Strata Technology Limited

DCP50 High Precision Pump
User Manual

Part No. S000016.4a

This manual is for use with MK2 pumps only i.e. pumps with the RS485 interface.

User Manual Issue History		Pump S/Nos
Issue 1	Original manual for MK1 pumps.	00001-00012
Issue 2	Updated to include changes introduced with MK2 pumps as follows • Addition of RS485 interface and re-designed USB interface • Design change to pistons including improved method of adjustment of seals • Mechanical changes to lighten weight • Labelling changes	00013-00032
Issue 3	Updated to include hardware change details and text changes as follows • Push-button internal LED's are now all RED. • More technical detail supplied regarding the Pulse Compensation and Bulk Modulus features. • Additional details regarding piston seal variation with temperature. • More detailed instructions supplied regarding cleaning of the switchover valve.	00033-
Issue 4	Clarification of flow rate accuracy	
Issue 4a	Additional section on fine adjustment of flow rates introduced with v1.6.0 firmware, using new version of Control& Acquisition program.	

Important user information

It is essential that all users read this User Manual completely in order to fully understand the safe use of the DCP50 High Precision Pump.

WARNING!

The **WARNING!** symbol shown here appears throughout the manual and highlights instructions that must be followed by the user, otherwise serious personal injury can occur. Wherever this sign appears, it is important not to continue until the stated instructions have been fully followed and are clearly understood.

CAUTION!
The **CAUTION!** sign appears wherever instructions are given in the manual that must be followed to avoid damage to the product or other equipment. It is important not to continue until the stated instructions have been fully followed and are clearly understood.

Note
The **Note** sign appears in the manual where information relating to trouble-free and optimal use of the pump appears.

CE Certifying
This product meets the requirements of applicable CE-directives. A copy of the corresponding Declaration of Conformity is shown at the rear of this User Manual.

The **CE** symbol and corresponding declaration of conformity is valid for the instrument when it is:

– used as a stand-alone unit, or

– connected to other CE-marked equipment and

– used in the same state as it was delivered from Strata Technology Ltd.

This is a Class A product for laboratory use only. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Should you have any technical queries regarding this product, or have any comments to make regarding this manual, we will be pleased to receive them at:

Strata Technology Limited
Unit 7, Brooklands Close
Sunbury-on-Thames
Middlesex
TW16 7DX
United Kingdom

Telephone: +44 (0) 1932 732340

Strata Technology Limited reserves the right to make changes in the specifications without prior notice.

Warranty and Liability

Strata Technology Limited guarantees that the DCP50 has been thoroughly tested in accordance with our procedures to ensure that it meets its published specifications. The warranty included in the conditions of delivery is valid for 13 months from the date of shipping, and only applies if the DCP50 has been installed and used according to the instructions provided in this User Manual.

The 'standard' DCP50 uses 316 grade stainless steel and Nitronic 60 wetted parts. For pumps being used with corrosive solvents e.g. brine, a version of pump is available with Hastelloy wetted parts which must be requested when ordering. If a 'standard' pump is returned for a warranty repair, and the fault is found to be due to a corrosive solvent having been used, this will invalidate any warranty placed upon it and the full cost of repair will be chargeable.

Strata Technology Limited will in no event be liable for incidental or consequential damages, including without limitation, lost profits, loss of income, loss of business opportunities, loss of use and other related exposures, however caused, arising from the faulty and incorrect use of this product.

The only user serviceable parts of the DCP50 are located behind the plastic cover as described in Chapter 7. The warranty is invalidated if the end user attempts to open the DCP50 case. The warranty also applies to the external power supply, which is also invalidated if it is damaged by the end user and any attempt made to repair it.

The DCP50 contains a 3V lithium button cell to maintain the real-time clock within the pump, which should last for 25 years. This is not a user changeable part, and in the unlikely event that it requires replacing, the pump must be returned to Strata Technology Ltd. to be changed.

Trademarks

DCP50 is a registered trademark of Strata Technology Limited.

Recycling

This symbol indicates that waste electrical and electronic equipment (WEEE) must not be disposed of as unsorted municipal waste, but must be collected separately by an authorised body. This product contains a single Lithium button cell. Please contact Strata Technology Ltd. for information concerning the decommissioning of equipment.

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Chapter 1 Introduction

The Strata Technology Limited DCP50 is a high precision dual-cylinder pump for use in laboratory applications where constant flow at pressures up to 50 bar (5 MPa, 725 psi) or constant pressure up to 50 bar is required. The DCP50 is very accurate and reproducible, especially at low flow rates over the whole pressure range. The pump's design is such that it has excellent chemical resistance.

The DCP50 operates by the use of two alternating pistons connected to a switchover valve via 1/16" tubing. While one piston is pumping solvent out, the other piston is drawing more solvent in. At the end of piston travel, the direction is reversed and the valve changes over the tubing connections to allow output flow to continue.

The flow rate/set pressure and pressure limit are easily and precisely set using front panel rotary controls, with the desired settings shown on a liquid crystal display (LCD). As various solvents with different bulk compressibility can be used with the pump, a 'Bulk Modulus' value can be set using the same controls via a menu screen.

The wetted metal parts of the standard pump are made from 316 grade stainless steel and Nitronic 60. A version of pump with Hastelloy wetted parts can be ordered if working with corrosive solvents e.g. brine. A rinsing system is fitted as standard, which feeds rinsing solution between the two cylinders behind the piston heads to clean the internal surface of the glass tubes during use. Although use of the rinsing system is optional, it is recommended for pumps being used with corrosive solvents.

The DCP50 is provided with USB and RS485 interfaces allowing remote control of the pump and data gathering, using software available to download from the Strata Technology Limited website www.stratatec.co.uk. Firmware updates for the pump are free, and can be programmed via the USB interface. Refer to the website for details as they become available.

The DCP50 operates from an external 24V DC supply provided by a desktop style power supply. The output lead of the power supply is fitted with a plug that locks into the mating socket on the pump ensuring that it cannot be accidentally pulled out during operation.

WARNING! When using the pump with hazardous chemicals, take suitable protective measures, such as wearing gloves that are resistant to the chemicals being used, and wearing protective safety glasses. Follow local regulations and instructions for safe operation and maintenance of the pump and any equipment connected to it.

WARNING! The tubing to the Switchover Valve is pre-installed on the DCP50, except for the inlet connection. It is important to note that if changing the existing tubing as part of the maintenance routine, the tubing is connected to the correct ports otherwise the pump will not operate correctly and could put the user at risk.

WARNING! If the DCP50 pump is used in a manner not specified by Strata Technology Limited, protection against personal injury inherent in the equipment's design can be rendered ineffective.

Chapter 2 Specifications

Flow Rate ranges	1-500mL/hour variable in steps of 1ml/h. 0.01 – 5.00mL/hour variable in steps of 0.01ml/hour
Constant Pressure range	0.1 – 50.0 bar in steps of 0.1 bar
Operating pressure	0-50 bar (725psi) for all flow rates
Flow rate accuracy	± 1.5% of setting or ± 0.5mL/hour (whichever is greater) in Constant Flow mode, independent of back pressure
Reproducibility	Better than 0.5% of set flow rate or pressure.
Flow rate precision	Better than 1% with the same solvent and temperature.
Bulk Modulus	Adjustable from 0.5 to 2.5 in 0.01 steps
Materials of wetted parts	Fluoroplastics (PTFE, ETFE, FEP, Tefzel, Teflon), PEEK, stainless steel, Nitronic 60, Hastelloy (optional when ordering), and borosilicate glass.
Pressure read out	0-50.5bar
Pressure limit	Protective shutdown, adjustable in the range 0 – 50.5bar in 0.1bar steps
Drive	DC Stepper motor
Maximum speed of piston travel	1.77mm/sec
PC Interface	Pump control, programming and data transfer via the following connectors • USB – Type B connector • RS485 – 9-way D-type male connector
Power supply	Input voltage : 100 - 240 V~, frequency 50/60 Hz Input current : max 1.7A @ 100V Output voltage : 24V DC Output current : 2.71A
Power consumption	<24VA
Environment	+4°C to +40°C, 20–95% relative humidity, 84–106kPa (840–1060mbar) atmospheric pressure.
Dimensions	410 x 203 x 172 mm.
Weight	10.2kg

Compliance with standards	The declaration of conformity is valid for the instrument only if it is: • used in laboratory locations • used in the same state as it was delivered from Strata Technology Ltd.
Safety standards	This product meets the requirement of the Low Voltage Directive (LVD) 2006/95/EC through the following harmonized standards: • IEC 61010-1: 2010 edition 3 including Cor 1: 2011 and Cor 2: 2013 Including all published deviations for Europe, USA and Canada
EMC standards	This device meets the requirements of the EMC Directive 89/336/EEC through the following harmonized standards: • CENELEC EN 61326-1 (emission and immunity) • EN 61000-3-2:2006 +A1:2009 +A2:2009 • EN61000-3-3:2013 This device complies with part 15 of the FCC CFR47 rules (emission). Operation is subject to the following two conditions: 1. This device may not cause harmful interference. 2. This device must accept any interference received, including interference that may cause undesired operation.

Chapter 3 Unpacking

Open the packing box carefully, and unpack the DCP50 pump and accessories, checking the contents of the box against the packing list supplied with it (also shown below).

CAUTION! The DCP50 has a weight of 10.2kg and care should be taken when lifting it. The pump should be lifted by placing the fingers under the unit at each end of the metal case and lifting. Never attempt to lift the pump by use of the plastic cover!

Save the foam insert packing material and the box as a precaution in the event that the pump needs to be returned to Strata Technology Limited. Check the DCP50 for any visible signs of damage that may have occurred during transit.

CAUTION! The system should be unpacked and left for 24 hours in case any condensation builds up inside the pump due to low temperatures it may have been subjected to during transit.

CAUTION! The system should be installed on a stable laboratory bench providing a suitable working area.

Place the DCP50 on the bench. Before operating the pump for the first time, carefully read Chapter 5 of this manual.

Note that there may be some water remaining in the glass tubes and the tubing that was used during the test and calibration routines. This will be flushed through once the pump is operating.

Packing List (also supplied separately)

Item	Description	Quantity
1	DCP50 Pump	1
2	Mains lead	1
3	Desktop power supply	1
4	Tubing kit comprising the following. • 1/16” inlet tubing – 500mm long • 1/8” outlet tubing – 500mm long • Nut and ferrule for 1/16” tubing • Nut and ferrule for 1/8” tubing	1
5	Tool kit comprising the following. • ¼” Vici socket wrench • 1.5mm Hex key • 2.5mm Hex key • 4mm Hex key • 5mm/4mm open ended spanner	1

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Chapter 4 Description

4.1 Front Cover

The DCP50 is fitted with two types of covers at the front (not shown in Figure 1). Metal guards are fitted over both piston rods to cover the two openings in the front of the pump to prevent the risk of operator fingers getting trapped in the mechanism, and to reduce the risk of solvent spillage entering the pump.

The outer cover is plastic and this fits over the whole of the piston assembly to protect the user from breakage of the glass tubes resulting from incorrect handling. It is held in position by four screws. Transparent windows in the cover allow a full view of the pistons in operation.

4.2 Front Panel Controls and Indicators

Please refer to figure 1.

Item No.	Description	Function
1	Solvent Change Button/Indicator	Use this button when wanting to change solvent as it speeds up flushing of the pump. The button has a red LED indicator to show that this feature is enabled. Details are provided in section 4.10.
2	Pulse Compensation Button/Indicator	Use this button when running the DCP50 against a backpressure of 5 bar or above. Operation is indicated by a red LED within the button. Details are provided in section 4.11 and 6.4.
3	Run Button/Indicator	Use this button to operate the pump. Operation is indicated by a red LED within the button. Details are provided in section 4.12.
4	Pressure Transducer	This monitors the output flow from the pump and feeds a signal back to the internal control circuit.
5	6-port Switchover Valve	The valve is connected to the pistons, and switches the direction of flow around the tubing system when the pistons change direction to ensure continuous output flow. Solvent input and output are also routed via this valve.
6	Over Pressure Indicator	This red LED indicates when the output pressure has exceeded the limit set by the rotary control. Pump operation stops when this happens.

Item No.	Description	Function
7	Pressure Safety Limit Control	This control sets the maximum pressure that the pump will operate at. Details are provided in section 4.13.
8	Liquid Crystal Display (LCD)	Shows the flow rate, back pressure, and the set pressure limit when running in Constant Flow mode, or set pressure, flow rate and set pressure limit when running in Constant Pressure mode. It will also show the menus for other features when selected as described in this User Manual.
9	Flow Rate/Pressure Control	This control sets the flow rate of the pump when in Constant Flow mode, and sets the required pressure when in Constant Pressure mode. Details are provided in section 4.14.
10	Power Switch	Switches power to the internal circuitry of the pump when turned on. O=Off, I=On

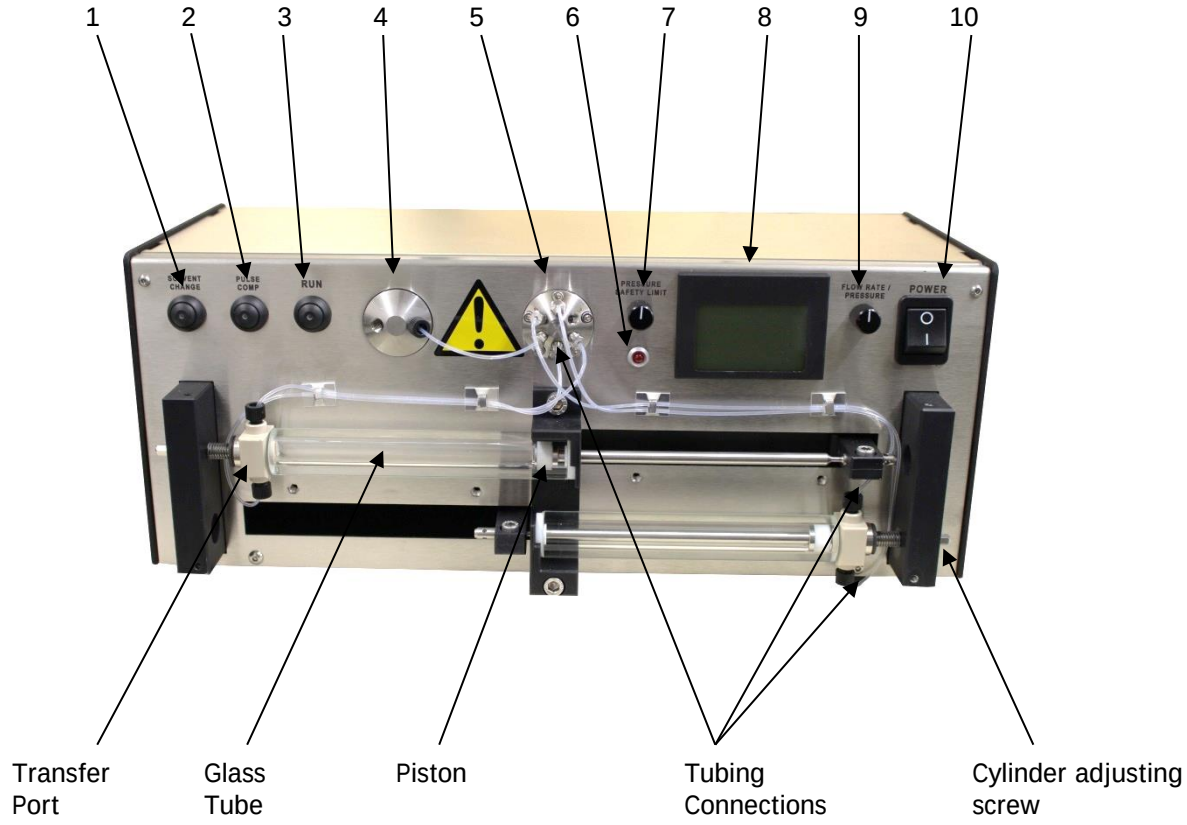

Figure 1 - DCP50 Front Panel with protective covers removed

4.3 Pump Options

The DCP50 can be supplied in two variants, which must be specified when ordering. The standard option uses stainless steel and Nitronic60 for the parts that come into contact with the solvents used. For users wishing to use corrosive solvents such as brine, the DCP50 can be supplied with Hastelloy wetted parts. Apart from the piston seal retainer (see section 4.4) which is user serviceable, the Hastelloy parts have to be fitted during manufacture.

4.4 Fluid Delivery

The DCP50 operates by the use of two alternating pistons fitted in high precision borosilicate glass tubes which are mounted at the front of the pump. The pistons are attached to the arms of a carrier mounted on a lead screw which is driven by a stepper motor via a toothed belt. The driving mechanism is located behind the front panel with only the carrier arms protruding through it. The pistons act in a reciprocating fashion so that as one piston is expelling solvent, the other piston is drawing in more solvent. At the end of travel, an opto-switch sends a signal to the micro-controller on the internal control board which then briefly stops the motor and operates the switchover valve. Following a successful switch, a signal is sent from the valve to the micro-controller which then reverses the direction of rotation of the drive motor and starts it running again, so that the full cylinder is now pumping out solvent and the empty one is drawing solvent in. This process then repeats when piston travel reaches the other end.

Each piston consists of four parts; the piston seal retainer, the piston seal, the piston washer and the piston rod (see Figure 2). The piston seal is tensioned by adjustment of the piston rod which is screwed onto the piston seal retainer. This causes the piston seal located between the piston seal retainer and the piston washer to expand outwards to seal against the wall of the glass tube.

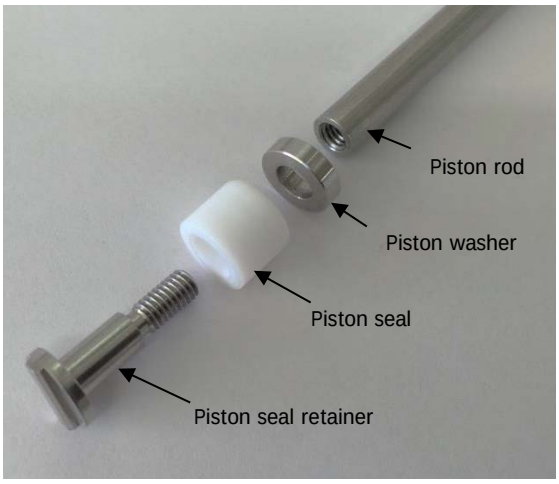

Figure 2 - Piston Assembly

4.5 Switchover Valve

The six port valve shown in Figure 1 and Figure 3 is a self-contained motorised rotary valve controlled by the internal circuitry of the pump. The valve has six tubing connections; one for the solvent input, one for solvent output, and four which are attached to the transfer ports mounted at the end of the pistons. The DCP50 is supplied with the 1/16” tubing already attached between the transfer ports and the switchover valve. Tubing to connect to the input and output ports is supplied in a kit with the pump, along with the necessary fittings.

A diagram showing how the tubing is attached and how the solvent flow is routed is shown in Figure 3.

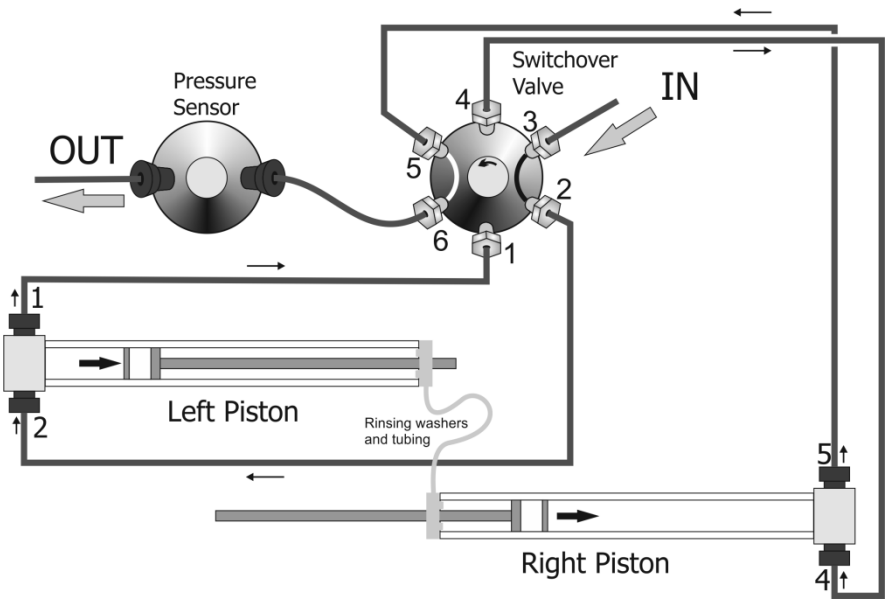

Figure 3 - Solvent Flow Diagram (including rinsing system)

In the configuration shown, the left piston is drawing in solvent via ports 3 and 2 of the Switchover Valve. Port 1 is blocked off by the Switchover Valve, so there is no flow in that segment of tubing. At the same time, solvent already in the right hand cylinder is pumped out via ports 5 and 6 of the Switchover Valve and then through the Pressure Sensor. Port 4 is blocked off so there is no flow in that segment of the tubing.

At switchover time, ports 3 and 4 and ports 1 and 6 are linked, and ports 2 and 5 are blocked off. As the pistons move in the opposite direction, solvent is drawn in by the right piston via ports 3/4 and pumped out of the left piston via ports 1/6. A return signal from the Switchover Valve is sent to the control board indicating a successful switchover. If this is not received, the driver motor stops running to prevent pressure being built up in the pump by a cylinder attempting to pump into a sealed port.

Note
Do not run the pump for long periods of time without any solvent/cleaning solution. The polymeric components within the switchover valve require being wetted to continue functioning correctly.

4.6 Rinsing System

The rinsing system (also shown in Figure 3) comprises the ‘rinsing washers’ fitted between the ends of the glass tubes and the central support, joined by a short length of flexible tubing. The system is initially primed by loading one of the cylinders with the rinsing solution behind the piston head. As the pump operates, the rinsing solution is passed between the two cylinders via the flexible tube to clean the internal surface of the glass. As the rinsing solution becomes contaminated, it can be pumped out and then replaced with new solution. It is recommended that the rinsing solution is replaced on a daily basis.

4.7 Pressure Sensor

The pressure sensor shown in Figure 1 and Figure 3 is connected to the output from the switchover valve and consists of a diaphragm with a four-active-arm strain gauge bridge. The diaphragm expands or contracts with variations in pressure causing the resistance in the bridge arms to change. This gives a signal output proportional to the pressure being applied. This signal is amplified and fed to the micro-controller circuit on the control board.

The sensor and associated circuitry have two main functions; the first is to continuously measure the operating pressure of the solvent pumped through it, and the second is to check that if the pressure exceeds the limit set on the front panel, the micro-controller turns off the drive motor and illuminates the Over Pressure indicator. Instructions for setting the pressure limit are given in Chapter 5.

When running in Constant Pressure mode, the output from the pressure sensor is continuously monitored and a PID Controller adjusts the flow rate accordingly to maintain constant pressure.

4.8 Tubing Connectors

The 1/16" diameter tubing used within the DCP50 is pre-fitted with nuts and ferrules and is connected between the transfer ports on the pistons, the switchover valve, and the pressure sensor.

The tubing kit supplied with the pump comprises the following.

- 500mm length of 1/16" inlet tubing and a stainless steel nut with ferrule for connection between the DCP50 and the solvent reservoir.
- 500mm length of 1/8" outlet tubing and a plastic nut with a two part ferrule (metal and plastic) for connection between the DCP50 and the laboratory equipment.

4.9 Rear Panel

The rear panel of the DCP50 has three connectors – DC Power, USB and RS485. The USB and RS485 interfaces provide serial communications with a PC for configuring the pump remotely and for gathering data using software available for download on the Strata Technology Ltd website. Either interface can be used, the only restriction being the length of the cable.

4.9.1 DC Connector ⎓

The circular DC connector at the rear of the DCP50 has three pins, the smallest of which is not used. The other two pins are for the +24V DC input and the 0V connection. The pin-out of this connector is shown in Figure 4.

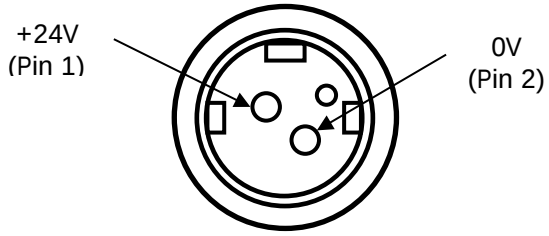

Figure 4 - DC Connector Pin-out (as viewed from rear of pump)

The plug of the external power supply is attached to the DC connector on the rear panel. The plug has a locking mechanism to prevent the power lead being pulled out accidentally.

4.9.2 USB Connector

The USB interface provides serial communication with a PC for remotely configuring the pump and for gathering data. It can also be used for field upgrades to the operating firmware of the pump. It is recommended that the USB cable length is kept to 3 metres or less.

This is a standard USB-B connector, the pin-out of which is shown in Figure 5.

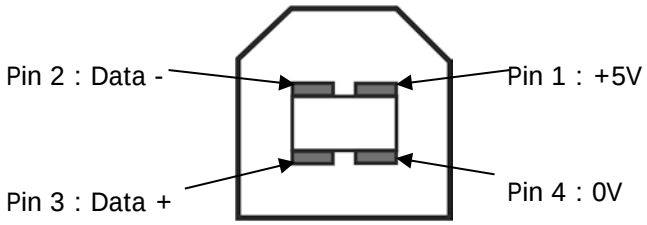

Figure 5 - USB Connector Pin-out (viewed from rear of pump)

4.9.3 RS485 Connector

The RS485 interface also provides serial communications with a PC but can be used over much greater distances than USB, with the only limitation being that data transfer becomes slower with a longer cable. The interface is configured for full-duplex data transmission. To calculate the transfer rate, divide 10^8 by the cable distance in metres, with the result being in bit/s e.g. a 50m cable would transfer data at 2Mbit/s.

The pin-out for this connector is shown in Figure 6

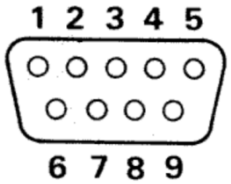

Figure 6 - RS485 Connector Pin-out (viewed from rear of pump)

Pin No.	1	4	5	8	9
Function	GND	RXD+	RXD-	TXD+	TXD-

4.10 Solvent Change Control

This push button only operates when the pump is not running and is in 'Standby' mode. To operate, the SOLVENT CHANGE button must be pressed. The red LED within the button will illuminate to indicate that it is active.

To start the solvent change program, the RUN button must be pressed after the SOLVENT CHANGE button is activated. The pump will then run at maximum speed (500ml/hour) for the duration of this process. During solvent change, the left (upper) cylinder will empty its solvent while the other cylinder is being filled with the new solvent. As the first cylinder is emptied, and the piston head is at the transfer port end, the piston will move backwards and forwards 10 times to ensure that as much of the old solvent as possible is flushed from the cylinder, while drawing in small amounts of the new solvent to help flush out the old. Following this, the emptied cylinder will draw in the new solvent and the full cylinder will flush out the mixture of old solvent and new solvent that it now contains, repeating the backwards and forwards movement. Once finished, the pump will stop and the SOLVENT CHANGE and RUN LED's within the push buttons will turn off.

SOLVENT CHANGE can also be used to drain the pump by simply leaving the inlet tubing out of the reservoir.

4.11 Pulse Compensation

When running the DCP50 pump, a slight drop in the operating pressure will occur when the pistons change direction. This is more noticeable at low flow rates and higher pressures.

To overcome this, a pulse compensation system is built into the DCP50 which operates while the PULSE COMPENSATION feature is active, as indicated by the illumination of the red LED in the PULSE COMPENSATION push-button. The feature toggles on and off with successive presses of the button.

It is recommended that this feature is enabled for most applications when running the pump – it functions across the whole flowrate and pressure range.

This 'Pulse Compensation' system operates as follows.

4.11.1 **Pulse Compensation OFF**

When a piston reaches its end position, the drive motor stops briefly while the switchover valve operates to redirect the solvent flow, resulting in a cessation of flow as the valve starts to switch. The newly-charged cylinder is then connected to the outlet via the switchover valve, the drive motor starts again, but the fluid in the full cylinder now needs to be compressed to operating pressure. At low flowrates and high pressures this can take a noticeable time, and results in a negative pressure pulse in the pump output flow.

4.11.2 **Pulse Compensation ON**

When a piston reaches its end position, the drive motor stops instantaneously but starts again running at high speed in the opposite direction as soon as the changeover valve has begun to move. This compresses the fluid in the full cylinder against the still-closed changeover valve. Once the calculated degree of compression has been applied to generate the operating pressure, the motor drops back to normal operating speed. This therefore results in the operating pressure returning to its original level much more quickly and with little disturbance to flow delivery.

For best results with PULSE COMPENSATION selected, the BULK MODULUS of the fluid being pumped should be entered, in accordance with the Bulk Modulus Setting instruction at 6.4 below.

4.12 Run Control

The RUN button is used to start and stop the DCP50 from running. The red LED within the button indicates when this function is active i.e. when illuminated, the DCP50 is in 'Run' mode, and when off it is in 'Standby' mode.

When the DCP50 is running, pressing RUN twice will reverse the direction of piston movement.

Note
If operating with SOLVENT CHANGE enabled, the pistons will not change direction as described above

4.13 Pressure Safety Limit Control

The DCP50 pump is equipped with a protective pressure safety limit control which automatically shuts down the pump if the back pressure should exceed the limit set on the overpressure circuit.

The pressure limit can be set either in the 'Run' or 'Standby' modes from 0.1 bar to 50.5 bar in 0.1 bar steps and is set as follows.

- The pressure limit currently set is shown on the LCD. To adjust it, press and hold the PRESSURE SAFETY LIMIT control for a few seconds until 'Pres. Limit unlocked' is shown at the bottom of the display, release the control and then rotate it to set the desired limit. Press and hold the control until 'Pres. Limit unlocked' is no longer displayed.
  N.B. This control automatically locks 10 seconds after last use.
- If the pump shuts down due to the pressure limit having been exceeded (indicated by the red 'Pressure Safety Limit' LED illuminating), check if the tubing or the equipment the pump is connected to have become blocked. After the condition has been corrected, restore pump operation by pressing the RUN button. This gives an opportunity to check the actual pressure limit and to change it if necessary before the pump operation is restored.

Once set as required, the safety limit remains at the set value until changed by the user.

4.14 Flow Rate/Pressure Control

The DCP50 has three modes of operation.

- Constant Flow delivering at rates of 1ml/hr to 500ml/hr in 1ml/hr steps
- Constant Flow (Slow) delivering at rates of 0.01ml/hr to 5.00ml/hr in 0.01ml/hr steps
- Constant Pressure delivering at pressures of 0.1 to 50.0 bar in 0.1 bar steps

The desired rate can be set either in the 'Run' or 'Standby' modes, and is set as follows.

- The current flow rate or set pressure (depending on operating mode) is shown on the LCD. To adjust it, press and hold the FLOW RATE/PRESSURE control for a few seconds until 'Flow Rate unlocked' or 'Pres. Set unlocked' is shown at the bottom of the display, release the control and then rotate it to set the desired flow rate or pressure. Press and hold the control again until 'Flow Rate unlocked' or 'Pres. Set unlocked' is no longer displayed.
  N.B. This control automatically locks 10 seconds after last use.

When the DCP50 is in either of the Constant Flow modes, the displayed back pressure may vary depending on the loading of the pump.

When the DCP50 is in Constant Pressure mode, the flow rate may vary to maintain the set pressure with any changes in the loading of the pump.

Once the Flow Rate is set as required, it will remain at the set value until changed by the user.

The Constant Pressure setting will remain as set by the user during the current session, but will revert to the default of 50bar every time the pump is switched off and on again.

4.15 DCP50 Menu System

The Operating Mode and other settings are accessed by menus displayed on the LCD screen. To select these menus, press and hold the PRESSURE SAFETY LIMIT and FLOW RATE/PRESSURE controls together and release when the menu is displayed. The serial number of the pump is shown at the bottom left hand corner of the display. The current version of the pump firmware will be shown at the bottom right hand corner of the display. This can be updated as new releases are made available by Strata Technology Ltd.

This initial menu comprises the following sub-menus, briefly described below. Each menu item is selected by use of the PRESSURE SAFETY LIMIT control, and where applicable, parameters are adjusted using the FLOW RATE/PRESSURE control. Detailed instructions for the use of these menus are provided in Chapter 6.

- Pump Mode – Use this menu to select the operating mode required
    - Constant Flow
    - Constant Pressure
    - Constant Flow (Slow)
    - Back to Menu
- Maintenance – Use this menu to position the piston carrier arms following pump maintenance e.g. piston seal replacement
    - Move to left end
    - Move to right end
    - Back to menu
- Settings – Use this menu to change system parameters e.g. calibration values.
    - Calibration
        - Zero Offset
        - Sensor Gain
        - Back (& save)
    - Bulk Modulus
        - Bulk modulus
        - Back (& save)
    - PID Tuning
        - Kp
        - Ki
        - Kd
        - Back (& save)
    - Miscellaneous
        - Data stream
        - Back (& save)
    - Back to Menu
- Exit

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Chapter 5 Installation

WARNING! Only use the mains cable and DC power supply delivered with the DCP50. Always connect the DCP50 power supply to a properly grounded mains outlet.

WARNING! In the event that an emergency arises when using the DCP50, the mains plug must always be accessible in order to disconnect it.

5.1 Operating Environment

The DCP50 is set up and calibrated in a controlled temperature environment of 21-23°C. Due to the thermal properties of the piston seals, adjustment may be required depending on the environment the pump will be used in. Please refer to section 6.8.

5.2 Tubing

WARNING! Strata Technology Limited will in no event be liable for incidental or consequential damage or harm arising from the use of tubing in the DCP50 that is not supplied by Strata Technology Limited, as it may not provide the required protection. Functionality of the pump may be impaired, and the warranty will be invalidated.

5.2.1 Internal Tubing

The tubing used internally in the DCP50 is 1/16” diameter with a 69 bar pressure rating and manufactured from FEP. Over a period of time this tubing may wear out or become brittle, depending on the solvents being used, and must be replaced with the same size, type, and pressure rating of tubing. Replacement tubing and fittings are available from Strata Technology Limited. See Chapter 9 for part numbers.

5.2.2 Inlet and Outlet Tubing

The tubing for the inlet and outlet connectors is supplied un-attached to the DCP50 so that the user can configure the tubing as required. The inlet tubing is the same 1/16” FEP tubing used internally by the pump. The outlet tubing is 1/8” diameter ETFE and also has a pressure rating of 69 bar. This tubing may also wear out or become brittle in time and must be replaced with the same size, type and pressure rating of tubing.

5.2.3 Attaching the inlet tubing

Ensure that the end of the 1/16” inlet tubing is cut square. Feed it through the metal nut and then through the metal ferrule as shown at the left of Figure 7 and connect to port 3 on the switchover valve (see Figure 3). Loosely screw the nut in position, and push the tubing as far into the port as possible. Tighten the nut fully using the ¼” wrench supplied with the pump, by fitting the slot in the wrench over the tubing to fit on the nut as shown at the right of Figure 7.

Figure 7 - Inlet tubing nut with ferrule (left) and wrench attached (right)

5.2.4 Attaching the outlet tubing

Ensure that the end of the 1/8” outlet tubing is cut square, and then feed it through the plastic nut so that the thread is towards the end of the tube. Fit the metal ferrule ring over the end of the tube. One end of the ring is slightly chamfered to make it easier to fit over the plastic ferrule so should be fitted with the chamfer towards the end of the tube. Fit the yellow plastic ferrule flush with the end of the tube as shown in Figure 8. Insert the tube into the outlet port of the Pressure Transducer housing, push it in as far as it will go and then secure in place with the plastic nut, making it finger-tight only, but tightening it as much as possible i.e. do not use a tool to tighten. This will cause the metal ring to slide over the plastic ferrule to clamp the ferrule to the tube.

Figure 8 - Outlet tubing nut and ferrule

Submerge the inlet tubing in a suitable reservoir filled with at least 100ml of de-gassed distilled water. Place the outlet tubing into a suitable container to collect the water as it is pumped out.

5.3 Start-up Procedure

The DCP50 is tested and calibrated prior to delivery. To ensure that it is functioning correctly at switch-on, the following checks should be performed.

5.3.1 Check that the power switch at the front of the pump is in the off position i.e. the ○ marker at the top of the switch is in the depressed position. Connect the DC connector from the power supply to the socket on the rear of the DCP50. The plug should be aligned so that the flat of the collar is uppermost. Push the plug fully into the connector until a 'click' is heard, indicating that it is locked in position. Check by pulling gently on the plug.

5.3.2 Connect the supplied mains lead between the desktop power supply and the mains supply, and switch on the mains supply. Check that the blue LED within the DC power supply is illuminated.

5.3.3 Operate the power rocker switch to turn on the DCP50 by pressing the lower part of the switch marked I, and check that the LCD initially shows 'DCP50' and then shows 'Flow Rate', 'Back Pressure' and 'Safety Limit' along with the current settings programmed into the pump.

5.3.4 Press and hold the 'PRESSURE SAFETY LIMIT' control for a few seconds until the bottom of the display shows 'Pres. Limit unlocked'. Rotate the 'PRESSURE SAFETY LIMIT' control to set the pressure limit to 5 bar. Press and hold the control again until 'Pres. Limit unlocked' is no longer displayed.

5.3.5 Press and hold the 'FLOW RATE/PRESSURE' control for a few seconds until the bottom of the display shows 'Flow Rate unlocked'. Rotate the 'FLOW RATE/PRESSURE' control to set the flow rate to 500ml/hr. Press and hold the control again until 'Flow Rate unlocked' is no longer displayed.

5.3.6 Start the pump running by pressing the RUN button. Check that the pump can be heard running and that the red LED within the RUN button is illuminated. Check that water from the reservoir is being drawn into one of the glass tubes, along with any air initially in the inlet tubing forming a bubble in the glass tube.

Check that when the piston drawing in the water reaches the end of its travel, there is a brief sound from the DCP50 (caused by the Switchover Valve operating) and then the piston reverses direction. When this happens, the other piston will start drawing in water while the filled piston is pumping water out. Eventually, water should be seen dripping regularly from the outlet tube once all of the air is expelled from the pump. Press the RUN button to stop the pump.

5.4 Priming the Rinsing System

If the rinsing system fitted to the DCP50 is going to be used during operation, it must first be primed with the rinsing solution (e.g. 20% ethanol). To access the rinsing tubing, remove the plastic guard at the front of the pump by unscrewing and removing the four button head screws securing it in place using the 2.5mm hex key from the tool kit.

5.4.1 Select the 'maintenance menu' as described in section 4.15, select 'Move to left side' and press the PRESSURE SAFETY LIMIT control to make the pistons move to the left side of the pump.

5.4.2 Free the rinsing tubing located between the left hand glass tube and the piston guard below it, and then CAREFULLY pull the rinsing tube from the upper rinsing washer by twisting slightly while pulling in a straight line away from the spigot.

5.4.3 Fit the free end of the tube into the container of rinsing solution, and then use the PRESSURE SAFETY LIMIT control to move the pistons to the right side of the pump.

5.4.4 As the pistons move, the rinsing solution will be drawn into the lower right hand glass tube between the piston head and the rinsing washer, along with the air that was already in the tube. To expel this air, carefully raise the left hand end of the pump so that the air in the right hand tube rises towards the rinsing washer forming a bubble in the top of the glass tube. Using the PRESSURE SAFETY LIMIT control, move the pistons to the left i.e. moving upwards while the pump is raised. The air bubble at the top of the right hand tube will now be pumped out of the glass tube via the rinsing tube into the container of solution. Once air bubbles can no longer be seen escaping into the container of solution, press RUN to stop the pump.

5.4.5 Keeping the rinsing tube in the solution, use the PRESSURE SAFETY LIMIT control to move the pistons to the right so that the solution is once again drawn into the glass tube, filling it.

5.4.6 When the pistons stop moving, remove the tube from the rinsing solution and then twist the tube so that it forms a loop and re-attach the free end of the tube to spigot on the upper rinsing washer. Locate the loop of tubing between the left hand glass tube and the piston guard below it as seen in Figure 9. Stand the pump back on its feet. As the pistons now move in each direction, the rinsing solution will be passed between the two cylinders to clean the bore surfaces.

Note
The small amount of air that was in the left hand rinsing washer will remain trapped in the left hand tube, and may initially be seen travelling along the tube with the piston head. If this happens, slightly raise the right side of the pump to cause the air bubble to rise towards the rinsing washer, which should then attach itself to the washer due to surface tension. This will ensure that all of the internal surface of the glass tube that comes into contact with the solvent will also come into contact with the rinsing solution.

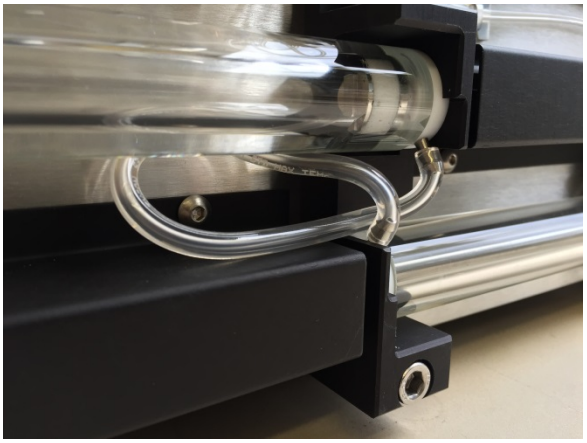

Figure 9 - Rinsing tubing in position

5.4.7 Exit the menu system using the PRESSURE SAFETY LIMIT control. Refit the plastic guard to the front of the pump using the screws removed previously, taking care not to trap the 1/16" tubing. Fit the front screws first but leave them loose, then fit the top screws and tighten them and finally tighten the front screws.

5.4.8 The rinsing solution should be changed daily, using the reverse process to priming the system. Prime the rinsing system with fresh solution as before.

5.5 Draining the pump

5.5.1 Disconnect the inlet tube from the reservoir. Connect the outlet tube to a container suitable for collecting the water remaining in the pistons. Press the SOLVENT CHANGE button and check that the red LED within the button illuminates. Press the RUN button. The pump will now run at maximum speed to pump the water from the cylinders. During this operation, the left (upper) piston will move towards its transfer port and then move backwards and forwards 10 times to empty the cylinder as much as possible. Following this, the other piston will move towards its transfer port and repeat the operation. When completed the pump will stop and the push-button LED's will turn off.

5.5.2 Switch off the pump. The pump is now ready for use. Before using or changing solvents, refer to section 6.6.

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Chapter 6 Operation

This section provides a guide for routine 'stand-alone' operation of the DCP50 and assumes that the pump has been installed in accordance with the instructions given in Chapter 5.

For information about remotely configuring the DCP50 from a PC e.g. flow rate or pressure, and for data gathering, refer to the Strata Technology Limited website at www.stratatec.co.uk.

WARNING! When using hazardous chemicals, it is essential that all protective measures are taken e.g. wear protective glasses and gloves that are resistant to the chemicals being used. It is important to follow local regulations and instructions for safe operation and maintenance of the system.

If the DCP50 has previously been used with a different solvent to that being used this time, and there are traces of the previous solvent still in the pump, drain the pump as much as possible by using the instructions given in section 5.5, ensuring that a suitable container is used to collect the old solvent.

CAUTION! Check that all solvent considerations are met, especially solvent miscibility if a change of solvent in the pump is required (see Section 6.6).

6.1 Operating Mode

The operating mode and settings of the DCP50 is stored in memory and therefore when switched on, they will be the same as the last time it was used. The current operating mode can be ascertained as follows.

With the mains lead connected to the power supply, and the power supply attached to the pump, turn on the power switch of the pump. The right side of the top 'gauge' on the display will show one of the following.

- Flow Rate – If the set rate is shown in whole figures, the pump is in 'Constant Flow' mode. If it is shown to two decimal places, the pump is in 'Constant Flow (Slow)' mode.
- Set Pressure – If this is displayed, the pump is in 'Constant Pressure' mode.

The Operating Mode is selected via a menu system accessed from the front panel. To change it, proceed as follows.

6.1.1 Press and hold the PRESSURE SAFETY LIMIT and FLOW RATE/PRESSURE controls until a menu is displayed.

6.1.2 Rotating the PRESSURE SAFETY LIMIT control will cause a selection marker (>) to appear on the menu. Rotate it to select 'Pump Mode', and then press the control to display the 'Pump Mode' menu.

6.1.3 Once again, use the PRESSURE SAFETY LIMIT control to select the desired operating mode and press the control. The mode is now set and the previous menu will be displayed.

6.1.4 Rotate PRESSURE SAFETY LIMIT to select 'Exit' and press the control to return to the main operating display.

6.2 Routine Operation

6.2.1 Fill the solvent reservoir with sufficient solvent for the task being undertaken.

6.2.2 Press and hold the FLOW RATE/PRESSURE control for a few seconds until either 'Flow Rate unlocked' or 'Pres. Set unlocked' appears at the bottom of the display (depending on the selected mode). Rotate the control to adjust it to the desired flow rate or pressure setting as displayed on the LCD. Press and hold the control once more until 'Flow Rate/Pres. Set unlocked' is no longer displayed and then release the control.
N.B. If the control is not locked manually, it will automatically lock 10 seconds after last use.

6.2.3 Set the pressure limit by pressing and holding the PRESSURE SAFETY LIMIT control for a few seconds until 'Pres. Limit unlocked' appears at the bottom of the display and rotate the control to adjust it to the required limit as displayed on the LCD. Press and hold the control once more until 'Pres. Limit unlocked' is no longer displayed.

6.2.4 Connect the outlet tubing from the pump to the inlet of the equipment that the pump is to be used with using suitable fittings e.g. injection valve, ensuring that the end of the tube is secured correctly.

6.2.5 Start solvent delivery by pressing RUN. If running with an operating pressure greater than 5.0 bar, and especially at slow flow rates, it is recommended that the pulse compensation circuit is activated by pressing the PULSE COMP button. The red LED within the push-button should now be illuminated.

Note
During manufacture, the piston seals are 'bedded-in' using de-ionised water. When solvents are used with the DCP50, the seals may require re-adjusting as described in section 7.1 due to the reaction between the solvent and the seal material. It may also be necessary to 'bed-in' the seals again using a closed-loop system. This can be achieved by feeding the output from the pump back into the inlet reservoir and leaving the pump running for several hours before re-adjusting the seals.

6.2.6 When the test being performed is completed, reduce any back pressure being applied to the pump to zero (as indicated on the display) using an appropriate method for the configuration being used. When complete, drain the pump if required before switching off.

CAUTION! Do not switch the pump off and on in quick succession while the pump is pressurised, as this could cause damage to the pump.

CAUTION! Never disconnect the outlet tubing from the pump while it is pressurised.

6.3 Pressure Calibration

The DCP50 is calibrated during manufacture. Calibration values are held by Strata Technology Ltd and are available upon request. They also appear on the Calibration Report delivered with the pump.

CAUTION! Entering the wrong calibration values could result in the DCP50 displaying the incorrect pressure. This could result in the pressure in the pump actually being higher than that displayed.

Should it become necessary to reload or change the calibration values, proceed as follows.

6.3.1 Press both of the rotary control switches on the front panel together to display the main menu. Release the controls.

6.3.2 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Settings' and then press the control to display the 'Settings' menu.

6.3.3 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Calibration' and then press the control to display the 'Calibration' menu.

6.3.4 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Zero Offset' and then rotate the FLOW RATE/PRESSURE control to set the required value.

6.3.5 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Sensor Gain' and then rotate the FLOW RATE/PRESSURE control to set the required value.

6.3.6 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Back (& save)' and then press the control to return to the 'Settings' menu.

6.3.7 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Back to Menu' and then press the control to display the main menu.

6.3.8 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Exit' and then press the control to exit this menu and return to the operating display.

Note
When in normal use, if the displayed Back Pressure reading is not 0 when there is no back pressure i.e. the outlet tube is disconnected, it may be necessary to adjust the 'Zero Offset' from its set value. In this case, repeat section 6.3 and adjust the Zero Offset until 0.0 or a slightly positive reading is displayed i.e. the Back Pressure reading must never have a negative value.

6.4 Bulk Modulus Setting – Pulse Compensation

Due to the different compressibility characteristics of the solvents and fluids that may be used in the DCP50, it is possible to set the 'Bulk Modulus' value to optimise pump operation for the particular fluid being used. When the ***Pulse Compensation*** mode is selected (see 4.11 above), the value of Bulk Modulus entered varies the amount of piston travel employed during cylinder changeover to pre-compress the contents of the new cylinder, so that when the switching is complete the pressure in the new cylinder is very close to the true operating pressure, and the changeover pressure pulse is minimised.

The 'Bulk Modulus' value can be set between 0.50 and 2.50 in 0.01 steps; the value required for a particular fluid may be found in references of fluid properties (in units of Giga Pascals - GPa). The default value pre-set in the pump is 2.0 (typical of water).

If it is necessary to change the 'Bulk Modulus' value for the solvent being used with the pump, proceed as follows:

6.4.1 Press both of the rotary control switches on the front panel together to display the main menu. Release the controls.

6.4.2 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Settings' and then press the control to display the 'Settings' menu.

6.4.3 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Bulk Modulus' and then press the control to display the 'Bulk Modulus' menu.

6.4.4 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Bulk modulus' and then rotate the FLOW RATE/PRESSURE control to set the required value.

6.4.5 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Back (& save)' and then press the control to return to the 'Settings' menu.

6.4.6 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Back to Menu' and then press the control to display the main menu.

6.4.7 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Exit' and then press the control to exit this menu and return to the operating display.

6.5 PID Tuning

The PID (Proportional-Integral-Derivative) Controller provides a control loop feedback system. It is used when the pump is running in Constant Pressure mode to adjust for variations in the 'load' to keep the pressure constant. Due to the way the software and hardware are configured, response time to pressure variations is virtually instantaneous.

The default settings of these parameters should normally be adequate for most applications, and should not be changed unless the user is familiar with the use of PID controllers.

In situations where the permeability of the load is such that a change of parameter is required, details of each parameter are given below.

- **Kp** is the **p**roportional parameter of the PID Controller and affects its sensitivity. The default setting is 5000 which gives a response of a change in flow rate of 50ml/hr for an error of 1 bar. i.e. this parameter acts upon the current error with a linearly proportional response. If a faster response is required, the value of this parameter may be increased. However, increasing it too much could cause the pump to run too fast, giving more pressure than required. This could then result in the pressure oscillating between values as the controller attempts to return the pressure to the required value and as it drops, Kp attempts to increase it.
- **Ki** is the **i**ntegral parameter of the PID Controller and has a default value of 2000. The controller monitors errors over a period of time and provides a cumulative value which is then multiplied by the value of Ki and added to the controller output to provide a more stable control.
- **Kd** is the **d**erivative parameter of the PID Controller and acts on any large value short term errors. Due to the speed that the pump operates at, the required conditions should be met by just adjusting Kp and Ki and therefore, it is recommended that this parameter is left at 0.

If it does become necessary to change the 'PID Controller' parameter values, proceed as follows. Note that as with all feedback loops, it may be necessary to make several adjustments of these parameters to get the desired results.

6.5.1 Press both of the rotary control switches on the front panel together to display the main menu. Release the controls.

6.5.2 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Settings' and then press the control to display the 'Settings' menu.

6.5.3 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'PID Tuning' and then press the control to display the 'PID Tuning' menu.

6.5.4 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Kp' and then rotate the FLOW RATE/PRESSURE control to set the required value.

6.5.5 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Ki' and then rotate the FLOW RATE/PRESSURE control to set the required value.

6.5.6 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Back (& save)' and then press the control to return to the 'Settings' menu.

6.5.7 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Back to Menu' and then press the control to display the main menu.

6.5.8 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Exit' and then press the control to exit this menu and return to the operating display.

6.6 Solvents

WARNING! To prevent the ignition of flammable solvent vapours that may occur as a result of spillage or damaged tubing (resulting in a flammable mist spray), ensure that the equipment is kept away from naked flames or any other sources of heat.

6.6.1 Degassing and Filtering

It is important to use filtered, degassed solvents and buffers in the DCP50 for maintenance-free operation. Particles in the solvent can block the channels in the switchover valve, shortening its operating life.

Degassing prevents the formation of air bubbles. Degassing and filtering of solvents, except for solvents with low boiling points, can be performed in a one-step procedure by filtering the solvent through a vacuum filter (0.45 micron filter is recommended). Solvents with low boiling points, e.g. methylene chloride, can be degassed in a sonic bath. The boiling point of the solvent should be checked prior to degassing.

6.6.2 Mixing Solvents

Prior to changing from one solvent to another, the miscibility of the solvents must be determined. Change of solvents which are immiscible will require an intermediate solvent, e.g. change from water to methanol can be made directly, while change from water to hexane requires an intermediate step such as 2-propanol.

6.6.3 Solvent Changeover

The DCP50 is equipped with an automatic wash program that facilitates solvent changeover.

To change solvent in the pump proceed as follows:

6.6.3.1 Put the pump in standby mode (red LED in the RUN button is off).

6.6.3.2 Submerge the inlet tubing in the new solvent reservoir (minimum 40 ml).

6.6.3.3 Disconnect the outlet tubing from whatever equipment it is attached to, and place the end of the tubing into a suitable container.

6.6.3.4 Start the wash program by pressing SOLVENT CHANGE followed by RUN. The previous solvent is now automatically rinsed out and replaced with the new solvent. The duration of the program is approximately 5 minutes.

6.6.3.5 If there are any air bubbles trapped in the glass tubes after completion of the wash program, a quick way to remove them is to press RUN to stop the pump, deselect SOLVENT CHANGEOVER, then press the RUN button again and leave running until a piston reaches its transfer port. As the piston changes direction, press RUN twice to change direction again. Press RUN twice to change direction several times until the air bubbles have been removed, then repeat for the other cylinder if required.

6.6.4 Solvent Resistance

The DCP50 pump can be used with all types of buffers, detergents and organic solvents. In addition, most inorganic and organic acids and bases e.g. diluted mineral acids, metal salt solutions, carboxy acids, anhydrides, aromatic and aliphatic hydrocarbons, alcohols, aldehydes, ketones, ethers, esters and chlorinated hydrocarbons can be used.

The following solvents should not be used in the pump: concentrated nitric acid, oxidising acids, organic bases, high concentrations of sulphonic acid, ethyl ether and fluoride solutions.

WARNING! If using solvents other than those listed above, ensure that they are chemically compatible with the list of 'wetted parts' given in Chapter 2.

Note
Do not leave acids, e.g. sulphuric acid, in the pump after use. Once the run is completed, the acid should be washed out. If using solvents such as brine in the pump, always wash out with water after use to prevent the built up of crystal deposits in the fluid system. Crystal deposits left in the cylinders can result in scratching of the glass tube which could cause it to crack when under pressure. Blockages can occur in the small diameter fluid pathways of the DCP50 pump if saturated solutions, such as high salinity brines, are used, due to precipitation of dissolved solids caused by temperature or pressure variations.

Once the pump has been primed and the pressure limit and flow rate have been set to their desired values and the bulk modulus value has been set, press RUN to start the pump running.

6.7 Pump Head Cleaning

It is recommended that regular cleaning of the glass tubes and tubing with a rinsing solution is performed. This prolongs the life of both the piston seals and the glass tubes, and also frees the pump from bacterial contamination.

To do this, it is recommended that a 20% ethanol solution is pumped through the system using the method described in section 6.6.3.

Pumps primed with rinsing solution to make use of the fitted rinsing system have the glass tubes cleaned while running. It is recommended that the rinsing solution is changed daily.

6.8 Operating at Low Temperatures

If the pump is to be used at low temperatures, consideration must be given to the fact that the piston seal material can slightly change in volume in the temperature range 10-20°C. If the operating temperature is going to be lowered from above 20°C, proceed as follows.

6.8.1 Place the pump in the colder room and wait approximately 30 minutes for the pump temperature to fall to the same as the room temperature.

6.8.2 Adjust both piston seals by tightening the piston rod in accordance with the instructions given in section 7.1.

6.8.3 Run the pump as required.

6.8.4 If the pump is going to be used at 'normal' room temperature again, the piston seals must be released again by performing the operation in reverse i.e. release the tension on the piston rod/piston seal assembly by partially unscrewing the piston rod.

6.8.5 After the pump has stood at room temperature for 30 minutes, re-tighten the piston seals in accordance with the instructions given in section 7.1.

6.9 Operating at Elevated Temperatures

The tension of the piston seals used in the DCP50 is factory set in a temperature controlled environment of 21-23C. If the pump is to be used at temperatures above this i.e. in warm countries with rooms without air conditioning, consideration must be given to the fact that the piston seal material can slightly increase in volume, which could cause the glass tube to crack. If the operating temperature is going to be above 25C, proceed as follows.

6.9.1 Before placing the pump in the room it will be used in, refer to Chapter 7 for instructions on how to remove the front guard and the piston guards. Loosen the clamp around the piston rod and slightly reduce the tension of the piston seals by turning the end of the piston rod in an anticlockwise direction when viewing from the adjusting end. Place the pump in the room where it will be used and wait approximately 30 minutes for the pump temperature to rise to the same as the room temperature.

6.9.2 Adjust both piston seals by tightening the piston rod in accordance with the instructions given in section 7.1.

6.9.3 Run the pump as required.

6.9.4 If the pump is then going to be used in a room at a lower room temperature again, follow the instructions in section 6.8.

6.10 Fine Adjustment of Flow Rates

The flow rates of DCP50 pumps supplied by Strata Technology are all within the specified tolerance of the selected flow rates, but some end users may require a tighter tolerance.

With the introduction of v1.6.0 firmware in the pump, three new parameters have been added, which are adjustable using the separate Control & Acquisition application available on the Strata web site and which is on the USB stick supplied with new pumps, along with instructions for adjusting the parameters.

These parameters allow for the following adjustments

- Flow Rate Compensation Gradient adjustment, where the flow rate can be increased as a percentage of the nominal flow rate.
- Flow Rate Compensation Offset adjustment, where the flow rate can be increased in fixed steps
- Baseline Offset which adjusts the value of the counters used internally by the firmware to calculate the rate at which the stepper motor rotates.

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Chapter 7 Maintenance and Servicing

Only the pistons and their associated parts, and the 'internal' tubing can be serviced by the end user, as described in this chapter. None of the internal parts are user serviceable and the pump must be returned to Strata Technology Ltd for any internal maintenance. If anybody other than an employee of Strata Technology Ltd or their representative opens the DCP50, it will invalidate the warranty placed upon it.

A list of spare parts and accessories available from Strata Technology Ltd is shown in Chapter 9.

It is recommended that the DCP50 pump is wiped with a damp cloth at regular intervals. See also section 6.7 for pump head cleaning.

WARNING! Remove liquid or dirt from the surfaces of the DCP50 using a cloth, and if necessary, a mild cleaning agent.

WARNING! When using hazardous chemicals, it is essential that all protective measures are taken e.g. wear protective glasses and gloves that are resistant to the chemicals being used. It is important to follow local regulations and instructions for safe operation and maintenance of the system.

WARNING! When using hazardous chemicals, make sure that the entire system has been flushed thoroughly with bacteriostatic solutions e.g. NaOH, and distilled water before service and maintenance.

7.1 Piston Seal Adjustment

Adjustment of the piston seals may be required occasionally due to solvent leakage past the piston seal into the tube behind the seal (and therefore the rinsing solution if being used). This can be due to wear in the piston seals over a period of time, porosity of the seals reacting with the solvent being used, or due to a change in operating temperature (see section 6.8).

To adjust the piston seals, proceed as follows.

7.1.1 Check that PULSE COMP is not activated and that there is no back pressure being applied to the pump, otherwise it makes it difficult to position the pistons for adjustment. Also ensure that the pump is in 'Standby' mode i.e. the red LED in the RUN button is not illuminated.

7.1.2 Remove the protective plastic cover by removing the four screws securing it in position using the 2.5mm hex key supplied with the tool kit. These screws are fully detachable so retain them in a safe place for when re-assembling.

7.1.3 Remove the metal guards over the piston rods by removing the screws securing them in place using the 2.5mm hex key. Once again retain these screws as they are fully removable. This now exposes the carrier arms that protrude through the front panel, and the piston rods that are attached to them.

7.1.4 Press both of the rotary control switches on the front panel together to display the main menu. Release the controls.

7.1.5 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Maintenance' and then press the control to display the 'Maintenance' menu.

7.1.6 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against one of the displayed options, depending on which piston seal needs adjusting e.g. if the left hand piston seal needs adjusting, select 'Move to left end'. Press the PRESSURE SAFETY LIMIT control. The pistons will now move to the left side of the pump, and stop when the piston seal retainer engages with its transfer port.

CAUTION! Keep fingers away from the pump while the carrier arms are moving! Although the carrier arms move slowly even at maximum speed, there is a crush risk if fingers become trapped between a carrier arm and the adjacent support. In emergency, press the RUN button to stop the pump and press it again to move the carrier arm in the opposite direction. Operating the POWER SWITCH will also stop the carrier arms moving as power will be removed from the pump.

7.1.7 Using the 4mm hex key supplied with the tool kit, loosen the carrier arm clamp on the piston rod to free the rod as shown in Figure 10.

7.1.8 Ensuring that the piston head is still engaged with the transfer port, fit the long arm of the 1.5mm hex key through the holes in the end of the piston rod. Position the hex key so that only the end is just through the holes, and then, applying pressure to the other end of the hex key, tighten the piston rod to the point where the key is bending and the rod is no longer rotating. Remove the key, and then re-tighten the carrier arm on the piston rod using the 4mm hex key.

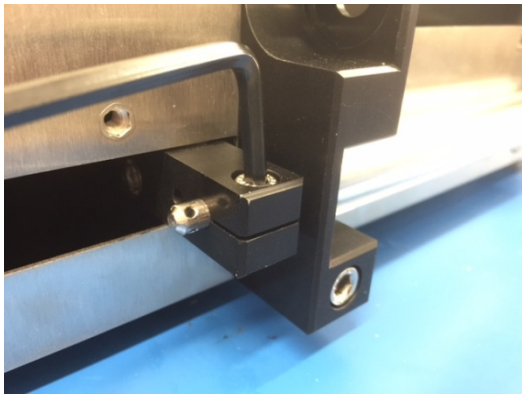

Figure 10 - Loosen the securing screw (right hand piston shown)

CAUTION! Applying pressure to anywhere other than the end of the hex key can result in too much pressure being applied. If the piston rod is over-tightened it can cause the piston seal to expand too much. This can result in the glass tube cracking, requiring replacement of the tube which is not a warranted item.

7.1.9 Repeat 7.1.6 to 7.1.8 for the other piston seal if required.

7.1.10 When finished, return to normal operating mode using the PRESSURE SAFETY LIMIT control to go back through the menus.

7.1.11 Run the pump and check for any leakage past the piston seals. If the seals are still leaking, change them following the instructions given in section 7.2.

7.1.12 Refit the metal guards in place, securing with the screws removed previously. When refitting the right hand guard, ensure that the two tubes from the transfer port do not become trapped by the guard, and then fit the tubes back in the clamp.

7.1.13 Refit the plastic cover, ensuring that the tubing is not trapped between the cover and the face plate, or between the cover and the centre support, and secure with the four screws removed previously. Fit the two front screws first leaving them loose, then fit and tighten the top screws before finally tightening the front screws.

7.2 Piston Seal Replacement

The following section provides instructions on how to replace worn piston seals. Before replacing the piston seals, flush any solvent from the DCP50 using the instructions given in section 5.5, taking note of the warnings given at the beginning of this chapter.

Note
If the rinsing system is being used, drain the rinsing solution as instructed in section 5.4 and then CAREFULLY pull the rinsing tube from the spigots on both rinsing washers by pulling in a straight line away from the washer.

7.2.1 Place the DCP50 on a clean working surface, and then follow the instructions given in steps 7.1.2 and 7.1.3 to remove the guards.

7.2.2 Using the instructions given in section 7.1 position one of the pistons so that its piston seal retainer is fully engaged with its transfer port.

CAUTION! Keep fingers away from the pump while the carrier arms are moving! Although the carrier arms move slowly even at maximum speed, there is a crush risk if fingers become trapped between a carrier arm and the adjacent support. In emergency, press the RUN button to stop the pump and press it again to move the carrier arm in the opposite direction. Operating the POWER SWITCH will also stop the carrier arms moving.

7.2.3 Using the 4mm hex key supplied with the tool kit, loosen the screw securing the piston rod to the carrier arm as shown in Figure 10.

7.2.4 The piston assembly comprises four parts (see Figure 2). The piston seal is fitted between the piston seal retainer and the piston washer. As the piston rod is screwed onto the thread of the piston seal retainer, the seal is compressed between the retainer and the washer causing it to expand outwards to form a seal between the piston head and the wall of the glass tube. To release this seal, the piston rod must be un-screwed. Using the 1.5mm hex key, turn the end of the piston rod anti-clockwise to reduce the tension in the piston seal, as shown in Figure 11.

Note
Note the angle of the spigot on each rinsing washer before continuing. When re-assembled, the spigots must be at the same angle.

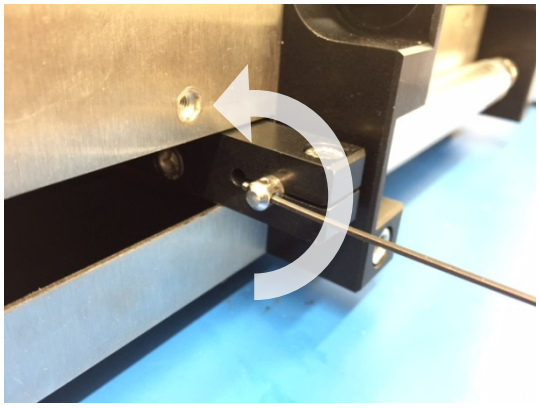

Figure 11 - Loosen end of piston rod (right hand piston shown)

7.2.5 Using the 5mm spanner supplied in the tool kit, loosen and unscrew the cylinder adjusting screw that pushes the transfer port against the glass tube as shown in Figure 12.

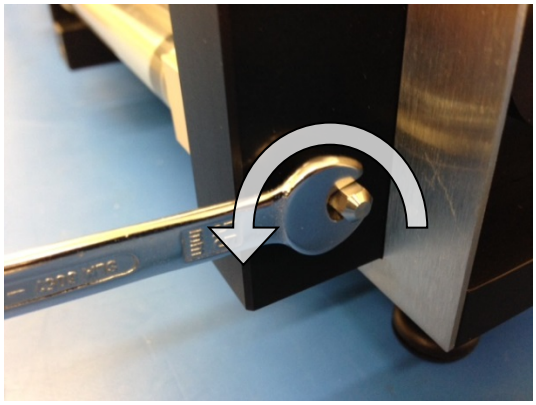

Figure 12 - Loosen the cylinder adjusting screw (right hand piston shown)

7.2.6 Unscrew the cylinder adjusting screw fully and move the transfer port out of the way as shown in Figure 13.

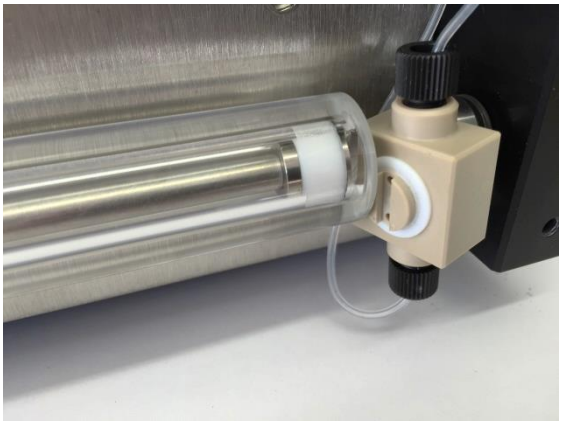

Figure 13 - Transfer port removal (right hand piston shown)

7.2.7 Check that the white sealing washer attached to the transfer port is not damaged, and replace if necessary by pulling it off of the port and fitting a new one in its place. A knife blade or similar may be required to ease the old one off, but take care not to damage the transfer port.

7.2.8 **Carefully** holding the glass tube, withdraw the tube and piston assembly away from the pump. If necessary, use the maintenance menu to move the carrier arm away from the end of the piston rod in order to give it clearance. Once clear, press RUN to stop the carrier arm from moving any farther.

7.2.9 Withdraw the piston assembly from the glass tube. If required, clean the inside of the glass tube. Place the glass tube on a clean surface taking care that it cannot roll off of the work surface.

Note
The rinsing washer, will remain attached to the piston rod due to the tight seal between them. Once the piston assembly is removed, carefully slide the rinsing washer off of the piston rod taking care not to damage it where it seals against the piston rod.

7.2.10 Repeat 7.2.2 to 7.2.9 to remove the second piston assembly and glass tube.

7.2.11 Unscrew the piston rod from the piston seal retainer. Slide the piston washer and the old piston seal off the piston seal retainer and discard it.
N.B. If the piston seal retainer is showing signs of corrosion due to the solvents used, replace this at the same time (see Chapter 9 for part numbers).

7.2.12 Fit the replacement seal to the piston seal retainer with the conical recess on the seal nearest to the ridged part of the piston seal retainer and the chamfered outer edge of the piston seal nearest to the piston washer (see Figure 14). Push the seal right up against the head of the piston seal retainer. Fit the piston washer behind the seal ensuring that it locates correctly on the piston seal retainer, and screw the piston rod back in place.

Figure 14 - Piston seal fitting

7.2.13 Fit the piston back inside the glass tube, feeding the piston rod through first so that the head fits in last.

7.2.14 Check the condition of the rinsing washer and replace if necessary. Fit the rinsing washer to the piston rod with the raised centre inside the glass tube. Fit the piston and tube assembly back into the centre support so that the rinsing washer locates in the recess in the centre support.

7.2.15 Position the transfer port back in place, ensuring that the tubing from the bottom of the transfer port is routed behind the cylinder adjusting screw. Hold the transfer port against the glass tube and piston assembly. Ensure that the transfer port, glass tube and rinsing washer are all aligned correctly, with the rear of the rinsing washer locating correctly in the centre support.

7.2.16 Rotate the glass tube/piston so that the spigot on the rinsing washer is at the same angle it was at before the assembly was dismantled.

7.2.17 Tighten the cylinder adjusting screw against the rear of the transfer port, ensuring that the thrust washer meets and aligns with the recess in the rear of the port all the time the screw is being adjusted. Make it finger-tight initially, ensuring that the transfer port, glass tube and rinsing washer are all located correctly, then using the 5mm spanner, tighten the cylinder adjusting screw by 1¼ turns to ensure a good seal between the transfer port seal, rinsing washer and the glass tube.

7.2.18 Push the piston assembly up to the transfer port, and rotate it so that the ridge on the piston seal retainer fits fully into the slot in the transfer port (see Figure 15). Use the maintenance menu to move the carrier arm over the end of the piston rod. Fit the long arm of the 1.5mm hex key into one of the holes in the end of the piston rod so that it just fits through the holes, and applying pressure to the other end of the hex key, rotate the rod to tighten the seal. Keep rotating it (changing holes in the piston rod if necessary) to tighten the seal to the point where the hex key is bending and the piston rod is no longer rotating. Remove the hex key.

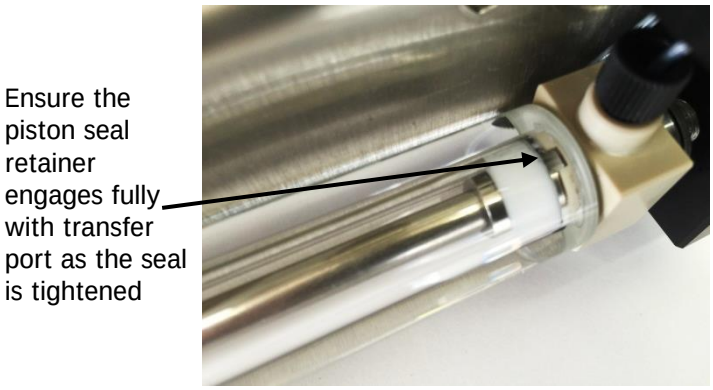

Figure 15 - Piston Seal Retainer alignment

7.2.19 Ensuring that the left hand piston seal retainer is still fully engaged with its transfer port, use the 4mm hex key to tighten the carrier arm on the piston rod.

7.2.20 Repeat 7.2.11 to 7.2.19 for the second piston.

7.2.21 Rotate the PRESSURE SAFETY LIMIT control to position the arrow (>) against 'Move to left end'. Press the PRESSURE SAFETY LIMIT control. The carrier arms will now move to the left side of the pump and the left side carrier arm should slide along its piston rod, and eventually stop.

7.2.22 Ensuring that the left hand piston seal retainer is still fully engaged with its transfer port, use the 4mm hex key to tighten the arm on to the piston rod.

7.2.23 Repeat 7.2.19 and 7.2.22 for the right hand piston.

7.2.24 Exit the menus using the PRESSURE SAFETY LIMIT control to return to the main operating display.

7.2.25 Fill the pump with solvent and run it to check for any leaks around the ends of the glass tubes, and also within the glass tubes indicated by solvent leaking past the piston seals. If a piston seal needs adjusting, follow the instructions given in section 7.1.

Note
It may be necessary to adjust new piston seals more than once as they become 'bedded in' through use.

7.2.26 Once checked, refit the metal piston guards ensuring that the 1/16" tubing of the right hand cylinder does not become trapped behind the guard.

7.2.27 If using the rinsing system, prime it with rinsing solution as described in section 5.4.

7.2.28 Replace the plastic cover and secure with the four screws removed earlier. Fit the two front screws first leaving them loose, then fit and tighten the top screws before finally tightening the front screws.

7.3 Glass Tube Replacement

If the glass tube requires replacing, e.g. because of scratches down the bore due to solvent deposits, follow the instructions given below to remove the tube and fit a new one in its place. Depending on the age of the seals, it us up to the user as to whether the seals are changed at the same time as the glass tubes are replaced.

7.3.1 Repeat the instructions given in section 7.2 to remove the glass tube(s).

Note
When fitting the replacement tubes, it may be necessary to force the piston back into the new tube due to the existing piston seal not returning to its original size when the piston rod was unscrewed. Take care when doing this!

7.3.2 Follow the instructions given in section 7.2 to refit the glass tube and piston assembly.

7.3.3 Run the pump with degassed water to check for leaks etc. and when satisfied that the pump is functioning correctly, refit the piston guards and plastic guard as instructed in 7.1.12 and 7.1.13.

7.4 Rinsing Washer Replacement

If the rising washers become damaged or show signs of leaking around the piston rod following prolonged use, they can be replaced as follows. If only one rinsing washer shows signs of requiring replacement, it is recommended that both are changed at the same time as will both have the same amount of wear.

7.4.1 Drain the pump and rinsing system of any fluids, taking precautions as necessary.

7.4.2 Remove the rinsing tubing from the spigots of both rinsing washers, by pulling in a straight line away from the spigot. Take care not to apply any sideways pressure to the spigot as it can damage it. Note the angle of the spigots, as the replacements will need to be positioned at the same angle.

7.4.3 Follow the instructions given in section 7.2 to separate the glass tube, piston rod and transfer port but **DO NOT** loosen the tension of the piston rod unless the piston seals are also being replaced. This ensures that the seal tension already set remains fixed.

7.4.4 Using the maintenance menu, move the carrier arm away from the end of the piston rod until it is clear enough to remove the piston rod and glass tube from the pump. Press RUN to stop the carrier arm moving any farther.

7.4.5 The rinsing washer will remain attached to the piston rod when the assembly is removed from the pump. Carefully slide the rinsing washer from the end of the piston rod, noting which way round the washer is fitted.

7.4.6 Fit the replacement washer to the end of the piston rod, and slide it up to the end of the glass tube.

7.4.7 Refit the glass tube/piston/rising washer assembly back in the pump ensuring that the rear of the rinsing washer fits correctly in the recess in the central support.

7.4.8 Re-position the transfer port against the end of the tube, ensuring that the 1/16” tubing from the bottom the port locates behind the adjusting screw, and tighten the adjusting screw just enough to hold the assembly together.

7.4.9 Rotate the glass tube so that the ridge on the piston seal retainer is aligned with the slot in the transfer port (unless the piston seal has also been replaced, in which case the piston assembly can be aligned as instructed in section 7.2).

7.4.10 Using the spigot to turn the washer, position so that the spigot is at the same angle as before disassembly. Some resistance will be felt when trying to rotate the washer due to the tight fit against the piston rod, but if the washer will not move, the adjusting screw is too tight.

7.4.11 Once the assembly is aligned, tighten the adjusting screw ensuring that the thrust washer fits in the recess in the rear of the transfer port and the rinsing washer still fits in the recess in the centre support. Make it finger tight initially, and then use the 5mm spanner to tighten the screw another 1¼ turns.

7.4.12 Use the maintenance menu to move the carrier arm back over the end of the piston rod and tighten the arm using the 4mm hex key.

7.4.13 Repeat the above procedure for the other rinsing washer, and when complete, refit the rinsing tubing to the spigots, priming with rinsing solution as required.

7.4.14 Refit the piston guards and the front cover as described in steps 7.2.26 and 7.2.28

7.5 Transfer Port Replacement

If a transfer port becomes damaged for any reason resulting in leaks, it can be replaced as described below. It is recommended that the transfer port sealing washer is replaced at the same time as the transfer port. Before replacing the transfer port, flush any solvent from the DCP50 using the instructions in section 5.5, taking note of the warnings given at the beginning of this chapter.

7.5.1 Place the DCP50 on a clean working surface. Repeat the instructions given in section 7.2 up to step 7.2.6 to free the transfer port being replaced.

7.5.2 Carefully open the two metal clips securing the tubing from the transfer port to free the tubing.

7.5.3 Using the wrench, loosen the two tubes on the switchover valve that are attached to the transfer port being replaced (see Figure 7) and withdraw them from the switchover valve. This is to enable the tubing to rotate freely when removed from the transfer port. If the tubes are not free, they will twist and distort when being removed from the transfer port, resulting in them being un-useable. Remove the transfer port and its tubing from the pump.

7.5.4 Unscrew the tubing from the transfer port, and discard the transfer port and sealing washer. Fit a new sealing washer to the replacement transfer port ensuring that it fits into the recess.

7.5.5 Re-attach the tubing to the transfer port, screwing the plastic nuts as finger-tight as possible to ensure a good seal.

7.5.6 Position the transfer port on the end of the glass tube ensuring that the central part of the transfer port fits inside the end of the tube. Also ensure that the longer of the two attached tubes is at the bottom of the transfer port and is routed up behind the cylinder adjusting screw.

7.5.7 With the transfer port in position and vertical, tighten the cylinder adjusting screw ensuring that the thrust washer locates in the recess in the rear of the transfer port. Adjust the screw until it is finger tight, and then tighten another 1¼ turns to ensure a good seal between the transfer port and the glass tube.

7.5.8 Re-attach the two 1/16” tubes to the switchover valve, ensuring that each tube goes to the correct port on the valve, otherwise this will prevent the pump from functioning correctly, resulting in a possible risk of harm to the user. Refer to the table below.

Transfer Port Connection	Switchover Valve Port
Left Transfer Port top	1
Left Transfer Port bottom	2
Right Transfer Port top	5
Right Transfer Port bottom	4

N.B. Left and right are designated as when facing the pump e.g. the Left Transfer Port is attached to the upper cylinder.

7.5.9 Route the 1/16" tubing back through the metal clips and secure in place by bending the clips over the tubing.

7.5.10 Refit the piston guards and the plastic guard as instructed in 7.1.12 and 7.1.13.

7.6 Cylinder Adjusting Screw Replacement

If, during use, there is leakage around the transfer port and seal, but on inspection these parts do not appear to be faulty, it could be due to the spring washers on the cylinder adjusting screw becoming weak after prolonged use.

To replace the cylinder adjusting screw assembly, the glass tube must first be removed as described in section 7.2 to allow space for the screw assembly to be removed and replaced.

Once there is clearance, screw the adjusting screw fully through the end support so that it comes out completely. Fit the replacement assembly (see Chapter 9 for part number) in the reverse order.

Re-assemble the glass tube etc. as described in section 7.2.

7.7 Tubing Replacement

WARNING! When replacing the internal tubing of the DCP50, it is vital that the new tubing is attached to the correct ports on the Switchover Valve and the two transfer ports, otherwise damage to the pump can occur. It is therefore recommended that only one tube is replaced at a time.

If it becomes necessary to change any of the internal tubing of the DCP50, always flush any solvent out of the pump first. It is recommended that if dismantling the front of the pump to replace one section of tubing, all tubing is replaced at the same time. The tubing between the Switchover Valve and the Pressure Transducer can be replaced without opening the front of the pump.

CAUTION
When replacing tubing, ensure that the correct size and type and pressure rating of tubing is used as detailed in section 5.2.

1/16" tubing for the DCP50 is available from Strata Technology Limited in lengths of 500mm. The length of tubing required for each section is as follows and should be cut square using a tubing cutter, also available from Strata Technology Limited. See Chapter 9 for part numbers.

Tubing location	Tubing length (mm)
Switchover Valve port 6 to Pressure Transducer	100
Switchover Valve port 5 to right transfer port top	290
Switchover Valve port 4 to right transfer port bottom	360
Switchover Valve port 2 to left transfer port bottom	300
Switchover Valve port 1 to left transfer port top	210

Place the DCP50 on a clean work surface. Remove the protective plastic cover by removing the four screws securing it in position using the 2.5mm hex key supplied in the tool kit, then remove the two metal guards over the pistons.

7.7.1 Open the metal clips securing the tubing in place between the transfer ports and the Switchover Valve and free the tubing.

Note
It is recommended that the tubing is replaced in sequence starting with the tubing going to port 1 on the Switchover Valve, then port 2, port 4, port 5 and then port 6. By replacing one length of tubing fully before going on to the next length of tubing, this will ensure that the each piece of tubing is connected to the correct port.

7.7.2 Using the ¼" wrench supplied with the toolkit, loosen the metal nut on the Switchover Valve securing the first tube being changed and then fully unscrew the nut. Pull the tube from the valve.

7.7.3 Unscrew and remove the other end of the tube from the transfer port. Discard the old tube with its attachments.

7.7.4 Ensure that both ends of the replacement tubing are cut square. Slide a new plastic nut over one end of the tube and fit the blue ferrule to the end of the tube so that it is flush with the end as shown in Figure 16.

Figure 16 - Transfer port nut and ferrule

7.7.5 Screw the nut and ferrule into the transfer port, making it finger-tight only but tightening as much as possible to prevent any leaking.

7.7.6 Route the tubing as required i.e. if attached to the bottom of a transfer port, route it behind the cylinder and cylinder adjusting screw. Fit a new metal nut and ferrule to the end of the tubing as shown in Figure 7 and then fit the tube into the port on the Switchover Valve. Push the tubing into the port as far as it will go and then screw in the nut. Tighten it fully with the supplied wrench to compress the ferrule as shown in Figure 7.

7.7.7 Repeat the above steps to replace the remaining tubing.

7.7.8 Before re-assembling the plastic and metal guards to the front, run the pump using de-gassed distilled water into equipment that will provide some back-pressure to ensure that there are no leaks from the new tubing. Tighten tubing if necessary and repeat the test.

Note
If the new tubing leaks around either of the transfer ports due to the nuts still being too loose, reduce the pressure in the system and drain the pump. Using the 5mm spanner supplied in the tool kit, unscrew the cylinder adjusting screw that pushes the transfer port against the glass tube. Unscrew fully and move the transfer port out of the way as shown in Figure 13 to get better access to the transfer port, tighten the plastic nuts on to the transfer port while gripping it securely, and then refit the transfer port in accordance with the instructions given in 7.2.15 and 7.2.17. Repeat the above tests to check for leaks.

7.7.9 Once checked, route the 1/16” tubes through the metal clips and secure them in place. Refit the metal guards and plastic cover in place as instructed in 7.1.12 and 7.1.13.

7.8 Switchover Valve Cleaning

The switchover valve operates by the use of a two position motor to which is mounted a ‘rotor’ containing two curved channels that the solvents flow through. The rotor is pressed tight against the polished sealing surface on the inside face of the ‘stator’. The 1/16” tubing is attached to the six ports on the outside of the stator. In one position, ports 3-4 and 1-6 are linked by the channels in the rotor, and in the other position, ports 3-2 and 5-6 are linked.

During use, it is possible that debris or solvent crystals get drawn into, and circulated around the pump. This can then get trapped inside the switchover valve, preventing it from operating correctly. Debris or crystals caught between the rotor and one of the port holes can prevent the valve motor from rotating, resulting in incorrect or no solvent flow. **As a last resort**, the front of the valve can be removed to clear the debris away. Care should be taken if any hazardous substances have been used in the pump prior to dismantling the switchover valve and it has not been possible to flush them out. Refer to the warnings at the beginning of this chapter.

Note
The polished sealing surface of the stator must be protected during any disassembly or cleaning procedure. Work in a clean environment and always set parts on a soft tissue or clean paper. Cleaning a valve can often be accomplished by flushing all the lines with air, nitrogen, or appropriate solvents.
Do not disassemble the valve unless system malfunction is definitely isolated to the valve.

7.8.1 Switch the pump off and disconnect the power supply and any data leads that may be attached.

7.8.2 Using the Valco wrench supplied in the DCP50 tool kit, disconnect all six tubes connected to the six ports attached to the stator of the switchover valve. Ensure that any drips from the tubing are cleaned away using appropriate equipment.

7.8.3 Carefully lay the pump on its back.

7.8.4 Use a 3/32" hex driver to remove the 5-40 socket head screws that secure the stator to the valve body. Alternate between the five screws in the sequence indicated in Figure 18 to keep an even pressure against the rotor. Loosen the screws in ¼ turn increments until all the load is removed i.e. the screws are free to move and then remove the screws. The stator sits on two pins protruding from the motor body (see Figure 17) and should remain attached to the motor body.

7.8.5 Carefully withdraw the stator from the pins to expose the rotor. To ensure that the sealing surface of the stator is not damaged, rest it on its outer face.

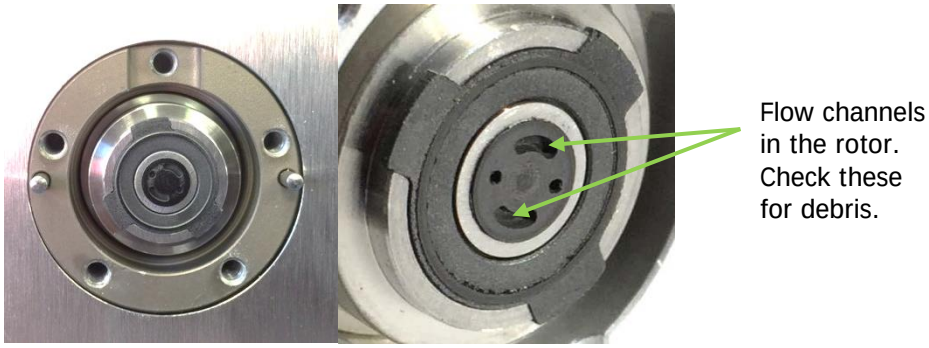

Figure 17 – Switchover valve with stator removed

7.8.6 With fingers or a small tool, gently pry the rotor away from the driver, **being careful not to let it drop inside the pump** (requiring a return to Strata Technology Limited).

7.8.7 Examine the rotor sealing surface for scratches. Check the two curved channels in the rotor for any signs of debris that may be causing the rotor to stick.

7.8.8 Examine the stator sealing surface and the six port holes for signs of debris, flushing through if necessary with an air-line.

7.8.9 Clean all the parts thoroughly with an appropriate solvent, taking care that no surfaces get scratched. A common problem is the formation of buffer crystals, which are usually water-soluble. It is not necessary to dry the rotor.

7.8.10 To re-assemble the valve, replace the rotor in the driver, making sure that the rotor sealing surface with its engraved flow passages is facing out, again **taking care not to let it drop inside the pump**. Ensure that the rotor is fitted back in the driver face correctly. The tabs on the rotor have an asymmetrical pattern to prevent assembly with improper orientation.

7.8.11 Replace the stator the correct way round. On the DCP50, port 1 marked on the stator should be at the bottom. Insert the five socket head screws and tighten them gently. As they begin to get snug, tighten them gradually in the order indicated in Figure 18 until all are snug.
Do not overtighten them – the screws simply hold the assembly together and do not affect the sealing force, which is automatically set as the screws pull the stator against the rotor.

Figure 18 - Loosening and tightening order for the screws

7.8.12 Once the stator is secured to the valve body, stand the pump the correct way up and re-attach the six tubes to the valve, ensuring that they are attached to the correct ports (refer to the table in section 7.7).

7.8.13 Run the DCP50 as normal and check that the valve is now operating correctly. If the problem is not resolved, the pump must be returned to Strata Technology Limited for further investigation.

7.9 Updating Firmware

The firmware program stored in the microcontroller within the DCP50 can be updated by the end user when new versions are made available by Strata Technology Ltd.

To check for the version number of the firmware currently installed in the DCP50, press the PRESSURE LIMIT and FLOW RATE controls together to display the main menu. The version number of the installed firmware is shown at the bottom right of the display, with the pump serial number at the bottom left.

Firmware updates, the installation program and installation instructions will become available on the Strata Technology Limited website at www.stratatec.co.uk at the time of release.

7.10 Returning the DCP50 for Service/Repair

If the DCP50 ever requires returning to Strata Technology Limited for servicing or repair, it is important that any solvents remaining in the pump are drained out in accordance with the instructions given in section 5.5, and then flushed through with bacteriostatic solutions e.g. NaOH, and then distilled water taking note of the warnings given at the beginning of this chapter.

Before returning the pump, contact Strata Technology Limited for a returns authorisation number. Pumps will not be accepted without this.

7.11 Recycling

This symbol indicates that waste electrical and electronic equipment (WEEE) must not be disposed of as unsorted municipal waste, but must be collected separately by an authorised body. Please contact Strata Technology Ltd. for information concerning the decommissioning of equipment.

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Chapter 8 Troubleshooting

8.1 Fault Finding

In the unlikely event of a fault occurring, the following table lists possible fault conditions that may occur and suggested causes and resolutions.

Problem	Possible Cause	Suggested Action
LED within DC power supply is not illuminated	Mains cable not attached correctly	Check that the mains cable is attached correctly between the mains supply and the external DC power supply.
	No mains supply at mains socket	Check supply by plugging another mains powered device e.g. desk lamp. If the problem still exists, contact an electrician.
LCD is blank when the DCP50 is switched on – no backlight.	The external DC power supply is not attached correctly	Check that the power supply lead is inserted fully into the socket on the rear of the pump and is locked in place.
LCD is blank when the DCP50 is switched on – backlight is illuminated.	Microcontroller on the Control Board has not initialised correctly.	Switch pump off and on again
	Control Board has failed.	Return the pump to Strata Technology Ltd.
Pump does not run when RUN button pressed	Push –button not working.	Check if the integral LED is illuminated.
	Back pressure within the equipment connected to the pump is greater than the set limit.	Check if PRESSURE SAFETY LIMIT LED is illuminated, and if possible increase the limit.
	Stepper motor or drive circuitry has failed.	Return the pump to Strata Technology Ltd.
Solvent Change button is not operating	Push-button is not working	Check if integral LED is illuminated.
	Pump is in ‘Run’ mode	Press RUN to stop the pump, and try again.

Problem	Possible Cause	Suggested Action
Air bubbles seen in the cylinder that is drawing in the solvent	The tubing connected to the inlet port is not tight enough.	Tighten nut on tubing fitted to port 3 on Switchover Valve.
	Tubing connected to the 'inlet' of the transfer port is not tight enough allowing air to be drawn in by piston.	Tighten the plastic nut on the transfer port
	Debris trapped in the Switchover Valve preventing it from operating correctly	Disconnect the tubing from the Switchover Valve and clean the channel in the valve by flushing nitrogen or air in reverse flow direction through the valve. If this does not clear the debris, see section 7.8.
	The inlet tubing from the switchover valve to its corresponding transfer port is jammed between the front panel and the protective cover	Remove the protective cover and release the tubing.
	Blockage somewhere in the inlet tubing system, preventing the solvent from being drawn in by the piston, thereby pulling air in past the piston seal. (This will not happen on pumps using the rinsing system as the rinsing fluid will be drawn in instead).	Remove and check tubing connections at the various points in the system e.g. transfer ports, switchover valve etc. for any debris that may be blocking it.
The pistons do not change direction and the switchover valve does not operate when a piston reaches its 'end stop'. The drive motor sounds as if it is juddering.	The piston was not in the correct position when the piston rod was locked to the drive carrier following piston seal maintenance.	Disconnect the piston from the drive carrier and re-adjust as described in step 7.2.23.
	The electronic circuitry is not detecting the end of travel of the drive carrier assembly.	Return the pump to Strata Technology Ltd. for servicing.
The motor stops when the pistons get to one end. RUN LED in push button still illuminated.	The Switchover Valve has failed to operate correctly resulting in no signal back to the control circuitry.	Return the pump to Strata Technology Ltd. for servicing.

Problem	Possible Cause	Suggested Action
Leakage of solvent from between the transfer port and the glass tube.	The cylinder adjusting screw compressing the sealing washer between transfer port and the cylinder is loose.	Tighten the cylinder adjusting screw to compress the sealing washer in accordance with instructions given in7.2.17.
	The sealing washer between the transfer port and cylinder is worn.	Replace the sealing washer following the instructions given in section 7.2.
Leakage of solvent past piston seals when running under pressure	Reaction between seals and solvent.	Leave running for a few hours to allow seals to settle. If necessary, re-adjust the seals as described in Chapter 7.
No output flow delivered by the pump and signs of leaking. Back pressure indicator on LCD does not indicate increase in back pressure.	The outlet port of the Switchover Valve is blocked.	Disconnect the tubing from port 6 and the port from the corresponding piston at the Switchover Valve end. Flush nitrogen or air through the valve in the reverse direction. If this does not clear the debris, see section 7.8.
Occasional ‘knock’ from pump when running with a high back pressure	Transfer Port jumping with change of piston direction, which can be felt by hand once front cover is removed.	Tighten cylinder adjusting screw for transfer port to prevent jumping.
Switchover valve producing longer sound than normal at switching time. Air being drawn into glass cylinders.	Debris or solvent crystals trapped in the switchover valve preventing it from turning correctly.	Disconnect the tubing from the Switchover Valve. Flush nitrogen or air through the valve to try to clear the blockage. If this does not clear the valve, see section 7.8.

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Chapter 9 Spare Parts and Accessories

9.1 Piston Assembly

Piston Rod ..... Part No. S000008
Piston Washer ..... Part No. S000041
Piston Seal Retainer (Stainless Steel) ..... Part No. S000040
Piston Seal Retainer (Hastelloy) ..... Part No. S000393
Piston Seal ..... Part No. S000039
Sealing Washer ..... Part No. S000017
Rinsing Washer ..... Part No. S000007
Borosilicate Glass Tube* ..... Part No. S000009
Transfer Port ..... Part No. S000014
Seal kit (2x S000039 and 2x S000017) ..... Part No. S002351

9.2 Tubing Fittings

Switchover Valve Nut and Ferrule (Stainless Steel) ..... Part No. S000034
Switchover Valve Nut and Ferrule (Hastelloy) ..... Part No. S002351
Transfer Port Nut and Ferrule (also fits Pressure Transducer inlet and S00002) Part No. S000030
Nut and Ferrule for 1/8” tubing ..... Part No. S000003

9.3 Tubing

1/16” OD FEP Tubing x 500mm (inlet)** ..... Part No. S000001
1/8” OD ETFE Tubing x 500mm (outlet) .....Part No. S000037
Rinsing System Tubing ..... Part No. S000025

9.4 Miscellaneous Items

Tube cutter ..... Part No. S000032
Adjusting Screw Assembly ..... Part No. S000029
Tool kit ..... Part No. S000027
Inlet Filter (order with 1x S000030) ..... Part No. S000002

9.5 Accessories

Mains Cord (UK) ..... Part No. S000022
Mains Cord (USA/Canada) ..... Part No. S000023
Mains Cord (Europe) ..... Part No. S000024
Power Supply ..... Part No. S000071

* If replacing a glass tube because it has cracked, it is advisable to order a replacement piston seal (S000039) at the same time as the existing seal may have been cut by the broken glass.

** If replacing individual lengths of tubing in the DCP50 between the transfer ports, switchover valve and pressure transducer, these can be cut from this part.

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STRATA TECHNOLOGY LTD

EC DECLARATION OF CONFORMITY

We Strata Technology Limited

of Strata House
Batavia Road
Sunbury-on-Thames
Middlesex
TW16 5LR
United Kingdom

Hereby declare that:

Equipment	DCP50 Dual Cylinder Pump (MK2)
Model Number	130-01

is manufactured in conformity with the applicable requirements of the EU Directives listed below

2014/30/EU	The Electromagnetic Compatibility Directive (EMC)
2014/35/EU	The Low Voltage Directive (LVD)
2011/65/EU	The Restriction of Hazardous Substances in Electrical and Electronic Equipment Directive (ROHS)
2006/42/EC	The Machinery Directive

The following harmonised standards are applicable

EN 61326-1
EN61000-3-2:2006 +A1:2009 +A2:2009
EN61000-3-3:2013
EN61010-1
EN61010-1:2010 edition 3

Signed _____ Date 06 Oct 2016.

Dr Roger Kimber - Managing Director
Strata Technology Ltd. Sunbury-on-Thames

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