LEVITRONIX®

LEVIFLOW® Ultrasonic Flowmeters
Ultraclean Fluid Handling

LFS Flowmeter Series

LFS-008:	0 – 0.8 l/min	**LFS-20:**	0 – 20 l/min
LFS-04:	0 – 4 l/min	**LFS-50:**	0 – 50 l/min
LFS-08:	0 – 8 l/min	**LFS-80:**	0 – 80 l/min

Ultraclean Non-Invasive Flow Measurement!

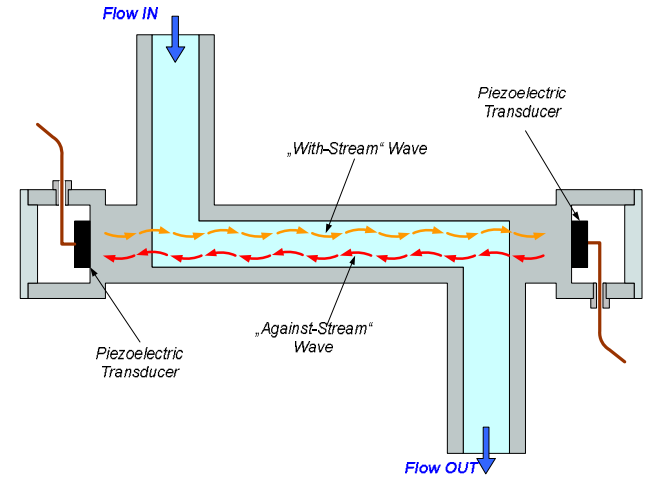


Figure 1: *Operating principle ultrasonic flowmeter sensor with Z-shape (same principle with U-shape)*

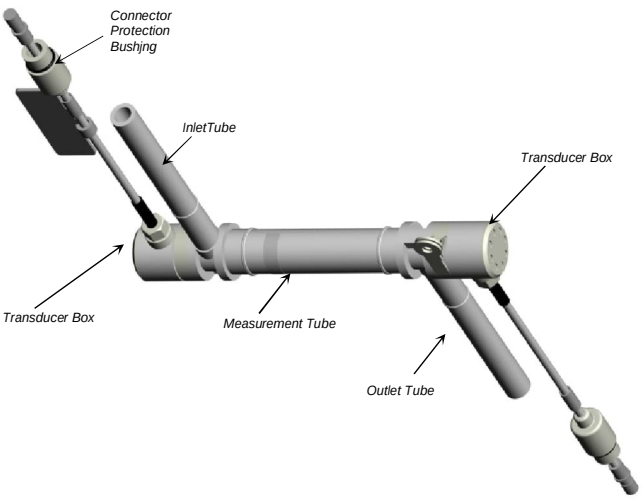


Figure 2: *Flow sensor design (example LFS-04 for 4 l/min)*

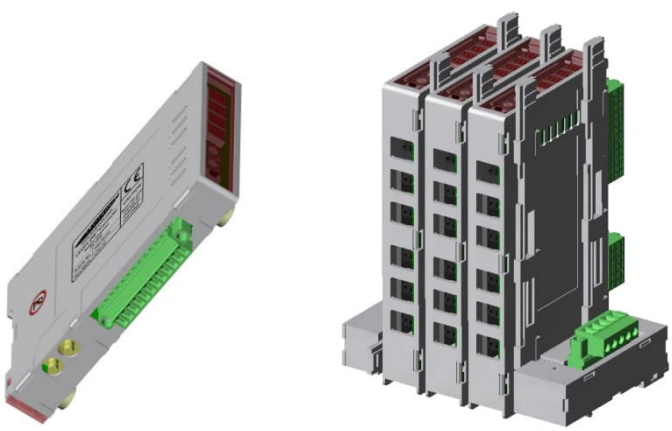


Figure 3: *Single channel (left) and multi-channel converter (right)*

INTRODUCTION

The *LEVIFLOW® LFS* flowmeter series is designed for non invasive high precision flow measurements of high purity fluids. *Figure 1* illustrates the operating principle. Two piezoelectric transducers, mounted at both ends of the measuring path of the fluid stream, generate and receive an ultrasonic wave. The wave going in direction of the flow (with-stream wave) is accelerated and the wave going against (against-stream wave) the flow direction is slowed down. The two waves are processed by a signal converter. The difference of the transmit time of both waves is proportional to the velocity of the fluid.

The standard configuration of the *LEVIFLOW®* flowmeters consists of a flow sensor (see *Figure 2*) and a converter (see *Figure 3*) with a digital signal processor (DSP) for processing the sensor signals. Five flow sensor sizes are available to measure flows from the ml/min range up to 80 l/min. Various signals (analog output, digital input and digital output) are provided and can be configured with a PC software. A two wire RS485 bus allows arrays of multiple flow-meters. In addition, the sensor value is shown on a 4-digit display.

For high volume applications multi-channel converters (see *Figure 8* or *Figure 9*) are available, which processes 6 sensors with one single converter. The sensor signals are available over a RS485 two wire bus or a PLC interface (see *Figure 9*), hence reducing significantly cabling, space and costs. The multi-channel converters can be stacked to a multiple array (see *Figure 3*).

SYSTEM BENEFITS

- No contamination due to non-invasive measurement
- High accuracy (1% of reading) and repeatability (≤ 0.5%)
- No moving parts -> no particle generation
- Improved bubble robustness due to DSP technology
- High precision flow control together with *Levitronix®* MagLev Pumps
- Easy configurable flow sensor parameters (PC software)

APPLICATIONS

- High purity liquid processes in Semiconductor manufacturing
- CMP slurry flow control
- Sterile non-invasive flow measurement in Pharmaceutical manufacturing
- Flow control in combination with *Levitronix®* MagLev pump systems

FLOW CONTROL IN COMBINATION WITH LEVITRONIX MAGLEV PUMP SYSTEMS

Without the need of additional controller hardware, precise ultrapure flow control systems can be realized with *LEVIFLOW®* flowmeters in combination with *Levitronix®* MagLev pumps (see *Figure 4*). The flow control firmware which comes with the *Levitronix®* pump systems *BPS-1*, *BPS-3*, *BPS-4*, *BPS-200*, *BPS-600 and BPS-2000* electronically regulates the pump speed in order to achieve the desired flow rate. With the current product family, flow control ranges from 30 ml/min up to 80 l/min can be realized.

To facilitate matters, *Levitronix®* provides either turnkey solutions for closed-loop flow control or helps to design your own flow control system. Experience has been gained with fluids such as CMP slurries, surface-conditioning chemicals, plating solutions, ultrapure water and solvents. A block-diagram for a typical point of use flow control system with an additional pre-pressure regulator is shown in *Figure 5*.

The versatility of *Levitronix®* flow control systems goes far beyond the capabilities of simple flow controllers. In addition to the flow control function, the *Levitronix®* control firmware comes with several condition monitoring features to monitor the integrity of the fluid circuit. *Levitronix®* flow control systems can generate alarms for preventive filter exchange, no-flow conditions or line clogging. Dynamic Condition Trending (DCT) enables failure prediction and scheduling of preventive maintenance (*Figure 6*).

SYSTEM BENEFITS

- Precise flow control from 30 ml/min up to 80 l/min (lower flows on request)
- Wide turn-down ratio compared to simple flow controllers
- Alarming capability for flow, speed, current, temperature, line clogging (elimination of catastrophic product loss by elimination of no-flow condition during processing), bubble detection
- Dynamic Condition Trending (DCT) capability (enables failure prediction and scheduling of preventive maintenance or filter exchange)
- Continuous, smooth process flow (stable flow, even with pressure fluctuations on the delivery line!)
- Fully independent from pressure on chemical delivery line (no minimum pressure required!)
- CMP-slurry savings based on reduced slurry flow rate

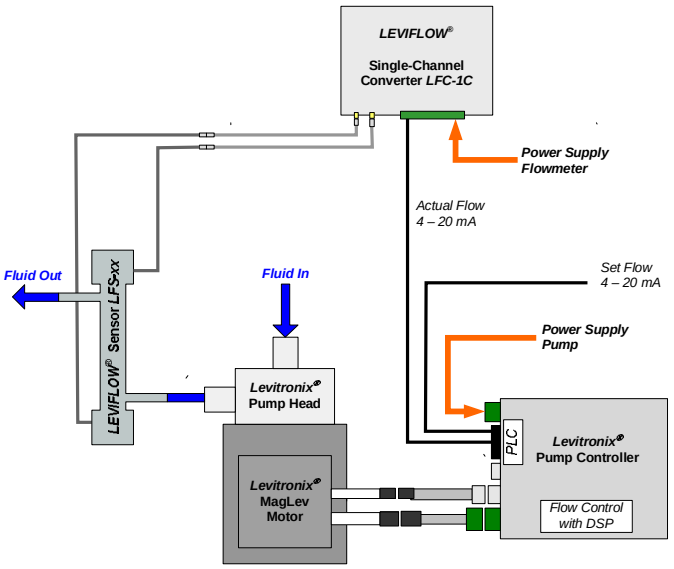


Figure 4: *Basic configuration for flow control with Levitronix® pump systems*

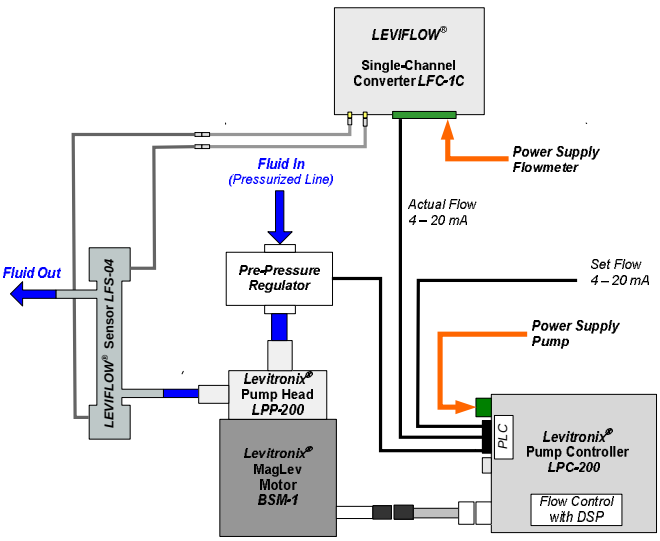


Figure 5: *Point-of-use flow control flowmeter LFS_04 and pump system BPS-200*

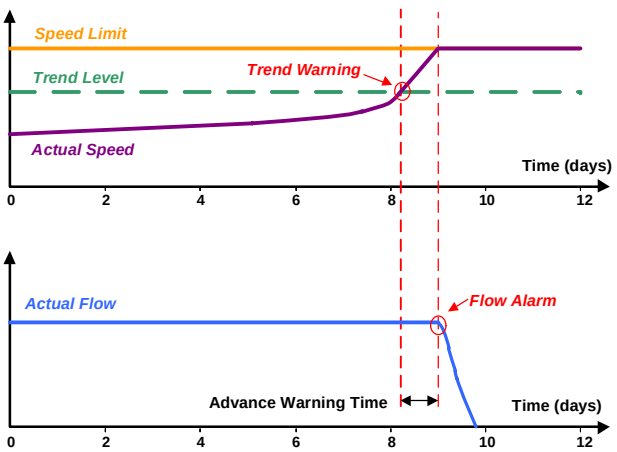
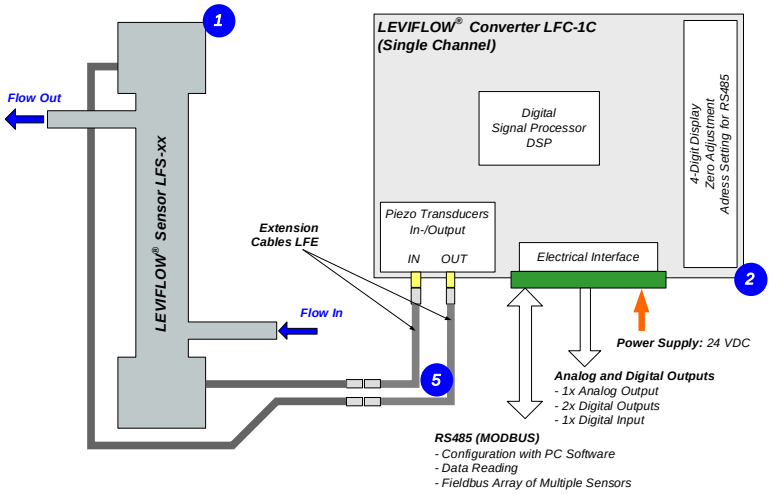


Figure 6: *Dynamic Condition Trending (DCT)*

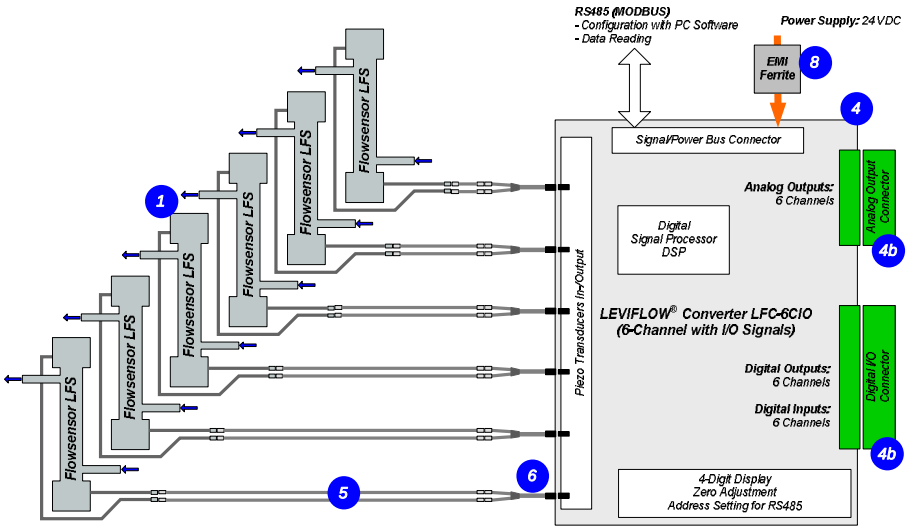


Analog Outputs (1x)	
Specification	**Standard Configuration**
4 - 20 mA (0 – 20 mA configurable) Load resistance < 600 Ohm	Flow reading 4-20 mA. Standard full scale flow range of each sensor model.

Digital Outputs (2x)	
Specification	**Standard Configuration**
Maximum rating: 30 VDC, 20 mA (open collector)	Digital Output 1: Parameter: Flow Alarm High Setting: 105% of full scale Digital Output 2: Parameter: Flow Alarm Low Setting: -5% of full scale Normally opened

Digital Inputs (2x)	
Specification	**Standard Configuration**
No-voltage contact or transistor open collector.	Zero adjustment.

Figure 7: *Standard system configuration of LFC-1C and LFC-1C-F4 (needed for LFS-008)*



Analog Outputs (6 Channels)	
Specification	**Standard Configuration**
4 - 20 mA Load resistance < 600 Ohm	Flow reading 4-20 mA. Standard full scale flow range of each sensor model. (0 – 20 mA configurable)

Digital Outputs (6 Channels)	
Specification	**Standard Configuration**
Maximum rating: 30 VDC, 20 mA (open collector)	Parameter: Flow Alarm High Setting: 105% of full scale Normally opened

Digital Inputs (6 Channels)	
Specification	**Standard Configuration**
No-voltage contact or transistor open collector.	Zero adjustment.

Figure 8: *Standard system configuration of LFC-6CIO (with RS485 bus and PLC interface)*

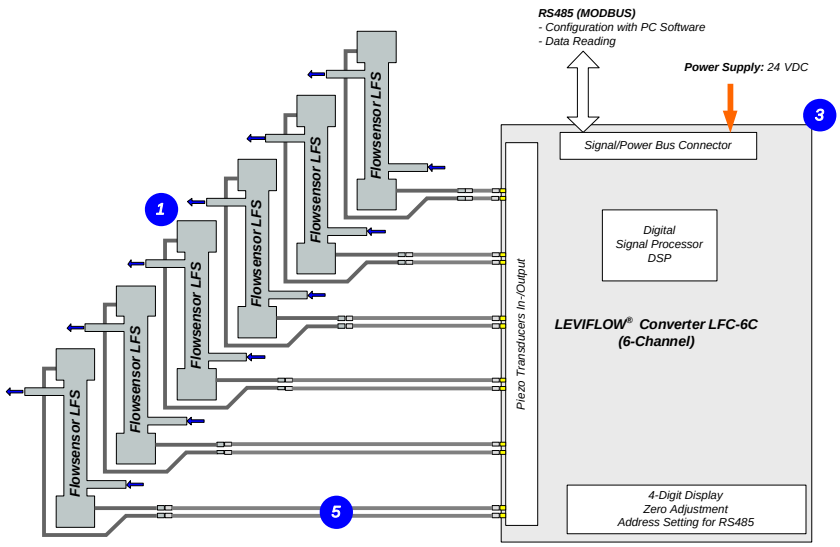


Figure 9: *Standard system configuration of LFC-6C (with RS485 bus)*

FLOW SENSOR SPECIFICATIONS

Characteristics \ Sensor Type		LFS-008	LFS-04(H)	LFS-08(H)	LFS-20(H)	LFS-50(H)	LFS-80(H)
Flow Range [lpm]		0 – 0.8	0 – 4	0 – 8	0 – 20	0 – 50	0 – 80
Fitting Tube Size (OD)		1/4”	1/4” or 3/8”	3/8”	1/2”	3/4”	1”
Measurement Path ID in [mm]		2.5	4	6	10	15	20
Accuracy Flow Velocity < 1 m/s	Flow Range [lpm]	0 – 0.035	0 – 0.8	0 – 1.7	0 – 4.7	0 – 10.6	0 – 18.8
	Accuracy [lpm]	see Figure 10	± 0.008	± 0 – 0.017	± 0.047	± 0.106	± 0.188
	Repeatability [lpm]	see Figure 10	< 0.004	< 0.009	< 0.024	< 0.053	< 0.094
Accuracy Flow Velocity > 1 m/s	Flow Range [lpm]	0.035 – 0.8	0.8 – 4	1.7 – 8	4.7 – 20	10.6 – 50	18.8 – 80
	Accuracy of Reading	± 1%	± 1%	± 1%	± 1%	± 1%	± 1%
	Repeatability of Read.	< 0.5%	< 0.5%	< 0.5%	± 0.5%	± 0.5%	± 0.5%
Wetted Surface Area [cm^2]		38.3	59.0 (for 3/8”)	61.7	87.5	155.9	233.1
Weight [g]		97	97	95	115	150	180
Pressure Drop Coefficient C $\Delta P = C \times Q^2$, Q = Flow [lpm], ΔP = Press. Drop [kPa]		16.8	1.80 for 3/8” 5.41 for 1/4”	0.88	0.06	0.01	0.003
Fluid Temperature		Normal range: 10 – 90 °C (50 – 194 °F) For LFS-xxH (high-temp version): 10 - 180 °C (50 - 356 °F)					
Ambient Temperature		0 – 60 °C (32 - 140 °F)					
Maximum Fluid Pressure		0 – 0.5 MPa (0 – 5 bar, 0 – 72.5 psi)					
Kinematic Viscosity		0.3 – 40 mm^2/s (0.8 – 40 cSt)					
Sound Speed		1000 – 2200 m/s					
Wet Materials		PFA					
Sensor Enclosure Classification		IP-65					
Cable Jacket Material		FEP (PVC on request and at minimum order quantities)					
Standard Cable Length		0.5m with extension cables for length variation (other length on request and at minimum order quantities)					
Electrical Connectors		SMB with protective PVDF cover (male with O-Ring, IP-65 protection)					

Table 1:: *Specifications of sensors (All data based on water at 20 °C)*

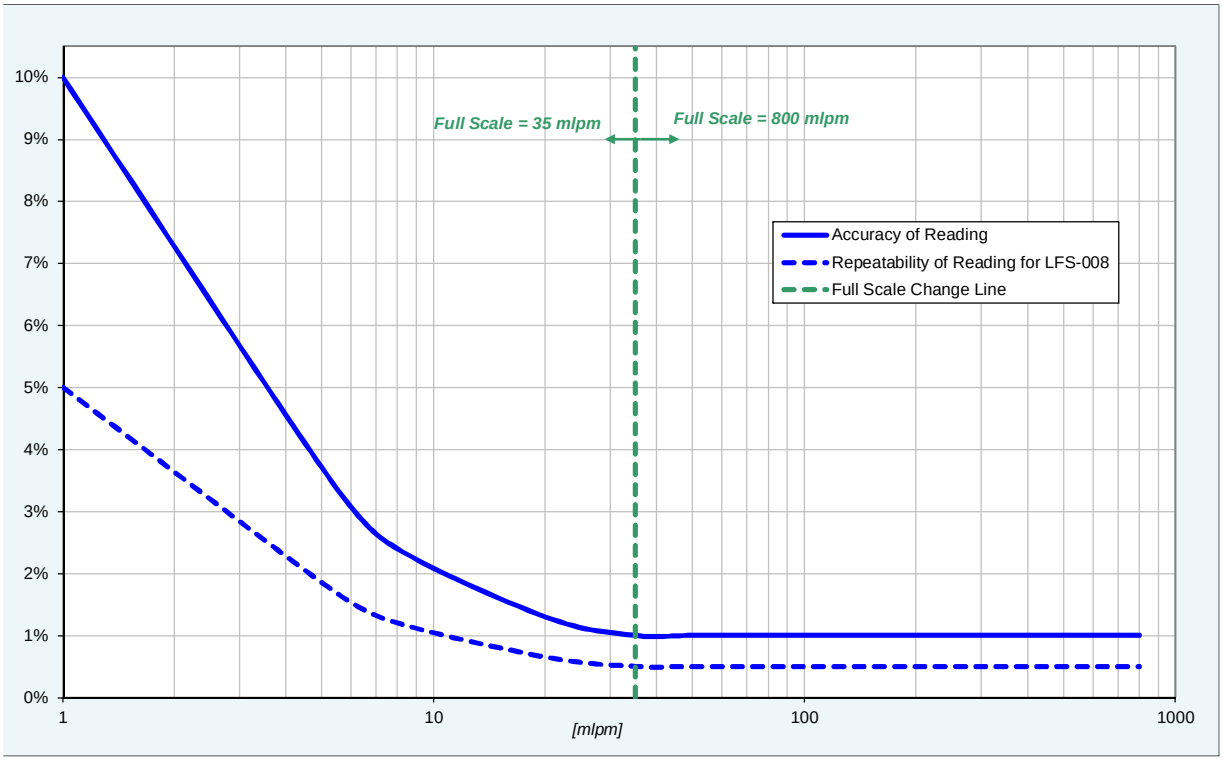


Figure 10: *Repeatability and accuracy specification for LFS-008 sensor*

CONVERTER SPECIFICATIONS

Characteristics	Single Channel Converter Types LFC-1C and LFC-1C-F4
Power Supply / Current / Inrush (Start) Current	24 VDC ± 10% / 150 mA / Peak 1.8 A within 100 µs
Ambient Temp / Humidity Range	0 – 50 °C (32 – 122 °F) / 30 - 85% R.H. (no condensation)
Enclosure Classification and Material	IP-20 (indoor use), ABS
Interfaces	- RS485 -> MODBUS protocol -> max. array of 99 channels - 1x Analog Output: 4 – 20mA (0 – 20mA configurable) - 2x Digital Outputs: Flow Alarm, Measurement Error, Volume Counter Pulse, Volume Counter Alarm, Flow as Frequency or Bubble Detection (default: normally open) - 1x Digital Input: Volume Counter Reset or Zero Adjust - 4 Digit display (flow rate, error codes), re-zero button - Address potentiometers for RS485 address setting
Configuration Parameters (Available and configurable with RS485/USB converter and configuration software)	- Viscosity - Low Cutoff, - Dampening time (filter) - Full scale setting, - Linearization (15 points) - Alarm Outputs (High and Low Alarm) - Volume Counter and Volume Counter Alarm Settings
Weight / Dimensions / Mounting	130 g / 123 x 75 x 17.5 mm / DIN rail
Duration for Activation of Manual and Digital Zeroing	3 sec
Duration of Zeroing Procedure	LFC-1C: normal 6 sec , maximum 15 sec LFC-1C-F4: normal 26 sec, maximum 60 sec.
Duration of Measurement Ready after Power-On Warm-Up Time for Full Performance Measurements	10 sec. 30 min.

Table 2: *Specifications for single-channel converters LFC-1C and LFC-1C-F4*

Characteristics	6-Channel Converter Types LFC-6C and LFC-6ClO
Power Supply / Current	LFC-6C : 24 VDC ± 10% / 150 mA LFC-6ClO : 24 VDC ± 10% / 270 mA
Power Supply In-Rush (Start) Current	LFC-6C : Peak 1.7 A within 180 µs LFC-6ClO : Peak 4.9 within 210 µs
Ambient Temp / Humidity Range	0 – 50 °C (32 – 122 °F) / 30 - 85% R.H. (no condensation)
Enclosure Classification and Material	IP-20 (indoor use), ABS
Interfaces	- RS485 -> MODBUS protocol -> max. array of 99 ch. - Stacking of max. 16 converters -> 5 ms DSP process/time per channel - 4 Digit display (flow rate, error codes), re-zero button - Address potentiometers for RS485 address setting For LFC-6ClO only: - 6x Analog Outputs: 4 – 20mA (0 – 20mA configurable) - 6x Digital Outputs: Flow Alarm, Measurement Error, Volume Counter Pulse, Volume Counter Alarm, Flow as Frequency or Bubble Detection (default: normally open) - 6x Digital Input: Volume Counter Reset or Zero Adjust
Configuration Parameters (Available and configurable with RS485/USB converter and configuration software)	- Viscosity - Low Cutoff - Dampening constant (filter) - Full scale setting - Linearization (15 points) - Alarm Outputs (High and Low Alarm) - Volume Counter and Volume Counter Alarm Settings
Weight / Dimensions / Mounting	LFC-6C: 170 g / 139 x 77 x 17.5 mm / DIN rail LFC-6ClO: 182 g / 139 x 77 x 18.5 mm / DIN rail
Duration for Activation of Manual and Digital Zeroing	3 sec
Duration of Zeroing Procedure	LFC-6C: normal 15 sec, maximum 30 sec. LFC-6ClO: normal 26 sec, maximum 60 sec.
Duration of Measurement Ready after Power-On Warm-Up Time for Full Performance Measurements	10 sec. 30 min.

Table 3: *Specifications for multi-channel converters LFC-6C and LFC-6ClO*

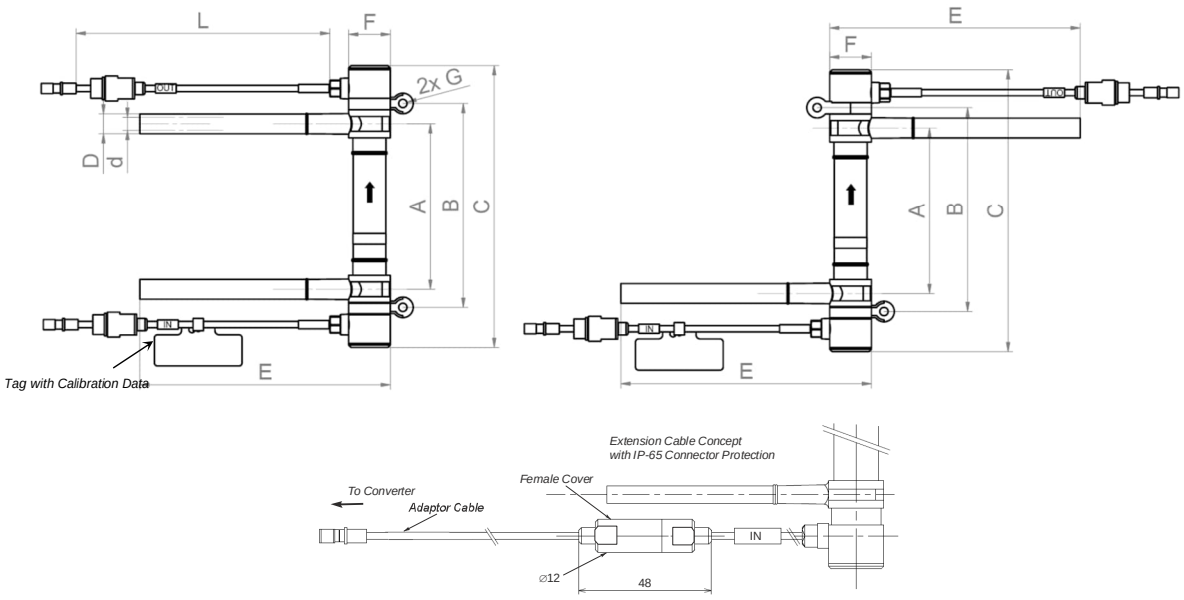


Figure 11: *Dimension legend for LFS-04 and LFS-08 sensors (left: U-shape, right: Z-shape)*

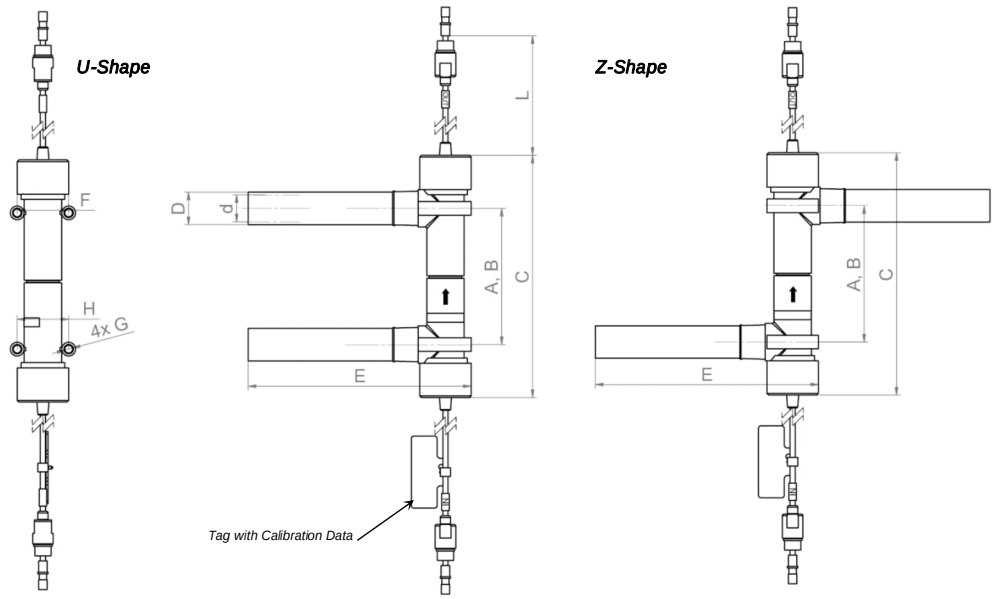


Figure 12: *Dimension legend for flowsensors LFS-20, LFS-50 and LFS-80 (left: U-shape, right: Z-shape)*

Sensor Type	Tube Size	Dimensions in [mm] A	B	C	D	d	E	F	G	H	L
LFS-008	1/4"	80 ±1	96 ±1	134 ±1	6.35	4.35	120	ϕ20	ϕ4	--	500
LFS-04(H)	3/8" 1/4"	80 ±1	98.5 ±1 (99 ±1) 96 ±1	136 ±1 134 ±1	9.53 6.35	6.33 4.35	120	ϕ20	ϕ4	--	500
LFS-08(H)	3/8"	80 ±1	98.5 ±1 (100 ±1)	136 ±1 (137 ±1)	9.53	6.33	120	ϕ20	ϕ4	--	500
LFS-20(H)	1/2"	80 ±1	80 ±1	136 ±1	12.7	9.5	120 (117.7)	ϕ30 (ϕ25.4)	M4 x 31 -> U-shape M4 x 30 -> Z-shape Max. Torque: 0.3 Nm	25	500
LFS-50(H)	3/4"	80 ±1	80 ±1	141.8 ±1 (143.8 ±1)	19	15.8	130 (127.7)	ϕ30 (ϕ25.4)	M5 x 31 -> U-shape M5 x 30 -> Z-shape Max. Torque: 0.5 Nm	30	500
LFS-80(H)	1"	80 ±1	80 ±1	148 ±1	25.4	22.2	140 (137.7)	ϕ30 (ϕ25.4)	M4 x 34 -> U-shape M4 x 30 -> Z-shape Max. Torque: 0.3 Nm	35	500

Table 4: *Sensor dimensions*

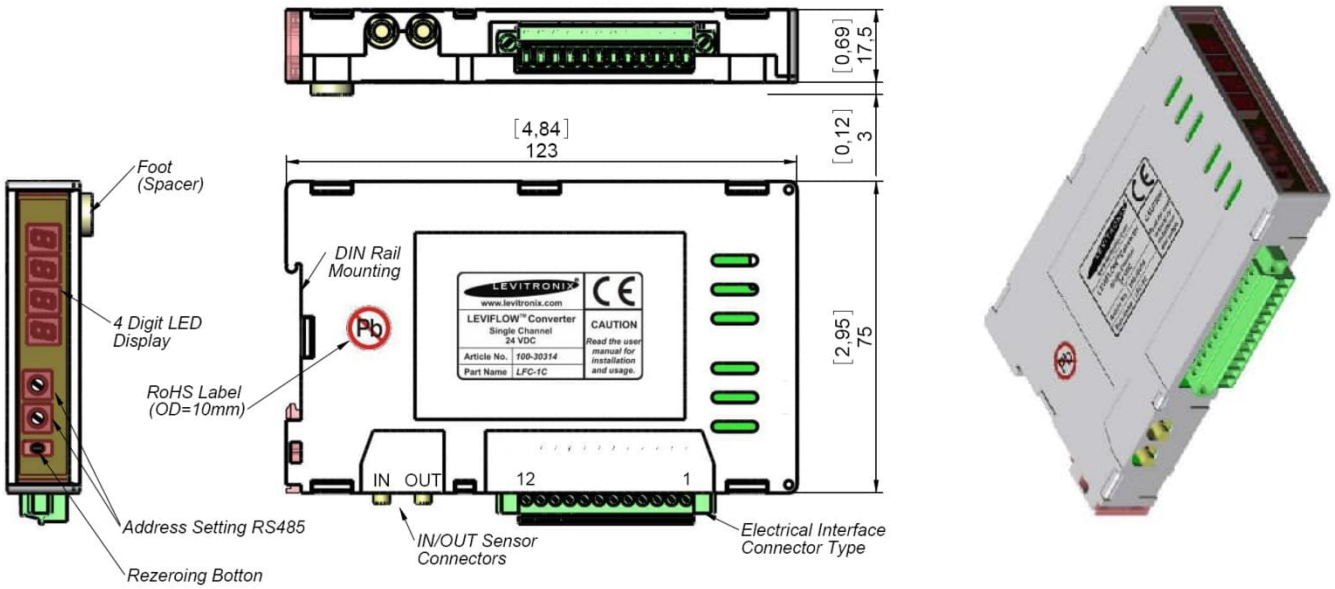


Figure 13: *Dimensions and layout of interfaces of single channel converter LFC-1C / LFC-1C-F4*

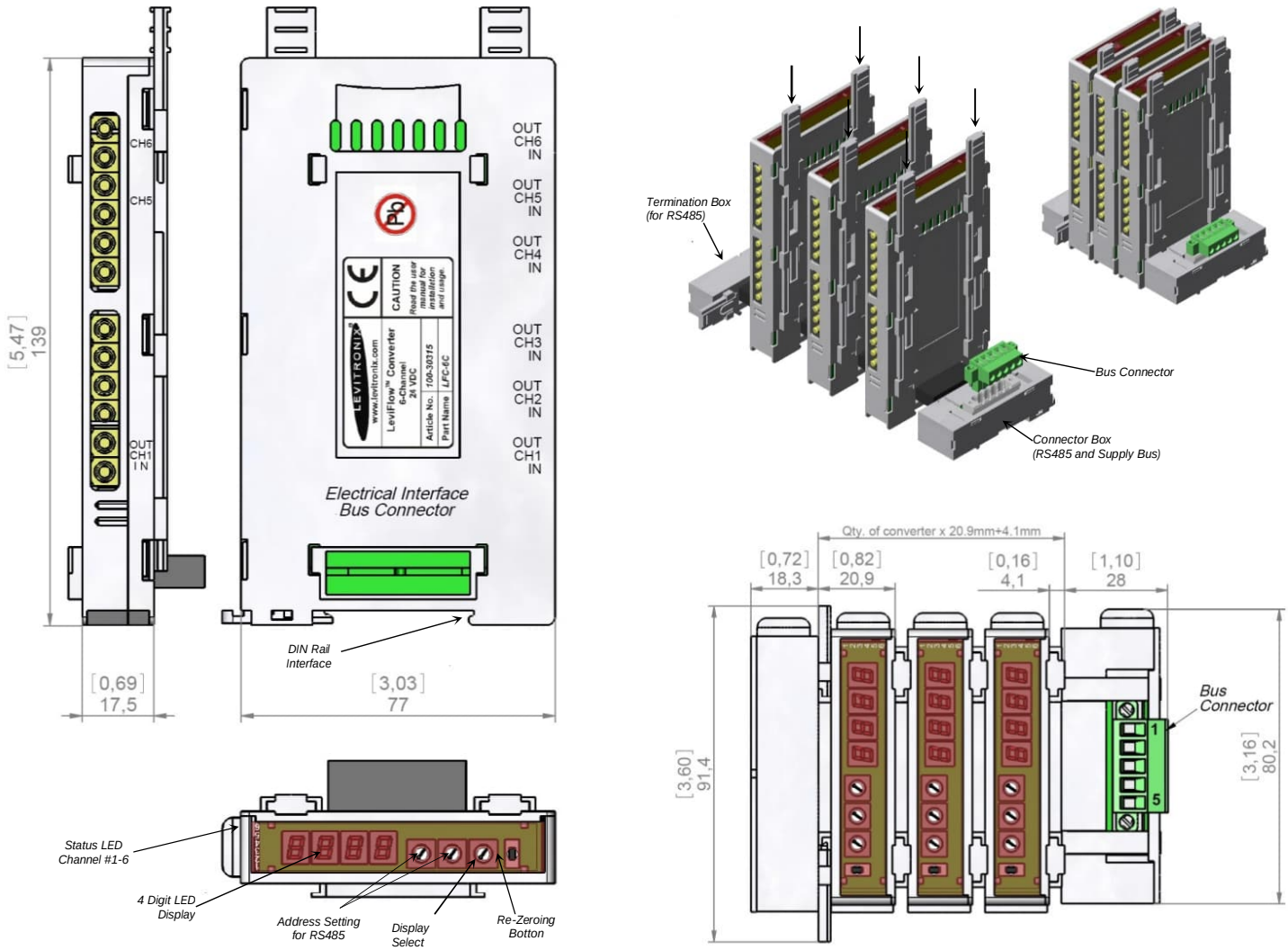


Figure 14: *Dimensions, mounting and stacking concept for LFC-6C*

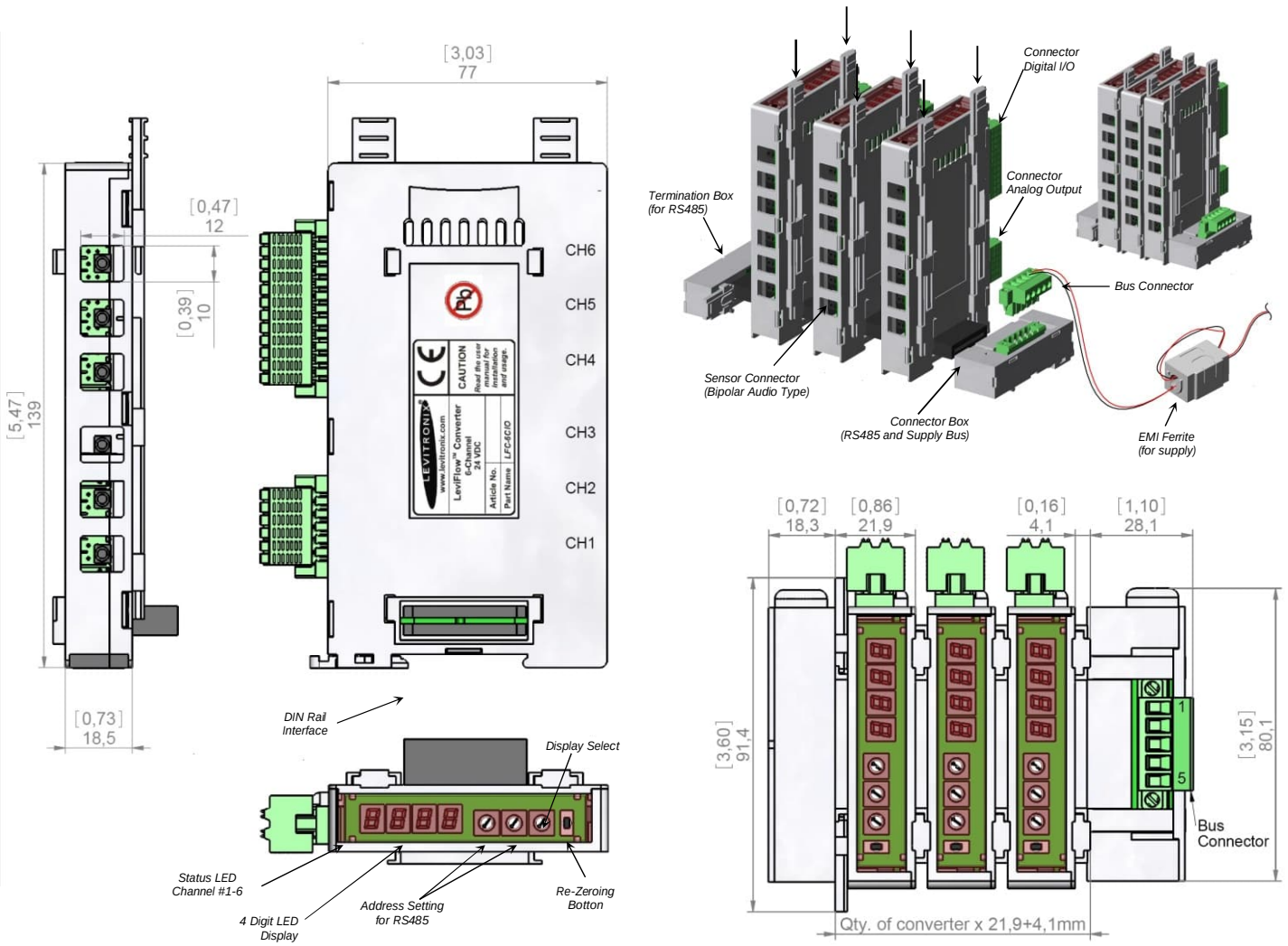


Figure 15: *Dimensions, mounting and stacking concept of LFC-6ClO*

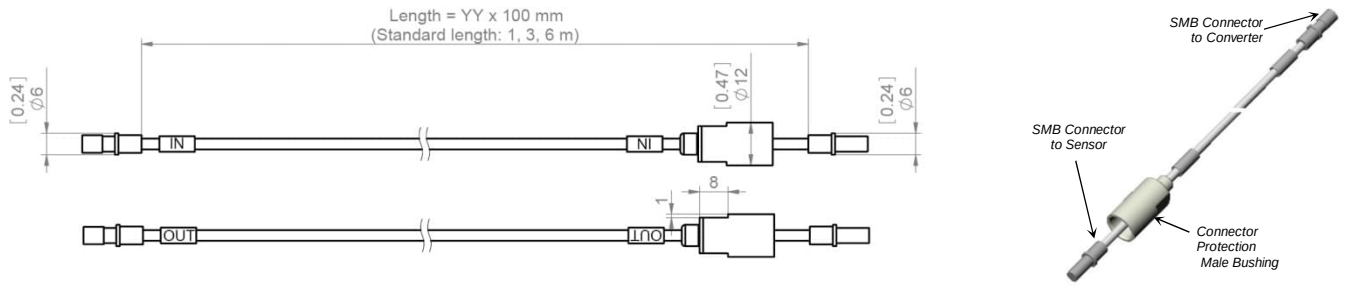


Figure 16: *Adaptor cable LFE-A.1 (delivered in pairs for "IN" and "OUT" sensor cable).*

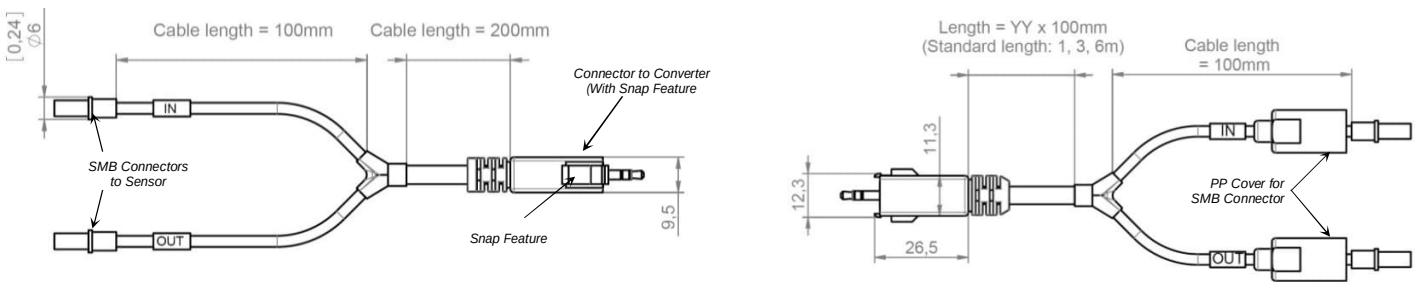


Figure 17: *Y-shape adaptor cables LFA-A.1 (left) and LFE-D.1-yy (right) for LFC-6ClO converter*

ORDER INFORMATION

Pos.	Part Name	Part #	Shape	Flow	Max. Liquid Temp.	Fitting (Tube)	Cable	Special Feature	Note
1a	LFS-008-Z / LFS-008-U	100-30323 / 100-30324	Z / U	0 – 0.8 lpm	90 °C	1/4"	FEP 0.5 m	PVDF male connector cover	Sensor specific parameter for converter calibration are delivered on a tag attached to the flowsensor.
1b	LFS-04-Z-T025 / LFS-04-U-T025	100-30321 / 100-30322	Z / U	0 – 4 lpm	90 °C	1/4"			
1c 1d	LFS-04-Z / LFS-04-U LFS-04H-Z / LFS-04H-U	100-30304 / 100-30305 100-30330 / 100-30331	Z / U	0 – 4 lpm	90 °C 180 °C	3/8"			
1e 1f	LFS-08-Z / LFS-08-U LFS-08H-Z / LFS-08H-U	100-30306 / 100-30307 100-30332 / 100-30333	Z / U	0 – 8 lpm	90 °C 180 °C	3/8"			
1g 1h	LFS-20-Z / LFS-20-U LFS-20H-Z / LFS-20H-U	100-30308 / 100-30309 100-30372 / 100-30373	Z / U	0 – 20 lpm	90 °C 180 °C	1/2"			
1i 1j	LFS-50-Z / LFS-50-U LFS-50H-Z / LFS-50H-U	100-30310 / 100-30311 100-30340 / 100-30341	Z / U	0 – 50 lpm	90 °C 180 °C	3/4"			
1k 1l	LFS-80-Z / LFS-80-U LFS-80H-Z / LFS-80H-U	100-30312 / 100-30313 100-30342 / 100-30343	Z / U	0 – 80 lpm	90 °C 180 °C	1"			

Table 5: *Standard flow sensor models*

Pos.	Article Name	Part #	Description	Interfaces
2a (with 2c)	LFC-1C	100-30314	Single Channel Converter (Interface connector 2c included)	Analog Output (4 – 20 mA), 2x Digital Output, 1x Digital Input, RS485 (MODBUS) Note: LFC-1C-F4 works with LFS-008 only.
2b (with 2c)	LFC-1C-F4	100-30325		
3	LFC-6C	100-30315	6-Channel Converter	- RS485 (MODBUS) - Order Bus Conn. (7a) and Terminat. Box (7b) as separate article (see *Table 7*) Note: Does not work with LFS-008 sensor.
4 (with A and B)	LFC-6CIO	100-30337	6-Channel Converter with I/O Interfaces (Digital I/O connector A and analog output connector B included)	- RS485 (MODBUS) protocol - 6 analog outputs (4 – 20 mA), 6 digital inputs, 6 digital outputs - Order Bus Conn. (7a) and Terminat. Box (7b) as separate article (see *Table 7*) - EMI ferrite (8) to be ordered as separate article (see *Table 7*)

Table 6: *Standard converters*

Pos.	Article Name	Part #	Description	Special Feature/Note
5a	LFE-A.1-10 LFE-A.1-30 LFE-A.1-60	190-10162 190-10163 190-10164	Cable length: 1 m, PVC Cable length: 3 m, PVC Cable length: 6 m, PVC	- PP female connector cover for IP-65 chemical protection - Flame retardant PVC white (UL VW-1 corresponds to EN-60332-1-2)
5b	LFE-A.2-10 LFE-A.2-30 LFE-A.2-60	190-10165 190-10166 190-10167	Cable length 1 m, FEP Cable length 3 m, FEP Cable length 6 m, FEP	PP female connector cover for IP-65 chemical protection
6a	LFE-D.1-10 LFE-D.1-30 LFE-D.1-60	190-10296 190-10297 190-10298	Y cable, 1 m, PVC, connector cover Y cable, 3 m, PVC, connector cover Y cable, 6 m, PVC, connector cover	For LFC-6CIO, with SMB connector cover for IP65 protection
6b	LFA-A.1	190-10268	Y adaptor cable, PVC	For LFC-6CIO
7a	Connector Box for LFC-6C	100-30316	COMBICON connector	For wiring RS485 and supply of stacks of LFC-6C and LFC-6CIO converters.
7b	Termination Box for LFC-6C	100-30317	--	For termination of RS485 bus of LFC-6C and LFC-6CIO.
8	LeviFlow Splitting Ferrite	100-30353	EMI filtering of DC supply	For LFC-6CIO supply needed.
9	USB to RS485 Adaptor-TR Isolated YN-485I-TR	100-30392	Structure/Design Purpose	USB connector (A) with termination resistor and cable with connector pair (B and C) for external RS485 wire connection. Magnetically isolated. Cable length is 2m. Included is a USB space saver cable (D). Communication over fieldbus of converter with PC.

Table 7: *Accessories*

Pos.	Part Name	Part #	Flow Range	Fitting (Tube)	Max. Liquid Temp.	Sensor Cable	Note
10a	LFS-008-Z + LFC-1C-F4 LFS-008-U + LFC-1C-F4	100-90625 100-90626	0 – 0.8 lpm	1/4"	90 °C	FEP 0.5 m	Converter is delivered with sensor specific parameters already stored. Extension cables to be ordered as separate article with specified length (see *Table 7*)
10b	LFS-04-Z-T025+LFC-1C LFS-04-U-T025+LFC-1C	100-90627 100-90628	0 – 4 lpm	1/4"	90 °C		
10c	LFS-04-Z+LFC-1C LFS-04-U+LFC-1C LFS-04H-Z+LFC-1C LFS-04H-U+LFC-1C	100-90604 100-90605 100-90630 100-90631	0 – 4 lpm	3/8"	90 °C 90 °C 180 °C 180 °C		
10d	LFS-08-Z+LFC-1C LFS-08-U+LFC-1C LFS-08H-Z+LFC-1C LFS-08H-U+LFC-1C	100-90606 100-90607 100-90813 100-90812	0 – 8 lpm	3/8"	90 °C 90 °C 180 °C 180 °C		
10e	LFS-20-Z+LFC-1C LFS-20-U+LFC-1C LFS-20H-Z+LFC-1C LFS-20H-U+LFC-1C	100-90608 100-90609 100-90835 100-90836	0 – 20 lpm	1/2"	90 °C 90 °C 180 °C 180 °C		
10f	LFS-50-Z+LFC-1C LFS-50-U+LFC-1C LFS-50H-Z+LFC-1C LFS-50H-U+LFC-1C	100-90621 100-90622 100-90802 100-90714	0 – 50 lpm	3/4"	90 °C 90 °C 180 °C 180 °C		
10g	LFS-80-Z+LFC-1C LFS-80-U+LFC-1C LFS-80H-Z+LFC-1C LFS-80H-U+LFC-1C	100-90623 100-90624 100-90715 100-90716	0 – 80 lpm	1"	90 °C 90 °C 180 °C 180 °C		

Table 8: *Flowmeter sets – flow sensor with single channel converter LFC-1C/LFC-1C-F4*

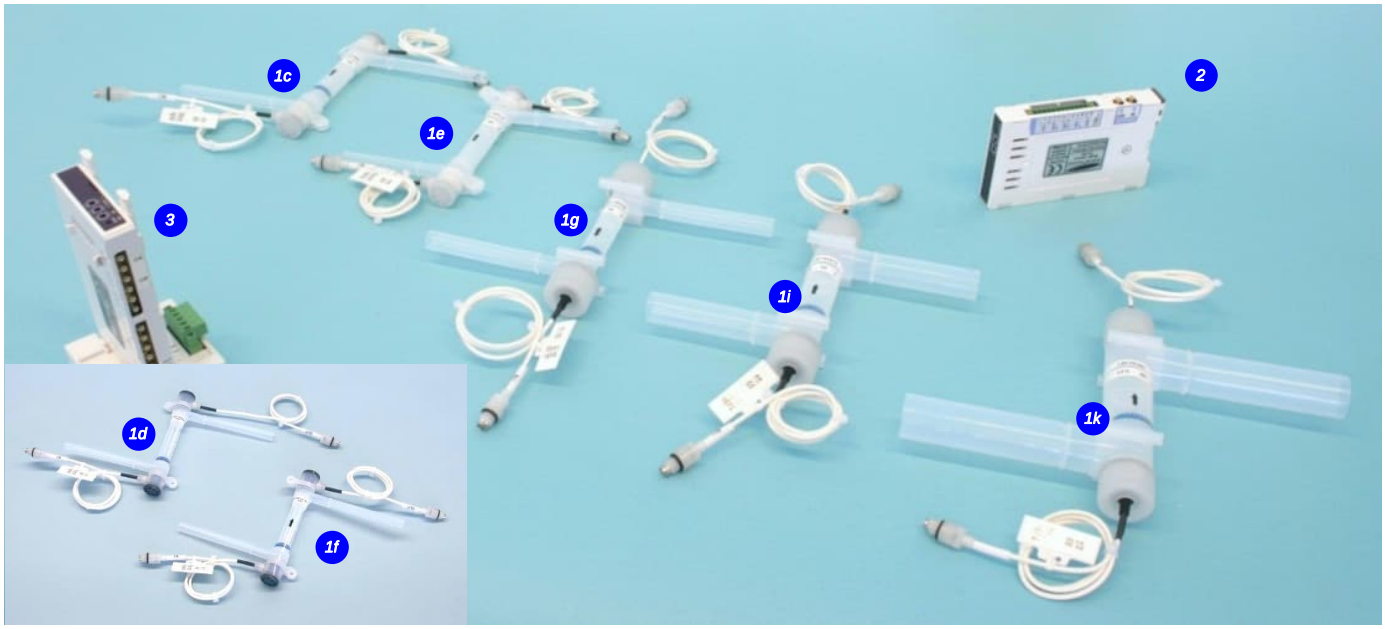


Figure 18: *Standard LEVIFLOW® LFS flow sensors*

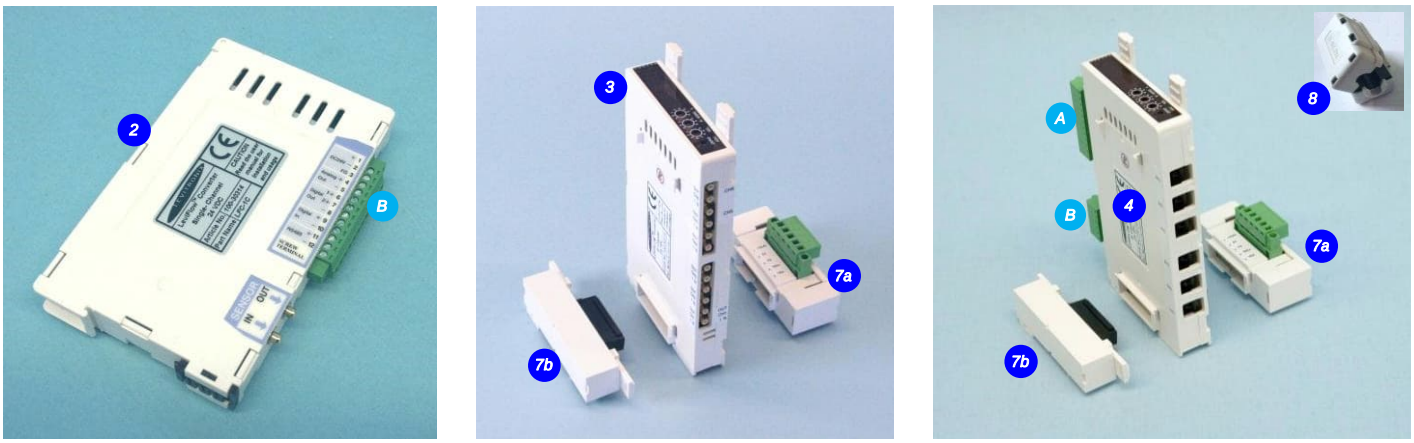


Figure 19: *Standard LEVIFLOW® LFC converters*

Figure 20: *LEVIFLOW® accessories*

LEVITRONIX® THE COMPANY

Levitronix® is the world-wide leader in magnetically levitated bearingless motor technology. *Levitronix®* was the first company to introduce bearingless motor technology to the Semiconductor, Medical and Lifescience markets. The company is ISO 9001 certified. Production and quality control facilities are located in Switzerland. In addition, *Levitronix®* is committed to bring other highly innovative products like the *LEVIFLOW®* flowmeter series to the market.

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