Universal continuous/switching version, i.e. reduced stocks
100 ms cycle time, i.e. also suitable for fast control loops
Customer-specific linearization for all sensors
Freely configurable analog output, e.g. as process value output
Settings can be blocked via password and internal switch for high security
Extended temperature range up to 60 °C allows mounting close to the process
Easy 2-point or offset measurement correction
Emergency operation after sensor break by means of the “output hold” function
Logical combination of digital outputs, e.g. for general alarm
Programmer with 4 segments and “end” signal
RS 422/485 Modbus RTU interface
Built-in transmitter power supply
Splash-water proof front (IP 65)

APPLICATIONS
- Furnaces and ovens
- Burners and boilers
- Plastics processing
- Driers
- Climatic chambers
- Heat treatment plants
- Sterilizers

DESCRIPTION
The universal temperature controller KS 4X-1 are intended for universal, precise, and cost-effective control tasks in all branches of industry. For this, the unit provides simple 2-point (on/off) control, continuous PID control, or 3-point stepping control. The process value signal is connected via a universal input. A supplementary analog input can be used for heating current measurement or as an external set-point input.

Every KS 4X-1 has three process outputs that can be 3 relays or 2 relays plus a universal output. This universal output can be used for operating a solid-state relay, a continuous current/voltage output or to energize a two-wire transmitter.

Plug-in module
KS 4X-1 controllers are built as plug-in modules. This enables them to be replaced very quickly without tools, and without disturbing the wiring.

Self-tuning
During start-up, the self-tuning function determines the optimum settings for fast line-out without overshoot. With three-point controller configuration, the „cooling” parameters are determined separately, thus ensuring an optimum match to the process.

Display and operation
Clear informations are given by ten indicator LED’s in the front panel that display operating mode, I/O states, and errors. The auto/manual key switches the controller into the manual mode directly, without lengthy operating sequences. If required, the direct switch over can be disabled or the key can be configured e.g. to start the internal timer. This results in a level of operational safety that is usually found only in controllers of a higher price category.

Front interface and Engineering Tools
Control parameter adjustment in seconds has now also been implemented in the KS 40 class of instruments. Via the BlueControl software incl. its simulation functions, and especially the convenient BluePort® front panel interface, the required set-up for a specific control task can be determined without a detailed study of the operating instructions.

Off cause almost all adjustments can be done comfortably over the instrument front. (see page 6, BlueControl)
**Password protection**

If required, access to the various operating levels can be protected with a password. Similarly, access to a complete level can be blocked.

**TECHNICAL DATA**

**INPUTS**

**SURVEY OF THE INPUTS**

<table>
<thead>
<tr>
<th>Input</th>
<th>Used for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>INP1</td>
<td>x (process value)</td>
</tr>
<tr>
<td>INP2</td>
<td>Heating current, ext. set-point</td>
</tr>
<tr>
<td>di1</td>
<td>Operation disabled, switch-over</td>
</tr>
<tr>
<td></td>
<td>to second set-point SP.2,</td>
</tr>
<tr>
<td></td>
<td>external set-point SP.E, fixed</td>
</tr>
<tr>
<td></td>
<td>output signal Y2, manual</td>
</tr>
<tr>
<td></td>
<td>operation, controller off,</td>
</tr>
<tr>
<td></td>
<td>disabled auto/manual key, reset</td>
</tr>
<tr>
<td></td>
<td>stored alarms, timer start (Y2)</td>
</tr>
<tr>
<td>di2</td>
<td>(option)</td>
</tr>
<tr>
<td>di3</td>
<td>(option)</td>
</tr>
</tbody>
</table>

**PROCESS VALUE INPUT INP1**

Resolution:  > 14 bits
Decimal point: 0 to 3 decimals
Digital input filter: adjustable 0,000...9999 s
Scanning cycle: 100 ms
Measured value correction: 2-point or offset correction

**Thermocouples (Table 1)**

<table>
<thead>
<tr>
<th>Thermocouple</th>
<th>Range</th>
<th>Accuracy</th>
<th>Resolution (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Fe-CuNi (DIN)</td>
<td>-100...900 °C</td>
<td>-148...1662 °F</td>
<td>≤ 2 K</td>
</tr>
<tr>
<td>J Fe-CuNi</td>
<td>-100...1200 °C</td>
<td>-148...2192 °F</td>
<td>≤ 2 K</td>
</tr>
<tr>
<td>K NiCr-Ni</td>
<td>-100...1350 °C</td>
<td>-148...2462 °F</td>
<td>≤ 2 K</td>
</tr>
<tr>
<td>N Nicrosil/Nisil</td>
<td>-100...1300 °C</td>
<td>-148...2372 °F</td>
<td>≤ 2 K</td>
</tr>
<tr>
<td>S PtRh-Pt 10%</td>
<td>0...1760 °C</td>
<td>32...3200 °F</td>
<td>≤ 2 K</td>
</tr>
<tr>
<td>R PtRh-Pt 13%</td>
<td>0...1760 °C</td>
<td>32...3200 °F</td>
<td>≤ 2 K</td>
</tr>
</tbody>
</table>

**Cold junction compensation**

Max. additional error  ± 0.5 K

**Sensor break monitoring**

Sensor current: ≤ 1 μA
Operating sense configurable (see page 4)

**Resistance thermometer**

Connection: 3-wire
Lead resistance: max. 30 Ω
Input circuit monitor: Break and short circuit

**Resistance measuring range**

The BlueControl software can be used to match the input to the sensor KTY 11-6 (characteristic is stored in the controller).

Physical measuring range: 0...4500 Ω
Linearization segments: 16

**Current and voltage signals**

Span start, end of span: anywhere within measuring range
Scaling: selectable -9999...9999
Linearization: 16 segments, adaptable with BlueControl
Decimal point: adjustable
Input circuit monitor: 12.5% below span start (2mA, 1V)

**Table 1 Thermocouple ranges**

<table>
<thead>
<tr>
<th>Thermocouple</th>
<th>Range</th>
<th>Accuracy</th>
<th>Resolution (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt100</td>
<td>-200...850 °C</td>
<td>-328...1562 °F</td>
<td>≤ 1 K</td>
</tr>
<tr>
<td>Pt1000</td>
<td>-200...850 °C</td>
<td>-328...1562 °F</td>
<td>≤ 2 K</td>
</tr>
</tbody>
</table>

**Table 2 Resistance transducers**

<table>
<thead>
<tr>
<th>Type</th>
<th>Sensor current</th>
<th>Range</th>
<th>Accuracy</th>
<th>Resolution (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt100</td>
<td>0.2 mA</td>
<td>-200...850 °C</td>
<td>-328...1562 °F</td>
<td>≤ 1 K</td>
</tr>
<tr>
<td>Pt1000</td>
<td>0.2 mA</td>
<td>-200...850 °C</td>
<td>-328...1562 °F</td>
<td>≤ 2 K</td>
</tr>
</tbody>
</table>

**Table 3 Current and voltage**

<table>
<thead>
<tr>
<th>Range</th>
<th>Input resistance</th>
<th>Accuracy</th>
<th>Resolution (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 Volt</td>
<td>110 Ω</td>
<td>≤ 0,1 %</td>
<td>0.6 mV</td>
</tr>
<tr>
<td>0-20 mA</td>
<td>49 Ω (voltage requirement ≤ 2.5 V)</td>
<td>≤ 0,1 %</td>
<td>1.5 μA</td>
</tr>
</tbody>
</table>

**Electrical connections:**

- Modbus RTU
  - RND
  - KU-5B
  - GND
  - R&D-5B
  - MA
  - DATA B
  - TXD-B
  - RS485
  - RS422

Dimensions (mm):

- KS 40-1: 28.5 x 28.5 x 96 (3.78")
- KS 41-1: 28.5 x 28.5 x 96 (3.78")
- KS 42-1: 28.5 x 28.5 x 96 (3.78")

* Pay attention to the internal switch!
**SUPPLEMENTARY INPUT INP2**

- Resolution: > 14 bit
- Scanning cycle: 100 ms
- Accuracy: better 0.1%

**Heating current measurement via current transformer**

- Measuring range: 0...50 mA AC
- Scaling: adjustable -1999..0,000..9999 A
- Input circuit monitor: 12,5% below span start (4..20mA → 2mA)

**CONTROL INPUT DI1**

- Configurable as direct or invers switch or push-button!
- Connection of a potential-free contact suitable for switching „dry“ circuits.
- Switched voltage: 2,5 V
- Switched current: 50 µA

**CONTROL INPUTS DI2, DI3 (OPTION)**

- Configurable as switch or push-button!
- Optocoupler input for active triggering
- Nominal voltage: 24 V DC, external
- Current sink (IEC 1131 Type 1)
- Logic „0“: -3..5 V
- Logic „1“: 15..30 V
- Current requirement: approx. 5 mA

**TRANSMITTER SUPPLY UT (OPTION)**

- Output: 22 mA / ≥18 V

If the universal output OUT3 is used there may be no external galvanic connection between measuring and output circuits!

**OUTPUTS**

**SURVEY OF THE OUTPUTS**

<table>
<thead>
<tr>
<th>Output</th>
<th>Used for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUT1</td>
<td>Control output heating/cooling or Open/Close, limit contacts, timer or programmer End *</td>
</tr>
<tr>
<td>OUT2</td>
<td>Relay or logic</td>
</tr>
<tr>
<td>OUT3</td>
<td>Control output, process value, set-point, control deviation, transmitter supply 13 V / 22 mA</td>
</tr>
</tbody>
</table>

* All logic signals can be OR-linked!

**RELAY OUTPUTS OUT1, OUT2**

- Contacts: 2 NO contacts with common connection
- Max. contact rating: 500 VA, 250 VAC, 2A at 48...62 Hz, resistive load
- Min. contact rating: 6 V, 1 mA DC
- Operating life (electric): 800,000 duty cycles with max. rating

**OUT3 USED AS RELAY OUTPUT**

- Contacts: Potential-free changeover contact
- Max. contact rating: 500 VA, 250 VAC, 2A at 48...62 Hz, resistive load
- Min. contact rating: 5 V, 10 mA AC/DC
- Operating life (electric): 600,000 duty cycles with max. rating

Note:
If the relays OUT1...OUT3 operate external contactors, these must be fitted with RC snubber circuits to manufacturer specifications to prevent excessive switch-off voltage peaks.

**OUT3 AS UNIVERSAL OUTPUT**

Galvanically isolated from the inputs.
- Freely scalable
- DA-converter limiting frequency T90: 50 ms
- Limiting frequency of the complete continuous controller: > 2 Hz
- Resolution: 11 bits

**Current output**

- Signal range: 0...approx. 21,5 mA
- Load: ≤ 500 Ω
- Load effect: 0,02 % / 100 Ω
- Resolution: ≤ 22 µA (0,1%)
- Error: ≤ 40 µA (0,2%)

**Galvanic isolations:**
- Safety isolation
- Functional isolation

**Example of the linkage of the internal functions:**

1. setpoint processing with programmer and timer
2. controller function with loop monitoring
3. limit monitoring, configurable with latch and suppression
4. heating current monitoring
5. output processing with logic or-combination and inverting
6. analog inputs with logical sensor fail signal
7. digital inputs and  key with lock function

KS 40-1 / KS 41-1 / KS 42-1
Voltage output
0/2...10V, configurable
Signal range: 0...11 V
Load: \( \geq 2 \ \Omega \)
Load effect: no Effect
Resolution: \( \leq 11 \text{ mV (0,1\%)} \)
Error: \( \leq 20 \text{ mV (0,2\%)} \)

OUT3 used as transmitter supply
Output: 22 mA / \( \geq 13 \text{ V} \)

OUT3 used as logic output
Load \( \leq 500 \ \Omega \) 0/\( \leq 20 \text{ mA } \)
Load > 500 \( \Omega \) 0/> 13 V

FUNCTIONS
Control behaviour
- Signaler with adjustable switching differential (ON/OFF controller)
- PID controller (2-point and continuous)
- Delta / Star / Off or 2-point controller with switch over from partial to full load
- 2 x PID (heating/cooling, 3-point and continuous)
- 3-point stepping controller
Self-tuning control parameters or adjustable manually via front keys or BlueControl software.

Set-point functions
- Adjustable set-point gradient 0,01...9999 °C/min
- Set-point control
- Set-point/cascade control
- Program controller with 4 segments (set-point/section time)
- Timer

Timer
Time \( \text{SP } 5 P \) adjustable from 0,1 to 9999 min
Timer Start:
- Mains on
- Control input
- \( \text{Y2} \) key (Y2 switch-over)
- Direct adjustment of running time

Behaviour with sensor break or short circuit:
- Control outputs switched off
- Switch-over to a safe output value
- Switch-over to a mean output value

LIMIT SIGNALLING FUNCTIONS
Max., Min. or Max./Min. monitoring with adjustable hysteresis.

Signals which can be monitored:
- Process value
- Control deviation
- Control deviation with suppression during start-up or set-point changes
- Effective set-point
- Output signal Y

Functions
- Input signal monitoring
- Input signal monitoring with latch (reset via front key or digital input)
Several limit signals or alarms can be OR-linked before being output.
Applications: Release of a brake with motor actuators, general alarms, etc.

ALARMS
Heating current alarm
- Overload and short circuit
- Open circuit and short circuit
Limit value adjustable 0...9999 A

Control loop alarm
Automatic detection if there is no response of the process to a change of output value.

Sensor break or short circuit
Depending on selected input type, the input signal is monitored for break and short circuit.
**MAINTENANCE MANAGER**

Display of error signals, warnings, and latched limit messages in the error list. Signals are latched, and can be reset manually.

Possible signals in the error list:

- Sensor break, short circuit, reversed polarity
- Heating current alarm
- Control loop alarm
- Fault during self-tuning
- Latched limit messages
  - e.g. re-calibration warning
  - If the adjusted operating hours are exceeded a message is displayed
- e.g. maintenance interval of actuator
  - If the adjusted switching cycles are exceeded a message is displayed
- Internal fault (RAM, EEPROM, ...)

**OPERATION AND DISPLAY**

**Display**

<table>
<thead>
<tr>
<th>KS40-1 / KS41-1</th>
<th>KS42-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process value: 10,5 mm LED</td>
<td>19 mm LED</td>
</tr>
<tr>
<td>Lower display:</td>
<td>7,8 mm LED</td>
</tr>
</tbody>
</table>

**POWER SUPPLY**

Depending on version:

**AC SUPPLY**

- Voltage: 90...260 VAC
- Frequency: 48...62 Hz
- Power consumption: approx. 7 VA

**UNIVERSAL SUPPLY 24 V UC**

- AC voltage: 20,4...26,4 VAC
- Frequency: 48...62 Hz
- DC voltage: 18...31 V DC
- Power consumption: approx. 7 VA (W)

**BEHAVIOUR WITH POWER FAILURE**

Configuration, parameters, and adjusted set-points, control mode:

Non-volatile storage in EEPROM

**BluePort® FRONT INTERFACE**

Connection of PC via PC adapter (see “Accessories”). The BlueControl software is used to configure, set parameters, and operate the KS 40-1.

**BUS INTERFACE (OPTION)**

Galvanically isolated

- Physical: RS 422/485
- Protocol: Modbus RTU
- Transmission speed: 2400, 4800, 9600, 19,200 bits/s
- Address range: 00...99
- Number of controllers per bus: 32
- Repeaters must be used to connect more controllers.

**ENVIRONMENTAL CONDITIONS**

**Protection modes**

- Front panel: IP 65
- Housing: IP 20
- Terminals: IP 00

**Permissible temperatures**

For specified accuracy: 0...60°C

- Warm-up time: < 15 minutes
- Temperature effect: < 100ppm/K
- For operation: -20...65°C
- For storage: -40...70°C

**Humidity**

75% yearly average, no condensation

**Shock and vibration**

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

- **Shock test Ea (DIN IEC 68-2-27)**
  - Shock: 15g
  - Duration: 11ms

**Electromagnetic compatibility**

Complies with EN 61 326-1

- Complies with the immunity requirements for continuous, unattended operation
- Complies with the emission requirements class B for rural areas
- Surge disturbances may increase the measurement error

**GENERAL**

**Housing**

- Material: Makrolon 9415, flame-retardant
- Flammability class: UL 94 V0, self-extinguishing

**Plug-in module, inserted from the front**

**Safety tests**

Complies with EN 61010-1 (VDE 0411-1):

- Over voltage category II
- Contamination class 2
- Working voltage range 300 VAC
- Protection class II

**Certifications**

**Type test to DIN 3440**

With certified sensors it can be used in:

- Heat generating plants with outflow temperatures up to 120°C to DIN 4751
- Hot-water plants with outflow temperatures above 110°C to DIN 4752
- Thermal transfer plants with organic transfer media to DIN 4754
- Oil-heated plants to DIN 4755

**UL certification (applied for)**

**Electrical connections**

Depending on version:

- Flat-pin connectors 1 x 6,3 mm or 2 x 2,8 mm to DIN 46 244
- Screw terminals for conductor cross-section from 0,5 to 2,5 mm²

**Mounting**

Panel mounting with two fixing clamps at top/bottom or left/right

Close mounting possible

- Mounting position: not critical
- Weight: 0,27 kg (9.52 oz)

**Accessories supplied with unit**

Operating instructions

2 fixing clamps
ACCESSORY EQUIPMENT

BlueControl (Engineering Tool)

PC-based program for configuring, setting parameters, and operating (commissioning) the KS 40-1 controller. Moreover, all the settings are saved, and can be printed on demand. Depending on version, a powerful data acquisition module is available, complete with trend graphics.

Software requirements:
The built-in simulation serves to test the controller settings, but can also be used for general training and observing the interaction between controller and control loop.

Configurations that can only be implemented via the BlueControl software (not via the front-panel keys):
- Customer-specific linearizations
- Enable „forcing” for inputs/outputs. Forcing allows to write the analog and digital inputs and outputs via Modbus interface.
- Adjustment of limits for operating hours and switching cycles
- Switch-over to 60 Hz mains frequency
- Disable operator actions and operating levels, plus password definition
- Prevent automatic optimization of cycle times T1, T2

Hardware requirements:
A PC adapter (see „Accessories”) is required for connecting the controller.

Updates and demo software can be downloaded from: www.pma-online.de

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Description</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current converter 50A AC</td>
<td>9404-407-50001</td>
</tr>
<tr>
<td>PC adapter, for connecting BlueControl software to the BluePort®</td>
<td>9407-998-00001</td>
</tr>
<tr>
<td>Standard rail adapter</td>
<td>9407-998-00061</td>
</tr>
<tr>
<td>Adhesive set of physical dimension labels with 31 different dimensions and 4 empty labels</td>
<td>4012-140-66041</td>
</tr>
<tr>
<td>Operating manual</td>
<td>9499-040-62718</td>
</tr>
<tr>
<td>Operating manual English</td>
<td>9499-040-62711</td>
</tr>
<tr>
<td>Operating manual French</td>
<td>9499-040-62732</td>
</tr>
<tr>
<td>BlueControl Mini German/English/French</td>
<td>9407-999-11001</td>
</tr>
<tr>
<td>BlueControl Basic German/English/French</td>
<td>9407-999-11001</td>
</tr>
<tr>
<td>BlueControl Expert German/English/French</td>
<td>9407-999-11011</td>
</tr>
</tbody>
</table>

ACCESSORIES

<table>
<thead>
<tr>
<th>Description</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

BlueControl, versions and functionality:

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Mini</th>
<th>Basic</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>parameter and configuration setting</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>controller and control loop simulation</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>download: writes an engineering to the controller</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>online mode/visualisation</td>
<td>SIM only</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>creation of user defined linearizations</td>
<td>SIM only</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>configuration of extended operating level</td>
<td>SIM only</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>upload: reads an engineering from the controller</td>
<td>SIM only</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>basic diagnosis function</td>
<td>SIM only</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>file, save engineering data</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>printer function</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>online documentation, help system</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>measurement correction (calibration procedure)</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>program editor</td>
<td>SIM only</td>
<td>SIM only</td>
<td>yes</td>
</tr>
<tr>
<td>data acquisition and trend function</td>
<td>SIM only</td>
<td>SIM only</td>
<td>yes</td>
</tr>
<tr>
<td>network and multiuser licence</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>personal assistant function</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>extended simulation</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>extended diagnostic and service functions</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>