The World's First System-level
Electromagnetic Immunity Scanner
SmartScan
api
amber precision instruments

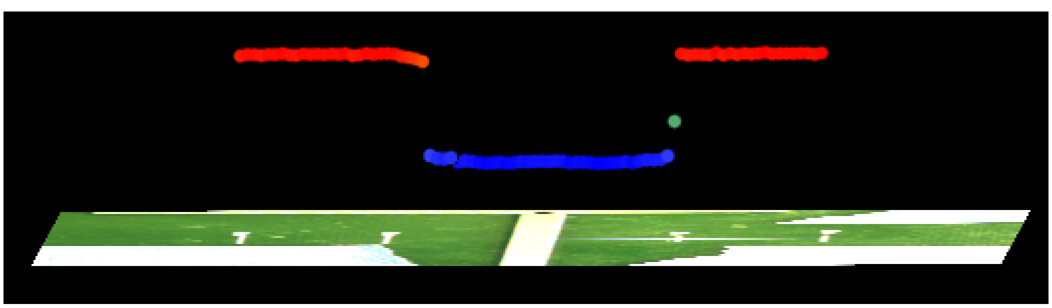
SmartScan Optional Items

1. Phase Measurement

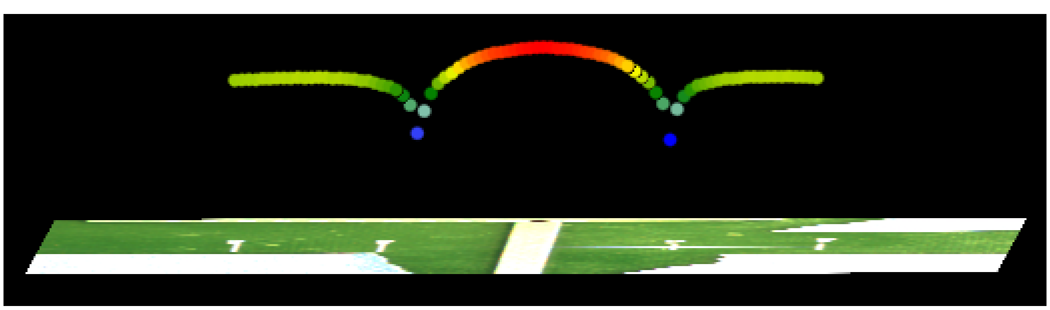
Near field scanning has been used over years to identify strong near field sources, and it has been used in the hope to identify the reasons for unwanted emissions, antenna structures and coupling paths and so on. The local magnetic or electric field strength usually does not reveal which of the sources will couple to a good antenna structure or form a good antenna structure. Answering this question is then left to the experience of the EMC engineer, for example, a weak 125 MHz signal at a location where it is not expected, might be much stronger sign of a design flaw, than a strong 125 MHz signal above a clock. Or a very local and strong source may contribute much less to the far field than a weak but distributed source, like a heat sink. To move beyond the inability of identifying the reasons of EMC problems and to obtain models that can be used for numerical simulation, and for module and IC qualification enhanced scanning methods are needed.

Maxwell's equation tell us that the knowledge of the near field in magnitude and phase around a source is sufficient to either reconstruct a model of the source, that emits exactly like the source or/and to obtain the far field emissions. A core requirement in this is the knowledge of the phase of the fields. The phase is defined as the phase (difference) between a reference point, and all other field points.

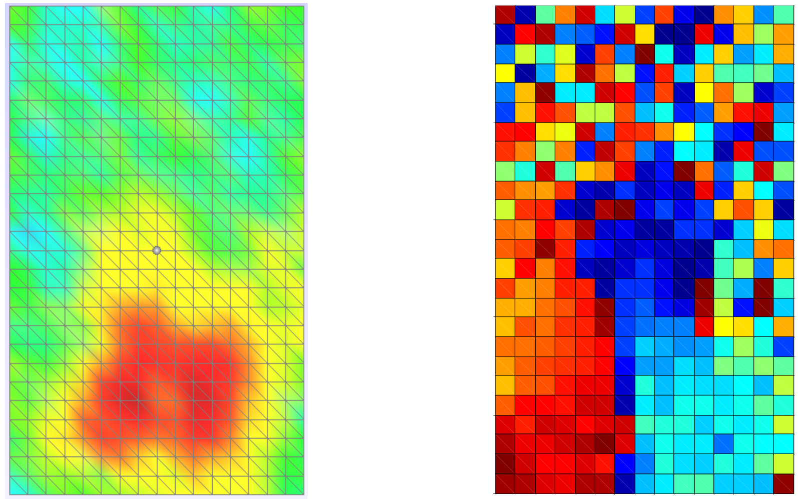
API offers automated near field measurement technology for phases of RF signals as well as conventional amplitude and frequency.



Hx phase over a 50 Ohm strip-line



Hx amplitude over a 50 Ohm strip-line



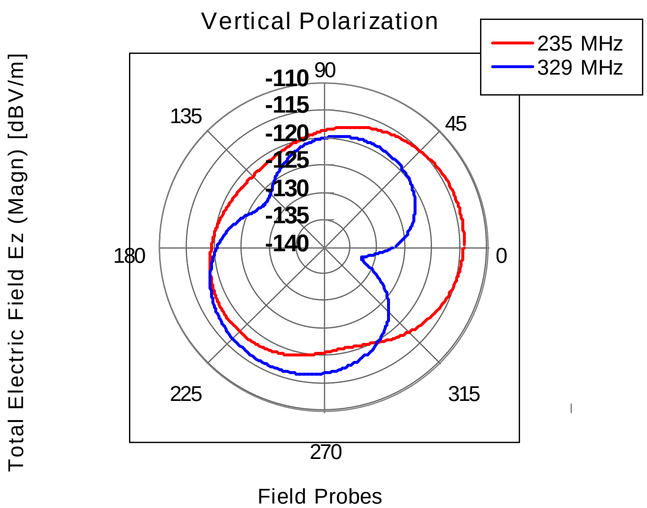
-137dB A/m ~ -78dB A/m 0° ~ 360°

Fig. 1 Near field measurement data: magnitude and phases of 235MHz Hy signal

Application of phase information

Near field to Far field correlation

Mathematically, the ability to perform near field to far field transformation is not new, first methodologies have been developed in the 1950's and a widespread application started to be possible from the 1980's on. This methodology is typically used for antenna characterization, and has been less frequently attempted for EMI prediction. With the available phase information, the maximized FF transformation from NF data showed acceptable match.



Freq (MHz)	Measured E (dBV/m)	Simulated E (dBV/m)
235	-117	-114
329	-115	-116

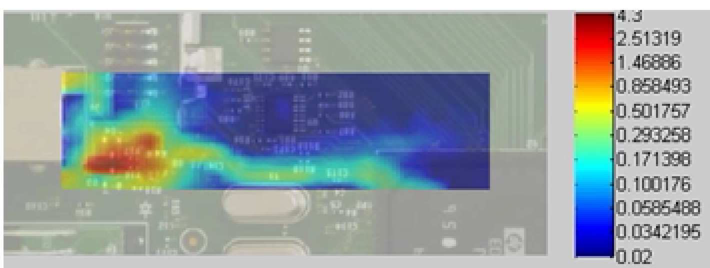
Fig. 2 NF to FF transformation with phase information

RFI Analysis

Objective in RFI prediction is to predict the coupling between noise sources, like ICs, camera modules, flex cables etc and wireless antennas. And the accuracy depends on how well the source models have been created. There are two types of sources; conducted sources and field coupled sources. Each type has its own advantages and disadvantage, and we believe the combination of scanned data for fields and voltage/current data from IBIS is the best modeling method. The phase information enables this combined approached possible. This way modules and ICs can be scanned, and the obtained data can be used to predict RFI coupling within systems, and it can then be used to qualify ICs and modules to reduce the chance of RFI problems later in the product design.

2. Current Spreading Scan

API's current spreading scan visualizes how ESD currents flow on a PCB, which is usually the first item in every EMC engineer's wish list. By using well controlled current sources, specially designed probes and accurate measurements over entire DUT, it provides videos showing how injected currents flow. This technology is very useful to compare the performance of clamping devices or to lead where protection elements have to be placed.



A snapshot of injected current through a TVS device. It shows a path of the current

Often, a protection device, i.e., a TVS is placed close to a connector. This protection device will divert current to ground, but also allow a residual current to flow to the IC it is supposed to protect. The current reconstruction scanning can visualize both: The current diverted to ground and the residual current. Current reconstruction has a timing resolution of better than 100ps.

3. Resonance Scanning

Resonances increase the coupling from the external field to the circuit. They are often the "missing link" between system level performance and local scanning. The most basic coupling mechanisms let us expect smooth coupling behavior, as shown in Fig 3. In practice, however, such a smooth frequency behavior is not observed in radiated immunity testing. Multiple authors show that immunity failures are usually not of broadband nature, but rather occur in relatively narrow frequency ranges as illustrated in Fig. 4.

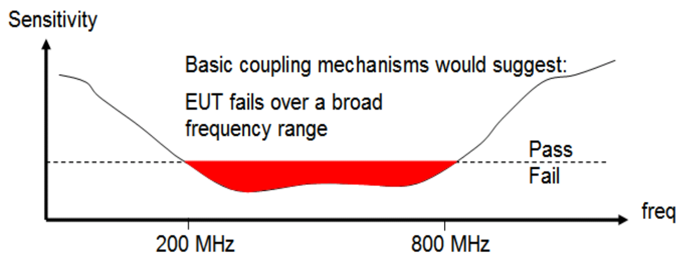


Fig. 3: Swept frequency susceptibility behavior expected from simple coupling mechanisms

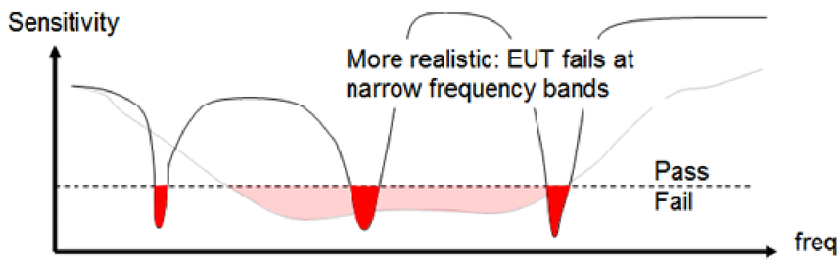


Fig. 4: Illustration of more typical swept frequency susceptibility behavior suggesting resonance enhanced coupling

At resonance, fields will be strongly enhanced. The strength of the enhancement depends on the quality factor of the resonance, which often reaches a factor of 10 and more. Thus, resonance scanning must not only identify the location and resonant frequency of resonating structures, but their quality factors as well.

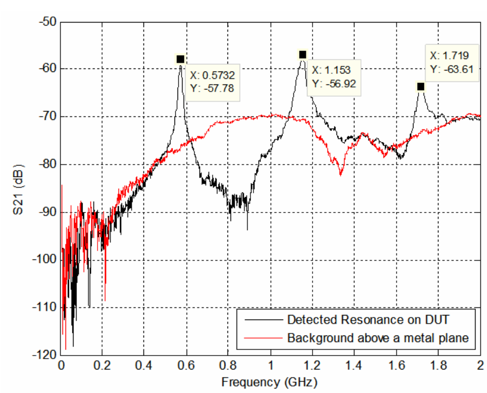


Fig. 5: *Red-direct coupling without resonating structure;, black-coupling in proximity to a resonating trace on a PCB. Resonance scanning clearly identifies potentially problem causing frequencies, rather than a broad range of problematic frequency*

Application of resonance scanning

For EMI scanning:

- First, resonance scan is performed. For this scan the DUT is turned off. Thus, the resonance frequency, locations and Q-factor of potentially resonating structures is identified. In the second step, the DUT is turned on and an EMI scan is performed. This determines at which structure which frequency components are present. EMI engineers know that resonating structures are much better antennas than non-resonating structures. Thus, in the third step one can identify which frequency components occur on resonating structures by comparing both scan results. If they occur on resonating structures, then a reasonable conclusion is that this resonating structure will contribute strongly to the EMI.

For Immunity scanning:

- A problem in immunity RF-sine wave scanning is that one cannot test every point at every frequency, as the frequency sweep at each point might take 20min. For that reason, it is useful to narrow the number of test points and test frequencies. Resonance scanning can help to solve this dilemma. At first, the DUT is turned off. The resonance scanning will determine the locations, resonance frequencies and Q-factors of resonating structures. In the second step the DUT is turned on and it is observed for failures. The probes now inject RF signals, e.g., modulated RF signals via field coupling. It is reasonable to only test at locations and frequencies at which resonances have been detected. The rational is that the external field (in a standard immunity test) would couple best to structures that are in resonance. This way one can reduce the test time of RF immunity sine wave scanning strongly.

4. Direct Voltage Measurement

The scanning system can measure the voltage at a trace by probing it. The probing captures the trace voltage without the need of a direct ground connection. The measurement bandwidth is from DC to 3 GHz +/- 2 dB.

What is the advantage of direct voltage probing over E-field probing for EMC?

In direct voltage probing one can see the voltage spectrum (or the time domain signal, if an oscilloscope is used) directly. E-field scanning has the problems of probe to board or component distance, probe size etc., thus E-field scanning only allows an estimation of the noises on traces, while direct voltage scanning allows a direct read out of the voltages. Further, direct voltage scanning, if measuring the "voltage" on a grounded part, will give an indication of the potential of this surface to radiate.

5. RF Immunity Scanning

This scanning technology is mainly to identify the sensitivity of a product to external or internal RF fields (for example, a cell phone disturbs a display), and the cause of the coupling. The scanning variables can be scan frequency, the modulation in the RF, the probe (electrical field or magnetic field, size and orientation), etc.

An RF signal or a modulated RF signal is fed into a probe. The probe is moved around the product while the product is observed for signs of disturbances. The strength of the disturbance is automatically recorded for each location. This way a map of the local sensitivity of the product is created, helping to understand the reason for the immunity problem.

6. EMI Scan with the Smallest Probe in the Market

Scanning results with two different sizes of probes show the ad With 1mm probe, all four traces show very similar field strength, but with 125um probe, the field strength from the top two traces are clearly different from the bottom two over wide frequency ranges

Examples of EMI scan using small and large probes