

**FLUKE®**

**Calibration**

## PG9000 Piston Gauges

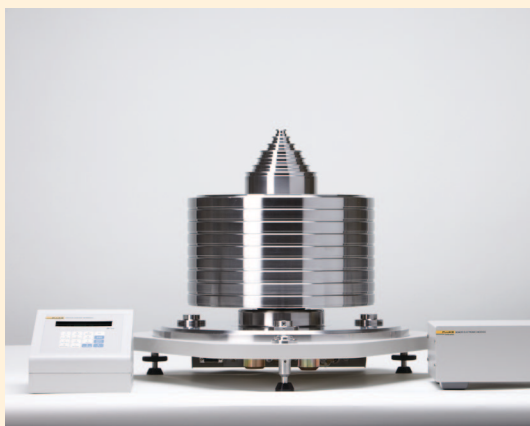
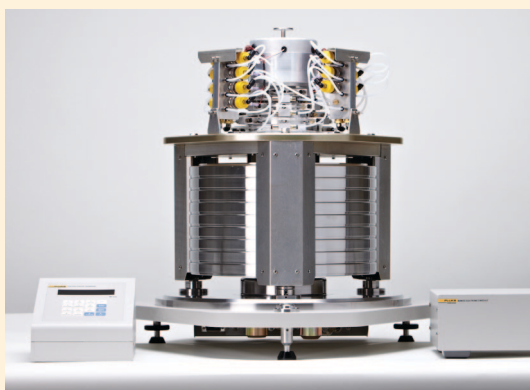
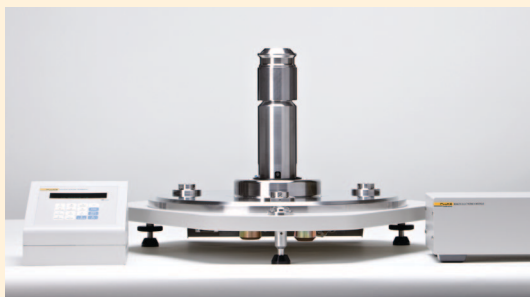


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Automated primary pressure reference for  
absolute and gauge pressures to 10 MPa

# Designed for fundamental metrology research



PG9000 piston gauges are the next generation of absolute pressure piston gauges from Fluke Calibration. They are designed to enable metrology and research institutes to realize and disseminate exceptional fundamental pressure measurements. Each PG9000 model supports the use of up to a 100 kg mass load in absolute and gauge pressure operation, creating a wide usable pressure range for each piston-cylinder and enabling more overlap of ranges for intercomparison.

## **Two PG9000 models are available:**

PG9607 defines gauge and absolute pressures from 11 kPa to 500 kPa with a single piston-cylinder. It is designed for use as a true primary pressure reference. Its performance is centered around a 50 mm piston-cylinder assembly with dimensional characteristics suitable for low-uncertainty dimensional traceability.

PG9602 includes multiple piston cylinder range options to support absolute or gauge pressure measurements from 12 kPa to 10 MPa.

Both models have mounting posts designed for greater confidence in the piston-cylinder temperature measurement. The platform architecture also promotes improved temperature stability around the piston-cylinder.

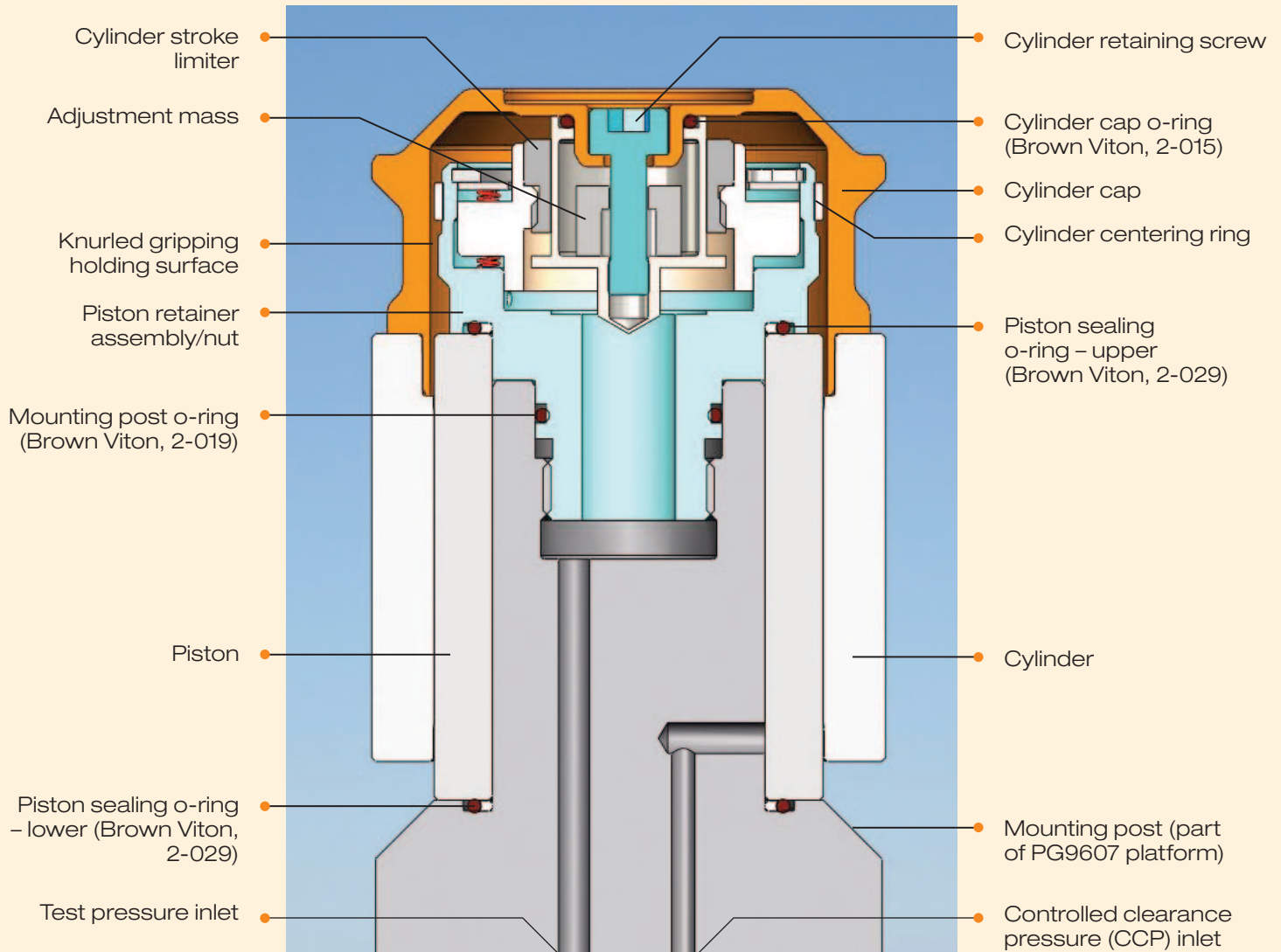
PG9000 piston gauges feature AMH automated mass handling technology to allow fully automated testing in both gauge and absolute mode. Manual steps are removed from their operation, saving time and delivering metrological advantages. When AMH is coupled with automatic pressure control and computer software, repeated and extended tests become practical, making PG9000 a powerful calibration and research tool.

PG9000 is the result of Fluke Calibration's extensive work with national metrology institutes (NMIs) to minimize pressure measurement uncertainty and years of supplying piston gauges to NMIs and other top pressure metrology labs worldwide.





## PC-9607-5 piston cylinder assembly





# Innovations to minimize uncertainty

## PG9607: Refined 50 mm piston-cylinder design

PG9607's piston-cylinder assembly builds upon more than 15 years of design, manufacture and calibration of 50 mm piston-cylinders. PC-9607-5 is a 5 kPa/kg piston-cylinder with a stationary piston and floating cylinder design. Improved manufacturing and testing methods are used to produce a very low distortion assembly. The 50 mm piston-cylinder provides exceptional performance—up to 500 kPa with a 100 kg mass load. The PG9607 mounting post allows an independent controlled clearance pressure to be applied to the inside of the piston, thus predictably varying the size of the gap between the piston and cylinder for advanced study.

## PG9602: Disseminate low uncertainty measurements to 10 MPa

PG9602 uses Fluke Calibration's unique integrated piston-cylinder assemblies to measure pressures up to 10 MPa. These piston-cylinder modules have been used for years with PG7000 piston gauges and are now selected and tested for low uncertainty operation with up to 100 kg of mass with PG9602. The PG9000 platform design and high mass load produce a wide range and high performance piston gauge that is the ideal instrument to disseminate primary PG9607 measurements to higher pressure ranges with the lowest possible uncertainty.

Two decades ago, the DH Instruments PG7000 family of piston gauges introduced the advantages of on-board sensing and monitoring technology, as well as other performance and ergonomic enhancements. The PG9000 platform adds several innovations to improve pressure measurements even further.

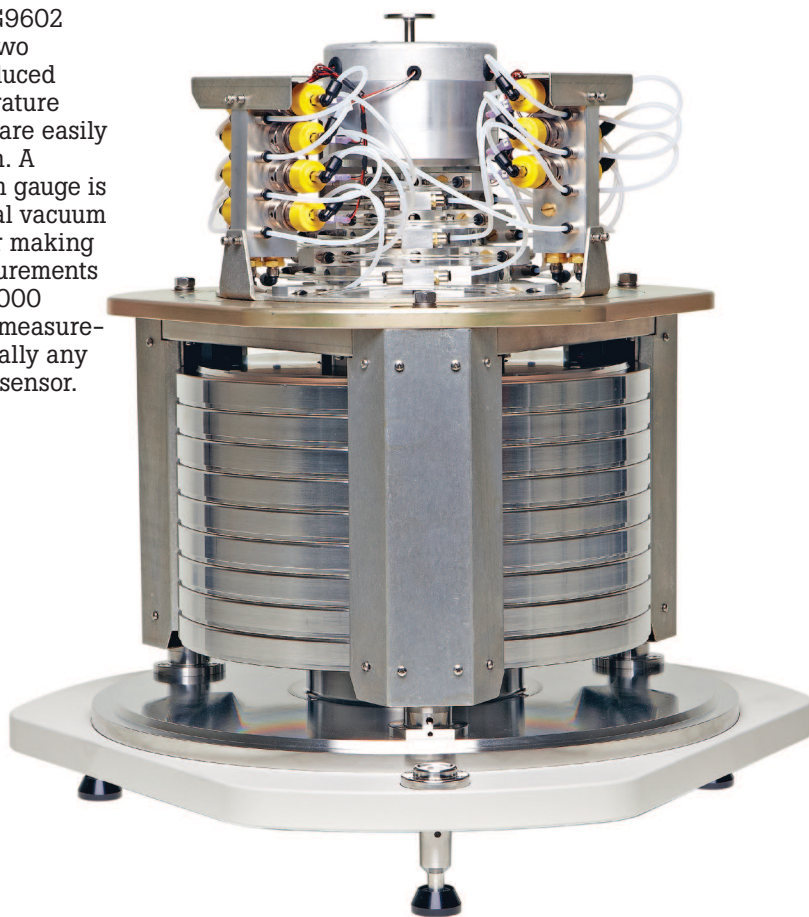
The platform consists of a piston gauge base, terminal, and a new remote electronics module. The terminal is the user interface. It stores metrological component data, reports operating and ambient condition status and calculates pressure.

The PG9000 piston gauge base supports automatic piston-cylinder rotation and mass handling, but all of the electronics to support the sensors and rotation control have been relocated to a remote electronics module. This architecture supports the best possible temperature stability at the base, even with prolonged vacuum operation, since any significant sources of heat are located away from the base.

Both PG9607 and PG9602 mounting posts have two integrated PRTs for reduced piston-cylinder temperature uncertainty. The PRTs are easily removed for calibration. A capacitance diaphragm gauge is included in the optional vacuum reference hardware for making residual vacuum measurements in absolute mode. PG9000 can also integrate the measurement output from virtually any user-supplied vacuum sensor.

## Metrology supported by automation

AMH automated mass handling technology is expanded on PG9000 to provide gauge and absolute operation with up to a 100 kg mass load. Eliminating manual mass loading minimizes mechanical wear, improving mass stability. The automated mass handler operates inside the evacuated bell jar, so the time to release and draw a vacuum while changing masses between test points is eliminated. The sustained vacuum produces lower and more static residual vacuum values. Total test time and productivity are greatly improved, especially on absolute pressure tests. More importantly, full automation promotes highly consistent measurements and allows extensive tests with many test points that would be impractical to perform manually. With the help of calibration management software like COMPASS® for Pressure, tests can be run fully unattended.



# Specifications

General		
Electrical power	85/264 V ac, 50/60 Hz, 22 VA maximum consumption	
Temperature	Operating: 15 °C to 35 °C (59 °F to 95 °F) Storage: -20 °C to 70 °C (-4 °F to 158 °F)	
Humidity	Operating: 5 % to 95 % RH, non-condensing	
Weight	Instrument platform with no mass or piston-cylinder loaded	
	PG9000 base (without vacuum hardware): 34 kg (74 lb)	
	Remote electronics module: 1.9 kg (4 lb)	
	PG terminal: 1.4 kg (3 lb)	
Dimensions (H x W x D)	Optional vacuum reference hardware: 16 kg (36 lb)	
	PG9000 base (without vacuum hardware): 34.1 cm x 54.3 cm x 52.3 cm (13.4 in x 21.4 in x 20.6 in) (Height: top of piston-cylinder assembly)	
	PG9000 (with optional vacuum bell jar and vacuum gauge connected): 56 cm x 54.3 cm x 52.3 cm (22 in x 21.4 in x 20.6 in) (Height: Top of bell jar)	
	Remote electronics module: 10.2 cm x 35.1 cm x 19.6 cm (4 in x 13.8 in x 7.7 in)	
Communication ports	PG terminal: 12 cm x 15 cm x 20 cm (4.7 in x 5.9 in x 7.9 in)	
	RS-232	COM1: Host computer
		COM2: Residual vacuum sensor (external)
		COM3: Automated pressure controller
		COM4: Unused/spare
Overall pressure range	IEEE-488	Host computer
	PG9607	Gauge and Absolute: 11 kPa to 500 kPa (1.6 to 72.5 psi) <sup>1</sup>
	PG9602	Gauge: 13 kPa to 10 MPa (1.9 to 1450 psi) <sup>1</sup>
Operating media	Gas: nitrogen, helium, dry air (dewpoint ≤ -40 °C)	
Maximum mass load	100 kg <sup>1</sup>	
Pressure connections	PG9000 base	Test port: DH200* Controlled clearance pressure (PG9607 only): DH200* *Gland and collar fitting for 6.35 mm (0.25 in) coned and left hand threaded tubes. Equivalent to AE SF250C, HIP LF4, etc.
	AMH drive	Quick connector equivalent to Swagelok QM Series (QM2-B-200). Use with DESO (double end shut off) type stem.
	AMH vent	Quick connector equivalent to Swagelok QM Series (QM2-B-200). Use with SESO (single end shut off) type stem only.
	Remote electronics module	ATM port: 10-32 UNF
	Vacuum bell jar	3x 40 mm ISO/KF flange, 1x 50 mm ISO/KF flange (top)
	CE conformance	All PG9000 models conform to CE requirements

<sup>1</sup> MS-AMH-100 mass set contains approximately 104.5 kg of mass. Combined with the piston or cylinder and bell assembly, total mass loads may be up to 106 kg, resulting in pressures of up to 530 kPa (5.3 bar, 76.9 psi) on the PG9607 or 10 600 kPa (106 bar, 1537.4 psi) on the PG9602.

## Embedded features

- Local control with 2 x 20 vacuum fluorescent display and 4 x 4 function driven keypad
- Real time (1 second update rate) display and measurement of ambient (pressure, temperature, humidity) and instrument (piston-cylinder temperature, cylinder position, cylinder drop rate, cylinder rotation rate, cylinder rotation decay rate, reference vacuum) conditions
- Real time (1 second update rate) mass-to-pressure and pressure-to-mass calculations taking into consideration all environmental and operational variables
- Full gas fluid head corrections including DUT head correction and piston position head correction
- Adjustable mass loading resolution 0.01 g to 0.1 kg
- Audible prompts of instrument status (piston movement, Ready/Not Ready indication) with override capability
- Integrated automated mass handling option (AMH-100-VAC)
- Interfacing and automatic exploitation of external barometer via RS-232
- Interfacing and automatic exploitation of standard or user-supplied external vacuum gauge via RS-232
- Automated differential mode to define low differential pressures at various static pressures between vacuum and atmosphere
- Storage and one step activation of metrological data on up to 18 piston-cylinder modules, 3 mass sets and 3 mass loading bells
- Continuous pressure Ready/Not Ready indication based on measured conditions
- Motorized, intelligent piston drive system based measured rotation rate with operator alert and manual override
- Integrated automated pressure control with standard PPC4 pressure controllers
- Full RS-232 and IEEE-488 communications with multi-level commands to set and read all instrument functions

# Specifications

AMH-100-VAC Automated Mass Handler (optional)	
Power requirements	15 V dc @ 2 A, 30 W maximum consumption
Temperature	Operating: 15 °C to 35 °C (59 °F to 95 °F)
Dimensions (H x W x D)	41 cm x 41 cm x 36 cm (16.3 in x 16.1 in x 14.1 in)
Weight	12 kg (25 lbs)
Power/communications	Custom 8-pin connector
AMH drive air supply	550 kPa (80 psi), ± 10 %, minimal flow
AMH vacuum supply	At least 50 kPa (7.5 pi) under atmosphere, minimal flow
Pressure connections	Pressure: Quick connector DESO (double end shut off) type stem Vacuum: Quick connector SESO (single end shut off) type stem

	PC-9607-5	PC-9602-10	PC-9602-20	PC-9602-50	PC-9602-100
Compatible platform	PG9607	PG9602	PG9602	PG9602	PG9602
Pressure to mass ratio	5 kPa/kg	10 kPa/kg	20 kPa/kg	50 kPa/kg	100 kPa/kg
Minimum pressure (using mass bell)	11 kPa (1.6 psi)	13 kPa (1.9 psi)	20 kPa (2.9 psi)	50 kPa (7.3 psi)	100 kPa (14.5 psi)
Maximum pressure (100 kg mass)	500 kPa (72.5 psi)	1 000 kPa (145 psi)	1 100 kPa (160 psi)	2 750 kPa (400 psi)	10 000 kPa (1450 psi)
Piston material	Tungsten Carbide	Tungsten Carbide	Tungsten Carbide	Tungsten Carbide	Tungsten Carbide
Cylinder material	Tungsten Carbide	Tungsten Carbide	Tungsten Carbide	Tungsten Carbide	Tungsten Carbide
Nominal diameter (mm)	50	35	25	16	11
Nominal area (mm <sup>2</sup> )	2000	1000	500	200	100
Mounting system	Controlled Clearance	Simple Free Deformation	Simple Free Deformation	Negative Free Deformation	Negative Free Deformation
Typ. N2 drop rate with full mass load (mm/min)	0.25	0.3	0.3	0.5	0.7
Sensitivity <sup>1</sup>	0.02 Pa + 0.5 ppm	0.02 Pa + 0.5 ppm	0.04 Pa + 0.5 ppm	0.1 Pa + 0.5 ppm	0.2 Pa + 0.5 ppm
Reproducibility <sup>2</sup> (ppm)	2	2	2	2	3

<sup>1</sup> Sensitivity: The smallest variation in input detectable in output

<sup>2</sup> Reproducibility: The root sum square of the stability of effective area and stability of the AMH-100 mass set for 1 year

Mass sets	
All masses are delivered in molded, reusable, transit cases with custom inserts.	
Masses > 50 g	Material: 304L non-magnetic stainless steel
	Finish: Electropolished
	Adjustment tolerance: ± 20 ppm of nominal value (manual mass sets, AMH automated mass handler mass sets do not have fixed adjustment tolerances)
	Uncertainty of measured values: ± 5 ppm or 1 mg, whichever is greater
Masses ≤ 50 g	Uncertainty of measured values: ± 1 mg

Ambient and instrument condition measurements				
		Range	Resolution	Measurement uncertainty
Temperature	Ambient	0 °C to 40 °C (32 °F to 104 °F)	0.1 °C (32.18 °F)	± 1 °C (33.8 °F)
	Piston cylinder module	0 °C to 40 °C (32 °F to 104 °F)	0.01 °C (32.02 °F)	± 0.1 °C (32.18 °F)
Barometric pressure with internal sensor		70 kPa to 110 kPa	10 Pa	± 140 Pa
		Barometric pressure can also be read automatically with any RS-232 device such as a Fluke Calibration RPM4.		
Relative humidity		5 % to 95 % RH	1 % RH	± 10 % RH
Piston position		± 4.5 mm	0.1 mm	± 0.2 mm (0.008 in)
Piston rotation (Rate and deceleration)		2 rpm to 99 rpm	1 rpm	
Vacuum (optional)		0 Pa to 13 Pa	0.01 Pa	± 0.05 Pa + 0.5 % of reading



# Ordering information

## A typical PG9000 pressure standard consists of:

### Select a PG9000 piston gauge platform:

#### PG9607 Platform, or PG9602 Platform

Gas operated piston gauges

- Includes base, terminal, remote electronics module, and basic pneumatic interconnections to pressure controller and UUT.
- All platforms are CE compliant and vacuum-capable, but vacuum reference hardware is not included.
- Delivered with reusable shipping cases and calibration certificates

### PG9600-VAC-REF optional Vacuum Reference Hardware

Hardware required for absolute pressure measurements. Consists of:

- Stainless steel vacuum chamber (bell jar) assembly including vent valve and accessories
- Vacuum measure kit with CDG, manual valve and interconnections, interface and accessories. Delivered with reusable shipping case and calibration certificate.

Vacuum pump and interconnections to bell jar assembly supplied separately.

### Piston-Cylinder Modules

Gas operated assembly

- Delivered with reusable shipping and storage case and calibration certificate.

## Pressure control options

### Automatic

#### PPC4 Automatic Pressure Controller/Calibrator

Automatic pressure control and piston floatation is possible with PPC4. Select the minimum controller range below that covers your piston gauge range.

Models and ranges:

Designator	Maximum pressure
PPC4 A2Mu	2 MPa (300 psi)
PPC4 A14Mu	14 MPa (2000 psi)

### Manual

#### 3990 Manual Gas Pressure Controller

Precision manual pressure control with model

3990 manual gas pressure controller.

Models and ranges:

Designator	Maximum pressure
3990-801	7 MPa (1000 psi)
3990-803	20 MPa (3000 psi)

## COMPASS® for Pressure Enhanced

Calibration management software enables full automation of tests and UUT data collection.

Designator	Pressure to mass ratio	Minimum pressure (using mass bell) (absolute and gauge)	Maximum pressure (100 kg mass) (absolute and gauge)
<b>For PG9607:</b>			
PC-9607-5	5 kPa/kg	11 kPa (1.6 psi)	500 kPa (72.5 psi)
<b>For PG9602:</b>			
PC-9602-10	10 kPa/kg	13 kPa (1.9 psi)	1 000 kPa (145 psi)
PC-9602-20	20 kPa/kg	20 kPa (2.9 psi)	1 100 kPa (160 psi)**
PC-9602-50	50 kPa/kg	50 kPa (7.3 psi)	2 750 kPa (400 psi)**
PC-9602-100	100 kPa/kg	100 kPa (14.5 psi)	10 000 kPa (1450 psi)

\*\* Maximum pressure may be limited to less than 100 kg load by piston-cylinder performance

# Ordering information

## Mass options

### Automatic

#### 3821508 AMH-100-VAC Automated Mass Handler

AMH is recommended, but not required for PG9607 operation. Select AMH or manual mass set depending on whether AMH-100-VAC is selected. Note that AMH-100 (gauge pressure model) is not compatible with PG9607 without modification.

#### 3071440 MS-AMH-100 Mass Set (for automatic operation with AMH)

MS-AMH mass sets for use with automated mass handler only. Mass sets smaller than 100 kg are available if the maximum pressure range is not required (see table). Mass set includes AMH mass carrying bell. Delivered with reusable mass shipping and storage cases and calibration certificate.

AMH mass set designator	Item number	Nominal total mass
MS-AMH-40	3071528	40 kg
MS-AMH-60	3071519	60 kg
MS-AMH-80	3071504	80 kg
MS-AMH-100	3071440	100 kg

### Manual

#### 3071537 MB-7002-0.8 Mass Bell

Mass bell must be purchased to use manual mass sets with PG9607. Mass bell is not included with the PG9607 platform or manual mass sets.

#### 3070017 MS-7002-100 Mass Set (for manual operation without AMH)

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 (see table). Delivered with reusable shipping and storage cases and calibration certificate.

Existing MS-7001/7002 mass sets from PG7000 piston gauge systems are compatible with PG9607.

Manual mass set designator	Item number	Nominal total mass
MS-7002-35	3069861	35 kg
MS-7002-40	3070021	40 kg
MS-7002-45	3069980	45 kg
MS-7002-55	3069877	55 kg
MS-7002-80	3070000	80 kg
MS-7002-100	3070017	100 kg

**Fluke Calibration.** *Precision, performance, confidence.™*

Electrical	RF	Temperature	Pressure	Flow	Software
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