
# KS 92
## Industrial Controller

universal line

***New:*** **Measurement value output and DAC®**

**Simple, menu-guided operation with standard symbols**

**Universal version for switching/continuous output**

**Programmer with search function**

**Spray-water proof front with protection type IP 65**

**Interface ports at front and rear**

## *PROFILE*

Safe, reliable control within close tolerances, and high plant availability are pre-requisites for economic production. Controllers with reliable and robust control algorithms are the basis for stable process conditions, also with varying operating parameters.
A self-tuning function ensures short start-up times. The "thinking" operator guidance system with standard symbols plus software and hardware interlocks prevents operating errors and thus reduces down-times.

## *DESCRIPTION*

The KS 92 is configurable for ON/OFF control, PID-control and motorized valve control. The output function can be configured for Δ/Y/Off, position control, and numerous 3-point combinations of switching/continuous control.
Control modes are set-point, set-point/cascade, and programmer, each with the possibility of set-point offset. The effect of offset can be additive (e.g. reduced standby set-point) or as a factor (e.g. $O_2$ correction or split load). Offset can be triggered by an external contact, whereby the value is defined via an analog signal or via an adjustable parameter.

*Additional control modes:*

- Ratio control (stoichiometric combustion, mixing ratios, additives, batching, inline blending)
- Mean-value calculation from two process values.

Apart from a correcting function for the measurement signal, it is possible to scale, linearize or square-root every input and output signal. This enables the controller to be matched precisely to the application without any supplementary equipment.
For everyday practice, *feed-forward control* has proved very useful to line out disturbances, e.g. with steam-generating plants.
If required, preset output limits can be used. This not only applies for continuous outputs, but also for switching and three-point stepping outputs (motor control).

### *DAC® ensures operational safety*

Digital Actuator Control monitors the most important functions of the actuator and is able to detect problems long before they cause large control deviations. Typical disturbances are a blocked actuator, a defective motor or capacitor and all related problems with an actuator.
The DAC® function is available for three-point stepping and continuous controllers with position feedback.

## *TECHNICAL DATA*

### *INPUTS*

Inputs INP1, INP5 and INP6 are galvanically connected. For each input, a filter is selectable with a time constant of 0...999,9 s.

### *UNIVERSAL INPUT INP1*

Optional functions:

- Linearization with 7 segments
- Scaling
- Square-rooting
- Filter

Limiting frequency: 1 Hz
Measurement cycle: 200 ms

***Thermocouples***

| Type | Range | Error | Resolution |
|---|---|---|---|
| L | 0...900°C | ≤2K | 0,05 K |
| J | 0...900°C | ≤2K | 0,05 K |
| K | 0...1350°C | ≤2K | 0,072 K |
| N | 0...1300°C | ≤2K | 0,08 K |
| S | 0...1760°C | ≤3K | 0,275 K |
| R | 0...1760°C | ≤3K | 0,244 K |
| T | 0...400°C | ≤2K | 0,056 K |
| W(C)[1] | 0...2300°C | ≤2K | 0,18 K |
| E | 0...900°C | ≤2K | 0,038 K |
| B[2] | (0)...400...1820°C | ≤4K | 0,3 K |

*[1] W5Re / W26Re*
*[2] Values apply above 400°C*

Display in °C or °F.
With linearization (temperature-linear).
Input resistance: =1MΩ

*Break monitoring*

Current through sensor: =1 µA
Action on break: configurable

*Reverse-polarity monitor*

Triggered, if input signal 30K below span start.

*Cold-junction compensation*

Built in (sensor leads or compensating leads must be taken up to the controller terminals).
Additional error: ≤ 0,5 K / 10 K at terminals
External CJ compensation selectable: 0...100 °C

***Resistance thermometer***

Pt 100 Ω to DIN IEC 751, and temperature-difference 2 x Pt 100 Ω

| Range | Error | Resolution |
|---|---|---|
| -200...250,0°C | ≤0,25K | 0,024 K |
| -200...850,0°C | ≤0,5K | 0,05 K |
| 2 x -200...250,0°C | ≤0,5 K | 0,024 K |
| 2 x -200...850,0°C | ≤1K | 0,05 K |

Display in °C or °F, decimal point selectable. With linearization (temperature-linear). Connection in three-wire technique, without lead adjustment. Two-wire connection with lead resistance adjustment.
Lead resistance: ≤30 Ω per lead
Sensor current: ≤1 mA

*Input circuit monitor*

Sensor and leads are monitored for break and short-circuit.
Output action: configurable

***Potentiometric transducer***

| Range | Error | Resolution |
|---|---|---|
| 0...500 Ω | ≤0,1 % | ≤0,02 Ω |

Resistance-linear
$R_{total}$ ≤500 Ω, including 2 x $R_{lead}$
Sensor current: ≤1 mA
For transducers 500...1000 Ω, a parallel resistor must be fitted. This does not affect linearity. Matching and scaling is done with transducer connected.

*Input circuit monitor*

Transducer and leads are monitored for break and short-circuit.
Output action: configurable

***Direct current***

| Range | Error | Resolution |
|---|---|---|
| 0/4...20 mA | ≤0,1 % | ≤0,8 µA |

Input resistance: 50 Ω
Measurement limits selectable in the range -999...9999.
Decimal point selectable.

*Input circuit monitor with 4...20 mA*

Triggered, if input signal ≤2 mA.
Output action configurable.

***Direct voltage***

| Range | Error | Resolution |
|---|---|---|
| 0/2...10V | ≤0,1% | ≤0,4 mV |

Input resistance: =100 kΩ
Measurement limits selectable in the range -999...9999. Decimal point selectable.

## *SIGNAL INPUT INP5*

Differential amplifier input. Max. 2 inputs can be cascaded, if there is another galvanic connection between the instruments. If not, up to 6 inputs can be cascaded.
Optional functions:
Scaling / square-rooting / filter

***Direct voltage and direct current***

Technical data as for INP1, but:
Limiting frequency: 0,25 Hz
Measurement cycle: 800 ms

## *SIGNAL INPUT INP6*

Optional functions:
Scaling / square-rooting / filter

***Potentiometric transducer***

Resistance-linear: $R_{total}$ =1000 Ω including 2 x $R_{lead}$
Sensor current: approx. 1 mA
Resolution: ≤ 0,04 Ω. Matching is done with transducer connected.

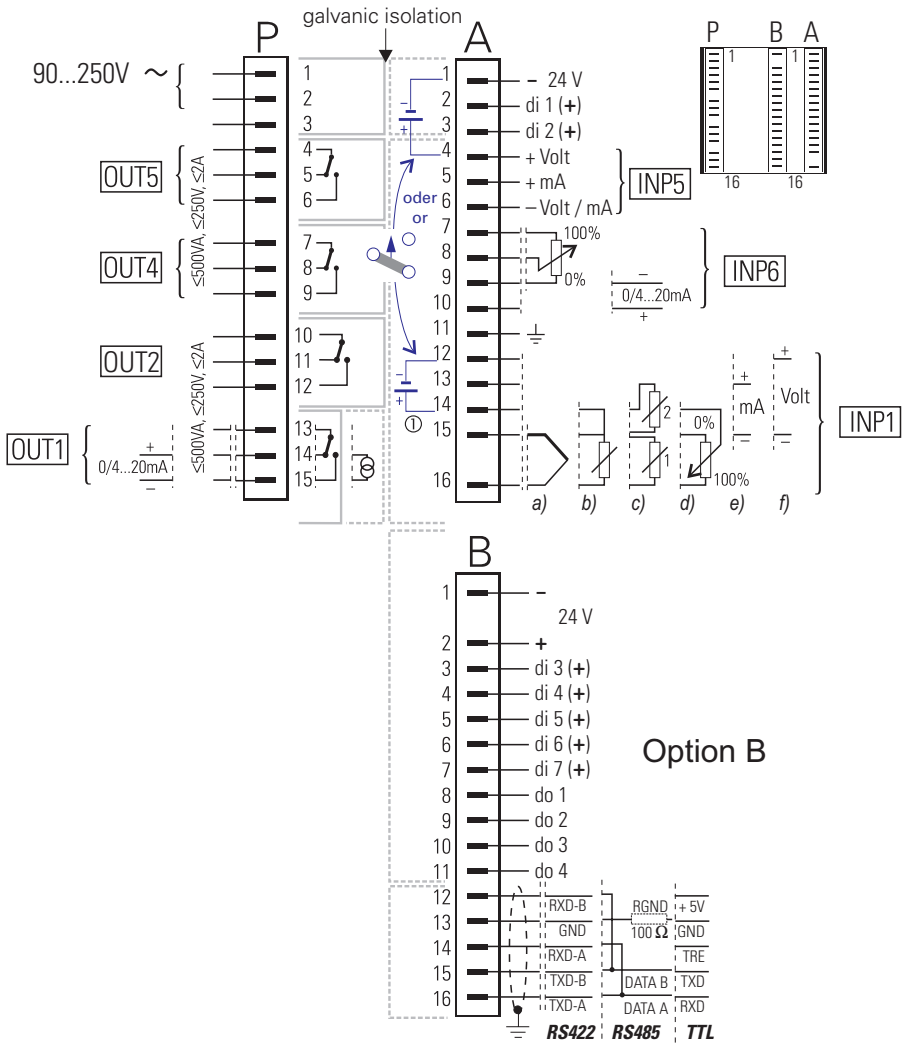
***Standard 0/4...20 mA signal***

Data as for INP1.

## *CONTROL INPUTS DI1, DI2*

Opto-coupler
Nominal voltage: 24 VDC (external)
Current sink (IEC 1131 Type 1)
Logic "0" = -3...5 V
Logic "1" = 15...30 V
Current demand: approx. 5 mA
The digital inputs are galvanically isolated from the other inputs/outputs, and from the mains supply.

*Fig. 1 Electrical connections*




① *only on versions with transmitter supply*

*a) Thermocouples*
*b) Pt 100*
*c) 2 x Pt 100 (Δt)*
*d) Potentiometric transducer*
*e) 0/4...20 mA*
*f) 0/2...10 V*

*: safety isolation*
*: functional isolation*

### CONTROL INPUTS DI3...DI7

Data as for di1 and di2, but galvanically connected with do1...do4.

### SURVEY OF INPUTS

| Input | Used for |
|---|---|
| INP1 | $x_1$ (process value) |
| INP5 | $w_{ext}$ (ext. set-point)<br>$x_2$ (ratio)<br>$dw_{ext}$ (ext. offset set-point) |
| INP6 | $Y_p$ (position feedback)<br>$dw_{ext}$ (ext. offset set-point)<br>$w_{ext}$ (ext. set-point)<br>z (feed-forward input) |
| di1 | $w/w_{ext}$ , $w/w_2$, $w/dw_{ext}$, auto/man, PI/P, auto/Y, controller off, program start/reset + stop, disabling [1] |
| di2 | as for d1 + start of set-point tracking |
| di3 | Local / remote |
| di4 | Program start/stop |
| di5 | Program reset |
| di6 | Select program 1 |
| di7 | Select program 2 |

*[1] Disabling of auto/manual key, set-point adjustment, output switch-off, parameters, programmer operation.*

#### Built-in transmitter supply (optional)

Can be used to energize a two-wire transmitter or up to 4 opto-coupler inputs. Galvanically isolated
Output: 17,5 VDC / 22 mA

*Factory setting*

The transmitter supply is available at terminals A12 and A14, if INP1 is configured for **current** or **thermocouple** input. By means of internal switches, the voltage can be applied to terminals A1 and A4, where it is always available, irrespective of the input configuration.

## OUTPUTS

### OUTPUTS OUT1, OUT2

Version-dependent, with relay output or continuous output/logic signal.

#### OUT1 and OUT2 with relay output

Relays 1 and 2 with potential-free switch-over contacts.
Contact rating:
Max. 500 VA, 250 V, 2 A at 48...62 Hz, resistive load
Min. 12 V, 10 mA AC/DC

*Note:*

If the relays operate external contactors, these must be fitted with RC snubber circuits to prevent excessive switch-off voltage peaks.

#### OUT1 with continuous output

Galvanically isolated from the inputs.
Freely scalable.
0/4...20 mA, configurable
Signal range: 0...approx. 22 mA
Resolution: =6 µA (12 bits)
Load: 600 Ω
Load effect: <0,1 %
Limiting frequency: approx. 1 Hz

#### OUT1 with logic signal

0/=20 mA with a load of =600 Ω
0/>12 V with a load of >600 Ω

### RELAY OUTPUTS OUT4, OUT5

Data as for OUT1 and OUT2

### SURVEY OF OUTPUTS

| Output | Used for |
|---|---|
| OUT1<br>**New function!** | Control outputs 1 & 2, Alarms 1, 2, 3, 4<br>Position feedback $Y_P$<br>Control deviation $x_W$<br>Process values $x_1$, $x_2$, $x_{eff}$<br>Set-points w, $w_{eff}$, $w_{ext}$, $dw_{ext}$, $w_{prg}$ |
| OUT2 | Control outputs 1 & 2, Alarms 1, 2, 3, 4 |
| OUT4 | Alarms 1, 2, 3, 4, Control outputs 1 & 2<br>Progr. output 1, 2, 3 or 4 Progr. end |
| OUT5 | Alarms 1, 2, 3, 4, Control outputs 1 & 2<br>Progr. output 1, 2, 3 or 4 Progr. end |
| do1 | Programmer switching output 1 |
| do2 | Programmer switching output 2 |
| do3 | Programmer switching output 3 |
| do4 | Programmer switching output 4 |

## ALARMS

#### Configurable alarms

- Sensor monitoring
- Sensor monitoring or input signal alarm
- Optional suppression during start-up or when changing the set-point.

#### Signals which can be monitored

- Process value $x_{eff}$, $x_1$, $x_2$
- Control deviation $x_W$
- Set-points $w_{eff}$, $w_{ext}$, $dw_{ext}$, $w_{Sel}$
- Input signals INP1...INP6
- Programmer times ($t_{net}$, $t_{gross}$, $t_{rest}$)

#### Adjustment limits

| Parameter | Limits |
|---|---|
| Lower limit LimL | -999...9999 |
| Upper limit LimH | -999...9999 |
| Switching difference XSd | 1...999 |

Decimal point adjustable

## CONTROL BEHAVIOUR

### Effect of D-action

Either on process input x or on the control deviation $x_w$.

### Configurable controller types

- Standard controller
- Ratio controller
- Feed-forward control $y_P$
- Mean value calculation

### Response on sensor break

Configurable as follows:

- neutral (outputs switched off)
- $y = y_{min}$ (0%...$y_{max}$)
- $y = y_{max}$ ($y_{min}$...100%)
- $y = y_2$ (fixed output value)
- $y = y_2$ (variable output value)

### Adjustment limits

| Parameter | Symbol | Limits |
|---|---|---|
| Proportional band | $X_{p1}$ | 0,1...999,9% |
| Proportional band | $X_{p2}$ | 0,1...999,9% |
| Integral action | $T_n$ | 0...9999s |
| Derivative action | $T_v$ | 0...9999s |
| Duty cycle | $T_1$ | 0,4...999,9s |
| Duty cycle | $T_2$ | 0,4...999,9s |
| Switch point separ. | $X_{sh1}$ | 0...999,9% |
| Switch point separ. | $X_{sh2}$ | 0...999,9% |
| Switch point separ. [2] | $X_{sh}$ | 2...999,9% |
| Motor actuator time | $T_m$ | 10...9999s |
| Shortest step | $T_{puls}$ | 0,1...999,9s |
| Switching diff.(sign.) | $X_{sd1}$ | 1...9999[1] |
| Switching differ. | $L_W$ | -999...9999[1] |
| Switching diff. (auxil.) | $X_{sd2}$ | 1...9999[1] |
| 2nd output | $Y_2$ | -105...105% |
| Output limiting | $Y_{min}$ | -100(0)...100% |
| Output limiting | $Y_{max}$ | -100(0)...100% |
| Working point | $Y_0$ | -100(0)...100% |

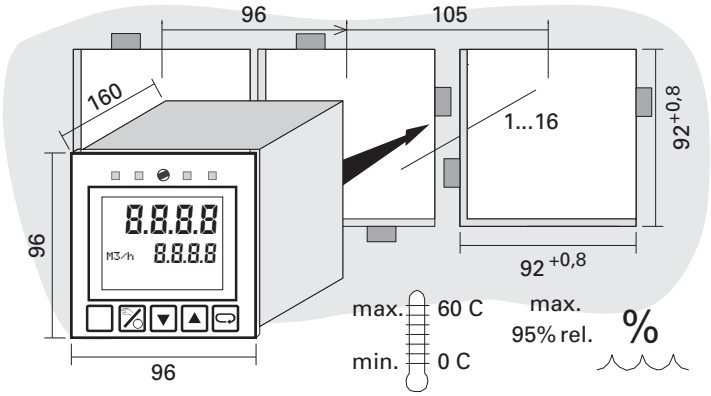
*1) Decimal point adjustable as for input range x1 (INP1)*
*2) Applies for three-point stepping output*

## SET-POINT FUNCTIONS

The following functions are configurable:

- Set-point control
- Set-point/cascade control
- Programmer
- Set-point with external offset ($dw_{ext}$)
- Set-point/cascade control with internal offset (dw)
- Set-point/cascade with external offset ($dw_{ext}$)
- Programmer with internal offset (dw)
- Programmer with external offset ($dw_{ext}$)
- Ratio control, with $(x_1+N_0)/x_2$ or $(x_1+N_0)/(x_1+x_2)$ or $(x_2-x_1+N_0)/x_2$

*Fig.2 Overall dimensions (in mm)*




### Special functions

- Tracking w = $w_{eff}$ when switching from external to internal
- Tracking w = x when switching from external to internal
- Mean value calculation with $x_1*(1-b)+x_2*b$

### Adjustment limits

| Parameter | Symbol | Limits |
|---|---|---|
| Set-point start | w0 | -999...9999[1] |
| Set-point end | w100 | -999...9999[1] |
| 2nd set-point | W2 | -999...9999[1] |
| Set-point offset | dW | -99,9...9999[1] |
| Positive SP gradient | Grw+ | 0,01...99,99[2] |
| Negative SP gradient | Grw- | 0,01...99,99[2] |
| SP gradient for W2 | Grw2 | 0,01...99,99[2] |

*1) Decimal point adjustable as for input range x1 (INP1)*
*2) Adjusted "per minute"; disabled with "----"*

## PROGRAMMER

One programs with 20 segments.
1 analog output and 4 switching outputs.
The analog output can be used as external set-point for the controller and/or be made available at OUT1.

### Without Option B (basic version)

- Run/Stop & Reset via common input di1 or di2.
- Alternatively, the programmer can be operated from the front panel or via the front interface (Run/Stop, Reset, Preset).
- Max. two switching outputs can be assigned to OUT4 and OUT5.

### With Option B

- Separate control inputs for Run/Stop (di4) and Reset (di5)
- Access to all 4 switching outputs via the opto-coupler outputs do1...do4 or via the relays OUT4, OUT5.

### Configurable programmer functions

*Response after mains failure:*

- Continue program
- Switch-over to w
- Automatic search (basic setting)
- Automatic search; switch-over to internal set-point w if not successful
- Continue program at time mark of mains return (real time clock required)

*Response at end of program:*

- Pause
- Reset ("Start" signal required)
- Continue with next program
- Next program and Reset ("Start" signal required)

### Timer functions

*(only on version with RS 485 interface)*

| | |
|---|---|
| y/Y2 | Switchover to fixed output |
| w/w2 | Switchover to 2nd set-point W2 |
| Controller off | Enabling/disabling the controller outputs |
| run | Start programmer |

- Two outputs adjustable for single-shot event in minutes; hours; day; month; year.

## OPERATING FUNCTIONS

The following functions are configurable:

*Auto / Manual key*

- Disabled
- Auto/Manual
- Automatic/$y_2$
- Int/Ext (set-point) or internal/programmer

*System menu*

- Start/stop self-tuning
- Program preset (option)
- Program reset (option)
- Program start/stop (option)
- Switch-over front/interface (option)
- Adjustment of real time clock (option)

*Extended operating level*

- 12 parameters and signals can be copied into the extended operating level.

## DISPLAYS

Multi-function "day & night" display with red backlighting:

- active illuminated in dark enviroment
- reflecting in bright enviroment.

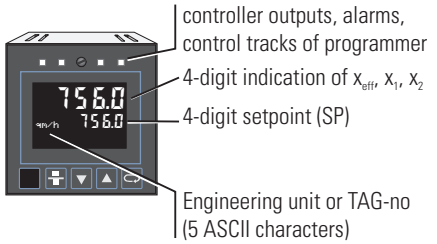
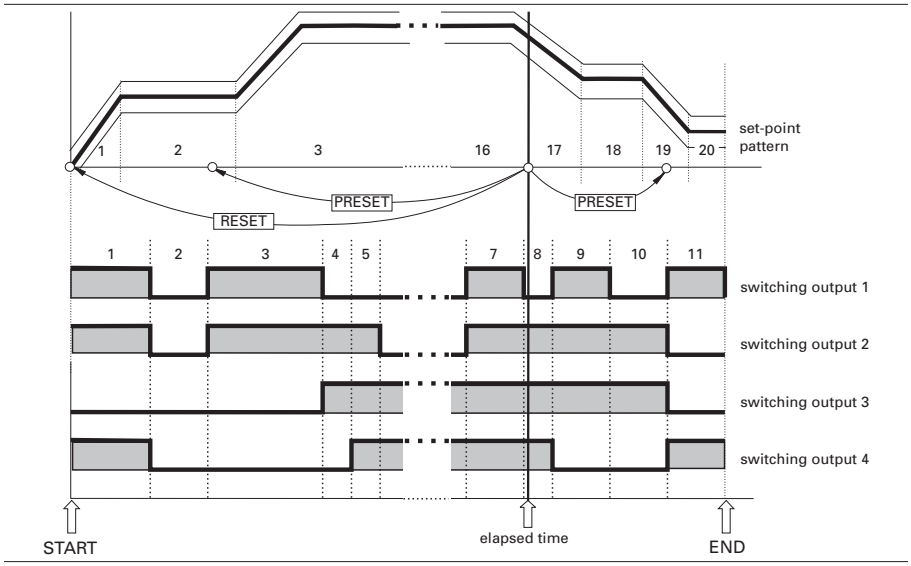



*Fig. 3 Programmer with analog output and 4 control outputs*




## POWER SUPPLY

***AC supply***

230 VAC
Frequency: 48...62 Hz
Power consumption: approx. 10 VA

***Behaviour after power failure***

*Configuration, parameters, set-points:*

Permanent data storage in an EEPROM.

*Programmer data (elapsed time):*

temporary storage in capacitor-backed up RAM (>1 hour).

*Real-time clock (optional)*

Buffer capacitor provides back-up for at least 2 days.

## FRONT INTERFACE (STANDARD)

Connection via PC adapter (see "Ordering Data for Accessory Equipment").
The Engineering Tool ET/KS 94 can be used for configuration, parameter setting, and operation of the KS 94.

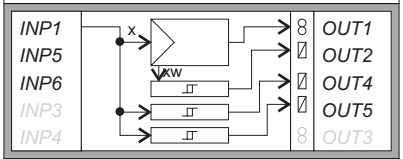
## BUS INTERFACE (OPTION B)

***TTL and RS 422/485***

Galvanically isolated, either TTL signals or RS 422/485
*Note*: In order to convert TTL signals to RS 422/485, an interface module is required (see "Accessory Equipment").
Protocol: ISO 1745
Transmission speed:
2400 / 4800 / 9600 / 19.200 bits/s
Address range: 00...99

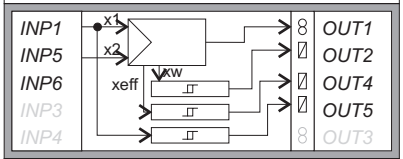
*Configuration examples:*

9407-901-XXXXX



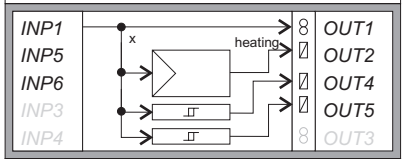

Continuous PID controller,
1 deviation alarm, 2 x-alarms (PV)

9407-901-XXXXX



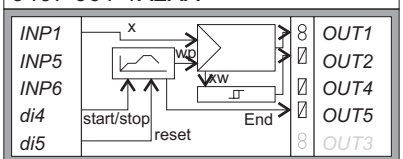

Ratio controller (continuous PID),
1 deviation alarm, 2 x-alarms (PV)

9407-901-XXXXX



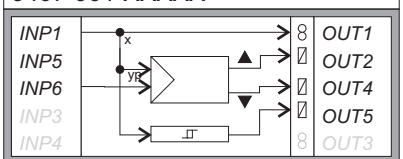

2-point controller (PID-heating) +
2 PV limit contacts + PV retrans.

9407-901-1X2XX




Continuous program controller,
1 deviation alarm

9407-901-XXXXX




Motorized stepping controller+
x-alarm (PV-alarm) + PV retrans.

*Number of controllers per bus*

With RS 422/485: 32
With TTL signals: max. 32 interface modules on one bus. Above this value, the only limit is the address range (00...99).

## ENVIRONMENTAL CONDITIONS

***Permissible temperatures***

For operation: 0...60°C
For specified accuracy: 0...55°C
Storage and transport: -20...60°C

***Climatic category***

KUF to DIN 40 040
Relative humidity: 75% yearly average, no condensation

***Shock and vibration***

*Vibration test Fc*

To DIN 68-2-6 (10...150 Hz)
Unit in operation: 1g or 0,075 mm
Unit not in operation: 2g or 0,15 mm

*Shock test Ea*

To DIN IEC 68-2-27 (15g, 11 ms)

## ELECTROMAGNETIC COMPATIBILITY

*Complies with EN 50 081-2 and EN 50 082-2 for unrestricted use within rural and industrial areas.*

***Electrostatic discharge***

Test to EN 61 000-4-2
8 kV air discharge
4 kV contact discharge

***High-frequency interference***

Test to EN 61 000-4-3
80...1000 MHz, 10 V/m
Effect: =1%

***HF interference on leads***

Test to EN 61 000-4-6
0,15...80 MHz, 10 V
Effect: =1%

***Low-frequency magnetic field***

Test to EN 61 000-4-8
No effect with 50 Hz, 30 A/m

***Fast pulse trains (Burst)***

Test to EN 61 000-4-4
2 kV applied to leads for supply voltage and signal leads

***High-energy single pulses (Surge)***

Test to EN 61 000-4-5
Test voltage applied to the following leads:
Supply leads:
1 kV symmetric, 2 kV asymmetric
Signal leads:
0,5 kV symmetric, 1 kV asymmetric

## GENERAL

***Housing***

Plug-in module, inserted from front.
Material: Makrolon 9415 flame-retardant, self-extinguishing
Flammability class: UL 94 VO

***Protection mode***

(to IEC 529, DIN 40 050)
Front: IP 65
Housing: IP 20
Terminals: IP 00

***Safety tests***

According to EN 61 010-1 (VDE 0411-1)
Overvoltage category III
Contamination class 2
Working voltage range 300 VAC
Protection class I

***CE marking***

The controller meets the European requirements regarding "Electromagnetic Compatibility" and "Low-voltage equipment" (see also "Safety tests")

***Electrical connections***

Flat-pin connectors to DIN 46 244 for 1 x 6,3 mm or 2 x 2,8 mm

***Mounting method***

Panel mounting with two fixing clamps at top/bottom

***Mounting position:*** *Not critical*

***Weight:*** *Max. 1,5 kg with all options*

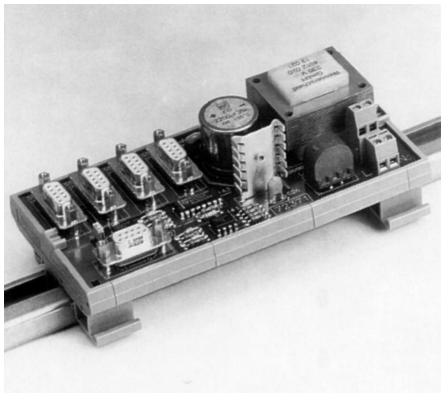
***Accessories***

3-language operating and safety instructions (GB/D/F)
2 fixing clamps
(Operating manual can be ordered separately, see "Ordering Data for Accessory Equipment")

## ACCESSORY EQUIPMENT

### INTERFACE MODULE

Up to 16 devices with TTL interface can be connected to the interface module. Connection is by means of the separately-ordered interface cable (1m



long). Via the RS 422/485 interface (D-type connectors), the data are transmitted up to a distance of 1km.

*Supply voltage*

230 VAC
Voltage tolerance: +10...-15%
Frequency: 48...62 Hz
Power consumption: approx. 5 VA

*Electrical connections*

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

*Mounting*

To standard DIN rail

*Protection mode*

Type IP 00 (mounting in cabinet)

*Permissible temperatures*

Operation: 0...60 °C
Storage and transport: -20...+60 °C
Relative humidity: <75 % yearly average, no condensation

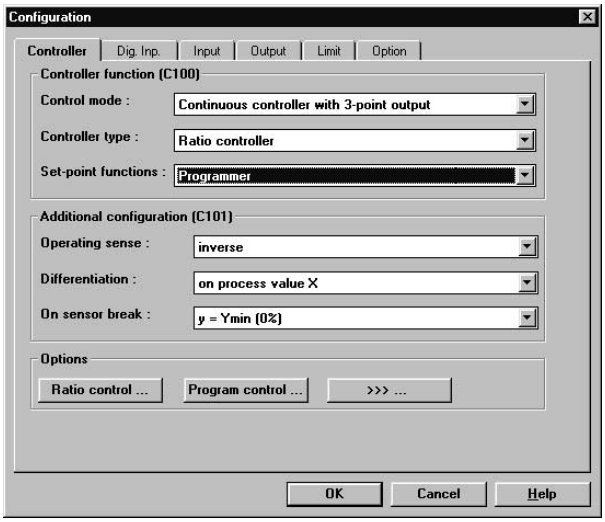
***Weight:*** *approx. 0,45 kg*

*Dimensions*

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

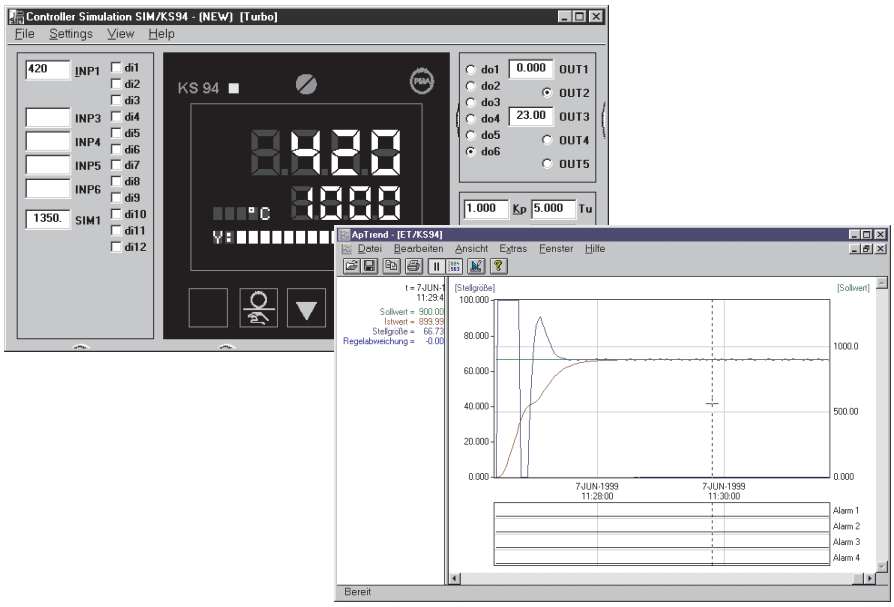
### *Engineering Tool ET/KS 94*

This PC-based program is used for configuration and parameter adjustment (commissioning) of the controllers KS 92 and KS 94. Furthermore, all settings are stored, and can be printed out, if required.
Together with the software package SIM/94 (see below) a trend display of the true process data is possible.
Software platform:
Windows 3.11 or Windows 95 must be installed and operable.
Hardware platform:
For connection to the controller, a PC adapter is required (see "Ordering Data for Accessory Equipment").




### *Controller simulation SIM/94*

This PC-based program is used to test the settings of industrial controllers KS 92 and KS 94 in a simulated control loop. The program enables you to test the controller settings and also to examine the interaction between a controller and the process without disturbing the real plant.
During simulation, the controller's front keys are operated via a mouse or the Engineering Tool.
The built-in trend graphics enable you to monitor the process value, set-point, and output value. The trend display can also be used to visualize the process response in the Engineering Tool.
Recorded data can be exported into external data processing programs such as spreadsheets, etc.
Software platform:
Windows 3.11 or Windows 95 must be installed and operable.

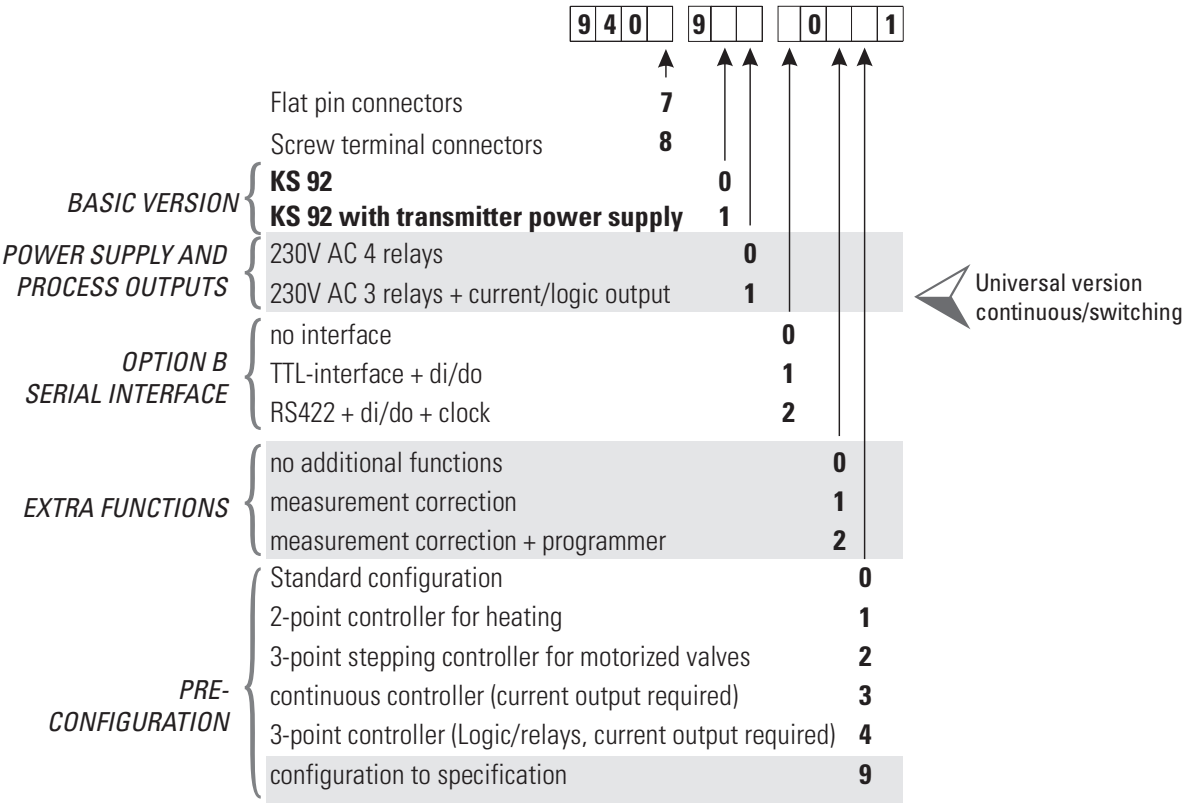



Updates and demonstration software available via:
www.pma-online.de

## *ORDERING DATA FOR ACCESSORY EQUIPMENT*

| Description | | Order no. |
|---|---|---|
| Interface cable, length 1 m | | 9404 407 50011 |
| Interface module, 230 VAC supply | | 9404 429 98001 |
| PC adapter, for connecting the Engineering Tool | | 9407 998 00001 |
| Engineering Tool ET/KS 94 | English/German | 9407 999 01801 |
| Engineering Tool ET/KS 94, 10x license | English/German | 9407 999 02801 |
| Controller simulation SIM/KS 94 | English/German | 9407 999 03801 |
| Controller simulation SIM/KS 94, 10x license | English/German | 9407 999 03901 |
| MSI Server - 32 Bit DDE-Server | English/German | 9407 999 07101 |
| Converter RS 232 to RS 422 (incl. RS 232 cable, 10m cable RS422) | | 9407 998 00041 |
| Operating instructions | German | 9499 040 44118 |
| | English | 9499 040 44111 |
| | French | 9499 040 44132 |
| Manual | German | 9499 040 44818 |
| | English | 9499 040 44811 |
| | French | 9499 040 44832 |
| Operating notes for ISO 1745 interface | German | 9499 040 45018 |
| | English | 9499 040 45011 |

## *ORDERING INFORMATION*



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