GeoMax GNSS

TAG

BEST PRACTISE

Version 1.00
English

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1 INTRODUCTION / WORKING PRINCIPLE

The Zenith35 TAG receiver contains additional sensors to determine the tilt value and the orientation of the GNSS receiver in order to derive corrected coordinates of measurements with tilted pole.

- A **tilt sensor** to determine the degree of inclination. At Zenith35 series the tilt angle is measured by accelerometers.
- A **compass** to determine the direction of tilt. At Zenith35 series the direction is measured by magnetometers. Since the compass principle is based on the earth magnetic field, measuring with the compass close to metal objects with an own magnetic field or objects generating magnetic fields such as generators is error prone.

2 GENERAL

2.1.1 Sensor Latency

The reaction time of the sensor when changing from carrying position (over shoulder) to vertical is about 2 sec.

2.1.2 Sensor output rate (Hz)

The maximum output rate of the tilt and orientation values is 20 Hz.

3 TIPS & TRICKS

3.1 CALIBRATION

3.1.1 Temperature impact

<u>Test setup:</u>

The receiver was properly calibrated and a position with tilted pole measured. Then the Zenith35 receiver was cooled down to -40°C. Afterwards the same point was measured, again with tilted pole. Those positions were compared to the initially measured position. This test should simulate temperature drops typical when taking out the receiver in winter times from the car to the outside.

<u>Conclusion:</u>

The temperature drop caused an increase of the error budget by about 3-4 cm. After recalibration under outside condition the receiver worked properly. → It is recommended to re-calibrate the units after a temperature shock.

3.1.2 Drop impact

<u>Test setup:</u>

The receiver was properly calibrated and a position with tilted pole measured. The antenna mounted on a pole was dropped vertically from a height of about 10 cm onto the street. After the drop the position of a known point was measured at various tilt angles and compared with the initial position. At the end a new calibration was done to verify that calibrating the antenna resets the error, caused by drop.This simulates e.g. the drop during surveying from a curb to the street.

Conclusion:

The drop caused an increase of the error budget by about 1-2 cm. After recalibration, the receiver worked properly. → It is recommended to re-calibrate the receiver after drops.

3.1.3 Vibration impact

Test setup:

The receiver was properly calibrated and a position with tilted pole measured. Then the Zenith35 was transported in its container 5 times for 100km over a period of 5 days. After each day the position of a known point was measured at various tilt angles and compared with the initial position.

These tests should show the influence of typical vibration and aging of calibration as appearing in daily use by a surveyor.

Conclusion:

The vibration caused an increase of the error budget by about 1-2 cm after 100km. After recalibration, the receiver worked properly. → It is recommended to re-calibrate the receiver after transporting.

3.1.4 Aging impact

Test setup:

The receiver was properly calibrated and a position measured. Then the unit was not used for 5 days. After 5 days the position of a known point was measured at various tilt angles and compared with the initially measured position.

These tests should show the influence of typical aging of calibration.

Conclusion:

After 5 days no aging impact was determined. Nevertheless after longer period a recalibration is recommended.

3.1.5 Tips for successful calibration

- The calibration process needs to be trained a few times in order to achieve a successful calibration.
- In cases the calibration failure rate seems to be very high, it could be that an magnetic storm is appearing currently. You can check online about the so called "k-index". The K-index is used to characterize the magnitude of geomagnetic storms
    - http://spaceweathernews.com
    - http://www.swpc.noaa.gov/
    - http://www.geomag.bgs.ac.uk/images/kandkp_bar.jpg

  In case of magnetic storms calibration process may fail.
- Check straightness of the pole. Using a bended pole fully effect the accuracy of subsequent measurements

- Use the same pole for measurements as used for calibration.
- Since the e-bubble is calibrated against the pole bubble, make sure the pole bubble is properly calibrated
- Read & follow the texts displayed at calibration process
- Rotate slowly & steadily. Please note that a special tool for holding the pole straight is not required.
- Calibrate in areas not disturbed by magnetic fields.
- At the last step of calibration when measuring a point in 4 directions with tilted pole, we recommend to lean the pole to the shoulder in order to keep the pole calm during the calibration process. Please take care that the GSM/UHF antenna is not bended to your body or the pole.
- When you are attaching the antenna to the calibration tool make sure you countersink the pin of the tool into the designed notch at the antenna's bottom.
- It is recommended to use the Extra-Safe mode for the RTK measurements.

Note that calibrating the compass in magnetic disturbed areas does not compensate the error caused by those disturbances!

3.1.6 Recommendations

A re-calibration of Zenith35 TAG is needed after …

- *a significant drop (e.g. from curb or pole topple over)*
- *a change of a location with different gravity*
- *a significant temperature change (≈ 30° or more)*
- *a long period without calibration*
- *a transport (→ vibration)*
- *a battery is inserted that was never inserted before*
- *a firmware upgrade*
- *a visit in Service*

3.1.7 Consequences not calibrating

Not calibrating the unit after events as listed above negatively affects the accuracy of the measured points.

3.2 Measuring with tilt & orientation (Single mode)

Measuring in "single mode" both sensors; the inclination sensor and the compass is used.

The inclination sensor provides the degree of pole tilt while the compass provides the direction in which the pole is tilted. Knowing both values, the software calculates the corrected position of the ground point.

3.2.1 Limitations/ Strengths & Use Cases

- Weak accuracy in magnetic disturbed areas (power lines, close to magnetic objects like cars, metal lamp poles, steal reinforced objects like houses, bridges, generators, steal pillars,…)
- Recommended maximum tilt range is 15° - equals a deflection of 52 cm from the vertical at 2 m pole height.

+ E-Bubble allows to concentrate on controller instead of continuously changing focus from pole-bubble to controller
+ Quality documentation since tilt values to each single point is stored in database.
+ No change compared to the usual workflow – only one measurement required
+ Improves the accuracy of points measured in "auto-mode", since tilt related tolerance levels can be applied.
+ Time savings up to 40% since there is no need any more to keep the pole vertical
+ Ideal for topographic survey and stake outs

3.2.2 Accuracy (typical)

Following values represent an average achieved during tests under normal to favourable conditions

2D- Position

5° Tilt:	About ±1 cm
10° Tilt:	About ±2 cm
15° Tilt:	About ±3 cm

1D- Position (Height)

5° Tilt:	About ±1 cm
10° Tilt:	About ±1.2 cm
15° Tilt:	About ±1.5 cm

!!! Please note that these error needs to be applied on top of the standard GNSS accuracy.

3.2.3 Examples & Findings

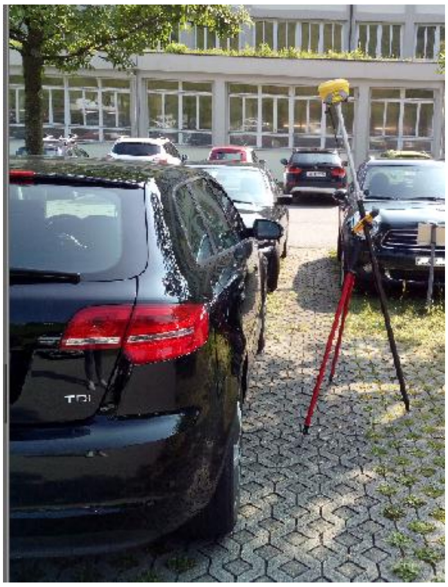
3.2.3..1 Good conditions to work with single measurement mode (tilt + compass)

Following examples showing locations with low to none magnetic influence, where you can expect the above listed typical point accuracy.

3.2.3..2 MEDIUM CONDITIONS TO WORK WITH SINGLE MEASUREMENT MODE (TILT + COMPASS)

Following examples showing locations with some magnetic influence, resulting in point accuracy worse as typical.

If the reached accuracy is not sufficient - in those cases it might be recommended **either to switch off the Single mode** at all **and measure in conventional way**, holding the pole vertical or if not possible, to **use the Dual mode**. Typical situations are measurement on car-parking lots, house corners, close to metal fences….



3.2.3..3 Bad conditions to work with single measurement mode (tilt + compass)

Following examples showing locations with high magnetic influence, resulting in a point accuracy about 5-10 times worse as typical. Errors of 30-50 cm appeared during our tests....

In those cases it is mandatory either to switch of the compensation at all and measure in conventional way, holding the pole vertical or if not possible, **to use the dual mode to eliminate the magnetic influence**.

Typical situations are measurement close to cars, lamp poles, and power lines






3.2.4 Recommendations

- Align the keypad towards yourself- this makes sure that the e-bubble reacts in the same direction as the bull`s eye bubble on the pole.
- Keep away from metal objects e.g. cars, lamp poles, steel constructions, concrete buildings with metal inlays
- Keep away of components generating magnetic fields like transformers, powerlines,…

3.3 Measuring with tilt only (Dual mode)

3.3.1 Limitations/ Strengths & Use Cases

- Two measurements required to calculate coordinate
+ Resistant to magnetic fields
+ Recommended maximum tilt range is up to 30°
+ Ideal for measuring inaccessible points (gully under car, eaves,…)
+ E-Bubble allows to concentrate on controller instead of continuously changing focus from pole-bubble to controller
+ Quality documentation since tilt values to each single point is stored in database.

3.3.2 Accuracy (typical)

The tilt sensor is specified with an accuracy of +- 0.1°, equals to ±3.4 mm at 2 m pole height.

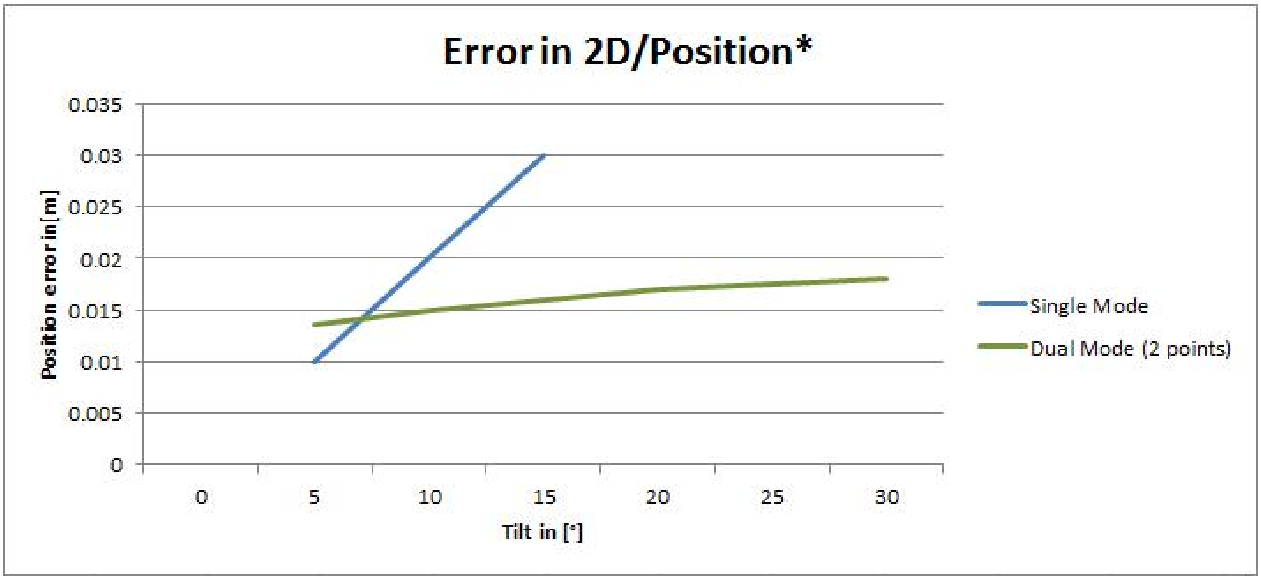
!!! Please note that this error needs to be applied on top of the standard GNSS accuracy.

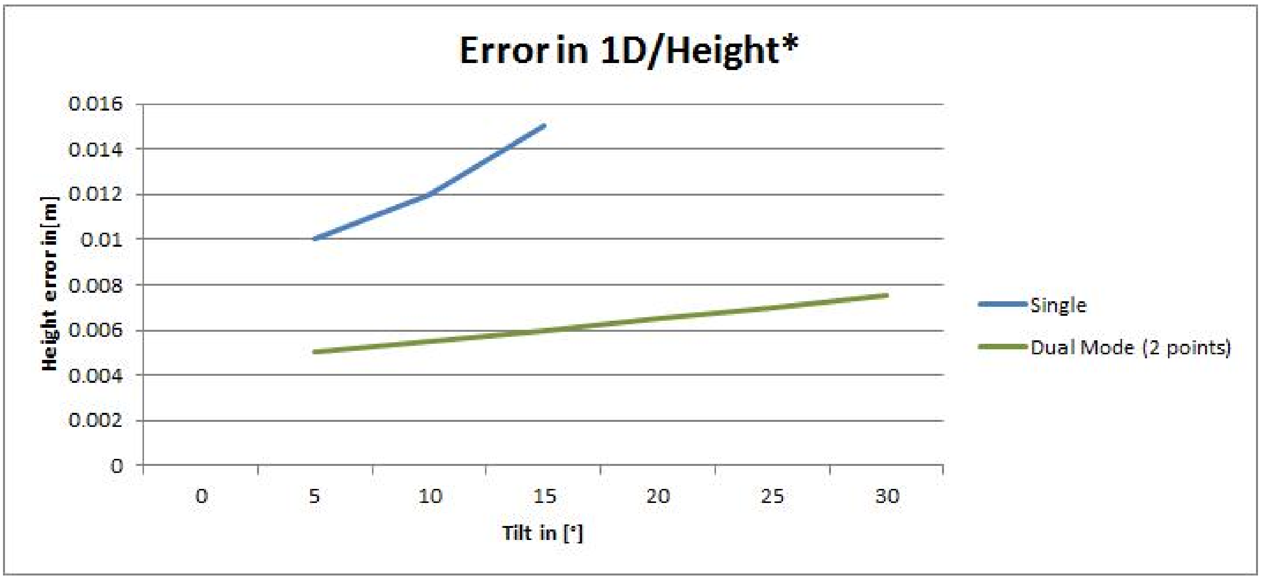
3.3.3 Examples & Findings

3.3.4 Recommendations

- Avoid glancing intersections of the pole positions. Intersection angle of 90 between both pole setups is ideal. → Same geodetic rule as for applied at TPS setups
- Accuracy depending on pole height → Reduce height as far as possible!

3.4 Accuracy comparison single vs dual mode





* The graph represents an average achieved during tests under normal to favourable conditions. These errors need to be applied on top of the standard GNSS accuracy.

Conclusion:

- For inclinations below 5°, the single mode delivers better 2D accuracy than the dual mode. For inclinations >15° the dual mode must be used.

3.5 ERROR MESSAGES & ITS MEANING

- **Magnetic interference (shown during calibration)**
    - This is just a message and can be a taken as a note there is some magnetic interference detected in this area.
- **Non-stationary (shown during calibration)**
    - The antenna is moving - keep the antenna fixed and do not move.
- **Keep tilt less than 0.5° (shown during calibration)**
    - Make sure your pole is not tilted more than 0.5°
- **Keep 25°<tilt angle<35°**
    - Your pole is tilted either less than 25° or more than 35°. Please make sure the pole is tilted between 25° and 35°.