EMC 101

What, Why, How

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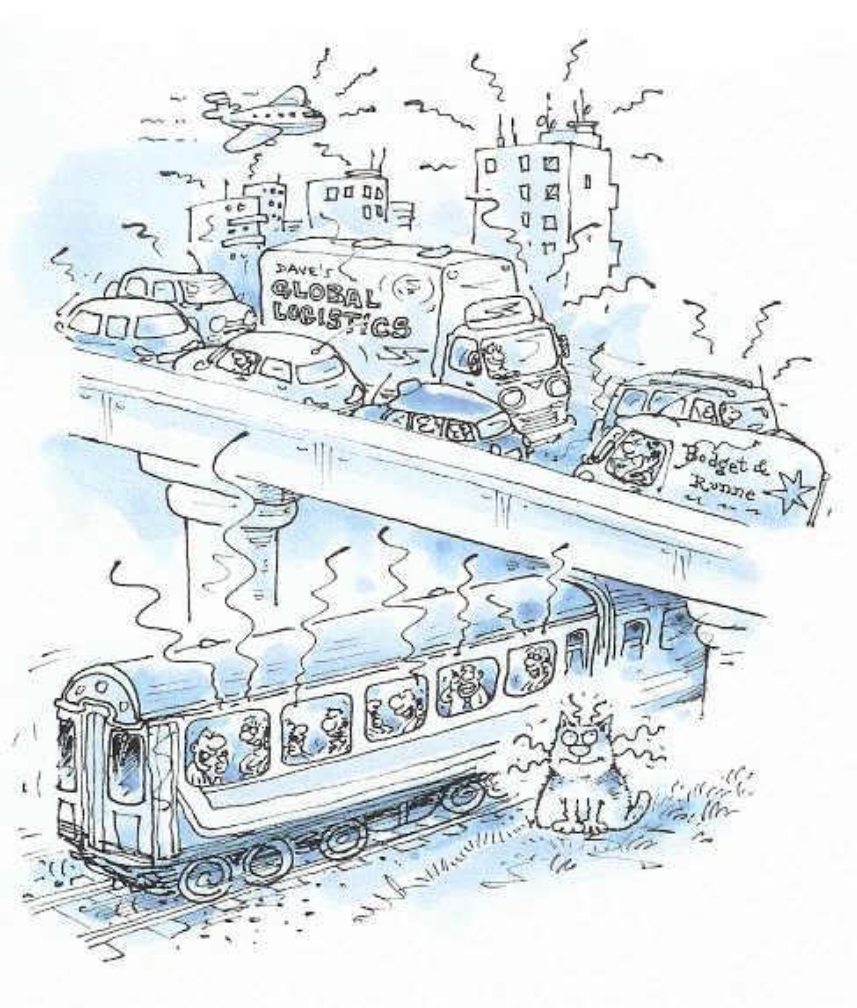
Amplifier Research

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 – **E**lectro**M**agnetic **C**ompatibility

Tested to prove compatibility in different electromagnetic environments.

EMI – **E**lectro**M**agnetic **I**nterference

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

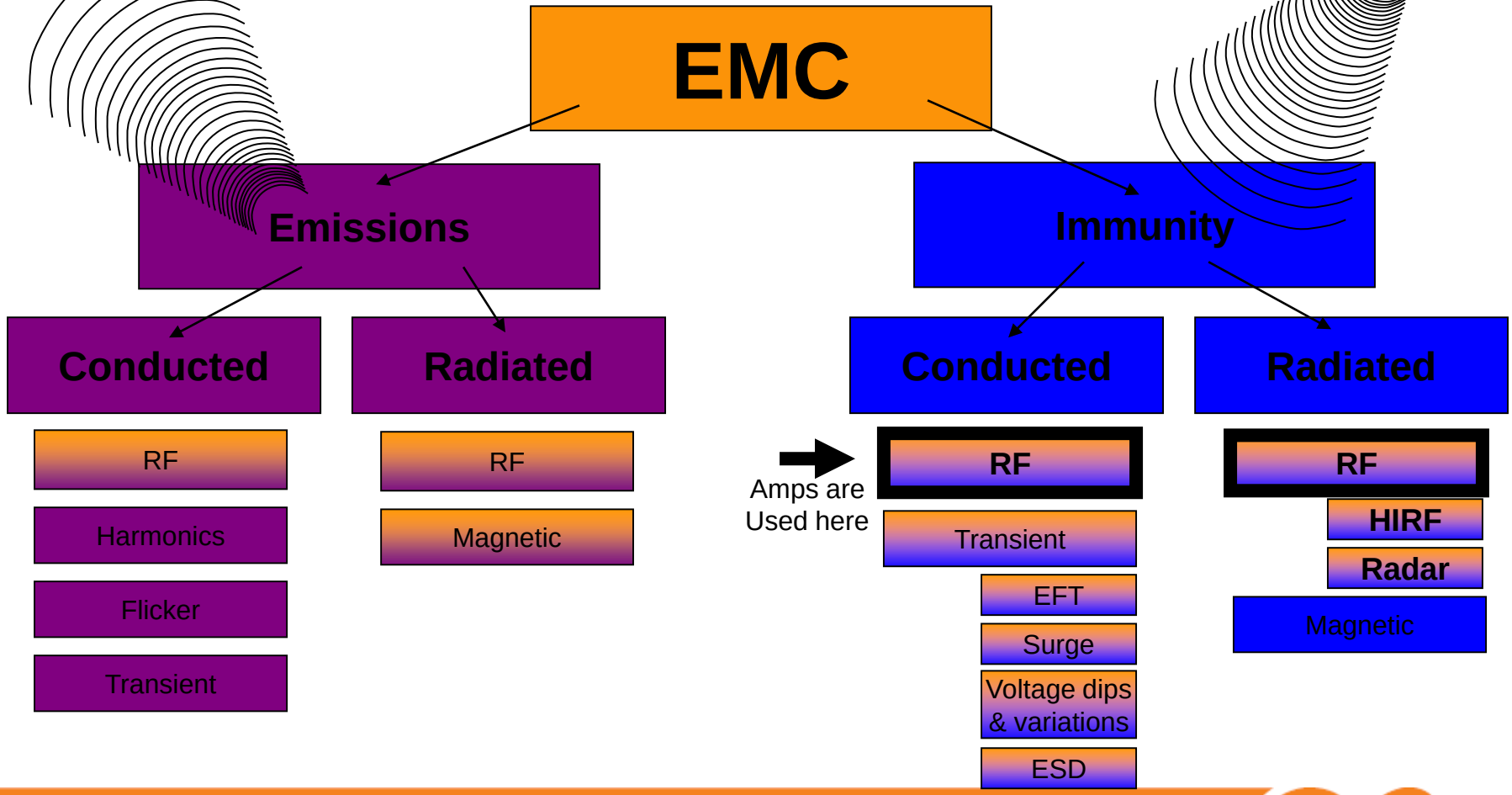
Why Test for EMC

- Meets standards to sell product into markets
- Customer Satisfaction
- Avoid Lawsuits

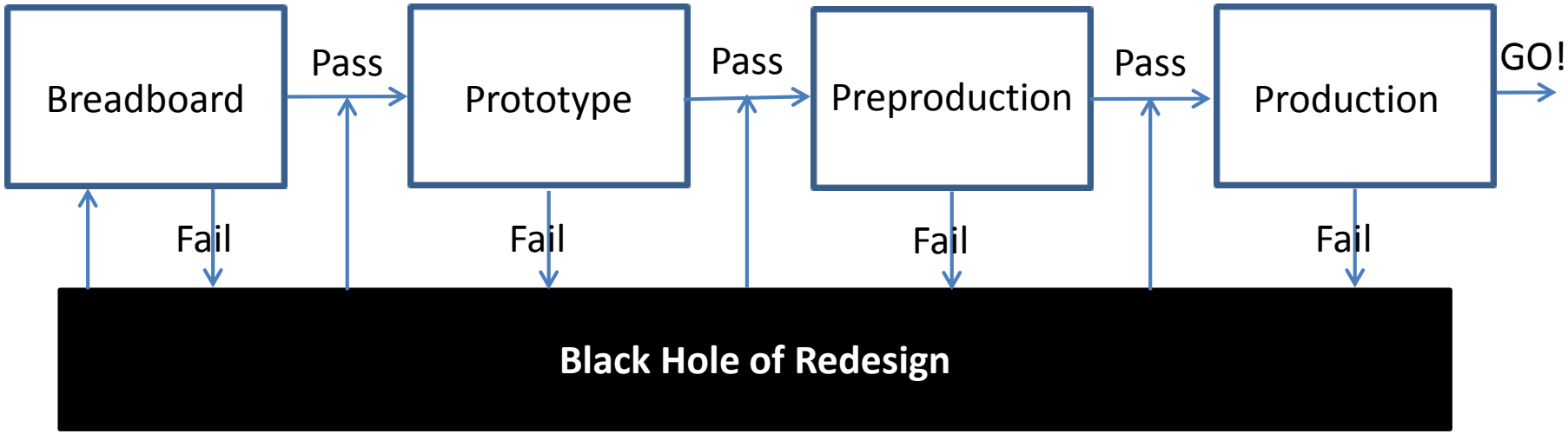
Types of EMC Testing

- 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

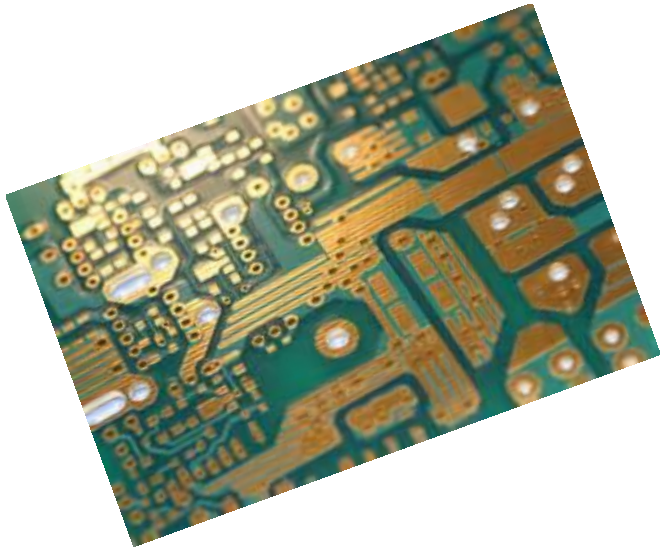


Product Development Cycle



Primary EMI Fixes

- Better PCB design
  - Signal paths
  - Vias
  - Grounding
- Shielding and Filters
  - Gaskets, Cans, Vents
  - Ferrite Beads
  - Input Band-Pass Filters

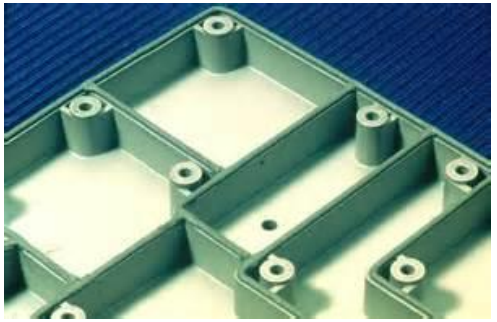


Primary EMI Fixes

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

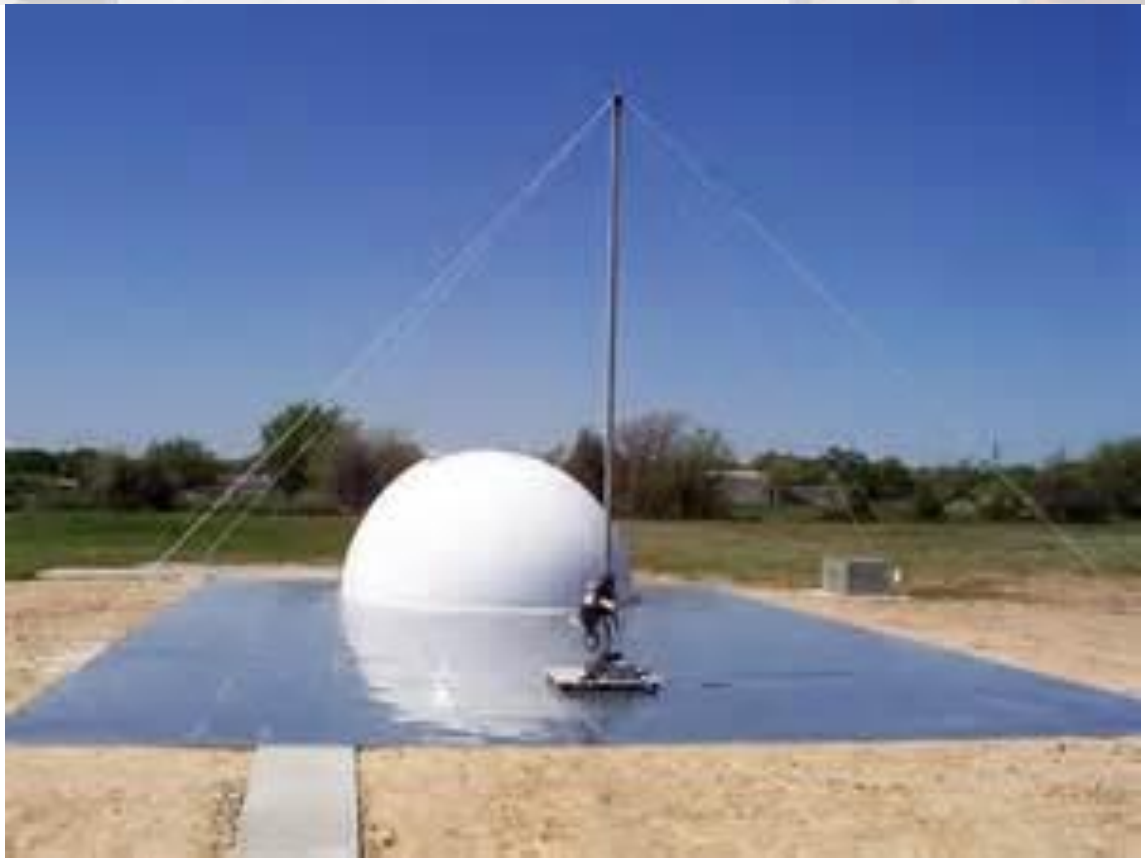
Test Equipment Needs

- 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

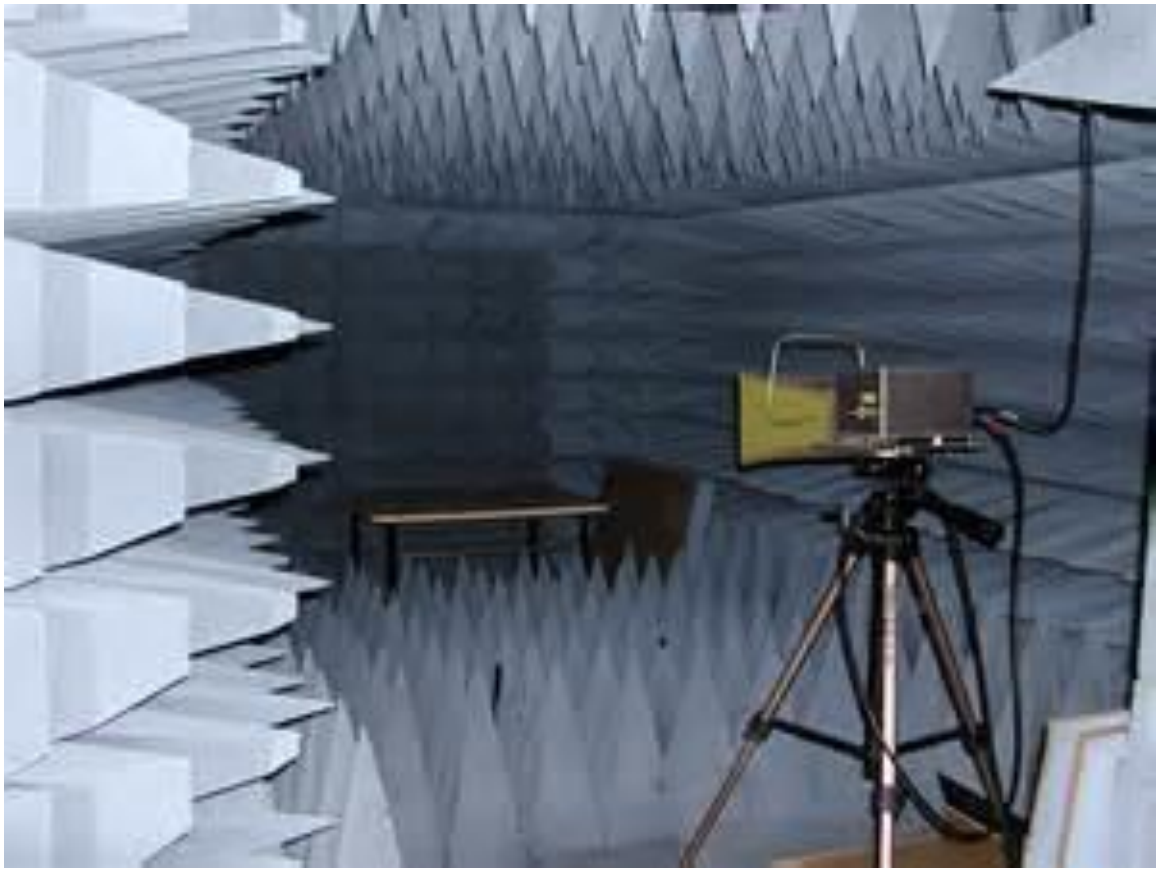
- Radiated Immunity
  - Semi Anechoic Chamber/GTEM/Reverb
  - Amplifiers
  - Signal Generator
  - Power Meter
  - Field Monitor
  - Antennas

Radiated Emissions Test Set Up



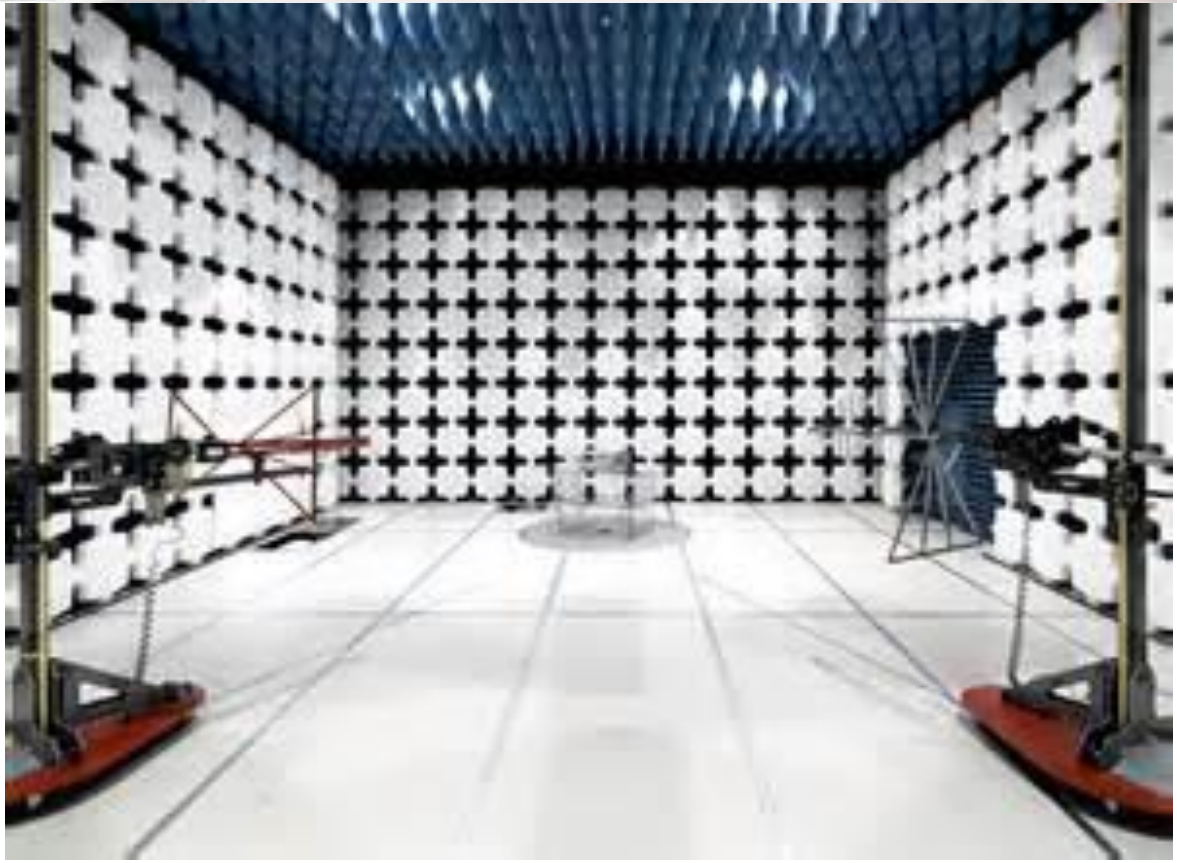
Open Area Test Site (OATS)

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

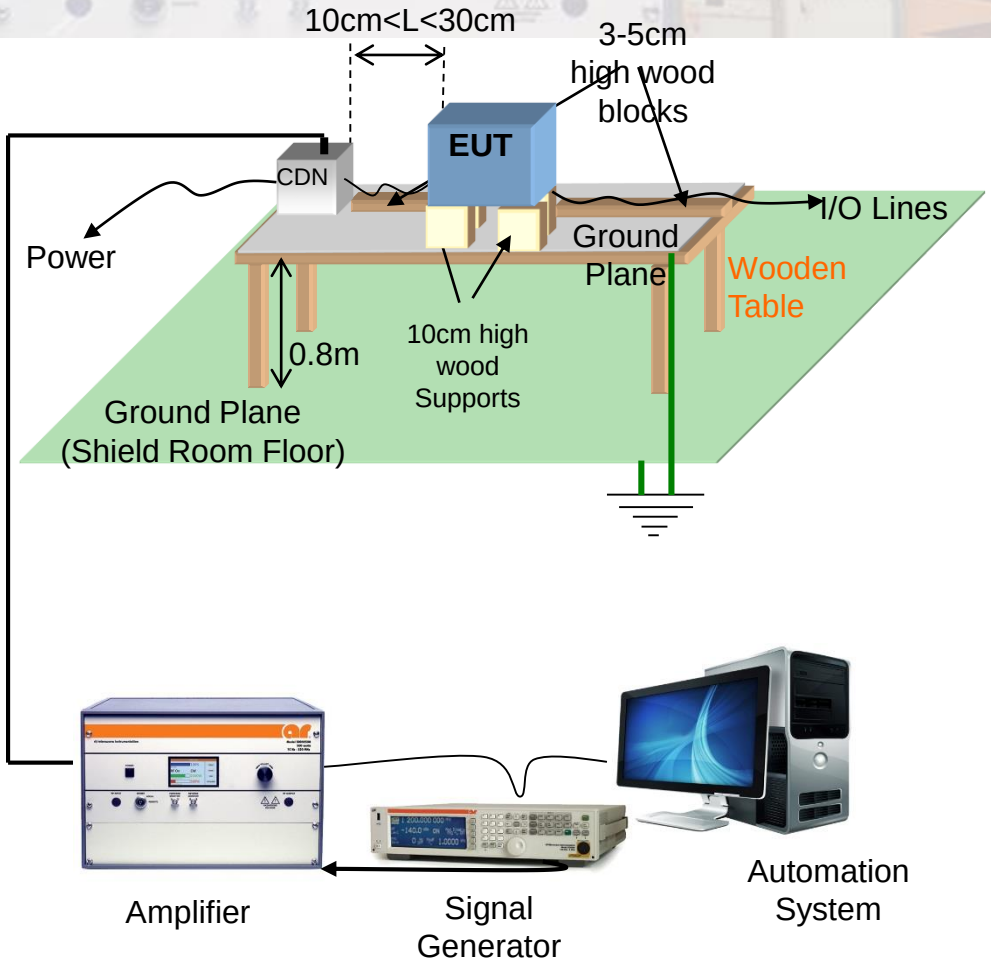
Test Equipment Needs (CE)

Current Clamps and LISNs

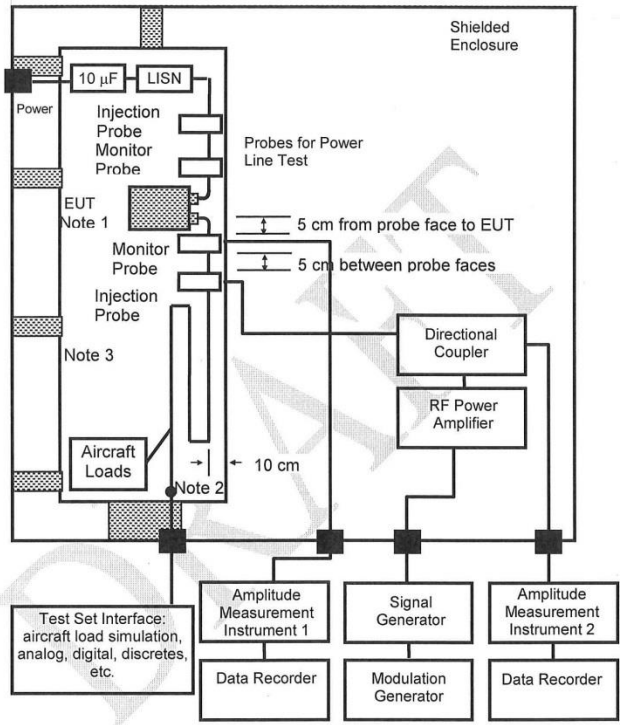
Transient Limiters

EMI Receiver

Conducted Immunity IEC 61000-4-6



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.

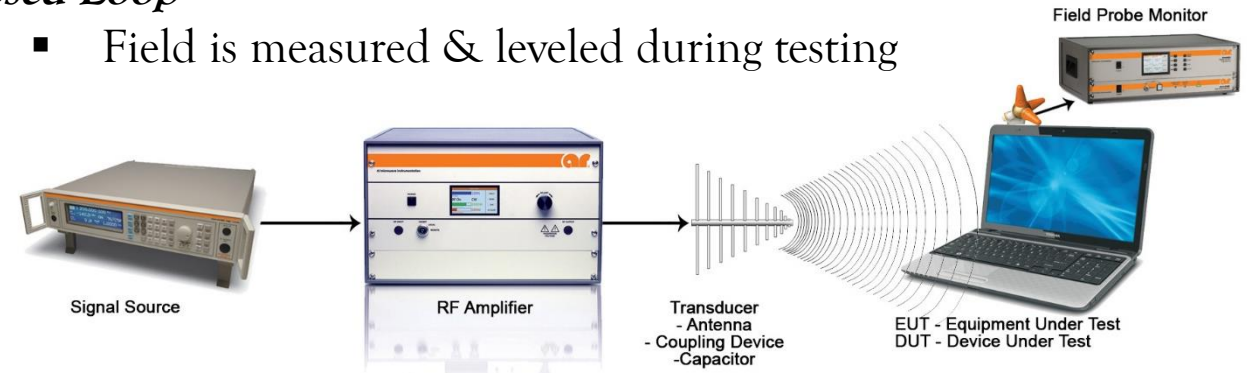
FIGURE 20-9 CONDUCTED SUSCEPTIBILITY TEST SETUP

Radiated Immunity

2 Methods

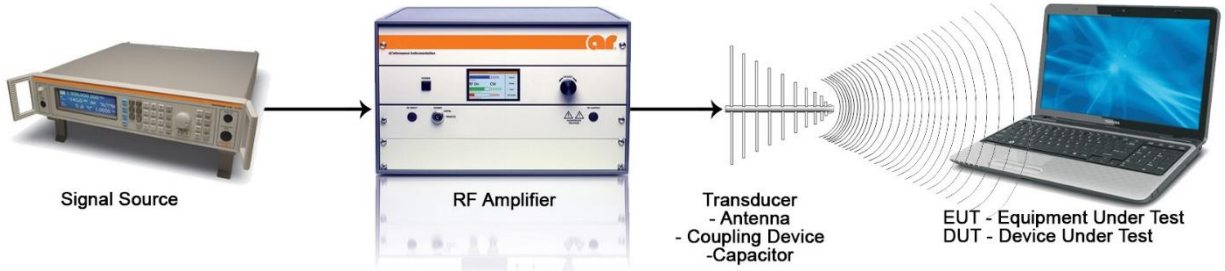
Closed Loop

- Field is measured & leveled during testing

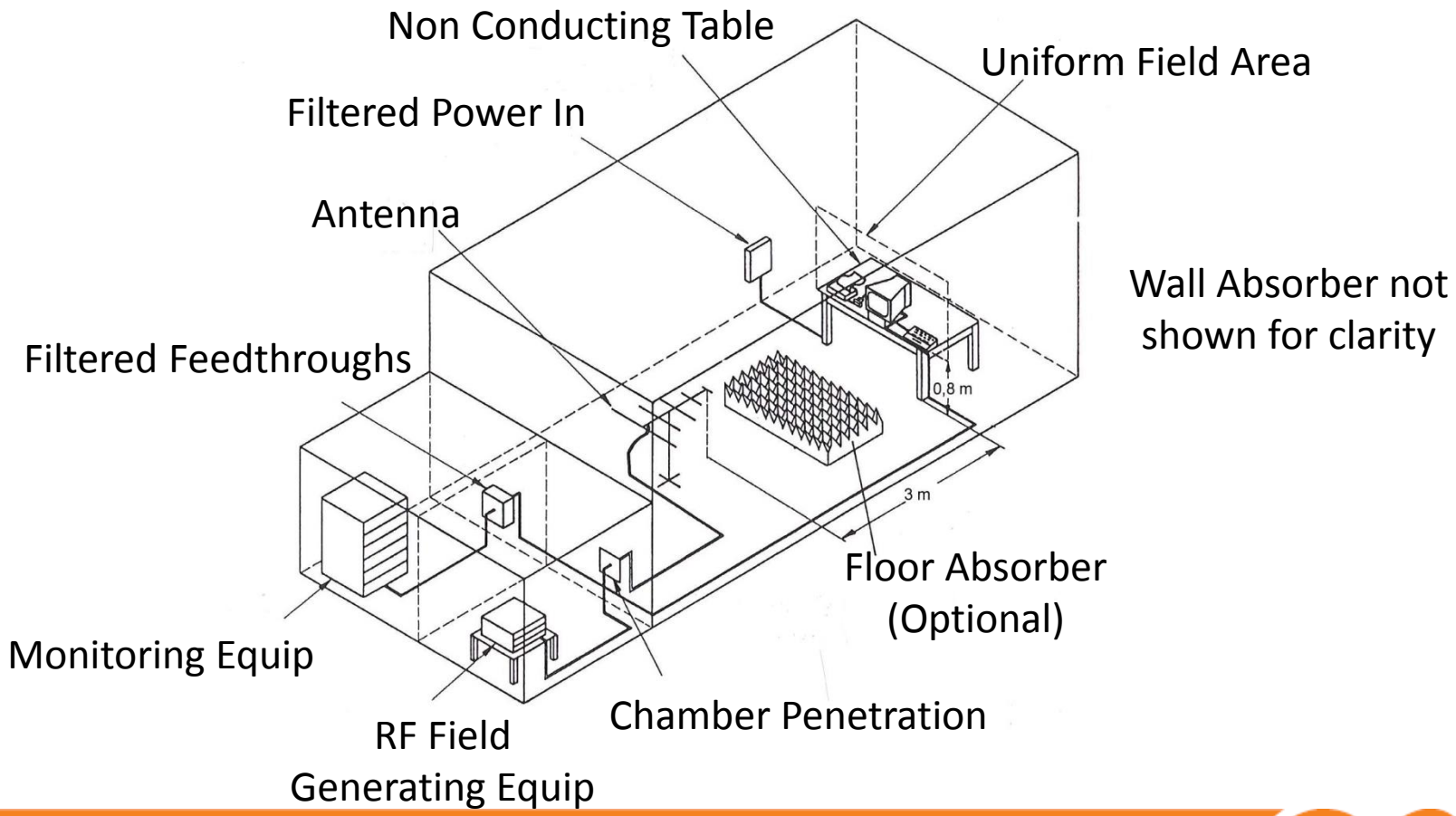


Substitution

- A calibrated field is applied during testing

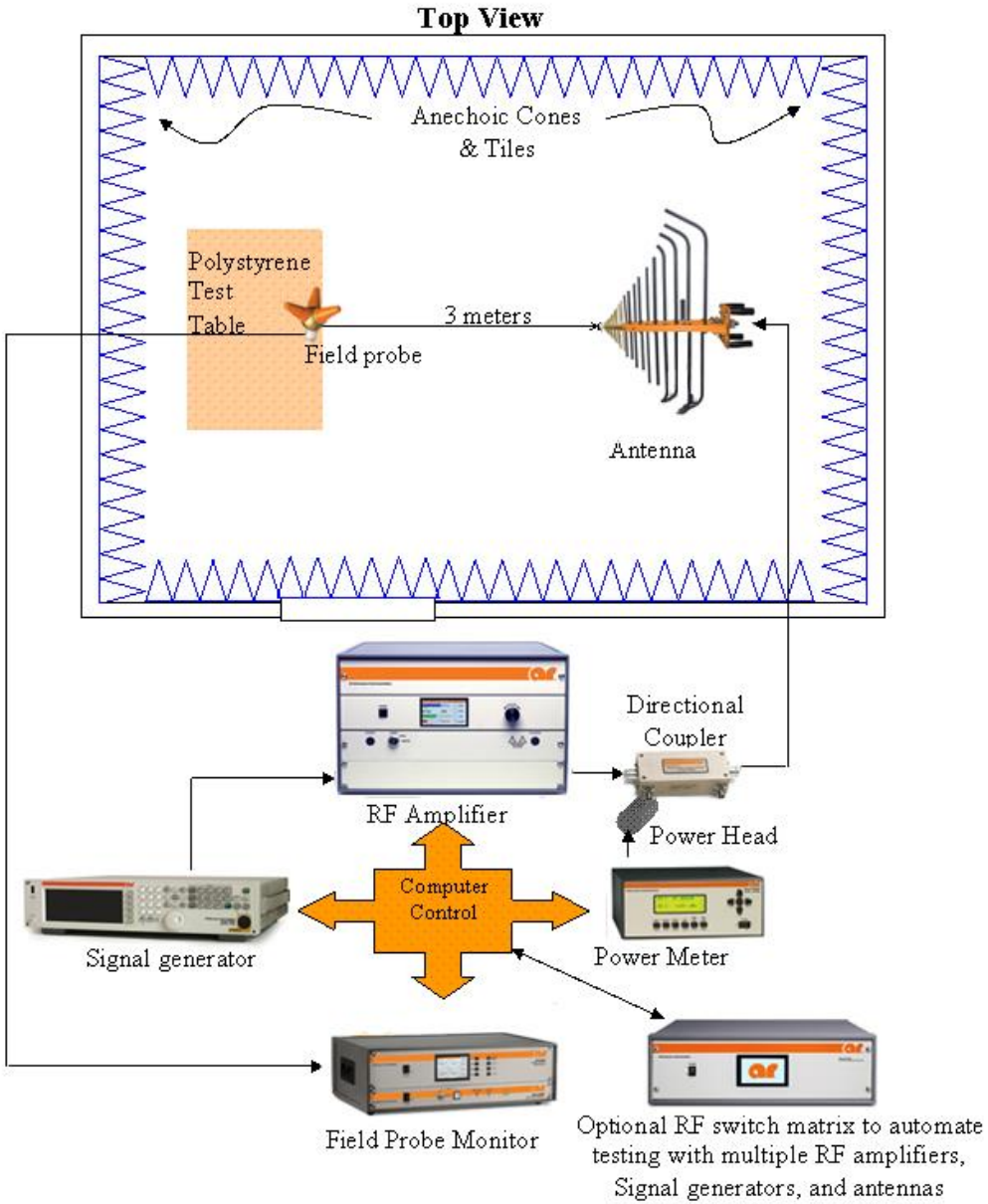


Radiated Immunity Test Set Up



Radiated Immunity

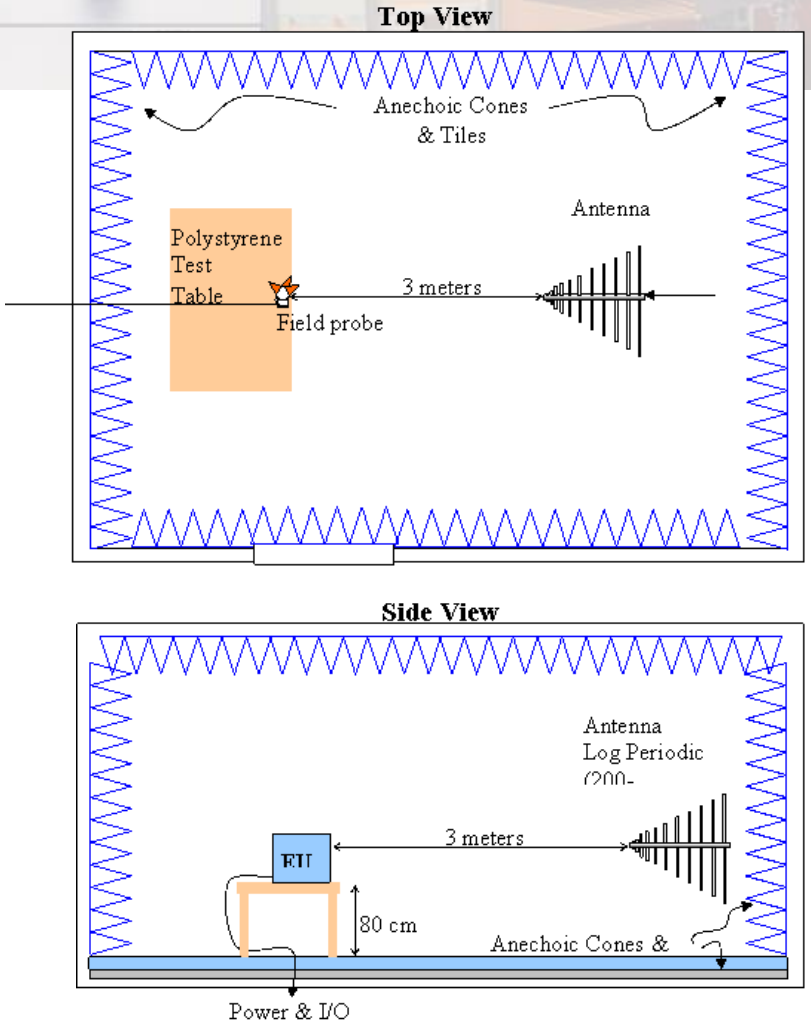
Typical test setup
Anechoic Chamber
IEC 61000-4-3



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)



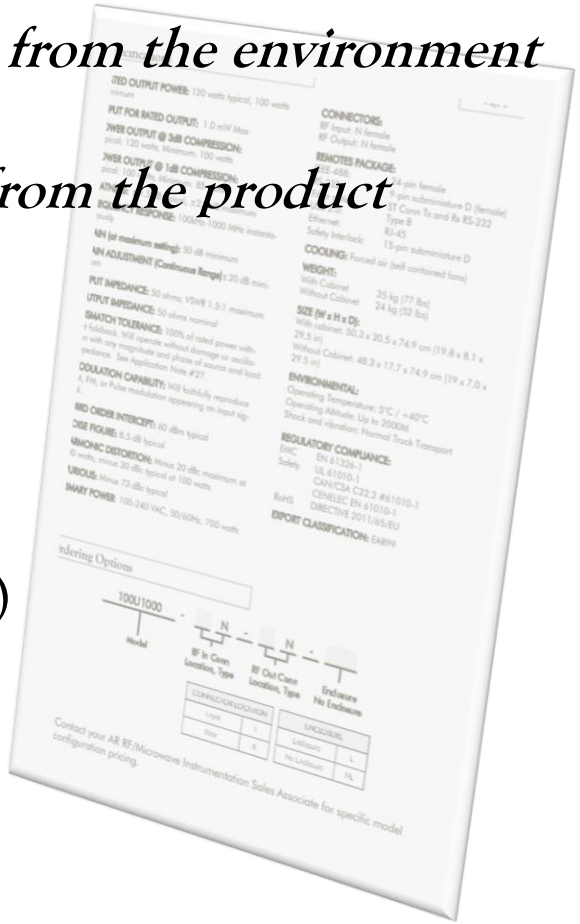
EMC Standards Overview

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

Radiated Immunity

- IEC 61000-4-3
- MIL-STD-461, RS103
- MIL-STD-464
- DO-160, Section 20
- ISO 11451, ISO 11452-2

Radiated Emissions

- CISPR 11, 22, 25, 32
- MIL-STD-461, RE102
- DO-160, Section 21

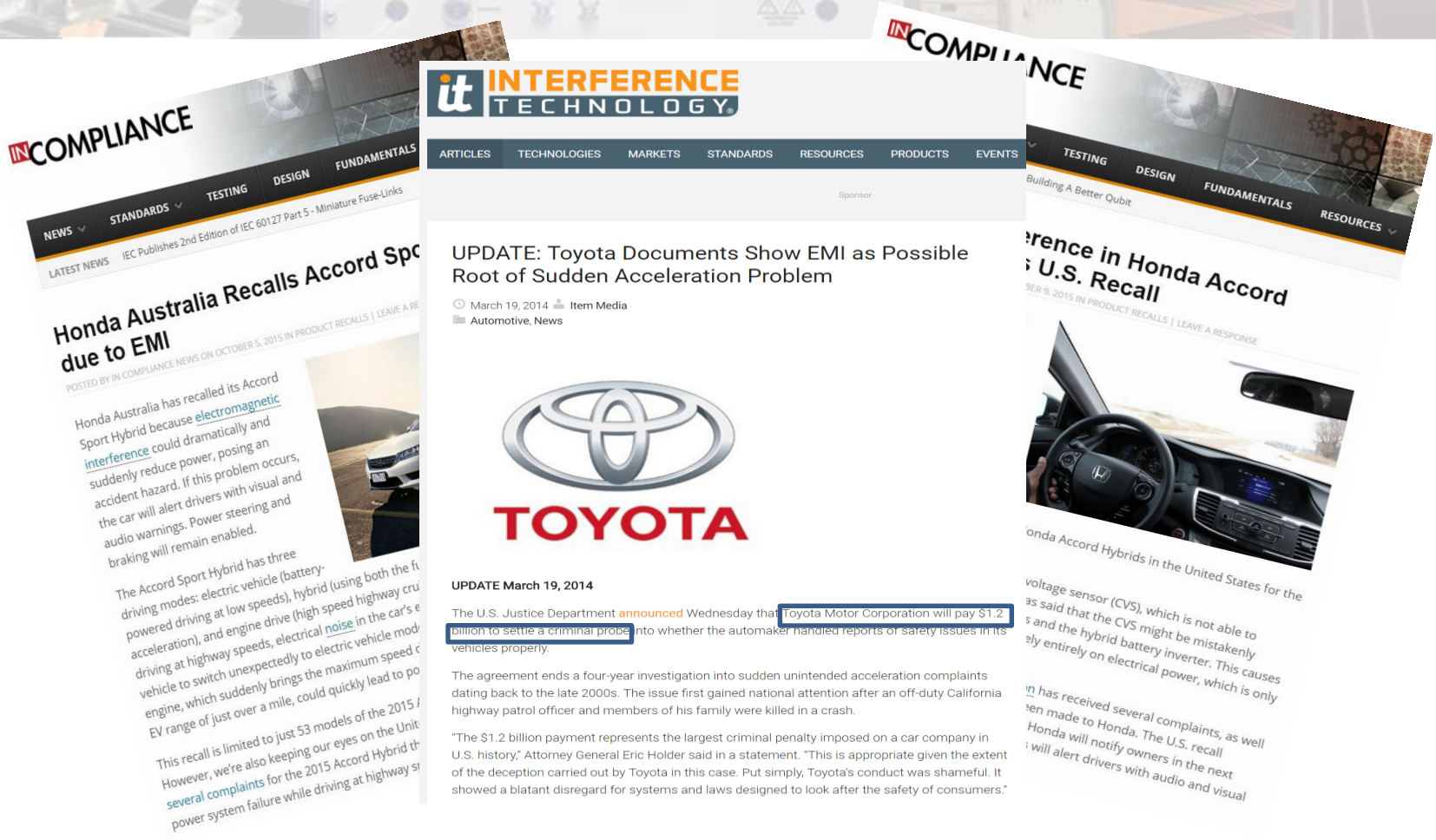
RF Conducted Immunity

- IEC 61000-4-6
- MIL-STD-461, CS114
- DO-160, Section 20
- ISO 11452-4

Conducted Emissions

- CISPR 11, 22, 25, 32
- MIL-STD-461, CE101, CE102
- DO-160, Section 21

Why do we need all this testing?



Questions?

THANK YOU!