Far-Field Approximation using a Magnetic Near-Field Scanner

Introduction

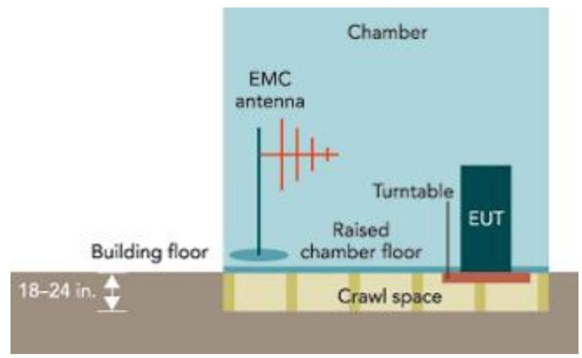
This summary requires that user be familiar with the FFA module in the EM-ISight software and the theory behind FFA. This paper offers methods to potentially reduce the testing time for the FFA.

1 Data Acquisition

The two diagrams below provide a brief summary on how data is gathered in an anechoic chamber and the EM-ISight near field.

1.1 EMC Chamber

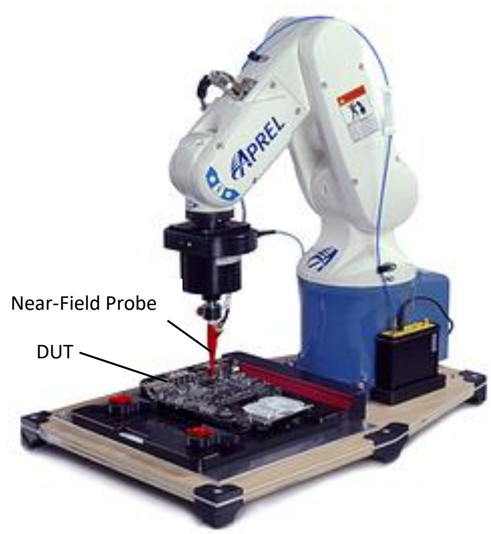
A typical chamber will have the EUT (Equipment Under Test) placed on a turntable with a EMC antenna placed a distance away (commonly 3 or 10 m away). Emissions are detected by the antenna while both the turntable is rotating and the antenna is moved up and down. Typically, the reported measurement is the maximized maximum hold for a full rotation of the turn table and boom height.



http://www.edn.com/design/test-and-measurement/4387708/Anechoic-chambers-rise-from-the-pits-4387708

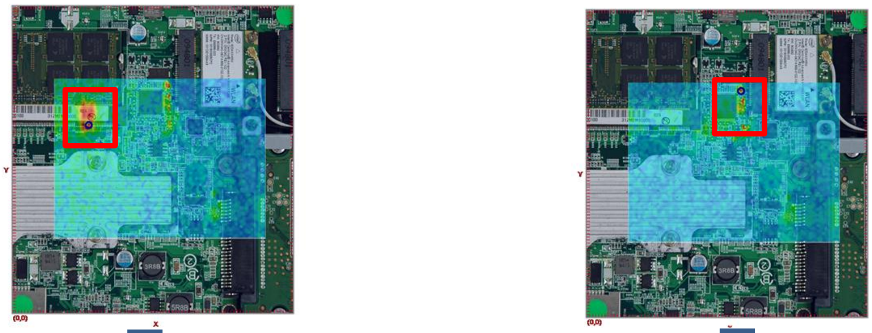
1.2 EM-ISight

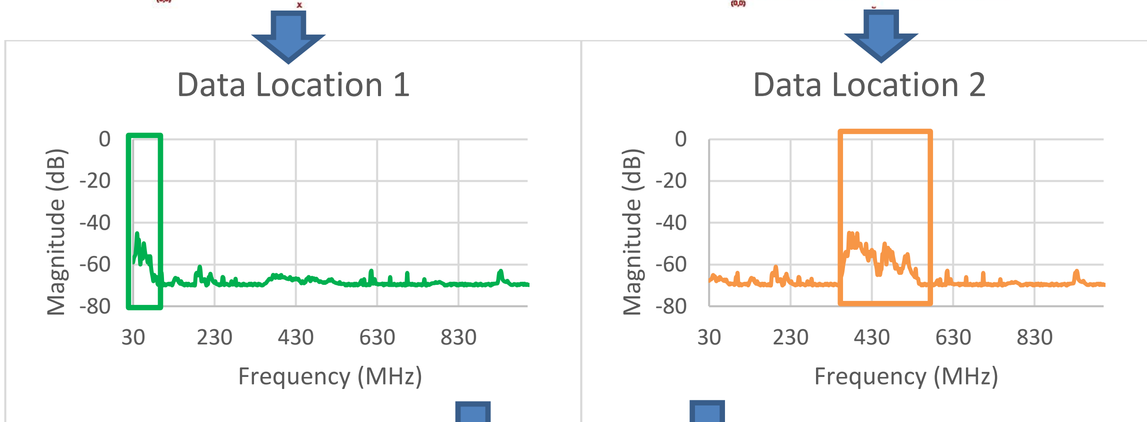
The EM-ISight system moves a near field probe over the DUT (Device Under Test) either at a specific distance away from each component or at set planar layers at user-defined heights. Precise robot positioning and a small H-Field magnetic loop with a high-spatial resolution allow the Near-field scanner to precisely locate the source of peak emission that directly contributes to a peak measurement of the electric-far-field in a chamber. The measurements reported for the near-field scanner are typically for the parts that are close to the magnetic field probe. They are not typically a maximized summary, but a close up result of the emission source.



2 Near-Field Measurement Process

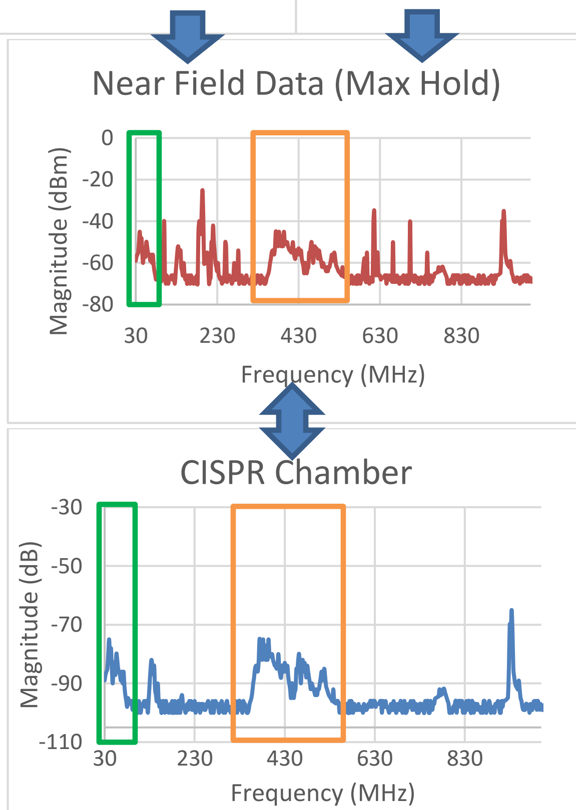
In the near field different areas of the DUT will emit different frequency bands





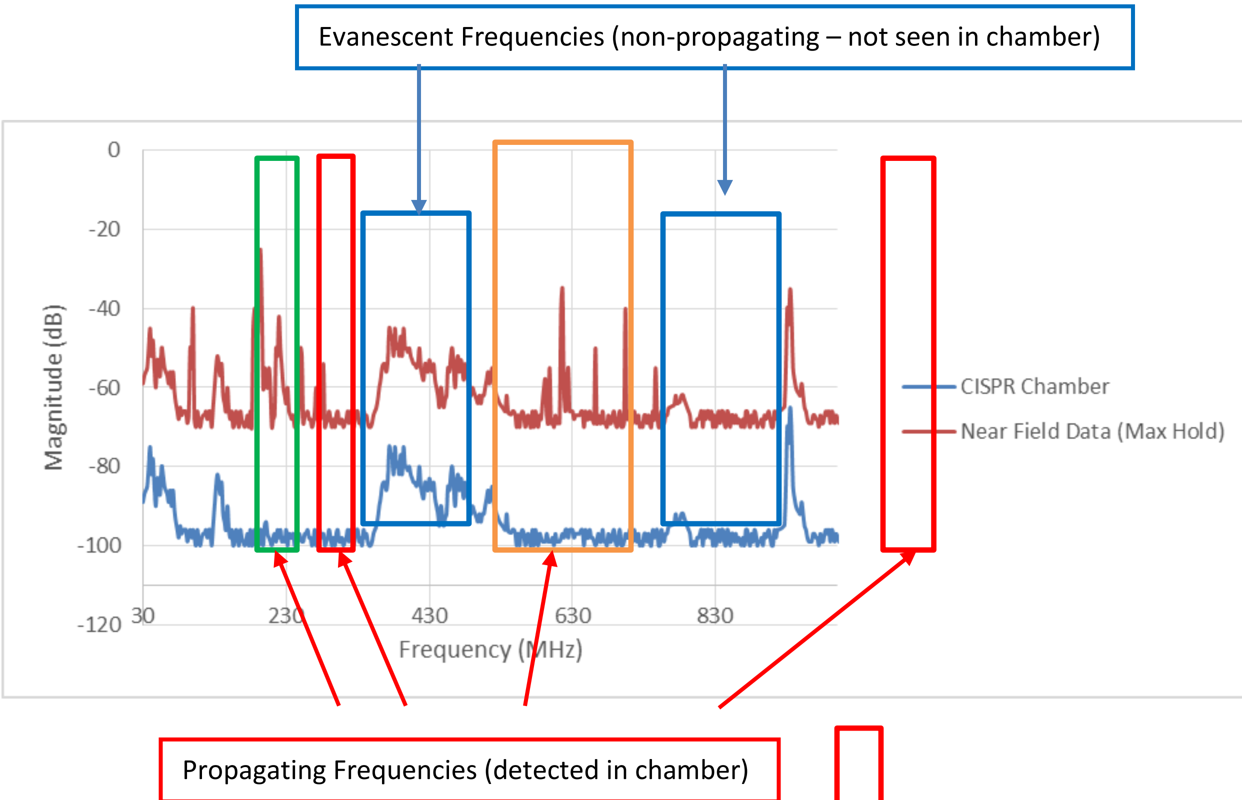
The software will compile all the largest magnitude values to a max hold trace

This will then allow to the user to correlate the near field data with the chamber data



Displayed in the example above, different frequencies will be the strongest on different sections of the DUT. For Location 1, the frequency is highest from roughly 30MHz to 100 MHz. For Location 2, the frequency is highest from 280 to 480 MHz. In both sets of data the peak frequencies are visible on the trace, however there is a dominant frequency band for each location.

If the DUT in the scan already has data from a CISPR chamber test, this will reduce the number of steps for the far-field approximation process.



The near-field data will generally have many more peak frequencies than the chamber data. Comparing the two data sets directly, it is possible to identify peak frequencies that are detected in the far-field chamber. In this case the FFA can be done directly on the near-field scan. If the chamber is unavailable however, a volumetric scan will be required for each frequency band of interest.
Please note there is a case where a propagating signal is detected on the board, but is not detected by the chamber antenna due to the angle of emission.

3 FFA process

1) Frequency Span\RBW and Scan time analysis based on target chamber capability
2) Course scan to find approximate emission source in the magnetic near-field
3) Time variant test at hotspot to verify signal type (Time variant or Continuous)
4) Evanescent test (Volumetric layer scan to measure Z deca

3.1 Spectrum Analysis for FFA

The type of spectrum analyser used for near-field measurement and the type of receiver used for chamber (far-field) measurement will also affect the FFA process. The goal for FFA is to approximate the chamber measurement based on a magnetic near-field measurement. The following factors must be managed by the Near-Field scanner operator for Far-Field Approximation measurements:

1) Is the measured signal time-variant?
    a. If so, can the chamber receiver accurately measure this signal?
    b. If so, can the near-field scanner Spectrum Analyzer accurately measure this signal?
2) Near-Field spectrum analyzer capability compared to target chamber receiver capability
3) Near-Field Signal to noise Ratio Control [Frequency Span, RBW], total Near-Field scanning time management

The First challenge for Near-field scanning is time-variant signals. Typical spectrum analysers use a swept-tuned detector or an FFT method. These methods are not able to measure time-variant signals accurately, especially when a frequency span of more than 1GHz with an RBW of less than 10KHz is used.

The second challenge to do FFA, is to ensure that the Spectrum analyzer that is used by the near-field scanner has the capability to measure the same result for the same signal as the Receiver that will be used in the chamber. If you're using an economy or technology that is 10 or more years old to try to get the same result as the newest and most expensive receiver in a chamber, then your FFA results won't match. The same applies to the reverse. If you are using the most expensive and advanced Spectrum Analyzer for your near-field measurements and are trying to match the chamber results that used a spectrum analyzer made in 1970 for the measurements, the FFA probably won't work; especially for time-variant signals. The RBW, detector type, frequency span, frequency step and the Chamber measurement process must be well documented. Each reported peak value should have a maximized turn table and boom height coordinate for each antennae orientation (Horizontal and vertical). Additionally the geometry of the cable and peripheral devices must be the same in both the near-field scanner test setup and the chamber setup to achieve optimum correlation.

The third challenge for near-field measurement is to manage the signal-to-noise ratio of the near-field measurements. There is a lot of instrument noise in a typical spectrum analyzer. There is typically more than 11dB of instrument noise. For chamber measurements, the receive antennae has high gain, and has a large surface area and hence, is sensitive to RF signals. Receivers can measure the DUT signal from 3m away with an RBW of 1MHz and have a signal-to-noise ratio of more than 20dB. For near-field measurements, the receive antennae is small, with less area, and to ensure that the magnetic field is not altered, has lower sensitivity. Because the near-field probe has less sensitivity we have to use alternate methods to improve the signal-to-noise ratio for FFA. We will need at least 10dB signal-to-noise ratio for a reliable FFA. The easiest way to find signal-to-noise ratio is to reduce the RBW of the spectrum analyzer. The spectrum analyzer hardware has some technology limitations. For most detector types, there is a measurement time trade-off between RBW and frequency span. The wider the frequency span and the further you go below 100KHz RBW, the longer that it will take for a single measurement.

For less than 100KHz RBW you will need to use a FFT, Vector, or DPX based detector type. The goal for a typical magnetic near-field probe is to have a noise floor of approximately -120 dBm in your analyzer output. The LNA noise figure will raise the noise floor by 4 or more dB. For Near-Field FFA, Ideally you will need a 1KHz RBW paired with a 30dB to 50 dB gain LNA with a noise figure of 4dB or less to achieve broad band FFA results. Additionally, if you would like to do broad band scans of 500 MHz or more, you will need to be able to do the broad band sweeps in less than 0.5 seconds per sweep to be able to measure the surface of your device in less than 1 hour. If you are trying to measure time-variant signals ensure that you are using a “real-time” spectrum analyzer or a scope with at least 1GHz analogue band width and frequency domain capability. Ideally, one measurement with one frequency span can be used to perform an FFA based on near-field measurements. If you have the best Spectrum Analyzer on the market, and best LNA (budget of over $200K) then you will be able to achieve this. If your budget is smaller than that, you will have to make a compromise, and repeat several near-field scans where the frequency span is customized for each target band to balance signal-to-noise ratio and overall measurement speed.