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Installation Guidelines

Lightning & Surge Protection

Eltek Valere DC Power Supply Systems

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1 Introduction

This document describes how to install a surge protection device (SPD) in an Eltek Valere Power systems; how to wire, what type of SPD and recommended voltage levels. The document covers surge protection for AC, DC and signal cables.

Along with this document, the local installation regulations specific to the country of use must be observed. The standard SPD kit for Eltek Valere DC power systems fits most AC configurations around the world. However, there are some special cases which require slightly different SPD kit. Please confirm type of AC grid in the actual area.

Eltek Valere engineering, support, service and sales departments need to be aware of these issues. Eltek Valere R&D is responsible for this document.

2 Protective zones

To get the overview of the installation protective zones are introduced. The different zones refer to the level of surge current that can be expected and the level the equipment in the zone has to able to withstand. The power system is located in zone 3. If any cable to or from the power system crosses a zone boundary it has to be protected accordingly.

Figure 2-1 shows zones and the corresponding protection device for the zone. Table 2-1 details the level for the zones.

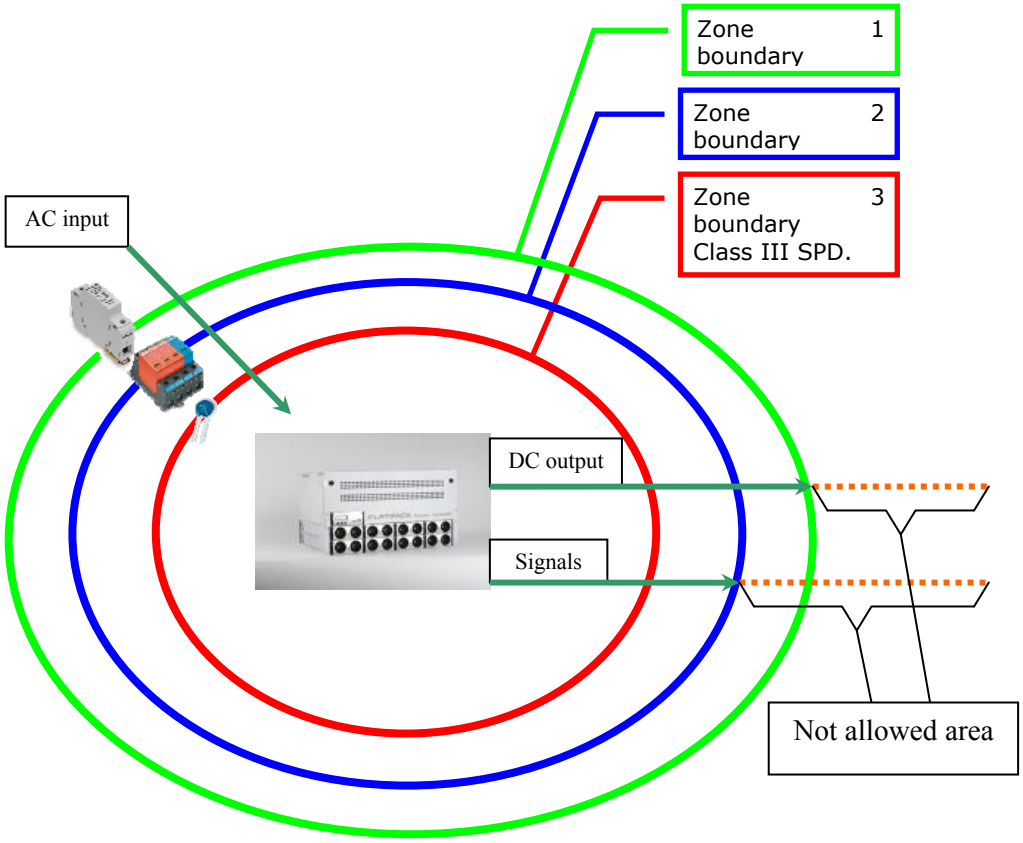


Figure 2-1 Protective zones

Zone 3	The power system is installed in zone 3. The protection into this zone is implemented in the power system. **AC:** IEC61000-4-5 level 3: ± 1 kV oc 1,2/50µs L-N ± 2 kV oc 1,2/50µs L/N-PE **DC:** IEC61000-4-5: ± 0,5 kV Differential protection ± 1 kV Common protection **Signal wires (CAN, I/O, other):** IEC61000-4-5: ± 1 kV (CAN) Screened cable to ground
Zone 2	Typical an Eltek Valere DC power system. For protection into this zone, it's required to use a Class II (C) SPD. **AC** Typical rated discharge current: 20kA (8/20µs) (10 times) Maximum rated discharge current: 40kA (8/20µs) (1 time) **DC:** Typical rated discharge current: 10kA (8/20µs) (10 times) Maximum rated discharge current: 40kA (8/20µs) (1 time) **Signal wires (CAN, I/O, other):** Not allowed area
Zone 1	Typical an upstream SPD. For protection into this zone, it's required to use a Class I (B) SPD. **AC** Typical rated discharge current 10-25kA L-N (10/350µs) Maximum rated discharge current 100kA N-PE(10/350µs) **DC:** Not allowed area **Signal wires (CAN, I/O, other):** Not allowed area

Table 2-1 Protective zone level definitions

As Table 2-1 reveals, there are different classes and classifications for SPDs; Table 2-2 gives and overview of the different classes.

Standard / Type/Description	IEC 61643-1	EN 61643-11 + A11 VDE 0675-6-11	Old Classifications
Lightning current arrester Combined lightning current and surge arrester	SPD class I	SPD Type 1	Class B
Surge arrester for distribution boards subdistribution boards, fixed installations	SPD class II	SPD Type 2	Class C
Surge arrester for socket outlets / terminal units	SPD class III	SPD Type 3	Class D

Table 2-2 Classification of SPDs according to IEC and EN/VDE

Arresters of Class I are positioned near the incoming supply and the main equipotential bonding system, arrester of Class II in Power system or near to the object to protect.

3 When do you need to install SPD?

Below you will find some basic check points helping the decision of installing optional SPD or not. **As a general rule, surge protection is required if any wiring (AC, DC or signal) is crossing the zone 2 boundary.** Having said that, there are many local factors which affect this and in addition to this guidance, it is important to base the decision on local experience and common engineering practice. It is recommended to ALWAYS install a SPD on the incoming AC.

- Study maps showing average number of lightning strikes per year. Lightning strikes up to 2-3 km away can damage electrical components. Is your site located in an area with many strikes per year?
- Is there any chance for surges and spikes above 4 kV on the incoming mains to the DC power system?
- Sites in sparsely populated areas and/or areas with overhead transmission lines are exposed for lightning strikes. Is your site located in such environment?

If you can answer "YES" to one of the above questions, it is recommended to install a CLASS II SPD kit on the incoming AC.

- Is your site exposed for direct lightning strikes (typical located in Zone 1), you should use a SPD of Class I, instead of Class II.

Eltek Valere's recommendation tells you what's needed to protected the DC power systems. Eltek Valere is not responsible for the choice of upstream SPD.

Figure 3-1 shows a map of the world with statistical number of lightning strikes per year and area (sq km).

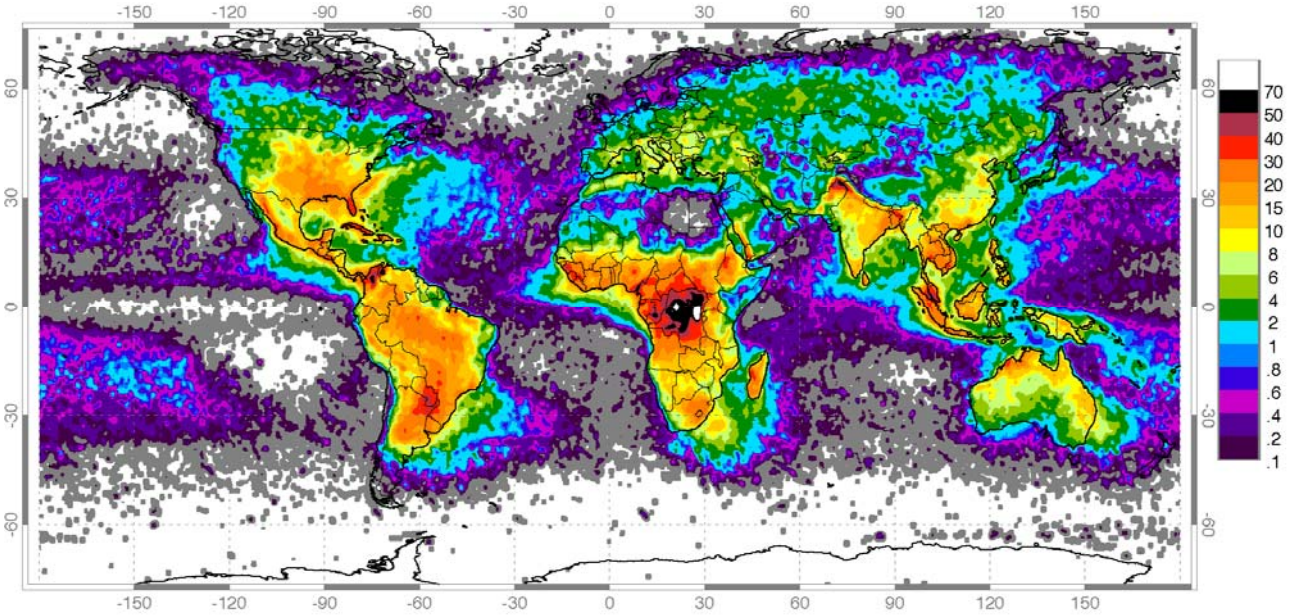


Figure 3-1 Statistical Lightning density (annual strikes / sq km)

4 Requirements for SPDs in Eltek Valere power systems

Below are the basic requirements for the SPD and the installation of the SPD in the Eltek Valere Power System. The requirements are divided into AC-side, DC-side and signals due to the different topologies and voltage levels for the different connections.

4.1 AC side

- Maximum continuous voltage ($U_{cont.}$) as low as possible. Recommend to use 280 Vac.
- Rated discharge current I_N, 20 kA (8/20 µs)
- Residual voltage less than 1.5 kV at nominal discharge current
- V-wiring
- For Y-connected systems : Varistors between L1(2,3)-N and arrester (spark gap) between N-PE
- For Δ (Delta) -connected systems : Varistors between L1-L2-L3 and L1-PE, L2-PE, L3-PE
- It is important to have good *differential* protection, i.e. L-N in Y-connected systems and L-L in Δ-connected systems
- Remote signal on Class II SPD

Figure 0-1 details what is differential and what is common protection.

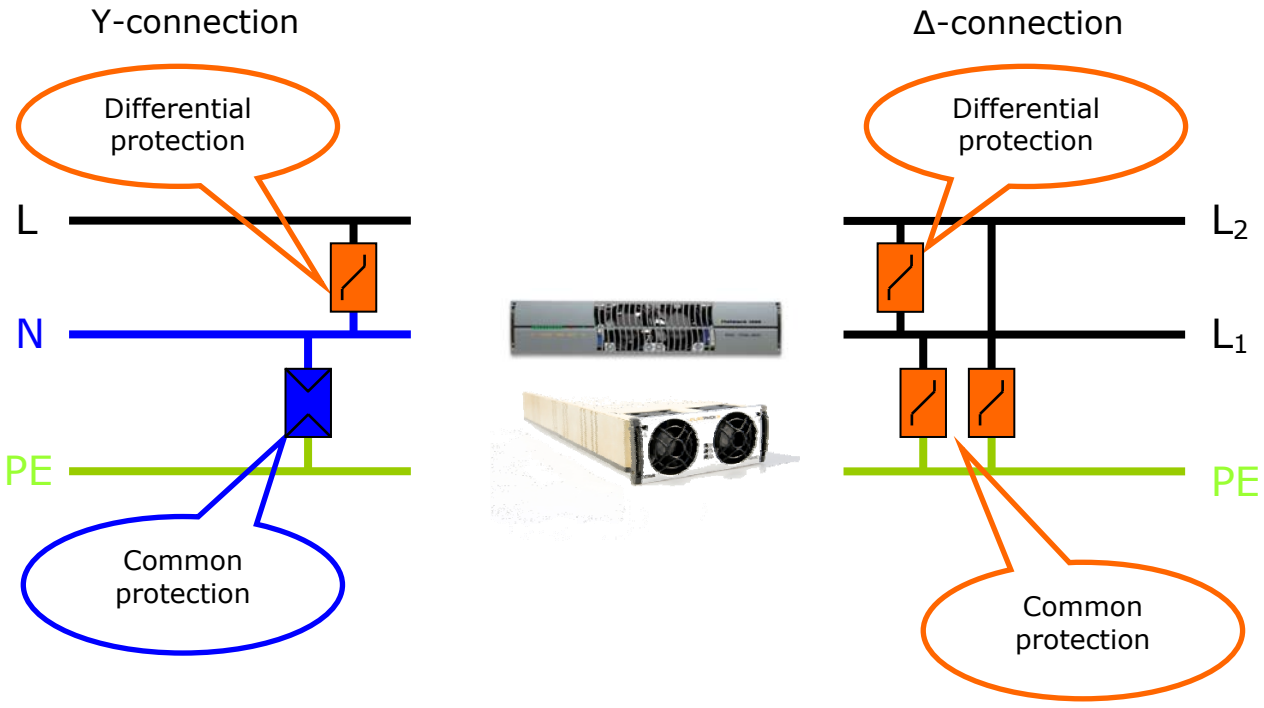


Figure 0-1 differential protection for Y- and D(elta) -connected systems

4.2 DC side

If one or more of the DC circuits crosses the Zone 2 boundary, the circuit must have surge protection to protect the power system.

The requirements for the protection are listed below.

- Maximum continuous voltage ($U_{cont.}$) as low as possible. Recommend to use 75 Vac device.
- Rated discharge current I_N, 10 kA (8/20 µs)
- Residual voltage less than 0,4 kV at nominal discharge current
- V-wiring
- Air-core choke between SPD and power system, minimum 25µH
- For grounded output systems : Varistor between live output and ground (PE)
- For floating output systems : Varistors between + (positive) to – (negative), + (positive) to PE and – (negative) to PE
- Remote signal on SPD

Figure 0-1 details what is differential and what is common protection.

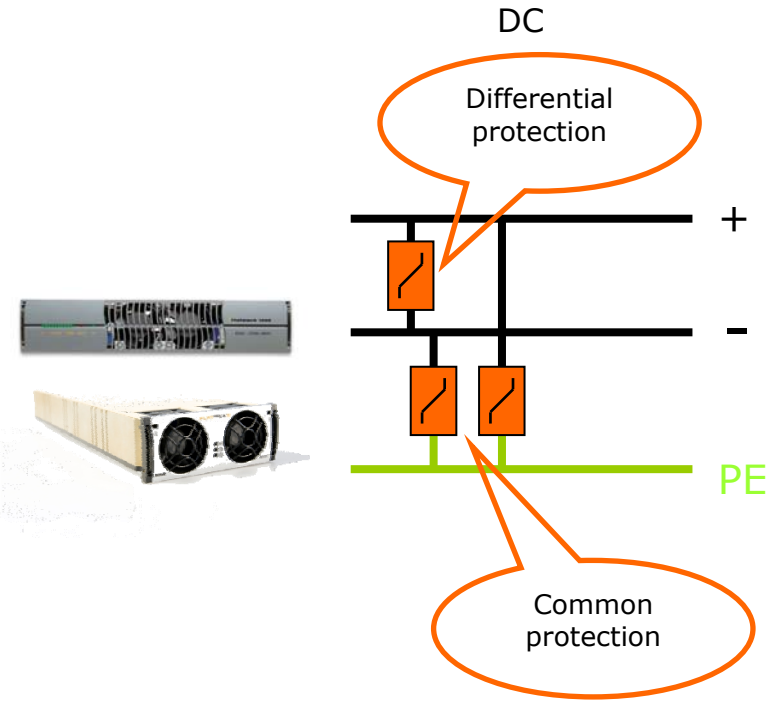
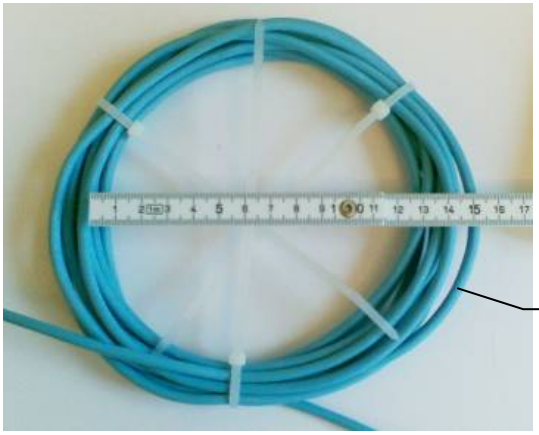
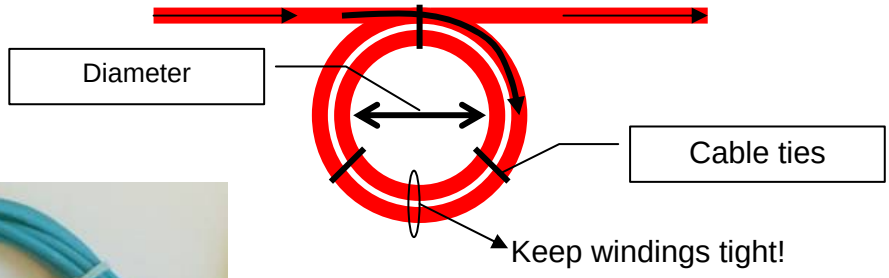


Figure 0-2 differential protection for Y- and D-connected systems

Air-core choke 25µH

- 25 µH ±10% @10-100 kHz
- Number of turns and diameter in table below
- Use as low gauge wire as possible, be aware of temperature problems in the windings





Example:
10 turns of 6.0mm^2 wire with approximately 130mm diameter of the winding. Impedance approx 25 µH at 10 - 100 kHz

Cable (mm^2)	Diameter (mm)	Turn	Inductance (µH)
1,5 / 2,5	165	9	25
4 / 6	130	10	25
10	165	10	25
16	160	11	25

4.3 Signals

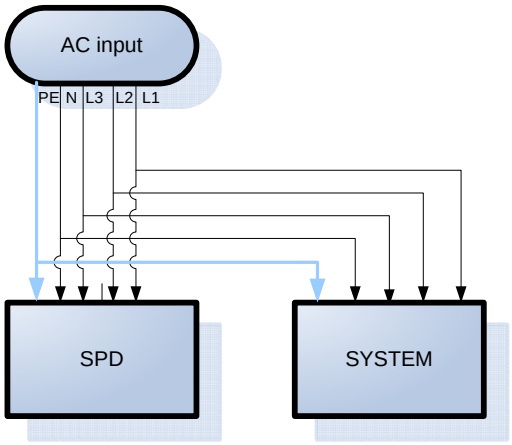
Not allowed to place signal cables out of Zone 1. (Signal cables are allowed only in Zone 1.)

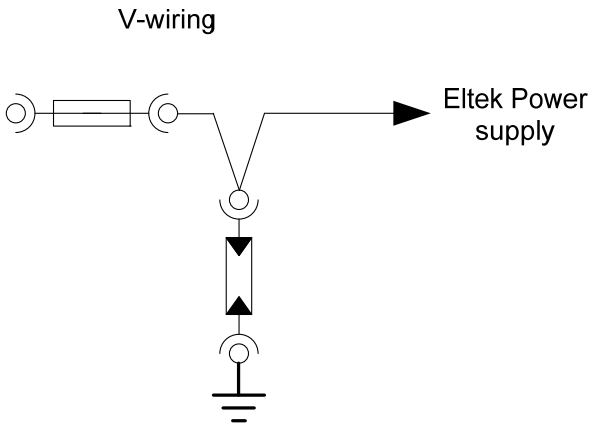
5 Installation

The SPD should be installed on the input, without any “dead ends”. This means that the input cables should ideally be run through the SPD contact point and then into the system. The next sections show how the SPD should be installed to achieve good protection.

5.1 Recommended SPD installation, V-wiring

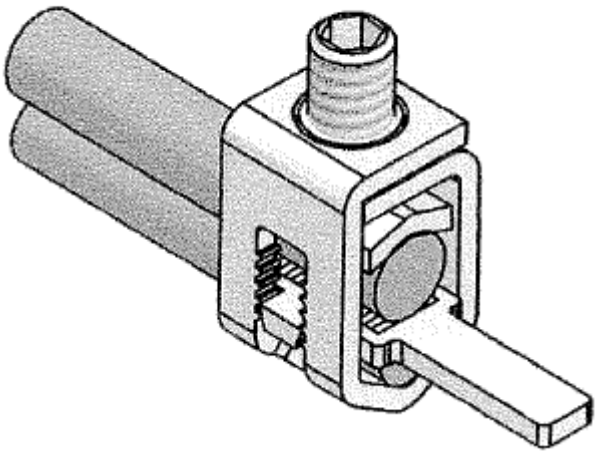
The actual level of the impulse voltage across the installation is crucial for the protection of the power systems. The optimum protective effect is achieved by using series connection system (V-wiring). With this wiring the impulse level across the installation to be protected is equal to the voltage protection level of the SPD, thus it is recommended to use V-wiring for connecting SPDs. This requires no separate conductor branches for connecting the SPD. The figures below show the basic wiring method and v-wiring.





A two-conductor terminal, shown below, can be used to make the installation easier and to avoid a terminal block.

Fig. 8.1.6.3 “Two-conductor terminals”



5.2 Not optimal SPD installation

If V-wiring for some reason is not possible, the cables to the SPD MUST be of the same dimensions as the input, and maximum length of 20 cm. This is important in order to limit the residual voltage seen by the power system.

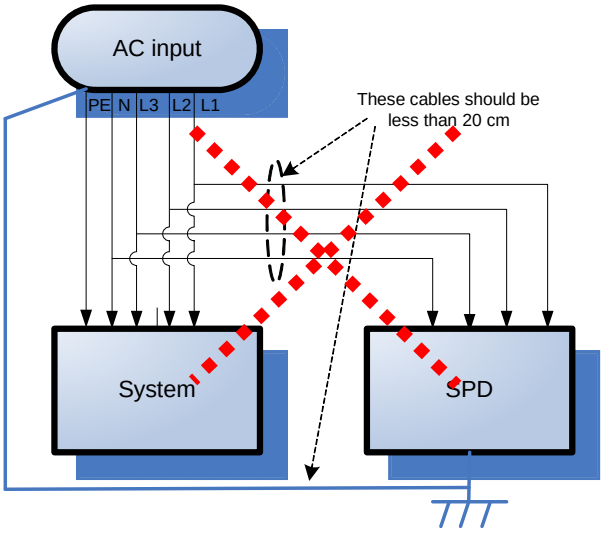
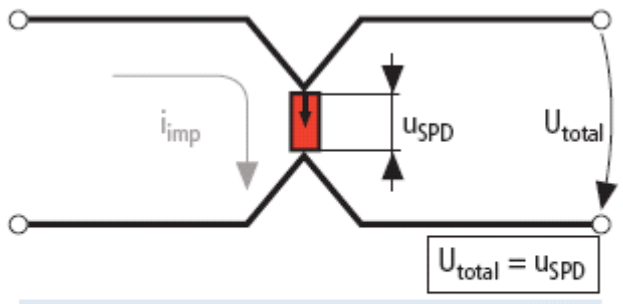
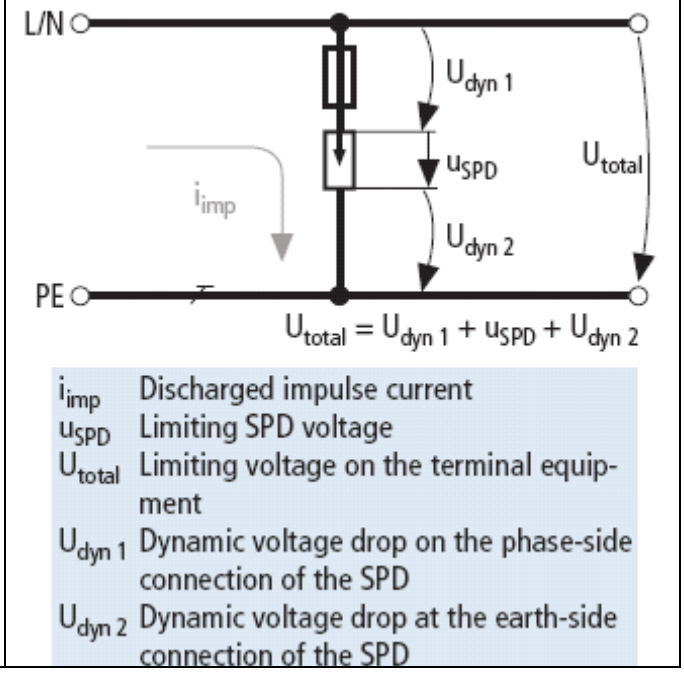


Figure 5-1 Non ideal wiring of the SPD

If it not possible to used v-wiring, keep in mind that the surge impulse current is in the kA-range, typically 20 – 30kA and of very short duration (10 – 50µs), and that only 50 cm of extra wire will increase the residual voltage for the system to protect to crucial levels, jeopardising the immunity level of the system. The figures below show the increased residual voltage when v-wiring is not used.





5.3 Routing of internal lines

Suitable routing of internal lines minimizes induction loops and reduces the creation of surge voltages internal in the Power System. The loop area can be minimized by routing the cables close to natural components in the Power System, which have been earthed and/or by routing power lines together.

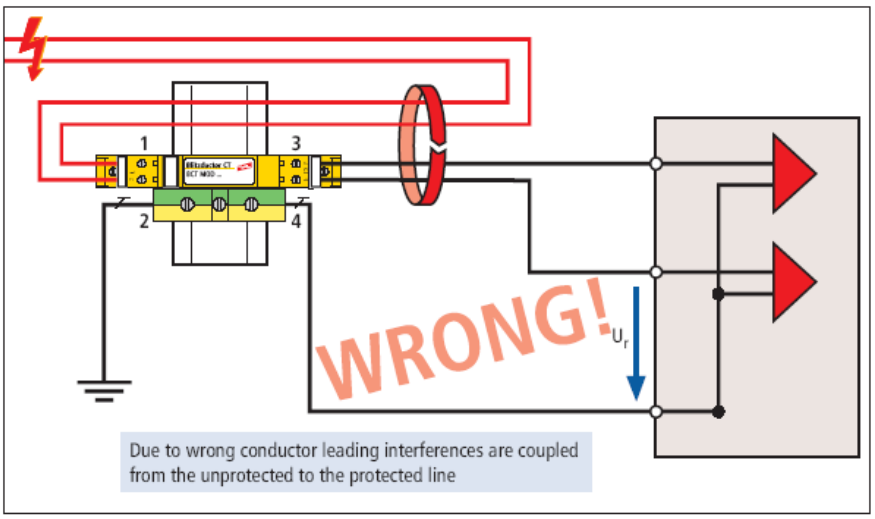


Figure 5-2 Incorrect routing of internal wires (shown on a class III SPD).

5.4 Earth connection

The earth connection should be min 10 mm^2 and as short as possible. A good earth connection to the site is very important, and will keep all equipment at the site on the same level. A common rule is that the impedance should be less than 1Ω, measured between DC power system chassis and main site earth.

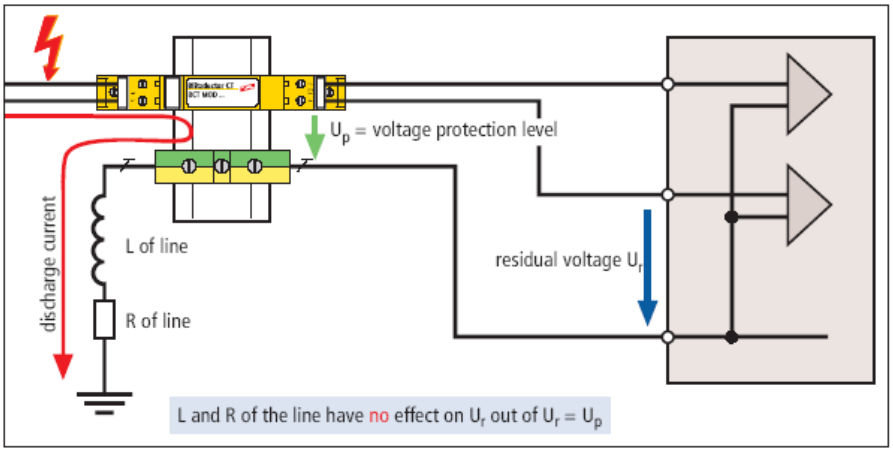


Figure 5-3 Correct wiring of the earth wire (shown on a class III SPD)

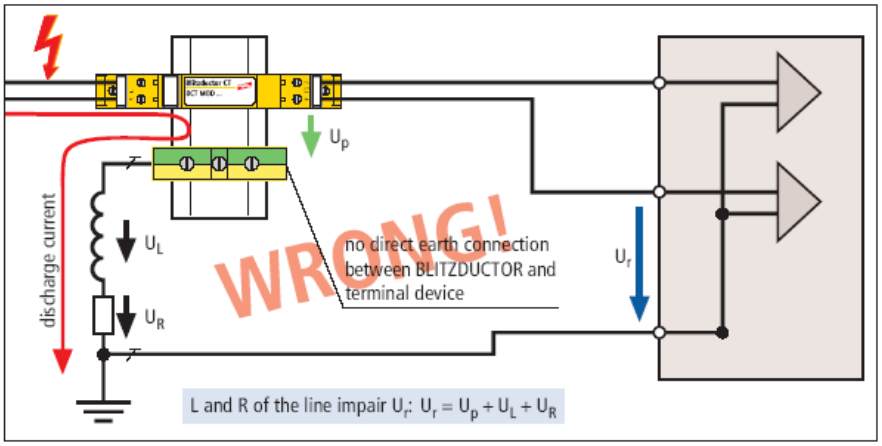
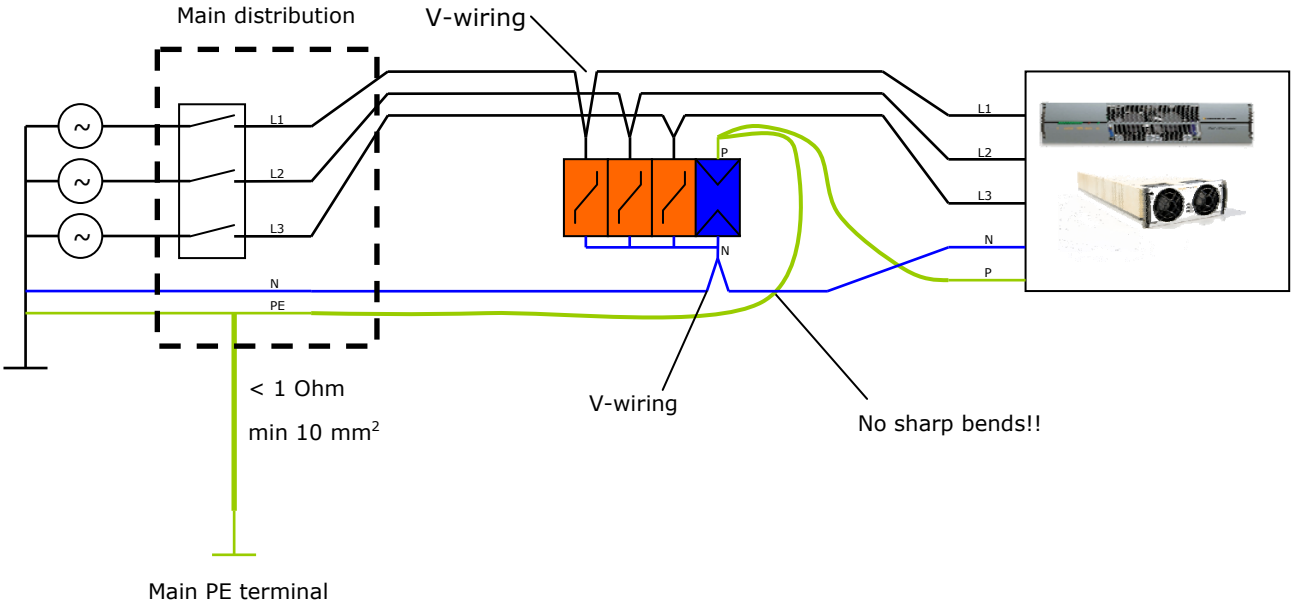


Figure 5-4 Incorrect wiring of the earth wire (shown on a class III SPD)

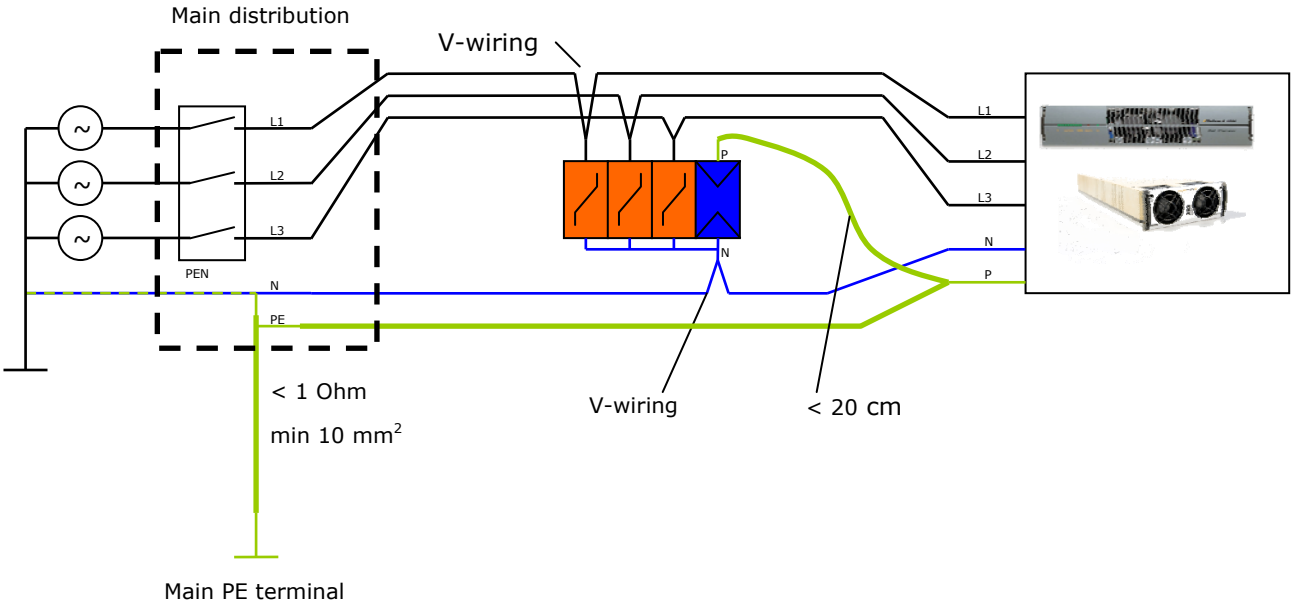
5.5 AC schematics

The next sections show basic wiring diagrams for different types of grid. The drawings cover most grid types, Y- and D-connected systems.

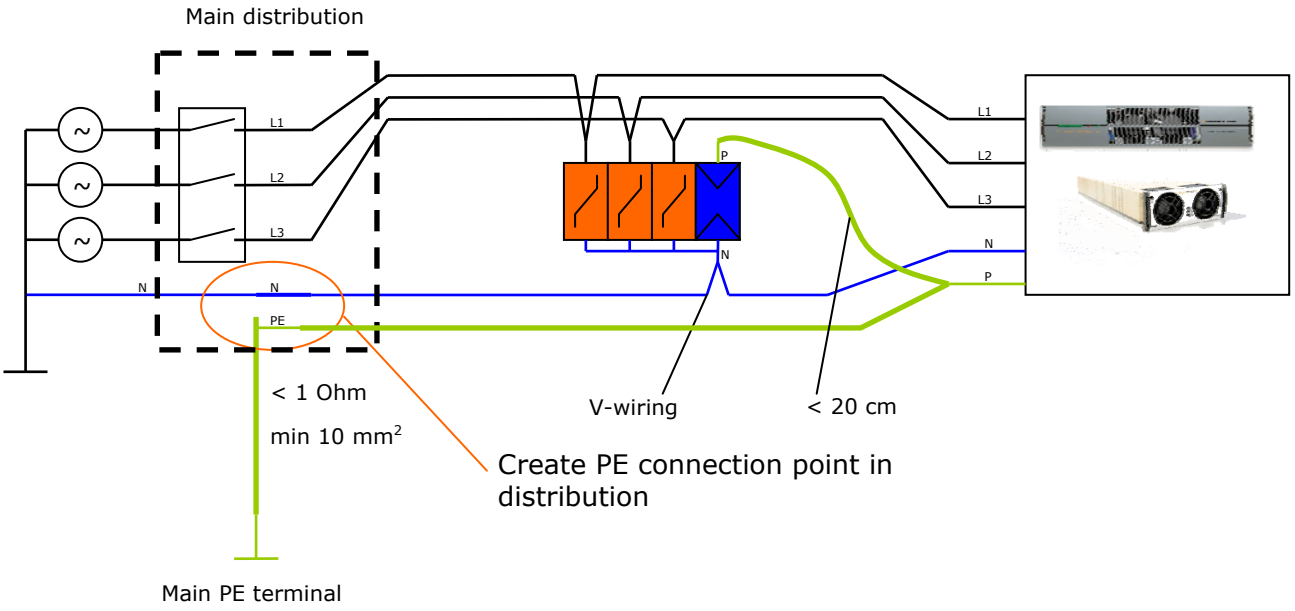
5.5.1TN-S 400V



5.5.2TN-C-S 400V

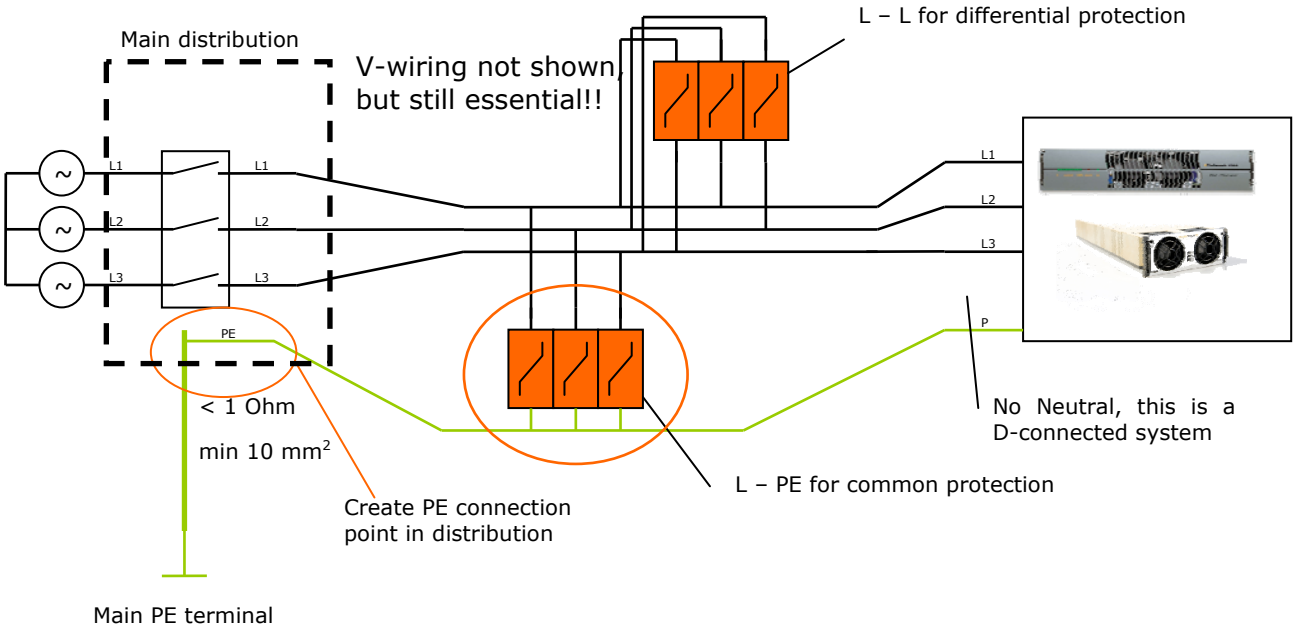


5.5.3TT 400V



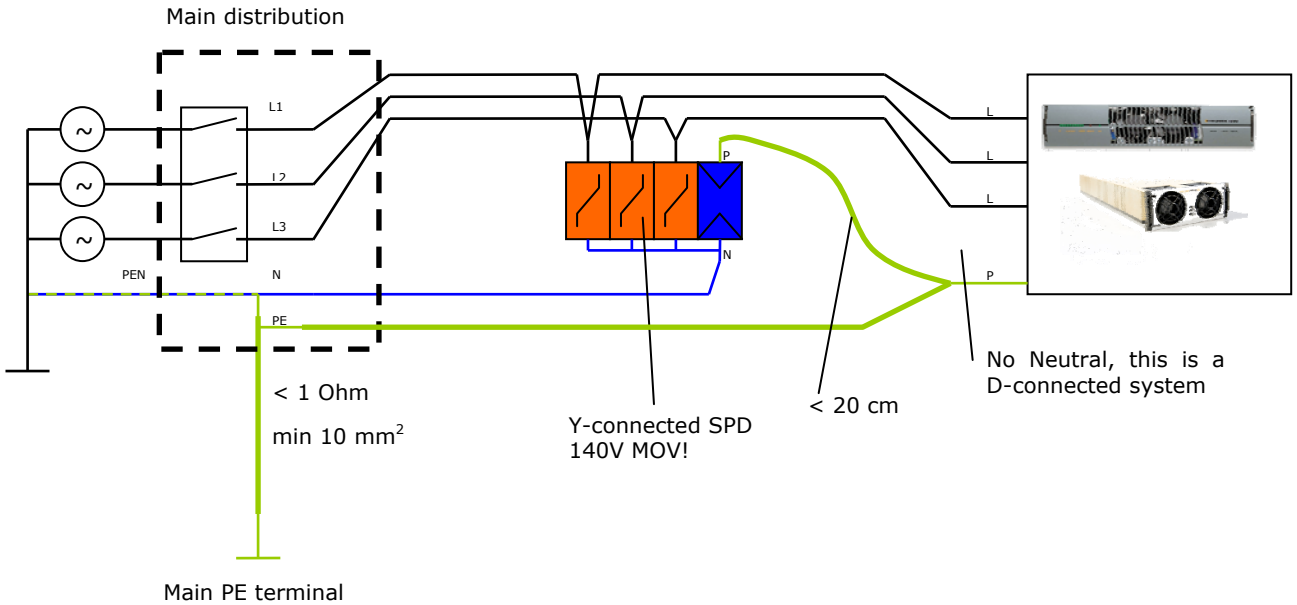
5.5.4IT 230V

This type of grid has no neutral conductor; the rectifier modules are D-connected. To achieve good differential protection, it is required to have one SPD between the lines in addition to the SPD from the lines to earth.



5.5.5TN-C-S 208V (1)

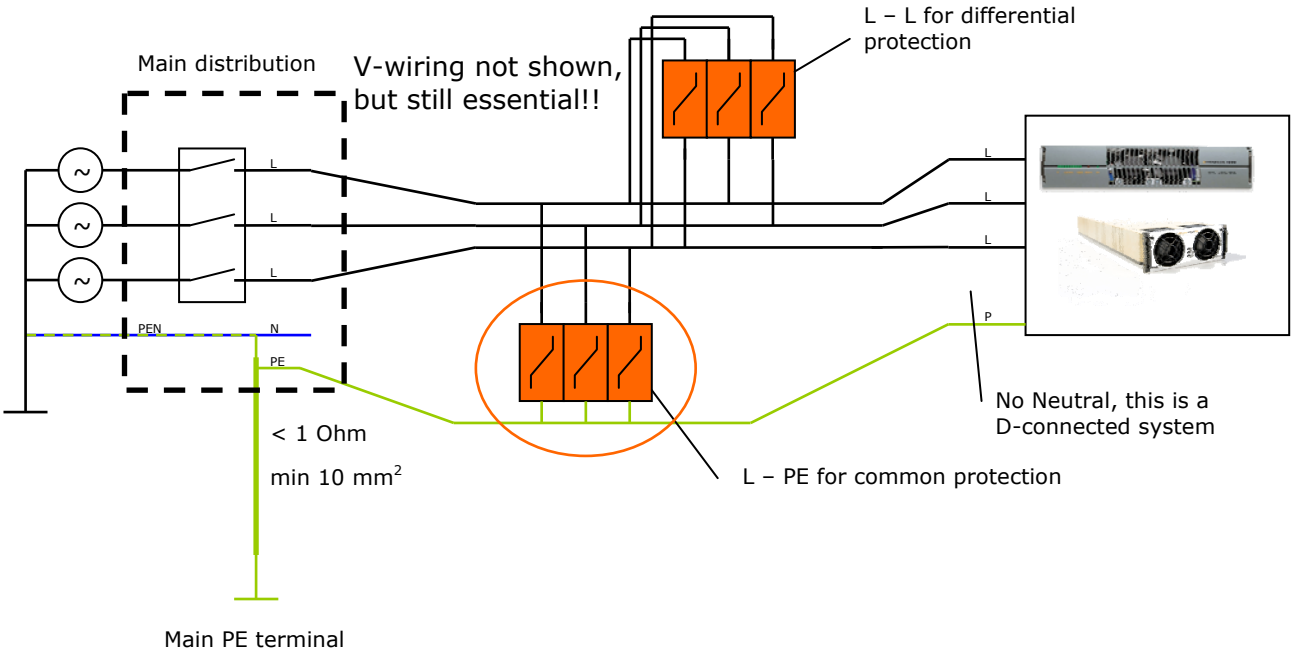
There are two solutions for this type of grid. The figure below shows a Y-connected SPD, for this connection it is essential to use 130/140V MOVs in the SPD to achieve good differential protection. The power system (rectifier modules) are D-connected (L-L), thus there are two MOVs in series for differential protection.



Solution number two is shown in the next section.

5.5.6TN-C-S 208V (2)

Solution number two uses two 3-pole SPDs, one for differential protection (L-L) and one for common protection. The rating of the MOVs is 280V. This configuration is seen where the N-conductor is not available at the site.

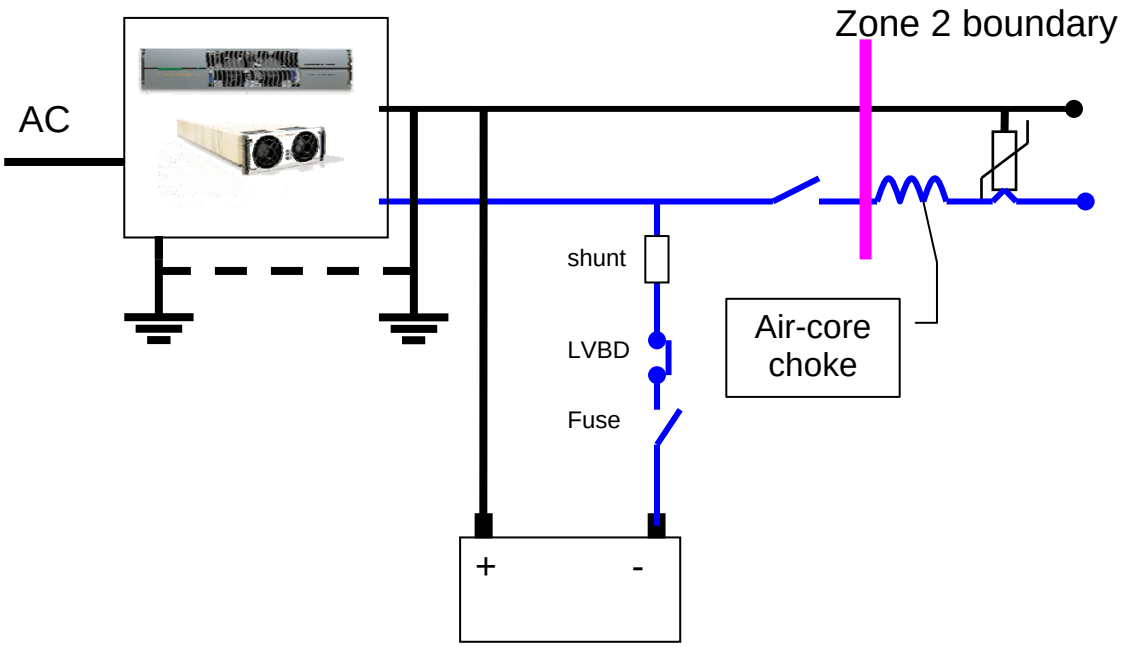


5.6 DC schematics

The next sections show basic wiring diagrams for different output wiring; grounded and floating outputs, positive and negative distribution.

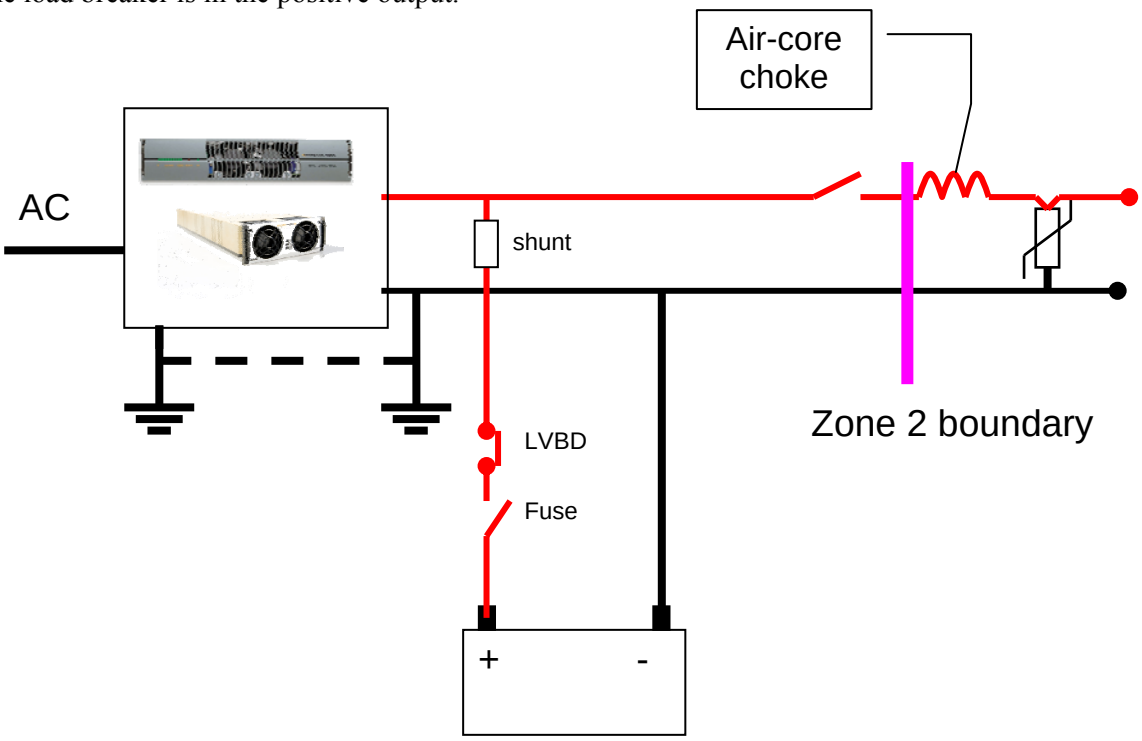
5.6.1Positive grounding, negative distribution (48V systems)

This configuration is the default configuration for 48V systems (neg 48). The positive output is grounded; the load breaker is in the negative output. Due to the grounding, only the live output needs protection.



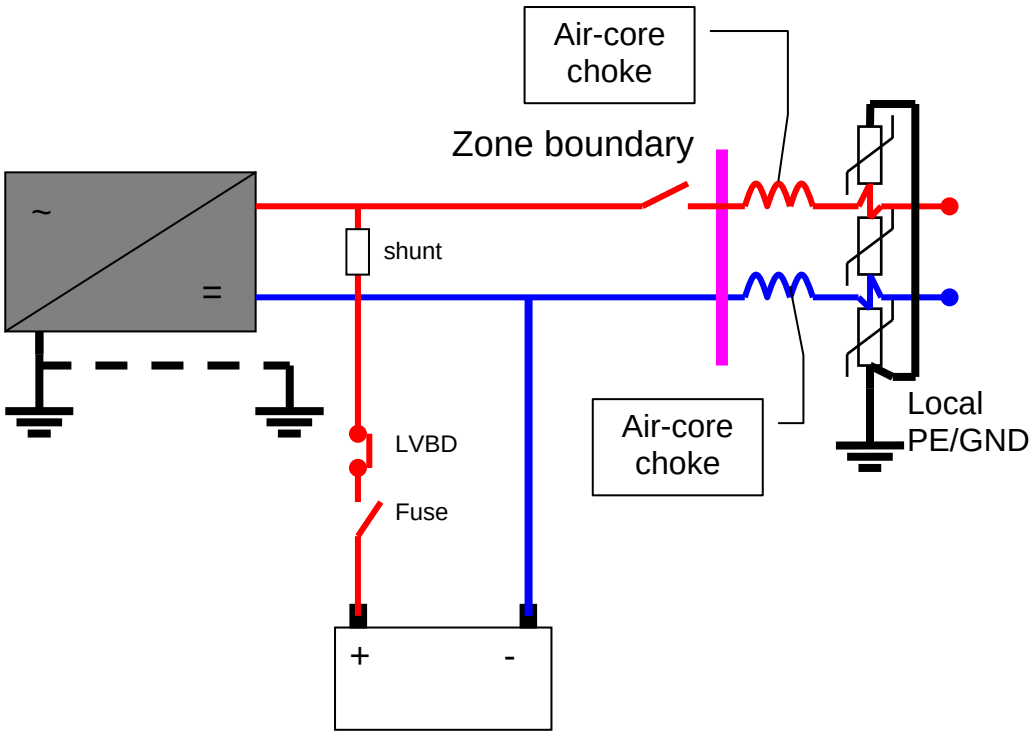
5.6.2Negative grounding, positive distribution (24V systems)

This configuration is the default configuration for 24V systems (pos 24). The negative output is grounded; the load breaker is in the positive output.



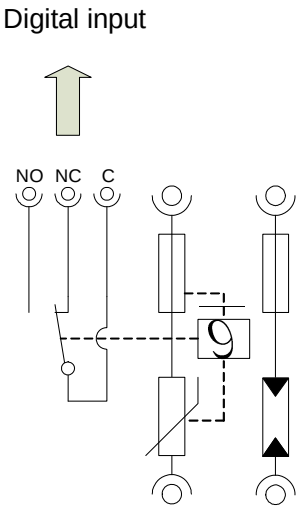
5.6.3 Floating output

In this configuration the output is not grounded, thus both outputs must be protected



5.7 Remote signal

It's important to use a remote signal from the SPD. This signal shall be connected to the Control unit (SmartPack or MCU). This is a requirement. Alarm service shall be available in the event of arrester failure. If the SPD is damaged it will not work properly, and the DC Power System will not be protected against lightning or surges.



If no remote signals are used, it must be stated in the user manual that there must be periodic service at the SPD.

6 List of standard Eltek Valere SPDs and accessories

Item	Part number	Part Description	Comment
1	219995	SPD TN 3p+1/R 280V 40 kA Cl.II G1	Standard 3-phase Y-connection
2	224559	SPD TN 3p+1/R 385V 40 kA Cl.II G1	3-phase Y-connection, increased maximum operating voltage
3	223556	SPD TN 1p+1/R 280V 40 kA Cl.II G1	Standard single-phase Y-connection
4	224561	SPD TN 1p+1/R 385V 40 kA Cl.II G1	Single-phase Y-connection, increased maximum operating voltage
5	224562	SPD TN 3p+1/R 130V 40 kA Cl.II G1	3-phase Y-connected SPD, D-connected system (TN-C-S 208, TN-S 220V)
6	224563	SPD TN 1p+1/R 130V 40 kA Cl.II G1	Single-phase Y-connected SPD, D-connected system (TN-C-S 208, TN-S 220V)
7	224564	SPD IT 3p+3/R 280V 40 kA Cl.II G1	3-phase D-connected SPD, D-connected system (TN-C-S 208, TN-S 220V, IT 230V)
8	224565	SPD IT 1p+2/R 280V 40 kA Cl.II G1	Single-phase D-connected SPD, D-connected system (TN-C-S 208, TN-S 220V, IT 230V)
9	256605	SPD DC 1p/R 75V 40kA Cl.II G1	Single pole for DC protection (75V)

To choose the correct SPD kit you need to know the following:

- Maximum operating voltage, it is highly recommend using 280 Vac as maximum continuous voltage ($U_{cont.}$). When increasing this voltage, the residual voltage will increase and the protection level for the Power System will be poorer
- Type of AC mains (TN, TT, IT etc) connected to the power system, see section 5.5

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