JUMO Level Measurement Probes

Hydrostatic level and filling level measurement

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Dear Reader,

Synergistic complete solution concepts are gaining importance in light of increasing market dynamism, advancing globalization, as well as the associated competitive and cost pressures.
At JUMO we offer a complete product portfolio across the entire measuring chain to enable our customers to carry out future-oriented activities and to meet their requirements. For this purpose we provide a range of sensors for recording various measurands (such as pressure, temperature, pH), a wide selection of transmitters, as well as various display units, evaluation units, and control devices. The offering is topped off with comprehensive customer service.
JUMO also offers complete solution concepts for pressure and filling level measurement equipment.
Sophisticated technologies that have been setting standards for pressure and hydrostatic filling level measurement technology for over 30 years. The knowledge and experience of more than 2100 employees worldwide. Flexibility due to considerable production depth. Optimum quality standards that are implemented using in-house sensor production and state-of-the-art production lines.

To further improve our quality standards and monitor implementation, we subject the measuring devices to a wide range of tests in our in-house testing laboratory.
Hydrostatic pressure can be measured using traditional level measurement probes. The proper application of these measurement probes offers countless opportunities.

Yours sincerely,
René Krug

Detailed information about our products can be found under the specified type / product group number at **www.jumo.net.**

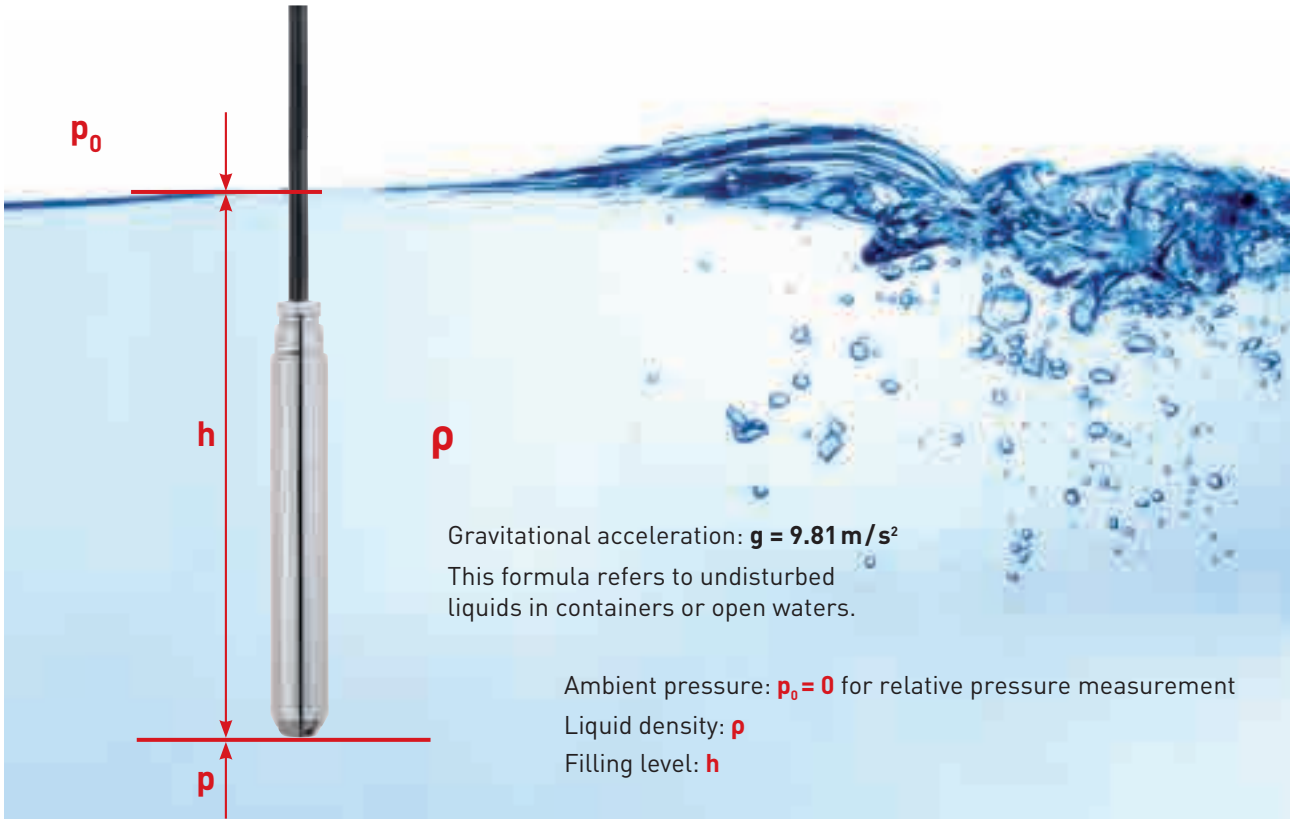
More than sensors + automation

Contents

Level measurement, filling level measurement, and product overview

Level measurement probes are used for hydrostatic filling level measurement in ventilated tanks or to determine levels in open waters. For pressurized filling level measurements in closed tanks, a differential pressure transmitter such as the JUMO dTRANS p20 DELTA (type 403022) or JUMO MIDAS DP 10 (type 401050) can be used. External measurements (applied, among other uses, for hygienic purposes), relative pressure measuring devices, such as the JUMO dTRANS p30 (type 404366) without display or the JUMO DELOS SI (type 405052) with display, can be used.

JUMO – your partner for level and filling level measurement



Calculation of the hydrostatic pressure: $p = p_0 + \rho \times g \times h$

Hydrostatic filling level measurement

The hydrostatic pressure in a liquid is generated by the weight of a liquid column above a body (SI unit: meter of water). The pressure rises as the depth increases, independent of the direction. Here, a 10 meter liquid column (mH 20) is equivalent to 0.98 bar (approx. 1 bar).

The hydrostatic pressure is derived from the force equilibrium conditions along with the mass. This is calculated using the ambient pressure, liquid density, filling level, and therefore the depth of the body.

Piezoresistive silicon sensor

If the level measurement probe has reached the immersion depth, a hydrostatic pressure acts on its stainless-steel separating diaphragm. This pressure is transmitted via filling oil to the sensor with resistance bridge. The change to the mobility of the electrodes of the sensor's silicon-crystal structure leads to a measurable change in resistance (piezoresistive effect).

Capacitive ceramic sensor

The ceramic capacitive pressure measurement represents – on an electronic level – a plate capacitor with two highly-resistant ceramic plates (AL_2O_3) that are isolated from one another. The capacity change of the plate capacitor is the extent of the pressure change and therefore of the filling level. Highly accurate measurement can be carried out using AL_2O_3, due to the linear deflection.

The capacitive ceramic sensor is used when there are high demands in terms of resistance to corrosion or when high mechanical loads are placed on the separating diaphragm. It enables a high overload capacity of up to 80-fold.

Level measurement probe product overview

• Suitable
– Not suitable

	Description	JUMO MAERA S25	JUMO MAERA S26	JUMO MAERA F27	JUMO MAERA S28	JUMO dTRANS p33
	Type / data sheet	401015	402090	404391	404392	404753
Application	Outdoor mounting[1] Indoor mounting[1]	– •	– •	• •	• •	• •
Application	ATEX	–	–	–	–	•
Application	Integrated overvoltage protection	–	–	•[2]	•	–
Application	Temperature probe Pt 100 (optional)	–	–	•[2]	•	•
Technical data	Measuring range	0.25 to 1 bar	0.25 to 2.5 bar	0.05 to 1.6 bar	0.25 to 10 bar	0.25 to 600 bar
Technical data	Medium temperature	0 to +50 °C		–20 to +60 °C	0 to +50 °C	–40 to + 70 °C
Technical data	Sensor	Piezoresistive silicon sensor		Capacitive ceramic sensor	Piezoresistive silicon sensor	
Technical data	Accuracy (linearity)	±0.3 %		±0.2 %	±0.2 % (> 2.5 bar), ±0.3 % (≤2.5 bar)	±0.5 %
Technical data	Overall accuracy at 20° C in % of the end value[3]	±0.5 %		±0.4 %	±0.3 % (>2.5 bar), ±0.5 % (≤2.5 bar)	±0.6 %
Technical data	Output signals	4 to 20 mA zl, 0 to 10 V dl, 0.5 to 4.5 V dl, 1 to 5.0 V dl, 1 to 6.0 V dl	0 to 20 mA dl, 4 to 20 mA zl, or dl, 0.5 to 4.5 V dl, 0 to 10 V dl, 1 to 5.0 V dl, 1 to 6.0 V dl	4 to 20 mA zl, 0.5 to 4.5 V dl	4 to 20 mA zl	

[1] These recommendations are based on many years of experience; however, in individual cases they may not be fully applicable. We would be happy to provide further information, including regarding additional applications.
[2] Only for stainless steel version with an output signal of 4 to 20 mA zl.
[3] Includes: linearity, hysteresis, repeatability, deviation of measuring range start (zero point), and measuring range end.

Recommendations for use of level measurement probes

• Suitable
– Not suitable

Application	Description	JUMO MAERA S25 Type 401015		JUMO MAERA S26 Type 402090		JUMO MAERA F27 Type 404391		JUMO MAERA S28 Type 404392		JUMO dTRANS p33 Type 404753	
		Probe	Cable	Probe	Cable	Probe	Cable	Probe	Cable	Probe	Cable
	Wastewater	–	–	–	–	•	FEP	–	–	•	FEP
	Well water (without salt content)	–	–	–	–	–	–	•[2]	FEP	–	–
	Heating oil	•	PA	•	FEP	–	–	–	–	–	–
	Car washes	•	PE	–	–	–	–	–	–	–	–
	Fuel: petrol	–	–	–	–	–	–	–	–	•	FEP
	Fuel: diesel	–	–	•	FEP	•	FEP	–	–	–	–
	Seawater	–	–	–	–	PTFE	FEP	–	–	–	–
	Caustic soda (20 %, 20 °C)	–	–	–	–	PTFE[3]	PE	–	–	–	–
	Rainwater	•	PE	•	PE	–	–	•	PUR	–	–
	Sulphuric acid (50 %, 20 °C)	–	–	–	–	PTFE	PE	–	–	–	–
	Swimming pools (disinfectant: chlorine)	–	–	–	–	PTFE	FEP	–	–	–	–

[1] These recommendations are based on many years of experience; however, in individual cases they may not be fully applicable. We would be happy to provide further information, including regarding additional applications.

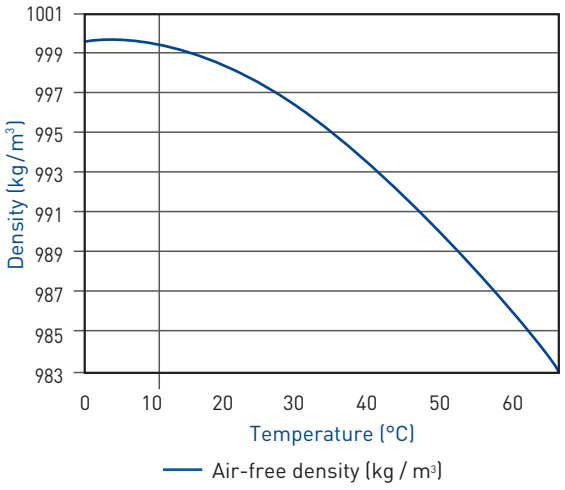
[2] Deep-well version: 4 to 20 bar with a free-hanging cable length of up to 100 m.

[3] Seal: EPDM.

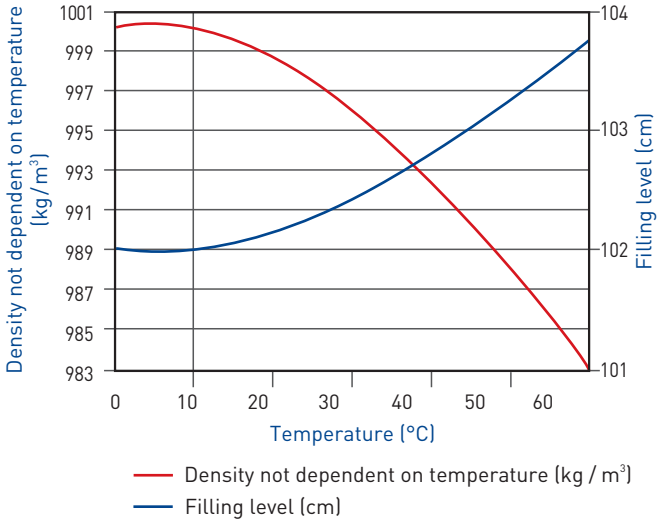
Notes on the product

A large number of criteria must be considered when selecting the right level measurement probe. One criterion is generally the measuring task that is going to be carried out. Considering that level / filling level measurement is a direct measurement, which involves the probe being placed into the medium on a cable especially selected for the relevant application, the medium itself is a highly relevant factor. The relevant resistant materials can be identified by considering the concentration, conductivity, density, and temperature.
The ambient conditions such as the operating location, the temperature, the plant setup, and the available mounting options should be considered when selecting the accessories and necessary extra codes.

Selecting the right product



Density not dependent on temperature (kg / m³) using the example of water



Filling level at 100 mbar taking into account the density not dependent on temperature using the example of water

Note on selecting the measuring range

The relative pressure measurement range to be selected depends on the maximum liquid column that is to be measured as well as the density and temperature of the liquid.

Influence of the density on the level

The density of a liquid is temperature-dependent. These dependencies are listed in tables. These show that at 5 °C the density value of water is 999.964 kg/m^3. However, this falls to 995.645 kg/m^3 when heated to 30 °C. The temperature-dependent density therefore affects the accuracy of the filling level measurement and therefore the filling level.

Example:

A cylindrical rainwater cistern with cold water at a temperature of 10 °C shows a height of 2.20 m. The integrated overflow is located at a height of 2.00 m, which equates to the maximum liquid column. The diagram above depicts the relationship between temperature and density with water as the liquid. At a water temperature of 10 °C the value is the density 999.699 kg/m^3. The maximum hydrostatic pressure acting on the separating diaphragm is calculated using the following formula:

$p = p_0 + \rho \times g \times h$

Taking into account the relative pressure $p_0 = 0$, the following result is obtained:

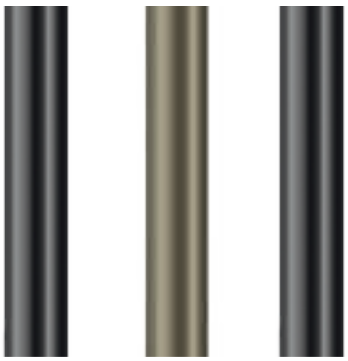
$p = \rho \times g \times h$

$p = 999.699\,kg/m^3 \times 9.81\,m/s^2 \times 2\,m$

$p = 19{,}614\,kg/(m \times s^2) = 19{,}614\,Pa = 196.14\,mbar$

For use in a rainwater cistern, we recommend the JUMO MAERA S25 level measurement probe with a polyethylene protective tube. The standard measuring range of 250 mbar can be used with a maximum hydrostatic pressure of 196.14 mbar.

Notes on product selection



Closed system | Open system | Cable designation: PE-LD | PUR[1] | FEP[1]

Process connection

The process connection system should be selected based on the liquid and substrate of the probe.

A closed connection protects the membrane from damage. On the other hand, an open system offers advantages for contaminated or high-viscosity media or if deposits may form. A process connection with an internal thread can be used to secure the level measurement probe to the base of the tank.

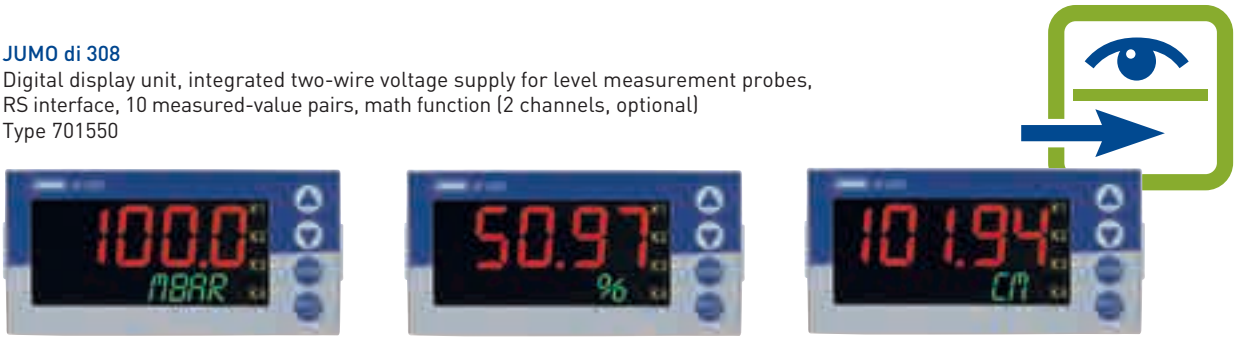
Cables

Special cables are normally used for recording the measurement data with a level measurement probe. These are positioned in the medium at the maximum lower water level, which means that they are positioned at the lowest level. With the exception of the JUMO MAERA S25 (type 401015), every cable can be supplied with every level measurement probe. The chemical composition of the medium and the ambient conditions, such as the temperature (both within and outside the medium), are key factors for selection of the cable material. UV resistance is therefore also indicated for all cables. The outer sheaths should be selected based on the relevant application. To avoid problems ranging from erroneous measured values to failure of the device, pressure compensation is achieved using an integrated polyamide pressure compensation tube that does not allow any moisture to penetrate. The penetration of liquid into the pressure compensation tube can be prevented using a pressure compensation filter. Furthermore, the bending radius of the pressure compensation tube must not fall below the preset value. Otherwise there is a danger of a lack of ambient pressure compensation resulting from a kink. The cable can also be lengthened cost effectively by using the optionally available terminal housing with pressure compensation.

[1] UV-resistant according to DIN ISO 4892-2

Notes on evaluation

JUMO di 308
Digital display unit, integrated two-wire voltage supply for level measurement probes, RS interface, 10 measured-value pairs, math function (2 channels, optional)
Type 701550



Technical descriptions can be called up by entering the relevant type number at www.jumo.net

As explained in the "Notes on product selection", the temperature-dependent density has an influence on the selected measuring range and therefore also on the result for the filling level.

Example

The hydrostatic pressure, which has an influence on the level measurement probe, equates to a relative pressure of 100 mbar in a cylindrical tank. The tank filled with cold water at a temperature of 5 °C shows a density of ρ = 999.964 kg / m³. The hydrostatic pressure is calculated using the following formula:

$$p = p_0 + \rho \times g \times h$$

After conversion of the formula according to h, the filling level, taking into account the relative pressure (p_0 = 0), the following equation is reached:

$$h = p/(\rho \times g)$$

After the Si conformity is taken into account:

$$100\ \text{mbar} = 10{,}000\ \text{Pa} = 10{,}000\ \text{kg}/(\text{m} \times \text{s}^2)$$

the filling level h is calculated as follows:

$$h = 10{,}000\ \text{kg} / (\text{m} \times \text{s}^2)/(999.964\ \text{kg} / \text{m}^3 \times 9.81\ \text{m} / \text{s}^2)$$

$$h = 1.01\ \text{m} = 101.94\ \text{cm}.$$

Assuming that the water has warmed to 30 °C and that therefore the density is 995.645 kg / m³, the filling level would be 102.38 cm. The difference, the influence of the temperature, equates to 0.89 cm.

One way to better take into account this influence is to use the JUMO di 308 digital display unit (type 701550). Two functions, referred to as math channels, can be entered in this unit. A channel can be used to calculate the temperature-dependent density with the help of a quadratic function. The temperature can be measured using an integrated temperature probe, as in the JUMO MAERA F27 and the JUMO MAERA S28 level measurement probes, or with an additional temperature probe.

The second channel then calculates the filling level taking into account the result for channel 1.

In the case of known measured-value pairs, a customer-specific linearization can also be added. It interpolates a graph to determine the filling levels using a stored allocation of measured values to display values.

Accessories

Once the level measurement probe has been selected, the ambient conditions determine which accessories should then be added to best complement the product and to ensure optimum mounting. One aim should be to prevent erroneous measured values resulting from medium fluctuations by using various methods for securing cables. A further aim should be to ensure that the pressure compensation, which ensures equalization of the ambient and measured pressure with relative pressure devices, is always carried out effectively.

Pressure compensation filter for PE-LD/PUR/FEP cables

The pressure compensation filter is a breathable filter that ensures aeration and ventilation without moisture penetrating.

Sealing screw

For closed containers or wells with a well head, the cable should be guided through and fastened by a sealing screw.

Cable clamp

The probe is immersed in the liquid with the help of the cable and it must be ensured that the cable does not become deformed during the mounting process. A compatible cable clamp is available to solve just this problem with a clamping range of 5.5 to 10.5 mm and a maximum tensile strain of 2.5 kN. Both a stainless steel version and a hot-dip galvanized version are available. The latter consists of clamping jaws and guide brackets made of fiberglass-reinforced polyamide.

Terminal housing with pressure compensation element

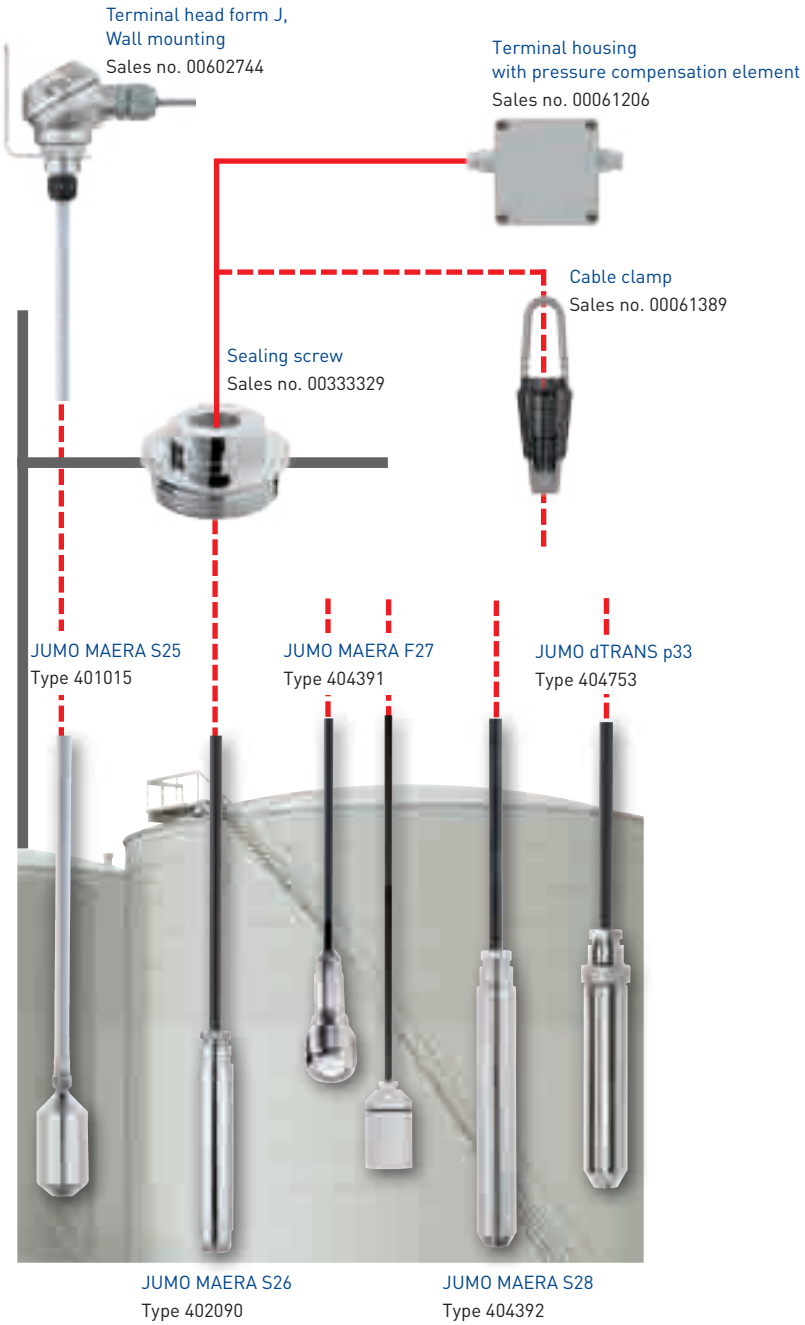
The terminal housing is used for the safe mounting of the probe cable. The end of the pressure compensation tube is always protected from deposits and condensation (IP 65). The remaining distribution can be performed with a cable without a pressure compensation tube.

Tube end piece for JUMO MAERA S25 (type 401015)

The tube end piece is used with the JUMO MAERA S25 level measurement probe. It prevents the protective pressure compensation tube from becoming constricted. It can therefore be used in wall openings (brickwork) and for clamping screw, cutting ring, and cable gland connections (in a tank/control cabinet).

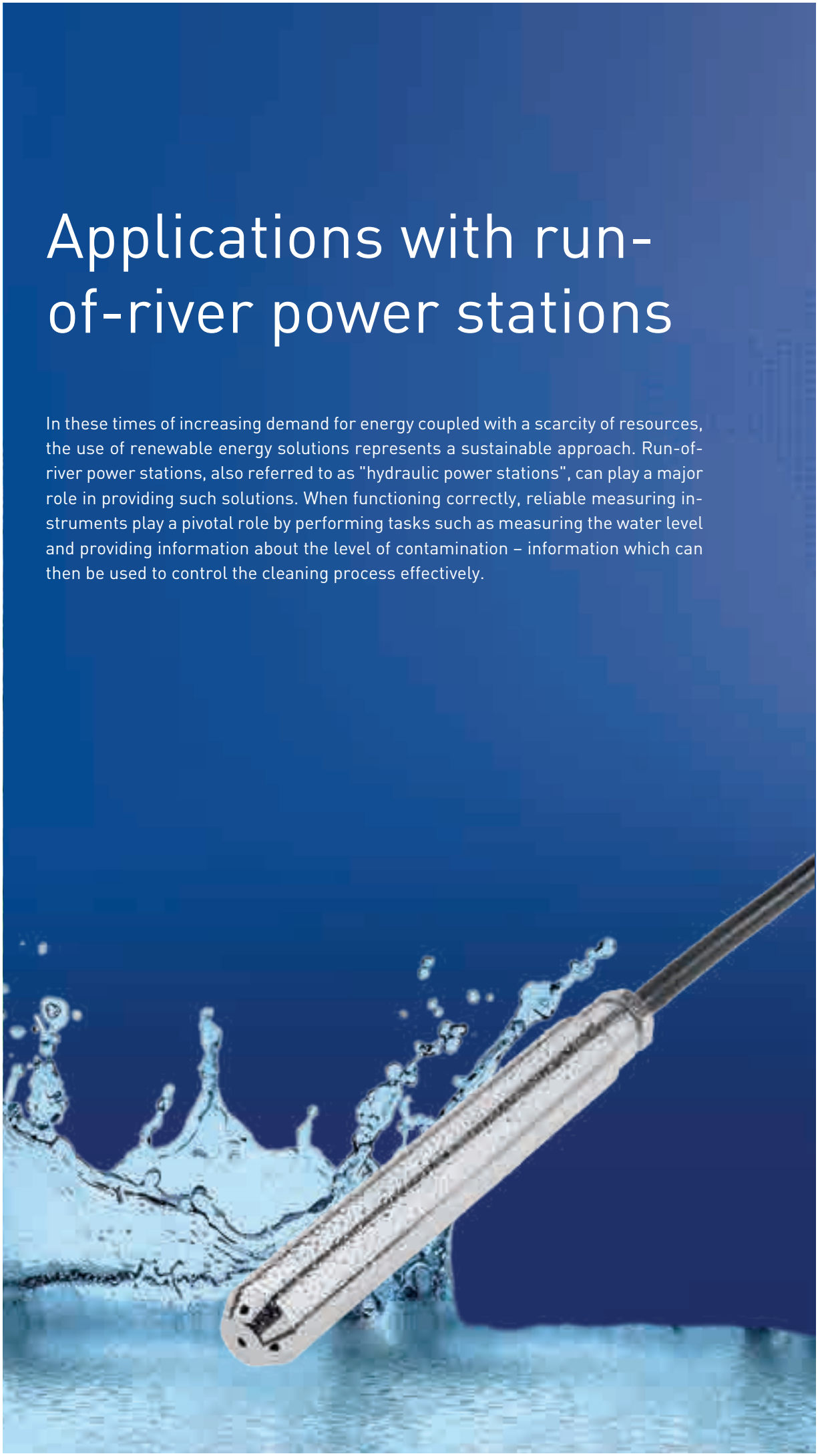
Terminal head form J for pressure compensation

The terminal head form J is applied with the level measurement probe variant JUMO MAERA S25 (type 401015). This terminal head is used to mount the level measurement probes in the best possible way. It corresponds to protection type IP 67. Tank cover and wall mounting variants are available. By using it locally, rapid pressure compensation can be achieved. Furthermore, the direction (for example to the control cabinet) can be individually specified. Any liquid that forms is absorbed by the drying capsule contained in the cover. The drying capsule changes color to indicate the level of saturation. For information on the electrical connection and other technical matters, please see the installation instructions included in the scope of delivery (B401015.4).



Applications with run-of-river power stations

In these times of increasing demand for energy coupled with a scarcity of resources, the use of renewable energy solutions represents a sustainable approach. Run-of-river power stations, also referred to as "hydraulic power stations", can play a major role in providing such solutions. When functioning correctly, reliable measuring instruments play a pivotal role by performing tasks such as measuring the water level and providing information about the level of contamination – information which can then be used to control the cleaning process effectively.



JUMO MAERA S28
Level measurement probe
Type 404392

Level measurement contributes to ensuring optimal operation of a run-of-river power station

Application

Even thousands of years ago, the energy potential of moving water was already being harnessed by watermills. Since very far back these also included design aspects to counteract the effects of fluctuating water levels.

In today's world, run-of-river power stations are used to harness large quantities of water with comparably low differences in water level such as on rivers and straits. With this type of system, a river is dammed and the outflowing water is guided into the turbine (a Kaplan turbine, for example) using low pressure. The turbine is protected by a front-placed raked purification plant. The difference determined between the level before and after raking is an indicator of the degree of contamination. This information can in turn be used to control the cleaning process.

A greater degree of contamination is present when the upper water level drops slowly behind the rake. After cleaning, the water level is the same again as the level before the rake.

The goal of a run-of-river power station is to gain electrical energy with optimum efficiency. The electrical energy is produced out of kinetic energy inside a generator. Here, the generator is operated through a variable flow of water with a differing drop height. To do this the position of the guide vanes on the distributor and the position of the impeller vanes must be coordinated to achieve the best possible efficiency.

When the system is placed in operation the guide vanes and impeller vanes are adjusted incrementally. The results are recorded in propeller curves and compared in terms of turbine output, drop height (difference between the upper and lower water level), and water flow rate. The result is operational control with optimized efficiency.

Applications

Rake control

– Upper water level before the rake
– Lower water level after the rake

Run-of-river power station

– Upper water level
– Lower water level

Solution

In the spirit of "one for all and all for one", the JUMO MAERA S28 level measurement probe offers the ideal solution for all applications. Filling levels can be calculated to an accuracy within 0.2 % of the end value. Due to its sturdy structure and the choice of used materials, it can be mounted outdoors, but the use of a sounding pipe should be considered due to external influences. If it is to be mounted outdoors, the probe will be supplied with integrated overvoltage protection to protect the level measurement probe from indirect lightning strikes.

Applications with heating oil tanks

Due to rising oil prices, knowledge about the current filling level is becoming increasingly important. Requirements-based planning of heating oil deliveries is therefore a means of coping with price fluctuations. This is yet another application for which JUMO offers first-class systems and solutions on which you can rely.

Product selection

The ideal, most cost-effective solution for a closed but ventilated heating oil tank with access from the tank cap is hydrostatic filling level measurement using a level measurement probe.

Depending on the medium and the temperature thereof, it is recommended to use the JUMO MAERA S26 level measurement probe with a special FEP cable for operating temperatures from 0 °C to +30 °C.

Alternatively, the JUMO MAERA S25 with polyamide protective tube can be used for selected measuring ranges as well as cable and sleeve lengths.

Level visualization and measured value documentation taking the tank geometry into account

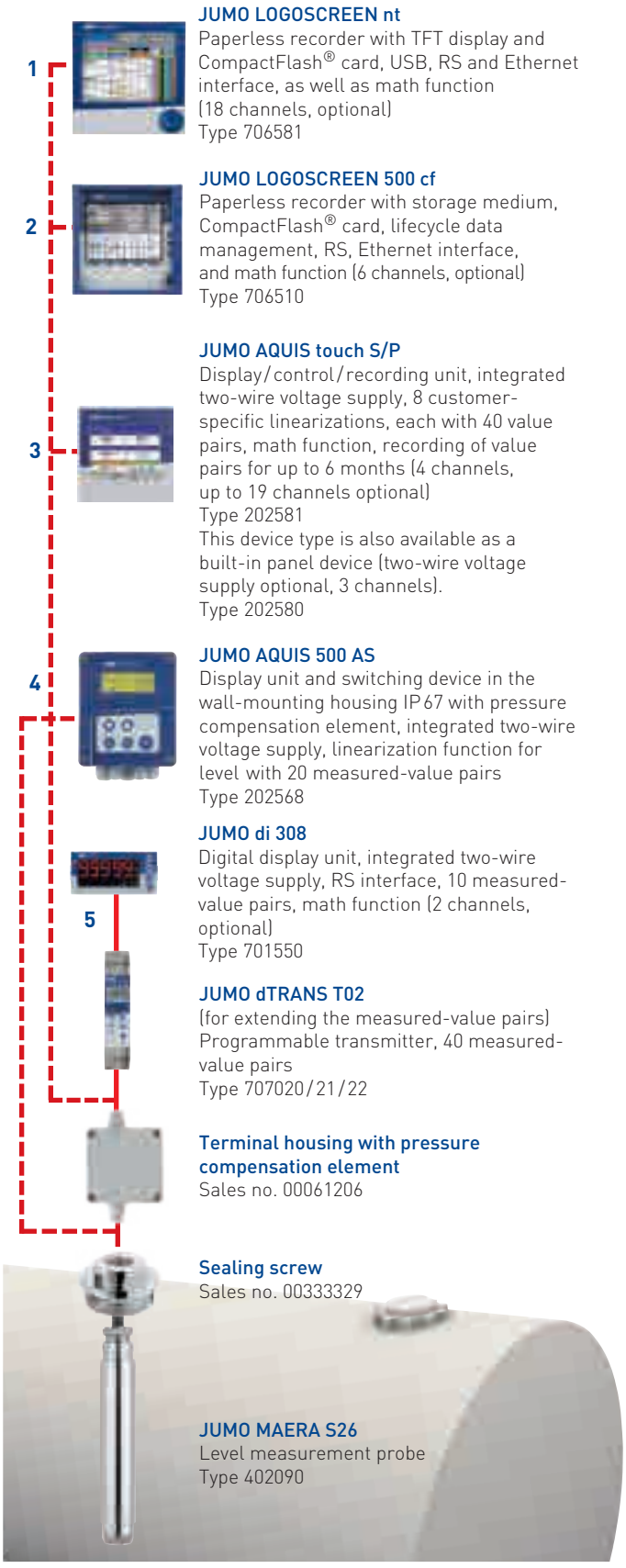
The preferred level of display accuracy should be considered when selecting the visualization and recording device for the measurement data.

A horizontal, cylindrical tank with a dished end exhibits a non-linear increase in volume with respect to filling level. To ensure correct modeling and documentation, a customer-specific linearization or a math function integrated into paperless recorders and display units can be used.

For customer-specific linearization, the display graph is interpolated with a number of measured-value pairs. Here, the measured-value pairs are determined from the measuring signal and the associated display value. An increasing number of measured-value pairs therefore always have a positive effect on the display accuracy. In practice an extension of the measured-value pairs can be achieved by switching a programmable transmitter in front of the display unit (connection variant 5).

Devices with a math function represent a more easy-to-use and highly accurate variant for determining the level. The linearization is calculated using a formula that takes the tank geometry into account.

The JUMO di 308 digital display unit provides the option of a customer-specific linearization or two math channels. It can also be used to supply level measurement probes, including the JUMO AQUIS 500 AS display unit and switching device, with an integrated two-wire voltage supply. A fill volume of up to 99,999 liters can also be shown using the 5-star display.



JUMO LOGOSCREEN nt
Paperless recorder with TFT display and CompactFlash® card, USB, RS and Ethernet interface, as well as math function (18 channels, optional)
Type 706581

JUMO LOGOSCREEN 500 cf
Paperless recorder with storage medium, CompactFlash® card, lifecycle data management, RS, Ethernet interface, and math function (6 channels, optional)
Type 706510

JUMO AQUIS touch S/P
Display/control/recording unit, integrated two-wire voltage supply, 8 customer-specific linearizations, each with 40 value pairs, math function, recording of value pairs for up to 6 months (4 channels, up to 19 channels optional)
Type 202581
This device type is also available as a built-in panel device (two-wire voltage supply optional, 3 channels).
Type 202580

JUMO AQUIS 500 AS
Display unit and switching device in the wall-mounting housing IP 67 with pressure compensation element, integrated two-wire voltage supply, linearization function for level with 20 measured-value pairs
Type 202568

JUMO di 308
Digital display unit, integrated two-wire voltage supply, RS interface, 10 measured-value pairs, math function (2 channels, optional)
Type 701550

JUMO dTRANS T02
(for extending the measured-value pairs)
Programmable transmitter, 40 measured-value pairs
Type 707020/21/22

Terminal housing with pressure compensation element
Sales no. 00061206

Sealing screw
Sales no. 00333329

JUMO MAERA S26
Level measurement probe
Type 402090

Services & Support

It is the quality of our products that is responsible for such a high level of customer satisfaction. But our reliable after-sales service and comprehensive support are also valued. Let us introduce you to the key services we provide for our innovative JUMO products. You can count on them – anytime, anywhere.

JUMO Services & Support – so that it all comes together!

Manufacturing Service

Are you looking for a competitive and efficient system or component supplier? Regardless of whether you seek electronic modules or perfectly fitting sensors – either for small batches or mass production – we are happy to be your partner. From development to production we can provide all the stages from a single source. In close cooperation with your business our experienced experts search for the optimum solution for your application and incorporate all engineering tasks. Then JUMO manufactures the product for you.
As a result you profit from state-of-the-art manufacturing technologies and our uncompromising quality management systems.

Customer-specific sensor technology

- Development of temperature probes, pressure transmitters, conductivity sensors, or pH and redox electrodes according to your requirements
- A large number of testing facilities
- Incorporation of the qualifications into application
- Material management
- Mechanical testing
- Thermal test

Electronic modules

- Development
- Design
- Test concept
- Material management
- Production
- Logistics and distribution
- After-sales service

Metal technology

- Toolmaking
- Punching and forming technology
- Flexible sheet metal machining
- Production of floats
- Welding, jointing, and assembly technology
- Surface treatment technology
- Quality management for materials

Information & Training

Would you like to increase the process quality in your company or optimize a plant? Then use the offers available on the JUMO website and benefit from the know-how of a globally respected manufacturer. For example, under the menu item "Services and Support" you will find a broad range of seminars. Videos are available under the keyword "E-Learning" about topics specific to measurement and control technology. Under "Literature" you can learn valuable tips for beginners and professionals. And, of course, you can also download the current version of any JUMO software or technical documentation for both newer and older products.

Product Service

We have an efficient distribution network on all five continents available to all of our customers so that we can offer professional support for everything concerning our product portfolio. Our team of professional JUMO employees is near you ready to help with consultations, product selection, engineering, or optimum use of our products. Even after our devices are commissioned you can count on us. Our telephone support line is available to give you answers quickly. If a malfunction needs to be repaired on site our Express Repair Service and our 24-hour replacement part service are available to you. That provides peace of mind.

Maintenance & Calibration

Our maintenance service helps you to maintain optimum availability of your devices and plants. This prevents malfunctions and downtime. Together with the responsible parties at your company we develop a future-oriented maintenance concept and are happy to create all required reports, documentation, and protocols. Because we know how important precise measurement and control results are for your processes we naturally also professionally calibrate your JUMO devices – on site at your company or in our accredited DAkkS calibration laboratory for temperature. We record the results for you in a calibration certificate according to EN 10 204.

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