

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 5 : CLEAN POWER AND SURGE
PROTECTION



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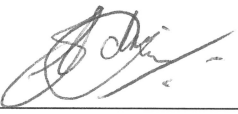

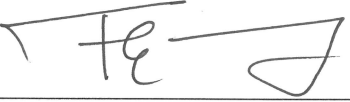
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INDEX

5	CLEAN POWER AND SURGE PROTECTION	4
5.1	Scope	4
5.2	Abbreviations.....	4
5.3	Standards	4
5.4	Uninterruptible Power Supply (UPS) General Requirements	5
5.5	UPS Rating.....	6
5.6	UPS Backup Batteries.....	6
5.7	UPS Standards.....	6
5.8	UPS Data Sheets	7
5.9	Surge Protection General.....	8
5.10	Surge Protection On Mains Power.....	11
5.11	Surge Protection On Field I/O	12
5.12	Surge Protection Data Sheets.....	17

5 CLEAN POWER AND SURGE PROTECTION

5.1 Scope

5.1.1 This specification covers the selection, installation, testing, marking and termination of Uninterruptible Power Supplies and Surge Protection used for low voltage power and control installations at Johannesburg Water wastewater sites.

5.2 Abbreviations

5.2.1 In this specification the following abbreviations will apply :-

SANS	: South African National Standards
IEC	: International Electrotechnical Commission
PLC	: Programmable Logic Controller
UPS	: Uninterruptible Power Supply
CE	: Official marking to indicate compliance with essential requirements of European Union directives
LGA	: Local Government Association
GS	: Geprüfte Sicherheit ("Tested Safety") is a voluntary certification mark
EMC	: Electromagnetic Compatibility
EN	: British Standard (BS EN)
PWM	: Pulse Width Modulation
THD	: Total Harmonic Distortion
Vpc	: Volts per cell
Ah	: Ampere hour
SPD	: Surge Protection Device
LPZ	: Lightning Protection Zone
ICASA	: Independent Communication Authority of South Africa

5.3 Standards

5.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises.
SANS 61643-1	: Surge protection devices – performance requirements and testing methods
IEC 61643-1	: Surge protection devices – performance requirements and testing methods
EN 50091-1, -2	: General and safety requirements for UPS
EN 61000-3-2	: Limits for harmonics

5.4 Uninterruptible Power Supply (UPS) General Requirements

- 5.4.1 The UPS must be a **TRUE** on-line, double conversion transformer-based unit (i.e. using a transformer which is an integral part of the UPS, on the **input** to the UPS). Hybrids, transformerless units or units with external, separate transformers will not be acceptable.
- 5.4.2 The UPS must employ PWM technology.
- 5.4.3 The UPS must have battery backup for at least 30 minutes at the **FULL RATED LOAD** of the UPS.
- 5.4.4 The output wave form shall be sinusoidal in form with the THD at full line load not exceeding 3%.
- 5.4.5 The output voltage variation must not exceed 2%.
- 5.4.6 Interference shall not exceed the limits laid down by ICASA.
- 5.4.7 The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.
- 5.4.8 The UPS must be accompanied by the tenderer's proof of their ability to install, test, service, repair, etc. these devices in the field and that they have a suitable after-sales infrastructure.
- 5.4.9 The UPS must be equipped with an integral static bypass switch as well as an integral manual/maintenance bypass switch.
- 5.4.10 The UPS static bypass switch must be upgradable in order to be matched to the load inrush current.
- 5.4.11 The tenderer must be willing and able to provide a complete factory load test, which can be witnessed by the engineer and/or client.
- 5.4.12 If it is an imported UPS, the vendor must be the **ACTUAL** importer of the UPS. In other words, a middleman who cannot provide factory load tests or suitable after-sales service and backup will not be acceptable.
- 5.4.13 A voltage free contact rated for 230V AC at 2 amps shall be provided in all the UPS units. This general alarm relay shall be internally wired to energise when a collective signal from all alarms is healthy. Alternatively, this relay shall de-energise when a fault occurs, raw mains is interrupted or the battery power is low.
- 5.4.14 The UPS must be supplied complete with maintenance free batteries and with a capacity to run the system for 30 minutes at full load. If external battery packs are provided, the battery charger must be adequately rated to re-charge the additional batteries at the C/10 rate.
- 5.4.15 The UPS system shall be suitable for operation from a 230V AC single phase supply and must supply a nominal single phase 230 Volt, 50 Hz output.
- 5.4.16 Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering.

- 5.4.17 The units shall be able to sustain an overload of 125% for one minute or 150% for ten seconds whereupon it shall switch itself off. A full short circuit shall cause the unit to switch off without sustaining damage.
- 5.4.18 The UPS must be able to operate normally in an ambient service temperature of 0°C to +35°C and a relative humidity of 5 to 95% non-condensing at 1500 to 3000m above sea level.
- 5.4.19 The rated output voltage must be user selectable from 220/230/240V.
- 5.4.20 The output frequency must not vary by more than 3Hz.
- 5.4.21 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

5.5 UPS Rating

- 5.5.1 The UPS should be able to supply a load with a power factor of 0.7 to unity. Tenderers must submit both the VA and Wattage rating of each UPS offered.
- 5.5.2 The UPS efficiency must be no less than 89% from zero to full load.
- 5.5.3 The UPS must be suitably rated to supply all the required equipment specified in this tender and any attached specifications and provide backup to this equipment for no less than 30 minutes at full load. Even if the equipment does not require it however, the UPS must not have a rating of less than 3kVA.

5.6 UPS Backup Batteries

- 5.6.1 Tenderers must state the exact number of batteries that will be used.
- 5.6.2 Tenderers must state the type of batteries that will be used.
- 5.6.3 Tenderers must state the Ah rating of the batteries that will be used.
- 5.6.4 Tenderers must state the design life of batteries that will be used (3-5years, 10 years, etc.).

5.7 UPS Standards

- 5.7.1 All imported UPSs must have a CE rating.
- 5.7.2 The UPS must have CE, LGA/GS markings.
- 5.7.3 The UPS must comply with safety conformance to EN-50091-1.
- 5.7.4 The UPS must have EMC conformance to EN-50091-2 and EN-61000-3-2.

5.8 UPS Data Sheets

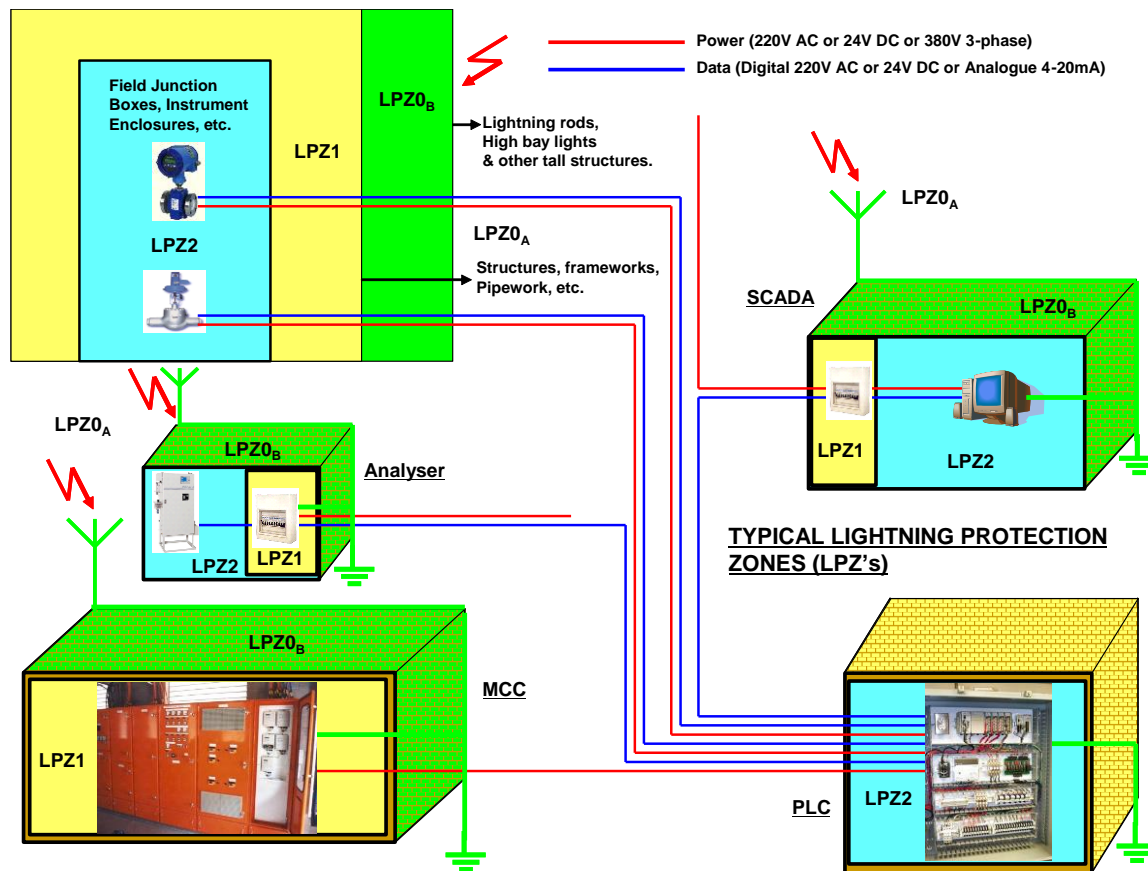
5.8.1 The tenderer must complete the data sheet below with his tender:

Technical Data Sheet: UPS

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model (E.g. true on-line, double conversion)	
Transformer-based unit (Y/N?)	
Technology employed (E.g. pulse width modulation)	
Output voltage variation	
Output frequency variation	
UPS rating (VA and Watts)	
UPS efficiency from zero to full load	
Maximum harmonic distortion at full load	
Overload handling capabilities (E.g. "x"% load for "y" minutes)	
Power backup period from batteries at full rated load	
Compliance with standards rating and markings (E.g. "Yes, full compliance" or "No".	
Tenderer to provide complete factory load test that can be witnessed by the Engineer?	
Staff available for installation, testing and backup service?	
Number of batteries to be used	
Type of batteries to be used	
Ah rating of batteries	
Design life of batteries	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

5.9 Surge Protection General

- 5.9.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).
- 5.9.2 The **Protection Level** required (i.e. Level I, Level II or Level III-IV in accordance with Table L.2 in SANS 10142-1:2003 Annex L) needs to be established for every installation where there is doubt about these requirements. This requirement looks at the consequential loss resulting from potential lightning hazards. Generally for all JHB Water wastewater sites in the Gauteng area, Level III-IV will suffice. In other words, a lightning impulse level of 100kA (10/350µs) needs to be considered when designing protection systems.
- 5.9.3 The function of the Surge Protection Device (SPD) is to prevent damage from occurring to the electrical and electronic devices due to destructive currents and voltages arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must comply with SANS 10142-1:2003 Annex L, SANS 61643-1/IEC 61643-1 and any other specifications referred to in SANS 10142-1:300 Annex L.
- 5.9.4 The definition of lightning protection zones (LPZs), as specified in SANS 61643-1/IEC 61643-1, must be used to determine the **Class** of SPD to be used (i.e. Class I, Class II or Class III in accordance with SANS 61643-1/IEC 61643-1). These classes (also referred to as IEC Classes or IEC Category Classes or Types) define the surge handling ability which SPDs must have for use in each Class.

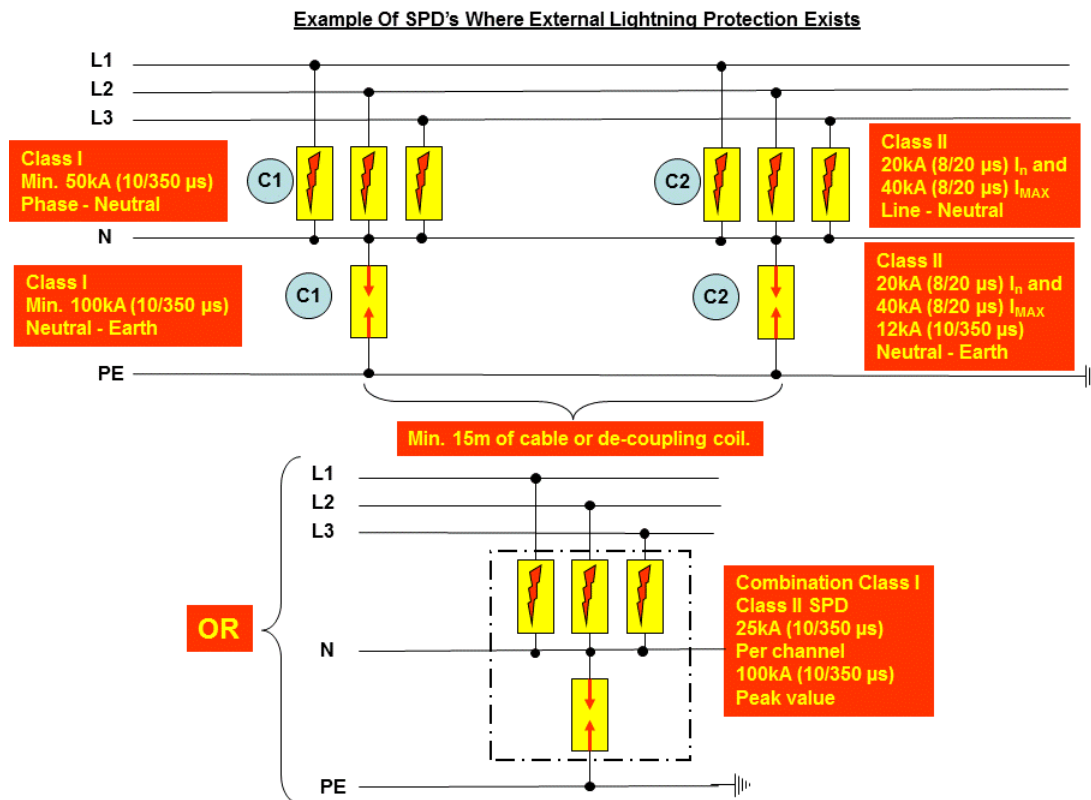


5.9.5 Notwithstanding the requirements of SANS 10142-1:2003 Annex L, the surge handling ability of the SPDs installed in the various LPZs for JHB Water applications must be as follows:

At the Interface Between:	IEC Class SPD Required	Min. Required SPD Rating
LPZ 0 _A and LPZ 1	Class I	For Single Units: $I_{imp} = 50\text{kA}$ (10/350 μs) for SPDs between PHASE and NEUTRAL $I_{imp} = 100\text{kA}$ (10/350 μs) for SPDs between NEUTRAL and PE and For Combination Units: $I_{imp} = 25\text{kA}$ (10/350 μs) per channel
LPZ 0 _B and LPZ 1	Class II	$I_{sn} = 20\text{kA}$ (8/20 μs) for SPDs between PHASE and NEUTRAL $I_{sn} = 12\text{kA}$ (10/350 μs) for SPDs between NEUTRAL and PE
LPZ 1 and LPZ 2	Class III	$I_{sn} = 5\text{kA}$ (8/20 μs)

Where: I_{imp} = The standard impulse current curve with a 10/350 μs waveform
 I_{sn} = The nominal discharge current or peak value of the current flowing through the SPD. It has an 8/20 μs impulse current waveform.

- 5.9.6 All SPDs used must limit the voltage to less than two times the nominal operating voltage for systems below 60V (AC or DC) and for systems above 60V it must limit the voltage to the values given in Table L.1 in SANS 10142-1:2003 Annex L.
- 5.9.7 In order to ensure that individual protective devices are selectively effective, i.e. each protection stage only takes on the amount of interference energy which it is designed for, if one protection stage is faced with the threat of an energy overload, the upstream, more powerful arrester must “respond” and thus take over the discharge of the interference energy.
- 5.9.8 Even though surge arresters (i.e. Class II and Class III devices), by definition, are only tested to pulse waveforms of 8/20 μ s, it is imperative to determine the ability of the device to carry an impulse current of the partial lightning currents with the waveform 10/350 μ s for the co-ordination between surge arrester (i.e. Class II and Class III devices) and lightning current arrester (i.e. Class I devices), and also for the SPD.
- 5.9.9 All SPDs must be DIN rail mounted.
- 5.9.10 Should the building (where the PLC, distribution board, etc. and surge protection is installed) have external lightning protection, then a combination of Class I lightning current arresters (min. rating of 50kA (10/350 μ s) each phase to neutral) plus one Spark Gap (min. rating of 100kA (10/350 μ s) neutral to earth) and Class II nominal discharge current $I_n = 20$ kA (8/20 μ s) and maximum discharge current $I_{MAX} = 40$ kA (8/20 μ s), non-linear surge arresters from each phase to neutral and one Spark Gap, nominal discharge current $I_n = 20$ kA (8/20 μ s) and maximum discharge current $I_{MAX} = 40$ kA (8/20 μ s) surge arresters must be installed as per SANS 10142-1:2003 Annex L (see the diagram below). In all other cases a minimum of Class II SPDs are required.
- 5.9.11 These surge arresters (Class I and II or combination Class I/Class II above) must be installed from each Phase to Neutral and from Neutral to Earth. It must be borne in mind that if Class I **and** Class II SPDs are used, a minimum of 15m of cabling is required between these two systems for de-coupling. Another alternative is to use the correct coils available on the market to simulate the 15m difference. Preference will however be given to **combination** Class I and Class II units with pluggable modules because this eliminates coils and long cables and it allows replacement/inspection without the need to disconnect cables.



5.9.12 For Class I lightning arresters the minimum conductor size is 16mm² and pre-fusing of 315 Amps is required if the upstream protection is greater than 250 Amps. Fuses must be connected in series with the SPDs and must have the same fault current level or higher than that of the panel or board where they are installed.

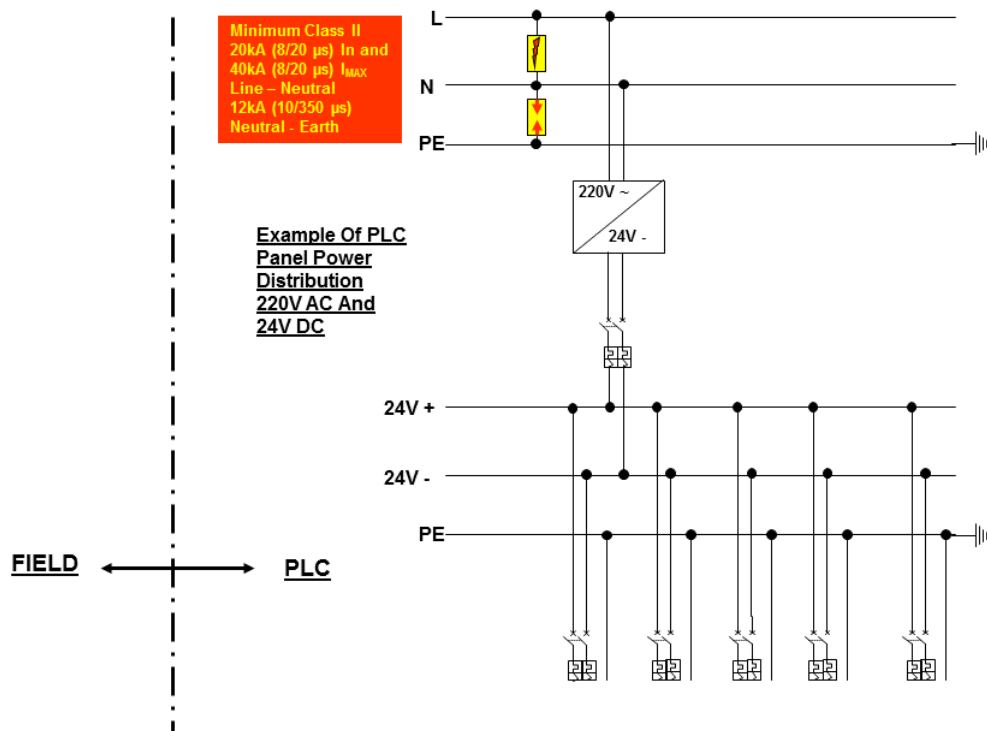
5.9.13 For Class II the minimum conductor size is 6mm² and pre-fusing of 125 Amps is required if the upstream protection is greater than 250 Amps. Fuses must be connected in series with the SPDs and must have the same fault current level or higher than that of the panel or board where they are installed.

5.10 Surge Protection On Mains Power

5.10.1 If there is no external lightning protection on the building, the protection units on the mains supply of the PLC panel must consist of at least IEC Category Class II, nominal discharge current $I_n = 20\text{kA}$ (8/20 μ s) and maximum discharge current $I_{MAX} = 40\text{kA}$ (8/20 μ s), non-linear surge arresters from each phase to neutral and one Spark Gap, nominal discharge current $I_n = 20\text{kA}$ (8/20 μ s) and maximum discharge current $I_{MAX} = 40\text{kA}$ (8/20 μ s), surge arrester from neutral to earth (same arrangement as the example shown above).

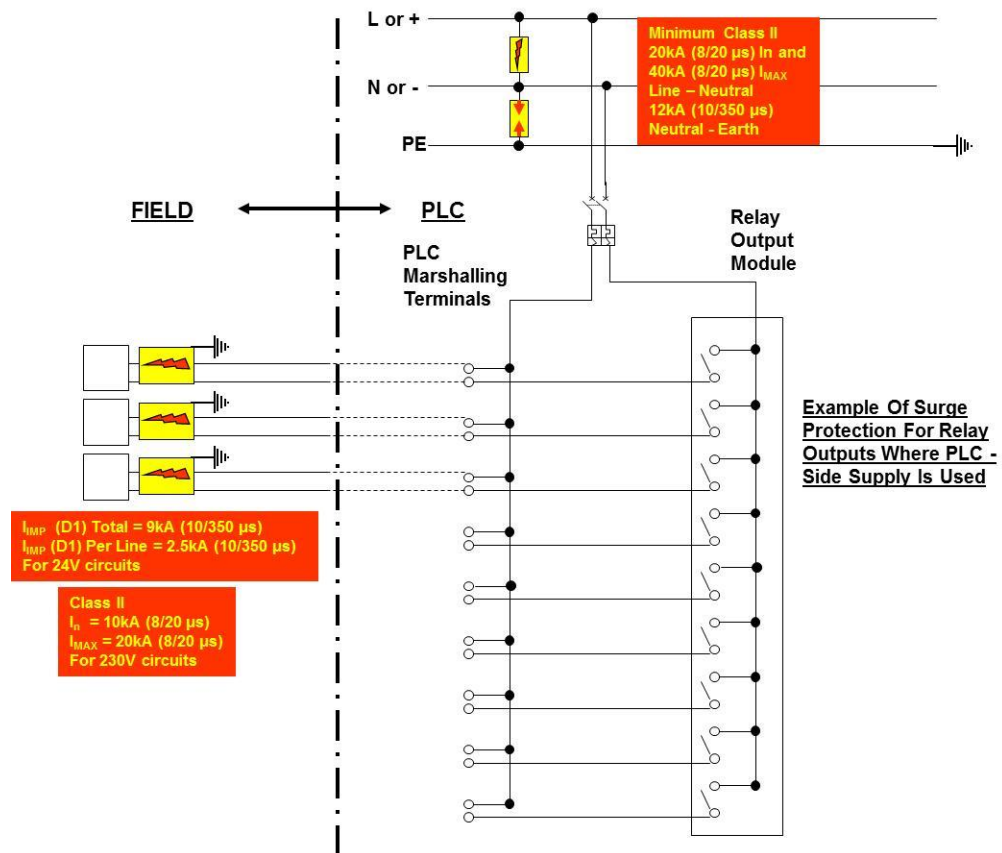
5.10.2 All the surge arresters must be DIN rail mounted and must comply with IEC 61643-1 (other designations, SANS 61643-1 and SANS IEC 61643-1) and there must be visual indication if the unit is over stressed (i.e. it has failed).

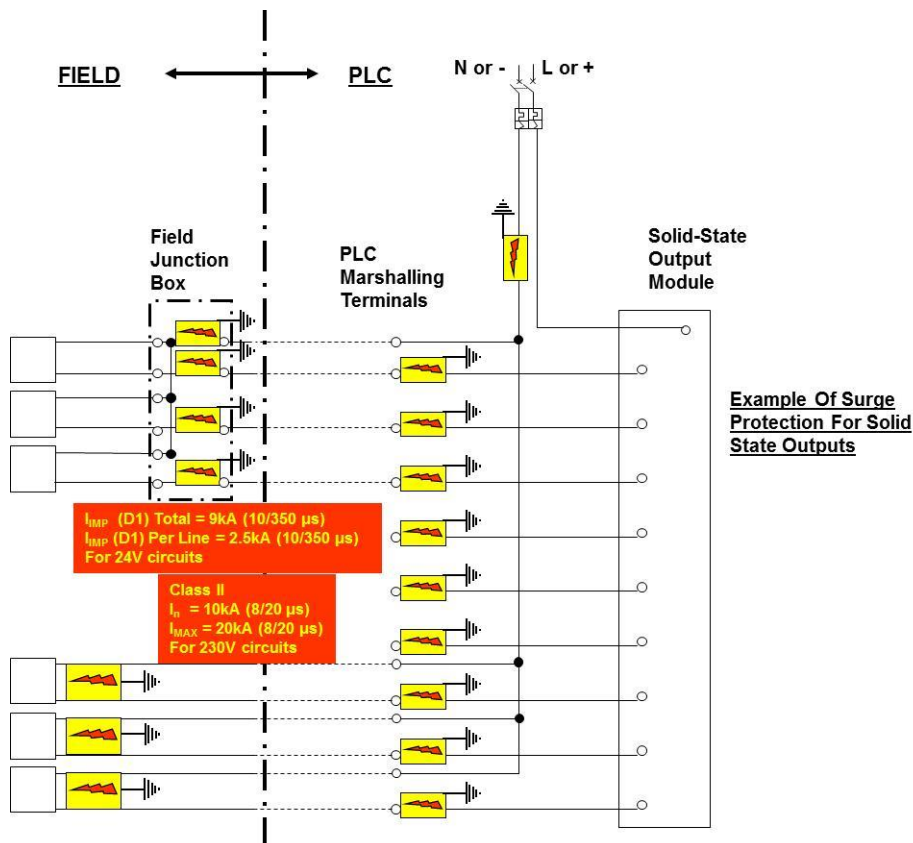
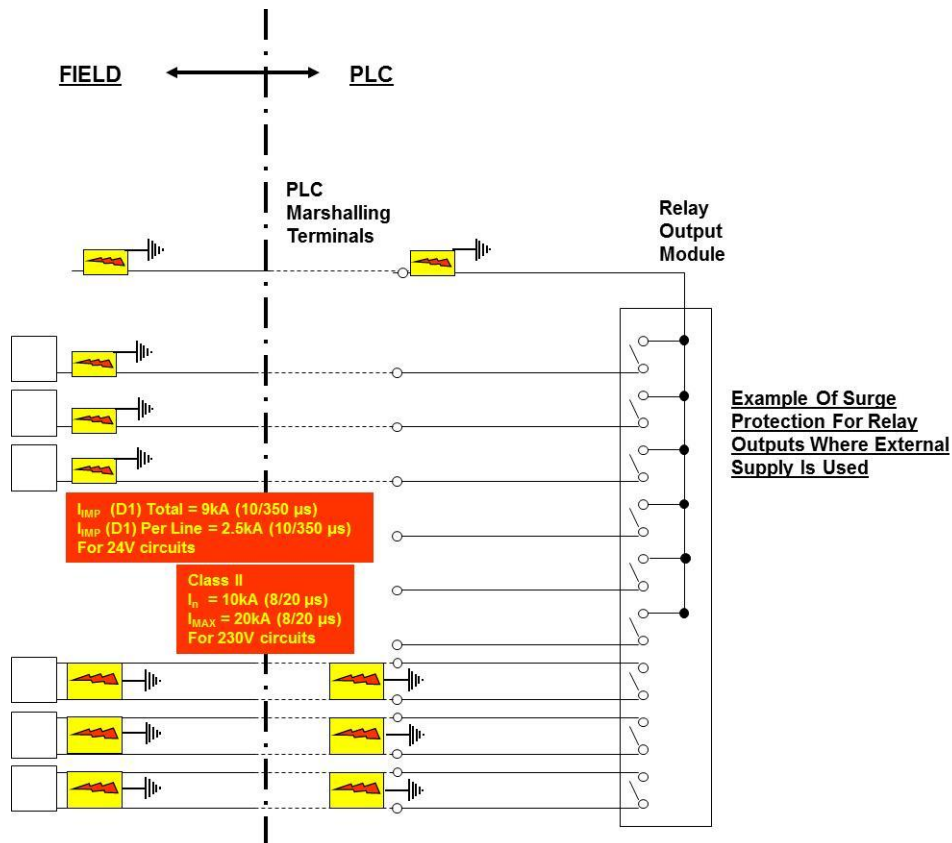
5.10.3 The spark gap must be able to withstand surges of 12kA (10/350 μ s) and must specifically bond between neutral and earth.

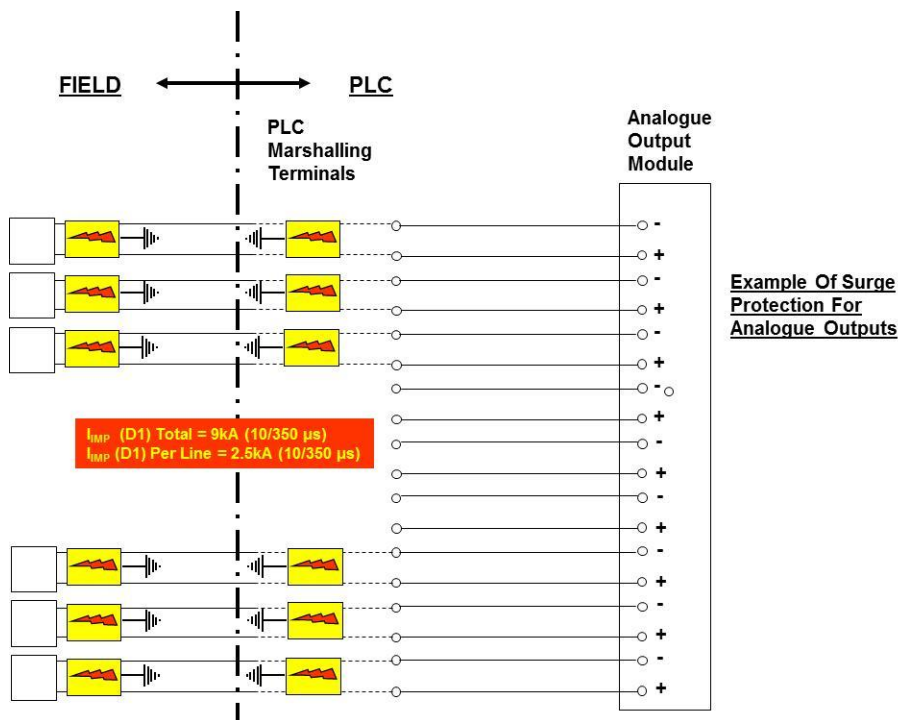
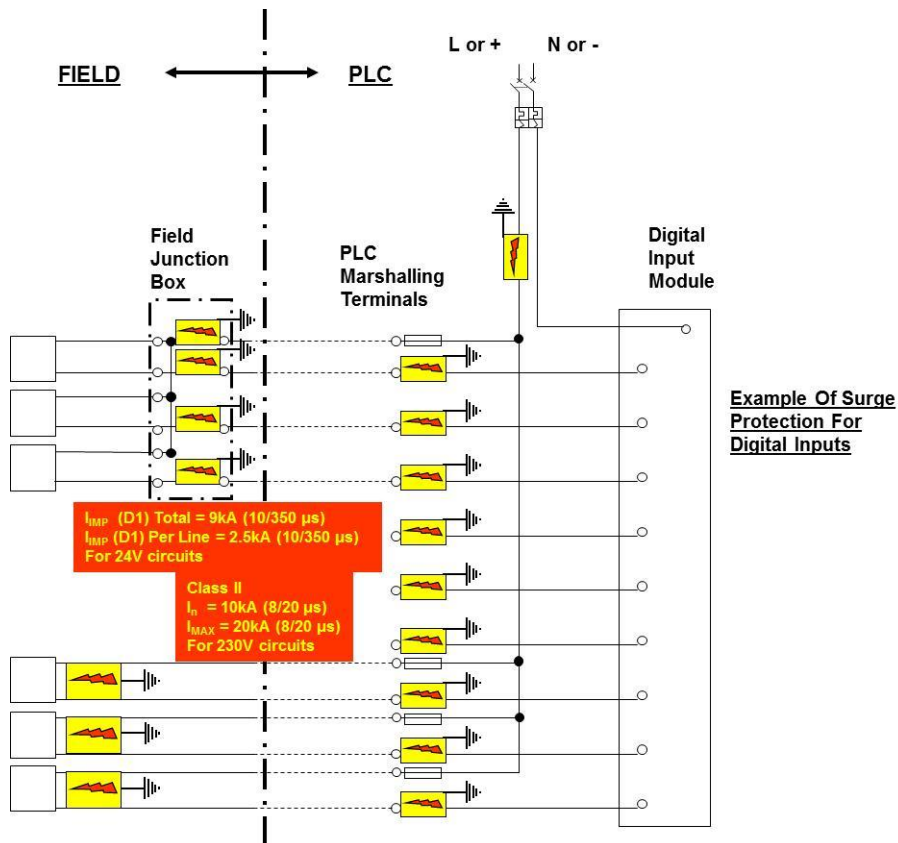


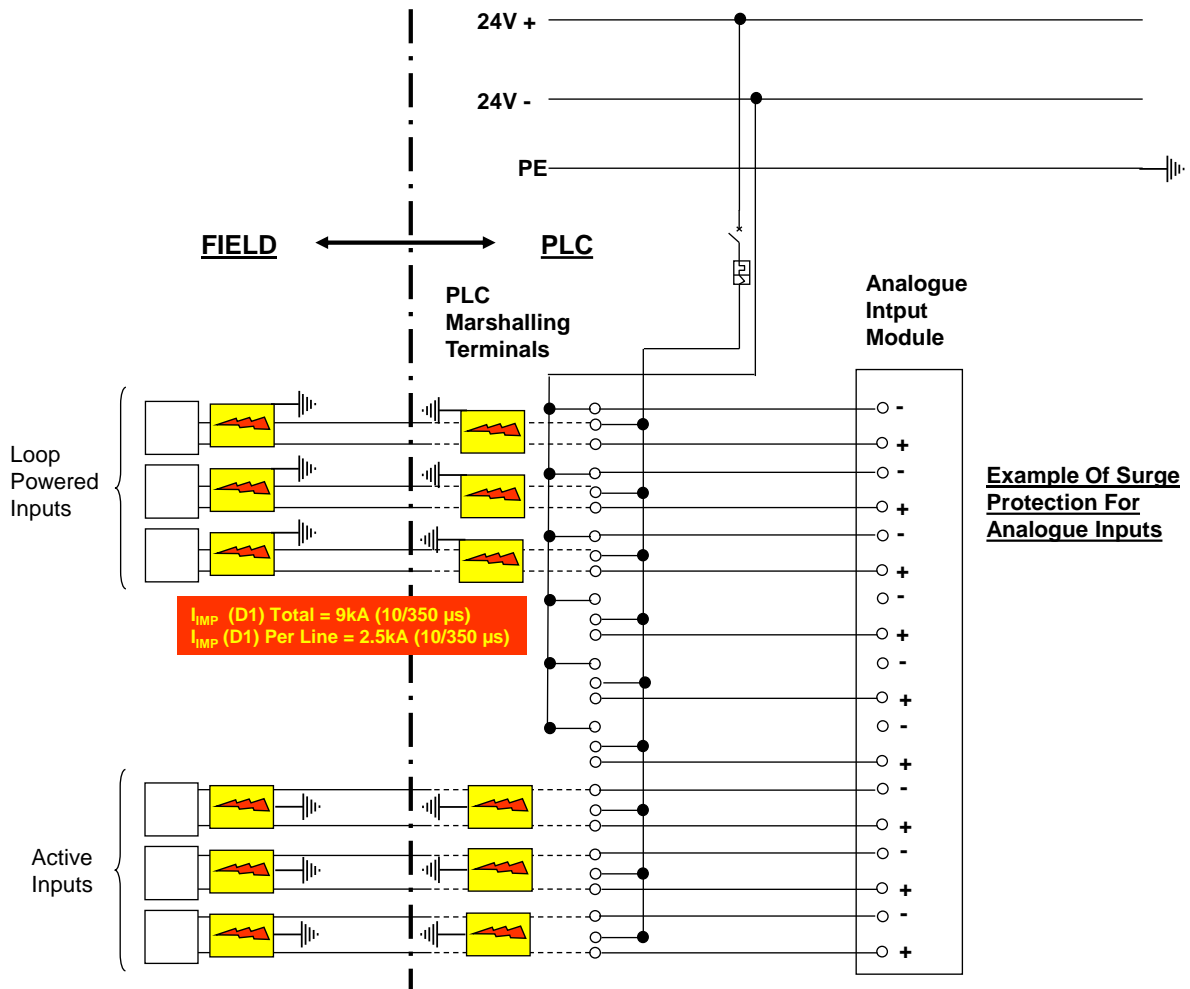
5.11 Surge Protection On Field I/O

- 5.11.1 SPDs used for data protection (i.e. of digital and analogue I/O connected to devices outside the PLC building where induced voltages and currents are possible) must be designed to repeatedly withstand direct lightning currents I_{imp} of 2.5kA (10/350 μ s) per line and nominal (i.e. peak) surges I_{sn} of 20kA (8/20 μ s) for 4-20mA control loops, 24V DC digital and analogue systems and 24V AC systems. SPDs used for 230V AC digital I/O connected to devices outside the PLC building where induced voltages and currents are possible, must be designed to repeatedly withstand nominal discharge currents I_n of 10kA (8/20 μ s) and maximum discharge currents I_{max} of 20kA (8/20 μ s). These 230V AC SPDs must be rated at least Class II according to IEC 61643-1 or Type 2 according to IEC 61643-11.
- 5.11.2 SPDs must be installed at both ends of each cable (i.e. at the PLC and at the field instrument, MCC, control panel, junction box, etc).
- 5.11.3 The LPZ in which the instrument, instrument distribution board or instrument junction box is, must be used to determine the ratings of the SPD. The ratings on digital and analogue I/O protection must just never be lower than the ratings mentioned in item 5.11.1 above.
- 5.11.4 The rated operating current for SPDs used for protection of I/O systems must not be less than 0.75Amp.
- 5.11.5 All SPDs must consist of a base and a pluggable top which can be disconnected without interrupting the signals.









5.12 Surge Protection Data Sheets

5.12.1 The tenderer must complete the relevant data sheets below with his tender:

Technical Data Sheet: Mains Surge Protection

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Class (E.g. Class I, Class II, combined Class I/Class II, etc.)	
Surge current rating at the relevant waveform (E.g. 20kA, 10/350µs, phase-to-neutral)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection 230V Digital I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Class (E.g. Class I, Class II, combined Class I/Class II, etc.)	
Discharge current rating at the relevant waveform (E.g. 20kA, 10/350µs, phase-to-neutral)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection 24V DC Digital I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Lightning Impulse Current and pulse form (E.g. 9kA - 10/350µs – total, 2.5kA - 10/350µs – per line, etc.)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection Analogue I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Lightning Impulse Current and pulse form (E.g. 9kA - 10/350µs – total, 2.5kA - 10/350µs – per line, etc.)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	