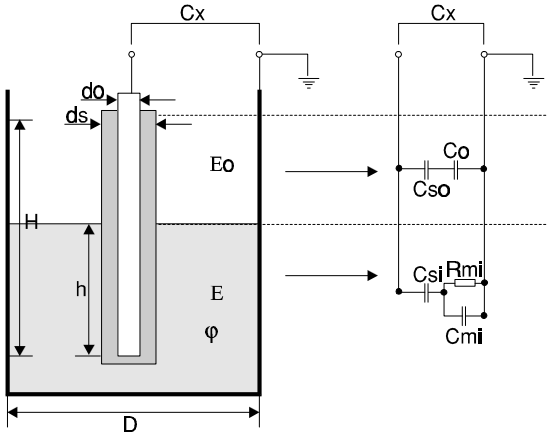
D A T A S H E E T

NIVOCAP CT-100

CAPACITANCE LEVEL TRANSMITTER
CT10-A9A4

1.PRINCIPLE OF MEASURING AND OPERATION



The NIVOCAP capacitance level transmitters are devices designed to measure the level in vessels filled with conductive or non-conductive liquids, powders, granular material. With the capacitance level metering, one armature of the condenser is represented by the insulated or uninsulated probe, the other one is formed by the metallic wall of the vessel or by an auxiliary probe (i.e. a concentric pipe around the probe or a rod close to and parallel to the probe). The dielectric is made up of the medium itself to be measured or by the insulation of the probe. The level changes may be correlated with the capacitance changes of the "condenser" and these will be transformed into 4 to 20 mA signals by the electronic unit in the probe head. The sketch below shows the physical parameters and typical capacitances for metallic vessels and insulated probes.
It can be observed that the value of the resulting capacitance, Cx, (derived from various capacitive and conductive circuit impedences) has to be measured to obtain level metering.

- Eo= dielectric constant of air
- E= dielectric constant of the medium
- ρ= specific resistance of the medium
- Co= capacitance of air
- Cso= capacitance of the probe insulation in the air
- Cmi= capacitance of the medium
- Rmi= resistance of the medium
- Cx= resulting capacitance
- Csi= capacitance of the probe insulation in the medium

Electrically conducting liquids. The Rmi is nearly nil. As a result, the Rmi shunts the capacity, i.e. in view of the measurement, the Cmi may be neglected. As a consequence of the above the resulting capacity of the measuring setup will be determined by the diameter the insulation and the immersion length of the probe. The parameters of the liquid will not influence the capacity, and consequently the accuracy will not be effected. Cx can be calculated from the basic capacity of the probe. The most accurate level measurement can be expected with conducting liquids. **For conductive liquids always use insulated probes.**

Electrically non-conducting liquids. The capacitances Cmi and Csi will be decisive for the Cx, but these are also influenced by the dielectric constant. By measuring electrically non conductive liquids, one has to note that the capacity and so the level reading will in direct proportion with the dielectric constant. With the raise of level, the capacitance Cmi of the condenser will increase, and that one of the condenser Co will decrease. The resultant capacitance Cx will only unambiguously increase with raising the level, if the value of E is significantly higher than Eo, that is, the capacitance increase is higher than its decrease. **For non-conductive liquids the use of uninsulated probes is permitted**.

The dielectric constant of materials related to that one of the air (E/Eo) is called the relative dielectric constant (Er). The level metering based on the capacitive principle may only be performed in a medium where $E \geq 1.5$.

The parameters Er and ρ of the medium to be measured are generally not known in advance with adequate accuracy, that is why the capacitance transmitter has always to be calibrated with the given vessel. After this calibration, the device may only be used with mediums of the same composition the calibration has been made with.

The relative dielectric constant of liquid and solid material usually stored is between 1 and 80 but mostly below 10. That one of aqueous solutions and wet materials is between 10 and 80, that of water is 80. With the capacitance level measuring, however, it has to be taken into consideration that the dielectric constant of homogeneous materials depends on the temperature, that one of inhomogeneous materials on the temperature and also the proportion of the constituents. It can be said on the whole that the relative dielectric constant increases proportionally to the temperature increase, although with some material, like plastics, their dielectric constant will remain unchanged up to a certain temperature but it suddenly increases from this point upwards. These variations may be neglected between narrow limits.
The table below shows the relative dielectric constants (Er) of some important material.

Material: liquids	Relative dielectric constant Er	Material: solids	Grain size	Relative dielectric constant Er
acetone	2.5-30	alum	f	4
ether	4	aluminium hydroxide	p	2,5
ethylacetate	4.1	aluminium sulphate	f/p	2,6
ethylenechloride	8.9	aluminium chloride	f	7
benzine	1.9-2.2	bauxite	c	2,5-3,4
benzole (benzene)	2.3	amber	g	2,6-2,8
butanol	11	ferric oxide	f/p	1,9
diesel fuel	2.1	flying ashes, coal powder ash	f/g	1,9-3,3
printing paint	4.6	corn	g	2,3-4,4
acetic acid	6.3	burnt lime	g	1,6
liquified gas	1.2-1.7	slaked lime	f/g	2,7-3
fuel oil, light	2.1	lime cream	f/g	2,5-3,3
diluted lye	20-30	gravel (dry)	g	2,9
methylalcohol	31	common salt	g	3,3-3,5
engine oil, generally	2.2-2.3	coal powder, 1 % moisture	p	2,3
transformer oil	2-2.5	coke, depending on grain size	c	1,1-2,2
paraffin oil	2-2.4	plastics, granular	g	1,4-2
propyleneglycol	3.2	flour	p	4,2-4,5
acid, diluted	20-30	milk powder	p	1,8-2,2
sulphuric acid, diluted	30	quartz flour	f	2
sulphuric acid, 96 %	8.3	sand, dry	f	3,8
pitch	4-4.6	sand, fine	f	2,9
carbon tetrachloride	2.3	sand, wet	f	15
turpentine	2.1-2.3	cement	f/g	1,5-2
toluol	2.3	sugar	g	3

Legend: f = fine, p = powder, g = granular, c = coarse grained

Applications with Er ≤ 2 and Er > 60 has to be consulted with the distributor.

2. TECHNICAL DATA

Unit type		Rod probe		Light cable probe		Heavy duty cable probe	
		C..R-100 C..S-100	C..P-100 C..T-100	C..K-100 C..V-100	C..L-100 C..W-100	C..N-100	C..M-100
Probe type		Insulated	Uninsulated	Insulated	Uninsulated	Insulated	Uninsulated
Probe length		0.2 to 3 m		1 to 20 m			
Material of vetted parts	Process connection	SS316Ti					
	Probe	Steel	SS316Ti	Steel	S316S31	Steel	S316S31
Insulation		PFA	-	FEP	-	PE	-
Mechanical strength		-	-	5 kN	5 kN	45 kN	35 kN
Capacity of insulated probe		≈600 pF/m	-	≈200 pF/m	-	≈1500 pF/m	-
Medium temperature		**CT**/**CN**: -25 to +120°C; **CH**/**CL**: -25 to +200°C				-25 to +80°C	
Medium pressure (abs.)		max. 16 bar @ 200°C					
Ambient temperature		-25 to +85°C					
Output		4 to 20 mA					
Capacitance ranges		200 pF / 1 nF / 5 nF; selectable					
ZERO adjustability (4 mA)		0 to 80% of measuring range					
SPAN adjustability (20 mA)		20 to 100% of measuring range					
Measuring frequency		25 kHz					
Supply voltage		U_S=12...30 V DC, max. 25 mA					
Maximum load resistance		$R_L = \frac{U_S - 12V}{}$					
Nonlinearity		<0,5%					
Temp. Coeff. of ZERO		2 µA/°C					
Temp. Coeff. of SPAN		3 µA/°C					
Electric connection		Pg16 for ∅8 to 15 mm cables; with 0.75 to 2.5mm^2 wire cross section					
Enclosure		IP65					
Electrical protection	normal vers.	Class III.					
	Ex version	Intrinsically safe					
Ex protection mark		**CT**: EEx ia/ib IIB T4, issued: TÜV-A Nr.96.C.003X				-	
Mass		0.4 kg + 0.1 kg/10cm		0.4 kg + 0.15 kg/m		0.4 kg + 0.8 kg/m	

Note: The 4 mA output current is scaled to the 0.2-fold value of the 1 nF range, whereas the 20 mA output current is scaled to the nominal length of the unit.

3. APPLICATION

The capacitance level transmitters are designed to measure the level of conducting or non-conducting liquids or free flowing solids in vessels, applying the principles previously described.

PROBE SELECTION CHARTS

MEDIUM	CONDUCTIVE: - Acids - Bases - Water-based solutions	ONLY INSULATED PROBE CAN BE USED
	NON-CONDUCTIVE: - Most petrochemicals - Solvents	INSULATED OR NON-INSULATED PROBE CAN BE USED

Tank or vessel	Made of conductive material (metal) and has paralell wells.	SIMPLE PROBE
	Made of non-conductive material (plastic) or if metal, it is irregulary shaped.	PROBE WITH AUXILIARY PROBE

The data of the vessel (e.g. vertical, horizontal, cylindrical, silo, tank, basin, part of an instrument etc.) significantly determine the type of the probe and its fastening possibilities. This is why the following factors have to be considered when selecting the location of measuring:

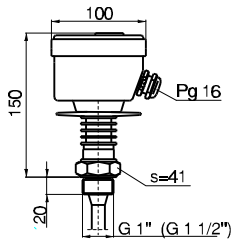
- it is a must that the probe in the vessel is continuously in contact with the medium to be measured (e.g. arching, cavity formation shall be avoided)
- the probe must only insignificantly be loaded mechanically
- the fastening and place of the probe must be stable and firm, without any vibrations
- the position of the probe is generally vertical; the lower end of the probe should be below the lowest level to be measured (the distance to the bottom of the vessel determines the lowest level that may be measured)
- if the material to be measured is prone to foaming, the probe should be shielded against foam
- the flexible probe rope may be stretched by a weight at its end, or it may be anchored to the vessel bottom. If the fluid surface is turbulent or its level changes rapidly, the probe has to be fixed by insulating intermediate pieces every 2 to 3 meters.

4. ACCESSORIES

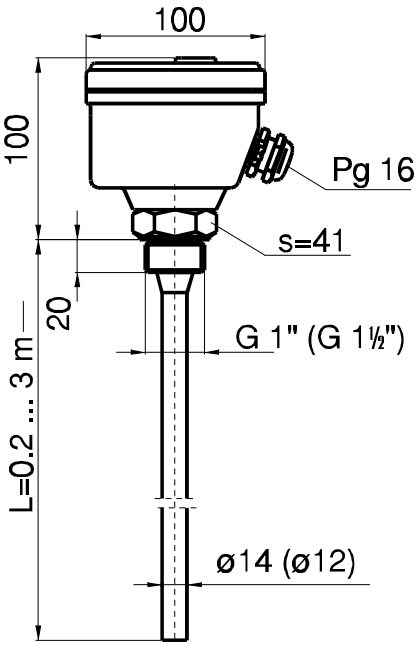
1 pc. user's manual; 1 pc. plug-and-socket type 2-pole terminal block

5. DIMENSIONS, MECHANICAL INSTALLATION

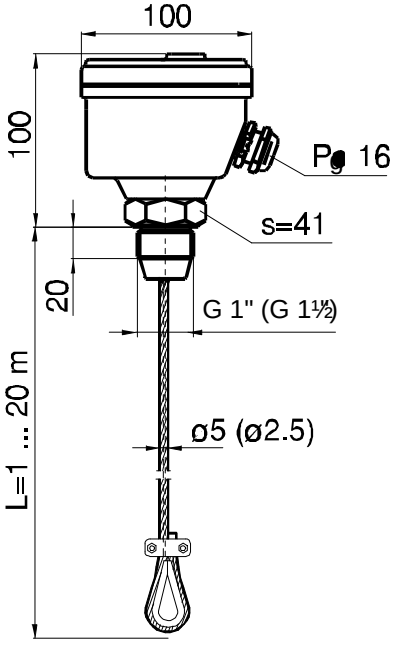
If level metering is made in horizontal cylindrical tanks or those ones made of insulating material, a metallic pipe must be mounted around the probe as on auxiliary probe. In case of flexible cable probes they should be fastened to the bottom of the vessel by using a rope cappel or a bore-hole, or a weight can be used. The probe should be protected against in-flowing material, i.e. it should be installed in a location where it is not exposed to considerable mechanical load. In case of appreciable vibration its damping shall be taken care of. The level transmitter is supplied with up to +200 °C heat resistant washer. All wetted metallic parts are made of stainless steel.



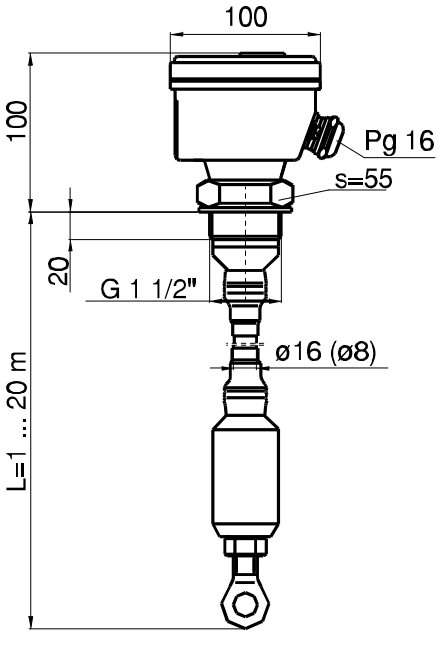
Upper part of the high temperature version



Rod probe



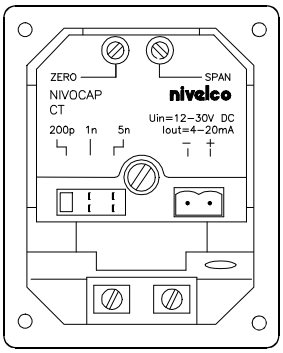
Light cable probe



Heavy duty cable probe

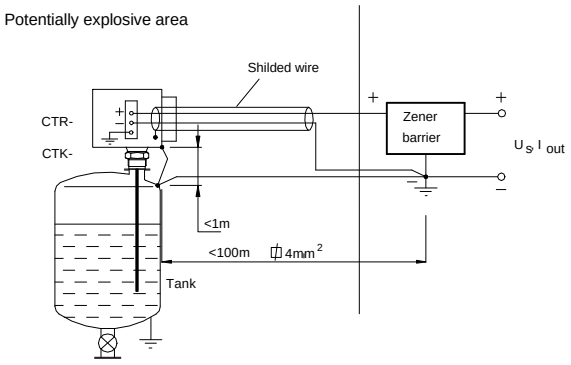
Remark: dimensions in bracket indicate uninsulated probe size.

6. ESTABLISHING ELECTRIC CONNECTION



The connecting cable can be lead via a stuffing box into the terminal block connector. The gauge of the cable core should be between 0.5 to 2.5 mm^2. At hazardous locations the types "Ex" must be applied, and a Zener barrier has to be installed in the circuit (e.g. STAHL 8901/31-280/075/00, MTL 728).

A 2x0.75 mm^2 shielded cable is recommended for the connection. The shielding has to be earthed at the side of the supply voltage. At the metallic housing of the device, you will find an earthing screw that has to be connected to the protection grounding wiring of the plant.

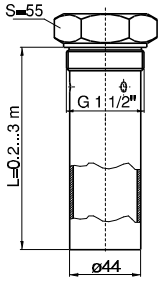


7. AUXILIARY PROBES

Auxiliary probes are needed to be used under special circumstances (see chapter 3: Probe selection charts).

CAF-1.. is a coaxial reference probe with 1" female thread, to accept 1" process connection size NIVOCAP rod probe capacitance transmitters.

Compact level transmitters provided with auxiliary probe are only manufactured in the rod probe version.



CAF-1..

8. TYPE DESIGNATION OF TRANSMITTERS WITH AUXILIARY PROBES

NIVOCAP C □□–1□□–□

Version	
Transmitter, BSP/Standard (120 °C)	T
Transmitter, BSP/High (200 °C)	H
Transmitter, NPT/Standard (120 °C)	N*
Transmitter, NPT/High (200 °C)	L*

Probe/Connection		
Rod	Insulated 1"	R
	Insulated 1½"	S
	Uninsulated 1"	P
	Uninsulated 1½"	T
Ligth cable	Insulated 1"	K
	Insulated 1½"	V
	Uninsulated 1"	L
	Uninsulated 1½"	W
Heavy duty cable	Insulated 1½"	N
	Uninsulated 1½"	M

Version	
Normal	-
Explosion proof	Ex

Rod protrusion length	
200 mm	02
⋮	
3000 mm	30

Cable protusion length	
1 m	01
⋮	
20 m	20

*8 weeks dellvery

Technical specification may be changed without notice.

Manufacturer:
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