# COMPRESSED AIR FLOW MEASUREMENT BASED ON THERMAL FLOWMETER AND FP4 FLOW TOTALIZER

The measurement of compressed air flow enables the analysis and control of medium consumption in an industrial plant. The measurement can be made based on e.g. thermal flowmeter, volumetric flowmeter or orifice. The measurement of the compressed air flow based on the thermal flowmeter is described below.

In applications where a thermal flowmeter and FP4/FP4W device are used, it is possible to count the flow of compressed air and expand the measuring system with an additional functions (e.g. alarms, control). The flow rate value transmitted by the flowmeter is counted and archived in the device internal data memory. Depending on the type of signal sent by the flowmeter (0/4-20 mA and PULS), in the FP4/FP4W device it is possible to count up to 4 flows or connect additional temperature and/or pressure sensors to monitor the system parameters. The device archive files can be a confirmation of the system's operating conditions.
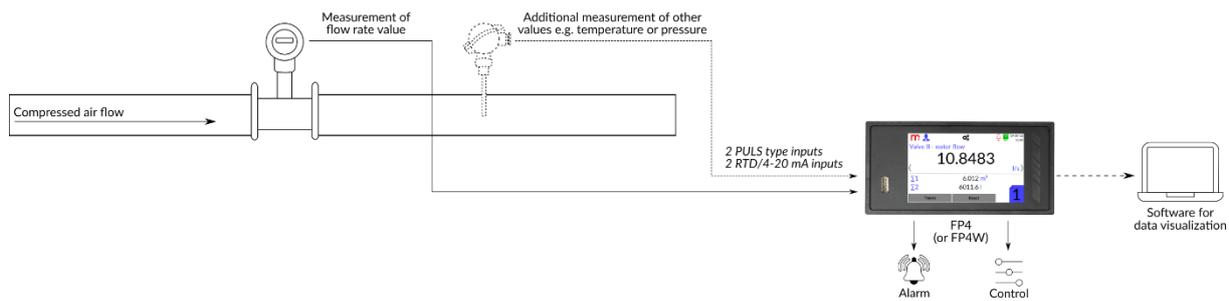
- ## Value reading and flow counting

Depending on the configuration of the flowmeter, the output signal is proportional to the normalized flow (Nm^3/h) or to the mass flow (kg/h, etc.). The output signal may be PULS type or analog 0/4-20 mA type. The flow rate signal is converted by the FP4/FP4W device based on the entered characteristic or based on user look-up table.

Each flow rate channel can have up to two independent flow totalizers. Totalizers can operate in daily, weekly, monthly, resettable or unresettable mode. It is possible to set up one or both totalizers. If the totalizer is enabled, its operating time is automatically counted (working time counter).

Typically, flowmeters are equipped with pulse or analog outputs. Both types of signals can be connected to the FP4/FP4W device. In the case of two flowmeters with analog output and two flowmeters with pulse output, the FP4/FP4W device can count the flow in 4 systems.

- ## Additional control measurements

In typical systems with compressed air, temperature and pressure are kept at approximately constant level. The FP4/FP4W device has two analog inputs for connecting sensors in R/RTD 2-wire., 0/4-20 mA, 0-10 V, -10-+10 V standards and two PULS type inputs. If the PULS type input is used for flow rate measurement, then temperature and/or pressure sensors can be connected to the analog inputs. Control monitoring and archiving parameters of the measured medium can be the used for confirming the operating conditions of the system.

- ## Math channels

Using the math channel, it is possible to determine the flow value in a selected unit and to convert e.g. mass flow into normalized volumetric flow. The FP4/FP4W device has two math channels that compute the formula implemented by the user: $[(A*Kx)\square(B*Ky)]+C$ (the $\square$ sign means the type of mathematical operation: +, -, ˟ or ÷). The coefficients A, B and C are fixed values, the value of the coefficient Kx and Ky can be selected using the drop-down list as the 0.0 value or as the value of the selected channel (*Channel 1 .. Channel 6*).

- ## Alarm and control

Each channel can have assigned two independent alarms regarding the process value. Two functions are available: alarm (latched type) or control (non-latched type). Exceeding the indicated value of flow rate, temperature or pressure (exceeding the alarm level) can cause alarm signaling and/or a change of state at the assigned relay output. The FP4/FP4W device has 4 relay outputs. For each channel, it is possible to set two alarm levels (L & H, L & LL, H & HH) and assign different relay outputs to them.

- ## Communication and data transfer

The flow rate value, totalizer values (counted flow) and working time counters (timers) as well as temperature and pressure values can be read using the Modbus TCP or Modbus RTU protocol. The device has one 4-20mA analog output which enable retransmission of any channel value (also math channel value). The FP4/FP4W device can be connected to the SCADA master system.

- **Displaying data**

Values of channels, totalizers and timers as well as information on alarm states are displayed on a 4" color touchscreen. The screen displays the status of relay outputs (closed, open) and the value of current at the analog output (if the device outputs are used). Additionally, information about the archiving status of channels and totalizers and about the device's internal memory usage are displayed.
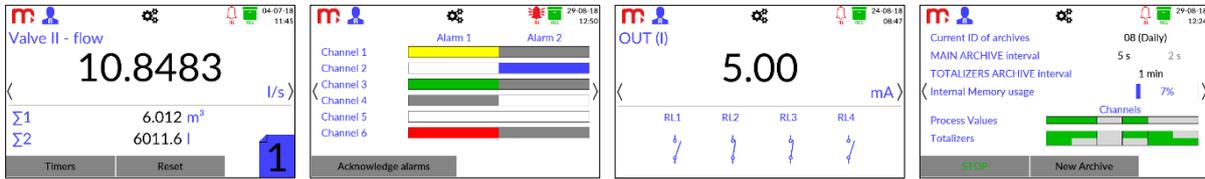
- **Reading and recording process data**

The FP4/FP4W device archives values of channels, values of totalizers and records exceeding the alarm levels, according to the entered settings. Archive files can be downloaded from the device using a portable memory (USB key) or using an Ethernet cable and a web server. Additional software on the PC enables visualization of archived data or current values (FP4-RP/FP4-RPplus, mLog).

- **Configuration**

Operation of the FP4/FP4W device with a flowmeter and/or temperature/pressure sensors requires configuration of the device (in addition, it may be necessary to change jumpers inside the device). The device can be configured using a dedicated PC program or from the device level.

Below, there is an example of the FP4 device configuration for operation with a flowmeter with pulse output, temperature sensor (Pt100) and pressure sensor with 4-20 mA output, performed from the device level. In the described configuration the following function of device are used: totalizers, alarms, relay outputs and analog output.

1. Configuration is possible from the Administrator level: ⚙ → 👥 → *Login* → **Login**.
2. Configure measurement inputs, relay outputs and the analog output:
   a. The input to which the temperature sensor (e.g. Pt100) is connected should be configured according to the sensor connection method (e.g. *R/RTD 2-w.*): ⚙ → ⬚ → **Inputs** → **IN1** → *R/RTD 2-w.* → **Adjustment** → *value* → ✓,
   b. The input to which the pressure sensor is connected must be configured according to the sensor connection method (e.g. *4-20mA*): ⚙ → ⬚ → **Inputs** → **IN2** → *4-20mA* → **Adjustment** → *value* → ✓,
   c. The input to which the flowmeter is connected must be configured according to the connection method (e.g. *Impulse*): ⚙ → ⬚ → **Inputs** → **IN3** → *Impulse* → ✓,
   d. Turn on the used relay outputs and select the output operation mode: ⚙ → ⬚ → **Outputs** → **RL1 / .. / RL4** → *Normally open* → ✓,
   e. For the analog output, select the source (channel number) and assign values for 4 mA and 20 mA. It is possible to enter an failure value that will be sent if the channel value is incorrect: ⚙ → ⬚ → **Outputs** → **Analog outputs** → **Source** → *Channel 3, value assignment for 4 mA and 20 mA* → **Failure** → *Constant* → *enter value* → ✓.
3. Inputs IN1-IN4 are automatically assigned to channels from 1 to 4, channels 5 and 6 are math channels:
   a. Depending on the input type, the device enable entering different types of characteristics (for R/RTD 2-w. input select from the list the type of sensor connected to the input e.g. *Pt100(^{o}C)*, for 4-20 mA input select the *Linear* characteristic and assign values for 4 mA and 20 mA, for the input in the *Impulse* mode, enter the value assigned for a single pulse): ⚙ → ⬚ → **Inputs** → **Channel Type** *Measurement* → **Input number** *IN1 .. IN4* → **Characteristic** → *selecting a characteristic from the list and/or entering a value*,
   b. Channels 5 and 6 are math channels. In the *Inputs* tab, select the *Formula* field. The *Operation* field enable choosing one of the four available formulas using a drop-down list and symbols: +, -, ^{x}, ÷. For the coefficients A, B and C enter the selected constant value. The values of Kx and Ky coefficients are selected using drop-down lists (value 0.0 or assigning the value of the selected channel). Disabling the calculated channel after selecting the *Off* option in the *Operation* field. Characteristics is also available for the math channel, if the channel should display calculated values without conversion, select the *Linear* characteristic and assign the values: 0.0 → 0.0 and 1.0 → 1.0.
   c. In the *General* tab it is possible, among other to enable archiving of the process channel value. If the channel is to have totalizers on, enter the time base (selection from the list: /s, / min, /h). Setting of the time base is necessary to configure the totalizers: ⚙ → ⬚ → **General** → **Unit** → *configuration* → **Resolution** → *select from the drop-down list* → **Time base** → */s* → **Archiving** → ✓ → ✓,
   d. Flow counting can be executed in a daily, weekly, monthly, resettable or unresettable mode. Each channel can have assigned two totalizers (Σ1 and Σ2) operating independently, it is possible to archive none, one or both totalizers. The totalizers perform precise pulse summation: ⚙ → ⬚ → **Σ1/Σ2** → **Mode** → *select from the drop-down list* → **Unit** → *entered Unit performs only the information function* → **Multiplier** → *1* → **Resolution** → *0.000* → **Archiving** → ✓ → ✓,
   e. In the Alarm 1 or Alarm 2 tab, it is possible to set the *high* or *low* alarm mode, indicate the alarm level and hysteresis value. Select e.g. the *control* option and indicate activated in pt. 2d. relay output. The device enables setting of two Alarms from exceedances for each channel, it is possible to archive none, one or both events: ⚙ → ⬚ → **Alarm 1/Alarm 2** → **Mode** → *high/low* → **Type** → *Control* → **Level** → *value* → **Hysteresis** → *value* → **Colour** → *select from the drop-down list* → **Output** → *RL1 .. RL4*),

4. Define the archiving settings. Archive files are created in a daily, weekly or monthly mode: ⚙ → ▇ → *configuration* → ✓ .

5. Exit the menu and confirm the willingness of making changes. The device will reboot with the new settings.

Note: To start the archiving process, press the **START** button in the Archive window (switching by using arrows). In the bottom part of the Archive window, an information regarding the current status of channels and totalizers archiving is displayed, the archived value is marked in green colour. Before connecting the signals, make sure that the jumpers inside the device are set in accordance with the intended way of connecting the sensors. Enabled channels are displayed as single result windows (switching by using arrows). Detailed information are in the device Operating Manual.

If temperature and pressure compensation is necessary, then the FP-30x1(N) flow computer should be used.

- ## Information from the Manufacturer

All functions of the recorder are subject to modifications for the benefit of technical progress.

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