



# EMC 101

## What, Why, How

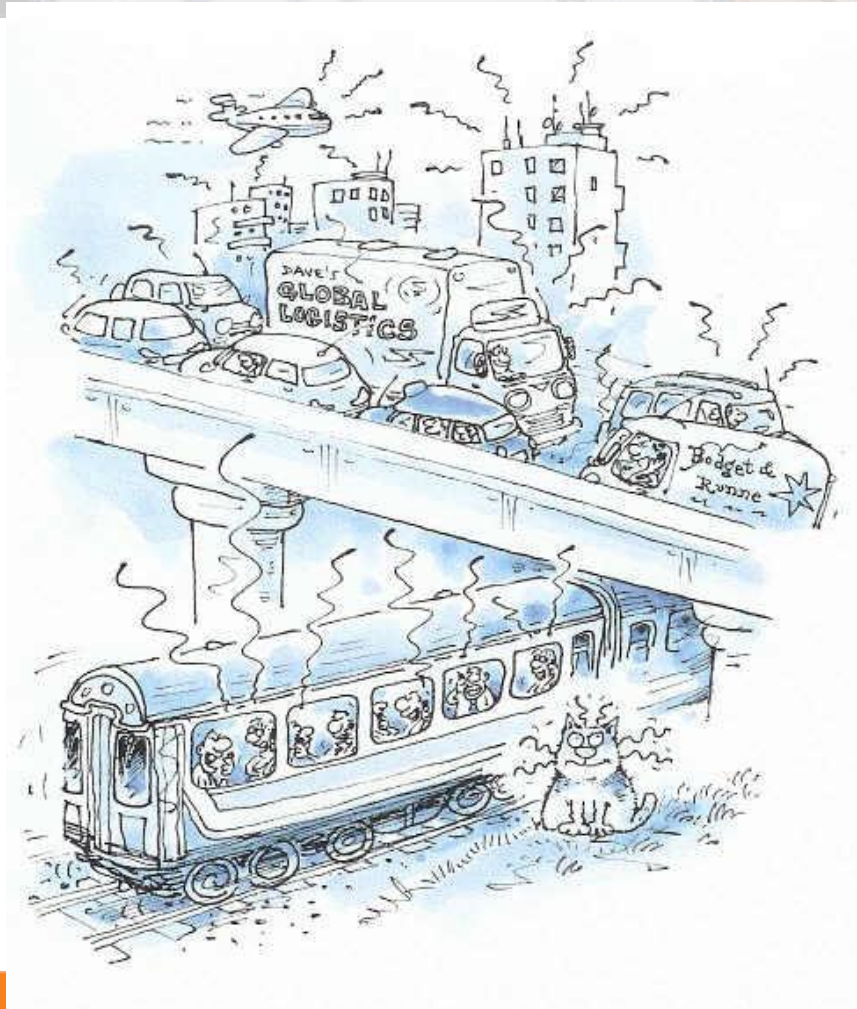
Presented by:  
Chuck Britten  
Amplifier Research



**rf/microwave instrumentation**

Other **ar** divisions: modular rf • receiver systems • ar europe

# 1<sup>st</sup> There was RF – Then Came RF Interference



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# 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

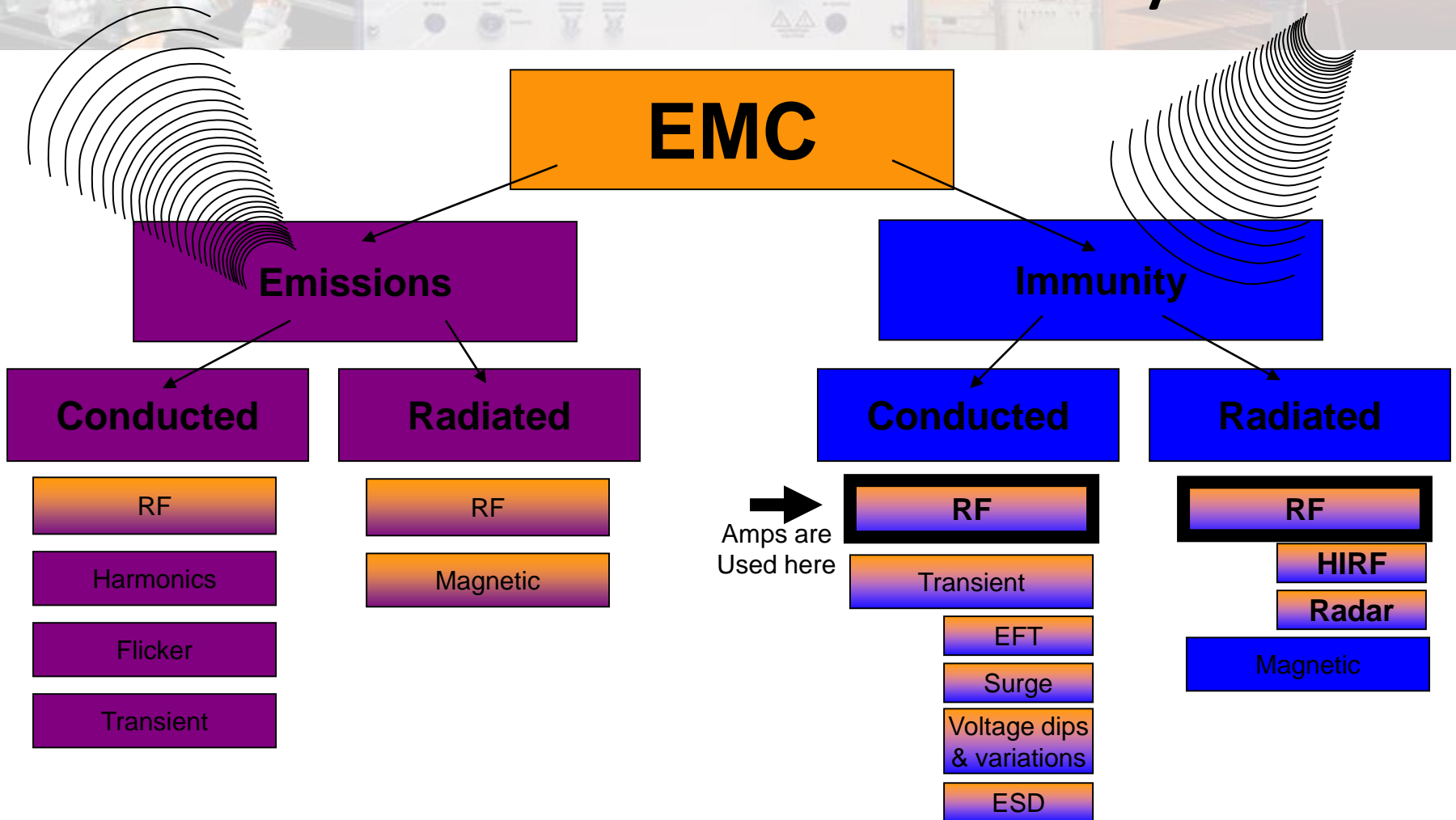


# Types of EMC Testing

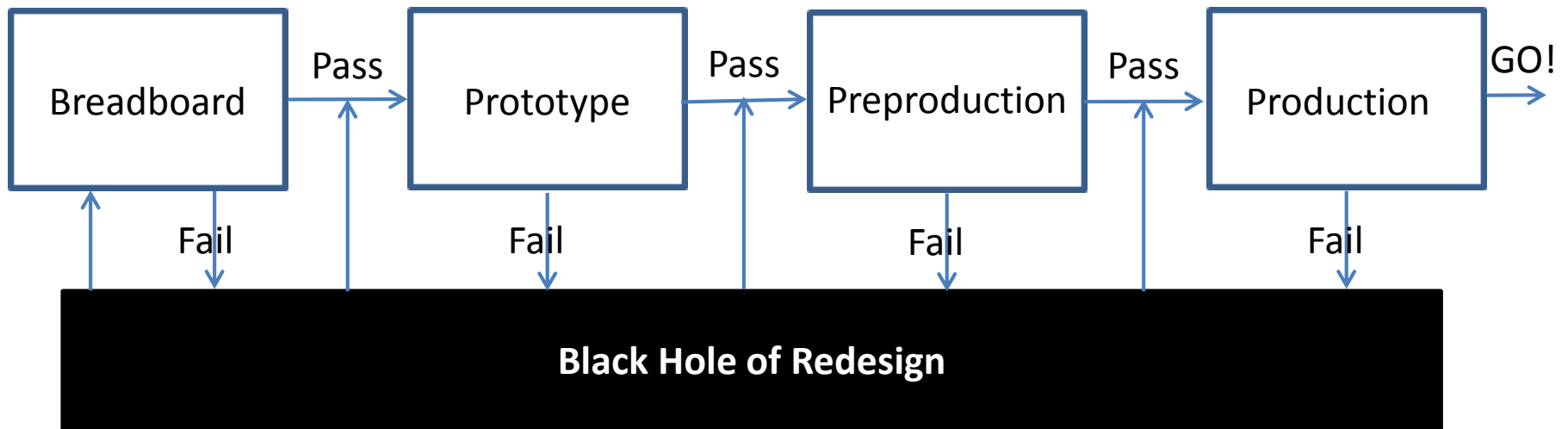
- CE – Conducted Emissions
- RE – Radiated Emissions
- CI/CS – Conducted Immunity/Susceptibility
  - Bulk Current Injection
- RI/RS – Radiated Immunity/Susceptibility
- Related Tests
  - ESD (Static) & Transients (Burst, Surge, Interrupts)



# Emissions vs. Immunity



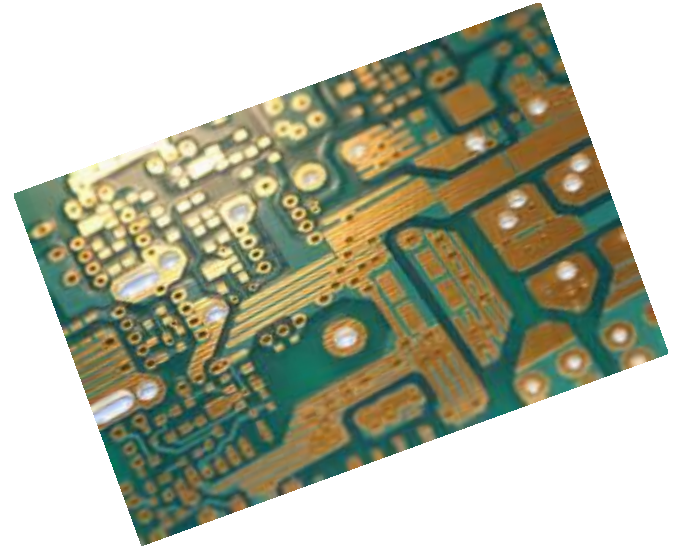
# Product Development Cycle





# Primary EMI Fixes

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



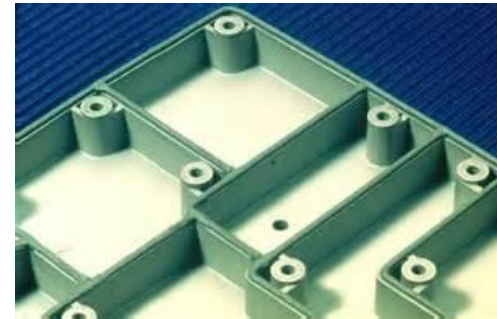
# Primary EMI Fixes



Ferrite Bead



Finger Stock, Mesh Over Foam, Vents,  
Gaskets



Gasket on Conductive  
Plastic



"Cans"



Power Line Filter



# Pre-Compliance vs. Compliance

## Compliance Labs

- Accredited
- In-House or 3<sup>rd</sup> Party

## Pre-Compliance

- Anything less than accredited
- Quick Scans to Full Tests



# In-House or 3<sup>rd</sup> 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 3<sup>rd</sup> Party Labs

- 3<sup>rd</sup> Party Lab Advantages
  - Accredited and trained personnel
  - Have the equipment
  - Run the tests often
  - Know the Certification System and Procedures
  - Reality check
- 3<sup>rd</sup> Party Lab Disadvantages
  - Cost
  - Scheduling



# In-House or 3<sup>rd</sup> 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)



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# Radiated Emissions Test Set Up



Anechoic Chamber



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# Radiated Emissions Test Set Up



Semi-Anechoic 10m Chamber



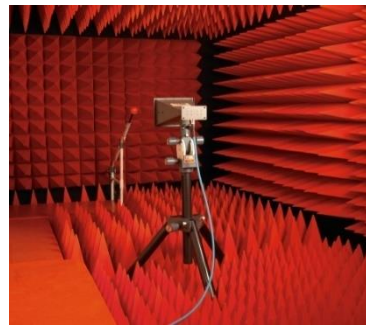
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# Test Equipment Needs (RE)



Horn And Log-periodic Antennas



Anechoic Chamber



Preamplifiers



EMI Receiver

# Test Equipment Needs (CE)



Current Clamps and LISNs

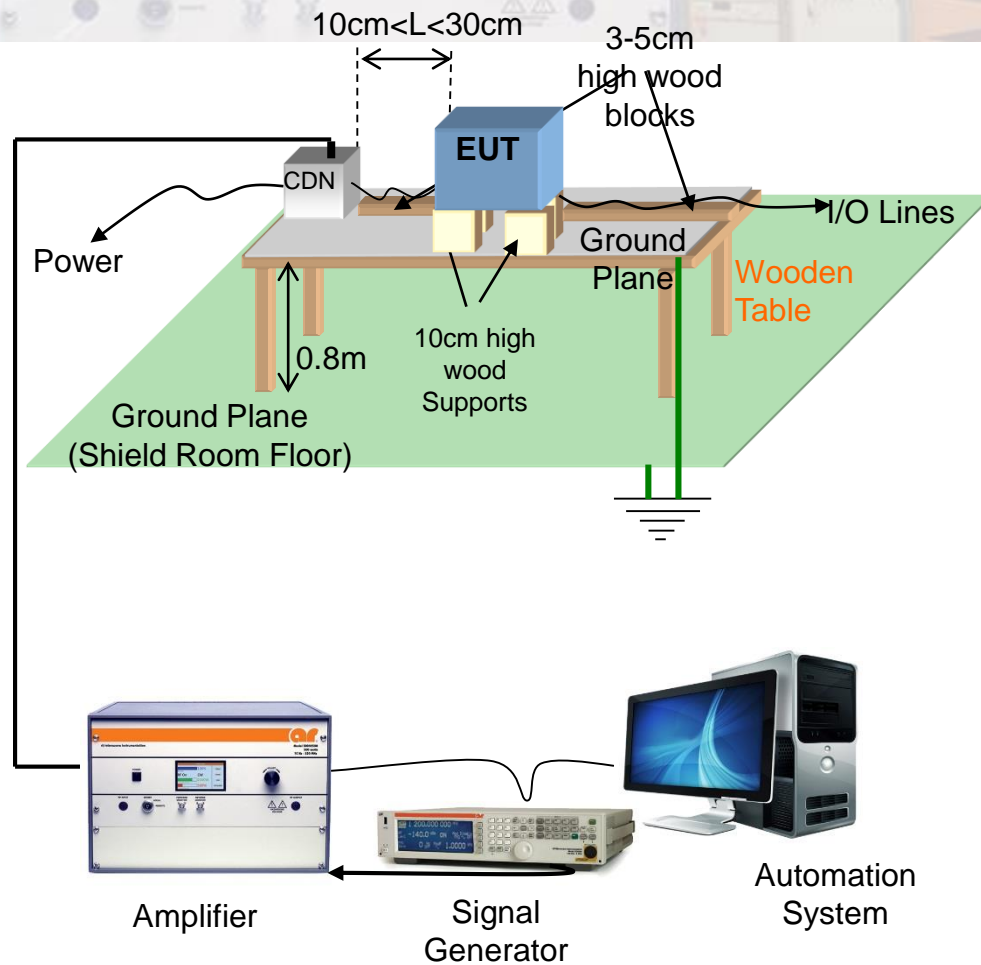


Transient Limiters



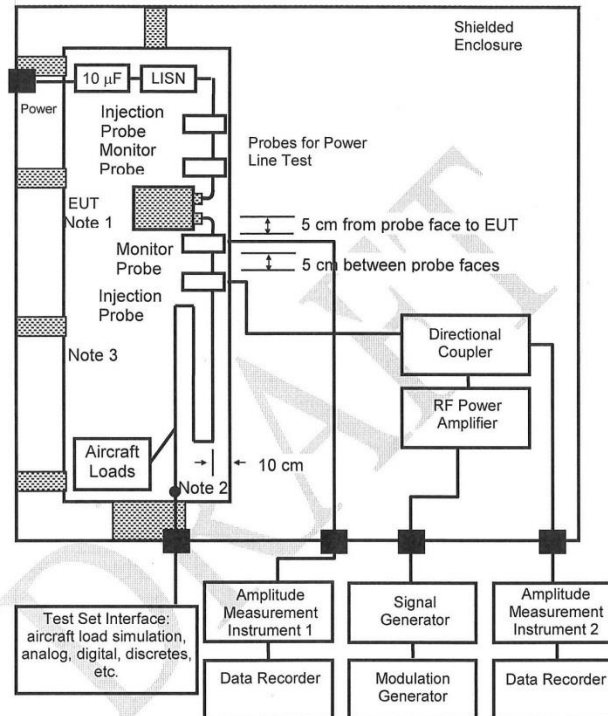
EMI Receiver

# 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

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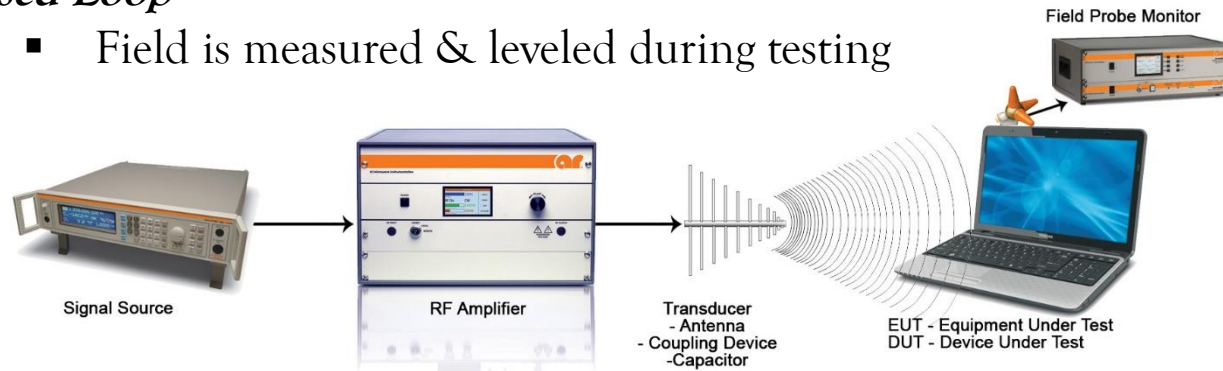
Other ar divisions: modular rf • receiver systems • ar europe

# Radiated Immunity

## 2 Methods

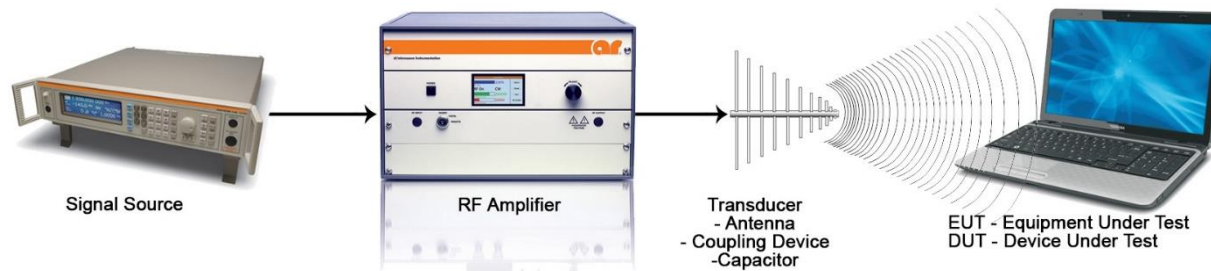
### *Closed Loop*

- Field is measured & leveled during testing

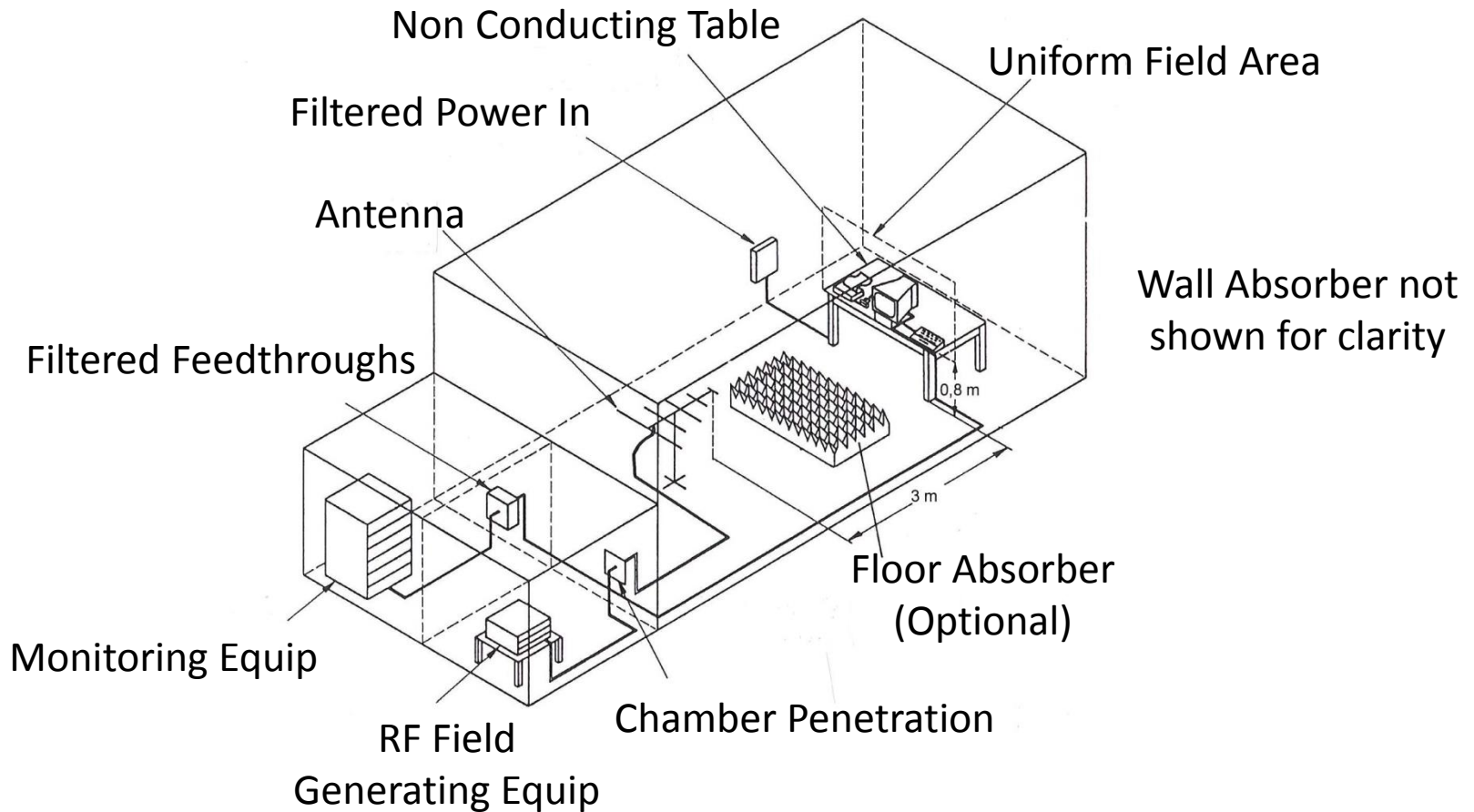


### *Substitution*

- A calibrated field is applied during testing



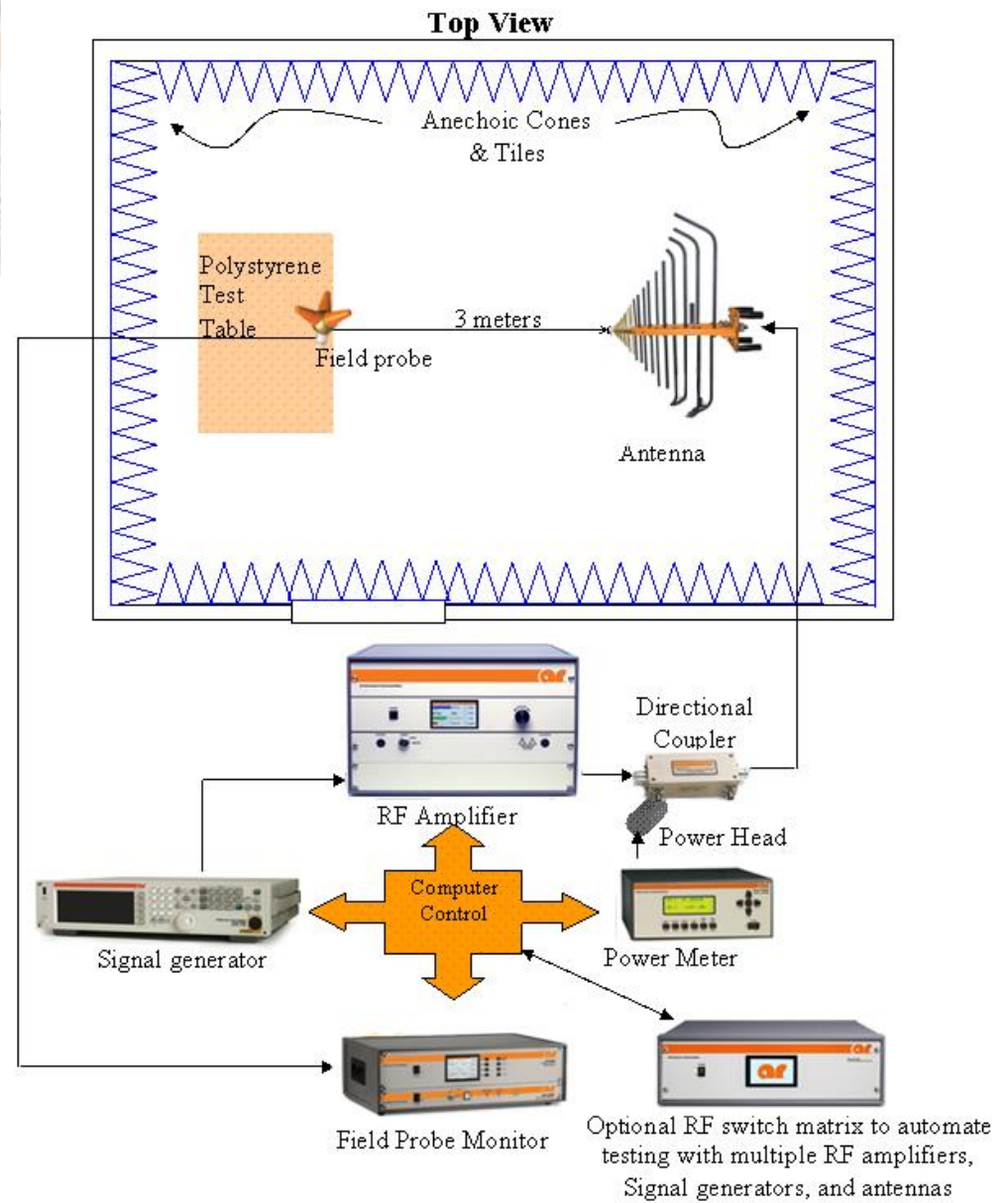
# Radiated Immunity Test Set Up





# Radiated Immunity

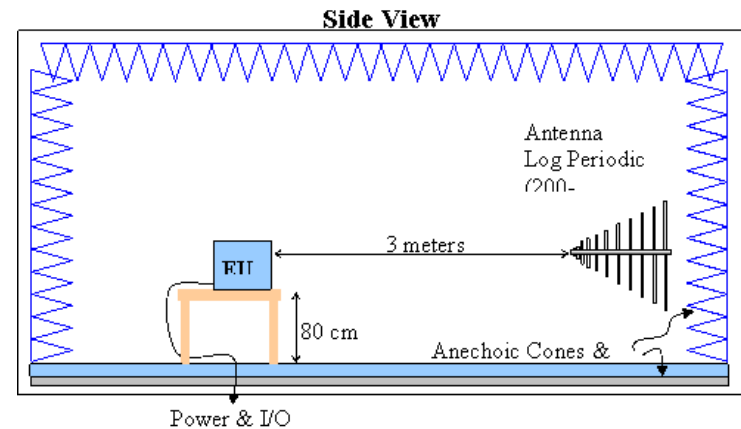
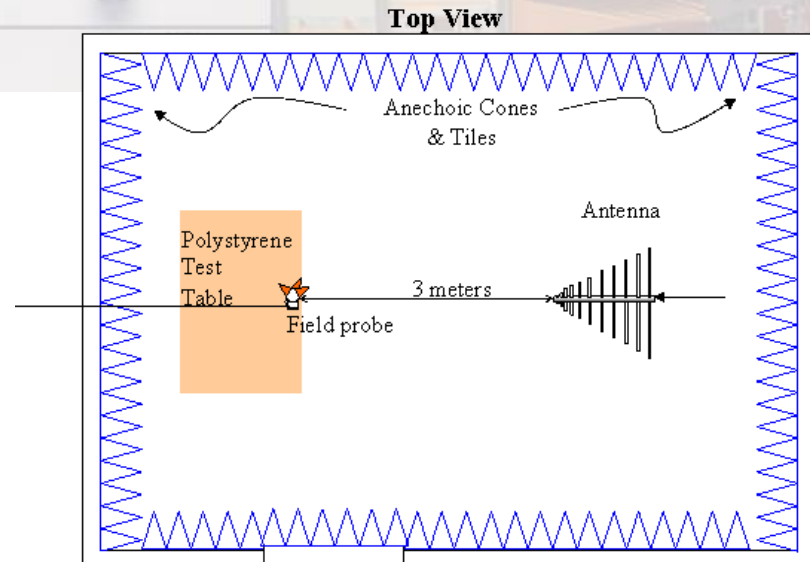
Typical test setup  
Anechoic Chamber  
IEC 61000-4-3



# 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)



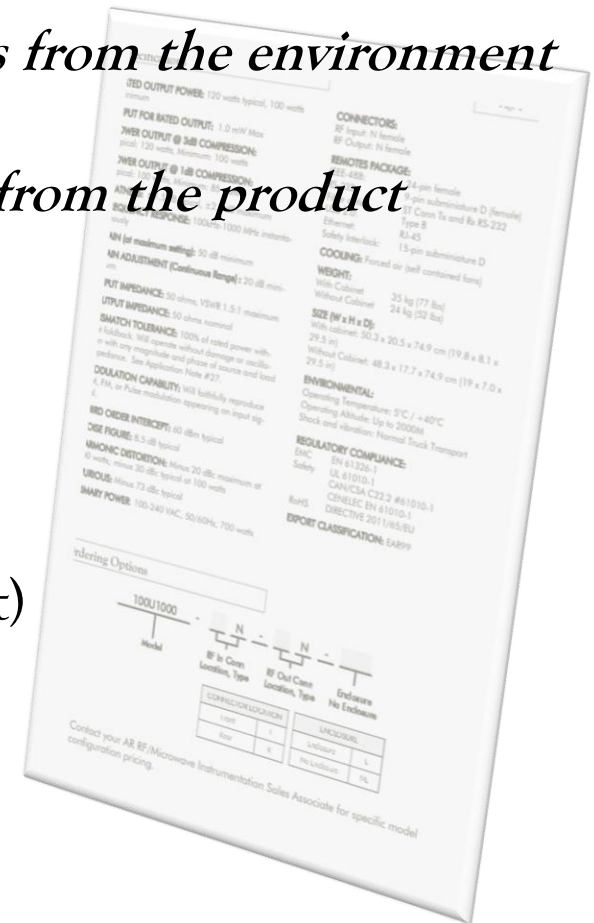
# EMC Standards Overview

*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?

IN COMPLIANCE

NEWS STANDARDS TESTING DESIGN FUNDAMENTALS

LATEST NEWS IEC Publishes 2nd Edition of IEC 60127 Part 5 - Miniature Fuse-Links

## Honda Australia Recalls Accord Sport due to EMI

Honda Australia has recalled its Accord Sport Hybrid because **electromagnetic interference** could dramatically and suddenly reduce power, posing an accident hazard. If this problem occurs, the car will alert drivers with visual and audio warnings. Power steering and braking will remain enabled.

The Accord Sport Hybrid has three driving modes: electric vehicle (battery-powered driving at low speeds), hybrid (using both the battery and engine drive (high speed highway cruising at high speeds, electrical noise in the car's engine, which suddenly brings the maximum speed of the vehicle to just over a mile, could quickly lead to power system failure while driving at highway speeds).

This recall is limited to just 53 models of the 2015 Accord Sport Hybrid. However, we're also keeping our eyes on the United States where several complaints for the 2015 Accord Hybrid that power system failure while driving at highway speeds.

it INTERFERENCE TECHNOLOGY

ARTICLES TECHNOLOGIES MARKETS STANDARDS RESOURCES PRODUCTS EVENTS

## UPDATE: Toyota Documents Show EMI as Possible Root of Sudden Acceleration Problem

March 19, 2014 Item Media Automotive, News



### UPDATE March 19, 2014

The U.S. Justice Department announced Wednesday that Toyota Motor Corporation will pay \$1.2 billion to settle a criminal probe into whether the automaker handled reports of safety issues in its vehicles properly.

The agreement ends a four-year investigation into sudden unintended acceleration complaints dating back to the late 2000s. The issue first gained national attention after an off-duty California highway patrol officer and members of his family were killed in a crash.

"The \$1.2 billion payment represents the largest criminal penalty imposed on a car company in U.S. history," Attorney General Eric Holder said in a statement. "This is appropriate given the extent of the deception carried out by Toyota in this case. Put simply, Toyota's conduct was shameful. It showed a blatant disregard for systems and laws designed to look after the safety of consumers."

IN COMPLIANCE

TESTING DESIGN FUNDAMENTALS RESOURCES

Building A Better Qubit

## Interference in Honda Accord Hybrid U.S. Recall



Honda Accord Hybrids in the United States for the

voltage sensor (CVS), which is not able to as said that the CVS might be mistakenly s and the hybrid battery inverter. This causes sly entirely on electrical power, which is only

in has received several complaints, as well ten made to Honda. The U.S. recall Honda will notify owners in the next : will alert drivers with audio and visual





# Questions?



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# THANK YOU!



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