The EMC Directive Revisited

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INTRODUCTION

This article is a follow-up to the 1992 *ITEM* paper "European Community EMC Directives for Information Technology Equipment."[1] The deadline for the European Community (EC) EMC rules, January 1, 1996, has arrived and as a result, marking all electrical/electronic equipment with the required CE mark is now mandated.

Much more is done in the U.S. than in Europe to implement the EMC directive as U.S. manufacturers can not chance being excluded from the European market because of the lack of or false CE marking. European manufacturers can obtain special permission from their local governments to market the equipment for an interim period without full EMC compliance.

From a technical standpoint, the emission limits are practically the same for all equipment except that a distinction is made between Class A and Class B equipment. Therein lies a major problem, because the Class A equipment cannot be used in a Class B environment (which is defined as residential, commercial, light industry and health care) without special permits from local governments. In the UK, Class A equipment is permitted in a Class B environment, but in Germany a test needs to be performed for each Class A equipment installation in a Class B environment.

THE EMC DIRECTIVE

The intent of EMC Directive 89/336/EEC is to mandate EMC emission and immunity control for any electrical/electronic product that is sold in the European Union (EU). However, the EMC Directive does not adequately address the details of the limits. The Directive was prepared under the "new approach" and contains only the legal (non-technical) requirements. The details are published in a notice in the Official Journal of the European Communities.

The EMC Directive is now fully implemented in the EU.

These notices are published whenever CENELEC finalizes another EMC specification that is adopted by the EU. A similar list was published quite a bit earlier in "The CEN/CENELEC/ETSI Bulletin of European Standards Organizations."†

The EMC Directive has been effective since January 1, 1996. It mandates that all electrical/ electronic products are labeled with the CE mark. The process of labeling is relatively simple for most products under the Conformity Assessment Module A procedure (Figure 1).

- The manufacturer performs (or contracts an EMC laboratory to perform) the required emission and immunity tests.
- Assuming that all tests are passed, the manufacturer prepares an "EU Declaration of Conformity" which provides a product description, the address of the manufacturer and the agent in Europe, and a list of all applicable European Norms (ENs) for which passing tests were performed.
- The manufacturer attaches the CE mark to the product or includes it in the user's manual if the product is too small (Figure 2).
- The product is marketed in Europe. The European representative must keep the EC Declaration of Conformity on file. Some manufacturers opt to keep the EC Declaration of Conformity in the user's manual.

The use of the CE mark requires some caution. The CE mark implies that the product complies with all applicable requirements. During 1996 it is possible to CE-mark most products on the basis of EMC compliance only. Starting in 1997, products must also comply with the electrical safety requirements. Notable exceptions exist for medical equipment, radio transmitters, and telephone terminal equipment, for which separate Directives were prepared. These Directives require that the product be qualified under Conformity Assessment Module B, which requires submission of the product to a Notified Body. In other words, the tests are performed by an official agency that was certified by the commission.

There is also considerable confusion about the Technical Construction File route of conformity assessment. This approach means that an interpretation of the test requirements for a complicated product needs to be made by a competent body that is audited per EN 45001 by a European auditor. The tests are performed by the competent body or by a licensee of that competent body. There are several labs in the U.S. that are licensed by European competent bodies. The lab then documents the test plan, test, and test report in the Technical Construction File. Even if the manufacturer follows the self-declaration route, it is generally best to keep all pertinent data in a technical file and give a copy of that file to the European representative.

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*See Advertisement on page 225.

THE EMISSION LIMITS

Within the available ENs there are numerous emission specifications. The limits of these ENs are compared in Table 1. A review of this table shows that the limits are the same for nearly all products. The narrowband (average) conducted limits from 0.15 to 30 MHz are 10 dB (13 dB for Class A) lower than the broadband (quasi-peak) levels. All radiated emission measurements are performed at a distance of 10 m except for Class A equipment identified in EN 55011, which requires a 30-m test distance. A 10-m distance may be used, but extrapolation (-10 dB) to the 30-m distance is not allowed.

The FCC also allows the use of the CISPR 22 (EN 55022) limits, provided that the detailed measurement methods of ANSI C63.4 are used.

Since all the limits are the same, why did the EC publish all the ENs? The answer lies with the parochial attitude of the IEC and CENELEC, which mandated that the product committees prepare the EMC requirements. Encouraging developments are the "Generic Limits" of EN 50081-1 and EN 50082-2. Table 1 shows that there is only need for three types of specifications:

- emission limit specifications for industrial locations (Class A)
- emission limit specifications for residential locations (Class B)
- test procedure specifications that state how to test each product family

This trend of consolidation was set by the work on CISPR 22. Since information technology equipment was the most widely traded product in the 1980s, the CISPR 22 limits are the consensus limits in use.

The present generic CENELEC Class B definition includes residential, commercial, light industry and health care locations. However, the commercial, light industry and health care equipment is frequently Class A equipment. Therefore, the

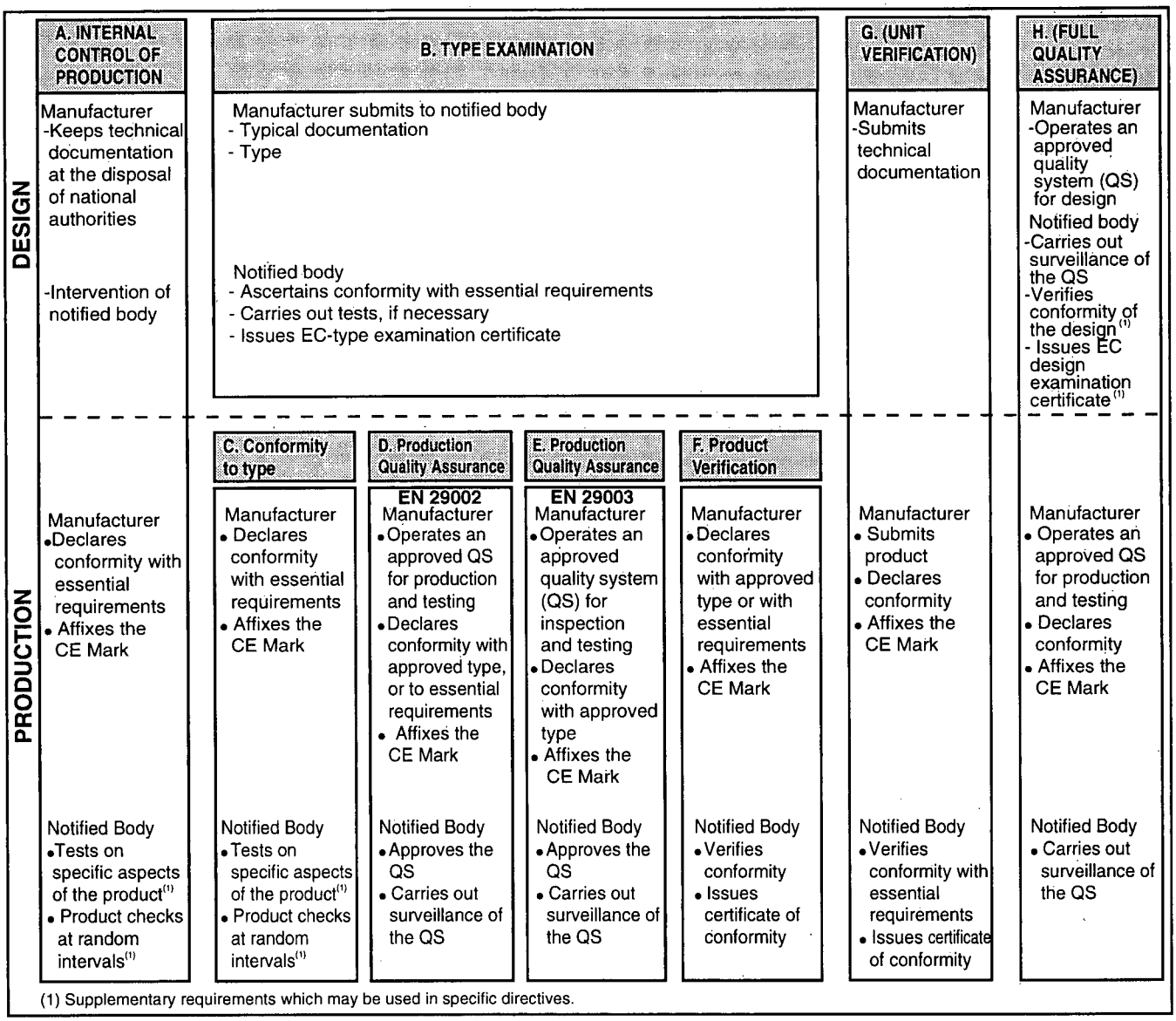

Figure 1. *Conformity Assessment Procedures.*

Figure 2. *CE Mark.*

WARNING
This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Figure 3. *Warning Notice Which Should Accompany Some Class A Equipment.*

Part 1, Class B Limits for Primarily Residential Areas									
Frequency Range, MHz									
0.15 → 0.5 → 5 → 30 → 230 → 1,000									
SPECIFICATIONS	dBµV		dBµV		dBµV		dBµV/m	dBµV/m	NOTES
	QP[1]	AVG[1]	QP	AVG	QP	AVG	QP	QP	
EN 50081-1 "B"	66-56	56-46	56	46	60	50	30	37	@10 m, B Limit
EN 55011 "B"	66-56	56-46	56	46	60	50	30	37	@10 m, B Limit
EN 50013 (2)	66-56	56-46	56	46	60	50	45-55[3]	-	dBpW, Absorbing Clamp
EN 50014	66-56	56-46	56	46	60	50	45-55[3]	-	dBpW, Absorbing Clamp
EN 55022 "B"	66-56	56-46	56	46	60	50	30	37	@10 m
FCC Part 15 "B"	-	(4)	61	48	61	48	40[4]	46	@ 3 m[4]
Part 2, Class A Limits for Industrial Areas									
EN 50081-2 "A"	79	66	73	60	73	60	30	37	@30 m, A Limit
EN 55011 "A"	79	66	73	60	73	60	30	37	@30 m, A Limit
EN 55022 "A"	79	66	73	60	73	60	30	37	@30 m
FCC Part 15 "A"	-	(4)	73	60	83	70	40[4]	46	@10 m[4]

NOTES:
(1)The dash between two numbers (e.g., 66-56) indicates that the limit decreases with the logarithm of frequency. The limits are plotted on semi-log paper, the vertical scale being the limit and the horizontal scale being the frequency. The two points shown are plotted and a straight line is drawn between them.
(2)EN 55013 also has other limits for antenna emissions from receivers and televisions.
(3)The absorbing clamp measurement is performed from 30-300 MHz.
(4)The FCC Class A and B Limits are as follows:

FREQUENCY	BLIMIT	ALIMIT
0.45 - 1.705	48 dBµV*	60 dBµV*
1.705 - 30 MHz	48 dBµV*	70 dBµV*
30 - 88 MHz	40 dBµV/m @3 m	40 dBµV/m @10 m
88 - 216 MHz	43 dBµV/m @3 m	43 dBµV/m @10 m
216 - 960 MHz	46 dBµV/m @3 m	46 dBµV/m @10 m
>960 MHz	54 dBµV/m @3 m	50 dBµV/m @10 m

* Narrowband Limit; Broadband Limit is 13 dB higher.

Table 1. *Comparison of Limits in Various RFI Specifications.*

CENELEC Class A and Class B definitions should be aligned with CISPR 22 as described here.

Class B equipment is primarily intended for use in an environment where the use of broadcast radio and television receivers may be expected within a 10-meter distance of the apparatus concerned. It may include:

- equipment with no fixed place of use, such as portable equipment powered by built-in batteries
- telecommunication terminal equipment powered by the network
- personal computers and peripherals

Class A equipment is the category for all other equipment which satisfies the Class A limits but not the Class B limits. Sales of such equipment should not be restricted but a warning should be included in the instructions for use (Figure 3).

THE EC IMMUNITY REQUIREMENTS

The EC immunity requirements were prepared by CENELEC TC110. The basis for these standards is the work of IEC TC77, EMC. Originally the documents were called IEC 801-1 through -XX. They are now called IEC 1000-4-1 through -25 or EN 61000-4-1 through -25. CENELEC specifications EN 50082-1 (residential) and EN 50082-2 (industrial) call out only the stress levels which are shown in Table 2. For the detailed test requirements, the IEC 1000-4-x series of specifications needs to be consulted. To make matters more confusing, product family immunity specifications are also being prepared for all types of equipment. At the time of this writing, EN 50082-1, EN 50082-2, EN 55014-2 (household) and EN 60601-1-2 (medical) are in force. Most equipment is being tested to EN 50082-1, which calls out only ESD, radiated RF and EFT requirements. For medical requirements the surge requirement is also added and the radiated immunity frequency range is extended from 26 MHz to 1000 MHz.

The newest requirement applies to household appliances and electric tools as specified in EN 55014-2. Fortunately there are several categories of equipment so that not all appliances need to be tested (Table 2).

- *Category I:* Contains no electronic circuits. No immunity tests required.
- *Category II:* Contains electronic circuits with clock speed of less than 15 MHz. All tests required.
- *Category III:* Battery powered equipment with clock speed of less than 15 MHz. Only ESD, EFT, RFCI is required. If batteries are charged from power mains, tests per Category II are also required.
- *Category IV:* All other equipment. Perform all tests. RFCI only to 80 MHz.

The individual immunity tests are performed with different performance criteria as follows:

- *Performance Criterion A:* Shall continue to operate as intended within ± 10 % of normal speed after RFCI and RFRI tests.

Specification	IEC 1000-4-2 Electrostatic Discharge (ESD)	IEC 1000-4-3 RF Radiated Immunity (RFRI)	IEC 1000-4-4 Electrical Fast Transient (EFT)	IEC 1000-4-5 Electrical Surge	IEC 1000-4-6 RF Conducted Immunity (RFCI)
EN 50082-1 Generic Limit, Residential	8,000 V Air Discharge B(1)	27-500 MHz 3 V/m A(1)	500 V, Signal 1,000 V, Power 5/50 ns, 5 kHz B(1)	Not Yet Proposed	Not Yet Proposed
EN 50082-2 Generic Limit, Industrial	8,000 V Air Discharge 4,000 V Contact B(1)	80 MHz-1,000 MHz 10 V/m, plus 900 ±5 MHz Pulse Modulate 200 Hz Square Wave A(1)	1,000 V, Signal 2,000 V, Power 5/50 ns, 5 kHz B(1)	Not Yet Proposed	0.15 MHz-80 MHz 10 V 80% AM, 1 kHz 150 Ω Source A(1)
EN 55014-2 Appliances and Power Tools	8,000 V Air Discharge 4,000 V Contact B(1)	80 MHz-1,000 MHz 3 V/m A(1)	500 V, Signal 1,000 V, Power 5/50 ns, 5 kHz	1,000 V, D.M. 2,000 V, C.M. on Power only 1.2/50 µs B(1)	0.15MHz -230 MHz Category II 0.15-80 MHz Category IV 1 V, Signal 3 V, Power A(1)
EN 60601-2 Medical Devices	8,000 V Air Discharge 3,000 V Contact (2)	26-1,000 MHz 3 V/m 80% AM 1 kHz	500 V, Signal 1,000 V, Power 5/50 ns, 5 kHz	1,000 V, D.M. 2,000 V, C.M. on Power only 1.2/50 µs	Not Yet Proposed

Notes: 1) The letter designates the performance criterion (See text for EN 55014-2).
2) For medical devices the performance criterion depends on the type of device.

Table 2. *Summary of EC Immunity Requirements.*

- *Performance Criterion B:* Shall continue to operate as intended after ESD, EFT and surge tests are complete.
- *Performance Criterion C:* Loss of function is permitted provided that it is recoverable. This pertains only to voltage dips and interruptions.

The medical device immunity requirements are given in EN 60601-1-2 (Table 2). Table 2 does not contain the power utilization requirements specified in EN 60555-2 (Harmonics) and EN 60555-3 (Interruptions). These tests also need to be considered although they are not really EMC tests.

SUMMARY

The emission requirements are relatively straightforward. Very few surprises are in the specification mill. The test distance of 30 m specified in EN 55011 should be changed for smaller equipment since it was primarily proposed for very large industrial RF heating ovens. But most equipment is smaller to make a test distance of 10 m acceptable.

The Class A equipment in a Class B environment is perhaps the hottest issue. An approach per EN 55022 is logical. Most commercial equipments are Class A. All point of sales and inventory systems, airline reservation systems and large computers are Class A. To lump these with a Class B requirement is absurd and must be revised by the EU. The approach used in the UK per EN 55022 guidelines should serve as a model for the rest of the EU.

There are many immunity requirements still in the specification mill. For 1997, new requirements will be established. The IEC Technical Committee 77 is already up to IEC 1000-4-25 and nobody knows when organizers will stop to generate immunity requirements for electrical/electronic equipment. The best approach is to become pro-active and join an EMC committee. Keeping abreast of the changes through a subscription to the CEN Newsletter is also advised.

REFERENCE

1. Herbert K. Mertel, "European Community EMC Directives for Information Technology Equipment," *ITEM* 1992, p. 116.

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