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Calibration

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PG7102 Piston Gauge

Highlights

Gas pressure up to 11 MPa

PG7102 covers gauge and absolute pressures above atmosphere with gas as the pressurized medium. Absolute mode is supported by automated measurement and addition of atmospheric pressure, using PG7102's internal barometer or any external barometer supporting RS-232 communications. PG7102 does not cover absolute or gauge pressures below atmospheric pressure.

The PG7102 includes all PG7000 standard features (see "Description" tab) as well as:

- Simplified gas operated platform does not include vacuum reference capability.
- Accepts same gas operated piston-cylinder modules as PG7601 platform.

Description

PG7000 Piston Gauge line features reference level pressure standards offering a unified solution from vacuum to 500 MPa

- State-of-the-art primary pressure standards for the lowest uncertainty levels
- Unified solution from vacuum to 500 MPa
- Outputs fully validated reference pressures in real time
- Intuitive local operator interface
- Manual, semi-automated and fully automated configurations

The PG7000 Series calibration standards are based on the fundamental principle of mass loaded onto a piston to apply a known force to a known effective area.

Integrated piston-cylinder modules

Each PG7000 piston-cylinder is an integrated metrological assembly that includes the critical piston-cylinder mounting components. All of the mechanical parts that affect piston cylinder metrology are associated with the individual piston-cylinder, rather than being common parts of the piston gauge platform, enabling the user to:

- Change ranges (piston-cylinders) in seconds, without using tools.
- Handle and interchange piston-cylinders without exposing critical surfaces to contamination.
- Protect the piston-cylinder from damage due to accidental shock or impact when handling.
- Improve measurement reproducibility by avoiding frequent assembly/disassembly of mounting components.
- Improve piston-cylinder mounting design by allowing each mounting system to be optimized for a piston-cylinder size and range.

Mass loading concentricity

The number of independent parts between the piston and mass load has been reduced to two—the piston cap and the mass loading bell. The piston head is effectively made part of the piston by machining it after installation concentrically to the piston within ± 20 microns.

Integrated electronics, software and remote interfacing

The electronics for monitoring all ambient and instrument conditions and functions are integrated into the PG7000 platform. RS-232 and IEEE 488 interfaces are included for remote communication. The system power supplies are also contained in the terminal to remove their heat source from the PG platform. For local operation, the user interacts with the PG7000 through a keypad and alphanumeric display on a compact terminal, allowing rapid, intuitive operation.

On-board measurement of operating conditions

PG7000 includes integrated on-board measurement of all the ambient and operating conditions needed to calculate pressure within tolerance, including relative humidity, barometric pressure, ambient temperature, piston-cylinder temperature, and reference vacuum. Individual measurements can be observed in real time, both locally through the PG terminal and remotely over the RS-232 or IEEE 488 interface. Verification and recalibration of the on-board sensors is supported by embedded software.

Monitoring piston behavior

PG7000 measures and provides real time indication of piston position, drop rate, rotation rate, and rotation deceleration. Piston position is measured on the LVDT principle, with a ring on the inside of the mass loading bell acting as the armature. Rotation rate is measured optically by a sensor in the mounting post, which detects the movement of a notched ring on the inside of the mass loading bell. Both measurement systems are completely non-interfering, with no influence on the free movement of the piston in any axis.

Ready/not ready indication

The “ready/not ready” indication provides the operator with a clear “go/no go” indication of when an in-tolerance measurement can be made. It is based on testing for a variety of operating conditions, including piston position, piston fall rate, piston rotation rate, piston rotation deceleration, piston temperature rate of change and vacuum reference (when applicable). A ready condition is indicated when all conditions fall within specific limits. The limits for the various ready/not ready criteria can be customized by the user if desired.

Piston near-float detection

One of the most tedious aspects of operating a conventional piston gauge is adjusting pressure to float the piston. The piston lifts suddenly and without warning at the exact pressure corresponding to the mass loaded on the piston. Finding that point without overshooting requires slow and cautious pressure control. PG7000 makes it easier to float the piston with a piston preloading system, which provides advance warning that the pressure is near the point where the piston will leave end of stroke. The preloading system only affects the piston when it is at end of stroke; it does not interfere with the free movement of the piston when it is floating.

Intelligent piston rotation

PG7000 is the first commercially available piston gauge to provide monitoring of rotation rate and decay in rotation rate. These measurements are used to assure that pressure readings are always made within limits. This relieves the operator of rotation rate monitoring responsibility and replaces subjective operator judgment with objective measurement.

Storage and shipping containers

The PG7000 piston gauge platform and mass set are packaged in heavy duty, weather proof, molded transit cases with custom inserts to provide optimum protection. PG7000 piston-cylinders modules are delivered in compact, virtually indestructible PVC bullet cases.

Advanced pressure generation and control components

All PG7000 pressure accessories are designed to increase the efficiency and ergonomics of piston gauge operation. These include manual, semi-automated and fully automated options to quickly and easily generate pressure and float the piston at the set point.

COMPASS® for Pressure calibration assistance software

COMPASS software sets up records for the units under test (UUT), defines and associates test procedures with UUTs, runs tests, acquires reference and test data, produces standard and custom calibration reports. All reference, UUT and test data is collected and stored in a database and standard delimited files. COMPASS can manage any kind of test from manual operator control and logging of test data to fully automated, unattended test execution.

A unified solution from vacuum to 500 MPa

The PG7000 line of piston gauges covers the complete range of pressure from very low absolute and differential in gas, up to 500 MPa (75 000 psi) in oil. While several piston gauge platforms and specialized accessories may be needed to cover different ranges and media, a consistent user interface and operational principles are maintained throughout the line. In most cases, complete gas and oil calibration capability can be achieved with just two PG platforms, four piston-cylinder modules and one mass set. Maintaining consistency from system to system makes them easier to learn and to use. Maintenance costs are reduced by minimizing the number of metrological elements to be supported.

PG7000 Piston Cylinder Modules

The piston-cylinder defines effective area and is the piston gauge's principal metrological element. The piston-cylinder's intrinsic characteristics and how it is mounted and exploited are the keys to piston gauge performance.

PG7000 piston-cylinders are manufactured by Fluke Calibration using proprietary production techniques that result in pistons and cylinders whose typical shape is within less than 0.2 micron from ideal geometry.

Pure gas operated piston-cylinders use large diameters and very small annular gaps to minimize gas species and operating mode effects and to maximize piston float times. For example, the typical annular gap of a 35 mm gas operated piston-cylinder is less than 1 micron. Oil operated piston-

cylinders use small diameters to reduce the quantity of mass needed to cover the typical high pressure range.

All Type 7000 pistons and cylinders are made of tungsten carbide. Each PG7000 piston-cylinder is a complete, integrated metrological assembly that includes the critical piston-cylinder mounting components for improved metrological performance. All Type 7000 piston-cylinders use free deformation mounting systems in which the cylinder is allowed to deform under the influence of applied pressure, without O-rings or seals along the cylinder length. For higher pressure gas assemblies, a new mounting system, negative free deformation, applies the measured pressure uniformly along the full length of the cylinder. This reduces deformation under pressure, so piston drop rates remain low even at high operating pressures, while avoiding the unpredictable strain points of conventional reentrant designs.

PG7000 Mass Sets

Masses loaded on the piston are accelerated by gravity to apply a known force on the piston against which the defined pressure is balanced.

A PG7000 manual mass set is made up of main masses of 10 kg or 5 kg, fractionary masses in 5-2-2-1 progression from 0.5 kg to 0.1 kg, and a trim mass set with masses from 50 kg to 0.01 g. Any desired mass value within the mass set range can be loaded to 0.01 g. All main and fractionary masses are machined from solid, nonmagnetic stainless steel and adjusted to their nominal values in the mass without cavities or trimming hardware which can reduce mass stability over time. Individual masses are comfortable to handle, with angled lifting surfaces on the edge of each mass and special mass trays that assist in orderly loading and unloading.

A PG7000 automated mass set is composed of main mass discs of 6.2 or 10 kg each and a set of tubular masses in binary progression from 0.1 to 3.2 or 6.4 kg.

A pneumatically driven automated mass handling accessory (AMH) loads requested mass values in increments of 0.1 kg. The AMH and mass set are easily removed to access the piston-cylinder module when necessary.

Specifications

General	
Power requirements	85 V ac to 264 V ac, 47 Hz to 440 Hz, 22 VA max consumption
Normal operating temperature range	18 °C to 28 °C (64 °F to 82 °F)
Weight	Instrument platform with no mass loaded: 13 kg (28 lb) PG terminal 1.4 kg (3 lb)
Dimensions	Instrument platform (HxWxD): 36 cm x 40 cm x 35 cm (14.5 in x 15.8 in x 13.8 in)

	Height: Top of mounting post with piston-cylinder module installed for PG terminal (HxWxD): 12 cm x 15 cm x 20 cm (4.7 in x 5.9 in x 7.9 in)
Communications ports	RS-232 COM1: Host computer COM2: AMH automated mass handler, external barometer COM3: Automated pressure controller IEEE-488.2: Host computer
Maximum pressure ranges	Actual range depends on piston-cylinder and mass set selection.
Operating media	Gas: air, helium, nitrogen
Pressure connections	Test port: DH200 Note: DH200 and DH500 are gland and collar type fittings for 1/4 in (6 mm) coned and left hand threaded tube. DH200 is equivalent to AE SF250C, HIP LF4, etc. DH500 is equivalent to AE F250C, HIP HF4, etc.
CE conformance	Available, must be specified

Masses

Mass set specifications	All masses are delivered in molded, reusable transit cases with custom inserts.
Masses	Material: 304L non-magnetic stainless steel Finish: Electropolished Adjustment tolerance: ± 20 ppm of nominal value Accuracy of measured values: ± 5 ppm or 1 mg, whichever is greater Traceability of measured values: National Institute of Standards and Technology (NIST)

Ambient and instrument condition measurements

Temperature	Piston - Cylinder Temperature Range: 0 to 40 °C
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	<p>Resolution: 0.01 °C Accuracy: ± 0.1 °C</p> <p>Ambient Temperature Range: 0 to 40 °C Resolution: 0,1 °C Accuracy: ± 1 °C</p>
Barometric pressure with internal sensor	<p>Range: 70 kPa to 110 kPa Resolution: 10 Pa Accuracy: ± 140 Pa</p> <p>Barometric pressure can also be read automatically from any RS-232 device such as RPM4</p>
Relative humidity	<p>Range: 5 % to 95 % RH Resolution: 1 % RH Accuracy: ± 10 % RH</p>
Piston position	<p>Range: ± 4.5 mm Resolution: 0.1 mm</p>
Piston rotation (rate and deceleration)	<p>Range: 2 to 150 rpm Resolution: 1 rpm</p>

Pressure measurement

PG7102

PC-7100/7600-10 and 10-L
Sensitivity1: 0.02 Pa + 0.5 ppm
Reproducibility2: ± 2 ppm
Typical measurement uncertainty3: $\pm (0.2 \text{ Pa} + 12 \text{ ppm})$
Typical drop rate (35 kg): 0.2 mm/min

PC-7100/7600-20
Sensitivity1: 0.04 Pa + 0.5 ppm
Reproducibility2: ± 2 ppm
Typical measurement uncertainty3: $\pm (0.2 \text{ Pa} + 14 \text{ ppm})$
Typical drop rate (35 kg): 0.2 mm/min

PC-7100/7600-50

Sensitivity1: 0.1 Pa + 0.5 ppm
 Reproducibility2: ± 3 ppm
 Typical measurement uncertainty3: $\pm (0.5 \text{ Pa} + 14 \text{ ppm})$
 Typical drop rate (35 kg): 0.5 mm/min

PC-7100/7600-100
 Sensitivity1: 0.2 Pa + 0.5 ppm
 Reproducibility2: ± 3 ppm
 Typical measurement uncertainty3: $\pm (1 \text{ Pa} + 20 \text{ ppm})$
 Typical drop rate (35 kg): 0.7 mm/min

PC-7100/7600-200
 Sensitivity1: 0.4 Pa + 0.5 ppm
 Reproducibility2: ± 5 ppm
 Typical measurement uncertainty3: $\pm (2 \text{ Pa} + 20 \text{ ppm})$
 Typical drop rate (35 kg): 1.00 mm/min

1 Sensitivity: The smallest variation in input detectable in output.
 2 Reproducibility: Combined long term stability of piston cylinder effective area and masses

Pressure measurement uncertainty

Typical pressure measurement uncertainty All sources of uncertainty under typical operating conditions are identified, quantified and combined following ISO/TAG4/WG3. The result is rounded upwards to provide conservative global uncertainty figures for the typical user under typical conditions

Models and Accessories

Model Name	Description
PG7102	Gas Operated Piston Gauge, with Motorized Piston Rotation
PG7102-CE	Gas Operated Piston Gauge with Motorized Piston Rotation, CE Compliant

Model Name	Description
PC-7100/7600-10-L	10 kPa/kg Lightweight Gas Piston-Cylinder Module Includes: <ul style="list-style-type: none"> • PVC “Bullet” Case • Calibration Report
PC-7100/7600-10 TC	10 kPa/kg Gas Piston-Cylinder Module Includes: <ul style="list-style-type: none"> • PVC “Bullet” Case • Calibration Report
PC-7100/7600-50	50 kPa/kg Gas Piston-Cylinder Module Includes: <ul style="list-style-type: none"> • PVC “Bullet” Case • Calibration Report
PC-7100/7600-200	200 kPa/kg Gas Piston-Cylinder Module Includes: <ul style="list-style-type: none"> • PVC “Bullet” Case • Calibration Report
MS-7001-35	Mass Set (for manual operation without AMH) Nominal total mass: 35 kg
MS-7002-35	Mass Set (for manual operation without AMH) Nominal total mass: 35 kg





Model Name	Description
MS-7002-40	Mass Set (for manual operation without AMH) Nominal total mass: 40 kg
MS-7002-45	Mass Set (for manual operation without AMH) Nominal total mass: 45 kg
MS-7002-55	Mass Set (for manual operation without AMH) Nominal total mass: 55 kg
MS-7002-80	Mass Set (for manual operation without AMH) Nominal total mass: 80 kg
MS-7002-100	<p>Mass Set (for manual operation without AMH) Nominal total mass: 100 kg</p> <p>Manual 100 kg mass set is typically used when AMH is not purchased. Smaller mass sets are available when maximum pressure range is not required.</p> <p>Delivered with reusable shipping and storage cases and calibration certificate.</p> <p>Existing MS-7001/7002 mass sets from PG7000 piston gauge systems are compatible with PG9607</p>

Accessories common to all models:

Accessory	Description
PK-7000-PPC/MPC	Interconnections Kit - connect PG7102 to PPC or MPC pressure controller, and device under test.

Accessory	Description
RPM4-BAROM-1	Barometric Pressure Monitor
MPC1-1000	Manually operated gas pressure controller, pressure range vacuum to 7 MPa (1,000 psi)
MPC1-3000	Manually operated gas pressure controller, pressure range vacuum to 20 MPa (3,000 psi)
OPG1-30000	Hydraulic pressure generator - Includes: 1 qt. Di-2 Ethyl Hexyl Sebacate (synthetic oil), External tubing/adaptors for connection to a PG7302 or RPM4, and Operation and maintenance manual.
COMPASS for Pressure	Software to automate testing, data acquisition, reporting and asset management
Automated Mass Handling	See AMH-100 and AMH mass sets for automated mass handling options.
PPC4	Gas Pressure Controller/Calibrator

Knowledge_and_information

Product Manuals
 PG7000™ Piston Gauges Operation and Maintenance Manual (3.3 MB)
 PG7000™ Piston Gauges Operation and Maintenance Manual Supplement (61.74 KB)
 PG7307™ Operation and Maintenance Manual (Use with PG7000 Manual).(546.13 KB)
 PG7601-SYS-AF™ Operation and Maintenance Manual (5.31 MB)

Product Manuals

 [PG7607 PISTON GAUGE Operation and Maintenance Manual \(Use with PG7000 Manual\) \(497.19 KB\)](#)

 [PG7000™/RPM™ to PPC™/3990 Interconnections Kit Installation Sheet \(513.49 KB\)](#)


Application Notes

 [Accounting for Gravity When Using a Deadweight Tester or Piston Gauge Application Note \(3.15 MB\)](#)

 [Pg7000 Differential Mode for Defining Low and Negative Differential Pressure at Various Static Pressures \(449.27 KB\)](#)

 [PG7000 Piston-Cylinder Modules Summary of Pressure Measurement Specifications \(51.23 KB\)](#)

 [PG7000 Vacuum Gauge Linearization Table Update \(60.14 KB\)](#)

 [Uncertainty Analysis for Pressure Defined by a PG7601, PG7102, PG7202 or PG7302 Piston Gauge \(2.73 MB\)](#)

 [Principles of Metrology \(400.44 KB\)](#)

Data Sheets

 [PG7000 Series Piston Gauges Data Sheet \(2.93 MB\)](#)

Software

[COMPASS for Pressure Calibration Software Download/Upgrade](#)

Firmware

[PG7000 Ver 1.05f Embedded Software](#)

[PG7000 Ver 2.01 Embedded Software](#)

[PG7000 Ver 2.07h Embedded Software](#)

[PG7000/PG9000 Ver 3.1.5.255 Embedded Software](#)

Instruction Sheets

 [PG7000™ Upgrade Instructions: Flash with EEPROM to Flash without EEPROM, Non-Flash to Flash without EEPROM \(322.38 KB\)](#)

 [Replacement EPROM kit For PG and FPG Terminals \(197.71 KB\)](#)

Papers / Articles

 [The Impact of the New SI on Industry \(948.69 KB\)](#)

On-Demand Webinars

[How to Create a Pressure Uncertainty Budget when Using a Piston Gauge](#)

[Pressure Series, Part 3 of 3, Advanced Pressure Calibration](#)

Product Images



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[2] https://eu.flukecal.com/print/products/pressure-calibration/piston-gauges/pg7102-piston-gauge?quicktabs_product_details=4#quicktabs-product_details

