

# Conducted noise measurement using the Tekbox 50µH LISN TBLC08 and EMCview Software

## 1 Introduction

This application note demonstrates how to carry out conducted noise pre-compliance measurements of mains operated LED luminaires using a Tekbox 50µH LISN TBLC08, a Rigol Spectrum Analyzer DSA815 and the EMCview software from Tekbox.

Choosing LED luminaires as DUT was rather random. Similar procedures can be applied to most mains operated equipment.

## 2 Applicable standards

In order to prepare the test set up for conducted noise pre-compliance measurement, it needs to be determined which standards apply to the DUT. Lightingeurope.org provides a document with information on all requirements for the conformity of luminaires. It can be downloaded from:

[http://www.lightingeurope.org/uploads/files/LightingEurope\\_EU\\_Compliant\\_Requirements\\_Products\\_Sheets\\_for\\_LUMINAIRES\\_1st\\_Edition\\_29112013.pdf](http://www.lightingeurope.org/uploads/files/LightingEurope_EU_Compliant_Requirements_Products_Sheets_for_LUMINAIRES_1st_Edition_29112013.pdf)

The document lists EN55015, as applicable standard for electromagnetic compatibility. This standard corresponds to CISPR15.

Following limits are defined for conducted noise at the AC terminals of the luminary:

Frequency range	Limits [dBµV]	
	Quasi peak	Average
9 kHz – 50 kHz	110	-
50 kHz – 150 kHz	90 to 80	-
150 kHz – 500 kHz	66 to 56	56 to 46
500 kHz – 5 MHz	56	46
5 MHz -30 MHz	60	50

Table 1: EN55015 (CISPR15) limits for conducted noise

CISPR 15 Conducted emission measurements are measured using two types of detectors– quasi-peak (QP) and average (AV). Typically, there are two limit lines on measurement reports. Noise levels measured with the quasi peak detector should be below the QP limit line and the noise levels measured with the average detector should be below the AV limit line. Quasi peak measurements should be measured starting at 9 kHz, while average detector measurements should be started at 150 Hz.

Resolution bandwidth in the frequency range 9 kHz to 150 kHz: 200 Hz  
 Resolution bandwidth in the frequency range 150 kHz to 30 MHz: 9 kHz

## 3 Spectrum analyzer considerations

As this document looks at how to carry out pre-compliance measurements in a development lab environment and not how to set up a 100% compliant conducted noise test, it is assumed that the tests are carried out with a spectrum analyser rather than with an EMI measurement receiver. With respect to EMI testing, a spectrum analyser has a few disadvantages compared to a measurement receiver. Consequently, a few things need to be considered upfront.

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### Detector

The time constant of the quasi peak detector depends on the measurement equipment, however referring to its specification in CISPR 16-1-1, 600ms per frequency point is a good approximation. Consequently, a measurement sweep across the full range would be very slow. Usually, a first sweep is carried out using the faster average detector instead of the quasi peak detector. This first sweep is also referred to as “pre-scan”. A final scan with the quasi peak detector would be carried out looking just at the peak values of the pre-scan.

### Frequency span

Modern spectrum analyzers don't have a continuous sweep range. As an example, the Rigol DSA815 has 601 discrete sweep points across the selected sweep range.

When doing a pre-compliance measurement, we want to ensure that we don't miss any noise spurious in between two adjacent measurement frequency points. Looking at the range of 9 kHz to 150 kHz, the specified resolution bandwidth for the conducted noise measurement is 200 Hz. Consequently, two adjacent measurement frequency points should not be spaced further apart than 200 Hz. Furthermore, we want to ensure that any signal at the input of the spectrum analyser appears within the flat section of the filter. This requirement will further reduce the distance between two consecutive frequency points.

A good choice for a RBW of 200 Hz is to choose frequency steps of 100 Hz. Similarly, we will choose frequency steps of 4.5 kHz in the frequency range where a RBW of 9 kHz has to be applied.

The resulting (sub) spans for the Rigol DSA815 are  $600 * 100 \text{ Hz} = 60 \text{ kHz}$  in the frequency range 9 kHz to 150 kHz and  $600 * 4.5 \text{ kHz} = 2.7 \text{ MHz}$  in the frequency range 150 kHz to 30 MHz.

### Sweep time

Relevant auto sweep time settings for the DSA815 are given in the table below:

Detector	Frequency span	RBW	Sweep time
Average	60 kHz	200 Hz	2.77 s
	2.7 MHz	9 kHz	67 ms
Peak	60 kHz	200 Hz	2.77 s
	2.7 MHz	9 kHz	67 ms
Quasi Peak	60 kHz	200 Hz	1200 sec
	2.7 MHz	9 kHz	540 sec

Table 2: DSA815 auto sweep times

In case that sweep time is configured manually, it shall not be set any faster than the auto sweep time.

Based on table 2, the measurement time for single frequency points in QP mode at 200Hz RBW would result in  $1200/601 = 20 \text{ sec}$  in case of 200Hz. The result for 9 kHz RBW is 890ms.

### EMCview

The EMCview software of Tekbox takes care of the considerations above. All relevant parameters are pre-configured. After checking that the maximum spurious levels are not above the input ratings of the spectrum analyzer, carrying out a measurement is straightforward. It does not take much more than connecting the PC to the spectrum analyzer, selecting the pre-configured CISPR 15 project and pressing the measurement button.

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### 4 Measurement Set up

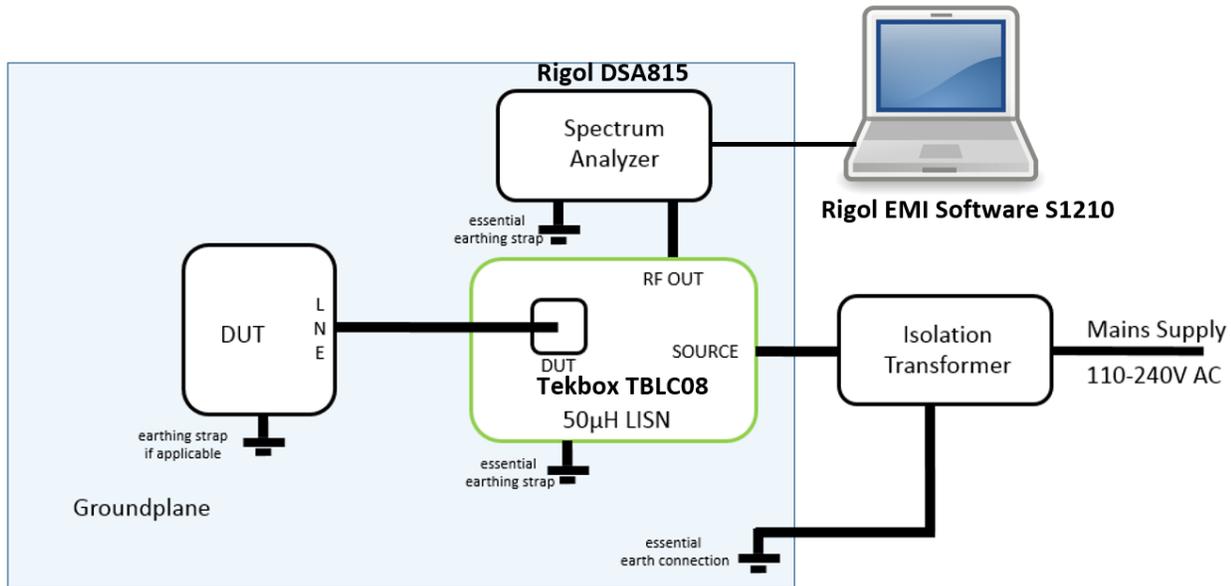


Figure 1: AC conducted noise measurement set up

The setup is not standard conformant, given the available space may be limited. In case that there is sufficient space, the relevant CISPR or EN standards contain descriptions and pictures of standard conformant set-ups. **It is absolutely necessary to use an isolation transformer for any 50 $\mu$ H LISN.** The internal capacitors draw much blind current and would cause the ground protection switch to trip without isolation transformer.

#### DUTs

The test shall investigate three LED luminaires.

- 1) 8W LED tube, Philips, Model Eco Fit 16G5 744
- 2) 8W LED tube, Model MD13H08
- 3) 10W LED tube, Kowo, Model LEDT8-0.6M



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### Spectrum Analyzer

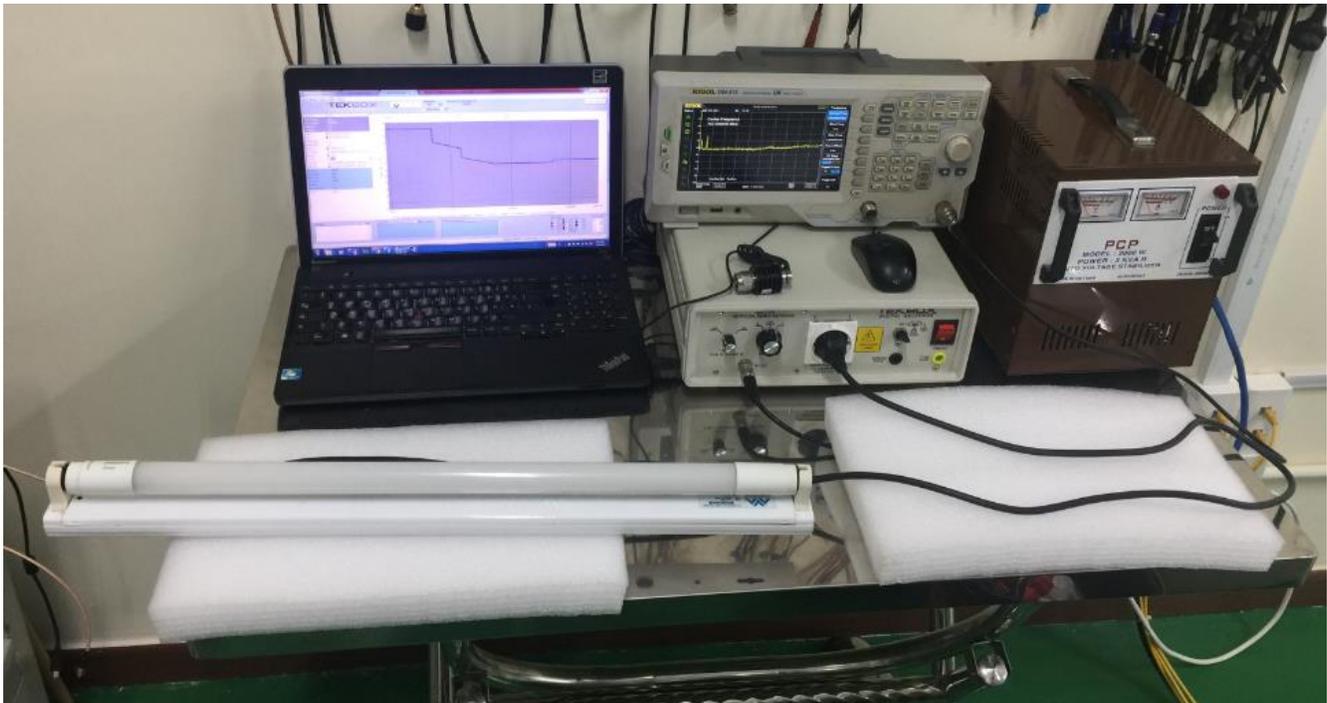
Rigol DSA815 TG with EMI option. The EMI option enables additional CISPR RBW settings of 200Hz, 9 kHz, 120 kHz plus a quasi-peak detector.

### LISN

Tekbox TBLC08

### PC software

Tekbox EMCview



*Figure 2: photo of the AC conducted noise pre-compliance measurement set up*

## 5 Software configuration

When using EMCview for conducted emission measurements, everything is pre-configured, however the settings for the internal attenuator and pre-amplifier of the spectrum analyzer may need to be matched with the actual emission level of the DUT in order to prevent ADC overload, avoid non-linear distortions and achieve optimum dynamic range.

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Before executing a conducted emission scan, it needs to be ensured that the spurious amplitudes are not exceeding the maximum input range of the spectrum analyzer. Skipping this step may risk damaging the RF input section of the spectrum analyzer. Refer to the instructions for spectrum analyzer input protection given in the manual of the TBLC08 50µH LISN.

In case of low wattage LED lamps, the risk of high spurious is rather limited, so a quick check is carried out over the span 9 kHz – 500 kHz with the attenuator/limiter of the LISN engaged. As the observed levels of the spurious were not critical with respect to the +20dBm limitation of the DSA 815 analyzer, the limiter attenuator was set to off for the consecutive measurement.

### Set up EMCview

Execute EMCview.exe.

Ensure that the spectrum analyzer is connected via USB or Ethernet. Assuming the analyzer is connected via USB, click menu **Device** and SA USB. In the pop up window, click **Search** and wait for the connected spectrum analyzer to be listed. Click at the listed spectrum analyzer model to highlight it and then click **Connect Visa**. You can validate the connection by pressing the **Get Info** tab.

Close the connection pop up window and click **File, Load Project**. Load **CN\_CISPR15.prj**.

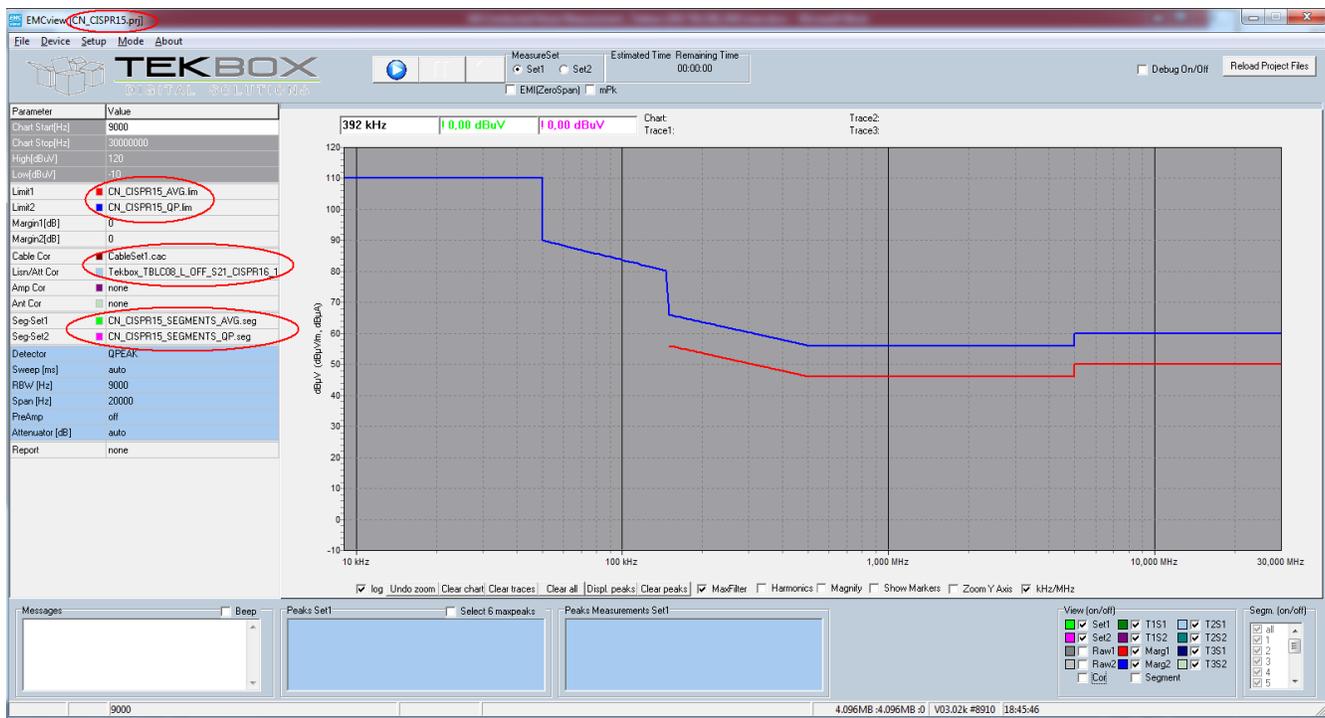


Figure 3: screenshot of EMCview with CISPR 15 project loaded

By loading the project file, all required configurations for a CISPR 15 conducted emission measurement are loaded: the correction file of the LISN, the correction file for the coaxial cable, the limit lines and the segment files. As the QP measurement starts at lower frequencies where the expected spurious are higher, the internal attenuator is configured to 10 dB. For the measurement with average detector, the internal attenuator of the spectrum analyzer is set to 0 dB. In case of poorly designed lamps, the spurious levels may be high enough to

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cause an IF-overload of the spectrum analyzer, which will be indicated with a pop up message and a beep. In this case it is recommended to turn the selector switch of the LISN to OFF and to stop the measurement. Then open the CISPR 15 AVG segment file, which is located in the SRC-directory of EMCview with a text editor and change the attenuator settings to 10 (dB).

### Start the measurement

- Ensure that the both the main switch and the selector switch of the LISN are set to OFF.
- Turn on the isolation transformer
- Turn on the main switch of the LISN. The LED tube will be lit then.
- Turn the selector switch of the LISN to 0 or 1, depending on whether you want to start the measurement with the neutral or phase line.
- Press the Play button in EMCview.

By default, the measurement will start with the Average detector (Set 1). The measurement will take approximately 7 minutes to complete.

Next, activate Set2 and press the Play button to start the Quasi-Peak detector measurement. This measurement will take approximately 2.5 hours.

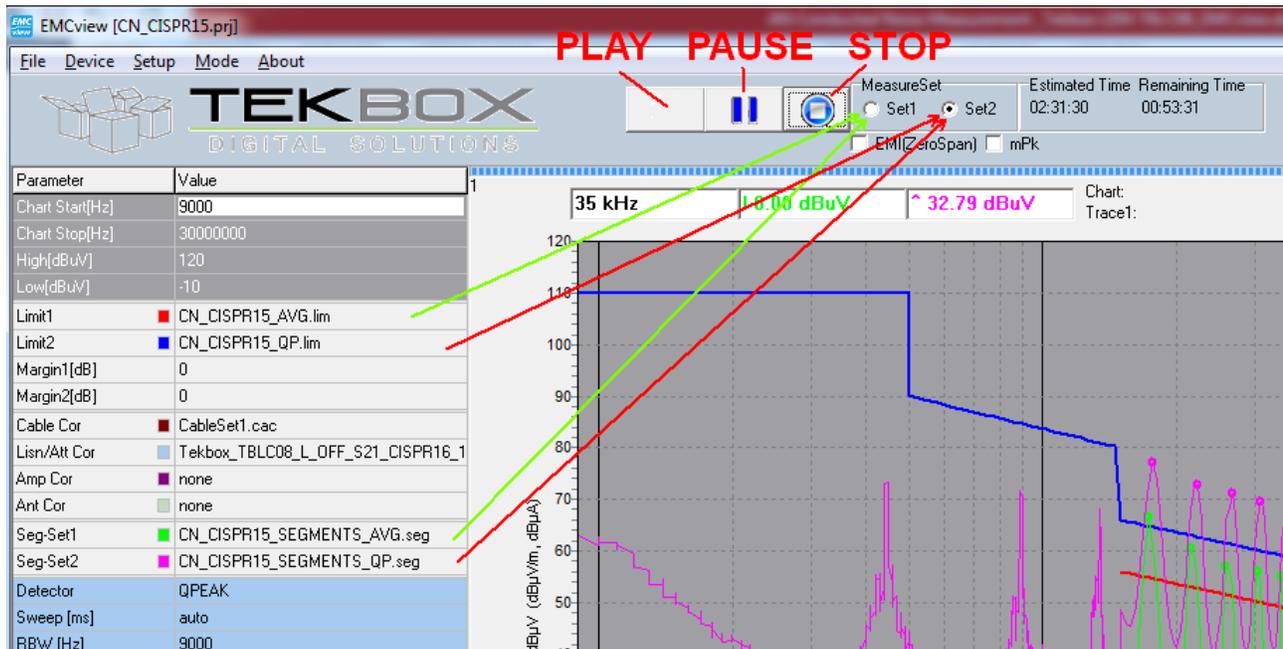


Figure 4: location of the Play/Pause/Stop buttons and the measurement configuration selection

If you don't have the time to carry out a full Quasi-Peak measurement, you can reduce it to a Peak measurement. In this case, EMCview will only measure dedicated frequency points or small frequency windows where peaks occurred during the average detector measurement. Refer to the EMCview manual on how to carry out a peak measurement.

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### 6 Measurement results

First, an empty measurement was carried out in order to see the ambient noise picked up by the measurement set up. The LISN main switch is turned OFF and the selector switched set to 1. In order to get an overview, it is sufficient to carry out an average detector measurement.

The resulting graph shows a peak at 600kHz and some AM broadcast noise in the region 15 MHz to 30 MHz.

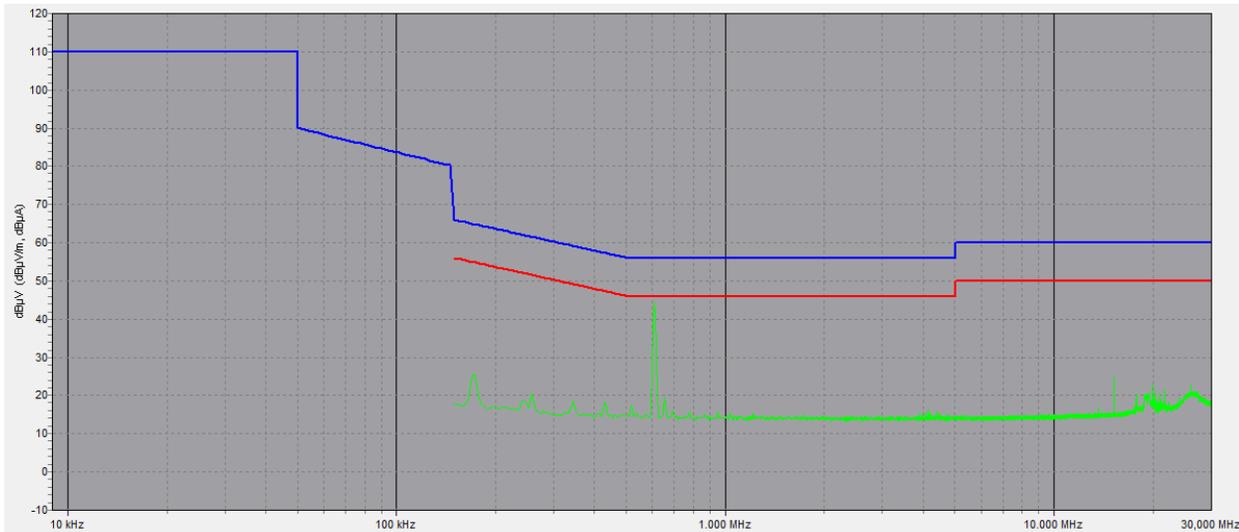


Figure 4: ambient noise with the DUT not powered

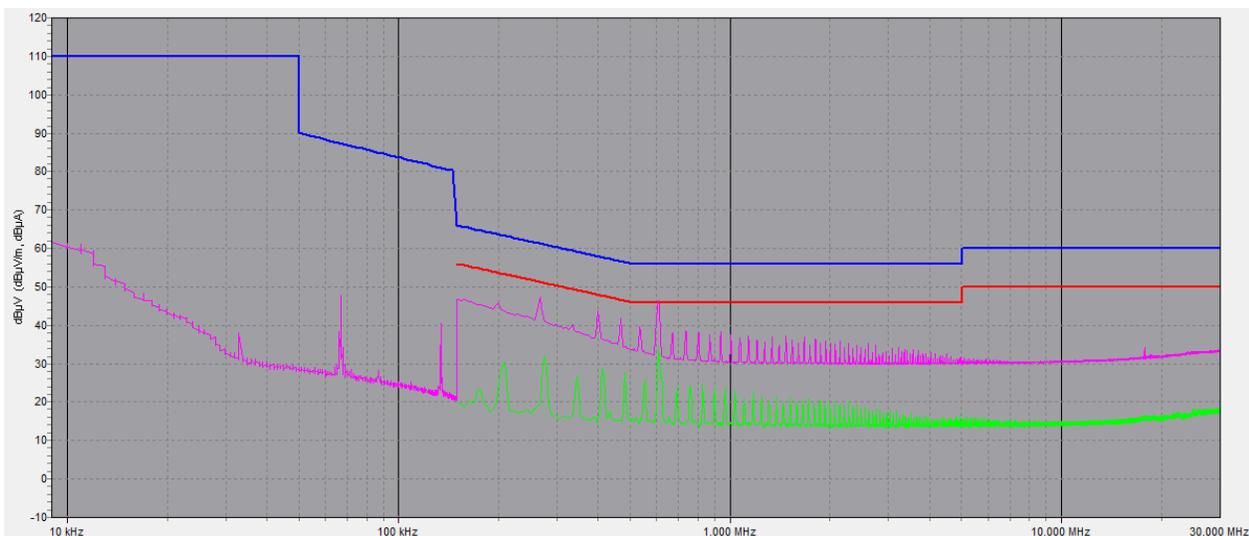


Figure 5: conducted noise result of DUT 1, Philips Eco Fit 16G5 744

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Figure 5 shows the conducted emissions of the Philips LED tube. The green graph represents the results of the measurement with the average detector. The corresponding limit line is in red color. The pink graph represents the results of the measurement with the quasi-peak detector. The corresponding limit line is in blue color. The jump at 150 kHz is caused by the change of the resolution bandwidth from 200 Hz to 9 kHz as specified in CISPR 16. The conducted noise results are very well within the limits of CISPR 15.

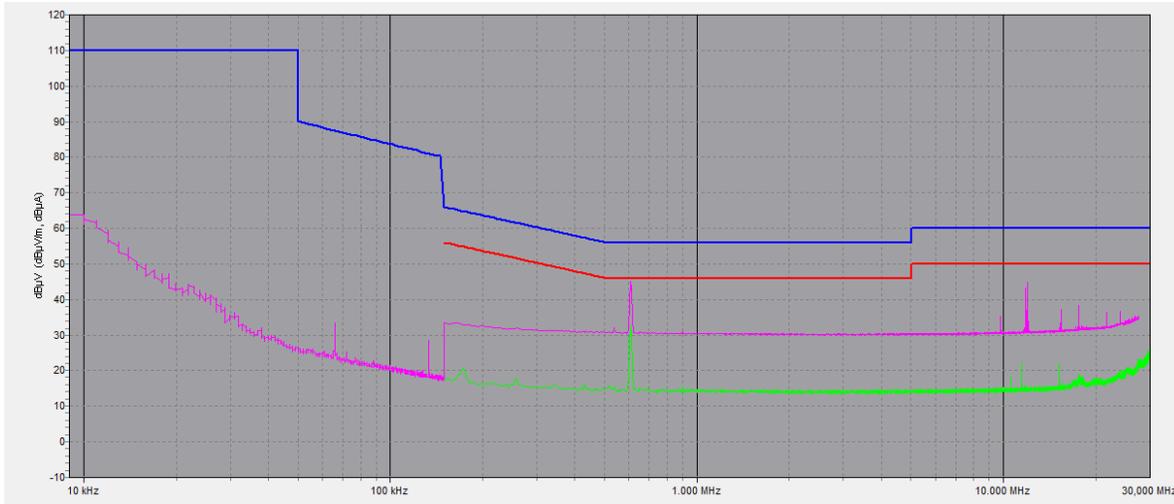


Figure 6: conducted noise result of DUT 2, MD13H08

Figure 6 shows the conducted emissions of the MD13H08 LED tube. The result reveals that the tube does not contain a switched mode regulator. Consequently it is equipped with an aluminum heat sink and less efficient as the Philips Eco Fit 16G5 744. The visible peaks are all ambient noise picked up by the measurement set up.

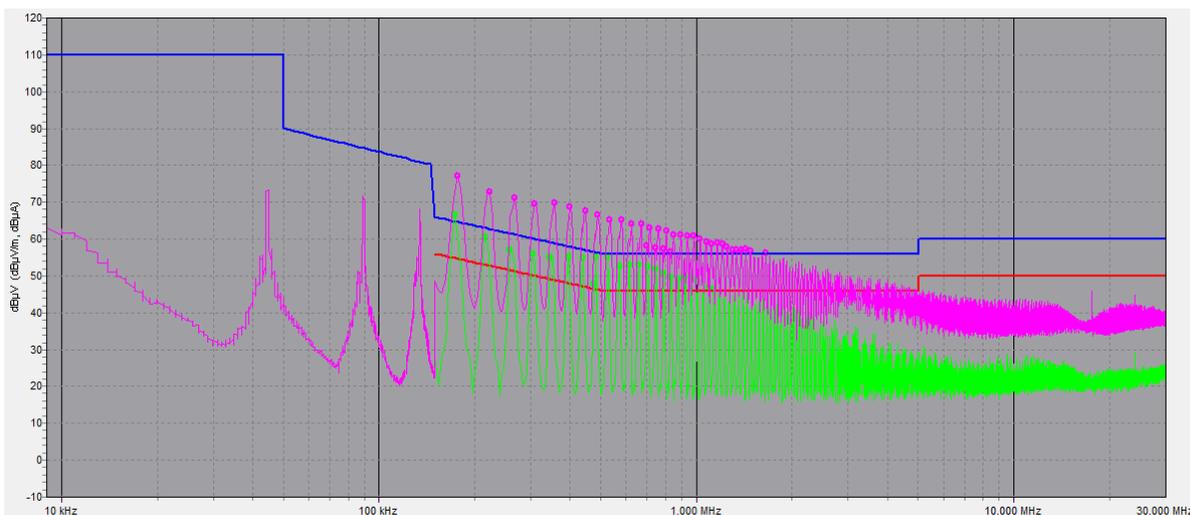


Figure 7: conducted noise result of DUT 3, Kowo LEDT8-0.6M

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Figure 7 shows the conducted emission results of DUT3, Kowo Model LEDT8-06M. It significantly exceeds the limits specified by CISPR 15.

### 7 Sources

[http://www.lightingeurope.org/uploads/files/LightingEurope\\_EU\\_Compliant\\_Requirements\\_Products\\_Sheets\\_for\\_LUMINAIRES\\_1st\\_Edition\\_29112013.pdf](http://www.lightingeurope.org/uploads/files/LightingEurope_EU_Compliant_Requirements_Products_Sheets_for_LUMINAIRES_1st_Edition_29112013.pdf)  
<http://www.rfemcdevelopment.eu/en/emc-basics/led-emc>

CEI EN 55015

CISPR 15

CISPR 16

CISPR 22

Rigol DSA800 series spectrum analyzer manual

### 8 History

Version	Date	Author	Changes
V1.0	30.4.2018	Mayerhofer	Creation of the document

Table 1 – History