WATSON-MARLOW

602U/R

Auto-control high-flow pump

Installation, calibration and operating instructions

INTRODUCTION

Thank you for purchasing this 602U/R peristaltic pump which comprises a 602U Auto-control drive module fitted with the 602R pumphead. It is probably the most sophisticated high-flow peristaltic pump available today, providing flow rates of up to 14.6 litre/min and incorporating comprehensive signal conditioning facilities.

It shares with its companion models the 202U/AA and the 501U/R two major features:

1 The method of control - manual, remote or automatic - may be changed at any time.

2 Within its auto-control mode the 602U/R may be factory or user set at any time to respond to a wide range of both voltage and current control signals, and it incorporates full mains isolation allowing earthed or un-earthed signals to be accepted.

Three further unique features are incorporated:

1 A front panel mounted LED illuminates to give warning of the input signal exceeding the maximum safe level for the programmed use.

2 A second LED illuminates if the rotor is stalled by overloading. The power supply to the motor is simultaneously shut off.

3 The voltage to the motor is inherently limited to a safe level by a toroidal isolating transformer, providing that the correct tappings for the local mains supply voltage are used.

USING THIS MANUAL

This manual is divided into three parts:

PART 1 should be read by all users and contains essential installation information.

PART 2 is for users who will operate the pump in the Control Mode in which it has been received.

PART 3 need only be consulted when the method of control (Manual, Remote or Auto) is to be changed, or when the pump is to be re-calibrated to respond to a different control signal.

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PART 1: INSTALLATION

Section 1: CHECK LIST

Please check that you have received the following items:

1 602U/R Pump.

A label on the rear panel indicates the control mode in which the Pump has been set. If not specified on your order, the 602U/R will be set to Manual Mode M1.

1 DIN plug, unwired

1 DIN plug, linked for use in Manual Mode

Pack of spare self-adhesive labels 'Set to Mode....'

... together with any accessories specified in your order.

Section 2: INSTALLATION

CAUTION For transit purposes, a small red plastic plug is fitted to the breather hole of the motor gearbox. This plug should be removed prior to operation

Ensure that the supply voltage and frequency corresponds with that marked on the nameplate at the rear of the unit.

If the supply voltage is outside the marked range then the tappings of the transformer must be changed.

Isolate the pump from the mains supply and remove the four screws securing the cover to gain access to the terminal block on the top chassis.

Links must be made as follows:

200-250V 50-60Hz	3 and 4 linked
90-130V 50-60Hz	2 and 4 linked 3 and 5 linked

The mains supply cable is colour coded in accordance with the following code:

Brown	Live
Blue	Neutral
Green/Yellow	Earth

The 602U/R can be operated at ambient air temperatures from -10°C to 40°C. Storage temperatures from -40°C to 65°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 602 Modules are stacked the normal foot mountings will provide the necessary ventilation between units.

It is recommended that, in accordance with normal practice, signal leads be kept as short as possible: in some cases screening may be required

WARNING Dangerous voltages (at mains potential) exist inside the pump. As calibration requires the cover to be removed, 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 Motor Overload LED is not indicating that the pump is stalled by incorrect fitting of tubing (see Section 9).

That the pumphead module is properly located and securely attached to the pump.

That the correct DIN plug is in position - see PART 2.

That the signal overload LED is not indicating an excessive signal.

CAUTION A label on the rear panel indicates for which mode of operation your 602U/R has been set. If the unit is set in a V (voltage) mode or C (current) mode, no attempt should be made to exercise normal control through the front panel potentiometer since this may have been set as part of the auto-control calibration.

Section 3: SPECIFICATIONS

Nominal Maximum Rotor Speed	165 rpm
Speed Control Ratio	20:1
Operating Voltage/Frequency	200-250V,50-60Hz
	or 90-130V,50-60Hz
Maximum Power Consumption	220VA
Operating Temperature	-10°C to 40°C
Storage Temperature	-40°C to 65°C
Relevant Standards	CEE10, IP34
Dimensions	250 x 200 x 395mm
Weight	16.6kg

Section 4: 602R PUMPHEAD

The 602R is a spring loaded twin roller pumphead pre-set in manufacture to accept tubing with a nominal wall thickness of 3.2mm. Tubing with bore sizes of between 4.8 and 19.0mm can be used.

This setting will meet most requirements, but adjustment of the setting for other wall thicknesses is a simple task.

The pumphead can be oriented to any of three positions to suit individual requirements. Only two screws are used to secure the track to the front panel. Re-positioning is carried out by removing the screws, rotating the track to the required position and replacing the screws.

4:1 Tube loading

WARNING Switch off the pump and isolate it from the mains supply before loading the pumphead

1 Fully open the hinged guard.

2 Select a length of tubing appropriate to the requirement, noting that a length of 410mm is need for the track system.

3 Offer up that part of the tubing to be housed in the pumphead. First ease the tubing into one of the adjustable clamps and then, whilst rotating the rotor (a tool is provided for this purpose), feed the tube between the rollers and the track. Care should be exercised to ensure that the tube lies naturally against the track and is not twisted or stretched. This is particularly important for the larger tube bore sizes.

4 Locate the other end of the loaded section of the tube into the second adjustable clamp, ensuring that the tube is not slack in the pumphead.

5 Clamp the tube firmly by turning the serrated adjustment wheel. Both clamps will grip the tube simultaneously. Ensure that the tool is removed and close the guard.

4:2 Adjustment of the rollers

The spring loaded twin rollers compensate for tolerance variations in the tubing, eliminating the manual adjustment normally required by peristaltic pumps.

The rotor is set in manufacture for 3.2mm wall thickness tubing of most bore sizes. This setting can advantageously be adjusted, however, in certain cases. For instance, where large bore tubing is used and the delivery head is low, tubing life can be further extended by increasing the normal pre-set gap of 5.2mm. Re-adjustment will also be required when tubing is used having a wall thickness other than 3.2mm.

There is an adjustment screw on each of the two roller arms. Correct and equal adjustment is important. Over-occlusion will reduce tube life. Under occlusion will reduce pumping efficiency.

As a general rule, the gap setting for a given tube should be 20% less than twice the wall thickness of the tube.

To adjust the gap setting, turn the adjustment screws

Clockwise for an increase in gap setting.

Anti-clockwise for a decrease in gap setting.

One complete turn of the screw changes the gap setting by approximately 1.0mm.

Should it appear that the roller arms are not equally adjusted, and it is desired that the original factory setting be restored, turn the adjusting screws until both rollers are just in contact with the track, then tighten each screw by five turns

Section 5: FLOW RATES

The flow rates given below were obtained pumping water at 20°C with nominal suction and delivery pressures. Where flow rate is critical it should be measured under operating conditions. The major factors affecting flow rate are suction and delivery heads, fluid viscosity, temperature, and tubing material used.

602U/R Flow Rates (litre/min) Minimum flows 5% of rates given

Drive module	rpm	Tubing internal diameter (mm) 4.8	6.4	8.0	9.6	12.7	15.9	19.0*
602U	165	1.80	2.70	3.60	4.60	8.00	11.6	14.6

* CAUTION 19.0mm bore tubing requires care in loading to avoid kinking.

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.

Bore mm	Material Viton	Neoprene	Butyl	Silicone	PVC	Tygon
1.6 mm Wall Thickness						
3.2	TU051	TU022	TU071	TU093	TU153	TU161
4.8	TU053	TU023	TU072	TU094	TU149	TU162
6.4	TU052	TU024	TU073	TU095	TU115	TU163
8.0	TU054	TU025	TU074	TU096		TU164
3.2 mm Wall Thickness						
3.2		TU027	TU075			
4.8				TU155		
6.4	TU055	TU028	TU076	TU097	)	TU165
8.0						TU166
9.6	TU057	TU029	TU077	TU098	TU111	TU167
12.7	TU056	TU030	TU078	TU099	TU112	TU168
15.9		TU031	TU079	TU156	TU113	TU169

Section 7: CARE AND MAINTENANCE

Scheduled maintenance of the 602U/R pump is not required for items other than brushes which should be replaced after each 1000 hours running time.

Should spillage of harmful liquids occur during use, it is recommended that the pumphead be removed and cleaned. This can be carried out quickly and easily after first ensuring that the pump is switched off and isolated from the mains. Remove any tubing in the pumphead.

Remove the rotor by unscrewing the retaining bolt one turn to release the collet, and withdrawing the rotor from the shaft.

Remove the track by unscrewing the two retaining screws and detaching the track from its spigot.

All moving parts of the rotor should be checked from time to time for freedom of movement.

Occasional lubrication of pivot points and rollers with light lubricating oil will help ensure trouble free operation.

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

Section 8: MOTOR OVERLOAD CUT-OUT

If the current to the motor rises to an unsafe level, the power to the motor is shut off and the motor overload LED on the front panel illuminates.

This circuit principally helps to protect the pump from damage caused by any accidental stalling of the rotor. Running can be restored by switching the pump off, isolating it from the mains, clearing the cause of the motor overload, reconnecting it to the mains and switching the pump on.

Section 9: SWITCHING DIRECTION OF ROTATION

WARNING The 602U/R is fitted with a combined ON/OFF and reversing switch. It is important that the pump is not switched rapidly from one direction of rotation to another. A pause of two seconds should be made in the central OFF postion when reversing the direction of rotation.

Failure to observe this warning may result in damage to the control circuitry.

The ON/OFF/Reversing switch is fitted with a uni-directional stop plate, which will normally allow the pump to be switched from OFF to clockwise rotation only.

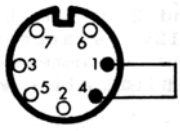
If anti-clockwise rotation is required, then the stop plate should be lifted when the switch is in the OFF postion, and the switch can then be turned to the anti-clockwise postion.

If the normal direction of rotation in a particular application is to be anti-clockwise, then the stop plate can be removed by unscrewing two screws and replaced in the reverse position.

Section 1: MANUAL CONTROL

If the 602U/R is to be operated in the Manual Mode first ensure that the rear panel label is printed 'MODE M1'.

The DIN plug wired for Manual Mode must be inserted in the rear panel DIN socket. The Pump will not operate if the wrong DIN plug is used. Should the pre-linked DIN plug be mislaid, then a 7 pin DIN plug should be linked as follows:

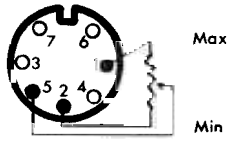


The Pump may now be operated and the front panel potentiometer will function as a speed (flow rate) control.

Section 2: REMOTE CONTROL

If the 602U/R is to be operated in the Remote Mode, first ensure that the self-adhesive label on the rear panel reads 'MODE M2'.

A remote potentiometer can now be connected to the unwired DIN plug as shown below:



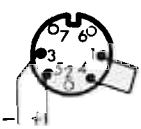
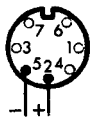
The Pump may now be operated remotely over its full speed range. The remote potentiometer should have a value of 4.7 to 10k ohms. A suitable potentiometer is available from Watson-Marlow as Part No. RV004 and the appropriate digital dial as Part No. DS007.

A complete case mounted (80 x 80 x 85mm) ten-turn potentiometer with digital dial and 3 metre flexible cord terminated in a DIN plug is also available from Watson-Marlow.

Section 3: AUTO-CONTROL

If the 602U/R is to be operated under auto-control, first ensure that the self-adhesive label on the rear panel is printed with the value of the signal you propose to use - eg 4-20mA.

The signal source should now be connected to the unwired DIN plug as shown below. Note that in some modes, pins 1 and 4 must be linked.

MODE			CONNECTION	MODE		CONNECTION
V1	C1	C8		V7	C14	
V2	C2	C9		V8	C15	
V3	C3	C10		V9	C16	
V4	C4	C11		V10	C17	
V5	C5	C12		V11	C18	
V6	C6	C13		V12		
	C7					
V13	C19			V16	C24	
V14	C30			V17	C25	
V15	C21			V18	C26	
	C22				C27	
	C23				C28	

CAUTION Do not adjust the front panel potentiometer. In certain modes it will have been pre-set, calibrating the module to a specified input signal.

The maximum voltage in to the unit must not exceed 60V. The maximum current permitted when the front panel potentiometer is in circuit is 20mA. When the front panel potentiometer is out of circuit, the maximum permissible current is 32mA.

Section 4: REMOTE STOI

In any of the three speed control modes - Manual, Remote or Auto, the 602U/R may be stopped and started from a remote position.

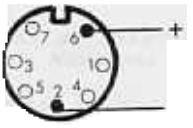
A suitable switch should be wired across pins 2 and 7 of the DIN plug. Open contacts to run, closed contacts to stop.

Section 5: MOTOR SPEED INFORMATION

A 0 to 12V DC (nominal) signal which varies directly with motor speed is present across Pins 6 and 2 of the Din socket. This may be used to monitor the motor speed. 12V is approximately equal to 165rpm. The output is load dependant but is immediately suitable for high impedance measuring devices including all digital multimeters.

If an analogue meter is to be used, the output must be matched to the measuring device. Seek the advice of a qualified electronics engineer.

CAUTION If a DIN plug is wired to monitor the motor speed signal, ensure that any links within the DIN plug necessary for the Mode for which the pump is set are made.



Section 1: TERMINOLOGY

The terms used in this section are defined as follows:

Signal Range
The change in signal level necessary to produce the required change in pumphead speed - normally zero to maximum rated speed.

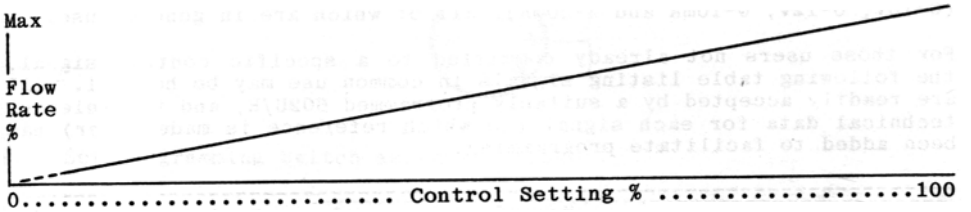
Signal Offset
The signal level at which the control signal is just about to take effect. Normally the point at which the pumphead is just about to rotate.

Non-Inverted Response
The pump is set to produce an increase in pumphead speed when the signal level increases.

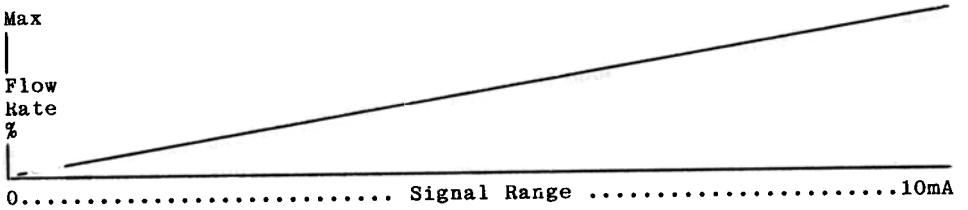
Inverted Response
The pump is set to provide an increase in speed when the signal level decreases.

Section 2: CONTROL CAPABILITIES

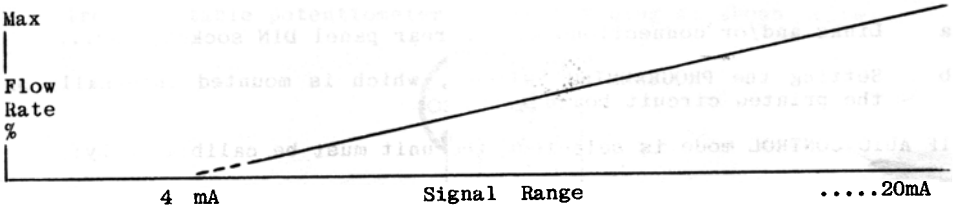
The 602U/R can be controlled manually, either from the front panel mounted potentiometer or by a remotely located potentiometer. The unit has a control ratio of 20:1, and the relationship between control settings and flow rates can be represented as shown below. Note that accurate control is not normally achieved below 5% of maximum flow.



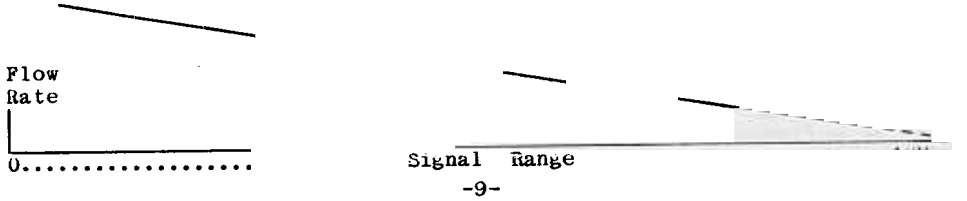
In addition, the 602U/R offers the facility of control of flow by virtually any of the process control signals in common use - for instance 0-10 mA as shown here



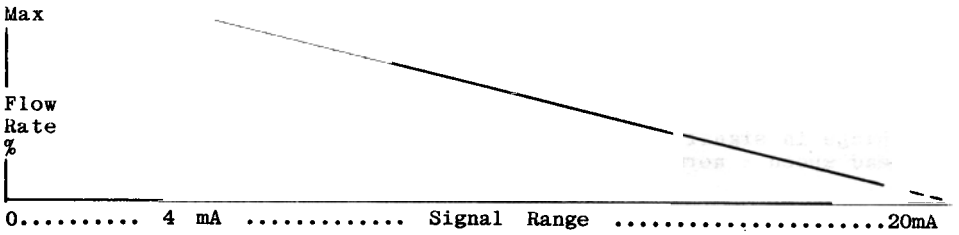
Similarly, control through a 4-20 mA signal would be as shown below. Here the pump will not respond to the signal until the OFFSET current of 4mA is exceeded. The SIGNAL RANGE in this case is 16 mA.



Furthermore the 602U/R will meet requirements in which the flow rate is to be inversely proportional to the control signal as shown below, in which the input signal varies from 0V, where flow is to be maximal, to 10V, where flow is to be minimal.

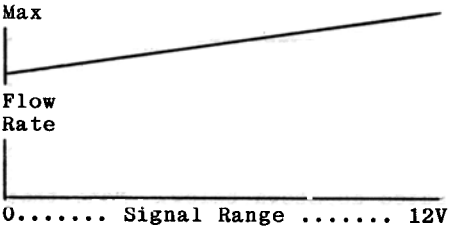


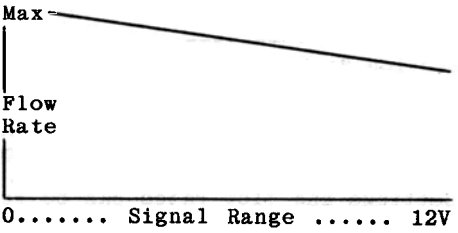
Again, the pump can be set to respond to a current signal with a SIGNAL OFFSET and in the next illustration the signal ranges from 4mA, where flow is to be at its highest, to 20mA where flow is at its lowest.



The above examples are a few of the numerous control options for which the unit can be programmed by following the instructions given in Part 3.

Additionally, the 602U/R has the ability to provide unusual reponses to signals as in the following examples in which the signal varies the speed of the pump over a limited speed range without bringing it to a standstill. Such responses require an unusual calibration procedure which may require specialist attention. See Section 8.





The examples shown above make reference to some control signals (0-10V, 0-12V, 0-10mA and 4-20mA). all of which are in general use.

For those users not already committed to a specific control signal, the following table listing signals in common use may be helpful. All are readily accepted by a suitably programmed 602U/R, and the relevant technical data for each signal (to which reference is made later) has been added to facilitate programming.

	Signal	Sense	Input Resistance	Mode
Current Signals	0-10mA	Non-Inverted	0.75k	C4
	0-20mA	Non-Inverted	1.2k	C5
	4-20mA	Non-Inverted	0.75k	C13
	0-10mA	Inverted	0.75k	C22
	0-20mA	Inverted	1.2k	C23
	4-20mA	Inverted	1.2k	C23
Voltage Signals	0-5V	Non-Inverted	100k	V2
	0-10V	Non-Inverted	100k	V2
	0-12V	Non-Inverted	200K	V3
	0-5V	Inverted	100k	V14
	0-10V	Inverted	100k	V14
	0-12V	Inverted	200k	V15

Section 3: MODE SELECTION PROCEDURE

The required mode is determined by selecting the appropriate combination of

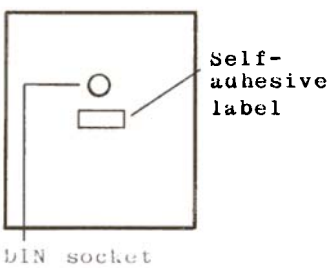
a Links and/or connections at the rear panel DIN socket, and...

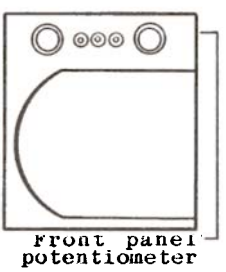
b Setting the PROGRAMMING SWITCH , which is mounted internally on the printed circuit board (pcb).

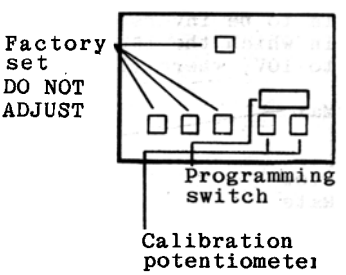
IF AUTO-CONTROL mode is selected, the unit must be calibrated by:

c Adjusting two pcb mounted POTENTIOMETERS, P1 AND P2, and in most cases...

d Adjusting and locking the front panel potentiometer.







Section 4: ACCESS TO PROGRAMMING SWITCH AND CALIBRATION PROCEDURE

WARNING Dangerous voltages (at mains potential) exist inside the pump case when it is connected to a mains supply.

1 Isolate the pump from the mains supply.

2 Remove the four screws securing the cover over the chassis and lift the cover clear, noting that the cover is connected to the chasssis by an earth bonding wire. DO NOT DISCONNECT THE EARTH BONDING WIRE.

3 The programming switch, which will be found near the bottom right the main pcb, is now accessible for resetting.

If MANUAL or REMOTE mode has been selected, resetting of the programming switch may be carried out (see Sections 5 and 6) and the cover replaced.

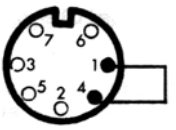
If an AUTO mode has been selected, re-connect the Pump to the mains supply before commencing calibration procedure which is detailed in Section 7.

CAUTION Potentiometers P3, P4, P5, and P6 are factory set and must not be tampered with if the specified performance under manual, remote and auto signals is to be maintained, and the Warranty is not to be invalidated.

Section 5: RECALIBRATING FOR MANUAL SPEED CONTROL, MODE 1

The 602U/R can be swiftly set or re-set to MANUAL MODE.

1 Insert the DIN plug linked for manual control into the rear panel socket. If the linked plug supplied is mislaid, link a 7 pin DIN plug as shown below.



2 Set Programming Switch as shown below.

	PROGRAMMING S								
Switch position	1	2	3	4	5	7	8	9	1
These switches 'ON'	1	2	3	4		7	8		1

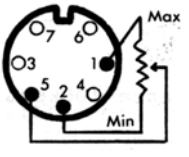
3 Mark one of the spare self-adhesive labels supplied 'Mode M1' and attach it to the rear panel in place of the now incorrect label.

If the module was previously set in the AUTO mode and is likely to be re-set in that mode, then the setting of the front panel potentiometer should be noted as it will need to be returned to this setting. The pcb mounted potentiometers are unaffected.

Section 6: RECALIBRATION FOR REMOTE SPEED CONTROL, M2

A pump can be set to this mode without interfering in any way with any AUTO mode calibration which might exist.

1 Wire a suitable potentiometer to the DIN plug as shown below.



Set the PROGRAMMING SWITCH as shown below.

	PROGRAMMING								SWITCH	
Switch position	1	2	3	4	5	6	7	8	9	10
These switches 'ON'	1	2					7	8		10

3 Mark one of the spare self-adhesive labels 'MODE M2' and cover or replace the now incorrect rear panel label.

NOTE Suitable potentiometers are available from Watson-Marlow - see Part 2, Section 2.

Section 7: RECALIBRATING FOR AUTO SPEED CONTROL

7:1 Mode Determination

With a given input signal response requirement for the pump, the first task is to determine which Auto mode will be most suitable. First, the Input Signal description must be re-stated in a way which provides the information necessary for Mode selection and, later, calibration of the Module.

Example 1

Signal 4-20mA Input resistance 0.75k. Flow rate required to rise as signal rises.

SENSE	NON-INVERTED
SIGNAL RANGE	16mA
INPUT RESISTANCE	0.75kohm
SIGNAL OFFSET	4mA
MAXIMUM SPEED SIGNAL	20mA

Turning to the selection chart for Current Modes (Section 7.8),this signal can be met by Mode C13 or Mode C17. The difference between these modes is that in C13 an internal potentiometer is used for the Signal Offset calibration, and in C17 the front panel potentiometer is used for that calibration.

The choice of C13 and C17 will depend on whether you prefer signal offset calibration to be accessible or inaccessible.

Example 2

Signal 0-10V. Input resistance 100kohm. Flow rate required to fall as signal rises

SENSE	INVERTED
SIGNAL RANGE	10V
INPUT RESISTANCE	100kohm
SIGNAL OFFSET	10V
MAXIMUM SPEED SIGNAL	0V

Remember that Signal Offset is defined as the point at which the pump is just about to start rotating. In this case, as the signal falls to 10V, rotation will commence and the offset is thus 10V.

The signal is best met by Mode V14 (see Selection Chart for Voltage Modes, Section 7:8), though V17 could be used. V14 is probably best since the front panel potentiometer is disabled and the calibration cannot be disturbed by adjustment of this control.

Example 3

Signal 0-5V. Input resistance 100kohm. Flow rate required to rise as signal rises.

SENSE	NON-INVERTED
SIGNAL RANGE	5V
INPUT RESISTANCE	100kohm
SIGNAL OFFSET	0V
MAXIMUM SPEED SIGNAL	5V

From the Selection Chart for Voltage Modes (Section 7:6), it can be seen that this signal can be accomodated by Modes V11 and V14. V11 is the recommended Mode since no Signal Offset is required, and the calibration procedure will be simpler than that for V14.

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A process signal (or suitable signal from other source) can be used i the calibration procedure providing that it meets the requirements se out below.

For Voltage Modes, a stable, variable DC voltage source (eg laboratory power supply having a source resistance of 5kohm or less) can be used in conjunction with a DC voltmeter. The maximum voltage into the unit must not exceed 60V.

For the Current Modes, the same DC voltage source may be used, (providing it will supply the current required) in conjunction with a DC milliamp meter. The maximum current permitted when the front panel potentiometer is in circuit is 20mA. When the front panel potentiometer is out of circuit, the maximum permissible current is 32mA.

In all cases, the signal output must be connected to the DIN socket in the manner shown in the Selection Chart.

Determination of rotational speeds

It is possible to use the factory calibrated Signal Overload LED facility to achieve setting of minimum and maximum rpm. This is carried out as follows:

Adjust signal range potentiometer P2 for maximum rpm, turning it in an anti-clockwise direction until the LED illuminates. Slowly turn P2 back until the light (just) goes off, then continue for a further half turn.

Where a more accurate determination of maximum speed is required or where it is required to assess intermediate speeds, either of the following methods can be used:

1 At lower speeds it is possible to use a stopwatch and count the actual revolutions.

Revolution Counter. This can be any type capable of giving the required accuracy a speeds of 170rpm or less.

The internal 12V reference has a olerance of ±5%, and the figures given in the Selection Chart or Offset are nominal.

Current Modes only: The on-board measuring resistors R15 and R16 have a tolerance of ±2% and the Signal Range figures given in the Selection Chart are nominal. The front panel potentiometer has a tolerance of ±5% and the current values given in the Selection Chart are nominal.

Should the input signal attain excessive levels during calibration or subsequently, the Signal Overload LED on the front panel will illuminate. The motor will continue to run but excessive voltage will not be applied to the motor because of the use of a limiting transformer. The Signal Overload LED will be found useful in calibration as an indication that maximum speed has been reached.

Tolerances of the mechanical limit stops of the front panel potentiometer may lead to ambiguity in the maximum readout on the digital dial. The dial is factory set to 000 when turned fully anti-clockwise. However, when turned fully clockwise the dial can indicate greater than 999, normally between 000 and 008. It is convenient to adopt 999 as 'maximum'.

Those less familiar with the term 'Input Resistance' referred to on the Selection Charts, will need to appreciate that this determines the 'loading effect' that the pump input circuitry has on the signal source. Ensure that the signal source is capable of operating correctly under this loading, which is listed for each Mode in the Selection Charts.

he unit attain normal working temperature - if practcabl allowing it to run for one hour. If a suitable control igna is not available, convert the unit to operate in the lode (Section 5).

ng wit th require Mode ified

3 Connect Signal Source to the DIN socket as indicated in the Selection Chart.

4 Ensure that potentiometers P1 and P2 are set to approximately mid-position.

5 Insert a length of tubing into the pumphead.

Now proceed to instructions relating to the selected mode as set out in Sections 7:5 and 7:7 remembering that the change of Control Mode of the pump should be recorded on the rear panel using one of the self-adhesive labels supplied.

7:5 Calibration procedure for Voltage Signals

V1,V2 and V3 (front panel potentiometer disabled)

1 Set signal source to the maximum speed signal
2 Adjust P2 for maximum speed.

V4,V5 and V6 (front panel potentiometer disabled)

1 Set signal source to the maximum offset and adjust P1 for zero speed.
2 Set signal source to maximum speed signal and adjust P2 for maximum speed.
3 Repeat 1 and 2 until interaction between adjustments is eliminated.

V7,V8 and V9 (Offset adjustment from front panel potentiometer)

1 Set signal source to the signal offset and adjust the front panel potentiometer for zero speed.
2 Set signal source to maximum speed signal and adjust P2 for maximum speed.
3 Repeat 1 and 2 until interaction between adjustments is eliminated.

V10,V11 and V12 (front panel potentiometer extends offset range adjustment)

1 Set signal source to the signal
and (a) When offset is required to be 12V or less, set top panel potentiometer fully anti-clockwise and adjust P1 for zero speed.
or (b) When offset is required to be between 12V and 36V, adjust P1 fully anti-clockwise and then adjust the front panel potentiometer for zero speed.

2 Set signal source to maximum speed signal and adjust P2 for maximum speed.
3 Repeat 1 and 2 until interaction between adjustments is eliminated.

V13,V14 and V15 (front panel potentiometer disabled)

1 Set source to the signal offset and adjust P1 for zero speed.
2 Set signal source to maximum speed signal and adjust P2 for maximum speed.
3 Repeat 1 and 2 until interaction between adjustments is eliminated.

V16,V17 and V18 front panel potentiometer extends offset range adjustment)

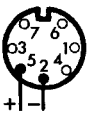
Set signal source to the signal offset

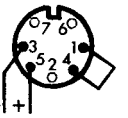
and (a) When offset is required to be 12V or less, adjust the front panel potentiometer fully anti-clockwise and adjust P1 for zero speed.
or (b) when offset is required to be between 12V and 36V, adjust the front panel potentiometer to fully clockwise postion and adjust P1 for zero speed.

2 Set the signal source to maximum speed signal and adjust P2 for maximum speed.
3 Repeat 1 and 2 until interaction between adjustments is eliminated.

SELECTION CHART Voltage (V) Mode

SENSE	MODE	INPUT SIGNAL RANGE min	INPUT SIGNAL RANGE max	OFFSET min	OFFSET max	INPUT RESISTANCE K ohm	PROGRAMMING SWITCH These switches 'ON' 1	2	3	4	5	6	7	8	9	10	DIN CONNECTIONS Rear view of plug
N	V1	1.5	6	0	0	100	1	2							9		
O	V2	3	12	0	0	100	1	2							9	10	
N	V3	6	24	0	0	200		2							9	10	
-	V4	1.5	6	0	12	100	1				5				9		
I	V5	3	12	0	12	100	1				5				9	10	
N	V6	6	24	0	24	200					5				9	10	
V	V7	1.5	6	0	12	100	1	2				6			9		
E	V8	3	12	0	12	100	1	2				6			9	10	
R	V9	6	24	0	12	200		2				6			9	10	
T	V10	1.5	6	0	24	100	1				5	6			9		
E	V11	3	12	0	24	100	1				5	6			9	10	
D	V12	6	24	0	36	200					5	6			9	10	
I	V13	1.5	6	1.5	12	100	1				5				9		
N	V14	3	12	3	12	100	1				5				9	10	
V	V15	6	24	6	24	200					5				9	10	
E	V16	1.5	6	1.5	24	100	1				5		7		9		
R	V17	3	12	3	24	100	1				5		7		9	10	
T	V18	6	24	6	36	200					5		7		9	10	
E																	
D																	





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C1,C2,C4 and C5

1 Set the front panel potentiometer fully anti-clockwise.
2 Set the signal source to maximum speed signal.
3 Adjust P2 for maximum speed.

C6,C7,C8,C9 and C10 (Front panel potentiometer extends signal range adjustment)

1 Set signal source to maximum speed signal.
2 Set the front panel potentiometer fully anti-clockwise, and then adjust P2 for maximum speed. If required speed cannot be obtained,leave P2 in maximum setting and then adjust the front panel potentiometer.

These modes are similar to C1,C2,C3,C4 and C5, but a wider choice of signal range is achieved by utilising the front panel potentiometer to provide the necessary increase in input resistance.

C11,C12 and C13

1 Set the front panel potentiometer fully anti-clockwise.
2 Set signal source to the signal offset and adjust P1 for zero speed.
3 Set signal source to the maximum speed signal and adjust P2 for maximum speed.
4 Repeat 2 and 3 until interaction between adjustments is eliminated.

C14,C15,C16,C17 and C18 (Offset adjustment from front panel potentiometer)

1 Set signal source to the signal offset and adjust the front panel potentiometer for zero speed.
2 Set signal source to the maximum speed signal and adjust P2 for maximum speed.
3 Repeat 1 and 2 until interaction between adjustments is eliminated.

C19,C20,C21,C22 and C23

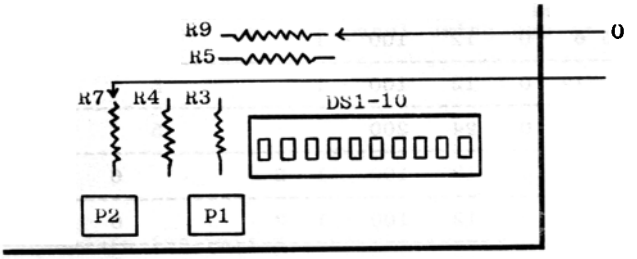
1 Set the front panel potentiometer fully anti-clockwise.
2 Set signal source to the signal offset and adjust P1 for zero speed.
3 Set signal source to the maximum speed signal and adjust P2 for maximum speed.
4 Repeat 2 and 3 until interaction between adjustments is eliminated.

NOTE The combination of the signal range and the offset must not be less than zero (e.g. 2.7 offset with 10 signal range = minus 7.3: this is not acceptable).

:25,C26,C27 and C28 (Offset adjustment from front panel potentiometer)

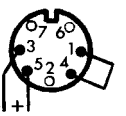
For Modes C24 and C25 adjust P1 to a voltage of + 5.7V. For Modes C26,C27 and C28 adjust P1 to a voltage of +11.5V. (see illustration below for measuring points).
Set signal source to the signal offset and adjust front panel potentiometer for zero speed.
Set signal source to maximum speed signal and adjust P2 for maximum speed.
Repeat 2 and 3 until interaction between adjustments is eliminated

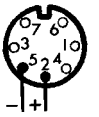
Slight readjustment of P1 may be necessary to achieve zero speed.



7:8 SELECTION CHART Current (C) mA Modes

SENSE MODE		INPUT SIGNAL RANGE min	max	OFFSET min	max	INPUT RESISTANCE kohm	PROGRAMMING SWITCH These switches 'ON' 1	2	3	4	5	6	7	8	9	10	DIN CONNECTIONS Rear view of plug
	C1	1.4	5	0	0	1.2	1	2	3						9		
	C2	2.2	8	0	0	0.75	1	2		4					9		
	C3	2.7	10	0	0	1.2	1	2	3						9	10	
N	C4	4.4	16	0	0	0.75	1	2		4					9	10	
O	C5	5.2	20	0	0	1.2		2	3						9	10	
N	C6	0.3	5	0	0	6.2-1.2	1	2	3						9		
-	C7	0.3	8	0	0	5.75-0.75	1	2		4					9		
I	C8	0.5	10	0	0	6.2-1.2	1	2	3						9	10	
N	C9	0.5	16	0	0	5.75-0.75	1	2		4					9	10	
V	C10	1.0	20	0	0	6.2-1.2		2	3						9	10	
E	C11	1.4	5	0	10	1.2	1		3		5				9		
R	C12	2.7	10	0	10	1.2	1		3		5				9	10	
T	C13	4.4	16	0	16	0.75	1			4	5				9	10	
E	C14	1.4	5	0	10	1.2	1	2	3			6			9		
D	C15	2.2	8	0	16	0.75	1	2		4		6			9		
	C16	2.7	10	0	10	1.2	1	2	3			6			9	10	
	C17	4.4	16	0	16	0.75	1	2		4		6			9	10	
	C18	5.2	20	0	10	1.2		2	3			6			9	10	
	C19	1.4	5	1.4	5	1.2	1		3		5				9		
I	C20	2.2	8	2.2	8	0.75	1			4	5				9		
N	C21	2.7	10	2.7	10	1.2	1		3		5				9	10	
V	C22	4.4	16	4.4	16	0.75	1			4	5				9	10	
E	C23	5.2	20	5.2	20	1.2			3		5				9	10	
R	C34	1.4	5	5	15	1.2	1		3		5		7		9		
T	C25	2.2	8	8	24	0.75	1			4	5		7		9		
E	C26	2.7	10	10	20	1.2	1		3		5		7		9	10	
D	C27	4.4	16	16	32	0.75	1			4	5		7		9	10	
	C28	5.2	20	20	30	1.2			3		5		7		9	10	





Section 8: UNUSUAL RESPONSES

The final two graphs in Part 2 illustrate the use of Speed Offset where the pump is set to run at some minimum speed regardless of signal level. Full range deflection of the signal will then vary the speed of the pump over the remainder of the speed range. This is perhaps best illustrated by the following example.

Signal 0-10mA. Input resistance 0.75kohm. Flow rate to rise with signal but output to vary over only 50 to 100%.

SENSE	NON-INVERTED
SIGNAL RANGE	10mA
INPUT RESISTANCE	0.75kohm
SIGNAL OFFSET	0 mA
MAXIMUM SPEED SIGNAL	10mA

Turning to the Selection Chart for Current Signals, Modes C13 and C17 are suitable because they cater for 0-10mA and 0.75kohm Input Resistance and have offset adjustment. Modes C4 and C9 are unsuitable because although they will handle the signals they do not have an offset adjustment. Potentiometer P1 can be used to give, in this case, Speed Offset instead of Signal Offset.

The choice between C13 and C17 is determined by whether external adjustment (through the front panel potentiometer) of the calibration control is required.

Calibrating the module is carried out as follows:

1 Carefully follow the access instructions given in Section 4

2 Set the Programming Switch and connect the signal to the unwired DIN plug as shown in the Selection Chart, Mode C13.

3 Set the front panel potentiometer fully anti-clockwise (000).

4 Set the signal source to 0mA and adjust P1 for the required minimum speed (eg 50% of maximum in this example).

5 Set the signal source to 10mA and adjust P2 for the required maximum speed (eg 100% in this example).

The pump will now operate as required in response to the 0-10mA control signal.

Section 9: FOR HIGHEST ACCURACY OF OPERATION

1 Effect of pumphead load when calibrating.

The instructions call for a pumphead and tubing to be fitted prior to calibration. Improved accuracy will be achieved when calibrating if the pump is fitted with the tubing which it is intended to use. It is not normally necessary for the tubing to contain fluid during calibration, but where large bore tubing and significant delivery pressures are being used, doing so will offer increased accuracy.

2 Setting at zero flow rate condition.

It is generally assumed in this manual that signal offset coincides with zero speed (and hence zero flow rate). In practice, the control range of the pump is finite, and no accurate control is available between 0 and 5% speed.

It may therefore be beneficial to set Signal Offset to give 5% of maximum speed. Thus in the second example given in Part 2 where 0 to 10mA is shown controlling the flow rate from zero to maximum, adjust the unit so that 0.5mA corresponds to 5% of maximum speed.

It must be recognised that this may result in the pump stopping before zero or continuing to rotate very slowly at zero.

Section 10: SPARE MODE SELECTION GRIDS

SENSE	DIN plug
SIGNAL RANGE	connections
INPUT RESISTANCE	
SIGNAL OFFSET	
MAXIMUM SPEED SIGNAL	

SENSE

SIGNAL RANGE

INPUT RESISTANCE

SIGNAL OFFSET

MAXIMUM SPEED SIGNAL

DIN plug connections

SENSE

SIGNAL RANGE

INPUT RESISTANCE

SIGNAL OFFSET

MAXIMUM SPEED SIGNAL

DIN plug connections

SENSE

SIGNAL RANGE

INPUT RESISTANCE

SIGNAL OFFSET

MAXIMUM SPEED SIGNAL

DIN plug connections

SENSE

SIGNAL RANGE

INPUT RESISTANCE

SIGNAL OFFSET

MAXIMUM SPEED SIGNAL

DIN plug connections

SENSE

SIGNAL RANGE

INPUT RESISTANCE

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MAXIMUM SPEED SIGNAL

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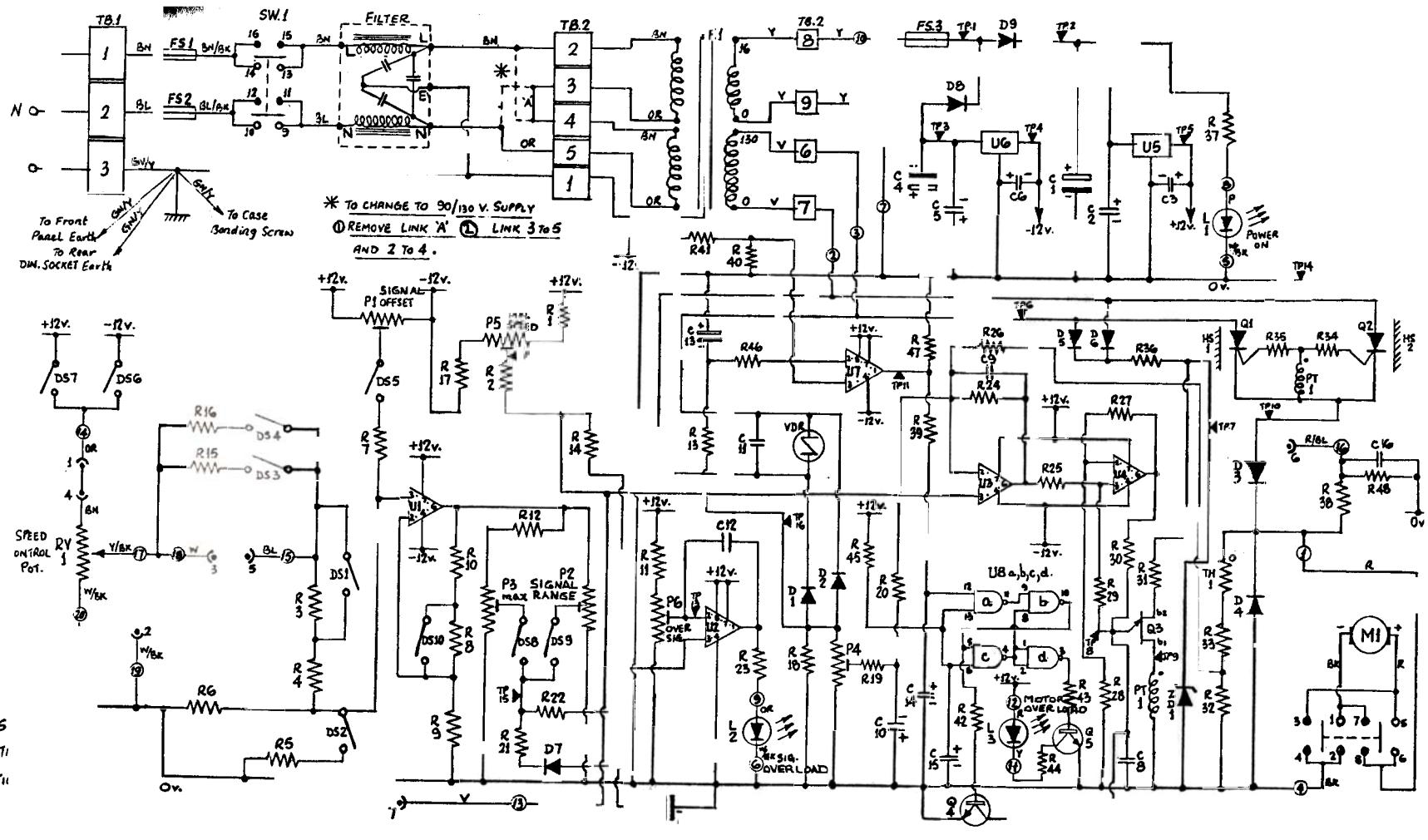
INPUT RESISTANCE

SIGNAL OFFSET

MAXIMUM SPEED SIGNAL

DIN plug connections


TB.1
SW.1
FILTER
TB.2
FS1
FS2
To Front Panel Earth
To Rear DIN. SOCKET Earth
To Case Bonding Screw
* TO CHANGE TO 90/130 V. SUPPLY
① REMOVE LINK 'A' ② LINK 3 TO 5 AND 2 TO 4.
TB.2
FS.3
D9
D8
U6
U5
POWER ON
SIGNAL OFFSET
SPEED CONTROL POT.
RV 1
DS7
DS6
DS5
DS4
DS3
DS2
DS1
P1 OFFSET
P2 SIGNAL RANGE
P3 max
P4
P5 SPEED
P6 OVER SIG.
U1
U2
U3
U4
U7
U8 a,b,c,d.
MOTOR OVER LOAD
OVER LOAD
VDR
Q1
Q2
Q3
M1
KEY:~
~ P.C.B. CONNECTIONS
~ TERM. BLK. CONNECTI
~ DIN. PLUG CONNECTI