

User Guide

LAST UPDATE | 23.02.2024

Geovane®

True North, the right way!

Get the most accurate wind direction measurement available today

Remove human errors from WRA

Allows for veer measurement (IEC 61400.12.1, 2017)

Determine the yaw alignment of wind turbines (True North orientation)



Index

1	GENERAL USER INFORMATION	7
1.1	Contact information	7
1.2	Warranty and liability	7
1.3	About this user manual	8
1.4	Product disposal	8
1.5	Laser safety	8
2	INTRODUCTION	9
2.1	About the Geovane	9
2.2	Geovane MM (for met mast)	9
2.2.1	Geovane MM: order options and included items	10
2.2.2	Geovane MM ordered without wind vane	11
2.2.3	Geovane MM ordered along with wind vane	12
2.3	Geovane WT (for wind turbine)	13
2.3.1	Geovane WT: order options and included items	14
2.3.2	Geovane WT ordered without wind vane	15
2.3.3	Geovane WT ordered along with wind vane	15
2.4	Accessories	16
3	UNDERSTANDING THE OUTPUT OF THE GEOVANE	19
3.1	Geovane MM + wind vane	19
3.2	Geovane WT	20
4	GEOVANE + WIND VANE	21
4.1	Geovane + wind vane alignment	21
4.2	Wind vane color code wiring (plug-and-play option)	24
4.3	Thies First Class wind vane: how to mount its tail	25
5	TECHNICAL DATA	26
5.1	Operation conditions	26
5.2	True North orientation measurement	26
5.3	Tilt measurement	27

5.4	Absolute maximum ratings	28
5.5	Average current consumption	28
5.6	Mechanics	29
5.7	Dimensions (mm)	30
5.7.1	Geovane.....	30
5.7.2	Alignment collar's dimensions (Geovane WT)	32
6	SENSOR OUTPUTS.....	33
6.1	Analog voltage outputs	33
6.2	Frequency output.....	34
6.3	RS-485 digital output.....	35
7	RS-485 DIGITAL OUTPUT: NMEA 0183	37
7.1	Answers from the Geovane.....	38
7.1.1	ORN message: True North orientation.....	38
7.1.2	ORX message: extended ORN message.....	39
7.1.3	SUN message: solar coordinates	41
7.1.4	RMC message: recommended minimum specific GNSS data	41
7.1.5	INF message: Geovane's features	43
7.1.6	ORT message: True North nacelle's orientation (Geovane WT)	43
7.2	Commands to the Geovane.....	46
7.2.1	PMGV00 command – Echo message request	46
7.2.2	PMGV01 command – ORN message request	46
7.2.3	PMGV02 command – SUN message request	47
7.2.4	PMGV04 command – RMC message request.....	47
7.2.5	PMGV05 command – INF message request.....	48
7.2.6	PMGV10 command – ORX message request	48
7.2.7	PMGV11 command – ORT message request (Geovane WT)	49
7.3	Digital NMEA 0183 communication example	49
8	RS-485 DIGITAL OUTPUT: MODBUS RTU (GEOVANE WT)	51
8.1	Format of the Modbus queries of the master	51
8.2	Format of the responses of the slave.....	52
8.3	Modbus register map	53

9	GEOVANE INSTALLATION (MECHANICAL AND ELECTRICAL)	56
9.1	Installation overview and tips	56
9.2	Mechanical mounting	60
9.3	Connector details and diagram	61
9.4	Cable details	61
9.5	Commissioning and troubleshooting	63
9.5.1	Commissioning: initial read values	63
9.5.2	Troubleshooting: output shows zero	64
9.5.3	Troubleshooting: no response to digital commands	64
9.6	Wind turbine installation and alignment (Geovane WT)	64
10	GEOVANE TOOLS SOFTWARE	70
10.1	Geovane Tools modules	71
10.2	Connecting the Geovane to the PC	72
10.3	Geovane Monitoring Tool module	72
10.4	Geovane Modbus RTU Tool module (Geovane WT)	75
10.5	Geovane Firmware Update Tool module	77
11	CONFIGURATION	80
11.1	Geovane Configuring Tool module	80
11.2	Default configuration	83
12	GEOVANE AND KINTECH DATA LOGGERS	84
12.1	Geovane and Orbit 360	84
12.1.1	Recommended interfacing	84
12.1.2	Channel configuration (Atlas and on-site)	85
12.1.3	Pairing wind vanes with Geovanes in Atlas	88
12.1.4	True wind direction data column (Atlas)	89
12.2	Geovane and EOL Zenith	89
12.2.1	Channel configuration (EOL Manager and on-site)	89
12.2.2	True wind direction data column (EOL Manager)	92
13	EC DECLARATION OF CONFORMITY	94

14	FIRMWARE & SOFTWARE RELEASE CHANGELOG.....	95
14.1	Firmware	95
14.2	Geovane Tools software.....	97

1 GENERAL USER INFORMATION

Thank you for purchasing the Geovane designed and manufactured by Kintech Engineering, a patented invention to finally resolve the inherent uncertainties in traditional wind direction measurement.

Kintech Engineering products are in continuous development. Specifications may be subject to change and design improvements. We invite you to sign up to our newsletter and get the latest news and important updates about the Geovane.

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1.2 Warranty and liability

Kintech Engineering guarantees that the product delivered has been verified and tested to ensure that it meets the published specifications. In case of any manufacturing defect, the product will be repaired or replaced within the first 24 months after the delivery date.

The warranty will not apply if the equipment has been modified or altered without authorization from Kintech Engineering or if the damage is caused by improper installation, intentional damages or external influences e.g., lightning exposure, heavy icing condition or mechanical stress due to inadequate handling. It also excludes, and Kintech Engineering shall not be liable for, any incidental or consequential damages caused by or related to the use of, inability to use or malfunction of this product.

Kintech Engineering does not reimburse expenses incurred for the repair or the reinstallation of the equipment and does not accept any responsibility for any damage caused by the above-mentioned points.

The Geovane does not require calibration, maintenance or glass cleaning.

Remark:

For the transport of the instrument, please use the original packaging.

1.3 About this user manual

Copyrights reserved by Kintech Engineering. Making copies of whole or parts of this document without permission from Kintech is prohibited.

This manual was last modified: 23.02.2024.

Should you have any comments on the product or this manual we will be pleased to receive them at: support@geovane360.com.

1.4 Product disposal

In accordance with the European directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE), these product components must be recycled. This should be done by returning the product to Kintech Engineering or by using an appropriate waste disposal company. This product should not be disposed of in general waste of landfill.

1.5 Laser safety

The Geovane includes a high-precision Class 1 laser beam emitter used to fixate its position with respect to the wind vane.

A Class 1 laser is safe under all conditions of normal use, conforming to the requirements of IEC 60825-1, however, do not stare into the laser beam or direct it towards other people unnecessarily.



2 INTRODUCTION

By adding a Geovane to your wind measurement campaign or to your wind turbine nacelle you are guaranteed to get the most accurate True North orientation measurement available on the market today.

There are **two different models of the Geovane** currently available: the Geovane for **met mast** (Geovane MM) and the Geovane for **wind turbine** (Geovane WT).

Thanks to the **Geovane MM**, it has now become possible for wind farm developers to get rid of the (up to now) greater uncertainty in traditional wind direction measurements: the wind vane mounting bias.

The **Geovane WT**, for its part, allows for high precision yaw adjustment of wind turbines with respect to True North. Aligning all your wind turbines towards the same reference point enables the wind farm operator to compare yaw alignment during operation and determine underperformance due to yaw misalignment.

Throughout this user guide, unless otherwise specified, the term “Geovane” will refer indistinctly to both Geovane MM and Geovane WT.

2.1 About the Geovane

The Geovane is not a wind vane; therefore, it does not provide a wind direction measurement. The Geovane is a solar compass, specifically designed to work in conjunction with wind vanes, ultrasonic anemometers and remote sensing devices; and to be permanently installed in any wind turbine’s nacelle.

Being equipped with high-resolution optoelectronic sensors, composed of 2048 photosensing pixels, the Geovane uses the Sun to **measure the geographical orientation from True North** of the sensor/turbine coupled to it (refer to chapter 3 “Understanding the True North orientation measurement output”).

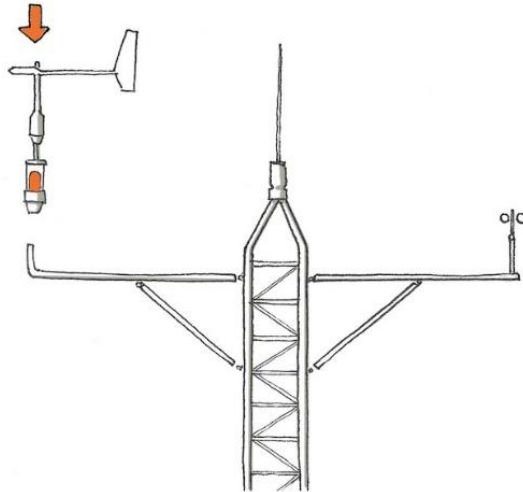
The True North orientation is obtained by comparing the theoretical solar azimuth angle calculated by the Geovane’s embedded processing unit with the observed azimuth value read by its built-in photosensing pixels.

The Geovane offers three types of outputs: frequency, analog voltage and digital over an RS-485 serial interface.

2.2 Geovane MM (for met mast)

The Geovane MM™ has been designed and engineered for its installation on wind resource assessment met mast. It can be installed on existing met masts to correct/verify previous wind direction datasets, in new installations for upcoming wind measurement campaigns, power performance tests, site calibrations, etc.

As soon as the Geovane has been mounted on the mast, together with its wind vane, and it receives sufficient direct radiation from the Sun, the Geovane will offer as output the orientation of the wind vane with respect to True North.



Both met mast and sensor booms can bend and twist over time or in harsh weather conditions, altering the wind direction measurements over time. The Geovane guarantees wind direction datasets immune to any of these effects. Throughout the measurement campaign, the Geovane will provide the updated orientation, achieving absolute accuracy and greater guarantees to external auditors and financial investors.

2.2.1 Geovane MM: order options and included items

The following two sections describe the content of the order options currently available for the Geovane MM: with or without wind vane.

		Item	Order code	
Geovane MM		No wind vane	Geovane	
		Thies FC wind vane	Potentiometer 2K 4.3151.10.312	Geovane001*
	Analog output (TMR) 4.3151.10.173		Geovane003*	
	+	Thies Compact wind vane	Potentiometer 2K 4.3129.10.712	Geovane004*
Analog output (TMR) 4.3129.70.773			Geovane005*	
		Vector wind vane	Potentiometer 1K W200P (see remark in section 2.2.2)	Geovane017*

*The Geovane MM and the Thies wind vane are supplied already coupled and aligned, in a single packaging, as a plug-and-play unit.

In case you want to order the Geovane MM along with a different Thies First Class / Thies Compact part number, please contact sales@geovane360.com or export@kintech-engineering.com.

Even though we do not offer in-house alignment for all the wind vanes on the market, the following list of wind vanes is fully compatible with the Geovane MM:

- Young Wind Monitor. (Default mechanics).
- K360V. (Upon request).

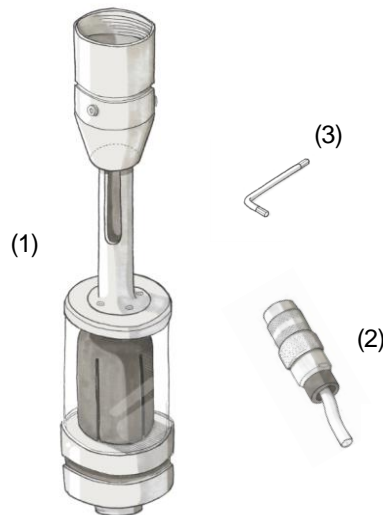
For models not on this list please contact support@geovane360.com.

2.2.2 Geovane MM ordered without wind vane

Arriving at the customer, the delivery includes:

- Geovane MM incl. vertical support boom* for the wind vane. (1)
- 8-pole plug connector. (2)
- 3mm Hex Wrench (Allen key) (3) and x2 DIN 916, M6 x 10 mm grub screws.
- Factory configuration sheet, quality control report and QR code to user guide.

*The vertical support boom has been redesigned and currently differs from the one shown in the drawing below. It consists now of a single piece, without any adapters (see picture on page 60).



Remarks:

This option requires precise alignment of the wind vane. Please carefully follow the instructions in chapter 4.

Vector W200P wind vane must be coupled via Geovane009 mounting adaptor. Refer to section 2.4 for more info on this accessory and to section 5.6 for dimensions.

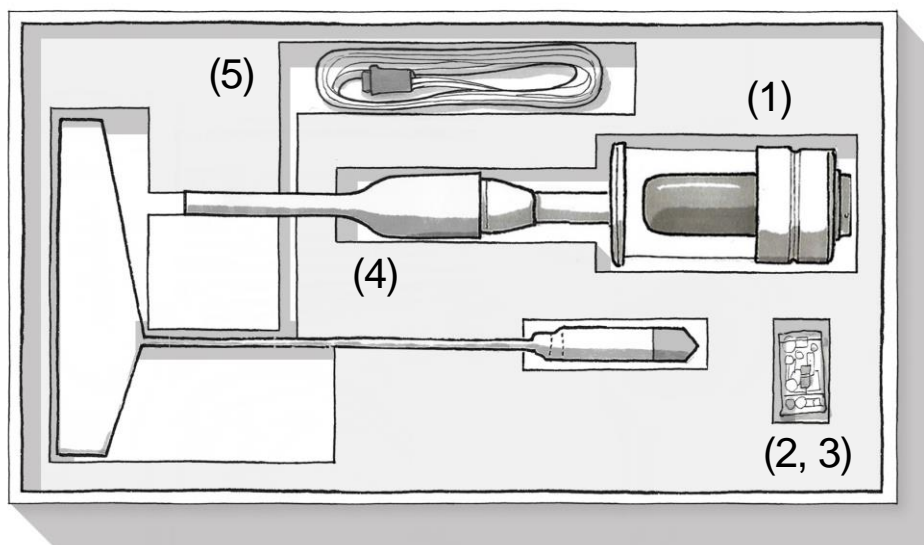
2.2.3 Geovane MM ordered along with wind vane

Kintech offers **complete “plug-and-play” units** in which the Geovane MM has already been aligned with a Thies wind vane (Compact or First Class).

In addition to the items described in section 2.2.2, the delivery includes:

- Thies Compact / First Class wind vane coupled and aligned to the Geovane MM by Kintech Engineering. (4)
- 5.35 m of 0.5 mm² cross-sectioned shielded cable (number of cores depending upon wind vane model), already plugged and secured into the wind vane, ended in an IP68 in-line connector. (5)
- Factory configuration sheet, quality control report and QR code user guide.
- Wind vane documentation and alignment certificate.
- Instructions on how to mount the tail of the TFC wind vane (if applicable).

Refer to section 4.2 for more info on the pinout and color scheme of the wind vane’s 5m cable that comes already connected to the wind vane.



Given that this is a “plug-and-play” unit, the only thing your installation team has to do on site, is to mount this unit on the boom (refer to chapter 9).

Remark:

Both devices are aligned and ready to install. **Do not untighten any of the screws** or the alignment could be lost. Kintech Engineering marks the unions between the wind vane and the geovane with white paint to allow its later verification.

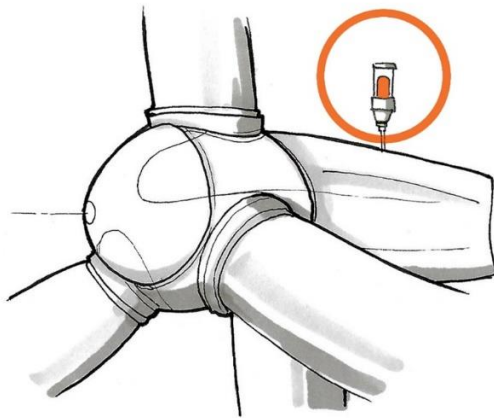
2.3 Geovane WT (for wind turbine)

The Geovane WT™ has been designed and engineered for its permanent installation on wind turbines. The Geovane WT provides the exact orientation of the wind turbine nacelle with respect to True North.

It is very common to encounter situations where the turbine does not orient itself correctly in the direction of the wind. This is known as *yaw misalignment*. The state of the art for detecting and correcting yaw misalignment comprises several methodologies: LiDAR-based measurements, spinner anemometers installed on the hub, control algorithms developed by the OEMs themselves and solutions based on SCADA time series analysis.

Several of these techniques require knowledge of the absolute nacelle orientation measured by the yaw encoder. Unfortunately, the yaw encoder data is not reliable since their zeros are very often misoriented to True North. As a result, the SCADA receives the orientation data with an offset of unknown value.

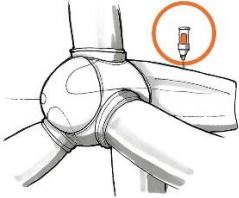
In addition to the zero-bias problem, incremental errors and reset-related errors are not uncommon. All this means that, in practice, wind farm operators cannot make use of the orientation data displayed by the SCADA. Geovane solves this.



Although the purpose of the Geovane WT is to determine the absolute orientation of the wind turbine's nacelle, it is still possible to couple and align a wind vane to it, hence Kintech offers the same wind vane alignment service and packaging than for the Geovane MM.

2.3.1 Geovane WT: order options and included items

The following two sections describe the content of the order options currently available for the Geovane WT: with or without wind vane.

Item		Order code	
Geovane WT	No wind vane	Geovane009	
	Thies FC wind vane	Potentiometer 2K 4.3151.10.212	Geovane010*
Thies Compact wind vane		Potentiometer 10K 4.3151.10.110	Geovane011*
		Analog output (TMR) 4.3151.10.173	Geovane012*
	Thies Compact wind vane	Potentiometer 2K 4.3129.10.712	Geovane013*
		Analog output (TMR) 4.3129.70.773	Geovane014*
	Vector wind vane	Potentiometer 1K	Geovane018*
		W200P (see remark in section 2.2.2)	

*The Geovane WT and the Thies wind vane are supplied already coupled and aligned, in a single packaging, as a **plug-and-play unit**.

In case you want to order the Geovane MM along with a different Thies First Class / Thies Compact part number, please contact sales@geovane360.com or export@kintech-engineering.com.

Even though we do not offer in-house alignment for all the wind vanes on the market, the following list of wind vanes is fully compatible with the Geovane WT:

- Young Wind Monitor. (Default mechanics).
- K360V. (Upon request).

For models not on this list please contact support@geovane360.com.

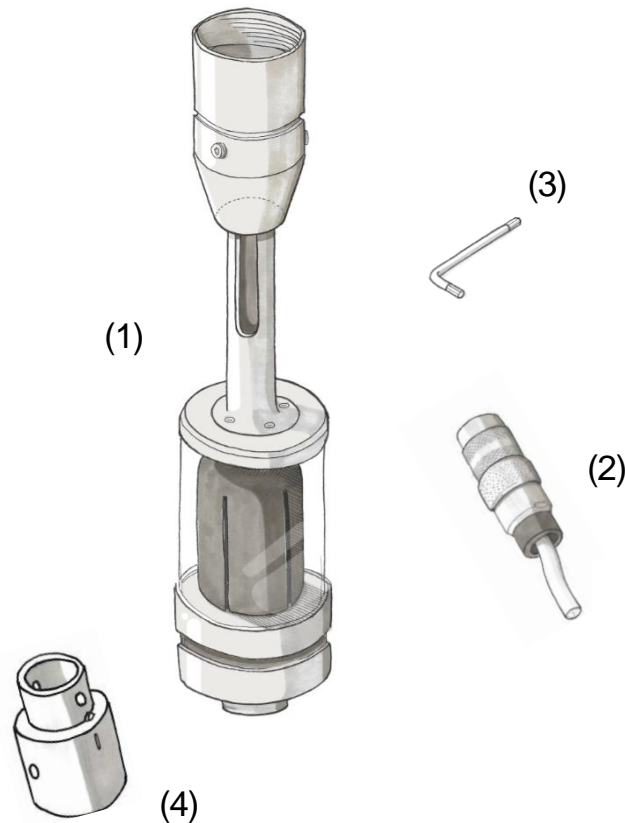
Remark:

The Geovane WT needs to be accurately aligned with the turbine axis by means of the **alignment collar** and the **laser alignment tool** provided by Kintech Engineering (see section 9.6).

2.3.2 Geovane WT ordered without wind vane

Arriving at the customer, the delivery includes:

- Geovane WT (1)*.
- 8-pole plug connector (2).
- 3mm Hex Wrench (Allen key) (3) and x2 DIN 916, M6 x 10 mm grub screws.
- Alignment collar for the precise orientation to turbine nacelle's axis (4).



*The Geovane WT can be ordered with a cover cap that includes the vertical support boom for a wind vane, although the factory **default** consists of a **flat cover cap**.

2.3.3 Geovane WT ordered along with wind vane

Kintech offers **complete “plug-and-play” units** in which the Geovane WT has already been aligned with a Thies wind vane (Compact or First Class).

In addition to the items described in section 2.3.2, the delivery includes:

- Thies Compact / First Class wind vane coupled and aligned to the Geovane WT by Kintech Engineering.
- Alignment certificate.

- 5.35 m of 0.5 mm² cross-sectioned shielded cable (number of cores depending upon wind vane model), already plugged and secured into the wind vane, ended in an IP68 in-line connector.

Refer to section 4.2 for more info on the wiring diagram of the coupled wind vane.

Remark:

Both devices are aligned and ready to install. **Do not untighten any of the screws** or the alignment could be lost. Kintech Engineering marks the unions between the wind vane and the geovane with white paint to allow later verification.



2.4 Accessories



Besides the above-mentioned order options, Kintech can provide the accessories displayed on the table below.

Items Geovane006 and Geovane007 are short wires that facilitate getting started with the Geovane, allowing for office tests and for communication between a PC and the Geovane (see section 9.3 and chapter 9).

Item **Geovane008** is necessary for the alignment of the **Geovane WT** to the rotor axis of the wind turbine’s nacelle (refer to section 9.6 for instructions regarding usage).

Item **Geovane009** is necessary to couple the Vector W200P wind vane to the Geovane.

	Item	Order code
	8-core cable with Geovane’s plug connector soldered (1.5 m)	Geovane006
	USB to RS-485 converter (1.8 m)	Geovane007

	Laser alignment tool including Laserboy II (for Geovane WT)	Geovane008
	Vector W200P mounting adapter	Geovane009

Item **Geovane006** provides full access to the pins of the Geovane for e.g., verifying its interfacing with a given data logger, re-configuring the unit and, in general, running any office tests. The color code for Geovane006 goes as follows:

Pin*	Color	Description	Function
1	White	Out (V1+)	Analog output #1
2	Pink	RS-485 A	RS-485 Data +
3	Green	Supply (+)	Supply 6... 30 V DC
4	Grey	RS-485 B	RS-485 Data -
5	Blue	Out (V2+)	Analog output #2
6	Red	Out (Hz)	Frequency output
7	Brown	Supply (-)	Supply ground
8	Yellow	Out (V-)	Analog output ground

*Refer to section 9.3 for connector details and diagram.

Remark:

Any 8-wire Geovane cable supplied by Kintech Engineering will follow the color code of Geovane006 described in the previous table.

Item **Geovane007** converts from USB standard (PC) to RS-485 (Geovane). The color code for Geovane007 goes as follows:

Color	Description	Function
Black	GND	Device ground supply pin
Red	Power*	+5 V
Orange	Data+(A)	RS-485 Data +
Yellow	Data-(B)	RS-485 Data -

*It can be used to power on the Geovane when configuring it (see chapter 9 for more details), even though a minimum of 6 V must be met in normal operation (see 5.1).

The green and brown wires of the Geovane007 item are not necessary for communicating with the Geovane (they correspond to the 120 Ω terminating resistance terminals).

Refer to section 10.2 for detailed information regarding the interfacing of the Geovane with a PC.

3 UNDERSTANDING THE OUTPUT OF THE GEOVANE

This chapter aims to provide an understanding of Geovane's output: the True North orientation. Geovane is able to precisely determine True North using the position of the Sun and can be accurately coupled and aligned with wind vanes and wind turbines to get their orientation from True North.

When it comes to wind vanes, or any other wind direction sensor, the orientation from True North must be added to the raw wind vane data to correct the dataset, as described in section 3.1. In the case of wind turbines, the Geovane's output indicates the orientation of the rotor axis of the wind turbine, as explained in section 3.2.

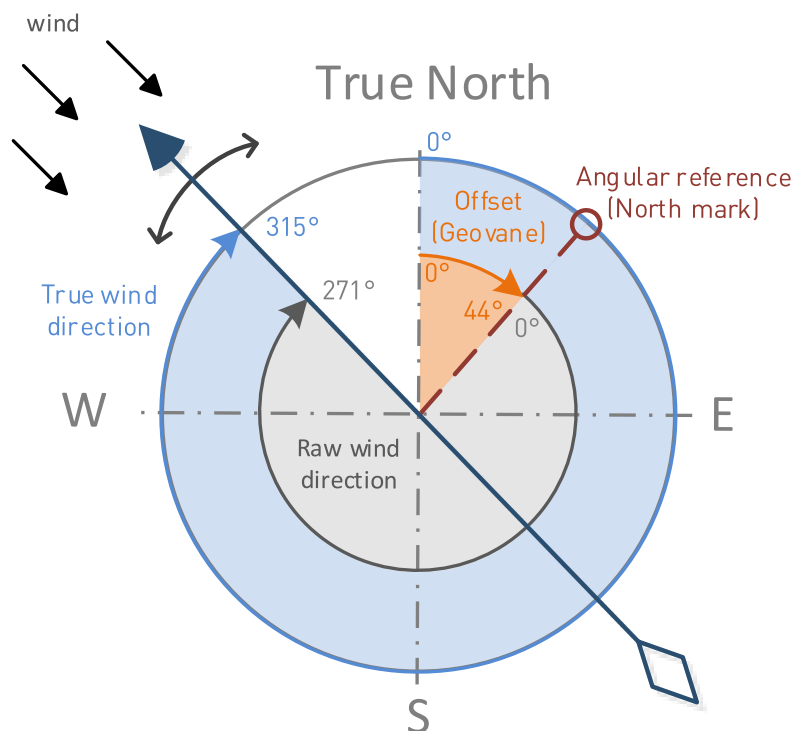
3.1 Geovane MM + wind vane

Assuming proper alignment between the Geovane and the wind vane (refer to section 4.1), the Geovane will provide the **orientation** of its attached wind vane **with respect to True North**. Therefore, the true wind direction can be obtained by means of the following equation:

$$\text{True wind direction} = \text{Raw wind direction} + \text{Output provided by the Geovane}$$

The True North orientation measurement is given in positive degrees, from 0° to 360°, and clockwise from the True North, as described in the next image.

$$\text{True wind direction} = 271^\circ + 44^\circ = 315^\circ$$



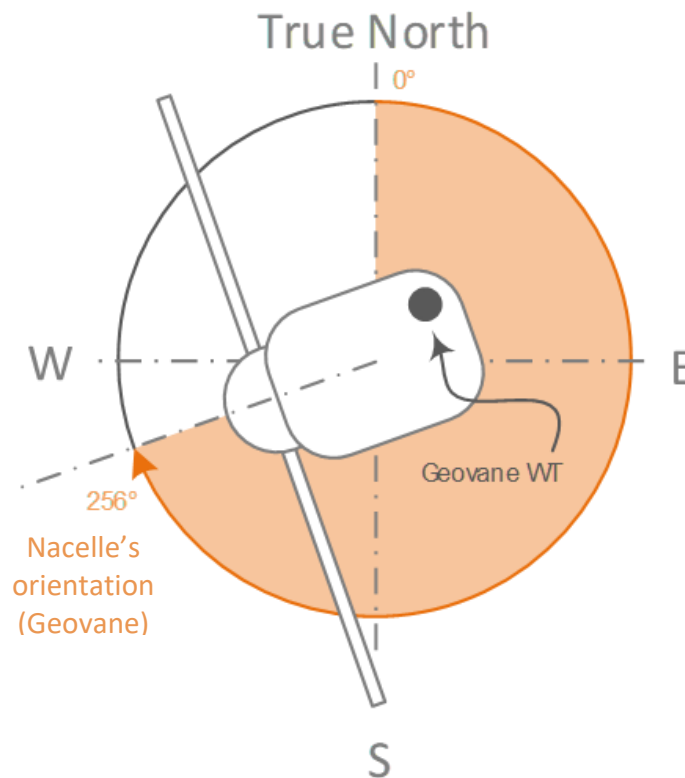
A common oversight consists of applying to the raw wind direction, besides the value that the Geovane has provided, the boom orientation provided by the met mast installer. This is completely wrong, and the final wind direction value will have an error equal to the boom orientation input by the installer.

3.2 Geovane WT

Assuming proper alignment between the Geovane and the wind turbine's rotor axis (refer to section 9.6), the Geovane will provide the instantaneous **orientation** of wind turbine **with respect to True North**, provided sunny conditions.

$$WT \text{ nacelle's orientation} = \text{Output provided by the Geovane}$$

The True North orientation measurement is given in positive degrees, from 0° to 360°, and clockwise from the True North, as described in the next image.



4 GEOVANE + WIND VANE

For the Geovane to measure the orientation from True North of the coupled wind vane, both devices must have their internal angular references perfectly aligned with each other.

If you have purchased the plug-and-play solution described in sections 2.2.3 and 2.3.3, in which the Geovane comes coupled to the wind vane, this alignment has already been carried out by Kintech Engineering, the only thing you need to take care of is not altering the alignment when installing the pack on the met mast (see section 4.2 for information on the wind vane's color code wiring).

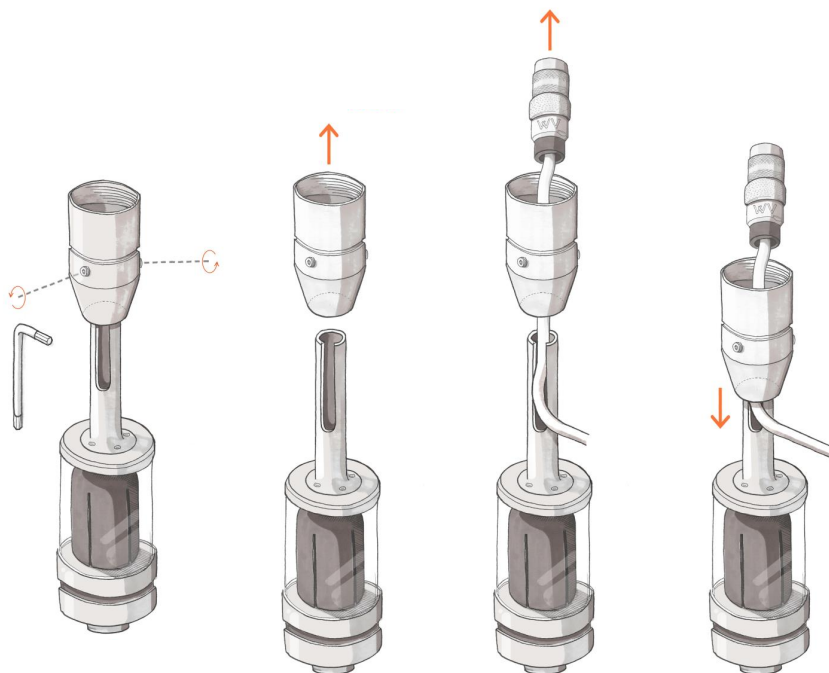
4.1 Geovane + wind vane alignment

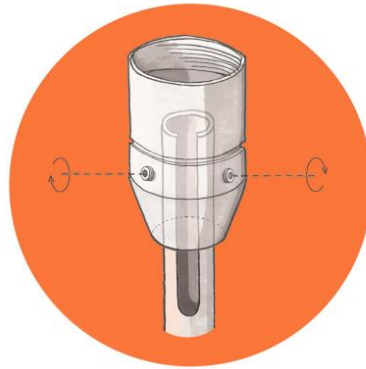
In case you have ordered the Geovane without a wind vane, or you need to align the Geovane with a new wind vane, please follow this procedure.

The alignment between Geovane and wind vane is **based on the wind vane's electrical signal** and not on the North Mark of the wind vane. In this way, both the potential installation error and the positioning error of the north mark made by the manufacturer are eliminated.

The accurate relative orientation between the Geovane and the wind vane is achieved through a precision laser-technology inside the Geovane.

STEP 1: loosen the two M6-Allen head screws to feed the cable of the wind vane through the adaptor sleeve, as shown below.

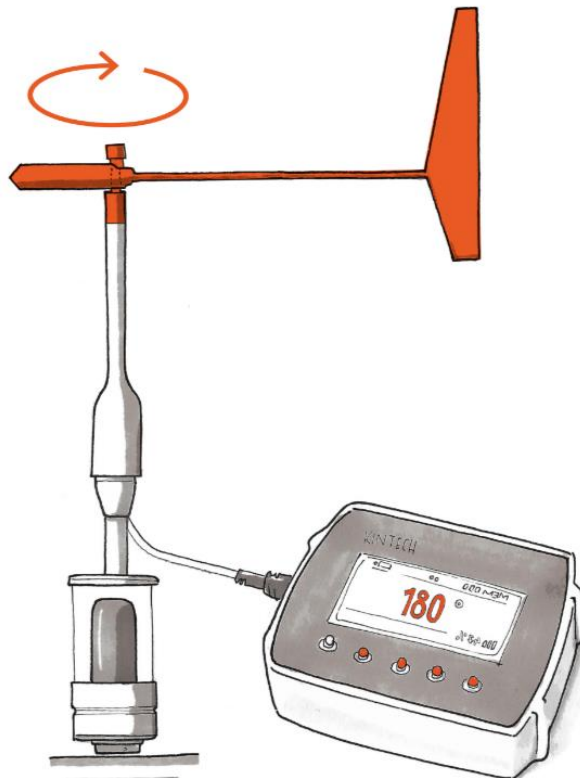




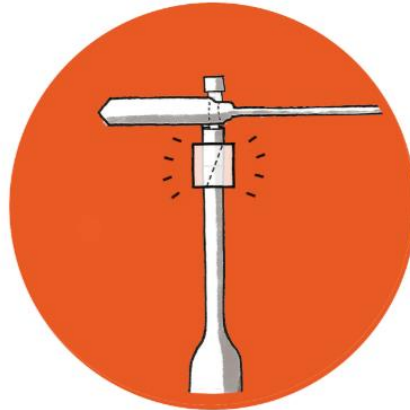
Remark:

The vertical support boom has been redesigned and currently differs from the one shown in the drawings below. It consists now of a single piece, without any adapters (see picture on page 60).

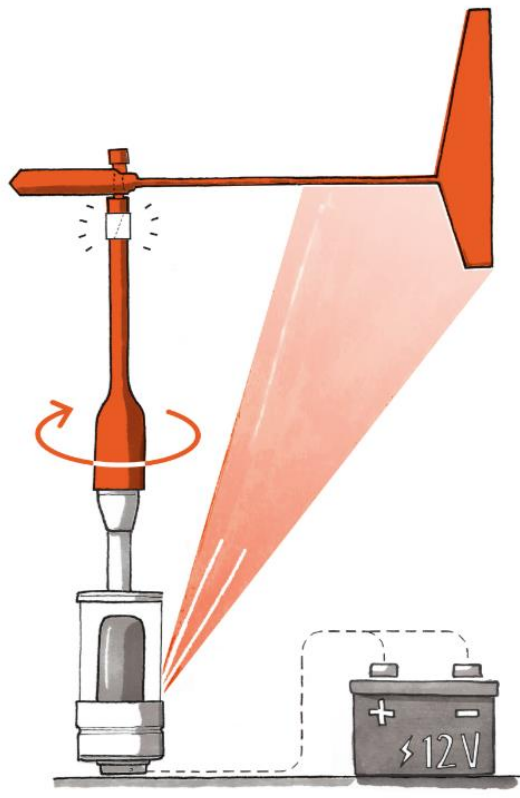
STEP 2: power on the wind vane, connect it to the data logger and **turn its tail until it outputs exactly 180°.**



STEP 3: while the wind vane is outputting exactly 180°, **block the wind vane.**



STEP 4: power on the Geovane. The Geovane will activate its line laser emitter for the next five minutes. With the wind vane still locked at 180°, **turn the wind vane from its base until the laser line hits the tail.** When this happens, the angular references from both sensors match. With the laser still projected on the wind vane tail, tighten the Allen screws on the wind vane base to fix it to the Geovane.



Once the two devices are aligned, the complete unit must stay fixed in this position and is ready for use.

Remarks:

Laser beam emitter (Class 1) is hard to detect outdoors during daylight hours: alignment in the workshop is strongly encouraged.

4.2 Wind vane color code wiring (plug-and-play option)

This section describes the wind vane's color code wiring for the Geovanes ordered along wind vanes as a **complete "plug-and-play" unit**, in which the Geovane has already been aligned with a Thies wind vane (see sections 2.2.3 and 2.3.3).

Depending upon the wind vane type you have chosen, the color code for the 5m of 0.5mm² cross-sectioned shielded cable already plugged and secured into the wind vane and ended in an IP68 in-line connector, will differ, according to the following tables:

Thies potentiometer pinout		Description	Color
First Class	Compact		
1	3	SIG (Potentiometer wiper)	White
2	2	GND (Ground)	Brown
3	4	+U _s (Power supply)	Green
Shield			Yellow
			Green

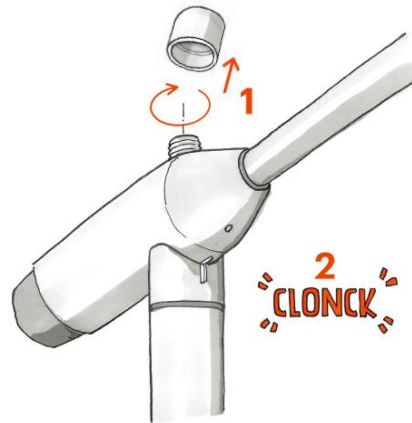
Thies TMR pinout		Description	Color
First Class	Compact		
1	3	SIG (Analog output)	White
2	2	GND (Supply ground)	Brown
3	1	+U _s (Power supply)	Green
6	4	AGND (Analog ground)	Yellow
Shield			Yellow
			Green

4.3 Thies First Class wind vane: how to mount its tail

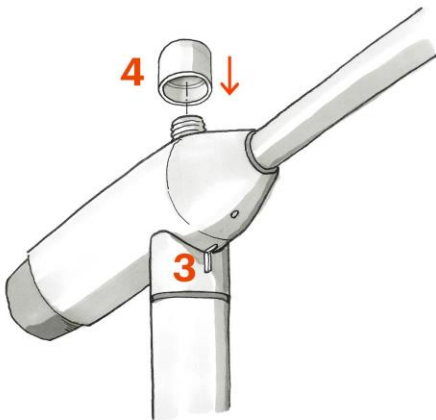
The tail of the Thies First Class wind vane comes separately and must be mounted on the body following these instructions:

1. Unscrew the cap from the upper part of the wind vane.

2. Put the tail of the wind vane onto the upper part of the body and turn it until it falls and locks into the **single position**.



3. The **marking lines** of the tail and the body must be aligned with each other.



4. Put the cap onto the thread and screw it strongly by rotating it clockwise by hand.

Remark:

The longer part of the tail's blade must indicate upwards.

5 TECHNICAL DATA

5.1 Operation conditions

Description	Value	Units	Comments
Operating voltage	12	V (DC)	Recommended
	6	V (DC)	Minimum

Remark:

The power supply should be able to provide at least 80 mA to account for the maximum current peak Geovane might demand.

5.2 True North orientation measurement

Description	Value	Comments
Reference	Geographical North	True North
Measurement Range	0... 380°	Clockwise rotation. (see remark below)
Resolution	<0.06°	RS-485
	0.11°	Analog voltage outputs
	<0.06... 0.16°	Frequency output
Absolute accuracy*	<1°	Moeller Operating Engineering
Measurement rate**	1, 5, 10, 30, 60 seconds	10 s by default

*Geovane MM: azimuth-based averaged TNO value, provided at least one sunny day of operation. Moeller Operating Engineering GmbH independent performance verification available upon request.

**A measurement rate set to 10 s means that the Geovane will scan its photosensing pixels trying to locate the Sun once every 10 seconds during daytime.

Remark:

Before the Geovane gets GPS signal, the True North orientation outputs are set to **380°** (GPS fix is typically obtained 30 seconds after power on, provided open-sky conditions).

Once the Geovane has obtained GPS signal and until it is able to measure for the first time, the True North orientation outputs are set to **370°**. In this way, the installer can verify that the Geovane is operating properly even in the absence of sunlight (see 9.5.2).

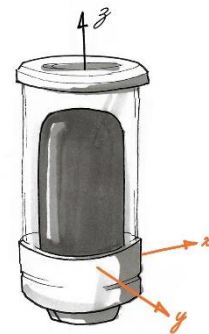
5.3 Tilt measurement

The Geovane is equipped with an internal 2-axis tilt sensor that permits it to compare the theoretical and observed solar azimuth angles even if the Geovane is not perfectly leveled. The tilt measurement is also provided as output to help verify the instrument mounting on the boom.

For an accurate absolute measurement of the tilt angle with respect to horizontal, every Geovane's tilt sensor is factory calibrated relative to a high-precision independent bubble level across a -10 to 60°C temperature range. The temperature correction coefficients of the tilt measurement are programmed during production and are available in the quality certificate that comes with the unit. The tilt sensor has an absolute accuracy of <1° between 0 and 90° tilt angle.

Once the Geovane and the wind vane have been properly aligned (refer to chapter 4):

- **Tilt X** output is referenced to the wind vane's North mark (Geovane's slit #1), being positive if tilted upwards and negative if tilted downwards.
- **Tilt Y** output is referenced to slit #7 (East of the wind vane), being positive if tilted upwards and negative if tilted downwards.



Remark:

Before the Geovane gets GPS signal, the tilt outputs are set to **0°** (GPS fix is typically obtained 30 seconds after power on, provided open-sky conditions).

5.4 Absolute maximum ratings

Description	Minimum value	Maximum value	Units
Input voltage	0	30	V
Operating temperature	-25	85	°C
RS-485 input voltage	-10.5	10.5	V

5.5 Average current consumption

Description	Duration	mA*
Measuring mode	Daytime	5
Sleep mode	Night-time	1.5
GPS ON	30 seconds at sunrise / startup	+17.8
Laser ON	5 min at startup	+16

*Typical. Powered at 12 V DC. Only digital output activated.

Depending on which outputs are activated, the current consumption increases accordingly to the following table:

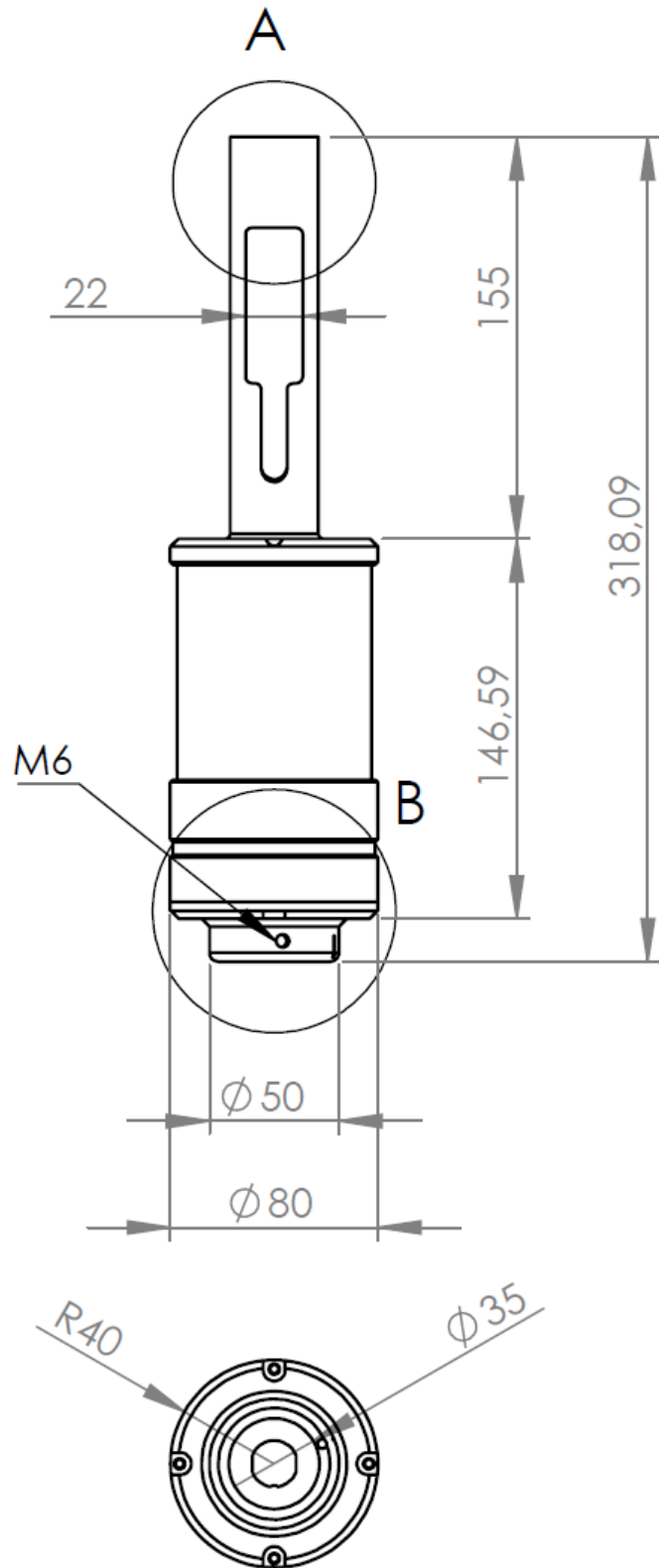
Description	mA
Frequency output activated	+1.1
One analog voltage output activated	+0.7
Both analog voltage outputs activated	+0.8

5.6 Mechanics

Description	Value	Comments
Weight	0.815 kg	Incl. wind vane adaptor
Dimensions	See section 5.7	
Housing material	Anodized aluminum	Main body
	Borosilicate Glass 3.3	Glass tube protector
Protection Class	IP67	-
Mounting	Onto mast tube \varnothing 34 mm	(Thies FC carrier)
\varnothing wind vane boom	34.5 mm	External diameter

5.7 Dimensions (mm)

5.7.1 Geovane

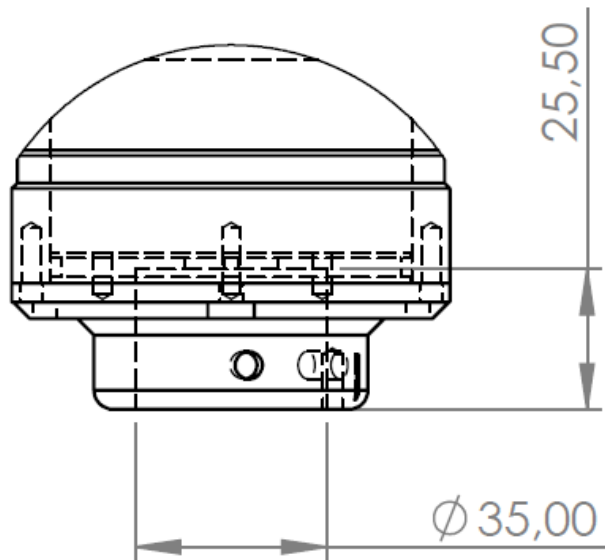


DETAIL A



Compatible wind vane	Thies First Class	Thies Compact	Vector W200P
Accessory required	None	None	Geovane009

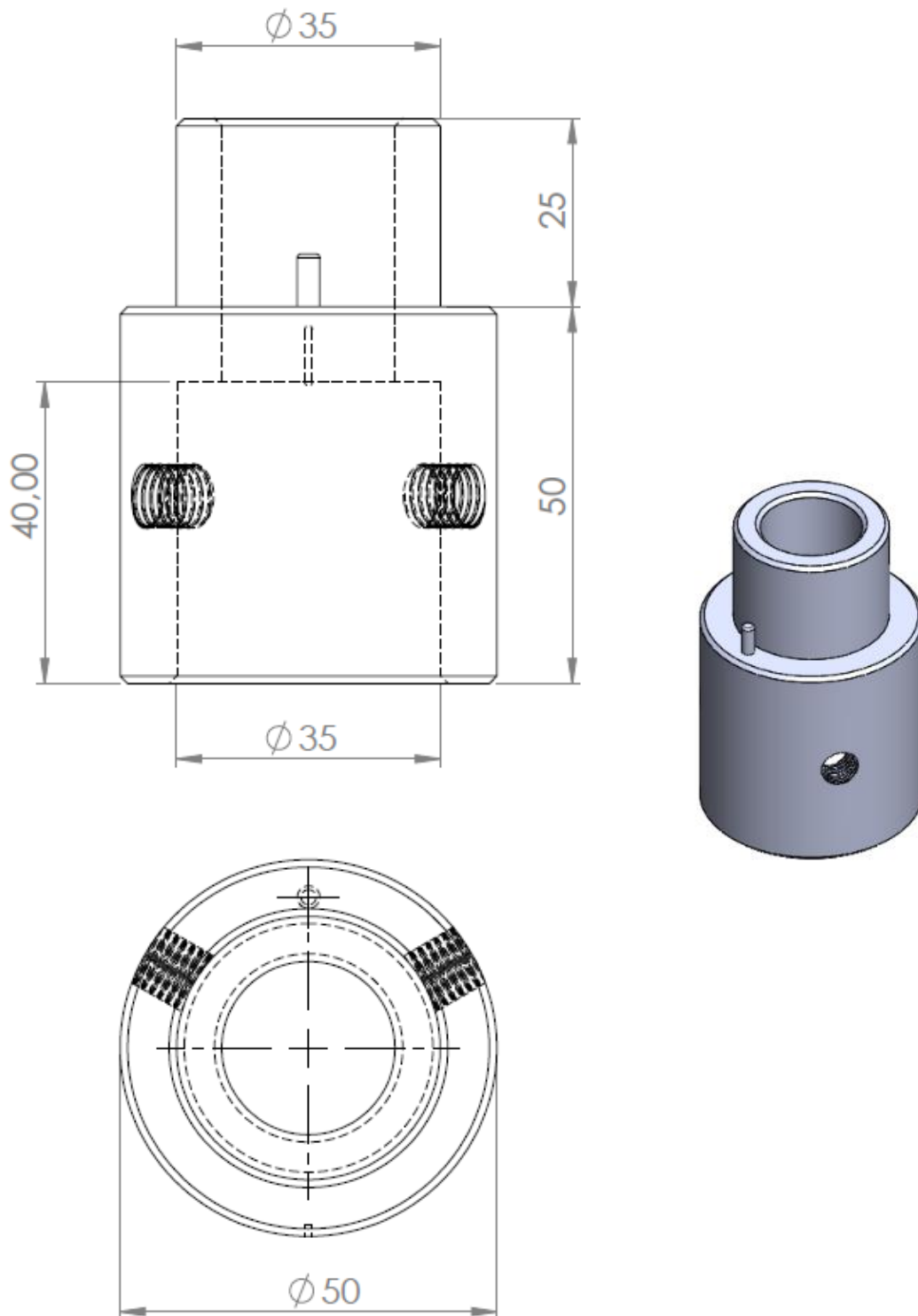
External diameter → 34.5 mm (for Thies First Class).
 Internal thread → PG21 (for Thies Compact).



DETAIL B

5.7.2 Alignment collar's dimensions (Geovane WT)

Refer to sections 2.3 and 9.6 for further details on the alignment collar.



6 SENSOR OUTPUTS

The Geovane offers three types of outputs, summarized in the below table:

Output*	Number	Data	Range	Comments
Frequency	x1	True North orientation	10... 136.67 Hz	0-5 V, push-pull, 50% duty cycle, square-wave, 50 mA of drive capability
Analog voltage	x2	True North orientation / Tilt X / Tilt Y	0.5... 4.72 V	12-bit resolution, 12 mA of drive capability
RS-485	x1	Refer to chapters 7 and 8	-	4800/9600/19200/38400 bps, 8N1, NMEA 0183, Modbus RTU

*For information on pin connections see section 9.3. For information on output configuration refer to chapter 11.

6.1 Analog voltage outputs

Each of the two analog voltage outputs can be configured to one of the following:

- True North orientation (see section 5.2).
- Tilt X (see section 5.3).
- Tilt Y (see section 5.3).

Both analog voltage signals are digitally generated by means of a 12-bit 0-5V Digital to Analog Converter and subsequently conditioned by an analog output stage with 12mA of drive capability.

The voltage outputs distinguish between “live zero” and “dead zero”. The 0% reading or “live zero” corresponds to 0.5 V, whereas 0 V is the “dead zero” (output not working).

Variable	Variable range	Voltage range	Resolution
True North orientation	0... 380° (see remark below)	0.5... 4.72 V	0.11°
Tilt X / Tilt Y	-90... 90°	0.5... 4.5 V	0.05°

The first analog voltage output, Out (V1+), is located at pin 1.

The second analog voltage output, Out (V2+), is located at pin 5.

Both analog outputs reference its voltage to Out (V-), located at pin 8. To ensure proper signal integrity, Out (V-) **must never** be connected to Supply(-) on the sensor side. Otherwise, the voltage drop in the negative power line will affect the accuracy of the measurement.

Remark:

Before the Geovane gets GPS signal, the True North orientation outputs are set to **380°** (GPS fix is typically obtained 30 seconds after power on, provided open-sky conditions).

Once the Geovane has obtained GPS signal and until it is able to measure for the first time, the True North orientation outputs are set to **370°**. In this way, the installer can verify that the Geovane is operating properly even in the absence of sunlight (see 9.5.2).

The True North orientation can be calculated from the measured volts according to the following equation:

$$\text{True North orientation} = \text{Voltage} * 90 - 45$$

Both Tilt X and Tilt Y can be calculated from the measured volts according to the following equation:

$$\text{Tilt} = \text{Voltage} * 45 - 112.5$$

6.2 Frequency output

The frequency output can be configured to:

- True North orientation (see section 5.2).

The frequency output consists of a 0-5 V digitally generated 50% duty cycle square-wave signal, subsequently buffered by a push-pull output stage with 50 mA of drive capability. The below table specifies its characteristics.

The frequency output distinguishes between “live zero” and “dead zero”. The 0% reading corresponds to 10 Hz (live zero), whereas 0Hz is the “dead zero” (output not working).

Variable	Variable Range	Frequency Range	Resolution	
True North orientation	0... 380° (see remark below)	10... 136.67 Hz	0.01°	0.16°
			(average)	(worst case)

The frequency output, Out (Hz), is located at pin 6.

Out (Hz) references its voltage to Supply (-).

Remark:

Before the Geovane gets GPS signal, the True North orientation outputs are set to **380°** (GPS fix is typically obtained 30 seconds after power on, provided open-sky conditions).

Once the Geovane has obtained GPS signal and until it is able to measure for the first time, the True North orientation outputs are set to **370°**. In this way, the installer can verify that the Geovane is operating properly even in the absence of sunlight (see 9.5.2).

The True North orientation can be calculated from the measured hertz according to the following equation:

$$\text{True North orientation} = \text{Hertz} * 3 - 30$$

6.3 RS-485 digital output

The digital output of the Geovane can provide the following information:

- True North orientation (see section 5.2).
- UTC data and time the last True North orientation measurement was taken.
- Tilt X and Tilt Y (see section 5.3).
- 3-axis vibration (Geovane WT only).
- Sun's coordinates (azimuth, altitude, declination, hour angle).
- GPS coordinates.
- Date and UTC time (GPS).
- Internal temperature.
- Geovane's hardware status (self-test function).
- Geovane's current configuration.
- Serial number, firmware and hardware version.

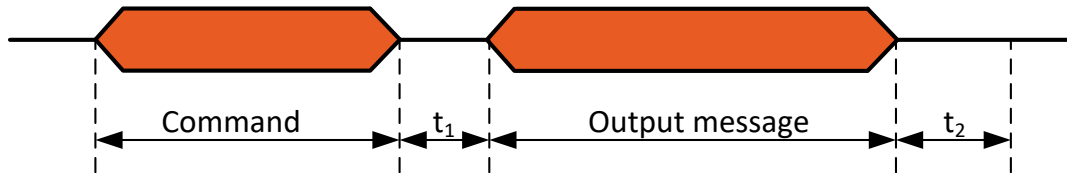
The Geovane is equipped with an RS-485 half-duplex serial interface (4800 / 9600 / 19200 / 38400 bps, 8N1). Reduced-slew-rate drivers are used to minimize EMI and reduce reflections caused by improperly terminated cables. Over the RS-485 interface, the Geovane implements two communication protocols:

- NMEA 0183, described in chapter 7.
- Modbus RTU (Geovane WT only), described in chapter 8.

If two or more Geovane units are to be installed it is possible to use the same 2-wire data link to connect all the Geovane units to a master, provided that each Geovane is configured with a different listener identifier (Listener ID / Modbus slave address).

Before using a Geovane in a multi-device system, the Listener ID of each Geovane must be set to a unique value (refer to chapter 11).

The digital output has timing constraints. When a valid command is received by the Geovane input buffer, there will be a delay while the command is being processed. The delay between the command and the output message is defined by the time t_1 and it depends on the internal processing cycle.



Once the last byte of the output message is sent by the Geovane, there must be an additional delay t_2 . This delay time ensures that the state of the internal driver is set to high impedance and, therefore, the driver can receive a new command. Thus, the poll frequency is limited by both delay times and baud rate. It is strongly recommended that the poll frequency does not exceed 4 Hz, i.e., 4 commands per second.

The default configuration corresponds to a baud rate of 9600 bps. The baudrate is user configurable via Geovane Tools software (see section 11.1) to any of the following options:

- 4800 bps.
- **9600 bps. (Default).**
- 19200 bps.
- 38400 bps.

The following table summarizes the timing constraints (typical values):

Description	Value	Units
Delay command-output message t_1	6*	ms
Delay after output message t_2	4**	ms
Maximum poll frequency	4	Hz

*Maximum.

**Minimum.

The Geovane features an internal 120 Ω termination resistor that can be configured to be connected or disconnected by the user (refer to chapter 11).

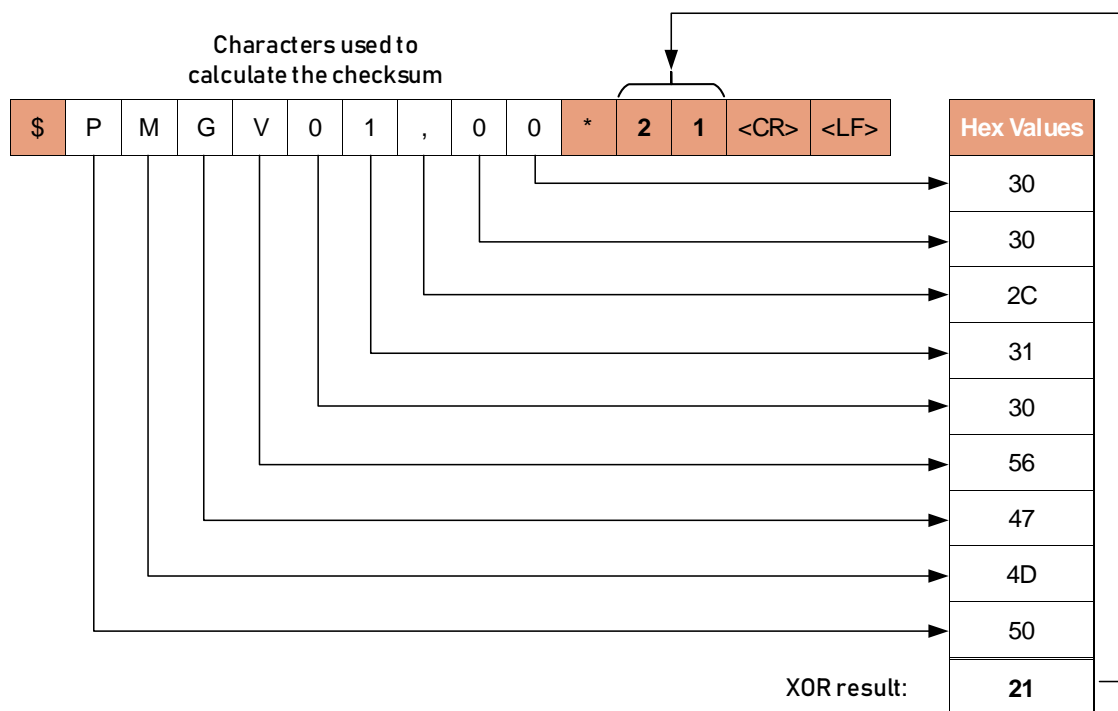
7 RS-485 DIGITAL OUTPUT: NMEA 0183

The digital communication protocol follows a **master-slave format**, where the Geovane is the slave, and an external device is the master. The master should send a command (list available in section 7.2), and the Geovane will answer the corresponding output message (section 0). Please refer to section 6.3 for general information on the RS-485 digital output of the Geovane.

All messages follow the NMEA 0183 standard. Every standard NMEA message begins with '\$' character (hex value 0x24) and ends with a Carriage Return (hex value 0x0D) and Line Feed (hex value 0x0A).

Following the start character comes the device identification, 'GV' for a Geovane device. The next three characters specify the message identification. After the message identification begins the data field, delimited by commas (','). The end of data fields is indicated by the character '*'.

The message includes a checksum field consisting in a bitwise XOR of all characters between (but not including) Start character '\$' and End-of-data character '*'. The resulting single byte value is then represented by two hexadecimal characters in the message string, as shown in the example below. The most significant character is transmitted first.



The Geovane is assigned with both a Listener and a Talker identifier address that allows an individual Geovane to be uniquely identified in a system comprising more than one Geovane. Whenever a message is sent to the Geovane, the identifier field of the message must correspond to the Geovane Listener identifier address, otherwise the Geovane will ignore the message.

In applications where more than one Geovane is connected to the RS-485 bus, you should assign each Geovane in the system a unique Listener ID. The master will then be able to address individually each Geovane.

Parameter	Factory settings	Selectable values
Baudrate	9600	4800, 9600, 19200, 38400
Data bits	8	8
Parity	None	None
Stop bits	1	1
Listener ID	00	00, 01, 02, 03... 99

7.1 Answers from the Geovane

This section describes all the messages sent by Geovane after receiving poll requests from the master (section 7.2).

7.1.1 ORN message: True North orientation

\$GVORN,274.20,+01.20,-00.80,01,00*7F<CR><LF>

Field	Example	Description
Start character	\$	
Talker identification	GV	Geovane identification
Message ID	ORN	Identifier associated to the type of message
True North orientation*	274.20	Angle between True North and the device reference, in degrees Range: 0... 360°
X-axis tilt angle**	+01.20	Angle between the X-axis and the horizontal plane in degrees Range: -90... 90°
Y-axis tilt angle**	-00.80	Angle between the Y-axis and the horizontal plane in degrees Range: -90... 90°

New True North orientation sample	01	A new True North orientation sample has been taken in the last pixel scan. 0 = No sample has been taken 1= New sample has been taken
Self-test hardware status code (HWSC)***	00	Byte of the status of the hardware, in hexadecimal format, where 1 means error and 0 OK. HWSC.7 (MSB): Not used. HWSC.6: Motion sensor status. HWSC.5: Photosensors status. HWSC.4: Accelerometer status. HWSC.3: DAC status. HWSC.2: Real Time Clock status. HWSC.1: EEPROM status. HWSC.0 (LSB): GPS status.
End-of-data character	*	
Checksum	7F	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

*Refer to sections 3.1 and 5.2.

**Refer to section 5.3 for specification about reference axis.

***HWSC.6, HWSC.5 and HWSC.4 are not evaluated until the Geovane has obtained GPS signal (set to 1 by default).

7.1.2 ORX message: extended ORN message

\$GVORX,274.20,+01.20,-00.80,01,00,+35.78,110312,151118*44<CR><LF>

Field	Example	Description
Start character	\$	
Talker identification	GV	Geovane identification
Message ID	ORX	Identifier associated to the type of message
True North orientation*	274.20	Angle between True North and the device reference, in degrees Range: 0... 360°

X-axis tilt angle**	+01.20	Angle between the X-axis and the horizontal plane in degrees Range: -90... 90°
Y-axis tilt angle**	-00.80	Angle between the Y-axis and the horizontal plane in degrees Range: -90... 90°
New True North orientation sample	01	A new True North orientation sample has been taken in the last pixel scan. 0 = No sample has been taken 1= New sample has been taken
Self-test hardware status code (HWSC)***	00	Byte of the status of the hardware, in hexadecimal format, where 1 means error and 0 OK. HWSC.7 (MSB): Not used. HWSC.6: Motion sensor status. HWSC.5: Photosensors status. HWSC.4: Accelerometer status. HWSC.3: DAC status. HWSC.2: Real Time Clock status. HWSC.1: EEPROM status. HWSC.0 (LSB): GPS status.
Internal temperature	+35.78	Internal temperature, in degrees Celsius
UTC time of the latest True North orientation measurement	110312	UTC time at which the Geovane took the latest True North orientation measurement
Date of the latest True North orientation measurement	151118	Date at which the Geovane took the latest True North orientation measurement
End-of-data character	*	
Checksum	44	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

*Refer to sections 3.1 and 5.2.

**Refer to section 5.3 for specification about reference axis.

***HWSC.6, HWSC.5 and HWSC.4 are not evaluated until the Geovane has obtained GPS signal (set to 1 by default).

7.1.3 SUN message: solar coordinates

\$GVSUN,216.16,66.24,-17.35,+018.25*55<CR><LF>

Field	Example	Description
Start character	\$	
Talker identification	GV	Geovane identification
Message ID	SUN	Identifier associated to the type of message
Sun's azimuth to North	216.16	Angle between True North and the horizontal projection of the sun's rays, in degrees (clockwise rotation) Range: 0... 360°
Sun's altitude	66.24	Angle between the sun's rays and the horizontal plane on the earth's surface, in degrees Range: 0... 90°
Sun's declination	-17.35	Angle between the earth-sun line and the equatorial plane, in degrees Range: -23.4... 23.4°
Sun's hour angle	+018.25	Angle on a horizontal plane between the local solar noon and the horizontal projection of the sun's rays, in degrees Range: -180... 180°
End-of-data character	*	
Checksum	55	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

7.1.4 RMC message: recommended minimum specific GNSS data

\$GVRMC,123927.000,A,4138.9405,N,00053.3174,W,0.62,335.42,220611,,,A*70<CR><LF>

Field	Example	Description
Start character	\$	

Talker identification	GV	Geovane identification
Message ID	RMC	Identifier associated to the type of message
UTC time	123927.000	Format: hhmmss.sss
Fix status	A	V = Invalid A = Valid
Geographical latitude	4138.9405	Format: ddmm.mmmm (degrees and minutes)
N/S Indicator	N	N = North S = South
Geographical longitude	00053.3174	Format: dmm.mmmm (degrees and minutes)
E/W Indicator	W	E = East W = West
SOG	0.62	Speed over ground, in knots
COG	335.42	Course on the ground, in degrees
Date	220611	Format: ddmmyy
Magnetic variation		Unsupported field
Magnetic variation course E/W		Course on the ground, in degrees (East/West)
Mode indicator	A	'N' = Data not valid 'A' = Autonomous mode 'D' = Differential mode 'E' = Estimated mode 'S' = Simulator mode 'M' = Manual input mode
End-of-data character	*	
Checksum	70	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

7.1.5 INF message: Geovane's features

\$GVINF,500107,0.01.06.07,01.00*4E<CR><LF>

Field	Example	Description
Start character	\$	
Talker identification	GV	Geovane identification
Message ID	INF	Identifier associated to the type of message
Serial Number	500107	Unique serial number identifier
Firmware version	0.01.06.07	
Hardware version	01.00	
End-of-data character	*	
Checksum	4E	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

7.1.6 ORT message: True North nacelle's orientation (Geovane WT)

Only the Geovanes WT can answer this message when polled with the PMGV11 command.

\$GVORT,154.35,+00.49,+02.69,01,00,+35.78,110312,151118,0098,04.12,0012,14.36,0054,04.12,1,X,X*70<CR><LF>

Field	Example	Description
Start character	\$	
Talker identification	GV	Geovane identification
Message ID	ORT	Identifier associated to the type of message
True North orientation*	154.35	Instantaneous angle between True North and the nacelle's rotor axis, in degrees Range: 0... 360°
X-axis tilt angle**	+00.49	Angle between the X-axis and the horizontal plane in degrees Range: -90... 90°

Y-axis tilt angle**	+02.69	Angle between the Y-axis and the horizontal plane in degrees Range: -90... 90°
New True North orientation sample	01	A new True North orientation sample has been taken in the last pixel scan. 0 = No sample has been taken 1= New sample has been taken
Self-test hardware status code (HWSC)***	00	Byte of the status of the hardware, in hexadecimal format, where 1 means error and 0 OK. HWSC.7 (MSB): Not used. HWSC.6: Motion sensor status. HWSC.5: Photosensors status. HWSC.4: Accelerometer status. HWSC.3: DAC status. HWSC.2: Real Time Clock status. HWSC.1: EEPROM status. HWSC.0 (LSB): GPS status.
Internal temperature	+35.78	Internal temperature, in degrees Celsius
UTC time of the latest True North orientation measurement	110312	UTC time at which the Geovane took the latest True North orientation measurement
Date of the latest True North orientation measurement	151118	Date at which the Geovane took the latest True North orientation measurement
X-axis vibration amplitude	0098	Amplitude of the vibration, in mg (Main harmonic. Up to 15 Hz)
X-axis vibration frequency	04.12	Frequency of the vibration, in hertz (Main harmonic. Up to 15 Hz. 0.12 Hz resol.)
Y-axis vibration amplitude	0012	Amplitude of the vibration, in mg (Main harmonic. Up to 15 Hz)
Y-axis vibration frequency	14.36	Frequency of the vibration, in hertz (Main harmonic. Up to 15 Hz. 0.12 Hz resol.)
Z-axis vibration amplitude	0054	Amplitude of the vibration, in mg (Main harmonic. Up to 15 Hz)

Z-axis vibration frequency	04.12	Frequency of the vibration, in hertz (Main harmonic. Up to 15 Hz. 0.12 Hz resol.)
Sunshine measurement	1	0 = nighttime (sun height < 0°) 1 = daytime (sun height > 0°) 2 = daytime AND sunny (<i>coming soon</i>)
Shadow flickering	N	Y = The operating wind turbine is casting shadow onto the specified area(s). N = The operating wind turbine is not casting any shadows onto the specified area(s). X = Not available
MQI	X	Measurement Quality Indicator (<i>coming soon</i>) X = Not available
End-of-data character	*	
Checksum	76	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

*Refer to sections 3.2 and 5.2.

**Refer to section 5.3 for specification about reference axis.

***HWSC.6, HWSC.5 and HWSC.4 are not evaluated until the Geovane has obtained GPS signal (set to 1 by default).

7.2 Commands to the Geovane

This section describes all the commands a master can send to the Geovane. All examples assume that the Geovane Listener ID is set to 00.

7.2.1 PMGV00 command – Echo message request

\$PMGV00,00*20<CR><LF>

Field	Example	Description
Start character	\$	
Header	PMGV	
Command ID	00	Identifier associated to the type of command: Echo message request
Listener ID	00	Geovane Listener identification
End-of-data character	*	
Checksum	20	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

Note: The Geovane will send back the echo message to the master.

7.2.2 PMGV01 command – ORN message request

\$PMGV01,00*21<CR><LF>

Field	Example	Description
Start character	\$	
Header	PMGV	
Command ID	01	Identifier associated to the type of command: ORN message request
Listener ID	00	Geovane Listener identification
End-of-data character	*	
Checksum	21	Bitwise XOR of all characters between Start character and End-of-data character

<CR><LF>		Carriage Return and Line Feed
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7.2.3 PMGV02 command – SUN message request

\$PMGV02,00*22<CR><LF>

Field	Example	Description
Start character	\$	
Header	PMGV	
Command ID	02	Identifier associated to the type of command: SUN message request
Listener ID	00	Geovane Listener identification
End-of-data character	*	
Checksum	22	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

7.2.4 PMGV04 command – RMC message request

\$PMGV04,00*24<CR><LF>

Field	Example	Description
Start character	\$	
Header	PMGV	
Command ID	04	Identifier associated to the type of command: RMC message request
Listener ID	00	Geovane Listener identification
End-of-data character	*	
Checksum	24	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

7.2.5 PMGV05 command – INF message request

\$PMGV05,00*25<CR><LF>

Field	Example	Description
Start character	\$	
Header	PMGV	
Command ID	05	Identifier associated to the type of command: INF message request
Listener ID	00	Geovane Listener identification
End-of-data character	*	
Checksum	25	Bitwise XOR of all characters between Start character and End-of-data character
<CR><LF>		Carriage Return and Line Feed

7.2.6 PMGV10 command – ORX message request

\$PMGV10,00*21<CR><LF>

Field	Example	Description
Start character	\$	
Header	PMGV	
Command ID	10	Identifier associated to the type of command: ORX message request
Listener ID	00	Geovane Listener identification
End-of-data character	*	
Checksum	21	Bitwise XOR of all characters between Start and End-of-data characters
<CR><LF>		Carriage Return and Line Feed

7.2.7 PMGV11 command – ORT message request (Geovane WT)

\$PMGV11,00*20<CR><LF>

Field	Example	Description
Start character	\$	
Header	PMGV	
Command ID	11	Identifier associated to the type of command: ORT message request
Listener ID	00	Geovane Listener identification
End-of-data character	*	
Checksum	20	Bitwise XOR of all characters between Start and End-of-data characters
<CR><LF>		Carriage Return and Line Feed

7.3 Digital NMEA 0183 communication example

The following paragraph shows a typical master-slave communication where ECHO, ORN, SUN and RMC messages are requested:

Echo command sent by the master:

\$PMGV00,00*20

Answer from the Geovane:

\$PMGV00,00*20

INF command sent by the master:

\$PMGV05,00*25

Answer from the Geovane:

\$GVINF,500107,1.01.07.02,01.00*4B

RMC command sent by the master:

\$PMGV04,00*24

Answer from the Geovane:

\$GVRMC,081428.000,A,4145.8042,N,00117.1531,W,0.00,000.00,190517,,,A*7D

SUN command sent by the master:

\$PMGV02,00*22

Answer from the Geovane:

\$GVSUN,096.53,37.63,+00.34,+112.10*55

ORN command sent by the master:

\$PMGV01,00*21

Answer from the Geovane:

\$GVORN,274.20,+01.20,-00.80,01,00*7F

ORX command sent by the master:

\$PMGV10,00*21

Answer from the Geovane:

\$GVORX,274.20,+01.20,-00.80,01,00,+35.78,110312,151118*44

ORT command sent by the master (Geovane WT only):

\$PMGV11,00*20

Answer from the Geovane WT:

**\$GVORT,154.35,+00.49,+02.69,01,00,+35.78,110312,151118,0098,04.12,0012,14.3
6,0054,04.12,1,X,X*70**

8 RS-485 DIGITAL OUTPUT: MODBUS RTU (GEOVANE WT)

In addition to the NMEA 0183 standard, described in chapter 7, the **Geovane WT** supports Modbus RTU protocol, over its RS-485 physical interface. The Modbus communication protocol follows a **master-slave format**, where the Geovane is the slave, and an external device is the master.

Modbus is widely used to connect the Supervisory Control and Data Acquisition (SCADA) system in the wind farm (master) with the different remote terminal units (RTU) connected to the bus (slaves).

The Modbus slave number can be set using the Geovane Tools software (refer to section 11.1). This slave number corresponds to the Geovane ID plus one. For example, if a Geovane ID is set to 03, its Modbus slave number will be 4.

Parameter	Factory settings	Selectable values
Baudrate	9600	4800, 9600, 19200, 38400
Data bits	8	8
Parity	None	None
Stop bits	1	1
Slave address	1	1, 2, 3... 100

Among the standard functions of the Modbus protocol, the Geovane WT implements function 03: "Read Holding Registers". The Geovane WT features 40 Modbus registers that are accessible through said function and start at address 0x0000 (PLC address: 40001).

Remark:

The master must read all 40 registers in a **single query**, it is not possible to access records individually.

8.1 Format of the Modbus queries of the master

The Geovane WT expects a query from the master that requires the 40 Modbus registers at once. As an example, the request that a Geovane WT with Modbus slave number 01 expects is shown below:

Modbus RTU query example (bytes in hexadecimal): **01030000002845D4**

Example	Byte	Description	No. of bytes
01	-	Geovane WT Modbus slave number	1
03	-	Function code for “Read Holding Registers”	1
00	High	Starting register address to be read	2
00	Low		
00	High	Number of words to be read (0x0028 = 40 registers)	2
28	Low		
45	High	Error check (CRC)	2
D4	Low		

8.2 Format of the responses of the slave

When queried by the master, the Geovane WT replies with the standard response of the protocol (bytes in hexadecimal):

0103500007A21A0003040003032C562C562C560100FEBEFF63000205AC000205AC000000C00260002FFCE051F0004000A07E400065AEAFFFFDD2002E70005000A07E400A4291D06F00000000000000000000EEBA

Example	Byte	Description	No. of bytes
01	-	Geovane WT Modbus slave number	1
03	-	Function code for “Read Holding Registers”	1
50	-	Byte count	1
00...	-	Requested data (40 registers, see section 8.3)	80
EE	High	Error check (CRC)	2
BA	Low		

40013	-	X-axis vibration frequency	Unsigned 16	0 to 1500 scale = 100	05AC 14.52Hz
40014	-	Y-axis vibration amplitude	Unsigned 16	0 to 4000	0002 2mg
40015	-	Y-axis vibration frequency	Unsigned 16	0 to 1500 scale = 100	05AC 14.52Hz
40016	-	Z-axis vibration amplitude	Unsigned 16	0 to 4000	0000 0mg
40017	-	Z-axis vibration frequency	Unsigned 16	0 to 1500 scale = 100	000C 0.12Hz
40018	-	Reserved	-	-	-
40019	-	Reserved	-	-	-
40020	-	Reserved	-	-	-
40021	-	UTC hour and minute of the latest True North orientation measurement	Unsigned 16	0 to 2359	051F 13:11 UTC
40022	-	Day of the latest True North orientation measurement	Unsigned 16	1 to 31	0004 4
40023	-	Month of the latest True North orientation measurement	Unsigned 16	1 to 12	000A 10
40024	-	Year of the latest True North orientation measurement	Unsigned 16	-	07E4 2020
40025	High	Geographical latitude (GPS)	Signed 32	-900000 to 900000 scale = 10000	00065AEA 41.6490°
40026	Low				
40027	High	Geographical longitude (GPS)	Signed 32	-1800000 to 1800000	FFFFDD20 -0.8928°
40028	Low				

				scale = 10000	
40029	-	UTC hour and minute (GPS)	Unsigned 16	0 to 2359	02E7 07:43 UTC
40030	-	Day (GPS)	Unsigned 16	1 to 31	0005 5
40031	-	Month (GPS)	Unsigned 16	1 to 12	000A 10
40032	-	Year (GPS)	Unsigned 16	-	07E4 2020
40033	-	Internal temperature	Signed 16	-400 to 1250 scale = 10	00A4 16.4°C
40034	-	Sun's azimuth to North	Unsigned 16	0 to 36000 scale = 100	291D 105.25°
40035	-	Sun's altitude	Unsigned 16	0 to 9000 scale = 100	06F0 17.76°
40036	-	Reserved	-	-	-
40037	-	Reserved	-	-	-
40038	-	Reserved	-	-	-
40039	-	Reserved	-	-	-
40040	-	Reserved	-	-	-

For additional information about the variables, please refer to section 7.1.6.

Below is a table detailing the content of the register 40009 (**example: 0x0100**):.

Not used	Not used	Not used	Not used	Not used	Not used	Not used	New TNO sample
0	0	0	0	0	0	0	1
HWSC.7	HWSC.6	HWSC.5	HWSC.4	HWSC.3	HWSC.2	HWSC.1	HWSC.0
0	0	0	0	0	0	0	0

9 GEOVANE INSTALLATION (MECHANICAL AND ELECTRICAL)



If you have ordered the Geovane together with a wind vane, the unit (Geovane + wind vane) has already been **aligned by Kintech Engineering** and the unit is ready for installation in the field.

Remark:

Keep beacon lights and reflective surfaces out of Geovane field of view during daytime. If the light strikes the Geovane from an artificial source or reflection instead of directly from the Sun, the measurement will be temporally affected.

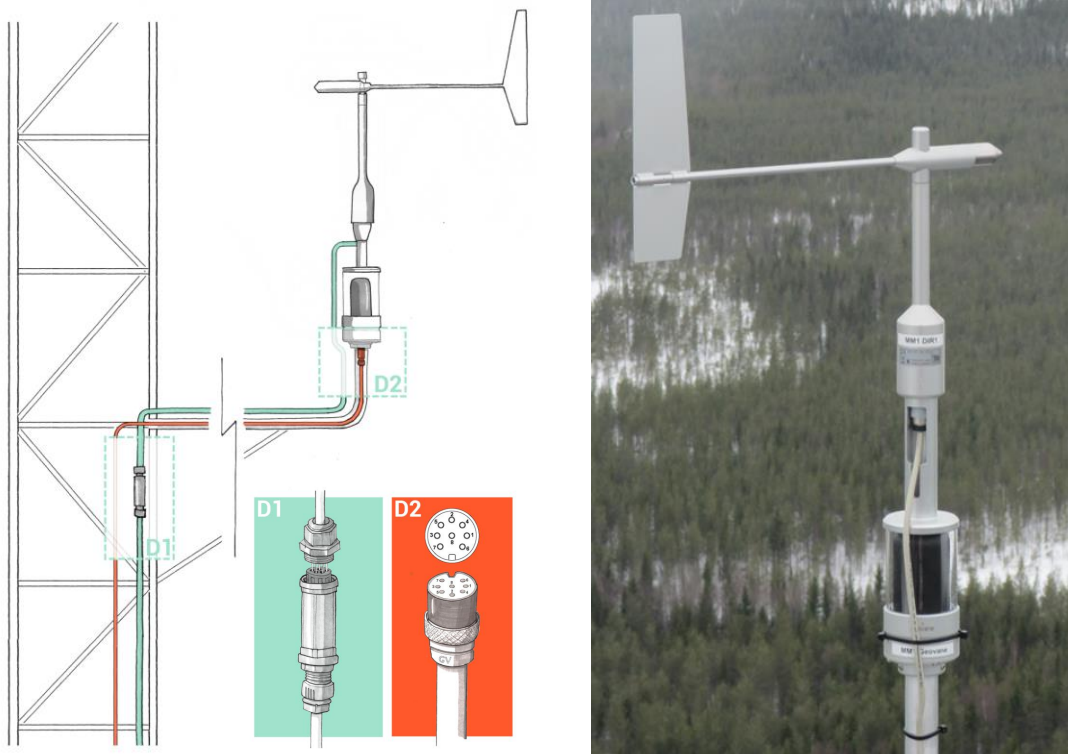
9.1 Installation overview and tips

The wind vane and the Geovane are not electrically connected in any way. From the point of view of the wind vane, the Geovane is simply seen as mechanical support. This means that the wind vane and the Geovane are individually connected to the datalogger by means of two separate cables.

The typical configuration for a met mast is described in the drawing below, where D1 displays the connection inside an IP68-protected in-line connector between the short cable coming from the wind vane and the long cable that goes down to the data logger,

whereas D2 shows the Geovane's 8-pole connector soldered to the a wire that runs straight down to the data logger.

It is suggested that the wind vane's cable is positioned in such a way that it runs down the side of the Geovane facing the nearest Earth's pole or the met mast. This is to reduce the shadow projection caused by the cable, however this is by no means critical for the accuracy of the measurements.



It is worth remembering that, once the Geovane and the wind vane have been aligned, they must be installed together **without altering** its accurately-established relative orientation. This entails that the connector of the wind vane is not accesible any more once the alignment is done.

In order to ease the installation procedure and avoid lifting the entire length of the cable, we recommend using two cable sections for the wind vane, properly linked at boom height, as detailed in the table below (and shown in the picture above):

Sensor cable	Length	Connected via...
Wind vane	From the sensor to the met mast (boom length, 5.35 m)	IP68 in-line connector*
	From the boom to the logger	
Geovane	From the sensor to the logger	-

* For instance, Techno TEETUBE ® TH400 In-line Connector.

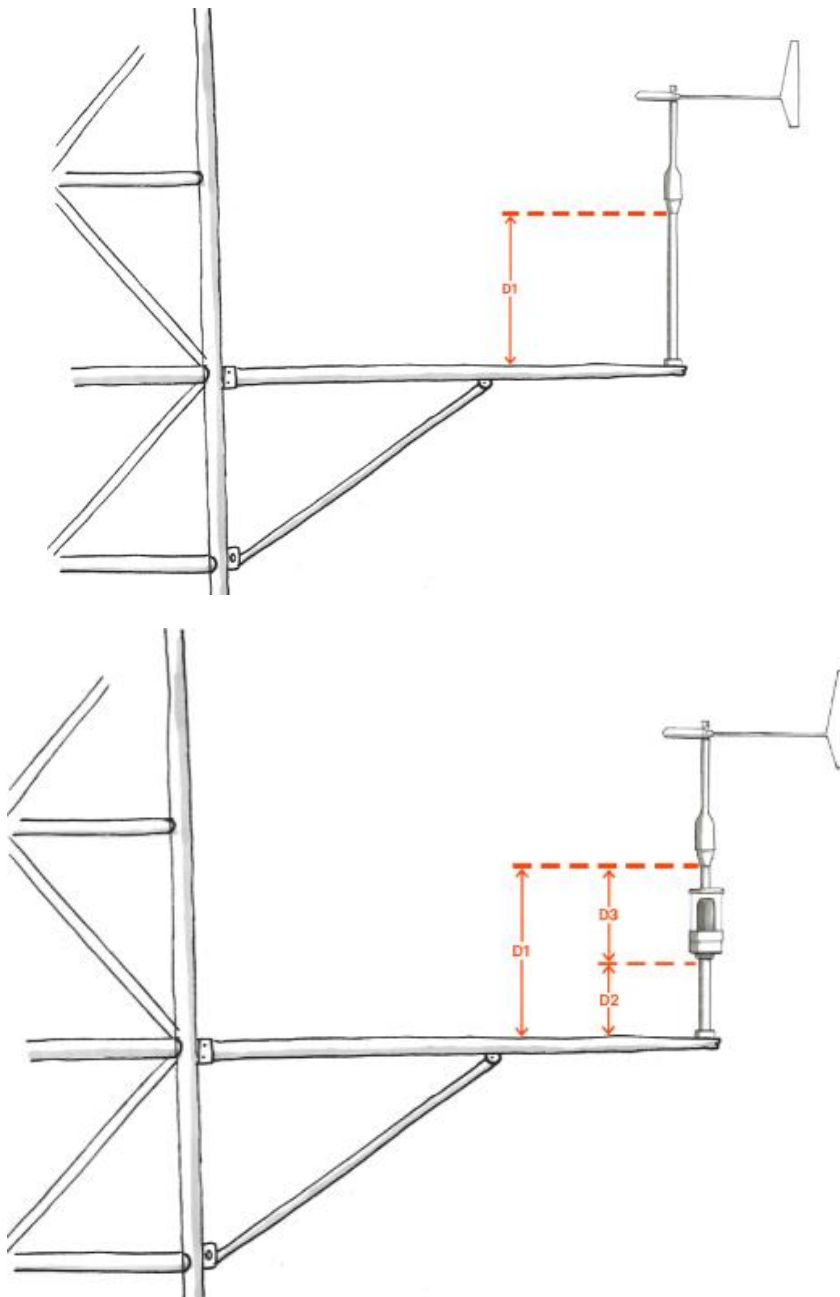
Remarks:

The Geovane housing features a mechanical slot intended to host a **plastic cable tie** for fixating the cable that runs down from the wind vane, as shown in the following picture. Failure to comply with this guideline may lead to excessive wear and tear of the **wind vane cable** under harsh weather conditions.



Remark:

As described in 5.7, the Geovane rises the wind vane by approximately 30 additional cm. The length of the met mast **vertical boom** should be **shortened** so the wind vane is kept at the same height that it would be in the absence of Geovane. Therefore the new length of the vertical support goes from D1 to D2, ensuring that $D2 + D3 = D1$ (see below).



9.2 Mechanical mounting

The Geovane and wind vane must be mounted on an instrument carrier suited for it (e.g. Ø34mm vertical tube). For dimensions of the Geovane please refer to section 5.7.

Tools required: 3 mm Hex Wrench (Allen key), provided along with the Geovane.

Procedure:

1. Push the cable of the Geovane through the borehole of the vertical boom and plug it into the connector in the base of the Geovane. Make sure the connection is correctly secured by manually tightening the connector.
2. Fix the Geovane to its carrier (i.e. the boom) by tightening the two M6-Allen head screws.

Remark:

The inner diameter of the Geovane carrier (e.g. the boom) should be greater than 20mm to allow enough room for both the plug and the cable to feed through.



9.3 Connector details and diagram

All electrical connections are made to the Geovane via an 8-pole plug connector (DIN 45326) located in the base of the sensor housing. Each pole is identified, on the soldered connection side, by a number.

The table below contains the pin assignment for the Geovane.

Pin	Description	Function
1	Out (V1+)	Analog output #1
2	RS-485 A	RS-485 Data +
3	Supply (+)	Supply 6... 30 V DC
4	RS-485 B	RS-485 Data -
5	Out (V2+)	Analog output #2
6	Out (Hz)	Frequency output
7	Supply (-)	Supply ground
8	Out (V-)	Analog output ground

Do **NOT** join pin 7 and pin 8 at sensor's side. Use dedicated wires for each ground.

9.4 Cable details

The connector for the Geovane is suitable for use with cables with overall diameters of up to 8mm and a core cross-section of 0.5 to 0.75 mm².

Depending on the number of pins to be used, the number of necessary wires can range from three (frequency output) to eight. See section 9.3 for detailed pinout and chapter 9 for how to configure.

When using the analog outputs with cable lengths over approx. 100 m it is advisable to wire two cores in parallel for pin Out (V-). Refer to section 6.1 for a more detailed explanation.

Remark:

It is recommended to always keep the RS-485 wires (pins 2 and 4) accessible from the ground so the Geovane can be re-configured and updated without having to dismount it from the met mast.

The following table shows the default color scheme for any 8-wire Geovane cables supplied by Kintech Engineering:

Pin	Color	Description	Function
1	White	Out (V1+)	Analog output #1
2	Pink	RS-485 A	RS-485 Data +
3	Green	Supply (+)	Supply 6... 30 V DC
4	Grey	RS-485 B	RS-485 Data -
5	Blue	Out (V2+)	Analog output #2
6	Red	Out (Hz)	Frequency output
7	Brown	Supply (-)	Supply ground
8	Yellow	Out (V-)	Analog output ground

It is critical that appropriate **shielding** is used to reduce EMI. The connection of the cable shield depends on whether the mounting of the Geovane on the boom is isolated.

If the mounting of the Geovane is isolated (i.e., non-metallic adaptor sleeve), the cable shield between the Geovane and the data acquisition system must be applied at both sides. When the mounting of the Geovane is non-isolated (i.e., metallic adaptor sleeve), the cable shield between the Geovane and the data acquisition system must be applied one-sided at the data acquisition device.

Both cases assume that the metallic measurement mast and the data acquisition system are grounded.

9.5 Commissioning and troubleshooting

Prior to installing the Geovane, we strongly recommend that a bench system test be carried out to confirm the system is configured correctly, is fully functional and electrically compatible with the selected host system and cabling, preferably utilizing the final cable length.

9.5.1 Commissioning: initial read values

Sometimes, the Geovane will not be able to obtain the True North orientation before the installation team departs, for example, if it's a cloudy day. To help confirm that the sensor has been correctly installed it is designed to provide 370° until it can perform the first measurement.

Besides, both analog voltage and frequency outputs distinguish between “live zero” and “dead zero”. The 0% reading or “live zero” corresponds to 0.5 V and 10 Hz respectively, whereas 0 Hz / 0 V are the “dead zero” (output not working).

The following table describes the possible values provided by Geovane and their interpretation. Values outside the specified ranges are also not valid.

Variable	Output	Hz / Volts	Degrees	Diagnosis
True North orientation	Frequency	0 Hz	-30°	Not working
		136.67 Hz	380°	No GPS signal
		133.33 Hz	370°	OK
		10... 130 Hz	0°... 360°	OK
	Voltage	0 V	-45°	Not working
		4.72 V	380°	No GPS signal
		4.61 V	370°	OK
		0.5... 4.5 V	0°... 360°	OK
Tilt X / Tilt Y	Voltage	0 V	-112.5°	Not working
		0.5... 4.5 V	-90... 90°	OK

9.5.2 Troubleshooting: output shows zero

Possible causes and proposed corrections for a "dead zero" are as follows:

1. The Geovane is not powered on → reset the Geovane and verify that the red laser inside the Geovane switches on (power supply requirements on section 5.1).
2. Incorrect wiring → refer to section 9.3.
3. The output is disabled → enable the output (see chapter 11).
4. The analog output ground, Out(V-) at pin 8, is not connected (only required for Analog voltage outputs) → connect Out (V-) to ground on the logger side.

9.5.3 Troubleshooting: no response to digital commands

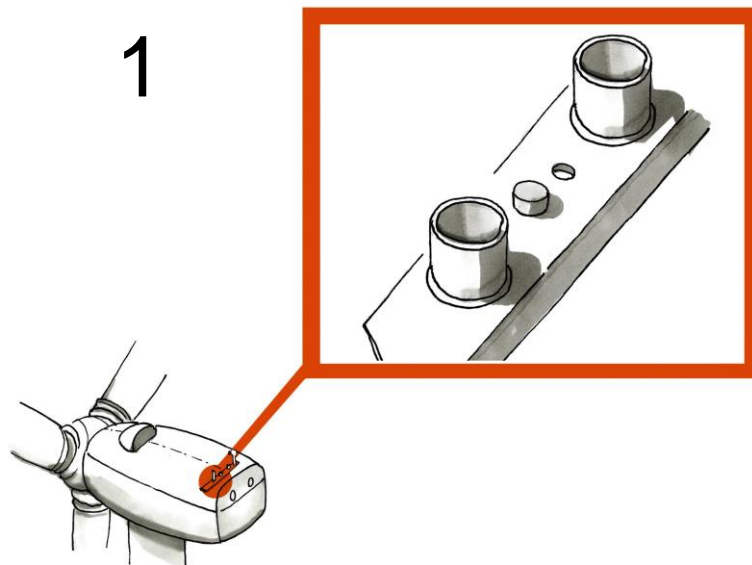
1. Verify wiring: pins 2 (RS-485 A) and 4 (RS-485 B) should be connected to Data + and Data – of the RS-485 bus respectively. The Geovane should be powered on according to the specifications described in section 5.1.
2. Verify that the communication parameters match the requirements listed in section 6.3.
3. Verify that the commands have been correctly typed. Take into account that the factory Listener ID is 00 and that it is user configurable.

9.6 Wind turbine installation and alignment (Geovane WT)

The following eight drawings describe the mounting and alignment of the Geovane with the wind turbine's nacelle. A video on the alignment procedure is also available in the following link: [Geovane Wind Turbine video](#).

1. The Geovane WT needs to be accurately aligned with the turbine axis by means of the **alignment collar** and the **laser alignment tool** provided by Kintech Engineering.

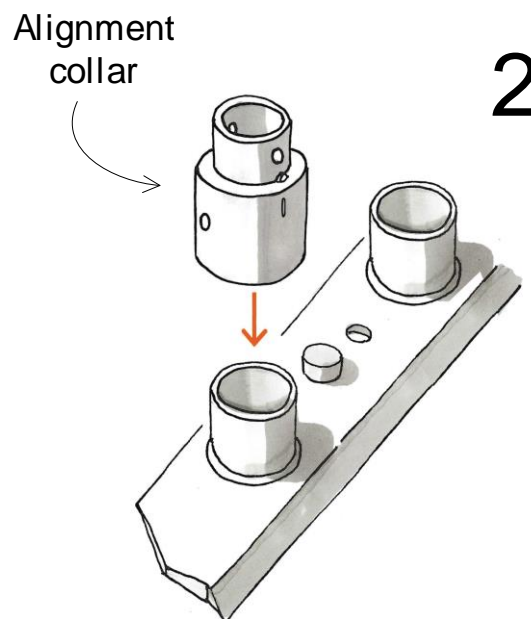
The Geovane WT is usually installed at the back of the nacelle, together with the rest of the sensors used to control the turbine, although it can be installed where best fits the user.



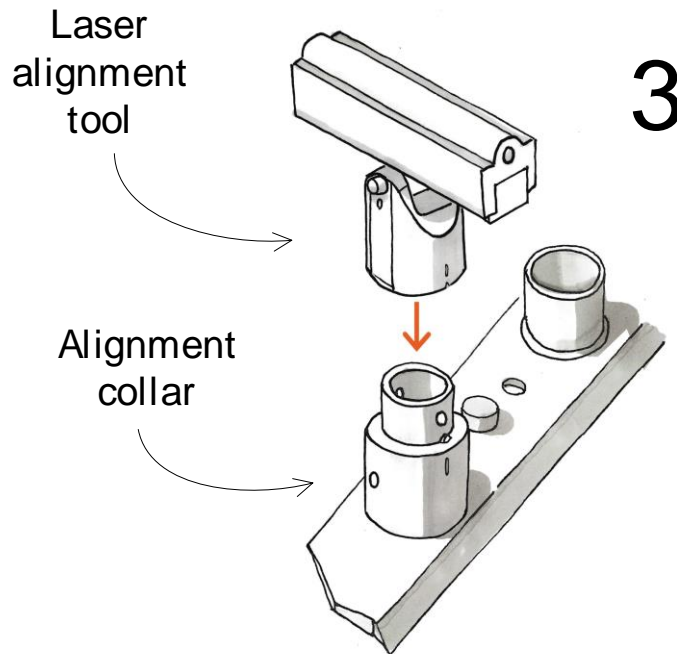
It is advised to avoid installing the Geovane WT where large obstacles cause shadows on the Geovane WT during long periods of time.

2. Every Geovane WT features an alignment collar (see 2.3.2), whose base has the same diameter as the Geovane and the Thies FC sensors (refer to mechanical specifications in section 5.7). This alignment collar needs to be aligned to the axis of the nacelle and, once aligned, fixated to the support.

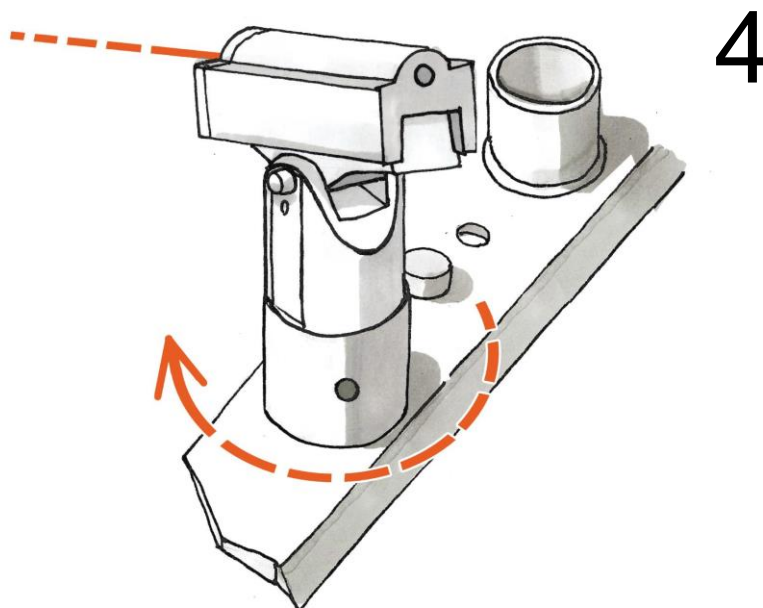
Once the alignment collar has been aligned and fixated, the Geovane will be mounted directly on it, accurately fitting in a unique position.



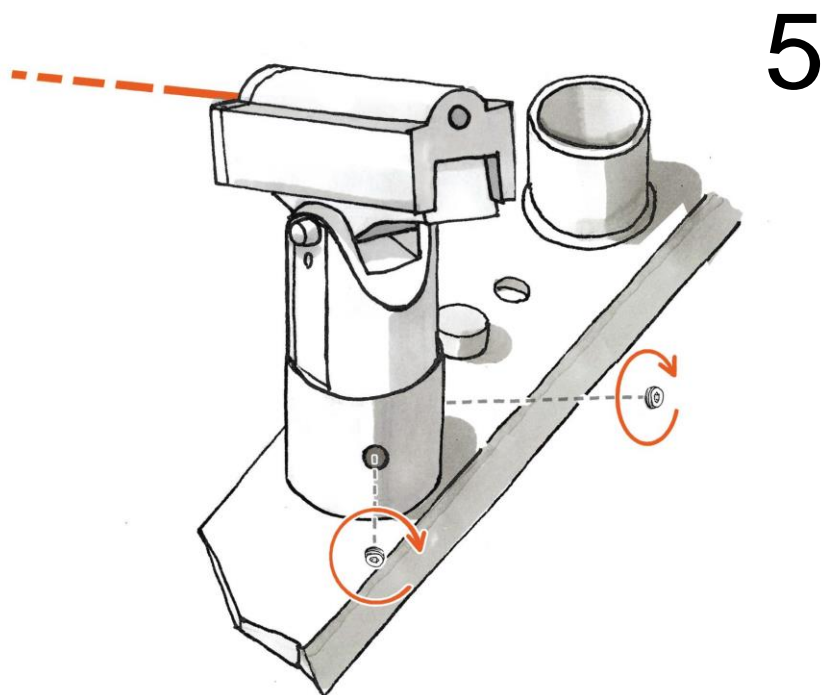
3. To line up the alignment collar Kintech provides the laser alignment tool (see section 2.4). In the same way as the Geovane, the laser alignment tool is mounted onto the alignment collar in a unique position, with both marking lines aligned with each other.



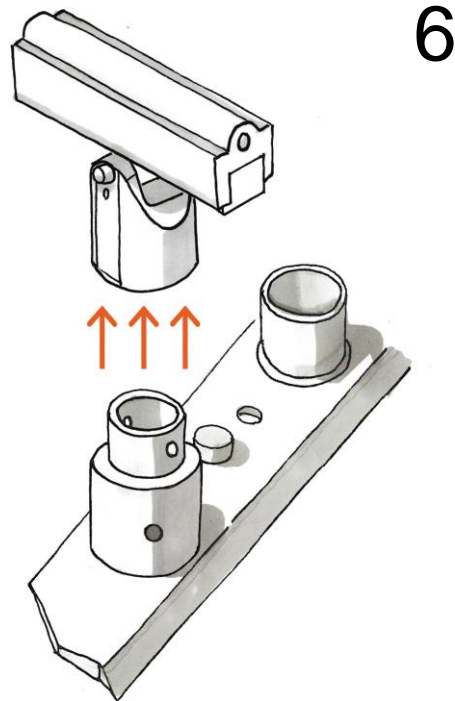
4. Turn on the laser alignment tool and point to the desired nacelle axis reference. The alignment laser tool has two degrees of freedom. The laser can be tilted up or down to account for different sizes of turbines (it can point farther or closer as needed).



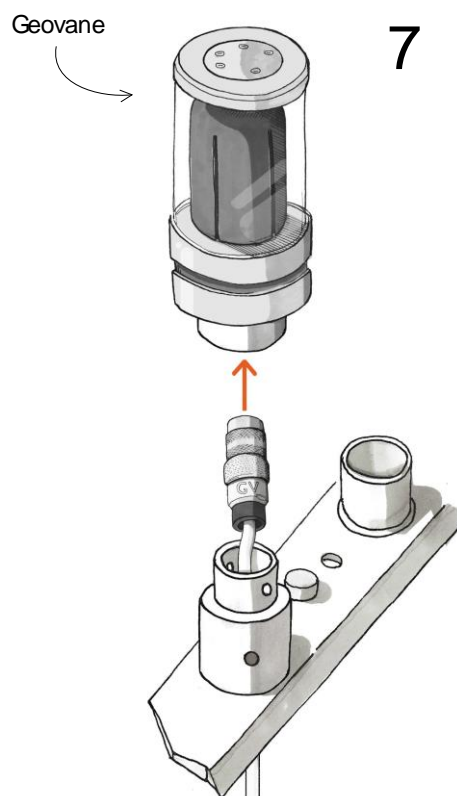
5. Once the laser is pointing in the right direction, fixate the alignment collar by means of its two screws without altering the alignment.



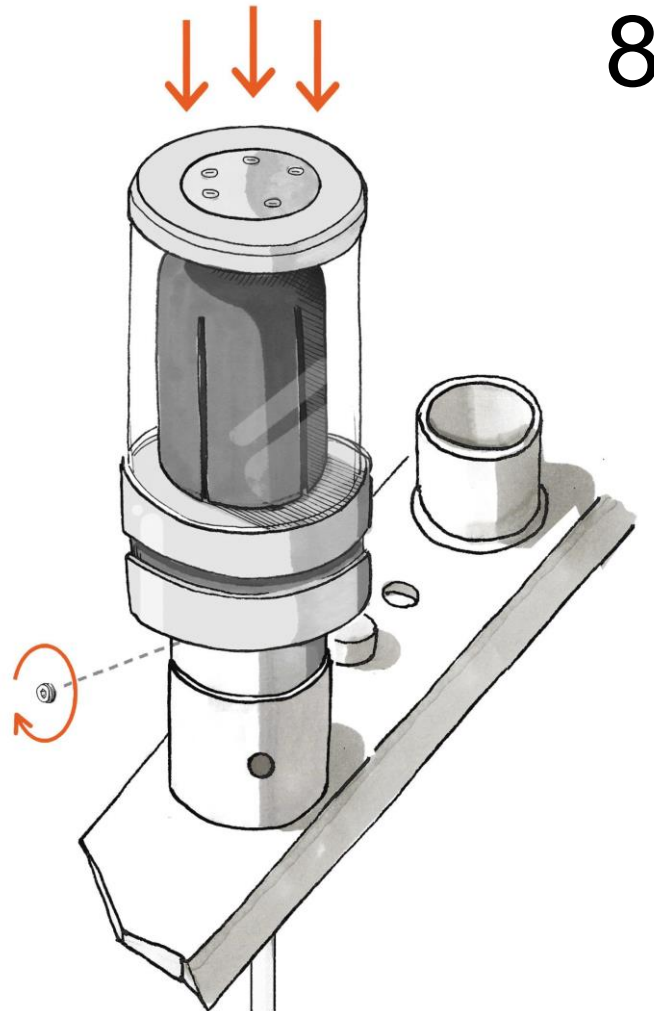
6. After fixating the alignment collar, remove the laser alignment tool.



7. Push the Geovane's wire through the alignment collar and connect it to the Geovane.



8. Place the already connected Geovane onto the alignment collar and tighten the screws to fixate the Geovane in its final position.

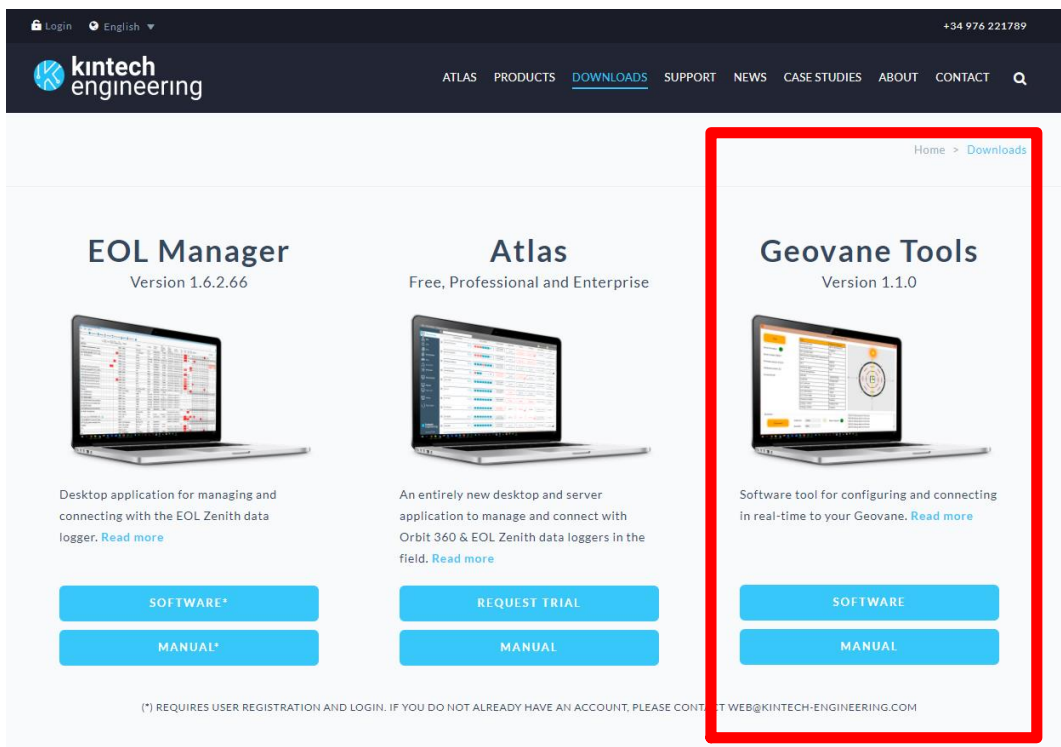


10 GEOVANE TOOLS SOFTWARE

Kintech Engineering has developed a software package named Geovane Tools to connect the Geovane to a PC and carry out configurations, updates or real-time connections in a very simple way.

It is advisable to install the Geovane Tools on a personal laptop have it hand in case it is needed. Note that the Geovane communicates through RS-485, hence a USB to RS-485 converter is required, such as the Geovane007 accessory in section 2.4.

To get the install file, please go to <https://www.kintech-engineering.com/downloads/>.



The screenshot shows the 'Downloads' page of the Kintech Engineering website. The page features three software products: EOL Manager (Version 1.6.2.66), Atlas (Free, Professional and Enterprise), and Geovane Tools (Version 1.1.0). The Geovane Tools section is highlighted with a red border. Below each product name is a laptop image showing the software interface, a brief description, and two buttons: 'SOFTWARE*' and 'MANUAL*'. A footer note states: '(*) REQUIRES USER REGISTRATION AND LOGIN. IF YOU DO NOT ALREADY HAVE AN ACCOUNT, PLEASE CONTACT US AT WEB@KINTECH-ENGINEERING.COM'.

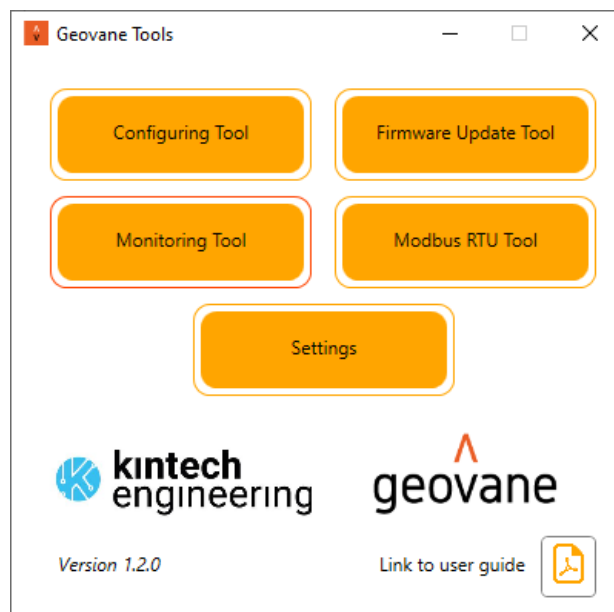
To help users keep track of their Geovanes, the Geovane Tools software automatically saves reports and screenshots of all configurations, firmware updates and real-time connections. Files are stored in folders according to the unit's serial number.

10.1 Geovane Tools modules

The Geovane Tools software contains various modules covering different aspects of Geovane, as described in the table below.

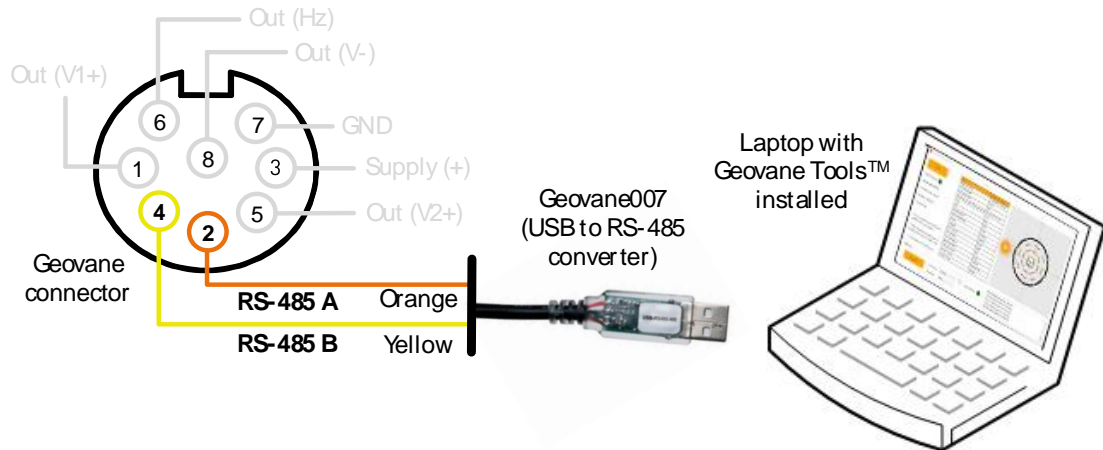
Software	Module	Function
Geovane Tools	Configuring Tool	Consult and modify the configuration of the Geovane (see chapter 11)
	Monitoring Tool	Connect to the Geovane in real time via NMEA 0183 (see section 10.3)
	Modbus RTU Tool	Connect to the Geovane WT in real time via Modbus RTU (see section 10.4)
	Firmware Update Tool	Update the Geovane's firmware (see section 10.5)
	Simulator Tool <i>(available upon request)</i>	Simulate the interaction between the Geovane and the Sun for any geographical location, date, time and Geovane's orientation

After launching the Geovane Tools software, a window will pop up from which it is possible to access the application settings, as well as any of the four modules available to configure / update / monitor the Geovane.

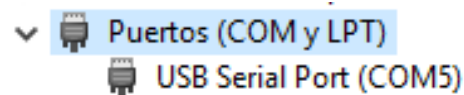


10.2 Connecting the Geovane to the PC

Follow the connection scheme below to connect the Geovane to your PC. A USB to RS-485 converter such as the Geovane007 accessory (see section 2.4) is required.



If the USB to RS-485 converter is properly installed, it will appear as a COM port on the device manager panel. (Driver installation may be required).



Please note that the Geovane must be powered on according to the specifications described in section 5.1 to be able to communicate.

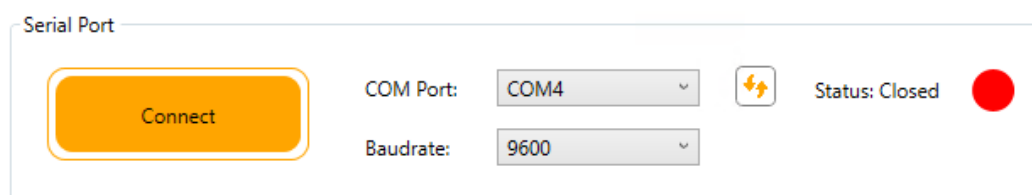
10.3 Geovane Monitoring Tool module

The Monitoring Tool module allows for real-time connections to the Geovane. It polls the Geovane using several of the NMEA 0183 commands described in chapter 7 and displays the gathered data in a user-friendly graphical interface.

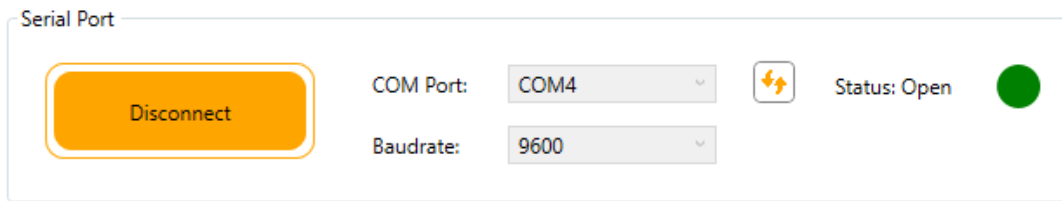
To carry out a real-time connection to the Geovane using the Monitoring Tool module, please follow these steps:

STEP 1: connect the Geovane to the PC as described in section 10.2.

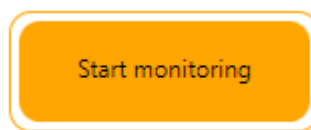
STEP 2: select the COM port to which the Geovane is connected and the baudrate that matches the one configured in the Geovane (default factory baudrate is 9600 bps).



STEP 3: click on 'Connect'. If the port is available, the red dot will become green, and the status will appear as 'Open'.



STEP 4: provided the Geovane is powered according to the specifications described in section 5.1, click on the 'Start monitoring' button.



While the real-time connection is in progress, the software will poll the Geovane every two seconds and fill in the table with the data received.

The image on the right of the Geovane Monitor window shows the actual orientation of the Geovane from True North, as well as the current position of the Sun (azimuth).

Field	Data from Geovane
Date & UTC time	22/09/2021 16:10:46
True North orientation*	276,20
New TNO sample	Yes
Date & time of latest TNO measurement	22/09/2021 16:10:41
Tilt X	-1,93
Tilt Y	-0,31
Hardware status**	0x00
Internal temperature	36,36
Latitude	41,64906
Longitude	-0,89276
Sun's azimuth	251,80
Sun's altitude	19,45
Sun's declination	0,00
Sun's hour angle	139,34
Frequency output	Enabled, TNO
Analog 1 output	Enabled, Tilt X
Analog 2 output	Enabled, Tilt Y

The Monitoring Tool GUI displays the following real-time data fields:

- Date & UTC time → Geovane's internal clock.
- True North orientation → Geovane's current orientation output.

- New sample taken → Yes / No, depending on whether a new True North orientation sample has been taken in the last pixel scan.
- Data & Time of the latest TNO measurement → UTC time at which the Geovane took the latest True North orientation measurement.
- Tilt X → angle between the X-axis and the horizontal plane, in degrees.
- Tilt Y → angle between the Y-axis and the horizontal plane, in degrees.
- Hardware status → byte of the status of the hardware (see 7.1.1).
- Internal temperature → Geovane's internal temperature, in degrees Celsius.
- Geographical latitude.
- Geographical longitude.
- Sun's azimuth → angle between True North and the horizontal projection of the sun's rays, in degrees (clockwise rotation)
- Sun's altitude → angle between the sun's rays and the horizontal plane on the earth's surface, in degrees.
- Sun's declination → angle between the earth-sun line and the equatorial plane, in degrees.
- Sun's hour angle → angle on a horizontal plane between the local solar noon and the horizontal projection of the sun's rays, in degrees.
- Frequency output configuration → enabled (TNO) / disabled.
- Analog 1 output configuration → enabled (TNO / Tilt X / Tilt Y) / disabled.
- Analog 2 output configuration → enabled (TNO / Tilt X / Tilt Y) / disabled.

Field	Data from Geovane
Date & UTC time	22/09/2021 16:10:46
True North orientation*	276,20
New TNO sample	Yes
Date & time of latest TNO measurement	22/09/2021 16:10:41
Tilt X	-1,93
Tilt Y	-0,31
Hardware status**	0x00
Internal temperature	36,36
Latitude	41,64906
Longitude	-0,89276
Sun's azimuth	251,80
Sun's altitude	19,45
Sun's declination	0,00
Sun's hour angle	139,34
Frequency output	Enabled, TNO
Analog 1 output	Enabled, Tilt X
Analog 2 output	Enabled, Tilt Y

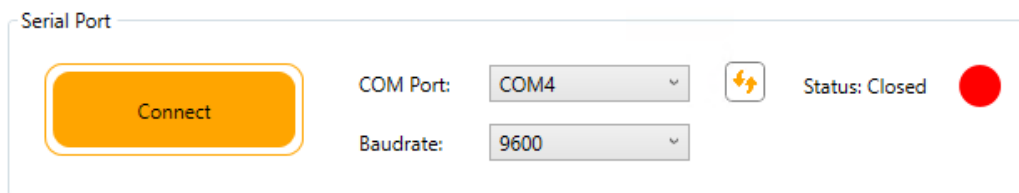
10.4 Geovane Modbus RTU Tool module (Geovane WT)

This Modbus RTU Tool module allows for Modbus RTU real-time connections to the Geovane WT, with the PC being the master and the Geovane the slave (see chapter 8). The received data is displayed in a user-friendly graphical interface.

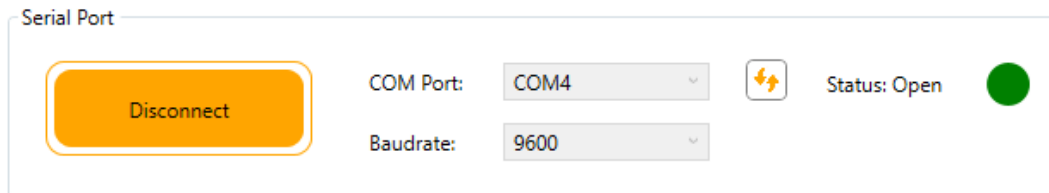
To carry out a real-time connection to the Geovane using the Modbus RTU Tool module, please follow these steps:

STEP 1: connect the Geovane to the PC as described in section 10.2.

STEP 2: select the COM port to which the Geovane is connected and the baudrate that matches the one configured in the Geovane (default factory baudrate is 9600 bps).



STEP 3: click on 'Connect'. If the port is available, the red dot will become green and the status will appear as 'Open'.



STEP 4: provided the Geovane is powered according to the specifications described in section 5.1, click on the 'Start' button.



While the real-time connection is in progress, the software will continuously query the Geovane and fill in the table with the received data.

The image on the right of the Geovane Monitor window shows the actual orientation of the Geovane from True North, as well as the current position of the Sun (azimuth).

Field	Data from Geovane
Date & UTC time	16:09 22/09/2021
Instantaneous True North orientation*	276,15
New TNO sample	Yes
Date & time of latest TNO measurement	16:09 22/09/2021
Tilt X	-1,93
Tilt Y	-0,31
Hardware status**	0x00
Internal temperature	36,3
Latitude	41,6490
Longitude	-0,8927
Sun's azimuth	251,52
Sun's altitude	19,72
Vibration X	1mg at 3,54Hz
Vibration Y	0mg at 0,61Hz
Vibration Z	0mg at 0,12Hz
Frequency output	Enabled, TNO
Analog 1 output	Enabled, Tilt X
Analog 2 output	Enabled, Tilt Y

The Monitoring Tool GUI displays the following real-time data fields:

- Date & UTC time → Geovane's internal clock.
- Instantaneous True North orientation → Geovane's orientation obtained in the last valid pixel scan.
- New sample taken → Yes / No, depending on whether a new True North orientation sample has been taken in the last pixel scan.
- Data & Time of the latest TNO measurement → UTC time at which the Geovane took the latest True North orientation measurement.
- Tilt X → angle between the X-axis and the horizontal plane, in degrees.
- Tilt Y → angle between the Y-axis and the horizontal plane, in degrees.
- Hardware status → byte of the status of the hardware (see 7.1.1).
- Internal temperature → Geovane's internal temperature, in degrees Celsius.
- Geographical latitude.
- Geographical longitude.
- Sun's azimuth → angle between True North and the horizontal projection of the sun's rays, in degrees (clockwise rotation)
- Sun's altitude → angle between the sun's rays and the horizontal plane on the earth's surface, in degrees.
- Vibration X → amplitude of the X-axis vibration main harmonic and its frequency (see table in section 7.1.6 for details).
- Vibration Y → amplitude of the Y-axis vibration main harmonic and its frequency (see table in section 7.1.6 for details).
- Vibration Z → amplitude of the Z-axis vibration main harmonic and its frequency (see table in section 7.1.6 for details).
- Frequency output configuration → enabled (TNO) / disabled.

- Analog 1 output configuration → enabled (TNO / Tilt X / Tilt Y) / disabled.
- Analog 2 output configuration → enabled (TNO / Tilt X / Tilt Y) / disabled.

Field	Data from Geovane
Date & UTC time	16:09 22/09/2021
Instantaneous True North orientation*	276,15
New TNO sample	Yes
Date & time of latest TNO measurement	16:09 22/09/2021
Tilt X	-1,93
Tilt Y	-0,31
Hardware status**	0x00
Internal temperature	36,3
Latitude	41,6490
Longitude	-0,8927
Sun's azimuth	251,52
Sun's altitude	19,72
Vibration X	1mg at 3,54Hz
Vibration Y	0mg at 0,61Hz
Vibration Z	0mg at 0,12Hz
Frequency output	Enabled, TNO
Analog 1 output	Enabled, Tilt X
Analog 2 output	Enabled, Tilt Y

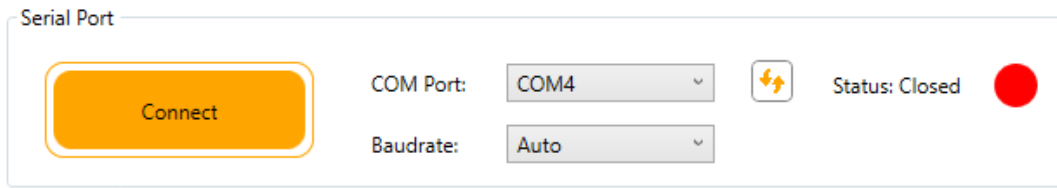
10.5 Geovane Firmware Update Tool module

Kintech Engineering releases new firmware versions to add functions, improve features and correct bugs. Firmware upgrades are not critical to the performance or accuracy of the Geovane. If at any point in time an update happens to be critical, Kintech Engineering will notify the users through the usual channels. The Firmware Update Tool module allows the user to update the Geovane firmware very easily.

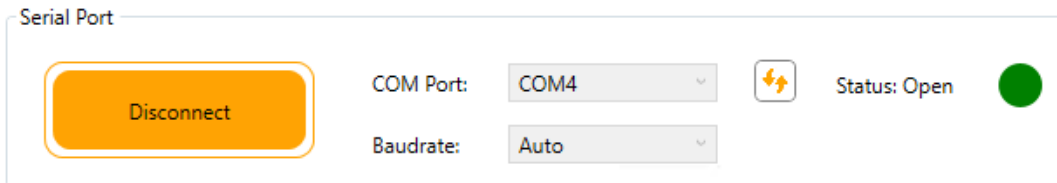
To update the firmware of your Geovane, follow these steps:

STEP 1: connect the Geovane to the PC as described in section 10.2.

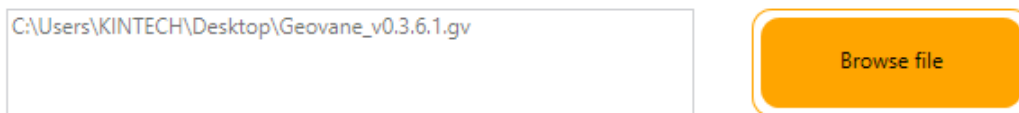
STEP 2: select the COM port to which the Geovane is connected.



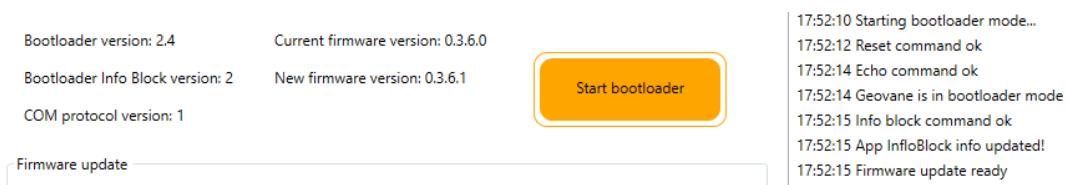
STEP 3: click on 'Connect'. If the port is available, the red dot will become green and the status will appear as 'Open'.



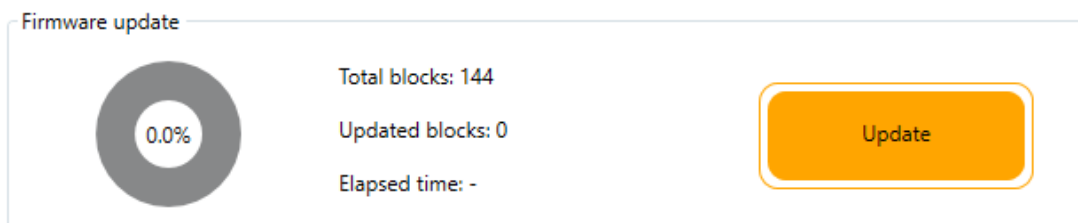
STEP 4: click on 'Browse file' and select the firmware file.

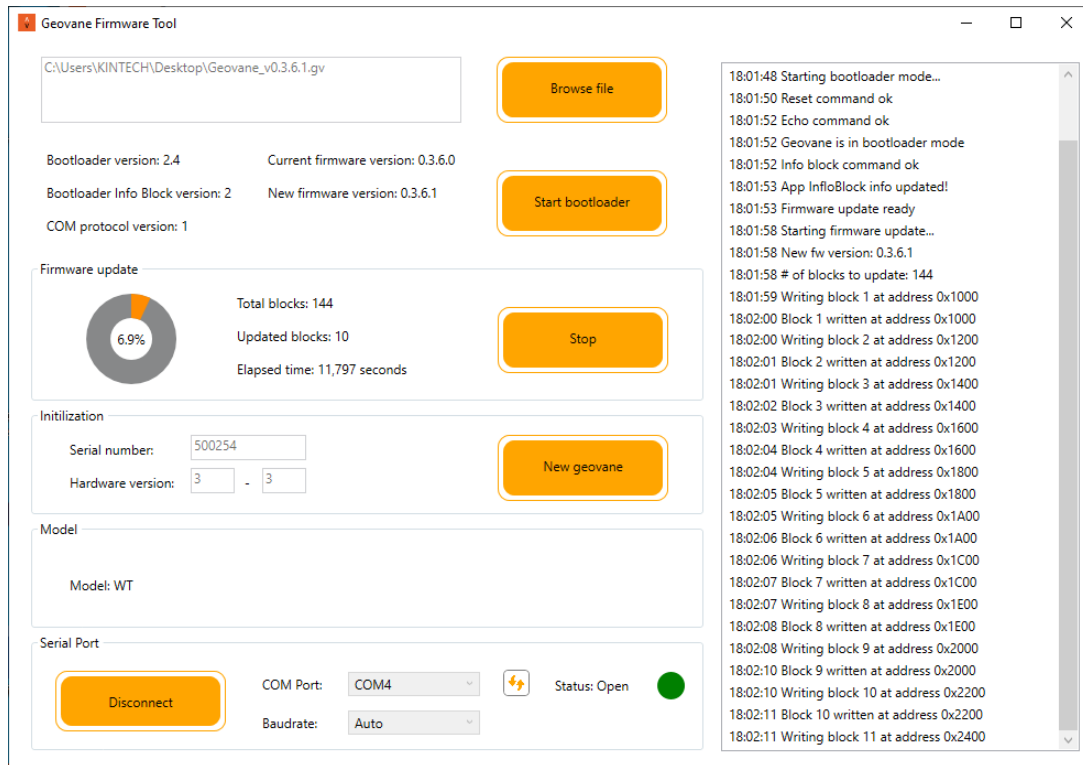
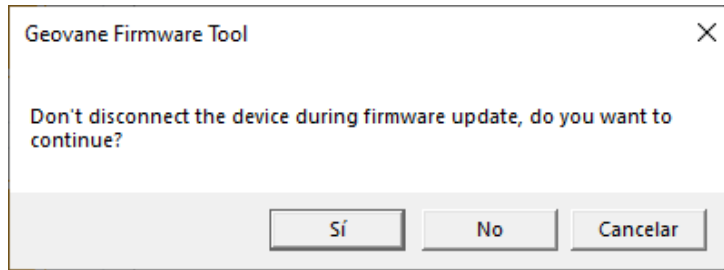


STEP 5: click on 'Start bootloader'. This will make the Geovane wait for a firmware update for the next 30 seconds. If nothing happens after 30 seconds, the Geovane will go back to its normal functioning mode (the update process can be re-started by clicking again on the 'Start bootloader' button).

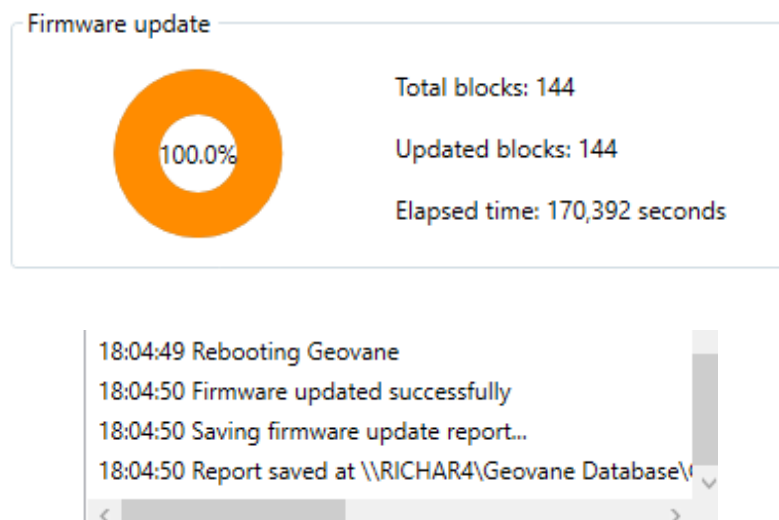


STEP 6: click on 'Update'. A pop-up confirmation window will ask if you want to continue with the process. Click on 'Yes' to begin the firmware update process.





STEP 7: wait until the update finishes. The Geovane will reboot itself and begin its normal operation.



11 CONFIGURATION

The Geovane can be configured to meet the requirements of every installation and user's preference concerning the interfacing with the data logger. The factory-preset default configuration is described in section 11.2.

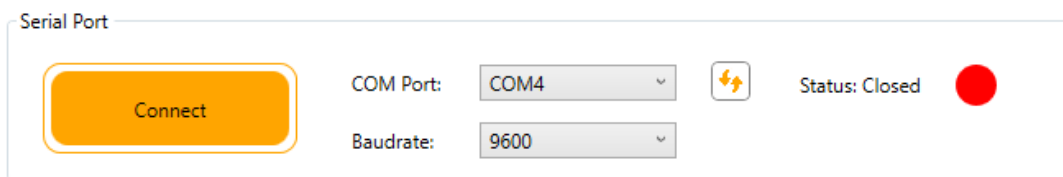
11.1 Geovane Configuring Tool module

In case you want to re-configure the Geovane, this process is done via the RS-485 serial interface. To assist the users with the configuration, Kintech Engineering provides the 'Geovane Configuring Tool' module (refer to chapter 9 for instructions on how to download and install Geovane Tools).

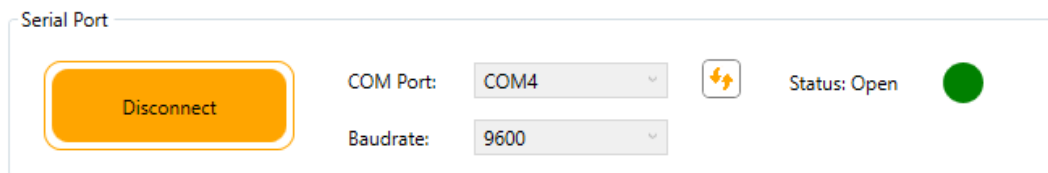
To re-configure the Geovane, please follow these steps:

STEP 1: connect the Geovane to the PC as described in section 10.2.

STEP 2: select the COM port to which the Geovane is connected and the baudrate that matches the one configured in the Geovane (default factory baudrate is 9600 bps).

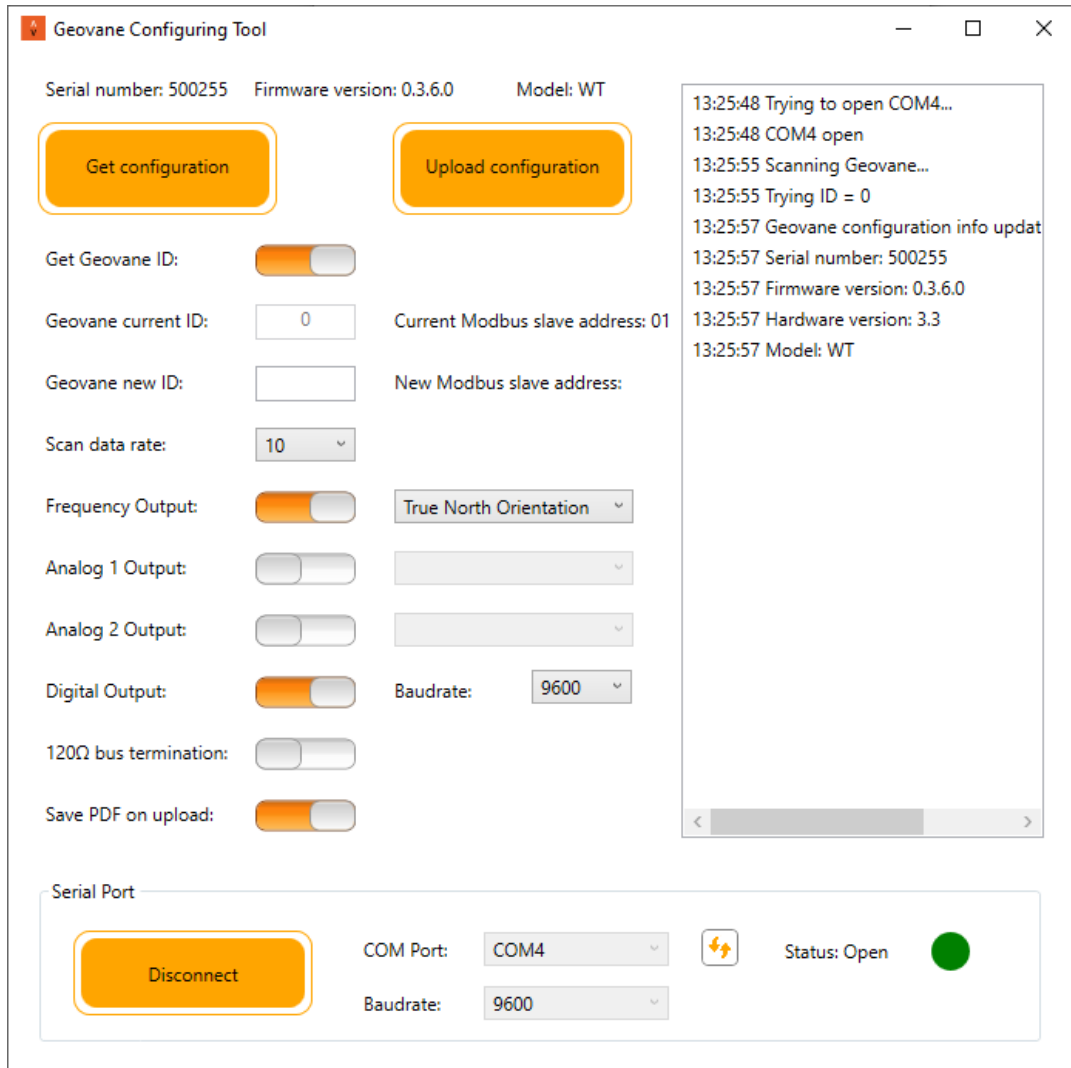


STEP 3: click on 'Connect'. If the port is available, the red dot will become green, and the status will appear as 'Open'.



STEP 4: fill in the 'Geovane Current ID' (default factory ID is 00) and click on 'Get configuration'. If you do not know what ID the Geovane has been previously given, activate the slide button 'Scan Geovane ID' and the software will try all the possible Geovane's ID (00 to 99).

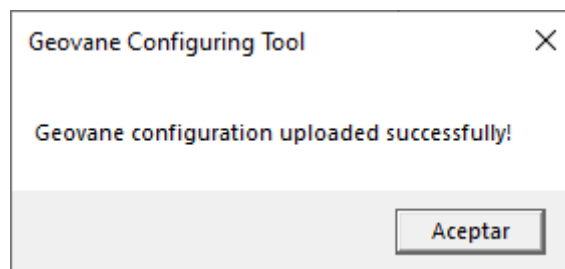
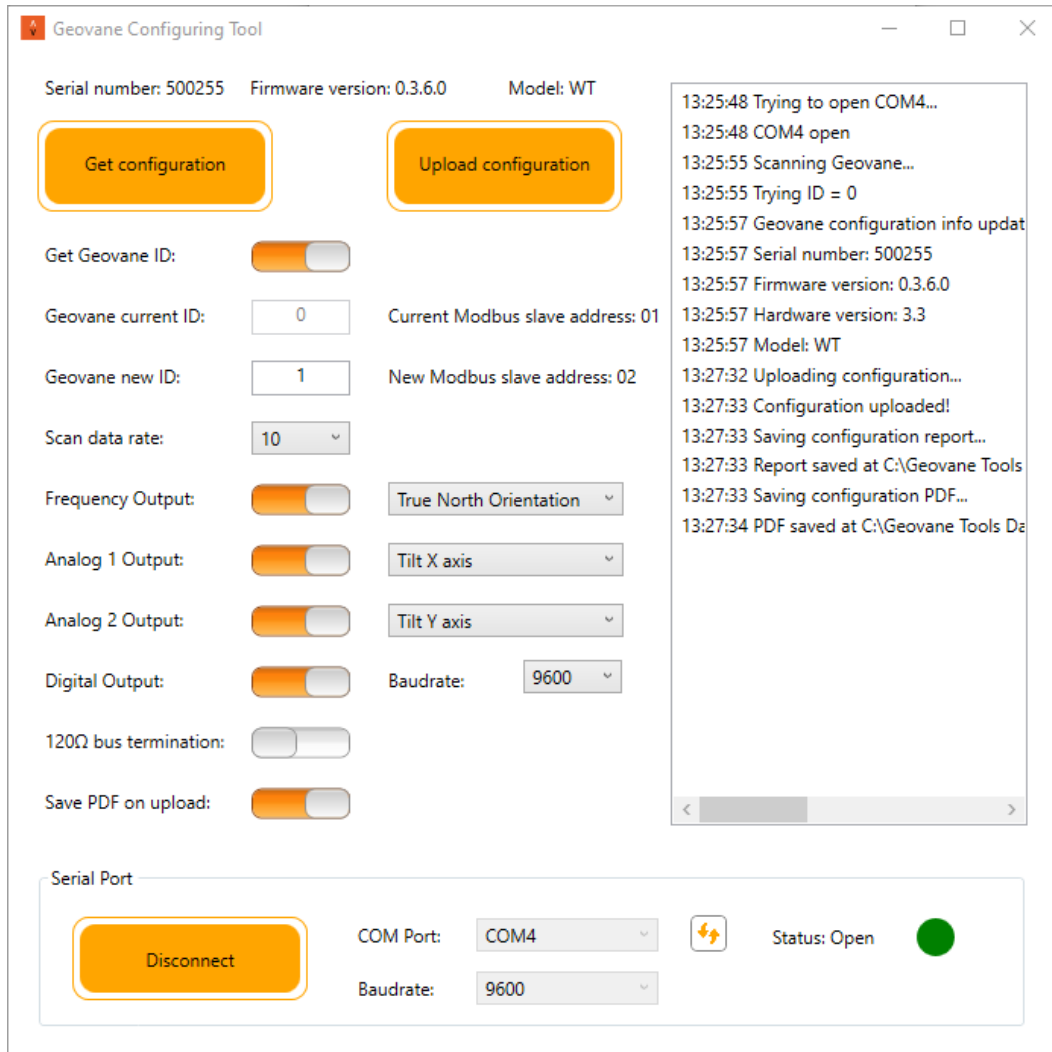
Once the Geovane is detected, the window will show the current Geovane's configuration, as well as its serial number and hardware and firmware version. Note that the Geovane Configuring Tool will always require getting the current configuration of the Geovane before uploading a new configuration.



STEP 5: set the desired new configuration and upload it to the Geovane by clicking on the 'Upload configuration' button. The configuration will be uploaded to the Geovane and it will be stored in its non-volatile internal memory (EEPROM).

A message in the prompt window, on the right, confirms whether the configuration has been successfully uploaded to the Geovane.

It is possible to generate a PDF report containing all the Geovane configuration parameters (for instance, to print it and include it in the box). To do it, simply activate the option 'Save PDF on upload' before uploading the new configuration.



Remark:

Some functionalities are hardware and/or firmware dependent. The Configuration Tool is able to automatically enable or disable the option to configure these functionalities depending on the characteristics of the Geovane to be configured.

11.2 Default configuration

The Geovane can be configured by Kintech Engineering, free of charge, if specified at the time of order. In case you do not know which the optimal output configuration to communicate with your data acquisition system is, do not hesitate to contact us.

Description		Default value	Comments
Scan data rate		10	Seconds
Listener ID		00	RS-485 device identifier
Modbus Slave Address		1	Listener ID + 1
Outputs*	RS-485	Enabled	Pin 2 and pin 4
	Frequency	True North Orientation	Pin 6
	Analog #1	Tilt X	Pin 1
	Analog #2	Tilt Y	Pin 5
Baudrate		9600	bps
120 Ω termination resistor		Disabled	-

*See configuration sheet inside box.

12 GEOVANE AND KINTECH DATA LOGGERS

The Geovane can be used with any data logger on the market that supports at least one of its three types of outputs (refer to sections 5.4 and 6). This chapter covers the use of the Geovane along with EOL Zenith and Orbit 360 data loggers by Kintech Engineering, and the advantages of doing so.

12.1 Geovane and Orbit 360

The Geovane can be connected to the Orbit 360 data logger by means of its frequency, analog or RS-485 outputs (Orbit Premium). Refer to chapter 9 for more info on how to configure the outputs of the Geovane.

Power the Geovane from either terminal #36 or terminal #40 of the Orbit 360 data logger. These terminals provide battery voltage while limiting the load current to 200mA.

12.1.1 Recommended interfacing

Orbit 360 Premium:

Variable	Geovane output	Logger channel
True North Orientation	RS-485	RS-485 bus
Tilt X	RS-485	RS-485 bus
Tilt Y	RS-485	RS-485 bus

Disabled Geovane outputs: Frequency output, Analog output #2.

Optional: map the True North Orientation to Analog output #1 and use it as backup of the digital output, connecting it to the last ANL channel available in the logger.

Orbit 360 Basic Plus:

Variable	Geovane output	Logger channel
True North Orientation	Frequency output	Frequency channel
Tilt X	Analog output #1	Analog channel
Tilt Y	Analog output #2	Analog channel

Optional: keep the RS-485 wires (pins 2 and 4) accessible from the ground so the Geovane can be re-configured and updated from the bottom.

12.1.2 Channel configuration (Atlas and on-site)

Frequency channel

To configure any of the frequency channels of the Orbit 360 data logger to connect a Geovane, go to Site Settings → Channels and set up the channel according to the table below.

Section	Frequency channels
Sensor type	Geovane
Sensor model	True North Orientation
Slope and Offset	Standard calibration

True North Orientation in frequency channel example:

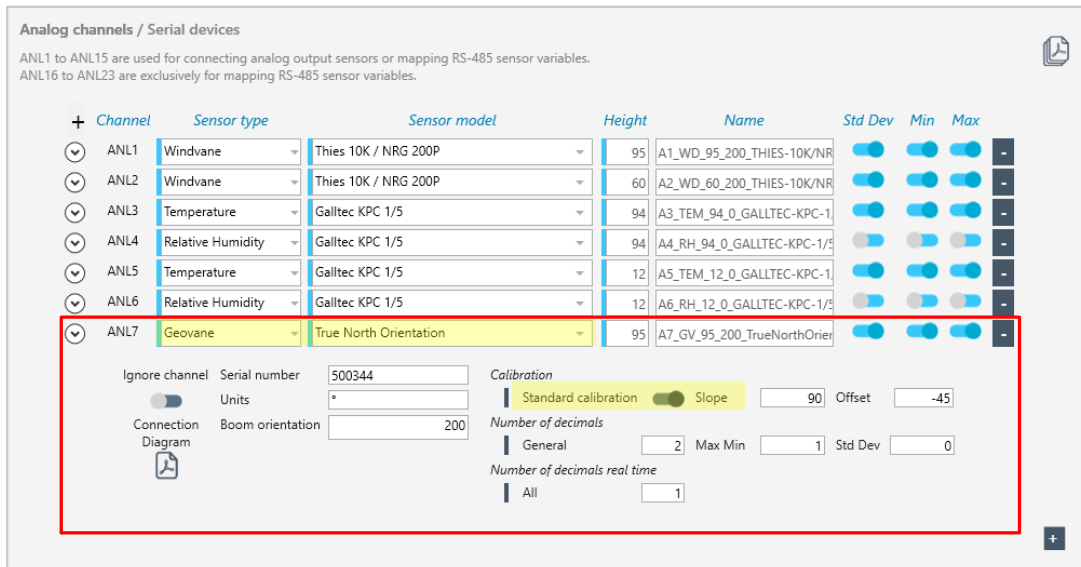
For on-site configuration via keypad, navigate to Sensor Model → select the channel number you want to configure → press the SET button → select #32 GEOVANE TRUE NORTH → press right arrow button to save the changes.

Analog voltage channel

To configure any of the analog channels of the Orbit 360 data logger to connect a Geovane, set up the channel settings according to the following table.

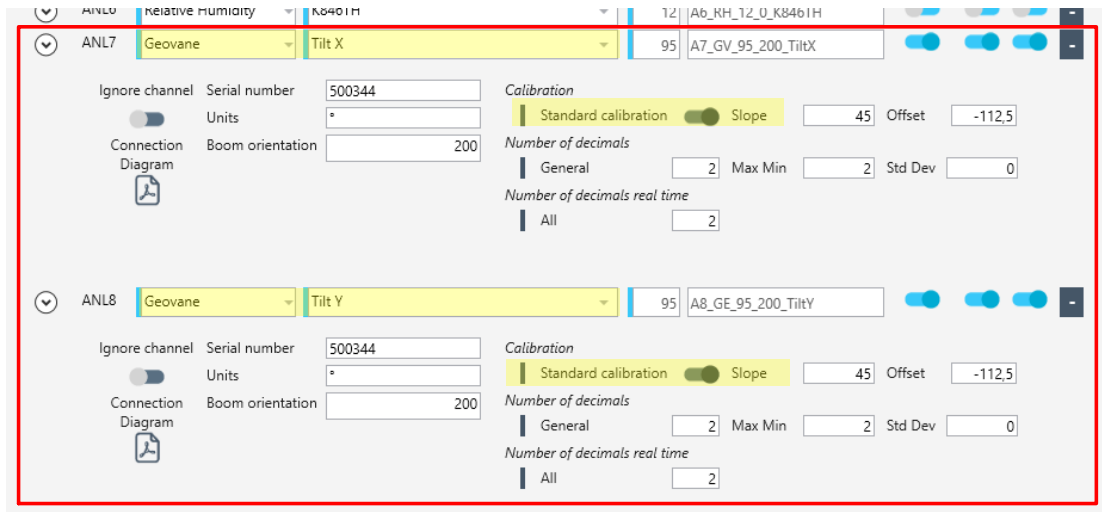
Section	Analog channels
Sensor type	Geovane
Sensor model	True North Orientation / Tilt X / Tilt Y
Slope and Offset	Standard calibration

True North Orientation in analog channel example:



For on-site configuration via keypad, navigate to Sensor Model → select the channel number you want to configure → press the EDIT button → select #60 GEOVANE TRUE NORTH → press right arrow button to save the changes.

Tilt X / Tilt Y in analog channels example:



For on-site configuration via keypad, navigate to Sensor Model → select the channel number you want to configure → press the SET button → select #61 GEOVANE TILT X or #62 GEOVANE TILT Y → press right arrow button to save the changes.

RS-485 bus

To configure any of the three RS-485 buses available in the Orbit 360 data logger to connect a Geovane, go to Site Settings → Channels and configure the bus and the channel according to the following indications.

1. Configure the baudrate of the serial bus to the value that matches the one configured in the Geovane (available logger options are either 9600 or 19200).

Section	Serial buses baud rates
Serial bus baud rate	9600 / 19200 bps

Input channels

Serial buses baud rates

Serial bus 1 baud rate

Serial bus 2 baud rate

Serial bus 3 baud rate

2. Create a new Geovane sensor and assign it to the selected serial bus.

Section	Serial channels
Bus	SERIAL1 / SERIAL2 / SERIAL3
ID (must match Geovane's ID)	A > 00, B > 01, C > 02, D > 03...
Sensor model	Geovane
Name	<i>User-customizable</i>

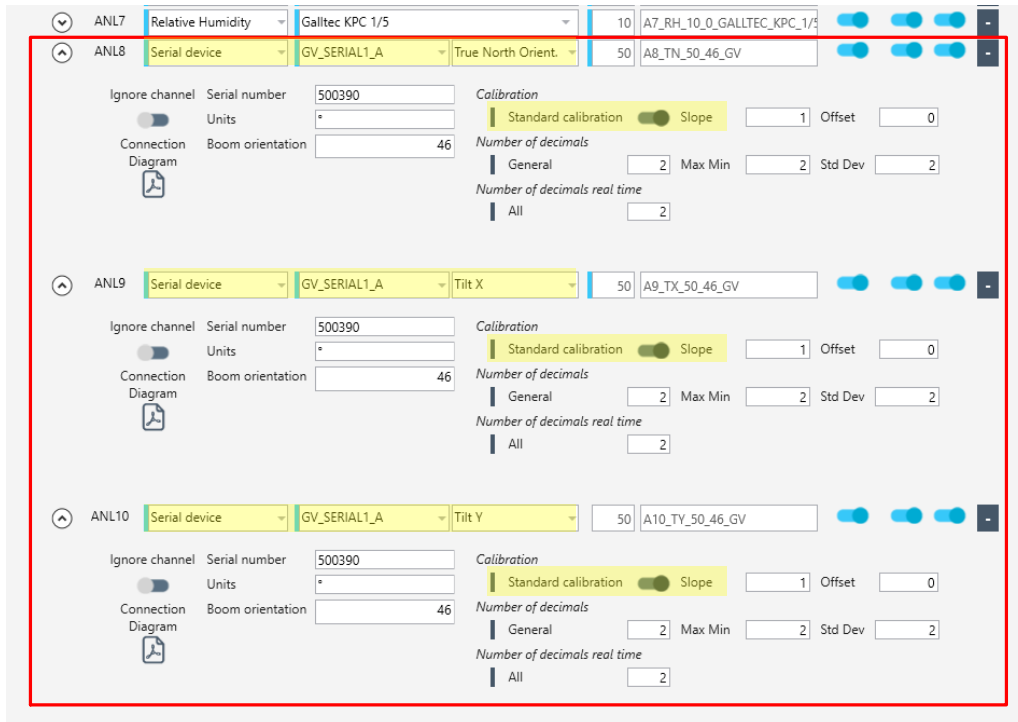
Serial channels 📄

Bus	ID	Sensor model	Name	
<input type="text" value="SERIAL1"/>	<input type="text" value="A"/>	<input type="text" value="Geovane"/>	<input type="text" value="GV_SERIAL1_A"/>	📄 -
<input type="text" value="SERIAL2"/>	<input type="text" value="A"/>	<input type="text" value="Geovane"/>	<input type="text" value="GV_SERIAL2_A"/>	📄 -

+

3. Create new sensor channels and assign them to the newly created Geovane.

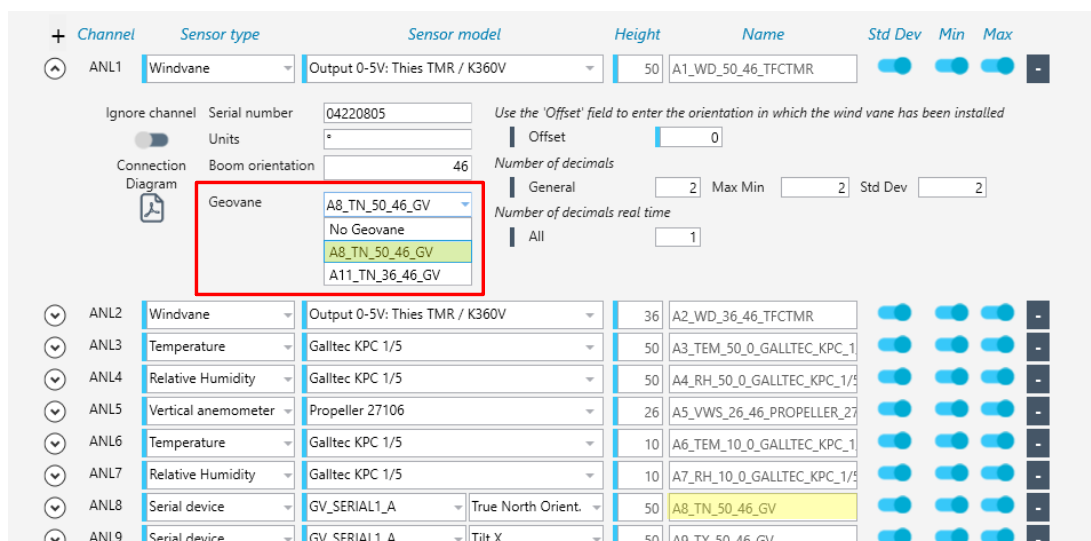
Section	Analog channels
Sensor type	Serial device
Sensor model	<i>Geovane's Name</i>
	True North Orient. / Tilt X / Tilt Y
Slope and Offset	Standard calibration



12.1.3 Pairing wind vanes with Geovanes in Atlas

Atlas allows the user to pair the wind vanes with the Geovanes. This way, the Site Settings in Atlas will reflect which wind vanes are equipped with which Geovanes for ease of site management and improved traceability.

To carry out the pairing, go to Site Settings → Channels, then open the settings of the wind vane to which you want to assign a Geovane and select the desired one from the list of installed Geovanes (identified by the field “Name”), as shown in the snapshot below.



12.1.4 True wind direction data column (Atlas)

Atlas will automatically generate the corrected wind direction data column at the times it decodes the .log raw data files for each wind vane paired to a Geovane (refer to section 12.1.3).

12.2 Geovane and EOL Zenith

The Geovane can be connected to any standard EOL Zenith data logger by means of its frequency and analog outputs. Refer to chapter 9 for more info on how to configure the outputs of the Geovane.

Power the Geovane directly from the plus and minus terminals of the battery for the required continuous supply (12 V recommended, refer to sections 5.1 and 5.4).

12.2.1 Channel configuration (EOL Manager and on-site)

Anemometer / Frequency channel

To configure any of the anemometer channels of the EOL Zenith data logger to connect a Geovane, please go to Logger Settings → Inputs tab and set up the channel according to the following table.

Frequency channel configuration for EOL Zenith firmware versions ≥ 0.61/1.61	
Section	Anemometers / Frequency
Type	Geovane
Model	True North Offset
Slope and Offset	Standard Calibration

True North Offset in anemometer/frequency channel example:

Ignore	Channel	Type	Model	Units	Serial Number	Height	Boom	Username	Std Cal	Slope	Offset	Std Dev	Max	Min
<input type="checkbox"/>	ANE1	Anemometer	THIES FIRST CLASS	m/s		120	0	WS1_120_0_FC	<input type="checkbox"/>	0.047850	0.242050	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	ANE2	Anemometer	THIES FIRST CLASS	m/s		117	240	WS2_117_240_FC	<input type="checkbox"/>	0.047870	0.233810	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	ANE3	Anemometer	THIES FIRST CLASS	m/s		90	240	WS3_90_240_FC	<input type="checkbox"/>	0.047960	0.225410	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	ANE4	Anemometer	THIES FIRST CLASS	m/s		65	240	WS4_65_240_FC	<input type="checkbox"/>	0.047910	0.239890	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	ANE5	Anemometer	THIES FIRST CLASS	m/s		40	240	WS5_40_240_FC	<input type="checkbox"/>	0.047820	0.263690	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	ANE6	Geovane	True North Offset	m/s		90	60	GV6_90_60_Tru...	<input checked="" type="checkbox"/>	3.000000	-30.000000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	ANE7	Anemometer	-----	m/s		0	0	WS7_0_0_-----	<input type="checkbox"/>	0.000000	0.000000	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	ANE8	Anemometer	-----	m/s		0	0	Anemo8	<input type="checkbox"/>	0.000000	0.000000	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	ANE9	Anemometer	-----	m/s		0	0	Anemo9	<input type="checkbox"/>	0.000000	0.000000	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	ANE10	Anemometer	-----	m/s		0	0	Anemo10	<input type="checkbox"/>	0.000000	0.000000	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

For on-site configuration via keypad, navigate to Sensor Model → select the channel number you want to configure → press the EDIT button → select #32 GEOVANE TRUE NORTH → press right arrow button to save the changes.

Remarks:

The voltage threshold of the EOL Zenith ANE channel used to connect the Geovane must be factory-set to 1V. Contact Kintech Engineering support for more info.

For EOL Zenith firmware versions < 0.61/1.61, the frequency channel must be configured according to the following table:

Frequency channel configuration for EOL Zenith firmware versions < 0.61/1.61	
Section	Anemometers / Frequency
Type	Frequency
Model	Hertz
Slope and Offset	Slope = 3, Offset = -30

For on-site configuration via keypad, navigate to Sensor Model → select the channel number you want to configure → press the EDIT button → select #28 Hertz → press right arrow button to save the changes.

Please contact Kintech Engineering if you want to update the firmware of your logger.

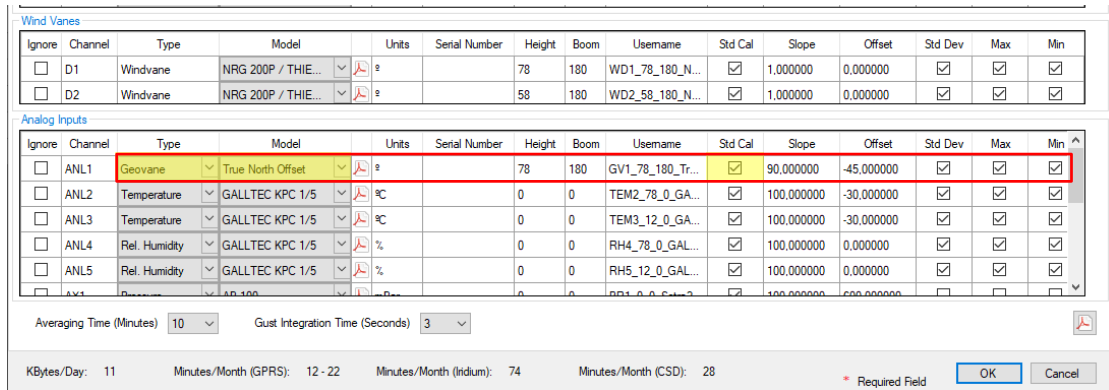
Analog voltage channel

To configure any of the analog channels of the EOL Zenith data logger to connect a Geovane, set up the channel settings according to the following table.

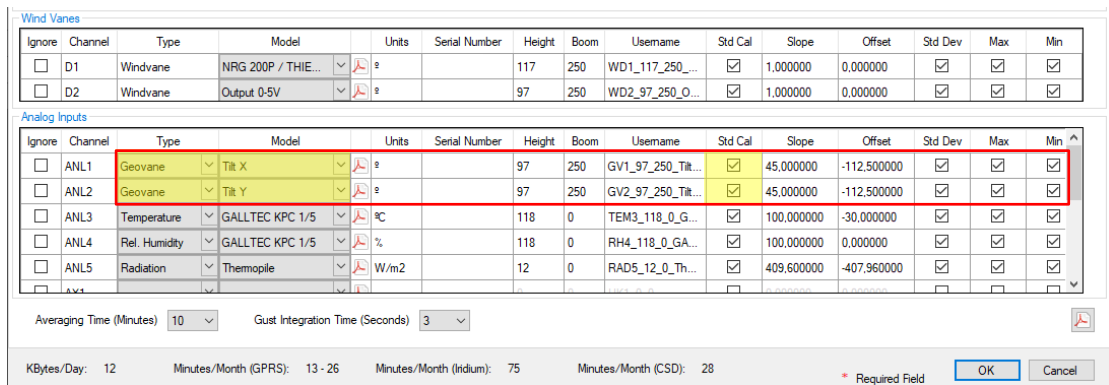
Analog channel configuration for EOL Zenith firmware versions ≥ 0.61/1.61	
Section	Analog Inputs
Type	Geovane
Model	True North Offset / Tilt X / Tilt Y
Slope and Offset	Standard Calibration

For on-site configuration via keypad, navigate to Sensor Model → select the channel number you want to configure → press the EDIT button → select #60 GEOVANE TRUE NORTH → press right arrow button to save the changes.

True North offset in analog channel example:



Tilt X / Tilt Y in analog channels example:



For on-site configuration via keypad, navigate to Sensor Model → select the channel number you want to configure → press the EDIT button → select #61 GEOVANE TILT X or #62 GEOVANE TILT Y → press right arrow button to save the changes.

For EOL Zenith firmware versions < 0.61/1.61, the analog channel must be configured according to the following table:

Analog channel configuration for EOL Zenith firmware versions < 0.61/1.61	
Section	Analog Inputs
Type	Voltage
Model	Volts
Slope and Offset	Slope = 90, offset = -45 (True North Offset)
	Slope = 45, offset = -112.5 (Tilt X / Tilt Y)

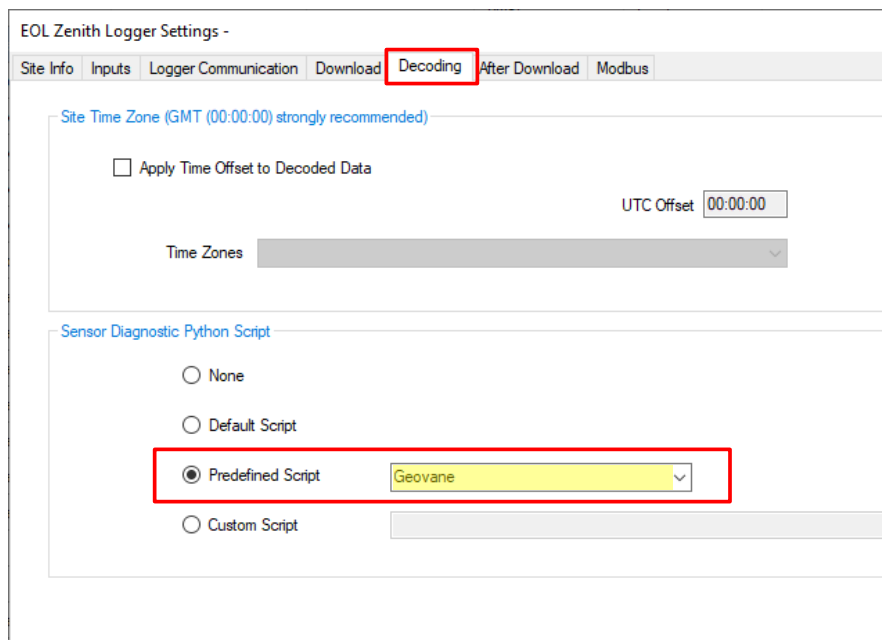
For on-site configuration via keypad, navigate to Sensor Model → select the channel number you want to configure → press the EDIT button → select #01 Millivolts → press right arrow button to save the changes.

Please contact Kintech Engineering if you want to update the firmware of your logger.

12.2.2 True wind direction data column (EOL Manager)

If the Geovane is used along with an EOL Zenith data logger, the corrected wind direction (true wind direction) can be automatically generated by the EOL Manager software at the times it decodes the .log raw data files.

To do so, please access the logger settings and select the “Geovane” script from the “Predefines Script” drop-down menu of the Decoding tab.



After doing this, EOL Manager will add, at the decoding of the data, an extra column with the true wind direction for every wind vane equipped with Geovane on the met mast, in a similar way to the example of chapter 0.

Notice that the script works no matter what offset value the user had filled into the Inputs tab of the logger settings. This is because before adding the True North orientation provided by the Geovane the script removes the user offset.

For every wind vane equipped with Geovane, the .wnd file will contain:

- 1) A column with the wind direction data result from applying the offset that the user has manually filled in the Logger Settings → Inputs tab corresponding field (set the offset to zero to get raw wind direction data).
- 2) A column with the true wind direction data result from applying the True North orientation provided by the paired Geovane.

Remark:

For the script to be able to pair the Geovanes with their wind vanes, it is necessary to fill the “Height” fields on both sensors, in the “Inputs” tab of the logger settings. In case that more than one wind vane is located at the same height, it will be also necessary to fill the “Boom” fields so the script can use the boom orientation to distinguish between wind vanes at the same height.

It is suggested to manually decode a test .log with the Geovane script to verify that all the necessary parameters have been correctly filled. To do so, right click on the logger whose data you want to decode → Decoding Tool → Select the .log(s) file(s) → Start.

The “Show Details” button in the Decoding Tool window will provide messages that can help you troubleshoot, as shown in the following examples:

```
***** GEOVANE PYTHON SCRIPT *****
```

```
Number of Geovanes detected: 1.
```

```
Geovane connected to channel ANE6 paired to windvane connected to channel D1.  
(Height: 117m).
```

```
WD2_117_255_Output_0-5V_OffsetFree column added!
```

```
*****
```

```
***** GEOVANE PYTHON SCRIPT *****
```

```
Number of Geovanes detected: 1.
```

```
||| WARNING ||| Number of Geovanes not paired to any wind vanes: 1.
```

```
Please verify height and boom orientation fields in Logger Settings => Inputs.
```

```
*****
```

```
***** GEOVANE PYTHON SCRIPT *****
```

```
Number of Geovanes detected: 1.
```

```
||| ERROR ||| It has not been possible to uniquely pair wind vanes and Geovanes.  
Please fill in and verify the boom orientations for all the wind vanes on the met  
mast (Logger Settings => Inputs).
```

```
*****
```

13 EC DECLARATION OF CONFORMITY



We, Kintech Instruments S.L.
Anselmo Clavé 37-45
50004 Zaragoza
Spain

in accordance with the requirements of the following directives:

2011/65/EU The Restriction of Hazardous Substances Directive (RoHS)
2014/30/EU The Electromagnetic Compatibility Directive

hereby declare under our sole responsibility that the product:

Geovane

has been designed to comply and is in conformity with the relevant sections and applicable requirements of the directives

A handwritten signature in black ink, appearing to be 'Iñigo Vázquez', written in a cursive style.

Íñigo Vázquez
Technical Manager
Kintech Instruments S.L.

November 24, 2017

14 FIRMWARE & SOFTWARE RELEASE CHANGELOG

14.1 Firmware

Kintech Engineering releases new firmware versions to add functions, improve features and correct bugs. Firmware upgrades are easily performed using the Firmware Update Tool module included in the Geovane Tools software (refer to chapter 9).

Firmware upgrades are not critical to the performance or accuracy of the Geovane. If at any point in time an update happens to be critical, Kintech Engineering will notify the users through the usual channels.

Do not hesitate to contact Kintech Engineering at support@geovane360.com for advice on the convenience of whether to upgrade the firmware of your Geovanes.

Firmware version	Description of modification / changes
0.2.2.0	True North orientation is set to 385° at startup and until the Geovane measures for the first time.
	Fixed problem which made tilt measurement wrong under some conditions.
0.2.3.0	ORN message now features a hardware status byte (see section 7.1.1).
	True North orientation is set to 385° at startup and until the Geovane gets GPS signal.
	True North orientation is set to 370° after the Geovane gets GPS signal and until it measures for the first time.
0.2.3.3	Fixed problem where certain geographical longitudes were considered not valid.
0.2.3.4	True North orientation is set to 380° at startup and until the Geovane gets GPS signal to prevent the analog output stages from reaching saturation.
0.2.3.5	Fixed bug where the carriage return of the ORN message had a different value than <CR>.
	Added ORX message (see sections 7.1.2 and 7.2.6).
0.2.3.6	The solar coordinates are now also updated in sleep mode (during night-time). Refer to section 7.1.3.

0.2.4.0	Fixed bug where the MA filter of the tilt measurement could get affected under some conditions. Enhanced power management functions.
0.2.5.1	New TNO processing added to account for dynamic operation (Geovane WT). Added ORT message (see section 7.1.6 and 7.2.7).
0.2.5.2	Fixed bug by which the Geovane might not answer to 1 out of approximately 86400 polls carried out by its master (1 poll per day, assuming 1 Hz polling).
0.3.2.5	Supports hardware v3.5 (2048 photosensing pixels arranged in two concentric rings). New Fast Fourier Transform (FFT) calculations added to provide the 3-axis nacelle's vibration (Geovane WT). ORT message modified to include the 3-axis vibration (Geovane WT).
0.2.5.3 / 0.3.2.6	The Geovane now discards any TNO measurements whose Sun's altitude does not exceed 2°.
0.3.4.0	Supports Modbus RTU protocol (Geovane WT). Instantaneous TNO (Geovane WT) now implements a fast-response digital filter to minimize the impact of cloud refraction on sunlight. Enhanced scan processing algorithm.
0.3.4.17	Fixed a bug where the GPS status bit (HWSC.0) of the Modbus registers was not updated until after getting GPS coverage.
0.2.5.6 / 0.3.5.6	Enhanced scan processing algorithm.
0.3.5.7	The Geovane WT now provides the instantaneous TNO measurement (WT output), in addition to through its ORX message / Modbus digital output, through its frequency and analog voltage outputs (they were previously providing the MM azimuth-based averaged TNO value). Fixed bug by which the fast-response digital TNO filter ("cloud filter", WT output) didn't consider the polar calculation at zero crossing.
0.3.5.8	Increased the threshold by which the azimuth-based averaged TNO value is reset (MM output), to prevent strong cloud refraction from triggering it.

0.3.6.0	Supports baudrate configuration (refer to section 6.3). Supports internal 120Ω RS-485 bus termination resistor activation / deactivation (hardware dependent feature, see table in section 14.2).
0.3.6.1	Fixed bug where the photosensors status bit (HWSC.5, see section 7.1.2) was not updated under some conditions.
0.3.6.2	Fixed bug where after 2400 unsuccessful attempts to get GPS fix the Geovane no longer tried to get GPS fix ever again. (GPS fix is usually obtained after 10 attempts, provided clear sky condition). Now the GPS status bit (HWSC.0, see section 7.1.2) is set to 1 until a valid fix is obtained. If subsequent daily updates fail to obtain GPS fix, HWSC.0 is updated to 1 as well. Improvements in GPS management functions.
0.3.6.3	Enhanced GPS management functions.
0.3.6.4	Fixed bug where the decimal degrees of the longitude were incorrectly parsed into ASCII when generating the RMC message.

To know what firmware version your Geovanes have you can:

- a) Check the configuration sheet that comes with the Geovane (factory settings).
- b) Use the Monitoring / Modbus RTU Tool.
- c) Poll them with the PMGV05 command to get the INF message (refer to sections 7.2.5 and 7.1.5).
- d) Contact Kintech Engineering at support@geovane360.com (factory settings).

14.2 Geovane Tools software

Refer to section 9 for information on the Geovane Tools software.

Software version	Description of modification / changes
1.0.16	The application now features: a) Configuring Tool, b) Firmware Update Tool and c) Monitoring Tool.
1.0.21	Improved interfacing.

1.0.41	The Monitoring Tool now automatically generates a snapshot at the end of every real time monitoring connection that the user carries out.
1.0.42	Improved interfacing. The application now features the Modbus RTU Tool to connect to the Geovane WT via Modbus RTU.
1.0.50	The Modbus Tool now automatically generates a snapshot at the end of every real time monitoring connection that the user carries out.
1.1.0	The Configuration Tool now: 1) enables the user to generate a PDF with the configuration that has been uploaded to the Geovane, 2) displays “WT” or “MM”, depending on the model and 3) for Geovanes WT, displays the former and new Modbus slave address.
1.2.0	The Configuration Tool now: 1) supports activating and deactivating the internal 120Ω resistor for terminating the RS-485 bus and 2) enables the user to configure the RS-485 baudrate (refer to section 6.3). Both functionalities are hardware and firmware dependent. The Configuration Tool can automatically enable or disable the option to configure these functionalities depending on the characteristics of the Geovane to be configured.