Microstructure Profiler MSS90

Operating instructions

User's manual

Version 5
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1 General system description

1.1 System properties

The MSS90 Profiler is an instrument for simultaneous microstructure and precision measurements of physical parameters in marine and limnic waters. It is designed for vertical profiling within the upper 2000 m.

Microstructure investigation requires an undisturbed measuring procedure of the profiling instrument. Effects caused by cable tension (vibrations) and the ship's movement have to be excluded by buoyancy driven free sinking of the MSS Profiler. This requires a slack in the cable near to the profiler. The loop in the cable is generated and kept during the profiling by immersing sufficient cable into the water.

For vertical sinking measurements, the profiler has to be balanced with a slightly negative buoyancy which gives it a sinking velocity in the range between 0.3 to 0.7 m/sec.

The profiler can be manually handled and recovered. For more convenient operation, special portable winches are available. The data are transmitted via electrical cable to an on board unit and further to a data acquisition PC. The on board unit generates the power supply for the profiler and the receiver of the data link. Data are stored online on the hard disc of the acquisition PC during the measuring process.

The basic hardware system for microstructure field measurements consists of several parts

- microstructure profiler
- USB Interface for power supply and data link to PC
- sea cable connection between interface and profiler
- winch (manual or electrical)
- PC, Laptop or Notebook with USB port

The measuring system can be powered either by mains (230VAC, standard version) or battery (9-36 VDC, special version).

For data acquisition, the **S**tandard **D**ata **A**cquisition program **SDA** is used. **SDA** is running on Windows 98 to XP. It displays the received data online and stores it on hard disk. Graphical functions allow a convenient operation and online control of the system. Conversion of the stored data files to ASCII is included.

For data evaluation, the program **DatPro** can be used. **DatPro** is specially designed for customers of the MSS Profiler. It has the character of a toolbox. It consists of a management program and many modules to carry out various steps of data evaluation. The management program handles all modules and manages the dialogue with the user of the program. The user of **DatPro** can select the various steps and the sequence in the data evaluation process dependent on his needs and aims of his investigation. Single modules can be combined to macros. The macros can be applied to one data file or to a list of data files. Graphical utilities enable a comfortable quick-look of the measured and processed data.

The MSS microstructure measuring system has some outstanding properties, which results to a superior performance related to other microstructure profilers. The MSS90 profiler has a high sample rate and high analogue band width. The system allows a number of sensors to be connected directly to the bottom of the profiler without the need to use underwater connections. The following table lists the most important features in a short review:

- Sample rate:	1024 data sets/sec
- Number of parameters	16 / dataset
- number of analogue channels:	15
- Bandwidth of microstructure channel:	150 Hz (-3dB)
- response time of MS channels	< 12 ms
- Resolution (all channels):	16 bit

Data transmission is 614,4 kbaud (tested for cable length up to 1000 m).

1.2 Sensor equipment

The MSS90 profiler may be equipped with up to 9 different sensors on the bottom cap, which can be subdivided in two different groups:

- Standard CTD sensors
- Microstructure sensors

The standard CTD sensors have a relatively slow response but high accuracy. The following sensors are available:

- Pressure
- Temperature (PT 100)
- Conductivity

- pH
- ORP
- Oxygen
- Fluorescence Chl A
- Turbidity

The microstructure sensors are especially designed for the measurement of small scale stratification and turbulence. They have a fast response and limited accuracy and long term stability.

Following sensors are available:

- Temperature (Thermistor NTC)
- Current shear
- Conductivity

Furthermore, housekeeping sensors are integrated in the profiler:

- Horizontal profiler acceleration
- Tilt (two components)
- Surface detector (for rising measurements)

Except the tilt sensor, all the above mentioned sensors will be mounted directly on the bottom cap of the profiler with no external underwater cable connection. The tilt sensor is placed inside the profiler housing. Details and a full description of all sensors are given in the following chapter.

1.3 Sensor specifications

The following specifications do not refer only to the sensor's properties but cover the complete instrument over the full temperature range from –2°C to 32°C.

1.3.1 Pressure sensor P

Principle:	temperature compensated piezoresistive full bridge
Ranges	10, 20, 50, 100, 200 Bar
Resolution	0.002% FS
Accuracy:	0.1%FS
Response time	150ms

1.3.2 Precision temperature sensor T

Principle:	linearized Wheatstone bridge with PT 100
Range	-2 … 36°C
Resolution	0,0006°C
Accuracy	+/-0.01°C
Response time	150 ms at 1 m/s flow

1.3.3 Precision conductivity sensor C

Principle:	symmetrical cell with 7 electrodes
Ranges	0 … 60, 0 … 6 mS/cm
Resolution	0.001 mS/cm, 0,0001 mS/cm
Accuracy	+/-0.02 mS/cm, +/- 0,005 mS/cm
Response time	150 ms

1.3.4 pH-sensor pH

Principle:	combination electrode with reference
Range	pH 3,5 ... 10,5
Resolution	0,0001 pH
Accuracy:	+/-0,05 pH
Response time	1 sec

1.3.5 Redox-sensor ORP

Principle:	combination electrode with reference
Range:	-2000 ... 2000 mV
Resolution:	0,01 mV
Accuracy:	+/-20 mV
Response time	1 sec

1.3.6 Dissolved oxygen O2

Principle:	self galvanizing clark elektrode
Range:	0 … 200%
Resolution:	0,01 %
Accuracy:	2%
Response time	3 sec

1.3.7 Turbidity TURB

Principle:	optical back scattering 90°
Range:	0 ... 25, 125, 500, 2500 FTU
Resolution:	0,01 %
Accuracy:	2%
Response time	100 ms

1.3.8 Fluorescence sensor FL

Principle:	fluorescence 180°
Range:	0 ... 50µg/L Chl A,
Resolution:	0,01 %
Accuracy:	1%
Response time	100 ms

1.3.9 Microstructure temperature sensor NTC

Principle:	NTC-resistor electronically linearized
Range:	-2 ... 32°C
Resolution:	0,0005°C
Accuracy:	+/- 0,02°C
Response time	12 ms at 1 m/s flow

1.3.10 Microstructure current shear sensor SHE

Principle:	piezoceramic bending element
Range	0 … 6 1/s (10^{-11} … 10^{-2} W/kg kinetic energy dissipation [*]
Resolution:	approx. 10^{-3} 1/s
Accuracy:	not specified
Response time:	approx. 4 ms

[*] dependent on measurements conditions

1.3.11 Acceleration sensor ACC

Principle:	piezoceramic bending element
Range:	0 … 3 m/sec^2
Resolution:	0,005 m/sec^2
Accuracy:	0,02 m/sec^2
Response time:	approx. 4 ms

1.3.12 Microstructure conductivity Cm

Principle:	capillary cell two electrodes
Range:	0..60 mS/cm
Resolution:	1µS/cm
Accuracy:	0,5 mS/cm
Response time:	approx. 5 ms

2. Microstructure profiler design

All mechanical parts are of the profiler are constructed under the premise of a low vibration level during the sinking (or rising) movement of the instrument in water. Furthermore, the housing of the MSS is designed to have a resonance frequency of the first bending mode above the frequency range used for computation of turbulence parameters from the shear measurement (approx. 1…50Hz).

2.1. The housing

The housing of the MSS profiler has to comply several conditions. It must have a certain length and weight in order to stabilize the instrument during profiling and to reduce tumbling in shear layers. Another important consideration is that the volume of the housing has to compensate the weight of the probe; the remaining negative buoyancy of the profiler in seawater should be compensated by floating elements mounted on the top end of the housing. On the other hand the instrument should not exceed in size and weight the limits of easy handling and simple deployment. But most important is to withstand the water pressure. All these aspects lead to the following different models, designed for different depth ranges and measurement conditions.

MSS90 and MSS90L

There are 3 different models available with the same electronic and sensor equipment. The photos below show on the left side the MSS90L with the housing length of 1,25m , the housing of the standard model MSS90 is only 1m long . This fact lead to a difference in weight (12,5kg /10kg) and to a different number of necessary buoyancy rings (8/6). The standard MSS90 is easier to handle especially from small ships, but the shear sensor data quality of the MSS90L is superior due to the higher mass and stability of the MSS90L. The deployment depth for MSS90 and MSS90L is 500m. For special applications, the MSS90 can be delivered with a lighter housing (smaller wall thickness). This version has a weight in air of approx. 9kg and an operation depth of not more than 300m.

MSS90D (photo middle and right)

This model is designed for a maximum depth of 6000m. The length of the housing is relatively short (62cm) compared with the other models. The MSS90D uses a single buoyancy element which is clamped with a POM ring on the top of the housing. The total weight in air is approximately 26kg (housing 8kg) the total length about 1,30m. The profiler stability is excellent and the best of all models.

All the different housings have the same diameter and are made of seamless drawn titanium tube.

MSS90 and MSS90L MSS90D complete MSS90D housing

2.2. The bottom cap

The bottom cap is designed to accept a high number of sensors on the smallest possible diameter. We have 9 positions for sensor mounting and a diameter of 90 mm. The inner four positions are intended for the mounting of the microstructure sensors, the 4 positions on the outer pitch circle should be occupied with standard sensors. All sensors have the same flange and fit in any mounting hole of the bottom cap. The sensors are fixed to the end cap by screws M4*8 (DIN 912). The pressure transducer is inserted into the base in the centre position inside and held by a brass nut M18 * 1 against the pressure from outside. A female thread ¼" UNF 28 THD is used as calibration connection for a pressure gauge. The bottom cap is made of titanium and is screwed to the pressure tube with 4 screws M3*6 (DIN912) and sealed with two O-rings 76*2.5 mm. On the inner side of the cap, there are four threads M4 for the mounting of the supporting plate and electronic boards. Electronic boards and sensors are connected by separable cable connectors for easy exchange of sensors

2.3. The top cap

The top cap has the same size and shape as the bottom cap and is made of titanium, fixing to the tube and sealing is done in the same way. It has a thread 7/16" UNF 20 THD for the mounting of the sea cable bulkhead connector . There are 2 threads M6 for the attachment of the sea cable suspension.

Inside the cap a circular shaped electronic board is mounted on 4 distant bolts. The board contains the DC-DC converters for power supply and the RS485 cable driver. The link between the top cap and the profiler electronic boards is done by a separable cable connection.

2.4. Profiler suspension to the sea cable

MSS90 and MSS90L
The suspension is screwed with 2 screws M6*16 (DIN 912) to the top cap and is necessary for the proper cable pull relief. The intention is to keep pulling forces off the moulding junction of the cable. The sea cable is first guided through a cable inlet which serves as anti-kink device to protect the cable from damage. Then it is winded in several turns on two bollards before it is definitely fixed in a clamp on the top of one bollard.

MSS90D
The suspension of the MSS90D is mounted to the top of the buoyancy element. Similar to the MSS90/90L version, the cable is guided through a cable inlet and is then wrapped in several turns and fixed on a bollard.

2.5. Weights and flotation elements

In order to adjust the sinking velocity, each MSS90 probe is supplied with flotation rings and a set of ring-shaped stainless steel weights. The standard set of weight rings consists of 10 rings with 125/90 mm diameter (2mm thickness) which provides a maximum total weight of approx. 1kg


The weights are located on the sensor protection cage and fixed by a clamp (photo left). The MSS90D requires more weight rings. The flotation rings are fixed at the upper end of the profiler housing (photo right)

weights	5*	125/90 mm	2 mm height	92 g each
	5*	125/90 mm	5 mm height	230 g each

The flotation elements are hollow cylinders made of syntactic foam. The size of these elements is

150/90 mm diameter, 42mm height, 0,3 kg buoyancy.

The flotation elements are clamped to the pressure pipe with two locking rings (made of POM) which have nearly neutral buoyancy (photo right). The uppermost flotation element has a ring of fringes which increases the drag of the profiler and prevents the generation of large eddies at the end of the profiler (which would increase the vibration level of the sinking instrument)

2.6. Weights and measures

	MSS90	MSS90L	MSS90D
Length overall approx. L[mm]	1400	1600	1600
Length of the housing L[mm] [1]	1020	1270	640
pipe diameter ∅[mm]	89	89	89
wall thickness [mm]	5,5	5,5	7,6
Sensor protection cage L[mm]	275	275	275
sensor protection cage ∅[mm]	255	255	255
probe suspension L[mm]	165	165	180
Weight overall approx. [kg] [2]	10	12.5	26

[1] including end caps

[2] without weights and buoyancy elements in air

2.7. Dismantling of the probe

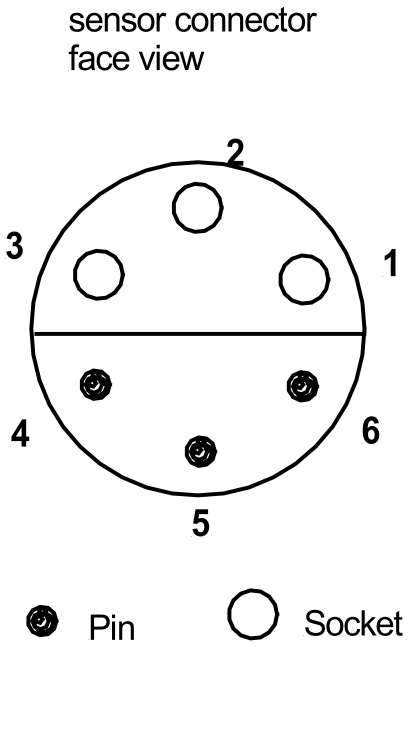
Sometimes it may be necessary to dismantle the profiler (e.g. for repair). Please keep the following sequence:

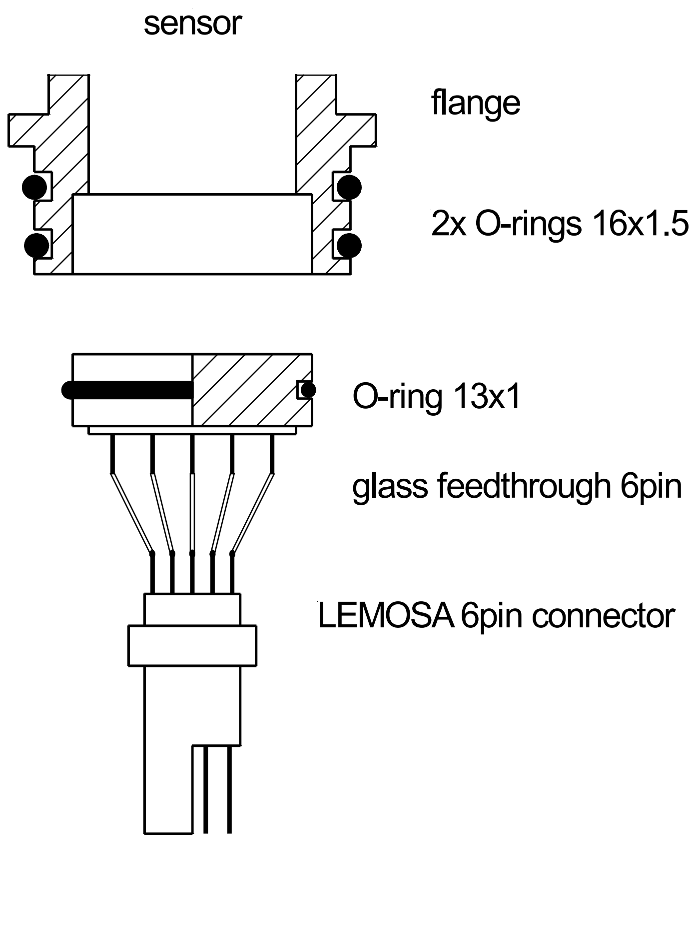
1. switch off the sea cable supply.
2. MSS90D remove the buoyancy element
3. MSS90/L/D pull off the top cap after removing 4 screws at the end of the tube (suspension and cap need not to be separated.
4. separate the cable connection between top cap and electronics
5. remove the sensor protection cage
6. pull off the bottom cap after removing 4 screws at the end of the tube. Be careful during handling in order not to damage the sensors. The assembling of the profiler is done in the reverse sequence.

3. The sensors

The standard sensors as well as the microstructure sensors have all the same flange. They can be plugged in any mounting hole of the bottom cap and are sealed to the cap with two O-rings 16*1,5. Each of the flanges have a built-in 6 pin glass feed-through, which is pressure resistant up to 400 bar and fitted with a small round connector for easy connection to the profilers electronic board . The sensors are attached to the bottom cap by screws.

This construction allows an easy and fast exchange of sensors without the need of opening the pressure housing. All you have to do is to remove the screws, pull the sensor out of the mounting hole and separate the connection. A new sensor will be mounted in the reverse way within a few minutes.





3.1. Pressure transducer

A piezo-resistive full bridge in OEM version with a diameter of 15 mm and a total height of 5 mm is used as pressure transducer (produced by the Swiss manufacturer KELLER). The casing and diaphragm are made of corrosion proved alloy C276. The transducer is delivered with a small SMD-PCB that includes a temperature compensation of the pressure measurement. The sensor is mounted in the base cap of the probe; the SMD-board has contacts and is plugged onto the main board of the probe.

Manufacturer:……………….. KELLER, Switzerland
Model:…………………………PA7-50 Progress (*)
Measurement range:……….. 50 Bar (*)
Burst pressure:……………… 150 %FS
Overall accuracy:…………….0,1%FS
Sensor diameter:…………….15 mm
Sensor height…………………5,6 mm
O-ring:…………………………13*1 mm

(*) = 50 standard range
10, 20, 100 Bar optional **F**ull **S**cale range for MSS90 and MSS90L

The sensor is a full Wheatstone bridge with a bridge resistance of 3,5kOhm at air pressure and driven by constant current. The actual temperature of the bridge silicon chip is measured via the bridge voltage and used for compensation of thermal drifts of zero point and sensivity. This results in good temperature and long term stability.

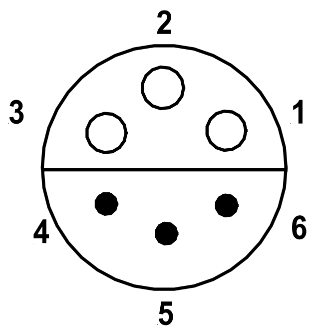
A female thread ¼"UNF 28THD with a depth of 10 mm in the center of the bottom cap allows the connection to a pressure gauge for calibration. Please take care that the maximum allowable thread length of the gauge connector does not exceed 10 mm.

The deep sea version MSS90D uses a different model as pressure transducer:

Manufacturer:……………….. KELLER, Switzerland
Model:…………………………PA8-200 Progress (*)
Measurement range:……….. 200 Bar (*)
Burst pressure:……………… 150 %FS
Overall accuracy:…………….0,1%FS
Sensor diameter:…………….15 mm
Sensor height…………………13 mm
O-ring:…………………………12*1,5 mm

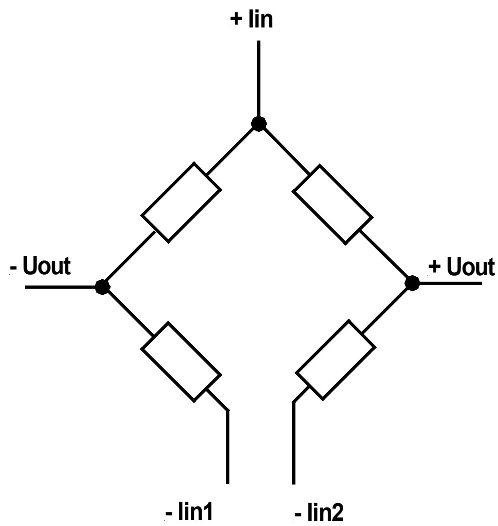
(*) = 200Bar standard range,
400, 600 Bar optional Full Scale range for MSS90D

Internal wiring and connector pin assignment of both transducers is depicted below



Lemosa connector
PSA.1S.306.ZLL
face view

○ socket ● pin



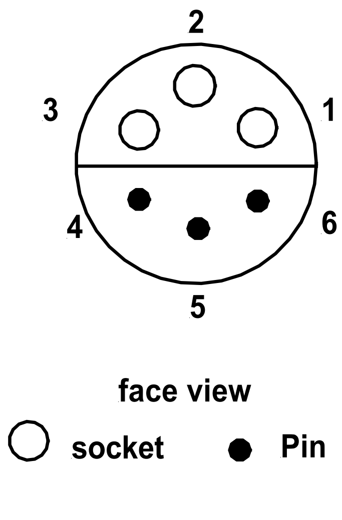
Pin-No.	**Signal**	**cable color**
1	+ I in	black
2	- I in 1	white
3	- U out	blue
4	+ U out	red
5	- I in 2	yellow
6	not connected	

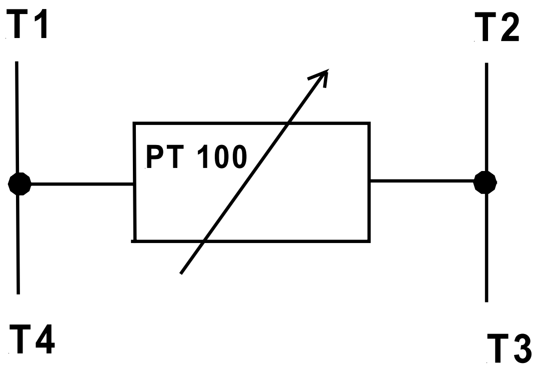
3.2. Temperature sensor Pt 100

is a platinum resistor of 100 Ohm at 0°C and a size of 0,9 mm diameter and 15 mm length. It is mounted into a thin titanium tube of 1,2*0,1 mm and approximately 35 mm length. The fine needle-shaped pipe is very sensitive against touching or bending and therefore sheltered by a perforated protecting tube of 10 mm diameter. The electrical connection is done in four wire technique in order to avoid the influence of the wire and the connector resistance.

Manufacturer:................SST
Pt100:............................Isotech P100/1509
Response time:.............150 ms at 1m/sec flow
Length:..........................90 mm

Lemosa connector PSA.1S.306.ZLL



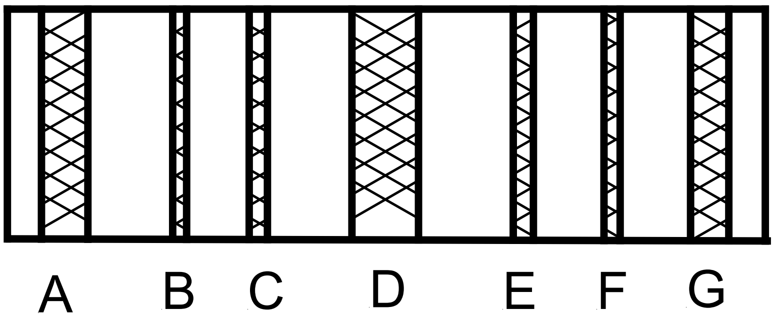


The sensor is connected in four-pole technique ,pin assignment is depicted below :

Pin1	T1	black	Pin4	T4	black
Pin2	T2	red	Pin5	not connected	
Pin3	T3	red	Pin6	not connected	

3.3. The conductivity sensor

uses a cylindrical 7 electrode quartz glass cell with platinum coated rings as electrodes in the inner side of the glass cylinder. The following schematic shows the electrode arrangement and cell geometry .

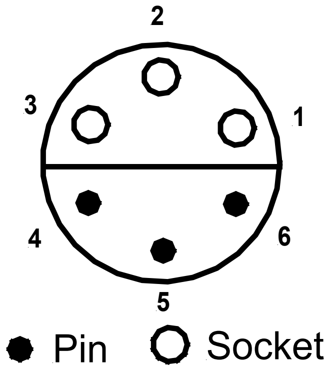


The outside and middle electrodes are the current electrodes, the smaller ones are the voltage sensing electrodes. The middle electrode (D) is driven by an alternating current while the outside electrodes (A,G) are held constant on sea water potential. This symmetrical arrangement leads to an independence of the conductivity measurement from boundary conditions because the electrical field is completely kept inside the glass cylinder. The great advantage is an easy and accurate calibration procedure with the same results in any surrounding. The housing of the conductivity cell is made of a special sealing compound founded in a mould.

Manufacturer: ....ADM
Type:..............................7 electrodes cylindrical cell
max. depth:................... 600 Bar
Ranges:..........................0 – 1 mS/cm, 0 - 6 mS/cm, 0 - 60 mS/cm (*)
Length:.........................15 mm
Connector:………………Lemosa PSA 1S.306.ZLL

(*) standard ranges, any other range between 1…70mS/cm is possible

The following diagram shows the face view of the sensor connector and gives the colours of the connection cable to the PCB.



Pin	Signal	colour
1	B	grey
2	C	blue
3	D	red
4	E	yellow
5	F	violet
6	G,A	green

Option: Combined T-C sensor

In case of insufficient space for sensors, SST can offer a T-C sensor with the same electrical specifications and pin assignments as described in chapter 3.2 and 3.3. The combined sensor is mounted on a single flange. The only restriction is the depth rating which is limited to 2000m.

3.4. Oxygen sensor

3.4.1 Oxyguard DO522M18

The oxygen sensor measures the dissolved oxygen in the water using polarographic methods. The platinum cathode has a diameter of 4mm and is encased with a teflon membrane. The oxygen current consumption ranges from 0 to 12 µA due to the big diameter of the platinum wire. The relative high current consumption requires a minimum current flow of 10 cm/sec in order to avoid oxygen depletion in front of the membrane.

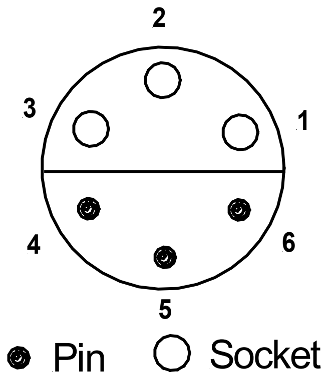
Oxygen sensor without protection cap

Oxygen sensor with protection cap

Technical data:

Manufacturer and model:……………Oxyguard DO522M18
Type of sensor: ………………………Clark electrode, self galvanizing
Polarisation voltage:………………… -0,7 VDC
Range:…………………………………0 – 200 %
Oxygen current:………………………0 – 12 µA
Temperature range:…………………-2°C – 30°C
Response time:………………………approx. 3s (63%), 10s (90%)
Accuracy:………………………………+ /-3%
Maximum depth:..…………………….2000 m
Output resistance:……………………1,5k

The Oxyguard Sensor is internally temperature compensated with a resistor and thermistor in the full ocean temperature range and thus provides a quite linear signal output . The sensor has a low output signal of approximately 30…40 mV for 100% saturation. Since the DO sensor is self galvanizing, the output voltage is always available an can be checked with a standard voltmeter between pin2 and pin3 of the sensor connector.



Pin	Signal	colour
1		
2	+Vout	brown
3	- Vout	blue
4		
5		
6		

3.4.2 AMT fast DO-sensor

The AMT fast DO shallow water sensor is a galvanic micro-sensor, which has been developed above all for the very fast in-situ profiling of dissolved oxygen with CTD probe systems for depths of up to 100 m.

The sensor has a very short response time. A streaming of the membrane - as it is well known from nearly all kind of Clark-type oxygen sensors - is not necessary. So profiling and stationary measurements without stirring the analyte become possible with a very high signal and local resolution. The sensor is self-polarising. This avoids long adjustment times after switching on. The adjustment time depends only on the membrane swelling in water (if the sensor was dryed out during storage) and on the exchange of oxygen concentration at the very small sensor membrane. The exchange of the sensor head is very easy and could be done by the customer himself.

Technical Specifications:

Manufacturer:	AMT
Model:	galvanic Clark-type micro-sensor
Polarisation:	approx.-0,7VDC, self-polarising
Range:	0 – 200 % saturation
Oxygen input current:	0 – 2.5 nA
Temperature range:	0°C – 30°C
Response time:	typ. < 1sec
Accuracy:	± 2%
Maximum depth:	100 m

Ranges up to 150 mg/L available on request.

To achieve the highest possible accuracy, the sensor has to be re-calibrated from time to time. This is especially recommended during the first weeks of the sensor life.

connector Lemosa	pin assignment colour	signal
Pin 1	n.c.	
Pin 2	yellow	current in 0..5 nA
Pin 3	black	signal GND
Pin 4	n.c.	
Pin 5	n.c.	
Pin 6	n.c.	

3.5. pH and ORP sensors

3.5.1 Depth range 0..500m

pH and ORP combined electrodes are industrial sensors using a solid reference system (stiff polymer mass containing KCl) and an aperture diaphragm which allows direct contact between reference electrolyte and sample medium. Regeneration of the glass membrane or filling up electrolyte is not possible. When the lifetime of the sensor is over, it has to be replaced by a new one. The sensor has a thread PG 13,5 and is screwed into a flange. A coaxial socket makes the electrical contact in the flange. Sealing between sensor and flange is achieved by an O-ring, which is part of the sensor.

Technical data:	pH	Redox
Manufacturer	Hamilton	Hamilton
Model	Polylite PRO 120 XP	Polylite RX 120 XP
Measuring range	4-10	-2000mV.. – 2000 mV
Maximum depth	500m	500 m
Shaft diameter	12 mm	12 mm
Length with flange	167 mm	167 mm
Response time	approx. 1 sec	approx. 1 sec.

3.5.2. Depth range 1200m

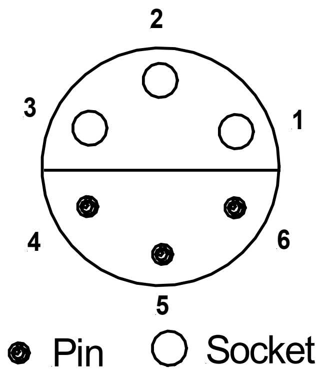
This pH/ORP Sensor uses a pressure-balanced plastic electrode with a reference to provide in-situ measurements up to 1200m depth. The sensor is equipped with a reference system using a solid gel (stiff polymer mass containing Ag^+-free KCl) and a ceramic pore diaphragm and with a pressure stable pH-sensitive glassy electrode.The pH probe is permanently sealed and supplied with a soaker bottle attachment. The bottle contents must be 3 mKCl solution (pH 4) that prevents the reference electrode from drying out during storage.

This kind of sensor is absolutely **H_2S resistant**.

	PH	Redox
Manufacturer	AMT GmbH	AMT GmbH
Measuring range	4-10	-2000mV – 2000 mV
Maximum depth*	1200m	1200 m
Shaft diameter	12 mm	12 mm
Shaft material	transparent plastic	transparent plastic
Bulkhead material	Stainless steel	stainless steel
Thread	G1/4 (ISO228)	G1/4 (ISO228)
Shaft length	84mm	84mm
Length with flange	117 mm	117 mm
Response time	approx. 1 sec	approx. 1 sec.

*This sensor is pressure resistant up to several thousand meters depth with a slight increase of pH/ORP values.

The connector pin assignment is the same for all models and depicted below:



pin	signal	colour
1	-	-
2	Ref	white
3	pH/ORP	blue
4	-	-
5	-	-
6	-	-

3.6. Seapoint turbidity sensor

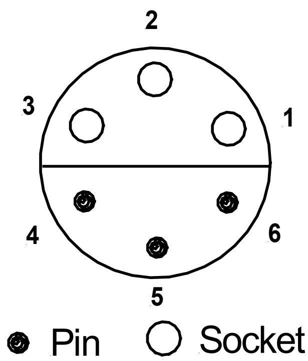
The bottom mounted turbidity sensor is based on the SEAPOINT turbidity meter in the bulkhead version, which is screwed onto a standard flange. Electrical connection is achieved by a separable 6 pin round connector.

The Turbidity sensor measures the concentration of suspended matter. It is equipped with a pulsed infrared light transmitter and detects the scattered light from the particles suspended in water. Transmitter and detector arrangement uses 90° scattering at a wavelength of 880 nm. The output signal is proportional to the particle concentration in a very wide range. For detailed description of Seapoint turbidity meter refer to the special user manual.

Specifications:

Power:…………………….. 7 – 20 VDC, 3,5 mA average
Signal:…………………….. 0...5 VDC (each range)
Scatterance angle:……… 90° avg. (15...150°)
Light source wavelength:.. 880 nm
Linearity:………………….. 2%
Depth capability: …………6000 m
Size:………………………..2,5 cm diameter, 11 cm length

The 4 ranges of the turbidity sensor can be selected by two control lines A and B. The user is able to select a suitable range by operating two small SIL switches on the mainboard 2 (please refer to circuitry documentation 002.E07.E).

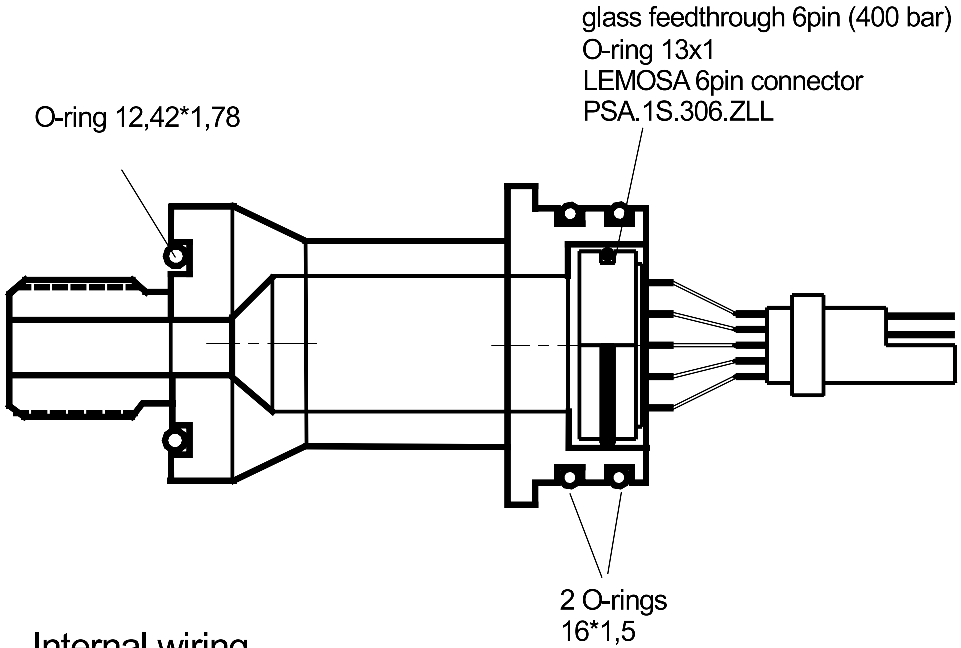


Pin	Signal	colour
1	O volt	brown
2	signal out	blue
3	Signal GND	green
4	10 volt	yellow
5	Gain A	orange
6	Gain B	red

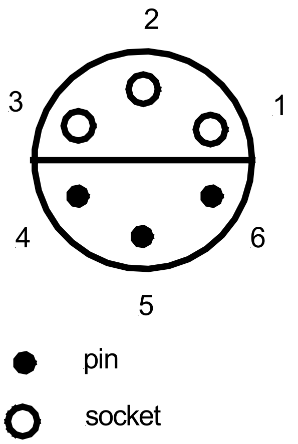
3.7. Cyclops 7 Fluorometer ChlA

The Cyclops 7 used here for MSS90 is not the standard instrument from Turner Design. In order to adapt the instrument to the pobe end cap the subconn connector was skipped and instead our standard flange was screwed into the connectors thread. To avoid corrosion problems the cyclops7 housing is made of titanium. The gain setting lines can be set to a range of 0..5, 0..50 or 0..500µg/l. The selection of the gain is made inside the profiler by the use of two jumpers. The instrument is deliverd with the range 0..50µg/l (gain setting = *10)

For details and hints for application please refer to turner´s user manual. The manual is available on the CD ROM.



Internal wiring



connector face view

Signal	colour	Lemosa
+Power	red	Pin 1
- Power	black	Pin 2
Signal out	orange	Pin 3
Signal AGND	green	Pin 4
Gain *10	blue	Pin 5
Gain *100	yellow	Pin 6

Gain *1	Pin 5 and 6 left open
Gain *10	Pin 5 tied to AGND
Gain *100	Pin 6 tied to AGND

3.8. LI-COR Quantum sensor

is used for measuring **P**hoto synthetically **A**ctive **R**adiation (**PAR**) in aquatic environments. Due to its 400 – 700 nm quantum response it is a suitable sensor for investigation of the primary production. LICOR offers two different underwater sensors:

LI-192SA cosine corrected quantum sensor (following Lambert's cosine law) measures the **P**hotosynthetic **P**hoton **F**lux **D**ensity (**PPFD**) through a plane surface (photon or quantum irradiance between 400 and 700 nm)

LI-193SA spherical quantum sensor determines specifically the **P**hotosynthetic **P**hoton **F**lux **F**luence **R**ate (**PPFFR**), the number of photons in the visible range incident per unit time on the surface of a sheer divided by its cross sectional area.

Both instruments are calibrated in $\mu mol/s*m^2$ (μE) where 1 µmol is 6,023 * 10^{-17} photons.

Specification:

Detector: silicon photodiode
Range: 0 ... 10000 $\mu mol/s*m^2$
Calibration accuracy: 5%
Linearity: 1%
Long term stability: 2% per year
depth capability: 350 m (LI-193SA) / 550 m (LI-192SA)
Sensitivity: typical 3 µA / 1000µE

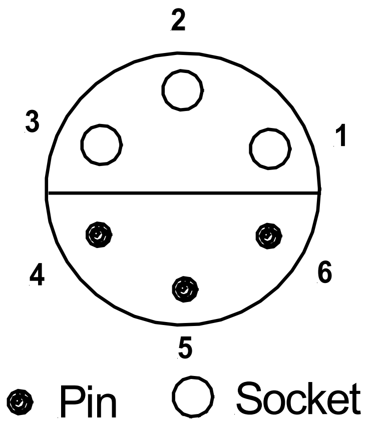
The sensor is mounted via a 4wire underwater cable. Please note: the light sensors must be mounted on the top of the probe to avoid shade of neighboured instruments.

4. The microstructure sensors

4.1. Temperature sensor NTC

This thermo probe consists of a small diameter glass coated thermistor bead hermetically sealed at the tips of shock resistant glass rods. The extremely small size allows an ultra fast response time of 7 ms at 1m /s flow. The thermistor beads are aged for extended periods at a temperature of 300 degree Celsius which results in an excellent long term stability and accuracy. The thermistor element is glued with adhesive into the sensor tip and protected by a perforated tube against impact and collision with other material. The angular width for undisturbed measurements is approximately 120 degrees which allows sinking velocities down to 10 cm/sec. The sensor tip is made of titanium and screwed into the microstructure flange. The microstructure flange has the same sensor shaft as the standard sensors but is distinctly longer. The sensitive elements of all microstructure sensors are located in a horizontal plane 220 mm above the bottom cap surface. Inside the microstructure flange there is a small printed circuit board containing the electronic circuitry for the preamplifier and linearization of the NTC-characteristic and offering optimum protection against electromagnetic induced noise.

Manufacturer:...................SST
Sensor element:...............Thermometrics FP07
Overall response time:.....11..12 msec
Power supply:...................+5 Volt, -5 Volt
Current consumption:.......+/- 1 mA
Analogue output…………-3..+3 Volt (-2°C..30°C)
Length:............................ 220 mm
Connector:……… ………. Lemosa PSA.1S.306.ZLL



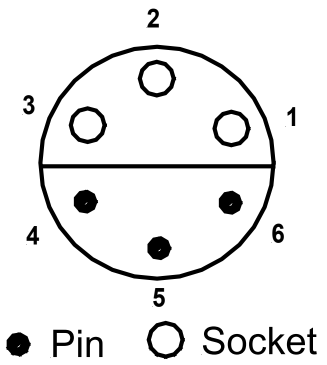
Pin	Signal	colour
1	+5volt	red
2	Analog out	green
3	-5volt	blue
4	+3volt Ref.	brown
5	GND	black
6	n. c.	

4.2.Current shear sensor

is used for the measurement of velocity microstructure. An axially symmetric airfoil of revolution stands out from a cone shaped metallic protection cap. The airfoil is connected by a cantilever with a piezoceramic beam inside the cap. The mean velocity due to the profiling speed of the probe is aligned with the axis of the airfoil. While the probe is not sensitive to axial forces the cross-stream (transverse) components of turbulent velocity produce a lifting force at the airfoil. The piezoceramic beam senses the lift force. The cantilever construction acts as a lever increasing the bending force at the position of the beam. The output of the piezoceramic element is a voltage proportional to the instantaneous cross-stream component of the velocity field. The axis of sensitivity of the shear probe is indicated by two marks at the housing of the sensor head near to the hexagonal section. The narrow gap between cantilever and cap prevents damage to the beam by strong bending. During in-situ operations, the interior of the cap is water filled. Side-holes at the upper end of the cap prevent air being trapped inside the cap.

The shear probe is screwed into the long microstructure flange. Because of the extremely high impedance output of the shear sensor, an ultra-low bias preamplifier on a small printed circuit board is mounted inside the flange.

Manufacturer:.........................ISW
Type:.......................................PNS01
Time constant:........................4 msec
Power supply:.........................+5 volt, -5 volt
Current consumption:.............<1 mA
Gain:....................................11
Filter:.....................................High pass 20dB/decade
Low frequency cutoff :............1 Hz (-3dB)
Connector:……………………..Lemosa PSA.1S.306.ZLL



Pin	Signal	colour
1	+5volt	red
2	Analog out	green
3	- 5volt	blue
4	n. c.	
5	GND	black
6	n. c.	

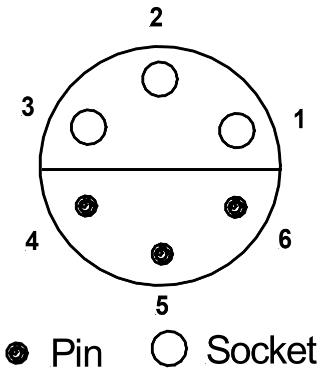
4.3. Acceleration sensor

To determine the level of vibration during the profiling process, the MSS probe is equipped with a highly sensitive vibration control sensor. The vibration control sensor measures the horizontal acceleration of the profiler in one direction using a piezoceramic element. Horizontal acceleration of the profiler generates a lifting force at a cantilever construction inside the ACC-sensor. The lifting force and thus the output of the sensor is proportional to the acceleration. Due to the lack of space on the bottom end cap the ACC-sensor is mounted inside the probe.

The housing of the ACC-sensor has a length of 70mm and a diameter of

10mm and is made of brass. At the bottom side is a mounting thread M4. Inside the brass cylinder is the piezo element and a tiny SMD preamplifier for the amplification of the ultra high impedance sensor signal.

Manufacturer:............................ISW
Type:...ACC
Time constant:...........................4 msec
Power supply:............................+5 volt, -5 volt
Current consumption:................<1 mA
Gain:...11
Filter:..High pass (20 dB/decade)
Low frequency cutoff:................1Hz (-3 dB)
Connector:…………………………Lemosa PSA.1S.306.ZLL

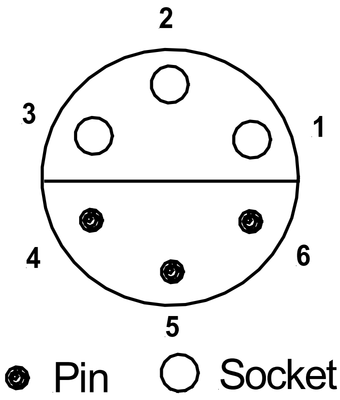


Pin	Signal	colour
1	+5volt	red
2	Analog out	yellow
3	-5volt	blue
4	n. c.	
5	GND	black
6	n. c.	

4.4. Microstructure conductivity

The microstructure conductivity sensor is a capillary type two electrode probe. The inner electrode in the conic sensor tip is a capillary tube with a diameter of 2 mm. The outer electrode is the surface of the cylindrical sensor. Both electrodes are made of stainless steel. The contact surface between the inner electrode and the water is approx. 2.3 cm^2. This guaranties a low current density at the electrode surface and consequently, a low level of contact polarisation noise. According to Gibson and Swartz: Detection of conductivity fluctuations in a turbulent flow field. J. Fluid Mech., Vol. 144, 357-364, the spatial response of the sensor is approximately 5 times the capillary tube diameter (10 mm).

The electrodes are driven by an alternating square wave at a frequency of 28 kHz. The sensor tip has a revision hole with a female thread M4, which is closed during operation by a screw with O-ring. This hole allows the cleaning of the sensor and calibration in laboratory under low water level conditions.

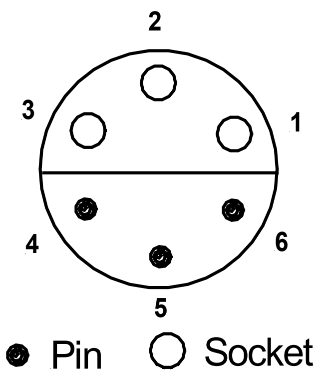


Pin	Signal
1	inner electrode
2	inner electrode
3	inner electrode
4	GND
5	GND
6	GND

4.5 Surface detector

The surface detector is used in the uprising mode to determine the exact moment, when the microstructure sensors push through the water surface. This sensor has a small titanium wire on the sensor tip and measures the polarisation of the water molecules independent of the actual conductivity. The comparator output changes within one ms after having detected the surface. An ultra bright high efficiency red LED is mounted inside the detector ´s transparent tip in order to assure a good visibility of the instrument in the darkness.

Connector Lemosa PSA.1S.306.ZLL (face view)



Pin	Signal	colour
Pin1	+5V	red
Pin2	signal out	grey
Pin3	-5V	blue
Pin4	not connected	
Pin5	0 Volt, AGND	black
Pin6	not connected	

5. Maintenance and routine service of the MSS probe

5.1. The underwater connector

is nearly maintenance-free. It is proved to lubricate the sealing surfaces (not the contacts) with silicone grease in order to reduce the forces during plugging and unplugging. Please observe the following recommendations:

- connectors are best cleaned with warm soap water, they do not have to be dried.
- avoid the use of chemical cleaners
- do not disconnect by pulling on cables
- avoid sharp bends at cable entry to connector
- to prevent corrosion of the contacts never plug or unplug the connectors under water
- unused connectors should never be left free. they must be protected against sea water by dummy caps.

5.2. The pressure transducer

doesn't need any special treatment. Never touch the stainless steel membrane with sharp or pointed tools in order to check the function of the transducer. Doing so will affect the calibration and long term stability and sometimes lead to lasting damage.

5.3. The temperature sensor

is maintenance-free. Dirt and sediments only increase the time constant but do not affect the accuracy. Be careful when cleaning the sensor. Please do not bend the extremely sensitive needle.

5.4. The conductivity sensor

Is principally not maintenance free. It must regularly be inspected for plant cover and electrolytic calcification. Both effects reduce the measured conductivity. It is appropriate if the probe is rinsed on deck with fresh water after each application. This prevents the formation of salt crystals on the cell surface. Calcareous deposits, which originate from the electrical current flow in the cell, are easily removed if the cell is immersed for a few minutes in a diluted acid. The quantity of rising CO_2-bubbles gives information on the rate of calcification. The cell is completely decalcified when the bubble formation has ceased.

Afterwards the cell has to be rinsed with fresh water. Depending on the operating time this procedure is only necessary every few months. Particular care has to be taken, that the metal components on the electrode surfaces are not scratched, nor must they come into contact with other metals. Otherwise the lifetime of the cell and the long-time stability of the conductivity measurements will be impaired. After the electrodes have been treated with acid a short-term increased conductivity reading may occur, this should normalize itself within an hour.

5.5. Oxyguard oxygen sensor

The oxygen sensor requires some attention from time to time. All the necessary maintenance like exchange of electrolyte and membrane is described in an OxyGuard leaflet in the appendix of this manual.

The red O-ring has two different positions:

1. in the **front position** (shown in the picture below) the O-ring prevents leakage of the electrolyte through the thread during storage. **This position should not be used for measurements but only for storage.**

2. in the **backward position** it allows the electrolyte to build a high impedance electrolytic connection between medium (sea water)and electrolyte room behind the membrane. This connection is **necessary for proper measurements. Please take care that during measurements the O-ring takes always the backward position**

The Oxyguard DO sensor is supplied by us with a sensor protection cap made of plastic . To achieve a tight fit to the sensor head the cap is equipped with an O-ring 21*1 mm and a 2mm hole in the centre of the bottom (see photo). The cap should be used as protection for the membrane and sensor head as well as useful tool for oxygen field calibration.

If the membrane tension is dropping during operation or time the sensors output signal is changing too. The zero point of the oxygen sensor remains fix during its lifetime but the sensitivity (slope) can vary. The user can execute a field calibration after each membrane exchange or when he doesn´t trust the measured values anymore.

Field calibration
The SDA software offers the possibility to perform a field calibration and to change the reading automatically. Let the SDA program run with the probe connected to the PC. The field calibration procedure is very simple:

- Keep the membrane of the DO sensor dry
- Put the red o-ring in the backward position
- plug the protection cap onto the sensor head with a proper fitting o-ring
- Fill a small plastic cup with water and immerse the sensor head up to the flange (small white plastic cup is part of the delivery)
- after a short time the enclosed air in the cap is water vapour saturated and the the oxygen reading should have 100% partial pressure.
- If the oxygen reading is stable click menu point **Calibrate** and **02 Field Calib**
- When **O2 Field Calib** is selected, the current oxygen reading is automatically stored. The default value **100%** is accepted when

clicking on the button **Calculate slope now.**

- The SDA programm calculates the new oxygen Field calibration coefficient (originally 1) and the reading is now 100%.

The field calibration method works in any basin or tank and the result is independent of the salinity. When putting the complete probe into a basin you have to estimate the immersion depth of the oxygen sensor (measured from the membrane to water surface). Every 10 cm immersion depth lead to an increase of the oxygen reading of 1%. So e.g. if the procedure is executed with the DO sensor 30cm below the water surface, the default value in the button field **Enter desired value** has to be changed to 103%.

5.6.1. AMT fast DO sensor

Mechanical stress of the sensor tip, especially cross forces, unintentional touch downs or strong vibrations have to be avoided. The sensor tip is very weak. Do not touch it. Mechanical damage of the sensor tip excludes repair covered by guarantee.

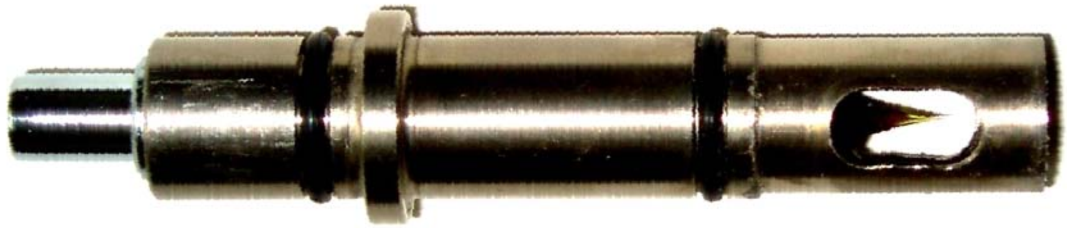
If the probe is used near the bottom, it is recommended to protect the sensor tip with an additional protection cap containing as much bore holes as necessary to guanrantee a good sample exchange. The experience shows, that a small hole in the bottom and two long holes on both sides of the cap are a good choice.For cleaning the sensor head rinse it in water only. Do not use organic solutions. If there should be any biofouling at the sensor tip, it is recommended to clean the sensor tip by immersing it into very diluted H_2SO_4 (<0,02 N H_2SO_4) or diluted NaOH (<0,02 N NaOH) for a maximum of up to 24 hours). In case of higher concentrations the sensor tip may be damaged.

Protect the sensor tip with the wetting cap during long breaks. Fill the wetting cap with less than ¼ with destilled water. If the sensor tip dries out, it takes some minutes for swelling the membrane in water, if the sensor is used again.

After buying a new sensor tip, please calibrate periodically within the first weeks (if necessary). Within the first weeks the sensor's slope will decrease until it stabilises. This is due to the adjustment of chemical and electrochemical equilibriums.

Please take care, that the wet sensor tip does not freeze out in winter during storage on board of a ship. This may damage the sensor tip .

5.6.2. Exchange of DO sensor heads



The exchange of sensor heads is very easy and could be done by the customer within a few minutes.For exchanging the sensor head, first push on the plastics cap to protect the sensor body and dry the sensor head (do never touch the glass tip !) a little bit to avoid the get-in of water into the plug connections. Unscrew the titanium screw now and pull out the sensor head carefully only by light turning of the sensor head. After this pull off the sensor head (do not twist!) very carefully and slowly only 1-2 cm until the connector and the cables are visible. Disconnect now carefully plug and socket. Avoid the damage of the cables when disconnecting this electrical link. For mounting a new sensor head take note, that the pins will not be damaged inside the connection when pushing on the sensor head into the plug. Therefore you will find red points on the plug and on the socket. These points have to be in opposite, when pushing on the sensor into the socket. Do not twist socket and plug. This may damage both sensor head and the socket leading to expensive repair work. Now lead the sensor head into the flange and screw on the titanium screw. Make sure, that the sensor is mounted correct and waterproof.

Please note: The repair of water damages or of broken pins is not covered by warranty.

Do not forget to make the correct inputs of coefficients and calibration constants after the exchange of the sensor head. From the AMT calibration sheet you have to transfer following new coefficients:

Sensor rawO2: O2 zero value (input Ug[mV])
A20 O2 (input XO2 value)
Sensor T_O2 A[0]…A[3] (input the coefficients of the ET-polynomial.

5.7. pH and ORP sensor

Both sensors are principally maintenance free. After its life span has ended the corresponding sensor has to be replaced. When unscrewing the sensors no moisture (e.g. water drops) what so ever must reach the contacts (dry beforehand). A single drop of saltwater is enough to cause long-lasting incorrect measurements – this is due to the high output impedance of 100 – 400 MΩ. So only replace sensors under clean and dry conditions please.

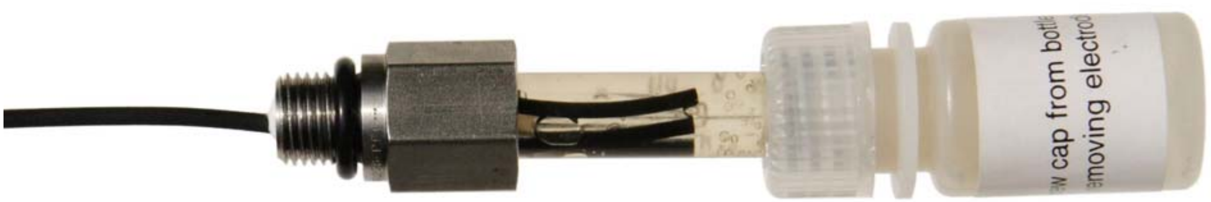
The life span of the sensors ceases when the time constant of the pH or redox measurement drastically increases. The life span has also ended when the reference electrolyte is dissolved down to the screw thread rim. Water can then possibly leak in through the bolting. The pH and Redox sensors are particularly endangered when they come into contact with H_2S in water.

Some minutes in hydrogen sulphide is enough to irreparably ruin the sensor. In most cases stable-measuring results cannot be achieved anymore despite lengthy rinses with cleansing or buffer solutions. If measurements in H_2S-concentrations are necessary we recommend to remove the sensors and to screw on locking caps (or to use the 1200m sensor; refer to 7.7.)

Special care has to be taken that before using the sensor no air bubble is to be found in the pH electrolyte directly behind the ion-permeable glass layer because it would interrupt the internal electrical connection to the pH electrode. The air bubble has to be shaken out – similar to the shaking of a thermometer. The air-bubble often occurs when the sensor has been stored horizontally for a longer time.

pH/ORP sensor (1200m, H_2S resistant)

Do never touch the sensitive tip. Protect the pH-sensor with the delivered soaker bottle containing the storage solution and avoid any dry out of the sensitive tip.



Avoid any air inside the bottle, fill completely with 3 M KCl. Make sure, that only 3 M KCl with pH 4 buffer is used for storage. It is not allowed to use other wetting caps in order to avoid any air pressing into the diaphragm leading to sensor malfunctions or damage. Damage because of using other wetting caps or storage without any wetting cap is not covered by guarantee. The pH sensor has to be rinsed carefully with fresh water after finishing the measurements.

The pH sensor is a replacement part and has to be changed , if the sensor has reached the lifetime. The sensor has a stainless steel thread G1/4A (titanium on request) which is screwed into a flange. The electrical contact is made by a socket in the flange. Sealing between sensor and flange is achieved by an O-ring which is part of the sensor. After the sensor's life span has ended, the sensor has to be replaced.

5.8. Seapoint turbidity meter

The turbidity sensor has to be cleaned from time to time. Especially the optical sensitive flat surfaces have always to be kept clean. Avoid the use of chemical solvents. Don't scratch the flat optical surfaces. When mounting the sensor protection cage keep the font before the flat side free from reflective materials (rods) . The sensitive volume is approximately 120°.

5.9. Cyclops 7

The Cyclops 7 is nearly maintenance free. From time to time clean the polished optical surfaces with a soft paper. Avoid the use of chemicals. Don't scratch the fine optical surface. Please note that the light beam has a certain angel to the instrument axis. To avoid reflections and hence zero shifts of the measured values the sensor light cone should always be directed away from the neighboured sensors.

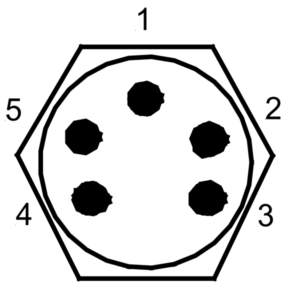
5.8. Microstructure sensors

The ACC and NTC sensors are maintenance free and do not require any attention. Cleaning procedures for shear sensor and microstructure conductivity will be found in appendix 3 and 4.

6. Power supply and sea cable signals

The MSS-profiler is connected to the board unit by a four conductor cable which has nearly neutral buoyancy and can carry weights of more than 50 kg. If the system is ordered without winch, a cable drum with slip rings is provided for the transport of the sea cable. The cable is fitted with the proper underwater inline connector SUBCONN MCIL5F and locking sleeve SUBCONN MCDLSF and on the ship side with a LEMOSA round connector . The cable drum is not intended to be used as hand winch.
The sea cable connection of the profiler is done by a male bulkhead underwater connector SUBCONN MCBH5M made of titanium and neoprene. The following figure shows the face view and the pin assignment of the underwater connector.

MCBH5M Subconn face view



Subconn	Signal
pin 1	+18-72 Volt
pin 2	0 Volt
pin 3	RS485A
pin 4	RS485B
pin 5	not connected

The power supplied by the board unit is about 60VDC. The basic version of the MSS profiler (C,T,D,NTC,2*SH,ACC) has a current consumption of approximately 25 mA on the short laboratory cable corresponding to 1,5W power consumption. Data transmission is done in a RS485 and RS422 compatible mode. The driver is able to supply 60 mA output current in differential mode. The sea cable is terminated at the board with 112 Ohm resistor between A and B line and 56Ohm to GND.

7. Short description of the electronics

The electronic circuitry inside the MSS-profiler consists of several printed circuit boards: the basic version of MSS90 comprises the following boards and circuitries:

7.1. Voltage regulation and RS485 driver
7.2. Mainboard1 with
- Data acquisition system
- Temperature bridge T
- Conductivity bridge C
- Pressure amplifier P
- Current Shear amplifier (2*) SHE
- Acceleration amplifier ACC
- NTC amplifiers and filters (NTC; NTCHP, NTCAC)

7.3. 1.NTC preamplifier
2.SHE preamplifier and ACC preamplifier

7.1. Voltage regulation and RS485 driver

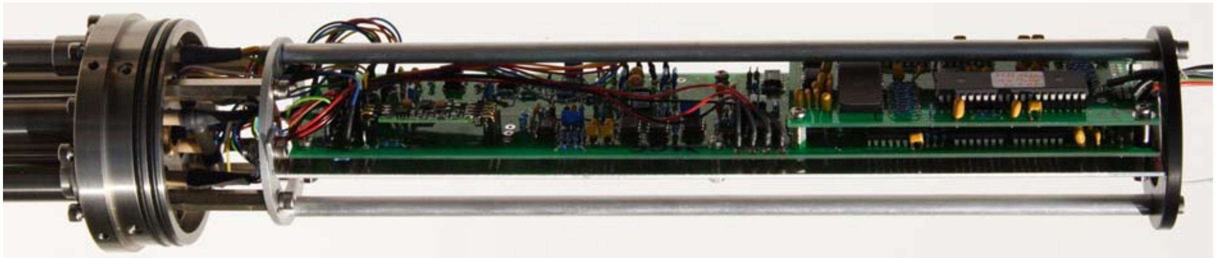
is a circular shaped board of 75 mm diameter mounted on 4 distant bolts inside the top cap of the probe. The basic circuitry of this board contains a polarity protection of the power input , a dc-dc converter (conversion of the input voltage to stabilized +5 volt and -5 volt.
Data received from the mainboard1 as asynchronous NRZ signal (5 volt TTL compatible) is converted into RS485 by a standard transceiver protected against ESDN and capable of sinking and sourcing up to 60 mA current to the sea cable in differential mode.

Documentation: drawing no. 002.E01.L (photo shows Version H)

7.2. The Mainboard1

is a rectangular board of size 305mm * 63 mm, which is mounted on a aluminium supporting plate fixed to the bottom cap of the profiler. The mainboard1 is electrically connected to the voltage regulation board by a four wire cable equipped with separable connectors.

Photo below shows MSS90 electronic mainboard1 with data acquisition module plugged on the right side and small progress print (pressure) on the left side.



documentation: drawing no. 002.E05.E sheet 1…5

7.2.1. The data acquisition system

is the heart of the MSS electronic. A 8 bit microcontroller controls the high speed sampling A-D-conversion and the 16 channel multiplexer and produces the exciting signal for the precision temperature and conductivity bridges. The analogue inputs range from -3 VDC to +3 VDC producing a raw data count from 0 to 65535. The raw data is transmitted via the microcontroller's serial port with 614,4 kBaud (16 sensors, 1024 complete datasets/s) to the RS485 transmitter. The voltage reference IC6 provides a high precision voltage of +3 volt with low temperature coefficient, the negative reference voltage (-3 volt) is produced by the A-D-converter and op amp IC9. On the mainboard1 are 9 analogue channels occupied , the remaining free channels can be accessed via the 50 pin connector CON1 from the mainboard2, which allows a system expansion up to 16 channels .

documentation: drawing no. 002.E02.C

7.2.2. The temperature bridge

is realized as a full Wheatstone bridge with the platinum sensor Pt 100 as a part of the bridge. The bridge is excited by a bipolar symmetrical square wave signal of 1kHz and 50% duty cycle. The nonlinear platinum resistor is linearized by a INIC (IC17B) . The output signal of the Wheatstone bridge is full wave rectified in a synchronous rectifier (IC15 and IC16A/B) and smoothed in a low pass filter (IC13A/B). All resistors used in the Wheatstone bridge have ultra low temperature coefficients of 1 ppm/°C.

documentation: drawing no. 002.E05.E sheet1/5

7.2.3. The conductivity bridge

is excited by the same precision ultra stable square wave signal as the temperature circuitry . The square wave signal is the reference input of an automatic integral control amplifier (IC24A) . The output of IC24B presents the actual value of the voltage sensing electrodes which is kept constant by the integral controller. The ac current flowing via the current sensing resistor R50 is linear dependent on the specific conductivity of the sea water. The ac voltage across R50 is amplified and full wave rectified in a synchronous rectifier (IC15, IC18A/B) and filtered in a low pass filter (IC14A/B).

documentation: drawing no. 002.E05.E sheet 1/5

7.2.4. The pressure amplifier

consists of two parts : one is the small SMD board named PROGRESS, delivered with the transducer and containing the full temperature compensation of zero point and sensitivity. The analogue output of this board is 0,1 - 2 volt DC with reference to the negative supply rail (-5 volt). The second part is a differential amplifier and low pass filter with a gain of 2,7 producing a bipolar output signal in the range of +/- 2,7 volt.

documentation: drawing no. 002.E05.E sheet 3/5

7.2.5. SHE and ACC amplifier

uses exactly the same circuitry; it is a non inverting amplifier with a bandwidth of 0,16Hz to 300Hz (-3dB) with a fixed gain of 1 (shear sensors) and 2 for acceleration sensor.

documentation: drawing no. 002.E05.E sheet 2/5 and sheet 4/5

7.2.6. The NTC amplifier

has three different analogue outputs NTC, HTCHP and NTCAC. The circuitry is described separately in the appendix

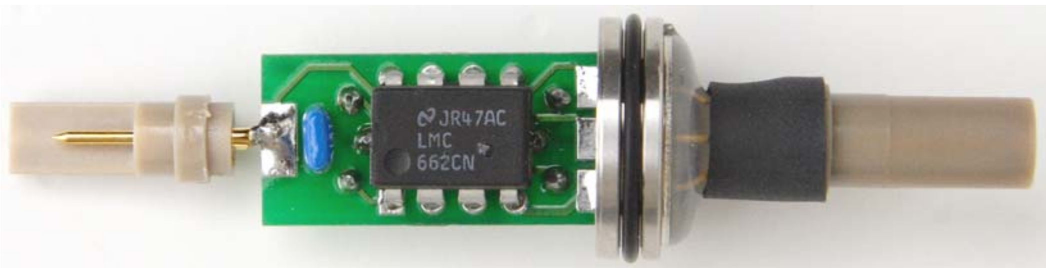
documentation: drawing no. 002.E05.E sheet 2/5

7.3. Microstructure sensors

All microstructure sensors (SHE,ACC,NTC) have integrated preamplifiers in their flange. The reason is to achieve a better performance by reducing the electromagnetic induced noise. Especially the ultra high impedance outputs of the shear and acceleration sensors need good magnetic and electric shields for an acceptable noise immunity. The printed circuit boards are supplied with +5 volt and - 5 volt and are soldered directly on the inner side of the glass feedthroughs. All boards and sensors are connected by separable 2 pin connectors inside the flange.

NTC preamplifier on the glass feedthrough

Shear preamplifier on the glass feedthrough



ACC and SHE have a gain of 11 and a high pass filter with a low cut off frequency of 0,16 Hz while the NTC amplifier has a linear response.

documentation: drawing no. 004.E01.A (NTC)
004.E02.A (SHE,ACC)

8. Serial data output and data format

The serial data uses an UART compatible NRZ format with the following characteristics:

.

Baudrate:.........................614400 (16 sensors)
Parity:.............................no
Character length:.............8
Number of stop bits.........1
Protocol:..........................none
Driver:.............................RS485
Signals:...........................A,B (Q,Q\)

Data is transmitted only in groups of 16 sensors at a repetition rate of 1024 complete datasets per second. Each of the 16 parameters is transmitted with 3 bytes according to the following scheme:

1. byte..........	D6	D5	D4	D3	D2	D1	D0	H
2. byte..........	D13	D12	D11	D10	D9	D8	D7	H
3. byte..........	A4	A3	A2	A1	A0	D15	D14	L

H,H,L...........statusbits
A0...A4.........5 binary adress bits of the parameter
D0...D15.......6 binary raw data bits of the parameter

Data transmission starts with the first byte from the right (LSB) to the left (MSB) and ends with the third byte. The 16 sensors are transmitted in an uprising sequence of their binary addresses. The parameters and their assigned binary addresses is listed in the following table. The first bit of every byte is a fixed status bit which enables the data acquisition program to assemble the 3 bytes of each parameter in the correct sequence. A complete data set is transmitted block wise starting with the binary address 0_{dec} and ending with the highest address 15 $_{dec}$ (16 sensors).

Address	parameter
	Basic version (mainboard1)
00	Counter
01	NTC microstructure temperature
02	P pressure
03	SH1 current shear 1
04	Pt100 precision temperature
05	SH2 current shear 2
06	C conductivity
07	ACC acceleration
08	NTCHP microstructure temperature with emphasis
09	NTCAC high resolution microstructure linear, differential
	Additional parameters on mainboard2 (MSS 36)
10	CMdc Microstructure conductivity / PAR
11	Cmac Microstructure conductivity differential
12	ChlA Cyclops 7
13	AMT fast DO
14	Redox
15	pH

9. Calculation of physical data

The physical values are calculated from the binary raw data by the MSDA program . The calculation is generally a polynomial of nth order:

$$\mathbf{Y = \Sigma A[i] * (n - 32768)^i} \qquad \text{calculation type } \mathbf{N}$$

Y............physical value of the parameter
n............decimal value (0...65535) of the binary raw data
Ai...........calibration coefficients, determined as the result of a regression calculation after a calibration procedure
i.............index 0...5

$$\mathbf{P = A5 + \Sigma A[i] * (n - 32768)^i} \quad i=0..4 \quad \text{calculation type } \mathbf{P}$$

A[5] is used for air pressure compensation (zeroing pressure display)

For sensors with two different successive calibrations the **NFC** type Is used (please refer to SDA manual page 47)

$$\mathbf{Y = A[4] + A[5] * X \quad X = \Sigma A[i] * (n - 32768)^i} \quad i= 0\ldots3$$

Such successive polynomial computations are used for PAR and fluorencence (ChlA).

For each physical parameter there exists a calibration protocol with raw data, physical data and physical values calculated according to the above described procedure.

Calculated sensors like salinity, density or sound velocity use the actual UNESCO formulas.

10. Accessories and spare parts

In the following tables you find a selection of consumption material necessary for maintenance and service.

10.1. Underwater connectors

SUBCONN MCBH5M titanium
Bulkhead connector on the top cap of the profiler

SUBCONN IL5F
Inline connector (60 cm pigtail) for termination of sea cable

SUBCONN MCDLSF
Locking sleeve

SUBCONN O-ring 12,42 * 1,78 mm
O-ring for bulkhead connector

10.2. Interface connectors

LEMOSA FFA.1E.304.CLAC50
Sea cable termination at the interface end

LEMOSA ERA.1E.304.CLL
Interface socket for sea cable connection

10.3. O-rings

76 * 2,5 mm	Sealing between end caps and tube 4 pcs
16 * 1,5 mm	Sealing between bottom cap and sensor flanges (2 pcs. per sensor)
12 * 1,5 mm	Pressure sensor PA7 and PA8
13 * 1 mm	glass feedthrough (all sensors)
8 * 1.5mm	Sealing between microstructure sensor tips and flanges

Appendix 1
The different microstructure temperature channels

11.1. Response time of the FP07 thermistor

Thermometrics is the manufacturer of the famous FP07 thermistor (NTC) which is used worldwide for the measurement of microstructure temperature. According to the company data sheet the response time of the FP07 should be about 7 ms or the signal band width approximately 23 Hz. This is obviously too optimistic because our own measurements of the response time result in 11..12ms (13..14Hz cut off frequency) which agrees very good with the measurements of other users. The frequency response of the linear FP07 NTC output is depicted in the plot as dark blue line in figure 1.

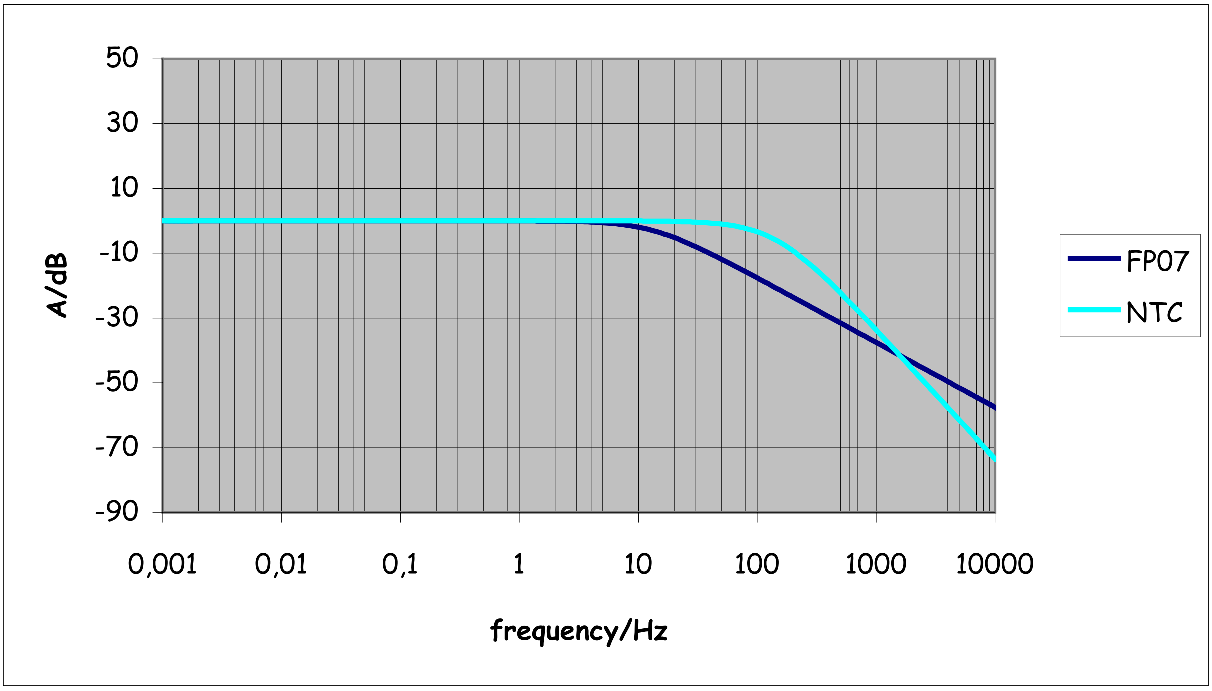


Figure 1

The practical results show that the relatively low cut off frequency of the FP07 thermistor is not sufficient to obtain good temperature spectra due to the drop of signal-noise ratio at higher frequencies.

In order to extend the FP07 signal band width, an additional circuitry is introduced (figure 2). The output of this temperature sensor **T1= NTC** removes the first low pass in the FP07 signal response.

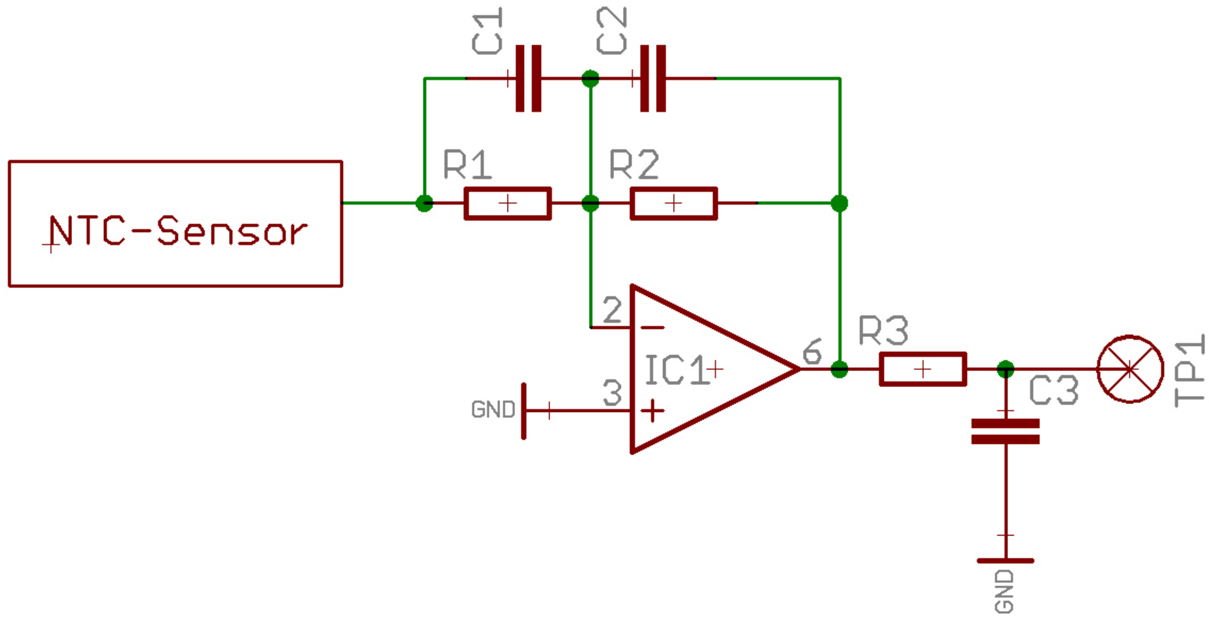


Figure 2

R1=R2=12k C1=1µF C2=100nF R3=1k C3 = 1µF

The exact cut off frequency is not known but the frequency response of this output is similar to the light blue line in figure 1. The following diagram depicts the principle structure of the NTC electronics for MSS90.

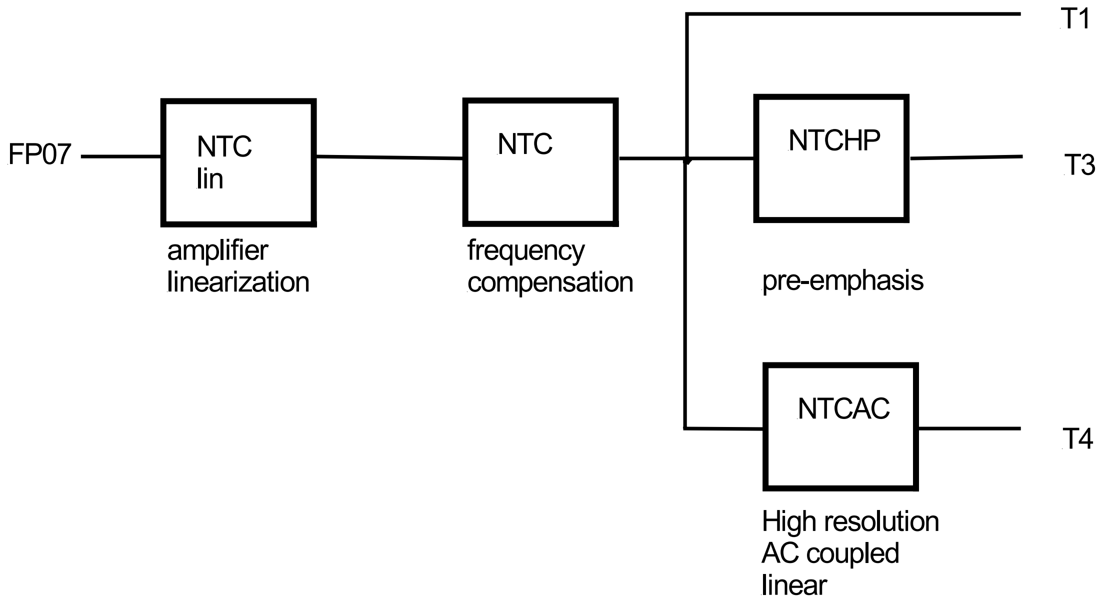


Figure 3

The block diagram shows the four different function blocks:

- **NTC lin** is a small circuitry mounted on a 15mm glass feedthrough with a six pole Lemosa round connector and plugged into the flange of the microstructure temperature sensor (please see photo chapter 7.3). This little board a preamplifier with a linearization of the nonlinear thermistor characteristic.
-
- **NTC** is the circuitry described in figure 2 and contains the electronic for the FP07 band width extension. The frequency response of the NTC output is quite linear even beyond the FP07 cut off frequency.

- **NTCHP** is a pre-emphasized analogue channel with a frequency dependent gain described in chapter11.2. This output should be used to achieve better signal to noise ratio at higher frequencies. The data derived from this temperature has to be de-emphasized later in order to get right scaled spectra.

- **NTCAC** is an ac-coupled linear amplifier with the gain G=10. the description of this circuitry is to be found in chapter11.3.

NTC, NTCHP and NTCAC are located on the analog mainboard:
Document 002.E.05.E sheet 2/5

11.2. The pre-emphasizeded temperature NTCHP

uses the well known principle of pre-emphasis of the higher frequencies. The circuitry is depicted in figure4:

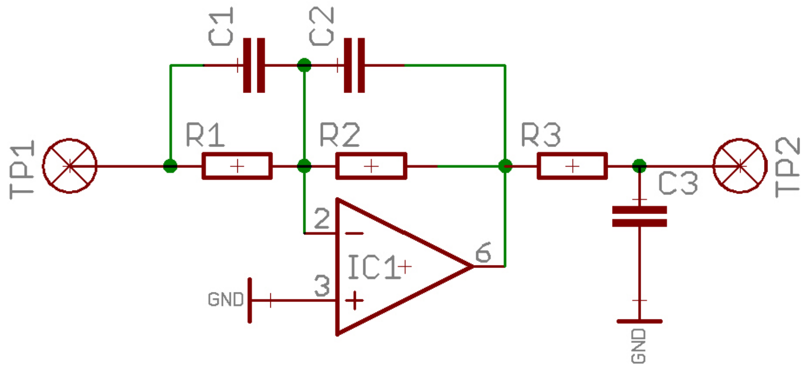


Figure 4

R1=R2=150k C1=1µF C2=10nF R3=1k C3=1µF

The relationship between Input voltage V_{in} and output voltage V_{out} Is described by a differential equation

(1) $$V_{out} = V_{in} + R2 * C1 * (dV_{in}/dt)$$

Vin input voltage at TP1
Vout output voltage at TP2 (f<100Hz)

(2) $$f_c = 1/(2\pi R_2 * C_1)$$

f_c start point of pre-emphasis (+3dB)
slope of the pre-emphasis +20dB/decade

R2*C1= 0,15sec f_c=1Hz

The NTCHP channel is calibrated in [°C] using a low pass filter with 0,2s response time. The frequency response of the NTCHP channel is shown in figure 5:.

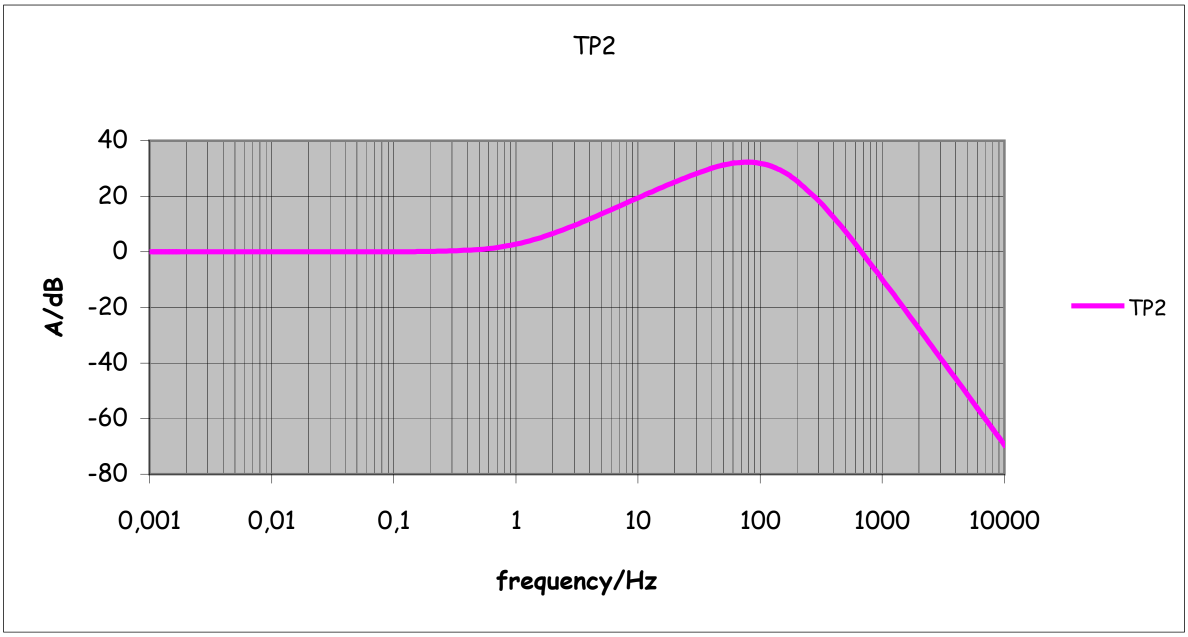


Figure 5

11.3.The linear high resolution channel NTCAC

Is designed for applications which require a linear characteristic with high resolution. The circuitry consists of a high pass filter with f_c=1Hz a linear amplifier with gain G=10 and a subsequent first order low pass filter with a cut off frequency of 150Hz. (see figure 6)

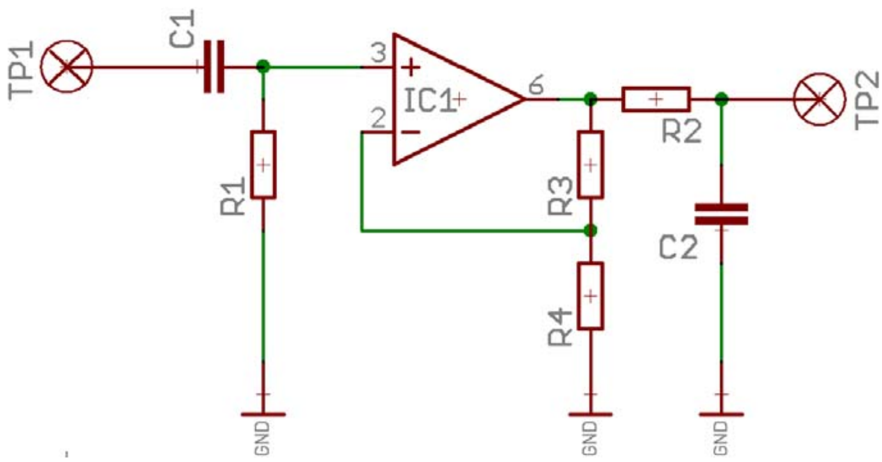
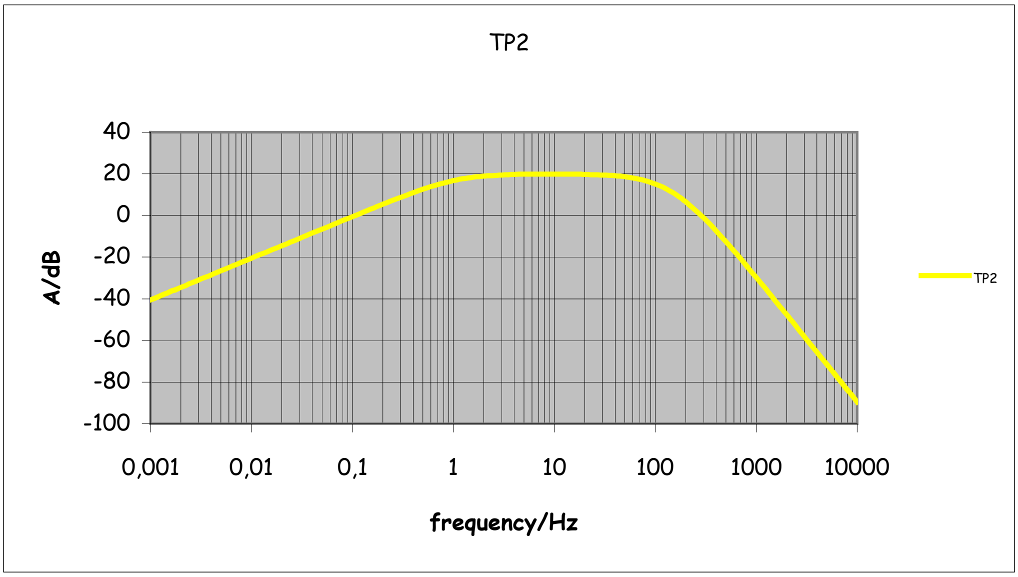


Figure 6

R1=150k C1=1µF R3=90k R4=10k R2=1k C2=1µF

The output is linear in the range 1…100Hz, frequency response given below in figure 7



Appendix 2

NTC data processing

De-emphasis of the digital NTCHP-signal

Please note:

$T1 = T_{NTC}$ Temperature calculated from $T1 = \Sigma A[i]*(n_1-2^{15})^i$
n1 raw data count from the NTC channel
$T3 = T_{NTCHP}$ Temperature calculated from $T3 = \Sigma A[i]*(n_3-2^{15})^i$
n3 raw data count from NTCHP channel

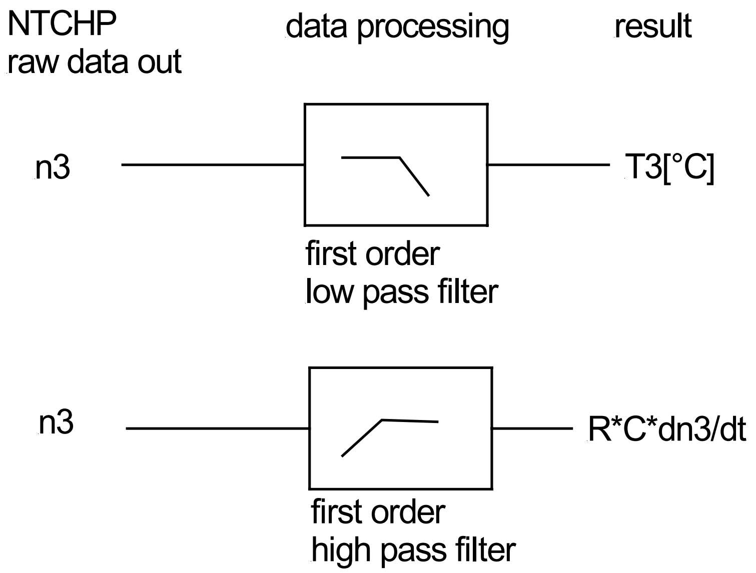


Figure 7

The temperature values are obtained from the NTCHP raw data output by sending the NTCHP raw data through a **first order low pass filter** with a cut-off frequency **$f_C = 1/2\pi\ R_2*C_1 = 1Hz$**. The de-emphasized temperature T3 is calculated according to the standard SST polynomial and supplied as calibration sheet:

(3) $$T_3[°C] = \Sigma A[i] * (n_3*-2^{15})^i = \Sigma B[i] * n_3^i$$

A[i] coefficients for polynomial with offset **2^{15}**
B[i] coefficients for polynomial without offset

Determination of the temperature gradient $\partial T/\partial z$ from NTCHP raw data

The use of a first order high pass filter with the cut-off frequency

$$f_C = 1/2\pi\ R_2*C_1 = 1Hz$$

will convert the frequency dependence of NTCHP (as shown in figure 5) to a high pass with the cut-off frequency of approximately 100 Hz. For frequencies <<100Hz the output raw data n of the high pass will obey the following relationship

$$\text{(4)} \quad n = R_2*C_1*\partial n_3/\partial t$$

Differenciation of SST´s temperature polynomial T3 leads to:

$$\partial T_3/\partial t = \partial T_3/\partial n_3 * \partial n_3/\partial t$$

$$\text{(5)} \quad \partial T_3/\partial t = \{B[1] + 2B[2]*n_3 + 3B[3]n_3^2 + 4B[4]n_3^3 + 5B[5]n_3^4\} * \partial n_3/\partial t$$

$$\partial T/\partial z = (1/v_z) * \partial T/\partial t$$

z vertical axis

v_z sinking velocity of the profiler

n raw data output of the high passed filtered NTCHP signal

$$\text{(6)} \quad \partial T/\partial z = \{n / (R_2*C_1* v_z)\} * \partial T^*/\partial n$$

Appendix 3

Shear sensor, description and maintenance

PNS01 shear probes for microstructure measurements

May 2006

ISW Wassermesstechnik Dr. Hartmut Prandke
Lenzer Strasse 5 OT Petersdorf
D- 17213 Fünfseen
Germany

Principle of operation

PNS01 shear probes are airfoil-type microstructure velocity fluctuation sensors designed for microstructure profiler.

The mean velocity due to the profiling speed V of the probe is aligned with the axis of the axially symmetric airfoil of revolution (see figure 1, red tip). While the probe is not sensitive to axial forces, the cross-stream (transverse) component of turbulent velocity u produces a lifting force at the airfoil. A piezoceramic beam, connected with the airfoil, senses the lift force in one dimension.

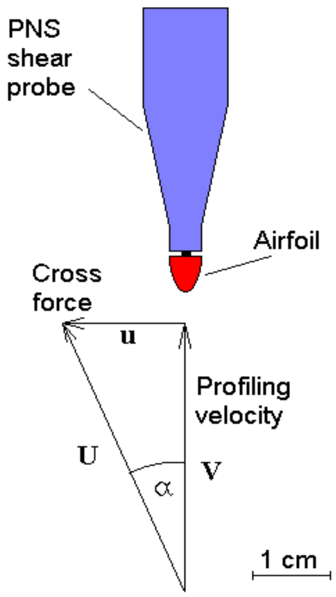


Figure 1
Measurement geometry of PNS shear probe

The output of the piezoceramic element is a voltage proportional to the instantaneous cross-stream component of the velocity field.

PNS shear probes are sensitive in the plain parallel to the marked site (notching) of the hexagon at the sensor socket.

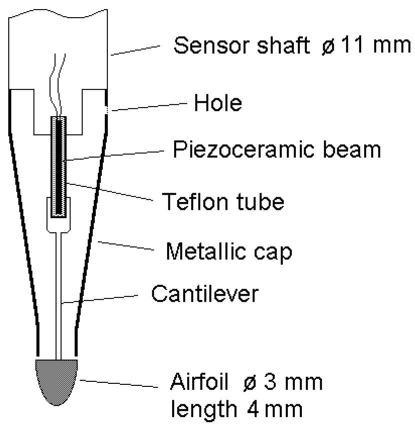
Shear probes measure the velocity fluctuation relative to the movement of the profiler. Consequently, shear measurements require a low vibration level of the profiler. Free sinking profiler operation with a slack in the cable between profiler and ship is recommended. At rising measurements, an additional buoyancy body below the profiler should be used to pull the cable from an underwater winch or a guide pulley.

Between profiler and buoyancy body a slack in the cable must be generated and kept during the measuring process.

To avoid falsification of the measured shear by resonant oscillation of the airfoil/cantilever construction, the profiling speed should not exceed 1 m/s.

Construction of PNS shear probes

The basic construction of the PNS01 shear probes is shown below.



<u>Figure 3</u>
PNS01 shear probe. Designed in 2001, produced since August 2002

The piezo-ceramic beam is inside a Teflon tube. The lift force is directly transmitted to the piezo-ceramic beam.

Properties of PNS01 shear probes

The properties of PNS01 shear sensors as described below have been determined during a series of laboratory tests and field measurements. The general behaviour of the sensor is described. Individual probes can have somewhat deviating properties.

Sensitivity

The sensitivity is in the order of $1{\cdot}10^{-4}$ $(Vms^2)/kg$. Individual calibration is necessary.

For the calibration of shear sensors, a special shear probe calibration system has to be used. ISW Wassermesstechnik provides a calibration service for shear probes. The following calibration arrangement is used: The probe rotates about its axis of symmetry at 1 Hz under an angle of attack α in a water jet of a constant velocity **U**. At different angles of attack, the rms. voltage output **E** of the probe is measured. The probe sensitivity is the slope of the regression (best fit of a cubic approximation) obtained from the equation $E/(qU^2) = S{\cdot}\sin 2\alpha$. q is the density of water, and S is the shear probe sensitivity in $(Vms^2)/kg$.
Thermal drift

Exposed to temperature changes, shear probes show an offset in its output voltage. The low frequency thermal drift (time scale several seconds) has to be filtered out in the procedure of shear computation.

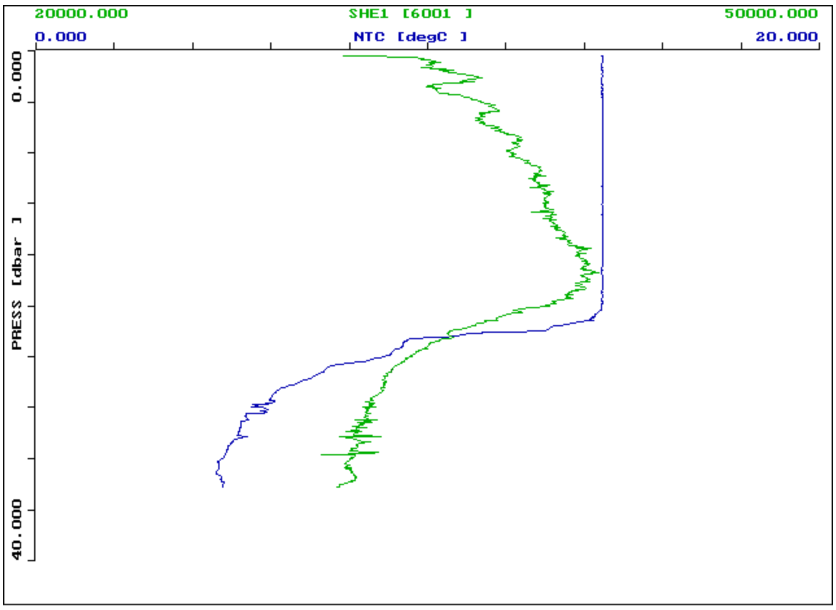


Figure 4
Shear measurements with a rising MSS profiler across a strong thermocline. Blue - temperature (measured with fast FP07 sensor). Green - output of shear sensors (raw data). The PNS01 shear probe shows a pronounced offset of the output voltage when crossing the thermocline. The low frequent oscillations near the surface are caused by waves.

Temperature dependency of sensitivity

The sensitivity of PNS01 shear probe is dependent on the temperature: it decreases with sinking temperatures. This effect is shown in figure 5.

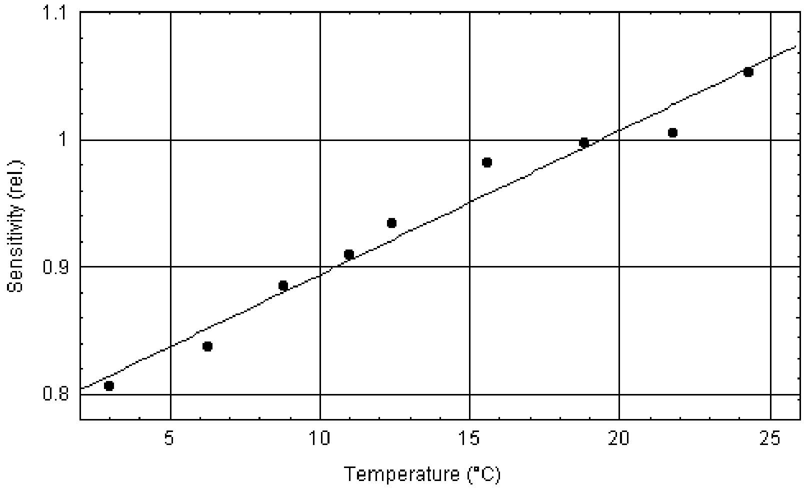


Figure 5
Typical dependency of the of **PNS01** shear probe sensitivity (in relative values) on the temperature.

The drop of the sensitivity with decreasing temperature can be approximated by the function

$$S_M/S_C = 1 - 0.011\,(T_C - T_M).$$

T_C and T_M are the temperatures (in °C) during the calibration and the shear measurements at sea, respectively. S_M and S_C are the sensitivities at the temperatures T_M and T_C. T_C belongs to 21 °C (for shear sensors calibrated by ISW Wassermesstechnik). The resulting correction factor for the dissipation rate is

$$1/(1 - 0.011\,(T_C - T_M))^2.$$

Long term stability

Piezo-ceramic beams as used in the PNS shear probes to detect lift forces have an extreme high impedance in the order of 10^{10} Ω (100 GΩ). If moisture penetrates through the isolation (during long term exposure of the shear probes to water), the impedance decreases. This leads to a decrease of the shear probe sensitivity.

At PNS01, the Teflon tube effect an excellent isolation against water. Even under high pressure the impedance of the piezo-ceramic beam remains for a long time above 100 GΩ (see figure 6).

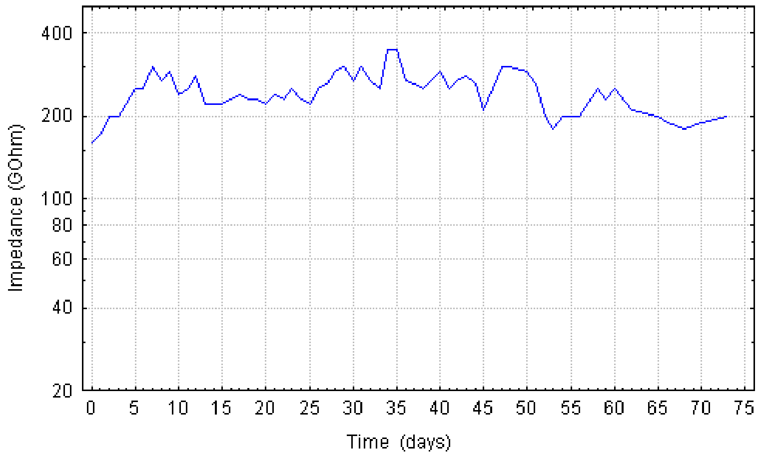


Figure 6
Measurement of the impedance of the piezo-ceramic beam of a **PNS01** shear probe in a pressure tank at 300 bar. There is no decrease of the impedance during the 75 days test period.

Maintenance

Don't let dry out salt water in the inside the shear probe. After recovery of the profiler, the shear probe should be flushed with fresh water. As shown in figure 10, a soft rubber tube is pressed to the conical cap for flushing the sensor. After flushing, the remaining water in the interior of the shear probe should be pumped out using the plastic bottle and rubber tube without water (profiler in vertical position).

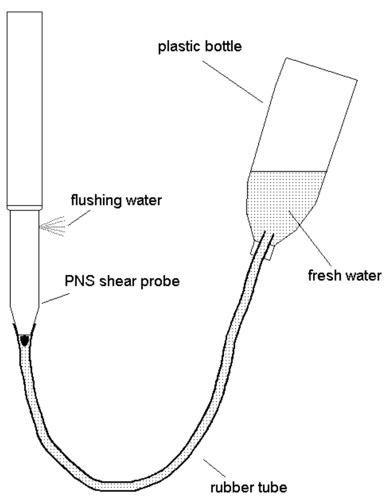


Figure 7 Arrangement to flush the PNS shear probes

In situations with high particle concentration, the PNS shear probes should be cleaned from time to time by additional flashing with fresh water.

Technical parameters

Impedance (piezo-ceramic beam)	typical 100 GΩ
Capacity (piezo-ceramic beam)	typical 1.6 nF
Piezoceramic beam isolation	Teflon
Resonance frequency	approx. 420 Hz
Depth range	max. 1000m (tested)
Airfoil dimensions	Ø = 3.0 mm, L = 4.0 mm

Sensor dimension:

Length (total)	65 mm
Diameter	11 mm

Materials:

Housing	Titanium
Airfoil	Plastic

Please notice:
The piezo-ceramic bending element in the shear probe can easily break.

Shear sensors are consumables!

Contact

ISW Wassermesstechnik Dr. Hartmut Prandke
Lenzer Strasse 5 OT Petersdorf
D - 17213 Fünfseen,   Germany
Phone: +49(0)39932/13189
Fax: +49(0)39932/13216
E-mail: prandke@t-online.de
Internet: www.isw-wasser.com

Technical parameters can be changed without notice!

Appendix 4

Microstructure conductivity sensor for the MSS Profiler

1. Principle of operation

The microstructure conductivity sensor is a capillary type two electrode probe. This type of conductivity sensor is based on developments of the Atlantis Branch of the P.P. Shirshov Institute of Oceanography. It's principle is described in detail in Paka, Nabatov, Lozovatski, Dillon: Oceanic Microstructure Measurements by BAKLAN and GRIF. JAOT Vol. 16,1519-1532, 1999).
The inner electrode in the conic sensor tip is a capillary tube with a diameter of 2 mm. The outer electrode is the surface of the cylindrical sensor. Both electrodes are made from stainless steel. The contact surface between the inner electrode and the water is approx. 2.3 cm^2. This guaranties a low current density at the electrode surface and consequently, a low level of contact polarisation noise. According to Gibson and Swartz: Detection of conductivity fluctuations in a turbulent flow field. J. Fluid Mech., Vol. 144, 357-364, the spatial response of the sensor is approx. 5 times the capillary tube diameter = 10 mm.
The electrodes are driven by an alternating current at approx. 28 kHz frequency.

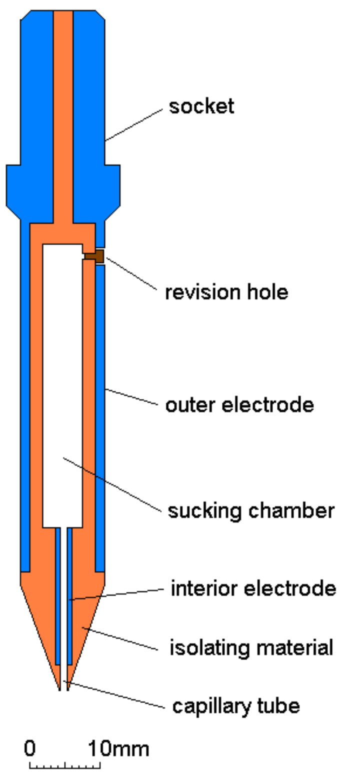


Figure 1
Schematic drawing of the C-microstructure sensor for the MSS Profiler.

2. Handling

Before starting the measurements, in the sucking chamber of the C-MS sensor should be no water. To remove water from the interior of the sensor, see further down. When soaked into water, the air in the sucking chamber is compressed by the hydrostatic pressure and the interior electrode has contact to the fluid. At depth greater approx. 0.5m, the inner electrode is completely wet.

3. Maintenance

After a cruise (or at a longer gap in the measuring program) the sea water in the sensor must be removed. The following procedure is recommended:

1. Bring the profiler with the C-MS sensor in a vertical position
2. Open the revision hole at the sensor tip
3. Use a plastic bottle with a rubber tube as shown in figure 2 to pump the sea water from the sucking chamber of the C-MS sensor
4. Put some fresh water in the plastic bottle and flush the remaining salt water from the interior of the sensor
5. Pump the remaining water out of the sucking chamber using the plastic bottle and rubber tube without water
6. Close the revision hole

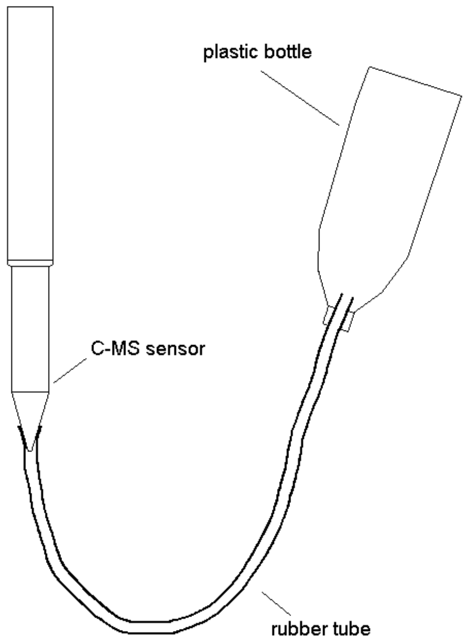


Figure 2
Arrangement to remove water from the sucking chamber an flush the interior of the C-MC sensor

Technical specifications can be changed without notice!

Appendix 5 Documentation

Sea cable

Sea cable connector	drawing no. 002.E04B
Sea cable wiring	drawing no. 002.E04B

MSS Profiler

Power supply and cable driver

Board layout and circuitry	drawing no. 002.E01.L
Internal connector	drawing no. 002.D04.B

Mainboard 1

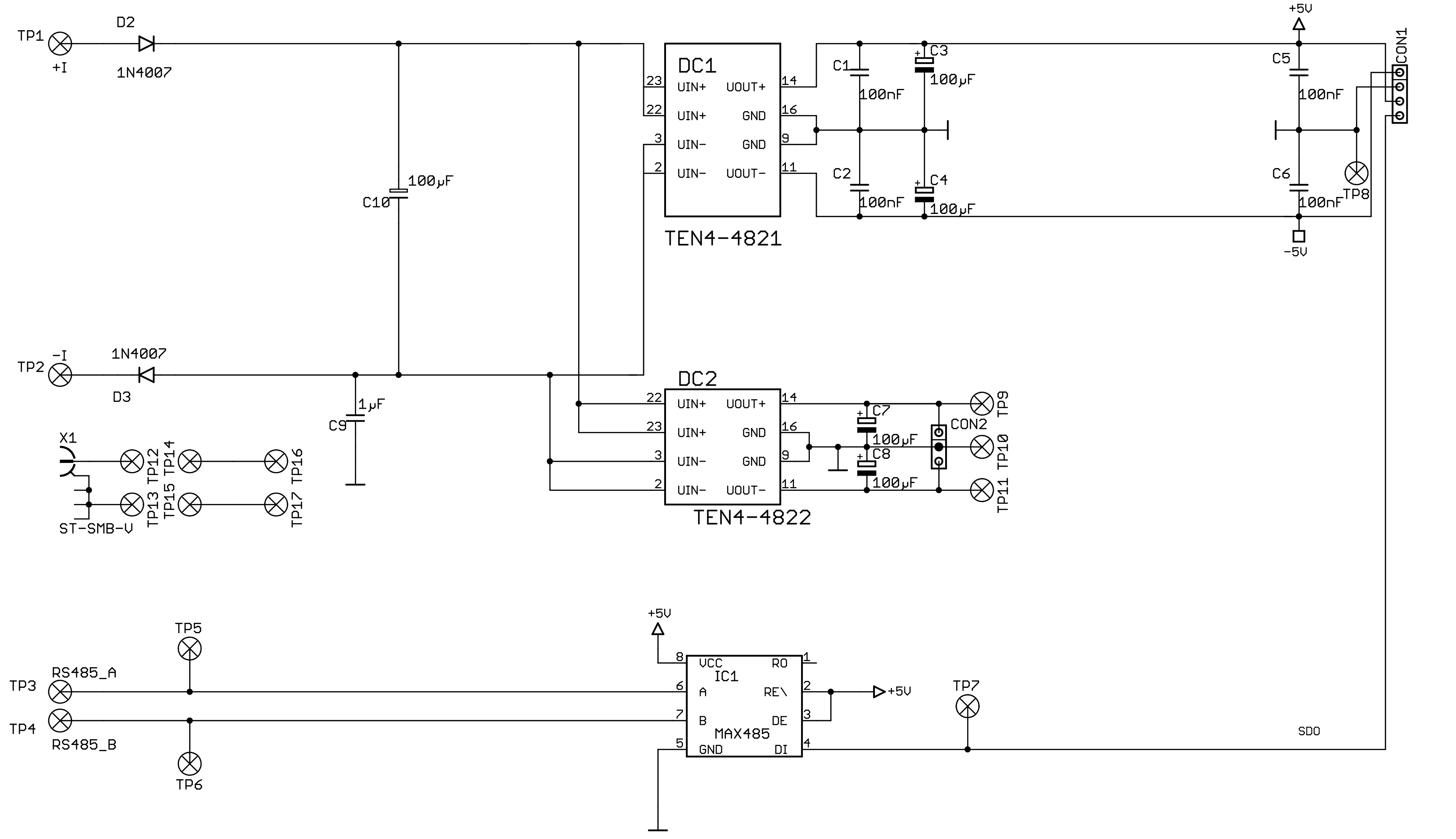
Mainboard1: **T** and **C** bridge	drawing no. 002.E05.E sheet 1/5
Mainboard1: **NTC** + **ACC** amplifier	drawing no. 002.E05.E sheet 2/5
Mainboard1: **P**ressure amplifier	drawing no. 002.E05.E sheet 3/5
Mainboard1: **SHE** amplifiers	drawing no. 002.E05.E sheet 4/5
Mainboard1: misc.	drawing no. 002.E05.E sheet 5/5
Mainboard1: Layout	drawing no. 002.E05.E
Mainboard1: Sensor connectors	
Sensor connectors **SHE** + **ACC**	drawing no. 002.E06A sheet 1/4
Sensor connectors **T** + **C**	drawing no. 002.E06A sheet 2/4
Sensor connectors **P** + **NTC**	drawing no. 002.E06A sheet 3/4
Mainboard1: data acquisition system	drawing no. 002.E02.C

Mainboard 2

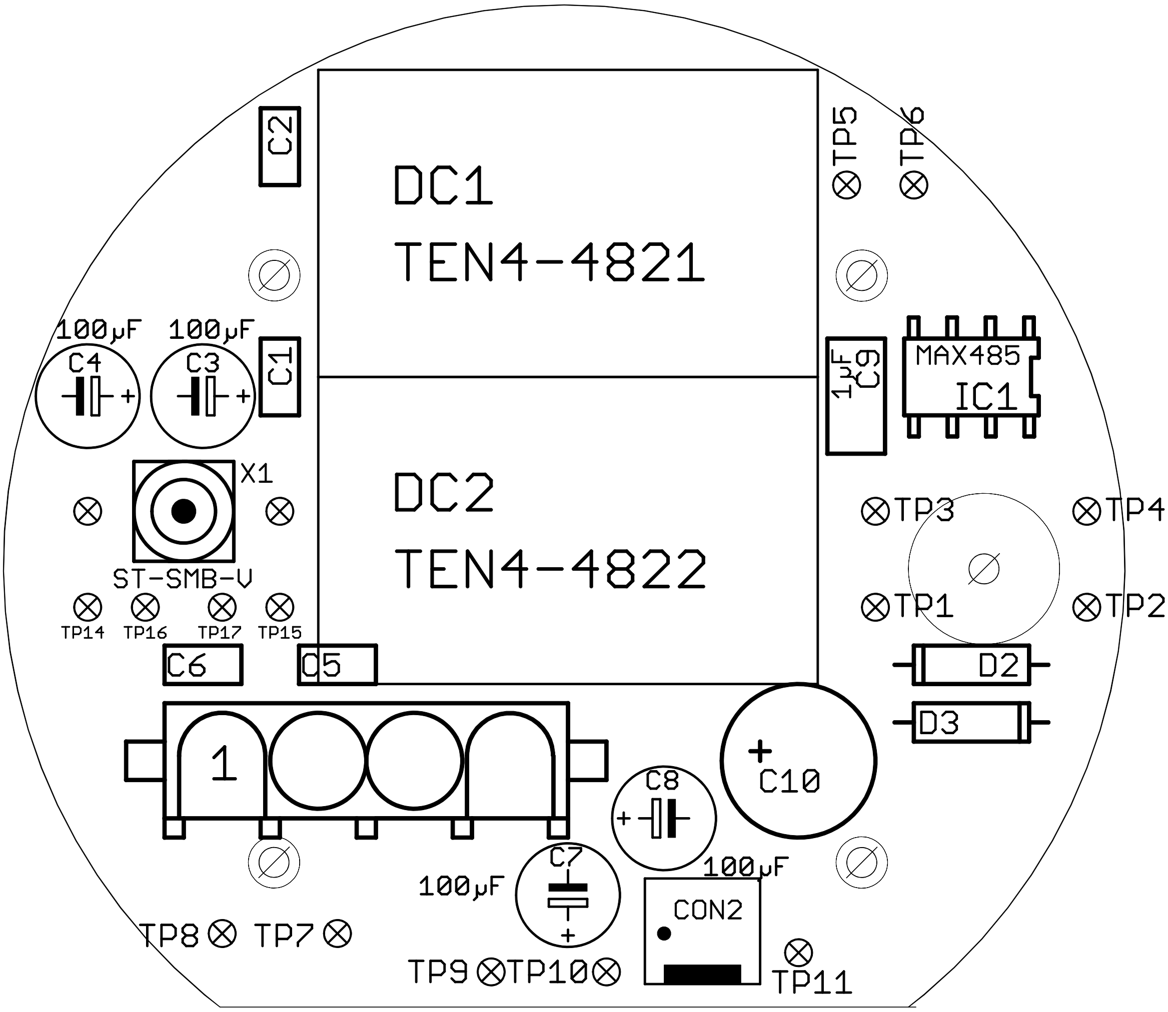
Mainboard2: **AMT DO, pH, ORP, PAR**	drawing no. 002.E07.F
Module **CM**	drawing no. 002.E10.D
Mainboard2: sensor connectors	MSS90 sensor connections

Mikrostructure sensors

NTC preamplifier	drawing no. 004.E01A
SHE + **ACC** preamplifier	drawing no. 004.E02A



Sea & Sun Technology 24610 Trappenkamp Erfurter Str. 2 Tel.:04323/910913 Fax:04323/910915	Gerät	Mikrostruktursonde	
	Baugruppe	Deckelplatine	
	Zeichn.-Nr.	002.E01.L	Sheet 1/1
	Bearbeitet	Gutt	20.09.2007 15:26:26
	Geprüft		002E01I



SST

Sea & Sun Technologies

24610 Trappenkamp
Erfurter Str. 2
Tel.:04323/910913
Fax :04323/910915

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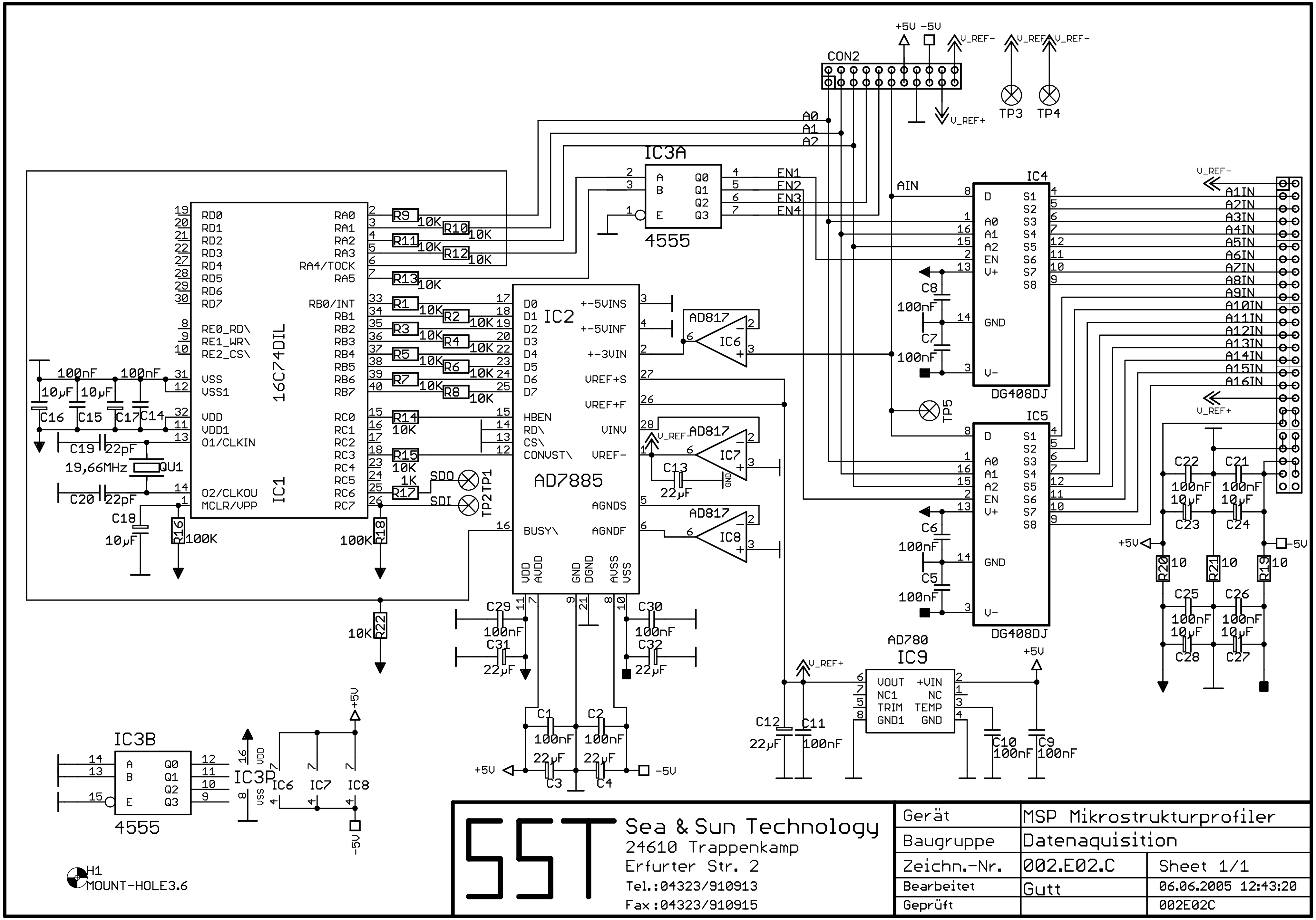
Objekt	Deckelplatine		
Zeichn.-Nr.	002.E01.L		
Bearbeitet	Gutt	20.09.2007 15:29:30	
Geprüft		002E01I	



Sea & Sun Technology
24610 Trappenkamp
Erfurter Str. 2
Tel.:04323/910913
Fax:04323/910915
Gerät
MSP Mikrostrukturprofiler
Baugruppe
Datenaquisition
Zeichn.-Nr.
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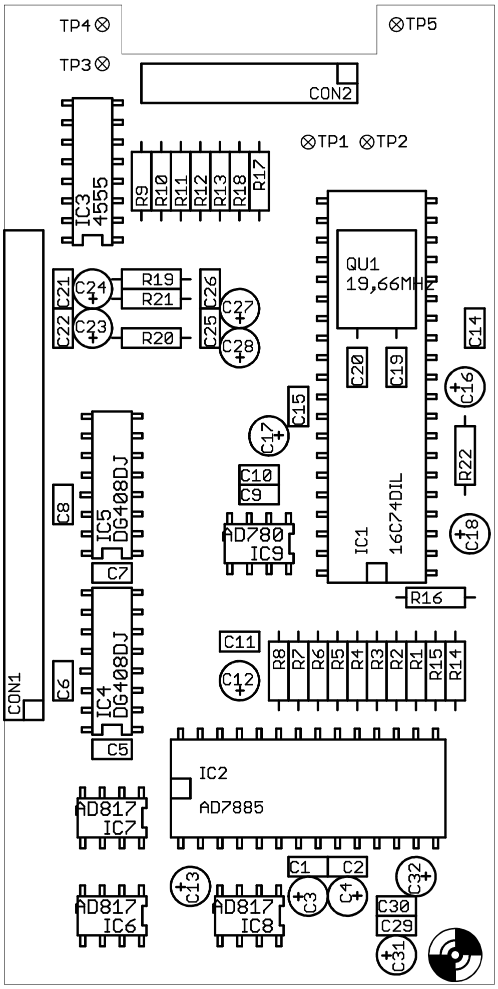

SST Sea & Sun Technologies	Gerät	MSP Mikrostrukturprofiler	
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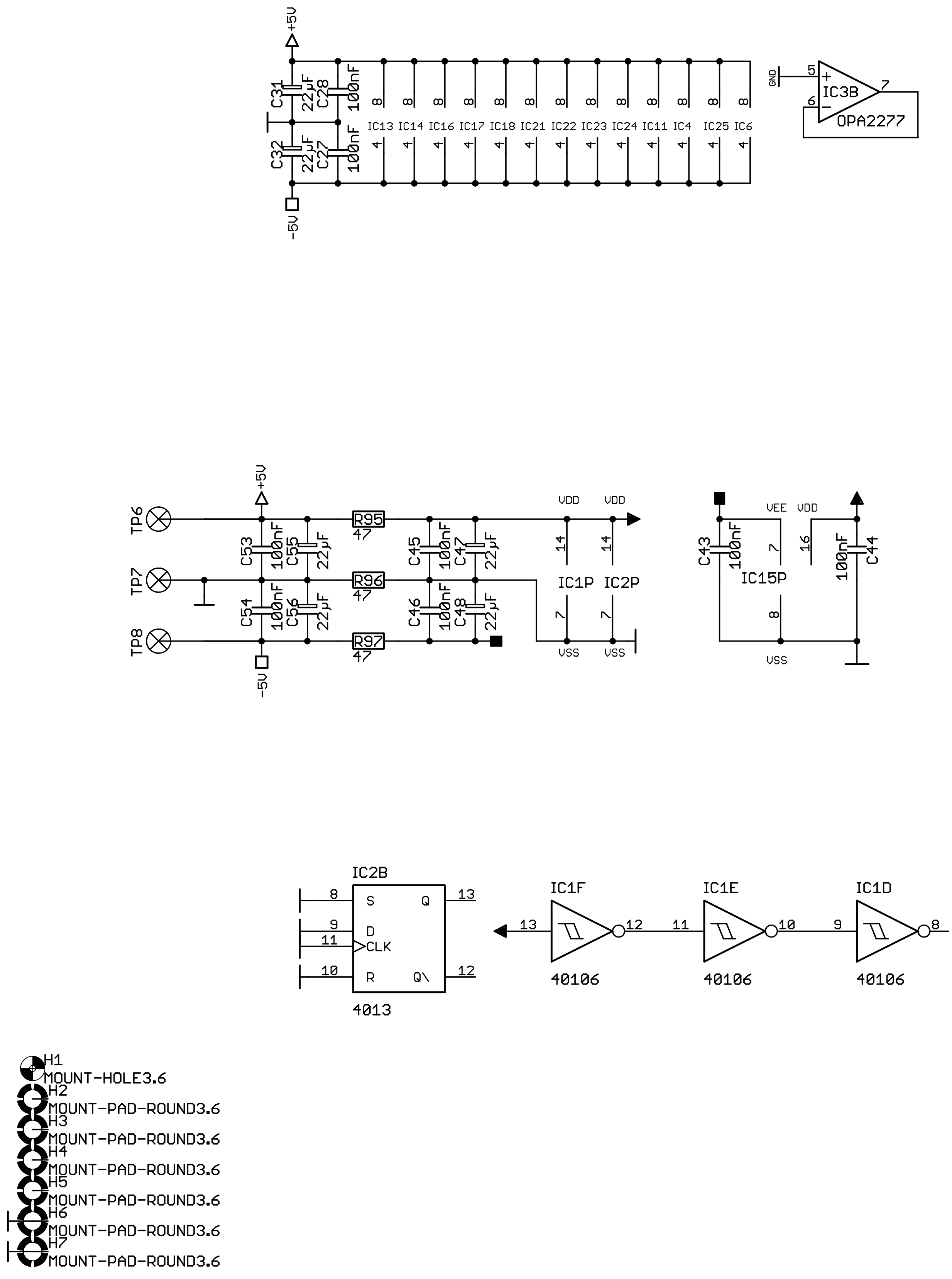
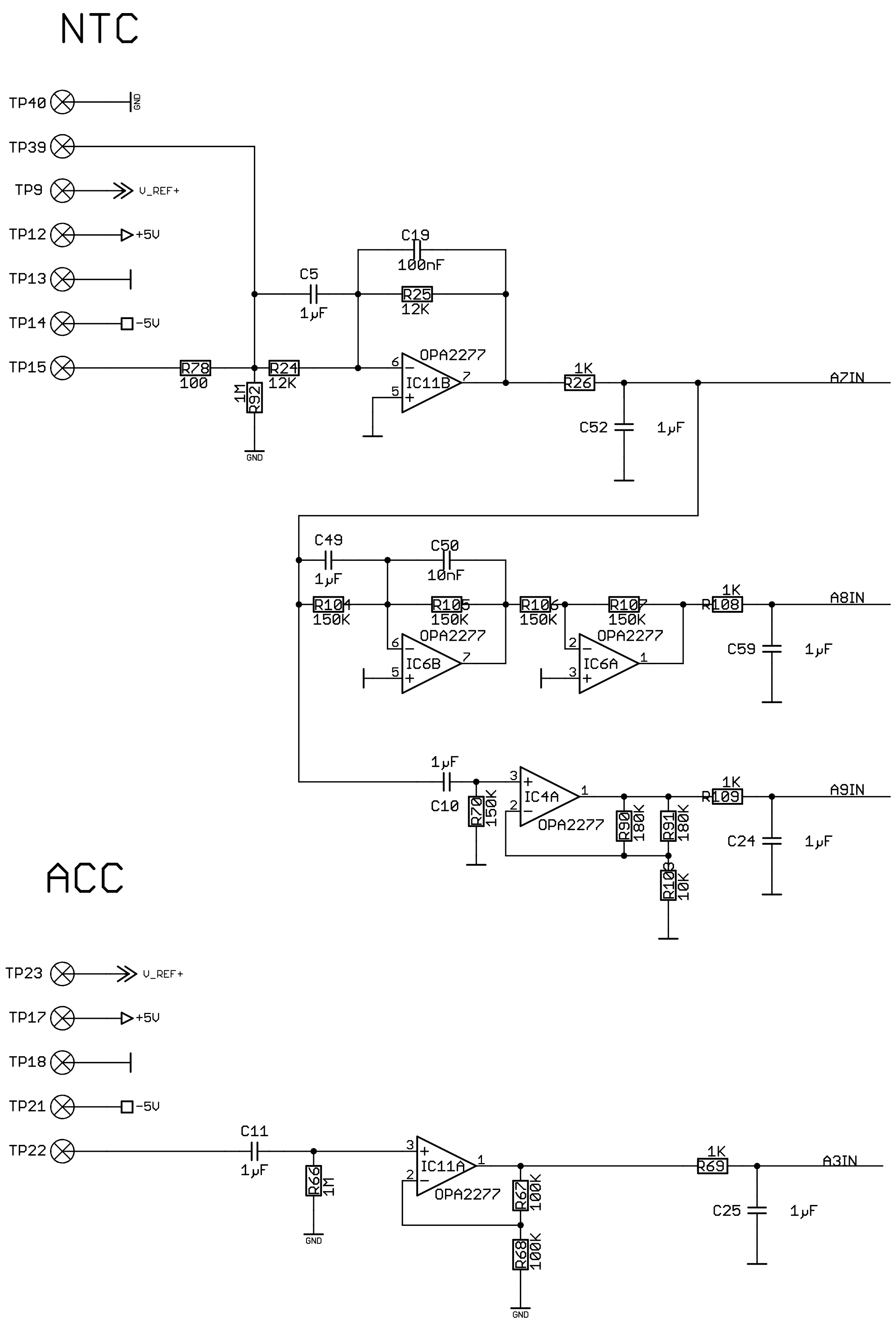
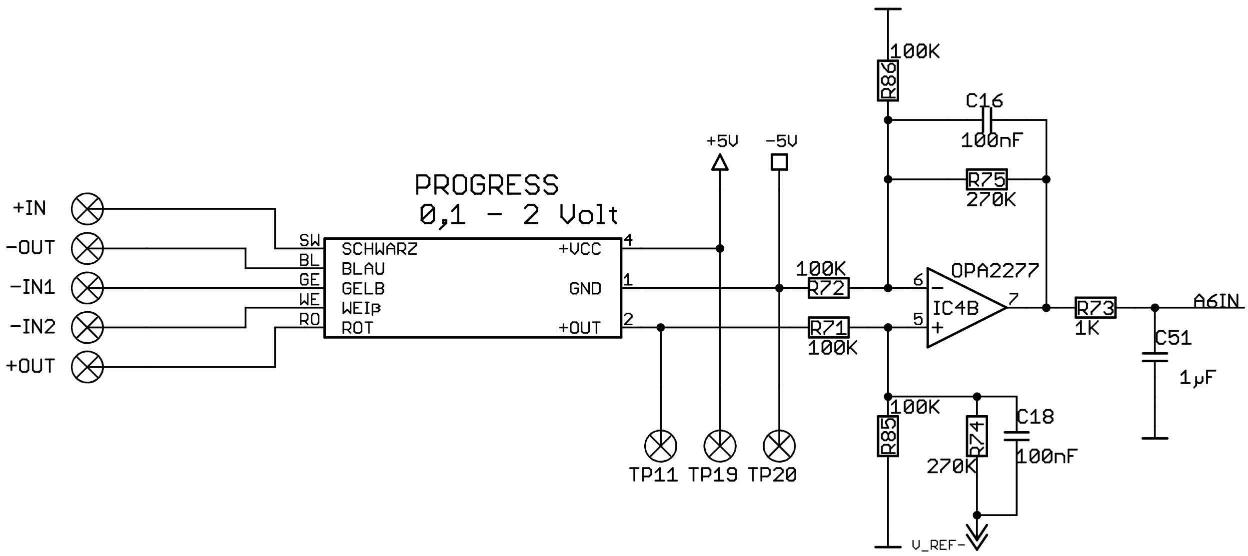
	Bearbeitet	Gutt	23.02.2006 13:04:52
24610 Trappenkamp	Geprüft		002E02C



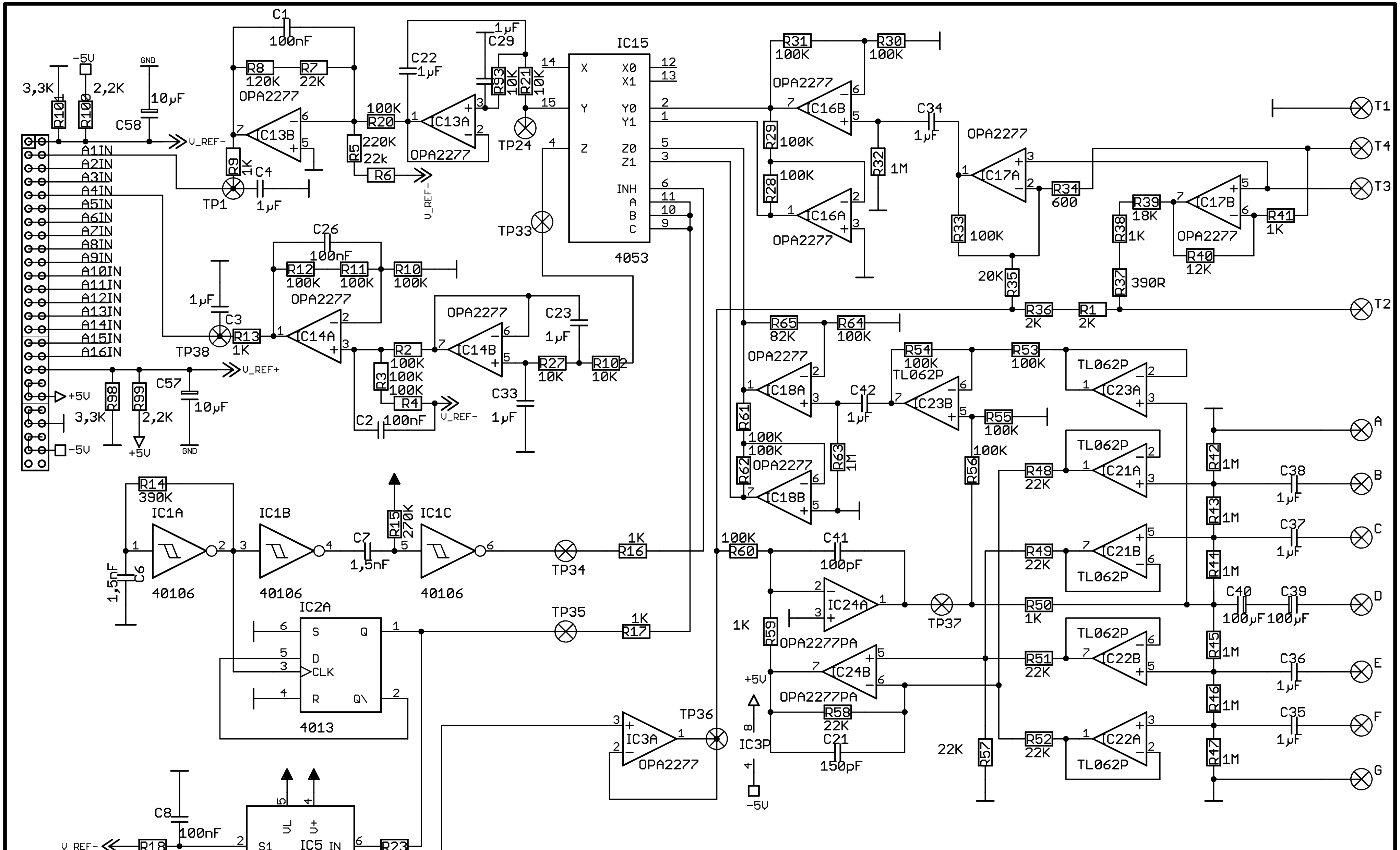
SST Sea & Sun Technology 24610 Trappenkamp Erfurter Str. 2 Tel.:04323/910913 Fax: 04323/910915	Gerät	MSP Mikrostrukturprofiler	
	Baugruppe		
	Zeichn.-Nr.	002.E05.E	Sheet 5/5
	Bearbeitet	Gutt	20.07.2006 14:03:46
	Geprüft		002e05e



SST Sea & Sun Technology 24610 Trappenkamp Erfurter Str. 2 Tel.:04323/910913 Fax: 04323/910915	Gerät	MSS Mikrostrukturprofiler	
	Baugruppe	NTC- und ACC-Verstärker	
	Zeichn.-Nr.	002.E05.E	Sheet 2/5
	Bearbeitet	Gutt	20.07.2006 14:03:46
	Geprüft		002e05e



SST Sea & Sun Technology 24610 Trappenkamp Erfurter Str. 2 Tel.:04323/910913 Fax: 04323/910915	Gerät	MSP Mikrostrukturprofiler	
	Baugruppe	Druckbrücke	
	Zeichn.-Nr.	002.E05.E	Sheet 3/5
	Bearbeitet	Gutt	20.07.2006 14:03:46
	Geprüft		002e05e



Gerät	MSS Mikrostrukturprofiler
Baugruppe	Temperatur-& Leitfähigkeitsbrücke
Zeichn.-Nr.	002.E05.E
	Sheet 1/5
Bearbeitet	Gutt
	20.07.2006 14:03:46
Geprüft	
	002e05e

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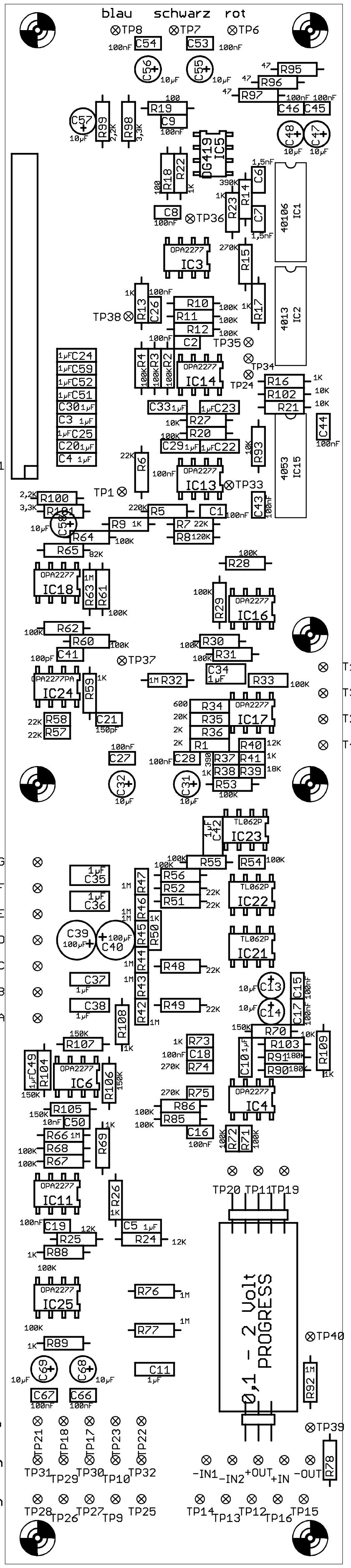

T

T1	schwarz
T3	rot
T2	rot
T4	schwarz

C

violett	F
gelb	E
rot	D
blau	C
grau	B
grün	A

	TP21	TP18	TP17	TP23	TP22
ACC =>	blau	schwarz	rot	frei	gelb

	TP31	TP29	TP30	TP10	TP32
SH2 =>	blau	schwarz	rot	frei	grün

	TP28	TP26	TP27	TP9	TP25
SH1 =>	blau	schwarz	rot	frei	grün

	-IN1	-IN2	+OUT	+IN	-OUT
P =>	gelb	weiß	rot	schwarz	blau

	TP14	TP13	TP12	TP16	TP15
NTC =>	blau	schwarz	rot	braun	grün

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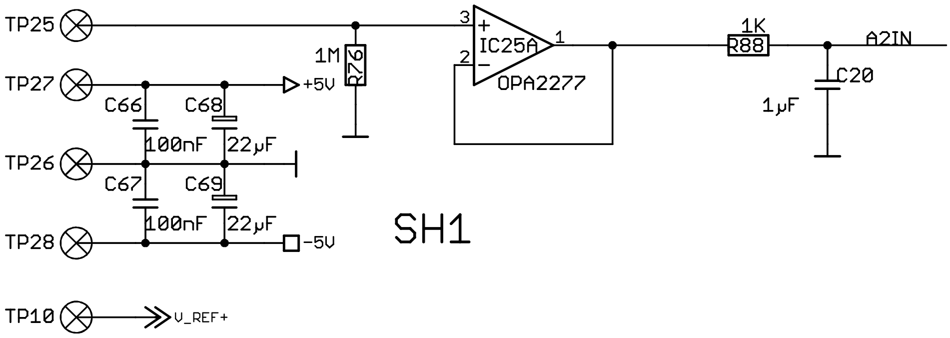
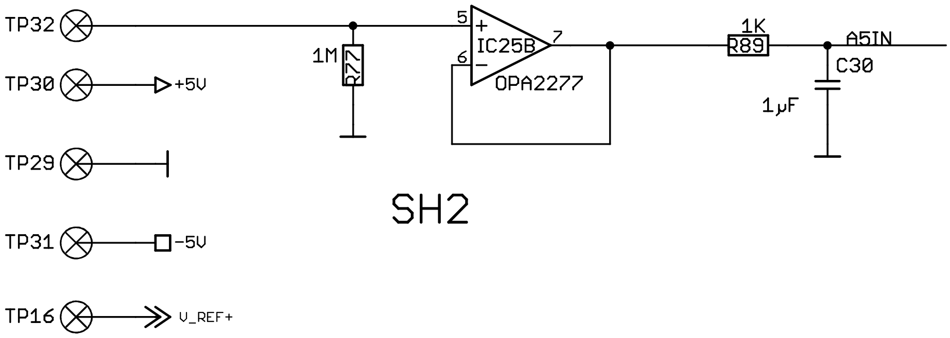
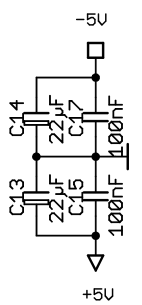
24610 Trappenkamp

Projekt	MSP Mikrostruckturprofiler	
Objekt	Analogboard	
Zeichn.-Nr.	002.E05.E	Sheet >SHEET
Bearbeitet	Gutt	20.07.2006 14:03:46
Geprüft		002e05e

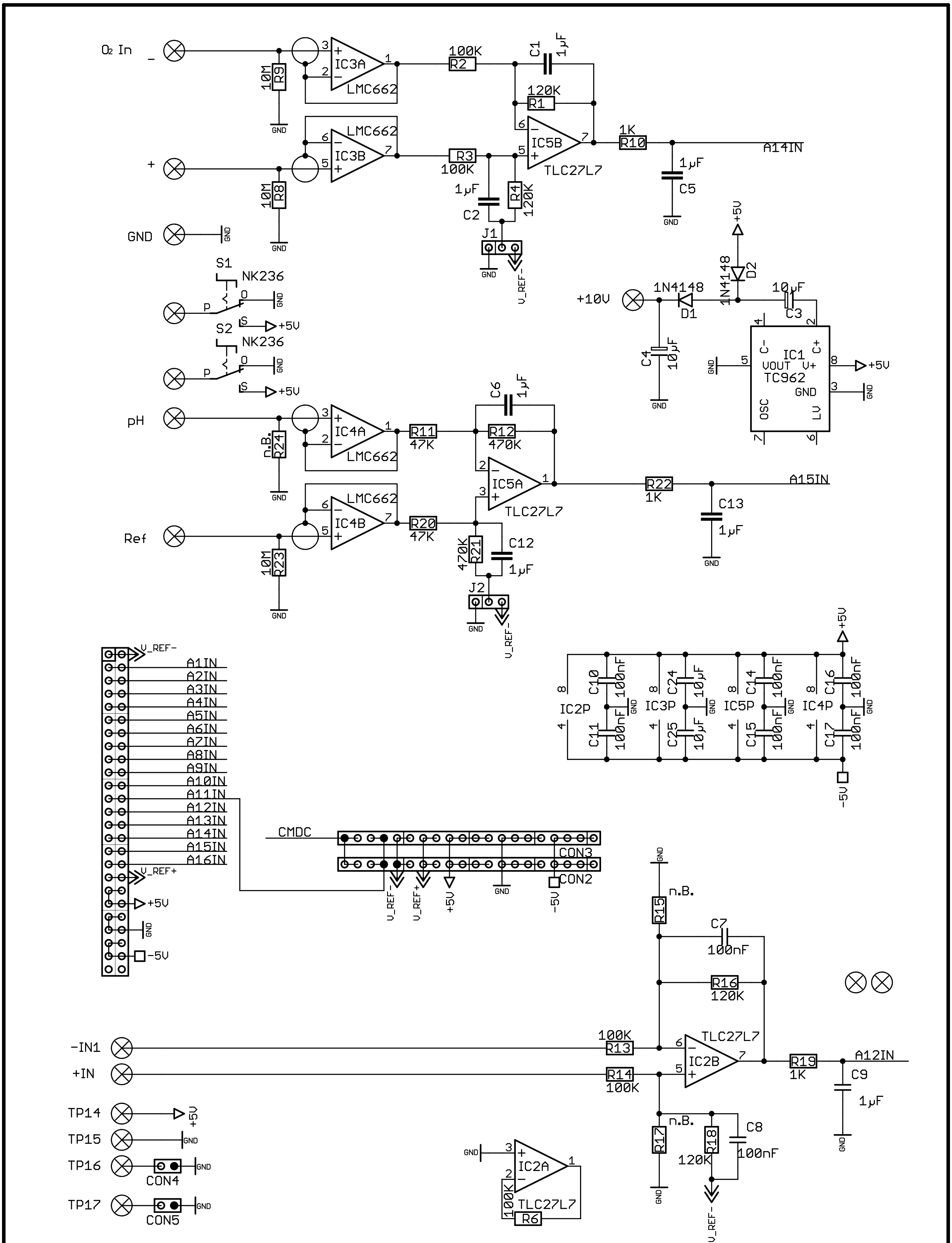
Scherungsverstärker





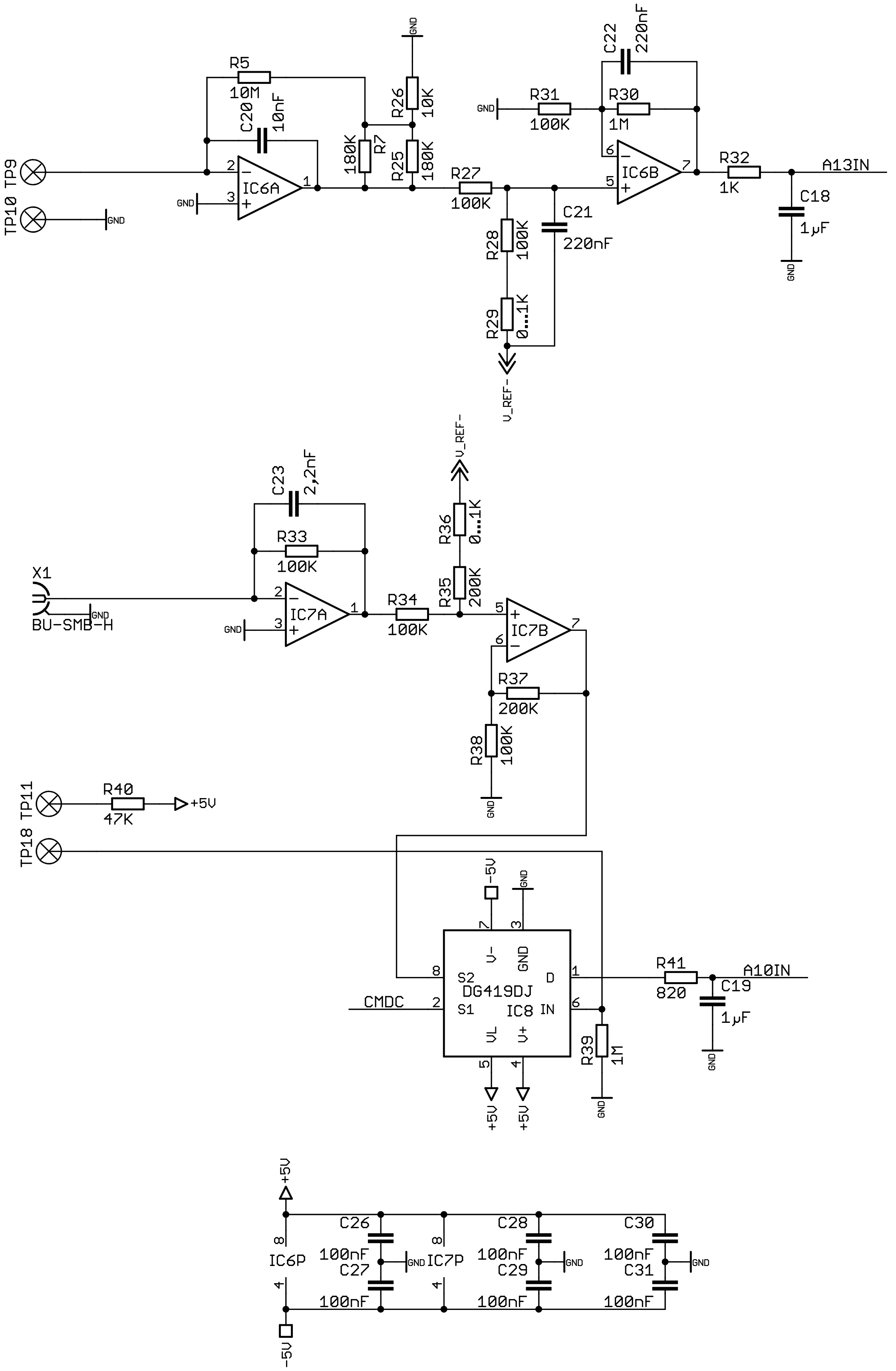


SST Sea & Sun Technology 24610 Trappenkamp Erfurter Str. 2 Tel.:04323/910913 Fax: 04323/910915	Gerät	MSS Mikrostrukturprofiler	
	Baugruppe	Scherungsverstärker	
	Zeichn.-Nr.	002.E05.E	Sheet 4/5
	Bearbeitet	Gutt	20.07.2006 17:28:14
	Geprüft		002e05e



SST Sea & Sun Technology	Gerät	MSS Mikrostrukturprofiler	
	Baugruppe	Analogplatine 2	
	Zeichn.-Nr.	002.E07.F	Sheet 1/2
	Bearbeitet	Gutt	07.09.2007 17:31:15
	Geprüft		002e07f

24610 Trappenkamp
Erfurter Str. 2
Tel.:04323/910913
Fax: 04323/910915



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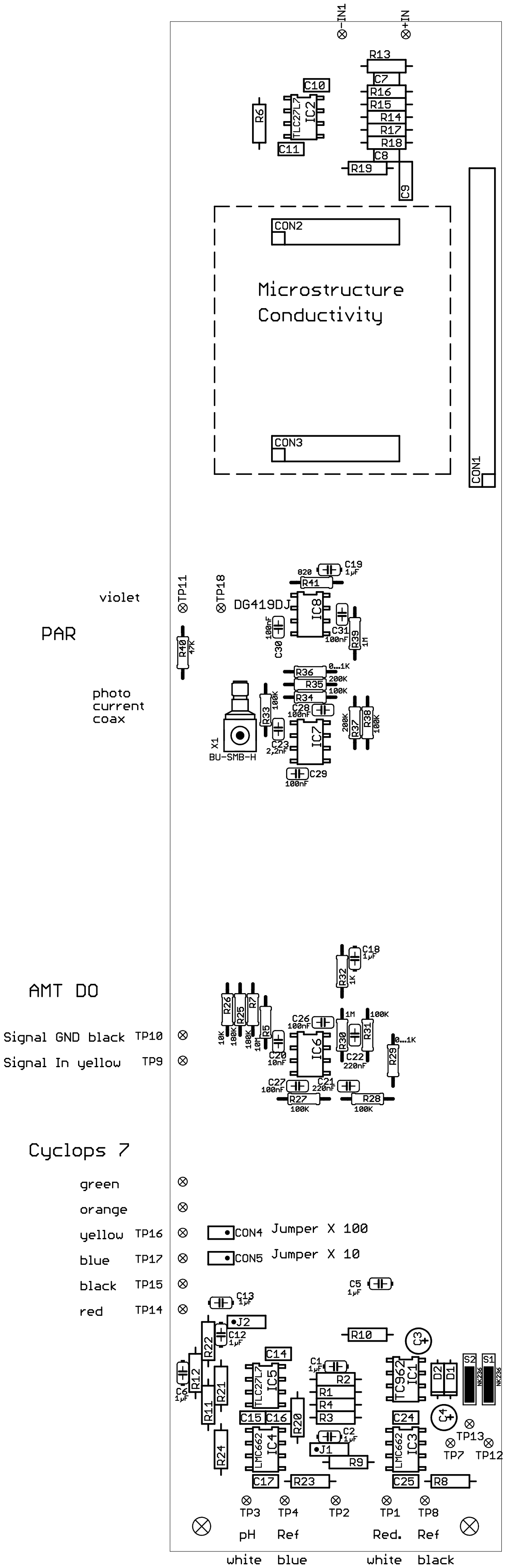
Sea & Sun Technology 24610 Trappenkamp Erfurter Str. 2 Tel.:04323/910913 Fax: 04323/910915	Gerät	MSS Mikrostrukturprofiler	
	Baugruppe	Analogplatine 2	
	Zeichn.-Nr.	002.E07.F	Sheet 2/2
	Bearbeitet	Gutt	07.09.2007 17:31:15
	Geprüft		002e07f



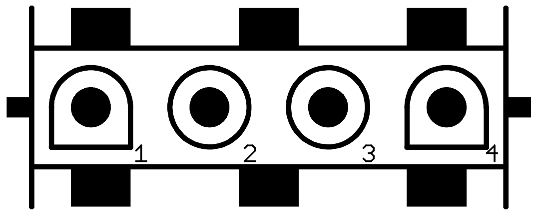
SST	Sea & Sun Technologies 24610 Trappenkamp	Projekt	Mikrostrukturprofiler	
		Objekt	Analogplatine 2	
		Zeichn.-Nr.	002.E07.F	Sheet >SHEET
		Bearbeitet	Gutt	20.09.2007 14:33:01
		Geprüft		002e07f

Mikrostructur profiler

Power supply board

Connector to probe electronics

Mate-N-Lock
Housing



1 -5V
2 0V
3 +5V
4 seriell data output NRZ

Connector face view

socket ○

pin ●

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Erfurter Str. 2
Tel.:04323/910913
Fax: 04323/910915

Gerät	Mikrostruktursonde	
Baugruppe	Seekabelkonfektionierung	
Zeichn.-Nr.	002.D04.B	Sheet 1/1
Bearbeitet	Gutt	20.07.2006 16:53:46
Geprüft		002d04b

Microstructure profiler

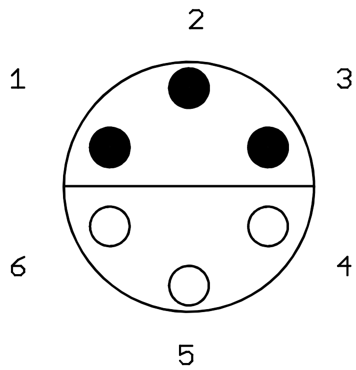
Mainboard

Sensor connector pin layout and assignment

Pressure transducer

Keller PA 7 - Progress

Connector	Lemosa FFA 1 S 306.ZLA	
Pin-No.	Signal	cable color
1	+Iout	black
2	-Iout 1	white
3	-Uin	blue
4	+Uin	red
5	-Iout2	yellow
6	nc	



cable length = 15 cm

"white" and "yellow" are connected on the SMD progress print

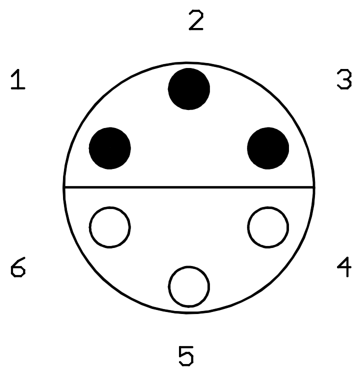
face view

pin

socket

NTC - Temperature Sensor

Connector	Lemosa FFA 1 S 306.ZLA	
Pin-No.	Signal	cable color
1	+5 Volt	red
2	Signal in	green
3	-5 Volt	blue
4	+3 Volt Ref	brown
5	GND	black
6	nc	



cable length = 12 cm

face view

SST

Sea & Sun Technology
24610 Trappenkamp
Erfurter Str. 2
Tel.:04323/910913
Fax: 04323/910915

Gerät	Microstructure probe	
Baugruppe	Mainboard pin layout and assignment	
Zeichn.-Nr.	002.E06.A	Sheet 3/4
Bearbeitet	Gutt	20.07.2006 14:41:10
Geprüft		002e06a

Microstructure profiler

Mainboard

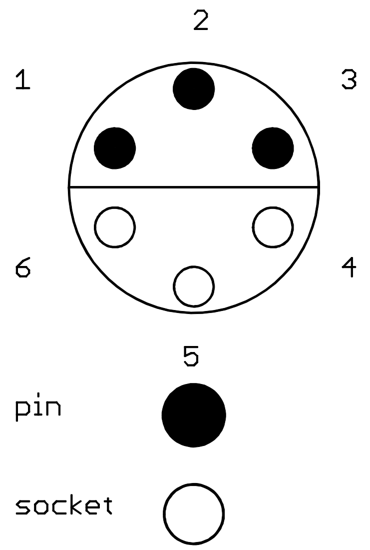
sensor connector pin layout and assignment

Current shear sensor

Connector	Lemosa FFA 1 S 306.ZLA	
Pin-No.	Signal	cable color
1	+ 5 Volt	red
2	Signal input	green
3	- 5 Volt	blue
4	nc	
5	GND	black
6	nc	

cable length = 10 cm

face view

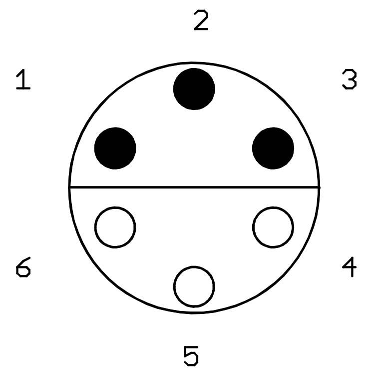


Acceleration sensor (shear reference)

Connector	Lemosa FFA 1 S 306.ZLA	
Pin-No.	Signal	cable color
1	+ 5 Volt	red
2	Signal input	yellow
3	- 5 Volt	blue
4	nc	
5	GND	black
6	nc	

cable length = 10 cm

face view



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Erfurter Str. 2
Tel.:04323/910913
Fax: 04323/910915

Gerät	Microstructure probe	
Baugruppe	Mainboard pin layout and assignment	
Zeichn.-Nr.	002.E06.A	Sheet 1/4
Bearbeitet	Gutt	20.07.2006 14:41:10
Geprüft		002e06a

Microstructure profiler

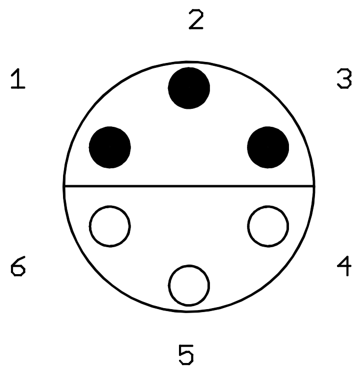
Mainboard

sensor connector pin layout and assignemt

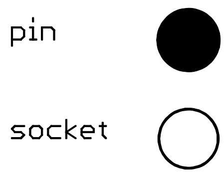
Temperature Pt 100

Connector	Lemosa FFA 1 S 306.ZLA	
Pin-No.	Signal	cable color
1	T1	black
2	T2	red
3	T3	red
4	T4	black
5	nc	
6	nc	

cable length = 25 cm



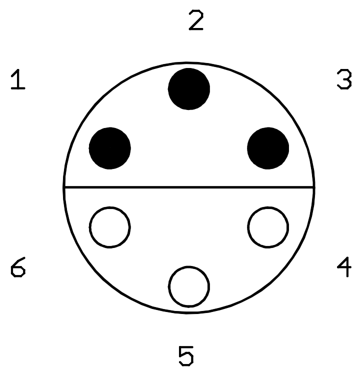
face view



Conductivity

Connector	Lemosa FFA 1 S 306.ZLA	
Pin-No.	Signal	cable color
1	B	grey
2	C	blue
3	D	red
4	E	yellow
5	F	pink
6	A,G	green

cable length = 20 cm



face view

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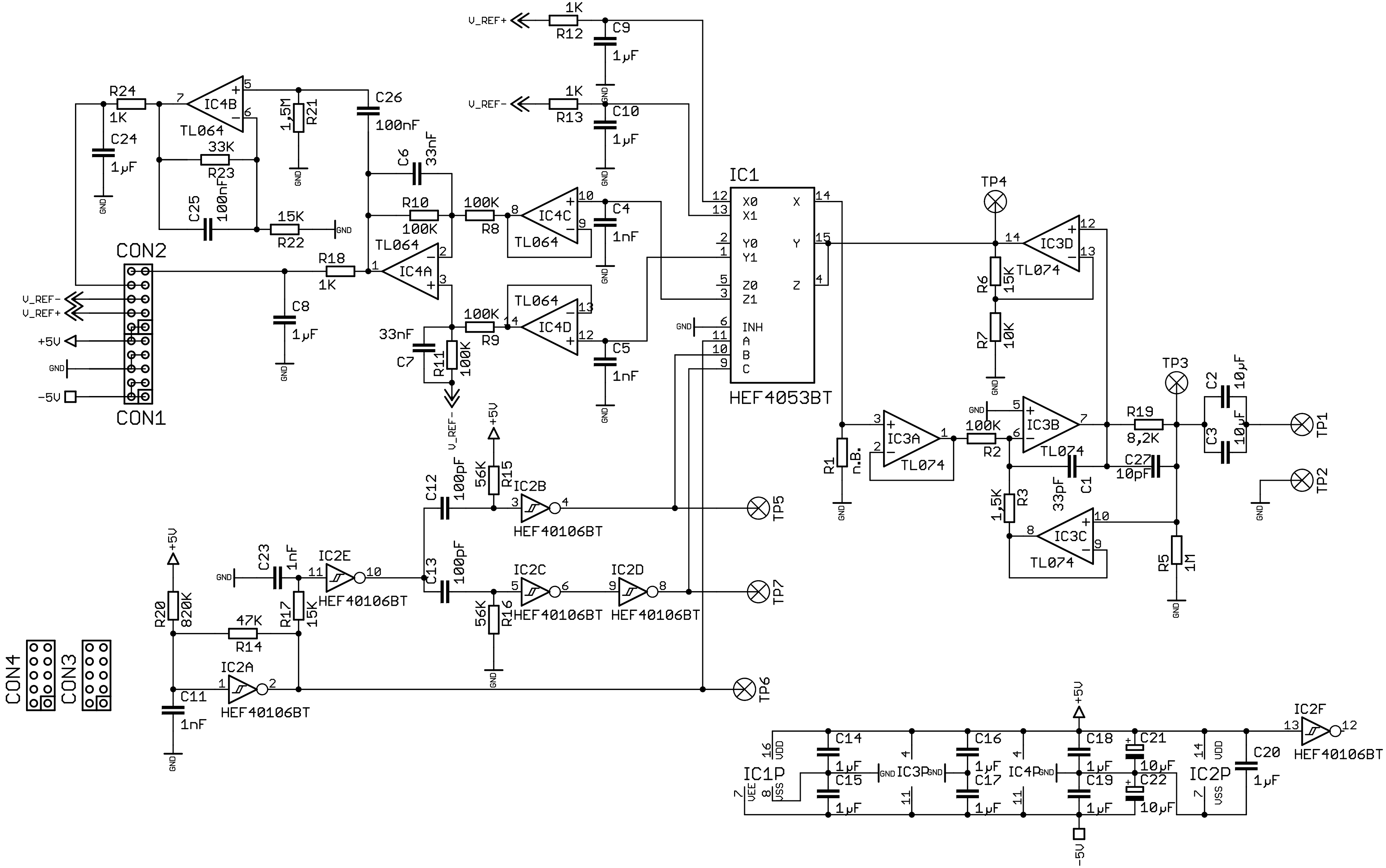
Erfurter Str. 2
Tel.:04323/910913
Fax: 04323/910915

Gerät	Microstructure probe	
Baugruppe	Mainboard pin layout and assignment	
Zeichn.-Nr.	002.E06.A	Sheet 2/4
Bearbeitet	Gutt	20.07.2006 14:41:10
Geprüft		002e06a



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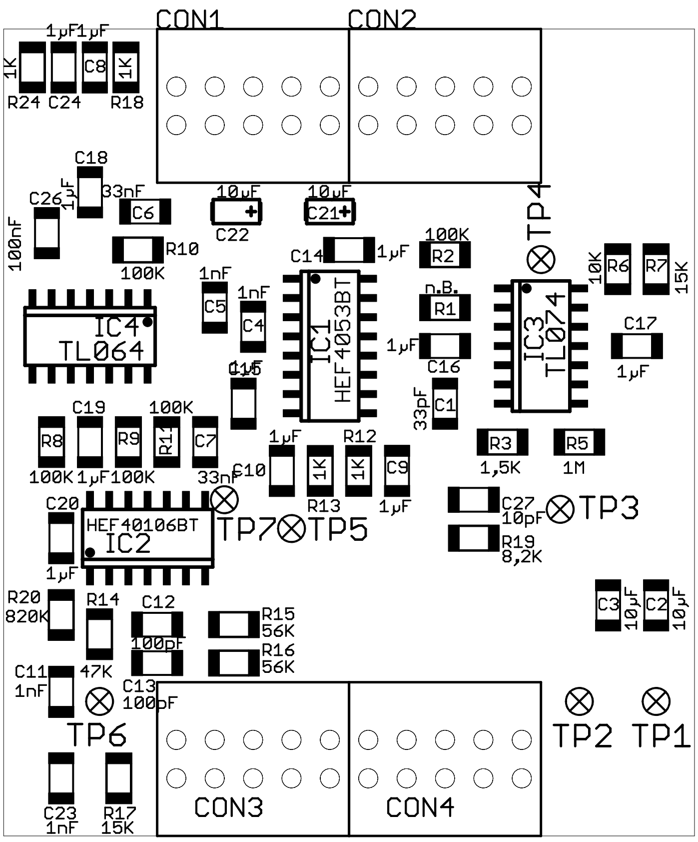
Erfurter Str. 2
Tel.:04323/910913
Fax:04323/910915

Gerät	Mikrostruktursonde	
Baugruppe	Leitfähigkeit	
Zeichn.-Nr.	002.E10.D	Sheet 1/1
Bearbeitet	Gutt	15.01.2007 16:52:08
Geprüft		002E10D



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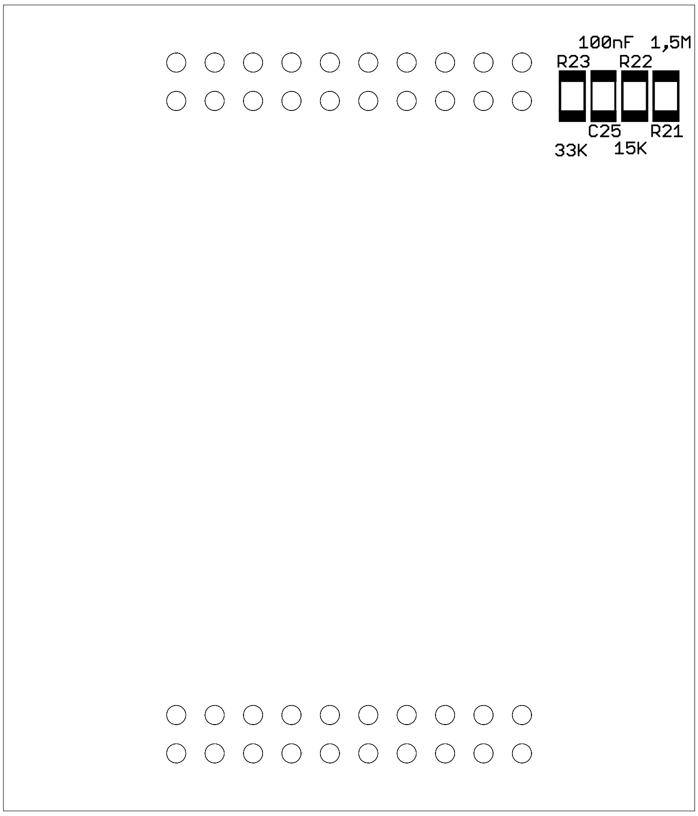
Erfurter Str. 2
Tel.:04323/910913
Fax :04323/910915

Projekt	Mikrostruktursonde		
Objekt	Leitfähigkeit		
Zeichn.-Nr.	002.E10.D	Top	
Bearbeitet	Gutt	15.01.2007 17:42:00	
Geprüft		002E10D	



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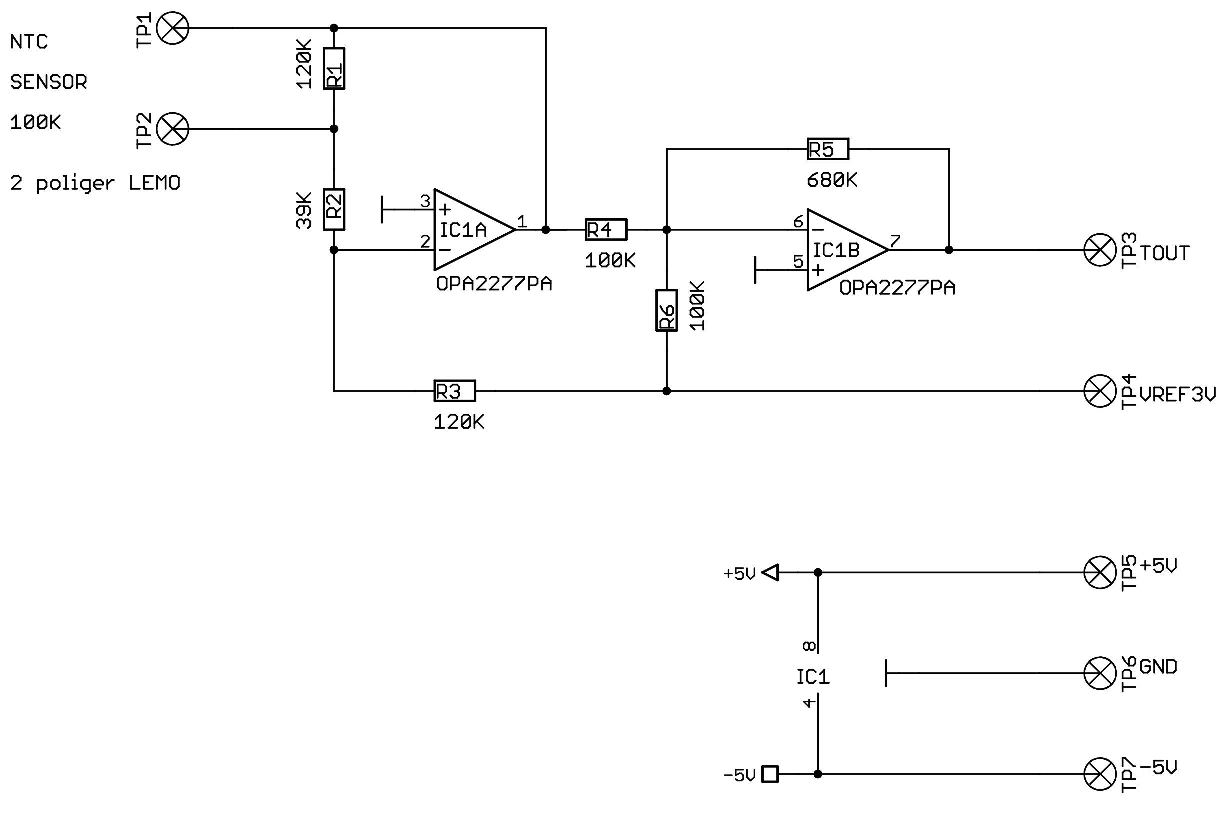
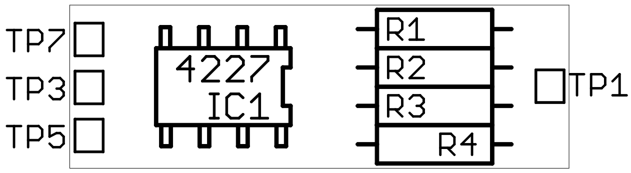
Erfurter Str. 2
Tel.:04323/910913
Fax :04323/910915

Projekt	Mikrostruktursonde		
Objekt	Leitfähigkeit		
Zeichn.-Nr.	002.E10.C	Bottom	
Bearbeitet	Gutt	15.01.2007 17:42:00	
Geprüft		002E10D	



SST Sea & Sun Technology 24610 Trappenkamp Erfurter Str. 2 Tel.:04323/910913 Fax: 04323/910915	Gerät	MSP Mikrostruktursensoren	
	Baugruppe	NTC-Vorverstärker	
	Zeichn.-Nr.	004.E01.A	Sheet 1/1
	Bearbeitet	Schelwat	20.07.2006 18:13:24
	Geprüft		004E01A



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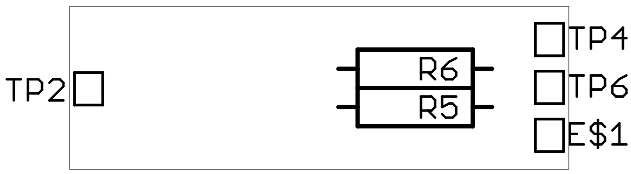
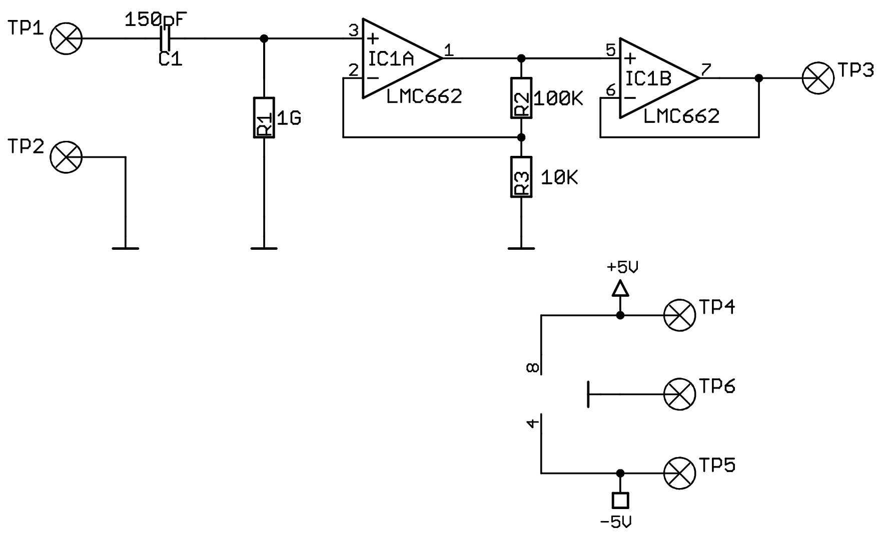
Projekt	MSP Mikrostruktursensoren		
Objekt	NTC-Vorverstärker		
Zeichn.-Nr.	004.E01.A	Top	
Bearbeitet	Gutt	20.07.2006 18:11:06	
Geprüft		004E01A	



SST Sea & Sun Technologies	Projekt	MSP Mikrostruktursensoren		
24610 Trappenkamp	Objekt	NTC-Vorverstärker		
Erfurter Str. 2	Zeichn.-Nr.	004.E01.A	Bottom	
Tel.:04323/910913	Bearbeitet	Gutt	20.07.2006 18:11:06	
Fax :04323/910915	Geprüft		004E01A	



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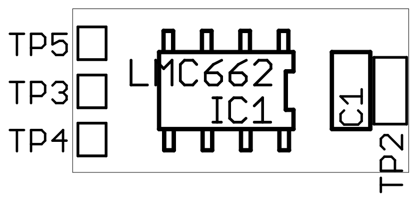
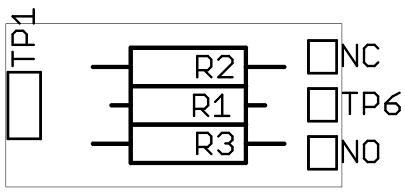
Tel.:04323/910913
Fax: 04323/910915

Gerät	MSP Mikrostruktursensoren	
Baugruppe	Scherungsvorverstärker	
Zeichn.-Nr.	004.E02.A	Sheet 1/1
Bearbeitet	Gutt	15.04.2005 11:36:14
Geprüft		004E02A



SST Sea & Sun Technologies	Projekt	MSP Mikrostruktursensoren		
24610 Trappenkamp	Objekt	Scherungsflansch		
Erfurter Str. 2	Zeichn.-Nr.	004.F02.A	Top	
Tel.:04323/910913	Bearbeitet	Gutt	20.07.2006 14:37:44	
Fax :04323/910915	Geprüft		004E02A	



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24610 Trappenkamp
Erfurter Str. 2
Tel.:04323/910913
Fax :04323/910915

Projekt	MSP Mikrostruktursensoren		
Objekt	Scherungsflansch		
Zeichn.-Nr.	004.F02.A	Bottom	
Bearbeitet	Gutt	20.07.2006 14:37:44	
Geprüft		004E02A	