3.6 Physical Transducers

3.6.1 Pressure Sensors

Basic Principles

The deflection of a membrane, caused by the pressure of a medium, is used for measuring a pressure and is converted into an electrical signal. In most cases two wire strain gauges are arranged so that one of them is expanded while the other one is compressed. The changes in resistance are analysed in a bridge circuit. The resulting signal can either be directly used (mV) or is provided as a standard signal (voltage or current). Different methods, tailored to the corresponding application, are used to manufacture pressure sensors.

Thick-Film Sensors:

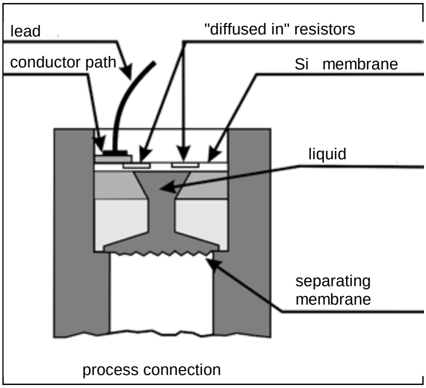
The expansion-sensitive elements are applied to a special steel membrane by means of screen printing technology.

Thin-Film Sensors:

In a demanding manufacturing process, the wire strain gauges are directly formed on a passivated special steel membrane by means of a chemical vapour deposition process.

Piezo-Resistive Sensors:

A silicon membrane with 'diffused in' expansion-sensitive resistors is used as the pressure-sensitive element. Due to its incompatibility with certain mediums, silicon would limit the use of the sensor. Therefore, a pressure transmission system, consisting of the filling liquid and the special steel membrane has been integrated. The pressure measuring cell is temperature-compensated and is manufactured in demanding vacuum processes.



Types

Pressure transducers are principally available as 4 types:

Relative pressure: pressure related to the environmental pressure

Absolute pressure: pressure related to vacuum (0 bar)

Overpressure: pressure related to atm. pressure at manufacturing (ca. 1bar)

Differential pressure: pressure related to a second, variable pressure

Sensor:	Advantages	Disadvantages
Thick-film sensors	compact design, especially suitable for use in simple monitoring and control circuits	limited temperature range, measured values have a certain long-term variation
Thin-film cells	very compact and homogeneous structure, high long-term stability and dynamic load capacity, especially suitable for robust industrial use and for medium and high relative pressure range	very elaborate manufacturing process
Piezo-resistive Sensors	high accuracy in a wide temperature range, especially suitable for use in high-quality measuring and control tasks, in particular well suited for use in the absolute pressure range and the lower to medium relative pressure range	elaborate, but at volume production still cost-effective manufacturing process

ALMEMO® Pressure Modules

The ALMEMO® sensor range provides piezo-resistive pressure modules with two connecting adapters for relative or absolute pressure measurement of gases (see 3.5.3). They can be directly plugged onto the measuring instruments. A similar module is also available for atmospheric pressure measurement (see 3.4.1).

Pressure Sensor FD A612-MR:

Measuring range:	±1000 mbar differential pressure other ranges see 3.5.3
Meas. accuracy (zero point corrected):	±0.5 % (typic. 0.2) of full-scale value
Overload capacity:	3x measuring range at maximum
Nominal temperature:	22°C ± 2K
Temperature coefficient:	±1.5 % (typic. 0.5) of full-scale value
Operating temperature:	-10 to +60 °C
Humidity range:	10 to 90%rH (non-condensing)
Dimensions:	37 x 36 x 22 mm
House connectors:	5mm Ø, 12mm long
Sensor material:	aluminium, nylon, silicon/silica gel

ALMEMO® Built-In Pressure Transducers

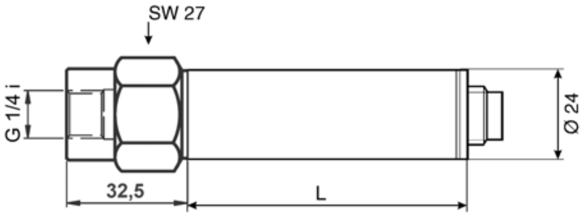
With all ALMEMO® Built-In Pressure Transducers the piezo-resistive measuring cell is suspended in an oil-filled, all-welded special steel enclosure. As all 'medium-contacting' parts are made from special steel, they are also suitable for use in chemically aggressive media.

As the pressure is transmitted to the pressure membrane through a small hole in the thread part, the liquids should not be prone to crystallise and gases should not be heavily contaminated with dust.

ALMEMO® pressure transducers are suitable for measurements in liquid and gaseous media in various industrial applications, e.g. medical technology, air conditioning systems, hydraulic controls, robotics, process control, motor controls, test benches.

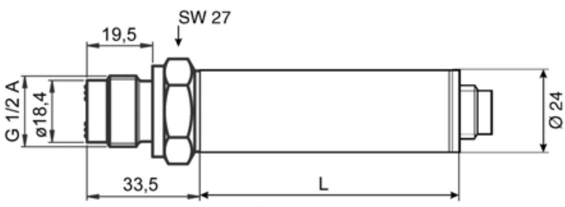
Temperature-Compensated Pressure Transducers FD 8214

Type FD 8214: Standard type with G1/4" internal thread.



L = 45mm
(L = 72mm
option media
temperature
up to 150°C
with cooling fins)

Type FD 8214 M: Membrane flush with front (welded with end of thread), external thread G1/2", easy to sterilise



L = 45mm
(L = 72mm
option media
temperature
up to 150°C
with cooling fins)

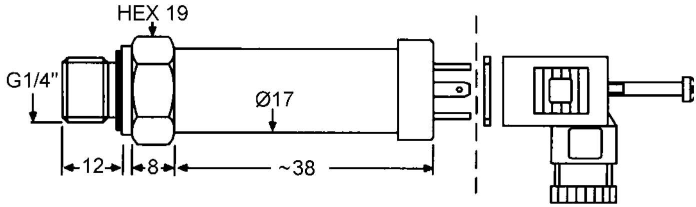
For use in the food and pharmaceutical industry, the pressure transducers are optionally also available with ASEOL Food filling.

Technical Data:

Measuring cell:	piezo-resistive
Overload	Ranges 600 bar, i.e. 1.5 times the final value (minimum 3 bar, maximum 850 bar) Ranges >600 bar, 1500 bar
Output signal:	Standard 0 to 2 volts, feed 6.5 to 13 volts (from ALMEMO device), current <4 mA Option : 0 to 10 volts, feed 15 to 30 volts, load >10 kilohms, current <4 mA Option : 0 to 20 mA, feed 9 to 33 volts, (>18 volts at load 500 ohms), current <25 mA Option : 4 to 20 mA, 2 conductors, feed 9 to 33 volts, (>18 volts at load 500 ohms), current <25 mA
Response time:	<1.5 ms / 10 to 90 % nominal pressure
Linearity:	Standard ±0.5 % of final value Option : ±0.25 % of final value for all ranges Option : ±0.1 % of final value for ranges >0.5 bar and up to 600 bar
Media temperature:	0 to +80°C, temperature comp.: 0 to +70°C option: –25 to +100°C, temperature comp.: –25 to +85°C –25 to +150°C, temperature comp.: –25 to +85°C
Temperature drift:	Zero-point <±0.04 % of final value / °C for ranges >0.5 bar Range <±0.02 % of final value / °C for all ranges
Nominal temperature:	22°C ±2 K, 10 to 90% rH non-condensing
Material:	housing, pressure connector, membrane: special steel 1.4435
Operat. environment/Sealing:	IP 67
Dimensions:	see drawing
Connecting threads:	Type 8214: internal thread G1/4", wrench SW 27 Type 8214 M: external thread G1/2", wrench SW 27 Other threads are available on request
Electrical connection	Flush-mounting connector, binder coupling 723, 5-pin
Weight:	approx. 180 g

Low-Cost Pressure Transducer FD A602L

Type FD A602L: Standard design with G1/4" external thread, membrane not flush with front



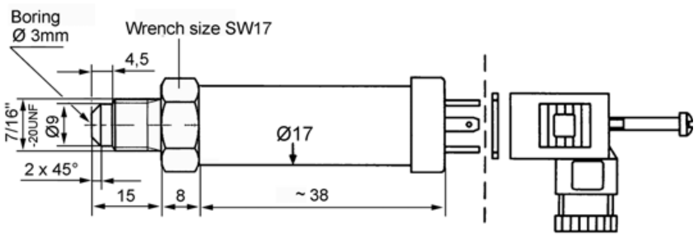
Technical Data:

Overload	1.3-fold of the final value
Output signal:	0.2 … 2.2V
Category of accuracy:	±0.5% of final value (linearity + hysteresis + reproducibility)
Temperature drift	
zero point	< 0.03 % of final value /K
steepness	< 0.03 % / K
Temp. range compensate	0 ... 50 °C
Nominal conditions:	22°C ± 2K, 10 to 90% rH non condensing
Power supply:	6 to 15VDC, <4 mA
Operating temperature:	–20 to +80°C
Fitting:	ext. thread G1/4", membrane not flush with front
Material medium contact:	stainless steel 1.4435
Weight:	75g
Electromagn. compatibility:	CE marked: test acc. to IEC 801.2 and 802.2
Protection system:	IP 65

Temperature Measurement with Pressure Sensors for Refrigerants

Absolute Pressure Transducer FDA602LxAK

Type FD A602LxAK: Version with 7/16" external thread,
membrane not flush with front.



Technical Data:

Same as the FDA602L, apart from:

Pressure resolution:	0.001 bar (programmed)
Connecting thread:	ext. thread 7/16", membrane not flush with front

ALMEMO® Device Option SB0000R (from Version V5)

Temperature Measuring Ranges for Refrigerants

The special option SB 0000-R provides the ALMEMO® measuring instrument with 8 additional measuring ranges for determining the temperature from the dew point pressure of different refrigerants (boiling point pressure on request). The measuring ranges are programmed as function channels in any absolute pressure sensor. The correspondingly scaled pressure measuring range, with a resolution of 0.001 bar, must be available as reference channel. During the manual programming of the temperature measuring ranges the corresponding abbreviations ´rxxx´ of the refrigerants between ´Ir 6´ and ´S120´ will be displayed. The ranges ´Ir 2´, ´Ir 3´ and ´L605´ are dropped from the series measuring ranges.

To ensure that the temperature indication automatically follows the changes of the pressure sensor, the pressure channel must, either, be manually selected beforehand, or it must be continuously measured by means of a continuous measuring point scan (see manual section 6.5.1.3). When using several refrigerants alternately it is possible to program up to 3 refrigerants to 3 function channels of a connector and to invoke them through channel selection.

Technical Data

Refrigerant:	**R22**	**R23**	**R134a**	**R404A**
Pressure range:	0..36 bar	0..49 bar	0..40.5 bar	0..32 bar
Temperature range:	-90..+79 °C	-100..+26 °C	-75..+101 °C	-60..+65 °C
Resolution:	0.1 K	0.1 K	0.1 K	0.1 K
Linearisation accuracy:	< -24°C: 0.2 K > -24°C: 0.1 K	< -24°C: 0.2 K > -24°C: 0.1 K	< -16°C: 0.2 K > -16°C: 0.1 K	0.1 K
Range abbreviation:	R22	R23	R134	R404
Range indication:	r22	r23	r134	r404
Interface command:	B20	B19	B21	B22

Refrigerant:	**R407C**	**R410**	**R417A**	**R507**
Pressure range:	0..46 bar	0..49 bar	0..27 bar	0..37 bar
Temperature range:	-50..+86 °C	-70..+70 °C	-50..+70 °C	-70..+70 °C
Resolution:	0.1 K	0.1 K	0.1 K	0.1 K
Linearisation accuracy:	< -30°C: 0.2 K > -30°C: 0.1 K	< -30°C: 0.2 K > -30°C: 0.1 K	< -35°C: 0.2 K > -35°C: 0.1 K	< -30°C: 0.2 K > -30°C: 0.1 K
Range abbreviation:	R407	R410	R417	R507
Range indication:	r407	r410	r417	r507
Interface command:	B23	B25	B26	B18

Note:

The final value of the temperature range results from the data of the refrigerants. In case of pressure transducers with smaller pressure ranges, the measurable final temperature will only be reduced.

3.6.2 Force Transducers

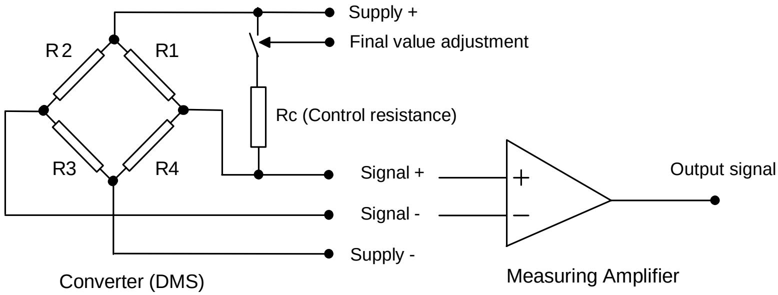
Basic Principles of Force Measurements

The technical features of the force transducers are substantially fixed by VDI/VDE guideline 2637. The most important terms are described below.

Term	Description
Measuring range	The load range in which the guaranteed error limits are not exceeded.
Nominal load	The nominal load is the upper limit of the measuring range. Depending on the sensor, the nominal load can be a pulling or a pressing load.
Service load	The service load is a load which can be applied to the sensor (exceeding the nominal load) without the specified properties of the sensor being affected. The service load range should only be used in special cases.
Maximum load	The maximum load is the maximum permissible load for the weighing cell, where no breakage of the measuring system is to be expected. The specific error limits are no longer applicable at this load.
Breakage load	The breakage load is the load at which a permanent change or breakage occurs.
Max. dynamic stress	Range of stress that is related to the nominal force resulting from a sinusoidally alternating force in direction to the measuring axis of the sensor. At a load of 10^7 cycles the sensor is not subject to significant changes of its measuring properties, when being re-used up to the nominal force.
Leakage error	The leakage error is the maximum change of the output signal of the sensor over the specified time, at a constant load and in stable environmental conditions.

Measuring Principle

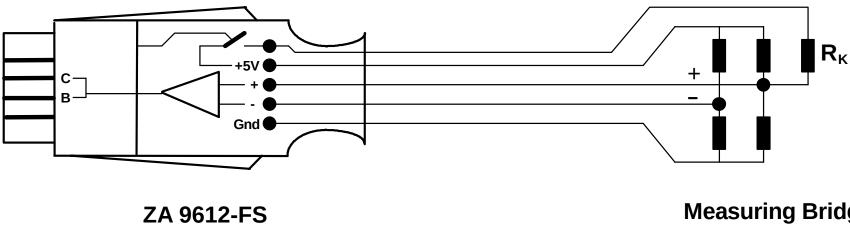
The measuring chain of a force transducer consists of a mechanical-electrical transducer and a measuring amplifier for normalisation of the signal. The wire strain gauges (DMS) are arranged in a 4-conductor full-bridge circuit, i.e. the wire strain gauges are supplied via two supply lines and the measuring signal is tapped via two further lines.



For final adjustment of the measuring range the force transducers are equipped with a matching control resistor, which allows for a verification and re-calibration.

ALMEMO® Measuring System

All ALMEMO® force transducers have, as a connector plug, the measuring amplifier module ZA 9612-FS with an integrated precision differential amplifier (gain 10) and a stable bridge voltage supply of 5V DC (0.5%, typ. 20ppm/K). The output signal is available on pins B and C to pin A (GND). With force transducers having an integrated calibration resistor RK the measuring amplifier module has been equipped with an electronic switch that allows for switching/adding this calibration resistor through the device.



The ALMEMO® connectors ZA9650FSx (see section 4.2.5) are used to connect third party force transducers that do not have a calibration resistance installed.

Tare function

For all measuring operations involving weight and force, the tare function is important; if there is an initial load or a zero-point error this function presets the measured value to zero. The function “BASIC VALUE” (see 6.3.11) performs this function on all ALMEMO® devices. To use this function the locking mode must be set to 4.

Force transducer correction (two-point correction)

Most of the ALMEMO® devices incorporate not only the usual zero-point correction but also automatic final value correction. The correction values for BASIC and FACTOR are saved as usual in the connector EEPROM. For complete scaling it may be necessary in certain circumstances to shift the decimal point and specify dimensions; (see 6.3.5 and 6.3.11). For all new devices the adjustment procedure using keys is described in the operating instructions under "Entering the setpoint"; the adjustment procedure via the interface is described in the Manual, section 6.4.2. For this purpose the locking mode must be set to 4.

Force transducer correction is performed under the function / display MEASURED VALUE.

1. Zero-point correction

Remove load from transducer.
Perform zero-point adjustment, with function “Measured value to zero”.
The zero-point error is saved as BASIC and the measured value is displayed as 0000.

2. Specify final value

Activate final value calibration resistance
(only on ALMEMO force transducers)
For transducers without calibration resistance, apply nominal load.
The final value should now be displayed.

3. Final value correction

Enter and adjust the setpoint, with function “Setpoint”
The gain error is saved as FACTOR such that the measured value displayed should correspond to the setpoint.
Step 3 can be repeated as and when necessary

4. Complete the correction procedure

Remove nominal load, if necessary.
Quit the adjustment function.
The calibration resistance is now deactivated and
the measured value is displayed as 00000 again.

On devices without setpoint entry the factor (setpoint value / actual value) can be calculated and programmed by the user. (see 6.3.11)

ALMEMO® Force Transducers

The ALMEMO® sensor range includes force transducers in 4 different types:

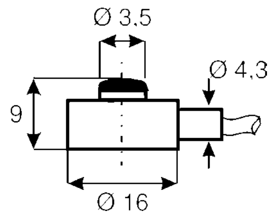
For compression:	1. FK A022:	100 N, 200 N, 500 N, 1000 N, 2000 N
	2. FK A613:	0.5 kN, 1 kN, 2 kN, 5 kN, 10 kN, 20 kN (50 kN on request)
For tension/compression:	3. FK A025:	0.02 kN, 0.05 kN, 0.1 kN, 0.2 kN, 0.5 kN, 1 kN, 2 kN, 5 kN, 10 kN, 20 kN, 50 kN
For tension:	4. FK A368:	10 N, 20 N, 50 N

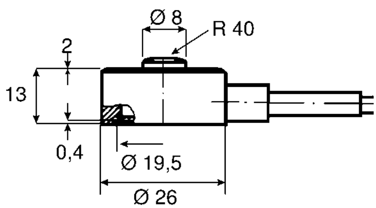
All measuring ranges that are specified in Newton can also be supplied in kg ranges. Optionally, ALMEMO® devices allow for subsequently re-calling N and kg.

3

Technical Data

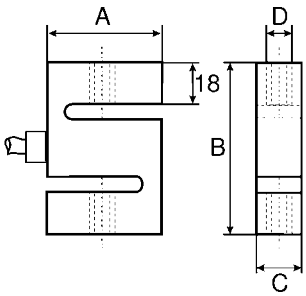
Tension Sensors FK A022, FK A613



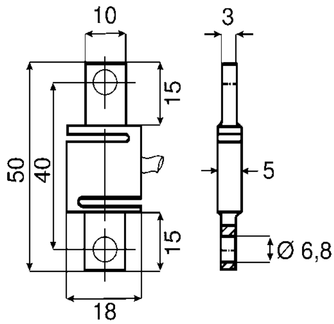


Compression Sensors:	FK A022	FK A613
Measuring ranges:	100 N, 200 N, 500 N, 1000 N, 2000 N	0.5 kN, 1 kN, 2 kN, 5 kN, 10 kN, 20 kN (50 kN on request)
Accuracy:	< ±0.5% of full scale value	
Nom. meas. distance:	< 0.2 mm	
Operating range:	–10 to +50°C	
Creep error at permanent load:	< 0.1% per 30 min	
Operating environment/Sealing:	IP 65	
Material:	stainless steel	

Tension and Compression Sensor FK A025
Tension Sensor FK A368



FK A025



FK A368

Force Sensors:	**Type K 25**	**Type K 1368**
Measuring ranges:	0.02 kN, 0.05 kN, 0.1 kN, 0.2 kN, 0.5 kN, 1 kN, 2 kN, 5 kN, 10 kN, 20 kN, 50 kN	10 N, 20 N, 50 N,
Accuracy for tension:	< ±0.1% of full scale value	< ±0.2% of full scale value
Accuracy for tension and compression:	< ±0.2% of full scale value	tension only
Nominal measuring distance:	< 0.15 mm	< 0.15 mm
Operating range:	–10 to +70°C	+5 to +45°C
Creep error at permanent load:	< 0.07% per 30 min	< 0.1% per 30 min
Permissible lateral force:	±60% of full scale value	not permissible
Operating environment/Sealing:	to 1 kN: IP 65 from 2 kN: IP67	IP 60
Material:	to 1 kN: aluminium from 2 kN: stainl. steel	aluminium
Dimensions in mm (only FK A025):	to 10 kN: A = 50, B = 75, C = 20, D = M12 20 kN, 50 kN: A = 65, B = 85, C = 40, D = M24 x 2	

3.6.3 Displacement Transducer, Displacement Tracer

Measuring Principle

Different methods can be used depending on the limiting and environmental conditions.

Measuring Method	Characteristics and Advantages
Linear inductive displacement transducer and displacement tracer	very accurate, high resoluting, robust, acceleration-resistant, cost-effective, interference-proof, very high long-term stability, environmentally stable (dirt, moisture), point-shaped, virtually non-contact measurement, simple mounting and handling
Non-contacting displacement measuring systems based on eddy current	very accurate, very fast, high resoluting, environmentally stable (dirt, moisture), interference-proof in electromagnetic environment, temperature-stable, long-term stable, can measure objects of all electrically conductive materials, non-magnetic and also ferromagentic, compact special designs, extensive operating temperature range
Non-contacting inductive displacement measuring systems	accurate, temperature-stable, fast, cost-effective, especially for ferromagnetic measuring objects
Long-travel sensors based on eddy current	large measuring distances, robust and compact, no mechanical wear, simple handling, pressure-resistant
Non-contacting optical displacement measuring system	point-shaped measurement, accurate, fast, large base spacing, material-independent
Cable-line displacement sensors	very accurate, long measuring travels, easy mounting, cost-effective
Non-contacting capacitive displacement measuring systems	very accurate, very temperature-stable, fast, high-resoluting, very high long-term stability, material-independent in case of metal object, also suitable for insulator materials, easy to operate, extensive operating temperature range
Conductive plastic potentiometer	high-resoluting, good linearity, cost-effective, good temperature and humidity coefficients, extensive operating temperature range

3

Linear inductive displacement transducer and displacement tracer:
Transducers according to the differential-transformator principle (LVDT) consist of one primary and two secondary coils. The coupling is performed via a soft-magnetic core. The voltages that are induced in the secondary coils act proportionally to the position of the core (ram). Transducers according to the differential-inductor principle consist of two coils that are switched to form a half-bridge and that have one shared moving magnetic core. A displacement of the core (ram) changes both coil inductances which, by the corresponding amplifier electronics, are converted into a displacement-dependent signal.

Non-contacting displacement meas. systems based on eddy current:
High-frequency alternating current flows through a coil that has been embedded in a plastic moulding. The electromagnetic coil field induces eddy currents in the conductive object under test, which absorb energy from the resonant circuit. The sensor amplitude changes dependent on the distance. When demodulated, linearised and amplified, this amplitude change provides a voltage that is proportional to the distance.

Non-contacting inductive displacement measuring systems:
A coil is part of a resonant circuit. The coil inductance changes on approach to a conducting object under test. The demodulated signal is proportional to the distance between the sensor and the object under test.

Long-travel sensors based on eddy current:
An aluminium tube is moved concentrically and without contact above a bar with an integrated coil. The tube position causes a mistuning of the coil, by inducing eddy currents.

Non-contacting optical displacement measuring systems:
A laser beam is directed onto the object. The light spot is optically guided to a linear detector that provides currents proportional to the light spot position.

Cable-line displacement sensors:
A linear movement is converted via a flexible steel rope into a rotation and is analysed by means of a potentiometer or encoder.

Non-contacting capacitive displacement measuring systems:
The ideal plate capacitor changes its capacitance when the plate spacing changes. For the capacitive method, the sensor and the opposite positioned object under test form a plate electrode. In the measuring system an alternating current with a constant frequency flows through the sensor. The voltage amplitude at the sensor is proportional to the distance between the sensor electrode and object under test and is demodulated in a special circuit.

Conductive plastic potentiometer:
Based on a voltage divider circuit and a conductive plastic resistor element, the slip ring voltage is, without load, tapped by means of an operational amplifier that is switched as a voltage follower.

Applications

The range of applications for displacement transducers and displacement tracers is various. Not every application can be directly identified as a displacement measurement. Often, it is a completely different measuring variable that can be traced back to a displacement or distance variable.

Displacement transducers

are suitable for direct, accurate measurement of displacements in automatic control and metrology. The pickup of the displacement is performed using a pull rod with a universal joint. This allows for an actuation that is free from backlash and transverse forces, even in case of parallel and angular displacements of transducer and measuring direction.

Displacement tracers

are suitable for direct measurements of displacement without a form-locking connection, position detection at stationary measuring objects, tolerance measurements and for continuous contour measurement. The pull rod, which is supported on both sides, allows for accepting transverse forces that, for example, occur during a continuous scanning of curves or spline parts. A rear limit stop is used to provide a simple mechanical coupling of automatic retraction systems, for example, pneumatic cylinders or electromagnets.

3

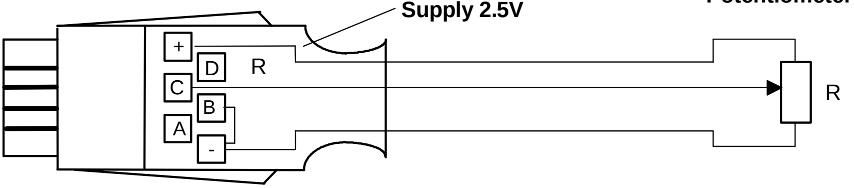
ALMEMO® Displacement Transducers/Tracers

The ALMEMO® sensor range includes a selection of conductive plastic potentiometers as displacement transducers and tracers for various travels:

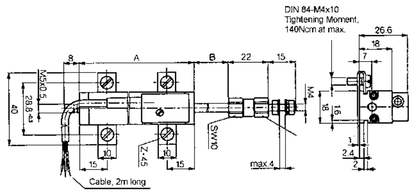
Travel	Resolution	Transducer	Tracer
25 mm	0.001 mm	FW A025 T	FW A025 TR
50 mm	0.01 mm	FW A050 T	FW A050 TR
75 mm	0.01 mm	FW A075 T	FW A075 TR
100 mm	0.01 mm	FW A100 T	FW A100 TR
150 mm	0.01 mm	FW A150 T	

The potentiometers are connected through the connector ZA9025FS3 with a stable 2.5V supply (see section 4.2.4). This leads to a measuring range from 0 to 2.5V for the overall travel. A pre-adjustment is performed in the factory through correction values.

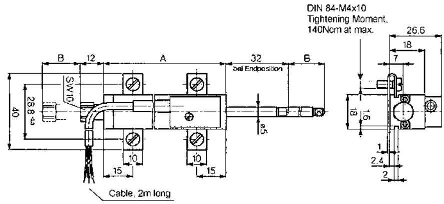
The precise adjustment can be locally performed by the user with final measures after the installation.



Dimensions



Displacement Transducers T



Displacement Tracers TR

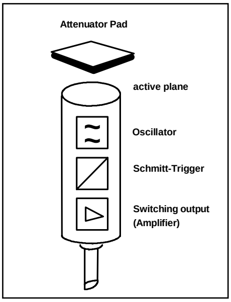
Technical Data

Displacement Transducer T/ Displacement Tracer TR	**T25/ TR25**	**T50/ TR50**	**T75/ TR75**	**T100/ TR100**	**T150**
Independent linearity:	±0.2%	±0.15%	±0.1%	±0.075%	±0.075%
Length of housing, in mm: (dim. A +1 mm):	63	88/94.4	113/134.4	138/166	188
Mechanical stroke, in mm (dim. B ±1.5 mm):	30	55	80	105	155
Total weight, in g (incl. 2m cable):	140/120	160/150	170/180	190/200	220
Mass of pull rod incl. coupling and slip ring block, in g:	35/25	43/36	52/48	58/57	74
Maximum actuation frequency (displacement tracer TR): (for most critical application "measuring tip upwards")	18 Hz	14 Hz	11 Hz	10 Hz	
Movability of universal joint (displacement transducer T):	±1 mm parallel displacement, ±2.5° angular displacement				
Actuation force (horizontal):	Transducer T: ≤ 0.30 N, Tracer TR: ≤ 5 N				
Reproducibility:	0.002 mm				
Dielectric resistance:	≥ 10 M Ω (at 500 V DC, 1 bar, 2 s)				
Dielectric strength:	≤ 100 µA (at 50 Hz, 2s, 1 bar, 500 V AC)				
Max. permissible. tightening torque of mounting screws:	140 Ncm				
Temperature range:	–30 to +100°C				
Temperature coefficient of the voltage divider ratio:	typically 5 ppm/°C				
Vibration:	5 to 2000 Hz/Amax = 0.75 mm / amax = 20 g				
Shock:	50 g/11 ms				
Life:	> 100 x 10^6 strokes				
Operating environment/Sealing:	IP 40				

3.6.4 Turbine Flow Meters for liquids

Measuring Principle

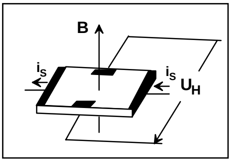
The sensor contains a vane or paddle that starts rotating when a flow is present. Unlike the optical method, this method also allows for measurements in cloudy and non-transparent liquids. The rotational speed is proportional to the corresponding quantity of flow. The electrical output signal can be generated by two different methods:



Inductive Proximity Switch:

The rotor blades are provided with special steel caps, so that the rotor blades approaching the transducer causes a change of the inductance and the generation of a pulse type output signal.

3



Hall Sensor:

The rotor is provided with permanent magnets that affect a Hall sensor, which is located on the transducer. The transducer electronics transforms the Hall signal into a pulse type electronical output signal.

ALMEMO® Turbine Flow Meters

For measuring the volume flow rate or for dosing tasks, the ALMEMO® sensor range includes turbine flow meters for different measuring ranges and operating conditions:

- Axial Turbine Flow Meter FV A915 VTH25 with rotating vane for large flow quantities
- Axial Turbine Flow Meter FV A915 VTH with rotating vane for small flow quantities

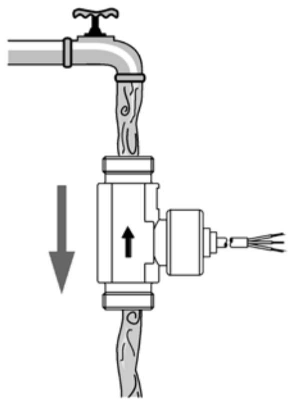
The flow signal is linear within the specified measuring range and accuracy of measurement. With flow controls, for example, with constant flow and clogging filter, the sensor can also be operated in the non-linear range as a satisfactory reproducibility is also available in this range. Because of their compact design and the large measuring range, the ALMEMO® Turbine Flow Meters are suitable for various applications, for example, medical technology, plastics industry, solar technology, machine tools, large kitchen machines, tap systems/dosing devices, refrigeration/air conditioning etc.

General Mounting Instructions

Before mounting, check whether the materials of the flow meter are suitable for the medium to be measured.

Due to the materials that are used, the types VTH (brass and plastic version) are not suitable for the measurement of oils. The stability of the plastic parts would be largely reduced.

1. The flow meter can be fitted in any position.
   The installation in horizontal conduits or in an upright housing facilitates the bleeding. For installation in vertical lines, an upward flow direction is preferred. A free flowing-out hole must be avoided.
2. The arrow mark provided on a flow meter sensor indicates the only possible flow direction.
3. The medium under test should contain as little solid substances as possible. Particles that may be present must not be larger than 0.5mm. If necessary, a filter must be used.
4. The flow meter should be provided with a 'straight' intake path of at least 10x DN, e.g. 15cm at DN15. After the flow meter, a 'straight' outlet path of 5x DN, e.g. 7.5cm at DN15 should be considered. The internal diameter of the intake and outlet path must correspond to the internal diameter of the flow meter, e.g. 15mm at DN15. The tube can be narrowed or widened ahead and behind.
5. To clean the flow meter from contaminations a thorough rinsing against the flow direction should be performed.



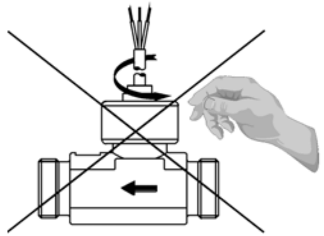
Cleaning of the flowmeters

Warning

Information:

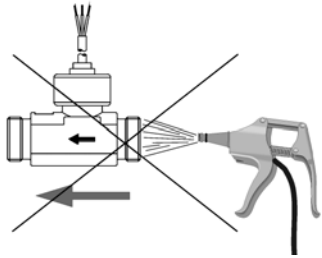
The union screw joint at the cable outlet is sealed !

If it is opened the positioning of the turbine system will loosen and damage can occur. A factory repair will be necessary !



For FVA 915VTHM/VTHK only:

Any blow through of the device using compressed air must only be performed against the flow direction.



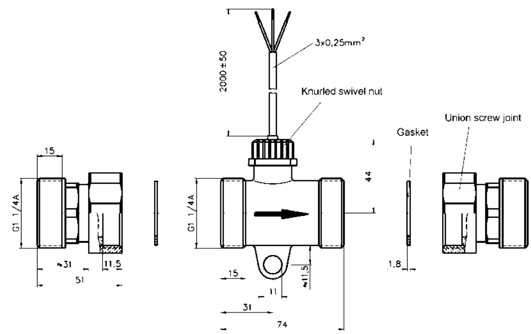
For FVA 915VTH25 only:

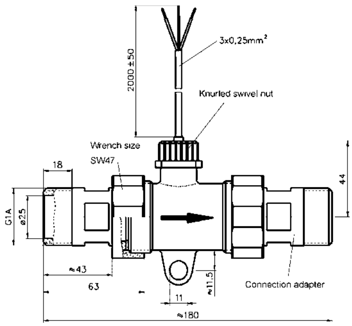
The device must NOT be blown through using compressed air. This might cause damage to the bearings.

3.6.4.1 Axial Turbine Flow Meter FV A915 VTH 25

Fitting into the Pipeline System

Firstly, the connection adapters are sealed into the pipeline. Please note that fibrous sealing materials (hemp or teflon tape) must not reach the turbine.
The installation of the turbine is then carried out by means of the knurled swivel nut and using the flat gaskets supplied.





VTH 25 M (brass)

Technical Data FV A915 VTH25

Turbine Type:	**FV A915 VTH25M**
Material pipe section	brass
Nominal diameter	DN 25
Measuring range	4 ... 160 l/min permanent load max. 80 l/min
Measuring accuracy	± 3 % of measured value
Reproducibility	± 0.5 %
Signal output from	< 1 l/min
Max. size of particles in medium	0.5 mm
Max. temperature of medium	85 °C
Nominal pressure	PN10
Process connection	G 1¼" external thread incl. connecting adapter to G 1" (obligatory)
Pressure loss	approx. 0.1 bar at 80 liters / minute, approx. 0.45 bar at 160 liters / minute
System of protection	IP 54
Output signal -pulse rate / K factor -resolution	 67 pulses/liter 15 ml/pulse
Signal form	NPN open collector
Sensing element	Hall effect sensor
Power supply	4,5 ... 24 V DC (from ALMEMO® device)
Electrical connection	PVC line, shielded (T_{max} =75°C) with ALMEMO® connector

A measurement of liquids of higher viscosities is possible and involves deviations from the data specified above.

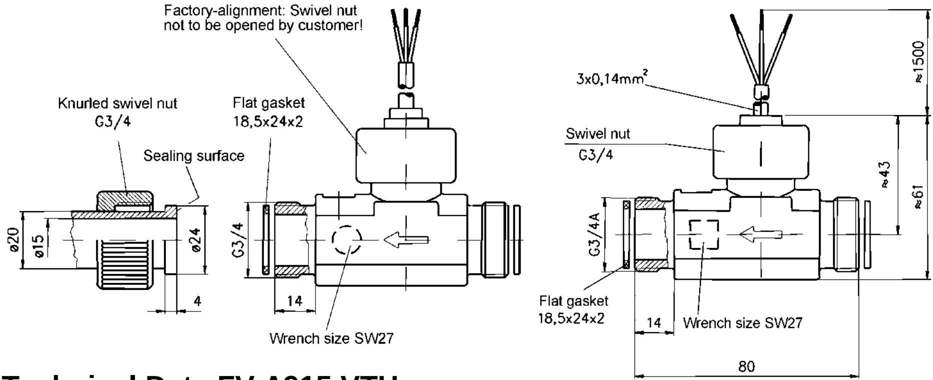
Materials

Turbine Type:	**FV A915 VTH25M**
Pipe section	brass CuZn36Pb2As
Flat gasket	Centelen
Turbine cage	PA Grivory HTV4X1
Rotating vane	PP
Rotor complements	permanent magnets, Recona 28 nickel-pla-ted
Axle / bearing	special steel 1.4436 / sapphire, PA
Sensor socket	PPO Noryl GFN 1630V
O-ring	72 NBR 872

3.6.4.2 Axial Turbine Flow Meter FV A915 VTH

Fitting into the Pipeline System

The pipeline to be connected must provide a collar. The face side of the collar serves as a raised and flat face and is pressed to the flat gasket by means of the milled swivel nuts. In case of a sealing at the external thread, attention must be paid to not let fibrous sealing material (hemp or teflon tape) into the flow.



Technical Data FV A915 VTH

Turbine Type:	**FV A915 VTH M**	**FV A915 VTH K**
Material pipe section	brass	plastic PPO
Nominal diameter	DN 15	
Meas. range	2 ... 40 l/min permanent load max. 20 l/min	
Measuring accuracy	± 1 % of final value	
Reproducibility	± 0.2 %	
Signal output	from 0.3 l/min	
Max. size of particles in medium	0.5 mm	
Max. temperature of medium	85 °C	
Nominal pressure	PN10	
Process connection	G ¾" external thread and swivel nuts	
Pressure loss in bar	$\Delta p = 0.00145 \times Q^2$ (Q in l/min)	
System of protection	IP 54	
Output signal -pulse rate / K factor -resolution	 855 pulses/liter 1.2 ml/pulse	
Signal form	rectangular signal NPN open collector	
Sensing element	Hall effect sensor	
Power supply	4,5 ... 24 V DC (from ALMEMO® device)	
Electrical connection	PVC line, shielded (T_{max} =70°C) with ALMEMO® connector	

A measurement of liquids of higher viscosities is possible and involves deviations from the data specified above.

Materials

Turbine Type:	FV A915 VTH M	FV A915 VTH K
Pipe section	brass	PPO Noryl GFN3
Flat gasket	NBR	
Turbine cage	PEI ULTEM	
Rotating vane	PEI ULTEM	
Rotor complements	hard ferrite magnets	
Axle / bearing	axle Arcap AP1D with hard metal pins in sapphire bearings	
Bearing support	Arcap AP1D	
Sensor	PPO Noryl GFN3	
O-ring	NBR	
Knurled swivel nut *	PA GF 30	

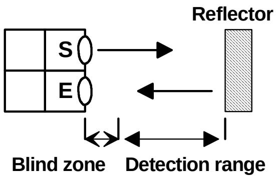
* no contact with flow medium

3.6.5 Tachometers

Measuring Principle

The optical reflection method has become the most accepted method for the measurement of revolutions of shafts, wheels, fans etc.

Retroreflective Light Barrier



With single unit retroreflective photoelectric sensors the transmitters and receivers form one single unit. The light sent by the transmitter is, by an opposite located object, reflected to the receiver. The sensor performs a switch when the reflected amount of light exceeds a specific, adjustable limit value at the receiver.

This quantity of light is depending on the size and the reflection properties of the object. When measuring revolutions, special reflective tapes should be used to increase the sensing range and to improve the signal-to-noise ratio.

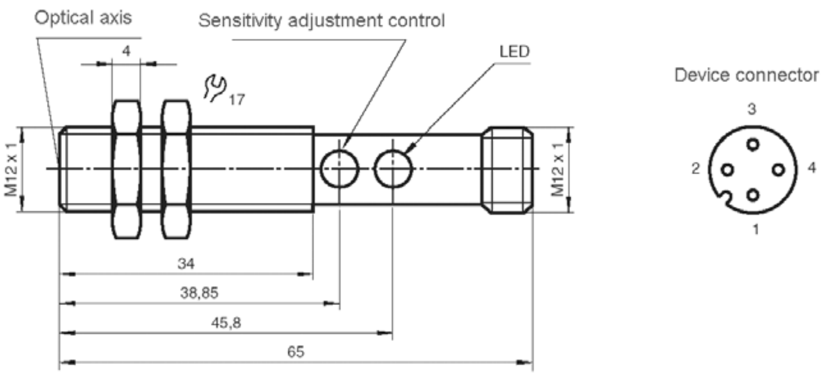
Measuring Method	Characteristics
Single unit retroreflective photoelectric sensor (DIN EN 60947: type D)	Can only detect opaque objects. The coverage depends on the reflection properties of the object, i.e. surface quality and colour. Sensitive with respect to contamination and changing reflection properties of the object(s). These influences can, within certain limits, be compensated by a sensitivity adjustment control. Easy installation as the sensor consists of only one unit and usually requires only a rough alignment.
Retroreflective Light Barrier (DIN EN 60947: type R)	Long sensing ranges and an improved signal-to-noise ratio are achieved by using retroreflectors. Low susceptibility to problems, therefore, well suited for applications with demanding operating conditions, e.g. outdoor operation or operation in contaminated environments.

ALMEMO® Tachometers

The ALMEMO® sensor product range includes the tachometer probe FU A919-2 for measurement of rotational speeds. It operates as a single unit retroreflective photoelectric sensor and its sensitivity can be adjusted with a potentiometer to increase the reliability. For evaluation of the pulses, the tachometer probe is equipped with a specific frequency meter module that calculates the number of revolutions per minute from the time period between two pulses (see 4.2.5). A stable read-out is achieved by averaging over a minimum of 500 ms.
The device under test must provide **<u>one</u>** prominent light/dark contrast at its outer diameter. If there are several light coloured sections (e.g. rotor blades) the speed will, consequently, be calculated too high. In these cases reflective objects (white or reflecting adhesive labels) as bright as possible must be applied as pulsers. For adjustment of the sensitivity the potentiometer must first be completely turned back and then slowly turned open until the monitoring LED is flashing regularly and a stable read-out is provided at the measuring device.
The upper limit of the measurement range is depending on the light/dark duty cycle. 30,000 rpm can be reached at a duty cycle of 1:1 (50%) and, consequently, less at a duty cycle of 1:10 (10%), i.e. only 6,000 rpm.

☞ The same probe can also be used with another frequency meter module as a light barrier for counting or for similar purposes.

Dimensions of the Tachometer Probe:



Technical Data

Measurement range:	8 to 30,000rpm (maximum)
Response time:	> 1ms
Resolution:	1rpm
Accuracy:	to 15,000rpm: ± 0.02% of aver. ± 1 digit to 30,000rpm: ± 0.05% of aver. ± 1 digit
Operating distance:	20 to 200mm (depending on reflector)
Sensitivity adjustment:	via potentiometer
Detectable object:	opaque, or reflector
Distance hysteresis:	≤ 10%
Indication of operating condition:	LED yellow
Type of light (emitter LED):	visible red light 660nm
Limit of external light sources:	sunlight: ≤ 20,000 lux halogen light: ≤ 5,000 lux
Ambient temperature:	-25°C to + 55°C
Storage temperature:	-40°C to +70°C
Operating environment/Sealing:	IP 67 (according to EN 60529)
Optics:	2-lens system PC
Permissible shock load:	b ≤ 30g, T ≤ 1ms
Permissible vibratory stress:	f ≤ 55Hz, a ≤ 1mm
No-load current:	≤ 20mA
Supply voltage:	> 8.5 V DC from measuring device, power supply adapter is recommended
Connection:	Device connector M12x1 including socket M12x1, angled, with 1.5 meters cable and ALMEMO connector
Material:	housing: brass, nickel-plated light Outlet: PMMA
Dimensions:	diameter: M12 x 1 mm length: 55 mm
Weight:	15g
Conformity to standards:	EN 60 947-5-2

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