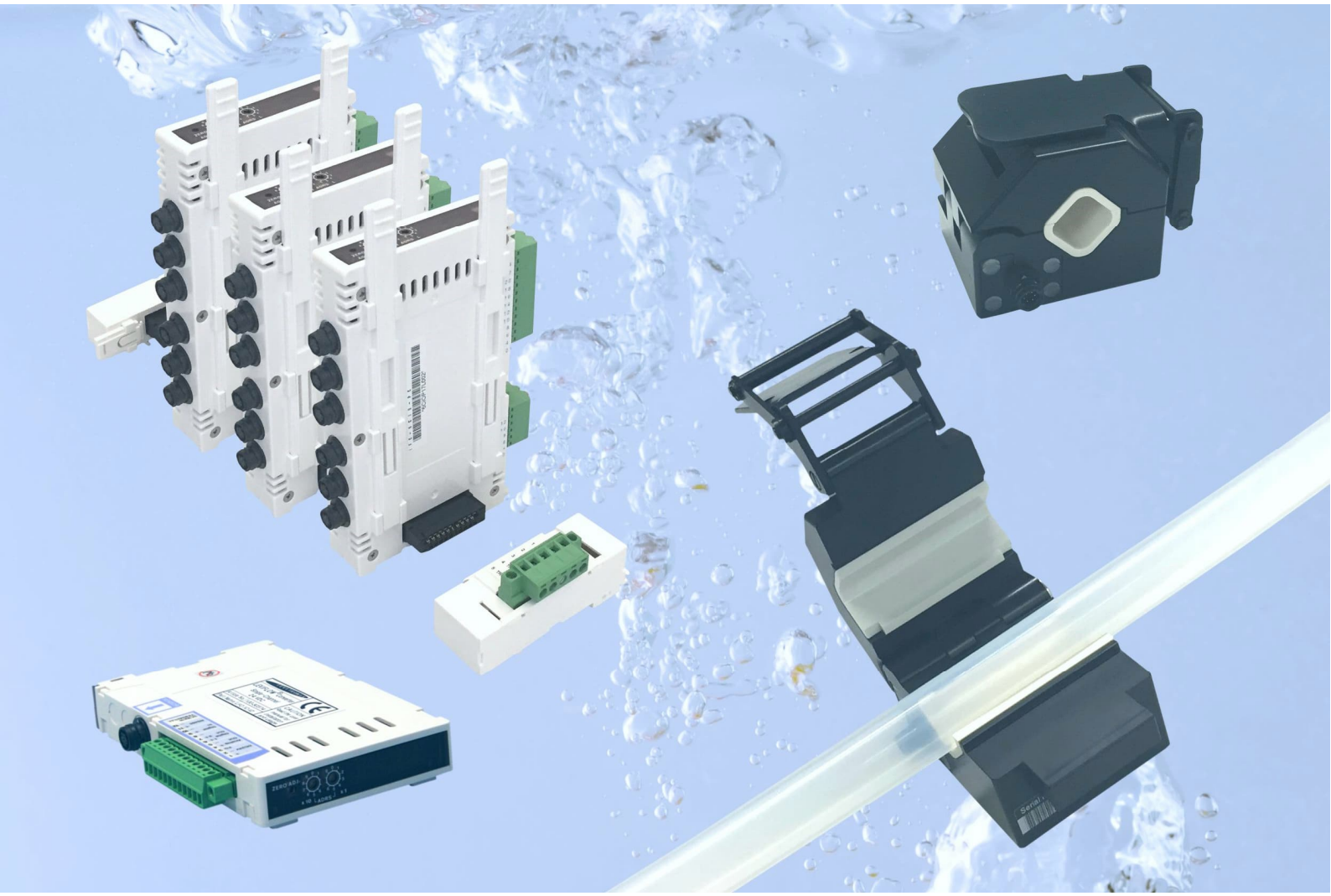
LEVIFLOW® Ultrasonic Technology
Clamp-On Flowmeter D-Series for PFA Tubing



LFSC-D Clamp-On Flowmeters

LFSC-06D.1: 1 l/min – 1/4” Tube
LFSC-09D.1: 4 l/min – 3/8” Tube
LFSC-11D.1: 20 l/min – 1/2” Tube
LFSC-17D.1: 50 l/min – 3/4” Tube
LFSC-23D.1: 80 l/min – 1” Tube
LFSC-30D.1: 160 l/min – 1 1/4” Tube
LFSC-35D.1: 320 l/min – 1 1/2” Tube

Ultraclean Non-Invasive Flow Measurement

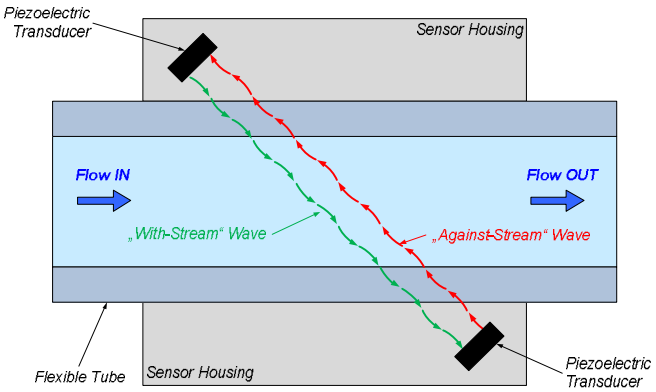


Figure 1: *Operating principle of ultrasonic clamp-on flow sensor (D-series)*

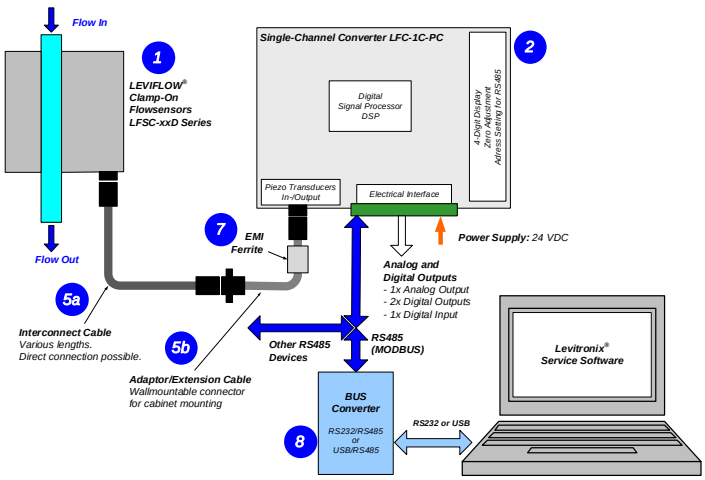


Figure 2: *Single channel system configuration with Levitronix® Service Software*
(See order info. for article description)

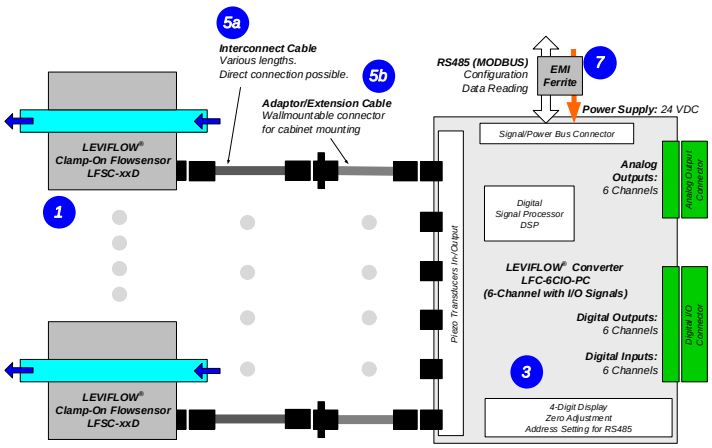


Figure 3: *Multi-channel (6 channels) system configuration.*
(See order info. for article description)

INTRODUCTION

The *LEVIFLOW®* clamp-on flowmeters are designed for non-invasive flow measurements of high purity fluids with PFA tubing in the Semiconductor industry. *Figure 1* illustrates the operating principle. Two piezo-electric transducers, mounted in the sensor housing, generate and receive an ultrasonic wave. The wave going in direction of the flow (with-stream wave) is accelerated and the wave going against the flow direction (against-stream wave) is slowed down. The two waves are processed by a signal converter. The difference of the transit time of both waves is proportional to the velocity of the fluid.

The standard single-channel configuration (see *Figure 2*) of the *LEVIFLOW®* clamp-on flowmeters consists of a flow sensor and a converter with a digital signal processor (DSP) for processing the sensor signals. The clamp on flowmeters can measure a flow up to 320 l/min. A stackable multi-channel converter (6 channels, see *Figure 3*) simplifies operation and installation of higher volumes of flowmeters. Various signals (analog output, digital input/output) are provided and can be configured with a PC software. A RS485 bus allows arrays of multiple flowmeters. In addition, the sensor value is shown on a 4-digit display. For debugging, data collection and configuration with a PC the *Levitronix® Service Software* is available at *Levitronix®* together with a USB to RS485 adaptor.

SYSTEM BENEFITS

- No contamination due to non-invasive flow measurement.
- No moving parts -> no particle generation.
- Easy and repeatable mounting to PFA tubing.
- Improved bubble robustness.
- Flow control together with *Levitronix®* MagLev Pumps.
- Easy integration into OEM equipment.
- Easy configurable flow sensor parameters (PC software).
- Low pressure loss.
- Integrated and configurable totalizer function.

APPLICATIONS

- High purity liquid processes.
- Monitoring of liquid consumption.
- Debugging of fluid circuits.
- Semiconductor, pharmaceutical and biotech processes.
- Flow control in combination with *Levitronix®* MagLev pump systems.

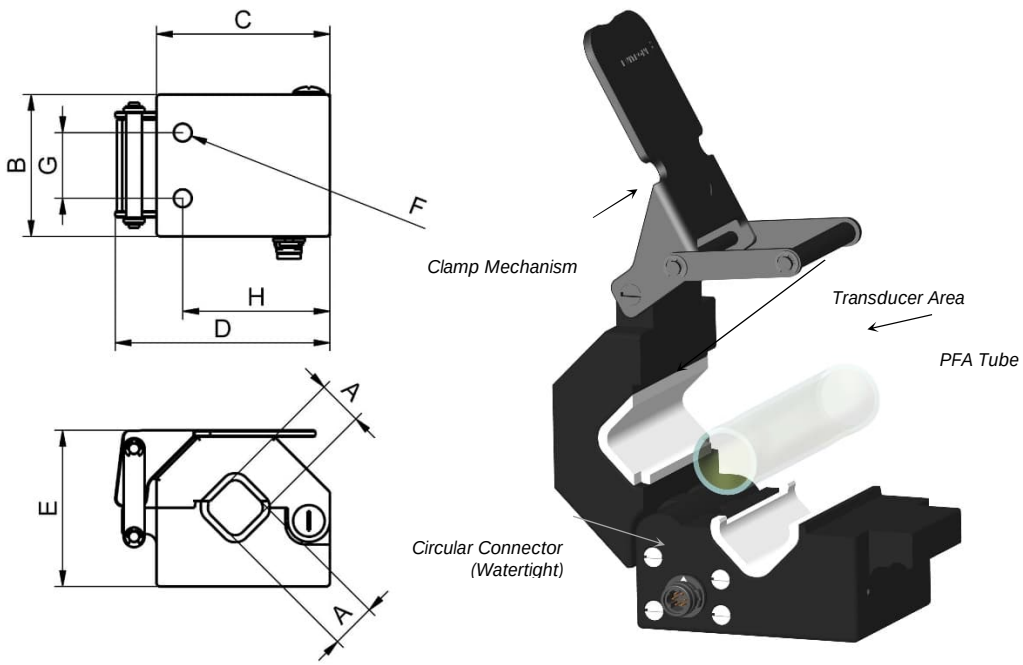
SENSOR SPECIFICATIONS

Characteristics		LFSC-06D.1	LFSC-09D.1	LFSC-11D.1	LFSC-17D.1	LFSC-23D.1	LFSC-30D.1	LFSC-35D.1
Flow Range [l/min]		0 – 1 l/min	0 – 4 l/min	0 – 20 l/min	0 – 50 l/min	0 – 80 l/min	0 – 160 l/min	0 – 320 l/min
Accuracy of Reading [3] (Tubing variation not included. For fully developed flow profiles.)	> 25% of FS < 25% of FS	±3 % ±7.5 ml/min	±2.5 % ±25 ml/min	±2 % ±100 ml/min	±2 % ±250 ml/min	±2 % ±400 ml/min	±1 % ±400 ml/min	±1 % ±800 ml/min
Maximum Fluid Pressure [4] (max. pressure of tube might limit this value)		6.5 bar	6.5 bar	6.5 bar	6.5 bar	5 bar	5 bar	5 bar
Pressure Drop Coefficient C [2] $\Delta P = C \times Q^2$, (for water), Q = Flow [l/min] ΔP = Press. Drop [kPa = 10 mbar]		$6.28\ 10^{-1}$ (5/32") at 20°C	$4.98\ 10^{-2}$ at 20°C	$4.92\ 10^{-3}$ at 20°C	$2.87\ 10^{-4}$ at 20°C	$4.37\ 10^{-5}$ at 20°C	$1.18\ 10^{-5}$ at 20°C	$4.30\ 10^{-6}$ at 20°C
Usable PFA Tubing Dimensions	ID	5/32" = 4.0 mm or 1/8" = 3.2 mm	1/4" = 6.4 mm	3/8" = 9.5 mm	5/8" = 15.9 mm	7/8" = 22.2 mm	1 1/10" = 27.9 mm	1 21/64" = 33.7 mm
	OD	1/4" = 6.4 mm	3/8" = 9.5 mm	1/2" = 12.7 mm	3/4" = 19.1 mm	1" = 25.4 mm	1 1/4" = 31.8 mm	1 1/2" = 38.1 mm
	Wall thickness	3/64" = 1.2 mm	1/16" = 1.6 mm	1/16" = 1.6 mm	1/16" = 1.6 mm	1/16" = 1.6 mm	3/40" = 1.9 mm	11/128" = 2.2 mm

Standard Tube Material	PFA	
Fluid Temperature	Normal range: 10 – 90 °C (50 – 194 °F)	Maximum temperature: 120 °C (248 °F)
Ambient Temperature	0 – 40 °C (32 - 104 °F)	
Kinematic Viscosity (Measurable Range)	0.3 – 40 mm^2/s (0.3 – 40 cSt)	Note: This is the measurable range.
Sound Speed (Measurable Range)	1000 – 1700 m/s (others on request)	
IP Classification	IP-65	
Electrical Connector	Circular type (IP-67), lock-release type	
Cables	Various extension cables available.	

Table 1: *Specifications of flow sensors*

Note 1: Pressure coefficient accounts for the clamp length only. Note 2: Calculated values. Note 3: Accuracy based on statistical measurements with 1x Stdv and 20°C water with zeroing after clamping. Note 4: Value at 20 °C liquid and ambient temperature.

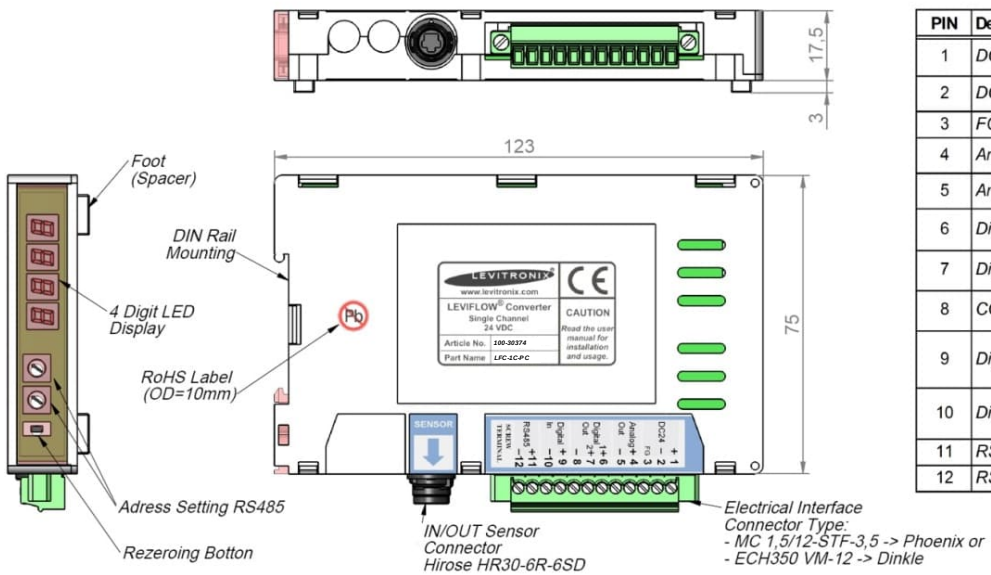


Sensor Type	Dimensions in [mm]							
	A	B	C	D	E	F	G	H
LFSC-06D.1	5.7	48	54	67.2	44.5	M6 x 6	20	35
LFSC-09D.1	8.4	48	54	67.2	44.5	M6 x 6	20	35
LFSC-11D.1	11.2	54	65	80.7	59.5	M8 x 10	25	56
LFSC-17D.1	17.1	54	65	80.7	59.5	M8 x 10	25	56
LFSC-23D.1	23.4	54	85.5	102.1	79.8	M8 x 10	25	30
LFSC-30D.1	29.5	54	85.5	102.1	79.8	M8 x 10	25	30
LFSC-35D.1	34.6	54	85.5	102.1	79.8	M8 x 10	25	30

Figure 4: *Dimensions for LFSC-D clamp-on flow sensors.*

Characteristics	Single Channel Converter Type LFC-1C-PC
Power Supply Current / Inrush (Start-Up) Current	24 VDC ± 10% 150 mA / 3.8 A during < 210 µs
Ambient Temp Humidity Range	0 – 40 °C (32 – 104 °F) 30 - 85% R.H. (no condensation)
Enclosure Classification and Material	IP-20 (indoor use), ABS
Interfaces (See Figure 5 for detailed PIN designation and electrical specification)	- 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 service software)	Viscosity, Low Cutoff, Dampening constant (filter) Full scale setting, Linearization (15 points), Alarm Outputs (High and Low Alarm) Volume Counter Settings
Weight / Dimensions	130 g / 123 x 75 x 17.5 mm (see *Figure 5* for details)
Mounting	DIN rail

Table 2: *Specification of converter LFC-1C-PC*



PIN	Designation	Specification
1	DC24V+	24 VDC ± 10% Current: 150 mA Starting: 4.4 A, 2ms
2	DC24V-	
3	FG	Field Ground
4	Analog Out +	4 - 20 mA (0 - 20 mA configurable) Load Resistance < 600 Ohm
5	Analog Out -	
6	Digital Out1 +	Max. rating: DC30V, 20mA (open collector) Various configurable options available depending on firmware
7	Digital Out2 +	
8	COM	
9	Digital In+	Various configurable options available depending on firmware No-voltage contact or transistor open collector
10	Digital In-	
11	RS485 +	RS485 with MODBUS Protocol
12	RS485 -	

Figure 5: *Dimensions (in [mm]) and layout of interfaces of single channel converter LFC-1C-PC*

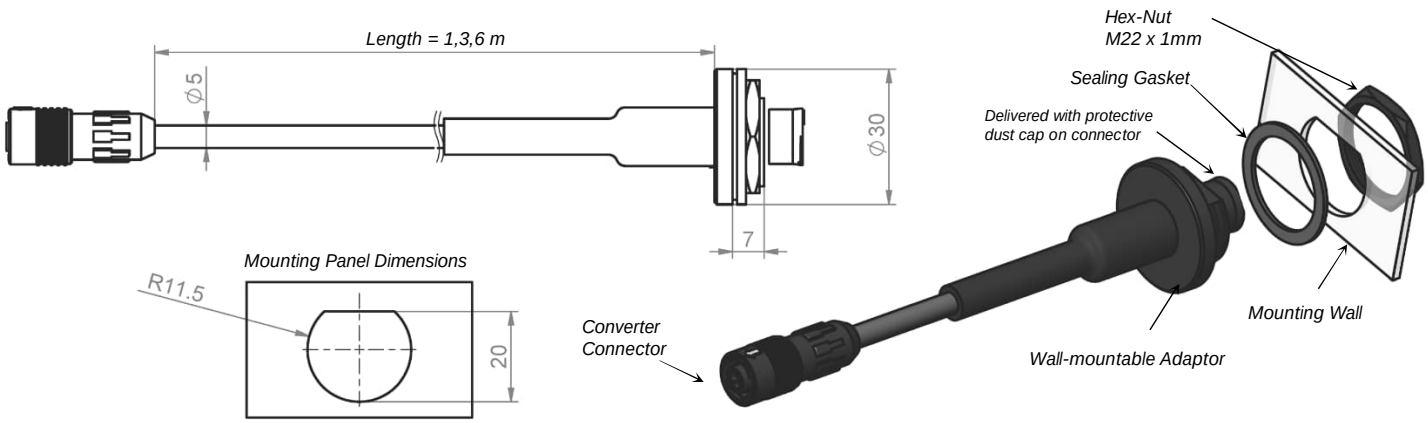


Figure 6: *Dimensions of wall mountable extension cables LFE-C.2*

Characteristics	6-Channel Converter Type LFC-6ClO-PC
Power Supply / Current / In-Rush (Start) Current	24 VDC ± 10% / 270 mA / 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 - 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 service 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	215 g / 140 x 77.3 x 20.5 mm / DIN rail

Table 3: *Specifications for multi-channel converter LFC-6ClO-PC*

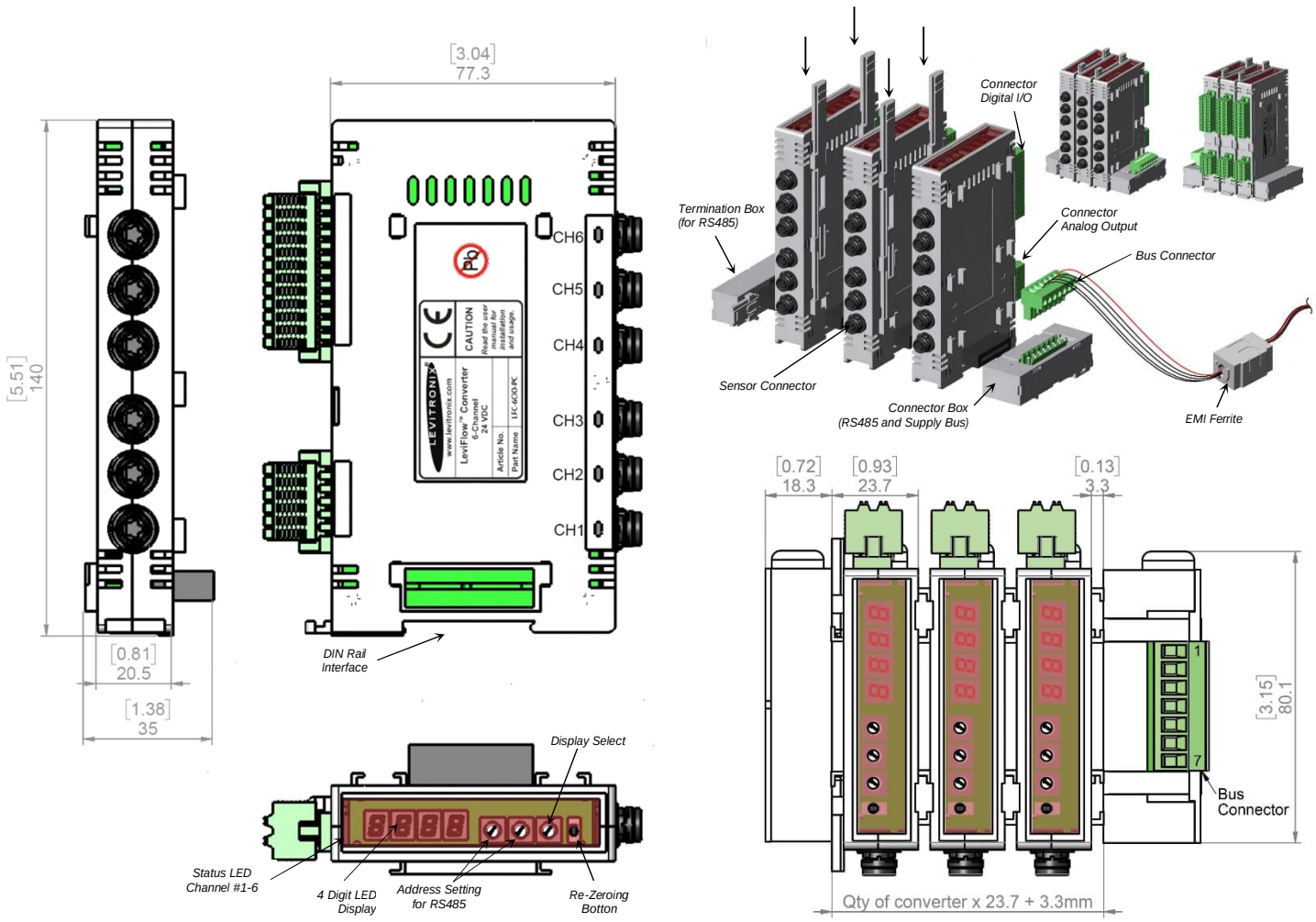


Figure 7: *Dimensions, mounting and stacking concept of LFC-6ClO-PC*

ORDER INFORMATION

Pos.	Part Name	Article #	Tube: ID x OD	Flow Range	Connector	Calibration Set	Note
1a	LFSC-06D.1-001 LFSC-06D.1-002	100-30439 100-30494	ID = 5/32"= 4.0 mm ID = 1/8"= 3.2 mm OD = 1/4"= 6.4 mm	1 lpm	Circular Hirose	Water @ 20°C PFA Tubing	Other parameter sets can be chosen *with Levitronix® Service Software*.
1b	LFSC-09D.1-001	100-30440	ID = 1/4"= 6.4 mm OD = 3/8"= 9.5 mm	4 lpm			
1c	LFSC-11D.1-001	100-30441	ID = 3/8" = 9.5 mm OD = 1/2" = 12.7 mm	20 lpm			
1d	LFSC-17D.1-001	100-30442	ID = 5/8" = 15.9 mm OD = 3/4" = 19.1 mm	50 lpm			
1e	LFSC-23D.1-001	100-30437	ID = 7/8"=22.2 mm OD = 1"=25.4 mm	80 lpm			
1f	LFSC-30D.1-001	100-30438	ID = 1 1/10" = 27.9 mm OD = 1 1/4" = 31.8 mm	160 lpm			
1g	LFSC-35D.1-001	100-30443	ID = 1 21/64" = 33.7 mm OD = 1 1/2" = 38.1 mm	320 lpm			

Table 4: *Standard flow sensor configurations (others on request)*

Pos.	Part Name	Article #	Description	Interfaces
2a (A+6)	LFC-1C-PC	100-30374	Single Channel Converter	Analog Output (4 – 20 mA), 2x Digital Output, 1x Digital Input, RS485 (MODBUS) protocol *Note 1: EMI ferrite (7) for flow sensor cable and signal connector (A) included in converter package.* *Note 2: Firmware version 24 or higher is needed for LFSC-D series with PFA tubing.*
3 (A+B)	LFC-6ClO-PC	100-30446	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. (6a) and Termination Box (6b) as separate article (see *Table 6*) *Note 1: EMI ferrite (7) for bus connector to be ordered as separate article (see Table 6). When stacking multiple converters EMI ferrite (7) is needed for every sensor cable (see manual for details).* *Note 2: Firmware version 07 or higher is needed for LFSC-D series with PFA tubing.*
4 (A-H)	LFC-1C-PC-SK	100-91072	Converter Starter Kit	Flow converter LFC-1C-PC (A) with Ferrite (B), AC/DC desktop supply (C) with international AC mains inserts, sensor cable LFI-C.1-30 (D), converter connection cable LFI-D.1 (E), RS485/USB cable YN-485I-TR (F), USB stick with Levitronix Service Software and product Literature (G).

Table 5: *LEVIFLOW® converter for clamp-on sensor*

Pos.	Part Name	Article #	Features	Special Feature / Description
5a	LFI-C.1-10 LFI-C.1-30 LFI-C.1-60	190-10307 190-10308 190-10309	Cable length: 1 m, PVC Cable length: 3 m, PVC Cable length: 6 m, PVC	Interconnect cable for connection between sensor and converter.
5b	LFE-C.2-10 LFE-C.2-30 LFE-C.2-60	190-10310 190-10311 190-10312	Cable length: 1 m, PVC Cable length: 3 m, PVC Cable length: 6 m, PVC	Extension cable with wall-mountable connector for cabinet mounting. Delivered with protective dust cap on wall-mountable connector side.
6a	Connector Box for LFC-6ClO-PC	100-30447	COMBICON connector	For wiring RS485 and supply of stacks of LFC-6ClO-PC converter.
6b	Termination Box for LFC-6C	100-30317	--	For termination of RS485 bus of LFC-6ClO-PC.
7	LeviFlow Splitting Ferrite	100-30353	EMI filtering of DC supply	For LFC-6ClO-PC supply needed. On flow sensor cables needed in case of stacking of multiple converters.
8	YN-485I-TR, USB to RS485 Adaptor-TR Isolated	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 space saver cable (D). Communication over fieldbus of converter with PC.

Table 6: *Accessories*

Pos.	Part Name	Article #	Flow Range	Calibration Set	Note
9a	LFSC-06D.1-001 + LFC-1C-PC LFSC-06D.1-002 + LFC-1C-PC	100-91300 100-91542	0 – 1 lpm	Water @ 20°C PFA Tubing	Extension and interconnect cables to be ordered as separate article with specified length (see *Table 6*).
9b	LFSC-09D.1-001 + LFC-1C-PC	100-91301	0 – 4 lpm		
9c	LFSC-11D.1-001 + LFC-1C-PC	100-91302	0 – 20 lpm		
9d	LFSC-17D.1-001 + LFC-1C-PC	100-91303	0 – 50 lpm		
9e	LFSC-23D.1-001 + LFC-1C-PC	100-91295	0 – 80 lpm		
9f	LFSC-30D.1-001 + LFC-1C-PC	100-91296	0 – 160 lpm		
9g	LFSC-35D.1-001 + LFC-1C-PC	100-91304 [1]	0 – 320 lpm		

Table 7: *Standard flowmeter sets – flow sensor with single-channel converter.*

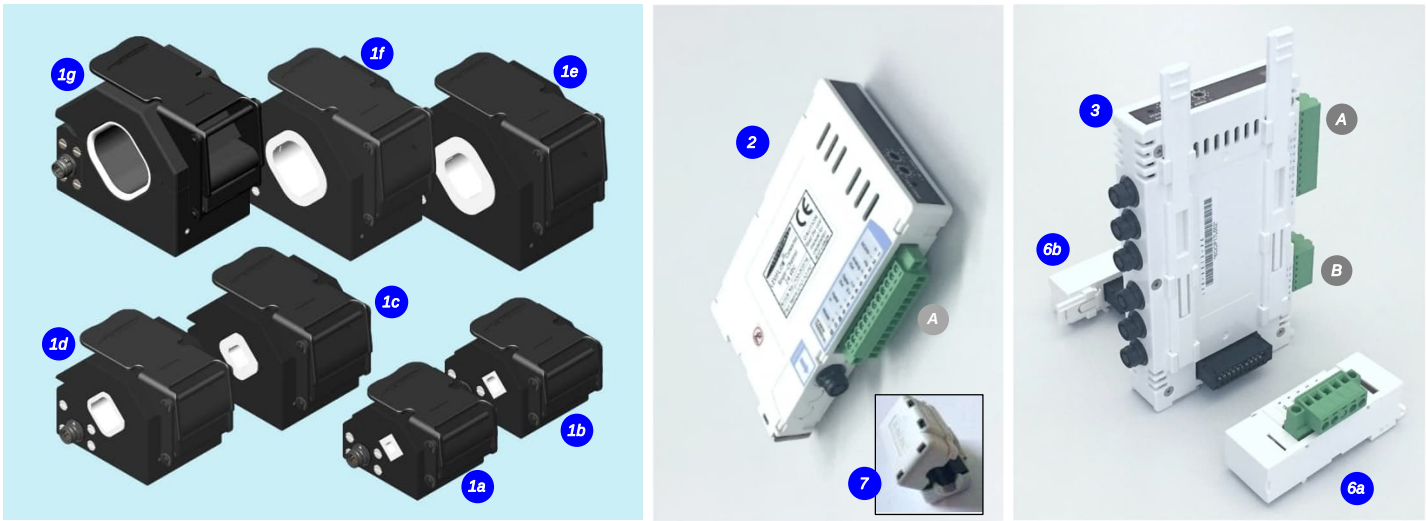


Figure 8: *Main LEVIFLOW® flowmeter components*

Figure 9: *Accessories*

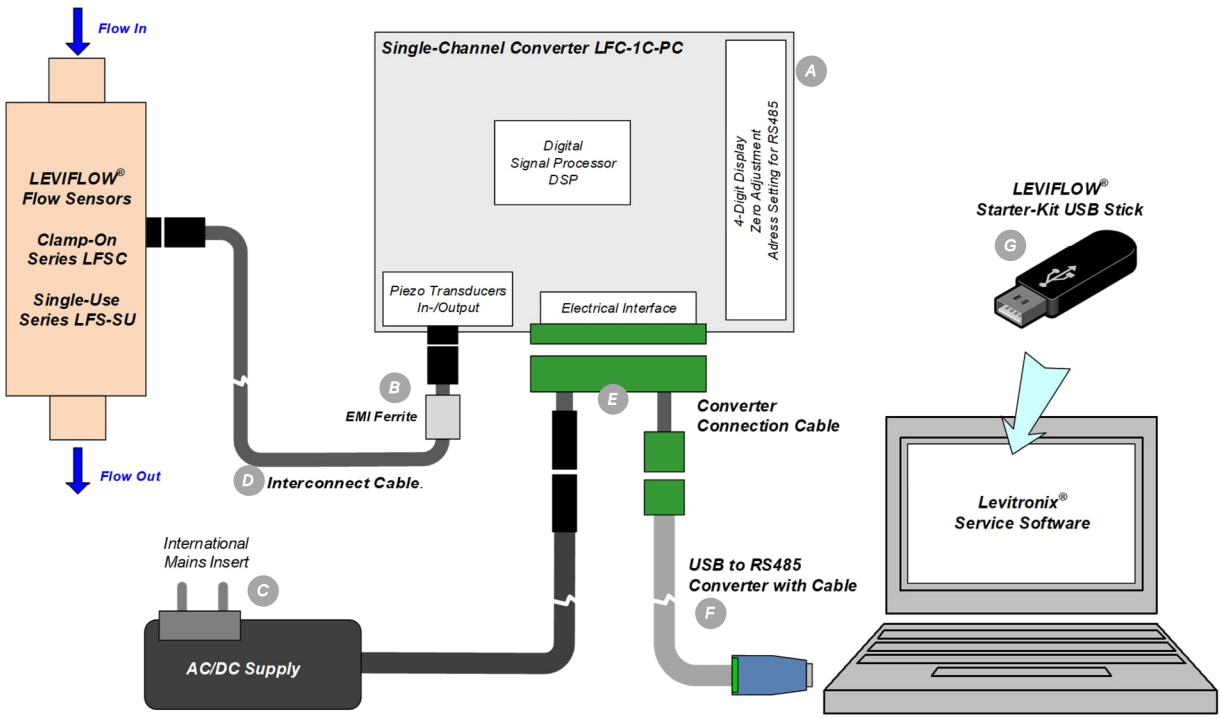


Figure 10: *Converter starter kit with components (flowmeters to be ordered as separate component).*

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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