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# Equipment Description **CE**

## Moisture measuring probes Type FS(x)



**Type FSV (Variable Depth Probe)**  
 (fig. incl. Optional holding/ mounting ring)



**Type FS1 (Disc Probe)**



**Type FSA (Arm Mounted Probe)**



**Type FSM (Mixer Probe)**



**Type FSH (High Temperature Probe)**  
 (fig. incl. Optional holding/ mounting ring)

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## 1. The moisture measuring probes

Werne & Thiel is an expert in the manufacturing of robust probes for measuring the moisture content of a variety of materials. The moisture probes provide an excellent price performance ratio. Over the last decades tens of thousands of our moisture probes have been successfully installed worldwide. We use only materials of the highest quality for our probes, so the casing and the mounting brackets are all made of stainless steel.

Werne & Thiel moisture probes are based on the legendary Arnold moisture probes which we modernised and improved further over the past years.

As shown on the first page five different models are available: FSV, FS1, FSA, FSM and FSH.

### Comparison of the different models:

Model	Area of application	Mounting
<b>FSV</b>	Adjustable flange probe for universal applications. Wide range of adjustment possible. Also suitable for thick wall situations. Can be mounted on a glider for measuring the moisture of materials on conveyer belts.	Adjustable flange ring with three fixing holes.
<b>FS1</b>	Universal application. The installation depth is fixed and is 9mm without abrasion protection and 11mm with abrasion protection.	Fixed installation flange with three holes.
<b>FSA</b>	<b>Arm</b> mounted probe with standard arm length of 0.2m, 0.5m or 1m. Appropriate for installation in silos.	Adjustable carrying arm for probe. Can also be supplied with folding arm or elbow fitting.
<b>FSM</b>	<b>Mixer</b> probe for installation in mixer applications. Designed for rough environments. Additional abrasion protection by the help of 8mm thick hardened or unhardened, replaceable reinforcing tube. The measuring surface is made of a 10mm thick ceramic abrasion protection.	Massive mounting ring with bolts on the sides for inserting and positioning the protected mixer probe.
<b>FSH</b>	High temperature probe withstanding up to <b>+190°C</b> at the measuring head.  <b>Attention:</b> Maximum ambient temperature at the backside electronics is <b>+80°C</b> .	Adjustable clamping ring with three mounting holes.

## 2. Applications

The following list shows a wide range of applications:

- Moisture of sands, gravels, etc. (concrete production)
- Reprocessing of foundry sand for desired moisture
- Moisture of quartz sand, e.g. for glass manufacturing
- Quality optimization in food processing
- Cereal moisture
- Fodder industry for animal food
- Ceramic powders and pastes
- Metal oxides
- Moisture of building and construction materials
- Applications in chemical and pharmaceutical industries
- Soil humidity
- Sludge from the sewage plants
- And many others

## 3. Measuring method

All current measuring systems (whether based on capacitive, microwave or conductivity methods) measure the water content of a medium only indirectly, by the help of a physical property. Water and the measured material must show a great difference in this physical property. The dielectric constant is such a useful property. Most materials like sand etc. have a rather low dielectric constant of about  $\epsilon = 3 \dots 10$ . Compared to this the dielectric constant of water is about  $\epsilon = 80$ . This is a huge difference which can easily be used for a measurement of the water content of a medium. Our moisture probes translate the varying mixture of water and material into a proportionally varying signal 0...10V or 0/4...20mA of high linearity.

The Werne & Thiel moisture probes not only determine the resulting dielectric constant of the mixture to calculate the water content, but also use another physical effect called the refraction of electrical field lines. Only by using this additional effect a high measuring linearity can be achieved. So, our moisture probe is far more than a simple capacitively working probe.

As the resulting dielectric constant of the wet medium not only depends on the mixture but also on the dielectric constant of the measured material itself, it becomes **always necessary to calibrate the measuring probe depending on the actual material**. It should be clear that a material with an  $\epsilon = 3$  will need an other calibration than a material with an  $\epsilon = 10$ .

### Trapped air in the medium, 'density effect'

Take care that there's no varying amount of air trapped in the medium during the measurement, as this will erroneously decrease the resulting dielectric constant of the mixture and result in measuring errors. In most cases this unwanted 'density effect' can easily be avoided by installing the moisture probe at the right place. Keep in mind that the penetration depth of the measuring field is up to 15cm.

### Measuring through a gap

Although not recommended, our moisture probes can measure the moisture of a medium even through a small gap between the medium and the probe. The gap can be made of an isolating material (conveyor belt, additional protective layers against abrasion, etc.) or even air. The gap width, however, must not vary. Also, using a gap may result in a certain loss of sensitivity. So, if possible, use always a mounting place allowing a direct contact with the medium.

**Of course, the gap must not be made of a metallic material. And the moisture probe cannot measure through a metallic wall, either.**

## Measurability of materials

- The material should have a dielectric constant  $\epsilon$  which is much smaller than the dielectric constant of water ( $\epsilon = 80$ ).
- The ohmic resistivity (Ohm/cm) should not be too low. So, there should not be a high contamination with salts, because high ionic conductivity can result in measuring errors. Our moisture probes aren't even affected by very hard tap water, but heavy contamination with sea water could be a problem.
- Finally, the density of the material should remain fairly constant during the measurement. So, e.g., there shouldn't be trapped a varying amount of air in the medium.

A material is measurable if the measurement is reproducible and if different moistures do not result in identical measuring signals. The moisture probe is then adjusted in such a way, that, e.g. an output signal of 1 Volt is assigned to a moisture of 1% and an output signal of 10V to a moisture of 10%. Alternatively, 1V = 2% and 10V = 20% is also possible, if a different range of measurement is wished.

This simplified assignment of moisture values to signals is only possible if the **calibration curve is linear** in a first order approximation. This is usually the case for sands used in the production of concrete, e.g. In some other cases it might be necessary to create a suited calibration curve using at least three different moisture values. The Werne & Thiel moisture measuring processor "FMP2" can accept up to six such calibration points for fabricating a calibration curve. Alternatively, such a linearisation can be carried out by the help of a computer or a programmable logic controller.

A medium can **become unmeasurable** when the moisture content is so high that the medium cannot absorb any more water but starts to saturate, which is when the water begins to run out of the medium. In such cases we stop calling it 'the water content of the medium' but instead talk of 'the solid content of the medium'. We suggest using the Werne & Thiel "OLAS" (Optical Light Absorption Sensor) for measuring the solid content of such media.

For media containing **very little water** (e.g. synthetic materials, where the water content may go down to the ppm region) the resulting dielectric constant of the mixture will show only very little changes. So, a huge gain would be necessary to generate a proper output signal, which makes no sense, because drift effects and other measuring errors would also be amplified by this huge gain. So, media of very little moisture should not be measured by our moisture probes. We suggest using an appropriate laboratory equipment (e.g. the Werne & Thiel "MB45") to carry out the measurements then.

## 4. Construction details

- All Werne & Thiel moisture probes are built inside robust stainless steel casings. The required supporting fixtures are also made of stainless steel. The mature measuring electronics is very compact and constructed using the latest SMD technology.
- The measuring electronics of the probe is fully potted inside a special casing guaranteeing a high mechanical and electronic stability for the application in extremely adverse conditions like the vibrating conveyor.
- The moisture probes comply with the IP68 protection standard. Moisture probe type FS1 complies with standard IP50.
- All moisture probes can be fitted with "0" and "%" calibration trimmers, optionally. These are accessible through a water tight cover at the rear of the casing or are mounted in an external trimmer box.
- The standard supply voltage is +/- 15V. +24V powered probes are also available.
- A 3m long 5-pole shielded cable with wire end ferrules is supplied for connecting the probe. An optional version with plug connector is also available. The new moisture probes containing the M12 male panel connector are supplied with a separate, 4m long cable.

**The measuring surface can be made of the following abrasion protection materials:**

Probe surface	Properties
<b>Synthetic material</b> (standard)	Special synthetic material for standard applications. Very little water absorption, good sliding characteristics and good abrasion resistance compared to other plastics. Not suited for highly abrasive materials.
<b>Ceramic</b> (replaceable)	Extremely hard. Extremely good abrasion resistance, but brittle. Risk of cracks from hitting stones or similar.
<b>Rubber</b> (replaceable)	Special elastic material. Good abrasion resistance. No risk of cracks.
<b>Teflon</b> (replaceable)	No adhesion of sticky materials. Also, often used in the food industry.

## **5. Temperature sensor for the material**

Optionally, moisture probes with built-in PT100 temperature sensor for monitoring the temperature of the medium (four conductor system) are available. The temperature sensor is located centrally behind the measuring surface of the moisture probe. Probes containing this temperature sensor come with an 8-pole shielded cable.

Of course, such a built-in temperature sensor would not measure the temperature of the medium very precisely because of the self heating of the probe and eventual delay effects of the thermal conduction through the surface of probe. For very precise temperature measurements an external temperature sensor (e.g. Werne & Thiel type "TS10") should be used. (Due to the very low power dissipation of our moisture probes the self heating is very low.)

## 6. Mounting instructions

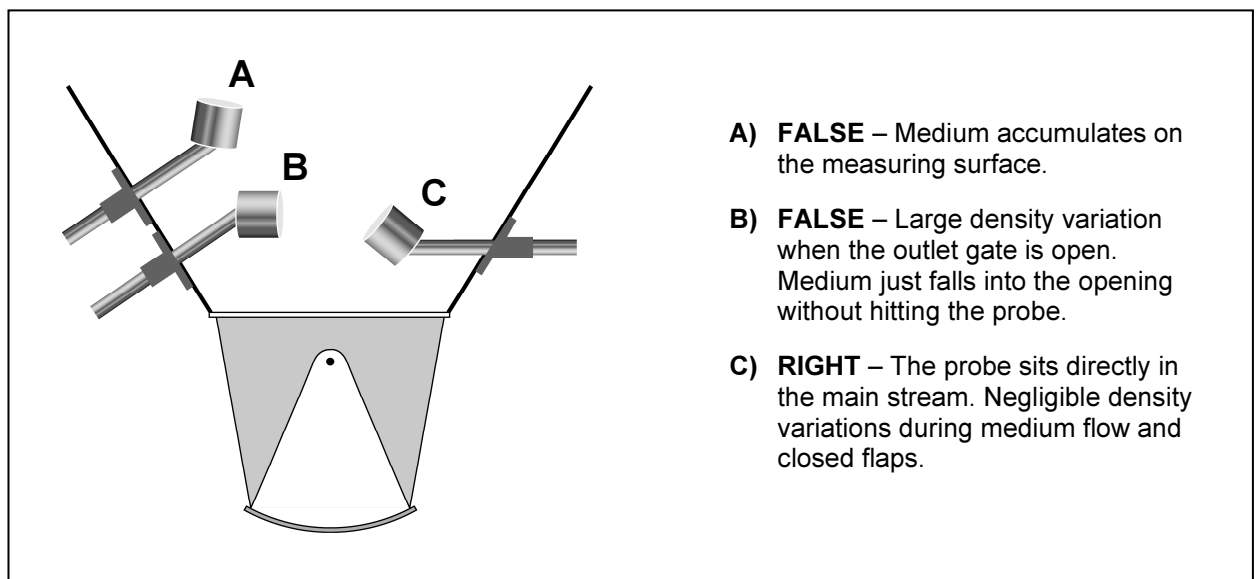
**Finding the right place for the sensor is of great importance for obtaining optimum measurement results!**

### Arm mounted probe (FSA) (see figure 1...3)

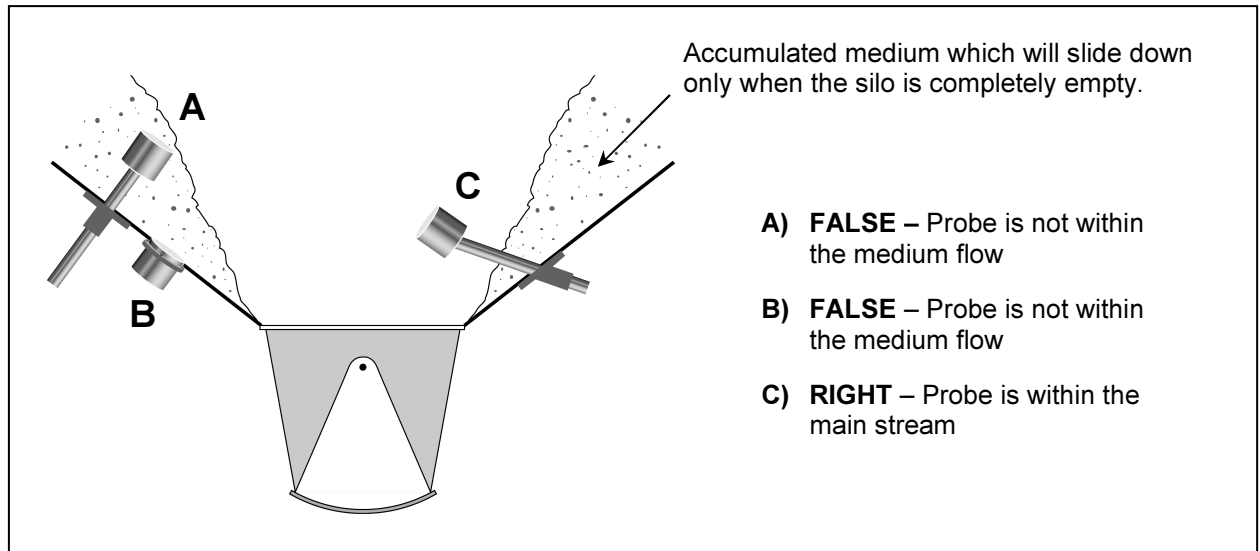
- The “head” of moisture probe is mounted at an angle of 45° to the arm. By turning the mounting arm it is possible to continuously adjust the angle between the measuring surface of the probe and the material flow.
- The measuring surface of the probe should make an angle of 35° to 50° to the direction of the flow of material. A marking at the rear end of the arm indicates the inclination of the measuring surface of the probe.
- The standard mounting plate is at an angle of 90° to the arm. Alternatively, also a 60° mounting bracket is available.
- The arm mounted probe (FSA) is also available with external calibration trimmers (“0” and “%”). They allow the measuring range of the probe to be varied for all the different kinds of materials. Standardly the probe is factory calibrated for sand.
- The head of moisture probe should be located 50...70cm above the discharge opening of silo.
- To simplify the fabricating of the mounting holes and the opening for the arm self sticking templates are supplied.
- The arm mounted probe can even be installed in a silo entirely filled with sand, as the sand does not flow out of the mounting hole (if the sand is not too dry). It is, however, necessary to hollow out the sand before inserting the probe.

**Tip:** Insert a tube with a smooth surface through the mounting hole and remove the excess sand.

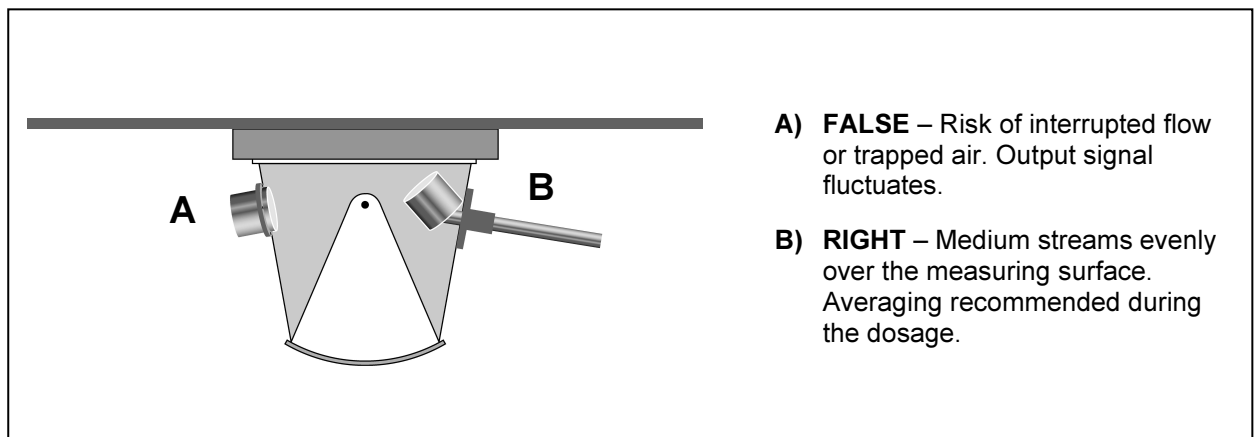
**Figure 1**



**Figure 2**



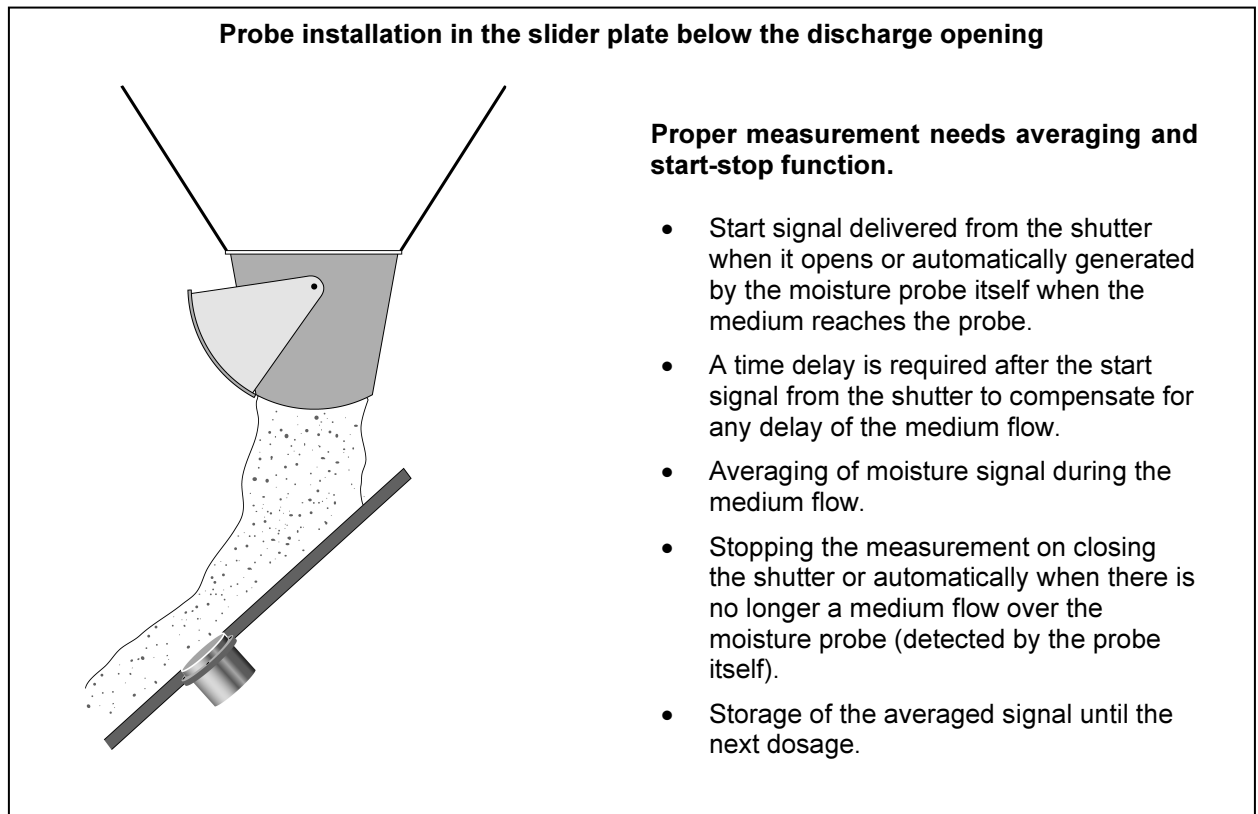
**Figure 3**





**Installation in the slider plate (FS1, FSV)** (see figure 4)

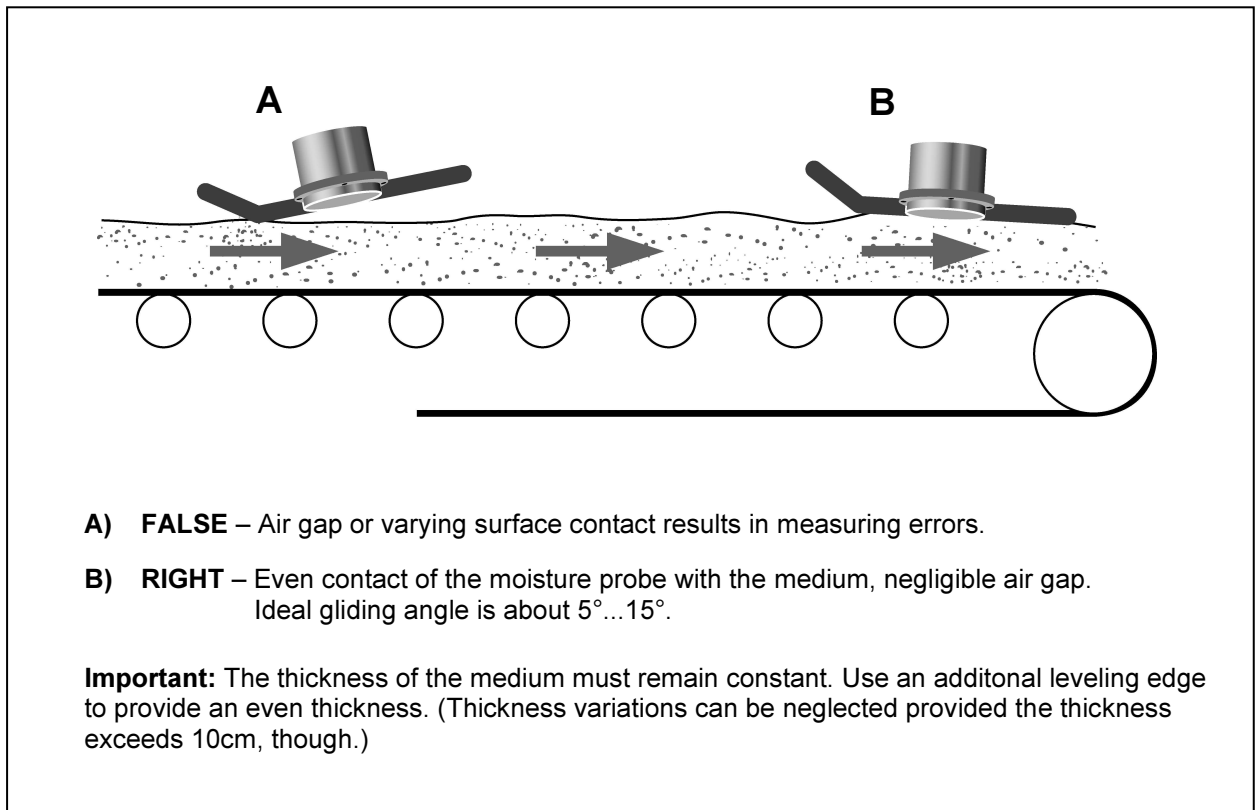
**Figure 4**



**Measurements on the conveyor belt using the glider (FS1, FSV)** (see figure 5)

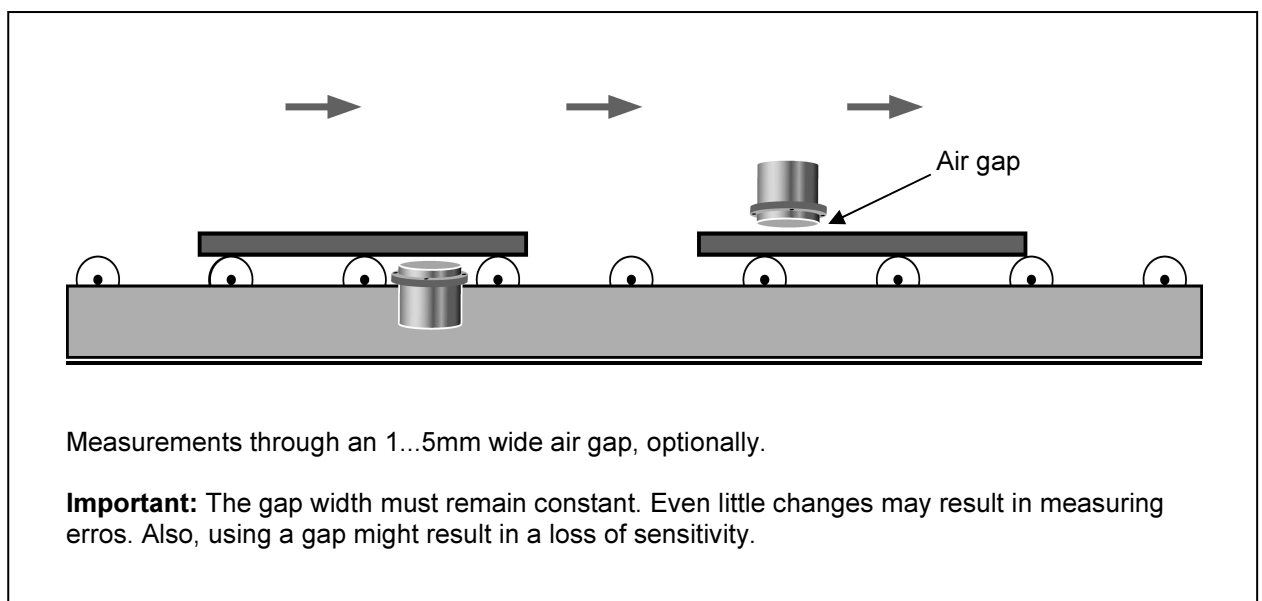
- The measuring surface of the probe must sit flush with the surface of the glider forming a continuous plane without gaps and steps.
- The surface of the glider should make an angle of 5°...15° against the direction of the medium flow.
- The adjusted angle should remain constant even if the thickness of the flowing medium undergoes changes. The mounting of the glider must be able to accept these thickness variations.
- Optionally, when measuring sticky materials, the glider together with the probe can be factory-coated with Teflon.

**Figure 5**



**Measurement of plates and slabs moving on roller conveyers** (see figure 6)

**Figure 6**



### **Mounting instructions for the mixer probe (FSM)**

- The probe must be positioned in such a way that always enough medium is in contact with the measuring surface of the probe while the mixer is in motion.
- For pan type mixers it is recommended to mount the probe on the mixing tray. For horizontal mixers the probe should be mounted on the front wall of the container.
- Eventual peaks in the signal due to the mixer arm can be suppressed by a suited processing electronics (setting of a limit, averaging, etc.). The Werne & Thiel averaging processor "MB1" can be used for this task.

### **Mounting instructions for the high temperature probe (FSH)**

- The mounting of the FSH probe is similar to the mounting of the FS1 and FSV probes.
- Only the front part of the FSH probe containing the measuring surface can withstand a temperature of +190°C max. The rear part of the probe containing the electronics should not be exposed to temperatures over +80°C.

### **ATTENTION**

- **During any welding work the probes must be fully disconnected electrically.**
- **When positioning the moisture probe inside a silo heating the probe above +80°C by external heating units must be avoided.**

## **7. Calibration of the moisture probe**

The calibration of the Werne & Thiel moisture probes is done by the help of two calibration trimmers, called "0" and "%".

The "0" trimmer is for adjusting the offset of internal signal and the "%" trimmer is for adjusting the amplification or the slope of the calibration curve. We also offer moisture probes without these trimmers. These are factory calibrated for sand and cannot be recalibrated for other materials.

The calibration of moisture probes always highly depend on the material to be measured and, to a certain degree, depends on the mounting condition of the moisture probe. So, each material has its unique calibration and no standard calibration can be given being valid for all the different materials.

For the calibration two samples of the medium are necessary, one sample providing a low water content of the medium (dry sample) and a second sample providing a high water content (wet sample). The samples should show representative moistures as they are expected in the later application.

By alternately placing the probe in the dry sample and the wet sample the calibration curve is adjusted: When applying the dry sample turn always the "0" trimmer and adjust the output signal of moisture probe to the lower moisture value of the dry sample, e.g. 2.3V for 2.3% moisture. When applying the wet sample turn always the "%" trimmer and adjust the output signal of moisture probe to the higher moisture value of the wet sample, e.g. 7.4V for 7.4% moisture. The "0" trimmer shifts the output signal up or down, whereas the "%" trimmer changes the gain of the internal signal amplification.

Because the settings of the two calibration trimmers influence each other, you should apply the dry and wet sample to the moisture probe a couple of times and refine the trimmer settings with each step. A suited sequence could be: "Dry sample, wet sample, dry sample and wet sample".

In the little example above with  $2.3V = 2.3\%$  moisture and  $7.4V = 7.4\%$  moisture,  $0V$  would represent  $0\%$  moisture and  $10V$  a moisture of  $10\%$ . Of course, other ranges are also possible, like  $0V = 0\%$  moisture and  $10V = 20\%$  moisture, e.g. Then,  $5V$  would mean a moisture of  $10\%$ .

### **Some hints and tips**

- When bringing the moisture probe in contact with the sample take care that there's enough of the medium around and in front of the moisture probe. A minimum of 10cm in each direction is recommended. Use a vessel made of synthetic material. Don't have metallic objects near the moisture probe during the calibration.
- Prepare the sample by forming a smooth surface and push the probe into the medium with slight pressure.
- The sensor surface should be cleaned when changing from the dry sample to the wet sample and vice versa.
- For many materials the absorbed water tends to settle down to the bottom of the vessel after some time. On the other hand, evaporation may change the moisture at the surface of the sample after a while. For these reasons the samples should be well stirred and mixed before each calibration.
- When not being used the vessels with the samples should be kept covered or even sealed. Don't place them under direct sun light, either.
- Have the same measuring conditions for both samples.

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- If the FSA, FSH, FSM or FSV moisture probe shall be mounted in the application sitting flush with a metallic surface, carry out the calibration with the according clamping ring or welding ring temporarily mounted on the probe. This ring should also sit flush with the surface of the moisture probe and will by this imitate the metallic surface of the application which results in a better calibration.
- If the Werne & Thiel moisture signal processor “FMP2” is used for the calibration, the moisture curve “0” should be selected. The displayed value in % then corresponds to the probe’s output voltage in Volt.
- The above two-point-calibration is only valid for materials for which the probe signal is linearly varying with the moisture which is the situation for the very most materials, like sand, e.g. For non-linear signals multiple samples with well defined moistures are required. With the help of integrated calibration trimmers “0” and “%” merely the measurement window of the moisture probe is adjusted. A following electronic processing unit (e.g. Werne & Thiel moisture measurement processor “FMP2”) or a programmable logic controller with a stored calibration curve can then be used to determine the actual moisture.
- Every moisture probe must be properly calibrated by the help of “0” and “%” trimmers, even if the signal is manipulated, corrected or linearized by any following processing electronics afterwards. The probe should at least be precalibrated in such a way that the output signal of the probe can swing in the range of interest. The signal of an improperly calibrated moisture probe running into saturation, on the other hand, cannot be corrected by any following signal stages.

## **8. Example calibration for sand**

Let's have an example. We want to calibrate the moisture probe for sand. The calibration of the probe is done in two steps:

- (1) "Ideal" calibration. Calibration with prepared samples in vessels under ideal conditions.
- (2) "In place" correction. Correction of the "ideal" calibration with the moisture probe sitting in the actual mounting place.

The second step is necessary because metallic objects near the moisture probe can influence the measuring field and by this the calibration. Also, the medium flow in the actual application might be different to what the moisture probe "sees" during the calibration with the vessels. So, the moisture probe could see more or less medium in the application compared to the calibration with the vessels. Or the density of the medium could vary due to a certain amount of trapped air which wasn't present during the calibration with the vessels. Or there's much more pressure in the final application, compressing the medium much more and resulting in a higher density of the medium, which is especially valid if an elastic material is to be measured.

Fortunately, in most situations a correction of the "ideal" calibration isn't necessary at all.

### **Preparing the samples**

Before starting the calibration we must prepare two samples, a "dry" sample and a "wet" sample. We take about 20 liter of wet sand, mix it thoroughly, divide it into two identical portions and put them into two identical plastic vessels. We seal both vessels and store them at a cool place. No moisture must escape from the vessels.

We take one of the vessels and carry out a laboratory analysis to determine the moisture of the sample. So, we measure the weight of the vessel with the wet sand ("moist weight"), dry it completely in an oven and measure again the weight of the vessel with the dry sand ("dry weight"). Afterwards we immediately seal the vessel with the dry sand again, so that no air humidity can increase the moisture of the dry sand.

### **Determination of the moisture content of the sample**

From these two weights we find the moisture of the sample by the following formula:

$$\text{Moisture} = ((\text{Moist weight} - \text{Dry weight}) / \text{Dry weight}) \times 100\%$$

Assume that the sample had a moisture of 7.4%. Now we have two samples: A dry sand sample with about 0% moisture and wet sand sample of 7.4% moisture. Remember, the sand moisture was identical in the two vessels.

### **"Ideal" calibration**

We switch on the probe and wait at least 10 minutes before starting the calibration (thermal equilibrium inside the moisture probe).

We allow the dry sand to completely cool down. During the calibration both samples must have the same temperature (e.g. room temperature.)

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#### “Ideal” calibration with the dry sand sample

We remove the seal from the vessel with the dry sand, mix the medium and form a smooth surface. The moisture probe is then first placed on the top of the surface of the sample and is then pushed in with light twisting motions of the hand. A light pressure is applied to the moisture probe with the hand during this procedure. The probe is then released from the hand without lifting or moving it.

Adjust the “0” trimmer until the output signal of moisture probe shows the correct “moisture”, which is 0V for the 0% moisture of the dry sand sample.

#### “Ideal” calibration with the wet sand sample

We remove the seal from the vessel with the wet sand, mix the medium and form a smooth surface. The moisture probe is then first placed on the top of the surface of the sample and is then pushed in with light twisting motions of the hand. A light pressure is applied to the moisture probe with the hand during this procedure. The probe is then released from the hand without lifting or moving it.

Now adjust the “%” trimmer until the output signal of moisture probe shows the correct “moisture”, which is 7.4V for the 7.4% moisture of the wet sand sample.

Because the trimmer settings influence each other you should repeat this procedure. A suited sequence would be: “Dry sample, wet sample, dry sample and wet sample”.

#### **Again some hints and tips**

- When bringing the moisture probe in contact with the sample, take care that there’s enough of the medium around and in front of the moisture probe. A minimum of 10cm in each direction is recommended. Use a vessel made of synthetic material. Don’t have metallic objects near the moisture probe during the calibration.
- The probe surface should be cleaned when changing from the dry sample to the wet sample and vice versa.
- For sand the absorbed water tends to settle down to the bottom of the vessel after some time. On the other hand, evaporation may change the moisture at the surface of the sample after a while. For these reasons the samples should be well stirred and mixed before each calibration.
- When not being used the vessels with the samples should be kept covered or even sealed. Don’t place them under direct sun light, either.
- Have the same measuring conditions for both samples.
- If the FSA, FSH, FSM or FSV moisture probe shall be mounted in the application sitting flush with a metallic surface, carry out the calibration with the according clamping ring or welding ring temporarily mounted on the probe. This ring should also sit flush with the surface of the moisture probe and will by this imitate the metallic surface of the application, which results in a better calibration.

#### **“In place” correction at the sand silo**

Now install the moisture probe at the final mounting place at the silo and switch it on. Allow moist sand to flow over the moisture probe and note the output signal. At the same time collect a representative sample of the sand and determine its moisture in the laboratory by using the drying method. If there is a difference between the measured moisture and the reference from the laboratory, slightly adjust the “%” trimmer. But take care: Only very little corrections should be done at this step, if at all. Allow also some measurement errors and carry out a correction only, if several checkings in a row showed the same tendency, e.g. “measuring signal always too high”.

It’s interesting to note, that, if at all, only the “%” trimmer needs to be adjusted during “in place” corrections.

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## 9. Type designation

# FS-X- X- X- X- X- X

Type	Option model	Remarks
<b>U</b>	Signal output 0...10V	Standard
<b>I</b>	Signal output 0...20mA	
<b>I4</b>	Signal output 4...20mA	
<b>UT</b>	Signal output 0...10V, integrated PT100	
<b>IT</b>	Signal output 0...20mA, integrated PT100	
<b>I4T</b>	Signal output 4...20mA, integrated PT100	
<b>X</b>	Surface made of synthetic material	Standard
<b>K</b>	Ceramic surface	
<b>TF</b>	Teflon surface	
<b>G</b>	Rubber surface	
<b>X</b>	Without calibration trimmers	Standard
<b>T</b>	Integrated calibration trimmers	
<b>TE</b>	Calibration trimmers in external trimmer box	
<b>G50</b>	Max. operational temperature +50°C	Standard
<b>G80</b>	Max. operational temperature +80°C	
<b>G190</b>	Max. operational temperature +190°C Also possible: <b>G120, G14, G160</b>	Ceramic surface (standard)
<b>15</b>	±15V DC supply	Standard
<b>30</b>	+24V DC supply	
<b>18H</b>	Compatible with old "18V probe"	only FS1, FSV, FSA
<b>1</b>	Disc probe with fixed flange	
<b>V</b>	Adjustable probe	
<b>A</b>	Arm mounted probe (0.2m, 0.5m or 1m)	
<b>M</b>	Mixer probe	Ceramic surface
<b>H</b>	High temperature probe (max. +190°C)	Ceramic surface

Please order necessary accessories (clamping ring, mounting ring, reinforcing tube, etc.) separately.

### Example: FSV-30-G80-T-K-IT

"Adjustable probe FSV, +24V DC supply, ambient temperature up to 80°C, integrated "0" and "%" trimmers, ceramic measuring surface, signal output 0...20mA and integrated temperature sensor PT100."



## **10. Technical data**

<b>Supply voltage</b>	+/-15V DC (allowed tolerance +/-0.5V) +24V DC (+9V...+32V), optional
<b>Supply current</b> (+/-15V probe)	max. 30mA (+15V, voltage output) max. 30mA (-15V, voltage output) max. 50mA (+15V, current output) max. 30mA (-15V, current output)
<b>Recommended fuses</b> (+/-15V probe)	"50mA T" in the +15V supply line and "50mA T" in the -15V supply line
<b>Supply current</b> (+24V probe)	max. 170mA (+10V supply) max. 130mA (+15V supply) max. 75mA (+24V supply) max. 60mA (+30V supply)
<b>Recommended fuses</b> (+24V probe)	"315mA T" in the +24V supply line
<b>Nominal signal output</b>	0...10V (into a load $\geq 10k\Omega$ ) 0/4...20mA (into a load $\leq 500\Omega$ ), optional
<b>Maximum signal output</b>	-0.7... $\approx$ 13V (voltage output) 0/4...24mA (current output)
<b>Source resistance</b>	50 $\Omega$ (voltage output) $\infty$ (current output)
<b>Maximum load current</b>	internally limited to $\leq 7mA$ (voltage output) internally limited to $\leq 24mA$ (current output)
<b>Probe calibration</b>	by "0" and "%" calibration trimmers, optional. Accessible through a water tight cover or sitting in an external trimmer box.
<b>Protection</b>	against overvoltage, reverse polarity and short-circuit at the output, provided that fuses are inserted in the supply lines. All inputs and outputs are protected against EMI, ESD, Burst and Surge.
<b>Operational temperature</b>	$\approx 0^{\circ}C$ ...+50 $^{\circ}C$ (G50 probe, standard) $\approx 0^{\circ}C$ ...+80 $^{\circ}C$ (G80 probe, optional) FSH probe: $\approx 0^{\circ}C$ ...+190 $^{\circ}C$ at the measuring surface. Max. +80 $^{\circ}C$ at the backside.
<b>Storage temperature</b>	-25 $^{\circ}C$ ...+80 $^{\circ}C$
<b>Protection class</b>	IP 68 (FSV, FSA, FSM, FSH) IP 50 (FS1)
<b>Temperature sensor</b>	Internal PT100 sensor, optional.
<b>Cable</b>	5 x 0.22 mm <sup>2</sup> , shielded, with wire end ferrules. Plug is optional.
<b>Conformance</b>	conforms to CE standard EMV89/336EWG

### **Abrasion protection of the measuring surface**

Standard:	Special synthetic material. Very little water absorption, good sliding characteristics and good abrasion resistance compared to other plastics.
Ceramic:	3 mm thick, extremely good abrasion resistance, but brittle. Danger of cracks.
Rubber:	Special elastic material. Good abrasion resistance and no danger of cracks.
Teflon:	No adhesion of sticky materials. Also for the use in the food industry.

FSM probe is always supplied with 10mm thick ceramic abrasion protection.

FSH probe is always supplied with 3mm thick ceramic abrasion protection.

Our measuring probes show very little adhesion to most media and are kind of "self cleanig" supported by the medium flow.

### **Installation depth**

FS1:	9 mm (synthetic material abrasion protection), 11 mm (ceramic, rubber or Teflon abrasion protection)
FSV, FSH:	Continuously adjustable from 0...50mm
FSA:	Continuously adustable over a wide range (arm lengths 0.2m, 0.5m or 1m)
FSM:	Continuously adjustable at the welding ring

### **Mounting options**

FS1:	Disc probe, with a fixed flange containing three mounting holes.
FSV, FSH:	Stainless steel clamping ring, continuously adjustable.
FSA:	Mounting bracket for the arm mounted probe. Extension of the arm can be adjusted. Massive and stable construction. Stainless steel finishing.
FSM:	Massive welding ring made of stainless steel. A 8mm thick stainless steel reinforcing tube is mounted around the probe to give additional abrasion protection. It is supported by the welding ring and can also be made of hardened steel.

## 11. Connector pinouts

Standard probes have a 5 pole plug.

Probes with built-in PT100 or external trimmer box have an 8 pole plug.

Probes with built-in PT100 and external trimmer box have a 12 pole plug.

### Connector pinout for probes with mounted M12 plug

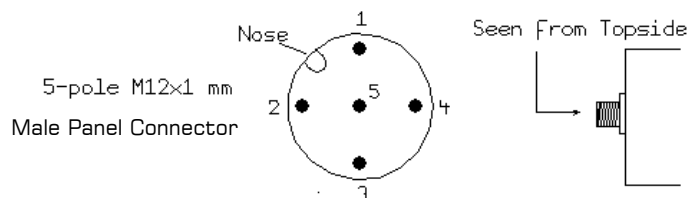
All new probes are fabricated with a male panel connector M12. (Excepted for he FS1 probe, which comes with a mounted cable.)

The probe cable (4m long) with mounted female coupling connector M12 and wire end ferrules is supplied with the moisture probe.

#### 5-pole plug pinout

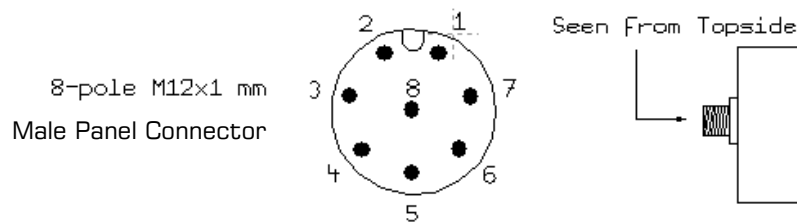


Backside of FSV, showing the male panel connector M12 and the protection cap.



Pin No.	Werne & Thiel Colours	Standard M12 Cable Colours	Wiring
1	white	brown	+24V DC (+15V)
2	brown	white	(-15V)
3	green	blue	Signal Output
4	yellow	black	not used
5	grey	grey (yellow/green)	0V

#### 8-pole plug pinout



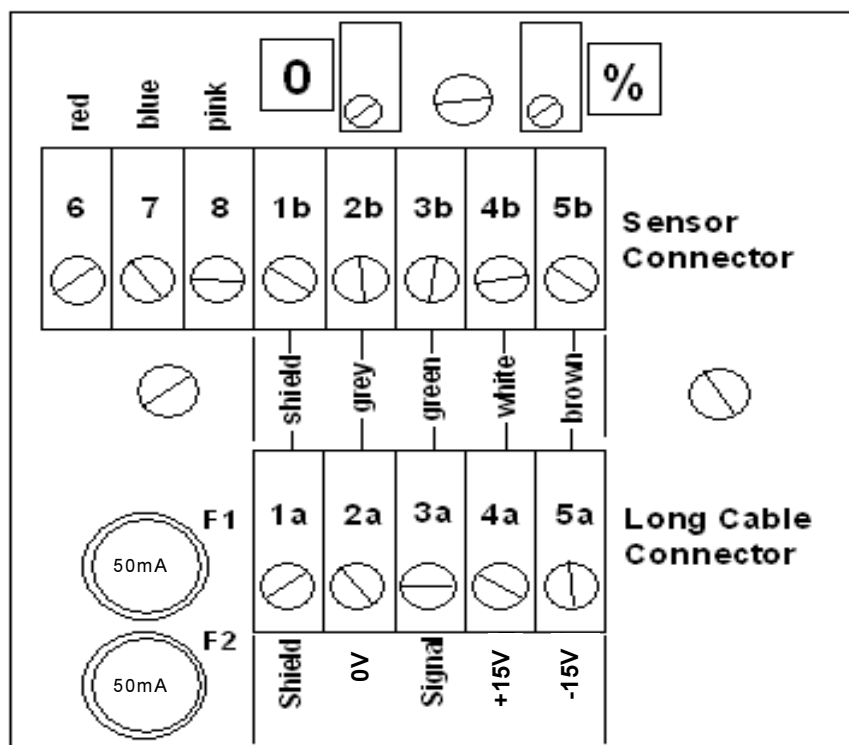
Pin No.	Werne & Thiel Colours	Standard M12 Colours	Wiring with ext. $\emptyset$ and $\frac{1}{2}$ -Trimmers	Wiring with PT100 - Sensor
1	white	grey	+24V DC (+15V)	+24V DC (+15V)
2	brown	white	(-15V)	(-15V)
3	green	black	Signal Output	Signal Output
4	yellow	blue	not used	PT100 (2-2)
5	grey	brown	0V	0V
6	pink	violet	$\frac{1}{2}$ -Trimmer Pin 1	PT100 (1-1)
7	blue	orange	$\emptyset$ + $\frac{1}{2}$ -Trimmer Pins 2	PT100 (2-1)
8	red	pink	$\emptyset$ -Trimmer Pin 3	PT100 (1-2)

## External trimmer box

There are applications where the moisture probe isn't accessible by the operator and the built-in calibration trimmers cannot be used. For these situations an optional external trimmer box is available which allows the remote calibration of our moisture probes over a 4m long cable. The FS1, FSV, FSM and FSH probes can be ordered with this optional external trimmer box. The FSA probe is fabricated without internal calibration trimmers. If a calibration by the customer is desired, this can only be done by the help of the external trimmer box.

The trimmer box is shipped with the probe cable mounted.

## External trimmer box connector pinout for +/-15V probes



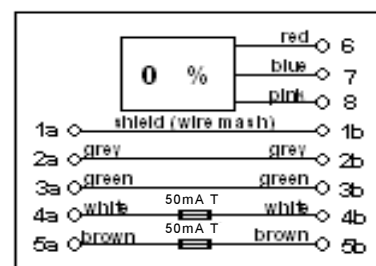
### Sensor connector:

Pin	Connection	colour
1b	Shield	black(wire mesh)
2b	0V	grey
3b	Sensor signal	green
4b	+15V	white
5b	-15V	brown
6	external adjustment	red
7	external adjustment	blue
8	external adjustment	pink

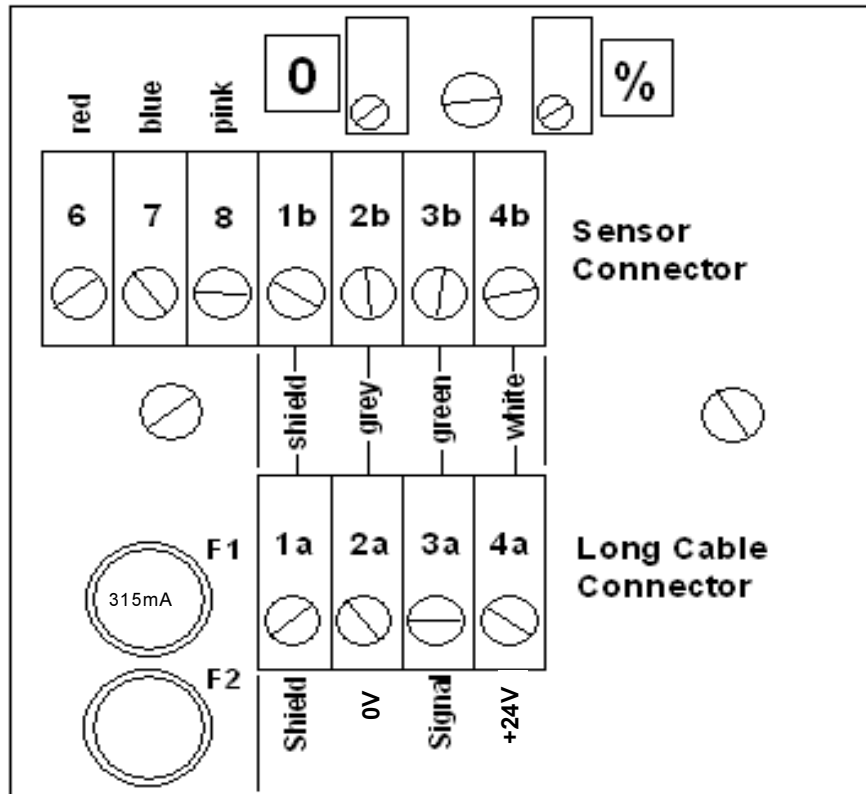
### Long cable connection:

Pin	Connection	colour
1a	Shield	black(wire mesh)
2a	0V	grey
3a	Sensor signal	green
4a	+15V	white
5a	-15V	brown

### Wiring diagram



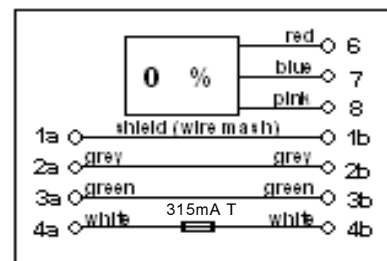
**External trimmer box connector pinout for +24V probes**



**Sensor connector:**

Pin	Connection	colour
1b	Shield	black(wire mesh)
2b	0V	grey
3b	Sensor signal	green
4b	+24V	white
6	external adjustment	red
7	external adjustment	blue
8	external adjustment	pink

**Wiring diagram**



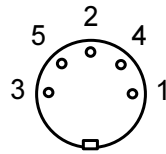
**Long cable connection:**

Pin	Connection	colour
1a	Shield	black(wire mesh)
2a	0V	grey
3a	Sensor signal	green
4a	+24V	white

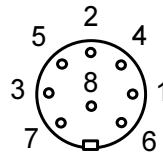
## Connector pinout for probes with mounted cables

### Connector plug (pin side view)

#### Type A:



#### Type B:



#### Probes with +/-15V Supplies:

Pin no.	Strand color
1	not used
2	Supply -15V
3	Supply +15V
4	0V
5	Signal output
	Cable shield

#### Probes with +/-15V Supplies and PT100:

Pin no.	Strand color
1	PT100 (1-1)
2	Supply -15V
3	Supply +15V
4	0V
5	Signal output
6	PT100 (1-2)
7	PT100 (2-1)
8	PT100 (2-2)
	Cable shield

#### Probes with +24V Supply:

Pin no.	Strand color
1	not used
2	not used
3	Supply +24V
4	0V
5	Signal output
	Cable shield

#### Probes with +24V Supply and PT100:

Pin no.	Strand color
1	PT100 (1-1)
2	not used
3	Supply +24V
4	0V
5	Signal output
6	PT100 (1-2)
7	PT100 (2-1)
8	PT100 (2-2)
	Cable shield

## **12. Cabling**

Keep the moisture probe and its cable away from heavy sources of EMI, like motors, pumps, power cables, etc. A minimum distance of 0.5m is recommended. Keep also in mind, that the HF-measuring field of our moisture probe can eventually disturb other sensitive equipment.

Route the probe cable inside well grounded, metallic channels or pipes if accessible on the plant. In outdoor applications route the cable inside such well grounded channels and pipes running in the soil. If not accessible route the cable lying on the soil. Please see also chapter 13 "protection against damage by lightning".

In our moisture probes the supply voltage and the output signal share a common 0V line. This 0V line must be connected to the 0V of supply voltage of process electronics and to the 0V of signal input of the process electronics. If these 0V locations are at separate places, far away from each other, and if both separate 0V are individually grounded, then there's a certain risk of creating a ground loop. In such a case, the 0V line of moisture probe should be connected to only one of the 0V places, the 0V of the signal input preferred.

Another option is the use of a supply voltage (e.g. SELV) which has no connection to ground (floating). Alternatively, a galvanically isolated signal input (floating) could be used which has no connection to ground either.

But in the very most cases there is no problem at all, because the processing electronics usually has the signal input terminals and the power supply terminals close together at the same place.

Inside our moisture probes the 0V isn't directly connected to the metallic enclosure, but via a small capacitor. This capacitor can withstand up to 4kV for a brief period.

## **13. Protection against damage by lightning**

Sometimes, especially in outdoor installations, the moisture probe is in danger to be damaged by lightning. In addition to reducing the risk according to VDE 185, Parts 1 and 2, it is crucial to have a proper potential equalization on the plant. All metallic equipments, like control cabinets, silos, tanks, etc. must have a good connection to the ground mesh grid running in the soil under the whole area of the plant. By this, the potential difference between separate places on the plant during a lightning strike can be drastically reduced, so that the usual internal protection devices can protect the electronics without being destroyed by the lightning itself.

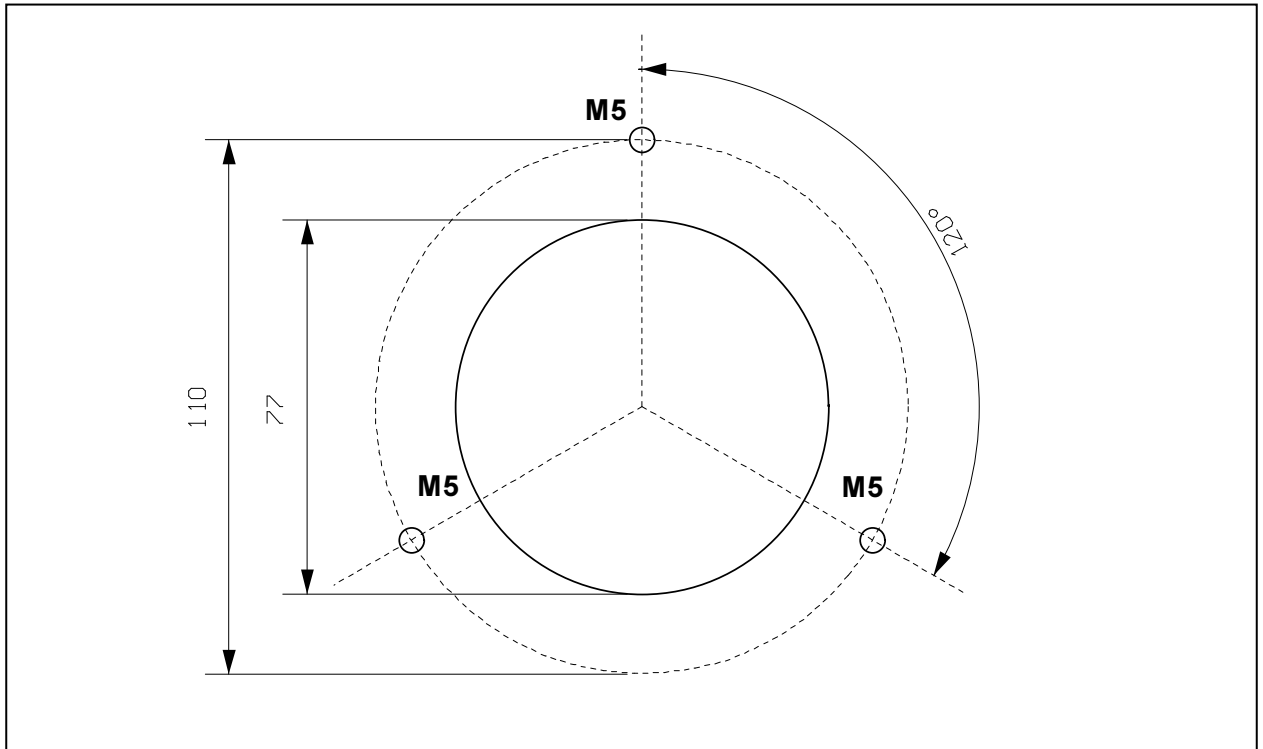
If you are not sure, whether a proper potential equalization exists on the plant, route an additional ground cable from the mounting place of the moisture probe to the process electronics. This is of special importance in an outdoor application. Connect the ground cable on the probe's end to the metal where the moisture probe is mounted on. E.g. a screw of the clamping ring is a good place. On the other end connect the ground cable to a good ground, e.g. the ground bar at the entry of control cabinet of process electronics. The additional ground cable must have a diameter of more than 3mm. Route the ground cable close to the probe cable and reduce the loop area which is formed by these two cables to a minimum.

The cable of the moisture probe has a shield, which isn't connected to the metallic enclosure of the moisture probe. The cable shield must be connected to ground at the other end of cable, near the process electronics. The ground bar at the entry of control cabinet is a perfect place for connecting the shield.

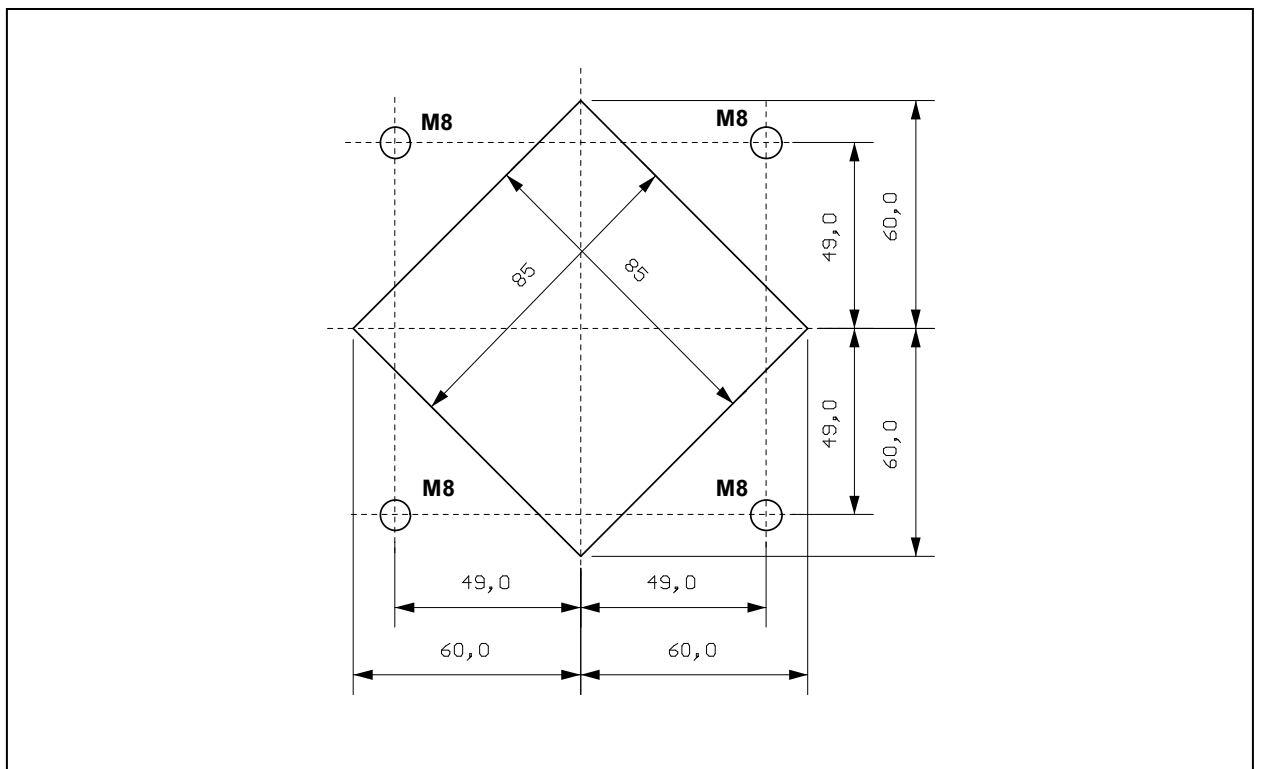
Full protection against damage by lightning is only achievable, if an external lightning protection exists, which is extended over the whole plant!

## 14. Mounting dimensions

### Adjustable probe FSV and high temperature probe FSH

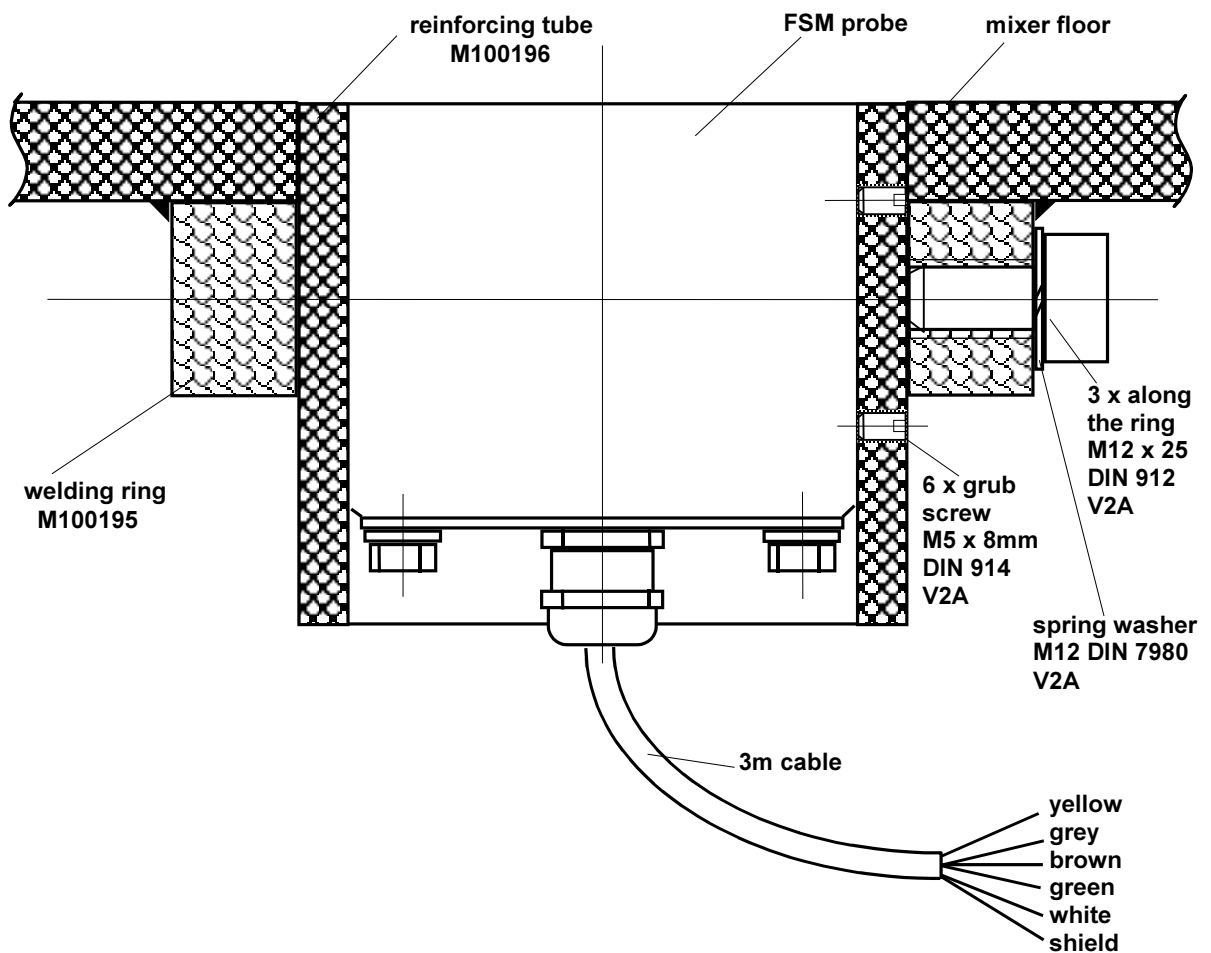
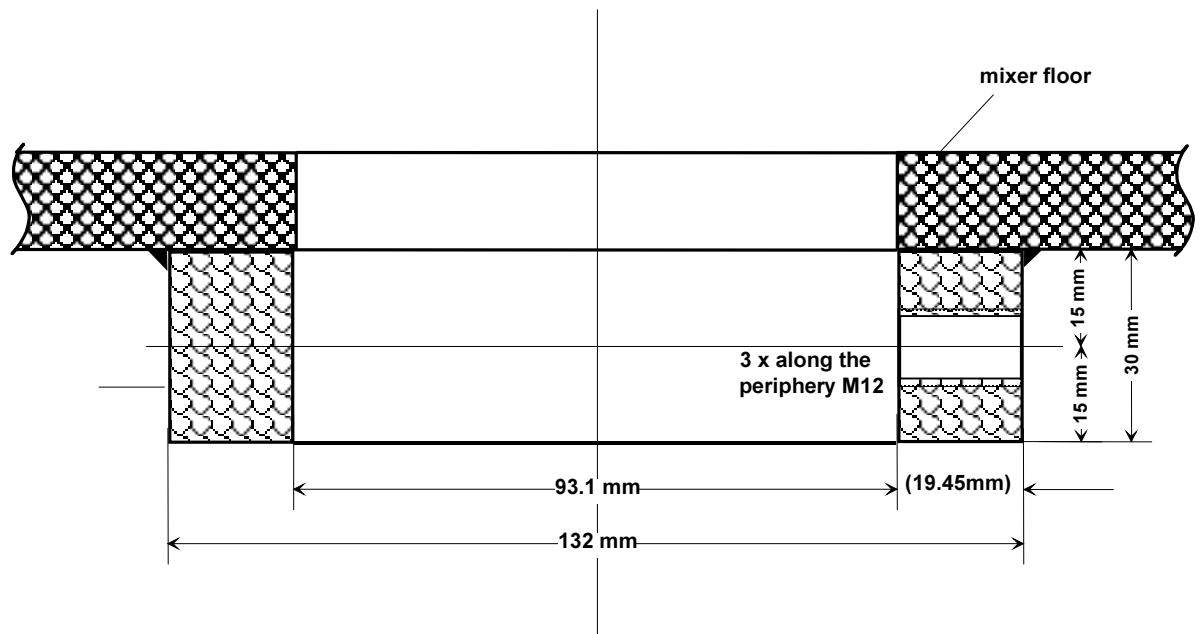


### Arm mounted probe FSA



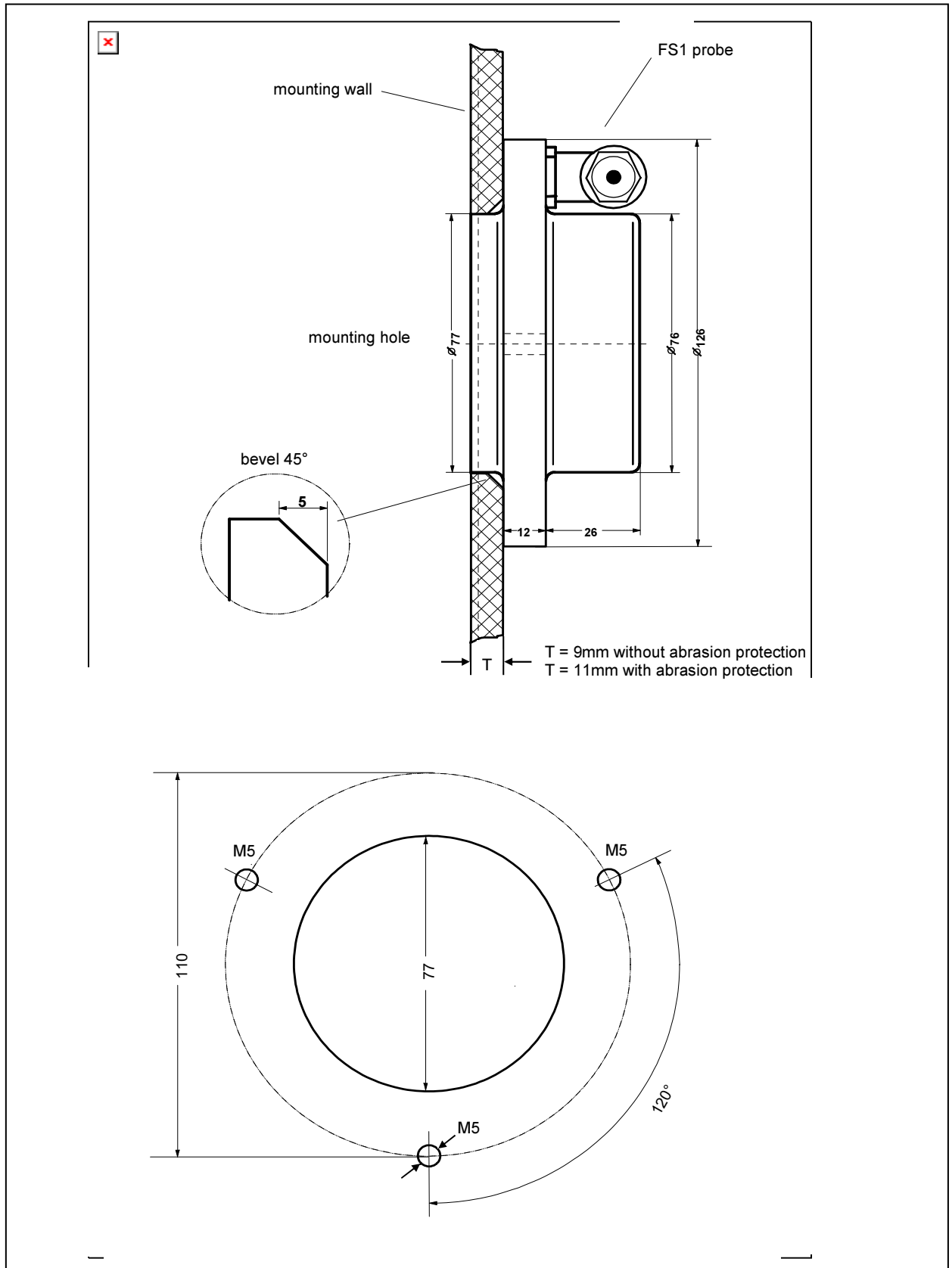


**Mixer probe FSM**



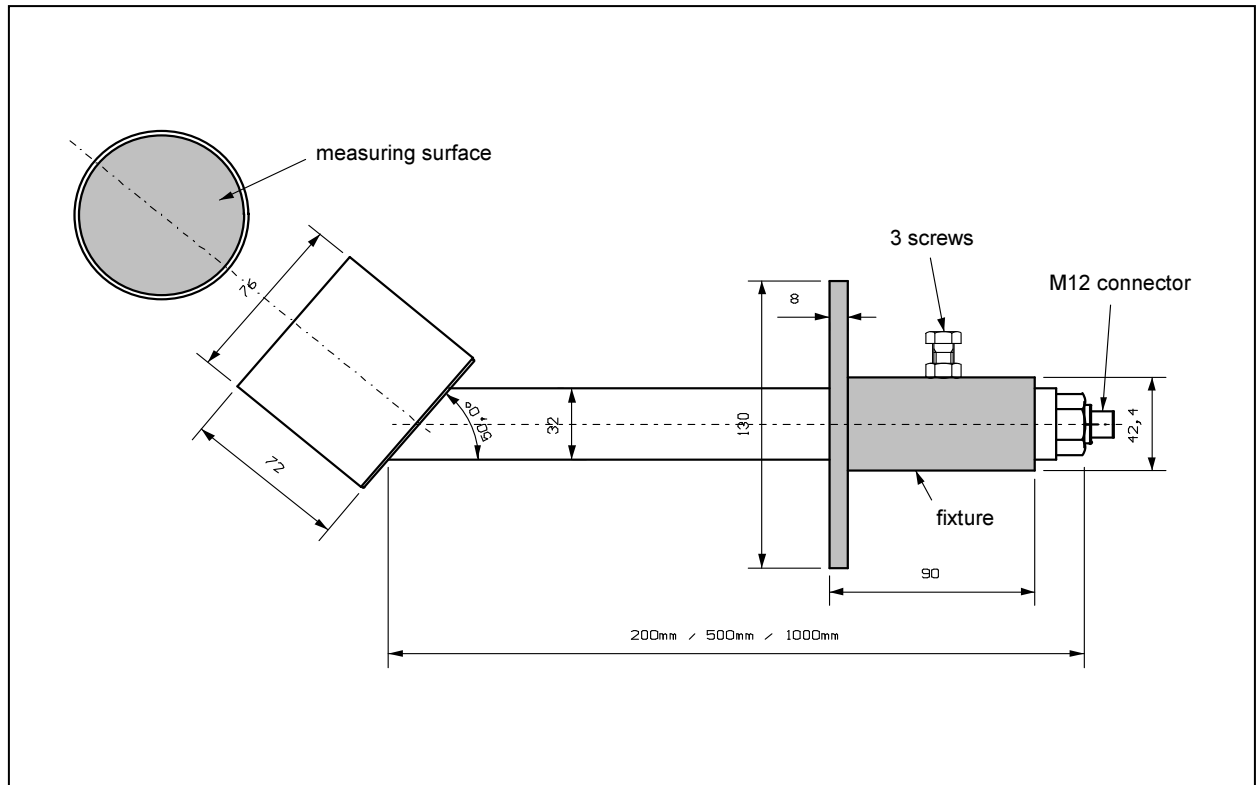
## 15. Mechanical dimensions

### FS1 probe

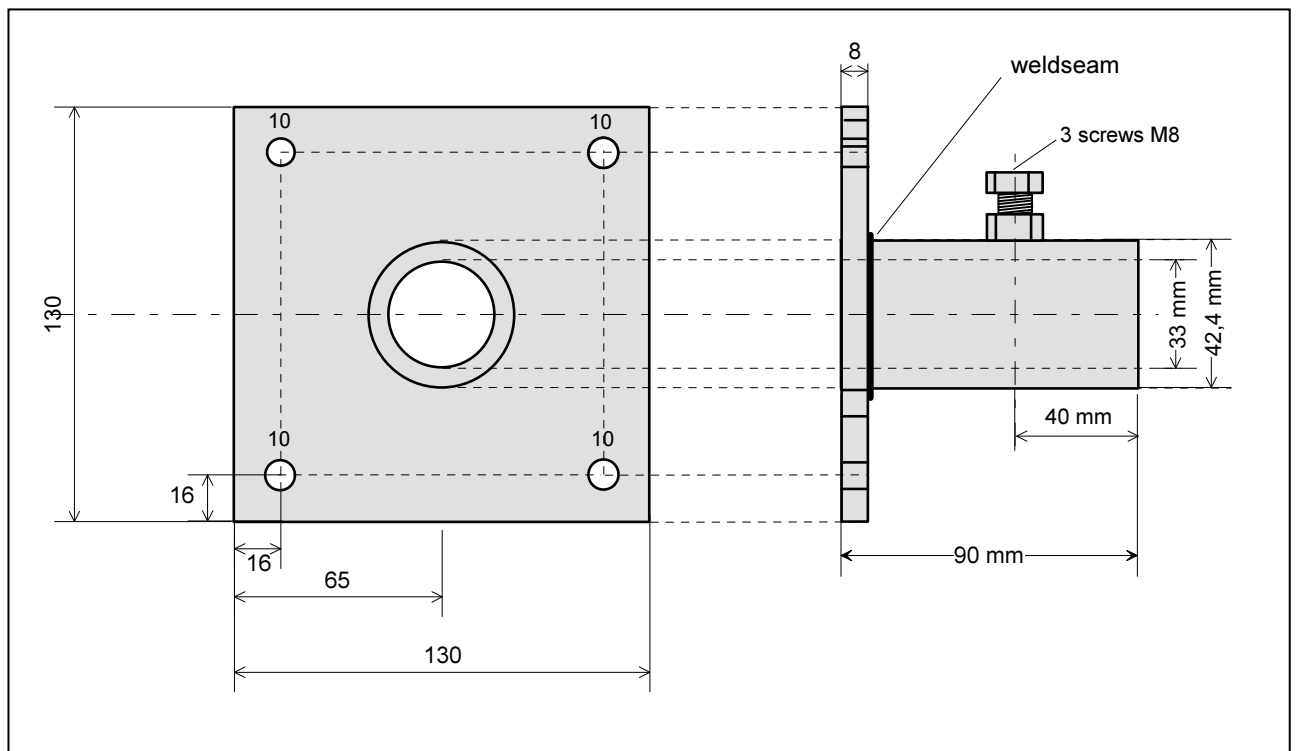


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**Arm mounted probe FSA**

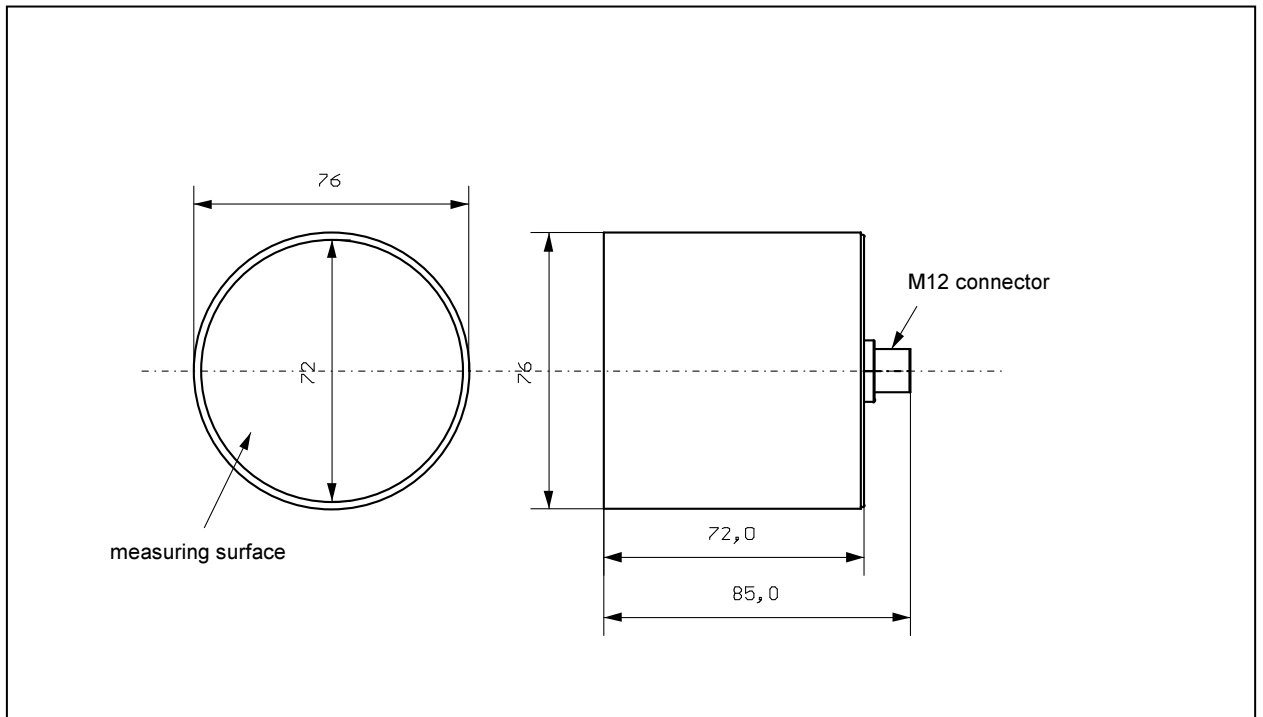


**90° fitting for the probe FSA (60° fitting optional)**

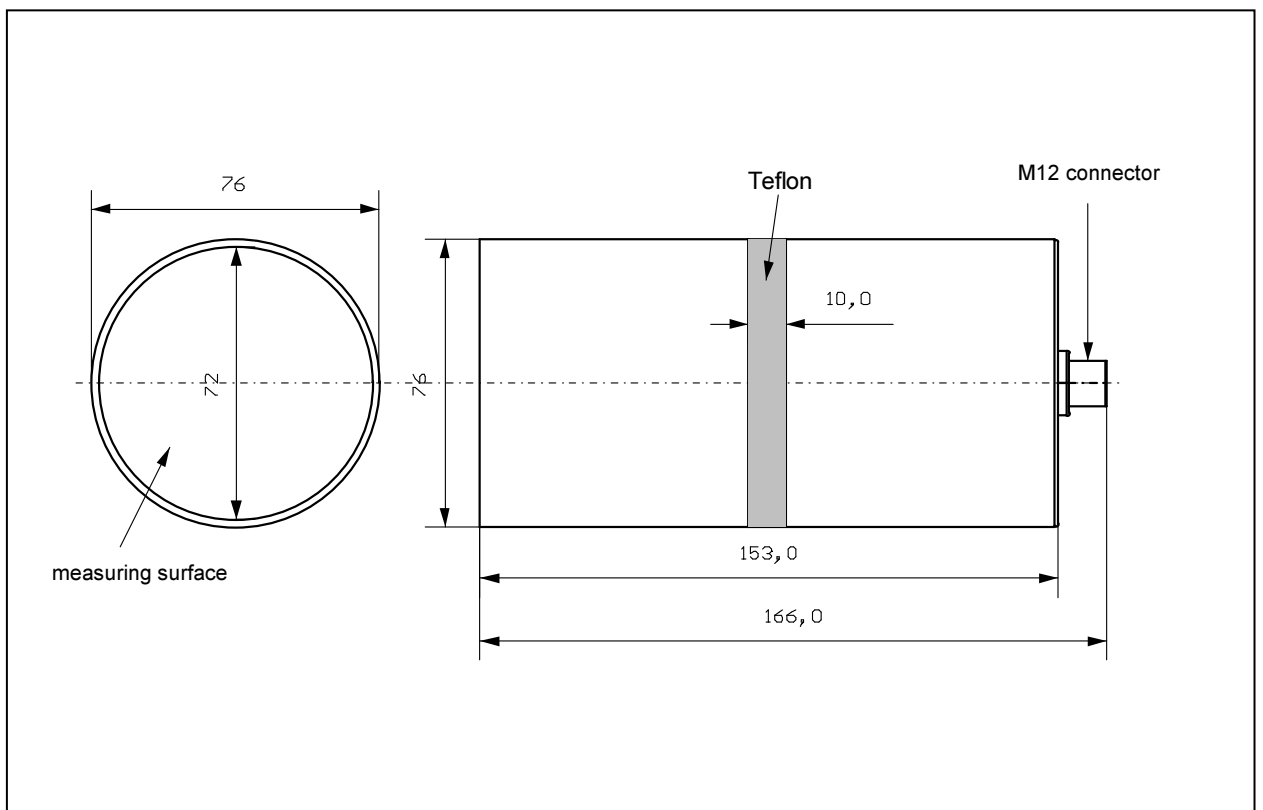


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**Adjustable probe FSV**



**High temperature probe FSH (maximum head temperature +190°C)**



## **16. Accessories**

- Clamping ring for probes FSV, FSH
- Welding ring for mixer probe FSM
- Reinforcing tube for mixer probe FSM
- Calibration disc for signal output 0 V (0% sand)
- Calibration disc for signal output 4 V (8% sand)
- Adjustable calibration disc
- Extension cable with coupling / plug
- Plug / coupling single (IP68)
- Stainless steel glider. For measurements on conveyer belts.