and set point (ie. PV-SV). This value is used to control the output 1 and output 2.

PV1 shows the process value of input 1 in the upper display.

PV2 shows the process value of input 2 in the upper display.

PB shows the current proportional band value used for control.

TI shows the current integral time used for control.

TD shows the current derivative time used for control.
Since the controller is performing an adaptive control the values of PB, TI, and TD may change from time to time.

CJCT shows the temperature at the cold junction, measured in °C independent of the unit used.

PVR shows the changing rate of the process in °C (°F or PU) per minute. It may be negative if the process is going down.

PVRH/PVRL The maximum and minimum changing rate of the process since power up, are measured in °C (°F or PU) per minute. PVRH is a positive value while PVRL is a negative value.

PVHI	`PVHI`
PVLO	`PVLo`
MV1	`H___`
MV2	`C___`
DV	`dV`
PV1	`PV1`
PV2	`PV2`
PB	`Pb`
TI	`ti`
TD	`td`
CJCT	`CJCt`
PVR	`PVr`
PVRH	`PVr.H`
PVRL	`PVr.L`

NOTE
The controller will never revert to its PV/SV display from Display Mode unless you press the [▲] [▼] keys.

3.22 Heater Current Monitoring

A current transformer, (order no. 9407 998 00051), should be equipped to measure the heater current. Select CT for IN2. The input 2 signal conditioner measures the heater current during the heater is powered and the current value will remain unchanged during the heater is unpowered. The PV2 will indicate the heater current. How to read PV2 value, Please refer to section 3-22.

NOTES

If the heater to be measured is controlled by output 1, then CYC1 should select 1 second or longer and O1TY should use RELY, SSRD or SSR . Similarly, if the heater to be measured is controlled by output 2, then CYC2 should select 1 second or longer and O2TY should use RELY, SSRD or SSR to provide an adequate time for A to D converter to measure the signal.
Since CT94-1 can detect a full-wave AC current only, a DC or half-wave AC can't be measured.

Accessory Installed:
CT94-1

Setup
IN2=CT
O1TY or O2TY=RELY,
SSRD or SSR
CYC1 or CYC2 >1 sec

Limitations
1. Linear output type can't be used.
2. CYC1 (or CYC2) should select 1 second or longer to detect heater current reliably.
3. Only full-wave AC current can be detected.

3.23 Reload Default Values

The default values listed in Table 1.4 are stored in the memory as the product leaves the factory. In certain occasions it is desirable to retain these values after the parameter values have been changed. Here is a convenient tool to reload the default values.

Operation

Press several times until dEFt ----. Then press . The upper display will show FiLE. Use up-down key to select 0 to 1. If °C unit is required, select 0 for FILE and if °F unit is required, select 1 for FILE. Then press for at least 3 seconds. The display will flash a moment and the default values are reloaded.

CAUTION

The procedures mentioned above will change the previous setup data. Make sure that if it is really required to be used.

FILE 0
°C Default File

FILE 1
°F Default File

4. Programming the Full Function

4.1 Event Input

Refer to section 2-10 for wiring an event input.
The Event input accepts a digital type signal. Three types of signal : (1) relay or switch contacts, (2) open collector pull low and (3) TTL logic level, can be used to switch the event input.

One of ten functions can be chosen by using E.I.Fn (EIFN) contained in setup menu.

NONE : Event input no function. If chosen, the event input function is disabled. The controller will use PB1, TI1 and TD1 for PID control and SP1 (or other values determined by SPMD) for the set point.

SP2: If chosen, the SP2 will replace the role of SP1 for control.

PID2: If chosen, the second PID set PB2, TI2 and TD2 will be used to replace PB1, TI1 and TD1 for control.
SP.P2 If chosen, the SP2, PB2, TI2 and TD2 will replace SP1, PB1, TI1 and TD1 for control.

NOTE: If the second PID set is chosen during Auto-tuning procedures, the new PID values will be stored in PB2, TI2 and TD2.

RS.A1: Reset Alarm 1 as the event input is activated. However, if alarm 1 condition is still existent, the alarm 1 will be retriggered again while the event input is released.

RS.A2: Reset Alarm 2 as the event input is activated. However, if alarm 2 condition is still existent, the alarm 2 will be retriggered again while the event input is released.

R.A1.2: Reset both Alarm 1 and Alarm 2 as the event input is activated. However, if the alarm 1 and/or alarm 2 are still existent, the alarm 1 and/or alarm 2 will be triggered again while the event input released.

The RS.A1, RS.A2 and R.A1.2 are particularly suitable to be used for a Latching and/or Latching/Holding alarms.

D.O1: Disable Output 1 as the event input is activated. The output 1 control variable MV1 is cleared to zero.

D.O2: Disable Output 2 as the event input is activated. The output 2 control variable MV2 is cleared to zero.

D.O1.2: Disable both Output 1 and Output 2 by clearing MV1 and MV2 values as soon as the event input is activated.

When any of D.O1, D.O2 or D.O1.2 is selected for EIFN, the output 1 and/or output 2 will revert to their normal conditions as soon as the event input is released.

LOCK: All parameters are locked to prevent from being changed.
See **Section 4-12** for more details.

Terminals:

⑭ Event input +
⑬ Event input −

EIFN

0 NONE
1 SP2
2 PID2
3 SP.P2
4 RS.A1
5 RS.A2
6 R.A1.2
7 D.O1
8 D.O2
9 D.O1.2

SP2F Function: Define format of SP2 value . If SP2F in the setup menu is selected with ACTU, the event input function will use SP2 value for its second set point. If SP2F is selected with DEVI, the SP1 value will be added to SP2. The sum of SP1 and SP2 (SP1+SP2) will be used by the event input function for the second set point value. In certain applications it is desirable to move second set point value with respect to set point 1 value. The DEVI function for SP2 provides a convenient way in this case.

SP2F=
Format of SP2 Value
ACTU:
SP2 is an actual value
DEVI:
SP2 is a deviation value

4.2 Second Set Point

In certatin applications it is desirable to change the set point manually or automatically without the need to adjust the set point. You can apply a signal to event input terminals (pin 14 and pin 13). The signal applied to event input may come from a Timer, a PLC, an Alarm Relay, a Manual Switch or other devices. Select SP2 for EIFN which is contained in setup menu.
This is available only for the cases that SP1.2, NIN.R or HR.R is used for SPMD. MIN.R and HR.R are for the ramping function.
See section 4.4.

Application 1: A process is required to be heated at a higher temperature as soon as its pressure exceeds a certain limit. Set SPMD=SP1.2, EIFN=SP2 (or SP.P2 if the second PID is required for the higher temperature too).
The pressure gauge is switched ON as it senses a higher pressure. Connect the output contacts of the pressure gauge to the event input.

Application 2: An oven is required to be heated at 300 °C from eight o'clock AM to six o'clock PM. After six o'clock PM it is desirable to be maintained at 80° C. Use a programmable 24 hours cycle timer for this purpose. The timer output is used to control event input. Set SPMD= SP1.2, and EIFN=SP2 (or SP.P2 if the second PID is required to be used for the second set point).

Example:
SP1 ist set to 300° C and SP2 to 80°C. Select ACTU=SP2. After 6pm the timer output is closed See section 4.1

SP1 is set with 300 LC and SP2 is set with 80 LC. Choose ACTU for SP2F. After six o'clock PM the timer output is closed. The event input function will select SP2 (=80 LC) to control the process.

Refer to Section 4-1 for more descriptions about SP2F function.

Apply Signal To

(14) Event input +
(13) Event input –

Setup

EIFN choose SP2 or SP.P2

Availability

SPMD choose

SP1.2
or MIN.R
or HR.R

Format of SP2 Value
SP2F choose

ACTU Actual Value
or DEVI Deviation Value

4.3 Second PID Set

In certain applications the process characteristics is strongly related to its process value. The KS20-I provides two set of PID values. During the process is changed to different set point, the PID values can be switched to another set to achieve an optimum condition.

Apply Signal To

⑭ Event input +

⑬ Event input -

Setup

EIFN choose PID2 or SP.P2

Auto-tuning Second PID

The optimal PID values for a process may vary with its process value and set point. Hence if a process is used for a wide range of set point, dual PID values are necessary to optimize the control behavior. If the first PID set is selected (event input is not applied) during auto-tuning procedure, the PID values will be stored in PB1, TI1 and TD1. Similarly, if the second PID set is selected (event input is applied while PID2 or SP.P2 is selected for EIFN) during auto-tuning, the PID values will be stored in PB2, TI2 and TD2 while auto-tuning is complete.

Application 1: Programmed by Set Point

Choose SP.P2 for EIFN then both set point and PID values will be switched to another set simultaneously. The signal applied to event input may come from a Timer, a PLC, an Alarm Relay, a Manual Switch or other devices.

EIFN= SP.P2

Application 2: Programmed by Process Value

If the process value exceeds a certain limit, 500 °C for example, it is desirable to use another PID values to optimize the control behavior. You can use a process high alarm to detect the limit of the process value. Choose PV1H for A1FN, A1MD selects NORM, adjust A1SP to be equal to 500 °C, and choose PID2 for EIFN. If the temperature is higher than 500 °C, then alarm 1 is activated. The alarm 1 output is connected to event input, the PID values will change from PB1, TI1 and TD1 to PB2, TI2 and TD2.

EIFN= PID2

Alarm output Controls the Event input

Refer to Section 5-8 for more details.

4.4 Ramp & Dwell

Ramp

The ramping function is performed during power up as well as any time the set point is changed. Choose MINR or HRR for SPMD, the unit will perform the ramping function. The ramp rate is programmed by using RAMP which is contained in user menu.

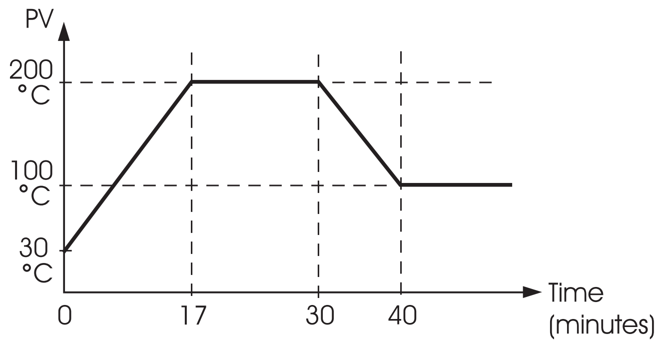
SPMD Choose
MINR Unit / minut
or HR.R Unit / hour

Adjust
RAMP RAMP

Example without Dwell Timer

Select MINR for SPMD, IN1U selects °C, DP1 selects 1-DP, Set RAMP=10.0. SP1 is set to 200 °C initially, and changed to 100 °C afer 30 minutes since power up. The starting temperature is 30 °C. After power up the process is running like the curve shown below:

RAMP Function



Note: During the ramp function is used, the lower display will show the current ramping value. However it will revert to show the set point value as soon as the up or down key is touched for adjustment. The ramping value is initiated to process value either power up or RAMP and /or set point are changed. Setting RAMP to zero means no ramp function at all.

Dwell

The Dwell timer can be used separately or accompanied with a ramp. If A1FN selects TIMR, the alarm 1 will act as a dwell timer. Similarly, alarm 2 will act as a dwell timer if A2FN selects TIMR. The timer is programmed by using TIME which is contained in user menu. The timer starts to count as soon as the process reaches its set point, and triggers an alarm as time out. Here is an example.

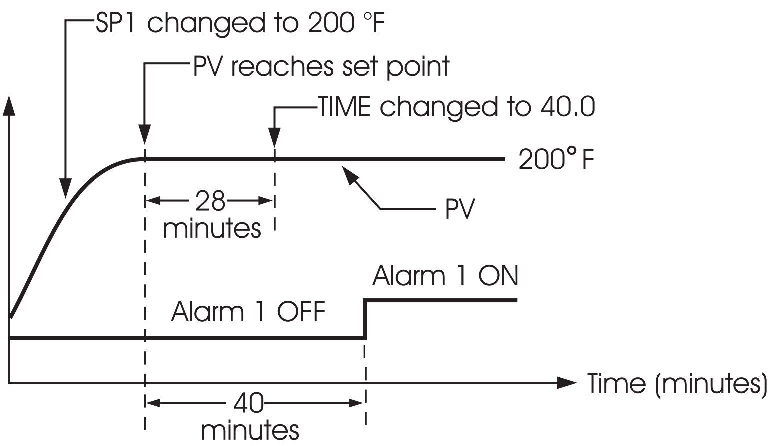
A1FN or A2FN Choose
TIMR TIMER

Adjust
TIME TIME

Example without Ramp

Select TIMR for A1FN, IN1U selects °F, DP1 selects NODP, Set TIME=30.0 SP1 is set to 400 °F initially, and corrected to 200 °F before the process reaches 200 °F. As the process reaches set point (ie. 200 °F) the timer starts to count. The TIME value can still be corrected without disturbing the timer before time out. The TIME is changed to 40.0 after 28 minutes since the process reached its set point. The behavior of process value and alarm 1 are shown below.

Dwell Timer



Once the timer output was energized it will remain unchanged until the power down or an event input programmed for resetting alarm is applied.

Note: The TIMR can't be chosen for both A1FN and A2FN simultaneously, otherwise an Er07 error code will produce.

Er07 Error Code

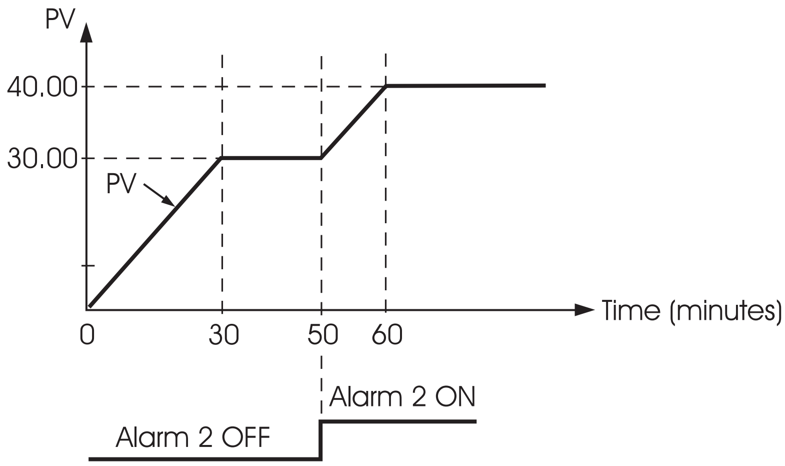
Ramp & Dwell

A ramp may be accompanied with a dwell timer to control the process. Here is an example.

Example with Ramp & Dwell

Select HRR for SPMD, IN1U selects PU, DP1 select 2-DP, Set RAMP=60.00 A2FN selects TIMR, Set TIME=20.0. As power is applied the process value starts from 0.00 and set SP1=30.00, SP2=40.00. The timer output is used to control event input.

Ramp accompanied with a Dwell Timer



4.5 Remote Set Point

SPMD selecting PV1 or PV2 will enable the KS20-I to accept a remote set point signal. If PV1 is selected, the remote set point signal is sent to Input 1, and Input 2 is used for process signal input. If PV2 is selected for SPMD, the remote set point signal is sent to Input 2, and Input 1 is used for process signal. To achieve this, set the following parameters in the Setup menu.

Setup
FUNC=FULL
SPMD=PV2, PVMD=PV1
or SPMD=PV1, PVMD=PV2

Case 1: Use Input 2 to accept remote set point
FUNC=FULL
IN2, IN2U, DP2, IN2L, IN2H, are set according to remote signal.
PVMD=PV1
IN1, IN1U, DP1, are set according to the process signal
IN1L, IN1H if available, are set according to the process signal
SPMD= PV2

Case 2: Use Input 1 to accept remote set point
FUNC=FULL
IN1, IN1U, DP1, IN1L, IN1H, are set according to remote signal.
PVMD=PV2
IN2, IN2U, DP2, are set according to the process signal
IN2L, IN2H if available, are set according to the process signal
SPMD= PV1

Note: If PV1 are chosen for both SPMD and PVMD, an Er01 Error Code will appear. If PV2 are chosen for both SPMD and PVMD, an Er02 Error Code will appear. You should not use such cases, otherwise, the KS20-I will not control properly.

Error Message
Er01
Er02

4.6 Differential Control

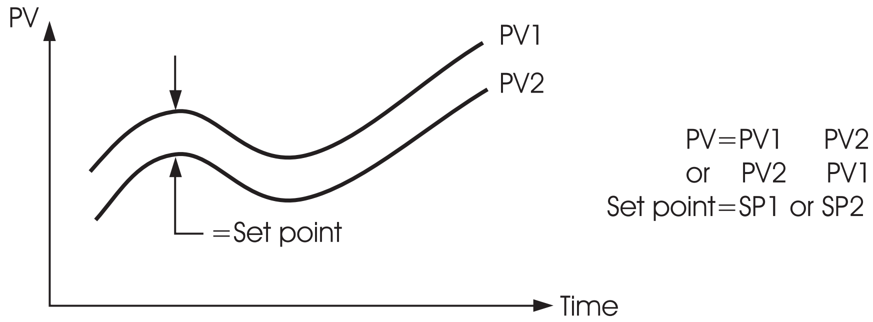
In certain applications it is desirable to control a second process such that its process value is always deviated from the first process with a constant value. To achieve this, set the following parameter in the Setup menu.

Setup
PVMD=P1-2
or PVMD=P2-1
SPMD=SP1.2

FUNC=FULL
IN1,IN1L,IN1H are set according to input 1 signal
IN2,IN2L,IN2H are set according to input 2 signal
IN1U, DP1, IN2U, DP2, are set according input 1 and input 2 signal
PVMD=P1-2 or P2-1
SPMD=SP1.2

The response of PV2 will be parallel to PV1 as shown in the following diagram

Relation between PV1 and PV2 for a Differential Control



The PV display will indicate PV1-PV2 value if P1-2 is chosen for PVMD, or PV2-PV1 value if P2-1 is chosen for PVMD. If you need PV1 or PV2 to be displayed instead of PV, you can use the Display Mode to select PV1 or PV2 to be viewed. See section 3-22.

Error Messages

If PVMD selects P1-2 or P2-1, while SPMD selects PV1 or PV2, an Er03 Error Code will appear.

The signals used for input 1 and input 2 should be same unit and same decimal point, that is, IN1U=IN2U, DP1=DP2, otherwise Er05 Error Code will appear.

Error Message
Er03
Er05

4.7 Output Power limits

Menu

PL1
PL2

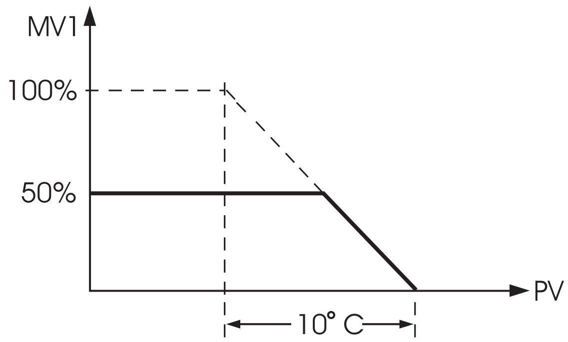
In certain system the heater (or cooler) is over-designed such that the process is too heavily heated or cooled. To prevent an excessive overshoot and/or undershoot you can use the Power Limit function.
Output 1 power limit PL1 is contained in User Menu. If output 2 is not used for cooling (that is COOL is not selected for OUT2), then PL2 is hidden. If the controller is used for ON-OFF control, then PL1 and PL2 are hidden.

Operation:

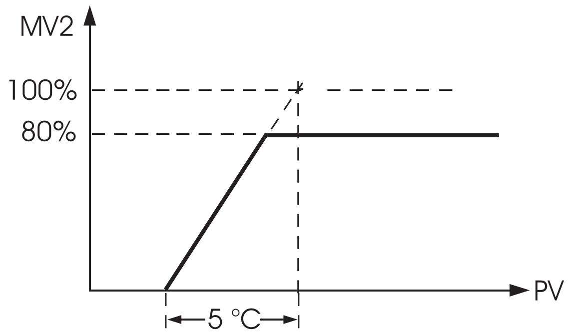
Press ↻ for 3 seconds, then press ↻ several times to reach PL1 and PL2.
The PL1 and PL2 are adjusted by using up-down keys with range 0 - 100%.

Example:
OUT2=COOL, PB1=100 °C, CPB=50, PL1=50, PL2=80
The output 1 and output 2 will act as following curves:

Power Limit Function



OUT1



OUT2

NOTE:
The adjusting range of MV1 (H) and MV2 (C) for manual control and/or failure transfer are not limited by PL1 and PL2.

4.8 Data Communication

Two types of interface are available for Data Communication. These are RS-485. Since RS-485 uses a differential architecture to drive and sence signal instead of a single ended architecture which is used for RS-232, RS-485 is less sensitive to the noise and suitable for a longer distance communication. RS-485 can communicate without error over 1 km distance while RS-232 is not recommended for a distance over 20 meters.

RS-485 Benefits:
Long distance
Multi-units

Setup
Enters the setup menu.
Select FULL (Full function) for FUNC.
Select 485 for COMM if RS-485 is required. Select RTU (ie. Modbus protocol RTU mode) for PROT. Set an unequal address for those units which are connected to the same port.
Set the Baud Rate (BAUD), Data Bit (DATA), Parity Bit (PARI) and Stop Bit (STOP) such that these values are accordant with PC setup conditions.

RS-485 Setup
FUNC=FULL
COMM=485
PROT=RTU
ADDR=Address
BAUD=Baud Rate
DATA=Data Bit Count
PARI=Parity Bit
STOP=Stop Bit Count

RS-485 Terminals
⑨ TX1
⑩ TX2

4.9 Analog Retransmission

Setup

Select FULL for FUNC in the setup menu.
COMM selects a correct output signal which should be accordant with the retransmission option used. Five types of retransmission output are available, these are : 4-20 mA, 0-20mA, 0-5V, 1-5V and 0-10V. There are 8 types of parameters can be retransmitted according to the Analog Function (AOFN) selected. These are : PV1, PV2, PV1-2, PV2-1, SV, MV1, MV2 and PV-SV. Refer to Table 1.4 for a complete description. AOLO selects a value corresponding to output zero and AOHI selects a value corresponding to output SPAN.

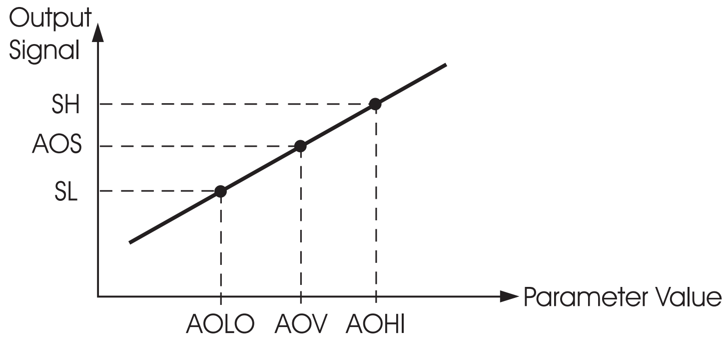
Setup Menu
FUNC
COMM
AOFN
AOLO
AOHI

Terminals
9 AO+
10 AO

How to Determine Output Signal:

AOLO and AOHI are set to map to output signal LOW SL (e.g. 4mA) and output signal High SH (e.g. 20mA) respectively. The analog output signal AOS corresponding to an arbitrary value of parameter AOV is determined by the following curve.

Conversion Curve for Retransmission



Formula: $AOS = SL + (AOV - AOLO)\ \frac{SH\ \ SL}{AOHI\ \ AOLO}$

$AOV = AOLO + (AOS - SL)\ \frac{AOHI\ \ AOLO}{SH\ \ SL}$

Notes:

The setup values used for AOHI and AOLO must not be equal, otherwise, incorrect value will happen. However, AOHI can be set either higher or lower than AOLO. If AOHI is set higher than AOLO a direct conversion is resulted. If AOHI is set lower than AOLO a reverse conversion is resulted.

NOTES
AOHI=AOLO
AOHI>AOLO:
Direct Conversion
AOHI<AOLO:
Reverse Conversion

Example

A control uses 4-20 mA analog output to retransmit difference value of input 1 and input 2 (PV1-PV2). It is required that if the difference value is -100, 4mA will be exported, and if the difference value is 100, 20mA will be exported.
Make the following Setup for KS20-I:
IN1U=PU, DP1=NODP, IN2U=PU, DP2=NODP, FUNC=FULL, COMM= 4-20, AOFN=P1-2, AOLO=-100, AOHI=100

4.10 Digital Filter

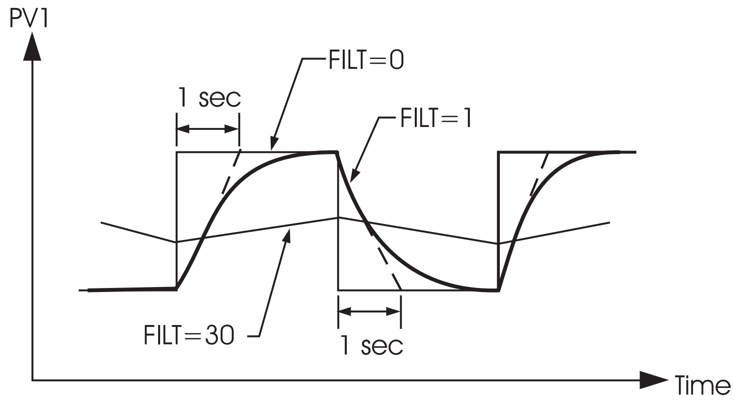
In certain application the process value is too unstable to be read. To improve this a programmable low pass filter incorporated in the KS20-I can be used. This is a first order filter with time constant specified by FILT parameter which is contained in setup menu. The FILT is defaulted with 0.5 sec. before shipping. Adjust FILT to change the time constant from 0 to 60 seconds. 0 second represents no filter is applied to the input signal. The filter is characterized by the following diagram.

Menu

FiLt FILT

Filter is used to stabilize the process display.

Filter Characteristics



Note

The Filter is available only for PV1, and the filter is performed for the displayed value only. The controller is designed to use unfiltered signal for control even if Filter is applied. A lagged (filtered) signal, if used for control, may produce an unstable process.

4.11 Sleep Mode

To Enter Sleep Mode:
FUNC selects FULL to provide full function.
SLEP selects YES to enable the sleep mode.
Press ⏶ ⏷ for 3 seconds, the unit will enter its sleep mode.
During sleep mode:

1. Shut off all display except a decimal point which is lit periodically.
2. Shut off all outputs and alarms.

To Exit Sleep Mode:
Press ⏶ ⏷ to leave the sleep mode

Sleep Function can be used to replace a power switch to reduce the system cost.

Default: SLEP=NONE, Sleep mode is disabled.

Note: If the Sleep mode is not required by your system, the SLEP should select NONE to disable sleep mode against undesirable occurrence.

Sleep Mode Features:
Shut off display
Shut off outputs
Green Power
Replace Power Switch

Setup Menu
FUNC=FULL
SLEP=YES

4.12 Remote Lockout

The parameters can be locked by an internal DIP-Switch, an external switch or both. If the external switch is open, the internal DIP switch determines which parameters are blocked. If you need the parameters to be locked by using an external switch (remote lockout function), then connect a switch to terminals 13 and 14 (see Section 2-10), and choose LOCK for EIFN (see Section 4-1).

If remote lockout is configured, all parameters will be locked as the external switch is closed. When the switch is left open, the lockout condition is determined by internal DIP switch (hardware lockout, see Section 1-2).

Hardware Lockout: Can be used only during initial setup.
Remote Lockout: Can be used any time.

Remote Lockout:
1. Connect external switch to terminal ⑬ and ⑭.
2. Set LOCK for EIFN
3. All parameters are blocked

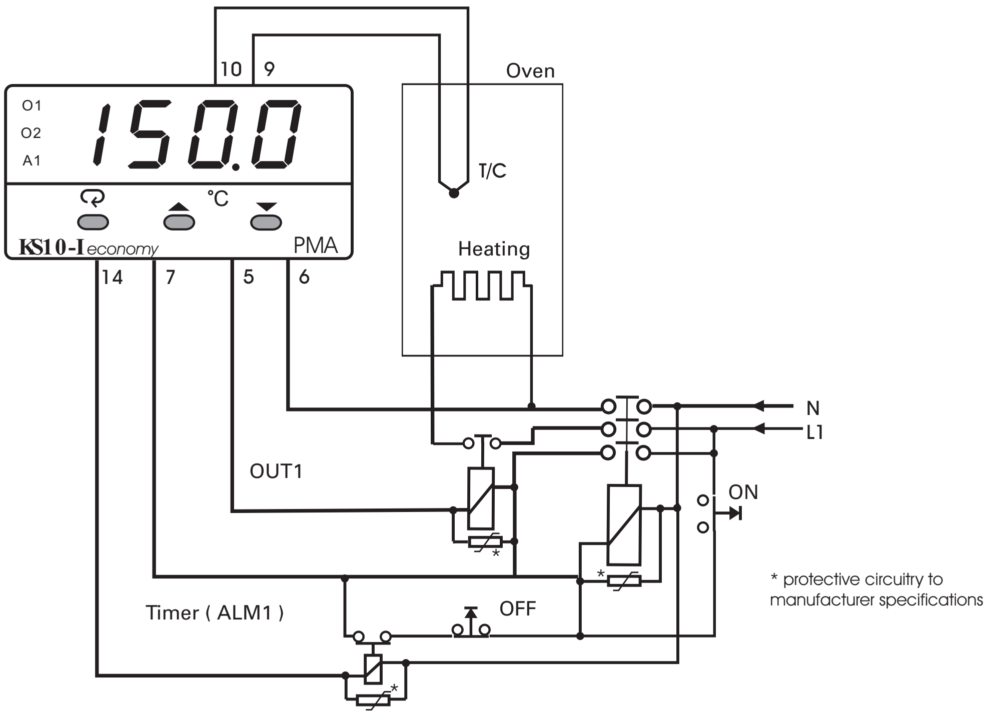
5. Applications

5.1 Heat Only Control

Products must be dried in an oven for 30 minutes at 150 °C.
Then the heating stops automatically until the process is started again.
For this purpose a KS20-I controller with timer relay is used.

For determining the optimum PID control parameters, self-tuning at the set-point at 150.0°C must be used when commissioning a new system.

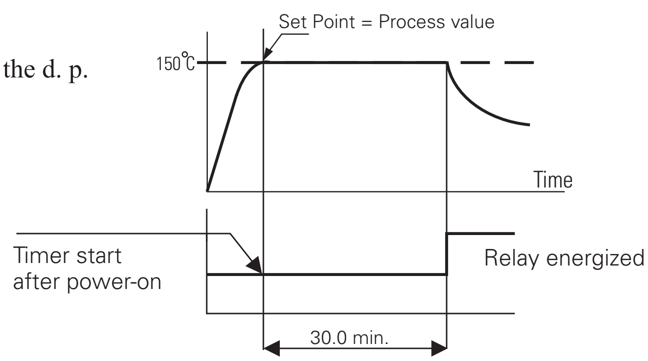
The system arrangement is as follows:



Parameter settings in the adjustment menu:
SP1=150.0
TIME=30.0 After switching on the supply voltage again, the timer is active again.

For this function, the following parameters must be set in the adjustment menu.

FUNC=BASC	Basic function
IN1= K_TC	Type K thermocouple
IN1U=°C	Display in °C
DP1= 1_DP	Display with one digit behind the d. p.
OUT1= REVR	Inverse output action
O1TY=RELY	Output 1 relay
CYC1=18,0	Cycle time output 1 18,0 sec. (process-dependent)
O1FT= BPLS	Correcting variable take-over with sensor break
A1FN= TIMR	Timer function for alarm 1
A1FT = ON	Alarm active
SELF = NONE	Self-tuning none



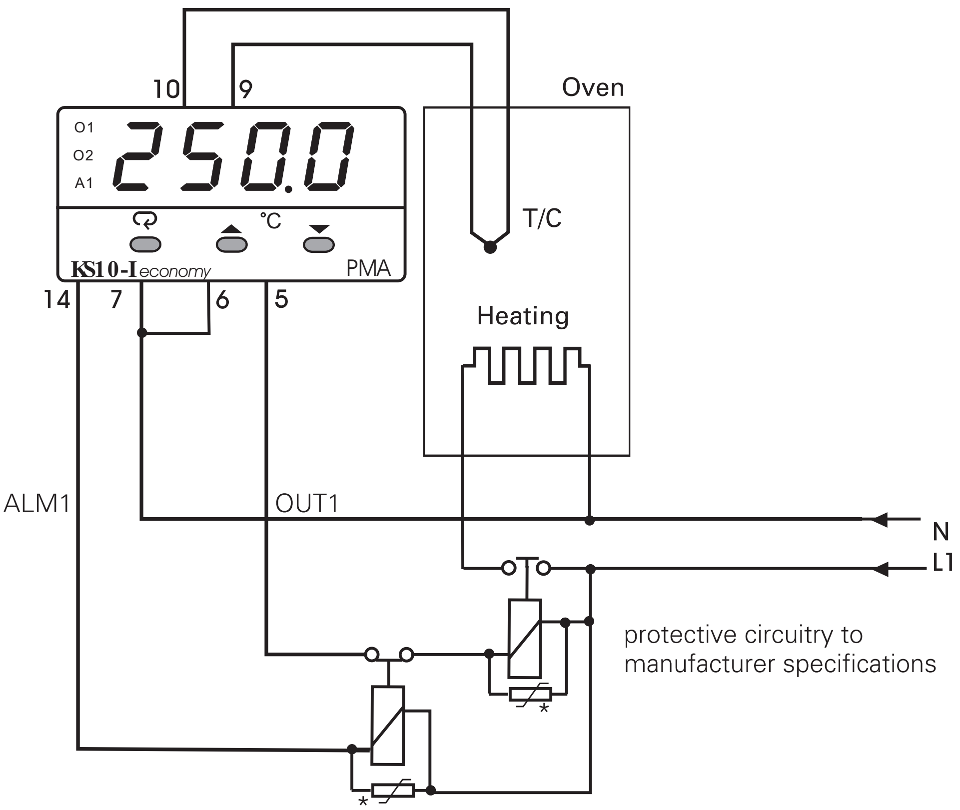
5.2 Heating Only Control with Loop Break Alarm

The loop break alarm is at a clock of 2 TI1 (double integral time, but max. 120 sec.). Unless the process value increases (or decreases) at maximum (or min.) correcting variable value during the clock, an input circuit alarm is triggered.

For determining the optimum PID control parameters, self-tuning at the set-point must be used when commissioning a new system. At 250,0°C in this example (autotuning).

Example of heating control with loop break alarm

The system arrangement is as follows:



Parameter settings in the adjustment menu:
SP1=250.0

For this function, the following parameters must be set in the adjustment menu:

FUNC=BASC	Basic function
IN1= K_TC	Type K thermocouple
IN1U=°C	Display in °C
DP1= 1_DP	Display with one digit behind the decimal point
OUT1= REVR	Inverse output action
O1TY=RELY	Output 1 relay
CYC1=18,0	Cycle time output 1 18,0 sec. (process-dependent)
A1FN= LB	Alarm function: loop break alarm
SELF = NONE	Self-tuning none

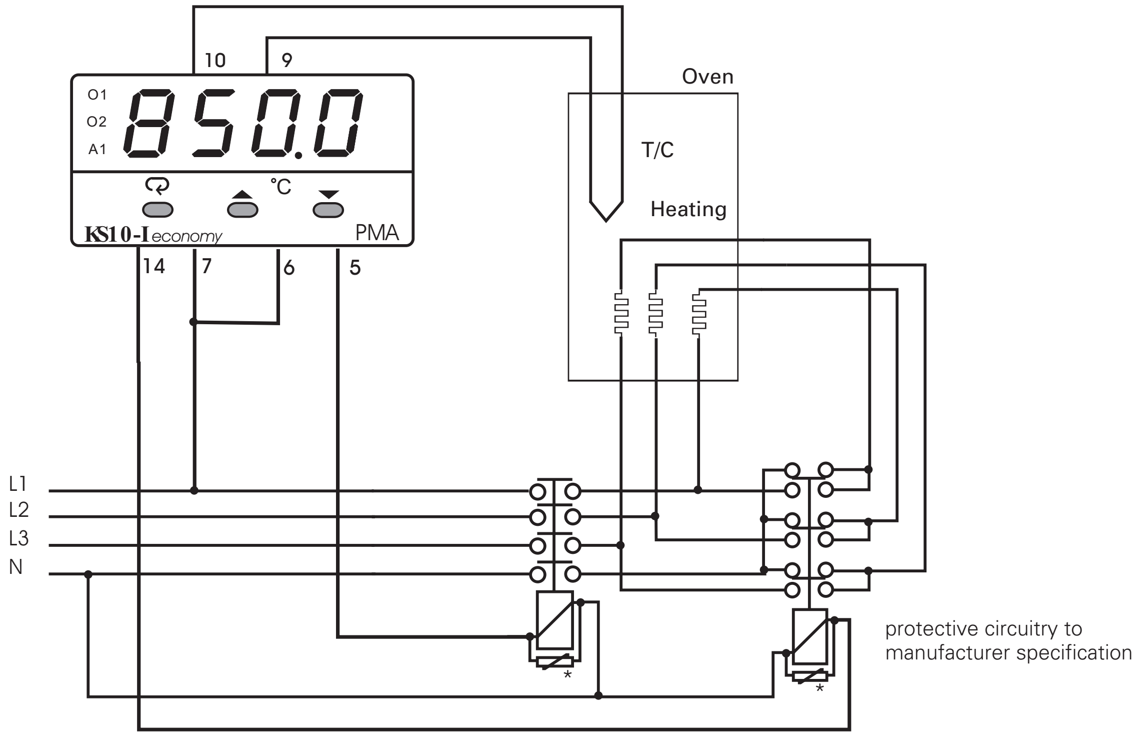
5.3 Heating Control with switch-over from full to partial load

For optimum furnace temperature control, starting with high heating power is necessary. Before reaching the temperature, the heating power must be reduced, because only the thermal losses must still be lined out at the set-point. For this purpose, the alarm contact is used for switching over from Δ-connection to Y-connection.

For determining the optimum PID control parameters, self-tuning at the set-point must be used during initial oven commissioning. (850,0°C autotuning in this example).

Example for Heating Control with Switch-over from full to partial load

The system arrangement is as follows:

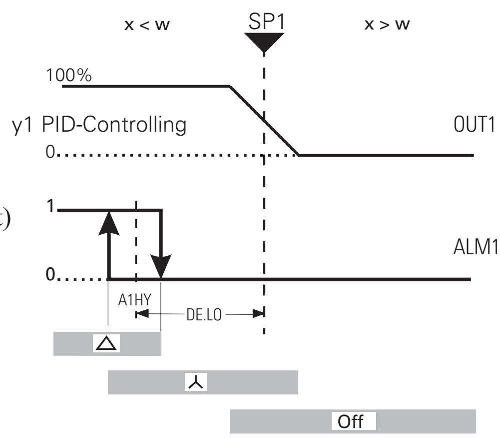


Parameter settings in the adjustment menu:

FUNC =	FULL
IN1 = K_TC	Type K thermocouple
IN1U = °C	Display in °C
DP1 = 1_DP	Display with one digit behind the decimal point
OUT1 = REVR	Inverse output action
O1TY = RELY	Output 1 relay
CYC1 = 18,0	Cycle time output 1 18,0 sec. (process-dependent)
A1FN = DE.LO	Alarm1 active below the trigger point
A1MD = NONE	normal alarm function

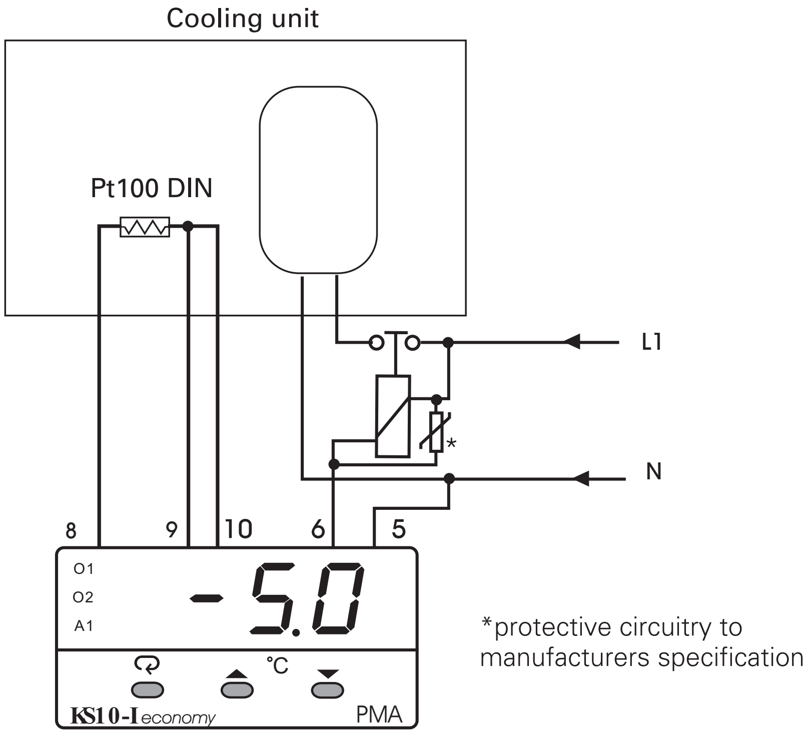
Settings in the operating menu:
A1HY= 2 switching hysteresis alarm 1 (process-dependent)
SP1 = 850,0°C set-point (process-dependent)

Behaviour of the controller KS20-I



5.4 Only cooling control with signaller (on-off control)

A refrigerator is controlled by a KS20-I at temperatures below 0°C.
To avoid set-point adjustments out of the permissible range, set SP1L to -10°C and SP1H to 0°C. As the temperature is below the ambient temperature, cooling is required. Therefore, OUT must be set to DIRT. Small temperature variations are permissible. For this reason, two-point control with signaller is used for overall cost reduction. Therefore, set PB1 to 0°C and O1HY to 0,1°C.



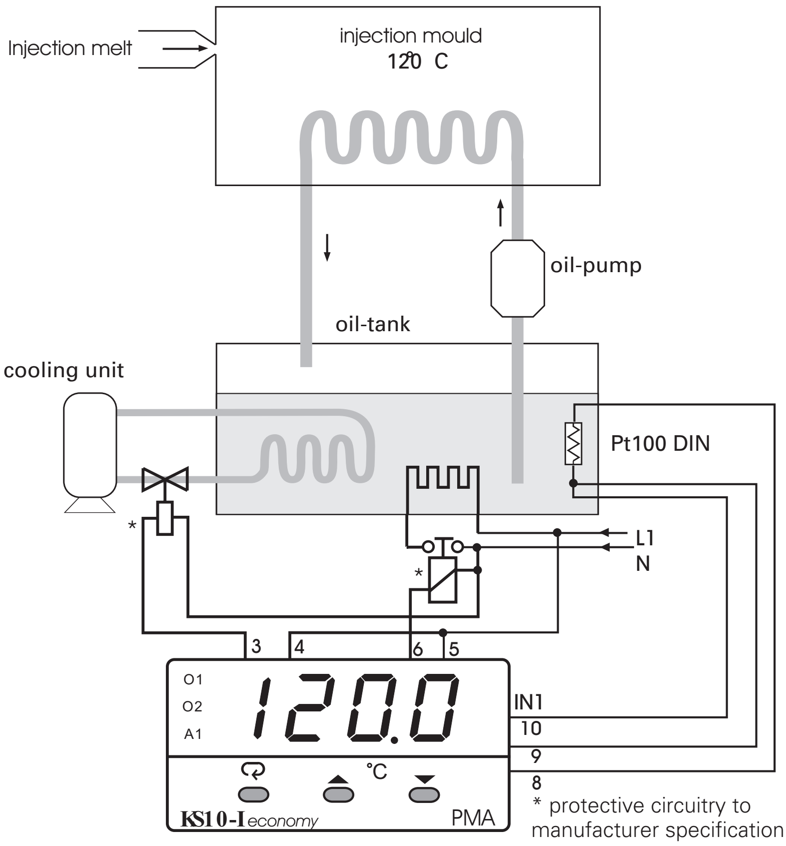
Adjustment parameter:

FUNC=	BASC	only basic functions accessible
IN1 =	PT.DN	Pt100 DIN
IN1U =	°C	Displayin °C
DP1 =	1-DP	Display with one digit behind the decimal point
OUT =	DIRT	Direct output action
O1TY=	RELY	Output 1 relay
SP1L =	-10°C	Set-point limiting start
SP1H =	0°C	Set-point limiting end
PB1 =	0 (°C)	Adjust a proportional band of 0 (signaller)
O1HY =	0.1°C	Switching hysteresis for signaller

5.5 Heating-cooling Control

To ensure consistent product quality, the temperature of an injection mould must be controlled to 120°C. As melt injection is at high temperature (e.g. 250°C), the circulating oil must be cooled when the temperature increases.

KS20-I has no dead band for heating-cooling. The dead band is implemented in the control algorithm and ensures that optimum process cooling by the cooling function is provided when the process value increases (whereby the set-point need not be exceeded). With decreasing process value, the adaptive dead band is matched and provides an immediate increase of the heating power and simultaneous reduction of the cooling power. In lined-out condition, heating and cooling are not simultaneous for minimization of the energy consumption.



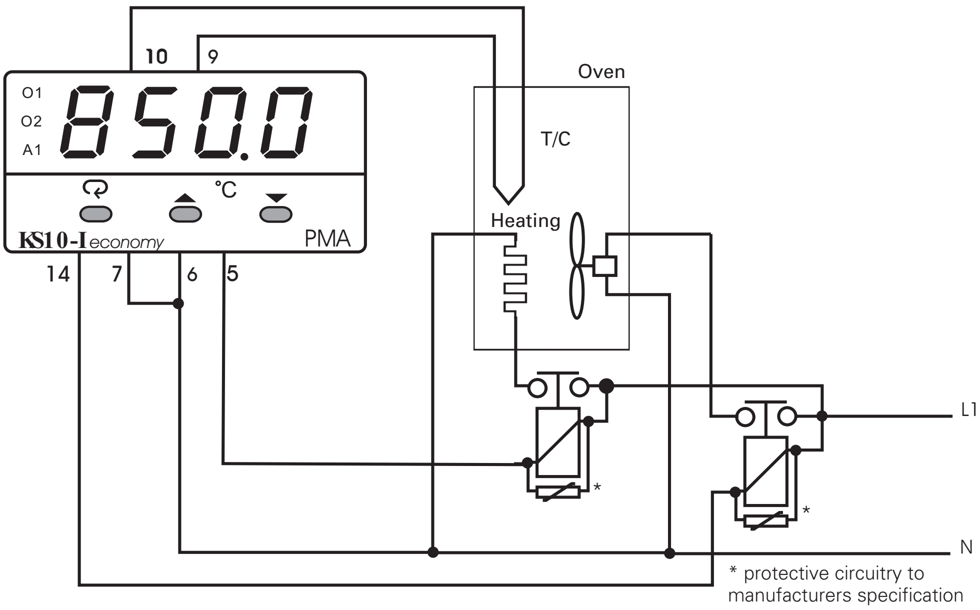
Adjustment parameter:
FUNC= BASC only basic function accessible
IN1=PT.DN Pt100 DIN Sensor
IN1U=°C Display in °C
DP1 = 1-DP Display with one digit behind the decimal point
OUT1= REVR Inverse output action
O1TY= RELY Output 1 relay
CYC1= 18,0 Cycle time output 1 18,0 sec. (process-dependent)
O1FT= BPLS Correcting variable take-over with sensor break
OUT2=COOL Output 2 used for cooling
O2TY=RELY Output 2 relay
CYC2= 20,0 Switching cycle time output 1 18,0 sec. (process-dependent)
O2FT=BPLS Correcting variable take-over with sensor break
SELF=YES self-tuning active

SP1 is to be set to 120°C and CPB to 100 (%)

5.6 Heating-cooling with two-point control (signaller) and neutral zone

When reaching the adjusted temperature, heating switch-off by output OUT1 is provided. With further temperature increase up to trigger point A2SP, cooling is switched on. Neutral zone (A2DV) and switching hysteresis (OHY1, A2HY) can be adjusted separately for the two trigger points.

The system arrangement is as follows:



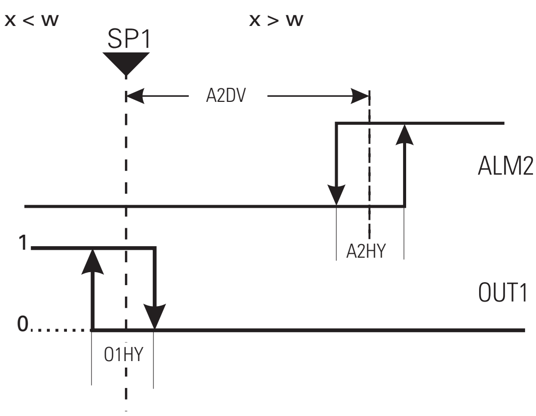
Parameter settings in the adjustment menu:

FUNC = FULL	
IN1 = K_TC	Type K thermocouple
IN1U = °C	Display in °C
DP1 = 1_DP	Display with one digit behind the decimalpoint.
OUT1 = REVR	Inverse output action
O1TY = RELY	Output 1 relay
OUT2 = AL2	
A2FN = DE.HI	Alarm2 active above x-w
A2MD = NONE	normal Alarmfunction

Settings in the operating menu:

O1HY =	Switching hysteresis OUT1 (process dependend)
A2HY =	Switching hysteresis AL2 (process dependend)
SP1 = 850,0°C	Set-point (process dependend)
A2DV =	deviation to set-point
PB1 = 0	Two-point control with signaller

<u>Behaviour of the controller KS20-I</u>



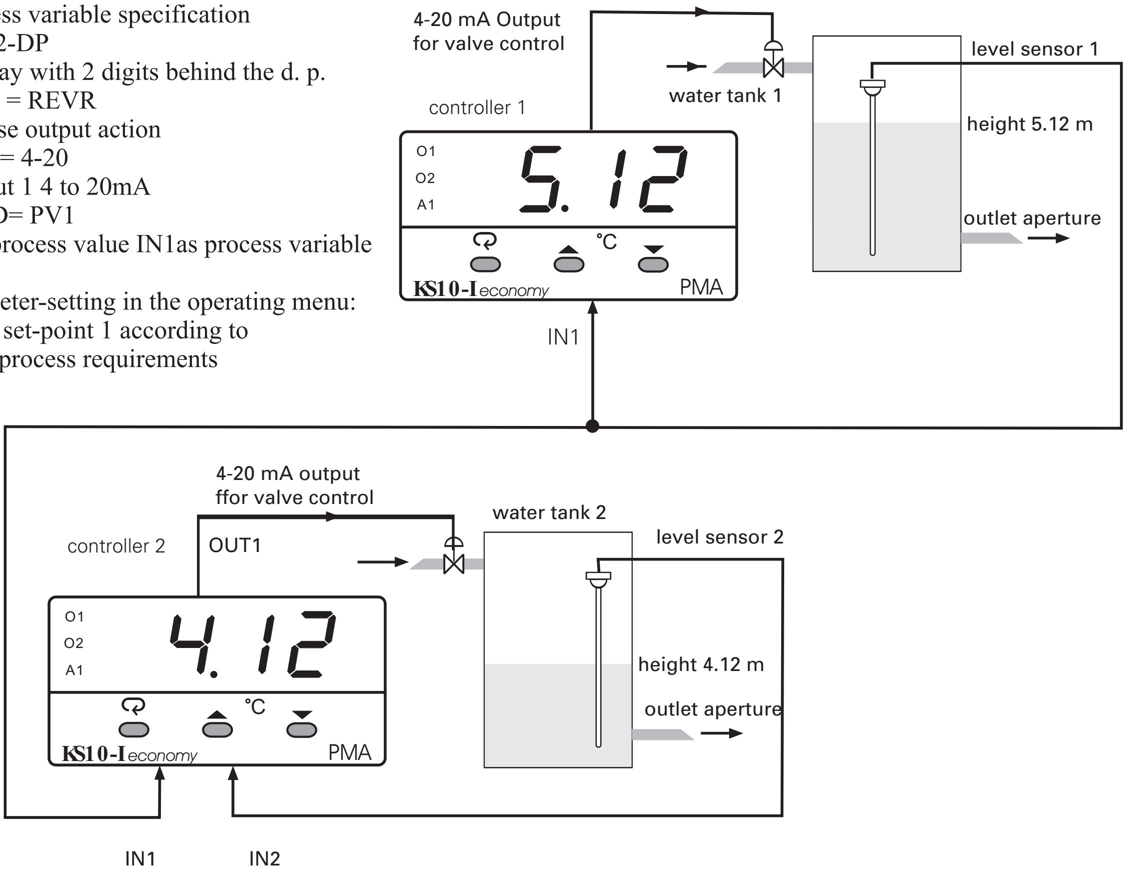
5.7 Differential Control

With certain applications controlling depends on a second process whose process value constantly deviates to the process value of the first process. The water level in container 1 has a height of 5,12m while in container 2 it should be 1m below. So the difference between container 1 and 2 must be controlled.

Example for Differential Control

Controller 1 parameter setting in the adjustment menu:
FUNC = FULL
IN1,IN1L, IN1H:
-dependent of signal sensor 1
IN1U = PU
-Process variable specification
DP1=2-DP
-Display with 2 digits behind the d. p.
OUT1 = REVR
-Inverse output action
O1TY= 4-20
-Output 1 4 to 20mA
PVMD= PV1
-Use process value IN1as process variable

Parameter-setting in the operating menu:
SP1 = set-point 1 according to
process requirements



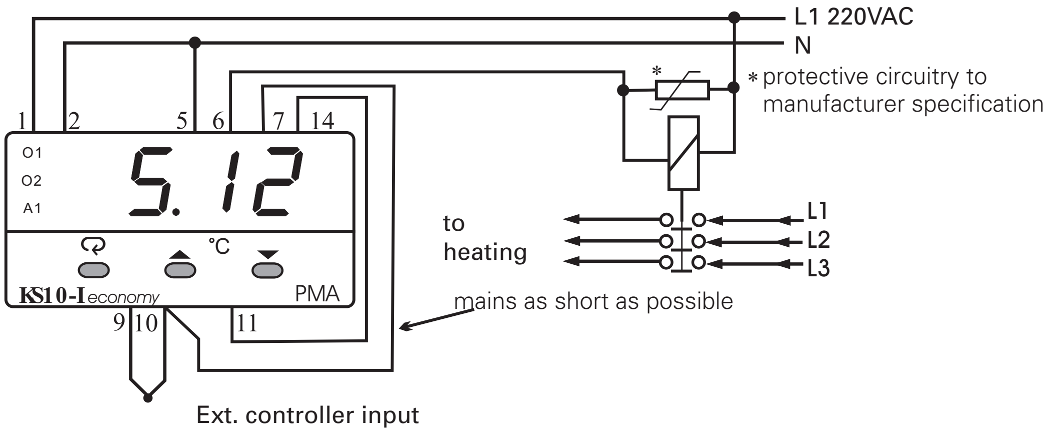
Controller 2 parameter setting in the adjustment menu:
FUNC = FULL
IN1,IN1L, IN1H: -dependent of signal sensor 1
IN1U = PU: -Process variable specification
DP1 = 2-DP: -Display with 2 digits behind the d. p.
IN2,IN2L, IN2H: -dependent of signal sensor 2
IN2U = PU: -Process variable specification
DP2 = 2-DP: -Display with 2 digits behind the d. p.
OUT1= REVR: -Inverse output action
O1TY =4-20 - Output 1 4 to 20mA
PVMD= P1-2 -process value is the difference between PV1-PV2
SPMD = SP1 -2 set-point SP1 or SP2

Parameter setting in the operating menu:
SP1 = set-point1 according to process requirements (1,00)

5.8 Switch-over to a second PID parameter set

Switch-over to a second PID parameter set when reaching a limit value.
KS20-I offers a possibility for switching over between two PID parameter sets. When reaching a limit value (A1SP), parameter set switch-over is by the event input. With set-point ramp control, the process value characteristic changes towards the higher process value, whereby the initial PID parameters are replaced by the second PID parameter set for optimum control behaviour over the complete range.

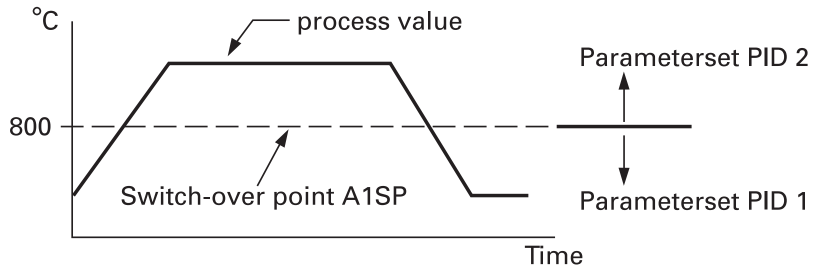
Example 1: Single set-point / double PID parameter set



Parameter settings in the adjustment menu:
FUNC = FULL
A1FN =PV1H Alarm 1 related to input 1 (IN1)
A1MD = NORM normal alarm behaviour
EIFN =PID2 Switch-over to parameter set PID 2 is by event input switch over
PVMD=PV1 process value IN 1 is used as process variable
SPMD=MINR The set-point is changed in °C/min. by a ramp function

Parameter settings in the operating menu:
A1SP = 800°C Switch-over point to the PID2 parameter set
A1HY = 1°C Hysteresis of alarm1
PL1 = 100% Correcting variable limiting to 100%
RAMP = according to process requirements
SP1 = set-point 1 according to process requirements

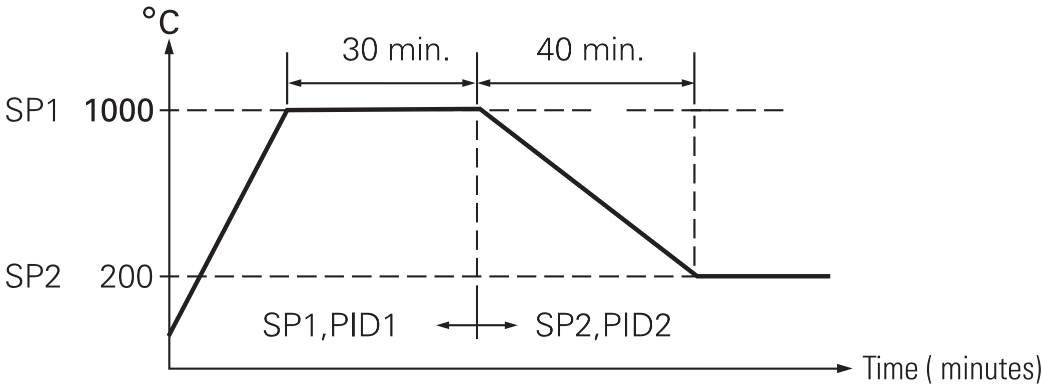
A thermal treatment oven has a temperature range within 400°C to 1200°C



Example 2: (same wiring as example 1.)

Only by changing the parameters in adjustment menu and operating menu, the function sequence can be changed so that parameter set PID1 is used for control when reaching set-point 1 and switch-over to set-point 2 with parameter set PID2 is after elapse of a time.

In a thermal treatment oven, moulds are tempered at a temperature of 1000°C during 30 minutes. Subsequently, the moulds are cooled down to a lower set-point (200°C) using a programmable set-point ramp (20°C/min.). For this application, the dual set-point/parameter set function with set-point ramp and time relay can be used.



Parameter settings in the adjustment menu:

FUNC = FULL
EIFN = SP.P2 Changing over to set-point 2 with the relevant parameter set is done by event input switch-over
PVMD = PV1 Process value IN1 is used as process variable
SPMD = MINR The set-point is changed by a ramp function.
AF1N = TIME Configure alarm 1 as a timer

Parameter settings in the operating menu:

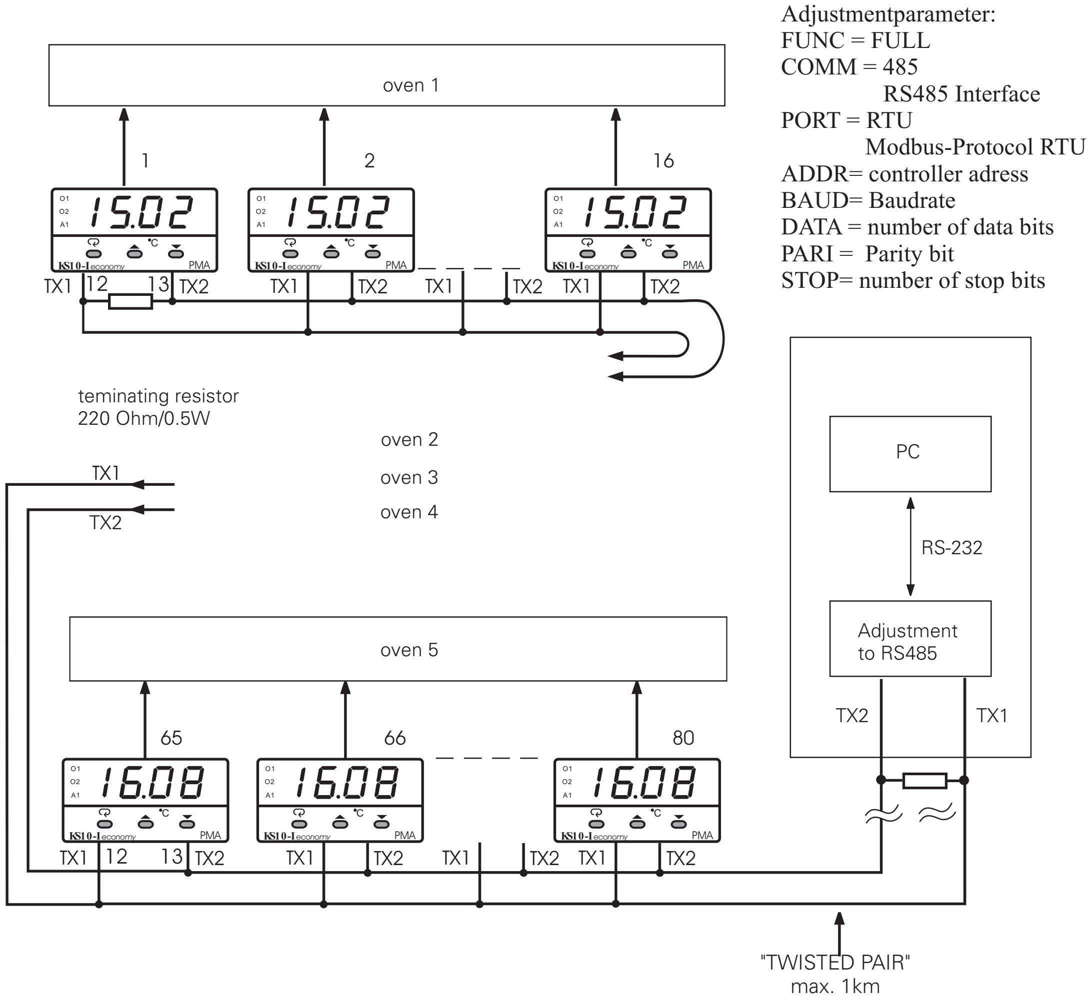
TIME = 30,0 min. Holding time after reaching set-point 1
RAMP = 20°C/min. Rate of set-point change after elapse of the holding time (change from 1000°C to 200°C. At 20°C/min = 40min.)
SP1 = 1000°C Set-point 1 (1000°C)
SP2 = 200°C Set-point 2 (200°C)
PL1 = 100% Correcting variable limiting output 1 (terminals 5 and 6)

5.9 RS-485-Application

In a 5-line production plant, 16 KS20-I controllers per production line are used. The programmable controllers monitor the process for increasing product quality and productivity. For realization of a more cost-effective solution for the application described above, 80 KS20-I controllers and a module for PC-interface RS232 to RS485 controller interface conversion are required. A Modbus RTU protocol is used for data transmission.

This interface (RS485) is less sensitive to interference and suitable for data transmission up to a distance of 1 km. For the controllers connected to the same port, a unique address must be adjusted. The settings for (BAUD), data bit (DATA), parity bit (PARI) and stop bit (STOP) must correspond to the PC settings.

RS-485 Application



5.10 Retransmission

An air-conditioned room uses two KS20-I to control its temperature and humidity. The temperature and humidity are required to be recorded on a chart recorder. The interesting ranges for these two quantities are 20°C to 30°C and 40% RH to 60%RH. the recorder inputs accept 0...20mA.

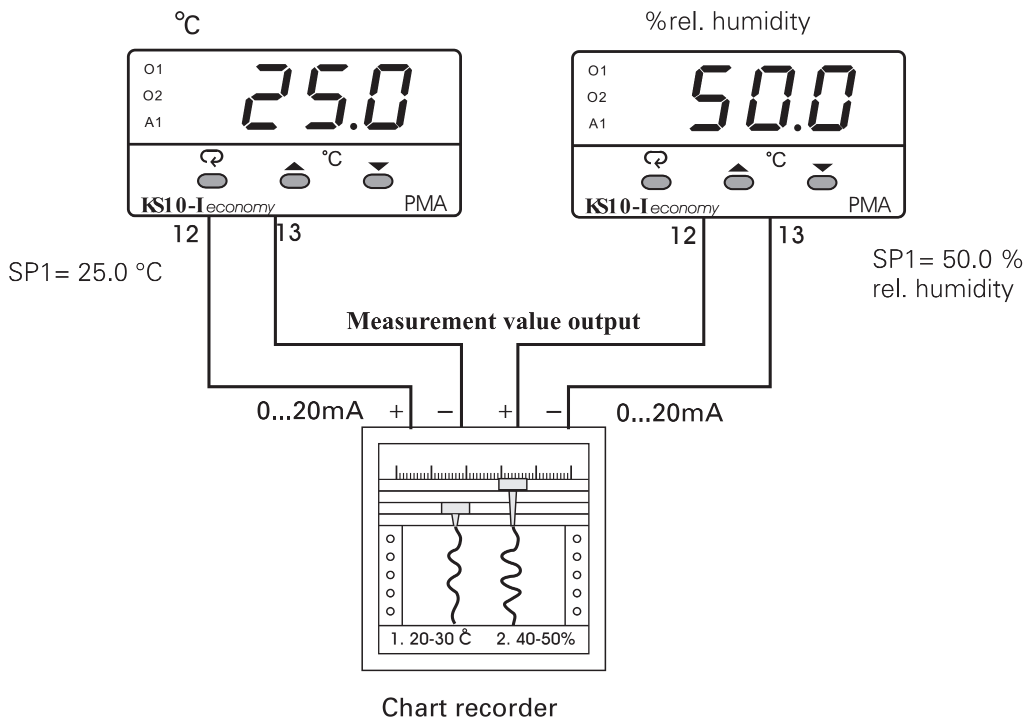
°C controller 1

FUNC=FULL
COMM=0-20mA
AOFN=PV1
AOLO=20,0(°C)
AOHI=30,0(°C)
IN1=PTDN
DP1=1-DP

% rel. humidity controller 2

FUNC=FULL
COMM=0-20mA
AOFN=PV1
AOLO=40,0(%))
AOHI=60,0(%)
IN1=0-1V (depending on humidity sensor)
DP1=1-DP

Measurement value output



6. Error Codes & Troubleshooting

⚠ This procedure requires access to the circuitry of a live power unit. Dangerous accidental contact with line voltage is possible. Only qualified personnel are to perform these procedures. Potentially lethal voltages are present.

Troubleshooting Procedures :

1. If an error message is displayed, refer to Table 6.1 to see how it is caused and apply a corrective action to the failure unit.

2. Check each point listed below. Experience has proven that many control problems are caused by a defective instrument.

   Line wires are improperly connected
   No voltage between line terminals
   Incorrect voltage between line terminals
   Connections to terminals are open, missing or loose
   Thermocouple is open at tip
   Thermocouple lead is broken
   Shorted thermocouple leads
   Short across terminals
   Open or shorted heater circuit
   Open coil in external contactor
   Burned out line fuses
   Burned out relay inside control
   Defective solid-state relays
   Defective line switches
   Burned out contactor
   Defective circuit breakers

3. If the points listed on the above chart have been checked and the controller does not function properly, it is suggested that the instrument be returned to the factory for inspection.
   Do not attempt to make repairs. It usually creates costly damage. Also , it is advisable to use adequate packing materials to prevent damage in shipment.

6.1 Error Codes and Corrective Actions

Error Code	Display Symbol	Error Description	Corrective Action
1	Er01	Illegal setup values used: PV1 is used for both PVMD and SPMD that is meaningless for control.	Check and correct setup values of PVMD and SPMD, PV and SV can't use the same value for normal control
2	Er02	Illegal setup values used: PV2 is used for both PVMD and SPMD that is meaningless for control	Same as error code 1
3	Er03	Illegal setup values used: P1-2 or P2-1 is used for PVMD while PV1 or PV2 is used for SPMD. Dependent values are used for PV and SV will produce incorrect result of control	Check and correct setup values of PVMD and SPMD. Difference of PV1 and PV2 can't be used for PV while PV1 or PV2 is used for SV
4	Er04	Illegal setup values used: COOL is used for OUT2, but DIRT (cooling action) is already used for OUT1 or PID mode is not used for OUT1 (that is PB1 or PB2 = 0, and TI1 or TI2 = 0)	Check and correct setup values of OUT2, PB1, PB2, TI1, TI2 and OUT1. IF OUT2 is required for cooling control, the control should use PID mode (PB ≠ 0, TI ≠ 0) and OUT1 should use reverse mode (heating action), otherwise, don't use OUT2 for cooling control
5	Er05	Illegal setup values used: unequal IN1U and IN2U or unequal DP1 and DP2 while P1-2 or P2-1 is used for PVMD or, PV1 or PV2 is used for SPMD or, P1.2.H, P1.2.L, D1.2.H or D1.2.L are used for A1FN or A2FN.	Check and correct setup values of IN1U, IN2U, DP1, DP2, PVMD, SPMD, A1FN or A2FN. Same unit and decimal point should be used if both PV1 and PV2 are used for PV, SV, alarm1 or alarm 2.
6	Er06	Illegal setup values used: OUT2 select =AL2 but A2FN select NONE	Check and correct setup values of OUT2 and A2FN. OUT2 will not perform alarm function if A2FN select NONE.
7	Er07	Illegal setup values used: Dwell timer (TIMR) is selected for both A1FN and A2FN.	Check and correct setup values of A1FN and A2FN. Dwell timer can only be properly used for single alarm output.
10	Er 10	Communication error: bad function code	Correct the communication software to meet the protocol requirements.
11	Er 11	Communication error: register address out of range	Don't issue an over-range address of register to the slave.
12	Er 12	Communication error: access a non-existent parameter	Don't issue a non-existent parameter to the slave.
14	Er 14	Communication error: attempt to write a read only data	Don't write a read only data or a protected data to the slave.
15	Er 15	Communication error: write a value which is out of range to a register	Don't write an over-range data to the slave register.
26	AtEr	Fail to perform auto-tuning function	1.The PID values obtained after auto-tuning procedure are out of range. Retry auto-tuning. 2.Don't change set point value during auto-tuning procedure. 3. Don't change Event input state during auto-tuning procedure. 4.Use manual tuning instead of auto-tuning.
29	EEPE	EEPROM can't be written correctly	Return to factory for repair.
38	Sb2E	Input 2 (IN2) sensor break, or input 2 current below 1 mA if 4-20 mA is selected, or input 2 voltage below 0.25V if 1 - 5V is selected	Replace input 2 sensor.
39	Sb1E	Input 1 (IN1) sensor break, or input 1 current below 1 mA if 4-20 mA is selected, or input 1 voltage below 0.25V if 1 - 5V is selected	Replace input 1 sensor.
40	AdEr	A to D converter or related component(s) malfunction	Return to factory for repair.

6.2 Menu Existence Conditions Table

Menu	Parameter Notation	Existence Conditions
User Menu	SP1	Exists unconditionally
	TIME	Exists if A1FN selects TIMR or A2FN selects TIMR
	A1SP	Exists if A1FN selects PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H or D12L
	A1DV	Exists if A1FN selects DEHI, DELO, DBHI, or DBLO
	A2SP	Exists if A2FN selects PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H or D12L
	A2DV	Exists if A2FN selects DEHI, DELO, DBHI, or DBLO
	RAMP	Exists if SPMD selects MINR or HRR
	OFST	Exists if TI1 is used for control (depends on Event input and EIFN selection) but TI1= 0 and PB1≠0 or if TI2 is used for control (depends on Event input and EIFN selection) but TI2= 0 and PB2≠0
	REFC	Exists if SPMD selects PUMP
	SHIF PB1	Exists unconditionally
	TI1 TD1	Exists if PB1≠0
	CPB	Exists if OUT2 select COOL
	SP2	Exists if EIFN selects SP2 or SPP2, or if SPMD selects PUMP
	PB2	Exists if EIFN selects PID2 or SPP2
	TI2 TD2	Exists if EIFN selects PID2 or SPP2 provided that PB2≠0
	O1HY	If PID2 or SPP2 is selected for EIFN, then O1HY exists if PB1= 0 or PB2 = 0. If PID2 or SPP2 is not selected for EIFN, then O1HY exists if PB1= 0
	A1HY	Exists if A1FN selects DEHI, DELO, PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H, or D12L
	A2HY	Exists if A2FN selects DEHI, DELO, PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H, or D12L
	PL1	If PID2 or SPP2 is selected for EIFN, then PL1 exists if PB1= Ø or PB2 = Ø. If PID2 or SPP2 is not selected for EIFN, then PL1 exists if PB1≠0
	PL2	Exists if OUT2 selects COOL

Menu Existence Conditions Table (continued 2/3)

Menu	Parameter Notation	Existence Conditions
Setup Menu	FUNC	Exists unconditionally
	COMM	Exists if FUNC selects FULL
	PROT ADDR BAUD DATA PARI STOP	Exists if COMM selects 485 or 232
	AOFN	Exists if COMM selects 4-20, 0-20, 0-1V, 0-5V, 1-5V, or 0-10
	AOLO AOHI	Exists if COMM selects 4-20, 0-20, 0-1V, 0-5V, 1-5V, or 0-10 and AOFN is not MV1 and MV2
	IN1 IN1U DP1	Exists unconditionally
	IN1L IN1H	Exists if IN1selects 4-20, 0-20, 0-1V, 0-5V, 1-5V, or 0-10
	IN2	Exists if FUNC selects FULL
	IN2U DP2 IN2L IN2H	Exists if IN2 selects 4-20, 0-20, 0-1V, 0-5V, 1-5V, or 0-10
	OUT1 O1TY CYC1 O1FT OUT2	Exists unconditionally
	O2TY CYC2 O2FT	Exists if OUT2 selects COOL

Menu Existence Conditions Table (continued 3/3)

Menu	Parameter Notation	Existence Conditions
Setup Menu	A1FN	Exists unconditionally
	A1MD	Exists if A1FN selects DEHI, DELO, DBHI, DBLO, PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H, D12L or LB
	A1FT	Exists if A1FN is not NONE
	A2FN	Exists unconditionally
	A2MD	Exists if A2FN selects DEHI, DELO, DBHI, DBLO, PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H, D12L or LB
	A2FT	Exists if A2FN is not NONE
	EIFN PVMD FILT	Exists if FUNC selects FULL
	SELF	Exists unconditionally
	SLEP SPMD	Exists if FUNC selects FULL
	SP1L SP1H	Exists unconditionally
	SP2F	Exists if EIFN selects SP2 or SPP2, or if SPMD selects PUMP
	SEL1 SEL2 SEL3 SEL4 SEL5	Exists unconditionally

Use the following Table as a master copy for your settings.

Contained in	Parameter Notation	Display Format	Default setting	Your setting*
User Menu	SP1		100°C (212,0°F)	
	TIME	ti mE	0,0	
	A1SP	A 1.SP	100°C (212,0°F)	
	A1DV	A 1.dv	10,0°C (18,0°F)	
	A2SP	A2.SP	100°C (212,0°F)	
	A2DV	A2.dv	10,0°C (18,0°F)	
	RAMP	rAmP	0,0	
	OFST	oFSt	25.0	
	REFC	rEFC	2	
	SHIF	SHi F	0.0	
	PB1	Pb 1	10,0°C (18,0°F)	
	TI1	ti 1	100	
	TD1	td 1	25.0	
	CPB	C.Pb	100	
	SP2	SP2	100°C (212,0°F)	
	PB2	Pb2	10,0°C (18,0°F)	
	TI2	ti 2	100	
	TD2	td2	25.0	
	O1HY	o 1.HY	0,1	
	A1HY	A 1.HY	0,1	
	A2HY	A2.HY	0,1	
	PL1	PL 1	100	
	PL2	PL2	100	
Setup Menu	FUNC	FunC	1	

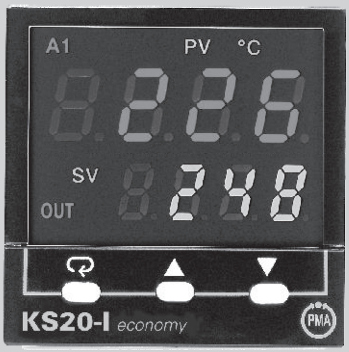
Contained in	Parameter Notation	Display Format	Default setting	Your setting*
Setup Menu	COMM	CoMM	1	
	PROT	Prot	0	
	ADDR	Addr	-	
	BAUD	bAud	5	
	DATA	dAtA	1	
	PARI	PAri	0	
	STOP	StoP	0	
	AOFN	Ao.Fn	0	
	AOLO	Ao.Lo	0°C (32,0°F)	
	AOHI	Ao.Hi	100°C (212,0°F)	
	IN1	in 1	1 (0)	
	IN1U	in 1.u	0 (1)	
	DP1	dP 1	1	
	IN1L	in 1.L	0	
	IN1H	in 1.H	1000	
	IN2	in2	1	
	IN2U	in2.u	2	
	DP2	dP2	1	
	IN2L	in2.L	0	
	IN2H	in2.H	1000	
	OUT1	out 1	0	
	O1TY	o 1.tY	0	
	CYC1	CYC 1	18.0	
	O1FT	o 1.Ft	BPLS	

* only note if deviant

Contained in	Parameter Notation	Display Format	Default setting	Your setting*
Setup Menu	OUT2	out2	2	
	O2TY	o2.tY	0	
	CYC2	CYC2	18.0	
	O2FT	o2.Ft	BPLS	
	A1FN	A1.Fn	2	
	A1MD	A1.nd	0	
	A1FT	A1.Ft	1	
	A2FN	A2.Fn	2	
	A2MD	A2.nd	0	
	A2FT	A2.Ft	1	
	EIFN	Ei.Fn	1	
	PVMD	PV.nd	0	
	FILT	FiLt	2	
	SELF	SELF	1	
	SLEP	SLEP	0	
	SPMD	SP.nd	0	
	SP1L	SP1.L	0°C (32,0°F)	
	SP1H	SP1.H	1000°C (1832,0°F)	
	SP2F	SP2F	0	
	SEL1	SEL1	0	
	SEL2	SEL2	0	
	SEL3	SEL3	0	
	SEL4	SEL4	0	
	SEL5	SEL5	0	

Contained in	Parameter Notation	Display Format	Default setting	Your setting*
Calibration Mode Menu	AD0	Ad0	-	
	ADG	AdG	-	
	V1G	V1.G	-	
	CJTL	CJt.L	-	
	CJG	CJ.G	-	
	REF1	rEF.1	-	
	SR1	Sr.1	-	
	MA1G	MA1.G	-	
	V2G	V2.G	-	
	MA2G	MA2.G	-	
Display Mode Menu	PVHI	PV.Hi	-	
	PVLO	PV.Lo	-	
	MV1	H___	-	
	MV2	C___	-	
	DV	dV	-	
	PV1	PV1	-	
	PV2	PV2	-	
	PB	Pb	-	
	TI	ti	-	
	TD	td	-	
	CJCT	CJCt	-	
	PVR	PVr	-	
	PVRH	PVr.H	-	
	PVRL	PVr.L	-	

* only note if deviant



KS 10-I/KS 20-I

Mini-controller

High-precision universal input
Precise control behaviour withshort scanning cycle of 100 ms,
Hardware switch for disabling operation
Two freely configurable alarm outputs for suppression, latch, and timer function
Monitoring of heating current and control loop
External contact for 2nd set-point and 2nd set of parameters
Precise, galvanically isolated measurement value output
RS 485 interface with Modbus RTU protocol
Front panel protection IP 65

PROFILE

With their compact dimensions, these mini-controllers can be mounted even in the smallest machines. They have one control output and two alarm outputs. Depending on configuration, they can be used as signallers or two-point controllers. By configuring one of the alarm outputs accordingly, they are also suitable for three-point control, i.e. all heating, cooling or heating/cooling applications.
High-resolution input circuit, fast scanning cycle, and self-tuning result in precise control behaviour.

SAFE OPERATION

Operation is done by means of 3 front-panel keys in the Operating, Parameter and Configuration Levels. Easily remembered mnemonics are displayed for every adjusted parameter, thus simplifying the unit's configuration. Alarm and control parameters can be selected for adjustment in the Operating Level. Two DIP switches enable the adjustment of set-point and parameters to be disabled.

HIGH-PRECISION UNIVERSAL INPUT INP1

The measurement input is configurable for all conventional applications. With thermocouple and Pt 100 input, resolution is 0,1°C. Optionally, the display can be in °F or in a linear engineering unit of your choice. Measurement value correction is fitted as standard. Current/voltage input signals are scalable in the range of -19999...+45536. Set-point limits are adjustable within the measurement range. In case of sensor break, the output goes to a pre-defined state.

SUPPLEMENTARY INPUT INP2

for heating current monitor, external set-point, or difference control Heating current is switched on by the two-point controller is monitored with an external current transformer, and compared with a preset limit. Alternatively, the supplementary input can be used for an external set-point, or for difference control.

ADDITIONAL DISPLAY MODE

Apart from the standard display of set-point and process value, it is possible to select a display mode for previous min/max process values together with their gradients. Heating current and output value can also be displayed in this way.

CONTROL OUTPUTS

with PID + Fuzzy behaviour plus self-tuning

Depending on version, control output OUT1 is either a relay, a logic signal, or a continuous 0/4...20 mA or 0...10 V signal. Due to the fast scanning time of 100 ms and the high input resolution, the controller is also suitable for fast control loops (e.g. air heating, pressure, and flow). At the push of a button, the autotuning function determines the optimum parameters for fast line-out without overshoot. For this step changes of the output are used for the calculation. Selftune is as well possible: The controller determines automatically the optimum parameters without producing a detectable disturbance to the process. By means of the alarm relay OUT 2, the unit can be configured as a three- point controller, e.g. for „heating/ cooling" applications.
The max. effec- tive output value is individually adjust- able for heating and cooling, whereby PID, PD, PI, or P control behaviour is selectable. With P or PID behaviour, permanent offset can be prevented by shifting the working point.
Output response in the case of sensor break is adjustable 0...100%. Alternatively, the „hold" function maintains the output at its previous mean value.
The input for an external contact can be used to activate a second set of parameters.

TWO UNIVERSAL, CONFIGURABLE ALARM OUTPUTS

Both alarm outputs operate on the working current principle; when triggered by an alarm, the relays are energized (logic output goes „High" with KS 10-I), and the front-panel LED lights. The switching difference is individually adjustable.Configurable alarm modes are: Absolute or relative measurement value alarm, min/max alarm, tolerance band alarm, or control loop monitoring. The absolute alarm is selectable for INP1 or INP2. Furthermore, alarm behaviour is configurable: Alarm suppression after power-up, alarm „latch" or alarm „on/off" in case of a fault, e.g. sensor break. Latched alarms can be reset via an external contact.

2ND SET-POINT

and 2nd set of parameters

By means of an external contact „W/W2", a 2nd set-point can be activated. If required, a separate parameter set can be assigned to the 2nd set-point.

SET-POINT RAMP FUNCTION / TIMER RELAY

The ramp function is initiated after power-up, whereby the set-point starts from the actual process value and increases at a defined rate (°C/min or °C/h) to the final value.
If one of the alarm relays is used for timing functions, the timer is started as soon as the process value reaches the set-point value. When the preset time has elapsed, the relay can be used e.g. to switch off a heater.

SLEEP FUNCTION

This function is used to disable the control outputs.

OPTION: INTERFACE OR MEASUREMENT VALUE OUTPUT

The RS 485 interface with Modbus RTU protocol can be used for remote access to all the parameters. The high-precision 0/4.. 20 mA measurement value output is galvanically isolated and configurable to represent the process value, the control deviation, or the controller output.

TECHNICAL DATA

UNIVERSAL INPUT INP1

Scanning cycle

100 ms

Input filter

Time constant adjustable: max. 60 s

Display

°C, °F or engineering unit selectable

Sensor break monitoring

Response time: approx. 1 s
Thermocouple and Pt 100 break protection

Lead break monitoring:

current <1 mA for 4...20 mA input;
voltage <0,025 V for 1...5 V input
Output response: adjustable 0...100.0 %
Alarm output action: adjustable On / Off

Sensor and signal types

Sensor/signal	Type	Measuring range		Error*
Fe-CuNi	J	-120...1000 °C	-184...1832 °F	2 K
Fe-CuNi	L	-200...900 °C	-328...1625 °F	2 K
NiCr-Ni	K	-200...1370 °C	-328...2498 °F	2 K
PtRh-Pt 10%	S	0...1767 °C	32...3214 °F	2 K
PtRh-Pt 13%	R	0...1767°C	32...3214 °F	2 K
PtRh-Pt 6%	B	0...1820°C	32...3308°F	2 K**
Cu-CuNi	T	-250...400°C	-418...752°F	2 K
Nicrosil/Nisil	N	-250...1300 °C	-418...2372 °F	2 K
NiCr-CuNi	E	-100...900 °C	-148...1652 °F	2 K
Pt 100		-210...700 °C	-346...1292 °F	0,1 K
Linear		4-20 mA	-19999...45536	0,05 %
Linear		0-20 mA	-19999...45536	0,05 %
Linear		0-1 V	-19999...45536	0,05 %
Linear		0-5 V	-19999...45536	0,05 %
Linear		1-5 V	-19999...45536	0,05 %
Linear		0-10 V	-19999...45536	0,05 %

* Error includes linearity, temperature compensation, lead resistance, and offset drift

* *For range 200...1820 °C

Current 0/4...20 mA

Input resistance: 70,5 Ω

Voltage

Input resistance: 302 kΩ

Lead resistance

Max. 100 Ω

Temperature compensation

Additional error: typically 0,1 K /10 K

Effect of compensating lead

Additional error: 0,1 µV / Ω

Resistance thermometer connection

2 or 3-wire connection

Measurement value correction

-200,0...200,0 °C

Decimal point adjustment

0 or 1 for thermocouple, Pt 100 ranges
0, 1, 2 or 3 for mA, V ranges

Interference suppression

Series mode rejection: 40 dB
Common mode rejection: 120 dB

INPUT INP2

Scanning cycle

500 ms
Alternatively for:

External current transformer type 9407 998 00051

Range: 0...50,0 A
Error: ±2% of indication ± 0,2 A or:

External set-point

0...1 V, 0...5 V, 1...5 V, 0...10 V
Input resistance: 302 kΩ
0/4...20 mA (only with KS 20-I)
Input resistance: 70,5Ω +0,8 V /1 mA

Digital input (external switch)

Configurable action:

Display	Description
NONE	No function
SP2	Second set-point W2
PID2	Second parameter set
SP.P2	Second W2 parameter set
RS.A1	Reset alarm 1 output
RS.A2	Reset alarm 2 output
R.A1.2	Reset Alarm 1&2
D.01	Output 1 disabled
D.02	Output 2 disabled
D.01.2	Output 1&2 disabled
LOCK	All parameters disabled

OUTPUTS

Relay contacts

Rating: 240 VAC, 2 A, resistive load

Logic output

Rating: >4V with R_L > 400Ω
max. 30 mA with R_L < 400Ω

Continuous output

Galvanically isolated, resolution < 0,1 %
0/4...20 mA (3,8...21 mA), load 500 Ω
0...10 V, load > 10 kΩ konfigurable for 0-1/5/10V, 1-5V

POWER SUPPLY

AC supply

90...264 VAC, 50/60 Hz

Universal supply

11-26 VUC

Power consumption

Max15VA /7 W

CONTROL BEHAVIOUR

Two-point and continuous controllers

Proportional band Pb1: 0...500,0 °C (0...9000 units)
Integral action time ti:: 0...3600 s
Working point (Offset): 0...100,0 %
Derivative action time td: 0...900,0s
Hysteresis of signaller (Pb1 = 0): 0,1...55,6 °C
Duty cycle: 0,1...100,0 s
Control action: Inverse („Heating") or direct („Cooling")
Output limiting: 0...100 %
Output signal in case of sensor break:
configurable 0...100 % or switch- over to last mean value of the output signal

THREE-POINT CONTROLLER

Alarm relay 2 configurable for „cooling":
Duty cycle: 0,1...100,0 s
Proportional band cooling CPb: 1...255 % of proportional band Pb1 „heating" Trigger point separation: Automatic adjustment
Output limiting: 0...100 %
Output signal in case of sensor break: adjustable 0...100 %

Set-point ramp function / Timer function

Gradient: 0...500,0 °C/min or 0...500,0 °C/hour. Dwell time at set-point for alarms 1 &2:0...6553,5 min (timer function independent of the ramp function)
Alarms 1 &2configurable for „On / Off"respectively

Sleep function

Outputs can be disabled; display point blinks

ALARM OUTPUTS 1 AND 2

KS 10-I

Alarm 1: Logic output 5 V /100mA
Alarm 2: Relay output

KS 20-I

Alarms 1 &2:Relay output
Contact rating: 240 VAC, 2 A, resistive load

Configurable alarm action

Alarm suppression on power up
Alarm latch
Alarm On / Off for sensor break

Configurable alarm functions

Min/max monitoring for process value (INP 1 and INP 2), control deviation or deviation band

Output loop break alarm

Detection time:
2 x integral action time, < 120 s

Adjustment of alarm trigger points

Absolute alarm: within measuring range
Relative alarm: -200,0...200,0 °C
Switching difference (hysteresis):
0,1...10,0 °C

OPERATION

Extension of the operating level

Additionally to the set-point, up to 5 alarm/control parameters can be selected for the adjustment in the operating level.

Set-point adjustment

Upper and lower limits of the set-point are selectable within the measuring range limits

Disabling DIP switches

1	2	Function
OFF	OFF	All parameters adjustable
ON	OFF	Only SP1 and selected parameters
OFF	ON	Only SP1 adjustable
ON	ON	All parameters disabled

Manual control mode

Control output adjustable:
0,0...100 % „Heating" /
0,0...100 % "Cooling"

Display mode

The following parameters can be displayed:

PVHI	Maximum process value
PVLO	Minimum process value
H_ _ _	Percentage power „heating"
C_ _ _	Percentage power "cooling"
DV	Control deviation (x-w)
PV1	Process value (INP 1)
PV2	Process value (INP 2)/heating current
PB	Proportional band value
TI	Integral action time
TD	Derivative action time
CJCT	Cold junction temperature
PVR	Process value rate
PVRH	Maximum process value rate
PVRL	PVRL Minimum process value rate

COMMUNICATION

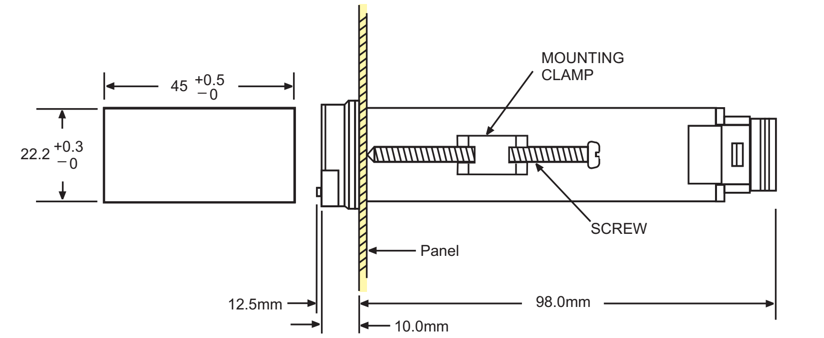
RS 485 interface

Data protocol: Modbus RTU
Interface address: 1...247
Transmission speed: max. 38.400 bits/s

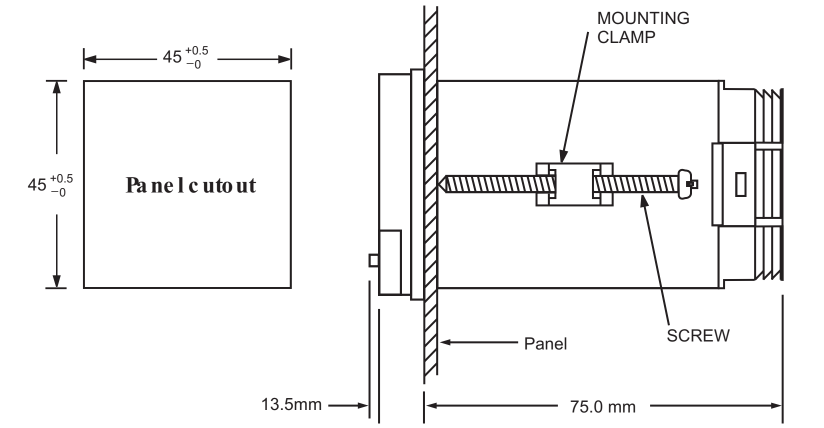
Measurement value output

0/4...20 mA , load 250 W
Galvanically isolated, scalable
Resolution: 0,025 %
Accuracy: ± 0,05 %
Configurable, scalable for representation of: Process value x, set-point w, control deviation x-w, correcting variable y

Overall dimensions of KS 10-I



Overall dimensions of KS 20-I



ENVIRONMENTAL CONDITIONS

Operating temperature

-10...+50 °C

Storage temperature

-40...+60 °C

Relative humidity

0...90 %, no condensation

Shock and vibration

Shock test: 20 g
Vibration test: 10...55 Hz, 1 mm

CONFORMITY TESTS

CE marking

The unit meets the relevant European Standards

Electrical safety

According to DIN EN 61 010-1
Over-voltage category II
Contamination degree 1
Working voltage range 300 V
Protection class II
UL approval (in preparation)
CSA approval (in preparation)

Electromagnetic compatibility

Meets EN 50 081-1, EN 50 082-2 and EN 61326

GENERAL

Housing KS 10-I

Front dimensions: 48 x 24 mm
Depth behind panel: 99 mm
Panel cut-out: 45+0,5 x 22,2+0,3 mm
(see dimension drawing)

Housing KS 20-I

Front dimensions: 48 x 48 mm
Depth behind panel: 75 mm
Panel cut-out: 45+0,5 x 45+0,5 mm
(see dimension drawing)
Protection mode
Front: IP 65 (NEMA 4X)

Electrical connection

Screw terminals for max. 2,5 mm²

Weight

KS 10-I: approx. 0,11 kg
KS 20-I: approx. 0,15 kg

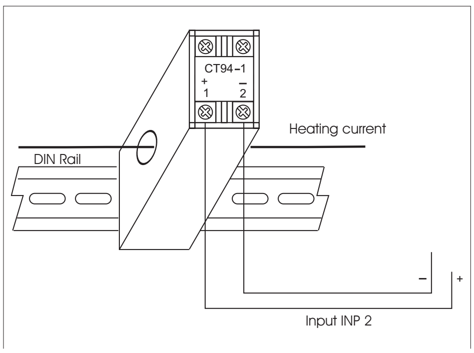
Accessories

Operating instructions (English, German)

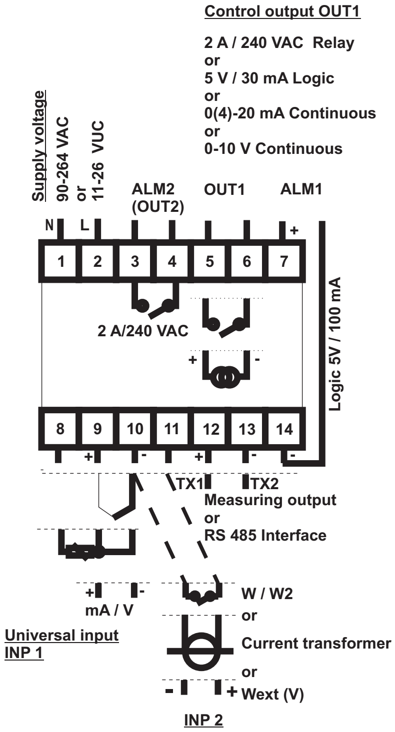
Current transformer

Dimensions: 25 x 55 x 70,6 mm
Weight: 59 g

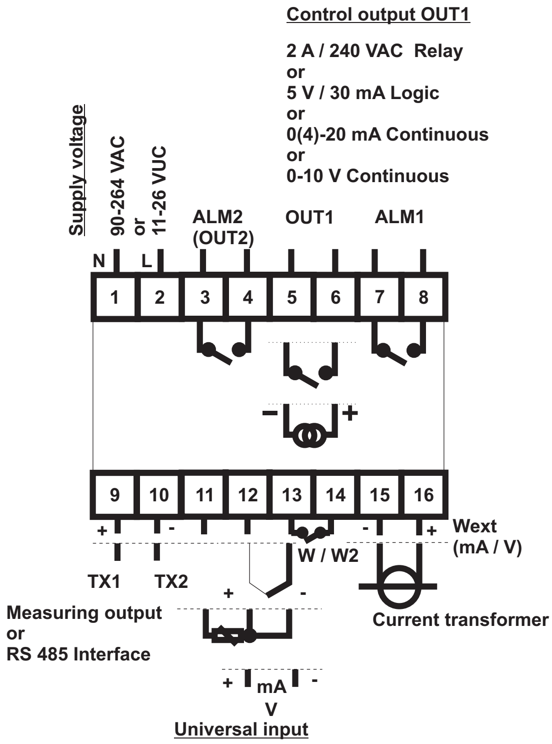
Ordering Number: 9407 998 00051



CONNECTION DIAGRAM KS 10-I



CONNECTION DIAGRAM KS 20-I



ORDERING DATA

KS 10-I economy	**9407 - 403 - x x x x 1**
Power supply	
90-264 VAC	**0**
11-26 VUC	**1**
Control output 1)	
Relay (2 A / 240 VAC)	**0**
Logic (5 V / 30 mA)	**1**
Continuous 0/4...20 mA	**2**
Continuous 0...10 V	**3**
Options	
None	**0**
Digital interface RS 485	**1**
Meas. value output 0/4...20 mA	**2**
Configuration 2)	
Basic configuration	**0**
Configuration to specification	**9**

Current transformer 0...50A	**9407 - 998 - 0 0 0 5 1**
Operating manual GB	**9499 - 040 - 5 80 1 1**
Operating manual D	**9499 - 040 - 5 8 1 1 8**
Operating manual F	**9499 - 040 - 5 8 2 3 2**

1) For two-point control „heating" or "cooling".
Three-point controller uses the alarm relay ALM 2 for „cooling".

ORDERING DATA

KS 20-I economy	**9407 - 404 - x x x x 1**
Power supply	
90-264 VAC	**0**
11-26 VUC	**1**
Control output 1)	
Relay (2 A / 240 VAC)	**0**
Logic (5 V / 30 mA)	**1**
Continuous 0/4...20 mA	**2**
Continuous 0...10 V	**3**
Options	
None	**0**
Digital interface RS 485	**1**
Meas. value output 0/4...20 mA	**2**
Configuration 2)	
Basic configuration	**0**
Configuration to specification	**9**

Current transformer 0...50A	**9407 - 998 - 0 0 0 5 1**
Operating manual GB	**9499 - 040 - 5 8 3 1 1**
Operating manual D	**9499 - 040 - 5 8 4 1 8**
Operating manual F	**9499 - 040 - 5 8 5 3 2**

2) Basic configuration: Two-point controller, thermocouple input (type J), alarm outputs monitor the max. control deviation.

PMA
Prozess- und Maschinen- Automation GmbH
P.O Box 31 02 29
D - 34058 Kassel
Tel.: +49 - 561 - 505 1307
Fax: +49 - 561 - 505 1710
E-mail: mailbox@pma-online.de
Internet: http://www.pma-online.de
Your local representative

For your notes

Postfach 310 229, D - 34058 Kassel