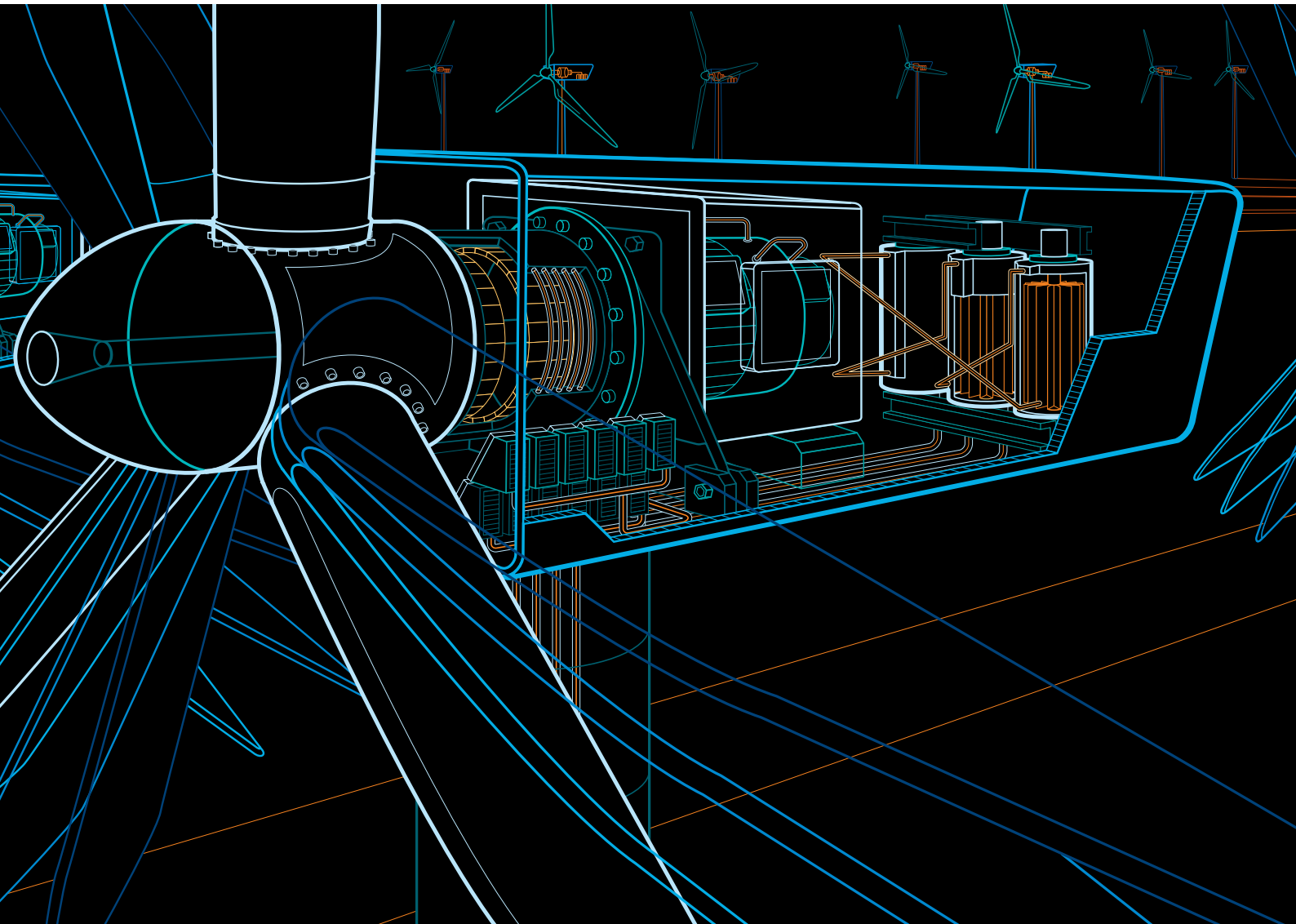
APPLICATION NOTE AN015

Protection of wind turbines

ESP AN015 for protection of power and data/signal/telecoms lines in wind turbines



Protection of power and data/signal/ telecoms lines in wind turbines

Wind turbines contain a substantial array of electronic systems, including power, control, and telecoms systems, which are all vulnerable to damage from partial lightning currents and transient overvoltages.

Partial lightning currents can enter a wind turbine following a lightning strike either to the blades, tower, or to incoming/outgoing power & data/ signal/ telecoms lines. Transient overvoltages can be electromagnetically induced onto the turbine's electrical network as a result of power switching or nearby lightning activity.

These overvoltages can result in severe damage to electronic circuitry and need to be effectively countered to avoid expensive downtime and repair/ maintenance costs.

Zonal approach to protecting electronic systems

Electronic systems in wind turbines are sited in a number of locations:

- The nacelle (generator, pitch & yaw controls and motors, sensor/ actuator controls)
- The turbine base (frequency converter, LV switchgear & transformer, control system)
- The local HV transformer station

For all of these locations, external and internal Lightning Protection Zones (LPZ) have been defined, in accordance with the principles established in BS EN/ IEC 62305 & IEC 61400, to protect key equipment (see Table 1).

This zonal approach regulates the Classification of SPD required (Type 1 or Type 2 mains and Type B or Type C data/signal/telecoms) to protect equipment in line with its voltage withstand and operating characteristics.

Table 1: Wind turbine equipment requiring protection

Equipment	Typical Location	Lightning Protection Zone (LPZ)
Generator	Nacelle	LPZ 0 to LPZ 1
Motor (yaw/pitch)	Nacelle	LPZ 0 to LPZ 1
Auxiliary circuits (aviation warning lights/anemometer)	Nacelle	LPZ 0 to LPZ 2
Frequency converter	Turbine base	LPZ 0 to LPZ 2
Wind turbine control system	Turbine base	LPZ 0 to LPZ 2
LV side of transformer + switchgear	Turbine base/ Transformer station	LPZ 0 to LPZ 1
HV side of transformer	Turbine base/ Transformer station	LPZ 0 to LPZ 1
Transformer station control systems	Transformer station	LPZ 0 to LPZ 2

Power line protection

Lightning current SPDs (Type 1) are required at boundaries between LPZ 0 and LPZ 1, to counter partial lightning currents, with transient overvoltage SPDs (Type 2) required between LPZ 1 and LPZ 2, to protect critical equipment within the wind turbine (see Figure 1).

Furse ESP combined 1+2 SPDs for 690 V systems and combined 1+2+3 SPDs for 230 V / 400 V systems prove highly suitable for protecting wind turbines. As combined SPDs they offer both low let-through voltage and full mode protection between all sets of conductors, for optimum surge protective performance to minimum LPZ 2.

SPDs should be installed on the line side, as close as possible to the equipment being protected. Where connected downstream equipment is greater than 10 m away, a second SPD should be installed at the subsequent equipment (in line with the guidance in DD CLC/TS 50529-22:2010).

690 V circuits require a SPD specific for the voltage level, such as the Furse **ESP 690/12.5/WT** or higher surge current **ESP 690/25/WT** SPDs.

Power lines at 230 V / 400 V AC and alternative voltages should also be protected by a suitable Furse SPD (See Table 2).

Where the main HV transformer is housed separately from the wind turbine, incoming/outgoing lines from both the wind turbine and the transformer station should be protected - LPZ boundary LPZ 0 to LPZ 1 (control system electronics where installed to minimum LPZ 2).

Table 2 : SPD selection

Location	SPD required	
Generator (690 V)	ESP 690/12.5/WT or ESP 690/25/WT	SPD
Frequency converter (690 V)	ESP 690/12.5/WT or ESP 690/25/WT	SPD
Transformer (690 V)	ESP 690/12.5/WT or ESP 690/25/WT	SPD
Control system (230 V)	ESP 240 D1 or ESP 240 M1	SPD
Aviation warning light (230 V)	ESP 240 D1 or ESP 240 M1	SPD
Hub control (230 V)	ESP 240 D1 or ESP 240 M1	SPD
(4-20 mA loop) (RS 485)	ESP SL30L/4-20 ESP SL06	SPD
Anemometer (24 V)	ESP SL30	SPD
Modem	ESP TN	SPD

Data/signal/telecoms line protection

Figure 1 also highlights the points at which Furse SPDs should be installed to protect data, signal and telecommunications lines. A wide range of Furse SPDs is available for this purpose, including Furse **ESP SL Series**, or Furse **ESP D, E, H Series**.

The SPD selected should be compatible with the system to be protected, and must offer sufficient protection to reduce overvoltages below the immunity threshold of the protected equipment. The SPD must not impede system performance and must have the ability to survive repeated transients.

Control equipment at the wind turbine is most likely to be networked to remote locations and, following BS EN/IEC 62305, protection at these remote points should also be risk assessed.

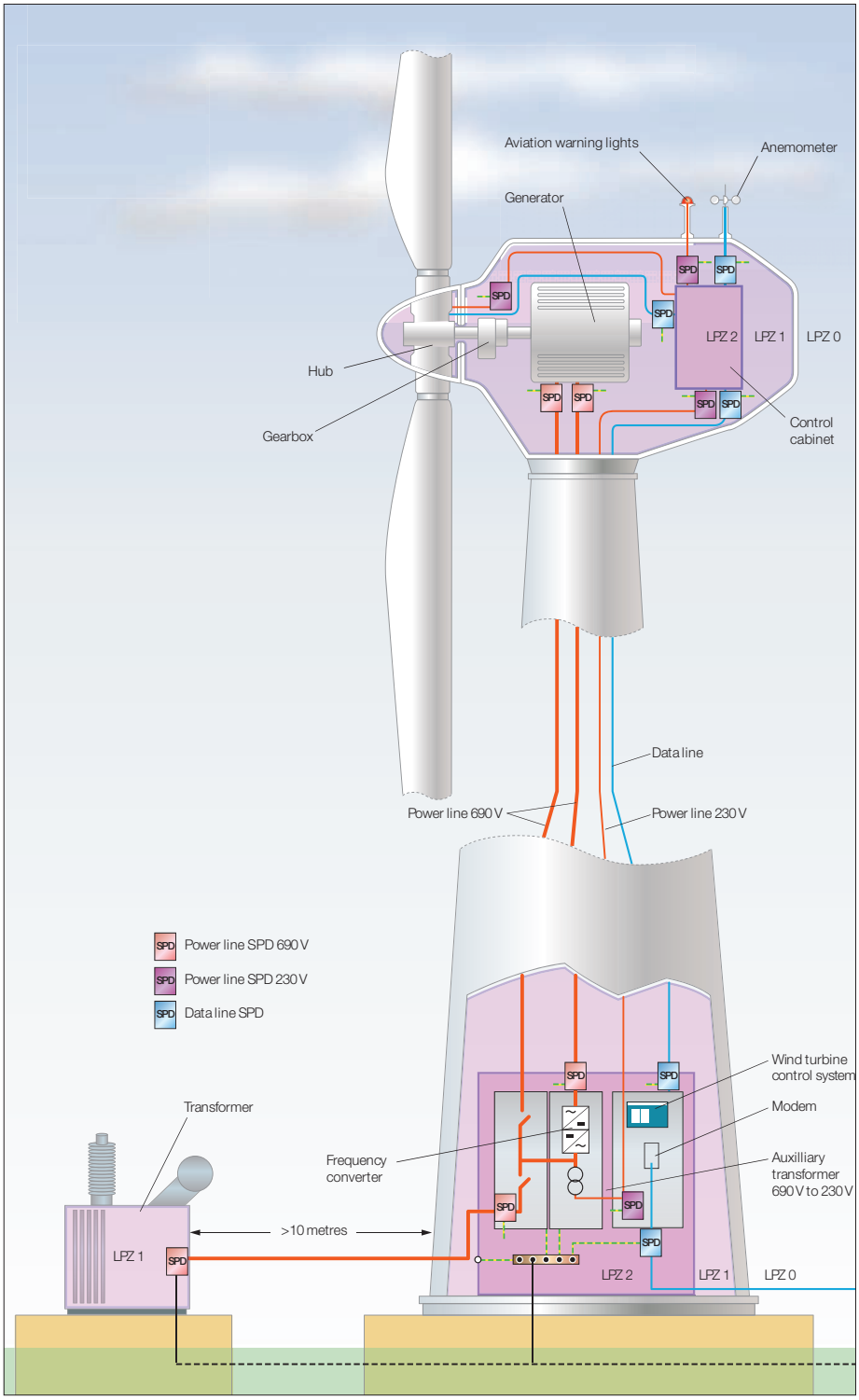


Figure 1: Application of SPDs within a typical wind turbine environment

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