

WATSON- MARLOW

501Z

“Intelligent” drive module

Installation and operating instructions

Thank you for choosing the Watson-Marlow 501Z 'Intelligent' Drive Module.

The 501Z can be combined with any of five different pumpheads to provide a range of peristaltic pumps with one to fifty channels, and flow rates of between 0.0003 to 1820 ml/min. Each is capable of storing dose information derived from an optical tachometer.

In CALibration mode, a count is made of the tachometer pulses generated during the delivery of the required dose. (The count is accessible after the divider as 5V pulses from pin 5 of the 7-pin DIN socket, relative to 0V on pin 2).

This count is stored in the memory where it will be retained for up to three months, even with the power off, using non-volatile logic which requires no stand-by battery supply.

The calibrated dose can now be repeated either singly (SINGLE mode) at intervals determined by the user or triggered by process signal, or at timed intervals (REPEAT mode) set by the front panel TIME OFF control.

All Start/Stop signals may be given from the front panel, or remotely from a Footswitch or Handswitch.

For the first time in peristaltic pumping, the remarkable ease of use of the 501Z makes dose control as easy as flow rate control.

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Section 1 : CHECK LIST

Please check that you have received the following items:

- 1 501Z Drive Module
- 1 6-pin DIN 'blanking' plug to couple to REMOTE REVERSE socket - pre-linked for normal operation
- 1 6-pin DIN plug to couple to REMOTE REVERSE socket - unwired
- 1 7-pin DIN plug to couple to REMOTE CONTROL socket - unwired

as well as any additional modules or accessories you may have ordered.

Section 2 : INSTALLATION

Ensure that the supply voltage and frequency corresponds with that marked on the rear of the unit. The mains supply cable is colour coded in accordance with the following code:

Brown	Live
Blue	Neutral
Green/Yellow	Earth

Ensure that the pre-linked 6-pin DIN 'blanking' plug is properly inserted into the REMOTE REVERSE socket on the rear panel. The REMOTE CONTROL socket does not require a 'blanking' plug.

Should the pre-linked 6-pin DIN plug supplied with the 501Z be mislaid at any time, its replacement must be linked as shown below.

6-pin REMOTE REVERSE



The 501Z can be operated at ambient air temperatures from -10°C to 35°C. Storage temperatures from -40°C to 70°C are permissible, but allow time for acclimatisation before operating. An operating unit should be positioned to enable a free passage of air around it. When 501Z modules are stacked, the normal foot mountings will provide the necessary ventilation space between units.

WARNING Dangerous voltages (at mains potential) exist inside the Drive Module. If access to internal components is required, seek qualified advice regarding electrical hazards.

Should the pump fail to operate, check the following:

- That mains electricity is available at the unit
- That all fuses are intact
- That the pump is not stalled by incorrect fitting of tubing
- That the pumphead module is properly located and securely attached to the Drive Module
- That the 6-pin DIN plug is correctly positioned in the rear panel REMOTE REVERSE socket.

Section 3 : SPECIFICATIONS

Nominal Maximum Rotor Speeds: standard	170 rpm
:to special order	10, 50 and 100 rpm
Speed Control Ratio	20:1
Operating Voltage/Frequency	200-250V 50-60Hz
.....OR	90-130V 50-60Hz
Normal Power Consumption	see rear panel
Operating Temperature	-10°C to 35°C
Storage Temperature	-40°C to 70°C
Relevant Standards	CEE10, IP44
Audible Noise	60 dBA maximum
Dimensions	Height 140 mm
.....	Width 200 mm
.....	Depth 325 mm
Weight	Approx. 6 kg

Section 4 : CARE AND MAINTENANCE

Scheduled maintenance of the 501Z is not required.

From time to time the unit may need cleaning. It is recommended that a cloth dampened with a solution of water and a mild detergent be used for this purpose. On no account should strong solvents be used.

Section 5 : PUMPHEAD MODULES AND FLOW RATES

The table indicates the typical flow rates obtained from pumpheads fitted with silicone tubing (except 502AA where PVC tubing was used) when pumping water at room temperature with negligible suction and delivery pressures.

The rated speeds are the maximum speeds for the respective drive modules, all of which have a control ratio of 20:1. The actual flow rate for a particular application should be determined under operating conditions, the important factors being suction and delivery pressures, temperature, fluid viscosity and the material of the tube being used.

For operating details of particular pumphead modules, see relevant data sheets.

501R FLOW RATES (ml/min)

Drive Module	rpm	Tubing internal diameter (mm)						
		0.5	0.8	1.6	3.2	4.8	6.4	8.0
501Z	10	0.4	1.3	4.2	19	39	64	96
	50	2.1	6.1	22	92	200	315	520
	100	4.2	12.4	43	186	405	635	1080
	170	7.1	21	73	320	700	1080	1820

301 FLOW RATES (ml/min)

Drive Module	rpm	Tubing internal diameter (mm)					6.4	8.0
		1.6	3.2	4.8				
501Z	10	3	9	20	30	40		
	50	14	45	95	140	200		
	100	25	85	190	300	400		
	170	42	145	320	510	680		

502AA FLOW RATES (ml/min)

Drive Module	rpm	Tubing internal diameter (mm)							Max. Channels
		0.127	0.190	0.250	0.380	0.520	0.630	0.700	
501Z	10	0.005	0.012	0.028	0.048	0.08	0.11	0.15	32
	50	0.024	0.062	0.14	0.24	0.39	0.57	0.77	32
	100	0.048	0.12	0.28	0.48	0.77	1.14	1.54	32
	170	0.082	0.21	0.48	0.82	1.33	1.94	2.62	20

Drive Module	rpm	Tubing internal diameter (mm)							Max. Channels
		0.880	1.020	1.140	1.290	1.420	1.470	1.520	
501Z	10	0.22	0.29	0.37	0.45	0.58	0.63	0.68	32
	50	1.09	1.44	1.85	2.25	2.89	3.16	3.42	32
	100	2.18	2.88	3.70	4.50	5.78	6.32	6.84	32
	170	3.71	4.90	6.29	7.65	9.83	10.7	11.6	20

Drive Module	rpm	Tubing internal diameter (mm)						Max. Channels
		1.650	1.850	2.050	2.280	2.540	2.790	
501Z	10	0.75	0.98	1.17	1.42	1.82	2.04	32
	50	3.76	4.88	5.87	7.12	9.12	10.2	32
	100	7.52	9.76	11.7	14.2	18.2	20.4	32
	170	12.8	16.6	20.0	24.2	31.0	34.7	20

501M FLOW RATES (ml/min)

Drive Module	rpm	Tubing internal diameter (mm)						Max. Channels
		1.0	1.5	2.0	2.5	3.0	4.0	
501Z	10	0.5	1.2	1.9	3.1	4.8	7.8	40
	50	2.6	5.8	9.6	15	24	39	40
	100	5.2	12	19	31	48	79	20
	170	8.8	20	32	52	82	134	10

501D FLOW RATES (ml/min)

Drive Module	rpm	Tubing internal diameter (mm)						Max. Channels
		1.0	1.5	2.0	2.5	3.0	4.0	
501Z	10	0.3	0.6	0.9	1.2	2.0	2.8	50
	50	1.4	2.9	4.5	6.2	10	14	50

Section 6 : TUBING RANGE

Please remember that flow precision depends upon the accuracy and consistency of the tubing. All Watson-Marlow tubing is formulated, manufactured and quality controlled to our own specifications.

We also distribute Tygon in the R3603 laboratory formulation and the B44-4X food and milk products formulation. Further details of Tygon tubing are available on request.

1.6 mm WALL THICKNESS TUBING FOR 501R AND 301DS1/A

Bore mm	Stock Code					
	Viton	Neoprene	Butyl	Silicone	PVC	Tygon
0.5	-	-	-	TU090	-	-
0.8	-	TU020	-	TU091	-	-
1.6	*TU050	TU021	TU070	TU092	*TU145	TU160
3.2	*TU051	TU022	TU071	TU093	TU153	TU061
4.8	*TU053	TU023	TU072	TU094	TU149	TU162
6.4	*TU052	TU024	TU073	TU095	TU115	TU163
8.0	*TU054	TU025	TU074	TU096	-	TU164

*0.8 mm wall thickness

MANIFOLD PUMP TUBING FOR 502AA

Colour Code	Bore mm	Vinyl	Silicone	Solvent Resistant	Acid Resistant
Orange/Black	0.127	TE018		TR018	
Orange/Red	0.19	TE019		TR019	
Orange/Blue	0.25	TE001		TR001	
Orange/Green	0.38	TE002		TR002	
Orange/Yellow	0.50	TE003		TR003	TV003
Orange/White	0.63	TE004	TS004	TR004	TV004
Black/Black	0.76	TE005	TS005	TR005	TV005
Orange/Orange	0.88	TE006	TS006	TR006	
White/White	1.02	TE007	TS007	TR007	TV007
Red/Red	1.14	TE008	TS008	TR008	TV008
Grey/Grey	1.29	TE009	TS009	TR009	TV009
Yellow/Yellow	1.42	TE010	TS010	TR010	TV010
Translucent	1.47		TS020		
Yellow/Blue	1.52	TE011	TS011	TR011	TV011
Blue/Blue	1.65	TE012	TS012	TR012	TV012
Green/Green	1.85	TE013	TS013	TR013	TV013
Purple/Purple	2.05	TE014	TS014	TR014	TV014
Purple/Black	2.28	TE015	TS015	TR015	TV015
Purple/Orange	2.54	TE016	TS016	TR016	TV016
Purple/White	2.79	TE017	TS017	TR017	TV017

THIN WALL TUBING FOR 501M AND 501D - SILICONE

Bore mm	Stock Code	Bore mm	Stock Code
1.0	TU100	2.5	TU103
1.5	TU101	3.0	TU104
2.0	TU102	4.0	TU105

PVC TUBE FOR TRANSMISSION USE

Bore mm	Wall mm	Stock Code	Bore mm	Wall mm	Stock Code
1.6	0.8	TE020	3.2	0.8	TE021

ACCESSORIES

Description	Stock Code
Nipple Type P for 1.0, 1.5 and 2.0 mm tubing	DE229
Nipple Type T for 2.5, 3.0 and 4.0 mm tubing	DE209
Tube of Silicone Grease	MS4

Section 7 : CONTINUOUS PUMPING

The 501Z can be used in conjunction with a suitable pumphead module, as an ordinary variable speed peristaltic pump for metering and transfer purposes by turning the Mode switch to CONTINUOUS.

The START/STOP switch is disabled, as is any handswitch or footswitch coupled to the REMOTE CONTROL socket. The pump must be started and stopped using the POWER switch.

Flow rate is varied by the speed control, which is calibrated from 5 to 100% of rated maximum speed.

Section 8 : DOSING/DISPENSING/SAMPLING

The 501Z is specifically designed for repetitive dosing, dispensing or sampling applications in which it will increase both accuracy and throughput.

8.1 Calibration

Set the pump up normally with tubing of an appropriate type and size loaded into the pumphead, and prime with the fluid to be handled. The speed control should be set to a suitable level, and a calibrated receptacle should be positioned under the tube outlet.

If a footswitch or handswitch is to be used, couple it to the REMOTE CONTROL socket on the rear panel. (For START/STOP switch in the text that follows, read FOOTSWITCH or HANDSWITCH).

Switch to CALibration mode. Start the pump with the START/STOP switch. Allow the pump to run until the required dose has been delivered and stop the pump with a second press of the START/STOP switch.

If the pump is stopped too soon and the dose volume is less than required, the pump may be re-started, the proper volume achieved and the pump stopped again. The two doses will automatically be summed by the memory, provided that the pump has remained in the CALibration mode.

If the pump is allowed to over-run on the calibration dose, and the required volume is exceeded, then the calibration procedure must be repeated - AFTER FIRST TURNING THE MODE SWITCH TO 'SINGLE' AND THEN BACK TO 'CAL' TO ERASE THE MEMORY.

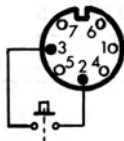
CAUTION Ensure that the pumphead rotates in a continuous manner, since otherwise incorrect calibration and subsequent dosing may result.

8.2 Single Dosing

After running the calibration dose, set the Mode switch to SINGLE.

When the START/STOP switch is depressed, the pump will deliver the calibrated dose volume then stop until the switch is depressed again to start a new cycle.

The START signal may also be given by a process signal. Wire the 7-pin DIN plug as shown below. Close contacts to start.



8.3 Repeat Dosing

After running the calibration dose, or after using the pump in SINGLE mode, turn the mode switch to REPEAT.

Set the interval time between doses using the TIME OFF control (calibrated 1 - 10) on the front panel. The calibrations are arbitrary but approximate to seconds.

When the START/STOP switch is depressed, the pump will commence cycling between delivery of the pre-calibrated dose and pausing for the pre-set interval time.

This START signal can also be given by process signal - see Single Dosing.

The cycle should be stopped by turning the power switch to OFF (0).

It should be noted that after the power switch has been set to OFF, re-applying power will cause the repeat cycle to commence after a 'time off' period has elapsed.

8.4 Cut-Off Facility

The 501Z is fitted with a CUT-OFF facility which reverses the direction of flow at the end of the delivery of a dose. The CUT-OFF is active only in the CALibration, SINGLE and REPEAT modes. It is not active in the CONTinuous mode and will not operate if a dose is terminated by switching off the power.

The CUT-OFF control is variable over an arbitrary scale of 1 - 10 (useful for logging purposes). At a setting of 1, the CUT-OFF has minimal effect and the usual slight over-run of the pumphead will be seen. At a setting of 10 the CUT-OFF causes the pump to reverse for approximately half a second. At some intermediate setting, it will be found that the pumphead rotation can be stopped dead at the end of the dose delivery.

The CUT-OFF can be used to prevent droplets forming at the delivery nozzle.

If the CUT-OFF facility is used, it should be set before the calibration dose is delivered, so that its effect on dose volume is taken into account.

Section 9 : ACCURACY CONSIDERATIONS

ADJUSTING SPEED SETTING DURING CALIBRATION

It is possible to adjust the speed setting whilst the calibration dose is being delivered. In particular, it can be helpful to slow the flow rate towards the end of the dose as the liquid level rises toward the calibration mark.

However, this will reduce accuracy to a small extent, and in critical applications the speed should be unchanged throughout the calibration dose.

2. CHANGING SPEED SETTING AFTER CALIBRATION

It is also possible to adjust the speed setting so that, for instance, the entire calibration dose is run slowly and the following SINGLE or REPEAT doses are run more rapidly.

But this too, will affect accuracy to a small degree, and users must judge whether benefits of easier calibration or faster dispensing are offset by the marginal loss of accuracy.

3. CHANGING CUT-OFF SETTING AFTER CALIBRATION

Clearly if the CUT-OFF setting is altered after the calibration dose is run, the dose volume will change.

The pump must therefore be re-calibrated if the CUT-OFF setting is changed.

RE-CALIBRATE IF THE TUBE IS CHANGED

The calibration dose is good only for the particular piece of tubing used in the pumphead during the calibration run.

For maximum accuracy, re-calibrate for each new tube used in the pumphead, and, if tubing is used for long periods, re-calibrate at least daily.

USE TUBING WITH THE SMALLEST PRACTICAL DIAMETER

This is probably the major factor in achieving accuracy. With any peristaltic pump, there is an inherent inaccuracy which is related to the position of the rollers when the pumphead rotation ceases. THIS INACCURACY IS CONSTANT and is not related to the number of pumphead revolutions made. In a dose requiring a small number of pumphead revolutions, this error will be relatively high. Equally, the larger the number of pumphead rotations, the smaller is this error, relatively.

Accordingly, it will generally be found better to use as small a size of tube as is practical with the pumphead running, if necessary, at a relatively high speed.

For example, using 8.0 mm bore tubing in a 501R pumphead running at 100 rpm, a dose of 50 ml could be delivered in about 3 seconds.

Greater accuracy would be obtained by using 6.4 mm bore tubing at 170 rpm, in which case the 50 ml dose would still be delivered in 3 seconds.

The difference is that in the first example, the pumphead will make 5 revolutions, and in the second example, the pumphead will make 8.5 revolutions.

Section 10 : VOLUMES DELIVERED IN ONE SECOND

Pumphead	RPM	Volume (ml)						
		Tubing internal diameter (mm)						
		0.5	0.8	1.6	3.2	4.8	6.4	8.0
501R	10	0.01	0.02	0.07	0.32	0.65	1.1	1.6
	50	0.03	0.10	0.37	1.5	3.3	5.3	8.7
	100	0.07	0.21	0.72	3.1	6.8	11	18
	170	0.12	0.35	1.2	5.3	12	18	30
301DS1/A	10	-	-	0.05	0.15	0.33	0.50	0.67
	50	-	-	0.23	0.75	1.6	2.3	3.3
	100	-	-	0.42	1.4	3.2	5.0	6.7
	170	-	-	0.70	2.4	5.3	8.5	11

Section 11 : MAXIMUM DOSE OR SAMPLE VOLUMES

The maximum volume which can be dosed or sampled is controlled by the maximum number of pumphead revolutions which can be counted in the CALibration mode and the size of the tubing used.

Taking the standard 170 rpm 501Z as an example, one revolution of the pumphead is achieved by 6.8 revolutions of the motor, and the motor tachometer has 120 slots. 816 pulses (6.8 x 120) are therefore generated for each pumphead revolution.

Before the pulses are counted, however, they pass through a divider which is factory set to pass only one pulse in each 128 received. The counter therefore sees only 6.4 (ie 816/128) pulses per pumphead revolution.

The capacity of the counter is 9999, so that a total of 1560 (ie 9999/6.4) pumphead revolutions can be stored.

This is equal to approximately 9 minutes running time on the standard 170 rpm 501Z. (ie 1560/170), or some 16 litres using 8.0 mm bore tubing and the 501R twin roller pumphead.

The three special order 501Z drive modules, with 10, 50 and 100 rpm nominal output speeds have their dividers factory set to also allow approximately 9 minutes running time. Using the 501R pumphead with 8.0 mm bore tubing, this gives maximum volumes of:

rpm	10	50	100	170
volume (litres)	0.9	4.7	10	16

Section 12 : CHANGING THE MAXIMUM DOSE OR SAMPLE VOLUME

As detailed in the previous section, 501Z drive modules of all nominal output speeds are set to give a maximum running time of some 9 minutes.

This is achieved by the setting of switch DS1 mounted at the top left of the main printed circuit board.

It is possible for users to adjust this switch to extend the maximum running time.

WARNING Dangerous voltages (at mains potential) are present inside the drive module. As re-setting of switch DS1 requires the cover to be removed, seek qualified advice regarding electrical hazards. Isolate the mains before removing the cover.

Viewing the printed circuit board from the components side, the switch positions on switch DS1 run from position 1 on the extreme left to position 8. The table below lists the maximum running times for all switch positions for the four 501Z output speeds.

Switch DS1 Position	Division Factor	Running time (minutes)			
		10 rpm	50 rpm	100 rpm	170 rpm
1	2048	272	158	147	147
2	1024	136	79	74	74
3	512	68	40	37	37
4	256	34	20	18	18
5	128	17	10*	9*	9*
6	64	9*	5	5	5
7	32	4	2	2	2
8	16	2	1	1	1

* Factory set position

No advantage will be found in using a higher numbered switch position than that which is factory set. The maximum running time will be reduced, but the theoretical increase in resolution will not be noticeable in practice. A lower numbered switch position will give a noticeable increase in maximum running time.

Section 13 : REMOTE REVERSE FACILITY

The direction of rotation of the 501Z may be remotely controlled. The unwired 6-pin DIN plug supplied with the 501Z should be wired as shown below to a suitable switch or relay.

