Surge Protection Measures (SPM) Design

Basis of calculation: IEC 62305-4:2024 (Ed. 3.0)

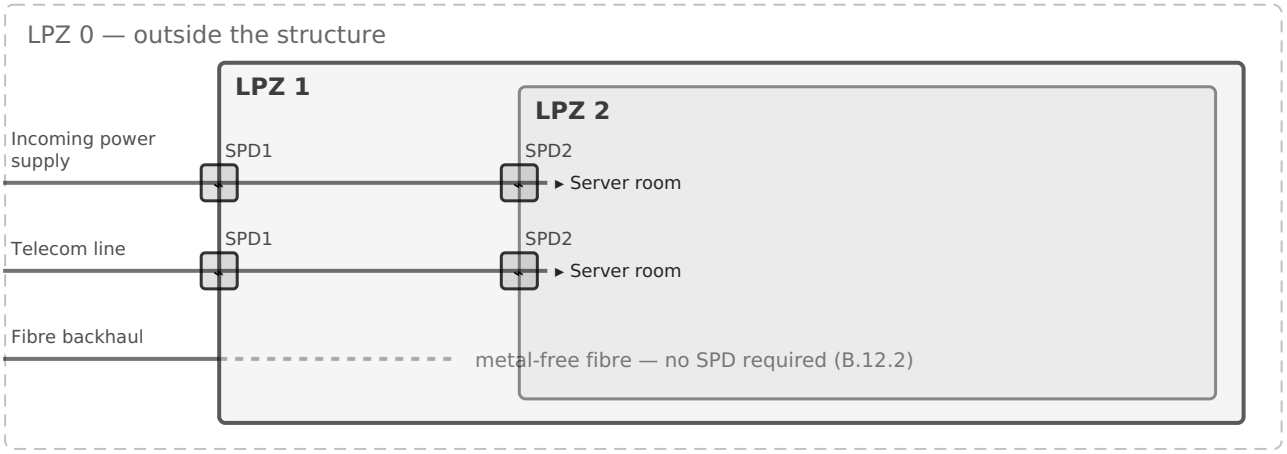
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Project	Data centre — shielded LPZ 2 (sample)	Client	(the client you name on the project)
Site address	(the site address you enter)		
Prepared by	(your name), (your company) · Reg. no. (your registration no.)		
Checked by	(the checker you name)	Approved by	(the approver you name)
Dimensions	(where you say the dimensions came from: measured, drawings or approximate) — (the drawings or survey you name)		

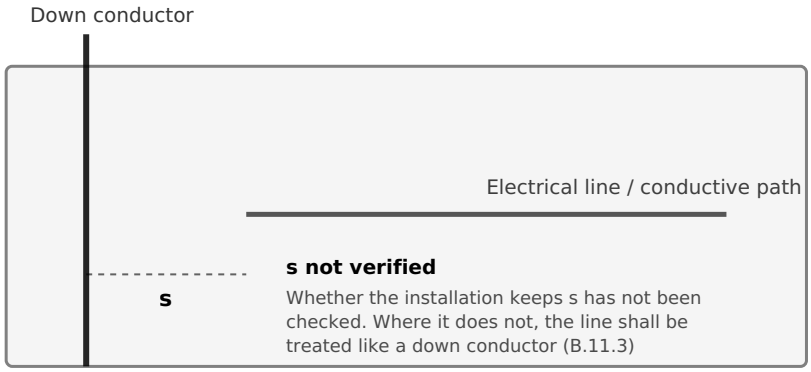
Rev.	Date	Description	Prepared	Checked	Approved
1	2026-07-01	First issue	(your name)	(the checker you name)	(the approver you name)

This document specifies the surge protection measures for the structure: the lightning protection zones, the earthing and bonding network, and a coordinated SPD system for every incoming service. The SPD specification is **manufacturer-neutral** — it states the required test class, discharge current and voltage protection level, and can be issued to any supplier.

Lightning protection zones



Lightning protection zones and the SPD positions of the computed schedule: one where each service crosses into an inner zone (IEC 62305-4:2024, Clause 7), and one at the equipment where its route puts it there (shaded). A service feeding several equipment groups branches after its entrance SPD, one row per group. Drawn from the entered services and equipment, not to scale. LPZ 0 is shown undivided: whether a point outside is LPZ 0A (a direct flash can reach it) or LPZ 0B (an air termination protects it) is a rolling-sphere question about the real geometry, which the LPS design answers for the roof and this figure does not assume.



Separation distance s between the LPS and the conductive paths entering the structure — not verified: whether the installation keeps s has not been stated, so neither case is asserted (IEC 62305-4:2024, Figure B.6, B.11.3). Schematic, not to scale; s itself is computed by the IEC 62305-3 LPS design, not here.

Server room `LPZ 0A → LPZ 1 → LPZ 2`

An LPZ 1 created by a normal external LPS in accordance with IEC 62305-3 has mesh widths and typical distances greater than 5 m, so its spatial shielding effect is negligible (IEC 62305-4:2024, B.14.5). Effective spatial shielding requires a mesh width typically below 5 m.

Equipotential bonding SPDs are always required at the entrance of an LPZ to bond incoming lines connected to internal systems within that zone. Using an interconnected or extended LPZ can reduce the number of SPDs required (IEC 62305-4:2024, 5.5).

IEC 62305-4:2024, 4.3.2 divides the region outside the structure into LPZ 0A and LPZ 0B, and which applies at a given point is decided by the rolling sphere against the real geometry (IEC 62305-3:2024, 5.2.2) — for the roof, by the LPS design; for a service's route outside the structure, by nothing modelled here. This design therefore assumes LPZ 0A at every line entrance, which is the more severe of the two: the threat is the direct flash and the full surge current. Where an air termination is shown to cover a line's approach, LPZ 0B applies instead and this design does not determine that. The assumption changes no SPD specified here — the test class required at the entrance is resolved from C.2.2 and does not depend on it — but the threat the installation is stated to be exposed to does.

LPZ 0A — IEC 62305-4:2024, 4.3.2 defines this zone as: "Zone where the threat is due to the direct lightning flash and the full lightning electromagnetic field. The internal systems can be subjected to full lightning surge current."

LPZ 0B — IEC 62305-4:2024, 4.3.2 defines this zone as: "Zone protected against direct lightning flashes but where the threat is the full lightning electromagnetic field. The internal systems can be subjected to partial lightning surge currents."

LPZ 1 — IEC 62305-4:2024, 4.3.3 defines this zone as: "Zone where the surge current is limited by current sharing and isolating interfaces and/or by SPDs at the boundary. Spatial shielding can attenuate the lightning electromagnetic field."

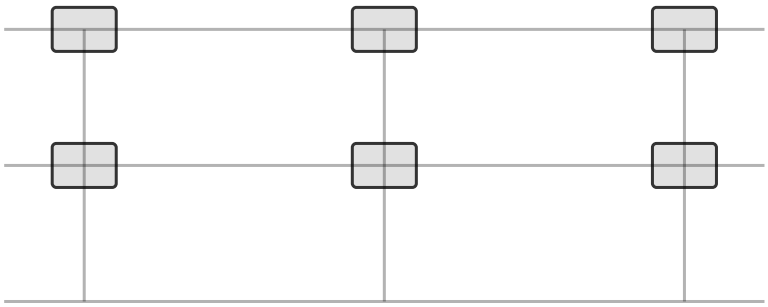
LPZ 2 — IEC 62305-4:2024, 4.3.3 defines LPZ 2…n as: "Zone where the surge current may be further limited by current sharing, isolating interfaces and/or by additional SPDs at the boundary. Additional spatial shielding may be used to further attenuate the lightning electromagnetic field."

Whether the separation distance s of IEC 62305-3 is maintained has not been verified for this installation. Where it is not, electrical lines carrying partial lightning currents shall be treated like down conductors (IEC 62305-4:2024, B.11.3), and where a ring conductor is bonded to each down conductor

for this reason, class I tested SPDs are required (B.3). State it on the basis of design once it has been checked.

Earthing and bonding network

MM



Configuration MM — internal systems integrated into the meshed bonding network at multiple points.

Earth-termination arrangement	Type B
Bonding network configuration	MM
Bonding network mesh width	5 m
Bonding bars	Cu / Fe 50 mm²
Conductors linking a bonding bar to the earthing system, or one bonding bar to another (carrying the full lightning current or a significant share of it)	Cu 16 mm²
Connecting conductors from internal metal installations to bonding bars (partial lightning current)	Cu 6 mm²
Earthing conductor to SPD tested to class I	Cu 16 mm²
Conductors connecting a class I SPD and its overcurrent protective device to live conductors	Cu 6 mm²
Earthing conductor to SPD tested to class II	Cu 6 mm²
Conductors connecting a class II SPD and its overcurrent protective device to live conductors	Cu 2.5 mm²

A Type B (ring or foundation) arrangement is used, as 5.2 recommends.

Meshed, integrated by multiple bonding points; metal components are not isolated from the earthing system. Preferred where internal systems extend over wide zones or many lines enter at several points.

Do not isolate the internal systems' metal parts from the earthing system; tie them into it at several points instead.

One earthing system serves the whole site. Giving the LPS, the SPDs, the power installation and the telecommunications installation an earth each is not an acceptable arrangement for lightning and surge protection; they must form a single integrated system (IEC 62305-4:2024, 5.2).

Bonding bars shall be installed for bonding of: all conductive services entering an LPZ, directly or via suitable SPDs; the protective earth conductor PE; metal components of the internal systems (cabinets, enclosures, racks); the magnetic shields of the LPZ, at the periphery and inside the structure (IEC 62305-4:2024, 5.4).

Where possible, incoming services should enter the LPZ at the same location and connect to the same bonding bar. Where services enter at different locations, each shall connect to a bonding bar and those bonding bars shall be interconnected — bonding to a ring bonding bar is recommended (IEC 62305-4:2024, 5.5).

Treat the bonding network as a protective path only: it should carry no power or signal return current. On that basis the PE conductor is tied into the bonding network and the PEN conductor is kept out of it, along with any metalwork connected to the PEN. A functional earthing conductor may be bonded straight to the low-impedance network. Keeping the PEN separate is what stops power-frequency current finding a way into the electronic systems (IEC 62305-4:2024, B.7 — Annex B is informative, so these are conditions of following its method rather than requirements standing on their own).

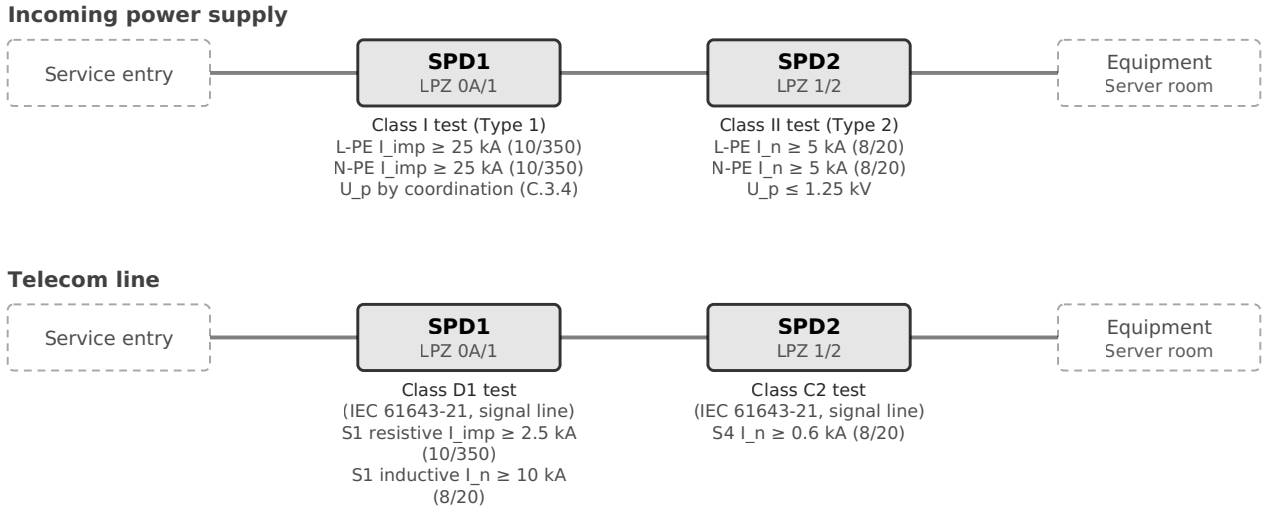
For efficient bonding the following installation rules are important: the basis for all bonding measures is a low impedance bonding network; run each bonding bar back to the earthing system by the most direct route the building allows; SPDs should be installed with the shortest possible connections to the bonding bar and to the live conductors, minimising inductive voltage drops; downstream of an SPD, mutual induction should be minimised by reducing the loop area or by using shielded cables or ducts earthed at both ends (IEC 62305-4:2024, 5.4).

Smaller cross-sections are permitted in some countries where the thermal and mechanical requirements of IEC 62305-1:2024, Annex D are satisfied (IEC 62305-4:2024, Table 1, footnote b). That verification is outside this tool's scope, so the tabulated minimum is applied.

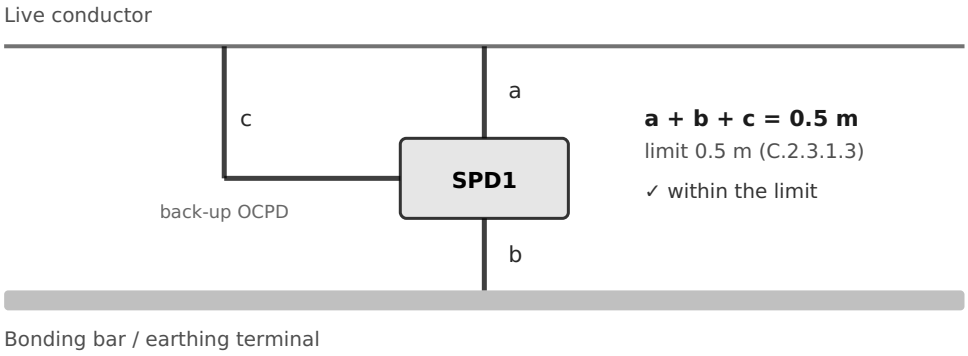
For SPDs in power applications the connecting conductors shall also be dimensioned according to IEC 60364-5-53 and IEC 61643-12 (IEC 62305-4:2024, Table 1, footnote c).

Earthing and bonding are required in every design — there is no case in which they can be left out. Every conductive service must be tied to earth where it enters the structure: directly where that is possible, and otherwise through an equipotential bonding SPD (IEC 62305-4:2024, Clause 4.4).

Coordinated SPD schedule



The coordinated SPD system for each service, from the entrance to the equipment, with the required test class and duty at each position (IEC 62305-4:2024, Annex C). A service feeding several equipment groups branches after its entrance SPD, one row per group. Manufacturer-neutral: any device meeting the stated duty at that position is acceptable.



Connecting-lead lengths at SPD1 on Incoming power supply. The 0,5 m limit applies to the **sum** of the legs, not to any single one (IEC 62305-4:2024, C.2.3.1.3). Individual legs are not to scale — only the declared total is known.

Position / parameter	Requirement
Incoming power supply — SPD1 at LPZ 0A/1	**Class I test (Type 1)**
L-PE I_imp	≥ 25 kA (10/350)
N-PE I_imp	≥ 25 kA (10/350)
U_p	set by coordination with the SPD downstream (C.3.4)
Incoming power supply — SPD2 at LPZ 1/2	**Class II test (Type 2)**
L-PE I_n	≥ 5 kA (8/20)
N-PE I_n	≥ 5 kA (8/20)
U_p	≤ 1.25 kV
Telecom line — SPD1 at LPZ 0A/1	**Class D1 test (IEC 61643-21, signal line)**
S1 resistive I_imp	≥ 2.5 kA (10/350)
S1 inductive I_n	≥ 10 kA (8/20)
Telecom line — SPD2 at LPZ 1/2	**Class C2 test (IEC 61643-21, signal line)**
S4 I_n	≥ 0.6 kA (8/20)

Cascaded SPDs shall be energy coordinated in accordance with IEC 61643-12 and IEC 61643-22; the SPD manufacturer should provide the information needed to achieve energy and voltage protection level coordination between the devices (IEC 62305-4:2024, C.3.4). This tool states the requirement but does not compute the coordination.

This is a telecommunication or signal line, so its discharge currents are not taken from Annex C: Tables C.3, C.4 and C.5 are keyed on the supply system and its modes of protection, and describe power lines only. IEC 62305-4:2024, C.2.2 provides the required current for a signal line in IEC 62305-2:2024, Annex B (Table B.8), and classifies the device under IEC 61643-21 — class D1 where a power SPD would be class I tested, and class C2 where it would be class II. Each source of damage carries its own waveform, so a device at this boundary has both a 10/350 and an 8/20 duty.

These currents are per line conductor, not the total through the cable (IEC 62305-1:2024, Table E.2: "All values refer to each line conductor"). A multi-core cable carries the sum, so a device protecting n cores must carry n times the figure above in total, and manufacturers' data sheets state both a per-line and a total rating. Check which one you are reading before comparing.

The figures above are those IEC 62305-2:2024, Table B.8 gives for overhead unshielded lines, which is its worst case. Its NOTE 3 permits the currents to be halved for a buried line, and halved for a shielded line. This design applies neither reduction, so the requirement stated here is conservative for a line that is buried, shielded, or both.

No voltage protection level is stated for this signal line. Every U_p ceiling in this schedule is a fraction of the equipment's rated impulse withstand U_W, and U_W is resolved from Table C.1, whose rows are line-to-neutral voltages of the power supply. The withstand of a telecommunication or signal port is a property of that interface and is declared by its manufacturer; select U_p against it, and against IEC 61643-21, rather than against the value used for the power lines here.

The voltage drop in the SPD connecting leads is computed from the approximation of IEC 62305-4:2024, eq. C.4 — 0,1 x I_SPD kV per metre. The standard notes that the true value depends on the current waveform, the conductor arrangement and the loop geometry; published manufacturer figures for the same case run up to about 20 % higher. The margin this consumes is small only while the leads are kept within 0,5 m, which is why that limit is a requirement and not a recommendation.

SPD selection and installation requirements

U_c, the maximum continuous operating voltage of each SPD, shall be equal to or higher than the value IEC 60364-5-53:2019+AMD1:2020, Table 2 gives for its mode of protection and the earthing arrangement, and the device shall withstand the temporary overvoltages of IEC 61643-11 for the same combination. Both are checked against a candidate's data sheet in the verification section, which needs the line-to-line voltage U of the supply — the Table C.1 band above does not fix it, since its 300 V row covers 230/400 V and 277/480 V alike.

Where SPDs are cascaded, a decoupling element or a minimum line length between them is required for correct energy coordination (IEC 62305-4:2024, Figure D.1). The required value is given in IEC 61643-12 and by the SPD manufacturer; a combined device may be used instead.

The back-up overcurrent protective device shall be the maximum permissible type specified by the SPD manufacturer, and shall be coordinated with the upstream system OCPD; where those two requirements conflict, the lower rating is generally the safer choice (IEC 62305-4:2024, C.2.8). That coordination is not computed here. The SPD's own short-circuit current rating I_SCCR shall not be lower than the maximum prospective short-circuit current at its connection points (IEC 60364-5-53:2019+AMD1:2020, 534.4.4.6), and the same holds for the follow current interrupting rating I_fi where the manufacturer declares one (534.4.4.7). Neither requirement applies to an SPD connected between the neutral conductor and PE in a TN or TT system — both clauses exempt that case, as the product standard IEC 61643-11 already covers it. Both are checked in the verification section against a prospective current you state, since it is a property of the installation rather than of the lightning protection design.

The behaviour of the back-up overcurrent protective device under partial lightning current or high impulse current should be considered as one of three cases (IEC 62305-4:2024, C.2.8.1). Case 1 — No melting and no tripping. The OCPD withstands the expected surge current through the SPD without tripping or melting. Case 2 — Melting and tripping permissible. The lightning impulse energy is enough to operate the OCPD. Case 3 — Mechanical destruction permissible. The impulse energy exceeds the OCPD's withstand level.

In cases 2 and 3 the installation is no longer protected against subsequent strokes within the same flash; additional SPDs on specific downstream circuits can maintain protection. Take care before replacing a blown OCPD or re-closing a tripped MCB, since the SPD may have failed into a short circuit. Because lightning behaves as an ideal current source, operation or destruction of the back-up OCPD does not reduce the impulse current the SPD must carry (IEC 62305-4:2024, C.2.8).

Where the circuit between the SPD and the equipment is long, propagation can lead to oscillation raising the overvoltage at an open circuit to as much as 2 x U_p/f, even where U_p/f <= U_W is satisfied (IEC 62305-4:2024, C.2.3.4). The effect is negligible where the SPD is installed at the equipment input.

Services connected to different ports of the same equipment shall not be connected to different points on the earthing system, except where those points are equipotential bonded (a densely meshed foundation electrode of the order of 1 m x 1 m, or a ring electrode welded or bolted to the steel reinforcement), or the internal services are shielded or in a metallic duct bonded at both ends, or a multiservice SPD able to withstand S1/S3 stress is provided between the ports (IEC 62305-4:2024, C. 2.6).

Assumptions and qualifications for this design

- Fibre backhaul: metal-free fibre optic cable: no additional protection measures are required (IEC 62305-4:2024, B.12.2)
- No dangerous-event rate was supplied from a risk assessment, so the C.2.2 NOTE 1 allowance — disregarding the S1/S3 SPD-failure risk where N_D + N_L + N_DJ does not exceed 0,01 per year — has not been applied. Running an IEC 62305-2 assessment first can reduce the required SPD test class.
- The voltage protection levels in this schedule were selected under Rule no. 1, the simple analysis for general applications of IEC 62305-4:2024, C.2.3.1. The detailed analysis of Rule no. 2 (C. 2.3.2), which evaluates U_p/f = (U_W - U_i) / k_r by eq. C.1, has not been carried out: the induced voltage U_i of C.2.3.5 and Annex H depends on the routing of each protected circuit, its distance from the down conductors and the shielding around it, none of which this tool collects. Where a protected circuit is neither shielded nor routed clear of the down conductors, U_i consumes part of the margin these ceilings assume, and the detailed analysis shall be carried out separately. Any spatial shielding, mesh width or down-conductor count entered above is recorded for the design record only and has not influenced these values.
- Where no specific current-sharing calculation is carried out, 50 % of the lightning current is assumed to be conducted to the structure's earthing system and 50 % to return via the equipotential bonding SPDs (IEC 62305-4:2024, D.3.2). A specific calculation — which requires the current-sharing model of IEC 62305-1:2024, Clause E.2 — can give a lower value, for example where three metallic services supply the structure.
- That detailed analysis is IEC 62305-4:2024, Annex E — it applies the IEC 62305-1 current-sharing model and generally requires numerical simulation — and it is outside this tool's scope.
- No externally installed equipment was declared, so IEC 62305-4:2024, B.11 raises nothing here. If the structure carries aerials, cameras, meteorological or process sensors, or any other equipment mounted outside it, add them: a direct flash to one of them puts lightning current on a cable running into the building.
- No candidate device figures were entered, so nothing was verified. The specification above is manufacturer-neutral and can be issued for quotation as it stands; the verification step is for checking what comes back.

Calculation trace

Every requirement above, with the clause that governs it — check any step against the standard.

Step	Formula	Values	Result	Reference
Incoming power supply — SPD1 at LPZ 0A/1: L-PE I_imp	I_imp from the LPL, supply system and connection type	LPL I, three-phase, CT1, L-PE	I_imp ≥ 25 kA — preferred rating 25 kA (Table D.1)	IEC 62305-4:2024, Table C.3
Incoming power supply — SPD1 at LPZ 0A/1: N-PE I_imp	I_imp from the LPL, supply system and connection type	LPL I, three-phase, CT1, N-PE	I_imp ≥ 25 kA — preferred rating 25 kA (Table D.1)	IEC 62305-4:2024, Table C.3
Incoming power supply — SPD2 at LPZ 1/2: L-PE I_n	I_n from the LPL, supply system and connection type	LPL I, three-phase, CT1, L-PE	I_n ≥ 5 kA — Table D.1 tabulates preferred values of I_imp for class I tested SPDs; it does not apply to I_n	IEC 62305-4:2024, Table C.4
Incoming power supply — SPD2 at LPZ 1/2: N-PE I_n	I_n from the LPL, supply system and connection type	LPL I, three-phase, CT1, N-PE	I_n ≥ 5 kA — Table D.1 tabulates preferred values of I_imp for class I tested SPDs; it does not apply to I_n	IEC 62305-4:2024, Table C.4
Telecom line — SPD1 at LPZ 0A/1: S1 resistive I_imp	I_imp from the LPL and the source of damage	LPL I, signal line, source S1 resistive	I_imp ≥ 2.5 kA — flash to the structure, resistive coupling; Table D.1's preferred ratings are reproduced from IEC 61643-11 and refer to SPDs connected line to neutral, so they do not apply to a telecommunication or signal line; rate this device from IEC 61643-21	IEC 62305-2:2024, Table B.8 (via IEC 62305-4:2024, C.2.2)
Telecom line — SPD1 at LPZ 0A/1: S1 inductive I_n	I_n from the LPL and the source of damage	LPL I, signal line, source S1 inductive	I_n ≥ 10 kA — flash to the structure, inductive coupling; Table D.1's preferred ratings are reproduced from IEC 61643-11 and refer to SPDs connected line to neutral, so they do not apply to a telecommunication or signal line; rate this device from IEC 61643-21	IEC 62305-2:2024, Table B.8 (via IEC 62305-4:2024, C.2.2)
Telecom line — SPD2 at LPZ 1/2: S4 I_n	I_n from the LPL and the source of damage	LPL I, signal line, source S4	I_n ≥ 0.6 kA — indirect flash to the line; Table D.1's preferred ratings are reproduced from IEC 61643-11 and refer to SPDs connected line to neutral, so they do not apply to a telecommunication or signal line; rate this device from IEC 61643-21	IEC 62305-2:2024, Table B.8 (via IEC 62305-4:2024, C.2.2)

Step	Formula	Values	Result	Reference
Simplified lightning current sharing	`I_imp = I0/MAX × 0,5 / n`	LPL I -> I0/MAX = 200 kA; 50 % to the earthing system, 50 % via the bonding SPDs; n = 4 conductors (three-phase plus neutral)	`I_imp = 25 kA per SPD`	IEC 62305-4:2024, D.3.2 and Table C.3

What this specification does not cover. Stated for every design, whether or not it applies to yours:

- Photovoltaic installations. Clause 7 requires SPDs for PV systems to comply with IEC 61643-31 and their selection and installation with IEC 61643-32, and Annex F gives the current sharing for roof-mounted and ground-mounted PV. None of that is implemented, and a PV array is not an input here — a site with one needs its DC side designed separately.
- The detailed analysis of Rule no. 2 (C.2.3.2) and the induced voltage U_i of C.2.3.5 and Annex H. Voltage protection levels come from Rule no. 1 (C.2.3.1) throughout; the caveat above says what that means for the shielding and down-conductor count entered on this design.
- Lightning current sharing by simulation modelling (Annex E). The schedule uses the simplified sharing of D.3.2.
- Isolation interfaces built on surge isolation transformers (Annex I). Where a service is declared as entering via an isolating interface the C.2.6 exemption and its Clause 8 limits are applied, but the interface itself is not designed here.
- Computation of the electromagnetic field inside a zone from shield geometry (Annex A), and system-level testing under lightning discharge conditions (Annex G).
- Electromagnetic interference causing malfunction rather than permanent failure. Part 4's own scope (Clause 1) puts this outside the document — it is covered by IEC 60364-4-44 and the IEC 61000 series — so a compliant SPM is not by itself an answer to a disturbance problem.
- Detailed design of the electrical and electronic systems being protected (Clause 1), and the LPS itself, which is IEC 62305-3 — use the LPS tool.
- Hazardous areas (explosive atmospheres). IEC 62305-3:2024, C.4.1.2 requires SPDs to be positioned outside a hazardous area where practicable, and any SPD inside one to be adequate for the zone it is installed in, with IEC 60079-14 governing its selection and installation; C.3 applies an explosives area's own requirements for electrical equipment to SPDs too, and Part 4 notes (4.1) that SPDs for explosive environments can need special approvals. None of that is applied here: hazardous areas are not an input, and this schedule neither places SPDs relative to one nor selects devices for use inside one.

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· Voltbench is a calculation aid intended for use by, or under the supervision of, a qualified engineer; results support and do not replace professional judgement.