William Cundiff

From: Burkard, Robert [BurkardRG@cdm.com]
Sent: Wednesday, October 20, 2010 2:04 PM
To: Rod Jané; neexpansion@aol.com
Cc: William Cundiff
Subject: Emailing: NEES APW Shadow Flicker Mitigation Plan Draft 092810 (2).docx, NEES APW Shadow Flicker - Shadow Impact Module.pdf
Attachments: NEES APW Shadow Flicker Mitigation Plan Draft 092810 (2).docx; NEES APW Shadow Flicker - Shadow Impact Module.pdf

<<NEES APW Shadow Flicker Mitigation Plan Draft 092810 (2).docx>> <<NEES APW Shadow Flicker - Shadow Impact Module.pdf>>
Rod,

As discussed, attached are comments on the flicker mitigation plan. I made comments both to the word and PDF document. There may be a few items to talk thru before finalizing. Any questions please let me know.

Thanks

Bob
The message is ready to be sent with the following file or link attachments:

NEES APW Shadow Flicker Mitigation Plan Draft 092810 (2).docx NEES APW Shadow Flicker - Shadow Impact Module.pdf

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Shadow Impact Module SIM

Manual for Version 3.0

Software Version 4.4

NorthTec GmbH

Windtest
Kaiser-Wilhelm-Koog GmbH

Manual for Shadow Impact Module Version 3.0

Software Version 4.4

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Table of Contents

1 Product Description

1.1 Applications

During sunny times of the day, the operation of wind turbine generators (WTG) may cause annoying periodic shadow impact to adjacent buildings. For this reason, building permits for the erection of WTGs increasingly demand the integration of automatic shut-down devices in order to prevent adjacent buildings from being impacted more than acceptable according to the recommended values. Normally, the authorities specify limit values regarding the maximum permitted daily and annual load.

The shadow impact module introduced herein serves as a technical solution for meeting these demands. A single shadow impact module can monitor up to 12 wind turbine generators in up to 100 places of immission (PI). If the limit values are exceeded in a place of immission, the WTG responsible is shut down for the duration of the shadow impact. Furthermore, the preload caused by up to 38 WTGs can be considered. In case the number of wind turbine generators to be monitored exceeds the maximum number of wind turbine generators controllable by a single shadow impact module, several shadow impact modules may be operated in parallel.

As an option, the shadow impact module provides for storage of all shadow impact events of at least one year in a first-in-first-out memory. The data collected include information on theoretical and actual shadow impact in the places of immission (listed with time and date of occurrence) as well as information on whether the limit value exceedances have resulted in wind turbine generator shut-downs. Using the serial interface of the shadow impact module and the Shadow Memory software, the data collected may be transmitted to a computer where they can be displayed or printed out in tabular format. Modifying the data is not possible.

Another optional feature of the shadow impact module is the shut-down of wind turbine generators at fixed points in time as it may be necessary in order to prevent noise emission during night time. For each day of the week and for each wind turbine generator individually, a period of time can be specified during which the wind turbine generators will be shut down. Furthermore, it is possible to specify shut-down periods for specific dates. These shut-downs can be recorded as well.

1.2 Installing the Shadow Impact Module

The shadow impact module is integrated in a steel cabinet with protection class IP65. It is installed on the inside of the wind turbine generator. A mains supply (230 V AC) must be available for voltage supply to the shadow impact module.

The light sensor and the radio controlled clock (RCC module) are installed outside of the wind turbine generator. The light sensor comes mounted on a cantilever. The cantilever is secured to the south side of the tower. Depending on the tower type, it can be mounted using stainless clamps or heavy-duty dowels. For connecting the light sensor and the RCC module to the shadow impact module, a drilling hole in the tower or an accessible empty conduit must be available for the connection cable.

If desired, the light sensor can be supplied mounted on a mast. In this case, the mast must be erected south of the wind turbine generator in order to exclude shadowing effects on the light sensor caused by the wind turbine generator tower.

Alternatively, the light sensor may be installed on top of the wind turbine generator nacelle. When choosing this type of installation, a shielded control line (7 x 0.5 mm²) must be provided for the connection of the light sensor located on top of the nacelle to the shadow impact module located in the tower feet.

In principle, when choosing a location for the light sensor, it should be ensured that shadowing effects on the light sensor caused by wind turbine generator components, trees or other kinds of obstacles are avoided. When choosing a location for the RCC module it should be ensured that the front of the module points towards the emitter sending out the time signal (e.g. Frankfurt/Main for Germany). For information on connection of the light sensor and the RCC module to the shadow impact module, please refer to Chapter 4.4.

For each wind turbine generator to be shut down by the shadow impact module when required, a floating relay contact (normally closed contact/normally open contact) is provided. In case several wind turbine generators are to be monitored by the shadow impact module, networking the wind turbine generators using copper cables or fibre optic cables is required. Each additional wind turbine generator to be monitored requires two copper cable wires or one optical fibre. When the wind turbine generators are monitored using fibre optic cables, external converter modules must be employed for signal conversion. The connections of the switching outputs are illustrated in sections 4.2 and 4.3. If a shadow impact module is to monitor more than one wind turbine generator, it is provided with an additional power supply unit (PSU2). The output voltage serves for activating coupling relays via telecommunication cables.

1.3 Functionality

One shadow impact module can take into account shadow impact in up to 100 places of immission. Since the authorities usually specify limit values for daily and annual shadow impact, there is a daily as well as an annual counter for each place of immission. For each of these counters, you can set a limit value. As soon as shadow impact is detected in one of these places of immission, the respective counters will be updated in cycles of one minute. If one of the counters reaches its limit value, the wind turbine generator causing the shadow impact is shut down. Once the rotor shadow has passed the place of immission or the light intensity has become too low to cause real shadow impact, the wind turbine generator is released. Shadow impact effects at a sun height angle of < 3° are not taken into account.
The annual period surveyed can be defined for each place of immission individually. In places of immission where shadow impact effects may occur all year round, setting the start of the annual period surveyed to the start of the strong wind period is an obvious choice. This way, shut-down hours during the strong wind periods due to exceedance of the maximum permitted annual immission can be reduced. As a result, these shut-down events are shifted to the summer months.

1.3.1 Shadow Impact Calculation

The shadow impact module cyclically determines the position of the sun. Using the position of the sun as well as the wind turbine generator data entered, the position and the size of the rotor shadow is calculated. The results of this calculation are then compared to the positions of the places of immission. Thus, the shadow impact module knows at any time, whether shadow impact effects are theoretically possible in one or more places of immission.
The exact time of day is a prerequisite for reliable shadow impact calculations. Therefore, the shadow impact module is provided with a radio controlled clock (RCC module).

1.3.2 Light Sensors

In order to determine whether shadow impact effects are actually possible, the shadow impact module is provided with one or more light sensors. The light sensors enable the assessment of the light conditions. The rotor shadow will be perceived only if the direct sun radiation is strong enough.

1.3.3 Shut-Down of Wind Turbine Generators

A wind turbine generator is shut down only if *real* shadow impact effects occur in a place of immission exceeding a shadow impact limit value.
If the shadow impact is eliminated due to cloudiness after a wind turbine generator has been shut down, the wind turbine generator is released. In order to prevent a wind turbine generator from being shut down and released in short intervals due to unstable weather conditions, you can define a follow-up time. As a result of setting a follow-up time, a wind turbine generator shut down by the shadow impact module is not released as soon as the sky clouds over. Only after the follow-up time has elapsed or shadow impact is no longer possible (according to the shadow impact calculation), the wind turbine generator is released. By setting a follow-up time, you can reduce the wear and tear on the wind turbine generators.

1.4 Configuration of the Shadow Impact Module

For the shadow impact calculations, the shadow impact module requires data defining the wind turbine generators and the places of immission. The data are entered using the keypad. For detailed information on how to enter the data, please refer to chapters 2.2.1 throughout 2.2.6. In addition, you will find a shadow impact module configuration example in the appendix (6.1). The data required for the configuration of a shadow impact module include the following:

Location of the shadow impact module (Menu 2.3)

- Degree of latitude and longitude (decimal)
  The data must be entered accurate to three decimal places.

Places of immission (Menu 2.4)

Places of immission are defined by walls and/or areas. For each place of immission, you may define up to 5 walls and up to 3 areas.

Wall of a place of immission (Menu 2.4.1.2):

- 2 pairs of Gauss-Krueger corner coordinates (easting and northing)
- Wall height in meters
- Orientation of the wall exterior

Area of a place of immission (Menu 2.4.1.3):

- 4 pairs of Gauss-Krueger corner coordinates (easting and northing)

Other data regarding the place of immission

- Height above sea level in meters (Menu 2.4.1.1)
- Maximum permitted daily and annual load times (Menu 2.4.1.4)

Wind turbine generators (Menu 2.5)

- Hub height (Menu 2.5.1.1)
- Rotor radius (Menu 2.5.1.2)
- Height above Sea Level (Menu 2.5.1.3)
- Gauss-Krueger coordinates of location (Menu 2.5.1.4)

1.5 Log Function (optional)

If the shadow impact module is provided with a log function, all shadow impact events are recorded. Each event is assigned a time stamp. The following events are logged:

- **Shadow Impact**
  The corresponding wind turbine generator causes real shadow impact in the corresponding place of immission.

- **Theoretical Shadow Impact**
  Theoretically, shadow impact may occur in the corresponding place of immission. However, the intensity of the direct sunlight is too low to cause actual shadow impact effects.

- **End of Shadow Impact**
  Since the sun has changed its position, the corresponding wind turbine generator can no longer cause actual shadow impact in the corresponding place of immission.

- **Stop WTG**
  The corresponding wind turbine generator was stopped by the shadow impact module.

- **Start WTG**
  The corresponding wind turbine generator was released.

For a log example, please refer to Appendix 6.2.

1.6 Azimuth Function (optional)

The shut-down periods of the wind turbine generators can be reduced to a minimum by taking into account the position of the rotor when calculating the duration of shadow impact. When the rotor is positioned at a right angle to the direction of the sun rays, the shadow ellipse of the rotor in the horizontal plane is at its maximum. As the position of the rotor changes towards the direction of the sunrays, the shadow ellipse reduces in size until only a small stripe remains.

The Azimuth function provides an analogue input for analysing the azimuth signal from the wind turbine generator. The input signal may be either a voltage or a current signal

The shadow impact log will indicate the wind direction for each invent.

1.7 Alarm Function (optional)

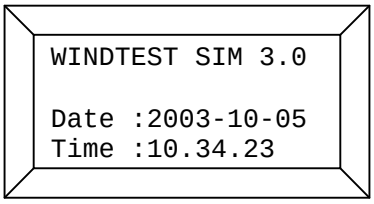
The Alarm function provides an additional floating relay contact (normally closed contact/normally open contact) which can be used to verify that the shadow impact module is operating properly. During normal operation, the relay contact is active. If the power supply to the shadow impact module is interrupted or the monitoring routines of the shadow impact module detects a failure in the light sensor or radio controlled clock, this relay contact is released.

1.8 Language Selection (optional)

If Language Selection is enabled, you can choose between German or English user interface.

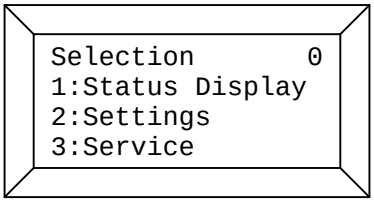
2 Menu Navigation

To start up the shadow impact module, please operate the main switch. After about 15 seconds, date and time will be displayed.



The shadow impact is ready for operation and you can now view the operating parameters or make settings.

After you have turned on the shadow impact module, please press the *Enter* key. The following will be displayed:



To go to the desired menu, please press the corresponding numerical key, e.g. 1 to go to the *Status Display* menu. In the second menu (2) you can configure the shadow impact module. The third menu is for manufacturer setting and adjustment menus which will not be described in detail in this manual.

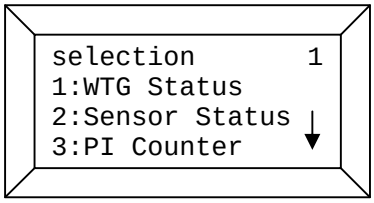
The number displayed in the upper right represents the menu counter. The menu counter will assist you in navigating trough the menu items. To go to a higher-level menu, please press *Clear*. Please note that your settings will only be applied if you confirm them by pressing the *Enter* key.

In the upper left of the display you will see a note indicating the menu function. Menu functions include the following: Display, Selection, Input and Action.
If you press and hold the *Shift* key and then press another key, you will perform the key function indicated on the respective key by the red symbol.

Note: The information in this chapter is listed in order of the menu items.

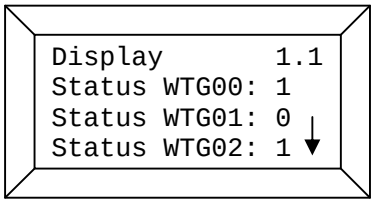
2.1 Status Display (Menu 1)

In the *Status Display* menu, you may view various operating parameters. To go to the desired sub menu, just press the corresponding numerical key. Use the arrow keys to move up and down the selection list.



2.1.1 WTG Operating Status Display (Menu 1.1)

This display mode enables you to find out whether one of the wind turbine generators to be monitored is currently shut down by the shadow impact module.

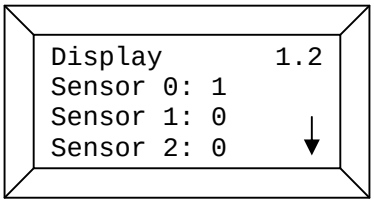


The display shows that WTG 1 has been shut down by the shadow impact module (status = 0) whereas WTG 0 and WTG 2 have not been shut down (status = 1). Use the arrow keys to move up and down the list. The status information of 50 WTGs (0-49) is displayed, even though the shadow impact module cannot monitor all of the WTGs. The display refers only to the shadow impact module switching outputs (Menu 2.5.1.5) responsible for the corresponding WTG; it does not indicate the actual operating status of the WTG.

Please press *Clear* to return to the selection menu of the status display.

2.1.2 Light Sensor Status Display (Menu 1.2)

The light sensors have the function of determining the direct portion of the visible sunlight. Actual

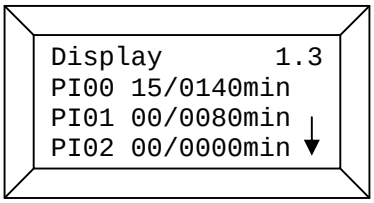


shadow impact is possible only if the direct portion is high enough. Menu 1.2 provides information on the light conditions at the respective light sensor. A status of 1 means that due to the light conditions, actual shadow impact is possible. With a status of 0, this is not possible.

Up to four light sensors may be connected to the shadow impact module. Using more than one light sensor is necessary in cases where the wind turbine generators are located far away from each other so that on days with slowly passing clouds there may be longer periods during which the light conditions at the wind turbine generators differ from each other. Employing a second light sensor may also serve the purpose of reducing the failure probability of the shadow impact module due to a damaged or dirty light sensor.

2.1.3 Daily and Annual Counter Display (Menu 1.3)

This display menu provides information on the load times of the places of immission.



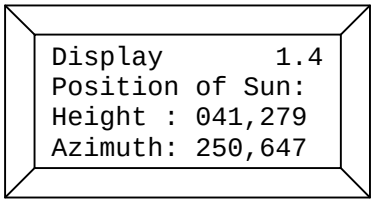
The load times shown on the display are to be read as follows. On the current day, PI 0 has been impacted for a total of 15 minutes and during the current year it has been impacted for a total of 140 minutes. On the current day, PI 1 has not been impacted at all; however, during the current year it has been impacted for a total of 80 minutes. PI 2 has not been impacted so far, neither on the current day, nor in the course of the current year.

Regarding the load times, the switchable as well as the non-switchable WTGs are taken into account.
The daily counter is reset to zero at midnight. The annual counter is reset to zero at the end of the year.

Use the arrow keys to move up and down the counter list.

2.1.4 Position of the Sun Display (Menu 1.4)

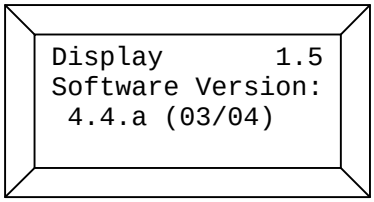
This menu displays the position of the sun continuously determined according to time and date. The height angle and the azimuth (direction angle) of the sun are represented in degrees.



The height angle is measured between the horizontal plane and the sun. When the sun is at the zenith, the height angle is 90°. At the horizon, the height angle is 0°. The azimuth of the sun is measured along the horizon in clockwise direction from north where it is 0°. (East: 90°, south: 180° etc.) In case the position of the sun indicated does not correspond to the actual conditions, you should check date and time and correct these data if necessary. Another source of error may be a location entered incorrectly. Please check the degree of latitude and longitude entered in Menu 2.3.

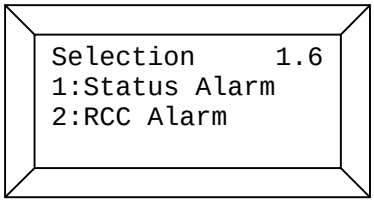
2.1.5 Software Version Display (Menu 1.5)

If you should have questions regarding the operation of the shadow impact module, please indicate to us the software version displayed in this menu.



2.1.6 Selecting Parameters for the Alarm Function (Menu 1.6)

From within this menu, you can display various parameters of the Alarm function.



2.1.6.1 Alarm Status Display (Menu 1.6.1)

This menu displays the current status of the Alarm function. The Alarm function monitors the operation of the light sensors and the radio controlled clock. Alarm status 1 indicates a malfunction in which case checking the shadow impact module is recommended. Alarm status 0 indicates that all the components monitored are operating properly.

2.1.6.2 RCC Alarm Counter Display (Menu 1.6.2)

Every night, the time of the shadow impact module is synchronised to the time signal received from the radio controlled clock (RCC). The RCC alarm counter indicates the number of consecutive times the reception of the time signal has failed. In case the RCC alarm counter exceeds the limit value entered in menu item 2.8.2.3, an alarm is triggered. 

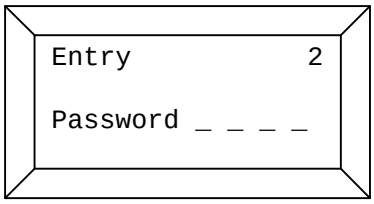
2.1.7 Rotor Azimuth Display (Menu 1.7)

This menu displays the absolute and relative azimuth of the rotor in degrees. The absolute azimuth (azimuth 1) indicates the position of the rotor where a value of 0° indicates orientation to north (90° = east etc.). The relative azimuth indicates the position of the rotor relative to the sun. A relative azimuth of 0° or 180° means that the rotor is positioned at a right angle to the direction of the sunrays.

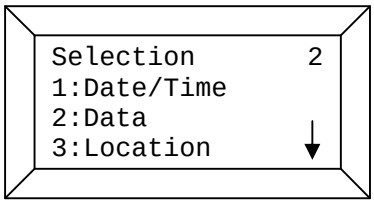
2.2 Settings (Menu 2)

Before you can go to the *Settings* menu, you must enter the four-digit user password. The password is preset to 0000. In Menu 2.8.1 you can change the password as desired. For secure operation of the shadow impact module, we recommend you disclose this password only to those persons authorised to change the settings of the shadow impact module.

Confirm your entry by pressing the *Enter* key. If the password you have entered is correct, you will now see the selection menu for the various setting options.



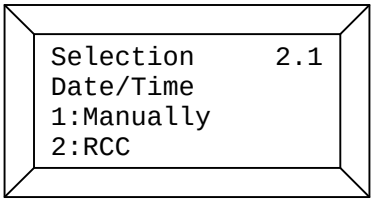
Please select the desired settings menu by pressing the corresponding numerical key. Use the arrow keys to move up and down the selection list.



Please carefully perform all of the following settings. Incorrect or inaccurate settings may result in malfunction of the shadow impact module. A malfunction would not cause damages; however, it could lead to unnecessary shut-downs resulting in loss of earnings.

2.2.1 Selecting Setting Options (Menu 2.1)

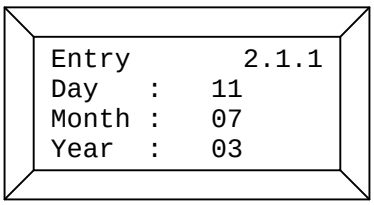
Within this menu, you can specify whether date and time are to be set manually or by time leveling using the RCC module.



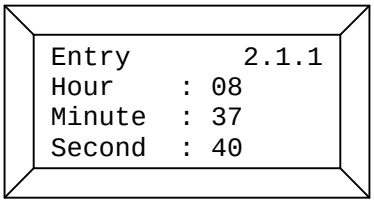
Make your selection using the numerical keys.

2.2.1.1Setting Date and Time Manually (Menu 2.1.1)

The data are entered using the numerical keys. Use the arrow keys to navigate through the items. The software's period of validity is from 01.01.2000 to 31.12.2056. If the module detects an incorrect date, such as 30.02.2003, an error message is issued. After pressing the *Enter* key, you can correct your entry.



Confirm your entry by pressing the *Enter* key. The display will show a time entry mask.

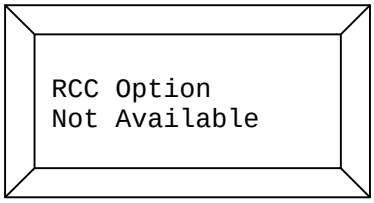


The procedure for entering the time is identical to the procedure for entering the date. Please note that the time you enter must be the wintertime! After you have confirmed your entry by pressing the *Enter* key, the processor clock adopts the new time data. Please double-check that the new date and time have been entered correctly.

Note: Please note that the time you enter must be the wintertime.

2.2.1.2Setting Date and Time by the RCC module (Menu 2.1.2)

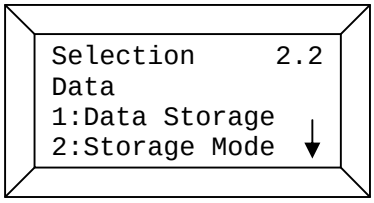
If the shadow impact module is provided with a RCC (radio controlled clock) module, the time is corrected automatically at night. In Menu 2.1.2 you can manually trigger the time setting process to be performed by the RCC module. If the shadow impact module is not provided with a RCC module, the following error message is issued upon selecting this menu.



Under optimum reception conditions, the time setting process takes 3 to 4 minutes. In case of disturbed reception, the frequency search is aborted after one hour. You can also stop the frequency search by pressing the *Clear* key.

2.2.2 Selecting Setting Options (Menu 2.2)

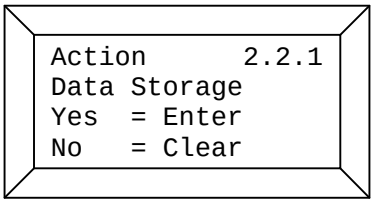
In this selection menu, you may choose menu items referring to data storage.



Make your selection using the numerical keys.

2.2.2.1 Data Storage (Menu 2.2.1)

Within this menu, the data entered are saved to permanent memory. In case of a power failure, all data which have not been saved to permanent memory are held in a buffer-accumulator-based main memory for about 1 week. After the buffer accumulator is discharged, all data as well as the current time setting will be lost. Data which have been saved to permanent memory will be maintained for at least one year after the power failure.

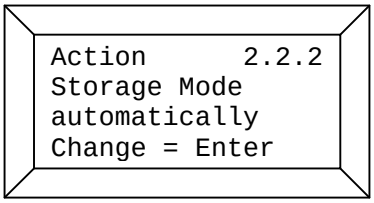


To save the data, please press the *Enter* key. To cancel the process, please press the *Clear* key. During a storage process, the shadow impact module should not be switched off.

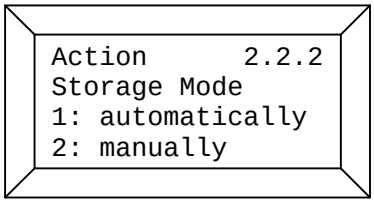
Note: All data regarding the configuration of the shadow impact module should be documented and kept in a secure place.

2.2.2.2 Setting the Storage Mode (Menu 2.2.2)

The shadow impact module has two storage modes. In the preset automatic storage mode, all data are saved immediately after they were entered. This storage mode provides the highest level of data security; however, each storage process takes about 5 seconds. In cases where a large amount of data has to be entered, this storage mode may be too time-consuming. In the manual storage mode, the data entered are not saved automatically. Instead, saving the data to permanent memory must be performed manually (please refer to Menu 2.2.1).



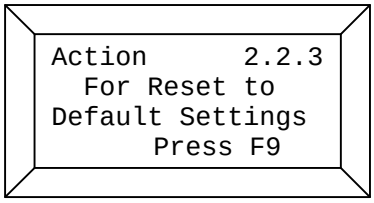
The current storage mode is displayed in the 3rd line. To change the storage mode, please press the *Enter* key.



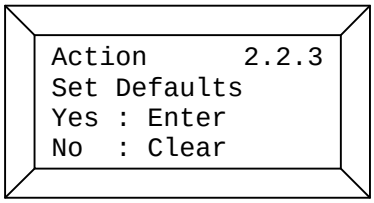
Now select the desired storage mode using the numerical keys.

2.2.2.3 Reset to Default Settings (Menu 2.2.3)

To reset the shadow impact module to the default settings, please press the *F9* key. Please note that this will delete all the data you entered and clear all counters.



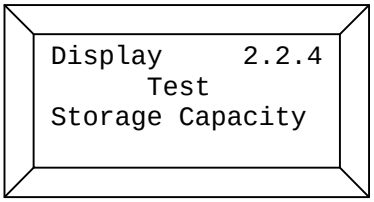
Confirm your selection by pressing the *Enter* key. To reject the deleting process, press the *Clear*

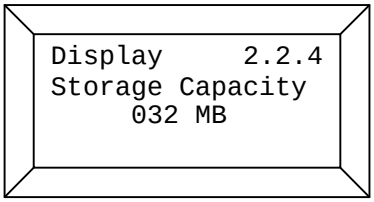


key. The deleting process will take about 45 seconds.

2.2.2.4 Storage Check (Menu 2.2.4)

The configuration and log data of the shadow impact module are saved to a Smart Media Card (SMC). When you select this menu item, the SMC will be checked and its size will be displayed.



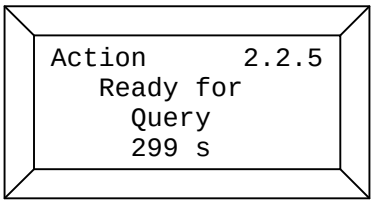


The storage capacity of the Smart Media Card can range from 16 to 128 MB.

2.2.2.5 Log Data (Menu 2.2.5)

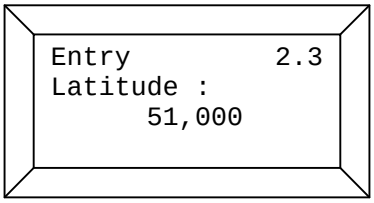
This menu item applies only to those shadow impact modules provided with a log function.

In this menu, the shadow impact module will wait for the log request from a computer connected to the serial interface. The computer to which the log data are to be transmitted must have the Shadow Memory software installed. This software is included with the log function. For detailed information on transmission of the log data, please refer to the Shadow Memory manual.

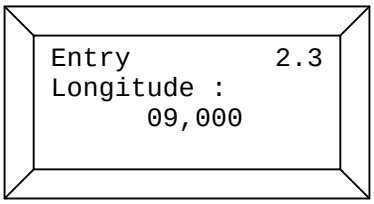


2.2.3 Setting the Location (Menu 2.3)

The location of the shadow impact module is defined by specifying the degrees of latitude and longitude. Always enter these two values accurate to three decimal places as these data represent an important basis for the calculation of the position of the sun. The format must be decimal as opposed to specification by minutes and seconds.



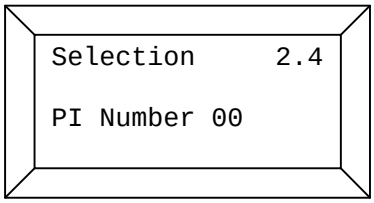
Please start by entering the degree of latitude. The degree of latitude is preset to 51.000 degrees. Use the arrow keys to change the position of the cursor. Please confirm your entry by pressing the *Enter* key. The display will now show the entry menu for the degree of longitude.



The degree of longitude is preset to 09.000 degrees. Again, please confirm your entry by pressing the *Enter* key.

2.2.4 Selecting the Place of Immission to Be Set (Menu 2.4)

The shadow impact module calculations can take into account 100 places of immission (0-99). Various settings must be performed for each place of immission. Please start by selecting the number of the place of immission to be set using the numerical keys.

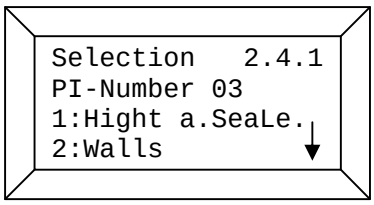


When the number of the desired place of immission is displayed, please confirm by pressing the *Enter* key. A new selection menu will now be displayed.

2.2.4.1Selection of Setting Options (Menu 2.4.1)

A place of immission must be defined by the following parameters: Height above sea level, the coordinates of an area or wall, and the permitted daily and annual load times. Each place of immission may be assigned up to 5 walls and up to 3 areas.

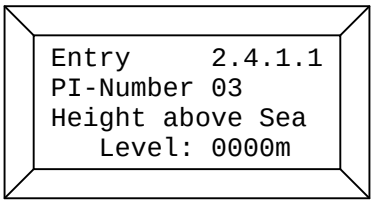
Please select the desired settings menu by pressing the corresponding numerical key. Use the



arrow keys to move up and down the selection list.

2.2.4.1.1 Entering the Height a. Sea Level for a Place of Immission (Menu 2.4.1.1)

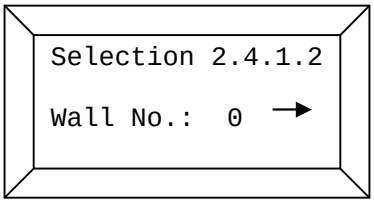
Please enter the place of immission's height above sea level in meters using the numerical keys. Start by entering an algebraic sign. If you skip this entry, the algebraic sign will remain positive.



Confirm your entry by pressing the *Enter* key. You will automatically return to the selection menu for further settings regarding the place of immission selected.

2.2.4.1.2 Entering the Wall of a Place of Immission (Menu 2.4.1.2)

A wall is defined by its corner coordinates, height and orientation.

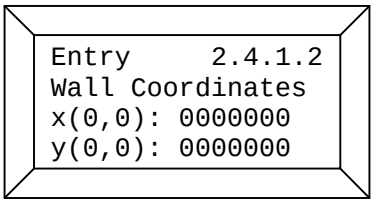


Start by using the arrow keys to select the number of the wall (wall 0 – wall 4) for which you plan to enter the corresponding parameters.

Please confirm the selected wall number by pressing the *Enter* key.

First you must enter the two pairs of corner coordinates (x and y or easting and northing) of the wall in 7-digit Gauss-Krueger format. Now enter the first pair of coordinates for the wall using the numerical keys. Use the arrow keys to navigate through the items.

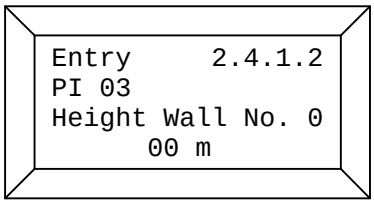
In the 3rd line, enter the x coordinate (easting); in the 4th line, enter the y coordinate (northing). The



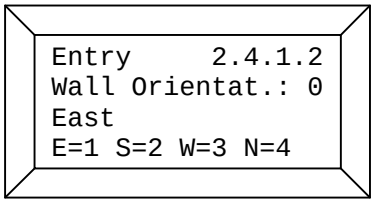
first index of the coordinates defines the wall number (0 – 4). The second index specifies the respective pair of coordinates (0 or 1) concerned.

Confirm your entry by pressing the *Enter* key. Now enter the pair of coordinates in the new window and confirm your entry.

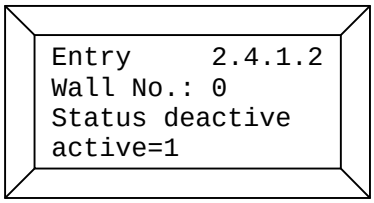
Please enter the wall height in meters in the following window.



After you have confirmed this entry, you will get to the menu for entering a direction to which the wall exterior is oriented.



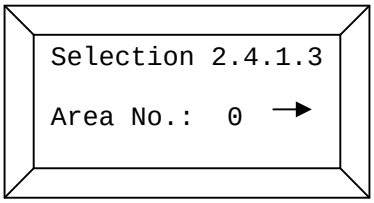
Select the direction using the respective numerical key, e.g. 2 = south. For example if the wall is oriented north-west you can enter either north or west. After you have confirmed your entry, you will get to the last menu item referring to the wall. Here, you can either activate or deactivate the wall. Only activated walls will be taken into account by the shadow impact calculations .



To activate the wall, please press the numerical key 1; to deactivate the wall, press 0. Confirm your entry by pressing the *Enter* key. Now you will automatically return to the selection menu for the wall number. If you do not wish to define another wall, you can quit this menu by pressing the *Clear* key.

2.2.4.1.3 Entering the Areas of a Place of Immission (Menu 2.4.1.3)

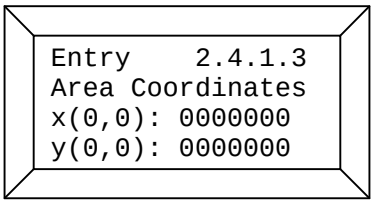
Start by using the arrow keys to select the number of the area (area 0 – area 2) for which you plan to enter the corresponding parameters.



Please confirm the selected area number by pressing the *Enter* key.

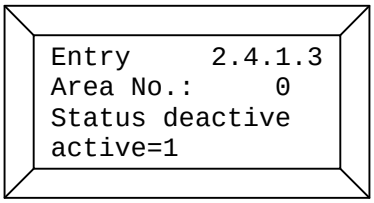
An area is defined by its four pairs of corner coordinates. Just like walls, areas are defined applying the Gauss-Krueger format.

Now enter the first pair of coordinates for the area using the numerical keys. Use the arrow keys to navigate through the items.



In the 3rd line, enter the x coordinate (easting); in the 4th line, enter the y coordinate (northing). The first index of the coordinates defines the area number. The second index specifies the respective pair of coordinates (0 or 3) concerned.

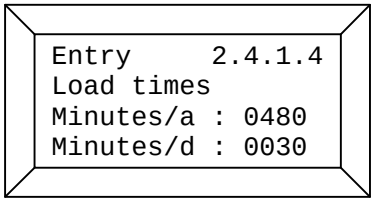
Confirm your entry by pressing the *Enter* key. Now enter the next pair of coordinates in the new window and confirm your entry. For each area, you must enter a total of four pairs of coordinates. After you have confirmed the last pair of coordinates, a menu for activating or deactivating the area will be displayed. Only activated areas will be taken into account by the shadow impact calculations.



To activate the area, please press the numerical key 1; to deactivate the area, press 0. Confirm your entry by pressing the *Enter* key. Now you will automatically return to the selection menu for the area number. If you do not wish to define another area, you can quit this menu by pressing the *Clear* key.

2.2.4.1.4 Entering the Permitted Load Times (Menu 2.4.1.4)

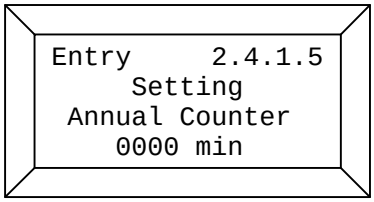
The places of immission must be assigned different maximum permitted daily and annual load times according to the limit values specified by the authorities. Use this menu item to enter the corresponding times. The annual load is preset to 480 min (=8 h); the daily load is preset to 30 min.



Use the numerical keys to enter the permitted limit value for the annual load in minutes in the 3rd line. In the 4th line, enter the permitted limit value for the daily load time in minutes. Use the arrow keys to navigate through the items. Please confirm your entry by pressing the *Enter* key.

2.2.4.1.5 Setting the Annual Counter (Menu 2.4.1.5)

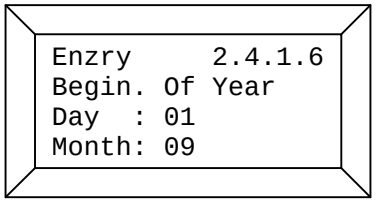
Here you can enter how many hours the respective place of immission has been exposed to shadow impact so far during the current year. This setting may be required in cases where the shadow impact module is installed e.g. in the middle of the year if the place of immission has been exposed to shadow impact for several hours prior to the installation.



The counter is set using the numerical keys. Use the arrow keys to navigate through the entry positions. Please confirm your entry by pressing the *Enter* key.

2.2.4.1.6 Setting the Beginning of the Year (Menu 2.4.1.6)

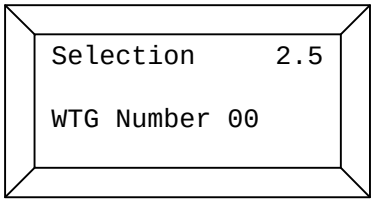
Here you can select the first day of the annual period to be considered on which the annual counters will be reset to zero. The beginning of the year is preset to 01.09. The ideal date to choose depends on the seasons during which the place of immission can be shadowed. As a general rule, the beginning of the year should be set to the beginning of the strong wind period.



Enter the desired date using the numerical keys. Confirm your entry by pressing the *Enter* key.

2.2.5 Selecting the Wind Turbine Generator to Be Set (Menu 2.5)

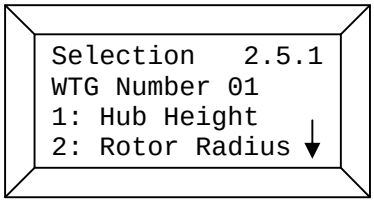
In the shadow impact module, wind turbine generators are defined by their hub height, rotor radius, height above sea level as well as the respective location coordinates. Up to 12 wind turbine generators can be assigned to one out of 12 switching outputs in the shadow impact module. The switching outputs are used to control the corresponding wind turbine generator. Please start by using the numerical keys to enter the number of the wind turbine generator for which you plan to perform the required settings. The selection ranges from 0 to 49. When the number of the desired



wind turbine generator is displayed, please press the *Enter* key. A new selection menu will now be displayed.

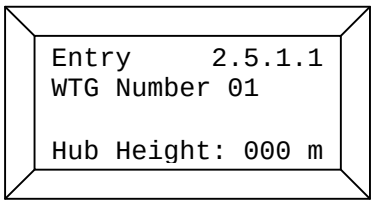
2.2.5.1 Selection of Setting Options (Menu 2.5.1)

Please select the desired settings menu by pressing the corresponding numerical key. Use the arrow keys to move up and down the selection list.



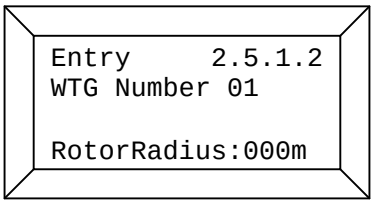
2.2.5.1.1 Entering the Hub Height of the Wind Turbine Generator (Menu 2.5.1.1)

Enter the hub height of the wind turbine generator in meters using the numerical keys and confirm your entry by pressing the *Enter* key. Use the arrow keys to navigate through the entry positions.



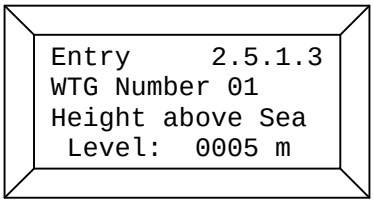
2.2.5.1.2 Entering the Rotor Radius (Menu 2.5.1.2)

Enter the rotor radius of the wind turbine generator in meters using the numerical keys and confirm your entry by pressing the *Enter* key. Use the arrow keys to navigate through the entry positions.



2.2.5.1.3 Entering the Altitude of the Wind Turbine Generator (Menu 2.5.1.3)

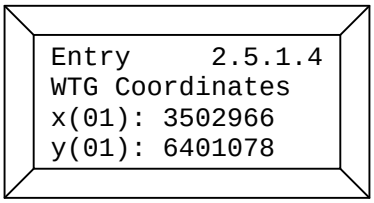
Please enter the height above seal level of the wind turbine generator in meters using the numerical keys. Start by entering an algebraic sign. If you skip this entry, the algebraic sign will remain positive.



Confirm your entry by pressing the *Enter* key. Use the arrow keys to navigate through the entry positions.

2.2.5.1.4 Entering the Coordinates of the Wind Turbine Generator (Menu 2.5.1.4)

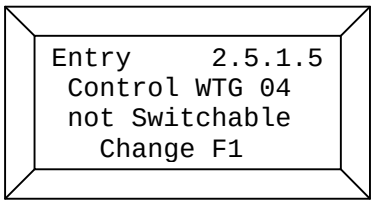
The location coordinates of the wind turbine generator are entered in 7-digit Gauss-Krueger format. In the 3rd line, enter the x coordinate (easting); in the 4th line, enter the y coordinate (northing). The index of the coordinates indicates the number of the wind turbine generator.



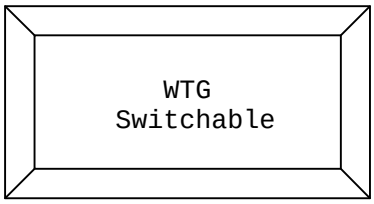
Enter the coordinates of the wind turbine generator using the numerical keys and confirm your entry by pressing the *Enter* key. Use the arrow keys to navigate through the entry positions.

2.2.5.1.5 Control (Menu 2.5.1.5)

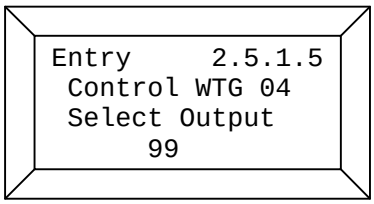
The shadow impact module can be provided with 1 to 12 switching outputs Each of the existing switching outputs may be assigned to one of the 50 wind turbine generators. By default, all of the wind turbine generators are non-switchable. This state applies to all those wind turbine generators which do cause shadow impact in a place of immission but are not monitored by a shadow impact module.



To change the mode of the wind turbine generator selected to "switchable", please press the *F1* key. For a short while, the following will be displayed:

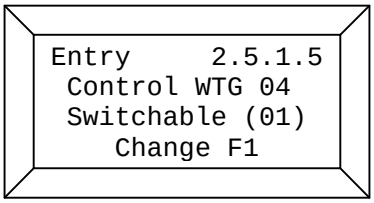


Then, the switching output assigned to the wind turbine generator will be displayed. The switching output is preset to 99. The number of physically existing switching outputs ranges from 0 to 11 (maximum number). Therefore, a shadow impact module for switching e.g. five wind turbine generators will have the physical switching outputs 0 to 4. If you select a switching output with a number exceeding the number of physical existing switching outputs for a wind turbine generator, this wind turbine generator will be regarded as switchable; however, the shadow impact module will not be able to shut down this wind turbine generator. This state applies to all those wind turbine generators monitored by a different shadow impact module running in parallel.



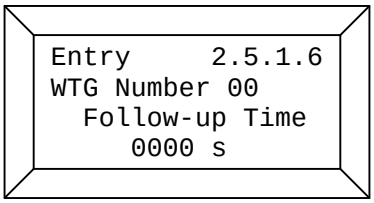
Set the desired switching output using the numerical keys and confirm your entry by pressing the *Enter* key. Please double-check your settings in the following display.

If the settings are correct, you can quit the menu by pressing the *Clear* key. To change the settings, press the *F1* key.



2.2.5.1.6 Entering the Follow-up Time for the Wind Turbine Generator (Menu 2.5.1.6)

As a result of setting a follow-up time, a wind turbine generator shut-down by the shadow impact module is not released as soon as the shadow impact is interrupted by a short period of cloudiness. This may serve the purpose of preventing wind turbine generators from being shut down and released in short intervals.

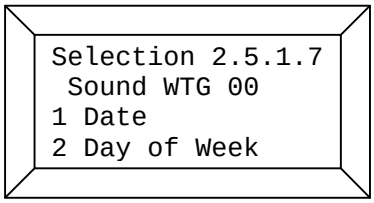


Enter the follow-up time using the numerical keys and confirm your entry by pressing the *Enter* key. Use the arrow keys to navigate through the entry positions.

2.2.5.1.7 Sound Option Selection (Menu 2.5.1.7)

This menu item and its sub items are relevant only if the shadow impact module is provided with the sound option.

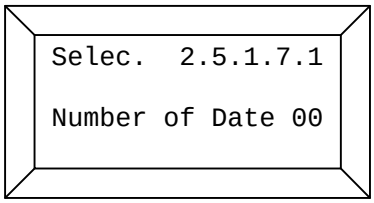
The sound option enables shutting down wind turbine generators for predefined periods of time. The shut-down may be set to be performed on specific days or on a regular basis (specific days of the week).



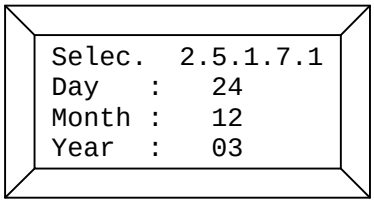
Select either shut-down by date or shut-down by day of the week by pressing the respective numerical key.

2.2.5.1.7.1 Shut-Down by Date (Menu 2.5.1.7.1)

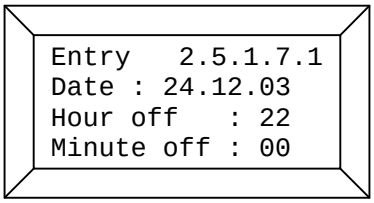
You may enter 20 different dates on which the wind turbine generator is to be shut down. Start by selecting a date number ranging from 0 to 19 using the numerical keys. Confirm your entry by pressing the *Enter* key.



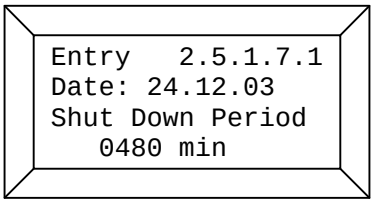
Then enter the date on which you would like the wind turbine generator to be shut down. Confirm your entry by pressing the *Enter* key.



Now please enter the shut-down time. Again, confirm your entry by pressing the *Enter* key.



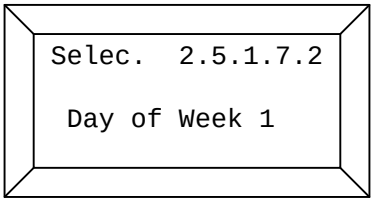
Finally, enter the shut-down period in minutes.



Confirm your entry by pressing the *Enter* key. The shut-down date is now active.

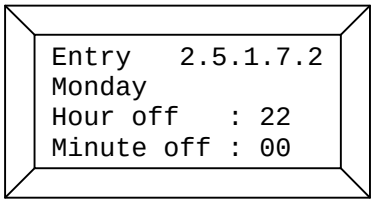
2.2.5.1.7.2 Shut-Down by Day of the Week (Menu 2.5.1.7.2)

For each day of the week, you may define a shut-down time. After the shut-down period set has elapsed, the wind turbine generator will be released.

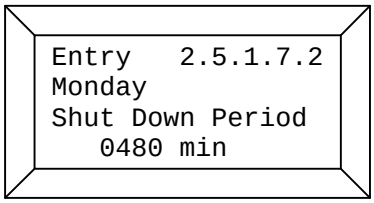


First, select the day of the week using the numerical keys and confirm your selection by pressing the *Enter* key. (1 = Monday, 2 = Tuesday etc.)

Proceed by setting the shut-down time for the selected day of the week using the numerical keys.



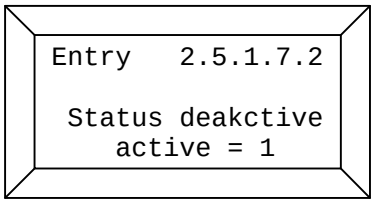
Confirm the shut-down time by pressing the *Enter* key.



In the next step, enter the shut-down period in minutes.

Confirm the shut-down duration by pressing the *Enter* key.

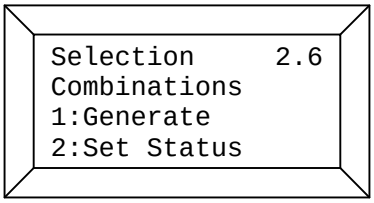
Finally, you should activate the shut-down set for the selected day of the week.



Press 1 to activate the shut-down; press 0 to deactivate the shut-down. The current status is displayed in the lower left. Confirm your entry by pressing the *Enter* key.

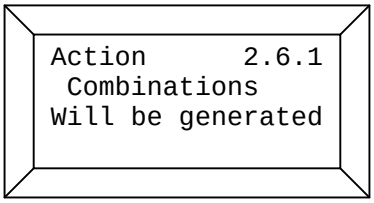
2.2.6 **Combinations (Menu 2.6)**

In order for the shadow impact caused by a wind turbine generator to be related to a place of immission, the wind turbine generator and the place of immission must be combined with each other. After the places of immission and the wind turbine generators have been entered, these are not automatically combined with each other. Combinations must be generated in Menu 2.6.1.



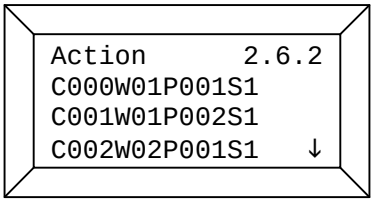
2.2.6.1 Generating the Combinations (Menu 2.6.1.1)

Upon selection of this menu item, all the places of immission are combined with all wind turbine generators. All the combinations generated during this process are assigned the active status (S=1). For a list of combinations, please refer to Menu 2.6.2.



2.2.6.2 Setting the Status of the Combinations (Menu 2.6.2)

After the combinations have been generated, they will be in active status (S=1) Therefore, the shadow impact module will assume that each wind turbine generator may cause shadow impact in each place of immission. However, if there is a visibility obstacle between a wind turbine generator

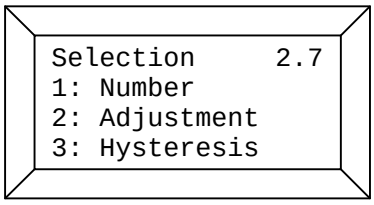


and a place of immission, real shadow impact is not possible in this place of immission. Yet, the shadow impact module will determine theoretical shadow impact. To avoid this, the respective combinations need to be deactivated. Menu 2.6.2. displays a list of combinations. You can use the up and down arrow keys to move up and down the list. The right and left arrow keys are used to move to the next 30 combinations in the list. A list item includes the consecutive number of the

combination (Cxxx), the number of the wind turbine generator (Wxx), the number of the place of immission (Pxxx) and the status of the combination (Sx). The list is sorted first by the numbers of the wind turbine generators, then by the numbers of the places of immission. To change the status of a combination, the respective list item must be in the first line of the portion of the list displayed. To deactivate a combination, please press 0; to activate a combination, press 1. Your settings will not be applied, unless you confirm by pressing the *Enter* key.

2.2.7 Selecting the Light Sensor Settings (Menu 2.7)

Up to four light sensors may be connected to the shadow impact module as required. Each light sensor can be adopted to the ambient conditions by adjusting the sensitivity. In addition, you can set a hysteresis determining how fast the shadow impact module responses to a change from sunshine to cloudy weather or vice versa.

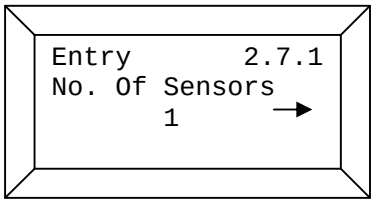


Please select the desired entry menu pressing the respective numerical key.

2.2.7.1 Entering the Number of Light Sensors (Menu 2.7.1.)

Use this menu to enter the number of light sensors connected to the shadow impact module. This parameter is preset to 1.

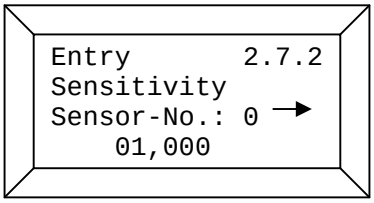
Use the arrow keys to select the number of light sensors, and confirm your selection by pressing the *Enter* key.



2.2.7.2 Adjusting the Sensors (Menu 2.7.2)

This menu allows for adjusting the light sensor sensitivity according to the ambient light conditions. The light sensitivity is preset to 1. Usually, you can retain this value. Increasing this value will increase the sensitivity of the light sensor. In case adjusting the sensitivity should be necessary, modify the value only slightly and observe the behaviour of the shadow impact module afterwards. Changing the sensitivity from 1 to 2 will cause the shadow impact module to consider shadow impact effects possible at half the direct sunlight portion.

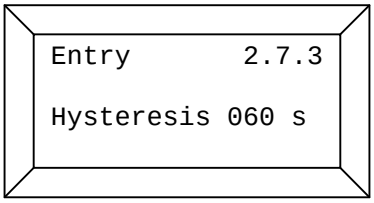
Use the numerical arrow keys to select the number of the sensor for which you wish to change the sensitivity. Confirm your entry by pressing the *Enter* key. Now you can revise the sensitivity using



the numerical keys. Confirm your entry by pressing the *Enter* key. To quit the menu, press the *Clear* key.

2.2.7.3 Entering a Hysteresis (Menu 2.7.3)

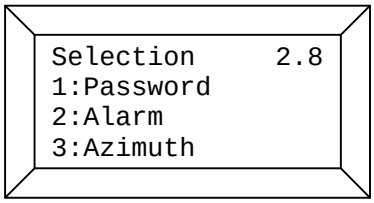
Only after the period defined by the hysteresis has elapsed, a change from "shadow impact" to "no shadow impact" will be taken into account. The hysteresis is preset to 60 seconds. To prevent the wind turbine generators from being shut down and released in short intervals due to unsettled weather conditions, the hysteresis should not be set too low.



Enter the hysteresis using the numerical keys and confirm your entry by pressing the *Enter* key. Use the arrow keys to navigate through the entry positions.

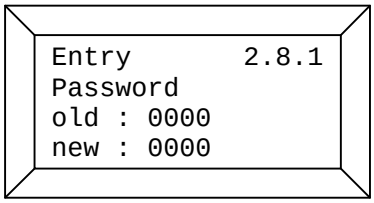
2.2.8 Miscellaneous (Menu 2.8)

Use this menu to change the password for the *Settings* menu, to set parameters for the Alarm and Azimuth function, or to select the menu language. Select a menu item by pressing the respective numerical key.



2.2.8.1 Setting the Password (Menu 2.8.1)

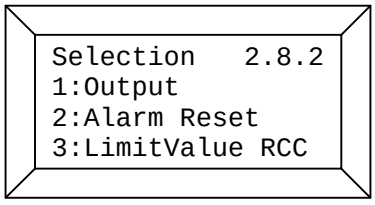
Enter your new password using the numerical keys. Confirm your entry by pressing the *Enter* key.



Note: The password is required for accessing the *Settings* menu. Please do not forget your password. The *Display* menu can be accessed without a password.

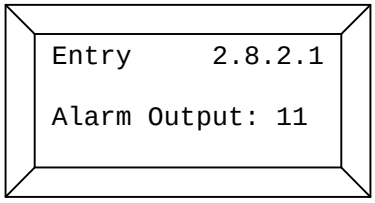
2.2.8.2 Parameters for the Alarm Function (Menu 2.8.2)

From this menu, you can navigate to the displays for setting the Alarm function parameters. Just press the desired numerical key.



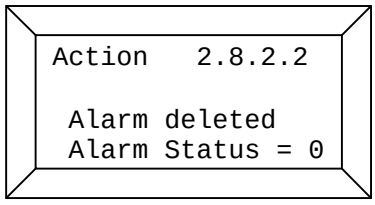
2.2.8.2.1 Entering the Alarm Output (Menu 2.8.2.1)

One shadow impact module can have up to 12 switching outputs (00 – 11). The switching output will drive the respective relay (K00 – K11) on the top hat rail. Use the numerical keys to select the switching output, and confirm your entry by pressing the *Enter* key.



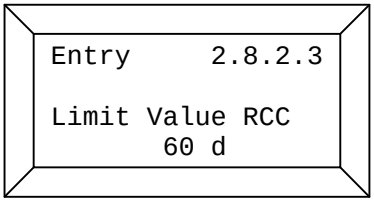
2.2.8.2.2 Clearing an Alarm (Menu 2.8.2.2)

Use this menu to clear a pending alarm.



2.2.8.2.3 Setting the RCC Limit Value (Menu 2.8.2.3)

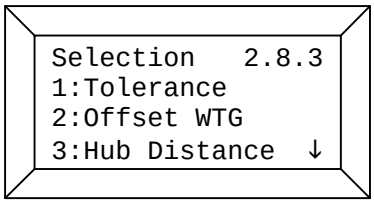
One of the purposes of the Alarm function is to monitor the proper functioning of the radio controlled clock. Once per night, the shadow impact module analyses the time telegram from the radio controlled clock in order to correct its system time. Each time the attempt to receive the time signal fails, a counter increases by one. Upon successful reception of the time signal, the counter is reset to zero. If the number of failed attempts reaches the limit value set in this menu, an alarm is triggered. The limit value is preset to 60 days. You can change this value using the numerical keys. To avoid unnecessary alarms, you should not set a value lower than the preset value. Confirm your entry by pressing the *Enter* key.



2.2.8.3 Parameters for the Azimuth Function (Menu 2.8.3)

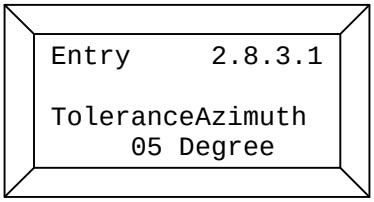
For the shadow impact calculation, the Azimuth function takes into account the azimuth of the rotor. When the rotor is positioned at a right angle to the direction of the sun rays, the shadow ellipse of the rotor is at its maximum. As the position of the rotor changes towards the direction of the sunrays, the shadow ellipse reduces in size until only a small stripe remains.

From this menu, you can navigate to the displays for setting the Azimuth function parameters. Just press the desired numerical key.



2.2.8.3.1 Setting the Azimuth Tolerance (Menu 2.8.3.1)

In order to take into account a potential inaccurateness of the azimuth signal provided by the wind turbine generator, you can enter an azimuth tolerance. The azimuth tolerance is entered in degrees. This valued is added to the angle between the direction of the sunrays and the position of

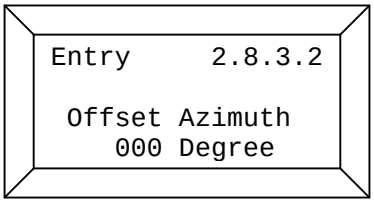


the rotor. The azimuth tolerance is preset to 5°. The higher the azimuth tolerance you set, the less effective the Azimuth function. However, if the value selected for the azimuth tolerance is too low, an inaccurate azimuth signal may cause the size of the rotor shadow to be underrated.

Enter the azimuth tolerance using the numerical keys and confirm your entry by pressing the *Enter* key.

2.2.8.3.2 Setting the Azimuth Offset (Menu 2.8.3.2)

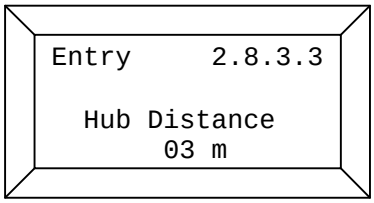
This menu can be used to compensate for a potential offset of the azimuth signal from the wind turbine generator. The offset, which is always positive, is subtracted from the azimuth. Example: if the azimuth signal differs from the actual azimuth by –10°, the azimuth offset must be 350°. The azimuth offset is preset to 0°.



Enter the azimuth offset using the numerical keys and confirm your entry by pressing the *Enter* key.

2.2.8.3.3 Entering the Hub Distance (Menu 2.8.3.3)

Use this menu to enter the distance of the rotor hub from the centre of the tower in meters. This input is required for the calculation of the position of the rotor which changes due to the rotation of the nacelle.

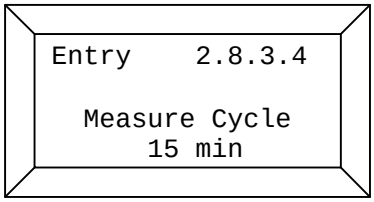


Enter the hub distance using the numerical keys and confirm your entry by pressing the *Enter* key.

2.2.8.3.4 Entering the Measuring Cycle (Menu 2.8.3.4)

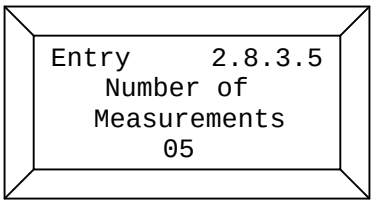
Use this menu to enter the time period between two measurements of the rotor azimuth in minutes.

Enter the measuring cycle using the numerical keys and confirm your entry by pressing the *Enter* key.



2.2.8.3.5 Entering the Number of Measurements (Menu 2.8.3.5)

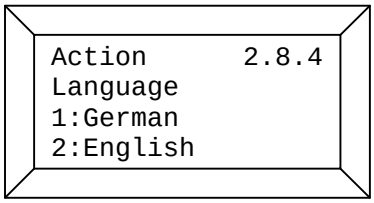
Depending on the method used to determine the azimuth of the rotor, it may be necessary to average the azimuth signal from the wind turbine generator. Use this menu to enter the number of measurements to be averaged later on.



Enter the number of measurements using the numerical keys and confirm your entry by pressing the *Enter* key.

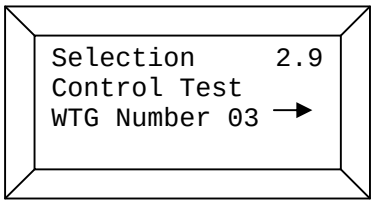
2.2.8.4 Selecting the Menu Language (Menu 2.8.4)

Use this menu to select the menu language by pressing the respective numerical key. The Language function is optional and therefore not available in every shadow impact module.

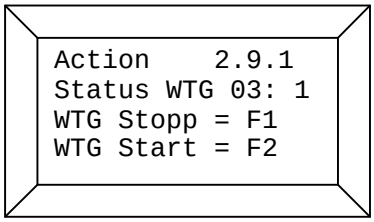


2.2.9 Control Check (Menu 2.9)

Within this menu you can shut down and release the wind turbine generators in order to check the connections between the controls of the wind turbine generators and the shadow impact module.



Start by using the arrow keys to select the wind turbine generator you wish to start/shut down. Confirm your entry by pressing the *Enter* key. The following will be displayed:



The current status of the wind turbine generator selected is displayed in the 2nd line. Status 1 means that the wind turbine generator is running, status 0 means that the wind turbine generator has been shut down by the shadow impact module.

To shut down the wind turbine generator, please press the *F1* key, to start, press the *F2* key. To quit the menu, press the *Clear* key.

3 Maintenance of the Shadow Impact Module

The shadow impact module is maintenance-free to a great extent. However, the light sensors must be checked for dirt and cleaned as necessary on a regular basis.

Also, the proper functioning of the RCC module should be checked every 4 months.

After commissioning the shadow impact module, you should check the shut-down times for plausibility in order to exclude errors in the shadow impact module configuration.

4 Technical Documentation

4.1 General Specifications

Operating temperature:	-20°C … 50°C
Protection class:	IP 65

Switch Cabinet with Module

Dimensions:	500 x 500 x 310 mm (H x W x D)
Weight:	approx. 23 kg
Supply voltage:	230 V AC
Max power consumption:	30 W

Switching Outputs

Max. switching current at 30 V DC:	10 A
Rated voltage / max. switching voltage:	250 V AC / 400 V AC
Max. switching power AC1:	2500 VA

Light Sensor

Dimensions:	80 x 65 x 80 mm (H x W x D)
Weight:	approx. 11 kg (cantilever incl.)
Cantilever length:	1.5 m
Supply voltage:	15 V DC (power supply unit installed inside the cabinet)

Radio Controlled Clock (RCC)

Dimensions:	90 x 90 x 50 mm (H x W x D)
Weight:	approx. 800 g
Supply voltage:	15 V DC (power supply unit installed inside the cabinet)

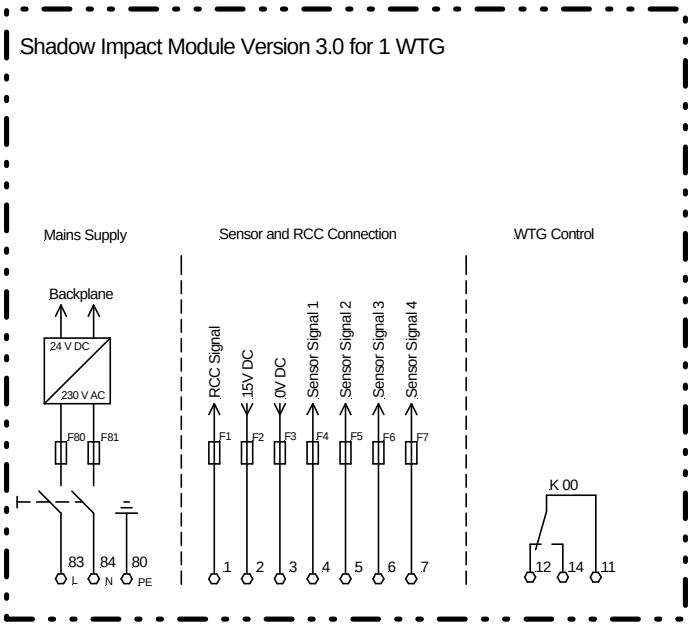
4.2 Fuses in Terminal Blocks

The terminal blocks 1 to 7 and 81/82 contain micro-fuses (5 x 20 mm) with the following values:

F1: F 160 mA
F2: F 160 mA
F3: F 160 mA
F4: F 160 mA
F5: F 160 mA
F6: F 160 mA
F7: F 160 mA
F81: F 1 A (230 V AC mains voltage!)
F82: F 1 A (230 V AC mains voltage!)

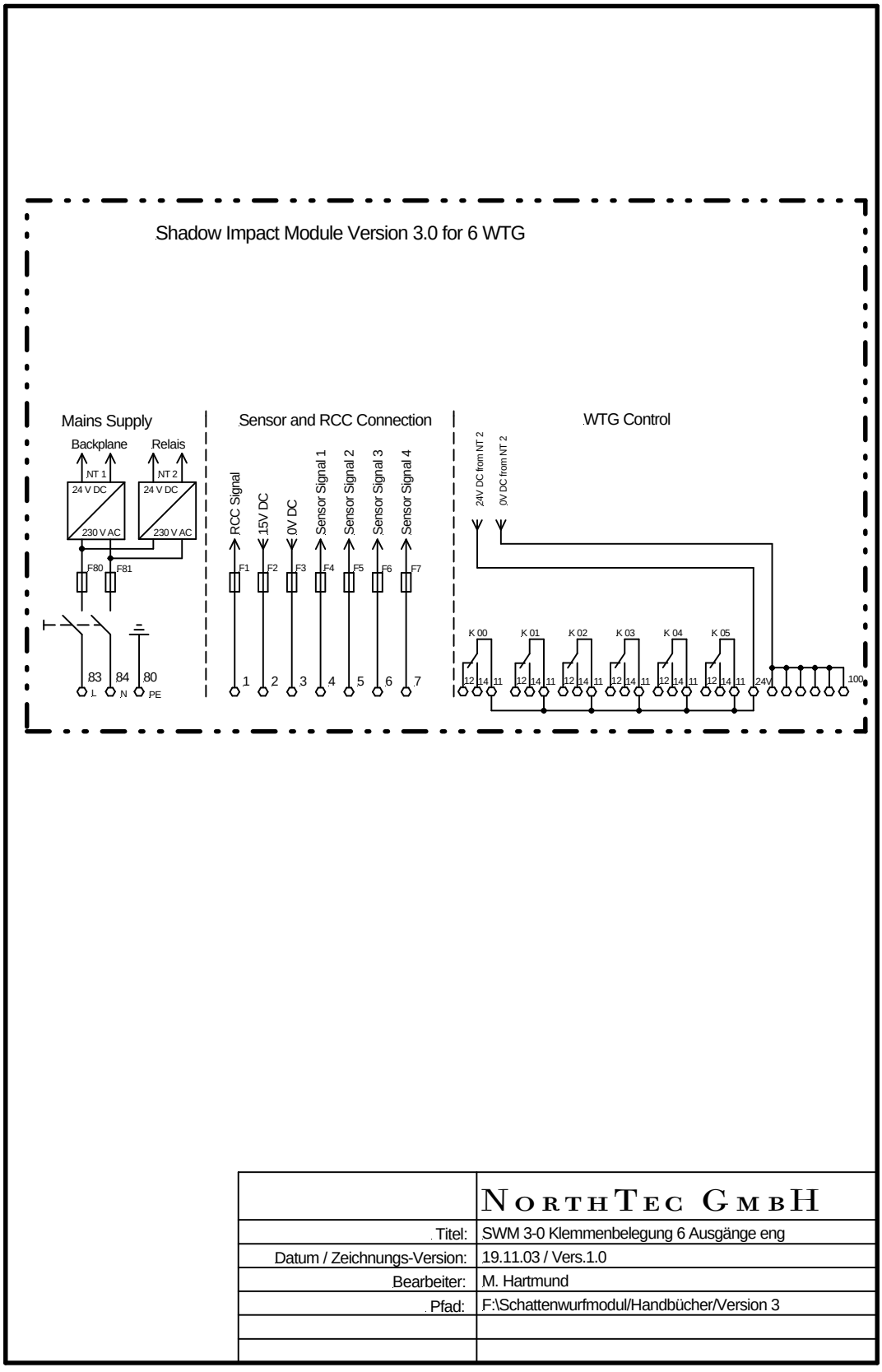
Attention! The fuses F81 and F82 are mains fuses. Disconnect the supply voltage from the shadow impact module by operating the OFF switch before you open the terminal blocks 81 and 82. Use an adequate measuring device to ensure that no voltage is present.

4.3 Shadow Impact Module Vers. 3.0 Terminal Connections for 1 WTG



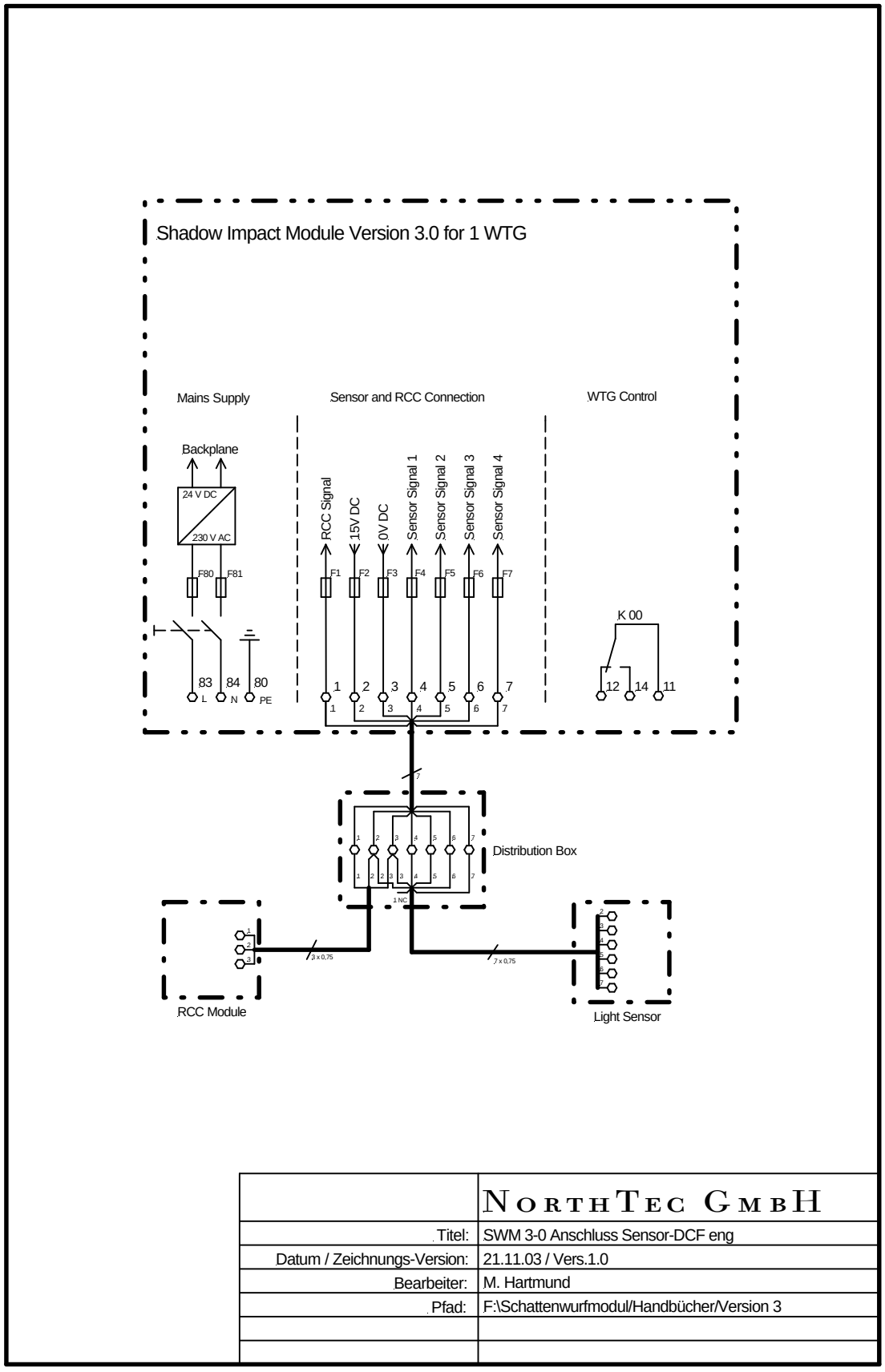
	NorthTec GmbH
Titel:	SWM 3-0 Klemmenbelegung 1 Ausgang eng
Datum / Zeichnungs-Version:	17.11.03 / Vers.1.0
Bearbeiter:	M. Hartmund
Pfad:	F:\Schattenwurfmodul/Handbücher/Version 3

4.4 Shadow Impact Module Vers. 3.0 Terminal Connections for 6 WTGs



	NorthTec GmbH
Titel:	SWM 3-0 Klemmenbelegung 6 Ausgänge eng
Datum / Zeichnungs-Version:	19.11.03 / Vers.1.0
Bearbeiter:	M. Hartmund
Pfad:	F:\Schattenwurfmodul/Handbücher/Version 3

4.5 Light Sensor and RCC Connection



	NORTHTEC GMBH
Titel:	SWM 3-0 Anschluss Sensor-DCF eng
Datum / Zeichnungs-Version:	21.11.03 / Vers.1.0
Bearbeiter:	M. Hartmund
Pfad:	F:\Schattenwurfmodul/Handbücher/Version 3

5 Appendix

5.1 Configuration Example

The following is the description of a shadow impact module configuration using an example. The shadow impact module is to monitor the shadow impact of two wind turbine generators (WTG 1 and WTG 2) in two places of immission (PI 1 and PI 2). PI 2 is exposed to shadow impact caused by a third wind turbine generator (WTG 3). Since WTG 3 has already been operated for 2 years and does not exceed any limit values by itself, it must be considered as preload. WTG 1 and WTG 2 are located west of the places of immission, WTG 3 is located east of the places of immission.
A maximum daily load of 30 minutes and a maximum annual load of 8 hours is allowed in the places of immission.
The shadow impact module is installed in WTG 1.
The following shadow impact module configuration data must be entered:
Location of the shadow impact module
The location of the shadow impact module has a degree of latitude of 52.175 ° N and a degree of longitude of 10.013 °E. The numbers to the right of the decimal point must be decimal numbers as opposed to minutes and seconds.
PI 1 has one wall which is oriented to WTG 1 and WTG 2. The relevant wall area has the following pairs of corner coordinates: (3569 746 / 5782 801) and (3569 744 / 5782 789). The wall height is 3 meters. The wall exterior is oriented north-west.
In front of the wall there is a patio area to be taken into account as well. The patio area has the following four pairs of corner coordinates: (3569 746 / 5782 801), (3569 745 / 5782 795), (3569 740 / 5782 795) and (3569 741 / 5782 802).
PI 2 has a wall which is oriented to WTG 1 and WTG 2 as well. The relevant wall area has the following pairs of corner coordinates: (3569 731 / 5782 723) and (3569 729 / 5782 711). The wall height is 5 meters. The wall exterior is oriented north-west. Another house wall is oriented to WTG 3. The relevant wall area has the following pairs of corner coordinates: (3569 752 / 5782 722) and (3569 751 / 5782 719). The wall height is 3 meters. The wall exterior is oriented south-east.
The height above sea level of the places of immission is 89 meters.
WTG 1 and WTG 2 have a hub height of 85 meters and a rotor radius of 35 meters. The location coordinates of WTG 1 are as follows: (3569 344 / 5782 850). The height above sea level is 92 meters. The location coordinates of WTG 2 are as follows: (3569 214 / 5782 653). The height above sea level is 93 meters. WTG 3 has a hub height of 60 meters and a rotor radius of 27 meters. The location coordinates of WEA 3 are as follows: (3570 093 / 5782 699). The height above sea level is 88 meters.
Using the above data, the shadow impact module can be completely configured. The coordinates are specified in Gauss-Krueger format. The first value represents "easting", the second value represents "northing".
After these data have been entered, the places of immission need to be combined with the wind turbine generators. Combining is necessary only if the wind turbine generator is actually capable of causing real shadow impact in the corresponding place of immission. Therefore, combining WTG 3 with PI 1 in this example would not make sense.

Menu 2.3 **Location**
Setting the location |
Degree of latitude 52.175 |
Degree of longitude 10.013 |

Menu 2.4
Places of immission
Menu 2.4.1
Place of immission 01 **PI 01**
Menu 2.4.1.1 |
Height above sea level: 89 m |
Menu 2.4.1.2 |
Wall 0 |
x(0.0): 3569 746 |
y(0.0): 5782 801 |
x(0.1): 3569 744 |
y(0.1): 5782 789 |
Height: 3 m |
Orientation: North or east |
Status: active |
Menu 2.4.1.3 |
Area 0 |
x(0.0): 3569 746 |
y(0.0): 5782 801 |
x(0.1): 3569 745 |
y(0.1): 5782 795 |
x(0.2): 3569 740 |
y(0.2): 5782 795 |
x(0.3): 3569 741 |
y(0.3): 5782 802 |
Status: active |
Menu 2.4.1.4 |
Permitted load times |
480 min/a |
30 min/d |

Menu 2.4.1
Place of immission 02 **PI 02**
Menu 2.4.1.1 |
Height above sea level: 89 m |
Menu 2.4.1.2 |
Wall 0 |
x(0.0): 3569 731 |
y(0.0): 5782 723 |
x(0.1): 3569 729 |
y(0.1): 5782 711 |
Height: 5 m |
Orientation: North or east |
Status: active |
Menu 2.4.1.2 |
Wall 1 |
x(0.0): 3569 752 |
y(0.0): 5782 722 |
x(0.1): 3569 751 |
y(0.1): 5782 719 |
Height: 3 m |
Orientation: South or east |
Status: active |
Menu 2.4.1.4 |
Permitted load times |
480 min/a |
30 min/d |

Menu 2.5
Wind turbine generators
Menu 2.5.1
WTG 01 **WTG 01**
Menu 2.5.1.1 |
Hub height: 85 m |
Menu 2.5.1.2 |
Rotor radius: 35 m |
Menu 2.5.1.3 |
Height above sea level: 92 m |
Menu 2.5.1.4 |
Location coordinates |
X(01): 3569 344 |
Y(01): 5782 850 |
Menu 2.5.1.5 |
WTG switchable |
Switching output 00 |

Menu 2.5.1
WEA 02 **WEA 02**
Menu 2.5.1.1 |
Hub height: 85 m |
Menu 2.5.1.2 |
Rotor radius: 35 m |
Menu 2.5.1.3 |
Height above sea level: 93 m |
Menu 2.5.1.4 |
Location coordinates |
X(01): 3569 214 |
Y(01): 5782 653 |
Menu 2.5.1.5 |
WTG switchable |
Switching output 01 |

Menu 2.5.1
WTG 03 **WTG 03**
Menu 2.5.1.1 |
Hub height: 60 m |
Menu 2.5.1.2 |
Rotor radius: 27 m |
Menu 2.5.1.3 |
Height above sea level: 88 m |
Menu 2.5.1.4 |
Location coordinates |
X(01): 3570 093 |
Y(01): 5782 699 |
Menu 2.5.1.5 |
WTG non-switchable |
Switching output 99 |

Menu 2.6
Combinations
Menu 2.6.1
Combination 000 **Combination 000**
Menu 2.6.1.1 |
WTG 01 |
Menu 2.6.1.2 |
PI 01 |
Menu 2.6.1.3 |
Status: active |
Menu 2.6.1
Combination 001 **Combination 001**
Menu 2.6.1.1 |
WTG 01 |
Menu 2.6.1.2 |
PI 02 |
Menu 2.6.1.3 |
Status: active |
Menu 2.6.1
Combination 002 **Combination 002**
Menu 2.6.1.1 |
WEA 02 |
Menu 2.6.1.2 |
PI 01 |
Menu 2.6.1.3 |
Status: active |
Menu 2.6.1
Combination 003 **Combination 003**
Menu 2.6.1.1 |
WEA 02 |
Menu 2.6.1.2 |
PI 02 |
Menu 2.6.1.3 |
Status: active |
Menu 2.6.1
Combination 0 04 **Combination 004**
Menu 2.6.1.1 |
WTG 03 |
Menu 2.6.1.2 |
PI 02 |
Menu 2.6.1.3 |
Status: active |

5.2 Example of a Log

Entry	Date	Time	PI	WTG	Daily Counter	Annual Counter	Wind Direction	Wind Speed	Power	WTG Status	Event
1	29.09.2003	8:15:23	2	3	0	347					Shadow Impact
2	29.09.2003	8:32:12	2	3	16	363					End of Shadow Impact
3	29.09.2003	16:07:12	2	2	16	363					Shadow Impact
4	29.09.2003	16:21:15		2							Stop WTG
5	29.09.2003	16:44:12	2	2	30	377					End of Shadow Impact
6	29.09.2003	16:44:23		2							Start WTG
7	29.09.2003	17:01:23	1	1	0	480					Theoretical Shadow Impact
8	29.09.2003	17:09:54	1	1	0	480					Shadow Impact
9	29.09.2003	17:09:07		1							Stop WTG
10	29.09.2003	17:25:34	1	1	0	480					End of Shadow Impact
11	29.09.2003	17:25:42		1							Start WTG

Entry 1: WTG 3 causes real shadow impact in PI 2.
Entry 2: The shadow impact in PI 2 caused by WTG 3 has ended as the sun has changed its position.
Entry 3: WTG 2 causes real shadow impact in PI 2.
Entry 4: WTG 2 is stopped because the limit value of 30 minutes has been exceeded in PI 2.
Entry 5: Since the sun has changed its position, WTG 2 can no longer cause shadow impact in PI 2.
Entry 6: WTG 2 is released.
Entry 7: WTG 1 could cause shadow impact in PI 1, provided the direct sun radiation is strong enough.
Entry 8: WTG 1 causes real shadow impact in PI 1.
Entry 9: WTG 1 is stopped because the limit value of 8 hours has been exceeded in PI 1.
Entry 10: Since the sun has changed its position, WTG 1 can no longer cause shadow impact in PI 1.
Entry 11: WTG 1 is released.

Douglas Woods Wind Farm

Flicker Mitigation Plan

American Pro Wind, LLC

September 28, 2010

Douglas Woods Wind Farm

Flicker Mitigation Plan

Background

American Pro Wind, LLC (APW) is developing a commercial-scale wind farm project on a 298-acre site in Douglas, Massachusetts located off of Route 16 and abutting the Webster town line. The project consists of 11 wind turbines. Each wind turbine is affixed to the top of a 100-meter tower with three 50-meter blades. Each turbine has a nameplate capacity of 2.5 MW. With a total capacity of 27.5 MW, the project is estimated to generate approximately 61 to 65 million KW hours of clean, renewable electricity annually, enough to power all the households in the towns of Douglas and Webster combined. It is estimated that the clean, renewable energy generated by this facility will avoid between 45,000 to 49,000 tons of CO2 emissions annually. It is also expected that the project will generate approximately $150,000 in additional annual PILOT (Payment-in-Lieu-of-Taxes) revenues for the town of Douglas and $82,000 in additional annual tax revenues for the Town of Webster. The project parcel has received a Height and Use Variance from the Douglas Zoning Board of Appeals (ZBA) establishing the legal right to construct up to 13 turbines on the project site and establishing 22 approval conditions. Among the conditions are the project's setback requirements including a requirement to construct the wind turbines no closer than 1,000 feet to any residential building existing as of May 6, 2009.

Shadow Flicker Explanation

During certain times of the day, usually very early morning or late afternoon when the sun is low on the horizon, the wind turbines may cause shadow flicker (moving shadow) at buildings within a certain distance of the turbines. The shadow flicker happens only when the turbine is located directly between the sun and the building. It is caused by the sunlight being intermittently blocked by the rotating blades as the sunlight passes through the turbine blades. This flicker effect is typically caused only in certain conditions when the sun is shining, the sun is low on the horizon, and the wind is blowing at a sufficient speed to rotate the blades. In addition, the amount of shadow flicker observed is influenced by the direction of the wind. For instance, when the wind is blowing in a direction which results in the blades rotating at a 90 degree angle to a direct line between the sun and the receptor (residential building), then the amount of shadow flicker is maximized. When the wind is blowing in a direction that results in the blades rotating in parallel to a direct line between the sun and the receptor (residential building), then the amount of shadow flicker is reduced to a minimum. Shadow flicker dissipates over distance and is typically not observed at all from distances of 1,000 meters (3,280 feet) or more from the turbines. In the case of the Douglas Woods Wind Farm, all of the residential buildings within 3,280 feet of the turbines are located to the west (specifically northwest, west, and southwest) of the affecting turbines. Therefore, the expected shadow flicker will occur only in the morning hours with the vast majority of it in the very early morning hours.

While the "moving" or "on-off" effect of shadow flicker does not pose any health risks, it can be annoying. Therefore, most commercial-scale wind farms provide for mitigation by shutting off the affecting turbines for a sufficient amount of time to ensure that the shadow flicker is not experienced by nearby residents for a prolonged period of time during the course of a day and the course of a year. Shadow flicker can also be mitigated by trees and vegetation acting as obstructions so that the shadow flicker is not observed, or it can be mitigated by the use of shades or blinds in the building.

Douglas Woods Wind Farm

Flicker Mitigation Plan

There are no state laws or local bylaws that restrict shadow flicker. Common practice is to minimize the amount of shadowing/flicker through siting and/or mitigation such that prolonged impacts are not felt by neighboring residences. A typically applied standard for wind farms in North America is that shadow flicker will be reduced to 30 expected (or experienced) hours per year or less for nearby residences. This standard results in residences experiencing no flicker for at least 99.7% of the time during any given year.

Purpose of the Plan

On May 6, 2009 a Height and Use Variance was granted by the Douglas ZBA allowing construction of up to 13 turbines on the project site. The site plan currently being proposed is for the construction of 11 wind turbines. The Variance Agreement created conditions for the construction of the wind energy project. For example, it established setbacks and requires that all turbines are constructed at least 1,000 feet from any existing residential buildings. This setback requirement in itself will reduce the number of nearby residents that will experience shadow flicker impact.

Condition #7 of the Variance Agreement specifically requires that "During Site Plan Review, the Applicant shall present mitigation of shadowing or flicker impacts as follow. As to any residential location existing as of May 6, 2009, where estimated shadowing/flicker exceeds 30 Experienced Hours per year, the Applicant shall provide to the Board with copies to the affected property owners, a Flicker Mitigation Plan for the Board's review and approval, prior to the submission of the building permit application. Said Mitigation Plan shall either: (i) provide for mitigation where shadowing/flicker is reduced to thirty (30) Experienced Hours or below per year; or (ii) set forth such other acceptable resolution that may be approved as part of the Mitigation Plan. "Experienced hours" are defined as hours a residence is in use and the occupants are awake. The purpose of this Flicker Mitigation Plan is to completely satisfy the requirements of Condition #7.

Shadow Flicker Analysis Study

A Shadow Flicker Analysis Study was conducted on behalf of American Pro Wind, LLC by Atlantic Design Engineers and completed on September 14, 2010. The study without Appendix A, which is 93 pages of very detailed data print-outs, is attached to this plan. The complete Shadow Flicker Analysis Study with Appendix A is available to the public at the Douglas Town Clerk's office. The study utilizes WindPRO software, which is commonly used within the wind energy industry to determine shadow flicker impacts. By entering the exact locations (GPS coordinates) and dimensions of the 11 turbines, the software can calculate the amount of shadow flicker hours/year that is expected to be observed in areas of close proximity to the project site. Figures 3 and 4 in the Shadow Flicker Study show aerial photos that utilize colored iso lines to show the areas that will receive certain ranges of expected flicker hours per year.

Douglas Woods Wind Farm

Flicker Mitigation Plan

As the Study shows, there are 34 residential buildings located within the orange line (50-74 hours), gold line (30-49 hours), and yellow line (20-29 hours) combined. All of these 34 residences are located in Webster, MA in the areas of Blueberry Hill, Douglas Road, and Old Douglas Road. The locations (GPS coordinates) of these 34 residential buildings were entered into the WindPRO software, which calculated the shadow flicker hours per year at each of the 34 locations – both the "astronomical (or theoretical)" worst case hours and the actual expected hours/year of shadow flicker. The "astronomical (or theoretical)" worst case hours assume that the sun is shining 100% of the time, the wind is blowing 100% of the time, the wind is blowing 100% of the time from the direction that will result in the rotors rotating perpendicular to the line from the residential building to the turbine creating maximum shadow flicker, and the turbine is available for operation 100% of the time. Of course, this scenario will never happen which is why it is called the "astronomical (or theoretical)" worst case.

In reality, the actual expected hours will be much lower because of times when it is cloudy, because of times when the wind is not blowing, because of times when the wind is not blowing in a direction that results in the blades rotating at a 90 degree angle to the line between the sun and the residential building, or because of times when the turbine is shut down for scheduled maintenance or repair. The expected hours can therefore be calculated by the Wind PRO software by starting with the "astronomical (or theoretical)" worst case hours and reducing that number to account for the percentage of time it is sunny versus cloudy, the percentage of time the wind speed is sufficient to rotate the blades, and the percentage of time that turbine is available for operation (and not down for planned maintenance or repair). The expected hours calculation is further reduced to account for the fact that the wind is not always blowing in a direction that results in the blades rotating at a 90 degree angle to the line between the sun and the residential building. Historical data for sunshine, wind speed, turbine availability, and wind direction were entered into the WindPRO software to make these calculations.

The output of the analysis includes the table on page 6 of the Shadow Flicker Analysis (attached) entitled "Estimated Shadow Flicker", which lists the 34 residences, their address, the "astronomical (or theoretical)" worst case shadow flicker hours/year, the expected shadow flicker hours/year, the astronomical (or theoretical) maximum shadow flicker minutes/day, and the expected shadow flicker minutes/day. As the table below shows, 17 of the 34 residential locations are expected to experience shadow flicker of more than 30 hours/year and will, therefore, require mitigation. In addition to the summary table, the output of the analysis also provides us with the calculated expected shadow flicker hours by day for an entire calendar year at each of the 17 residential buildings. This is shown in the attachment entitled SHADOW - Main Result, which shows for each of the 17 residences the daily flicker impact in minutes, the time at which the flicker is expected to begin and end, and the particular number of the turbine(s) causing the shadow flicker (see Shadow Flicker Analysis for project layout and turbine #'s). The Flicker Mitigation Plan submitted to the Planning Board will include this annual calendar with expected daily shadow flicker impacts for all 17 residences. The Plan submitted to affected residents will include the calendar of expected daily shadow flicker impact for their particular residence.

Douglas Woods Wind Farm

Flicker Mitigation Plan

In reality, many of the 34 residences listed are located in close proximity to trees which may act as an obstruction that can reduce or eliminate any potential shadow flicker impacts. As a result, it is likely that some of the 34 residences listed will experience substantially reduced shadow flicker times compared to those shown in the analysis. However, the extent of the benefit of these obstructions is hard to predict and could be variable (i.e. foliage disappears in the winter on non-evergreen trees). Therefore, in order to be appropriately conservative, APW has assumed in this analysis that no trees or obstructions exist. This will help assure that all potential shadow flicker impacts on nearby residences will be fully captured by the analysis.

Flicker Mitigation Plan - Objectives

In order to satisfy Condition #7 of the Height and Use Variance Agreement, the objective of the Flicker Mitigation Plan is to reduce shadow flicker hours to 30 Experienced Hours/year or less at all residential buildings existing as of May 6, 2009. "Experienced Hours" is further defined by the Variance Agreement as hours that the residence is in use and the occupants are awake. This definition would typically reduce the amount of expected shadow flicker hours at many households because much of the flicker occurs very early in the morning when occupants may be sleeping. In reality, it is virtually impossible to determine at any given time who in the residence is awake or sleeping. Therefore, to be appropriately conservative, the calculation of expected shadow flicker hours/year assumes that the occupants are always awake. To be additionally conservative, the target maximum Experienced Hours/Year allowable at each of the 17 affected residences (after mitigation) has been reduced from 30 to 29 hours to reduce any potential margin of error. Based on the Shadow Flicker Analysis, Exhibit A (next page) lists the 17 residences that will receive more than 30 expected hours/year of shadow flicker, and therefore will be provided with mitigation. It also lists the expected shadow flicker hours/year for each of the 17 residences and the corresponding mitigation hours/year required to reduce the net expected shadow flicker hours (after mitigation) to 29 hours, which is below the 30 hour maximum required by Condition #7 For example, the table below shows that the calculated expected shadow flicker hours/year for 70 Old Douglas Road prior to mitigation is 38 hours and 55 minutes. As Exhibit A shows, the estimated mitigation required to reduce the shadow flicker hours/year at 70 Old Douglas Road to 29 hours/year is 9 hours and 55 minutes per year. Exhibit A shows that the worst case shadow flicker occurs at 4 Dream Street, which is expected to experience 54 hours and 2 minutes of shadow flicker per year prior to mitigation. The estimated mitigation hours/year required at this residence is 25 hours and 2 minutes in order to reduce the shadow flicker hours/year to 29 hours.

A secondary objective of the Flicker Mitigation Plan, although not required by the Variance Agreement, is to mitigate the shadow flicker for the 17 residences in a way that assures that none of the 17 residences in Exhibit A receive more than 30 minutes of shadow flicker in any one day. This objective was added to the plan as a result of input from the Douglas Planning Board.

Douglas Woods Wind Farm

Flicker Mitigation Plan

Exhibit A

ESTIMATED SHADOW FLICKER AND MITIGATION PLAN

SHADOW RECEPTOR	ESTIMATED SHADOW FLICKER			
Receptor Name	Astronomical Maximum Value Hours/Year	Expected Hours/Year	Mitigated Hours/Year	Net Expected Hours/Year After Mitigation
A. – 135 Douglas Road	122:59 hours/year	34:03 hours/year	≈ 5:03 hours/year	≈ 29 hours/year
B. – 78 Old Douglas Road	101:08 hours/year	32:25 hours/year	≈ 3:25 hours/year	≈ 29 hours/year
C. – 4 Dream Street	153:28 hours/year	54:02 hours/year	≈ 25:02 hours/year	≈ 29 hours/year
D. – 63 Blueberry Way	97:49 hours/year	37:19 hours/year	≈ 8:19 hours/year	≈ 29 hours/year
E. – 133 Douglas Road	112:44 hours/year	30:44 hours/year	≈ 1:44 hours/year	≈ 29 hours/year
H. – 76 Old Douglas Road	99:22 hours/year	32:25 hours/year	≈ 3:25 hours/year	≈ 29 hours/year
I. – 74 Old Douglas Road	132:39 hours/year	45:18 hours/year	≈ 16:18 hours/year	≈ 29 hours/year
J. – 72 Old Douglas Road	116:51 hours/year	40:29 hours/year	≈ 11:29 hours/year	≈ 29 hours/year
K. – 70 Old Douglas Road	112:04 hours/year	38:55 hours/year	≈ 9:55 hours/year	≈ 29 hours/year
L. – 68 Old Douglas Road	89:03 hours/year	30:15 hours/year	≈ 1:15 hours/year	≈ 29 hours/year
M. – 66 Old Douglas Road	89:38 hours/year	31:53 hours/year	≈ 2:53 hours/year	≈ 29 hours/year
P .– 61 Blueberry Hill	99:15 hours/year	37:38 hours/year	≈ 8:38 hours/year	≈ 29 hours/year
T. – 53 Blueberry Hill	89:20 hours/year	32:34 hours/year	≈ 3:34 hours/year	≈ 29 hours/year
U. – 51 Blueberry Hill	102:35 hours/year	37:02 hours/year	≈ 8:02 hours/year	≈ 29 hours/year
V. – 49 Blueberry Hill	120:21 hours/year	43:51 hours/year	≈ 14:51 hours/year	≈ 29 hours/year
W. – 47 Blueberry Hill	97:36 hours/year	34:55 hours/year	≈ 5:55 hours/year	≈ 29 hours/year
Y. – 3 Dream Street	115:43 hours/year	41:53 hours/year	≈ 12:53 hours/year	≈ 29 hours/year

Douglas Woods Wind Farm

Flicker Mitigation Plan

More discussion is needed on the background work that will need to be done to set up the module such as taking a critical look at each receptor to obtain the coordinates of walls/areas to be input for each immersion point(receptor). It would be useful to include in the plan an explanation of how this will be done. A simple statement in the plan that refers to the example in the appendix 5 might due. Similarly, a discussion of the combinations analysis see 2.2.6 is needed. The tasks and methodology that will be performed to ensure accurate input to the module needs to be fully explained in this plan at a minimum assuming there will be some form of oversight of the qa/qc process once the facility is constructed and the module is being set up. E.g. some of the detailed submittal requirements of the inputs to the module. If the current framework doesn't allow for this (I.e., once the site plan is approved the planning board's job is over) then the board may want to require more up front work on the mitigation plan now before it is accepted.

Flicker Mitigation Plan - Method

In order to mitigate the shadow flicker hours sufficiently to reduce experienced hours to 30 hours/year or less at each of the 17 residential locations, APW will install a Shadow Impact and Switch Off Module as well as a photo voltaic light sensor to control Turbines # 1, 4, 7, and 9. Which turbine will the module be located in.? How many light sensors will be ~~These~~incorporated? These are the primary turbines causing the greatest amount of shadow flicker impact on the 17 residences. A single Shadow Impact Module can monitor and control up to 12 wind turbines in up to 100 receptors (residential locations). The Shadow Impact Module is manufactured by NorthTec GmbH and will be installed by Nordex, the manufacturer of the turbines. Detailed information regarding the module is provided by the attachment entitled "Shadow Impact Module SIM - Manual for Version 3.0." This automated method of shutting down turbines to mitigate the Experienced Hours of shadow flicker to 30 hours/year or less is the most effective way to ensure proper mitigation. Setting a fixed schedule would not work. Even though we can provide a fairly accurate estimate of the expected hours of shadow flicker per year, we cannot predict the exact timing of the flicker because we cannot predict the exact times when the sun will shine, the exact times when the wind will blow, and the exact times when the wind is blowing a certain direction. The automated module determines when these conditions exist and shuts down the turbines accordingly. It will track the actual hours of Experienced shadow flicker at each of the 17 affected residences and automatically shuts the affecting turbines off when the maximum allowances have been reached. Therefore, it is the most reliable method to mitigate the shadow flicker impact to a specific number of Experienced Hours.

The module is programmed with the exact locations (GPS coordinates) of the turbines (#1, 4, 7, and 9) and the exact locations (GPS coordinates) of the 17 residences that require mitigation. There is a lot more input than this see 2.2.4 & 2.2.6 for example. This should be explained here in the plan. The Shadow Impact Module determines the position of the sun relative to the turbines(s) and relative to each residence and calculates the times of the year and the times of each day that shadow flicker is theoretically possible. This is essentially the same as the "astronomical (or theoretical)" worst case calculated in the Shadow Flicker Analysis described above. Whenever the shadow flicker is theoretically possible based upon the position of the sun, then the automatic module and light sensor detect if the conditions exist (sunshine, wind speed, wind direction) that can result in potential shadow flicker actually occurring. If all the conditions exist which can result in actual experienced shadow flicker at any one of

the 17 residences, since the module can accept up to 100 immersion points board should require that additional immersion points beyond the 17 identified in the study at the request of the board, due to excessive complaints etc. be included if necessary once the facility is ~~the~~operational the module starts counting the minutes of flicker for that particular residence. When the counter reaches the maximum limit of 30 minutes/day or 29 hours/year for a particular residence, the module will automatically shut off the affecting turbine(s) for the rest of the day or for the rest of the year the module is more complicated than this. it would be to APWs advantage to take advantage of the functions that would also try to optimize the times with respect to wind (start the calendar year during the high wind months so that once the limits are reached, the shutdowns occur during the less windy months see 2.2.4.2.6 whenever the conditions allowing actual shadow flicker impact are present. This will ensure that each of the 17 residences will receive a maximum of 29 Experienced Hours of flicker per year and a maximum of 30 Experienced Minutes of flicker per day.

Douglas Woods Wind Farm

Flicker Mitigation Plan

Maintenance

Nordex will be responsible for the maintenance of the Turbines and the Shadow Impact Module. The Shadow Impact Module itself is requires little maintenance. However, the light sensors will be checked for dirt and cleaned on a regular basis, at least every 4 months. Also, the proper functioning of the Radio Controlled Clock (RCC) module will be checked every 4 months. After commissioning the Shadow Impact Module, Nordex will check the shut-down times for plausibility in order to exclude potential errors in the shadow impact module configuration. Finally, Nordex assure reliable operation of the Shadow Impact Module by reviewing the daily logs and quarterly reports to confirm that the maximum allowable flicker limits of 30 hours per year and 30 minutes per day have not been exceeded at any of the 17 affected residences that require mitigation, and if the limits have been reached to verify that the affecting turbines are being automatically shut off accordingly when flicker conditions exist.

Tracking/Reporting

APW will install an optional log function on the Shadow Impact Module which tracks, records, time stamps (using the radio controlled clock installed on the turbine) and stores all shadow flicker impact events at each of the 17 residential locations (referred to as "Places of Immission" in the attached Shadow Impact Module manual) during the course of a one year period. The events recorded by the log include:

1. **Shadow Impact:** Real shadow flicker impact is actually occurring at a specific residential location.

2. **Theoretical Shadow Impact:** Theoretically, shadow flicker impact may occur at a specific residential location based on the position of the sun. However, all of the conditions (sunshine, wind speed, turbine availability, wind direction) are not present that would allow actual shadow flicker to occur.
3. **End of Shadow Impact:** Since the sun has changed its position, the corresponding wind turbine can no longer cause actual shadow flicker impact at the corresponding residential location.
4. **Stop WTG:** The corresponding wind turbine generator was stopped by the shadow flicker impact module because either the daily or annual maximum limit of actual experienced shadow flicker hours has been exceeded at the corresponding residential location.
5. **Start WTG:** The corresponding wind turbine generator was released and allowed to turn back on because the conditions (sunshine, sun position, wind speed, wind direction) that would allow potential shadow flicker to occur no longer exist.

Douglas Woods Wind Farm

Flicker Mitigation Plan

By reviewing the logs, one will be able to tell the following information on a daily or annual basis for each of the 17 residential locations:

2. The number of hours of "theoretical (or astronomical)" worst case shadow flicker when the sun was in a position to create potential shadow flicker impact assuming that all the conditions (sunshine, wind speed, wind direction, turbine availability) necessary to allow flicker impact are present all the time.
3. The number of hours of expected shadow flicker (prior to mitigation) when all the conditions (sunshine, wind speed, wind direction, turbine availability) required to cause shadow flicker impact are present.
4. The number of hours that the affecting turbines were shut down to provide mitigation because the maximum limits of daily or annual shadow flicker had been exceeded at that particular residential location.
5. The number of net (after mitigation) actual Experienced Hours of shadow flicker at a particular residential location.

APW will investigate the feasibility of providing on-line access to these reporting logs. If this capability exists, then the reporting logs will be made accessible to the public via the Town of Douglas web site. In any case, a quarterly tracking report will be submitted by Nordex to the Town of Douglas, which will be

available for public viewing. The quarterly report will list the following information for each of the 17 affected residences being provided with mitigation:

1. The theoretical (worst case) of shadow flicker – both the number of minutes for each day during the quarter and the cumulative hours year-to-date
2. The actual expected (pre-mitigation) shadow flicker – both the number of minutes for each day during the quarter and the cumulative hours year-to-date
3. The mitigation time when the affecting turbines are shut off automatically because either the daily maximum or the annual maximum has been exceeded – both the mitigation minutes per day for each day during the quarter and the cumulative mitigation hours year-to-date
4. The net Experienced (after mitigation) shadow flicker – both the Experienced minutes for each day during the quarter and the cumulative hours year-to-date