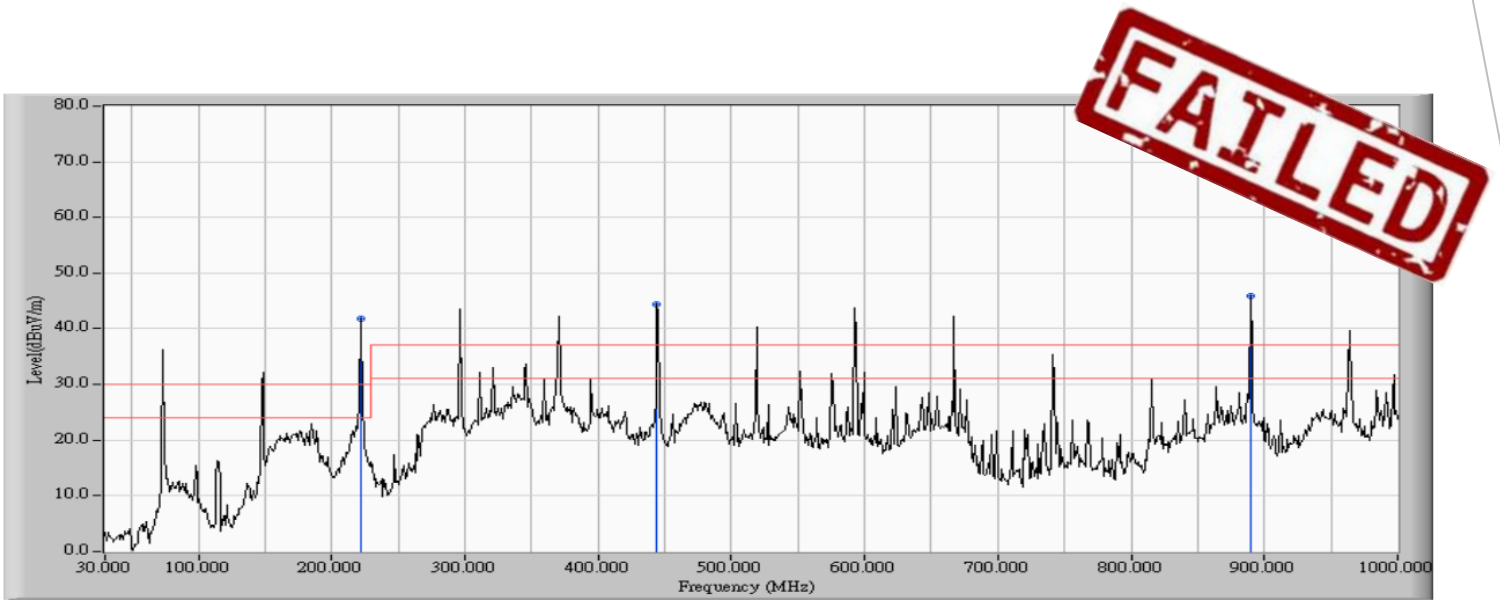
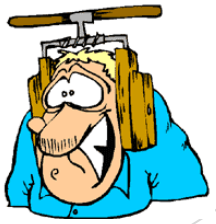
Failing EMC testing?



> 50% of products fail EMC testing first time around



Situation

An engineer of a small or medium size enterprise usually has to rely on his experience and on best practice methods in order to design an EMC compliant product.
Nevertheless, it is estimated that > 50% of products fail testing first time around. Anytime an engineer sends a new product for compliance testing, it is a shot in the dark.
Failing is very expensive. Not only that re-testing costs are high, but also the project schedule and market introduction gets delayed.

What to do?

Besides applying best practice with respect to all EMC related aspects of the design, it is essential to carry out pre-compliance testing

- **Pre – compliance testing in a test house**
- **Pre – compliance testing in-house**

EMC pre-compliance testing

Pre – compliance testing in a test house

Radiated emission tests are typically carried out in anechoic chambers, using antennas to pick up the radiated signals. Due to bandwidth limitations, several antennas are required to cover the complete frequency range. Furthermore, it requires much space and the cost of the equipment for a standard conformant setup is immense.

Advantage: standard compliant test set up and accurate measurement results
Disadvantage: very expensive; time consuming – a test house is not always around the corner and not any time available; quick modifications of the DUT can not be carried out as conveniently as in the own lab

Pre – compliance testing in-house

Advantage: there are solutions for any budget; convenient; modifications can be checked with respect to their effect on EMC immediately;
Disadvantage: depending on the available equipment, the set-up may not be standard conformant; measurement results may need to be considered being rather qualitative or relative than quantitative,
results must be interpreted carefully in order to develop countermeasures
historical data needs to be tracked to form meaningful limits on radiation

Tekbox EMC pre-compliance solutions

One of the key components for an in-house EMC compliance test set up is a spectrum analyzer. Spectrum analyzers have significantly dropped in price over the last years. Entry level models already start at approximately 1,5K USD. However price of the remaining equippment required for pre-compliance testing is still high.
In the laboratory of Tekbox, various EMC pre-compliance accessories were built over the years for the purpose of in-house testing. It significantly reduced our failure rate. Consequently we decided to industrialize our tools and to offer it at a very competitive price. With Tekbox products, EMC pre-compliance testing has become affordable for any company. A complete pre-compliance set up may cost less than repeating a failed EMC test at the test house.

Products:

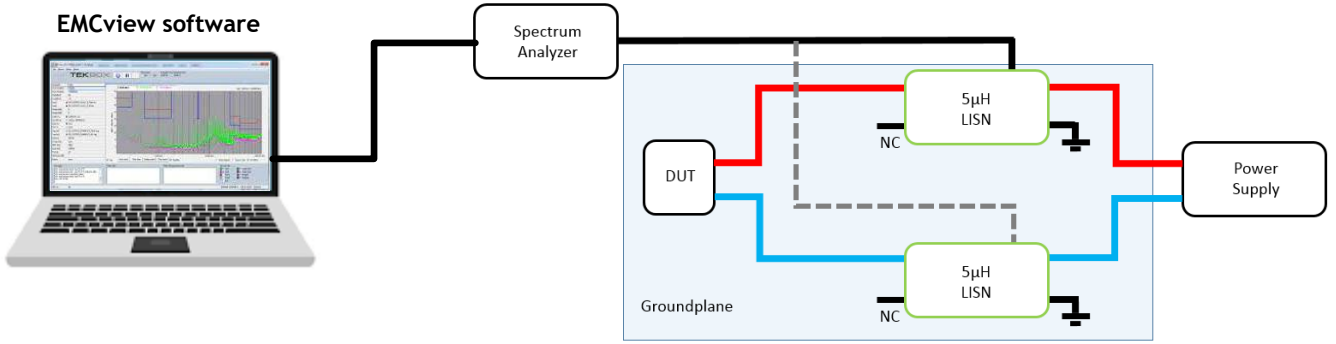
5µH LISN for conducted emission testing of DC powered equipment
50µH LISN for conducted emission testing of AC powered equipment
RF current monitoring probes for conducted emission testing on power, control or data cables
TEM cells in various sizes for radiated emission and immunity testing
Measurement antennas for various frequency ranges for radiated emission and immunity testing
EMC probe set to localize the origin of emissions or to localize the origin of immunity issues
Coupling / De-coupling networks for conducted immunity testing
Bulk current injection probes for conducted immunity testing
Modulated power amplifiers for immunity testing
Near field probes for localizing sources of radiation and immunity issues on PCB
EMCview software for CISPR 16 compliant measurements using spectrum analyzers

EMC precompliance test flow

- **Step 1: Conducted emission testing and improvement**
  Conducted emissions often go hand in hand with radiated emissions. Reducing conducted emissions also reduces radiated emissions
  Required equipment: spectrum analyzer, LISN, RF current monitoring probes
- **Step 2: Radiated emission testing**
  Check the radiated spectrum for spurious with excessive level
  Required equipment: spectrum analyzer, TEM cell, measurement antennas
- **Step 3: Localize the source(s) of excessive radiation and improvement**
  Scan the board with near field probes to track down the sources of radiation and apply countermeasures
  Required equipment: spectrum analyzer, RF near field probes
- **Conducted immunity testing and improvement**
  Required equipment: RF signal generator, Modulated power amplifier, CDN or BCI probe
  alternatively: Spectrum analyzer tracking generator substituting RF signal generator
- **Step 4: Radiated immunity testing**
  Required equipment: RF signal generator, Modulated power amplifier, TEM cell
  alternatively: Spectrum analyzer tracking generator substituting RF signal generator
- **Step 5: Localize the origin of immunity issues and improvement**
  Feed the near field probes with an RF signal and scan the board to track down the origin of immunity issues; apply countermeasures
  Required equipment: RF signal generator + (RF power amplifier) + EMC near field probes
  alternatively: Spectrum analyzer tracking generator driving TBMDA1

Conducted emission testing

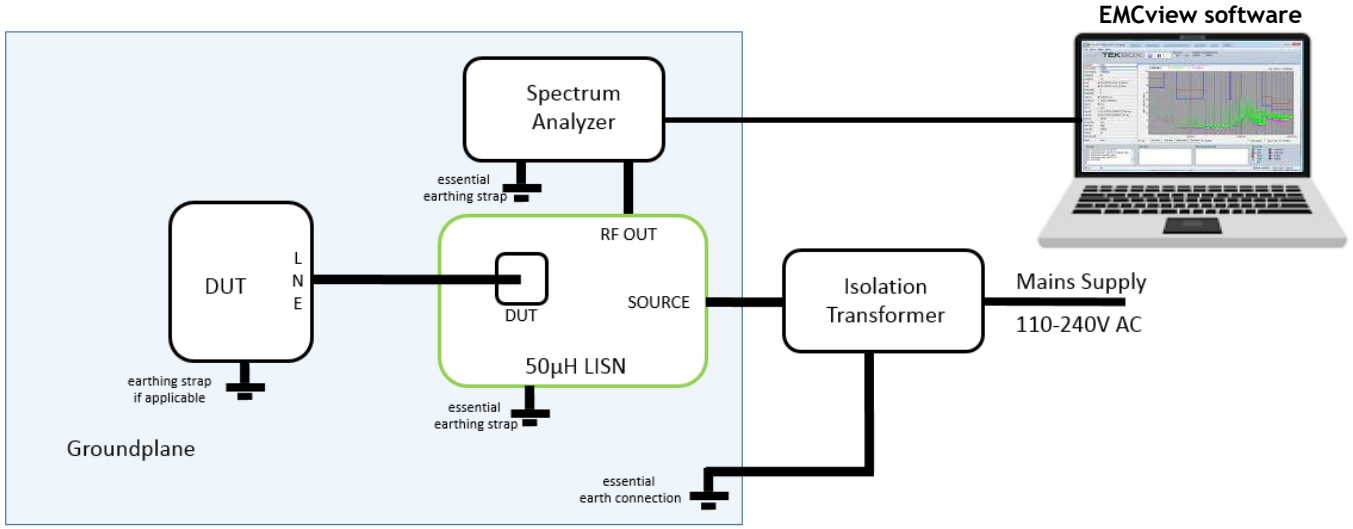
Setup for conducted emission testing of automotive equipment (e.g. CISPR25)



The DUT shall be isolated and elevated from the groundplane. The spectrum analyzer shall measure the conducted emissions on both supply lines. The RF output of the unused LISN shall be terminated with 50 Ohm. If the power return line is less than 200 mm, a set up with a single LISN is sufficient. For the exact details of the set up and for the limits of conducted emissions refer to the CISPR 25 or relevant applicable standard.

Conducted emission testing

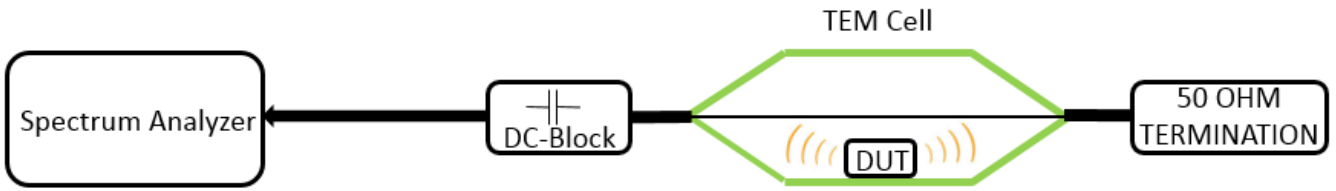
Setup for conducted emission testing of AC-powered equipment (e.g.CISPR16)



The DUT shall be isolated and elevated from the groundplane. The spectrum analyzer shall measure the conducted emissions on both line and neutral.
The value of the parallel combination of the capacitors is 12µF from line and neutral to ground. This causes around 0.75A flowing into the earth connection and would trip the ground fault switch. Hence, an insulation transformer is required and good grounding is essential for safety.
For the exact details of the set up and for the limits of conducted emissions refer to the CISPR 16 or other relevant applicable standard. A built in limiter or a limiter between the LISN RF output and spectrum analyzer is essential for the protection of the equipment.

Radiated emission testing

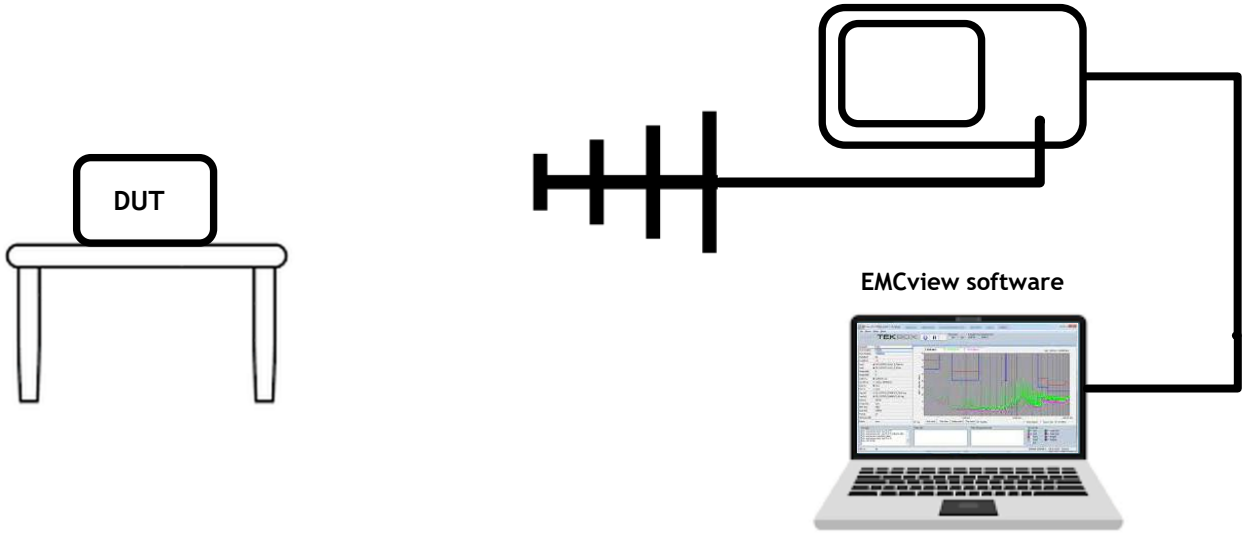
Setup for radiated emission testing



Terminate any of the two ports of the TEM cell with the 50Ω load, connect the DC-Block to the other port and connect it to the input of the spectrum analyzer. Place the DUT under the septum and power it on.
Monitor the radiated spectrum.
As a rule of thumb, given that the PCB is positioned not much higher than 1-2cm above the bottom wall, any spurious with amplitudes higher than 40dμV may potentially cause a failed compliance test.
Use compliance tested DUTs and the corresponding test reports as a reference for measurements in the TEM cell.
Read chapter 3 of https://www.tekbox.com/product/QA_OpenTEMCells.pdf for more information on conversion of measurement results.
Affordable Tekbox measurement antennas complement TEM cell measurements for an optimum approach to pre-compliance radiated noise testing.

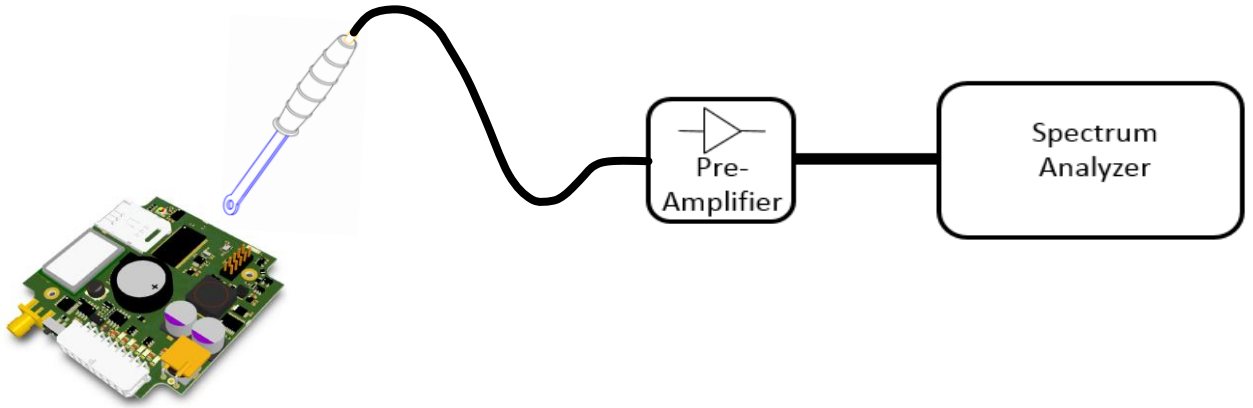
Radiated emission testing

Radiated emission testing using measurement antennas and EMCview



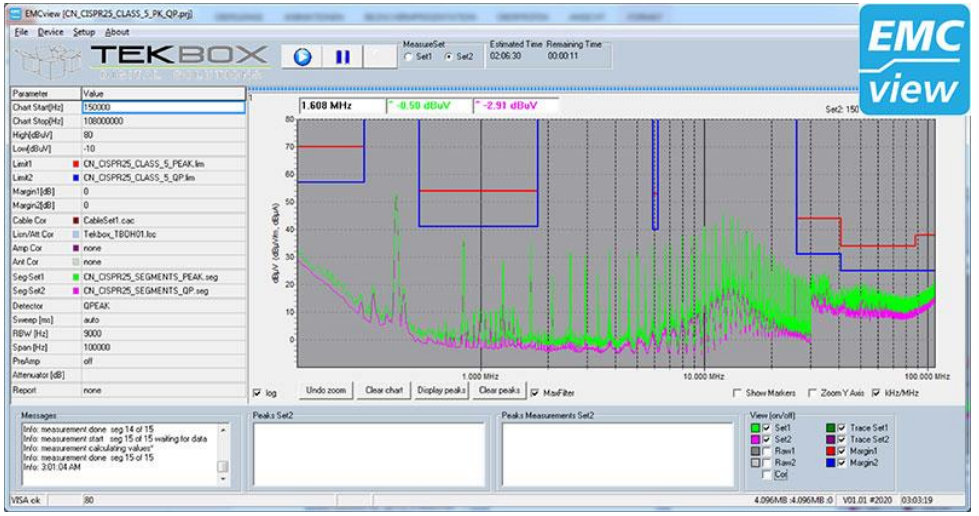
Use EMCview to apply the antenna factors to the measured spurious levels

Localizing the source of emissions



Localize the source of unwanted emissions on the DUT PCB using near field probes and a spectrum analyzer.
Implement counter measures and re-test the DUT inside the TEM cell to verify if the modifications result in a reduction of the radiated emissions

Simplify testing with EMCview

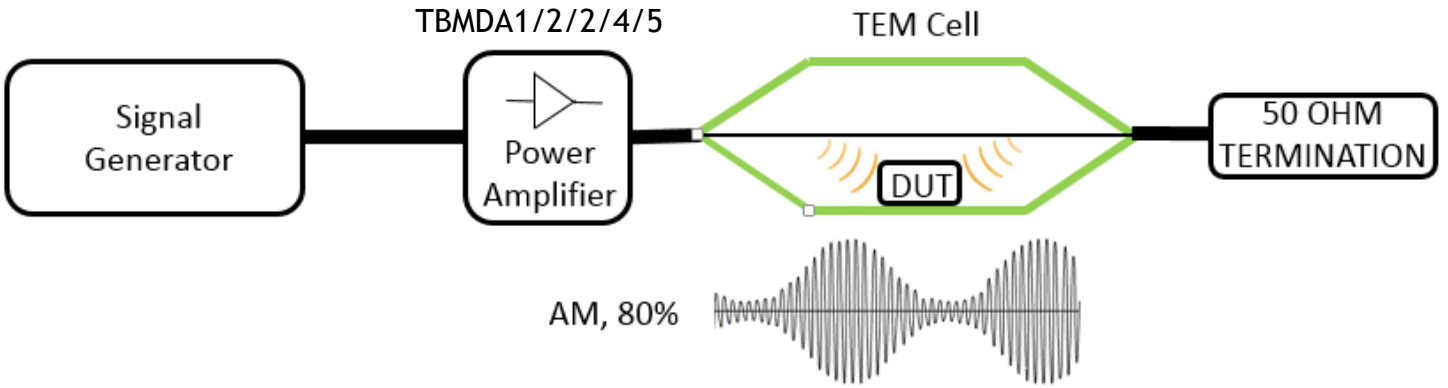


- numerous pre-configured project files for CISPR-xx (EN550xx) emission measurements
- Graph supports two complete measurement runs, same as in test house
- fast Quasi-Peak scan of critical peaks, immune to frequency drift of the selected peaks
- configurable limit lines and segment files
- configurable correction files for cable, LISN, amplifier, antenna etc.
- configurable margins for the identification and selection of critical peaks
- supports import and overlaying of reference measurements for comparison purpose
- linear or logarithmic frequency axis
- automatic creation of test reports
- many import/export-functions
- Selective measurement of frequency segments
- RF-coverage measurement mode
- modifications result in a reduction of the radiated emissions

Supports all Rigol and Siglent spectrum analyzer models. Support for Rohde & Schwarz FPC and FPH series. Support of Owon analyzers.
Check our website for the latest list of supported analyzers and for the latest EMCview version.

RF immunity testing

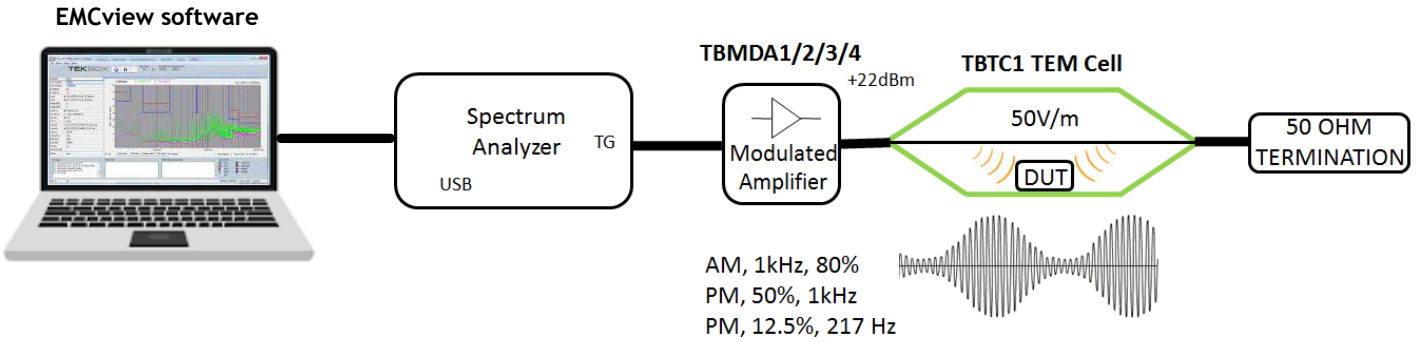
Setup for RF immunity testing



Terminate any of the two ports of the TEM cell with the 50Ω load, and connect the signal generator + power amplifier to the other port. The signal needs to be AM modulated (80%) according to most standards. The power of the signal has to be chosen according to the required field strength. Place the DUT under the septum and power it on.
Sweep the signal generator and monitor the DUT for RF immunity issues.
The picture above shows a minimum setup. Inserting a directional coupler with connected RF power meter in between power amplifier and TEM cell would be of advantage to monitor power levels.
Depending on selected TEM cell and Tekbox modulated power amplifier, field strength of up to 600V/m can be generated.

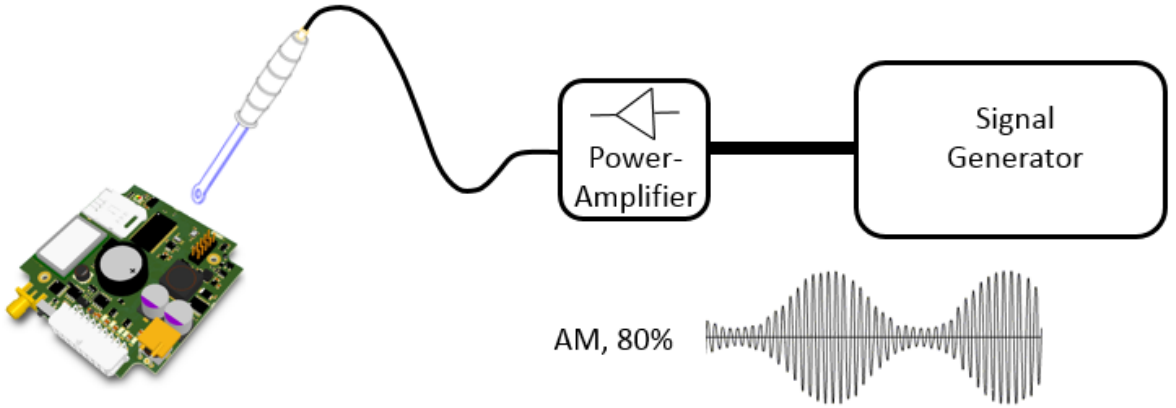
Radiated immunity testing

Alternative set up for RF immunity testing using a tracking generator as signal source



EMCview can also be used to control the tracking generator of spectrum analyzers. Various modes such as manual frequency stepping, fixed frequency, frequency sweep with configurable step size and dwell time and more enable versatile control of the tracking generator.

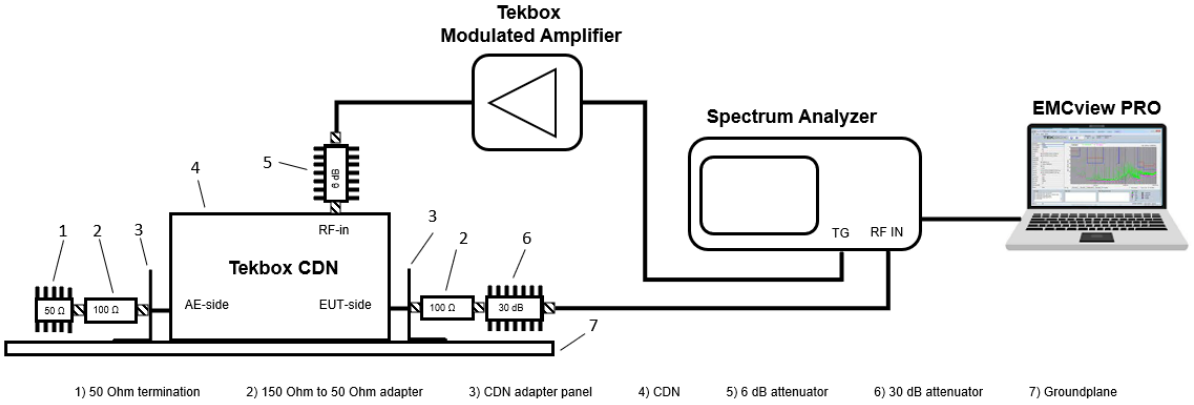
Localizing the origin of immunity issues



Localize the section on the DUT PCB which is susceptible to RF.
Use a power amplifier only, if the output power of the Signal generator alone was not sufficient to reproduce the immunity issue.
Implement counter measures and re-test the DUT inside the TEM cell to verify if the modifications removed the RF immunity issues.

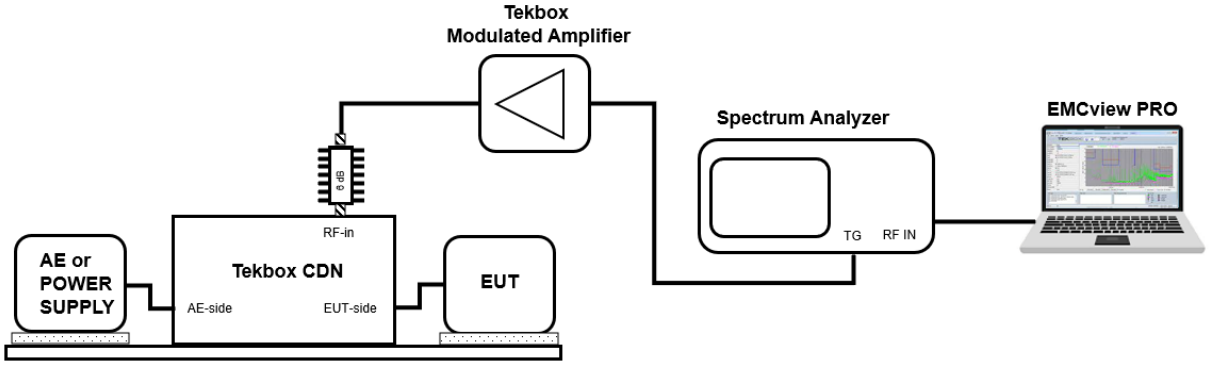
Conducted immunity testing using CDNs

Conducted immunity calibration set up using EMCview PRO



1) 50 Ohm termination 2) 150 Ohm to 50 Ohm adapter 3) CDN adapter panel 4) CDN 5) 6 dB attenuator 6) 30 dB attenuator 7) Groundplane

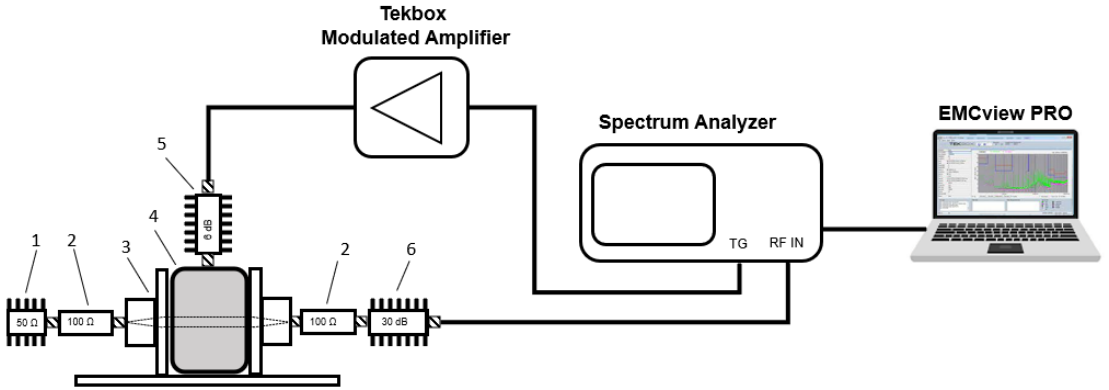
Conducted immunity measurement set up using EMCview PRO



Use EMCview Pro to calibrate the set up and run the immunity test.

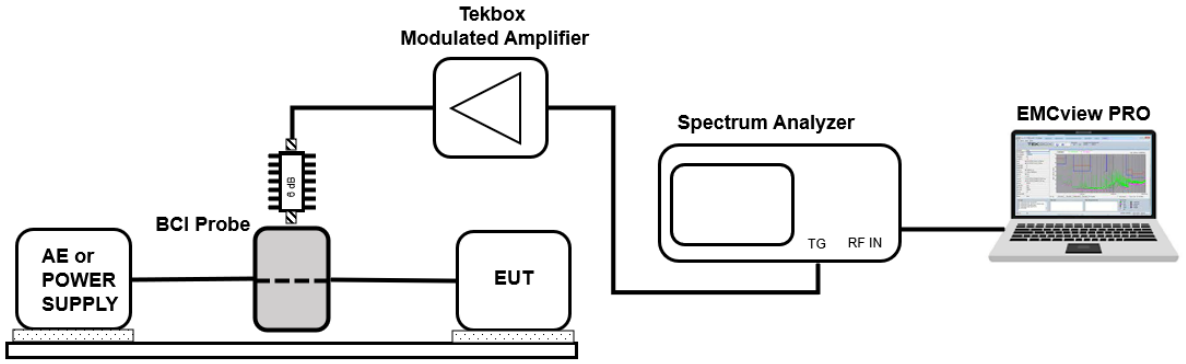
Conducted immunity testing using BCI probes

300 Ohm loop BCI calibration set up using EMCview PRO



1) 50 Ohm termination 2) 150 Ohm to 50 Ohm adapter 3) BCI probe calibration fixture 4) BCI probe 5) 6 dB attenuator 6) 30 dB attenuator

Conducted immunity measurement set up using a BCI probe and EMCview PRO



Use EMCview Pro to calibrate the set up and run the immunity test.

Further details can be found in our product manuals and application notes on www.tekbox.com