

General Description

This demonstration board utilizes AL8853AQ to build a cost-effective solution for boost LED drivers.

The AL8853AQ is an automotive AEC-Q100 controller designed for boost converters in a constant frequency mode. It implements a peak current mode control scheme and an internal trans-conductance amplifier to accurately control the output current over a wide input and load conditions.

This user guide includes a bill of materials that describes the parts used on this board. A schematic and a PCB layout are also included along with measured system performance characteristics and test waveforms. These materials can be used as a reference design for your products to improve your product's time to market.

Key Features

1. AEC-Q100 Grade 1 Qualified
2. Wide Input Voltage Range: 6V to 40V
3. Constant Current Mode PWM Controller
4. PWM to Analog Dimming Mode
5. Fixed 400kHz Switching Frequency
6. Built-in Comprehensive Protections
 - a) Undervoltage Lock Out (UVLO)
 - b) Overvoltage Protection(OVP)
 - c) Overcurrent Protection(OCP)
 - d) Overtemperature Protection (OTP)
 - e) LED Open Protection
 - f) Output Short Protection
 - g) Diode & Inductor Short Protection
 - h) LED Cathode Short to GND Protection
7. Low system BOM cost

Applications

- Head Lights
- Head up displays (HUD)
- Exterior lights
- Auto Backlight displays

Specifications

Parameter	Value
Input Voltage	9V~16Vdc
Output Power	27W
Output Current	800mA
Output Voltage	34V
Efficiency	>90%
Dimension	96mm*55mm*12mm
RoHS Compliance	Yes

Evaluation Board



Figure 1. Top View

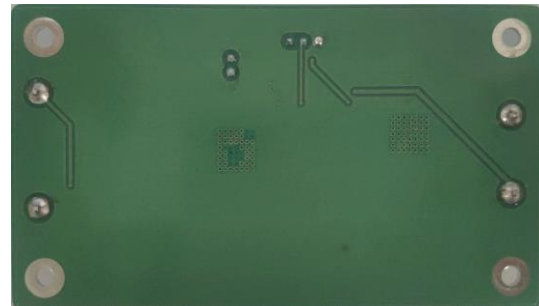


Figure 2. Bottom View

Connection Instructions:

DC Positive Input: Red Test Point (VIN)
 DC Negative Input: Black Test Point (GND)
 PWM Signal Input: J1 (PWM)
 GND Signal Input: J1 (GND)
 Positive Output: Red Test Point (LEDA)
 Negative Output: Black Test Point (LEDK)

Board Layout

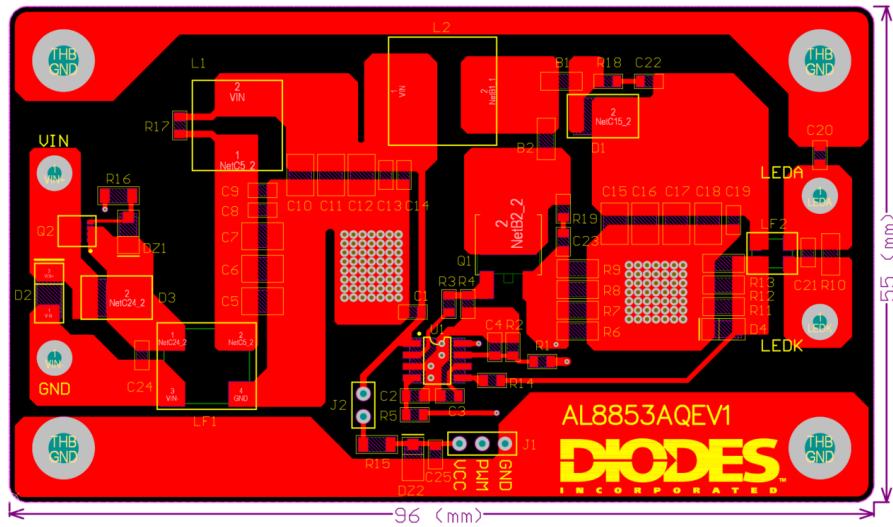


Figure 3. PCB Layout Top View

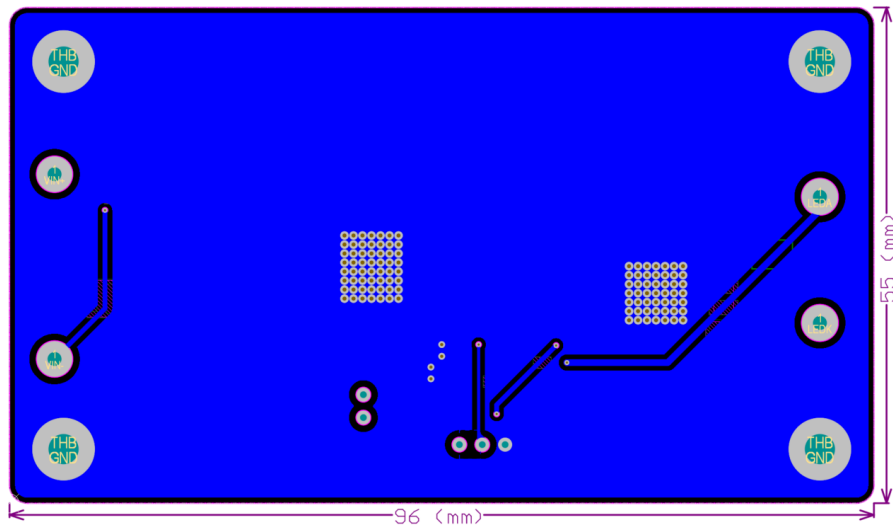


Figure 4. PCB Layout Bottom View

Bill of Material

NO.	Location	Description	Package	Quantity
1	U1	AL8853AQ, Boost controller, Diodes Incorporated (Diodes)	SO-8	1
2	L1	784325065, WE-HCIA, 6.5 μ H, IR=8.5A, 10*10*4.5mm, AEC-Q200	SMD	1
3	L2	7447709330, WE-PD 33 μ H, IR=4.2A, 12*12*10mm, AEC-Q200	SMD	1
4	LF1	744273801, WE-SL5-HC 9 μ H, 800 Ω @100MHz, IR=3.5A, 9.5*8.3mm	SMD	1
5	LF2	744235801, WE-CNSW 1.3 μ H, 800 Ω @100MHz, IR=1A, 4.5*3.2mm AEC-Q200	SMD	1
6	Q1	N-MOS, DMN6068LK3Q, 60V/8.5A, TO-252 (DPAK), AEC-Q101, Diodes	TO-252	1
7	Q2	P-MOS, DMP6023LFGQ, 60V/7.7A, PowerDI3333-8, AEC-Q101, Diodes	PowerDI3333-8	1
8	D1	Schottky Rectifier, PDS5100Q, 100V/5A, PowerDI5, AEC-Q101 Diodes	PowerDI5	1
9	D2	TVS, SMAJ36CAQ, 36V, SMA, AEC-Q101	SMA	1
10	DZ1	Zener, BZT52C6V8Q, 6.8V, SOD123, AEC-Q101	SOD123	1
11	DZ2	Zener, BZT52C3V3Q, 3.3V, SOD123, AEC-Q101	SOD123	1
12	B1	7427922, WE-CBF, 60 Ω @100MHz Id=5A, AEC-Q200	1206	1
13	B2	742792113, WE-CBF, 120 Ω @100MHz Id=3A, AEC-Q200	1206	1
14	R1	0805, 475k Ω , 1%	0805	1
15	R2	0805, 18.2k Ω , 1%	0805	1
16	R3	0805, 10 Ω , 1%	0805	1
17	R4	0805, 10k Ω , 5%	0805	1
18	R5	0805, 0 Ω , 1%	0805	1
19	R6,R7,R8,R9	1206, 0.24 Ω , 1%	1206	4
20	R11,R12,R13	1206, 0.75 Ω , 1%	1206	3
21	R14	0805, 1k Ω , 5%	0805	1
22	R15,R16	1206, 1k Ω , 5%	1206	2
23	C1	0805, X7R, 1 μ F, 50V, AEC-Q200	0805	1
24	C2	0805, NP0, 100pF, 50V, AEC-Q200	0805	1
25	C3	0805, X7R, 220nF, 50V, AEC-Q200	0805	1
26	C4	0805, NP0, 470pF, 50V, AEC-Q200	0805	1
27	C6,C7,C11,C12, C16,C17,C18	1210, X7R, 4.7 μ F, 100V, AEC-Q200	1210	7
28	C8,C13,C19, C20,C21,C24	0805, X7R, 100nF, 50V, AEC-Q200	0805	6
29	C9,C14	0805, X7R, 10nF, 50V, AEC-Q200	0805	2
30	VIN, LEDA	Connector, Red color	DIP	2
31	GND, LEDK	Connector, Black color	DIP	2
32	J1	Connector, 3pin, pitch=2.54mm	DIP	1
33	J2	Connector, 2pin, pitch=2.54mm	DIP	1
34	J1(VCC-PWM),J2	Jumper, 2pin, pitch=2.54mm	DIP	2

System Performance

The AL8853AQ evaluation board has excellent system performance. With very low BOM cost, the system can achieve high efficiency and good dimming linearity. To enhance reliability, AL8853AQ also integrates comprehensive protections.

System Efficiency

Figure 6 shows the efficiency curve. The efficiency is measured with 12V DC input and 10*LED as load.

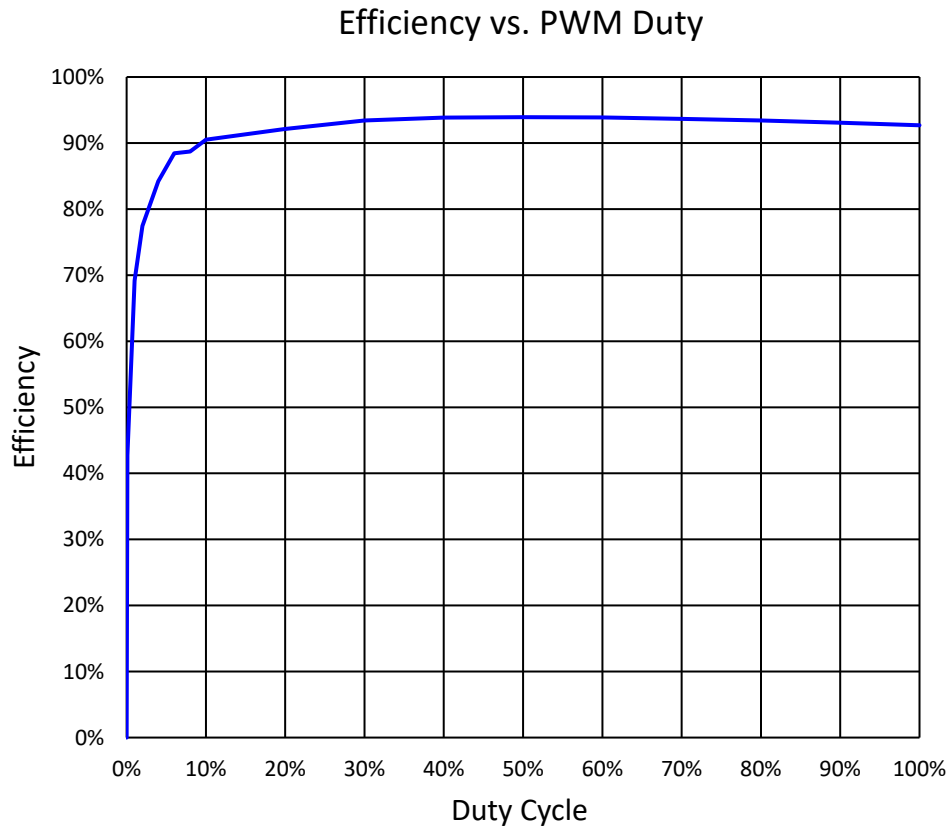


Figure 6. Efficiency vs. PWM Duty

Dimming Performance

AL8853AQ can support PWM dimming with frequency ranging from 5 kHz to 50 kHz. Figure 7 shows the dimming curve with measured data. AL8853AQ dimming linearity is quite good with PWM duty from 1% to 100%.

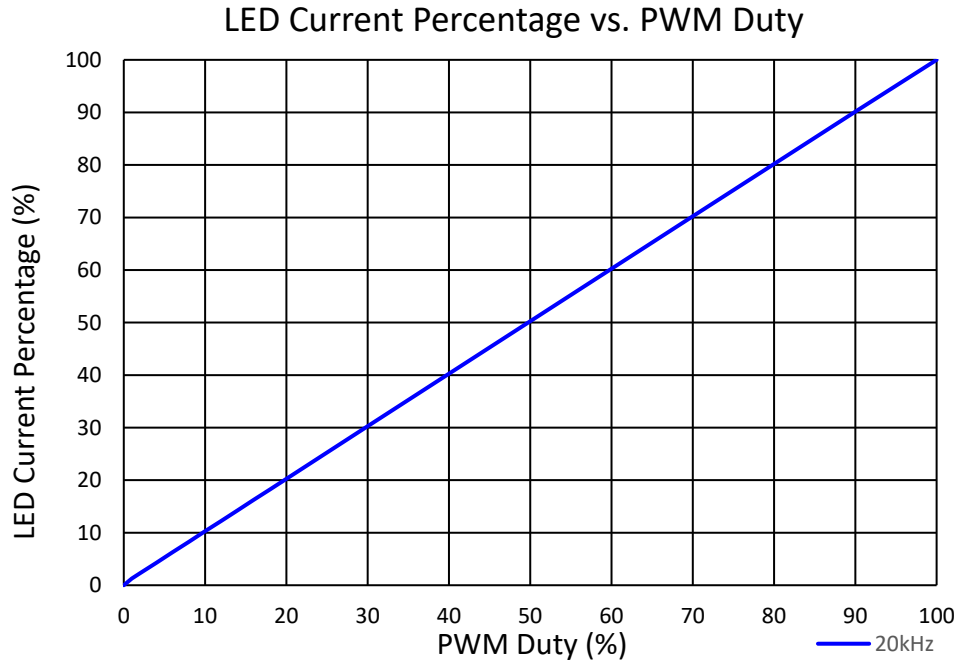


Figure 7. LED Current Percentage vs. PWM Duty

LED Open Protection

AL8853AQ monitors the output voltage through the OVP pin. If the LED string is open, the output voltage will exceed the preset level and the converter will be shut down.

Figure 8 illustrates the LED open protection procedure. In the waveform, channel 1 (yellow) is the GATE signal, channel 2 (red) is the COMP signal, channel 3 (blue) is the OVP pin signal, and channel 4 (green) the LED current. From the waveforms, when V_{OVP} reaches 2.0V, AL8853AQ enters LED open protection and the converter shuts down; once the V_{OVP} drops by the hysteresis value (100mV), the converter continues to switch.

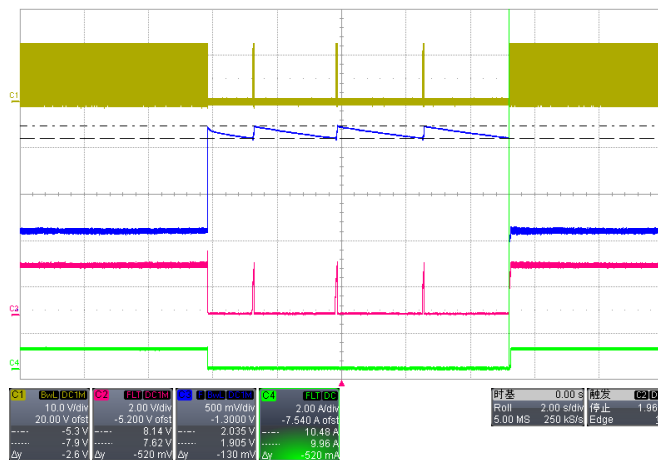


Figure 8. LED Open Protection with 100% Duty

LED Cathode Short to GND Protection

To prevent LED cathode short to ground, AL8853AQ monitors the COMP pin voltage. If V_{COMP} is continuously greater than 3.2V for 50ms, the converter will be shut down.

Figure 9 depicts the LED cathode short to ground protection procedure. In the waveforms, channel 1 (yellow) is the GATE signal, channel 2 (red) is the COMP signal, channel 3 (blue) is the CS signal, and channel 4 (green) the FB signal. From the waveforms, when LED cathode is short to GND, FB drops to $\sim 0V$ and V_{COMP} rises. When V_{COMP} reaches 3.2V and lasts for $\sim 50ms$, AL8853AQ enters protection and latches the system.

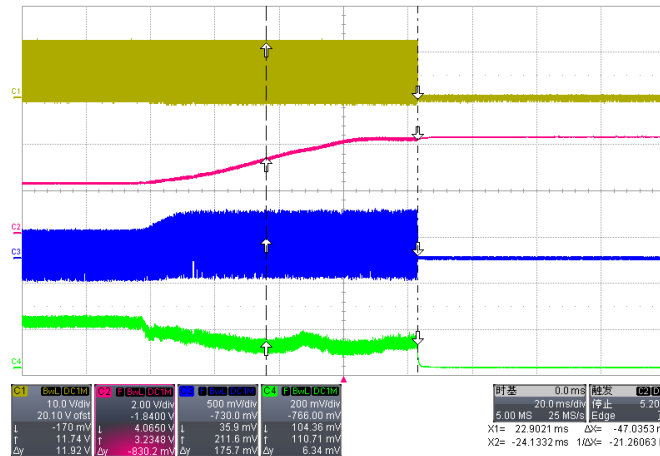


Figure 9. LED Cathode Short to GND Protection with 100% Duty

V_{OUT} Short Protection

AL8853AQ monitors the OVP pin voltage. If V_{OUT} is short, V_{OVP} will drop, and if V_{OVP} drops below 0.25V, the converter will be shut down.

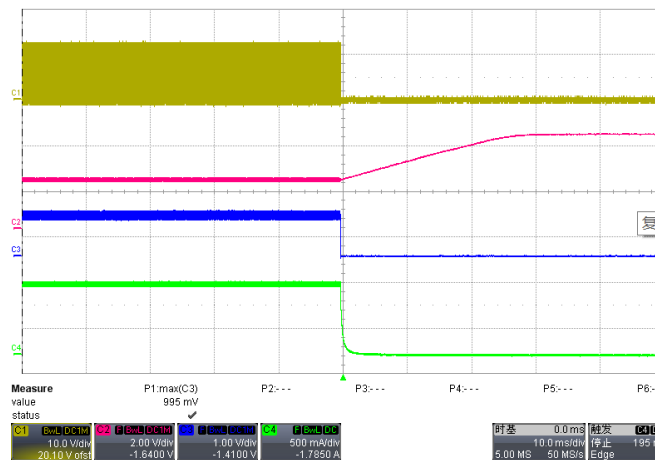


Figure 10. V_{OUT} Short to GND Protection with 100% Duty

Figure 10 shows the V_{OUT} short to ground protection procedure. In the waveforms, channel 1 (yellow) is the GATE signal, channel 2 (red) is the COMP signal, channel 3 (blue) is the OVP signal, and channel 4 (green) the LED current. From the waveforms, when V_{OUT} is short to GND, OVP drops to $\sim 0V$, below 0.25V, and then AL8853AQ enters protection and latches the system.

Overtemperature Protection

When the junction temperature exceeds +160°C, AL8853AQ enters protection and the converter shuts down.

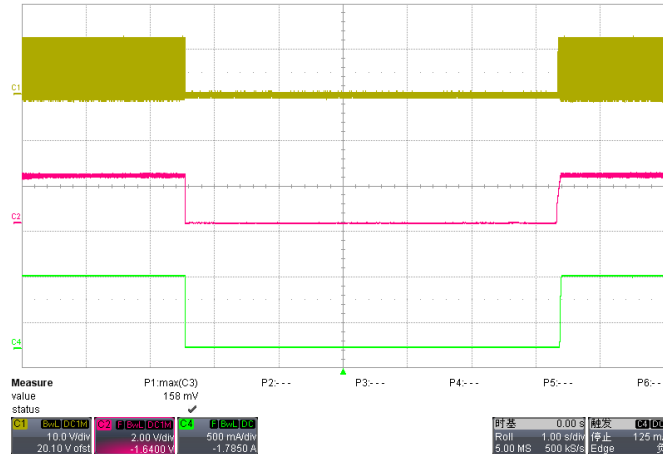


Figure 11. Overtemperature Protection with 100% Duty

Figure 11 illustrates the overtemperature protection procedure. In the waveforms, channel 1 (yellow) is the GATE signal, channel 2 (red) is the COMP signal and channel 4 (green) is the LED current. From the waveforms, when the IC junction temperature exceeds the threshold temperature +160°C, AL8853AQ shuts down; once IC junction temperature drops by 30°C, AL8853AQ automatically restarts.

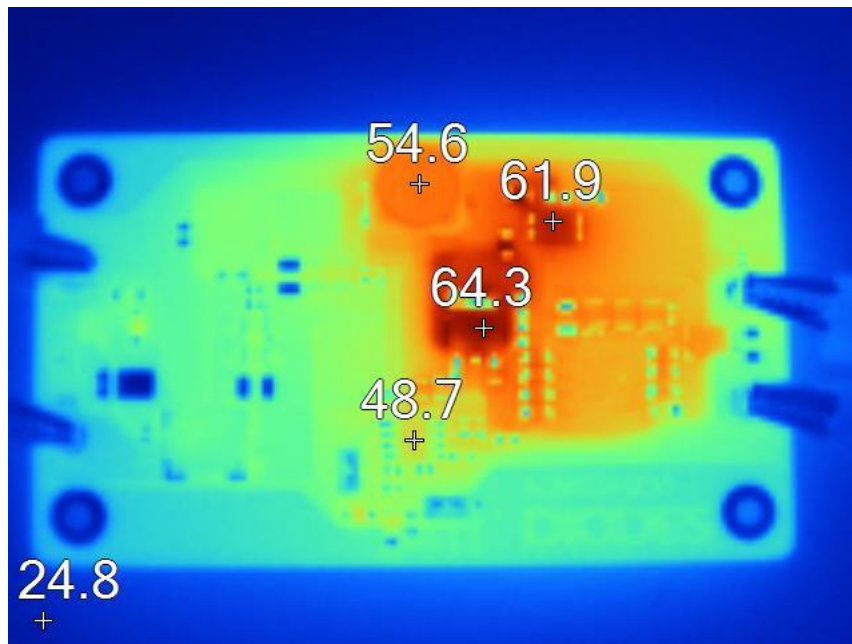
LED Anode Short to GND

If the LED anode short to GND protection is required, the diode D4 is in need to prevent the FB pin from damaging. A diode should be placed to D4 whose peak repetitive reverse voltage should be no less than 100V and output current should be no less than 2A.

Thermal Test:

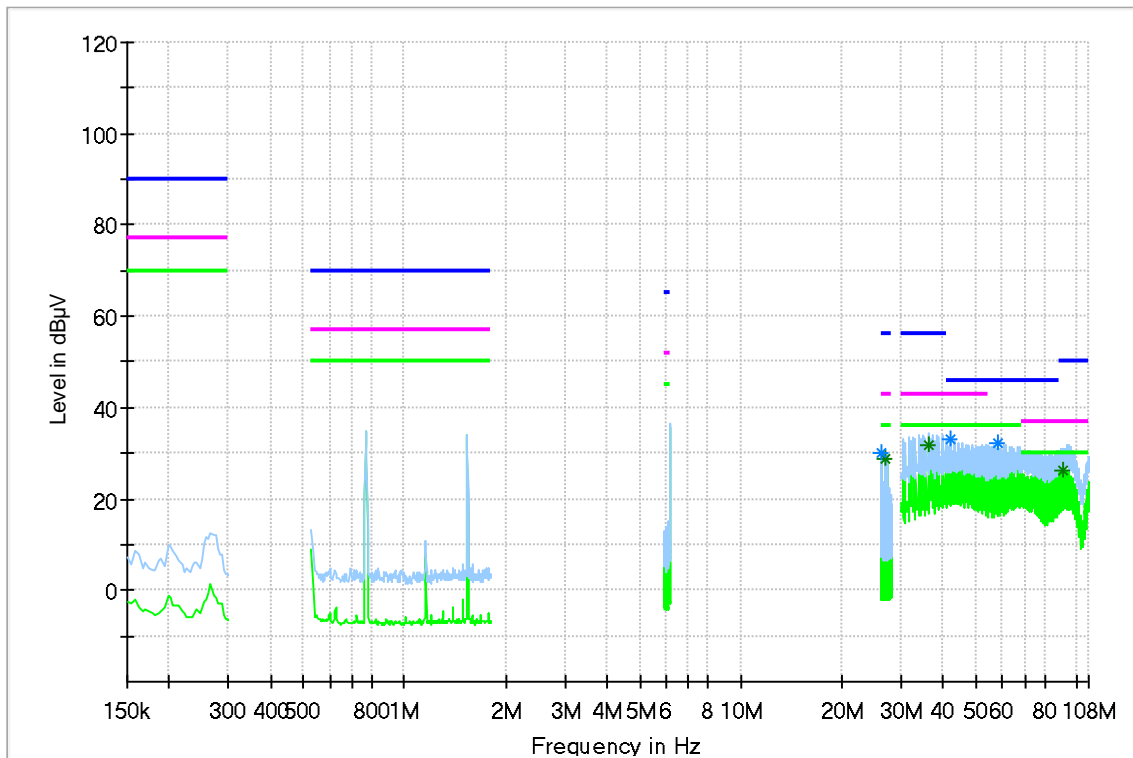
Test condition: $V_{IN}=12V$, $V_O=34V$ (10LEDs), $T_a=24.8^{\circ}C$

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency (%)	Power Inductor Temp (C°)	Power Mos Temp (C°)	Diode Temp (C°)	IC Temp (C°)
12	2.48	33.849	0.8147	92.7	54.6	64.3	61.9	48.7



Conductive Emission Test:

Test condition: $V_{IN}=12V$, $V_O=34V$ (10 LEDs)



Frequency	Max Peak	Average	Limit	Margin	Meas._Time	Bandwidth	Line	Corr.
MHz	dBµV	dBµV	dBµV	dB	ms	kHz		dB
26.144	30.15	---	56.00	25.85	---	---	Single Line	0.7
26.904	---	28.82	36.00	7.18	---	---	Single Line	0.7
36.100	---	31.77	36.00	4.23	---	---	Single Line	0.8
41.900	33.05	---	46.00	12.95	---	---	Single Line	0.9
58.000	32.35	---	46.00	13.65	---	---	Single Line	1.0
90.300	---	26.45	30.00	3.55	---	---	Single Line	1.4

IMPORTANT NOTICE

1. DIODES INCORPORATED (Diodes) AND ITS SUBSIDIARIES MAKE NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO ANY INFORMATION CONTAINED IN THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).
2. The Information contained herein is for informational purpose only and is provided only to illustrate the operation of Diodes' products described herein and application examples. Diodes does not assume any liability arising out of the application or use of this document or any product described herein. This document is intended for skilled and technically trained engineering customers and users who design with Diodes' products. Diodes' products may be used to facilitate safety-related applications; however, in all instances customers and users are responsible for (a) selecting the appropriate Diodes products for their applications, (b) evaluating the suitability of Diodes' products for their intended applications, (c) ensuring their applications, which incorporate Diodes' products, comply the applicable legal and regulatory requirements as well as safety and functional-safety related standards, and (d) ensuring they design with appropriate safeguards (including testing, validation, quality control techniques, redundancy, malfunction prevention, and appropriate treatment for aging degradation) to minimize the risks associated with their applications.
3. Diodes assumes no liability for any application-related information, support, assistance or feedback that may be provided by Diodes from time to time. Any customer or user of this document or products described herein will assume all risks and liabilities associated with such use, and will hold Diodes and all companies whose products are represented herein or on Diodes' websites, harmless against all damages and liabilities.
4. Products described herein may be covered by one or more United States, international or foreign patents and pending patent applications. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks and trademark applications. Diodes does not convey any license under any of its intellectual property rights or the rights of any third parties (including third parties whose products and services may be described in this document or on Diodes' website) under this document.
5. Diodes' products are provided subject to Diodes' Standard Terms and Conditions of Sale (<https://www.diodes.com/about/company/terms-and-conditions/terms-and-conditions-of-sales/>) or other applicable terms. This document does not alter or expand the applicable warranties provided by Diodes. Diodes does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.
6. Diodes' products and technology may not be used for or incorporated into any products or systems whose manufacture, use or sale is prohibited under any applicable laws and regulations. Should customers or users use Diodes' products in contravention of any applicable laws or regulations, or for any unintended or unauthorized application, customers and users will (a) be solely responsible for any damages, losses or penalties arising in connection therewith or as a result thereof, and (b) indemnify and hold Diodes and its representatives and agents harmless against any and all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim relating to any noncompliance with the applicable laws and regulations, as well as any unintended or unauthorized application.
7. While efforts have been made to ensure the information contained in this document is accurate, complete and current, it may contain technical inaccuracies, omissions and typographical errors. Diodes does not warrant that information contained in this document is error-free and Diodes is under no obligation to update or otherwise correct this information. Notwithstanding the foregoing, Diodes reserves the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes.
8. Any unauthorized copying, modification, distribution, transmission, display or other use of this document (or any portion hereof) is prohibited. Diodes assumes no responsibility for any losses incurred by the customers or users or any third parties arising from any such unauthorized use.
9. This Notice may be periodically updated with the most recent version available at <https://www.diodes.com/about/company/terms-and-conditions/important-notice>

The Diodes logo is a registered trademark of Diodes Incorporated in the United States and other countries.
All other trademarks are the property of their respective owners.
© 2023 Diodes Incorporated. All Rights Reserved.

www.diodes.com