SPES™-108

Underwater Eddy Current Proximity Sensor
User's Manual

Safety Information

The following manual contains information and warnings. They must be followed in order to keep the instrument in a working condition and ensure safe operation.

Safety and Electrical Symbols

⚠	**Warning - Danger -** Identifies conditions or practices that could cause physical harm or death.
⚠	**Caution** - Identifies conditions or practices that could result in a permanent loss of data or damage the measuring chain and/or other equipment to which it is connected.
❗	**Important Information -** Identifies important information, hints, and tips that must be read and applied.
⎍	Shield connection location

Safety Precautions

⚠ Warning - Danger ⚠ Caution
• **To use the described product correctly and safely, read and follow all safety instructions or warnings that appear throughout this manual.**
• **This product in intended to be used by qualified operators and maintenance personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information before using this product.**
• **Install and use this product only as specified in this manual or the protection provided by this product might be impaired.**
• **When in doubt that safety protection has been impaired, make this product inoperative and secure it against any unintended operation.**

TABLE OF CONTENTS

1. SPES-108 SENSOR OVERVIEW

1.1 Description

The SPES-108 proximity sensor is designed to measure the relative distance of an underwater metallic target surface. It is usually used to measure blade tip clearance in Kaplan turbines as well as runner band clearance in Francis turbines. The sensor can sustain high levels of underwater pressure and is equipped with built-in conditioning circuitry allowing it to be directly connected to processing instrumentation.

The SPES-108 covers a 0 to 8 mm *[0 to 315 mils]* measuring range.

SPES-108 Underwater Proximity Sensor
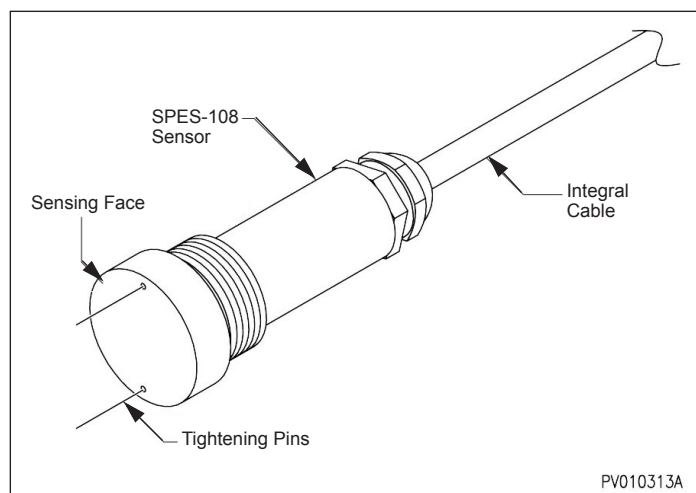
1.2 Main Unit Interventions

• A hole must be bored in the throat ring or bottom ring.

• Integral cables must be routed and protected from the sensor all the way to the acquisition unit.

⚠ Caution
• Installation guidelines and connection instructions must be thoroughly followed to ensure a safe and proper operation. • In order to complete the commissioning, VibroSystM must be contacted when Section 2.2 (Assessing the actual sensitivity) is reached.

2. SENSOR OPERATION

2.1 Connecting the SPES-108 Sensor

The SPES-108 sensor must first be connected to a 24VDC power supply and a receiving instrument. It is important to confirm the sensor's functionality before proceeding with a permanent installation.

Integral Cable Color Code	Designation	Specifications
Red	Power Supply	+24 VDC
White	Current Output	7.2-20 mA (proportional to sensor's full range)
Blue	Common	0 V
Yellow	Voltage Output	2 - 10 V (proportional to sensor's full range)

Load at current output: 500 Ω max.
Load at voltage output: 10 kΩ min.

⚠ Important Information
• The integral cable shield on the SPES-108 **is not** connected to the sensor side. It must always be connected to the ground on the instrumentation side.

2.2 Assessing the Actual Sensitivity

The SPES-108 proximity sensor is calibrated to produce a linearized output based on an FE360 steel target. Because the sensitivity of eddy current sensors is affected by the target's material, the actual sensitivity must be determined.

ⓘ Important Information
• Failure to correctly assess and compensate the sensitivity will result in incorrect measurement results as presented in the illustration below.

SPES-108 Calculated Distance vs Sensor Current Output
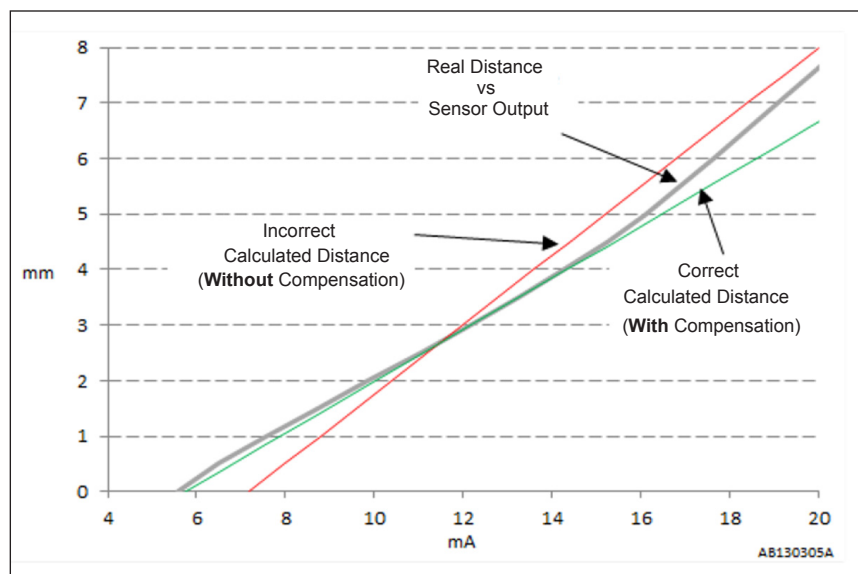
! Important Information
• Section 2.2.1 must be completed **BEFORE** installing the sensor. Sections 2.2.2, 2.2.3, and 2.2.4 must be completed **AFTER** installing the sensor.
• In the examples below, calculations are in metric format. All distances may also be measured in inches with the resulting values used in the same formulas.

2.2.1 Measuring Current Output (I_{out}) and the Corresponding Distance

To assess the sensor's actual sensitivity, physical distance and current measurements must first be taken using a target made of the **same material** as the real target. Minimum dimensions for the target are: 75mm x 75mm x 2mm *[3" x 3" x 1/16"]*.

Proceed as follows:

Fill the table with measurements (distance vs current), equally distributed on the full current scale. Add **non- metallic** spacers between the sensor's tip and the target until I_{out} max. is approximately reached. Note down the current value and the distance (total spacer thickness) in the table. Gradually remove spacers to approximately reach the next I_{out} level and again, write down the current value and distance. Repeat until the table is filled. The last I_{out} value is measured without spacers (0mm), with the sensor's tip placed directly against the target.

Recorded Distance Values vs I_{out} for SPES-108

Ideal level of I_{out} (mA)	20	17.9	15.7	13.6	11.5	9.3	7.2
Measured I_{out} (mA)							
Measured distance (mm)							0

Example of Recorded Distance Values vs I_{out} for SPES-108

$$I_{op} = 11.9 \text{ mA}$$

$I_{out\,B}$ $I_{out\,A}$

Measured I_{out} (mA)	20.5	18	15.5	13	10.6	8.1	5.6
Measured distance (mm)	8	6.2	4.65	3.35	2.3	1.2	0

d_B d_A

2.2.2 Taking a Measurement with the Sensor Installed

With the sensor now installed, take a measurement and note the real operating current (I_{op}).

ⓘ Important Information
• For Kaplan turbines, I_{op} has to be measured with the blade positioned in front of the sensor.

Example with SPES-108: I_{op} = 11.9 mA

2.2.3 Calculating the Sensitivity

Select two points in the table on either side of the value closest to I_{op}. These two points (A & B) will be used to define the linear equation. The selected points should be at an equal distance from I_{op}. Ideally, point A should be at I_{op} - 2.5 mA and point B at I_{op} + 2.5 mA.

For example, if I_{op} = 11.9 mA:

Point A: I_{op} - 2.5 mA= 9.4 mA   (closest correspondence in the table: $I_{out\,A}$ = 10.6 mA, d_A = 2.3 mm)

Point B: I_{op} + 2.5 mA=14.4 mA (closest correspondence in the table: $I_{out\,B}$ = 15.5 mA, d_B = 4.65 mm)

a) Using selected points A and B, calculate «**m**» (the sensitivity or gain).

	Example	
$m = \dfrac{d_B - d_A}{I_{outB} - I_{outA}}$	$m = \dfrac{4.65 - 2.3}{15.5 - 10.6}$	**= 0.48**

b) Using the formula below, calculate «**b**» (the y-intercept) of the linear equation.

	Example with values closest to I_{op}	
$b = d - (m \times I_{out})$	$b = 4.65 - (0.48 \times 15.5)$	**= - 2.79 mm**

c) The equation to calculate the compensated distance corresponding to the sensor current output is the following:

d_C = (m x I_{out}) + b

  Where:
    d_C is the calculated distance (in mm)

d) Verify the «**m**» and «**b**» calculated values by applying the following formula on the measured value between the **A** and **B** coordinates:

for I_{out} to equal 13 mA, verify that d_C = 3.35 mm (± 10% of range):

d_C = (0.48 x 13) - 2.79 = **3.45 mm**

2.2.4 Adjustment Through the ZOOM Configuration Software

Proceed with the final adjustment through the ZOOM Configuration software. Select **Sensor Configuration**, and in the **Range** tab of the dialog window, enter the **Maximum** and **Minimum** values of the **Raw output range**.

Formulas for Adjusting the Raw Output Range

Maximum = (m x 20 mA) + b
Minimum = (m x 4 mA) + b

Note: In the **Trending and alarm range** section, the **Maximum** and **Minimum** values must be within the limits of the **Raw output range**.

Example with Calculated Values

Trending and alarm range adjusted to the limits of the raw output range

Maximum = (0.48 x 20 mA) - 2.79
Minimum = (0.48 x 4 mA) - 2.79

3. SENSOR INSTALLATION OVERVIEW

3.1 Sensor Positioning

⚠️ **Caution**
• The SPES-108 sensor must be connected correctly with the cable well protected against any sort of mechanical damage.

Before deciding where to install the sensor, consider the following:

- The sensor's sensing face must face the target.

- The maximum cable length (integral cable + extension) must be established. From the SPES-108 sensor to the acquisition unit, the maximum distance is 300 m *[984 ft]* for the current output and 100 m *[328 ft]* for the voltage output.

- The cable and the back of the sensor must be protected against debris and turbulence. The submersible cable must be firmly secured to prevent premature aging.

ℹ️ **Important Information**
• VibroSystM recommends relying on the services of a trained technician for supervising the installation of these proximity sensors and finalizing configuration of the ZOOM® Software.

3.2 Positioning in a Kaplan Turbine

VibroSystM recommends using one SPES-108 sensor per turbine blade. If the turbine is in place, install the sensors between the blades to avoid damage.

Sensors must be equally distributed around the unit. All sensors must be aligned at exactly the same vertical height, corresponding to the center of the blades (or the blades' rotation axis, if applicable).

Kaplan Turbine Sensor Positioning


PV120528B
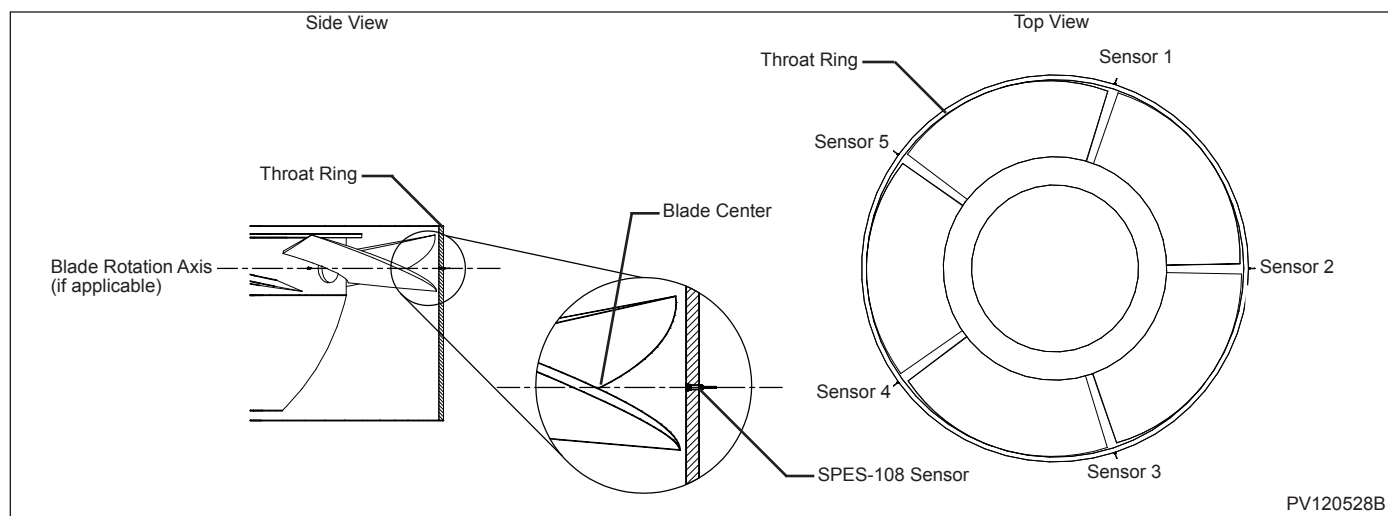
⚠️ **Caution**
• The SPES-108 and the blade's angular positions in relation to the synchronization probe must be established. This information will be required during configuration in the ZOOM software.

3.3 Positioning in a Francis Turbine

To monitor turbine displacement in a Francis turbine installation, sensors must be installed at a 90-degree angle from each other, facing the runner band. The sensor's angular position in relation to the synchronization sensor must also be determined.

Francis Turbine Sensor Positioning


SIDE VIEW   TOP VIEW

PV050313A
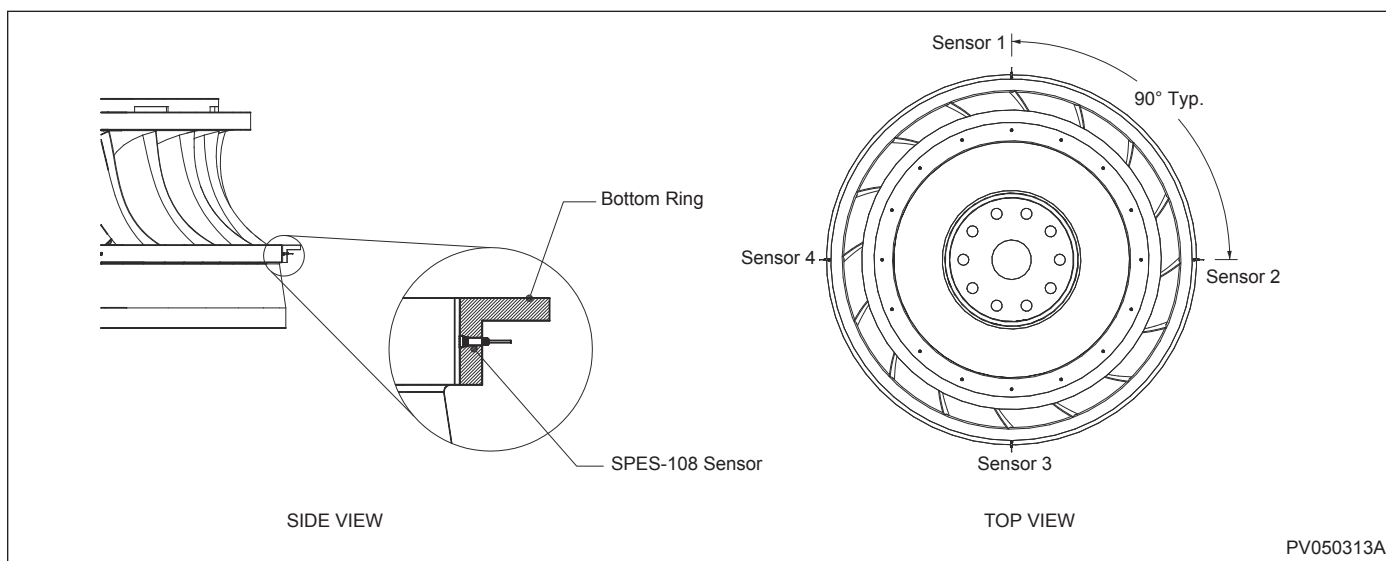
3.4   Preparing the Chamber for the Sensor

The chamber must be perpendicular to the throat ring or bottom ring. When preparing the chamber for the sensor, the precision of the boring is critical for a tight fit installation.
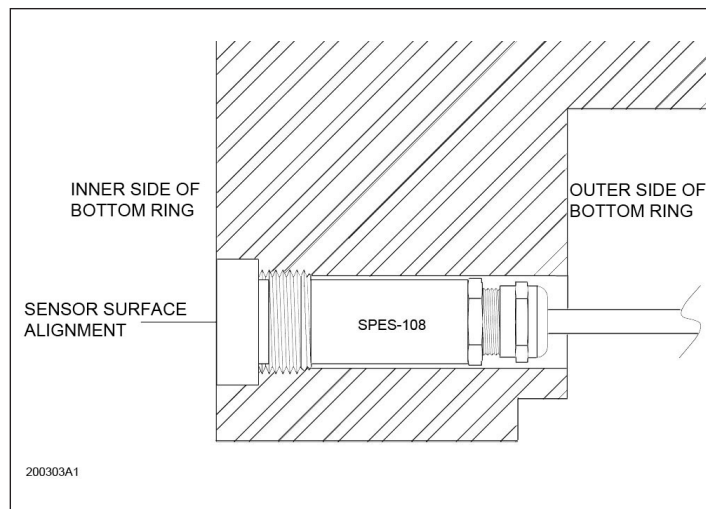
⚠ Important Information
• In order to get the sensor properly secured inside the chamber, the drilling must be concentric.
• The following installation guidelines are for installation on a bottom ring.

Chamber Preparation
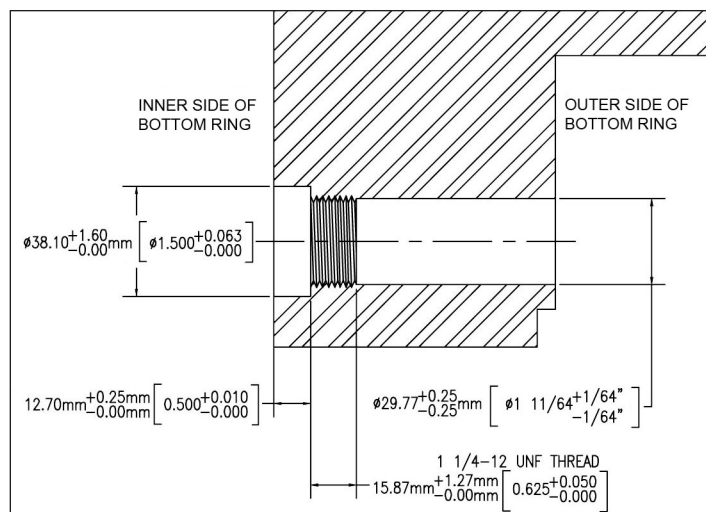
1.   Drill the chamber into the ring.

Fitting the Sensor Inside the Chamber

2.   Place a rod between the tightening pins, hold it firmly with a pair of pliers and turn clockwise to temporarily insert the sensor inside the chamber. Make sure the sensor can be easily inserted and fits perfectly inside the chamber.
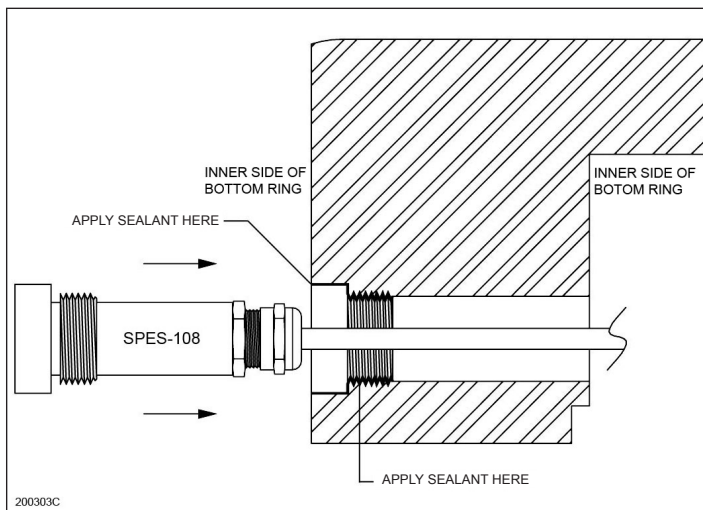
3.5 Installing the Sensor

⚠ Caution
• To preserve the sensor's long-term waterproofness, do not install it if the integral cable's outer sheathing shows any signs of damage.

Thread Sealant Application

1. To ensure waterproofness, apply sealant as pointed out in the illustration.

2. Place a rod between the tightening pins, hold it firmly with a pair of pliers and turn clockwise until the sensor is firmly secured inside the chamber. Make sure that it fits perfectly inside the chamber.

3. Once the SPES-108 sensor is firmly secured, remove the tightening pins.

4. Let the sealant dry according to manufacturer specifications.

APPENDIX: TEMPLATE FOR RECORDING DISTANCE VALUES VS I_{out}

Unit no.: _____ Sensor S/N: _____ Position: _____

Measured I_{out} (mA)							
Measured distance (mm)							0

Unit no.: _____ Sensor S/N: _____ Position: _____

Measured I_{out} (mA)							
Measured distance (mm)							0

Unit no.: _____ Sensor S/N: _____ Position: _____

Measured I_{out} (mA)							
Measured distance (mm)							0

Unit no.: _____ Sensor S/N: _____ Position: _____

Measured I_{out} (mA)							
Measured distance (mm)							0

Unit no.: _____ Sensor S/N: _____ Position: _____

Measured I_{out} (mA)							
Measured distance (mm)							0

Unit no.: _____ Sensor S/N: _____ Position: _____

Measured I_{out} (mA)							
Measured distance (mm)							0