

PACE

Pressure Automated Calibration Equipment Calibration Manual



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Introduction

This technical manual provides calibration instructions for the PACE Pressure Controllers and Indicators.

The features shown and described in this manual may not be available on some models.

For the full specification and user manual, refer to Druck website:



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Safety



WARNING Do not apply pressure greater than the maximum safe working pressure.

The manufacturer has designed this equipment to be safe when operated using the procedures detailed in this manual. Do not use this equipment for any other purpose than that stated, the protection provided by the equipment may be impaired.

This publication contains operating and safety instructions that must be followed to make sure of safe operation and to maintain the equipment 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 technicians* and good engineering practice for all procedures in this publication.

Pressure

Do not apply pressures greater than the maximum working pressure to the equipment. It is the responsibility of the calibration technician to apply pressures within the published pressure range and to only use external pressure equipment with correctly rated fittings and components.

Toxic Materials

There are no known toxic materials used in construction of this equipment.

Maintenance

The equipment must be maintained using the procedures in this publication. Further manufacturer's procedures should be done by an authorized service agents or the manufacturer's service departments.






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Technical Advice

For technical advice contact the manufacturer.

* A qualified technician must have the necessary technical knowledge, documentation, special test equipment and tools to carry out the required work on this equipment.

Symbols

Symbol	Description
	This equipment meets the requirements of all relevant European safety directives. The equipment carries the CE mark.
	This symbol, on the equipment, indicates that the user should read the user manual.
	This symbol, on the instrument, indicates that the user should refer to the user manual. This symbol, in this manual, indicates a hazardous operation. Ce symbole, sur l'instrument, indique que l'utilisateur doit consulter le manuel d'utilisation. Ce symbole, dans le manuel, indique une situation dangereuse.
	This symbol warns the user of the danger of electric shock. Ce symbole alerte l'utilisateur sur le danger de choc électrique.
	Do not dispose of this product as household waste. Use an approved organization that collects and/or recycles waste electrical and electronic equipment. For more information, contact one of these: - Our customer service department: Druck.com - Your local government office.



WARNING Turn off the source pressure(s) and carefully vent the pressure lines before disconnecting or connecting the pressure lines. Proceed with care.

Only use equipment with the correct pressure rating.

Before applying pressure, examine all fittings and equipment for damage. Replace all damaged fittings and equipment. Do not use any damaged fittings and equipment.

Do not exceed the maximum working pressure of the instrument.

This equipment is not rated for oxygen use.



CAUTION The ground lead of the instrument must be connected to the AC supply protective safety ground.

Isolate the power supply before making any electrical connections to the rear panel.

Abbreviations

The following abbreviations are used in this manual. Abbreviations are the same in the singular and plural.

Abbreviation	Description
ac	Alternating Current
ft	Foot
H ₂ O	Water
Hg	Mercury
in	Inch
kg	kilogram

Abbreviation	Description
m	Metre
mbar	millibar
Pa	Pascal
PACE	Pressure Automated Calibration Equipment
psi	Pounds per square inch
REF	Reference
SCPI	Standard Commands for Programmable Instruments
°C	Degrees Celsius
°F	Degrees Fahrenheit
+VE	Pressure input

Associated Publications

The following table lists the Druck publications referenced in this manual:

Publication	Title
K0467	PACE1000 Quick Start and Safety Instructions
K0470	PACE1000 User Manual
K0447	PACE5000/6000 User Guide and Safety Instructions
K0443	PACE5000/6000 Pressure Control Module User Manual
K0476	PACE Pressure Control Module User Guide and Safety Instructions
K0469	PACE Heritage Communications Manual
K0472	PACE Series SCPI Manual

1. Introduction

PACE controllers and indicators incorporate a calibration facility. For the PACE to stay within specification, a calibration check should be carried out at chosen intervals. If the as found calibration data of the PACE is not within the permissible deviation, carry out a calibration adjustment.

2. Calibration Status

The **Measured Pressure/Instrument Status** menu displays the calibration status of the instrument on the front panel screen. The **Calibration History** lists the dates of the stored calibration corrections.

Note: The Date and Time must be set correctly in the **Measured Pressure/Global Set-up/Calibration** menu.

3. Calibration Equipment

The original Druck Calibration Certificate shows the measurement uncertainty of the original pressure calibration standard. To preserve uncertainty of the PACE calibration, checks and adjustments must be performed using a calibrator uncertainty of less than or equal to the original pressure calibration standard.

4. Preliminary Operations

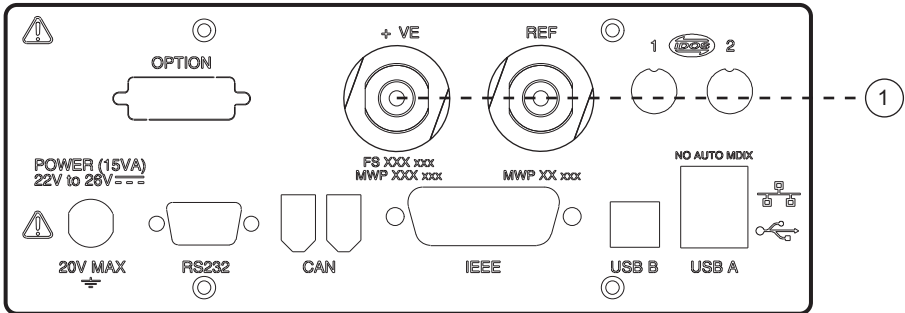
Review and become familiar with the whole procedure before performing a calibration.

Before performing a calibration:

1. Turn the PACE on and allow it to thermally stabilise (for at least 2 hours) in a thermally stable environment.
2. Carry out a leak test as detailed in PACE User Manual K0443.

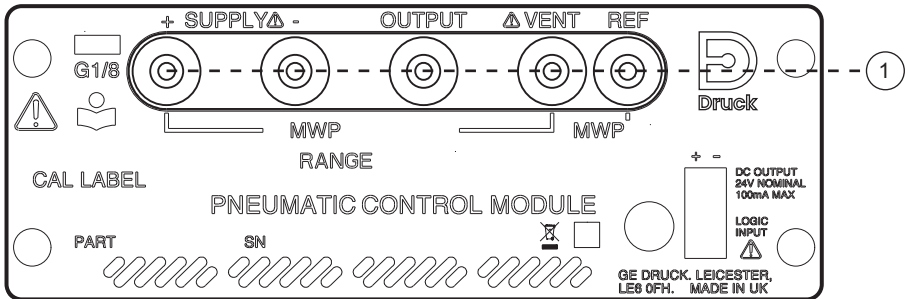
5. Notes on Calibration

The pressure calibration standard output port and the PACE reference level must be at the same level. See illustrations below for PACE reference level. If the pressure calibration standard is not at the PACE reference level, use height-corrected applied pressure.



1 Reference Level

Figure 1: PACE1000 Reference Level



1 Reference Level

Figure 2: PACE Control Module Reference Level

Set the PACE units of pressure to one of the required units for calibration.

5.1 Pressure Connection Overview



WARNING Turn off the source pressure(s) and carefully vent the pressure lines before disconnecting or connecting the pressure lines. Proceed with care.

Only use equipment with the correct pressure rating.

Before applying pressure, examine all fittings and equipment for damage.

Replace all damaged fittings and equipment. Do not use any damaged fittings and equipment.

Do not exceed the maximum working pressure of the instrument.

This equipment is not rated for oxygen use.

5.1.1 Pressure Adaptors

Figure 3 shows the available range of PACE pressure adaptors.

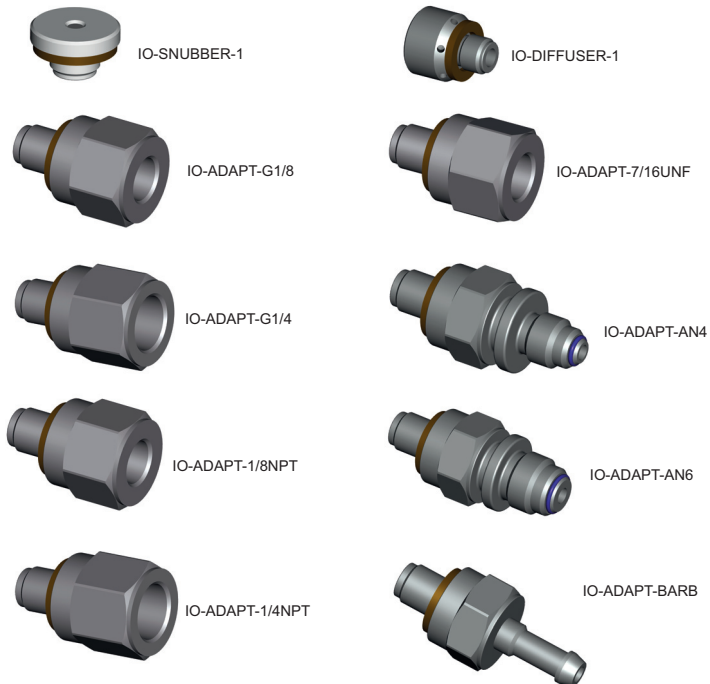


Figure 3: Pressure Adaptors

Refer to Table 1 and the Data Sheet for more information.

Table 1: Pressure Adaptor Specification

Adaptor Part Number	Specification
IO-SNUBBER-1	Restrictor/Snubber
IO-DIFFUSER-1	Diffuser
IO-ADAPT-1/4NPT	ISO 228 G1/8 Male to 1/4 NPT Female.

Table 1: Pressure Adaptor Specification

Adaptor Part Number	Specification
IO-ADAPT-1/8NPT	ISO 228 G1/8 Male to 1/8 NPT Female.
IO-ADAPT-7/16UNF	ISO 228 G1/8 Male to 7/16-20 UNF Female.
IO-ADAPT-AN4	ISO 228 G1/8 Male to AN4 37° Male.
IO-ADAPT-AN6	ISO 228 G1/8 Male to AN6 37° Male.
IO-ADAPT-BARB	ISO 228 G1/8 Male to 1/4 Hose.
IO-ADAPT-G1/4	ISO 228 G1/8 Male to ISO 228 G1/4 Female.
IO-ADAPT-G1/8	ISO 228 G1/8 Male to ISO 228 G1/8 Female.

5.1.2 Pressure Connection



WARNING Parallel threads must be used. Female thread type is parallel thread to ISO228/1 (DIN ISO228/1, JIS B0202) G1/8.

Tapered threads not allowed.

The PACE has parallel thread pressure connectors. Use only the connector type specified in Table 2.

Table 2: PACE Pressure Connector Thread Specification

PACE Connector	Thread Specification
Supply +, Supply -, Output, Vent, Reference	ISO228/1 G1/8 Parallel Threads (DIN ISO228/1, JIS B0202)

Refer to Figure 4 for connection to the PACE pressure connectors.

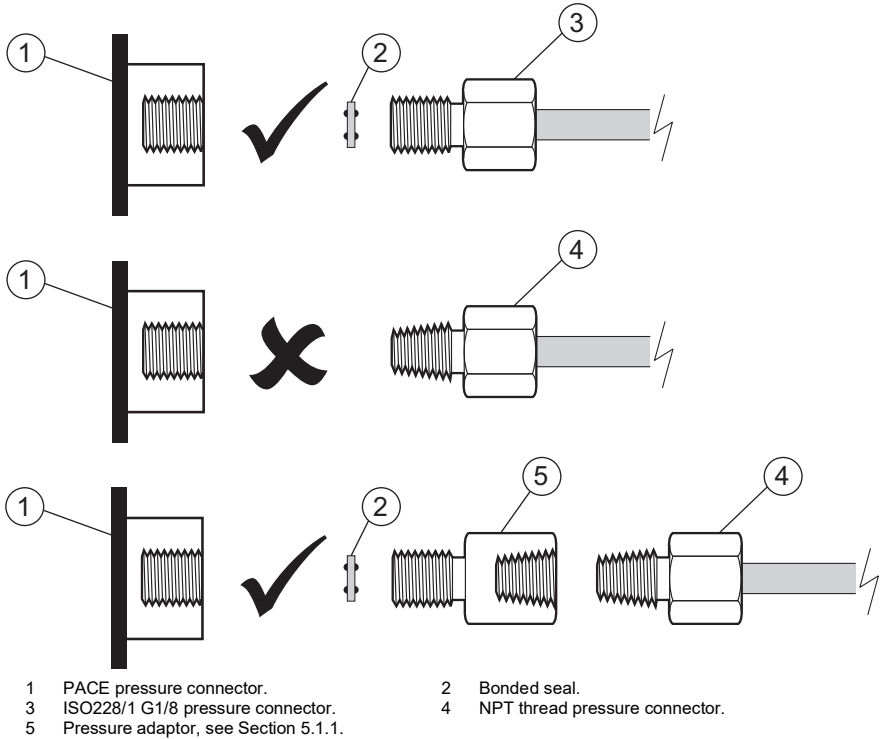


Figure 4: PACE Pressure Connection

For pressures less than 100 bar (1450 psi), see alternative sealing method in Figure 5.

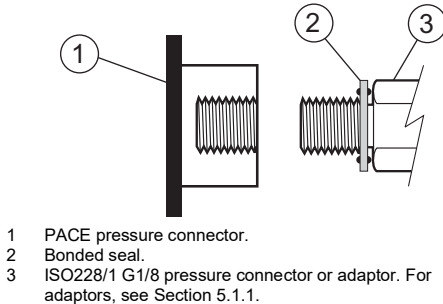


Figure 5: Alternative Sealing Method for < 100 bar (1450 psi)

5.2 PACE Controller Connection for Output Sensor Calibration

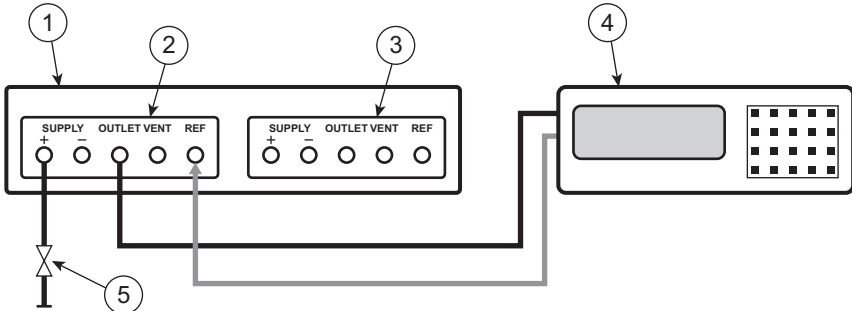


WARNING On completion of calibration, open the on/off valve (5) to vent trapped pressure from the SUPPLY + port to atmosphere.



INFORMATION For optimum performance, connect the PACE reference port to the pressure calibration standard. If unavailable, fit snubber IO-SNUBBER-1 to the PACE reference port.

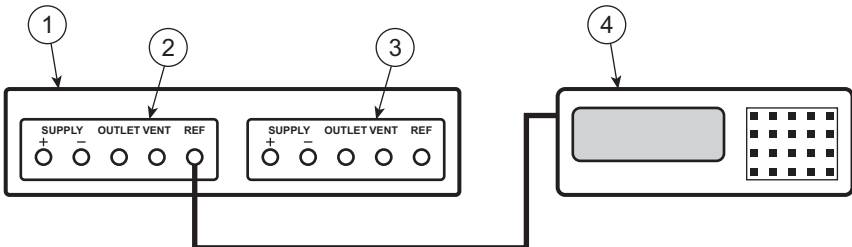
1. Fit a blanking plug to the SUPPLY – input of the PACE controller.
 2. Fit an on/off valve to the SUPPLY + input of the PACE controller. Leave the other side of the valve open to atmosphere.
 3. Turn the on/off valve to the closed position.
 4. Connect the output of the pressure calibration standard to the PACE module output port.
- Note:** For gauge sensor calibration, apply positive and negative gauge pressures to the PACE output port.
5. To attenuate changes in atmospheric pressure, or changes due to drafts, connect the PACE reference port to the pressure calibration standard reference port. If a reference connection is unavailable, fit snubber IO-SNUBBER-1 to the PACE reference port.



- | | | | |
|---|--|---|--------------------------------|
| 1 | PACE Pressure Controller (viewed from rear). | 2 | Control Module 2. |
| 3 | Control Module 1. | 4 | Pressure calibration standard. |
| 5 | On/Off valve. | | |

5.3 PACE Controller Connection for Barometric Sensor Calibration

1. Connect the output of the pressure calibration standard to the PACE module reference port.



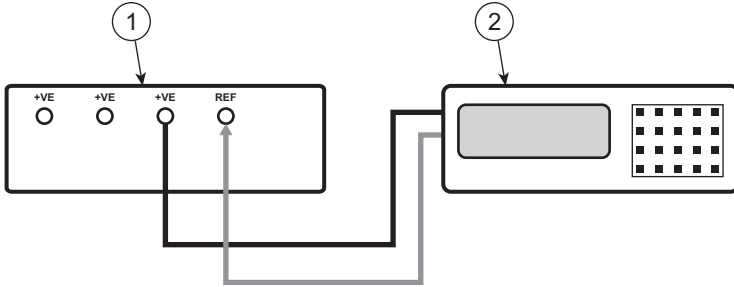
- | | | | |
|---|--|---|--------------------------------|
| 1 | PACE Pressure Controller (viewed from rear). | 2 | Control Module 2. |
| 3 | Control Module 1. | 4 | Pressure calibration standard. |

5.4 PACE Indicator Connection for Input Sensor Calibration



INFORMATION For optimum performance, connect the PACE reference port to the pressure calibration standard. If unavailable, fit PACE snubber IO-SNUBBER-1 to the PACE reference port.

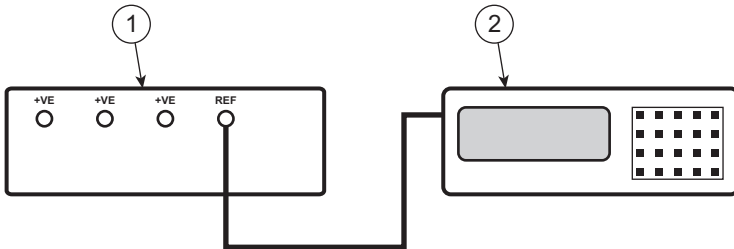
1. Connect the output of the pressure calibration standard to the PACE input port.
Note: For gauge sensor calibration, apply positive and negative gauge pressures to the PACE input port.
2. To attenuate changes in atmospheric pressure, or changes due to drafts, connect the PACE reference port to the pressure calibration standard reference port. If a reference connection is unavailable, fit snubber IO-SNUBBER-1 to the PACE reference port.



1 PACE Pressure Indicator (viewed from rear). 2 Pressure calibration standard.

5.5 PACE Indicator Connection for Barometric Sensor Calibration

1. Connect the output of the pressure calibration standard to the PACE reference port.



1 PACE Pressure Indicator (viewed from rear). 2 Pressure calibration standard.

6. Calibration Check



INFORMATION Gauge ranges (for CM3 8 bar absolute ranges and above see Section 8) should be zeroed immediately prior to a calibration check. Zeroing is not required for CM3 2 bar / 3.5 bar.

Note: The PACE adds the barometric reading to a gauge range to produce a pseudo-absolute range (for CM2 and below). For CM3 the PACE adds the barometric reading to an absolute range to produce a pseudo-gauge range.

For PACE calibration menus, refer to Appendix A

To check the calibration of PACE, proceed as follows:

1. Connect the PACE to the pressure calibration standard. Refer to Section 5.
2. Press **Task** and select **Basic**.

3. With the pressure calibration standard connected to the correct pressure port, select **Measured Pressure** and press **Range** to select the pressure range to be checked.
4. Barometric pressure can be displayed in the status area for -B variants.
5. Set maximum displayed resolution.
6. Press **Measured Pressure/Zero** to zero the selected gauge range.
7. On completion of the zero operation, the display shows Zero completed successfully.
8. Adjust calibration pressure to the first pressure value and wait until this pressure, as displayed on PACE, is stable to less than 5 ppm (0.0005%) for CM2 and below (aim for 1 ppm (0.0001%) on CM3). Display filtering may be required.
9. Compare the pressure value on the pressure calibration standard to the value displayed on the PACE and record the difference.
10. Repeat (8) and (9) for each pressure, as prompted by the PACE.
11. If the recorded difference exceeds the permissible deviation (accuracy) for the selected range, the calibrator requires a calibration adjustment for that range. Refer to PACE Data Sheet for permissible precision deviation and accuracy.

Note: If it has been less than 24 hours since calibration, the PACE specification equals the Data Sheet precision specification with respect to the original pressure calibration standard. If it has been greater than 24 hours since calibration, the PACE specification is the sum of the Data Sheet precision and the long term stability specification with respect to the original pressure calibration standard. It is recommended that an adjustment is performed on a new instrument and/or if the deviation measured is greater than 70% of the 1-Year uncertainty specification.

12. Select the next pressure range for a calibration check.
13. After completing all calibration checks, adjust the pressure calibration standard to atmospheric pressure.
14. Disconnect pressure calibration standard from the output.
15. If no further calibration is required, switch off the PACE.

7. Calibration Adjustment

For PACE calibration menus, refer to Appendix A

To adjust the calibration of PACE, proceed as follows:

1. Connect the PACE to the pressure calibration standard. Refer to Section 5.

Note: Calibration adjustments may be carried out in any order. Three calibration points are required for gauge sensors. Two calibration points are required for absolute sensors.
2. Select **Measured Pressure/Global Set-up/Calibration** and enter the Calibration **PIN (4321)**.
3. Select **Sensor Correction**.
4. Select the pressure range to be corrected.
5. Select the pressure sensor to be corrected.
6. Select **Calibration Adjustment**.
7. The display shows the first value to be set on the pressure calibration standard and to press **OK** when the applied pressure is stable to less than 5 ppm (0.0005%) for CM2 and below (aim for 1 ppm (0.0001%) on CM3). Use the numeric keys to enter the precise applied pressure.

Note: The display also shows throughout this procedure the message Calibrating and the selected pressure range.

8. Select **Accept** to store the first value and the display goes to the next pressure value to be set.
9. Select **Repeat** to re-apply the same pressure and **Quit Calibration** to exit the calibration of this pressure range.
10. Repeat steps (6) to (8) for the next value.
11. Carry out a calibration check to verify this procedure. Refer to Section 6.
12. After completing the calibration procedures, adjust the pressure calibration standard to atmospheric pressure. Disconnect the pressure calibration standard from the PACE.
13. If no further calibration is required, switch off the PACE.

8. Calibration Procedure for CM3 8 bar Absolute and Above Ranges

1. Carry out a calibration check (Section 6 steps (1) to (5) and (8) to (14)) on the Barometer first. If the recorded difference exceeds the permissible deviation then the Barometer must be adjusted (see Section 7).

Note: If stability is difficult to maintain then the home screen (showing pressure readings) can be used with 7 digits. If the number of digits is reduced, then the error due to reduced resolution must be considered with respect to the error budget.

2. Carry out an atmospheric zero on the CM3 reference sensor as per Section 6 of the user manual K0443 prior to the calibration check. This will zero the reference sensor against the barometer to remove any drift.
3. Carry out steps (1) to (5) and (8) to (15) of Section 6 for the reference sensor. Note that the gauge control sensor does not require calibration on CM3 units.

Note: To enable the barometric reading, select the Status Area > Global Setup > Display > Status Area > Barometric. It is important to consider that this step is not possible with the barometer unless the CM3-B option is enabled in the module identity window within the engineering menu (only accessible by Druck service centers). If this option is not available then skip step (2).

9. Recommended Calibration Check Points

9.1 Barometric Variant

750 mbar
900 mbar
950 mbar
1050 mbar
1150 mbar
1050 mbar
1000 mbar
950 mbar
900 mbar
750 mbar

9.2 2 bara / 1 barg up to 21 bara / 20 barg

35 mbara / -965 mbarg
20% of full-scale pressure
40% of full-scale pressure
60% of full-scale pressure
80% of full-scale pressure
100% of full-scale pressure
80% of full-scale pressure
60% of full-scale pressure
40% of full-scale pressure
20% of full-scale pressure
35 mbara / -965 mbarg

9.3 36 bara / 35 barg and Above

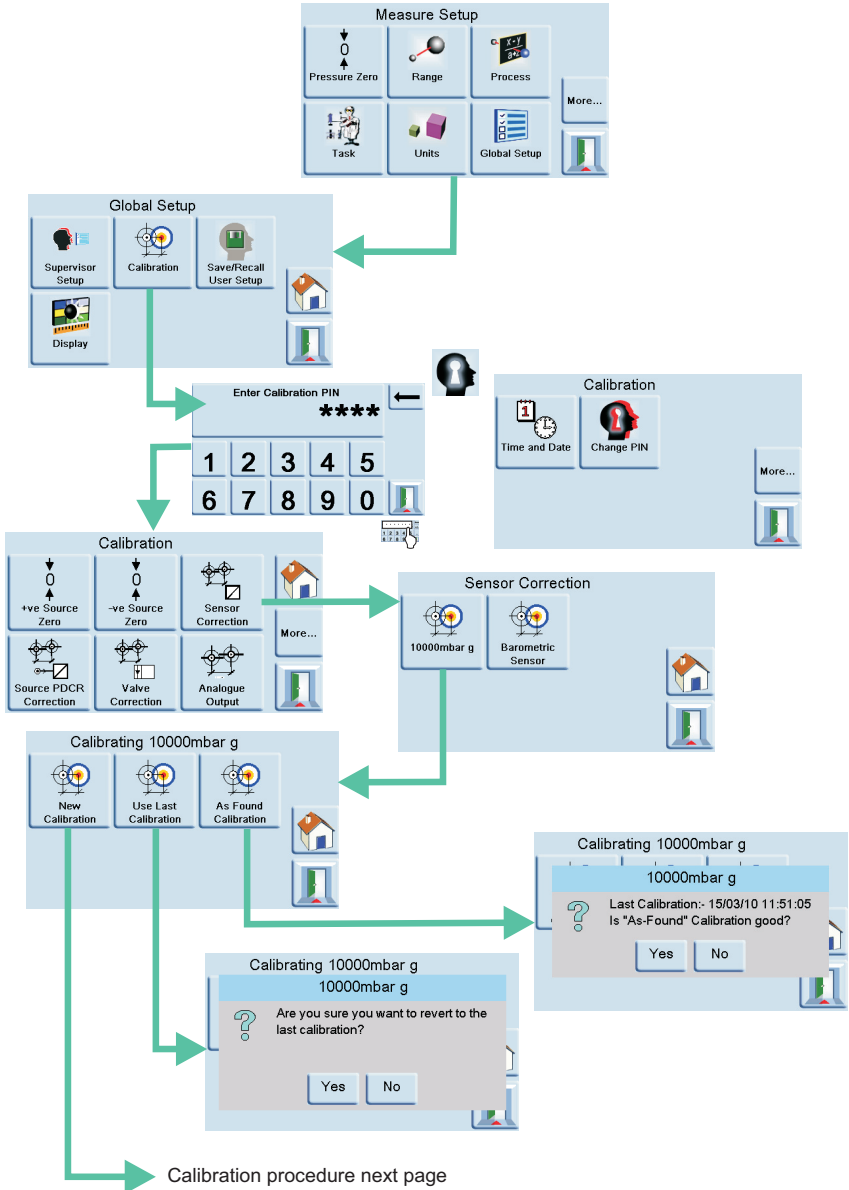
Atmospheric / 0 mbarg
20% of full-scale pressure
40% of full-scale pressure
60% of full-scale pressure
80% of full-scale pressure
100% of full-scale pressure
80% of full-scale pressure
60% of full-scale pressure
40% of full-scale pressure
20% of full-scale pressure
Atmospheric / 0 mbarg

9.4 All Other Variants (700 mbarg and Below)

0 mbarg
-100% of full-scale pressure
-80% of full-scale pressure
-60% of full-scale pressure
-40% of full-scale pressure
-20% of full-scale pressure
0 mbarg
20% of full-scale pressure
40% of full-scale pressure
60% of full-scale pressure
80% of full-scale pressure
100% of full-scale pressure
0 mbarg

Appendix A. PACE Menus and Screens

A.1 PACE Controller Menus



A.2 PACE Controller Screens

Calibrating 10000mbar g

Measure mbar

478.91

Apply the lowest range pressure (point 1 of 3)
Note the applied value
Accept when measured value is stable


Edit if required. mbar

479.02

←

+/-

1	2	3	4	5	.
6	7	8	9	0	




Calibrating 10000mbar g

Measure mbar

479.11

Apply the mid range pressure (point 2 of 3)
Note the applied value
Accept when measured value is stable




Calibrating 10000mbar g

Measure mbar

994.42

Keep the second calibration point? (point 2 of 3)
Accept to continue
Press Retry to repeat Measure/Enter




Calibrating 10000mbar g

Measure mbar

1494.05

Keep the third calibration point? (point 3 of 3)
Accept to continue
Press Retry to repeat Measure/Enter




Calibrating 10000mbar g

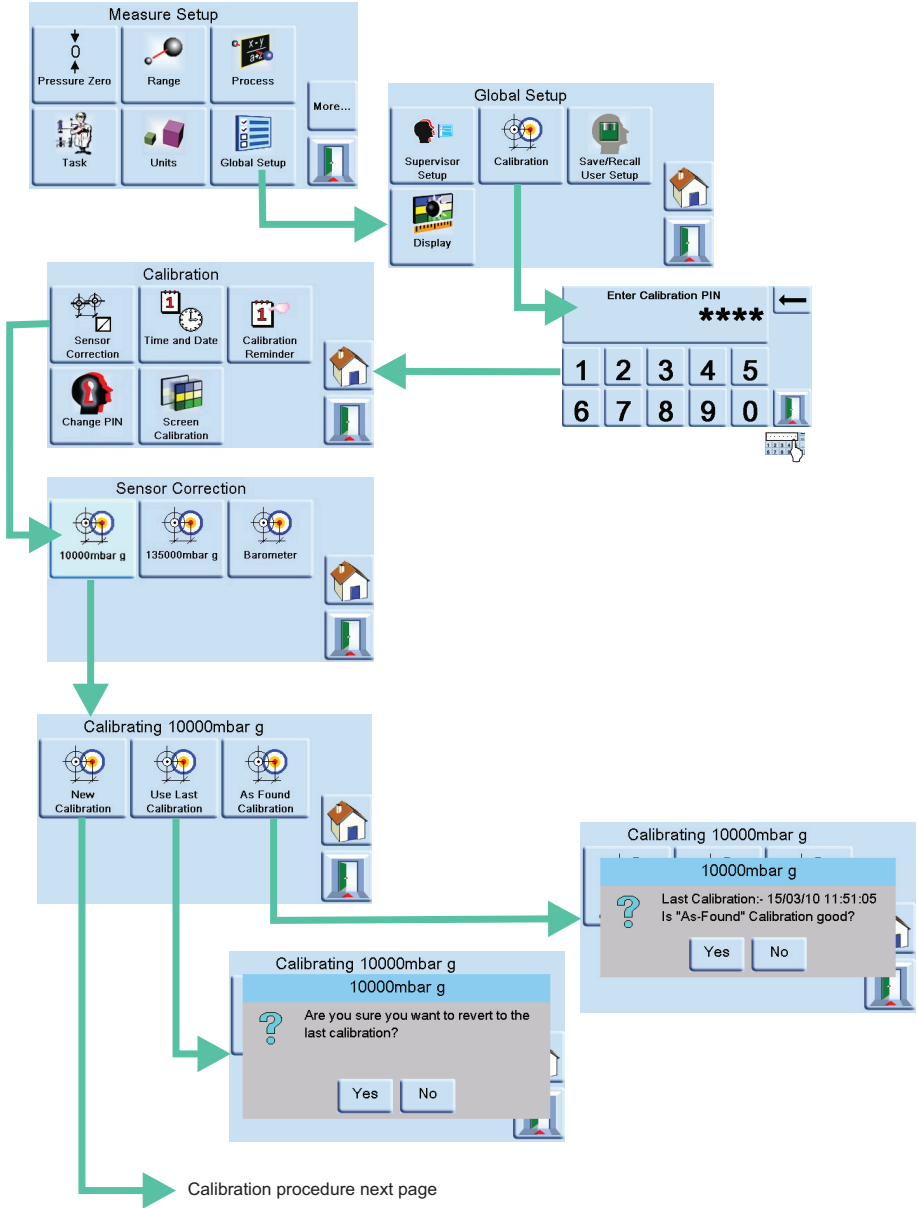
Measure mbar

1493.45

Calibration complete. Accept the calibration to return to the calibration menu. Press Escape to reject the calibration.



A.3 PACE Indicator Menus



A.4 PACE Indicator Screens

Calibrating 10000mbar g

Measure mbar

478.91


Apply the lowest range pressure (point 1 of 3)
Note the applied value
Accept when measured value is stable


Edit if required. mbar

479.02

←

+/-

1	2	3	4	5	.
6	7	8	9	0	




Calibrating 10000mbar g

Measure mbar

479.11

Apply the mid range pressure (point 2 of 3)
Note the applied value
Accept when measured value is stable





Calibrating 10000mbar g

Measure mbar

994.42

Keep the second calibration point? (point 2 of 3)
Accept to continue
Press Retry to repeat Measure/Enter







Calibrating 10000mbar g

Measure mbar

1494.05

Keep the third calibration point? (point 3 of 3)
Accept to continue
Press Retry to repeat Measure/Enter







Calibrating 10000mbar g

Measure mbar

1493.45

Calibration complete. Accept the calibration to return to the calibration menu. Press Escape to reject the calibration.



Appendix B. Pressure Units and Conversion Factors

Pressure Units	Factor (hPa)	Pressure Units	Factor (hPa)
mbar	1.0	cmH ₂ O @ 20°C	0.978903642
bar	1000.0	mH ₂ O @ 20°C	97.8903642
Pa (N/m ²)	0.01	kg/m ²	0.0980665
hPa	1.0	kg/cm ²	980.665
kPa	10.0	torr	1.333223684
MPa	10000.0	atm	1013.25
mmHg @ 0°C	1.333223874	psi	68.94757293
cmHg @ 0°C	13.33223874	lb/ft ²	0.4788025898
mHg @ 0°C	1333.223874	inH ₂ O @ 4°C	2.4908891
inHg @ 0°C	33.86388640341	inH ₂ O @ 20°C	2.486413
mmH ₂ O @ 4°C	0.0980665	inH ₂ O @ 60°F	2.487641558
cmH ₂ O @ 4°C	0.980665	ftH ₂ O @ 4°C	29.8906692
mH ₂ O @ 4°C	98.0665	ftH ₂ O @ 20°C	29.836983
mmH ₂ O @ 20°C	0.097890364	ftH ₂ O @ 60°F	29.8516987

To convert from pressure VALUE 1 in pressure UNITS 1, to pressure VALUE 2 in pressure UNITS 2, calculate as follows:

$$\text{VALUE 2} = \text{VALUE 1} \times \frac{\text{FACTOR 1}}{\text{FACTOR 2}}$$

Appendix B. Pressure Units and Conversion Factors

Office Locations

Headquarters

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