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# Acceptance and verification PCI tests according to MIL-STD-188-125

*Bertrand Daout, montena technology*

*V1 - August 2013*

**CONTENTS**



## 1. Introduction

This document describes the acceptance and the verification HEMP PCI tests according to MIL-Std-188-125, especially the set-up, the coupling / decoupling network and the selection of the termination loads.

## 2. Definitions

The PCI (Pulsed Current Injection) shall be carried out successively in two different phases: the acceptance test and the verification test. The standard MIL-Std-188-125 gives the following definitions:

- **Acceptance test** (paragraph 3.3.9): An acceptance test of a system, subsystem, or component performed to ensure that specified HEMP performance characteristics have been met. HEMP acceptance tests, conducted near the conclusion of a hardening construction or installation contract, are tests for the purpose of demonstrating that at least minimum performance requirements of the HEMP protection subsystem have been achieved before the subsystem is accepted by the Government from the contractor.
- **Verification test** (paragraph 3.3.39): Tests conducted for demonstrating that the installed HEMP protection subsystem provides the required HEMP hardness. These tests are performed after the construction and acceptance testing are complete and after the equipment is installed and functioning to determine if the operational system suffers mission-aborting damage or upset due to simulated HEMP excitations. Verification is normally a Government-conducted test and is not part of a facility construction contract.

The acceptance test set-up is different from the verification test set-up as shown in the next paragraphs.



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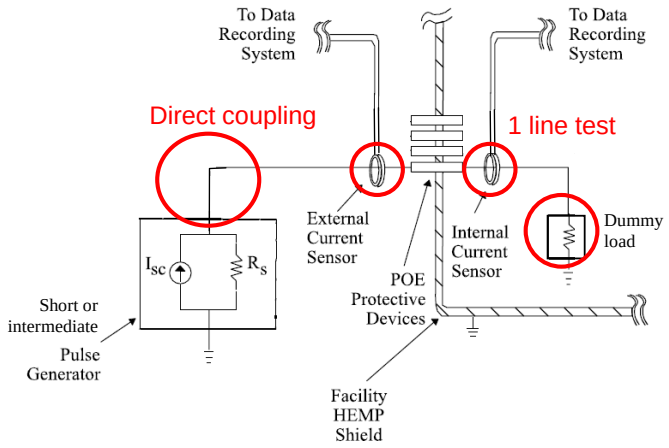
# 3. Schematic of the test setup with use of couplers

## 3.1 Acceptance tests

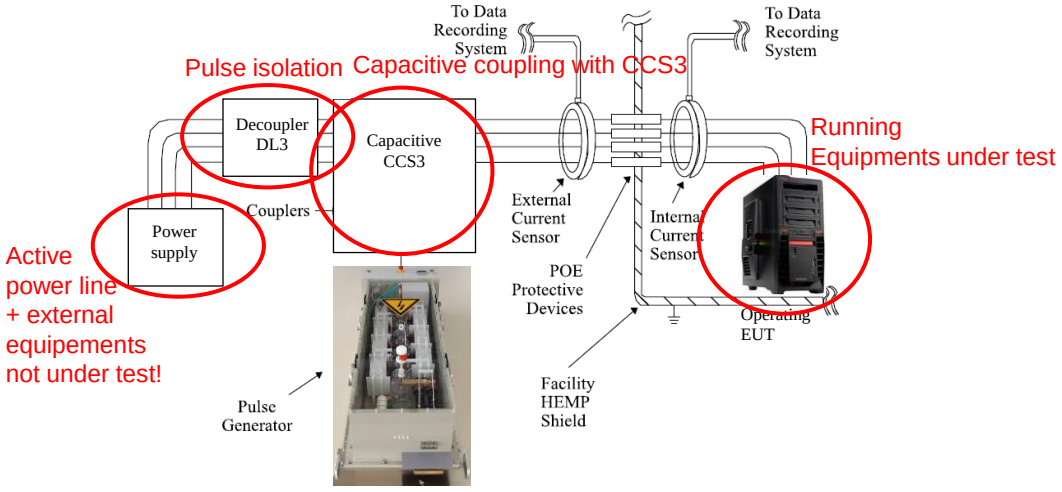



Acceptance tests require wire to ground tests only. The pulse generator is directly connected to the protecting device (direct coupling). The line on the protected side is terminated by a dummy load.

Injected and residual current are measured and compared to pass-fail criteria of the standard.

## 3.2 Verification tests

### 3.2.1 Short pulse verification test




The above picture shows a common mode injection with the CCS3 coupler. Wire to ground test is the same as common mode, but with coupling on one line only.

- The capacitive coupler CCS3 allows an injection of the generator output pulse to all connected wire without shortcutting them together.
- The decoupling box DL3 is a 4 lines filter to block as much as possible the injected transient current towards the power grid side.



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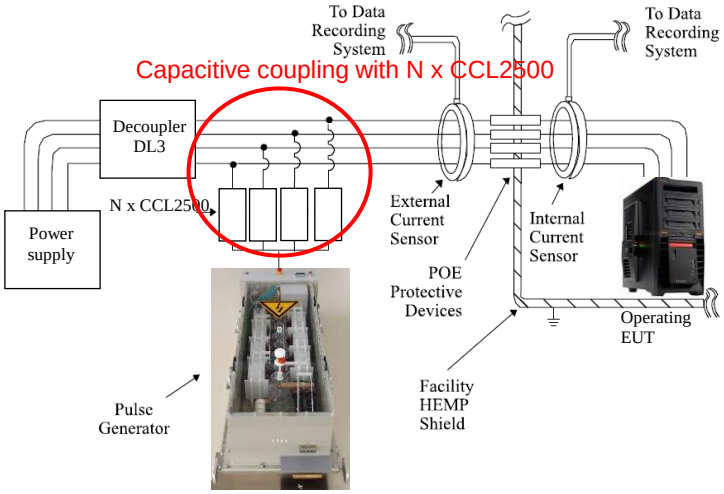
Injected and residual current are measured and compared to pass-fail criteria of the standard.

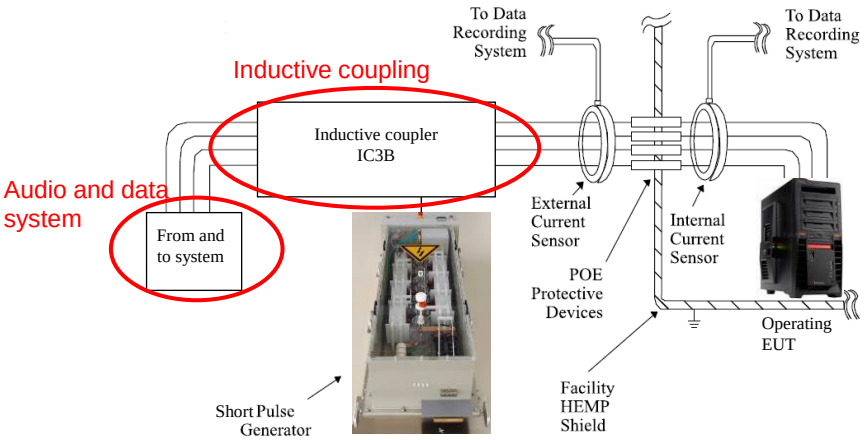
For series of tests on power line filters, it can be useful to install short cables with power plugs connectors on the CCS3 and the DL3 to ease the test procedure. The CCS3 and the DL3 are designed for up to 60 $A_{rms}$ current per phase.

We also propose a set of CCL2500 couplers. These couplers have the same functionality than the CCS3, but are in a different packaging: each CCL3 is for one single wire and has a output short cable with an alligator clamp. This is especially interesting to do the injection on high current power lines, for which the CCS3 cannot be used due to its 60 $A_{rms}$ limitation.




The above picture shows a common mode injection with the 4 x CCL2500 couplers. Wire to ground test is the same as common mode, but with coupling on one line only.

We propose an inductive coupler (= large injection clamp) for common mode injection on high number of wires. This is especially useful to test protection device of multiple wire data cables.
The magnetic couple has some high frequency limitation and shall only be used when no other solution is applicable.



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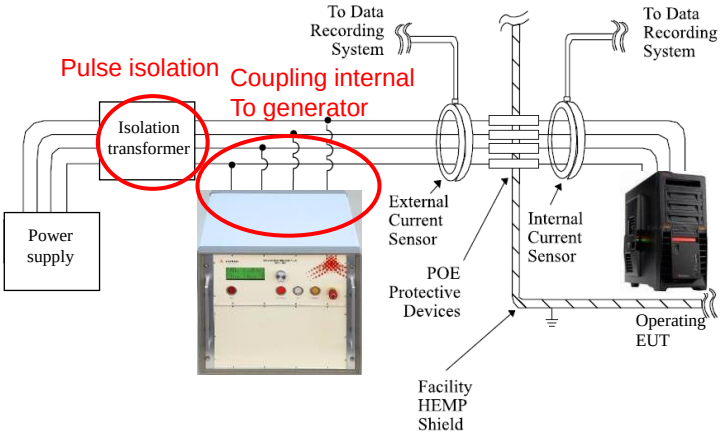
### 3.2.2 Intermediate pulse verification test




a. Common mode test configuration.

The intermediate pulse generator has 4 independent outputs which can be connected to 4 wires for common mode injection or to one single wire for wire to ground injection. There is no need for couplers.

Due to the low frequency content of the intermediate pulse, it is not possible to have proper filters to block the propagation of the current pulse back to the power grid side on each wire individually. Only common mode pulse can be blocked by the upstream 3 phases power transformer.

### 3.2.3 Charge line verification test

Charge line test on antenna entry point shall be done as shown in the below diagram.

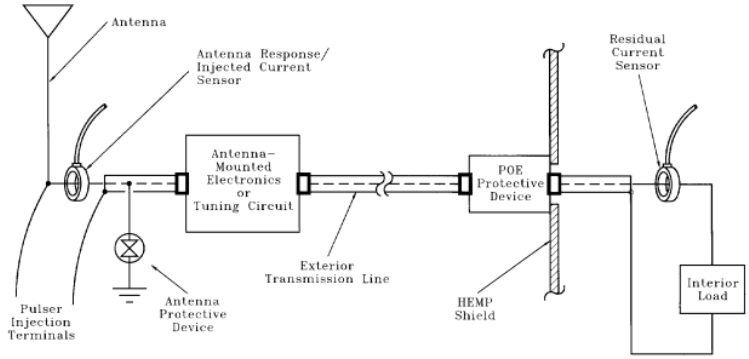



FIGURE B-4. Antenna subsystem configuration for coupling measurements and PCI testing.

The charge line test shall be performed on shield-to-ground and wire-to-shield configurations. In both configurations no coupler is needed. The output of the charge line generator can be connected to the wire or to the shield directly.



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## 4. Resistor value of the termination load

Termination load are only used during the acceptance tests. The standard refers to following resistor values:

- 50 ohm in some cases or
- 2 ohm or $V_{rated}$ / $I_{rated}$, whichever is smaller in other cases.

In most of the cases the specified 50 ohm and 2 ohm resistors values are sufficient to perform the tests. Smaller resistor values are only required in case of acceptance test on low voltage, high current filters. We propose 0.5 ohm and 0.2 ohm values. This corresponds for instance to following examples:

- For 12 V power filter, the 2 ohm resistor shall be used for filters with nominal current up to 6 A.
  The 0.5 ohm corresponds to a nominal current of 24 A.
  The 0.2 ohm for a nominal current of 60 A.
- For 48V power filter, the 2 ohm resistor shall be used for filters with nominal current up to 24 A.
  The 0.5 ohm corresponds to a nominal current of 96 A.
  The 0.2 ohm for a nominal current of 240 A.
- For 230V power filter, the 2 ohm resistor shall be used for filters with nominal current up to 130 A.

The resistor shall be non-inductive and it is not possible to design continuously variable non inductive resistor for the expected voltage, current and frequency. We recommend using the available resistor with the nearest value. But we can provide other values of resistors if desired.



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