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Performance. Precision.

Technical Note TN004:
Disc Pump Drive PCB

1 INTRODUCTION

Disc Pump is a high-performance micropump which operates by generating a high pressure, ultrasonic standing wave within a carefully designed acoustic cavity. The standing wave is rectified into DC flow by a patented, high-speed passive valve.

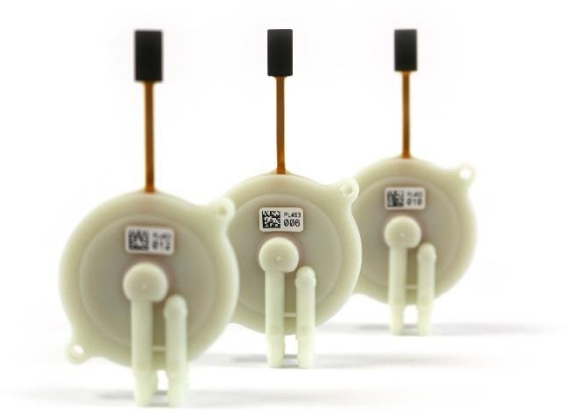

Figure 1 - Disc Pump

The piezoelectric actuator used to drive the acoustic cavity must be driven by a custom electrical waveform. Efficiently generating this waveform requires dedicated electronics and software.

TTP Ventus offers a Disc Pump Evaluation Kit containing everything necessary to get up and running with our pumps. Following initial testing, customers may elect to integrate their own pump drive electronics with an existing system PCB. To support this, TTP Ventus offers an Electronics Reference Design Package, containing PCB and firmware designs and supporting technical guides, together with support from our Applications Engineering team as required.

TTP Ventus can also supply the smaller, postage-stamp-sized Disc Pump Drive PCB (normally mounted on the larger Evaluation Kit motherboard) to support further testing, product development and series production. This PCB handles the pump drive requirements and provides a variety of easy-to-use interfaces which enable simple integration with test systems, prototype devices, and final products. For the most basic use cases a two-wire connection (3-5.5V supply and ground) is all that is needed. For more sophisticated use cases, the Disc Pump Drive PCB can be controlled over a serial link. The Drive PCB also supports closed-loop control (e.g. for pressure or flow control).

This Application Note provides information to aid the integration of the Disc Pump Drive PCB with your system.

Figure 2 – Disc Pump Drive PCB

2 DISCLAIMER

This Application Note is provided "as is" and without any warranty of any kind, and its use is at your own risk. TTP Ventus does not warrant the performance or results that you may obtain by using this Application Note. TTP Ventus makes no warranties regarding this Application Note, express or implied, including as to non-infringement, merchantability, or fitness for any particular purpose. To the maximum extent permitted by law TTP Ventus disclaims liability for any loss or damage resulting from use of this Application Note, whether arising under contract, tort (including negligence), strict liability, or otherwise, and whether direct, consequential, indirect, or otherwise, even if TTP Ventus has been advised of the possibility of such damages, or for any claim from any third party. Use of any products (including software or firmware) provided by TTP Ventus is subject to TTP Ventus' standard terms of sale.

3 ABSOLUTE MAXIMUM RATINGS*

Input Voltage (VCC to GND)	-0.3V, +5.8V
Output Current (2V5 output)	0mA, 100mA
I2C / PWM / UART / SWD / GPIO pin voltage	GND – 0.3V to 2.8V
I2C / PWM / UART / SWD / GPIO pin current	+/- 10mA
Analog pin voltage	-10 to +10V
Analog pin current	+/- 1mA
Operating Temperature Range	-20°C to 50°C

* These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

4 HEALTH AND SAFETY

WARNING
The Disc Pump Drive PCB is capable of producing DC voltages up to 60V, and output AC voltages up to 120V peak- to- peak, at frequencies between 19 and 23 kHz. It is the user's responsibility to ensure that the Disc Pump Drive PCB is used and/or integrated within any product in a safe manner.

WARNING
Take care during use of the Disc Pump Drive PCB not to create short circuits between exposed conductive parts of the board. Short circuits may lead to malfunctioning and heating.

5 DRIVE PCB VARIANTS

TTP Ventus provides two variants of the Drive PCB. These are:

- **59017-200-0002 Fast Response Drive PCB**: this is a highly responsive PCB best suited for applications that require rapid on/off speed and/or high-speed control of pressure, vacuum or flow.
- **59017-200-0003 Cost Optimised Drive PCB**: this is a lower-cost drive PCB with lower output control bandwidth. This PCB also offers highest efficiency.

A detailed comparison of the performance of the two PCBs is provided in TN011 Drive PCB Performance Comparison, available from the support section of the TTP Ventus website.

The Drive PCBs share a common electro-mechanical interface (meaning they are drop in replacements for one another). For the purposes of this document, the Figures show the Fast Response Drive PCB; however, the technical information applies to both designs.

6 DISC PUMP DRIVE PCB CONNECTIONS

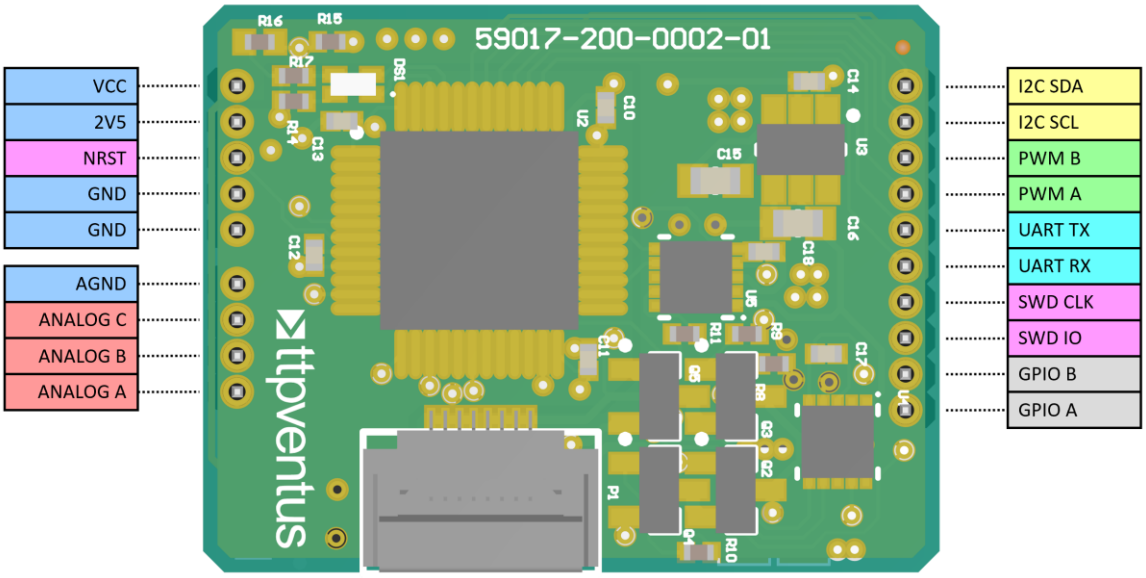

Figure 3 – Disc Pump Drive PCB pinout

Pin No.	Pin Name	Function	Min	Max	Unit
1	VCC	Power Supply	3	5.5	V
2	2V5	2.5V from the on-board voltage regulator.		50	mA
3	NSRT	Onboard microcontroller reset. Active low.	0	2.5	V
4-5	GND	Power ground.			
6	AGND	Analog ground.			
7-9	ANALOG C-A	3x high impedance analog inputs	0	2.5	V
10	GPIO A	Pump enable digital toggle signal.	0	2.5	V
11	GPIO B	General purpose IO. No function with the default firmware.	0	2.5	V
12	SWD IO	Onboard microcontroller, software debug IO	0	2.5	V
13	SWD CLK	Onboard microcontroller, software debug clock	0	2.5	V
14	UART RX	The receive connection for the serial comms.	0	2.5	V
15	UART TX	The transmit connection for the serial comms.	0	2.5	V
16-17	PWM A-B	General use PWM outputs.	0	2.5	V
18	I2C SCL	I2C clock, master and slave compatible.	0	2.5	V
19	I2C SDA	I2C serial data, master and slave compatible	0	2.5	V

Table 1 – Disc Pump Drive PCB Pinout with Typical Ratings

7 DISC PUMP DRIVE PCB LAYOUT

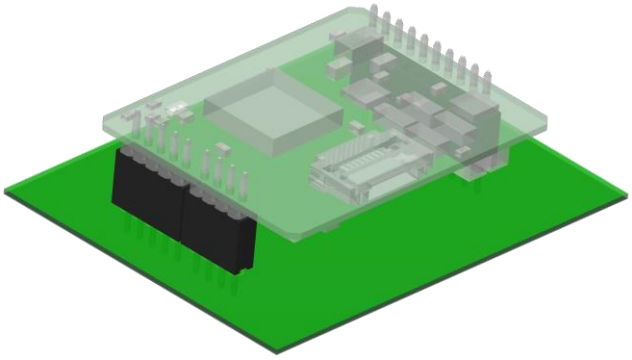

Figure 4 – Disc Pump Drive PCB mounted on a PCB

The Disc Pump Drive PCB mounts to a motherboard through three 1.27mm pitch, female, single in-line headers. Nine connections are present on both sides of the PCB, but the left-hand connections are split over two separate headers; keying the connector so that the PCB can only be oriented one way.

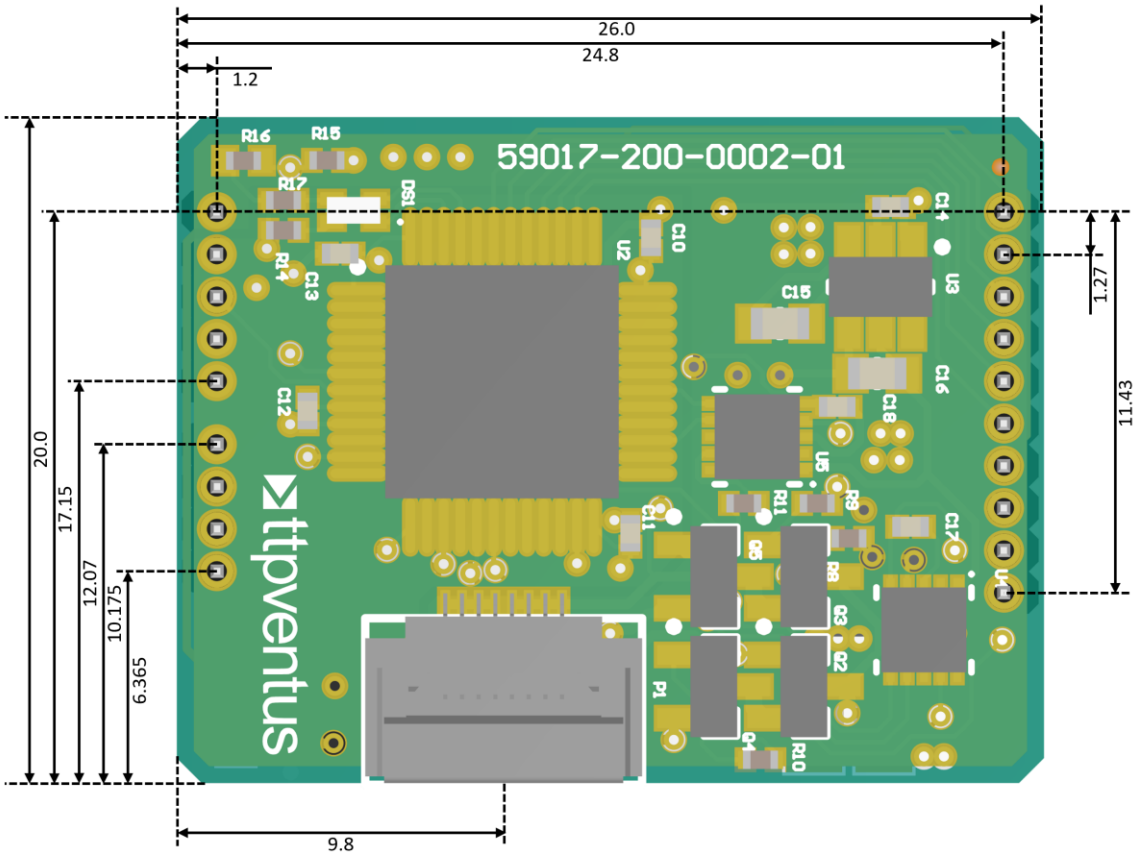

Figure 5 – Disc Pump Drive PCB dimensions (millimetres)

Example headers compatible with the Disc Pump Drive PCB are:

- Harwin M50-3531042 (9 pin)
- Harwin M50-3530542 (5 pin)
- Harwin M50-3530442 (4 pin)

8 CONFIGURATION OF THE DISC PUMP DRIVE PCB

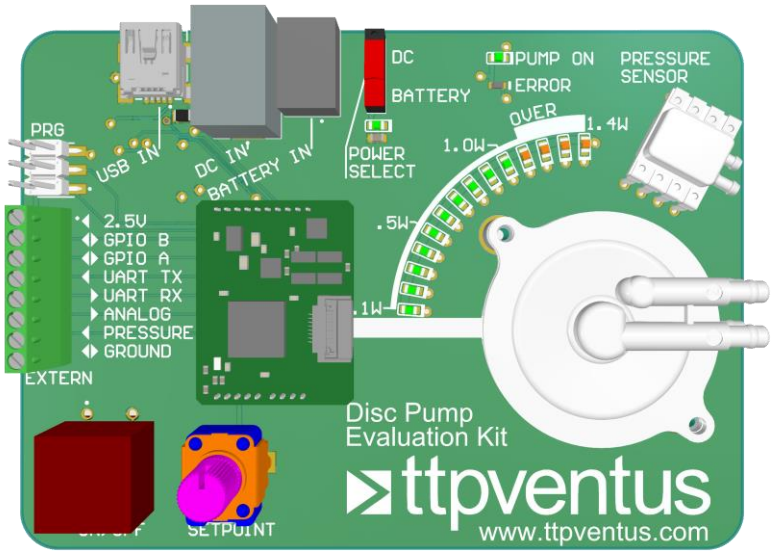

Figure 6 – TTP Ventus Disc Pump Evaluation Kit

8.1 Configuration via the Disc Pump Evaluation Kit

The TTP Ventus Evaluation Kit provides a useful platform for configuring the Disc Pump Drive PCB using the Windows PC application bundled with the Evaluation Kit. The Drive PCB is mounted on the larger Evaluation Kit board with the same interface as set out in Section 6. Drive PCBs can be easily swapped in and out with this interface. Some useful Disc Pump Drive PCB pins are broken out for various tasks on the Evaluation Kit, shown in Table 2.

Pin No.	Pin Name	Breakout Description
1	VCC	Broken out through the ‘DC in’ connector. In addition a lithium-ion cell can be connected through the ‘battery in’ connection.
2	2V5	2.5V from the on-board voltage regulator, through a screw terminal
4-5	GND	Ground, available through a screw terminal.
7	ANALOG C	Broken out as “analog” through a screw terminal.
8	ANALOG B	Connected to the on-board analog pressure sensor, also which is broken out as ‘pressure’ through a screw terminal.
9	ANALOG A	Connected to the on-board potentiometer (which is powered from the 2V5 line)
10	GPIO A	Pump enable digital toggle signal. Any state change on this pin will toggle the enabled state of the pump. Pulled high by default.
14	UART RX	The serial receive connection, broken out through a screw terminal
15	UART TX	The serial transmit connection, broken out through a screw terminal

Table 2 – Useful Disc Pump Drive PCB pins mapped to Evaluation Kit connections.

The Drive PCB can be configured to run in one of three modes: power control (this is akin to an open-loop mode), PID control (closed loop control) and bang-bang pressure control (closed-loop hysteresis control). See the Disc Pump Evaluation Kit manual for details on the operation of each.

8.2 Configuration via serial communication

The onboard serial communications link can be used for applications where the Disc Pump Drive PCB needs to be configured and controlled by an external system. Please visit the support section of the TTP Ventus website (https://www.ttpventus.com/support) to download the 'Serial Communications Guide' for instruction on the communications protocol used.

9 FURTHER SUPPORT

The support section of TTP Ventus website (https://www.ttpventus.com/support) provides technical information, FAQs, a "How To" video on the operation of the evaluation kit and documentation for download.

For additional technical support, please contact TTP Ventus at support@ttpventus.com.

10 REVISION HISTORY

Date	Version	Change
03 August 2021	r210803a	Updated to TN in new document format.
13 July 2020	r200713a	Corrected GPIOA toggle function description.
29 July 2020	r200629a	Updated Table 1.
03 Jun 2020	r200603a	Added GPIOA gating function to Table 1.
12 November 2019	r191112a	Updated Section 4.
28 May 2019	r190528a	Initial release.