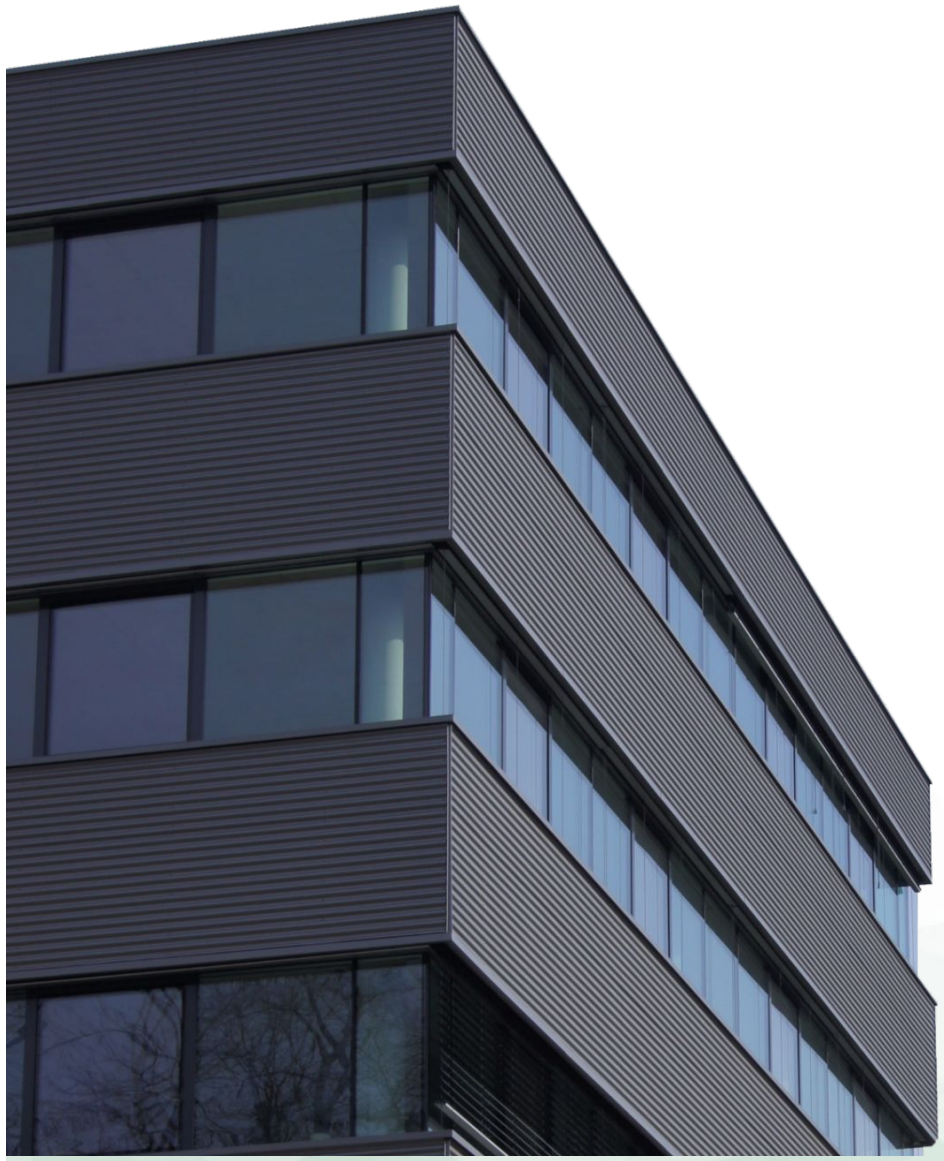
Indirect Lightning Test: To The Core.

Byungkyu Yoo (BK)
Marketing und Verkauf

EMC Partner AG



EMC PARTNER AG

- ✔ Founded in 1994
- ✔ **Swiss** private company, headquarters in Laufen
- ✔ Largest choice of impulse generators
- ✔ Market leading supplier, reputed worldwide
- ✔ Development, production and testing in house
- ✔ Global network of representatives

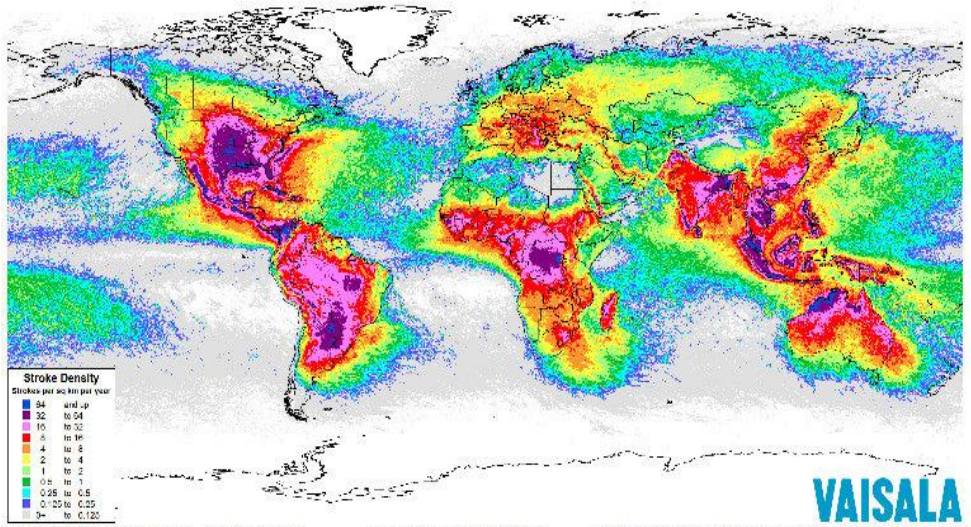
When a bolt of lightning strikes you, what will happen?

A typical lightning flash can carry 3 GV, 30 kA and 5 GJ.
It is equivalent to approx. TNT 1.2 T!

Lightning effects after a strike

- The strike hits a victim, leaving severe physical damages.
  - **Direct effects** of lightning

- A large amplitude of current is injected.
- The electrical current circulates overall electrically conducting parts while finding its way out.
- Unwanted transient injected into the victim
  - **Indirect effects** of lightning → **E**lectro**M**agnetic **issue**



Stroke Density Map - 20 km grid **Average: 2013-2017** **GLD360 v2.0 data: 8,761,390,744 strokes**

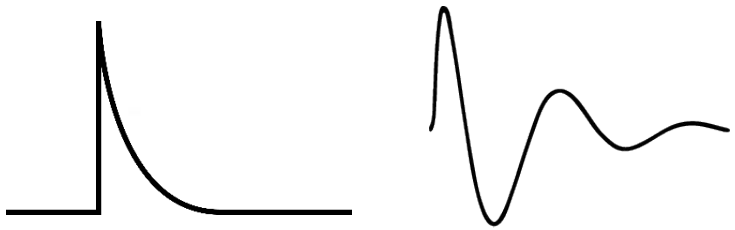
Source: Holle, Ronald & Cooper, Mary Ann. (2018). Lightning Fatalities in Africa From 2010-2017. 1-4. 10.1109/ICLP.2018.8503315.

Then, what should be tested?

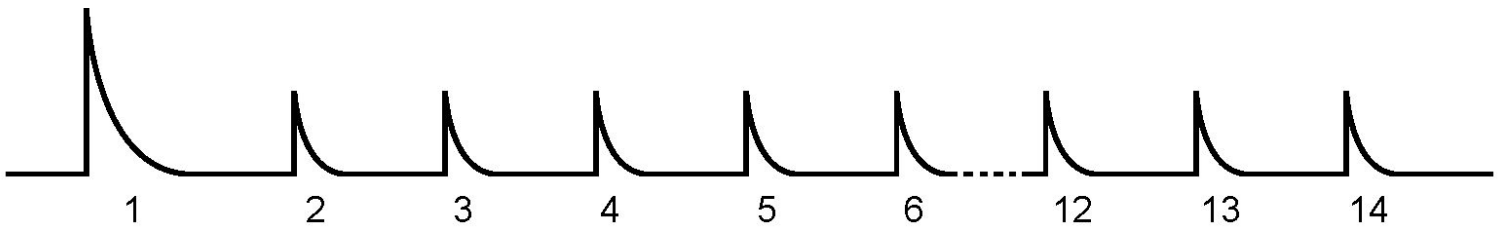
Here is a brief introduction of an expansive topic for you.

What to inject?

Single stroke SS



Multiple stroke MS

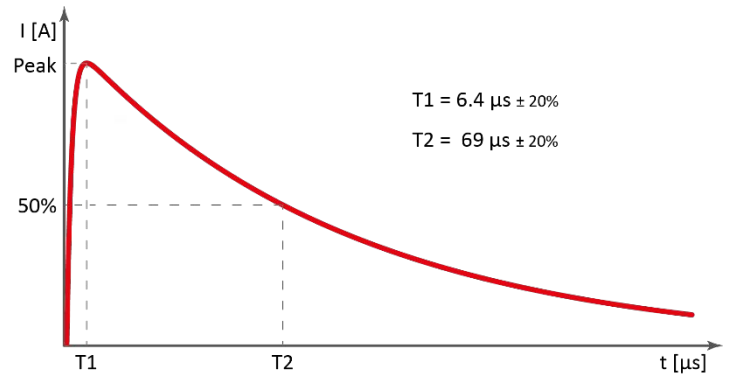


RTCA DO-160
Section 22
&
MIL-STD-461
CS117

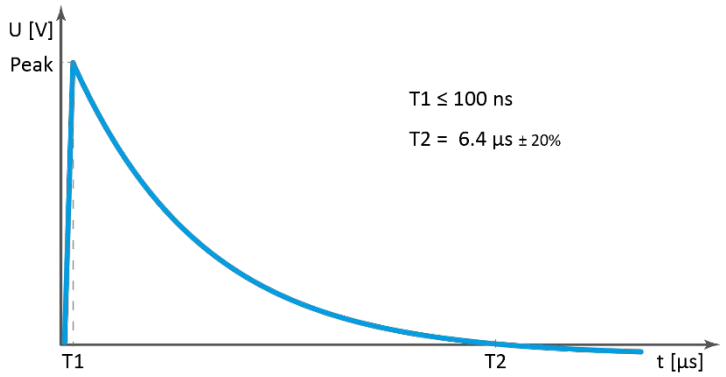
Multiple Burst MB

Waveform variations

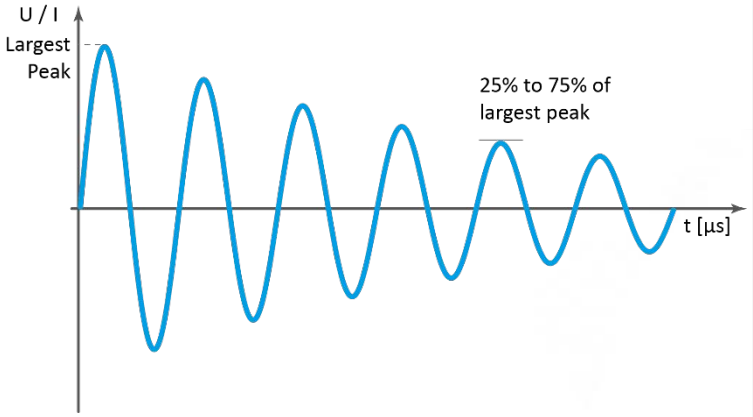
WF1



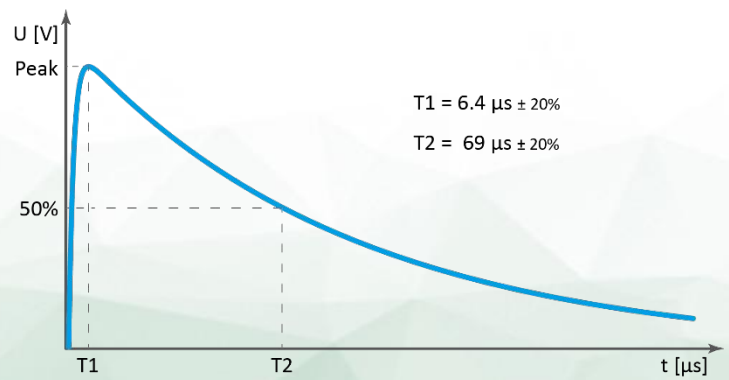
WF2



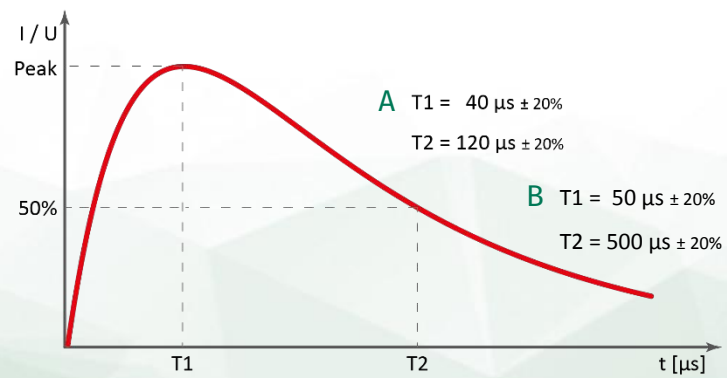
WF3



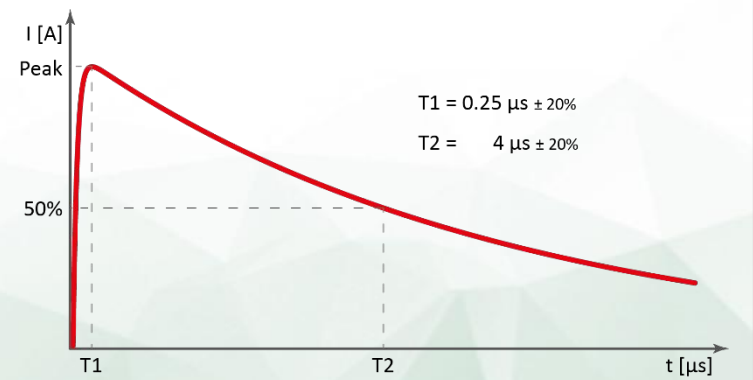
WF4

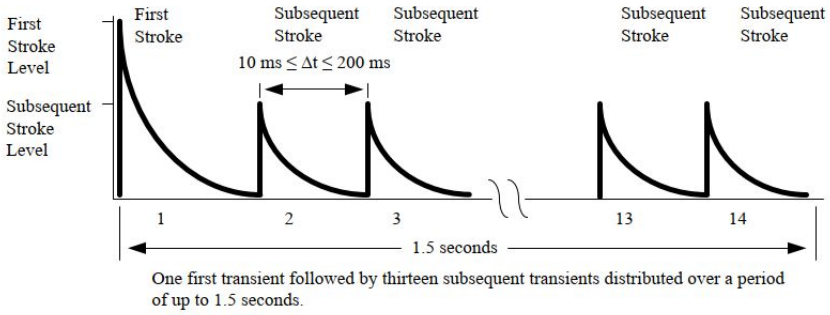


WF5 A / B

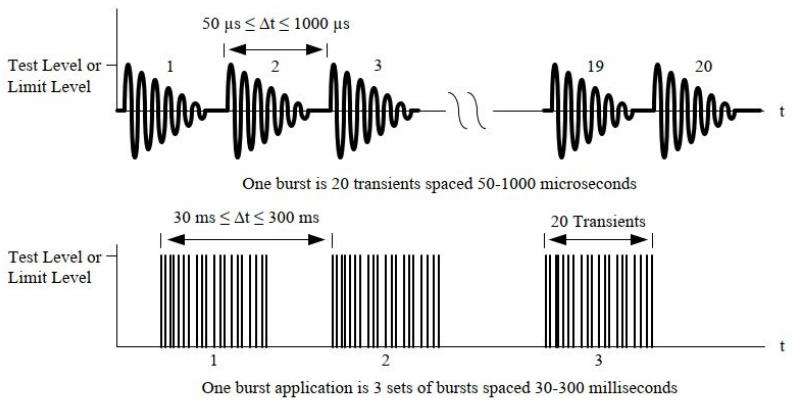


WF6





One first transient followed by thirteen subsequent transients distributed over a period of up to 1.5 seconds.



One burst is 20 transients spaced 50-1000 microseconds

One burst application is 3 sets of bursts spaced 30-300 milliseconds

Multiple Stroke

Several high-energy transients in sequence

- Simulation of lightning's multiple return strokes

Severe

- Each stroke is similar in magnitude to single stroke
- Rapid succession

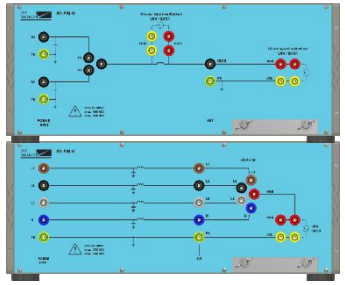
Multiple Burst

A series of lower-energy transients over a short period

- Simulation of the stress that stroke may not

Less severe

- Lower voltage/current per burst
- Cumulated stress

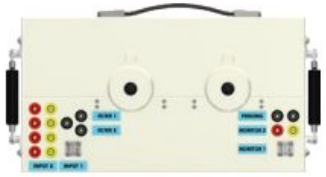
Method 1: Pin Injection

Direct injection of waveforms into pins

- Simulation of direct conduction of lightning into pins
- Testing of internal circuit immunity

Straightforward - worst case scenario

- Check if EUTs work after the test - robustness
- Assessing of damage tolerance

Method 2: Cable Bundle Injection

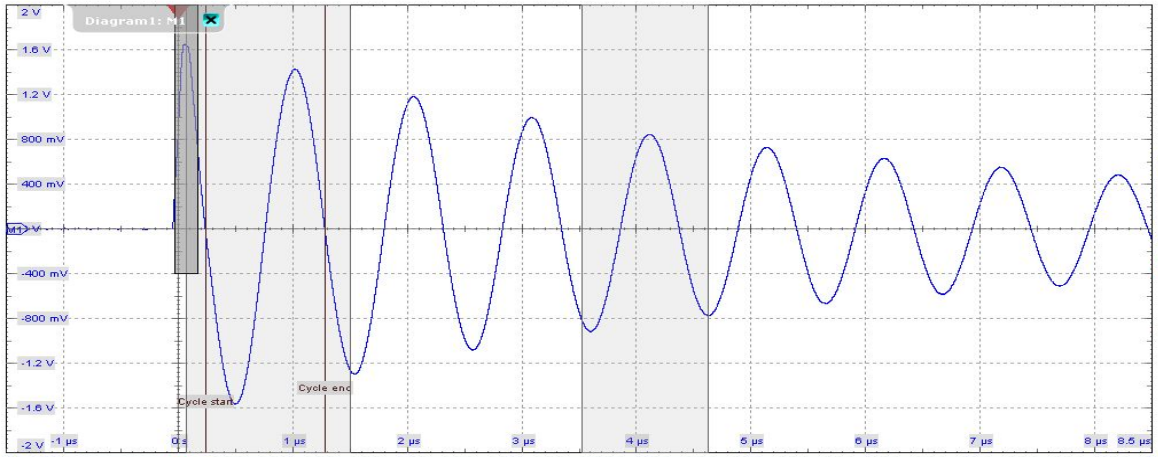
Coupling of waveforms onto the cable bundle

- Simulation of lightning induced on wirings
- Testing of system immunity via external wiring

More realistic – complex mechanism

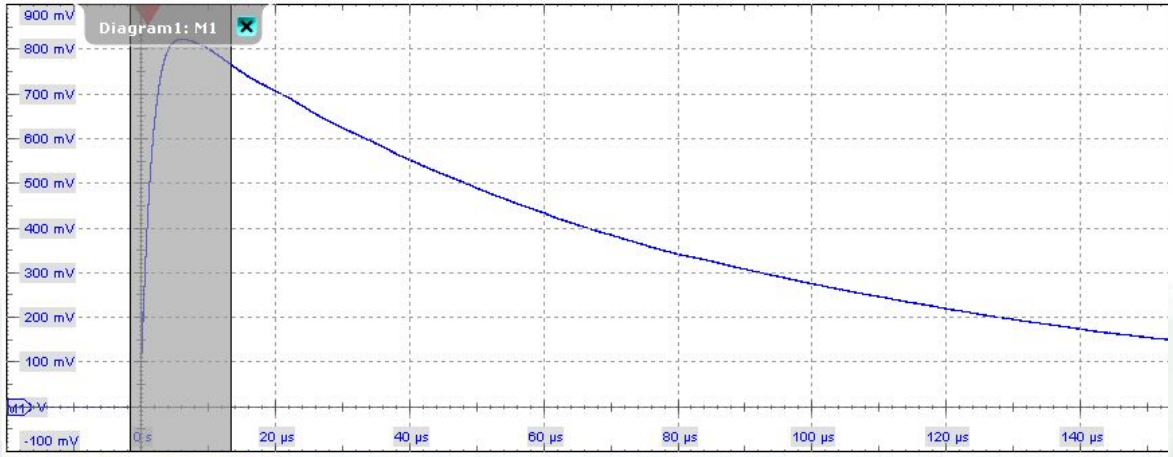
- Check if EUTs work throughout the test - operations
- Assessing of upset tolerance

How do the actual waveforms look alike? (Measured with R&S DSO)



Waveform 3 (1MHz) Pin 3200 V

Waveform 4 Pin 1600 V



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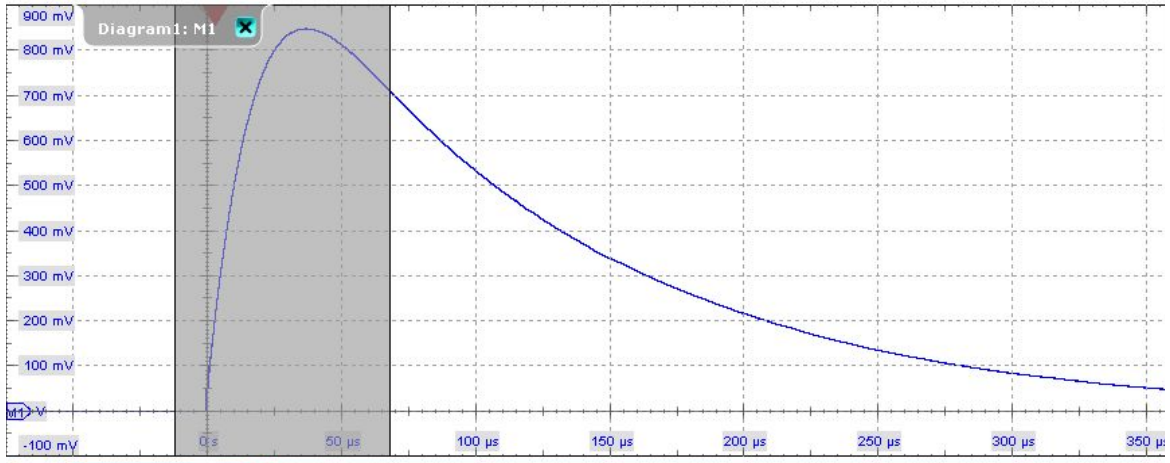


Waveform 5A Pin 1600 V

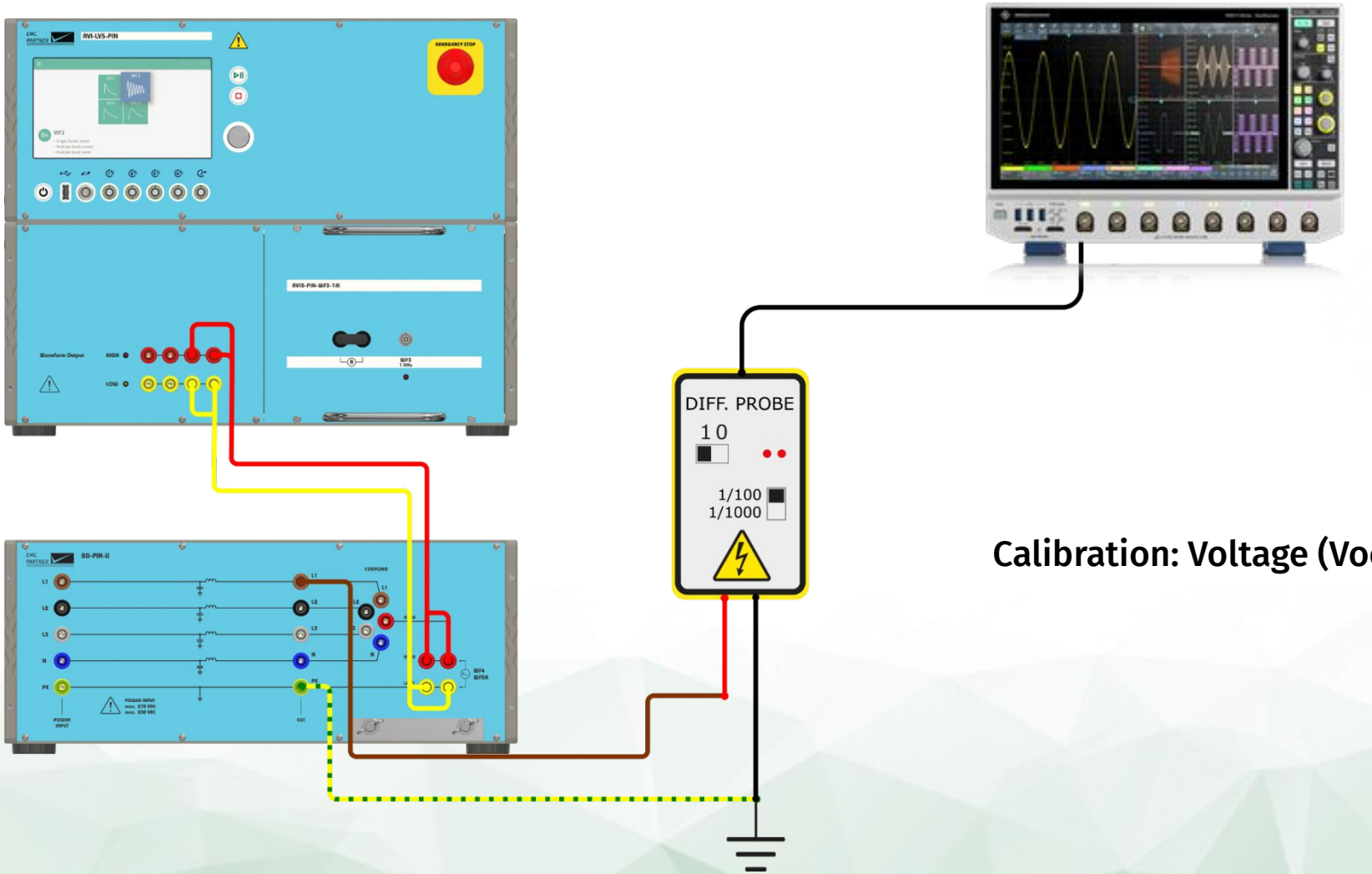
Waveform 5A Pin 2400V

How to test?

Cable injection is a familiar topic.

Let’s look at a case of pin testing.

Example: power pin testing of WF 4 / WF 5A, ungrounded return lead



Calibration: Voltage (Voc)

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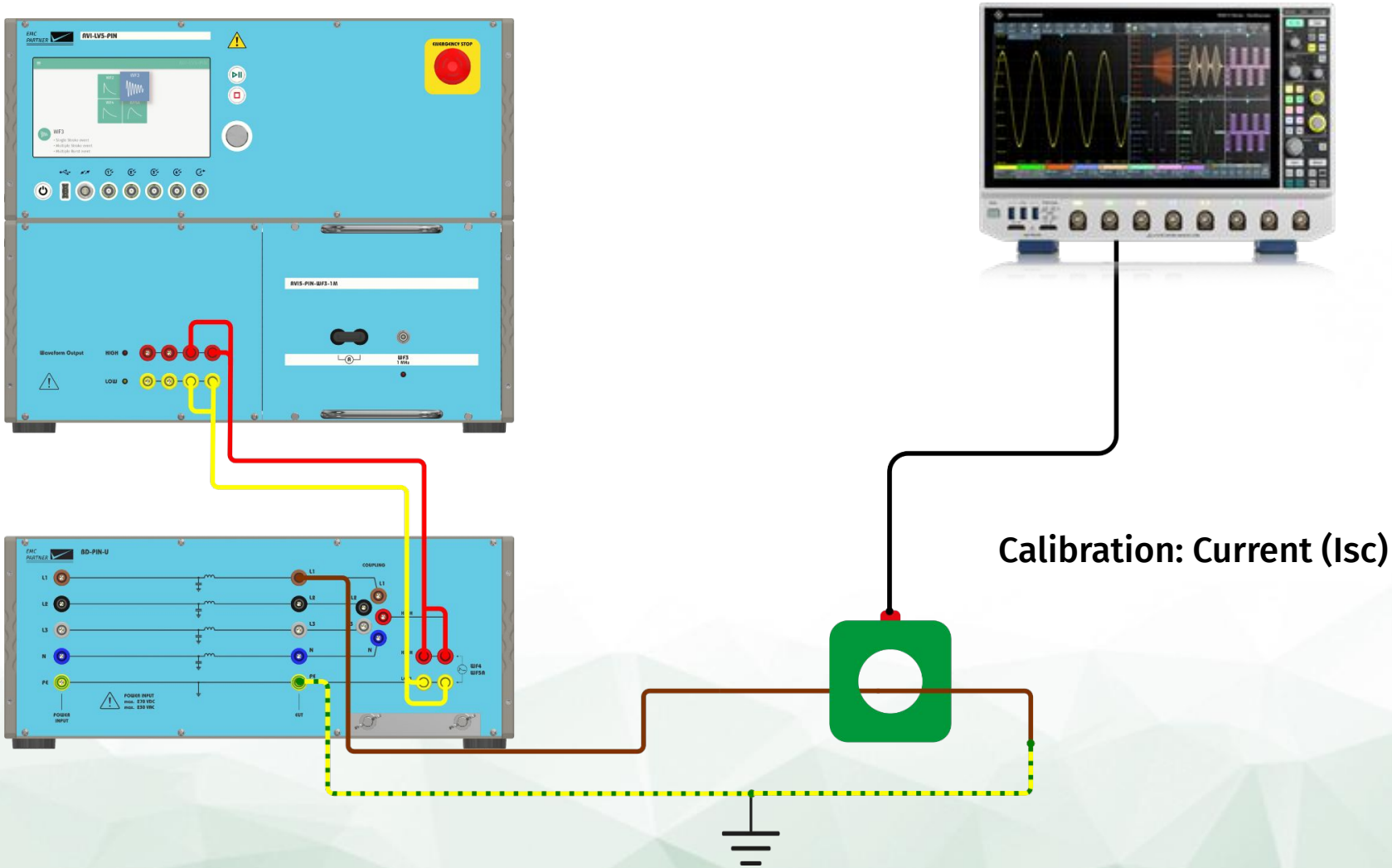

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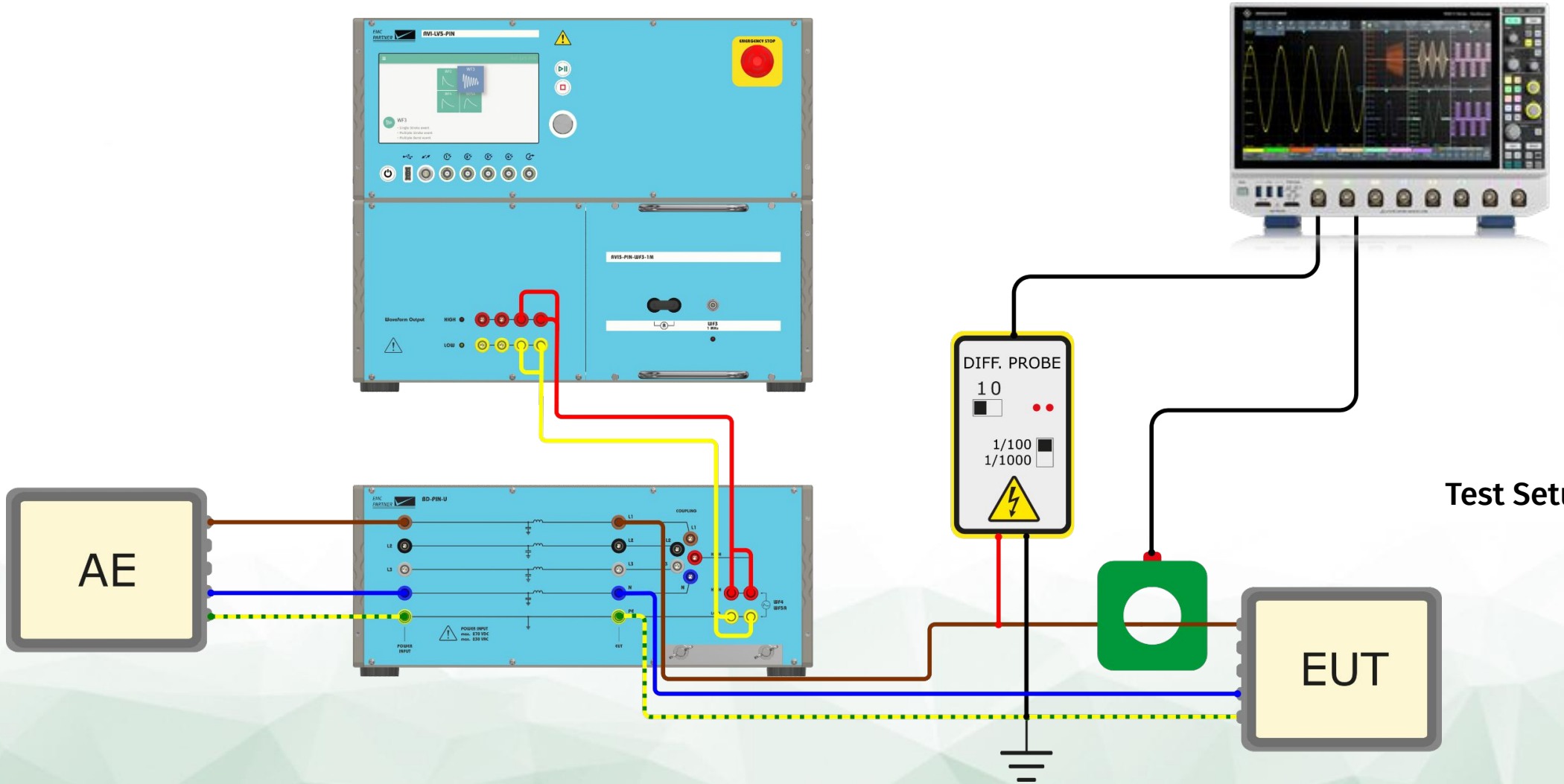


Test Setup

Defence and Aerospace Test – the reference in the market

MIL-STD-461
- CS106 (CS06)
- CS115
- CS116
- CS117
- CS118

RTCA DO-160
- Section 17
- Section 19
- Section 22

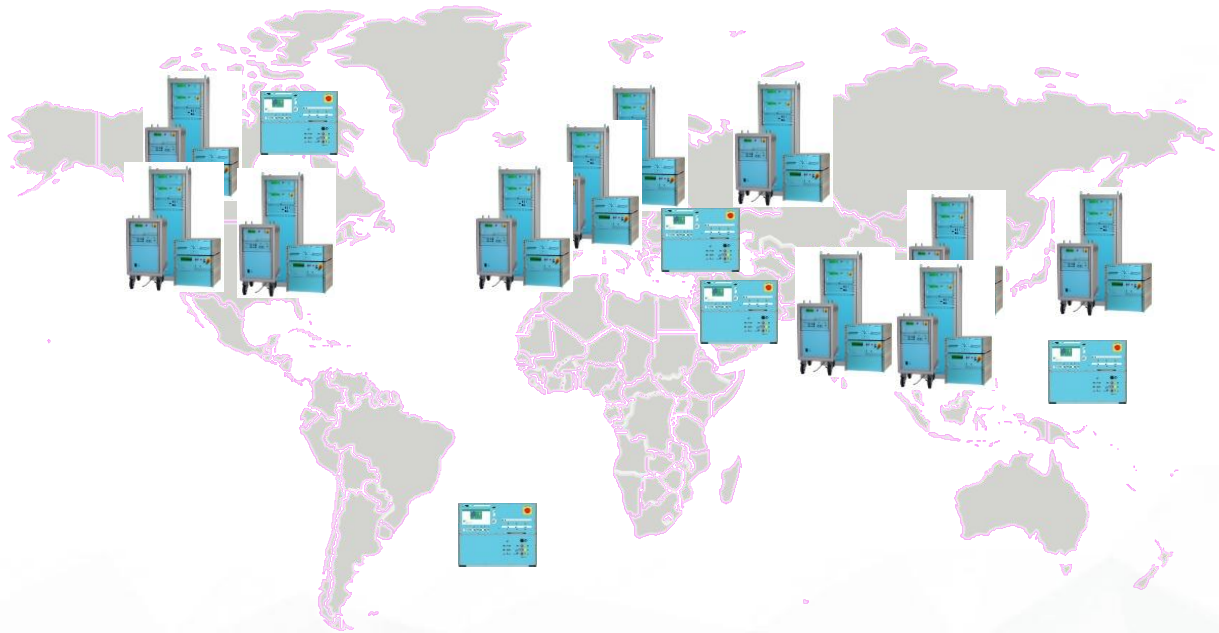
MIL-STD-1275

NASA GP 11461

ECSS-E-ST-20-07C

EUROCAE ED-14
- Section 22

OEM
- Airbus, Boeing, etc.



End of Presentation

Thank you!

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