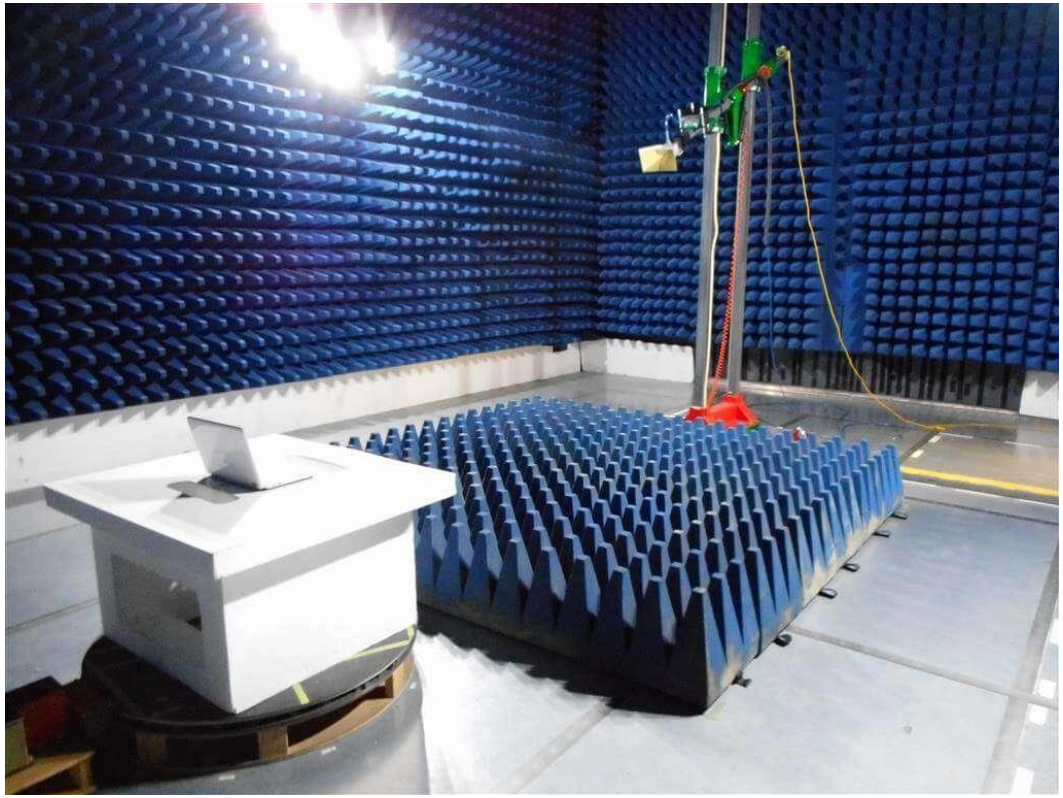
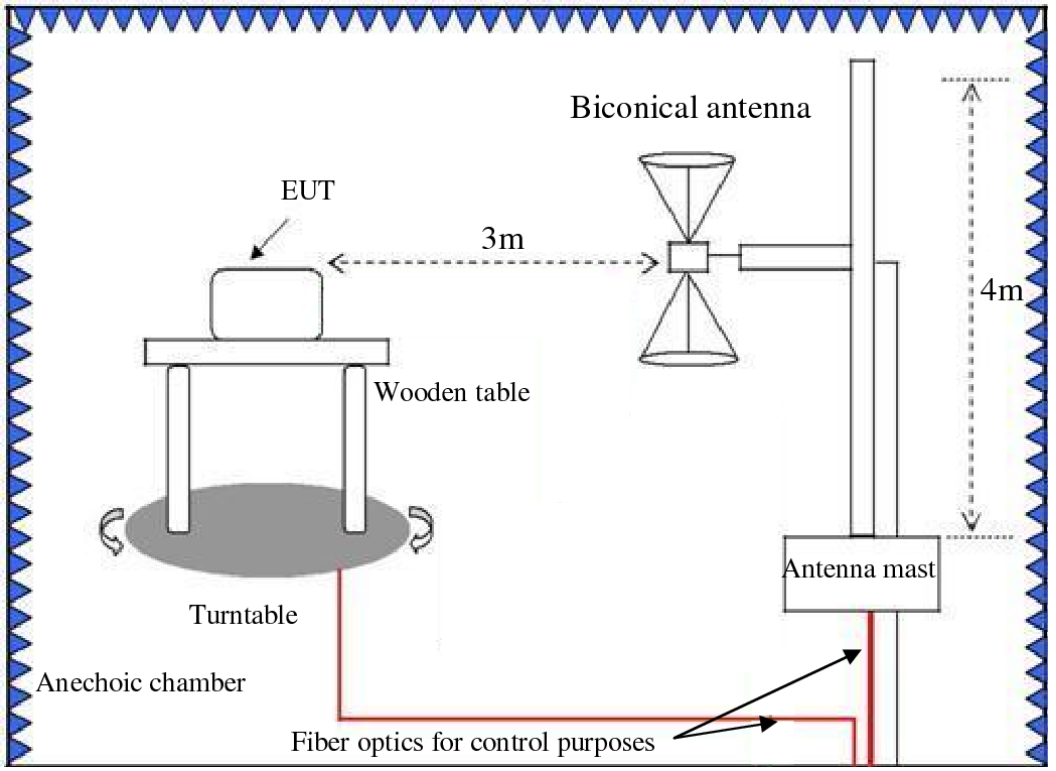
Radiated emission testing



Radiated emission testing
CISPR xx, except CISPR 25

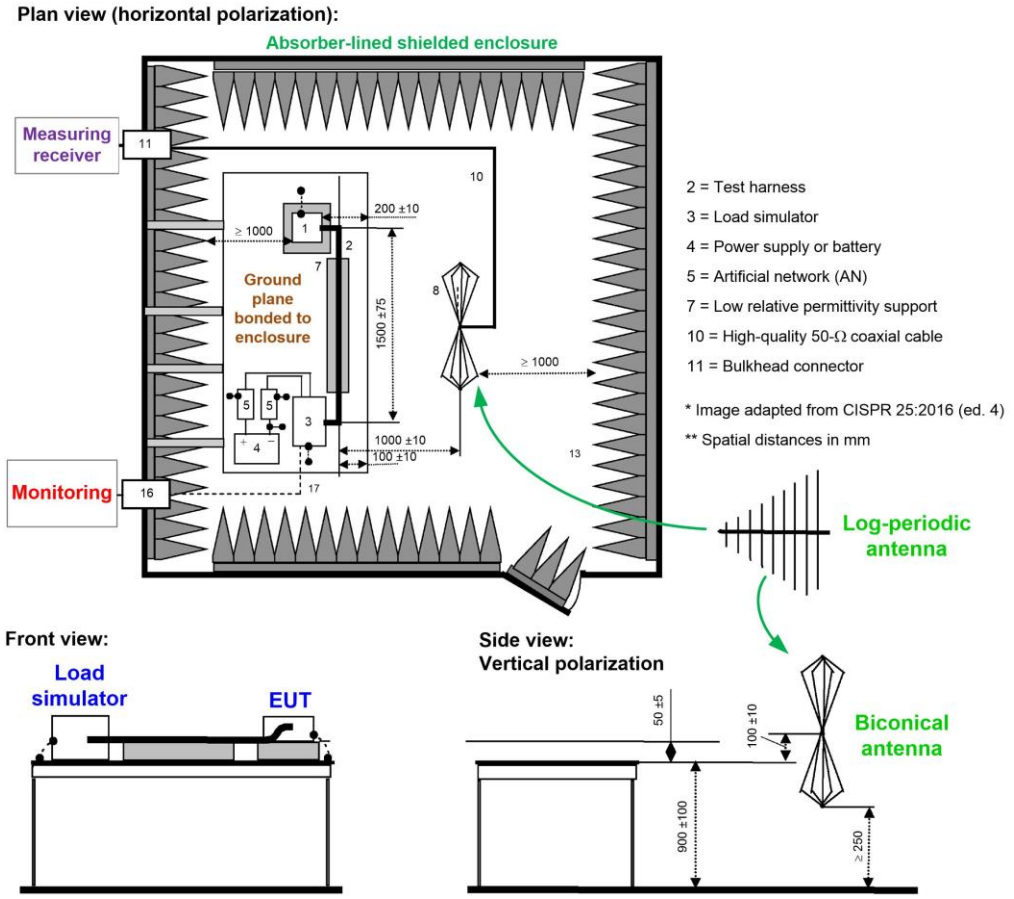
- **3m distance**
- **Variable antenna height, 1m - 4m**
- **Rotating table**



Tests with 10m or 30m antenna spacing are typically carried out in OATS (open area test sites)

Radiated emission testing
CISPR 25

- **Fixed height, 1m**
- **Fixed distance, 1m**
- **Fixed table**



Radiated emission testing antennas

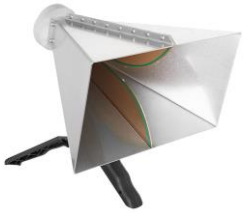
CISPR band	Frequency range	Resolution bandwidth	Antenna
A	9 kHz – 150 kHz	200 Hz	loop, LLA
B	150 kHz – 30 MHz	9 kHz	Monopole, loop, LLA
C	30 MHz – 300 MHz	120 kHz	Biconical, bico-log
D	300 MHz – 1 GHz	120 kHz	Log-periodic, bico-log
E	> 1 GHz	1 MHz	horn

TBMA6-P

TBMA1

TBMA2

TBMA3



TBMA4

V1.0 Pre-compliance radiated emission testing approaches

The main obstacle with pre-compliance radiated emission testing is the unavailability of an anechoic chamber.

Setting up an antenna in the lab: high ambient noise levels, reflections can cause measurement errors up to 20 dB

Setting up an antenna in the open area: good measurement accuracy can be achieved, however high ambient noise levels; solution for the ambient noise problem is needed.

Pre-compliance radiated emission testing
Ambient noise reduction

- Lab environment: reflection may cause errors up to 20 dB; use a characterized comb generator as reference
- Try various locations: flat roof, empty parking space, field.
  Rural environment is always better compared to urban environment
- Power supply availability: UPS; battery & inverter; handheld analyzer
- Shorten measurement distance
- Use the TEM cell to get a spectral plot upfront to a OATS measurement

V1.0 Pre-compliance radiated emission testing
Shorten measurement distance

Shortening the measurement distance offers a relatively simple way to increase the measured emission's signal strength. Moving the receiving antenna closer to the EUT increases the EUT's emission strength relative to the ambient signals and noise by the square of the difference in distance from the EUT to the antenna.

For example, at frequencies of 30 MHz and above, where electric fields dominate the measurement, a 20-dB-per-decade-of-distance rule applies. Thus, cutting the measurement distance from 30 m to 10 m will boost the EUT's emissions by nominally 10 dB. Similarly, path reductions from 10 m to 3 m and 3 m to 1m will each yield additional 10-dB gains. Below 30 MHz, where magnetic fields dominate, a 40-dB-per-decade-of-distance rule applies, so that respective reductions in the measurement distance would each yield 20-dB gains.

EMC engineers often reduce measurement distance when measuring a very “quiet” EUT. Of course, if the receiver detects only ambient noise—and no EUT emissions—as the antenna gets closer, then the EUT's emission are so low that it easily will meet regulatory emissions requirements.

If you move the receiving antenna to a distance less than 1 m from the EUT, you'll introduce new measurement problems caused by nonlinear near-field effects. Near-field effects make it difficult, if not impossible, to extrapolate the emission signal's strength to the original measurement distance.

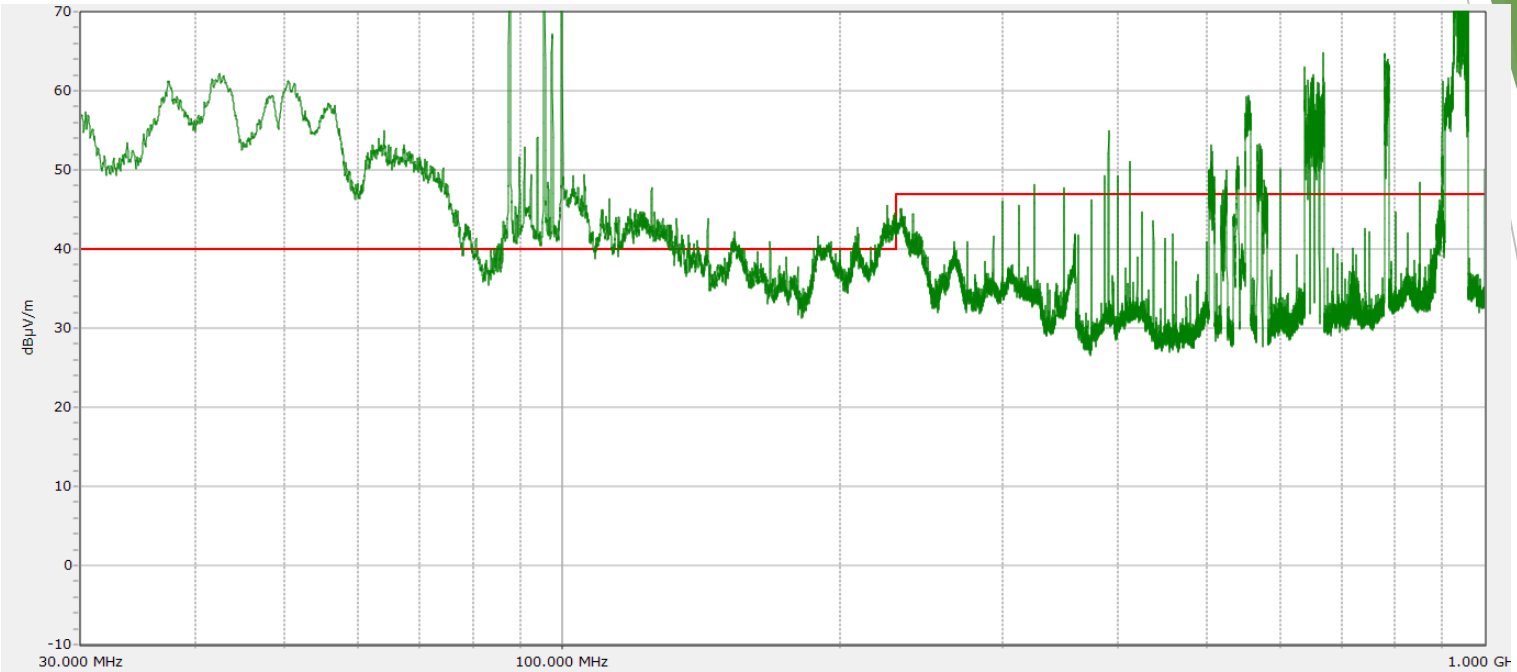
V1.0

Pre-compliance radiated emission testing
Ambient noise example, EUT off

Ambient noise, lab room, TBMA1 antenna
With every scan, spurious disappear and new spurious pop up
The scan was taken at night, during day it is even worse

V1.0

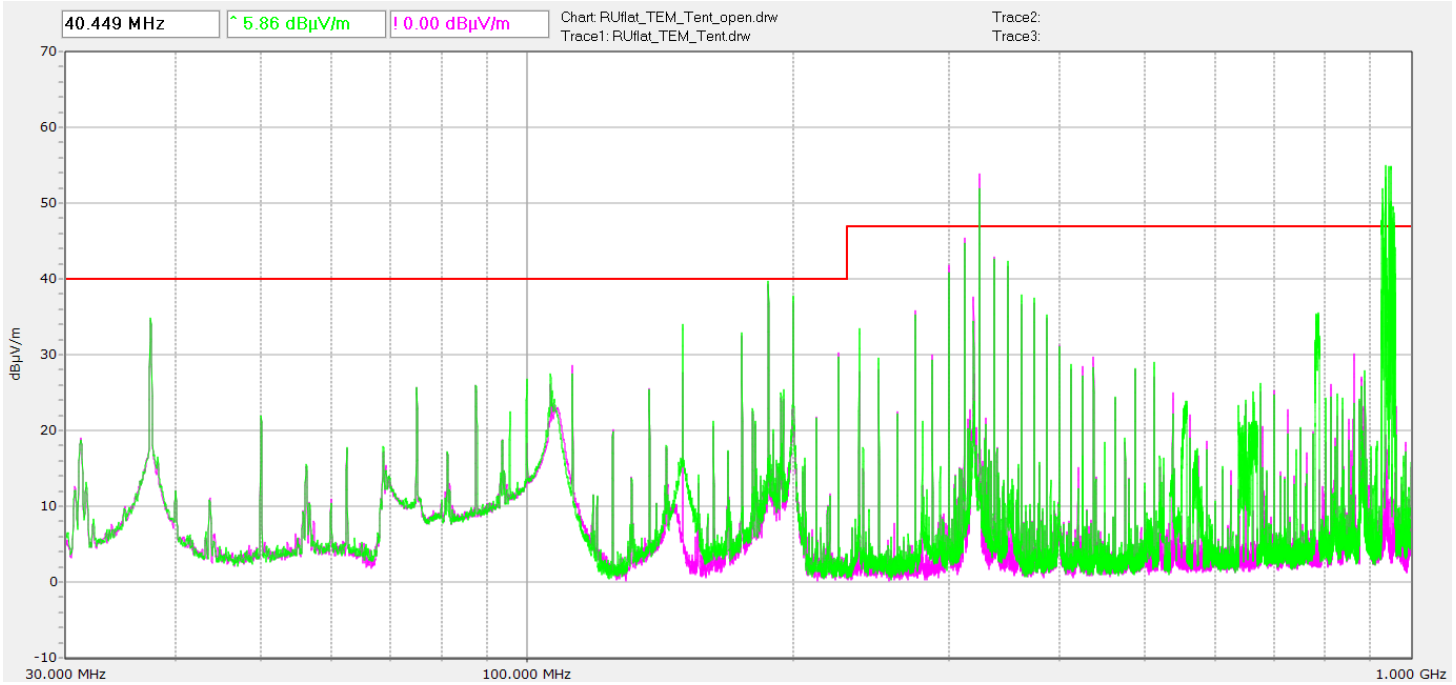
Pre-compliance radiated emission testing
Ambient noise example, EUT on



Ambient noise, lab room, TBMA1 antenna
It is difficult to differentiate ambient noise from EUT emissions

V1.0 Pre-compliance radiated emission testing TEM cell measurement, EUT on

Spectral plot of EUT in TEM cell as reference for open area measurement

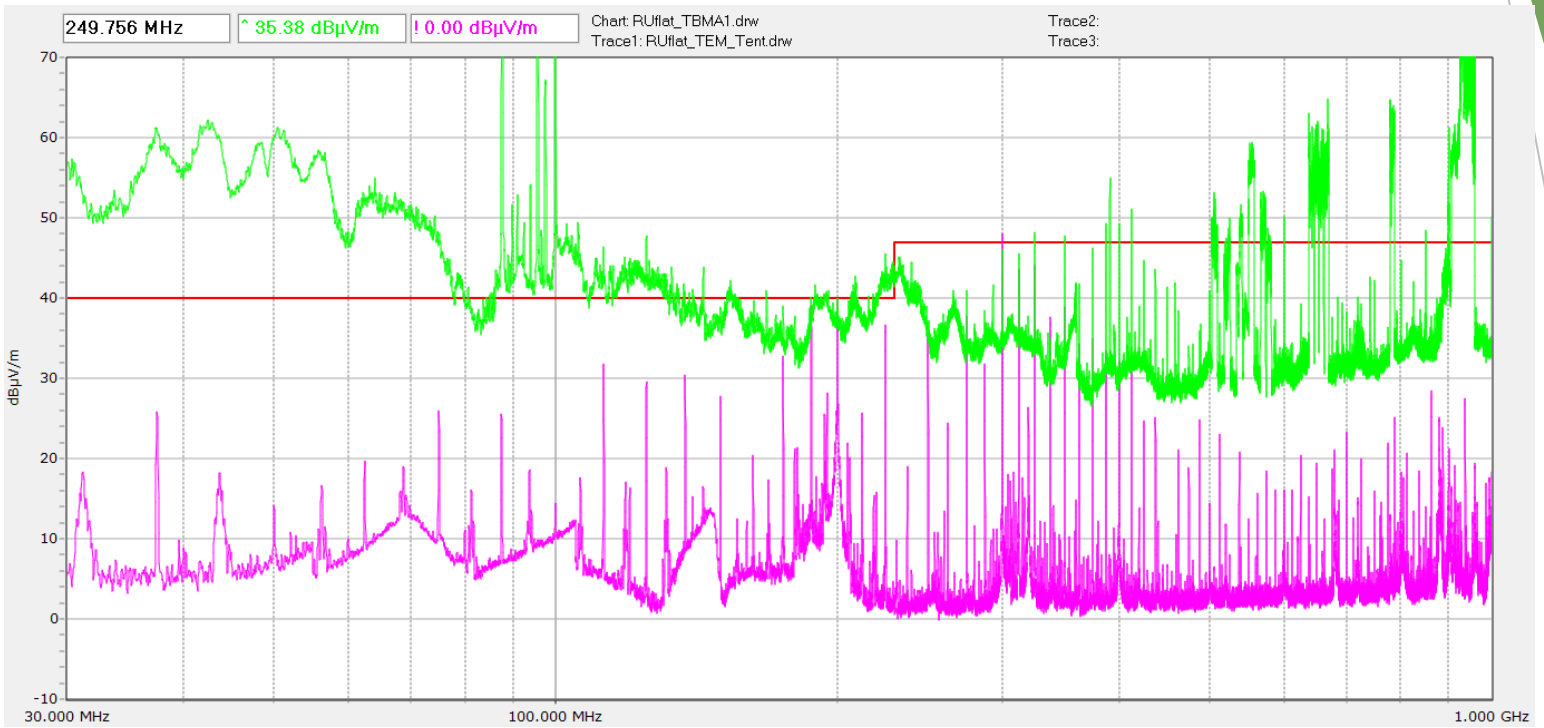


Green: TEM cell not shielded
Pink: TEM cell inside shielded tent

V1.0

Pre-compliance radiated emission testing
TEM cell versus OATS measurement

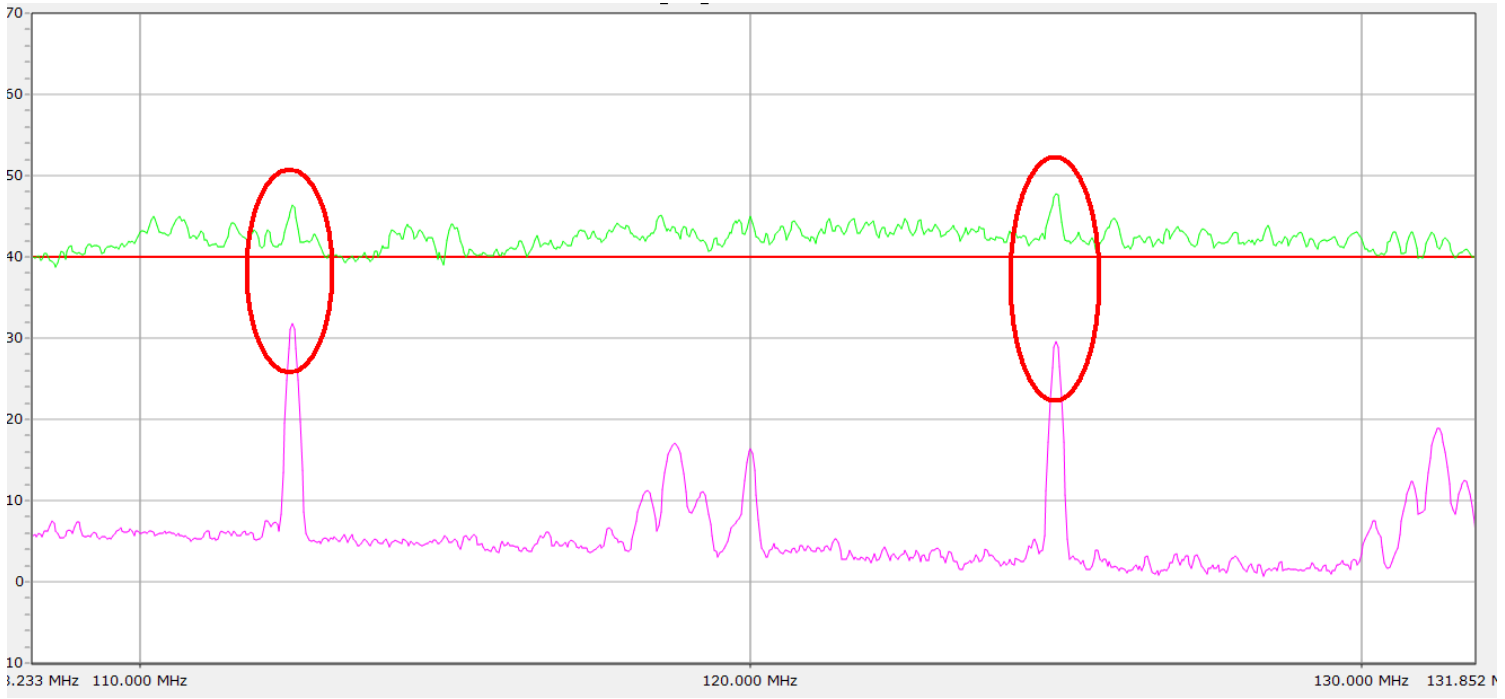
Spectral plot of EUT in TEM cell as reference for open area measurement



Green: OATS measurement
Pink: TEM cell measurement

Pre-compliance radiated emission testing
TEM cell - OATS comparison 1

Zoom into the graph to identify EUT spurious, which exceed the limit

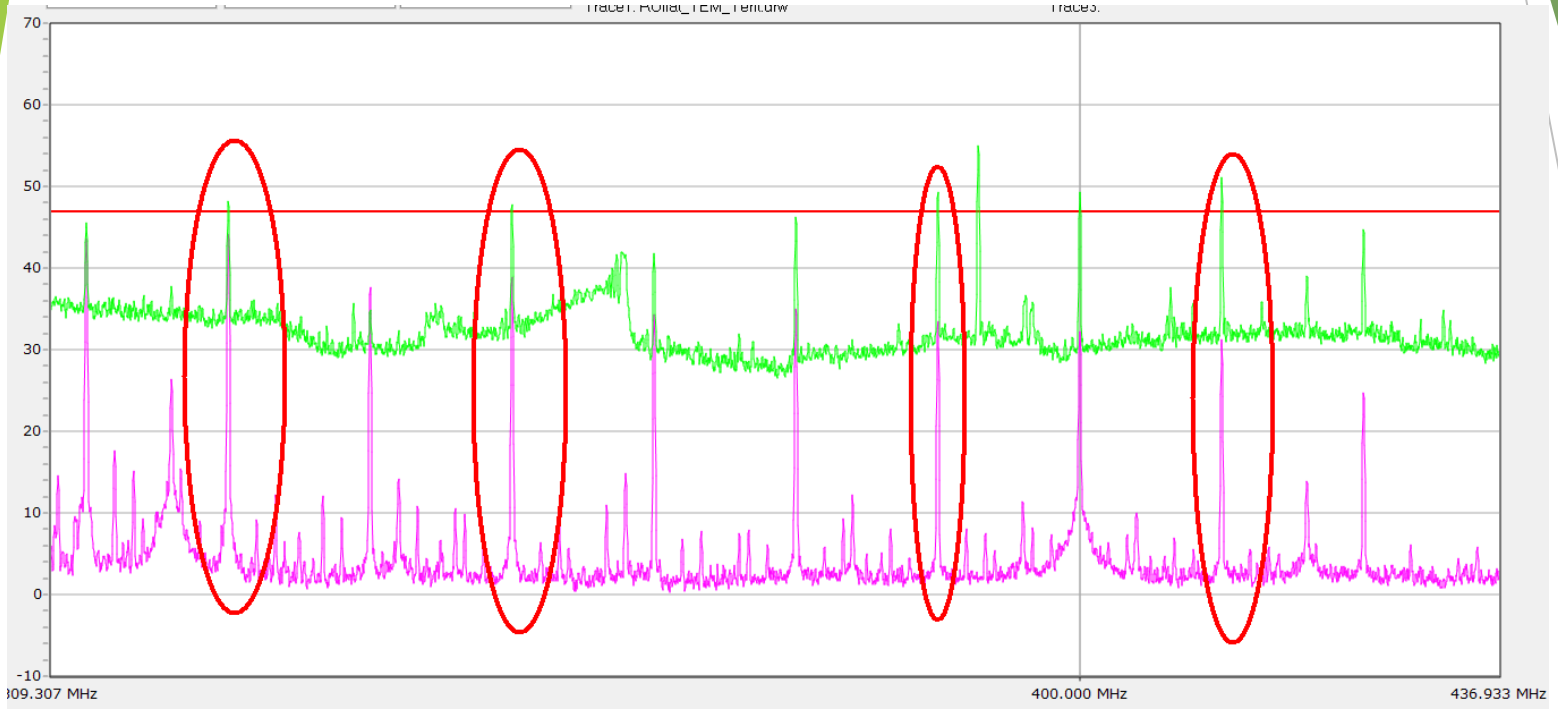


Green: OATS measurement
Pink: TEM cell measurement

V1.0

Pre-compliance radiated emission testing
TEM cell - OATS comparison 2

Zoom into the graph to identify EUT spurious, which exceed the limit



Green: OATS measurement
Pink: TEM cell measurement

Pre-compliance radiated emission testing
Summary / Procedure

1. Lab measurement of the EUT emissions in the TEM - cell
2. Measure the EUT emissions with the antenna in an open area
3. Compare the measurements to identify critical spurious
4. Return to the lab and try to improve the EUT. Use the TEM cell to track emissions after modifications.
5. When you think that the EUT is sufficiently improved, return to the open area and measure the emissions with the antenna
6. Continue with step 3 and repeat the process, until all spurious are below the limit

The TEM cell is one of the most versatile tools for EMC pre-compliance testing and debugging