



DPI 740



Portable Pressure Calibrator



User Guide M-2912

omega.com™**CEOMEGA®****OMEGAnet™ On-Line Service**
<http://www.omega.com>**Internet e-mail**
info@omega.com**Servicing North America:****USA:**
ISO 9001 CertifiedOne Omega Drive, Box 4047
Stamford, CT 06907-0047
Tel: (203) 359-1660
e-mail: info@omega.com

FAX: (203) 359-7700

Canada:976 Bergar
Laval (Quebec) H7L 5A1
Tel: (514) 856-6928
e-mail: canada@omega.com

FAX: (514) 856-6886

For immediate technical or application assistance:**USA and Canada:** Sales Service: 1-800-826-6342 / 1-800-TC-OMEGA™
Customer Service: 1-800-622-2378 / 1-800-622-BEST™
Engineering Service: 1-800-872-9456 / 1-800-USA-WHEN™
TELEX: 996404 EASYLINK; 62958934 CABLE: OMEGA**Mexico and
Latin America:**Tel: (95) 800-TC-OMEGA™ FAX: (95) 203-359-7807
En Español: (203) 359-1660 ext: 2203 e-mail: espanol@omega.com**Servicing Europe:****Benelux:**Postbus 8034, 1180 LA Amsterdam, The Netherlands
Tel: (31) 20 6418405 FAX: (31) 20 6434643
Toll Free in Benelux: 06 09920344
e-mail: nl@omega.com**Czech Republic:**Ostravska 767, 733 01 Karvina
Tel: 42 (69) 6311899 FAX: 42 (69) 6311114
e-mail: czech@omega.com**France:**9, rue Denis Papin, 78190 Trappes
Tel: (33) 130-621-400 FAX: (33) 130-699-120
Toll Free in France: 0800-4-06342
e-mail: france@omega.com**Germany/Austria:**Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
Tel: 49 (07056) 3017 FAX: 49 (07056) 8540
Toll Free in Germany: 0153 11 21 66
e-mail: germany@omega.com**United Kingdom:**ISO 9002 Certified25 Swannington Road,
Broughton Astley, Leicestershire,
LE9 6TU, England
Tel: 44 (1455) 285520
FAX: 44 (1455) 283912P.O. Box 7, Omega Drive,
Irlam, Manchester,
M44 5EX, England
Tel: 44 (161) 777-6611
FAX: 44 (161) 777-6622

Toll Free in England: (800) 458-488

e-mail: uk@omega.com

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WARNING: These products are not designed for use in, and should not be used for, patient connected applications.

DPI 740

Precision Pressure Indicator

User Manual

M-2912



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Safety

- The manufacturer has designed this instrument to be safe when operated using the procedures detailed in this manual. Do not use this instrument for any other purpose than that stated.
- This publication contains operating and safety instructions that must be followed for safe operation and to maintain the instrument in a safe condition. The safety instructions are either warnings or cautions issued to protect the user and the equipment from injury or damage.
- Use qualified* personnel and good engineering practice for all procedures in this publication.

Pressure

Do not apply pressure greater than the maximum safe working pressure to the instrument.

Toxic Materials

There are no known toxic materials used in this instrument.

Maintenance

The instrument must be maintained using the manufacturer's procedures and should be carried out by authorized service agents or the manufacturer's service departments.

Technical Advice

For technical advice contact the manufacturer, agent or subsidiary refer to the list at the rear of this manual.

- * A qualified person must have attended a product training course given by the manufacturer or appointed agent and successfully completed the training course on this instrument.



This product meets the essential protection requirements of the relevant EEC directives. Further details of applied standards may be found in the product specification.

Battery Safety

This instrument is fitted with three size AA batteries either rechargeable (nickel cadmium) or non-rechargeable (alkaline).

Before storing this instrument remove the batteries.

When fitting batteries make sure the electrical contacts are clean and observe the correct polarity.

The battery compartment should be inspected for corrosion caused by leaking batteries. Corrosion must be removed using approved methods*.

When storing and transporting batteries make sure that they cannot be short circuited. A short circuited battery can become very hot and can, in certain circumstances, explode. It is recommended that a suitable container is used for storing and transporting batteries.

Dispose of old batteries using a safe, approved method.*

*Refer to the Battery Manufacturer for this information.

Software Version

This manual contains operating instructions for instruments with software version 1.XX. Further changes to the instrument's software may require a change to the operating instructions and an issue number change of the manual.

Abbreviations

The following abbreviations are used in this manual.

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

ABS	acrylonitrile butadiene styrene
atm	atmosphere
BS	British standard
cmHg	centimeter of mercury
CTS	clear to send
DC	direct current
DCE	data circuit terminating equipment
DTE	data terminal equipment
DUCI	Druck Universal Communication Interface
ftH ₂ O	feet of water
FS	full-scale
hPa	hecto Pascal
Hz	Hertz
ICAO	International Civil Aviation Organisation
i/d	inside diameter
inHg	inch of mercury
inH ₂ O	inch of water
ISA	International standard atmosphere
kg	kilogram
kgf/cm ²	kilogram force per square centimeter
kgf/m ²	kilogram force per square meter
kPa	kilo Pascal
lbf/ft ²	pound force per square foot
LCD	liquid crystal display
mA	milli Ampere
mbar	millibar
mbar a	millibar absolute
mm	millimeter
mmHg	millimeter of mercury
mHg	meter of mercury
MPa	mega Pascal
mV	millivolt
Ni Cad	nickel cadmium
o/d	outside diameter
Pa	Pascal

Abbreviations continued

PCB	printed circuit board
ppm	parts per million
psi	pound per square inch
QFE	barometric pressure at airfield level (local)
QFF	calculated sea level pressure including air temperature
QNH	calculated sea level pressure
RPT	resonant pressure transducer
RTS	ready to send
RS232	Serial data communication standard
Rx	receive
Tx	transmit
V	Volt
VA	Volt amp
°C	degrees Celsius
°F	degrees Fahrenheit

Symbols

The following symbols are used to identify hazards on this instrument.



Static sensitive components handle with extreme care.



This symbol, on the instrument, indicates that the user should refer to the user manual.

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1 Introduction

The Omega DPI 740 precision pressure indicator uses a silicon resonant pressure transducer producing a pressure reading in units of pressure measurement and altitude.

The instrument is contained in a molded enclosure of a composite ABS material and can be used as a hand-held indicator or, using a retractable stand, as a bench instrument. The instrument can also communicate, through a serial RS232 connector, with a compatible computer system or printer.



Figure 1-1 General view

1.1 Specification

Dimensions

Weight: (nominal) 0.2 lbs (0.5 kg)

Size: height = 7.48" (190 mm) width = 3.54" (90 mm),
depth = 1.42" (36 mm)

Environmental

Temperature:

Operating 15° to +120° F (-10° to +50° C)

Storage -40° to +160° F (-40° to +70° C)

Pressure medium: Any gas compatible with pyrex,
silicon, stainless steel and epoxy resin

Sealing standard NEMA 4 (IP54)

Pressure

Connector 0.236" (6 mm) o/d

or 0.157" (4 mm) i/d hose fitting

Accuracy

Non-linearity, hysteresis and repeatability:

over the range of 50° to +70°F (10° to 30° C)

..... ±0.02 % FS

over the range of 32° to +105°F (0° to 40° C)

..... ±0.03 % FS

over the range of 15° to 120°F (-10 to +50°C)

..... ±0.045 % FS

Stability <100 ppm/year

Range (barometric) 22 to 34 inHg a
(750 to 1150 mbar a)

alternative ranges:

..... 1 to 38 inHg a
(35 to 1300 mbar a)

..... 1 to 75 inHg a
(35 to 2600 mbar a)

..... 1 to 100 inHg a
(35 to 3500 mbar a)

Maximum safe working pressure 129 inHg a
(4375 mbar a)

Specification (contd)**Display**

Read-out 999999 LCD digits, 0.535" (13.6 mm) high
with additional 16 text characters

Overload indication

Error code flashing at nominal 110% FS

Response

..... nominal 2 readings/second

Resolution

0.001 inHg (e.g., 1.034 inHg a)

Electrical Power Supply

Batteries: 3 x 1.5 V alkaline size AA

Connections

external power adaptor/charger

..... International power jack

RS232 serial communications

..... 6-way LEMO type

Electrical safety

This instrument meets:

..... BS EN 61010 as applicable

Electromagnetic compatibility

This instrument meets:

.. EN50081-1 (emissions)

... EN50082-1 (immunity)

*Continuing development some needs necessitates
specification changes.*

1.2 Accessories and Options

The instrument is delivered with the following:

Accessories

- i. User manual KA200 (this publication).
- ii. Calibration certificate.
- iii. Carrying case.

Options

A Enhanced barometric accuracy

over the range of 40° to 70° F (10° to 30° C)
..... ± 0.004 inHg (± 0.15 mbar)

B NiCad batteries and power adaptor/charger

Adaptor/charger

External Power

100 to 240 V AC. (nominal)

..... 10 VA, 47-65 Hz

Output

12 V DC., 800 mA (maximum)

Connection

International power jack

C Adaptor cable

For RS232 connecting the 6-pin LEMO to standard
9-way D type.

D Transit case

2 Installation

WARNING:

DO NOT ATTEMPT TO CHARGE NON-RECHARGEABLE BATTERIES. TO PREVENT ACCIDENTAL CHARGING OF NON-RECHARGEABLE BATTERIES THE CHARGE LINK LK2 MUST BE IN THE DISABLED POSITION (X).

CAUTION:

DO NOT LEAVE DISCHARGED BATTERIES IN THE INSTRUMENT.

OLD BATTERIES CAN LEAK AND CAUSE CORROSION.

WHEN FITTING THE BATTERIES MAKE SURE THE ELECTRICAL CONTACTS ARE CLEAN AND OBSERVE THE CORRECT POLARITY.

Note: For further information, refer to the safety page at the front of this manual and to the battery manufacturer.

2.1 Battery (Figure 2-1)

Three batteries are fitted in the battery compartment.

For non rechargeable batteries make sure the charging link LK2 is fitted in the disabled position (X).

For rechargeable batteries make sure the charging link LK2 is fitted in the enabled position (✓).

Note: The charging link LK2 is located on the instrument PCB. To access this link remove the top case assembly.

To replace the batteries, unscrew the captive screw and slide off the battery compartment cover. Make sure the polarity of the new batteries is correct.

If the battery capacity is low the display shows:

- The battery symbol (approximately 1 hour left).
- The flashing message **Battery Very Low** for 15 to 20 minutes.
- The message **Batteries Dead!** followed, after a short time, **Switching Off!!** the instrument then automatically switches off.

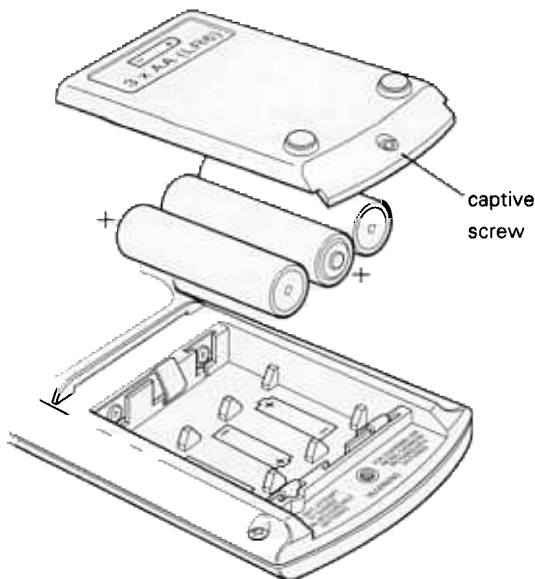


Figure 2-1 Fitting the Battery

2.2 Electrical connections **(Figure 2-2 and 2-3)**

The optional adaptor/charger is supplied with a set of interchangeable connectors so that the unit can be used worldwide. To change the power pin adaptor push the adaptor from the charger body, align the replacement adaptor and push onto the charger body.

Battery charger

This is a two-pole, 0.1" (2.5 mm), center pin connector:

- ve - center pin.
- +ve- outer connector casing.

RS232 connections

Option C is the adaptor cable recommended for use with the RS232 serial communication interface. The adaptor cable has, at one end, 6-pin LEMO type connector and, at the other, a 9-way D type connector. The instrument's serial communication settings and the data terminal equipment (DTE) settings must be the same. The recommended initial settings are as follows:

Baud rate	-	9600
Data bits	-	8
Stop bits	-	1
Parity	-	none
Handshaking	-	none

Adaptor Cable

Instrument (DCE)			PC (DTE)		
LEMO connector			D type Connector		
			9-way		25-way
Pin No.	Function	Flow	Function	Pin No.	Pin No.
1	RxD input	←	TxD	3	2
2	CTS input	←	RTS	7	4
3	GND (screen)	↔	GND	5	7
4	not used	-	-	-	-
5	RTS output	→	CTS	8	5
6	TxD output	→	RxD	2	3

Notes

- The function column for the D type connector uses RS232 terminology with respect to DTE.*
- In the D-type connector DTR and DSR should be connected together as follows:*

9-way	pin 4 and 6
25-way	pin 20 and 6
- The instrument's serial communication settings can be changed using the set-up menu.*

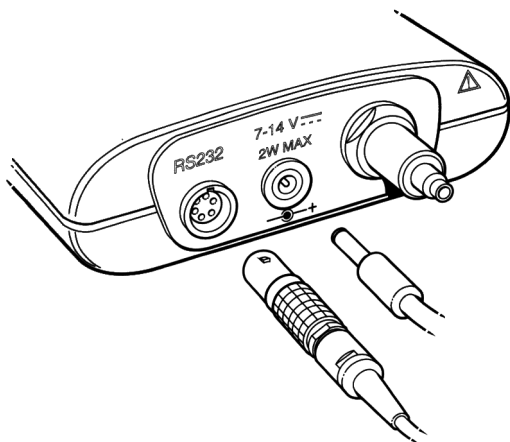


Figure 2-2 Electrical connection

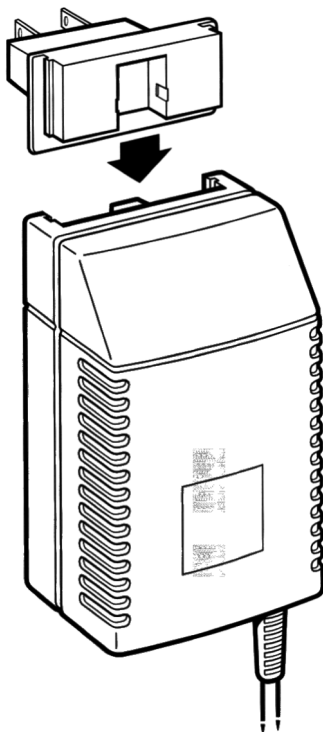


Figure 2-3 Adaptor/charger connector

2.3 Initial Settings

The instrument is shipped with the following settings:

Standard Instrument Settings

Units of pressure measurement (selected by F2) inHg, mbar, psi
Battery charging link (LK2) disabled (X)
Calibration link (LK1) disabled (X)
PIN 000
Time-out	enabled (1 minute)

Option B Instrument Settings

Units of pressure measurement (selected by F2) inHg, mbar, psi
Battery charging link (LK2) enabled (✓)
Calibration link (LK1) disabled (X)
PIN 000
Time-out	enabled (1 minute)

3 Operation

3.1 General (Figure 3-1)

The instrument is switched on by the ON/OFF push-button and powers up in the last selected mode and units of measurement. The instrument "times-out" after a period of one minute if no push-button selections are made. To keep the instrument in the powered-up state the ON/OFF and MODE push-buttons should be pressed together. The display briefly shows a "Time-out Disabled" message. Pressing the MODE push-button steps through the three pressure measurement modes. Pressing the SET push-button steps through the set-up menu (described in 3.3).

3.2 Measurement Modes (Figure 3-1)

Selecting the MODE push-button, changes the measurement mode between:

Local (QFE unprocessed pressure at the pressure port).

Sea (QFF calculated pressure at sea level).

Altitude (calculated height from pressure datum).

Selecting the push-button F2 changes the units of pressure measurement, continuous pressing steps between three pre-selected units, the display shows the units for each measurement mode.

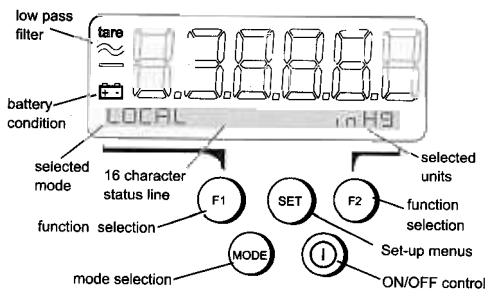


Figure 3-1 Instrument front panel

Local (QFE) Measurement (Figure 3-3)

This is the direct measurement of the absolute pressure sensed at the pressure port. In addition to measuring local pressure the instrument can, with the use of a hose and a connector, measure absolute pressure at a system test point.

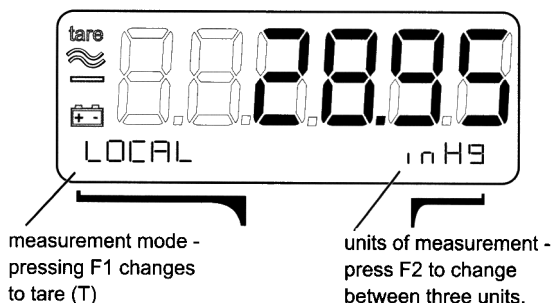


Figure 3-3 Local pressure measurement

Sea Level (QFF) Measurement (Figure 3-4)

This mode measures the sea level pressure. It is the meteorological presentation (QFF) of barometric pressure at mean sea level and is a calculated value based on the local height above sea level and the local air temperature.

Note: *QNH is a derivative of QFF without a correction*

Setting local height and temperature data

These correction factors are entered for a particular site and remain stored in nonvolatile memory to correct the pressure value when **Sea** (QFF) is selected. The two correction factors are mean height above sea level in meters or feet (units selected in altitude mode) and the local air temperature in °C.

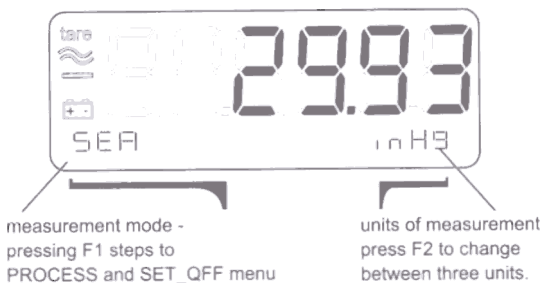


Figure 3-4 Sea level measurement

Entering Local Height and Temperature Data for Sea Level Pressure Measurements

The instrument stores the local height and temperature data used in the sea level pressure measurement in nonvolatile memory. To enter this data proceed as follows:

1. Press the MODE push-button to select sea level pressure measurement mode (confirmed by the display showing "Sea" on the status line).
2. Press F1 to show the measurement menu.
3. Press F2 selecting the SET_QFF parameter (confirmed by the display flashing "Enter Height ASL").
4. Press either F1, F2 or SET to allow the height to be entered (the display stops flashing).
5. Use F1 to increase the height value and F2 to decrease the height value.

Note: *Pressing and holding either F1 or F2 changes the value at a fast rate. Pressing and holding MODE and either F1 or F2 accelerates this fast rate.*

6. When the height is correct press SET, the display changes to flash "Enter Temp".
7. Repeat steps 4, 5 and 6 to enter the temperature value. The display returns to sea level pressure measurement, corrected using the new height and temperature data.

Note: *Pressing the MODE push-button steps menu back one setting, allowing a value to be corrected.*

Altitude Measurement (Figure 3-5)

This mode measures the vertical distance between a level and a specific pressure datum. Measurements of altitude are calculated from local pressure according to ICAO standard atmosphere tables defined in BS 2G 199: 1984. The default pressure datum is the ISA, 29.92 inHg (1013.25 mbar). A user defined pressure datum can be entered by the SET_ALT menu. This datum can be a specified pressure datum known or required by the user such as true sea level pressure or airfield ground pressure at the time of measurement.

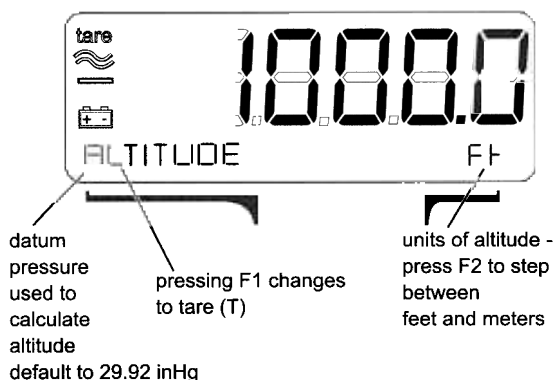


Figure 3-5 Altitude measurement

Entering a Pressure Datum for Altitude Measurement

The instrument stores the pressure datum used in altitude measurement in volatile memory with a default value of 29.92 inHg. To enter a new pressure datum proceed as follows:

1. Press the MODE push-button to select altitude measurement mode (confirmed by the display showing "ALTITUDE" on the status line).
2. Press F1 to show the measurement menu.
3. Press F2 to change the altitude settings by selecting "SET_ALT".
4. Press F1 if the datum required is the ISA. To enter any other datum press F2.
5. Press either F1, F2 or SET to allow the datum to be entered (the display stops flashing).
6. Use F1 to increase the datum value and F2 to decrease the datum value.

Note: *Pressing and holding either F1 or F2 changes the value at a fast rate. Pressing and holding MODE and either F1 or F2 accelerates this fast rate.*

7. When the datum value is correct press SET, the display returns to altitude measurement corrected using the new pressure datum.

Note: *Pressing the MODE push-button steps menu back one setting, allowing a value to be corrected.*

Processing Measurements (Figure 3-6)

The instrument can process the measurement results in the following ways:

- Tare
- Filter
- Max/min

Tare

Each measurement can be individually "tared". The tare function subtracts the presently measured value from all subsequent measurements. When the tare function is enabled, the display flashes the **tare** symbol. To enable and disable the tare function, proceed as follows:

1. Press the MODE push-button to select the measurement to be tared.
2. Press F1 to enter the instrument menu.
3. Press F1 to view the process options.
4. Press F1 again to view the tare options.
5. Press F1 to enable tare or F2 to disable tare.

Filter

When switched on the low pass filter is applied to all measurements in all three measurement modes. Before switching on, the two parameters of BAND and TIME should be set.

Note: *When the time constant in the sample is large and the filter is active at power-up, enough time must be allowed for the sample to be received and a stable reading to be displayed.*

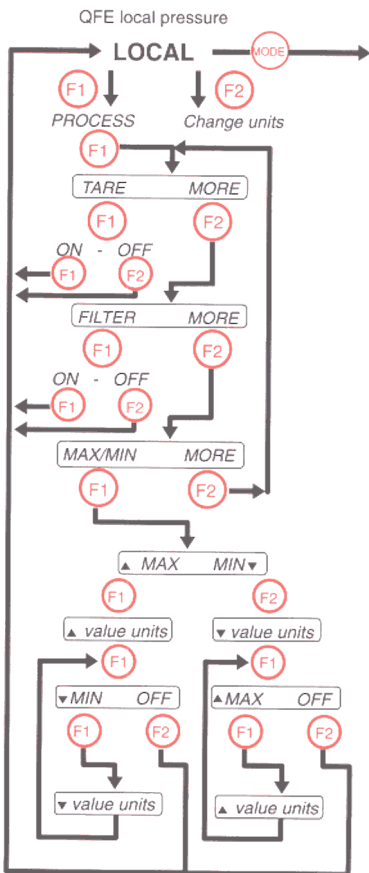
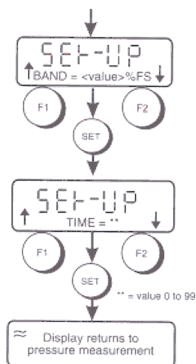


Figure 3-6 Process sub-menu

Entering the Filter Parameters

BAND → % of FS is the maximum percentage change in reading that can occur before the filter directly follows the changing pressure. This parameter can be set between 0 and 10% FS.

TIME is the time constant of the filter; when a small step change in pressure is applied (less than the band setting), it is the time to reach approximately 63% of the final value. The final value will be reached in five time constants.



Example

With the TIME set to 2 seconds, the display shows the full pressure value after 10 seconds.

Proceed as follows:

1. Make sure the instrument is in measurement mode and displaying pressure.
2. Press SET twice and status line shows "MAX/MIN FILTER".
3. Press F2 to select FILTER settings.
4. Use F1 ↓ and F2 ↑ to set the BAND value.
5. Press SET when the display shows the required value.
6. Repeat steps 4 and 5 to enter the TIME value. Pressing SET returns the instrument to measurement mode with the new filter settings stored and ready for use.

Note: *The filter parameters are nonvolatile and remain stored with the instrument switched off.*

Switching the Filter ON or OFF

To switch the filter on proceed as follows:

1. Make sure the instrument is in measurement mode and displaying pressure.
2. Press F1 to enter the instrument menu.
3. Press F1 to enter view process options.
4. Press F2 to view the next option (FILTER).
5. Press F1 to view the filter options.
6. Press F1 to switch filter on or F2 to switch filter off.

Note: When the filter is switched on, the display shows the \approx symbol.

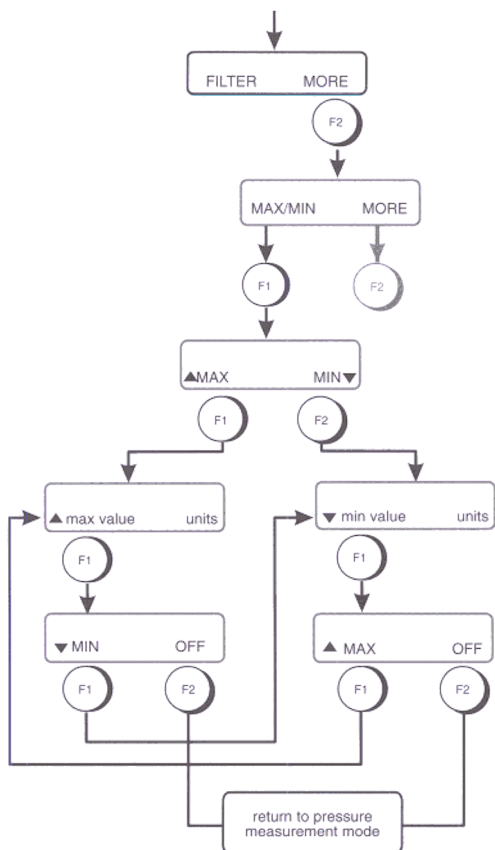
MAX/MIN

In normal measurement mode the max/min measurements are recorded as a background task. The store is reset when the instrument is switched on or can be reset at any time.

Resetting the Maximum/Minimum Store

Proceed as follows:

1. Make sure the instrument is in measurement mode and displaying pressure or altitude.
2. Press SET twice (status line shows "MAX/MIN FILTER").
3. Press F1 to select the MAX/MIN sub-menu.
4. Press F1 to reset the MAX/MIN store and return the instrument to measurement mode.

**Figure 3-7 MAX/MIN menu**

Viewing the Maximum and Minimum

Proceed as follows:

1. Make sure the instrument is in measurement mode and displaying pressure.
2. Press F1 to enter the instrument menu.
3. Press F1 to view process options.
4. Press F2 until the status line shows MAX/MIN.
5. Press F1 to view max/min options.
6. Select MAX (F1) or MIN (F2) the status line shows the recorded value.
7. Press F1 then F2 to switch off either the maximum or minimum value. Press F1 twice to view the other maximum or minimum value.

Note: *The Max/Min options must be re-selected after changing to another measurement mode.*

3.3 Set-up Menu (Figure 3-8)

To change other less used facilities and background tasks, enter the set-up menu by pressing the SET push-button. Pressing SET again steps to the next sub-menu set. In each sub-menu the function push-buttons F1 and F2 are used to select the required task.

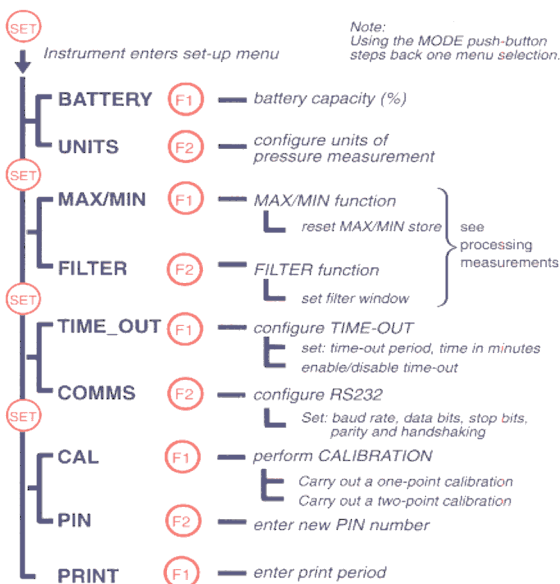


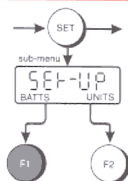
Figure 3-8 Set-up Menu

Battery

This sub-menu shows the capacity charge compared to the full charge capacity shown as a percentage in 25% bands.

example:

Battery 75-100%



Units

When in the local or sea level measurement modes pressing F2 changes the units of pressure measurement between three preselected units, held in nonvolatile memory. When shipped, the instrument's units of pressure measurement are: inHg, mbar and psi. These units of pressure measurement can be change to any from the following list:

0	-	mbar	12	cmH ₂ O
1	-	bar	13	mH ₂ O
2	-	Pa	14	torr
3	-	hPa	15	atm
4	-	kPa	16	psi
5	-	MPa	17	lbf/ft ²
6	-	kgf/cm ²	18	inHg
7	-	kgf/m ²	19	inH ₂ O20, (20°C)
8	-	mmHg	20	inH ₂ O04, (4°C)
9	-	cmHg	21	ftH ₂ O20, (20°C)
10	-	mHg	22	ftH ₂ O04, (4°C)
11	-	mmH ₂ O	23	inH ₂ O60, (60°F)

Changing the preselected units of pressure

Proceed as follows:

1. Press the SET push-button.
2. Press F2 to select UNITS.
3. Use F1 and F2 move up and down the list of units.
4. Press the SET push-button to select the required unit.
5. Repeat steps 3 and 4 to select the second and third units

Notes

The storing of the new units takes place when the SET push-button is pressed for the third unit. The instrument then returns to the pressure measurement mode with the three new units and available on push-button

2.**Units of Altitude Measurement**

When the instrument is in altitude measurement mode, pressing F2 changes the units of height measurement between feet and meters. These two units are held in nonvolatile memory.

Time-out

The time-out period can be set between 1 and 15 minutes (default 1 minute). In the enabled state, if no push-buttons have been pressed, the time-out switches the instrument "off" after the time elapsed. Pressing the ON/OFF push-button "on" resets the time-out and switches the instrument back on. When this function is disabled the instrument can only be switched off by the ON/OFF push-button.

Notes

- 1. The time-out function is disabled in calibration mode.*
- 2. When switching the instrument on, the time-out can be disabled by pressing MODE and on/off push-button together.*

Adjusting the Time-out Period

Proceed as follows:

1. Make sure the instrument is in measurement mode and displaying pressure.
2. Press SET until the status line shows "TIME_OUT".
3. Press F1 to select time-out settings.
4. Use F1 ↑ and F2 ↓ to adjust to the required time-out period.
5. Press SET.
6. Press F1 to enable (ON) the time-out function and press F2 to disable (OFF) the function.

Note: *The instrument stores the adjust time-out period as the default value in nonvolatile memory.*

Serial Communications (Figure 3-9)

The instrument uses RS232 communication parameters as follows:

Baud rate	- 19200, 9600 , 4800, 1200, 600, 300 & 150
Data bits	- 7,8
Stop bits	- 1,2
Parity	- none , even, odd
Handshaking	- none , software, hardware

Notes

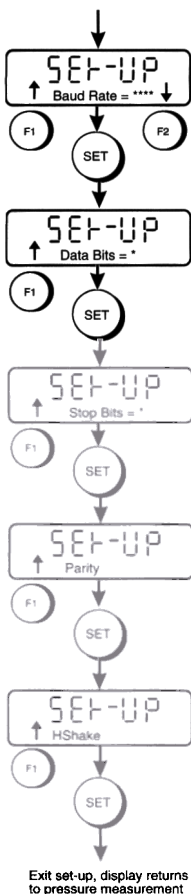
- 1. The parameters set on shipment are in bold.*
- 2. The instrument stores any adjusted communication setting in nonvolatile memory.*
- 3. To review the current settings select the sub-menu and press the SET key to step through the sub-menu.*
- 4. Pressing the MODE push-button returns the instrument to the previous setting.*

Setting the communication parameters (Figure 3-9)

Proceed as follows:

1. Make sure the instrument is in measurement mode and displaying pressure.
2. Press SET until the display shows COMMS on the status line.
3. Press F2, selecting the COMMS option.
4. Use F1 and F2 to select the required baud rate and then press SET.
5. Repeat step 4 to set the remaining parameters.

When all the parameters are entered the instrument uses the new settings immediately and returns to measurement mode.

**Figure 3-9 Communications set-up**

Entering a new PIN

The instrument calibration is protected by a PIN, which must be entered before accessing the calibration menu. The default PIN set at manufacture is 000.

Changing the PIN

Proceed as follows:

1. Make sure the instrument is in measurement mode and displaying pressure.
2. Press SET until the display shows PIN on the status line.
3. Press F2 to change the PIN.
4. Using F1 ↑, F2 ↓ and SET to enter the current PIN.
5. Using F1 ↑, F2 ↓ and SET to enter the new PIN.
6. Using F1 ↑, F2 ↓ and SET to enter the new PIN again. The instrument compares the first new PIN with the second new PIN to verify the entry.
7. If verified successfully the display briefly shows New PIN Accepted on the status line.

Note: *If not verified the display briefly shows Verify Failure on the status line.*

Sending Measurements to a Printer or PC

The measured pressure or altitude can be sent to a printer or PC through the RS232 communications connector. The instrument sends the current selected measurement mode data.

Sending Data

Proceed as follows:

1. Set the RS232 communications parameters of the instrument to match the device receiving the data.
2. Press SET until the display shows PRINT on the status line.
3. Press F1 to select the PRINT menu. The display shows the flashing message "Ent Print Period". This is the rate at which measurements are transmitted by the instrument.
4. Use F1, F2 and SET to enter the print period. Pressing SET returns the instrument to measurement mode with the instrument transmitting data at the selected rate.

Error Message

When an error is detected an error message is sent in the following form:

ERRORnn - where nn is a decimal number.

Error numbers are:

04	Bad data detected by checksum
16	Hardware fault
32	Pressure outside range

4 CALIBRATION

The instrument is supplied with a calibration certificate. For the instrument to stay accurate it is recommended that it is checked every 12 months.

- The recommended equipment for calibration is a compensated deadweight pressure standard or similar equipment to provide the required accuracy.
- The following procedures should be carried out in a controlled environment by qualified instrument calibration personnel.
- If the accuracy of the instrument is not within the specification, carry out a calibration adjustment procedure.
- The manufacturer offers a comprehensive and, if required, NIST accredited calibration service.

• Calibration Check

A calibration check should be carried out at chosen intervals. The readings of the instrument should be compared with a pressure standard and, after any adjustments for accuracy (traced to National Standards), the differences recorded. The adjusted differences can then be compared with the required accuracy for the instrument. If necessary a calibration adjustment can be carried out.

The recommended procedure is to check at increasing and then decreasing intervals of 0, 20, 40, 60, 80 and 100% of full-scale.

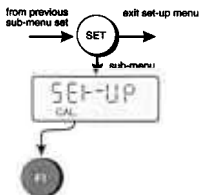
c Procedure (Figure 3-10)

This sub-menu divides into two selections, a one-point calibration and a two-point calibration.

CAUTION: **THIS INSTRUMENT CONTAINS STATIC SENSITIVE COMPONENTS HANDLE WITH EXTREME CARE.**



The calibration procedure is protected by a PIN and the CAL option link LK1 located on the PCB. To carry out a calibration LK1 must be in the ✓ position.



With the instrument connected to an appropriate pressure standard, access the calibration sub-menu through the set-up menu.

One-point calibration

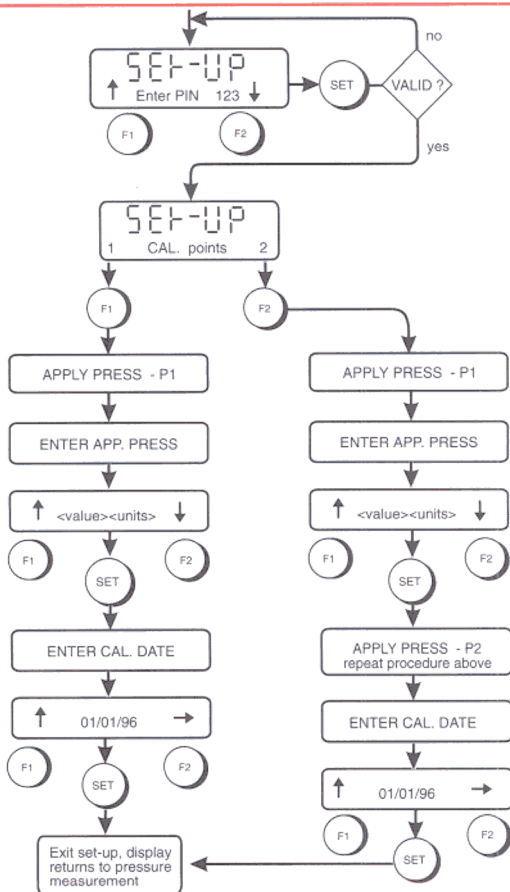
For the one-point calibration the instrument stores the relationship between pressure and output.

Important note

The calibration carried out at manufacture is a two-point calibration against a pressure standard traceable to National Standards. Carrying out a one-point calibration can significantly downgrade the instrument's accuracy if in doubt consult the manufacturer before proceeding.

Two-point calibration

This calibration provides a more accurate reading of the applied pressure, the instrument calculating a more complex correction for the displayed reading.

**Figure 3-10 Calibration**

Two-point calibration

Proceed as follows:

1. Make sure the instrument is in measurement mode and displaying pressure.
2. Press SET until the display shows CAL on the status line.
3. Press F1 to select the CAL menu.
4. Use F1, F2 and SET to enter the PIN.
5. Press F2 to select a two point calibration, the display prompts for the first calibration point.
6. Adjust the pressure standard for the first calibration point.
7. Use F1 ↑ and F2 ↓ to set the first calibration value.
8. When the pressure is stable press SET to enter the first calibration point. The display prompts for the second calibration point.
9. Repeat steps 5 to 7 for the second calibration point.
10. Press F1 to accept the calibration values, the display prompts for the calibration date.
11. Use F1 ↑ and F2 → to set the calibration date.

5 Maintenance

5.1 General

User maintenance on this unit is limited to battery replacement, fault finding and cleaning.

5.2 Fault finding

Displayed error messages

- ▣ If the pressure sensed by the instrument exceeds 110% of the full-scale pressure value the display flashes the message **OVERRANGE ERROR**. Reduce the applied pressure until the error message goes out.

If the calibration or set-up of the transducer or the instrument's operation becomes corrupted the display shows **SYSTEM ERROR**. Return the instrument to the manufacturer or agent for repair.

5.3 Cleaning

Clean the case of the unit with a damp lint-free cloth and mild detergent. Make sure that there is no debris in the pressure port.

6 Communications

6.1 Introduction

The instrument can be used either in direct mode or as part of a network, in the addressed mode. The communications protocol used by the instrument is the Omega Universal Communication Interface (OUCI). In this section the commands that apply to the instrument are detailed and described, for further information contact Omega.

Direct Mode

One instrument can be connected directly to a control computer with no addressing is required.

Addressed Mode

The instrument can be connected into a network of devices, each device has a unique address (0 to 99). The network consists of a ring with the transmit line of one device connected to the receive line of the next device. Hardware and software handshaking are not supported.

6.2 General Command Format

The instrument is controlled by a sequence of letter codes, some commands require numeric values to follow the letters. The correct number of parameters must be sent for the particular command. The instrument accepts upper-case or lower-case letters.

Commands should be in the form:

`<start>ddssxx:<CS><terminator>`

where

`<start>` is the start of a command block indicator that can be * or # character. The * character causes all command block data to be echoed around the network. The # character suppresses the echoing of the data block and can be used for commands such as AA - automatic addressing.

dd is a two digit destination address 00 to 99

ss is a two digit source address 00 to 99

xx is a two character command. This can be followed by additional data, a number can be added to this command to select a channel.

`<CS>` is a block checksum and takes the form: NN where NN is a two digit checksum that is the modulo 100 sum of all the ASCII codes of the character in the string including the `:`.

Note: *This checksum feature can be disabled so that the instrument does not use checksums, in which case the checksum must not be sent. When the checksum feature is enabled, commands are only interpreted if the checksum is correct. An error is reported if an incorrect checksum is received.*

`<terminator>` is the string termination characters
`<CR><LF>`

The address 99 is a global address recognized by all instruments.

As characters are received by the instrument they are instantly echoed on to the next instrument unless the command block character is a `#`. On receiving the termination characters the received destination address is checked for the global address 99 or against the instrument's address. If this matches the command is interpreted or the command is ignored.

Commands can be stringed together in a data packet. This allows a more efficient data transfer as the destination and source addresses do not have to be sent with each command.

example

```
#0099IC=PIU=16<CR><LF>
```

The command separator `;` can be used:

example

```
#0099IC=P;IU=16<CR><LF>
```

This command sent by instrument 99 to instrument 00 to set-up input channel to measure pressure and select pressure units of inHg.

Query facility

In addition to sending commands to instruments, data can be queried by adding the ? character to the command.

example

```
#0099IC?<CR><LF>
```

This command interrogates instrument 00 for the parameter on input channel 1.

Replies from the instruments follow a similar pattern except the start indicator is different. Replies are echoed round the network and not interpreted.

```
!ddssxx<CS><terminator>
```

The following reply sent from instrument 00 to instrument 99 indicates that the input channel is measuring pressure.

```
!9900IC=P
```

example program

#sa?;	query instrument address
!SA=00;	reply address is 00
#fa=1;	put instrument in addressed mode
#0099ic=p;	send command to instrument 00 from instrument 99 input channel is pressure
#0099pc=~(ir,10,1);	set-up process channel to filter 'input reading ir time constant 10, band 1'
#0099iu=16;	units to psi
#0099pr?;	get reading from process channel
!9900PR1=14.318;	reply of pressure in psi (filtered reading)
#0099ir?;	get unfiltered reading
!9900IR=14.318;	reply of pressure in psi
#0099iu=18	units to inHg
#0099pr?;	get reading from process channel
!9900PR1=29.152;	filtered pressure reading in inHg
#0099fa=0;	take QFF addressed
#iu?;	query units
!iu=18;	units = 18 = inHg (see table 6-1)

This example is reproduced using QBASIC in Table 6-3.

6.3 Command Summary

The following functions can be performed using the serial link:

Input Commands

IC=<param type>	Set-up input
IR?	Get input reading
IU=<index>	Set-up input units (see table 6-2)
IA=k	Enable automatic sending of input reading

Process Commands

PC =<process definition>	Set-up Process
PC =~(IR),<value>,<value>	filter
PC =T(IR)	tare
PC =T(IR),<value>	
PC =<(IR)	maximum
PC =>(IR)	minimum
PC =Q(IR),<value>,<value>	QFF
PC =A(IR),<value>	altitude
PR ?	Get process reading
PA =k	Enable automatic sending of process reading
PM	Reset process maximum and minimum values

Instrument Set-up Commands

SA=<nn>	Set instrument address
SUn=<units index>	Set-up regular units

Calibration Commands

CT=<cal type>	Specify calibration type
CP=<value>[,<temperature>]	Enter calibration point
CN?	Get no. of calibration points reqd.
CA	Calibration accept
CX	Calibration abort
CD	Calibration date

PIN commands

PP=<pin> PIN protect command

Automatic Commands

AA=<device address> Automatic device address

AE=<error mask> Automatic error reporting
(see table 6-1)

Read Commands

RB? Read battery volts

RI? Read instrument type and version
number

RE? Read error status (see table 6-1)

Protocol Format Commands

FC=<flag> Enable/disable message checksum

FA=<flag> Enable/disable addressed mode

Key Commands

KM=<flag> Front panel key-pad operating mode

6.4 Command Set

All commands are of the format described in 6.2. In the following command description the start and terminating characters have been removed for clarity. Parameters enclosed in [] are optional.

Input commands

Command: IC - Set-up input

Format: IC=<param type>

Description: Set-up input to measure parameter <param type>, the index 'i' specifies the measurand. <param type> can be any of the following:

P	pressure input
I	current input
V	voltage input
T	temperature input

Note: Only use pressure P for this instrument.

Query: The corresponding query command allows the interrogation of the currently selected parameter.

xam

*i=P
put =*

Command: IR - Get input reading

Format: IR?

Description: Request for a reading

sample

IR?

*The instrument replies IR=<value>
where: <value> is the reading in
selected units (e.g., IR=3*

Query: This is a query only command.

IU - Set-up input units

Format: IU=<index>

Description: Set-up the units for the input in volatile storage. The units are specified as <index>, defined in Table 6-2.

A query of this command returns the index units.

IU?

Reply: IU = <index>

Example: a reply of IU=18 means units are inHg

Command: IA - Enable automatic sending of input reading

Format: IA = k

Description: Enables automatic sending of input reading. The value 'k' corresponds to 'send every 'k'th conversion'. If 'k' is 0, the automatic send feature is disabled.

*Example: IA = 10
send a value every 10th conversion.
IA = 0
disable the automatic feature.*

A query responds with an integer of the automatic send interval in conversions.

*Example. IA?
Reply: IA = 10*

Process commands

Command: **PC - Set-up process**

Format: PC = <process definition>

Description: This command sets and defines the required process of the instrument. The <process definition> must be in the format shown in the following table:

PC = <process definition>	Set-up Process
PC = ~(IR), <value>, <value>	filter
PC = T(IR), <value>	tare
PC = <(IR)	maximum
PC = >(IR)	minimum
PC = Q(IR), <value>, <value>	QFF
PC = A(IR), <value>	altitude
PR ?	Get process reading
PA = k	Enable automatic sending of process reading
PM	Reset process maximum and minimum values

Process definitions

Example: ~ filter

PC = ~(IR, 0.15, 0.01)

Define filter input reading changing the <time constant> and <band>.

Note: *This filter does not affect the normal instrument filter.*

T tare $PC=T(IR)$

Full tare of input reading.

 $PC=T(IR,100.00)$

Define tare of input reading, subtracts 100 from reading. The value specified in the command is in the currently selected units.

Note

This tares the value but does not change the displayed value.

Example: $PC=/(IR)$ **< minimum**

Defines the minimum value of the input reading. To reset this value use PM command.

Example: $PC=>(IR)$ **> maximum**

Defines the maximum value of the input reading. To reset this value use PM command.

Example:**Q QFF** $PC=Q(IR,200,20)$

Define the derived QFF input value changing both the <height> and <temp> parameters.

Example:**A altitude** (also see command PA) $PC=A(IR,120.00)$

Define the derived ALTITUDE input value changing the current or default setting of <datum pressure> to 120.00.

Command: PR - Get reading

Format: PR?

Description: Requests the reading.

Query: This is a query only command.

Example: OR?

Reply: OR = 29.53

*reading in inHg***Command: PA - Enable automatic sending of reading**

Format: PA = k

Description: Enables automatic sending of input reading. The value 'k' corresponds to 'send every 'k'th conversion'. If 'k' is 0, the automatic send feature is disabled.

Example: PA = 10

*send value every 10th conversion.
PA = 0 disable the automatic feature.*

Query: A query responds with an integer of the automatic send interval in conversions.

Example: PA?

Reply: PA = 10

Command: PM- Resets process maximum and minimum values

(also see PC command '<' and '>')

Format: PM

Description: Sets maximum and minimum values equal to the current reading, in effect resetting both values.

Query: There is no corresponding query command.

Set-up commands**Command: SA - Set instrument address**

Format: SA = <nn>

Description: Set instrument address to <nn>. Changes the network address of the instrument in the range 0 to 98. Address 99 is used for global commands.

Example: SA=10 sets instrument address to 10

Query: SA? query instrument address

Reply: SA=10

Command: SU - Set-up "regular" units

Format: SUn = <units index>

Description: Selects the pressure units that appear as default selection F2 in measurement mode. Both required parameters must be specified i.e. the push-button sequence n (1, 2 or 3) and the <units index>.

*Example: SU1=16 sets first units (1) to psi
SU2=18 sets second units (2) to inHg*

Query: The corresponding query command returns the index to the pressure units selected for the specified option.

SU1?

Reply: SUn=<units index>

SU1=16

Calibration commands**C - User Calibration**

This command allows the user to perform a two point calibration on the output of the device. The calibration routine requires two pressures to be applied within the operating extremes. The software calculates an offset and gain correction to all subsequent readings.

Command: CT - Specify calibration type

Format: CT= <cal type>

Description: Specify the type of calibration to be performed. The instrument must be in calibration mode before this command becomes valid.

<cal type> = 1 two point matching
calibration

*Example: CT=1
perform two point matching calibration*

Query: A query of this parameter CT? returns the type of calibration in progress.

CT? query calibration type

Reply: CT = 1

The instrument is now ready for the application of calibration pressure, both the calibration points must be entered to complete the procedure. When the pressure stabilizes, the instrument must be sent the applied value in the currently selected units, using the CP command.

Command: CP - Enter Calibration Point

Format: CP = <value>

Description: The calibration point value is given by <value> in the currently selected units.

Query: A query of this parameter CP? returns the number of calibration points already recorded by this command. The instrument also indicates that it is ready for the next calibration point.

Reply:

*example**CP = 0**no cal points**recorded**CP = 2**2 cal points**recorded*

After entering all the points required to calibrate the instrument, the accept calibration command CA must be sent to update the data in the instrument's nonvolatile memory.

Command: CN - Get number of calibration points required

Format: CN?

Description: Returns the minimum and maximum calibration points required to carry out the specified calibration procedure.

Example: IU = 16 set-up input as psi
PP = 123 PIN entered, puts instrument into calibration mode
CT = 1 perform two point calibration
CN?
CN=1,2 requires between 1 and 2 calibration points

Query: This is a query only command.

Command: CA - Calibration Accept

Format: CA

Description: Accepts the calibrated data. If the correct number of calibration points have been entered with the CP command then the calibration coefficients are calculated and stored in the instrument's nonvolatile memory. The instrument returns to measurement mode.

Query: There is no associated query command.

Command: CX - Calibration abort

Format: CX

Description: Aborts the calibration procedure.

Example: IU = 18 set-up input as inHg
PP = 123 PIN entered, puts instrument into calibration mode
CT = 1 perform two point calibration
CP = 5.92 applied pressure 5.92 inHg
CX abort calibration

There is no associated query command.

Command: CD - Calibration date

Format: CD = <dd/mm/yy>

Description: Sets calibration date, only valid in calibration mode.

Example: CD = 24/01/98

set cal date to 24 January 1998

Query: CD? query date of last calibration.

Reply: CD = 24/01/97

Example of a two point calibration*IU = 18 set-up input as inHg**PP = 123 PIN entered put instrument
into calibration mode**CT = 1 perform two point calibration**CP = 23.62 applied pressure 23.62 inHg**CP = 32.48 applied pressure 32.48 inHg**CA calibration accepted**CD calibration date***Command: PP - PIN protection**

Format: PP = <pin>

Description: This command is used to change the PIN of the instrument which is used to protect the calibration data and configuration.

<pin> = 123 calibration PIN code

Example: PP = 123 PIN entered p
instrumen*into calibration mode*

Query: There is no corresponding query command.

Automatic commands**Command: AA - Automatic addressing**

Format: AA = <device address>

Description: This command can only be used with the # command header block. It automatically sets the addresses of the instruments in the network to sequentially increasing addresses.

Example: AA = 10

With three instruments in the network, this command sets the instrument addresses 10, 11 and 12.

Query: There is no query for this command.

Command: AE - Automatic error reporting

Format: AE = <error mask>

Description: This command enables error reporting. A 16 bit (hexadecimal) value <error mask> defines the bit image of errors to be acted on if set. If the error occurs, the "RE" error message is automatically.
<error mask> is defined in Table 6-1.

Note: An automatic error response does not clear the error bit. The RE? command must be issued to clear the error.

Example. AE = 0001 an error is reported when a syntax error is generated.
AE = FFFF an error is reported for every error.

Query: A query responds with a hexadecimal value corresponding to the bit image of the error mask.

Read Battery Volts

RB?

Read battery voltage

RB? query battery voltage

Reply:

RB = <voltage>

RB = 3.9 battery 3.9 volts

Query: There is a query only command.

RI - Read instrument type and version number

Format: RI?

Description: Read device equipment, this returns the instrument type on the network including the version of the code, in the form:

RI = <string>

where: the string is in the format:

"DPI_{nnn}, V_{m.mm}"

nn = instrument type

m.mm = version and issue number

*RI? query instrument version and
issue number*

RI = DPI740, V1.10

Query: There is a query only command.

Command: RE - Read error status

Format: RE?

Description: Report errors. This query command reports any error since the last RE? command. The errors are stored as bits (16 bits max) and set if the error occurred. After issuing this command all errors are cleared. The error codes are defined in Table 6.1.

Note: *Errors are only set for commands sent to the instrument. All other commands are ignored.*

where: the string is in the format:

*Example: RE? reports errors
RE = 0000 no errors, since last report.*

Query: There is a query only command.

Protocol format commands**Command: FC - Enable/disable message checksum**

Format: FC=<flag>

Description: Format checksum command. Enables/disables the checksum feature of the data transactions.

<flag> = 0 disable checksum feature
 1 enable checksum feature

Example: FC = 0 disable checksum feature
FC = 1 enable checksum feature

Query: There is no corresponding query command.

Command: FA - Enable/disable addressed mode

Format: FA=<flag>

Description: Format addressing mode command. Enables/disables the addressed mode feature of the data transactions. When addressed mode is disabled, one to one communication (direct mode) is assumed.

<flag> = 0 disable addressed mode
 1 enable addressed mode

Example: FA = 0 disable addressed mode
FA = 1 enable addressed mode

Query: There is no corresponding query command.

Key commands

Command: **KM-** **Local/remote operating mode**

Format: KM=<flag>

Description: Sets the push-button mode so that the instrument can be operated remotely. This command locks/unlocks the push-buttons.

Example: *KM = L local mode*
(push-buttons enabled)
KM = 2 remote mode
(push-buttons disabled)

Query: The query command returns the local/remote status.

KM? query operating mode

Reply: KM=L (operating in local mode)
or
KM=R (operating in remote mode)

Table 6-1
Table of Error Definitions

The 16-bit hexadecimal mask defined below can be specified using the AE command. It is used for automatic error reporting by the RE message transmitted by the instrument.

Bit Error	Description
0 syntax error	Set if the command syntax was not understood.
1 parameter error	Set if the parameters in the command were out of range or not valid.
configuration error	The configuration parameters can only be changed if the configuration PIN is sent with the commands. If the PIN is not sent or is incorrect this error is reported.
address error	An invalid address packet was received.
checksum error	The received command checksum did not match with the calculated checksum. With this error, the command is not executed and this error reported. An error occurred while trying to zero a measurand, probably because the zero offset is too large.
calibration error	Error in the instrument's calibration procedure; not enough calibration points.
sequence error	A valid command was received, but can not be processed because the instrument was not in the correct state to execute command.
8 command not available	This command was not available on this instrument.
9 range error	Reading outside range.
10 reserved	
11 reserved	
12 reserved	
13 reserved	
14 reserved	
15 reserved	

Table 6-2**Table of Measurement Units**

The <index> used to identify all the units of measurement are defined below and are used by the IU and SU commands.

0	-	mbar
1	-	bar
2	-	Pa
3	-	hPa
4	-	kPa
5	-	MPa
6	-	kgf/cm ²
7	-	kgf/m ²
8	-	mmHg
9	-	cmHg
10	-	mHg
11	-	mmH ₂ O
12	-	cmH ₂ O
13	-	mH ₂ O
14	-	torr
15	-	atm
16	-	psi
17	-	lbf/ft ²
18	-	inHg
19	-	inH ₂ O20, (20°C)
20	-	inH ₂ O04, (4°C)
21	-	ftH ₂ O20, (20°C)
22	-	ftH ₂ O04, (4°C)
23	-	inH ₂ O60, (60°F)
70		meters
71		feet

Table 6-3
Example Program in QBASIC

```
start:
EOFch=26
CLS
port%=1
PRINT SPC(20); "DPI 740 Omega Universal Communications
Interface : Example Program" PRINT SPC (19);
"=====
PRINT
PRINT Before commencing, ensure that the DPI 740
Communications Parameters are set as follows:"
PRINT
PRINT "Baudrate : 9600, Parity : None, Handshaking : None,
Databits : 8, Stopbits : 1"
PRINT
PRINT "The PC serial comms port used is COM";
PRINT port%
PRINT
PRINT "Please note DOS File Name : Pressure Readings will be
Logged in this File"
PRINT
INPUT Nm$
PRINT
PRINT "Ready"
PRINT "                                     Press <CTRL><BREAK> to exit"
PRINT "Starting communications"
OPEN Nm$ FOR OUTPUT AS #2
IF port% = 2 THEN
    OPEN "COM2:9600,N,8,1,RS,RB6000" FOR RANDOM AS #1
ELSE
    OPEN "COM2:9600,N,8,1,RS,RB6000" FOR RANDOM AS #1
END IF
PRINT "Comm port opened OK"
a$=""
PRINT #1, "#sa?" + CHR$(13);
PRINT #2, "#sa?" + CHR$(13) + CHR$(10);
GOSUB GetReply
address$=RIGHT$(a$,4)
address$=LEFT$(address$,2)
```



```
PRINT #1, "#fa=1" + CHR$(13);
PRINT #2, "#fa=1" + CHR$(13) + CHR$(10);
PRINT #1, "#" + address$ + "99" + "ic=p" + CHR$(13);
PRINT #2, "#" + address$ + "99" + "ic=p" + CHR$(13) + CHR$(10);
PRINT #1, "#" + address$ + "99" + "pc=~(ir,10,1)" + CHR$(13);
PRINT #2, "#" + address$ + "99" + "pc=~(ir,10,1)" + CHR$(13) + CHR$(10);
PRINT #1, "#" + address$ + "99" + "iu=16" + CHR$(13);
PRINT #2, "#" + address$ + "99" + "iu=16" + CHR$(13) + CHR$(10);
PRINT #1, "#" + address$ + "99" + "pr?" + CHR$(13);
PRINT #2, "#" + address$ + "99" + "pr?" + CHR$(13) + CHR$(10);
GOSUB GetReply
pressure$=RIGHT$(a$,10)
pressure$=LEFT$(pressure$,8)
PRINT "Pressure of the Day is " + pressure$ + "psi" + CHR$(13);
PRINT #1, "#" + address$ + "99" + "ir?" + CHR$(13);
PRINT #2, "#" + address$ + "99" + "ir?" + CHR$(13) + CHR$(10);
GOSUB GetReply
PRINT #1, "#" + address$ + "99" + "iu=18" + CHR$(13);
PRINT #2, "#" + address$ + "99" + "iu=18" + CHR$(13) + CHR$(10);
PRINT #1, "#" + address$ + "99" + "pr?" + CHR$(13);
PRINT #2, "#" + address$ + "99" + "pr?" + CHR$(13) + CHR$(10);
GOSUB GetReply
pressure$=RIGHT$(a$,10)
pressure$=LEFT$(pressure$,8)
PRINT "Pressure of the Day is " + pressure$ + "inHg" + CHR$(13);
PRINT #1, "#" + address$ + "99" + "fa=0" + CHR$(13);
PRINT #2, "#" + address$ + "99" + "fa=0" + CHR$(13) + CHR$(10);
PRINT #1, "#iu?" + CHR$(13);
PRINT #2, "#iu?" + CHR$(13) + CHR$(10);
GOSUB GetReply
CLOSE#1
CLOSE#2
END

GetReply:
a$=""
DO
    b$=INPUT$(1,#1)
    a$=a$+b$
LOOP UNTIL b$=CHR$(10)
PRINT #2,a$
RETURN
```



WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit should malfunction, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED.
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. P.O. number to cover the COST of the repair,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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