Report - EMP measurement
Pulse current injection test

Filter serie: UHP

Summary

This test procedure describes the test in form of steps, from the identification of the DUT to the final inspection. The test procedure lists the types of used generators and measurement devices. The measurement uncertainties and bandwidths are indicated.

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# Tabel of contents

1 **Introduction** ................................................................. 3
   1.1 Purpose of document ......................................................... 3
   1.2 Documentation and legal basis ............................................... 3

2 **Execution of test** ............................................................. 4
   2.1 Procedure ........................................................................... 4
   2.2 Measuring methods, measuring equipment, uncertainties ............... 5

3 **Test results** ...................................................................... 7
1. **Introduction**

1.1 **Purpose of document**

The present document describes the test procedure and the measurements to be performed on an EMI-RFI Filter (DUT) according to MIL-STD-188-125-1.

The Filter should withstand current pulses (E1) of 2'500 A to 5'000 A peak of short duration in the nanosecond range as well as (E2) 250 A of intermediate duration in the millisecond range.

The DUT must withstand the tests without damage. Diverse electrical measurements, such as capacitance, electrical resistance etc. are conducted before and after the current injection in order to determine the physical condition of the DUT.

1.2 **Documentation and legal basis**

- MIL-STD-188-125-1 (fixed systems) or MIL-STD-188-125-2 (mobile systems) which differ mainly in the form of the application in which the DUT will be applied.
2. Execution of test

2.1 Procedure

The test procedure comprises the following steps:

DUT identification: type, serial number etc.

Receiving inspection:

- Measurement of the DC resistance
- Measurement of the Inductance
- Measurement of the Capacitance
- Measurement of the Conductance
- Leakage current
- Functional test or/and measurement of scattering parameters

Current Injection E1

Intermediate inspection:

The values of the different parameters are compared to the results of the receiving inspection. The same instrumentation and measurement schematics as for the receiving inspection has to be used.

Current injection E2

Final inspection:

The values of the different parameters are compared to the results of the receiving inspection. The measured quantities can vary depending on temperature, input voltage etc. and should be corrected and interpreted as well as possible. No order between E1 and E2 has to be observed. If necessary, E2 can be done before E1.
2.2 Measuring methods, measuring equipment, uncertainties

**DC-Resistance:**
- Measuring method: Tension-current measurement
- Measuring equipment: 2 multimeters Fluke or equivalent
- Uncertainties: better than 3% for each multimeter

**Inductance:**
- Measuring method: Wien bridge
- Measuring equipment: RLC-Metrapont
- Uncertainties: unknown

**Capacitance:**
- Measuring method: Wien bridge
- Measuring equipment: RLC-Metrapont
- Uncertainties: unknown

**Conductance:**
- Measuring method: specialized meter
- Measuring equipment: xxx
- Uncertainties: unknown

**Leakage current:**
- Measuring method: Tension-current measurement
- Measuring equipment: 2 multimeters Fluke or equivalent
- Uncertainties: better than 5% for each multimeter

**Functional test:**
- No measurement

**S-parameter test:**
- Measuring equipment: Network analyzer
  - Auxiliary equipment depending on the band of the filter (max 9 GHz)
- Uncertainties: After calibration, no uncertainties will be computed
  - The measurement of the s-parameter cannot be used to qualify the filter

The measurement uncertainties of the inspections are not relevant because only a comparison between the results of the same measurements at different time is made.
Report - EMP measurement
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Current Injection E1:

Equipment: High voltage pulse generator of VEPES HEMP simulator

Chain for current measurement:
Current probe: Eaton 93686-4M, Shunt Hilotest
Fiber optic link: Thales fiber optic processor/receiver P100
Optical voltage sensor / transmitter V400 channel 1, 50Ω
Bandwidth: 100 kHz to 130 MHz (with Eaton Sensor)
Bandwidth: 180 Hz to 50 MHz (with Hilotest Sensor)

Chain for residual voltage measurement:
Voltage probe: Barth Mod 202 NMFP-X, 20dB
Fiber optic link: Thales fiber optic processor/receiver P1004
Optical voltage sensor / transmitter V1004 SN211, CH1, 50Ω
Bandwidth: 1 kHz to 1.2 GHz typical

Oscilloscope: Agilent Infiniium HP 54845 or equivalent
Bandwidth: DC to 1.5 GHz

Uncertainties:
- Rise time: -6 + 3 ns
- FWHM: -0 + 100 ns
- Peak-Values: ± 10 %

Current Injection E2:

Generator: Hilo-Test PG 5-4005

Generator test parameters:
Wave shape: 250 A 1.5/5000 μs in short circuit
Output Impedance: 2 x 40Ω in parallel
Charging Voltage: max 5 KV,
Pulse Polarity: + or –
Capacitance: 100 F to 400 F depending on the load

Oscilloscope: Agilent Infiniium HP 54845 or equivalent
Bandwidth: DC to 1.5 GHz

Current measurement: Shunt embedded in generator
Bandwidth: DC to 50 MHz

Voltage measurement: Tektronix P6015, P6009 or equivalent
Bandwidth: DC to 30 MHz

Uncertainties:
- Rise time: ± 0.1 μs
- FWHM: ± 10 μs
- Peak-Values: ± 10 %
## 3 Test results

**PCI (Pulsed Current Injection)**

![Diagram of PCI setup](image)

<table>
<thead>
<tr>
<th>Pulse type</th>
<th>Type of injection</th>
<th>Peak 1 (A)</th>
<th>FWHM range (ns)</th>
<th>Maximum risetime (us)</th>
<th>Source resistance (ohm)</th>
<th>Approx capacitance (nF)</th>
<th>Peak 1 * Rs (V)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1 (short pulse)</td>
<td>Common mode</td>
<td>2500</td>
<td>500 - 550</td>
<td>&lt; 20</td>
<td>60</td>
<td>~13 nF</td>
<td>150</td>
<td>Passed</td>
</tr>
<tr>
<td>E1 (short pulse)</td>
<td>Wire-to-ground</td>
<td>2500</td>
<td>500 - 550</td>
<td>&lt; 20</td>
<td>60</td>
<td>~13 nF</td>
<td>150</td>
<td>Passed</td>
</tr>
<tr>
<td>E2 (intermediate pulse)</td>
<td>Common mode</td>
<td>250</td>
<td>3 - 5</td>
<td>&lt; 1.5</td>
<td>10</td>
<td>~600 uF</td>
<td>2500</td>
<td>Passed</td>
</tr>
<tr>
<td>E2 (intermediate pulse)</td>
<td>Wire-to-ground</td>
<td>250</td>
<td>3 - 5</td>
<td>&lt; 1.5</td>
<td>10</td>
<td>~600 uF</td>
<td>2500</td>
<td>Passed</td>
</tr>
<tr>
<td>E3 (long pulse)</td>
<td>Common mode</td>
<td>1000</td>
<td>20 - 25</td>
<td>&lt; 0.2</td>
<td>5</td>
<td>~6.5 F</td>
<td>5000</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>