February 2012

ECN-Wind Memo-12-010

# Offshore Meteorological Mast IJmuiden

## Abstract of Instrumentation Report

E.J. Werkhoven
J.P. Verhoef

| Authorization | Name | | Signature | Date |
|---|---|---|---|---|
| Checked | H.E. Oostrum | Project manager | | 5-4-2012 |
| Approved | LWMM Rademakers | Group manager | | 19-4-2012 |

## Acknowledgement/Preface
This measurement campaign is carried out on the authority of the Ministry of Economic Affairs, Agriculture and Innovation of The Netherlands.

ECN project nr. : 5.1008

## Revisions

| Rev. | Date | Description |
| --- | --- | --- |
| 0.1 | February 2012 | First draft for approval |
| | | |
| | | |

## Archiving

\\ECN\Groups\g_owprojects\Lopende projecten\5.1008 Meteorologisch onderzoek Wind op Zee\Reports\Instrumentation report\ECN-Wind Memo-12-xxx Abstract of Instrumentatierapport Meetmast IJmuiden.doc

## Abstract
This report describes the “as-built” instrumentation of the Offshore meteorological station, located 85 km from the coast of IJmuiden.

In this report the following is appointed:
- description of the mast
- signal list
- the as-built instrumentation, including specifications of sensors and their locations
- the wave buoy

# Contents

## List of figures



## List of Tables

# Summary

This report describes the “as-built” instrumentation of the offshore meteorological station located 85 km from the IJmuiden coast (in the following denoted as MMIJ). The instrumentation is intended to measure a number of meteorological quantities.

In this report the following is appointed:

- description of the mast
- signal list
- the as-built instrumentation, including specifications of sensors and their locations
- the wave buoy

# 1. Introduction

On the authority of the Ministry of Economic Affairs, Agriculture and Innovation of The Netherlands, ECN is performing measurements on the offshore meteorological station IJmuiden (in the following denoted as MMIJ), situated 85 km from the coast of IJmuiden. These measurements will run for 4 years, and all measured data will be made publicly available.

The station consists of a platform with a control room, a meteorological mast (Metmast), and a wave buoy that has been deployed close to the mast.

This document describes the as-built instrumentation that is being used for the measurements, and is built-up as follows:

Chapter 2 gives general information of the meteorological station and the measurement system.

Chapter 3 discusses the signals that are being measured.

Chapter 4 gives a description of the hardware installed on the station.

Chapter 5 discusses data handling.

Chapter 6 discusses the signal calibration.

Chapter 7 describes the calculation of pseudo-signals.

# 2. Test Environment and provisions

## 2.1 Test site

The offshore meteorological station is located 85 km from the coast of IJmuiden, coordinates N52°50.89' E3°26.14'. The water depth on site is about 28 meters. The location is depicted in Figure 2.1.


Figure 2.1: *Location of the offshore meteorological station*

## 2.2 Platform

On a monopile, a platform has been built with a size of approximately 12 x 10.5 meters. On the platform a control room and the meteorological mast are present. The platform height is 18 meter above LAT. The top of the met mast is 92 meters above LAT.

On the container and in the mast 10 solar panels and 8 small wind turbines are installed to provide power for the measurement system and all safety lights / communication systems. In the container two diesel generators are installed to provide power in case the solar panels and the wind turbines do not provide enough power to keep all systems running.

The platform is accessible by means of a ladder from the boat-landing provision. Above the ladder a hatch provides access to the platform. The hatch is locked to prevent unauthorized access to the platform.

## 2.3 Met-mast

The met-mast is placed on top of the platform, next to the container. A picture of the offshore meteorological station can be seen in Figure 2.2.

Figure 2.2: *The offshore meteorological station*

The orientation of the platform, the mast and the container can be seen in Figure 2.3.

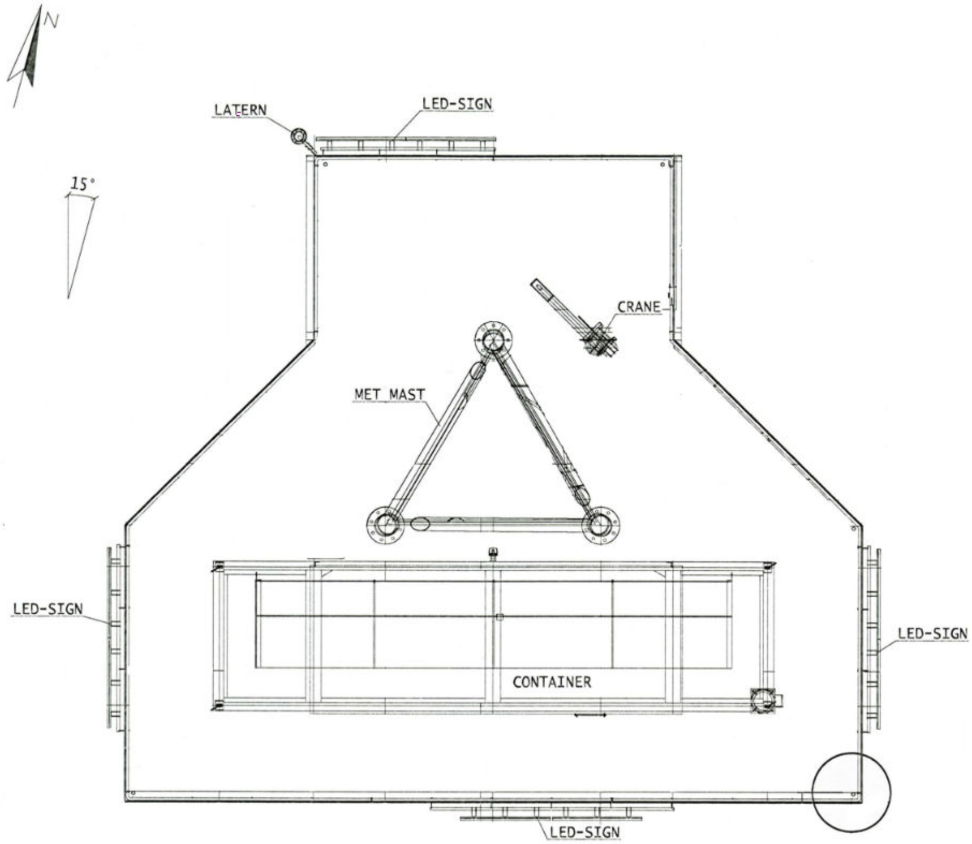



Figure 2.3: *platform & mast orientation*

## 2.4 Booms

On heights of 25.5 meter, 57 meter and 86.5 meter, booms have been installed on the mast in three directions, pointing outward from each face of the mast. In the signal list (listed in Appendix A), we call the booms the 0, 120 and 240 degree booms, although this is not quite right. The platform is oriented almost according Figure 2.3, in reality the 15 degree angle is 13.5 degrees. So the 0 degree boom points in a 46.5 degree direction, the 120 degree boom points in a 166.5 degree direction, and the 240 degree boom points in a 286.5 degree direction.
All measurement data will be corrected for this, so that the delivered data will contain true wind directions.

## 2.5 Sensor locations

In the metmast and on the container roof sensors have been installed to measure wind speed, wind direction, air pressure, air temperature and relative humidity. Table 1 shows the location of all installed sensors, together with their output signals, working down from the top of the mast.

| Installed sensors met-mast | | | | |
|---|---|---|---|---|
| **Sensor** | **level** | **Location** | **Signal(s)** | **unit** |
| | | | | |
| Thies First Class Advanced anemometer | 92 m | 150 cm above North-East leg of mast | MMIJ_H92B180_Ws_Q1 | m/s |
| Thies First Class Advanced anemometer | 92 m | 150 cm above South-West leg of mast | MMIJ_H92B300_Ws_Q1 | m/s |
| Vaisala PTB210 air pressure sensor | 90 m | North-East side of top platform | MMIJ_H90_Pair_Q1 | hPa |
| Vaisala HMP155D | 90 m | North-West side of top platform | MMIJ_H90_Tair_Q1 | deg C |
| | | | MMIJ_H90_Rh_Q1 | % |
| | | | | |
| Thies First Class wind vane | 87 m | 70 cm above end of 86.5 m boom, 46.5 deg | MMIJ_H87B0_Wd_Q1 | deg |
| Thies First Class wind vane | 87 m | 70 cm above end of 86.5 m boom, 166.5 deg | MMIJ_H87B120_Wd_Q1 | deg |
| Thies First Class wind vane | 87 m | 70 cm above end of 86.5 m boom, 286.5 deg | MMIJ_H87B240_Wd_Q1 | deg |
| Metek USA-1 sonic anemometer | 85 m | 150 cm below end of 86.5 m boom, 46.5 deg | MMIJ_H85B0_WsXSon_Q1 | m/s |
| | | | MMIJ_H85B0_WsYSon_Q1 | m/s |
| | | | MMIJ_H85B0_WsZSon_Q1 | m/s |
| | | | MMIJ_H85B0_SSon_Q1 | - |
| | | | MMIJ_H85B0_WsHor_Q1 | m/s |
| | | | MMIJ_H85B0_WsMag_Q1 | m/s |
| Metek USA-1 sonic anemometer | 85 m | 150 cm below end of 86.5 m boom, 166.5 deg | MMIJ_H85B120_WsXSon_Q1 | m/s |
| | | | MMIJ_H85B120_WsYSon_Q1 | m/s |
| | | | MMIJ_H85B120_WsZSon_Q1 | m/s |
| | | | MMIJ_H85B120_SSon_Q1 | - |
| | | | MMIJ_H85B120_WsHor_Q1 | m/s |
| | | | MMIJ_H85B120_WsMag_Q1 | m/s |
| Metek USA-1 sonic anemometer | 85 m | 150 cm below end of 86.5 m boom, 286.5 deg | MMIJ_H85B240_WsXSon_Q1 | m/s |
| | | | MMIJ_H85B240_WsYSon_Q1 | m/s |
| | | | MMIJ_H85B240_WsZSon_Q1 | m/s |
| | | | MMIJ_H85B240_SSon_Q1 | - |
| | | | MMIJ_H85B240_WsHor_Q1 | m/s |
| | | | MMIJ_H85B240_WsMag_Q1 | m/s |
| | | | | |
| Thies First Class Advanced anemometer | 58,5 m | 150 cm above end of 57 m boom, 46.5 deg | MMIJ_H58B0_Ws_Q1 | m/s |
| Thies First Class Advanced anemometer | 58,5 m | 150 cm above end of 57 m boom, 166.5 deg | MMIJ_H58B120_Ws_Q1 | m/s |
| Thies First Class Advanced anemometer | 58,5 m | 150 cm above end of 57 m boom, 286.5 deg | MMIJ_H58B240_Ws_Q1 | m/s |
| Thies First Class wind vane | 58 m | 70 cm above 57 m boom, 46.5 deg | MMIJ_H58B0_Wd_Q1 | deg |
| Thies First Class wind vane | 58 m | 70 cm above 57 m boom, 166.5 deg | MMIJ_H58B120_Wd_Q1 | deg |
| Thies First Class wind vane | 58 m | 70 cm above 57 m boom, 286.5 deg | MMIJ_H58B240_Wd_Q1 | deg |
| | | | | |
| Thies First Class Advanced anemometer | 27 m | 150 cm above end of 25.5 m boom, 46.5 deg | MMIJ_H27B0_Ws_Q1 | m/s |
| Thies First Class Advanced anemometer | 27 m | 150 cm above end of 25.5 m boom, 166.5 deg | MMIJ_H27B120_Ws_Q1 | m/s |
| Thies First Class Advanced anemometer | 27 m | 150 cm above end of 25.557 m boom, 286.5 deg | MMIJ_H27B240_Ws_Q1 | m/s |
| Thies First Class wind vane | 26 m | 70 cm above 25.5 m boom, 46.5 deg | MMIJ_H27B0_Wd_Q1 | deg |
| Thies First Class wind vane | 26 m | 70 cm above 25.5 m boom, 166.5 deg | MMIJ_H27B120_Wd_Q1 | deg |
| Thies First Class wind vane | 26 m | 70 cm above 25.5 m boom, 286.5 deg | MMIJ_H27B240_Wd_Q1 | deg |
| | | | | |
| Thies Disdro laser precipitation sensor | 21 m | Railing of container, South side | MMIJ_H21_Prec_l_Q5 | % |
| | | | MMIJ_H21_Synop_l_Q5 | - |
| | | | MMIJ_H21_amount_l_Q5 | mm |
| | | | MMIJ_H21_intens_l_Q5 | mm/min |
| | | | MMIJ_H21_OK_l_Q5 | % |
| | | | MMIJ_H21_qual_l_Q5 | % |
| | | | MMIJ_H21_visib_l_Q5 | m |
| Thies Disdro laser precipitation sensor | 21 m | Railing of container, South side | MMIJ_H21_Prec_r_Q5 | % |
| | | | MMIJ_H21_Synop_r_Q5 | - |
| | | | MMIJ_H21_amount_r_Q5 | mm |
| | | | MMIJ_H21_intens_r_Q5 | mm/min |
| | | | MMIJ_H21_OK_r_Q5 | % |
| | | | MMIJ_H21_qual_r_Q5 | % |
| | | | MMIJ_H21_visib_r_Q5 | m |
| Vaisala HMP155D | 21 m | Railing of container, North side | MMIJ_H21_Tair_Q1 | deg C |
| | | | MMIJ_H21_Rh_Q1 | % |
| Vaisala PTB210 air pressure sensor | 21 m | Railing of container, North side | mmij_pair21 | hPa |

Table 1: *Sensor locations and signals*

Besides these sensors, a Lidar has been installed for wind speed and wind direction measurements above metmast level, as well as a wave buoy for wave height and current measurements.

Datasheets of all sensors can be found in Appendix F.

## 2.6 Sensor mounting

To minimize mast influence on the measurements, the wind speed and wind direction sensors have been mounted on vertical spigots mounted on the booms. Table 2 shows the distance of the sensor to the mast and the length of the vertical spigot each sensor has been mounted on. The boom lengths on the anemometer locations is about 3 times the face width of the mast at that position.

The top level anemometers have been mounted on vertical spigots so that the anemometers are 1.5 m above the top of the mast.

| Sensor mounting | | |
|---|---|---|
| **Sensor** | **Distance from mast [m]** | **Spigot length [cm]** |
| | | |
| Wind vane 87 m | 4.60 | 70 |
| Sonic anemometer 85 m | 4.60 | 150 |
| Cup anemometer 58.5 meter | 7.00 | 150 |
| Wind vane 57.7 meter | 4.35 | 70 |
| Cup anemometer 27 m | 9.20 | 150 |
| Wind vane 26.2 meter | 5.60 | 70 |

Table 2: *Sensor mounting data*

The air pressure, air temperature and relative humidity sensors have been mounted close to the mast so that they can be reached easily for maintenance.

The 21 meter level sensors (2 x Thies laser precipitation sensor, air temperature sensor, relative humidity sensor, air pressure sensor) have been mounted on the railing of the container roof.

# 3. Definition of Signals

## 3.1 Metmast signals

For the mast and platform level sensors, the list of measured signals is shown in Table 3. The signal list can also be found in Appendix A.

| Measured signals Met-Mast | | | | | |
|---|---|---|---|---|---|
| Nr | level | Signal | Short name | unit | freq [Hz] |
| | | | | | |
| Top level, 92 m | | | | | |
| 1 | 92 m | wind speed 92m, 180 deg | MMIJ_H92B180_Ws_Q1 | m/s | 4 |
| 2 | 92 m | wind speed 92m , 300 deg | MMIJ_H92B300_Ws_Q1 | m/s | 4 |
| 3 | 90 m | air pressure | MMIJ_H90_Pair_Q1 | hPa | 4 |
| 1st level 85 m | | | | | |
| 4 | 87 m | wind direction, 0 deg | MMIJ_H87B0_Wd_Q1 | deg | 4 |
| 5 | 87 m | wind direction, 120 deg | MMIJ_H87B120_Wd_Q1 | deg | 4 |
| 6 | 87 m | wind direction, 240 deg | MMIJ_H87B240_Wd_Q1 | deg | 4 |
| 7 | 85 m | wind speed X, 0 deg | MMIJ_H85B0_WsXSon_Q1 | m/s | 4 |
| 8 | 85 m | wind speed Y, 0 deg | MMIJ_H85B0_WsYSon_Q1 | m/s | 4 |
| 9 | 85 m | wind speed Z, 0 deg | MMIJ_H85B0_WsZSon_Q1 | m/s | 4 |
| 10 | 85 m | Sonic Status, 0 deg | MMIJ_H85B0_SSon_Q1 | - | 4 |
| 11 | 85 m | wind speed X, 120 deg | MMIJ_H85B120_WsXSon_Q1 | m/s | 4 |
| 12 | 85 m | wind speed Y, 120 deg | MMIJ_H85B120_WsYSon_Q1 | m/s | 4 |
| 13 | 85 m | wind speed Z, 120 deg | MMIJ_H85B120_WsZSon_Q1 | m/s | 4 |
| 14 | 85 m | Sonic Status, 120 deg | MMIJ_H85B120_SSon_Q1 | - | 4 |
| 15 | 85 m | wind speed X, 240 deg | MMIJ_H85B240_WsXSon_Q1 | m/s | 4 |
| 16 | 85 m | wind speed Y, 240 deg | MMIJ_H85B240_WsYSon_Q1 | m/s | 4 |
| 17 | 85 m | wind speed Z, 240 deg | MMIJ_H85B240_WsZSon_Q1 | m/s | 4 |
| 18 | 85 m | Sonic Status, 240 deg | MMIJ_H85B240_SSon_Q1 | - | 4 |
| 19 | 90 m | temperature | MMIJ_H90_Tair_Q1 | °C | 4 |
| 20 | 90 m | relative humidity | MMIJ_H90_Rh_Q1 | % | 4 |
| 3rd level, 58,5 m | | | | | |
| 21 | 58,5 m | wind speed, 0 deg | MMIJ_H58B0_Ws_Q1 | m/s | 4 |
| 22 | 58,5 m | wind speed, 120 deg | MMIJ_H58B120_Ws_Q1 | m/s | 4 |
| 23 | 58,5 m | wind speed, 240 deg | MMIJ_H58B240_Ws_Q1 | m/s | 4 |
| 24 | 58,5 m | wind direction, 0 deg | MMIJ_H58B0_Wd_Q1 | deg | 4 |
| 25 | 58,5 m | wind direction, 120 deg | MMIJ_H58B120_Wd_Q1 | deg | 4 |
| 26 | 58,5 m | wind direction, 240 deg | MMIJ_H58B240_Wd_Q1 | deg | 4 |
| 4rd level, 27 m | | | | | |
| 27 | 27 m | wind speed, 0 deg | MMIJ_H27B0_Ws_Q1 | m/s | 4 |
| 28 | 27 m | wind speed, 120 deg | MMIJ_H27B120_Ws_Q1 | m/s | 4 |
| 29 | 27 m | wind speed, 240 deg | MMIJ_H27B240_Ws_Q1 | m/s | 4 |
| 30 | 27 m | wind direction, 0 deg | MMIJ_H27B0_Wd_Q1 | deg | 4 |
| 31 | 27 m | wind direction, 120 deg | MMIJ_H27B120_Wd_Q1 | deg | 4 |
| 32 | 27 m | wind direction, 240 deg | MMIJ_H27B240_Wd_Q1 | deg | 4 |
| Platform level 21 m | | | | | |
| 33 | 21 m | precipitation, left | MMIJ_H21_Prec_l_Q5 | 1/0 | 4 |
| 34 | 21 m | precipitation,right | MMIJ_H21_Prec_r_Q5 | 1/0 | 4 |
| 35 | 21 m | temperature | MMIJ_H21_Tair_Q1 | °C | 4 |
| 36 | 21 m | relative humidity | MMIJ_H21_Rh_Q1 | % | 4 |
| 37 | 21 m | air pressure | MMIJ_H21_Pair_Q1 | hPa | 4 |

Table 3: *Metmast signals*

From the measured metmast signals, so-called pseudo-signals are calculated which are also stored. A list of pseudo-signals is shown in Table 4.

| Calculated pseudo- signals Met-Mast | | | | | |
|---|---|---|---|---|---|
| Nr | level | Signal | Short name | unit | freq [Hz] |
| | | | | | |
| 38 | 90 m | Air density | MMIJ_H90_AirDensity_Q1 | kg/m$^3$ | 4 |
| 39 | 87 m | True wind direction | MMIJ_H87_Wd_Q1 | deg | 4 |
| 40 | 85 m | True wind speed | MMIJ_H85_Ws_Q1 | m/s | 4 |
| 41 | 85 m | Horizontal wind speed 0 deg | MMIJ_H85B0_WsHor_Q1 | m/s | 4 |
| 42 | 85 m | Wind speed magnitude 0 deg | MMIJ_H85B0_WSMag_Q1 | m/s | 4 |
| 43 | 85 m | Horizontal wind speed 120 deg | MMIJ_H85B120_WsHor_Q1 | m/s | 4 |
| 44 | 85 m | Wind speed magnitude 120 deg | MMIJ_H85B120_WsMag_Q1 | m/s | 4 |
| 45 | 85 m | Horizontal wind speed 240 deg | MMIJ_H85B240_WsHor_Q1 | m/s | 4 |
| 46 | 85 m | Wind speed magnitude 240 deg | MMIJ_H85B240_WsMag_Q1 | m/s | 4 |
| 47 | 58 m | True wind speed | MMIJ_H58_Ws_Q1 | m/s | 4 |
| 48 | 58 m | True wind direction | MMIJ_H58_Wd_Q1 | deg | 4 |
| 49 | 27 m | True wind speed | MMIJ_H27_Ws_Q1 | m/s | 4 |
| 50 | 27 m | True wind direction | MMIJ_H27_Wd_Q1 | deg | 4 |
| 51 | 21 m | Air density | MMIJ_H21_AirDensity_Q1 | kg/m$^3$ | 4 |

Table 4: *List of pseudo signals*

For a detailed description of these pseudo-signals, see Chapter 7.

## 3.2 Signal name convention

Although the names of the signals look complicated at first glance, the signal names have been built-up in a way that they give as much information as possible, so that the reader does not need to start searching where the signal is being measured.
The signal names have been built-up as follows :

MMIJ_HxxBxxx_SignalType_Quality

Where:

MMIJ_ Indicates that the signal is coming from the Meteo Mast IJmuiden
Hxx Indicates the height (in meters) on which the signal is being measured
Bxxx Indicates the bearing of the signal with respect to the mast. Note that there are booms on 0, 120 and 240 degrees (which are actually 46.5, 166.5 and 286.5 degrees), and two anemometers on the mast's legs, which we give a 180 and 300 degree bearing.
SignalType Indicates the kind of signal being measured, like Ws for wind speed, Wd for wind direction, etc. The types are explained in the signal lists.
Quality Indicates the signal Quality. Signal Quality can be numbered from Q1 to Q5, with the following meanings:

- Q1 - ISO 17025 approved signal quality, in accordance with IEC61400-12
- Q2 - Signal measured under QA of another MEASNET member
- Q3 - Signal measured under external QA, checked by ECN or other MEASNET member.
- Q4 - Signal measured under external QA, but not checked.
- Q5 - Signal not calibrated or calibration not checked

## 3.3 Lidar wind speed measurement

On a height of 20.88 above LAT, a Lidar system has been installed on a platform in the met-mast. The Lidar has been installed in the South-West corner of the mast, with its North mark in the 46.5 degree direction. A picture of the installed Lidar is shown in Figure 4.4. The Lidar has been installed in a way that it has enough free sight to perform wind speed measurements, and measures the wind speed and wind direction on heights of 90, 115, 140, 165, 190, 215, 240, 265, 290 and 315 meter above LAT. The Lidar provides some general signals and a list of measuring signals for each measuring height. The total list of signals coming from the Lidar is shown in figure Table 5.

| Measured signals Lidar | | | |
|---|---|---|---|
| Level | Signal | Signal short name | Unit |
| | | | |
| 21 | Battery Voltage | MMIJ_Li_BatVoltage_m | V |
| 21 | Max temperature inside Lidar | MMIJ_Li_TempMax_m | deg C |
| 21 | Min temperature inside Lidar | MMIJ_Li_TempMin_m | deg C |
| 21 | CPU temperature in Lidar | MMIJ_Li_TempCPU_m | deg C |
| 21 | Relative humidity inside Lidar | MMIJ_Li_HumPod_m | % |
| 21 | Lidar bearing | MMIJ_Li_Bearing_m | deg |
| 21 | Lidar tilt angle | MMIJ_Li_Tilt_m | deg |
| 21 | Air temperature at Lidar position | MMIJ_Li_H21_Tair_m | deg C |
| 21 | Air pressure at Lidar position | MMIJ_Li_H21_Pair_m | hPa |
| 21 | Relative humidity at Lidar position | MMIJ_Li_H21_RH_m | % |
| 21 | Wind speed measured by Lidar meteo station | MMIJ_Li_H21_WsMet_m | m/s |
| 21 | Wind direction measured by Lidar meteo station | MMIJ_Li_H21_WdMet_m | deg |
| 21 | Precipitation measured by Lidar meteo station | MMIJ_Li_Rain_m | % |
| | | | |
| | For every measuring height : | xxx : measuring height | |
| | | | |
| xxx | # measuring points | MMIJ_Li_Hxxx_npts_m | - |
| xxx | # missed points | MMIJ_Li_Hxxx_missed_m | - |
| xxx | # packets in fit | MMIJ_Li_Hxxx_npackets_m | - |
| xxx | Wind direction | MMIJ_Li_Hxxx_Wd_m | deg |
| xxx | Horizontal wind speed average | MMIJ_Li_Hxxx_WsHor_avg_m | m/s |
| xxx | Horizontal wind speed std deviation | MMIJ_Li_Hxxx_WsHor_std_m | m/s |
| xxx | Horizontal wind speed minimum | MMIJ_Li_Hxxx_WsHor_min_m | m/s |
| xxx | Horizontal wind speed maximum | MMIJ_Li_Hxxx_WsHor_max_m | m/s |
| xxx | Vertical wind speed average | MMIJ_Li_Hxxx_WsVer_m | m/s |
| xxx | Spatial variation | MMIJ_Li_Hxxx_SpVar_m | - |
| xxx | CS | MMIJ_li_Hxxx_CS_m | - |
| xxx | Backscatter | MMIJ_Li_Hxxx_BS_m | - |
| xxx | Horizontal confidence | MMIJ_Li_Hxxx_Hconf_m | - |
| xxx | Turbulence intensity | MMIJ_Li_Hxxx_TI_m | % |
| | | | |

Table 5: *List of Lidar signals*

## 3.4 Wave and current measurement

To measure wave and current data, a Triaxys wave buoy has been placed in the water near the met-mast. The Triaxys measures the signals that are listed in Table 6. The wave buoy sends these signals by means of an Iridium connection once every hour.

| **Measured signals wave buoy** | | |
|---|---|---|
| Signal | Signal Name | Unit |
| | | |
| **Current data** | | |
| Latitude | MMIJ_BC_Latitude | deg |
| Longitude | MMIJ_BC_Longitude | deg |
| Water depth | MMIJ_BC_Depth | m |
| Water Temperature | MMIJ_BC_Temperature | deg C |
| Speed of sound | MMIJ_BC_SoundSpeed | m/s |
| | | |
| for 50 depths (1..50m): | | |
| Velocity 1 | MMIJ_BC_Vel1 | m/s |
| Direction 1 | MMIJ_BC_Dir1 | deg |
| ... | ... | ... |
| Velocity 50 | MMIJ_BC_Vel50 | m/s |
| Direction 50 | MMIJ_BC_Dir50 | deg |
| | | |
| **Status data** | | |
| Battery Voltage | MMIJ_BS_BatteryVoltage | V |
| Status Code | MMIJ_BS_Status | - |
| Solar Current | MMIJ_BS_SolarCurrent | A |
| | | |
| **Wave data** | | |
| Number of zero crossings | MMIJ_BW_NrZeroCrossings | - |
| Average wave height | MMIJ_BW_WaveHeightAvg | m |
| Zero upcrossing wave period | MMIJ_BW_Tz | s |
| Maximum wave height | MMIJ_BW_WaveHeightMax | m |
| Significant wave height | MMIJ_BW_WaveHeightSig | m |
| Significant wave period | MMIJ_BW_WavePeriodSig | s |
| H10 | MMIJ_BW_H10 | m |
| T10 | MMIJ_BW_T10 | s |
| Mean period | MMIJ_BW_PeriodMean | s |
| Peak period | MMIJ_BW_PeriodPeak | s |
| Tp5 | MMIJ_BW_Tp5 | s |
| Hm0 | MMIJ_BW_Hm0 | m |
| Mean magnetic direction | MMIJ_BW_MagDirAvg | deg |
| Mean Spread | MMIJ_BW_SpreadAvg | deg |
| Mean True direction | MMIJ_BW_TrueDirAvg | deg |
| Te | MMIJ_BW_Te | s |
| Wave steepness | MMIJ_BW_Steepness | - |

Table 6: *List of Wave buoy signals*

# 4. Instrumentation

## 4.1 Met Mast Equipment

In the metmast a number of sensors have been installed to measure wind speed, wind direction, air pressure, air temperature and relative humidity. Besides that, some sensors have been installed on the top of the container, measuring air pressure, air temperature, relative humidity and precipitation. In Figure 4.1 an overview of the measuring system used for the measurements in the metmast is shown.

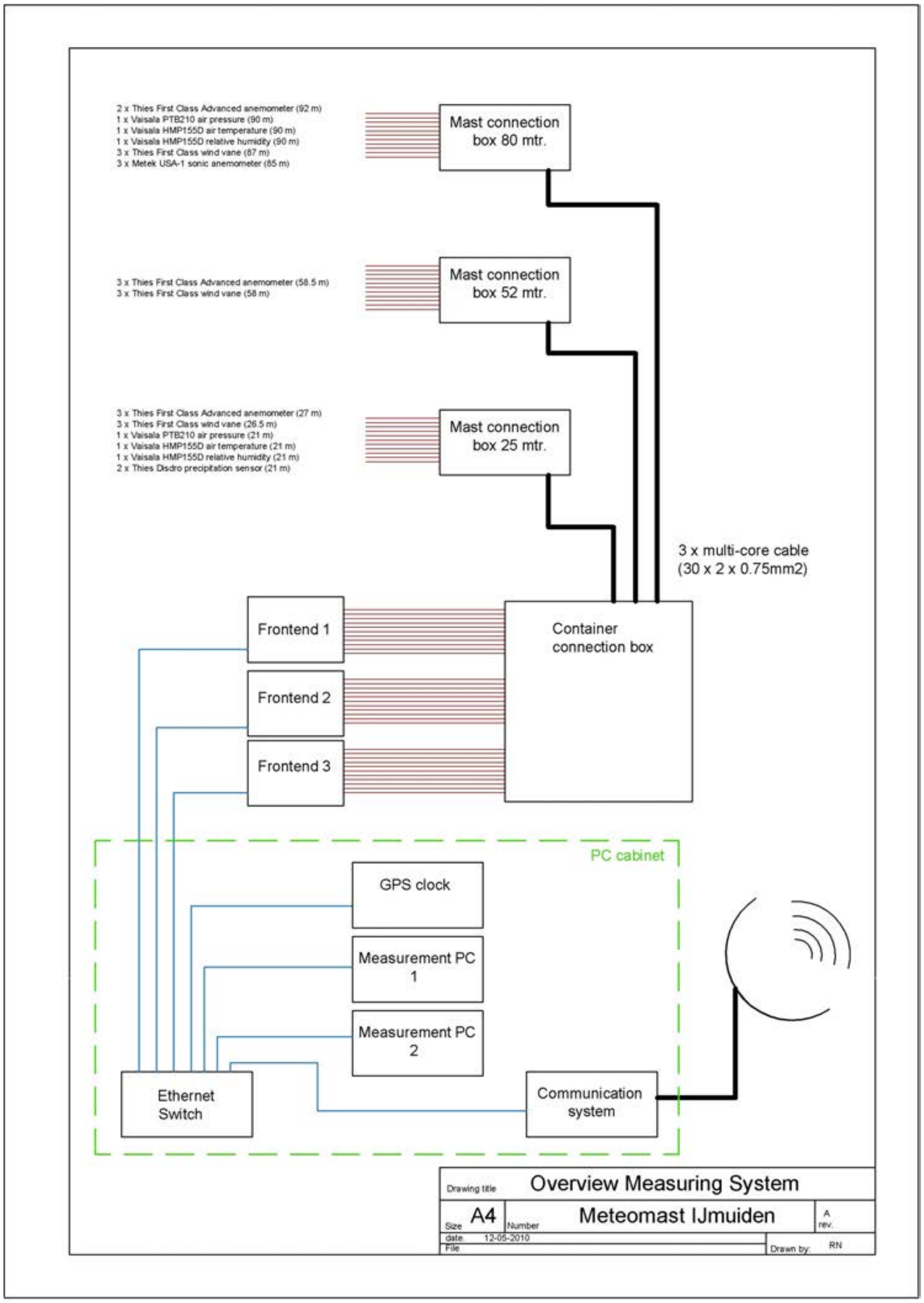



Figure 4.1: *Overview of met-mast measuring system*

### 4.1.1 Mast connection boxes

In the met-mast three connection boxes have been installed, each as near as possible to a measurement level. All sensor cables at the corresponding measurement level are routed to this cabinet. In the cabinet over-voltage protection units have been installed to protect the installation against over-voltage in case one of the sensors is hit by lightning..
In the cabinet the sensor cables are connected to one multi-core cable, that runs down to the container connection box.

### 4.1.2 Container connection box

In the container connection box over-voltage protection units have been installed to protect the measuring system against over-voltage in case of lightning somewhere in the met-mast. In the cabinet the multi-core cable entering the container connection box is connected to single signal cables each connecting one signal to a measuring system.

### 4.1.3 Frontends

The measuring systems used are so-called Dante frontends. These frontends are modular measuring systems. For each sensor to be measured, a module can be inserted in the frontend to supply the sensor with power and to collect its measuring data. Up to 16 modules can be installed in one frontend. A detailed description of the frontends systems can be found in Appendix C.
The signals have been distributed among the frontends in such a way that upon failure of one frontend only one boom per level will fail, leaving 2 functioning measuring booms per level.
The configuration of the DANTE frontends is depicted in Appendix E.

In the frontends several types of modules are used, which are described in Appendix C. The calibration values in the modules are set in such a way that the signals are represented in the units given in Appendix A.

### 4.1.4 PC cabinet

In the container a Rittal 19” cabinet (see F.12) has been placed in which the following equipment has been installed:

- The measurement PC’s
- The network clock
- The communication system transmitter
- The Ethernet switch
- The remote I/O controller

### 4.1.5 Measurement PC's

Two industrial PC's are installed in the PC cabinet, measuring all signals in parallel. The computers used are industrial PC's (Siemens IPC627C). A datasheet of the PC's can be found in F.10.
Each PC contains two independent hard disks on which the measurement data is written.

### 4.1.6 Network

The Dante frontends are connected to an Ethernet network across which the frontends send the measured data to the measurement PC's. In the network, the following devices have been connected, each with their own IP address :

| Device name | IP address | Purpose |
|---|---|---|
| | | |
| Network clock | 192.168.111.11 | Synchronize measuring systems |
| Remote I/O controller | 192.168.111.12 | Switch devices on/off remotely |
| Frontend 1 | 192.168.111.13 | Measuring system 1 |
| Frontend 2 | 192.168.111.14 | Measuring system 2 |
| Frontend 3 | 192.168.111.15 | Measuring system 3 |
| Measurement PC 1 | 192.168.111.16 | Primary measurement PC |
| Measurement PC 2 | 192.168.111.17 | Secondary measurement PC |
| Zephir | 192.168.111.18 | Lidar system |
| Communication system | unknown | Communication with onshore location |
| Maintenance laptop | 192.168.111.19 | Maintenance on site |

Table 7: *List of used IP adresses*

Some of the devices need some extra explanation:

#### 4.1.6.1 Network clock

The network clock is a GPS clock, set to UTC time. The clock sends the actual UTC time across the network every second. The frontends and the measurement PC's use this clock to synchronize all measured data within 20 milliseconds.

#### 4.1.6.2 Remote I/O controller

The Remote I/O controller is a device with a WEB interface, housing 8 relays that can be switched on and off remotely. The system is used to allow us to switch the following groups of devices on or off :

- The 3 Frontends, together with the sensors powered from the frontends
- The met-mast (cabinet heating, sonic anemometers and Disdro precipitation sensors)
- Measurement PC 1
- Measurement PC 2

This way we are able to reset all devices remotely, if necessary. A drawing of the connections of the remote I/O controller can be found in Appendix B.

In the table below the I/O controller outputs are listed, together with their function.

| I/O output | Position | Function |
|---|---|---|
| | | |
| Do 0 | Off | Frontends On |
| Do 0 | On | Frontends Off |
| Do 1 | Off | Met-mast sensors & cabinet heaters On |
| Do 1 | On | Met-mast sensors & cabinet heaters Off |
| Do 2 | Off | Not used |
| Do 2 | On | Not used |
| Do 3 | Off | Not used |
| Do 3 | On | Not used |
| Do 4 | Off | Bi-stable relay PC 1 Off-side inactive |
| Do 4 | On | PC 1 Off-side activated |
| Do 5 | Off | Bi-stable relay PC 1 On-side inactive |
| Do 5 | On | PC 1 On-side activated |
| Do 6 | Off | Bi-stable relay PC 2 Off-side inactive |
| Do 6 | On | PC 2 Off-side activated |
| Do 7 | Off | Bi-stable relay PC 2 On-side inactive |
| Do 7 | On | PC 2 On-side activated |

For switching the measurement PC's bi-stable relays have been used. This way, a measurement PC can be switched on or off and its state will not be influenced by a reset of the I/O controller. That means that in case of a power failure, the measurement PC's will return to their On/Off state they had before the power failure after the power failure has been solved.
The bi-stable relays have two coils: one coil to move the relay to the "On" side, one coil to move the relay to the "Off"-side. It is not wise to activate both coils at the same time, so care should be taken when operating these relays. Therefore, switching a PC off or on needs to be done in the following switch order (example switches PC 1 Off and On):

| | | |
|---|---|---|
| Do 4 | Off | Bi-stable relay Off-side not activated. |
| Do 5 | Off | Bi-stable relay On-side not activated. |
| Do 4 | On | Bi-stable relay Off-side activated: PC 1 switches Off |
| Do 4 | Off | Bi-stable relay Off side not activated. |
| Do 5 | On | Bi-stable relay On-side activated: PC 1 switches On |
| Do 5 | Off | Bi-stable relay On-side not activated. |

Note that the other devices' relays are normal relays, which will be inactivated after a reset of the I/O controller. Therefore the other devices will all be ON after a reset of the I/O controller.

### 4.1.7 Power supply

To power all devices, a 24 Volt power supply is supplied by SSC Montage. From SSC montage we receive three 24 Volt power cables, which can all be powered down under certain circumstances.
A schematic drawing of the 24V power supply cabling is shown in Figure 4.2.

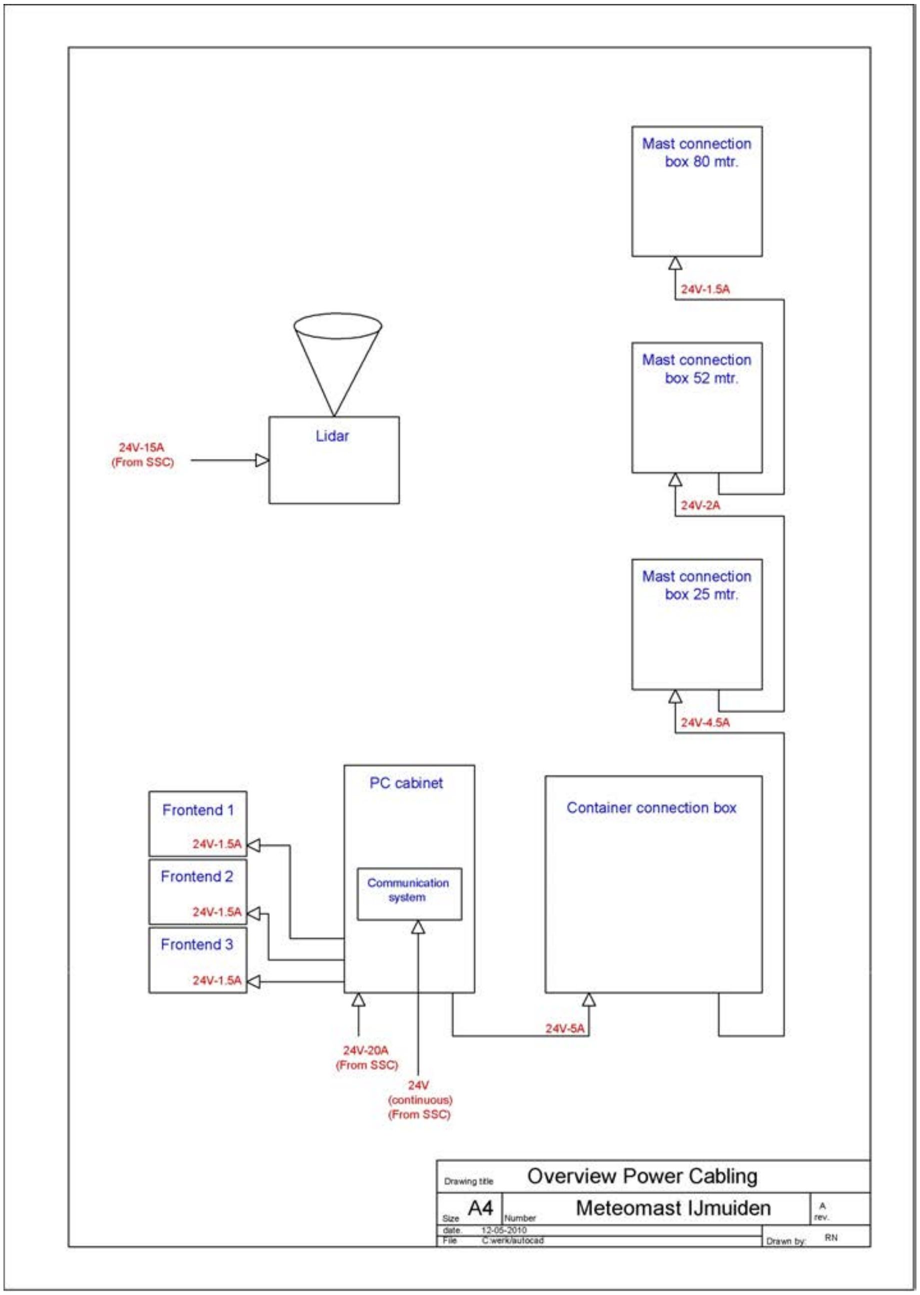



Figure 4.2: *Overview power cabling*

The three 24V power cables have the following functions:

1. A power cable to supply the communication system
   This 24 Volt supply has been routed directly from SSC power supply to the communication system. The line will be ‘up’ as long as possible. Even when the battery power would drop to a level on which all measuring systems are powered down this line will be kept on 24 Volt (if possible).

2. A power cable to supply the Lidar system
   This 24 Volt power cable is routed directly from the SSC power supply to the Lidar system. In case the battery voltage would drop below a certain level, the Lidar is the first system to be powered down.

3. A power cable to supply all other measuring equipment
   This 24 Volt cable is routed from the SSC power supply to the PC cabinet. In the PC cabinet, the cable has been split up to power the following devices separately, so they can be switched on or off independently using the remote I/O controller:
   - The 3 Frontends, together with the sensors powered from the frontends
   - The metmast (cabinet heating, sonic anemometers, Disdro precipitation sensors)
   - Measurement PC 1
   - Measurement PC 2

### 4.1.8 Lidar Wind speed measurement system

On a platform on a height of 2.40 meter in the mast, a Zephir 300 Lidar system has been installed to perform wind speed measurements on levels above the metmast. The Lidar has been oriented so that its North marker points to 46.5 degrees. A datasheet of the Lidar system can be found in F.7. To power the Lidar, it needs a voltage of 12 Volts. As the power cable coming from SSC is a 24 Volt cable, a DC/DC converter has been placed close to the Lidar to convert the 24 Volts to the required 12 Volts.

The Lidar system measures the wind speed using a rotating laser beam pointing upward in a 15 degree angle with respect to the vertical (see Figure 4.3) . The cone angle is thus 30 degrees.

Figure 4.3: *Zephir 300 Lidar system*

The reason to choose this Lidar system is that it is able to detect where the laser beam hits obstacles and remove these measuring points from the results. As the Lidar has been built into the met-mast (see Figure 4.4), the beam will see quite some obstacles when moving around.

Figure 4.4: Top view of *Lidar system installed in met-mast*

Enough data is left, though, to measure the wind speed on heights of 90, 115, 140, 165, 190, 215, 240, 265, 290 and 315 meter above LAT. Figure 4.5 shows an extract of the Lidar data measured on 2012-01-11. Note that the heights shown here are the measuring heights as seen from the Lidar, not according LAT.

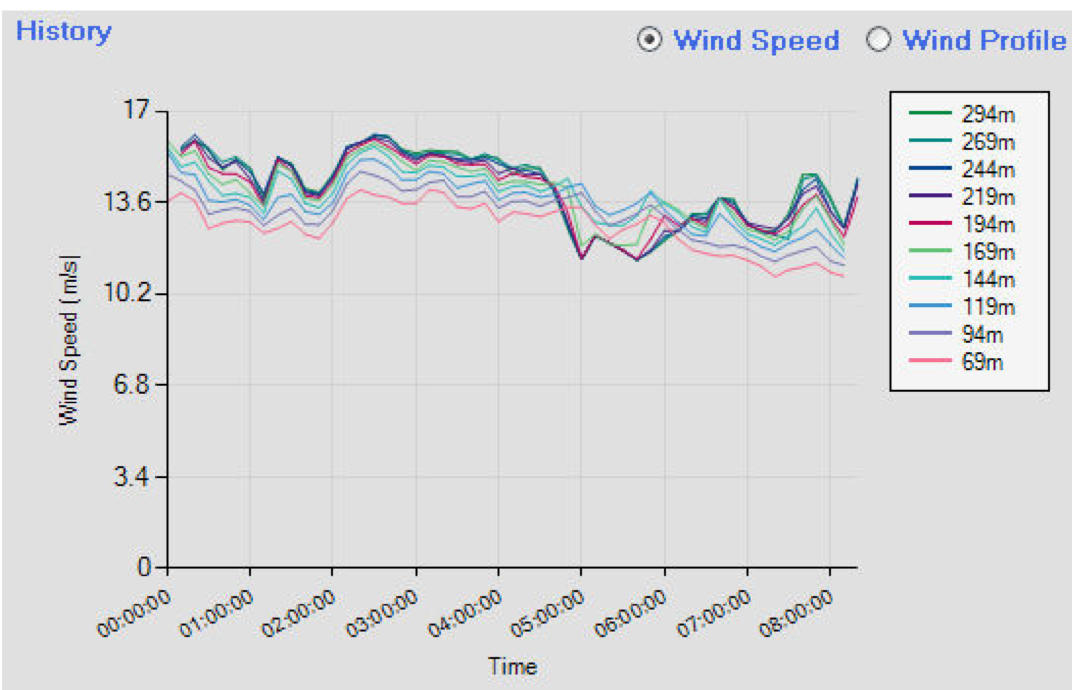



Figure 4.5: *Example of Lidar wind speed data (2012-01-11).*

The Lidar has been connected to the Ethernet network in the container. The measurement PC's extract the data from the Lidar and include the Lidar data in the data package that will be sent to ECN at night.

## 4.2 Triaxys wave and current measuring system

Close to the met-mast, a Triaxys wave and current buoy has been deployed (see Figure 4.6).

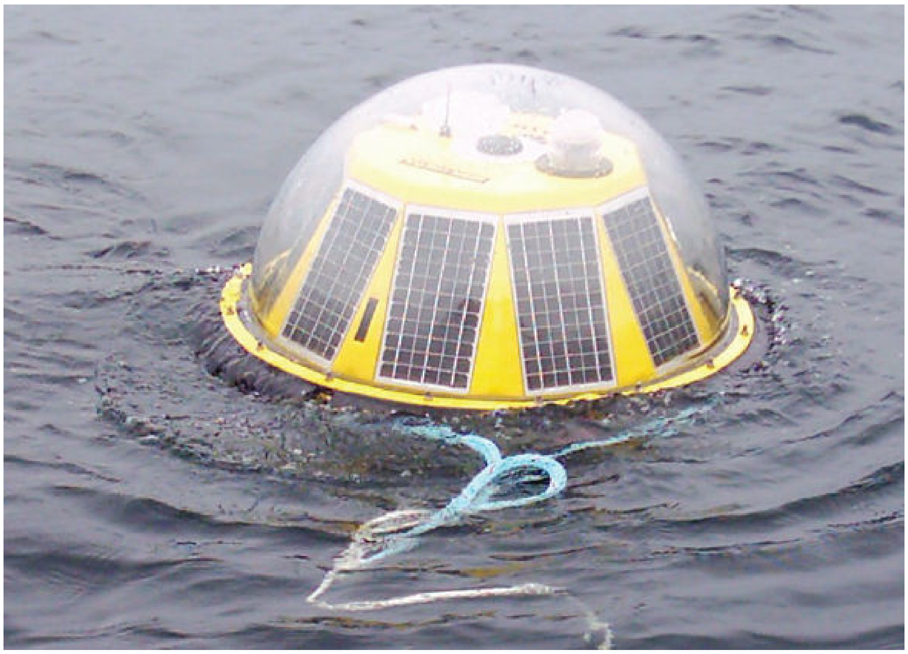


Figure 4.6: *Triaxys wave buoy*

The wave buoy measures wave- and current data. A datasheet of the Triaxys wave buoy can be found in F.8.
A complete list of the signals measured by the wave buoy can be found in Appendix A.
The wave buoy is powered using solar panels under the transparent waterproof dome. An Iridium connection is used to send the measured data to ECN, where the data is imported in the database as soon as it arrives.

# 5. Data handling

## 5.1 Local data storage

Each measurement PC stores the measured data on an internal hard disk, and a copy on a second hard disk. For each day, the measurement data takes about 80 MB of disk space. The 250 GB data disks have more than enough space to store measurement data of 5 years of measurements.

## 5.2 Data transfer

On the measurement PC's a script is running, doing the following each night at 02:00:

- Transfer the data from the Lidar to the PC
- Collect all met-mast data of the previous full day
- Store the Lidar and met-mast data together in one zip file

At ECN, a script is started at 02:15 each night, doing the following:

- Transfer the data from one of the measurement PC's to ECN across the satellite connection.
- Extract the data from the zip file, and store the metmast data separated from the Lidar data on the database server.

## 5.3 Import in ECN database system

Each night at 05:00, the database system imports all transferred data and calculates the pseudo-signals and statistical values, providing the 10-minute average, standard deviation, minimum and maximum values.
Back-up facility is foreseen by daily back-up of the measurement data on a server at ECN in Petten.

## 5.4 Data validation

The validity of data is a vitally important aspect of the system. Unfortunately, while measuring many things can go wrong. Some of these problems are detected by self-diagnosis and a flag is set for that data by the data acquisition system, but others may go by undetected. The first source of erroneous data is incomplete ten-minute intervals; these files are invalid. Then, still, some data may be wrong for which an analyst must minutely run through the data and make the so-called post-validation by hand. Validation covers entire ten-minute time series.

Summarizing: two levels of validation are identified:

- Auto-validation is done by the data acquisition system itself. It is based on status signals from the hardware plus range-checks of the variables.
- Post-validation is performed manually.

# 6. Signal Calibration

## 6.1 Sensor calibration

All sensors on the met-mast, excluding the Thies Disdro laser precipitation monitors, are calibrated according ISO 17025. The calibration sheets are all available at the ECN Wind Energy laboratory. As there is no way to calibrate the Thies laser precipitation monitors according ISO 17025, we only have a functional test sheet for these sensors. Therefore, their signals have the Q5 quality level (see § 3.2).

## 6.2 Module calibration

All used Dante modules have been calibrated according ISO 17025. The calibration sheets are all available at the ECN Wind Energy laboratory.

## 6.3 Wind vane alignment

To measure the wind directions accurately, the alignment of the wind vanes after installation is important. For this alignment, ECN Wind Energy uses the following procedure:

The sensor is being mounted on its location, with the sensor aligned in the correct wind direction visually.
With the boom still raised, the wind vane is held in position with a special clamp, so that it points exactly towards the anemometer that is mounted at the end of the boom (see Figure 6.1). The wind direction measured by the measuring system at that moment, denoted as Wr, is written down.

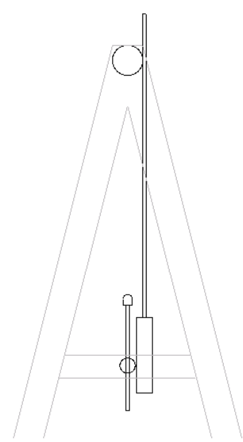


Figure 6.1 *Aligning the wind vane on the boom*

As the direction of the boom is well known, it is possible to calculate an offset for the wind vane by subtracting the measured value Wr from the boom direction :

offset = Boom direction - Wr (measured with clamp)

This offset is entered in the ECN measuring system, after which the wind direction is measured correctly. Using a mod 360 function in the measuring system prevents the measured wind direction from becoming lower than 0 or higher than 360 degrees.

# 7. Pseudo Signal Calculation

From the measured signals, a number of calculated signals are calculated. We call these signals 'pseudo'-signals. The pseudo-signals are listed in Table 8. In this chapter the way the pseudo-signals are calculated will be explained.

| Calculated pseudo- signals Met-Mast | | | | | |
|---|---|---|---|---|---|
| Nr | level | Signal | Short name | unit | freq [Hz] |
| | | | | | |
| 38 | 90 m | Air density | MMIJ_H90_AirDensity_Q1 | kg/m$^3$ | 4 |
| 39 | 87 m | True wind direction | MMIJ_H87_Wd_Q1 | deg | 4 |
| 40 | 85 m | True wind speed | MMIJ_H85_Ws_Q1 | m/s | 4 |
| 41 | 85 m | Horizontal wind speed 0 deg | MMIJ_H85B0_WsHor_Q1 | m/s | 4 |
| 42 | 85 m | Wind speed magnitude 0 deg | MMIJ_H85B0_WSMag_Q1 | m/s | 4 |
| 43 | 85 m | Horizontal wind speed 120 deg | MMIJ_H85B120_WsHor_Q1 | m/s | 4 |
| 44 | 85 m | Wind speed magnitude 120 deg | MMIJ_H85B120_WsMag_Q1 | m/s | 4 |
| 45 | 85 m | Horizontal wind speed 240 deg | MMIJ_H85B240_WsHor_Q1 | m/s | 4 |
| 46 | 85 m | Wind speed magnitude 240 deg | MMIJ_H85B240_WsMag_Q1 | m/s | 4 |
| 47 | 58 m | True wind speed | MMIJ_H58_Ws_Q1 | m/s | 4 |
| 48 | 58 m | True wind direction | MMIJ_H58_Wd_Q1 | deg | 4 |
| 49 | 27 m | True wind speed | MMIJ_H27_Ws_Q1 | m/s | 4 |
| 50 | 27 m | True wind direction | MMIJ_H27_Wd_Q1 | deg | 4 |
| 51 | 21 m | Air density | MMIJ_H21_AirDensity_Q1 | kg/m$^3$ | 4 |

Table 8: *List of pseudo signals*

## 7.1 Air density

Signals : MMIJ_H90_AirDensity_Q1, MMIJ_H21_AirDensity_Q1
Unit: kg/m$^3$

The air density is calculated from the air pressure and air temperature measured at the same heights :

MMIJ_Hxx_AirDensity_Q1 = (MMIJ_Hxx_Pair_Q1 * 100) / (287.05*(MMIJ_Hxx_Tair_Q1 + 273.15))

## 7.2 True Wind Direction

Signals : MMIJ_H87_Wd_Q1, MMIJ_H58_Wd_Q1, MMIJ_H27_Wd_Q1
Unit : deg

The wind direction is measured on each height with 3 wind vanes. For each wind direction, one or two wind vanes measure a correct wind direction, while one or two wind vanes are disturbed by mast influence.
From the three measured wind directions, the true wind direction is determined as follows :

Looking at the measured values of the three wind vanes, one wind vane measures the lowest value, one will measure the middle value, one will measure the highest value. From the three values, we pick the middle one, and we call this the MWD (Middle Wind Direction).

Now we do the following to calculate the True Wind Direction (TWD):

```
If ( MWD > 16.5 and MWD <= 76.5) or (MWD >196.5 and MWD <= 256.5) then
        TWD = (MMIJ_HxxB120_Wd_Q1 + MMIJ_HxxB240_Wd_Q1) / 2
Else
        IF ( MWD > 76.5 and MWD <= 136.5) or (MWD > 256.5 and MWD <=316.5) then
                TWD = (MMIJ_HxxB0_Wd_Q1 + MMIJ_HxxB120_Wd_Q1) / 2
        Else
                TWD = (MMIJ_HxxB0_Wd_Q1 + MMIJ_HxxB240_Wd_Q1) / 2
        Endif
Endif
```

Figure 7.1 shows a top view of the mast booms and will clarify this a little more:

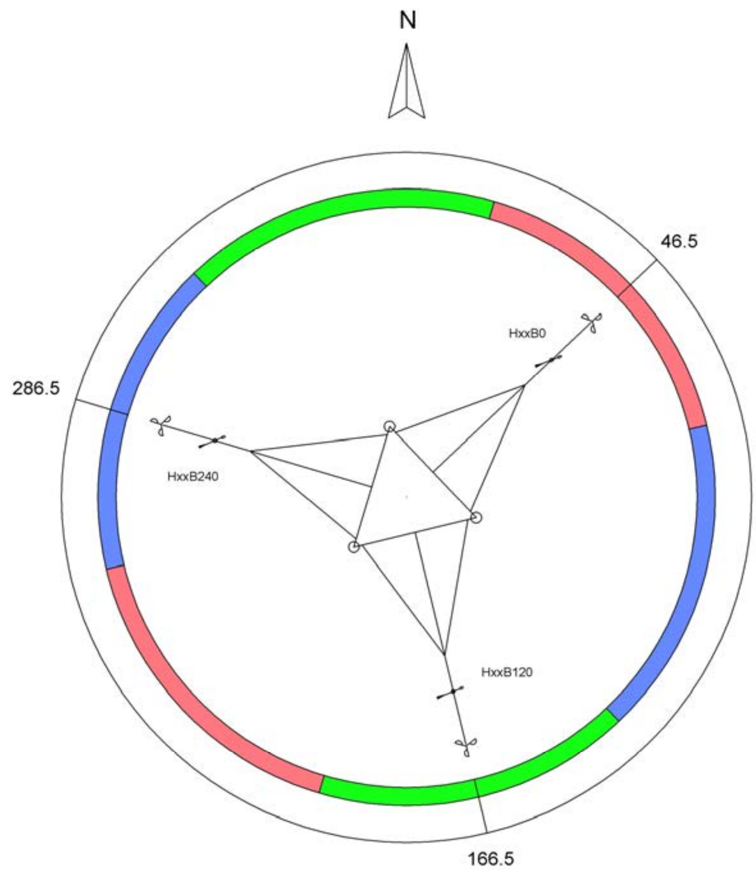



Figure 7.1: *Determining the True Wind Direction*

If the Middle Wind Direction (MWD) is from the red zones, the True Wind Direction (TWD) is the average between the measured wind directions from wind vane HxxB120 and HxxB240 .

If the Middle Wind Direction (MWD) is from the blue zones, the True Wind Direction (TWD) is the average between the measured wind directions from wind vane HxxB0 and HxxB120 .

If the Middle Wind Direction (MWD) is from the green zones, the True Wind Direction (TWD) is the average between the measured wind directions from wind vane HxxB0 and HxxB240 .

## 7.3 Horizontal Wind Speed Sonic Anemometer

Signals : MMIJ_H85B0_WsHor_Q1, MMIJ_H85B120_WsHor_Q1, MMIJ_H85B240_WsHor_Q1
Unit : m/s

The sonic anemometers measure the wind speed in 3 independent directions: the X, Y and Z axes, where the X and Y axes are in the horizontal plane and the Z direction is upwards. To calculate the horizontal wind speed the following formula is used :

WsHor = SQRT( (MMIJ_H85Bxxx_WsXSon_Q1)^2 + (MMIJ_H85Bxxx_WsYSon_Q1)^2 )

Where xxx specifies the bearing of the sonic anemometer.

## 7.4 Wind Speed magnitude Sonic Anemometer

Signals : MMIJ_H85B0_WsMag_Q1, MMIJ_H85B120_WsMag_Q1, MMIJ_H85B240_WsMag_Q1
Unit : m/s

The sonic anemometers measure the wind speed in 3 independent directions: the X, Y and Z axes, where the X and Y axes are in the horizontal plane and the Z direction is upwards. To calculate the wind speed magnitude (the actually measured 3D wind speed) the following formula is used :

WsMag =
SQRT( (MMIJ_H85Bxxx_WsXSon_Q1)^2 + (MMIJ_H85Bxxx_WsYSon_Q1)^2 + (MMIJ_H85Bxxx_WsZSon_Q1)^2 )

## 7.5 True Wind Speed

Signals : MMIJ_H85_Ws_Q1, MMIJ_H58_Ws_Q1, MMIJ_H27_Ws_Q1
Unit : deg

The wind speed is measured on each height with 3 cup anemometers or sonic anemometers. For each wind direction, one or two anemometers measure a correct wind speed, while one or two anemometers are disturbed by mast influence.
From the three measured wind speeds and the calculated True Wind Direction (see §7.2) on the same level, the True Wind Speed (TWS) is determined as follows :

```
If ( TWD > 46.5 and TWD <= 166.5 ) then
	TWS = (MMIJ_HxxB0_Ws_Q1 + MMIJ_HxxB120_Ws_Q1) / 2
Else
	If ( TWD > 166.5 and TWD < 286.5 ) Then
		TWS = (MMIJ_HxxB120_Ws_Q1 + MMIJ_HxxB240_Ws_Q1) / 2
	Else
		TWS = (MMIJ_HxxB0_Ws_Q1 + MMIJ_HxxB240_Ws_Q1) / 2
	Endif
Endif
```

Figure 7.2 shows this in a picture:

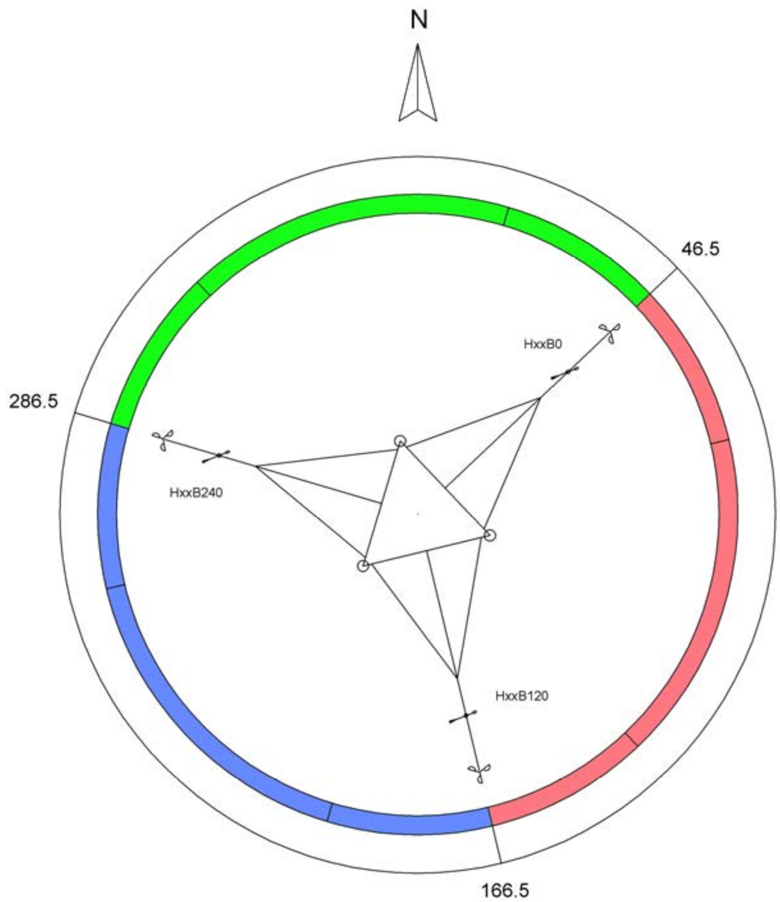



Figure 7.2: *Determining True Wind Speed*

If the True Wind Direction (TWD) is from the red zone, the True Wind Speed (TWS) is the average between the measured wind speeds from anemometer HxxB0 and HxxB120 .

If the True Wind Direction (TWD) is from the blue zone, the True Wind Speed (TWS) is the average between the measured wind speeds from anemometer HxxB120 and HxxB240 .

If the True Wind Direction (TWD) is from the green zone, the True Wind Speed (TWS) is the average between the measured wind speeds from anemometer HxxB0 and HxxB240 .

# Appendix A : Signal list

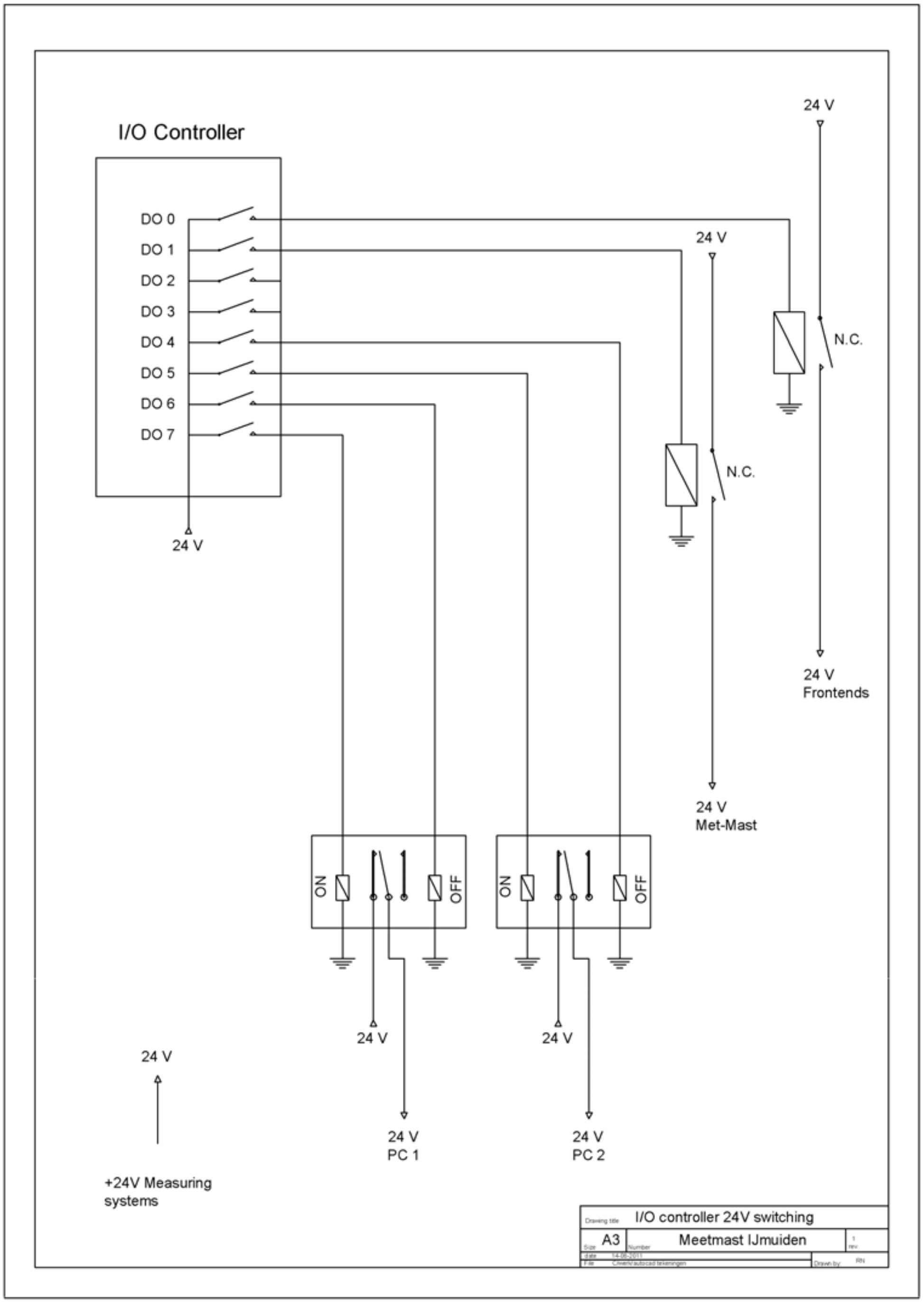
| Measured signals Met-Mast | | | | | |
|---|---|---|---|---|---|
| Nr | level | Signal | Short name | unit | freq [Hz] |
| | | | | | |
| Top level, 92 m | | | | | |
| 1 | 92 m | wind speed 92m, 180 deg | MMIJ_H92B180_Ws_Q1 | m/s | 4 |
| 2 | 92 m | wind speed 92m , 300 deg | MMIJ_H92B300_Ws_Q1 | m/s | 4 |
| 3 | 90 m | air pressure | MMIJ_H90_Pair_Q1 | hPa | 4 |
| 1st level 85 m | | | | | |
| 4 | 87 m | wind direction, 0 deg | MMIJ_H87B0_Wd_Q1 | deg | 4 |
| 5 | 87 m | wind direction, 120 deg | MMIJ_H87B120_Wd_Q1 | deg | 4 |
| 6 | 87 m | wind direction, 240 deg | MMIJ_H87B240_Wd_Q1 | deg | 4 |
| 7 | 85 m | wind speed X, 0 deg | MMIJ_H85B0_WsXSon_Q1 | m/s | 4 |
| 8 | 85 m | wind speed Y, 0 deg | MMIJ_H85B0_WsYSon_Q1 | m/s | 4 |
| 9 | 85 m | wind speed Z, 0 deg | MMIJ_H85B0_WsZSon_Q1 | m/s | 4 |
| 10 | 85 m | Sonic Status, 0 deg | MMIJ_H85B0_SSon_Q1 | - | 4 |
| 11 | 85 m | wind speed X, 120 deg | MMIJ_H85B120_WsXSon_Q1 | m/s | 4 |
| 12 | 85 m | wind speed Y, 120 deg | MMIJ_H85B120_WsYSon_Q1 | m/s | 4 |
| 13 | 85 m | wind speed Z, 120 deg | MMIJ_H85B120_WsZSon_Q1 | m/s | 4 |
| 14 | 85 m | Sonic Status, 120 deg | MMIJ_H85B120_SSon_Q1 | - | 4 |
| 15 | 85 m | wind speed X, 240 deg | MMIJ_H85B240_WsXSon_Q1 | m/s | 4 |
| 16 | 85 m | wind speed Y, 240 deg | MMIJ_H85B240_WsYSon_Q1 | m/s | 4 |
| 17 | 85 m | wind speed Z, 240 deg | MMIJ_H85B240_WsZSon_Q1 | m/s | 4 |
| 18 | 85 m | Sonic Status, 240 deg | MMIJ_H85B240_SSon_Q1 | - | 4 |
| 19 | 90 m | temperature | MMIJ_H90_Tair_Q1 | °C | 4 |
| 20 | 90 m | relative humidity | MMIJ_H90_Rh_Q1 | % | 4 |
| 3rd level, 58,5 m | | | | | |
| 21 | 58,5 m | wind speed, 0 deg | MMIJ_H58B0_Ws_Q1 | m/s | 4 |
| 22 | 58,5 m | wind speed, 120 deg | MMIJ_H58B120_Ws_Q1 | m/s | 4 |
| 23 | 58,5 m | wind speed, 240 deg | MMIJ_H58B240_Ws_Q1 | m/s | 4 |
| 24 | 58,5 m | wind direction, 0 deg | MMIJ_H58B0_Wd_Q1 | deg | 4 |
| 25 | 58,5 m | wind direction, 120 deg | MMIJ_H58B120_Wd_Q1 | deg | 4 |
| 26 | 58,5 m | wind direction, 240 deg | MMIJ_H58B240_Wd_Q1 | deg | 4 |
| 4rd level, 27 m | | | | | |
| 27 | 27 m | wind speed, 0 deg | MMIJ_H27B0_Ws_Q1 | m/s | 4 |
| 28 | 27 m | wind speed, 120 deg | MMIJ_H27B120_Ws_Q1 | m/s | 4 |
| 29 | 27 m | wind speed, 240 deg | MMIJ_H27B240_Ws_Q1 | m/s | 4 |
| 30 | 27 m | wind direction, 0 deg | MMIJ_H27B0_Wd_Q1 | deg | 4 |
| 31 | 27 m | wind direction, 120 deg | MMIJ_H27B120_Wd_Q1 | deg | 4 |
| 32 | 27 m | wind direction, 240 deg | MMIJ_H27B240_Wd_Q1 | deg | 4 |
| Platform level 21 m | | | | | |
| 33 | 21 m | precipitation, left | MMIJ_H21_Prec_l_Q5 | 1/0 | 4 |
| 34 | 21 m | precipitation,right | MMIJ_H21_Prec_r_Q5 | 1/0 | 4 |
| 35 | 21 m | temperature | MMIJ_H21_Tair_Q1 | °C | 4 |
| 36 | 21 m | relative humidity | MMIJ_H21_Rh_Q1 | % | 4 |
| 37 | 21 m | air pressure | MMIJ_H21_Pair_Q1 | hPa | 4 |

| Calculated pseudo- signals Met-Mast | | | | | |
|---|---|---|---|---|---|
| Nr | level | Signal | Short name | unit | freq [Hz] |
| | | | | | |
| 38 | 90 m | Air density | MMIJ_H90_AirDensity_Q1 | $kg/m^3$ | 4 |
| 39 | 87 m | True wind direction | MMIJ_H87_Wd_Q1 | deg | 4 |
| 40 | 85 m | True wind speed | MMIJ_H85_Ws_Q1 | m/s | 4 |
| 41 | 85 m | Horizontal wind speed 0 deg | MMIJ_H85B0_WsHor_Q1 | m/s | 4 |
| 42 | 85 m | Wind speed magnitude 0 deg | MMIJ_H85B0_WSMag_Q1 | m/s | 4 |
| 43 | 85 m | Horizontal wind speed 120 deg | MMIJ_H85B120_WsHor_Q1 | m/s | 4 |
| 44 | 85 m | Wind speed magnitude 120 deg | MMIJ_H85B120_WsMag_Q1 | m/s | 4 |
| 45 | 85 m | Horizontal wind speed 240 deg | MMIJ_H85B240_WsHor_Q1 | m/s | 4 |
| 46 | 85 m | Wind speed magnitude 240 deg | MMIJ_H85B240_WsMag_Q1 | m/s | 4 |
| 47 | 58 m | True wind speed | MMIJ_H58_Ws_Q1 | m/s | 4 |
| 48 | 58 m | True wind direction | MMIJ_H58_Wd_Q1 | deg | 4 |
| 49 | 27 m | True wind speed | MMIJ_H27_Ws_Q1 | m/s | 4 |
| 50 | 27 m | True wind direction | MMIJ_H27_Wd_Q1 | deg | 4 |
| 51 | 21 m | Air density | MMIJ_H21_AirDensity_Q1 | $kg/m^3$ | 4 |

| Measured signals wave buoy | | |
|---|---|---|
| Signal | Signal Name | Unit |
| | | |
| **Current data** | | |
| Latitude | MMIJ_BC_Latitude | deg |
| Longitude | MMIJ_BC_Longitude | deg |
| Water depth | MMIJ_BC_Depth | m |
| Water Temperature | MMIJ_BC_Temperature | deg C |
| Pressure | MMIJ_BC_Pressure | ?? |
| Speed of sound | MMIJ_BC_SoundSpeed | m/s |
| | | |
| for 50 depths (1..50m): | | |
| Velocity 1 | MMIJ_BC_Vel1 | m/s |
| Direction 1 | MMIJ_BC_Dir1 | deg |
| ... | ... | ... |
| Velocity 50 | MMIJ_BC_Vel50 | m/s |
| Direction 50 | MMIJ_BC_Dir50 | deg |
| | | |
| **Status data** | | |
| Battery Voltage | MMIJ_BS_BatteryVoltage | V |
| Status Code | MMIJ_BS_Status | - |
| Solar Current | MMIJ_BS_SolarCurrent | A |
| | | |
| **Wave data** | | |
| Number of zero crossings | MMIJ_BW_NrZeroCrossings | - |
| Average wave height | MMIJ_BW_WaveHeightAvg | m |
| Zero upcrossing wave period | MMIJ_BW_Tz | s |
| Maximum wave height | MMIJ_BW_WaveHeightMax | m |
| Significant wave height | MMIJ_BW_WaveHeightSig | m |
| Significant wave period | MMIJ_BW_WavePeriodSig | s |
| H10 | MMIJ_BW_H10 | m |
| T10 | MMIJ_BW_T10 | s |
| Mean period | MMIJ_BW_PeriodMean | s |
| Peak period | MMIJ_BW_PeriodPeak | s |
| Tp5 | MMIJ_BW_Tp5 | s |
| Hm0 | MMIJ_BW_Hm0 | m |
| Mean magnetic direction | MMIJ_BW_MagDirAvg | deg |
| Mean Spread | MMIJ_BW_SpreadAvg | deg |
| Mean True direction | MMIJ_BW_TrueDirAvg | deg |
| Te | MMIJ_BW_Te | s |
| Wave steepness | MMIJ_BW_Steepness | - |

| Measured signals Lidar | | | |
|---|---|---|---|
| Level | Signal | Signal short name | Unit |
| | | | |
| 21 | Battery Voltage | MMIJ_Li_BatVoltage_m | V |
| 21 | Max temperature inside Lidar | MMIJ_Li_TempMax_m | deg C |
| 21 | Min temperature inside Lidar | MMIJ_Li_TempMin_m | deg C |
| 21 | CPU temperature in Lidar | MMIJ_Li_TempCPU_m | deg C |
| 21 | Relative humidity inside Lidar | MMIJ_Li_HumPod_m | % |
| 21 | Lidar bearing | MMIJ_Li_Bearing_m | deg |
| 21 | Lidar tilt angle | MMIJ_Li_Tilt_m | deg |
| 21 | Air temperature at Lidar position | MMIJ_Li_H21_Tair_m | deg C |
| 21 | Air pressure at Lidar position | MMIJ_Li_H21_Pair_m | hPa |
| 21 | Relative humidity at Lidar position | MMIJ_Li_H21_RH_m | % |
| 21 | Wind speed measured by Lidar meteo station | MMIJ_Li_H21_WsMet_m | m/s |
| 21 | Wind direction measured by Lidar meteo station | MMIJ_Li_H21_WdMet_m | deg |
| 21 | Precipitation measured by Lidar meteo station | MMIJ_Li_Rain_m | % |
| | | | |
| | For every measuring height : | xxx : measuring height | |
| | | | |
| xxx | # measuring points | MMIJ_Li_Hxxx_npts_m | - |
| xxx | # missed points | MMIJ_Li_Hxxx_missed_m | - |
| xxx | # packets in fit | MMIJ_Li_Hxxx_npackets_m | - |
| xxx | Wind direction | MMIJ_Li_Hxxx_Wd_m | deg |
| xxx | Horizontal wind speed average | MMIJ_Li_Hxxx_WsHor_avg_m | m/s |
| xxx | Horizontal wind speed std deviation | MMIJ_Li_Hxxx_WsHor_std_m | m/s |
| xxx | Horizontal wind speed minimum | MMIJ_Li_Hxxx_WsHor_min_m | m/s |
| xxx | Horizontal wind speed maximum | MMIJ_Li_Hxxx_WsHor_max_m | m/s |
| xxx | Vertical wind speed average | MMIJ_Li_Hxxx_WsVer_m | m/s |
| xxx | Spatial variation | MMIJ_Li_Hxxx_SpVar_m | - |
| xxx | CS | MMIJ_li_Hxxx_CS_m | - |
| xxx | Backscatter | MMIJ_Li_Hxxx_BS_m | - |
| xxx | Horizontal confidence | MMIJ_Li_Hxxx_Hconf_m | - |
| xxx | Turbulence intensity | MMIJ_Li_Hxxx_TI_m | % |
| | | | |

# Appendix B : I/O controller connections



# Appendix C : Measuring system specification

## ECN distributed data-acquisition system

**Introduction**

ECN has developed a new, distributed data-acquisition system to carry out experimental work at wind turbines for R&D and design verification measurements.

The result is a very rugged yet highly flexible system, suitable for measurements in harsh environments like (offshore) wind farms.

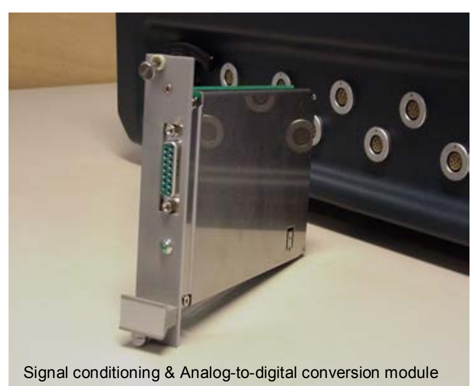
The system uses a separate signal-conditioning and analog-to-digital conversion module for each connected sensor.

ECN front-end system

Inside the front-end system

**Specifications :**

* Sample rate of 128 Hz max.; for each of max. 512 channels.
* 12 bit resolution
* Modules for strain gauges, voltage, current, frequency, the ECN telemetric system for rotor signals, quadrature input, etc.
* Custom-made modules for special (digital) sensors
* Isolated inputs and power supply for all inputs
* The system fully complies to the industrial immunity standard EN 50082-2 according to :
  - EN 61000-4-2 (electrostatic discharge test)
  - EN 61000-4-5 (surge test)
  - EN 61000-4-3 (radiated RF test)



Signal conditioning & Analog-to-digital conversion module

**ECN Contacts**

H.B. Hendriks, Head of the greup Experiments, unit ECN Wind Energy, tel. +31 224 564900; h.hendriks@ecn.nl

E.J. Werkhoven, instrumentation engineer in Group Experiments, unit ECN Wind Energy, tel. +31224564277; werkhoven@ecn.nl

Postal address :
ECN Wind energy
P.O. Box 1,
1755 ZG Petten,
The Netherlands

Visiting address :
ECN Wind energy
Westerduinweg 3,
1755 LE Petten,
The Netherlands

ECN is a member of MEASNET

# Technical data

**<u>The ECN data-acquisition system in use</u>**

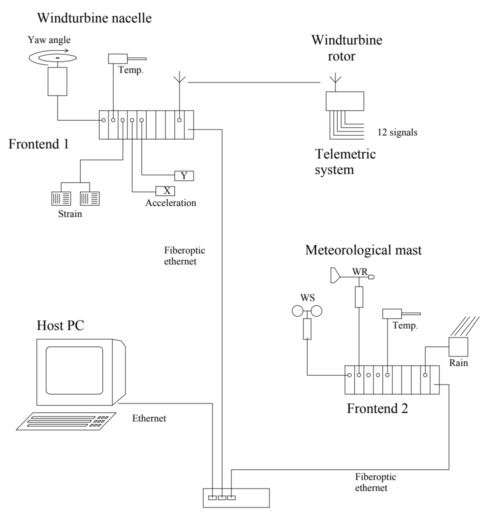
Installation of the distributed ECN data-acquisition system is quite simple. At each physical location where sensors must be installed, a front-end system will be placed, e.g. in the turbine nacelle, at the bottom of the meteorological mast or in the turbine tower base.

For each sensor, a dedicated signal conditioning & analog-to-digital-conversion module will be installed in the front-end. Up to a maximum of 16 sensors can be connected to a front-end. These sensors can be strain gauges, rotary encoders, anemometers, wind vanes, temperature sensors, accelerometers, etc.

A special module has been developed to interface with the ECN telemetric system. With this system it is possible to measure up to 12 signals from the turbine rotor.

Optical fibers connect all front-end systems to the host computer, completing the data-acquisition system.

A maximum of 16 front-ends can form one data-acquisition system, each front-end at a maximum of 15 kilometers away from the host computer.




Example of a simple configuration

**<u>System description</u>**

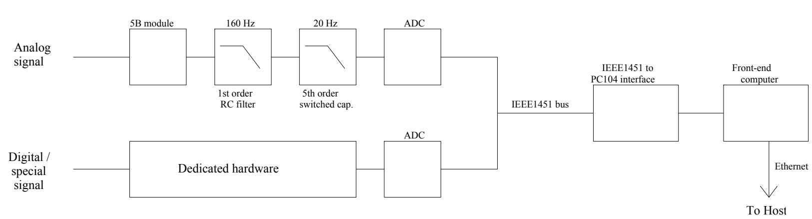
The main task of the data-acquisition system is performed in the signal conditioning & analog-to-digital-conversion modules. One sensor is connected to each dedicated analog or digital input module.

For 'standard' signals, a standard 5B module converts the sensor signal to a +/- 5V signal, after which the signal passes a 20 Hz low-pass filter to avoid aliasing.

For non-standard signals like the ECN 12-channel telemetric system, a dedicated signal conditioning module has been developed. For future sensor types, other dedicated modules can be developed.

Behind the anti-aliasing filter the signal is digitised (12 bits) with a sample rate of 128 Hz. The 128 Hz output of the module complies to the IEEE 1451 data communications standard.

The PC104 based computer in the front-end system collects all signal data using a dedicated IEEE 1451-to-PC104 interface, and adds a time stamp. The connected host PC collects the data from a maximum of 16 front-end systems, and stores the data on disk.




Data flow in the front-end system

**DANTE measurement system**

Most specifications of the ECN DANTE measuring system can be found in the included leaflet. More specifications of a frontend system are:

| | |
|---|---|
| System size | width: 54 cm, height 32 cm, depth 48 cm |
| System weight | ca. 20 kg |
| Required power | 230 V AC, less than 30 Watt |
| | |
| System output | fiber-optic Ethernet (single mode fiber) |

# Appendix D : Used Dante Frontend Modules


Dante Frontend modules come in several types; in the picture a 0..100 Hz frequency input moudle is shown. In the following text a short description of all applied Dante module types is given.

1. Module: Frequency 0..1000 Hz

This module measures the frequency of one connected input signal (pulses) up to 1000 Hz. The output value is in Hz. The module is used for measuring the Thies First Class Advanced anemometer signals.

2. Module: Thies First Class Windvane

This module receives the RS422 input signal from a Thies First Class windvane. The output value is in degrees.

4. Module: Vaisala HMP155D RH&T sensor.

The HMP155D RH&T sensor sends its output data (Relative Hu,idity and Temperature) via an RS422 serial line. The data is being read by this module, and the module converts the data string into two separate signals: Temperature (unit degrees C) and Relative Humidity (unit %).

5. Module: Vaisala PTB210 air pressure sensor

The Vaisala PTB210 air pressure sensor sends its measured air pressure to the module via a serial RS422 output. The serial data is read by the module, and converted to an air pressur in hPa.

6. Module: Metek USA-1 sonic anemometer

The Metek USA-1 Sonic anemometer sends 4 signals across a serial line: the wind speed in 3 directios (X, Y, Z) and a status signals indicating the validity of the signal values. The module receives the input string and converts the string into the 4 separate signals. The wind speed signals are expressed in m/s and the status signal is a unity value.

7. Module: Thies Distro laser precipitation sensor module

The Thies Distro sensor sends a number of signals to the module via an RS422 connection. The Dante module converts the input stream to 7 different signals:

Precipitation
Specifies whether there is precipitation (100) or not (0).

Synop code
Specifies the kind of precipitation, if any :

| Synop Code | Precipitation type |
|---|---|
| | |
| 51, 52, 53 | Drizzle (also freezing) |
| 58, 59 | Drizzle with rain |
| 61, 63, 65 | Rain (also freezing) |
| 68, 69 | Rain and/or Drizzle with snow |
| 71, 73, 75 | Snow |
| 87, 88 | Ice pellets, Soft hail |
| 77 | Snow grains (also ice prisms), Ice crystals / needles |
| 89, 90 | Hail |

Amount
Amount of precipitation fallen after last sensor reset [mm].

Intensity
Intensity of precipitation in mm/min

OK
Specifies whether the sensor is OK (0% .. 100%)

Quality
Specifies the quality of the measurement at the moment (0% .. 100%)

Visibility
Specifies the current visibility distance in m (0 .. 99999)

# Appendix E : Frontend configurations

| Measured signals Frontend 1 | | | | | |
|---|---|---|---|---|---|
| N | level | Signal | Short name | unit | freq [Hz |
| 1 | 92 m | wind speed 92m, 180 deg | mmij_ws92_180 | m/s | 4 |
| 6 | 87 m | wind direction, 240 deg | mmij_wd87_240 | deg | 4 |
| 15 | 85 m | wind speed X, 240 deg | mmij_WsXSon85_240 | m/s | 4 |
| 16 | 85 m | wind speed Y, 240 deg | mmij_WsYSon85_240 | m/s | 4 |
| 17 | 85 m | wind speed Z, 240 deg | mmij_WsZSon85_240 | m/s | 4 |
| 18 | 85 m | Sonic Status, 240 deg | mmij_SSon85_240 | - | 4 |
| 22 | 58,5 m | wind speed, 120 deg | mmij_ws58_120 | m/s | 4 |
| 25 | 58,5 m | wind direction, 120 deg | mmij_wd58_120 | deg | 4 |
| 27 | 27 m | wind speed, 0 deg | mmij_ws27_0 | m/s | 4 |
| 30 | 27 m | wind direction, 0 deg | mmij_wd27_0 | deg | 4 |
| 33 | 21 m | precipitation, left | mmij_prec21_l | 1/0 | 4 |
| 35 | 21 m | temperature | mmij_tair21 | °C | 4 |
| 36 | 21 m | relative humidity | mmij_rh21 | % | 4 |

| Measured signals Frontend 2 | | | | | |
|---|---|---|---|---|---|
| N | level | Signal | Short name | unit | freq [Hz |
| 2 | 92 m | wind speed 92m , 300 deg | mmij_ws92_300 | m/s | 4 |
| 4 | 87 m | wind direction, 0 deg | mmij_wd87_0 | deg | 4 |
| 7 | 85 m | wind speed X, 0 deg | mmij_WsXSon85_0 | m/s | 4 |
| 8 | 85 m | wind speed Y, 0 deg | mmij_WsYSon85_0 | m/s | 4 |
| 9 | 85 m | wind speed Z, 0 deg | mmij_WsZSon85_0 | m/s | 4 |
| 10 | 85 m | Sonic Status, 0 deg | mmij_SSon85_0 | - | 4 |
| 23 | 58,5 m | wind speed, 240 deg | mmij_ws58_240 | m/s | 4 |
| 26 | 58,5 m | wind direction, 240 deg | mmij_wd58_240 | deg | 4 |
| 28 | 27 m | wind speed, 120 deg | mmij_ws27_120 | m/s | 4 |
| 31 | 27 m | wind direction, 120 deg | mmij_wd27_120 | deg | 4 |
| 34 | 21 m | precipitation,right | mmij_prec21_r | 1/0 | 4 |
| 37 | 21 m | air pressure | mmij_pair21 | hPa | 4 |

| Measured signals Frontend 3 | | | | | |
|---|---|---|---|---|---|
| N | level | Signal | Short name | unit | freq [Hz |
| 3 | 90 m | air pressure | mmij_pair90 | hPa | 4 |
| 5 | 87 m | wind direction, 120 deg | mmij_wd87_120 | deg | 4 |
| 11 | 85 m | wind speed X, 120 deg | mmij_WsXSon85_120 | m/s | 4 |
| 12 | 85 m | wind speed Y, 120 deg | mmij_WsYSon85_120 | m/s | 4 |
| 13 | 85 m | wind speed Z, 120 deg | mmij_WsZSon85_120 | m/s | 4 |
| 14 | 85 m | Sonic Status, 120 deg | mmij_SSon85_120 | - | 4 |
| 19 | 90 m | temperature | mmij_tair90 | °C | 4 |
| 20 | 90 m | relative humidity | mmij_rh90 | % | 4 |
| 21 | 58,5 m | wind speed, 0 deg | mmij_ws58_0 | m/s | 4 |
| 24 | 58,5 m | wind direction, 0 deg | mmij_wd58_0 | deg | 4 |
| 29 | 27 m | wind speed, 240 deg | mmij_ws27_240 | m/s | 4 |
| 32 | 27 m | wind direction, 240 deg | mmij_wd27_240 | deg | 4 |

# Appendix F : Data Sheets

## F.1 Thies First class advanced 4.3351.xx.140 cup anemometer

## Wind Sensor >>first class advanced<<

**For site assessment and measurement of power performance of wind energy power plants.**
**Class A, B and S accredited according to IEC 61400-12-1 (2005-12) ISO 17713-1, Measnet; Classcup**

- **High quality anemometer class 0.5**
- **Optimised dynamic behaviour even at high turbulence intensity**
- **minimum over-speeding**
- **excellent linearity r > 0,99999**
- **low power**
- **high survival speed**
- **excellent price performance ratio**

**patented design EP 1 489 427, DE 103 27 632, EP 1 398 637**

**1.Application**
The wind transmitter is designed for the acquisition of the horizontal component of the wind speed in the fields of meteorology and environmental measuring technology. The measuring value is available at the outputs in digital form It can be transmitted to display instruments, recording instruments, dataloggers, as well as to process control systems. For winter operation the instrument is equipped with an electronically regulated heating, which guarantees a smooth running of the ball bearings, and prevents the shaft and slot from icing-up.

**2. Construction and Mode of Operation**
A low-inertia cup star with 3 cups, made of carbon-fibre-reinforced plastic, is set into rotation by the wind. The rotation is scanned opto-electronically, and is converted into a square wave signal. The frequency of this signal is proportional to the number or rotations. Depending on the supply voltage, the output signal ranges between maximal output voltage and ground or a potential (life-zero), lifted by approx. 1,2 V. The supply of the electronics can be done by DC-voltage of 3,3 V up to 42 V at a very low current consumption. An AC- or DC-voltage of 24 V is intended for the separate supply of the optional heating. In all probability, the heating guarantees a trouble-free function of the Wind Transmitter First Class even under extreme meteorological icing-conditions.
The outer parts of the instrument are made of corrosion-resistant anodised aluminium. Highly effective labyrinth gaskets and O-rings protect the sensitive parts inside the instrument against humidity and dust. The instrument is mounted onto a mast tube; the electrical plug-connection is located in the transmitter shaft.

**Order-No. 4.3351**
**.00.xxx** with heating
**.10.xxx** without heating
**.xx.000** frequency output: 0,3…75 m/s – 1082 hz
**.xx.140** analogue output: 0,3…75 m/s – 0…20 mA
**.xx.141** analogue output :0,3…75 m/s – 4… 20 mA
**.xx.161** analogue output :0,3 …75 m/s – 0…10 V

## F.2 Metek USA-1 Sonic anemometer

**Specifications METEK Ultrasonic Anemometer USA 1**

| | |
|---|---|
| Ultrasonic Anemometer USA-1 | |
| Operation mode | Raw data or averages |
| Variables | Standard sensor: x, y, z and T -or- vel, dir, z and T -or- Propagation times |
| Measuring ranges | x, y, z, vel 0 ... 60 m/s<br>Direction 0 ... 360 °<br>Temperature -40 ... 60 ° |
| Sampling rate | Standard 0.1 ... 25 Hz (average data)<br>Fast version 0.1 ... 50 Hz (average data) |
| Analog input channels (option, 12 Bit or 16 Bit) | 2 x Pt-100 -50 ... +50 °C<br>6 x Voltage -10 ... +10 V -or- -5 ... +5 V<br>2 x TTL counter |
| Internal datalogger (option) | Storage capacity:<br>Standard USA-1 16383 datasets<br>USA-1 with turbulence extension 2047 datasets<br>FIFO organisation, direct connection to modem possible |
| Power supply | Without heating 9 ... 36 VDC, 2.5 W<br>With heating 24 VDC, max 55 W |
| Data transfer | RS 232<br>optional RS 422<br>optional Analog, 12 Bit 0 ... 10 V -or- 0 ... 5 V -or- 0 ... 2.5 V number range adjustable |
| Cable length | Data cable RS 232 12 m (standard)<br>Data cable RS 422 12 m (standard) extension up to 1200 m available<br>Power cable 12 m (standard) extension available |
| Dimensions | Sensor head (diameter x height) 320 mm x 240 mm<br>Length of sound paths 175 mm<br>Electronic unit 120 mm x 120 mm x 90 mm<br>Electronic / sensor head Combined -or- separated (optional, max.8 m distance)<br>Two different sensor heads (see pictures) |
| Weight | approx. 3.5 - 7.0 kg (depends on configuration) |
| All components waterproof (IP65) | |
| - All specifications are subject to change without notice - | |

## F.3 Thies First class Windvane anemometer

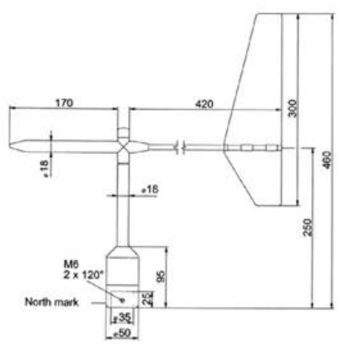
Note: The wind vane depicted here is the Thies First Class wind vane with a potentiometer output. The RS485 output connection is shown below it.

Ammonit

# Thies Wind Vane First Class

**Order-No: P 6200H - heatable**

- Robust wind vane for highest demands
- Potentiometric wind direction transmitter
- High quality potentiometer 0...2 k Ohm
- Full Range 0 ... 360°, no North gap




### Measurement principle

With the help of a potentiometer the physical property is converted into an analogue resistor output signal.

At zero the transducer has to pass the „north transition" between the margins of zero and 2 kΩ. Wind direction signal conditioning and data processing in all Ammonit data acquisition systems carefully pays attention to this speciality.

The wind vane is equipped with an electronically regulated heating system in order to prevent ice from the bearings. To use this heating the connection cable must have additional cores and you should provide a sufficient power supply (mains connection).

### Mounting

Mount the transmitter onto a pipe socket of R1" (Ø 33,5 mm) and a length of at least 25 mm. The pipe socket must have an internal diameter of at least 25 mm. The wind transmitter will be connected electrically with a plug from below. After connection the wind transmitter is put onto the pipe socket, and is fixed at the mast or hanger by means of 2 threaded pins (female hexagon 3 mm).

To avoid damage due to lightning, a protection rod and proper grounding of all metal parts is to be recommended.

### Maintenance

When mounted properly, the wind vane operates almost maintenance-free. Dust or dirt may clog the space between the rotating parts and the shaft. Therefore you should check for plausibility of measurement results at regular terms and clean the device if necessary. In true long-term operation (years) the bearings may be subject to wear and tear showing delayed start-up behaviour or even stand-still of the vane. Should such a defect occur we would recommend that you return the instrument for repairs.

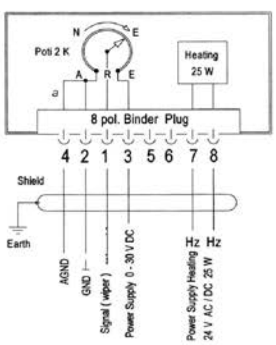
page 1 / 2

Ammonit Gesellschaft für Messtechnik mbH;
Wrangelstrasse 100; D-10997 Berlin; T: +49-30-600 31 88-0; E: info@ammonit.com; W: www.ammonit.com

Ammonit

## Specification Wind Vane First Class P6200H:

| | |
|---|---|
| Measuring range: | 0 ... 360 ° without north gap |
| Measuring accuracy: | 0.25% [1°] |
| Survival speed | 85 m/s to 0.5 h [without damages] |
| Ambient temperature: | -50 to +80°C<br>All occuring conditions of relative humidity including dew moistening |
| Measuring principle: | Potentiometer 2 kOhm |
| Electr. Output: | Voltage Us: 0 ...30 V DC, max. 20 mA<br>Current: < Supply current divided with potentiometric resistance |
| Linearity: | 0.25% [1°] |
| Starting threshold: | < 0,5 m/s at 10° amplitude |
| Delay distance: | < 1 m [acc. to ASTM D 53666 – 96] |
| Damping ratio: | D > 0,25 [acc. to ASTM D 53666 – 96] |
| Quality factor: | K > 1 |
| Heating: | Surface temperature of housing neck > 0 °C at 20 m/s up to –10 °C air temperature, at 10 m/s up to –20 °C applying Thies icing standard 012002 on the housing neck. Heating regulated with temperature sensor. |
| Electr. Output Potentiometer: | Voltage: 0 - 24 V DC [galvanic separation from casing]<br>Current: < 2,5 mA, transfer from 0 - 360° and 360 - 0° |
| Electr. Output Heating: | Voltage: 24 V AC/DC [galvanic separation from casing]<br>Capacity: 25 W |
| Connection: | 8-pole plug |
| Mast fixture: | Mounting onto mast 1", e. g. DIN 2441<br>1½ " with separate adapter [optional] |
| Weight: | approx. 0,7 kg |
| Protection: | IP 55 [DIN 40050]<br>EMV EN 61000-6-2:2001 EN 55022:2001, Class B |
| Exchange of bearings | Recommended approx. every 24 months |
| Manufacturer: | Thies |




| Connection | | Color of cores | Connector data logger <plug> 12-pol. | |
|---|---|---|---|---|
| | | | Wind vane 1 | Wind vane 2 |
| 4 | a | white | G | M |
| 2 | A | brown | E | M |
| 1 | R | green | F | J |
| 3 | E | yellow | D | K |
| 5 | | n.c. | | |
| 6 | | n.c. | | |
| 7 | Heating 1 | grey, rosa | | |
| 8 | Heating 2 | blue, red | | |

Cable type without heating cores: LiYCY 4 x 0,25 $mm^2$
Cable type with heating cores: LiYCY 8 x 0,25 $mm^2$

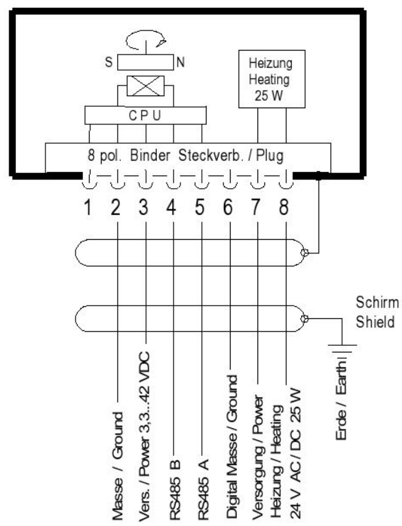
page 2 / 2

Ammonit Gesellschaft für Messtechnik mbH;
Wrangelstrasse 100; D-10997 Berlin; T: +49-30-600 31 88-0; E: info@ammonit.com; W: www.ammonit.com

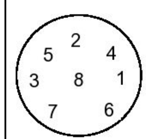
## 6 Connecting Diagram

Order-No.

4.3150.00.400
4.3150.10.400*




View on the soldered joint of the counter plug




- *Order-no 4.3150.10.xxx (w/o heating) PIN 7 and 8 are not connected

| Contact | Name | Function |
|---|---|---|
| 1 | ------ | Do not apply |
| 2 | GND | Supply ground |
| 3 | +Vcc | Supply 3.3 V ... 42 V DC |
| 4 | Serial B | RS 485 (B), serial- synchron Clock |
| 5 | Serial A | RS 485 (A), serial- synchron Clock |
| 6 | DGND | Digital ground |
| 7 | HZG | Heating supply:<br>Voltage: 24 V AC/DC<br>Power: 25 W |
| 8 | | |
| *Order-no 4.3150.10.xxx (w/o heating) PIN 7 and 8 are not connected | | |



*RS485 connection Thies First Class Windvane*

## F.4 Vaisala PTB210 Air Pressure Sensor

# PTB210 Series Digital Barometers

### APPLICATIONS

- Weather stations
- Data buoys and ships
- Airports
- Agrology
- Laser interferometers
- Engine test benches

### SEVERAL PRESSURE RANGES

The PTB210 series digital barometers are designed for various pressure ranges. The barometers are available with two basic configurations: serial output for 500...1100 hPa and 50...1300 hPa and analog output with different scalings between 500...1300 hPa for 0...5 V and 0...2.5 V.

### FOR HARSH ENVIRONMENTS

The PTB210 series barometers offer an excellent solution for outdoor installations. They are designed to operate in a wide temperature range, and the electronics housing provides IP65 standardized protection against sprayed water. The rugged corrosion-resistant housing in combination with the PTB210's compact size facilitates easy installation and insures a long lifetime of service.

The PTB210 can be directly integrated with Vaisala's static pressure head. This combination offers accurate measurement in all wind conditions.

### ACCURATE AND STABLE MEASUREMENT

All the PTB210 barometers are digitally adjusted and calibrated by using electronic working standards. A higher accuracy barometer, that is fine tuned and calibrated against a deadweight tester, is available for the 500...1100 hPa pressure range.


The PTB210 barometers use the BAROCAP® silicon capacitive absolute pressure sensor developed by Vaisala. The BAROCAP® sensor provides excellent hysteresis and repeatability characteristics and has an outstanding temperature and long-term stability. All PTB210 barometers are delivered with a factory calibration certificate.

## TECHNICAL DATA PTB210

### OPERATING RANGE

| | |
|---|---|
| Pressure range (order specified) | |
| serial output | 500...1100 hPa |
| | 50...1300 hPa |
| analog output | 500...1300 hPa |
| | 800...1060 hPa |
| | 600...1060 hPa |
| | 900...1100 hPa |
| Operating temperature range | -40...+60°C |
| Humidity range | non condensing |

### ACCURACY

**Serial output** (units in hPa)

| Pressure range | 500...1100 | | 50...1300 |
|---|---|---|---|
| | **Class A** | **Class B** | |
| Non linearity* | ± 0.10 | ± 0.15 | ± 0.20 |
| Hysteresis* | ± 0.05 | ± 0.05 | ± 0.10 |
| Repeatability* | ± 0.05 | ± 0.05 | ± 0.10 |
| Calibration uncertainty** | ± 0.07 | ± 0.15 | ± 0.20 |
| Total accuracy (20°C)*** | ± 0.15 | ± 0.20 | ± 0.35 |
| Temperature dependence (-40...+60°C)**** | ± 0.20 | ± 0.20 | ± 0.40 |
| Total accuracy*** (-40...+60°C) | ± 0.25 | ± 0.30 | ± 0.50 |
| Long term stability (hPa/year) | ± 0.10 | ± 0.10 | ± 0.20 |

**Analog output**

| | |
|---|---|
| Non linearity* | ± 0.20 hPa |
| Hysteresis* | ± 0.05 hPa |
| Repeatability* | ± 0.05 hPa |
| Calibration uncertainty** | ± 0.15 hPa |
| Total accuracy (20°C)*** | ± 0.30 hPa |
| Temperature dependence (-40...+60°C)**** | ± 0.50 hPa |
| Total accuracy*** (-40...+60°C) | ± 0.60 hPa |
| Long term stability | ± 0.10 hPa/year |

* Defined as the ±2 standard deviation limits of end-point non-linearity, hysteresis error or repeatability error.

** Defined as ±2 standard deviation limits of inaccuracy of the working standard including traceability to NIST.

*** Defined as the root sum of the squares (RSS) of end-point non-linearity, hysteresis error, repeatability error and calibration uncertainty at room temperature.

**** Defined as ±2 standard deviation limits of temperature dependence over the operating temperature range.

### GENERAL

(* Factory setting)

**Serial output**

| | |
|---|---|
| Current consumption | |
| normal mode | < 15 mA* |
| power down mode | < 0.8 mA |
| shutdown mode | 0.2 mA |
| Shutdown | ON/OFF |
| Settling time at power up | 2 s |
| Serial I/O (factory setting *) | RS232C |
| | RS232C /TTL (optional) |
| | RS485, non isolated (optional) |
| parity | none, even*, odd |
| data bits | 7*, 8 |
| stop bits | 1*, 2 |
| Baud rate | 300, 600, 1200, 2400, 4800, 9600*, 19200 |
| Response time | 1 s* |
| Resolution | 0.01 hPa (1 measurement/s) |
| | 0.05 hPa (20 measurements/s) |

**Analog output**

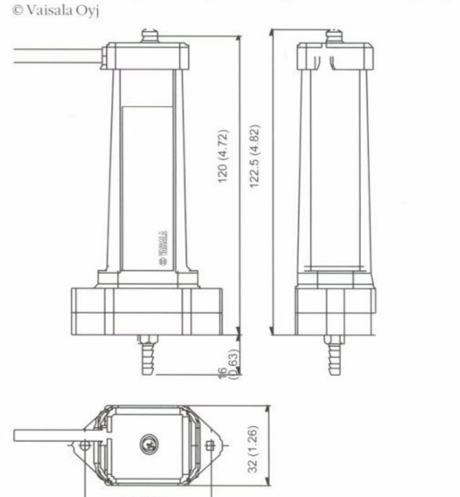
| | |
|---|---|
| Outputs | 0...5 VDC, 0...2.5 VDC (order specified) |
| Current consumption | |
| normal mode | < 8 mA |
| shutdown mode | 0.2 mA |
| Shutdown | ON/OFF |
| Response time | 500 ms |
| Resolution | 300 µV |
| Measurement rate | 3 measurement/s |

**All models**

| | |
|---|---|
| Supply voltage | (reverse polarity protected) 8...18 VDC |
| Max. pressure | 5 000 hPa abs. |
| Pressure connector | M5 (10-32) internal thread |
| Pressure fitting | barbed fitting for 1/8" I.D. tubing |
| Housing | |
| electronics | IP65 |
| sensor | IP53 |
| Housing material | PC plastic |
| Supply/output cable length | 1, 2, 3, 5 or 10 m |
| Weight | |
| Instrument | 110 g |
| Cable | 28 g/m |

Fully electromagnetically compatible according to standards EN50081-1 and EN 50082-1.

BAROCAP® is a registered trademark of Vaisala.
Specifications subject to change without prior notice.


Dimensions in mm (inch)

Vaisala Oyj
P.O. Box 26
FIN-00421 Helsinki
FINLAND
Tel: (+358-9) 89 491
Fax: (+358-9) 89 49 485
E-mail: industrialsales@vaisala.com
Homepage: www.vaisala.com

## F.5 Vaisala HMP155 digital RH&T sensor

VAISALA www.vaisala.com

# HMP155 Humidity and Temperature Probe

*HMP155 with a new, stable HUMICAP®180R sensor and an additional temperature probe.*

### New probe for reliability

The new Vaisala HUMICAP® Humidity and Temperature Probe HMP155 provides reliable humidity and temperature measurement.

### Long-term stability

The HMP155 has a new generation Vaisala HUMICAP®180R sensor that has excellent stability and withstands well harsh environments. The probe structure is solid and the sensor is protected with a sintered teflon filter, which gives maximum protection against liquid water, dust, and dirt.

### Warmed probe and high humidity environment

Measuring humidity reliably is challenging in environments where humidity is near saturation. Measurements may be corrupted by fog, mist, rain, and heavy dew. A wet probe may not give an accurate measurement in the ambient air.

This is an environment to which Vaisala has designed a patented, warmed probe for reliable measuring. As the sensor head is warmed continuously, the humidity level inside it stays below the ambient level. Thus, it also reduces the risk of condensation forming on the probe.

### Fast temperature measurement

What's more, with its fast response time, the additional temperature probe for the HMP155 is ideal for measurement in environments with changing temperatures.

### Features/Benefits

- Vaisala HUMICAP®180R sensor - superior long-term stability
- Optional warmed humidity probe
- Plug-and-play
- Chemical purge
- USB connection for service use
- Installation kits for DTR13 and DTR502 radiation shields and also for a Stevenson screen
- Weather-proof housing IP66
- New, fast temperature probe
- Different output possibilities: voltage, RS-485, resistive Pt100
- Applications: meteorological applications, aviation and road weather, instrumentation

### Long lifetime

Protecting the sensor from scattered and direct solar radiation, and precipitation will increase its lifetime. Thus, Vaisala recommends installing the HMP155 in one of the following radiation shields: DTR503, DTR13, or a Stevenson screen.

### Easy maintenance

The probe can be calibrated using a pc with a USB cable, with the push buttons, or with the MI70 indicator.

# Technical data

## Performance

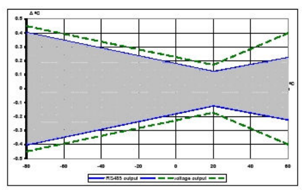
| | |
|---|---|
| RELATIVE HUMIDITY | |
| Measurement range | 0 ... 100 %RH |
| Accuracy (incl. non-linearity, hysteresis and repeatability) at | |
| +15 ... +25 °C (+59 ... +77 °F) | ±1 %RH (0 ... 90 %RH) |
| | ±1.7 %RH (90 ... 100 %RH) |
| -20 ... +40 °C (-4 ... 104 °F) | ±(1.0 + 0.008 x reading) %RH |
| -40 ... -20 °C (-40 ... -4 °F) | ±(1.2 + 0.012 x reading) %RH |
| +40 ... +60 °C (+104 ... +140 °F) | ±(1.2 + 0.012 x reading) %RH |
| -60 ... -40 °C (-76 ... -40 °F) | ±(1.4 + 0.032 x reading) %RH |
| Factory calibration | ±0.6 %RH (0 ... 40 %RH)* |
| uncertainty (+20 °C /+68 °F) | ±1.0 %RH (40 ... 97 %RH)* |
| * Defined as ±2 standard deviation limits. Small variations possible, see also calibration certificate. | |
| Recommended humidity sensor | HUMICAP®180R(C) |
| Response time at +20 °C in still air with a sintered PTFE filter | |
| 63 % | 20 s |
| 90 % | 60 s |
| TEMPERATURE | |
| Measurement range | -80 ... +60 °C (-112 ... +140 °F) |
| Accuracy with voltage output at | |
| -80 ... +20 °C | ±(0.226 - 0.0028 x temperature) °C |
| +20 ... +60 °C | ±(0.055 + 0.0057 x temperature) °C |
| passive (resistive) output | |
| according to IEC 751 1/3 Class B | ±(0.1 + 0.00167 x ltemperaturel)°C |
| RS485 output | |
| -80 ... +20 °C | ±(0.176 - 0.0028 x temperature) °C |
| +20 ... +60 °C | ±(0.07 + 0.0025 x temperature) °C |
| Accuracy over temperature range (opposite) | |
| Temperature sensor | Pt100 RTD 1/3 Class B IEC 751 |
| Response time with additional temperature probe in 3 m/s air flow | |
| 63 % | <20 s |
| 90 % | <35 s |
| OTHER VARIABLES | |
| dewpoint/frost point temperature, wet bulb temperature, mixing ratio | |

## General

| | |
|---|---|
| Operating temperature range | -80 ... +60 °C (-112 ... +140 °F) |
| Storage temperature range | -80 ... +60 °C (-112 ... +140 °F) |
| Connection | 8-pin male M12 connector |
| Connection cables | 3.5, 10, and 30 m |
| Cable material | PUR |
| Wire size | AWG26 |
| Service cables | USB connection cable |
| | MI70 connection cable |
| Additional T probe cable length | 2 m |
| Housing material | PC |
| Housing classification | IP66 |
| Sensor protection | sintered PTFE |
| Weigth (probe) | 86 g |
| Electromagnetic compatibility: Complies with the EMC standard EN61326-1, Electrical equipment for measurement control and laboratory use - EMC requirement for use in industrial locations | |

## Inputs and outputs

| | |
|---|---|
| Operating voltage | 7 ... 28VDC* |
| *Note: minimum operating voltage 12 V with 0 ... 5 V output and 16 V with 0 ... 10 V output, probe heating, chemical purge or XHEAT. | |
| Outputs | |
| voltage output | 0 ... 1 V, 0 ... 5 V, 0 ... 10 V |
| resistive Pt100 (4-wire connection) | |
| RS485 | |
| Average current consumption (+15 VDC, load 100 kOhm) | |
| 0 ... 1 V output | <3 mA |
| 0 ... 10 V output | +0.5 mA |
| RS485 | <4 mA |
| during chemical purge | max. 110 mA |
| with warmed probe | max. 150 mA |
| Settling time at power-up | |
| voltage output | 2 s |
| RS485 | 3 s |



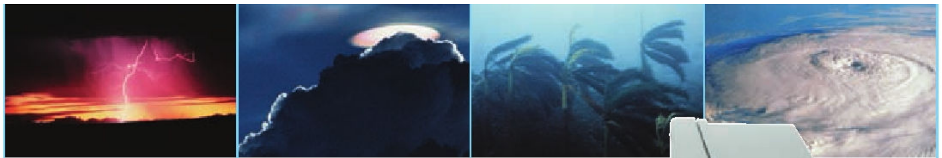

VAISALA

For more information, visit www.vaisala.com or contact us at sales@vaisala.com



CE

## F.6 Thies Disdro Laser precipitation monitor



### Laser Precipitation Monitor

5.4110.xx.xxx

### Technical Data

| | |
|---|---|
| **Priciple of operation** | Laser 785 nm max. 0.5 mW<br>Optical power, laser class 1M |
| **Measuring area** | 46 cm² (23.0 x 2.0 cm) |
| **Distrometer** | |
| Classification | 440 classes (22 diameter *20 speed) |
| **Precipitation** | |
| Particle size | 0.16 ... › 8 mm |
| Particle speed | 0.2 ... 20 m/s |
| Distinction of<br>Precipitation kinds:<br>drizzle, rain, hail, snow | › 97% compared with<br>synopt. Observer |
| Minimum intensity | 0.005 mm/h drizzle |
| Maximum intensity | 250 mm/h |
| Visibility precipitation | MOR 0 ... 99.999 m |
| **Weather codes** Synop | $w_a w_a$ 4680, ww 4677 |
| Metar | 4678 |
| **Radar reflectivity** | Z = -9.9 ... 99.9 dBZ |
| **Data output** | RS 485 1200 ... 115200 Bd.<br>Full duplex, half-duplex<br>2 opto-couplers 24 V DC, 1 mA<br>for precipitation amount pulses<br>(resolution 0.1, 0.01 or 0.005 mm)<br>rsp. frequency for kind of precipitation |
| **Optional Inputs** | PT100, 0 - 1 V, 0 - 1000 Hz<br>Serial synchronous |
| **Ambient temperature** | -40 ... +70 °C; 0 ... 100% r. Hum.<br>option: -60 ... +70 °C; 0 ... 100% r. Hum. |
| **Protection** | IP 65 |
| **Mounting** | Mast 48 mm ... 102 mm; 1.9 ... 4 inch |
| **Power supply** | 24 VAC/DC 750 mA, alternatively<br>230 V AC or 115 V AC<br>incl. standard heater<br>protection against interchanging of wires |
| **Optionally** | 12 V DC model |
| **Add. heater** | 230 VAC/150 VA |
| **Housing** | Al die-cast, stainless steel<br>(270 x 170 x 540) mm |
| **weight** | 4.8 kg<br>6.5 kg (Option. Add. heater) |
| **Accessories** | Software for graphic presentation<br>and analysis for Windows based<br>systems: WIN 98, 2000, XP<br>9.1700.99.000<br>PC program LNM view |

Thies CLIMA

**ADOLF THIES GMBH & CO KG**
Meteorology - Environmental Technology
Box 3536 + 3541
D-37025 Göttingen
Phone +49 551 7 90 01 –0
Fax +49 551 7 90 01 –65
E-Mail info@thiesclima.com
www.thiesclima.com

TÜV CERT
DIN EN ISO 9001
Certificate: 08/100/1688

010287/10/05

## F.7 Zephir 300 Lidar

| Performance | ZephIR |
|---|---|
| Range(min) | 10metres |
| Range(max) | 200metres |
| Extended range | 300 metres |
| Probelength@10m | 0.07metres |
| Probe length @ 100m | 7.70 metres |
| Heights measured | 10 (user configurable) |
| Sampling rate | 50Hz |
| Averaging period | 1 second upwards (user configurable) |
| Scanning cone angle | 30° (other angles available) |
| Speed accuracy** | <0.5% |
| Speed range | <1m/s to 70m/s |
| Direction accuracy | <0.5° |

| Operations | ZephIR |
|---|---|
| Temp range (min)<br>Temp range (max) | -40°C<br>+ 50°C |
| Powre consumption | 69 Watts |
| Power input DC | 12V |
| Weight | 55kg |

| Data | ZephIR |
|---|---|
| 10 minute averaged data | 80K/day |
| 3 second data | 3MB/day |

| Safety | ZephIR |
|---|---|
| Laser classification | Class 1 |
| Eye safety standard | IEC 60825-1 |
| IP Rating | IP67 (excl. external fans) |
| EMC compliance | EN55022 Class A, EN61326 Industrial,<br>FCC Radiated & conducted Emissions |

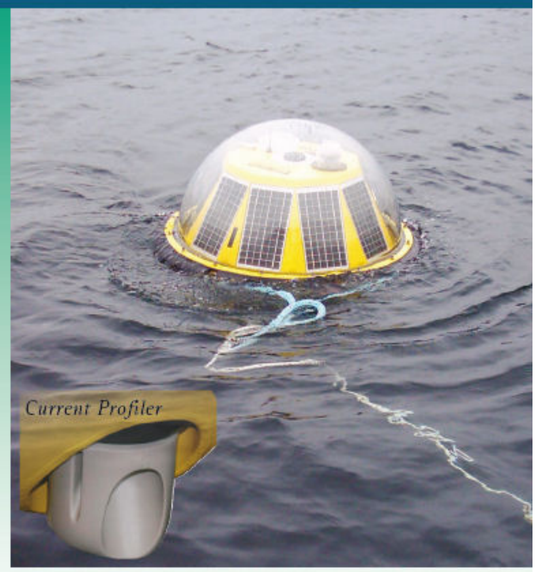
## F.8 Triaxys Wave Buoy

AXYS TECHNOLOGIES INC.

# TRIAXYS™ WITH CURRENTS

### FEATURES & BENEFITS:

- Integrated current profiling
- Spin and impact resistant
- Reliable operation in extreme weather or geographical locations
- 5 year rechargeable battery life
- Supports any telemetry
- >5 years of data storage capacity
- Continuous wave sampling
- WaveView data display software




*The TRIAXYS™ with Currents Buoy was developed to meet the demand for a combined wave and current measuring solution that overcomes the limitations inherent to seabed-mounted instrumentation.*

TRIAXYS™

WITH CURRENTS

*A Revolution in Wave and Current Measurement*

# TRIAXYS™ WITH CURRENTS

The TRIAXYS™ with Currents Buoy measures directional waves and 3D currents accurately and precisely. The wave sensor unit is comprised of three accelerometers, three rate gyros, a Fluxgate compass and the proprietary TRIAXYS™ Processor. Current data is obtained from a fully integrated current profiler. The economical and rugged TRIAXYS™ with Currents Buoy can withstand the rigors associated with deployment and recovery operations including, impact shock, spinning and temporary submergence.

The buoy's modular components are easily accessed by removing the impact resistant polycarbonate clear dome. The buoy is solar powered with rechargeable lead acid batteries to minimize operating costs. The buoy's spun stainless steel corrosion resistant hull has a high strength to weight ratio and provides secure mooring and lifting points.

The heart of the TRIAXYS™ with Currents Buoy is developed from the AXYS WatchMan500™, which integrates sensor systems and provides onboard data processing, data logging, telemetry, and diagnostic/set-up routines. Full directional wave spectra are computed by the CHC maximum entropy method. The onboard computer uses an iterative algorithm based on Fast Fourier Transform analysis to solve the full non-linear equations of motion in six degrees of freedom, as measured by accelerometers and angular rate gyros.

The current profiler works equally well in typical ocean surface water and in the high sediment suspensions found near the coast or in rivers. A variety of head designs ensures optimal measurement conditions, regardless of deployment surroundings. The current profiler is insensitive to biofouling and has no moving parts.

The current profiler provides current speed and direction in up to 128 different layers of the water column. The system electronics integrates Doppler velocity with temperature, pressure, tilt, and compass sensors – all standard with each instrument. The system also has a built-in solid state recorder and batteries. State-of-the-art power management and miniaturized electronics combine in a compact single-canister design.

The removal of an external magnetic key activates the buoy. Set-up and communication takes place through the dome via the infrared port, eliminating the need to remove the dome. All the set-up parameters and buoy activity can be adjusted and monitored using this port, enabling easy field configuration and testing.

The data transmitted from the buoy include wave statistics, HNE (Heave, North and East Displacements), MeanDir (Wave Direction and energy as a function of frequency), directional and non-directional wave spectra, buoy configuration, status data, position, and WatchCircle™ alarm messages. All data is stored on the internal data logger, and wave and current profile data are displayed on AXYS WaveView software (included).


- **Telemetry Options**
  - VHF
  - INMARSAT D+
  - IRIDIUM
  - CDMA, GPRS (cellular)

## Specifications

- **Physical description**
  **Diameter:** 1.10m (43.5 inches) outside bumper
  0.91m (36 inches) hull
  **Weight (including four batteries):** 200 kg (440 lb)
  **Weight (excluding batteries):** 93 kg (205 lb)
  **Obstruction Light:** Amber LED source. Programmable flash sequence with three miles visibility.
- **Materials**
  **Hull:** stainless steel
  **Dome:** impact resistant polycarbonate
  **Solar Panel Assembly:** fiberglass over foam
  **Clamping ring:** stainless steel
- **Sensors/Processor**
  **Processor: WatchMan500™**
  **Water temperature:** Thermilinear composite network
  **Accelerometers:** Flexure suspension servo (Range ±2g)
  **Rate:** Piezoelectric vibrating gyroscope (Maximum angular velocity ±80°/s)
  **Compass:** Microprocessor controlled Fluxgate (Accuracy ±0.5°)
  **GPS:** 12 channel
- **Current Profiler**
  **Nortek Aquadopp 600KHz or 400KHz ADP**
  or
  **Monitor 600 KHz Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP)**
- **Power System**
  **Operational system voltage:** 11.0 to 19.6 VDC
  **Batteries:** 4 @ GNB SunLyte 5000X 12 Volt, 100 Amp hr
  **Solar Panels:** 10 @ 6 Watt
  **External On/Off Switch:** Turns buoy on when Magnetic Key is removed.

**Current Profiler Instrument Resolution/Accuracy**

| | Range | Resolution | Accuracy |
|---|---|---|---|
| Heave | ±20 m | 0.01 m | Better than 2% |
| Period | 1.6 to 30 seconds | 0.1 sec | Better than 2% |
| Direction | 0 to 360° | 3° | 3° |
| Currents | 0 - 10 m/s | 1 cm/s | ±10 cm/s |
| Water Temp. | -5 to +50°C | 0.1°C | ±0.5°C |


AXYS TECHNOLOGIES INC.

2045 Mills Road West, Sidney, British Columbia Canada V8L 5X2
Phone: +1(250) 655-5850 Fax: +1(250) 655-5856
E-mail: info@axys.com Website: www.axystechnologies.com

## F.9 ESP SATConnect system

**SATConnect**


**EuroSkyPark GmbH**
Telefon: +49 (0) 681 / 97617-200
Fax: +49 (0) 681 / 976172-290
Nell-Breuning-Allee 6
D-66115 Saarbrücken
info@euroskypark.com

 - - 1 - -

## Technical Data

| | |
|---|---|
| Power Supply: | 95 … 260 V AC, or<br>18 … 72 VDC |
| Power Consumption: | up to 30 W with DC, or<br>up to 35 VA with AC |
| Dimensions: | Width 482 mm (for 19"-installation), Height 89 mm (2 HE), Depth 250 mm |
| Weight: | ~ 3,5 kg |
| Operating temperature: | 0° … 40°C |
| Storage: | -20° … 70°C |
| Humidity: | 10 … 70%, noncondensing |

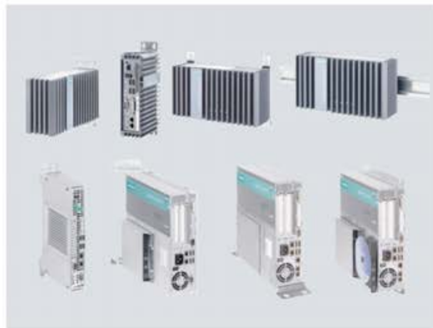
## F.10 Siemens MicroBox PC (IPC 627C)

### Flexible installation positions and mounting options

SIMATIC Box PCs are optimized for flexible implementation in confined spaces in the switching cabinet and directly at the machine:

- For easy installation and fast cabling, all the interfaces are accessible from one side
- Versatile mounting possibilities and installation positions with retention of assured characteristics, such as ambient temperatures up to 55 °C:
  - Mounting on standard rails without tools (IPC227D/427C)
  - Flexible wall mounting with interfaces above or below
  - Space-saving portrait mounting with a small footprint
  - Side mounting with the smallest space requirement

→ More details on page 48.



| | **IPC627C**<br>Maximum performance in a minimum of space with Intel Core processors | **IPC827C**<br>Maximum performance and expansion capability with Intel Core processors |
|---|---|---|
| **Available operating systems** (preinstalled and activated) | Windows 7 Ultimate (32 and 64-bit) / Windows XP Professional / Windows Embedded Standard 2009 | Windows 7 Ultimate (32 and 64-bit) / Windows XP Professional / Windows Embedded Standard 2009 |
| **Available memory media** | HDD 250, 500 GB; 2 x 250 GB; SSD 50 GB (SATA, SLC); RAID1, 2 x 250 GB; 1 x CFC up to 8 GB, second internal CFC up to 8 GB optional | HDD 250, 500 GB; 2 x 250 GB; SSD 50 GB (SATA, SLC); RAID1, 2 x 250 GB; 1 x CFC up to 8 GB |
| **Networking options** (onboard) | 2 x Gigabit Ethernet<br>1 x MPI/PROFIBUS (optional)<br>1 x PROFINET (3 ports, optional) | 2 x Gigabit Ethernet<br>1 x MPI/PROFIBUS (optional)<br>1 x PROFINET (3 ports, optional) |
| **Expandability with cards** | 2 x PCI or 1 x PCI and 1 x PCIe x16 | 3 x PCI, 1 x PCIe x4 and 1 x PCIe x16 |
| **Integrated retentive memory** | Battery-backed SRAM 2 MB, 128 KB of which usable for WinAC | |
| **Long-term availability** | | |
| Availability | 3 to 5 years | 3 to 5 years |
| Repair and spare parts service | Additional 5 years | Additional 5 years |
| **Industrial compatibility** | | |
| Shock/vibration | 5 g / 1g | 5 g / 1g |
| Ambient temperature during operation | 5 ... 55 °C | 5 ... 55 °C |
| **Options for increased system availability** | | |
| Mirror disk technology (RAID1) | ■ | ■ |
| Diagnostics software: DiagMonitor | ■ | ■ |
| Remote access (Intel AMT) | ■ | ■ |
| Backup software: Image & Partition Creator | ■ | ■ |

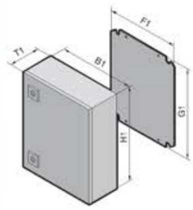
SIMATIC Box PC 21

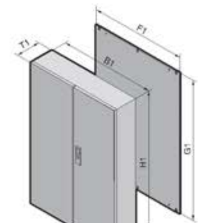
## F.11 Connection Boxes

Note: in the mast connection boxes 1007.500 have been used, in the container 1019.500

# Roestvaststaal

**Wandkasten AE**




B
1.6
Roestvaststaal

**Materiaal:**
Roestvaststaal
Kast en deur: roestvaststaal
Montageplaat: plaatstaal
Knevelsluiting: zinkspuitwerk, vernikkeld

**Oppervlak:**
Kast en deur:
in één richting geschuurd, korrel 240
Montageplaat: verzinkt

**Beschermklasse:**
IP 66 volgens EN 60 529/ 09.2000
bij AE 1001.XX0 – AE 1017.XX0, aan NEMA 4x wordt voldaan
IP 55 volgens EN 60 529/ 09.2000
bij AE 1018.XX0/AE 1019.XX0, aan NEMA 12 wordt voldaan

**Levering:**
Kast, deur(en) met ingeschuimde afdichting, 3-punts sluitsysteem, bij AE 1017.XXX en AE 1019.XXX, montageplaat

**Toelatingen:**
zie pagina 28.

**Detailtekening:**
zie pagina 1179.

| | | LE | | | | | | | | | | | Pagina |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Breedte** (B1) mm | | | 500 | 500 | 380 | 600 | 600 | 760 | 800 | 800 | 1000 | 1000 | |
| **Hoogte** (H1) mm | | | 500 | 500 | 600 | 600 | 760 | 760 | 1000 | 1200 | 1000 | 1200 | |
| **Diepte** (T1) mm | | | 210 | 300 | 210 | 210 | 210 | 300 | 300 | 300 | 300 | 300 | |
| Montageplaatbreedte (F1) mm | | | 449 | 449 | 334 | 549 | 549 | 704 | 739 | 740 | 939 | 940 | |
| Montageplaathoogte (G1) mm | | | 470 | 470 | 570 | 570 | 730 | 730 | 955 | 1155 | 955 | 1155 | |
| **Bestelnr. AE** | 1.4301 (AISI 304) met PU-afdichting | 1 st. | **1007.600** | **1013.600** | **1008.600** | **1010.600** | **1012.600** | **1014.600** | **1016.600** | **1017.600** | **1018.600** | **1019.600** | |
| | 1.4301 (AISI 304) met siliconen-afdichting | 1 st. | **1007.620**[1] | **1013.620**[1] | **1008.620**[1] | **1010.620**[1] | **1012.620**[1] | **1014.620**[1] | **1016.620**[1] | **1017.620**[1] | – | – | |
| | 1.4404 (AISI 316L) met PU-afdichting | 1 st. | **1007.500**[1] | **1013.500**[1] | **1008.500**[1] | **1010.500** | **1012.500**[1] | **1014.500**[1] | **1016.500**[1] | **1017.500**[1] | **1018.500**[1] | **1019.500** | |
| | 1.4404 (AISI 316L) met siliconen-afdichting | 1 st. | **1007.520**[1] | **1013.520**[1] | **1008.520**[1] | **1010.520**[1] | **1012.520**[1] | **1014.520**[1] | **1016.520**[1] | **1017.520**[1] | – | – | |
| Deur(en) | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | |
| Gewicht kg | | | 15,7 | 18,4 | 15,1 | 23,5 | 30,2 | 42,5 | 52,9 | 61,5 | 71,0 | 76,0 | |
| **Toebehoren** | | | | | | | | | | | | | |
| Regendak | | 1 st. | 2362.000 | – | 2472.000 | 2473.000 | 2473.000 | 2474.000 | 2475.000 | 2475.000 | 2363.000 | 2363.000 | 969 |
| Wand-bevestigings-beugel | 1.4301 (AISI 304) | 4 st. | 2433.000 | 2433.000 | 2433.000 | 2433.000 | 2433.000 | 2433.000 | 2433.000 | 2433.000 | 2433.000 | 2433.000 | 975 |
| | 1.4404 (AISI 316L) | 4 st. | 2433.500 | 2433.500 | 2433.500 | 2433.500 | 2433.500 | 2433.500 | 2433.500 | 2433.500 | 2433.500 | 2433.500 | 975 |
| Wandbevestigingshoek | | 1 st. | 2583.000 | 2583.000 | 2583.000 | 2583.000 | 2583.000 | 2583.000 | 2583.000 | 2583.000 | 2583.000 | 2583.000 | 976 |
| Mastbevestiging | | 1 st. | 2584.000 | 2584.000 | 2584.000 | 2584.000 | 2584.000 | – | – | – | – | – | 976 |
| Knevelsluiting 1.4404 (AISI 316L) | | 1 st. | 2304.000 | 2304.000 | 2304.000 | 2304.000 | 2304.000 | 2304.000 | 2304.000 | – | 2304.000 | – | 955 |

**Sluitsystemen**

Standaard dubbelbaardsluiting, bij kasten met knevelsluiting (behalve AE 1017.600 / AE 1019.600) vervangbaar door binnenwerken van 41 mm, veiligheidscilinder, kunststof handgreep, knevelgrepen, uitvoering C, zie pagina 954 – 957.
Bij AE 1018.600 alleen vervangbaar door binnenwerken van 41 mm, uitvoering C, zie pagina 956.
Bij kasten met espagnoletsluiting, vervangbaar door binnenwerken van 27 mm, uitvoering A, zie pagina 956 en sluitsysteem Ergoform-S, zie pagina 953.

[1] Prijs en levertijd op aanvraag.

**Toebehoren** pagina 890 **Wandkasten AE plaatstaal** pagina 128 **Wandkasten AE, IP 69K** pagina 131 **Wandkasten Hygienic Design** pagina 297

## F.12 Rittal 19” Cabinet.

IW6901.100