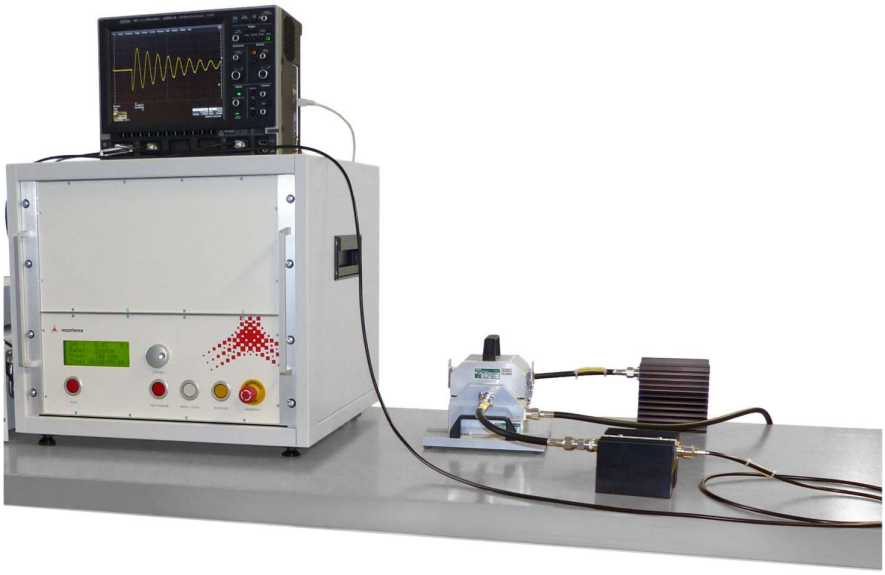
Test setup for MIL-STD 461 D/E/F/G CS116



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1. Test setup description

1.1 INTRODUCTION

MIL-STD 461 CS116 test setup comprises following elements:

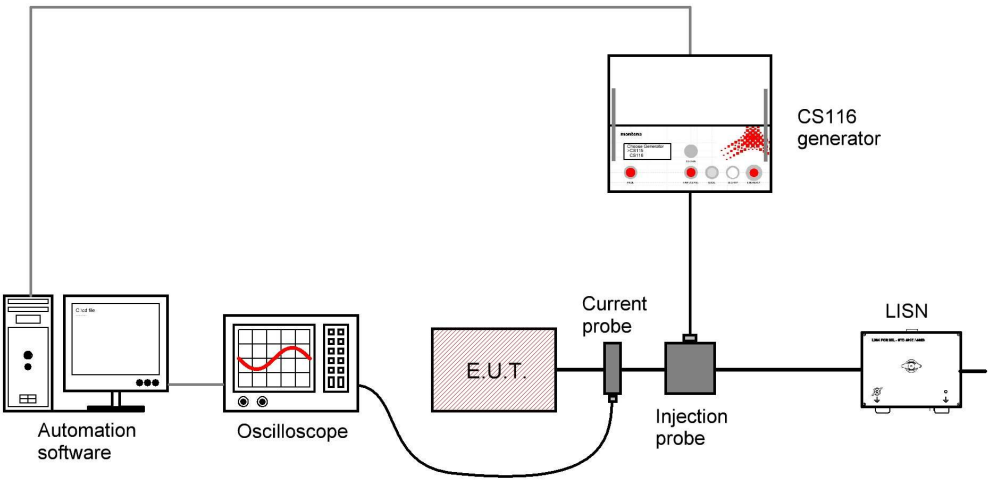


Figure 1: schematic of a typical CS116 test setup

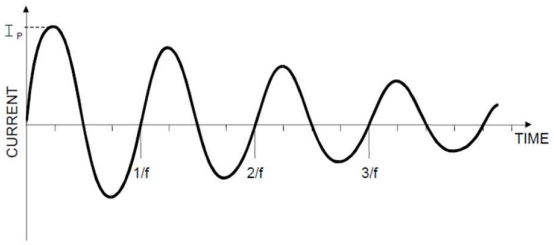
The damped sinusoidal generator delivers the high voltage pulse to the injection probe to test the conducted susceptibility of the EUT.

An oscilloscope connected to a current probe checks the level of the injected perturbation. LISN are to be used to control the impedance on the power line.

A PC with a control software allows fully automatic calibration and test sequences, as well as the automatic generation of test reports.

1.2 PULSE SHAPE

Montena's CS116 test installation delivers a damped sinusoidal waveform according to MIL-STD 461 D, E, F and G versions.



NOTES: 1. Normalized waveform: $e^{-(\pi f t)/Q}\sin(2\pi ft)$

Where:
f = Frequency (Hz)
t = Time (sec)
Q = Damping factor, 15 ±5

2. Damping factor (Q) shall be determined as follows:

$$Q = \frac{\pi(N - 1)}{\ln(I_P/I_N)}$$

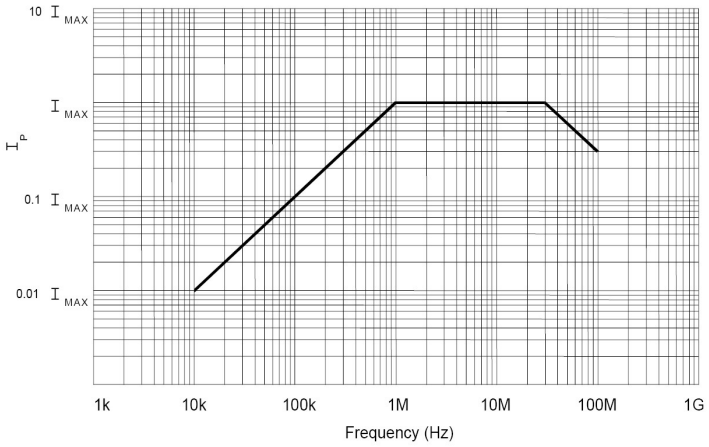
Where:
Q = Damping factor
N = Cycle number (i.e. N = 2, 3, 4, 5,…)
I_P = Peak current at 1st cycle
I_N = Peak current at cycle closest to 50% decay
In = Natural log

3. I_P as specified in Figure CS116-2

Figure 2 : MIL-STD-461 D/E/F/G CS116 waveform shape

1.3 CURRENT INJECTION LEVEL

The damped sinusoidal waveform level can be manually tuned to obtain the required current injection level.



Note: in the MIL-STD 461 D&E versions, two levels are defined with

1. For Army and Navy procurements, I_{MAX} = 10 amperes
2. For Air Force procurements, I_{MAX} = 5 amperes

Figure 3 : MIL-STD-461 D/E/F/G CS116 current injection level

In the automatic mode (software controlled) the current injection level can be defined for each available discrete frequency and the system calibration phase will automatically determine the required generator output level to obtain the specified current injection level.

2. Damped sinusoidal pulse generator

The damped sinusoidal generator POG-CS116 can be supplied with 6 to 17 discrete frequencies.

Figure 4: Montena pulse generator for CS116 test

Menu driven control panel

The menu driven control panel allows the user to select the desired pulse voltage level, the repetition rate, the discrete frequency and the test duration.

`>Set :  70.0% 1325 V`	Voltage set in % of maximum level and measured value
`Rate:  0.5 pps`	Repetition rate (single, 0.5 and 1 pps)
`Freq:  1 MHz`	Frequency
`Time: 00:00|05:00 L`	Test duration (actual time | set time)

One single signal output

The generator has one signal output for all available discrete frequencies. By having one single output, the whole calibration and measurement procedure can be performed without any need to change the cabling, considerably reducing the test duration.

From 6 to 17 frequencies

The MIL-STD 461 D, E, F & G CS116 test method requires testing the susceptibility of the EUT at 6 discrete frequencies (in bold in the table) between 10 kHz and 100 MHz.

Montena's CS116 generator provides additional test frequencies too:

OSCILLATION FREQUENCY	MAXIMAL CURRENT [1]	POG-CS116 - 6	POG-CS116 - 9	POG-CS116 - 17
10 kHz	**0.1 A**	**x**	**x**	**x**
18 kHz[2]	0.2 A			x
30 kHz[2]	0.3 A		x	x
56 kHz[2]	0.6 A			x
100 kHz	**1 A**	**x**	**x**	**x**
180 kHz[2]	2 A			x
300 kHz[2]	3 A		x	x
560 kHz[2]	6 A			x
1 MHz	**10 A**	**x**	**x**	**x**
1.8 MHz[2]	10 A			x
3 MHz[2]	10 A		x	x
5.6 MHz[2]	10 A			x
10 MHz	**10 A**	**x**	**x**	**x**
18 MHz[2]	10 A			x
30 MHz	**10 A**	**x**	**x**	**x**
56 MHz[2]	5.5 A			x
100 MHz	**3 A**	**x**	**x**	**x**

[1] At 100 % voltage setting and with a 2 m 50 Ω coaxial cable, with the dedicated injection probe (e.g. Prâna IP-DR250) and calibration jig, on the 100 ohm calibration load.
[2] These frequencies are not required by the MIL-STD 461 but we recommend them for a better coverage of the frequency range.

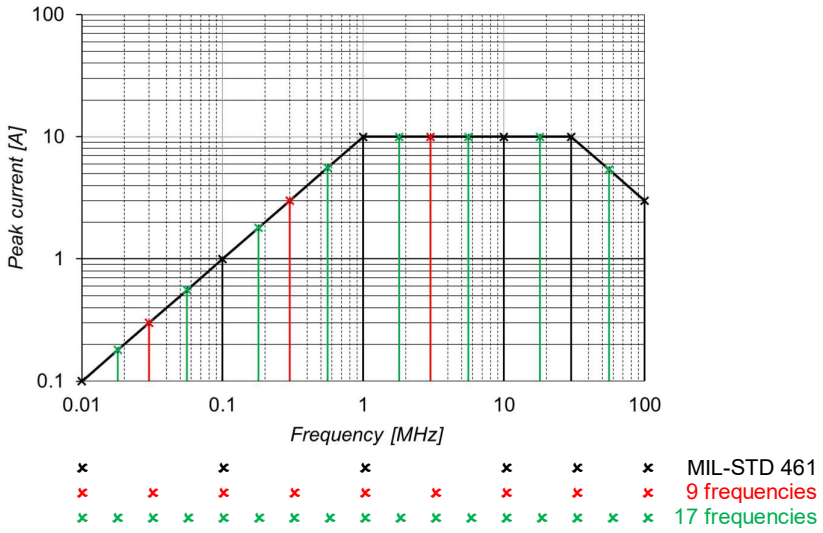


Figure 5: available CS116 test frequencies

In the 9 or 17 frequencies version, the test frequencies are evenly distributed between 10 kHz and 100 MHz for better coverage of potential system resonances.

In some cases, it is very interesting to be able to test the susceptibility of the equipment with some in-between frequencies which will be present in the real deployment and will threaten the equipment's performances.
Optionally montena can provides some additional discrete frequencies anywhere in the range comprised between 10 kHz and 100 MHz.

3. Control interface for fully automated system

The CS116 test setup is supplied with a dedicated control software application which comprise :

- A **main** panel to select the desired tests to be performed;
- A **calibration** panel allowing a fully automated calibration of the system;
- A **test** panel enabling a fully automated measurement process with sequential injection of the defined current level according to the selected test standard and calibration results;
- A **report generation** to keep track of all measurements and calibration values.

Calibration panel - main features

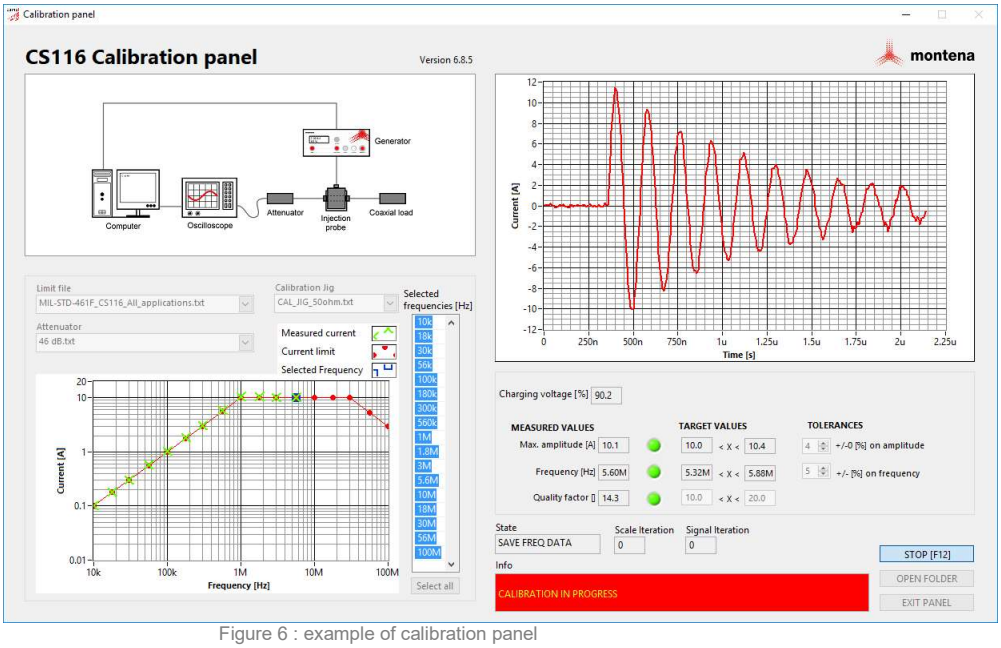


Figure 6 : example of calibration panel

In order to ease the system calibration procedure, the control software provides:

- A selection of the standard to apply (limit files);
- An integration of the measurement correction factors (calibration values of the resistor, factors of the injection probe, attenuators, ...);
- A selection of the frequencies to be applied;
- An automatic calibration procedure: for each frequency -> slowly increase the generator loading voltage until the desired injected current is obtained -> record generator setting -> switch to next frequency -> ….;
- Automatic configuration of the oscilloscope;
- Display or the injected pulses;
- Automatic edition of a system calibration report.

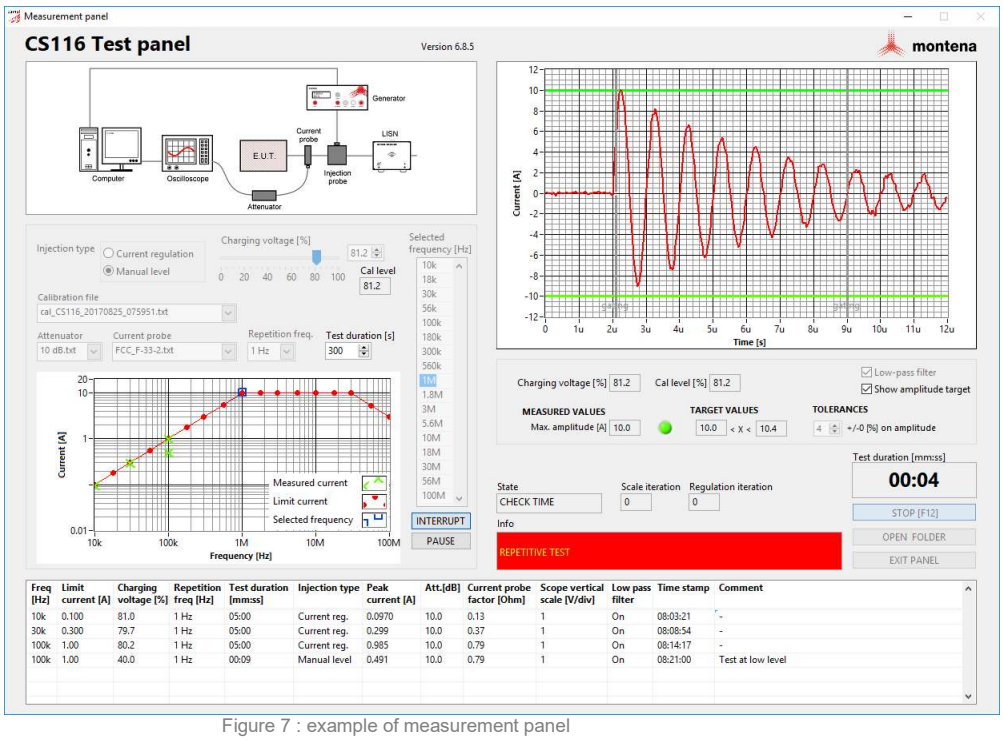


Figure 7 : example of measurement panel

In order to ease the test procedure, the control software provides:

- A selection of the values to be applied (in the form of a system calibration results file);
- An integration of the correction factors and attenuators;
- An automatic measurement procedure: for each frequency-> increase the generator output signal until the value of calibration file is reached -> switch to next frequency -> ….;
- Automatic configuration of the oscilloscope;
- Display of the test progress;
- A test report generation.

TEST PROCEDURE SUMMARY

With montena test setup and automation software, the operator only has to:

1. Build the calibration setup according to the schematic displayed on the calibration panel;
2. Select the standard to apply (i.e. MIL-STD 461G CS116, …);
3. Select the probes and attenuators factors (Probexxx_SNxxxxx.txt, …);
4. Automatically calibrate the system:
   Press once "Start Calibration"
5. Generate the calibration report;
6. Build the test setup according to the schematic displayed on the test panel;
7. Select the system calibrated data to apply (i.e. Cal_CS116_01Jan2021.txt)
8. Select the probes and attenuators factors
9. Apply all test frequencies sweeping :
   Press once "Start Measurement"
10. Generate the test report.

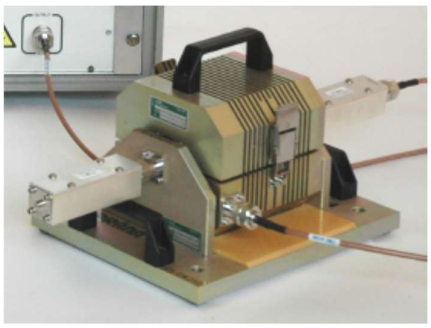
- ✓ **Automatic calibration for the whole test frequency range**
- ✓ **Application of all test frequencies automatically, level can be selected or automatic**
- ✓ **NO need to manually configure the measurement equipment**
- ✓ **NO need to manually integrate the transfer function of probes and attenuators**
- ✓ **Generation of test reports, NO need to record all values read from the measurement equipment**
- ✓ **Generation of calibration reports, NO need to record all calibration setting parameters.**

4. Accessories

Injection probe with calibration jig

The injection probe is required for both, the calibration and the test procedures.

For the system calibration phase, the current injection probe is calibrated with help of a calibration jig, an attenuator and a 50 ohm termination load.



LISN

LISN's (Line Impedance Stabilisation Network) are used to provide standardised impedance in common mode to the power lines connected to the device under test. This allows a better reproducibility of the tests.

The proposed LISN's have the following specifications:

- 150 kHz – 100 MHz
- 50 Ω // 50 µH
- 1 x 20 A
- 250 Vac 50 Hz, 140 Vac 400 Hz

5. Services

Onsite installation and training

Montena provides onsite installation and training performed by either an engineer from montena or by a local authorized representative support engineer.

A training session is usually given directly after installation. This training includes both the system installation and the test procedure.

Maintenance

No periodic maintenance is required other than a calibration of the measurement equipment.

6. Technical specifications

Technical specifications of the CS116 pulse generator

SPECIFICATIONS

Type	**POG-CS116-6**	**POG-CS116-9**	**POG-CS116-17**
Test frequencies	10, 100 kHz 1, 10, 30, 100 MHz	10, 30, 100, 300 kHz 1, 3, 10, 30, 100 MHz	10, 18, 30, 56, 100, 180, 300, 560 kHz 1, 1.8, 3, 5.6, 10, 18, 30, 56, 100 MHz
Standard	MIL-STD 461 D / E / F / G , CS116		
Output waveform	damped oscillatory wave		
Output current	10 A on 100 ohm (depends on the frequency)		
Output impedance	< 100 ohm		
Damping factor	15 +/- 5		
Repetition rates	single, 0.5 Hz, 1 Hz		
Output signal connection	N 50 ohm		
Power rating	90 - 250 Vac / 50 - 60 Hz / 35 W / 75 VA		
Storage / operating temperatures	5 - 50 °C / 20 - 45 °C		
Generator weight	complete unit: 34.5 kg / 19-inch rack only: 17.0 kg		
Dimensions (L x W x H)	630 x 530 x 485 mm / 19-inch rack only: 630 x 485 x 405 mm (9HU)		

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