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Instrumentation report

L2-FA-1 Lidar measurement campaign

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Instrumentation report

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Contents

Abbreviations

EPL	Europlatform
IEC	International Electrotechnical Commission
IECRE WE	IEC system for certification to standards relating to equipment for use in Renewable Energy applications - Wind Energy
LEG	Lichteiland Goeree
Lidar	Light Detection And Ranging
MSL	Mean Sea Level
OWEZ	Offshore Wind farm Egmond aan Zee
TNO	Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (Netherlands Organisation for applied scientific research)
TNW	Ten Noorden van de Wadden
VPN	Virtual Private Network
WGS 84	World Geodetic System 1984

Summary

In order to better understand the wind conditions at the North Sea for future offshore wind farms a ZX Lidars ZX300M lidar was installed at the L2-FA-1 platform of NAM B.V. in 2023. This report describes the background of the measurement campaign, the platform itself, the used lidar system and installation, data handling and operational aspects.

1 Introduction

1.1 Offshore wind energy deployment

The Netherlands has set clear ambitions to accelerate the energy transition and wind energy plays an essential role. The energy agreement outlines the route for implementation of offshore wind energy and by 2030 an installed capacity of 21.5GW needs to be achieved. Upscaling the offshore wind capacity is happening across all North Sea countries and this agreement is established in the Esbjerg Offshore Wind declaration[1].

The Offshore Wind Energy Act gives the government the option of issuing lots for the development of offshore wind farms. Recently the Dutch Government has planned to open 5 new areas for offshore wind farm development to accommodate these revised ambitions and targets [2], see fig. 1.1.

To enhance these developments, TNO performs offshore wind measurements at different platforms across the Dutch North Sea.

Figure 1.1: Locations of existing wind farms (yellow), wind farms under development (green) and TNO offshore measurement locations (red).

1.2 TNO leading role on offshore measuring campaigns

Before the integration of lidars in offshore wind resource assessments, meteorological masts (met mast) have been widely used by TNO. Notable examples include the met mast IJmuiden (MMIJ), as well as the met mast at Offshore Wind farm Egmond aan Zee (OWEZ).

Since 2014, TNO is performing for the Dutch Ministry of Economic Affairs and Climate Policy measurement campaigns with lidars at three strategically locations in the North Sea. These campaigns are part of the 'Wind op Zee' project to support the Dutch wind offshore roadmap. These three locations are: Lichteiland Goeree (LEG), Europlatform (EPL) and K13-A, see fig. 1.1. In 2023 a fourth platform L2-FA-1 has been added in the north part of the Dutch North Sea.

This report focusses on the instrumentation on platform L2-FA-1. A description of the L2-FA-1 platform is found in chapter 2 and in chapter 3 detailed information can be found on the ZX lidars ZX300M lidar. The installation is elaborated on in chapter 4 and chapter 5 focusses on the data handling. Finally, chapter 6 covers the operation and maintenance aspects.

1.3 Open-access and public datasets

Since 2020 TNO has published annually reports on the wind conditions for each measurement campaign location. These reports are available at the TNO offshore wind measurements website: https://offshorewind-measurements.tno.nl/en/ [3]. Here the data sets from L2-FA-1 starting from 2023 until now are available.

2 L2-FA-1 offshore platform

The L2-FA-1 offshore platform owned by NAM B.V. is located north of the Frysian Islands (Ten Noorden van de Wadden – TNW), 80 km from the coast, see fig. 1.1. The platform serves as a production platform for natural gas. Since beginning of 2023 wind measurements are carried out by TNO using a platform-mounted (38 m above MSL) lidar ZX300M, see fig. 3.1. An aerial picture of the platform can be seen in fig. 2.1.

Figure 2.1: L2-FA-1 platform.

Some specific data concerning the L2-FA-1 are:

- Coordinates (WGS 84): 53°57′38″N, 4°29′46″E
- Water depth: 40 m to MSL
- L2-FA-1 platform heading: True North

A top view and side view drawing of the L2-FA-1 platform can be seen in fig. 2.2 and fig. 2.3.

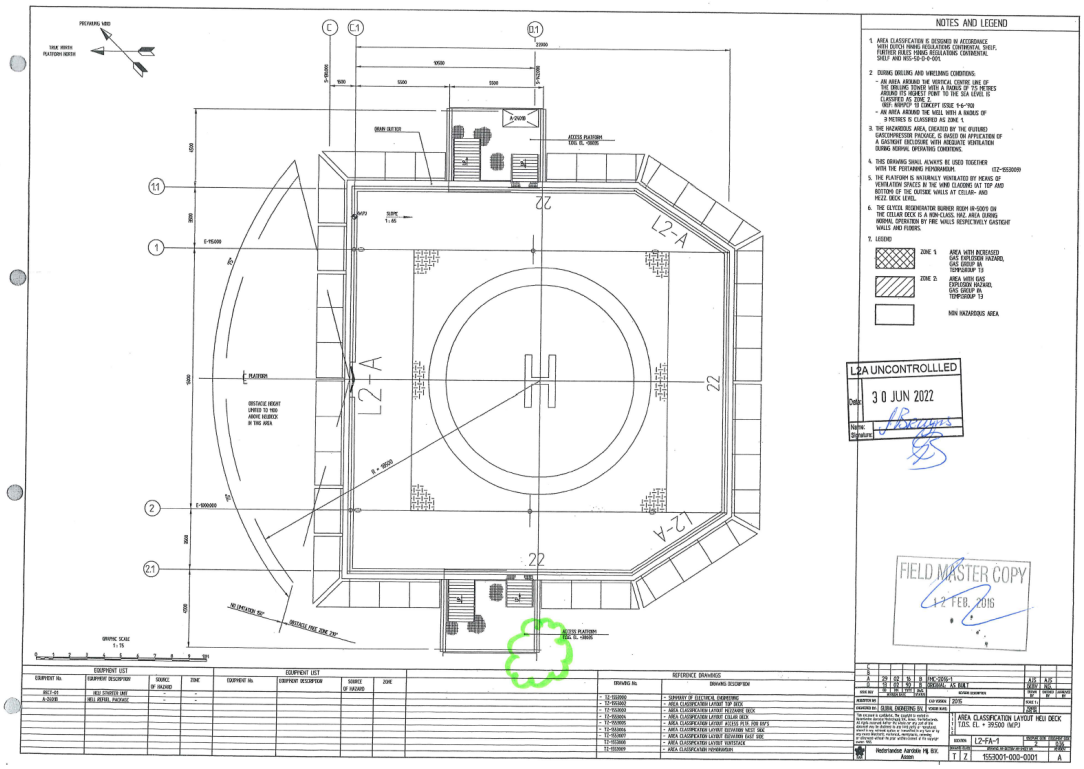

Figure 2.2: Top view the L2-FA-1 helideck, in green position of the lidar.

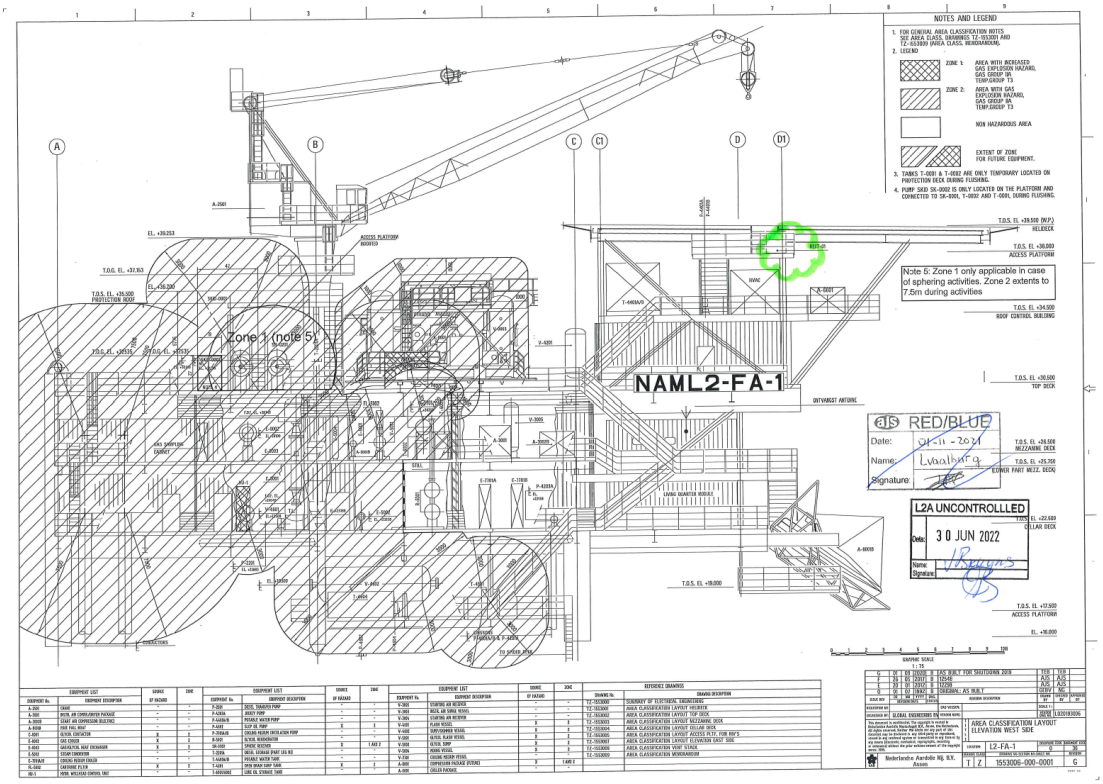

Figure 2.3: Side view of the L2-FA-1 platform, in green location of the lidar.

3 Lidar ZX300M

The lidar ZX300M v2 consists of a tripod-shaped housing, with dimensions of ca. 90 x 90 x 90 cm. The inclined top of the housing contains the lens through which the laser beam is projected upwards. A picture of the system can be seen in fig. 3.1 and the dimensions in fig. 3.2.

Figure 3.1: Lidar ZX300M (v2).

The laser beam of this lidar points up with an angle of 30° with respect to the vertical, and sweeps to describe full circles, as can be seen in fig. 4.3.

The v2 version is the successor of the ZX300M initial version and improved the offshore robustness of the lidar by, among other, applying a single user connector panel with MacArtney Subconn connectors.

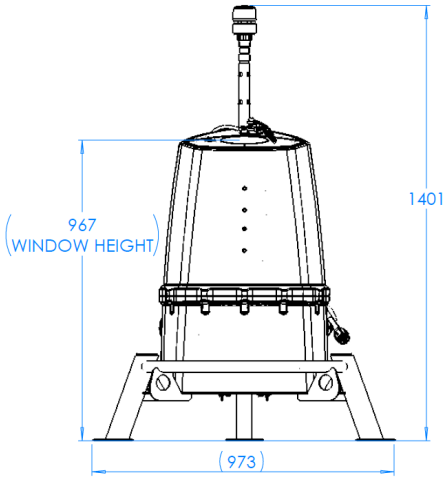

Figure 3.2: ZX Lidars ZX300M dimensions.

4 Installation lidar ZX300M

The lidar ZX300M is installed at the top of the accommodation building, just below and east of the helicopter deck, see fig. 4.1. The lidar mounting frame is bolted onto a mounting plate using six bolts. The lidar platform height is 38 m above MSL and the helicopter deck is 39.5 m above MSL. From this location the lidar has a clear view. The meteo station is mounted on the railing with the sensor just below the helicopter deck height.

Figure 4.1: ZX300M lidar mounted on top of the accommodation building at L2-FA-1.

4.1 Electrical installation

4.1.1 Power supply

To be able to operate, the lidar needs a 12VDC power supply. At the lidar platform a junction box is available with 230VAC power supply. The 230VAC is converted to 12VDC by the AC-DC converter mounted at the bottom of the lidar. The power requirements of the lidar is 55 Watt, see appendix A.

4.1.2 Communication

To be able to transfer the data measured by the lidar to TNO, a TNO VPN router is installed inside the computer room. This router is wired to a Tampnet switch which provides internet

connection. From the TNO office a VPN connection is setup. Using this connection the local TNO PC and lidar can be accessed. An overview of the network layout can be found in fig. 4.2.

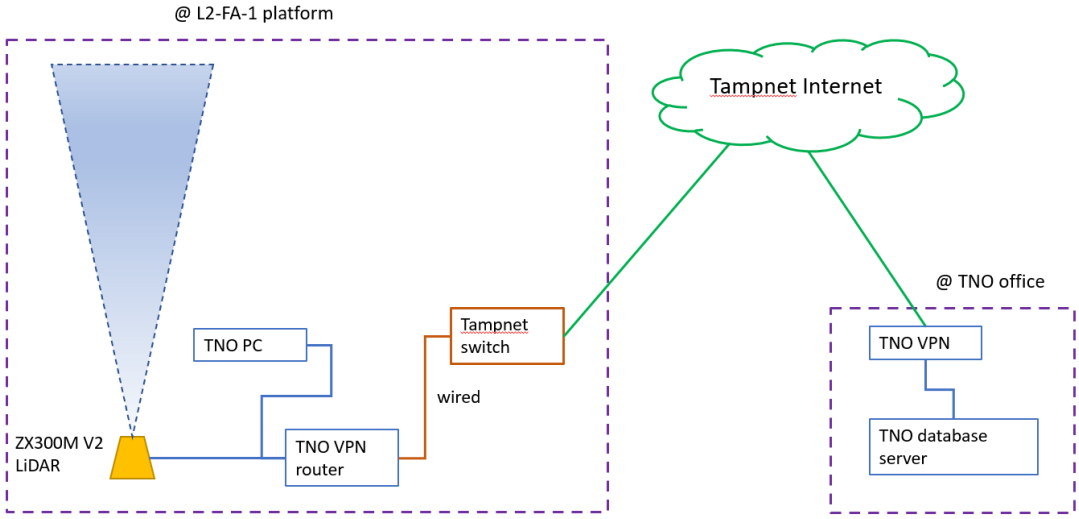

Figure 4.2: L2-FA-1 lidar campaign network layout.

4.2 Orientation of the lidar

The lidar has been installed with the 'north' marker of the lidar 30° East to the platform North, which is aligned to True North. Therefore a 30° bearing is configured in the lidar settings, see fig. 4.3.

4.3 Obstacles

The ZX300M lidar is installed just below the helicopter deck on the accommodation deck to the side of the helicopter deck, see fig. 2.2 and fig. 4.1, therefore the lidar experiences free sight for the complete scan circle of the lidar beam with an opening angle of 30° to the vertical. The meteo station of the lidar however experiences blockage and wake effects due to the platform. This can result in periods with a 180° offset as explained in section 5.4.

4.4 Lidar settings

We have chosen to configure the measurement heights (MSL) at the L2-FA-1 platform identical to the heights measured at the Lichteiland Goeree platform. These are based on the meteorological mast IJmuiden (MMIJ) measurement height configuration, which performed measurements from November 2011 to March 2016.

The lidar lens height is about 39 meters above MSL. The heights configuration in the lidar is relative to the lens height. Based on the orientation of the lidar as elaborated on in section 4.2 the bearing of the lidar is 30°. The measuring heights and bearing as configured in the lidar can be seen in fig. 4.3. table 4.1 gives the corresponding measurement heights above MSL as well.

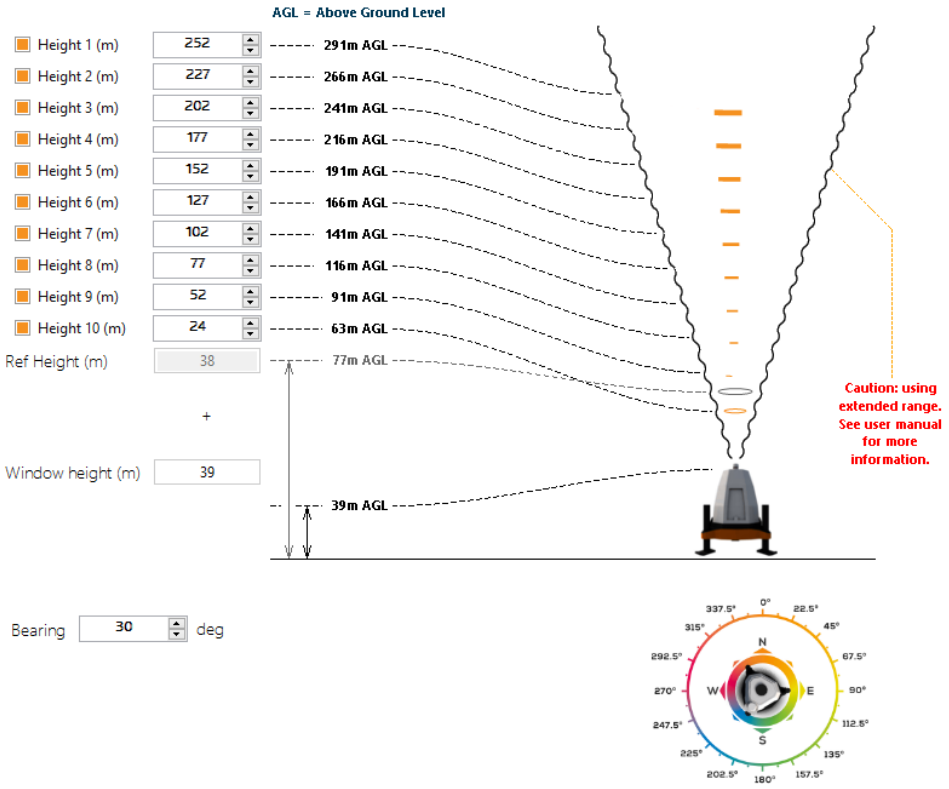

Figure 4.3: Height and bearing configuration of the ZX300M lidar.

Table 4.1: lidar configured heights and measurement height to MSL.

No.	lidar height configuration	measurement height to MSL
	[m]	[m]
1	24	63
2	52	91
3	77	116
4	102	141
5	127	166
6	152	191
7	177	216
8	202	241
9	227	266
10	252	291

5 Data handling

In this chapter we will consider the three TNO data sources / flow as well as the additional available data sources, namely:

- Standard produced ZX300M data files, 10-minute statistical data and fast data
- TNO database handling, checking, correction and filtering
- TNO data export via https://offshorewind-measurements.tno.nl/en/

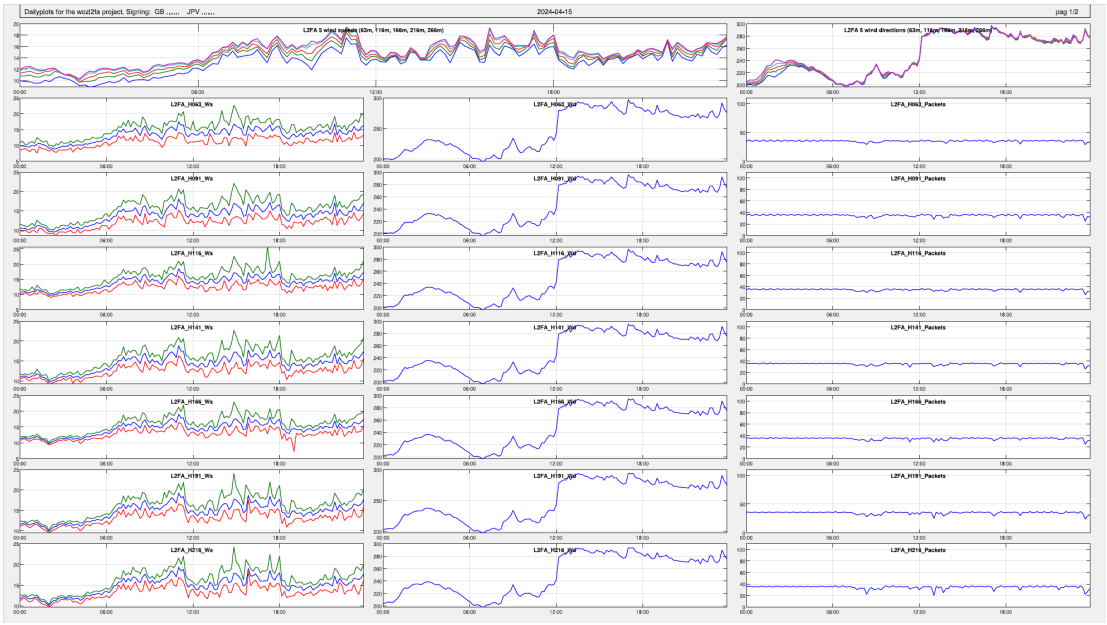

Figure 5.1: Automatically generated and distributed 'daily-plot' example of the L2-FA-1 measurement signals.

5.1 Lidar ZX300M data files

The ZX300M lidar delivers data files in CSV format. Two different files are created by the lidar on a daily basis, one file with the 10-minute statistical data, recognized from the prefix 'Wind10_' and one file containing the fast data with prefix 'Wind_'. Approximately every 1.5 s one height is measured. So with 10 configured measuring heights the refresh rate is close to 15 s. All produced CSV files are transferred on a daily basis to the data server at TNO. Only the 10-minute statical data is imported into the project database and processed. The fast data is stored and available for further processing when requested.

The complete filename is build up as described below:

Wind10_"ID"@Yyyyy_Mmm_Ddd.CSV (Wind_"ID"... in case of the fast data file)
"ID": ZX300M serial number
yyyy: year of data
mm: month of data
dd: day of data

For an overview of the measured signals see Appendix B.

5.2 TNO data base

After data transfer, the data is imported into the project data base and then an automated ‘daily-plot’, see fig. 5.1, of the measured signals is created. This is distributed by email to the project team as PDF file who evaluate the signals on a daily basis. If needed TNO can perform a post-validation on the data in the database so that a specific data period is marked ‘invalid’ and is no longer visible.

The wind directional signals are manually corrected for the 180° shifts, see section 5.4.

5.3 Data export L2-FA-1

TNO makes the 10-minute statistical data available via the TNO offshore wind measurements website: https://offshorewind-measurements.tno.nl/en/. Here you can find the historical data of the lidar measurement campaign.

The order for export and presentation on the website will be as follows:
L2FA-yyyy-mm.CSV for the previous month(s).

After a quarter is completed the monthly files will be replaced by:
L2FA-yyyy-Qx.CSV (where x stands for the actual quarter)

After the year is completed the quarterly files will be replaced by a yearly file:
L2FA-yyyy.CSV

5.4 Wind direction correction

The ZX300M is based on the continuous wave technology. It changes focus point for every measurement height. Using the doppler shift in the backscattered data the wind speed can be determined but the direction of the doppler shift cannot be determined, which can result in a 180° shift. For this the ZX300M is equipped with an sonic anemometer mounted at a pole near the lidar, used as a reference wind direction. However when installed at the side of this platform, the sonic wind direction measurement is disturbed. This results in periods where the wind direction determination of the lidar fails it is shifted 180°. These shifts are most of the time easy identifiable by looking into the wind direction data. Comparing the data to an available reference wind direction can help to identify the periods in which the direction is off by 180° however at the L2-FA-1 platform no reference wind direction data is available.

For the wind direction correction a TNO developed tool is used, which helps to identify the shifted periods and efficiently convert the identified periods to wind direction corrections in the project database. This correction is done on a monthly basis before the data is made publicly available.

6 Operational and maintenance aspects

The first TNO lidar at the L2-FA-1 platform was installed on 2023. In Table 3 an overview is given of the used lidar(s) and the period that they were operational. Before installation the lidar is verified against an IEC compliant meteorological mast [4]. As defined by TNO's ISO17025:2017 quality system, the lidar should be replaced every three years and serviced every year. All operational aspects with respect to installation and maintenance of the lidar are recorded in the logbook.

Table 6.1: Overview of the installed lidar (s) at the L2-FA-1 platform.

lidar	TNO code	Period	Reason for replacement
ZX1525	22003516	01-11-2023 to	first installation

The quality of the signals is checked on a daily basis via the automatically distributed 'daily-plot', see fig. 5.1. Using the manufacturers software Waltz, we can directly connect to the lidar and monitor the measurements and status, see fig. 6.1.

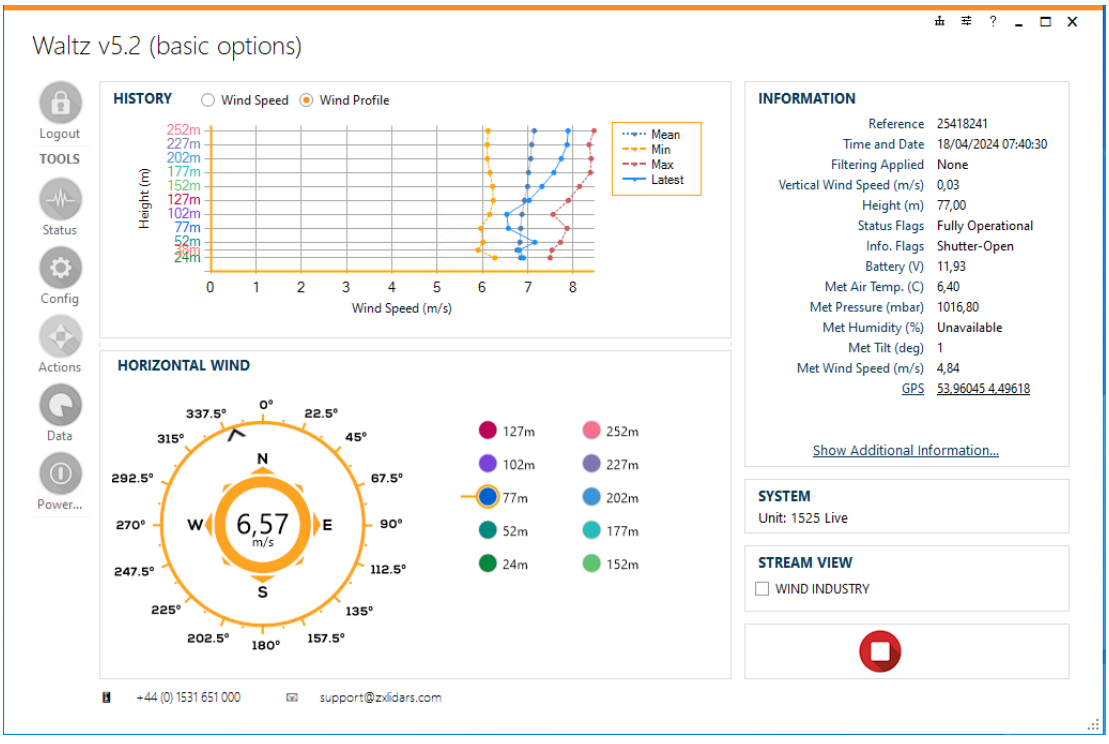

Figure 6.1: Screenshot of ZX Lidars software Waltz.

References

[1] *THE ESBJERG DECLARATION. on The North Sea as a Green Power Plant of Europe*. Rijksoverheid.

[2] *Kamerbrief aanvullende routekaart windenergie op zee 2030, Den Haag*. DGKE-E / 22235501.

[3] *https://offshorewind-measurements.tno.nl/en/*.

[4] R. MateToth. *LIDAR FACTORY VERIFICATION AND PERFORMANCE VERIFICATION CERTIFICATE*. ZX1525. ZX Lidars, Oct. 10, 2022.

Signature

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Author(s)	G. Bergman and J.P. Verhoef	
Principal(s)	Dutch Ministry of Economic Affairs and Climate Policy	
Project number	060.59137	
Programme(s)	Wind Energy	

Abstract

As part of the '2024 Wind Conditions @ North Sea' project a ZX Lidars ZX300M lidar is installed at a new offshore location, platform L2-FA-1. This report describes the measurement location, lidar system, installation, data handling and operation and maintenance.

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Expert review	J.P. Verhoef	Project manager	ValidSigned by Hans Verhoef on 2024-05-28 13:47:33
Generic review	C.B.H. Eeckels	Project manager	ValidSigned by Catherine Eeckels on 2024-05-28 15:00:08
Approval	R.H.M. Giepman	Deputy research manager	ValidSigned by Rogier Giepman on 2024-05-28 13:36:59
Authorization	E.D. Nennie	Research manager	ValidSigned by Erik Nennie on 2024-05-31 16:16:28

Appendix A

ZX Lidars ZX300M specifications

Range	10 – 300 metres (Lidar measurement) 0 – 10 metres (onboard met weather station)
Probe length	± 0.07 metres @ 10 metres ± 7.70 metres @ 100 metres
Height measured	10 User configurable 1 Additional met weather station measurement
Sampling rate	50Hz (up to 50 measurement points every second)
Averaging rate	True 1-second averaging 10 Minute averaging
Accuracy wind speed	0.1 m/s*
Direction variation	< 0.5°

Figure A.1: Measurement specifications.

Service interval	36 months from new
Size	805 x 845 x 966mm
Weight	53.4kg
IP Rating	IP68
Power consumption	55W
Power input	12V
Temperature range	-40 to +50°C
Warranty	3 years
Maintenance	No annual maintenance or calibration in this period

Figure A.2: Product specifications.

Appendix B
ZX300M measured signals

Name	Location	Short name (Signal name)	Sensor	Unit	installed	Freq	Campaign
Height independent signals							
Battery Voltage	L2-FA-1	L2FA_Battery_avg	ZXLidars ZX300M V2	V	TNO	10-min stat	Wind@Sea
Lower temperature inside Lidar		L2FA_Lower_Temp_avg		deg C			
Upper temperature inside Lidar		L2FA_Upper_Temp_avg		deg C			
Relative humidity inside Lidar		L2FA_Pod_Humidity_avg		%			
Relative humidity inside Lidar		L2FA_Met_Air_Temp_avg		deg C			
Lidar met station bearing		L2FA_Met_Compass_Bearing_avg		deg			
Lidar met station relative humidity		L2FA_Met_Humidity_avg		%			
Lidar met station air pressure		L2FA_Met_Pressure_avg		hPa			
Lidar met station tilt angle		L2FA_Met_Tilt_avg		deg			
Lidar met station wind direction		L2FA_Met_Wind_Dir_avg		deg			
Lidar met station wind speed		L2FA_Met_Wind_Speed_avg		m/s			
External supply voltage		L2FA_Generator_avg		V			
LiDAR status flags		L2FA_Status_Flags_avg		-			
LiDAR info flags		L2FA_Info_Flags_avg		-			
Proportions of packets		L2FA_Proportion_Of_Packets_with_Rain_avg		#			
Error flags		L2FA_Proportion_Of_Packets_With_		#			
For every measuring height (m):		xxx : 63, 91, 116, 141, 166, 191, 216, 241, 266, 291					
Horizontal wind speed average	L2-FA-1	L2FA_Hxxx_Ws_avg	ZXLidars ZX300M V2	m/s	TNO	10-min stat	Wind@Sea
Horizontal wind speed std deviation		L2FA_Hxxx_Ws_std		m/s			
Horizontal wind speed minimum		L2FA_Hxxx_Ws_min		m/s			
Horizontal wind speed maximum		L2FA_Hxxx_Ws_max		m/s			
Vertical wind speed average		L2FA_Hxxx_WsV_avg		m/s			
Wind direction		L2FA_Hxxx_Wd_avg		deg			
Turbulence intensity		L2FA_Hxxx_TI_avg		-			
Package in average		L2FA_Hxxx_Packets_avg		#			

Figure B.1: ZX300M measured signals.

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