6-Channel Charge Pump White LED Driver with 64 Dimming Steps and I2C Compatible Interface

BD2606MVV Evaluation Board

BD2606MVV-TSB-001 (2.7V to 5.5V Input, 120mA)

Introduction

This user's guide will provide the necessary steps to operate the Evaluation Boards of ROHM's BD2606MVV LED Driver. This includes the external parts, operating procedures and application data.

Description

This Evaluation Board was developed for ROHM's BD2606MVV 6-Channel Charge Pump White LED Driver with multi-level brightness Control. This multi-level brightness control white LED driver not only ensures efficient boost by automatically changing the boost rate but also works as a constant current driver in 64 steps, so that the driving current can be adjusted finely. This IC is best suited to turn on white LEDs that require high-accuracy LED brightness control.

Application

This driver is applicable for various fields such as mobile phones, portable game machines and white goods.

Recommended Operating Conditions

Table 1. Recommended Operating Conditions

Parameter	Min	Typ	Max	Units	Conditions
Input Voltage	2.7	3.6	5.5	V	
Charge pump output current	-	-	120	mA	VOUT = 4.0V, VIN = 3.6V
LED current absolute precision	-	-	±6.5	%	ILED = 16.5mA (LEDxCNT Data = 20h), LED pin voltage 1.0 V
LED current relative precision	-	0.5	±3.75	%	ILED = 16.5mA (LEDxCNT Data = 20h), LED pin voltage 1.0 V (Note 1)
LED control voltage	-	0.20	0.25	V	ILEDA*/B*/C*
Oscillation frequency	0.8	1.0	1.2	MHz	Address = 03h, Data D6 = '0' (Note 2)

(Note) Unless otherwise specified, Ta is 25°C and VIN is 3.6V.

(Note 1) LED current relative precision = ((ILEDmax - ILEDmin) / (ILEDmax + ILEDmin)) * 100

ILEDmax : Maximum value among all channels

ILEDmin : Minimum value among all channels

(Note 2) Oscillation frequency can be selected by setting address <Address: 03h, Data: D6>

The switching frequency of a charge pump is set as follows:

'0': 1MHz

'1': 250kHz

When '250kHz' is selected, the flying capacitor of C1, C2 and C3(COUT) must be set to 10µF.

Evaluation Board

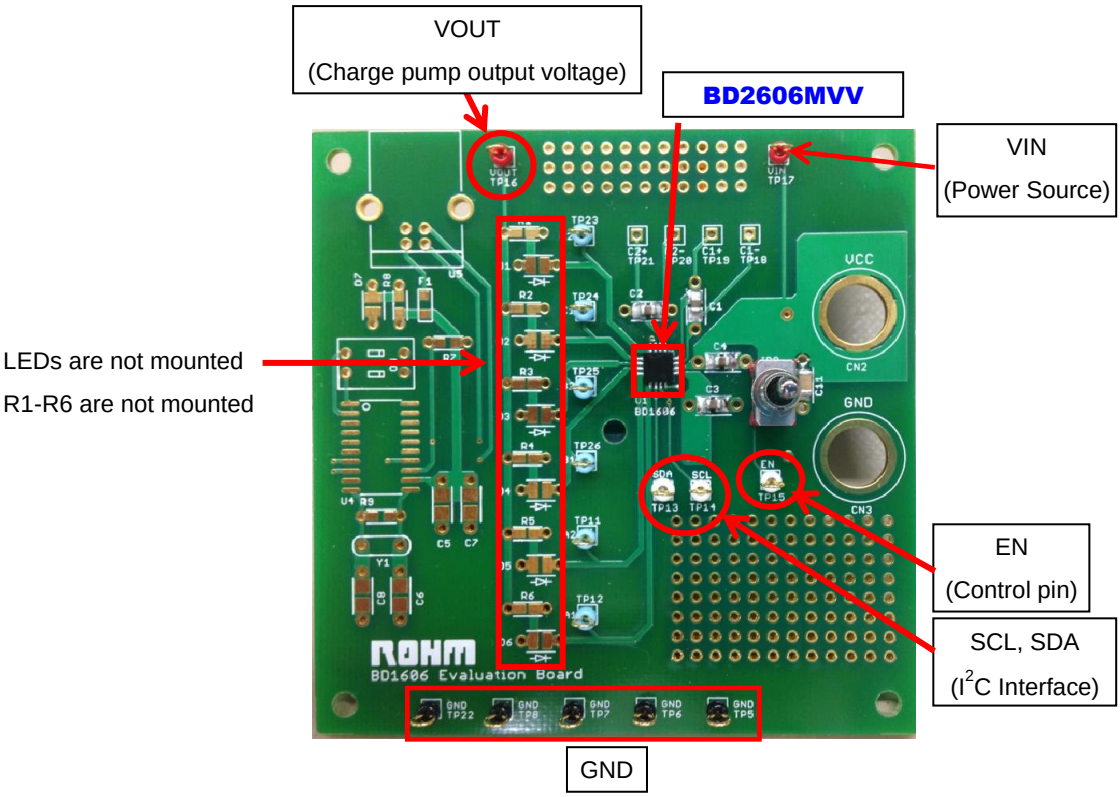


Figure 1. Evaluation Board Top View

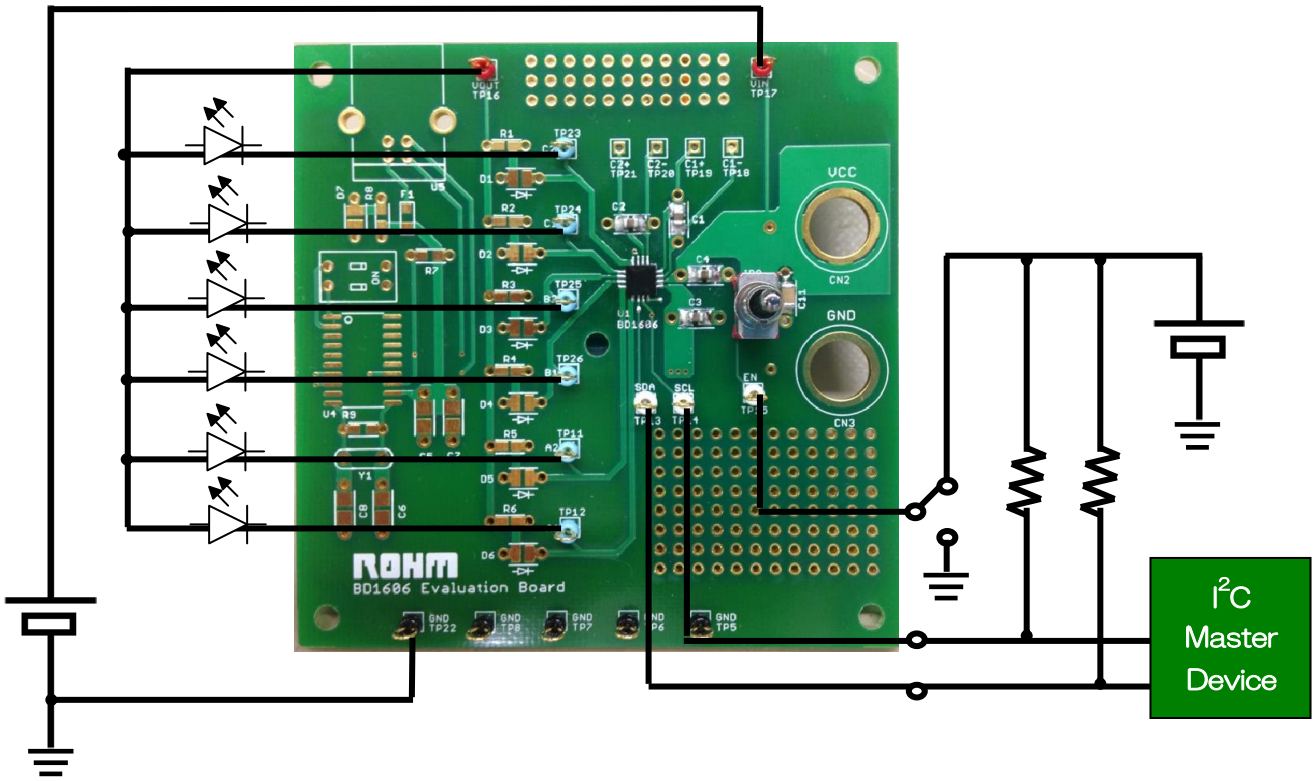


Figure 2. Example of Connection

Schematic

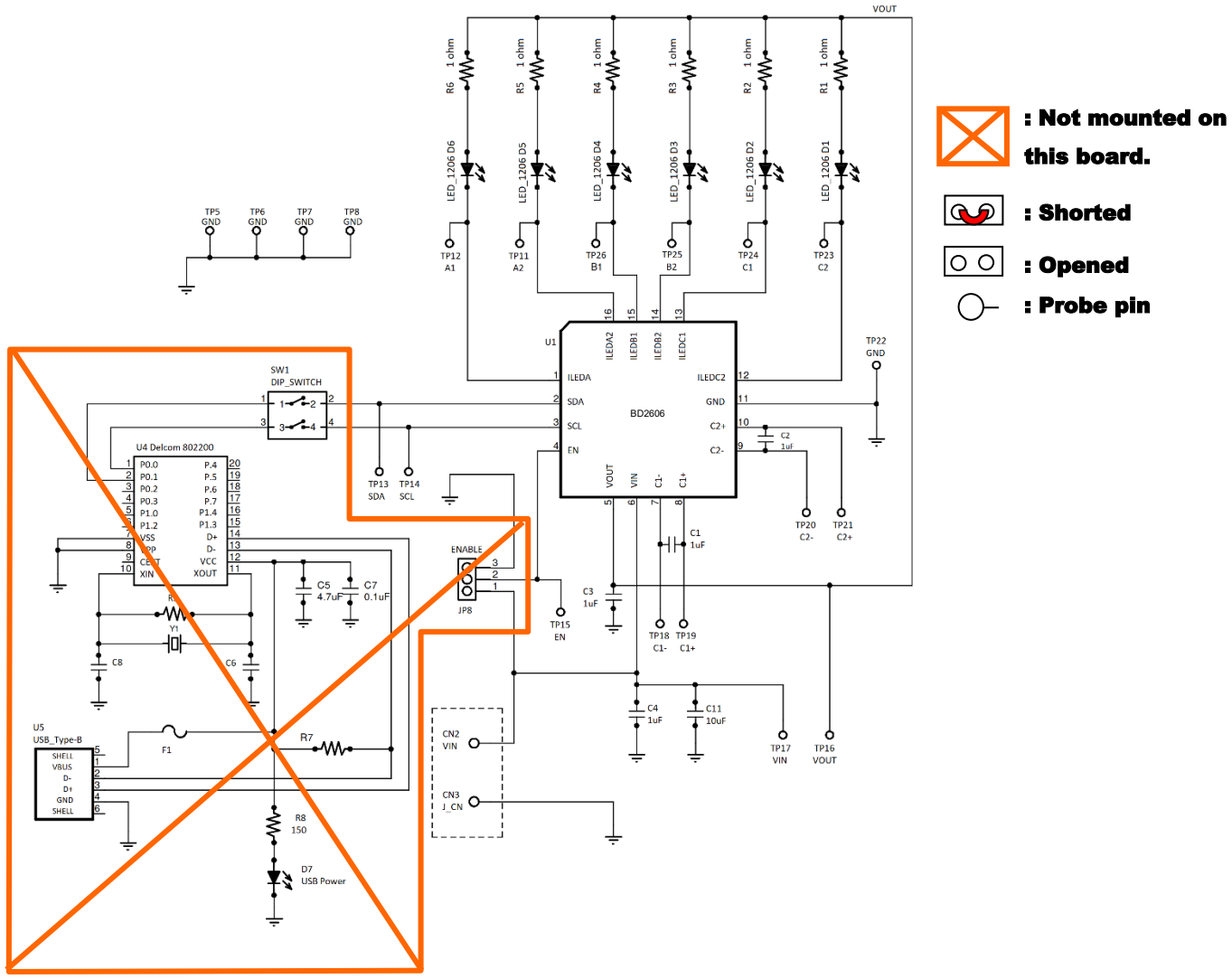


Figure 3. Circuit Diagram

The procedure of how to use the evaluation board:

1. Please connect the power source across VIN and GND pin (Typical VIN = 3.6V).
2. Please connect the I²C master device to SCL and SDA pins.
3. Input 'H' level at EN. (Typical 'H' Level = 1.8V)
   (EN voltage level should be the same as the Pull-up voltage level of the I²C interface.
   When EN is fixed to 'H', register address should be inputted after 350us or more.)
   (Refer to the following figure ①)
4. Please set the LED current.
   (Please set the current value with the register address "00h, 01h, 02h" (refer to register map on page 7)
   (Refer to the following figure ②)
5. Please turn ON the LED and confirm if the LED is lighted.
   (Please set the LED on/off register with the register address 03h.)
   (Refer to the following figure ③)
6. When the LED current setting is changed, the LED brightness changes.
   (Refer to the following figure ④)
7. When EN is set to 'L' (Typical 'L' level = 0.0V) or when all LED registers are set to OFF, the LED will turn OFF. (When EN is set to 'L', the LED ON/OFF register is initialized.)
   (Refer to the following figure ⑤)

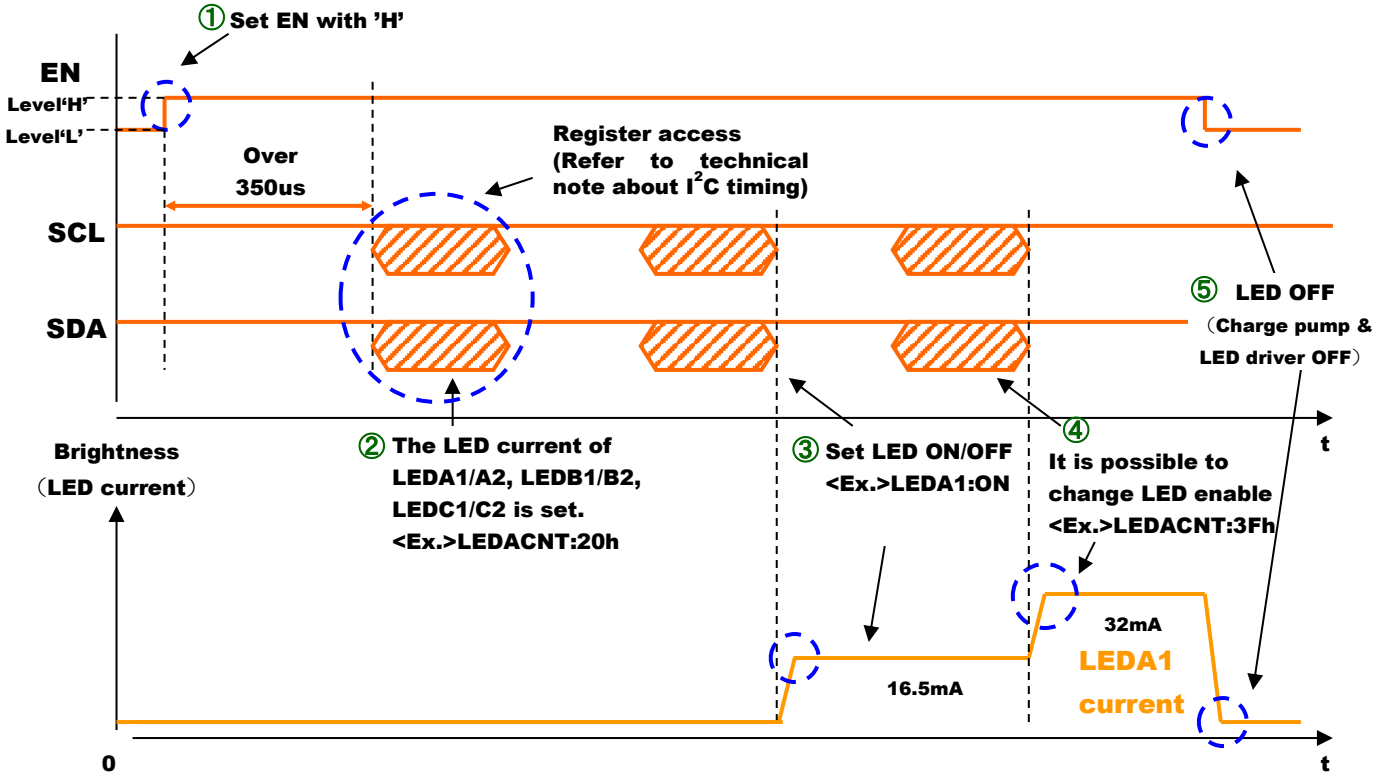


Figure 4. Example of the Procedure

Description of Block Operations

1. LED driver

・I²C BUS interface

BD2606MVV can control the LED ON/OFF, brightness and charge pump switching frequency by writing to the register via the I²C BUS interface. The control by the I²C BUS interface is active when EN is at 'H' level. When EN is at 'L' level, this LSI is completely shut down and control and associated functions via the I²C BUS interface are all stopped.

As shown in Figure 5 below, the I²C BUS interface of BD2606MVV operates using the Ven voltage (buffered EN pin voltage) as supply voltage. For this reason, it is desirable that the 'H' voltage level in the I²C BUS interface is equal to the EN pin voltage.

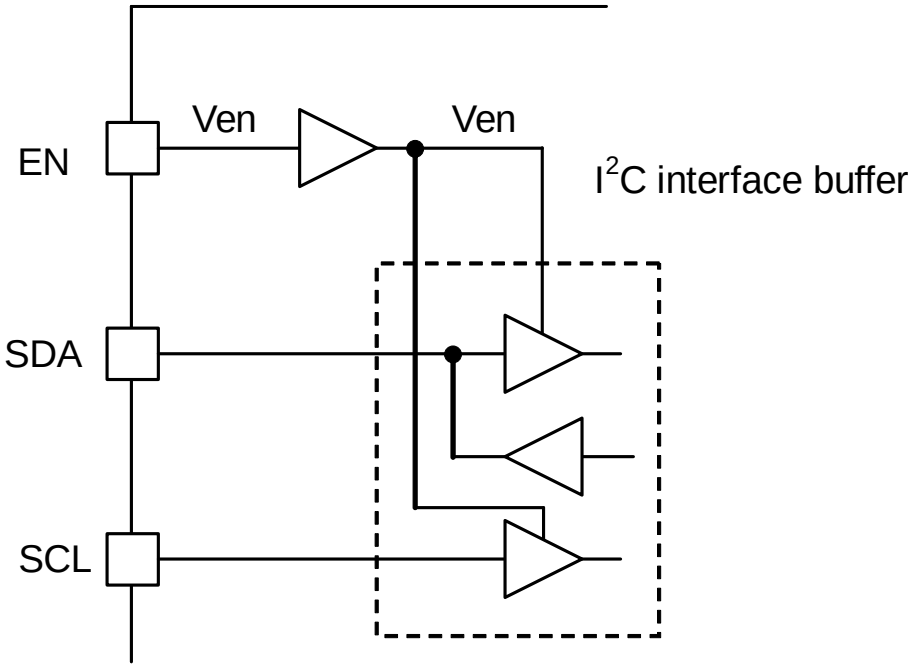


Figure 5. I²C BUS Interface Buffer

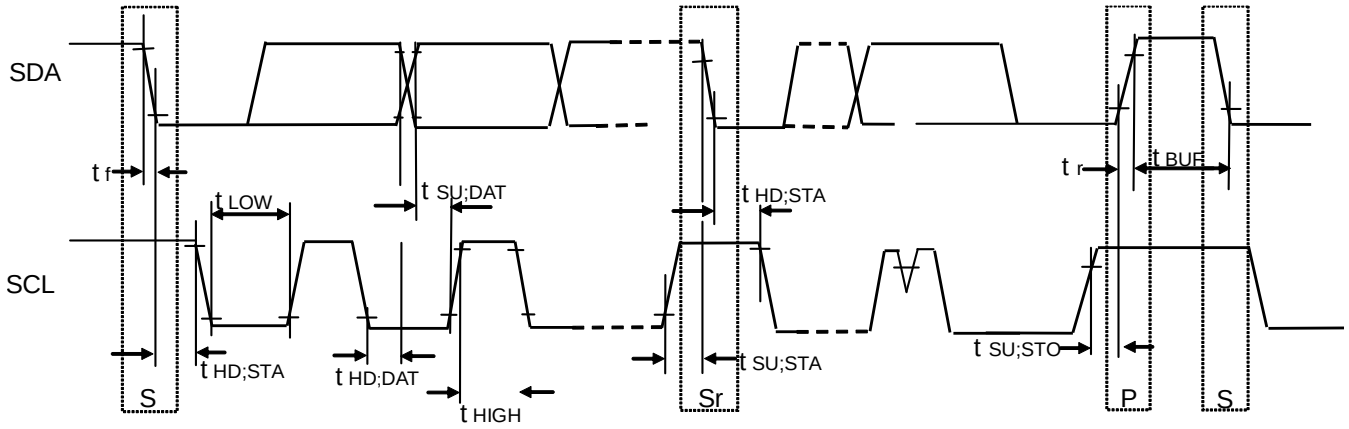


Figure 6. I²C BUS Interface Timing

Serial Interface

BD2606MVV works as slave device of I^2C BUS interface.

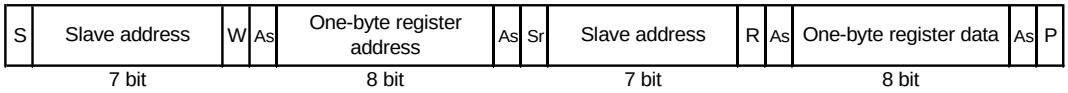
(a) Slave address

A7	A6	A5	A4	A3	A2	A1	R/W
1	1	0	0	1	1	0	1/0

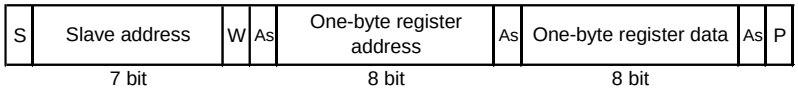
(b) Data format

The data format is shown below.

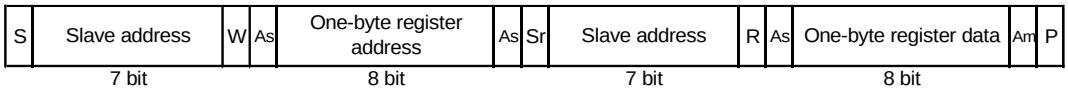
Write format:



Or



Read format:



(Note) S: Start condition

W: '0 = Write

R: '1 = Read

As: Acknowledge (slave -> master)

Am: No acknowledge

Sr: Repeated start condition

P: Stop condition

Register Map

(a) Register map

Address (Hex)	Register Name	R/W	D7	D6	D5	D4	D3	D2	D1	D0	Function
00h	LEDACNT	R/W	-	-	LEDACNT						ILEDA1/2 current setting
01h	LEDBCNT	R/W	-	-	LEDBCNT						ILEDB1/2 current setting
02h	LEDCCNT	R/W	-	-	LEDCCNT						ILEDC1/2 current setting
03h	LEDPWRCNT	R/W	-	FREQ CNT1/0	LEDC2	LEDC1	LEDB2	LEDB1	LEDA2	LEDA1	Current driver ON/OFF control

(Note) '-': Invalid at write time

'-': 'L' at read time

(b) Description of registers

*LEDACNT (initial value: undefined) --- <Address: 00h, Data: [D5:D0]>

*LEDBCNT (initial value: undefined) --- <Address: 01h, Data: [D5: D0]>

*LEDCCNT (initial value: undefined) --- <Address: 02h, Data: [D5: D0]>

LED current values are controlled. LEDA1/A2, LEDB1/B2 and LEDC1/C2 are controlled via the registers LEDACNT, LEDBCNT and LEDCCNT respectively, and 2 channels can be set at the same time using one current setting register. For the current setting value in each register setting, please refer to 'LED Current Setting Table' on Table 2.

*LEDA1 (initial value: '0) --- <Address: 03h, Data: D0>

*LEDA2 (initial value: '0) --- <Address: 03h, Data: D1>

*LEDB1 (initial value: '0) --- <Address: 03h, Data: D2>

*LEDB2 (initial value: '0) --- <Address: 03h, Data: D3>

*LEDC1 (initial value: '0) --- <Address: 03h, Data: D4>

*LEDC2 (initial value: '0) --- <Address: 03h, Data: D5>

The ON/OFF setting of each LED driver channel is as follows:

'0': OFF

'1': ON

*FREQCNT (initial value: '0) --- <Address: 03h, Data: D6>

The switching frequency of a charge pump is set as follows:

'0': 1MHz

'1': 250kHz

When '250kHz' is selected, the flying capacitors C1, C2, and C3(COUT) must be set to 10µF.

(c) LED current setting table

The following table lists the current setting values in respective register settings.

Table 2. LED Current Setting Table

D5	D4	D3	D2	D1	D0	Output current (mA)	D5	D4	D3	D2	D1	D0	Output current (mA)
0	0	0	0	0	0	0.5	1	0	0	0	0	0	16.5
0	0	0	0	0	1	1.0	1	0	0	0	0	1	17.0
0	0	0	0	1	0	1.5	1	0	0	0	1	0	17.5
0	0	0	0	1	1	2.0	1	0	0	0	1	1	18.0
0	0	0	1	0	0	2.5	1	0	0	1	0	0	18.5
0	0	0	1	0	1	3.0	1	0	0	1	0	1	19.0
0	0	0	1	1	0	3.5	1	0	0	1	1	0	19.5
0	0	0	1	1	1	4.0	1	0	0	1	1	1	20.0
0	0	1	0	0	0	4.5	1	0	1	0	0	0	20.5
0	0	1	0	0	1	5.0	1	0	1	0	0	1	21.0
0	0	1	0	1	0	5.5	1	0	1	0	1	0	21.5
0	0	1	0	1	1	6.0	1	0	1	0	1	1	22.0
0	0	1	1	0	0	6.5	1	0	1	1	0	0	22.5
0	0	1	1	0	1	7.0	1	0	1	1	0	1	23.0
0	0	1	1	1	0	7.5	1	0	1	1	1	0	23.5
0	0	1	1	1	1	8.0	1	0	1	1	1	1	24.0
0	1	0	0	0	0	8.5	1	1	0	0	0	0	24.5
0	1	0	0	0	1	9.0	1	1	0	0	0	1	25.0
0	1	0	0	1	0	9.5	1	1	0	0	1	0	25.5
0	1	0	0	1	1	10.0	1	1	0	0	1	1	26.0
0	1	0	1	0	0	10.5	1	1	0	1	0	0	26.5
0	1	0	1	0	1	11.0	1	1	0	1	0	1	27.0
0	1	0	1	1	0	11.5	1	1	0	1	1	0	27.5
0	1	0	1	1	1	12.0	1	1	0	1	1	1	28.0
0	1	1	0	0	0	12.5	1	1	1	0	0	0	28.5
0	1	1	0	0	1	13.0	1	1	1	0	0	1	29.0
0	1	1	0	1	0	13.5	1	1	1	0	1	0	29.5
0	1	1	0	1	1	14.0	1	1	1	0	1	1	30.0
0	1	1	1	0	0	14.5	1	1	1	1	0	0	30.5
0	1	1	1	0	1	15.0	1	1	1	1	0	1	31.0
0	1	1	1	1	0	15.5	1	1	1	1	1	0	31.5
0	1	1	1	1	1	16.0	1	1	1	1	1	1	32.0

Pin Configuration

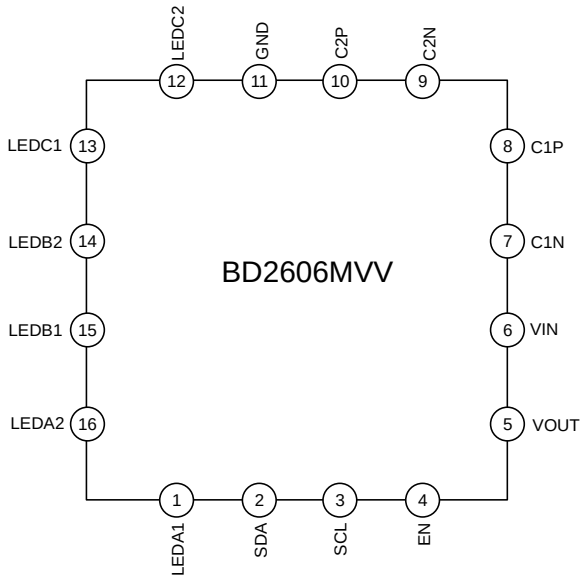


Figure 7. Pin Configuration (Top View)

Pin Description

Table 3. Pin Description

Pin number	Pin name	In/Out	Function	Pin number	Pin name	In/Out	Function
1	LEDA1	Out	LED current driver output	9	C2N	In/Out	Flying capacitor pin negative (-) side
2	SDA	In/Out	I^2C BUS control pin	10	C2P	In/Out	Flying capacitor pin positive (+) side
3	SCL	In	I^2C BUS control pin	11	GND	-	GND
4	EN	In	ON/OFF control	12	LEDC2	Out	LED current driver output
5	VOUT	Out	Charge pump output	13	LEDC1	Out	LED current driver output
6	VIN	-	Power supply	14	LEDB2	Out	LED current driver output
7	C1N	In/Out	Flying capacitor pin negative (-) side	15	LEDB1	Out	LED current driver output
8	C1P	In/Out	Flying capacitor pin positive (+) side	16	LEDA2	Out	LED current driver output
-	Thermal PAD	-	Heat radiation PAD of back side. Connect to GND	-	-	-	-

Parts list

Table 4. Parts List

Part No	Value	Type	Manufacturer
C4(CIN)	1μF	Ceramic Capacitor	Murata
C3(COUT) (Note 1)	1μF	Ceramic Capacitor	Murata
C1 (Note 1)	1μF	Ceramic Capacitor	Murata
C2 (Note 1)	1μF	Ceramic Capacitor	Murata
C11	10μF	Ceramic Capacitor	Murata
D1, D2, D3, D4, D5, D6	LED_1206	Resistor	ROHM
R1, R2, R3, R4, R5, R6	1Ω	Resistor	ROHM
U1	BD2606MVV	IC	ROHM
TP11	A2	Check Pin	-
TP12	A1	Check Pin	-
TP23	C2	Check Pin	-
TP24	C1	Check Pin	-
TP25	B2	Check Pin	-
TP26	B1	Check Pin	-
TP13	SDA	Check Pin	-
TP14	SCL	Check Pin	-
TP15	EN	Check Pin	-
TP5	GND	Check Pin	-
TP6	GND	Check Pin	-
TP7	GND	Check Pin	-
TP8	GND	Check Pin	-
TP22	GND	Check Pin	-
TP16	VOUT	Check Pin	-
TP17	VIN	Check Pin	-

(Note 1) When switching frequency '250kHz' is selected by setting <Address: 03h, Data: D6 = '1'>, the flying capacitor of C1, C2 and C3(COUT) must be set to 10μF.

When different parts from those included in Table 4 will be used, please select equivalent parts.

Board Layout

Evaluation Board PCB information

Number of Layers	Material	Board Size	Copper Thickness
2	FR4	80mm x 80mm x 1.6mm	1.0 oz.

The layout pattern of BD2606MVV is shown below.

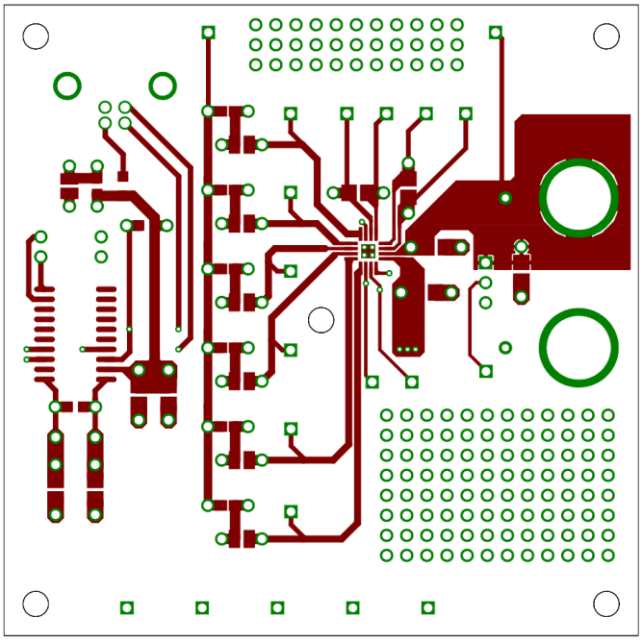


Figure 8. Top Layer Layout
(Top View)

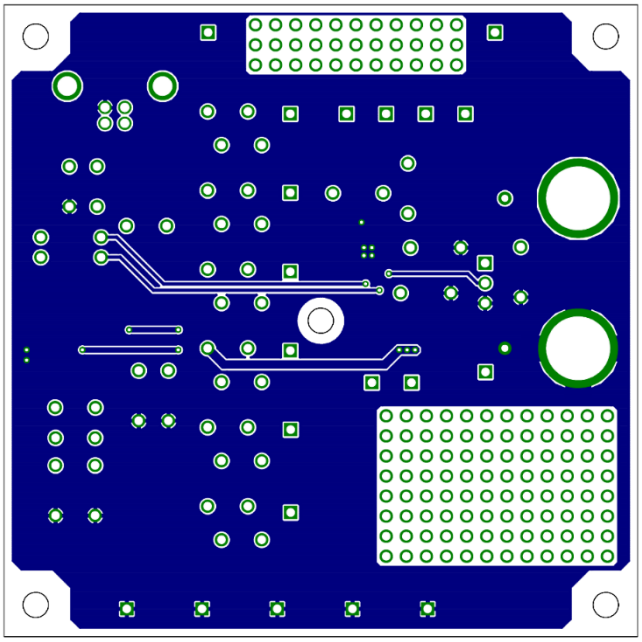


Figure 9. Bottom Layer Layout
(Top View)

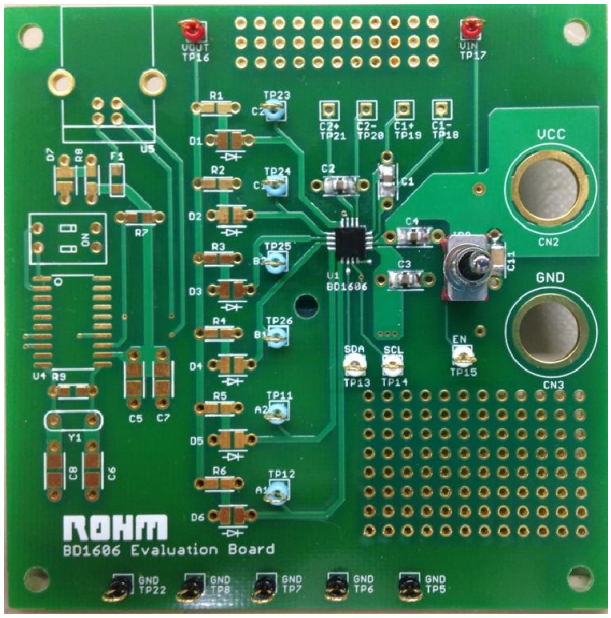


Figure 10. Evaluation Board
(Top View)

Reference Application Data

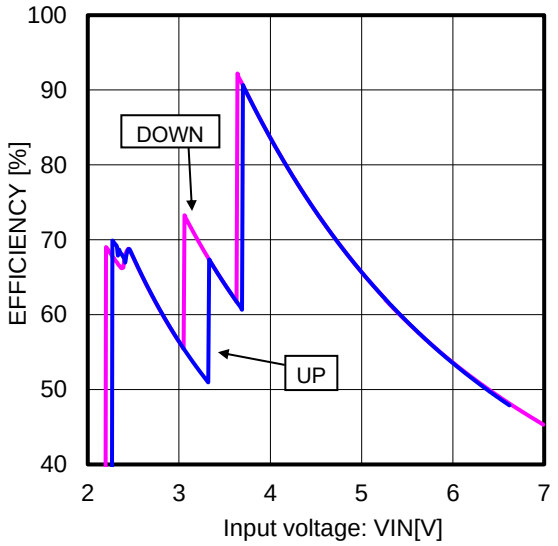


Figure 11. Efficiency Hysteresis
(13mA x 6 Lights)

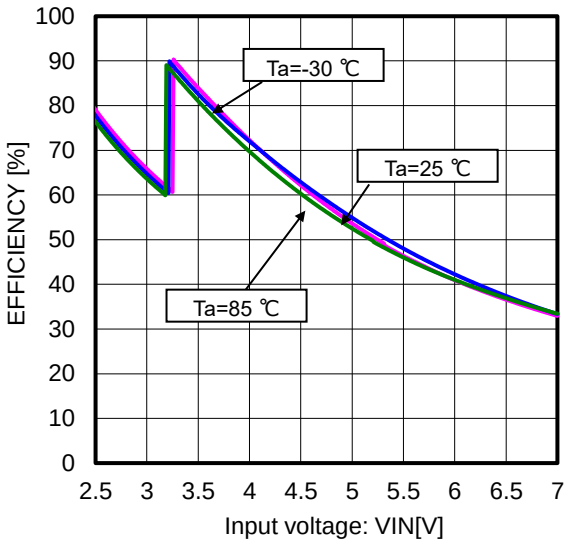


Figure 12. Efficiency
(3.5mA x 6 Lights)

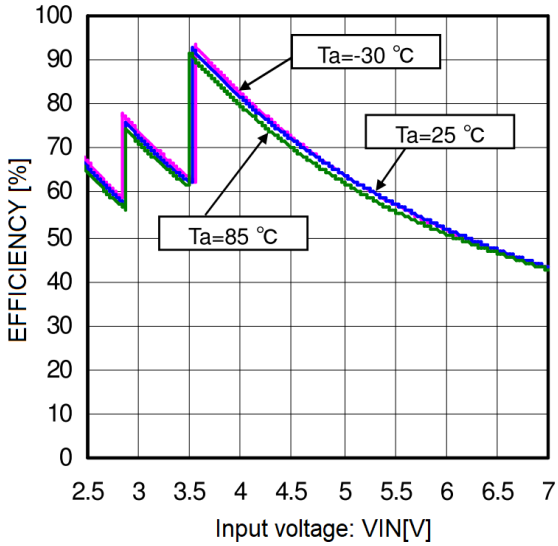


Figure 13. Efficiency
(10mA x 6 Lights)

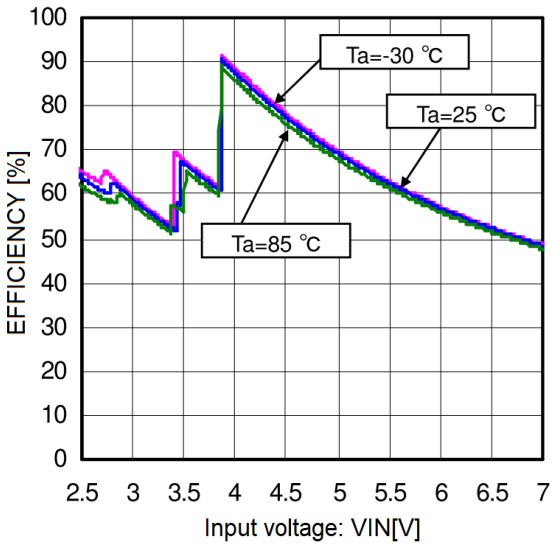


Figure 14. Efficiency
(20mA x 6 Lights)

● **Reference Application Data – continued**

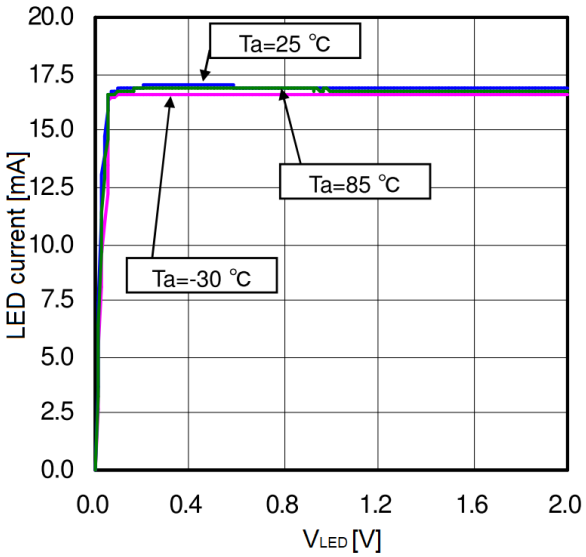


Figure 15. LED Current Characteristics
(LED current 16.5mA)

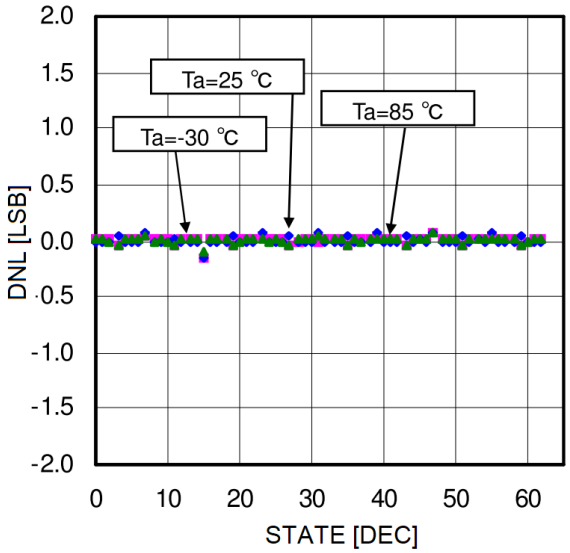


Figure 16. LED Current Characteristics
(Differential Linearity Error)

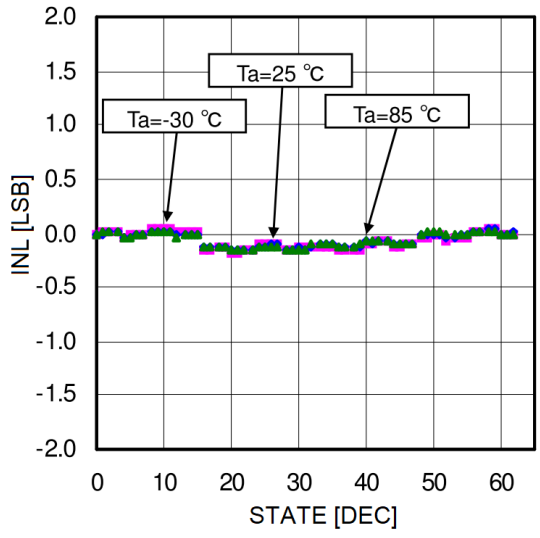


Figure 17. LED Current Characteristics
(Integral Linearity Error)

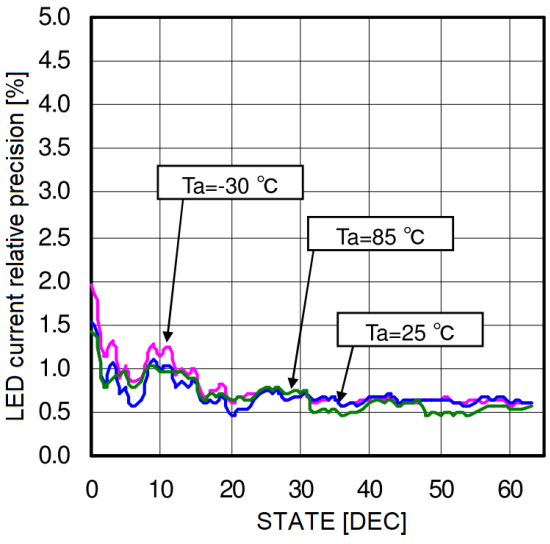


Figure 18. LED Current Matching

● **Reference Application Data - continued**

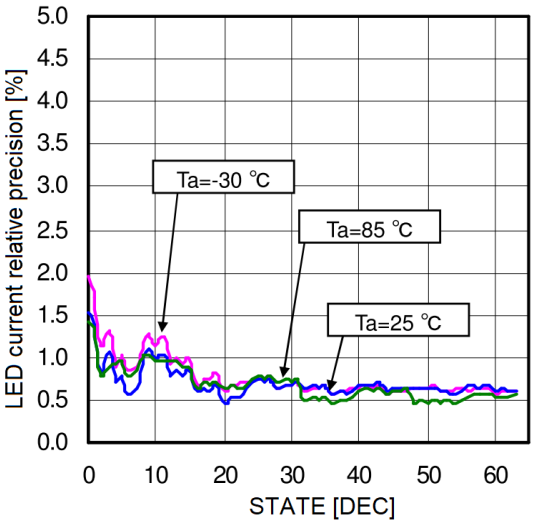


Figure 19. LED Current – Input Voltage
(LED current 16.5mA)

Other application data refer to datasheet.

Revision History

Date	Revision Number	Description
28.July.2021	001	New Release

Notes

1) The information contained herein is subject to change without notice.

2) Before you use our Products, please contact our sales representative and verify the latest specifications :

3) Although ROHM is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors.
Therefore, in order to prevent personal injury or fire arising from failure, please take safety measures such as complying with the derating characteristics, implementing redundant and fire prevention designs, and utilizing backups and fail-safe procedures. ROHM shall have no responsibility for any damages arising out of the use of our Poducts beyond the rating specified by ROHM.

4) Examples of application circuits, circuit constants and any other information contained herein are provided only to illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

5) The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by ROHM or any other parties. ROHM shall have no responsibility whatsoever for any dispute arising out of the use of such technical information.

6) The Products specified in this document are not designed to be radiation tolerant.

7) For use of our Products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a ROHM representative : transportation equipment (i.e. cars, ships, trains), primary communication equipment, traffic lights, fire/crime prevention, safety equipment, medical systems, servers, solar cells, and power transmission systems.

8) Do not use our Products in applications requiring extremely high reliability, such as aerospace equipment, nuclear power control systems, and submarine repeaters.

9) ROHM shall have no responsibility for any damages or injury arising from non-compliance with the recommended usage conditions and specifications contained herein.

10) ROHM has used reasonable care to ensure the accuracy of the information contained in this document. However, ROHM does not warrants that such information is error-free, and ROHM shall have no responsibility for any damages arising from any inaccuracy or misprint of such information.

11) Please use the Products in accordance with any applicable environmental laws and regulations, such as the RoHS Directive. For more details, including RoHS compatibility, please contact a ROHM sales office. ROHM shall have no responsibility for any damages or losses resulting non-compliance with any applicable laws or regulations.

12) When providing our Products and technologies contained in this document to other countries, you must abide by the procedures and provisions stipulated in all applicable export laws and regulations, including without limitation the US Export Administration Regulations and the Foreign Exchange and Foreign Trade Act.

13) This document, in part or in whole, may not be reprinted or reproduced without prior consent of ROHM.

ROHM SEMICONDUCTOR

Thank you for your accessing to ROHM product informations.
More detail product informations and catalogs are available, please contact us.

ROHM Customer Support System

https://www.rohm.com/contact/