AL8853AQEV1 User Guide
High-Performance Boost LED Controller

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

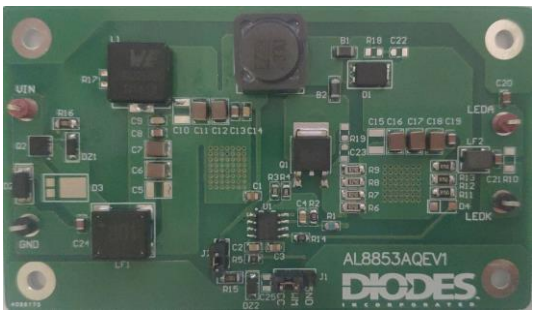


Figure 1. Top View

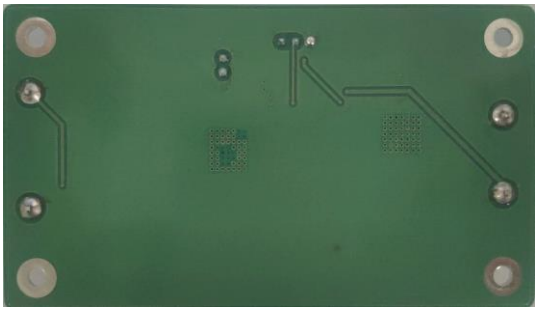


Figure 2. Bottom View

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

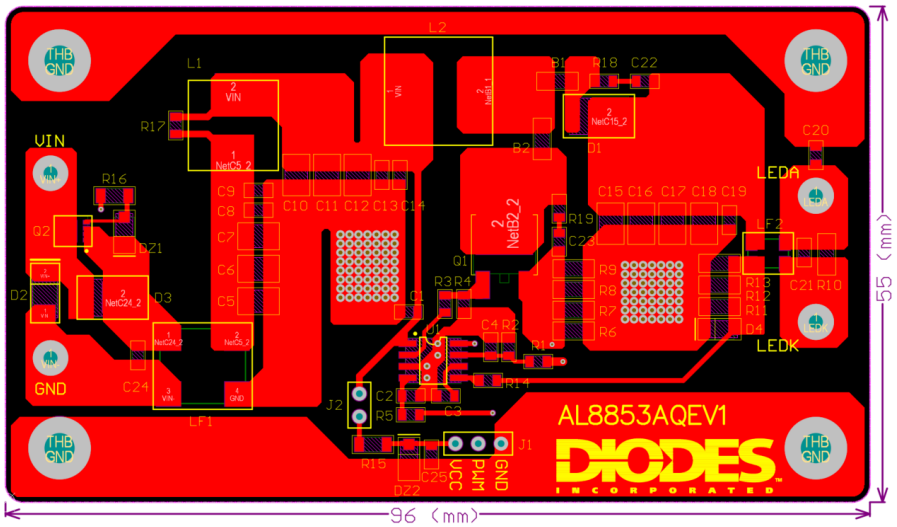


Figure 3. PCB Layout Top View

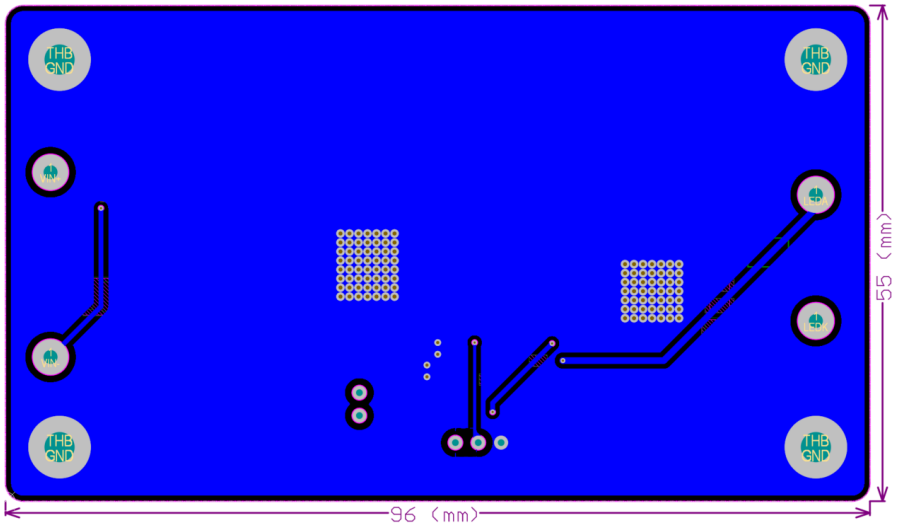


Figure 4. PCB Layout Bottom View

Quick Start Guide

1. By default, the evaluation board is preset Jumper on J1 (VCC to PWM) and J2.
2. Ensure that the power supply and the PWM signal are switched OFF or disconnected.
3. Connect the LED power supply to the test point “VIN” and “GND”.
4. Connect the LED string anode to the test point “LEDA”.
5. Connect the LED string cathode to the test point “LEDK”.
6. Turn on the LED power supply. The LED string will light on and output the preset current.
7. Dimming mode:
   a. Remove the Jumper on J1 and J2.
   b. Connect the LED PWM signal to J1 “PWM” and “GND”.

Schematic

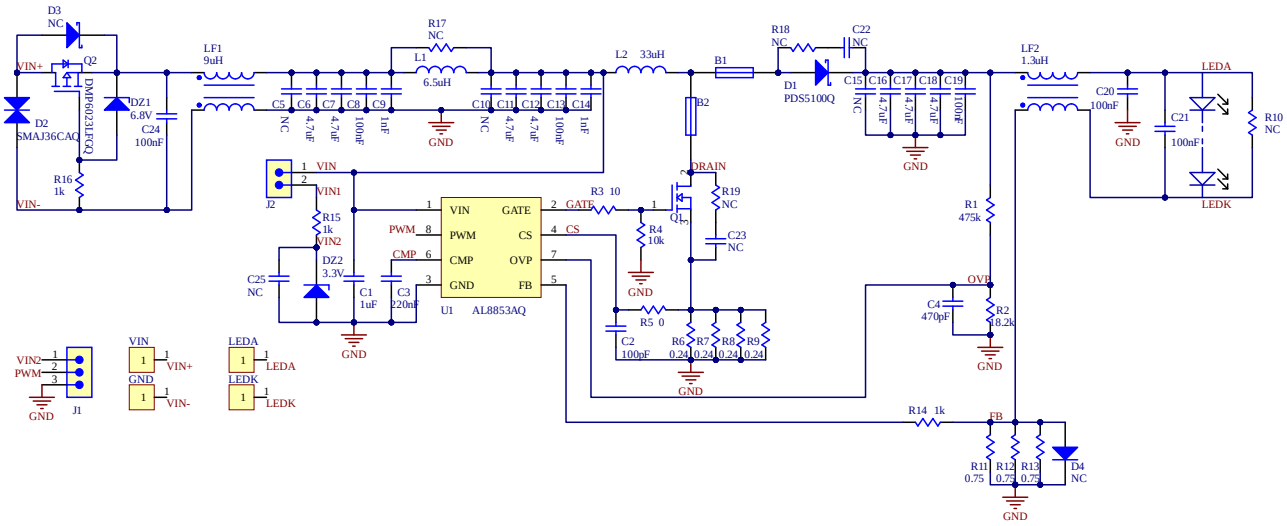


Figure 5. Schematic Circuit

Bill of Material

NO.	Location	Description	Package	Quantity
1	U1	AL8853AQ, Boost controller, Diodes Incorporated (Diodes)	SO-8	1
2	L1	784325065, WE-HCIA, 6.5µH, IR=8.5A, 10*10*4.5mm, AEC-Q200	SMD	1
3	L2	7447709330, WE-PD 33µH, IR=4.2A, 12*12*10mm, AEC-Q200	SMD	1
4	LF1	744273801, WE-SL5-HC 9µH, 800Ω@100MHz, IR=3.5A, 9.5*8.3mm	SMD	1
5	LF2	744235801, WE-CNSW 1.3µH, 800Ω@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, 60Ω@100MHz Id=5A, AEC-Q200	1206	1
13	B2	742792113, WE-CBF,120Ω@100MHz Id=3A, AEC-Q200	1206	1
14	R1	0805, 475kΩ, 1%	0805	1
15	R2	0805, 18.2kΩ, 1%	0805	1
16	R3	0805, 10Ω, 1%	0805	1
17	R4	0805, 10kΩ, 5%	0805	1
18	R5	0805, 0Ω, 1%	0805	1
19	R6,R7,R8,R9	1206, 0.24Ω, 1%	1206	4
20	R11,R12,R13	1206, 0.75Ω , 1%	1206	3
21	R14	0805, 1kΩ, 5%	0805	1
22	R15,R16	1206, 1kΩ, 5%	1206	2
23	C1	0805, X7R, 1µF, 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, 4.7µF, 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.

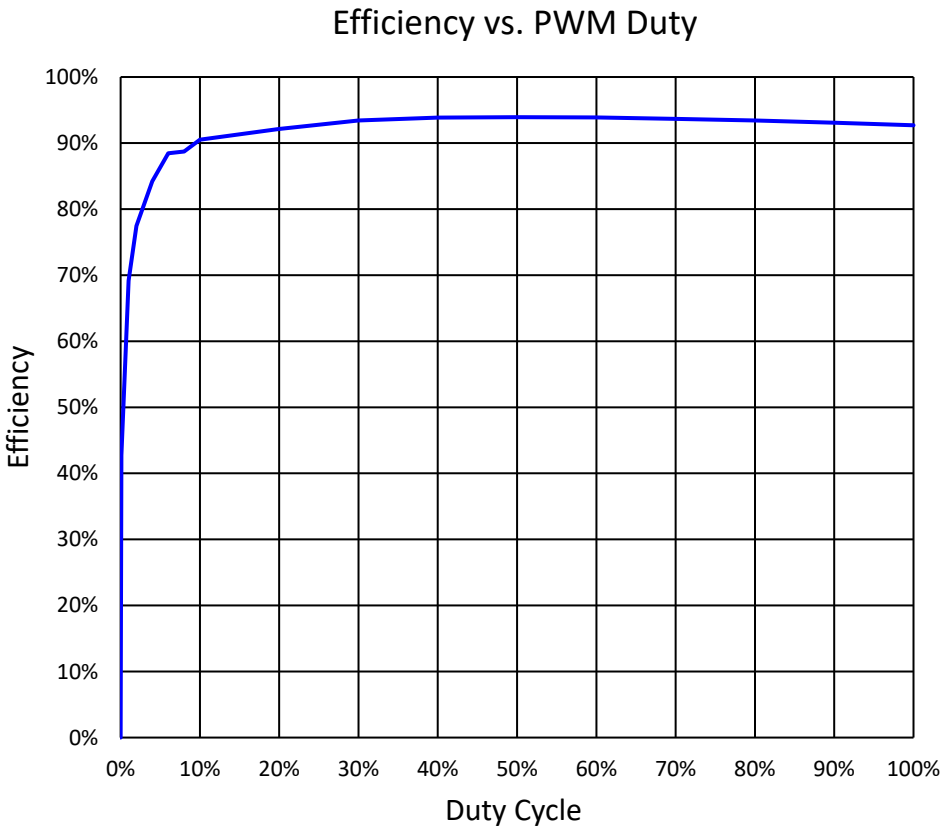


Figure 6. Efficiency vs. PWM Duty

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%.

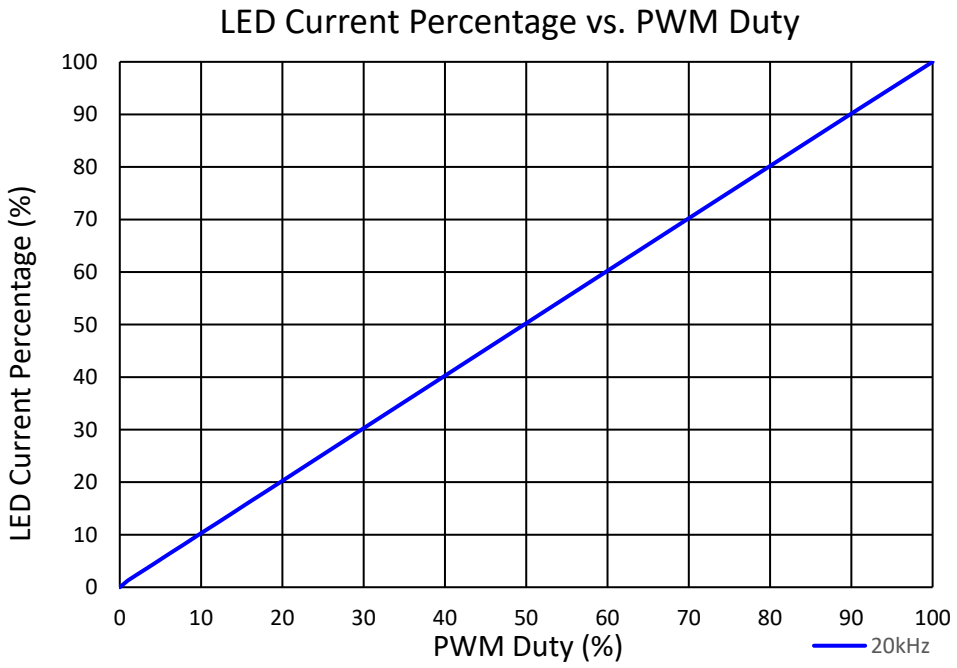


Figure 7. LED Current Percentage vs. PWM Duty

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 convertor shuts down; once the V_{OVP} drops by the hysteresis value (100mV), the convertor continues to switch.

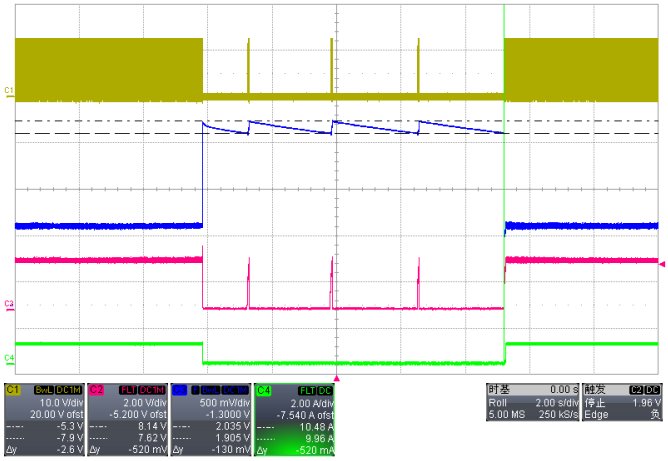


Figure 8. LED Open Protection with 100% Duty

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 ~0V and V_{COMP} rises. When V_{COMP} reaches 3.2V and lasts for ~50ms, AL8853AQ enters protection and latches the system.

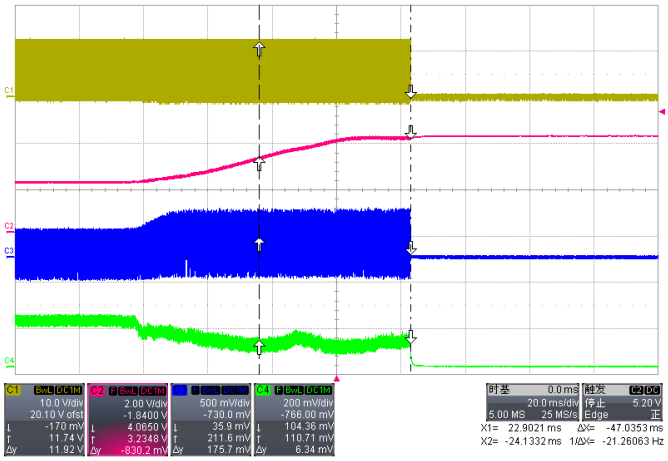


Figure 9. LED Cathode Short to GND Protection with 100% Duty

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.

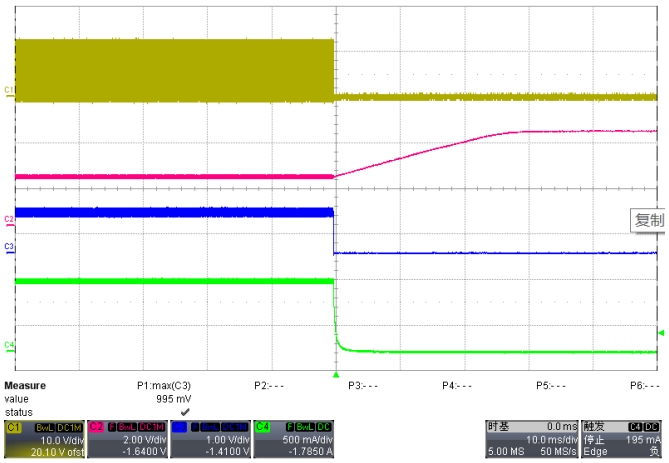


Figure 10. VOUT Short to GND Protection with 100% Duty

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 VOUT is short to GND, OVP drops to ~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.

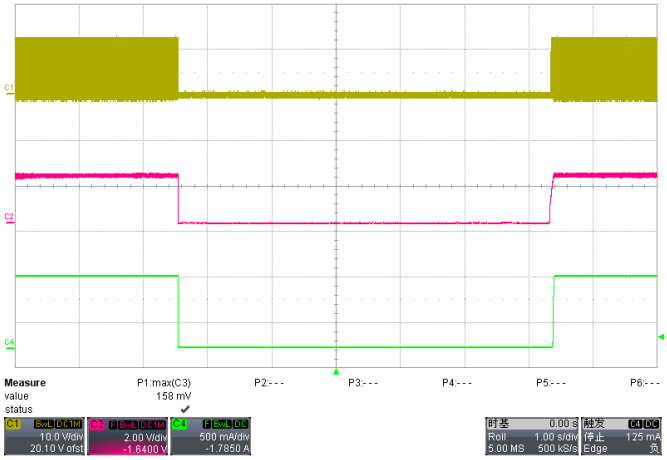


Figure 11. Overtemperature Protection with 100% Duty

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.

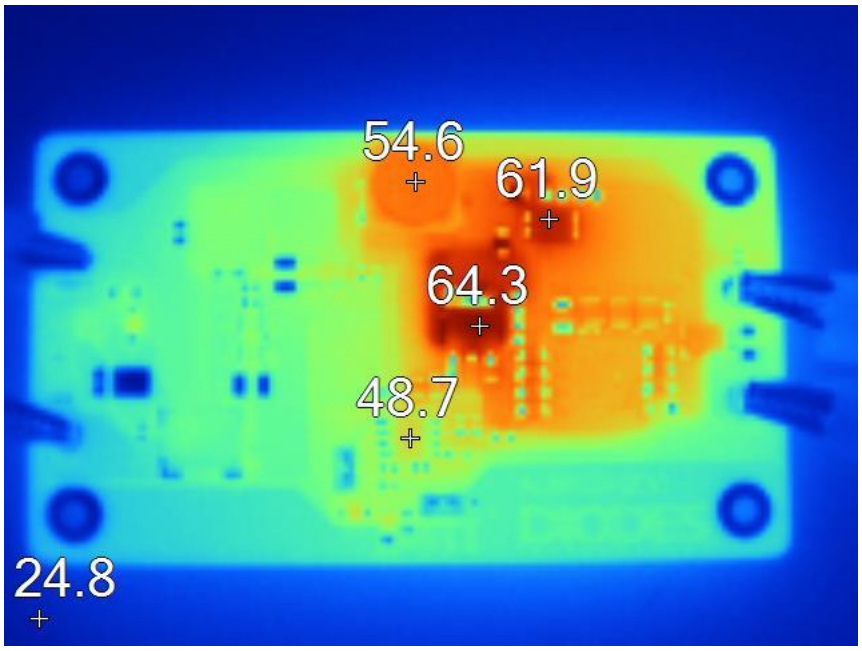
LED Anode Short to GND

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:

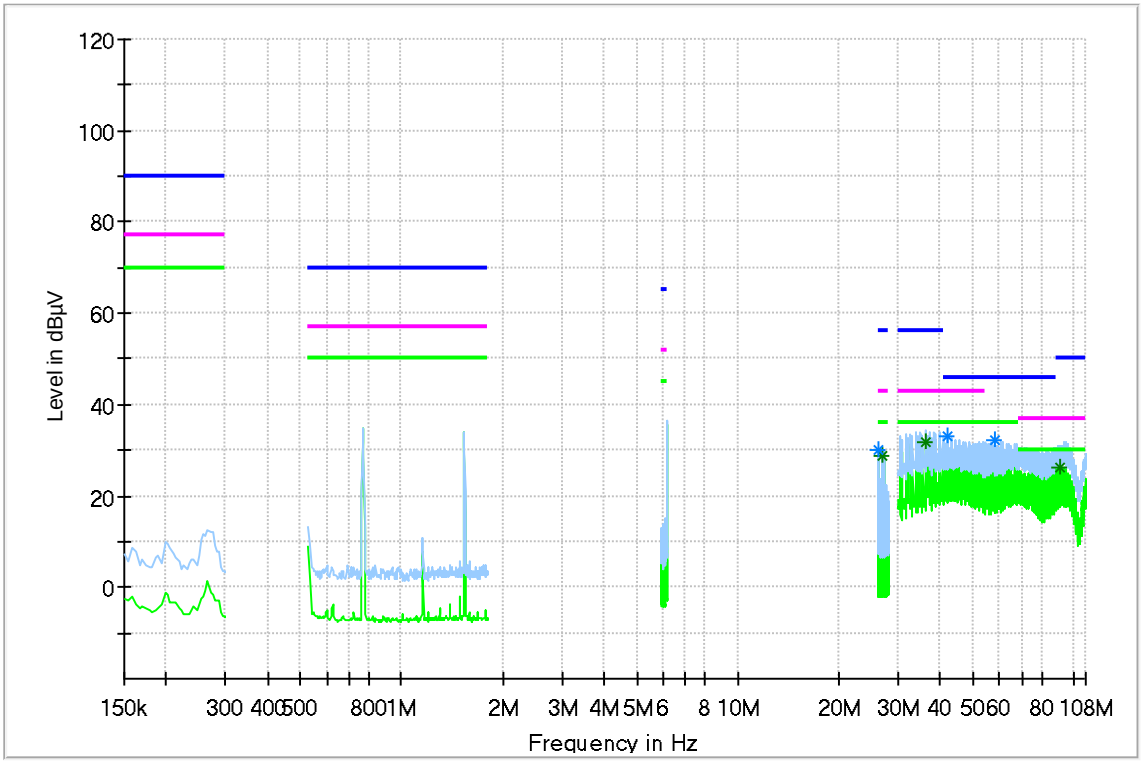
Test condition: V_{IN}= 12V, V_O=34V (10LEDs), Ta=24.8°C

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

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