

Earth termination systems for concrete and hybrid towers in wind power plants

White Paper



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Due to the increasing hub height of wind turbines, a growing number of concrete towers and hybrid towers, made of concrete at the bottom and tubular steel at the top, are being erected (**Figure 1**).

As well as protective and functional earthing, earth-termination systems in wind turbines provide lightning protection earthing. They can only be installed if all the conductive parts, from the nacelle and tower right down to the foundations, are integrated in the equipotential bonding. Their functionality must be guaranteed for the total life cycle of the wind turbine.

Configuration in a concrete tower

The configuration of these earth-termination systems is dealt with in the standard IEC 61400-24 which describes the necessary continuous connection of the reinforcements in the concrete towers of wind turbines. The reinforcements can be used as down conductors provided they are connected by 2–4 parallel and vertical links. In addition, these vertical connections must be tethered to a horizontal ring conductor every 20m by way of a lightning current carrying conductor. This is the only way to achieve adequate lightning current distribution and thereby reduce the magnetic field inside the tower.



Figure 1 Hybrid tower made of prefabricated concrete elements

As the tower is also used for protective and equipotential bonding, fixed earthing terminals should be installed on the reinforcements at convenient points inside the tower in order to ensure connection points for electric equipment and conductive constructions, such as ladders or elevators. Direct lightning strikes in the tower are to be expected because of its height and should be considered in the design. If an external lightning protection concept is implemented, this must be connected to the reinforcements of the tower and executed according to IEC 62305-3 Protection against lightning - Part 3: Physical damage to structures and life hazard.

Example of tower earthing

The vertical down conductors in the concrete are ideally made of 10mm round steel or 30 mm x 3.5 mm galvanised strip steel. When selecting materials for use in concrete, one must ensure that they are lightning current carrying and have sufficient strength to guarantee a long service life. These down conductors

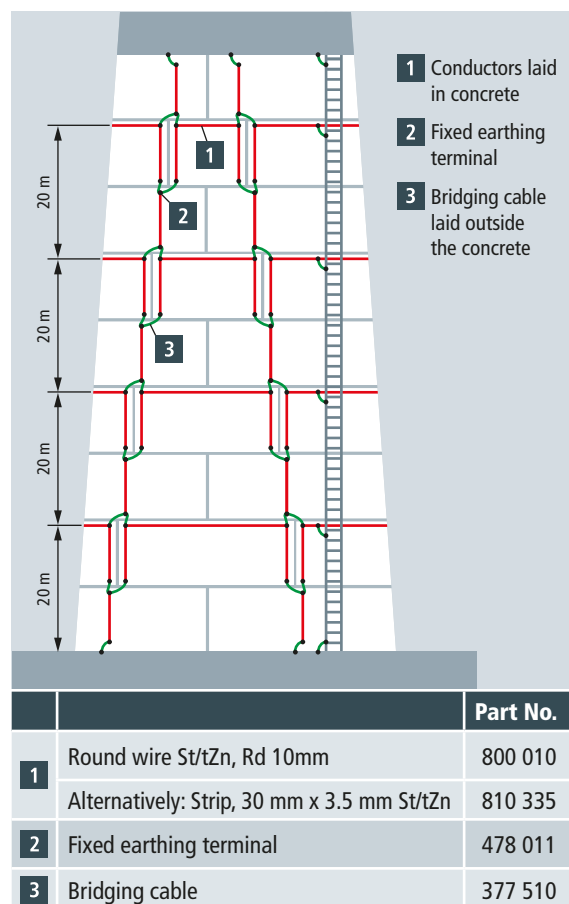


Figure 2 Schematic representation of the individual tower segments with attached ladder

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must be connected to the reinforcement at intervals of 2 m to create the equipotential bonding. If the rebars are continuously connected (e.g., welded) and their cross-section is sufficient, the reinforcements can be used as down conductors.

Bridging cables can be used to connect the individual tower elements inside the tower. These are connected to the fixed earthing terminals which have been attached, e.g. welded, to the down conductors in the concrete. It is important to ensure that all the components used are capable of carrying lightning current. 10 mm round wire or 30 mm x 3.5 mm steel strip can

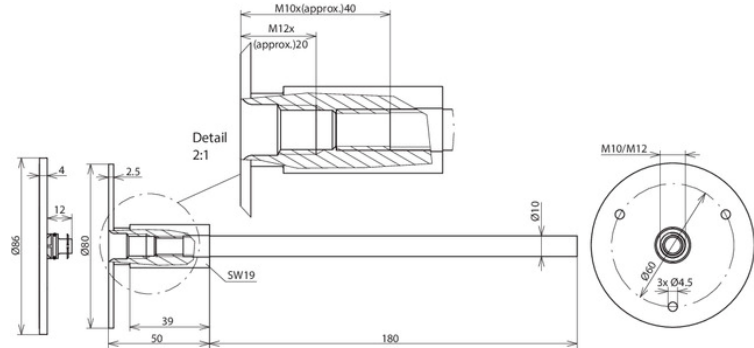
also be used for the horizontal connections. Here too, connection with the reinforcements is required at 2 m intervals. All the metal components inside the tower must be integrated in the equipotential bonding. Ladders must be connected to the equipotential bonding at both ends, at intervals of 20 m and on each platform (**Figure 2**). Components like prestressing cables, elevator cables and busbars must be connected to the equipotential bonding at both ends. The planning should include a sufficient number of fixed earthing terminals for this purpose.

Fixed earthing terminal

 **EFPM M10 12 V4A L230 STTZN (478 011)**



Figure without obligation



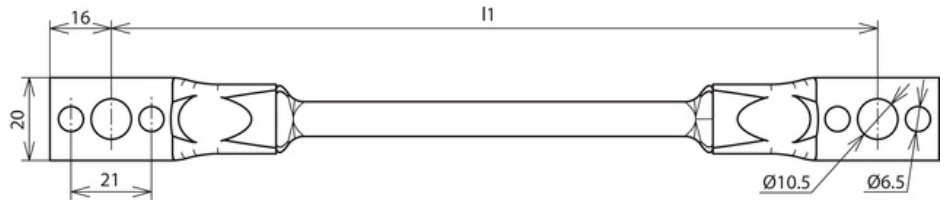
Type	EFPM M10 12 V4A L230 STTZN
Part No.	478 011
Connection thread	M10 / M12
Material of plate	StSt (V4A)
Material No.	1.4571 / 1.4404 / 1.4401
ASTM / AISI:	316Ti / 316L / 316
Material of axis	St/tZn
Connection plate Ø	80 mm
Dimension of connection axis (Ø / length)	10 / 180 mm
Short-circuit current (50 Hz) (1 s; ≤ 300 °C)	6.5 kA
Standard	EN 62561-1
UL approval	UL467
Minimum lengths of screws M10	35 mm (thread length 40 mm)
Minimum lengths of screws M12	15 mm (thread length 20 mm)
Weight	301 g
Customs tariff number (Comb. Nomenclature EU)	85389099
GTIN	4013364033054
PU	10 pc(s)

Bridging cable

UEBS 16 L500 B10.5 B6.5 AL CU (377 510)



Figure without obligation



Type	UEBS 16 L500 B10.5 B6.5 AL CU
Part No.	377 510
Length (l1)	500 mm
Material of cable lug	Al
Material of cable	Cu
Cross-section	16 mm ²
Fixing	[4x] Ø6.5 / [2x] Ø10.5 mm
Application notes	according to DIN EN 62305-3 Supplement 1, materials ≥ 0.5mm thick shall be connected by 2 rivets Ø6mm, or materials ≥ 2mm thick by 2 tapping screws Ø6.3mm StSt (on both sides)
Insulation	rubber EM5 black
Temperature range	-40 °C ... +80 °C
Cable type	flexible
Standard	EN 62561-1
Weight	110 g
Customs tariff number (Comb. Nomenclature EU)	85389099
GTIN	4013364033399
PU	10 pc(s)

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Round wire

RD 10 STTZN R81M (800 010)



Figure without obligation

Steel wire according to EN 62561-2 with zinc coating $\geq 50 \mu\text{m}$ average (about 350 g/m^2), for use in lightning protection and earth-termination systems.

Type	RD 10 STTZN R81M
Part No.	800 010
Diameter \varnothing conductor	10 mm
Cross-section	78 mm^2
Material	St/tZn
Standard	based on EN 62561-2
Zinc sheath	$\geq 50 \mu\text{m}$ average (about 350 g/m^2)
Conductivity	$\geq 6.66 \text{ m} / \text{Ohm mm}^2$
Resistivity	$\leq 0.25 \text{ Ohm mm}^2 / \text{m}$
Short-circuit current (50 Hz) (1 s; $\leq 300 \text{ }^\circ\text{C}$)	5.5 kA
Weight	617 g/m
Customs tariff number (Comb. Nomenclature EU)	72172030
GTIN	4013364018723
PU	81 m

Strip

BA 30X3.5 STTZN R50M (810 335)



Figure without obligation

Steel strip according to EN 62561-2 with zinc coating $\geq 70 \mu\text{m}$ average (about 500 g/m^2), for use in lightning protection and earth-termination systems.

Type	BA 30X3.5 STTZN R50M
Part No.	810 335
Width	30 mm
Thickness	3.5 mm
Cross-section	105 mm^2
Material	St/tZn
Standard	EN 62561-2
Zinc coating	$\geq 70 \mu\text{m}$ average (about 500 g/m^2)
Conductivity	$\geq 6.66 \text{ m} / \text{Ohm mm}^2$
Resistivity	$\leq 0.15 \text{ Ohm mm}^2 / \text{m}$
Short-circuit current (50 Hz) (1 s; $\leq 300 \text{ }^\circ\text{C}$)	7.3 kA
Weight	840 g/m
Customs tariff number (Comb. Nomenclature EU)	72123000
GTIN	4013364032880
PU	50 m

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Safety Equipment
DEHN protects.

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