

METROLOGY RANGE



The 60000 is the latest generation of an Automatic Pressure Balance which is a development done on our 50000 Series, first introduced in the early 1980's.

The 60000 is a fundamental standard designed to operate at the metrological level but also providing the advantages of computer controlled loading and automatic pressure generation and control.

The combination provides the best measurement system available.

60000 AUTOMATIC PRESSURE BALANCE

Accuracy: 20ppm of reading

- Fundamental Primary Standard
- Full local and remote control
- Automatic mass loading
- Automatic pressure generation
- Range up to 100MPa (gas)
- Range up to 500MPa (oil)
- Gauge and absolute operation
- 100kg mass set in Austenitic Stainless Steel



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Measurement Principle

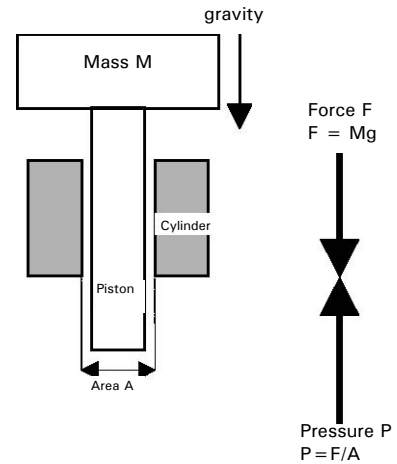
The 60000's measuring principle is based on the fundamental equation of pressure $P = F/A$ with:

P as the measured pressure, expressed in Pa.

A as the piston-cylinder assembly effective area expressed in m^2

F as the force (in N) created by masses **M** (in kg) submitted to gravity g (in $m.s^{-2}$).

$$\text{Therefore } P = Mg / A$$



Automatic Pressure Standard and Generation System

Electronic Rack



60000 Pressure Standard

Pressure Generation System

**60316 (hyd)
or
60212 (gas)**

Priming Module

Pneumatic Module

SCVV Module

The complete 60000 pressure standard consists of four inter-connected systems mounted into two separate standard rack enclosures.

The Electronic Interface

The PC based Electronic module is used to control mass loading, piston position, pressure generation and displays current system status.

The Pressure Standard

It consists of the mass set, mounting post for the Piston & Cylinder and the interchangeable Tungsten carbide Piston & Cylinder assembly. Hydraulic operation requires the model 60316 and for gas model 60212 is used.

The Pneumatic Module

It contains several solenoids which operate the pneumatic cylinders to control the loading of the masses.

Pressure Generation System

The automatic system uses a servo controlled variable volume. As an option a pre-filling system is available, which allows the standard to work with larger volumes. A manual system is available as an alternative.



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The Electronic Control System

The 60000 pressure standard can be controlled and monitored in two ways:

1. In-built electronic control module.
2. External computer and software via IEEE488 (SCPI protocol)



The computer driven controller carries out all monitoring, control functions and does all metrological corrections for factors of influence, the pressure displayed is therefore the true pressure.

The unit consists of an internal computer, a TFT screen with a wide viewing angle and a 23 key keypad, it controls the generation of pressure and the loading of masses. The user can input the target pressure, the computer will then determine the value of masses required taking into account all factors of influence or alternatively the user can input directly the value of mass to be loaded. The system can operate in one of 10 standard pressure units or a user defined unit.

The system includes an EMM (Environmental Monitoring Module) which has sensors for ambient temperature, humidity and air pressure which are used to determine the air density and carry out corrections for air buoyancy effects. The temperature of the piston & cylinder assembly is also measured and appropriate corrections completed.

The TFT screen displays all critical parameters, including: True Pressure, Piston Equilibrium Status, Piston Stability Zone, Pressure Set Point, Mass Set Point, Calculated True Mass, Pressure Unit in use plus graphical display of Variable Volume Position and most importantly Piston Position.

The unit can operate in absolute pressure mode with the addition of an optional DPM Barometric sensor connected to an RS232 port, this provides high accuracy absolute pressure measurement at pressures above ambient.

The Piston and Cylinder Assembly



The **PCA (Piston / Cylinder Assembly)** is the heart of the pressure balance. These are manufactured in tungsten carbide and are honed and lapped to provide critical geometry better than 0.1 μm . Six sizes of metric PCA are available (PCAs are also available in psi units), these are mounted in four types of mounting post as shown in the table below. PCAs are interchangeable within the same type of mounting post and can be exchanged very easily in less than one minute. The mounting post also holds the 30 rpm drive motor for optimum piston rotation, the RTD temperature probe and the fiber optic piston position sensor.

Range	Pr Increment	Pressure Medium		PCA Diameter	Kn Factor	Mounting Post *	
		Oil (60316)	Gas (60212)			Oil (60316)	Gas (60212)
0.15 to 10	0.1	yes	yes	11.2	0.1	RE	REG
0.3 to 20	0.2	yes	yes	7.9	0.2	RE / FD1	REG
0.75 to 50	0.5	yes	yes	5.0	0.5	RE / FD1 / FD2	REG
1.5 to 100	1	yes	yes	3.5	1	RE / FD1 / FD2	REG
3 to 200	2	yes		2.5	2	FD1 / FD2	
7.5 to 500	5	yes		1.6	5	FD2	

* Mounting posts types are dependant upon operating medium and PCA size, options are: Oil – RE(re-entrant), FD1(Free deformation 1) & FD2(Free deformation 2). Gas – REG(re-entrant)

The Mass Loading System



Qty	Mass kg
Piston	1.5
1	1
1	2
1	4
1	8
1	16
1	24
1	24
1	24

There are a total of 8 masses as detailed in the table below, the initial mass is 1.5kg; this is the piston assembly and the mass carrier. Masses are made of Austenitic non magnetic stainless steel (AISI 304 L), the density of which is 7920 kg/m³.

The starting point is 1.5kg, the second one will be 3kg and after the following steps are 1kg up to 100kg.

Technical Specifications

Metrological Specifications

Measuring Range:	0.2 to 500 Mpa
Intrinsic Accuracy:	< 20 ppm of rdg
Mass Resolution:	1 kg
Piston Sensitivity:	from 1 Pa
Hysteresis	Negligible
Stability:	< 2 ppm of rdg per year
Piston Float Time:	> 20 Mins @ Max P
Global Uncertainty*:	S2 Class < ± 50 ppm of rdg S Class < ± 100 ppm of rdg
Pressure Medium:	Oil – Sebecate Oil Gas – Clean & Dry N2

* This uncertainty includes the uncertainty of reference standards uncertainty, transfer errors, the uncertainty on the determination of the piston-cylinder assembly effective area, the uncertainty on the masses, the intrinsic performance of the instrument, stability over time, and the influence of environmental conditions. In accordance with prevailing rules and standards, it is expressed in two standard deviations (K=2). These uncertainties are those achievable in our own COFRAC accredited laboratory, calibration at the LNE will result in much lower uncertainties.

Pressure Generation System

Maximum Operating Pressure:	500 MPa
Time to se-point**:	60 secs
Internal Reservoir:	3000 cc
Priming Pressure:	20 to 200 bar (with optional rack)

General Specifications

Computer connection:	IEEE 488
Barometer Connection:	Reserved RS232
Electrical Supply:	380 VAC - 50 & 60 Hz
Air Drive:	8 bar, filtered to 5 µm
Air Connection:	Festo KSV-PK2 plug
Floor Area Required:	600 x 600 x 1800 mm & 550 x 1250 x 1000
Packed Weight:	250, 200 & 135 kg, approx

** Time to produce a 70 bar pressure step with a volume under test of 100 cc. Due to our policy of continuous improvement and product development our specifications are subject to change without notice.

Germany

DH-Budenberg GmbH,
Raiffeisenstrasse 2,
D-63110 Rodgau,
Deutschland
Tel: 49 (0) 6106 82 940
Fax: 49 (0) 6106 82 9417
E-mail: kontakt@dh-budenberg.de

United Kingdom

DH-Budenberg Ltd.
2 Gilchrist Road
Northbank Industrial Estate, Irlam
Manchester M44 5AY
United Kingdom
Tel: 44 (0) 870 787 73 70
Fax: 44 (0) 870 787 73 69
E-mail: sales@dh-budenberg.co.uk

France

DH-Budenberg SA
56, rue des Ecoles, BP125,
93303 Aubervilliers Cedex,
France
Tel: 33 (0) 1 48 39 83 00
Fax: 33 (0) 1 48 33 65 90
E-mail: dhonline@desgranges.com

USA

DH-Budenberg, Inc.
201A Barnes Drive
San Marcos, TX 78666
USA
Toll free: 1 877 713 2733
Tel: 1 512 353 3133
Fax: 1 512 353 3106
E-mail: sales@dh-budenberg.com