Pressure calibration equipment

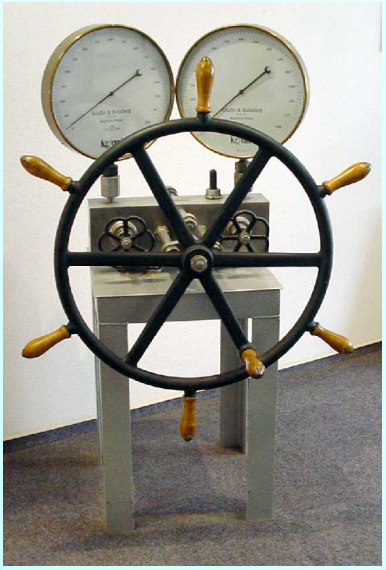
STIKO
MEETAPPARATENFABRIEK BV

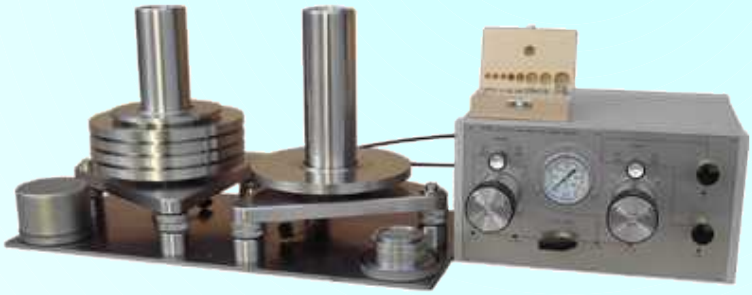
A pleasure to measure !

Pressure calibration evolution

1925 Westertoren in Amsterdam
30 meter mercury column (±40 bar)

1950 comparison test pump





21st century
Stiko gas driven
differential deadweight
tester

Contents

A pleasure to measure !

Introduction

Stiko has more than 40 years experience in pressure equipment and calibrations and offers a complete line of pressure calibration equipment such as deadweight testers, comparison test pumps and a variety of accessories.

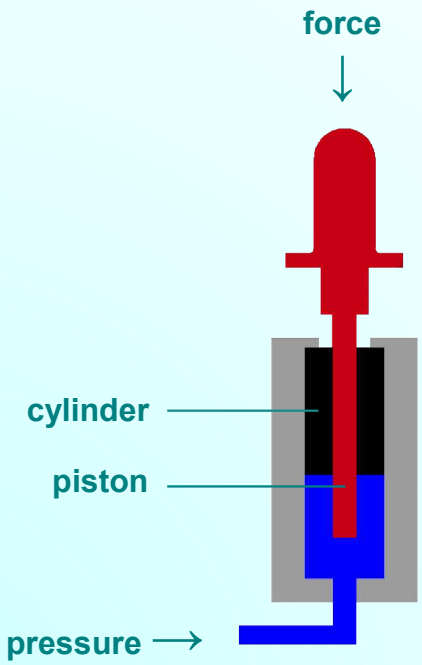
Deadweight testers
Deadweight testers are the basic primary standard used and its principle is world-wide accepted for the most accurate measurement of pressure.

No other piece of equipment for pressure measurement can match the stability, repeatability and accuracy of the deadweight tester. It is ideal for calibrating pressure transducers, pressure gauges, transfer standards, recorders, digital calibrators, etc. and can also be used to measure directly the pressure in systems and processes where precise measurements are important.

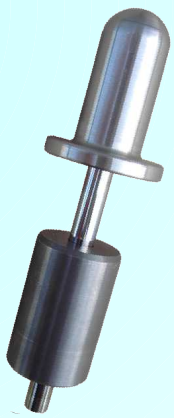
Basic principle of deadweight tester
A deadweight tester is based on a high accurate manufactured piston and cylinder assembly. This cylinder is mounted in a column. The piston can rotate and move freely up and down. Accurate calibrated masses are loaded on top of the vertical mounted piston. A pressure is applied on the bottom of the piston to lift the piston with masses. This creates a balance between the force made my the masses (downwards) and the force made by the pressure (upwards) and the effective area of the piston cylinder assembly.
In formula:

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

p : pressure
F : force
A : area (of the piston)



Piston cylinder assembly
The piston cylinder assembly is the hart of the deadweight tester and responsible for its high accuracy. Stiko manufactures piston cylinders with accuracies from 0.015% up to 0.008% of reading. To give an idea of the manufacturing skills the space between the piston and the cylinder is in the µm range and can only be measured in a climatic room.



Effective area

For all deadweight testers the effective area is determined by cross floating with a known reference primary standard deadweight tester. With a formula the exact pressure can be calculated. In the formula compensation factors are listed for air buoyancy, local gravity, surface tension of the used oil and temperature and pressure expansion of the piston cylinder assembly.

$$p_e = \frac{m_c \cdot (1 - \rho_a / \rho_m) \cdot g_l + \tau . \pi . d}{A_{20,0} \cdot (1 + (\alpha_p + \alpha_c) \cdot (t - 20)) \cdot (1 + \lambda . p_{nom})}$$

where:

pe	: gauge pressure at reference level	[kPa]
m_c	: conventional mass	[kg]
$1 - \rho_a / \rho_m$	: air buoyancy correction (= 0,99985)	[-]
g_l	: local gravity	[N/kg]
$\pi.d$	: piston circumference	[m]
τ	: surface tension oil (=0,031)	[N/m]
$A_{20,0}$	: effective area at 20 oC / zero pressure	[m²]
$\alpha_p + \alpha_c$	: thermal expansion coefficient piston + cylinder	[°C-1]
t	: piston cylinder temperature	[°C]
λ	: pressure distortion coefficient piston +cylinder	[MPa-1]
p_{nom}	: nominal working pressure	[MPa]

All necessary data are listed in the calibration certificate provided with all deadweight testers.

Mass set

The masses of the Stiko deadweight tester are made of non magnetic stainless steel. They are marked with a serial number and mass or the equivalent pressure. The weights are tared out to add stainless steel to an internal chamber. This is easy for recalibration or adjustments for gravity compensation. The mass of all weights are listed in the certificate. For small pressure steps a box with small weights from 1 gram up to 50 gram is available as an option.

Pressure generating and control

The oil operated deadweight testers are supplied with a hand screw pump. This pump has a large displacement of 26cc, therefor a priming pump is not necessary. The pump is made of stainless steel as well as the tubing. The oil reservoir is combined with the vent valve and has a transparent cover to check easily the oil level. The vent valve has an easy to replace O-ring sealing. Because all used O-rings are listed in the manual it is possible to buy them locally as well at Stiko.

Accuracy

Stiko manufactures deadweight testers with an accuracy from 0.015% up to 0.008% of reading. Without additional costs they can be calibrated according to the local gravity instead of the standard gravity of 9.80665 N/kg.

Certification

Deadweight testers with accuracy 0.015% of reading (model DOS0015) are delivered with a Stiko calibration certificate which is traceable to national and international standards. For the higher accuracies of 0.01 and 0.008% of reading a third party *EA* certificate [1] is provided by Minerva meettechniek B.V. Also certification by a national or international accredited laboratory is available to additional costs. We recommend a recalibration every 2 to 3 years depending on the amount of use.

Construction

All Stiko deadweight testers are of a simple well proofed rugged construction. Most used material is stainless steel, and therefor a long life of the calibration standard is guaranteed.

Scope of delivery

All deadweight testers are delivered fully operational with a stainless steel mass set in stainless steel carrying cases.

The delivery includes:
An English operating manual;
A calibration certificate;
⅛”, ¼”, ⅜”, ½” BSP female adapters;
Spare multiseal for the pressure connection;
A bottle of deadweight tester oil;
A dust cover and bolts for mounting on a bench for type DOS001; DOS0008; DGS001, and DGDP001;

[1] European Accreditation, see http://www.european-accreditation.org

DOS series

oil deadweight testers

DOS0015

The oil operated deadweight tester DOS0015 has an accuracy of 0.015% of reading. This is a typical deadweight tester for industrial use and the weight set is transferred into a pressure unit. A traceable certificate is standard and a RVA certificate is possible as an option. The certificate shows the effective area as well as a list of all masses. The deadweight tester can be leveled with adjustable feet. An extra set of adjustable feet are included for fixing the dead weight tester to a bench. Three different pistons are available to cover ranges from 0.5 – 30 bar up to 10 – 1400 bar. Also ranges in psi and kg/cm² are available.

Ranges

The table gives a list of masses corresponding with the ranges. At the moment three different diameter of pistons are available but in the near future it will be expanded to more different pistons sizes.

mass set	0.5 bar	0.05 bar	0.1 bar	0,5 bar	1 bar	5 bar	10 bar	lo piston range	mid piston range	hi piston range
	5 bar	0,5 bar	1 bar	5 bar	10 bar	-	50 bar			
	10 bar	-	1 bar	5 bar	10 bar	50 bar	100 bar			
kg	carrier	number of masses						bar	bar	bar
12	1	1	4	1	4	1	2	0,5 - 30	5 - 150	-
16	1	1	4	1	4	1	3	0,5 - 40	5 - 200	-
20	1	1	4	1	4	1	4	0,5 - 50	5 - 250	-
24	1	1	4	1	4	1	5	0,5 - 60	5 - 300	-
28	1	1	4	1	4	1	6	0,5 - 70	5 - 350	10 - 700
32	1	1	4	1	4	1	7	0,5 - 80	5 - 400	10 - 800
36	1	1	4	1	4	1	8	0,5 - 90	5 - 450	10 - 900
40	1	1	4	1	4	1	9	0,5 - 100	5 - 500	10 - 1000
44	1	1	4	1	4	1	10	0,5 - 110	5 - 550	10 - 1100
49	1	1	4	1	4	1	11	0,5 - 120	5 - 600	10 - 1200
53	1	1	4	1	4	1	12	0,5 - 130	5 - 650	10 - 1300
57	1	1	4	1	4	1	13	0,5 - 140	5 - 700	10 - 1400

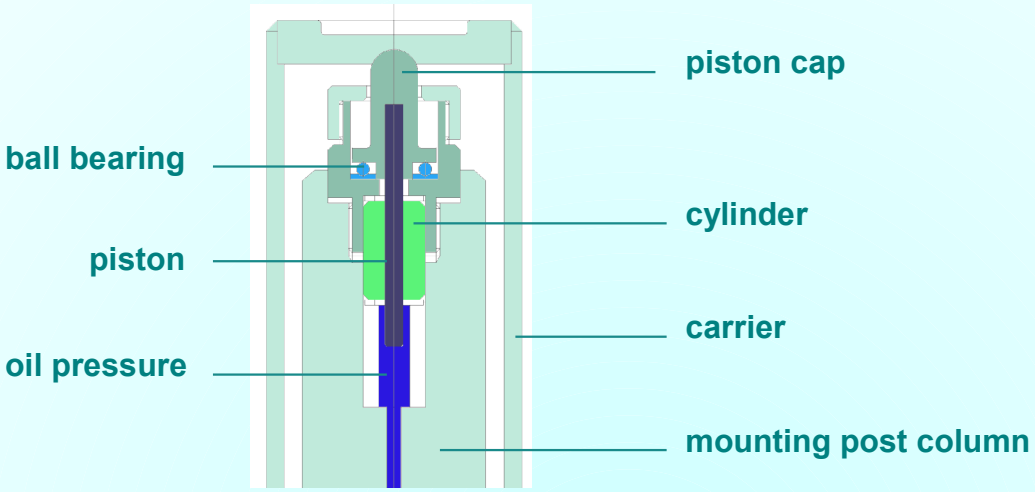
mass set	10 psi	1 psi	5 psi	10 psi	50 psi	100 psi	150 psi	lo piston range	mid piston range	hi piston range
	100 psi	10 psi	50 psi	100 psi	500 psi	-	1000 psi			
	200 psi	20 psi	-	100 psi	500 psi	1000 psi	1500 psi			
kg	carrier	number of masses						psi	psi	psi
14	1	4	1	4	1	1	2	10 - 500	100 - 3000	-
17	1	4	1	4	1	1	3	10 - 650	100 - 4000	-
22	1	4	1	4	1	1	4	10 - 800	100 - 5000	-
28	1	4	1	4	1	1	5	10 - 1000	100 - 6000	200 - 10000
31	1	4	1	4	1	1	6	10 - 1100	100 - 7000	200 - 11000
35	1	4	1	4	1	1	7	10 - 1250	100 - 8000	200 - 12500
39	1	4	1	4	1	1	8	10 - 1400	100 - 9000	200 - 14000
43	1	4	1	4	1	1	9	10 - 1550	100 - 10000	200 - 15500
47	1	4	1	4	1	1	10	10 - 1700	-	200 - 17000
52	1	4	1	4	1	1	11	10 - 1850	-	200 - 18500
56	1	4	1	4	1	1	12	10 - 2000	-	200 - 20000

DOS series

oil deadweight testers

DOS001
The oil operated deadweight tester DOS001 has an accuracy of 0.01% of reading. The piston cylinder is made of tungsten carbide which is extremely hard and wear-resistant. The weight column and pump are mounted on a stainless steel base plate. A triangle frame is used to make a steady and firm base for the weight column and can be leveled out by a spirit level. The weight carrier is of a hanging type and therefor insensible for any negative influences like friction of a support piston. The picture below shows the design of a DOS001. An *EA* RVA certificate by an accredited third party is standard. The certificate shows the effective area as well as a list of all masses.

Design of DOS001/DOS0008



DOS0008
The oil operated deadweight tester DOS0008 has an accuracy of 0.008% of reading. The design is similar to the DOS001, but the piston cylinder assembly is even more accurate. To correct the temperature error a PT100 with LCD display is applied.

DOS series

oil deadweight testers

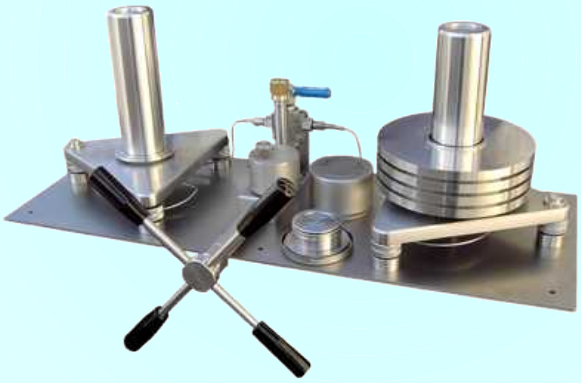
Mass set for DOS001 and DOS0008

The oil deadweight tester DOS001 and DOS0008 can be ordered with different mass sets. Mostly it is delivered in kg. With the mentioned formula and the data listed in the certificate the best accuracy is achieved. By ordering the mass set in a pressure unit (for instance bar, psi or kg/cm²) the deadweight tester can be used without using the formula. In this case the disagreement is larger then by using the formula. The weight set can be adjusted to the local gravity to increase the accuracy.

Ranges

The table gives a list of masses corresponding with the ranges. At the moment two different diameter of pistons are available but in the near future it will be expanded to more different pistons sizes. For small pressure steps a box with small weights from 1 gram up to 50 gram is available as an option.

mass set	carrier 1 kg	4 kg	2 kg	1 kg	0.5 kg	0.2 kg	0.1 kg	lo *p* range	hi *p* range
kg	number of masses							bar	bar
5	1	0	1	1	1	2	1	5 - 25	20 - 100
10	1	1	1	2	1	2	1	5 - 50	20 - 200
15	1	2	2	1	1	2	1	5 - 75	20 - 300
25	1	5	1	1	1	2	1	5 - 125	20 - 500
35	1	7	2	1	1	2	1	5 - 175	20 - 700
45	1	10	1	1	1	2	1	5 - 225	20 - 900
55	1	12	2	1	1	2	1	5 - 275	20 - 1100
65	1	15	1	1	1	2	1	5 - 325	20 - 1300
75	1	17	2	1	1	2	1	5 - 375	20 - 1500
85	1	20	1	1	1	2	1	5 - 425	20 - 1700
101	1	24	1	1	1	2	1	5 - 505	20 - 2020



DOS001 with dual piston and double platform: DOD001

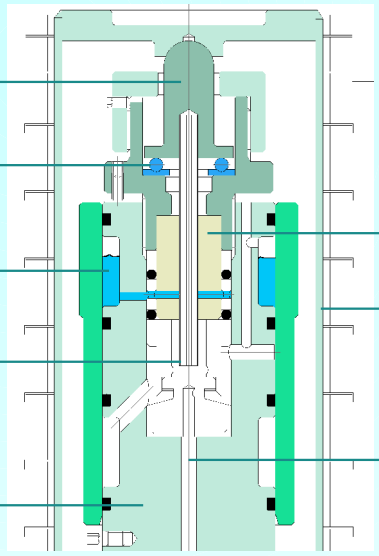
DGS series

gas deadweight testers

DGS001
The gas operated deadweight tester DGS001 has an accuracy of 0.01% of reading. The piston cylinder assembly is made of tungsten carbide which is extremely hard and wear-resistant. The weight column is mounted on a stainless steel base plate. A triangle frame is used to make a steady and firm base for the weight column and can be leveled out by a spirit level. The weight carrier is of a hanging type and therefor insensible for any negative influences like friction of a support piston. An *EA* RVA certificate by an accredited third party is standard. The certificate shows the effective area as well as a list of all masses.

Oil lubricated / gas operated
The oil lubricated / gas operated piston of the DGS series is specially designed to have superior performance at higher gas pressures without the problems of other types of pistons: Gas lubricated / gas operated pistons cylinders have better sensitivity then oil lubricated pistons, however the natural drop rate at higher line pressure make them difficult to operate. Oil lubricated pistons have no significant drop rate as the oil acts as a seal. There are a lot of deadweight tester manufacturers who claim oil lubrication / gas operation, but they use a traditional oil / oil piston and an oil-gas interface. The biggest and obvious disadvantage of this solution is that the surface level of the oil-gas interface precisely has to be known. The added uncertainty especially in high line pressure applications make this solution not ideal. The piston cylinder assembly of the DGS series is really different. The oil is lead to the gap between piston and cylinder by means of an oil reservoir around the cylinder. As the oil surface is slightly higher than the entrance bore in the cylinder the oil pressure is also slightly higher than the gas pressure ensuring enough lubrication between piston and cylinder. The benefits of this design are:
- excellent turning time of the piston;
- very small fall rate (also at higher pressures);
- excellent leak rate, because the oil acts as a seal;
- the oil avoids dirt and dust entrance between piston and cylinder.

Design of DGS001



DGS series

gas deadweight testers

Ranges

The table gives a list of the masses corresponding with ranges. At the moment two different diameters of pistons are available but in future it will be expanded to more different sizes pistons. For small pressure steps a box with small weights from 1 gram up to 50 gram is available as an option.

mass set	carrier 1	4	2	1	0.5	0.2	0.1	lo *p* range	hi *p* range
kg	kg	kg	kg	kg	kg	kg	kg	bar	bar
5	1	0	1	1	1	2	1	5 - 25	20 - 100
10	1	1	1	2	1	2	1	5 - 50	20 - 200
15	1	2	2	1	1	2	1	5 - 75	-
25	1	5	1	1	1	2	1	5 - 125	-
35	1	7	2	1	1	2	1	5 - 175	-
45	1	10	1	1	1	2	1	5 - 225	-

DGS0008

The gas operated deadweight tester DGS0008 has an accuracy of 0.008% of reading. The design is similar to the DGS001, but the piston cylinder assembly is even more accurate. To correct the temperature error a PT100 with LCD display is applied

Differential deadweight tester type DGDP001

The gas operated deadweight tester is also available in a differential pressure model. The DGDP001 combines the benefits of the oil lubricated piston cylinder assembly with the need to calibrate at a specific static pressure. This deadweight tester allows you to make differential pressure from 5 mbar up to the maximum pressure of 225 bar with static pressures from 5 bars up to 220 bars. It can be used to calibrate differential pressure transmitters with accuracies of 0.1 or 0.05%. The accuracy of the DGDP is 0,01% of reading. A differential regulator is used to set the line (static) pressure and to ad the differential pressures.

GPR series

gas pressure regulators

Gas pressure regulators are used to control and fine regulate gas pressures. They are necessary in combination with gas deadweight testers, but can also be used for other calibration purposes. All regulators must be connected to a bottle of compressed nitrogen or any other gas. The maximum inlet pressure is 220 bar. All regulators are equipped with minimess flexible tubing.

GPR120 S

This gas pressure regulator is an easy to use max. 120 bars regulator with a fine to adjust inlet and vent valve. The reference and instrument under test can be mounted direct on top of the housing. Adapters with ⅛”, ¼”, ⅜”, ½”BSP female thread are included as well as minimess tubing to connect it to a nitrogen filled bottle.

GPR200

This gas pressure regulator is a regulator with an extreme fine to adjust variable volume. It is specially designed to work with the gas driven deadweight tester DGS001. Minimess tubing is included to connect it to a nitrogen filled bottle.

GPR200D

This gas pressure regulator is a double GPR200 regulator. It is specially designed to work with the gas driven differential deadweight tester DGDP001. A by-pass valve in included between the two regulators. Minimess tubing is included to connect it to a nitrogen filled bottle.

GPR200 SP

This gas pressure regulator is a GPR200 with built in pressure reducer. To reduce the pressure just above to required pressure an even better adjustment of the needed pressure is achieved. Minimess connections are situated at the back as well on the front of the housing.

COP series

comparison test pumps

These pumps are used for checking pressure instruments against a master test gauge or transducers. They are portable and rugged. A stainless steel bottom plate with mounting holes is applied for stable bench mounting.

COP700/1400

This large volume (26cc) comparison test pump is easy to operate. The oil reservoir is combined with the vent valve and has a transparent cover to check easily the oil level. The vent valve has an easy to replace O-ring sealing. Because all used O-rings are listed in the manual it is possible to buy them locally as well at Stiko. All pumps are delivered with adapters to ⅛", ¼", ⅜", ½"BSP female thread.
A variety of models are available:

Model	Medium	Presure bar	Option
COP700	oil	0 - 700	Skydrol
COP1400	oil	0 - 1400	-
COP700 water	water	0 - 700	Oxygen cleaned
COP1000 water	water	0 - 1000	Oxygen cleaned

COP4000 / COP7000

This high pressure comparison test pump has a maximum pressure of 4000 or 7000 bar. A priming pump of 26cc is applied to prime the system and to operate up to 700 bar. The large high pressure hand pump is used to obtain the maximum pressure. A large oil reservoir with transparent cover is applied to check the oil level. All ports can be shut off by high pressure valves to isolate a specific circuit. All components are mounted in a strong rugged stainless steel frame to protect the operator at any time.

COP035

The air hand pump is an easy way to generate pressure up to 35 bar. Despite its compact dimensions, the COP35 is easy to operate. It is fitted with a fine adjustment valve for the precise adjustment of pressures. To generate vacuum a change-over switch is applied. A reference instrument can be mounted directly on top of the pump. The instrument under test is connected by means of a connection tube incorporating an adapter 1/4" BSP rotating female (or 1/4" NPT female) port. Also higher (oil) pressure hand pumps are available.

C4P-e series

automated calibration solution

C4P-e

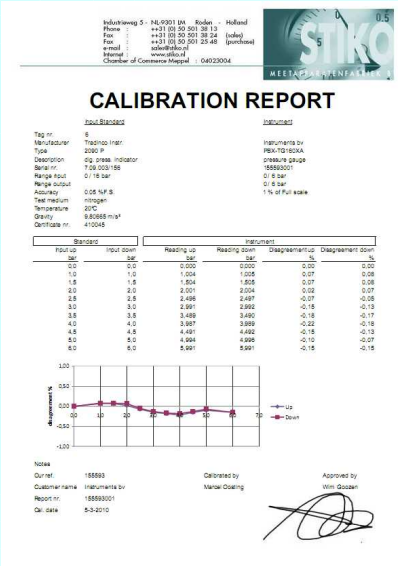
The C4P-e (Compass for pressure embedded) is an unique concept of integrating high accuracy pressure transducers with an industrial panel-pc and the most flexible calibration software currently available on the market. The product makes it possible to run and store calibration routines without the need of additional hardware and instantly generate calibration certificates. With the Compass for Pressure software it is possible to communicate with pressure transducers having a large variety of communication protocols. By connecting a printer calibration certificates can be printed directly. The software allows you to make own designed lay outs for these certificates.

specifications

panel pc	: 10” touch screen industrial panel PPC
operating system	: Microsoft Win7
interfacing	: 5 x RS232 / 6 x USB
network	: 2 ultra high speed ethernet
calibration software	: Fluke, DHI division Compass for Pressure basic
range	: 0 – 10 Pa up to 0 - 2000 bar max, 2 calibrated ranges optional
measurement uncertainty	: up to 0,01% full scale
dimensions	: 385 x 305 x 315 mm (w x d x h)
housing	: stainless steel

options

- fitted together with manual oil pressure controller type COP (see page 12)
- manual gas pressure regulator type GPR (see page 11)
- other ranges
- other transducers (uncertainties)
- adapter set



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STIKO MEETAPPARATENFABRIEK

CALIBRATION REPORT

Input Standard		Instrument
Tag nr.	6	
Manufacturer	Tradinco Instr.	Instruments bv
Type	2090 P	PBX-TQ1620A
Description	dig. press. indicator	pressure gauge
Serial nr.	T.09 003/156	165593001
Range input	0 / 16 bar	0 / 6 bar
Range output		0 / 6 bar
Accuracy	0.05 %F.S.	1 % of Full scale
Test medium	nitrogen	
Temperature	20°C	
Gravity	9.80665 m/s²	
Certificate nr.	410045	

Standard		Instrument			
Input up bar	Input down bar	Reading up bar	Reading down bar	Disagreement up %	Disagreement down %
0.0	0.0	0.000	0.000	0.00	0.00
1.0	1.0	1.004	1.005	0.07	0.08
1.5	1.5	1.504	1.505	0.07	0.08
2.0	2.0	2.001	2.004	0.02	0.07
2.5	2.5	2.496	2.497	-0.07	-0.05
3.0	3.0	2.991	2.992	-0.15	-0.13
3.5	3.5	3.489	3.490	-0.16	-0.17
4.0	4.0	3.987	3.989	-0.22	-0.18
4.5	4.5	4.491	4.492	-0.15	-0.13
5.0	5.0	4.994	4.996	-0.10	-0.07
5.0	5.0	5.491	5.491	-0.15	-0.15

Notes

Our ref.	165593	Calibrated by	Approved by
Customer name	Instruments bv	Marcel Oosting	Wim Goozen
Report nr.	165593001		
Cal. date	5-3-2010		

customized calibration report

accessories

calibration equipment

Dirt / moisture trap (max. 200 bar)
This stainless steel dirt / moisture trap is used to protect pneumatic calibration systems from dirt and oil. Any dirt and moisture can be seen through the inspection glass. The unit is easy to drain by means of a drain plug. The maximum allowable pressure is 200 bar. It is delivered including filter, free standing frame and a ⅛”, ¼”, ⅜”, ½” BSP female adapter set.

Oxygen tester (max. 700 bar)
Oxygen devices have to be absolutely free from oil and grease. Also many other devices have to be kept clean. They have to be tested on air, water or other suitable liquids. This oxytester (oil-water separator) guarantees an absolute separation between reference liquid of the calibration equipment and the device under test liquid. The separator is sometimes used to prevent a tester from being contaminated by solids or liquids from gauges being calibrated.

Instrument stand
This stainless steel instrument stand is used to connect pressure gauges, transducers and other pressure equipment. The instrument stand is supplied with a ⅛”, ¼”, ⅜”, ½” BSP female adapter set and a minimess quick tubing connection. The maximum pressure is limited by the minimess tubing. With capillary or tube piping higher pressures can be achieved.

Adapters
A large variety of adapters can be supplied like angle adapters and adapters with a special thread i.e autoclave or other high pressure connections. For instruments under test with NPT thread a ⅛”, ¼”, ⅜”, ½”NPT female adapter set is available.

A pleasure to measure !

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