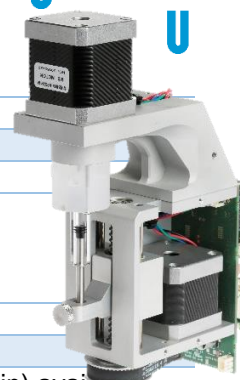


SPM – Zero dead volume dilutor

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Environmental conditions

Operating temperature	5-40°C (41-104°F)
Humidity	20-80%, non-condensing
Max pressure	5 bars (72 psi)

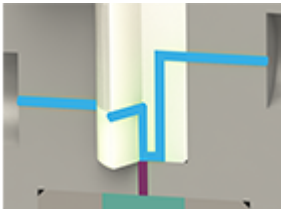
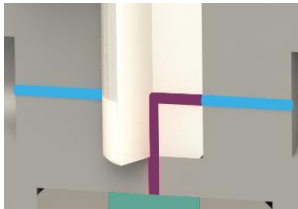
Fluidic characteristics

Tube port fittings	Standard ¼-28 UNF, flat-bottom
Wetted materials	PTFE, PCTFE and borosilicate glass
Channel diameter	0.5 mm (0.020 in) / 0.4-1 mm (0.015-0.039 in) available upon request

Mechanical characteristics

VALVE MODELS

Default model: VD2-6

Ref. #	VD2-6	VD1-6
Name	7-PORT/6-POSITION, ultra-low carryover volume	7-PORT/6-POSITION
Liquid path		
Number of channels inside rotary part	2	1
Internal volume	4.45 µL	4.24 µL
Carryover volume	1.4 µL	2.47 µL
Dead volume	None	

Glossary reminder

Internal volume: Volume inside the system, from entrance to exit (does not include the volume in the syringe)

Dead volume: Volume that is “stuck” in the system (dead end), which is not cleanly swept and relies on diffusion to clear out.

Carryover volume: Volume of liquid that will be mixed with the next liquid or sample. It is not stuck, but will be swept next time a liquid passes.

PLUNGER DETAILS

Travel length	30 mm with 96'000 micro-steps
Resolution	Selectable 3'000 steps or 24'000 steps
Drive	Screw drive with linear encoder for step loss detection
Materials	PTFE or UHMW-PE

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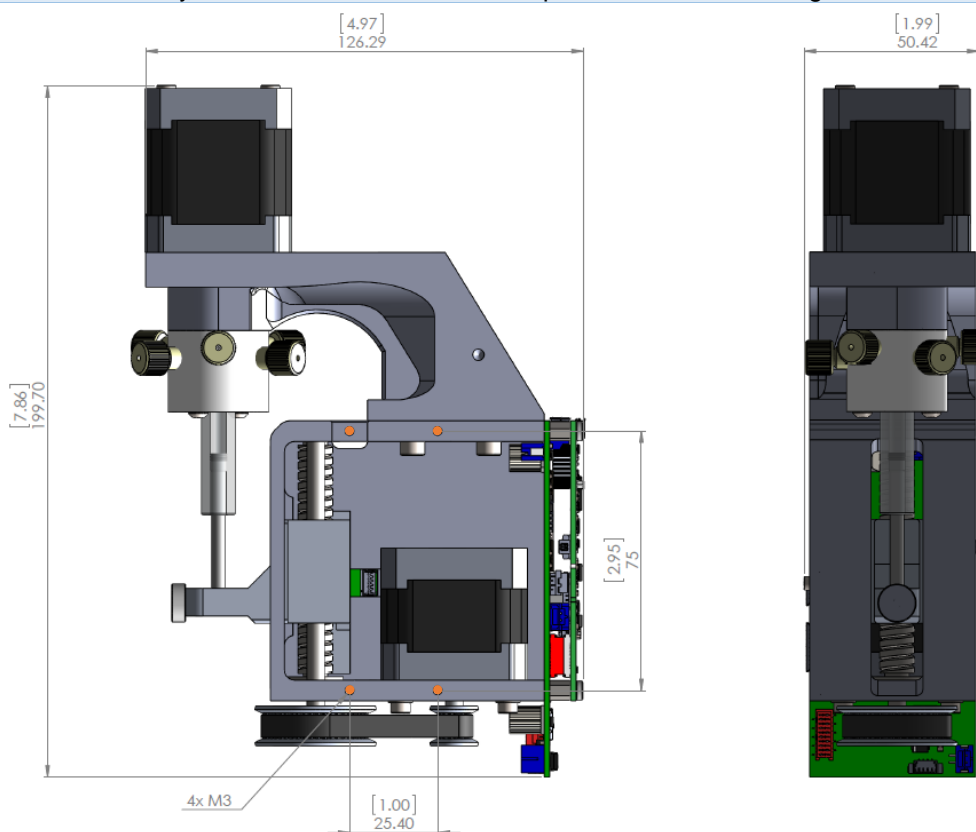
SYRINGE MODELS

Default model: S500-P

Ref. #	Plunger material	Syringe volume [μL]	Min. flow rate [μL/min]	Max. flow rate [μL/min]	Min. dosing volume [μL]
S25-P	PTFE	25	0.25	750	0.05
S50-P	PTFE	50	0.5	1'500	0.1
S100-P	PTFE	100	1	3'000	0.2
S100-U	UHMW-PE	100	1	3'000	0.2
S250-P	PTFE	250	2.5	8'000	0.5
S500-P	PTFE	500	5	15'000	1
S500-U	UHMW-PE	500	5	15'000	1
S1000-P	PTFE	1'000	10	30'000	2

COMPLETE MODULE (Ref. P100-O)

Weight	1.5 kg
Dimensions	199.7 x 126.3 x 50.5 mm
Default configuration	500 μL syringe with PTFE plunger (S500-P) 7-port/6-position valve with ultra-low carryover volume (VD2-6)
External fixation system	4x M3 screws, position shown in orange



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Dimensions are in mm [inch]

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Electrical characteristics

Power	18-24 VDC, 2.2 A peak
Required cables for operation	USB mini to USB, Power cord (power jack 2mm)

Communication interface

Interface	USB mini, RS-232 or RS-485
Communication type	Serial communication

The valve controller is seen as a virtual serial port. There is an on-board FTDI USB to serial chip, so the drivers are automatically installed on recent Windows 7 and above.

SERIAL COMMUNICATION PARAMETERS

Baud rate	9600
Data Bit	8
Parity	None
Stop Bit	1
Handshake	None
End line	<CR>

COMMANDS

A command is in the following format: `/1 + command + R + <CR>`

For example, the pump is initialised with the command Z, so the instruction to send to the pump would be `/1ZR<CR>`

A new command can only be sent once the first one is done, or if an error appears. A *status message* is always sent from the pump, so it is possible to debug the system in case of error. You will find a list of most used commands below. Please refer to the operating manual for an extensive list of commands and error codes.

Pump configuration commands

Command	Operand n range	Default value	Operand description	Command description
N<n>	0..1	0	<0> = 0.01 mm resolution microstep <1> = 0.00125 mm resolution microstep	Initialise the plunger drive and do valve homing

E.g. `/1N1R<CR>` will choose the 0.01 mm resolution microstepping mode.

Control commands

Command	Operand n range	Default value	Operand description	Command description
R	-	-	-	Execute command string
X	-	-	No trailing [R]	Re-execute last executed command string
G<n>	0..60000	0	0 = loop forever	Mark the start of a repeat sequence
g	-	-	Loop depth = max 10	Mark the start of a repeat sequence
M<n>	0..86400000		Milliseconds	Delay command execution
T	-	-	No trailing [R]	Hardstop – initialisation required

E.g. `/1gP2000D2000G3R<CR>` will trigger 3 back-and-forth 2000-step moves from the plunger.

Initialisation commands

Command	Operand n range	Default value	Operand description	Command description
Z or Y	-	-	-	Initialise the plunger drive and do valve homing

Plunger movement commands

Command	Operand n range	Default value	Operand description	Command description
A<n> or a<n>	0..3000 with N=0 0..24000 with N=1	-	-	Absolute position
P<n> or p<n>	0..3000 with N=0 0..24000 with N=1	-	-	Relative pickup
D<n> or d<n>	0..3000 with N=0 0..24000 with N=1	-	-	Relative dispense

Valve commands

Command	Operand n range	Default value	Operand description	Command description
O<n>	1..6	-	Counter-clockwise plug movement (valve seen from above)	Move to valve port
I<n>	1..6	-	Clockwise plug movement (valve seen from above)	Move to valve port.

Port numbering has been configured such that going to the next port number (e.g. the valve is on port 1 and moves to port 2) rotates the plug by 60 degrees only.

E.g. `/1M10000I2R<CR>` will wait 10 seconds before moving the plug to port 2 in a clockwise direction.

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Set commands

Command	Operand n range	Default operand	Power up default	Operand description	Command description
V<n>	5..1600	-	150	Peak speed (pulses/sec)	Set peak speed
S<n>	10..40	-	22	Cf. table below	Set speed

Speed code	Value (pulses/sec)	Seconds/stroke (N=0, N=1)
10	1600	1.885
11	1400	2.15
12	1200	2.5
13	1000	3
14	800	3.75
15	600	5
16	400	7.5
17	200	15
18	190	15.79
19	180	16.665
20	170	17.645
21	160	18.75
22	150	20
23	140	21.43
24	130	23.075
25	120	25
26	110	27.275
27	100	30
28	90	33.335
29	80	37.5
30	70	42.855
31	60	50
32	50	60
33	40	75
34	30	100
35	20	150
36	18	166.665
37	16	187.5
38	14	224.235
39	12	250
40	10	300



Setting the speed is a delicate process. Tubings of small inner diameter will act as restrictions for the flow and pushing liquids at high speed through such tubings will lead to high pressure in your microfluidic circuit.

High pressure will increase the leakage in the circuit and could even block the pump as too much force would be required to dispense the syringe content. Finally yet importantly, high pressure can blow up the weakest part of a microfluidic setup. Therefore, we recommend choosing speeds according to a pressure estimation.

Report commands

These commands do not need the trailing *R* character.

Command	Description
Q	Current status
?	Report absolute plunger position
?1	Report start speed
?2	Report maximal speed
?3	Report cutoff speed
?4	Report actual position of plunger
?6	Report valve position
?10 or F	Report command buffer status
?12	Report number of backlash increments
?13	Report status of input #1 (J5, Pin7)
?14	Report status of input #2 (J5, Pin 8)
?20 or #	Report firmware checksum
?23 or &	Report firmware version
?29	Same as Q (query, status and error bytes)
?76	Report pump configuration
*	Report supply voltage (x0.1 V)
?9000	Unique ID
?9100	Detailed status of the pump
?9200	Detailed status of the valve

Error codes

The pump immediately sends a response every time an instruction is sent to it. Only errors 2 and 3 can be found through this immediate response. The user must send the command Q to get the status in case of further errors.

Error byte							
Bit	7	6	5	4	3	2	1 0
Value	0	1	Status bit	0	Error code		

Status bit value	Description
X = 0	The pump will only accept report commands or terminate command (T)
X = 1	The pump is ready to accept new instruction

Error byte	ASCII symbol		Error	
	If X = 0	If X = 1	Code	Description
7 6 5 4 3 2 1 0				
0 1 X 0 0 0 0 0	@	'	0	No error
0 1 X 0 0 0 0 1	A	a	1	Initialisation
0 1 X 0 0 0 1 0	B	b	2	Invalid command
0 1 X 0 0 0 1 1	C	c	3	Invalid operand
0 1 X 0 0 1 1 1	G	g	7	Device not initialised
0 1 X 0 1 0 0 0	H	h	8	Internal failure
0 1 X 0 1 0 0 1	I	i	9	Plunger overload
0 1 X 0 1 0 1 0	J	j	10	Valve overload
0 1 X 0 1 0 1 1	K	k	11	Plunger move not allowed
0 1 X 0 1 1 0 0	L	l	12	Internal failure
0 1 X 0 1 1 1 0	N	n	14	A/D converter failure
0 1 X 0 1 1 1 1	O	o	15	Command overflow