TEX Equipamentos Eletrônicos

FlowTEX Sensor
FT02

Technical Manual

Rev 1.3

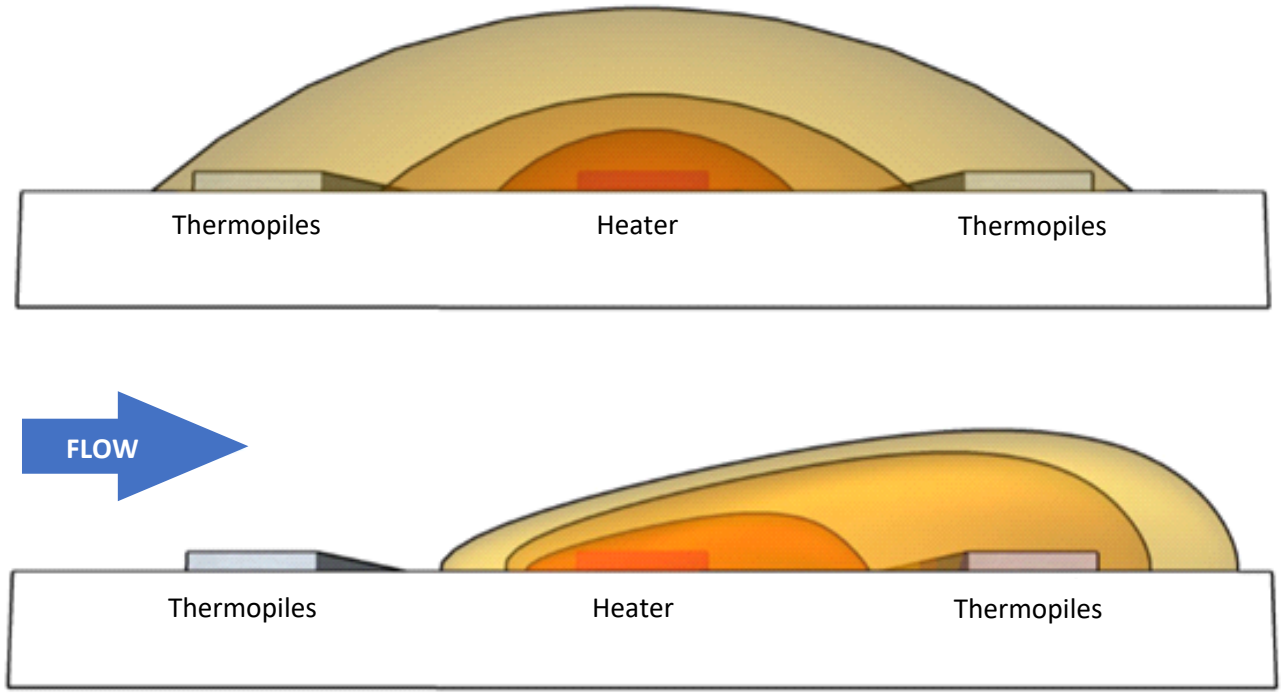
October/2024

1. APPLICATION

The FlowTEX sensor was entirely developed in Brazil for use with inert gases, supporting pressures of up to 17 bar. It can be used in various types of equipment such as digital flow meters, calibration standards, welding equipment, air collection devices, electromedical equipment, test benches, etc. Its anodized aluminum body makes it more robust and resistant to high working pressures, while also meeting *eco-friendly* requirements, making it environmentally sustainable.

2. OPERATION

Mass flow measurement involves the heat transfer from a heater to two thermopiles via the gas flow. This transfer is proportional to the measured flow. This technology offers excellent long-term stability and response speed compared to similar flow meters with thermistors and hot wire systems. The FlowTEX sensor has an internal thermal compensation algorithm that ensures excellent zero stability and precise measurement under varying temperature and atmospheric pressure conditions.



3. Product Coding

FT02qqq/ c p d a g t i p ee

Flow Range	
101	10 Sccm
201	20 Sccm
501	50 Sccm
102	100 Sccm
202	200 Sccm
502	500 Sccm
503	5 Slpm
104	10 Slpm [1]
204	20 Slpm
504	50 Slpm
105	100 Slpm
205	200 Slpm

Pneumatic Connection	
0	Manifold
2	1/8” BSP
3	1/4” BSP
4	3/8” BSP
8	3/8” Extended BSP
9	19mm Manifold with o-ring
A	22mm Manifold with o-ring
B	22mm Conical
C	12mm Manifold without o-ring

Maximum Pressure	
0	2 bar
1	8 bar
2	17 bar

Flow Direction	
0	Unidirectional
1	Bidirectional
2	Unidirectional - Reverse flow

Application Type	
0	Standard
1	*Low Drop* [2]

Calibration Gas	
0	Compressed Air/N2/O2
1	Argon (Ar)
A	Nitrous Oxide (N2O)

Standardization	
0	0 °C
1	15 °C
2	20 °C
3	21°C

Communication Interface	
0	I²C + USART TTL (EM1)
1	~~I²C + RS-232 (EM1)~~ [9]
2	I²C + USART TTL (TexNET)
3	~~I²C + RS-232 (TexNET)~~ [9]

Protection	
0	~~*Electrical Protection Level 2 and Stainless Steel Housing*~~ [3][9]
1	~~*Electrical Protection Level 1 and Stainless Steel Housing*~~ [4][9]
2	*Electrical Protection Level 1* [5]
3	~~*Electrical Protection Level 2 and Aluminum Housing*~~ [6][9]
4	*Electrical Protection Level 1 and Aluminum Housing* [7]

Special Code [8]	
00	Default

[1] – 10 Slpm range: used only for nitrous oxide.

[2] – Low Drop: ultra-low pressure drop.

[3] – Electrical Protection Level 2 and Stainless Steel Housing: with electromagnetic protection (stainless steel housing) and electrical protection in accordance with the IEC 60601-1-2 / IEC 61000-4-2 / IEC 61000-4-3 / IEC 61000-4-4 / IEC 61000-4-6 / IEC 61000-4-8 / IEC ABNT NBR CISPR 11 standards.

[4] – Electrical Protection Level 1 and Stainless Steel Housing: with electromagnetic protection (stainless steel housing) and electrical protection in accordance with the IEC 61000-4-3 / IEC 61000-4-8 / IEC ABNT NBR CISPR 11 standards.

[5] – Electrical Protection Level 1: without electromagnetic protection (no housing) and electrical protection in accordance with the IEC 61000-4-3 / IEC 61000-4-8 / IEC ABNT NBR CISPR 11 standards.

[6] – Electrical Protection Level 2 and Aluminum Housing: with electromagnetic protection (aluminum housing) and electrical protection in accordance with the IEC 60601-1-2 / IEC 61000-4-2 / IEC 61000-4-3 / IEC 61000-4-4 / IEC 61000-4-6 / IEC 61000-4-8 / IEC ABNT NBR CISPR 11 standards.

[7] – Electrical Protection Level 1 and Aluminum Housing: with electromagnetic protection (aluminum housing) and electrical protection in accordance with the IEC 61000-4-3 / IEC 61000-4-8 / IEC ABNT NBR CISPR 11 standards.

[8] – Special Code: customization available upon request.

[9] – Discontinued.

4. Technical Specifications

Parameter	Condition	Value	Unit
Flow Rate	Air/O_2 (21 °C)	5 / 20 / 50 / 100 / 200	Slpm [1]
		10 / 20 / 50 / 200 / 500	Sccm[2]
Accuracy		± 0.1 %	F.S. (< 5% F.S.)
		± 2 %	R.M. (5~100% F.S.)
Resolution		0.005 %	F.E.
Repeatability		±0.025 %	F.S. (< 5% F.S.)
		±0.75 %	M.V. (5~100% F.S.)
Zero Drift		±0.025 %	F.S.
Acquisition Time		< 1	ms
Response Time 63%		< 5	ms
Compatible Gases [4]	Ar, O_2, N_2O, N_2		
Materials in Contact with Flow	Body	Anodized Aluminum	
	Seals	Silicone	
	Sensor	ENIG / Silicon / Epoxy	
Operating Temperature		+5.0 ~ +45.0	°C
Storage Temperature		-20.0 ~ +60.0	°C
Pressure Drop [5]	Air /O_2 @200 Slpm	< 5	cmH_2O
Working Pressure	Air /O_2	< 2.0 / 8 / 17[3]	bar
Maximum Pressure	Air /O_2	< 3.0 / 9 / 20	bar
Weight		120	g

[1] – Slpm = Standard Liters/min: 1 atm / 21°C (temperature as per model).
[2] – Sccm = Standard cubic centimeters / min.
[3] – As per model.
[4] – Other gases on request.
[5] – Low Drop model of 200 Slpm and 22mm conical pneumatic connection.

5. Electrical Specifications:

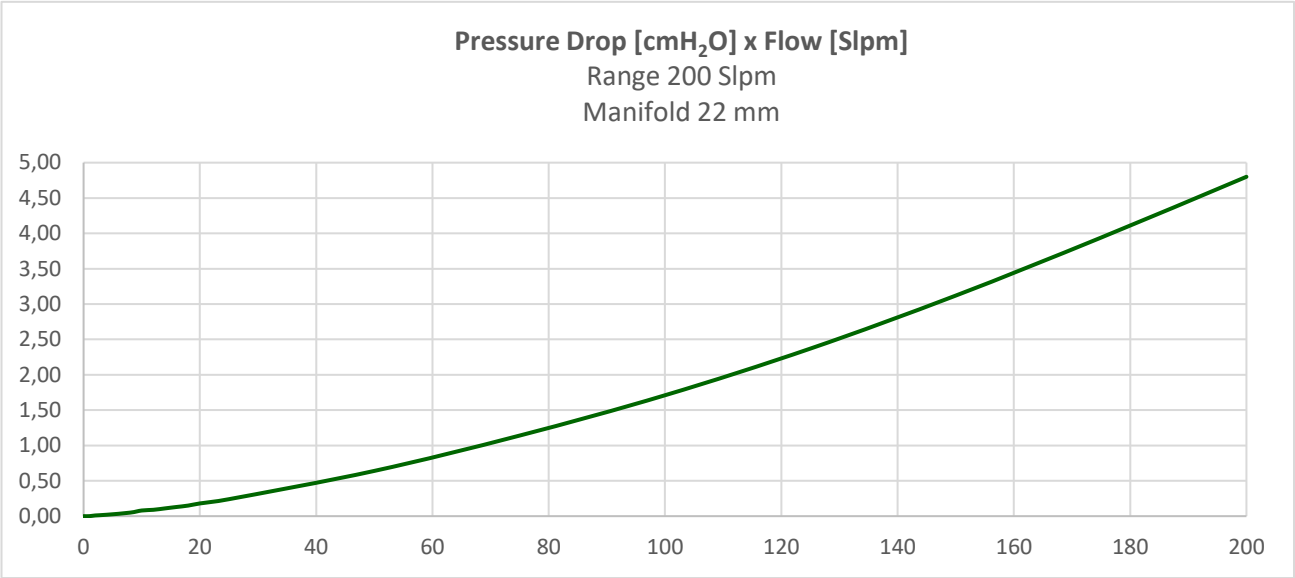
Property	Value
Supply Voltage	5 Vcc ± 5% [1] or +3.0...+30 Vcc [2]
Supply Current	11 mA @5 Vcc
Power Consumption	55 mW @5 Vcc
Interfaces	I^2C, UART(TTL), RS-232(optional)
I^2C Clock (SCL)	Up to 400kHz
Logic Level 0	0... +0.6Vcc
Logic Level 1	+2.7... +3.3Vcc
Electrical Connector	MOLEX 2.00mm Pitch, vertical, 9-pin Connector PN: 510650900 Terminals PN: 502128000
Compliance	IEC 60601-1-2 / IEC 61000-4-2 / IEC 61000-4-3 / IEC 61000-4-4 / IEC 61000-4-6 / IEC 61000-4-8 / CISPR 11

[1] – For basic electrical protection.
[2] – For full electrical protection.

6. Connector Pinout

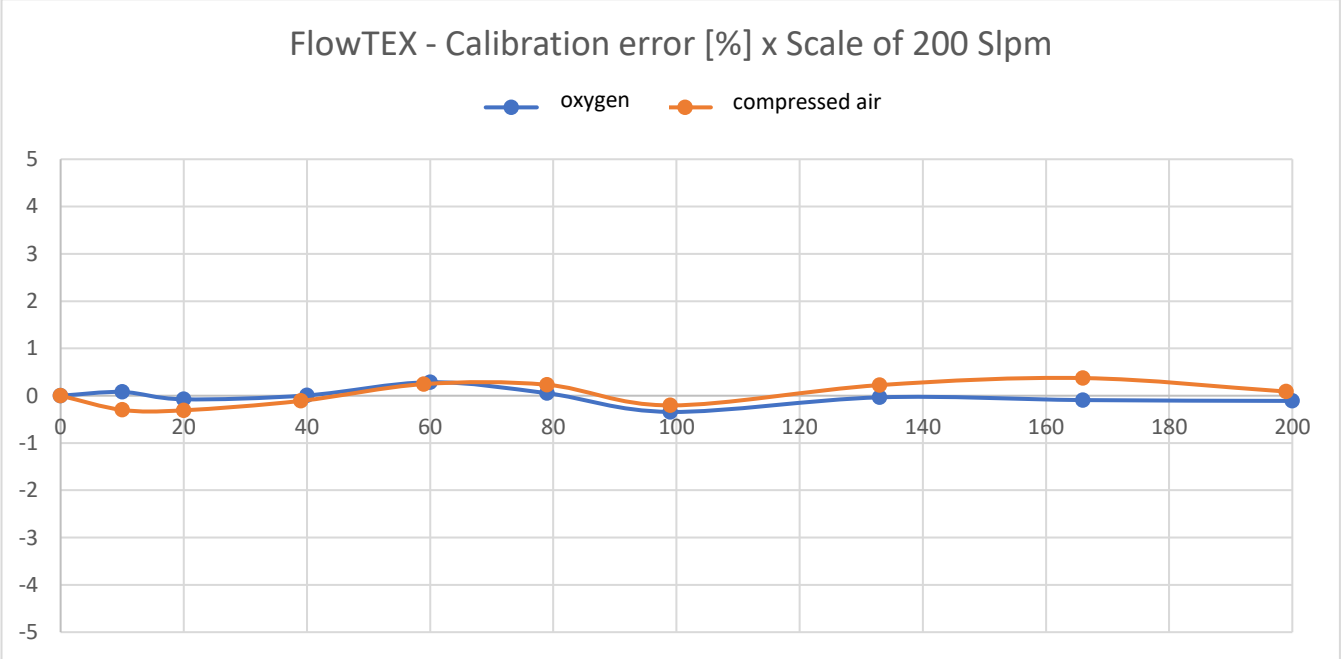
Pin	Function
1	GND
2	VDD
6	SCL (I2C)
7	SDA (I2C)
8	RXD (UART)
9	TXD (UART)

7. Pressure Drop



***Note*: This condition applies only to the *Low Drop* model.**

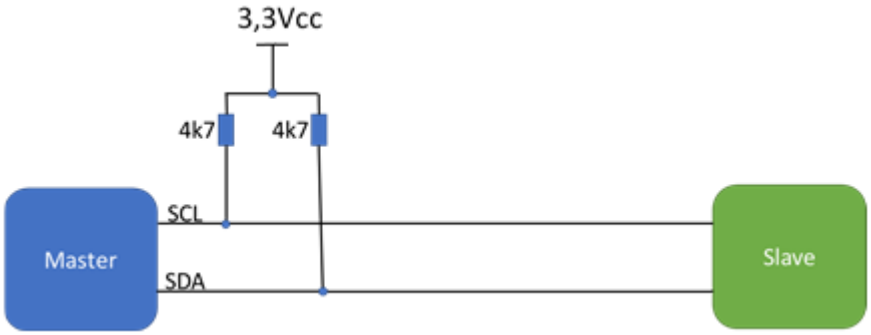
8. Calibration Comparison with Air and O_2



The reading variation between the two gases is smaller than the declared uncertainty (sensor error margin).

9. I2C Protocol

9.1. Wiring Diagram:



FlowTEX

Note 1: **For I2C communication, it is recommended to use 4k7 pull-up resistors on the master side connected to 3.3VDC. This does not necessarily need to be the power supply for the sensor, which can be powered according to the technical specifications.**

Note 2: **Due to the limitations of the I2C interface, it is recommended that the cable length from the sensor to the microprocessor be as short as possible, less than 30 cm. For cables longer than 10 cm, shielding with grounding is mandatory.**

9.2. ***FlowTEX I2C Address:*** *32 (0x20 hex)*

Note**: The address can be changed using PC software. Contact TEX support if you need assistance changing it.**

9.3. I2C Registers:

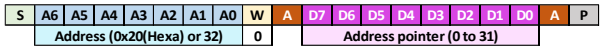
Data Type	Memory Address	Bytes	Parameter	Notes
uint8_t flow[3]	0	3	Flow	-F.S. = 0x800000; 0 = 0x000000; +F.E. = 0x7FFFFF (24bits)
uint8_t flowChks	3	1	Flow Checksum	Two's complement of the sum of the flow bytes
uint8_t temp[2	4	2	Temperature	Temperature in °C multiplied by 100
uint8_t tempChks	6	1	Temperature Checksum	Two's complement of the sum of the temperature bytes
uint8_t fullScale[3]	7	3	Sensor Full Scale	Sensor full scale value in 24-bit integer
uint8_t fullScaleChks	10	1	Full Scale Checksum	Two's complement of the sum of the full-scale bytes
uint8_t serialNumber[10]	11	10	Serial Number	ASCII string of the serial number
uint8_t serialNumberChks	21	1	Serial Number Checksum	Two's complement of the sum of the serial number bytes
uint8_t version[4]	22	4	Software Version	Each byte represents a version digit
uint8_t versionChks	26	1	Version Checksum	Two's complement of the sum of the version bytes
uint8_t fwChks[4]	27	4	Firmware Checksum	Firmware checksum. If it is 0xFFFFFFFF, the firmware is invalid
uint8_t fwChksChks	31	1	Firmware Checksum Checksum	Two's complement of the firmware checksum bytes
uint8_t range[3]	32	3	Sensor Range	Range value in 24-bit integer
uint8_t rangeChks	35	1	Sensor Range Checksum	Two's complement of the sum of the range bytes
uint8_t rangeFloat[4]	36	4	Sensor Range in Float (32 bits)	Sensor range in Sccm in float format
uint8_t rangeFloatChks	40	1	Float Range Checksum	Two's complement of the sum of the range float bytes
uint8_t fullScaleFloat[4]	41	4	Sensor Full Scale in Float (32 bits)	Full scale (Sccm) in float format
uint8_t fullScaleFloatChks	45	1	Full Scale Float Checksum	Two's complement of the sum of the full-scale float bytes
uint8_t flowFloat[4]	46	4	Flow in Float (32 bits)	Current flow always in Sccm in float format
uint8_t flowFloatChks	50	1	Flow Float Checksum	Two's complement of the sum of the flow float bytes

9.4. Byte Order:

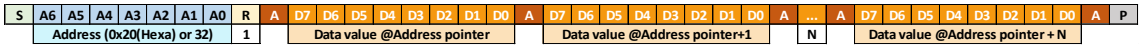
Little endian (LSB First).

9.5. I2C Protocol Application:

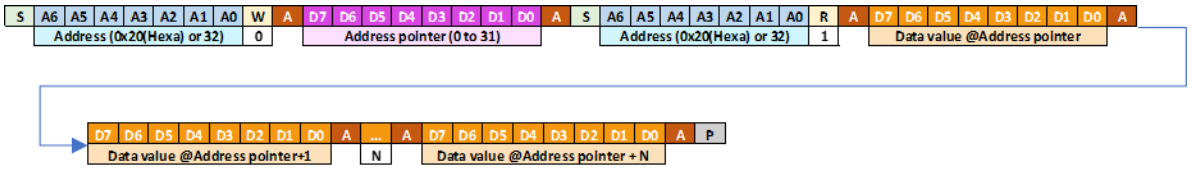
Setting the Address Pointer:



Reading Memory Pointed by Address Pointer:



Setting the Address Pointer and Sequentially Reading the Memory Pointed by Address Pointer:



- S - Start condition
- Ax - Slave address bits
- W - Write bit (0)
- R - Read bit (1)
- A - ACK
- Dx - Address pointer data bit
- Dx - Data value bits
- ... N - Variable number of data frames
- P - Stop condition

9.6. Conversion of 24-bit Flow to Sccm Based on the Range Value:

General Formula:

$$Flow\ in\ Sccm = (Flow\ in\ 24\ bits) * \frac{Range}{0x6AAAAA}$$

Scale:

Flow [24 bits]	Flow [Sccm]
0x7FFFFF	0x7FFFFF * $\frac{Range}{0x6AAAAA}$
.	.
.	.
0x000001	0
0x000000	0x000000 * $\frac{Range}{0x6AAAAA}$
0xFFFFFF	-0x000001 * $\frac{Range}{0x6AAAAA}$
.	.
.	.
0x8000000	-0x7FFFFF * $\frac{Range}{0x6AAAAA}$

9.7. Conversion of 24-bit Flow to Sccm Based on the Full Scale Value:

General Formula:

$$Flow\ in\ Sccm = (Flow\ in\ 24\ bits) * \frac{Full\ Scale}{0x7FFFFF}$$

Scale:

Flow [24 bits]	Flow [Sccm]
0x7FFFFF	0x7FFFFF * $\frac{Full\ scale}{0x7FFFFF}$
.	.
.	.
0x000001	0
0x000000	0x000000 * $\frac{Full\ scale}{0x7FFFFF}$
0xFFFFFF	-0x000001 * $\frac{Full\ scale}{0x7FFFFF}$
.	.
.	.
0x8000000	-0x7FFFFF * $\frac{Full\ scale}{0x7FFFFF}$

10. TexNET Protocol

The TexNET protocol allows message exchange between devices in master-slave mode via a TTL/RS-232 serial interface. Communication is initiated by the master through a REQUEST, and the slave device responds with a message using the same OPCODE from the REQUEST or replies with a NACK byte in case of a checksum failure. The message includes a CHECKSUM byte to ensure message integrity.

10.1. Serial Communication

Below is the serial port configuration used in the TexNET protocol with the FlowTEX sensor:

Baudrate	115200
Data bits	8
Parity	None
Stop bits	1

10.2. Message Format:

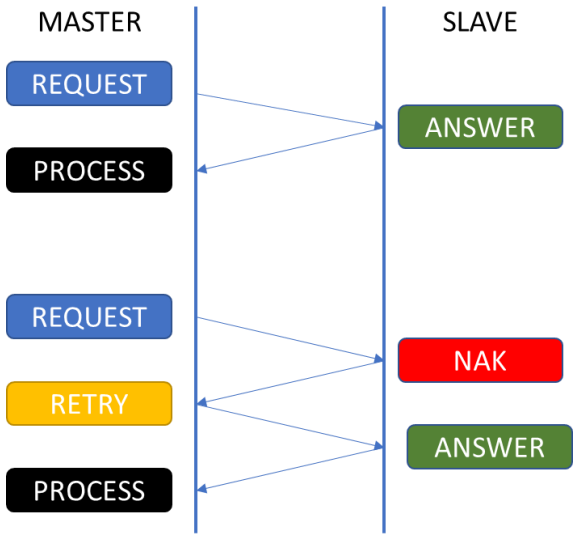
STX	OPCODE	LENGTH	MESSAGE	CHKS

Where:

STX	- 1 byte ASCII character 0x02
OPCODE	- 1 byte representing the message OPCODE
LENGTH	- 1 byte representing the message size (0-255)
MESSAGE	- 0 to 255 bytes, depending on the LENGTH
CHKS	- *Checksum of all bytes between OPCODE and the last byte of the message*
NAK	- 1 byte ASCII character 0x03 for checksum failure

10.3. Message Flow:

All REQUEST messages sent by the master must receive a response, either a message or a NAK indicating that the received message was incorrect.



Where:

REQUEST - Request message sent by the master to the slave

ANSWER - Response message sent by the slave to the master

NAK - Control character NAK (0x03) indicating failure in the last message

RETRY - Communication failure handling process by the master, generating a message retransmission

PROCESS - Response handling process by the master

10.4. Example OPCODE to Read Version 0x76:

REQUEST

STX	OPCODE	LENGTH	CHKS
0x02	0x76	0x00	0x76

ANSWER

STX	OPCODE	LENGTH	MESSAGE										CHKS
0x02	0x76	0x0A	0x31	0x2E	0x30	0x2E	0x31	0x2E	0x31	0x31	0x00	0x00	0xFE

10.4.1. *Checksum Calculation:*

0x76 + 0x0A + 0x31 + 0x2E + 0x30 + 0x2E + 0x31 + 0x2E + 0x31 + 0x31 + 0x00 + 0x00 = 0x1FE

Consider only the least significant byte, in this case, 0xFE.

10.5. Read Version:

10.5.1. *REQUEST*

Field	Value	Type	Size	Obs.
OPCODE	0x76	byte	1	
LENGTH	0	byte	1	
MESSAGE	----	----	0	

10.5.2. *ANSWER*

Field	Value	Type	Size	Obs.
OPCODE	0x76	byte	1	
LENGTH	10	byte	1	
MESSAGE	Versão	string	10	

10.6. Read Firmware Checksum

The firmware checksum verifies the integrity of the software stored in memory. Two values are provided: one as the expected checksum and another as the calculated value. The firmware is considered valid if the two values match; otherwise, it will indicate that the memory content is invalid.

10.6.1. *REQUEST*

Field	Value	Type	Size	Obs.
OPCODE	0x68	byte	1	
LENGTH	0	byte	1	
MESSAGE	----	----	0	

10.6.2. *ANSWER*

Field	Value	Type	Size	Obs.
OPCODE	0x68	byte	1	
LENGTH	8	byte	1	
MESSAGE	Expected Checksum	int32	4	
	Calculated Checksum	int32	4	

10.7. Read Flow

The sensor's flow is always reported in ccm, and the temperature is in °C.

10.7.1. *REQUEST*

Field	Value	Type	Size	Obs.
OPCODE	0x46	byte	1	
LENGTH	0	byte	1	
MESSAGE	----	----	0	

10.7.2. *ANSWER*

Field	Value	Type	Size	Obs.
OPCODE	0x46	byte	1	
LENGTH	8	byte	1	
MESSAGE	Flow in ccm	float	4	
	Temperature in °C	float	4	

10.8. Read Serial Number

10.8.1. *REQUEST*

Field	Value	Type	Size	Obs.
OPCODE	0x6E	byte	1	
LENGTH	0	byte	1	
MESSAGE	----	----	0	

10.8.2. *ANSWER*

Field	Value	Type	Size	Obs.
OPCODE	0x6E	byte	1	
LENGTH	10	byte	1	
MESSAGE	Serial Number	String	10	

10.9. Read Model

10.9.1. *REQUEST*

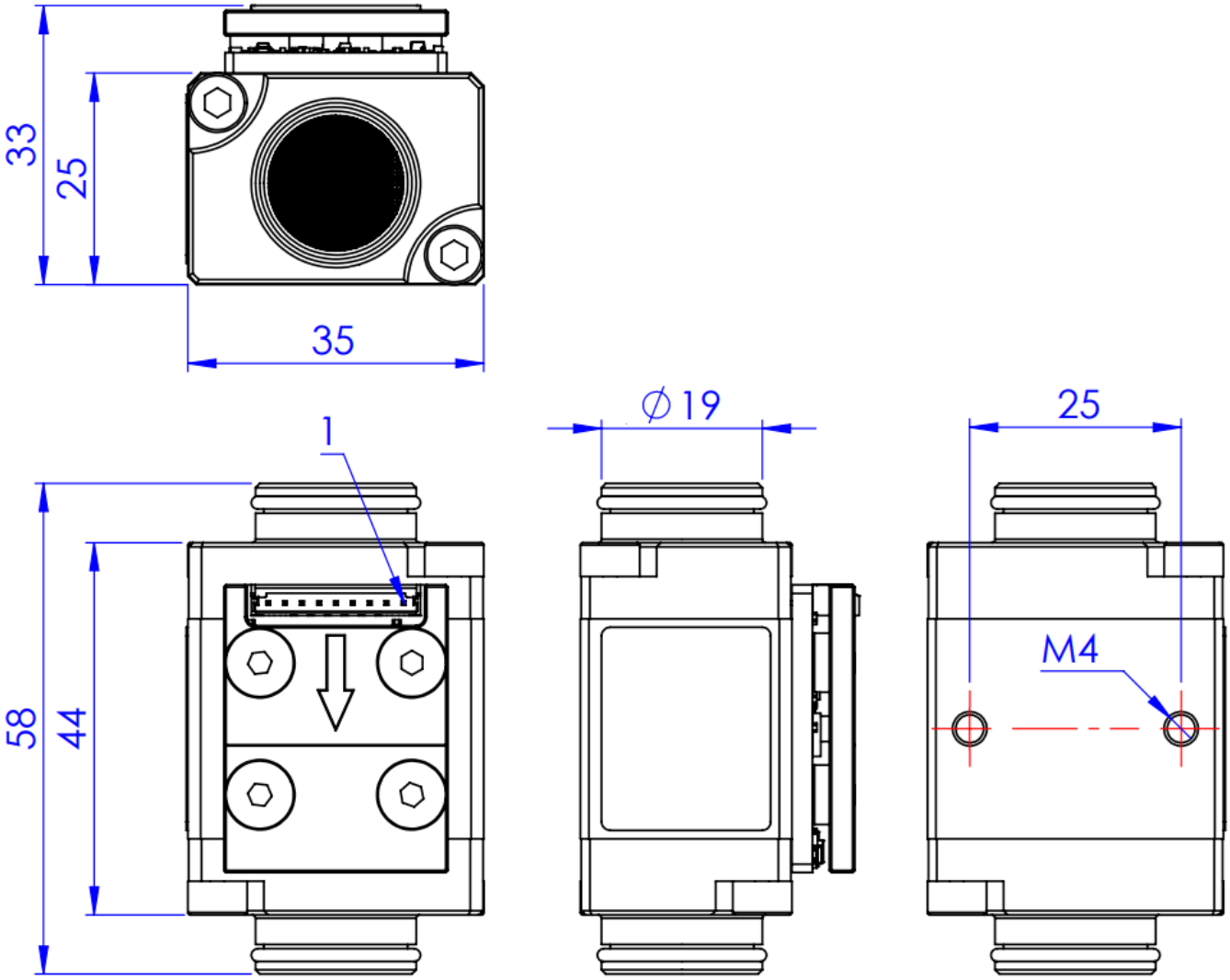
Field	Value	Type	Size	Obs.
OPCODE	0x6D	byte	1	
LENGTH	0	byte	1	
MESSAGE	----	----	0	

10.9.2. *ANSWER*

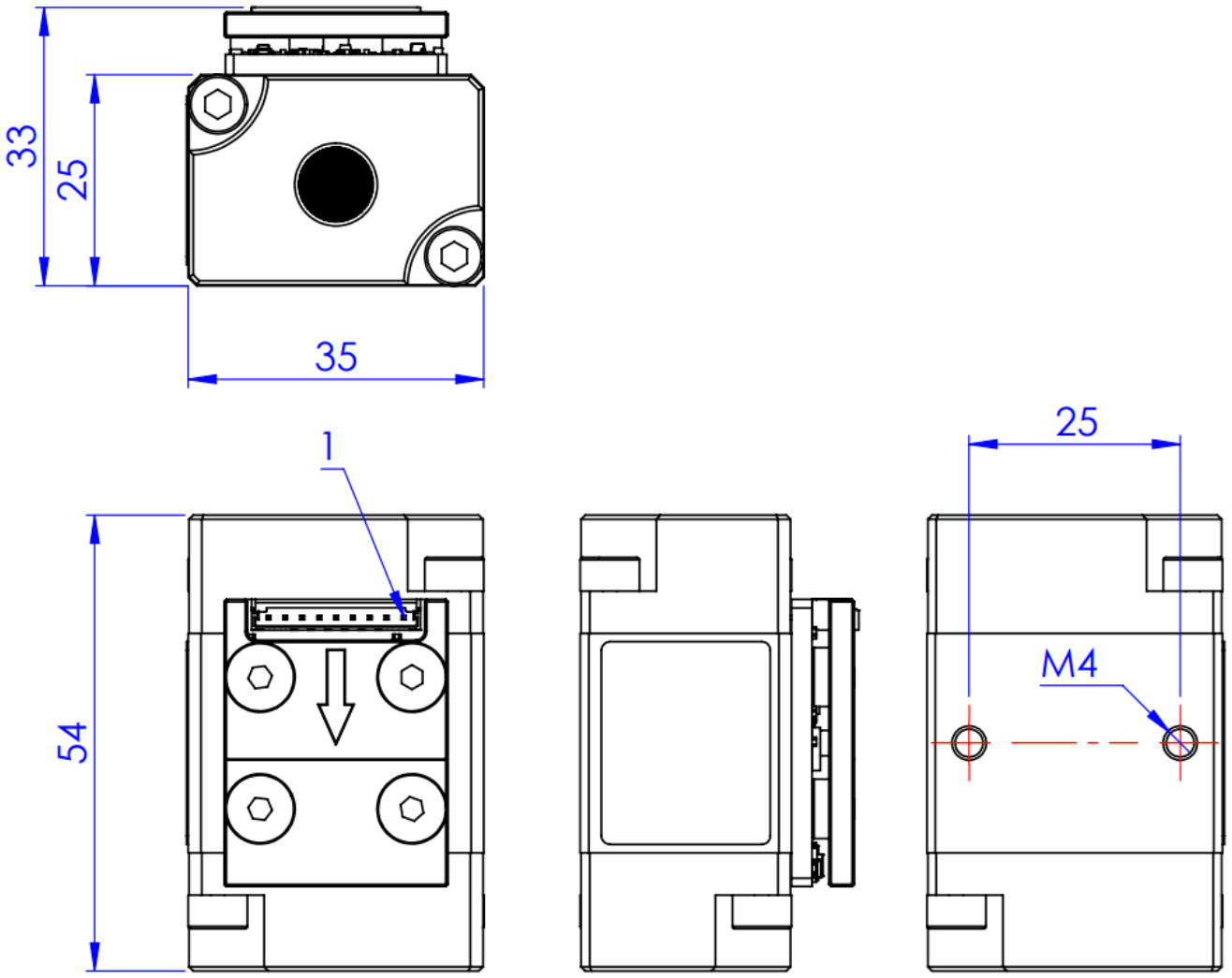
Field	Value	Type	Size	Obs.
OPCODE	0x6D	byte	1	
LENGTH	20	byte	1	
MESSAGE	Model	String	20	

11. Drawings with dimensions

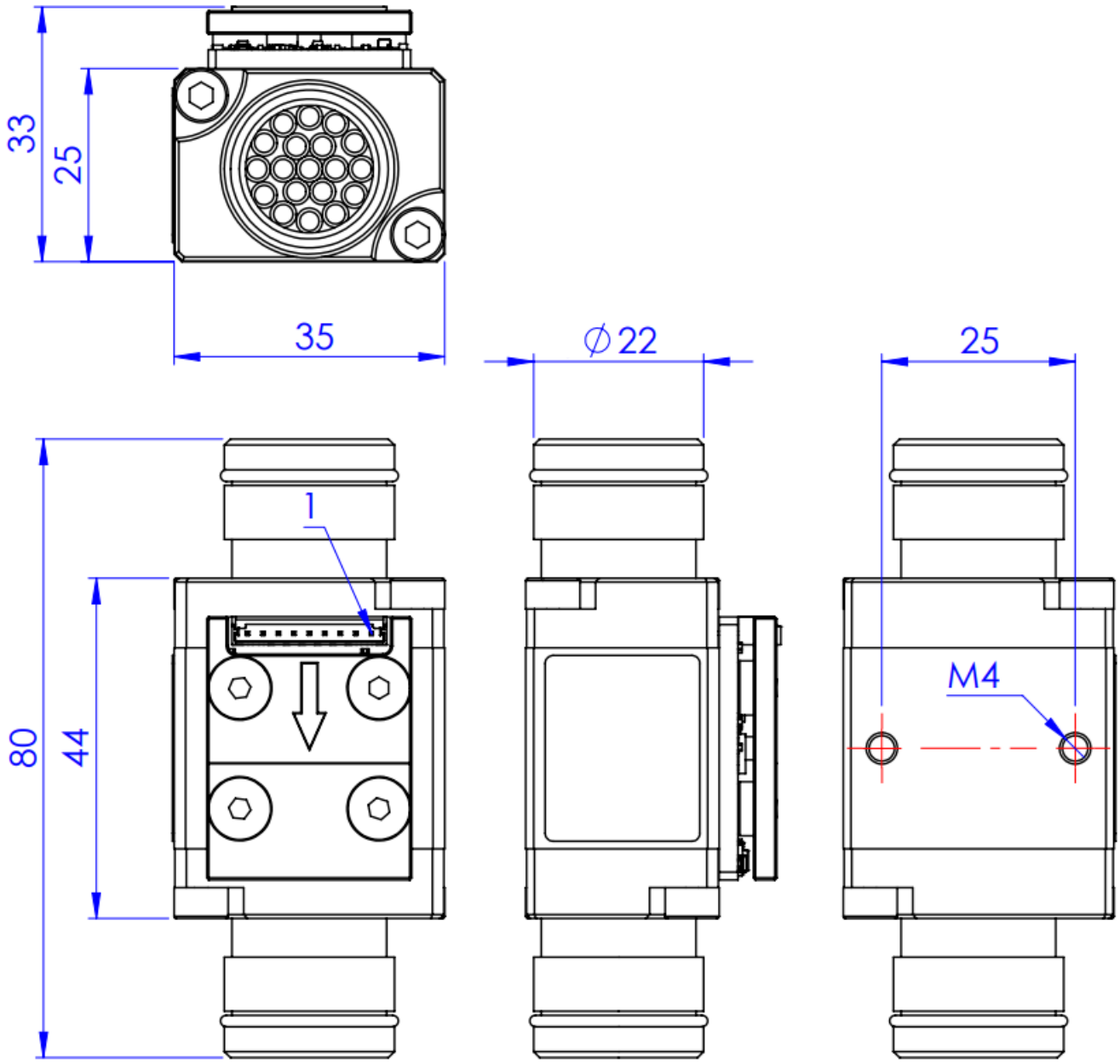
11.1. Manifold Models with 19mm O-Ring (Φ16.7mm x Φ15mm - Viton):



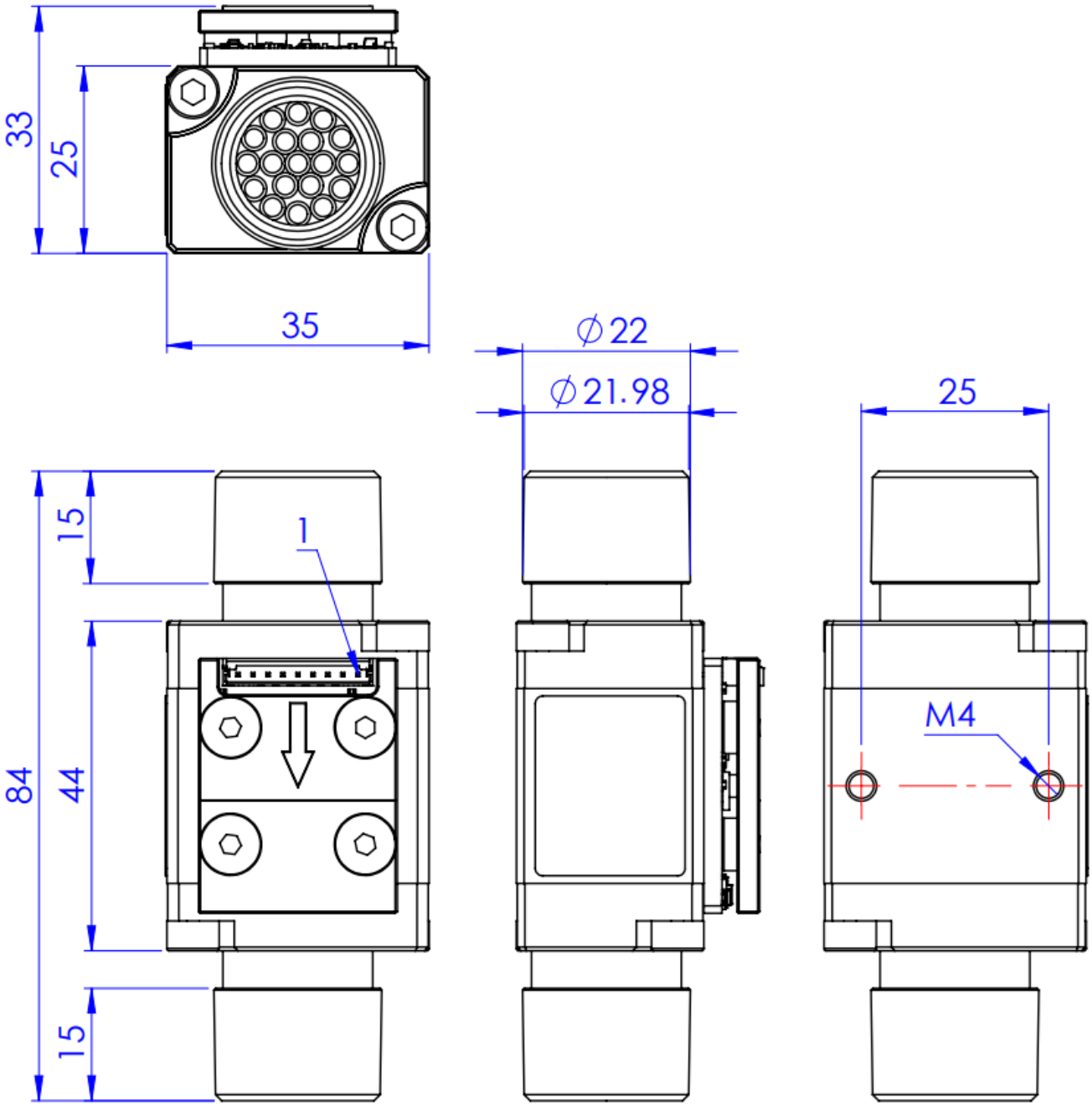
11.2. Models with Female BSP Threaded Connection of 3/8”, 1/4”, and 1/8”:



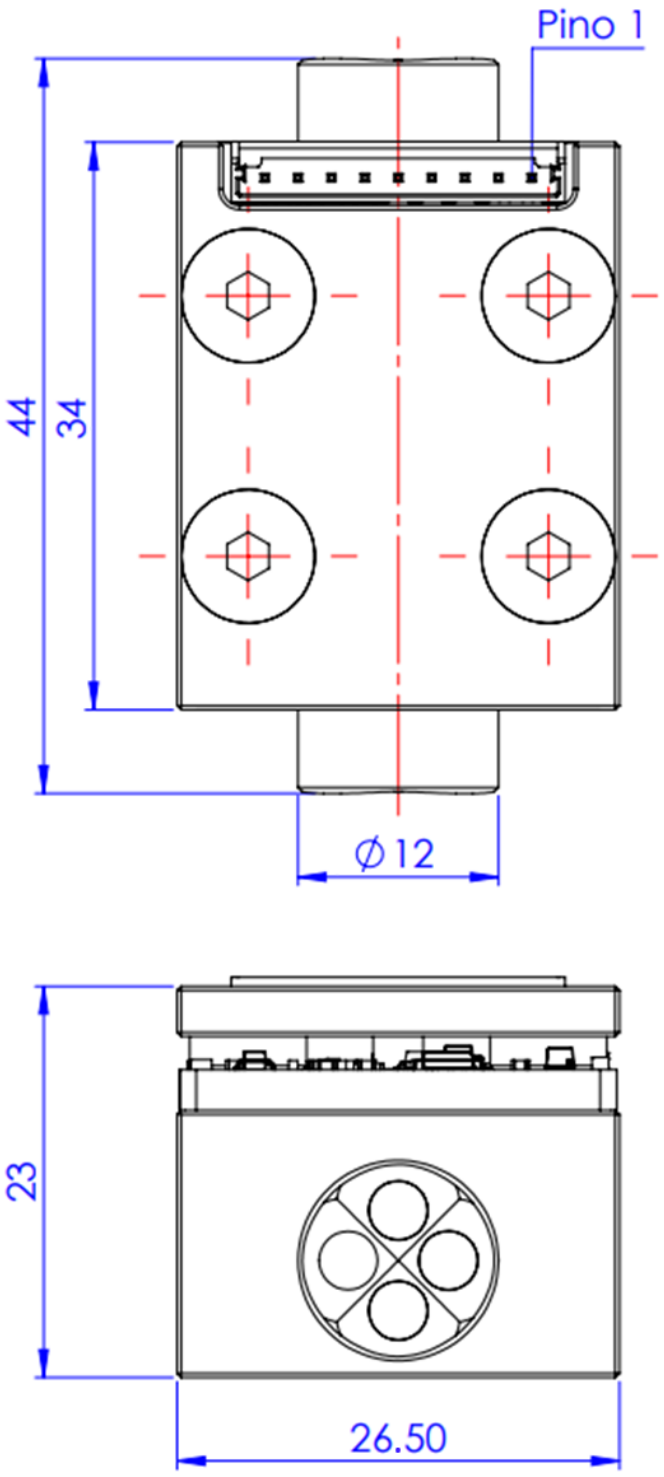
11.3. Manifold Models with 22mm O-Ring (Φ19mm x Φ15mm - Viton):



11.4. Conical 22mm Connection Models:



11.5. Manifold Models with 12mm (using radial sealing by an o-ring whose dimensions are defined by the user, or top sealing with an o-ring of 1mm cross-sectional diameter and 12mm internal diameter):



12. LEGAL WARNINGS

CRITICAL USE:

DO NOT use this product as a safety or emergency locking device, or in any other application where product failure could result in personal injury. Use in such equipment must necessarily be accompanied by other fail-safe safety devices. Failure to follow these instructions may result in death or serious injury.

MISUSE OF DOCUMENTATION:

The information provided in this product datasheet is for reference only. If you have any questions about the use of the product, request further details from TEX.
The purchaser is responsible for the application of this product. TEX is not responsible for the manner or equipment in which this product is installed.

13. Contact Information

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