Radiated Susceptibility Consideration

INTRODUCTION

Electronic devices not only generate electromagnetic interference but are also susceptible to it. To manage the electromagnetic environment to a safe operating level, the national and international organizations have established EMC standards and test procedures regulating the manufacture of electronic devices. Following the regulatory standards, electronic devices must function properly in an intended electromagnetic environment as well as not interfere with other devices operating in the same environment.

In the United States, the Federal Communications Commission (FCC) regulates the use of radio and wire communications. The requirements for compliance are divided into three sectors:

• FCC part 15 is for radio frequency products.

• FCC part 18 is for industrial, scientific, and medical devices.

• FCC part 68 is for devices connected to the telephone network.

In Europe, European Union established an EMC directive (and European Norms, EN standards) for electromagnetic compatibility requirements that includes immunity in addition to the emissions. This is the difference between EU EMC directive and FCC regulation.

ELECTROMAGNETIC ENVIRONMENT AND REGULATORY STANDARDS

The environment we are now living in is soaked with electromagnetic radiation caused by televisions, computers, cordless phones, broadcast antennas, WIFI, wireless phones and so on. It is not unusual if there is an electric field strength of ~1-2V/m surrounding us. Thus, it is important for electronic product design engineers provide adequate radio frequency protection besides the emissions suppression in the design stage.

The IEC6100-4-3 radio-frequency electromagnetic field immunity tests and measurement techniques standard defines four test levels as shown in Table 1. These depend on the intended electromagnetic environment the electronic devices operate in and lets product committees to specify additional fifth level of test requirements for special situations.

Level	Test field strength *V/m*
1	1
2	3
3	10
4	30
x	Special
NOTE: x is an open test level and the associated field strength may be any value.	

Table 1 RF Field Immunity Levels from IEC 61000-4-3

At each test level, the electric field strength is specified. The difference between test levels based mainly on the most realistic installation area where the devices should typically operate. For power supplies, it is usually required to meet level 2 (3V/m) for residential/commercial application and level 3 (10V/m) for industrial application. Any product with susceptibility level less than 3V/m is more likely to experience interference from RF fields some time in its useful life.

For medical application, the IEC60601-1-2 4th Edition radiated immunity requirement is 10V/m (level 3) for home healthcare and 3V/m (level 2) for professional/hospital.

The Pass/Fail criteria for each test level are classified into four categories:

• Criteria A: Performance within specification limits.

• Criteria B: Temporary degradation and self-recoverable.

• Criteria C: Temporary degradation and requires operator intervention.

• Criteria D: Loss of function and not recoverable.

RADIATED SUSCEPTIBILITY TEST ENVIRONMENT

The radiated susceptibility (RS) test requires test equipment creating sufficient RF field. Below are the list of test Instruments and equipment needed:

- RF generator
- RF power amplifier
- Directional coupler
- Power meter
- Field probe
- Transmitting Antenna
- Anechoic chamber

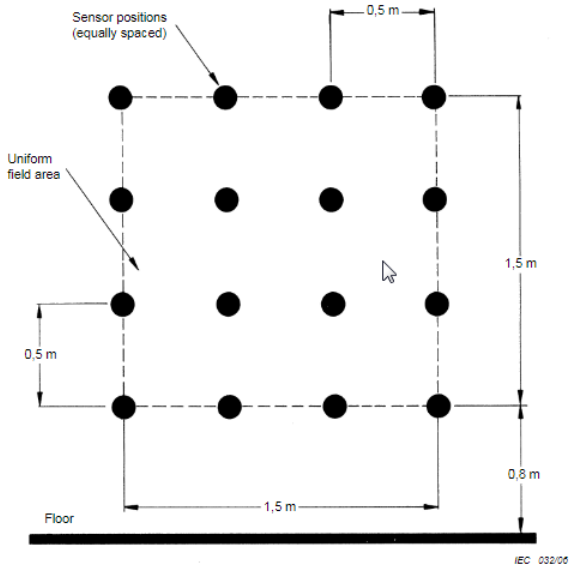
The RS test calibration is normally performed in the frequency range 80MHz to 1GHz with equipment immunity requirements often from 80-2600MHZ. However, for Immunity to RF wireless communications equipment the test is performed in frequency range 380MHz to 5.8GHz with various bands and test levels that represents in Table 9 of the IEC60601-1-2 and shown in Table 2 of this paper.

Table 9-Test specification for ENCLOSURE PORT IMMUNITY to RF wireless communication equipment

Test frequency (MHz)	Band [a] (MHz)	Service [a]	Modulation [b]	Maximum power (W)	Distance (m)	Immunity test level *(V/M)*
385	380-390	TETRA 400	Pulse modulation [b] 18 Hz	1,8	0,3	27
450	430-470	GMRS 460, FRS 460	FM [0] ± 5 KHz deviation 1 kHz sine	2	0,3	28
710	704-787	LTE Band 13, 17	Pulse modulation [b] 217 Hz	0,2	0,3	9
745						
780						
810	800-960	GSM 800/900, TETRA 800, IDEN 820, CDMA 850, LTE Band 5	Pulse modulation [b] 18 Hz	2	0,3	28
870						
930						
1720	1700-1900	GSM 1800; CDMA 1900; GSM 1900; DECT; LTE Band 1, 3, 4, 25; UMTS	Pulse modulation [b] 217 Hz	2	0,3	28
1845						
1970						
2450	2400-2570	Bluetooth, WLAN, 802, 11 B/G/N, RFID 2450, LTE Band 7	Pulse modulation [b] 217 Hz	2	0,3	28
5240	5100-5800	WLAN 802, 11 a/n	Pulse modulation [b] 217 Hz	0,2	0,3	9
5500						
5785						

Table 2 IEC60601-1-2 RF Wireless RF Immunity Requirements.

The UUT must be fully covered by the uniform field area obtained from the field calibration. A field calibration should be performed once a year or when there is a change in equipment or set-up. The Uniform Field Area (UFA) shown in Figure 1, is a vertical plane of field divided into positions with a spacing of 0.5m. A field is considered uniform if its magnitude measured at each position lies within -0/+6dB with not less than 75% of all positions. The calibration is performed at 1.8 times the target field strength since the RS test is done with 80% amplitude modulation.



Calibration of field, dimensions of the uniform field area

Figure 1 RF Field Uniform Field Area Test Point example.

POWER SUPPLY DESIGN CONSIDERATIONS

There are three factors impacting radiated susceptibility: source of radiation, receiving component and means of coupling.

Source of radiation: it is the electromagnetic environment that the power supply operates in. Most of the time, we have no control over the EM environment.

Receiving component: it is the noise sensitive circuit in the power supply.

Means of coupling: it can be the input/output cables and/or the printed circuit board. The cables can either radiate or pick up RF energy. A cable that is a quarter or half wavelength of a transmitted wave is an efficient antenna to radiate or pick up noise. A low frequency electromagnetic energy often couples directly to the cables while a high frequency electromagnetic energy couples to the printed circuit board.

There are three characteristics of RF field that make power supply a victim of interference. First, the RF field must be at frequencies that the power supply circuitry is susceptible to. Second, the amplitude of the RF field is large enough to affect the power supply circuitry. Third, the time the power supply circuitry susceptible to the RF field. Keep in mind, by changing one of these three characteristics, the problem can be minimized or eliminated.

RF SUSCEPTIBILITY MITIGATIONS

RF susceptibility involves audio rectification. Hence, the power supply that is susceptible to RF energy must pick up this energy and often rectify it within IC's in the power supply control network. A dc offset will be produced and cause interference with the power supply function. Thus, preventing RF energy pick-up and/or signal rectification by sensitive components can make power supply immunity to RF. Analog devices such as transistor, amplifier and voltage regulator are susceptible to RF energy.

A good practice in power supply design is applying a decoupling capacitor to the input of the controller IC and the regulator of the feed-back loop. A capacitor value of 100pf to 1000pf is sufficient. A ferrite bead in series with the input of the amplifier creating a RC network will give more protection. A carefully designed common mode choke at the input and output of the power supply providing impedance at the susceptible frequency can help emissions as well as immunity. Shielding sensitive components and/or circuitry should also be considered during a design stage. Twisted or shielded cables and broadband ferrite cores can minimize the RF energy pick-up. If cable shielding is used, the shield must be properly terminated for effectiveness.

Ultimately, the power supply must be testing according to the application RF immunity standard to verify compliance. This is often do at the end of the design or in a system level test. Find out there is a problem at that stage in a product development often lead to schedule delays and "band-aid" solutions to avoid printed circuit board updates. Consequently, it is highly recommended to conduct RF immunity testing early in the design cycle.

SL Power Electronics develops power supplies for medical, industrial and LED lighting markets. EMC compliance is critical to the successful integration of power supplies into end use product. To adequately support customer during product development, SL Power invested in RF immunity and other EMC test equipment to verify power supply compliance early in the design cycle and also assist customer system testing early in their development cycle to reduce time to market and expensive re-design due to late cycle product compliance testing. For more information contact SL Power Electronics support or Applications Engineering at SLPOWER.COM/contact-forms.