

Highlights

- Silicon-MEMS thermal mass flow sensor
- Firmware running on a standard microcontroller delivers digital flow and differential pressure sensing solutions
- Fully temperature-compensated readings
- Measures to 500 slm or more in bypass flow configurations
- Firmware-programmable operating modes and features
- Ultra-small surface mount package
- Fully compatible with SMD assembly processes



6-pin DFN package
3.5 mm × 3.5 mm footprint
3 mm overall height

FLS110 is suitable for high-volume consumer products and high-precision medical or industrial applications. It will add value to your product whether you are trying to detect an obstruction or monitor a flow profile in detail. The FLS110 is very versatile, and our digital integration solution gives you the flexibility to optimise performance-cost ratio in your application.

Digital flow sensing solutions with FLS110

The FLS110 has two analogue sensing elements integrated in a MEMS die: a tungsten wire for sensing flow and a temperature sensor. Firmware provided by Flusso, running on a standard microcontroller, drives the sensing elements, digitises their response to mass flow through the FLS110 and calculates readings for:

- Flow temperature
- Mass flow – using the principle of hot-wire anemometry
- Volumetric flow or differential pressure (DP) – when given flow pressure by the host application

Figure 1 illustrates a system with the FLS110 in a flow bypass configuration and the firmware running on a dedicated microcontroller. Application software on the host processor controls the FLS110 firmware and obtains readings using write and read transactions over a serial digital interface (typically I²C-bus®).

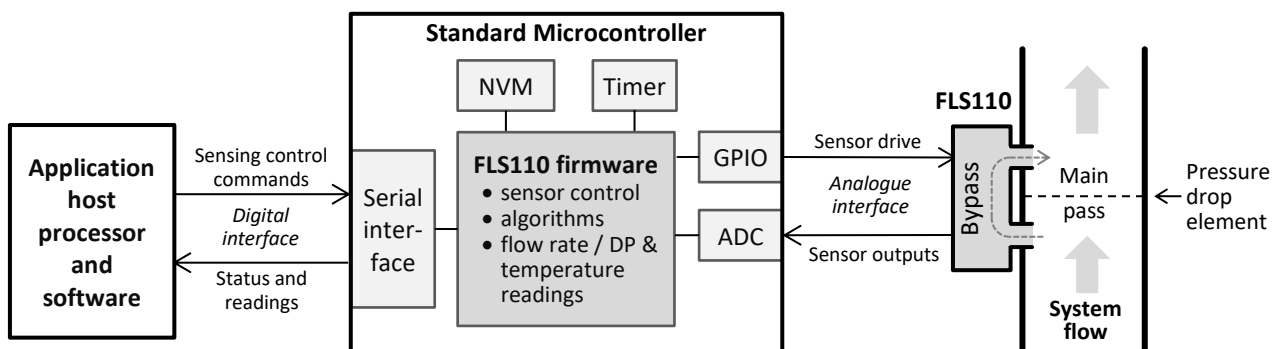


Figure 1: Example of an FLS110 flow sensing solution with dedicated microcontroller

The FLS110 firmware can also be compiled and linked with application code to run on a single, shared microcontroller. The application then uses API calls instead of the serial interface.

By virtue of system-level flow characterisation during end-product development, or calibration of individual product units, FLS110 firmware calculates and reports **system flow**, i.e., not just the flow through the bypass and FLS110 itself.

Calibration functions supported in the firmware enable straightforward optimisation of FLS110 flow sensing algorithms to your system characteristics and sensing accuracy requirements.

Refer to *Developing Your Flow Sensing Solution with FLS110* for a more extensive overview of FLS110 flow sensing solutions and how you can rapidly implement them in your product design.

1 Sensing performance

Unless otherwise stated, sensing performance is specified at mean $\pm 3\sigma$ under these standard conditions:

- A through-flow system configuration (see section 2)
- FLS110-STM32 reference design sensor module with VDD = 3.3 V (see section 5)
- Ambient temperature T_{amb} and flow temperature T_{flow} of 25 °C
- FLS110 standard firmware operating in Continuous mode with averaging over 8 measurements
- Clean air with flow pressure $p_{flow} = 101.3$ kPa and relative humidity $\phi_{flow} = 0$ %
- Flow temperature sensor offset determined at $T_{ref} = 25$ °C (see section 5.6.1)
- Three-point system calibration (see section 5.6.2)

1.1 Mass flow readings

The unit of mass flow adopted for performance specification is the standard cubic centimetre per minute (sccm), with standard conditions defined as $T_{flow} = 25$ °C and $p_{flow} = 101.3$ kPa. Span accuracy and repeatability are specified over the nominal operating range 4 sccm to 200 sccm full scale (f.s.). Operation outside this range is safe, subject to Absolute maximum ratings specified in section 4. Below 4 sccm the effects of device orientation and inlet conditions in the application are unpredictable.

| Parameter | | Max | Units | Note |
|------------------------|---------------|------------|-----------|---|
| Repeatability | Zero flow | 0.5 | sccm | Equivalent to 0.25 % of full scale (f.s.) |
| | Span > 4 sccm | 0.5 | % m.v. | % of measured value |
| Accuracy | Zero flow | 1 | sccm | Equivalent to 0.5 % of full scale (f.s.) |
| | Span | ± 5 | % m.v. | % of measured value |
| Temperature dependence | Zero flow | ± 0.2 | sccm/°C | |
| | Span | ± 0.05 | % m.v./°C | Multiply by $ T_{ref} - T_{flow} $ in °C |

1.2 Differential pressure (DP) readings

Span accuracy and repeatability are specified over the nominal operating range 0 Pa to 500 Pa full scale (f.s.). Operation outside this range is safe, subject to Absolute maximum ratings specified in section 4.

| Parameter | | Max | Units | Note |
|------------------------|---------|------------|-----------|--|
| Repeatability | Zero DP | 0.5 | Pa | Equivalent to 0.1 % of full scale (f.s.) |
| | Span | 1 | % m.v. | % of measured value |
| Accuracy | Zero DP | 1 | Pa | Equivalent to 0.2 % of full scale (f.s.) |
| | Span | ± 5 | % m.v. | % of measured value |
| Temperature dependence | Zero DP | ± 0.2 | Pa/°C | |
| | Span | ± 0.05 | % m.v./°C | Multiply by $ T_{ref} - T_{flow} $ in °C |

1.3 Flow temperature (T_{flow}) readings

Typical performance is specified for

- $T_{flow} = T_{amb}$ stable in the range -20 °C to +85 °C (equilibrium conditions).
- Mass flow in the range 0 sccm to 200 sccm and differential pressure in the range 0 Pa to 500 Pa.

Note: flow temperature measurements are affected by the thermal environment in your product.

| Parameter | | Typ | Units | Note |
|---------------|-------------------------|---------|-------|-------------------|
| Repeatability | | 0.5 | °C | |
| Accuracy | At $T_{flow} = T_{ref}$ | ± 2 | °C | See section 5.6.1 |

| | | | | |
|--|------|----|-----------|--|
| | Span | ±3 | % m.v./°C | Multiply by $ T_{ref} - T_{flow} $ in °C |
|--|------|----|-----------|--|

2 System flow path configurations

The FLS110 can be applied in through-flow or bypass system configurations, illustrated in Figure 2.

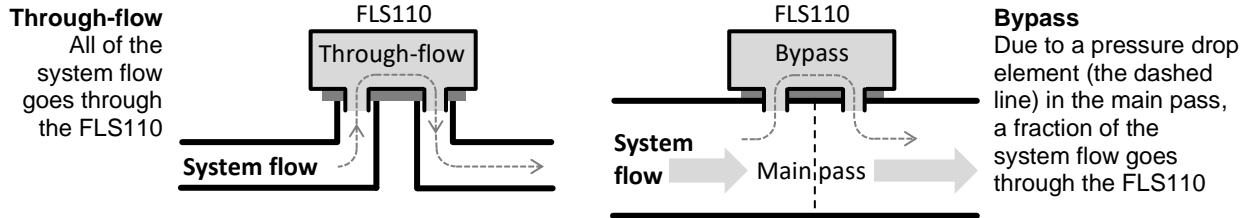


Figure 2: Through-flow and bypass system configurations

Flow and DP sensing performance is specified in section 1 for a through-flow configuration. Corresponding performance can be achieved in bypass configurations with much higher system flow rates. Technical note *Mechanical and Fluidic Integration of the FLS110* gives guidance for integrating FLS110 into your flow path.

3 Normal operating conditions

Device reliability might be compromised if the FLS110 is operated outside the conditions specified in Table 1.

Table 1: Normal operating conditions

| Parameter | Symbol | Min | Max | Units | Notes |
|----------------------|--|-----|-----|-------|-------------------|
| Flow pressure | p_{flow} | 70 | 125 | kPa | Absolute pressure |
| Ambient temperature | T_{amb} | -20 | +85 | °C | |
| Flow temperature | T_{flow} | -20 | +85 | °C | |
| Humidity in the flow | ϕ_{flow} | | 90 | %RH | Non-condensing |
| Gas in flow | Air. Contact Flusso for information about sensing flow of other gases. | | | | |

4 Absolute maximum ratings

Permanent damage might result from exposure to conditions in excess of those specified in Table 2. FLS110 is not qualified for sensing liquid flow. Liquids will cause permanent damage to the device.

Table 2: Absolute maximum ratings

| Parameter | Symbol | Min | Max | Units | Notes |
|-------------------------|---------------|-------|-------|-------|---|
| Storage temperature | T_{store} | -40 | +85 | °C | |
| Storage humidity | | | 90 | %RH | Non-condensing |
| Ambient temperature | T_{amb} | -40 | +85 | °C | |
| Ambient humidity | ϕ_{amb} | | 90 | %RH | Non-condensing |
| Flow temperature | T_{flow} | -40 | +85 | °C | |
| Flow humidity | ϕ_{flow} | | 90 | %RH | Non-condensing |
| Mass flow rate | \dot{m} | -2000 | +2000 | sccm | Through-flow, from inlet port to outlet port |
| Differential pressure | Δp | -5000 | +5000 | Pa | Inlet port pressure minus outlet port pressure |
| Flow pressure | p_{flow} | | 200 | kPa | Above ambient pressure |
| Voltage between pins | V_{in} | | 3.6 | V | Between any two functional pins. See section 6. |
| Flow sensor power | P_{FS} | | 50 | mW | |
| Electrostatic discharge | | | 500 | V | Human body model, JS-001-2017 |
| | | | 1000 | V | Charged device model, JS-002-2018 |

5 FLS110-STM32 reference design

FLS110 sensing functionality and performance specifications (section 1) are achieved with a sensor module implementation of the FLS110-STM32 reference design running Flusso’s standard firmware. It is a “dedicated microcontroller” architecture (see Figure 1 on page 1) with an I²C-bus interface for the host. Two variants of the module are available as part of the FLS110 Evaluation Kit:

- FL-001168-PT with an independent I²C pressure sensor fitted
- FL-001068-PT without the pressure sensor fitted

What follows is an overview of the hardware design and firmware functionality. Further information is available in technical notes *FLS110 Hardware Design Guide* and *FLS110 Firmware Integration Guide*, including how the hardware design and firmware can be tailored to your particular application requirements.

5.1 Hardware design

The FLS110-STM32 reference design schematic and a sensor module are shown Figure 3. The module is the FL-001168-PT with independent I²C pressure sensor fitted (not shown in schematic) The FLS110 firmware runs on a STMicroelectronics™ STM32L031G6U6 microcontroller. It operates the analogue interface of the FLS110 and presents an I²C slave interface to a host (the I²C master) via the 10-way connector. Refer to STMicroelectronics datasheet DS10668 and the STM32L0x1 Reference Manual RM0377 for full information about the processor.

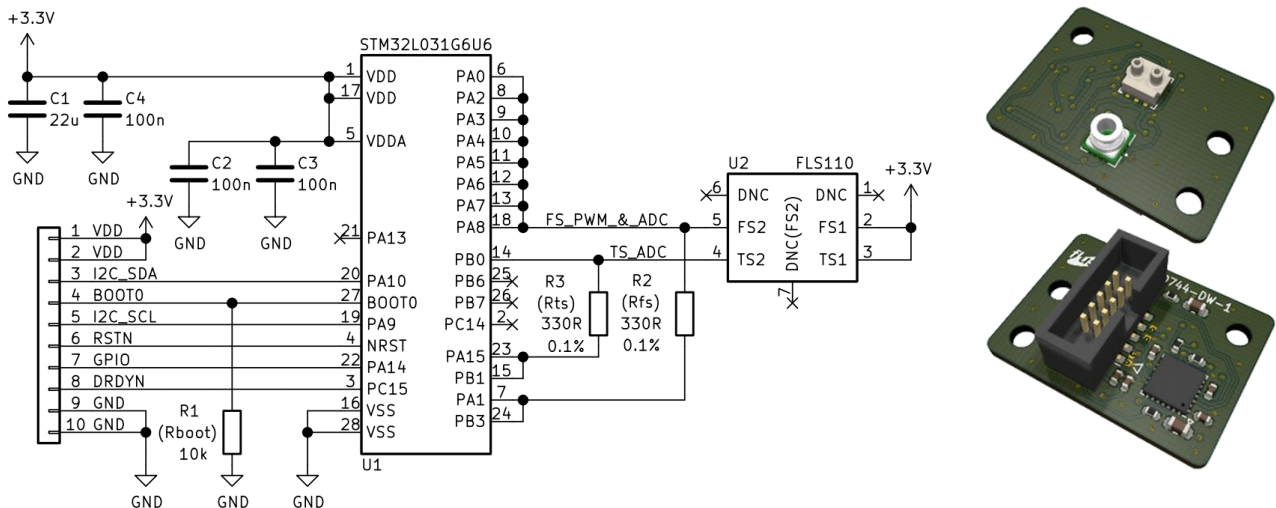


Figure 3: FLS110-STM32 reference design schematic and module implementation

The FLS110 flow sensor pin FS2 is pulse-driven by the firmware. To deliver the peak current requirement, a number of open-drain outputs are connected in parallel. In the FLS110-STM32 reference design seven are connected, typically four or five are sufficient. The connector pin functions are summarised in Table 3, below.

Table 3: FLS110-STM32 reference design connector pin definitions

| Pin | Name | Description |
|------|---------|--|
| 1,2 | VDD | Power supply to the module. |
| 3 | I2C_SDA | I ² C-bus data. A pull-up resistor (2.2 kΩ to 4.7 kΩ) is required on the host side. |
| 4 | BOOT0 | Drive high during power-up to load a firmware image over the I ² C-bus |
| 5 | I2C_SCL | I ² C-bus clock. A pull-up resistor (2.2 kΩ to 4.7 kΩ) is required on the host side. |
| 6 | RSTN | Pull low to reset the processor. |
| 7 | GPIO | A general-purpose IO, not used by the standard FLS110 firmware. |
| 8 | DRDYN | Open drain. Pulled low when a new reading is ready or certain firmware operations complete (see section 5.5.3). A pull-up resistor (2.2 kΩ to 4.7 kΩ) is required on the host. |
| 9,10 | GND | System ground (0 V). |

5.2 Operating parameters

The main operating parameters of the FLS110-STM32 reference design are listed in Table 4. Some are referred to in explanations of firmware functionality in sections that follow.

Table 4: FLS110-STM32 reference design operating parameters

| Parameter | Symbol | Min | Typ | Max | Units | Comment |
|---|----------------------|-----|---------|-----|-------|--|
| Power supply | VDD | 3.0 | 3.3 | 3.6 | V | |
| Total current consumption (including the STM32L031 micro) | I _{DD_CONT} | | | 15 | mA | Continuous or Single Shot mode |
| | I _{DD_IDLE} | | | 2 | µA | In Idle mode |
| Power-up / reset time | t _{start} | | | 10 | ms | After which I ² C interface is ready |
| I ² C clock (I2C_SCL) frequency | f _{I2C} | | | 400 | kHz | Depending on application design |
| Time to first reading in Continuous mode or a new Single Shot reading | t _{FSS} | | 56 + 4n | | ms | Where n is the number of measurements being averaged |
| Time to next reading | t _c | | 4 | | ms | In Continuous mode |

5.3 Standard firmware I²C registers

The FLS110-STM32 standard firmware presents I²C registers that the host can read to obtain information and write to make settings and initiate firmware functions. Table 5 on page 6 lists the registers, further information about use of them is given in sub-sections after the table.

Figure 4 and Figure 5 illustrate write and read transactions. They follow the I²C-bus Specification and User Manual Rev. 6 nomenclature and shading conventions: transmissions from the master are shaded grey, those from the slave are unshaded. Multi-byte data values are little-endian.

- S is the I²C START condition
- The FLS110-STM32 reference design slave address is 0x31 (7 bits)
- W is a WRITE bit, value '0'
- R is a READ bit, value '1'
- P is the I²C STOP condition
- A is the ACKNOWLEDGE bit, SDA low, or NOT ACKNOWLEDGE bit, SDA high

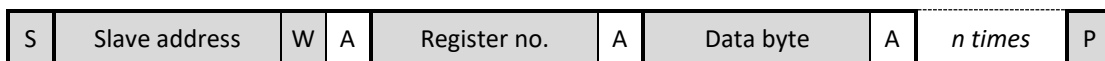


Figure 4: I²C Register Write of n Bytes

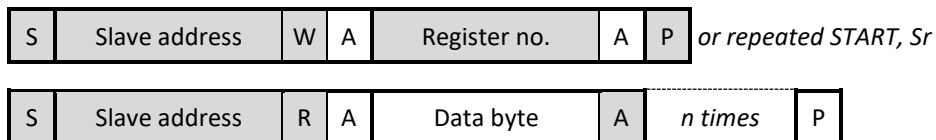


Figure 5: I²C Register Read of n Bytes

Table 5: FLS110-STM32 reference design standard firmware I²C registers

The Data column gives the number of bytes transferred and the number format (U: unsigned integer, S: signed integer, F: IEEE 754 single precision floating point). Differential pressure is abbreviated as DP. Default values are for the standard FLS110 firmware build – you can change them in your custom build if you wish.

| Group | Register | No. | Data | Description |
|---|--|----------------------|------|--|
| Static information (section 5.4) | FW_ID | 0x10 | 3U | Read 0x0F100A, the FLS110-STM32 standard firmware ID |
| | UNIQUE_ID | 0x11 | 12U | Read The STM32L0 processor unique device ID |
| | FW_BUILD | 0x12 | 4U | Read Firmware build number |
| | FW_RELEASE | 0x13 | 4U | Read Firmware release number |
| Firmware settings and status (section 5.5) | AVG_WINDOW | 0x20 | 1U | Write Number of measurements in a moving average window to calculate readings:1 to 128, defaults to 1. |
| | MODE | 0x21 | 1U | Write Set the firmware operating mode. 0: Idle, 1: Continuous, 2: Single Shot Read The current operating mode |
| | READY | 0x2F | 1U | Read Status of the latest reading or calibration step. 0: still in progress, 1: complete. See section 5.5.3. |
| | PFLOW | 0xE0 | 4U | Write Flow pressure (p_{flow}) in Pa. Defaults to 101325 Pa. Read The value last written, or the default if none written. |
| Readings and sensor information (section 5.6) | READING | 0x40 | 4U | Read A system flow or DP reading x 256, in the basis and units that were selected for calibration. |
| | H | 0x41 | 4S | Read Measure of heat power transfer (h) to the flow x 2^{32} . |
| | POWER | 0x42 | 4U | Read Power in W x 2^{32} dissipated by the mass flow sensor during the last measurement period (t_c). |
| | TFLOW | 0x43 | 2S | Read T_{flow} in °C x 256. |
| Offsets and system-level calibration Refer to technical note <i>FLS110 System Characterisation and Calibration</i> for full information about use of these registers. | TREF | 0xFC | 2S | Write FLS110 device temperature T_{ref} in °C x 256 to determine the T_{flow} sensor offset or write 0x8000 to use the microcontroller's on-chip temperature sensor. Read The temperature, T_{ref} in °C x 256, at which T_{flow} offset was determined, or 0x8000 if not done yet. |
| | ZEROPOINT | 0xF0 | 4U | Write Any value to determine the zero-point reading offset Read Returns 0 if zero-point offset has been determined or 0x8000 if it hasn't. |
| | SETPOINT1 SETPOINT2 SETPOINT3 | 0xF1 0xF2 0xF3 | 4U | Write 256 x the system flow or DP setpoint Read The flow rate or DP setpoint x 256 that was previously written (reads 0 if none has been written) |
| | CALIBRATE | 0xFF | 1U | Write After writing to SETPOINT_n registers, write 1 for single-point calibration or 3 for three-point calibration. C_1 , C_2 and C_3 are calculated. Read Returns the number of setpoints used (1 or 3), or an error code if calibration was unsuccessful. |
| | C1 C2 C3 | 0xC1 0xC2 0xC3 | 4F | Write The value of the coefficient to be set manually. Read The coefficient value previously written. |
| | BASIS | 0xCB | 1U | Write Set the basis for calculation of readings: 0 for mass flow, 1 for volumetric flow or DP. Read The selected basis for calculation of readings. |
| | NOTE0 | 0x50 | 4U | R/W Any number, used to identify calibration settings. |

5.4 Static information

The value in the **UNIQUE_ID** register is the concatenation of the U_ID registers of the STM32L031G6U6 microcontroller. Refer to the STM32L0x1 Reference Manual RM0377 for further information. It is useful as a unique ID or serial number for your FLS110 flow sensor module.

The values in the **FW_ID**, **FW_BUILD** and **FW_RELEASE** registers are defined in the firmware and can be customised in your build.

5.5 Firmware settings and status

5.5.1 Averaging of measurements (AVG_WINDOW register)

The firmware can be configured to take an average over a number of measurements for calculation of readings. Averaging is applied to flow or DP readings (in the **READING** register) and flow temperature measurements (in the **TFLOW** register). It is a moving window so does not affect the update rate in Continuous mode but increases the time taken for a first or Single Shot reading to be ready (t_{FSS}). In Idle mode, write the number of measurements to be included in the moving average to the **AVG_WINDOW** register, up to 128.

5.5.2 Operating mode (MODE register)

After power-up or reset the FLS110 firmware starts in **Idle mode** - power consumption is minimised, and no flow rate or flow temperature measurements are taken. Writing 1 to the **MODE** register changes the operating mode to Continuous mode, writing 2 triggers a Single Shot reading.

In **Continuous** mode the first flow/DP and temperature readings are ready after t_{FSS} . Thereafter they are updated at intervals of t_c . The firmware stays in Continuous mode until deliberately changed.

In **Single Shot** mode new flow/DP and temperature readings are ready after t_{FSS} and the firmware automatically returns to **Idle** mode. This mode is useful for reducing average power consumption.

5.5.3 Operating status (READY register and DRDY signal)

Firmware operating status is available to the host by two means:

1. Polling the I²C **READY** register
2. Using the active low **DRDYN** signal to trigger an interrupt

The **READY** register reads 1 and **DRDYN** is asserted (pulled low) when

- A new flow temperature reading is ready in the **TFLOW** register (see section 5.6.1)
- A new flow or differential pressure reading is ready in the **READING** register (section 5.6.2)
- An offset or calibration step has completed
(see technical note *FLS110 System Characterisation and Calibration*)

The **READY** register reads 0 and **DRDYN** is de-asserted (set to high impedance) when

- Entering Continuous or Single Shot mode, by writing to the **MODE** register
- Flow temperature is read from the **TFLOW** register
- System flow (or differential pressure) is read from the **READING** register
- Writing to any of the “Offset and system calibration” registers (see Table 5)

5.5.4 Flow pressure (PFLOW register)

Flow pressure (p_{flow}) is used in the calculation of volumetric flow and differential pressure readings (see section 5.6.2). The FLS110 does not have a built-in flow pressure sensor, instead the host application can write flow pressure (in pascals) to the **PFLOW** register at any time.

5.6 Readings and sensor information

Note: Content of the **READING**, **TFLOW**, **H** and **POWER** registers is only valid when the **READY** register reads 1 and **DRDYN** is asserted, as described section 5.5. Averaging, if selected using the **AVG_WINDOW** register, is applied to measurements to produce readings with less noise.

5.6.1 Flow temperature (T_{flow}) measurement

The FLS110 has a built-in, analogue temperature sensor that is driven by the FLS110-STM32 reference design firmware via the TS2 pins (see section 5.1). Its digitised output (also at the TS2 pin) is used to:

- Provide T_{flow} readings in °C for the host application via **TFLOW** register.
- Temperature-compensate mass flow measurements (see section 5.6.2)
- Calculate volumetric flow and differential pressure readings (see section 5.6.2)

Conversion of the digitised output of the temperature sensor to Celsius (°C) or Kelvin (K) scales requires an offset term, which must be determined for every end-product unit using a simple procedure during your production test. The FLS110 must be at a known, stable temperature (T_{ref}), which your test system software writes to the **TREF** register. Please refer to technical note *FLS110 System Characterisation and Calibration* for full information.

5.6.2 Flow and differential pressure readings

Readings can be calculated and provided to the host application on either **mass flow** or **volumetric flow / differential pressure basis**. Please refer to our technical note *Choosing the Measurement Basis for your FLS110 Application* for further information. The basis and units in which readings are provided is set during system-level **characterisation** or end-product unit **calibration**. This is explained in technical note *FLS110 System Characterisation and Calibration*.

The FLS110 **mass flow** sensing element is a heated wire. It is pulse-driven by a control loop in the FLS110-STM32 reference design firmware (via the FS2 pin) and maintained at a predetermined target temperature under any flow conditions. Mass flow readings are calculated as follows:

1. Heat power transfer (h) to the flow is calculated with compensation for flow temperature (T_{flow}). A **zero-point offset** is applied so that h is zero when there is no flow through the system. h increases with mass flow, but not linearly.
2. Mass flow (\dot{m}) on a linear scale is calculated as a cubic function of h :

$$\dot{m} = C_3 h^3 + C_2 h^2 + C_1 h$$

The zero-point offset must be determined for every product unit, typically during your production test. Figure 6 shows the typical cubic relationship between heat power transfer to the flow (h) and mass flow through the FLS110 (\dot{m}) under the conditions specified in section 1.

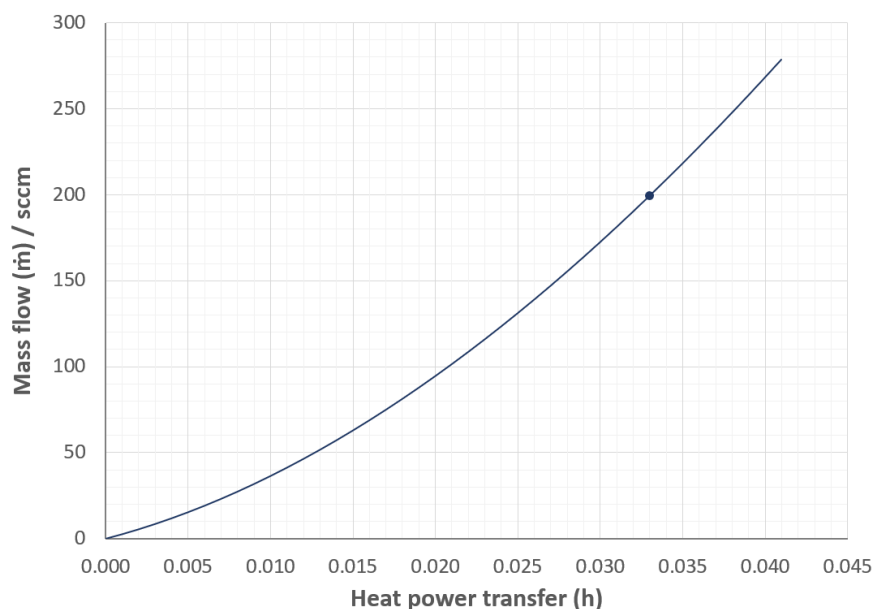


Figure 6: Typical relationship between mass flow (\dot{m}) through the FLS110 and heat power transfer (h)

Procedures for determination of the zero-point offset and calibration to determine the coefficients of the cubic function are explained in technical note *FLS110 System Characterisation and Calibration*. The procedures are fully supported in the FLS110 firmware and are the same for through-flow and bypass configurations.

Mass flow sensing accuracy is specified for the FLS110-STM32 reference design in a through-flow configuration with coefficients determined by three-point calibration at 10 %, 50 % and 90 % of the full scale over which performance is specified, i.e., 20 sccm, 100 sccm and 180 sccm, using a mass flow controller.

In a bypass system configuration (see Figure 2), you would typically design the pressure drop element in your main pass for mass flow in the bypass of about 200 sccm at the highest system flow rate of interest in your application, which corresponds to h of about 0.033. Coefficients C_1 , C_2 and C_3 that result in **system mass flow readings** (as opposed to mass flow just in the bypass) are obtained by either:

- **System-level calibration** of each product unit, which generates optimum, unit-specific values.
- **Characterisation** of your design to generate typical or “default” values, by calibrating a number of representative prototype units and combining their respective sets of coefficients.

If **mass flow** (\dot{m}) measurement basis was selected during determination of the zero-point offset (by writing 0 to the **BASIS** register), system mass flow (\dot{m}) readings are made available to the host application via the **READING** register. Heat power transfer (h) is made available via the **H** register.

If **volumetric flow** (Q) / **differential pressure** (Δp) measurement basis was selected during determination of the zero point offset (by writing 1 to the **BASIS** register), the calculation of readings takes into account the ratio of flow density when a mass flow measurement is made to what it was when the zero-point offset was determined. Gas density is proportional to pressure and inversely proportional to absolute temperature, so:

$$Q \text{ or } \Delta p = (C_3 h^3 + C_2 h^2 + C_1 h) \cdot \frac{T_{flow}}{T_0} \cdot \frac{p_0}{p_{flow}}$$

Where:

T_0 was the flow temperature (in kelvin) when the zero-point offset was determined.

p_0 was the flow pressure (in pascals) when the zero-point offset was determined.

T_{flow} is the flow temperature (in kelvin), measured using the FLS110 integrated temperature sensor.

p_{flow} is the flow pressure (n pascals). p_{flow} can be determined from a separate sensor in the system and provided via the **PFLOW** register or it can take a default value hard-coded in the FLS110 firmware.

Figure 7 shows the typical cubic relationship between heat power transfer to the flow (h) and differential pressure across the FLS110 ports (Δp), under the conditions specified in section 1.

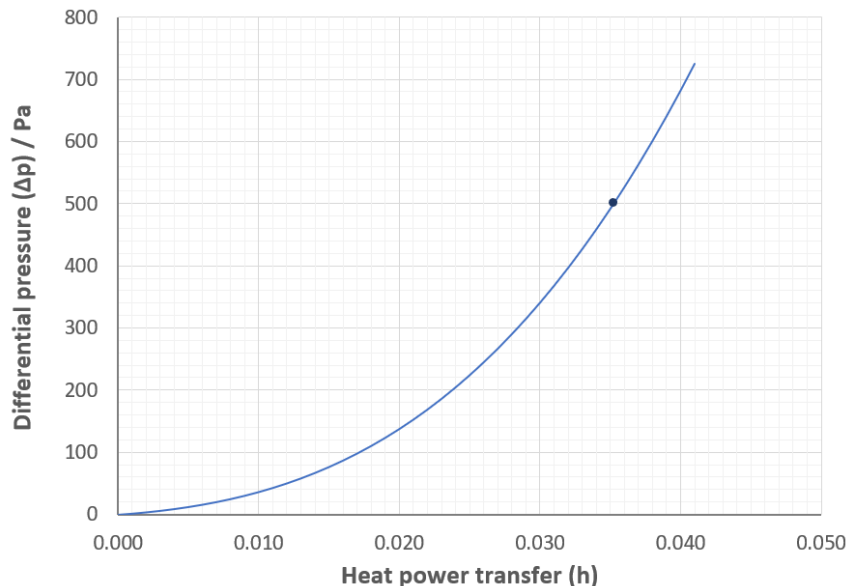


Figure 7: Typical relationship between differential (Δp) across the FLS110 ports and heat power transfer (h)

Differential pressure sensing accuracy is specified for the FLS110-STM32 reference design (section 1.2) with coefficients determined by three-point calibration at 5 %, 50 % and 95 % of the 0 Pa to 500 Pa range over which performance is specified (i.e., 25 Pa, 250 Pa and 475 Pa). As in the case of mass flow readings, volumetric flow and DP readings are made available to the host application in the **READING** register.

5.6.3 Mass flow sensing power consumption

The average power dissipated by the mass flow sensing element during the last measurement period (t_c) is made available in the **POWER** register. This information can be useful if you wish to experiment with the trade-off between power consumption and measurement rate in Single Shot mode.

6 Pin and port assignments

FLS110 device pin assignments and positions are shown in Table 6, below. Refer to section 5.1 and the *FLS110 Hardware Design Guide* for information about intended connection to the FLS110 pins.

Table 6: Pin assignments

| Pin | Name | Function |
|-----|------|---|
| 1 | - | Solder pad only. Do not connect. |
| 2 | FS1 | Flow rate sensor connection to supply voltage. |
| 3 | TS1 | Flow temperature sensor connection to supply voltage. |
| 4 | TS2 | Flow temperature sensor drive connection. |
| 5 | FS2 | Flow rate sensor drive connection. |
| 6 | - | Solder pad only. Do not connect. |
| 7 | - | Solder pad only. Do not connect. |

FLS110 port assignments are shown in Figure 8. Flow in the reverse direction (outlet to inlet) is not damaging to the device but readings will not be as accurate.

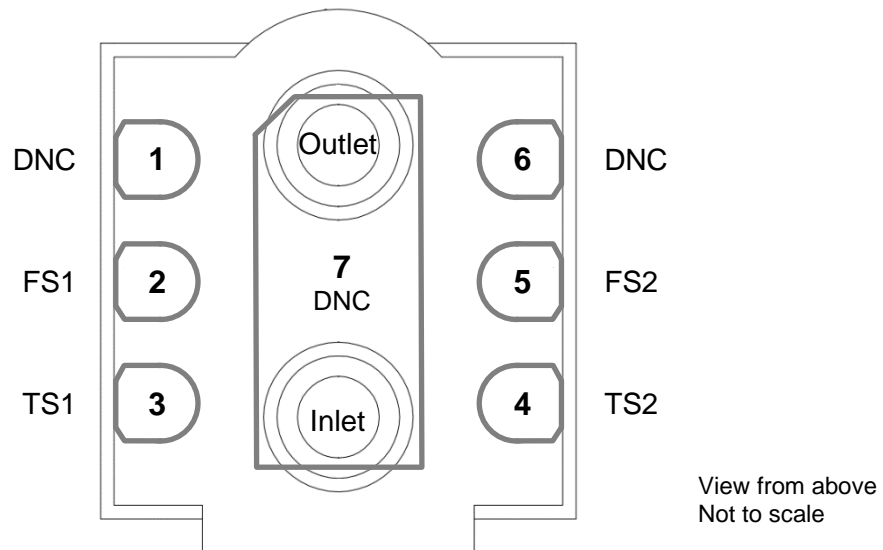


Figure 8: Pin and port positions

7 Package dimensions and marking

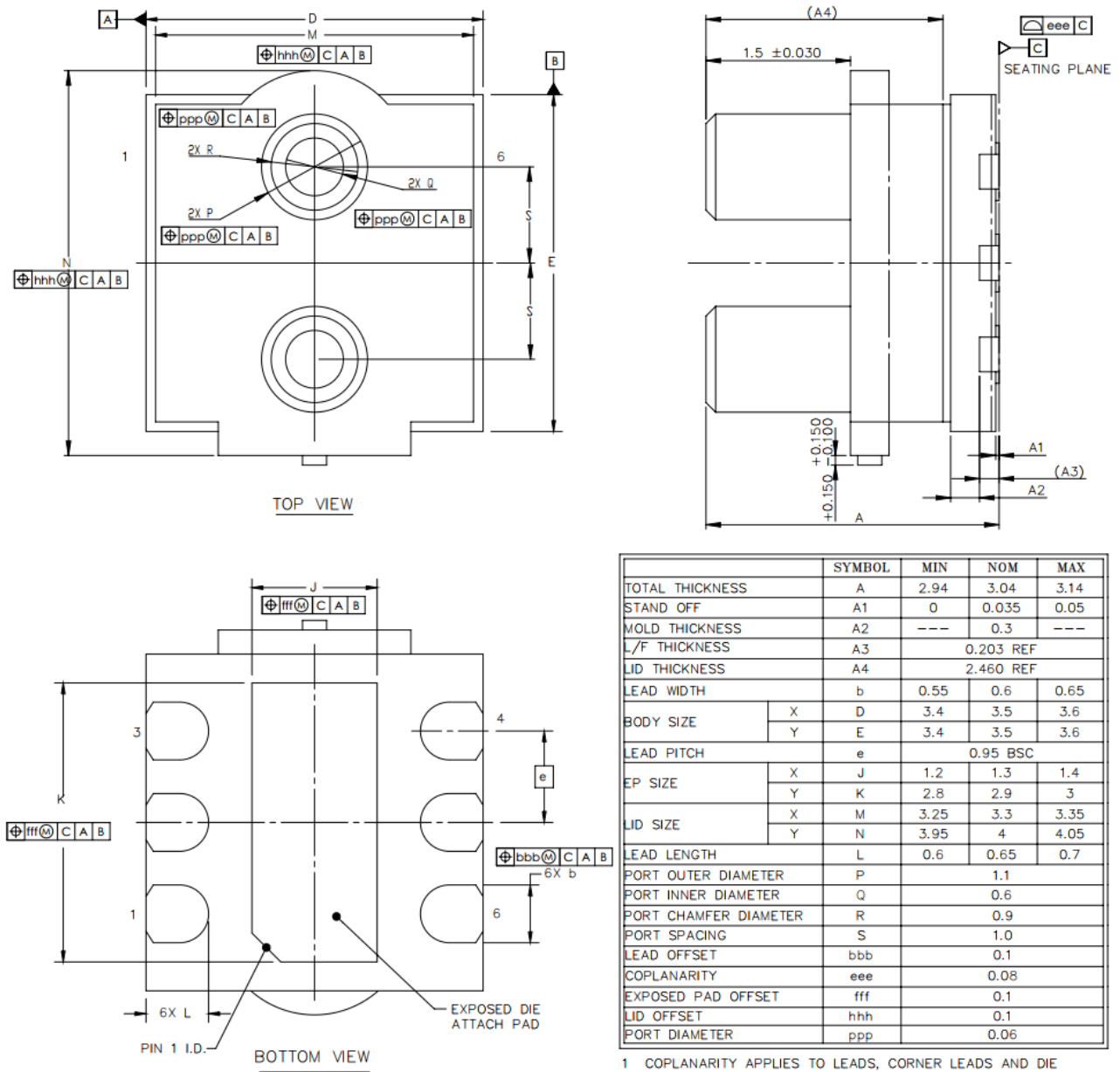
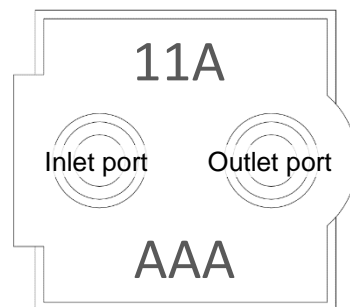


Figure 9: Package dimensions



11 = FLS110 product type number
A = assembly traceability code

Figure 10: FLS110 Package marking (not to scale) and ports

8 Handling and surface mount assembly

FLS110 should be handled in accordance with IPC/JEDEC J-STD-033B.1 for devices with Moisture Sensitivity Level 3.

FLS110 is supplied on tape and reel. It can be picked and placed with standard tools and equipment but vacuum should not be applied to the open ports.

Flusso recommends an IPC/JEDEC J-STD-020E Pb-Free Assembly infra-red (forced convection) reflow profile with $T_P \leq 250\text{ °C}$ and time t_p above 245 °C not exceeding 30 seconds. Ensure that solder and flux do not enter the FLS110 ports during reflow.

Vapour phase reflow soldering is not recommended because of the risk of contamination via the ports.

The FLS110 ports should be protected from ingress of liquid or particulate contaminants during handling and assembly processes, for example solvent cleaning, blown air cleaning and PCB singulation.

9 Materials

FLS110 complies with RoHS, REACH and halogen-free requirements.

10 Ordering and packing information

| Product | Packing Type | Size | Quantity | Order code | Comment |
|---------|--------------|--------------------|--------------|--------------|------------------------|
| FLS110 | Tape & reel | 7" | 500 | FLS110-TR07 | |
| | Waffle tray | 100 mm x 100 mm | 324 (max) | FLS110-WT324 | Sample quantities only |

Datasheet Status

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| Datasheet Status | Product Status | Datasheet Content |
|------------------|----------------|---|
| Preview | Development | Target specifications for development of the product. Specifications, designs, and descriptions provisional and subject to confirmation. Flusso reserves the right change specifications or discontinue development of the product without notice. |
| Preliminary | Qualification | The product is undergoing testing to confirm datasheet specifications for functionality, performance, quality, and reliability. Flusso reserves the right change specifications or discontinue development of the product without notice. |
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