



Technical Guide 2: Serial Communications Guide

1	INTRODUCTION	2
	1.1 Disc Pump	2
	1.2 Communication Interface	2
2	COMMUNICATIONS INTERFACE	3
	2.1 Attaching the PCB to your computer	3
	2.2 Opening the COM port	3
	2.3 Reading and Writing to the PCB	3
	2.4 Error Reporting	4
3	COMMANDS	5
	3.1 Control Mode	5
	3.2 Pump Enable / Disable	5
	3.3 Voltage Setpoint	6
	3.4 Measured Voltage	6
	3.5 Power Setpoint	6
	3.6 Maximum Power	7
	3.7 Measured Power	7
	3.8 Pressure Setpoint	7
	3.9 Measured Pressure	8
	3.10 PI Control Loop Coefficients	8

REVISION HISTORY

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1 INTRODUCTION

1.1 Disc Pump

Disc Pump is a silent, high-performance piezoelectric micropump.

Owing to its operating mechanism, Disc Pump can be controlled with unmatched precision, yet at the same time respond to full-scale set point changes in a matter of a few milliseconds. The compact form factor means it can be tightly integrated into products, increasing portability.



Figure 1. A Disc Pump

1.2 Communication Interface

This Technical Guide provides details of the commands recognized by the Disc Pump Evaluation Kit Drive PCB via a serial-over-USB connection. For more general operating instructions for the Evaluation Kit, please refer to its user manual.

The information in this Technical Guide is believed to be accurate and complete, however TTP Ventus does not accept any liability whatsoever for any consequential damage or losses arising from any errors, inaccuracies, or omissions.

2 COMMUNICATIONS INTERFACE

The Disc Pump evaluation PCB implements a serial-over-USB interface, accessible via a micro-USB port.

2.1 Attaching the PCB to your computer

The PCB is attached to your computer via a micro-USB to USB lead. A suitable lead is supplied with our evaluation system. Please note that similar leads supplied (e.g. with bicycle lights) for battery charging tend not to have the data lines connected and are therefore not suitable.

Connecting the PCB to your computer should result in a COM port being installed by the operating system software. If this does not happen automatically, please download and install the appropriate device driver from the FTDI website:

<https://www.ftdichip.com/FTDrivers.htm>

Once the COM port is installed, make a note of the port number. In Windows this can be identified by looking in the “Ports” section of the “Device Manager” window. With the Ports section open, unplug the USB cable connecting your computer to the PCB and note which COM port disappears. Reconnect the USB cable once the port is identified.

2.2 Opening the COM port

The PCB's COM port runs at a baud rate of 921,600, 8 bits, no parity, and one stop bit.

Please refer to the documentation supplied with your chosen software development environment for details of how to open a serial port.

2.3 Reading and Writing to the PCB

The operation of the PCB is controlled by a number of registers, which are either “read” or “read/write”.

To write to a PCB register, a command is written to the appropriate COM port (which must first be opened within your software). The command to write to a register takes the form:

```
#W,<REGISTER_NUMBER>,<VALUE>\n
```

Please refer to the documentation supplied with your chosen software development environment for details of how to write to a COM port. Please note that the new-line character ‘\n’ must be appended to all commands.

The PCB responds to “write” commands by echoing the command back. This response should be read and checked by the controlling software to confirm that the command has been received correctly. In the event that the command causes an error the PCB responds with “#E,” followed by the command which caused the error.

To read from a PCB register, a command is written to the appropriate COM port (which must first be opened within your software), and the response is then read from the COM port. The command to read from a register takes the form:

```
#R,<REGISTER_NUMBER>,<NUMBER_OF_SEQUENTIAL_REGISTERS_TO_READ>\n
```

The second parameter should normally be set to 1, in order to read the selected register number only. The PCB responds to “read” commands by echoing the command back, followed by a comma-separated list of value(s) for the register(s) read.

2.4 Error Reporting

In the event that a command sent to the PCB causes an error, the PCB responds with “#E,” followed by the command which caused the error.

Example:

Command: #W,41,2500\n

Response: #E,W,41,2500\n (Power is out of range)

3 COMMANDS

3.1 Control Mode

The PCB offers three control modes:

- In Voltage Control Mode the pump is driven at a constant voltage, set using the **Set Voltage** command.
- In Power Control Mode the pump is driven at a constant power, set using the **Set Power** command. This is the recommended control mode for the pump.
- In Pressure Control Mode the pump is driven to maintain a target pressure set-point, set using the **Set Pressure** command. In pressure control mode the maximum power is limited by the PCB, meaning that only target pressures within the normal range can be achieved.

Register Identifier	Read /Write	Values
7	R/W	0=Voltage Control 1=Power Control 2=Pressure Control

Example:

#W,7,1\n Sets Power Control Mode (recommended)

3.2 Pump Enable / Disable

The pump is turned on and off by writing to register 6. The status of the pump can be read from register 6.

Register Identifier	Read /Write	Values
6	R/W	0=off, 1=on

Examples:

#W,6,1\n Turns the pump on

#R,6,1\n Read whether the pump is on or off

3.3 Voltage Setpoint

This sets the pump voltage setpoint, which is used when the PCB operates in Voltage Control Mode. The setpoint is in mV and must be an integer number. Note that the setpoint is the voltage of the DC rail which supplies the pump output stage, i.e. it is half of the peak-to-peak voltage driving the pump.

Register Identifier	Read /Write	Values	Limits
40	R/W	Voltage in mV (integer)	0 to 30000 (i.e. 0V to 30V)

Example:

`#W,40,10000\n` Sets a pump voltage of 10V

3.4 Measured Voltage

This reads the actual voltage being delivered by the PCB. Note that the measured voltage is that of the DC rail which supplies the pump output stage, i.e. it is half of the peak-to-peak voltage driving the pump.

Register Identifier	Read /Write	Values
47	R	Voltage in mV (integer)

Example:

`#R,47,1\n` Reads the measured voltage, in mV (integer).

3.5 Power Setpoint

This sets the pump power when the PCB operates in Power Control Mode. The setpoint is in mW and must be an integer number.

Register Identifier	Read /Write	Values	Limits
41	R/W	Power in mW (integer)	0 to 1000*

Example:

`#W,41,800\n` Sets a pump power of 800mW

* Note that the Maximum Power is set to 1W by default. A higher power limit may be set using the Maximum Power function (up to a maximum of 1.4W).

3.6 Maximum Power

This sets the maximum pump power. This limits the power that can be set using the Power Setpoint function, as well as limiting the maximum power that the PCB will deliver when operating in Voltage Control or Pressure Control modes, or when controlled using the PCB's analogue input. The value is in mW and must be an integer number.

Register Identifier	Read /Write	Values	Limits
42	R/W	Maximum Power in mW (integer)	0 to 1400

Example:

```
#W,41,1000\n           Limits pump power to 1000mW
```

We recommend that the average pump power is kept below 1W, i.e. if the pump should not be run continuously above this power. Please also note that higher power drive will result in reduced pump lifetime.

3.7 Measured Power

This reads the actual power being delivered by the PCB.

Register Identifier	Read /Write	Values
49	R	Power in mW (integer)

Example:

```
#R,49,1\n           Reads the measured power, in mW (integer).
```

3.8 Pressure Setpoint

This sets the target pressure when the PCB operates in Pressure Control Mode. The setpoint is in mmHg and must be an integer number. Note that in pressure control mode the maximum power is limited by the PCB, meaning that only target pressures within the normal range can be achieved.

Register Identifier	Read /Write	Values	Limits
43	R/W	Target pressure in mmHg (integer)	-500 to 500

Example:

```
#W,43,100\n           Sets a pressure setpoint of 100mmHg
```

3.9 Measured Pressure

This reads the pressure, as read by the PCB-mounted pressure sensor.

Register Identifier	Read /Write	Values
51	R	Pressure in mmHg (floating point)

Example:

#R,51,1\n Reads the pressure, in mmHg (floating point).

3.10 PI Control Loop Coefficients

The pressure control function makes use of a PI (Proportional, Integral) control loop, with an Integral Limit. The optimal values of these parameters depend on the pneumatic system connected to the output of the pump.

The default values are:

Proportional 500
 Integral 5
 Integral Limit 30000

N.B. If you wish to control to a negative (i.e. below atmospheric) pressure then it is necessary to set a negative pressure target, and to set negative values for the Proportional and Integral control loop parameters (the Integral Limit remains positive).

The relevant registers are:

Register Identifier	Read /Write	Values	Limits
53	R/W	Proportional coefficient	-10000 to 10000
54	R/W	Integral coefficient	-10000 to 10000
55	R/W	Integral limit	0 to 30000

Examples:

#W,54,5\n Write an integral coefficient of 5 to the PCB

#R,53,3\n Read the three PID loop coefficients.