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Colin Hinson

In the village of Blunham, Bedfordshire, UK.

Druck

Precision transducer systems
and electronic equipment
for research and industry

DPI 501 MK II
DIGITAL PRECISION PRESSURE CALIBRATOR

K 032

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DPI 501 MK II
DIGITAL PRECISION PRESSURE CALIBRATOR

K 032

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Issue Date 23rd November 1989

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1 INTRODUCTION

The DPI 501 combines a high stability pressure controller as developed by Druck for the DPI 500 range of products, with a high accuracy barometric pressure transducer, all under the supervision of a microprocessor.

The transducer gives a high accuracy frequency signal which is related to the absolute pressure, though not by a linear law. The microprocessor measures this frequency and by applying a complex formula, calculates the absolute pressure which is then displayed on the front panel LED display.

The controller holds a stable pressure, the value of which is set by the microprocessor working through a Digital to Analogue convertor. If this pressure is found, upon measurement by the frequency transducer, to be in error to the setpoint entered via the front panel keyboard, then the microprocessor can adjust the Analogue voltage to the controller accordingly.

The DPI 501 is supplied as standard with RS232 data interface and as an option the IEEE 488 interface can also be provided.

An automatic calibration mode is also available on the DPI 501 which enables the user to update the instrument calibration as required. This is carried out by applying high accuracy pressures which are used by the internal micro-processor to perform a least squares fit to recalibrate the internal sensor.

2 POWER CONNECTION

2.1 Supply Voltage

The DPI 501 is normally shipped set for operation from an a.c. supply with the following specifications:

200 - 260V a.c. 45 - 400Hz

By changing an internal selector switch or by special order on shipment, the DPI can be set for:

100 - 130V a.c. 45 - 400Hz

To remove the cover, remove 2 screws at the top of the rear panel and two screws on the underside of the instrument, near the front edge. Then slide the cover off. To refit the cover, reverse the procedure.

2.2 Connection

A.C. Power is applied to the instrument via the 3 pole connector on the rear panel (to specification IEC 320/BS 4491). A mating connector and lead is supplied with the instrument to which a plug suitable for the local supply should be fitted. The standard colour convention should be followed:

Brown	-	Line
Blue	-	Neutral
Green/Yellow	-	Earth

For safety the earth is permanently connected to the metalwork.

2.3 Fusing

On the rear panel above the power inlet is the power on/off switch and fuse. The fuse has the following specification:-

20mm long, 500mA, anti surge 250V ac ceramic

and should only be replaced by similar types. The power switch is protected by the fuse. This implies that while power is supplied to the unit, the fuse holder is live. The fuse holder meets VDE and SEMKO standards as shock-safe. It has a bayonet style screwdriver release.

3 INSTALLATION

3.1 The instrument is a bench mounted unit available in two configurations. The display and keyboard may either be mounted in the upper front panel of the unit or in a separate control pod capable of being mounted up to 1 metre distance from the main instrument. The pressure connections are all at the rear of the instrument. The connections are:

Vacuum - applied to the VENT port.

Pressure - applied to the SOURCE port.

This is required if the demand pressure is to be above the current atmospheric value - it should not exceed 125% F.S.

3.2 The normal installation will have the SENSE port blanked off and the OUTLET connected to the test chamber or device. The MEASURE port connects directly to the frequency transducer and should be coupled to the OUTLET via a Tee piece near to the DPI 501.

3.3 The SENSE shut off valve must be set in the fully anti-clockwise position for INTERNAL operation.

4 OPERATION

4.1 Initial Turn-on

4.1.1 On initial switch on the instrument will assume a measurement mode and indicate atmospheric pressure. A preset setpoint equivalent to 1000mbara and a LOW rate (500 ft/min on altimeter version) are established to ensure safe operation if the controller is turned on.

4.1.2 A warm up period of 15 minutes is recommended before full accuracy is achieved and the unit used for calibration.

4.2 Use of the Instrument

4.2.1 The controller is turned on and off by simply pressing the CONTROLLER ON/OFF key. The LED indicates controller operation.

4.2.2 The current value of setpoint is displayed by pressing the SETPOINT DISPLAY key. While the setpoint is being displayed the SETPOINT DISPLAY LED illuminates, the controller continues to operate and the pressure continues to move towards the demanded setpoint.

4.2.3 With the setpoint so displayed the value can be changed by entering a value on the keyboard. In the event of a wrong entry the display can be cleared with the CLR key.

To enter the setpoint being displayed press the ENTER SETPOINT key.

4.2.4 The pressure will then begin to change to the new setpoint at the rate displayed on the front panel. The rate can be increased at any time by pressing the SELECT RATE key. If it is desired to decrease the rate from MED to LOW (3000 ft/min to 500 ft/min on altimeter version) then the controller should be turned off while selecting the rate to avoid going at maximum rate.

Other rates may be selected using the IEEE option if fitted.

4.2.5 The flashing of the LOW (500'/min) or MED (3000'/min) LED shows that the pressure being demanded by the instrument is not being attained. This is due to the vacuum or pressure sources being unable to provide sufficient air flow for the rate selected. This can occur for large system volumes or high rates of change particularly at very low pressures.

The DPI 501 automatically reduces the rate when not tracking (LED flashing) to allow the pressure to catch up.

If a setpoint is entered that is greater than the SOURCE pressure (or less than the VENT pressure) the internal rate will rapidly reduce to zero when not tracking starts (LED flashing). If a new setpoint is now entered with LOW or MED rate selected there will be a delay of approximately 30 seconds before the pressure starts to change. There is no delay if MAX rate is selected.

4.2.6 During the slow pressure ramp the controller continually buzzes as the valves operate to keep the pressure rising. This is of no detriment to the controller.

4.2.7 The 'stab' control on the front panel adjusts the stability of the controller. The required setting will vary depending on the volume of the air system being controlled. Turning the 'stab' control clockwise increases the stability.

To find the optimum setting of the 'stab' control, connect the DPI 501 to the system to be controlled or a system of similar volume. It is best not to have any sensitive instruments connected to the system at this stage. Select a setpoint near full scale, MAX rate and switch the controller on. Turn the 'stab' control anti-clockwise until the controller goes unstable. This is indicated by rapid flashing of the A & R LEDs and clattering of the valves. Then turn the control clockwise until the instability stops.

4.3 RS232 Serial Output

4.3.1. Introduction

The RS232 facility on the DPI 501 allows the current pressure reading to be sent to a computer, VDU or printer either on demand or automatically every reading update, as well as providing the link to the powerful automatic calibration mode.

Both software and hardware handshakes are implemented, and the baud rate is selectable.

4.3.2 Sending Readings to a Printer

Readings may be continuously sent to a suitable printer by setting the mode select switch to the printer mode position (See switch settings). The printer must have an RS232 serial interface.

When the DPI is in printer mode, each new reading (approx 1 per second) is output to the printer. This mode is intended for use with dumb devices which cannot request a reading from the DPI.

If the new reading occurs before the last reading has been completely transmitted, then the new reading will be lost. Subsequent readings will only be output if all characters of the old reading have been output and an X-OFF condition does not exist (see handshakes below).

4.3.3 Sending Readings To A Computer (Sending Readings On Demand)

Readings may be transmitted from the DPI on demand. To select this mode, the mode select switch must be set to the computer mode position (see switch settings).

In computer mode, a reading will be output every time a carriage return is received. Proceeding characters will be ignored unless they are relevant e.g. entering calibration mode. To indicate that a reading has been demanded, the front panel Ren LED will flash.

4.3.4 Output Data Format

The output data is always of the form:

(sign) (6 digits with floating point) (space) (carriage return) (line feed)*

* Line feed is only transmitted if the DPI is in printer mode.

4.3.5 **Handshakes**

Software Handshake (X-ON, X-OFF)

The DPI supports the standard X-ON/X-OFF software handshake. Upon reception of an X-OFF, character output is suspended until receipt of an X-ON character.

Hardware Handshake

Hardware handshaking may be implemented using the RTS/CTS pins on the 25 way D-Connector.

When data is ready to be transmitted, the DPI will assert the request to send (RTS) pin (+12v), and wait until the clear to send (CTS) pin is asserted (>+3v) before commencing transmission. CTS may be left unconnected if required as it has an internal pull-up resistor.

Note that if CTS is taken low during transmission, there may be a one character over-run due to a character having already been placed in the transmit buffer.

4.3.6 **Baud rate and Serial Mode Switch Selection**

The Baud rate is selected internally by SW1-2 to SW1-4 on the computer board.

The following table shows the switch positions for the available baud rates. Switches off correspond to a '1'

SW 1 4 3 2	Baud	Diagram of SW set for 1200 Baud in printer mode as viewed from the rear of the DPI.
0 0 0	9600	
0 0 1	150 (110) see note	4 3 2 1
0 1 0	300	1 x
0 1 1	600	0 x x x
1 0 0	1200	
1 0 1	2400	
1 1 0	4800	
1 1 1	9600	

NB 110 baud is internally selectable on the COMPUTER board if Link 1 is replaced by Link 2 and SW1-2 to 4 are set to select 150 baud.

SW1-1 is the serial mode select switch.

0 Printer mode (reading every update).

1 Computer mode (reading on demand).

The unit is factory preset to 1200 Baud in the printer mode.

The serial data is sent as 1 start bit, 8 data bits with 1 stop bit. The msb is zero.

4.3.7 Pin Connections

Pin 2	-	TXD Transmitted data (from DPI)
Pin 3	-	RXD Received data (to DPI)
Pin 4	-	RTS Request to send (from DPI)
Pin 5	-	CTS Clear to send (to DPI)
Pin 7	-	Ground
Pin 20	-	DTR Data Terminal Ready (from DPI) - Connected to 12v via 470ohms.

4.3.8 Example Program to Input Readings from a DPI 501

The following BASIC program demonstrates taking readings on demand when the DPI is in 'computer mode'.

```
10 OPEN "SERIAL" AS FILE # 1          Open the RS232 port as file # 1
20 PRINT "HIT RETURN TO TAKE READING"
30 INPUT A$                           Wait for user Keyboard input
40 PRINT #1," "                       Send a carriage return to demand
                                      reading
50 INPUT #1,R$                        Input Reading from RS232
60 PRINT R$                           Print Input string
70 GOTO 20
```

Line 10 should be adjusted to suit the computer being used so that file #1 is opened for input and output.

5 CALIBRATION

5.1 Introduction

The DPI 501 is equipped with an automatic calibration facility which enables the user to update the instrument calibration using a primary pressure standard and an RS232 compatible terminal or computer.

A number of known pressures are applied and their values entered via the terminal. When all the pressures have been applied, the instrument performs a least squares fit using the known pressures and the pressures displayed. The changes in zero and span constants are displayed and the calibration can either be accepted or rejected.

5.1.1 Factory Calibration

The DPI 501 is calibrated during manufacture to meet the specification in section spec under ACCURACY RESET CALIBRATION. This is the default mode calibration that is used after a RESET command. Additionally, during final calibration before shipping, small adjustments are made using the Automatic Calibration Facility to produce the specification in section 6 under ACCURACY FINAL CALIBRATION. This is the accuracy of the DPI 501 as received by the customer. This calibration will be used unless the user carries out a calibration or activates the RESET command.

The production calibration certificate is supplied in the rear of this handbook.

5.2 To Perform An Automatic Calibration

To perform a calibration the DPI 501 must be connected to any standard RS232 terminal. See for connection details. The DPI must be set up in 'computer mode'. The terminal should be set in full-duplex mode. i.e. no local echo back. It is recommended to depress the CAPS LOCK key as all inputs are expected to be in upper-case.

At any point during a calibration, the DPI may be switched off and the old calibration will remain valid.

Also, if a calibration is accepted, it is possible to revert back to the original calibration during manufacture by use of the RESET command.

To enter Calibration mode.

Type K. <return>
(Both the 'K' and the '.' are required to avoid accidental setting of the mode).

The DPI will respond 'Calibration mode' and on the next line it will ask for a 'Pressure?'. A known pressure should be applied and when stable the value should be entered followed be <return>. The value should be entered in the units the pressure is displayed in and in the same format as the display e.g. '1013.25'. The DPI will then take and display three readings at this pressure and ask for a new pressure value. Between 2 and 10 calibration pressures may be applied. A numeric overflow error will occur if all the pressures are the same or nearly the same.

When all the points have been entered, the user should press <return> without a calibration pressure.

The DPI will display 'Calculating....' and there will be a pause for several seconds while the internal microprocessor calculates the new calibration constants. When these have been calculated, the change in zero (%FS) and span (%RD) from the previous calibration will be displayed. The new calibration can now be accepted or rejected. If rejected, the previous calibration will remain.

To accept the new calibration, the user should type 'Y', any other character will reject the calibration.

5.3 Pressure Media

Dry air must be used to calibrate the DPI to maintain accuracy and repeatability. Nitrogen or other gasses must not be used as the transducer is density sensitive.

5.4 Reset Command

If the user wants to revert back to the original calibration during manufacture he should set up the DPI to communicate in computer mode and send the DPI a RESET command.

Type R!

When the unit is using the original calibration, the instrument display will show '0.0.0.0.0.0.' rather than being blank for a second immediately after power-on. This will also happen if the latest calibration constants have been corrupted.

The accuracy after a RESET command is shown in section spec under ACCURACY RESET CALIBRATION.

6 SPECIFICATION

Operating Pressure Ranges

35-1150mbar absolute
35-2600mbar absolute
35-3500mbar absolute

Pressure Scale

As specified on order

Resolution

Display Capability 0 to 999999 e.g. 1 bar absolute version resolution 0.01mbar

Accuracy Final Calibration

Including calibration traceability Temp. effects 10°C-30°C, linearity, Hysteresis, repeatability & 1 year Long term stability.
Altimeter version ±0.012% RD ±0.008% FS
Other ranges ±0.015% RD±0.007% FS
Unless otherwise stated.

Accuracy Reset Calibration

Following a RESET command the accuracy will be within twice the above specification.

Stability

Over 12 months period stability will hold within 0.005% of FS as a typical value.

Overpressure

3 x the full scale value will not cause significant calibration change.

Pressure Media

Calibrated for use on dry air.

Rate of Climb

3 settings available from keyboard.
LOW 1.5% FS/Min (500ft/min altimeter version).

MED 8.3% FS/Min (3000ft/min altimeter version)
MAX unlimited
The ft/min values are nominal equivalents of pressure v. altitude relevant to values under 10000ft. These rates are approximate values (±5% only). Rate can be any required value using IEEE option.

Overshoot

When the controller is operating on LOW (500ft/min) or MED (3000ft/min) overshoot into a dead-end system will be within the specification of the instrument, approached from above or below the value.

Control Response

On unlimited position approx 10 secs into dead end system.

Control Stability

0.004% of full scale

Position Effect

Negligible

Supply Pressure

Source input should not be greater than +25% of full scale pressure.
Full vacuum causes no damage.
Zero air consumption at control point.

Leak Detection

Leaks in the system can be detected by switching the controller off.

Weight

8.2Kg nominal

Display

11mm seven seqment L.E.D 6 digit.

Operating Temperature Range

0°-50°C

Calibrated Temperature Range

10°-30°C

Power Supplies

110V or 240V 45-400Hz at 30VA max.

Pressure Connections

G1/8 (female) ports. 1/4" Tube adaptors are available.

Dimensions

222mm (wide) x 177mm (high) x 298mm (deep) Panel mounting facilities available.

Standard Output Facility

RS232 V24 serial communication ASCII handshaking. Baud rate selectable 110-9600 baud.
Printer mode - transmits every reading.
Computer mode - transmits on demand.

Automatic Calibration Mode

For automatic calibration mode any standard ASCII terminal is connected to the RS232 port. With calibration pressures applied the DPI 501 reads these pressure values and uses them to perform a least squares straight line fit resulting in new correction constants for the sensor. The user can elect to accept the new data or reject. If accepted the calibration is automatically updated. Revision to original factory figures is possible if required.

Calibration Standards

Instruments manufactured by Druck Ltd are calibrated against precision calibration equipment which is traceable to the U.K National Physical Laboratory.

7 OPTIONS

7.1 IEEE 488 Option

7.1.1 Introduction

The IEEE 488 Bus is a standardised instrumentation interconnection system which allows up to 15 instruments to be controlled from a single computer. Each instrument is given a unique "address" by switches or links in the instrument.

By using this address the computer can, by sending the relevant codes over the IEEE 488 bus, demand data from the instrument (TALK mode) or send control data to the instrument (LISTEN mode).

The IEEE 488 bus allows instruments to request service by activating the common SRQ (Service Request) line. The DPI 501 can be configured to use this facility to signal the occurrence of an error, an end of pressure conversion cycle, or the controlled pressure coming inside a predefined limit.

7.1.2 Operation for Pressure Indication

Figure 1 lists the control codes relevant to the DPI 501.

At power-on the instrument will be in local (Keypad) control, and the Remote-enable (Ren) light on the front panel will be off.

When in local control the current DPI reading and status can be obtained simply by addressing the DPI to "TALK". The front panel ren LED will flash on to show that the DPI has been addressed.

The exact information returned depends on the last notation code (N0, N1 or N2) sent to the DPI. (N0 being the power on default).

At any time codes which select different functions can be sent. However codes which effect the state of the controller (i.e. C,S or P) may only be sent when in remote control.

7.1.3 Operation for Remote Control - The R control code

Remote control can be enabled by sending the "R1" code to the DPI. When in remote control the front panel Ren light will be lit and the keypad will be disabled. The Ren LED will now flash off every time the DPI is addressed to TALK or LISTEN.

To return to local control "R0" must be sent. Any of the control codes may be sent when in remote mode.

7.1.4 Receiving Data

Figure 2 shows the formats for the various notation codes in which the DPI returns its data when addressed to "TALK".

7.1.4.1 N0 returns the current reading on the display. In remote mode, this will always be the latest pressure reading. However, in local mode it will return the current setpoint entered or being entered when the setpoint LED is on. @10 will also be sent as no new pressure reading is available in this condition.

7.1.4.2 N1 returns the in-limit status. This is "1" if the current pressure reading is within 0.02% F. of the setpoint pressure entered.

NOTE: If max (S2) rate is selected it is possible for the controller to overshoot, going in and then out of the limit.

7.1.4.3 N2 returns the general status of the DPI:

Current setpoint		(e.g. +1001.23)
Remote/Local	R1 =	remote, R0 = local
Controller on/off	C1 =	on, C0 = off
Selected rate	S0 =	LOW (500'/min)
	S1 =	MED (3000'/min),
	S2 =	max
	SV =	variable rate
SRQ Interrupts enabled	I0 =	no SRQ interrupts
	I1 =	error interrupt
	I2 =	in limit interrupt
	I3 =	in limit & error interrupts
	I4 =	End of conversion (EOC) interrupt
	I5 =	error & EOC interrupt
	I6 =	in limit & EOC interrupts
	I7 =	in limit, error & EOC interrupts
Tracking flag	T0	Not tracking
	T1	Tracking O.K

T0 Indicates that the setpoint pressure being demanded is not being attained. For a full explanation see Note, unlike the rate indicator LEDs, the T flag will also show if the instrument is not tracking on the maximum rate. The end of conversion (EOC) interrupt can be used to inform the host computer that a new pressure reading is available. This update is approx. 5 times per second.

7.1.4.4 **Error Indication**

Error indication can be turned off by sending the @0 code, and can be turned on again with @1. The @0 code does not have any effect on the SRQ on error interrupt.

(See srq)

@1 is default on power on.

Any error occurring is indicated by the addition of:

@ value
at the end of the data string. In modes N0 and N1 the occurrence of the '@' symbol changes the data to an impure numeric string, (i.e. a non numeric character occurs), which may give a convenient error detection process for the controlling computer.

This value is a two digit octal number giving the total representation of the 6 error functions.

Bit 0 - Programming data error
Bit 1 - Remote not enabled error
Bit 2 - Not used
Bit 3 - Data not ready

E.G. @01 indicates a wrong code sent to the DPI
@02 indicates an attempt to change the status of the controller before remote mode has been entered.
@03 indicates both the above errors have occurred.
@10 indicates no new pressure reading available since last reading (Only when in N0)
@12 indicates both @02 and @10

NOTE: The no new reading available error will not cause an SRQ error interrupt. The error acts only as a flag, and is cleared when a new reading is available. (A new reading is available approx. once per second). The reading given is the current pressure reading.

7.1.5 Service Request (SRQ) in error

By setting the Interrupt parameter to I1, I3, I5 or I7 the SRQ line will be pulled low whenever an error occurs. The line is then latched low until a serial poll occurs or until the DPI is next addressed to talk.

7.1.6 SRQ on in limit and end of conversion

The DPI can also be set up to interrupt when the DPI reading comes within 0.02% FS of the setpoint, and on the end of conversion of a new pressure reading. The interrupts are set up using the 'I' code. See Fig 1, for relevant I codes.

7.1.7 Serial Poll

The DPI has been designed to respond to a standard IEEE serial poll sequence. The serial poll response byte is as follows:

Bits 0-4	-	Error bits
Bit 5	-	End of conversion caused SRQ
Bit 6	-	SRQ bit. Set if the DPI caused the SRQ
Bit 7	-	SRQ caused by new reading coming in limit

7.1.8 Typical programming example

The following programmes are written in BASIC for the PET and HP 85 computers, but their principles can be applied to any IEEE System Controller. The routines allows direct entry of all the control codes via the keyboard and when Z is typed on the keyboard, data is requested from the DPI and then displayed.

7.1.8.1 Pet IEEE Interface with DPI 501

```
10 OPEN 1,add              add = DPI address (Switch
                           set.
                           See ISW (default address 19)
20 INPUT A$                input command string from
                           Keyboard
30 IF A$ = "Z" THEN 100    detect data demand
40 PRINT#1,A$              send command string to DPI
100 INPUT#1,A$             input data from DPI
110 PRINT A$               print data from DPI
120 GOTO 20                continue in loop
```

7.1.8.2 HP-85 IEEE Interface with DPI 501

```
10    IMAGE K                  causes the number to be output in compact
                               format
15    DIM V$[80]               define string size
20    INPUT V$                 input command from keyboard
30    IF V$ = "Z" THEN         detect Z command for
      GOTO 100                 data demand
40    OUTPUT 719 USING 10; V$  send command string to DPI (address 19)
                               using image specifier in line 10
100   ENTER 719; V$            input data from DPI
110   DISP V$                  display data on screen
120   GOTO 20                  continue in loop
```

7.1.8.3 Operating the program

Typing Z (return) will initiate the routine at line 100 and the current DPI data will be displayed. At power on notation 0 (N0) is default, so the data displayed Should be:

+1003.54 (for example)

Typing 'N2' (return) will select notation 2, which will display the setpoint and the status of the controller

+1000.00 R0 C0 S0 10 T11

4 OPERATION

4.1 Initial Turn-on

4.1.1 On initial switch on the instrument will assume a measurement mode and indicate atmospheric pressure. A preset setpoint equivalent to 1000mbara and a LOW rate (500 ft/min on altimeter version) are established to ensure safe operation if the controller is turned on.

4.1.2 A warm up period of 15 minutes is recommended before full accuracy is achieved and the unit used for calibration.

4.2 Use of the Instrument

4.2.1 The controller is turned on and off by simply pressing the CONTROLLER ON/OFF key. The LED indicates controller operation.

4.2.2 The current value of setpoint is displayed by pressing the SETPOINT DISPLAY key. While the setpoint is being displayed the SETPOINT DISPLAY LED illuminates, the controller continues to operate and the pressure continues to move towards the demanded setpoint.

4.2.3 With the setpoint so displayed the value can be changed by entering a value on the keyboard. In the event of a wrong entry the display can be cleared with the CLR key.

To enter the setpoint being displayed press the ENTER SETPOINT key.

7.1.9 Operation of the controller (Sending control codes)

Control codes are obeyed as soon as they are proven valid. If a string contains an error, the remainder of the string will be ignored.

For a complete list of control codes see figure 1.

Control codes may be grouped together to form a control string. Codes may be separated if desired by spaces or commas to add clarity, but this is not compulsary. The following are examples of valid control strings.

```
R0
N0
R0N0
R0 N0
R0,N0
R1 C1 N2 S2,P+815.7
R1C0,N0 S2,P950 C1
```

Commands which effect the controller status(i.e. the C,S & P codes) may only be sent after setting the DPI into remote mode with the R1 command.

To enter a new setpoint, the P code is used.

E.g. 'P 800' would enter a setpoint of 800.00

The 'P' may be followed by a space or a '+' before the first digit of the setpoint.

Example control string 'R1 N0 S1 P+346.5 C1' would set remote control, select pressure readings as output, select MED (3000'/min) rate, enter a setpoint of 346.5 and turn the controller on.

7.1.10 **Variable Rate**

As well as using S0 and S1 for low and MED rates, the V command can be used to select any required rate of change from 0.015mbar/min to 960mbar/min.

The format of the V command is similar to the format of the P command. The value associated with the V command determines the rate and should be an integer between 0 and 65535.

$$\text{Value} = \frac{78741}{\text{F.S.}} \times n$$

Where n is the required change/min and FS is the full scale of the DPI. n and FS must be in the same units.

E.g 20mbar/min for 1150mbar FS.

$$\text{Value} = \frac{78741}{1150} \times 20 = 1369.4$$

use value = 1369

When variable rate is selected, all the rate LEDs on the front panel will be off and the status returned in notation N2 will be SV instead of S0,1 or 2.

Selecting S0,1 or 2 will return the rate to the appropriate preset value. Selecting R0 will return the rate to low (500'/min).

As part of the no overshoot system, the internal rate builds up to the rate entered over approximately 5 seconds. The rate also decreases as the setpoint is approached. This should be borne in mind if testing rate of change indicates such as aircraft rate of climb meters.

The pressure difference at which the rate starts to decrease can be calculated by:

Pressure = rate no x 0.00016% F

NOTE Med (3000'/min) rate no. = 7092
LOW (500'/min) rate no. = 1182

Note that overshoot may result for large system volumes if the vacuum or pressure sources cannot provide the required flow rate.

7.1.11 Technical Specification

7.1.11.1 IEEE subsets implemented

The interface meets the IEEE 488 requirements for SH1, AH1, T6, TE0, L4, LE0, SR1, RL1 *, PP0, DC0, DT0.

* The "local lockout" is stimulated by sending the data code R1, not by universal command "LLO". The "go to local" is stimulated by sending the data code "R0", not by the universal command "GTL".

7.1.11.2 Received data format

The DPI will respond to control codes in a string provided:

1. There are no spaces within control codes except in 2 or 3. (Spaces and commas are valid control code separators).

2. The numeric value associated with the P command is sent in the following format:

<optional spaces><optional '+' sign><optional spaces>

<at least 1 digit><optional '.'><optional digits after

'.' > Excess digits are ignored.

3. The numeric value associated with the V command is sent in the following format:

<optional spaces><optional '+' sign><optional

spaces> <from 1 to 5 digits>

4. Valid codes must be followed by one of:

    1. another valid control code
    2. a space (ASCII (32))
    3. a comma
    4. Carriage return (ASCII (13))
    5. Line feed (ASCII (10))

5. If an erroneous code is sent, error @01 is set, no further action is taken and the rest of the string is ignored.

7.1.11.3 **Transmitted data format**

The data sent following the command to talk consists of one data string which is terminated by CR, LF, or CR LF depending on the setting of SW1. See ISW (default CR LF).

The EOI is sent with the last character.

The format of the data depends on the notation selected, but general rules apply:

1. A space follows each item in the string, acting as a separator.
2. All parameter code values are one digit without sign, terminated with a space.
3. The DPI reading and setpoint always consists of <sign> <six digits and one floating point ><space>
4. Error conditions are indicated by <@ 2 digit value> <space> except when disabled by the '@0' code.

The complete parameter is omitted in the absence of any errors.

7.1.11.4 **Address Switch & Data Output Format**

The DPI address is set internally by SW1 on the IEEE board. The address is set up on SW1-1 to SW1-5, SW1-1 being the least significant. The address is factory set to 19. Switches off correspond to a '1'.

SW1-8 and SW1-7 control the end of line format of the data sent.

The following end of line formats can be selected. (EOI is always sent with the last character).

FORMAT	**SW1-8**	**SW1-7**	
0	0	0	RESERVED.
1	0	1	LF with EOI
2	1	0	CR with EOI
3	1	1	CR, LF with EOI

The factory setting is 1,1.

SW1-3 is reserved.

The address switch setting and line format can be checked by holding down button "2" while switching the DPI on. The line format is shown on the right hand digit and the address in the middle. The switches can be changed while displaying the numbers.

Switch the DPI off and on to restore normal operation.

ADD	SW1 5	4	3	2	1
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0
31	NOT A VALID ADDRESS				

e.g Add 19, sending CR and 1F with EOI as viewed from the rear of the DPI

SW1	8	7	6	5	4	3	2	1
1	x	x		x			x	x
0			x		x	x		

Fig. 1 DPI 501 IEEE - 488 control codes

```
*     C0   Controller off
*     C1   Controller on
d     I0   No SRQ interrupts
      I1   SRQ on error
      I2   SRQ on in-limit
      I3   SRQ on error and on in-limit (= I1 with I2)
      I4   SRQ on End of conversion
      I5   = I1 with I4
      I6   = I2 with I4
      I7   = I1 with I2 and I4
d     N0   notation 0   (DPI pressure reading)
      N1   notation 1   (DPI In-limit status)
      N2    notation 2    (DPI setpoint & controller
      status)
*     P(value)enter new setpoint

d     R0   Local control
      R1   Remote control
d*    S0  Select LOW climb rate (500'/min on altimeter
      version)
*     S1  Select MED climb rate (3000'/min on altimeter
      version)
*     S2   Select maximum climb rate
*     V (value) enter new rate of change
      @0   Disable error reporting
d     @1   Enable error reporting

*     Only valid in remote control
d     default power on condition
```

Fig. 2 DPI 501 Notation Code Data Formats

```
N0   +x.xxxxx @xx
N1   x @xx
N2   +x.xxxxx Rx Cx Sx Ix Tx @xx
```

1. x is a numeric value 0-9
2. position of point can vary in N0 and N2, but is always after an 'x' and is always present
3. @xx is only sent if there is an error
4. Error code is octal representation of

Bit 0	Programming data error	@01)
Bit 1	Not in remote mode	@02)
Bit 2	reserved	@04)
Bit 3	no new data available	@10)

Fig. 3 DPI 501 Serial Poll Response Byte

Bit 0	Programming data error
Bit 1	Not in remote mode error
Bit 2	reserved (error)
Bit 3	no new data available error
Bit 4	reserved
Bit 5	In limit caused SRQ
Bit 6	1 if DPI caused SRQ
Bit 7	End of conversion

A P P E N D I X A

HUMIDITY OF PRESSURE MEDIA

The DPI 501 is calibrated for use on dry air and errors will result from using moist air. An increase in Relative Humidity (R.H.) will cause an increase in reading in the form of a span shift. The change In span has a non-linear relation to temperature. As the temperature increases, the error increases and the rate of change of error with temperature increases.

Expected errors for a change from 0 to 70% R.H. at various temperatures are shown below.

Temperature (°C)	Error (% reading)
10	+0.004
25	+0.010
30	+0.013

The error is approximately proportional to the change in % R.H.

Unacceptable errors may result from moisture entering the transducer (directly behind the 'MEASURE' port) and condensing on its internal surfaces.

To maintain specification, any tubing used in the system should be metal or polythene. Materials such as rubber or nylon exhibit significant out-gassing of moisture at low pressure which may increase the relative humidity of the air.

Before calibrating with dry air, the system should be purged to remove any moisture.

End of Handbook