MIL Standard 461 G
final release December 11th, 2015

EMC PARTNER - Largest range of impulse test equipment up to 100kV and 100kA
EMC PARTNER AG

- Founded in 1994
- Swiss private company, headquarters in Laufen (CH)
- Largest choice of impulse generators
- Market leader, reputed worldwide
- Development, production and testing in house
- Global representative network

Largest range of impulse test equipment up to 100 kV and 100 kA
Introduction

EMC Partner provides conducted immunity test solutions for a broad range of sectors:

- Industry & Household
- Components
- Renewable energy
- Avionics
- Military
- Telecom
Military domain

Equipment categories:

<table>
<thead>
<tr>
<th>Equipment and Subsystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Ships</td>
</tr>
<tr>
<td>Submarines</td>
</tr>
<tr>
<td>Aircraft, Army, Flight Line</td>
</tr>
<tr>
<td>Aircraft, Navy</td>
</tr>
<tr>
<td>Aircraft, Air Force</td>
</tr>
<tr>
<td>Space systems, Launch Vehicles</td>
</tr>
<tr>
<td>Ground, Army</td>
</tr>
<tr>
<td>Ground, Navy</td>
</tr>
<tr>
<td>Ground, Air Force</td>
</tr>
</tbody>
</table>
EMC Partner provides test solutions for current MIL Std 461:

<table>
<thead>
<tr>
<th>Test</th>
<th>Version F</th>
<th>Version G</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 106</td>
<td>yes</td>
<td>-</td>
</tr>
<tr>
<td>CS 115</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS 116</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS 117</td>
<td>-</td>
<td>yes, new</td>
</tr>
<tr>
<td>CS 118</td>
<td>-</td>
<td>yes, new</td>
</tr>
</tbody>
</table>
## Index

CE, RE, RS: same structure of standard

<table>
<thead>
<tr>
<th>Test</th>
<th>Version F</th>
<th>Version G</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS101</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS 103</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS104</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS 105</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS 106</td>
<td>yes</td>
<td>deleted</td>
</tr>
<tr>
<td>CS 109</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS 114</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS 115</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS 116</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>CS 117</td>
<td>not defined</td>
<td>yes, new</td>
</tr>
<tr>
<td>CS 118</td>
<td>not defined</td>
<td>yes, new</td>
</tr>
</tbody>
</table>

- CS 106: transients, power leads – deleted
- CS 117: lightning induced transients - new
- CS 118: personnel borne Electrostatic Discharge - new
CS 115 – bulk cable injection, impulse excitation

Waveform and test levels

30 ns. (Minimum)

REPETITION RATE = 30Hz
50 Ω termination is included in CN-BT6

2 x 20dB/50Ω, N-BNC cable and 20 dB att. Are included in VERI-MIL3
CS 115
Test setup

EUT
L1
L2
L3
N
PE

I-PROBE-CS-P8585C*

CN-BT6

L1
L2
L3
N
PE

50 Ω

MIL3000 + MIL3-REC
CS 116 – damped sinusoidal transients, cables and power leads, 10 kHz – 100 MHz

\[ e^{-\frac{\pi f t}{Q}} \sin(2\pi ft) \]

- \( f \) – frequency
- \( t \) – time
- \( Q \) – damping factor 15 ± 5

\[ Q = \frac{\pi(N - 1)}{\ln(I_P/I_N)} \]
CS 116 – damped sinusoidal transients, cables and power leads, 10 kHz – 100 MHz

Test levels
CS 116 Calibration setup 10 kHz – 10 MHz
CS 116 Test setup 10 kHz – 10 MHz
CS 116
Special EMCP calibration setup 10 kHz – 10 MHz – reduced level
CS 116
Special EMCP test setup 10 kHz – 10 MHz – reduced level
CS 116
Calibration setup 30 MHz – 100 MHz
CS 116
Test setup 30 MHz – 100 MHz
Unique features of MIL3000

- Touch screen with EPOS operating system (lifetime free upgrade)
- Contextual help and explanatory diagrams
Unique features of MIL3000

- Modular, expandable system
- Built-in synchronization circuit up to 400 Hz
Unique features of MIL3000

- Only 1 coupler for CS115 and CS116 (all frequencies)
- No change of EUT cables’ position/setup during test
- Electronic change of polarity

CN-BT6
Unique new software for MIL3000

- Lifetime upgrade at no extra charge
- Up to 4 generators controlled in parallel
- DSO control
- Sequence mode
- Protocol
- Norm library
CS 117 – Lightning induced transients
Tests derived from RTCA DO160 G, Section 22

DO-160G – Environmental Conditions and Test Procedures for Airborne Equipment – Section 22
CS 117 – Lightning induced transients
Tests derived from RTCA DO160 G, Section 22

Lightning stroke (click to play)  Slow replay (click to play)
CS 117 – Lightning induced transients
Tests derived from RTCA DO160 G, Section 22
CS 117 – tests derived from RTCA DO160G, S. 22

Test types from DO160G:

- Damage tolerance test
  - Lightning damage test
  - Pin injection

Immunity test
- Functional upset
- Cable bundle
CS 117 – tests derived from RTCA DO160G, S. 22

Signal types from DO160G:

- Single stroke SS
  ![Single stroke SS diagram]

- Multiple stroke MS
  ![Multiple stroke MS diagram]

- Multiple Burst MB
  ![Multiple Burst MB diagram]
CS 117 – tests derived from RTCA DO160G, S. 22

Waveforms from DO160G:

<table>
<thead>
<tr>
<th>WF1</th>
<th>WF2</th>
<th>WF3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="WF1 Graph" /></td>
<td><img src="image2" alt="WF2 Graph" /></td>
<td><img src="image3" alt="WF3 Graph" /></td>
</tr>
</tbody>
</table>

- **WF1**:
  - Peak
  - T1 = 6.4 microseconds ±20%
  - T2 = 69 microseconds ±20%

- **WF2**:
  - Peak
  - T1 = 100 nanoseconds maximum
  - T2 = 6.4 microseconds ±20%

- **WF3**:
  - Peak
  - Largest Peak
  - 25% to 75% of Largest Peak

<table>
<thead>
<tr>
<th>WF4</th>
<th>WF5 A/B</th>
<th>WF6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="WF4 Graph" /></td>
<td><img src="image5" alt="WF5 Graph" /></td>
<td><img src="image6" alt="WF6 Graph" /></td>
</tr>
</tbody>
</table>

- **WF4**:
  - Peak
  - T1 = 6.4 microseconds ±20%
  - T2 = 69 microseconds ±20%

- **WF5 A/B**:
  - Peak/5A
  - T1 = 40 microseconds ±20%
  - T2 = 120 microseconds ±20%
  - 5B: T1 = 30 microseconds ±20%
  - T2 = 300 microseconds ±20%

- **WF6**:
  - Peak
  - T1 = 0.25 microseconds ±20%
  - T2 = 4 microseconds ±20%
CS 117 – tests derived from RTCA DO160G, S. 22

Waveforms and associated test types from DO160G:

<table>
<thead>
<tr>
<th>Test type</th>
<th>Signal</th>
<th>WF1</th>
<th>WF2</th>
<th>WF3</th>
<th>WF4</th>
<th>WF5A/B</th>
<th>WF6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin injection</td>
<td>SS</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>WF5A</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td>MS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MB</td>
<td></td>
<td></td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td></td>
</tr>
</tbody>
</table>

Pin injection tests and Cable Bundle SS not required in MIL 461G
CS 117 – tests derived from RTCA DO160G, S. 22

Multiple stroke: test levels in MIL 461 G
Level 1: internal equipment
Level 2: external equipment

Multiple Stroke: First stroke [-0%;+20%]
Subsequent strokes: [-0%;+50%]

<table>
<thead>
<tr>
<th>Test level</th>
<th>Waveforms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 / 1</td>
</tr>
<tr>
<td></td>
<td>VL / IT</td>
</tr>
<tr>
<td></td>
<td>[V/A]</td>
</tr>
<tr>
<td>1 FS</td>
<td>300 / 600</td>
</tr>
<tr>
<td>Sub.</td>
<td>150 / 150</td>
</tr>
<tr>
<td>2 FS</td>
<td>750 / 1500</td>
</tr>
<tr>
<td>Sub.</td>
<td>375 / 375</td>
</tr>
</tbody>
</table>

Levels between L3 and L5 from DO 160G
Possibility to reduce test level as function of line number
CS 117 – tests derived from RTCA DO160G, S. 22

Multiple burst: test levels in MIL 461 G
Level 1: internal equipment
Level 2: external equipment

<table>
<thead>
<tr>
<th>Test level</th>
<th>Waveforms</th>
<th>3 / 3</th>
<th>6 / 6 *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VT / IL</td>
<td></td>
<td>VL / IT</td>
</tr>
<tr>
<td></td>
<td>[-0%;+20%]</td>
<td></td>
<td>[-0%;+20%]</td>
</tr>
<tr>
<td></td>
<td>[V/A]</td>
<td></td>
<td>[V/A]</td>
</tr>
<tr>
<td>1</td>
<td>360 / 6</td>
<td>600 / 30</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>900 / 15</td>
<td>1500 / 75</td>
<td></td>
</tr>
</tbody>
</table>

Levels L3 and L4 from DO 160G
Possibility to reduce test level in function of individual power leads
CS 117 – tests derived from RTCA DO160G, S. 22

Test equipment (chapter 5.15.3.2):

✓ Lightning transient generator(s)
✓ Injection transformers
✓ Oscilloscope
✓ Attenuators, 50Ω
✓ Voltage and current probes
✓ Calibration loop, low Z
✓ Capacitor >28’000 μF for DC inputs
✓ LISNs

Decouplers, loads, shunt for cal.
CS 117 – tests derived from RTCA DO160G, S. 22

Test duration?

Up to 3 tests in parallel due to real modularity and flexibility
CS 117 – tests derived from RTCA DO160G, S. 22

Couplers:

- CN-GI-CI-V
- CN-GI-CI
- CN-MIG-BT5
- CN-MIG-BT3

✓ Test levels guaranteed at output of coupler
✓ Only one coupler needed for one test level as per DO 160
✓ Easy to use, easy to transport
✓ Same coupler for WF2, WF3, WF6
CS 117 – tests derived from RTCA DO160G, S. 22
High performance probes:

I-PROBE-MS
WF 1, 4, 5A

V-PROBE-PHV
WF 1, 4, 5A

I-PROBE-MB-P1
WF 2, 3, 6

V-PROBE-SI
WF 2, 3, 6
EMC Partner is #1 worldwide in indirect lightning tests:

20 years of experience and continuous improvement

Unique technology, highly appreciated

Compliant and worldwide recognized tests

Accurate, reproducible and reliable results

EMC - PARTNER
CS 118 – Personnel born electrostatic discharge
Test requirements similar to IEC 61000-4-2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge module</td>
<td>150 pF, 330 Ω</td>
</tr>
<tr>
<td>Max. voltage</td>
<td>8 kV CD, 15 kV AD</td>
</tr>
<tr>
<td>Current verification at</td>
<td>± 2 kV and ± 8 kV</td>
</tr>
<tr>
<td>Indirect discharge</td>
<td>Not required</td>
</tr>
</tbody>
</table>
CS 118 – Personnel born electrostatic discharge

Verification of ESD voltage required: 20 GΩ divider, connected directly to oscilloscope, ratio: 1:20’000
CS 118 – Personnel born electrostatic discharge

Compact: no base unit
Optimal weight distribution

Very light:
730 g without batteries
1050 g with batteries

Batteries: 10 AA type,
8 hours: 1 Hz @ 30 kV
CS 118 – Personnel born electrostatic discharge

ESD target as per IEC 61000-4-2 ed. 2.0, special calibration targets available: 2 Ω, 50 Ω, 500 Ω

Safety switch to short circuit generator’s output, necessary when testing explosive devices
CS 118 – Personnel born electrostatic discharge

Test cabinet for explosive EUT devices and module remote connection

Optical link connection cable (10m long) and remote control software
Conclusions

- New requirements are planned in MIL STD 461G
- EMC Partner is already prepared to provide suitable equipment
Thank you,

www.emc-partner.com