

# EMI BASICS, STANDARD SETUPS AND EQUIPMENT

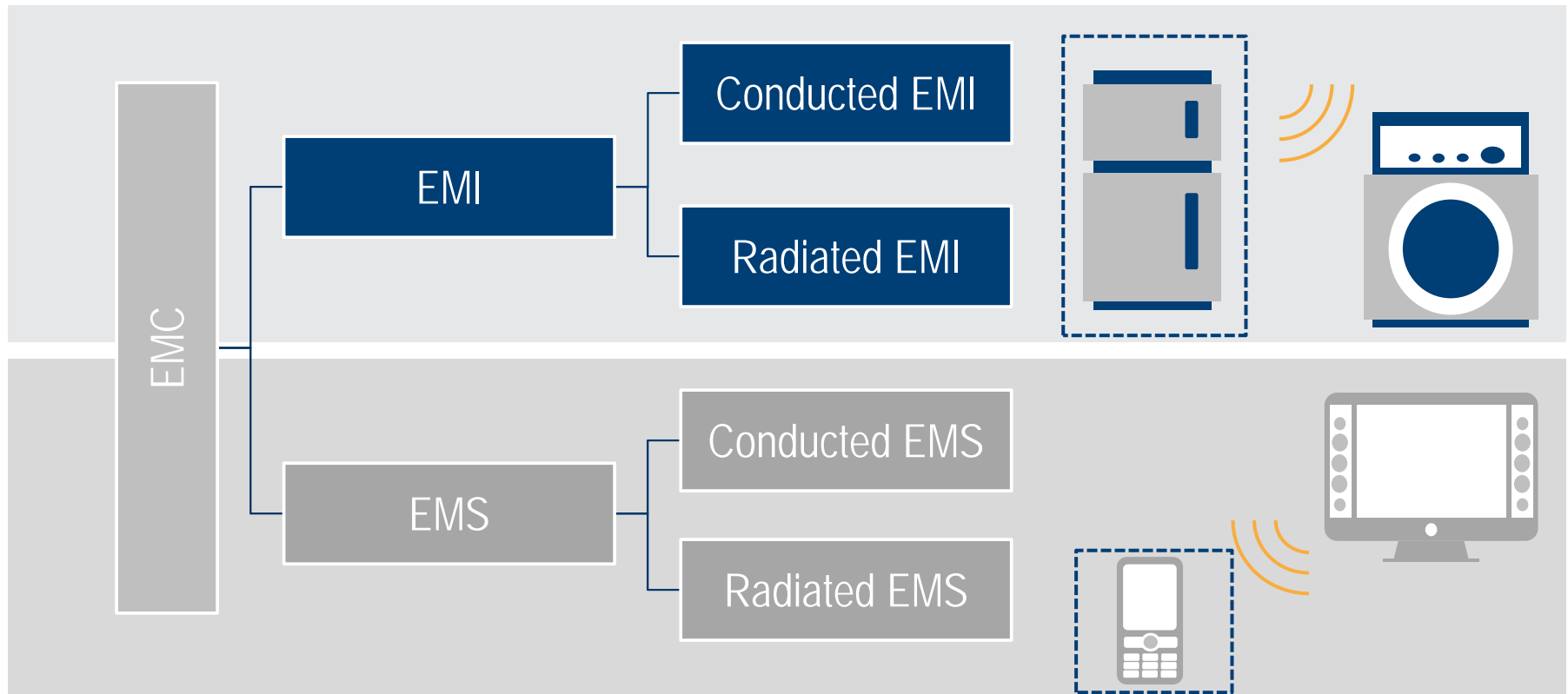
Li Jianfei – Senior Application Engineer

**ROHDE & SCHWARZ**

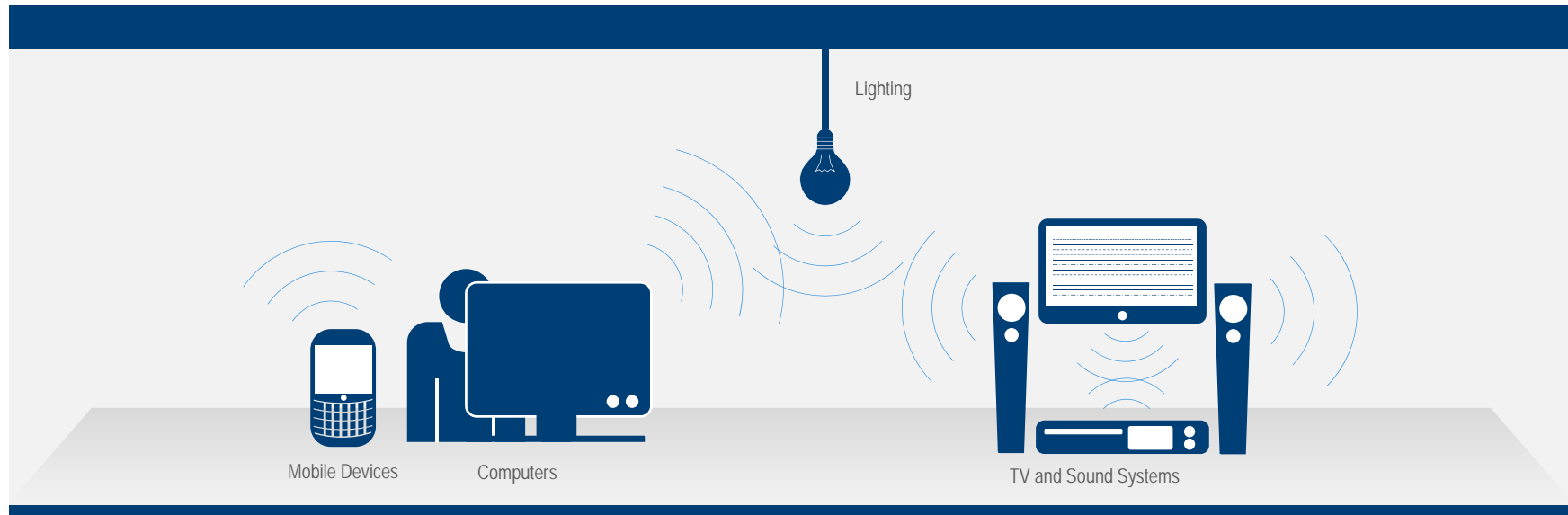
Make ideas real



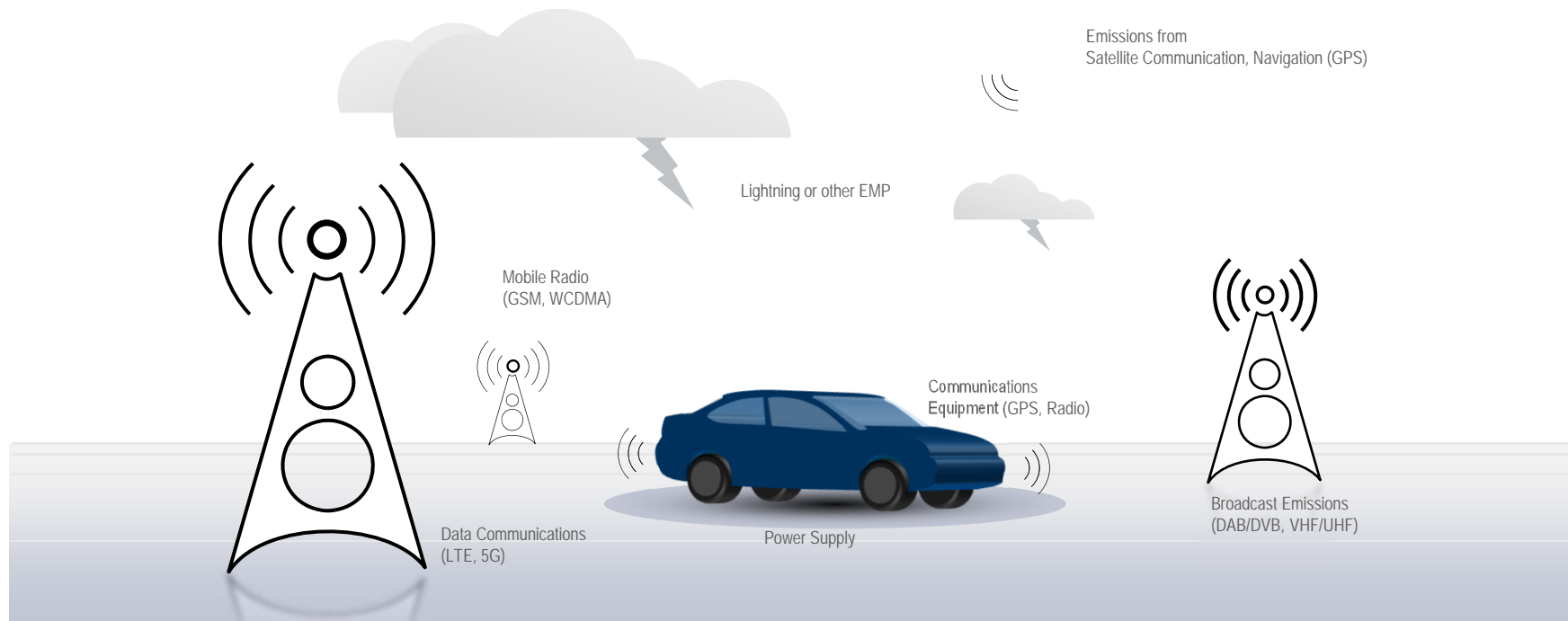
# WHAT IS EMC?



# Importance of EMC | Indoor Environment (Living Room)



# Importance of EMC | Outdoor Environment



# MODES OF EMISSION

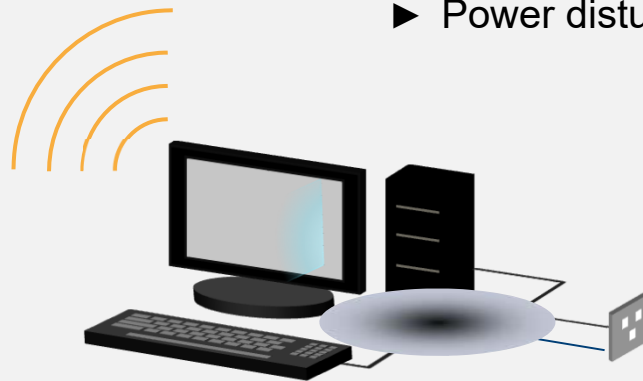
## EMI

### Radiated EMI

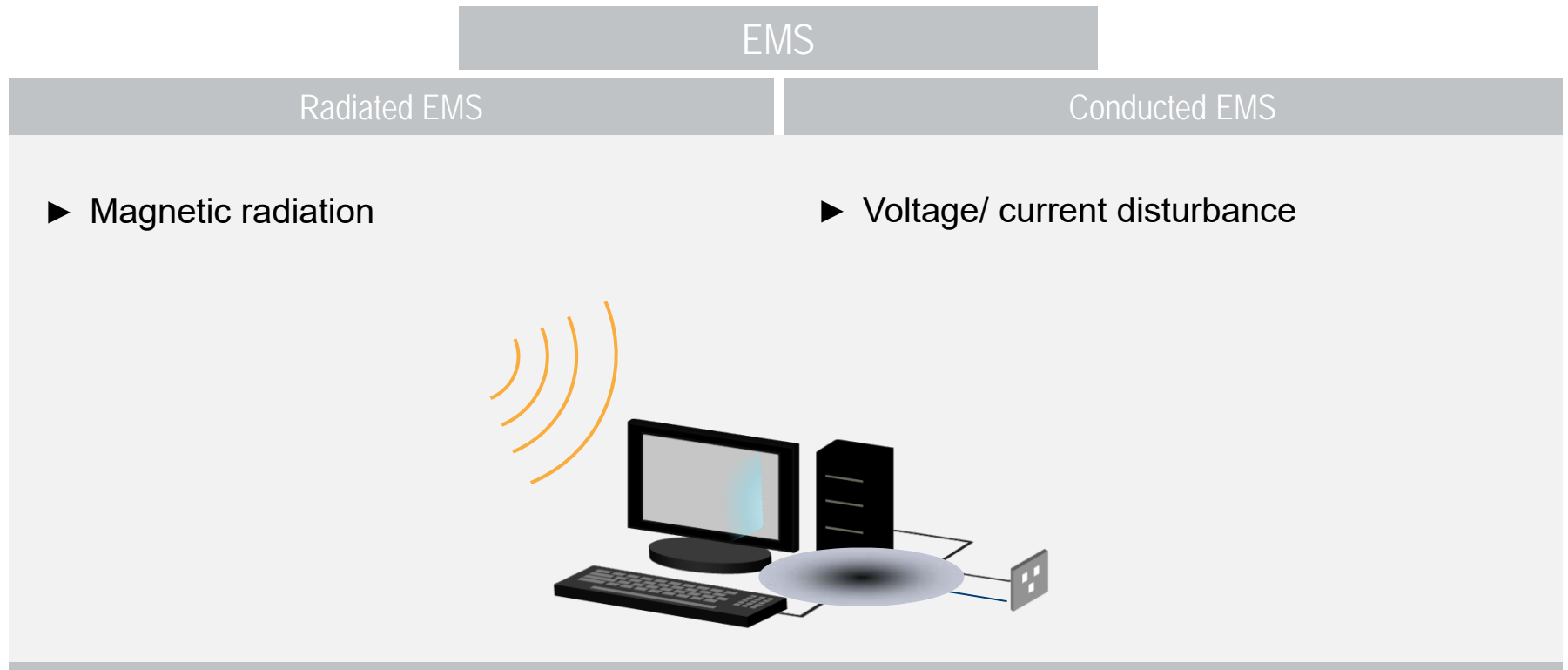
- ▶ Magnetic radiation
- ▶ Electric radiation

### Conducted EMI

- ▶ Voltage disturbance
- ▶ Power disturbance



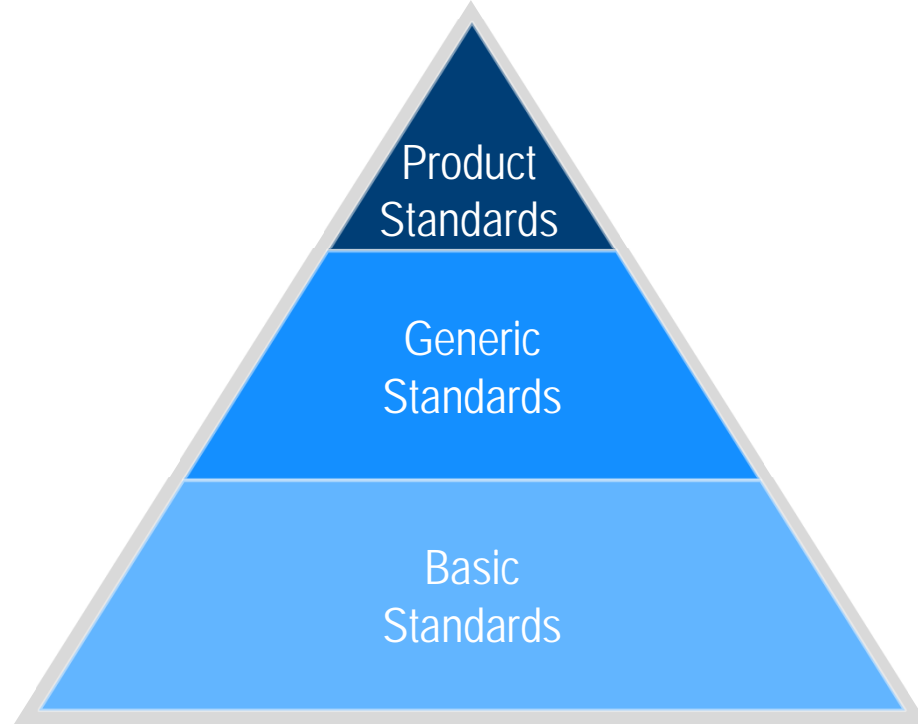
# MODES OF SUSCEPTIBILITY



# STANDARDS



# EMC STANDARDS STRUCTURE



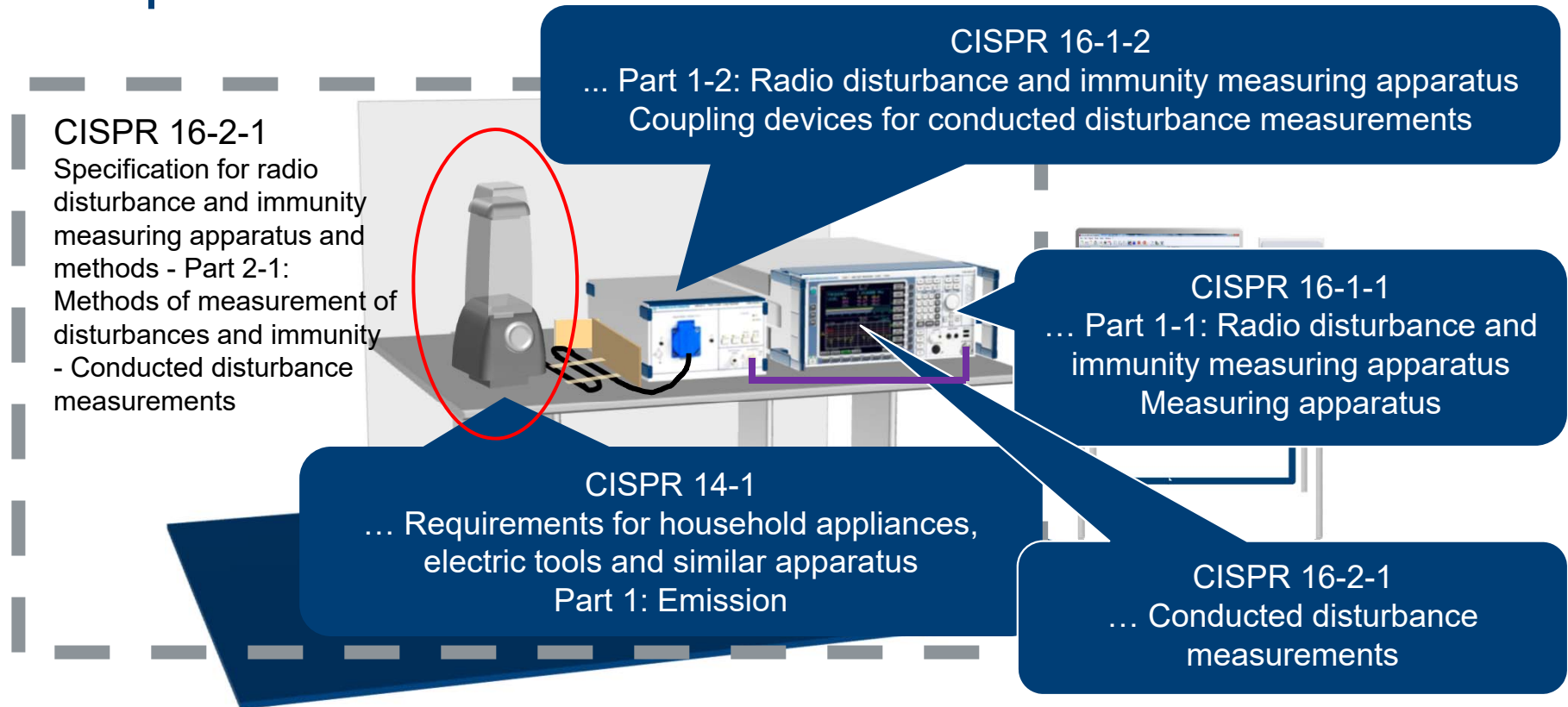
Measurement methods and limits, adjusted to respective product group  
(e.g. CISPR 11/15/32)

Applied when no product standards present and are divided by operation environment of EUT (e.g. IEC 61000-6-x)

Basic requirement on measurement methods and limit levels  
(e.g. CISPR 16-1-1 , CISPR 16-2-3)

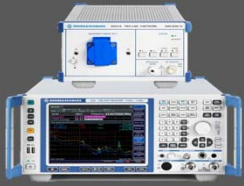


# Example: Conducted disturbance measurements



# CISPR SUB-COMMITTEES

## CISPR A



Measurements & statistical methods  
E.g. CISPR 16

## CISPR B



ISM RF apparatus  
E.g. CISPR 11

## CISPR D



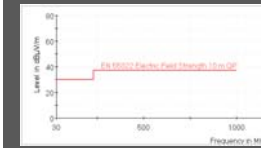
Protection of on-board & off-board receivers of vehicles  
E.g. CISPR 12, CISPR 25

## CISPR F



Household appliances, tools lighting and similar equipment  
E.g. CISPR 14, CISPR 15

## CISPR H



Sets limits for protection of radio services

## CISPR I



Measurements & statistical methods  
E.g. CISPR 22, CISPR 32

# CISPR EMI STANDARDS (COMMERCIAL PRODUCTS)

CISPR 11



Industrial, Science  
and Medical

CISPR 14-1



Household  
Appliances

CISPR 15



Lighting

CISPR 25



Automotive

CISPR 32



Multimedia  
Equipment

# DIFFERENT EMC STANDARDS

## ► FCC Part15

Conducted Emissions			
	Frequency (MHz)	Quasi-Peak Limit (dBuV)	Average Limit (dBuV)
<b>Class A</b>	0.15 – 0.5	79	66
	0.5 - 30.0	73	60
<b>Class B</b>	0.15 – 0.5	66 to 56 *	56 to 46 *
	0.5 – 5	56	46
	5 - 30	60	50

General Radiated Emission		
	Frequency (MHz)	Field Strength Limit (uV/m)
<b>Class A (10 meters)</b>	30 – 88	90
	88 – 216	150
	216 – 960	210
	above 960	300
<b>Class B (3 meters)</b>	30 – 88	100
	88 – 216	150
	216 – 960	200
	above 960	500

## ► MIL-STD-461E

Req't	Description
<b>CE101</b>	Conducted Emissions, Power Leads, 30 Hz to 10 kHz
<b>CE102</b>	Conducted Emissions, Power Leads, 10 kHz to 10 MHz
<b>CE106</b>	Conducted Emissions, Antenna Terminal, 10 kHz to 40 GHz
<b>CS101</b>	Conducted Susceptibility, Power Leads, 30 Hz to 50 kHz
<b>CS103</b>	Conducted Susceptibility, Antenna Port, Intermodulation, 15 kHz to 10 GHz
<b>CS104</b>	Conducted Susceptibility, Antenna Port, Rejection of Undesired Signals, 30 Hz to 20 GHz
<b>CS105</b>	Conducted Susceptibility, Antenna Port, Cross Modulation, 30 Hz to 20 GHz
<b>CS109</b>	Conducted Susceptibility, Structure Current, 60 Hz to 100 kHz
<b>CS114</b>	Conducted Susceptibility, Bulk Cable Injection, 10 kHz to 200 MHz
<b>CS115</b>	Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation
<b>CS116</b>	Conducted Susceptibility, Dampened Sinusoidal Transients, Cables & Power Leads, 10 kHz to 100 MHz
<b>RE101</b>	Radiated Emissions, Magnetic Field, 30 Hz to 100 kHz
<b>RE102</b>	Radiated Emissions, Electric Field, 10 kHz to 18 GHz
<b>RE103</b>	Radiated Emissions, Antenna Spurious and Harmonic Outputs, 10 kHz to 40 GHz
<b>RS101</b>	Radiated Susceptibility, Magnetic Field, 30 Hz to 100 kHz
<b>RS103</b>	Radiated Susceptibility, Electric Field, 10 kHz to 40 GHz
<b>RS105</b>	Radiated Susceptibility, Transient Electromagnetic Field

# DIFFERENT EMC STANDARDS

## ► EU Standard (Emission)

Standard	Description
EN50081-1	Generic emissions standard for residential, commercial and light industrial environments.
EN50081-2	Generic emissions standard for industrial environment
EN55022	Limits and methods of measurement of radio disturbance characteristics of information technology equipment (Also known as CISPR-22)
EN55011	Industrial, scientific and medical (ISM) radio frequency equipment - Radio disturbance characteristics - Limits and methods of measurement (Also known as CISPR-11)
EN55013	Limits and methods of measurement of radio disturbance characteristics of broadcast receivers and associated equipment
EN55014-1	Emission requirements for household appliances, electric tools and similar apparatus
EN55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
EN61000-3-2	Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)
EN61000-3-3	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems

## ► EU Standard (Immunity)

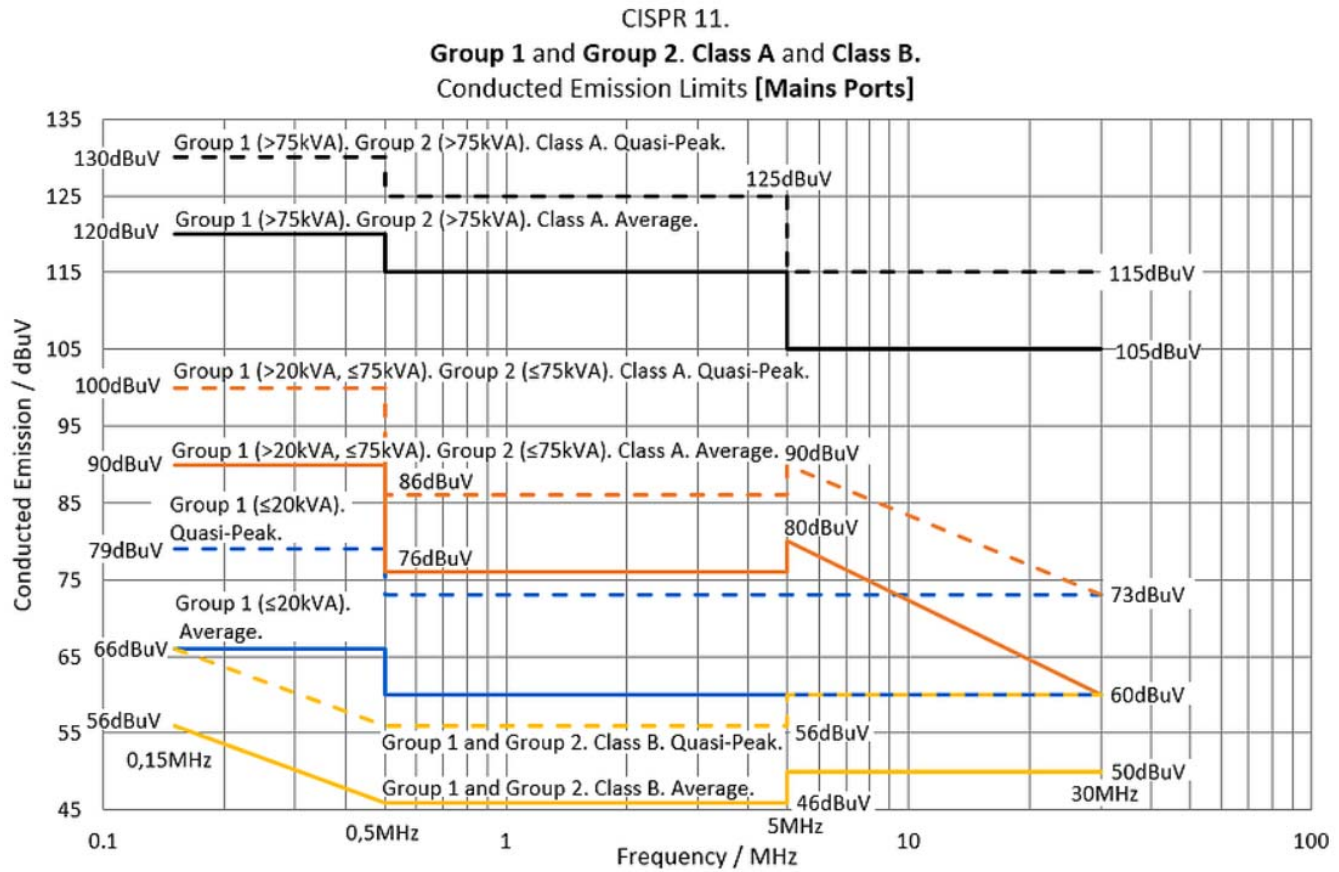
Standard	Description
EN61000-4-2	Electrostatic Discharge
EN61000-4-3	Radiated Susceptibility Test
EN61000-4-4	Electrical Fast Transient/Burst Test
EN61000-4-5	Surge Test
EN61000-4-6	Conducted Immunity Test
EN61000-4-8	Power Frequency Magnetic Test
EN61000-4-11	Voltage Dips and Interruptions Test
EN61000-6-1	Immunity for residential, commercial and light-industrial environments
EN61000-6-2	Immunity for industrial environments
EN61547	Equipment for general lighting purposes — EMC immunity requirements
EN12016	Electromagnetic compatibility — Product family standard for lifts, escalators and passenger conveyors — Immunity

# DIFFERENT EMC STANDARDS

## ► RTCA DO-160: Environmental Condition and Test Procedure for Airborne Equipment

Section	Title	Notes
16	Power Input	115 VAC, 28 VDC and 14 VDC Power Voltage/frequency range, interruptions, surges
17	Voltage Spike	Power Leads Up to 600 V or 2x Line Voltage
18	Audio Frequency Conducted Susceptibility - Power Inputs	0.01 - 150 kHz or 0.2 - 15 kHz
19	Induced Signal Susceptibility	Interconnection Cabling E field and H Field 400 Hz - 15 kHz and spikes
20	Radio Frequency Susceptibility (Radiated and Conducted)	Conducted: 0.01-400 MHz Radiated: 0.1-2, 8 or 18 GHz
21	Emission of Radio Frequency	Power Lines: 0.15-30 MHz Interconnecting Cables: 0.15-100 MHz Radiated: 2-6,000 MHz
22	Lightning Induced Transient Susceptibility	Pin & Bulk injection, Pulse & Dampened Sine

# CISPR11 LIMITS



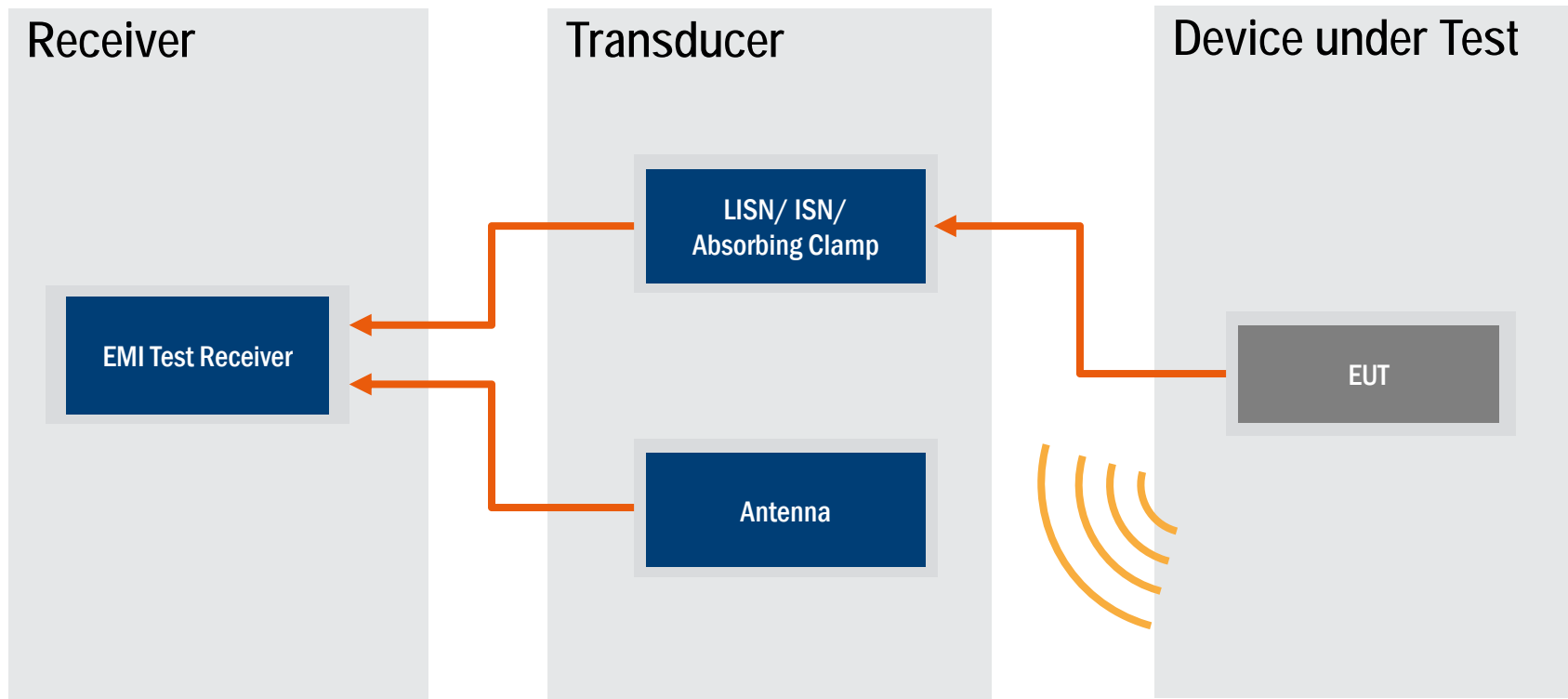
# EMI TESTS IN SUMMARY

	CISPR 11 ISM	CISPR 14 HOUSEHOLD EQUIPMENT	CISPR 15 LIGHTINGS	CISPR 25 Automotive	CISPR 32 MUTLIMEDIA
CONDUCTED EMI (MAINS PORTS)	✓	✓	✓	✓	✓
CONDUCTED EMI (TELECOM PORTS)				✓	✓
RADIATED EMI (MAGNETIC FIELD)	✓	✓	✓		
RADIATED EMI (ELECTRIC FIELD)	✓	✓	✓	✓	✓
POWER DISTURBANCE		✓			

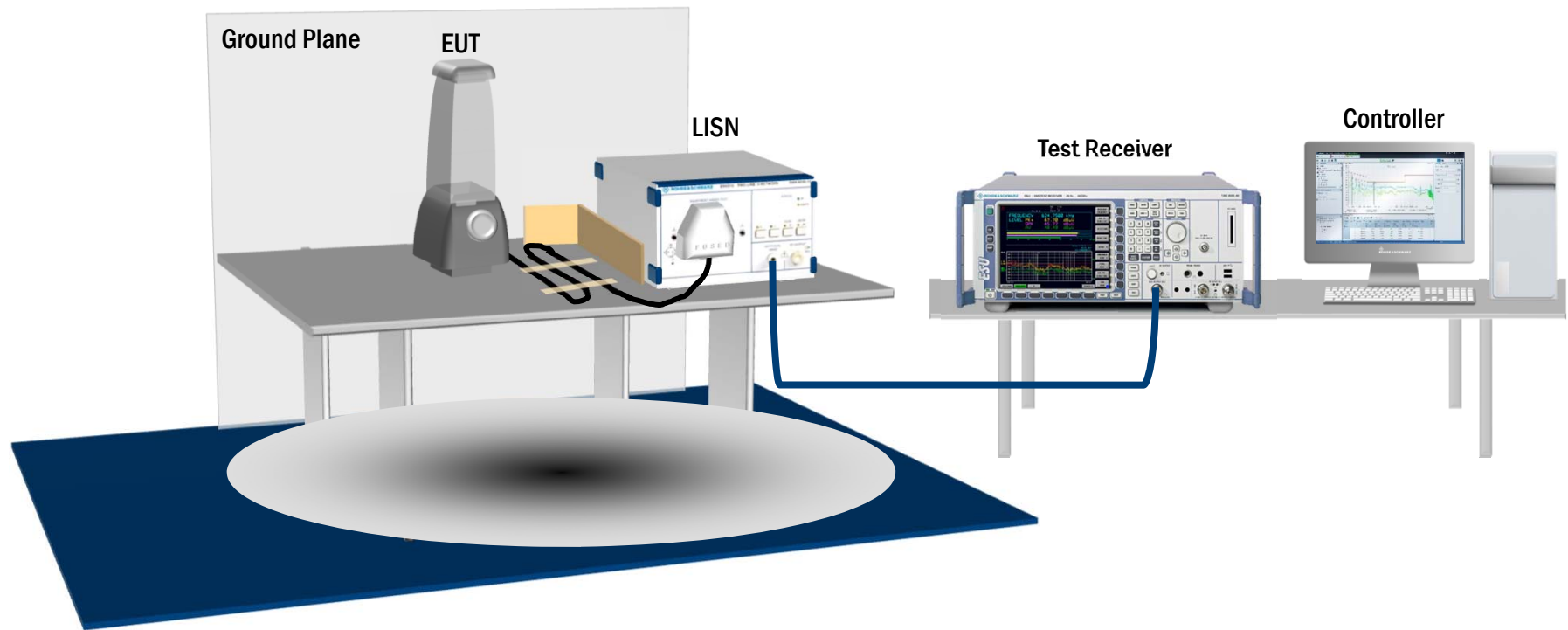


# SETUP AND TOOLS FOR EMC MEASUREMENTS

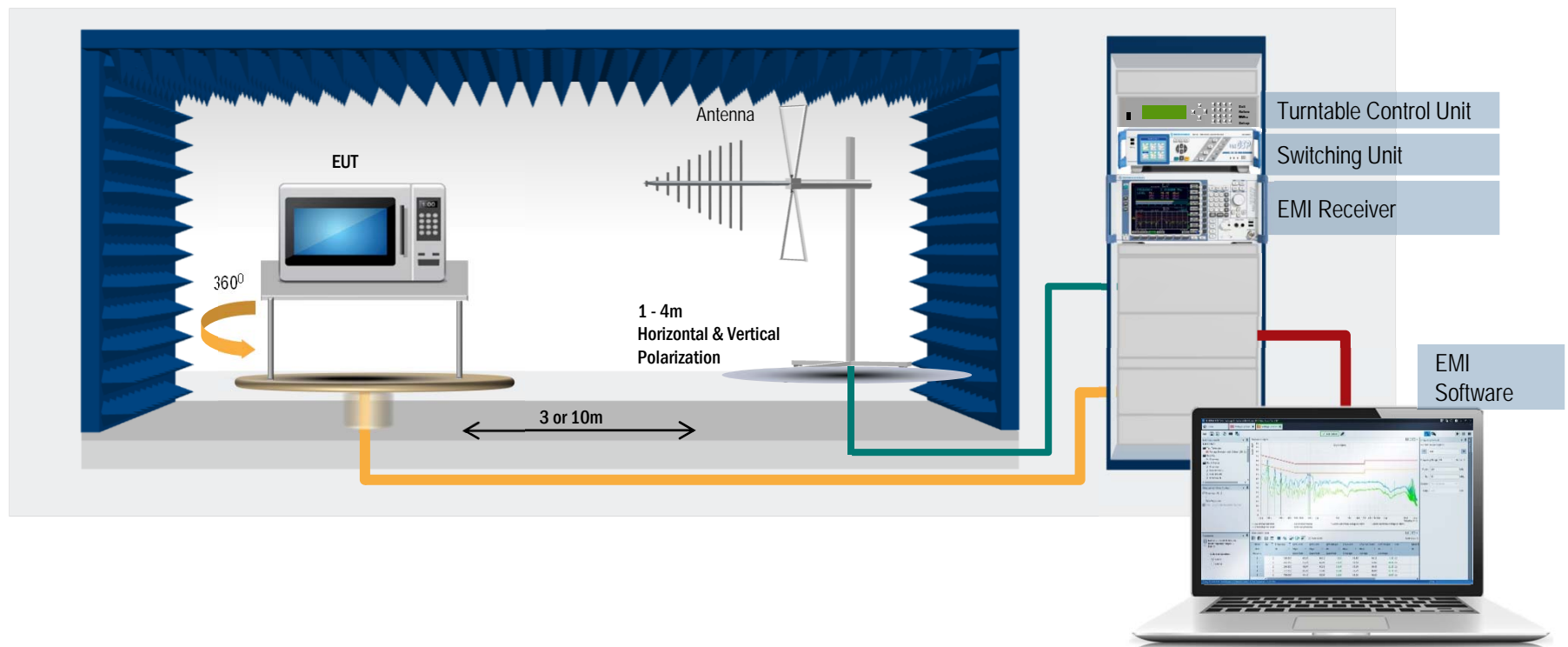
# SYSTEM CONFIGURATION



# COMPLIANCE CONDUCTED EMISSION TEST

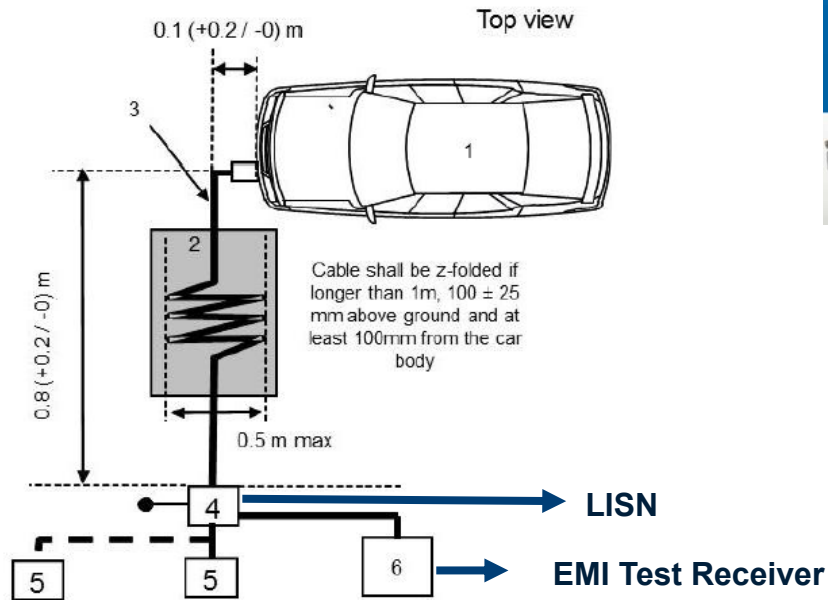


# COMPLIANCE RADIATED EMISSION TEST

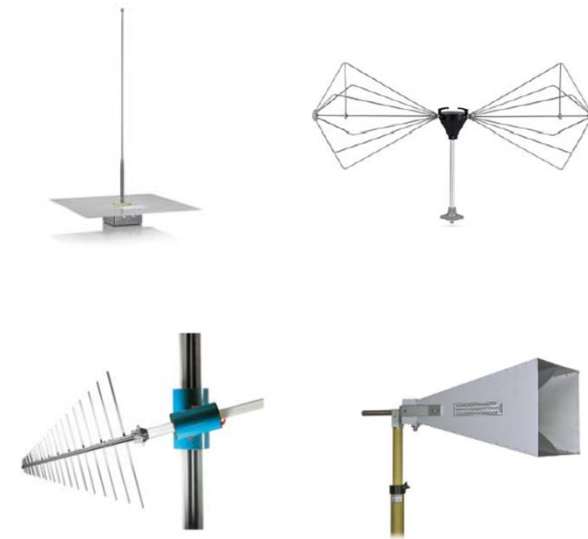
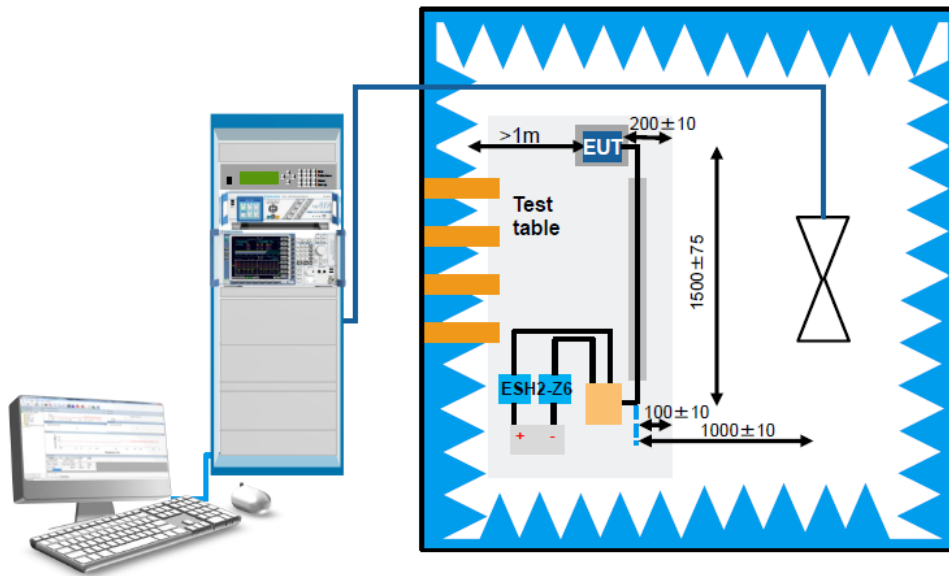




# COMPLIANCE CONDUCTED EMISSION TEST – CISPR 25



# COMPLIANCE RADIATED EMISSION TEST – CISPR 25



# PERFORMANCE LEVELS OF INSTRUMENTATION SELECTING THE RIGHT TOOL

EMI receivers compliant to  
CISPR 16-1-1, FCC (40 GHz),  
MIL-Std



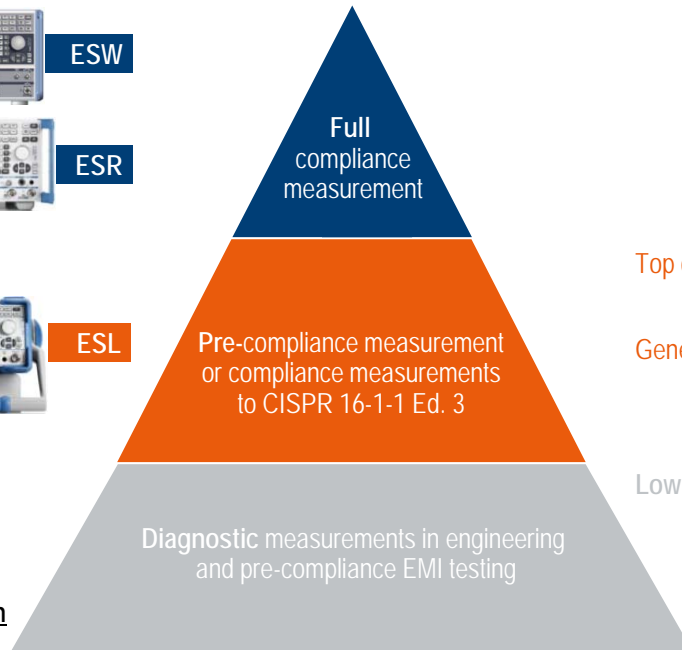
Compliance EMI testing  
CISPR 16-1-1, 26 GHz



EMI testing referring to limits



Diagnostic  
measurements  
without relation  
to limits



Full  
compliance  
measurement

Pre-compliance measurement  
or compliance measurements  
to CISPR 16-1-1 Ed. 3

Diagnostic measurements in engineering  
and pre-compliance EMI testing

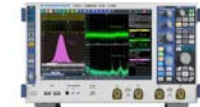
Top class spectrum analyzers



General purpose spectrum analyzers



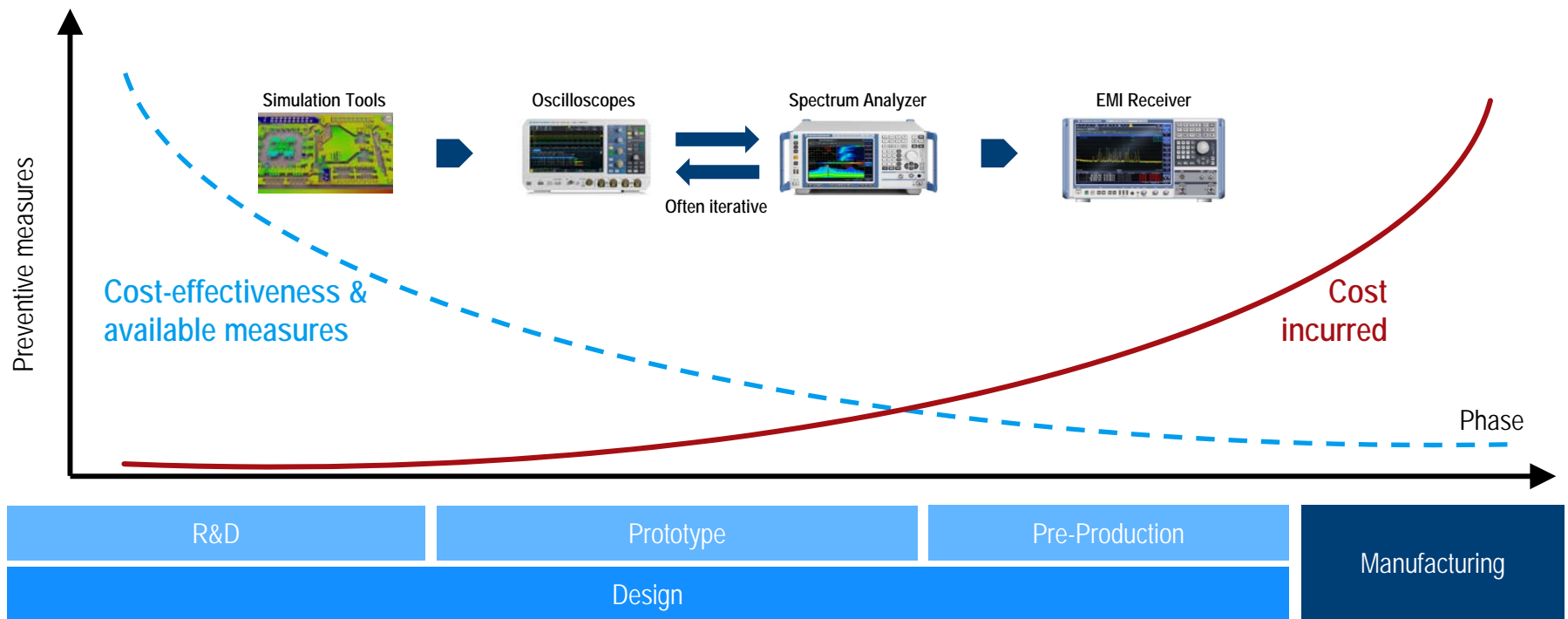
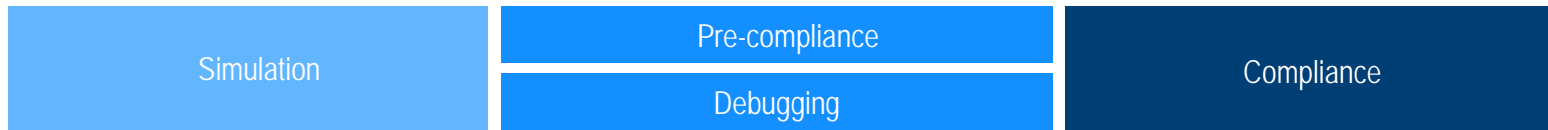
Low cost spectrum analyzers, voltmeters, oscilloscopes



Scopes & Spectrum Analyzer

Receivers





# COMPARISON BY FEATURES

Feature	EMI Receiver	Spectrum Analyzer	Oscilloscope
Auto-ranging		-	-
EMI detectors / bandwidths		(K54 Option)	-
Gapless recording	Very long	Long	-
Limit lines		(K54 Option)	Only masks / indicative
Dynamic / Sensitivity	Very high / Very good (With pre-selector)	High / Very Good	Medium / Good
Log-scale View		(K54 Option)	(some models)
Scan types	All (Sweep, step, time-domain, zero-span)	Some (Sweep, zero-span)	No scan (full bandwidth measurement)
Time/frequency correlation possible	(real-time option)	(real-time option, selected models)	
Typically available at	EMC test lab (in-house or external)	Pre-compliance test setup	R&D department

THANKS YOU !