

PACE E Series

Pressure Automated Calibration Equipment Calibration Manual



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Introduction

This technical manual gives calibration instructions for the PACE E Series Pressure Controllers and Indicators.

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

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



Safety



WARNING Turn off the source pressure(s) and carefully release pressure from 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 fittings and equipment that have damage. Do not use any fittings and equipment that have damage. Do not apply more than the maximum working pressure of the instrument.

This equipment is not rated for oxygen use.

Do not use with media that has an oxygen concentration > 21 % or other strong oxidizing agents.

This product contains materials or fluids that may degrade or combust in the presence of strong oxidizing agents.

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 shown, or it is possible that the protection given by the equipment will not work.

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.

This manual has user instructions and safety information for the PACE instruments. All personnel must be correctly trained and qualified before they use or do maintenance on the instruments. The customer must make sure this occurs.

Pressure

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.

Maintenance

This manual does not include maintenance details for the equipment. Refer to the separate User Manuals for maintenance details. Refer to our website to find other documents associated with these products.

Technical Advice

Contact the manufacturer for technical advice.

Symbols

Symbol	Description
	This equipment meets the requirements of all relevant European safety directives. The equipment carries the CE mark.
	This equipment meets the requirements of all relevant UK Statutory Instruments. The equipment carries the UKCA mark.
	This symbol, on the equipment, indicates that the user must read the user manual.
	This symbol, on the instrument, indicates that the user must 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.
	Druck is an active participant in Europe's Waste Electrical and Electronic Equipment (WEEE) take-back initiative (directive 2012/19/EU). The equipment that you bought has required the extraction and use of natural resources for its production. It can contain hazardous substances that could impact health and the environment. In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end life equipment in a sound way. The crossed-out wheeled bin symbol invites you to use those systems. If you need more information on the collection, reuse, and recycling systems, please contact your local or regional waste administration. Please visit the link below for take-back instructions and more information about this initiative.



<https://druck.com/weee>

Glossary

This manual uses these terms. Abbreviations are the same in the singular and plural.

Term	Description
bar	Unit of pressure
bara	bar - absolute
barg	bar - gauge
CM	Control Module
FS	Full Scale
ft	Foot
H ₂ O	Water
Hg	Mercury
in	Inch
kg	kilogram
m	Meter
mbar	millibar
Pa	Pascal
PACE	Pressure Automated Calibration Equipment
ppm	Parts per million
psi	Pounds per square inch
REF	Reference
SCPI	Standard Commands for Programmable Instruments
°C	Degrees Celsius
°F	Degrees Fahrenheit
+VE	Pressure input
UUT	Unit under test

1. Calibration Check or Adjustment?

PACE E Series instruments include a calibration function. Do a calibration **check** at chosen intervals to make sure the instrument is within specification. Do a calibration **adjustment** if the 'as found' calibration data of the instrument is outside the permitted deviation.

2. Calibration Date and History

From any screen on the instrument, you may select **Settings > System Information** and select the module (or modules) to see general details about when the sensors in the module (or modules) were last calibrated. You may also select **Settings > System Information > History > Calibration** to see more specific details about when the sensors in the module (or modules) were last calibrated and to export the logs.

For PACE E series screens, refer to Appendix A.

3. Calibration Equipment

The original Druck Calibration Certificate shows the measurement uncertainty of the original pressure calibration standard. For preservation of the uncertainty of the PACE calibration, checks and adjustments must be done using a calibrator uncertainty of less than or equal to the original pressure calibration standard. It is important when measuring the stability of a sensor that the unit is returned to the same calibration lab and ideally the same primary standard is used. This removes differences between standards from the drift calculation.

4. Preliminary Operations

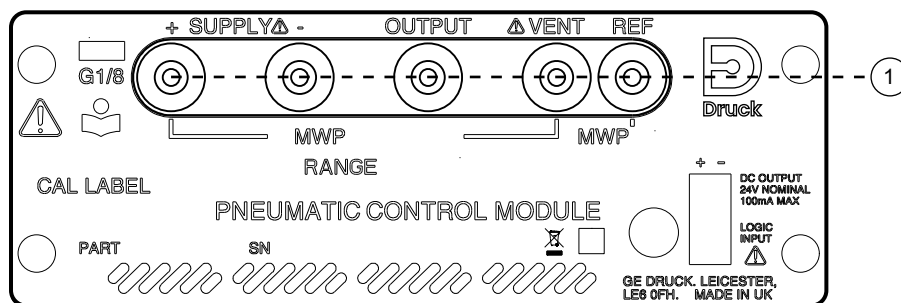
Review and understand the whole procedure before doing a calibration.

Before doing a calibration:

1. Energize the PACE instrument and allow it to thermally stabilize for at least 2 hours in a thermally stable environment.
2. Do a Leak Test as detailed in the User Manual for the instrument.

5. Notes on Calibration

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



1 Reference Level

Figure 1: PACE Control Module Reference Level

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

5.1 Pressure Connection Overview



WARNING Turn off the source pressure(s) and carefully open the pressure lines to atmosphere 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 fittings and equipment that have damage. Do not use any fittings and equipment that have damage.

Do not apply more than the maximum working pressure of the instrument.

This equipment is not rated for oxygen use.

5.1.1 Pressure Adapters

We can supply a range of pressure adapters for the instruments. Refer to the Sales Datasheet for information.

5.1.2 Pressure Connection



WARNING Use only parallel threads. Female thread type is parallel thread to ISO228/1 (DIN ISO228/1, JIS B0202) G1/8.

DO NOT CONNECT TAPERED THREADS DIRECTLY TO THE INSTRUMENT PRESSURE CONNECTIONS. Connect NPT tapered threads through a suitable pressure adapter.

The PACE has parallel thread pressure connectors. Use only the connector type shown in the Sales Datasheet.

Table 1: 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 2 for connection to the PACE pressure connectors.

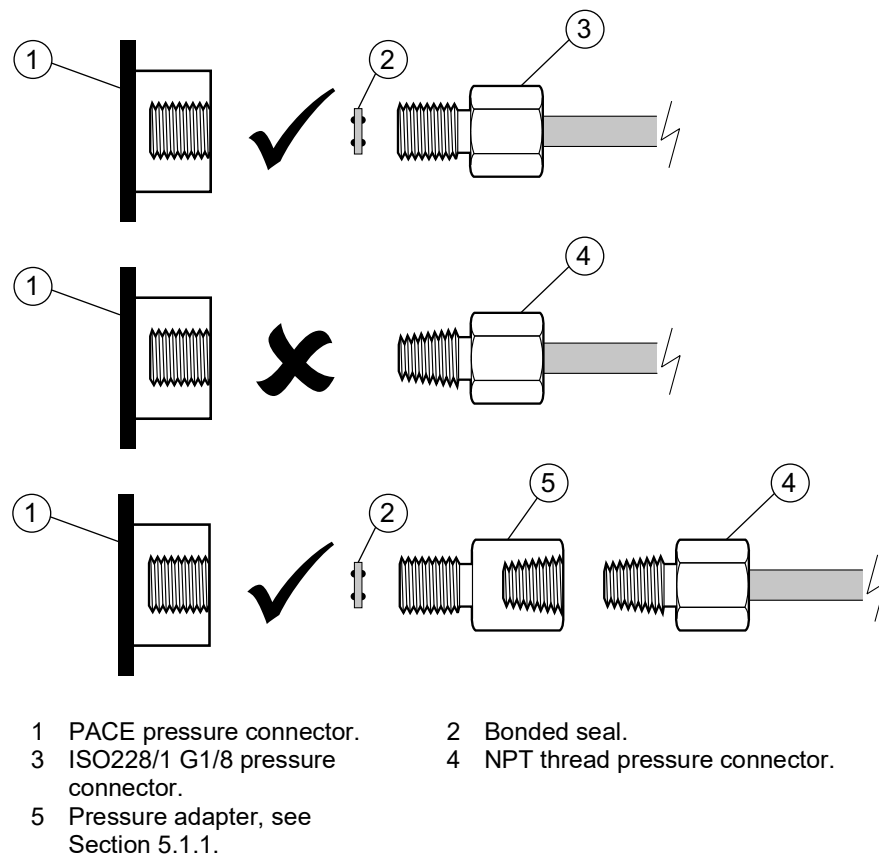
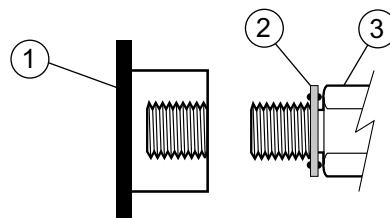


Figure 2: PACE Pressure Connection

For pressures less than 100 bar (1450 psi), see alternative sealing method in Figure 3.



- 1 PACE pressure connector.
- 2 Bonded seal.
- 3 ISO228/1 G1/8 pressure connector or adapter. For adapters, see Section 5.1.1.

Figure 3: Alternative Sealing Method for < 100 bar (1450 psi)

5.2 PACE5000 E and 6000 E Connection for Output Sensor Calibration



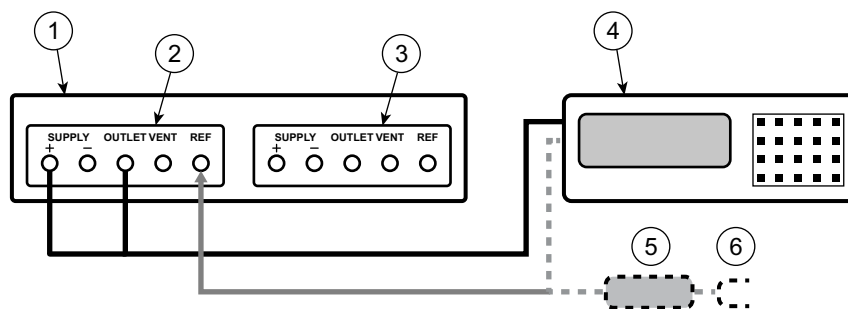
WARNING Except for the barometric sensor calibration, connect the SUPPLY + port to the OUTLET port when calibrating the Control Module.

Failure to follow this procedure may result in the sudden uncontrolled release of trapped pressure.



INFORMATION For optimum performance, connect the Control Module reference port to the pressure calibration standard with a snubber to atmosphere. This is not normally necessary for pressure ranges of 7 bar and above.

1. Connect the output of the pressure calibration standard to the Control Module as shown in the diagrams.
Note: For gauge sensor calibration, apply both positive **and** negative gauge pressures to the Control Module outlet port.
2. For Control Module types CM0, 1 and 2, to attenuate changes in atmospheric pressure, or changes due to drafts, connect the REF (reference) port to the pressure calibration standard reference port. Add a snubber (IO-SNUBBER-1) to the connecting pipe to prevent line pressure changes due to temperature changes.



- 1 PACE Instrument (seen from rear).
- 3 Control Module 1.
- 5 Snubber.

- 2 Control Module 2.
- 4 Pressure calibration standard.
- 6 Atmosphere

Figure 4: Connections for Control Modules Type CM0, 1 and 2

3. For Control Modules type CM3, connect only the module outlet and Supply +ve to the calibration standard.

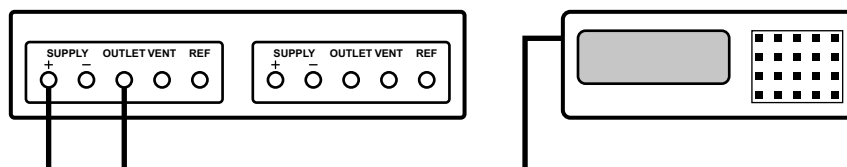


Figure 5: Connection for Control Module Type CM3

5.3 PACE5000 E and 6000 E Connection for Barometric Sensor Calibration

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

Note: You do not need to connect the Supply+ and Outlet port for this connection.

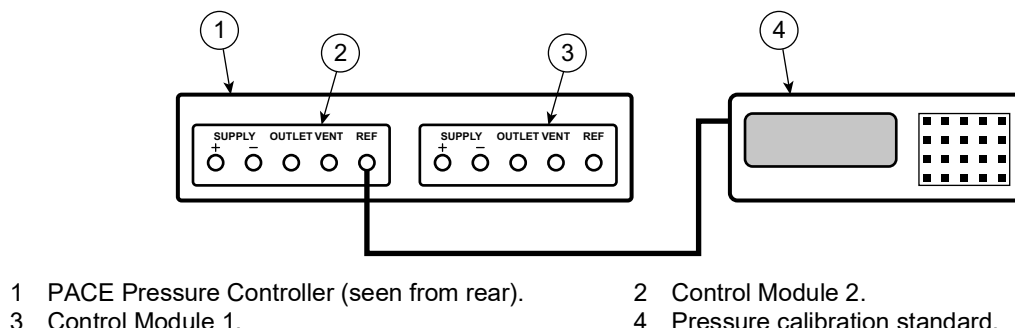


Figure 6: Connection for Barometric Sensor Calibration

5.4 PACE5000 E and 6000 E Controller Connection for Low Pressure Calibration

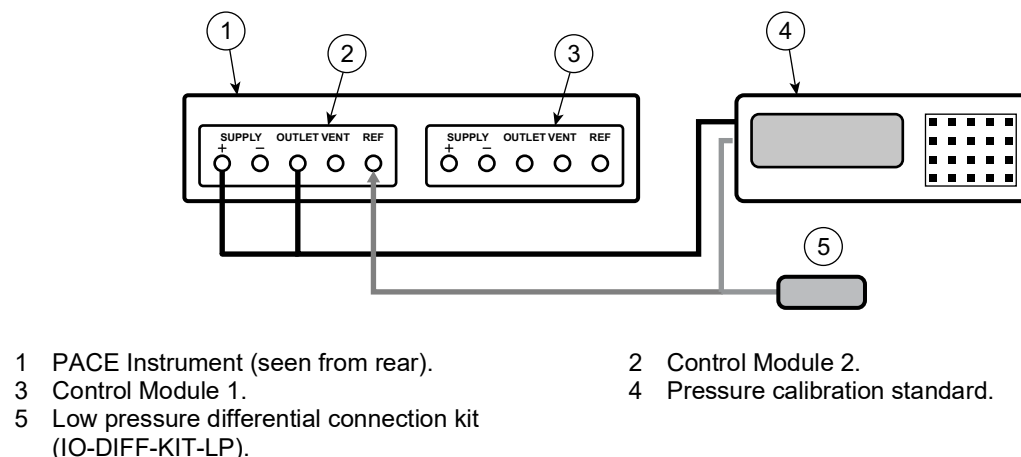


Figure 7: Connection for Low Pressure Measurement

6. Calibration Check A - Control Modules



INFORMATION This check is for Control Modules CM0, 1 and 2 (and CM3 up to and including 3.5 bar Absolute).

Zero the gauge ranges (CM0, CM1, CM2) immediately before a calibration check.

For CM3 8 bar absolute ranges and above, zero the Reference Sensor. See the user manual.

Zeroing is not necessary for CM3 2 bar and 3.5 bar ranges.

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 subtracts the barometric reading from an absolute range to produce a pseudo-gauge range.

Note: Use the Calibration check mode, as this removes any additional pressure processing enabled by the user.

For PACE calibration screens, refer to Appendix A.

To check the calibration of PACE, proceed as follows:

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

2. With the pressure calibration standard connected to the correct pressure port, on the PACE screen, select a **Basic** task and **Measure** mode. If using the PACE6000 E, select P1 or P2 as necessary. Now select the sensor range to be checked.
3. For gauge ranges (CM0, 1, 2), apply zero pressure to the UUT.

- a. If necessary, select the **Expand** button  to open the **Process Settings**. Select

the **Zero** button  from the **Process Settings** to zero the selected gauge range. The screen will show a pop-up to confirm that you are to zero the channel. Select **OK**.

- b. The pop-up will show that the zero process is working, then on completion it will show 'Zero complete'. Select **OK**.

4. Select the **Settings** icon , then the **Calibration** option. Enter the PIN (654321), then select **Sensor Correction**.
5. Select the pressure sensor to be checked.
6. Select **Calibration Check** to open the Calibration Check screen.

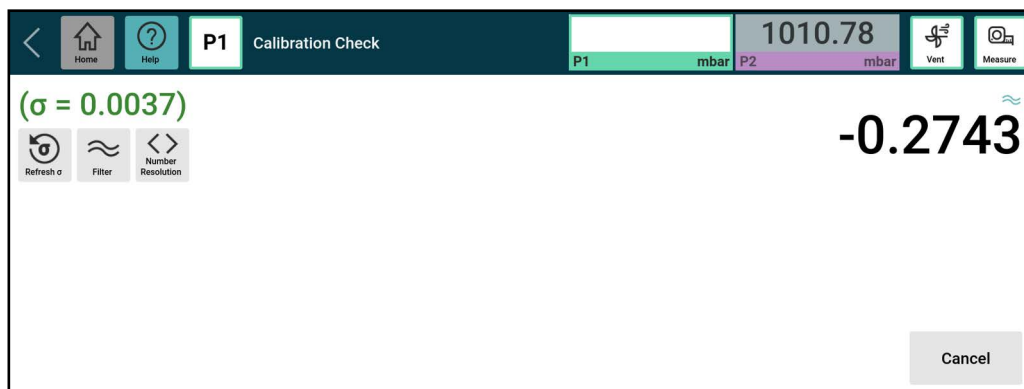


Figure 8: Calibration Check screen

7. Adjust the applied calibration pressure to the first pressure value and wait until this pressure, shown on PACE is stable to less than 5 ppm (0.0005%) for CM2 and below (aim for 1 ppm (0.0001%) on CM3). The standard deviation of the measured pressure is shown on the screen in the pressure units to help with measuring the deviation in pressure.
8. Compare the pressure value on the pressure calibration standard to the value shown on the PACE and record the difference.
9. Repeat for each calibration pressure.
10. If the recorded difference is more than the permitted deviation (Precision) for the selected range, it is necessary to do a calibration adjustment for that range on the calibrator. Refer to PACE Datasheet for permitted precision deviation and accuracy.

Note: If it has been less than 24 hours since calibration, the PACE specification equals the Datasheet 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 Route-Sum-

Squared (RSS) of the Datasheet precision and the long term stability specification with respect to the original pressure calibration standard.

11. If no adjustment has been done and the calibration check is within the precision limits, then the calibration date can be updated by selecting the **Update Calibration Date** option.
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 the pressure calibration standard from the output.
15. If no further calibration is necessary, de-energize the PACE.

7. Calibration Adjustment A1 - Control Modules



INFORMATION This adjustment is for all ranges of Control Modules CM0, 1 and 2. It is also for Control Module CM3 up to and including 3.5 bar absolute.

For PACE calibration screens, refer to Appendix A.

To adjust the calibration of PACE:

1. Connect the PACE to the pressure calibration standard. See Section 5.
Note: Calibration adjustments can be carried out in any order. Three calibration points are necessary for gauge sensors. Two calibration points are necessary for absolute sensors.
2. With the pressure calibration standard connected to the correct pressure port, on the PACE screen, select a **Basic** task and **Measure** mode. If using the PACE6000 E, select P1 or P2 as necessary. Now select the sensor range to be checked.



3. Select the **Settings** icon , then the **Calibration** option. Enter the PIN (654321), then select **Sensor Correction**.
4. Select the pressure sensor to be corrected.
5. Select **Adjust** to open the **Adjust** screen.

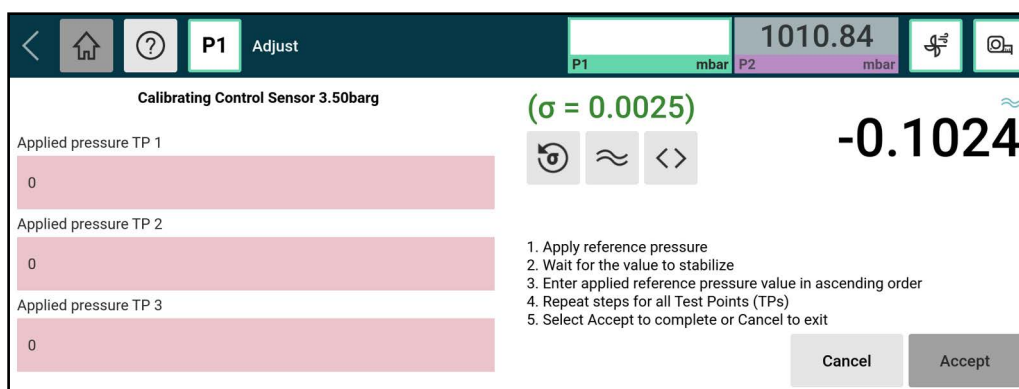


Figure 9: Adjust Screen

6. Adjust the applied calibration pressure to the first pressure value (Test Point) and wait until this pressure, shown on the PACE, is stable to less than 5 ppm (0.0005%) for CM2 and below (aim for 1 ppm (0.0001%) on CM3).

7. In the **Adjust** screen, select the first Test Point (TP1). Use the on-screen keypad to enter the applied pressure, then select OK to save it.
8. Repeat for the second and third Test Points (TP2 and TP3), determined by whether you have an absolute or gauge sensor.
9. Select **Accept** to accept the new calibration points.
10. Do a calibration check to make sure this procedure worked. See “Calibration Check A - Control Modules” on page 5.
11. After completing the calibration procedures, adjust the pressure calibration standard to atmospheric pressure. Disconnect the pressure calibration standard from the PACE.
12. If no further calibration is necessary, de-energize the PACE.

8. Calibration Adjustment A2 - Control Modules



INFORMATION This adjustment is for Control Modules CM3 and CM3-B at 8 bar absolute and above.

CM3 and CM-3B control modules both have barometers that need a calibration check and if required adjustment.

Note: Zeroing the Reference Sensor is not necessary for calibration adjustment as this is reset automatically during the adjustment process.

1. Do a calibration check (see “Calibration Check A - Control Modules” on page 5) on the Barometer first. If the recorded difference is more than the permitted deviation then the Barometer must be adjusted (see Section 7).
2. Do the steps in Section 7 Calibration Adjustment A1.

9. Recommended Calibration Check Points

Table 2: Barometric Variants

Barometric Variant	2 bara	1 barg up to 21 bara / 20 barg
750 mbar	35 mbara	-965 mbarg
900 mbar	20% of full-scale pressure	
950 mbar	40% of full-scale pressure	
1050 mbar	60% of full-scale pressure	
1150 mbar	80% of full-scale pressure	
1050 mbar	100% of full-scale pressure	
1000 mbar	80% of full-scale pressure	
950 mbar	60% of full-scale pressure	
900 mbar	40% of full-scale pressure	
750 mbar	20% of full-scale pressure	
-	35 mbara	-965 mbarg*

*Note: under some atmospheric conditions this value will not be achievable. In this case, use the lowest pressure that can be achieved. We recommend a value between -965 and -900 mbar.

Table 3: All Other Variants

36 bara / 35 barg and Above	All Other Variants (700 mbarg and Below)
Atmospheric / 0 mbarg	0 mbarg
20% of full-scale pressure	-100% of full-scale pressure
40% of full-scale pressure	-80% of full-scale pressure
60% of full-scale pressure	-60% of full-scale pressure
80% of full-scale pressure	-40% of full-scale pressure
100% of full-scale pressure	-20% of full-scale pressure
80% of full-scale pressure	0 mbarg
60% of full-scale pressure	20% of full-scale pressure
40% of full-scale pressure	40% of full-scale pressure
20% of full-scale pressure	60% of full-scale pressure
Atmospheric / 0 mbarg	80% of full-scale pressure
-	100% of full-scale pressure
-	0 mbarg

10. Recommended Calibration Adjustment Pressures

Table 4: Recommended Calibration Adjustment Pressures

Sensors	Pressures
IRS and TRS (absolute)	20% of the full-scale range of the sensor
	80% of the full-scale range of the sensor
IPS (gauge)	80% of the negative range
	0 pressure
	80% of the positive range.

Appendix A. PACE ‘E’ Series Screens

Note: These images show the PACE6000 E screens. The PACE5000 E screens are similar. The screens only include those relevant to the calibration process.

A.1 Finding Calibration History from a Typical Home Screen

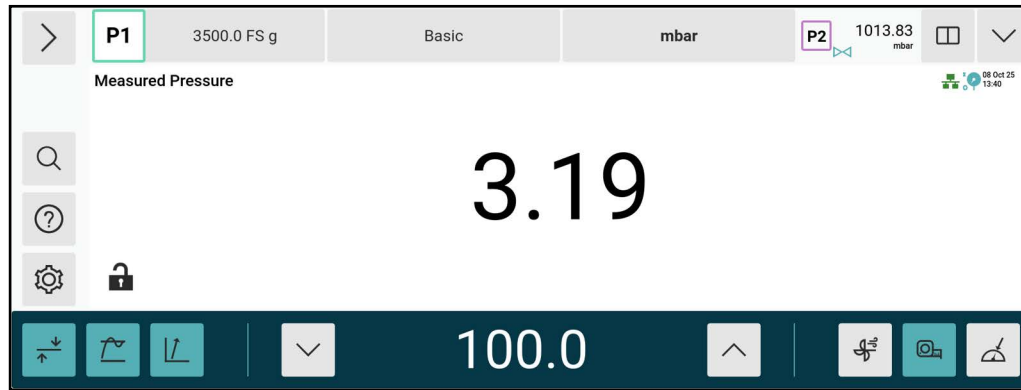


Figure A-1: Typical Home Screen

Figure A-1 shows a typical Home screen with a **Basic** Task selected and in **Measure** mode.

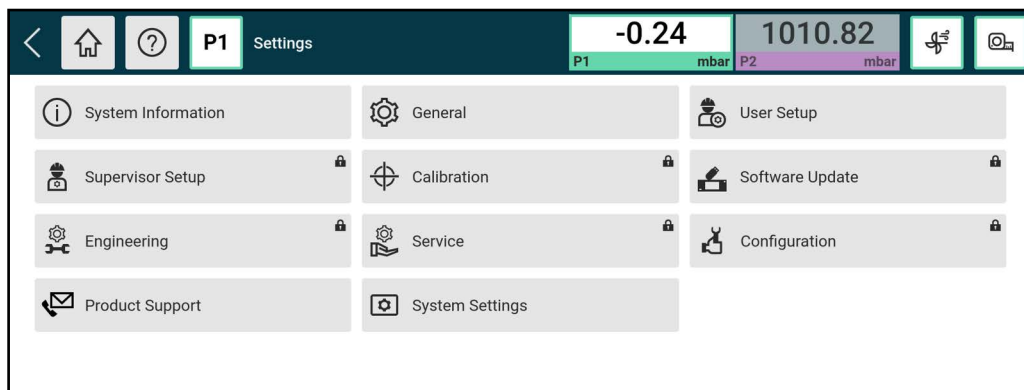


Figure A-2: Settings Screen

Figure A-2 shows the **Settings** screen, where you can select the **System Information** or the **Calibrations** screens.

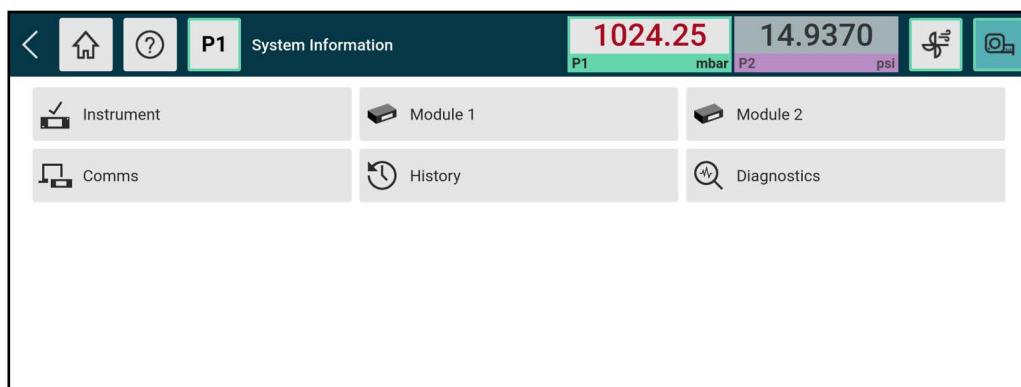


Figure A-3: System Information Screen

Appendix A. PACE ‘E’ Series Screens

Figure A-3 shows the System Information Screen where you can select information for the instrument and its module or (modules). To find it, select the **Settings** icon, then **System Information**.

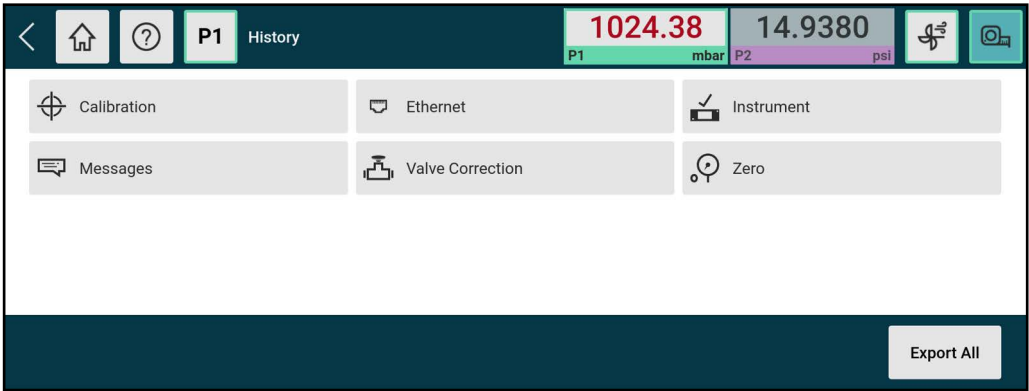


Figure A-4: History Screen

Figure A-4 shows the **History** screen where you can select history data about calibration and other areas including ethernet communications. To find it, select the **Settings** icon, then **System Information > History**.

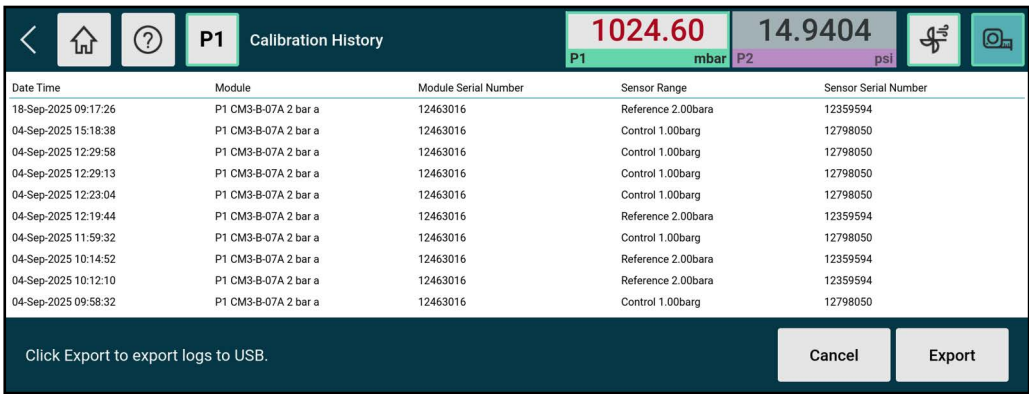


Figure A-5: Calibration History Screen

Figure A-5 shows the **Calibration History** screen where you can see data about the calibration of the control module (or modules) fitted to the instrument. To find it, select the **Settings** icon, then **System Information > History > Calibration**.

A.2 Calibration Screens

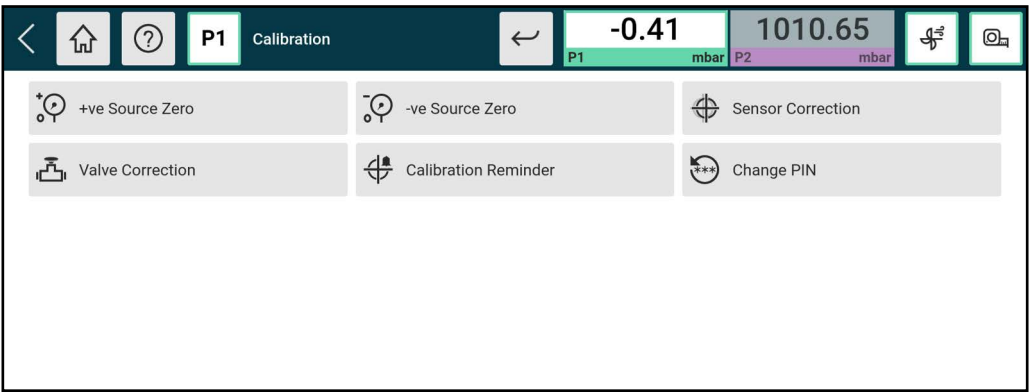


Figure A-6: Calibration Screen

Figure A-6 shows a **Calibration** screen. To find it, select the **Settings** icon, then **Calibration** and enter the calibration PIN.

This screen has a set of options:

- **+ve Source Zero** and **-ve Source Zero** - Open a pop-up that asks if you want to set the +ve or -ve source range to zero. Make sure that the +ve or -ve port of the control module is open to atmosphere or connected to the reference you need to zero against.
- **Sensor Correction** - selects the **Sensor Correction** screen (see Figure A-7).
- **Valve Correction** - selects the **Valve Correction** screen to check and adjust the valve. For use by Service Personnel.
- **Calibration Reminder** - to change the calibration period (default 365 days) for the calibration reminder.
- **Change PIN** - to change the PIN necessary to enter the Calibration Screen.

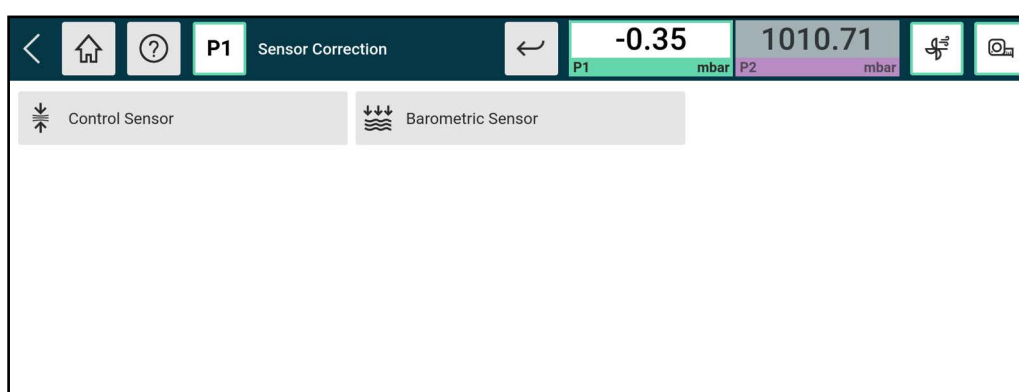


Figure A-7: Sensor Correction Screen

Figure A-7 shows the **Sensor Correction** screen, where you select the sensor to be checked or adjusted. This can be the Control Sensor or the Barometric Sensor as shown, or others as fitted to the Control modules. To find this screen, select the **Settings** icon, then **Calibration** and enter the calibration PIN, then select **Sensor Correction**.

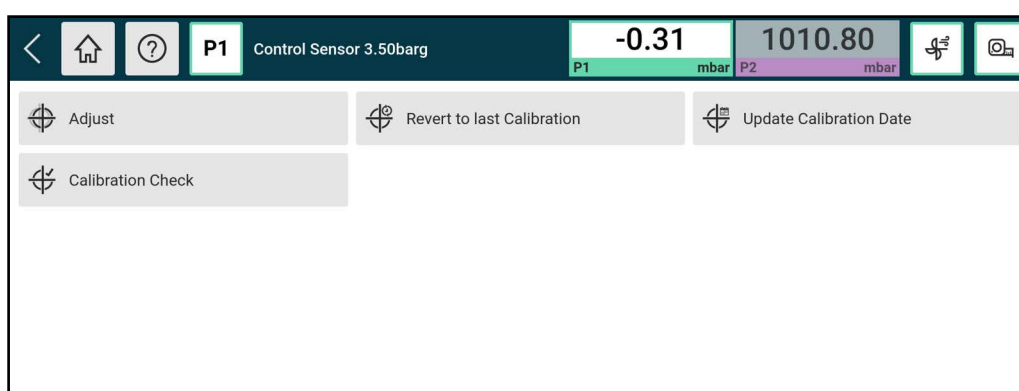


Figure A-8: Typical Sensor Screen

Figure A-8 shows a typical sensor screen. This example shows the Control Sensor selected. To find this screen, select the **Settings** icon, then **Calibration** and enter the calibration PIN, then select **Sensor Correction** and select the sensor to be calibrated.

This screen has a set of calibration options:

- **Adjust** - opens the **Adjust** screen for the selected sensor. See Figure A-10.

Appendix A. PACE 'E' Series Screens

- **Revert to last Calibration** - opens a pop-up to revert the sensor calibration to the last settings.
- **Update Calibration Date** - opens a pop-up to update the calibration date to the current date. This is useful if the calibration check shows that the sensor does not need calibrating and will not need rechecking until the next calibration due date.
- **Calibration Check** - opens the **Calibration Check** screen. See Figure A-9.

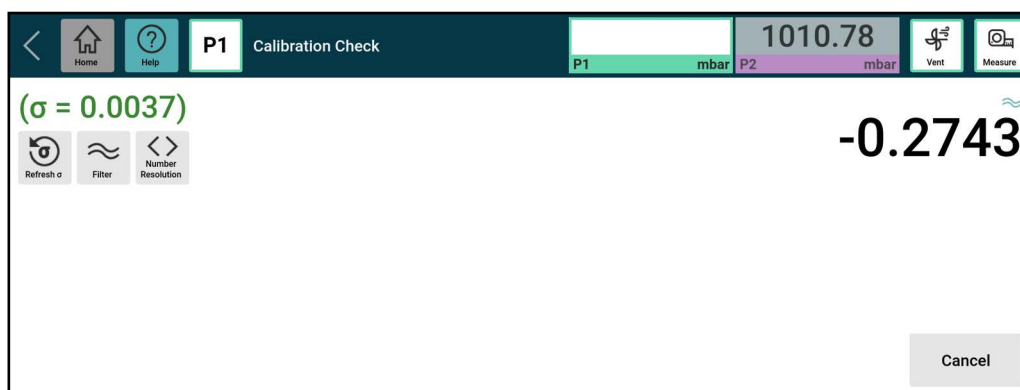


Figure A-9: Calibration Check Screen

Figure A-9 shows the **Calibration Check** screen that you use to check (not calibrate) a sensor. To find this screen, select the **Settings** icon, then **Calibration** and enter the calibration PIN, then select **Sensor Correction** and select the sensor to be calibrated. Finally select **Calibration Check**.

Note: The upper display of pressure for the selected sensor is not filtered, so it will be blank to avoid confusion with the filtered value shown in this screen.

This screen shows a filtered value of the measured pressure and the standard deviation (sigma σ) of the measured value. Use the controls on this screen to refresh the sigma value, change the filter ($\approx$) settings or adjust the resolution ($\langle \rangle$) of the measured value. The default filter settings are 10 seconds and 0.5% Full Scale.

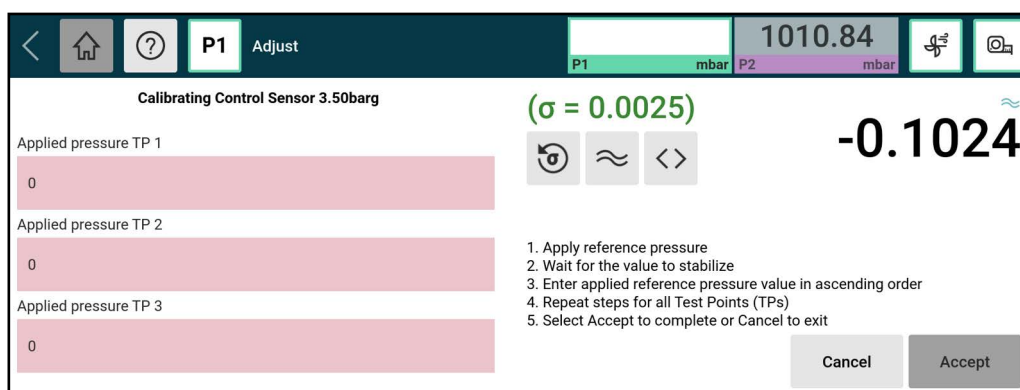


Figure A-10: Sensor Adjust Screen

Figure A-10 shows the sensor **Adjust** screen that you use to calibrate the pressure sensors. To find this screen, select the **Settings** icon, then **Calibration** and enter the calibration PIN, then select **Sensor Correction** and select the sensor to be calibrated. Finally select **Adjust**.

Note: The upper display of pressure for the selected sensor is not filtered, so it will be blank to avoid confusion with the filtered value shown in this screen.

This screen shows a filtered value of the measured pressure and the standard deviation (sigma σ) of the measured value. You may use the controls on this screen to refresh the sigma value, change the filter ($\approx$) settings or adjust the resolution ($\langle \rangle$) of the measured value. The default filter settings are 10 seconds and 0.5% Full Scale.

This screen includes numbered instructions on how to calibrate the selected sensor, and three boxes to enter the pressure applied from the reference source. Selecting each box opens a numerical keypad for you to enter the pressure. Finally, select the **Accept** button. The instrument re-calibrates the sensor to the reference source.

Appendix B. Pressure Units and Conversion Factors

Pressure Units	Factor (hPa)	Pressure Units	Factor (hPa)
mbar	1.0	cmH ₂ O @ 20°C	0.978902756
bar	1000.0	mH ₂ O @ 20°C	97.8902756
Pa (N/m ²)	0.01	kg/m ²	0.0980665
hPa	1.0	kg/cm ²	980.665
kPa	10.0	torr	1.3332240
MPa	10000.0	atm	1013.25
mmHg @ 0°C	1.333224	psi	68.94757
cmHg @ 0°C	13.33224	lb/ft ²	0.4788026
mHg @ 0°C	1333.224	inH ₂ O @ 4°C	2.4908205
inHg @ 0°C	33.863890	inH ₂ O @ 20°C	2.486413
mmH ₂ O @ 4°C	0.0980638	inH ₂ O @ 60°F	2.488432
cmH ₂ O @ 4°C	0.980638	ftH ₂ O @ 4°C	29.889846
mH ₂ O @ 4°C	98.0638	ftH ₂ O @ 20°C	29.836956
mmH ₂ O @ 20°C	0.097890276	ftH ₂ O @ 60°F	29.861188

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

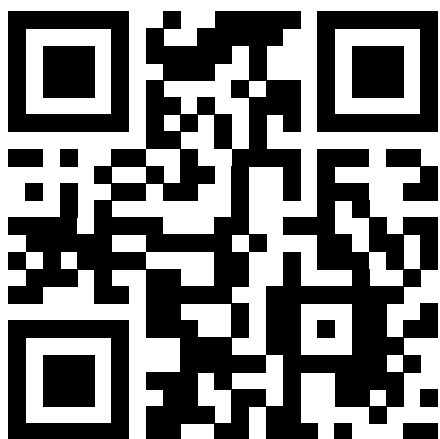
$$\text{VALUE 2} = \text{VALUE 1} \times (\text{FACTOR 1} / \text{FACTOR 2})$$

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