Identifying the root cause of EMC Compliance Problems at a PCB level

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Agenda

- Radiated Emissions Testing
- Very-Near-Field Implementation
- High Resolution Scanner
- Sample Results
- Far Field Prediction
- Conclusion
EMSCAN Introduction

World Leading Developer of Fast Magnetic Very-Near-Field Measurement Applications

Real-Time Visual Test Solutions for Antenna and PCB Designers and Verification Engineers

Pre-Compliance Not Compliance
EMSCAN Products

- **EMxpert**
  - EMC/EMI diagnostic tool enabling designers to rapidly diagnose and solve EM problems in a single design cycle in their own lab environment

- **RFxpert**
  - APM tool enabling engineers to quickly evaluate and optimize their designs with real-time antenna performance characterization at their desk
Radiated Emissions Testing

OVERVIEW
Existing Solutions

• Chambers
  – Slow testing
    • Compliance
  – High CAPEX (in-house)
    • Real-estate
    • Qualified technicians
  – High OPEX (third party)

• Probes
  – Slow testing
  – Resolution nm

• Simulation software
  – Time consuming to customize per PCB
  – Extensive training required
Every EMI (electromagnetic interference) problem ultimately starts or ends at an electronic circuit

Daryl Gerke and Bill Kimmel
IN COMPLIANCE MAGAZINE JULY 2013
PCB Radiated EMC Issues

- EMC prevention an afterthought
- Little interest in EMC
- EMC as a black art
Very-Near-Field Implementation

A BETTER SOLUTION
Scanning Array of Probes

- 1218 probes in a 29 x 42 array
- Magnetic field loop probes
  - Sensitive down to -135 dBm
  - Inefficient for EMI isolation
  - Broadband
- 7.5 mm to 0.12 mm resolution
- Scan area 21.8cm x 31.6cm
- Real-time measurements (<1 sec)
System Configuration

- Sensor Array
- Software Application
- Controller
- Spectral Analyzer
- External Trigger

Connections:
- USB
- LAN/USB
- RF
Spectral Scan

- Identify the frequencies of emission

Spectral (Compensated)
Amp [3.0 to 78.9 dBuV] Freq [10.000 to 100.000 MHz]
Resolution Bandwidth: 100.0 KHz
Attenuator Value: 0 dB
Scanner Module: ISM-L4G-Xi-M7, 29 X 42
Date: 4/22/2010 9:13:22 AM
Spatial Scan

- Visualize where the emissions are coming from
High Resolution Scanner

BEST OF BOTH WORLDS
Higher Resolution Spatial Scan

- Probe spacing is 7.5mm
- Move the entire probe array to synthesize small probe spacing
- Up to Level 7 (0.1mm)

![Diagram showing probe array and level scans]
Higher Resolution Spatial Scan

- Detail of small feature available
- Even inside components like ICs
Sample Results

FOLLOWING EMISSIONS ACROSS A PCB
Analyzing a PCB

- First view of a scan give spectral content and aggregate spatial content
Analyzing a PCB

- Jump around by frequency or location to follow signals
- Load new PCB layers to correlate to features

Energy coupled onto power plane

Energy coupled onto control line
Analyzing a PCB

• Able to follow the signal on the traces as it goes between layers.
Sample Results

PEERING INSIDE AN IC
Emissions From Inside the IC

- Small PIC with die exposed
- About 2 minutes per scan

100 MHz  120MHz  130MHz
Emissions From Inside the IC

- Intel SSD
- Start with spectral emissions
Emissions From Inside the IC

• Then analyze spatial distribution
Comparable to Other Techniques

Probe Array Method

Single Probe Method
Combining both worlds

BOARD LEVEL AND IC LEVEL
Board Level Testing

• Quick scan identifies many emissions
• Isolate by location or by frequency
Board Level Testing

- Highlight on IC and identify relevant frequencies
IC Level Testing

- Go to high resolution
- Identify which frequencies are related

![Imageries of different frequencies: 264MHz, 231MHz, 363 MHz, 50-500MHz]
Other Applications

TYPICAL EMC CONCERNS
Real-Time

- Changes in real-time
- Intermittent events
- Functional testing
- Different operating modes
- Firmware modifications
A/B Comparison

- Obsolescence management
- Production unit versus gold standard
- Fault diagnosis
Effectiveness of Filters

- Immediate feedback means trial and error can be used
Testing Shielding or Absorbers

- Look for leakage points or new radiation mechanisms
- Test uniformity and effectiveness

Strong Emissions from Inductor and ICs

Emissions reduced with small ferrite tile
Non-EMC Applications

- Coexistence
  - PIM 1\textsuperscript{st} to 3\textsuperscript{rd} harmonic 120 dBc
  - Self-interference (de-sense)

- NFC
Impact for EMC Compliance

CHAMBER PREDICTIONS
Far-Field Prediction

- VNF results to predict Open Area Test Site (OATS) or free space radiated EMI of PCB
Measure Very-Near-Field

- Measure the very-near-field emission from real source
- Use this as a source model in a simulation package
- Amplitude and phase needed
Import into Simulation

- A complex simulated source is replaced with simple surface

Near-field source region

Source magnetic fields at 1 GHz
Far-Field Prediction

- Simulation could include large scale effect like cables, enclosures, etc.
Conclusion

VERY-NEAR-FIELD ARRAY BASED MEASUREMENT
Very-Near-Field Pros and Cons

• **Strengths**
  – Continuous peak hold scan for spurious events
  – Real-time view of emission sources and currents
  – Fast pre-compliance regulatory data

• **Limitations**
  – PCB diagnostic not product compliance
  – DUT no bigger than scanner for pre-compliance
    • Any size for diagnostic
  – Mezzanine PCB might need disassembly for testing
Exciting Value Proposition

Substantially **Reduce** Project Development Costs
Dramatically **Increase** Designer Productivity
Significantly **Accelerate** Time-to-Market

1 **Hour** in a Chamber or 1 **Second** with a Scanner?
Thank You

If you are interested in testing your PCB on the EMxpert system for free please contact us at

www.emscan.com
info@emscan.com
Thanks for attending!

Don’t miss our Test Bootcamp!
November 16, 2016
www.emclive2016.com