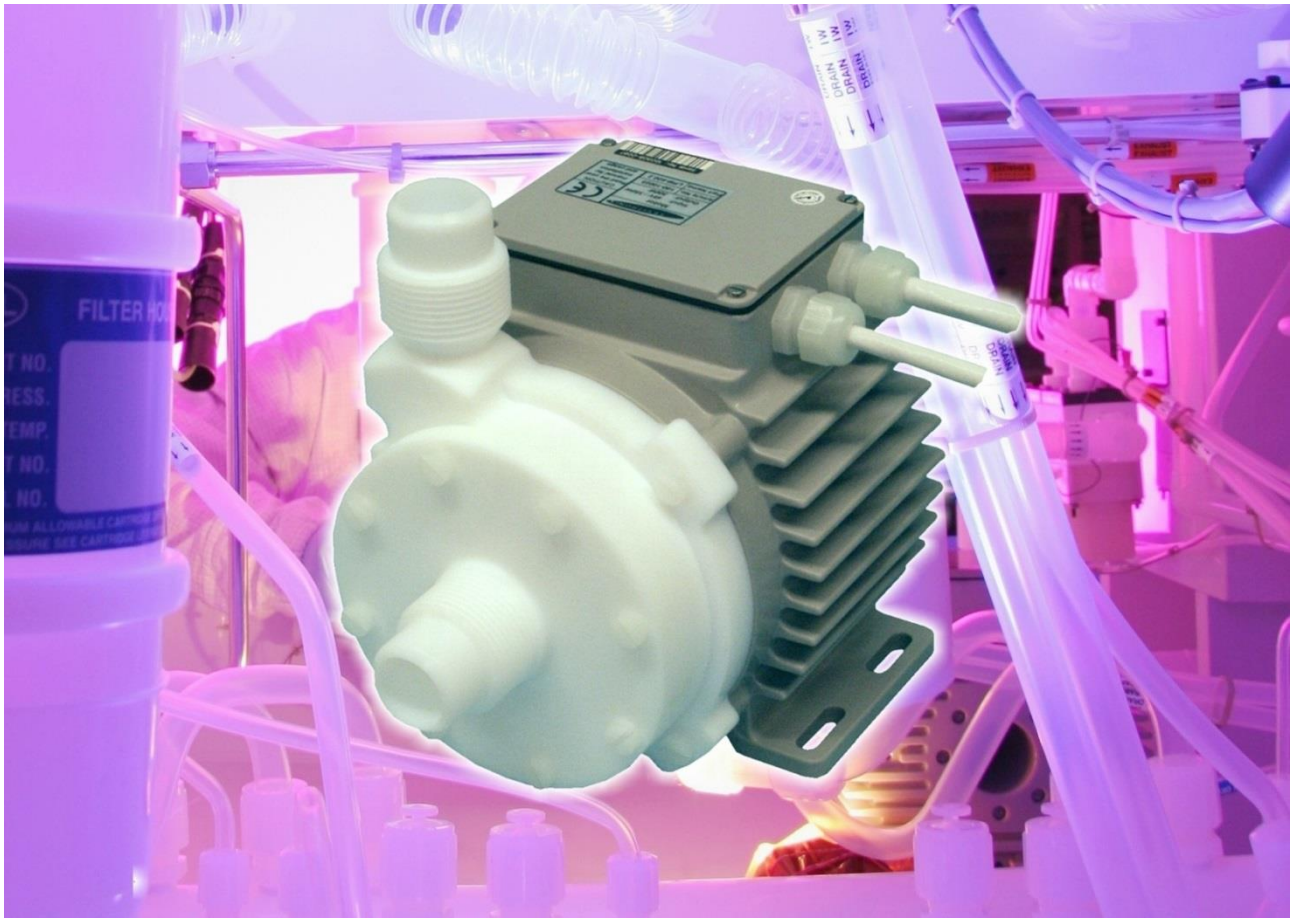
BPS-600

3.2 bar (46 psi)
75 liters/min (20 gallons/min)

USER MANUAL



This manual contains information necessary for the safe and proper use of the *BPS-600*. Included are specifications for the standard configurations of the pump system and instructions regarding its use, installation, operation, adjustment, inspection and maintenance. For special configurations of the pump system refer to accompanying information. Please familiarize yourself with the contents of the manual to ensure the safe and effective use of this product. After reading this manual, please store the manual where the personnel responsible for operating the pump system can readily refer to it at any time.

Table of Contents

1 Safety Precautions

The *BPS-600* pump system is designed to be used in industrial production machines and equipment containing hydraulic circuits. Typical applications are Semiconductor and chemical manufacturing equipment. Installation shall be done by qualified personnel only. Following safety precautions and all "CAUTION", "WARNING" and "DANGER" indications in the relevant sections shall be followed.

CAUTION

Do not under any circumstances open the controller or motor. Levitronix® does not assume responsibility for any damage, which occurs under such circumstances.

CAUTION

High magnetic field strength of pump impeller.

The pump system contains a rotor magnet with high field strength. This may alter or damage the calibration of sensitive electronic devices and measuring instruments in the immediate surroundings. Keep at a safe distance from computers, monitors and all magnetic data storage media (e.g. disks, credit cards, audio and video tapes etc.)

⚠ WARNING

Hazardous voltage may be present.

In case of the usage of an inadequate AC/DC power supply, mains voltages may be present (even if the system is designed for 48VDC). The usage of a galvanic separated power supply, which is certified by a 3rd party (UL or CE), is highly recommended.

The controller must be grounded and placed in a spill protected electrical cabinet. Do not under any circumstances open the powered controller.

Always isolate the electrical power supply before making or changing connections to the unit. To remove the power it is recommended to use an isolating device.

⚠ WARNING

High magnetic field strength of pump impeller.

The pump system contains a rotor magnet with high field strength. Pacemakers may be influenced and magnetic forces may lead to contusions. Keep distance to pace makers and handle impeller with care.

⚠ WARNING

TOXIC CHEMICALS may be present.

When using the system to pump chemicals skin contact and toxic gases may be hazardous to your health. Wear safety gloves and other appropriate safety equipment.

⚠ WARNING

Motors for ATEX / IECEX applications. Only specific types of motors LPM-600 are classified for the use in Ex classified locations. Refer to the corresponding section in the manual.

2 Specifications

2.1 Specification of Components

Figure 1 shows the main system components (motor, controllers, pump head) and *Figure 2* illustrates the according accessories.

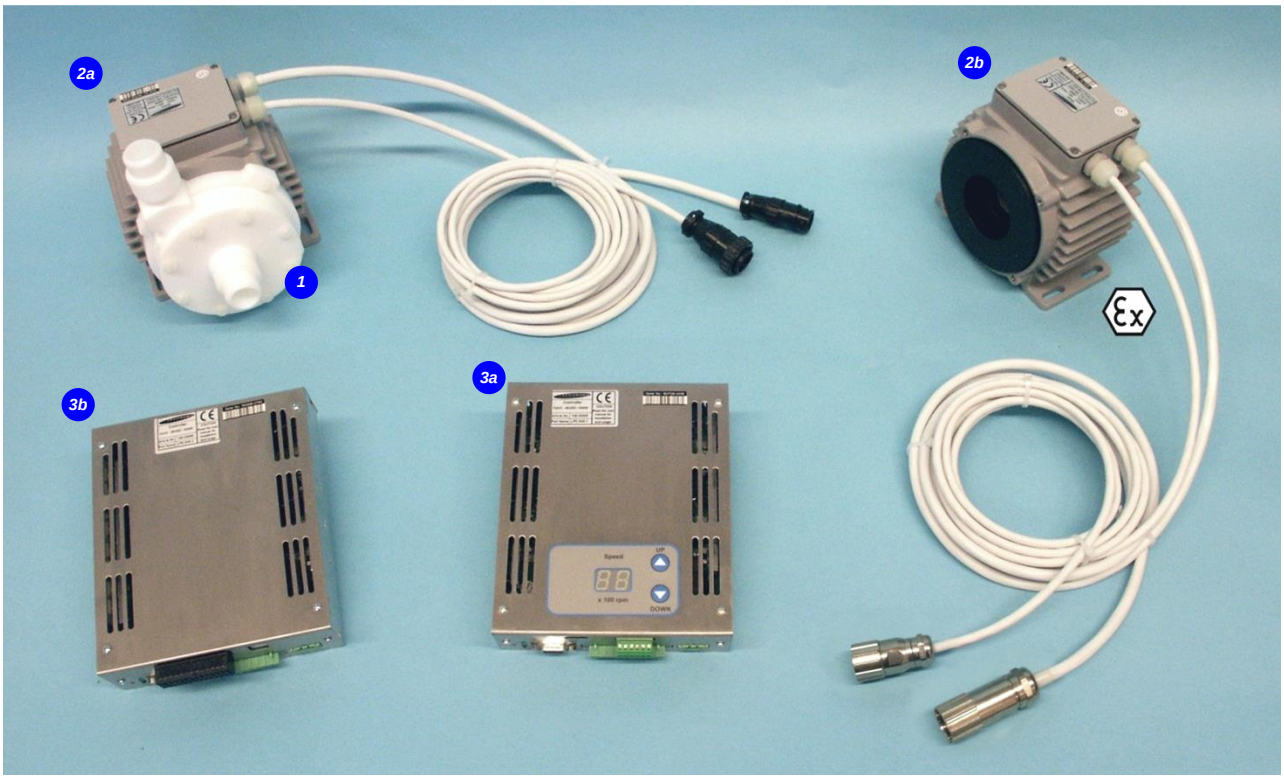


Figure 1: Standard components

Figure 2: Accessories

System Name	Article #	Pump Head	Motor	Controller	Note
BPS-600.1	100-90171	LPP-600.1	LPM-600.2	LPC-600.1	*Adaptor/Extension (0.5 - 10m) cables according to Table 3 (position 4a and 4b) have to be ordered as separate article with specified length.*
BPS-600.2	100-90172		LPM-600.2	LPC-600.2	
BPS-600.5 (ATEX / IECEx)	100-90356		LPM-600.4 (ATEX)	LPC-600.1	*Adaptor/Extension (0.5 - 10m) cables according to Table 3 (Position 5a and 5b) have to be ordered as separate article with specified length.*
BPS-600.6 (ATEX / IECEx)	100-90357		LPM-600.4 (ATEX)	LPC-600.2	*ATEX Cable Sealing System to be ordered according to Table 4.*

Table 1: Standard system configurations

Pos.	Component	Article Name	Article #	Characteristics	Value / Feature
1	Pump Head	LPP-600.1	100-90242	Impeller / Pump Housing Sealing Ring Fittings	*PFA / PTFE* *Kalrez® perfluoroelastomer [1]* *Flaretek 1" [2]*
				Max. Flow Max. Diff.-Pressure Max. Viscosity	*75 liters/min / 20 gallons/min* *3.2 bar / 46 psi* *100 cP*
				Max. Liquid Temp.	*90°C / 194°F*
2a	Motor	LPM-600.2	100-10025	Housing	*- ETFE (chemical resistant) coated Aluminum* *- waterproofed (IP67 without connectors)*
				Cable / Connectors	*2x 3m cables with FEP jacket / 2x circular (AMP types)*
2b	Motor (ATEX)	LPM-600.4	100-10038	ATEX Marking	CE Ex II 3G Ex nA IIC T5 Gc CE Ex II 3D Ex tc IIIC T100°C Dc
				Cable / Connectors	*2x 3m cables with FEP jacket / 2x circular (M23, IP67)*
3a	Standalone Controller (User Panel)	LPC-600.1	100-30005 (Controller with power supply cable and Enable connector incl. in 100-90315)	Voltage / Power	*48V DC / 600 W*
				Housing Protection	*IP20*
				Interfaces for Standalone Controller	*Panel to set speed (automatic storage on internal EEPROM)*
				PLC with	*1x analog input ("Speed") — 4 - 20 mA* *1x digital input ("Enable") — 0 - 24 V (optocoupler)* *1x digital output ("Status") — 0 - 24 V (relais)*
				Standard Firmware	*D6.25*
3b	Extended Controller (PLC and USB)	LPC-600.2	100-30004 (Controller with power supply cable and PLC connector incl. in 100-90314)	Interfaces for Extended Controller	*PLC with* *- up to 4 digital inputs — 0 - 24V (optocoupler)* *- up to 4 digital outputs — 0 - 24 V (relais)* *- up to 2 analog inputs — 4 - 20mA* *- up to 2 analog inputs — 0 – 10 V* *- up to 2 analog outputs — 0 – 5 V*
					USB interface (for service and system monitoring)
				Standard Firmware	*D6.48*

Table 2: Specification of standard components

1: Kalrez® is a registered trademark of DuPont Dow Elastomers

Pos.	Component	Article Name		Article #		Characteristics	Value / Feature
		Sensor Cable	Power Cable	Sensor	Power		
4a 4b	Extension Adaptor Cable for Sensor (a) and Power (b) Wires	MCAS-600.1-05 (0.5m) MCAS-600.1-30 (3m) MCAS-600.1-50 (5m) MCAS-600.1-70 (7m) MCAS-600.1-100 (10m)	MCAP-600.1-05 MCAP-600.1-30 MCAP-600.1-50 MCAP-600.1-70 MCAP-600.1-100	190-10122 190-10123 190-10124 190-10101 190-10125	190-10118 190-10119 190-10120 190-10102 190-10121	Jacket Material Connector Types Connector Material	*PVC* *Circular AMP to D-SUB* *Plastics (PA)*
5a 5b	Extension Adaptor Cable for Sensor (a) and Power (b) Wires	MCAS-600.3-05 (0.5m) MCAS-600.3-30 (3m) MCAS-600.3-50 (5m) MCAS-600.3-70 (7m) MCAS-600.3-100 (10m)	MCAP-600.3-05 MCAP-600.3-30 MCAP-600.3-50 MCAP-600.3-70 MCAP-600.3-100	190-10158 190-10159 190-10130 190-10160 190-10161	190-10154 190-10155 190-10129 190-10156 190-10157	Jacket Material Connector Types Connector Material	*PVC* *Circular M23 (IP-67) to D-SUB* *Metallic – Nickel coated*

Table 3: Specification of adaptor/extension cables

Pos.	Component	Article Name	Article #	Characteristics	Value / Feature	
6	Air Cooling Module **(Not for ATEX applications)**	ACM-600.2	190-10140	Material / Connection Port	*PP (+ 40% Talkum) / NPT ¼"*	
				Air Pressure / Consumption	*~1 - 3 bar (14 – 43 psi) / 100 Liter/min @ 1 bar (14.5 psi)*	
7 (a+b+ c+d)	Impeller Exchange Kits	IEK-600.1	100-90515	Impeller LPI-600.2 (7a) O-Ring (7b) Pump Housing Screws (7c) Motor Mounting Screws Exchange Tool IET-3.1 (7d)	*PFA* *O-Ring, Kalrez, 72.62x3.53* *PVDF, 8pcs M6x25* *PVDF, 4pcs M6x25* *POM-C*	
8	Ex Cable Sealing System	ACS-A.1 (Roxtec)	100-90292	Sleeve (a) and Gasket (b) Frame (c) Cable Module (d)	*Stainless Steel and EPDM* *Roxylon (EPDM rubber)* *Roxylon (EPDM rubber)*	*Note: Lubricant (e) and measurement plates (f) are included.*
9	AC/DC Power Supply	TSP 600-148-M (M = Modified Levitronix design from Traco)	100-40013 (Traco ID Number: T1068-01A)	Voltage / Power Output Voltage Input	*48 VDC / 600 W* *85 – 265 VAC (automatic detection)*	
				Certification or Standards	*CB, UL, CSA, Semi F47*	
10	Screw Set	Screw Set SS+PTFE	100-90412	Number/Dimensions Material	*12 pcs M6x25* *Stainless Steel+ PTFE coating*	*Needed to increase maximum static pressure of pump head. (see also Section 2.6)*

Table 4: Specification of accessories

2.2 Standard System Configurations

2.2.1 Stand-Alone System Configuration

The stand-alone pump system configuration (*Figure 3*) consists of a controller with an integrated user panel to set the speed manually. The speed is automatically stored in the internal EEPROM of the controller. As an option, the speed can also be set with an analogue signal.

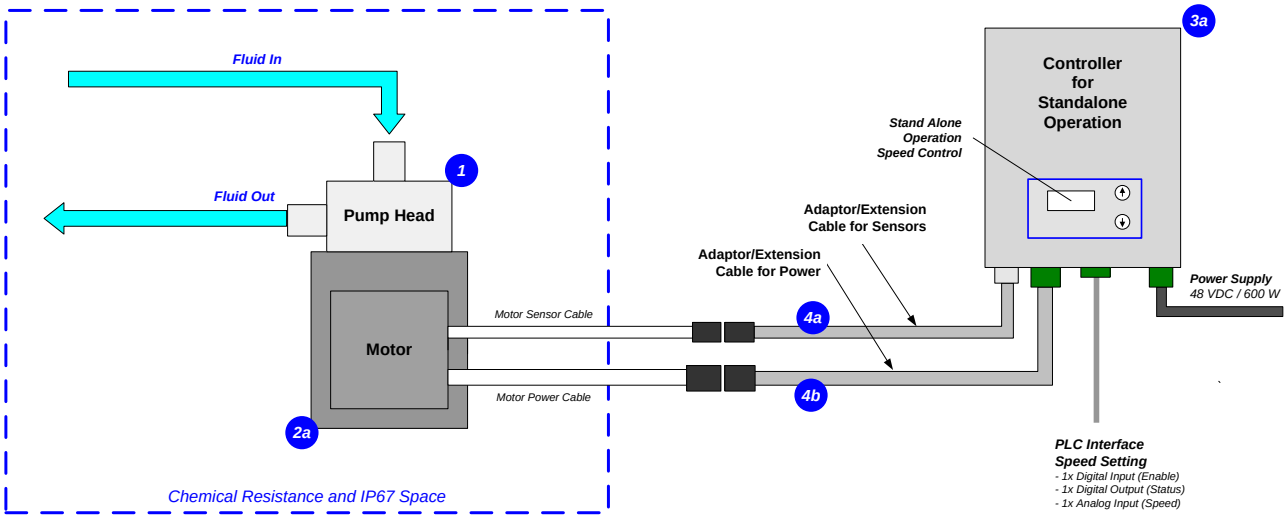


Figure 3: Standard system configuration for standalone operation
(Speed setting with integrated user panel)

2.2.2 Extended System Configuration

The extended version of the pump system (*Figure 4*) consists of a controller with an extended PLC interface. This allows setting the speed by an external signal and enables precise closed-loop flow or pressure control in connection with either a flow or a pressure sensor. A USB interface allows communication with a PC in connection with the *Levitronix® Service Software*. Hence parameterization, firmware updates and failure analysis are possible.

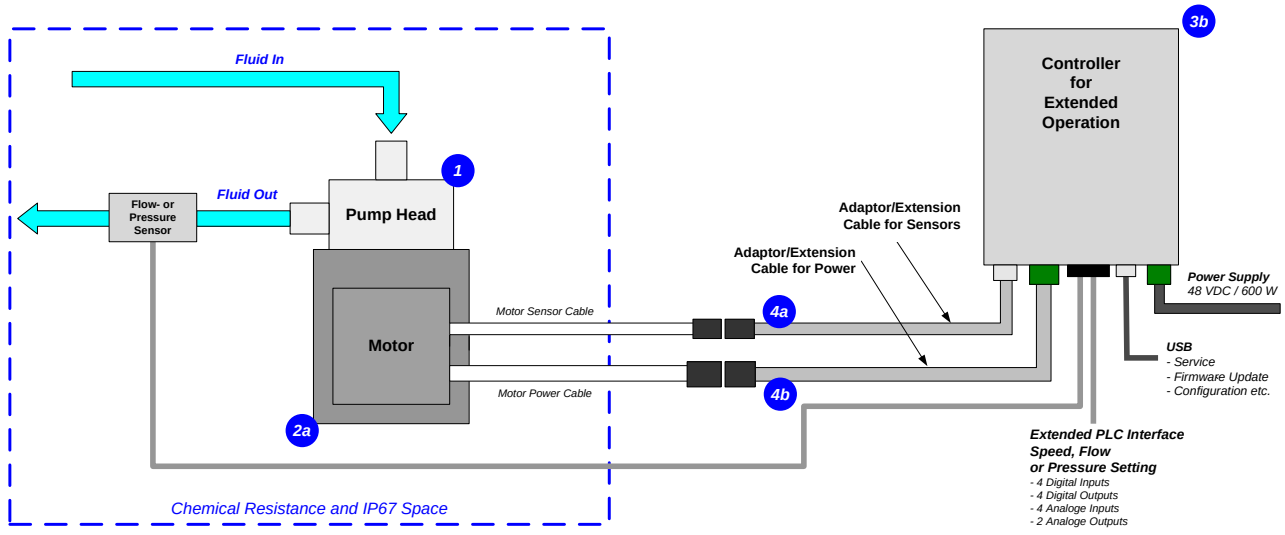


Figure 4: Extended operation (flow or pressure control) with extended controller

2.2.3 *ATEX / IECEx* System Configuration

Together with the standard pump head and controllers an *ATEX / IECEx* certified motor allows installation of motor and pump head within an Ex classified area (see *Figure 5*). The *ATEX / IECEx* motor comes delivered with special connectors and relevant extension cables (*see Table 3*). One option to lead the cables outside of the *Ex* area is an ATEX certified cable sealing system as listed in *Table 4*.

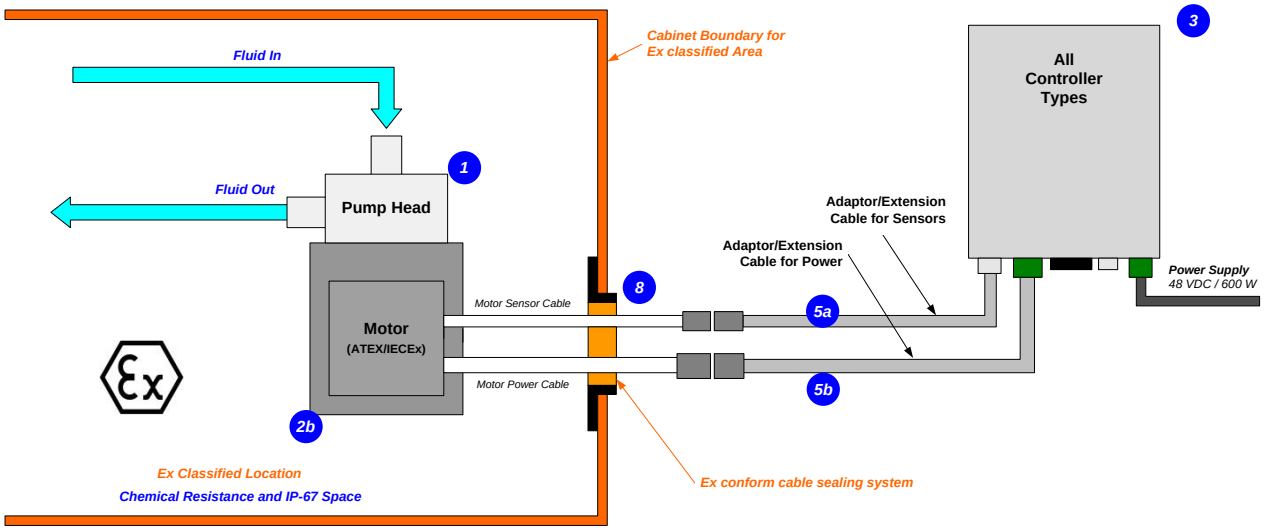


Figure 5: System configuration for ATEX / IECEx applications

2.3 General Environmental Conditions

Usage	Indoor (motor with pump head can be placed outdoor)
Altitude	Up to 2000 m
Operating ambient temperature	0 to 40 °C
Storage ambient temperature (Extremes for Transportation)	-20 to 80 °C
Operating humidity range (relative humidity)	15 – 95% (non-condensing)
Storage humidity range (relative humidity) (Extremes for Transportation)	15 – 95% (non-condensing)
Normal storage conditions	Ambient temp.: 20 to 30 °C Relative humidity: 50% (non-condensing)
DC supply fluctuations	± 5% of nominal voltage
Transient over-voltages typically present on the mains supply	Surge immunity according to EN 61000-4-5 (tested together with certified AC/DC power supply)
Pollution degree	2

Table 5: Environmental conditions for pump system

2.4 Pressure-Flow Curves

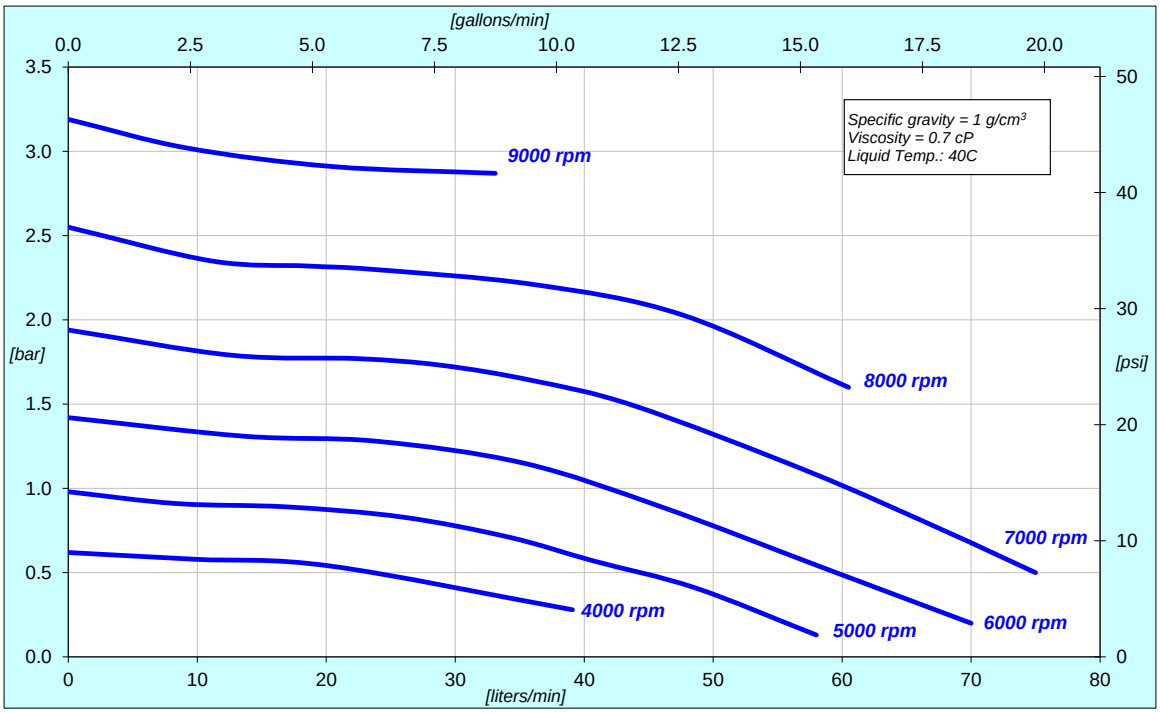


Figure 6: Pressure/flow rate charts
(Measured with pump head LPP-600.1)

2.5 NPSHr Curves

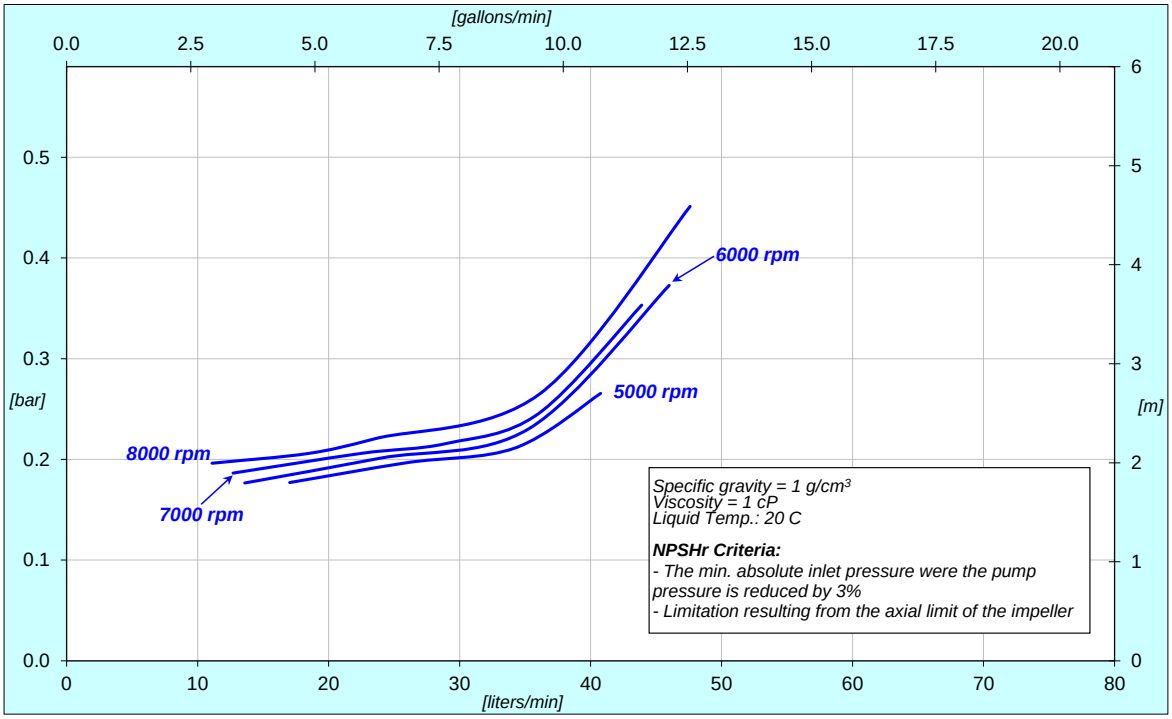


Figure 7: NPSHr curves
(Measured with pump head LPP-600.1)

2.6 Maximum Static Pressure for Pump Head

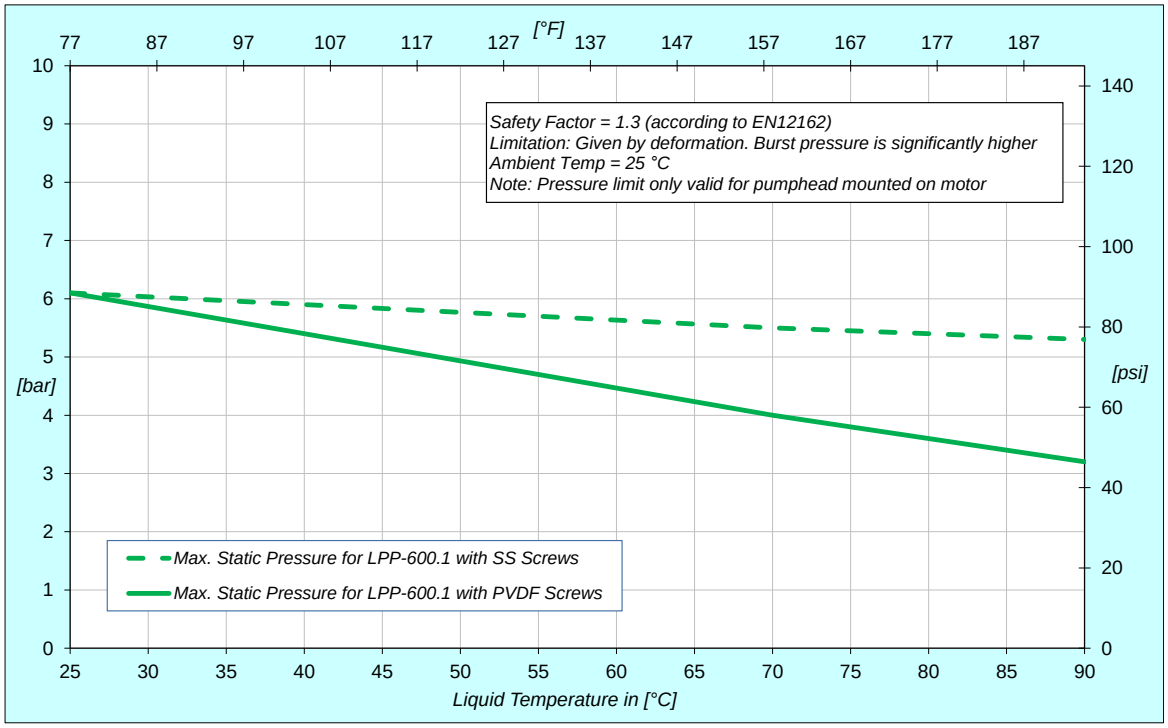


Figure 8: Specification for maximum static pressure of pump heads LPP-600.1
(Pressure limits only valid for pump head mounted on motor. Stainless steel screws (SS) according to Table 4.)

It is recommended to use stainless steel (SS) pump head screws, which are available as an accessory (see *Table 4*), at higher liquid temperature or when hammering effects (dynamic static pressure peaks) are expected, which might result in longer term deformation effects of the standard PVDF screws.

2.7 Basic Dimensions of Main Components

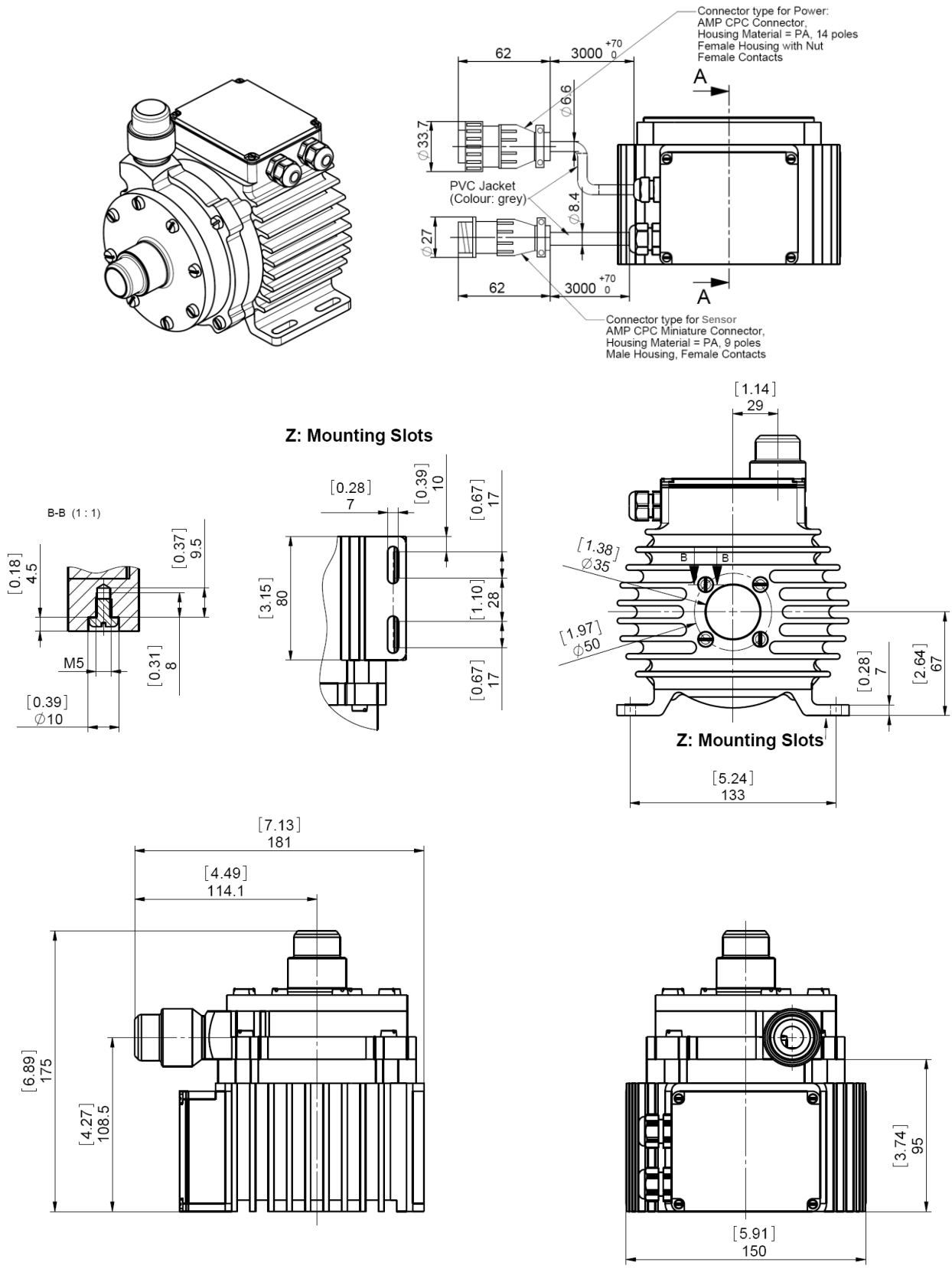


Figure 9: Basic dimensions (in mm and [inch]) of motor LPM-600.2 with pump head LPP-600.1
(for other configurations refer to according drawings)

Cable Jacket	Cable OD Motor Sensor	Cable OD Motor Power	Minimum Bending Radius Permanent Installation	Minimum Bending Radius Sometimes Moved
FEP	6.60 mm	8.40 mm	7x Cable OD	15 x Cable OD
PVC	7.20 mm	11.1 mm	5x Cable OD	11 x Cable OD

Table 6: Specifications for min. bending radius of motor and adaptor cables
Note: If not mentioned explicitly all the cables are not suited for constant dynamic bending and movement!

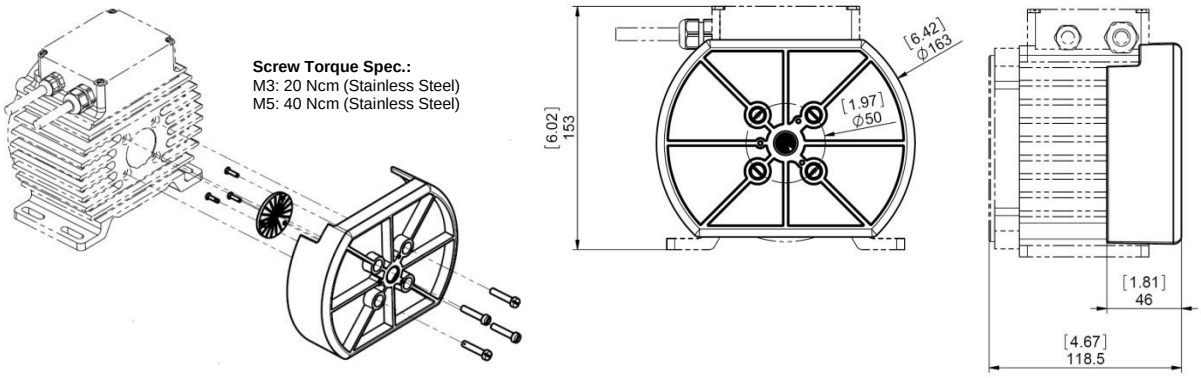


Figure 10: Basic dimensions (in mm and [inch]) motor with air cooling module ACM-600.2
(Not to be used in ATEX / IECEx applications)

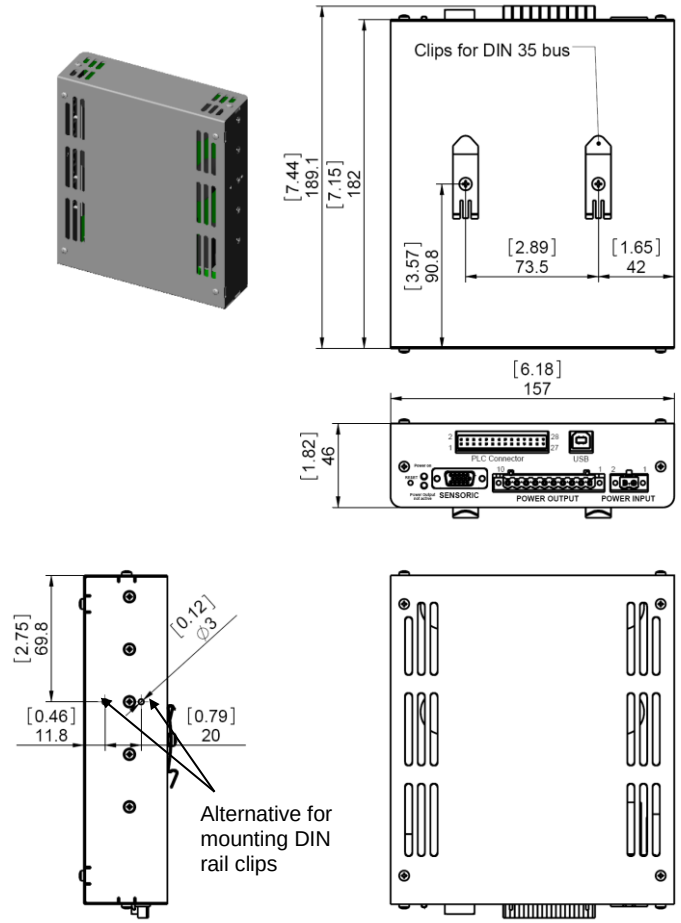


Figure 11: Basic dimensions (in mm) of controller LPC-600.2
(same basic dimensions for LPC-600.1)

3 Engineering Information

3.1 Sealing and Material Concept

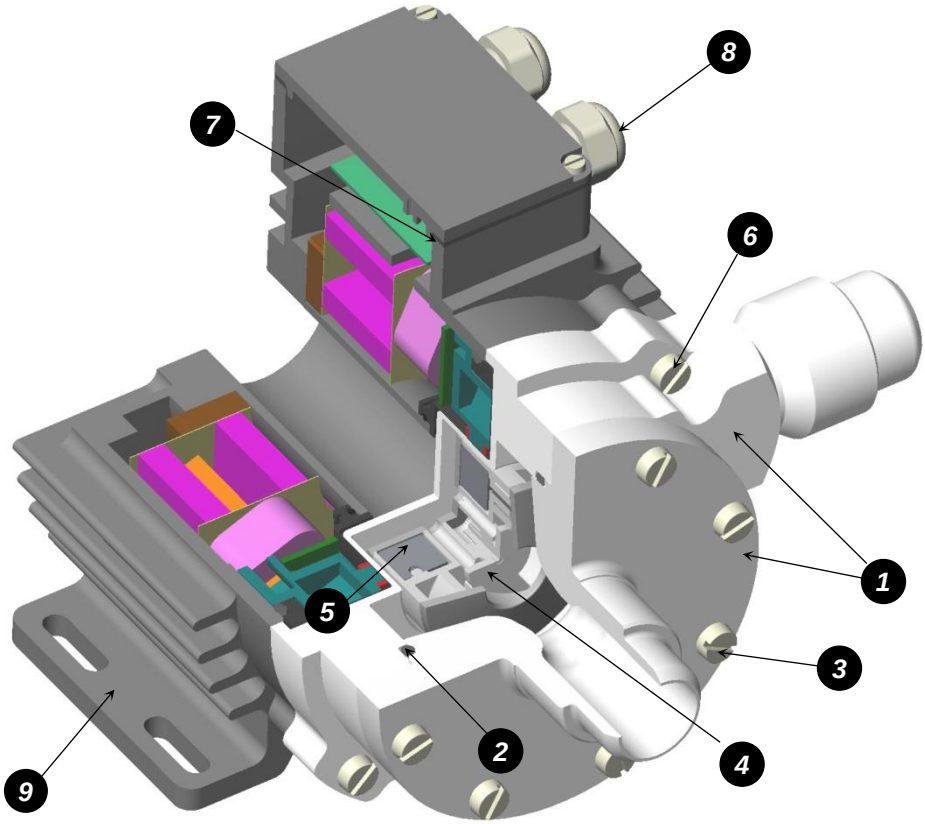


Figure 12: Sealing and material concept

System Component	Item		Materials
	No	Description	
Pump head *LPP-600.1*	1	Pump housing (lid and bottom)	PTFE
	2	Static sealing O-ring of pump casing	Kalrez
	3	8 screws for pump housing	PVDF
	4	Impeller *LPI-600.2*	PFA
	5	Rotor magnet	NdFe (rare-earth material)
	6	4 screws for pump/motor mounting	PVDF
Motor *LPM-600.2*	7	Flat gasket for motor housing	FPM (= FKM)
	8	Cable bushing	PVDF, cable jacket is FEP
	9	Motor housing	ETFE coating, waterproof (IP-67) Coils and electromagnetic circuit potted with an epoxy compound (UL94 V0).

Table 7: Materials used in the LPM-600.2 motor and LPP-600.1 pump head

3.2 Power Consumption

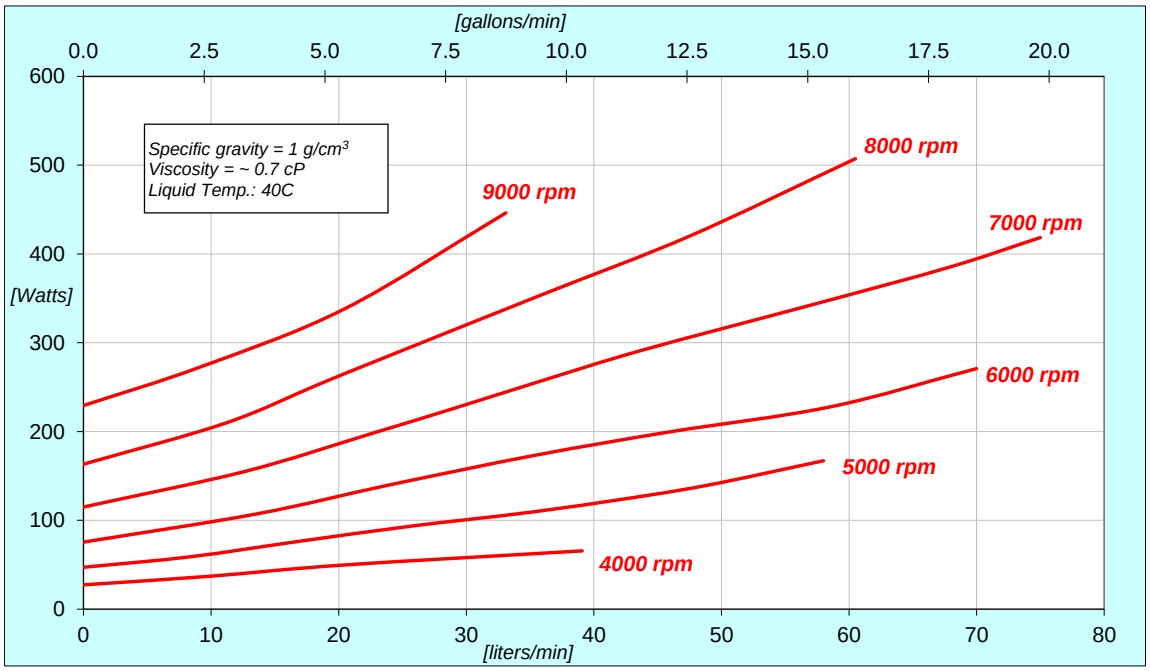


Figure 13: Electrical power consumption
(Controller LPC-600.x with pump head LPP-600.1)

3.3 Temperature Monitoring

To avoid overheating of the system, the controller and motor temperatures are monitored. If the controller temperature exceeds *70°C (158°F)* or the motor temperature *90°C (194°F)* for a duration of more than 10 minutes, the system goes into an error state and the pump stops. At *80°C (176 F)* controller temperature or *100°C (212°F)* motor temperature, the system stops immediately.

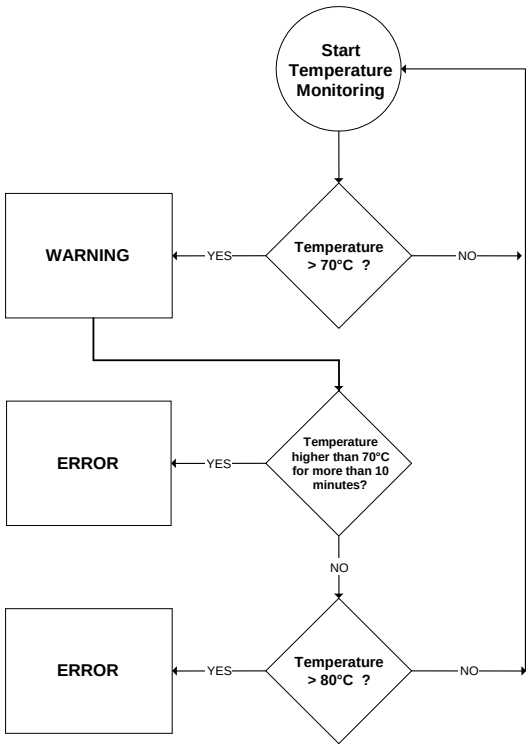


Figure 14: Controller temp. monitoring

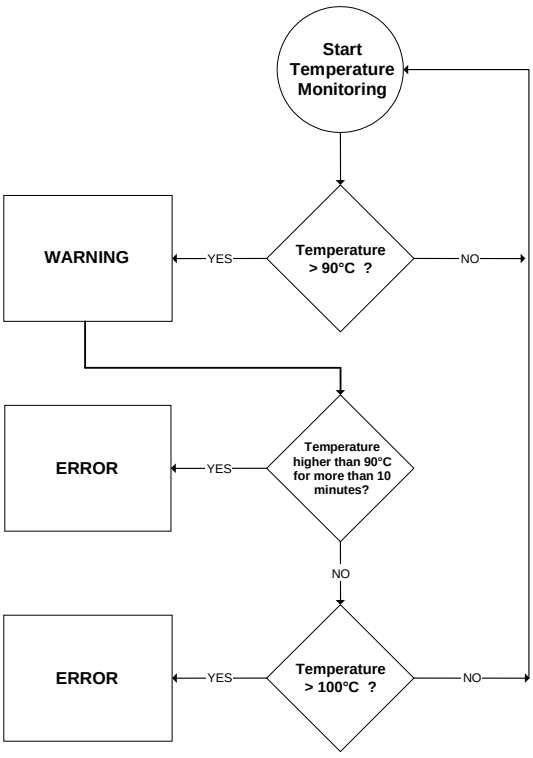


Figure 15: Motor temperature monitoring

3.4 Thermal Management

3.4.1 Motor Temperature

The motor temperature depends on the ambient and liquid temperature, as well as on the hydraulic operation point. *Figure 16*, *Figure 17* and *Figure 19* illustrate the temperature characteristics of the motor depending on these parameters. For higher liquid temperatures and hydraulic operating points active cooling is recommended for example with the air cooling module *ACM-600.2 (see Figure 18).*

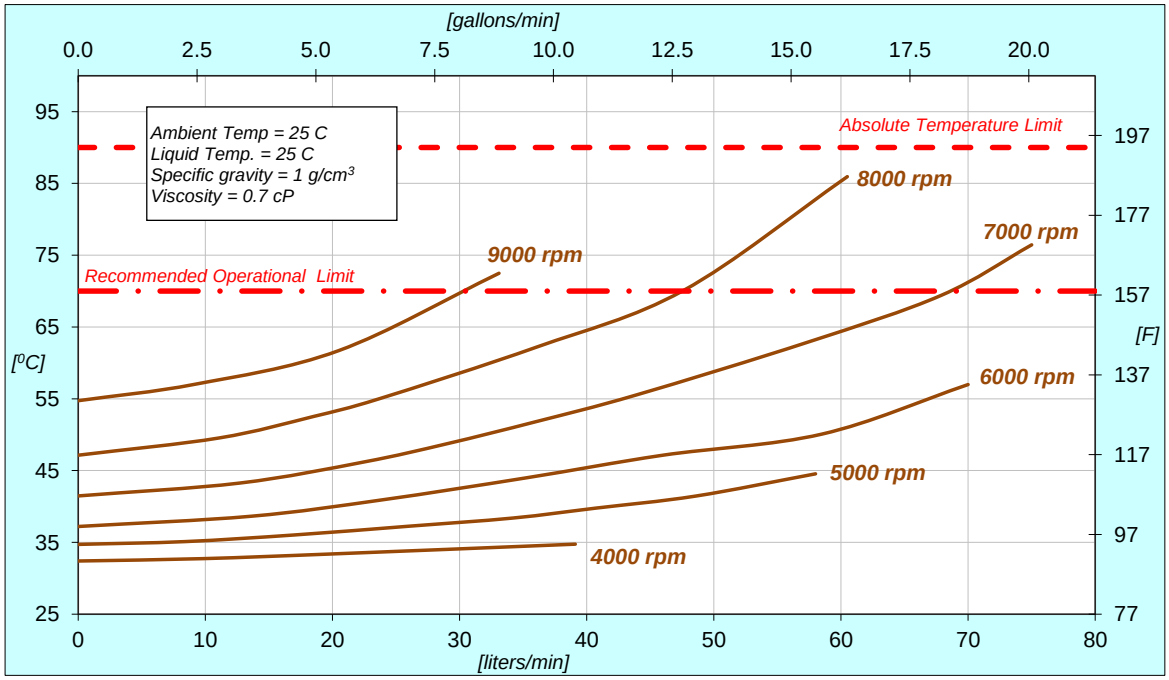


Figure 16: Temperature curves for the LPM-600.2 motor @ 25 ^{0}C liquid temperature
(Pumping with pump head LPP-600.1, temperature is measured inside of the motor, contact temperature of surface is below this temperature)

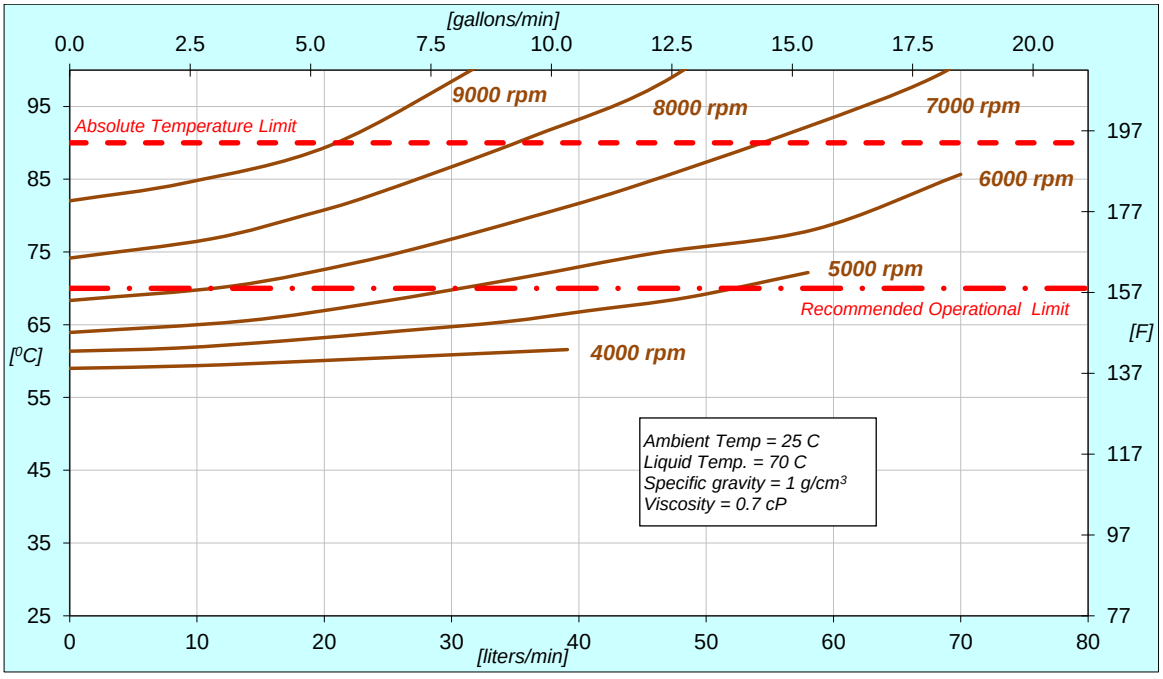


Figure 17: Temperature curves for the LPM-600.2 motor @ 70 ^{0}C liquid temperature
(Pumping with pump head LPP-600.1, temperature is measured inside of the motor, contact temperature is below this temperature)

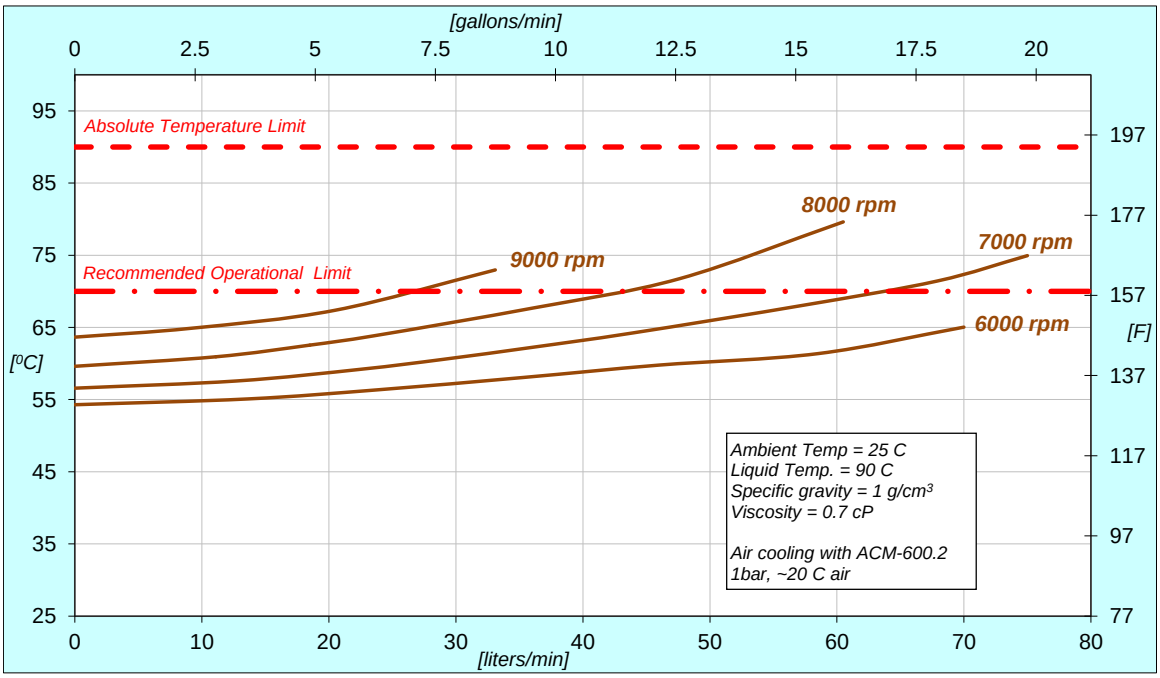


Figure 18: Temperature curves of motor LPM-600.2 with air cooling module ACM-600.2
(Pump head LPP-600.1, liquid. temp = 90 °C, Air Cooling Module ACM-600.2 with 1bar air at 20 °C)

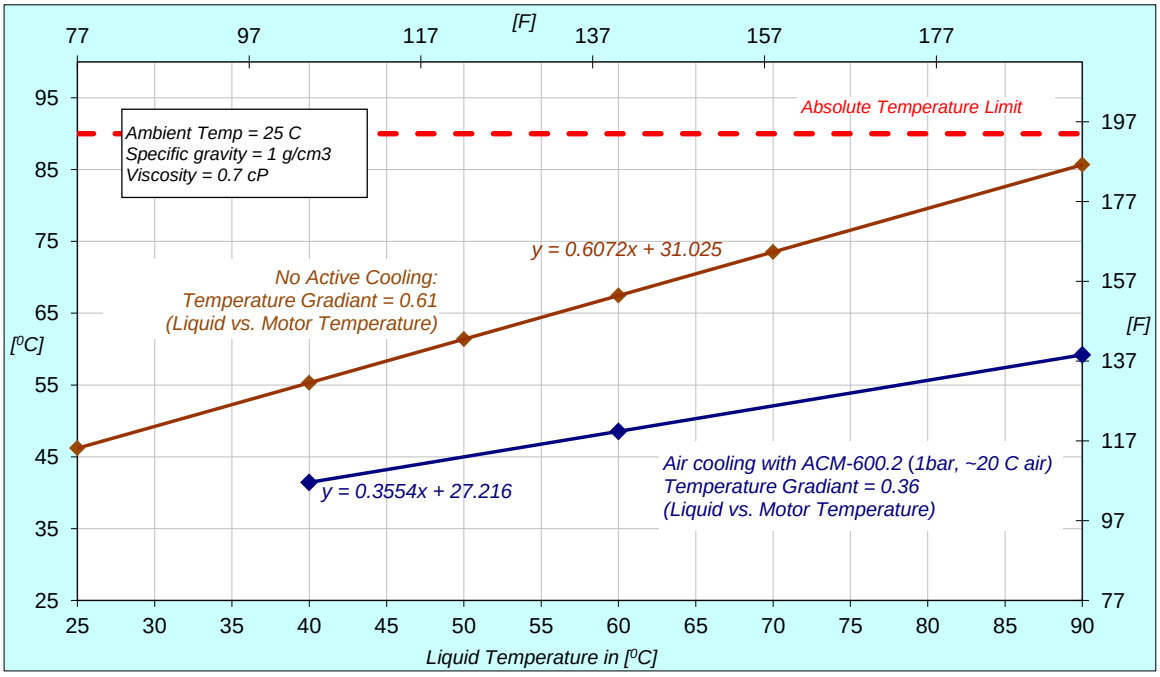


Figure 19: Influence of liquid temperature on motor temperature
(Measurement at 7000 rpm 23 lpm but gradiants are representative for other operational points)

The above curves are measurements of the motor temperature at certain liquid and ambient temperatures. Equation *(Eq. 1)* shows how to calculate the motor temperature for other liquid and ambient temperatures based on these curves.

$$T_M(T_L,T_A) \approx \underbrace{T_M(T_L = 25^0C, T_A = 25^0C)}_{see\ Figure\ 16} + (T_L - 25^0C)\cdot \underbrace{tg_{LM}}_{see\ Figure\ 19} + (T_A - 25^0C)$$

(Eq. 1)

T_M = *Motor temperature* T_L = *Liquid temperature*

T_A = *Ambient temperature* tg_{LM} = *Temperature gradient liquid/motor*

In order to account for thermal variations (like ambient temperature, closed chemical cabinets or corners without ventilations) and to not significantly reduce the MTBF of the motor it is recommended to keep about 20 ^0C safety distance to the absolute thermal limit of the motor (90 ^0C) when designing the thermal concept of the pump system.

3.4.2 Controller Temperature

Depending on the ambient temperature and the placement of the controller additional cooling may be required (see *Figure 20*). To improve cooling of the controller, place the device into a moving air stream. If the controller is mounted in a compact area or adjacent to additional heat sources (e.g. a 2nd controller) ensure that there is sufficient ventilation.

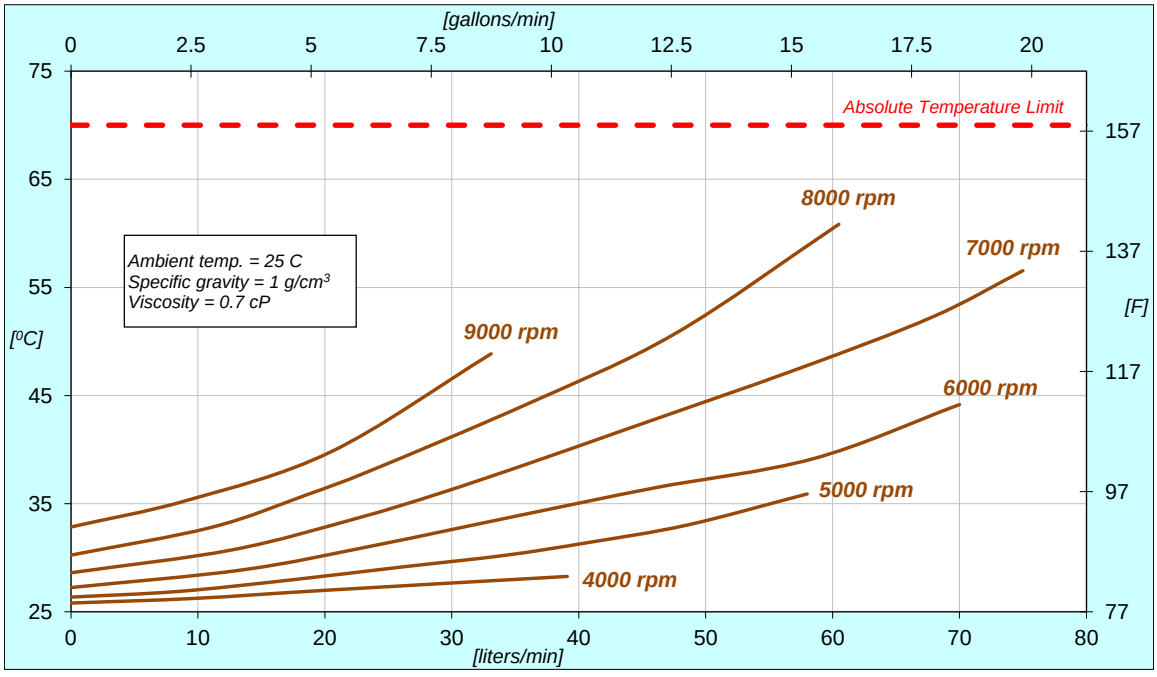


Figure 20: Temperature curves of controller LPC-600 vs. flow and speed
(for pumping with pump head LPP-600.1 and motor LPM-600.2)

The above curves are measurements of the controller temperature at 25^0C ambient. Equation *(Eq. 2)* shows how to calculate the controller temperature for at other ambient temperatures based on this curve.

$$T_C(T_A) \approx \underbrace{T_C(T_A = 25^0C)}_{see\ Figure\ 20} + (T_A - 25^0C)$$

T_C = *Controller temperature*

T_A = *Ambient temperature*

(Eq. 2)

3.5 Hydraulic Circuit Design

Following general design rules for the hydraulic circuit shall be considered for a robust operation of the pump system and optimum priming behavior:

1. The general rule for optimum priming behavior is to minimize the pressure drop in the inlet circuit and avoid negative pressure at the inlet of the pump head.

2. Minimize tubing length at the inlet of the pump head and maximize the ID (not smaller than the pump head inlet ID of 22.5 mm is recommended). This reduces the pressure drop and the tendency of cavitation.

3. Avoid any restrictions, valves, elbows, bended tubing and sharp edges at the inlet circuit of the pump head, which potentially causes cavitation resulting in gas bubble collection in the pump head with the danger of priming loss.

4. Place the pump at the lowest point of the hydraulic circuit. Optimum is as much as possible below a tank or reservoir. This optimizes priming behavior and removal of gas bubbles.

5. Keep the liquid level in the reservoir tank or bag as high as possible, which increases the inlet pressure of the pump head and minimized heat up of the liquid.

6. In general the pump system placement and circuit shall be designed that gas bubbles can leave the pump housing and that the pump head remains primed.

7. To minimize heat up of the liquid the overall pressure drop in the hydraulic circuit shall be reduced as much as possible.

8. It shall be avoided to pump longer times against a closed valve, which can cause heat-up of the liquid.

9. At higher liquid temperature above rules become more important due to higher cavitation tendency of the liquid.

10. Load and stress at the inlet and outlet by heavy tubing and improper mounting alignment shall be avoided (see *Figure 21*) as this can cause leakage issues due to distortion of the plastic pump housing.

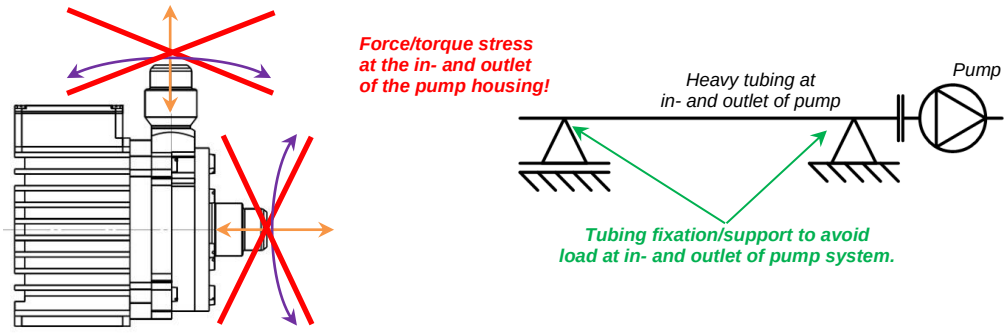


Figure 21: Avoidance of stress forces and torques at the inlet and outlet of the pump head

Contact the *Levitronix® Technical Service* department (see *Section 8*) for more detailed considerations and support on the design of the hydraulic circuit.

4 Installation

4.1 Electrical Installation of Controller

4.1.1 Overview

The *LPC-600* controllers have signal processor controlled power converters with four switched inverters for the drive and the bearing windings of the motor. The signal processor allows precise control of pump speed and impeller position. *Figure 22* shows the interfaces of the standalone controller *LPC-600.1* with stand-alone and minimal PLC functions and *Figure 23* the interfaces of the controller *LPC-600.2* with extended PLC functions and USB interface for communication.

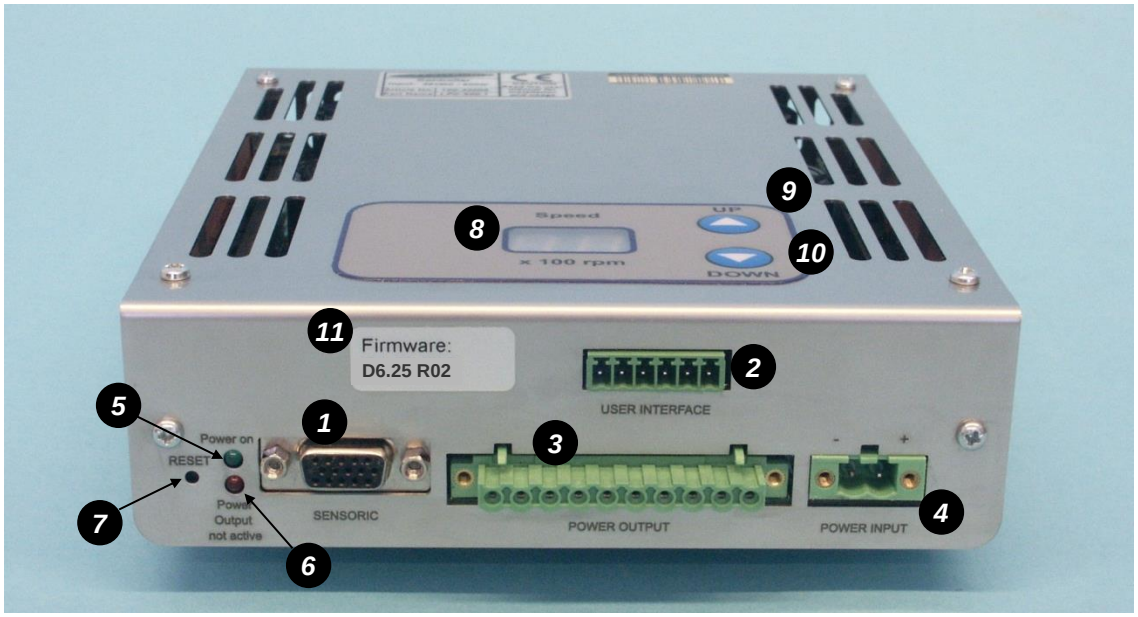


Figure 22: Overview of the controller LPC-600.1 for standalone operation

	Interface (as labeled)	Description	
1	"SENSORIC"	Position, field and temperature sensor signals from motor Torque spec. for tightening of connector screws: Min. = 0.4, Max. = 0.6 Nm	
2	"USER INTERFACE"	1 Digital Input	- Galvanic isolation with optocoupler - Lowest input voltage for high level detection: min. 5 V Typical 24 V / 16 mA, maximal 30 V / 20 mA - Highest input voltage for low level detection: max. 0.8 V - Minimum input resistance: R_{IN} = 2.2 kΩ
		1 Digital Output	- Galvanic isolation with relay - Relay: 1A / 30VDC, 0.3A / 125 VAC
		1 Analoge Input	- Analog current input: 4 – 20 mA - 450 Ohm shunt input
3	"POWER OUTPUT"	Drive and bearing currents of the motor [1] Torque spec. for tightening of connector screws on motor side: Min. = 0.5 Nm, Max. = 0.6 Nm	
4	"POWER INPUT"	DC power input [1] Torque spec. for tightening of connector screws on motor side: Min. = 0.5 Nm, Max. = 0.6 Nm	
5	"Power on" Green LED	LED is on if supply voltage of signal electronics is present.	
6	"Power Output not active" Red LED	Red LED is off if the switched output stage of the controller is enabled. If the LED is on, the bearing and drive coils of the motor carry no current.	
7	"RESET" Button	Reset button of the controller stage. The button is sunk mounted and can be activated for example with a small screw driver.	
8	2-Digit Display "Speed"	Rotational speed display in 100rpm	
9	"UP" Button	Button for speed increasing	
10	"DOWN" Button	Button for speed decreasing	
11	"Firmware" Label	Firmware version and revision number	

Table 8: Description of interfaces of LPC-600.1 controller

1: Connectors are not made for multiple connection cycles. Avoid connections cycles > 25.

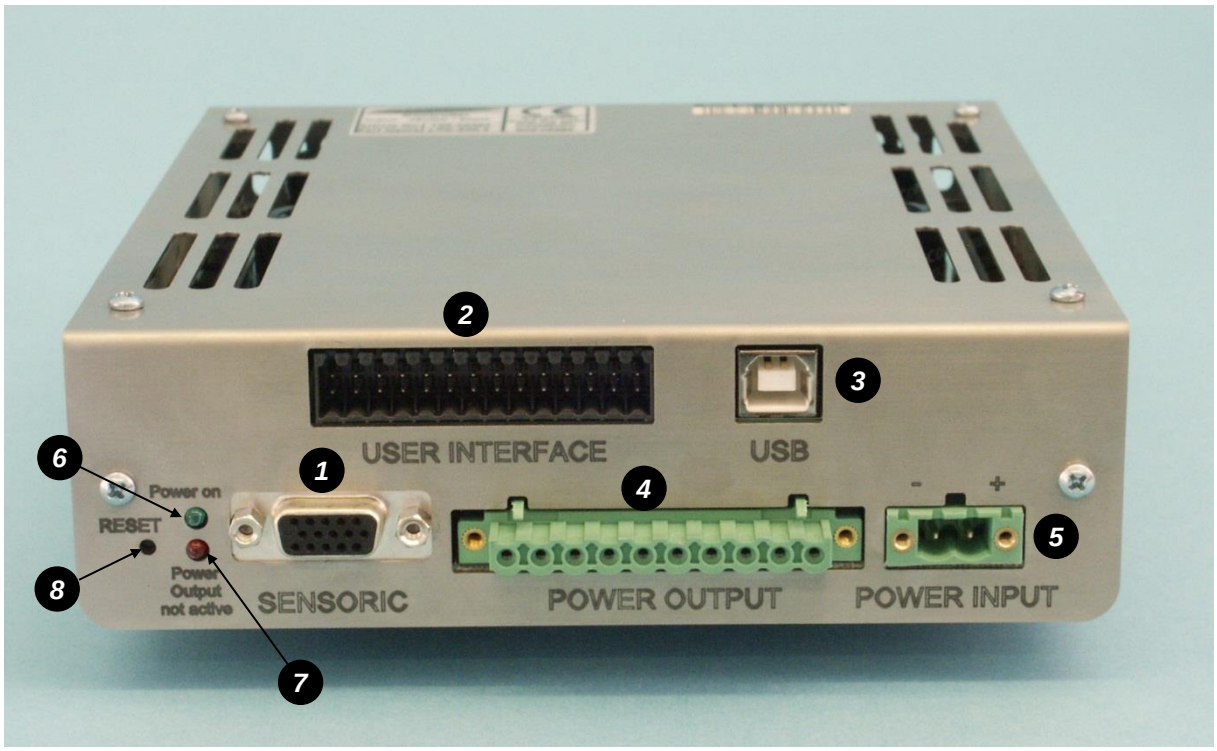


Figure 23: Overview of the controller LPC-600.2 for extended operation

	Interface (as labeled)	Description	
1	"SENSORIC"	Position, field and temperature sensor signals from motor. Torque spec. for tightening of connector screws: Min. = 0.4, Max. = 0.6 Nm	
2	"USER INTERFACE"	2 Analog Input	- Analog current input: 4 – 20 mA - 450 Ohm shunt input
		2 Analog Input	- Analog voltage input 0 – 10 V - Direct connection, no galvanic isolation - 7.8 kΩ input resistance
		2 Analog Output	- Analog voltage output: 0 – 5 V - Direct connection, no galvanic isolation - Max. Output current: 2mA
		4 Digital Input	- Galvanic isolation with optocoupler - Lowest input voltage for high level detection: min. 5 V Typical 24 V / 16 mA, maximal 30 V / 20 mA - Highest input voltage for low level detection: max. 0.8 V - Minimum input resistance: R_{IN} = 2.2 kΩ
		4 Digital Output	- Galvanic isolation with relay - Relay: 1A / 30VDC, 0.3A / 125 VAC
3	"USB"	USB interface	
4	"POWER OUTPUT"	Drive and bearing currents of the motor [1] Torque spec. for tightening of connector screws on motor side: Min. = 0.5 Nm, Max. = 0.6 Nm	
5	"POWER INPUT"	DC power input [1] Torque spec. for tightening of connector screws on motor side: Min. = 0.5 Nm, Max. = 0.6 Nm	
6	"Power on" Green LED	LED is on if supply voltage of signal electronics is present.	
7	"Power Output not active" Red LED	LED is off if the switched output stage of the controller is enabled. If the LED is on, the bearing and drive coils of the motor carry no current.	
8	"RESET" Button	Reset button of the controller stage	

Table 9: Description of interfaces of LPC-600.2 controller

1: Connectors are not made for multiple connection cycles. Avoid connections cycles > 25.

4.1.2 General Installation Instructions

⚠ WARNING

Hazardous voltage may be present.

Always isolate the electrical power supply before making or changing connections to the unit.

In case of the usage of an inadequate AC/DC power supply, mains voltages may be present (even if the system is designed for 48VDC). The usage of a galvanic separated power supply, which is certified by a 3rd party (UL or CE), is highly recommended.

The controller housing must be properly grounded and placed in a spill protected electrical cabinet. Use one of the DIN-rail screws on the back side of the controller housing.

Do not use different and longer screws, which may result in short-circuit within the controller.

1. The controller casing must be grounded. The screws of the DIN-rail bracket can be used for grounding (see *Figure 24*).
2. Connect the two motor connectors (“Power Output” and “Sensoric”) to the controller.
3. Connect the controller type specific connectors: see *Section 4.1.3* for standalone operation with the *LPC-600.1*, *Section 4.1.4* for extended operation with *LPC-600.1* and *Section 4.1.5* for extended operation with *LPC-600.2*
4. The pump system requires 48 VDC supply voltage at a maximum power of 600 W. Depending on the hydraulic operational point power supplies with smaller power or bigger supplies to supply several pump systems simultaneously may be used. *Figure 13* shows the power consumption depending on the pressure and flow rate. Contact Levitronix for consulting and support on the power supply solution.
5. Connect the DC power supply connector with the cable (included in the controller delivery). Make sure that the polarity is correct (see *Figure 22* and *Figure 23*) and that AC/DC power supply is off.
6. To secure the connectors, tighten all retaining screws according to the torque specifications in *Table 8* for *LPC-600.1* and *Table 9* for *LPC-600.2* controller.

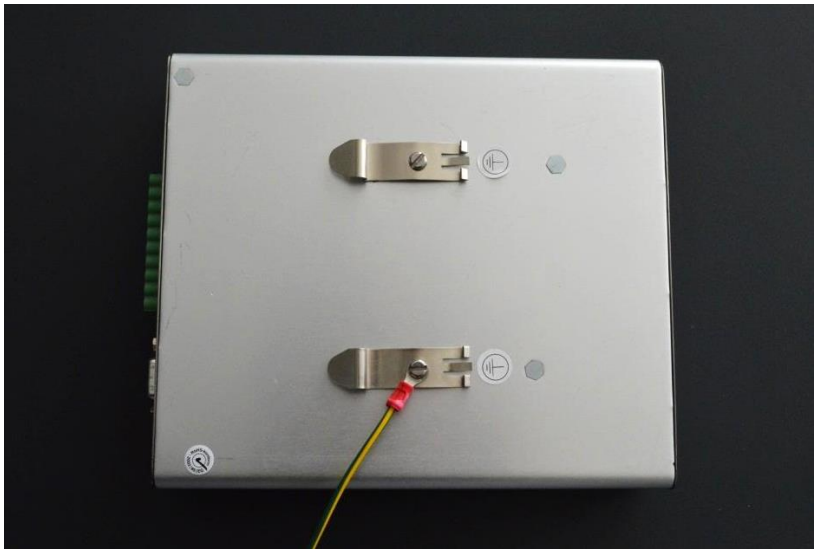


Figure 24: Grounding of LPC-600 controller

4.1.3 Electrical Installation of Controller *LPC-600.1* for Standalone Operation

For standalone operation the *LPC-600.1* is disabled when power is turned on. It can be enabled manually by using the "UP" button on the display. If the controller shall be enabled automatically, when power is applied the "ENABLE" pin on the "USER INTERFACE" connector (see *Table 10*) has to be active (typically 24V).

4.1.4 Electrical Installation of Controller *LPC-600.1* for Extended Operation

If the *LPC-600.1* shall to be controlled with external signals the "USER INTERFACE" can be used with the PIN designations described in *Table 10*.

Pin Name	Connector Pin Number	Designation	Levels	Note
Analog In, (Signal)	5	*Reference Speed*	4..20 mA = 0..10000 rpm -> Speed Limit = 9000 rpm ≙ 18.4 mA -> Cut-off (min.) speed = 300 rpm	Direct connection, no protection. Galvanic isolation on the user side is required.
Ground Analog In	6			
Digital In, (Signal)	3	*Enable*	24 *V* ⇒ active 0 *V* ⇒ not active	Is needed to enable the system with an external signal.
Ground Digital In	4			
Digital Out	1	*Status*	Relay closed ⇒ active, system on Relay open ⇒ not active, system off	This signal indicates if the system is active.
Ground Digital Out	2			

Table 10: Description of „USER INTERFACE" connector
(Description is for firmware D6.25 with Revision > 01, for other configurations refer to alternate firmware documentation)

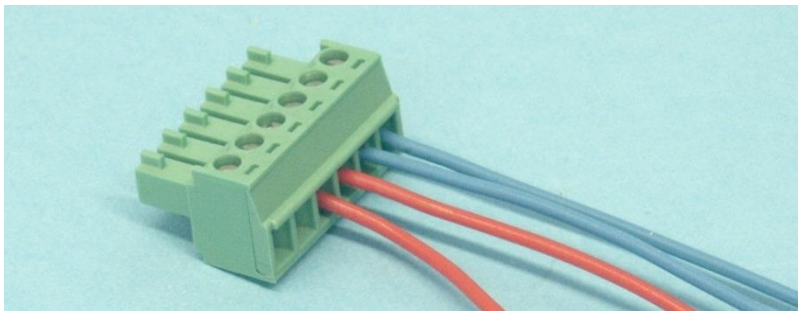


Figure 25: „USER INTERFACE" connector
- Delivered with controller LPC-600.1
- Supplier: PTR Messtechnik GmbH, Germany
- Connector Type: AK1550/06-3.81-GREEN

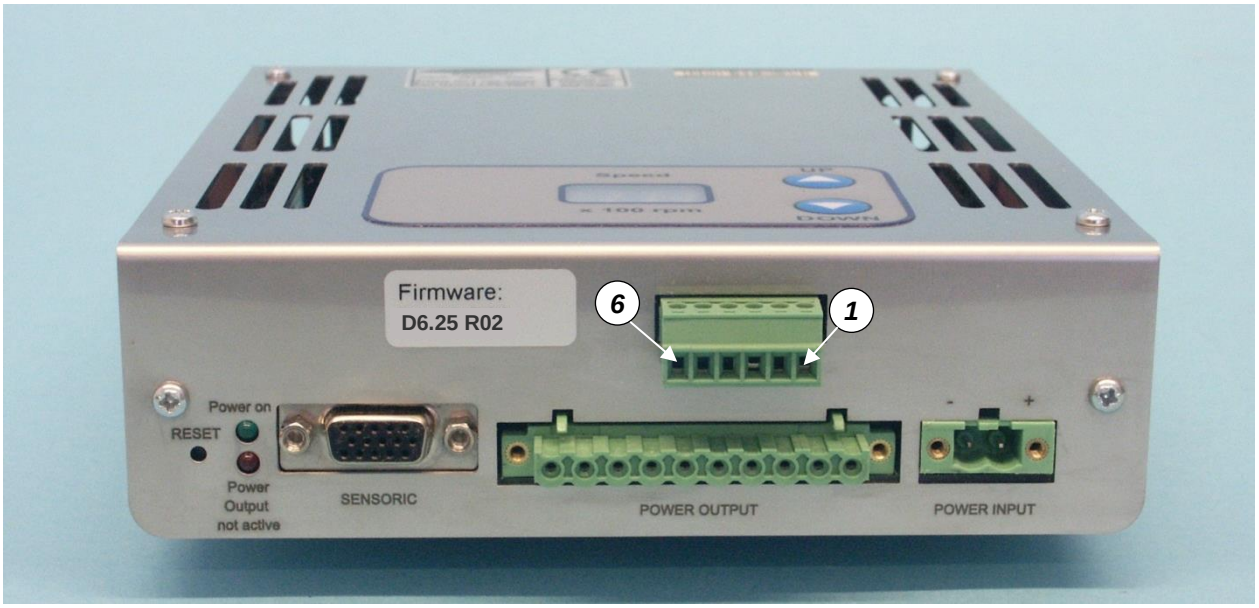


Figure 26: Mounted "USER INTERFACE" connector and Pin numbering

4.1.5 Installation of PLC Interface for Extended Controller *LPC-600.2*

To operate the pump system with a PLC, a minimum set of two digital inputs and one analog input is needed. The digital and analog outputs can be used to monitor the pump status and operating parameters.

CAUTION

The analog inputs and outputs are not galvanic isolated from the controller electronics. To avoid ground loops and malfunctions, use floating analog signals.

1. Detach the PLC connector from the controller
2. Connect the designated wires of a cable the pins of the detached connector according to *Table 11.* Assignment and functions of the I/Os can be changed with the controller firmware version (refer to according firmware documentation).
3. Connect the PLC connector (*Figure 27*) to the controller.

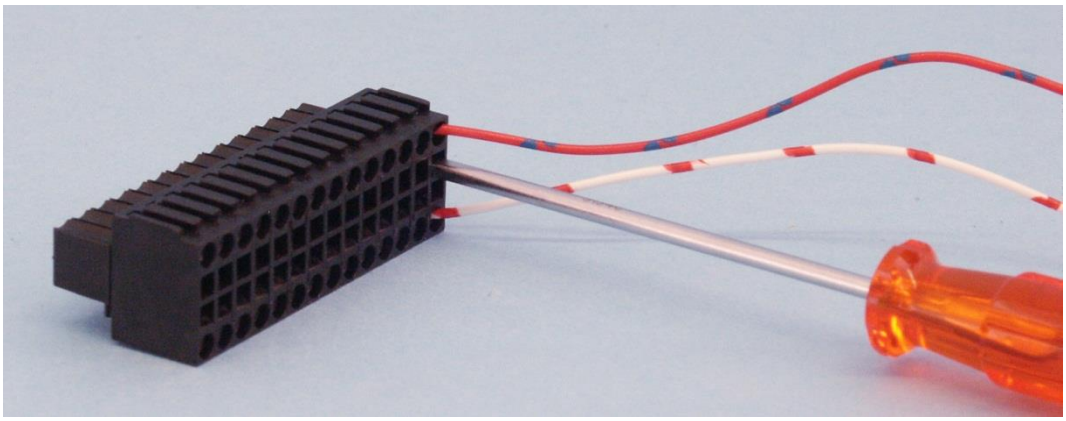


Figure 27: PLC connector
- Delivered with controller LPC-600.2
- Supplier: Weidmüller
- Connector Type: B2L 3.5/28 SN BK BX

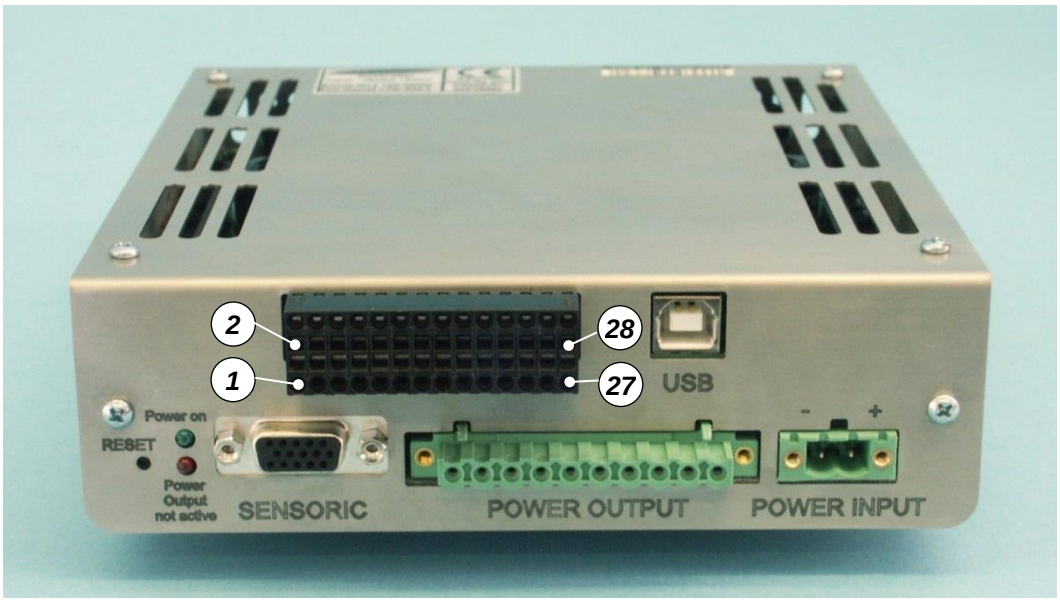


Figure 28: Mounted PLC connector and Pin numbering

Pin Name	Connect. Pin #	Designation	Levels	Note
Analog In1, (Signal)	18	*Ref Value (Current Input)*	4..20 mA = 0..10000 rpm *(speed mode)* -> Speed Limit = 9000 rpm ≙ 18.4mA -> Cut-off (min.) speed = 300 rpm 4..20 mA = 0..100% *(process mode)*	- Grounds are internally connected - Direct connection, no protection. Galvanic isolation on the user side is required. - Default input settings: Current inputs selected. Voltage input can be selected with EEPROM–editor in Service Software (consult detailed firmware specification Service Software Manual with Doc.# *PL-2034-00*)
Ground Analog In1	17			
Analog In2, (Signal)	20	*Actual Process Control Value (Current Input)*	4..20 mA = 0..100%	
Ground Analog In2	19			
Analog In3, (Signal)	22	*Ref Value (Voltage Input)*	0..10 V = 0..10000 rpm -> Speed Limit = 9000 rpm ≙ 9 V -> Cut-off (min.) speed = 300 rpm 0..10 V mA = 0..100% *(process mode)*	
Ground Analog In3	21			
Analog In4, (Signal)	24	*Actual Process Control Value (Voltage Input)*	0..10 V = 0..100 %	
Ground Analog In4	23			
Analog Out1, (Signal)	26	*Actual Speed*	0..5 V = 0..10000 rpm	Direct connection, no protection. Galvanic isolation on the user side is required. 5V is given by firmware, hardware allows up to 10V output voltage.
Analog Out2, (Signal)	28	*Actual Process Control Value*	0..5 V = 0..100%	
Com. Ground Analog Out	25, 27	--	--	
Digital In1, (Signal)	2	*Reset*	24 *V* ⇒ active 0 *V* ⇒ not active	Resets error state
Ground Digital In1	1			
Digital In2, (Signal)	4	*Process mode*	24 *V* ⇒ active 0 *V* ⇒ not active	Switches between process mode and speed mode
Ground Digital In2	3			
Digital In3, (Signal)	6	*Enable*	24 *V* ⇒ active, system on 0 *V* ⇒ not active, system off	The Enable signal switches the pump system on and off.
Ground Digital In3	5			
Digital In4, (Signal)	8	*Not used*	--	--
Ground Digital In4	7			
Digital Out1	10	*Status*	Relay closed ⇒ active, system on Relay open ⇒ not active, system off	This signal indicates the state of the pump system.
Ground Digital Out1	9			
Digital Out2	12	*Error*	Relay closed ⇒ not active, system on Relay open ⇒ active, system off	When active, the system drives the impeller to zero rpm and shuts down. With a reset pulse the system can be re-initialized.
Ground Digital Out2	11			
Digital Out3	14	*Warning*	Relay closed ⇒ not active, system o.k. Relay open ⇒ active, system not o.k.	The warning signal indicates if a system fault has been detected. The warning signal indicates a system fault but the system does not shut down
Ground Digital Out3	13			
Digital Out4	16	*Default Setting: Trend Warning*	Relay closed ⇒ warning active Relay open ⇒ warning not active	Default setting: Relay closed if trend warning is active. Can be changed in EEPROM with Service Software
Ground Digital Out4	15	*Option: Priming Valve Signal*	Relay closed ⇒ Priming valve active Relay open ⇒ Priming valve inactive	Can be used to control a priming valve for priming of the pump. Feature can be activiated and configured with Service Software.

Table 11: Signals of the PLC connector for standard firmware D6.48
- For other configurations of PLC Inputs and Outputs refer to alternate firmware documentation
- Configurations ca be done with Levitronix Service Software (see Manual with Doc.# PL-2034-00)

4.2 Mechanical Installation of the Pump/Motor

- The motor can be fixed with four screws on the motor feet (see *Figure 9*)
- As an alternative the motor can be mounted with four screws on the (see *Figure 9*) backside
- The motor can be mounted in either the horizontal or vertical position
- Each motor is identified with a unique serial number. This serial number consists of a series of 6 digits were the 5th and the 6th digit representing the manufacturing year.

4.3 Installation of *ATEX / IECEx* Motors

⚠ WARNING

Only specific types of motors LPM-600 are classified for the use in Ex classified locations. Refer to the corresponding section in the manual.

⚠ WARNING

Cable and cable glands of the motor must be protected against impact energy.

⚠ WARNING

The usage of the cooling module ACM-600.2 is not allowed in Ex 2 classified locations.

An *ATEX / IECEx* conform solution is needed for the motor cables to leave the *Ex* area (see *Figure 5*). One option is an ATEX certified cable system as listed in *Table 4* and shown in *Figure 2*.

A protective earth wire shall be attached to the *ATEX / IECEx* specific motor housings by using one of the four M5 threads on the backside of the motor.

- Remove one of the four M5 screws on the backside of the motor
- Use a crimp-type end together with a spacer sleeve to connect a earth wire
- Attach the grounding wire with a M5 stainless steel screw to the motor according to *Figure 29*

Figure 29: Attachment of a protective earth wire to the backside of the motor
(Screw dimensions: M5 x 15 mm, spacer dimensions: OD = 9mm, ID = 6 mm, Length = 6 mm)

4.4 Mechanical Installation of the Controller

⚠ WARNING

Hazardous voltage may be present.

In order to avoiding fluid spills shorting mains or other voltages within the controller, place the controller in a spill protected electrical cabinet.

If explosive flammable gases are present, place the controller in an explosion-proof cabinet.

CAUTION

Make sure the controller is mounted in a position that allows free air circulation around the controller. A minimum distance of 10cm (4") to other objects above or below the controller casing is recommended.

- Use the Din-Rail bracket to mount the controller.
- If no forced air-cooling is used, mount the controller in upright position.
- The Din-Rail brackets can also be mounted on the controller side according to *Figure 11*

CAUTION

Use only 3,5 x 6,5mm self-tapping screw for the fixation of the Din-Rail brackets. The controller may be damaged if other type or too long screws types are used!

4.5 Mechanical Installation of Adaptor/Extension Cables

For connecting the motor to the controller the adaptor cables *MCAP-600.x* (for power cable) and *MCAS-600.x* (for sensor cable) shall be used (see *Table 3* for adaptor cables). For the cables which use an *M23* threaded metallic Hummel connector type, check the connection according to the following pictures:

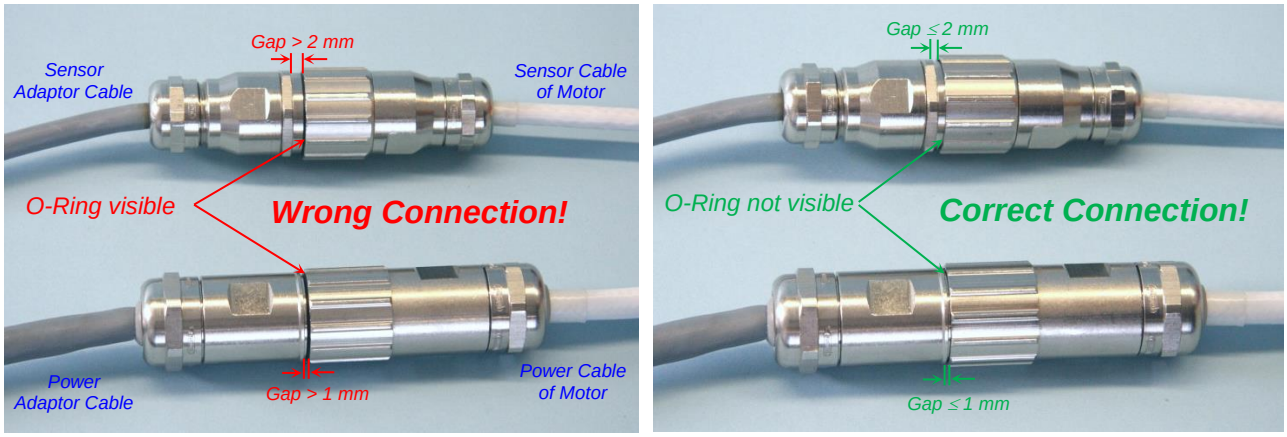


Figure 30: Wrong and correct Hummel connector type assembly

5 Operation

5.1 System Operation with Controller *LPC-600.1* (Stand-Alone)

5.1.1 State Diagram of *LPC-600.1*

The controller *LPC-600.1* allows stand-alone operation with manual speed setting ("Button Control Mode") as well as extended operation with analoge speed setting (Analoge Control Mode). *Figure 31* shows the state diagram which can be controlled with the manual buttons and the signals on the "USER INTERFACE" connector. The operation mode can be choosen by pressing the "UP" and "DOWN" buttons simultaneously during 5 seconds. For the standard firmware D6.25 default setting ex factory is "Button Control Mode".

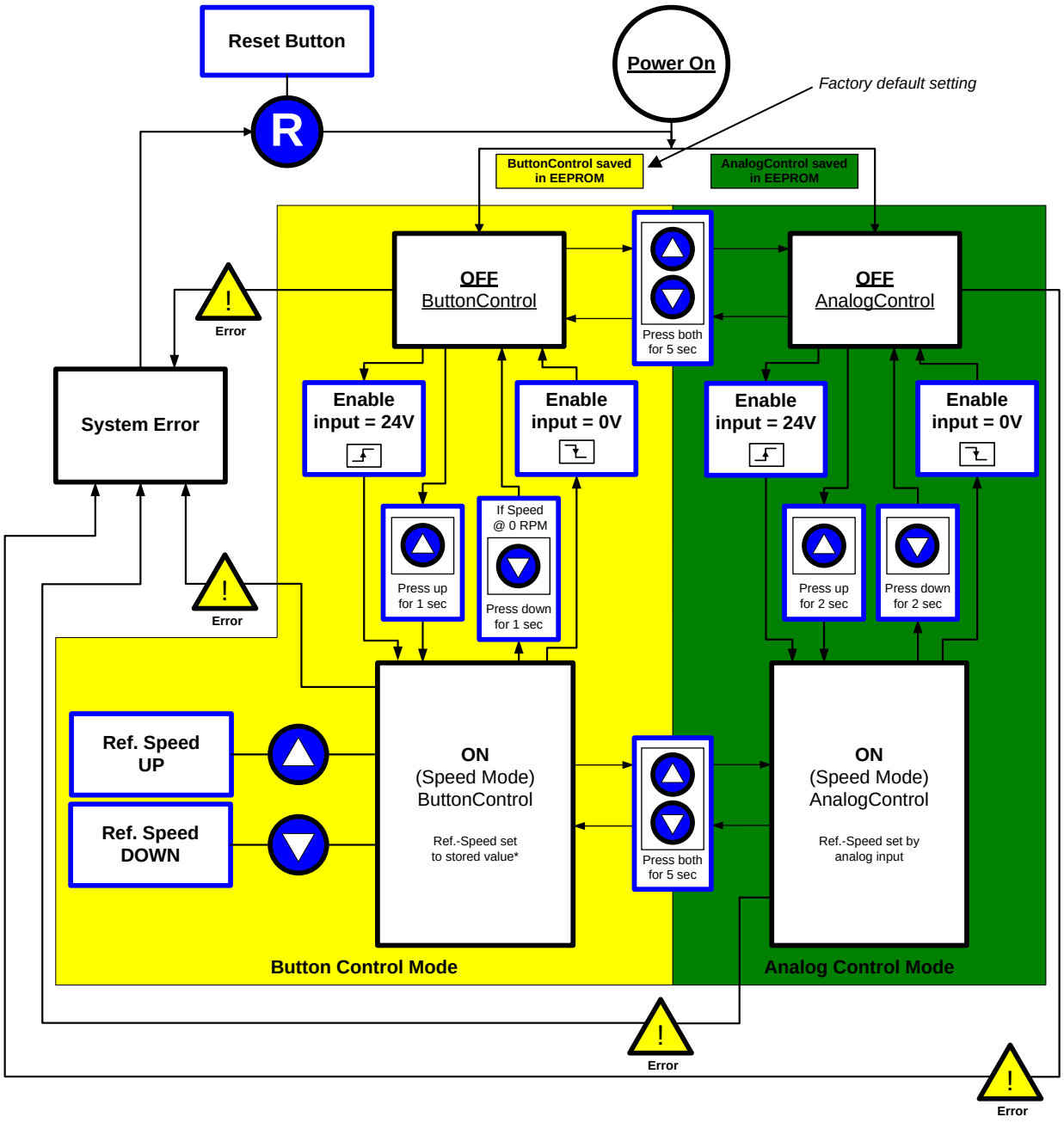


Figure 31: State diagram for operation with LPC-600.1 controller

(Description is for firmware D6.25 with Revision > 01, for other configurations refer to alternate firmware documentation)

5.1.2 Standalone Operation (Button Control Mode)

- When applying power the system defaults into the *"Button Control Mode*" and goes into the status *"OFF Button Control"* according to *Figure 31*. Levitation is disabled and the display indicates *"OF"*.
- Levitation can be enabled by pressing the *"UP"* button during 1 second (display shortly indicates *"ON"*) or by activating (typically 24V) the *"ENABLE"* pin on the *"USER INTERFACE"* connector (see *Table 10*). The system goes then into the status *"ON Button Control"* and is running at the speed, which is stored in the EEPROM.
- The speed can be changed by pressing accordingly the *"UP"* and *"DOWN"* buttons. As long as the digits on the display are blinking the set speed is shown. As soon as blinking stops the actual speed is shown and the set-speed is stored in the EEPROM of the controller.
- The system can be disabled by pressing the *"DOWN"* button until 0 rpm is achieved. Pressing further 1 second the *"DOWN"* button the system disables levitation and shows *"OF"* on the display. The system can also be disabled by deactivating (0 V) the *"ENABLE"* pin on the *"USER INTERFACE"* connector (see *Table 10*). Before disabling the system the speed is automatically reduced to 0 rpm and the impeller is properly touched down without grinding the wall.
- In case of an error the *"RESET"* button (see *Figure 22*)
-) can be used to restart the system or the power can be switched off and on.
- For error analysis the codes described in *Table 12* are displayed (blinking between *"Er"* and the according code number).
- If the system shall be enabled automatically, when power is applied the *"ENABLE"* pin on the *"USER INTERFACE"* connector (see *Table 10*) has to be active (typically 24V). When switching on the power the system is running with the stored speed.
- For monitoring purposes a digital output on the *"USER INTERFACE"* connector (see *Table 10*) indicates the status of the system. When the impeller is rotating the digital output *"Status"* turns active.

The digital input *"ENABLE"* is normally edge-triggered to allow control by digital input and buttons in order to enable/disable systems simultaneously. An exception is, when the system is powered up or a system reset occurs: than the system checks the level of the digital input and switches to the desired state. Hence on startup a high level of the digital input *"ENABLE"* is sufficient to switch on the system and a transition from low to high is not required.

5.1.3 Extended Operation ("Analog Control Mode")

- In order to be able to control the pump with external signals (PLC) the mode *"Analog Control Mode"* has to be set with the display buttons. The *"UP"* and *"DOWN"* buttons have to be pressed simultaneously during 5 seconds. The display should feedback the change by blinking between the stored speed value and *"An"*. The chosen mode is then stored in the EEPROM of the controller. After startup the system returns to the operation mode selected previously.
- The system and levitation can be enabled/disabled with the digital input on the *"USER INTERFACE"* connector (see *Table 10*). When disabling the running system the speed is automatically reduced to 0 rpm and the impeller is properly touched down without grinding the wall. The display is blinking between *"An"* and *"OF"*. Alternatively *"UP"* button is also able to switch on system, with *"DOWN"* button the system can be switched off.
- The speed can be set with an analog signal on the *"USER INTERFACE"* connector according to *Table 10*. It is strongly recommended to use galvanic separated signal values.
- For monitoring purposes a digital output *"Status"* on the *"USER INTERFACE"* connector (see *Table 10*) indicates the status of the system. When the impeller is rotating the digital output *"Status"* turns active.

5.1.4 Error Display on the Integrated Panel

Error Source	Errors	Error Code on Display
Motor	No Motor	*Er 01*
Motor	Motor cable (power wires) not connected to controller	*Er 02*
Motor	Motor cable (sensor wires) not connected to controller	*Er 03*
Motor	No Rotor	*Er 04*
Controller	Short circuit	*Er 05*
Controller	Over current in the bearing coils	*Er 06*
Controller	Over current in the drive coils	*Er 07*
Controller	DC-Link voltage out of range (< 40 or > 54 V DC) If the voltage is out of range the system starts to reduce the speed and a warning is generated. When reaching 0 rpm and the voltage is still out of range the system is disabled and an error is generated. In case the voltage is again within the range during speed reduction the system switches to normal operation and no Error is generated.	*Er 08*
Controller	Communication problems EEPROM Controller	*Er 09*
Motor	Communication problems EEPROM Motor	*Er 10*
Controller	Controller temp. over 80 ^{0}C or more than 10 minutes above 70 ^{0}C	*Er 11*
Motor	Motor temp. over 100 ^{0}C or more than 10 minutes above 90 ^{0}C	*Er 12*
Pump	Dry running of pump circuit: -> Pump keeps running on reduced speed (5000 rpm) -> The system accelerates to the original speed value when the pump is refilled with liquid. -> Note that the speed is only reduced during dry running if the pump speed was ≥ 6000 rpm.	*Blinking dots on display*

Table 12: Errors and warnings with indication on display of LPC-600.1
- In case of an error the system can only be restarted with a reset or a power supply restart
- Standard firmware is D6.25
- For other configurations of error codes refer to alternate controller or firmware documentation

5.2 System Operation with Controller *LPC-600.2* (Extended PLC)

5.2.1 State Diagram of the PLC Interface

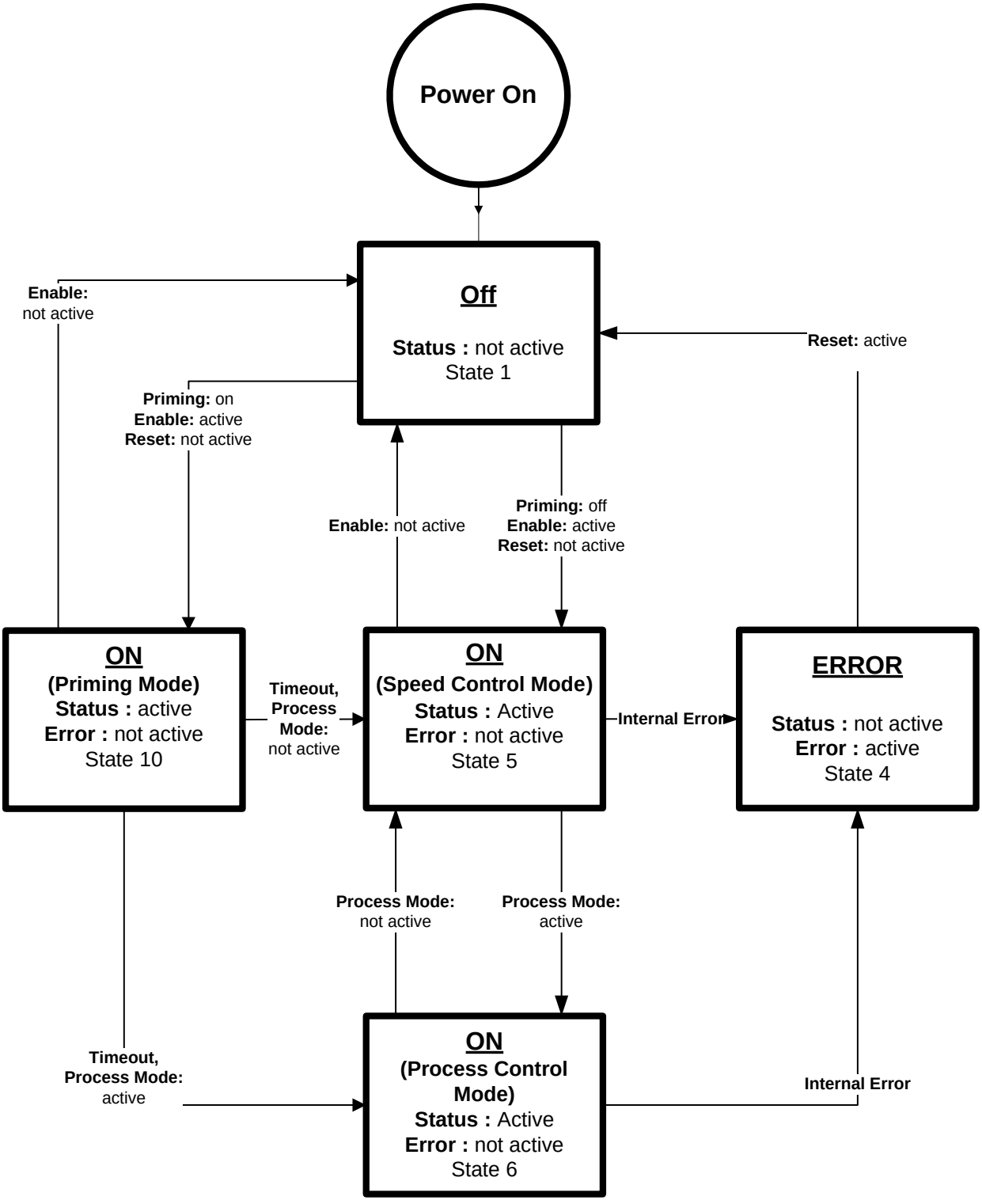


Figure 32: PLC interface state diagram for standard firmware D6.48
(For other configurations refer to alternate firmware documentation)

State "Off":

The pump system is switched off and the motor has no power. In this state, Levitronix Service Software has full control.

State "ON" (speed control mode):

The pump system is switched ON and the impeller is rotating with the referenced speed. The motor has electrical power when in this state.

State "ON" (process control mode):

The pump system is switched ON and the impeller is rotating with the priming speed. The motor has electrical power when in this state. In this state, the Manual User Interface LUI is disabled. This mode can only be accessed by activating priming feature within EEPROM-editor in *Levitronix® Service Software*. Priming speed and Timeout-time can also be configured within EEPROM-editor.

State "Error":

If an error according to *Table 13*. occurs in the pump system, the system defaults to the *Error* state. The designated digital output on the PLC Interface is activated. The pump system is switched OFF. By activating the "*Reset"* input the system gets back to the "*Off"* state.

Error Source	**Errors**	**Effect on Designated Digital Output of the PLC**
Motor	No rotor	*Error = relay open*
Motor	Temperature over 100°C	*Error = relay open*
Motor	Temp. was higher than 90°C for more than 10 minutes.	*Error = relay open*
Motor	Temperature more than 90°C	*Warning = relay open*
Motor	No motor temperature signal	*Warning = relay open*
Motor	Motor power cable not connected with controller	*Error = relay open*
Motor	Motor sensor cable not connected with controller	*Error = relay open*
Controller	Over-current	*Error = relay open*
Controller	Power channel interrupted	*Error = relay open*
Controller	Temperature over 80°C	*Error = relay open*
Controller	Temp. was higher than 70°C for more than 10 minutes.	*Error = relay open*
Controller	DC link (supply voltage) out of range (< 40 or > 54 V DC) If the voltage is out of range the system starts to reduce the speed and a warning is generated. When reaching 0 rpm and the voltage is still out of range the system is disabled and an error is generated. In case the voltage is again within the range during speed reduction the system switches to normal operation and no Error is generated.	*Error = relay open*
Controller	Temperature over 70°C	*Warning = relay open*
Controller	Dry Running Detection -> Pump keeps running on reduced speed (5000 rpm) -> The system accelerates to the set speed value when the pump is refilled with liquid -> Note that the speed is only reduced during dry running if the pump speed was ≥ 6000 rpm	*Warning = relay open*
Controller	Trend warning (actual speed too high)	*Warning = relay open*

Table 13: Errors and warnings with indication on PLC interface for standard firmware D6.48
(For other configurations refer to alternate firmware documentation)

5.3 System Operation for *ATEX / IECEx* Applications

Specific precautions may be considered while using the pump system in potential explosive gas atmospheres according to ATEX / IECEx category 3G/3D (*Zone 2* and *22*).

The user shall prevent priming issues during normal pump operation. Especially precautions have to be considered during installing and maintenance operations to prevent the occurrence of combustible atmospheres.

The user shall prevent electrostatic charging of the system at cleaning processes by using dry cleaning cloth. User shall use wet cleaning rags to avoid issues with charging at a cleaning process.

CAUTION

Precautions have to be considered to prevent priming issues during installation operation and maintenance of the pump head / motor.

WARNING

Operational Temperature 100°C T5
Maximum allowed pump liquid temperature is 90°C / 194°F for the use in Ex classified applications.

WARNING

Do not operate the pump against closed valves
Refer to the corresponding section in the manual.

6 Inspection and Maintenance

6.1 Replacement Interval of the Impeller

The impeller has a limited lifetime depending on the chemical type, concentration and temperature of the fluid which is pumped. Therefore a preventive periodical exchange of the impeller is recommended. Contact the *Levitronix Technical Service Department* (see *Section 6.2*) for further information on replacement times.

6.2 Impeller Replacement Procedure

6.2.1 Preparation

Before starting the impeller replacement procedure the parts and tools illustrated in *Figure 33* and *Figure 34* should be prepared. Impeller exchange kits, which contain this parts and tools are available at Levitronix (see *Table 4*). Please verify that you have the right types of impellers, O-rings and screws.

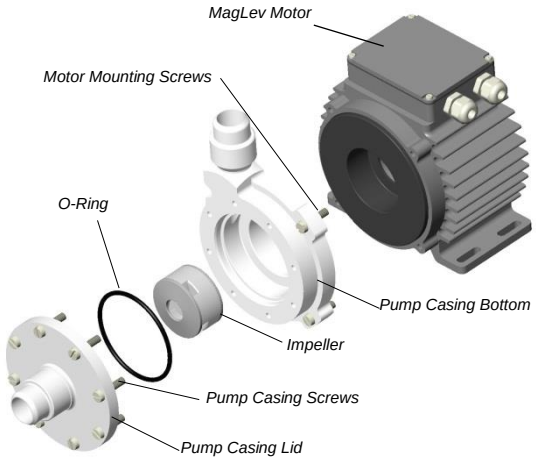


Figure 33: Explosion view of pump head with motor

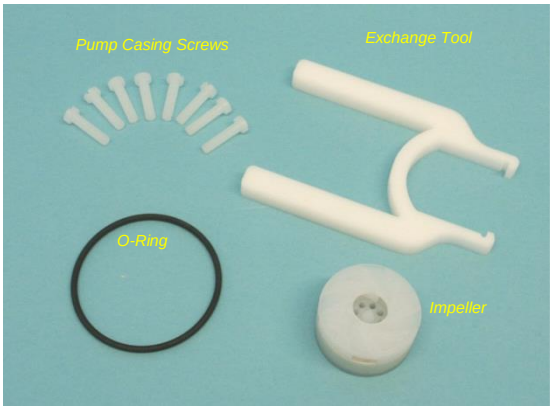


Figure 34: Components for impeller replacement
(The 4 M6x25 screws for motor mounting are not on the picture)

The following warnings and cautions should be read carefully before starting the replacement of the impeller.

⚠ WARNING

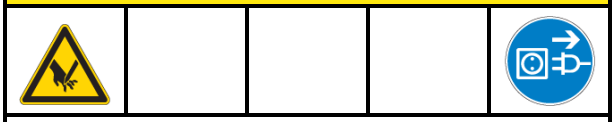
The impeller could splash TOXIC or CORROSIVE CHEMICALS because of the strong magnetic forces. Flush the pump housing before opening it.

⚠ WARNING

HARMFUL CHEMICALS may be present.

Skin contact and toxic gases may be hazardous to your health. Wear safety gloves and other appropriate safety equipment.

⚠ CAUTION



The rotating impeller could cause injury. Do not run the pump system when opening the pump head.

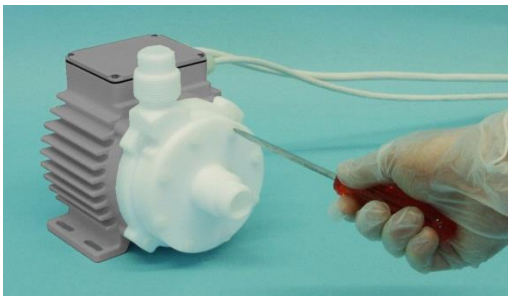
CAUTION

Pay attention to the magnetic forces when handling the impeller. The attraction of magnetic parts and particles should be avoided in order to keep the impeller and the pump head clean and free of contamination.

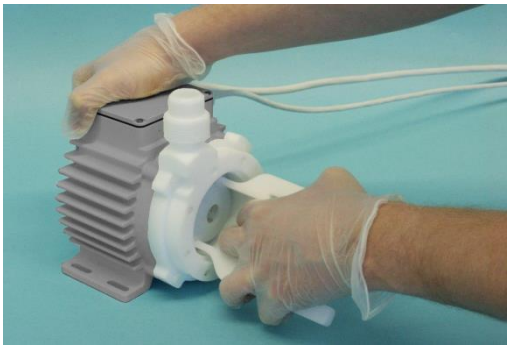
6.2.2 Instructions for Replacement

1. Power down the pump system and remove the AC power. If necessary, allow the housing to cool down to a workable temperature.

2. Unscrew the top of the pump head and remove it along with the sealing ring.

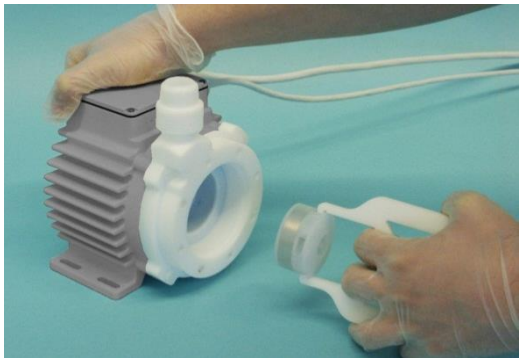


3. Remove the impeller with the *Impeller Exchange Tool*. Hook the claws of the *Impeller Exchange Too*l into two opposing orifices of the impeller.



4. Inspect the wet area of the pump head carefully. In case of material damage, also replace the pump casing.

5. Place the new impeller into the pump casing using the *Impeller Exchange Tool*.



6. If necessary, remove the existing *O-Ring* and gently press the new *O-Ring* into the lid of the pump casing.

CAUTION

Use the correct O-Ring type for your process. If necessary, consult the Levitronix Technical Service Department.

Do NOT twist or roll the O-Ring as this may cause leaking to occur.

7. Press the lid with the O-ring flush into the bottom of the pump casing.

8. Carefully tighten the *8* screws. The screws should not be used to press the lid with the O-ring into the bottom of the pump casing. Do not apply too much torque. The torque specifications are:

Maximum torque for pump screws
PVDF M6: 50 Ncm

Note: These are typical values for the standard pump head LPP-600.1. Refer to the relevant pump head specification drawings for other configurations, which may have different values.

9. Start up the system and check if the impeller is rotating properly and the pump head doesn't leak.

10. If the pump head leaks, check and make sure the lid and the O-Ring are properly pressed into the bottom of the pump casing. It may be necessary to change the O-Ring if it has been damaged.

7 Troubleshooting

7.1 Troubleshooting for Operation with Controller *LPC-600.1*

For troubleshooting and failure analysis with the stand-alone controller *LPC-600.1* the following procedure is recommended:

- Check the status of the LEDs. The specific LEDs are described in *Table 8*
- Use the ERROR codes on the display. The specific error codes are described in *Table 12*
- A digital output on the "USER INTERFACE" connector ("Status") indicates if the system is active. However, the source of an error cannot be identified by this signal

7.2 Troubleshooting for Operation with Controller *LPC-600.2*

The integrated *PLC* provides a Warning and an Error signals according to *Table 13*. However, the source of error cannot be identified by these signals.

For more detailed analysis the *Levitronix® Service Software* can be used with a PC and a USB interface to the controller.

7.3 Troubleshooting with Service Software

The *Levitronix® Service Software* allows communication with the pump system in connection with a PC and a USB interface. The software can be used for performing detailed troubleshooting. For usage of the Service Software refer to the *Service Software User Manual* (Document #: *PL-2034-00*), which is available in the download section on the Levitronix Web-page or contact the *Levitronix® Technical Service Department* (see under *Section 8*).

Note: the Service Software can not be used with the standalone controller *LPC-600.1*.

8 Technical Support

For troubleshooting, support and detailed technical information contact *Levitronix® Technical Service Department*:

Levitronix®
Technical Service Department
Technoparkstr. 1
CH-8005 Zurich
Switzerland

Phone for US: 888-569 07 18
Phone for outside US: +1 888-569 07 18
E-Mail: support@levitronix.com

9 Appendix

9.1 Regulatory Status

9.1.1 CE Marking

The *Centrifugal Pump System BPS-600*, in its various configurations as listed below, is in conformity with the above mentioned *European Directives*.

Part Name	***Description***
LPP-600.x	Pump casing configurations consisting of variations concerning fittings, O-Rings, wet materials and performance and impellers with various materials and performance variations
LPM-600.x	Bearingless motors: *LPM-600.x* (x = various cable, connector and coating options)
LPC-600.x	Controllers with 48V DC / 600 W supply inputs: *LPC-600.x* (x = various interfacing options, galvanic separated from high-voltage side)
Accessories	Motor controller adaptor cables of various length, air cooling module and others

Machinery Directive 2006/42/EC:
The machinery directive essentially has been followed by a risk analysis, according mitigation actions and a user manual for safe operation. For the design and testing the following standards are used as a guideline:

EN809	Pumps for Fluids: basic requirements are followed.
EN12162	Procedure for hydrostatic pressure testing in fluid pumps: used for max. pressure testing of pump head.
ISO12100	Safety for machinery – principles for risk assessments: used for system risk analysis.

EMC Directive 2014/30/EC:
The following standards of the EMC directive are tested and confirmed at a certified laboratory:

EN61000-6-2	Generic standards, Immunity for industrial environments
EN61000-6-4	Generic standards, Emission standard for industrial environments

9.1.2 IECEE CB Safety Certification

Specific motors with pump heads and controllers of the ***Centrifugal Pump System BPS-600*** are 3rd party tested and certified by *Electrosuisse* following the *IECEE CB Scheme* according to the following safety standards:

IEC61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use.

The CB certification number is *CH-7696*.

Available on Request

9.1.3 NRTL/ETL Safety Certification and Marking

Specific motors with pump heads and controllers of the ***Centrifugal Pump System BPS-600*** are tested by the US national recognized laboratory (NRTL) *Intertek* according to the following safety standards:

UL61010-1	Safety requirements for electrical equipment for measurement, control and laboratory (US Standard).
CSA-C22.2 No. 61010-1-12	Safety requirements for electrical equipment for measurement, control and laboratory use (Canadian Standard).
UL1004-1	*Rotating Electrical Machines - General Requirements (US standard).*

The ETL control number for the listing is *4010272*.

Available on Request

9.1.4 *ATEX / IECEx* Certification and Marking

Specific motors together with the pump head of the ***BPS-600*** pump system are in conformity with the requirements of the *Directive 2014/34/EU* and the applicable *IEC* standards. The following standards are tested and confirmed at a certified laboratory.

IEC / EN 60079-0	Electrical apparatus for explosive gas atmospheres. General requirements.
IEC / EN 60079-15	Electrical Apparatus for explosive gas atmospheres. Construction, test and marking of type of protection, “nA” non-sparking electrical apparatus.
IEC / EN 60079-31	Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosure “t”.
IEC / EN 13463-1	Non-electrical equipment for use in potentially explosive atmospheres – Part1: Basic method and requirements.
IEC / EN 13463-5	Non-electrical equipment for use in potential explosive atmospheres – Part5: Protection by constructional safety “c”.

The *Levitronix*® Ex motors are marked clearly and in accordance to the *ATEX* Directive and the relevant *IECEx* standards. The protection “*Ex nA*” means non sparking electrical apparatus.

CE Ex

II 3G Ex nA IIC T5 Gc
II 3D Ex tc IIIC T100°C Dc

IECEx Available on Request

Classification:	*Category 3GD* (*Zone 2 for Gas* and *Zone 22 for Dust)*
Explosion Groups:	*Group IIA: Propane (IPA), Methane, Acetone, Acetaldehyde* *Group IIB: Ethylene, Ethylenglycol* *Group IIC: Acetylene, Hydrogen (not carbon disulphide*) *Group IIIC: conductive dust*
Thermal Classification:	Thermal classification of motor is 100°C (T4) (100 ^{0}C = 212 ^{0}F) for maximum full-load operating temperature at a maximum liquid temperature of 90^{0}C / 194 ^{0}F.
UL Correspondence:	*ATEX / IECEx* listing corresponds to UL hazardous location *Class 1 Division 2*.

9.2 Symbols and Signal Words

Symbol / Signal Word	Description	Type	Source
DANGER	Indication of an imminently hazardous situation that, if not avoided, will result in death or severe injury. Limited to the most extreme situation	Signal word	SEMI S1-0701
WARNING	Indication of a potentially hazardous situation which, if not avoided, could result in death or severe injury.	Signal word	SEMI S1-0701
CAUTION	Indication of potentially hazardous situations which, if not avoided, could result in moderate or minor injury. Also alert against unsafe practice. Without safety alert indication of hazardous situation which, if not avoided, could result in property damage.	Signal word	SEMI S1-0701
	Safety alert for “Warning” and “Caution”	Safety alert	SEMI S1-0701
	Safety alert for “Danger”	Safety alert	SEMI S1-0701
	Caution (refer to accompanying documents) (is used on article labels for reference to manual)	Refer to manual	ISO 3864
	Toxic material, poison	Hazard identification	IEC 61310
	Corrosive material, corrosion	Hazard identification	IEC 61310
	Cut/sever hand, sharp object	Hazard identification	ANSI Z535.3
	Strong magnetic field	Hazard identification	SEMI S1-0701
	Danger: electricity, electrical hazard	Hazard identification	IEC 61310, ISO 3864
	Wear safety gloves	Hazard avoidance Mandatory action	IEC 61310
	Wear face shield	Hazard avoidance Mandatory action	SEMI S1-0701
	No pacemakers	Hazard avoidance Prohibition	SEMI S1-0701
	ATEX Logo	Used for hazard identificat. in warnings	--

Table 14: Safety symbols and signal words