ZEN PRO

CALIBRATION MANUAL

v1.0

smartsystem

MADE IN ITALY

General Index

1 Why recalibration is important once in a while

In the ever-evolving landscape of precision measurement, the accuracy of digital level indicators is paramount, particularly those utilizing MEMS (Micro-Electro-Mechanical Systems) sensors. As these sensors are inherently sensitive to a broad spectrum of environmental factors, periodic recalibration becomes essential to maintain their reliability and precision.

MEMS-based sensors, integral to modern digital level indicators, exhibit remarkable sensitivity to external influences such as varying magnetic fields and changes in gravitational pull sensed by gyroscopes. Over time, these influences can cause subtle drifts in sensor readings, potentially leading to measurement errors. This is due to the fact that MEMS sensors rely on microscopic mechanical elements that can be affected by environmental conditions, aging of materials, and even internal stresses that develop over time.

Recalibration ensures that these sensors are adjusted to align with their intended performance specifications. By recalibrating, we account for discrepancies that arise from external magnetic interference, recalibrate gyroscopes to compensate for drift, and correct any non-linearities that might have developed. This process not only enhances the accuracy of the digital level indicator but also extends its operational lifespan by addressing minor issues before they escalate into significant faults.

In conclusion, periodic recalibration of digital level indicators with MEMS sensors is not merely a procedural formality but a crucial maintenance practice. It ensures that these instruments continue to deliver reliable and precise measurements, adapting to the variable influences that can affect their performance.

2 Preparing for Accurate Sensor Calibration.

Calibration of sensors is a crucial process that ensures accurate and reliable sensor performance.

One vital aspect of this calibration process is selecting an environment free from electromagnetic interference.

Such interference can severely affect the sensor's ability to measure accurately, leading to skewed data or inconsistent readings. By performing calibration in an area devoid of electromagnetic interference, we minimize these risks, thereby enhancing the precision of the sensor's output.

Additionally, conducting calibration on a non-metallic surface, such as a **wooden table,** further reduces potential interference. Metal structures, commonly found in standard tables, can inadvertently introduce electromagnetic fields or affect the sensor's magnetic measurements. A wooden table, by contrast, acts as a neutral surface that does not interact with the sensor's magnetic and electric fields, helping to preserve the purity of the calibration process.

It is crucial that the table used for calibration is as flat and as level with the ground as possible in all directions, especially for defining the Sensors’ Absolute Offsets.

Ensuring these conditions during calibration helps in setting a reliable baseline and ensures that the sensors operate optimally in their intended applications, ultimately contributing to the integrity and accuracy of any data they collect.

It is suggested to remove the clamp hook and the knob from the Zen PRO to take advantage of the flat planes offered by the clamp as fulcrum, anchor or reference plane for the following procedures.

During this procedure, the Zen PRO should be powered solely through its 2-pin port, with no XT Device connected. It is completely normal for the status LED to blink red in standard operating mode. This indicates to the user that no XT Device is detected, as outlined in Paragraph 12 of the Zen PRO User Manual. This information is reiterated here for your convenience.

Color	Appearance	Mode	Description
Blue	Solid	Normal	Normal Operation
Red	Blinking	Normal	XTBus communication error
Purple	Solid	Calibration	Sensors in internal calibration mode
White	Solid	Calibration	Sensors in absolute offset calibration mode

3 Running the Internal Calibration for Sensors

After identifying an optimal environment as described in Paragraph 2, we can proceed with the procedure to execute the internal calibration for sensors.

To enter in this mode, just click 5 times the main button.

The status LED will illuminate in **WHITE**, confirming that the device is now in calibration mode.

To exit this mode without overwriting the internal calibration parameters, press the main button five times again.

The Offset and Balance LEDs indicate the quality of the parameters stored in the sensors relative to the previous calibration.

A **green** color signifies a good calibration value, while a **red** color indicates a poor one compared to the values stored at the factory.

Please note that the **OFFSET LED** reflects the **mechanical** aspects of the sensor, while the **Balance LED** pertains to the **magnetic** components. It's normal for the Balance LED to initially display red, as magnetic fields are constantly fluctuating over time.

During the calibration process, the colors of the two LEDs will change, indicating the current status of the calibration. Be attentive to these indicators and review them once the device is returned to its standard position. This position not only facilitates easy access to ports and controls but also aligns the device for optimal performance and interaction.

This involves placing the device with the connector facing upwards and ensuring that the engraving marks are directly in front of the operator.

The internal calibration of the sensors involves two primary steps:

- Six Steady Positions
- Rotation Around each Axis

The goal of this procedure is to achieve both LEDs displaying green, which confirms a successful and reliable calibration.

This desired result can sometimes be achieved immediately after completing the first step.

3.1 Six Steady positions

A crucial part of this process involves methodically placing the device on a flat surface, exposing each of its six faces to the table. By doing so, you ensure that the sensors can accurately capture data from all orientations, which is vital for devices that rely on multi-directional inputs.

Step-by-Step Guide:

1. **Preparation:**
    - Choose a stable and level surface, like a wooden table, to minimize interference during calibration.
    - Ensure the area is free from electromagnetic interference and any objects that could obstruct the device's placement.

2. **Positioning Each Face:**
    - Begin by placing one face of the device flat against the table. Ensure that it's stable and not at an angle, allowing the sensors to gather accurate data.
    - Hold the device in this position for at **least five seconds**. This duration allows the sensors to stabilize and adjust, capturing the necessary information related to this orientation.

3. **Rotating the Device:**
    - Carefully rotate the device to present a different face to the table. It’s important to be gentle during this transition to avoid introducing any additional movement that might skew sensor readings.
    - Once positioned, hold this new face steady on the table for another five seconds. Repeat this process for all six faces of the device.

4. **Maintaining Consistency:**
    - Throughout the process, ensure that each face rests completely flat against the table and remains steady for the entire duration. Consistency is key to obtaining reliable calibration data.

5. **Final Checks:**
    - After all six faces have been measured, review the process to ensure no steps were missed. A complete rotation and positioning cycle is crucial for thorough calibration.

After completing the calibration process by positioning each of the six faces of the device against the flat surface, the next step is to return the product to its standard operating position.

Keep it in Standard position **for at least 2 minutes** without any intervention and vibration on the table. After this period has passed, press and hold the menu button until the device exits calibration mode and returns to normal operation.

This ensures that all calibration settings are finalized and the device is ready for accurate use.

If both LEDs were green before pressing the menu button, there is no need to proceed executing the Rotation Around an Axis procedure.

3.2 Rotation Around each Axis

If the Six Steady Position procedure does not result in both LEDs turning green, it is necessary to perform the Rotation Around Each Axis procedure. To re-enter calibration mode, simply press the main button five times, as you did previously.

To complete the Rotation Around Each Axis procedure, the user must rotate the product around each of the three axes: Roll, Tilt, and Pan.

1. **Roll Axis:**
   - Start by rotating the device 360 degrees clockwise, then return it to its initial position.
   - Next, rotate it 360 degrees counterclockwise and return it to the initial position.
2. **Tilt Axis:**
   - Perform a 360-degree clockwise rotation, then bring the device back to its starting position.
   - Follow with a 360-degree counterclockwise rotation, again returning to the initial position.
3. **Pan Axis:**
   - Rotate the device 360 degrees clockwise and return to the starting point.
   - Then, rotate it 360 degrees counterclockwise and return to the initial position.

Each rotation should be completed in approximately 2 seconds. This precise movement ensures that the sensors are calibrated accurately across all orientations.

After completing all of these rotations, place the product in its standard position, with the connector facing upwards and the engraving marks in front of you. Hold it in this position for at least 2 minutes. This allows the sensors to stabilize and ensures that all calibration data is accurately logged for optimal device performance.

Just as with the Six Steady Positions procedure, once you have placed the product in its standard position, press and hold the menu button until the device exits calibration mode and returns to normal operation.

If, after completing this procedure, you still do not achieve an all-green LED setup, shut down the product and attempt the calibration in a different location. The magnetic field in the current environment may be interfering with the calibration process.

4 Recalibrate the Sensors' Absolute Offset

Once the sensors are correctly calibrated internally, recalibrating the absolute offset values is typically unnecessary. This process requires a granite flat plane that is perfectly parallel to the earth, which adds complexity that is usually not needed with a successful internal calibration.

Instructions:

1. **Verify Internal Calibration:**
    - Ensure that the internal calibration has been completed properly. If both LEDs indicate a green status, your device is calibrated and ready for use.
2. **Consider Absolute Offset Recalibration Only If Necessary:**
    - Recalibration of absolute offsets should only be considered if you have specific requirements that demand it.
    - It involves using a granite flat plane precisely parallel to the earth, making it a complex and precise task.
3. **Proceed Only If Equipped:**
    - If you decide to proceed with absolute offset recalibration, ensure you have access to the appropriate tools and settings required for this process.

Recommendation: In most cases, a successful internal calibration makes recalibrating the absolute offsets unnecessary, thus saving time and maintaining optimal device performance.

If you choose to proceed with recalibrating the sensors' absolute offsets, it is essential to find a wooden table that is as parallel as possible to the earth's ground in both directions. The use of a wooden table helps minimize interference from metallic surfaces, ensuring a more accurate recalibration process.

To enter in this mode, just click 4 times the main button.

The status LED will illuminate in **PURPLE**, confirming that the device is now in absolute offset calibration mode.

To exit this mode without overwriting the parameters, press the main button four times again.

Unlike the internal calibration procedure, which addresses all aspects of the sensor's internal components, the absolute offset calibration **allows for specific orientations to be overwritten**. This capability helps maintain consistent data by adjusting only those parameters that exhibit unusual behavior during normal operation, while preserving the factory settings for other orientations.

In absolute offset calibration mode, the OFFSET LED will blink to represent the specific orientation of the device. This visual cue helps the user verify whether the LED pattern changes as the device's orientation is altered. Meanwhile, the Balance LED will operate according to the following table:

Color	Description
Blue	New Offset saved in RAM for the specific orientation
Red	No Offset is present for the specific orientation
Green	A valid Offset is present for the specific orientation

To save a new offset in **RAM**, position the Zen PRO in the desired orientation and press the menu button once. The corresponding LED will turn blue, indicating that the new offset has been successfully saved **but not committed to flash memory.**

Once you have completed the procedure for all the axes you intend to adjust, press and hold the main button until the product re-enters normal operating mode.

This action commits the new values to the internal memory, confirming the successful execution of the procedure.

If you decide not to save the new parameters, simply click the menu button four times to exit the calibration mode without saving. In an urgent situation, you can also remove the power from the product to prevent any changes from being saved.