4ch White LED Driver Built-in Current Driver Boost DC/DC Converter for Automotive BD83A04EFV-M Evaluation Board

REFLED002-EVK-001

User's Guide

＜High Voltage Safety Precautions＞

◇ Read all safety precautions before use

Please note that this document covers only the BD83A04EFV-M evaluation board (REFLED002-EVK-001) and its functions. For additional information, please refer to the datasheet.

To ensure safe operation, please carefully read all precautions before handling the evaluation board

Depending on the configuration of the board and voltages used,

Potentially lethal voltages may be generated.

Therefore, please make sure to read and observe all safety precautions described in the red box below.

Before Use

[1] Verify that the parts/components are not damaged or missing (i.e. due to the drops).
[2] Check that there are no conductive foreign objects on the board.
[3] Be careful when performing soldering on the module and/or evaluation board to ensure that solder splash does not occur.
[4] Check that there is no condensation or water droplets on the circuit board.

During Use

[5] Be careful to not allow conductive objects to come into contact with the board.
[6] **Brief accidental contact or even bringing your hand close to the board may result in discharge and lead to severe injury or death.**
Therefore, DO NOT touch the board with your bare hands or bring them too close to the board.
In addition, as mentioned above please exercise extreme caution when using conductive tools such as tweezers and screwdrivers.
[7] If used under conditions beyond its rated voltage, it may cause defects such as short-circuit or, depending on the circumstances, explosion or other permanent damages.
[8] Be sure to wear insulated gloves when handling is required during operation.

After Use

[9] The ROHM Evaluation Board contains the circuits which store the high voltage. Since it stores the charges even after the connected power circuits are cut, please discharge the electricity after using it, and please deal with it after confirming such electric discharge.
[10] Protect against electric shocks by wearing insulated gloves when handling.

This evaluation board is intended for use only in research and development facilities and should by handled **only by qualified personnel familiar with all safety and operating procedures.**
We recommend carrying out operation in a safe environment that includes the use of high voltage signage at all entrances, safety interlocks, and protective glasses.

LED Driver for Automotive Panel Backlight

4ch White LED Driver Built-in Current Driver Boost DC/DC Converter for Automotive BD83A04EFV-M Evaluation Board

REFLED002-EVK-001

Introduction

This user's guide will provide the necessary steps to operate the Evaluation Board of ROHM's BD83A04EFV-M LED Driver. This document includes the external parts, operating procedures and application data.

Description

This Evaluation Board was developed for ROHM's LED Driver BD83A04EFV-M. BD83A04EFV-M is a white LED driver for LCD Backlight. Built-in MOS for Boost and 4ch Current Driver for LED Drive, and it is suitable for high illumination LED drive.
It is suitable for middle size LCD panel drive because LED pin maximum voltage is 50 V.
The dimming is controlled by the PWM signal and can be set up to 20,000: 1@100 Hz.
It also supports analog dimming and can accommodate even higher brightness ranges by combining with PWM dimming.
DC/DC converters can be controlled for boost applications, and the input operating voltage range is 4.5V to 48V.

Application

Automotive backlight application for CID, cluster panel, car navigation, HUD, or car audio system

Evaluation board operating condition (default setting)

Table 1. Evaluation board operating condition (default setting)

Parameter	Min	Typ	Max	Unit
Power supply voltage *1	7	13.5	18	V
LEDs in series	6	-	10	pcs
LEDs in parallel	-	4	-	ch
Output voltage *2	19	-	36	V
Output current (per channel)	-	80	-	mA
DC/DC oscillation frequency	-	415 *3	-	kHz
Over voltage limit	-	41.1	-	V
Over current limit	-	3.6	-	A

*1 This indicates the voltage near the VCC pin. Be careful of voltage drop by the impedance of power line.

*2 Output voltage is determined by the Vf value of the connected LED and the numbers of series. Since this evaluation board has a boost-configuration, output voltage should be higher than input voltage. Also, output voltage should be lower than OVP voltage.

*3 The default frequency is set to 415kHz so that it is higher than the EMC standard (LW: 150kHz to 300kHz) even if variations and SSCG functions are considered.

Evaluation board

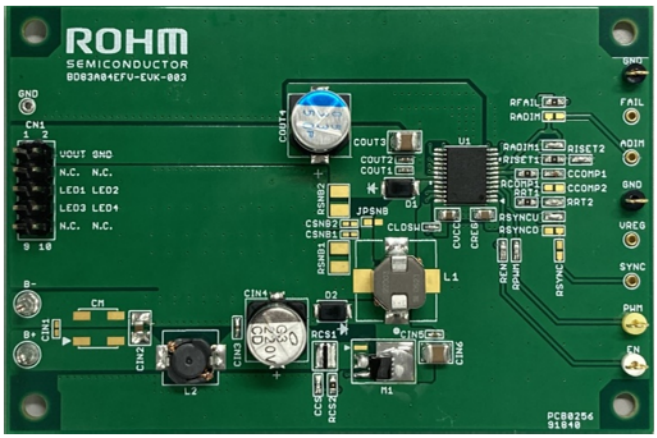

Figure 1. Top view

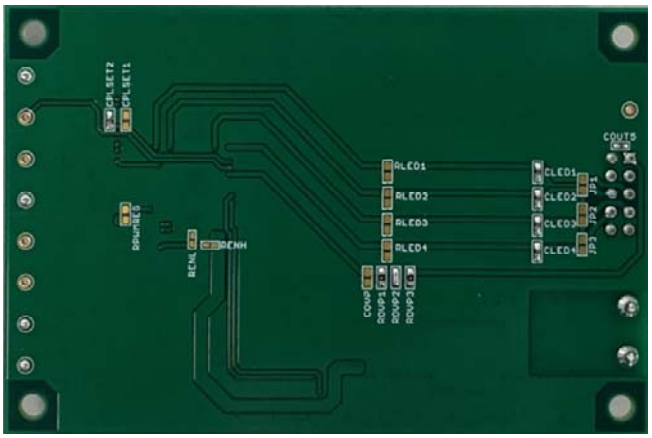

Figure 2. Bottom view

Evaluation board setup

Figure 3. Evaluation board setup

Operating procedure

1. Connect panel or LEDs to evaluation board. (Anode to VOUT-pin. Cathode to LEDx-pin.)
2. Connect power supply to +B-pin and –B-pin of the evaluation board.
3. Connect power supply to EN-pin. It must be less than 7V.
4. Connect pulse generator to PWM-pin. It should be 100Hz to 25kHz and the minimum pulse width must be longer than 0.5µs.
5. Turn on the power supply for +B-pin.
6. Turn on the power supply for EN-pin.
7. Turn on the pulse generator for PWM-pin.

Operation mode settings

The table below describes the settings for SYNC terminals.

Table 2. Mode settings

Terminal	Setting	Function
SYNC	GND or OPEN	Fixed Frequency Mode Determined by RRT
	VREG50	Spread Spectrum Mode (SSCG) of the Frequency determined by RRT
	Pulse Input	Synchronizing to the frequency applied in SYNC pin

For unused channels, pull down the LED pin to GND with 10kΩ.

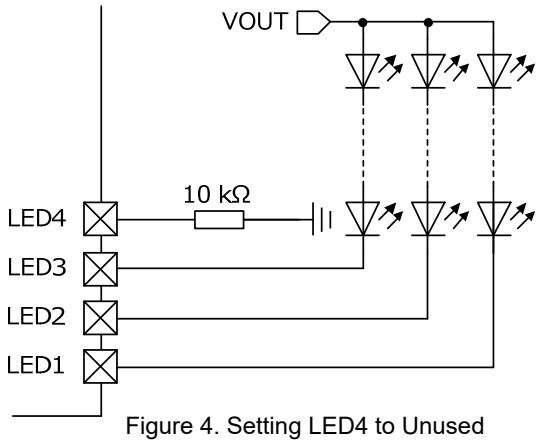

Figure 4. Setting LED4 to Unused

The ISET terminal voltage can be adjusted according to the voltage input to the ADIM terminal.

The LED current can be calculated from the following equation.

$$I_{LED} = \frac{V_{ISET}}{R_{ISET}} \times 10^6 \quad [\text{mA}]$$

$V_{ISET} = 1.21$ [V] (when 1.21 V ≤ V_{ADIM} ≤ V_{REG})

$V_{ISET} = V_{ADIM}$ [V] (when 0.40 V < V_{ADIM} < 1.21 V)

I_{LED} is the output current per 1ch (LED current)

(Recommended operating condition : 20 mA to 120 mA)

V_{ISET} is the ISET pin voltage 1.21 V (Typ)

(When ADIM pin voltage is $V_{ADIM} = V_{REG}$)

R_{ISET} is the LED current setting resistor

(Recommended operating condition : 11kΩ to 53kΩ)

V_{ADIM} is the ADIM pin input voltage

(Recommended operating condition : 0.40 V to V_{REG})

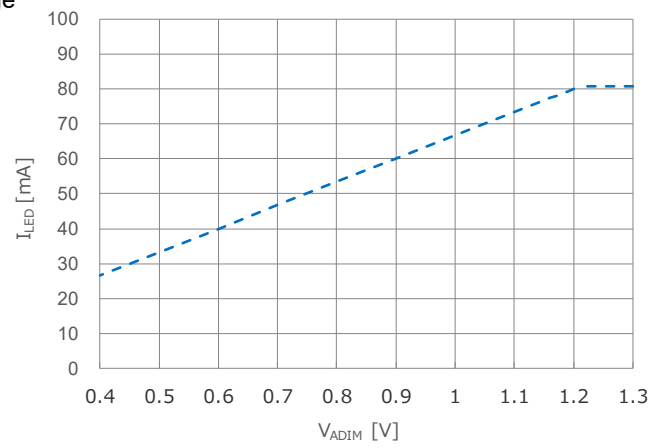

Figure 5. I_{LED} vs V_{ADIM} (R_{ISET} = 15.1 kΩ)

By applying the divided voltage by RADIM2 and RADIM3 of the power supply voltage (shown as VCC) to ADIM terminal, the output current can be reduced at low VCC voltage. This makes it possible to avoid excessive heat generation of the IC and external parts at low VCC voltage. It also avoids the need to select excess high rating external components.

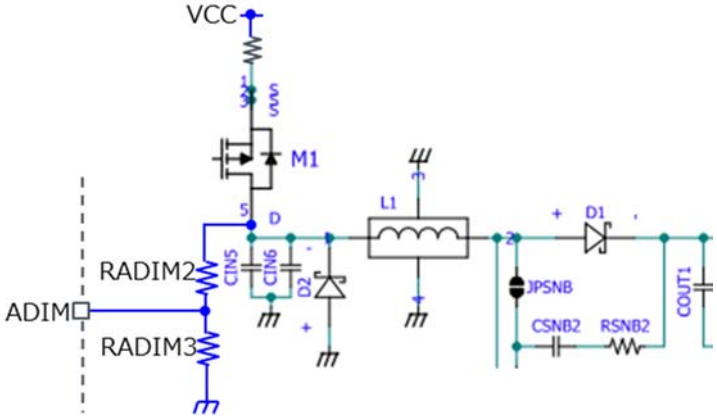

Figure 6. Countermeasure circuit for low power supply voltage
(In cases where RADIM2 is short or RADIM3 is open, a voltage higher than the rating is applied to the ADIM terminal. If necessary, consider measures such as splitting the resistance (RADIM2,3) or adding a diode for protection.)

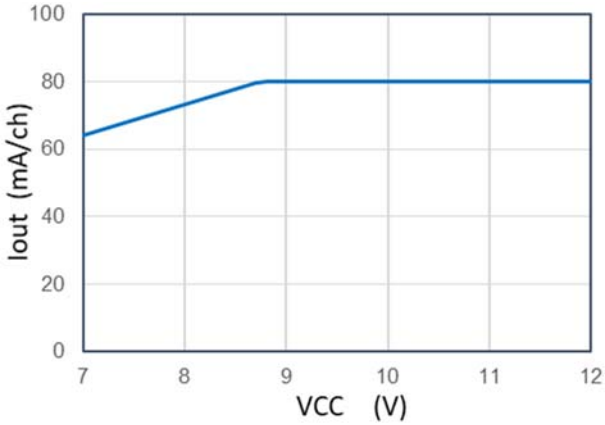

Figure 7. Iout vs VIN
(RADIM2=150kΩ / RADIM3=24kΩ)

Pin configuration

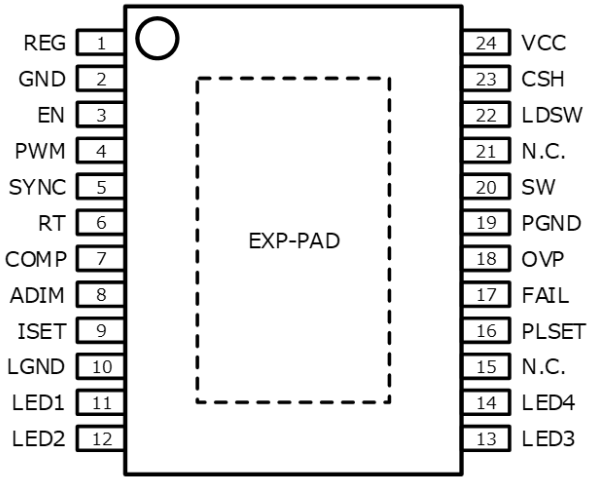

Figure 8. Pin configuration

Evaluation board schematic

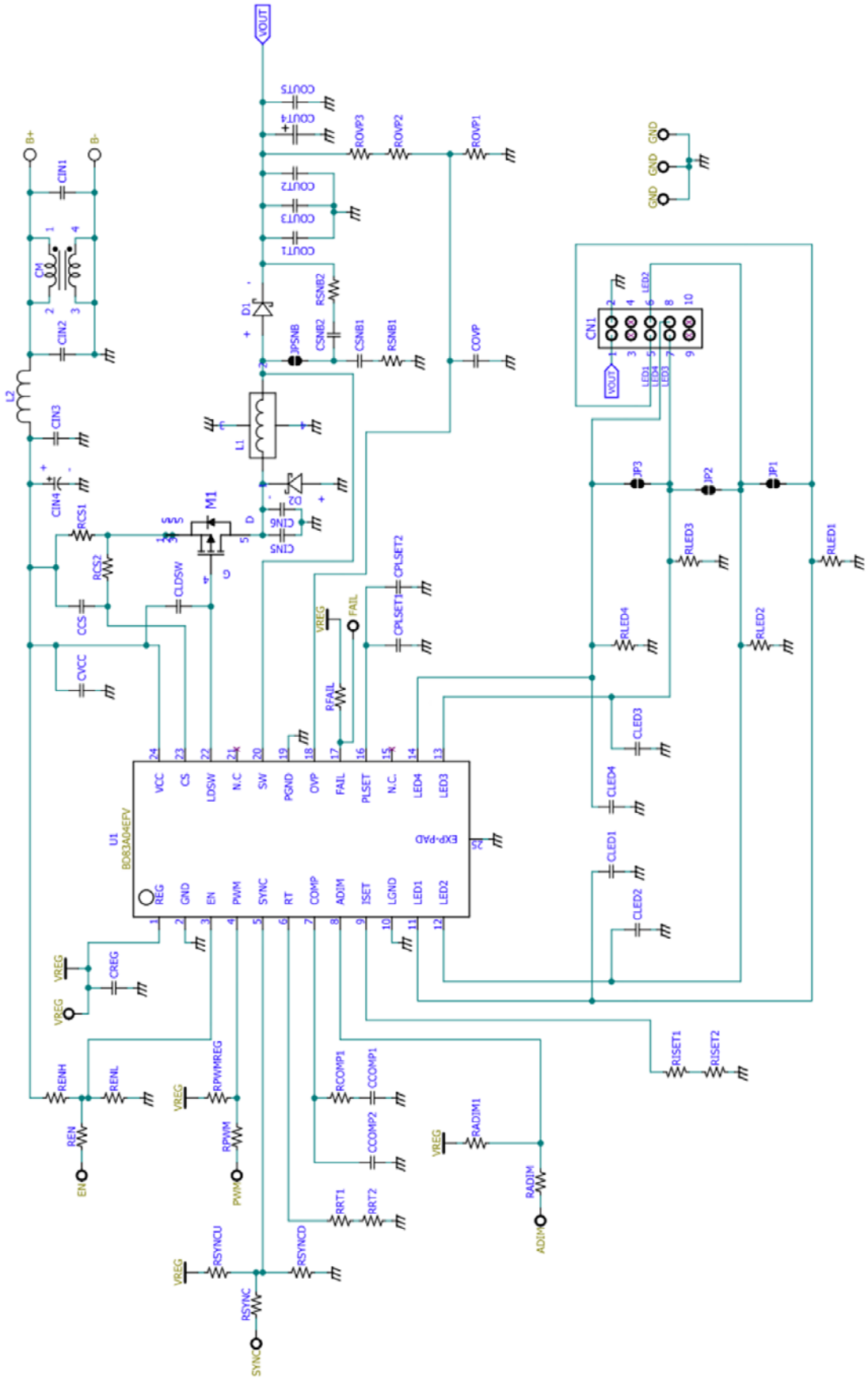

Figure 9. Evaluation board schematic

Parts list 1

Table 3. Parts list

No	Package	Parameters	Part name(series)	Type	Manufacturer
CIN1	-	Open	-	-	-
CIN2	3225	10μF, X7S, 50V	GCM32EC71H106KA01	Ceramic	Murata
CIN3	1608	0.01μF, R, 50V	GCM188R11H103KA01	Ceramic	Murata
CIN4	φ8 x L10mm	220uF/35V	UCD1V221MNL1GS	Electrolytic	Nichicon
CIN5	1005	0.1μF, X7S, 50V	GCM155R71H104KE37	Ceramic	Murata
CIN6	3225	10μF, X7S, 50V	GCM32EC71H106KA01	Ceramic	Murata
CVCC	2012	1μF, X7S, 50V	GCM21BR71H105KA01	Ceramic	Murata
CM	-	-	-	-	-
RCS1	1632	15mΩ	LTR18	Resistor	Rohm
RCS2	1608	100Ω	MCR03 series	Resistor	Rohm
CCS	1608	100pF	GCM1882C1H101JA01	Ceramic	Murata
CLDSW	1608	100pF	GCM1882C1H101JA01	Ceramic	Murata
RCOMP1	1608	100Ω	MCR03 series	Resistor	Rohm
CCOMP1	2012	1μF, X7S, 50V	GCM21BR71H105KA01	Ceramic	Murata
CCOMP2	-	Open	-	-	-
RRT1	1608	27kΩ, 1/10W	MCR03 series	Resistor	Rohm
RRT2	-	Open	-	-	-
RFAIL	1608	100kΩ, 1/10W	MCR03 series	Resistor	Rohm
CREG	1608	2.2μF, X7R, 6.3V	GCM188R70J225KE21	Ceramic	Murata
L1	W7.0×L7.4×H4.5mm	22μH	SPM7054VT-220M	Inductor	TDK
M1 *1	W3.3×L3.3×H0.8mm	-40V/-27A	RQ3G270BJ	MOSFET	Rohm
L2	W6.3×L6.0×H4.5mm	3.3μH	CLF6045NIT-3R3N-D	Inductor	TDK
D1	W4.7×L2.5×H0.95mm	60V/5A	RB088LAM-60	SBD	Rohm
D2	W3.5×L1.6×H0.8mm	60V/1A	RBR1MM60ATF	SBD	Rohm
COUT1	1005	0.01μF, R, 50V	GCM155R11H103KA40	Ceramic	Murata
COUT2	1005	0.1μF, X7S, 50V	GCM155R71H104KE37	Ceramic	Murata
COUT3	3225	10μF, X7S, 50V	GCM32EC71H106KA01	Ceramic	Murata
COUT4	φ6.3 x L7.7mm	33μF/50V	50HVPF33M	Hybrid	SunCon
COUT5	1005	0.1μF, X7S, 50V	GCM155R71H104KE37	Ceramic	Murata
ROVP1	1608	10kΩ, 1/10W	MCR03 series	Resistor	Rohm
ROVP2	-	Short	-	-	-
ROVP3	1608	330kΩ, 1/10W	MCR03 series	Resistor	Rohm
COVP	-	Open	-	-	-
RISET1	1608	15kΩ, 1/10W	MCR03 series	Resistor	Rohm
RISET2	-	Short	-	-	-
CPLSET1	-	Open	-	-	-
CPLSET2	1005	1500pF, R, 50V	GCM155R11H152KA01	Ceramic	Murata

*1 The land pattern of M1 is SOT-669 (5mm x 6mm).

Parts list 1 - continued

Table 3. Parts list - continued

No	Package	Parameters	Part name(series)	Type	Manufacturer
JPSNB	-	Open	-	-	-
CSNB1	-	Open	-	-	-
RSNB1	-	Open	-	-	-
CSNB2	-	Open	-	-	-
RSNB2	-	Open	-	-	-
CLED1	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CLED2	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CLED3	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CLED4	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
REN	-	Short	-	-	-
RENH	-	Open	-	-	-
RENL	-	Open	-	-	-
RSYNC	-	Open	-	-	-
RSYNCU	-	Short	-	-	-
RSYNCD	-	Open	-	-	-
RPWMREG	-	Open	-	-	-
RPWM	-	Short	-	-	-
RADIM	-	Open	-	-	-
RADIM1	-	Short	-	-	-
RLED1	-	Open	-	-	-
RLED2	-	Open	-	-	-
RLED3	-	Open	-	-	-
RLED4	-	Open	-	-	-
JP1	-	Open	-	-	-
JP2	-	Open	-	-	-
JP3	-	Open	-	-	-

Parts list 2 (Countermeasure circuit for low power supply voltage)

Table 4. Parts list

No	Package	Parameters	Part name(series)	Type	Manufacturer
CIN1	-	Open	-	-	-
CIN2	3225	10μF, X7S, 50V	GCM32EC71H106KA01	Ceramic	Murata
CIN3	1608	0.01μF, R, 50V	GCM188R11H103KA01	Ceramic	Murata
CIN4	φ8 x L10mm	220uF/35V	UCD1V221MNL1GS	Electrolytic	Nichicon
CIN5	1005	0.1μF, X7S, 50V	GCM155R71H104KE37	Ceramic	Murata
CIN6	3225	10μF, X7S, 50V	GCM32EC71H106KA01	Ceramic	Murata
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CCS	1608	100pF	GCM1882C1H101JA01	Ceramic	Murata
CLDSW	1608	100pF	GCM1882C1H101JA01	Ceramic	Murata
RCOMP1	1608	100Ω	MCR03 series	Resistor	Rohm
CCOMP1	2012	1μF, X7S, 50V	GCM21BR71H105KA01	Ceramic	Murata
CCOMP2	-	Open	-	-	-
RRT1	1608	27kΩ, 1/10W	MCR03 series	Resistor	Rohm
RRT2	-	Open	-	-	-
RFAIL	1608	100kΩ, 1/10W	MCR03 series	Resistor	Rohm
CREG	1608	2.2μF, X7R, 6.3V	GCM188R70J225KE21	Ceramic	Murata
L1	W7.0×L7.4×H4.5mm	22μH	SPM7054VT-220M	Inductor	TDK
M1 *1	W3.3×L3.3×H0.8mm	-40V/-27A	RQ3G270BJ	MOSFET	Rohm
L2	W6.3×L6.0×H4.5mm	3.3μH	CLF6045NIT-3R3N-D	Inductor	TDK
D1	W4.7×L2.5×H0.95mm	60V/5A	RB088LAM-60	SBD	Rohm
D2	W3.5×L1.6×H0.8mm	60V/1A	RBR1MM60ATF	SBD	Rohm
COUT1	1005	0.01μF, R, 50V	GCM155R11H103KA40	Ceramic	Murata
COUT2	1005	0.1μF, X7S, 50V	GCM155R71H104KE37	Ceramic	Murata
COUT3	3225	10μF, X7S, 50V	GCM32EC71H106KA01	Ceramic	Murata
COUT4	φ6.3 x L7.7mm	33μF/50V	50HVPF33M	Hybrid	SunCon
COUT5	1005	0.1μF, X7S, 50V	GCM155R71H104KE37	Ceramic	Murata
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ROVP2	-	Short	-	-	-
ROVP3	1608	330kΩ, 1/10W	MCR03 series	Resistor	Rohm
COVP	-	Open	-	-	-
RISET1	1608	15kΩ, 1/10W	MCR03 series	Resistor	Rohm
RISET2	-	Short	-	-	-
CPLSET1	-	Open	-	-	-
CPLSET2	1005	1500pF, R, 50V	GCM155R11H152KA01	Ceramic	Murata

*1 The land pattern of M1 is SOT-669 (5mm x 6mm).

Parts list 2 - continued

Table 4. Parts list - continued

No	Package	Parameters	Part name(series)	Type	Manufacturer
JPSNB	-	Open	-	-	-
CSNB1	-	Open	-	-	-
RSNB1	-	Open	-	-	-
CSNB2	-	Open	-	-	-
RSNB2	-	Open	-	-	-
CLED1	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CLED2	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CLED3	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CLED4	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
REN	-	Short	-	-	-
RENH	-	Open	-	-	-
RENL	-	Open	-	-	-
RSYNC	-	Open	-	-	-
RSYNCU	-	Short	-	-	-
RSYNCD	-	Open	-	-	-
RPWMREG	-	Open	-	-	-
RPWM	-	Short	-	-	-
RADIM	-	Open	-	-	-
RADIM1	-	Open	-	-	-
RLED1	-	Open	-	-	-
RLED2	-	Open	-	-	-
RLED3	-	Open	-	-	-
RLED4	-	Open	-	-	-
JP1	-	Open	-	-	-
JP2	-	Open	-	-	-
JP3	-	Open	-	-	-
RADIM2 *1	1005	150kΩ	MCR01 series	Resistor	Rohm
RADIM3 *1	1005	24kΩ	MCR01 series	Resistor	Rohm

*1 There is no mounting pattern for RADIM2 and RADIM3. Please refer to the Figure 6 (P.4).

Board layout

Evaluation board PCB information

Material	FR-4 High TG
Board thickness	1.6mm
Copper thickness	1 oz
Number of layers	4
Board size	60X90mm
Minimum copper width	0.15mm
Minimum air gap	0.15mm
Minimum hole size	0.3mm

The layout of BD83A04EFV-M is shown below.

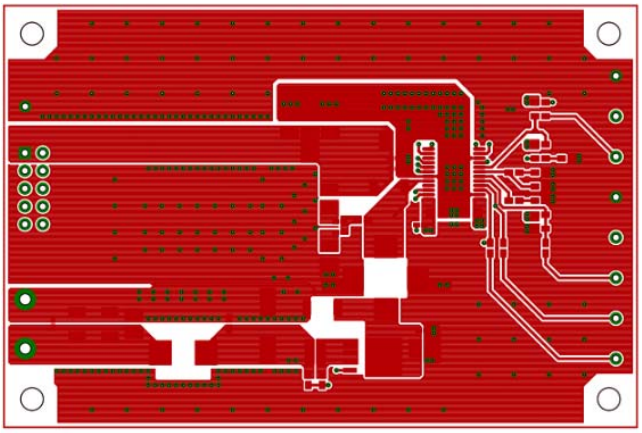

Figure 10. Top layer layout
(Top view)

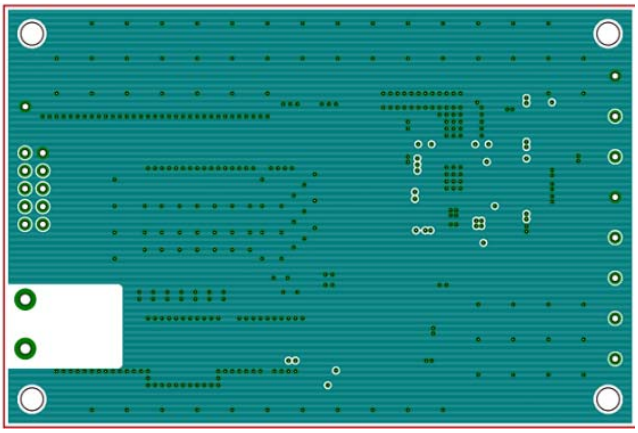

Figure 11. 2nd layer layout
(Top view)

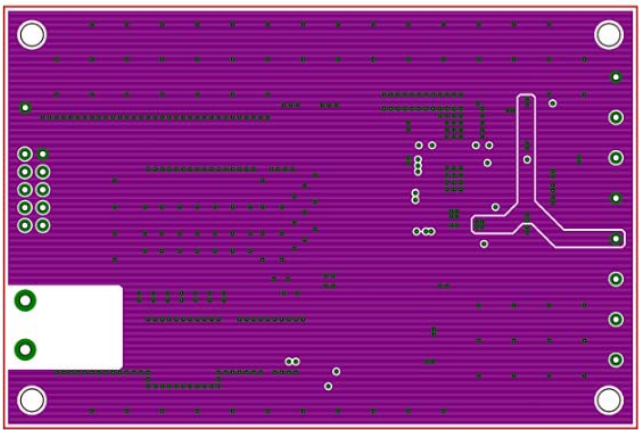

Figure 12. 3rd layer layout
(Top view)

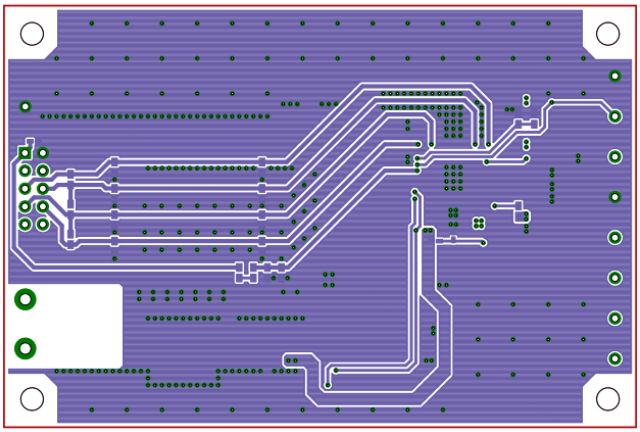

Figure 13. Bottom layer layout
(Top view)

Reference application data 1

(Ta=25°C, Output voltage=28V, Iout=80mA x 4ch, refer Parts list 1)

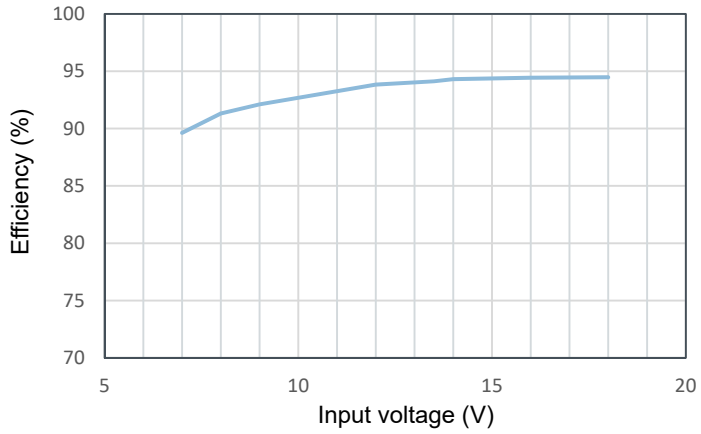

Figure 14. Efficiency vs Input voltage

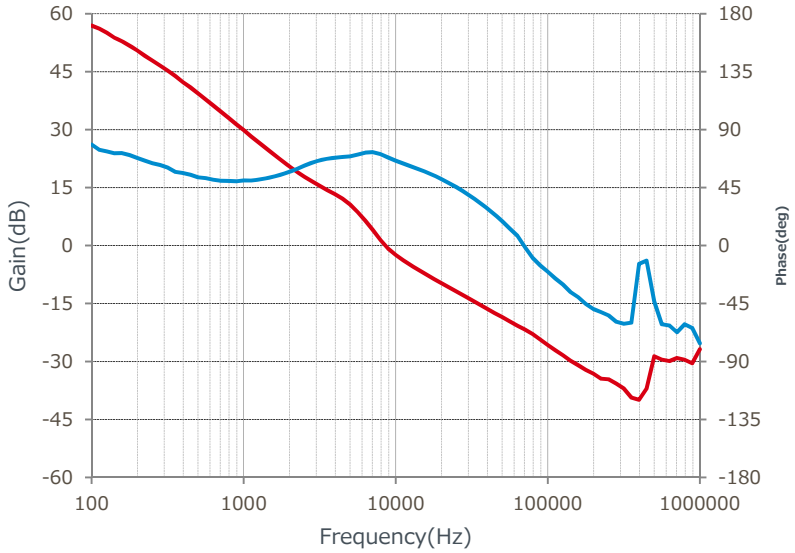

Figure 15. Gain, Phase vs Frequency (VIN=13.5V)

Reference application data 2 (Countermeasure circuit for low power supply voltage)

(Ta=25°C, Output voltage=34V, Iout=80mA x 4ch, refer Parts list 2)

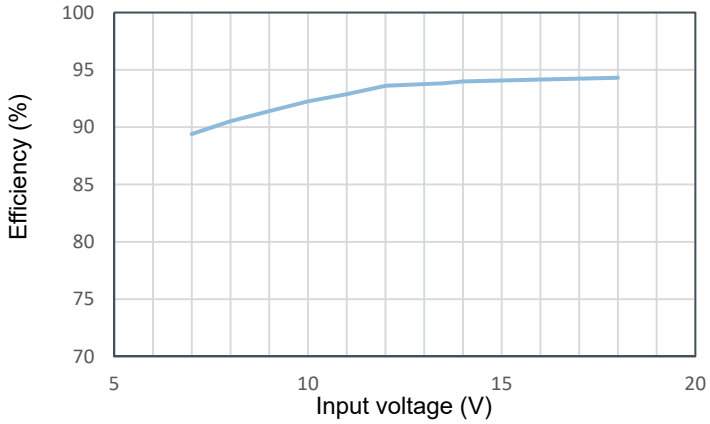

Figure 16. Efficiency vs Input voltage

(Countermeasure circuit for low power supply voltage)

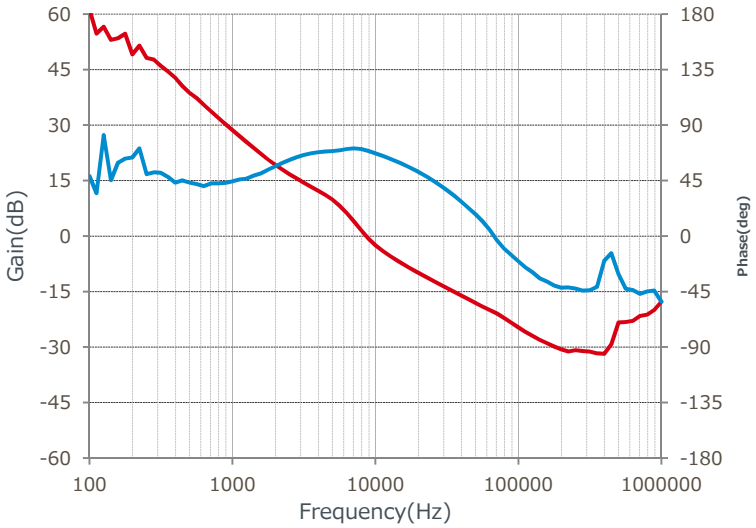

Figure 17. Gain, Phase vs Frequency (VIN=13.5V)

(Countermeasure circuit for low power supply voltage)

Revision history

Date	Revision number	Description
31. Mar. 2022	001	Initial release
2. Dec. 2022	002	P.6 Changed part mane of M1 P.8 Changed part mane of M1
12. Jul. 2023	003	P.6 Changed about CIN2 P.7 Changed about REN, RENH, RENL, RPWMREG, RPWM P.8 Changed about CIN2 P.9 Changed about REN, RENH, RENL, RPWMREG, RPWM P.10 Changed board information and layout

Notice

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