AL8866Q EV2 User Guide
Boost, Buck-Boost 1A LED Driver

General Description

The AL8866Q is a Buck-Boost, Boost, Buck, and SEPIC (single-ended primary-inductance converter) DC-switching controller designed to drive an external MOSFET for high-power automotive LED applications. The AL8866Q operates within a wide input power supply range of 4.5V to 85V.

The AL8866Q is based on a fixed-frequency, peak current-mode control architecture to incorporate spread spectrum frequency modulation technique, achieving low-EMI performance.

The AL8866Q modulates the LED current with analog or PWM dimming techniques. Analog dimming responses with over 100:1 linear range is obtained by varying the voltage at the DIM pin. PWM dimming is achieved by directly modulating the same DIM pin with the desired duty cycle.

The AL8866Q integrates soft-start function, which limits the current through the inductor and external power switch during initialization start up. It gradually increases the inductor and switch current to minimize potential overvoltage and overcurrent at the output.

The AL8866Q, with an open-drain fault output, indicates when protection conditions trigger, such as LED output overvoltage, LED output open/short, cycle-by-cycle overcurrent protection, sense resistor and inductor/diode shorts, diode open, and thermal shutdown.

The AL8866Q is available in the enhanced thermal SO-8EP and wettable U-DFN3030-10 packages. The demo board uses a DFN package.

Applications

- Automotive front lighting
- Automotive high beams, low beams
- Automotive daytime running lights
- Automotive fog lights, turn lights. and position lights
- Other automotive LED lighting

Key Features

- AEC-Q100 (Grade 1) Qualified
- Wide Input Voltage Range from 4.5V to 85V
- Pre-Fixed 400kHz Switching Frequency (Factory Set)
- Spread Spectrum Frequency Modulation for Low EMI
- Analog Dimming Range: 1% to 100%
- 100% Dimming Level ±3% Current Accuracy
- 20% Dimming Level ±12% Current Accuracy
- PWM Dimming Ratio 100:1 at 200Hz PWM Frequency
- Programmable Soft Start
- Fault Status Indicator for Protections
- Output Overvoltage and LED Open Circuit Protection
- Output Undervoltage and LED Short Circuit Protection
- Cycle-by-Cycle Overcurrent Limitation Protection
- Sense resistor Shorted Circuit Protection
- Diode/Inductor Shorted Circuit Protection
- Diode Open Circuit Protection
- Thermal Shutdown

AL8866Q EV2 Specifications

Parameter	Value
Input Voltage	9VDC to 16VDC
LED Current	1A
Number of LEDs	1~7pcs
XY Dimension	113mm x 58mm

Figure 1: Top View

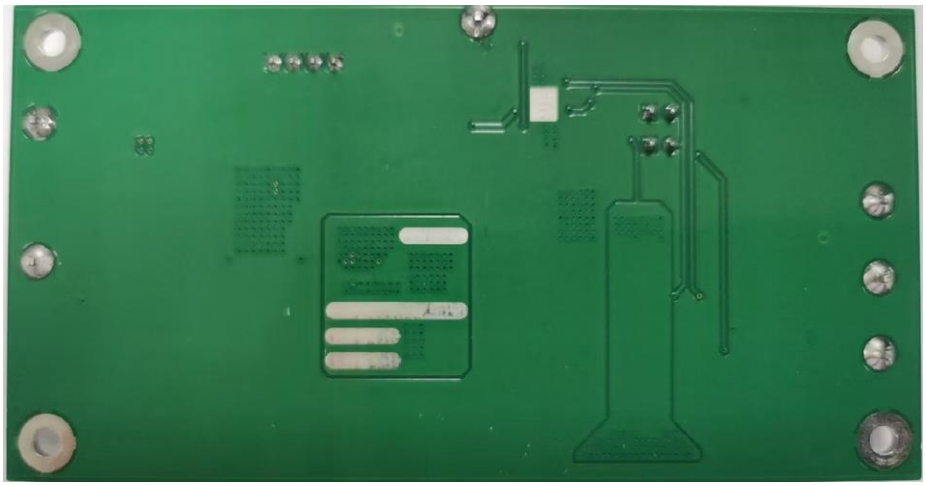


Figure 2: Bottom View

Connection Instructions &Quick Start Guide

1. Ensure that the DC source is switched OFF or disconnected before soldering or connecting.
2. By default, the LED current of the evaluation board is preset at 1000mA output.
3. Connect the anode wire of the external LED string to the **LEDA** connector.
4. Connect the cathode wire of the external LED string to the **LEDK2** connector for Boost applications; **LEDK1** connector for Buck-Boost applications. This Demo Board, by default, uses buck-boost topology by shorting R23, R24. Shorting R25, R26 are optional for boost applications.
5. Power Supply Input: 9~16VDC between **VIN+** and **GND**.
6. For optional Boost applications, OVP protection is obtained by the jumper shorting the J2 connector. Buck-Boost OVP by the jumper shorting J3 by default. J1 is a common GND for prompt testing.
7. Ensure that the area around the board is clear and safe. The board and LEDs are preferably enclosed in a transparent safety cover.
8. Turn on the main switch. The LED string should light up.

Evaluation Board Schematic

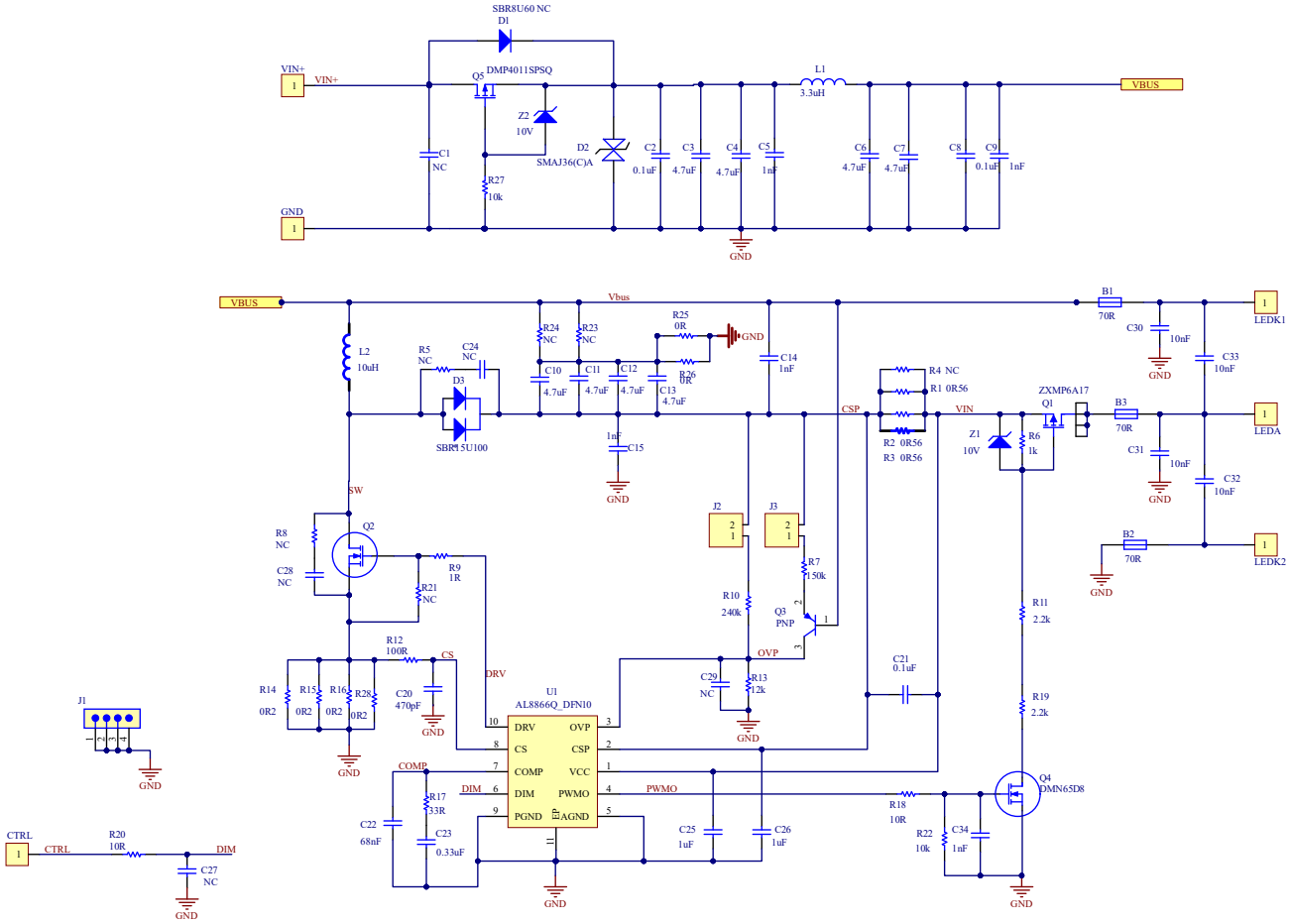


Figure 3: Evaluation Board Schematic

Evaluation Board Layout

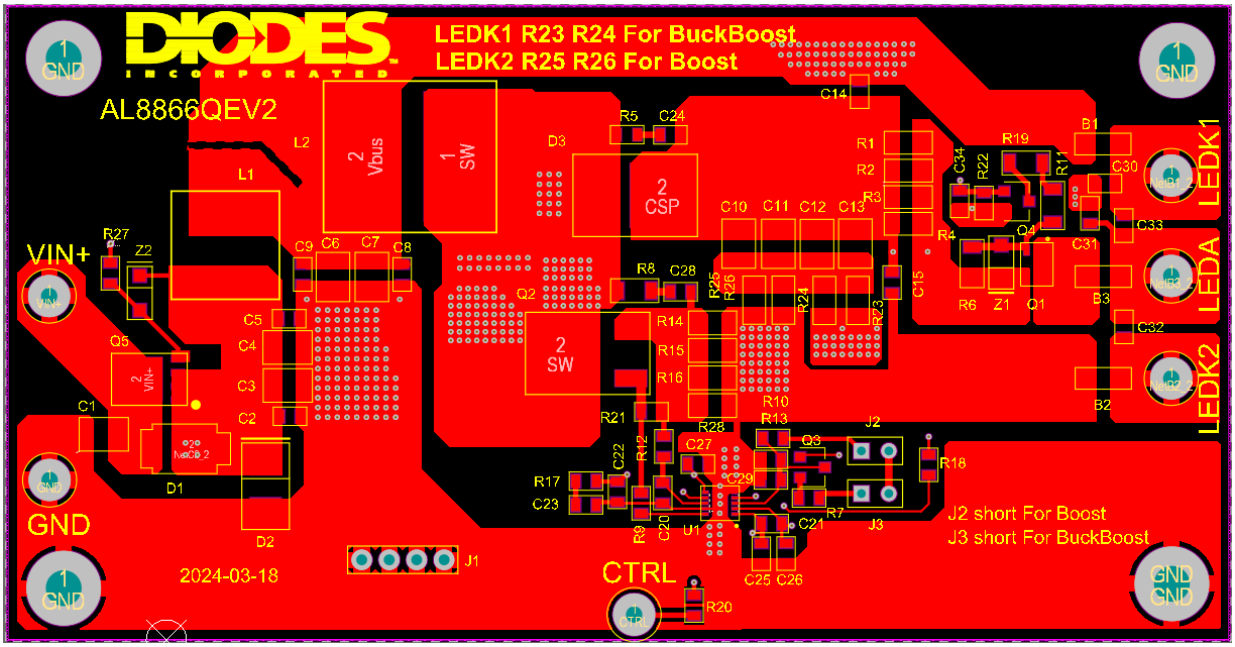


Figure 4: PCB Layout Top Layer View

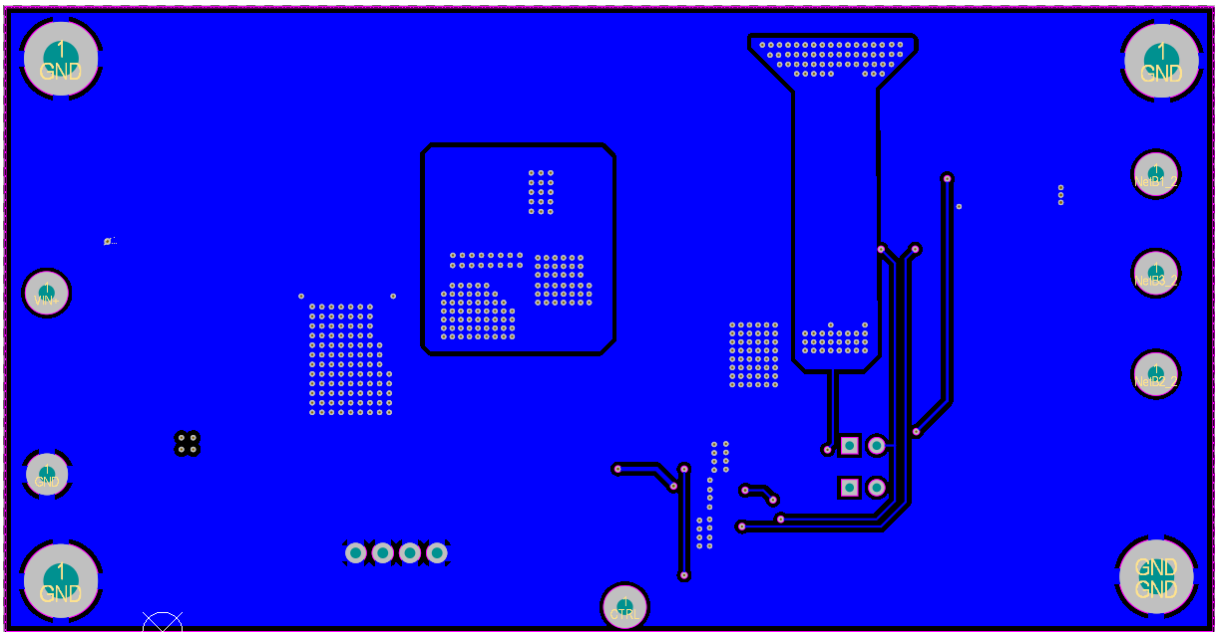


Figure 5: PCB Layout Bottom Layer View

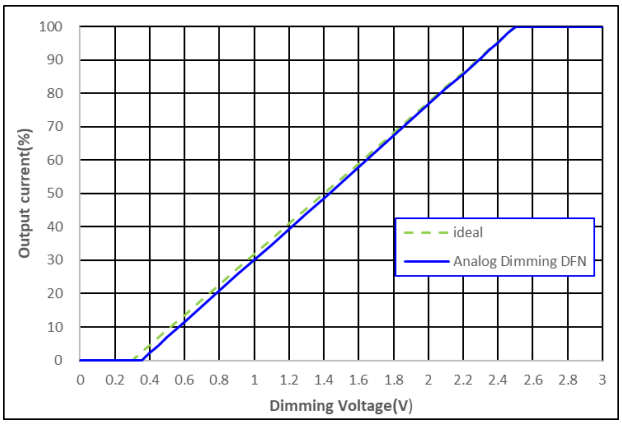
Bill of Materials

Num.	Designator	Description	Qty.
1	C2, C8, C21	Cap, Cer, CGA4J2X7R2A104K125AA, 100nF,100V, X7R, 0805, -55°C~125°C, AEC-Q200, TDK	3
2	C3, C4, C6, C7, C10, C11, C12, C13	Cap, Cer, GCJ32DC72A475KE01L, 4.7uF, 100V, X7S, 1210, -55°C~125°C, AEC-Q200, Murata	8
3	C5, C9, C14, C15	Cap, Cer, CGA4J2X7R2A102K125AA, 1nF,100V, X7R, 0805, -55°C~125°C, AEC-Q200, TDK	4
4	C30, C31, C32, C33	Cap, Cer, CGA4J2X7R2A103K125AA, 10nF, 100V, X7R, 0805, -55°C~125°C, AEC-Q200, TDK	4
5	C20	Cap, Cer, CL21C471JCC1PNC, 470pF, 100V, NP0, 0805, -55°C~125°C, AEC-Q200, Samsung	1
6	C22	Cap, Cer, CGA4J2X7R2A683K125AA, 68nF,100V, X7R, 0805, -55°C~125°C, AEC-Q200, TDK	1
7	C23	Cap, Cer, CGA4J2X8R1H334K125AA, 330nF, 50V, X8R, 0805, -55°C~150°C, AEC-Q200, TDK	1
8	C25, C26	Cap, Cer, CGA4J3X7R1H105K125AB, 1uF, 50V, X7R, 0805, -55°C~125°C, AEC-Q200, TDK	2
9	R1	Resistor 0R62 1% 1206	1
10	R2, R3	Resistor 0R56 1% 1206	2
11	R14, R15, R16,	Resistor 0R15 1% 1/2W 1206	3
12	R23, R24	Resistor 0R 1% 1206	2
13	R6	Resistor 1k 1% 1206	1
14	R11, R19	Resistor 2.2k 1% 1206	2
15	R7	Resistor 150k 1% 0805	1
16	R10	Resistor 240k 1% 0805	1
17	R13	Resistor 12k 1% 0805	1
18	R21, R22, R27	Resistor 10k 1% 0805	3
19	R9	Resistor 1R 1% 0805	1
20	R12	Resistor 100R 1% 0805	1
21	R17	Resistor 33R 1% 0805	1
22	R18 R20	Resistor 10R 1% 0805	2
23	VIN+, LEDA,	Connector, Red color	2
24	GND, LEDK1, LEDK2	Connector, Black color	3
25	CTRL,	Connector, Yellow color	1
26	D2	Diode TVS SMAJ36CA 36V SMA DIODES	1
27	D3	Diode SBR15U100CTLQ DPAK DIODES	1
28	Z1 Z2	Diode BZT52C10Q 10V SOD123 DIODES	2
29	J1	Connector_4PIN_2.54mm	1
30	J2, J3	Connector_2PIN_2.54mm	2
31	J3,	Jumper for CON J3	1
32	B1, B2, B3	BeadCore,70R 2.5A 74279215, WURTH	3
33	L1	Inductor SMD 3.3uH 12A, 784325033, WURTH	1
34	L2	Inductor SMD 10uH 8.8A 744373965100, WURTH	1
35	Q1	P-MOS, ZXMP6A17E6Q 60V 3A SOT26, DIODES	1
36	Q2	N-MOS, DMTH10H015SK3Q DPAK DIODES	1
37	Q3	TR PNP ZXTP5401FLQ SOT23 DIODES	1
38	Q4	N-MOS, DMN65D8LQ 60V 0.3A SOT23 DIODES	1
39	Q5	P-MOS, DMP4011SPSQ, DI5060 DIODES	1
40	U1	IC AL8866QFN-7 DIODES	1
41	PCB	PCB FR4 2sides, 1.6mm 2OZ,113X58.6mm	1

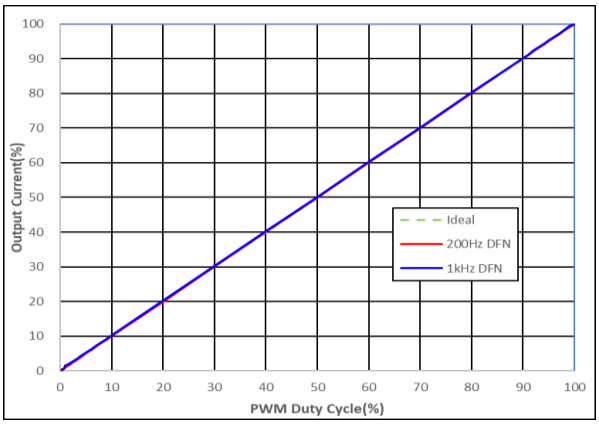
Efficiency Test

Input(V)	Iin(A)	Pin(W)	Io(A)	Vo(V)	Po(W)	Eff(%)
9.0	2.605	23.45	1.002	20.32	20.36	86.8
10.0	2.331	23.31	1.002	20.33	20.37	87.4
11.0	2.108	23.19	1.001	20.32	20.34	87.7
12.0	1.934	23.21	1.000	20.33	20.33	87.6
13.0	1.780	23.14	1.000	20.27	20.27	87.6
14.0	1.655	23.17	1.000	20.31	20.31	87.7
15.0	1.548	23.22	1.000	20.30	20.30	87.4
16.0	1.450	23.20	1.000	20.29	20.29	87.5

Dimming Curve



Analog Dimming



PWM Dimming

Operating Waveforms

Turn On & Off by Vin, Buck-Boost, Test condition: VIN=12V, Io=1A Vo=21V

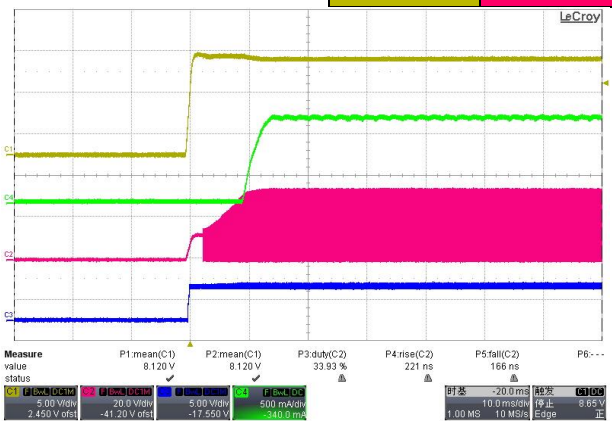


Figure 6 Turn on @ DIM Floating

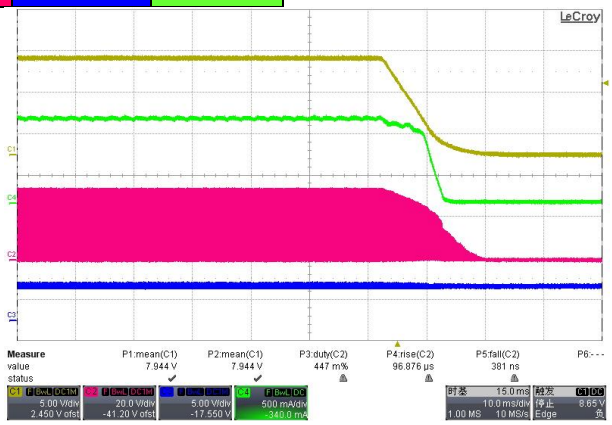


Figure 7 Turn off @ DIM Floating

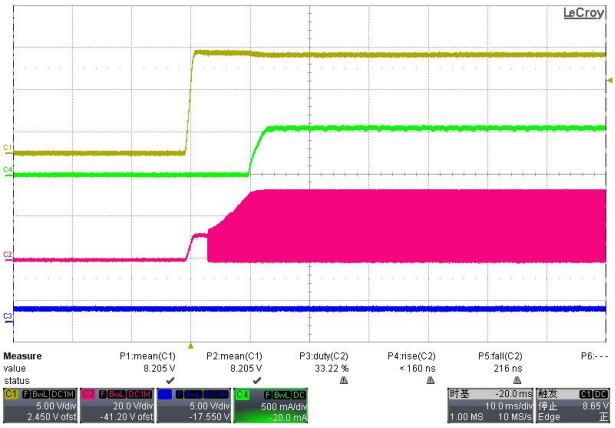


Figure 8 Turn on @ADim= 1.5V

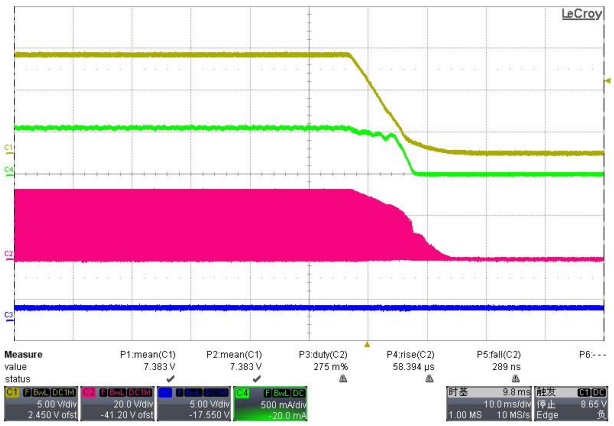


Figure 9 Turn off @ ADim= 1.5V

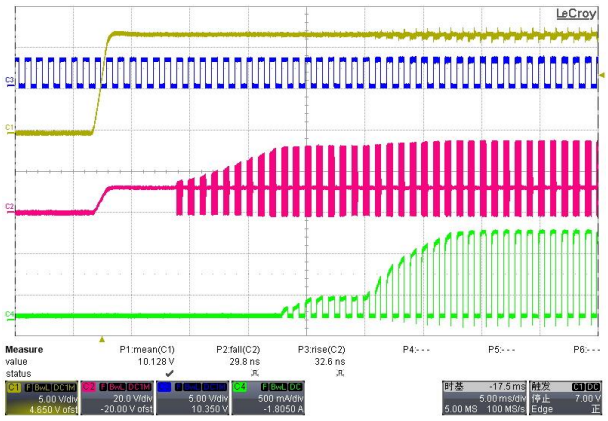


Figure 10 Turn on @ PWM=50% 1kHz

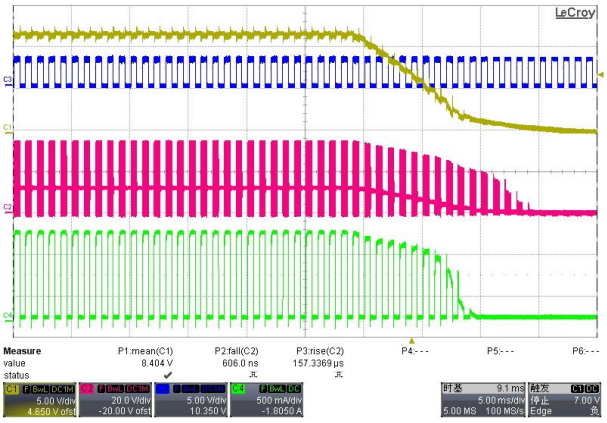


Figure 11 Turn off @ PWM=50% 1kHz

Operating Waveforms (continued)

Stable Operating, Buck-Boost, VIN=12V, Io=1A Vo=21V

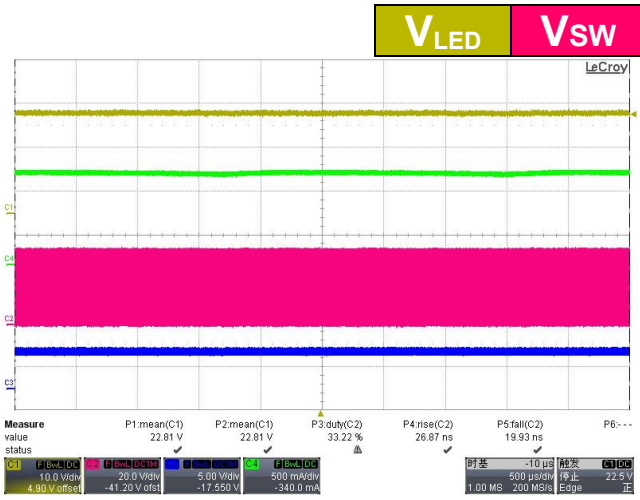


Figure 12 Stable waveform at Dim Float

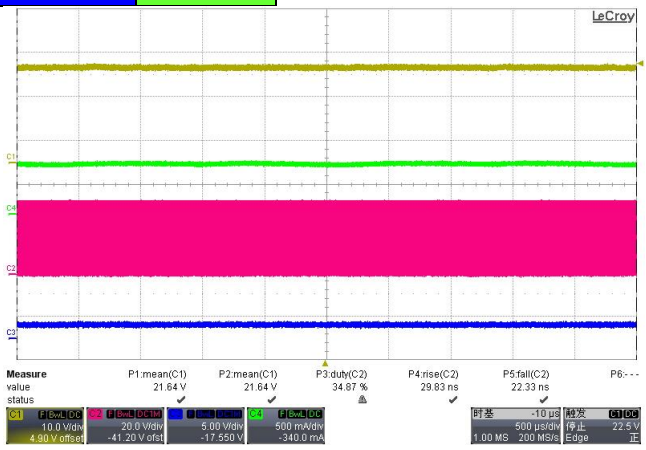


Figure 13 Stable waveform at Dim=1.5V

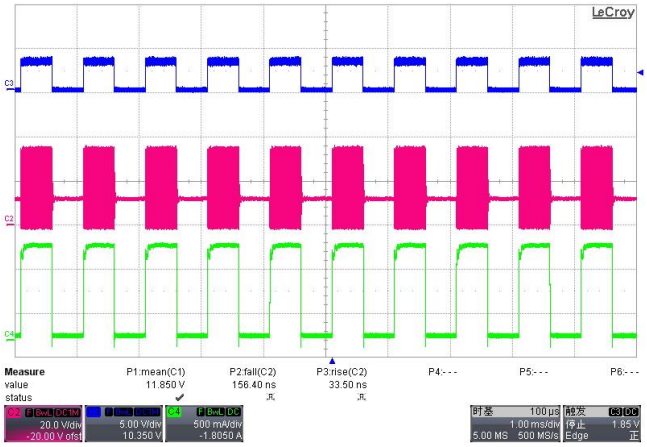


Figure 14 PWM Dimming at 1kHz 50%

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