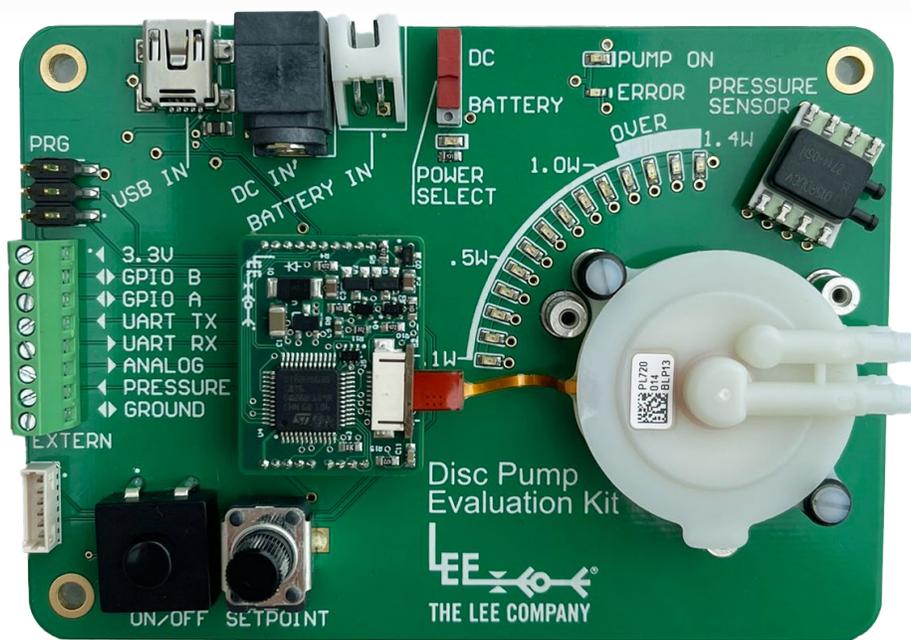


PIEZOELECTRIC DISC PUMP EVALUATION KIT (UEKA05xxxxxxx)

USER MANUAL





PIEZOELECTRIC DISC PUMP EVALUATION KIT (UEKA05xxxxxxx) USER MANUAL:

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1. DISCLAIMER

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Use of the Evaluation Kit, including all software and firmware provided with it, is subject to The Lee Company's standard terms and conditions of sale. The contents and packaging of the kit will vary depending on your individual orders.

2. SPECIAL NOTICES

Throughout this User Manual, special notices relating to the safe and correct operation of the Evaluation Kit are formatted and highlighted as follows:



CAUTION

Instructions to ensure correct operation of the equipment and/or for avoiding damage to the equipment.



WARNING

Instructions relating to the safety of the operator and avoiding injury.

3. INTRODUCTION

3.1. Piezoelectric Disc Pump Evaluation Kit

The Piezoelectric Disc Pump Evaluation Kit has been designed to enable the demonstration and evaluation of our disc pump technology for pumping gases and the potential use in disc pump enabled products. This document provides details of the system. The disc pump is a gas pump, however it can be used to move fluids using pressure driven flow, using the appropriate equipment (please our Application Notes for further examples).

3.2. Piezoelectric Disc Pumps

The Lee Company's piezoelectric disc pumps are a multi-award winning technology which makes use of advances in the field of non-linear acoustics, to offer the following unique features for pumping gases:

- silent operation
- ultra-smooth flow
- millisecond responsiveness
- compact form factor
- high-precision controllability

In contrast to conventional air pumping mechanisms (such as diaphragm and piston pumps), our disc pumps do not rely on the bulk compression of air within a cavity. Instead, our micropumps generate a high amplitude, high frequency acoustic standing wave within a specially designed acoustic cavity.

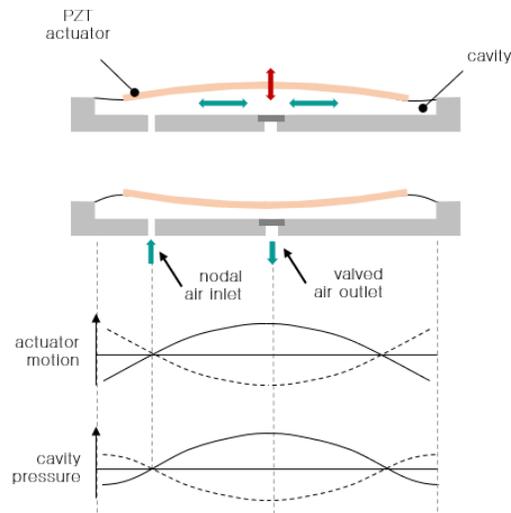


Figure 1. Principle of operation

Figure 1 shows a simplified schematic: the out-of-plane motion of the actuator drives in-plane (radial) motion of the gas in the cavity and creates a standing pressure wave, resulting in the oscillating cavity pressure shown. The motion of the actuator is highly exaggerated: there is virtually no net volume change of the cavity during operation and at any given point in time there exists both a region of compression and a region of rarefaction within the cavity.

Rectification of the alternating cavity pressure is the key to delivering useful pump performance and device lifetime. The Lee Company has addressed this need by developing a family of innovative valve designs based on lightweight polymer valve flaps.

Our disc pump technology is protected by a portfolio of both patent applications and granted patents.

4. SYSTEM COMPONENTS

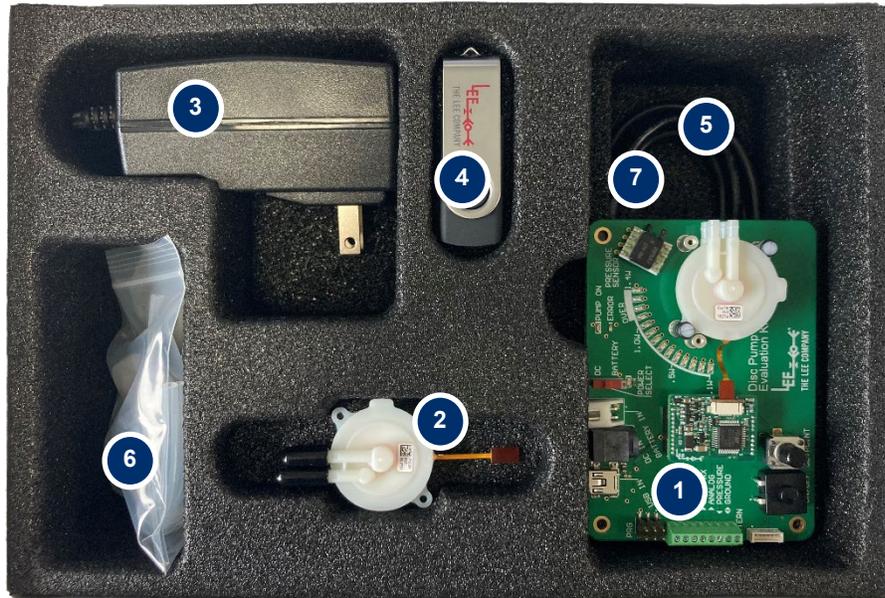


Figure 2. Piezoelectric Disc Pump Evaluation Kit components – kit components and packaging may vary depending on customer order.

Item	Description
1	Motherboard PCB, on which is mounted one of the two pumps included, together with the postage-stamp sized pump drive PCB. This is packed within an ESD (electro-static discharge) bag. Note: for custom evaluation kits, the pumps may be provided separately
2	A second pump. Note: for custom evaluation kits, the pumps may be provided separately
3	Mains power supply which converts AC to DC for the motherboard. Typically, a region-specific adapter will have been fitted for you. Note: for custom evaluation kits, the mains power supply may not be present, and the system can be run using USB power instead.
4	USB flash drive containing PC application software. User Manual and supporting documentation.
5	USB cable, which enables the PC application to communicate with the drive PCB, included in the pocket beneath the evaluation kit PCB.

6	Accessories kit including tubing, fittings, and filters.
7	Quick Start card.

Table 1. Component description

5. SAFETY



WARNING

The equipment described in this document is research and development hardware intended for laboratory use by skilled and competent personnel only. Further, the components of this evaluation system have been provided in a 'bare' format enabling users to integrate the pump, drive electronics and power supply into test fixtures and prototype product assemblies.

The user should satisfy themselves that the equipment is and remains fit for the intended use. The user accepts that The Lee Company shall not be held responsible or liable for any injury, damage or loss to property, person or otherwise, resulting from use of the equipment.

To aide with safety assessment of the use of the equipment, the following indicative electrical data are provided:

A.C. voltage on the Drive PCB: 120 Vpp max. (at 19 – 23 kHz)
D.C. voltage on the Drive PCB: 60 V max.

All Disc Pumps emit ultrasound in operation. The following data are provided for operation at maximum power (1.4W) at a distance of 30cm:

Sound pressure level: 70-80 dBA typ. (at 19-23 kHz)¹

1. Equivalent to <10 phon per ISO 226:2003 and related studies, 30 cm equivalent measurement distance



WARNING

Take care during use of the Evaluation Kit not to create short circuits between exposed conductive parts of the PCBs. Short circuits may lead to malfunctioning and heating.

5.1. General Purpose Disc Pump Drive PCB protective cover

High voltages may be present on certain parts of the General Purpose Disc Pump Drive PCB. To protect the user from exposure, the Evaluation Kit is supplied with a protective cover fitted to the Drive PCB. The protective cover should remain fitted at all times when power is applied to the Drive PCB.

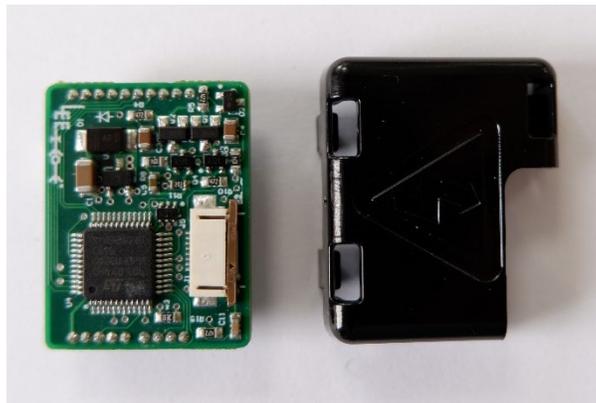


Figure 3. General Purpose Disc Pump Drive PCB (left) and protective cover (right)



Figure 4. Disc Pump Evaluation Kit with the protective cover fitted to the General Purpose Disc Pump Drive PCB

To fit the protective cover:

- Hook the corner marked 'A' below so it clips over the board as shown in Figure 5, leaving the pump connector '4' accessible.
- Apply downwards pressure over the tabs marked 'B' and 'C', until the cover clicks into place.

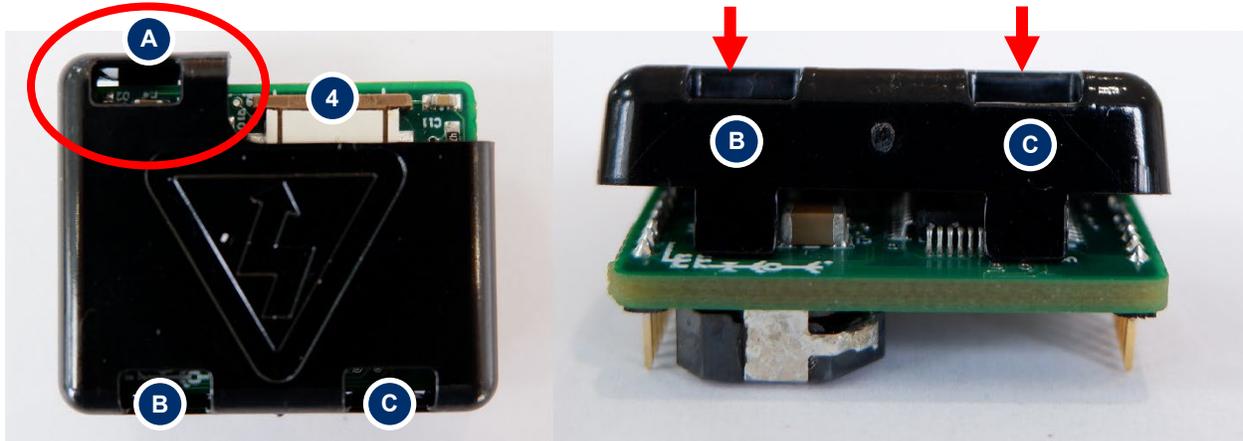


Figure 5. Fitting the protective cover to the General-Purpose Pump Drive PCB

To remove the protective cover:

- First remove the General Purpose Disc Pump Drive PCB and protective cover from the motherboard together by pulling vertically upwards.
- The protective cover can then be removed by gently pulling the clips 'B' and 'C' away from the PCB.

6. PIEZOELECTRIC DISC PUMP EVALUATION KIT – DETAILS

The piezoelectric disc pump must be driven with an AC drive signal at a frequency optimised to suit each pump and its operating conditions. The General Purpose Disc Pump Drive PCB is responsible for generating the necessary drive signal. The pump and drive PCB are mounted onto a motherboard as shown in Figure 6. The motherboard provides a range of convenient and easy-to-use connections, user interface elements and functionality, as detailed in Table 2.

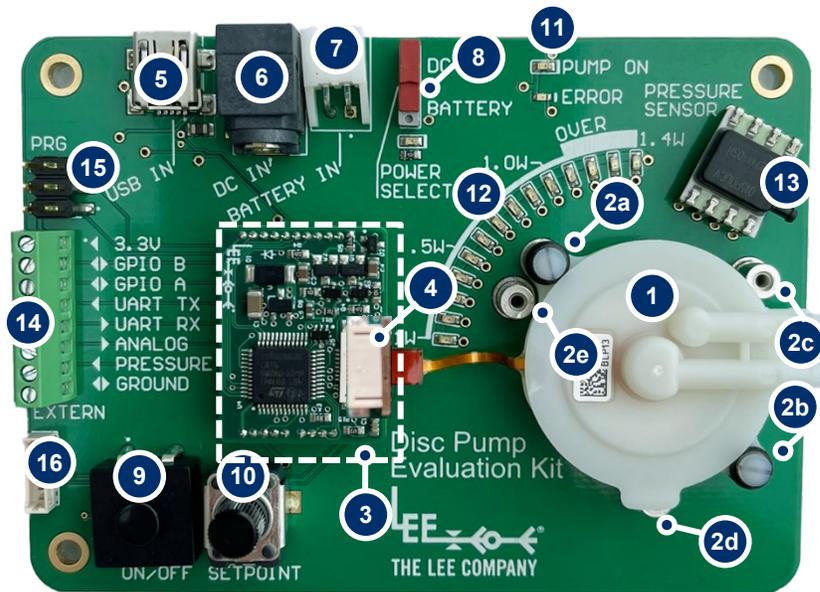


Figure 6. Evaluation Kit Motherboard

Item	Details
1	The Lee Company Disc Pump (UltraSlim has 3 mounting lugs, other models 2)
2a/b/c/d/e	Pump mounting stand-offs (UltraSlim 2c,d,e). Note that whilst disc pump operates ultrasonically and is therefore inaudible, it is possible for the pump to vibrate against the mounting features or casework. To prevent this vibration causing audible noise, the pump is mounted with compliant O-rings and nylon bolts. When swapping the pump over, be sure to repeat this mounting arrangement (see §7.1).
3	General Purpose Disc Pump Drive PCB

4	Flexible printed circuit (FPC) connector: electrical connection between pump and PCB (see §7.4)
5	USB IN – connect at PC to the PCB with the supplied USB cable to allow the disc pump control software to communicate with the PCB. There is a solder bridge on the underside of the board (SB1) which, when bridged, allows the evaluation system to be powered from USB IN without the need for the mains power adapter. Note that the USB port providing power must be capable of supplying 500 mA or greater.
6	POWER IN – connection for the mains transformer to power the system.
7	BATTERY IN – optional connection for a single cell 3.7 V lithium-ion battery (not supplied). Pin 1 (marked with a dot) is ground. Note that the motherboard includes a charge circuit that can recharge a lithium battery. With the battery connected and battery power source selected, connect the mains power supply to begin charging. Note that the charge current is limited to 100 mA.
8	Battery / mains power source selector switch: enables selection between mains (“DC”) or battery power. Always ensure a battery is connected when battery power is selected.
9	ON/OFF – pump on/off switch. A single click will toggle the pump on/off. The pump may also be turned on/off by the PC application.
10	SETPOINT – rotary control allowing the system setpoint to be adjusted. By default, this adjusts the drive power supplied to the pump, although it can be configured to control other parameters via the PC application.
11	PUMP ON – green LED indicating the pump on/off state. ERROR – red LED indicating the error state of the system. Errors can be cleared by toggling the pump off and on again, or by power cycling the system. If the error persists, check the contact with the flexi tail and the drive PCB. If contact appears satisfactory but the error light stays on, try installing another pump. If the error disappears, contact with the original pump may not have been satisfactory or the original pump may be faulty.
12	Power gauge: array of LEDs to indicate the drive power being supplied to the pump. For continuous operation, The Lee Company recommends that drive power is limited to 1 W. For intermittent use, we recommend a maximum limit of 1.4 W.
13	Differential pressure sensor: when connected to the pneumatic circuit, allows the pressure generated by the pump to be measured and displayed in the PC application. The top barb on the pressure sensor is intended to be connected to positive pressures and the bottom barb to negative pressures. The evaluation system is capable of PID/closed-loop control of the pump pressure.

<p>14</p>	<p>External signal connections: screw terminal block providing the following connections:</p> <p>3.3V – output from GP drive PCB that can be used to power 3.3V devices (max 10 mA). The previous design of drive PCB output was 2.5V.</p> <p>GPIOA – 3.3V-level digital toggle signal IO for enabling / disabling pumping with an external signal.</p> <p>GPIOB – Reserved for future use.</p> <p>UART T/RX – 3.3V-level serial data transmitted from / received by the PCB. The evaluation system can be controlled by the customer’s host PCB/system via these connections.</p> <p>ANALOG – 0 to 3.3V analog input. The evaluation kit can be configured to be controlled by this signal in the PC application.</p> <p>PRESSURE – 0 to 3.3V analog output representing the pressure measured by the on-board sensor. The mapping is:</p> <p style="padding-left: 40px;">0.00 V = -15psi (-775 mmHg) (differential between ports)</p> <p style="padding-left: 40px;">1.25 V = 0 mmHg</p> <p style="padding-left: 40px;">2.50 V = +15psi (+775 mmHg)</p>
<p>15</p>	<p>PRG – programming header that can be used to programme the drive PCB.</p>
<p>16</p>	<p>External Liquid Flow Sensor connector header (See AN007 for set-up, referenced in §8)</p>

Table 2. System details

7. SYSTEM OPERATION

7.1. Pump mounting guidance

The Evaluation Kit is shipped with a pump mounted on the motherboard (with the exception of custom orders). Depending on the pump model, each pump has either two or three mounting eyelets. When swapping pumps, make sure that two O-rings are used per mounting eye (one above and one below the eye), and use the supplied Nylon M2 bolts. This mounting scheme isolates high-frequency vibration and prevents audible noise. Note that metal bolts are not recommended for this reason.

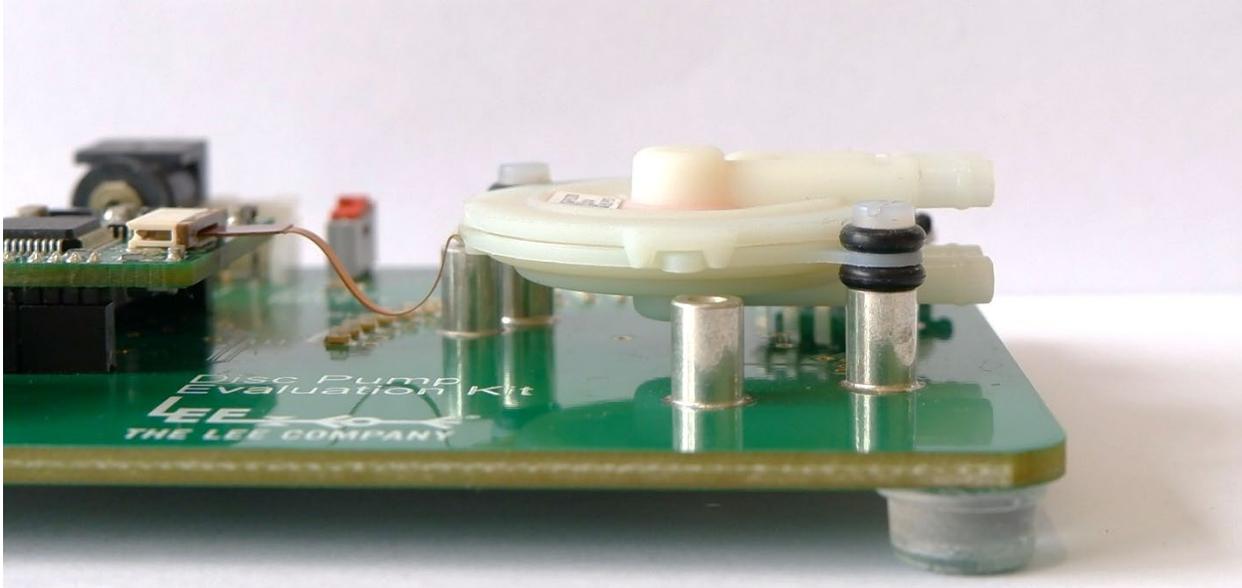


Figure 7. Example of recommend pump mounting

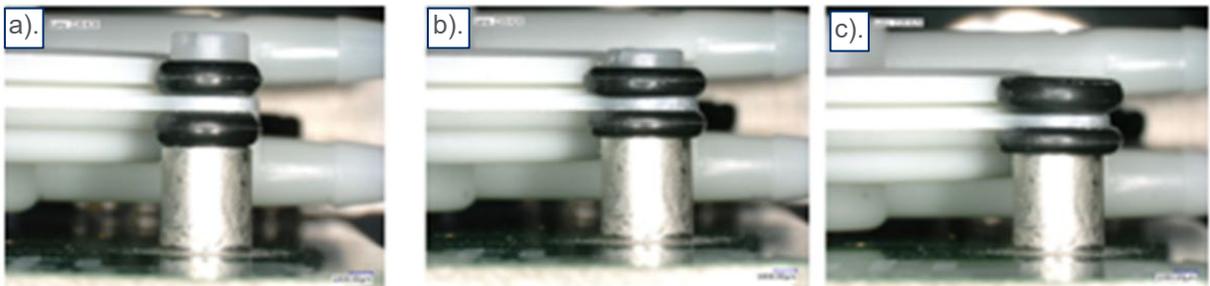


Figure 8. Images showing O-ring appearance as the nylon bolt is tightened. O-rings should be well compressed as shown in (b). Under tightening (a) or over tightening (c) may lead to audible noise

TAKE NOTE!



Failure to mount the pump correctly can result excessive movement of the Flexi (power cable) in the FPC connector. This can result in a short circuit and permanent damage.

7.2. Electrical connection

The disc pumps use an FFC (flat flex connector) compatible with most 8-way 0.5mm pitch FFC connectors. The General Purpose Disc Pump Driver has such a connector, and it is important that the disc pump “Flexi Tail” is properly seated in this connector, see Figure 9 below.

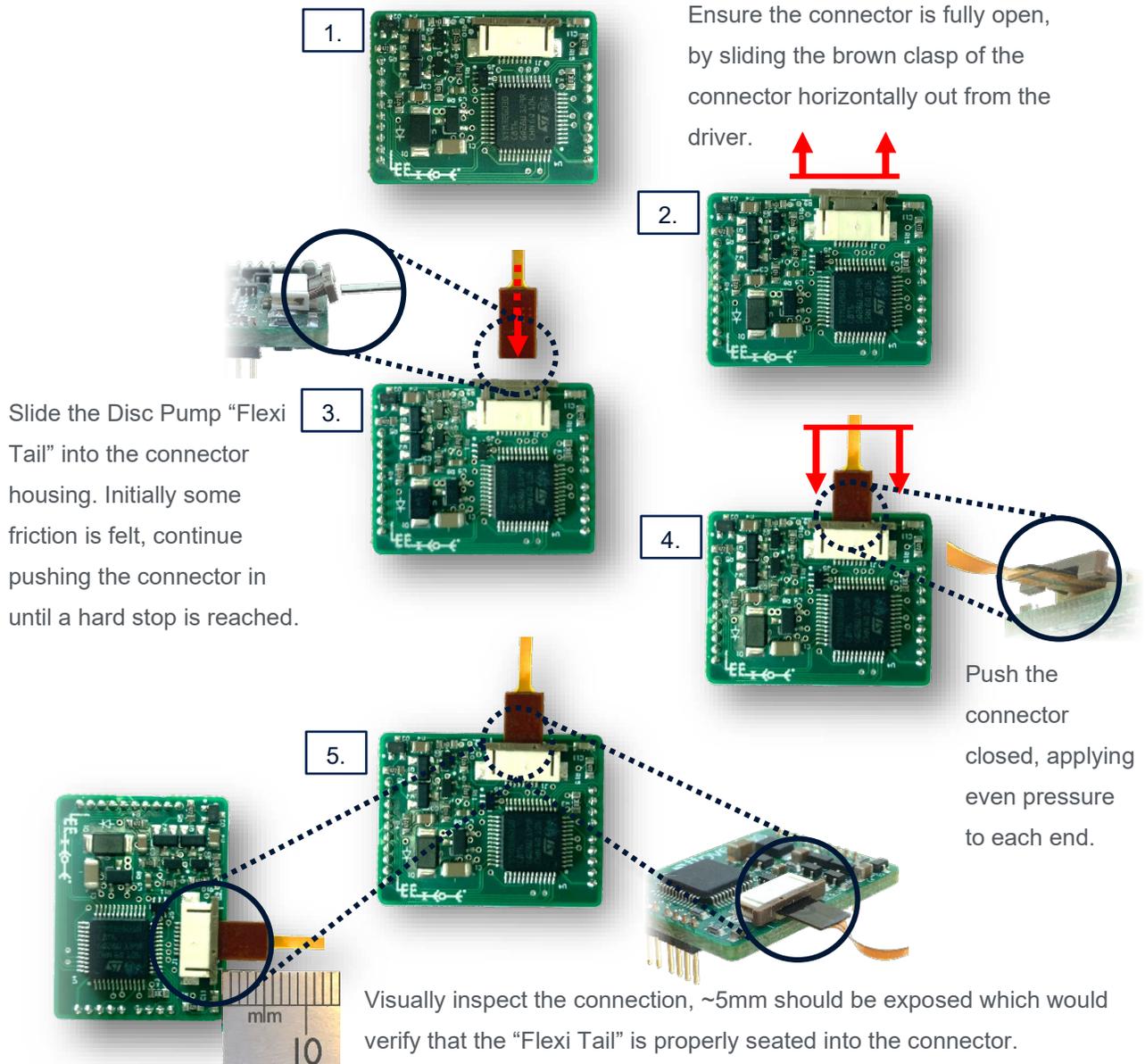
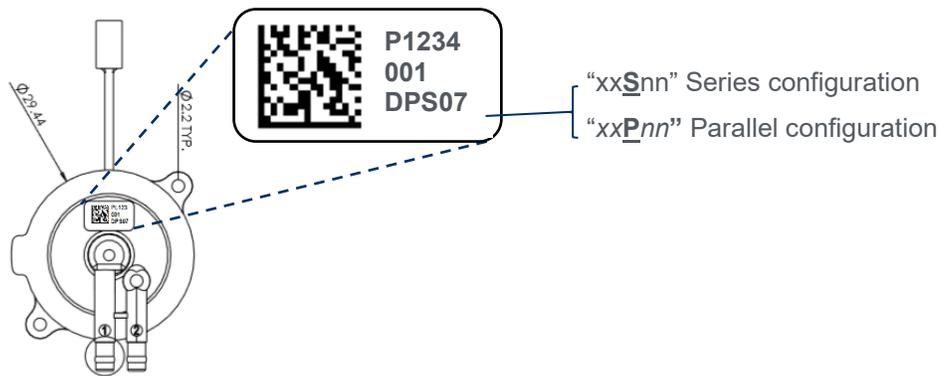


Figure 9. FPC connecting and reverse for removal

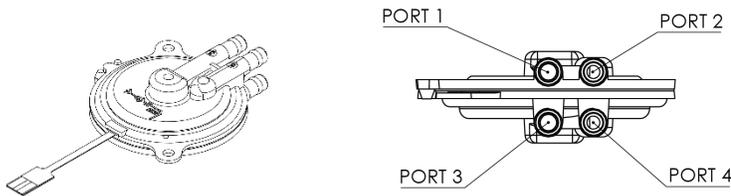
7.3. Pump pneumatic connections

7.3.1. BL/XP/LT Series pumps

- Take note of the pump configuration according to the pump labelling:



- Ensure the pump ports are connected according to the following diagram:



For series configuration pumps:

- Ports 2 and 4 must be linked (see the Pump Accessories for suggested coupler)
- Port 3 is inlet
- Port 1 is discharge



For parallel configuration pumps:

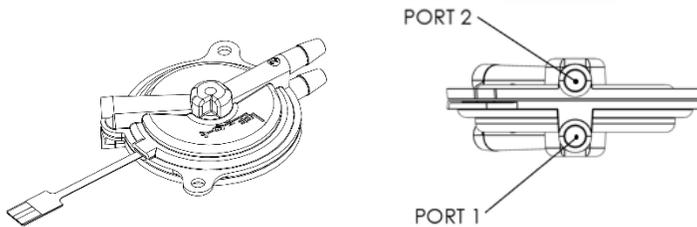
- Ports 2 and 4 are the common inlet and should be linked*
 - Ports 1 and 3 are the common discharge and should be linked *
- *(see the pump [Accessories](#) for suggested coupler)



7.3.2. HP Series pumps

For HP Series pumps:

- Ports 2 is the inlet
- Ports 1 is the discharge



7.3.3. US Series pumps

For US Series pumps:

- Ports 1 is the outlet
- The inlet is filtered and not connectable

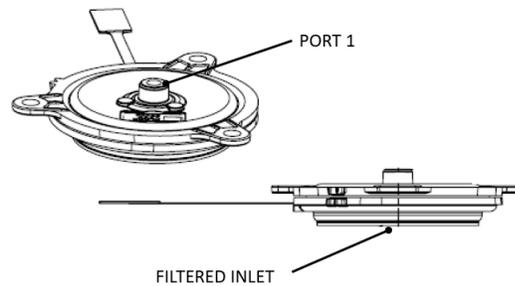


Figure 10. US Series pumps - port numbering



TAKE NOTE!

Ensure that a filter is connected to the pump inlet during operation.

7.4. Running the system

- Remove the motherboard PCB (Figure 2 - 1) from protective ESD bag.
- Connect the pump ports (see Section 7.3).
- Power the board with the mains power supply (Figure 2 - 3) connected to the POWER IN (Figure 6 - 6).
- Turn pump on/off with the ON/OFF switch (Figure 6 – 9).
- Adjust pump power with the SETPOINT dial control (Figure 6 – 10).
- The USB flash drive (Figure 2 - 4) contains manuals, a video on system operation and PC software for configuration, control and data logging.
- Also included is a second pump (Figure 2 - 2), USB cable (Figure 2 - 5) and accessories kit of tubing, filters and connectors (Figure 2 - 6).

7.5. Removing / installing a pump

CAUTION



Whether removing or installing a pump, always power down the Evaluation Kit first by removing the mains power supply (or battery, if in use) and USB cable. Failure to do so may result in damage to the system.

Removing a pump:

- Power down the system and remove the USB cable.
- Pull out the brown clasp evenly on the FPC connector (reverse of Figure 9) so that it is in the open position.
- Remove the pump flexi-tail from the FPC connector (reverse of Figure 9).
- Unscrew the pump mounting screws (Figure 6 – 2a/b for models other than UltraSlim).
- Retain the O-rings used to mount the pump for later use.

Installing a pump:

- If a pump is currently installed on the board, remove it per the instructions above.
- Fit the pump to the stand-offs (Figure 6 – 2a/b or 2c/d/e) with the screws and O-rings provided (ensure that one O-ring is above and below each mounting eye).
- Ensure the brown clasp is pulled out on the FPC connector (Figure 9)
- Insert the pump flexi-tail into the FPC connector (Figure 9).
- Push in the brown clasp evenly on the FPC connector so that it locks in the Flexi tail (Figure 9).
- Reinsert the USB cable.

7.6. Power over USB and troubleshooting

The Evaluation Kit can be powered over the USB cable provided. Most USB ports are capable of supplying sufficient current of at least 500mA, however this is not always the case. Some older USB ports or crowded USB hubs are only capable of supplying 100mA which is not enough to power the Evaluation Kit.

In the event of connecting the Evaluation kit to a USB port that is not capable of supplying sufficient current, the following error message will appear on screen (see Figure 11). The error means the USB port has been turned off to prevent damage to the computer. To fix the problem disconnect the Evaluation Kit and dismiss the error message by clicking “Reset”. Connect the Evaluation kit to a wall power adapter and once the Kit has powered on, connect it to the computer via USB.



Figure 11. Error when connecting the Evaluation Kit to a low power USB port



WARNING

Enabling power over USB requires the user to apply solder to a designated solder bridge only. This operation should only be carried out by suitably trained personnel. If in doubt, do not proceed.

For older versions of the Evaluation Kit (Motherboard v8 and earlier) this feature is disabled by default.

To enable this feature:

- Power down the system and remove all cables.
- Apply solder to the solder bridge designated “SB1” on the underside of the motherboard, as per Figure 12.

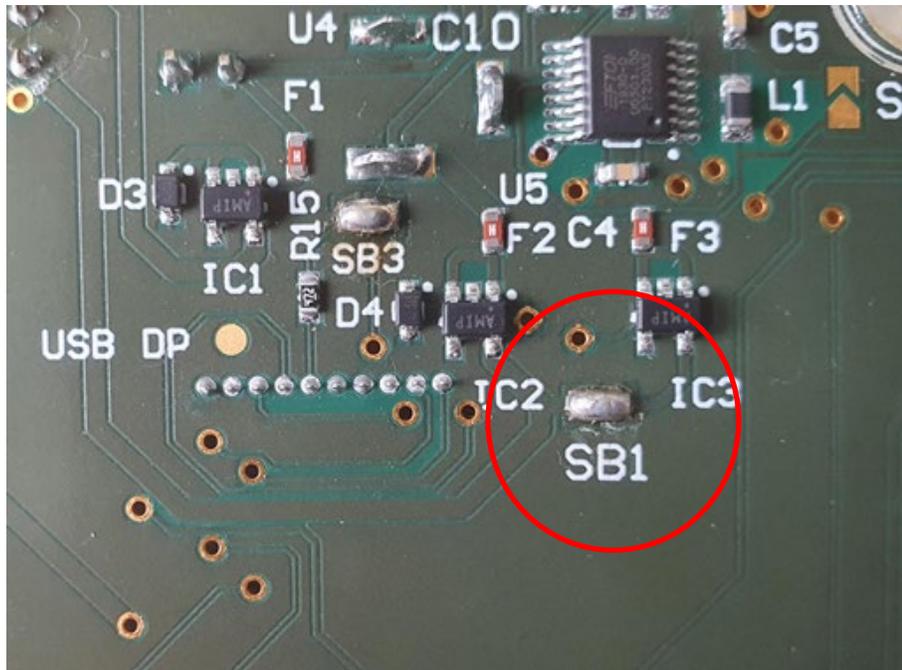


Figure 12. Solder applied to solder bridge “SB1” to enable power over USB

8. Disc Pump Control App

To configure the PCB, a bespoke application (Disc Pump Control App) is provided:

To install the application:

- Copy the Disc Pump Control App folder from the USB flash drive provided to a destination folder on the target PC. The App software is also available on The Lee Company website.

To download the relevant drivers:

- Ensure the PC is connected to the internet.
- Connect the PCB to the PC with the USB cable.
- If the PC is running Windows 7 or later, all drivers should automatically be downloaded and installed.
- Drivers can be download from here: <https://ftdichip.com/drivers/vcp-drivers/>



CAUTION

Ensure that the driver installation process has completed successfully before proceeding

8.1.Starting the Application

With the PCB connected to the PC via the USB cable, double click on the “Disc Pump Control App.exe” executable file.

- Select the appropriate COM port from the top-left dropdown menu and click connect.
- The application should now be connected and display all the current settings on the GUI.

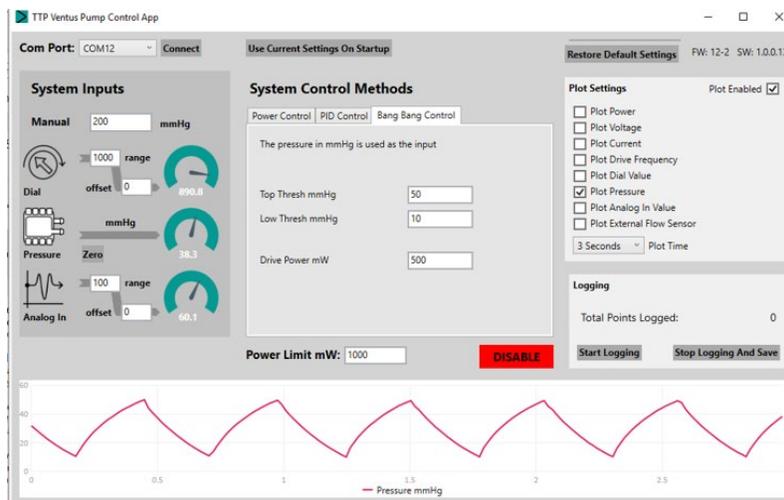


Figure 13. Disc Pump Control App GUI

8.1.1. System inputs

The user interface has a panel displaying the System Inputs on the left-hand side – these are:

- a manual setpoint entered via the software
- the setpoint dial on the evaluation kit motherboard
- the pressure sensor, also on the motherboard and
- a 0 to 2.5 V analog input signal on the screw terminal block, also on the motherboard.

The values for these inputs are displayed under the dials on the user interface.

The dial and analog-in inputs have a range and an offset associated with them. This allows these inputs to be arbitrarily mapped to power and pressure setpoint variables. Use of the range and offset values is explained in §8.1.3 and §8.1.4.

8.1.2. System controls methods

In the centre of the user interface is the System Control Methods panel. There are three control modes:

- Power Control,
- PID pressure control,
- Bang-bang pressure control.

8.1.3. Power control mode

Power Control mode controls the drive power supplied to the pump.

- Select the Power Control tab.
- Select the target power source from the dropdown menu:
- **Manual:** the power target is entered manually into the “System Input” section. The units are milliwatts.
- **Potentiometer:** the power target is controlled by the position of the SETPOINT potentiometer control (Figure 6 – 10) on the motherboard.
- **Analog Input:** the power target is controlled by the 0 to 2.5V analog input supplied on the external connections screw terminal block on the motherboard (Figure 6 – 14).
- Note that the potentiometer and analog in control input values are displayed in the “System Inputs” section of the PC application. Each has a range and offset associated with it, allowing the mapping of the input to the target power to be configured.
- Example mappings:

Desired full-scale range mapping	Range	Offset
0 to 1000 mW	1000	0
0 to 500 mW	500	0
200 to 400 mW	200	200

Table 3: Example mappings of the Range and Offset variables

- Click the “Enable/Disable” button on the GUI to toggle the pump output. Alternatively, use the ON/OFF button on the motherboard.
- Tick the “Plot Power” check box to observe the drive power supplied to the pump.

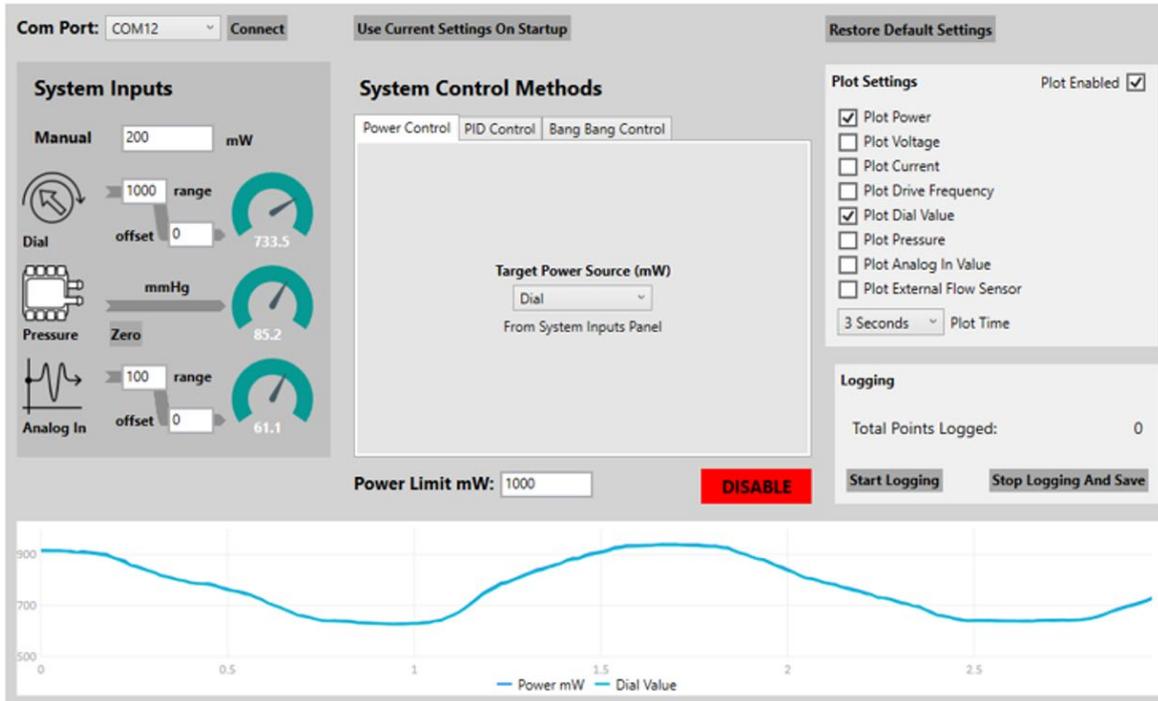


Figure 14. Power controlled to a target controlled by the SETPOINT dial on the motherboard.

8.1.4. PID control mode

PID Control mode adjusts the pump drive power until a target pressure is reached.

TAKE NOTE

Connect the upper barb of the pressure sensor to the pneumatic circuit.



For positive pressure control, connect the pressure sensor to the outlet of the pump. Within the control app, use positive pressure setpoint targets and positive values for the P, I and D coefficients which determine the behaviour of the PID control loop.

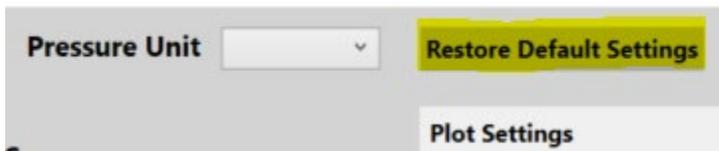
For negative pressure control, connect the pressure sensor to the inlet to the pump. Within the control app use negative pressure setpoint targets and negative

values for the P, I and D coefficients which determine the behaviour of the PID control loop.

The pressure sensor reading can be zeroed by clicking the “Zero” button next to the pressure sensor icon.



The zero offset can be reset by clicking “Restore Default Settings”



- Connect the on-board pressure sensor to the pneumatic circuit.
- Select the PID Control tab.
- Select the pressure control setpoint from the dropdown menu:
- **Manual:** the pressure target is entered manually into the “System Input” section
- **Dial:** the pressure target is controlled by the position of the SETPOINT dial control on the motherboard.
- Note that the dial control input value is displayed in the “System Inputs” section of the PC application. It has a range and offset associated with it, allowing the mapping of the input to the target pressure to be configured. Example mappings for the Dial control are:

Desired full-scale range mapping	Range	Offset
0 to 100 mmHg	100	0
0 to 200 mmHg	200	0
100 to 200 mmHg	100	100

Table 4: Example mappings of the Range and Offset variables

- **Analog Input:** the pressure target is controlled by the analog input.
- Click the “Enable/Disable” button on the GUI to toggle the pump output. Alternatively, use the ON/OFF button on the motherboard.

- Tick the “Plot Pressure” check box to observe the pressure measured by the sensor.
- The P, I and D coefficients should be configured to optimise performance of the loop for the customer’s specific setup. Factors such as the volume of the pneumatic circuit need to be considered when tuning the pressure control loop.

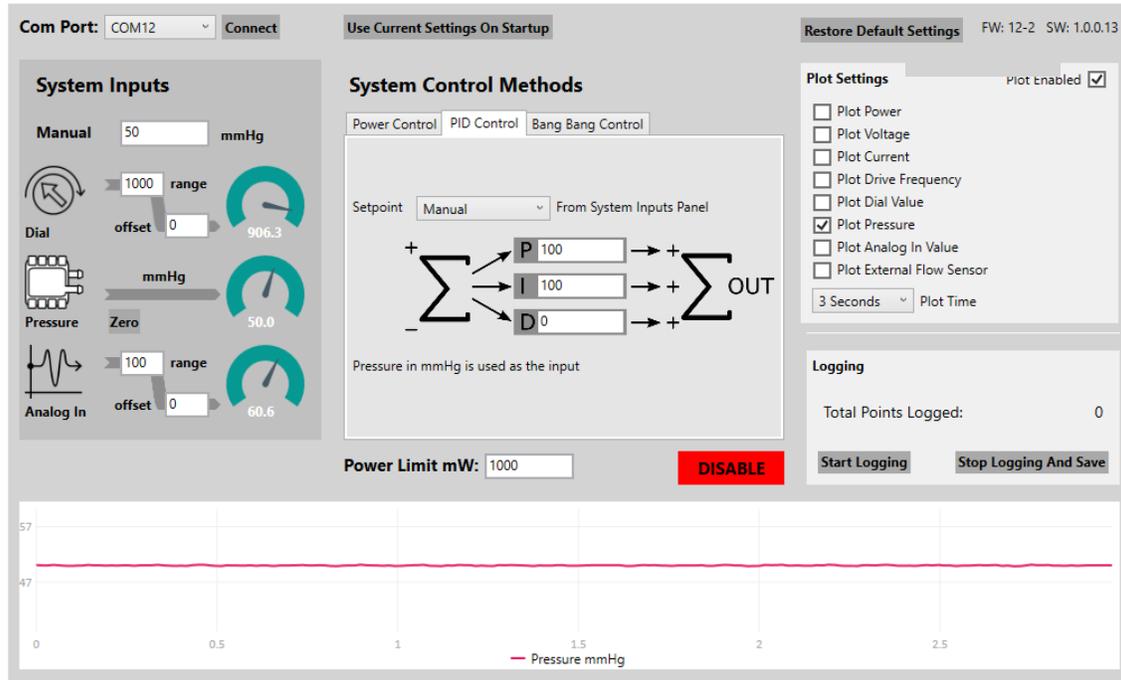


Figure 15. Pressure controlled to 50 mmHg under PID control mode

8.1.5. Bang Bang Control Mode

“Bang Bang” control mode is a simple on-off controller that switches the pump on and off to control the output pressure between two defined pressure limits.

TAKE NOTE



For positive pressure control, connect the *upper* barb of the pressure sensor and the outlet of the pump to the rest of the system.

For negative pressure control, connect the **lower** barb of the pressure sensor and the outlet of the pump to the rest of the system. Note that for negative pressure control, positive pressure values should be interpreted as vacuum values: use **positive** upper and lower threshold values and interpret positive measured pressure as vacuum magnitude.

- Connect the on-board pressure sensor to the pneumatic circuit.
- Select the Bang Bang Control tab.
- Enter the upper pressure limit in the Top Thresh field.
- Enter the lower pressure limit in the Low Thresh field.
- Enter a value for Drive Power mW – this is the drive power supplied to the pump when it is on; if in doubt, start with 1000 mW, but reduce it if the pressure overshoots above the upper threshold is an issue, or to reduce the rate of inflation.
- Click the “Enable/Disable” button on the GUI to toggle the pump output. Alternatively, use the ON/OFF button on the motherboard.
- Tick the “Plot Pressure” check box to observe the pressure measured by the sensor.



Figure 16. Pressure cycling between two limits under bang-bang control

8.1.6. Toggling the pump output with GPIOA

TAKE NOTE

Feature only available for Disc Pump Control App v 1.0.0.9 or later with compatible firmware. If in doubt, please contact your Lee Sales Engineer to discuss.

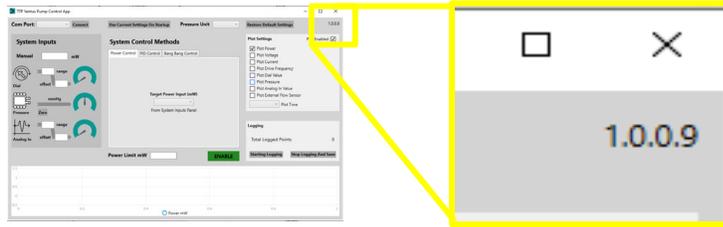


Figure 17. GPIO A is used for gating

GPIO A on the screw terminal block is a 2.5V-level digital control input that enables toggling of the pump output. This pin is normally pulled high by the Disc Pump Driver PCB. A state change on this pin will toggle the enabled state of the pump. This functionality can be used as a simple means of enabling / disabling the pump from an external source. It can also act as a rudimentary gate, allowing higher frequency duty-cycling of the pump up to approximately 10 Hz.

Note that in the System Control Methods panel of the Pump Control App, there is a check box to reset the PID loop on pump enable. When checked, the “I” integral term of the PID loop will be reset each time the

pump is enabled; when unchecked, the integral value will persist. In essence, when unchecked, the system's closed-loop control behaviour is to 'pick up where it left off' through a gating cycle, whereas when checked the behaviour is to reset each cycle. For high frequency (>1 Hz) gating, it is recommended to leave this check box *unchecked*, as resetting the PID loop each cycle may cause undesirable results. For lower frequency gating and simple enable/disable functionality, this box should be checked/unchecked on a case-by-case basis, depending on the desired functionality.

8.1.7. Using the Analog Input

The analog input can be used in a variety of ways to control of pump performance. This can be useful for initial system integration work, for example.

To control pump power The analog input can be used to variably control the pump drive power. See Section 8.1.3 for further details.

To 'gate' the pump drive for short pulse control The analog input is sampled at around 1kHz, enabling the pump to be switched on and off quickly to any desired power level using power control mode (see Section 8.1.3). This feature can be used to deliver a short pulse of air, e.g. for microfluidic control applications.

To control the output pressure setpoint The analog input can be used to provide the target pressure for the on-board PID control loop, with the on-board pressure sensor being used to monitor the actual pressure. See Section 8.1.4 for further details.

As an input from an external pressure sensor The analog input can be used as an input from an external pressure sensor to the on-board PID control loop, with the target pressure set manually or via the software. See Section 8.1.8 for further details.

8.1.8. Tracking pressure via the Analog Input

It is possible to use the evaluation kit to follow a specific pressure profile controlled through the analog input to the board. The following set up shows how this can be achieved.

For the purpose of this guide an XP parallel pump (part number UXPB540000A) has been used. The same set up applies for any model disc pump providing that the pump discharge is connected as detailed below.

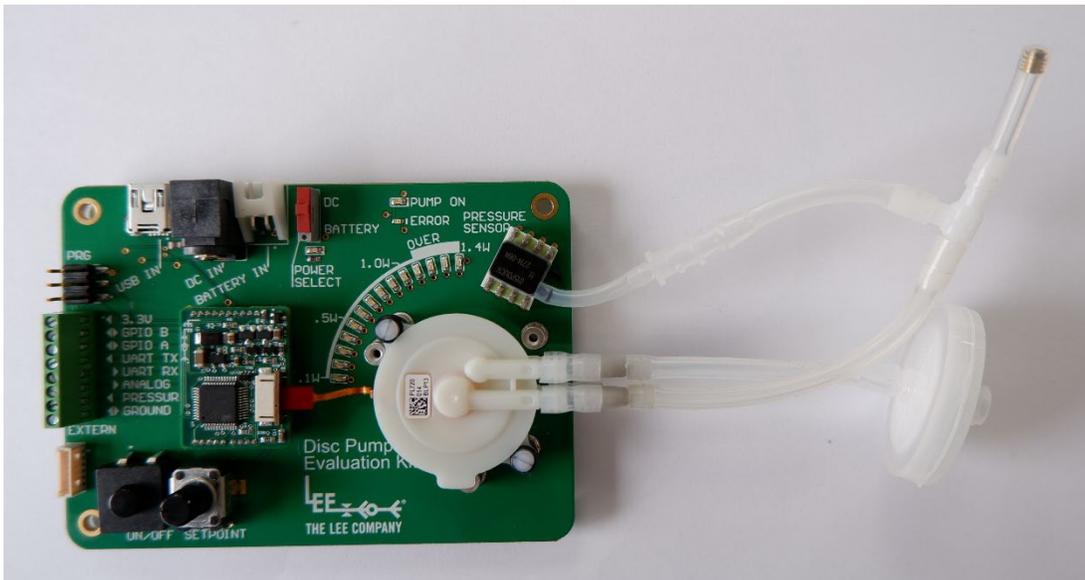


Figure 18. Pump setup tracking pressure via analog input

To set up pressure tracking:

- Connect the output of the pump to the PCB-mounted pressure sensor and to a small fixed orifice via a T-piece.

The orifice allows the pressure in the discharge line (or system) to decay when the pump is not running. The size of the vent orifice needed will depend on the pump performance, system requirements and the response time needed.

- Having set up the system as shown, open the Disc Pump Control App and select the PID Control tab.

For the purposes of this example, the setpoint dial on the PCB has been selected as the control input (Dial). To control using the analog input instead, select 'Analog Input' as the control input. The range and offset parameters associated with the control input can be mapped as detailed in Section 8.1.4.

- In the second drop down box below the PID variables, select Pressure Sensor. (This is the variable which is controlled by the PID loop to match the control input) as shown in Figure 16.
- Enable the pump.

The pump drive power will be adjusted by the PID loop to achieve the desired target pressure.

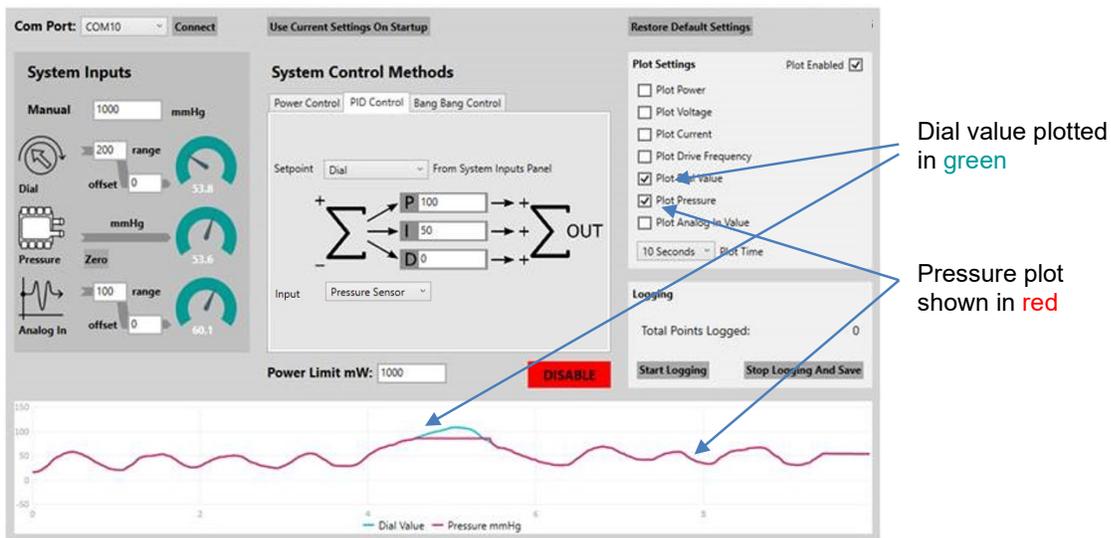


Figure 19. GUI showing PID control setup

Figure 20 shows how the output pressure profile matches the setpoint dial value (our simulated analog input) exactly. The only time the waveforms do not match is when the pump is asked to produce a pressure higher than it is capable of achieving against the vent orifice and within the constraints of the power limit set in the software.

TAKE NOTE

Since every system is different it will be necessary to adjust the proportional and integral coefficients (i.e. the values in the P and I boxes) to achieve the best response to setpoint changes.

To make the pump follow a pressure profile defined by the analog input voltage you will need to change the Setpoint to 'Analog Input' in the GUI and provide a control voltage that corresponds to the target pressure signal.

Finally, where an external pressure sensor is used to monitor pressure, this can be used as the "Input" to the PID loop (appropriately scaled using the "System Inputs" panel), with the "Setpoint" set to either "Manual" or "Dial".

8.1.9. Plotting

Various parameters can be plotted on the graph presented in the PC application.

- In the "Plot Settings" panel, tick the "Plot Enabled" check box.
- Tick the check boxes for the values to be plotted.
- Select the "Plot Time" from the dropdown menu – this is the maximum duration of data displayed in the graph.
- It is possible to zoom on the graph by scrolling whilst hovering over it with the mouse cursor.
- Panning up and down the Y axis is possible by clicking and dragging up and down.
- The value at a given point for a given curve on the graph can be displayed by rolling over the point.

8.1.10. Logging

Data can be logged to a CSV file for offline analysis.

- In the "Logging" panel, click the "Start Logging" button.
- Observe that the Total Points Logged counter is increasing.
- When finished, click the "Stop Logging And Save" button.

8.1.11. Power limit

The evaluation kit has a function to limit the drive power supplied to the pump to prevent damage to the pump. The Power Limit mW field allows this limit to be set. Initially, we recommend that this limit is set to

1000 mW. For intermittent (i.e. non-continuous) use, higher limits can be used up to a maximum of 1400 mW. Intermittent use is defined as having:

- Mean power \leq 1000 mW
- A duty cycle period of less than 20 s.

8.1.12. Saving settings

It is possible to save the evaluation kit settings to be used at start up (when the system is next powered). To do this, click the Use Current Settings On Start-up button.

9. ACCESSORIES

The following accessories are available.

9.1. UEKA0300050A (Evaluation Kit Motherboard)

A spare or replacement motherboard can be purchased.

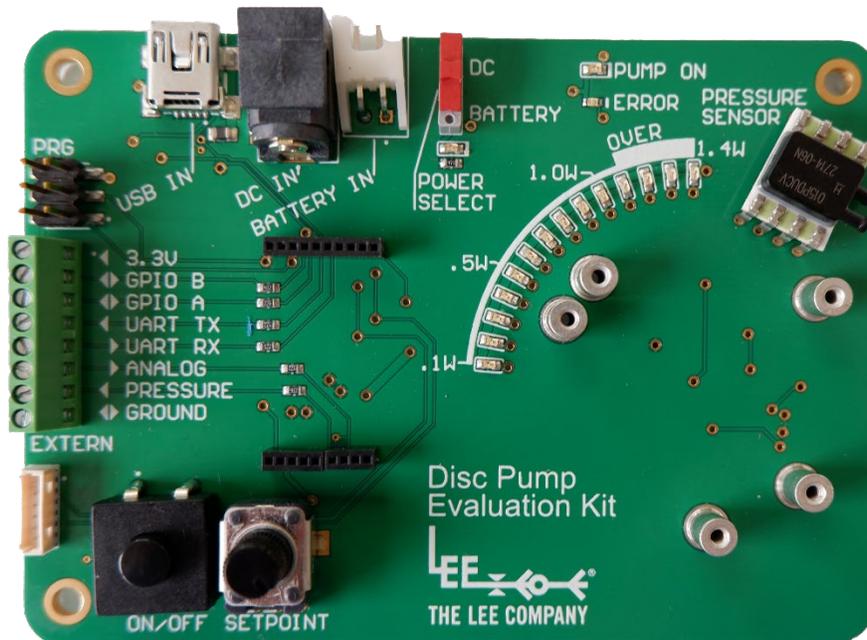


Figure 20: Motherboard

Materials: Printed circuit board PCB

Notes:

- Motherboard alone is unable to drive a Pump. A Pump Drive Board (e.g. UEKA0300000A) is also required to provide a complete pump drive system

10.SUPPORT

The disc pump product pages of The Lee Company website provides technical information, FAQs, troubleshooting and documentation for download, including a range of application notes, including:

- ‘TG001: Disc Pump Drive Guide’: a guide on how to drive Disc Pump effectively with your own electronics.
- ‘TG003: PCB Communications Guide’: a serial communications guide, for taking control of the evaluation kit (or smaller drive PCB) with your own hardware.
- ‘TG005: Disc Pump Wear Characteristics’
- ‘AN007: Microfluidics Driver – Disc Pump Application Note’: – Prototyping with the Disc Pump Evaluation Kit and Sensirion SLF3x Series Flow Sensor
- ‘AN002: Microfluidics - Disc Pump Application Note’
- ‘AN049: Pipetting - Disc Pump Application Note’
- ‘Disc Pump Reference Design Package’: a pack of reference designs for the firmware and drive PCB.

For additional technical support, please contact your local Lee Sales Engineer.

11.REVISION HISTORY

Revision	Date	Details
V01	June 2023	Updated branding and addition of accessories. Added troubleshooting section to USB power section.
230127	27 January 2023	New company details
221201	01 December 2022	Update images for V8 motherboard with UltraSlim pump and update company name
210809	09 August 2021	Corrections/updates to Table 2, Figure 12 and § 7.5.12. & Support section document numbers.

210324	24 Mar 2021	Updates for v7 motherboard.
200713	13 July 2020	Corrected error in gating information.
200624	26 Jun 2020	Added information on gating pump output.
191112	12 Nov 2019	Added § 7.2.7
190521	21 May 2019	Updated Quick Start in § 6. Corrected typing error in § 4.
190128	28 Jan 2019	Clarifications to § 6.2.5.
190121	21 Jan 2019	Initial release.