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1. Introduction

Starting with EMCview version 8.42, the EMCview PRO license variant introduces real-time analysis capabilities and advanced immunity testing features. Customers can choose between a standard EMCview license and EMCview PRO, with standard license holders having the option to upgrade to the PRO version at any time.

The pre-compliance immunity features in EMCview are designed to simulate conducted and radiated immunity tests at low cost. However, this focus on affordability requires certain workarounds, which users should understand to avoid misconceptions and measurement errors.

1.1 Signal Generation:

Signal generators and power meters are essential components for standard-compliant conducted and radiated immunity testing. To keep the cost of pre-compliance setups as low as possible, these components are replaced by low-cost spectrum analyzers equipped with a tracking generator (TG).

Most analyzers couple the tracking generator frequency with the analyzer's frequency sweep and span settings. To perform an immunity test, the spectrum analyzer is set to zero-span mode, enabling the tracking generator to output a CW signal at a specific frequency. The immunity test's frequency range is then covered by stepping the TG output frequency across the required spectrum. While some analyzers allow independent tracking generator control, EMCview is designed to support a wide range of instruments, utilizing a 'lowest common denominator' approach to ensure compatibility across all models. Tracking generators are typically limited to a minimum frequency of 100 kHz, with some models starting as high as 1 MHz.

1.2 Amplitude control:

Tracking generators typically have a **40 dB output dynamic range** (-40 dBm to 0 dBm), with amplitude control available in 1 dB steps. Some older analyzers offer a range of only 20 dB, which is insufficient for immunity tests that specify a variable stress amplitude profile versus frequency.

In such cases, EMCview may be unable to control the TG output level across the entire profile, resulting in the error message: **“TG level too high.”** As a workaround, the test can be split into multiple frequency bands, using an external attenuator for regions where lower power is required.

Conversely, if the power amplifier cannot produce sufficient output amplitude, the software displays the error message: **“TG level too low.”** If a more powerful amplifier is unavailable, the only option is to disregard the warning. Consequently, the desired stress level will not be reached, and the EUT will instead be exposed to the amplifier's maximum available output power. Even if the target levels cannot be achieved, EMCview does not stop the calibration; the resulting TG levels are still saved to the calibration table and applied during the test.

How an analyzer behaves when switching frequency points depends entirely on the model. Most analyzers cannot perform seamless switching, which can cause a signal gap of a few milliseconds or more. Some analyzers may briefly jump to 0 dBm, while others drop to -40 dBm. In most cases, an amplitude glitch occurs during frequency steps. These gaps and glitches must be accepted unless an RF signal generator is used instead of a tracking generator.

To address this, Tekbox recently released an SG option for EMCview, which supports signal generators from Rigol, Siglent, and UNI-T. Utilizing a signal generator also enables significantly more accurate amplitude control, bypassing the ±1 dB amplitude inaccuracy caused by the 1 dB step limitation of standard tracking generators.

1.3 Modulation:

While most radiated and conducted immunity standards mandate amplitude or pulse-modulated interference signals, tracking generators are limited to CW output. Tekbox addresses this by providing modulated amplifiers featuring integrated modulators for 1 kHz / 80% AM, 1 kHz / 50% duty cycle PM, and 217 Hz / 12.5% duty cycle PM.

Because EN 61000-4-6 and ISO 11452-4 define stress levels in RMS voltage respectively RMS current, this must be factored into the immunity setup calibration.

For an unmodulated signal with a CW power P_{CW}, the amplifier must be capable of delivering a peak envelope power (PEP) of P_{CW} + 5.1 dB.

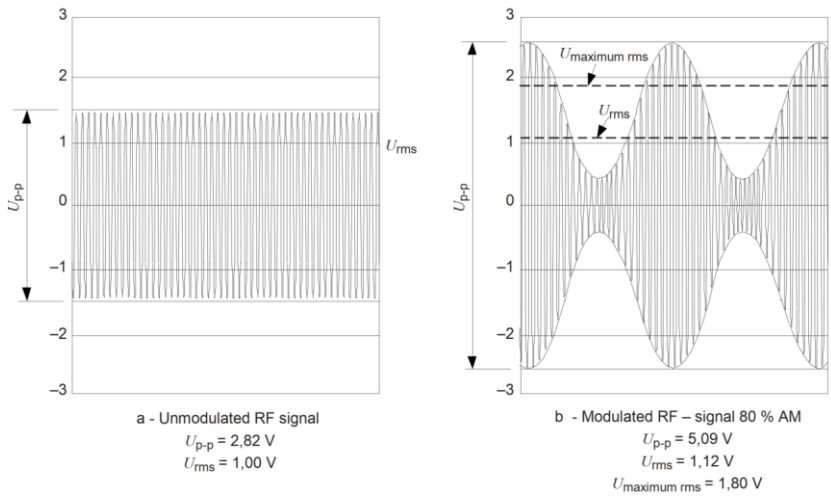


Figure1: modulated vs unmodulated signal, from EN 61000-4-6-20

80% AM modulated signal	Linear ratio to peak	Logarithmic ratio
Peak Power	1	0 dB
RMS Power *	0.4074	- 4.01 dB
Carrier Power	0.3086	- 5.11 dB
Total Sideband Power	0.0988	-10.05 dB
*)Note "RMS power" is technically a misnomer because taking the root-mean-square of a power waveform itself has no valid physical meaning—instead, power is calculated using the RMS values of voltage and current		

Table1: power ratios

Standards such as MIL-STD-461H (CS114, RS103) and the test cases in DO-160 Section 20 specify susceptibility tests using 1 kHz / 50% duty cycle pulse modulation. The specified limits, expressed in dBµA or mA, correspond to the RMS level of the continuous wave (CW) or unmodulated carrier signal before applying the pulse modulation envelope.

1.4 Power measurement:

EMCview utilizes the spectrum analyzer for power measurement in immunity pre-compliance setups. The screenshot below illustrates the signal from an RF generator configured for 0 dBm with 1 kHz / 80% AM.

Analyzer settings: Zero span, RBW = 10 kHz, sweep time = 10 ms, video trigger.

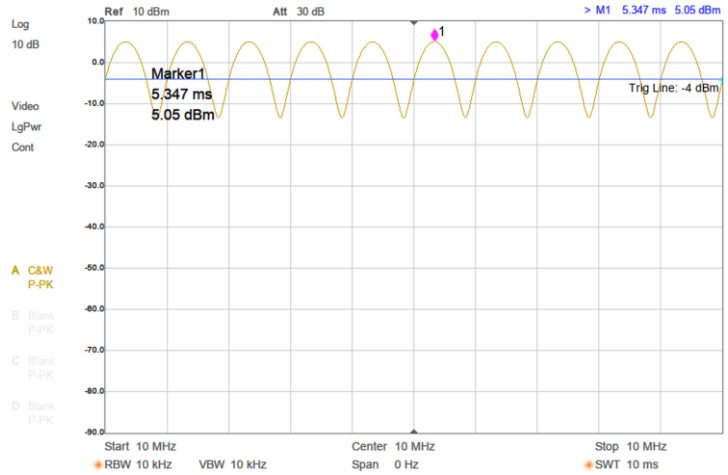


Figure2: zero span display of a 0 dBm 80% AM signal

The measured peak envelope power is approximately 5.1 dBm, which matches the value in *Table1*.

When querying peak power via SCPI, some supported analyzers cannot reliably detect peaks in zero-span mode. Consequently, EMCview measures the carrier power by reducing the RBW to 300 Hz in zero-span mode:

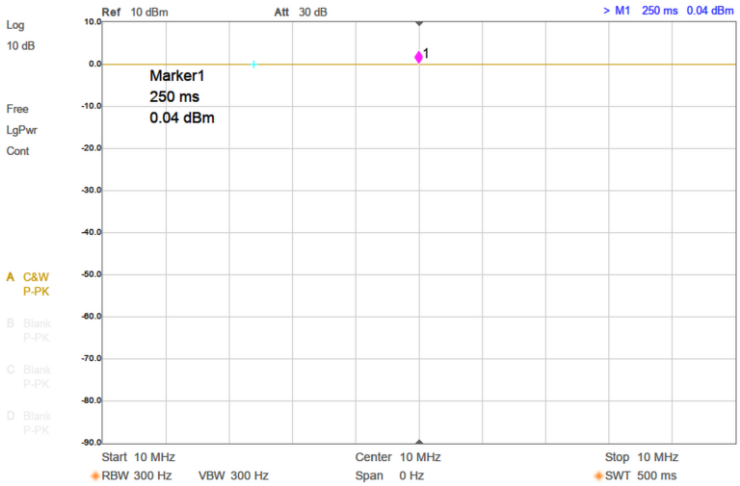


Figure2: zero span display of a 0 dBm 80% AM signal

The sidebands contribute to the total RMS power of the 80% AM-modulated signal, making it 1.1 dB higher than the carrier power. Consequently, EMCview automatically adds 1.1 dB when calculating the target power during the calibration of immunity setups.

1.5 Tekbox modulated amplifiers:

Tekbox modulated wideband amplifiers are cost-optimized solutions designed for affordable RF power delivery. They utilize voltage-controlled attenuators in their input stages as modulators. When the modulator is enabled, the carrier power drops by 5 to 6 dB (nominally 5.5 dB) to provide the headroom needed for the AM envelope. Calibration is performed using CW. This allows EMCview to detect amplifier saturation during calibration and cap the input drive. During the test phase, activating the AM modulation switch automatically lowers the carrier power by 5.5 dB via the hardware, maintaining the necessary margin for the AM envelope even if the amplifier was calibrated near saturation.

Furthermore, it must be taken into account that the RMS power of the AM modulated signal is 1.1 dB above the carrier power. Consequently, an offset of 5.5 dB – 1.1 dB = 4.4 dB is factored into the target power (calibration level) calculation.

It is also good practice to provide an additional margin of 2 dB, as EMCview may drive the amplifier into saturation, rather than stopping at the 1 dB compression point P_{1dB}.

Tekbox modulated amplifiers do not fulfill the harmonic suppression requirements specified in immunity standards. Meeting these standards would require highly linear amplifiers, which would significantly increase costs. The harmonic suppression requirement primarily aims to prevent ambiguous test results; the higher the harmonic suppression, the less likely a failure is caused by a harmonic instead of the fundamental frequency. In pre-compliance testing, simply monitor repeated failures. For example, if a failure recurs at an integer multiple of a previous frequency, it is likely caused by a harmonic, appearing again when another harmonic sweeps across the same frequency point.

1.6 General purpose wideband power amplifiers:

General purpose wideband power amplifiers can be used instead of Tekbox modulated amplifiers, using RF signal generators controlled by the SG-option of EMCview.

1.7 Calibration:

Most immunity tests are preceded by a calibration in a well-defined setup.
The procedure is explained with a EN 61000-4-6 setup employing a CDN:

EN 61000-4-6 calibration set up using EMCview PRO

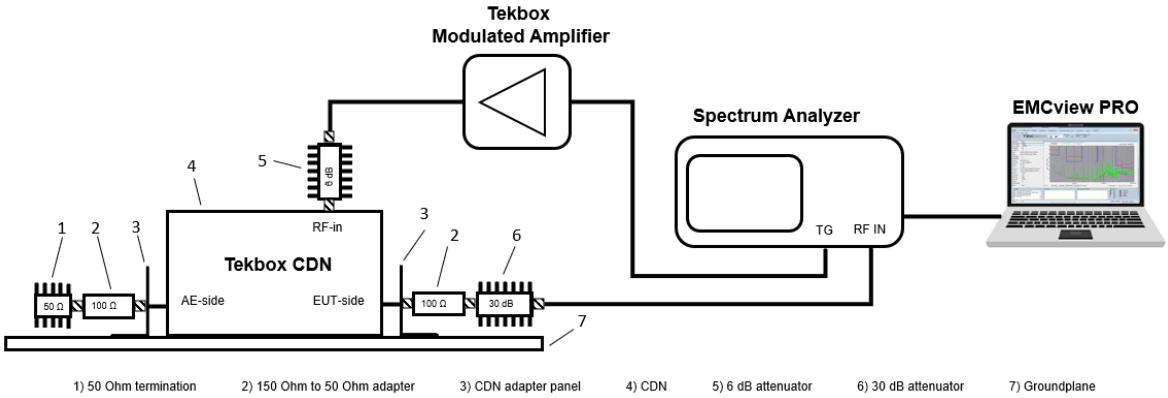


Figure3: Calibration setup of a EN 61000-4-6 conducted immunity test, employing a CDN

The calibration aims to establish a defined stress level at the CDN´s EUT terminals.

EN 61000-4-6 specifies following stress levels:

Level	Voltage level (e.m.f.)	
	U_0 [V_{RMS}]	U_0 [dBµV_{RMS}]
1	1	120
2	3	129.5
3	10	140
X*	Special	
* "X" can be any level, above, below or in between the others. The level has to be specified in the dedicated equipment specification		

Table2: EN 61000-4-6 stress levels

The test levels are open circuit voltages set at the EUT port of the coupling devices. For testing of the equipment, this signal is 80 % amplitude modulated with a 1 kHz sine wave to simulate actual threats.

Actual voltages:

The EUT terminals are loaded with 100 Ω (150 Ω to 50 Ω adapter) in series with 50 Ω (input impedance of the attenuator / analyzer). The voltage divider has a division ratio of 3:1, means the loaded voltage at the EUT terminals is three times the voltage at the attenuator input. The corresponding e.m.f. voltage is twice as high as the loaded voltage, resulting in a 6:1 division ratio when compared to the voltage at the attenuator input.

Level	Voltage (e.m.f.) at the EUT terminals of the CDN		150 Ω/50 Ω adapter output		Analyzer input (30dB att.)	
	U_0 [V_{RMS}]	U_0 [dBμV_{RMS}]	$U_{50\Omega}$ [V_{RMS}]	$U_{50\Omega}$ [dBμV_{RMS}]	U_{SA} [dBμV_{RMS}]	P_{SA} [dBm]
1	1	120	0.166	104.4	74.4	-32.6
2	3	129.5	0.5	114	84	-23
3	10	140	1.66	124.4	94.4	-12.6

Table3: actual voltages of the setup in Figure3

Note, that the power at the analyzer input is not yet the target power for the corresponding stress level. The analyzer actually measures the carrier power. As the carrier power is 1.1 dB lower than the RMS power of the amplitude modulated signal, 1.1 dB has to be subtracted from P_{SA}. Furthermore, the calibration is performed with a CW signal. When switching the amplifier from CW to AM, the carrier power will be reduced approximately 5.5 dB. Consequently, the target power is 5.5 -1.1 = 4.4 dB higher compared to P_{SA}.

Based on the target power at the analyzer input, the required power at the output of the power amplifier can be estimated.

P_{PA} [dBm] = P_{Target} + 30 dB (attenuator) + 11 dB (CDN + 150Ω/50Ω adapter + cables) + 6 dB (attenuator)

Level	Target Power at analyzer input [dBm]	Required PA output power [dBm]	Required PA output power [W]
1	-28.2	18.8	0.08
2	-18.6	28.4	0.7
3	-8.2	38.8	7.6

Table4: Required amplifier power

During calibration, the tracking generator amplitude is adjusted at every frequency point until the target power at the amplifier output is reached. Once achieved, the corresponding tracking generator level is stored in a frequency table. If the target power cannot be reached, the TG amplitude that provides the closest possible value will be used instead.

This TG-level-versus-frequency table is then used to play back the required output levels during the actual immunity test.

- When an RF signal generator is used, EMCview keeps it in CW mode during calibration. For the actual measurement with an AM signal, EMCview drops the signal generator output amplitude by 5.5 dB relative to the calibration table levels. This replication mimics switching a modulated amplifier from CW to AM, maintaining consistency in calculations and levels between TG and signal generator setups. Additionally, this approach allows EMCview to determine if the available power falls short of the required stress level.

2. EN 61000-4-6 CDN

Access the immunity features in menu **Mode:**

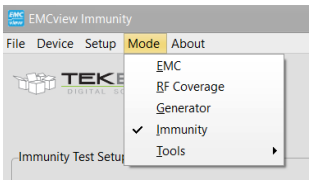


Figure4: Mode menu

Figure5 shows the EN 61000-4-6 immunity feature for testing with CDNs. The immunity test is a two-step process. First, the setup needs to be calibrated (left screen - section). Next, the EUT and supply need to be connected and the immunity test needs to be performed (right screen - section).

Note that the calibration is carried out with a CW signal and the test is performed with AM modulation.

- When using the tracking generator as signal source, make sure the amplifier´s modulation switch is in **OFF-position** during **calibration**.
- When using the tracking generator as signal source, make sure the amplifier´s modulation switches are in **ON-position** and **AM-position** during **test**.
- When using a signal generator as source, and a TBMDA amplifier, make sure the amplifier´s modulation switch is in **OFF-position** during **calibration and test**. When using a general purpose amplifier, this does not apply of course. For both calibration and test, EMCview will take full control of the RF signal generator.

Immunity Calibration:

Set up the equipment as depicted in the *Figure4*. Select the desired stress level in the **calibration setup calculator** window.

- For a correct calibration it is essential to enter the correct value of the attenuator at the analyzer input. The calculator will then display the corresponding power at the RF input of the spectrum analyzer (calibration/target level). The calibration level will be transferred into the parameter list of the **Immunity Test Setup Calibration** window.

The calibration does not use the attenuation of the CDN or the attenuator value at its RF input. These values have informative character and are used to calculate the approximate required power at the amplifier output.

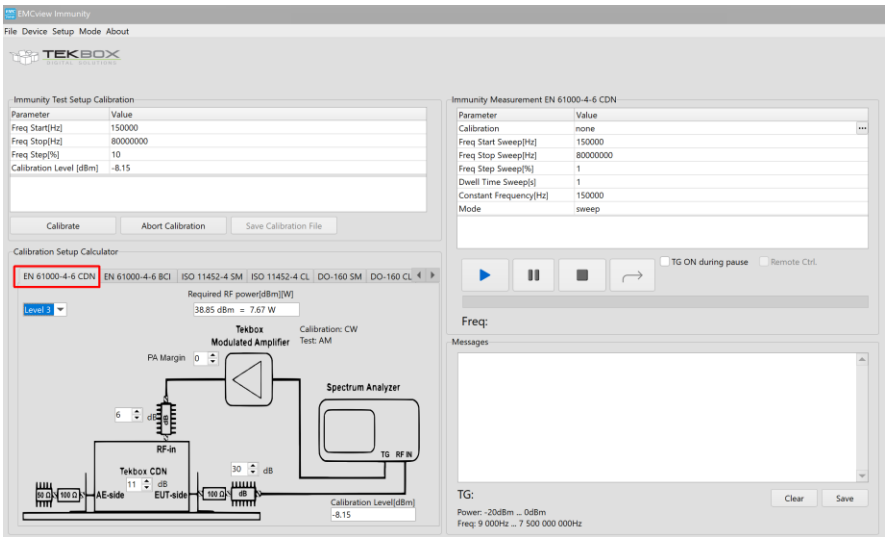


Figure5: EN 61000-4-6 conducted immunity test using a CDN

Next, set the desired frequency range and step size in the **Immunity Test Setup Calibration** window and click **Calibrate**. During calibration, the tracking generator sweeps across the configured frequency range, adjusting its output level at each step to achieve the target stress voltage (test level).

Once the sweep is complete, save the resulting calibration file. This file contains a table, mapping frequency points to their corresponding tracking generator levels. During the actual immunity test, the software uses this table to look up and set the TG level, compensating for the frequency response of the tracking generator, power amplifier, and CDN. Note that the 1 dB step limitation of the TG amplitude resolution introduces an error of ±1 dB, while the amplifier's AM modulator contributes an additional error of ±0.5 dB.

If the desired stress voltage cannot be achieved at one or more frequency points, EMCview will display a warning message indicating that the target level was not reached. In this case, the tracking generator output level will be set to a value that results in the closest possible stress voltage. The calibration file can still be used; however, keep in mind that the stress voltage at these specific frequencies will be lower than targeted. As a workaround, you can reduce the 6 dB attenuator to 3 dB or use a more powerful amplifier, such as the TBMDA-CDN25.

You may also receive a warning that the stress voltage is too high, causing the tracking generator to drop to its minimum setting. This usually happens when the stress voltage is set to Level 1 and the analyzer is unable to output a TG level lower than -20 dBm. As a workaround, connect a 10 dB attenuator to the TG output of the analyzer.

Immunity Test:
Set up the equipment as depicted below:

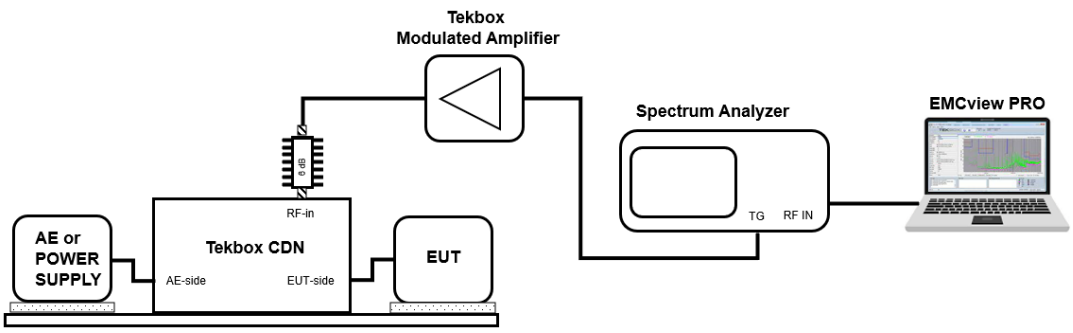


Figure6: EN 61000-4-6 conducted immunity test setup; simplified – check EN 61000-4-6 for accurate setup details

In order to run the immunity test, the corresponding calibration file needs to be specified first.

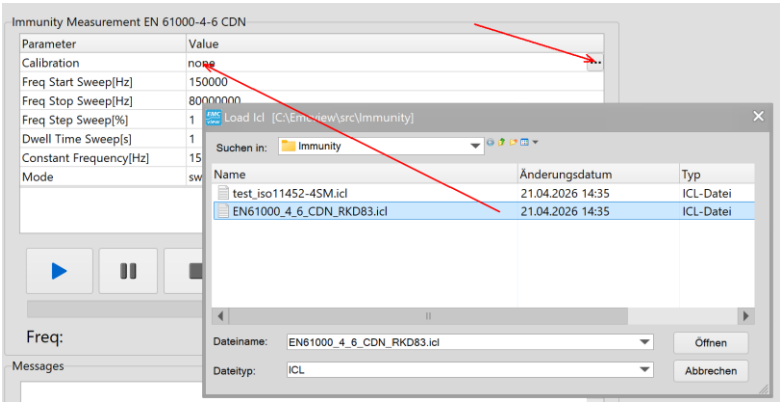


Figure7: EN 61000-4-6 conducted immunity test configuration

Select the calibration file, configure the remaining parameters as desired and click the **start (play)** button. Upon observing an immunity issue, the sweep can be paused. The sweep can be continued by clicking the **pause** button again. The direction of the sweep can be reversed, by clicking the **arrow** button.

Power Considerations:

Using CDNs for immunity tests is preferred by EN 61000-4-6 and the most efficient method in terms of RF power. The TBMDA-CDN25 with an output power of 25 W is our recommended amplifier for immunity pre-compliance testing with CDNs. It can achieve test level 3 and stress voltages even beyond 10V.
Test levels are specified in terms of voltage; Level 1 – 1V, Level 2 – 3V, Level 3 – 10V.

Level	Target Power at analyzer input [dBm]	Required PA output power [dBm]	Required PA output power [W]
1	-28.2	18.8	0.08
2	-18.6	28.4	0.7
3	-8.2	38.8	7.6

Table5: Required amplifier power

In case of availability of other amplifiers which do not have the power capability of the TBMDA-CDN25, a workaround is to replace the 6 dB attenuator with a 3dB model.

Amplifier model	Modulation	Attenuator	Test levels	Freq. Range
TBMDA-CDN25	AM 80%, 1 kHz	6 dB	Level 1 - Level 3	150 kHz - 230 MHz
TBMDA4B	AM 80%, 1 kHz	6 dB	Level 1, Level 2	150 kHz – 80 MHz
		3 dB	Level 1 - Level 3	150 kHz – 80 MHz
TBMDA5	AM 80%, 1 kHz	6 dB	Level 1, Level 2	150 kHz – 230 MHz
		3 dB	Level 1, Level 2	150 kHz – 230 MHz
TBMDA3B	AM 80%, 1 kHz	6 dB	Level 1, Level 2	10 MHz – 230 MHz
		3 dB	Level 1 – Level 3	10 MHz – 230 MHz

Table6: Capability of Tekbox modulated amplifiers

Note that certain spectrum analyzers have the tracking generator amplitude limited to the range from -20 dBm to 0 dBm. If there is a warning message “TG level too high”, connect a 10 dB or 20 dB attenuator to the tracking generator output to achieve Level 1.

3. EN 61000-4-6, BCI

Enter the immunity mode and click at the EN 61000-4-6 BCI tab

The immunity test is a two-step process. First, the setup needs to be calibrated (left screen - section). Next, the EUT and supply need to be connected and the immunity test needs to be performed (right screen - section).

Note that the calibration is carried out with a CW signal and the test is performed with AM modulation.

- When using the tracking generator as signal source, make sure the amplifier´s modulation switch is in **OFF-position** during **calibration**.
- When using the tracking generator as signal source, make sure the amplifier´s modulation switches are in **ON-position** and **AM-position** during **test**.
- When using a signal generator as source, and a TBMDA amplifier, make sure the amplifier´s modulation switch is in **OFF-position** during **calibration and test**. When using a general purpose amplifier, this does not apply of course. For both calibration and test, EMCview will take full control of the RF signal generator.

Immunity Calibration:

Set up the equipment as depicted in the *Figure8*. Select the desired stress level in the **calibration setup calculator** window.

- For a correct calibration it is essential to enter the correct value of the attenuator at the analyzer input. The calculator will then display the corresponding power at the RF input of the spectrum analyzer (calibration/target level). The calibration level will be transferred into the parameter list of the **Immunity Test Setup Calibration** window.

The calibration does not use the attenuation of the BCI-probe or the attenuator value at its RF input. These values have informative character and are used to calculate the approximate required power at the amplifier output.

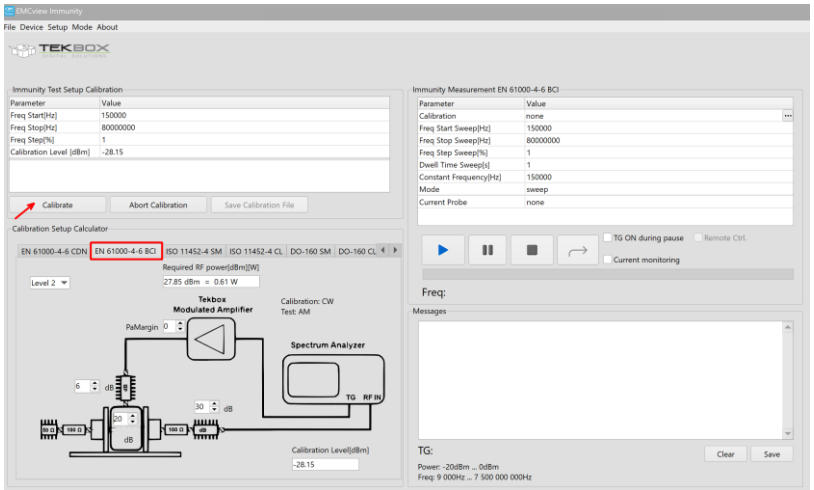


Figure8: EN 61000-4-6 conducted immunity test using a bulk current injection probe

Next, set the desired frequency range and step size in the **Immunity Test Setup Calibration** window and click **Calibrate**. During calibration, the tracking generator sweeps across the configured frequency range, adjusting its output level at each step to achieve the target stress voltage (test level).

Once the sweep is complete, save the resulting calibration file. This file contains a table, mapping frequency points to their corresponding tracking generator levels. During the actual immunity test, the software uses this table to look up and set the TG level, compensating for the frequency response of the tracking generator, power amplifier, and CDN. Note that the 1 dB step limitation of the TG amplitude resolution introduces an error of ±1 dB, while the amplifier's AM modulator contributes an additional error of ±0.5 dB.

If the desired stress voltage cannot be achieved at one or more frequency points, EMCview will display a warning message indicating that the target level was not reached. In this case, the tracking generator output level will be set to a value that results in the closest possible stress voltage. The calibration file can still be used; however, keep in mind that the stress voltage at these specific frequencies will be lower than targeted. As a workaround, you can reduce the 6 dB attenuator to 3 dB or use a more powerful amplifier, such as the TBMDA-CDN25.

You may also receive a warning that the stress voltage is too high, causing the tracking generator to drop to its minimum setting. This usually happens when the stress voltage is set to Level 1 and the analyzer is unable to output a TG level lower than -20 dBm. As a workaround, connect a 10 dB attenuator to the TG output of the analyzer.

Immunity Test:
Set up the equipment as depicted in Figure9.
Optionally, a current probe can be added to the setup to monitor the injected current. The measured current is displayed in the message box.

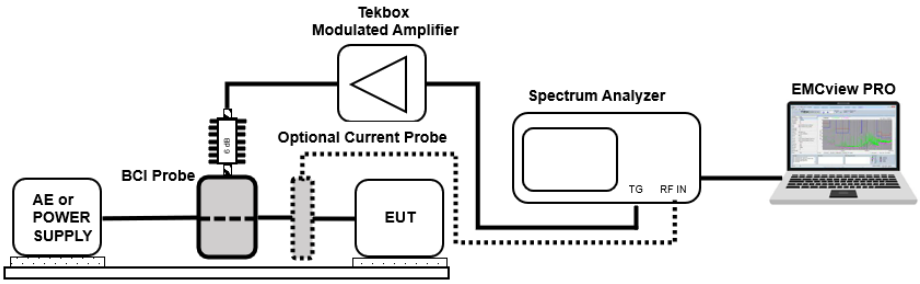


Figure9: EN 61000-4-6 conducted immunity test setup; simplified – check EN 61000-4-6 for accurate setup details

In order to run the immunity test, the corresponding calibration file needs to be specified first.

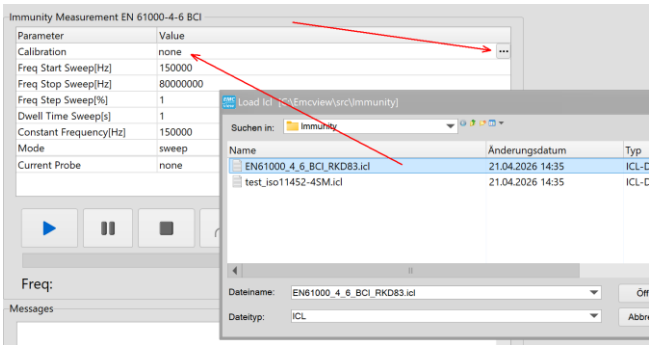


Figure7: EN 61000-4-6 conducted immunity test configuration

Select the calibration file, configure the remaining parameters as desired, and click the **Start (Play)** button.

If an immunity issue is observed, the sweep can be paused and then resumed by clicking the **Pause** button again. The sweep direction can be reversed by clicking the **Arrow** button. If you are using a current probe, ensure that the corresponding transimpedance file is loaded.

Power Considerations:

While BCI probes are less RF-power-efficient for immunity tests, they allow common-mode disturbances to be injected into any cable bundle if a suitable CDN is unavailable.
For pre-compliance immunity testing with BCI probes, a 25 W amplifier such as the TBMDA-CDN25 is insufficient to achieve Level 3. The TBMDA-BCI100 is a better alternative. Although it is designed for a frequency range of 1 MHz to 400 MHz, it can still achieve Level 3 at frequencies above 250 kHz.
Test levels are specified in terms of voltage; Level 1 – 1V, Level 2 – 3V, Level 3 – 10V.

The stress level corresponds to the e.m.f. RMS voltage at the probe fixture output. The target power at the analyzer is calculated in the same manner as for CDNs. The approximate required PA output power largely depends on the coupling loss of the BCI-probe.

$P_{PA\ [dBm]} = P_{Target}$ [dBm] + 30 dB (attenuator) + 20 dB (BCI + 150Ω/50Ω adapter + cables) + 6 dB (attenuator)

Level	Target Power at analyzer input [dBm]	Required PA output power [dBm]	Required PA output power [W]
1	-28.2	27.8	0.6
2	-18.6	37.4	5.5
3	-8.2	47.8	60.3

Table5: Required amplifier power

Achieving Level 3 is challenging with a 25 W amplifier like the TBMDA1-CDN25. However, it may be reached at higher frequencies, where the BCI probe has lower insertion loss and by replacing the 6 dB attenuator with a 3 dB attenuator. Note that the calculation is also based on the maximum coupling loss of a typical BCI probe.

Another option to approximate the test level is switching to Level X and entering a voltage slightly below Level 3, such as 8 V or 9 V.

Amplifier model	Modulation	Attenuator	Test levels	Freq. Range
TBMDA-BCI100	AM 80%, 1 kHz	6 dB	Level 1, Level 2	150 kHz – 230 MHz
		3 dB	Level 1, Level 2, Level 3	150 kHz – 230 MHz
TBMDA-CDN25	AM 80%, 1 kHz	6 dB	Level 1, Level 2	150 kHz – 230 MHz
		3 dB	Level 1, Level 2, Level 3	2.5 MHz – 230 MHz
TBMDA4B	AM 80%, 1 kHz	6 dB	Level 1, Level 2	150 kHz – 80 MHz
		3 dB	Level 1, Level 2	150 kHz – 80 MHz
TBMDA3B	AM 80%, 1 kHz	6 dB	Level 1	10 MHz – 230 MHz
		3 dB	Level 1, Level 2	10 MHz – 230 MHz

Table6: Capability of Tekbox modulated amplifiers

Note that certain spectrum analyzers have the tracking generator amplitude limited to the range from -20 dBm to 0 dBm. If there is a warning message “TG level too high”, connect a 10 dB or 20 dB attenuator to the tracking generator output to achieve Level 1.

4. EN 61000-4-6, EM Clamp

Immunity testing with an EM clamp can be performed, using the EMCview implementation of the test utilizing BCI-clamps.

5. ISO 11452-4, BCI, Substitution Method

ISO 11452-4 BCI testing is performed with both AM and unmodulated Continuous Wave (CW) disturbance signals. Modulation details are specified in ISO 11452-1.

For both the substitution and closed loop levelling methods, and for tests with unmodulated and amplitude-modulated signals, the test severity levels of the ISO 11452 series (electric field, current, voltage, or power) are expressed in terms of the equivalent root-mean-square level value of the unmodulated wave (CW).

Both testing methods apply a constant peak level for unmodulated and AM test signals. When switching to AM modulation, Tekbox amplifiers instantly throttle the carrier power to clamp the peak envelope of the AM signal to the peak amplitude of the CW signal. Similarly, if a standard signal generator provides the modulation rather than a tracking generator, EMCview lowers the AM carrier power by 5.1 dB to keep the peak envelope perfectly aligned with the CW baseline value.

According to ISO 11452-4, immunity testing can be executed using either the Closed-Loop method—which eliminates the need for a separate calibration—or the Substitution method, which relies on a prior calibration process.

Furthermore, while the stress levels in EN 61000-4-6 are expressed in terms of voltage, the limits in ISO 11452-4 are specified in terms of injected current.

The Substitution Method implemented in EMCview is constrained by relying solely on the spectrum analyzer for power measurements. To control the injected current, the software utilizes a two-step calibration procedure as a workaround. First, the required TG level is determined to attain the target current. Subsequently, the TG levels acquired in this first step are applied to measure the corresponding RF forward power. The resulting calibration file then maps the forward power levels versus frequency necessary to generate the target injected current. The transducer file of the VSWR bridge must be loaded. It is stored in the EMCview\COMP\Amplifier folder.

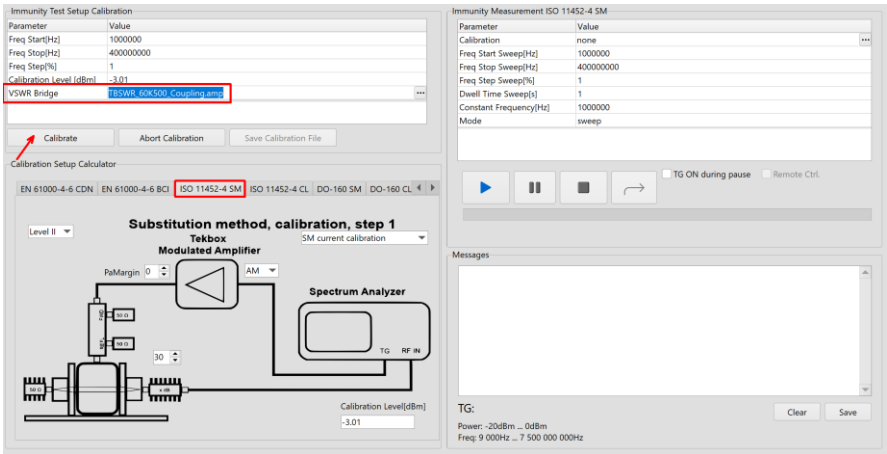


Figure8: ISO 11452-4 substitution method conducted immunity test configuration

<u>Calibration step 1:</u>

Set up the equipment as shown below. In EMCview, select *ISO 11452-4 SM, SM current calibration*, and set the desired stress current level. Select the frequency range, and frequency step size, then load the correction file for the relevant VSWR bridge or directional coupler.

- Ensure that the amplifier's modulation switch is in the OFF position.
- Next, click the Calibrate button.

EMCview PRO automatically adjusts the tracking generator (TG) output level to achieve the specified stress current for each frequency step across the selected range. This process generates a calibration file containing the tracking generator levels versus frequency for that specific stress level. A message box will notify you once the calibration is complete. Finally, click the Save Calibration File button to store the data.
When using the TBMDA-BCI25 25-watt amplifier, Level IV (200 mA) can be achieved.

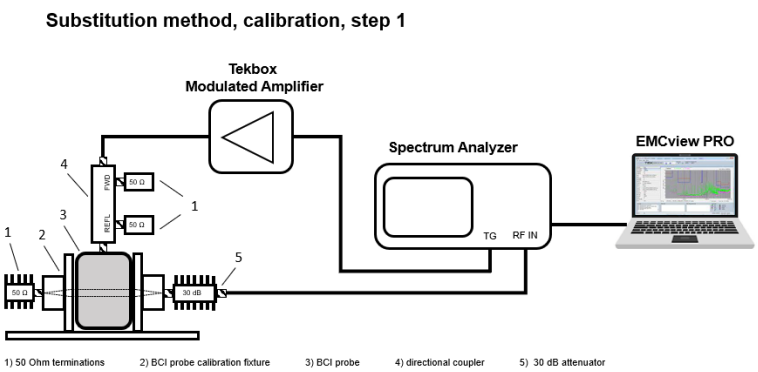


Figure9: EMCview implementation of ISO 41452-4 substitution method, wiring for calibration step 1

Calibration step 2:

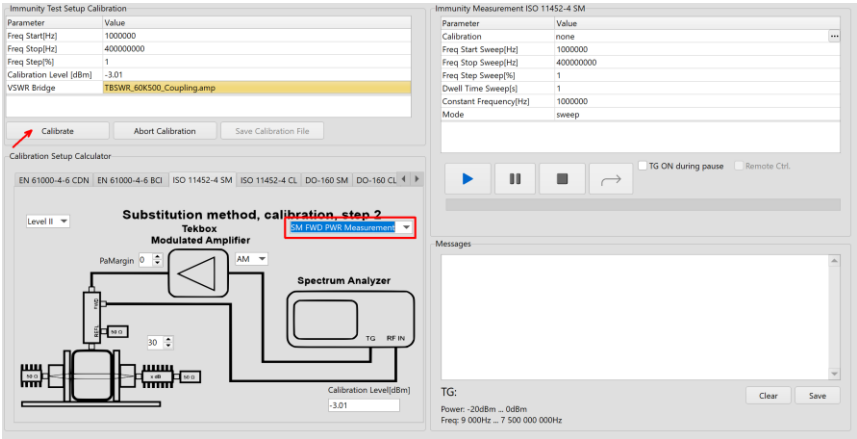


Figure10: EMCview implementation of ISO 41452-4 substitution method, wiring for calibration step 2

Set up the equipment as shown below, then click the Calibrate button.
The tracking generator (TG) output is automatically set based on the data within the temporary calibration file created in Step 1. The software then measures the equivalent RF forward power for each frequency point. A message box will notify you once the calibration process is complete. Next, click the Save Calibration File button to permanently store the data. The resulting calibration file maps out the exact RF forward power required to achieve the specified injected current at each frequency step.

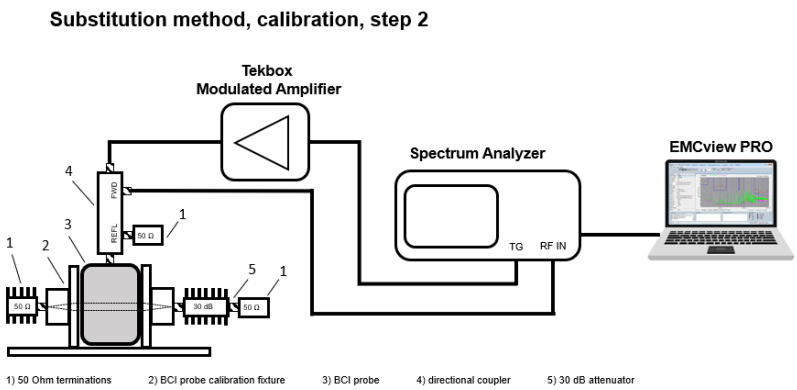


Figure11: EMCview implementation of ISO 41452-4 substitution method, wiring for calibration step 2

Step 3, actual immunity test:

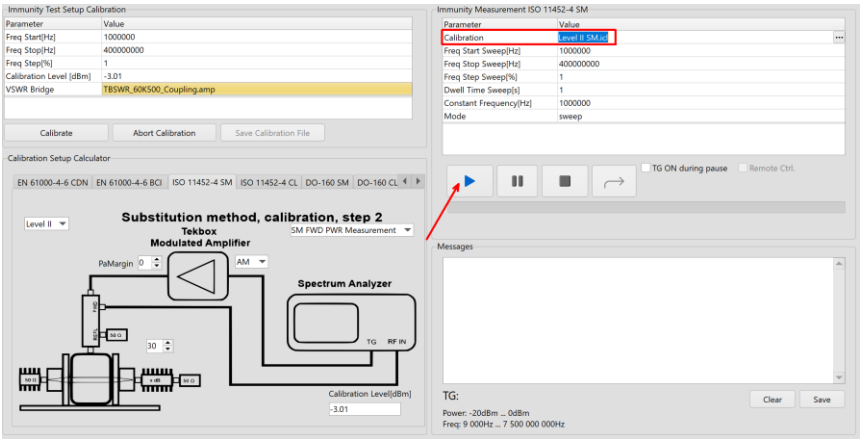


Figure12: EMCview implementation of ISO 41452-4 substitution method, test run

Set up the equipment as illustrated below, incorporating any additional specific details mandated by the standard. Load the calibration file and click the Play button. During the test, EMCview PRO automatically adjusts the tracking generator (TG) output for each frequency point to replicate the precise RF forward power levels defined in the calibration file.

Note on Setup Layout: This diagram is highly simplified, as the actual configuration depends heavily on the specific characteristics and properties of the EUT. It does not illustrate the artificial networks (AN/LISN) or potential simulators required in the AE/supply paths, nor does it detail the cable layout, BCI probe placement, or EUT grounding configurations. For exact setup guidelines, please refer strictly to Annex D of ISO 11452-4.

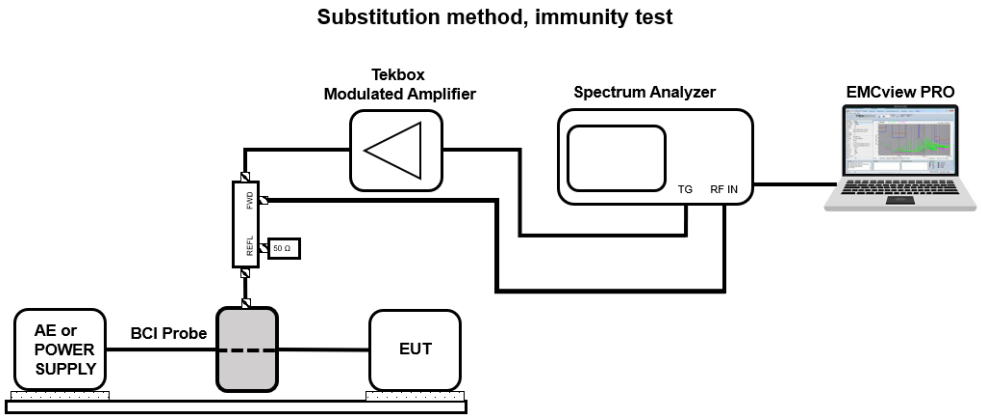


Figure13: EMCview implementation of ISO 41452-4 substitution method; test setup, simplified diagram

Power Considerations:

Test levels:

Level I: 60 mA
Level II: 100 mA
Level III: 150 mA
Level IV: 200 mA
Level V: x mA

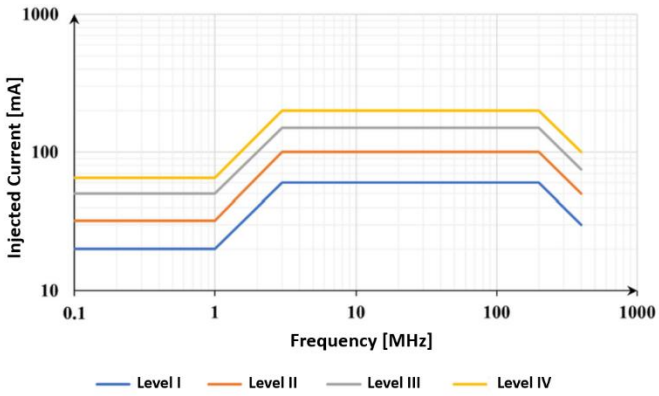


Figure14: ISO 41452-4 test levels

$P_{PA\,[dBm]} = P_{Target}$ [dBm] + 30 dB (attenuator) + 6 dB (BCI + VSWR bridge + cables) *BCI coupling loss above 1MHz

Level	Target Power at analyzer input [dBm]	Required PA output power [dBm]	Required PA output power [W]
I	-7.4	28.6	0.72
II	-3	33	2
III	0.5	36.5	4.5
IV	3	39	7.9
V	6.5 (example 300mA)	42.5	17.8

Amplifier model	Modulation	Test levels	Freq. Range
TBMDA-BCI25	CW / AM 80%, 1 kHz	Level I – Level IV; 300mA	1 MHz - 400 MHz
TBMDA-BCI100	CW / AM 80%, 1 kHz	Level I - Level V;	<1 MHz - 400 MHz *lowest possible frequency depends on required level and current probe coupling loss characteristics

6. ISO 11452-4, BCI, Closed Loop Method

The Closed Loop Method controls the injected current by measuring the actual injected current using a current probe. Click at the ISO 11452-4 BCI tab and configure the equipment as illustrated below, incorporating any additional specific details mandated by the standard. Load the calibration file and click the Play button. During the test, EMCview PRO automatically adjusts the tracking generator (TG) output for each frequency point to replicate the precise RF forward power levels defined in the calibration file.
Note on Setup Layout: This diagram is highly simplified, as the actual configuration depends heavily on the specific characteristics and properties of the EUT. It does not illustrate the artificial networks (AN/LISN) or potential simulators required in the AE/supply paths, nor does it detail the cable layout, BCI probe placement, or EUT grounding configurations. For exact setup guidelines, please refer strictly to Annex D of ISO 11452-4.

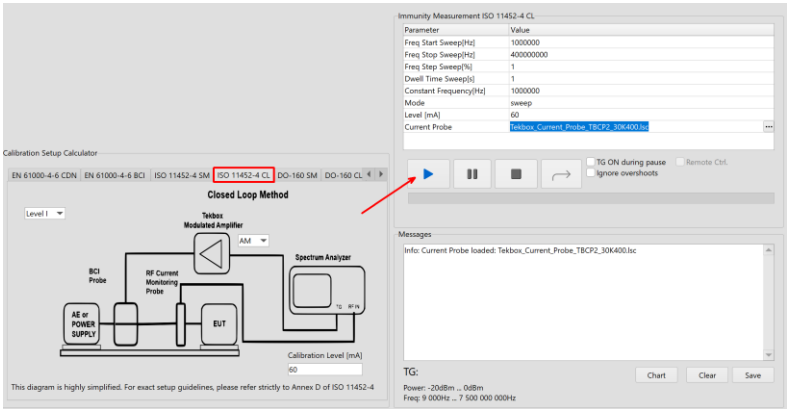
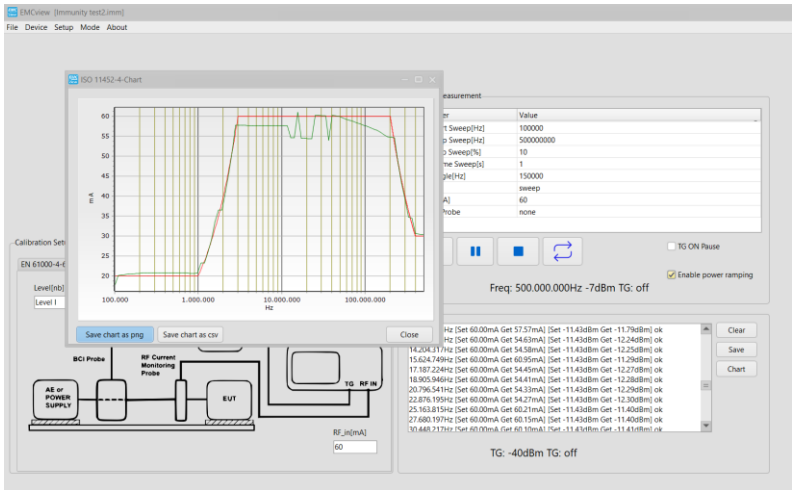


Figure12: EMCview implementation of ISO 41452-4 closed loop method; test setup

Select the RF current monitoring probe model and the other test parameters and press the Play button.
The injected current level will be displayed in a pop-up graph window.
The injected current may not be achievable for any frequency, especially if ungrounded EUTs are used. At parallel resonances of the cable, the impedance will become very high and maintaining the set current level might exceed the capabilities of the RF power amplifier. This is a common issue associated with the closed loop method. It is documented in the graph, which displays the actual injected current vs frequency. The graph can be saved as image or as CSV file.



Power Considerations:

It is hard to predict the required for any EUT. In case of remotely grounded EUTs, the common mode current can only flow via the parasitic capacitance of the EUT to the ground plane. Consequently, it requires high

power to inject current, especially, if the EUT is small. The value of the parasitic capacitance will then be very low as well.

7. History

Version	Date	Author	Changes
V 1.0	3.10.2026	Mayerhofer	Creation of the document