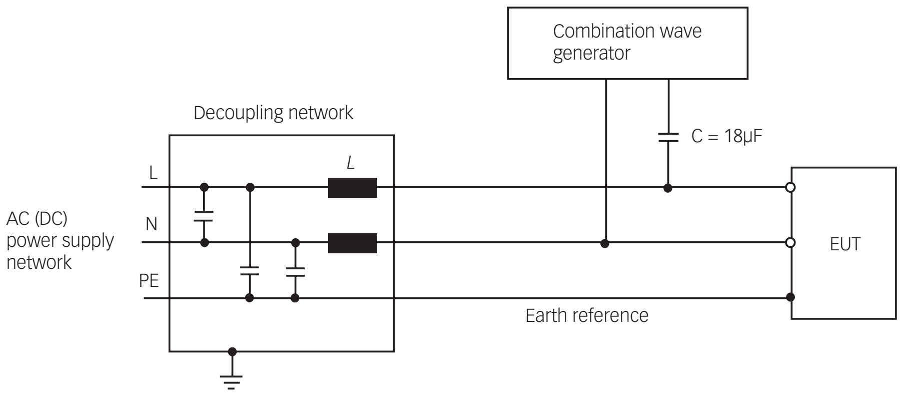
STANDARDS

Pulse integrity vs. voltage drop of high current surge coupling/decoupling networks (CDN)



Schematic of a surge CDN (single phase)

Rationale: This document gives some background on the physics of high current surge CDNs, the compromises that are to be made in real applications, how these compromises are quantified in some standards; and puts numbers on these compromises, which are mentioned but not quantified in specifications of some other standards.

The Ideal CDN would perfectly block the coupled surge in the direction of the mains, so that the entire surge pulse energy goes to the EUT. For this to take place, the value of the decoupling choke should be as high as possible.

Therefore: L as high as possible

Also, the ideal CDN should not generate any mains supply voltage drop. This requires that the decoupling choke should be as low as possible.

Therefore: L as low as possible

As these two aspects are contradictory, the practical solution consists of a compromise; choosing a choke value generating less than 10% voltage drop, with the best possible pulse decoupling behaviour.

As the voltage drop is directly proportional to mains frequency and current through the CDN, the higher the EUT current is, the lower the decoupling choke needs to be.

Compromise made in IEC 61000-4-5.

For the reasons listed above, the IEC 61000-4-5 release published in 2005 defines clear pulse performance criteria in relation to EUT current.

Notes:

- The compromise is to relax the pulse width (Time to Half value) tolerances at the CDN output. Therefore the higher the CDN current is, the lower the pulse width is allowed to be.
- In order to obtain a good decoupling performance, the impedance presented by the CDN (Zcdn) needs to be much higher than the impedance of the EUT (Zeut). Therefore: Zcdn >> Zeut.
- When testing high current EUTs, Zeut will naturally be lower, therefore Zcdn can also be lower and still ensure good decoupling performance.
- The specifications given by IEC 61000-4-5 and shown in the table above take account of these effects. In fact, the relaxation is metrological - in all cases the pulse gets measured with a high impedance termination, whereas in practice, a high current CDN will be terminated by a low impedance EUT.
- The short-circuit current specifications are not changed for high current CDNs.

Surge voltage parameters:	**Coupling impedance:**	
	18 µF	9 µF + 10 Ω
Front time:	1.2 µs ± 30%	1.2 µs ± 30%
Time to half value:		
Current rating < 25 A	50 µs + 10 µs/-10 µs	50 µs + 10 µs/-25 µs
Current rating 25 - 60 A	50 µs + 10 µs/-15 µs	50 µs + 10 µs/-30 µs
Current rating 60 - 100 A	50 µs + 10 µs/-20 µs	50 µs + 10 µs/-35 µs

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Continuation: Pulse integrity vs. voltage...

This method ensures that the right pulse energy gets delivered to the respective EUT in any case. One must be aware that if a low current EUT is tested with a high current CDN the test may be less stringent than if it would be tested with a low current CDN due to a different CDN backfilter impedance which will generate more losses in the CDN, especially for high impedant EUTs. With other words: A EUT which passes the test with the high current CDN may fail if tested with a low current CDN. However both test methods are conform to the IEC standard.

Surge voltage parameters:	Coupling impedance:	
Front time:	**Line to ine coupling** 1.2 µs ± 30%	**Line(s) to ground coupling** 1.2 µs ± 30%
Time to half value:		
Current rating < 25 A	50 µs + 10 µs/-10 µs	50 µs + 10 µs/-25 µs
Current rating 25 - 60 A	50 µs + 10 µs/-15 µs	50 µs + 10 µs/-30 µs
Current rating 60 - 100 A	50 µs + 10 µs/-20 µs	50 µs + 10µs/-35µs

Position of ANSI Recommendations C62.41 and C62.45

ANSI Recommendations C62.41 and C62.45 are not so clear about the metrological compromises to be made. Even the above case, which is mentioned several times in the documents (see references below), there are no numbers assigned to the allowed pulse tolerances. This may leave the user or auditor believing that the tolerances given in § 9.2.1 and 9.2.2 (10% tolerance) can be met in any case, for any coupling path setting (up to 4 lines coupled simultaneously), and also for very high current CDNs, which is physically not realistic.

To clarify this situation, and in order to have clear tolerance values which can be used by calibration personnel and auditors, it makes sense to use the tolerance numbers and ranges given by the IEC 61000-4-5 specification when assessing high current CDNs to be used for ANSI testing.

These are the values used by Teseq AG in the design of the CDN 3061 and CDN 3063 series.

Some references to relaxations that can be found in the ANSI recommendations:

- C62.45-2002 § B.3: A compromise is necessary, however, between having a filter that presents an adequately high impedance to the surge, particularly if the surge is of long duration , and a filter of low impedance that would not excessively limit the power frequency current.

- C62.45-2002 §7.2: The coupler should conduct the surge energy, with reasonable waveform fidelity, from the test surge generator into the EUT.

- C62.41.2-2002, note f below table 3…, recognizing that the waveform might be slightly changed.

- C62.41.2-2002,§ 8.Concluding remarks: Once again, it is imperative to note that these descriptions of the environment and test waveform recommendations should be used as the basis for a realistic and successful application, including an appropriate risk analysis, and not as a blind procurement specification.

This application note can be downloaded from our Website under Service & support, technical information.

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