EMC 101
What, Why, How

Presented by:
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Amplifier Research
1st There was RF –
Then Came RF Interference
RF Sources

RF Immunity testing is designed to test products to RF fields it could possibly be subjected to in normal use.

- Radio Towers
- Cell phones
- Cordless Phones
- High Intense Radiated Field (HIRF)
- Digital devices
- Radar Towers
- Machine Shop Motors
- Walkie-talkies
- TV Transmitters
- Cell Phone Transmitters
- Airport Radio Tower
- Blender
- Microwaves
- Florescent lights
- Amplifiers
EM What?

**EMC** – *ElectroMagnetic Compatibility*
Tested to prove compatibility in different electromagnetic environments.

**EMI** – *ElectroMagnetic Interference*
Testing for Radiated or Conducted Interference *from* a product

An electronic or electrical product shall work as intended *in* its environment. The electronic or electrical product shall not generate electromagnetic disturbances, which may influence other products.
Why Test for EMC

- Meets standards to sell product into markets
- Customer Satisfaction
- Avoid Lawsuits
Types of EMC Testing

- CE – Conducted Emissions
- RE – Radiated Emissions
- CI/CS – Conducted Immunity/Susceptibility
  - Bulk Current Injection
- RI/RS – Radiated Immunity/Susceptibility
- Related Tests
  - ESD (Static) & Transients (Burst, Surge, Interrupts)
Emissions vs. Immunity

**EMC**

**Emissions**
- Conducted
  - RF
  - Harmonics
  - Flicker
  - Transient
- Radiated
  - RF
  - Magnetic

**Immunity**
- Conducted
  - RF
  - Transient
  - EFT
  - Surge
  - Voltage dips & variations
  - ESD
- Radiated
  - RF
  - HIRF
  - Radar
  - Magnetic

Amps are Used here
Product Development Cycle

Breadboard → Pass → Prototype → Pass → Preproduction → Pass → Production → GO!

Black Hole of Redesign

Fail → Fail → Fail → Fail
Primary EMI Fixes

• Better PCB design
  – Signal paths
  – Vias
  – Grounding

• Shielding and Filters
  – Gaskets, Cans, Vents
  – Ferrite Beads
  – Input Band-Pass Filters
Primary EMI Fixes

- Ferrite Bead
- Power Line Filter
- Finger Stock, Mesh Over Foam, Vents, Gaskets
- Gasket on Conductive Plastic
- “Cans”
Pre-Compliance vs. Compliance

Compliance Labs
- Accredited
- In-House or 3rd Party

Pre-Compliance
- Anything less than accredited
- Quick Scans to Full Tests
In-House or 3rd Party Labs

• Why Have an In House Lab?
  – Can evaluate throughout development
  – Easier to schedule
  – No travel costs
  – Get to market faster

• Why Not Have an In House Lab?
  – High initial cost
  – Need trained personnel
  – May not get efficiently used
In-House or 3rd Party Labs

• 3rd Party Lab Advantages
  – Accredited and trained personnel
  – Have the equipment
  – Run the tests often
  – Know the Certification System and Procedures
  – Reality check

• 3rd Party Lab Disadvantages
  – Cost
  – Scheduling
In-House or 3rd Party Labs

• Build or Contract Services
  – How much do you spend – All costs?
  – How much is EMC a problem?
  – Does it effect time to market?
  – Can we start small and build?
Test Equipment Needs

- ESD/Transients
  - Grounded table/Work Station
  - ESD Simulator/Gun
  - Specialized Transient Generators
Test Equipment Needs

• Radiated and Conducted Emissions
  – OATS or Semi Anechoic Chamber
  – EMI Receiver or High-end SpecAn
  – Antennas and/or Clamps
Test Equipment Needs

- Conducted Immunity/Bulk Current Injection
  - Grounded Table/Work Station
  - Amplifier
  - Signal Generator
  - Power Meter
  - Clamps and Calibration Fixtures
  - or Dedicated Test Set
Test Equipment Needs

• Radiated Immunity
  – Semi Anechoic Chamber/GTEM/Reverb
  – Amplifiers
  – Signal Generator
  – Power Meter
  – Field Monitor
  – Antennas
Radiated Emissions Test Set Up

Open Area Test Site (OATS)
Radiated Emissions Test Set Up

Anechoic Chamber
Radiated Emissions Test Set Up

Semi-Anechoic 10m Chamber
Test Equipment Needs (RE)

- Horn And Log-periodic Antennas
- Anechoic Chamber
- EMI Receiver
- Preamplifiers
Test Equipment Needs (CE)

Current Clamps and LISNs

Transient Limiters

EMI Receiver
Conducted Immunity IEC 61000-4-6

- Wooden Table
- Ground Plane (Shield Room Floor)
- Amplifier
- Signal Generator
- Automation System
- Power
- I/O Lines
- 10cm < L < 30cm
- 3-5cm high wood blocks
- 10cm high wood supports
- 0.8m
- Signal Generator
- CDN
- EUT
DO 160 Conducted Immunity Set-Up

NOTE 1: See Section 20.3 for EUT general requirements.
NOTE 2: End of exposed cable. Unshielded cable may be shielded from here to the wall.
NOTE 3: Bonding strap.

FIGURE 20.9 CONDUCTED SUSCEPTIBILITY TEST SETUP

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Radiated Immunity

2 Methods

Closed Loop
- Field is measured & leveled during testing

Substitution
- A calibrated field is applied during testing
Radiated Immunity Test Set Up

- Non Conducting Table
- Uniform Field Area
- Filtered Power In
- Antenna
- Filtered Feedthroughs
- Monitoring Equip
- RF Field
- Generating Equip
- Chamber Penetration
- Floor Absorber (Optional)
- Wall Absorber not shown for clarity
Radiated Immunity

Typical test setup
Anechoic Chamber
IEC 61000-4-3
Radiated Immunity Test Environments

Most all testing is performed in a Anechoic Chamber, Reverb Chamber, Test Cell or Shielded room

- Disruption to communications is illegal
- Minimize outside influence for test since it is a closed stable environment
- Human safety
- But some customers do test in the open (military)
EMC Standards Overview

RI/CI Standards are designed to protect products from the environment

RE/CE are designed to protect the environment from the product

Standards are created to normalize testing:

- Results are reproducible
- Variables are reduced or eliminated
- Safety factors (test higher than environment)
- Applicable products tested to same criteria
Industries Performing RF Immunity

- **Military** - MIL-STD-461G, MIL-STD-464
- **Automotive** - ISO, SAE, FORD, GM, DCX, Honda, Toyota...
- **Aerospace** - DO-160G
- **Commercial** (European CE Mark mostly) IEC/EN, ANSI, IEC 61000-4-3
  - **Telecom** – ETSI standards
  - **Medical** - FDA, EN 60101-1-2

Basically all electronic Manufacturers
# Common EMC Test Standards

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Why do we need all this testing?
Questions?
THANK YOU!