By means of a modern control concept, a continuous steady pressure can be maintained in public water supply networks. Furthermore, seemingly unavoidable pressure peaks (water hammer) are prevented reliably. With the systems installed so far, the number of damaged or ruptured pipes was reduced drastically to 10% of the previous value. This is achieved with a compact, specially configured KS 94 universal controller, connected to a flow meter, a pressure sensor, and to the pumps. Due to the precise and sensitive control loop, energy consumption is reduced as well as the outlay for maintenance of the pumps, fittings, and actuators.

### DESCRIPTION

Pumps 1 to 3 are operated in such a way that the pressure is always maintained at a constant value, e.g. 5 bar (± 0.05 bar). For this, pump P1 operates for flows between 0 and \( L_{inH1} \). If \( L_{inH1} \) is reached, pump P2 is started, and both pumps are operated for a flow of \( Q/2 \). If a flow of \( L_{inH2} \) is reached (only in case of an unusually high demand, e.g. for fire fighting), pumps 1 and 2 are switched off, and the total flow is provided by pump P3. The purpose is to ensure that every pump is operated in its most efficient delivery range.

The activated pumps maintain the network pressure at the required value for the corresponding delivery flow. For this, the analog output of the KS 94 controller is used to control the frequency converter for pump speed.

Depending on the instantaneous flow, the pressure setpoint is increased automatically, thus preventing water hammer in the pipes.

The constantly changing pressure setpoint is determined automatically by the controller from the measured flow and pressure values. If the pressure falls below an (adjustable) minimum value \( L_{inL3} \), a fault in the network is assumed, and a relay generates an alarm signal.

### FRONT INTERFACE AND ENGINEERING TOOL

By means of a PC or laptop connected to the controller’s front interface, it is possible to display the trend values of flow and pressure over time, thus enabling the system’s operation to be monitored.
DISPLAY

The “day & night” display is equally suitable for poor lighting conditions and strong sunlight, and not only indicates setpoint, process value and output value, but also provides messages in plain text, e.g. which pumps are in operation, possible disturbances, etc.

PARAMETER LEVEL

Pressing the \( \mathbf{3} \) key opens the extended Operating and Parameter Levels. The various signals and parameters are selected by means of the \( \mathbf{\Delta} \) and \( \mathbf{\nabla} \) keys (see table).

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{INP6} )</td>
<td>Actual measured flow-</td>
<td>-</td>
</tr>
<tr>
<td>( \text{LimH1} )</td>
<td>Cut-in value for pump 2</td>
<td>20 m³/h</td>
</tr>
<tr>
<td>( \text{LimH2} )</td>
<td>Switchover to main pump 3</td>
<td>45 m³/h</td>
</tr>
<tr>
<td>( \text{LimL3} )</td>
<td>Min. pressure monitor (pressure loss)</td>
<td>2.0 bar</td>
</tr>
<tr>
<td>( \text{Ymin} )</td>
<td>Lowest output value</td>
<td>2 %</td>
</tr>
<tr>
<td>( \text{Xp1} )</td>
<td>Controller proportional band</td>
<td></td>
</tr>
<tr>
<td>( \text{Tn1} )</td>
<td>Controller integral action time</td>
<td></td>
</tr>
<tr>
<td>( \text{m6} )</td>
<td>Max. value of flow transmitter</td>
<td>50 m³/h</td>
</tr>
</tbody>
</table>

Interlock

Via digital input di2 it is possible to disable parameter adjustments in the extended Operating Level. A good solution is to connect a switch-key to di2, thus preventing unauthorized changes.

Alarm

Relay OUT4 is used to signal a pressure sensor fault and if the pressure falls below the minimum level LimL3. The relay is configured to give an alarm in case of a power outage (fail safe).

Connecting diagram of KS 94 Aqua
TECHNICAL DATA

INPUTS

Input INP1 (pressure)
Universal input, configured for 4…20 mA
Limiting frequency: fg = 1 Hz
Measurement cycle: 200 ms

<table>
<thead>
<tr>
<th>Meas. span</th>
<th>Error</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>4…20 mA</td>
<td>0,1 %</td>
<td>0,8 µA</td>
</tr>
</tbody>
</table>

Input resistance: 50 Ω
Input circuit monitor for 4…20 mA
Triggered, if input signal ≤ 2 mA

Integrated transmitter supply
Used to energize a 2-wire transmitter, galvanically isolated. Output: =17,5 VDC / 22 mA

INPUT INP5 (FLOW)
Differential amplifier input:
Max. 2 inputs cascadable, if there is another galvanic connection between the units. Else max. 6 inputs can be cascaded.

Direct voltage & current
Technical data as for INP1, except limiting frequency: fg = 0,25 Hz
Measurement cycle: 800 ms

INPUT INP6 (FLOW)
Potentiometric transducer or standard signal 0/4…20 mA
Configured for 4…20 mA
Technical data as for INP1

CONTROL INPUTS DI1, DI2
Optocoupler
Nominal supply: 24 VDC external
Current sink (IEC 1131, Type 1)
Logic “0” = -3…5 V Logic “1” = 15…30V
Current demand approx. 5 mA
Digital inputs are galvanically isolated from the other inputs/outputs and from the supply voltage.

OUTPUTS

Relay outputs OUT1, OUT2, OUT4, OUT5
Potential-free switchover 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.

CONTINUOUS OUTPUT OUT3
Control of the frequency converter
Galvanically isolated
Configurable for 0/4…20 mA
Control range: 0…approx. 22 mA
Resolution: 6 µA = 12 bits
Load: 600 Ω
Load effect: < 0,1 %
Limiting frequency: approx. 1 Hz

POWER SUPPLY

AC supply
90…260 VAC
Frequency: 48…62 Hz
Power consumption: approx. 10 VA

Behaviour after power failure
Configuration, parameter settings and setpoints: permanent EEPROM storage

REAR BUS INTERFACE (OPTION B)

PROFIBUS-DP INTERFACE (OPTION B)
➢ See data sheet 9499 737 37213

INTERBUS INTERFACE
➢ See data sheet 9498 737 36713

ENVIRONMENTAL CONDITIONS

Permissible temperatures
For specified accuracy: 0…55°C
For operation: 0…60°C
Storage and transport: -20…60 °C

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

ELECTROMAGNETIC COMPATIBILITY

Complies with EN 50 081-1 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 61 000-4-60,15,80 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 61 000-4-42 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

KS 94 Aqua 3

Trend recording of flow and pressure during a 24-hour period.
The recording was made at the high-level reservoir in Eggenfelden, Bavaria.
**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 V AC
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 each 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)
4 fixing clamps
(Operating manual can be ordered separately)

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**ORDERING DATA**

<table>
<thead>
<tr>
<th>Description</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS 94 Aqua</td>
<td>9407-933-01092-036 CONF-094-00485</td>
</tr>
<tr>
<td>KS 94 Aqua Profibus-DP</td>
<td>9407-933-31092-036 CONF-094-00485</td>
</tr>
<tr>
<td>KS 94 Aqua InterBus S</td>
<td>9407-933-41092-036 CONF-094-00485</td>
</tr>
<tr>
<td>Pressure sensor PM4, process coupling G1/2 A, DIN 16 288, HART protocol, measuring span 0...16 barr.</td>
<td>9404-218-04111</td>
</tr>
<tr>
<td>Engineering Tool ET/KS94</td>
<td>9407-999-01801</td>
</tr>
<tr>
<td>Simulation software SIM/KS 94 with trend module [ET/KS 94 and SIM/KS 94 are required for trend display!]</td>
<td>9407-999-03801</td>
</tr>
<tr>
<td>PC adapter for connecting the Engineering Tool</td>
<td>9407-998-00001</td>
</tr>
</tbody>
</table>

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