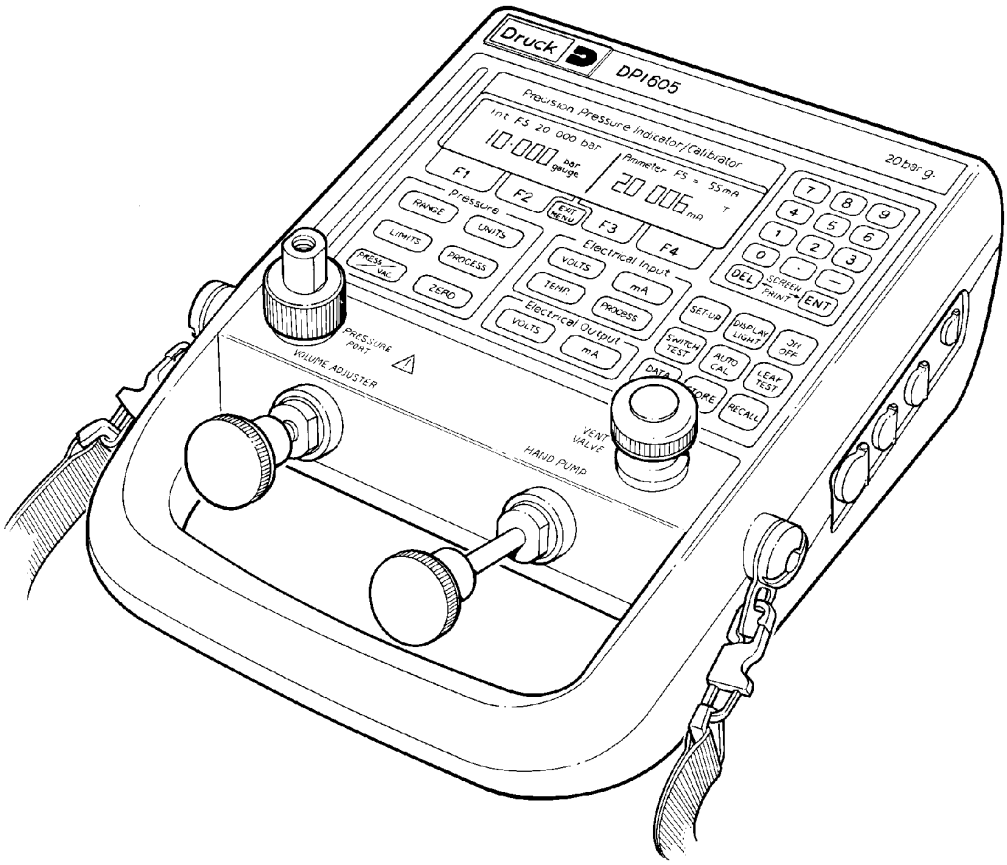
GE
Sensing

Druck DPI 605

Precision pressure calibrator/indicator

Service manual - K139



DPI 605 SERIES
PRECISION PRESSURE CALIBRATOR/INDICATOR
SERVICE MANUAL
K139

INTRODUCTION

General

The aim of this publication is to provide information for the service of the Precision Pressure Calibrator/Indicator DPI 605.

This publication contains procedures which provide instructions to enable an operator to maintain the instrument in a serviceable condition. It is divided into four parts and sub-divided into chapters detailed in the table of contents.

The information in DESCRIPTION provides a detailed constructional and functional description of the instrument.

The instructions in SERVICING contain detailed routine maintenance, dismantling, inspection and assembling procedures. Together with FAULT FINDING the condition and probable cause of a malfunction can be established. The operator can carry out the recommended rectification procedures to return the instrument to a serviceable condition. After rectification, the integrity of the instrument can be verified by detailed testing and the accuracy by calibration.

The PARTS LIST itemises the parts of the unit that can be replaced. It is intended for use in the provision and requisitioning of replacement parts.

SAFETY

This publication contains information and warnings which must be followed to ensure the safe operation and to maintain the equipment in a safe condition. Use qualified personnel and good engineering practice for all procedures and practices in this publication.

The equipment must not be used for any other purpose than that stated.

ASSOCIATED DRUCK PUBLICATIONS

K136 DPI 605 USER MANUAL
K151 DPI 605R USER MANUAL

LIST OF CONTENTS

ABBREVIATIONS

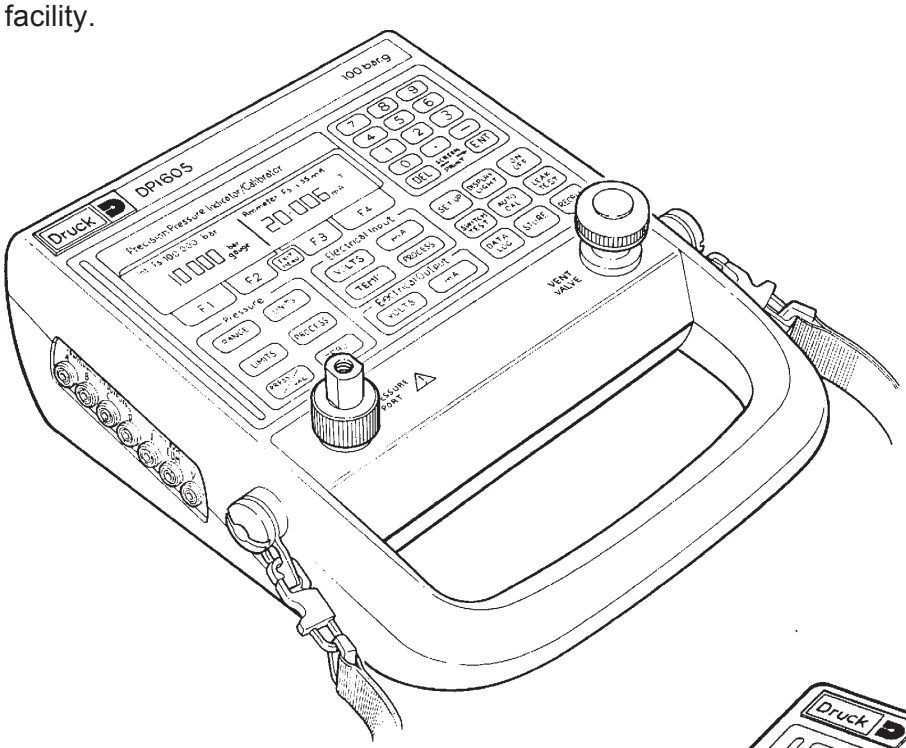
Note: Abbreviations are the same in the singular and plural.

abs	absolute
AC	alternating current
A to D	analogue to digital
BS	British Standard
°C	degrees Celsius
CH	channel
contd	continued
CR	carriage return
DC	direct current
DVM	digital volt meter
DMM	digital multimeter
EPROM	erasable program read only memory
FS	full-scale
ft	feet
ft/min	feet/minute
GRD	ground (earth)
Hz	Hertz
kg	kilogram
LCD	liquid crystal display
LED	light emitting diode
in Hg abs	absolute pressure in inches of mercury
kHz	kilo-Hertz
max	maximum
MED	medium
sec	second
min	minimum or minute
Mohm	mega-ohm
mbar	milli bar
mbar/min	milli bar/minute
mV	milli Volt
No.	number
-ve	negative
PCB	printed circuit board
PL	plug
+ve	positive
PSU	power supply unit
PWM	pulse width modulator
RAM	random access memory
RF	radio frequency
RV	variable resistor
SW	switch
V	Volt
V ac	Volts alternating current
V dc	Volts direct current

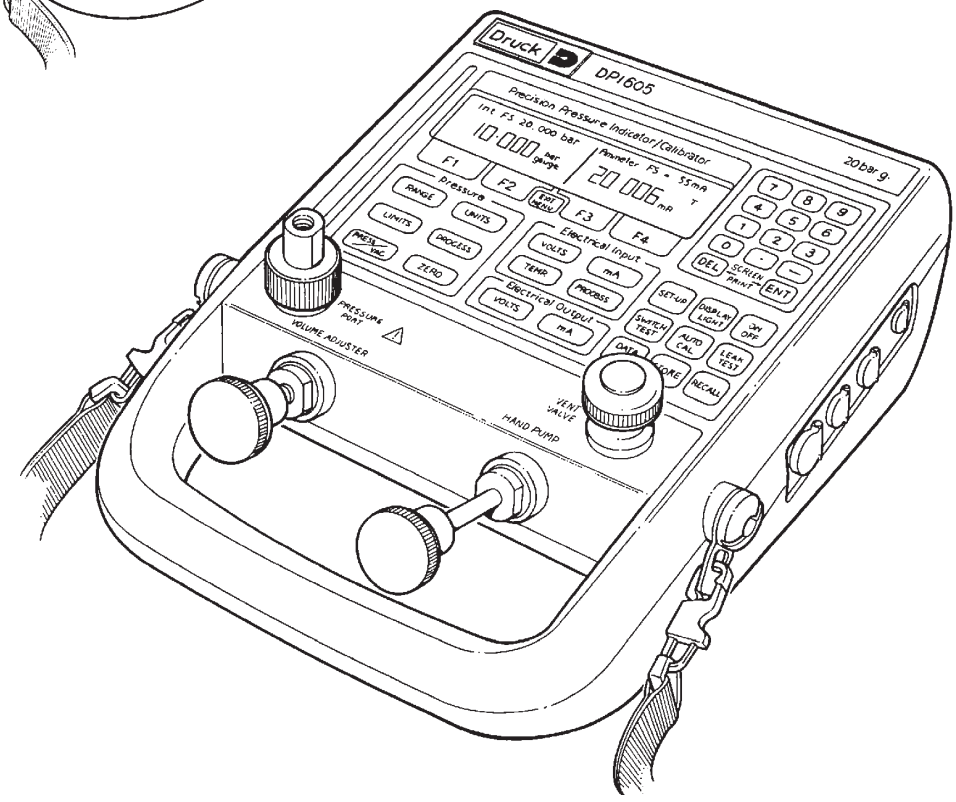
PART 1
DESCRIPTION

General

The DPI 605 calibrator generates and indicates pressures up to 20 bar gauge. The instrument's primary pressure indicating range, 20 bar gauge (21 bar absolute with the barometric option), can be extended to 700 bar by external transducers. In addition to generating pressure the instrument produces analogue voltages and currents. These analogue outputs can be programmed to any level within the range of the instrument or be linearly related to the indicated pressure, the relationship is programmable to a defined straight line. A digital multimeter is built into the instrument permitting independent monitoring of voltage and current signals. External connections are provided for a Pt 100 temperature probe and RS232 serial data link.
The indicator version of the DPI 605 instrument is available with a primary pressure range up to 350 bar. It has all the operational features of the calibrator but without the pressure generating facility.



DPI 605 Indicator Version



DPI 605 Calibrator Version

Constructional Description

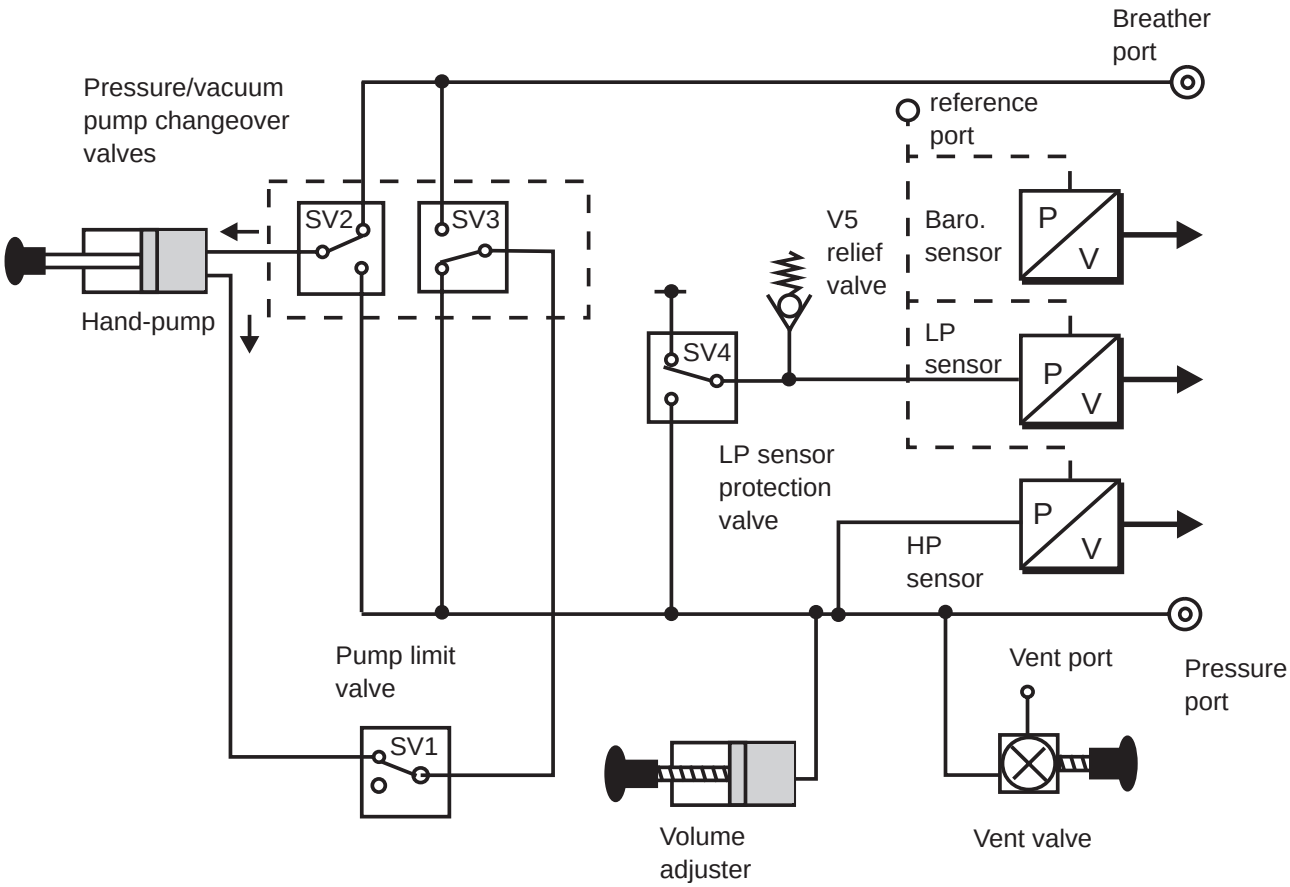
The DPI 605 calibrator/indicator comprises an instrument case and base assembled together to enclose pneumatic and electronic equipment.
The instrument base is a moulded polyethylene case that houses a power supply board and in a separate compartment a battery pack. On the outer surface of the case, two rubber feet locate in grooves and are secured to the case. A set of re-chargeable batteries locate into a moulded container. A flush-fitting connector locates on the moulded container and aligns with a corresponding connector in the battery pack compartment. Spring metal connection strips allow for a set of non-rechargeable, alkaline batteries. A metal lid, secured by two captive screws, secures the battery compartment.
The instrument case is a moulded polyethylene case, with integral handle, that houses the main electronics board, pneumatic assembly and the pneumatic and electrical connections.
The pneumatic equipment is mounted on a shaped and drilled bracket. The pneumatic circuit consists of a vent valve, hand-pump and volume adjuster all connected together with small bore tubing to a manifold. Two pressure transducers, one mounted on the end of the volume adjuster, the other on the bracket, measure pressure at the pressure port. The manifold houses four solenoid valves and connections for the small bore tubing. The hand-pump and volume adjuster locate through holes in the bracket and instrument case and are secured to the instrument case by nuts screwed on the hand-pump and volume adjuster end fittings. Knobs are attached to the piston rods of the hand-pump and volume adjuster.
The vent valve locates through a hole in the upper surface of the instrument case and is attached by a nut. A knob is attached to the spindle of the vent valve and secured by a nut. A plastic cap inserted in the top of the knob covers the securing nut. The outlet bore of the vent valve is threaded to receive a strap securing boss.
With the vent valve closed, the hand-pump generates pneumatic pressure. The volume adjuster provides fine adjustment of the generated pressure. The vent valve controls a partial or complete de-pressurisation of the system. Turning anti-clockwise opens and clockwise closes the valve.
The hand-pump generates pressure enabling the instrument to calibrate a pressure gauge.
The volume adjuster is a cylinder and piston assembly providing adjustment of the applied pressure.
The indicator version is similar to the calibrator but without the hand-pump and volume adjuster. Internally, there is one transducer, no solenoid valves or relief valve.

Pneumatic Circuit (calibrator)

The pneumatic circuit consists of a hand-pump connected to a pressure port through a series of latching, solenoid-operated, control valves. A volume adjuster and vent valve also connect to the pressure port. The volume adjuster allows small adjustments of system volume to be made providing fine adjustments to output port pressure. The vent valve allows the pressure in the pressure port to be vented to atmosphere.

The pressure at the pressure port is monitored by two, digitally-characterised transducers, one (LP) senses pressure between 0 and 2 bar the other (HP), senses pressure between 0 and 20 bar.

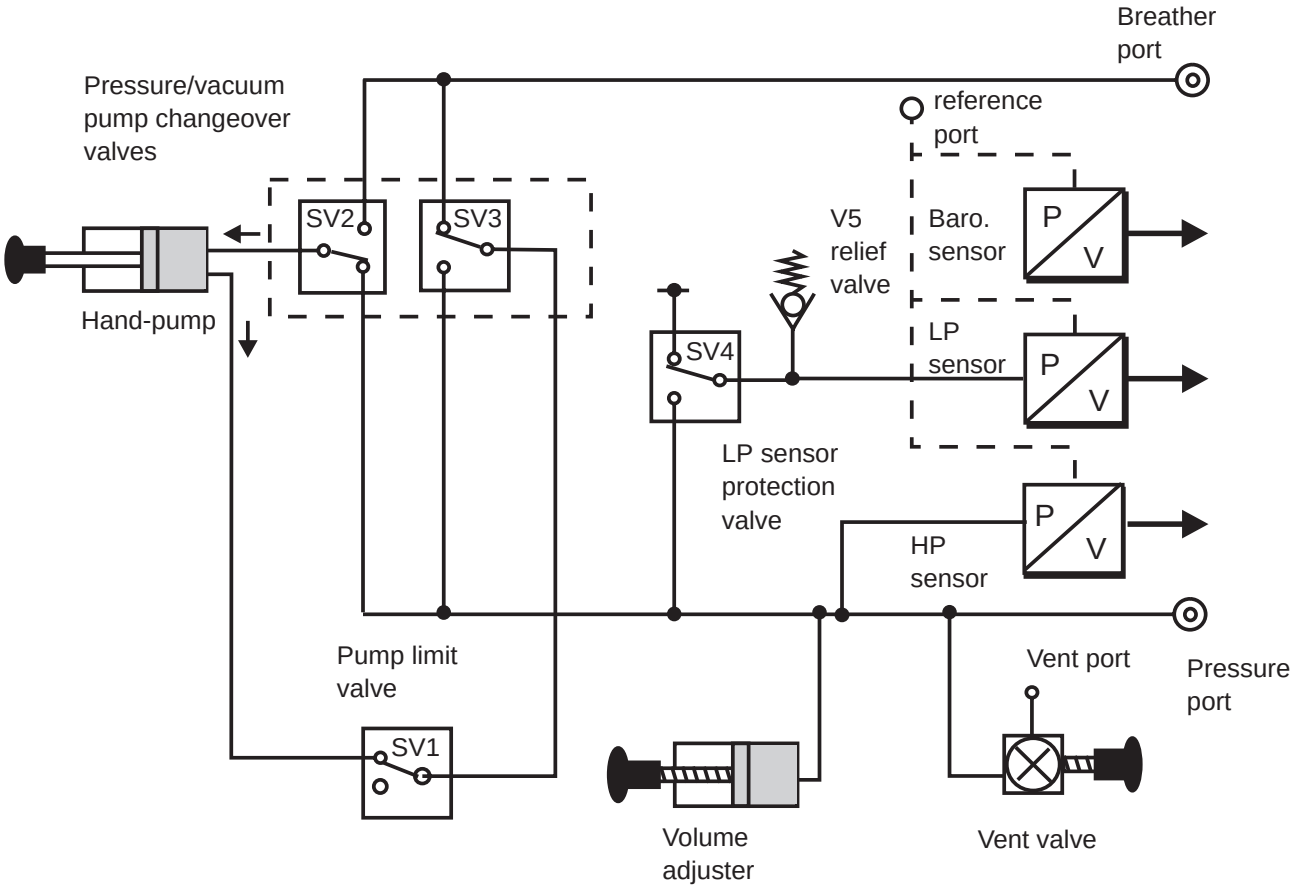
When the pressure is below 2 bar, protection valve SV4 is closed by the control system and the output of the LP sensor provides the system with pressure data. When the system pressure is above 2 bar, protection valve SV4 opens, isolating the LP sensor from the pressure. A relief valve V5 provides additional protection of the LP sensor, protecting against pressure transients and if SV4 fails to operate.



Pneumatic circuit - pressure selected

After connecting the pressure port to a device or system under test, output pressure is generated by closing the vent valve and using the hand-pump. When the hand-pump is used, air draws into the pump though SV2. Integral one-way valves, permit the flow of air though the pump.

If negative pressure is required, vacuum is selected from the keyboard which causes SV2 and SV3 to change-over providing that there is no pressure at the pressure port.
When the hand-pump is used, air draws from the pressure port through SV2 into the inlet side of the pump. The outlet side of the pump exhausts to atmosphere though SV1, SV3 and the breather port.

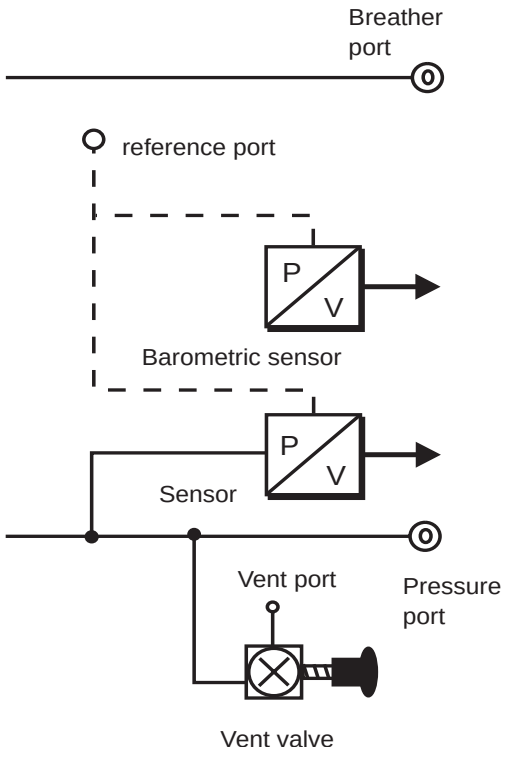


Pneumatic circuit - vacuum selected

A pump limit valve SV1 blocks the outlet of the pump when a preset system pressure is reached. Normally SV1 is closed leaving the pump outlet port open. When the alarm limit is reached, the instrument control system closes SV1, blocking the outlet of the pump and preventing further operation of the pump.

Pneumatic Circuit (Indicator)

The indicator version of the instrument differs from the calibrator, it does not have a pressure generating system. There are two types of pneumatic circuit for different pressure ranges.



Pneumatic circuit - indicator

Electronic Circuit

The block diagram shows all the main functional electronic blocks within the instrument. These are contained in two printed circuit board assemblies, the power supply board assembly and the main board assembly.

Power supply board

Based on a small board (140 mm x 90 mm approximately), the power supply board comprises two separate switch mode power supplies, ON/OFF control logic and power input steering logic.

- Power Input Steering Logic
  This allows one of three separate sources of power to be used.

- AC power through an external battery charger eliminator.
  This provides 12 V dc to the instrument and powers the instrument irrespective of batteries being fitted.

- Rechargeable battery pack
  This powers the instrument for up to 20 hours before requiring re-charge. The battery pack can be charged when the fitted in the instrument by using the battery charger eliminator. Charging takes place with the instrument switched ON or OFF. Alternatively, the battery pack can be charged by directly connecting the battery charger into the battery pack. The charging current is controlled by circuitry within the battery pack, the full charge condition takes approximately 14 hours. Prolonged charging of the batteries is not recommended as this can damaged the batteries.

- Dry cells
  Six , D size, cells are fitted in place of the rechargeable battery pack. Alkaline cells are recommended because of the high power consumption of the instrument. The instrument circuitry prevents these batteries from being charged when the battery charger/eliminator is connected to the instrument.

- ON/OFF Control Logic
  This circuitry continuously monitors the ON/OFF key on the membrane keyboard. If the instrument is OFF and the ON/OFF key pressed, the control logic turns ON the main switch mode power supply that powers the instrument. When the instrument is ON and the key is pressed the microprocessor detects this action and finishes performing the current tasks and signals the ON/OFF control logic to switch OFF the main switch mode power supply, turning OFF the instrument.

- Main Switch Mode Power Supply
  This is controlled by the ON/OFF control logic and provides the main power supply to the instrument together with separate floating supplies used to power the instrument RS232 port.

- Auxiliary Switch Mode Power Supply
  This is controller by the microprocessor so that it is only active when the programmable outputs of the instrument are in use. It provides power solely for the programmable outputs and the associated circuitry.

Main Board Assembly

This board is the heart of the instrument, a description of the main blocks is given below:

- Microprocessor
  This controls all instrument functions. The program for the microprocessor is held in EPROM of either 256 kilobytes or 512 kilobytes. The calibration and set-up data for the instrument is stored in EEPROM (8 kilobytes). 128 kilobytes of RAM provides for data log storage, some set-up storage and general purpose RAM for the use of the microprocessor. A real-time clock provides time and date information. A built-in lithium battery supports the real-time clock and the RAM when the instrument is switched OFF.

- RPT Interface
  This provides signal conditioning of the temperature and frequency output of the RPT together with power control for the RPT. To conserve instrument battery life power is removed when the RPT is not in use.

- Valve Drivers
  The valve drivers provide either positive or negative going control signals to either open or close the latching solenoid valves. Power for the valves is supplied through the valve drivers from the batteries or battery charger eliminator and not through either of the switch mode power supplies in the power supply board.

- Main Multiplexer
  This takes all the analogue signals to be measured by the instrument and, under microprocessor control, selects the signal to be routed through the main amplifier.

- Main Amplifier
  This is a high precision instrumentation amplifier used to amplify the selected signal by a factor of approximately twenty.

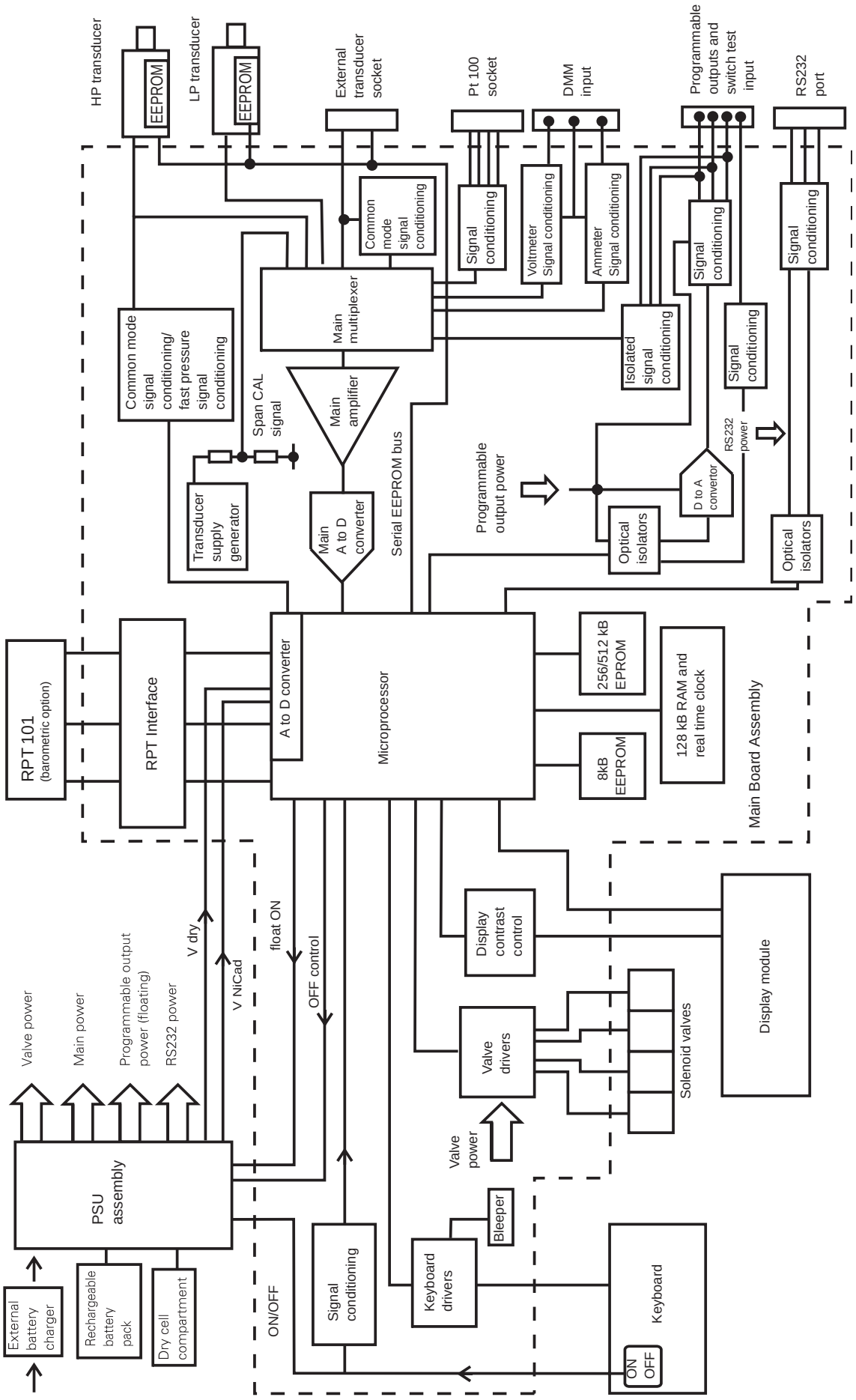
- Main A to D Convertor
  This takes the output from the main amplifier and converts it to a twenty bit number for the microprocessor to read.

- Fast Pressure/Common Mode Signal Conditioning for the High Pressure Transducer Signal

  This block can be configured to implement one of two tasks:

  - Fast Pressure Signal Conditioning
    For the Calibrator version of the instrument this block is configured by links and resistors to provide a pressure signal with high bandwidth. The low resolution (8 bit) fast A to D convertor built into the microprocessor continuously monitors the pressure and promptly operates the solenoid valves. This is particularly important in the case of the low pressure transducer protection valve.

  - Common Mode Signal Conditioning
    For the indicator version of the instrument where there are no solenoid valves fitted a fast pressure signal is not required. The block is re-configured to provide a signal related to the common mode voltage of the transducer fitted in the high pressure transducer position. This is, in turn, related to the temperature of the transducer and is used by the microprocessor to implement temperature compensation additional to that built into the transducer.



DPI 605 block schematic diagram

- Common Mode Signal Conditioning for External Transducers
  This provides a signal related to the temperature of the external transducer in the same way and for the same purpose as the indicator version fast pressure signal conditioning. However, the high speed ability requirement is not present for this signal and therefore the signal is processed by the slower Main multiplexer/Main Amplifier A to D Convertor route.

- Pt 100 Signal Conditioning
  This takes the form of a constant current source, the voltage developed across the Pt 100 sensor is then processed through the main measurement channel.

- Voltmeter Signal Conditioning
  This takes the form of an inverting amplifier with a switchable gain of x1.0, x0.1, x0.01 and x0.001. The appropriate gain for the input signal is selected by the microprocessor.

- Amplifier Signal Conditioning
  This is a current shunt of approximately 2 Ohms together with a self-resetting fuse of 200 mA rating.

- Programmable Outputs
  The programmable outputs (really one output configured by the microprocessor to be either voltage or current) together with the switch test input forms a large sub-system on the main board assembly. The whole sub-system is galvanically isolated from the rest of the instrument by one of the switch mode power supplies in the power supply board. Optical isolators are fitted on the main board for the exchange of control and data signals with the microprocessor.
  When a programmable output is requested, through the key board, the microprocessor turns on the switch mode power supply. After waiting a short time the signal conditioning circuitry is set to either current or voltage output and a number is sent to the serial input D to A convertor in order to set the output to the required value. The isolated feedback circuit is activated and this allows the continuous measurement of the actual output and readjustment to compensate for variations due to load changes.

- Switch Test Input
  This provides through signal conditioning circuitry an input where the state of a simple switch or logic signal may be monitored by the instrument.

- RS232 Port
  This provides the digital communication interface for the instrument. It is galvanically isolated from the rest of the instrument in order to avoid any earth (ground) loop problems when using the interface to connect the instrument to other equipment such as data loggers or computers.

- Display Contrast Control
  The contrast of the display is settable through the keyboard at any time, the microprocessor sending the appropriate signal to the contrast control circuitry. In addition to the interfacing between the display module and the microprocessor, the circuitry provides the required temperature compensation of the contrast voltage to the display in order to make it readily legible over the operating temperature of the instrument.

PART 2
SERVICING

Chapter 1 Introduction

General

Routine maintenance is carried out to ensure that the equipment remains in a serviceable condition. To rectify faults dismantling will be required. To determine the extent of dismantling, refer to FAULT DIAGNOSIS. This will establish the condition of the equipment or the most probable cause of its malfunction.

Absolute cleanliness of the work area, tools and equipment must be observed at all times. Discard all o-rings and bonded seals when removed from the equipment.

Special Tools and Materials

Note: Equivalent substitutes may be used.

The following special tools are required and must be used as directed.

TABLE 2-1 SPECIAL TOOLS

Part No	Description	Usage
251-004	Pliers, tubing	Helical tubing clamps
-	Wrench, strap	Pneumatic equipment

The following materials are required.

Note: Equivalent substitutes may be used.

TABLE 2-2 MATERIALS

Material	Specification	Usage
Foam cleaner	-	Cleaning
Lint-free cloth	-	Cleaning
Acetone	-	Cleaning
Compressed air	-	Cleaning
Grease	RS Components multi-purpose	Assembling
Thread sealant	Loctite 648	Assembling

Chapter 2 Routine Maintenance

General

Routine maintenance is limited to cleaning and visual inspection.

Cleaning

Clean the case with damp lint-free cloth and mild detergent.

Clean the electrical connections using foam cleaner and a soft brush. Remove any dirt or debris from the instrument.

Inspection of Instrument

Examine the unit generally for signs of corrosion and damage.

Examine the electrical connectors for cracks to the insulation, damage to the socket connections and cleanliness.

Further Maintenance

No further maintenance procedures are required unless a fault in the unit occurs, refer to PART 3 FAULT DIAGNOSIS. The dismantling and subsequent assembling of components for maintenance detailed in Chapters 3 and 5 respectively. Reference is made to the appropriate chapter and paragraph for these operations and the subsequent testing and calibration detailed in Chapters 6 and 8 respectively.

Chapter 3 Dismantling

General

The purpose of this chapter is to detail the extent of dismantling procedures and must be used in conjunction with FAULT DIAGNOSIS in Part 3. Maintenance is carried out to ensure that the instrument remains in a serviceable condition. Absolute cleanliness of the work area, tools and equipment must be observed at all times.

Note: Dismantling instructions for the Rack mounted version will be included at a later date.

Electronic Equipment

All the electronic components are located in the case, with the exception of the Power Supply Board which is located in the base of the case. To gain access to the main components remove the base from the instrument.

Procedure

- Turn the instrument upside down and unscrew the eight posi-drive countersunk screws.
- Release the two black clips and disconnect cable connector from Con 1 on the Power Supply Board. Separate the base and case.

Power Supply Board

The Power Supply Board locates in the instrument base.

- Disconnect connectors PL1 and PL2 on the power supply board.
- Four white plastic pegs secure the board to the base. Press, in turn, each peg to release the board.

Main Board (PCB)

- Disconnect the following connectors from the main board: PL1, PL2, PL3, PL4, PL5, PL7, PL8, PL9, PL10, PL11, PL12 and PL13.
- Unscrew and remove the four screws securing the main board and collect the four shake-proof and plain washers.
- Carefully remove the main board from the instrument case.

Display Board

- Remove the main board for access.
- Unscrew and remove the four screws securing display board and collect the four shake-proof and plain washers.
- Remove the display board.

  Note: It may be necessary to loosen the pillar next to the display board

Key Pad

- Using a 5.5 mm spanner, unscrew and remove the four pillars and four nuts, collect the eight shake-proof and eight plain washers.

- Collect the ribbon connector clamp and remove the key pad.

Pneumatic Equipment

Procedure

- Using the tubing pliers, carefully disconnect the appropriate tubing from the pneumatic equipment to be removed. After disconnecting collect and retain the small spring tubing clamps.

Hand-pump

- Unscrew and remove the hand-pump knob. Unscrew and remove the retaining nut, remove the hand-pump from the instrument case.

- Unscrew and remove the non-return valves complete with bonded seals from the end fitting of the hand-pump.

- Restrain the hand-pump end fitting and unscrew and withdraw the body of the hand-pump. Remove the o-ring from the end fitting.

- Remove the rubber piston ring and anti-extrusion ring from the piston. If necessary, unscrew the piston from the pump plunger.

  Note: On later instruments, Loctite thread sealant is used to secure the piston.

Volume Adjuster

- Unscrew the grub screw and remove the volume adjuster knob. Unscrew and remove the retaining nut, remove the volume adjuster from the instrument case.

- Unscrew and remove the two connections from the end fitting of the volume adjuster.

- Disconnect the connector PL3 on the main board. Using two spanners, restrain the volume adjuster and unscrew the 20 bar transducer.

Note: On earlier instruments there are no flats for a spanner on the volume adjuster . Use a strap wrench to restrain the volume adjuster.

- Unscrew and withdraw the body of the volume adjuster. Remove the rubber piston ring from the piston.

Vent Valve

- Using a small screwdriver remove the centre cap of the vent valve knob. Unscrew and remove the centre nut retaining the vent valve knob.

- Slacken the large nylon nut retaining the strap securing boss, unscrew and withdraw the strap securing boss. Collect the large nylon retaining nut and washer.

- Using a spanner, unscrew the nut securing the vent valve to the case. Withdraw the vent valve from the case.

Transducer (20 bar)

- Disconnect the transducer connector PL3 from the main board.
- Using two spanners, restrain the volume adjuster and unscrew the transducer.

Note: On earlier instruments there are no flats for a spanner on the volume adjuster. Use a strap wrench to restrain the volume adjuster.

Transducer (2 bar)

- Disconnect the transducer connector PL4 from the main board. Using a spanner restrain the transducer, slacken the retaining nut and remove the transducer.

Manifold/valve Assembly

Procedure

To access this assembly the complete pneumatics assembly must be removed. Using the tubing pliers, carefully disconnect the appropriate tubing from the pneumatic assembly. After disconnecting collect and retain the small spring tubing clamps.

- Unscrew and remove the knob and retaining nut of the hand-pump. Unscrew the grub screw and remove the volume adjuster knob. Unscrew and remove the retaining nut.
- Disconnect the following connectors from the main board: PL2, PL3, PL4 and PL10.
- Carefully lift out the complete pneumatic assembly.
- Unscrew and remove the two screws securing the manifold/valve assembly. Disconnect the cable assembly from the assembly.
    - To remove a solenoid valve from the assembly, unscrew and remove two screws securing the solenoid to the manifold.

Chapter 4 Cleaning and Inspection

Procedure

- To enable a component to be visually inspected for damage and signs of malfunction, each component must be thoroughly cleaned using the appropriate cleaning agents and methods.

Cleaning

Clean the case with damp lint-free cloth and mild detergent.

Clean the electrical connections using foam cleaner and a soft brush. Remove any dirt or debris from the instrument.

Note: All new components should be cleaned before fitting.

Inspection of Instrument

Examine the unit generally for signs of damage.

Examine the wiring for signs of overheating, damaged insulation and security.

Examine the terminals of electrical components for security of attachment and signs of damage.

Inspection of Pneumatic Components

Examine the piston of the hand-pump for wear. Make sure the piston ring and split backing ring show no signs of wear or splitting. Examine the o-ring located in the non-return valve housing of the pump for damage and wear.

Examine the plunger of the volume adjuster for wear. Ensure that the plunger sealing ring shows no sign of wear or splitting.

Examine the bore of the hand-pump and volume adjuster for signs of scoring and wear.

Printed Circuit Boards

Cleaning

Partially immerse the printed circuit board in a bath of Acetone and brush using a soft brush.

Partially immerse the printed circuit board in a bath of clean Acetone, remove and allow to dry.

Inspection

Examine the printed side of the printed circuit board for signs of cracks and corrosion.

Ensure that the printed circuits are firmly bonded to the boards over the complete area.

Examine the connector mounting nuts for security of attachment. Ensure that the connector pins clean and show no signs of distortion or corrosion.

Examine all electronic components for signs of overheating and security of attachment.

Chapter 5 Assembling

General

- Ensure all parts are clean before assembling. Absolute cleanliness of the work area, tools and equipment must be observed at all times.
- After assembling, the unit must be tested in accordance with Chapter 6 and if necessary, calibrated in accordance with Chapter 8.
- Ensure that all cables and ribbon connectors are routed correctly and do not protrude or foul.
- Carry out the leak test and pneumatic test procedure after re-assembly of the pneumatic component is complete.

Pneumatic Equipment

Manifold/Valve Assembly

- Make sure that the mating surfaces of the solenoid valve and manifold are clean before assembly.
- Insert the two screws in the solenoid valve and locate the plate washer over the screws. Make sure the holes in the plate washer align with the holes in the valve face. Secure the assembled valve with the two screws. Torque load the screws to 60 cNm (5.3lbf/in).
- Locate the manifold/valve assembly on the pneumatic assembly and secure with two screws.
- When the pneumatic assembly is complete and installed, connect the following connectors to the main board: PL2, PL3, PL4 and PL10.

Vent Valve

- Locate the vent valve in the instrument case and temporarily secure with the nut.
- Locate the crinkle washer, strap attachment and black spacer over the strap securing boss. Insert the assembled strap securing boss into the instrument case, locate the white nylon washer and retaining nut over the end of the strap securing boss. Align the strap securing boss with the port of the vent valve and screw boss into the port. Secure the strap securing boss with the white nylon retaining nut. Tighten the nut securing the vent valve.
- Locate the knob over the vent valve spindle and secure with centre retaining nut. Fit the centre cap in the knob.
- Locate the washer and a new bonded seal on the union and screw the union into the vent valve port. Using the pliers, reconnect the pipe to the union.

Transducer (2 bar)

- Screw the retaining nut onto the union of the transducer, locate and secure the transducer on the mounting bracket.
- Screw the union onto the transducer union.
- Connect the transducer to PL4 on the main board.
- Using the tubing pliers, connect the nylon tubing ,with the relief valve fitted, to the union.

Transducer (20 bar)

- Fit a bonded seal to the transducer union and tightly screw the transducer into the end of the volume adjuster.
- Connect the transducer to PL3 on the main board.

Volume Adjuster

- Fit a new rubber piston ring to the piston. If necessary, fit the piston on the piston rod and screw the end cap on the piston rod.
- Lightly lubricate the bore of the body tube and the piston with grease. Carefully insert, the piston into the body tube and screw the end cap onto the body tube.
- Lightly lubricate a new o-ring with grease and fit into the groove in the internal bore of the end fitting. Screw the end fitting onto the assembled body.
- Fit a bonded seal to each of the three adaptors and screw into the holes in the end cap.

Note: Take care not to over-tighten the adaptors.

- Fit a bonded seal to the transducer union and tightly screw the transducer into the end of the volume adjuster.
- Temporarily locate the assembled volume adjuster on the pneumatic assembly bracket.
- Using the tubing pliers, connect and secure the nylon tubing to the adaptors of the vol ume adjuster with the small spring clamps.

Hand-pump

- Fit a new rubber piston ring and anti-extrusion ring to the piston.

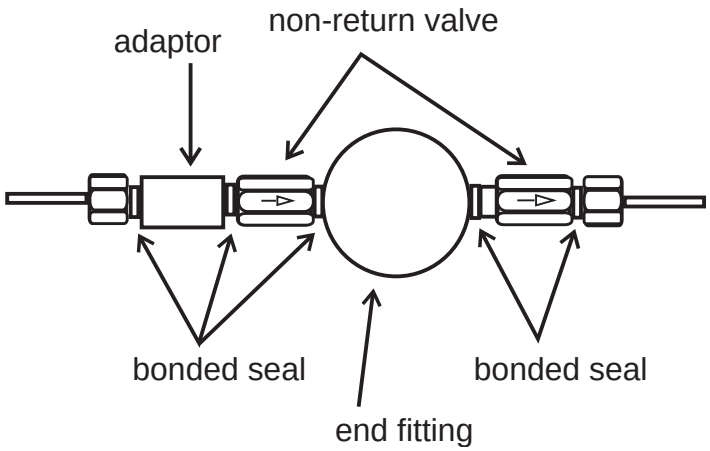
Note: The anti-extrusion ring is fitted nearest the piston rod.

If necessary, apply thread sealant to the threads of the piston rod and screw the piston on the piston rod.

- Lightly lubricate the bore of the body tube and the piston with grease. Carefully insert, the piston into the body tube and screw the end cap onto the body tube.
- Lightly lubricate a new o-ring with grease and fit into the groove in the internal bore of the end fitting. Screw the end fitting onto the assembled body.

- Fit a bonded seal to each of the two non-return valves and screw into the holes in the end cap.

Note: Take care not to over-tighten the non-return valves.



- Fit a bonded seal over the thread of the non-return valve and screw the adaptor onto the non-return valve.

- Fit a bonded seal over the thread of the union and screw the union into the adaptor. Repeat this operation for the non-return valve.

- Using the tubing pliers, connect and secure the nylon tubing onto the metal tubes of the unions.

Electronic Equipment

Key-pad

- Locate the studs of the key-pad in the instrument case. Locate the ribbon connector clamp over the ribbon connector and secure with pillar, nut, shake-proof and plain washers. Secure the key-pad with the remaining pillars, nuts shake-proof and plain washers.

Display Board

- Align the board over the ribbon connector clamp and threaded studs. Secure with the four screws, shake-proof and plain washers.

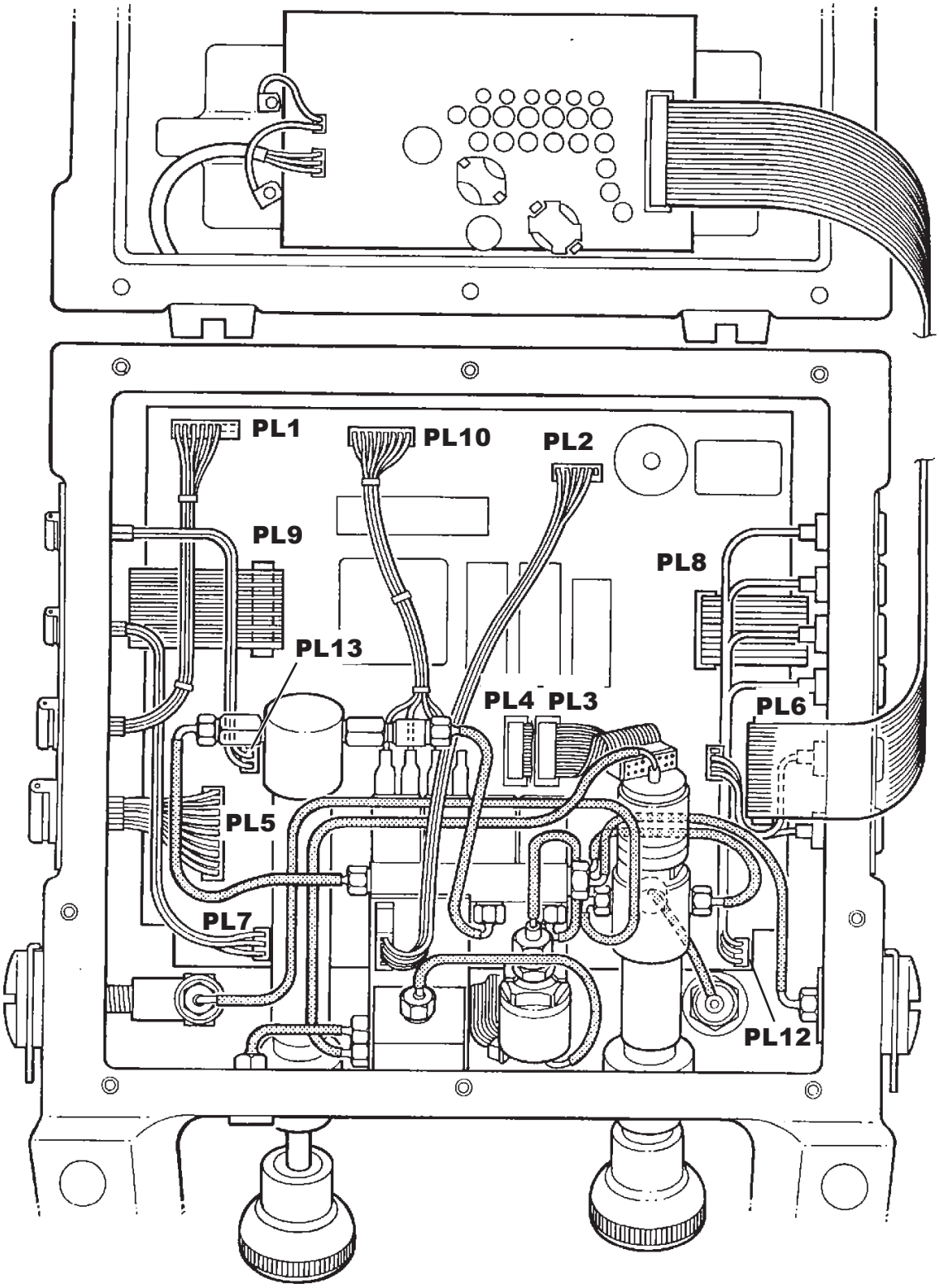
Note: On earlier instruments, it may be necessary to loosen the pillar next to the display board for alignment.

Main Board

- Carefully locate the board over the four threaded studs holes and secure with screws, shake-proof and plain washers.

- Connect the key-pad connector PL8. Connect the following connectors: PL5, PL7, PL9, PL10, PL11, PL12, PL13 and if the pneumatic assembly is fitted connectors: PL2, PL3, PL4, PL10.

Note: Make sure PL3 and PL4 are connected to the 20 bar and 2 bar transducers respectively.



Pneumatic Equipment and Main Board Connections

Power Supply Board

- Locate the power supply board over the four white plastic pegs, press the board firmly on the pegs. Each peg should click when the board is in place.

- Connect PL 1 and 2 on the power supply module connector. Connect the ribbon connector from the main board (PL6).

Final Assembling

- Make sure that the ribbon connectors and wires are not trapped, fit the base to the instrument and secure with the eight countersunk screws.

Chapter 6 Testing

General

- The following tests should be carried out whenever it is necessary to establish serviceability. The tests, together with Fault Diagnosis, should indicate the extent of any dismantling.

Equipment

The following test equipment is required and must be used as directed.

Note: Equivalent substitutes may be used.

- Pressure standard
- Digital Voltmeter (DVM)

Pneumatic Test

The tests should be carried out if any part of the pneumatic circuit has been disturbed. When an indicator instrument requires testing use an external, regulated pressure source.

Calibrator

- Open the vent valve. Switch on and zero the instrument, turn the volume adjuster to a mid-way position.
- Close the vent valve, turn the volume adjuster clockwise and check the pressure reading increases. Operate the hand-pump to approximately half-scale pressure.
- Turn the volume adjuster anticlockwise and check the pressure reading decreases. Make sure that the pressure reading change is smooth. Release the pressure by opening the vent valve.

Pump Blocking

- Set the safety limit to 5 bar, close the vent valve, operate the hand-pump and make sure that the pump blocking operates. Release the pressure by opening the vent valve.
- Reset the safety limit to 22 bar.

Leak Test (Calibrator)

- Close the vent valve and carefully operate the hand-pump for the following values.
- Select the leak test mode and set 5 minute wait time and 1 minute test time.
  The permissible leak rate for the pressure range are:

20 bar gauge	±0.0040 bar/minute
2 bar gauge	±0.0020 bar/minute
-1 bar gauge	±0.0015 bar/minute

Leak Test (Indicator)

- Close the vent valve and apply pressure for the following values

  Select the leak test mode and set 5 minute wait time and 1 minute test time. The permissible leak rate for the pressure ranges are 0.02% of full-scale/minute.

Leak Detection

- If a leak is present, switch off the instrument and disconnect the power supply.
- Protect the electronic components from moisture contamination when using the leak detector spray.
- Using leak detector spray, check the pneumatic system for leaking.
- Open the vent valve to release the pressure.

Switch Test

Select switch test mode and observe the switch status changing from open to close when terminals A and B are connected together.

RS232 Port

Link the data out to data in (pin 1 to pin 3) and link CTS and RTS (pin 2 to pin 5) on the RS232 port connector. Use the built-in RS232 self-test facility to establish that the RS232 port is correctly functioning.

Chapter 7 Configuration

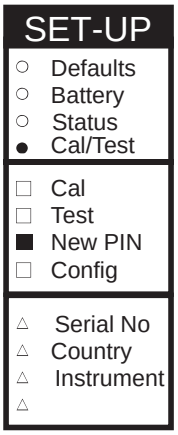
Instrument Configuration

- After changing a main board, the instrument must be configured for the particular application.Configuration involves the setting of the following parameters.

  - Serial Number
  - Country (UK, USA or Japan)
  - Instrument type (calibrator, indicator or rack mounted)

- To configure an instrument, proceed as follows:

  - Switch the instrument to ON
  - Press the SET-UP key
  - Select (Cal/Test) (F4) from the set-up menu.



The instrument will now prompt for entry of the current password as follows:

Cal/Test - Enter PIN number ☐

Note: Press the Set-up key and not the ENT key for this next operation.

- Enter the PIN of 777 on the numeric keyboard and press **Set-up**.

This gives access to the factory Config/Cal/Test as follows:

Factory Config/Cal/Test ☐

Cal Test New PIN Config

Select the **Config** option F4 from the menu, the display shows the options under **Config**:

Configuration ☐

Serial No. Country Instrument

Serial No.

Select **Serial No.** (F1) from the configuration menu and at the prompt :

Serial No☐

enter the required serial number (refer to the label on the base) and press ENT.

- Press **Exit Menu** to return to the configuration menu.

Country

Select **Country** (F2) from the configuration menu. The instrument responds by displaying the three options available:

UK USA Japan

Select the required option by pressing the appropriate function key (e.g., UK [F1]). The selected version will then be displayed in the status line above the function key:

UK Version
UK USA Japan

Selecting the country option has the effect of setting the default units for the pressure reading as follows:

Country	F1	F2	F3	F4
UK	bar	psi	inH_2O	mbar
USA	psi	inHg	inH_2O	kPa
Japan	kg/cm^2	inH_2O	mmHg	mbar

Instrument

Select **Instrument** from the configuration menu. The instrument responds by displaying the options available:

Indicator Calibrator Rack mount

Select the required option by pressing the appropriate function key (e.g., Calibrator [F2]). The instrument responds by displaying the instrument status above the function keys and requesting entry of then instrument type:

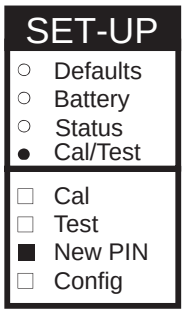
Calibrator Version
Commercial IS

- Select the appropriate version by pressing the relevant key (e.g., Commercial [F1]).

Note: If the rack mount version is selected for a portable instrument, the display contrast is drastically reduced. Other features e.g., Auto power-off will no longer be available.

- Press **Exit Menu** three times to quit Set-up.

- Set PIN number
  After configuring the new instrument, set-up the Cal/test PIN number as follows. This can be carried out directly from the SET UP menu or if the SET-UP has been exited, proceed as follows:



- Switch the instrument to ON
- Press the SET-UP key
- Select (Cal/Test) (F4) from the set-up menu. The instrument will now prompt for entry of the current password as follows:

Cal/Test - Enter PIN number ☐

- Enter the PIN of 777 on the numeric keyboard and press set-up. This gives access to the Factory Config/Cal/Test as follows:

Factory Config/Cal/Test ☐

Cal Test New PIN Config

- Select **New PIN** (F3), enter the required PIN number and press ENT.

Example:

- Enter new PIN number <3779>
- Pressing ENT sets no PIN.

Note: If no PIN number is specified, set the PIN to 123 (to correspond with the factory installed PIN)

- At the **Verify new PIN Number** prompt, enter the new PIN via the numeric key-pad and press ENT. If the new PIN is correctly entered, the instrument responds with Verification OK and exits the Set-up menu. If the new PIN is incorrectly entered at the **Verify new PIN Number** prompt, the instrument responds with **PIN numbers do not agree** and exits the Set-up mode and any old PIN number is returned.

Chapter 8 Calibration

General

The following procedures should be carried out whenever it is necessary to establish accuracy of the instrument.

Note: The tolerances stated in this chapter do not include the 90 day stability tolerance detailed in the data sheet.

Equipment

The following equipment is required and must be used as directed.

Note: Equivalent substitutes may be used.

- Pressure standard
- Digital Voltmeter (DVM) Datron 1061A Voltmeter or DMM20 (ATE) Datron 4700 Calibrator.
  For current measurement use resistance standard type RS3 as current shunt.
  For thermometer calibration use precision resistors of 0.01% accuracy.
- Frequency counter (Barometric option calibration only)

Calibration Adjustment

To access the calibration adjustment functions use the Cal/Test selection in the set-up menu. Press set-up key and select F4 for Cal/Test. Press the ENT key or enter the PIN.
In the CAL menu there are three selections:

- Ratio - a special calibration adjustment to enable the instrument to make very accurate and stable pressure readings from the Druck digitally-characterised transducers fitted in the instrument.
- Pressure - For accessing all pressure-related calibration adjustments.
- Electrical - For accessing all electrical-related calibration adjustments.

Calibration Adjustment of Pressure Ranges

Ratio

Calibration adjustment of ratio is achieved by measuring the voltages "PDCR Supply" and "Span Cal Sig" and entering the precise values through the keyboard. "PDCR Supply" and "Span Cal Sig" signals are, with respect to PL15 pin 3 (0 V), on PL15 pin 1 and pin 2 respectively. Pressure calibration adjustment must be carried out after this change.

Pressure Calibration

The standard 20 bar version of the instrument has two digitally-characterised transducers, 0 to 2 bar (gauge) and 2 to 20 bar (gauge). Linearity and temperature compensation data is contained in each internal transducer. It is only necessary to perform a two point span and zero calibration check.
To maintain instrument accuracy in vacuum a negative calibration check (-1 bar) should be performed. Negative pressures are applied by connecting a positive pressure to the reference port.

- Connect a pressure standard to the outlet port and apply pressures detailed in table 1. Check that all the points are within the stated tolerance.

- If a point is outside the tolerance a full linearity adjustment must be performed on the low pressure range transducer. This adjustment must include one of the five points at -1 bar (+1 bar applied to the reference port).

Indicator Version

- The standard indicator version contains one, non-digitally-characterised transducer, which connects to PL3 on the main board. Procedures and values are the same as the calibrator version.

Nominal Applied Value (bar)	Permissible Deviation (± 1 digit UOS)
0	±0.05 mbar
0.2	±0.025% reading
0.5	±0.025% reading
1	±0.025% reading
5	±0.025% reading
10	±0.025% reading
15	±0.025% reading
20	±0.025% reading
15	±0.025% reading
10	±0.025% reading
2	±0.025% reading
1	±0.025% reading
0.5	±0.025% reading
0.2	±0.025% reading
0	±0.05 mbar

Table 1 Calibrator, Internal Pressure Range - Positive Pressure

Nominal Applied Value (mbar)	Permissible Deviation (± 1 digit UOS)
0	±0.05 mbar
200	±0.025% reading
400	±0.025% reading
600	±0.025% reading
800	±0.025% reading
1000	±0.025% reading
800	±0.025% reading
600	±0.025% reading
400	±0.025% reading
200	±0.025% reading
0	±0.05 mbar

Table 2 Calibrator, Internal Pressure Range - Negative Pressure

Nominal Applied Value as per cent of full-scale	Permissible Deviation (± 1 digit UOS) <70 bar	70 bar to <700 bar
0	±0.01% FS	±0.016% FS
20%	±0.05% reading	±0.08% reading
40%	±0.05% reading	±0.08% reading
60%	±0.05% reading	±0.08% reading
80%	±0.05% reading	±0.08% reading
100%	±0.05% reading	±0.08% reading
80%	±0.05% reading	±0.08% reading
60%	±0.05% reading	±0.08% reading
40%	±0.05% reading	±0.08% reading
20%	±0.05% reading	±0.08% reading
0	±0.01% FS	±0.016% FS

Table 3 Indicator, Internal Pressure Range and All External Pressure Ranges

External Range

Generally, any Druck transducer, operating from 5 V dc excitation with a nominal output of 100 mV, can be fitted to the external port. The instrument prompts the data required on installation (i.e., serial number, type [absolute, gauge or differential] and required full-scale value). Make sure the existing linearity and temperature compensation (TC)points are "cleared" for the external transducer; any stored values gives spurious data affecting future readings. A two point span and zero calibration should be carried out, followed by a linearity check. If the linearity check is not within specification a linearity calibration adjustment must be performed. TC points are not required for non-digitally-characterised transducers.

Barometric Reference

- Each barometric transducer is supplied with 20 sets of data. A data set consists of 18 device constants with the serial number and checksum. The data, 18 constants, serial number and checksum, must be entered through the keyboard. A mistake made entering the data results in a checksum violation message.

- The frequency measurement must be calibrated by measuring the instrument's internal reference frequency, (nominally 10MHz) and entering the exact value through the keyboard. The frequency signal is measured on PL14 between pin 2 (+ve) and pin 3 (0V).

- The diode measurement must be calibrated by measuring the diode voltage and entering the exact value through the keyboard. The voltage signal is measured on PL16 between pin 1 (+ve) and pin 2 (0V).

- When these three procedures are complete, the instrument should display the barometric pressure ±1 mbar.

- The final stage of calibration adjustment of the barometric reference is the single point adjustment. This is carried out to correct any residual error left after completing the three procedures. This is achieved by selecting "1 point" from the barometric reference calibration menu and entering the accurate "pressure of the day".

Nominal Applied Value (mbar)	Permissible Deviation (± 1 digit UOS)
800	±0.15 mbar
890	±0.15 mbar
975	±0.15 mbar
1060	±0.15 mbar
1150	±0.15 mbar
1060	±0.15 mbar
975	±0.15 mbar
890	±0.15 mbar
800	±0.15 mbar

Table 4, Barometric Option

Electrical Calibration

Voltmeter

The voltmeter is auto-ranging in the normal operation, but during calibration adjustment each of the four individual ranges is separately adjusted. A two point span and zero calibration is carried out on each range. The zero point is achieved by shorting out the voltmeter input terminals. The upper point is achieved by applying a positive dc voltage of approximately the full-scale value for the range and entering the precise value through the keyboard.
The appropriate voltages for each range are as follows:

Range	Voltage
100 mV	95 to 105 mV
1 Volt	0.99 to 1.01 Volts
10 Volts	9.9 to 10.1 Volts
50 Volts	45 to 48 Volts

Nominal Applied Value (Volts)	Permissible Deviation (± 1 digit UOS)
0	
0.1	±0.01% reading
1.0	±0.01% reading
10.0	±0.01% reading
50.0	±0.01% reading
10.0	±0.01% reading
1.0	±0.01% reading
0.1	±0.01% reading
0	
-0.1	±0.01% reading
-1.0	±0.01% reading
-10.0	±0.01% reading
-50.0	±0.01% reading
-10.0	±0.01% reading
-1.0	±0.01% reading
-0.1	±0.01% reading
0	

Table 5, Voltmeter

Ammeter

Calibration adjustment of the ammeter is a two point span and zero calibration. The lower point is achieved by leaving the ammeter terminals disconnected. The upper point is achieved by applying a current of approximately full-scale (between 49 and 51 mA) and entering the precise value through the keyboard.

Nominal Applied Value (mA)	Permissible Deviation (± 1 digit UOS)
0	
25	±0.001 mA
50	±0.001 mA
25	±0.001 mA
0	
-25	±0.001 mA
-50	±0.001 mA
-25	±0.001 mA
0	

Table 6, Ammeter

Thermometer

The thermometer function within the instrument is a measurement of resistance of an external temperature sensor which is then related to a defined law and interpreted as a temperature reading. To calibrate the thermometer function apply two resistance values to the temperature probe input connector. Connect a resistor of 174 ±2Ω to the temperature probe input connector and enter the precise value through the keyboard. Repeat this operation with a resistance of 82 ±2Ω.

Nominal Resistance Value (Ohms)	Permissible Deviation (± 1 digit UOS)
82	±0.03°C
130	±0.03°C
174	±0.03°C

Table 7, Thermometer

Voltage Output

Calibration adjustment of the voltage output is a two point calibration. This is achieved by accurately measuring, in turn, two values of the output and entering the precise values through the keyboard. The voltmeter is connected between output terminals B (+ve) and C (-ve), the nominal output voltages are 10% and 90% of full-scale.

Nominal Output Value (Volts)	Permissible Deviation (± 1 digit UOS)
0	
5	±0.007% FS
10	±0.007% FS
15	±0.007% FS
20	±0.007% FS
24	±0.007% FS
20	±0.007% FS
15	±0.007% FS
10	±0.007% FS
5	±0.007% FS
0	

Table 8, Voltage Output

Current Output

Calibration adjustment of the current output is a two point calibration. This is achieved by accurately measuring, in turn, two values of the output and entering the precise values through the keyboard. The ammeter is connected between output terminals B (+ve) and C (-ve), the nominal output currents are 10% and 90% of full-scale.

Nominal Current Output (mA)	Permissible Deviation (± 1 digit UOS)
0	
10	±0.005% FS
20	±0.005% FS
30	±0.005% FS
40	±0.005% FS
50	±0.005% FS
40	±0.005% FS
30	±0.005% FS
20	±0.005% FS
10	±0.005% FS
0	

Table 9, Current Output

PART 3
FAULT DIAGNOSIS

CHAPTER 1 Fault Diagnosis

General

The following procedures are to be used in conjunction with the testing detailed in Part 2 Chapter 6 and should indicate the most probable cause of the defect and the recommended rectification.

Procedure

The following procedures list symptoms, the probable cause and the recommended action. The replacement of the components referred to are detailed in Part 2, Chapters 3 and 5, dismantling and assembling respectively.

Pneumatic Equipment Fault Finding

Symptom	Probable Cause	Action
Leak greater than the permitted rate	Leak in piping or connections	Check pipes for connections and obvious damage
	External leak in equipment	Carry out leak detection procedures detailed in testing
	Internal leak in equipment	Replace seals, washers and rings in the pneumatic equipment
Pressure readings erratic during pump and/or volume adjuster operations	Worn seals or piston rings	Replace seals and piston rings in the pump and/or volume adjuster
	Bore of pump and/or volume adjuster scored or worn	Replace pump and/or volume

Pneumatic Valve Fault Finding (calibrator)

It is important that no pressure is in the system during this test.

The four solenoid valves of the instrument can be individually selected and operated. To carry out a valve test, enter the set-up menu, select test and then pneumatics. The display shows a valve number above each function key.

Example:

Pressing F1 selects SV1, the display then shows an ON and OFF selection above the function keys and the name of the valve (for SV1 - pump limiting valve).

The valve can be selected and confirmed by the sound of the solenoid energising.

Note: This procedure does not prove that the valve seat is forming an airtight seal.

After completion of this test the instrument must be reset by re-cycling the ON/OFF switch.

Electrical Fault Finding

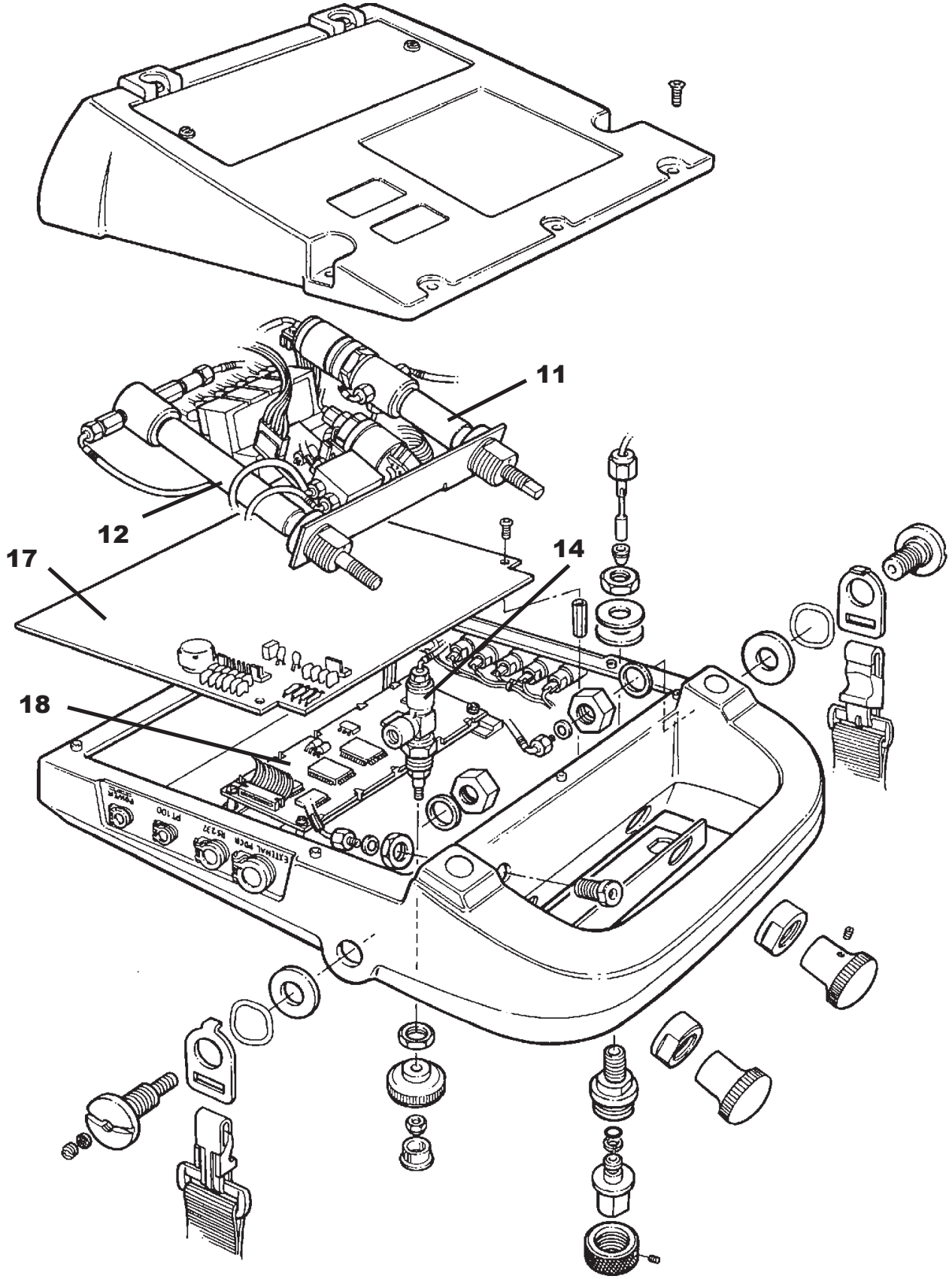
Symptom	Probable Cause	Action
Instrument will not switch ON.	Discharged batteries.	Connect charger or replace Alkaline batteries.
Switches OFF after short period of time.	Batteries almost discharged.	Recharge or replace.
No data transfer on RS232.	Difference in comms set-up between instrument and external system.	Check comms set-up must be the same at both ends.
Printer will not print.	Printer power or comms set-up. Incorrect printer selected.	Check printer supply and comms set-up.
Cannot select external transfer	External transducer fault	Exit the current mode and re-enter, or reset instrument by switching ON and OFF

PART 4
PARTS LIST

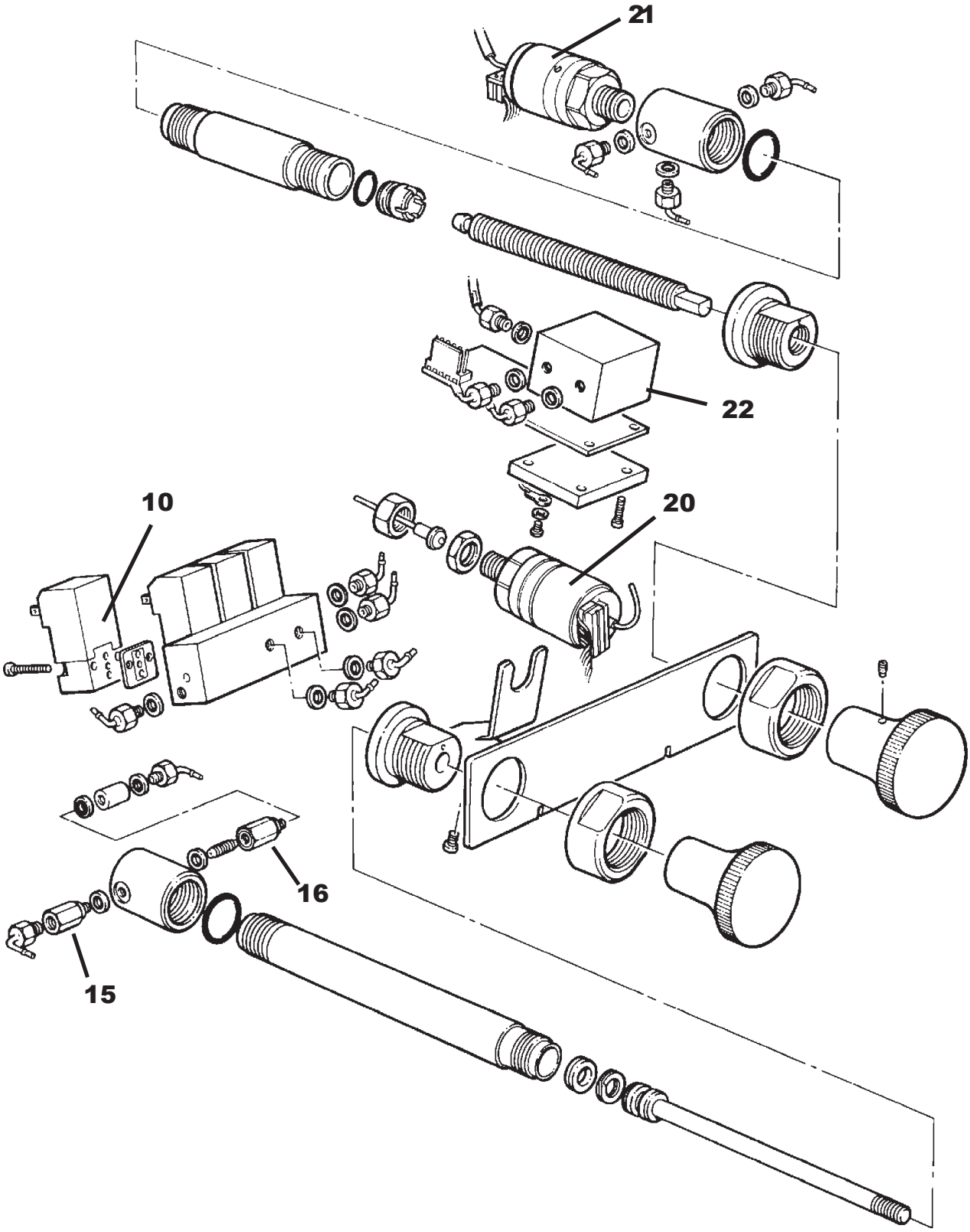
PARTS LIST

The following list gives details of all the parts that are available to the user. The parts are itemised to assist the user in locating each part. In general, parts list are in order of disassembly and are indented to show the relationship to the next higher assembly. The NI in the description column indicates the items that are not illustraited. The quantity shown is the quantity required for one instrument. The cost of these parts is issued on a separate price list.

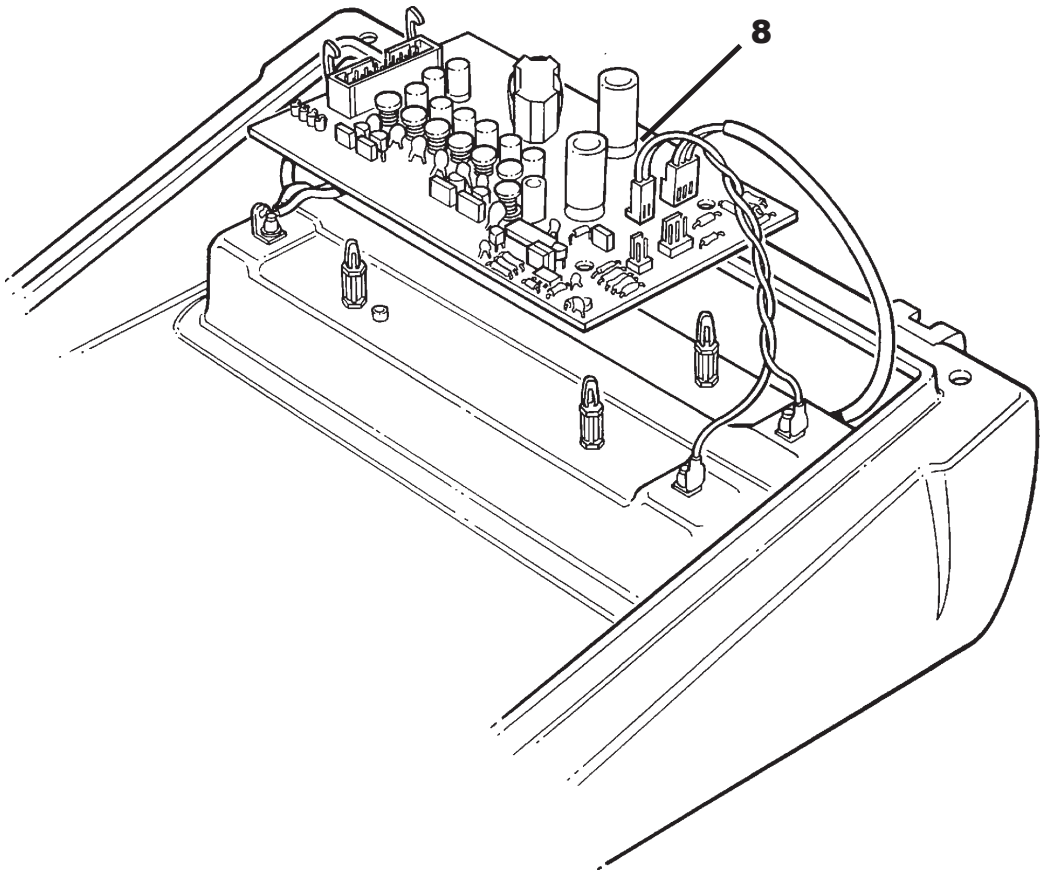
Item	Part Number	Description		Quantity
1	IA2046-1-V0	KIT, SHIPPING (INCLUDING OPTION F)	NI	1
2	197-156	.MANUAL, USER K136	NI	1
3	860-064	.CASE, CARRY	NI	1
4	209-148	.KIT, TEST LEAD	NI	1
5	191-080	.PACK, BATTERY (OPTION F)	NI	1
6	IA2067-1-V0	.ADAPTOR RS232-605	NI	1
7	IA2038-1-V0	BASE ASSEMBLY		1
8	IA2036-1-V0	. BOARD, PSU		1
9	IA2087-1-V0	KIT, SPARES, MANIFOLD/VALVE		1
10	176-031	. VALVE SOLENOID		4
11	IA2044-1-V0	VOLUME ADJUSTER ASSEMBLY		1
12	IA2045-1-V0	HAND-PUMP ASSEMBLY		1
13	IA2088-1-V0	KIT, SPARES, SEAL	NI	1
14	176-001	VALVE, VENT		1
15	176-002	VALVE MANIFOLD, NON-RETURN		1
16	176-018	VALVE, NON-RETURN, LP		1
17	IA2035-1-V0	PCB ASSEMBLY, MAIN		1
18	193-065	BOARD ASSEMBLY, DISPLAY		1
19	200--45	KEY-PAD	NI	1
20	D900- -07-1327	TRANSDUCER, PDCR 900, 2 bar gauge		1
21	D900- -13-1414	TRANSDUCER, PDCR 900 20 bar gauge		1
22	RPT101-1-01	TRANSDUCER, RPT101 800 to 1150 mbar absolute		1



DPI 605 Calibrator general view



Pneumatic Equipment



Power Supply Board

Customer service

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