

Effective EMC Test Planning And Performance



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Common Mistakes

- Not Understanding EUT Operation
- Improper Grounding Of EUT
- Improper Harnessing
- Poorly Defined EUT Susceptibility Criteria
- Specifying Non-Valued Added Tests
- Not Understanding The Intent Of Specific Tests
- Improper Design of EUT Monitoring Equipment
- Overly Dependent On Boilerplate Test Procedures
- Not Following Test Procedure
- Writing Poor Test Reports

Successful EMC Test Planning

- Understand How The EUT Works
 - Operational Modes
 - Interface Signal Types
 - Amplitude
 - Frequency
 - Timing
- Select Proper Operational Modes By Test
 - Noisy Modes For Emissions Tests
 - Critical Modes For Susceptibility Tests
 - Any Finite EUT Processing Loops To Consider?
- Understand How EUT Test Equipment Works
 - Will It Support The EMC Tests?
 - Unique Power Requirements
- Test Equipment EMC Design Considerations
 - Will Test Equipment Influence Test Results?
 - What Modifications MUST Be Made To Enable This?
- EUT Harnessing
 - Use Same Type That EUT Will Use In The Actual Installation

Successful EMC Test Planning (Continued)

- EUT Grounding
 - Conductive Ground Plane
 - Composite Ground Plane
 - No Ground Plane
- EUT Power Return
 - Thru Chassis
 - Dedicated Wire Return
- Carefully Select Meaningful Susceptibility Criteria
 - That Can Be Monitored
- Write Useful EMC Test Procedures
 - Don't Rely Heavily On Boilerplate EMC Test Procedures
 - Understand The Intent Of Every Test
 - Use Writing Test Procedure As A Means To Plan For A Smooth Running EMC Test
 - Use Detailed Diagrams Of Connections And Interfaces To EUT Test Equipment
 - Determine If Special Test Aids or Fixtures Are Required
- Follow The Approved EMC Test Procedure
 - Document Deviations
 - Keep EMC Test Logbook

Harnessing

- Should Be Representative Of Actual Installation
 - No Shielding
 - Wrap Cables With Al Foil To “Pass” The Test
 - Too Much Shielding
 - Masks Problems
 - “Pass” At ALL Costs -vs- Find Problems
- Usually Overlooked Prior To Test
 - Questionable Test Results Likely

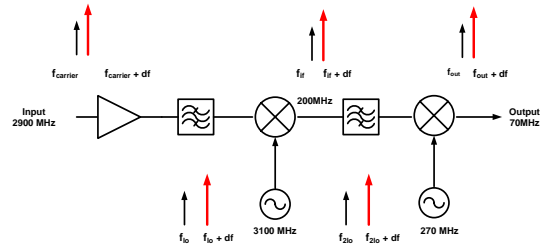
EUT Grounding

- Is EUT Mounted On Conductive or Non-Conductive Surface?
 - Test Setups Should Incorporate This Fact
- Single Point or Multi-Point Ground?
 - Often A Source Of Confusion
 - Improper Configuration Will Yield Different Results

EUT Operation

- How Does The EUT Work?
- KEY Performance Parameters
- Typical Operational Modes
 - Which Mode(s) Are Most Susceptible?
- Critical Frequencies of System and EUT
 - Pick Test Frequencies Just “OFF” Critical Frequencies

System Block Diagram



Define Susceptibility Criteria

- Parameters To Be Monitored Must Be Determined Ahead Of Time
- Which Signals Are Critical To EUT Operation
- Neglecting Out of Band Requirements
 - Same As In-Band Requirements
 - May Be Too Conservative
 - Increased Test Time and Cost

Sample Susceptibility Criteria

- Power Supplies
 - Voltage Ripple on Secondary Voltages
 - DC Regulation
- Amplifiers
 - AM Modulation Of Carrier
 - Direct Frequency Response
 - Non-Linearities (Overload, Intermodulation Products)
- Scientific Instruments
 - Corruption of Data
 - Undesired Activation Of Mechanical Parts
- Receivers and Telemetry Units
 - Signal Lock
 - Bit Error Rate (BER)
- Controllers
 - Sensor Inputs
 - Mode Switches
 - False Commands
- Frequency Sources
 - Close In Phase Noise
- Sensors (Sun, Earth, Star Tracker, Gyros, Inertial Reference Units)
 - Offset Errors
 - Pointing Error
 - Data Corruption

Only Specify Value Added Tests

- Understand The Intent Of Every Test
- Understand Which Tests To Specify
- Understand Which Tests Aren't Applicable
- Limiting The Frequency Range of Test Where Appropriate
 - However, Sometimes It Is Easier And More Cost Effective To Do The Test Than Argue!

Improve EMC Test Setups

- Not Understanding The Limitations Of The Test Equipment
 - Know Your Test Equipment!
- Understand Test Amplifier Characteristics
 - Frequency Range
 - Power (input, output, maximum)
 - Intermodulation
 - Broadband Noise
- Understand EMI Receiver Characteristics
 - Maximum Input Power
 - 1 dB Compression
 - Linearity Specifications
 - Overload Conditions
 - Sweep time to Resolution Bandwidth
- Understand The Effects Voltage Probes Can Have On Accuracy

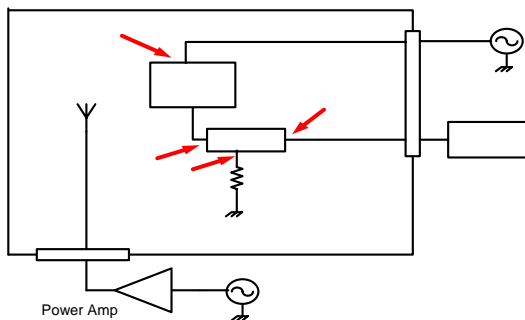
Review EMC Design Of EUT Monitoring Equipment

- Good EMC Design Practices Must Also Be Applied To EUT Monitoring Equipment!
 - Practice What We Preach!
- Prevent Monitoring Equipment From Being The Dominant Noise Source
- Prevent Monitoring Equipment From Inducing EUT Susceptibility
- Prevent Monitoring Equipment From Being Susceptible
- Analyze Susceptibility Test Signal Coupling Paths

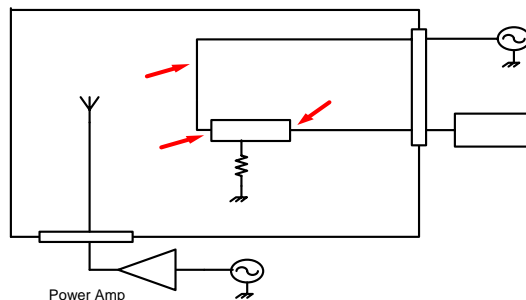
Estimate Required RF Isolation

- Review EUT Intentional Signal Levels
- Review EUT Susceptibility Levels
- Focus In On Lowest Signal Levels In Measurement Chain
- Determine Worst Case RF Susceptibility Test Levels
- Calculate Received Isotropic Power (RIP) At EUT Operating Frequency
- Compare Lowest Signal Levels To RIP
- Estimate Required Isolation
- Adjust Test Setup If Required Isolation >70 - 80 dB
 - Check Adapters, Cables, Waveguide Flanges, Couplers, RF Switches and Attenuators
 - Minimize Connections Where Possible

Potential RS103 Leakage Points



Check RF Leakage of Test Setup

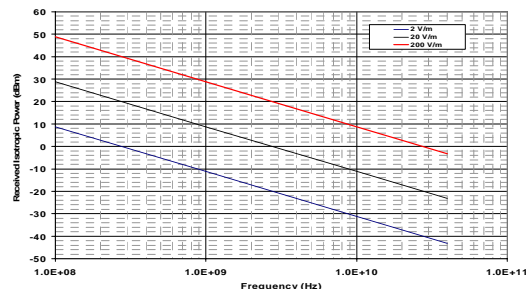


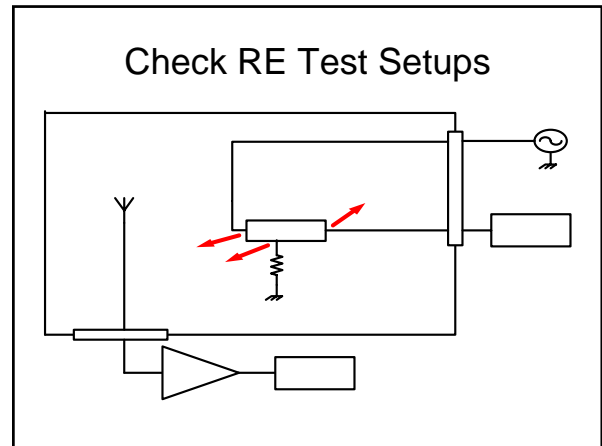
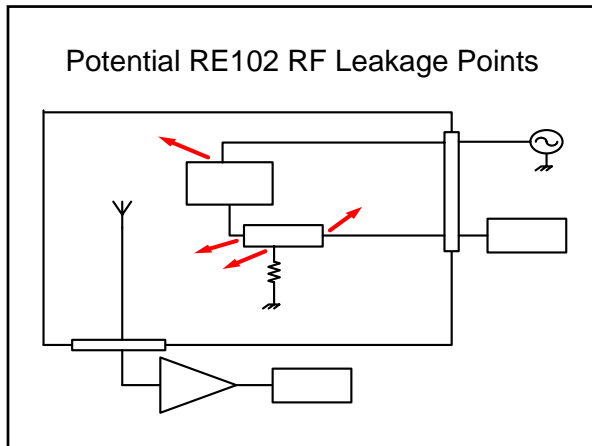
Sample Isolation Budgets

Spur Requirement	-55 dBc
E-Field Level	20 V/m
EUT Frequency	2 GHz

		Spur Level (dBm)	RIP (dBm)	Isolation (dB)
Pinput	-2 dBm	-57	3	60
EUT Gain	55 dB	0		
Poutput	53 dBm	-2	3	5
Coupling Factor	40 dB	-15		
Coupler Output	13 dBm	-42	3	45

Received Isotropic Power





- ### Test Performance
- Follow Test Procedure As Written
 - If Deviations Are Necessary
 - Consult With Proper Authority
 - Document All Deviations
 - Redline The Test Procedure

- ### Troubleshooting
- Carefully Review Test Data Prior To Performing Troubleshooting
 - Make Sure There Is Problem With EUT
 - Make Sure Test Equipment Is Not The Culprit
 - Make Sure Test Requirements Are Correct
 - Carefully Plan Your Troubleshooting Approach
 - Only Change ONE Variable At A Time!
 - Have An Idea Of What To Expect
 - Make Sure Cause/Effect Is Repeatable

- ### Test Reports
- Keep A Detailed Test Log (You Will Soon Forget What You Just Did!)
 - Document Special Configurations
 - Document Troubleshooting Configurations
 - Test Equipment List
 - Model Numbers
 - Serial Number
 - Calibration Due Dates
 - Summarize Tests Performed And Results
 - Tests Passed
 - Tests Failed
 - Test Setup Photographs
 - Document Test Setup Details
 - Take Useful Photos But Don't Overload It With Photos!
 - Test Data
 - Tabular Form For Susceptibility Test Data
 - X-Y Plots of Emissions Test Data
 - Carefully Annotate Plots With Test Point, Operational Mode, Antenna Polarization, Time, and Date
 - Transducer Factors
 - Antenna Factors
 - Current Probe Transfer Impedance
 - Low Noise Amplifier Gain
 - Test Cable Insertion Loss
 - Copy of Redlined Test Procedure

- ### Summary
- Successful EMC Tests Are Possible
 - Careful Preparation Necessary
 - EUT Operation Must Be Understood
 - EUT Test Equipment Must Not Influence Test Data
 - Thorough EMC Test Procedures Are Required
 - Documenting What Was Done Is VERY Important
 - Redline EMC Test Procedure
 - Troubleshooting Must Be Disciplined
 - Always Keep A Detailed Test Logbook