Procedure for Installation, Operation and Maintenance Manual Subsea Sensor

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### Revision List

<table>
<thead>
<tr>
<th>Rev</th>
<th>Date</th>
<th>Description</th>
<th>Author</th>
<th>Reviewed</th>
<th>Approved</th>
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<tbody>
<tr>
<td>R</td>
<td>29.05.2012</td>
<td>Added abbreviations and reference list.</td>
<td>CF</td>
<td>PKS</td>
<td>EV</td>
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<td>Added CRC in abbrev. list</td>
<td>CF</td>
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<td>TKG</td>
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<td>Updated correct numbering</td>
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<td>09.02.2015</td>
<td>New layout</td>
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<td>X</td>
<td>31.08.2015</td>
<td>New Teamcenter ID's under chapter 3 References</td>
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## 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

FAT Factory Acceptance Test
PPE Personal Protective Equipment
API American Petroleum Institute
SIL Safety Integrity Level
RTU Remote Terminal Unit
CANopen CAN Standard based on EN50325
CiA CAN In Automation
NMT Network Management, CAN Application Layer
SYNC Synchronous Transmission
PDO Process Data Object
CANopen FT CANopen Fault Tolerant
CANopen HS CANopen High Speed
PFD Probability of Failure on Demand
SIF Safety Instrumented Function
SIS Safety Instrumented System
SFF Safe Failure Function
CRC Cyclic Redundancy Check
# 3 REFERENCES

<table>
<thead>
<tr>
<th>Ref</th>
<th>Doc. No.</th>
<th>Version</th>
<th>Title</th>
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<td>[1]</td>
<td>00003816</td>
<td>H</td>
<td>Packing, Preservation, Handling and Shipping</td>
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<tr>
<td>[2]</td>
<td>CiA 401</td>
<td>3.0</td>
<td>CANopen, Device Profile for Generic I/O Modules</td>
</tr>
<tr>
<td>[3]</td>
<td>CiA 301</td>
<td>4.2.0</td>
<td>CANopen application layer and communication profile</td>
</tr>
<tr>
<td>[4]</td>
<td>CiA 443</td>
<td>1.0</td>
<td>CANopen®, Device Profile for SIIS level-2 devices</td>
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<td>[8]</td>
<td>00020428</td>
<td>A</td>
<td>Safety Requirement Specification (SRS) - WEPS-5 Fast Response (4-20mA) PT/TT Transmitter Meeting IEC61508</td>
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<td>[9]</td>
<td>00020429</td>
<td>A</td>
<td>Safety Requirement Specification (SRS) - WEPS-100 4-20mA</td>
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<tr>
<td>[12]</td>
<td>00007070</td>
<td>B</td>
<td>Weps-3 Profibus Specification</td>
</tr>
<tr>
<td>[14]</td>
<td>00004614</td>
<td>C</td>
<td>CANopen Interface specification for Subsea Instrumentation with profile CiA-401</td>
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</tbody>
</table>
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 advice that the units 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 Subsea Sensors high own weight makes a dangerous combination if the transportation cases is handled roughly (dropped, turned from upright positions etc).

Be sure that the Subsea Sensor is stored in clean environment and preferably at room temperature. If the Subsea Sensor is stored more than six - 6 - months before installation on any subsea structure, a test of the sensor signal over the entire pressure and or temperature range is recommended. If the results from the test shows any drift in the sensor signal compared to the FAT-results, a full re-calibration is required at SIEMENS AS.

**Note:** For further information regarding packing, handling and storage specifications, see ref [1].
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 15 to 35 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.

Manual Handling by an individual at this weight should be avoided at all times. Suitable mechanical lifting aids should be identified avoiding Musculoskeletal damage to the operator.

Personal Protective Equipment in the form of:
  o Safety Shoes/ Boots
  o 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 Siemens.

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.
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

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

Mechanical interface: API 2 1/16", 5kpsi, 10kpsi, BX-152, 8 bolts.  
Mechanical interface: API 1 13/16", 5kpsi, 10kpsi, BX-151, 8 bolts.  
Mechanical interface: API 1 11/16", 5kpsi, 10kpsi, BX-150, 4 bolts.  
Mechanical interface: API 2 1/16", 15kpsi, BX-152, 8 bolts.  
Nuts and bolts used for installation : According to Clients specifications.  
Material : According to Clients specifications.  
Torque Settings : According to Clients specifications.

No Requirements regarding orientation.  
All surfaces shall be cleaned before installation.  
Nuts, bolts and gaskets are not Siemens responsibility.

CAUTION: AT ANY TIME DURING ANY TYPE OF WELDING OR SAND BLASTING OPERATIONS ON THE XMAS TREE OR OTHER STRUCTURES NEAR THE SUBSEA SENSORS, ALL SUBSEA SENSOR(S) INSTALLED AND SUBSEA SENSOR(S) TO BE TIG WELDED OR SAND BLASTED SHALL BE GROUNDED.

TWIST THE FLYING LEADS OF THE SUBSEA SENSOR(S) TOGETHER AND ENSURE THAT THEY ARE PROPERLY CONNECTED TO THE SUBSEA SENSOR HOUSING.

IT IS RECOMMENDED TO KEEP THE FLYING LEADS TWISTED TOGETHER AND CONNECTED TO SENSOR HOUSING AT ALL TIMES UNTIL IT IS TO BE CONNECTED TO THE SYSTEM.
Never use air tools when fixing the remote seal- and main body bolts. Also avoid other types of shock and vibration impact.

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

7 OPERATION INSTRUCTIONS

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

7.1 ANALOGUE SENSORS

Measure the outputs with a loop tester. 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 Bara and deg C is as follows:
Pressure = {((mAvalue - 4) * ((MaxCalibPress - MinCalibPress/16))) + MinCalibPress.
Temp. = {((mAvalue - 4) * ((MaxCalibTemp. - MinCalibTemp)/16)) + MinCalibTemp.

NOTE:
Regarding SIL rated analogue sensors please see ch. 7.3 – 7.6.
7.2 DIGITAL SENSORS

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

The sensor signal is transmitted in engineering units (Bara/°C).

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.

7.2.1 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.

Ref. Interface specification document for the specific sensor for more details.

The format of each byte in RTU mode is:

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

7.2.2 RS485 PROFIBUS

The electrical interface between the master and the sensor is based on the Profibus DP standard, EN 50170.

See the corresponding Profibus specification Weps-2 and Weps-25 ref.[11] or Weps-3 ref .[12] for details.

<table>
<thead>
<tr>
<th>Interface</th>
<th>RS485 (two-wire)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baud rate</td>
<td>Auto (9600 or 19200)</td>
</tr>
</tbody>
</table>
7.2.3 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.
Ref. Interface specification document for the specific sensor for more details.

<table>
<thead>
<tr>
<th>Interface</th>
<th>RS485 (two-wire)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baud rate</td>
<td>1200</td>
</tr>
<tr>
<td>Coding system</td>
<td>8-bit binary</td>
</tr>
<tr>
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<td>1</td>
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<tr>
<td>Data bits</td>
<td>8</td>
</tr>
<tr>
<td>Parity</td>
<td>No</td>
</tr>
<tr>
<td>Stop bits</td>
<td>1</td>
</tr>
<tr>
<td>Error checking</td>
<td>Checksum</td>
</tr>
</tbody>
</table>

7.2.4 CANopen

The sensor can be configured before delivery to support two different device profiles: CiA-401 or CiA-443.
Ref. Interface specification document for the specific sensor for more details.

7.2.5 Device Profile 401

If the sensor is configured for device profile 401, ref [2] and ref[14], 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 ref [3] CiA 301.

7.2.6 Device Profile 443

If the sensor is configured for device profile 443, ref [4], 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, ref [5] chapter 6 for complete overview of the object dictionary. 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.

<table>
<thead>
<tr>
<th>Interface</th>
<th>CANopen (two-wire)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baud rate</td>
<td>CANopen FT:</td>
</tr>
<tr>
<td></td>
<td>- 50 (default) and 125kbit</td>
</tr>
<tr>
<td></td>
<td>CANopen HS:</td>
</tr>
<tr>
<td></td>
<td>- 10, 20, 50 (default) 125 and 250kbit</td>
</tr>
</tbody>
</table>

**NOTE:**
Regarding SIL rated digital sensors please see the following chapters.

### 7.3 SIL RATED

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.

SIEMENS SIL 1, SIL 2 and SIL 3 rated sensors are suitable for application in SIL 1, SIL 2 and SIL 3 Safety Instrumented System respectively. All SIEMENS 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 sensor’s interface speciation for SIL rated sensor. The Interface specification should provide information or refer to other document about communication protocol being used, safe state indication, PFD and SFF etc.

#### 7.3.1 SIL 1

#### 7.3.2 SIL 2
- WEPS-6122/6152, see ref [7] (Safety Requirement Specification) for details.
- WEPS-5 Fast Response, see ref [8] (Safety Requirement Specification) for details.
- WEPS-100 Analogue, see ref [9] (Safety Requirement Specification) for details.

#### 7.3.3 SIL 3
- WEPS-100 Analogue, see ref [9] (Safety Requirement Specification) for details.
- WEPS 6153 SIL3, see ref [10] (Safety Requirement Specification) for details.
8 MAINTENANCE

Before installation, be sure that the Subsea Sensor(s) is(are) stored in a clean environment at room temperature. If the Subsea Sensor(s) is(are) stored for more than six - 6 - months before installation, a test of the sensor signal at ambient pressure and temperature should be carried out.

If the result from the test shows any drift in the sensor signal compared to the FAT-results, the sensors should 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 periodically control 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) for the specific sensor.

If the structure for any reason should be retrieved after installation, the sensor should be controlled as in item 7 (Operating Instructions) above or returned to the manufacturer for a complete check/recalibration.