



Products: R&S IMS, R&S NRP-Z91

R&S IMS Hardware Setup according IEC / EN 61000-4-6 (conducted immunity)

Application Note

This application note describes the general setup and required equipment for EMC measurements according to the EMS standard IEC / EN 61000-4-6



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2 General Remark

The aim of this application note is to describe the setup and putting into operation for a typical measurement setup.

The application note consists of two main parts:

- EMC Standards
Background information on the range of EMC tests for commercial equipment and on details of IEC/EN61000-4-6
- Hardware Configuration
Guide for the selection of appropriate hardware and accessories

There are four application notes covering the commercial standards IEC / EN 61000-4—3 and -6:

- 1SP31 / R&S IMS - Hardware Setup according IEC / EN 61000-4-6 (conducted immunity)
- 1SP32 / R&S IMS -Hardware Setup according IEC / EN 61000-4-3 (radiated immunity)
- 1SP33 / R&S IMS - Software Configuration according IEC / EN 61000-4-6 (conducted immunity)
- 1SP34 / R&S IMS - Software Configuration according IEC / EN 61000-4-3 (radiated immunity)

Note:



To carry out measurements according to the EMC standards requires detailed knowledge of these standards and EMC practice, which can not be covered by this application note.

The setups, especially the equipment, are recommendations. They are based on many years of experience in the design and implementation of EMC systems and have been optimised for best system performance. The use of other components than the recommended ones may result in significant performance changes (e.g. use of other antennas).

In addition the achievable system performance depends not only on the test equipment, but also on the test environment e.g. the anechoic chamber performance. The configurations described in this application note can therefore not guarantee the fulfilment of the respective standards in any case.

3 EMC Standards

The aim of this chapter is to provide background information, for what type of equipment this application note applies. Because the EMC standardisation depends on the local legislation this overview is limited to the European market.

In addition it describes the main requirements of a test setup according IEC/EN 61000-4-6.

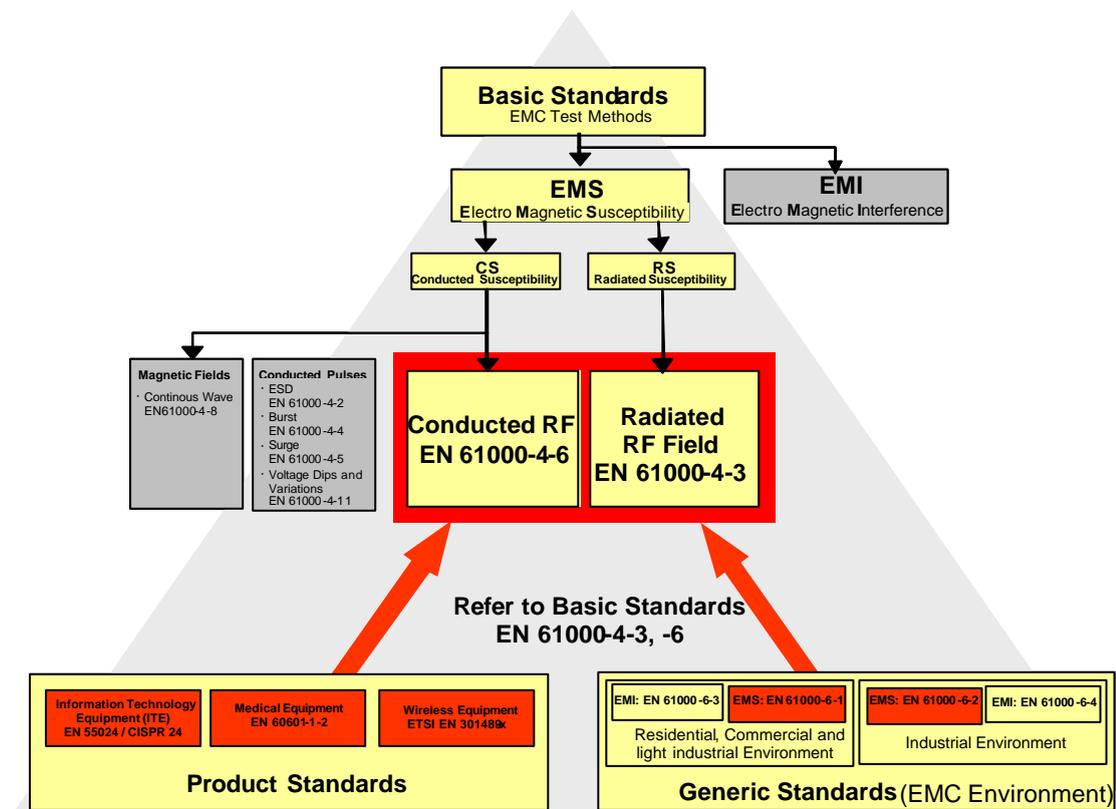
3.1 Applicable commercial EMC standards (EU)

Generally the EMC-Standards are divided into three groups:

- Basic Standard: Describes measurement techniques
- Generic Standard: Describes product environment, references to basic standard
- Product Standard: Describes measurements for type of product, references to basic standard

EN 61000-4-3, -6 are the Basic Standards for radiated and conducted immunity (EMS).

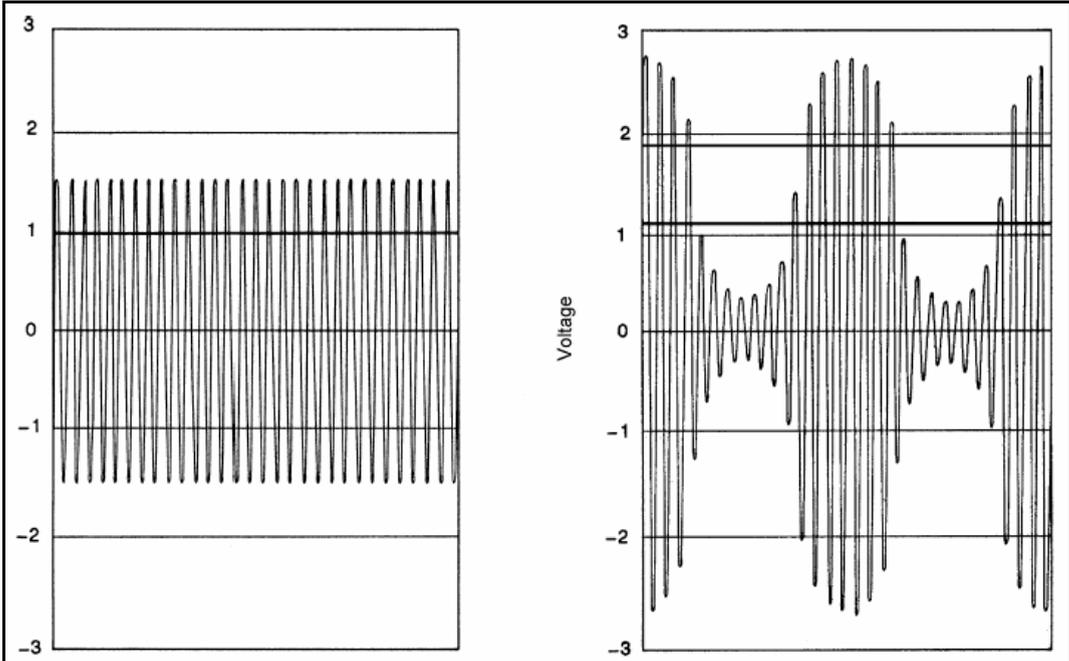
The following diagram gives an excerpt from the covered main standards:



Also other product standards may refer to EN 61000-4-3 and -6, because it is one of the most used basic standard in commercial EMS testing.

3.2 General Setup acc. IEC/EN61000-4-6

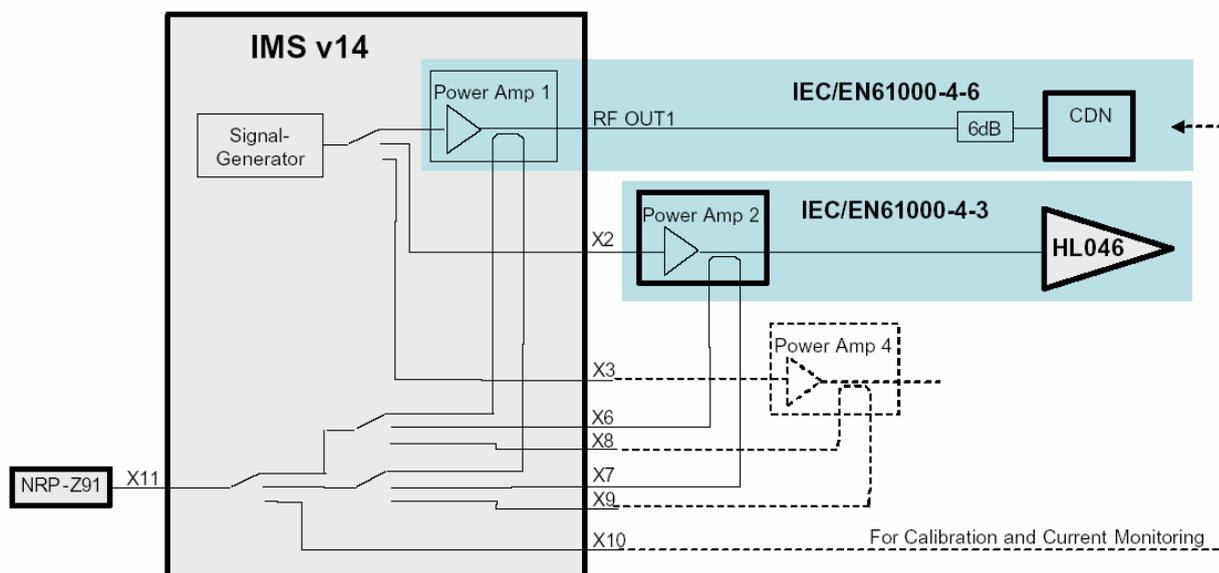
IEC/EN 61000-4-6 describes conducted EMS-tests for commercial equipment. To carry out these tests detailed knowledge of the standard is necessary. The following is only a short overview of the main parameters, that influence the test system:

Frequency Range	150 kHz to 80 MHz
Modulation	80% Modulation with 1 kHz  <p>a) Unmodulated RF-signal $V_{p-p} = 2,8 \text{ V}$ $V_{rms} = 1,0 \text{ V}$</p> <p>b) Modulated RF-signal 80 % AM $V_{p-p} = 5,1 \text{ V}$ $V_{rms} = 1,12 \text{ V}$ $V_{\text{maximum RMS}} = 1,8 \text{ V}$</p> <p>Remark: To achieve 1,8 times higher interference voltage (80% modulation) 3,24 times more amplifier power is necessary.</p>
Harmonics	< 15 dBc
Coupling Methods	CDN (Coupling Decoupling Network, preferred method) EM-Clamp BCI (Bulk Current Injection, Current clamp)
Impedance	150 Ω (at output of coupling network)
Test Environment	Shielded room
Test Setup	Test table with conducting surface and grounding connection Cable length EUT – coupling device: 0,1 to 0,3 m Cabling height: 0,1 m over conducting surface (with non-conducting supports) All coupling devices have to be grounded properly.
Frequency step	$\leq 1\%$, measurement time per step depends on the EUT, but must be $\geq 1,5 \cdot 10^{-3}$ decades/second

4 Test System Hardware Configuration

4.1 General Configuration

The block diagram shows the basic system setup described in this application note:



Basic System Setup

Different alternatives are shown in the respective sections of this chapter.

4.2 Hardware for Conducted EMS (IEC / EN 61000-4-6)

4.2.1 General Remark

For measurements acc. IEC/EN 61000-4-6 three methods of coupling into the EUT (Equipment Under Test) are possible:

- **CDN (Coupling Decoupling Network)**
Coupling via CDN is the most common test method. It requires least power. It is always used, when appropriate CDNs for the type of signal are available.
- **EM-Clamp**
The EM-Clamp is used, when a CDN is not possible, e.g. for shielded or complex cables. The clamp and the separate decoupling clamp are placed around the cable.
- **BCI (Bulk Current Injection)**
Similar use as EM-clamp. A monitoring of the injected current is strongly recommended.

At first step the test setup with CDN is shown. Modifications for EM-Clamp and BCI are dealt with afterwards.

4.2.2 IEC / EN 61000-4-6 with CDN

4.2.2.1 Site Requirements

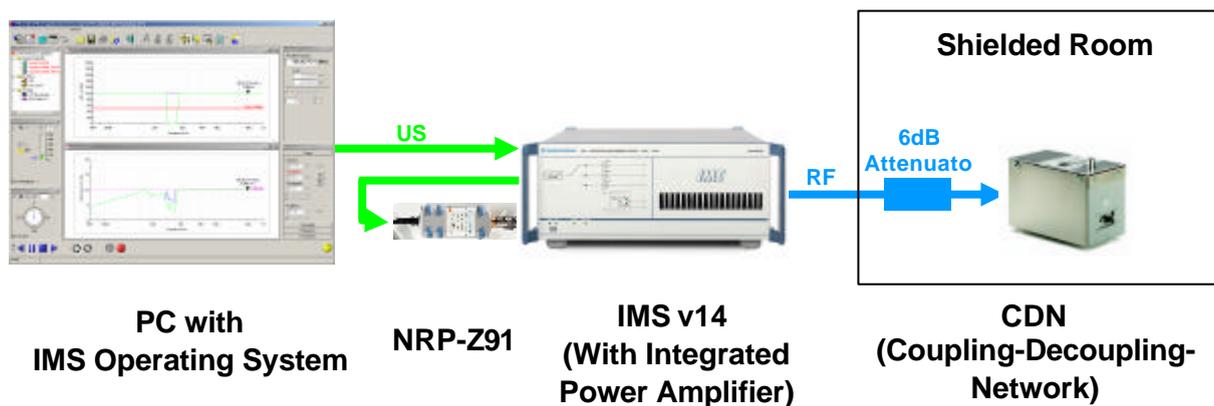
For operation of the test system it is necessary to have

- Shielded room
- Test table acc. IEC / EN 61000-4-6 incl. connection to the shielding
- 2 x RF feedthrough N-type into the shielded room

Remark: This equipment is mostly delivered completely with the shielded room.

4.2.2.2 Equipment List

The block diagram shows the basic configurations for measurements according IEC / EN 61000-4-6 with CDN.



The following equipment is necessary for the test system:

Equipment	Manufacturer	Type	Immunity Level (e.m.f.)		
			1 V	3 V	10 V
Integrated Measurement System R&S IMS with integrated power amplifier	R&S	1502.0009.14	☺ ¹⁾	☺ ¹⁾	☺ ¹⁾
Documentation Calibration Values R&S IMS	R&S	0240.2193.14	✓✓	✓✓	✓✓
Power Sensor R&S NRP-Z91	R&S	1168.8004.04	☺	☺	☺
USB-Adaptor (passive) for R&S NRP-Z	R&S	1146.8001.04	☺	☺	☺
6 dB Attenuator, 25 W	Bird ²⁾		☺	☺	☺
CDN for 2 and 3 phase power line, 16 A	Luethi ²⁾	L801-M2/3	☺	☺	☺
Further CDN			Depends on EUT		
Calibration Adaptors for CDNs	Luethi ²⁾	L801-CR100	☺	☺	☺
Optional:					
RF Load, 25 W (for amplifier calibration)	Bird ²⁾		✓✓	✓✓	✓✓
PC for System Control			☺	☺	☺

☺: Mandatory equipment

✓✓: Recommended equipment

¹⁾ Possible alternative to R&S IMS v04: R&S IMS v02 and external power amplifier.

²⁾ This equipment is highly standardised and can be replaced by other manufacturers.

4.2.2.3 Cabling

The following cables are necessary:

Signal Path Name	From	To	Type	Connector	Length	Remark
Amplifier1 – CDN	IMS RF OUT1	CDN Input	RG214	N	Max. 20 m ¹⁾	Split at feedthrough into shielded room and 6 dB attenuator
CAL Adaptor – RFSensor1	CAL Adaptor	IMS X10 MON IN	RG214	N	Max. 20 m ¹⁾	Split at feedthrough into shielded room
Interlock cable						See chapter 4.3

¹⁾ The total length of the RF cable is not critical (It should be less than 20 m). It depends on the layout of the shielded room.

4.2.3 Alternative: IEC / EN 61000-4-6 with CDN, EM-Clamp and BCI

4.2.3.1 Equipment List

The following equipment is necessary for the test system:

Equipment	Manufacturer	Type	Coupling Device and Immunity Level (e.m.f.)					
			CDN		EM-Clamp		BCI	
			3 V	10 V	3 V	10 V	3 V	10 V
Integrated Measurement System R&S IMS	R&S	1502.0009.12	✓ ¹⁾	✓ ¹⁾	✓ ¹⁾	☺	☺	☺
Documentation Calibration Values R&S IMS	R&S	0240.2193.14	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Power Sensor R&S NRP-Z91	R&S	1168.8004.04	☺	☺	☺	☺	☺	☺
USB-Adaptor (passive) for R&S NRP-Z	R&S	1146.8001.04	☺	☺	☺	☺	☺	☺
6 dB Attenuator, 150 W	Bird ²⁾		☺	☺	☺	☺	☺	☺
CDN for 2 and 3 phase power line, 16 A	Luethi ²⁾	CDN-M2/3	☺	☺	✓✓	✓✓	✓✓	✓✓
Further CDN			Depends on EUT					
Calibration Adaptors for CDNs	Luethi ²⁾		☺	☺				
EM-Clamp and Absorption Clamp	Luethi ²⁾	EM101 + FTC101			☺	☺		
BCI Clamp	FCC	F120-9A					☺	☺
Calibration Fixture	FCC	BCICF-4					☺	☺
Monitoring Clamp	FCC	F-52					✓✓	✓✓
Power Amplifier 9 kHz – 250 MHz, 75 W	Bonn	BSA0125-75	✓ ¹⁾	✓ ¹⁾	✓ ¹⁾	☺	☺	
Power Amplifier 9 kHz – 250 MHz, 150 W ³⁾	Bonn	BSA0125-150						☺
Option Integrated Monitor and USB Interface for Power Amplifier	Bonn		✓ ¹⁾	✓ ¹⁾	✓ ¹⁾	☺	☺	☺
Optional:								
RF Load, 150 W (for amplifier calibration)	Bird ²⁾		✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
PC for System Control			☺	☺	☺	☺	☺	☺

R&S IMS - Hardware Setup according IEC / EN 61000-4-6 (conducted immunity)

☺: Mandatory equipment

✓: Equipment possible, but better alternative (☺) available

✓✓: Recommended equipment

¹⁾ Possible alternative to R&S IMS v12 and external power amplifier: R&S IMS v14.

²⁾ This equipment is highly standardised and can be replaced by other manufacturers.

³⁾ Minimum required power is 100 W.

4.2.3.2 Cabling

The following cables are necessary:

Signal Path Name	From	To	Type	Connector	Length	Remark
Generator – Amplifier1	IMS X1 RF OUT1	Amplifier1 Input	RG58 ¹⁾	N	Typ. 0,5 m	
Amplifier1 – RFSensor1 (FWD)	Amplifier1 FWD	IMS X4 FWD1	RG58 ¹⁾	N	Typ. 0,5 m	Directional coupler of amplifier 1, forward power
Amplifier1 – RFSensor1 (REV)	Amplifier1 REV	IMS X5 REV	RG58 ¹⁾	N	Typ. 0,5 m	Directional coupler of amplifier 1, reverse power
Amplifier1 – CDN	RF OUT1	Input Transducer	RG214	N	Max. 20 m ²⁾	Split at feedthrough into shielded room
Monitoring Clamp – RFSensor1	Monitoring Clamp / CAL Adaptor	IMS X10 MON IN	RG214	N	Max. 20 m ²⁾	Split at feedthrough into shielded room
USB Amplifier Control	IMS USB OUT	Amplifier 1	USB Type B			
Interlock Cable						See chapter 4.3

¹⁾ Cable type is uncritical for small distances (< 1,5 m)

²⁾ The total length of the RF cable is not critical (It should be less than 20 m). It depends on the layout of the shielded room.

4.3 Interlock Connection

The interlock is a safety feature, which ensures, that the RF power is only switched on, when the doors to the measurement site are closed. For implementation of the interlock contacts on the entrance doors of the anechoic room are necessary.

Note:



The Interlock is a safety feature. It makes sure, that no person is exposed to hazardous fields or voltages. Therefore a proper installation of an interlock loop is strongly recommended.

The interlock has to be realised by a loop between pin 1 and pin 3 of the IMS interlock connector. The loop has to be equipped with potential free contacts e.g. at the chamber doors. Tests can only be carried out, as long as this loop is closed. Otherwise the test will stop and the signal generator is switched off. In addition with option IMS-B3, the input of the active power amplifier is disconnected from the signal generator output and terminated to 50 Ohm. If the power amplifiers are connected correctly, they are also switched inactive.

If no interlock shall be used due to low amplifier power or because the safety is realised in another way, pins 1 and 3 of the IMS interlock connector have to be bridged.

In addition the interlock connector provides status signals for the power amplifiers and a contact for a display "Test in Progress".

The interlock cable is customer specific and therefore not delivered with the IMS.

The table shows the pin assignment for the cable, based on three power amplifiers:

Signal	R&S IMS Interlock 25-pol. D-Sub	Bonn PA1 Remote Control 15-pol. D-Sub	Bonn PA2 Remote Control 15-pol. D-Sub	Bonn PA4 Remote Control 15-pol. D-Sub	Signal Type
Interlock zu PA1	8, 15	8, 15	—	—	
Interlock zu PA2	7, 14	—	8, 15	—	
Interlock zu PA3	6, 13	—	—	8, 15	
Status RF ON PA1	5	2	—	—	
Status RF ON PA2	9	—	2	—	
Status RF ON PA3	17	—	—	2	
Error PA1	12	6	—	—	
Error PA2	4	—	6	—	
Error PA3	16	—	—	6	
Interlock signal to test room	1	—	—	—	+12 V, 0,2A to interlock loop (e.g. chamber door)
Interlock from test room	3	—	—	—	Input of interlock loop
Connection for signal lamp "Test in Progress"	10, 11	—	—	—	Potential-free relay contact, max. 100 V, 0,5 A
Ground	2, 24, 25	7, 14	7, 14	7, 14	

4.4 Combined Conducted and Radiated EMS Test System (IEC / EN 61000-4-3, -6)

Both test systems for conducted EMS (this application note) and radiated EMS (application note 1SP32) can be combined together using the same R&S IMS.

Remark: The only restriction is, that IMS-B2 for the radiated test system (version 3 V/m or 30 V/m with 2 amplifiers) requires IMS v12. In this case the conducted amplifier has to be external.