LEVITRONIX®

# Ultrapure Fluid Handling
# Integrated Flow Controller Series

## BPS-iF30

Pump Pressure / Flow: 1.5 bar / 7.4 l/min

Flow Control Range:
0 - 4 l/min

## High Precision. No Bearings. No Contamination!

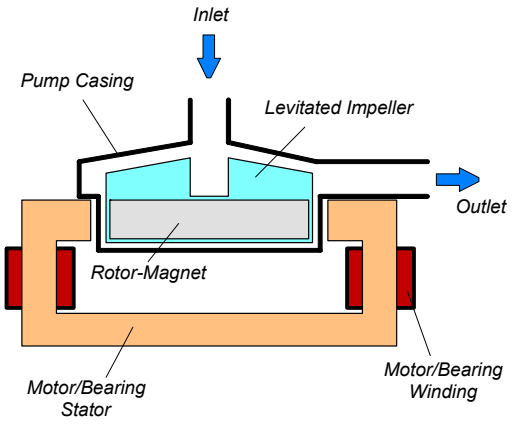



**Figure 1:** *Schematic of the main elements of the MagLev centrifugal pump*

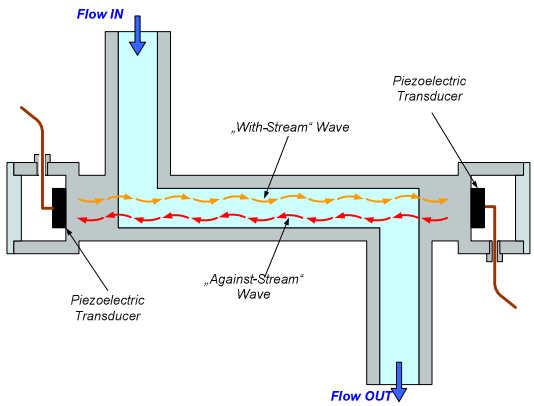



**Figure 2:** *Operating principle ultrasonic flowmeter sensor with Z-shape (same principle with U-shape)*

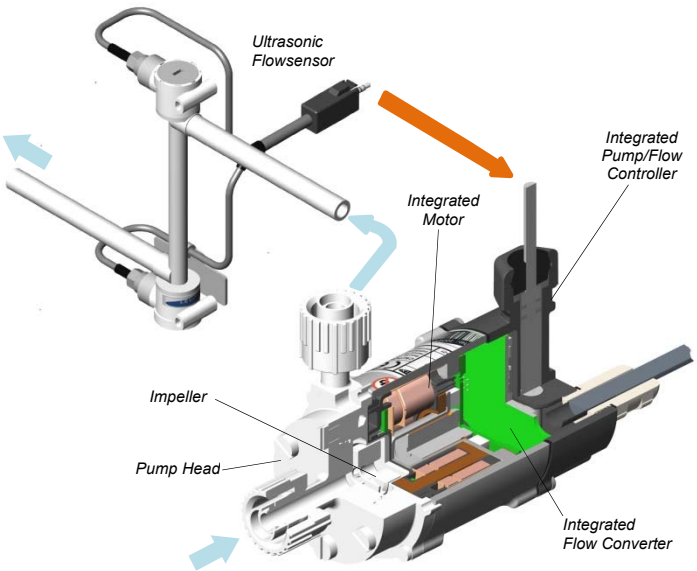



**Figure 3:** *Integrated MagLev flow control system with ultrasonic flow sensor.*

## INTRODUCTION

With the *BPS-iF30* flow control system *Levitronix*® combines its unique magnetic levitation pump technology with its ultrasonic flow measurement technology. The result is a highly integrated precise flow controller with an integrated pressure source.

The centrifugal pump, as a pressure source, has no bearings to wear out or seals to break down and fail. The pump impeller is suspended, contact-free, inside a casing and is driven by the magnetic field of the motor (*Figure 1*).

The flow is measured with the proven *LEVIFLOW*® ultrasonic sensor technology not invading into the fluid path (*Figure 2*).

The pump head and flow sensor is fabricated from chemical-resistant high purity fluorocarbon resins. The pump controller, motor and flow converter are integrated into the driver housing (see *Figure 3*). This reduces cabling and setup effort significantly. Fluid flow rate is precisely controlled by electronically regulating the impeller speed without pulsation.

## SYSTEM BENEFITS

- High precision, dynamics and turndown ratio.
- No dependency on external pressure source.
- Extremely low particle generation due to the absence of mechanically contacting parts.
- Increased equipment uptime with lower maintenance costs by eliminating valves, bearings, rotating seals and costly rebuilds.
- Very low integration costs as no external controller is needed for flow control.
- Reduced risk of contamination due to the self-contained design with magnetic bearings and ultrasonic technology.
- Very gentle to sensitive fluids due to low-shear design.
- No narrow gaps and fissures where particles or microorganisms could be entrapped.
- Smooth, continuous flow without pressure pulsation.
- Proven pump and ultrasonic flow measurement technology

## APPLICATIONS

- Semiconductor wet processing (Cleaning, CMP etc.).
- Flip chip and advanced packaging.
- Solar cell production.
- Flat panel display manufacturing.
- Hard-disk fabrication.
- Printer ink handling.
- Pharmaceutical production.
- Plating.
- Circulation in flow batteries.

## BASIC SYSTEM CONFIGURATION

*Figure 7* illustrates the interfacing of the integrated flow control system. Various PLC signals allow a simple setup with precisely setting the speed via an analog input. Various digital inputs and outputs allow controlling and monitoring of the system.

A *RS485* interface allows communication with a PC in connection with the *Levitronix® Service Software*. Hence parameterization, firmware updates and failure analysis are possible. Furthermore the user hence is able to optimize the system to various specific situations.

The *RS485* can also be used as a fieldbus to implement more intelligent concepts of flow control. The fieldbus also allows control of multiple systems.

## FLOWCONTROL CONCEPT AND MAIN BENEFITS

*Figure 5* illustrates the flow control concept with the *BPS-iF30*. Flow control, pressure generation and flow measurement is done with one unit. This allows realization of sophisticated flow control algorithms and optimizations to various situations.

There is a linear relationship between flow and speed (see *Figure 5*). The speed is precisely controlled with a high resolution over a wide speed range. This allows a flow control with high resolution and high turndown ratio compared to non-linear flow control with valve type flow control concepts. Additionally the highly dynamic speed controller allows fast flow step responses.

As the speed is monitored and the pressure cannot increase uncontrolled at a given speed, there is no need to protect the hydraulic circuit against over-pressure situations as for example for roller pumps in tube clogging situations.

## CAPABILITIES OF FLOWCONTROL SYSTEM

The versatility of the *BPS-iF30* 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*).

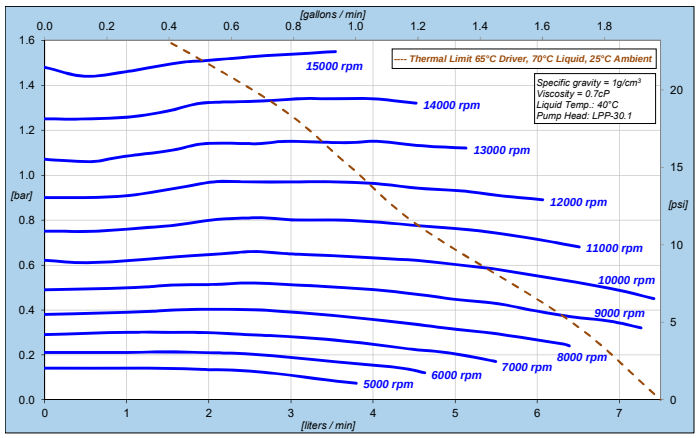



***Figure 4:*** *Pressure/flow curves for aqueous liquids (similar to water)*

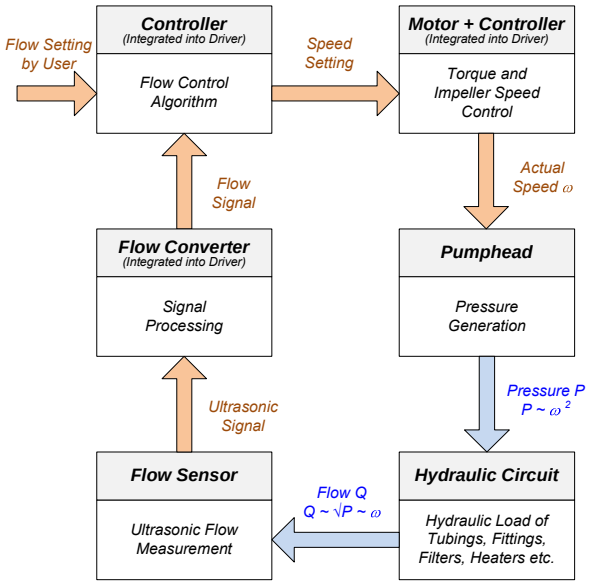



***Figure 5:*** *Simplified block schematics of flow control with BPS-iF30*

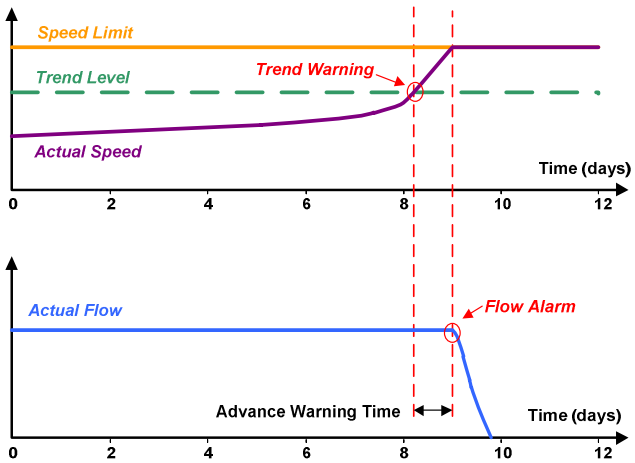
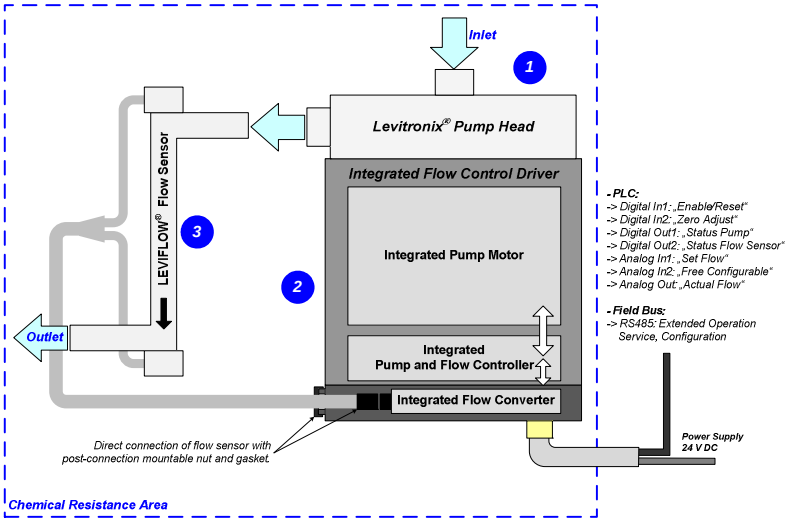



***Figure 6:*** *Dynamic Condition Trending (DCT)*




| Wire Name | Description | Standard Designation | Hardware Specification |
|---|---|---|---|
| P+ | + 24 VDC | Supply | Voltage: 24 VDC<br>P- to be connected to earth |
| P- | Power Input Ground / Earth | | |
| Ain1 | Analog Input 1 (Current Input) | Reference Value (Set Flow) | Analog current input: 4 – 20 mA (450 Ohm shunt input, no galvanic isolation) |
| Ain2 | Analog Input 2 (Voltage Input) | Free Configurable | Analog voltage input: 0 – 10V (7.9 kOhm, no galvanic isolation) |
| Ain_GND | Analog Input, Ground | -- | Reference for Ain1 and Ain2 |
| Din1 | Digital Input 1 | Enable (Reset) | Galvanic separation with optocoupler<br>2.2 kΩ input resistance, 5-24V for active input |
| Din2 | Digital Input 2 | Zero Adjust | |
| Din_COM | Common Digital Input | -- | -- |
| Aout1 | Analog Output | Actual Flow | 0 – 10V (no galvanic isolation)<br>AGND is reference |
| Dout1 | Digital Output 1 | Status Pump | Open drain, max. 24V, 100mA<br>Reference ground is AGND |
| Dout2 | Digital Output 2 | Status Flow Sens. | |
| AGND | Analog Ground | -- | Reference for Aout1, Dout1 and Dout2 |
| RS485+ | RS485 + | Field Bus | Modbus protocol |
| RS485- | RS485 - | | |
| Internal | Internal Bus | Do not connect | -- |
| Internal | Internal Bus | Do not connect | -- |
| Shield | Shielding | Shielding | To be connected to earth<br>(see wire P-) |

***Figure 7:*** *Standard system configuration of flow control system BPS-iF30*
*Note: Parameters of closed loop control can be configured via Levitronix® Service Software over RS485*

| Characteristics \ Flow Controller Type | BPS-iF30 for up to 4 l/min (with LFSC-04L-SC Sensor) | | |
|---|---|---|---|
| Flow Range [ml/min] | 0 – 35 | | 35 – 4000 |
| Accuracy of Reading | see *Figure 8* | | ± 1% |
| Repeatability of Read. | see *Figure 8* | | < 0.5% |
| *Response Time: Step from 10 – 90% of full scale.* | < 1s *Note: Value for to the specific hydraulic circuit optimized flow control parameters. Standard settings are tuned for general flow control stability and may be higher.* | | |
| Fluid Temperature / Ambient Temperature | 10 – 70 °C (50 – 158 °F) | / | 0 – 40 °C (32 – 104 °F) |
| Maximum Fluid Pressure | 0 – 0.5 MPa ( 0 – 5 bar, 0 – 72.5 psi) | | |
| Sound Speed / Kinematic Viscosity | 1000 – 2200 m/s | / | 0.8 – 40 $mm^2/s$ (0.8 – 40 cSt) |
| Wet Materials / Enclosure Classification | PFA for flow sensors and pump head | / | IP-65 for flow sensor mounted on flow control driver |

***Table 1:*** *Specifications of flow controller systems BPS-iF30 (All data based on water at 20 °C)*

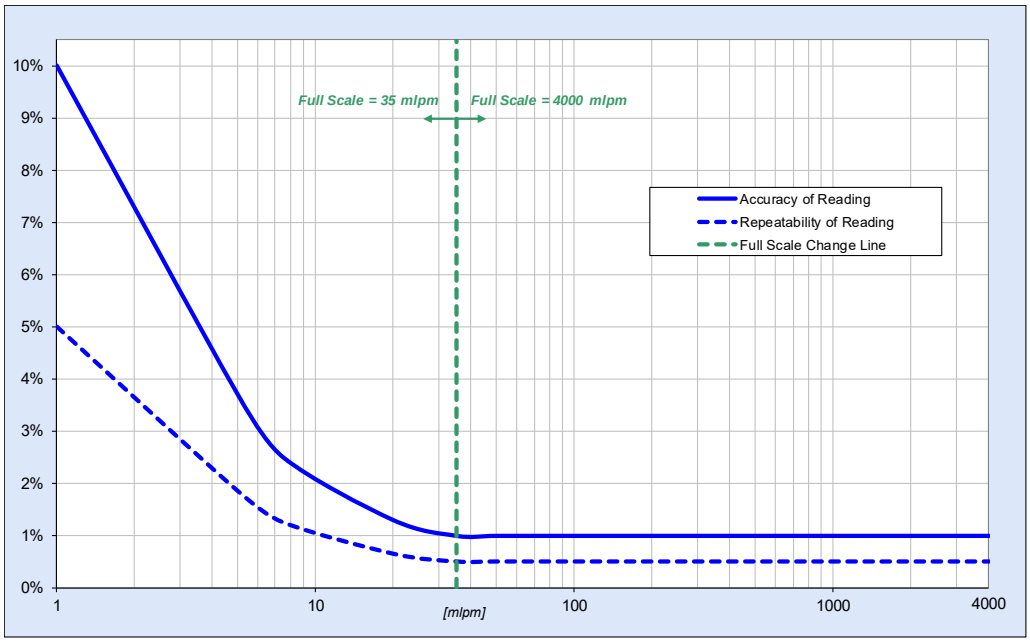



***Figure 8:*** *Accuracy and repeatability specifications of flow control system BPS-iF30 with LFS-04L-SC flow sensors*

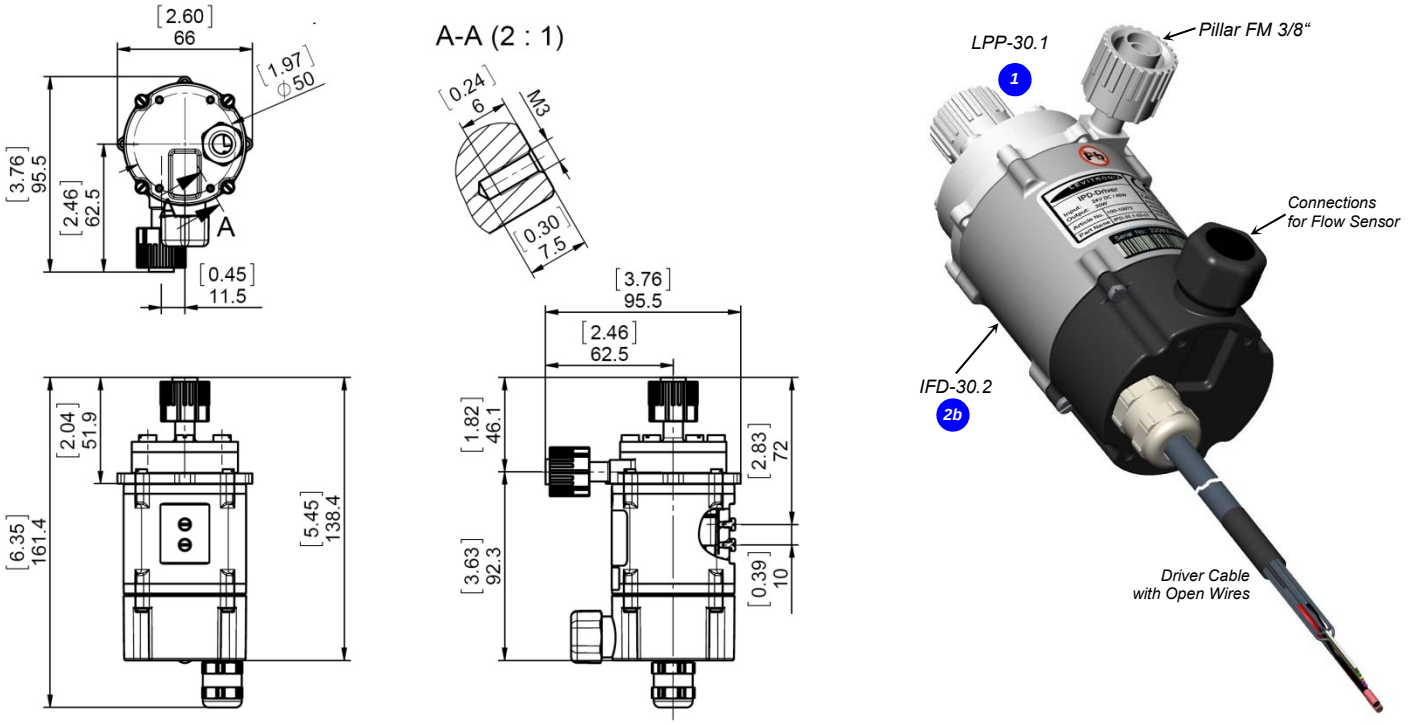



*Figure 9: Dimensions of integrated flow control driver with pump head (in mm and [inch])*

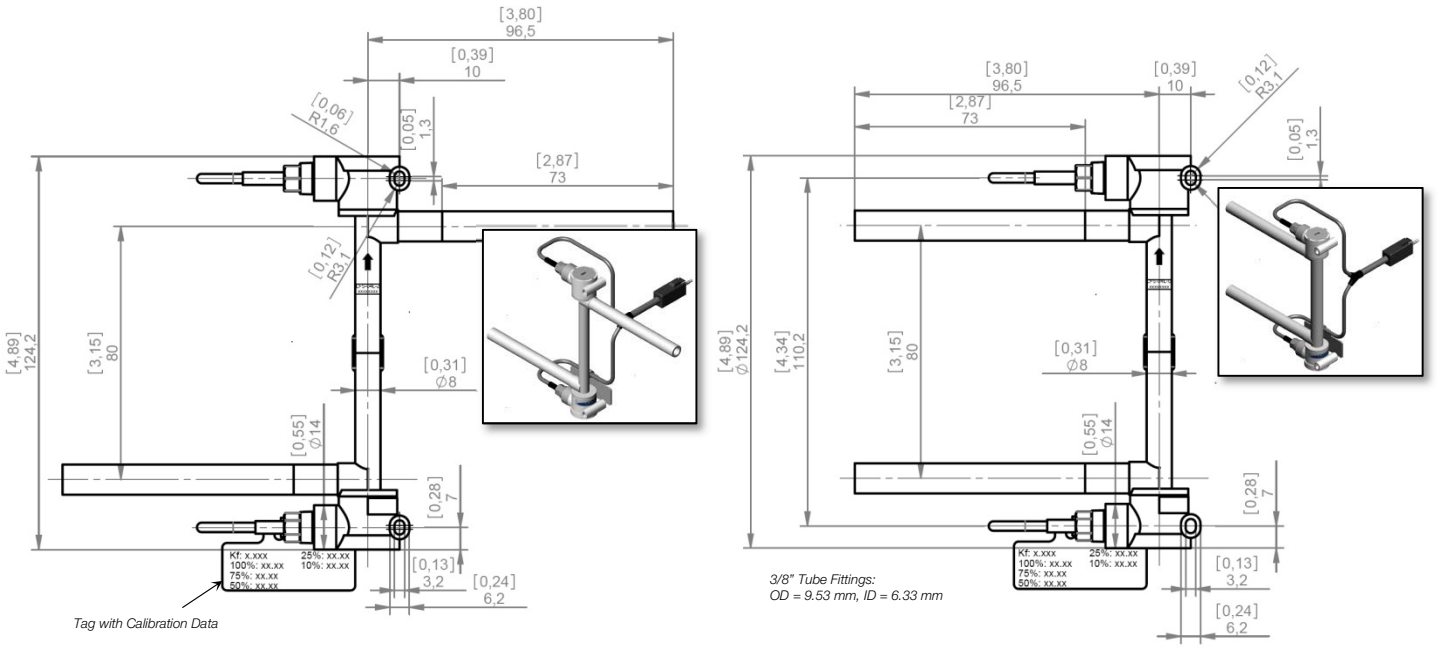



*Figure 10: Dimensions of LFS-04L flow sensor (dimensions in [mm])*

# ORDER INFORMATION

| System Name | Article # | Flow Sensor | Flow Control Driver | Pump Head | Note |
|---|---|---|---|---|---|
| BPS-iF30.1-04LZSC1 | 100-91027 | LFS-04L-Z-SC1 (4 l/min, 0.6m) | IFD-30.1-50-01 (Epoxy Coating, PVC Cable) | LPP-30.1 | *Flow control driver comes delivered with flow sensor calibration parameters stored in driver if ordered as a set.* |
| BPS-iF30.1-04LUSC1 | 100-91028 | LFS-04L-U-SC1 (4 l/min, 0.6m) | | | |
| BPS-iF30.2-04LZSC1 | 100-91029 | LFS-04L-Z-SC1 (4 l/min, 0.6m) | IFD-30.2-50-01 (ETFE Coating, FEP Cable) | | |
| BPS-iF30.2-04LUSC1 | 100-91030 | LFS-04L-U-SC1 (4 l/min, 0.6m) | | | |

***Table 2:*** *Standard flow control system configurations*

| Pos. | Component | Article Name | Article # | Characteristics | Value / Feature |
|---|---|---|---|---|---|
| 1 | Pump Head | LPP-30.1 | 100-90828 | Impeller / Pump Housing<br>Sealing O-Ring<br>In-/Outlet Fittings<br>Max. Flow<br>Max. Diff.-Pressure<br>Max. Viscosity<br>Max. Liquid Temp. | *PTFE / PTFE*<br>*Kalrez® perfluorelastomer [1]*<br>*3/8" Pillar Super 300 FM (female)*<br>*7.4 liters/min / 2 gallons/min*<br>*1.5 bar / 23 psi*<br>*10 cP*<br>*70 °C / 158 °F* |
| 2a | Integrated Flow Control Driver | IFD-30.1-50-01 [2] | 100-10094 | Voltage, Power<br>Housing<br>Cable<br>Interfaces<br><br><br><br><br>Standard Firmware | *24 VDC ±10%, 35 W*<br>*Epoxy (corrosion resistant) coated Aluminum, waterproofed IP-65 [3]*<br>*PVC jacket, open wires, cable length 5 m*<br>*PLC with* - *1 analog input* *4 – 20 mA*; - *1 analog input* *0 – 10 V*; - *1 analog output* *0 – 10 V*; - *2 digital inputs* *0 – 24 V (optocoupler)*; - *2 digital outputs* *0 – 24 V / 100 mA (open drain)*<br>*RS485 interface (for service and extended field operation). Modbus protocol.*<br>*K1.48* |
| 2b | Integrated Flow Control Driver | IFD-30.2-50-01 [2] | 100-10099 | Housing<br>Cable | *ETFE (highly chemical resistant) coated Aluminum, waterproofed IP-65 [3]*<br>*FEP jacket, open wires, cable length 5m* |

***Table 3:*** *Specification of standard components*

*1: Kalrez® is a registered trademark of DuPont Dow Elastomers. 2: Interchangeability of drivers with sensors is under investigation. 3: Designed and tested for IP-67.*

| Pos. | Article Name | Article # | Shape | Flow Range | Fitting | Cable | Special Feature | Note |
|---|---|---|---|---|---|---|---|---|
| 3a | LFS-04L-Z-SC1 | 100-30388 | Z | 0 – 4 l/min | 3/8" | PVC jacket 0.6 m | *Calibration for 35-4000 ml/min 1% accuracy range.* | *Sensor specific parameter for controller calibration delivered on a tag attached to the flow sensor.* |
| 3b | LFS-04L-U-SC1 | 100-30386 | U | | | | | |

***Table 4:*** *Standard flow sensors*

| Pos. | Component | Article Name | Article # | Characteristics | Value / Feature |
|---|---|---|---|---|---|
| 4 | Impeller Exchange Kit | IEK-30.1 | 100-90837 | Impeller LPI-30.1 (a)<br>Sealing O-Ring (b)<br>Pump Housing Screws (c)<br>Pump Motor Screws (d)<br>Exchange Tool IET-30.1 (e) | *PTFE*<br>*O-Ring, Kalrez® 28.3 x 1.78 mm*<br>*6 pieces, stainless steel PTFE coated, M5 x 14 mm*<br>*4 pieces, stainless steel PTFE coated, M3 x 10 mm*<br>*POM-C* |
| 5 | Mounting Base Plate | MBP-i30.1 | 190-10313 | Material<br>Feet Mounting Screws | *PP + 30% GF*<br>*2 pieces, stainless steel FEP coated, M3 x 10 mm* |
| 6 | AC/DC Power Supply | TPC 055-124 (Traco) | 100-40014 | Voltage / Power Output<br>Voltage Input<br>Basic Dimensions<br>Certification or Standards | *24 VDC / 55 W*<br>*85 – 264 VAC, 47-63 Hz*<br>*45 x 90 x 96.5 mm (mountable on DIN rail 35 mm)*<br>*UL, CSA, CB, Semi F47* |
| 7 | USB to RS485 Adaptor-TR Isolated | YN-485I-TR | 100-30392 | Structure/Design<br><br><br>Purpose | *USB connector (7a) with termination resistor and cable with connector pair (7b and 7c) for external RS485 wire connection. Magnetically isolated. Cable length is 2m.*<br>*Communication over fieldbus of driver with PC* |

***Table 5:*** *Specification of accessories*

*1: Designed and tested for IP67.*


*Figure 11: Flow control driver and pump head*

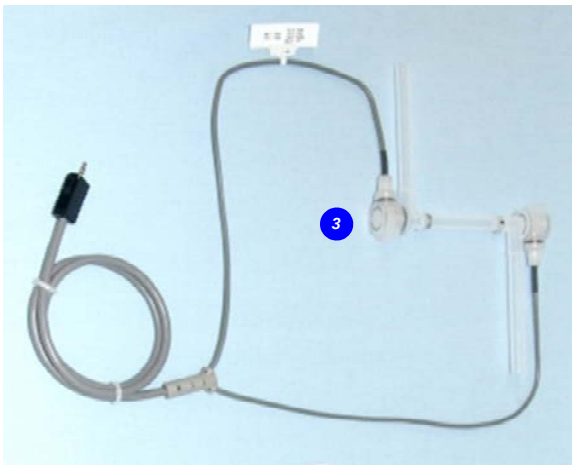



*Figure 12: Flow sensor*


*Figure 13: Accessories*

*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 Life Science 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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