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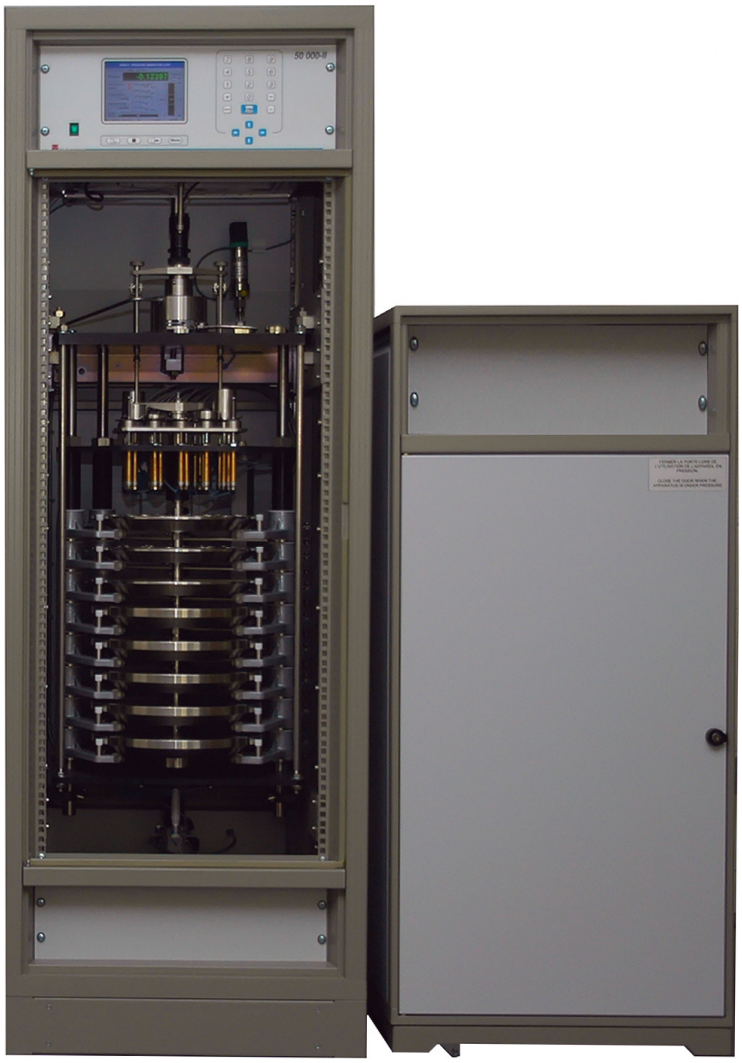
The Pressure Reference

METROLOGICAL RANGE



50000 SERIES

Full Automatic Pressure Standard

COMBINING AUTOMATION WITH PRIMARY STANDARD ACCURACY

A POWERFUL SOLUTION TO TEST AND CALIBRATE HIGH SPECIFICATION SENSORS & TRANSMITTERS.

1 YEAR TYPICAL RETURN ON INVESTMENT

AUTOMATIC CALIBRATION AND VERIFICATION OF PRESSURE INSTRUMENTS

ACCURACY TO 20 PPM OF READING

RANGE UP TO 1000 BAR (GAS), 5000 BAR (OIL)

FULLY COMPREHENSIVE, TURNKEY SYSTEM

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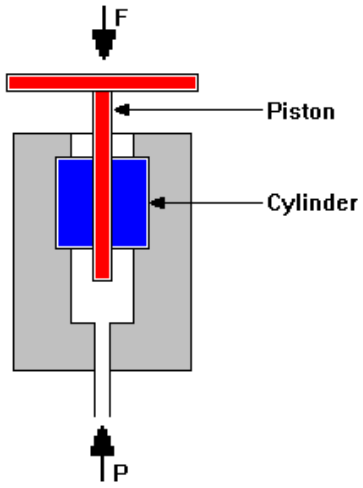
MEASUREMENT PRINCIPLE

Type 50000 automatic pressure balances are high accuracy fundamental pressure standards that define the derived unit of pressure directly from the fundamental units of mass, length and time following the formula :

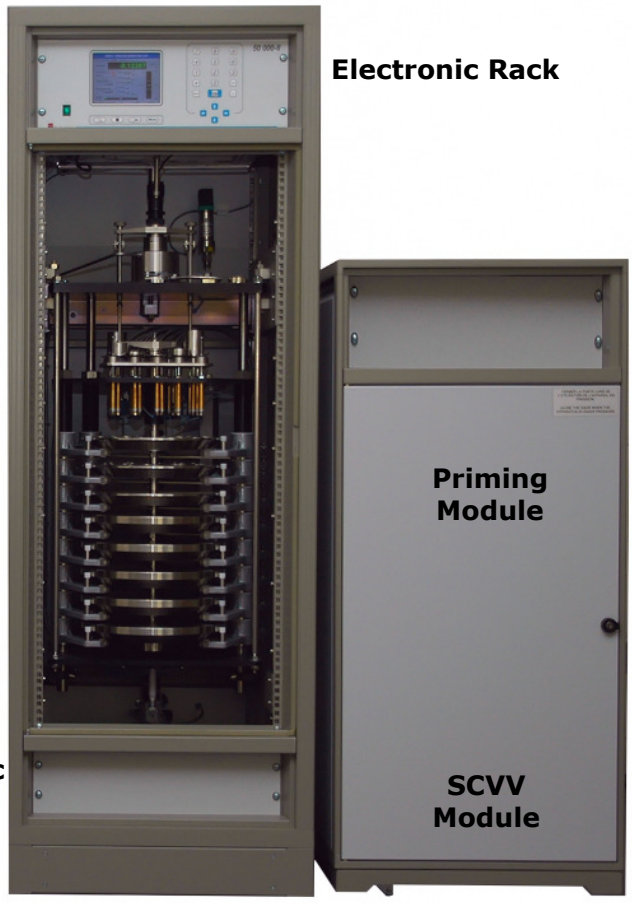
$$P = \frac{F}{A}$$

Where : P = Pressure (Pa)
F = Force (N) resulting from mass (kg) Accelerated by gravity (m/s^2)
A = Piston-cylinder effective area (m^2)

It combines the high metrology level of a classical pressure standard with the simplicity of use of a full automatic instrument.



AUTOMATIC PRESSURE STANDARD AND GENERATION SYSTEM



The complete 50000 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 50316 and for gas model 50212 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, this 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 50000 pressure standard can be controlled and monitored in two ways:

- By using the in-built electronic control module and his keypad.

- By using External computer and software via IEEE488 (SCPI protocol)

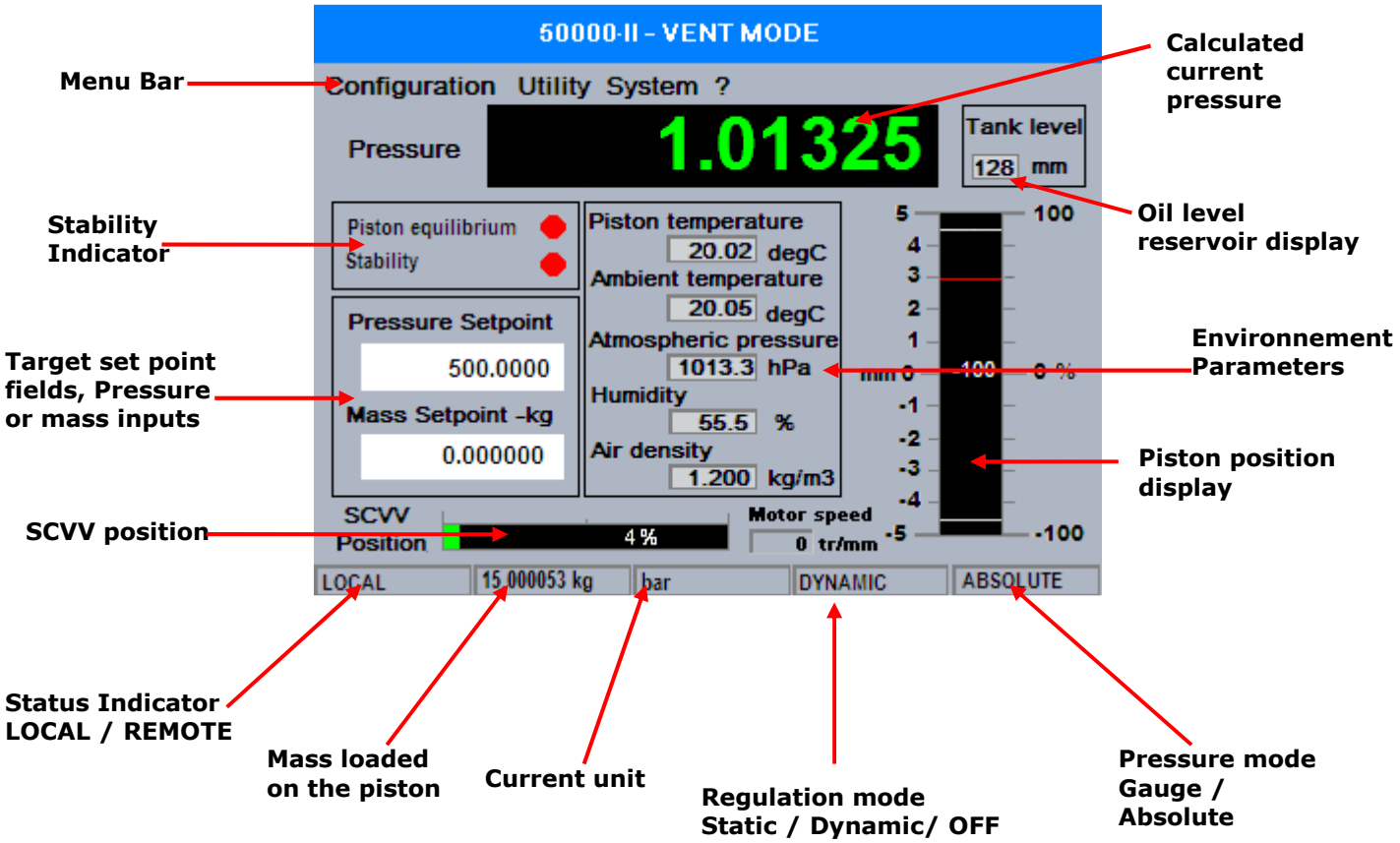
The computer driven controller carries out all monitoring, control functions and does all metrological corrections for factors of influence, the pressure displayed is therefore the true pressure.

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, and 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.



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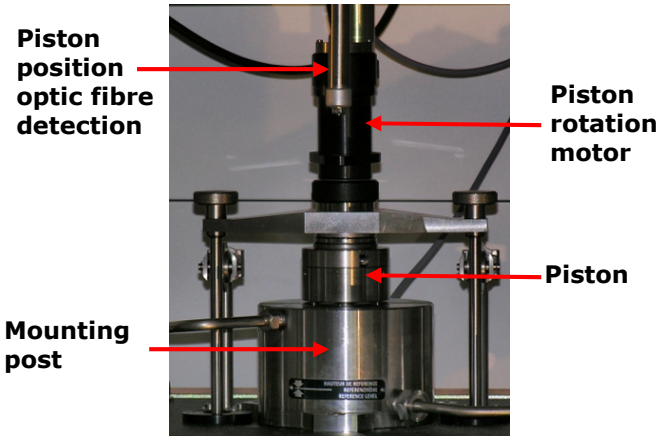
THE PISTON CYLINDER, HEART OF THE SYSTEM

All Type 50000 piston-cylinders and masses are built around a nominal mass to pressure conversion coefficient, Kn. The nominal effective area of each piston-cylinder size is such that, under standard conditions, the piston loaded with 1 kg of mass floats at a whole number pressure value such as 100 psi or 2 MPa. All mass values, including the mass of the piston are adjusted to be a whole number or fraction of the kilogram. The nominal pressure defined by any Type 50000 standard is calculated as Kn X the mass loaded in kg. Corrections are applied to Kn to calculate the pressure defined within the accuracy tolerance of the Type 50000 standard used.
The use of Kn and whole number masses in no way affects the traditional pressure equation or the factors that affect a pressure measurement made with a pressure balance. Kn is the basis of a coherent relationship between mass, effective area and pressure throughout the Type 50000 series.

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. There is 13 sizes of PCA available to cover range from 0.2 MPa to 500 MPa. Depending of the diameter of the piston, they are mounted in four types of mounting post. 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 RTD temperature probe.



PCU AVAILABLE RANGE

Kn	Piston Diameter (mm)	Range Covered	Size available for
0.1 MPa/kg – 1 bar/kg	11.2	0.2 to 10 MPa – 2 to 100 bar	Gas or Oil machine
20 psi/kg	9.5	40 to 2000 psi	Gas or Oil machine
0.2 MPa/kg – 2 bar/kg	7.9	0.4 to 20 MPa – 4 to 200 bar	Gas or Oil machine
50 psi/kg	6.0	100 to 5000 psi	Gas or Oil machine
0.5 MPa/kg – 5 bar/kg	5.0	1 to 50 MPa – 10 to 500 bar	Gas or Oil machine
100 psi/kg	4.3	200 to 10000 psi	Gas or Oil machine
1 MPa/kg – 10 bar/kg	3.5	2 to 100 MPa – 20 to 1000 bar	Gas or Oil machine
200 psi/kg	3.0	400 to 200000 psi	Oil machine only
250 psi/kg	2.7	500 to 25000 psi	Oil machine only
2 MPa/kg – 20 bar/kg	2.5	4 to 200 MPa – 40 to 2000 bar	Oil machine only
300 psi/kg	2.4	600 to 30000 psi	Oil machine only
500 psi/kg	1.9	1000 to 50000 psi	Oil machine only
5 MPa/kg – 50 bar/kg	1.6	10 to 500 MPa – 100 to 5000 bar	Oil machine only

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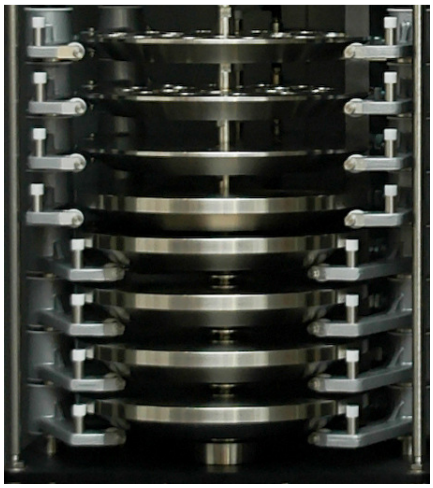
THE MASS LOADING MECHANISM AND THE MASS SET

The mass set of the 50000 is unique in the world. Made in AISI316 austenitic, non magnetic stainless steel, it is composed of several masses multiple or sub-multiple of the kilogramme and in binary progression. The smallest one is **0.1 g** and the bigger one is **16384 g**. This unique design allows the machine to load any mass value between 2 kg (the starting point of the machine) and 100 kg by step of 0.1 g, this give a mechanical resolution of **1 ppm**. A special option is also available with smallest mass down to 0.01 g and achieves a resolution of **0.1 ppm !**.
Each mass is loaded / unloaded onto the piston with an individual actuator. The complete sequence to load or unload a mass value is done within 10 seconds.
Each mass is calibrated and adjusted with a tolerance down to 10 ppm of his nominal value and all values are stored in the electronic rack for the calculation.



The main masses (from 2048 g up to 16384 g) are loaded / unloaded with three arms linked to a pneumatic actuator. All movement are user adjustable.

The small masses (from 0.1 g to 1024 g) are directly loaded / unloaded with a small actuator. The masses from 16 g up to 1024 g are composed of 2 masses of half weight (i.e. 32 g=2 masses of 16 g) and they are physically in opposed position to keep a good centring of the piston and not apply lateral perturbation force.

PRESSURE GENERATOR

HYDRAULIC

The pressure generator is constituted by a servo controlled variable volume. A piston move in a chamber to compress the fluid. It is controlled by a brushless motor and his linked to the position of the measuring piston cylinder. The priming is done by applying the drive air in the oil reservoir or by using a priming rack which enclosed an hydro pneumatic pump and several valves. This priming rack allows also performing several complete stroke of the variable volume. This feature is useful when the volume under test is large. It is totally managed by the electronic interface of the mass loading rack.

HYDRAULIC

99 % of the generation is done by using a pressure controller which enclosed several dome valves as well as classical valve. The end of the generation is done by using the same servo control variable volume as the hydraulic version.

This pneumatic controller requires an external gas or air supply such as a nitrogen cylinder or a gas booster with a pressure capability at least equal to the pressure required.

This controller can work with nitrogen or clean and dry compressed air correctly filtered (0.1 micron recommended).

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GENERAL CHARACTERISTICS

Dimension (mm) :	Mass loading rack 600 x 600 x 1800	Pressure generator 550 x 1250 x 1000
Weight (in kg) :	200 kg	170 kg
Drive air supply :	8 to 10 bar	
Power supply :	240 Vac 50-60 Hz (For country using 110 Vac, a power transformer is required)	
Computer connection :	GPIB (SCPI protocol)	
Ranges :	Up to 1000 bar in pneumatic	Up to 5000 bar in hydraulic
Mass set :	100 kg in binary progression	
Material :	AISI316 austenitic, non magnetic stainless steel	
PCA material :	Tungsten Carbide	

METROLOGICAL CHARACTERISTICS

Intrinsic Accuracy:	< 20 ppm of reading
Mass Resolution:	0.1 g as standard **//** 0.01 g in option
Piston Sensitivity:	from 1 Pa
Hysteresis :	Negligible
Stability:	< 2 ppm of reading per year
Piston Float Time:	> 20 Minutes @ Max P
Global Uncertainty*:	S2 Class < ± 50 ppm of reading **//** S Class < ± 100 ppm of reading
Pressure Medium:	Oil – Sebacate 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.

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