

# A Review of EMI Standards, Part 1 – Conducted Emissions



Timothy Hegarty

In general, electrical products must meet some type of electromagnetic interference (EMI) performance metric, whether established in the product’s design specifications or to comply with regulatory requirements. It’s important to take into account any functional specifications that stipulate limits for EMI during the design phase of a project, particularly with respect to printed circuit board (PCB) layout and noise filtering. In part 1 of this series, I’ll review standards for conducted EMI in automotive, communications and industrial applications. [Table 1](#) provides a list of relevant abbreviations.

**Table 1. Common Acronyms**

|             |  |
|-------------|--|
| IEC         | <i>International Electrotechnical Commission</i>   |
| CISPR 25    | <i>Comité International Spécial des Perturbations Radioélectriques, an IEC technical committee</i> |
| EN 55032    | <i>A modified derivative of CISPR 32 prepared by CENELC and ratified by the EU</i>                 |
| FCC Part 15 | <i>Federal Communications Commission; Part 15 subpart B applies to unintentional radiators</i>     |
| UNECE       | <i>United Nations Economic Commission for Europe</i>   |
| CE Mark     | <i>Conformité Européene</i>  |
| CENELEC     | <i>Comité Européene de Normalisation Électrotechnique</i>  |
| EN          | <i>European Norm</i>   |

## EMI Standards for Automotive

From a regulatory standpoint, [UNECE Regulation 10](#), titled “Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility,” replaced the European Union’s (EU) Automotive Electromagnetic Compatibility (EMC) Directive 2004/104/EC in November 2014. UNECE Regulation 10 requires that manufacturers gain type approval for all vehicles, electronic sub-assemblies, components and separate technical units. Of course, automotive manufacturing has evolved into a global business, and the requirements and standards in this specification have broader relevance than the EU.

From an automotive electronic product designer’s perspective, the [CISPR 25](#) product standard specifies the critical conducted emissions tests that apply at both the overall vehicle level as well as to automotive components and modules. Measurements are performed using one or two 5µH/50Ω artificial networks, depending on the grounding configuration. Conducted noise is measured over a frequency range from 150kHz to 108MHz. Because CISPR 25 refers to the “protection of on-board receivers,” the relevant frequency bands are dispersed across the AM broadcast, FM broadcast and mobile service bands, as shown in [Figure 1](#). The limit lines in red and blue are the Class 5 peak (PK) and average (AVG) limits. PK limits are generally 20dB higher than the AVG limits.

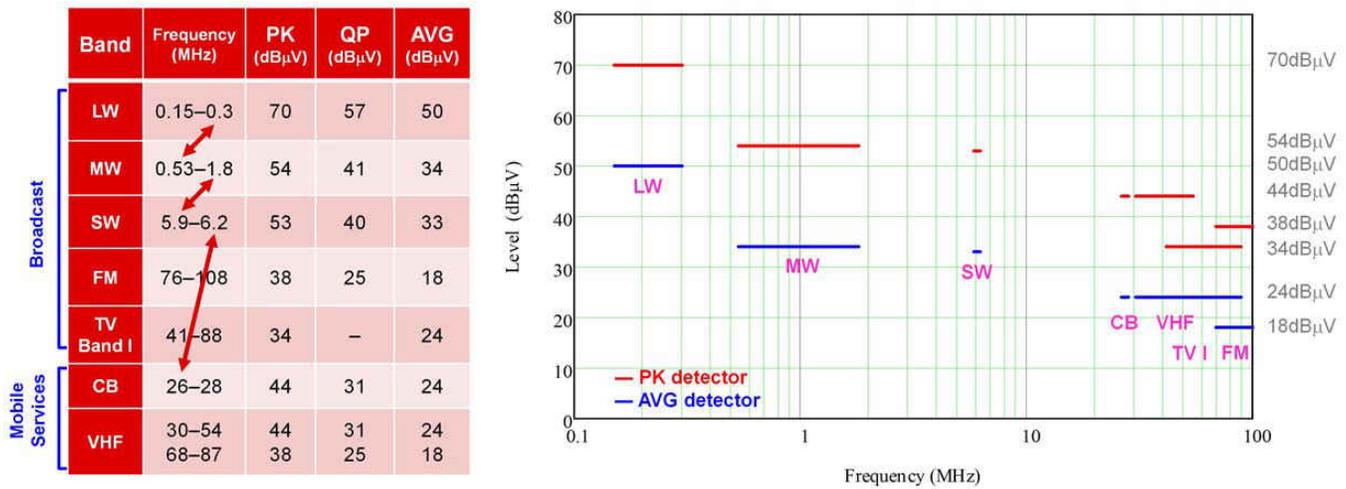


Figure 1. CISPR 25 Class 5 Conducted Emission Limits with Peak (PK) and Average (AVG) Detectors

Figure 1 also plots the relevant limit lines for Class 5, the most stringent requirement from CISPR 25. Automotive manufacturers typically leverage this standard and may choose to extend or adjust the limits and frequency ranges according to their specific in-house requirements. The limits are extremely challenging, particularly the 18dB $\mu$ V average (and 38dB $\mu$ V peak) limit in the VHF and FM bands (68MHz to 87MHz and 87MHz to 108MHz, respectively).

### EMI Standards for Communications Equipment

Power-supply products marketed for communications products and information technology equipment (ITE) within the EU have typically used the well-known CISPR 22 (or its European Standard equivalent, EN 55022) over many years, with the CE Declaration of Conformity (DoC) for external power supplies referencing this standard to show conformance with the EU’s EMC Directive 2014/30/EU. CISPR 22/EN 55022 was recently subsumed into CISPR 32/EN 55032, however. This new standard, targeted at multimedia equipment, becomes effective as a harmonized emission standard in compliance with the EMC directive. More specifically, any product previously tested under EN 55022 that is shipped into the EU after March 2, 2017, must now meet the requirements of EN 55032.

Figure 1 shows the EN 55022/32 Class A and Class B limits for conducted emissions with quasi-peak (QP) and AVG detectors over the frequency range of 150kHz to 30MHz.

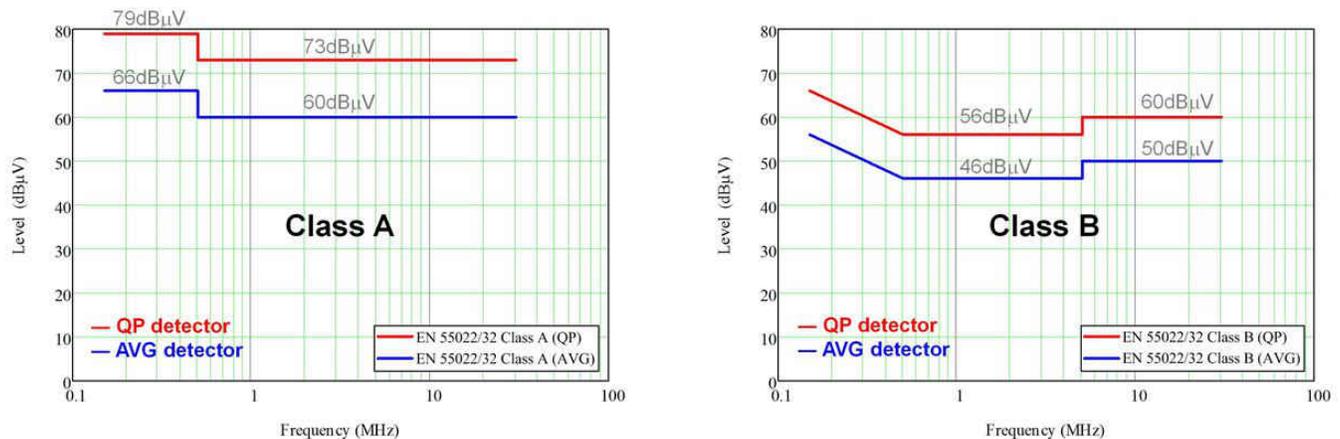


Figure 2. EN 55032 Class A and Class B Conducted Emission Limits

Similarly, products designed for North American markets have complied with equivalent limits established by the FCC Part 15 Subpart B for unintentional radiators. Section [15.107](#) establishes limits for conducted emissions effectively equivalent to those in CISPR 22.

## EMI Standards for Industrial

[CISPR 11](#) is the international product standard for EMI disturbances from industrial, scientific and medical (ISM) equipment. Groups 1 and 2 are defined with scope for general-purpose and ISM radio-frequency applications, respectively. Each group is further subdivided in two classes: Class A equipment is for use in all establishments other than domestic and may be measured on a test site or in situ, whereas Class B covers domestic establishments and is measured only on a test site.

Meanwhile, [IEC 61000-6-3](#) and [IEC 61000-6-4](#) are “generic” EMC standards that apply to products targeted for residential/commercial/light-industrial and industrial environments, respectively, particularly if a product-specific standard is unavailable.

## Summary

EMI is an increasingly challenging topic for fast-switching power converters. Commercial products for automotive, industrial and communications equipment are designed to minimize the amount of EMI produced during normal operation. Thus, an understanding of the EMI standards pertaining to the application is essential. The first installment of this blog series reviewed relevant standards for conducted EMI. In [part 2](#), I'll discuss standards for radiated EMI.

## Additional Resources

- Read the article series, “[The engineer’s guide to EMI in DC/DC converters.](#)”
- Take the EMI training webinar, “[Understanding EMI and mitigating noise in DC/DC converters.](#)”
- Examine the CISPR 22/25 EMI results provided with these reference designs in the TI Designs library:
  - [CISPR-22 EMI-optimized reference design featuring LMR23630 synchronous DC/DC buck converter.](#)
  - [Front end power supply reference design with cold crank operation, transient protection, EMI filter.](#)
  - [Integrated power front end and multi-phase processor supply automotive reference design.](#)
- Order the [EMI-optimized evaluation module](#) for the LM73606-Q1 36V, 6A automotive buck converter.
- Read the Analog Applications Journal article, “[Reduce buck-converter EMI and voltage stress by minimizing inductive parasitics.](#)”
- Download the white paper, “[An overview of conducted EMI specifications for power supplies.](#)”

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