

Version 406

Version 407

KS 40

Compact industrial controller

- Simplest operation
- Bright LED display
- Plug-in controller module
- Confident handling under extreme conditions
- Precise control behaviour
- Self-tuning
- Long life
- Low price and fast delivery

PROFILE

The new generation of KS 40 compact controllers features microcomputer operation for precise, cost-effective temperature control in all branches of industry: from flow-soldering lines to textile driers, from steam boilers to packing machines, from mould heating to furnaces. An optional digital interface permits communication with computers and PLC's.

Consistent application of modern technology (mask-programmed processor, ASIC, SMD) enabled the volume of the electronic components to be reduced to a minimum, which also means low internal temperatures. Modern production methods ensure highest quality and reliability, plus short delivery times.

Furthermore, the KS 40 controllers meet European Standards EN 50 081 - 1 and EN 50 082 - 2, and have therefore qualified for CE-marking. Their construction meets the safety regulations of VDE 0411. Each unit is tested with 3 kV before shipment.

DESCRIPTION

Plug-in controller modules

KS 40 controllers are plug-in modules which ensures fast replacement without any tools. Electrical connections are made via rear flat-pin connectors.

Two hardware versions, freely configurable

Version 406 with single display has a circuit board with 2 relays. Version 407 with dual display is available with 2 or 3 relays or as a continuous controller with one alarm contact; an optional digital interface is possible. Input, control function and alarms are freely configurable.

Fig. 1 Operating concept

Standard on all versions are self-tuning, a second set-point with ramp function, an additional input for monitoring heating current, a logic output for heating, and a 115/230 V mains transformer.

Simple operation

Only three robust keys are used for all settings and adjustments. Tactile feedback from the keys and an automatic increase in rate of change when a key is pressed for a longer period ensure fast and safe settings.

Clear operating concept and lockable parameter adjustment

All operating functions are user-friendly and clearly structured as follows:

Operating Level for set-point adjustment.

Parameter Level for adjusting the required control parameters, limit values, etc.

Configuration Level for adjusting the controller functions.

An internal switch provides controlled access to the Parameter and Configuration levels.

Display and operating functions

It is possible to disable set-point adjustment and display in the Operating level. On version 407 the permissible set-point limits can be adjusted in the Parameter level.

Input circuit monitoring

In case of faults in sensor or leads, the built-in monitor provides increased operational safety. When the monitor is triggered, controller output is upscale on version 406, and can be configured for upscale or downscale action on version 407.

The outputs are set to 0% with three-point controllers.

Thermocouple input

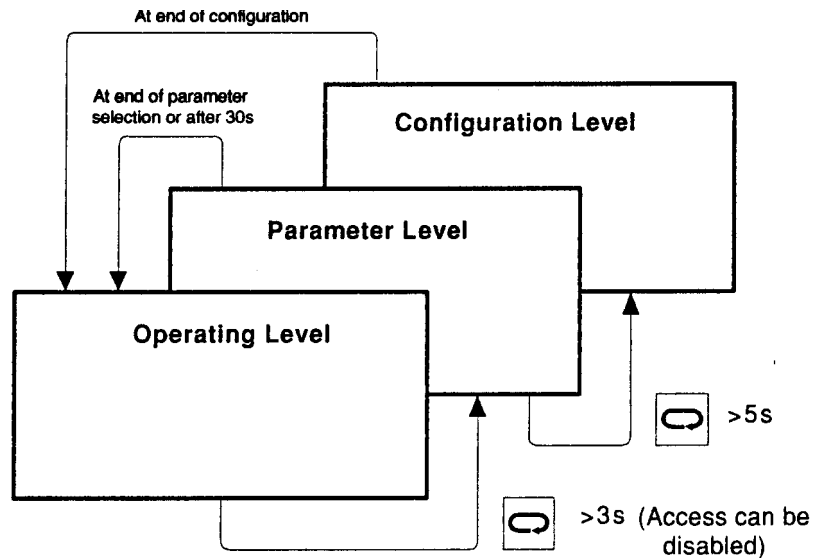
The monitor detects an open-circuit sensor and also if the polarity is reversed.

Resistive input

The input is monitored for a break or a short circuit in the sensor and leads.

Input 4...20 mA (version 407)

The monitor is triggered if the current is less than 2 mA.



Monitoring and display of heating current

Version 406: These versions are fitted only with monitor for defective heating.

Version 407: The controllers are fitted with an input for connection of an external current transformer. The heating current and its adjustable limit value are displayed as a parameter. With configuration "Monitoring for actuator break and short circuit", the monitor is activated with relay 1 energized or active logic output and exceeded minimum limit and also with relay 1 de-energized or inactive logic output and heating current above 0,4 A: Red LED, alarm contact. When configured for "Excess current monitoring", monitoring is only active with relay 1 energized or active logic output and exceeded maximum limit.

Controller and positioner functions

Version 406: The unit is configurable as a two-point controller (heating), or as a three-point controller (heating/cooling).

When configured as a positioner, the unit works without an input signal. The output has an adjustable duty cycle of 0...100%.

Version 407: When fitted with 2 or 3 relays, the unit is configurable as a signaller, two-point controller, three-point controller or three-point stepping controller. When fitted with a continuous output and an additional relay, it is possible to configure the function "logic output for heating/continuous output for cooling".

When configured as a positioner, the output has an adjustable duty cycle of 0...100% or an adjustable current signal of 0...105%.
With the three-point stepping positioner it is possible to operate the motor actuator manually. Process value x is displayed with these functions.

The controller structure can be modified by disabling the integral and/or derivative action.

Disabled outputs

The controller outputs can be disabled by adjusting the set-point to a value under the lower limit (all outputs in de-energized state).

Alarm functions

The alarm contact output is configurable as follows:

- a) **Relative alarm** for monitoring the control deviation (relative to set-point).
- b) **Absolute alarm** for limit monitoring (independent of set-point setting).
- c) **Relative alarm with alarm suppression (Version 407)**. The alarm is not triggered during start-up or after a change of set-point.

Second set-point with ramp function and the program controller

The external control contact W/W2 is used to activate a second set-point (safety set-point, which is also effective after a mains failure).
The second set-point becomes effective after an adjustable time has elapsed.

Version 407: Three additional set-points with corresponding segment times can be used for program control. Start and re-start after mains failure are executed from the momentary process value x.

Set-point gradient function

Version 407: The set-point gradient function (see Fig. 3) can be adjusted by means of parameter Gr with the corresponding controller version. In case of set-point adjustment, after re-start and switch-over from W2 to W, set-point changing starts from process value x at the adjusted speed (e.g. 50 °C/min) and LED W2 blinks. With Gr=----, the function is switched off.

Version 407 with optional digital interface

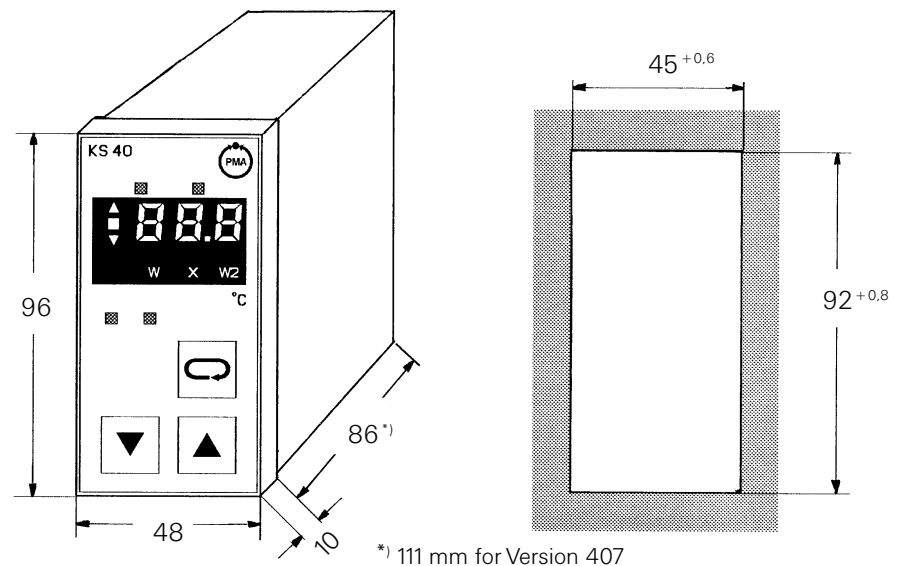
A separate RS 422/485 interface module is available, making the controllers bussable. Max. 4 controllers can be connected to each module via interface cables of 1m length. The max. transmission speed is 19.600 bits/s.

External operation and visualization with IQT 150

Max. six interface modules, each of which incorporates 4 controllers, enable central control and monitoring of systems, incorporating 24 controllers. Operation and visualization is performed by the IQT unit. The required software is integrated and enables application-specific pictures of the process, flow diagrams and specific input sections to be generated.

The distance between interface modules and IQT can be max. 1,000 m.

Fig. 4 Overall dimensions and panel cut-out (mm)



TECHNICAL DATA	VERSION 406	VERSION 407
INPUTS	Configurable	Configurable
Thermocouples	Types L, J	Types L, J, K, N, S, R
Ranges	See Ordering Data Display in °C	See Ordering Data Display in °C or °F
Linearization	Built in	Built in
Display error	$\leq 3K \pm 1$ digit	$\leq 3K \pm 1$ digit
Input resistance	$>1\text{ M}\Omega$	$>1\text{ M}\Omega$
TC break monitor	Sensor current 1 μA	Sensor current 1 μA
Polarity monitoring	Triggered when $X < 0^\circ\text{C}$	Triggered when input signal is $> 30\text{ K}$ below span start
Action on break	Upscale	Downscale or upscale, selectable
Resistance thermometer	Pt 100 DIN/IEC	Pt 100 DIN/IEC
Measuring ranges	0...99,9 °C or 0...400 °C	-99,9...500,0 °C or -148...932 °F
Linearization	Built in	Built in
Display error	$\leq 1K \pm 1$ digit	$\leq 1K \pm 1$ digit
Connection	3-wire technique, no lead adjustment	3-wire technique, no lead adjustment
Lead resistance	$\leq 5\ \Omega$ per lead	$\leq 30\ \Omega$ per lead
Sensor current	$\leq 1,5\text{ mA}$	$\leq 1,5\text{ mA}$
Input circuit monitor	Break in sensor or lead, or short circuit	
Action on break	Upscale	Downscale or upscale, selectable
Direct current	—	0/4...20 mA linear
Input resistance	—	15 Ω
Measurement limits	—	Selectable within -999...9999, decimal point adjustable
Display error	—	$<0,1\%$
Input circuit monitor	—	4...20 mA: with $I < 2\text{ mA}$
Action on break	—	Upscale or downscale, selectable
Direct voltage	—	0...10 V linear
Input resistance	—	$\geq 110\text{ k}\Omega$
Measurement limits	—	Selectable within -999...9999, decimal point adjustable
Display error	—	$<0,1\%$
Measurement earth	Connection to system earth or protective earth	
Current transformer input	Fitted as standard. See "Accessory equipment" for current transformer.	
Control inputs		
Switch W2	Ramp	Ramp/programmer
Switch L/R	—	Local/Remote switchover with digital interface
Control signal	Contacts, npn-transistor, or active logic signal: Low $\leq 1\text{ V}$, High = 3...6 V	
Digital interface	—	RS 422/485 (optional)
Interface module and interface cable	—	See "Accessory equipment"
Controller address	—	0...99
Transmission speed	—	2400, 4800, 9600, 19200 bits/s

TECHNICAL DATA**VERSION 406****VERSION 407****OUTPUTS**

Can be disabled with setting W----

Switching controllers2 relays and
1 logic output2 or 3 relays and
1 logic output

Relay contacts

Open when de-energized

Open when de-energized

Contact rating

Max.500 VA, 250 V, 3 A; 48...62 Hz; resistive load

Logic output

(galvanically connected with input)

0/≥ 5 V with a load of ≥ 500Ω, or
10 mA with a load of ≤ 500 Ω0/13 V with a load of ≥ 1300 Ω, or
10 mA with a load of ≤ 1300 Ω**Continuous controller with 1 relay (limit contact)**

(input and output are galvanically connected)

—

0/4...20 mA

Working point Y₀ (P-controller)

—

0 or 4 mA

Resolution

—

<0,1 mA

Load / load effect

—

≤ 500 Ω / ≤ 0,1 %

Relay data

—

See switching controllers

POWER SUPPLY

230 V AC / 115 V AC; +10...-15%, 48...62 Hz

Power consumption

approx. 4,5 VA

approx. 6,5 VA

CONTROL CHARACTERISTICS

Configurable as:

Configurable as:

—

Signaller (switching differential 0,2%)

Two-point controller with

Two-point controller with

DPID behaviour

DPID behaviour

Three-point controller with

Three-point controller with

DPID/DPID behaviour

DPID/DPID behaviour

—

Three-point stepping controller with
DPI behaviour (shortest step 200 ms)

—

Continuous controller with DPI
behaviour**Control parameters**Self-tuning or fixed parameters:
See "Functions and parameter
settings" (Fig. 6)Self-tuning or adjustable parameters:
See "Functions and parameter
settings" (Fig. 11)**Positioner function**

Selectable for "heating" or "heating/cooling" (or stepping output with 407)

ALARM FUNCTIONSConfigurable as relative or absolute alarm, optionally in combination with
the heating current monitor (or as relative alarm with alarm suppression on
Version 407).**HEATING CURRENT MONITOR**

Display of heating current

0...30,0 A_{rms} with resistive load, external current transformer (see "Accessory
equipment")

Display error

±5%

±5%

Heating current limit

Adjustable 0...30,0 A, optionally acting on alarm relay

Alarm indication

Red LED lights, if current is below
the limit valueVersion with monitoring for actuator
break and short circuit: Red LED on
with heating current below limit value
or heating current above 0,4 A
(actuator short circuit)
Version with excess current monitoring:
Red LED on with heating current above
limit value**SET-POINT**

Adjustment range

Same as measuring range

Upper and lower limits adjustable

DISPLAYS

Multi-function display	Red 3-digit LED display Digit height 10 mm	Two red 4-digit LED displays Digit height: process value X = 10 mm set-point W = 7,6 mm
Display range	0...999	-999...9999
3 LEDs for control deviation:	yellow-green-yellow green $X_w = 0... \pm 1\%$ yellow & green $X_w = \pm 1... 2\%$ yellow $X_w > 2\%$	
LEDs for status display:	yellow for set-point W yellow for process value X yellow for set-point W2	yellow for set-point W2 or programmer "On", or remote operation
LEDs for relay status:	Both versions: yellow = relay 1 "On" or relay 2 "On"	
LED for alarm relay:	Both versions: green = process within limits	
LED for heating current:	Both versions: red = current below limit value	
Input circuit monitoring:	Both versions: FbF (sensor break) and POL (reversed polarity)	

ENVIRONMENTAL CONDITIONS (both versions)

Permissible temperatures	Operation	0...60 °C
	For specified accuracy	0...55 °C
	Storage and transport	-20...70 °C
Climatic category	KUF to DIN 40 040	
	Relative humidity: $\leq 75\%$ yearly average, no condensation	

INFLUENCING FACTORS (both versions)

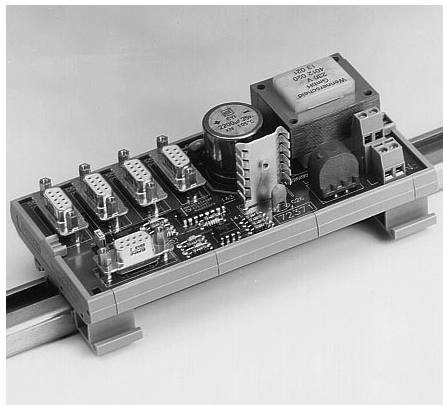
Power supply effect	None (with mains failure, data security is ensured by a non-volatile EEPROM)
Series mode interference	<0,1 V
Low-frequency magnetic field	No effect up to 400 A/m at 50 Hz
High-frequency field	<1K with types L and J up to 300 MHz; 3V/m (IEC 801-3, Sect. 9.2)
Shock and vibration	Vibration test Fc: to DIN IEC 68-2-6
	Transport test: 10...150 Hz; 0,15 mm; 2g (Operational test 1g)
	Shock test Eb: to DIN IEC 68-2-29 Transport test: 10 g, 16 ms

GENERAL (both versions)

Housing	Plug-in module, inserted from front
Material	Makrolon 9415 non-flammable, self-extinguishing
Flammability class	UL 94 VO
Front dimensions	48 mm x 96 mm
Depth behind panel	86 mm (111 mm for version 407)
Protection mode (to DIN VDE 0470 / EN 60 529)	Front: IP 54 (vertical mounting $\pm 15^\circ$)
	Housing: IP 20 Terminals: IP 00
Electrical safety	According to EN 61010-1 (VDE 0411-1); Overvoltage category II; Contamination class 2; Working voltage range 300 VAC; Protection class I
Electromagnetic compatibility	Complies with EN 50 081-1 and EN 50 082-2 for unrestricted use in rural and industrial areas.
Electrical connections	Flat-pin connectors to DIN 46 244 for 1 x 6,3mm or 2 x 2,8 mm
Mounting method	Panel-mounting with 2 fixing clamps at top/bottom or sides
Weight	Approx. 0,35 kg (version 407 approx. 0,45 kg)
Accessories	Operating instructions and 2 fixing clamps

ACCESSORY EQUIPMENT

Interface module / interface cable



Interface module/interface cable
Up to four controllers can be connected to the interface module; also in combination with other PMA equipment. Connection is by means of the separately-ordered interface cable (1 m long).

Via the RS 422/485 interface (D-type connectors), the data are transmitted up to a distance of 1 km. The data protocol conforms to ISO 1745 (fast select mode).

Supply voltage

230 VAC or 115 VAC, depending on version

Voltage tolerance: + 10 ... - 15 %

Frequency: 48 ... 62 Hz

Power consumption: approx. 5 VA

Electrical connection

Screw terminals: 2,5 mm² solid or 1,5 mm² flexible

Mounting

To standard rail, e.g. type NS 35 (U-rail) or type NS32 (C-rail)

Protection mode

Type IP 00 (mounting in enclosure)

Permissible temperatures

For operation: 0 ... 60 °C

For storage: - 20 ... + 70 °C

Relative humidity: $\geq 75\%$ yearly average, no condensation

Mounting position: Not critical

Dimensions

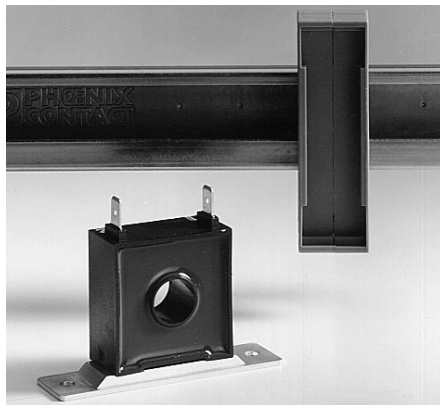
158 x 78 x 60 mm (L x W x H)

Weight: approx. 0,37 kg

Accessories

Operating leaflet

Current transformers



Current transformers are available in single-phase and three-phase versions. All versions are suitable for mounting to standard rails. The mounting clip for the single-phase version (photo) must be ordered separately (e.g. Phoenix).

Dimensions

Single-phase: 38 x 38 x 20 mm

Three-phase: 137 x 77 x 86 mm

Weight

Single-phase: 70 g

Three-phase: 310 g

ORDERING DATA FOR ACCESSORY EQUIPMENT

Description	Order no.
Single-phase transformer 0...30 A, complete with mounting plate for wall mounting	9404 407 50001
Three-phase transformer 3 x 10 A or 3 x 30 A depending on connection	9404 407 50021
Interface module for max. 4 controllers 230 VAC 115 VAC	9404 429 98001 9404 429 98011
Interface cable Length 1m, one per controller	9404 407 50011
Dummy panel black, 48 x 96 mm	9404 723 11231
Labels for engineering unit (qty. 27)	4012 140 66041

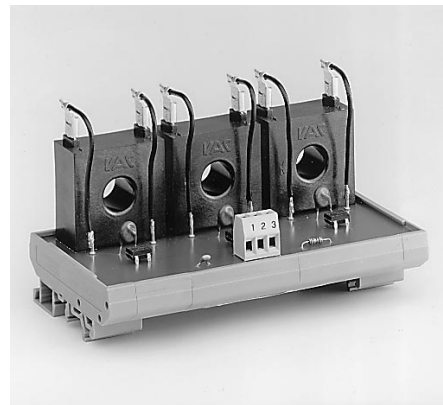


Fig. 5 Connecting diagrams for Versions 406 and 407

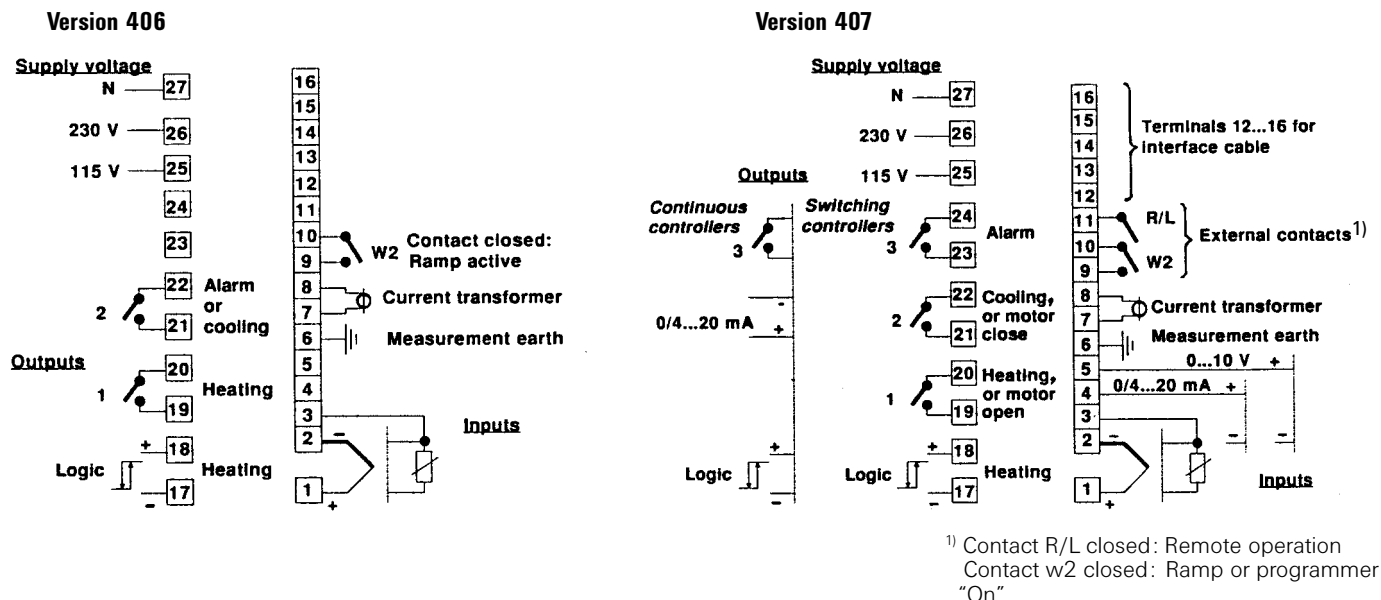


Fig. 6 Parameter adjustment for Version 406

Parameter	Symbol	Adjustment
Second set-point w2	SP2	as measuring range
Segment time t2 (ramp)	Pt2	0 ... 999 min
Low limit contact	LCL ²⁾	0 ... 999 (1...999 with rel. alarm)
High limit contact	LCH ²⁾	0 ... 999 (1...999 with rel. alarm)
Heating current	HC	only display
Heating current alarm	HCA	0 ... 30,0 A
Blocking of operation External contact	Loc	0 ... 3 (see below)

Loc 0: Display of x and w with adjustment and self-tuning

Loc 1: Display of x and w with adjustment

Loc 2: Only display of x and w

Loc 3: Only display of x

²⁾ Switching difference 1 digit

Fig. 7 Second set-point w2 with ramp

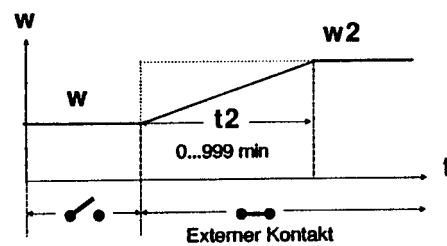
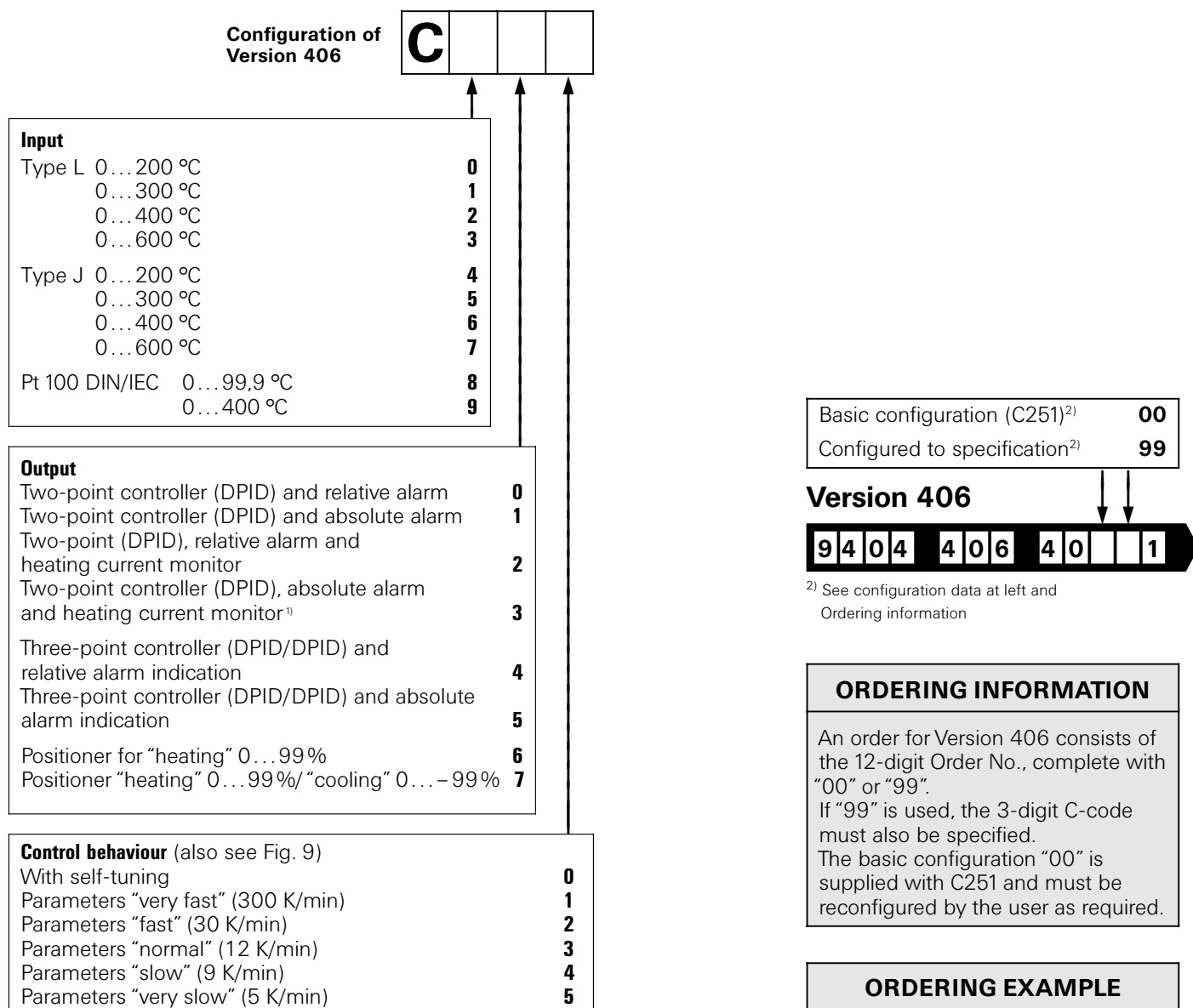
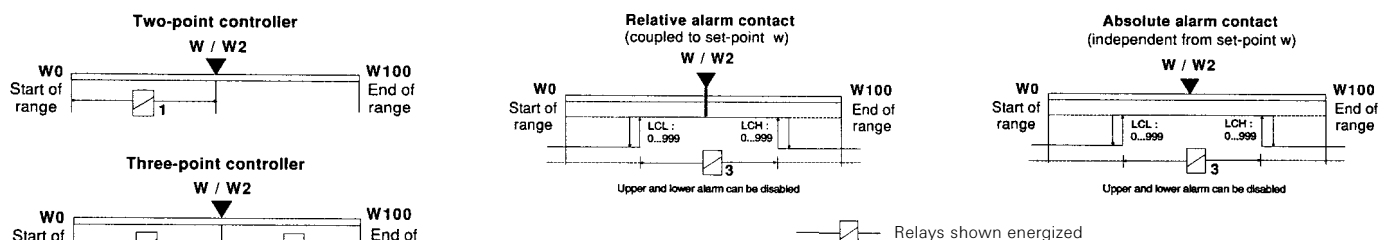


Fig. 8 Controller and alarm functions of Version 406



¹⁾ Current transformer required, see Accessory Equipment

Fig. 9 Control loop characteristics

Code	Loop behaviour	Delay time T_u	Rate of change V_{max}	On/off ratio and switching frequency	
1	very fast	5 s	5.0 K/s	1 s	60/min
2	fast	40 s	0.5 K/s	5 s	12/min
3	normal	120 s	0.2 K/s	15 s	4/min
4	slow	180 s	0.15 K/s	20 s	3/min
5	very slow	300 s	0.08 K/s	20 s	3/min

Item	Order no./Description	Qty.
1	9404 406 40991 C620	1
2	Current transformer 9404 407 50001	1

Fig. 10 Controller and alarm functions of Version 407

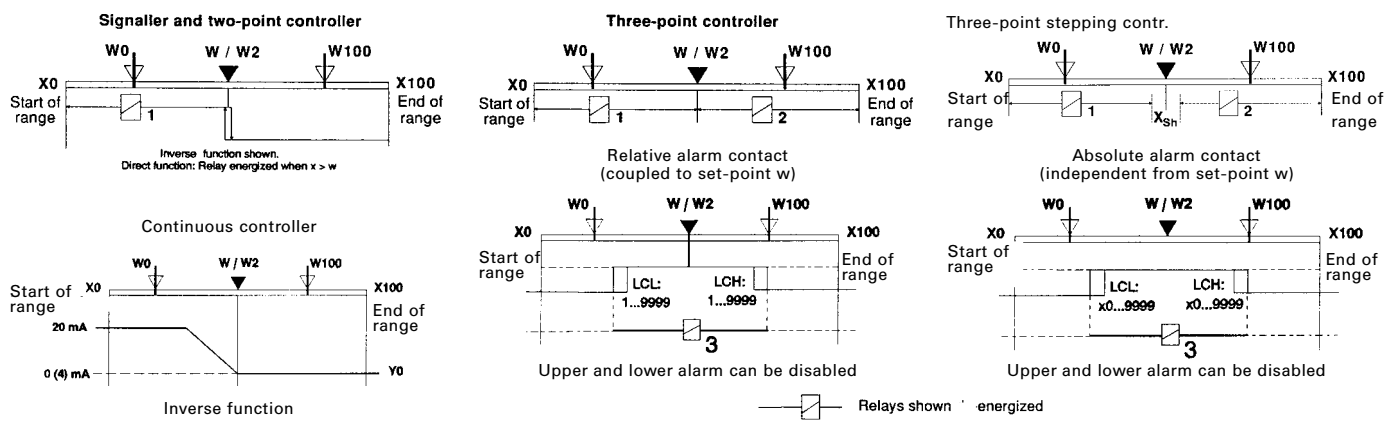


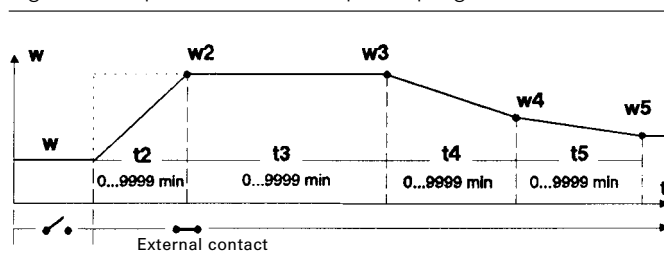
Fig. 11 Parameter adjustment

Parameter	Symbol	Adjustment range ¹⁾
2nd set-point w2 (ramp)	SP2	w0...w100
Segment time t2 (ramp)	Pt2	0...9999 minutes
3rd set-point w3	SP3	w0...w100
Segment time t3	Pt3	0...9999 minutes
4th set-point w4	SP4	w0...w100
Segment time t4	Pt4	0...9999 minutes
5th set-point w5	SP5	w0...w100
Segment time t5	Pt5	0...9999 minutes
Low limit contact	LCL	Relative: 1...9999 Absolute: x0...9999
High limit contact	LCH	Relative: 1...9999 Absolute: x0...9999
Switching difference x _{sd} for both limit contacts	Sd	1...9999
Heating current	HC	only display
Heating current alarm	HCA	0...30,0A
Blocking of operation	Loc	0...3 (see right)
Lower set-point limit w0	SPL	x0...x100
Upper set-point limit w0	SPH	x0...x100
Set-point gradient	Gr	0,1...999,9/min
Proport. band Xp1 (heating)	Pb1	0,1...999,9%
Proport. band Xp2 (cooling)	Pb2	0,1...999,9%
Integral action time Tn	ti	0...9999 seconds (0 = no I-action)
Derivative action time Tv	td	0...9999 seconds (0 = no D-action)
Motor actuator time Tm	tt	20...300 seconds
Switching differential Xsh	SH	0,2...20%
Duty cycle for heating	t1	0,4...999,9 sec
Duty cycle for cooling	t2	0,4...999,9 sec
Decimal point	dP²⁾	0 or 1 (0 = no dec. point)
Measuring span start x0	InL²⁾	-999...9999
Measuring span end x100	InH²⁾	-999...9999
Interface addresses	Adr	0...99

¹⁾ Values in % referred to range x0...x100

²⁾ Only with input 0/4...20 mA or 0...10 V

Fig. 12 Set-point w2 with ramp and program controller



Blocking of operation

Loc 0: Display of x and w with adjustment and self-tuning
Loc 1: Display of x and w with adjustment
Loc 2: Only display of x and w
Loc 3: Only display of x
 Note: After selecting Loc 1, 2 or 3, all subsequent parameters are not displayed.

ORDERING EXAMPLES					
Example 1 Required is a two-point controller with inverse output, absolute alarm contact, Pt 100 input, and interface for 9600 Bd:			Example 2 Required is a three-point stepping controller, absolute alarm, input 0...20 mA, programmer, no interface:		
Pos.	Order no./Description	Qty.	Item	Order no./Description	Qty.
1	9404 407 41991 C06313000	1	1	9404 407 42991 C07910100	1
2	Interface module 9404 429 98001	1	Example 3 Required is a continuous controller, display in °F, thermocouple Type N, relative alarm with current monitor, and output 0...20 mA:		
3	Interface cable 9404 407 50011	1	Item	Order no./Description	Qty.
			1	9404 407 44991 C23820010	1
			2	Current transformer 9404 407 50001	1

ORDERING INFORMATION
An order for Version 407 consists of the 12-digit Order No., complete with "00" or "99". If "99" is used, the 8-digit C-code must also be specified. The basic configuration "00" is supplied with C00510100 (3 relays) or C00310100 (2 relays) or C00710110 (continuous) and must be re-configured by the user as required.

Output configuration of Version 407

Configuration as:	Output 1 Relay 1	Output 2 Relay 2/ Continuous	Output 3 Rel. 3 (Alarm)	Logic Output
Versions with: 2 relays 9404 407 40xx1 9404 407 41xx1 9404 407 60xx1 9404 407 61xx1	0/1 Signaller	Signalling	–	LC / HCA
	2/3 Two-point DPID	Heating	–	LC / HCA
	4 Positioner	Heating	–	see above
	0...4 see above	see above	–	see above
3 relays 9404 407 42xx1 9404 407 43xx1 9404 407 62xx1 9404 407 63xx1	5 Three point DPID / DPID	Heating	Cooling	LC / HCA
	6 Positioner "H / C"	Heating	Cooling	HCA
	7 Positioner "stepping"	Motor open	Motor close	–
	9 Three-point stepping	Motor open	Motor close	LC
	0...3 for logic output	–	–	LC / HCA
Continuous (with relay 3) 9404 407 44xx1 9404 407 45xx1 9404 407 64xx1 9404 407 65xx1	4 Positioner	–	0 / 4...20 mA	–
	5 Three-point DPID / DPID	–	0 / 4...20 mA Cooling	LC / HCA
	6 Positioner "H / C"	–	0 / 4...20 mA Cooling	HCA
	7 Continuous, direct	–	0 / 4...20 mA	LC
	8 Continuous, inverse	–	0 / 4...20 mA	LC

Note

On versions with 2 or 3 relays, output 1 (heating) is available in parallel as a relay contact and a logic signal. For optimum control of fast control loops ($T_u < 30$ s), an on/off ratio of < 10 s is necessary. For such applications, the wear-free logic output should be used together with a solid-state relay. Relay 1 can be disabled by opening a wire-hook switch.

Configuration of Version 407



Display/input circuit monitor

Degrees C/upscale	0
Degrees C/downscale	1
Degrees F/upscale	2
Degrees F/downscale	3

Input

Type L 0... 900 °C	0
Type J 0... 900 °C	1
Type K 0... 1350 °C	2
Type N 0... 1300 °C	3
Type S 0... 1760 °C	4
Type R 0... 1760 °C	5
Pt 100 DIN/IEC – 99,9...500,0 °C	6
0...20 mA, linear	7
4...20 mA, linear	8
0...10 V, linear	9

Controller function (outputs 1 and 2)

Signaller, direct	0
Signaller, inverse	1
Two-point DPID, direct	2
Two-point DPID, inverse	3
Positioner "heating"	4
Three-point-DPID/DPID ¹⁾	5
Positioner "heating/cooling" ¹⁾	6
Continuous, direct (or 3-point stepping positioner)	7
Continuous, inverse	8
Three-point stepping	9

Alarm contact (output 3)

Relay de-energized on alarm

Relative alarm	0
Absolute alarm	1
Relative alarm with current monitoring ²⁾	2
Absolute alarm with current monitoring ²⁾	3
Relative alarm with alarm suppression	8

Relay energized on alarm

Relative alarm	4
Absolute alarm	5
Relative alarm with current monitoring ²⁾	6
Absolute alarm with current monitoring ²⁾	7
Relative alarm with alarm suppression	9

¹⁾ Continuous controller also configurable as follows:

"Heating" via logic output,
"Cooling" with 0 (4) ... 20 mA

²⁾ Current transformer required, see Accessory Equipment

Heating current monitoring

0	Monitoring for actuator break and short circuit
1	Excess current monitoring

Output

0	Switching
1	0...20 mA
2	4...20 mA

Program controller

0	Ramp output
1	Programmer output

Interface/Transmission speed

0	Without interface
1	2400 bits/s
2	4800 bits/s
3	9600 bits/s
4	19200 bits/s

Basic configuration¹⁾

00

Configured to specification²⁾

99

Version 407



2 relays for heating/alarm	0
2 relays as above, with digital interface	1
3 relays for heating/cooling/alarm or three -point stepping/alarm	2
3 relays as above, with digital interface	3
Continuous with 1 relay (alarm contact) and logic output	4
Continuous as above, with digital interface	5

¹⁾ See Ordering Information (previous page)

²⁾ See configuration data at left