halstrup walcher

Measurement technology

Differential pressure (stationary/mobile)
Calibration devices and services
Air meter and volume flow
Absolute pressure

A FAMILY-OWNED AND HIGHLY INNOVATIVE SUPPLIER OF CUSTOMISED SOLUTIONS

halstrup-walcher GmbH was founded in 1946 and has been in family ownership ever since. We plan for the long-term and see ourselves as a partner. We have close and long-standing relationships not only with our customers but also with our approx. 110 employees, our local community in Kirchzarten and our suppliers.

halstrup-walcher GmbH is a successful company in three areas: we develop and manufacture positioning systems for mechanical engineering applications, pressure and volume flow measurement technology for building technology and OEM customers as well as spur gearboxes and actuators for OEM customers.

halstrup-walcher GmbH manufactures both catalogue products and customer-specific devices. We are renowned for our high level of expertise in development and manufacturing. Our strong quality assurance programme and lean processes have made us a highly professional supplier of customised products with impressive performance in terms of quality, cost and punctuality.

THE HALSTRUP-WALCHER GROUP: SPECIALISTS IN THREE SECTORS

PRESSURE AND VOLUME FLOW MEASUREMENT TECHNOLOGY

You have to regulate the air pressure in your cleanroom to prevent the entry of contaminated air. You have to monitor the air filters or ventilators in your air-conditioning system. Your machine requires a constant over- or underpressure to operate correctly. Or you need to measure a volume flow.

halstrup-walcher offers both standard and customer-specific solutions for performing high precision measurements. We also offer calibration services in our accredited, in-house calibration laboratory. To the highest standards of precision.

POSITIONING SYSTEMS

As a manufacturer of machine tools, your customers expect you to supply highly flexible solutions with minimal retooling times. Format changes should be performed automatically and as quickly as possible. The positioning systems required to do this must be compatible with all standard bus systems. And, naturally, you want to be able to offer your customer optimum availability of the machine – supported by condition monitoring for your positioning systems.

halstrup-walcher supplies positioning systems with the wide range of forms, features and bus systems required by professional machine tool manufacturers. With a maximum of precision.

SPUR GEARBOXES AND ACTUATORS

You need to make parts move, linear or rotary. Optimised for the existing construction space and with a sharp eye on the costs. With a constantly high level of precision. You need this solution quickly and tailored to your specific requirements. With or without housing. As a motor/gearbox combination. Regulated or with a control system or as a purely mechanical solution. With analog or digital communication.

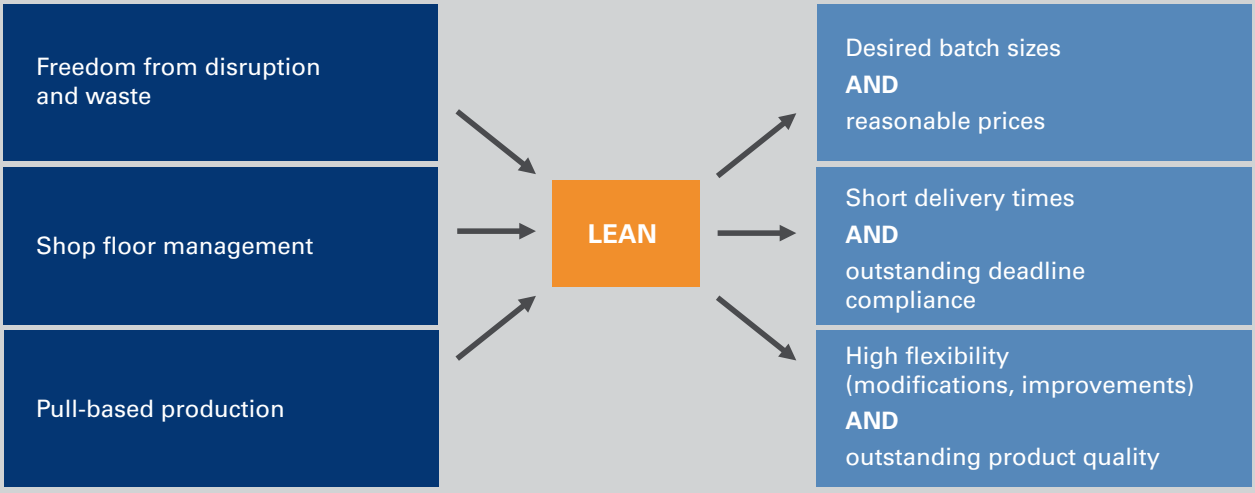
halstrup-walcher offers solutions covering every aspect of spur gearboxes and actuators. We develop mechanical designs, electronics and all the relevant stages of the manufacturing process in-house – from milled gear wheels to assembled SMD circuit boards. Tailor-made.

LEAN MANAGEMENT AT HALSTRUP-WALCHER

Focus on the customer and optimised internal processes

A number of years ago, business theorists spoke of a "magic triangle" of quality (Q), costs (C) and punctuality (P). These three factors were considered magical because any measures for improvement could benefit no more than two of them at any time – and these gains could only be obtained at the expense of the third. With the help of lean management, halstrup-walcher has succeeded in breaking the spell of this "magic triangle". We have done so by eliminating errors and failures from all the relevant processes and systematically tackling waste in every area. This liberates the whole team to concentrate fully on the real needs of our customers.

"Shop floor management" has also brought previously unimaginable successes. Employees in every department attend a meeting every working day, where they are able to raise awareness of and discuss current problems. Measures for eliminating these problems immediately and permanently are discussed and agreed at follow-up meetings in the company. These take into account all the relevant information. Everyone contributes, no problem is brushed under the carpet and solutions to the problems are implemented without delay. It is a culture that has won the hearts and minds of both our staff and our customers. halstrup-walcher has now begun "exporting" its insights into lean management and offers these as a service to medium-sized enterprises.



CONTENTS

halstrup-walcher

Pressure sensors and OEM solutions

HALSTRUP-WALCHER PRESSURE SENSOR TECHNOLOGY

Differential pressure transmitters and volume flow measurement devices made by halstrup-walcher GmbH are designed for use with non-aggressive, gaseous media. The instruments operate using the principle of inductive measurement. At the heart of the technology lies a membrane made from beryllium bronze. Inductive displacement transducers measure the deflection of this membrane without any contact.

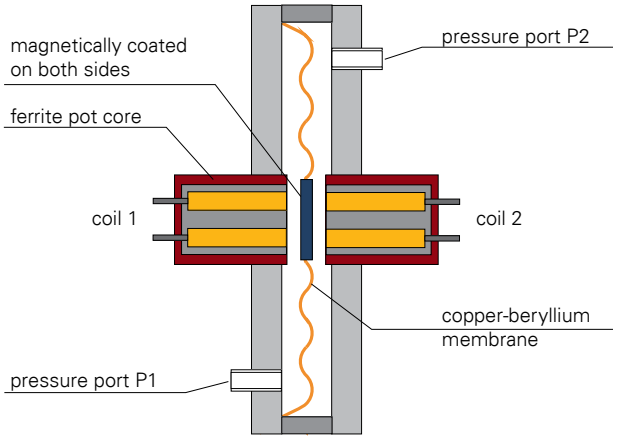
The membrane is situated between two measurement chambers and can therefore provide readings of both positive and negative differential pressures. The measuring cell has no frictional parts or parts subject to mechanical wear. Beryllium bronze is a highly elastic material that is stabile for long periods of time, behaves well under a variety of temperature conditions and is extremely resistant to hysteresis. As a result, this technology is ideal for use in high quality pressure gauges that are capable of taking measurements at pressures as low as a few Pa.

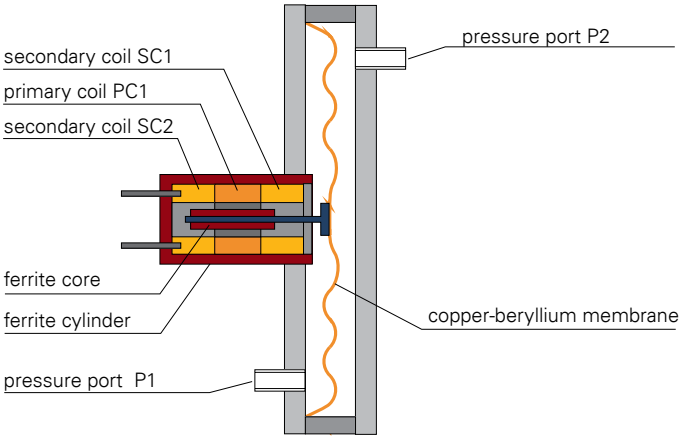
OUR MEASUREMENT SYSTEMS

The patented **dual coil sensor** developed and manufactured by halstrup-walcher sends a differential signal that is linearised by an electronic analysis unit. This system is perfectly suited for use in manufacturing high-quality differential pressure transmitters and digital pressure gauges.

Due to the excellent linearity afforded by its design, the **differential coil sensor** (LVDT) is primarily used for pressure calibration devices.

For basic applications, a piezo-resistive precision measuring cell is also used.



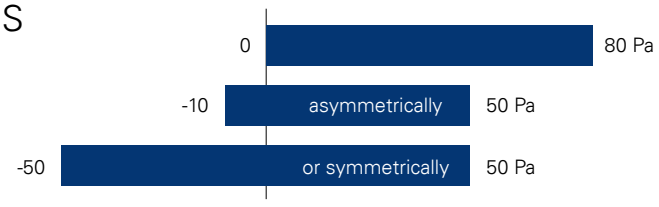


ADVANTAGES OF HALSTRUP-WALCHER MEASUREMENT SYSTEMS

- Ideal even for small measurement ranges
- Exceptional long-term stability guarantees reliable operation over many years
- Absolute zero-point stability (see p. 7)
- High overload resistance (see p. 7)
- Perfect for positive and negative differential pressures
- For symmetrical or asymmetrical measurement ranges
- Separation of the two connection sides (no overflow)

TAILOR-MADE MEASUREMENT RANGES

Many halstrup-walcher measurement devices can be scaled in accordance with customer-specific requirements. This enables them to be integrated into the process with the maximum efficiency.

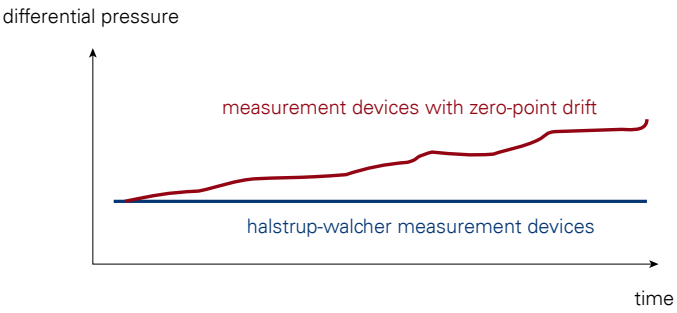


3 examples of a scale in the 100 Pa measurement range

WITHOUT ZERO-POINT DRIFT

The stability of the measurement signal is critical in any application but even more so when measuring small differential pressures. Any drift renders the measurements unreliable. If an instrument is being used to monitor and maintain overpressure in a cleanroom, for example, inaccurate measurements could result in microbe or dust levels rising above the permitted limits. Excessive operating costs can result if a measurement value recorded is too low.

halstrup-walcher sensor technology offers a long-term solution to this problem with integrated solenoid valves for regular zero-point correction in addition to exceptionally stable sensors. During this patented procedure, the previous signal is held to prevent interruption of the measurement value. This ensures stable and reliable measurements – even after many years of service!



Advantages of zero-point correction

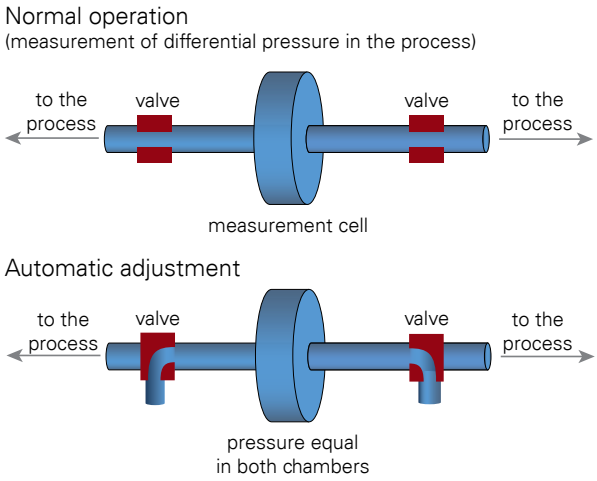
- Excellent reliability of the differential pressure value
- No costly and time-consuming adjustments required
- Process safety guaranteed at all times

AUTOMATIC ZERO-POINT ADJUSTMENT

Solenoid valves regularly open the two chambers of the measurement cell to the interior of the device. The microprocessor now sets the current differential pressure value to zero.

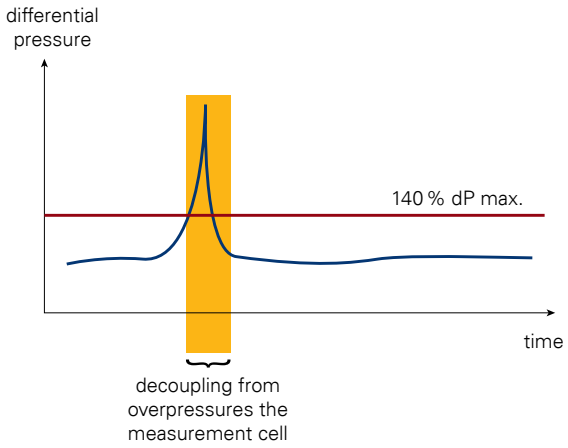
This patented zero-point adjustment procedure is initiated automatically after measurement begins. The process is subsequently repeated at regular intervals – hourly in most devices – and takes only about four seconds, during which time the previous signal is held.

For special applications it is also possible to deactivate the zero-point calibration or select and request it via a digital interface.



HIGH OVERLOAD RESISTANCE

Pressure measurement technology should, of course, be highly sensitive. Yet it must also be protected to prevent damage. Here, too, halstrup-walcher sensors provide the optimum solution: If the measurement cell detects a pressure value that is too high (pressure peak or overload), the solenoid valves close within milliseconds. This prevents the measurement membrane from becoming deformed. Shortly afterwards, a new measurement is taken to determine whether normal measurement operations can resume. If the situation has normalised, a zero-point adjustment is performed automatically. The result is a durable technology that not only offers excellent reliability but also outstanding protection for your investment.



CONVERSION TABLE

	Pa	hPa / mbar	kPa	bar	psi	mmH_2O	inH_2O	mmHg	inHg
Pa	1	0.010	0.001	0.00001	0.0001	0.102	0.004	0.008	0.0003
hPa / mbar	100	1	0.100	0.001	0.015	10.197	0.401	0.750	0.030
kPa	1 000	10	1	0.010	0.145	101.968	4.014	7.502	0.295
bar	100 000	1 000	100	1	14.514	10196.798	401.445	750.188	29.499
psi	6891.799	68.966	6.894	0.069	1	703.235	27.701	51.813	2.036
mmH_2O	9.804	0.098	0.010	0.000098	0.001	1	0.039	0.073	0.003
inH_2O	249.004	2.490	0.249	0.00249	0.036	25.381	1	1.865	0.073
mmHg	133.316	1.333	0.133	0.00133	0.019	13.624	0.536	1	0.039
inHg	3386.387	33.898	3.386	0.03386	0.491	345.901	13.624	25.381	1

Please read the lines from left to right. Example: 1 bar = 100 kPa

MEASUREMENT UNCERTAINTY IN PRACTICE

The degree of **measurement uncertainty** is a statistical value, which takes into account the "error contributions" of the measurement device itself as well as other influencing factors. These also include errors in the reference (applied for adjustment in the manufacturing process). It describes the range in which the actual value is scattered around the measured value with a probability of 95 %.

Example: The P 26 differential pressure transmitter offers a degree of measurement uncertainty of "± 0.2 % of max. value, but not less than 0.3 Pa". "of max. value" means "of the upper range value". For a measurement range of 0 .. 80 Pa, for example, the upper range value of 100 Pa must be used as this is the max. value of the next largest sensor. "Not less than 0.3 Pa" is a consequence of the degree of measurement uncertainty in the reference. In this example, the degree of measurement uncertainty is calculated as follows:

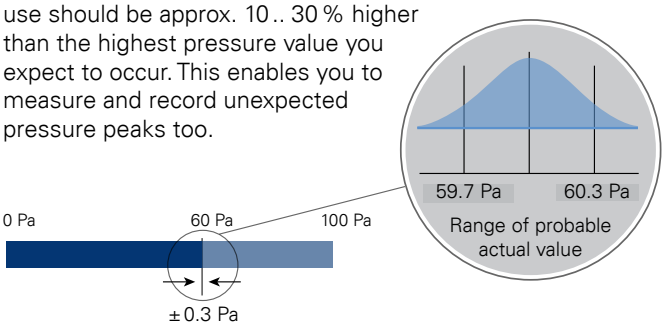
a) ± 0.2 % of max. value = ± 0.2 % x 100 Pa = ± 0.2 Pa

b) But not less than 0.3 Pa

→ In this case, the total degree of measurement uncertainty is 0.3 Pa

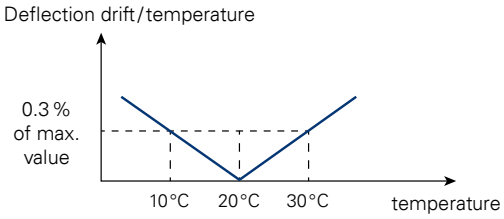
→ If you measure a value of 60 Pa, you can therefore assume with a 95 % probability that the actual value lies somewhere between 59.7 Pa and 60.3 Pa, see graph below

Practical tip: The upper range value of the sensor you use should be approx. 10 .. 30 % higher than the highest pressure value you expect to occur. This enables you to measure and record unexpected pressure peaks too.



In addition, the term **deflection drift / temperature** is used to describe the deviations that can occur if the pressure transmitter performs its measurements not at 20 °C but, e.g. at 35 °C (i.e. 15 K higher). According to the data sheet, a value of e.g. 0.03 % of max. value / K should be used for the P 26. In the example given above (at an ambient temperature of 35 °C) there is an additional "temperature error in the measurement range" of 0.03 % of max. value / K x 100 Pa x 15 K = 0.45 Pa.

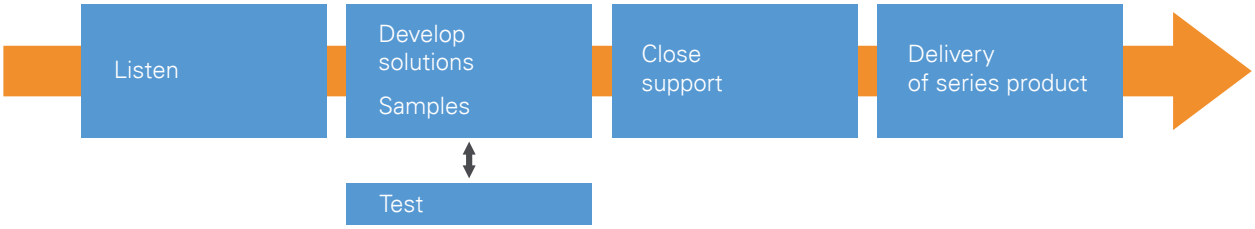
For a measured value of 60 Pa (= 6 / 10 of the measurement range) an additional degree of uncertainty of ± 0.27 Pa should be applied.



Practical tip: If possible, install the pressure transmitter in a protected position with room temperature. The connecting tubing from the measurement point to the pressure transmitter can be several metres in length as long as it is not exposed to sources of heat.

CUSTOMER-SPECIFIC DEVELOPMENT

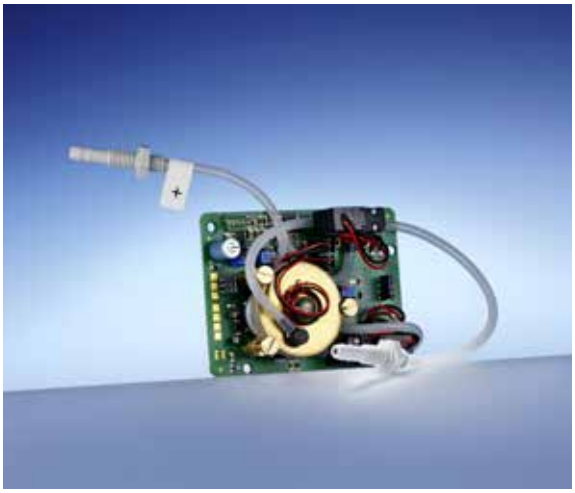
halstrup-walcher supplies a wide range of attractive series products, which are presented in this catalogue. In addition, halstrup-walcher is a specialist in the development of customer-specific solutions, which meet the highest quality standards and can be supplied over a period of years.

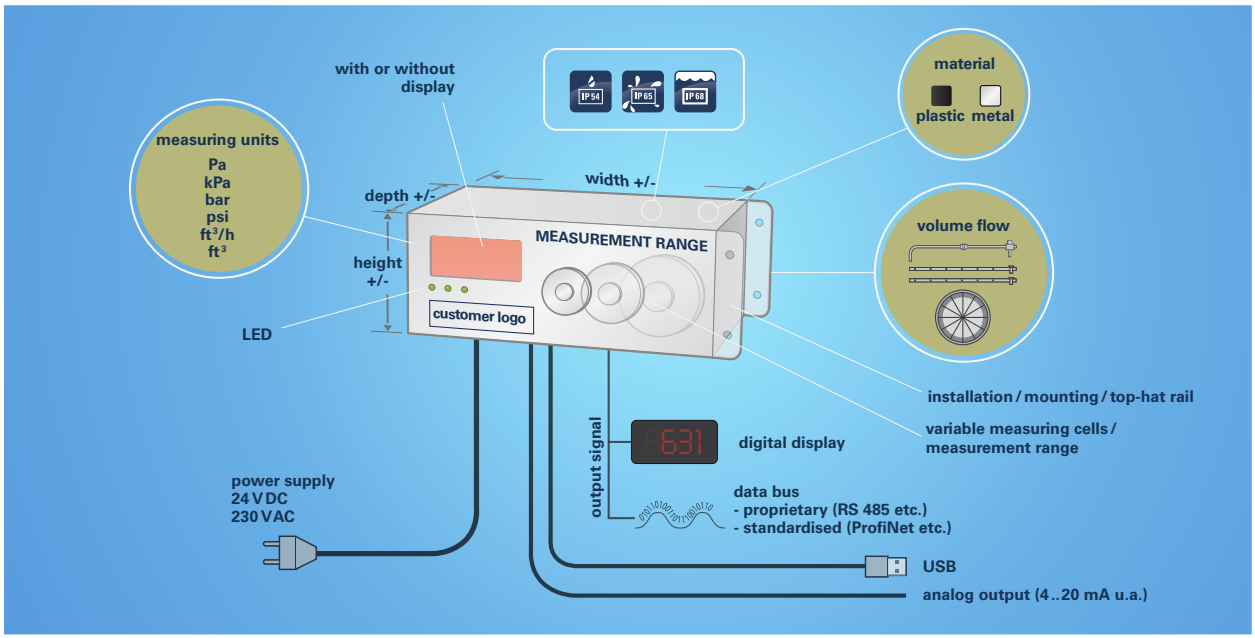


We can adjust all the relevant parameters of our products and developments to your specifications:

- housing size and form
- measurement units (differential pressure, absolute pressure, volume flow, temperature)
- accuracy specifications
- output signals (analog, digital, bus)
- supply voltage
- type of display, LEDs and other signals
- mechanical modules for integration into your process (mountings, primary elements, etc.)

Special feature: We have optimised our processes to enable us to offer you deliveries of small quantities each year at attractive prices. Naturally, we guarantee traceable quality and punctual delivery for all our products.





In air ducts and processes:

Measurement of volume flows

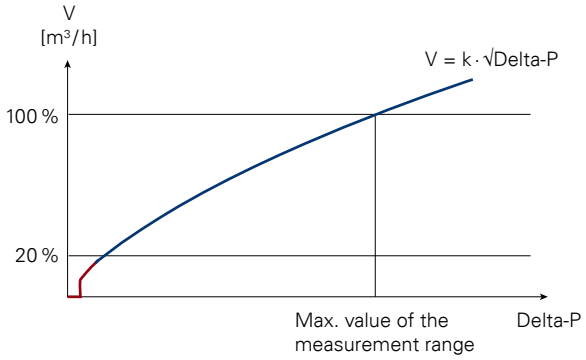
VOLUME FLOW MEASUREMENT

In building and process technology, it is necessary to measure the quantities of air flowing into rooms or processes or being circulated in the plant. The quantity of air transported in a given period of time is known as the volume flow (most common unit: m^3 or ft^3 per hour). Accuracy down to the last decimal point is not usually critical in these applications. The key features are reliability, robust build quality and good value for money.

The most commonly used method of measuring volume flows is based on the principle of differential pressure. This has a number of specific advantages:

- low investment costs, especially for ducts with medium or large cross-sections
- minimal calibration costs (see also "cost-effective calibration" on p. 13)
- process technology: can also be used in plants where temperatures differ significantly from room conditions

Please note that the differential pressure method of measuring volume flow cannot accurately record very small volume flows. These low measurement values are therefore suppressed (creep suppression), e.g. the lowest 3 % of the differential pressure measurement range. However, in typical air conditioning and ventilation systems, as well as in most process technology plants, the volume flows lie between 20 and 100 % of the maximum measurement range so this does not result in any significant limitations.



SUITABLE DEVICES

halstrup-walcher offers a choice of high quality differential pressure transmitters with square-root output. All these devices are designed for indoor room conditions as well as for system pressures of up to 6 bar optional (P 26). To complete the measurement point, select a primary element (see p. 12) and request an on-site calibration (p. 42).

	P 26	**P 29**	**P 82 R**
Details on	**p. 14 (air meter) p. 22**	**p. 23**	**p. 25**
			
Special feature	Scalable, large selection of units	Similar to P 26, can be used in applications with natural gas	For standard applications, also available with metal housing (optional)
Volume flow	✓	✓	✓
Volume (consumption)	✓ (optional)	-	-
Differential pressure	✓	✓	✓
Accuracy	✓ ✓	✓ ✓	✓

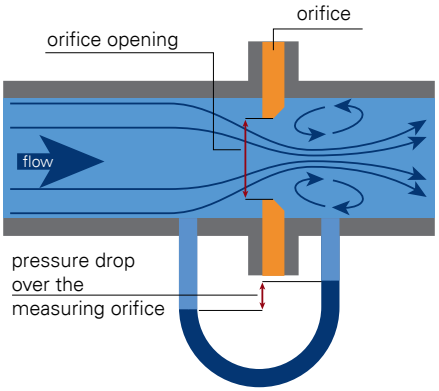
CONVERSION TABLE

	m^3/h	**m^3/min**	**ft^3/h**	**ft^3/min**
m^3/h	1	0.0167	35.3147	0.5886
m^3/min	60	1	2118.8800	35.3147
ft^3/h	0.0283	0.0005	1	0.0167
ft^3/min	1.6990	0.0283	60	1

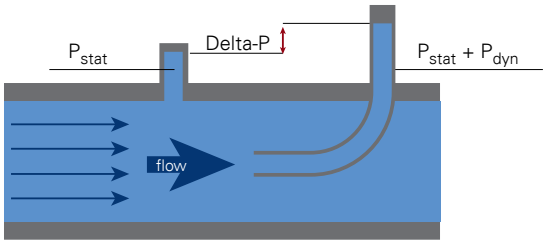
Please read the lines from left to right.
Example: 1 m^3/h corresponds to 35.3147 ft^3/h.

PRIMARY ELEMENTS – MODE OF OPERATION AND SELECTION

In order to convert the volume flow into a differential pressure, so-called primary elements are installed in the air duct or process. This either constricts the cross-section concentrically (orifice plate, cone, venturi).



Or the sum of the static and dynamic pressure is measured and recorded (pitot tube, flow tube, Wilson flow grid) at one or several points and the static pressure subtracted. The latter group of primary elements offer the advantage that there is only a minimal loss of pressure – which noticeably reduces operating costs!



The primary element can be newly designed and supplied by halstrup-walcher. It is also possible to connect the halstrup-walcher pressure transmitter to a primary element that is already installed.

Case 1: Using an primary element that is already installed; supplements a differential pressure transmitter.

The differential pressure transmitter can be combined with any suitable primary element that has already been installed.

- Customer data: max. volume flow [m^3/h or ft^3/h] and the associated max. differential pressure*
- halstrup-walcher: selection of the differential pressure transmitter measurement range above this max. differential pressure value

Case 2: Complete package of primary element and transmitter from halstrup-walcher

- Customer data: max. volume flow [m^3/h or ft^3/h] and air duct dimensions (width x height or diameter)*
- halstrup-walcher: Selection of the primary element, calculation of the max. differential pressure, selection of the appropriate measurement range for the differential pressure transmitter

***Process technology**: Please also state the air temperature and pressure.

Primary element (1)	Image	Order number (length [mm]) (2)	Accuracy
Pitot tube / flow tube [a]	 The pitot tube measures at a single point (centre of the duct)	Supplied in "L"-form with threaded adjustable collar: 9052.0007 (305 mm), 9052.0008 (483 mm), 9052.0009 (795 mm)	✓
(Two) flow probes / X-grid [b]	 The 2 flow probes record measurements at several points. Can be installed in parallel or rotated by 90° ("X-grid").	9052.0001 (100 mm), 9052.0002 (150 mm), 9052.0003 (200 mm), 9052.0004 (300 mm), 9052.0005 (400 mm), 9052.0006 (500 mm)	✓ ✓
Wilson flow grid	The flow grid measures at many positions 	9052.0010 (round, D: 100 .. 500 mm) 9052.0011 (round, D: 501 .. 1 000 mm) 9052.0012 (rectangular, W x H of 100 x 150 to 450 x 450 mm)	✓ ✓ ✓

[a] The pitot tubes/flow tubes are supplied with a screw clamp.
[b] A "set" of flow probes comprises the following parts: 2 flow probes, approx. 2 m tubing, 2 sealing rings (for the probes), operating instructions, 2 elbows (for connecting tubing)

(1) We are also pleased to offer primary elements for process technology or customer-specific applications, see p. 13

(2) Pitot tube and flow probes: length must be less than the width of the air duct. Flow grid: please state precise dimensions.

Straight inlet (= 10 D) and outlet (= 5 D) pipes are ideal (D = inner diameter)
Recommended for on-site adjustment: Multi-point flow measurements in accordance with DIN EN 12599 (average value calculated from multiple measurement points per m^2 of cross-sectional area). Please enquire about our range of services (see p. 42). You can find further accessories on p. 17.

COST-EFFECTIVE CALIBRATION USING THE DIFFERENTIAL PRESSURE PRINCIPLE

One advantage of using the principle of differential pressure to measure volume flows is that it is possible to calibrate the measurement points much more cost-effectively than when using other methods. This firstly applies to the laboratory calibration where the costs of regular pressure calibrations are lower than for volume flow calibrations. Secondly, measurement points can be calibrated on-site, which generates further tangible cost advantages.

The range of KAL products from halstrup-walcher are ideal for calibrating pressure measurements, see p. 37. DAkkS-calibrated KAL devices enable customers to perform ISO calibration of (pressure or volume flow based on the differential pressure principle) measurement points themselves.

VOLUME FLOW MEASUREMENT IN PROCESSES

Accurate measurement of volume flow in air ducts or ventilation systems (e.g. in m^3/h or ft^3/h) is becoming increasingly important. This is because volume flow is an important process technology parameter, e.g. for ensuring a specific drying quality or the ability of a test facility to function correctly. But it is also essential to monitor minimum volume flows in critical air-conditioning systems, such as those used for cleanrooms.

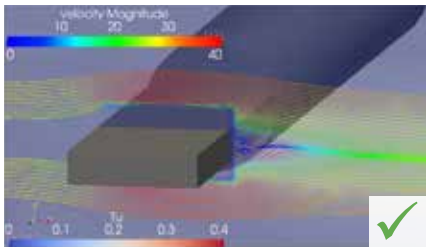
Your volume flow partner, halstrup walcher

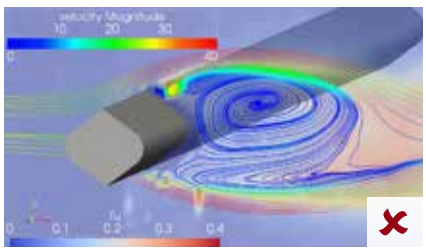
- provides support in designing measurement points and primary elements (incl. optional temperature sensors)
- takes responsibility for installation on-site
- calibrates and adjusts equipment on-site

This ensures that all the installation conditions (and resulting asymmetries of the flow profile) are taken into account to produce the optimum result.

For process technology, halstrup-walcher supplies process probes with optimised geometries (see photo). As you can see from the flow simulation, these prevent the generation of vortexes, which are created by standard flow pressure probes. Higher accuracy and lower sensitivity to shorter inlet routes are the results.

The following design parameters must be stated: medium (air or non-aggressive gases), temperature (special versions for use at temperatures > 400 °C are possible), static pressure (up to 6 bar), design volume flow (e.g. 5000 m^3/h), air duct dimensions or installation dimensions as well as the ambient conditions (indoor, non-Ex, …).



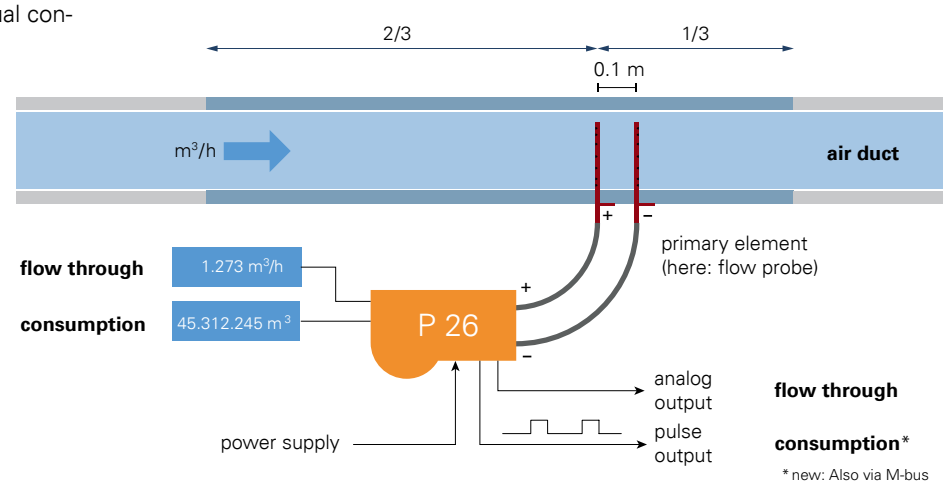


P 26 AIR METER / MEASUREMENT OF AIR CONSUMPTION

APPLICATION

Today, it is very rare to measure air consumption for individual users. Costs are usually apportioned based on the total costs and the respective share of the total area occupied. For example, a tenant renting 23 % of the total area will always pay 23 % of the air-conditioning costs. This is unfair in terms of user behaviour and different air conditioning requirements for different room types – and importantly it offers no incentive to find savings. However, particularly in commercial properties which are rented out to a number of tenants, air consumption is seen as being identical to other consumed media (electricity, water, etc.) and there are demands for these costs to be apportioned fairly in the same way, i.e. based on actual consumption. The same applies equally to industrial companies with an energy management system.

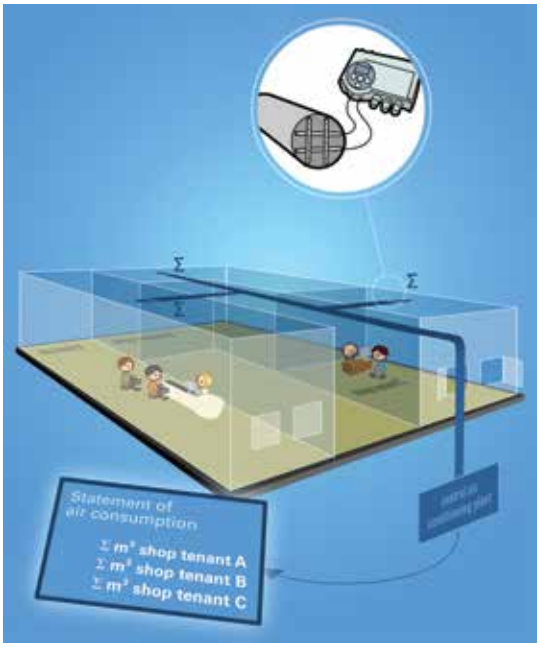
The P 26 air meter takes the following approach: based on the volume flow measurement using the principle of differential pressure (please select a suitable primary element, see p. 12), the P 26 air meter adds up and displays the volumes consumed (m^3 or ft^3 of air) and makes the data available via a pulse output (optionally also via M-bus).



FEATURES

- legally secure through traceable on-site calibration
- security: code-protected function, no unauthorised operation
- the total volume consumed (and an operating hour counter) can be reset after entering a code either to zero or to a "total before reset" saved as a backup
- the pulse valency (m^3 or ft^3 per pulse), pulse length and pulse interval can be set individually
- an internal operating hour meter provides a time reference – operational security without batteries.

You can find technical data and ordering information on p. 15.



Air meter in shopping centre:
metered consumption replaces apportionment of costs per m^2

ORDERING OPTIONS FOR P26 AIR METER

Order code	A	B	C	D	E	F	G
P26	–	–	–	–	–	–	–

Analog output	A
0..20 mA	0
0..10 V	1
4..20 mA	4

Measurement range	C
Selected by halstrup-walcher based on your design data	-

Display, keyboard	E
without	0
with [a]	LC

[a] recommended for air meter

The meter is configured either using the display (E = LC), the device's internal RS232 interface or the external USB port (G = US).

Power supply	B
24 VAC/DC	24ACDC
24 VAC	24AC
230/115 VAC	230/115

Degree of measurement uncertainty	D
±0.2 % [b]	2
±0.5 % [b]	S

[b] of max. value, based on pressure value

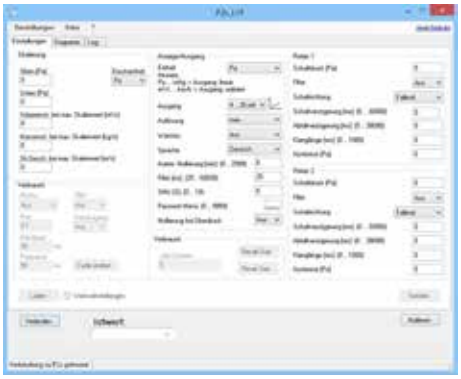
Switch output + pulse output	F
1 x relay (switch output) max. 230 VAC, 6 A and 1x pulse output (air meter)	1

Digital interface [c]	G
without	0
USB, incl. cable	US

[c] Please enquire about communication via M-bus.

LEGALLY SECURE ON-SITE CALIBRATION

After the primary element and P26 differential pressure transmitter have been mounted, the latter is parameterised and adjusted on the basis of an on-site calibration. This is legally secure and traceable to national standards. Adjustments are made either via a user-friendly operating menu or using simple PC parameterisation software. This software is available to download from our website. halstrup-walcher is also pleased to offer services for complete on-site commissioning of the air meter measurement point; see also p. 42.



P26 air meter parameterisation software

TECHNICAL DATA FOR P26 AIR METER

Units	m^3/h, m^3, ft^3/h, ft^3, kg/h, kg	Overload resistance	200x, max. 6 bar
Sampling rate	1x per second	Operating temperature	10..50 °C
Saves sum value, sum before reset, operating hour counter	every 10 min and when device powers down	Storage temperature	-10..70 °C
Max. no. of values without sum reset	> 2 billion measured values [m^3, ft^3, kg]	Power consumption	approx. 6 VA
Max. period of time without sum reset	199999 hours or > 20 years	Weight	approx. 0.75 kg (P26 without differential pressure producer)
Value per pulse (meter output)	0.1..10000 m^3 3.6..350000 ft^3 (freely selectable) 0.1..10000 kg	Meter modes (adjustable)	• Only positive volume flows (VF) • Balance of positive and negative VF • Total sum of positive and neg. VF
Pulse length	20..2000 ms	Pressure ports	for tubing NW 6 mm
Pulse interval	50..2000 ms	Protection class	IP65, with USB IP40
Measuring accuracy	with measurement probes approx. ±4 % (in straight measurement sections)	Time constant	25 ms..60 s (adjustable)
Medium	Air, non-aggressive gases	Cable gland	3 x M 16
Certification	CE, CSA	Dimension drawing	see P26 on p. 22

Differential pressure transmitters

MEASUREMENT OF DIFFERENTIAL PRESSURE

Measurement of differential pressure is useful in a broad range of applications. It is used in ventilation and air-conditioning technology but also in many areas of air handling process technology. The table below shows a number of these. You can find more information about pressure sensor technology on p. 6.

halstrup-walcher offers a wide range of products for stationary measurement of differential pressure.

	PUC 24	PUC 28 (K)	P 26	P 29	P 82 R	PU / PI / PIZ	PS 27	REG 21
Details on	**p. 20**	**p. 21**	**p. 22**	**p. 23**	**p. 25**	**p. 24**	**p. 26**	**p. 27**
								
Application	Process monitoring for clean-rooms (Pa, °C, % rH)	Process monitoring panel (optional: with calibration port) (Pa, °C, % rH)	High precision, scalable differential pressure transmitter	Like P 26, for natural gas	Square-root standard differential pressure transmitter	For standard applications. PIZ: PI in two wire technology	A basic sensor for simple applications	Measurement and regulation of pressure
Housing installation	Installed in wall (panel)		Mounted on a wall / top-hat rail					Rack
Max. measurement range	± 250 Pa		± 100 kPa		± 20 kPa	± 100 kPa		
Min. measurement range	± 100 Pa		± 10 Pa	± 250 Pa	± 100 Pa	± 50 kPa	± 50 Pa	
Degree of measurement uncertainty	0.5 % [1] (standard)	0.5 % [1] (standard)	0.2 % [1] [2] (optional) 0.5 % [1] [2] (standard)	0.2 % [1] (optional) 0.5 % [1] (standard)	1 % [1]	0.2 % [1] [2] 0.5 % [1] [2] 1 % [1]	2 % [1] (≥ 100 Pa) 3 % [1] (for 50 Pa)	0.5 % [1] [2] 1 % [1]
Square-root (volume flow)	-	-	✓	✓	✓	-	-	-
Display	✓	✓	optional	optional	optional	optional	optional	✓

[1] Max. value of upper range value
[2] But not less than 0.3 Pa

ACCESSORIES

Certificates	**Order no.**
DAkkS calibration certificate (German)	9601.0003
DAkkS calibration certificate (English)	9601.0004
ISO factory calibration certificate	9601.0002

Connecting components	
Silicone tubing ID 5 mm, OD 9 mm, red (please state length required)	9601.0160
Silicone tubing ID 5 mm, OD 9 mm, blue (please state length required)	9601.0161
Neoprene tubing (please state length required)	9061.0132
Y-piece for tubing	9601.0171

Pressure ports:

We can supply a wide range of customer-specific pressure ports, e.g. various cutting ring couplings or hose connectors.

MEASUREMENT OF DIFFERENTIAL PRESSURE AND REGULATION OF PRESSURE

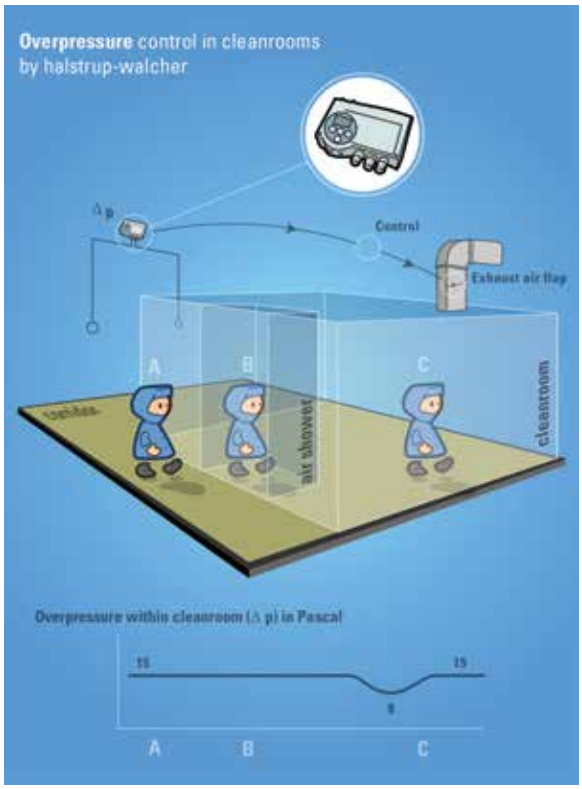
... IN CLEANROOMS

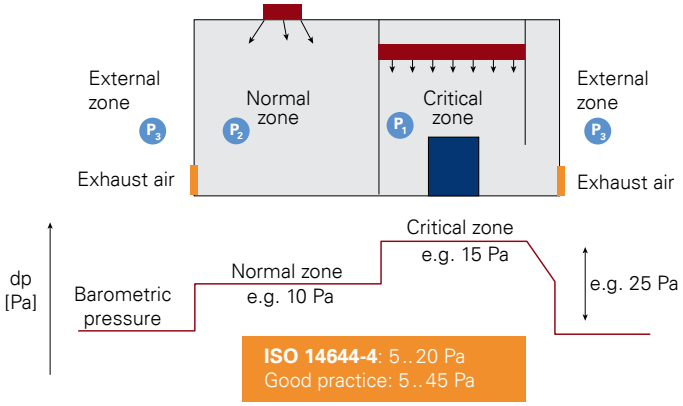
In cleanrooms, it is vital to prevent contaminated air flowing in from corridors or areas with lower cleanroom classifications. This can be achieved by **maintaining a continuous overpressure** inside the cleanroom. The heart of this system is a high-precision differential pressure transmitter operating in the low Pascal range

- → for installation in a wall (panel), (e.g. PUC, see p. 20 and p. 21)
- → for installation in a control cabinet (top hat rail) (e.g. P26, see. p. 22)
- → for mounting on a wall (e.g. P26, see. p. 22)

The standard ISO 14644 requires continuous monitoring and regulation of pressure for all cleanrooms. In addition, spot checks must be performed at regular intervals.

- → use of the KAL portable, high precision calibration and measurement device (see p. 38 and 39)

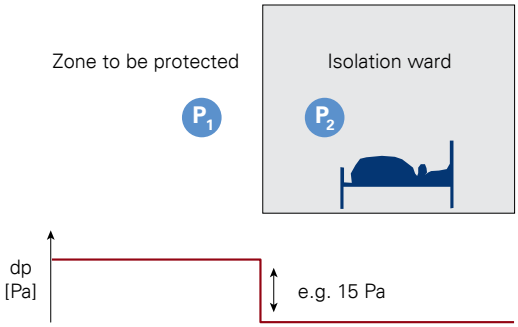




... IN HOSPITALS

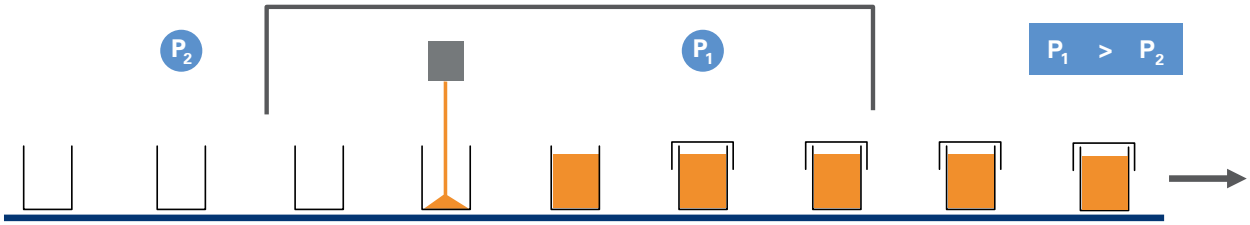
Excluding air that contains bacteria can be a matter of life and death, especially in hospitals, e.g. operating theatres. Here, too, this is achieved by ensuring a constant **overpressure** in the room that prevents contaminated air entering it from surrounding areas.

The opposite applies to isolation wards, which are used to prevent the spread of epidemics. In this case, the room must be kept at a constant **underpressure** relative to its surroundings in order to prevent bacteria/viruses escaping.



MEASUREMENT OF DIFFERENTIAL PRESSURE AND REGULATION OF PRESSURE

... IN FILLING MACHINES AND HYGIENIC PLANTS



Hygiene and bacteria-free environments are key requirements in both the pharmaceutical and food processing industries. This is achieved through selecting the appropriate materials and time-consuming cleaning processes. But what happens if the goods being protected come into contact with the surrounding air? If this air has not been correctly processed, it will transport microbes and other contaminants (oil aerosols, particles etc.) directly to the endangered product.

For larger hygienic production plants, the construction of whole cleanrooms is a viable option. However, this approach may be inefficient if only a small, enclosable hygienic area is required. The solution to this problem was the development of "mini-environments" – isolated, hygienic areas. These ensure that no microbes or contaminants are able to penetrate the protected area.

Measurement and regulation of differential pressure are the keys to maintaining a constant and safe **overpressure** within the mini-environment. Long-term stability is critical in order to prevent unplanned decreases in pressure over time. halstrup-walcher is a specialist in this type of application and offers

- → for mounting on walls or top-hat rails: P 26 (see p. 22)
- → for mounting in walls (panel version): PUC 24 or PUC 28 K (see p. 20/21)

The **pressure** in the filling room must be **higher** than that of the surrounding areas or particles/oil etc. may enter the zone in which the product is being handled.

PUC 24

Measurement ranges	± 100 Pa or ± 250 Pa freely scalable within this range
Margin of error	0.5 % of max. value
Deflection drift/temperature	0.03 % of max. value/K (10..50 °C)
Zero-point drift/temperature	± 0 % (cyclical zero-point correction)
Overload capacity	200 x
Medium	Air, all non-aggressive gases
Max. system pressure	10 kPa
Sensor response time	25 ms
Time constants	25 ms..40 s (adjustable)
Input signal humidity/temperature module (galvanically separated)	0..10 V, R_i = 470 kΩ 0/4..20 mA, R_i = 50 Ω adjustable
Operating temperature	10..50 °C
Storage temperature	-10..70 °C
Power consumption	approx. 7 VA
Weight	approx. 1 kg
Pressure ports	for tubing NW 3..6 mm
Protection class	IP65 (installed)
Certificates	CE

Supply voltage
24 V DC, ± 10 % smoothed

Output
0..10 V (R_i > 2 kΩ) 0/4..20 mA (R_i < 500 Ω) adjustable
2 contact points, 6 A, 230 V AC, may be configured as desired within this pressure range

Measurement range	**A**
± 100 Pa	0
± 250 Pa	1

Data interface	**B**
None	0
Profibus DP (optional)	DP
RS232 (optional)	2

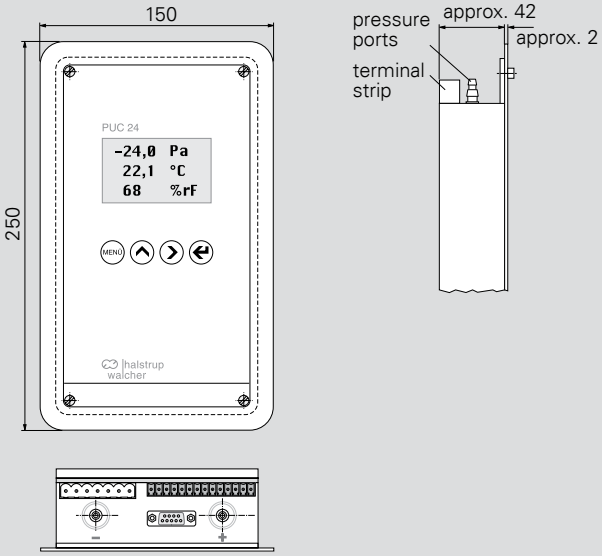
Bus connection	**C**
None	0
9-pin Sub-D flush type connector*	D
Sub-D plug with 150 mm cable	DK
Round pin connector M12 with 150 mm cable	RK

* not suitable for wall thicknesses greater than 5 mm

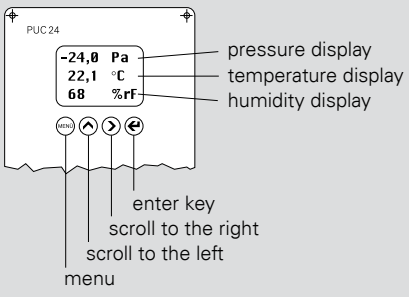
Order code	**A**	**B**	**C**
PUC 24	–	–	–

Features

- Cleanroom panel (stainless steel) for displaying air-conditioning data
- Integrated, high precision measurement of differential pressure
- % rH/°C pressure transmitter, switchable (independent of manufacturer)
- Optimum cleanroom design (TU Munich/Weihenstephan)
- Solvent resistant stainless steel surface
- 3 analog outputs, optional digital interface
- Acoustic alarm when the threshold value is exceeded, acknowledgement via key
- Bilingual menu (German/English)
- Two contact points (6 A/230 V AC)



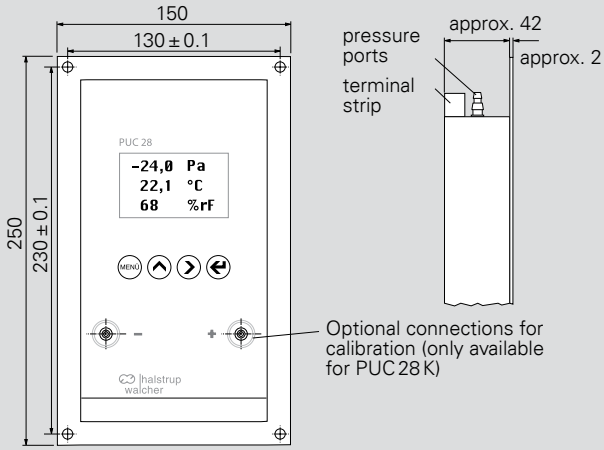
Instrument controls

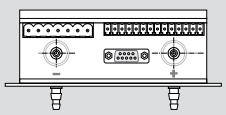


PUC 28 / PUC 28 K

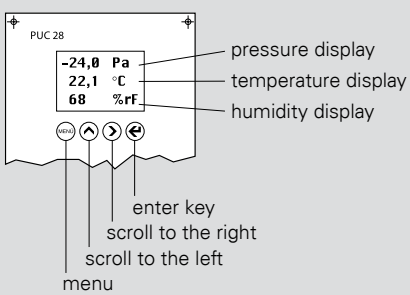
Features

- Process panel for displaying air-conditioning data
- Integrated, high precision measurement of differential pressure
- % rH / °C pressure transmitter, switchable (independent of manufacturer)
- Anodised, aluminium housing with easy-to-clean front surface
- With external calibration ports (design "K"), for on-site calibration without disassembly
- 3 analog outputs, optional digital interface
- Acoustic alarm when the threshold value is exceeded, acknowledgement via key
- Multilingual menu (German / English)
- Two contact points (6 A / 230 V AC)





Instrument controls



Measurement ranges	± 100 Pa or ± 250 Pa freely scalable within this range
Margin of error	0.5 % of max. value
Deflection drift / temperature	0.03 % of max. value / K (10 .. 50 °C)
Zero-point drift / temperature	± 0 % (cyclical zero-point correction)
Overload capacity	200 x
Medium	Air, all non-aggressive gases
Max. system pressure	10 kPa
Sensor response time	25 ms
Time constants	25 ms .. 40 s (adjustable)
Input signal humidity / temperature module (galvanically separated)	0 .. 10 V, R_i = 470 kΩ 0 / 4 .. 20 mA, R_i = 50 Ω adjustable
Operating temperature	10 .. 50 °C
Storage temperature	-10 .. 70 °C
Power consumption	approx. 7 VA
Weight	approx. 1 kg
Pressure ports	for tubing NW 3 .. 6 mm
Protection class	IP 65 (installed)
Certificates	CE

Supply voltage
24 V DC, ± 10 % smoothed

Output
0 .. 10 V (R_i > 2 kΩ) 0 / 4 .. 20 mA (R_i < 500 Ω) adjustable
2 contact points, 6 A, 230 V AC, may be configured as desired within this pressure range

Model	Measurement range	A
PUC 28	± 100 Pa	0
PUC 28	± 250 Pa	1
PUC 28 K*	± 100 Pa	K2
PUC 28 K*	± 250 Pa	K3

* "K": with externally accessible (no disassembly) pressure calibration ports (see photo)

Data interface	B
None	0
Profibus DP (optional)	DP
RS 232 (optional)	2

Bus connection	C
None	0
9-pin Sub-D flush type connector*	D
Sub-D plug with 150 mm cable	DK
Round pin connector M12 with 150 mm cable	RK

* not suitable for wall thicknesses greater than 5 mm

Order code	A	B	C
PUC 28	–	–	–

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P 26

for P 26 with air meter function see p. 14

Measurement ranges others available upon request	10/50/100/250/500 Pa 1/2.5/5/10/20/50/100 kPa freely scalable from 10 .. 100 % within a measurement range
Margin of error (0.3 Pa margin of error for reference)	± 0.2 % of max. value (min. 0.3 Pa) or ± 0.5 % of max. value (min. 0.3 Pa)
Deflection drift/temperature	0.03 % of max. value/K (10 .. 50 °C)
Zero-point drift/temperature	± 0 % (cyclical zero-point correction)
Max. system pressure/ Overload capacity	600 kPa for measurement ranges ≥ 2.5 kPa 200 x for measurement ranges < 2.5 kPa
Medium	Air, all non-aggressive gases
Sensor response time	25 ms
Time constants	25 ms .. 40 s (adjustable)
Operating temperature	10 .. 50 °C
Storage temperature	-10 .. 70 °C
Power consumption	approx. 6 VA
Weight	approx. 750 g
Cable glands	3 x M 16
Pressure ports	for tubing NW 6 mm, others available on request
Protection class	IP 65, with USB: IP 40
Certificates	CE, CSA

Output*	**A**
0 .. 10 V ($R_L \geq 2$ kΩ)	1
0 .. 20 mA ($R_L \leq 500$ Ω)	0
4 .. 20 mA ($R_L \leq 500$ Ω)	4
± 5 V ($R_L \geq 2$ kΩ)	5

* output signals can be configured freely

Power supply	**B**
24 VAC/DC	24ACDC
24 VAC with galvanic separation	24AC
230/115 VAC	230/115

Measurement range	**C**
Measurement range e.g. 0 .. 10 Pa, -10 .. 50 mbar, 0 .. 100 mmHg (etc.)	

Margin of error	**D**
± 0.2 % of max. value (min. 0.3 Pa)	2
± 0.5 % of max. value (min. 0.3 Pa)	S

LCD	**E**
none	0
LCD and keyboard	LC

Contact points	**F**
none	0
Air meter (see p. 14)	1
2 relays (changeover contacts) max. 230 VAC, 6 A	2

Data interface	**G**
none	0
USB, data cable supplied	US
External zero-point calibration	EX

Order code	**A**		**B**		**C**		**D**		**E**		**F**		**G**
P 26	–		–		–		–		–		–		–

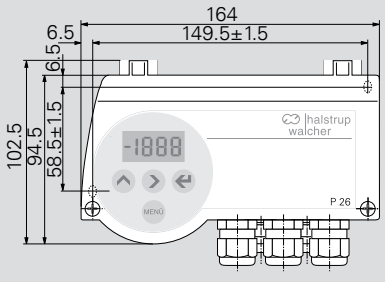
Features

- High precision differential pressure transmitter for top-hat rail or wall mounting (air-conditioning, cleanroom, process)
- Wide range of units available for pressure and volume flow, also ± measurement ranges
- Scalable measurement ranges and units
- Zero-point calibration prevents zero-point drift
- Built-in valve provides a high level of overpressure protection
- Multilingual menu (German/English/Italian/French)

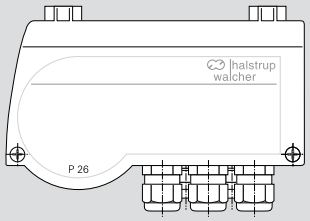
Optional

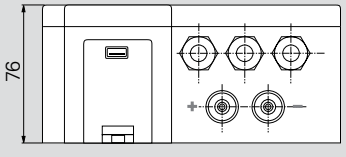
- Contact points with adjustable switching outputs
- Set the zero-point via the interface
- USB interface (free parameterisation software at www.halstrup-walcher.com)
- Air meter function (see p. 14)

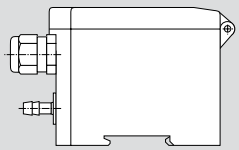
P 26 with Display



P 26 without Display





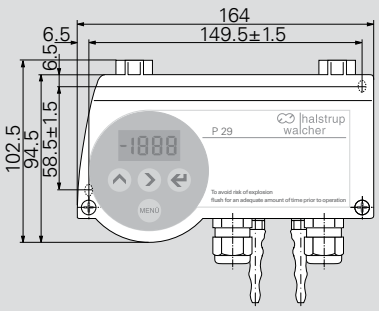


P 29

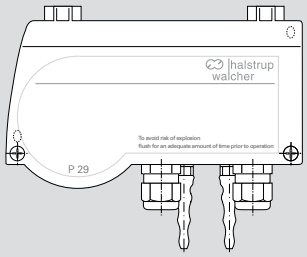
Features

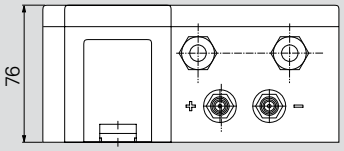
- TÜV-tested differential pressure transmitter for natural gas
- Design changes and technical modifications keep ignition source and gas mixture safely separated (not suitable for Ex-applications)
- Scalable measurement range and display
- For pressure and volume flow measurement
- Zero-point calibration prevents zero-point drift
- Built-in valve provides a high level of overload protection
- Also suitable for top-hat rail mounting
- Multilingual menu (German/English/Italian/French)

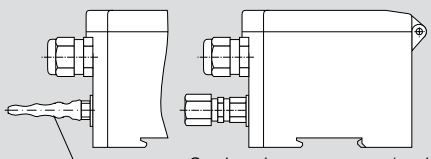
P29 with Display



P29 without Display







Cutting ring connector (optional)

Laboratory nozzle in accordance with DIN 12898

Measurement ranges others available upon request	250/500 Pa 1/2.5/5/10/20/50/100 kPa freely scalable from 10 .. 100 % within a measurement range
Margin of error (0.3 Pa margin of error for the reference)	± 0.2 % of max. value or ± 0.5 % of max. value
Deflection drift/temperature	0.03 % of max. value/K (10 .. 50 °C)
Zero-point drift/temperature	± 0 % (cyclical zero-point correction)
Overload capacity	100 kPa for measurement ranges ≥ 2.5 kPa 200 x for measurement ranges < 2.5 kPa
Medium	Natural gas
Max. system pressure	100 kPa for all measurement ranges
Sensor response time	25 ms
Time constants	25 ms .. 60 s (adjustable)
Operating temperature	10 .. 50 °C
Storage temperature	-10 .. 70 °C
Power consumption	approx. 6 VA
Weight	approx. 750 g
Cable glands	2 x M 16
Pressure ports	2 x laboratory nozzle DIN 12898
Protection class	IP 65
Certificates	CE, EN1127-1:2007

Output*	**A**
0 .. 10 V (R_L ≥ 2 kΩ)	1
0 .. 20 mA (R_L ≤ 500 Ω)	0
4 .. 20 mA (R_L ≤ 500 Ω)	4
± 5 V (R_L ≥ 2 kΩ)	5

* output signals can be configured freely

Power supply	**B**
24 V DC	24 DC

Measurement range	**C**
Measurement range e.g. 0 .. 250 Pa, -10 .. 50 mbar, 0 .. 100 mmHg (etc.)	

Margin of error	**D**
± 0.2 % of max. value	2
± 0.5 % of max. value	S

LCD	**E**
none	0
LCD and keyboard	LC

Tubing connections	**F**
Standard for tubing NW 5-8 mm	0
Cutting ring coupling 8 mm	S

Order code	**A**		**B**		**C**		**D**		**E**		**F**
P29	–		–		–		–		–		–

TÜV-tested:

As long as a specified flushing process is observed, special electronic encapsulation safely separates any ignition sources from natural gas.

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PU/PI/PIZ

Measurement ranges others available upon request	50/100/250/500 Pa 1/2.5/5/10/20/50/100 kPa
Margin of error	0.2 % of max. value, min. 0.3 Pa or 0.5 % of max. value, min. 0.3 Pa or 1 % of max. value
Deflection drift/temperature	0.04 % of max. value/K (10..50 °C)
Zero-point drift/temperature	0.04 % of max. value/K (10..50 °C)
Zero-point drift/time	0.5 % of max. value/year
Overload capacity	10 x for measurement ranges ≤ 20 kPa 2 x for measurement ranges > 20 kPa
Medium	Air, all non-aggressive gases
Max. system pressure	10 kPa for measurement ranges ≤ 10 kPa Max. nominal pressure of the sensor for measurement ranges above10 kPa
Sensor response time	20 ms
Operating temperature	10..60 °C
Storage temperature	-10..70 °C
Power consumption	PU/PI approx. 3 VA PIZ: max. 0.6 VA
Weight	approx. 0.8 kg
Cable glands	PU/PI: 2 x PG 7, others available upon request PIZ: 1 x PG 7, others available upon request
Pressure ports	for tubing NW 6 mm
Protection class	IP65
Certificates	CE, CSA

Output	A
0..10 V ($R_L \geq 2$ kΩ)	U
0..20 mA ($R_L \leq 500$ Ω)	I0
4..20 mA ($R_L \leq 500$ Ω)	I4
4..20 mA two-wire ($R_L \leq 50$ [UB (V) -10 (V)] Ω)	IZ

Measurement range	B
Measurement range e.g. 0..100 Pa, 0..60 mbar, 0..110 mmHg (etc.)	

Margin of error	C
0.2 % of max. value min. 0.3 Pa	02
0.5 % of max. value min. 0.3 Pa	05
1 % of max. value	1

Supply voltage	D
24 VDC, +20 %/-15 % *	24D
24 VAC, +6 %/-15 % (50/60 Hz) *	24A
115 VAC, +6 %/-15 % (50/60 Hz) *	115
230 VAC, +6 %/-15 % (50/60 Hz) *	230
10..30 VDC (two-wire system)	PIZ

* not for PIZ

Time constant	E
none	0
1 s	1
2 s	2
5 s	5

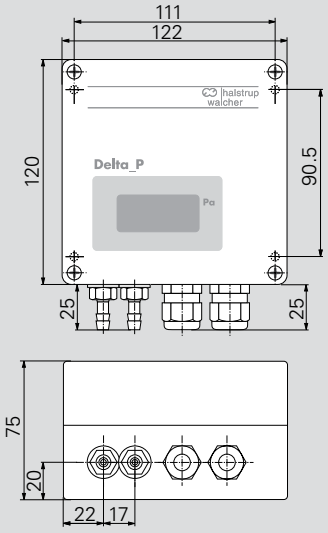
LCD	F
none	0
3 1/2 digit (see foto)	3
4 1/2 digit (only for PU/PI)	4

Order code	A	B	C	D	E	F
P	–	–	–	–	–	–

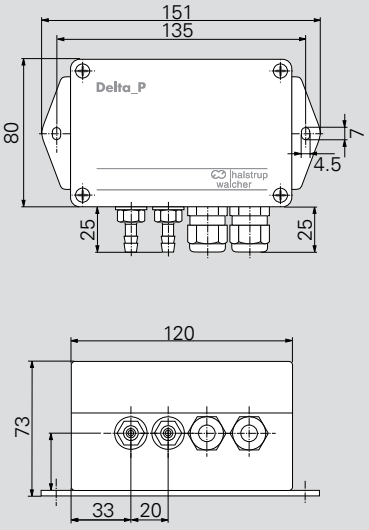
Features

- Differential pressure transmitter with linear curve for air-conditioning applications
- Also available as a two-wire system ("PIZ" model)
- Also for ± measurement ranges and asymmetric measurement ranges
- With optional LCD

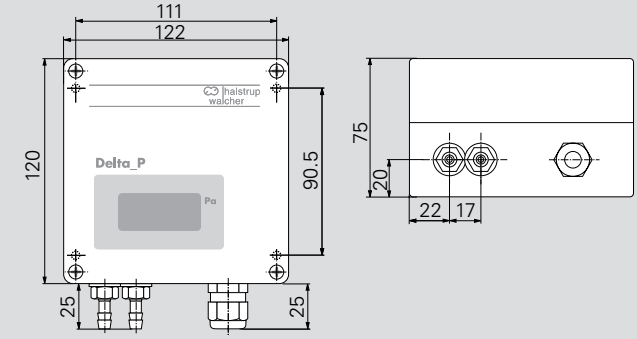
PU / PI with Display



PU / PI without Display



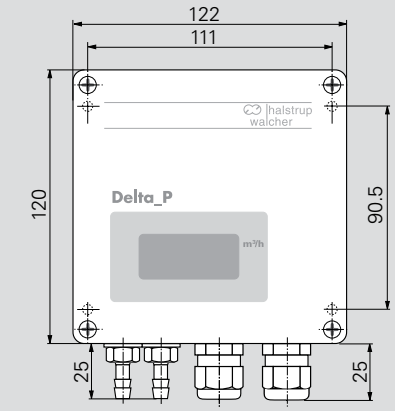
PIZ with Display

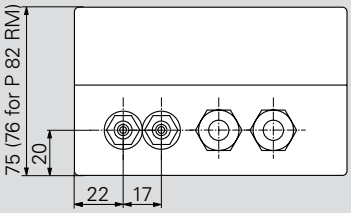


P 82 R

Features

- Differential pressure transmitter with root-extracted curve for volume flow applications
- High level of accuracy and long-term stability
- Very little hysteresis; largely independent of temperature
- Easy-to-read display (optional)
- With optional metal housing (P 82 RM)





Measurement ranges others available upon request	100/250/500 Pa 1/2.5/5/10/20 kPa
Margin of error	1 % of max. value
Deflection drift/temperature	0.04 % of max. value/K (10 .. 50 °C)
Zero-point drift/temperature	0.05 % of max. value/K (10 .. 50 °C)
Zero-point drift/time	0.5 % of max. value/year
Overload capacity	5 x
Medium	Air, all non-aggressive gases
Max. system pressure	10 kPa for measurement ranges ≤ 10 kPa max. nominal pressure of sensor for measurement ranges above 10 kPa
Sensor response time	20 ms
Creep suppression	adjustable 0 .. 10 % of max. value
Operating temperature	10 .. 60 °C
Storage temperature	-10 .. 70 °C
Power consumption	approx. 3 VA
Weight	approx. 0.8 kg
Cable glands	2 x PG 11
Pressure ports	for tubing NW 6 mm
Protection class	IP 65
Certificates	CE, CSA

Output	**A**
0 .. 10 V ($R_L \geq 5$ kΩ)	1
0 .. 20 mA ($R_L \leq 500$ Ω)	0
4 .. 20 mA ($R_L \leq 500$ Ω)	4

Power supply	**B**
24 V DC	24D
24 V AC	24A
115 V AC	115
230 V AC	230

Measurement range	**C**
Measurement range in m³/h, Pa, etc. (e.g. 0 .. 100 m³/h or 0 .. 210 Pa)	

Time constants	**D**
none	0
1 s	1
2 s	2
5 s	5

LCD	**E**
none	0
3 1/2 digit (see foto)	3
4 1/2 digit	4

Order code	**A**		**B**		**C**		**D**		**E**
P 82 R	–		–		–		–		–

halstrup walcher

PS 27

Measurement ranges others available upon request	50/100/200/500 Pa 1/2.5/5/10/20/50/100 kPa
Margin of error	2 % of max. value ≥ 100 Pa or 3 % of max. value for 50 Pa
Deflection drift/temperature	0.1 % of max. value/K
Zero-point drift/temperature	0.1 % of max. value/K
Overload capacity	12 x for measurement ranges ≤ 20 kPa 4 x for measurement ranges ≥ 20 kPa
Medium	Air, all non-aggressive gases
Max. system pressure	10 kPa for measurement ranges ≤ 10 kPa Max. nominal pressure of sensor for measurement ranges above 10 kPa
Sensor response time	20 ms
Time constants	20 ms .. 4 s adjustable (factory-provided)
Operating temperature	-20 .. 60 °C with Display 0 .. 50 °C
Storage temperature	-20 .. 70 °C
Power consumption	approx. 1 VA
Weight	approx. 0.25 kg
Cable glands	2 x M12
Pressure ports	for tubing NW 4-6 mm
Protection class	IP65
Certificates	CE

Output*	**A**
0 .. 10 V (R_L ≥ 50 kΩ)	1
2 .. 10 V (R_L ≥ 50 kΩ)	2
0 .. 20 mA (R_L ≤ 500 Ω)	0
4 .. 20 mA (R_L ≤ 500 Ω)	4
0 .. 5 V (R_L ≥ 50 kΩ)	5

* the output signal can be configured using jumpers

Power supply	**B**
24 V AC/DC (without galvanic separation)	AC/DC
15 .. 32 V DC (two-wire) (only for A = 4)	ZWL

Measurement range	**C**
Standard (e.g. 0 .. 100 Pa) *	
toggles between: 100/250/500/1 000 Pa	1
toggles between: 250/500/1 000/2 500 Pa	2
toggles between: 1/2.5/5/10 kPa	3
toggles between: 10/25/50/100 kPa	4

* others available upon request

Contact point	**D**
none	0
1 relay (changeover contacts) max. 230 V AC, 6 A (min. required switching capacity 300 mW) (not for two-wire)	1

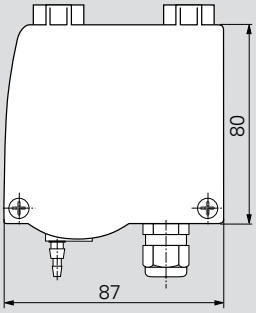
LCD	**E**
none	0
4-digit	1

Order code	**A**	**B**	**C**	**D**	**E**
PS 27	–	–	–	–	–

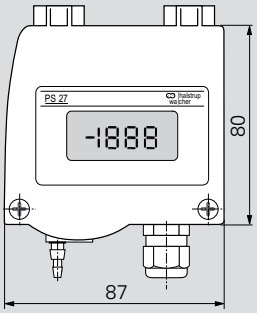
Features

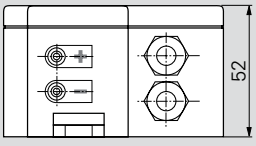
- Compact differential pressure transmitter
- For basic applications
- Also available with two-wire technology (optional)
- With optional display
- Either with one fixed measurement range or toggling between 4 different measurement ranges
- With ± measurement ranges and asymmetric measurement ranges
- With option relay (6 A)

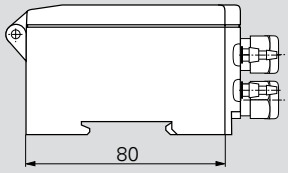
without Display



with Display



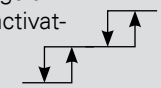




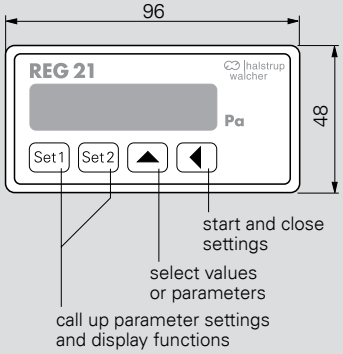
REG 21

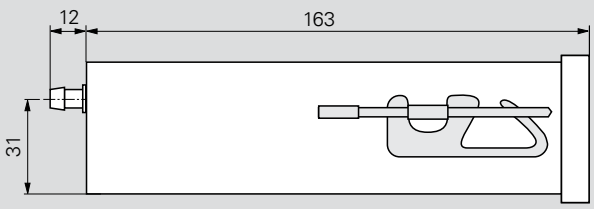
Features

- Pressure measurement and regulation in a device
- Accurate measurement of differential pressure with automatic zero-point calibration and high overload protection
- Switching outputs can be used as 2-point regulator (pressure switch), for activating/deactivating a final control element (e.g. pump), with relay hysteresis
- Switching outputs can be used as a 3-point regulator (e.g. ON 1 - OFF - ON 2) for activating/deactivating two final control elements, (e.g. air intake/outflow fans), with relay hysteresis
- Asymmetry also possible, e.g. 10..40 mbar



Panel housing / control panel installation





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Measurement ranges others available upon request	50/100/250/500 Pa 1/2.5/5/10/20/50/100 kPa
Margin of error	0.5 % of max. value, min. 0.3 Pa or 1 % of max. value
Deflection drift/temperature	0.04 % of max. value/K (10 .. 50 °C)
Zero-point drift/temperature	± 0 % (cyclical zero-point correction)
Overload capacity	200 x for measurement ranges < 2.5 kPa 600 kPa for measurement ranges ≥ 2.5 kPa
Medium	Air, all non-aggressive gases
Max. system pressure	10 kPa for measurement ranges ≤ 10 kPa Max. nominal pressure of sensor for measurement ranges above 10 kPa
Sensor response time	20 ms
Display	4 1/2-digit
Time constants	Adjustable up to 10 s
Operating temperature	10 ..60 °C
Storage temperature	-10 .. 70 °C
Power consumption	approx. 5 VA
Weight	approx. 0,8 kg
Pressure ports	for tubing NW 6 mm
Certificates	CE

Output	**A**
0 .. 10 V ($R_L \geq 2$ kΩ)	1
± 5 V ($R_L \geq 2$ kΩ)	5
0 .. 20 mA ($R_L \leq 500$ Ω)	0
4 .. 20 mA ($R_L \leq 500$ Ω)	4

Measurement range	**B**
Measurement range (e.g. 0 .. 100 Pa, -10 .. 40 mbar, 0 .. 200 mmHg etc.)	

Margin of error	**C**
0.5 % of max. value, min. 0.3 Pa	05
1 % of max. value (standard)	1

Power supply	**D**
24 V DC, + 20 % / -15 %	24D
24 V AC, + 6 % / -15 % (50/60 Hz)	24A
115 V AC, + 6 % / -15 % (50/60 Hz)	115
230 V AC, + 6 % / -15 % (50/60 Hz)	230

Contact points	**E**
2 relays with floating changeover contacts 230 V AC (50/ 60 Hz), 6 A	R
2 transistors with open collector UCE ≤ 50 V; IC ≤ 200 mA, floating	T

Order code	**A**		**B**		**C**		**D**		**E**
REG 21	–		–		–		–		–

Portable digital pressure gauges

OVERVIEW

	EMA 200	EMA 84
Details on	**p. 30**	**p. 31**
		
Features	Portable digital pressure gauge with min./max. value memory and free selection of units, also suitable for flow measurements	Rugged, portable digital pressure gauge
Measurement ranges	± 200 Pa (± 2 mbar) ± 2 kPa (± 20 mbar) ± 20 kPa (± 200 mbar) ± 200 kPa (± 2 000 mbar)	0 .. 100 Pa (0 .. 1 mbar) 0 .. 1 kPa (0 .. 10 mbar) 0 .. 10 kPa (0 .. 100 mbar) 0 .. 100 kPa (0 .. 1 000 mbar)
Margin of error	0.5 % of max. value	0.2 % of max. value, min. 0.3 Pa for measurement ranges 1 .. 50 kPa or 0.5 % of max. value for measurement ranges ≥ 1 kPa or 1 % of max. value

The EMA 200 is available with 4 measurement ranges. The units (Pa, kPa) are shown in the display or printed on the keyboard film (mbar, mmH_2O, inH_2O).

The EMA 84 is also available with 4 measurement ranges. The following units may be selected: Pa/mbar and mbar/kPa. The measurement range selected (incl. the units) is printed on the device.

ACCESSORIES

	Order no.
Carrying bag EMA 200	9074.0001 1
Carrying bag EMA 84	9063.0001 2
Carrying bag EMA 84 (with LCD viewing window)	9064.0001 3
DAkkS calibration certificate, German	9601.0003
DAkkS calibration certificate, English	9601.0004
ISO factory calibration certificate	9601.0002
Connecting components	see p. 17
Pitot tube for flow measurements	see p. 12


1


2

APPLICATION

After start-up of an air-conditioning system and cleanroom, or during maintenance or validation work, it is necessary to monitor a large number of pressure values. It is therefore essential to measure and record the following values accurately:

- ventilator pressure
- pressure drop at power units and filters
- overpressure in the cleanroom
- flow in the air duct and rooms

The EMA range of handheld pressure gauges are simple to operate, have a rugged design and are optimised for long-term use in building services engineering and industrial applications.

3

EMA 200

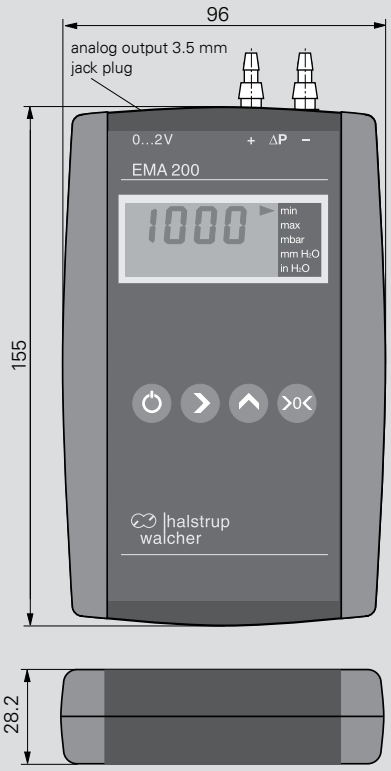
Margin of error	0.5 % of max. value
Overload capacity	10 x for measurement ranges ≤ 10 kPa 2 x for measurement ranges > 10 kPa 1.2 x in the 200 kPa measurement range
Calculation of air speed	$v = 1{,}291 * \sqrt{\Delta p}$ with v in m/s and Δp = differential pressure at the pitot tube in Pa (pitot factor and density adjustable) for selection of the primary element: see p. 12
Zero-point calibration	Performed electronically by pressing zero-point key
Medium	Air, all non-aggressive gases
Analog output	0..2 V ($R_L \geq 2$ kΩ) 0..1..2 V ($R_L \geq 2$ kΩ) for negative and positive measurement ranges
Display	3 1/2 digit, LCD, character height = 10 mm
Time constants	1-10 s
Operating temperature	0..50 °C
Storage temperature	-10..70 °C
Power supply	9 V battery (service life approx. 100 h) (display reads "low bat" when power falls below a certain minimum level) Switches off automatically after approx. 20 min.
Weight	approx. 0.4 kg
Pressure ports	for tubing NW 4-6 mm
Certificates	CE

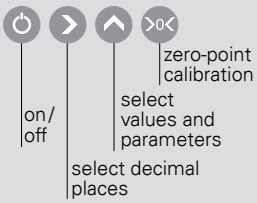
Measurement range			A
±200 Pa	(±2 mbar)	1.5..18 m/s	0
±2 kPa	(±20 mbar)	5..58 m/s	1
±20 kPa	(±200 mbar)	15..180 m/s	10
± 200 kPa	(±2000 mbar)		100

Order code	A
EMA 200 –	

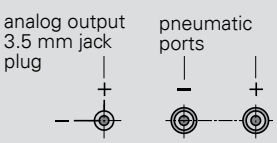
Features

- High-end pressure gauge for differential pressure and flow measurements
- Adjustable pitot factor and density
- Zero-point calibration at the push of a button
- Min./max. value memory





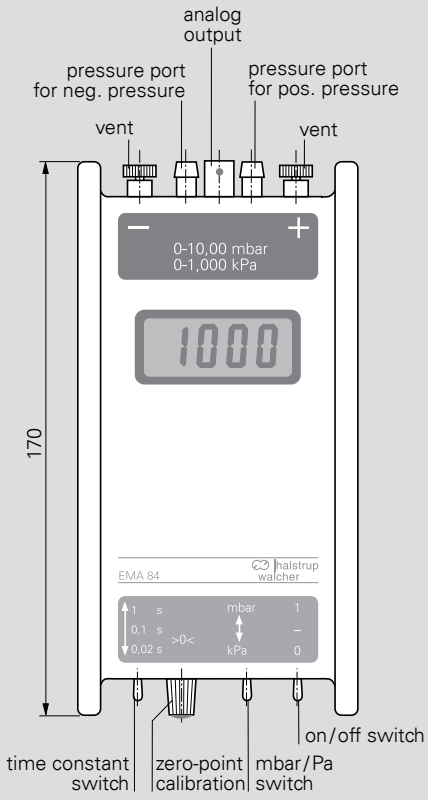
Connection diagram

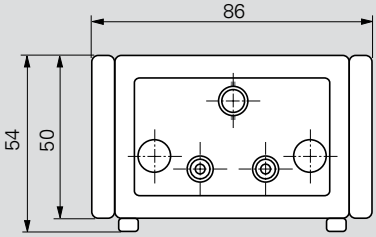


EMA 84

Features

- Very robust digital pressure gauge
- Ideal for service technicians, easy-to-read display
- High level of accuracy
- Manual zero-point calibration
- With optional analog output for writer/power/voltage logger





Margin of error	0.2 % of max. value for measurement ranges 1 .. 50 kPa or 0.5 % of max. value for measurement ranges ≥ 1 kPa or 1 % of max. value
Overload capacity	10 x for measurement ranges ≤ 10 kPa 2 x for measurement ranges > 10 kPa
Zero-point calibration	Via potentiometer on front face
Medium	Air, all non-aggressive gases
Analog output	0..1 V (R_L ≥ 2 kΩ) BNC connector
Display	3 1/2 digit, LCD, character height = 13 mm
Time constants	toggles between 0.02 s; 0.2 s; 1 s
Operating temperature	10..60 °C
Storage temperature	-10..70 °C
Operating position	Preferably horizontal
Power supply	9 V battery
Weight	approx. 0.8 kg
Pressure ports	for tubing NW 6 mm
Certificates	CE

Measurement range		**A**
0..100 Pa	(0..1 mbar)	0
0..1 kPa	(0..10 mbar)	1
0..10 kPa	(0..100 mbar)	10
0..100 kPa	(0..1000 mbar)	100

Margin of error	**B**
0.2 % of max. value (only for measurement ranges 1..50 kPa)	2
0.5 % of max. value (only for measurement ranges ≥1 kPa)	5
1 % of max. value	1

Analog output	**C**
none	0
0..1 V (optional)	1

Order code	**A**	**B**	**C**
EMA 84	–	–	–

Absolute pressure transmitters

ABSOLUTE PRESSURE TRANSMITTERS

Absolute pressure measurements are essential for determining atmospheric pressure. Here, the current pressure is compared with a vacuum. While atmospheric pressure measurements are only able to record (weather-dependent) ambient pressure, i.e. approx. 1013.25 hPa ± 50 hPa, "traditional" measurements of absolute pressure are also able to compare other pressure values, e.g. 0.75 hPa, to the vacuum depending on the selected pressure range.

	AD 1000	**BA 1000**	**BA 90**
Details on	**p. 34**	**p. 34**	**p. 35**
			
Features	Absolute pressure transmitter	Atmospheric pressure transmitter	Digital precision barometer
Measurement range	0 .. 50 kPa 0 .. 100 kPa 80 .. 120 kPa 90 .. 110 kPa 100 .. 0 kPa	80 .. 120 kPa 85 .. 115 kPa 90 .. 110 kPa 95 .. 115 kPa	913.3 - 1113.3 hPa
Margin of error	± 1 % of measurement range reference ± 0.5 hPa with respect to sea level		± 0.4 hPa ± 1 digit Reference ± 0.5 hPa with respect to sea level
Display	3 1/2 digit (optional), see foto 4 1/2 digit (optional)		4 1/2 digit (LED)

ACCESSORIES

	Order no.
DAkkS calibration certificate, German	9601.0003
DAkkS calibration certificate, English	9601.0004
ISO factory calibration certificate	9601.0002
Connecting components (tubing etc.)	see p. 17

APPLICATION

Weather forecasting is one area where it is vital to be able to measure atmospheric pressure accurately. Air-conditioning systems, too, often measure the current level of atmospheric pressure in order to avoid excessive differences in pressure, e.g. in entrance areas/air curtains.

Precise measurements of absolute pressure are also vital in many scientific and production processes where it is essential to have a (weather-dependent) process pressure value, e.g. frequently required for pressure compensation of volume flow measurements.

AD / BA 1000

Margin of error	± 1 % of measurement range Reference ± 0.5 hPa with respect to sea level
Temperature effect	0.04 % / K (10 .. 50 °C)
Calibration temperature	22 °C
Operating temperature	10 .. 60 °C
Storage temperature	-10 .. 70 °C
Long-term drift	0,3 hPa/year
Reduction	0 .. 850 m above sea level (please indicate when placing your order)
Power consumption	approx. 3 VA
Cable glands	2 x PG 7 (for a 80 x 120 housing) 2 x PG11 (for a 120 x 122 housing)
Protection class	IP 54
Weight	approx. 0.6 kg
Pressure ports [1]	for tubing NW 6 mm
Certificates	CE

[1] AD 1000: 2 pressure ports, BA 1000: 1 pressure port

Product	Measurement range	A
AD 1000	0 .. 50 kPa	50A
	0 .. 100 kPa	100A
	80 .. 120 kPa	80A
	90 .. 110 kPa	90A
	100 .. 0 kPa	0A
BA 1000	80 .. 120 kPa	80B
	85 .. 115 kPa	85B
	90 .. 110 kPa	90B
	95 .. 115 kPa	95B

Output	B
0 .. 10 V ($R_L \geq 2$ kΩ)	1
0 .. 20 mA ($R_L \leq 500$ Ω)	0
4 .. 20 mA ($R_L \leq 500$ Ω)	4

Power supply	C
24 V DC	24D
24 V AC	24A
115 V AC	115
230 V AC	230

LCD	D
none	0
3 1/2 digit, see foto	3
4 1/2 digit	4

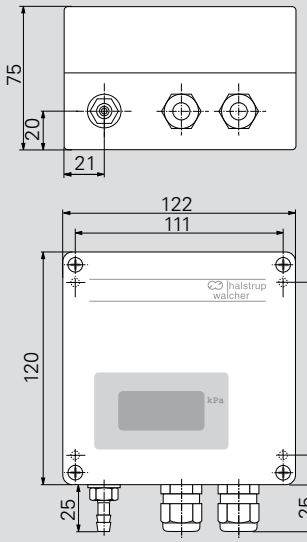
Reduction	E
none	0
please indicate in meters (e.g. 2 m)	

Order code	A		B		C		D		E
AD-BA 1000		–		–		–		–	

Features

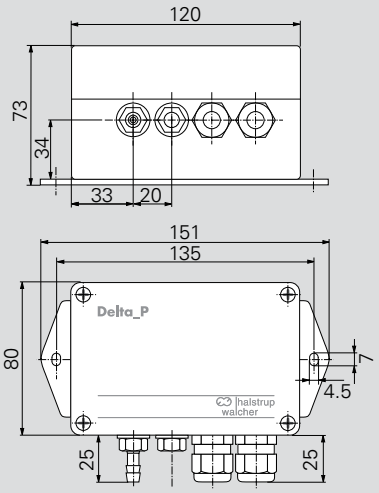
- Precise absolute pressure transmitter
- AD: for absolute pressure
- BA: for atmospheric pressure
- High level of accuracy and long-term stability
- Little zero-point drift or hysteresis; largely independent of temperature
- The size of the optional display can be adjusted (reduced) in the factory to correspond to the height of the installation site, see DIN ISO 2533 (only BA 1000)

with Display



BA 1000: 1 pressure port

without Display

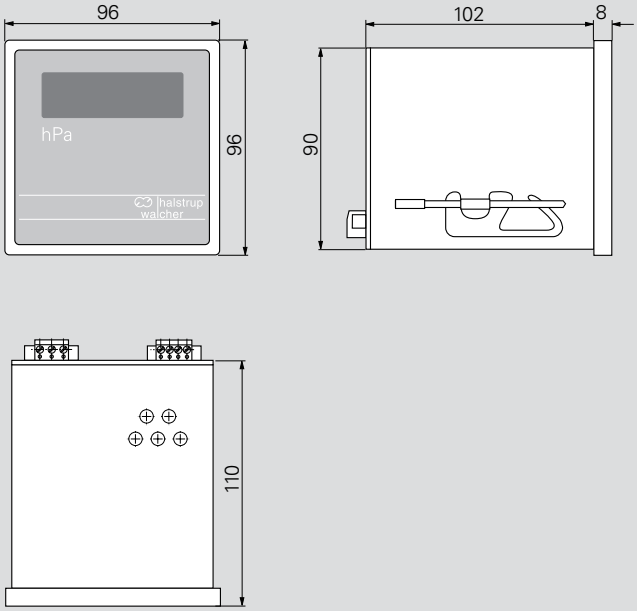


AD 1000: 2 pressure ports

BA 90

Features

- Precise digital barometer for installation in control cabinets
- A potentiometer can be used to adjust (reduce) the display to correspond to the height of installation site (see DIN ISO 2533)
- High level of accuracy and long-term stability
- Little zero-point drift or hysteresis; largely independent of temperature



Measurement range	913.3 - 1113.3 hPa
Margin of error	± 0.4 hPa ± 1 digit Reference ± 0.5 hPa with respect to sea level
Resolution	0.1 hPa
Temperature effect	± 0.2 hPa/K in the temperature range 20 .. 50 °C
Calibration temperature	22 °C
Operating temperature	0 .. 50 °C (Temperature compensation in the range 20 .. 50 °C)
Storage temperature	-10 .. 70 °C
Long-term drift	0.3 hPa/year
Supply voltage	230 VAC + 6/-15 % or 115 VAC + 6/-15 % or 12 .. 28 VDC (universal voltage adapter)
Display	4 1/2 digit (LED)
Reduction	0 .. 850 m above sea level using potentiometer
Power consumption	approx. 5 VA
Weight	approx. 0.8 kg
Certificates	CE

Output	**A**
0 .. 20 mA ($R_L \leq 250\ \Omega$)	0
-2 .. 2 V ($R_L \geq 5\ k\Omega$)	1
4 .. 20 mA ($R_L \leq 250\ \Omega$)	4

Order code	**A**
BA 90	–

Pressure calibration

mobile calibration devices

HIGH PRECISION ON-SITE MEASUREMENT AND CALIBRATION

The KAL range from halstrup-walcher comprises three pressure calibration devices that offer outstanding value for money and can be used either for stationary (e.g. in a customer's own laboratory) or mobile applications. They combine the following features:

- integrated pressure generation (for setting the calibration point)
- high precision pressure measurement (for recording the calibration value)

In the KAL 84, the pressure is generated using a manual pump and integrated pressure bellows. In the KAL 100/200, the calibration point (target pressure) is entered via a keyboard/display and automatically generated using a high precision pump. With these devices, the user can select not only the display language but also the unit of pressure. In addition, the KAL 200 has a USB interface so that pressure sequences can be programmed using supplied PC software. This makes it possible to produce time-optimised calibration sequences.

	KAL 200	**KAL 100**	**KAL 84**
Details on	**p. 38**	**p. 38**	**p. 39**
			
Pressure generation	Automatic		Manual
Applications	Mobile or stationary (laboratory)		
Measurement ranges	0..100 Pa (0..1 mbar)/0..500 Pa 0..1 kPa (0..10 mbar)/0..5 kPa 0..10 kPa (0..100 mbar)/0..50 kPa 0..100 kPa (0..1 000 mbar) ±100 Pa ±1 kPa ±10 kPa ±100 kPa		0..100 Pa (0..1 mbar) 0..1 kPa (0..10 mbar) 0..10 kPa (0..100 mbar) 0..100 kPa (0..1 000 mbar) 0..300 mmHg (0..400 mbar) 0..750 mmHg (0..1 000 mbar)
Margin of error	0.1 % of max. value ± 1 digit Measurement ranges 1, 10 and 100 kPa 0.3 % of max. value ± 1 digit Measurement range 100 Pa	0.2 % of max. value ± 1 digit Measurement ranges 1, 10 and 100 kPa 0.5 % of max. value ± 1 digit Measurement range 100 Pa	0.2 % of max. value ± 1 digit Measurement ranges ≥ 1 kPa - ≤ 50 kPa 0.5 % of max. value ± 1 digit
Interface	USB (standard)	USB (optional)	-
Analog measurement input for test object	✓	optional	-
Battery life (rechargeable)	8 h	8 h	2 h
Factory calibration certificate	✓	Accessory	Accessory

ACCESSORIES

	Order no.
Carrying bag KAL 84	9062.0001 (1)
Hand pump KAL 84	9601.0036 (2)
Transport case KAL 100/200	9220.0001 (3)
Carrying bag KAL 100/200	supplied as standard
DAkkS calibration certificate, German	9601.0003
DAkkS calibration certificate, English	9601.0004
ISO factory calibration certificate	9601.0002 (included for KAL 200)

Hand pump KAL 84
Order no. 9601.0036

Carrying bag KAL 84
Order no. 9062.0001

Transport case KAL 100/200
Order no. 9220.0001


Carrying bag KAL 100/200
supplied as standard

halstrup walcher

KAL 100/200

Margin of error KAL 100	0.2 % of max. value ± 1 digit only for 1, 10 and 100 kPa measurement ranges 0.5 % of max. value ± 1 digit Measurement range 100 Pa
Margin of error KAL 200	0.1 % of max. value ± 1 digit only for 1, 10 and 100 kPa measurement ranges 0.3 % of max. value ± 1 digit Measurement range 100 Pa
Hysteresis	0.1 % of max. value
Overload capacity	600 kPa measurement ranges 10 kPa, 100 kPa 200 x for measurement ranges 100 Pa, 1 kPa
Temperature effect (zero-point)	± 0 % (cyclical zero-point correction)
Temperature effect (span)	KAL 100: 0.04 % of max. value/K (10..50 °C) KAL 200: 0.03 % of max. value/K (10..50 °C)
Calibration temperature	22 °C
Medium	Air, all non-aggressive gases
Measurement input/ supply voltage (test object)	0-10 V, 0/4-20 mA Accuracy: 0.2 % of max. value 24 V DC/100 mA
Display	Alphanumeric display with 2 x 20 characters, backlighting
Operating temperature	10..40 °C
Storage temperature	-10..70 °C
Weight	approx. 4.5 kg
Pressure ports	Ø 6 mm, for tubing NW 5 mm
Certificates	CE

Model	**A**
KAL 100	100
KAL 200	200

Measurement ranges	**B**
0..100 Pa (0..1 mbar)	0
0..500 Pa	05
0..1 kPa (0..10 mbar)	1
0..5 kPa	5
0..10 kPa (0..100 mbar)	10
0..50 kPa	50
0..100 kPa (0..1 000 mbar)	100
± 100 Pa	0A
± 1 kPa	1A
± 10 kPa	10A
± 100 kPa	100A

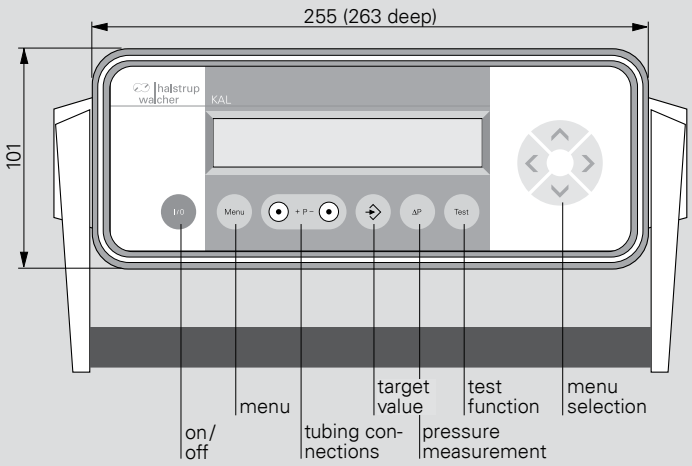
Power supply	**C**
115 V AC, +6 %/-15 % (50/60 Hz)	1
230 V AC, +6 %/-15 % (50/60 Hz)	2
115 V AC, +6 %/-15 % (50/60 Hz) and rechargeable lithium ion battery	1A
230 V AC, +6 %/-15 % (50/60 Hz) and rechargeable lithium ion battery	2A

Data interface	**D**
None	0
USB + measurement input (standard for KAL 200)	1

Order code	**A**	**B**	**C**	**D**
KAL	–	–	–	–

Features

- High precision measurement and calibration device in one
- Runs on mains supply or battery, highly flexible (optional)
- Battery life approx. 8 hours, ideal for mobile applications
- Automatic zero-point calibration provides high zero-point stability
- Internal pump quickly and accurately generates negative or positive differential pressures of up to 100 kPa
- Optional USB interface available (Standard for KAL 200)
- Unit conversion (e.g. mmHg, mmH_2O, psi, etc.)
- Multilingual menu (German/English/Italian/French/Spanish)
- With power supply and measurement input for the external test object (transmitter being calibrated)

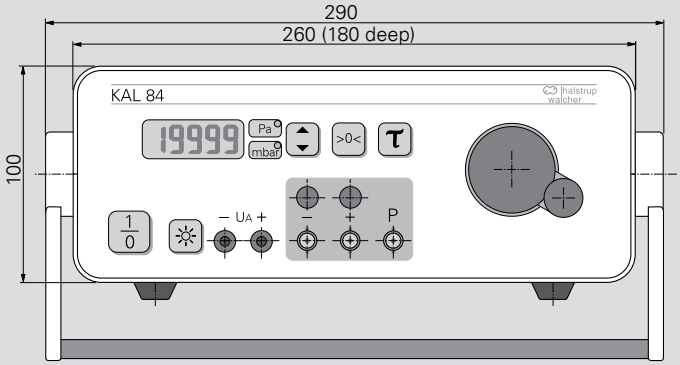


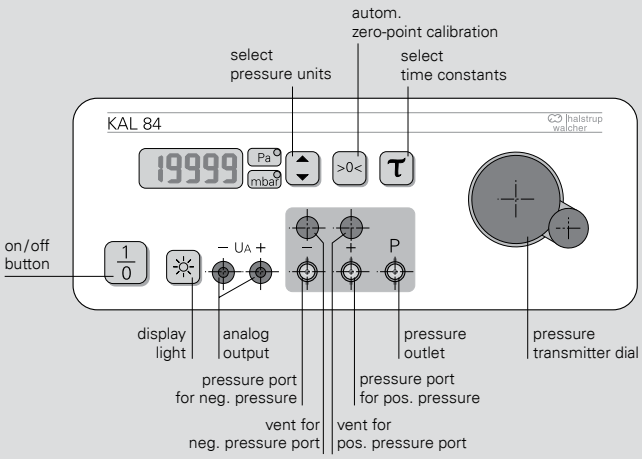
User software

KAL 84

Features

- Highly accurate, reproducible results
- Internal pressure generation using pressure transmitter dial
- Very rugged and light
- Excellent for service applications
- Unit conversion, e.g. mmHg/kPa, mbar/kPa
- Rechargeable battery allows for portable operation





Margin of error*	0.2 % of max. value ± 1 digit or for measurement ranges 1 .. 50 kPa 0.5 % of max. value ± 1 digit
Hysteresis	0.1 % of max. value
Temperature effect (zero-point)	Not applicable Panel button for resetting zero-point
Temperature effect (span)	0.04 % of max. value/K (10 .. 50 °C)
Calibration temperature	22 °C
Medium	Air, all non-aggressive gases
Displacement volume	approx. 100 cm^3 (1, 10, 100 kPa) approx. 200 cm^3 (100 Pa)
Analog output	0 .. 1 V (R_L ≥ 2 kΩ) 2 connectors Ø 4 mm
Display	4 1/2 - digit LCD character height = 10 mm
Time constants	toggles between 0.1 s; 1 s
Operating temperature	10 .. 40 °C
Storage temperature	-10 .. 70 °C
Power supply	NiCd rechargeable 9 V battery with AC adaptor
Weight	approx. 3 kg
Pressure ports	for tubing NW 6 mm
Certificates	CE

* All measurement ranges have a 99 % overrange.

The display has 4½ digits and always uses round 10 s, 100 s etc. as the standard measurement ranges, i.e. 1.0000, 10.000, 100.00 oder 1000.0 (exception 0 .. 300 mmHg). The theoretical display range, however, extends not up to 10.000 but 19.999, i.e. for a measurement range of 10.000 kPa, the device can display values of up to 19.999 kPa.

Measurement ranges*	**A**
0 .. 100 Pa (0 .. 1 mbar)	0
0 .. 1 kPa (0 .. 10 mbar)	1
0 .. 10 kPa (0 .. 100 mbar)	10
0 .. 100 kPa (0 .. 1 000 mbar)	100
0 .. 300 mmHg (0 .. 400 mbar)	300
0 .. 750 mmHg (0 .. 1 000 mbar)	750

* others available upon request

Margin of error	**B**
0.5 % of max. value	1
0.2 % of max. value (measurement ranges 1 .. 50 kPa) (optional)	2

Power supply	**C**
230 V AC adaptor	230
115 V AC adaptor	115

Order code	**A**	**B**	**C**
KAL 84	–	–	–

APPLICATIONS FOR THE "KAL" CALIBRATION DEVICE

The high performance rechargeable battery makes the KAL range ideal for on-site applications. "Mobile calibration" removes the need to send pressure measurement devices to an external calibration laboratory and thus saves a great deal of time and expense. Customers can now perform ISO calibrations themselves by using a DAkkS-calibrated KAL device.

The KAL range provides the optimum solution for the following typical applications:

- mobile or stationary calibration of pressure values in cleanrooms (pharma, semiconductors etc.)
- mobile or stationary calibration of blood pressure monitoring equipment in hospitals etc.
- mobile or stationary calibration of differential pressures in air-conditioning systems

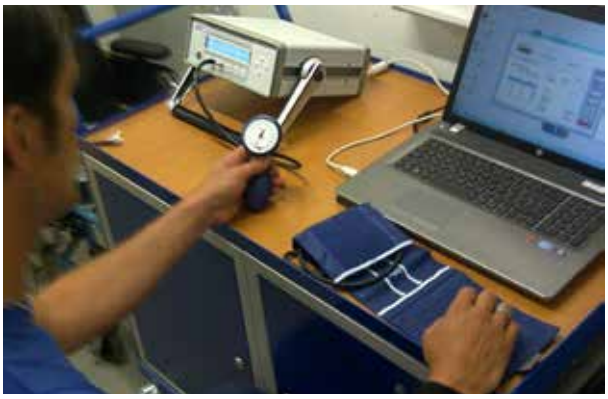
EFFICIENCY AND REGULATORY COMPLIANCE – CALIBRATING BLOOD PRESSURE MONITORS ON-SITE

Every hospital and nursing home now uses blood pressure monitors. It is vital that these instruments operate precisely and reliably. Moreover, the equipment must retain its accuracy over months and years of use. False readings from blood pressure monitors are a matter of life and death. The greatest risk, however, is posed by drug dosage errors, which risk straining the patient's circulatory system. Instruments are calibrated each year to prevent incidents such as these from occurring, a process that involves comparing measured values to highly precise control values.

If measurements are relevant to human health, regular instrument calibration is required by law. The "Ordinance on Medical Devices" stipulates that regular testing be performed and documented. The responsibility for risk assessment lies with the operator.

One legally secure method accepted by auditors is to document the calibration in the facilities management software. But how can a calibration of this type be performed efficiently? On-site calibration by a qualified technical service is more efficient than removing a number of the blood pressure monitors from the wards every few weeks and sending them to an external laboratory for calibration.

The battery powered KAL 200 pressure calibration device from halstrup-walcher is the ideal solution. Pressure sequences can be pre-programmed using the supplied software. The KAL 200 pressure generator then generates each pressure (the target value) with extreme precision and reads the actual value on the test object (blood pressure monitor). The actual value is then entered on-site in standardised test records that are administrated by the facilities management software. The data are now available at any time – ensuring efficiency and regulatory compliance.



In practice: Blood pressure monitors in the nursing home Solina in Spiez (Switzerland) are calibrated by the technician responsible.

Calibration of pressure and volume flow

Calibration services

CALIBRATION SERVICES

DAKKS AND ISO CALIBRATIONS IN THE LABORATORY FOR PRESSURE MEASUREMENT TECHNOLOGY

Germany's national metrology institute (Deutsche Akkreditierungsstelle GmbH) has certified Walcher Meßtechnik GmbH – a member of the halstrup-walcher group of companies – to perform pressure calibrations in accordance with DIN EN 17025. This allows Walcher Messtechnik GmbH to issue DAkkS calibration certificates for differential pressure transmitters, calibration devices, absolute pressure transmitters and portable pressure gauges. Services also include recalibration of products (factory calibration certificates) as directed by the ISO 9000 quality management system for measuring equipment. The DAkkS calibration allows the customer to perform ISO compliant pressure calibrations independently.

Calibration and, on request, adjustment of measurement or calibration devices is offered for instruments from all manufacturers.

Overview of services provided by our certified calibration laboratory for pressure measurements in accordance with DIN EN 17025:

- absolute pressures of 0.25 bar to 20 bar in gases (laboratory medium: air)
- negative and positive overpressures of -10 mbar to 20 bar in gases
- ISO, DAkkS certificates and adjustment

ISO CALIBRATIONS ON-SITE

In many cases, it is not economically viable to send measurement devices to a laboratory for calibration. Moreover, wherever possible, it is preferable to avoid the need to disassemble equipment and maintain stocks of spare devices. This is why customers are increasingly taking advantage of solutions for on-site calibration, such as those supplied by halstrup-walcher – in the form of on-site ISO calibration for pressure and volume flow – in air and for system pressures of up to 1 bar.

On-site pressure calibration with KAL

On-site volume flow calibration using an impeller pressure gauge in accordance with DIN EN 12599

APPLICATION REPORT VOLUME FLOW

LOAD-DEPENDENT VOLUME FLOW FOR DRYING VEHICLE FINISHES – COST BENEFITS FOR AUTOMAKERS

The atmosphere in the plant's gigantic paint shop of the Volkswagen plant in Emden, is one of professional calm. The 1 200 cars that enter here each day leave as high-gloss versions of themselves in every conceivable colour. Detert Ackermann, who helps maintain the finishing lines, proudly presents "his" finishing line. The clear highlights of the line are the curing ovens, which bake the finishing layer previously applied by painting robots. Vehicle bodies first pass through two radiant heating zones before entering the next three zones, where recirculating air produces a high-gloss finish that will last for many years.

"The painting process generates over forty percent of the energy costs at an automotive plant," says Ackermann. "So this was where we focused our work with Crone Wärmetechnik, an equipment builder from Rhauderfehn, Germany, and with CVET of Clausthal, Germany. The collaboration produced huge savings in the curing and drying process!" From a technical perspective, the process has two outcomes: it provides the ovens with thermal energy, while eliminating the harmful substances in the oven waste gas that pose a hazard to human health and to the environment. The entire process must keep costs at a minimum without sacrificing the quality of the finish.

Post-combustion techniques have been used for many years to minimize paint residues in waste gas, and the recuperators employed for this job are optimized with respect to their energy balance. Recovering the waste heat from the post-combustion process and using it to preheat the oven intake air represents yet another important way of helping minimize consumption.

The concept was the code-named LAVA (a German acronym for load-dependent volume flow adjustment) and refined still further, with additional savings focusing primarily on the air volume flow through the ovens. Classic paint-baking ovens and post-combustion equipment are operated at a constant volume flow, which is always set for the maximum load. The maximum load, in this case, refers to the (maximum) number of vehicle bodies to be dried per day. The LAVA approach, however, involves adjusting the volume flow to match the current load. After all, the number of bodies to be painted is not the same every hour of the week. "In other words, we regulate the volume flow in response to the load," explains Ackermann, who provided project support.

In concrete terms, this means that less air flows through the system when loads are light, which in turn decreases the amount of air – and the paint residues it contains – returned to the recuperator to be treated. While this reduces the power consumed by the fans, it also generates huge savings by cutting the amount of natural gas used in the recuperator. During its over 12 months of operation at the VW plant in Emden, the system has generated impressive savings of 25 percent – a figure achieved without compromising the quality of the finish.

Fig. 4: The volume flow is recorded by the highly precise P 26 differential pressure transmitter from halstrup-walcher

Fig. 3: Dynamic pressure probe for measuring the flow of the 300 °C air used for drying vehicle finishes.

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