Agenzia nazionale per le nuove tecnologie, l'energia
e lo sviluppo economico sostenibile

Ministero dello Sviluppo Economico

RICERCA DI SISTEMA ELETTRICO

Identificazione e collaudo di un sistema di misura non intrusivo per i profili di velocità in piombo. Specifica tecnica di fornitura e documentazione relativa all'installazione e collaudo

I. Di Piazza, G. Galgani, M. Tarantino

Report RdS/2012/051

IDENTIFICAZIONE E COLLAUDO DI UN SISTEMA DI MISURA NON INTRUSIVO PER I PROFILI DI VELOCITA' IN PIOMBO. SPECIFICA TECNICA DI FORNITURA E DOCUMENTAZIONE RELATIVA ALL'INSTALLAZIONE E COLLAUDO.

I. Di Piazza, G. Galgani, M. Tarantino - ENEA

Settembre 2012

Report Ricerca di Sistema Elettrico
Accordo di Programma Ministero dello Sviluppo Economico - ENEA
Area: Governo, gestione e sviluppo del sistema elettrico nazionale
Progetto: Nuovo nucleare da fissione: collaborazioni internazionali e sviluppo competenze in materia nucleare

Responsabile del Progetto: Mariano Tarantino, ENEA

ENEA Ricerca Sistema Elettrico	Sigla di identificazione NNFISS – LP3 - 042	Distrib. L	Pag. 1 di 48

Titolo

Identificazione e collaudo di un sistema di misura non intrusivo per i profili di velocità in piombo. Specifica tecnica di fornitura e documentazione relativa alla installazione e collaudo

Descrittori

Tipologia del documento:	**Specifica Tecnica di Fornitura**
Collocazione contrattuale:	Accordo di programma ENEA-MSE: tema di ricerca "Nuovo nucleare da fissione"
Argomenti trattati:	Tecnologia dei metalli liquidi Termoidraulica dei reattori nucleari Generation IV Reactors

Sommario

Nel presente documento è riportata integralmente la specifica tecnica di fornitura di un misuratore di portata ad induzione elettromagnetica da installare sull'impianto a metallo liquido pesante NACIE. Sono inoltre allegati i seguenti documenti: la nota di consegna dello strumento, il Commissioning report sull'installazione e calibrazione in situ ed il manuale di istruzioni.

Note

Autori: I. Di Piazza, G. Galgani, M. Tarantino

Copia n. **In carico a:**

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0	EMISSIONE	18/09/2012	NOME	I. Di Piazza	A. Del Nevo	M. Tarantino
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REV.	DESCRIZIONE	DATA		REDAZIONE	CONVALIDA	APPROVAZIONE

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OVERVIEW

In the frame of the research activities planned to support the development of a Lead cooled Fast Reactor (LFR), ENEA assumed the commitment to run experimental tests to simulate the thermal-hydraulic behavior of a pin fuel bundle cooled by heavy liquid metal.

These activities, which will be performed in the context of the Program Agreement between ENEA and Ministry of Economical and Sustainable Development (MSE), will be carried out on NACIE (NAtural Circulation Experiment) facility loop, located by ENEA Brasimone Research Centre.

NACIE ([1], [2]) is a rectangular loop facility which allows to perform experimental campaigns in the field of the thermal-hydraulics, fluid-dynamics, chemistry control and heat transfer and to obtain correlations essential for the design of nuclear systems cooled by heavy liquid metals. A sketch of NACIE is shown in Fig. 1. It basically consists of two vertical pipes (O.D. 2.5"), working as riser and downcomer, connected by two horizontal pipes (O.D. 2.5"). In the bottom of the riser a heat source is installed, while a heat exchanger is placed in the upper part of the downcomer.

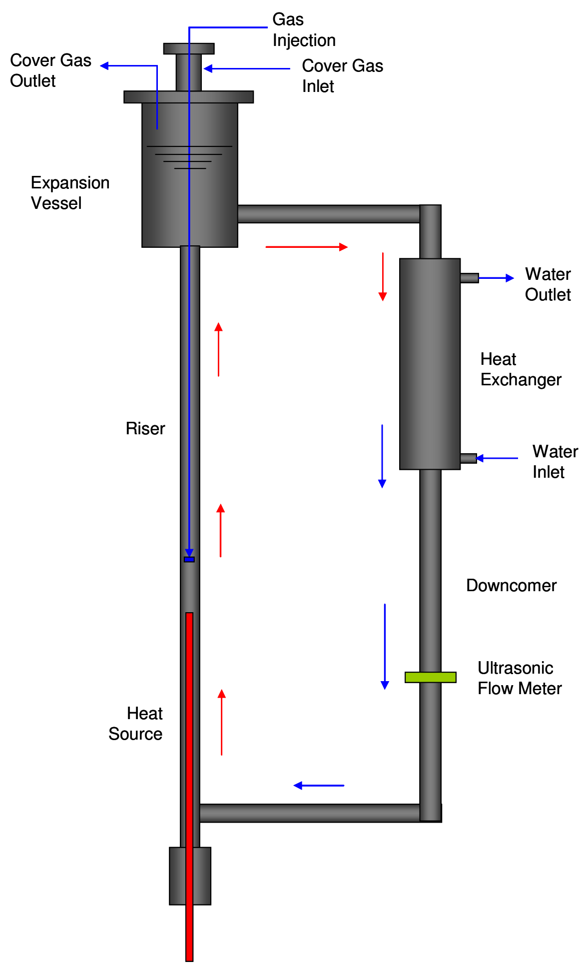


Fig. 1:Sketch of the NACIE facility.

NACIE is made in stainless steel (AISI 304) and can use both lead and the eutectic alloy LBE as working fluid (about 1000kg). The lop has been designed to work up to 10 bar and 550°C. NACIE allows both natural and enhanced circulation regime. Enhanced circulation measurements are realized injecting Argon gas at the bottom of the riser, immediately above the heat source. The gas promotes the circulation of the LBE and is recollected in the expansion vessel above the riser.

The heat source will consist of 19 electrical pins with a heat flux of q" = 1 MW/m^2. The bundle will be closed by a hexagonal wrapper. The total power of the new pin fuel bundle is ≈ 235 kW.

An inductive flow meter will be installed on NACIE to allow accurate measurements, to be supplied by HZDR, which has a wide experience with the measuring techniques with Liquid Metals.

In the past the HLM flow rate has been estimated applying a heat balance through the heat source [3]; the proposal is to apply this methodology to calibrate on site the inductive flow meter which will be supplied.

The goals of the experimental campaigns planned on the NACIE loop facility with the new inductive flow meter and the new heat source are:

- the measurement of the pin wall temperature;
- the measurement of the subchannel temperature;
- the characterization of hot spots points;
- the observation of the axial thermal stratification of the coolant fluid and its entrance length in the bundle subchannels;
- the measurement of the mass flow rate of LBE during natural and gas enhanced circulation experiments.

The new flow meter will be an inductive phase-shift sensor able to measure the perturbation of the magnetic field by the flow. It is characterized by a high temporal resolution and it can be applied at high temperature (up to 450°C).

A sketch of the new flow meter for NACIE is shown in Fig. 2 (image from HZDR)

SCOPE OF THE SUPPLY

The aim of the Supply is

- the procurement of an inductive flow meter able to measure mass flow rate with HLM, in a range of temperature of 150 – 450 °C and in a range of velocity of 0.1 – 2 m/s;
- the procurement of the electronic equipment needed to properly operate the sensors;
- the shipment of the components by the C.R. ENEA Brasimone, Italy;
- support for the installation of the sensor on NACIE loop; for this purpose, the thermal insulator (100 mm thickness) and the heating cable (O.D. 10 mm) will be removed from the

pipe zone where the sensor will be installed, for a maximum length of 200 mm.

- support for the on-site calibration of the flow meter on the NACIE loop;
- support on-site for a past-evaluation of the sensors performance (if required by ENEA)

The flow rate will be installed on NACIE loop, in the vertical pipe downstream the heat exchanger.

The flow rate sensor will remain at ENEA after the installation.

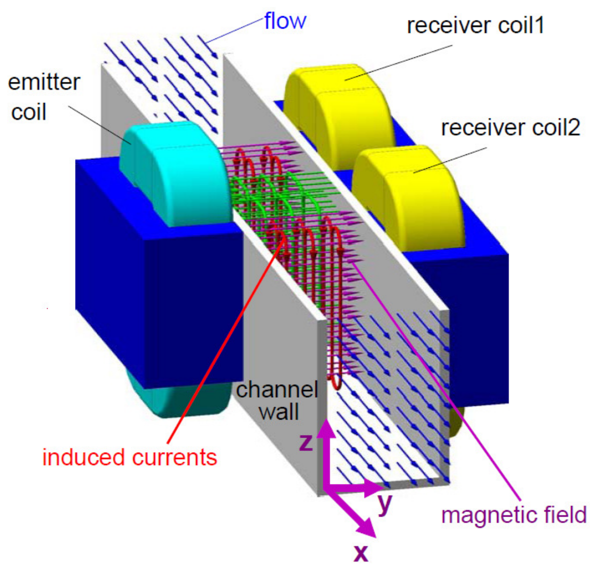


Fig. 2:Sketch of the new inductive flow meter for NACIE.

DOCUMENTATION FOLLOW UP

The supply will be completed by a documentation set follow up. The following documents will be delivered:

- Inductive Flow Meter: Scientific Background, Installation and Operation Handbook
- Pre-calibration Report
- Calibration procedure on site
- End of Manufacturing, Performed tests and Calibration Report

All the documents will have to be reviewed by ENEA (usually one week is allocated for that action).

CALIBRATION SET-UP BY ENEA

The calibration set-up of the flow meter will be performed by ENEA on the NACIE loop, by the HZDR support on site.

The Supplier will communicate two weeks before the calibration on-site the actions to be performed on the loop aiming to properly install the flow meter (i.e. length of the free part for the sensors installation).

DELIVERY TIME

The flow meter has to be delivered within three months after the order.

The on-site calibration will take place within two months after the delivery of the flow meter.

PAYMENTS

- 30% of the total selling price after the delivery of the following documentation:
  - Inductive Flow Meter: Scientific Background, Installation and Operation Handbook.
  - Pre-Calibration Report.
- 40% of the total selling price after the delivery of the sensor and the related electronic equipment.
- 30% of the total selling price after the calibration on site and the delivery of the documents
  - Calibration procedure on site.
  - End of Manufacturing, Supply and Calibration Report.

The Payments will be performed by Bank Transfer within 30 days after the invoice.

GUARANTEE, PENALTIES, SHIPMENT

The supplier will not be responsible concerning the performance of the flow meter.

Anyway the sensors and the electronic equipment will be guaranteed for a period of 24 months after the delivery.

In case of a delay on the delivery, a liquidity damage of 0.3% of the total selling price a week with a maximum limited to 10% of the total selling price will be applied.

The shipment will be Delivered Duty Unpaid (DDU), by the C.R. ENEA Brasimone, Italy, packaging free of charge.

ANNEX I: FLOW METER TECHNICAL SPECIFICATION

NACIE (LBE loop)	
Outer Diameter Pipe	73.02 mm
Inner Diameter Pipe	62.7 mm
Thickness Pipe	5.16 mm
Temperature	150 – 450 °C
Velocity	0.1 – 2 m/s
Mass flow rate	3 – 65 kg/s
Density range	10,140 – 10,535 kg/m^3
Latent heat of melting at the normal melting point	38.5 kJ/kg
Boiling point	1,670 °C
Heat of vaporisation at the normal boiling point	854 kJ/kg
Saturation vapour pressure	7.93 x 10^{-14} – 3.17 x 10^{-4} Pa
Surface tension	0.389 – 0.409 N/m
Thermal expansion	1.26 x 10^{-4} – 1.31 x 10^{-4} K^{-1}
Sound velocity	1,699 – 1,766 m/s
Heat capacity at constant pressure	143 – 149 J/kg K
Dynamic viscosity	1.40 x 10^{-3} - 2.94 x 10^{-3} Pa s
Kinematic viscosity	1.4 x 10^{-7} - 2.8 x 10^{-7} m^2/s
Electrical resistivity	1.08 x 10^{-6} – 1.23 x 10^{-6} Ω m
Thermal conductivity	10.3 – 14.6 W/m K
Working Time (per year)	3000 h

REFERENCES

[1] "*Natural circulation in a liquid metal one dimensional loop*", M. Tarantino, S. De Grandis, G. Benamati, F. Oriolo, *Journal of Nuclear Materials*, 376 (2008), 409 - 414.

[2] "*Experimental Investigation of the Thermal – Hydraulic behaviour of Heavy Liquid Metal Cooled Reactors*", M. Tarantino, Ph.D thesis, University of Pisa, Academic Years 2005 – 2007.

[3] "*Natural and gas enhanced circulation tests in the NACIE Heavy Liquid Metal loop*", M. Tarantino, D. Bernardi, G. Coccoluto, P. Gaggini, V. Labanti, Proceedings of ICONE 18, 18th International Conference in Nuclear Engineering, May 17 – 21, Xi'an, China.

Helmholtz-Zentrum Dresden Rossendorf
Bautzner Landstraße 400
01328 Dresden, Germany

To:
ENEA
Experimental Engineering Technical Unit
Brasimone Research Center
40032 Camugnano Bologna
Italy

Delivery order

For a contactless, electromagnetic flow meter,

referring to order:

CJG No. 318 206 4248,
CUP No. J31 J11 000 13 000 6

1) Manual instruction (cfr sensor)

Herewith we confirm the receipt of a manual instruction for a contactless electromagnetic flow meter including all necessary specifications and technical details. Furthermore all details of mechanical and electrical adjustments are contained with a guidance of calibration.

Signature (ENEA): Ivan Di Piazza

2) Contactless, electromagnetic flow meter (cfr sensor)

Included Components

The delivered flow meter device consists of the measuring element and a supply/analysis unit.

Signature (ENEA):

Installation at the NACIE-loop, ENEA-Brasimone

Measuring element as well as the supply- and analysis unit will be installed at the NACIE loop. An electro-mechanical adjustment of the device for stable operation is included.

Signature (ENEA):

Calibration of the device at NACIE-loop, ENEA-Brasimone

The flow meter has to be calibrated for specified flow rates and operational temperatures (calibration letter).

Signature (ENEA):

Helmholtz-Zentrum Dresden Rossendorf
Bautzner Landstraße 400
01328 Dresden, Germany

To:
ENEA
Experimental Engineering Technical Unit
Brasimone Research Certer
40032 Camugnano Bologna
Italy

Commissioning report

referring to order:

CJG No. 318 206 4248,
CUP No. J31 J11 000 13 000 6

Editor: Dr. D. Buchenau (HZDR)

Dresden, den 12.07.2012

The following commissioning report relates to the works performed in the period from Thuesday (02.07.2012) to Wednesday (03.07.2012). All steps with respect to the preparation and execution of the commissioning phase of the inductive flow meter at the NACIE loop were carried out by the following nominated persons as members of the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) and the SAAS-GmbH.

Dr. D. Buchenau
HZDR, Institute of Fluiddynamics, Department of Magnetohydrodynamics, 01328 Dresden, Bautzner Landstraße 400, Germany.
Dr. S. Lenk
SAAS-GmbH, 01728 Bannewitz/Possendorf, Poisentalstraße 03, Germany
M. Flöter
SAAS-GmbH, 01728 Bannewitz/Possendorf, Poisentalstraße 03, Germany

The customer is represented by the following person:

Dr. Ivan Di Piazza
ENEA, UTIS-TCI C.R. Brasimone, 40032 Camugnano (Bo), Italy.

Following steps during installation and calibration of the contactless flow meter EMD-ps were performed:

Period	Results
3.7.2012 9:00 to 13:00 o'clock	Assembly of the sensor system including mechanical adjustment of the system and installation of all necessary electrical connections between supply/measurement unit and sensor head at the NACIE-facility.
3.7.2012 14: 00 to 17:00 o'clock	Basic functional tests. Adjustment of all necessary parameters of the sensor system, Admission of ENEA costumers to the device based on the delivered manual instruction.
3.7. 2012 17:00 to 4.7.2012 9:00 o'clock	Heating of the NACIE-loop to an operational temperature of 300°C. Periodically appearing fluctuations of the sensor output at a fixed

	loop temperature were observed. Presumably the fluctuations are caused by switching on and switching off heating elements of the loop causing an additional flow driven heat convection in the closed loop measured by the flow meter.
4.7.2012 9:00 to 13:00 o'clock	Calibration of the contactless flow meter with a buoyant driven flow at a fixed temperature. The flow rate of liquid metal in the loop is adjustable by an Argon injector. The Argon flow rate was determined in NL/min (Tab. 1). The adjusted/generated flow rate was determined by a temperature equilibrium measurement located close to a heating element (10-20 kW). According to ENEA the used calibration process delivers flow rates within a measurement uncertainty of approx. 10% (Tab. 1).

Volume flow rate (Argon)	***Calculated mass flow rate***
0 NL/min	0 kg/s
1 NL/min	10,1 kg/s
2 NL/min	12,4 kg/s
6 NL/min	16,5 Kg/s

Tab. 1: Adjusted Argon flow rates and calculated mass flow rates.

Volume flow rate	***Calculated mass flow rate***	***Result / Sensor***
0 NL/min	0 kg/s	0,02 kg/s
1 NL/min	10,1 kg/s	11,3 kg/s
2 NL/min	12,4 kg/s	12,4 -12,6 kg/s
6 NL/min	16,5 Kg/s	18,4 kg/s

Tab. 2: Calibration points of the contactless flow meter.

4.7.2012 14:00 to 16:00 o'clock	Measurements in the Tab. 2 were taken at a loop temperature at 300°C. Different calibration points were adjusted and compared with the flow meter measurements. Reproducibility and zero drift were compared within the agreed conditions of contract.

OT Possendorf, Poisentalstr. 3, D-01728 Bannewitz

Systemanalyse & Automatisierungsservice GmbH

EMD *ps*

Manual / Operating Instruction

Content:

1. Functionality and Application of the Device

The device EMD *ps* is intended for the recording of the flow rate for liquid metal in pipes. The measurement principle is based on the recording of current dependent distortions of phases induced by alternating voltage. The alternating voltage is induced into the fluid by a transmitter coil. A receiving coil which is also placed in the flow channel detects the induced voltage. A distortion in phases exists between the sent and received voltage, which is linear related to the average flow velocity of the fluid (Fig. 1).

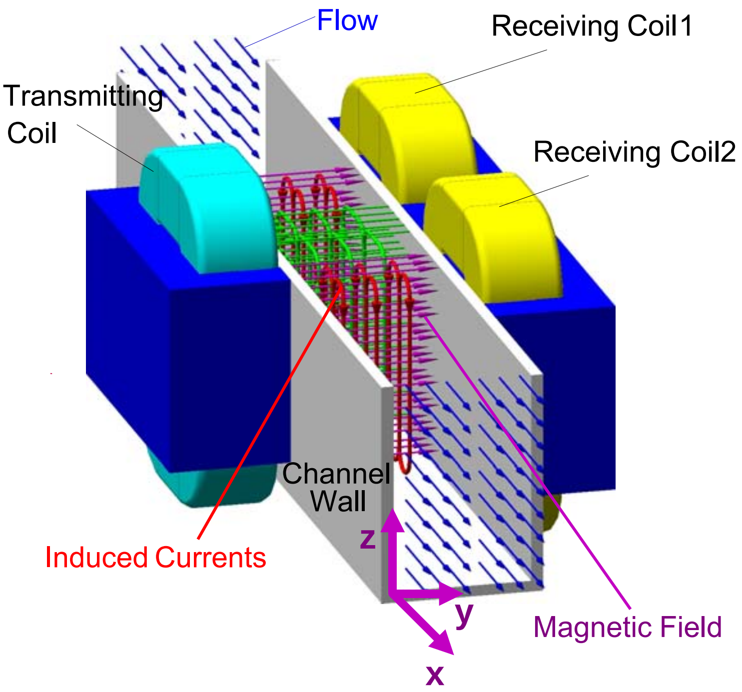


Fig.1 Principle of Measurement (origin from HZDR)

The measuring device consists of the following:

- Sensor unit, to be assembled on a pipe
- Evaluating unit transducer wall mounted

The maximum distance (cable length) between the sensor and transducer is 20m.

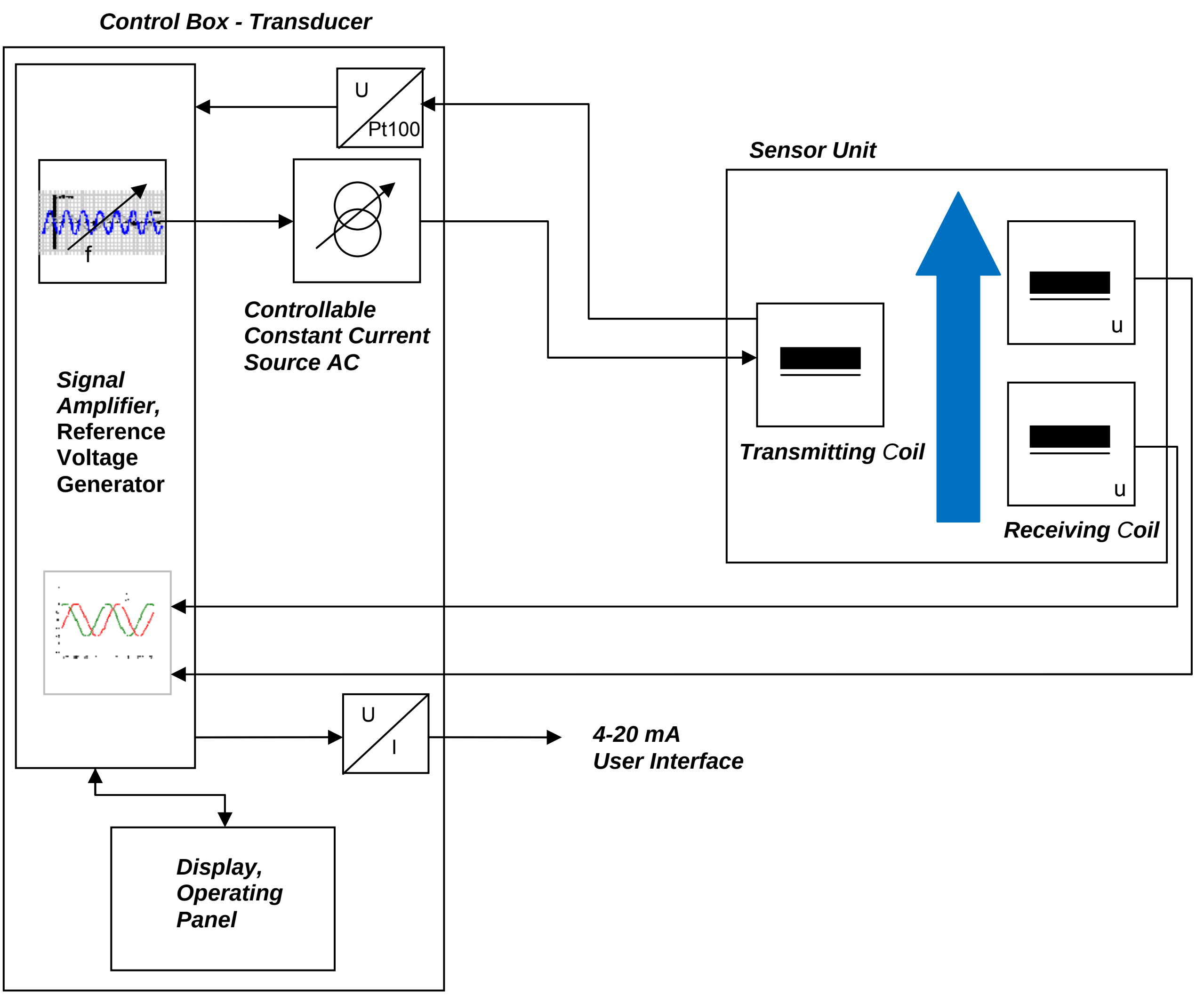


Fig. 2: Block Diagram of **EMD *ps***

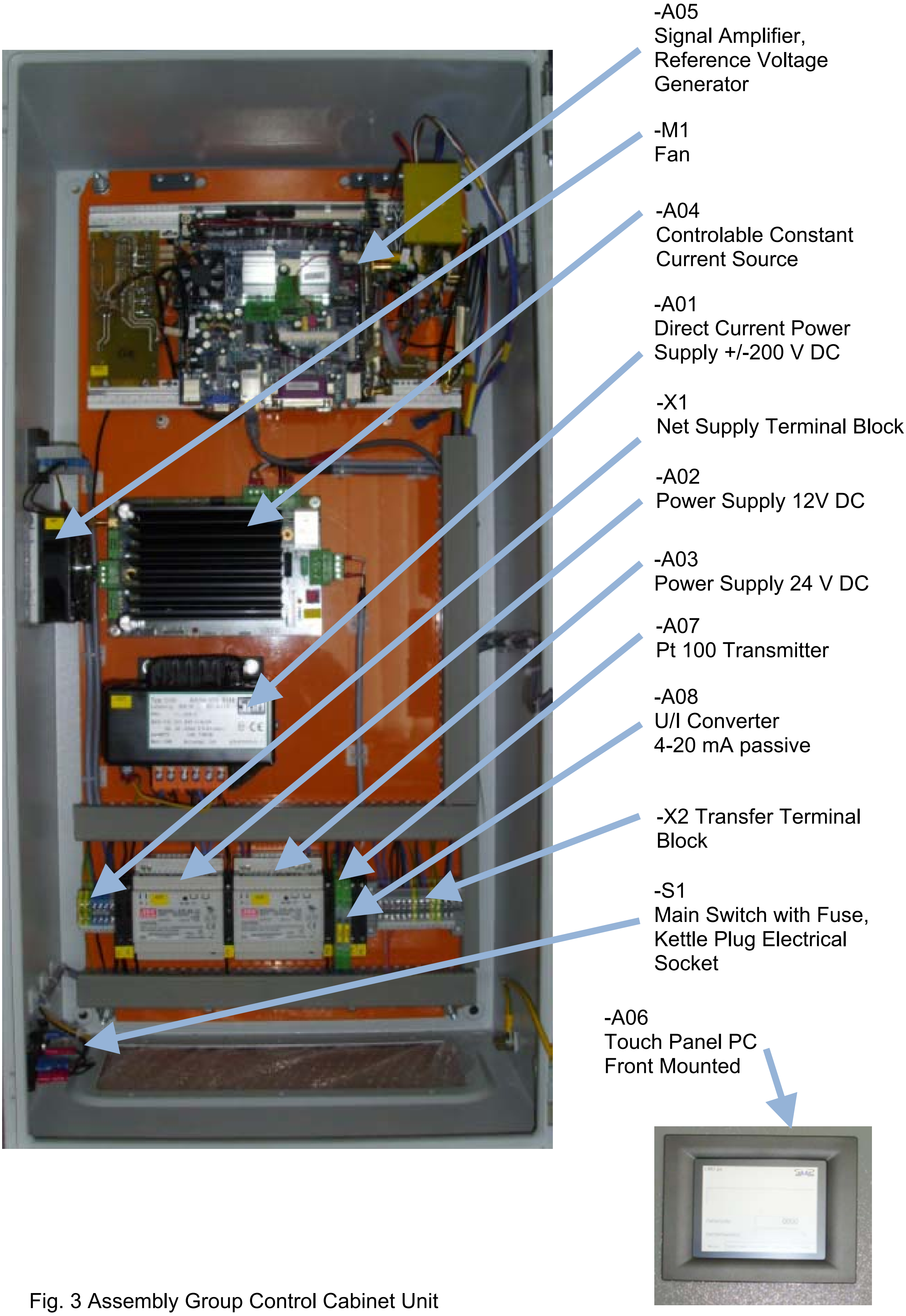


Fig. 3 Assembly Group Control Cabinet Unit

2. Information for the Electrical Safety

The control cabinet unit is operating with a power supply with kettle plug.

Before Opening the Device Remove the Power Plug!
Energized Parts up to 200 V DC!

The power supply voltage of transmitting coil is +/ - 200 V DC

Before Opening the Sensor Casing Disconnect
Induction Current Supply
(Open Fuse Clip -F5, -F6)!

Do Not Disconnect 200 V DC
Power Supply from Signal Amplifier!
Danger Because of Residual Voltage at the
200 V DC Power Supply Module after
Supply Voltage 230 V AC Was Switched off!

The device has the degree of protection IP 54 and is therefore suitable for usage in dry and frost-free rooms.

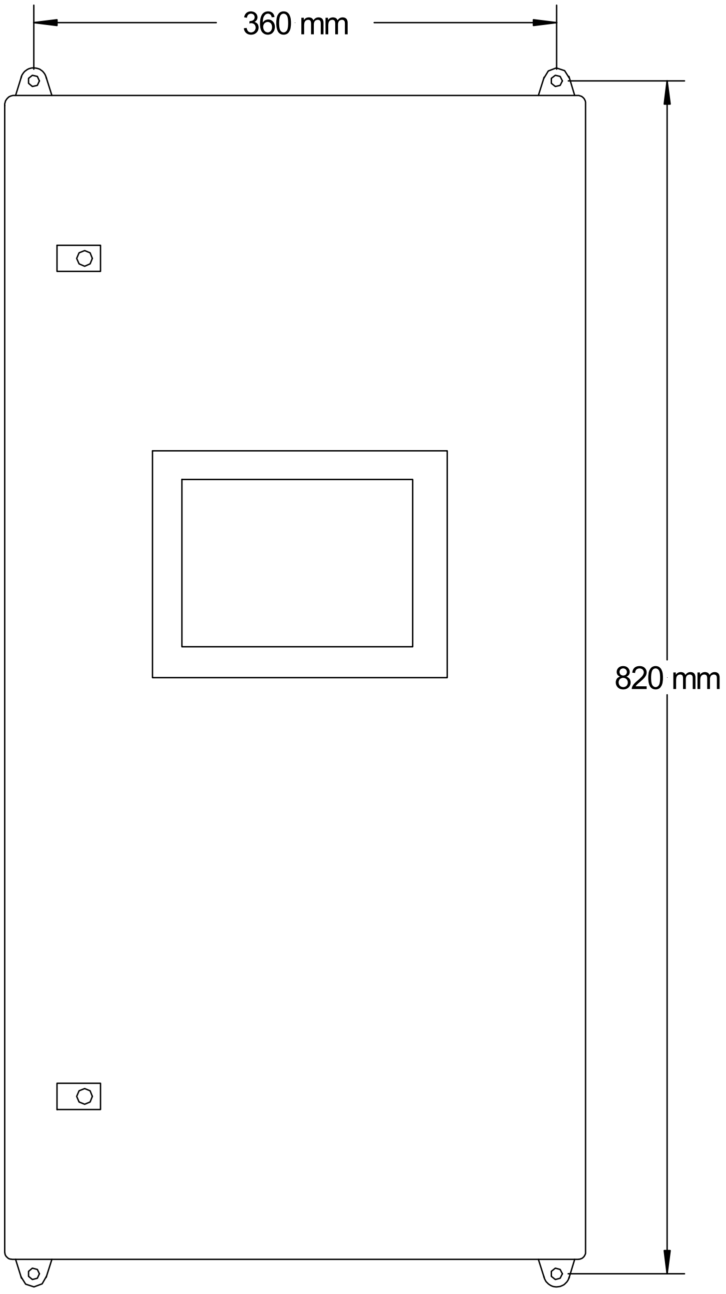
Inside of the Control Box Is Not
Completely Screen Protected against
Electric Shocks!

3. Installation and Wiring

Step 1: Installation of Control Box - Transducer

The control box is designed for wall installation

Dimensions:



Detail:

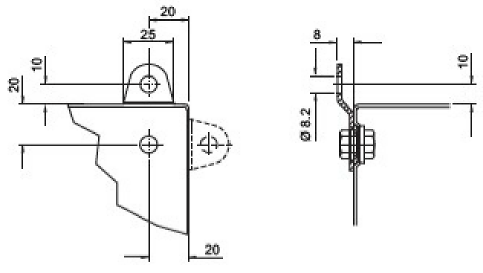
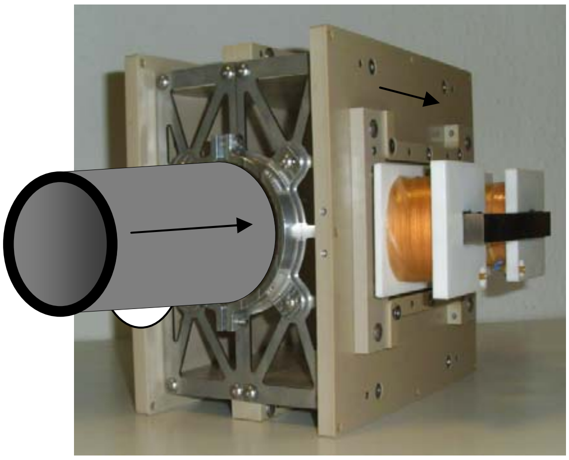


Fig. 4 Wall Fastening of Control Box -Transducer

Step 2: Sensor Installation on the Pipe:
The sensor unit consists of two symmetrical components, after removing the sensor casing (1), which are mounted around the pipe with the stream to be captured and (2) the aluminum clamps (1) which were constructed custom-fit to stream pipe, that secure the sensor. The measured positive direction of fluids flow is marked with an arrow.



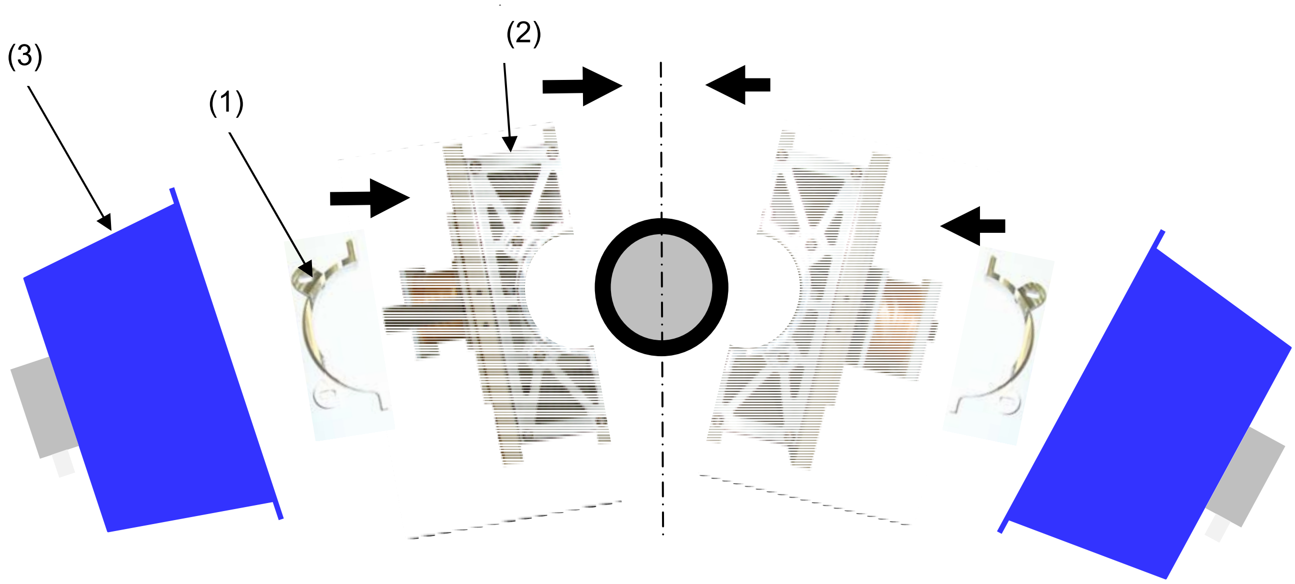


Abb. 5 Sensor Unit Assembling

Step 3: Attachment of the Sensor Unit and the Control Cabinet without the Sensor Casing.

For this purpose, the wires W100, W101, W102 and W103 are used to extend the connection between the coils and the control box -transducer. The sensor casing (3) Fig. 5 should be kept clear as far away as possible during the adjustment of the sensor, to minimize the influence of the alternating field. The wiring between the sensor and the control cabinet is to be carried out suitable to local terms. The wire W101 has to have a distance of 100mm minimum to the wires W102 and W103.

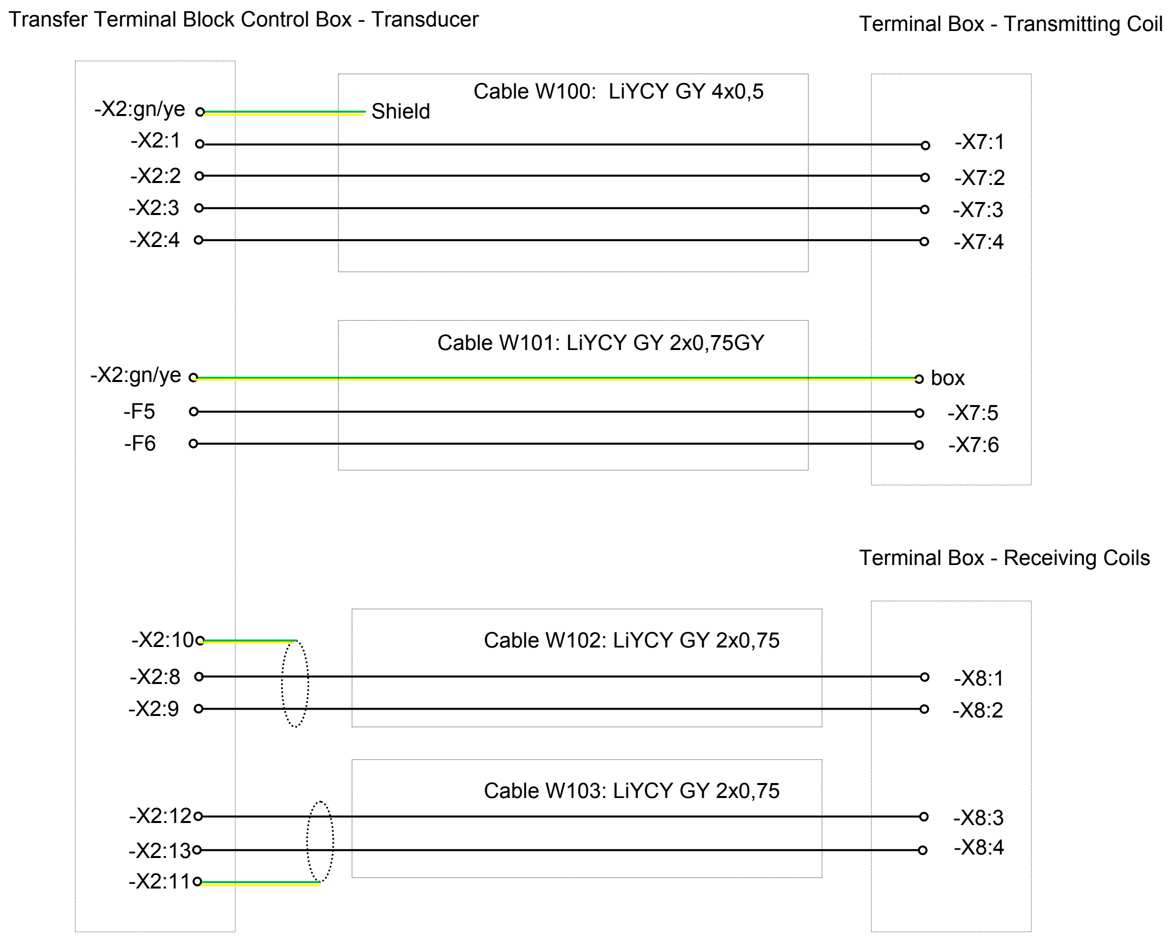


Fig. 6: General Wiring Diagram Sensor Unit – Control Box - Transducer

For equipotential bonding the following connections (Fig 7) have to be realised:

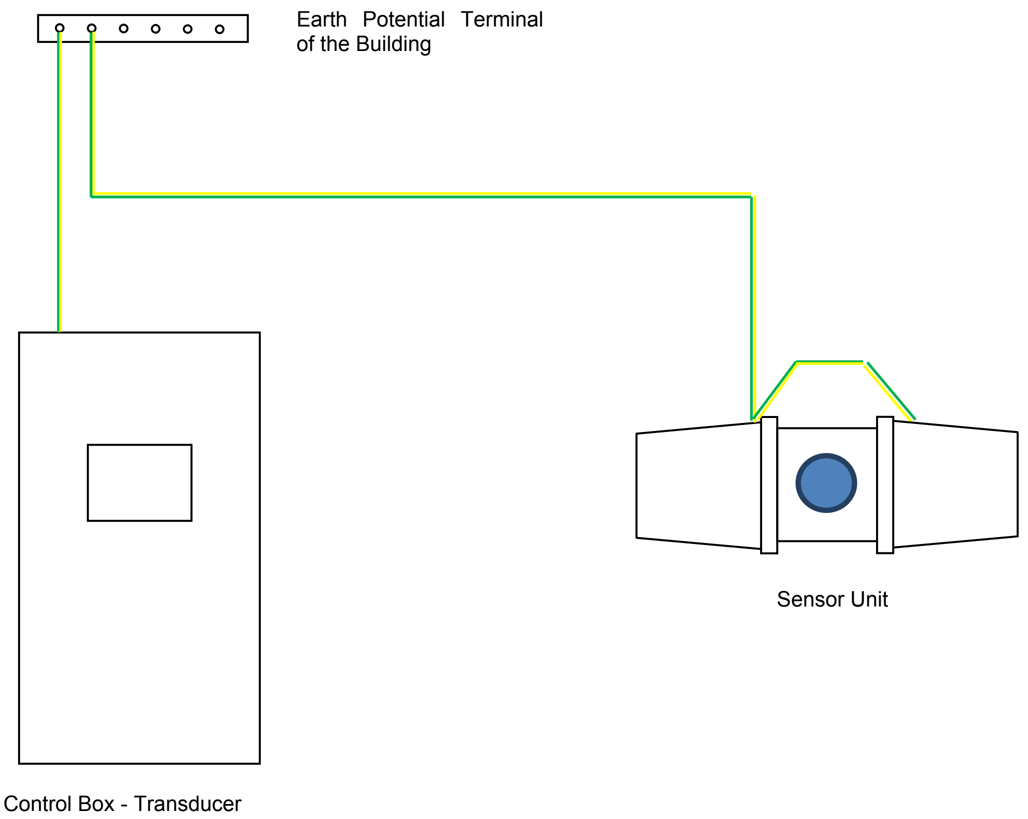


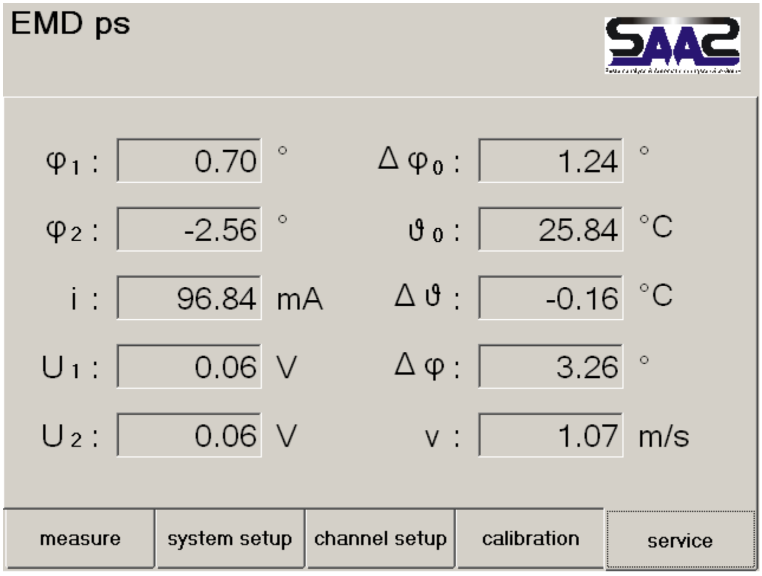
Fig.: 7 Equipotential Bounding between the EMD Components

4. Initiation and Symmetry Alignment

Completely wired and assembled, the device can also be launched by turning on the main switch, even if the device has a sensor without a sensor casing.
The error code is 0000H and green, if all components are working correctly.

<u>The Device Requires an Adaption Phase of about an Hour after Being Switched on.</u>

The main operating parameters can be observed in the menu under Service. The excitation frequency and current and are bound to type and preset.



Objective of the implementing and adjustment is the preferably symmetrical distribution of the receiving magnetic field onto the receiving coils without flowing medium.

The main operating parameters can be observed in the menu under Service. The excitation frequency and current and are bound to type and preset.

Objective of the implementing and adjustment is the preferably symmetrical distribution of the receiving magnetic field onto the receiving coils without flowing medium.

The voltages u_1 and u_2 are to be adjusted as well as the minimization of the phase difference $\Delta\varphi$. This process is possible on both the sending and receiving side and if needed can be done on both these sides.
The procedure for this process is the following:

1. Remove lock pins (1), drive through with suitable tool, loosening the attachment bolts until one can move the core mounting (3)
2. Slide the core using the adjustment screws (4) until the induced voltage is the same and the phase difference is at its minimum.

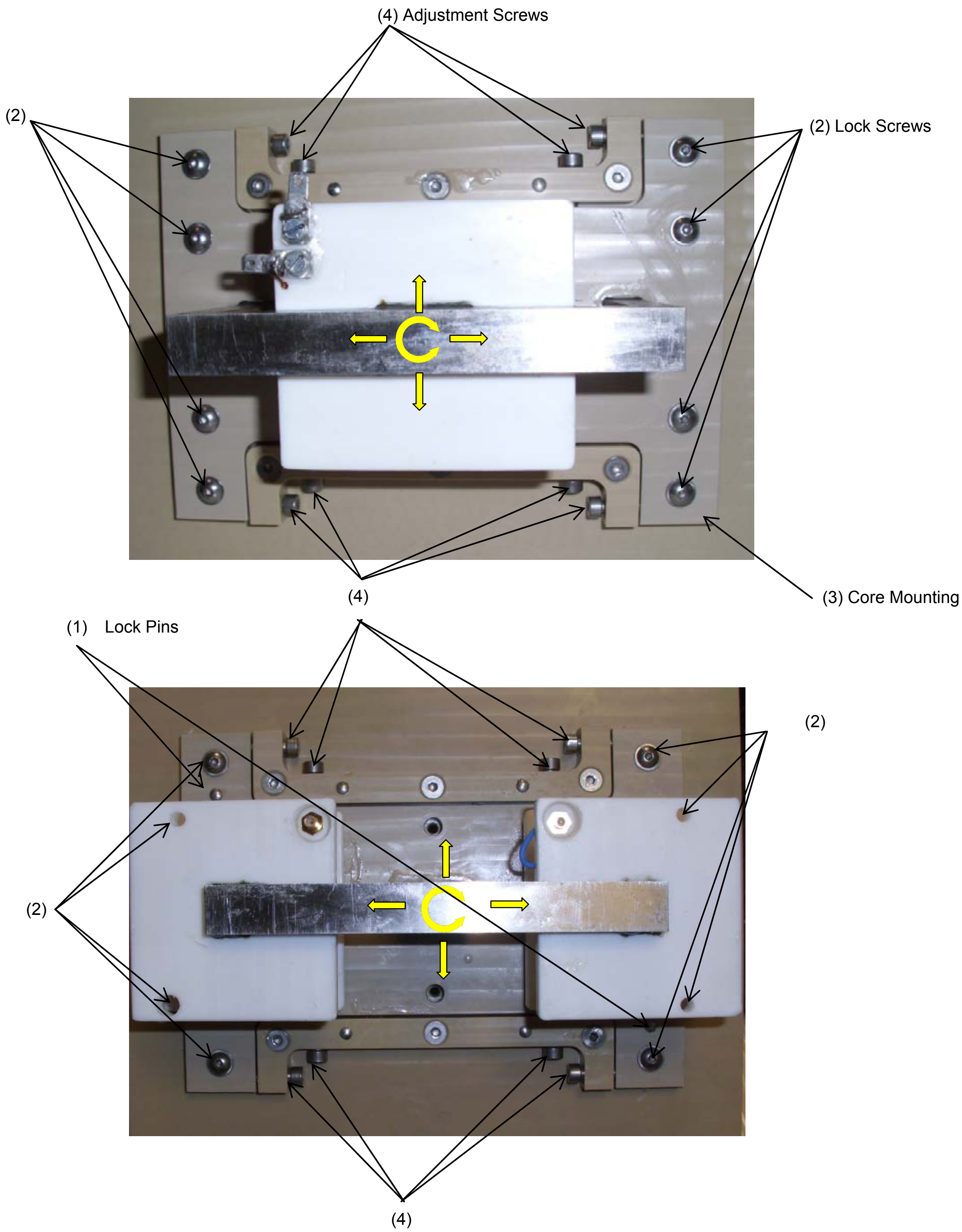


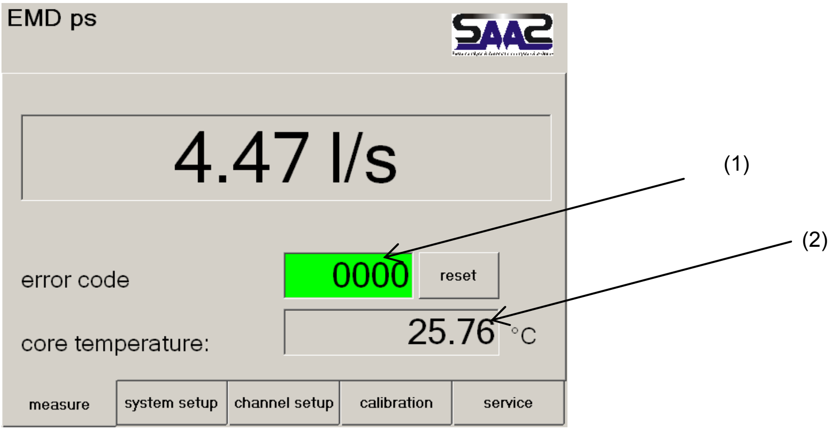
Fig. 8 Alignment of Sensor Unit

The result has to be checked after the installation of the sensor casing and may be readjusted.

5. Menu for the Operating of the Device

The device EMD *ps* used a touch panel to operate.

5.1. “Measurement” – Measurement Value, Error Notifications

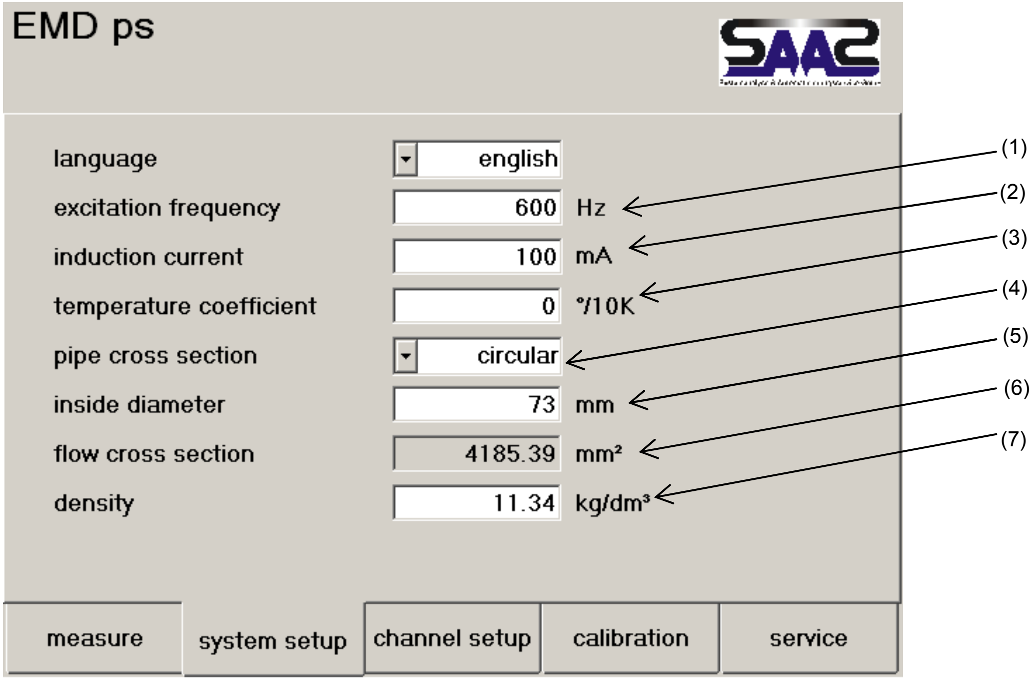


The error notification (1) is coded in hexadecimal notation. The error code is 0000 and green, if all components are working correctly. Warnings are marked yellow. Error notifications which lead to the shutdown of the excitation current or a downtime of the measurement are red. The error can be reset after removing the error source by using the reset button. The temperature of the magnetic core (2) gives information about the thermal situation around the sensor.

List of error notifications:

Position	Error	Description	Action
2^0	SetErrormA	Measurement value out of range	Warning
2^1	CurrentFailure	Induction current out of range (deviation more than 10 % from set point)	ShutDown
2^2	NoConnection	No connection between panel and signal amplifier	HoldOn
2^3	Temperature Failure	Temperature measurement out of range, wire break	Warning
2^4	U1Failure	Low voltage from transceiver coil 1	Warning
2^5	U2Failure	Low voltage from transceiver coil 1	Warning
2^6	CalibrationFailure	Result “ not a number” division by zero	Last calibration will be used further on
2^7 - 2^{15}	Unused		

5.2. "System Setup" – Input of System Parameters (secured by password)



The input of the nominal value of excitation current is restricted to a maximum of 500mA (2).

The restriction for the excitation frequency is 300Hz (1).

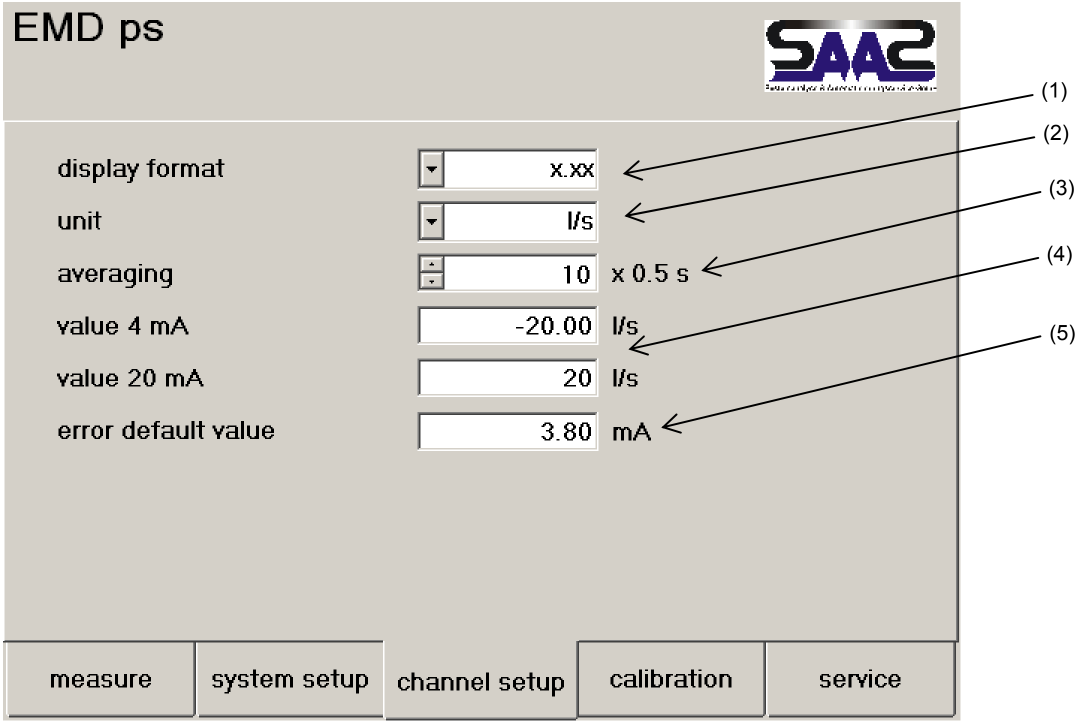
The temperature coefficient of the measurement value (3) is dependent on the fluid and therefore has to be determined by it.

The preset values are sensor specific and should not be changed.

There is the possibility to either save the diameter (5) of the pipe by selecting circular (4) or the area (6) directly.

For the calculation of the flow stream the density (7) of the fluid can be set as a constant.

5.3. „ Channel Setup” – Input of Channel Parameters (secured by password)



It is possible to determine 3 formats for the decimal place depending on the calibration of the display of the measurement value (1):

xxx xx,x x,xx

The following engineering units are available for the display of the measurement value (2):

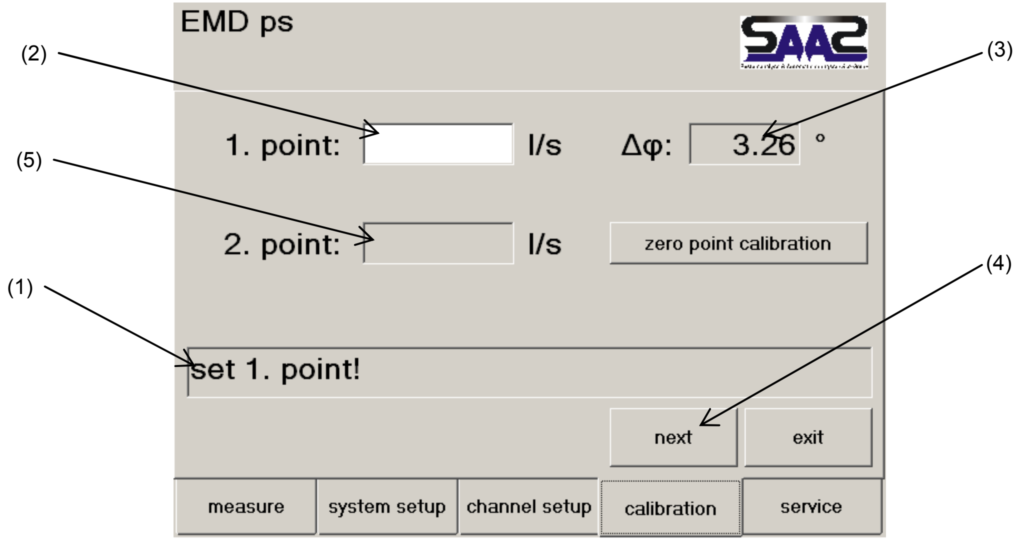
l/s, l/min, m^3/h, kg/s, t/h

The display value of the flow stream can be set to a moving average. A value is collected every 500ms. The input of 1 to 10 changes the duration of this cycle in multiples of 500ms (3). The device EMD ps has an analog output interface. Output is the displayed analog value. The dimensioning of the current output results from the ending points of the current range (4):

4 mA und 20 mA

In case of error, if no correct measurement value can be recorded, a preset value is being displayed (5).

5.4. „Calibration“ – Two Point Calibration, Zero Point Calibration



The device EMD ps has a linear characteristic line and is calibrated over two points. Since the device can determine the flow rate in both directions, the entry will not be verified for plausibility. Division by ZERO, due to an incorrect entry of calibration data will lead to a warning and interruption of the calibration.

See section 5.1 List of error notifications

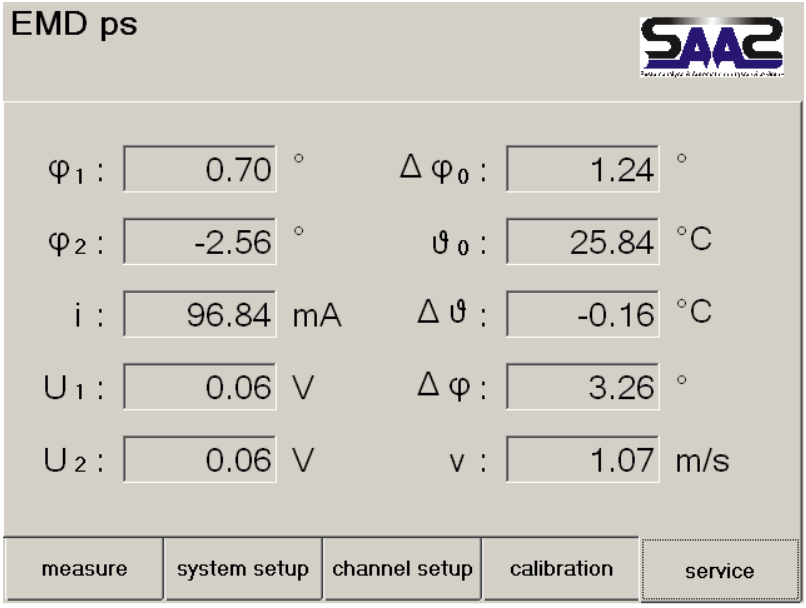
Therefore the calibration consists of two steps:

Step 1:
The menu contains the order “set 1. Point! ” (1)
Adjustment of the flow rate, with reference value of the wanted rate, usually flow rate =0 and entry of the number in the appointed unit. (2)
If the shown value of phase difference (3) does not change anymore, press “next” button. (4)

Step 2:
Adjustment of the flow rate, with the second reference value of the wanted second rate and entry of the number in the appointed unit.(5)
If the shown Value if phase difference does not change anymore, press “next” button.(4)
The calibration will be completed and the device will return automatically to the measured value display. If the calibration was correct, the measured value display will now show the second calibration value.
The calibration is now complete. With the button “exit” the calibration can be aborted anytime and the old calibration value will be kept. (6)

For fast calibration there is the option of zero balance.(7) By pressing the according button the present measurement value will be identificated as zero value. The according offset will be added to the present calibration. The bracing of the characteristic line will be kept. After the zero point calibration the device will return automatically to the measured value display.

5.5. „Service“ – Measurement value control



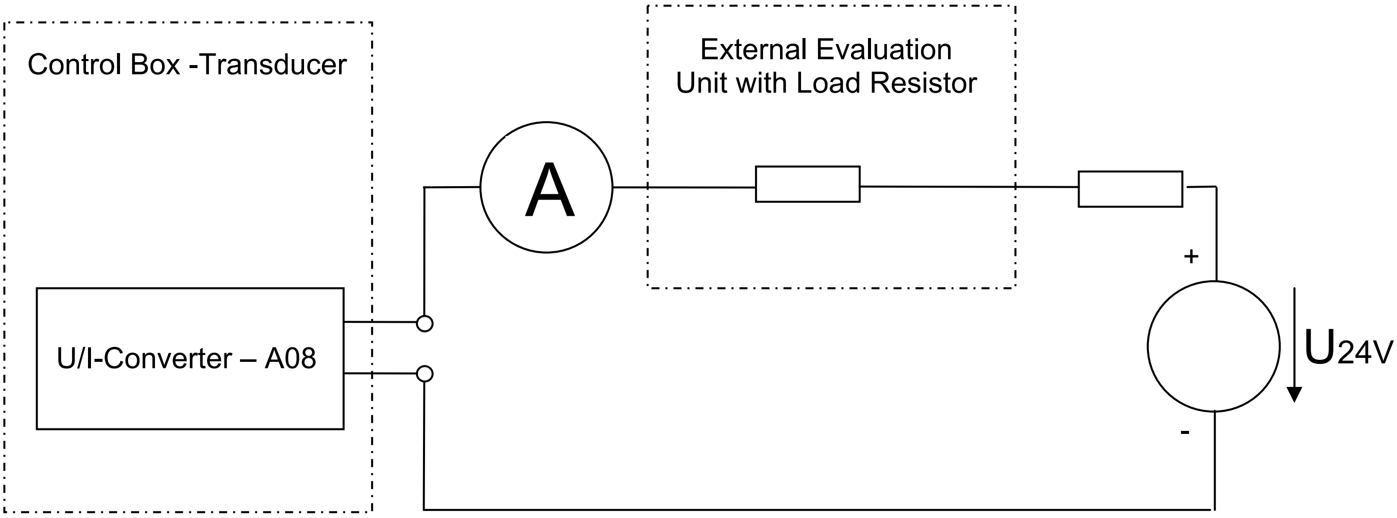
Single measurement values can be monitored under this sub menu. Furthermore additional information corresponding to the values of calibration and the present values are displayed. In the following these values are defined:

- φ_1 – phase-shift signal receiving coil 1
- φ_2 – phase-shift signal receiving coil 2
- i – induction current
- U_1 – voltage signal receiving coil 1
- U_2 – voltage signal receiving coil 2
- $\Delta\varphi_0$ – deviation of phase-shift difference in reference to the calibration
- ϑ_0 – core temperature in the moment of calibration
- $\Delta\vartheta_0$ – deviation of core temperature in reference to the calibration
- $\Delta\varphi$ – phase-shift difference between φ_1 and φ_2 (rough value)
- v – velocity of flow

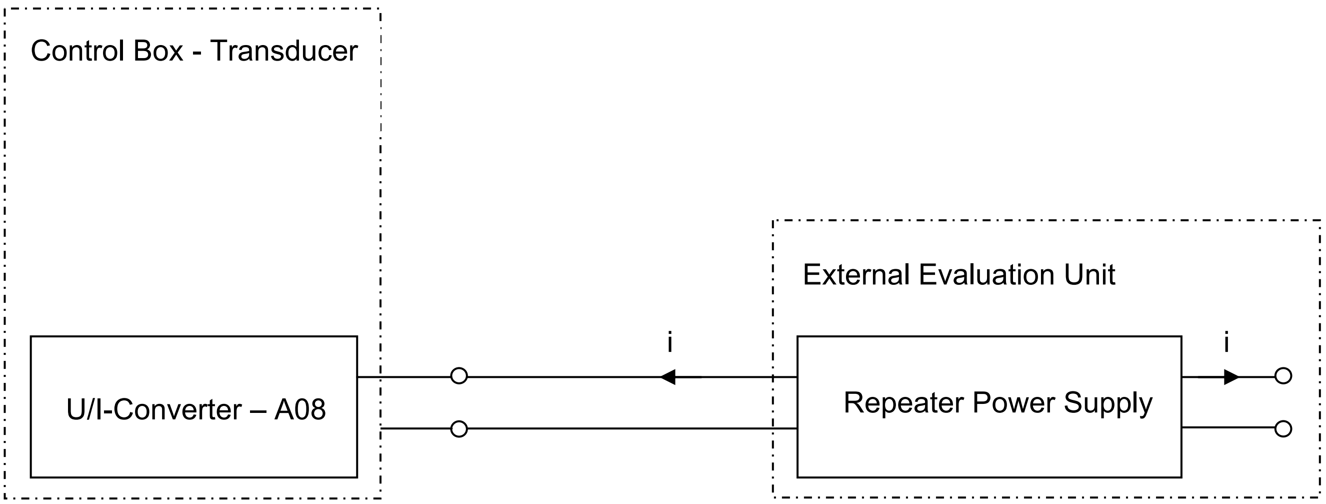
6. Analog Output of EMD *ps*

The device has a passive analog 4-20 mA interface to evaluate the measurement signal. This interface can be energized externally by a supply voltage between 13,5V up to 26V DC. Preferably a customary in trade repeater with power supply should be foreseen.

Alternative 1:



Alternative 2:



7. USB-Interface for Data Storage

For data storage you can connect an USB device at the USB port of the touch panel pc. The measurement date of the last two measurement days will be stored. Please wait for a minimum of 10 seconds before you unplug the USB device. Now the data location is in the folder “EMD-Data”. The measurement data are saved as CSV-file and you can read them with the right application (like Excel). The structure of the data is built as follows:

timestamp	φ 1[°]	φ 2[°]	U1[V]	U2[V]
timestamp	φ 1[°]	φ 2[°]	current raw value	temperature raw value
timestamp	φ 1[°]	φ 2[°]	U1[V]	U2[V]
timestamp	φ 1[°]	φ 2[°]	current raw value	temperature raw value

for example

08:55:17.890	-6.639	-6.377	0.089	0.092
08:55:18.515	-6.634	-6.372	3.990	0.492
08:55:19.140	-6.631	-6.369	0.089	0.092
08:55:19.765	-6.631	-6.367	3.991	0.488

In order to built the real excitation current and the temperature you have to transform the raw values in the right way. You get the excitation current with:

excitation current = current raw value * 100.

With the following equation you can built the temperature.

temperature = temperature raw value * 40

8. Technical data sheet

Power Supply:

Supply Voltage:	230V AC
Power Input:	1 A (Switch on Current: 4 A)

Dimensions/Weight:

Dimension Transducer Control Box WxHxD:	400x800x300 Wall Fastening Box
Dimension Sensor Unit WxHxD:	215x20x510
Weight Transducer	35 kg
Weight Sensor	8,5 kg
Installation Standard Pipe	d_o 73 mm
Maximum of Cable Length between Sensor Unit and Transducer Box	20 m, More on Enquiry
Mounting Position Sensor Unit	In Any Order
Degree of Protection of Enclosure Sensor / Transducer:	IP54 / IP54

Fluid, external conditions:

Maximum Temperature Work Environment	0°C to 30°C
Maximum Relative Humidity Work Environment	<85%
Other Mounting Conditions	Indoor
Maximum Operating Temperature of Sensor	<500°C Fluid Temperature
Fluid	Liquid Metal Elec. Conductivity >10^5 S/m and <=10^7 S/m

Ranges:

Flow Range:	0,05 l/s – 10 l/s, Free of Blow Holes
Measures:	l/s, l/min, m³/h, kg/s, t/h (Other on Enquiry)
Pipe Dimensions:	Standard: 20 mm – 73 mm (Major Dimensions on Enquiry)
Excitation Frequency:	150 Hz – 800 Hz to Parameterize
Induction Current:	0 mA – 500 mA to Parameterize
Output Signal / Interfaces	4 – 20 mA
Measurement Uncertainty:	3% of Meas. Range under Condition of Constant and Balanced Temperature
Inlet Path:	5 x d_I (Inside Diameter)
Outlet Path:	3 x d_I (Inside Diameter)

Operation:

Display:	Touch Panel
Menu Item „Measure“:	Display of Measurement Value with Unit, Error Code, Recent Temperature of Sensor Core
Menu Item „System Setup“:	Input of System Parameters
Menu Item „Channel Setup“:	Input of Channel Parameters
Menu Item „Calibration“:	Two Point Calibration, Alternative: Zero Point Calibration
Menu Item „Service“:	Display of Additional Parameters

Parameter Settings - EMDps

Transducer:		Sensor:
Assembly Site:	**TagNr.:**	**Customer:**

System Parameters	Unit	min	max	adjusted
language	german ; english ; italian			
excitation frequency	Hz	150	300	
induction current	mA	0	500	
temperature coefficient	°/10K	-1	1	
pipe cross section	circle ; other			
inside diameter	mm	20	100	
flow cross section	mm^2	300	10000	
density	kg/dm^3	0,1	20	

Channel Parameters	Unit	min	max	adjusted
display format	xxx ; xx.x ; x.xx			
unit	l/s ; l/min ; m^3/h ; kg/s ; t/h			
averaging	s	1x0,5	10x0,5	
value 4mA	current unit			
value 20mA	current unit			
error default value	mA	3,8	20	

Other	Unit	min	max	adjusted
IP-amplifier				192.168.100.115
IP-touch panel PC				192.168.100.133
PW setup				1404

Parameter Settings - EMDps

Transducer:		**Sensor:**
Assembly Site:	**TagNr.:**	**Customer:**

System Parameters	Unit	min	max	adjusted
language	german ; english ; italian			
excitation frequency	Hz	150	300	
induction current	mA	0	500	
temperature coefficient	°/10K	-1	1	
pipe cross section	circle ; other			
inside diameter	mm	20	100	
flow cross section	mm^2	300	10000	
density	kg/dm^3	0,1	20	

Channel Parameters	Unit	min	max	adjusted
display format	xxx ; xx.x ; x.xx			
unit	l/s ; l/min ; m^3/h ; kg/s ; t/h			
averaging	s	1x0,5	10x0,5	
value 4mA	current unit			
value 20mA	current unit			
error default value	mA	3,8	20	

Other	Unit	min	max	adjusted
IP-amplifier				192.168.100.115
IP-touch panel PC				192.168.100.133
PW setup				1404

Parameter Settings - EMDps

Transducer:		Sensor:
Assembly Site:	**TagNr.:**	**Customer:**

System Parameters	Unit	min	max	adjusted
language	german ; english ; italian			
excitation frequency	Hz	150	300	
induction current	mA	0	500	
temperature coefficient	°/10K	-1	1	
pipe cross section	circle ; other			
inside diameter	mm	20	100	
flow cross section	mm²	300	10000	
density	kg/dm³	0,1	20	

Channel Parameters	Unit	min	max	adjusted
display format	xxx ; xx.x ; x.xx			
unit	l/s ; l/min ; m³/h ; kg/s ; t/h			
averaging	s	1x0,5	10x0,5	
value 4mA	current unit			
value 20mA	current unit			
error default value	mA	3,8	20	

Other	Unit	min	max	adjusted
IP-amplifier				192.168.100.115
IP-touch panel PC				192.168.100.133
PW setup				1404

0	1	2	3	4	5	6	7	8	9

WUPE001D 20.07.1999

SAAS GmbH

Poisentalstraße 3
01728 Bannewitz/ OT Possendorf
Tel.: 035206/23871

name of construction:	EMDps measuring transducer and sensor unit
manufacturer (firm):	SAAS GmbH
name of project:	EMDps 73
type:	EMD-ps-MU500 & EMD-ps-S73
responsible person of project:	Marcel Flöter

create at:	12.04.2012		
edit at:	26.06.2012	by (abbreviation):	saas_user

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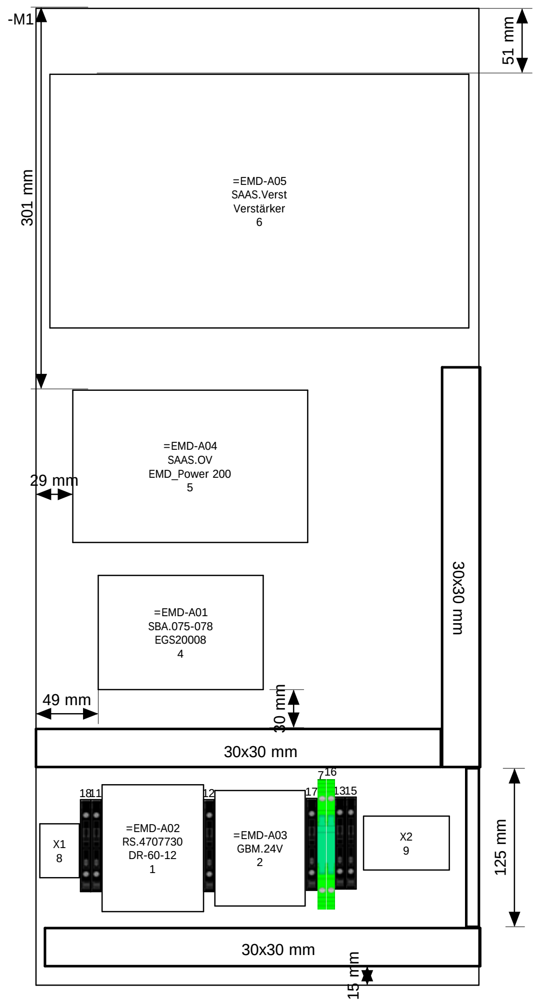

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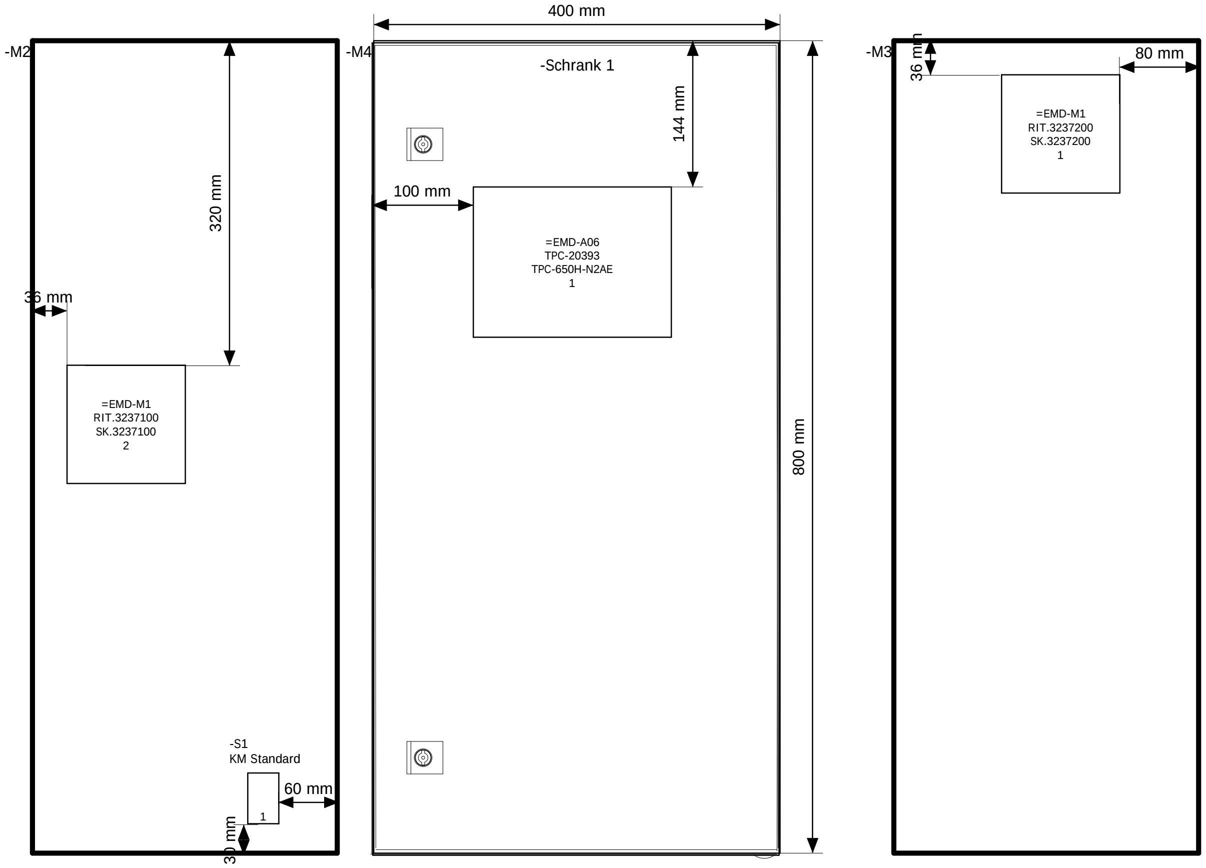
			Ed.	saas_user		Poisentalstraße 3		+ S1
			Appr		EMDps measuring transducer and sensor unit	D-01728 Bannewitz / Germany		GB_tpl001
Modification	Date	Name	Original		Replacement of / Replaced by			Blatt: 3 / 10 Seite: 3



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		Appr		EMDps measuring transducer and sensor unit	D-01728 Bannewitz / Germany		GB_tpl001	Blatt: 4 / 10
Date	Name	Original		Replacement of / Replaced by				Seite: 4

Enclosure legend

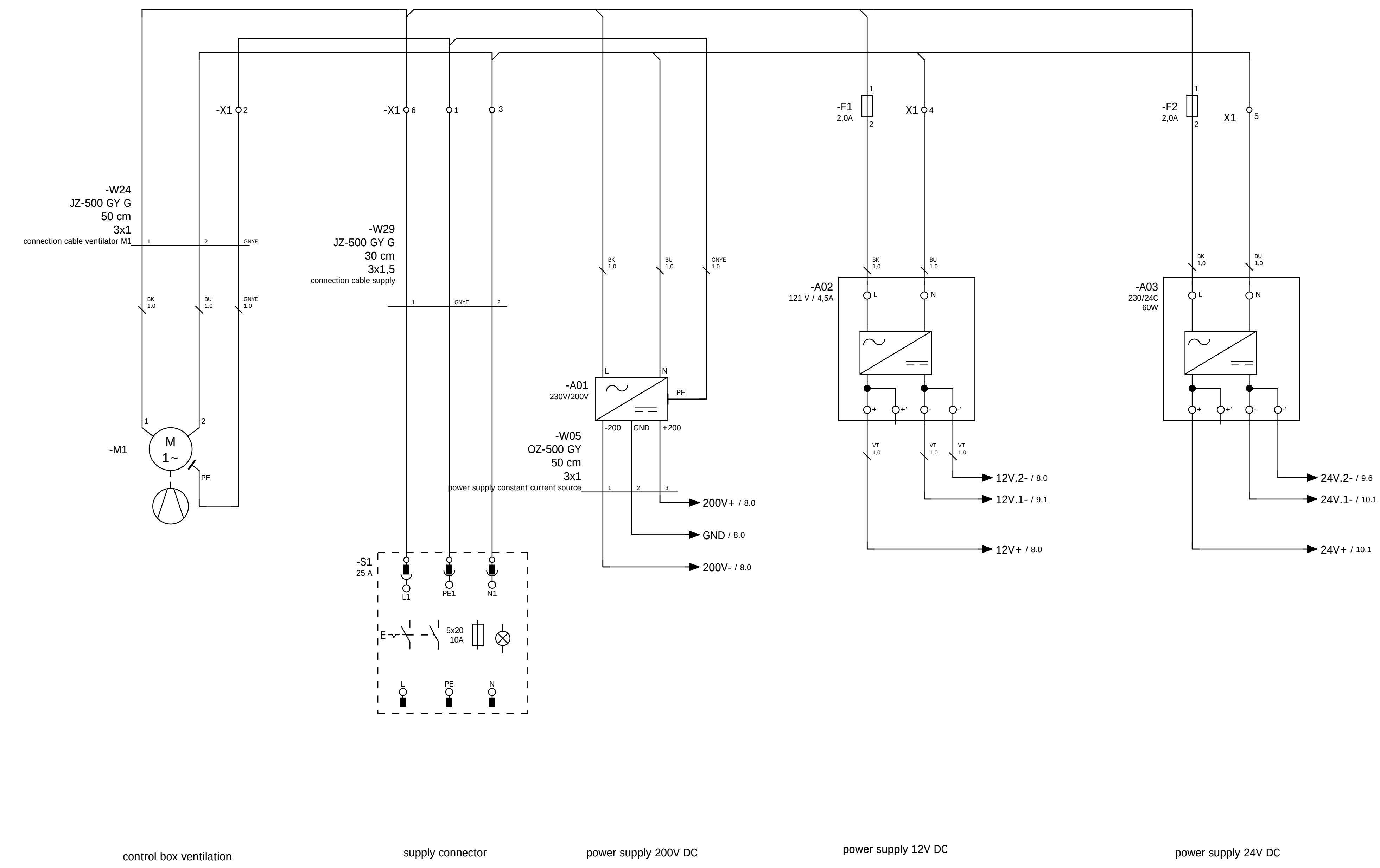
F18_001

item number	device tag	Type number	part number	manufacturer	function text
1	A02	DR-60-12	RS.4707730	RS	
2	A03	PS/1AC/24DC/ 60W	GBM.24V	GBM	
4	A01	EGS20008	SBA.075-078	SBA	
5	A04	EMD_Power 200	SAAS.OV	SAAS	
6	A05	Verstärker	SAAS.Verst	SAAS	
7	A07	MINI MCR-SL-PT100-UI-200-NC	PXC.2864370	PXC	
8	X1				
9	X2				
16	A08	MINI MCR-SL-UI-2I	PXC.2902829	PXC	

Cable overview

F10_001

Cable name	Source (from)	Target (to)	cable type	all conductors	Conductors used	Cross-section [mm]	Length [m]	function text	Graphical page of cable diagram
-W05	-A01	-A04-P23	OZ-500 GY	3	3	1	0,5	power supply constant current source	
-W06	-A05	-A04-P27	RG 174/U	1	1	7x0,16	0,8	reference signal from amplifier	
-W07	-A04-P28	-F5	TRONIC-CY (LiY-CY) GY	2	2	0,75	0,4	excitation signal to transmitting coil	
		-F6							
-W22	-A02	-A05-X1	JZ-500 GY G	3	2	1	1	power supply amplifier	
	-F3								
-W23	-X2	-A04-P24	JZ-500 GY G	3	3	1	0,7	power supply hall sensor	
	-A02								
	-F3								
-W24	-X1	-M1	JZ-500 GY G	3	3	1	0,5	connection cable ventilator M1	
-W27	-X2	-A06	JZ-500 GY G	3	3	1	1	power supply touch panel pc	
	-A03	-A06-X1							
	-F4								
-W28	-A05	-A06	RJ45 crossover	8	1		1	Datentransfer Verstärker - Touch Panel PC	
-W29	-S1	-X1	JZ-500 GY G	3	3	1,5	0,3	connection cable supply	
-W100	-X2	+PR-X07	LiY-CY GY	4	4	0,75	5	PT100 measurment value	
	-SH								
-W101	-X2	-F5	LiY-CY GY	2	2	0,75	5	excitation signal LS	
	+PR-X07	-F6							
-W102	-X2	+PR-X08	LiY-CY GY	2	2	0,75	5	receiving signal LE1	
-W103	-X2	+PR-X08	LiY-CY GY	2	2	0,75	5	receiving signal LE2	



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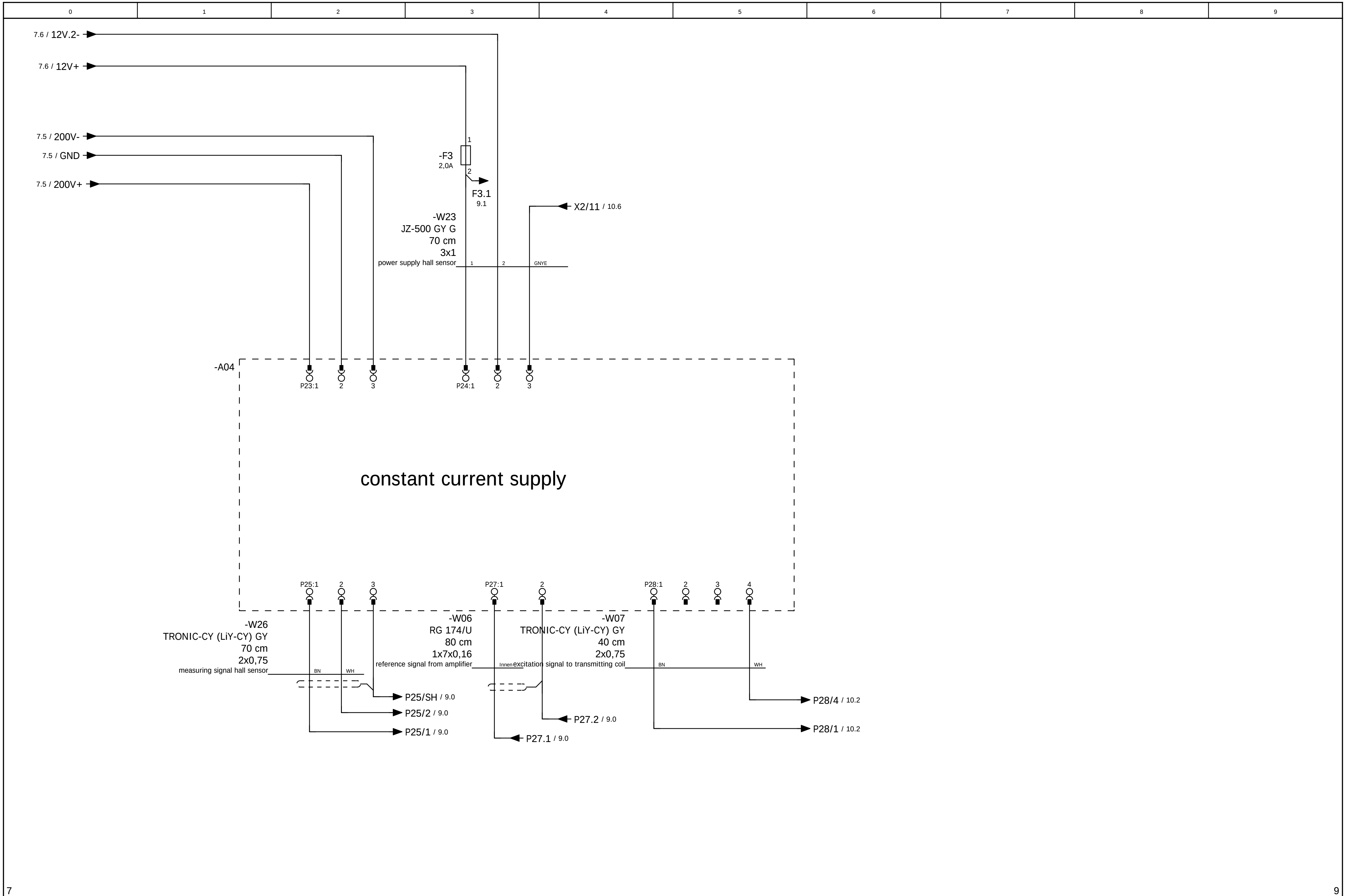
			Appr		EMDps measuring transducer and sensor unit	D-01728 Bannewitz / Germany	
Modification	Date	Name	Original		Replacement of / Replaced by		

= EMD
+ S1
GB_tpl001
Blatt: 7 / 10
Seite: 7



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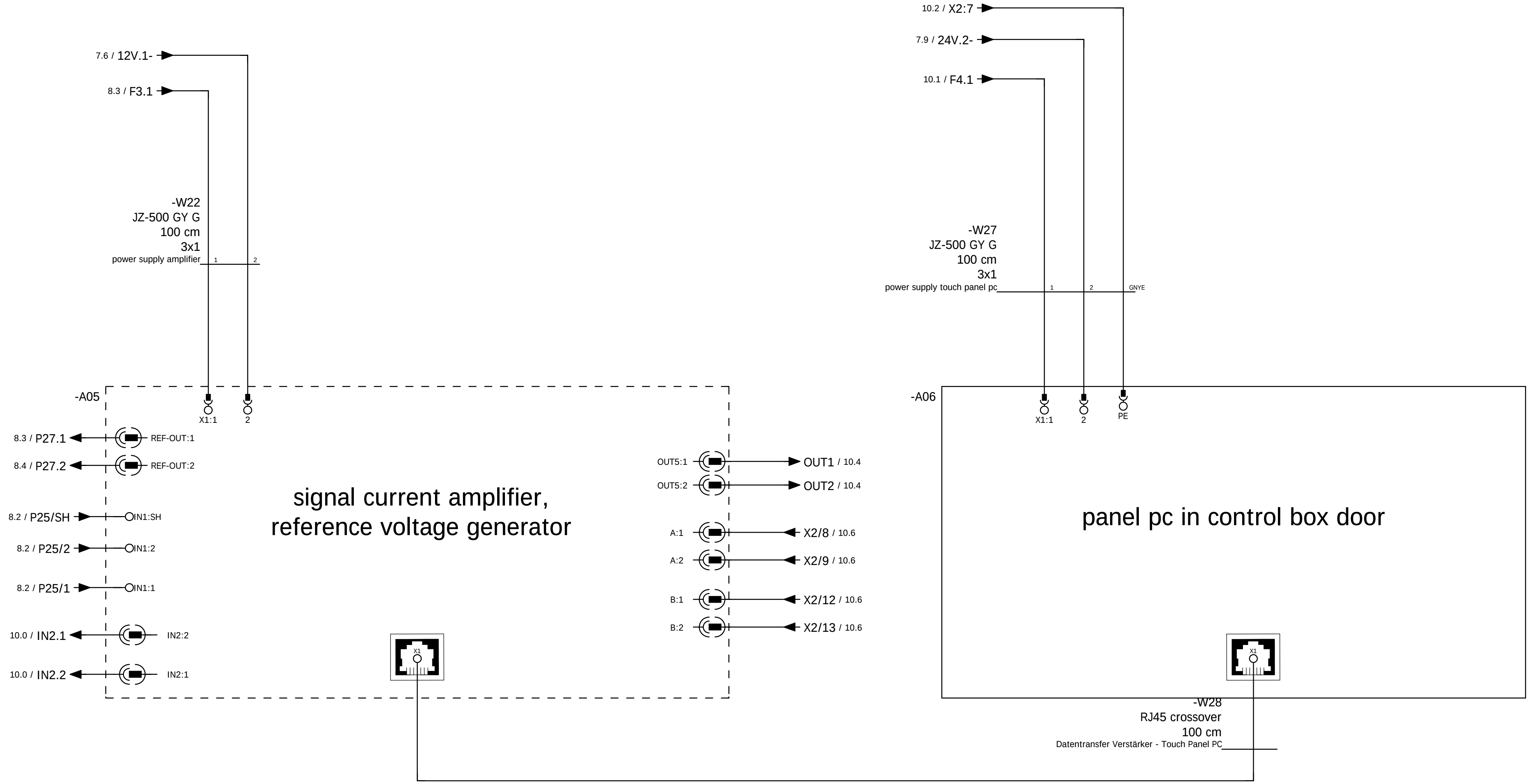
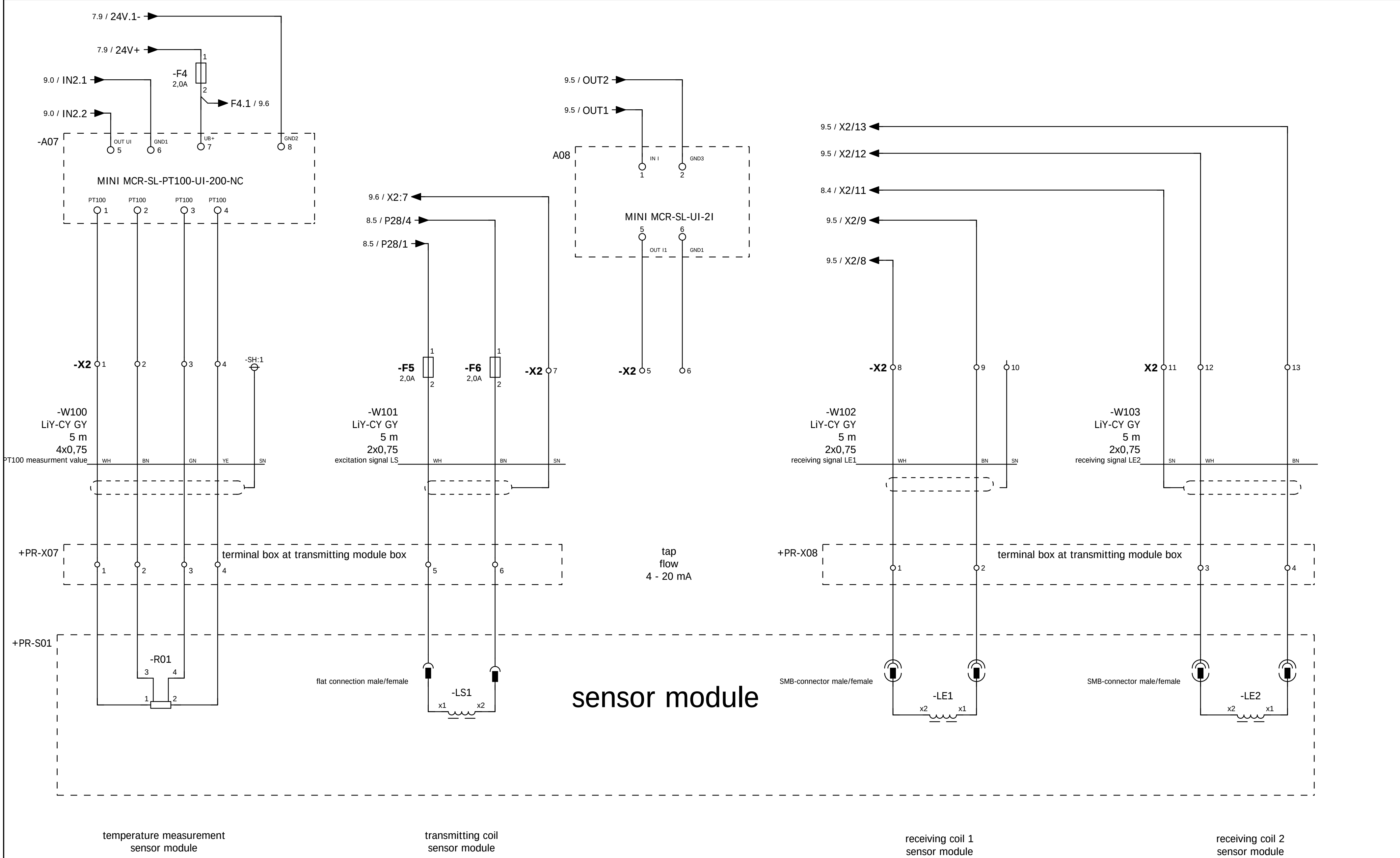
			Appr		EMDps measuring transducer and sensor unit	D-01728 Bannewitz / Germany	GB_tpl001	Blatt: 8 / 10
Modification	Date	Name	Original		Replacement of / Replaced by			Seite: 8


7.6 / 12V.1-
8.3 / F3.1
-W22
JZ-500 GY G
100 cm
3x1
power supply amplifier
1
2
-A05
X1:1
2
8.3 / P27.1
REF-OUT:1
8.4 / P27.2
REF-OUT:2
8.2 / P25/SH
IN1:SH
8.2 / P25/2
IN1:2
8.2 / P25/1
IN1:1
10.0 / IN2.1
IN2:2
10.0 / IN2.2
IN2:1
signal current amplifier,
reference voltage generator
X1
OUT5:1
OUT1 / 10.4
OUT5:2
OUT2 / 10.4
A:1
X2/8 / 10.6
A:2
X2/9 / 10.6
B:1
X2/12 / 10.6
B:2
X2/13 / 10.6
10.2 / X2:7
7.9 / 24V.2-
10.1 / F4.1
-W27
JZ-500 GY G
100 cm
3x1
power supply touch panel pc
1
2
GNYE
-A06
X1:1
2
PE
panel pc in control box door
X1
-W28
RJ45 crossover
100 cm
Datentransfer Verstärker - Touch Panel PC

8
10

0	1	2	3	4	5	6	7	8	9



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			Appr		EMDps measuring transducer and sensor unit	D-01728 Bannewitz / Germany		GB_tpl001	Blatt: 10 / 10
Modification	Date	Name	Original		Replacement of / Replaced by				Seite: 10

Notes:

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