

# Design with EMI in Mind: Test Early, Test Often

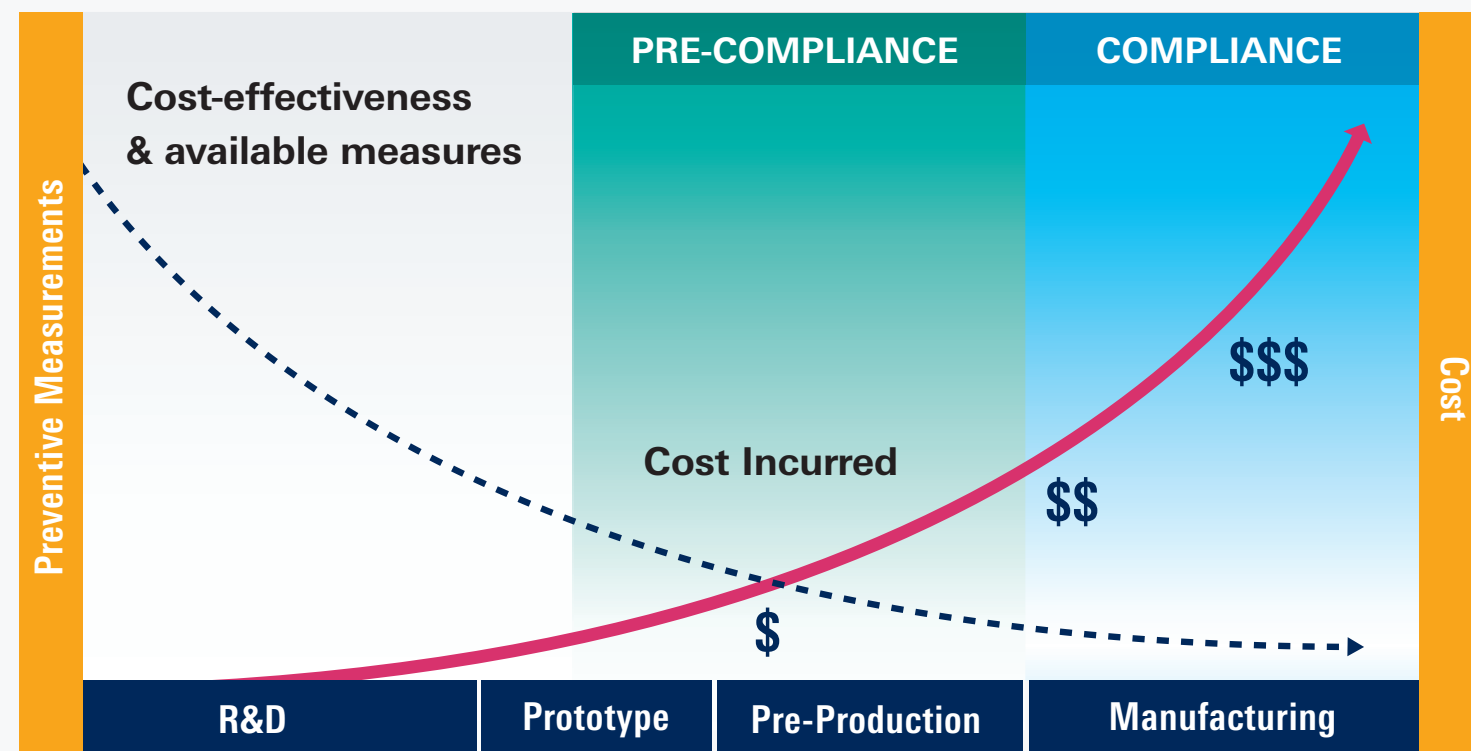


## Design Considerations

## Prototyping & Debug

## Solutions

### VALUE OF SOLVING EMI PROBLEMS EARLY IN THE CYCLE



Solving EMI problems early in the design cycle is more cost effective than solving them later. This is an iterative process of employing best practices and checking. Of course, this is a trade off – this needs to be balanced against functionality and schedule. But solving problems & verifying early helps reduce cost.

#### EMI Design Checklist

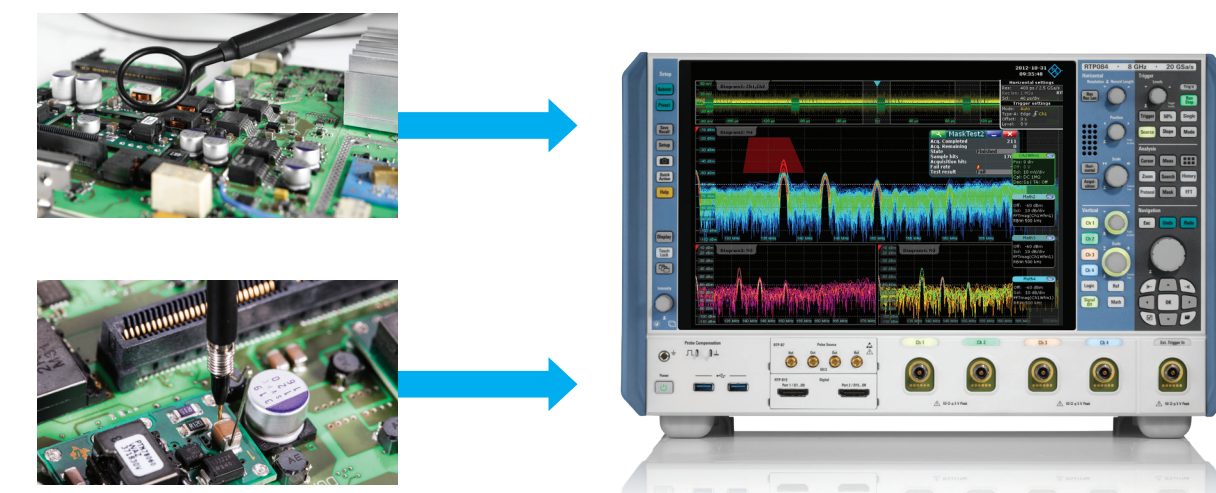
<b>PC board Partitioning</b>	Digital, analog, power, RF, motor control, etc., should be located in separate partitions on the board.
<b>Power Circuitry</b>	Should be located close to the power entry of the board. This will keep associated return currents separated.
<b>Connectors</b>	Group all power and I/O connectors located close together and along the same side of the board.
<b>Filtering of power line and I/O</b>	Filter circuits should be located very close to their respective power or I/O connector.
<b>PC board Stack-up</b>	All signal layers and power planes (or routed power) should have an adjacent return plane.
<b>Crossing through multiple planes</b>	All critical signals passing through multiple planes should have adjacent stitching vias between planes (multiple ground return planes) or stitching capacitors between planes (multiple ground return and power planes).
<b>Crossing return plane gaps</b>	High frequency signals should never cross gaps or slots in the return plane, which can lead to EMI.
<b>Cable shield termination</b>	Cable shields should be bonded in short paths to the EUT enclosure. This is easiest to accomplish if all I/O and power connector shells are bonded directly to the EUT enclosure.
<b>Bare PC boards</b>	Power up and measure radiated EMI for a baseline emissions. This will help when testing the rest of the device without the use of an enclosure provided the antenna and RF background environment stays constant.
<b>Power Supplies</b>	Characterize and test 3rd party supplies for radiated and conducted emissions. Use both active and passive loads to select the best power supply for EMI.
<b>LCD Displays</b>	Ensure shielding and ability for multiple bond places. Watch RGB or LVDS video cable pinouts for EMI issues. Test these early in the design process.
<b>HDD's</b>	Test for emissions early in the design process before committing to a vendor.

### EMI DEBUG

Scope, Spectrum Analyzer, or PreCompliance Receiver

A Receiver has the best dynamic range & is closest to the full compliance receiver. A spectrum analyzer is great but less dynamic range for this application. A scope has the least dynamic range, but can be a great troubleshooting tool to understand more about the unwanted signals causing problems.

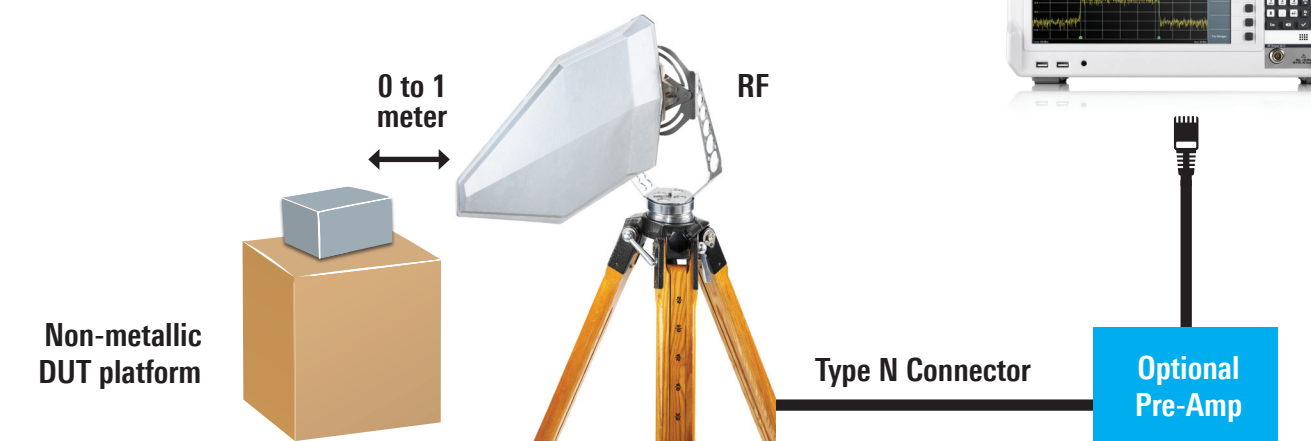
- Near field and probing measurements
- Ideal for debugging with both time and frequency base trigger capabilities
- Instrument dynamic range can be important depending on your DUT's output power & potential limits.



### PRECOMPLIANCE

Why do PreCompliance testing

- ✓ Avoid unexpected results in test labs during EMC compliance tests
- ✓ Identify surprises before real problems occur
- ✓ Use near-field and current probes to locate interference sources



#### PRECOMPLIANCE SETUP

The goal is to get as close as possible to the compliance chamber & obtain results that will correlate. The DUT is placed on a non-conductive platform and the antenna is also held by a non-conductive tripod. The DUT is powered on so the radiated emissions can be measured with a spectrum analyzer. If background signals are too large, consider using a chamber, screen room, or test enclosure. On the spectrum analyzer, use the appropriate limit lines if you can obtain similar signal conditions like those found in the compliance chamber. This test is for Radiated emissions. Note that many people also check Conducted emissions as well as using a LISN, as shown below in the Certification section.

#### Analyzing EMI with an Oscilloscope

- High capture bandwidth and easy navigation in frequency domain
- Overlap FFT implementation with color-coded display of spectral components
- Gated FFT for correlated time-frequency analysis
- Capturing sporadic events with the zone trigger measurement tasks
- Remote control of V-networks (LISN) via built-in AUX port

#### Analyzing EMI with a Spectrum Analyzer

- Standard-compliant EMI detectors: peak, quasi-peak, CISPR-average, RMS-average
- EMI bandwidths for commercial and military standards
- Limit lines and transducers for typical measurement tasks
- AM/FM audio demodulation for easier identification of interferers
- Remote control of V-networks (LISN) via built-in AUX port

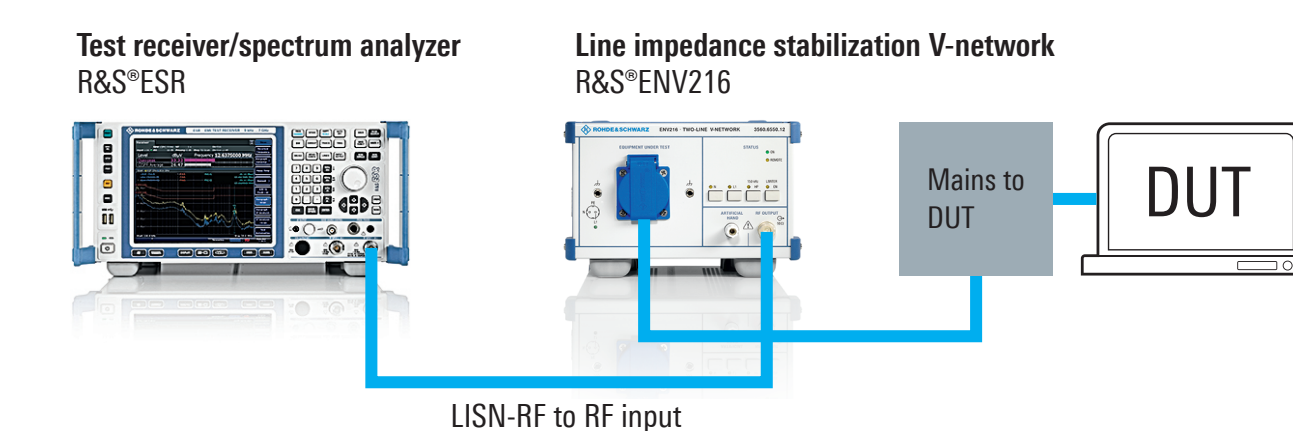
## Certification

### FULL-COMPLIANCE

#### RADIATED EMISSIONS TEST

Rohde & Schwarz supports all relevant commercial, automotive, military and aerospace standards, as well as ETSI and FCC standards for radiated spurious emissions.

#### CONDUCTED EMISSIONS TEST



A LISN (line impedance stabilization network) placed between an AC or DC power source and the EUT creates a known impedance, provides an RF noise measurement port and isolates unwanted RF signals from the source.



#### EXPLORE OUR EMC SOLUTION

From standalone instruments to customized turnkey solutions and for any kind of DUT, Rohde & Schwarz offers you a variety of solutions. Exploring our new **Interactive EMC Solution** allows you to discover our exceptional range of EMC and field test equipment without ever leaving your desk. Launch it at [www.ExploreEMC.com](http://www.ExploreEMC.com)

### EMI STANDARDS BY APPLICATION AND INDUSTRY

Choose the standard that applies to the what kind of device you are making, as well as which region the device will be sold into.

Market Segments <sup>1</sup>	Equipment Type <sup>2</sup>	IEC/CISPR	Standards CENELEC/EN	FCC
ISM Medical	Industrial, scientific and medical equipment	IEC 16326	EN 16326	CFR Title 47 Part 18
	Medical electrical apparatus	IEC 60601-1-2 and CISPR 11	EN 60601-1-2 and CISPR 11	CFR Title 47 Part 15
Automotive	Vehicles, boats and internal combustion engines	CISPR 12	EN 55012	CFR Title 47 Part 15
	Components and modules on board vehicles	CISPR 25	EN 55025	Does not apply
ITE & Multimedia	ITE and Audio/video/multimedia equipment (ITE/MME)	CISPR 32	EN 55032	CFR Title 47 Part 15
Appliances	Electrical devices, household appliances and tools	CISPR 14-1	EN 55014-1	CFR Title 47 Part 15
	Induction cooking devices, microwave ovens	CISPR 14-1	EN 55014-1	CFR Title 47 Part 15 and Part 18
Luminaires	Fluorescent lamps and luminaires	CISPR 15	EN 55015	CFR Title 47 Part 15 and Part 18

<sup>1</sup> This table provides an overview of EMC test requirements. If the equipment type includes cellular connectivity, there will be additional test requirements by the cellular providers. Military and Aerospace applications have many additional standards.

<sup>2</sup> Most equipment types will need to meet the EMC Directive or Radio Equipment Directive (RED) for import into the EU.



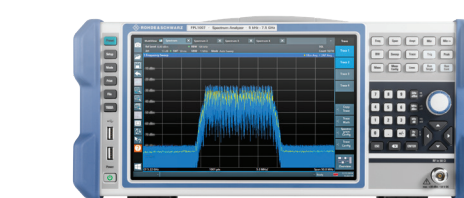
#### R&S RT0

An oscilloscope with a front-end sensitivity that compares to a modern spectrum analyzer enables EMI debugging on a design engineer's desk. Not only does the R&S RT0's hardware accelerated FFT allow for faster EMI analysis, it allows for insight into time and frequency domains simultaneously.



#### R&S FSV3000

Versatile Signal and spectrum analyzer for design, validation, and EMI PreCompliance and troubleshooting. With powerful RF performance and up to 200 MHz bandwidth up to 44 GHz, it supports mobile wireless and IOT standards for additional work in R&D and Validation.



#### R&S FPL1000

Portable benchtop for general-purpose Spectrum and Signal Analyzer and EMI PreCompliance and troubleshooting with compact footprint. With very good RF performance and 40 MHz bandwidth up to 7.5 GHz, it supports general purpose spectrum and signal analysis.



#### R&S FPC

Value instrument with basic spectrum analysis, signal generation, and vector network analysis for use with ELEKTRA software for EMI PreCompliance and troubleshooting.



#### R&S EMI Receiver

EMI test receiver and signal/spectrum analyzer combined in one box. Designed for EMI PreCompliance applications with built-in pre-selection, time domain scan, and limit lines for easy reference.



#### R&S ELEKTRA

EMC test software for both EMI and EMS applications with a library of limit lines for relevant standards, flexible hardware configurations, preconfigured test settings, and interactive measurements.



#### R&S RF Diagnostic Chamber

In most lab environments there are too many background signals to adequately measure emissions coming from a device. RF diagnostic chambers are essential for reliable testing.



#### R&S EMC Test System

A fully integrated solution of multiple products including an EMI receiver, antenna, chamber, pre-amplifier, and all necessary EMC components you need to make correlated and corrected EMC measurements.



#### R&S HZ-14

R&S HZ-14 probe set for E and H near-field measurements detecting EMC trouble spots



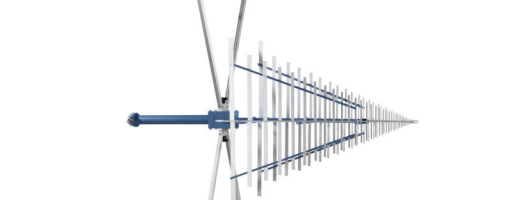
#### R&S HK116E

R&S HK116E biconical antenna



#### R&S HZ-15

R&S HZ-15 probe set for E and H near-field emission measurements with test receivers and spectrum analyzers spots



#### R&S HL562E

R&S HL562E combined biconical and log-periodic broadband antenna





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**Service that adds value**

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**About Rohde & Schwarz**

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, radionavigation and radiolocation. Founded more than 80 years ago, this independent company has an extensive sales and service network and is present in more than 70 countries. The electronics group is among the world market leaders in its established business fields. The company is headquartered in Munich, Germany. It also has regional headquarters in Singapore, Columbia, Maryland, USA, to manage its operations in these regions.

**Sustainable product design**

- + Environmental compatibility and eco-footprint
- + Energy efficiency and low emissions
- + Longevity and optimized total cost of ownership

ISO 9001

ISO 14001

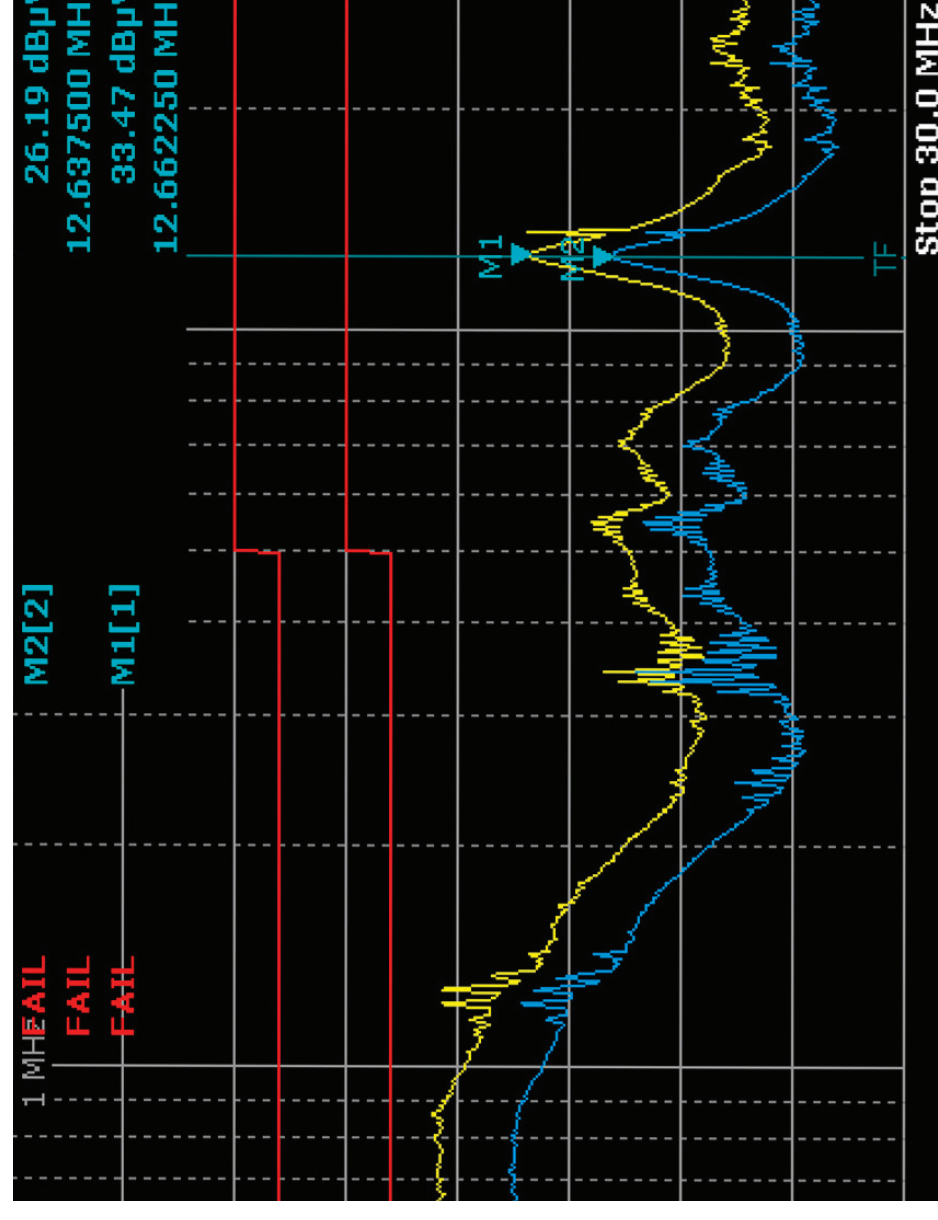
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