CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

CS120 Visibility Measurement Solution

CS120 Visibility Measurement for Intelligent Control of Wind Turbine Obstruction Lights

The visual impacts of wind turbines are familiar to us all, and are at the root of many concerns about new wind farm deployments close to population centres. Bright flashing lights shining through the windows of homes or workplaces could be a source of great distraction or annoyance for many people living or working near wind farms. The aircraft warning lights that are used on wind turbines are typically of a very high intensity of over 20,000 Candela – an essential aid to navigation in poor weather conditions, but nonetheless an intrusion in urban areas when visibility conditions are good.

The wind farm permitting and construction processes are already notoriously challenging, and it is therefore in the best interests of project developers to have local community and governmental support. Campbell Scientific has developed an affordable visibility sensor that is ideal for managing the effects of wind turbine obstruction lights. It allows visibility measurements to dim lights in clear weather conditions.

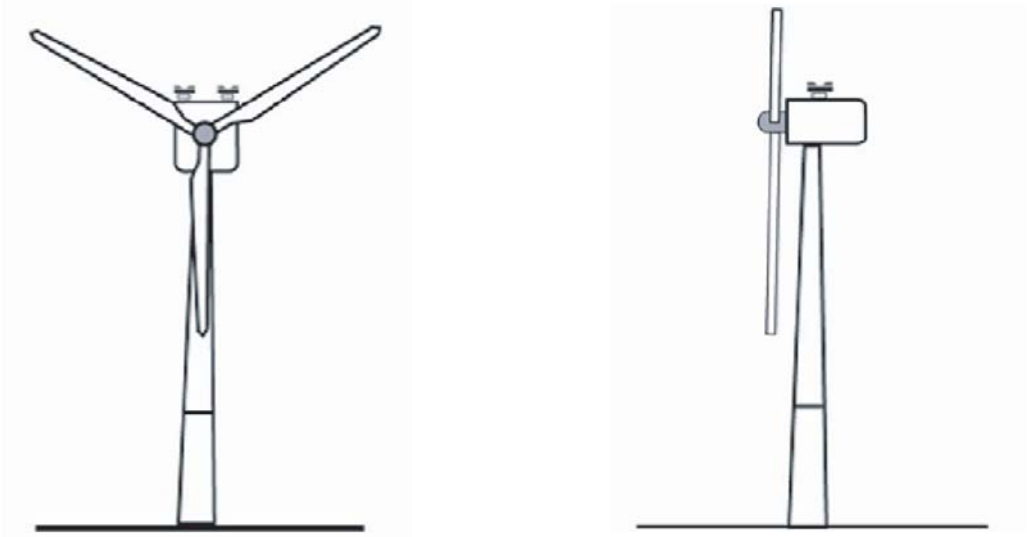
International Regulation for Visibility Controlled Wind Turbine Obstruction Lights

Germany has in recent years passed legislation to allow for the luminous intensity of navigation lights to be adapted to visibility conditions. German law now stipulates that lights must only burn at 30% of their original intensity when visibility is above 5km and at only 10% of original intensity when visibility is above 10km (Bundesanzeiger, no. 81/2007). It is worth considering that the weather in Germany is clear enough to have visibility above 10km 90 out of 100 days.

Similarly, the United States FAA General Operating and Flight Rules (FAR Part 91) prescribe visual flight rules (VFR) weather minimums for governing the operation of aircraft within the U.S. (see next page).

Time Period	Meteorological Visibility Statute (miles)	Distance Statute (miles)	Intensity (candelas)
Night	3 (4.8km)	2.9 (4.7km)	1,500 (± 25%)
		3.1 (4.9km)	2,000 (± 25%)
		1.4 (2.2km)	32
Day	1 (1.6km)	1.5 (2.4km)	200,000
		1.4 (2.2km)	100,000
		1.0 (1.6km)	20,000 (± 25%)
Day	3 (4.8km)	3.0 (4.8km)	200,000
		2.7 (4.3km)	100,000
		1.8 (2.9km)	20,000 (± 25%)
Twilight	1 (1.6km)	1.0 (1.6km) to 1.5 (2.4km)	~20,000 (± 25%)
Twilight	3 (4.8km)	1.8 (2.9km) to 4.2 (6.7km)	~20,000 (± 25%)

Table 1. Minimum obstruction light intensities for given meteorological visibility in varying conditions under U.S. FAA FAR Part 91 operating standards (FAA 1989). Justification for using these values in Visibility Statutes are provided in FAA documents.



Front View *Side View*

Figure 1. Typical lighting of a stand-alone wind turbine as shown in the U.S. FAA Advisory Circular AC 70/7460-1K

Public Opposition to Wind Turbines

A number of studies conducted in 2010 and 2012 analysed feedback from members of the public living near 13 wind farms in Germany. Many respondents indicated that wind farm obstruction lights were a source of great annoyance, and there was evidence of discernible stress effects. On clear nights the obstruction lights were even more of a disturbance. The studies showed that residents living near wind farms without visibility-adjusted obstruction light intensity were most affected.

The IEA Wind Social Acceptance of Wind Energy Projects recommends: applying light intensity adjustments using visibility measurements, as well as the use of demand-oriented solutions to improve local acceptance of wind turbine obstruction lights. The wind power industry is constantly looking for and testing new demand-oriented solutions such as aircraft surveillance radar systems installed at wind farms or transponders installed on aircraft. Both of these concepts allows the activation of obstruction lights only when aircraft are in the vicinity of the wind farm. Regardless of what new industry solutions are adopted, visibility measurements can still complement these by providing supporting information to ensure that the light intensity is appropriate for the meteorological conditions when they need to be activated.

Campbell Scientific Visibility Measurement Solution

The Campbell Scientific Visibility Sensor CS120 uses tried and tested infra-red forward scatter technology and utilises the proven 42° scatter angle to report Meteorological Observable Range (MOR). Its measurement range of 10m – 32,000m supports the visibility requirements established for wind turbine light control. It combines a high specification with a very competitive price and is ideal for wind energy environments.

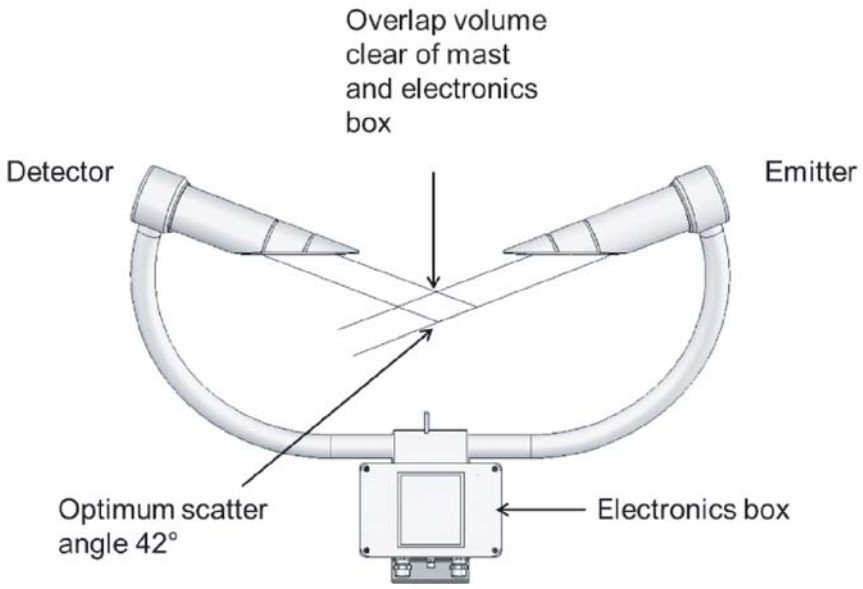
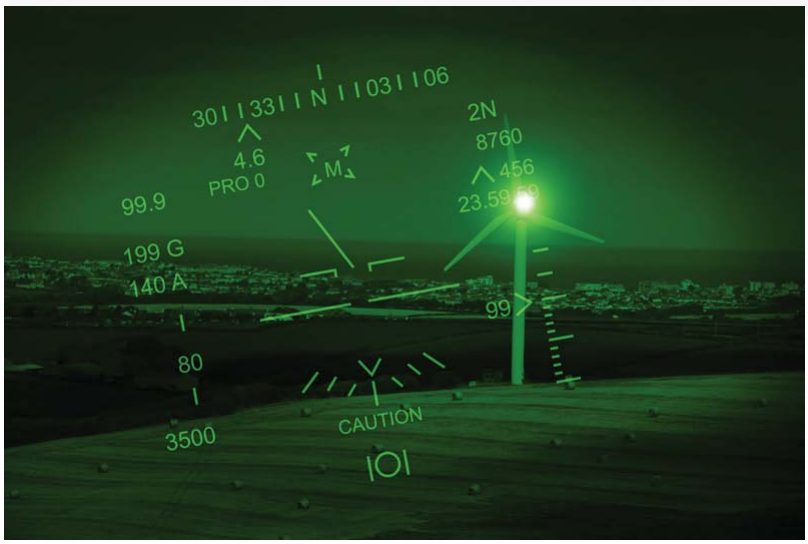


Figure 2. Campbell Scientific CS120 operating principle. The transmitted signal is backscattered into the receiver to measure meteorological visibility.



Many other sensors that operate in the near infra-red wavelengths experience problems when in the vicinity of obstruction lights that contain these wavelengths. The CS120 has been tested against these lights and is proven to operate without any interference whatsoever. High speed sampling improves the accuracy of measurements taken during mixed weather and during events which return intermittent signals such as rain and hail – both known weaknesses of some competing systems.

Compared to many such sensors, the CS120 design means that visibility is being measured in a relatively 'clean' space because the position of the heads and body minimise disturbance of the airflow at the measurement volume.

The sensor hoods point downwards, which also eliminates the possibility of sunlight shining directly into the lens detector and giving measurement errors – a well-known problem in other manufacturers' sensors. Its design also prevents contaminants from entering the sensor hoods.

Integrated low power heaters prevent the build-up of dew and higher powered anti-icing heater are also included. All heaters are automatically controlled for simple operation in all weather.

Figure 3. Campbell Scientific CS120 Visibility Sensor

The sensor is very power efficient, drawing just 3W during normal operation including the dew heaters. Power can be reduced further by reducing the sample rate and manual control of the heaters. Two configurable alarm outputs are provided and, via relays, can be used to switch the intensity of wind turbine warning lights depending upon current visibility levels.

This sensor and the technology which it is based on has been extensively tested in the field, at sites such as airports, wind farms, meteorological stations and road weather applications. It has a high level of corrosion resistance superior to other manufacturers and can therefore withstand the harsh conditions encountered in offshore applications.

Field trials have shown that the Campbell CS120 Visibility Sensor performs particularly well in the following areas:

1. The CS120 hardware and software filtering allows it to be used in close proximity to aircraft warning light sources.
2. Its geometry and downwards-pointing sensor hoods avoid the well-documented problems associated with sunlight shining directly into the lens, which gives errors for other manufacturers' sensors.
3. The CS120 is vibration tested and can withstand the large amount of vibration on wind turbines.

The CS120 should be mounted on the nacelle next to the existing wind sensors on the rear of the turbine hub, facing away from the rotating blades. The collected visibility data can be used to adjust aircraft warning lights appropriately.

For more information on this application please contact the Optical Products team at Campbell Scientific Europe using the contact information on the rear of this document.