



Any one would expect a safety device like SPD- Surge protection Device to “fail safely” in case of any abnormalities above the SPD’s limit. Also, situations like Neutral cut or shift in a power supply system is not uncommon. There were few incidences of SPD explosion & fire accidents in India. Now, manufacturers of SPDs no longer get away with this problem that, the failure is due to abnormal conditions. IEC 61643-11 precisely addresses this issue apart from all other safety issues. All new concepts, to gain confidence from customers, need to be tested as per the latest international standard so that the safety is not compromised. When it comes to safety devices, it is all the more important to adhere to latest standards because more & more safety features are getting added to ensure that safety devices- in this case SPDs act & save the electronic equipment & in case of failure due to abnormalities in the incoming supply, shall “FAIL SAFE” without causing fire hazards.

All SPDs manufactured from April 2011 should have valid Test Certificate as per IEC 61643-11 Ed. 1 which has been published in March 2011. It deals with “Low Voltage SPDs- Part 11- SPDs connected to Low Voltage power systems- Requirements and test methods”. It supersedes IEC 61643- 1 Ed 2, published in 2005. The biggest advantage of IEC 61643-11 is that, not all testing methods are totally new. SPDs tested as per IEC 61643-1 needs to undergo few safety tests to get qualified. Because, IEC 61643-1 talks only about “PERFORMANCE TESTS” whereas IEC 61643-11 talks about “Safety & Performance Tests”.

Though the differences between IEC 61643- 1 & IEC 61643-11 is given in the Table below, let us analyze all the important safety parameters which are added

in IEC 61643-11 , so that the benefits are enjoyed by the customer and also enable them to use more & more safety compliance SPDs to protect their electronic & electrical equipment from lightning and switching surges.

Given below are the most significant additions in IEC 61643-11 related to safety of SPDs.

- TOVs (Temporary Over Voltage) caused by “faults” in the medium and high voltage system.
- New TOV test parameter is added. It is 120 minutes for LV system faults in distribution system and loss of neutral. After this test, either SPD shall withstand this stress of high voltage or “fail safe” without causing fire or explosion hazards.
- Class II Operating Duty Test is made more stringent by applying 15 impulses at crest value of Open Circuit Voltage of the Combination Wave Generator
- Pass criteria has been increased significantly.
- Additional tests are added for SPD failure mode simulation.
- Easily available “tissue paper” is utilized for testing rather than more difficult & stringent requirement of “muslin paper” & ‘Cheese cloth”

Let us examine the “safety features” associated with each of the above points.

### TOVs caused by “faults” in the medium and high voltage system

In a developing country like India, TOV issues are more due to faults in medium & high voltage systems. IEC

defines the levels of various voltages as below.

- Voltage up to 1000 V AC RMS or 1500 V DC comes under “Low Voltage”
- Voltage above 1000 V AC RMS to 100 kV comes under “Medium Voltage”
- Voltage above 100 KV AC RMS comes under “High Voltage”.

Due to very long distance of travelling of MV & HV lines and the presence of overhead lines (when compared to underground lines in developed countries) compound the problems in MV & HV lines in India. Though there are transformers to convert HV & MV to LV, presence of parasitic capacitance in transformer does not avoid surges getting propagated through the LV transformer resulting in failure of equipment in LV power distribution board (ex. Failure of electronic energy meters, RS 485 ports in MCCBs etc.). A safety device like SPD should not catch fire or cause explosion due to abnormalities in the incoming power lines, which is the most significant safety feature required in SPD.

This can be best understood by the below example.

SPDs connected in L-PE (Protective Earth) in TT type power distribution systems shall be tested at a voltage higher of the two following cases- TOV stated by the manufacturer or 1.32 times,  $U_{ref}$ .  $U_{ref}$  in this case is 255 V AC RMS for L-PE of 3 phase TT system with neutral distribution. Hence this voltage is 337 V. If the manufacturer declares a value of 330 V (say), then the SPD shall be tested at 337 V.

Note: There are basically 3 types of power distribution system namely TN systems, TT systems & IT systems. Please refer IEC 60364-5-54 Ed. 2 2011- Selection & Erection of electrical equipment- Earthing arrangements & protective conductors for more details. The revised IS 3043- Code of practice for Earthing will incorporate these details, when released.

### New TOV test parameter of 120 minutes for LV system faults and loss of neutral.

According to IEC 61643-11, whenever there is LV system fault or loss of neutral, either the SPD shall withstand this abnormal condition or “fail safely” without causing explosion or failure. It is obvious that, an SPD designed to withstand this abnormal condition is costlier than the “fail safe” design. It is the application- critical or normal- decides which one is best suited.

For TT system L-PE voltage is already explained above. For the SPD connected between L-N, this voltage is 1.732 times  $U_{ref}$ . i.e. 442 V AC RMS. It means an SPD can be designed to withstand 442 V AC RMS for 120 minutes or “fail safely” after getting stressed to this high voltage level for 120 minutes. In neither case, SPD shall explode or catch fire.



### Class II Operating Duty Test is made more stringent by applying 15 impulses at crest value of Open Circuit Voltage of the Combination Wave Generator

This is very simple parameter because, when SPD is subjected to more & more impulses, the stress is more on SPDs & they shall withstand these stringent conditions when compared to more relaxed 10 impulses at progressive values of open circuit voltage as defined in IEC 61643-1. Ed 2, 2005.

### Pass criteria has been increased significantly.

This is understandable because, IEC 61643-1 addresses only ‘PERFORMANCE TEST’ & IEC 61643-11 addresses ‘SAFETY & PERFORMANCE TEST’.

There are 15 pass criteria in IEC 61643-11 (SI. No. A to O), when compared to FOUR pass criteria in IEC 61643-1.

### Additional tests are added for SPD failure mode simulation.

As IEC 61643-11 is more stringent which also includes safety parameters, following additional tests are added so that the SPD is more robust when subjected to abnormal conditions.

- Rated load current test
- Environmental test
- SPD with separate isolated circuit test
- Measurement of voltage rate of rise (dv/dt.)
- Compliance to EMC.

It is very obvious from the above facts that, an SPD tested as per IEC 61643-11 is safer to withstand abnormal & harsh conditions when compared to SPDs tested as per IEC 61643-1. Moreover, the testing is made simple for SPD manufacturers, who have tested their SPDs as per

TABLE- 1: Quick- Comparison Chart

Sl No.	IEC 61643-1 ed 2 2005 -03	IEC 61643-11 ed 1 2011-03
1	addresses performance test ONLY	addresses safety and performance test
2	talks about AC and DC in the scope	talks only about AC in the scope
3	normative references have several unwanted standards which are not connected with this subject.	while normative references removes, unwanted standards, it adds IEC 61000 all parts- EMC & IEC 61180 -1 HV test techniques for LV equipment
4	Class II test is for I <sub>max</sub>	class II test is for I <sub>n</sub>
5		12.5 and 25 kA for I impulse is added and charge 6.25 and 12.5 As added
6		preferred value of U <sub>c</sub> many voltages are added
7		installation instructions for type of LV system that is TN, TT and IT are added
8		behavior under TOV caused by faults in MV and HV are added
9		EMC is added
10		test on terminals are added
11		metallic screen test setup and use of tissue paper is added in general testing procedure
12	preconditioning test is performed to prepare this sample for the test	there is no preconditioning test ; EUT is directly used for the test.
13	class III operating duty test involves applying a total of 10 impulses BUT @ 10%, 25%, 50%, 75%, 100% of open circuit voltage	class III operating duty test involves applying 15 impulses at crest value of open circuit voltage
14	Number of pass criteria is much lesser (3 - 4 conditions)	pass criteria A-O (15 conditions)
15	muslin paper and cheese cloth are used for testing	tissue paper and metallic screen are used for testing



IEC 61643-1 Ed 2 to test only some extra features so that they comply with IEC 61643-11 Ed. 1. In fact, it is possible that some manufacturers falsely claim that their

SPDs have “pass criteria” by testing as per IEC 61643-1, Ed 1, 1998, which is much more dangerous. Because in 1998 edition, Voltage protection level was declared for a spark gap by taking into account the “AVERAGE VALUE” of 10 test impulses. Say, for ex, as per 1998, an SPD would have been declared to have Voltage protection level of 1.2 kV (say) but as per 2011, voltage protection level should be declared as 4 kV (say), because in this case, is the “MAXIMUM VALUE” of 10 test impulses. One small change in the testing procedure has a very high impact on the declared value, which one should not fail to note. Hence all the users of SPD shall ensure that, the SPDs they buy for their requirement complies all the safety & performance test as per IEC 61643-11 so that their installation is safe for both the people and the equipment. ■

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