Electromagnetic Compatibility of Lighting Equipment

Application Note

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EMC Requirements for Lighting

Testing standards for lighting have been updated, created and implemented along with some still in a draft stage, to help ensure there is a uniform evaluation of EMC for the various lighting equipment being developed and released by manufactures around the world. This paper will review the various standards that relate to the lighting product.

Requirements for US, Canada and Europe

While other safety standards come into play for the US and Canada below are the specific EMC standards to consider.

In the US, lighting products must comply with FCC Part 15, subpart B or FCC part 18 depending on the application and function of lighting device. With the testing method being called out by ANSI C63.4. ANSI C63.29 is being develop specifically for lighting products.

In Canada, ICES-003 or ICES-005 are the standards to evaluate lighting products against.

Europe has some additional requirements beyond emissions to consider. EN 55015 defines emission requirements, EN 6100-3-2 evaluates harmonics, EN 61000-3-3 deals with flicker, EN 61547 defines immunity requirements and EN 62493 looks at Electromagnetic field requirements.

Emission requirements: EN 55015, FCC, ICES

These standards apply to all lighting equipment and its accessories. Exceptions may apply such as in EN 55015 with equipment operating in ISM (industrial, scientific, medical) frequency bands, as well as lighting technology in aircraft and airports and other specifically exempted equipment. Each standard specifies the frequency range of concern along with corresponding limits for conducted and radiated interference emission. Please consult the standard or test house for detail in regard to your specific item. The following is a brief review of EN 55015:

Conducted Noise Emission

Figure 1 shows the emission limits and corresponding frequencies for EN55015 applied to the mains connection. A quasi-peak (QP) of 110 dBµV is permissible between 9 kHz and 50 kHz. From 50kHz to 150kHz, the limit value runs linearly to the logarithm of frequency from 90 to 80dBµV. The limits for QP and average (AV) from 150 kHz and up comply with the generic standard EN 61000-6-3: Emission standard for residential, commercial and light-industrial environments.

Since the electronics and the illuminant do not always form a unit, and interferences can therefore also be emitted through the cable to the lighting means, limit values are also specified for lamp connections. They are QP (AV) 80 (70) dBµV from 150 to 500 kHz and QP (AV) 74 (64) dBµV from 0.5 to 30 MHz. A setup and test with a load emulation of the illuminant are likewise described. Limit values are defined for control inputs, if the electronics have them.

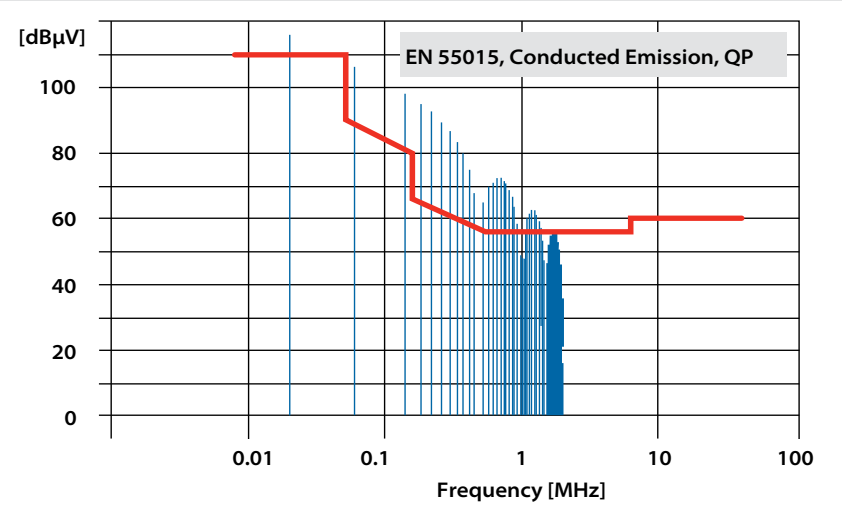

Figure 1:
Limit values with non-suppressed harmonics of a fixed-frequency switching regulator

Radiated Interference Emissions

A QP limit value for EN55015 of 30 dB (µV/m) for field-based noise emission applies between 30 MHz and 230 MHz, and a value of 37 dB applies from 230 to 300 MHz, with a measuring distance of 10m.

EN 61000-3-2

This standard describes the permissible harmonic current emissions for devices with an input current of up to 16 A per phase. Lighting equipment and accessories are assigned to class C.

Up to an effective input power of 25 W, the moderate limit values that can be achieved without a correction of the power factor apply to lighting equipment for discharge lamps (Table 1). For all other lighting equipment (e.g. LED lamps, ignition and starting devices), no limit vales for harmonics are prescribed up to 25 W.

Harmonic order [n]	Permissible maximum value of the harmonic current per W [mA/W]	Permissible value of the harmonic current [A]
3	3,4	2,3
5	1,9	1,14
7	1,0	0,77
9	0,5	0,040
11	0,35	0.,33
13–39	3,85/n	0.15 × 15/n

Table 1

The following limits apply to devices with an effective input power of >25 W:

Harmonic order [n]	Permissible maximum value of the harmonic current in percent of the input fundamental oscillation current [%]
2	2
3	30 λ *
5	10
7	7
9	5
11–39	3

Table 2:
*** λ is the power factor of the circuit**

The standard permits the use of several operating devices with <25 W in a lamp with the limit values for <25 W.

EN 61000-3-3

This standard describes the limit values for voltage fluctuations and flicker in low-voltage supply systems up to 16 A per phase. No limit values apply to lamps. Lighting fixtures with incandescent lamps up to 1000 W rated power and lighting fixtures with discharge lamps up to 600 W rated power need not need to be tested.

EN 61547

The interference immunity requirements for devices for generic lighting purposes are established here. Refer to the relevant generic standards EN 61000-4-x for tests such as electrostatic discharge, HF-EM field, LF-EM field, burst, surge and voltage dips. The intensity of the tests as well as the criteria for the various types of lighting devices (e.g. starter units, discharge lamps, emergency lighting) are set individually.

EN 62493

This defines how much human exposure to electromagnetic fields is allowed from lighting equipment.

The objective of the noise mitigation is to avoid propagation of the interference currents generated in the electronics. Conducted interference is primarily emitted via the mains line and the line to the illuminant. For lighting devices with larger power, the use of IEC power entry modules or single-phase EMC filters on the mains side is possible. Figure 2 represents how an EMI filter could easily be integrated into the circuit to assist with compliance.

EMC Filters in Lighting Technology

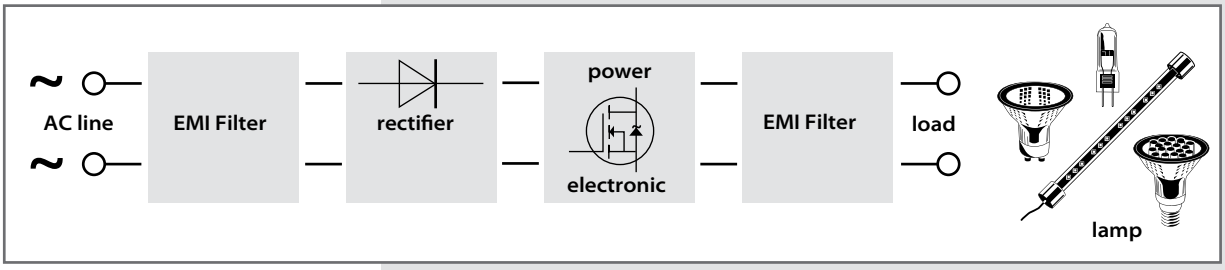

Figure 2:
Block schematic with an EMI filter

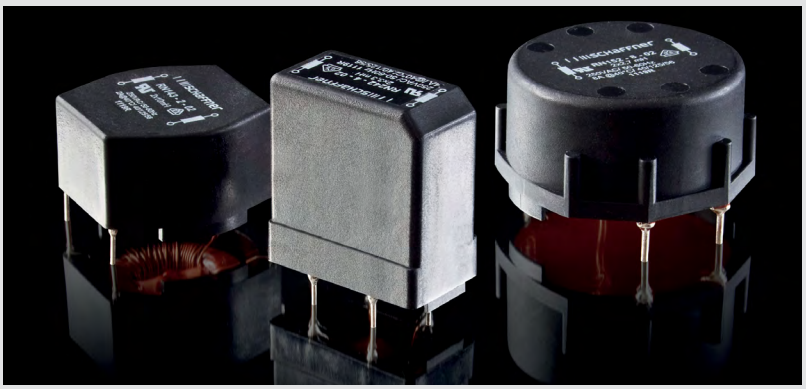

Figure 3:
Current-compensated toroidal core chokes from Schaffner for 0.3 to 10 A

The integration of the filters on the circuit board using current-compensated chokes represented in Figure 3 is advisable for lower powers. The RN series makes the construction of EMC filters with high power density possible due to the use of toroidal cores, and has high saturation resistance as well as outstanding thermal behavior.

Schaffner offers various choke families such as RN, RC, EV and EH series that are less sensitive to electromagnetic coupling than other designs because of the closed toroidal core and the compact design of the magnetic circuit.

The mode of operation of the individual components will be briefly explained with reference to a typical mains filter. The parasitic capacitances of the interference source to earth are one propagation path for interference. The heat sink is a typical example of this for power electronics. The noise currents flow via the parasitic capacitor to ground and back to the interference source via the mains lines or other lines. This noise is called common-mode or asymmetric interference.

To avoid propagation via the mains line, the load-side Y-capacitors in the filter form a noise sink. At the same time, the impedance of the mains line is increased by a current-compensated choke. For low power, small parasitic capacitance to earth or high requirements for leakage currents (as in medical technology), noise elimination with Y-capacitors can also be left out.

The second path for propagating noise is differential mode or symmetrical interference. The typical source for this is the voltage ripple caused by the switching process and impedances of parallel components such as capacitors and the circuit path to their terminals.

These interferences would mainly propagate via the connected mains conductors P and N to mains.

The load-side x-capacitor Cx-2 is an interference sink for these noise currents. With a load-side inductor (PFC choke or DC reactor) the x-capacitor forms a first low-pass filter and symmetrises the noise level on the two mains lines. The stray inductance of the current-compensated choke, the additional differential mode core, together with mains-side capacitor Cx-1, forms another low-pass filter to suppress the propagation of symmetrical interference to mains.

Mains Filter Design for Lighting Technology

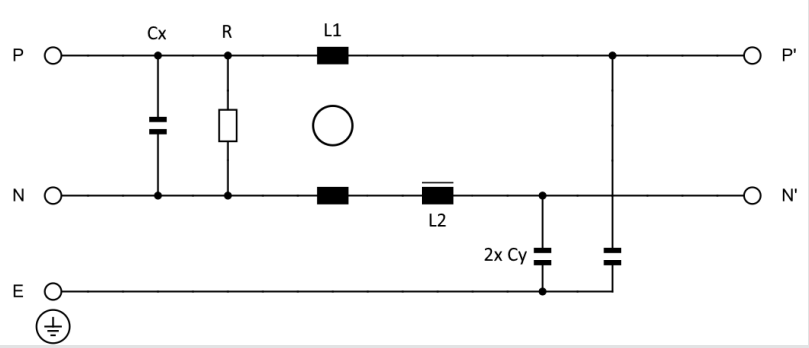

Figure 4:
Typical arrangement of a mains filter

In general, a structure as shown in Figure 4 is sufficient. The requirement for damping can be found by measuring the module without interference suppression with the network emulation

If measurement of the non-interference-suppressed module containing the load-side x-capacitor shows that limit values have been exceeded, an appropriate preselection can be made based on the damping curves of the RN choke (see Figure 6).

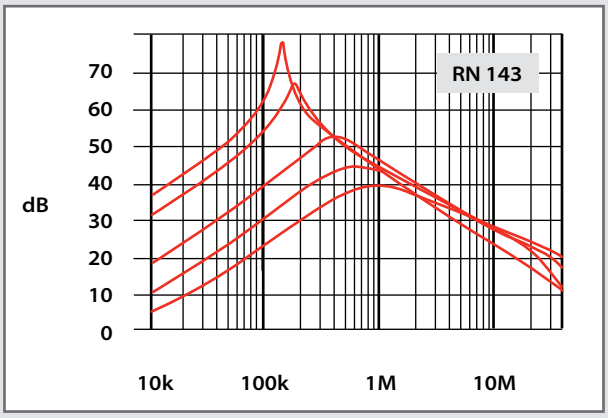

Figure 6:
Damping curves of the Schaffner RN143 series

The rated value for the choke current must be measured for the lowest possible mains voltage, the largest load case, and the highest permissible temperature under full load. By matching the resonant frequency to the spectrum of the switching processes, it is possible to damp the third harmonic at 144 kHz by about 70 dB with an RN143-05-02, if necessary. The decisive factor is ultimately the measurement with the network emulator, however.

Current-compensated Chokes for The Load and Control Terminals

In addition to their use as mains filters, current-compensated chokes can also be used for noise suppression of the load terminal. For ballasts with an ignition voltage, this level must match the rated voltage of the choke.

For control terminals, chokes such as RN, RC, EV and EH can not only help suppress the propagation of interference, but can also improve interference immunity in order to meet the criteria of the interference immunity tests "Fast transients" (EN 61000-4-4) and "Surge voltages/surge currents" (EN 61000-4-5).

Chokes and Filters – Proven Quality

The RN, RC, EV and EH chokes along with the FN2580 filter that is specifically designed for lighting have extended temperature ranges and are constructed with the high quality one expects from Schaffner EMC. They are available from stock anywhere through a world-wide distribution and sales network:

Inventory
Datasheet

More Information on EMC

More information on noise suppression for power electronic modules is provided by our EMC brochure "Basics in EMC and Power Quality".

Short Form-Catalog
Basics in EMC and Power Quality

For further information visit our website www.schaffner.com, or contact your local Schaffner branch office or the nearest Schaffner partner for individual consultation.

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SCHAFFNER EMC INC.
52 Mayfield Avenue
Edison, New Jersey 08837
+1 800 367 5566
+1 732 225 4789
usasales@schaffner.com
www.schaffnerusa.com

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