Procedure for Installation, Operation and Maintenance of Subsea Sensors Rev AR

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NORWAY

262331, rev. AR

Unrestricted

Revision List

Rev	Date	Description	Author	Reviewed	Approved
AL	14.10.2021	Corrected reference to 6A + improved wording	SKL	EV	AE
AM	15.12.2023	Changed doc. no to 262331 (earlier 00003075). Added info regarding WEPS-100 CAN SIL, WEPS-300 Modbus and WEPS-300 CAN HS. Removed references to legacy sensors. Removed section for Profibus (legacy). Updated references (documents and rev.) Updated section for analogue sensors.	EV	PM	AE
AN	18.11.2025	**Ch. 2** Providing definition, **Section 6.2** Expanded wording, **Ch. 7** Expanded wording, **Section 8.2** Revised wording, **Section 8.3** formatting, **Section 10.2.1** Improved wording, **Section 10.2.2** Improved wording, **Section 10.2.3** Improved wording.	IA	EV	AE
AO	09.12.2025	Changed sentence in ch. 6.2 regarding replacement of installed sensors and harnesses. Updated references with latest doc . number and revisions.	EV	JIF	AE
AP	08.09.2026	Section 6.2 – Added sensor orientation guidance. Section 7. Typo fixed ‘1Gohm.’ Section 10 – Profibus removed. Section 12. Added	AE	SB	EOH
AQ	18.09.2026	Added WEPS-300 4-20mA	AE	SB	EOH
AR	23.10.2026	Section 6.3 – Added probe bore recommendation (Ø42mm) and 2mm clearance statement. Section 6.3 – Added probe recess recommendation, ref. doc. no. 10161421. Section 6.3 – Added guidance on standard vs 80mm extended housing for insulated applications.	AE	SB	EOH

TABLE OF CONTENTS

1 CAUTIONS 4

2 ABBREVIATIONS 5

3 REFERENCES 6

4 PACKING AND TRANSPORTATION 7

5 HEALTH AND SAFETY STATEMENTS 8

6 INSTALLATION 9

6.1 INSTALLATION INSTRUCTIONS 9
6.2 MECHANICAL INTERFACE 9
6.3 HOOK UP AND ORIENTATION INSTALLATION RECOMMENDATION 10

7 INSULATION RESISTANCE TESTING 11

8 WELDING 12

8.1 NO FLYING LEADS 12
8.2 HOW TO GROUND FLYING LEADS 13
8.3 SENSORS WITH FLYING LEADS 17
8.4 SENSOR SUPPLIED WITH CONNECTOR 17
8.5 SENSOR HARNESS 18

9 PAINTING ON STRUCTURE 19

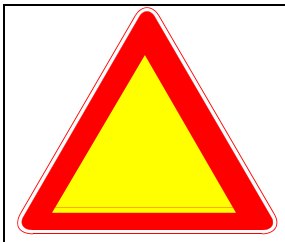
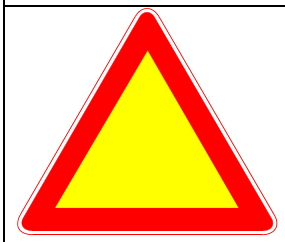
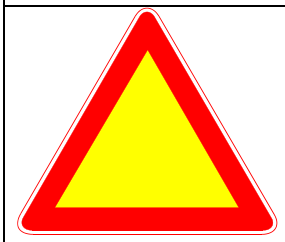
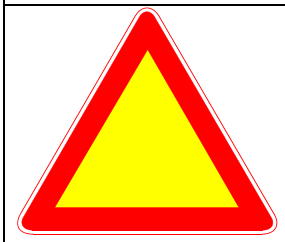
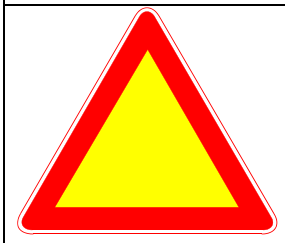
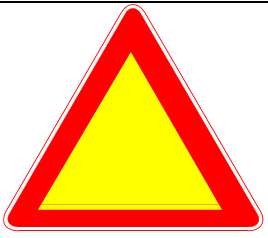
10 OPERATING INSTRUCTIONS 19

10.1 ANALOGUE SENSORS 19
10.2 DIGITAL SENSORS 20
10.3 SIL RATED SENSORS 23

11 MAINTENANCE 24

12 CONTACT DETAILS AND FEEDBACK 24

1 CAUTIONS

	PLEASE READ THE COMPLETE INSTALLATION, OPERATION AND MAINTENANCE MANUAL BEFORE ANY WORK START.
	Avoid manual handling ! Manual Handling by an individual at this weight should be avoided at all times. Suitable mechanical lifting aids should be identified, and used for the movement of Sensors, avoiding Musculoskeletal damage to the operator. The weight of the sensor will be found on the Weight Certificate for each individual type of sensor.
	Unless the sensor is within its transport case, it shall only be handled by personnel authorised by the client. Installation shall only be undertaken by personnel authorised by the client.
	Never use air tools when fixing the remote seal- and main body bolts. Avoid other types of shock and vibration impacts
	At any time during any type of welding operations in vicinity of the sensor, all cables shall be grounded. Twist all leads of the sensor and ensure that they are properly connected to the sensor housing.
	Membrane system must be handled with extreme care, do not: • Touch or come near the membrane surface by hand or any object. Note that the membrane is very thin and fragile, even the slightest contact with a sharp object may permanently damage the complete sensor.

2 ABBREVIATIONS

Abbreviation	Description
API	American Petroleum Institute
EUT	Equipment Under Test.
KOS	Kongsberg Offshore Data Protocol.
CAN	Controller Area Network
CANopen	CAN Standard based on EN50325
CiA	CAN in Automation
CRC	Cyclic Redundancy Check
FAT	Factory Acceptance Test
FT	Fault Tolerant (low speed)
HS	High Speed
LSS	Layer setting Service.
NMT	Network Management, CAN Application Layer
PDO	Process Data Object
PFD	Probability of Failure on Demand
PPE	Personal Protective Equipment
RTU	Remote Terminal Unit
SFF	Safe Failure Function
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SRS	Safety Requirement Specification
SYNC	Synchronous Transmission

3 REFERENCES

Ref	Doc. No.	Version	Title
[1]	CiA-443	1.0, 2.0, 3.0 or 4.0	CANopen Device Profile for SIIS level-2 devices
[2]	CiA-401	3.0	CANopen Device Profile for Generic I/O Modules
[3]	CiA-301	4.2.0	CANopen application layer and communication profile
[4]	API 6A	2019	Specification for Wellhead and Christmas Tree Equipment
[5]	API 17F	5th:2023	Standard for Subsea Production Control Systems
[6]	00002015	C	Safety Manual WEPS-100 Series 4-20 mA SIL
[7]	262319	P	Procedure for Packing, Preservation, Handling and Shipping of Subsea Pressure and Temperature Sensors
[8]	SD00007069	C	Specification of Communication Interface RS485 Modbus Fuji DP Transmitter
[9]	295210	H	Specification SDP Omterra Modbus Interface
[10]	00004616	H	Specification WEPS-100 Series Modbus Interface
[11]	00004617	E	Specification WEPS-100 Series RS485 KOS Interface
[12]	263090	S	Specification WEPS-100 Series CANopen Interface
[13]	00004799	D	Specification WEPS-100 Series 4-20 mA SIL Interface
[14]	294485	F	Software Manual WEPS-900 HT Series CANopen CiA-443 SIL3
[15]	269100	D	Specification WEPS-100 Series 4-20 mA PT Interface
[16]	10000659	E	Specification WEPS-100 Series 4-20 mA TT Interface
[17]	10001535	D	Safety Manual WEPS-900 Series HT CANopen SIL
[18]	10024259	B	Software Manual WEPS-900 HT Series CANopen CiA-443
[19]	275917	F	Software Manual WEPS-900 HP and WEPS-100 FT SIL Interface
[20]	284310	C	Software Manual for WEPS-900 HP Series CANopen CiA-443
[21]	361813	D	Safety Manual WEPS-900 Series HP CANopen SIL
[22]	269152	14	Software Manual WEPS-300 Series CANopen CiA-443 FT
[23]	311445	D	Software Manual WEPS-300 Series CANopen CiA-443 HS
[24]	283173	03	Software Manual WEPS-300 Series RS-485 Modbus
[25]	295618	02	Software Manual WEPS-300 Series RS485 KOS
[26]	10172685	03	Safety Manual WEPS-100 Series CANopen FT SIL
[27]	520372	01	Specification for WEPS-300 Series 4-20 mA PT Interface
[28]	520374	01	Specification for WEPS-300 Series 4-20 mA TT Interface

4 PACKING AND TRANSPORTATION

Avoid excessive shock and vibrations during transport and handling, even though the equipment itself is resistant towards shock and vibration, this is only true when the units are properly fixed and secured.

A special transport case is prepared for packing, storing and transport of the subsea sensor. We strongly advise that the unit is kept secured in this box until the final installation destination is reached.

The transportation case must be in its upright position at all times (see marking on the case).

The weight of the subsea sensor makes a dangerous combination if the transportation cases is handled roughly (dropped, turned from upright positions etc).

Storage temperature limits are defined as -40 to +70°C, however it is recommended to store the subsea sensors at room temperature if possible. Humidity control is not required.

Note: For further information regarding packing, handling and storage specifications, see ref. [7].

5 HEALTH AND SAFETY STATEMENTS

It is recommended that the client performs a risk Assessment for all aspects of the sensor Installation from initial delivery to final dispatch, to identify the hazards associated with the work.

Each Sensor unit weighs between 10 to 55 Kgs. Those staff preparing to move a sensor unit from the delivery box must ensure that they assess the identified hazards for each movement of the sensor.

Sensors with large flanges such as 3 1/16” 15K or 2 1/16” 20K are provided with dedicated threaded holes on the flange edge for eyebolts. Eyebolts are not Omterra scope of supply, however Omterra insist that only suitably rated and approved eyebolts are used.

Manual handling by an individual at this weight should be avoided at all times. Suitable mechanical lifting aids should be used to avoid musculoskeletal damage to the operator.

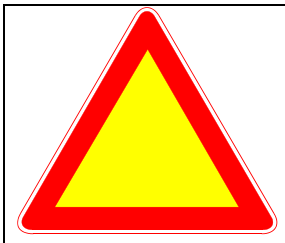
Personal Protective Equipment in the form of:

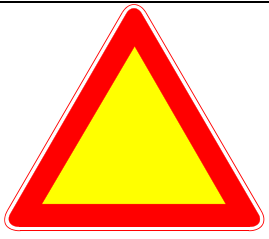
- Safety Shoes/ Boots
- Protective Gloves

Is highly recommended for the protection of staff whilst working with Sensors. Additional PPE may be required for the working environment / Client Safety Rules.

The sensors do not contain any chemicals or compositions that could be hazardous upon exposure.

During soldering operations it is recommended that fumes are removed from the immediate working area to avoid inhalation by the operator.

	Any soldering shall not take place unless the soldering procedure and/or soldering company have the appropriate skills and are approved by Omterra.

	Care in the selection of the correct tools for the final “Torque Setting of the API Bolts” is important to avoid accidents through damaged/poorly maintained tooling. See API 6A ref. [4]

6 INSTALLATION

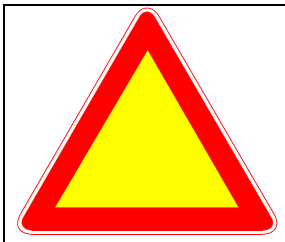
6.1 INSTALLATION INSTRUCTIONS

CAUTION: **UNLESS THE SUBSEA SENSOR IS WITHIN ITS *TRANSPORT CASES/CRADLE IT SHALL ONLY BE HANDLED BY PERSONNEL AUTHORISED BY THE CLIENT.***

INSTALLATION SHALL ONLY BE UNDERTAKEN BY PERSONNEL AUTHORISED BY THE CLIENT.

HANDLE THE SUBSEA SENSOR WITH CARE - HEAVY SHOCK AND/OR VIBRATIONS, HIGH TEMPERATURES MAY DAMAGE THE UNIT.

6.2 MECHANICAL INTERFACE

	Never use air tools when fixing the remote seal- and main body bolts. Also avoid other types of shock and vibration impact.

The Subsea Sensor shall be installed with BX Ring in accordance with the respective mechanical interface drawing for the Subsea Sensor.

Available flanges according to API 6A, ref. [4]:

- 2 1/16”, 5k PSI, BX-152, 8 bolt.
- 2 1/16”, 10k PSI, BX-152, 8 bolt.
- 1 13/16”, 5k PSI, BX-151, 8 bolt.
- 1 13/16”,10k PSI, BX-151, 8 bolt.
- 2 1/16”, 15k PSI, BX-152, 8 bolt.
- 3 1/16”, 10k PSI, BX-154, 8 bolt.

In addition following flange alternatives:

- 1 11/16”, 10k PSI, BX-150, 4 bolt.
- 1 11/16”, 15k PSI, BX-150, 6 bolt.
- 2 1/16”, 15k PSI, BX-152, 10 bolt.
- 2 1/16”, 20k PSI, BX-152, 10 bolt.

Nuts and bolts used for installation : According to clients specifications.
Material : According to clients specifications.
Torque Settings : According to Clients specifications.

6.3 HOOK UP AND ORIENTATION INSTALLATION RECOMMENDATION

No specific requirements regarding sensor orientation. Where possible, the sensor should be installed with a slight positive inclination to promote free draining and minimise the accumulation of debris

All surfaces shall be cleaned and inspected for damage before installation.

Nuts, bolts and gaskets are not part of Omterra delivery, however sensors are designed to be used with nuts, bolts and gaskets according to API 6A ref. [4].

Protection caps and spring for grounding needs to be removed prior to installation.

The sensors are designed to be intrusive into the process and can not be replaced subsea unless there is a way to close the process by valves or similar. The harness can be replaced if diver mateable connectors are utilized.

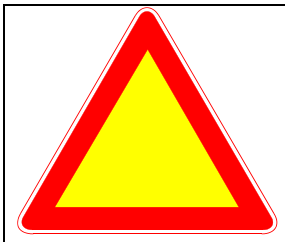
Deployment and retrievable rate shall be done with a Pressurization rate < 18 bar/min Depressurization rate < 24bar/min.

Sensor probe diameter is Ø38mm. To allow sufficient space around the probe recommended probe bore is Ø42mm. 2mm clearance is provided on each side of the probe to accommodate minor deviations in straightness.

The probe shall always be recessed and never protrude into the flow. The recommended probe recess is bore diameter × 0.2 (i.e. 8.4mm for a Ø42mm bore), in accordance with Omterra document no. 10161421, Probe Recess Calculation, Rev. D. To ensure optimal temperature measurement and correct erosion analysis, a full CFD/temperature analysis should always be used to determine the final probe length.

As a general rule, a standard housing sensor should be used where the pipework or structure is not thermally insulated. Where thermal insulation is applied, an extended housing sensor (housing extended by 80mm) should be selected so that the sensor electronics remain outside the insulation. Contact Omterra if in doubt.

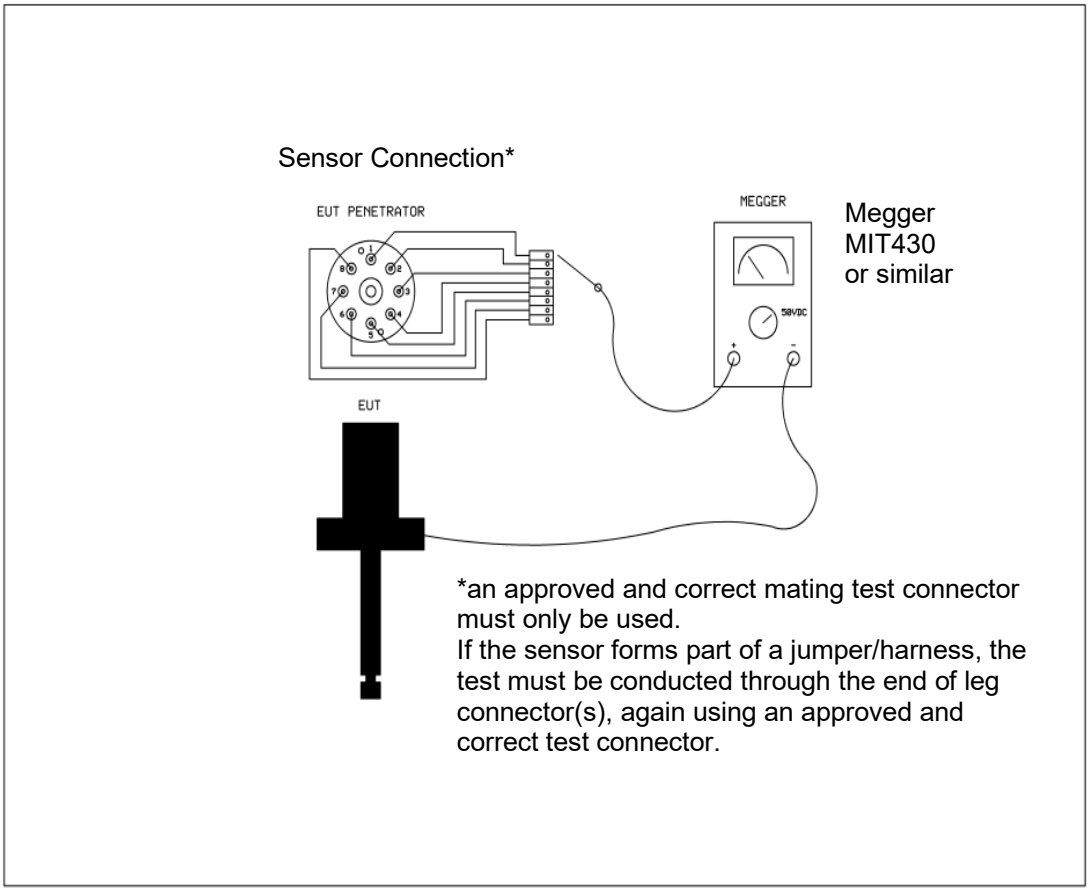
7 INSULATION RESISTANCE TESTING



Insulation Resistance Test:
Test voltage shall never exceed 50 VDC.

If there is a need to conduct insulation resistance testing of the sensor on site, the following best practice routine is to be followed.

1. Hook up the EUT as per the sketch below.



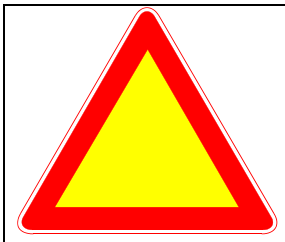
2. Connect the insulation tester with the negative terminal to the metallic body of the sensor. Connect all pins to the insulation tester positive terminal.

3. Measure the insulation resistance at 50VDC @ dry conditions for 1 minute.

4. If the insulation resistance value is below the acceptance criteria, contact Omterra for further assistance.

Acceptance Criteria: From factory IR ≥ 5Gohm, on site IR ≥1Gohm.

8 WELDING

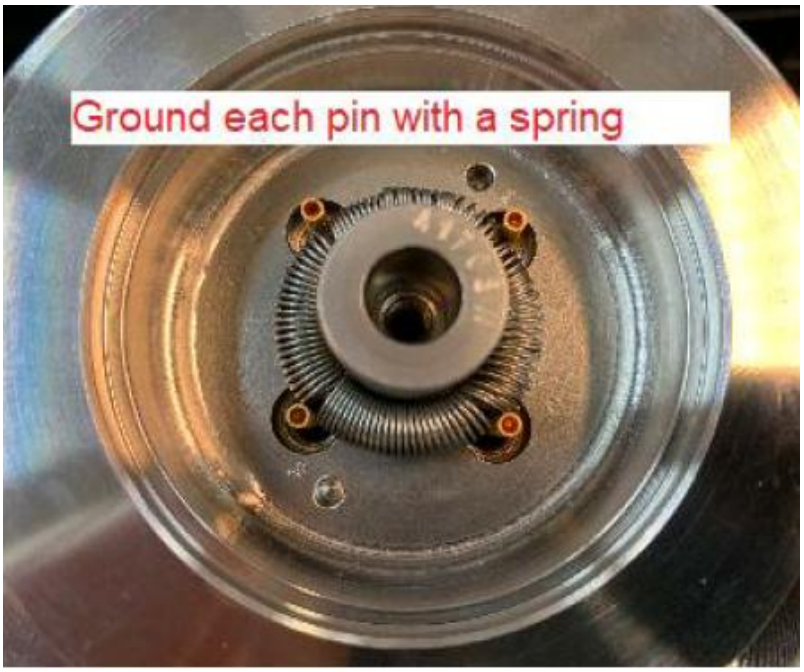
	Always ensure sensor is removed from the structure or grounded before commencing any welding.

At any time during any type of welding operations in the vicinity of the sensor, the sensor needs to be removed from the structure being welded entirely or grounded.

Best practice for grounding the sensor is:

8.1 NO FLYING LEADS

For sensors supplied with no flying leads the sensor is grounded by spring between the pins and the sensor housing. This spring is supplied and mounted by Omterra before shipping. The picture below shows a spring mounted onto a four pin penetrator with no flying leads. The same spring can be used for sensors supplied with 8-pin penetrators.



8.2 HOW TO GROUND FLYING LEADS

Remove the insulation from the end of the leads, as demonstrated in picture below. About 1cm should be sufficient.

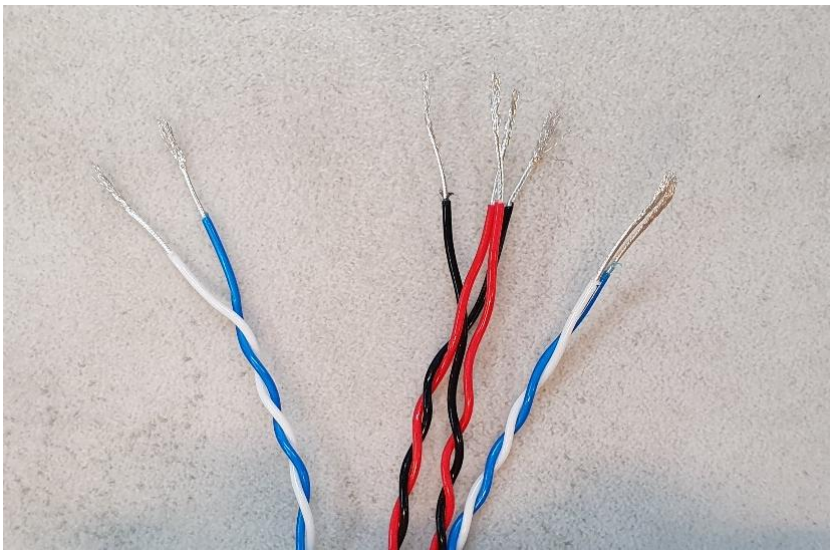


Figure 1: Example of flying leads with insulation removed at ends.

Wind a steel wire around (max) four flying leads at a time. The steel wire mounted onto the flying leads and supplied by Omterra before shipping can be used for this.

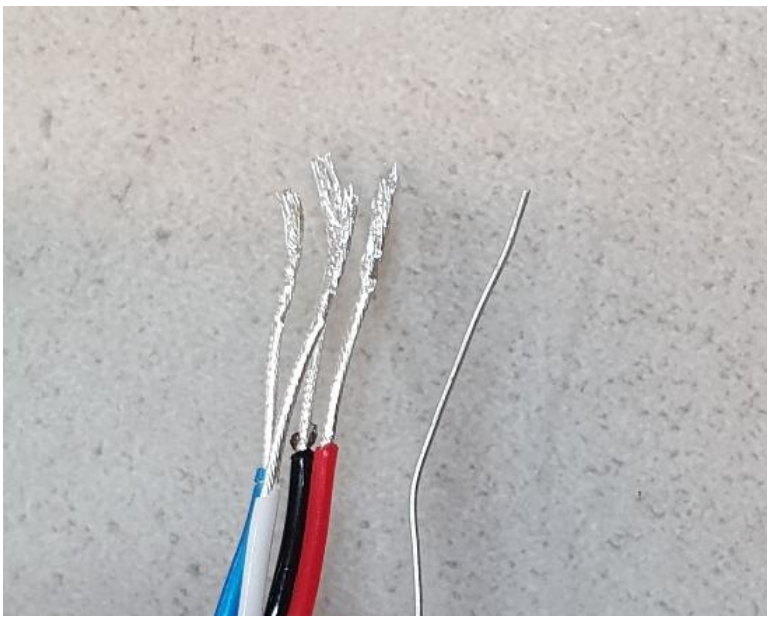


Figure 2: Steel wire ready to be wound around set of four flying leads.

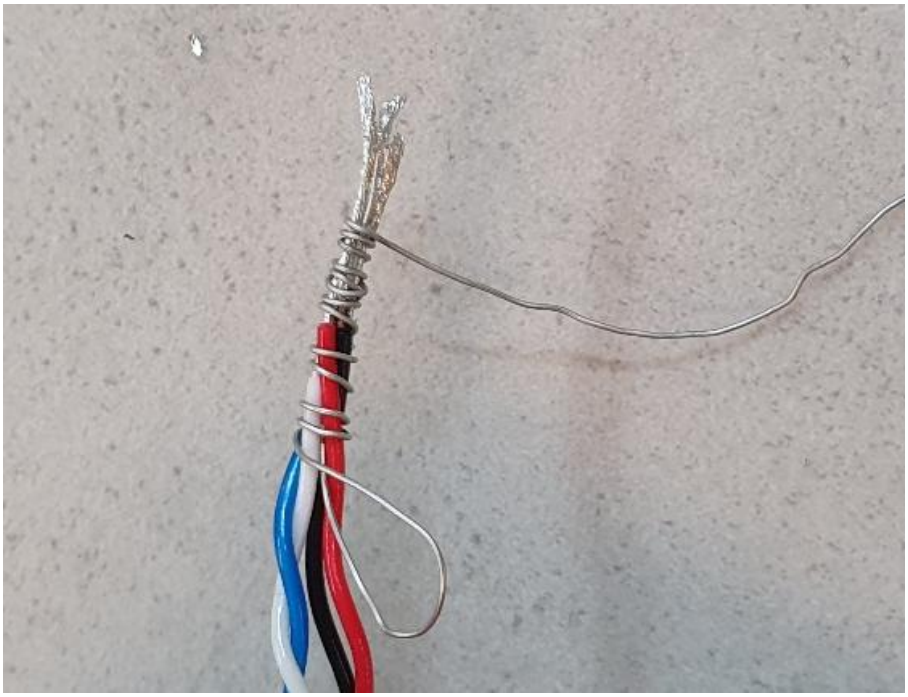


Figure 3: Example of steel wire wound around a set of four flying leads.

Use the same steel wire to ground several sets of four (or less) flying leads. This is demonstrated in picture below.

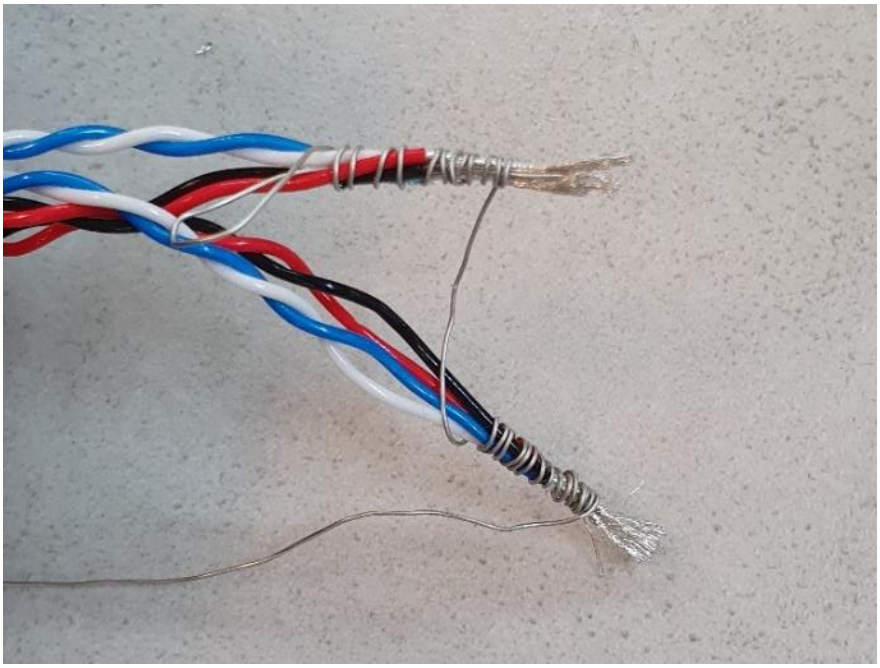


Figure 4: Example of steel wire wound around several sets of four flying leads.

Note: It is also possible to use phoenix connectors to ground flying leads. The leads are then assembled to the phoenix connector. A steel wire is used to connect all leads inside the connector and then connected to metal part of sensor as demonstrated below.



Figure 5: Example of grounding using phoenix connector.

The sensor is grounded when all the flying leads are in contact with a steel part of the sensor. Best practise is to use a clamping tool as demonstrated in the picture below. The steel wire which is in contact with all flying leads is wound around the clamp to ensure contact with steel part of sensor.

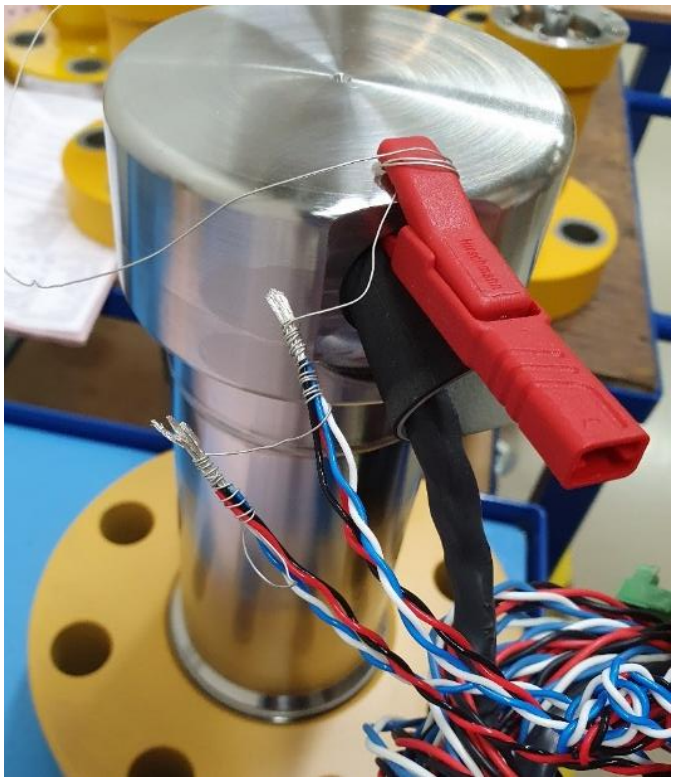


Figure 6: Example of how to ensure flying lead contact with steel part of sensor. Steel wire clamped to housing.

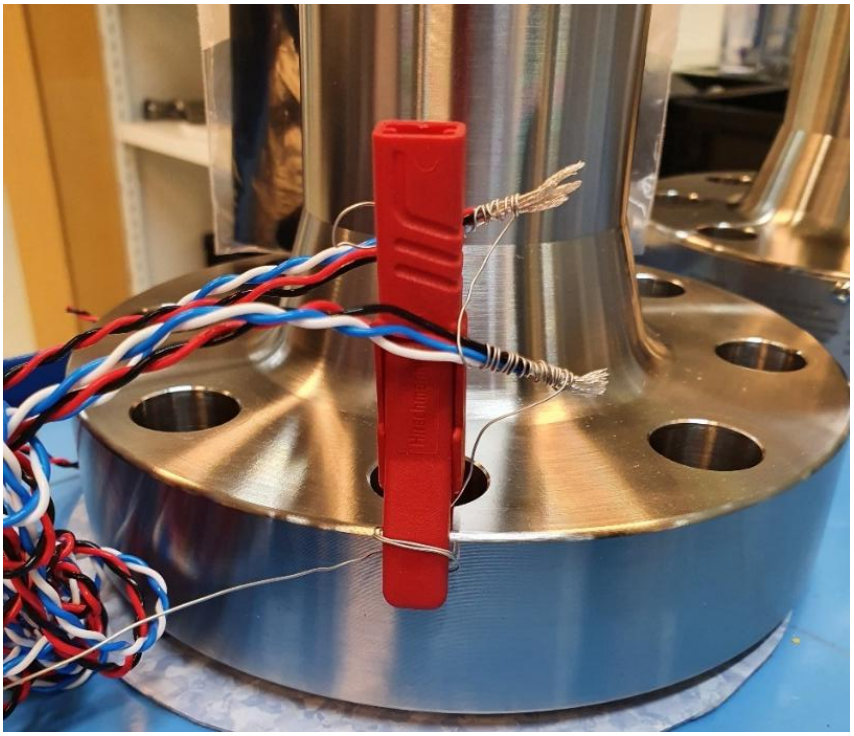


Figure 7: Example of how to ensure flying lead contact with steel part of sensor. Steel wire clamped to flange.

Test connectors with flying leads are grounded in the same manner.



Figure 8: Example of test connector – grounded using phoenix connectors

8.3 SENSORS WITH FLYING LEADS

All flying leads must be grounded before welding can start. Please refer to chapter 8.2 for information on how to ground flying leads.

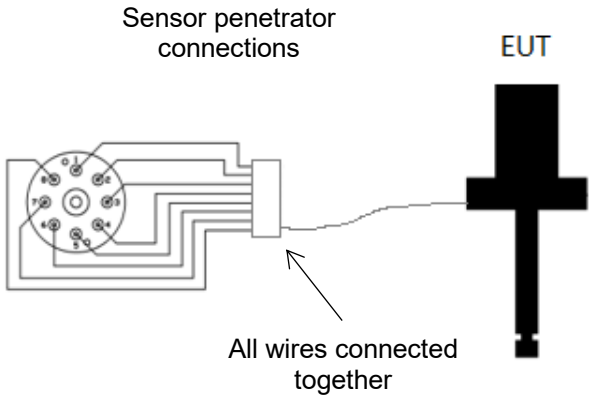


Figure 9: Sketch demonstrating grounding of all pins.

8.4 SENSOR SUPPLIED WITH CONNECTOR

For sensors supplied with connector best practice is to use a test connector with flying leads. The flying leads are then grounded. Please refer to chapter 8.2 for information on how to ground flying leads.

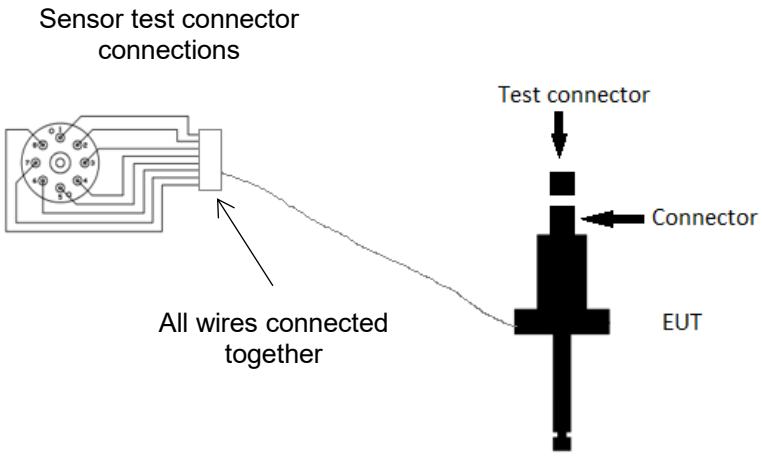
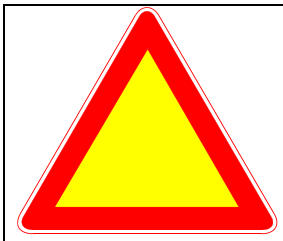


Figure 10**:** Sketch demonstrating grounding of sensor using test connector.

8.5 SENSOR HARNESS

	Always use test connectors to ground sensor harnesses.

Sensor harness, both 1 leg and multiple leg harness must be grounded using test connectors. Please refer to chapter 8.2 for information on how to ground flying leads and test connector.

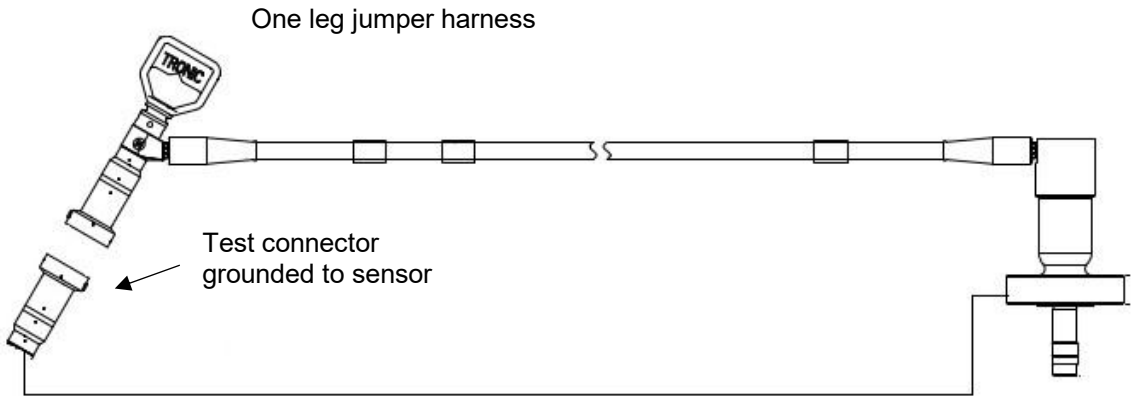


Figure 11: Sketch demonstrating grounding of sensor 1 leg jumper harness using test connector.

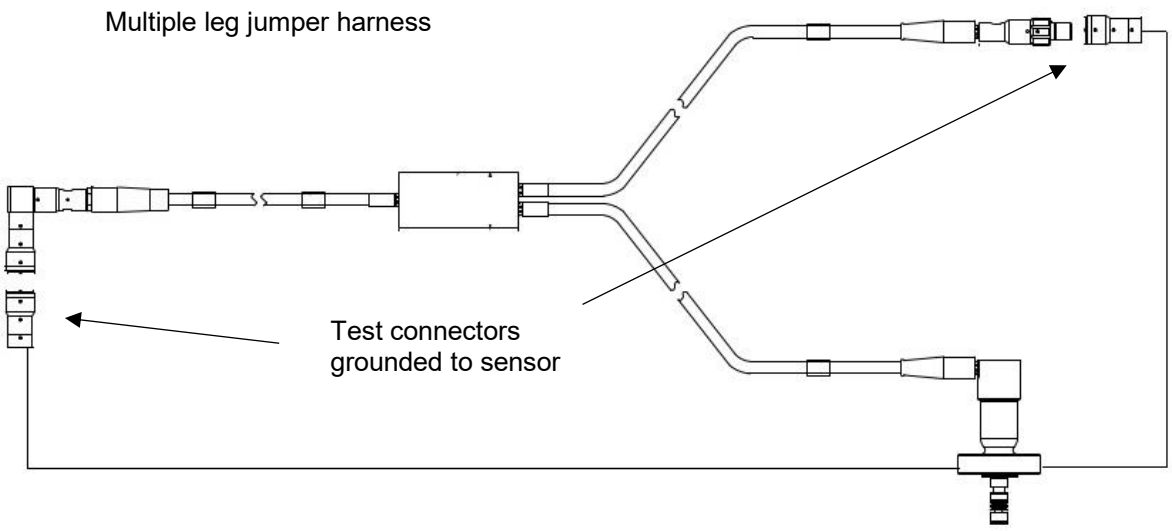
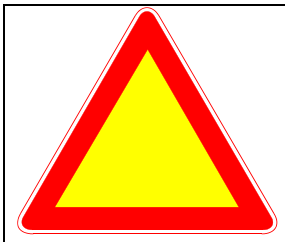


Figure 12: Sketch demonstrating grounding of sensor multiple leg jumper harness using test connectors.

9 PAINTING ON STRUCTURE

	Always ensure sensor is removed from the structure or grounded before commencing any blasting.

If the sensor is supplied un-painted, the sensor can be prepared and painted along with the host structure. During surface preparation, e.g. blasting, Pin Hole Tests or other test methods that utilising an electrical method, the sensor needs to be grounded as described in section 8.
Special consideration should be taken towards masking of the electrical connector.

10 OPERATING INSTRUCTIONS

After installation, check the Subsea Sensor(s) at ambient pressure and/or temperature to verify that the sensor is still functioning properly.

10.1 ANALOGUE SENSORS

The output can be measured by the use of a loop tester. The loop tester should be according to API 17F, Annex D, ref. [5], capable of providing 24 Volt for minimum of 40mA during start up.

Recommended loop testers: Drück UPS III or Additel 210.

Note: *The Fluke 707 instrument has a current limitation lower than specified in API 17F Annex D and could prevent the sensor from starting up correctly and cannot be used as an instrument to read this sensor.*

The pressure output(s) shall give a mA output according to the calibrated range and the ambient pressure. The temperature output(s) shall give a mA-value corresponding to the calibrated range and the ambient temperature.

The pressure output(s) are calibrated from: MinCalibPress to MaxCalibPress. This is the calibrated sensor range for pressure. See sensor marking.

The temperature output(s) are calibrated from: MinCalibTemp to MaxCalibTemp. This is the calibrated sensor range for temperature. See sensor marking.

The conversion from mA to engineering units such as Bara and deg C is as follows:

Pressure = {(mAvalue - 4)* ((MaxCalibPress - MinCalibPress/16))} + MinCalibPress.

Temp. = {(mAvalue - 4)* ((MaxCalibTemp. - MinCalibTemp)/16)} + MinCalibTemp.
For more details regarding the 4-20 mA interface for WEPS-100/300 Series of sensors please see the following interface specifications:

- WEPS-100 Series PT: Ref. [15].
- WEPS-100 Series TT: Ref. [16].
- WEPS-100 Series SIL: Ref.[13].
- WEPS-300 Series PT: Ref. [15].
- WEPS-300 Series TT: Ref. [16].

NOTE:
Regarding SIL rated analogue sensors please see also ch. 10.3 and ch. 11.

10.2 DIGITAL SENSORS

The Subsea sensors will communicate with the supply/receiver circuitry through RS485 (KOS/Modbus) protocol or on CANopen.

The sensor signal is transmitted in engineering units. Most often this is in Bara/°C, but sensors can also be delivered with PSI /Fahrenheit on request.

After installation subsea, the signal from the subsea sensor will form a part of the client's main system, and all operational instructions should be according to the client's procedures.

10.2.1 RS485 Modbus

The master unit can start communication with the sensor 5 seconds after power up. The master needs to send request to the sensor, then it will transmit messages with sensor data in return.

The electrical interface between the master and the sensor is based on the RS485 standard.

The format of each byte in RTU mode is:

Interface	:	RS485 (two-wire)
Baud rate	:	default 1200 (2400, 4800, 9600, 19200 and 38400 is available)
Coding system	:	8-bit binary
Number of start bits	:	1
Data bits	:	8
Parity	:	No
Stop bits	:	1 (2 stop bit is available on request)
Error checking	:	CRC

For more details regarding the Modbus interface, please see the corresponding interface specification:

- WEPS-100 Series Modbus: Ref. [10].
- WEPS-300 Series RS-485 Modbus: Ref. [24].
- SDP Series Fuji Modbus: Ref. [8].
- SDP Series Omterra Modbus: Ref. [9].

10.2.2 RS485 KOS

After power up, the sensor starts transmitting messages within 5 seconds. The protocol is unidirectional.

Messages are sent from the sensor when new measurements are ready, twice a second.

The electrical interface between the master and the sensor is based on the RS485 standard, optional RS422.

Interface	:	RS485 (two-wire)
Baud rate	:	1200
Coding system	:	8-bit binary
Number of start bits	:	1
Data bits	:	8
Parity	:	No
Stop bits	:	1
Error checking	:	Checksum

For more details regarding the KOS interface, please see the corresponding interface specifications:

- WEPS-100 Series RS485 KOS : Ref. [11].
- WEPS-300 Series RS485 KOS : Ref. [25].

10.2.3 CANopen

The sensor can be configured before delivery to support two different device profiles: CiA-401 or CiA-443.

Device Profile 401

If the sensor is configured for device profile 401, ref.[2], the sensor enters the application and NMT pre-operational mode after power-on. In pre-operational mode, the sensor application starts to read and calculate process values (typically pressure and temperature). When the sensor receives the “NMT start command” it will enter NMT state operational (if no failures detected). After the start command is received the sensor will start to transmit process data according to the transmission type and configuration.

Process measurements are transmitted periodically (according to configuration) by the means of PDO, using transmission type 254. It is possible to use SYNC transmission 1-240. See CiA-301, ref.[3].

For more details regarding the sensor interface, please see the corresponding interface specifications or user manual:

- WEPS-100 Series CiA-401 : Ref. [12].
- WEPS-900 HP and WEPS-100 FT SIL : Ref. [19]

Device Profile 443

If the sensor is configured for device profile 443, ref.[1], the sensor stays in boot loader program and enters NMT pre-operational mode after power-on.

In the boot loader program only the LSS layer and some dictionary objects are implemented. Process measurements and PDO are not implemented; hence setting the boot loader program in NMT operational mode makes no sense.

The application is started by using the dictionary object 1F51h Program Control, writing 1 to sub-index 1.

The application will then start up in NMT pre-operational mode and the sensor starts to read and calculate process values (typically pressure and temperature). When the sensor receives the NMT start command it will enter NMT operational mode (if no failures detected).

After the start command is received the sensor will start to transmit process data according to the transmission type and configuration.
Process measurements are transmitted continuously (according to configuration) by the means of PDO using transmission type 255. It is possible to use SYNC transmission 1-240, or transmission type 254.

Interface	:	CANopen (two-wire)
Baud rate	:	CANopen FT: 50 (default) and 125kbit CANopen HS: 10, 20, 50 (default) 125, 250kbit or 500kbit

For more details regarding the sensor interface, please see the corresponding interface specifications or user manual:

- WEPS-100 Series CiA-443 : Ref. [12].
- WEPS-900 HT Series CiA-443 : Ref. [18].
- WEPS-900 HP Series CiA-443 : Ref. [20].
- WEPS-300 Series with CiA-443 FT : Ref. [22].
- WEPS-300 Series with CiA-443 HS : Ref. [23].

NOTE:
Regarding SIL rated digital sensors please see ch.10.3 and ch.11.

10.3 SIL RATED SENSORS

SIL is a measure of safety system performance, or probability of failure on demand (PFD) for a SIF or SIS. The higher the SIL level, the lower the probability of failure on demand for the safety system and the better the system performance.

OMTERRA SIL 2 and SIL 3 rated sensors are suitable for application in SIL 2 and SIL 3 Safety Instrumented System respectively.

All OMTERRA SIL rated sensor are independently certified and approved by certification authority.

Type of communication protocol that is suitable for SIL rated sensor is dependent on type of platform for which sensors have been developed, for example 4-20mA, CAN bus etc.

Please refer to independent senor’s interface speciation, software manual or safety manual for SIL rated sensor. This documentation will provide information about communication protocol being used, safe state indication, PFD and SFF etc.

- WEPS-100 Series 4-20 mA SIL3 : See ref. [6], Safety Manual.
- WEPS-100 Series CANopen SIL3 : See ref. [26], Safety Manual.
- WEPS-900 Series CANopen HT SIL3 : See ref. [17], Safety Manual.
- WEPS-900 Series CANopen HP SIL3 : See ref. [21], Safety Manual.

11 MAINTENANCE

Before installation, confirm if the Subsea Sensor(s) have been stored for more than six - 6 - months, if so, a test of the sensor signal at ambient pressure and temperature should be carried out. Use of calibrated reference instruments is required to ensure correct test results.

If the result from the test shows any discrepancy (≥1Bar / ≥1°C) in the sensor signal contact Omterra for further assistance. If required the sensors could be returned to the manufacturer for adjustment or a note should be made of the difference and adjusted on the Company's topside system after installation subsea.

After installation subsea, it will not be possible to carry out any maintenance of the sensor. However, if possible, a periodical test of the sensors should be carried out. At known pressure the signal from the pressure outputs should correspond to the reference pressure. If it is possible to have a known temperature reference, a similar test should be carried out for the temperature outputs. In case of any drift, the sensor signal should be corrected on the topside system. The top side system has to have the facility of an offset adjustment of the sensors to be able to carry out this test.

SIL rated sensors should have proof test on regular basis, ref. Safety Requirement Specification (SRS) or Safety Manual for the specific sensor.

If the structure for any reason should be retrieved after installation, the sensor should be controlled as in section 10, (Operating Instructions) above or returned to the manufacturer for a complete check/recalibration.

12 CONTACT DETAILS AND FEEDBACK

For additional information or questions regards the products contact the following.

Department	E-mail address
Technical Support	bomlo-eng@siemens-energy.com
Sales	connectorsales.gb@siemens-energy.com