DEMO Wind Turbine Gearbox 'model 7' user manual

DEMO User manual made with the DITA 1.3 standard, with aspects of machinery directive, software and programming domains, etc.

Colophon

Describing how this document was created

Selection of software and tools used to make this publication

Software	Tool
XML Copy edit	dita-OT 3.2 -> 3.3
XMetal	Inkscape 0.924
Java 8 b. 201	Paint shop
Komodo Edit 11	Dita 1.3 spec
Word 2013	Bootstrap fw
Freefilesync 10	PowerShell 6
Framemaker 2015	XMLBlueprint 15

Contents

Preface

Introduction

This document presents experimentation as one way of evaluating the xml-based Dita 1.3 architecture in the production of technical content. I have used multiple editing methods (Framemaker, XML editors,) and publishing techniques (Framemaker, Dita Open Toolkit 3.2,) The applications are mainly found in the machinery industry, hardware, software programming, engineering, manuals, ...

The main object is to illustrate what can be achieved in pdf-output by working with the extended Dita 1.3 standard, with a focus on the features of the technical content domain. In the process I try to see in what form newly added Dita 1.3 features roll out of the pipeline. Meanwhile I try to find out what is not yet fully implemented in the latest version of Dita-OT: 3.3.

Certain features can be produced in html-deliverables, but they do not get rendered in pdf-output.

Kurt Van Oproy

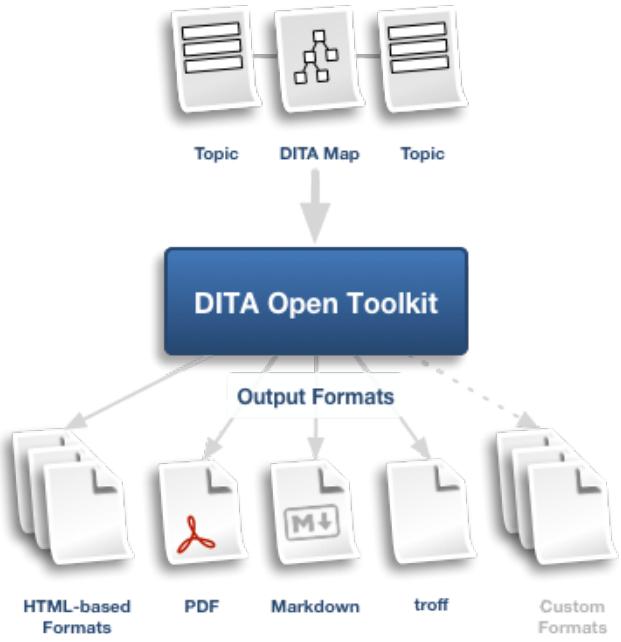


Figure 1: Output formats

Gearbox model 7 introduction

What is a genuine model 7 Shift Gearbox ?

The model 7 Shift is the 7th generation Gearbox. It works by using several planetary gearbox sets. Unsafe rotation speeds and harmful temperatures are prevented by a monitoring device.

Figure 2: planetary gearbox

⚠ WARNING	
	Heavy objects! Moving objects due to gravity! Crushing or trapping of body parts, or injuries caused by impact. Fasten the gearbox chassis securely **before moving the crate parts** Attach at least 4 cables to the chassis of the gearbox before unpacking Use crane or electro-lift as lifting aid.

Tip: Complete the start task to verify that your order on delivery is complete.

Related tasks

Wind turbine delivery task on page 10
Count all items on reception of the delivery to confirm its completeness. Before you begin this task, you need to apply some safety measures to avoid harm by heavy objects.

Wind turbine delivery task

Count all items on reception of the delivery to confirm its completeness. Before you begin this task, you need to apply some safety measures to avoid harm by heavy objects.

- IEC 61400-4:2012
- Make sure to have enough free space available to safely remove the panels, and other packaging materials of the crates, from the turbine hardware.
- Handlers must have obtained a safety certificate or minimum level Safety Certificate 'basic', or VCA-attest 'basis'
- Minimum 2 handlers and 1 supervisor
- Mechanic
- Crane handler; or lift operator
- 10 - 20 minutes
- Minimum 3 safety cables (Lifting load > 3000 kg),
- Minimum 3 fixation points, or security anchors
- Lifting materials with electro motor,
- Checklist, e.g. printout of the list of "Components of a wind turbine"
- 1 pen
- 2 spare safety cables

1. **⚠ WARNING**

   Heavy objects! Moving objects due to gravity!

   Crushing or trapping of body parts, or impact injuries

   Fasten the gearbox chassis securely **before moving the crate parts**

   Attach least 4 cables to the chassis of the gearbox before unpacking

   Use lifting aids.

   Work only on a dry and clean floor, where all unnecessary objects are removed.
2. The supervisor has made arrangements to keep other personnel at least 10 meters away from the crates and the hardware. (tape, boards, signs ...)

Checking the delivered items.

1. Does the delivery contain 1 gearbox (nr. 10 on the list) ?
   If there is a gearbox, go to the next step.

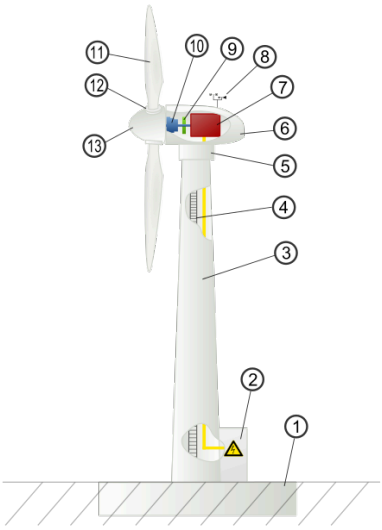


Figure 3: Components of a wind turbine

a. Foundation with underground structures
b. Transformer station
c. Tower
d. Access ladder
e. Wind orientation control & Yaw system
f. Nose cone
g. Generator
h. Instruments as anemometer, weather devices
i. Rotor break, drive chain break
j. Gearbox (nr. 10)
k. 3 Rotor blades
l. Blade pitch control
m. Rotor hub

Check the image "Components of a wind turbine" to help you to identify the correct components.

2. There should be 3 blades available.

   - In case you have received 3 blades (nr. 11), this is normal.
   - In case you have received less than 3 blades, send us an email.

   All building blocks for the wind turbine are now at your disposal. You can go to the next step.

3. Can you find a user manual in paper form ?
   Keep the manual in a safe place.

   In case there is no manual present, you can consult this link: www.zf.com/manuals/model7.pdf

Model 7 ball bearing monitoring technology

Model 7 handles higher wind speeds by design and through monitoring

Model 7 can handle higher wind speeds by a top notch ball bearing design.

There is much more technology available under the hood!

The 7th Gen gearbox monitors its own ball bearings.

The Integrated control unit or ICU takes care of the monitoring task.

RESTRICTION	
	Malfunction of monitoring, damage to, or unwanted behavior of the turbine drive train. **Qualified personnel only** are allowed to configure the monitoring device.

ICU device introduction

The device will decouple, or auto-block, the drive train when it detects certain high temperatures.

The program can independently record and plot all parameters which have been selected.

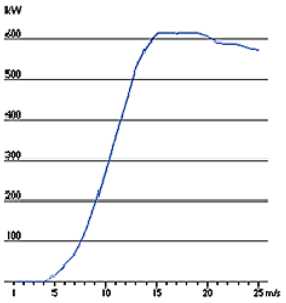
In case of mechanical or program failures, you can find more info by using the program: `Ball bearing temperature monitoring.`

A **golden rule** for avoiding any damage: the parameter Shaft rotation speed / bearing temperature ratio ,which you can access on the screen as `##.## [Rotations vs bearing temperature ratio]` , may never exceed the amount of 25 Rotations* δK / minute* δV.

Equations

$$P[\frac{W}{m^2}] = \frac{1}{2} \rho U^3 A C_p$$

P=Power
P=Density of air=1.225 kg/m3
U=Wind Velocity [m/s]
A=Swept Area [m^2]
Cp=Coefficient of Power



SOURCE: Danish Wind Industry Association

Technical documentation

Non-technical users can find more info about the ICU in our brochure. You can find it at ... http://M7.io/M7_ICU.pdf

Figure 4: The new Model 7 can monitor its own ball bearings

ICU configuration instructions

Start up and configure the ICU monitor

The ICU installation program must have been successfully completed on a users PC **before** you can begin this task.

Tip: You can find the DVD inside the front of the manual.

1. Turn on the display of the ICU monitoring device by pushing "ON" in the right corner.
2. Start the ICU configuration program. One option is to launch from the cmd prompt:**Start** > **"System"** > **Execute**
3. Enter in the Command prompt (runbox) `C:\boot -ICU` Note the command which was used `boot`
4. Load the sampling program of the desired physical property. Consult the file "bearings7-parametry.pdf" for an overview of all monitoring programs we have provided.
5. In the location ... `%install-dir*\gearbox7_project\monitoring\` you can find several preprocessed scripts for sensor set monitoring. You can use the file named 'Bearings_Temp.ps1' to select the bearings temperature sensors . Start the program by entering in the prompt : `Cscript` and use argument Bearings_Temp.ps1.
6. Enter the command **prt** to indicate the output mode `prt -BT -o *` In the meanwhile you can chose the appropriate output device: Screen -o term1 , or a plotter -o plot1
7. Determine the critical value of the temperature ratio. Enter the cmd **£ plot** with arg. `temperature ratio $R/BTr` state: temperature ratio critical value=24.5 Note that the cmd prompt should be returning: `ratio R/BT set`
   For example, enter `£ plot $R/BTr`
   The plotter is now recording BT values.
8. Click on **End configuration.**
   The **Configuration Options** window pops up for 2 minutes with your selection(s) highlighted. It will close automatically, or you can click the **close** button.
9. Turn OFF the display of the monitor when you're done.
   The monitoring of the selected temperatures by the ICU is now active, and the chosen parameters are being recorded.
10. A summary:
    a) Required: Select the sensor set which should monitor certain temperatures.
    b) Optional: Select an output mode.

Selection of program	**selection of a program file for a particular monitored area**
Select OG.ps1	outer gear temperatures monitoring
Select IG.ps1	inner gear temperatures monitoring

Some syntax for your advise:

This code example is a basic method signature:

```
methodName (-pList1, -pList2*) [--returnType=]
```

where

pList1

is the first variable declaration passed to methodName

pList2

is the second variable declaration passed to methodName

*

optional arguments

OpenFile
`OPENF`
input-filename `*INFILE`
output-filename `*OUTFILE`

Troubleshooting: User cannot log on

Troubleshooting when Login attempts have failed

The system does not accept your login credentials.

Cause

The CapsLock key might be on.

Remedy:

Verify that the CapsLock key is off.

Unknown account name

The account name you are using does not match the one stored in the system.

Remedy:

Keyboard layout or language settings might have changed. Consult your systems language and region settings.

Wrong password

The password that you are using does not match the one that is stored in the system.

Call the helpdesk

Cause

Unknown reason

Remedy:

If none of the previous solutions work, consider asking for help. Contact your system administrator if your organization has one; otherwise, contact our support team.

References for gearboxes

References for gearboxes of wind turbines, official publications and standards

Technical info

Wind turbine http://en.wikipedia.org/wiki/Wind_turbine

Electric generator http://en.wikipedia.org/wiki/Electric_generator

Gearbox capabilities document *(local)* Gearbox capabilities

Official publications and standards

Safety of Machinery IEC 12100:2010 *(local)* Safety of machinery — General principles on design

IEC 60204-1:2005, Safety of machinery — Electrical equipment of machines — Part 1: General requirements

IEC 60050-415:1999 International Electrotechnical Vocabulary - Part 415: Wind turbine generator systems

IEC/IEEE 60076-16:2018 RLV Power transformers - Part 16: Transformers for wind turbine applications

IEC 61400:2015 OC IEC 61400 - ONLINE COLLECTION - Wind turbines

IEC 61400-1:2005+AMD1:2010 CSV Wind turbines - Part 1: Design requirements

IEC 61400-2:2013 Wind turbines - Part 2: Small wind turbines

IEC 61400-3:2009 Wind turbines - Part 3: Design requirements for offshore wind turbines

IEC 61400-3-1:2018 PRV Wind energy generation systems - Part 3-1: Design requirements for fixed offshore wind turbines

IEC 61400-4:2012 Wind turbines - Part 4: Design requirements for wind turbine gearboxes

IEC 61400-11:2012+AMD1:2018 CSV Wind turbines - Part 11: Acoustic noise measurement techniques

IEC 61400-12-1:2017 RLV Wind energy generation systems - Part 12-1: Power performance measurements of electricity producing wind turbines

link: this list continues by clicking

Various documents

Document name	Document type	Document description
Safety of Machinery IEC 12100:2010	pdf document	official guideline
AcuRite 01036 Weather Station User Manual	pdf	User Manual
Greek Alphabet Symbols & Characters	link	

Programming Weather Alarms

Using the Professional Weather Center: Programming Weather Alarms

- Place the display unit in a dry area free of dirt and dust.

  To ensure accurate temperature measurement, place out of direct sunlight and away from heat sources or vents.

  Display unit stands upright for tabletop use or is wall-mountable.
- Learning Mode is **off.**
- The Self-Calibrating Forecasting uses a unique algorithm to analyze changes in pressure over a time period (called Learning Mode) to determine your altitude.

- Minimum 1 person
- Technician, electrician, engineer.
- High school
- 30 minutes

- Professional Weather Center model 01036 / 351543

- Instruction Manual for model 01036 / 351543
- Power Adapter
- 6 batteries AA

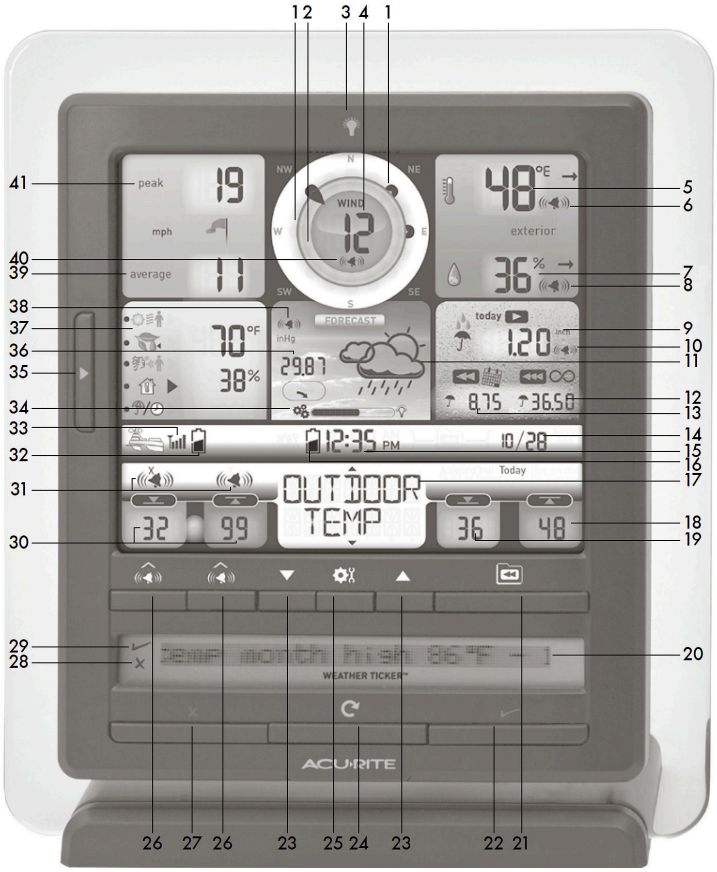
- USB Cable for PC Connection
- 3 batteries AA

1. | ⚠ DANGER | |
   |---|---|
   | ⚠ | Falling from high altitudes
Access to tower is only allowed during low wind speeds. |

   Maximum allowed wind force is 6 Beaufort when working in the tower. (measured 10 meters above ground)
2. Gale wind force must be lower than 70 km/ hour.

Each Selectable Weather Category features an alarm option. When an alarm sounds, the display unit emits audible beeping and flashes the affected category, its alarm settings, and any other relevant data. Some alarms can be customized to alert you when your programmed value is reached. Alarms include: outdoor temperature, outdoor humidity, wind speed, heat index, dew point, wind chill, indoor temperature and indoor humidity. The rain alarm does not require a preset numerical value, but instead sounds as soon as rain is recorded. Similarly, the storm alarm sounds when a large atmospheric pressure drop occurs, which usually

indicates an oncoming storm. Note: The storm alarm is NOT intended to be a safety device or warning system.



1. After tuning for 14 days, the Learning Mode icon disappears from the display screen. At this point, the self-calibrated pressure is tuned in to your location and the unit is ready for superior weather prediction.

Programming Weather Alarms.

2. Choose the weather category for which you wish to set an alarm by pressing the up or down arrow buttons until the category is displayed on the Selectable Category part of the display unit.
3. To program a value (only applies to alarms that require a value), press AND HOLD the " 🔔" button underneath the alarm you wish to set until the "🔧 " indicator appears and the alarm setting flashes.
4. Adjust the alarm value by pressing the up or down arrow buttons.
5. Press the "🔔 "button to confirm a value.
6. Next, press the " 🔔"button to activate the alarm
7. the X indicator disappears when alarm is activated
8. Alarm is now programmed and turned on.

Silencing a Sounding Alarm

9. The alarm sounds initially for a few minutes, then silences itself.
10. The alarm then sounds every few minutes afterwards until one of the following happens:

    - "SNOOZE" - Press any button.
    - Turn alarm "OFF"

    Deactivates alarm.

    Alarm silences, but sounds again if the alarm condition(s) reoccurs.

11. Are there no longer alarm signals sounding or displaying?
    The setup of the Weather station is now completed!

Related information

Wind force on page 24
Wind force measured in Bft, km/h, and m/s

Setting up Display Unit & 5-in-1 Sensor

Setup of Display Unit & 5-in-1 Sensor can be done beforehand.

Display and sensor have to be connected, and a switch must be correctly set.

5-in-1 Sensor Setup

1. Set the A-B-C Switch of the sensor. It can be set to A, B or C.

Display Unit Setup

2. Set the A-B-C Switch of Display Unit.
   Sensor and display are connected.

   The A-B-C switch is located inside the battery compartment. It can be set to A, B or C. However, you must select the same letter choices for both the sensor and the display unit in order for the units to synchronize.
3. Plug Power Adapter into Electric Outlet.
4. Write Down the MAC ADDRESS: 12 digit unique ID needed for online connectivity functions.
5. Install or Replace Backup Batteries (optional) Insert 6 x AA alkaline batteries into the battery compartment, as shown. Follow the polarity (+/-) diagram in the battery compartment.
   Sensor and display have been setup.

Appendix

A

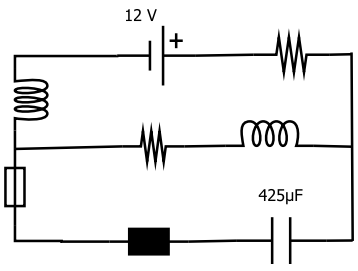
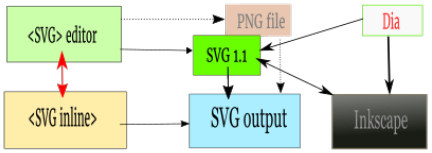
Tower elements list

Turbine and tower elements list, and other useful resources.

1. Foundation with underground structures
2. Transformer station
3. Tower
4. Access ladder
5. Wind orientation control / Yaw system
6. Nose cone
7. Generator
8. Instruments as anemometer, weather devices
9. Rotor break / drive chain break
10. Gearbox (nr. 10)
11. 3 Rotor blades
12. Blade pitch control
13. Rotor hub

The online article *Specialization in the wind turbine gearbox elements and tower architecture* provides a detailed explanation of how to reach new horizons.

Table 1: SVG collection

SVG 1	SVG 2
	

Appendix
B

Wind force

Wind force measured in Bft, km/h, and m/s

Beaufort scale (Wind force)

In de weather forecast reports, the RMI uses the Beaufort scale to define the wind intensity taking the average wind speed, calculated over a period of 10 minutes and on a height of 10 m above the observation station.

Used term	**Beaufort scale**	**Speed in km/h**	**Speed in m/s**	**Speed in knots**
Windstill	0	Less than 1	0 to 0,2	Less than 1
Weak wind	1-2	1 to 11	0,3 to 3,3	1 to 6
Average wind	3-4	12 to 28	3,4 to 7,9	7 to 16
Moderate Strong wind	5	29 to 38	8 to 10,7	17 to 21
Forceful wind	6	39 to 49	10,8 to 13,8	22 to 27
Strong wind	7	50 to 61	13,9 to 17,1	28 to 33
Stormy wind	8	62 to 74	17,2 to 20,7	34 to 40
Storm	9	75 to 88	20,8 to 24,4	41 to 47
Heavy storm	10	89 to 102	24,5 to 28,4	48 to 55
Very heavy storm	11	103 to 117	28,5 to 32,6	56 to 63
Hurricane	12	More than 117	More than 32,6	More than 63

Appendix
C

Experiments

Abbreviations and Experiments

Vergelijkingen

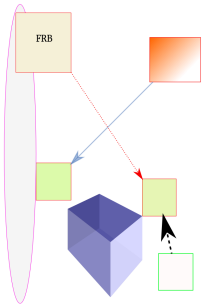
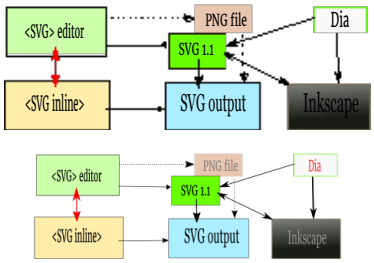
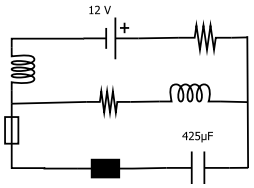
The Schrödinger Hamiltonian eq.: as (2πν=ω) follows $H(x)=\psi_x\ d^3x$

Laplacian

Laplace operator as png:

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$$

testing some svg's:

1 png	2 svg fixed	3 svg fixed.
		

Software features and programming domain

```
 import numpy as np
                plot np.mathtools.graph   -8 {Hl (c: 1/2*c)=
 8hr }
boolean: yes
 next code phrase
```

```
4  term  hierna   TERM
varname = 'var'  ↑ ↓ key break  or not?
5 Thus text is placed on the next line
```

```
<?xml version="1.0" standalone="no"?>
<!DOCTYPE svg
  PUBLIC "-//W3C//DTD SVG 20000303 Stylable//EN"
  "http://www.w3.org/TR/2000/03/WD-SVG-20000303/DTD/svg-20000303-stylable.dtd">
<svg width="4cm" height="3cm">
  <title>Example stylable 01</title>
  <desc>Draws a rectangle filled in red, stroked in blue</desc>
```

```
  <rect x="1cm" y="1cm" width="2cm" height="1cm" style="fill:red; stroke:blue"></
rect>
</svg>
```

Turbine glossary

Anemometer

Measures the wind speed and transmits wind speed data to the controller.

Blades

Lifts and rotates when wind is blown over them, causing the rotor to spin. Most turbines have either two or three blades.

Brake

Stops the rotor mechanically, electrically, or hydraulically, in emergencies.

Controller

Starts up the machine at wind speeds of about 8 to 16 miles per hour (mph) and shuts off the machine at about 55 mph. Turbines do not operate at wind speeds above about 55 mph because they may be damaged by the high winds.

Furling

Furling works by decreasing the angle of attack, which reduces the induced drag from the lift of the rotor, as well as the cross-section. One major problem in designing wind turbines is getting the blades to stall or furl quickly enough should a gust of wind cause sudden acceleration. A fully furled turbine blade, when stopped, has the edge of the blade facing into the wind. Loads can be reduced by making a structural system softer or more flexible. This could be accomplished with downwind rotors or with curved blades that twist naturally to reduce angle of attack at higher wind speeds. These systems will be nonlinear and will couple the structure to the flow field - thus, design tools must evolve to model these non-linearities.

Standard modern turbines all furl the blades in high winds. Since furling requires acting against the torque on the blade, it requires some form of pitch angle control, which is achieved with a slewing drive. This drive precisely angles the blade while withstanding high torque loads. In addition, many turbines use hydraulic systems. These systems are usually spring-loaded, so that if hydraulic power fails, the blades automatically furl. Other turbines use an electric servomotor for every rotor blade. They have a small battery-reserve in case of an electric-grid breakdown. Small wind turbines (under 50 kW) with variable-pitching generally use systems operated by centrifugal force, either by flyweights or geometric design, and employ no electric or hydraulic controls.

Gearbox

In conventional wind turbines, the blades spin a shaft that is connected through a gearbox to the generator. The gearbox converts the turning speed of the blades 15 to 20 rotations per minute for a large, one-megawatt turbine into the faster 1,800 revolutions per minute that the generator needs to generate electricity.

Integrated Control Unit

The ICU takes care of the device integrity by parameter monitoring and surveying tasks.

Integrated Control Unit (ICU)

ICU

Nacelle

A nacelle is a cover housing that houses all of the generating components in a wind turbine, including the generator, gearbox, drive train, and brake assembly.

Safety of Machinery standard

This International Standard specifies basic terminology, principles and a methodology for achieving safety in the design of machinery. It specifies principles of risk assessment and risk reduction to help designers in achieving this objective.

Safety of Machinery standard (EN 12100)

EN 12100, ISO 12100, or IEC 12100

Safety of machinery directive IEC 12100

Machinery standard, machinery guidelines

Wind turbine

A machine that captures the force of the wind. Called a Wind Generator when used to produce electricity. Called a Windmill when used to crush grain or pump water.

Yaw

Rotation parallel to the ground. A wind generator Yaws to face winds coming from different directions.

Index

Special Characters

Numerics

A

B

I

L

M

P

S

V

W