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#### Characteristics of Electromagnetic Interference LED Lightings for Passenger Train

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This study discusses the analysis of electromagnetic field characteristics of Light Emitting Diode (LED) lamp. The LED electromagnetic field characteristics measurements are done in two stages: radiated emission (RE) measurement and conducted emission (CE) measurement. The measurements were performed on several types of LED lamps installed for the passenger train. In this research, it is found that LED lamp has the highest RE level at 30-70 MHz frequency range. In conducted emission measurement shows that each LED lamp has the highest CE level at frequency range 150 kHz-0.2 MHz

**Keywords:** LED, characteristics, electromagnetic, train.

#### 1. Introduction

In recent years, the Indonesian government through the ministry of energy and mineral resources (ESDM) intensively encouraged energy-saving programs to the community. Saving or efficiency can be done in two ways, i.e. energy efficiency by reducing electricity consumption and cost efficiency by reducing electricity bill<sup>1</sup>. In Indonesia, about 21% of the average consumption of electricity is for lighting. One of alternative lighting efficiency is the use of Light-Emitting Diode (LED) lightings technology<sup>2</sup>.

To improve the lighting quality and safety of passenger trains, PT Indonesia Kereta Api (PT INKA) has made a transitional shift of LED lightings in railway passenger train. The use of LED lightings will reduce energy costs significantly because it uses less energy than other types, in addition, to be more durable. In addition, it will reduce maintenance costs for lamp replacements, reduce electricity costs, and reduce waste for light products.

However, although today's LEDs are capable of long life, and delivering high light output levels with very little power consumption, most need to be paired with a drive circuit to provide constant current sourcing to operate in our homes and offices, and that's where the problem comes in. These switching drive circuits operate at increasingly higher frequencies, and in order to maintain the highest efficiency, and highest LED longevity possible, they need to maintain very high slew rates. These factors contribute to the overall unwanted emissions from each individual lighting element, increasing the electromagnetic background noise. LED lightings are containing LED driver (not the actual LED lightings module) that emits too much electromagnetic interference<sup>3</sup>. Most of the interference may be caused by very high-frequency emissions, typically in the 30-300 MHz range, and possibly higher<sup>4</sup>. In this study, electromagnetic interference measurement of LED lamps installed in the train has been done to figure out the characteristics from 5 types of LED lamps and to know the differences of each other. Measurements only include conducted emission test at a frequency of 150 kHz-30 MHz and radiated emission test at a frequency of 30 MHz-1 GHz.

#### 2. Experimental Details

The stages of this study consist of a series of structured and planned activities as follows: discussion and observation in the field, selection the LED train lamps test sample, measurement in the Electromagnetic

Compatibility (EMC) laboratory (conducted and radiated emission measurement) and data analysis to draw the conclusions.

The LED lamps in this study as shown in Figure 1 are 30-Watt LED lamp R2M with dimming system, 30-Watt LED lamp non dimming system, 30-Watt weatherproof (IP65) LED lamp, 9-Watt downlight LED lamp, 3-Watt reading and desk LED lamp. The entire LED lamps sample is produced by one of LED manufacturer in Indonesia and using 36W constant current type driver.

### 3. Results and Discussion

#### 3.1. Radiated Emission

The radiated emission testing involves measuring the electromagnetic field strength of the emissions that are unintentionally generated by the test product or test sample<sup>5</sup>. It used measuring equipment, i.e. TESEQ CBL6112D bilog antenna, ADVANTEST U3751 spectrum analyzer and AGILENT N9038A Electromagnetic Interference (EMI) receiver. The frequency range measurement is 30 MHz to 1GHz. The data obtained are the frequency and level of electromagnetic emission. Measurements were made in Semi-Anechoic Chamber with the LED lamp placed on the table 80 cm, 3 m from the antenna and switched on.

The results of the measurements can be seen in figure 3. The blue lines is the emission graph when the antenna at vertical polarization and the green lines is the emission graph when the antenna at horizontal polarization. The graphics describe that in the 30-Watt LED lamp R2M with dimming system has the peak of 59.071 MHz frequency with a level of 39.5 dB $\mu$ V/m while the result in 30-Watt LED lamp non-dimming system are 34.468 MHz of the peak frequency and 26.8 dB $\mu$ V/m of the emission level. By comparing to the 30-Watt weatherproof (IP65) LED lamp, we can see that it is lower than LED non-dimming that is 29.7 dB $\mu$ V/m of field strength level and 149.009 MHz of frequency, while the 9-Watt downlight LED lamp is 30.7 dB $\mu$ V/m emission levels and at 177.721 MHz frequency. In other hand, the 3-Watt reading and desk LED lamp emission graph is the highest among others that have the emission level 41.5 dB $\mu$ V/m and at 33.977 MHz frequency. The emission level is high in certain frequency range probably caused by the variation of the switching frequency of the LED driver. The measurement graphs show that each LED lamp has the highest level of frequency range 30-300 MHz and in vertical polarization of the antenna mast.

#### 3.2. Conducted Emission

The intent of the conducted emission is to know the noise current passing out through the sample's ac power cord<sup>6</sup>. The main equipment's used are TESEQ NNB52 Line Impedance Stabilization Network (LISN), ADVANTEST U3741 spectrum analyzer and SCHAFFNER SCR3511 EMI receiver. The frequency range measurement is 150 kHz to 30 MHz. Measurements are done in a shielded chamber; the LED lamp is placed on an 80 cm table and switched on.

The result of the measurements can be seen in Figure 4. The green lines are when the noise came out to the line phase and the blue lines is when the noise came out to the neutral phase on power cord. The graphics shows that the emission level emitted by 30-Watt LED Train R2M with dimming system is at the frequency of 0.0455 MHz with the level of 82.7 dB $\mu$ V. By comparing to the 30-Watt LED lamp non-dimming system, we can see that the peak frequency is about 0.03 MHz with the emission level close to 90 dB $\mu$ V while the 30-Watt weatherproof (IP65) LED lamp is 54.8 dB $\mu$ V of emission level and 0.0459 MHz of frequency, also 9-Watt downlight LED lamp have the peak level of 56.7 dB $\mu$ V at 0.0456 MHz frequency. Last, 3-Watt reading and desk LED lamp is the highest field strength among others with the highest level of 83.7 dB $\mu$ V at a frequency of 0.1532 MHz. Reading and desk LED lamp have more complicated electrical wiring arrangement and no box or casing to shielded it, so probably that's makes very high the emission level. The graph shows that each LED lamp has the highest level at the frequency range 150 kHz-0.2 MHz.

### 4. Conclusion

Radiated emission measurement shows that the lowest emission level is 9-Watt downlight LED lamp where the level is 25.3 dB $\mu$ V/m. While the highest emission level is 3-Watt reading lamps and desk LED lamp with the level of 41.5 dB $\mu$ V/m.

Conducted emission measurement, the highest emission level is 3-Watt reading and desk LED lamps with a level of 83.7 dB $\mu$ V. In other hand, the 30-Watt non-dimming system LED lamps are the lowest emission with a level of 52.3 dB $\mu$ V.

Both measurement in 3-Watt reading lamps and desk LED lamp is the highest than the others. Beside from the driver that the main source EMI, the lamp is very complicated in the wiring arrangement. The wiring is no taping to shielded or filters it. So the noise is spread out to the surrounding and power cord.

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### References

1. S. Sanford, *Energy Efficiency Series*, (2014)
2. F. Pop, C. Munteanu, A. Racasan, C. Pacurar, S. Prusu, and G. Mihai, *IEEE International Conference on Communications (COMM)*, (2016)
3. A. S. de Beer, A. Emlah, H. C. Ferreira, and A. J. Han Vinck, *IEEE 17th International Symposium on Power Line Communications and Its Applications*, (2013)
4. F. Wan, H. Cao, S. An, C. Feng, G. Hu, and J. Ge, *IEEE Electronics Letters*, (2016)
5. International Electro-technical Commission, CISPR 15 : 2013, *Limits and Methods of Measurement of Radio Disturbance Characteristics of Electric Lighting and Similar Equipment* (2013)
6. Clayton R. Paul, *Introduction to Electromagnetic Compatibility* (2006)

### Figure Caption

- Figure 1. 5 types of LED lamps  
 Figure 2. Radiated and conducted emission test setup  
 Figure 3. Radiated emission graph result  
 Figure 4. Conducted emission graph result

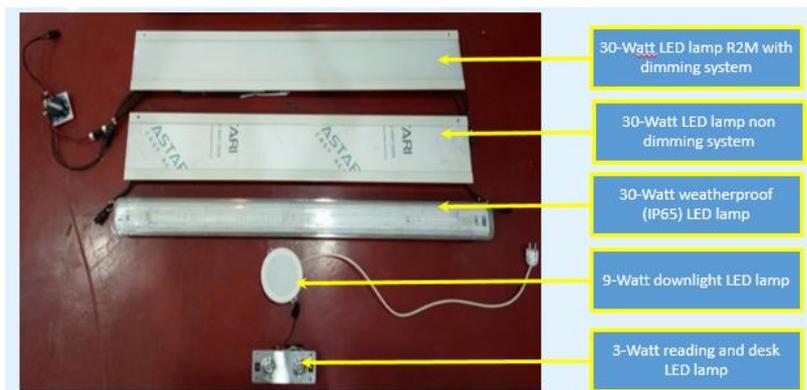


Figure 1. Nugroho et al.

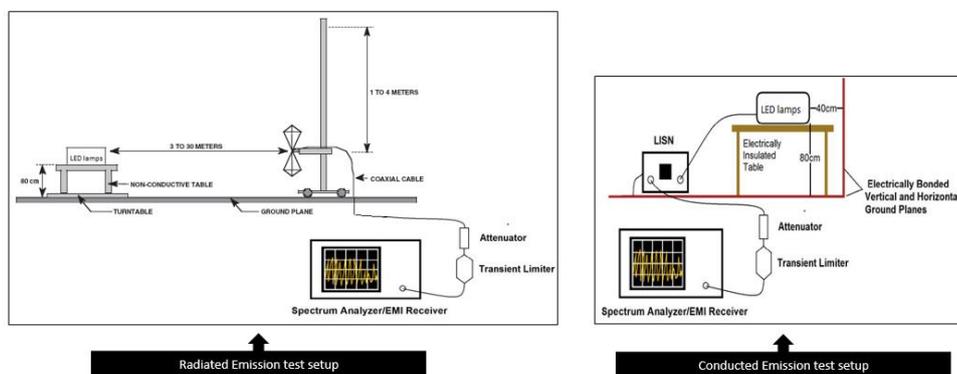


Figure 2. Nugroho et al.

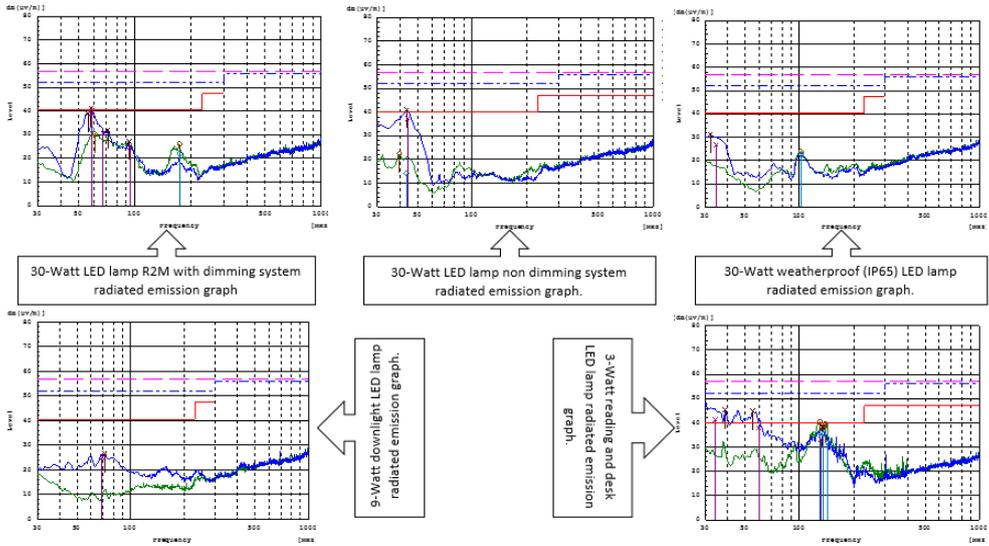


Figure 3. Nugroho et al.

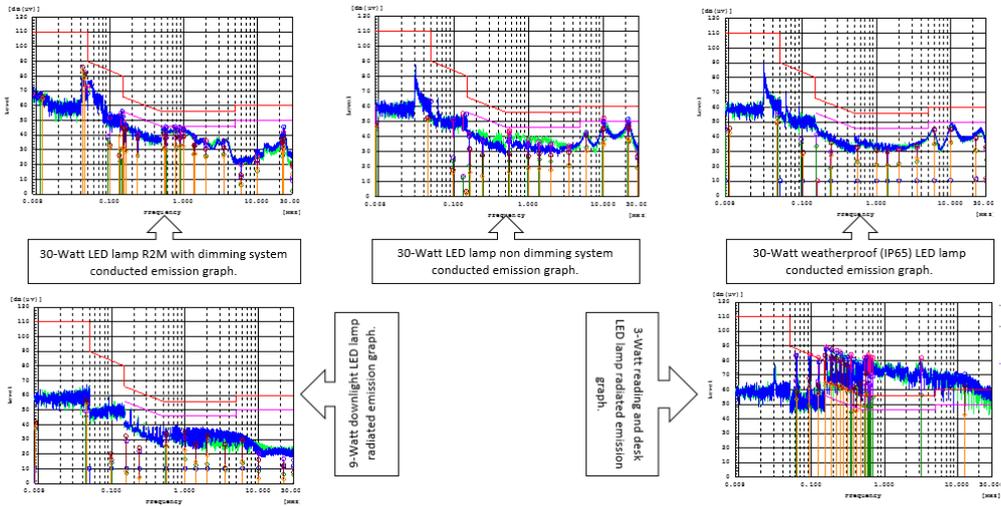


Figure 4. Nugroho et al.