TRIME®-ES

OPERATING INSTRUCTIONS

Silver Medal Innovation Award
1999 of the DLG
(German Agricultural Society)

Innovation Award of the State
of Baden-Württemberg

IMKO
MICROMODULTECHNIK GMBH

Thank you for buying IMKO.

Should you have any queries please
don't hesitate to contact your local
distributor or address directly to IMKO:

IMKO Micromodultechnik GmbH

Im Stoeck 2
D-76275 Ettlingen
Germany

Phone: +49-7243-5921-0
Fax: +49-7243-90856
e-mail: info@imko.de
internet: http://www.imko.de

Table of contents (as of July 1st, 2001)

1 Functional Description TRIME-ES2 / -ES3

The intelligent and compact TRIME-ES sensors are measurement devices for continuous and non-destructive determination of volumetric soil moisture. They are designed for stationary subterranean field use. Varied installation orientations (greater depth, vertical or horizontal orientation) offer a broad application range.

TRIME-ES have to be supplied with external power 9-24V/DC. They are designed for being connected to a data logger or a PC for monitoring and data logging purposes.

1.1 Data Logger Operation

TRIME-ES are supplied with an IMP232 Micronet interface **or**, on request, with both analogue output 0..1V, 0..20mA or 4..20mA and RS232 interface. Analogue datalogger must have differential inputs.

1.1.1 IMP232 Micronet output for use with the *TRIME-Logger* or *ENVISLog* *(operation mode A)*

TRIME-ES can be connected directly to the IMP232 Micronet. Networking several TRIME-ES is possible either parallel (using distribution modules) or serial. IMKO supplies 3-port, 6-port and 12-port distribution modules. The number of simultaneously measuring sensors can be set.

Please note that the IMP232 Micronet's cable length and cable diameter have to be harmonized. Otherwise the energy consumption of the TRIME sensors (200mA during 10..15s) can cause a voltage drop.

TRIME-ES sensors are configured at works for use within the IMP232 Micronet (internal code = operation mode A).

1.1.2 Analogue output for analogue data logger

TRIME-ES sensors can easily be connected to conventional analogue data loggers. Depending on application and energy supply it can be chosen between two operation modes B and C:

- operation mode B:
  single measurement after power on. The measured value is available until power off.
- operation mode C:
  cyclic measurement with permanent power supply. The measurement rate is adjustable.

The operation modes are set at works. Re-configuration by use of software TRIMESET possible.

1.1.2.1 Single measurement (operation mode B)

Enables low power consumption in field installations. TRIME-ES is started by the data logger relay. The measurement takes 10..15s and consumes 200mA. After the measurement the power supply switches off. The measurement value is available at the analogue output and is stored in the TRIME-sensor until the next measurement is started by the data logger relay.

In case a voltage drop occurs when several TRIME sensors measure simultaneously the probe numbers (please note: **probe number ≠ serial number**) can be set in series and thus a serial, retarded measurement start can be forced. Then TRIME sensor number 1 measures immediately after power on, number 2 measures 20s retarded, number 3 measures 40s retarded, etc. The probe number can be configured using SMCAL or SMTOOLS.

1.1.2.2 Cyclic measurement (operation mode C)

Operation mode C requires mains supply. TRIME-ES enable automatic interval measurement in stand-by modus. Measurement rates between 10 and 3600s can be configured via PC/RS232/software TRIMESET. The measurement takes 10 .. 15s and consumes 200 mA. During stand-by 8 .. 10 mA are consumed. The measurement value is available and stored in the TRIME-sensor until the next measurement starts.

1.1.3 PC-connection via RS232

The TRIME-ES can be connected to a PC via the RS232 connector and the appropriate cable, in order to carry out datalogging, changing the operating mode, or calibration.

1.2 External power supply

Within the IMP232 Micronet the energy supply of sensors can be ensured by battery, solar cells or mains supply. For serial connection of a great number of sensors or long IMP232-bus cables a power amplifier module (SM-23LV) or decentralised power supply is advisable

1.3 Error codes

Only valid with the IMP232 Micronet: In case of failure an “Error No.” and an “Error Address” is given out

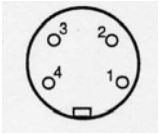
Error No.	Error Text	Possible Cause of Error
1-29	No text	internal error
30	TDR may be defective	TDR electronic or probe cable defective
31	TDR level not found	TDR level searching lasted too long, may occur with bad signal quality due to conductive soil or material
33	Salinity too high	Electrical conductivity of soil/material too high
34	Invalid probe data	Data in probe connector not plausible or probe connector defective

2 Technical data

Power supply:		9V..24V-DC	
Supply current:		8mA stand-by	
		200mA during 10..15sec. of measuring	
Measuring range:		0..100% volumetric water content	
Accuracy:		probe type dependent:	
		P2/P3-probe	P2C/P3C-probe
	Range 0..40 vol.%:	+-1%	+-2%
	Range 40..70 vol.%:	+-2%	+-3%
	Repeating accuracy:	+-0,5%	+-0,5%
Bulk conductivity range:		0..2dS/m	0..10dS/m
Pore water conductivity range:		0..12dS/m	0..50dS/m
Temperature range:		-15°C...50°C (other temperature ranges on request!)	
Temperature caused drift:		max. +-0.5%	
Interfaces:		standard: IMP232 MICRONET	
		option: RS232/V24 and analogue output: 0..1V or 0(4)..20mA	
Calibration data:		freely configurable	
Case:		weatherproof sealed aluminium die cast (IP67)	

3 Connectors IMP232 Micronet Version

In this version TRIME-ES has three connectors, one for the probe and two network IMP bus connectors:

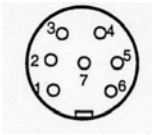


IMP232 Micronet Bus

PIN1: +VS
PIN2: R/T network
PIN3: 0V power supply
PIN4: COM network

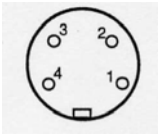
4 Connectors Analogue Output Version

In this version TRIME-ES has three connectors, one for the probe, one analogue output connector and one RS232 connector:



Analogue output

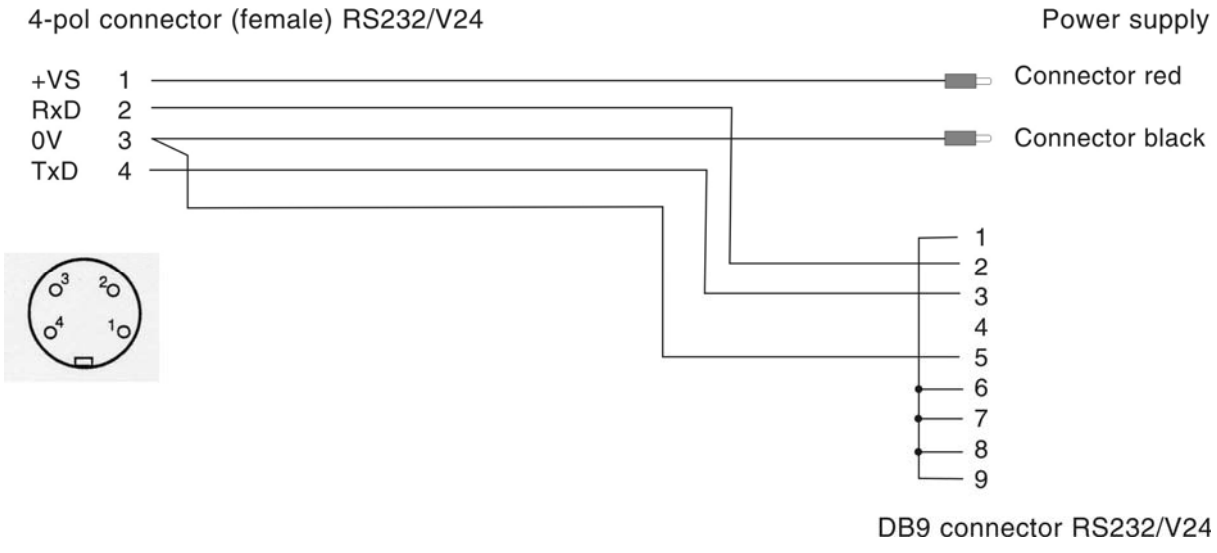
PIN1: +VS
PIN2: R/T network
PIN3: 0V power supply
PIN4: COM network
PIN5: Analogue out (0..1V, 0..20mA or 4..20mA)
PIN6: Analogue ground (0V)
PIN7: not connected (NC)



RS232/V24

PIN1: +VS
PIN2: RxD
PIN3: 0V power supply
PIN4: TxD

5 RS232/V24 Cable for TRIME-ES

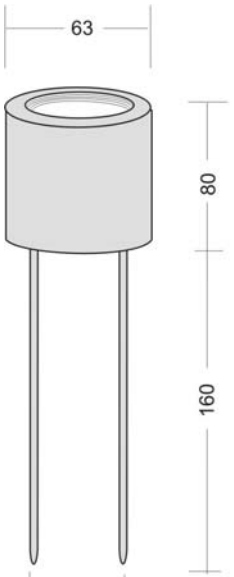


6 Probes Connectable

☝ Only one probe is connectable at a time.

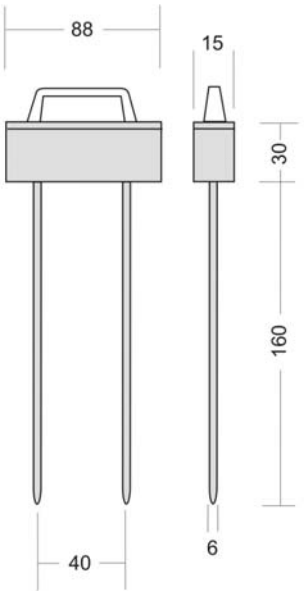
6.1 TRIME-ES2

P2Z



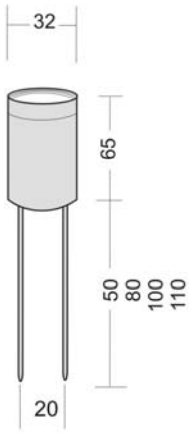
Rod diameter: 6mm

P2G



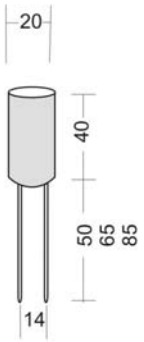
Rod diameter: 6mm

P2



Different rod length: 50, 80, 100mm
Rod diameter: 3,5mm

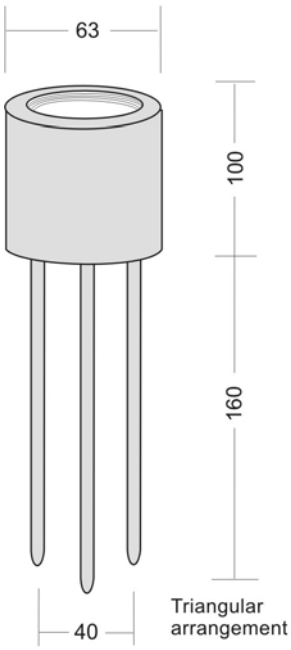
P2D



Different rod length: 50, 65, 85mm
Rod diameter: 2,4mm

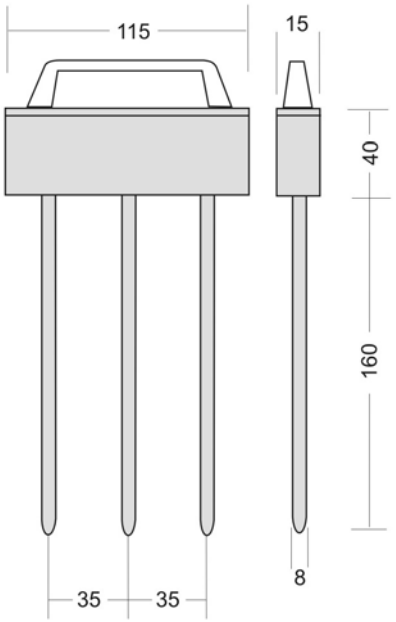
6.2 TRIME-ES3

P3Z

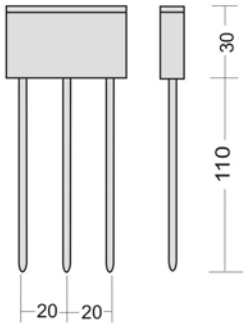


Triangular arrangement

P3



P3S



Rod diameter: 3,5mm

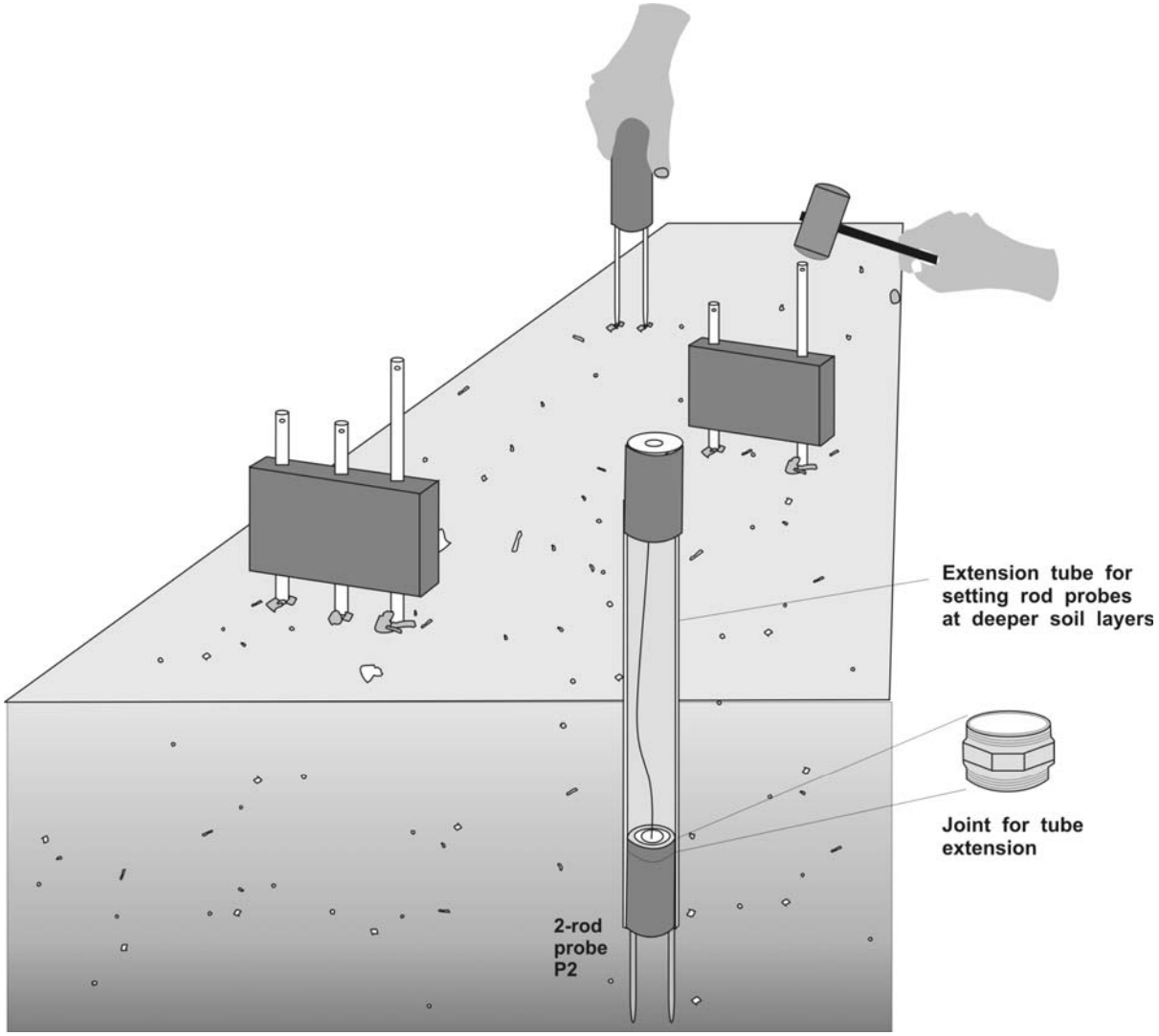
Rod diameter: 8mm

7 Installation hints

Please assure a careful installation of the probes with close contact between rod and soil. It is important to avoid air gaps around the rods as the highest measuring sensitivity is directly around them. Air gaps lead to too low moisture values. In case of water saturated soils the measured values will be too high then.

IMKO supplies pre-boring sets for an optimal preparation of the installation point avoiding compaction of soil due to insertion of the rods.

7.1 Preparation Rods and Extension Tube



Extension tubes can be screwed to the sensor to ease the sensor installation in greater depth, e.g. boreholes

Pre-boring by using the preparation rods for P2 and P3 avoids

- compaction of soil (which would reduce the measurement accuracy)
- damaging the probe's rods or rod tips. A defect PVC rod coating or a blank rod is sensitive to electromagnetic charge and may destroy the electronics of sensor.

8 Distant Power Supply of TRIME Sensors

The operation of TRIME sensors may cause problems when power has to be supplied via long cable lengths. There are limitations regarding the maximum cable length depending on the cable diameter.

When power is supplied distantly the maximum cable length depends on the cable cross section ***A***, the distribution voltage V_s and the number ***n*** of the sensors measuring simultaneously. Furthermore, device-specific data also enter the formula:

Power consumption during measurements: I_s= 200 mA
Minimum sensor voltage at circuit end: V_{min} = 7 V

The maximum possible circuit length I_{max} can then be calculated in the following manner:

$$I_{\max} = \frac{A \cdot (V_s - V_{\min})}{0.038\Omega \frac{mm^2}{m} \cdot n \cdot I_s}$$

This is explained in the following example:
In the IMP232 environmental measurement system a bus cable with a wire cross section of A = 0.34 mm^2 is normally used. We further assume that the power supply voltage is V_s =12 V and only one sensor is designated to measure. Thus n = 1.

$$I_{\max} = \frac{0.34mm^2 \cdot (12V - 7V)}{0.038\Omega \frac{mm^2}{m} \cdot 1 \cdot 0.20A} = 160m$$

In the above calculation, no tolerance is included; for security reasons the calculated cable length should be reduced by 10% to obtain a realistic value.

In order to increase the maximum possible cable length several solutions are feasible.

1. Using cables with larger conductor diameters
   by using 6-core conductor cables instead of 4-core, the cable length can be doubled as two extra cores can be used for power supply. cables with conductors having larger diameters will increase even further the maximum possible cable length.
2. Increasing the power supply voltage
   power supply voltage can be increased up to 17V. Thus the maximum length will increase from 160 m to 320 m in the example calculation above.
3. Installation of buffer batteries in the distributor
   additional storage batteries close to the TRIME sensors, e.g. in the distributor, allow cable lengths up to 1km and enable simultaneous measurement of several sensors. However, this method requires an additional charging circuit for the buffer storage battery.
4. Installation of a voltage regulator at the distributor
   voltage loss in the cable can be reduced with a 30V power supply and an installation of a voltage regulator directly in front of the TRIME sensor, thus allowing circuit lengths of up to 1km.

Which solution is suiting best mainly depends on the nature of power supply of the measurement system:

- **battery supply**: solution 1 and possibly solution 3 should be considered, the latter being relatively expensive.
- **mains supply**: solutions 1 and 2 could be combined, or, more expensive, solutions 2 or 4 could be chosen.

9 Basic Alignment with the Calibration Set

9.1 What is a basic alignment?

The basic alignment serves to compensate the cable length and tolerances of the probe mechanics (thickness of the rod coating, rod length, etc.). After two measurements, one in dry and one in water saturated glass beads, the calibration data is calculated and stored in the TRIME probe.

Every TRIME-P2/-P3 probe must be calibrated before it can supply proper measurement results. The basic alignment is carried out by IMKO at works before shipment.

9.2 What are the benefits of the calibration set for the user?

With the calibration set you can easily carry out the basic alignment with your TRIME sensor yourself.

If defective probe rods must be changed you are able to make the required basic alignment by yourself.

The calibration set can **not** be used for establishing a material (soil) specific calibration. For this purpose a measurement data set must be created on the specific material. In order to calculate the calibration data for this data set and to download it to the TRIME-probe the calibration program SMCAL is required.

9.3 How to make the basic alignment?

9.3.1 Preparation of the glass beads

The glass beads, which are supplied with the calibration set, have to be prepared first:

Fill up one bucket until the rods of the probe can be inserted completely. To achieve a constant density knock the bucket several times against the ground.

The density of the glass beads increases with frequent insertion of probes. Therefore the glass beads should be poured out into another bucket and poured back to achieve the original density.

Now the second bucket has to be filled with water in order to be able to fill in the glass beads without air-bubbles remaining. An additional precaution to remove air-bubbles is to stir slightly while filling in the glass beads. The container must now be knocked against the ground several times to achieve a constant density. The surplus water must be poured out until the thickness of the water film above the glass beads is below 2mm.

The water saturated glass beads should be in a temperature range between 20°C and 25°.

Attention: Water dissolves Na_2O and K_2O from glass which causes a rising pH-value and an increased electrical conductivity. **New glass beads have to be washed intensively with tap water!!!**

1. Fill a bucket with water
2. stir the beads under water
3. pour out the water. This procedure should be done with new glass beads at least five times, each time with fresh water. If the glass beads have been in use for a longer time, three times is sufficient.

Please note that the electrical conductivity of the water saturated glass beads medium increases already after a few days storage. Therefore the glass beads must be washed again before the next calibration.

9.3.2 Basic alignment procedure

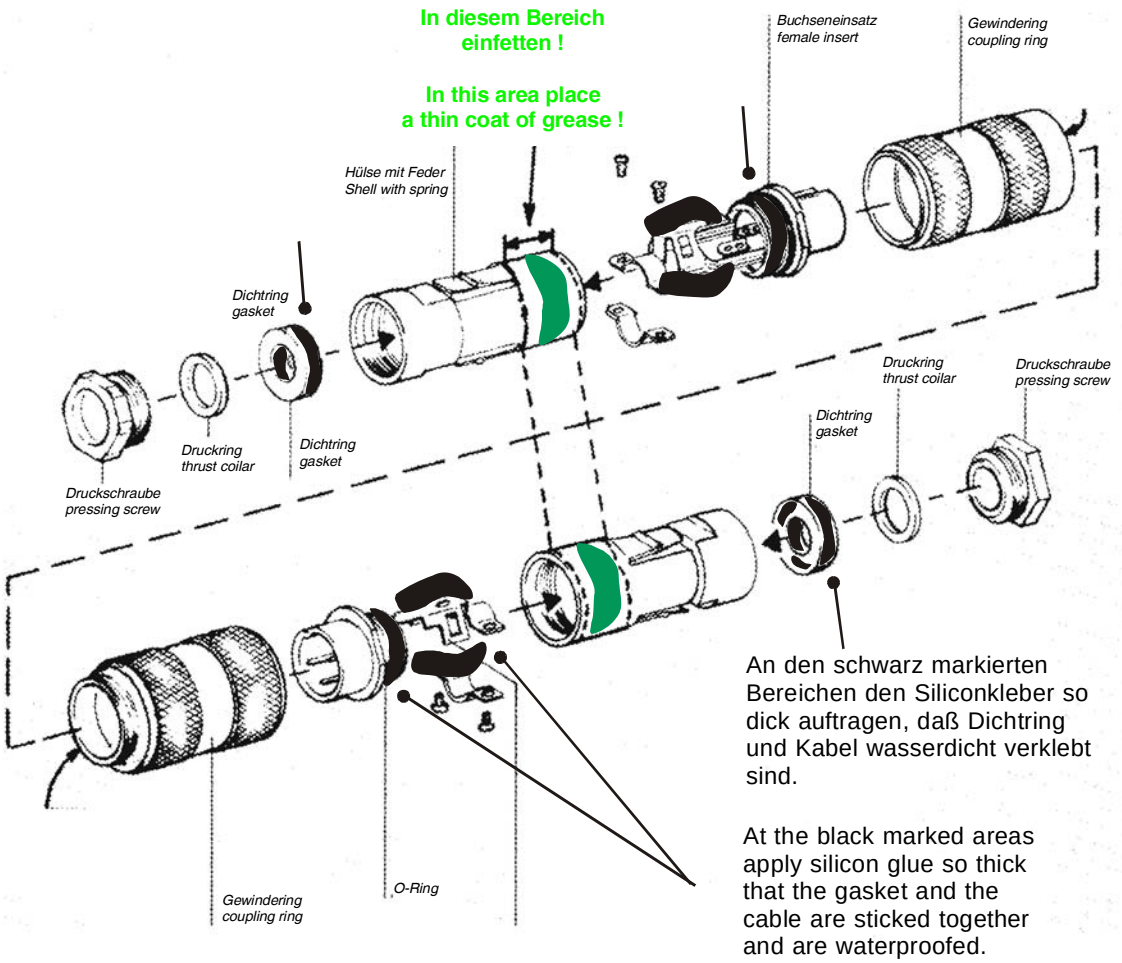
The basic alignment has to be carried out using the calibration program SMCAL. Please read the information about the basic alignment with SMCAL in the file README.TXT in the subdirectory BASICCAL of the SMCAL-disk.

10 Connector’s Mounting

The water tightness of connectors (IP67 = 30min / 1m water column) can only be guaranteed by observing the following:

- In case of carrying out the cabling of the distribution modules yourself, please make sure that the cable seals fit tightly. Only cables with a sheath diameter of 5 to 8mm shall be used. With smaller diameters water may enter the connector, the distribution box or the sensor. Altered measurements or destroyed electronics can be the consequence. IMKO supplies special seals.
- All unused connectors have to be protected by blind covers. IMKO supplies all equipment respectively all open connecting terminals protected by blind covers. Additional ones can be obtained at IMKO.
- When installing the connectors, special attention has to be paid to the connectors being threaded with care. The threads have to be aligned correctly to ensure efficient tightness. In addition, the connector should only be hand-screwed, i.e. without use of tools (e.g. pliers).

11 Connector’s Assembly



12 EMV/EMI Precaution

EMV/EMI precaution by means of ferrite filters ensures better disturbance suppression and therefore improves measurement accuracy. Ferrite filters are integrated in the TRIME sensor and at the connector side of the sensor cable.

13 Information on Lightning Protection of the ENVIS Environmental Measurement System

(IMP232 Micronet Bus, Logger and integrated Sensors)

13.1 Introduction

Lightning strokes can cause considerable and costly damages to unprotected electronics. The equipment is often totally destroyed. A good number of users are not or only partially insured. Customers who have a lightning protection insurance must comply with defined clauses regarding lightning and excess voltage. Insurances only cover the damage when the defined clauses have been complied demonstrably. IMKO strongly recommends adequate lightning / excess voltage protection equipment for ENVIS environmental measurement systems.

13.2 Excess voltage protection on 110/220V mains supply

Lightning strokes in proximity to high-voltage transmission lines can cause excess voltage in the mains power supply which may result in damage of electronic components. Environmental measurement systems with 110/220V mains supply are endangered by this excess voltage. It may affect the whole system through the power supply unit and the central station (SM-MUX4 or SM-23U). Excess voltage can even enter the measuring system through the data acquisition computer's mains power supply. An excess voltage protection is highly recommended for all 110/220V devices connected to the ENVIS system

13.3 Protection of modem and telephone lines

Telephone lines are endangered by excess voltage. If a modem is connected to the measurement system the telephone line should also be protected by a lightning protection module.

13.4 Excess voltage protection for network modules by "SM-Blitz"

Excess voltage caused by lightning strokes in close proximity to the environmental measurement test system may enter the IMP232 Micronet bus transmission lines. Longer lines increase the risk of lightning stroke. Theoretically maximum protection is achieved by installation of a lightning protection module (SM-Blitz) in front of each SM-Module. But actually reasonable compromises between costs and maximum protection level has to be found, i.e. interconnection of adjacent SM-Modules to lightning protected groups.

13.5 Lightning protection on meteorological towers

SM-Modules installed on meteorological towers cannot be protected from a lightning strokes. The field strength resulting from the electromagnetic fields and the associated accumulated energy will cause damage to the electronics. Two solutions for the problem:

- Erect a higher lightning conductor close to the meteorological tower serving as a lightning collector.
- Install the measuring modules in a distance of some meters. Then all lines coming from the tower have to be protected by lightning protection modules.

13.6 Installation instructions for SM BLITZ lightning protection modules

Basically, there are two potential risk sources in the field of environmental measurement technology: transmission lines and sensors or network devices. Lightning protection modules should always be installed at the beginning and at the end of a circuit in order to protect the electronics from excess voltage (Attention: SM-Blitz modules have a protected and an unprotected side).

The SM-BLITZ lightning protection module has to be grounded using a ground conductor with a wire cross section of at least 6 mm^2 screwed to the long side of the module. A grounding rod length 2 meter may serve as ground conductor. Grounding is optimal when the grounding rod is in direct contact with ground water.

13.7 Conclusion

Only a limited protection against excess voltage is possible when it comes to natural phenomenon such as lightning stroke. Direct lightning strokes may cause damage nevertheless.

If you have any questions regarding lightning protection do not hesitate to contact us.

Phone: 0049 - (0)7243 - 5921-0

Fax: 0049 - (0)7243 – 90856

e-mail: info@imko.de