

Instruction and operation manual

S 421

Thermal mass flow sensor



Dear Customer,
thank you for choosing our product.

The operating instructions must be read in full and carefully observed before starting up the device. The manufacturer cannot be held liable for any damage which occurs as a result of non-observance or non-compliance with this manual.

Should the device be tampered with in any manner other than a procedure which is described and specified in the manual, the warranty is cancelled and the manufacturer is exempt from liability.

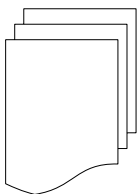
The device is destined exclusively for the described application.

CS-iTEC offers no guarantee for the suitability for any other purpose. CS-iTEC is also not liable for consequential damage resulting from the delivery, capability or use of this device.

Table of contents

| | |
|---|----|
| 1. Safety instructions..... | 4 |
| 2. Application..... | 7 |
| 3. Features..... | 7 |
| 4. Technical Data..... | 8 |
| 4.1 General..... | 8 |
| 4.2 Electrical Data..... | 8 |
| 4.3 Output-Signals..... | 9 |
| 4.4 Accuracy | 9 |
| 5. Dimensional drawing..... | 10 |
| 6. Installation considerations..... | 13 |
| 7. Inlet and Outlet section..... | 13 |
| 8. Sensor Installation | 14 |
| 8.1 Removal of the flow sensor | 15 |
| 8.2 Electrical connection | 16 |
| 9. Sensor signal outputs..... | 18 |
| 9.1 Analog output..... | 18 |
| 9.2 Pulse output..... | 18 |
| 9.2.1 Pulse Connection Diagram..... | 20 |
| 9.3 Modbus output..... | 21 |
| 10. Sensor display (option)..... | 21 |
| 10.1 Starting process..... | 22 |
| 10.2 Configuration using the display..... | 22 |
| 11. Calibration..... | 23 |
| 12. Maintenance..... | 23 |
| 13. Disposal or waste..... | 23 |
| 14. Warranty..... | 24 |
| Appendix..... | 25 |

1. Safety instructions



Please check if this instruction manual accords to the product type.

Please observe all notes and instructions indicated in this manual. It contains essential information which have to be observed before and during installation, operation and maintenance. Therefore this instruction manual has to be read carefully by the technician as well as by the responsible user / qualified personnel.

This instruction manual has to be available at the operation site of the flow sensor at any time. In case of any obscurities or questions, regarding this manual or the product, please contact the manufacturer.



WARNING!

Compressed air!

Any contact with quickly escaping air or bursting parts of the compressed air system can lead to serious injuries or even death!

- Do not exceed the maximum permitted pressure range (see sensors label).
- Only use pressure tight installation material.
- Avoid that persons get hit escaping air or bursting parts of the instrument.
- The system must be pressureless during maintenance work.



WARNING!

Voltage used for supply!

Any contact with energized parts of the product, may lead to a electrical shock which can lead to serious injuries or even death!

- Consider all regulations for electrical installations.
- The system must be disconnected from any power supply during maintenance.
- Any electrical work on system is only allowed by authorized qualified personal.

**WARNING!****Permitted operating parameters!**

Observe the permitted operating parameters, any operation exceeding this parameters can lead to malfunctions and may lead to damage on the instrument or the system.

- Do not exceed the permitted operating parameters.
- Make sure the product is operated in its permitted limitations.
- Do not exceed or undercut the permitted storage and operation temperature and pressure.
- The product should be maintained and calibrated frequently, at least annually.

General safety instructions

- It is not allowed to use the product in explosive areas.
- Please observe the national regulations before/during installation and operation.

Remarks

- It is not allowed to disassemble the product.
- Always use spanner to mount the product properly.

**ATTENTION!****Measurement values can be affected by malfunction!**

The product must be installed properly and frequently maintained, otherwise it may lead to wrong measurement values, which can lead to wrong results.

- Always observe the direction of the flow when installing the sensor. The direction is indicated on the housing.
- Do not exceed the maximum operation temperature at the sensors tip.
- Avoid condensation on the sensor element as this will affect accuracy enormously.

Storage and transportation

- Make sure that the transportation temperature of the sensor without display is between -30°C... 70°C and with display between

-10°C... 60°C.

- For storage and transportation it is recommended to use the packaging which comes with the sensor.
- Please make sure that storage temperature of the sensor is between -10°C... 50°C.
- Avoid direct UV and solar radiation during storage.
- For the storage the humidity has to be <90%, no condensation.

2. Application

The S 421 is a flow sensor which is designed to measure the consumption of compressed air and gases within the permissible operating parameters. These parameters can be found in the technical data section.

The S 421 can measure the following values:

- Volume flow of the compressed air or gas.
- Total consumption of the compressed air or gas.

The default factory settings are: Velocity in m/s, Volume flow in m³/h and Total Consumption in m³. Other units can be programmed by the optional display or the service kit.

The S 421 flow sensor is not developed to be used in explosive areas. For the use in explosive areas please contact the manufacturer.

The S 421 flow sensor is mainly used in compressed air systems in industrial environment.

3. Features

- Inline type sensor for high accuracy in small tube diameters.
- Thermal mass flow measurement, virtually independent of pressure and temperature changes.
- IP65 casing provides robust protection in the industrial environment.
- Very fast response time.
- Particularly suitable for measuring process gases such as N₂, Ar, O₂, CO₂ etc.
- Optional display directly on the sensor, showing velocity, volume flow and consumption.
- Modbus interface (optional).
- 2 gas calibration (optional).

4. Technical Data

4.1 General

| | |
|--|--|
| CE | |
| Parameters | Standard unit flow: m ³ /h Other units: m ³ /min, l/min, l/s, cfm, kg/h, kg/min, kg/s Consumption units: m ³ , ft ³ , kg |
| Reference conditions | ISO1217 20°C 1000 mbar (Standard-Unit) DIN1343 0°C 1013.25 mbar (Norm-Unit) |
| Principle of measurement | Thermal mass flow |
| Sensor | Glass coated resistive sensor |
| Measuring medium | Air, gas (non corrosive gas) |
| Operating temperature | -30... 140°C fluid temperature -30... 70°C casing -10... 50°C display (optional) |
| Humidity of the meas. medium | < 90%, no condensation |
| Operating pressure | 0...1.6 MPa |
| Housing material | PC + ABS |
| Material of the probe tube, sensor head (wetted parts) | Stainless steel 1.4404 (SUS 316L) |
| Protection class | IP65 |
| Dimensions | See dimensional drawing on the next page |
| Display (optional) | 2.4" colour graphics display with keypad |
| Tube diameter | DN32...DN80 |
| Process connection: | G1/2" (ISO 228/1) |
| Weight | 0.6 kg (instrument only, doesn't include the measuring section) |

4.2 Electrical Data

| | |
|--------------|-----------------------|
| Power supply | 15 ... 30 VDC, 200 mA |
|--------------|-----------------------|

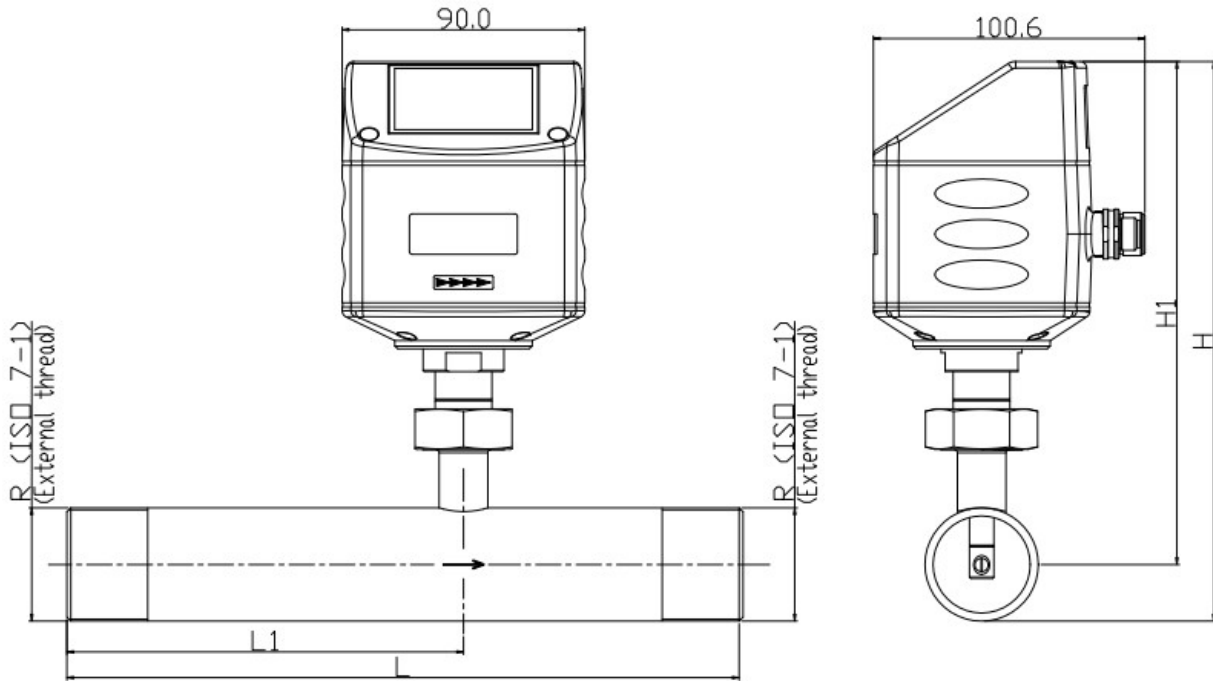
4.3 Output-Signals

| | |
|-----------------|---|
| Analogue output | Signal: 4... 20 mA, isolated Scaling: 0 to max flow Max load: 250R |
| Pulse output | 1 pulse per consumption unit, isolated switch, max. 30 VDC, 200 mA (pulse length: 10...120 ms, depends on flow rate) |
| Modbus output | See chapter 9.3 |

4.4 Accuracy

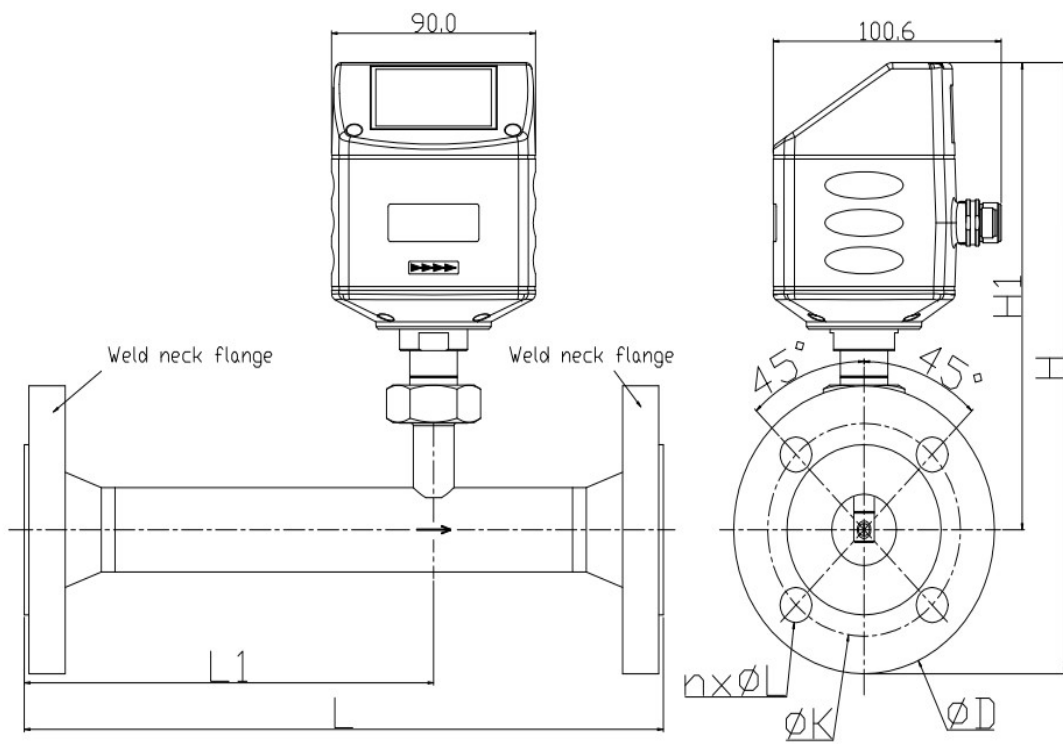
| | |
|--------------------|--|
| Accuracy | $\pm 1.5\%$ of reading $\pm 0.3\%$ FS (optional 1% of reading) Temperature drift: $< 0.05\%/K$ |
| Stated accuracy at | Ambient/process temperature $23^{\circ}C \pm 3^{\circ}C$ Ambient/process humidity $< 90\%$ Process pressure at 0.6 Mpa |
| Repeatability | $\pm 0.25\%$ of reading |

5. Dimensional drawing



| | Pipe nominal size inch(DN) | L total length [mm] | L1 inlet length [mm] | H total height [mm] | H1 from pipe center to casing top [mm] | R External thread |
|--------------|----------------------------|---------------------|----------------------|---------------------|--|-------------------|
| S 421-1 1/4" | 1 1/4"/ (DN32) | 475 | 275 | 207.9 | 186.7 | R 1/4" |
| S 421-1 1/2" | 1 1/2"/ (DN40) | 475 | 275 | 210.9 | 186.7 | R 1/2" |
| S 421-2" | 2"/(DN50) | 475 | 275 | 216.9 | 186.7 | R 2" |

S 421 flange type



| | Pipe nominal size inch(DN) | L total length [mm] | L1 inlet length [mm] | H total height [mm] | H1 from pipe center to casing top [mm] | Flange (EN 1092-1 PN40) | | |
|--------------|----------------------------|---------------------|----------------------|---------------------|--|-------------------------|---------|-------------|
| | | | | | | ØD (mm) | ØK (mm) | n x ØL (mm) |
| S 421-1 1/4" | 1 1/4"/ (DN32) | 475 | 275 | 256.7 | 186.7 | 140 | 100 | 4xØ18 |
| S 421-1 1/2" | 1 1/2"/ (DN40) | 475 | 275 | 261.7 | 186.7 | 150 | 110 | 4xØ18 |
| S 421-2" | 2"/ (DN50) | 475 | 275 | 269.2 | 186.7 | 165 | 125 | 4xØ18 |
| S 421-2 1/2" | 2 1/2"/ (DN65) | 475 | 275 | 287.1 | 194.6 | 185 | 145 | 8xØ18 |
| S 421-3" | 3"/ (DN80) | 475 | 275 | 301 | 201 | 200 | 160 | 8xØ18 |

| | Pipe nominal size inch(DN) | L total length [mm] | L1 inlet length [mm] | H total height [mm] | H1 from pipe center to casing top [mm] | Flange (ANSI/B16.5 class 300) | | |
|--------------|----------------------------|---------------------|----------------------|---------------------|--|-------------------------------|---------|-------------|
| | | | | | | ØD (mm) | ØK (mm) | n x ØL (mm) |
| S 421-1 1/4" | 1 1/4"/ (DN32) | 475 | 275 | 253.4 | 186.7 | 133.3 | 98.5 | 4xØ19 |
| S 421-1 1/2" | 1 1/2"/ (DN40) | 475 | 275 | 264.4 | 186.7 | 155.4 | 114.3 | 4xØ22.3 |
| S 421-2" | 2"/ (DN50) | 475 | 275 | 269.3 | 186.7 | 165.1 | 127 | 8xØ19 |
| S 421-2 1/2" | 2 1/2"/ (DN65) | 475 | 275 | 289.9 | 194.6 | 190.5 | 149.3 | 8xØ22.3 |
| S 421-3" | 3"/ (DN80) | 475 | 275 | 305.8 | 201 | 209.5 | 168.1 | 8xØ22.3 |

6. Installation considerations

In order to maintain the accuracy stated in the technical data, the sensor must be installed inline and fitted to tubes with the same diameter. Please make sure it exists unhindered flow characteristics. Unhindered flow characteristics are achieved if the section in front of the sensor (inlet) and behind the sensor (outlet) is sufficiently long, absolutely straight and free of obstructions such as edges, seams, curves etc..

Please consider that enough space exists at your site for a adequate installation as described in this manual.



ATTENTION!

Wrong measurement is possible, if the sensor is not installed correctly.

- Careful attention must be paid to the design of the inlet and outlet section. Obstructions can cause counter-flow turbulence as well as turbulence in the direction of the flow.
- The sensor is for indoor use only! At an outdoor installation, the sensor must be protected from solar radiation and rain.
- It is strongly recommend not to install S 421 permanently in wet environment as it exists usually right after a compressor outlet.

7. Inlet and Outlet section

For diameters from DN32 - DN65, the S 421 has a shortened inlet

section and requires additional straight sections at the inlet and outlet. The additional length for the particular diameters are listed in the table below.

Remarks:

A new solution with reduced inlet/ outlet requirements is under development.

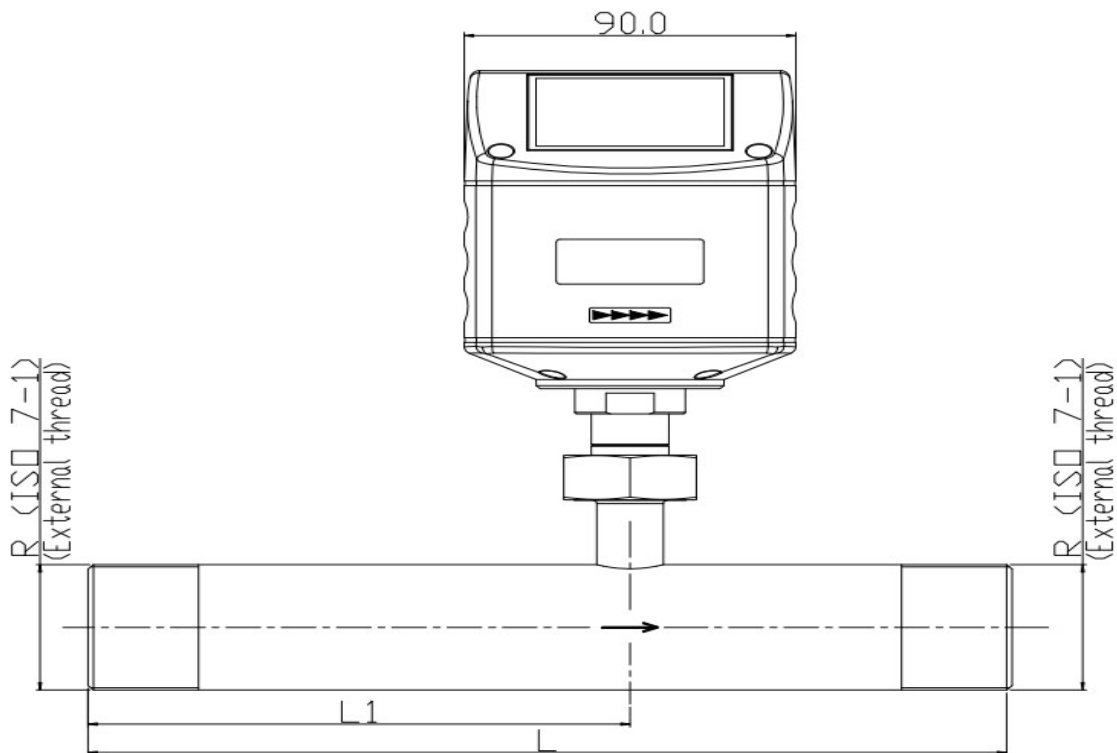
8. Sensor Installation

Before installing the sensor, please make sure that all components listed below are included in your package.

| Qty | Description | Item No. |
|-----|-------------------------|--|
| 1 | Sensor | S695 4120 |
| 1 | Sealing ring | No P/N |
| 2 | M12 plug | C219 0059 |
| 1 | Instruction manual | No P/N |
| 1 | Calibration certificate | No P/N |
| 1 | Measuring section | A1304 ... A1306 (R thread) A1324 ... A1328 (Flange, EN-1092-1) A1344 ... A1348 (Flange, ANSI 16.5) |

The S 421 is always shipped with mounted measurement section.

Please make sure that the sensor is installed correctly to the flow direction in the tube. For this observe the flow direction indicated on the housing, it must match the flow direction of the compressed air or gas. The gas flows from the inlet (long pipe section) to the outlet (short pipe section) like illustrated in the picture below.



8.1 Removal of the flow sensor

The following steps explain the procedure of an appropriate removal of the sensor.



ATTENTION!

Only remove the sensor if the system is in a pressurless condition.



1. Hold the flow sensor.
2. Release the terminal nut at the connection thread.
3. Pull out the shaft slowly.
4. The measuring section can be closed with the optional closing cap, so the system can be operated normal during maintenance.

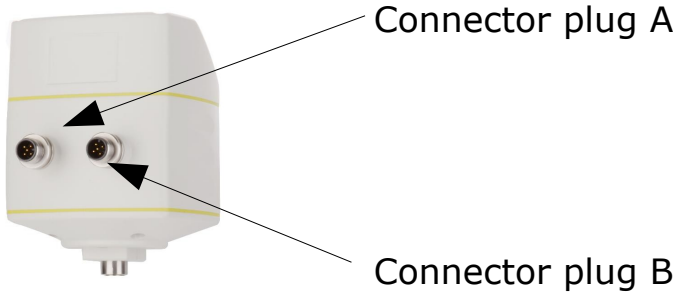


Re-installation after maintenance:

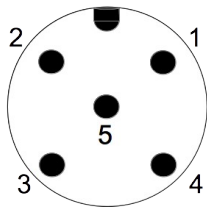
- The re-installation of the measurement device is simple as the sensor unit fits into the pipe section only in one position.
- Please make sure that the o-ring is inserted.
- Close the terminal nut tightly to mount the sensor correctly.

8.2 Electrical connection

The flow sensor is equipped with two Connector plugs "A" and "B". The cables are connected to the sensor through the M12 connector.



Connection pins connector plug M12



Connection pins (top view on the sensor)

Pin assignment connector plug M12

| Output Version | Connector | Pin 1 | Pin 2 | Pin 3 | Pin 4 | Pin 5 |
|------------------|-----------|-------|-------|-------|-------|-------|
| Modbus | A | SDI | -VB | +VB | DIR | DIR |
| | B | GND | -VB | +VB | D+ | D- |
| Pulse and analog | A | SDI | -VB | +VB | DIR | DIR |
| | B | NC | SW | SW | +I | -I |
| M-Bus | A | SDI | -VB | +VB | DIR | DIR |
| | B | NC | -VB | +VB | M | M |
| Wire colour | | brown | white | blue | black | grey |

Legend to pin assignment

- GND: Ground for Modbus
- SDI: Digital signal (internal use)

| | |
|------|----------------------------|
| -VB: | Negative supply voltage |
| +VB: | Positive supply voltage |
| +I: | Positive 4...20 mA signal |
| -I: | Negative 4... 20 mA signal |
| SW: | Isolated pulse output |
| DIR | Flow direction input |
| D+: | Modbus data + |
| D-: | Modbus data - |
| M: | M-Bus data |
| NC: | Not connected |

**ATTENTION!**

Do not screw the M12 plug using force. Otherwise, it may damage the connecting pins.

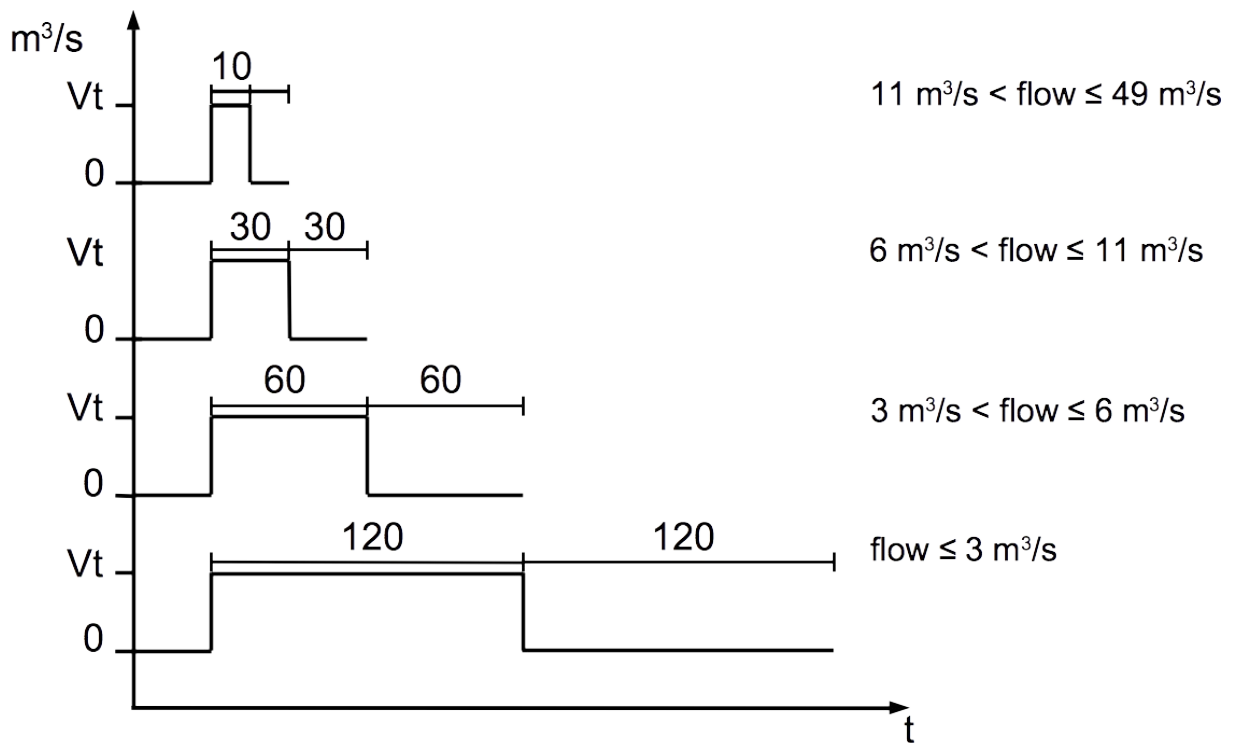
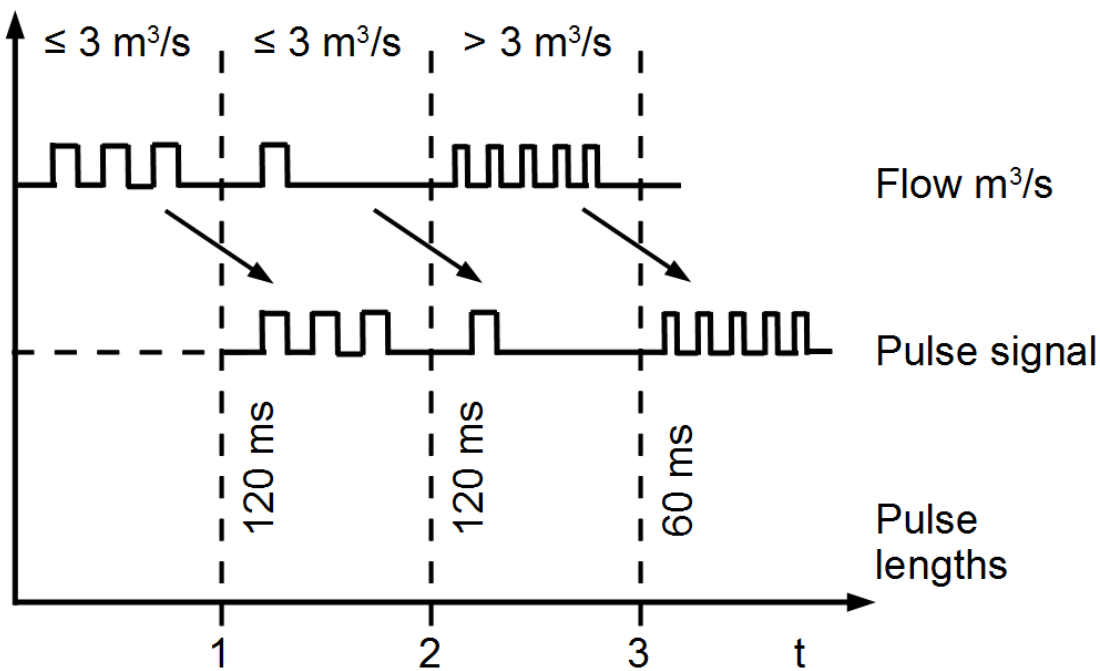
9. Sensor signal outputs

9.1 Analog output

The sensor has an analog output range of 4... 20 mA. This output can be scaled to match a desired measuring range. Standard scaling is from 0 to max flow. The corresponding flow in different pipe sizes can be found in the Appendix section. For other ranges, please contact the manufacturer.

9.2 Pulse output

The sensor will send out one pulse per consumption unit. This pulse output can be connected to an external pulse counter to count the total consumption. The number of m³ per second are summed up and indicated after one second. Pulse length depends on flow rate.

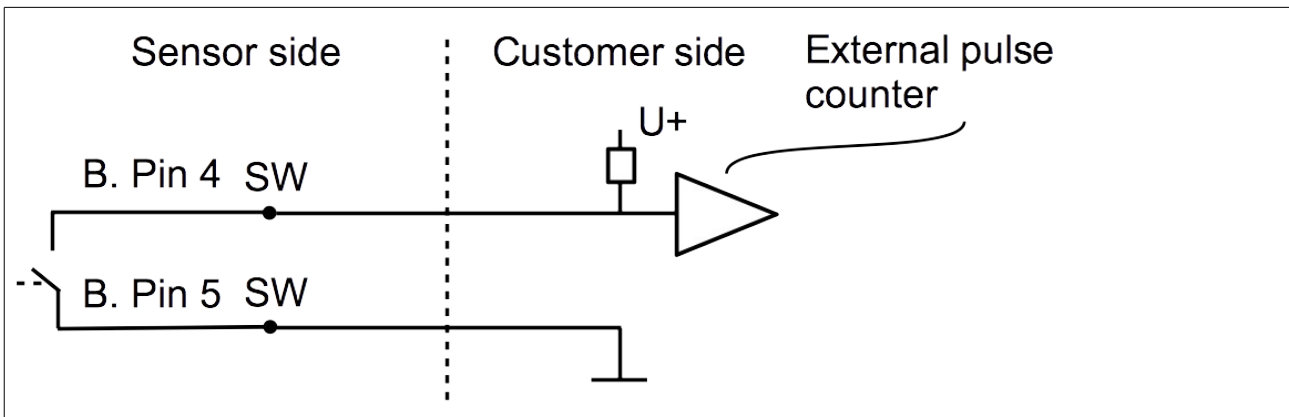


In case the flow rate is too high the S 421 can not output the pulses with default settings (one pulse per consumption unit). For this the pulse can be set by our service software or a connected display to 1 pulse per 10 consumption units or 1 pulse per 100 consumption units. For example, if set to 1 pulse per $10 m^3$, the sensor will send one pulse each $10 m^3$. Example (1 pulse per $10 m^3$):

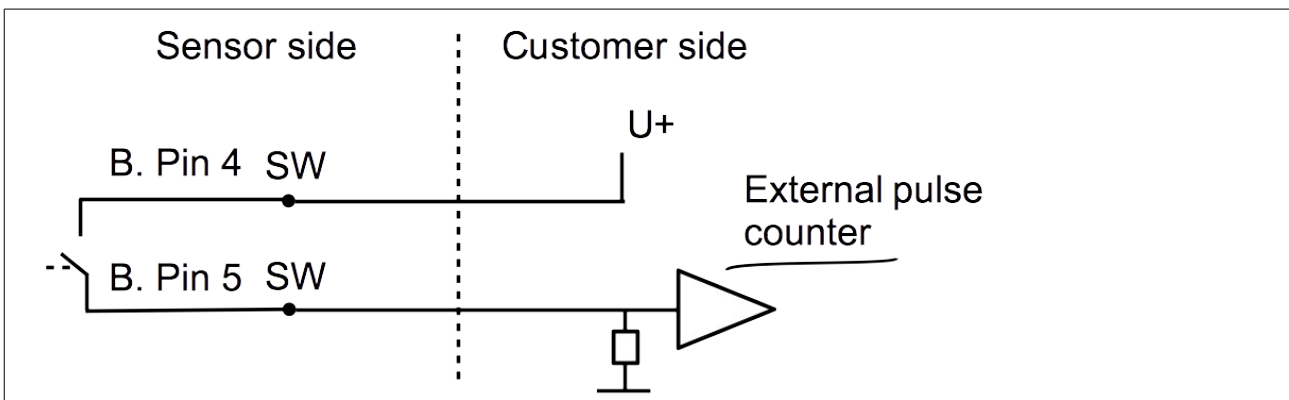
| Volumetric flow [m ³ /s] | Volumetric flow [m ³ /h] | Pulse length [ms] | Max. pulse output per hour |
|-------------------------------------|-------------------------------------|-------------------|----------------------------|
| ≤ 3 | ≤ 10800 | 120 | 1080 |
| > 3 | > 10800 | 60 | 2880 |
| > 6 | > 21600 | 30 | 3960 |

9.2.1 Pulse Connection Diagram

Variant 1:



Variant 2:



9.3 Modbus output

| | |
|-----------------------------|------------|
| Mode | : RTU |
| Baud rate | : 19200 |
| Device address | : 1 |
| Framing / parity / stop bit | : 8, N, 1 |
| Response time | : 1 second |
| Response delay | : 0 ms |
| Inter-frame spacing | : 7 char |

Remarks

- Modbus communication settings can be changed by the service software.

| Index | Channel description | Unit | Resolution | Format | Length | Modbus address |
|-------|---------------------|-------------------|------------|--------|--------|----------------|
| 1 | Flow | m ³ /h | 0.1 | FLOAT | 4 Byte | 6 |
| 2 | Consumption | m ³ | 1 | UNIT32 | 4 Byte | 8 |
| 3 | Temperature | °C | 0.1 | FLOAT | 4 Byte | 0 |
| 4 | Reverse consumption | m ³ | 1 | UNIT32 | 4 Byte | 14 |
| 5 | Flow direction | | 1 | UNIT32 | 4 Byte | 42 |


Remark


- All numbers are in little-endian format.
- Function code: 03.
- Different units have different resolutions.


10. Sensor display (option)

With the Sensor display it is possible to show the value of the flow and the consumption. Moreover it shows error messages and it is possible to change the configuration setting of the sensor.



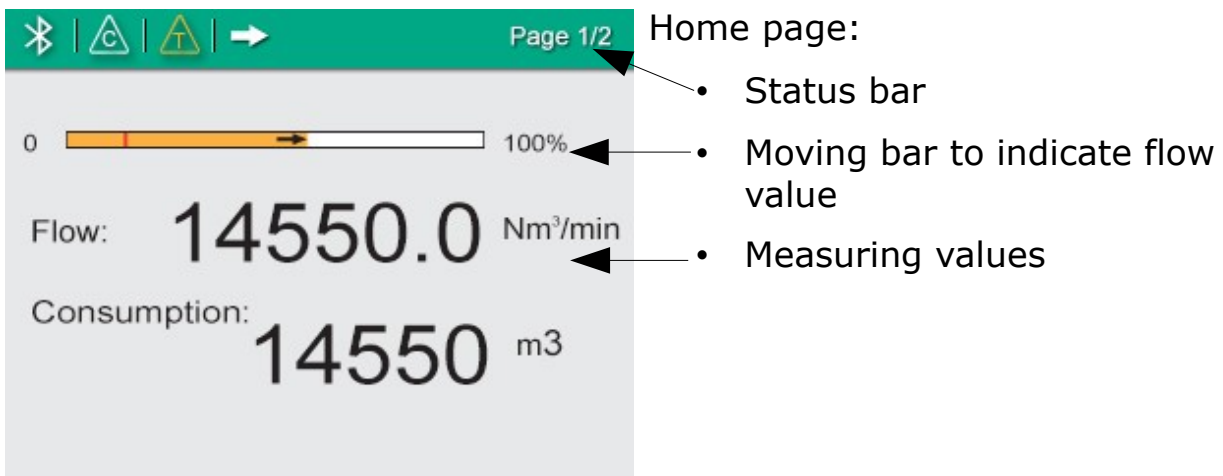
“Enter key” = 

“Up key” = 

“Down key” = 

10.1 Starting process

After power up, the display starts automatically with a initialisation procedure. During the next eight seconds the display will show the current software version and starts the connection to the sensor. Now the display goes to the standard mode, showing the online values.

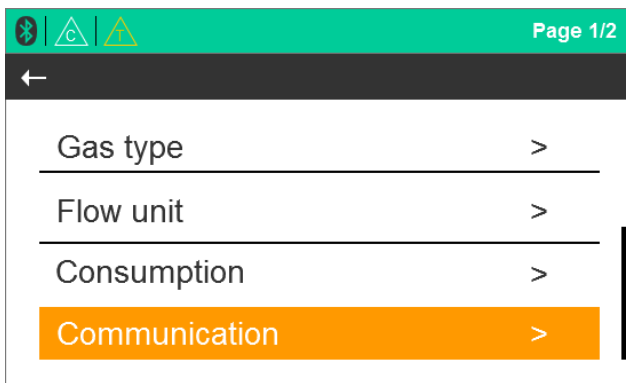


10.2 Configuration using the display

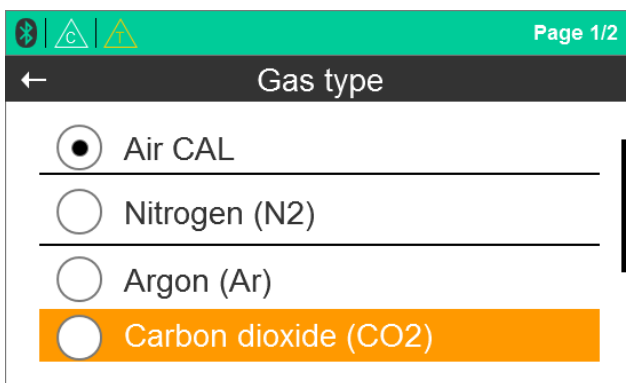
The following settings can be changed via display or service software.

- Gas type – select the gas to be measured.
- Flow unit – select unit for flow value.

For this please observe the following steps:



1. Please press "Enter" (>3s) key to check and change settings (unlock code:12).
2. Use the "Up" and "Down" key on the keyboard to choose the setting which should be changed.



3. Also use these two buttons to select desired entry box or adjust the values.
4. Please press "Enter" button to confirm the changes.

11. Calibration

It is recommended to calibrate respectively adjust the sensor annually. For this please contact the manufacturer. Please check the date of the last calibration in the attached calibration certificate.

12. Maintenance

To clean the sensor it is recommended to use distilled water or isopropyl alcohol only.



ATTENTION!

Do not touch the surface of the sensor plate.

Avoid mechanical impact on the sensor (e.g with a sponge or a brush).

If the contamination can not be removed the sensor has to be inspected and maintained by the manufacturer.

13. Disposal or waste

Electronic devices are recyclable material and do not belong in the household waste.

The sensor, the accessories and its packings must be disposed according to your local statutory requirements. The dispose can also be carried by the manufacturer of the product, for this please contact the manufacturer.

14. Warranty

CS-iTEC provides a warranty for this product of 24 months covering the material and workmanship under the stated operating conditions from the date of delivery. Please report any findings immediately and within the warranty time. If faults occurring during the warranty time CS-iTEC will repair or replace the defective unit, without charge for labour and material costs but there is a charge for other service such as transport and packing costs.

Excluded from this warranty is:

- Damage caused by:
 - Improper use and non-adherence to the instruction manual.
 - Use of unsuitable accessories.
 - External influences (e.g. damage caused by vibration, damage during transportation, excess heat or moisture).

The warranty is cancelled:

- If the user opens the measurement instrument without a direct request written in this instruction manual.
- If repairs or modifications are undertaken by third parties or unauthorised persons.
- If the serial number has been changed, damaged or removed.

Other claims, especially those for damage occurring outside the instrument are not included unless responsibility is legally binding.

Warranty repairs do not extend the period of warranty.



ATTENTION!

Batteries have a reduced warranty time of 12 month.

Appendix

Scaling table analogue output:

Medium: Air at ISO 1217; 20°C; 1000 mbar

| Tube | | | Flow | | | | | | | |
|--------|------------------|-------|-------------------|---------------------|--------|--------|---------|---------|--------|------|
| inch | nominal Diameter | mm | m ³ /h | m ³ /min | l/min | l/s | cfm | kg/h | kg/min | kg/s |
| 1 1/4" | DN 32 | 36.00 | 500.0 | 8.33 | 8,333 | 138.89 | 294.3 | 593.9 | 9.90 | 0.16 |
| 1 1/2" | DN 40 | 41.90 | 700.0 | 11.67 | 11,667 | 194.44 | 412.0 | 831.4 | 13.86 | 0.23 |
| 2" | DN 50 | 53.10 | 1,000.0 | 16.67 | 16,667 | 277.78 | 588.6 | 1,187.8 | 19.80 | 0.33 |
| 2 1/2" | DN 65 | 68.90 | 1,500.0 | 25.00 | 25,000 | 416.67 | 882.9 | 1,781.7 | 29.69 | 0.49 |
| 3" | DN 80 | 80.90 | 2,500.0 | 41.67 | 41,667 | 694.44 | 1,471.4 | 2,969.4 | 49.49 | 0.82 |

Medium: Other gases at DIN 1343; 0°C; 1013,25 mbar

| Tube | | | | N2 | | CO2 | | O2 | |
|--------|------------------|------|-------|-------------------|--------|-------------------|--------|-------------------|--------|
| inch | nominal Diameter | mm | PF | m ³ /h | cfm | m ³ /h | cfm | m ³ /h | cfm |
| 1 1/4" | DN 32 | 36 | 0.784 | 444.7 | 261.8 | 460.5 | 271.0 | 476.8 | 280.6 |
| 1 1/2" | DN 40 | 41.9 | 0.797 | 622.6 | 366.5 | 644.7 | 379.4 | 667.5 | 392.9 |
| 2" | DN 50 | 53.1 | 0.812 | 889.4 | 523.5 | 921.0 | 542.1 | 953.6 | 561.3 |
| 2 1/2" | DN 65 | 68.9 | 0.825 | 1334.2 | 785.3 | 1381.4 | 813.1 | 1430.4 | 841.9 |
| 3" | DN 80 | 80.9 | 0.830 | 2223.6 | 1308.8 | 2302.4 | 1355.1 | 2384.1 | 1403.2 |

| Tube | | | | Nat. Gas | | Ar | | He | |
|--------|------------------|------|-------|-------------------|-------|-------------------|--------|-------------------|-------|
| inch | nominal Diameter | mm | PF | m ³ /h | cfm | m ³ /h | cfm | m ³ /h | cfm |
| 1 1/4" | DN 32 | 36 | 0.784 | 296.0 | 174.2 | 809.1 | 476.2 | 63.5 | 37.4 |
| 1 1/2" | DN 40 | 41.9 | 0.797 | 414.3 | 243.9 | 1132.7 | 666.7 | 89.0 | 52.4 |
| 2" | DN 50 | 53.1 | 0.812 | 591.9 | 348.4 | 1618.2 | 952.4 | 127.1 | 74.8 |
| 2 1/2" | DN 65 | 68.9 | 0.825 | 887.9 | 522.6 | 2427.3 | 1428.6 | 190.6 | 112.2 |
| 3" | DN 80 | 80.9 | 0.830 | 1479.8 | 870.9 | 4045.5 | 2381.1 | 317.7 | 187.0 |

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