Operation manual Water in Oil saturation measurement FRG00035-xx-xxx-xx

Feature overview

- *Sensors FRG00035-xx-…*
- *Connection box GHG02088-5*
- *3x relay outputs*
- *Analog output for oil saturation and oil Temperature*
- *optional: Indicator box GHG02088-51 with analog indicator(s), operating devices and acoustic alarm*

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1. Water in oil saturation measurement

A well-known method to measure water concentration in oil is to measure the ppm content of said water. This measurement is necessary since too much water content will lead to damages in bearings of moving parts.
Investigations have proven that small droplets of water in the oil cause these damages. The amount of solved water in oil before such droplets, or “free water”, occur depends on additives, the aging and type of the oil as well as in particular its temperature.
In addition to the absolute amount of water in the oil its saturation point must be measured to prevent the occurrence of free water. Since this varying water saturation point cannot be measured by ppm measurement kits their results lack the crucial part of the information about actually reached water saturation level (aw).
Taking this into consideration tests were carried out with different oils at different temperatures to come to the conclusion that the relation between aw- and ppm-value depends on the oil type. For example, a standard 4-stroke lube oil at 23°C shows with 200ppm/l water content a water saturation of approx. 68% and with same ppm content it shows at 85°C approx. only 35 % saturation.
This means only the aw-value shows clearly the gap to the limit where free water is present in the oil loop.
The aw sensors provide very precise measurement results, compensating both temperature and aging effects. Basically, the sensor provides an alert function containing pre-alarm at 0.5aw (which correlates with 50% saturation of the oil by water) and main alarm at 0.9aw (which correlates with 90% saturation of the oil by water).
These two alert values are showing that the oil is penetrated by water which can come from air humidity or leakages in coolers, purifiers piping and so on. As long as the saturation is below 100% no damage caused by water should occur as the water is dissolved in the oil.
These limit values can be set differently depending on the needs of the application.
Installed in a robust stainless-steel housing, our Water in Oil Sensor withstands the most demanding environmental conditions.

Please note:

1. No cleaning of the sensor is needed.

2. It is possible that after a longer time of still stand of the engine, alarm is given. It needs some time of running the engine and oil separators, before a limit of less than 0.5 AW is reached.

3. Gaseous chemicals such as volatile organic compounds (VOCs) are known to pollute the sensitive layer of the humidity sensor element. If such pollutants are present in the surrounding atmosphere of the sensor, they diffuse into the polymer where they occupy spaces reserved for water molecules. This process often results in lower humidity readings. Please give the sensor some time (several hours) for adjustment after changing its location.

2. Water in Oil (WiO) system parts

The basic stand-alone version of the water in oil sensor consists of:
- Sensor type FRG00035-R/N-…+ cable KSG032xxx for bearing monitoring systems
  or
- Sensor type FRG00035-A/AC/C- as standalone versions
- Connection cable KSG032xxx with standard length of 15m
- Connection box type GHG02088-5

Options:
- indicator box
- analog instrument
- touch panel

2.1. Optional: Analog Indicators

for displaying of measuring result for local installation options, Aout1 and Aout2
Devices EA 96x96.2slw DW, can be connected to pin 21…24 for connection box GHG02088-4or visual inspection of the measured data.

2.2. Optional: Indicator Box

with analog Indicator(s), function buttons and acoustic alarms. (Stand-alone or optionally connected to AMS).
A yellow signal lamp will be illuminated once pre-alarm occur, a further red signal lamp as well as an acoustic alarm will come up once main alarm occur.

3. Sensor description

3.1. FRG00035-R/N-xx

These sensors are used only for usage with our bearing monitoring system.
The sensors are connected with a cable type KSG03252-15 standard length 15 (longer cables are available as option).

3.2. FRG00035-A-xx

This sensor is the so-called low-cost sensor and supplies the aw value and the oil temperature via it's 4-20 mA current loop. The sensor does not need to be connected to the terminal box GHG02088-5.

3.3. FRG00035-AC-xx

In addition to its 2 analog outputs the sensor does provide two digital outputs, one for 50% and one for 90% saturation. The sensors must be always connected to a terminal box GHG02088-5.

3.4. FRG00035-C-xx

This sensor is also a low-cost version which supplies two switching outputs, one for 50% saturation and one for 90% saturation. The sensor does not need to be connected to a terminal box GHG02088-5.

4. Function

The sensor starts its measurement and output after power on.
A start-up routine is testing the sensor.

4.1. LED Indication

The green LED of the connection box indicates that sensor is powered on.
The sensor will display its normal state by a green LED color.

4.2. Indication if water content is > PAV (Pre-Alarm Value)

If water content > PAV, the PAV LED in the connection box cover turns on and the sensors LED will change its color to orange (50% saturation of the oil by water).

4.3. Indication if water content is > MAV (Main Alarm Value)

If the detected water content > PAV is still rising and the value runs > MAV, the MAV LED in the connection box cover turns on and the sensors LED will change its color to orange (90% saturation of the oil by water)

4.4. Sensor - LED indication table

LED colour	Indication
green	Normal operation phase / water content <PAV
orange	Water content >PAV ➔ High alarm
red	Water content >MAV ➔ High / High alarm
off	Fault, sensor not connected

4.5. Terminal box - LED indication table

Ready LED	Pre-Alarm LED	Main Alarm LED	Indication
on	off	off	Normal operation phase
on	on	off	Water content >PAV ➔ High alarm
on	off	on	Water content >MAV ➔ High / High alarm
off	on / off	on / off	Fault

Attention: Inside the terminal box the signal mode of the Alarm LEDs can be changed by jumpers from normally open (N.O. = default settings) to normally closed (N.C.) - if necessary.

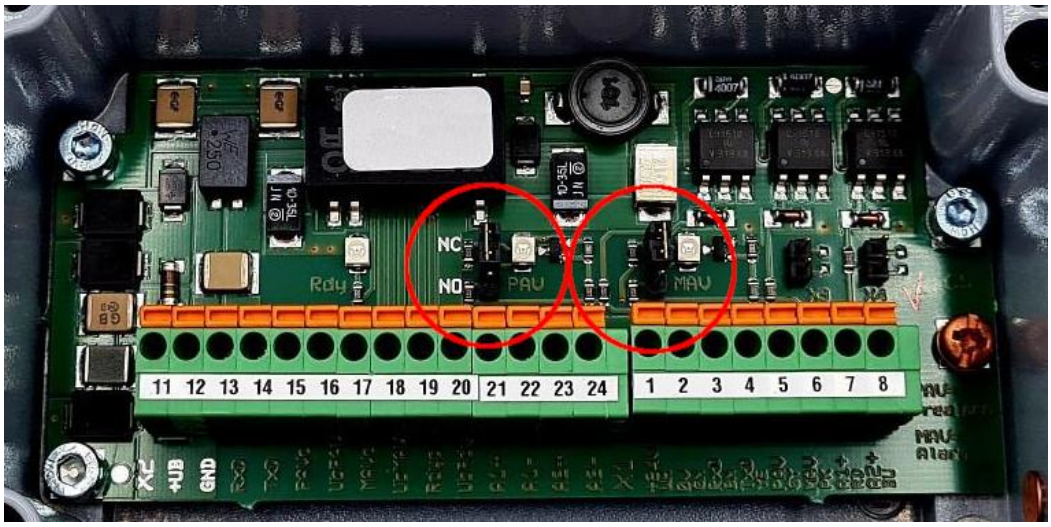


Figure 1 Jumpers to change LED signal mode from N.O. to N.C. if necessary

4.6. Indicator Box – LED indication table / acoustic alarm table

- Normal operation phase: The analog indicators are permanently showing the measuring result of “AW” or “C”.
- Water content > PAV: the yellow signal lamp is flashing.
- Water content > MAV: the red signal lamp is flashing and the acoustic alarm is coming up. By pressing the red signal lamp, the acoustic alarm is reset, only for the current alarm.
- System fault: Please check LED status of WiO sensor and LED status of the terminal box.

5. Relay operation table of GHG02088-5 box

Ready relay Position	**Status**
Open	Sensor power not connected
Closed	Sensor power OK
Water content relay >PAV Position	**Status**
Closed	water content <PAV
Open	water content >PAV ➔ High alarm
Water content relay >MAV Position	**Status**
Closed	water content <MAV
Open	water content >MAV ➔ High / High alarm

6. Alarm function test

After power up an internal auto-check starts.
The green LED of the connection box indicates that sensor power exists.
The PAV LED will light up (the sensors LED will light up orange) followed by the MAV LED lighting up too (the sensors LED will light up red).
After this the internal auto-check is finished.

7. Operation and action

PAV → wait

- If the engine crankcase doors had been opened or the lube oil pump had been switched OFF, and sensor at its place of installation might be at that high air humidity in the engine room, the sensor gives alarm. This alarm must go off after lube oil pump starts.
- Attention: It may take up to 24hrs with running lube oil purifier to separate the water from the oil and to set back the Pre-Alarm Value (PAV) to normal.
- Before removing the sensor because of alarm. Please wait for this time to allow the drain-off of the water from the lube oil.

MAV → immediate action = OFF

- If the engine crankcase doors had not been opened, but after engine start gets a water alarm, most probably an inrush of water into the lube oil system causing this alarm. Check water level inside compensation tank and check oil with the on-board oil analysing kit.

8. Installation and Replacement

8.1. Sensor FRG00035-…

The sensor part must be inserted in the inlet pressure line close to the main engine in accordance and within the limits of Drawing 9 & Drawing 10.

Note:

1. Use a new sealing when replacing the sensor (regular variant).
2. Make sure to stop lube oil pump; drain lube oil pipe; ensure that lube oil pipe is drained before replacing the sensor (regular variant)
3. Remove the sensor cable before removing the sensor
4. For sensor installation in the inlet pressure line a ¾” threaded socket is needed.
   Note: Torque moment for tighten all parts see below.
5. Please do not use rude pliers for the installation of the sensor – see drawing below. Only use the hexagon part above the ¾” thread with a matching wrench for installation. Whenever possible use a ring wrench.

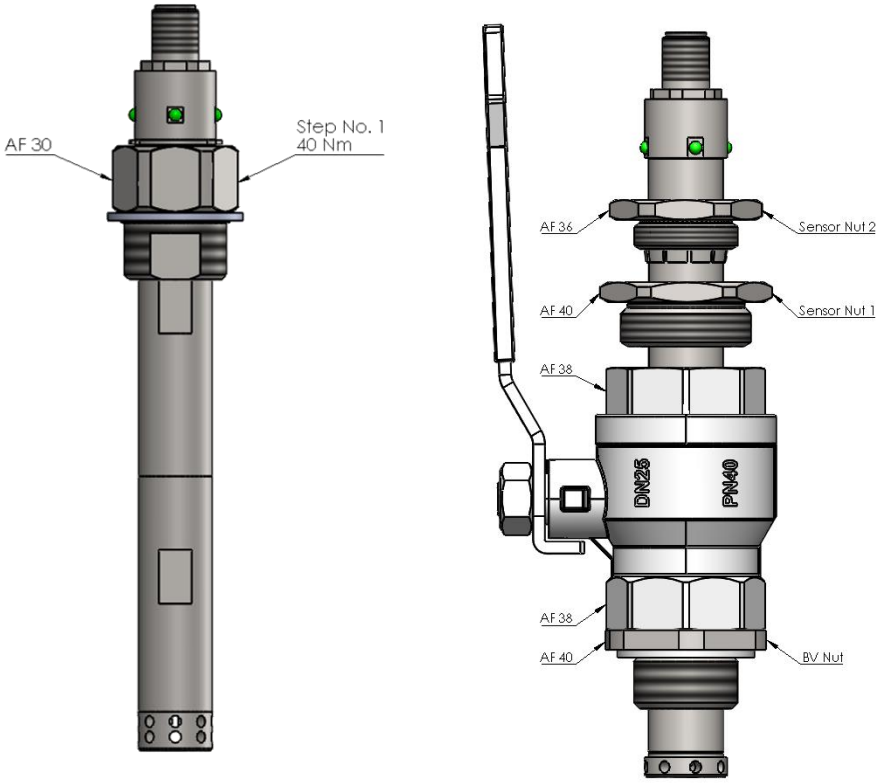
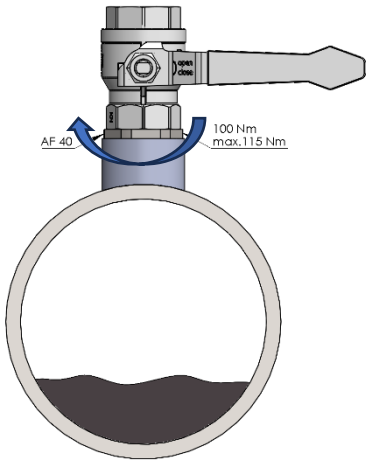


Figure 2 Sensor installation step overview with torques (regular variant left, ball valve right)

8.2. Installation Sensor FRG00035-A-138-BV

Step 1: Install the ball valve

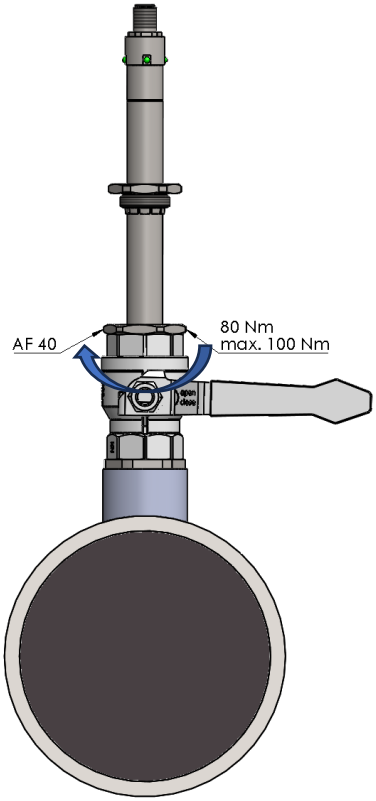


Install the ball valve (by tightening the BV nut) to the ¾" threaded socket on the inlet pressure line.

⚠ CAUTION **Make sure there is no oil pressure applied!**

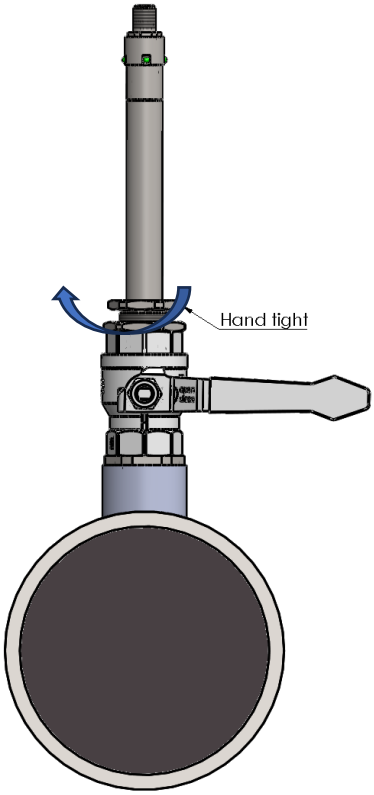
Close the ball valve handle to make sure there will be no oil leakage in case of reapplying the oil pressure after installation.

Step 2: Insert sensor



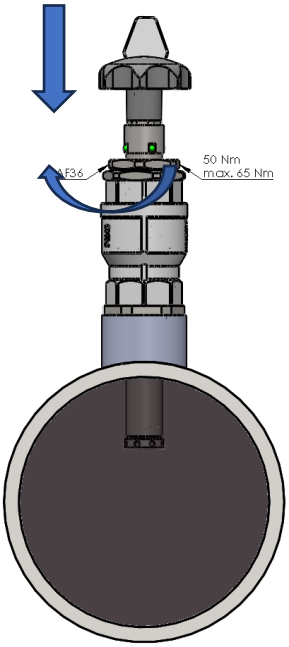
While still having the ball valve handle in a closed position insert the sensor into the ball valve.
Tighten the sensor nut 1 with a torque of 80 Nm.

Step 3: Hand tighten sensor nut 2



Tighten the sensor nut 2 by hand.

Step 4: Tighten sensor nut 2



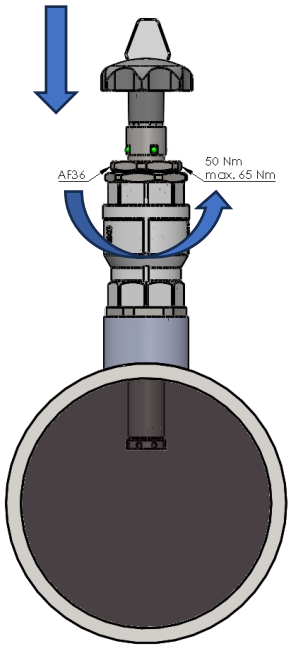
To tighten the sensor proceed as follows:

- Press down the sensor
- Open the ball valve by turning the ball valve handle to be able to push the sensor down to its final position
- Tighten the sensor nut 2 with a torque of 50 Nm

⚠ CAUTION	**The sensor might snap back until the nut is fully tightened**

Sensor Removal

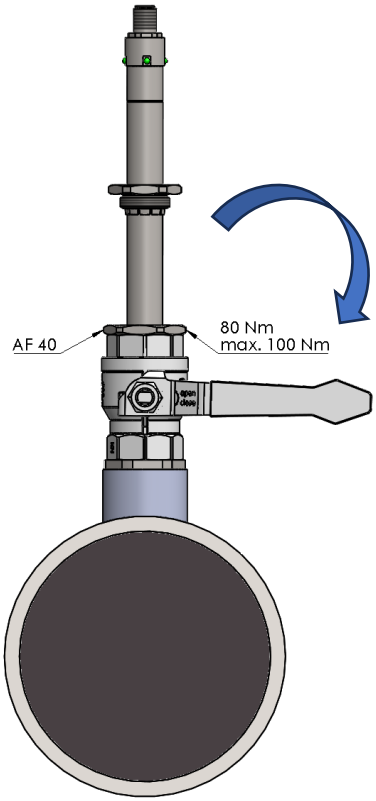
Step 1: Press down and open sensor nut 2



Press the sensor down with the handle while loosening the sensor nut 2. The sensor is pushed out by the pressure. Please pull out as far as it will go.

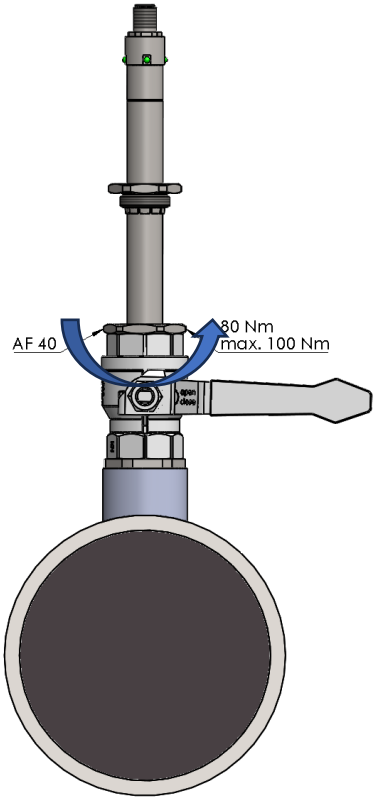
⚠ CAUTION **The sensor can come loose suddenly!**

Step 2: Close valve



Close the ball valve with the ball valve handle.

Step 3: Open sensor nut 1



Open the sensor nut 1 and remove the sensor.

8.3. Terminal box GHG02088-5

The terminal box GHG02088-5 must be placed within the distance of 15m, which is the length of the connection cable.

Attention:
Remove the paint under the connection point of the PE screw !
Please connect the PE wire of the terminal box correctly to the mounting plate and ensure that the mounting plate is also connected to GND.

The terminal box GHG02088-5 must be mounted in a position which allows a free view to the LEDs.

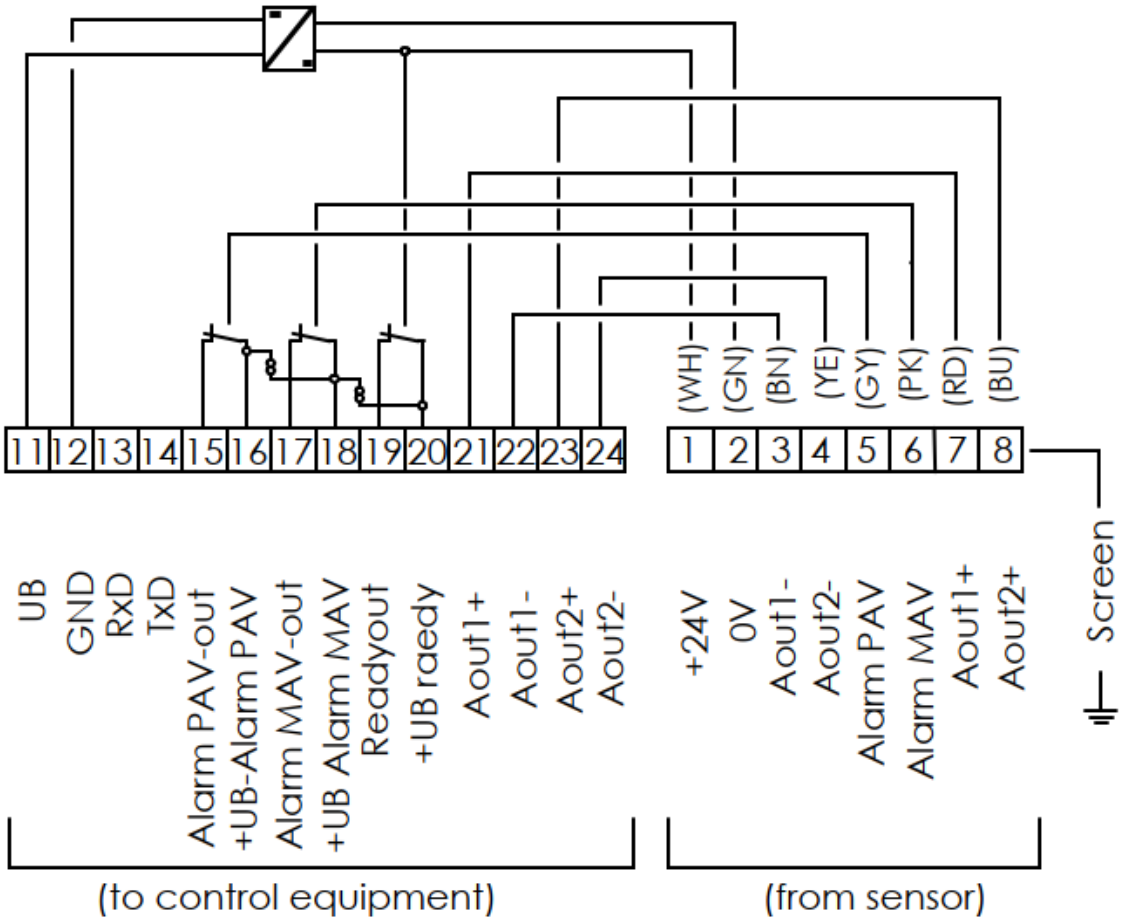
8.4. Connection to the sensor part type FRG00035-AC-...

For connection between the sensor and the terminal box GHG02088-5, please use the connection cable type KSG03244-1.
The cable plug nut has to be connected with the socket of the sensor head.
Please pay attention to the internal plug nose of the cable plug and insert the plug carefully into the thread socket of the sensor head.

8.5. Connection to the terminal box type GHG02088-5

After removal of the cover of the terminal box type GHG02088-5, the other side of the connection cable can be inserted into the connection terminals 1…8.

Note: The internal wiring in the connection box is already made ex-factory.



The 24VDC power supply must be made to the connection terminals 11 ($+U_B$) and 12 (0V/GND).
The alarm relay connection for PAV water in oil is to be made at 15 (- Signal) and 16 (+24 VDC)
The alarm relay connection for MAV water in oil is to be made at 17 (- Signal) and 18 (+24 VDC)
The ready relay connection must be made at 19 (- Signal) and 20 (+24 VDC)

The analog water content connection must be made at 21 (+24 VDC) and 22 (- Signal)
The analog oil temperature connection must be made at 23 (+24 VDC) and 24 (- Signal)

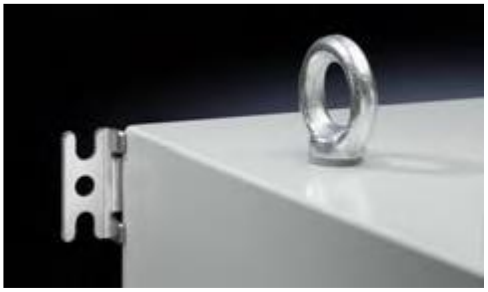
Usually, the relay outputs are connected to the Alarm Monitoring System (AMS).

Otherwise, analog signal can be used for the water content indication at the Engine Control Room.

Note: Operator / The yard is responsible for the alarm settings of the AMS.

8.6. Installation of optional Indicator Box

The indicator box should be placed in the Engine Control Room (ECR). Please take note of the location in reference to the length of 50 Meter of the connection cable, which is part of the system. **Please ensure that the indicator box is also connected to GND.**



The indicator box is prepared for wall mounting. Depending on the location, compact accessories are optional available.

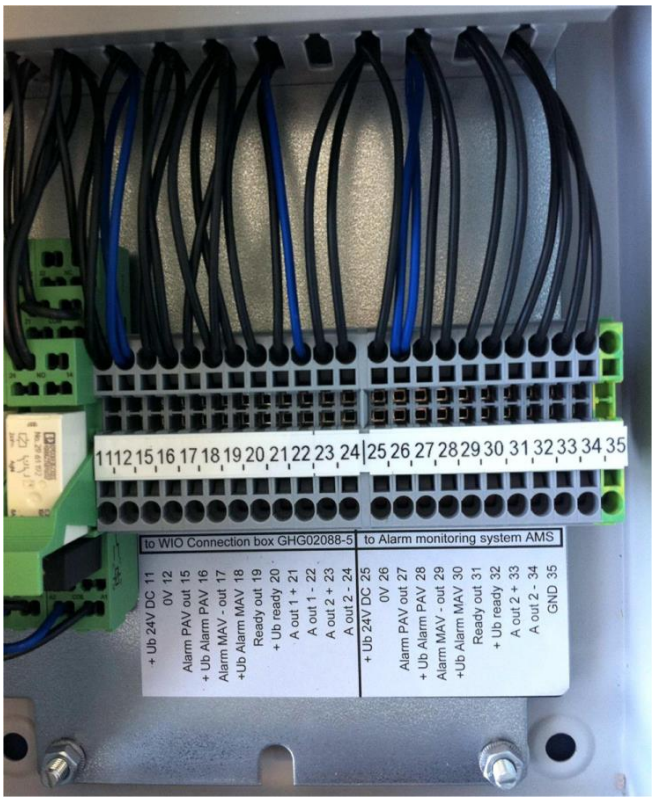
Easily accessible GND/PE earthing bolt on the back plate.
Door earthing via perforated door strip.
Earth straps in various cross-sections and lengths are available as optional accessories.

A gland plate for easy installation is supplied loose.

For fast, time saving installation of the indicator box, use wall mounting brackets. Simply insert the expandable dowel into the hole on the backside of the box from the outside and screw-fasten the wall bracket from the outside. In this way the wall bracket securely can by tighten without opening the box door.

8.7. Electrical wiring of Indicator Box

Terminal Box



Indicator Box

The terminals of the indicator box have to be connected with the terminals of the terminal box. The lines 11 up to 24 of the terminals have to be connected in parallel. The line 13 and line 14 of the terminal box staying free, because the indicator box doesn't have line 13 and line 14.

For connection of the Alarm Monitoring System (AMS) of the Ship Network to the Indicator Box see also Chapter 8.4. Equivalent to the terminal lines 15 up to 24 of the terminal box, the terminal lines 27 up to 34 have to be used in case to WiO stand-alone system should be connected with the AMS. The lines 25 and 26 should be connected to power supply. Line 35 is connected to GND.

9. Technical data

9.1. Sensor FRG00035-R/N

Power supply	18...32 VDC
Current consumption	<60mA
Wrong polarity protection	yes
Output current max.	5 mA
Operating temperature	-25…+85°C
Protection degree	IP67
Pressure resistance against medium	10bar

9.2. Sensor FRG00035-A/AC/C

Power supply	18...32 VDC
Current consumption	<60mA
Wrong polarity protection	yes
Output current max.	5 mA
Operating temperature	-25…+85°C
Protection degree	IP67
Pressure resistance against medium	10bar
Aout1 + Aout2 burden max.	500 Ω

9.3. Terminal box GHG02088-5

Power supply	18…32 VDC
Current consumption	60mA
Polarity protection	yes
Photo-MOS outputs	<60VDC
Alarm relays: PAV, MAV, Ready	
Output current	<300mA (Short Circuit Protected)
Operating temperature	-25…+85°C
Protection degree	IP67
Spring cage terminals	
max. cross section	1mm²
Analog output: Water in oil (Aout1)	4…20 mA (equiv. 0…1AW)
Analog output: Temperature (Aout2)	4…20 mA (equiv. 0…100°C)

9.4. Indicator Box GHG02088-51

Power supply	18…32 VDC
For other data see GHG02088-5	

10. Sensor test

10.1. Sensor FRG00035-N/R-xxx

This sensor type is used with bearing monitoring system BMS 2 and is equipped with a RS-232C interface. After sensor power up the measurement values can be read out at the display unit MDA312xxx or with the sensor ID set tool. After that the actual WiO readings can be read a t the display unit MDA312xxx (see manual BMS 2)

10.2. Sensor FRG00035-A/AC/C-xx

These sensor types are equipped with outputs and/or limit switches.
Version AC must be connected to terminal box GHG02088-5, versions A and C can be used without terminal box.
After being powered on the sensors will start a self-test. The outputs (analog as well as relays) will go to 50% followed by 90% saturation for 5s each before continuing normal operation.

11. FAQ

- Why is the water in oil (WiO)sensor more sensitive than so called shaking tests with chemicals?

The WiO measures the oil continuously for its saturation level by water at the given online temperature, these values are different to the “shaking-test” as temperature is different there and shaking test is measuring ppm values only.

- Why is oil leaking out of the WiO connection piece?

If the threaded connection piece (lower part at gasket) is not tightened connected with the correct torque of 40Nm (regular sensor variant) and the wrong gasket (green one) is used.

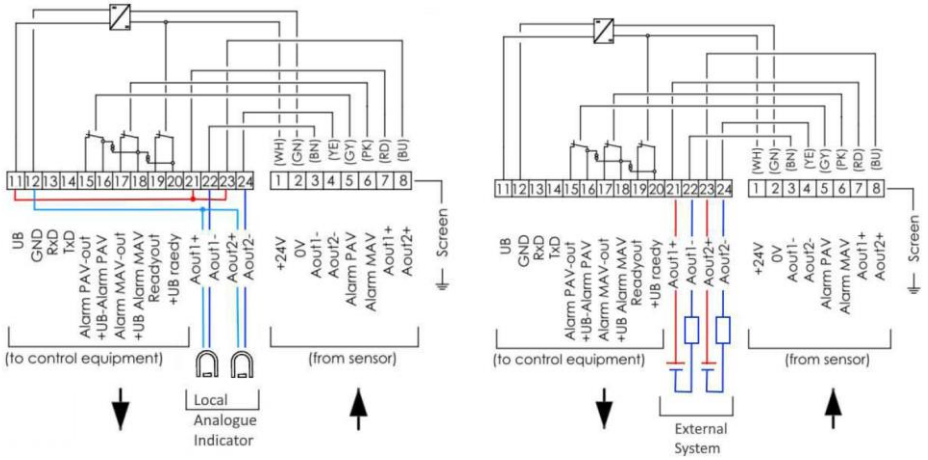
Correct gaskets see below

Make sure that threaded connection piece is installed correctly as shown above.

- Why is there no 4-20mA output to measure

The sensor is using a current loop as analog output. This means, that it does need an external supply to provide its output.

For connection see below



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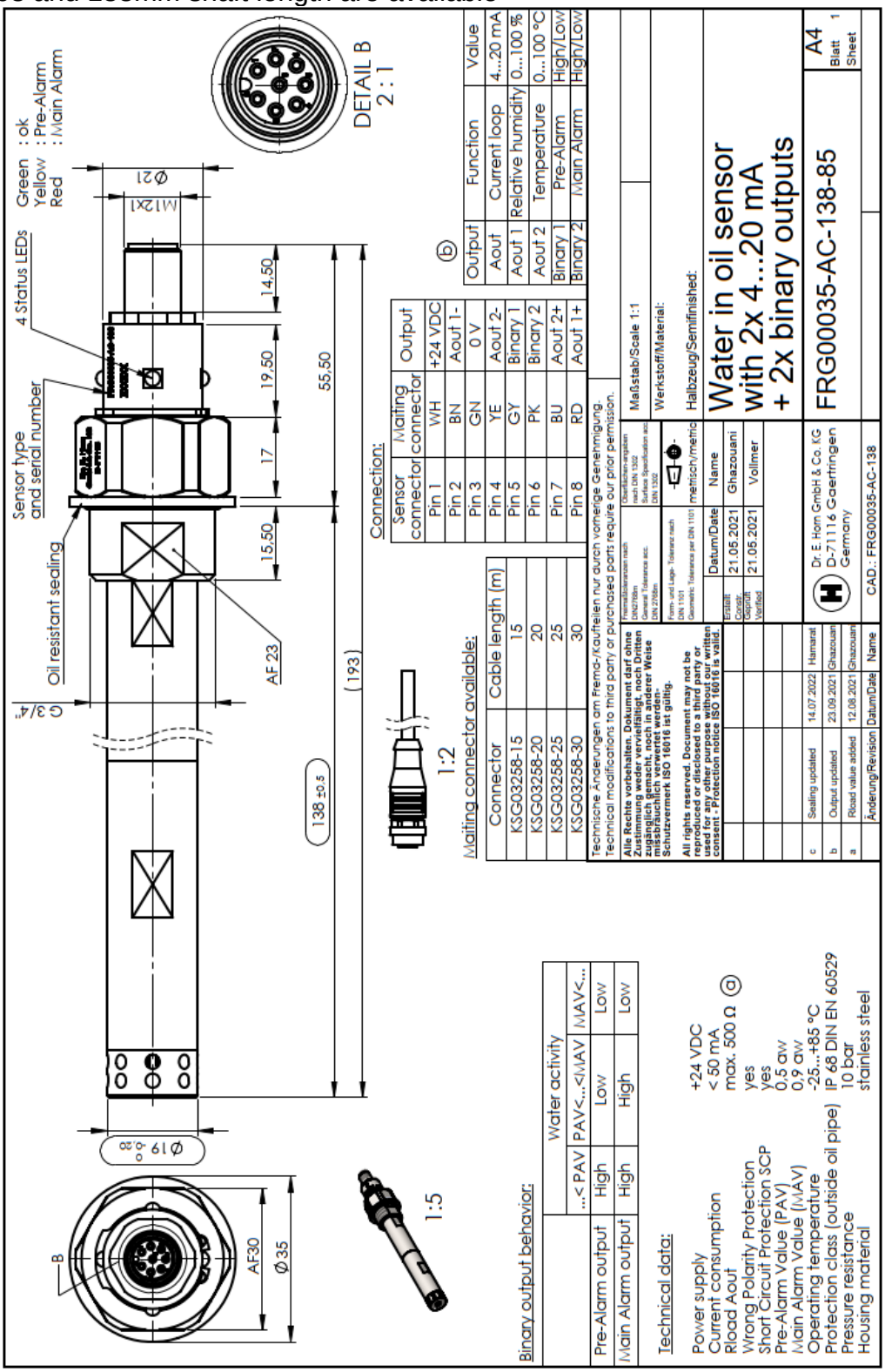
12. Drawings

Versions with 68 and 138mm shaft length are available



Drawing 1 FRG00035-AC-138

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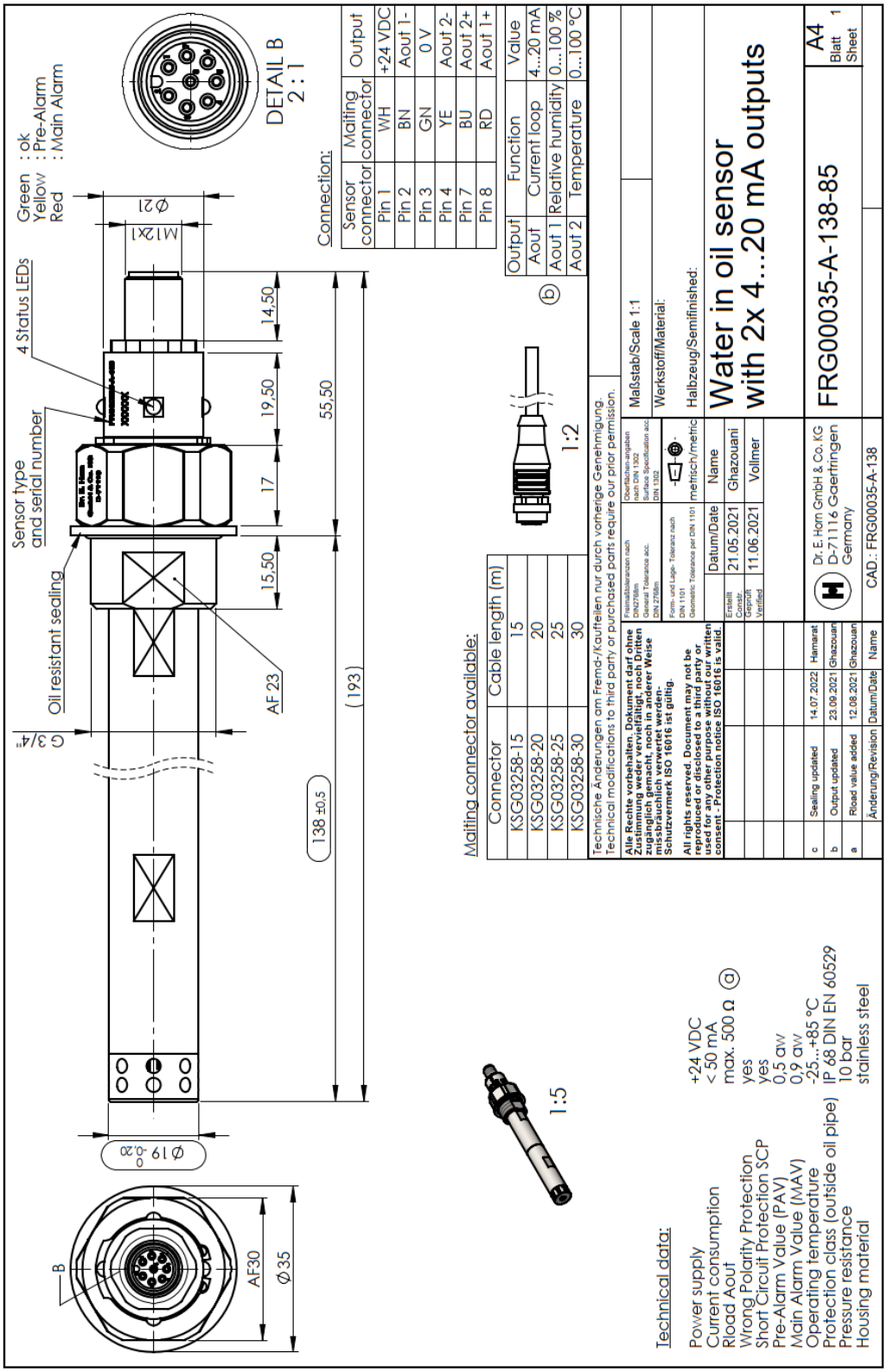

Drawing 2 FRG00035-A-138

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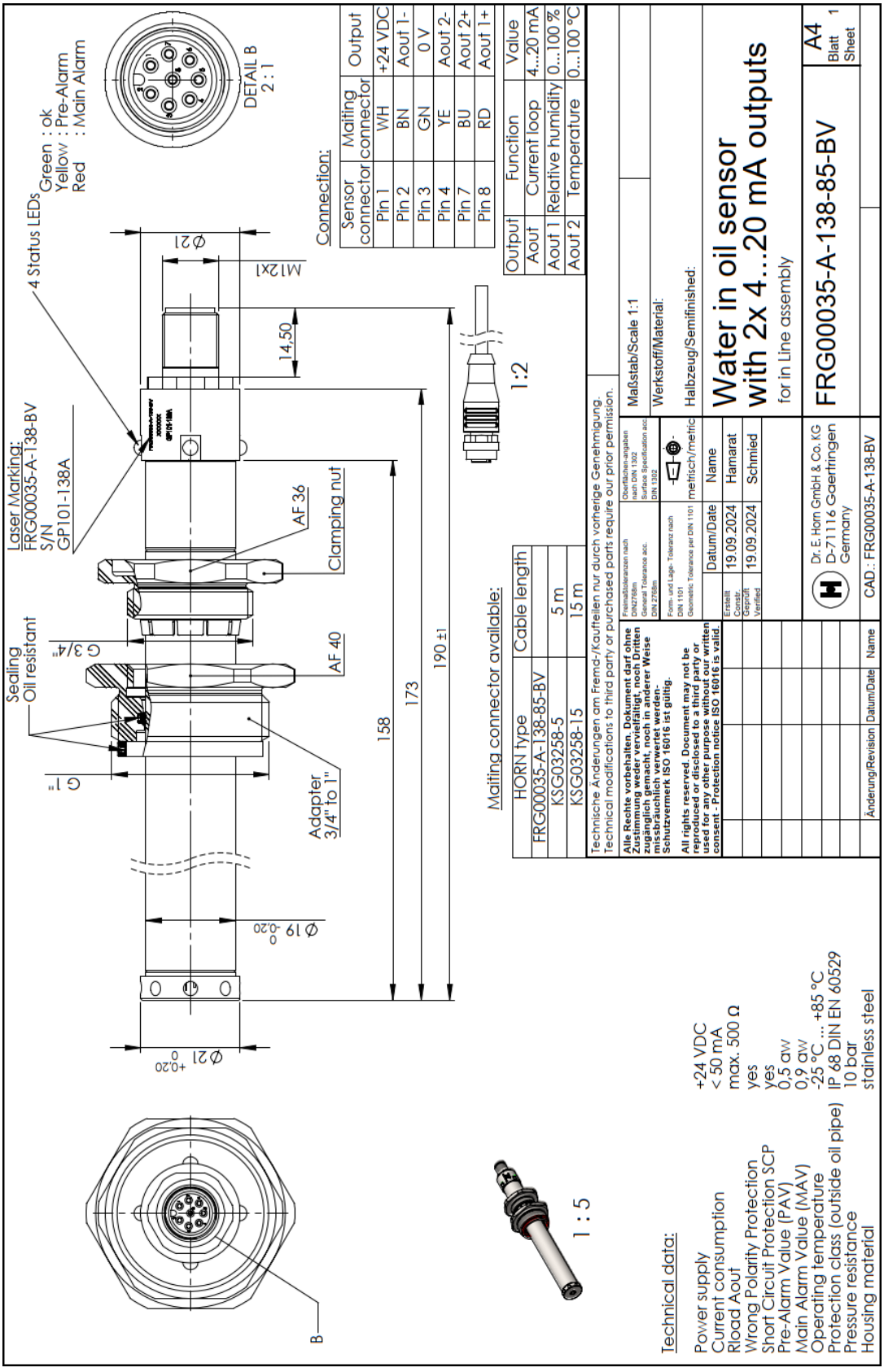

Drawing 3 FRG00035-A-138-BV

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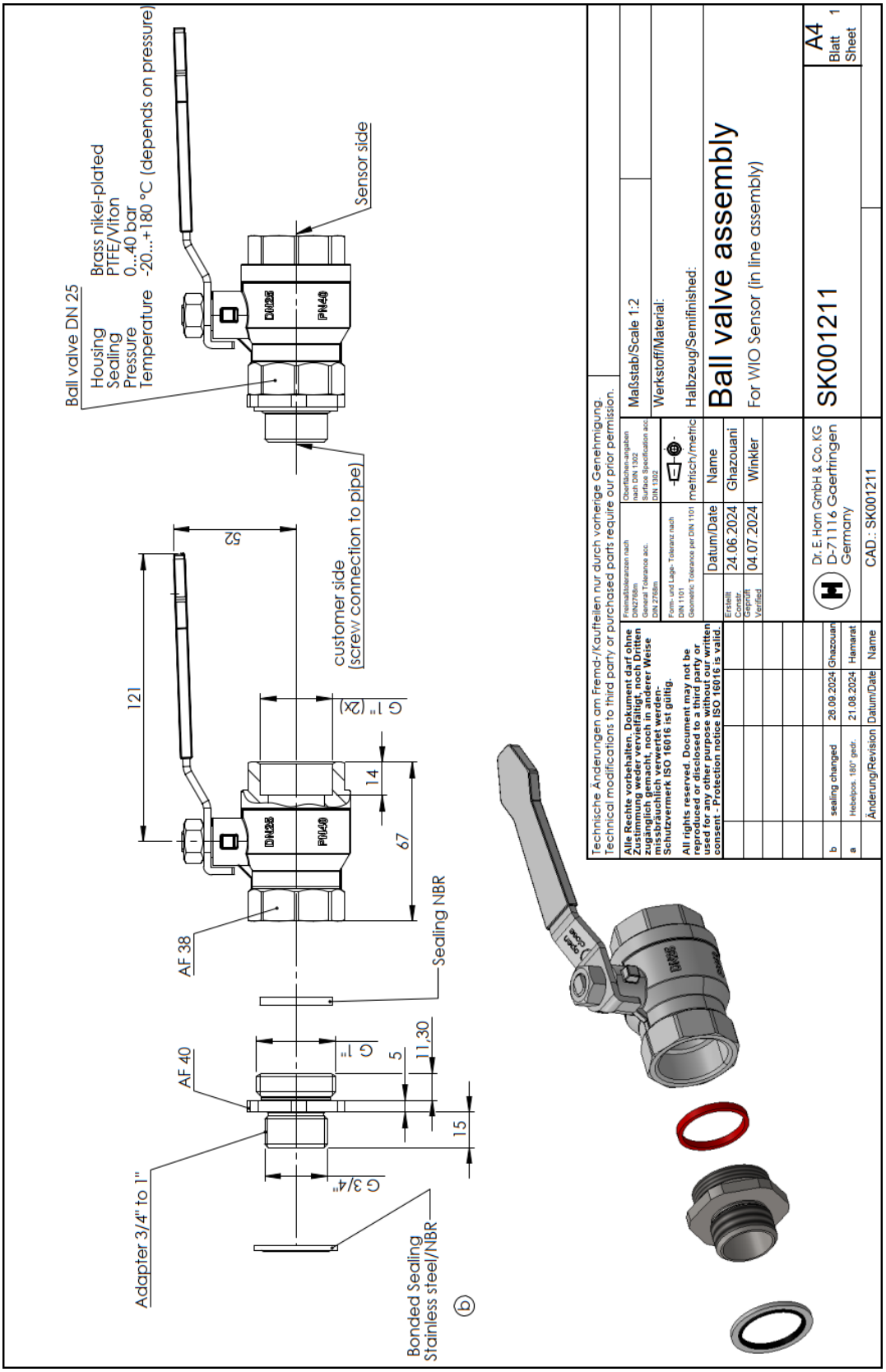

Drawing 4 SK001211 ball valve

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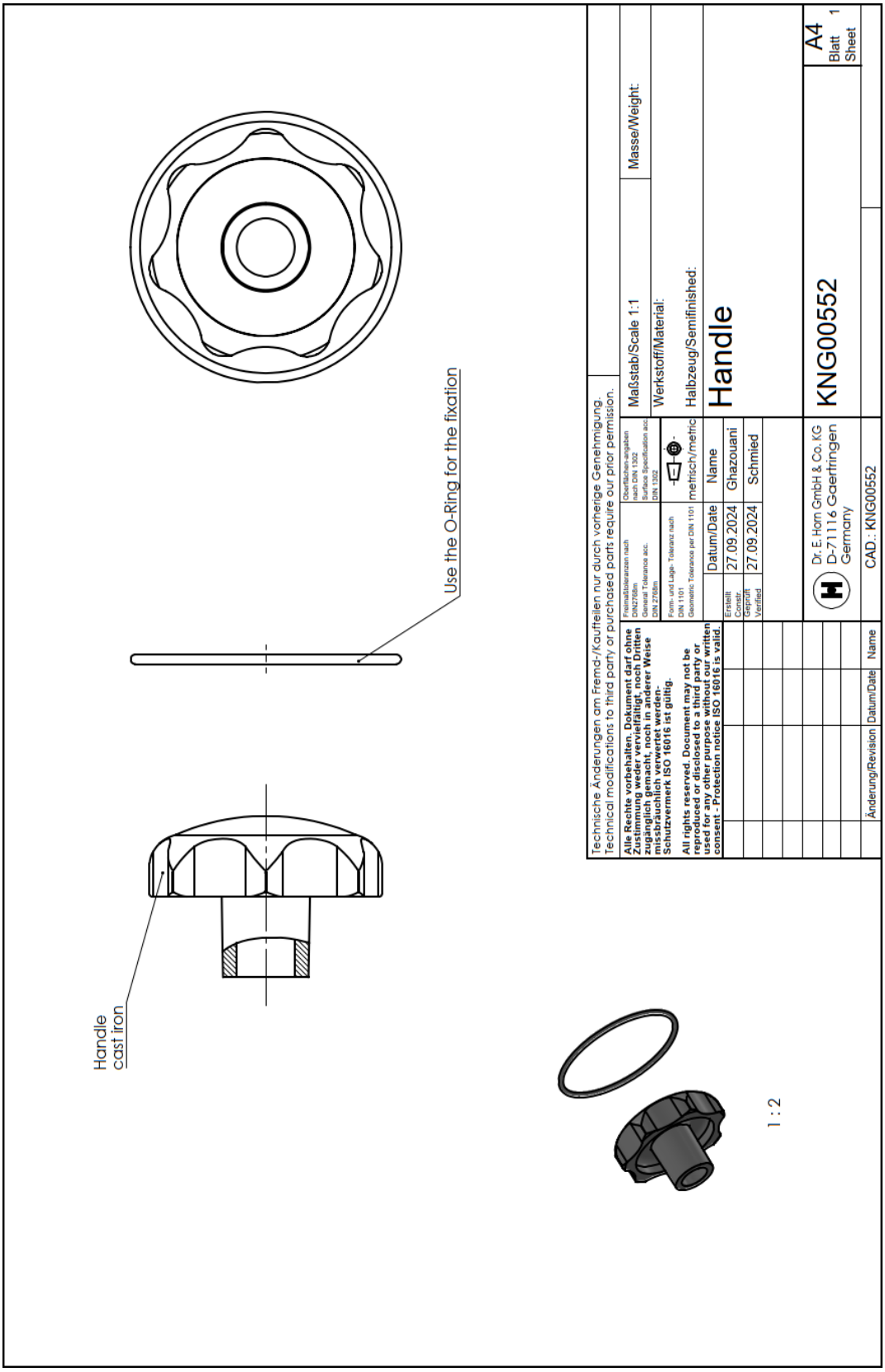

Drawing 5 KNG00552 Handle

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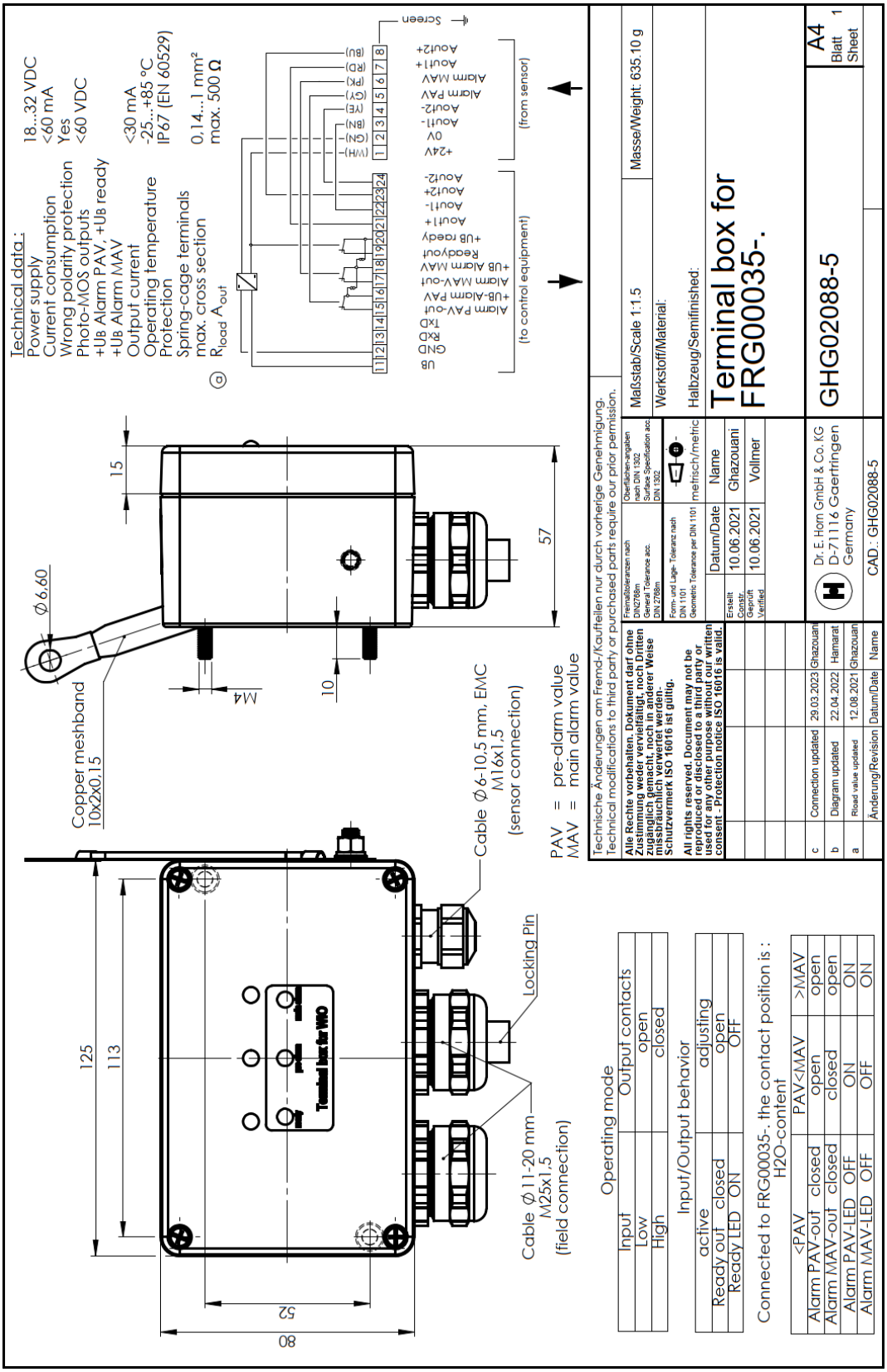
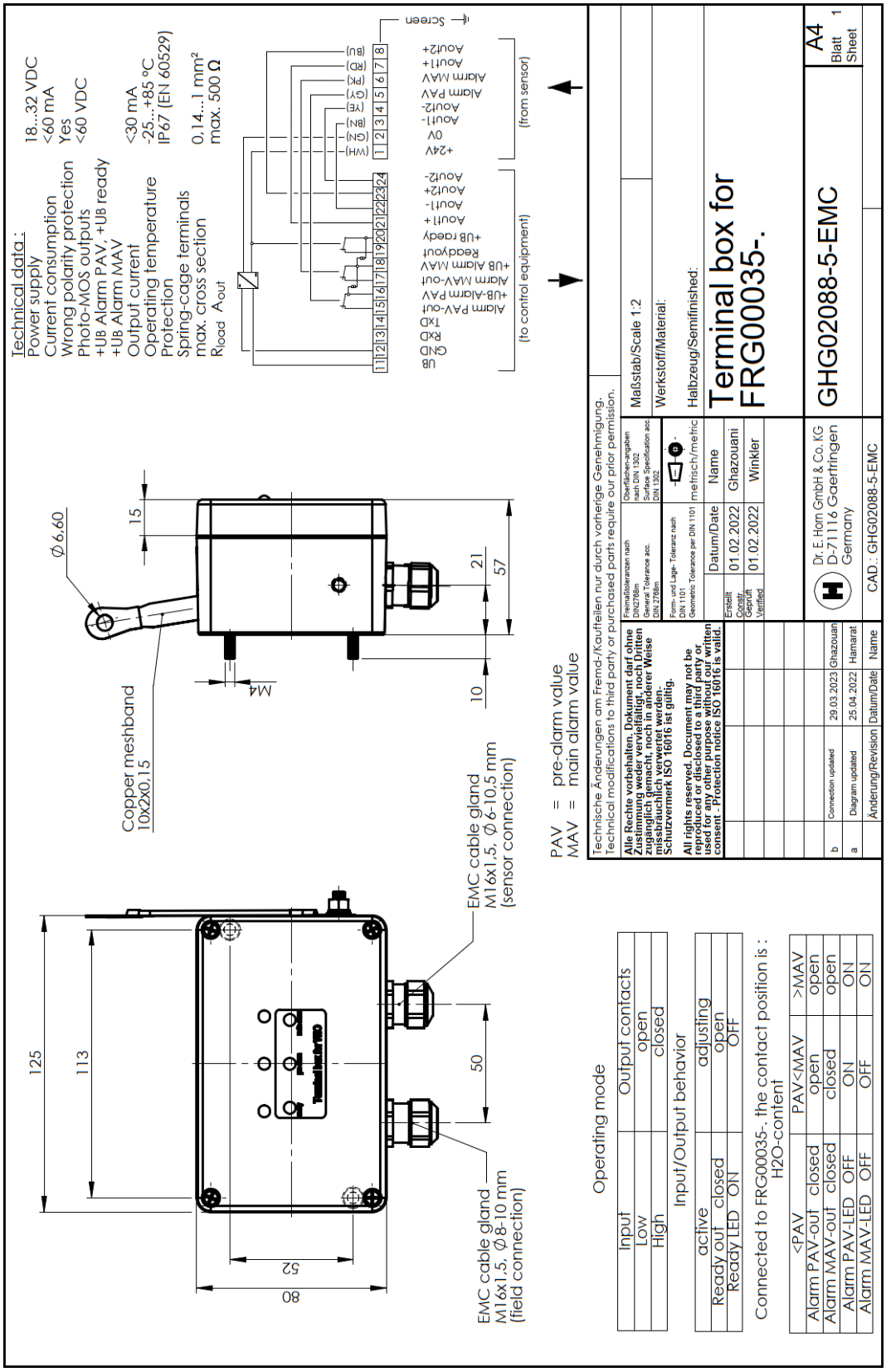
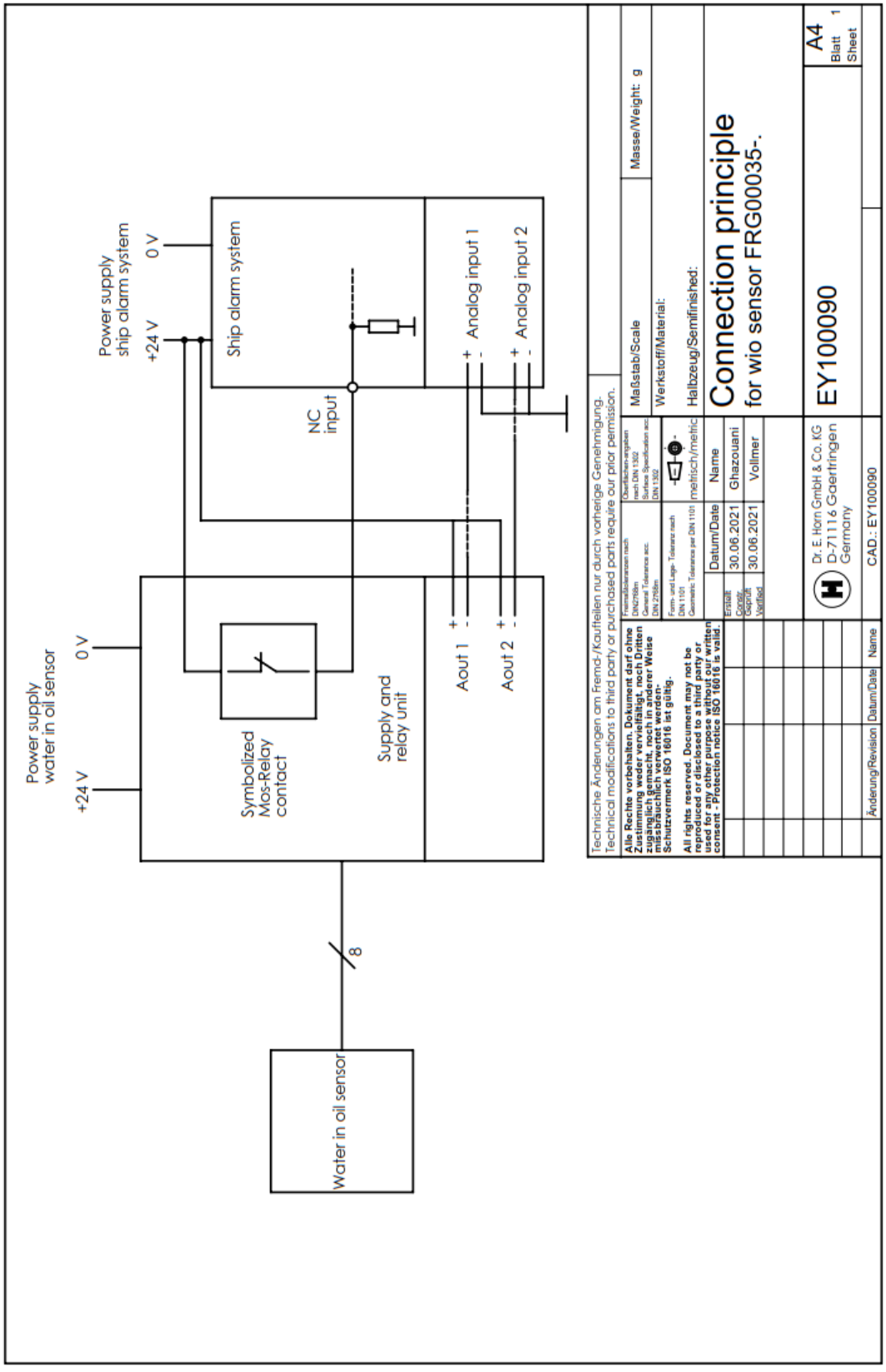


Drawing 6 Connection box type GHG02088-5



Drawing 7 Connection box type GHG02088-5-EMC



Drawing 8 Connection principle

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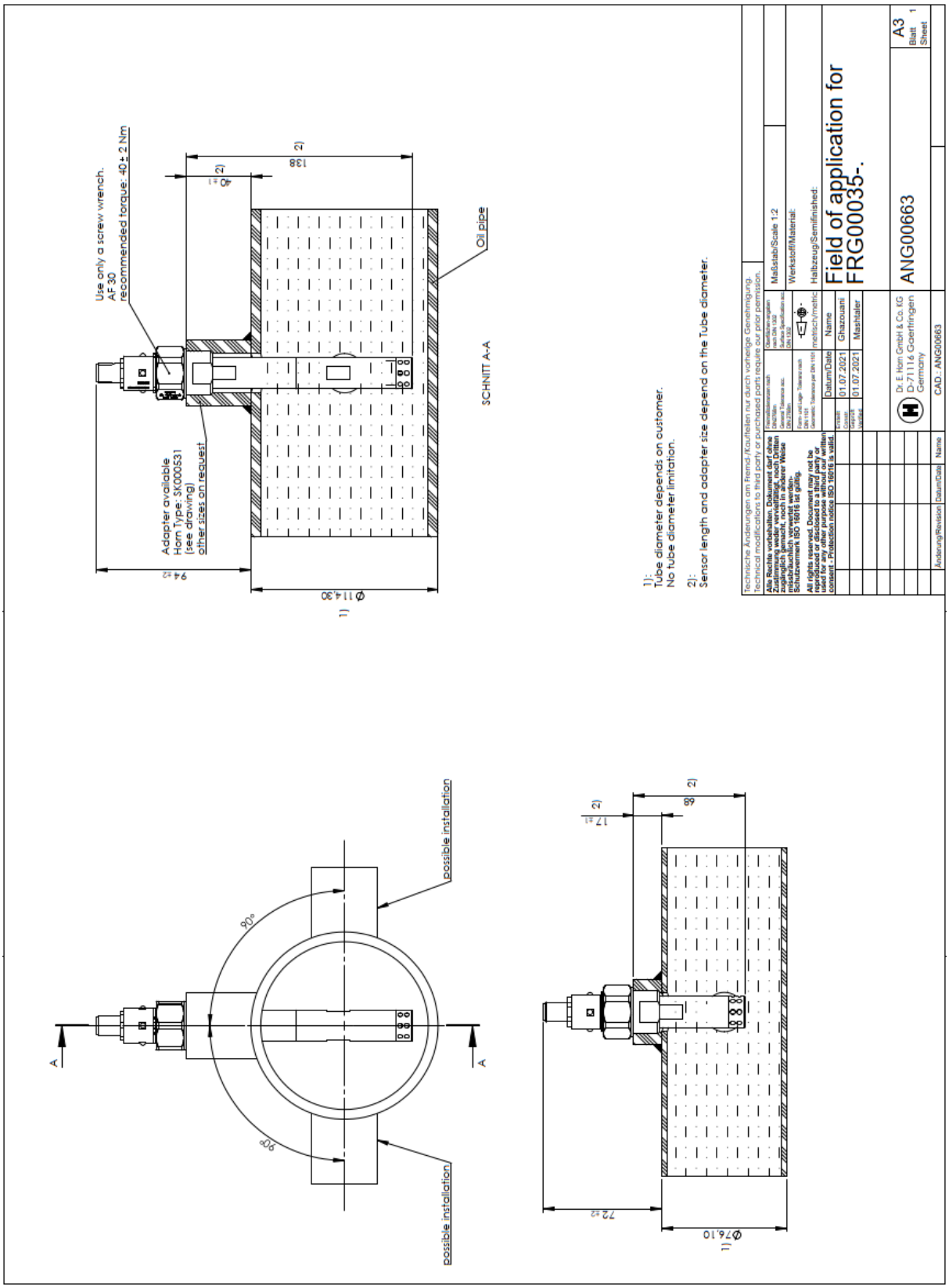
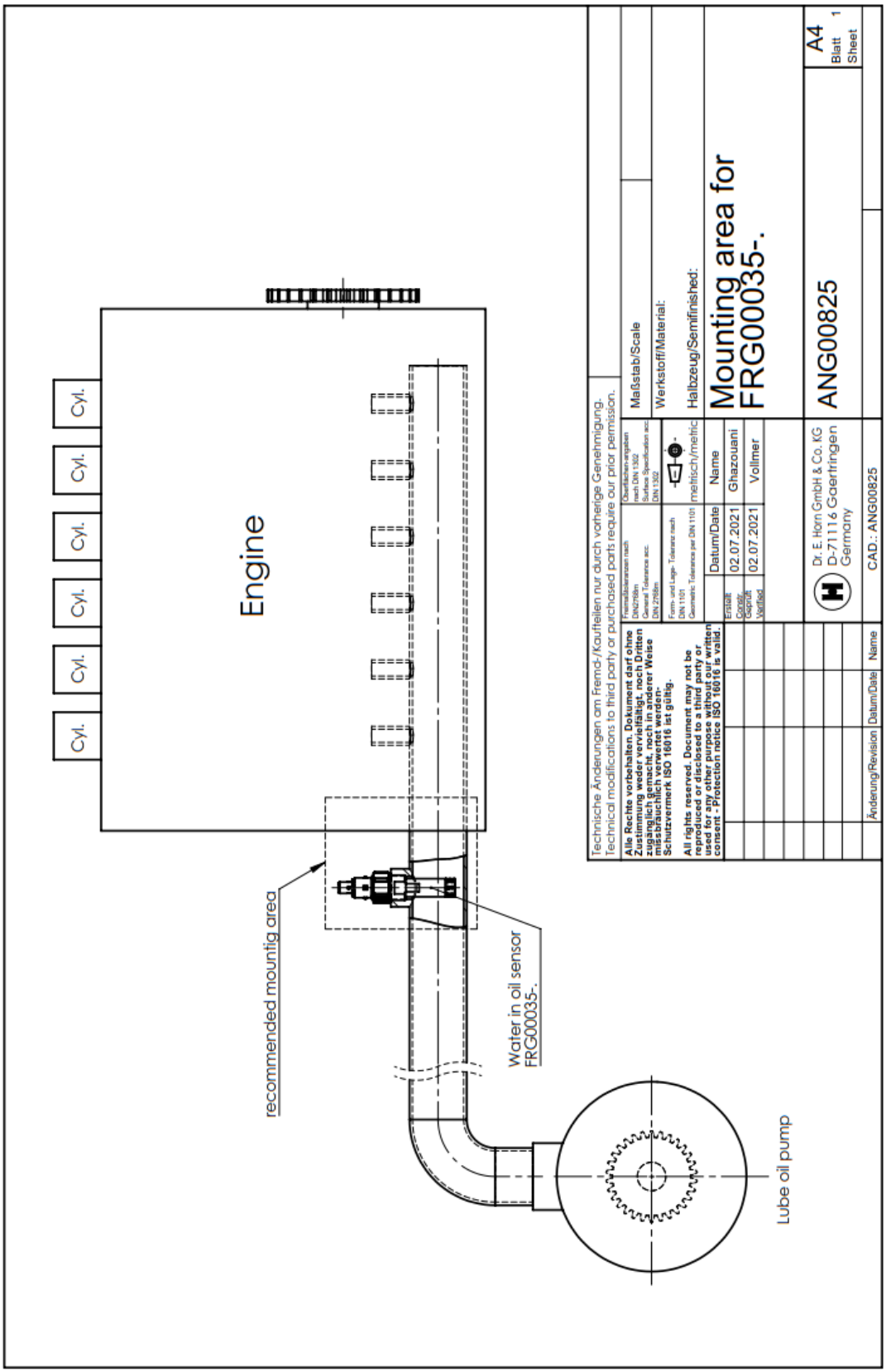
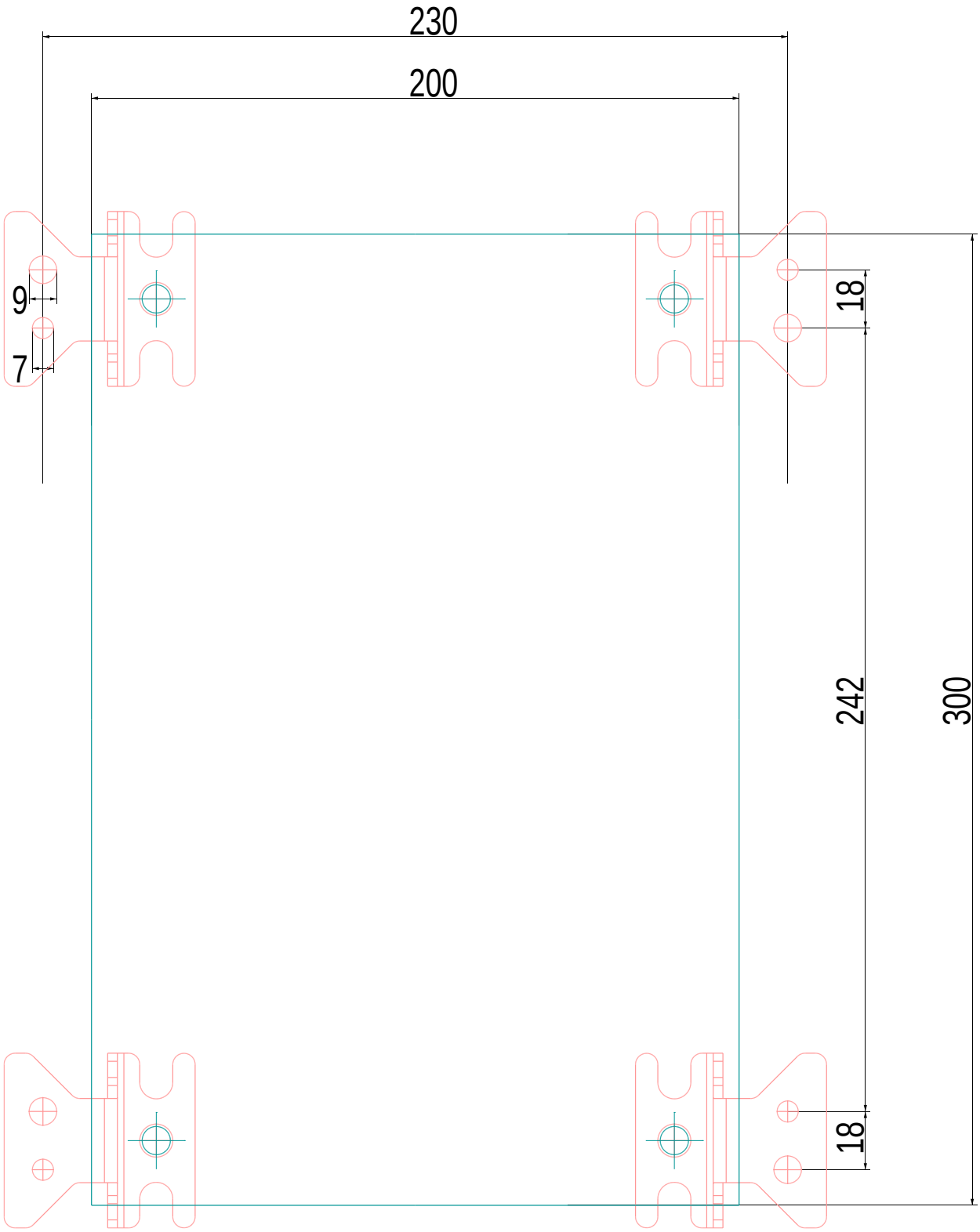


Drawing 9 Possible position of Water in Oil sensor in oil tube



Drawing 10 Possible location of Water in Oil sensor

Verfasser / *author*: Vollmer	Geprüft von / *checked by*: Winkler
Datum: 01.10.2024	Datum: 01.10.2024



Drawing 11 Fixing and mounting sizes [mm] of Indicator Box

Verfasser / *author*: Vollmer	Geprüft von / *checked by*: Winkler
Datum: 01.10.2024	Datum: 01.10.2024