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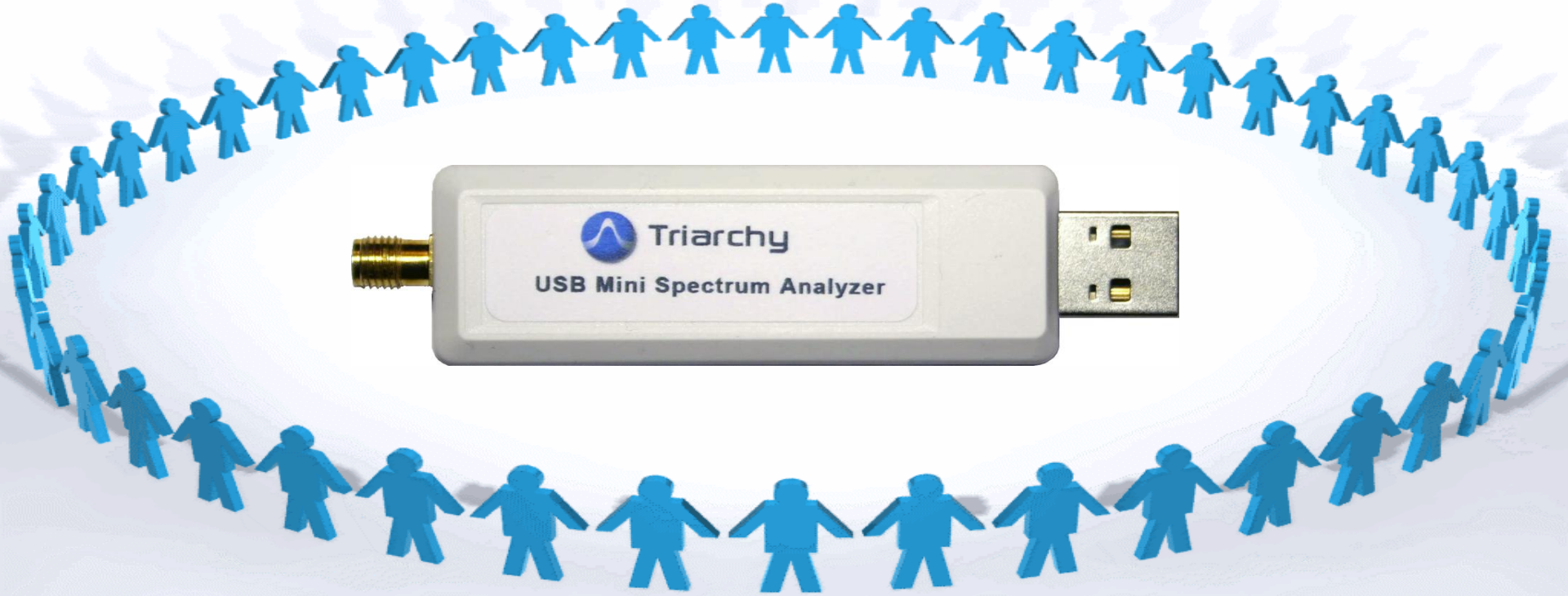
EMC pre testing with TSA USB mini spectrum analyzer and TNP6Gx near field probe



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EMC testing for CE&FCC

- Pre testing of EMC
- EMC standard overview
- Conductive EMC test
- 3m or 10m Field test for reference level
- Testing in Shielding box
- Near field testing with TNP6Gx
- 3m or 10m Field test for final checking

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Pre testing of EMC

- Most large quantity products need to do approval test. An area of difficulty is EMC
- Approval test in a certificated test lab is expansive. Failure of approval test results in extra cost of repeat testing.
- To prevent extra costs incurred by failing the approval test. A pre-test is important to make sure that your product can passed the test before submission to test lab. This is the cost effective way to handle the approval test.

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Pre testing of EMC

- It is still expensive to send your product to test lab for preliminary tests, and Some company do not have RF test lab with chamber or RF equipment; Acquiring those equipment requires a large initial investment.
- *TSA USB mini spectrum analyzer* and *TNP6Gx* offers a low cost solution to your pre-testing needs.

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EMC test standard overview

- Most popular standards are the American FCC and the European CE. Standards vary by country; for example, Canada has the IC Standard.
- FCC part 15 is related to the EMC item. Specific subparts being tested depend on your product.
- For the CE, the EMC item can be found at EN55011.
- Some products follow special requirements, you need check those based on your product.

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EMC test standard overview

- Normal test frequency band will be:

1) 9KHz ~30MHz

2) 30MHz to 1000MHz

3) 1GHz up to 6GHz or 12GHz

- Please check the specific Standard to get the detailed and up to date requirements, on frequency bands and their passing levels.
- You can also contact test lab doing the approval tests. Check with them about the requirements before you send products to them for testing.

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Conductive EMC test

- Directly connect tested product （UUT） to *TSA USB mini spectrum analyzer's* input SMA connector.
- Try to find a reference frequency point to measure, such as LO signal and its harmonic crystal frequency and its harmonic.
- If the signal is large at the reference frequency point, try to find the reason, then figure out a way to solve the issue.
- Our USB Mini Spectrum Analyzer model *TSA5G1* can measure from 1MHz to 5350MHz, and model *TSA12G5* can measure from 4900MH to 13500MHz. The measured signal level can be low as -90dBm.

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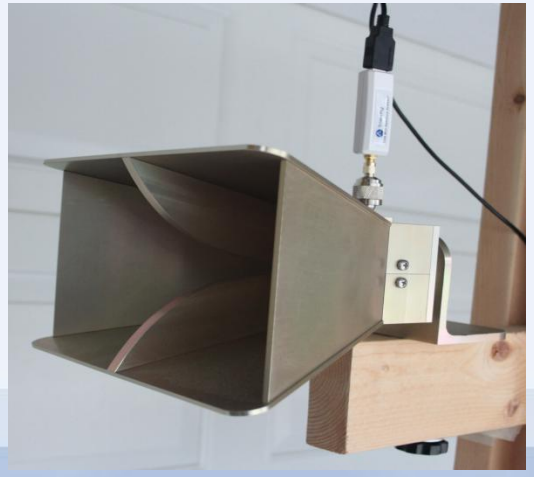
EMC wide band antenna

- If you want to setup a 3m field test, you will need a wide band antenna.
- The Standard EMC wide band antenna will be:
  - Log periodic antenna for below the 1GHz
  - Horn antenna for above the 1GHz
- TSA Spectrum Analyzers can directly connect to antenna to eliminate cable loss.



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3m and 10m field test for reference level

- Normally, it would require a RF chamber to do field test. If test occurred at an open area, there will be a lot of interference signal. you may not be able to differentiate between signals from UUT or from outside interference.
- To do this with out a RF Chamber, you need to setup testing in a shielding box. try to find which frequency has large emission. Then, only test those few points at open field area with 3m or 10m. This way, you can avoid the interference of outside signal from air. It is need to get a reference level for operating inside a shielding box.
- For example: if you need to test FCC 15.427, the requirement is that limit will be 54dBuv/m above the 1GHz.
- Using Horn antenna to connect *TSA5G35 USB Spectrum Analyzer* at 2GHz or 4GHz, using whip antenna to connect to RF signal generator at 3m to simulate the UUT. To fine tune the output level of RF the signal generator, make sure that received the signal level is at 54dBuv/m to match FCC requirement. The resulting output level of RF signal generator is the reference level = Lref (it may be -40dBm), which will represent the UUT maximum emission. If UUT signal level is larger than the Lref, the product will fail FCC. The circuits need modification to reduce emission.

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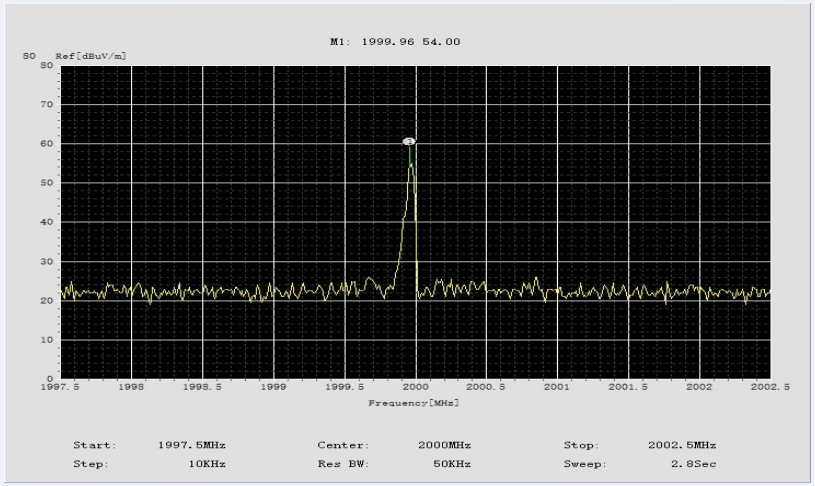
3m and 10m field test for reference level



For frequencies below 1GHz :

Frequency of Emission (MHz)	Field strength (microvolts/meter)	Field Strength (dB microvolts/meter)
30 – 88	100	40.0
88 – 216	150	43.5
216 – 960	200	46.0
Above 960	500	54.0

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Testing in Shielding box

- A shield box is a cheaper alternative to RF chambers. If you need a even cheaper solution, you can modify an microwave to serve as an shield box. Note that the microwave will be unable to used for its original purpose after the modifications, so it's recommended that you use an old microwave.

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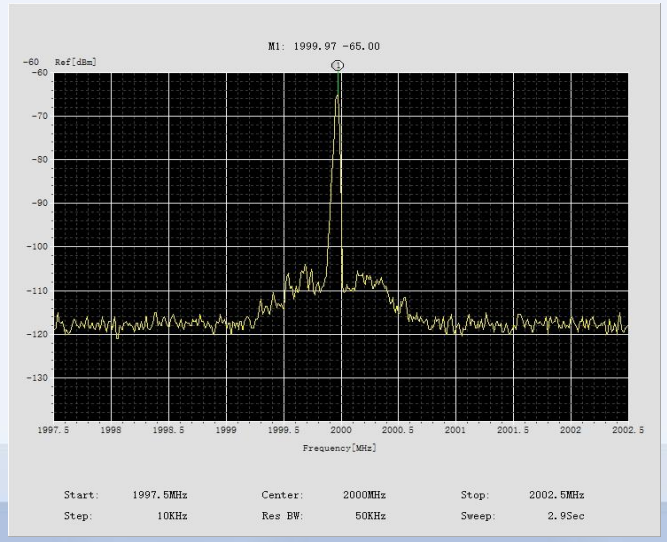
Testing in Shielding box

- Put two antenna into the shielding box, one is connected to a RF signal generator, another antenna connect to the *TSA5G35 USB Spectrum Analyzer*.
- Set RF signal generator output level at Lref (-40dBm), this antenna will simulate the UUT emission at shielding box.
- TSA5G35 will receive the signal from antenna with Lref signal. Test signal level and record it as reference Sref, .
  In this case, Sref=-65dBm.



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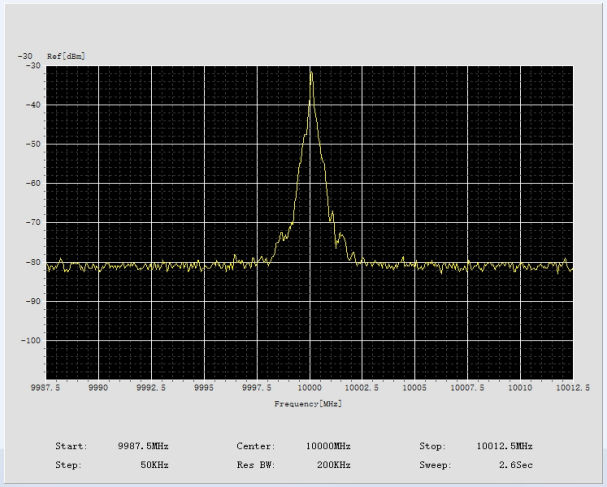
Testing in Shielding box

- Remove the one antenna, and put UUT into the shielding box.
- Test all the band, and compare the signal level with Sref.
- If the singal is larger than Sref, there must be a problem. If the signal is close to the Sref, it still require attention.
- Record the each emission point, then study them at near field testing with TNP6Gx probe.



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Near field test with TNP6Gx

- From the shield box testing, you can get an idea of which point will be not passed, which point will be marginal.
- Use the *TNP6Gx near field probe* to study which location or which component or circuit causing the problem.
- If the frequency is larger than 1GHz, use 10mm stub probe or 5mm stub probe.
- If frequency is lower than 100MHz, use 40mm loop probe or 15 mm loop probe.
- If frequency between 100MHz to 1GHz, you can use both stub and loop probe.
- Try moving the probe while positioned close to the circuit. Find biggest signal, after moving the probe, you can find which location has large emissions.

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Near field test with TNP6Gx

- The shielding gap will sometimes cause emission. Change the shielding configuration, and soldering point to reduce the emission
- Some interface wire from shielding box will cause emissions, try to add small cap in to circuit. Please note: when frequency is high, the decoupling cap value will be reduced. For example 900MHz will be around 10P, 2.4GHz will be 6.8P, and 5.8GHz will be 3.9P or smaller.
- Most RF emission comes from power line, try to add inductor or ferrite bead in the power line. It’s not easy to eliminate RF emission from RF amplifier power, try to use PCB inductor to block the emission.
- The clock circuit is another emission source at low frequency, try to avoid placing long PCB trace at top layer.

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Near field test with TNP6Gx

- When you are using the stub probe, you need to try different directions. Emission signal sometimes will be significant only a particular direction. The RF test lab will be using a turning table which will be able to find emission from every possible direction.
- After you find a large emission point, try to modify the circuit to improve it. The process can be difficult. Change the component, such as RF amplifier, harmonic is very large for certain components; add cap and inductor; change the PCB layout; some trace can go into mid layer instead of top and bottom layer; Increase the ground; Using multi layout PCB can improve the EMC issues.

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Near field test with TNP6Gx

- If you do not have the conditions to setup 3m or 10m field test and shielding box test, the near field test is still help you to do pre EMC test.
- You need a passing golden sample, then try to do a comparison test. You also need to know some critical points, such as transmitter harmonic, LO signal, crystal frequency. Try to compare those critical points.
- Even if you don't have golden sample, you can still roughly test the EMC standards. using a10mm stub probe from the *TNP6Gx set*, if you find the signal is close to -30dBm, it will definitely not pass the FCC. If the signal is larger than -40dBm, it will likely not pass. If the signal is smaller than -60dBm, it may pass, having smaller emissions.

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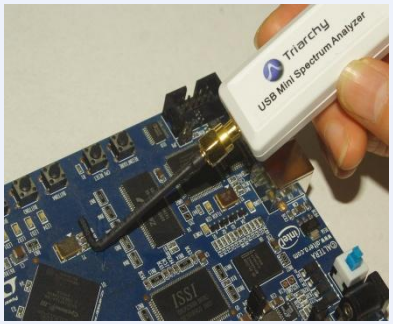
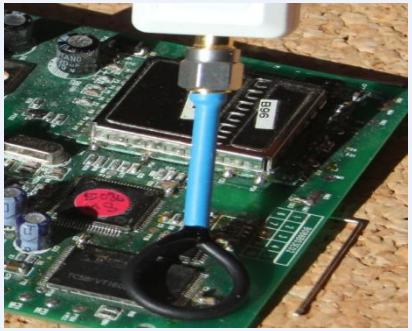
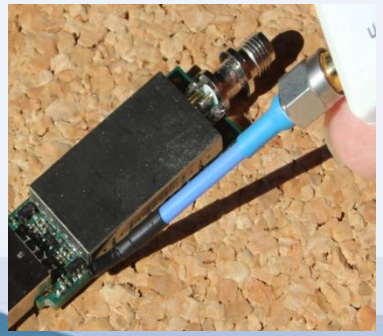
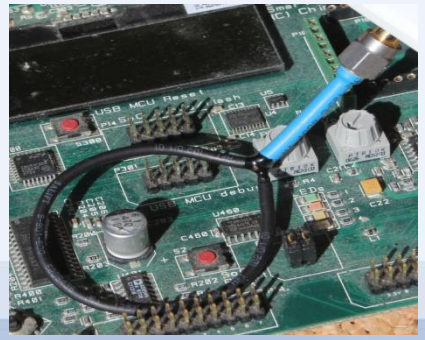
Near field test with TNP6Gx

- When you use the probe to do testing, try to position probe as close as possible the component, gap of shielding, or PCB trace, then move it and rotate it to get maximum level.









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3m or 10m Field test for final checking

- When you are doing the testing with a shielding box, you can find several the frequency points which will be critical. Mark these points and study them using *TNP6Gx* near field probes.
- You can use *TNP6Gx* near field probe to find the location of critical points, then try to reduce the emission at those points. Repeat the test in shield box again to make sure the emission is reduced. Finally, your product needs to be checked at 3m or 10m open field test.
- You can only check the critical points, try to use the turning table to test all the directions and to check emission level with MAX HOLD. If the emission is too large, you shall go back to near field probe test stage, figure out why the emission is large and find solution to reduce emission. This process may be repeated several times to solve the issue to maximize the chances of passing the EMC approval test.

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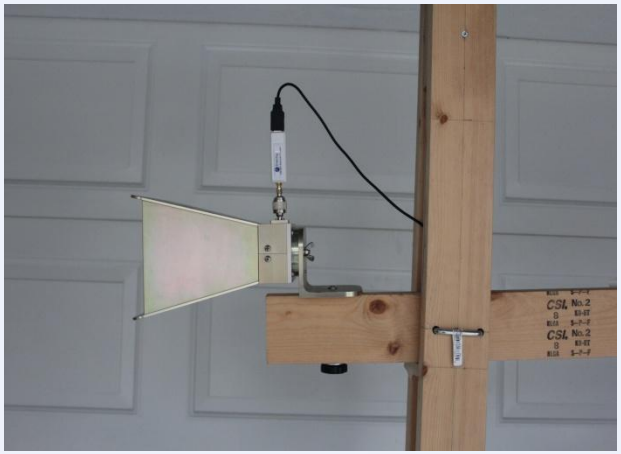
3m or 10m Field test for final checking

- When you check the full band, there will be lot of interference from air. because the test is not in a RF chamber. you need to make sure they are really interference and are not emission from the UUT. To do this, you need to go back to shielding box test stage, to verify that the large signals are not from UUT.



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3m or 10m Field test for final checking

- The 3m or 10m field test is the final test. The emission will be captured by the *TSA USB mini spectrum analyzer*. Please pay attention to the UUT working mode. If UTT is working at normal mode yet the signal output is in bursts, you need to increase the sweep time and try to catch any signal at any slot.
- UUT can be setup at special test mode during testing to force the UUT work at CW mode. You can check UUT at test mode, try to solve the issue, then go back to normal mode to check again to make sure the emission is small and pass test.
- After all the tests and making sure that the emission is small, you can send UUT to the test lab. Sometimes, the test lab will still find that some point emission are too big. You need repeat those conditions at your test environment, then find way to solve the issue.