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Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



A large, semi-transparent image of an MR16 lamp is centered on the page. The lamp is white with a circular lens and a base, and it is shown from a slightly elevated perspective.

Electronic Transformer Compatible Step-down Converter for 7W/10W MR16 Lamp with **ILD4001 & BSR302N**

Application Note

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1 Introduction

1.1 Features

- Deliver 7 W / 10 W power
- Temperature shut down mechanism
- Compatible with electronic transformer
- Low LED current drift over temperature
- Integrated push-pull stage for fast on/off switching
- Minimum external component required
- Small package: SC-74

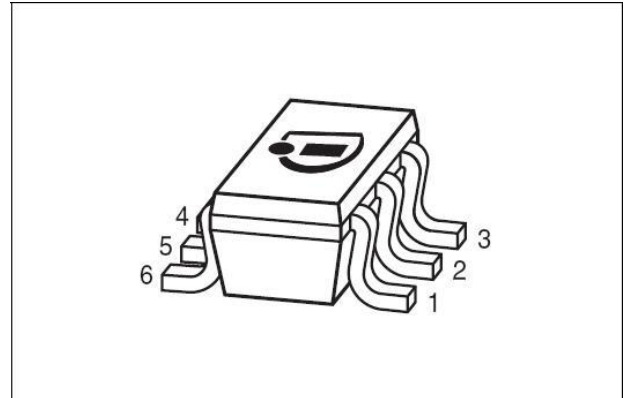


Figure 1 ILD4001

1.2 Description

This document contains the information about the demo board with the device ILD4001 LED driver which is suitable for the use in an MR16 lamp.

ILD4001 is a hysteretic buck LED controller IC for industrial applications.

The demo board has two input connections to be powered up by 12 V_{AC} from electronic transformer, and two output connections to the LED. The boards are preset to deliver 7 W or 10 W powers into the LED load.

These MR16 boards are suitable and tested to drive 2 LEDs in series and 4 LEDs (2 LEDs in series and 2 in parallel). For 4 LEDs design, it is recommended to use the LED with the same forward voltage to ensure the current matching for the LEDs in parallel.

1.3 Operating specification

This demo board for MR16 application is based on the ILD4001 buck converter. The objective of this demo board is to provide a constant DC current to the LED load in order to eliminate the flickering issue caused by the electronic transformers.

Since the output current to the LEDs is constant DC current, regardless of the input voltage is either 12 V_{AC}, 12 V_{DC} or 12 V_{AC} from electronic transformer, the MR16 board is able to maintain the constant current deliver to the load. Therefore this solution is not only applicable to retrofit replacement market for 7 W and 10 W MR16 solutions; it is also suitable for the new installation market which generally using a constant voltage supply.

Below table are the **MR16's** target specification driven by an electronic transformer:

Table 1 MR16 7 W operating specification

Input voltage to electronic transformer	230 V _{AC}
Output LED voltage (2 LEDs in series)	6.5 V
Output LED current	0.77 A
Input Power	~ 7 W

Table 2 MR16 10 W operating specification

Input voltage to electronic transformer	230 V _{AC}
Output LED voltage (2 LEDs in series)	6.6 V
Output LED current	1.02 A
Input Power	~ 10 W

2 Application Information

2.1 Schematic

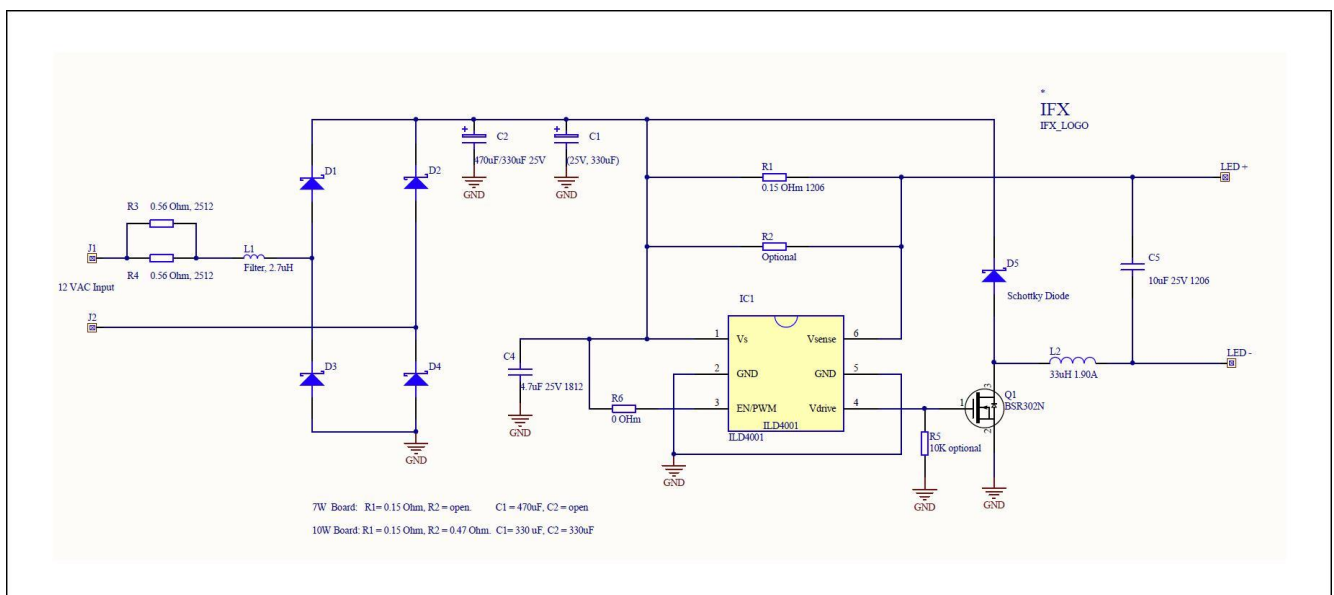


Figure 2 Schematic of the demonstration board

The value of R1, R2, C1 and C2 are different for 7 W and 10 W boards. Please refer to Table 3. Bills of material for details.

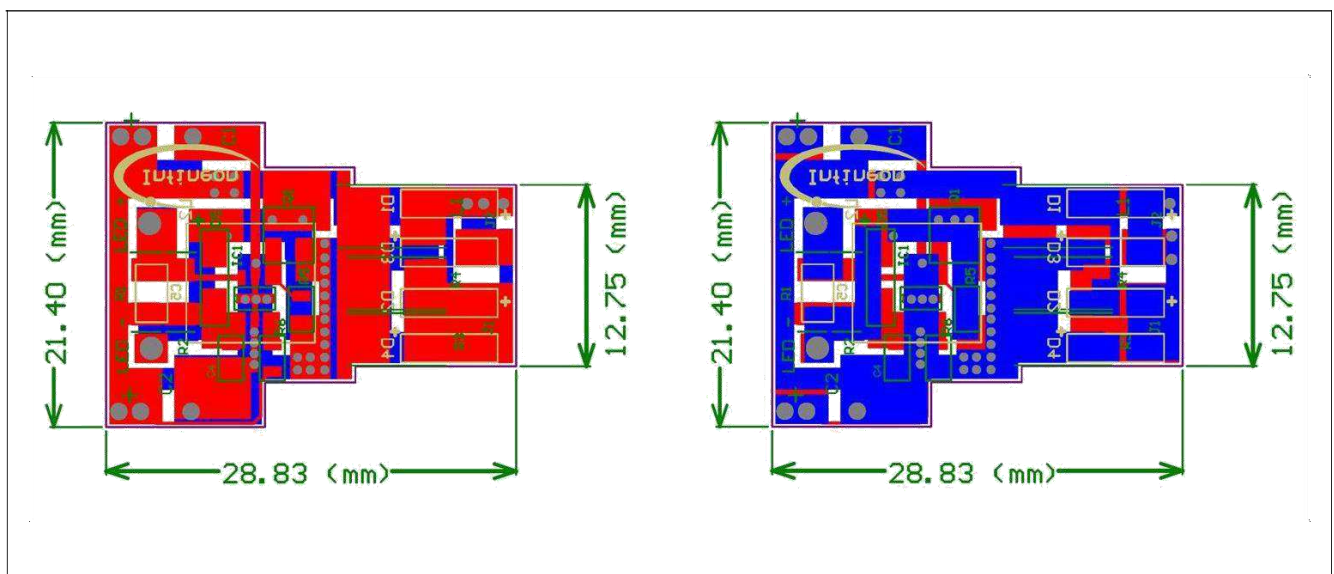


Figure 3 PCB layout of the demonstration board

2.2 PCB Photo for 7 W Application

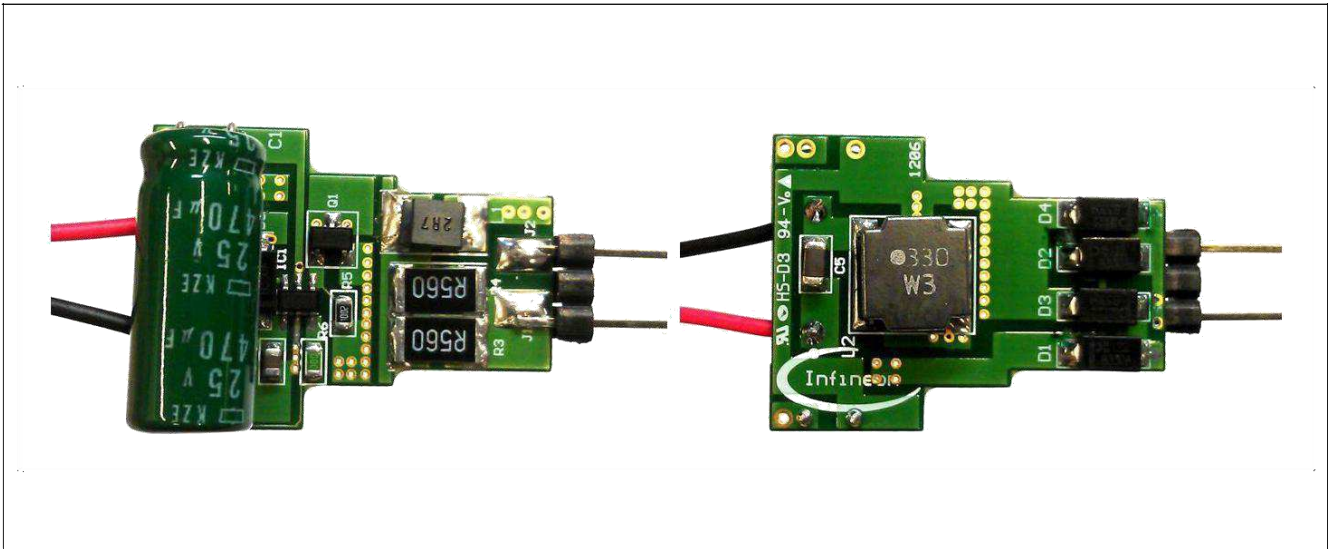


Figure 4 PCB photo of the 7 W demonstration board

2.3 PCB Photo for 10 W Application

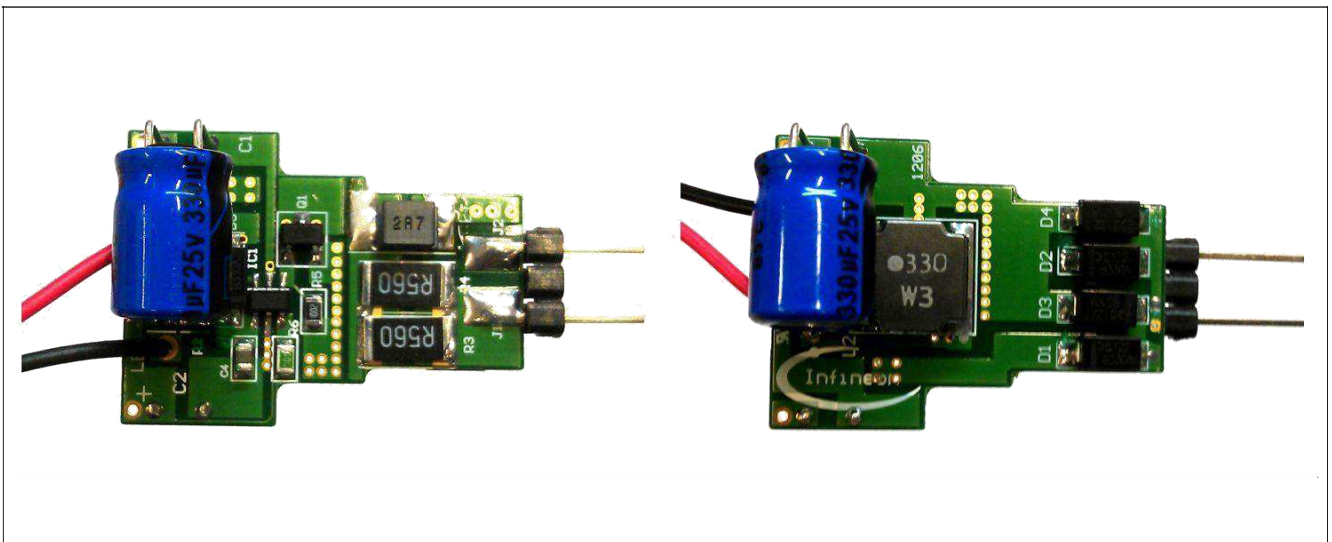


Figure 5 PCB photo of the 10 W demonstration board

Table 3 Bill-of-Materials

Symbol	Value	Unit	Size	Manufacturer	Comment
IC1	ILD4001		SC-74	INFINEON	Hysteretic Buck controller and LED driver
R1	0.15	Ω	0805		Part of the current sense resistor
R2	Open ¹ / 0.47 ²	Ω	0805		Part of the current sense resistor
R5	10	k Ω	0805		Gate resistor
D1 ~ D5	B330A-13-F		SMA	DIODES	3.0 A Surface Mount Schottky Barrier Rectifier
Q1	BSR302N		SC-59	INFINEON	OPTIMOS [®] 2 Small Signal Transistor
C1	470 ¹ / 330 ²	μ F			Electrolytic capacitor, 25 V
C2	Open ¹ / 330 ²	μ F			Electrolytic capacitor, 25 V
C4	4.7	μ F	0805		Ceramic, 50 V
C5	10	μ F	0805		Ceramic, 50 V
R1	0.56	Ω	0805		SMD resistor
R2	0.56	Ω	0805		SMD resistor
L1	2.7	μ H	3 x 4 mm	TAIYO YUDEN	Inductor
L2	33	μ H	8 x 8 mm	TAIYO YUDEN	Shielded Power Inductor

The demo boards are available for evaluation. For the 7 W board, the board name is “MR16 7W BOARD” and the product ID is “SP000960028”. For the 10 W board, the board name is “MR16 10W BOARD” and the product ID is “SP000960030”. Please contact your local sales representative to order the demo boards.

3 Measurement Results

3.1 Driven by electronic transformer

The MR16 boards were tested with different brand of electronic transformers in the market. In this session, some of the measurement results and output waveform of the LED load will be shown. 3 cases are chosen to be included in this application note are:

1. 7 W MR16 driven by Philips ET-E60.
2. 10 W MR16 driven by Tridonic TE0060.
3. 3pcs of 7 W MR16 driven by Osram HTM105.

The electronic transformers list will be provided in session 3.5.

¹ For 7 W version

² For 10 W version

3.2 7 W MR16 driven by Philips ET-E60

The 7 W MR16 board were tested with the Philips’s **electronic transformer**. **Below tables and figures show the measurement results** for the MR16 board driven by the electronic transformer. The test was carried out using 2 pcs of LEDs in series as load and the temperature condition at room temp 25°C.

For the input power measurement, the input power is measured at the input mains 230 V_{AC} by using the digital power meter WT210. The output power is measured by the oscilloscope with the mathematic function by multiplication of the LED voltage and LED current.

Figure 6 shows the output waveforms. Channel 1 (Yellow) is V_f of the LEDs, Channel 2 (Green) is I_{LED} and Channel M (Purple) is output power.

Table 4 7 W board measurement results with Philips ET-E60.

Input voltage to electronic transformer	230 V_{AC}
f(avg)	6.45 V
LED(avg)	777 mA
in	6.94 W
out	5.08 W
Efficiency	73.2 %

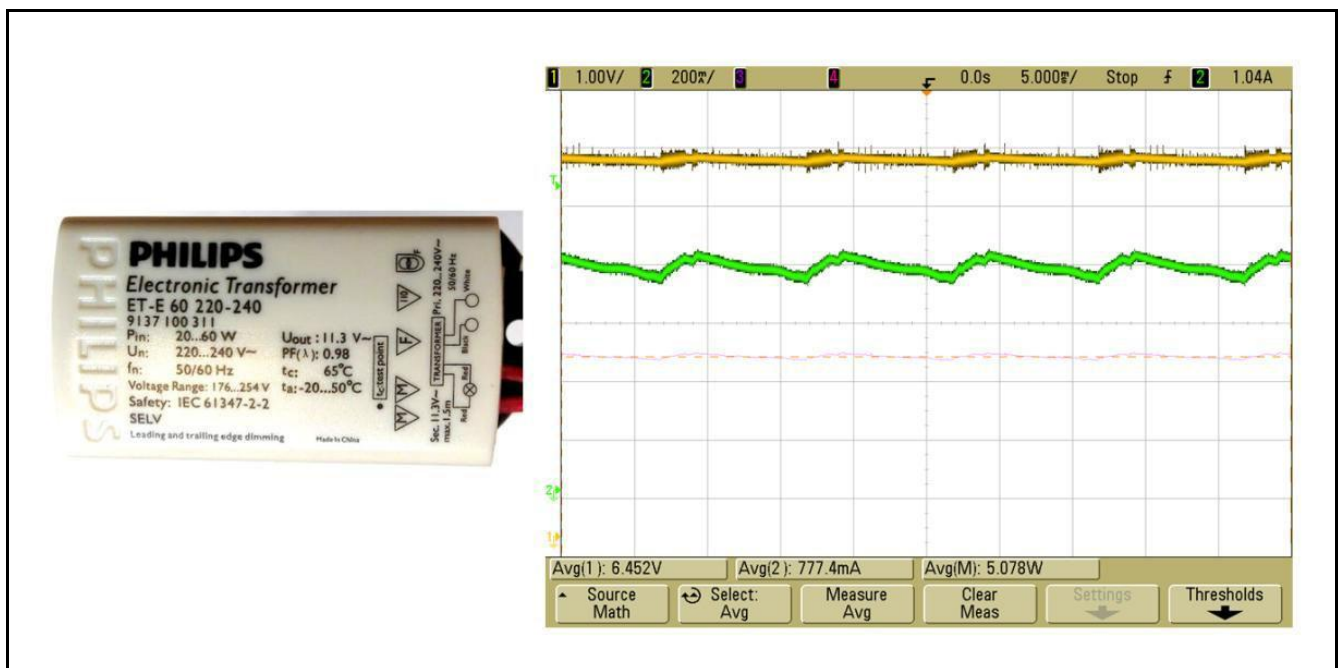


Figure 6 Output waveform for the 7 W MR16 board driven by Philips ET-E60.

3.3 10 W MR16 driven by Tridonic TE0060

A single 10 W MR16 were tested with Tridonic TE0060 and the results as shown in Table 5 and Figure 7. The load condition and temperature condition are the same in session 3.2. The measurement of input power and output power are also the same as in session 3.2.

Table 5 10 W board measurement results with Tridonic TE0060.

Input voltage to electronic transformer	230 V_{AC}
$v_{f(avg)}$	6.63 V
$v_{LED(avg)}$	1.05 A
P_{in}	9.8 W
P_{out}	7.1 W
Efficiency	72.4 %

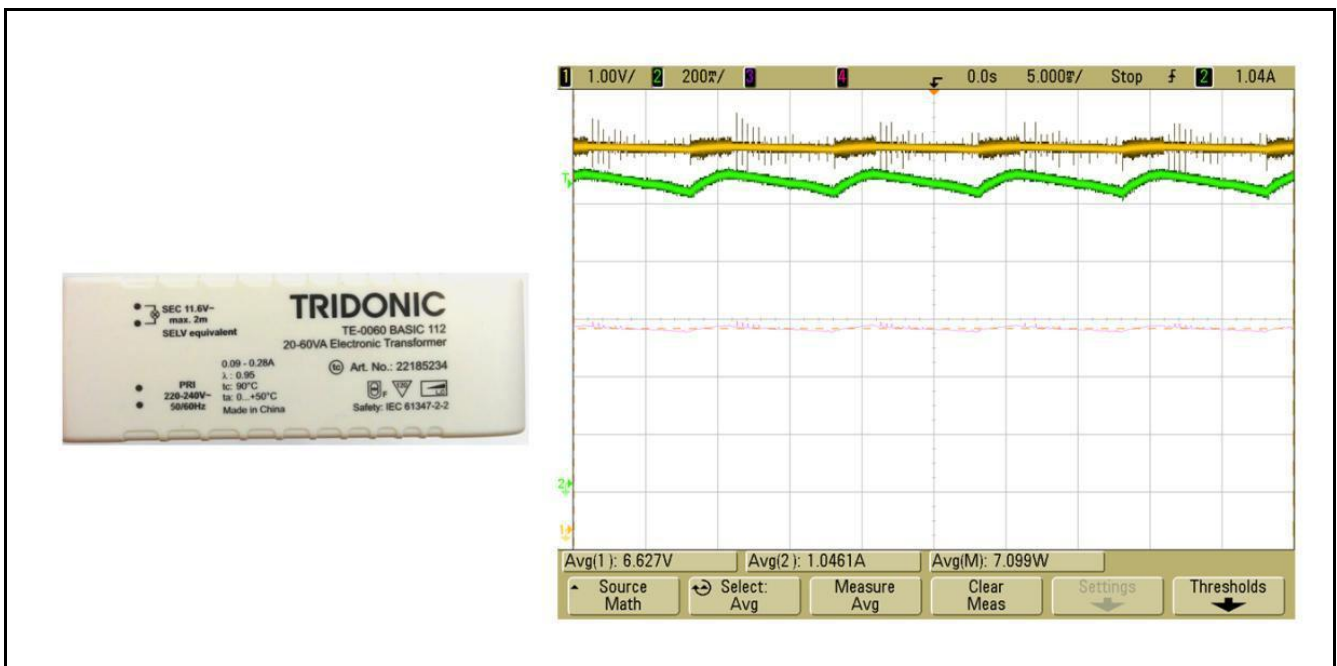


Figure 7 Output waveform for the 10 W MR16 board driven by Tridonic TE0060.

3.4 3pcs of 7 W MR16 driven by Osram HTM105

3pcs of 7 W MR16 were tested with an Osram HTM105. The temperature condition is at room temp 25°C. The setup is shown in Figure 8.

The input power is directly measured at the power supply source by power meter WT210. In this case, the total output power is measured each lamp individually and sum up together, i.e. $P_{out} = P_{out1} + P_{out2} + P_{out3}$. In fact the output power of each lamp is not exactly the same due to the forward voltage of the LEDs are different.

Figure 9 shows the single channel output waveform of the 7 W MR16 lamp. The overall system efficiency for this case is 74%. The Osram HTM105 is suitable to drive 1, 2 or up to 3 pcs of 7 W MR16 lamp without any flickering issue. For 10 W MR16, it could drive up to maximum of 2 lamps.

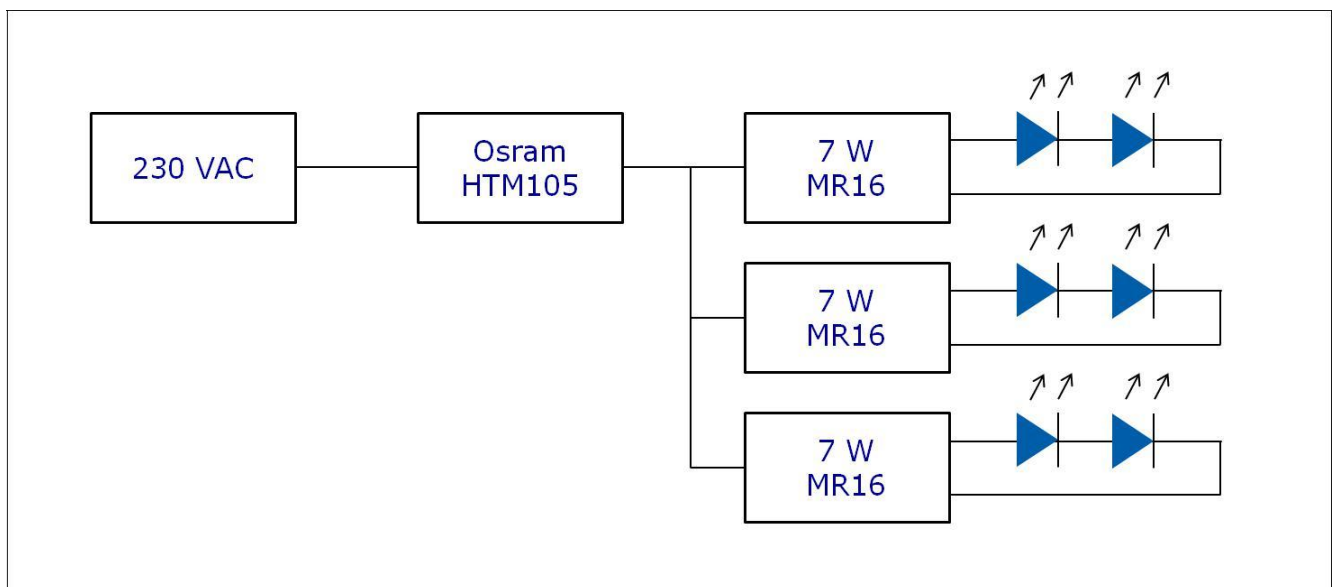


Figure 8 Test setup of 3pcs of 10 W MR16 driven by Osram HTM105

Table 6 3pcs of 7 W board measurement results with Osram HTM105.

Input voltage to electronic transformer	230 V_{AC}
$f_{(avg)}$	6.62 V
LED _(avg)	775 mA
P_{in}	21.83 W
P_{out}	16.17 W
Efficiency	74 %

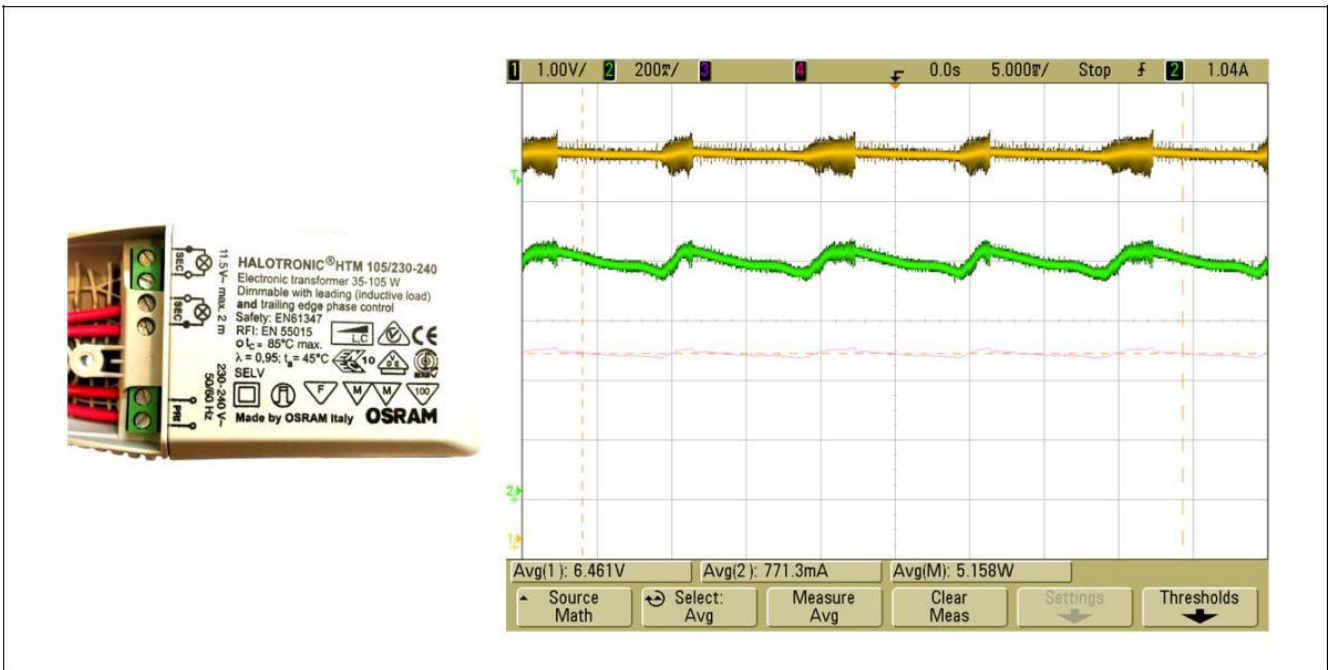


Figure 9 Output waveform for the 7 W MR16 board driven by Osram HTM105.

3.5 Electronic transformer list

The 7 W and 10 W MR16 boards are tested and compatible with below electronic transformers. The number indicated in the table represents the number of MR16 lamp can be driven by the electronic transformer.

For a 60W rated electronic transformer, it can only drive a 7 W MR16 or 10 W MR16. The reason is because the 7 W MR16 is to replace a 35 W halogen bulb, so it can only be 1 to 1 replacement. It is also applicable to 10 W MR16 for the replacement of a 50 W halogen bulb.

For the Osram HTM105, the power rated at 105W. It is capable to drive either 3 pcs of 35 W halogen bulb or 2 pcs of 50W halogen bulb. Therefore, for the retrofit MR16 replacement, it is also suitable to drive 3 pcs of 7 W MR16 or 2 pcs of 10 W MR16.

Dimmer list *IS NOT* included in this application note as this solution is not meant for dimmable solution.

Magnetic transformer list *IS ALSO NOT* included in this application note as this solution has not been tested with the magnetic transformer in the lab.

Table 7 Electronic transformers list

E- transformer Model	7 W MR16	10 W MR16
Philips ET-E60	1	1
Osram ET-A60	1	1
Osram HTM 105	1,2 or 3	1 or 2
Tridonic TE-0060	1	1

4 References

Please refer to the ILD4001 Datasheet for more information:

<http://www.infineon.com/dgdl/ILD4001-Step-down-LED-Controller-Rev2.0.pdf?folderId=db3a30431f848401011fcfb2ab4c04c4&fileId=db3a30433072cd8f01308fc1af03786b>

Please refer to the AN213 Application note for more information:

<http://www.infineon.com/dgdl/AN213.pdf?folderId=db3a304313b8b5a60113d4239297042f&fileId=db3a304330d34290130e5572ce63ea5>

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