1. Introduction

MIL-STD-461 CS109 is an EMC-test that measures an equipment's immunity to currents flowing directly through its chassis or enclosure. It verifies that systems can handle structure currents (ranging from 60 Hz to 100 kHz) without suffering performance degradation or malfunctions.

Applicability:
CS109 is applicable from 60 Hz to 100 kHz for equipment and subsystems that have an operating frequency of 100 kHz or less and an operating sensitivity of 1 µV or better (such as 0.5 µV). Handheld equipment is exempt from this requirement.

Limit:
The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the values shown in the graph below. The maximum injected current is 120 dBµA (1 A_{RMS}).

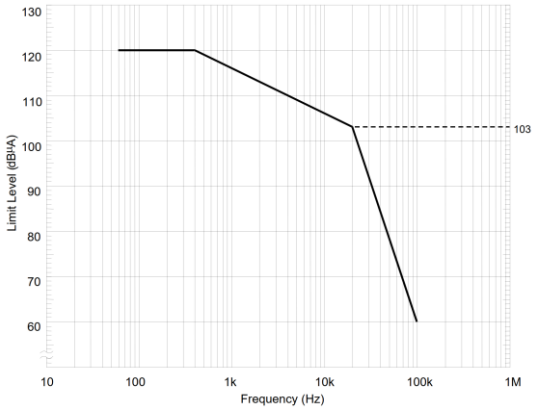

Figure 1: CS109 limit (copied from MIL-STD-461G)

2. CS109 Test setup

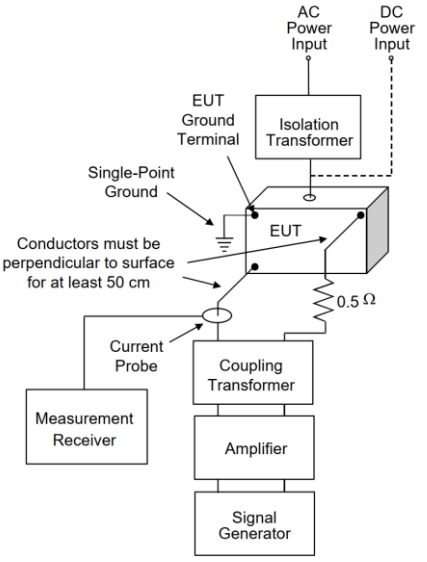

Figure 2: test configuration (copied from MIL-STD-461G)

A 4:1 coupling transformer connects a low output impedance power amplifier to a 0.5 Ohm load resistor, thereby isolating the amplifier ground from the single point ground.

3. CS109 Application for TBMR-110M

The PC software for the Tekbox TBMR-110M contains a measurement feature for automated CS109 testing. Start the TBMR-110M software to access the CS109 app:

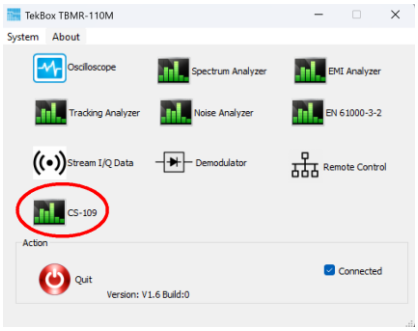

Figure 3: TBMR-110M application selection window

The TBMR-110M measurement receiver contains a signal / tracking generator, which is controlled to generate a current matching the graph in figure 1. The tracking generator of the TBMR-110M replaces the signal generator shown in the CS109 setup of MIL-STD-461. Depending on the amplifier gain, it may be necessary to add the tracking generator amplifier Tekbox TBCS101-TGA. The recommended current probe is a TBPCP1-20100. The power amplifier, coupling transformer and 0.5 Ohm resistor is equipment, which is also used for CS101 testing.

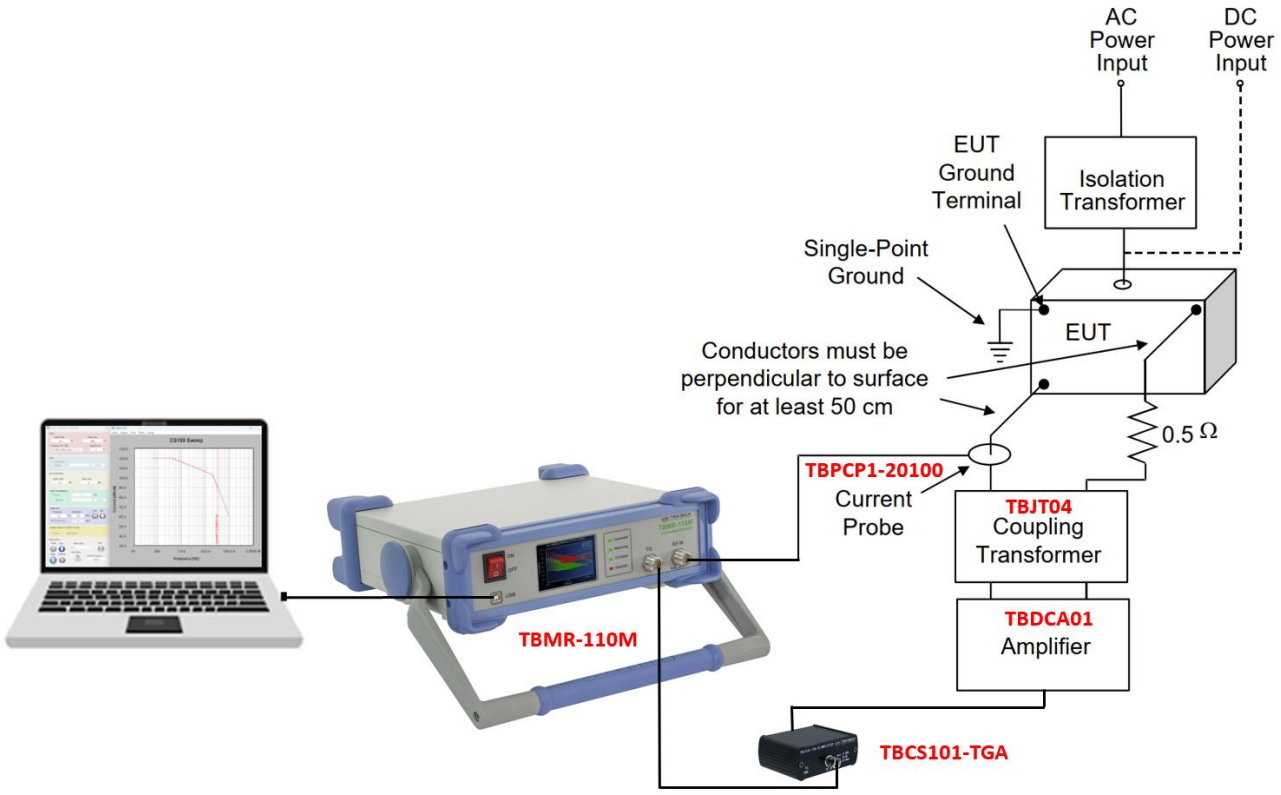

Figure 4: CS109 setup using Tekbox equipment

A Tekbox TBRFCI1 current amplifier may be used to implement an alternative setup. The TBRFC1 is a four-quadrant RF current source that can inject RF currents up to 1 A_{RMS}. This is adequate to meet the CS109 limits. The TBRFCI1 is a current source, capable to directly drive a 0 Ω load such as the enclosure of the EUT. The 1A/V input of the current amplifier is driven by the output of the TG-amplifier in order to achieve 1V_{RMS} drive voltage.
There is no need for a current probe, as the current is measured at the current monitor output of the TBRFCI1.
To isolate the PC, measurement receiver and current amplifier from the single point ground, an additional isolation transformer is required.

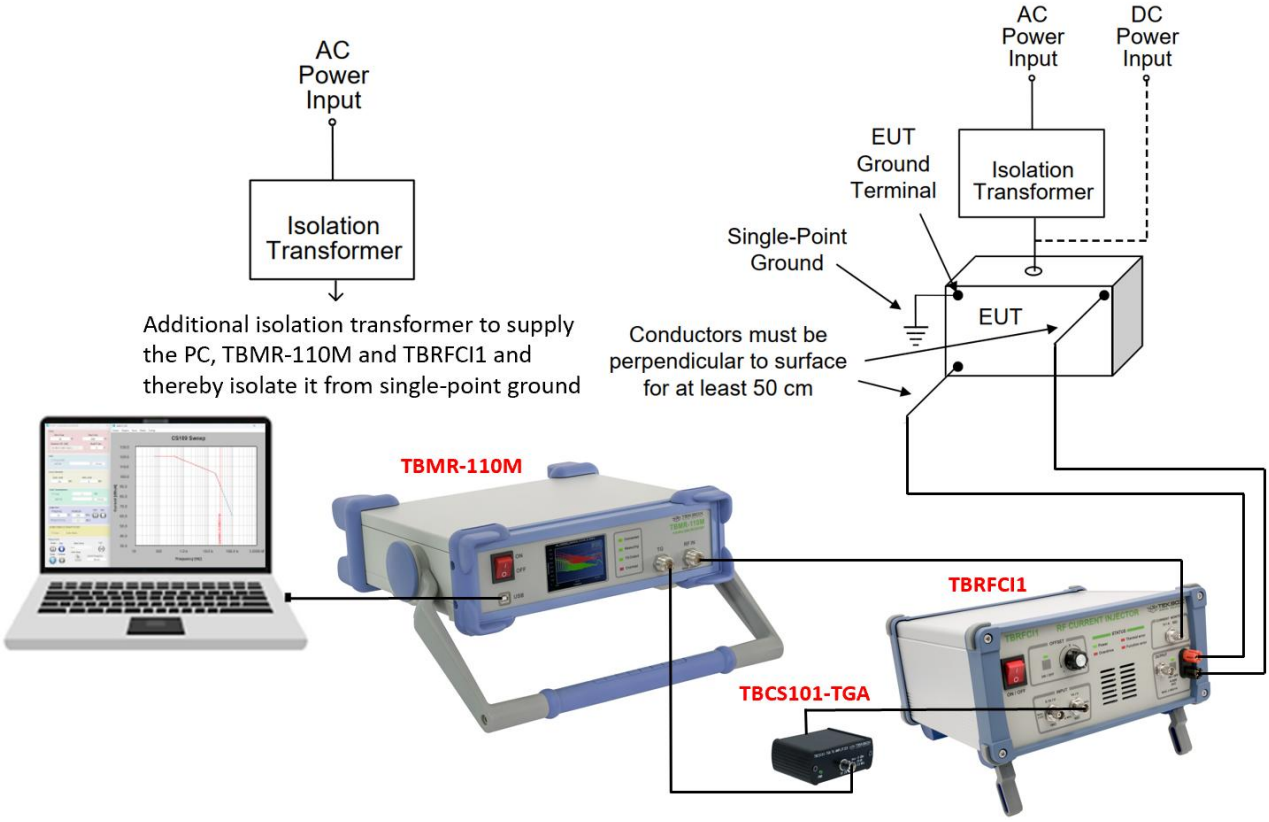

Figure 5: Alternative CS109 setup using Tekbox equipment

Upon starting the CS109 app, the Start Frequency of 60 Hz, the Stop Frequency of 100 kHz and the dwell time is preconfigured in accordance with CS109 / MIL-STD-461. The frequency steps are also following MIL-STD-461 specifications.
The Receiver Attenuation/Gain and the corresponding maximum RF input level shall match the expected maximum output voltage of the current probe at 1A structure current. An attenuation of 10 dB (15 dBm maximum input level is suitable for both the trans-impedance of the recommended current probe and the current monitor output of the TBRFCI1.
Choose the CS109 limits according to MIL-STD-461 or customize your own limits. The source parameter defines the TG level window, within which it tries to find an appropriate value to achieve 1A_{RMS} through the 0.5 Ohm resistor or at the output of the current amplifier in order to start a closed loop sweep.
Enter the trans-impedance value of the current probe or the monitor output of the TBRFCI1 and start the CS109 sweep by pressing the sweep button.

If any immunity issues of the EUT occur in a certain frequency range, the setup can be driven at constant frequency configuring a single point frequency and the corresponding current.

Note that the TBMR-110M tracking generator amplitude can be set accurately within a dynamic range of 50dB. Further attenuation requires digital configuration of the DDS with reduced accuracy. This can cause the output current for very low amplitude values to deviate from the CS109 limits. Interrupting the sweep at a

current of 70 dBµA, manually inserting a 10 dB attenuator at the TG output and resuming the sweep is a workaround to achieve perfect accuracy at low currents.

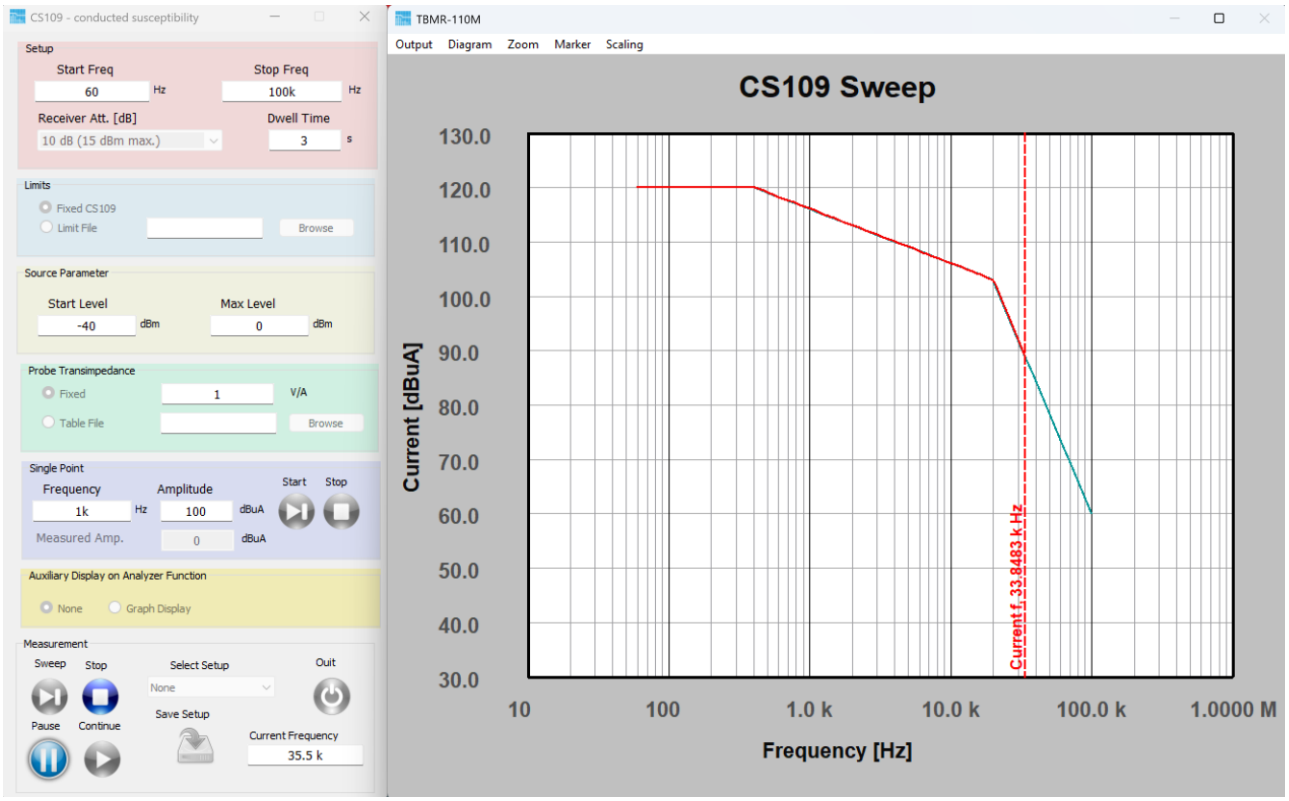

Figure 6: CS109 app configuration and screenshot taken during a sweep:
Green trace: CS109 limit
Red trace: current measured during sweep

Version	Date	Author	Changes
V 1.0	8.5.2025	Mayerhofer	Creation of the document