2-Channel RGB Charge Pump LED Driver with Illumination BD2812GU Evaluation Board

BD2812GU-TSB-001 (2.7V to 5.5V Input, 30.48mA)

Introduction

This user’s guide will provide the necessary steps to operate the Evaluation Board of ROHM’s BD2812GU LED Driver. This includes the external parts, operating procedures and application data.

Application

- Mobile phone, portable device, home electrical appliance, and general consumer equipment.
- Device provided with LED display application.
- LED display.
- Amusement, Traffic Signboards, hobby, etc.

Description

This Evaluation Board was developed for BD2812GU, ROHM’s 2-Channel RGB LED driver specifically engineered for decoration purposes. This RGB driver incorporates lighting patterns and illuminates without imposing any load on CPU. This RGB driver is best-suited for illumination using RGB LEDs, and decoration using monochrome LEDs. The DC/DC block adopts an inductorless charge pump system. This RGB driver has been miniaturized through the use of a VCSP85H3 (3.1 mm x 3.1 mm x 1.0 mm) chip size package.

Recommended Operating Conditions

Table 1. Recommended Operating Conditions

Parameter	Min	Typ	Max	Units	Conditions
Input Voltage VBAT	2.7	3.6	5.5	V	
VIO pin voltage	1.65	1.8	3.3	V	
LED maximum current	-	-	30.48	mA	RGB1 group, RGB2 group, RGBISET = 100kΩ
LED current step		128		step	RGB1 group, RGB2 group,
LED current accuracy	18	20	22	mA	RGB1 group, RGB2 group, Terminal voltage = 1V, ILED = 20mA setting, RGBISET = 120kΩ
LED current matching	-	5	10	%	Between RGB1 group and RGB2 group, Terminal voltage = 1V, ILED = 20mA setting (Note 1)
Oscillation frequency	0.8	1.0	1.2	MHz	

(Note 1) LED current matching = ((ILEDmax - ILEDmin) / (ILEDmax + ILEDmin)) × 100

ILEDmax : Maximum value of RGB1 group and RGB2 group current

ILEDmin : Minimum value of RGB1 group and RGB2 group current

(Note) Equipped with two LED Driver channels of RGB1 and RGB2 groups, each channel has a slope function that can control the drivers independently. The current value can be set by ILEDmax [A] = 3.048 / RISET [kΩ] (Typ)

(Note) Unless otherwise specified, above conditions are Ta is 25℃, VBAT is 3.6V and VIO is 1.8V.

Evaluation Board

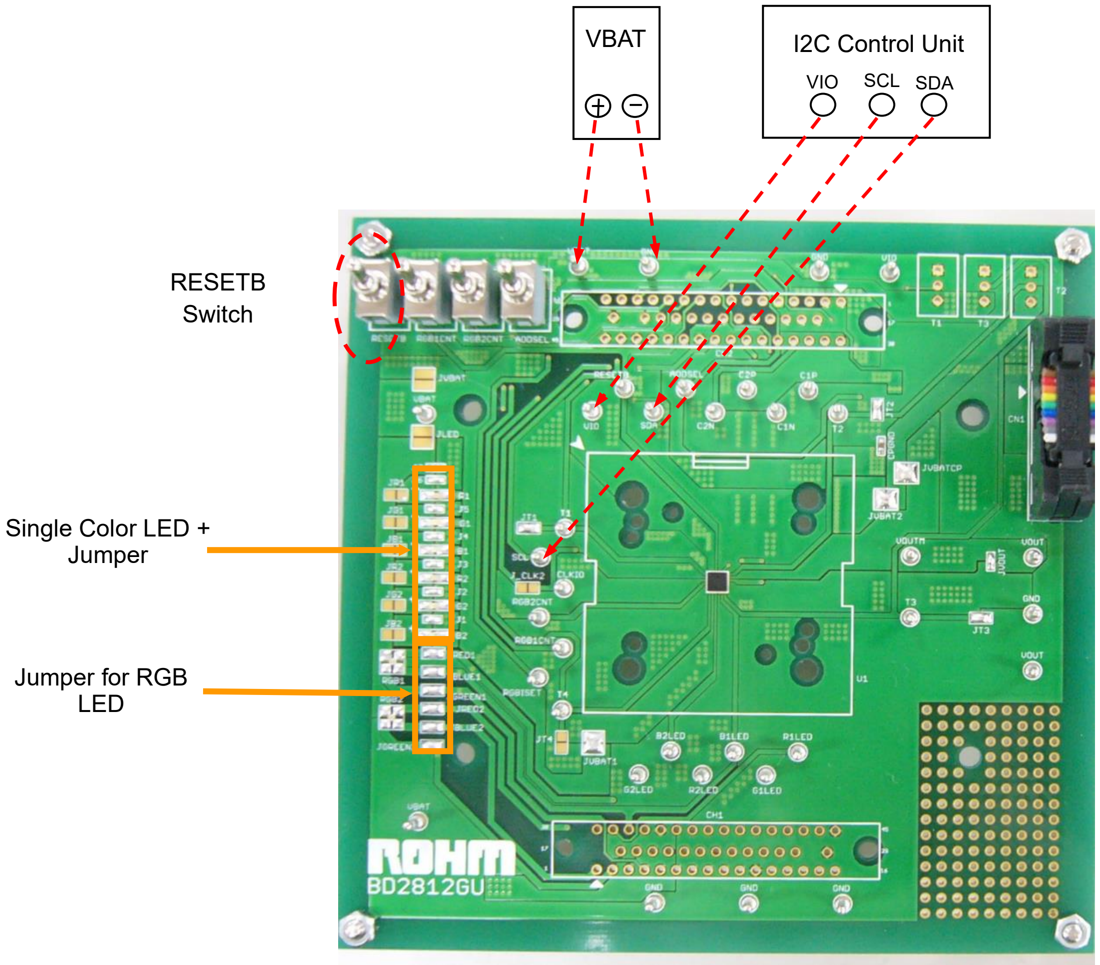


Figure 1. Evaluation Board Top View

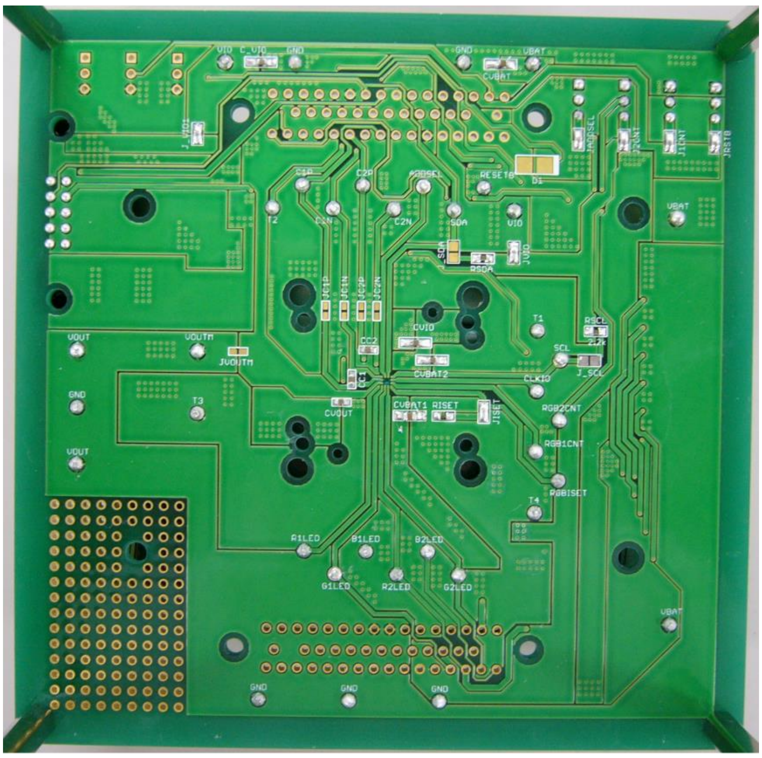


Figure 2. Evaluation Board Bottom View

BD2812GU Evaluation Board Manual

1. Items Needed to be Prepared/Done Before the Evaluation

- Evaluation Board
- Power Supply
- Communication control device for I2C

2. Evaluation Set Up

Please refer to Figure 1 on page 2 for the evaluation setup.

3. Power-up Procedure

1) Connect a Power Supply (VBAT) and an I^2C Control unit.
2) Move the RESETB switch to the "L" position then turn-on the power supply (VBAT).
3) Move the RESETB switch to the "H" position.
4) Send I^2C command.

Note: All the GND pins are shorted on the circuit board.

4. LED Settings

Single color and three colors LEDs are mounted on the board.

Single color or three colors LED can be selected by changing the connection of the jumpers.

Please refer to the table below on how to select the LED to be used.

Table 2. LED Jumper Settings

Channel	LED Type	Jumper Set Up	
R1	Single color	J6 : Short	JRED1 : Open
G1		J5 : Short	JGREEN1 : Open
B1		J4 : Short	JBLUE1 : Open
R1	Three colors	J6 : Open	JRED1 : Short
G1		J5 : Open	JGREEN1 : Short
B1		J4 : Open	JBLUE1 : Short
R2	Single color	J3 : Short	JRED2 : Open
G2		J2 : Short	JGREEN2 : Open
B2		J1 : Short	JBLUE2 : Open
R2	Three colors	J3 : Open	JRED2 : Short
G2		J2 : Open	JGREEN2 : Short
B2		J1 : Open	JBLUE2 : Short

4. Switch Settings

The switches are located on the upper part of the Evaluation Board. Please refer to the table below for the function and operation of these switches.

Table 3. Switch Settings

Name	Function	Operation	
		H	L
RESETB	Reset input	Reset cancel	Reset
RGB1CNT	RGB1 External synchronizing signal *	On	Off
RGB2CNT	RGB2 External synchronizing signal *	On	Off
ADDSEL	I2C Device address changeover terminal	1Bh	1Ah

* A setup of a register is separately necessary to make it effective.

6. About the part with the outside

Refer to the PCB circuit diagram when you replace a part and make sure that the mounting orientation and the withstand voltage are correct.

7. Note

- Be careful not to short-circuit adjacent pins.
- Some differences may arise between the actual board and the evaluation board due to wiring. Please confirm by evaluation if there is no problem with the actual board.
- Supply voltage (VBAT and VIO) should not exceed the maximum rated value of the IC. If exceeded, it is possible that the IC will be damaged and will stop working properly.

Schematic

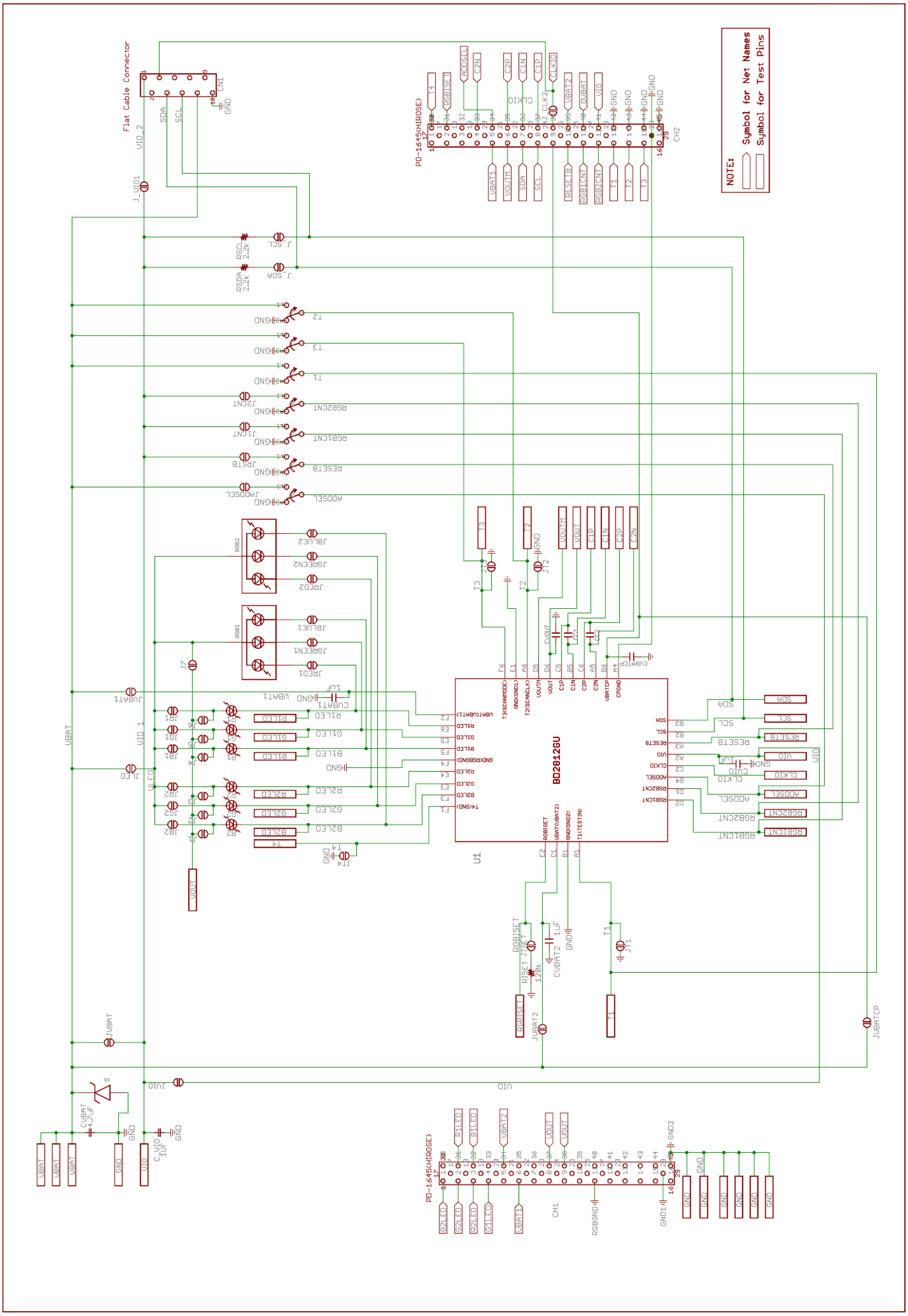


Figure 3. Circuit Diagram

Pin Configuration

	1	2	3	4	5	6
F	T4	VBAT1	B2LED	RGBGND	B1LED	T3
E	GND1	RGBISET	G2LED	R2LED	G1LED	R1LED
D	RGB2CNT	RGB1CNT			VOUTM	VOUT
C	VBAT2	CLKIO	index		C1P	C2P
B	GND2	SCL	SDA	ADDSEL	C1N	VBATCP
A	T1	VIO	RESETB	CPGND	C2N	T2

Figure 4. Pin Configuration (Bottom View)

Pin Description

Table 4. Pin Description

No	Pin No.	Pin Name	I/O	Description
1	B6	VBATCP	-	Battery is connected
2	F2	VBAT1	-	Battery is connected
3	C1	VBAT2	-	Battery is connected
4	A1	T1	-	Test Pin (short to GND)
5	A6	T2	-	Test Pin (short to GND)
6	F6	T3	-	Test Pin (short to GND)
7	F1	T4	-	Test Pin (short to GND)
8	A2	VIO	-	I/O voltage source is connected
9	A3	RESETB	I	Reset input (L: RESET, H: RESET cancel)
10	B3	SDA	I/O	I^2C data input
11	B2	SCL	I	I^2C clock input
12	A4	CPGND	-	Ground
13	E1	GND1	-	Ground
14	B1	GND2	-	Ground
15	F4	RGBGND	-	Ground
16	B5	C1N	I/O	Charge pump Capacitor is connected
17	C5	C1P	I/O	Charge pump Capacitor is connected
18	A5	C2N	I/O	Charge pump Capacitor is connected

No	Pin No.	Pin Name	I/O	Description
19	C6	C2P	I/O	Charge pump Capacitor is connected
20	D6	VOUT	O	Charge pump Output terminal
21	D5	VOUTM	O	Charge pump Output terminal
22	E2	RGBISET	I	RGB LED reference current
23	E6	R1LED	I	Red LED1 connected
24	E5	G1LED	I	Green LED1 connected
25	F5	B1LED	I	Blue LED1 connected
26	E4	R2LED	I	Red LED2 connected
27	E3	G2LED	I	Green LED2 connected
28	F3	B2LED	I	Blue LED2 connected
29	D2	RGB1CNT	I	RGB1 LED external ON/OFF Synchronism (L:OFF, H:ON)*
30	D1	RGB2CNT	I	RGB2 LED external ON/OFF Synchronism (L:OFF, H:ON)*
31	B4	ADDSEL	I	I^2C device address change terminal
32	C2	CLKIO	I/O	Standard clock input-and-output terminal

* A setup of a register is separately necessary to validate it.

Parts List

Table 5. Parts List

Part No	Value	Part Name (Series)
C_VIO	1uF	CAP
ADDSEL	-	SWITCH
B2	-	LED
CH1	-	PD-1645TH
CH2	-	PD-1645TH
CN1	-	FKV10VRTH
CVBAT	4.7uF	CAP
CVBAT1	1uF	CAP
CVBAT2	1uF	CAP
CVIO	1uF	CAP
D1	-	ZENER DIODE
G2	-	LED
CC1, CC2, CVBATCP, CVOUT	-	MCH18FN104
R2	-	LED
B1	-	LED
G1	-	LED
R1	-	LED
RESETB	-	SWITCH
RGB1	-	LED ARRAY
RGB1CNT	-	SWITCH
RGB2	-	LED ARRAY
RGB2CNT	-	SWITCH
RISET	120kΩ	RES
RSCL	2.2kΩ	RES
RSDA	2.2kΩ	RES
U1	-	BD2812GU

(Note)

When terminating the unused terminals, be sure to set the test terminals and unused terminals as summarized in the following table.

Terminal Name	Remarks
T1, T2, T3, T4	Test input terminals. Short these terminals to GND.
Unused LED terminals	Short these terminals to GND. In this case, don't set the registers related to unused LEDs.
RGB1CNT, RGB2CNT	Short these terminals to GND. (Terminal has a built-in pull-down resistance)
CLKIO	Short this terminal to GND. (Terminal has a built-in pull-down resistance)
ADDSEL	Be sure to short this terminal to VBAT or GND.

(Note) LED Jumper setting refer to Table2.

Board Layout

Evaluation Board PCB information

Number of Layers	Material	Board Size	Copper Thickness
4	FR4	120mm x 120mm	1 oz. (35μm/35μm)

The layout pattern of BD2812GU is shown below.

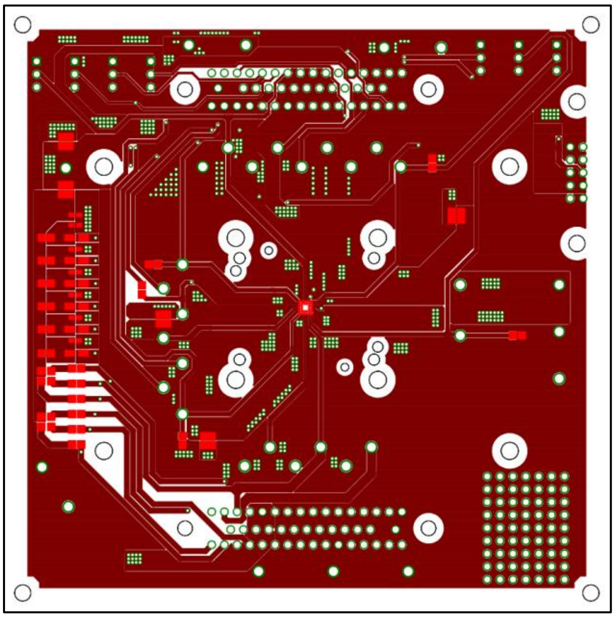


Figure 5. Top Layer Layout
(Top View)

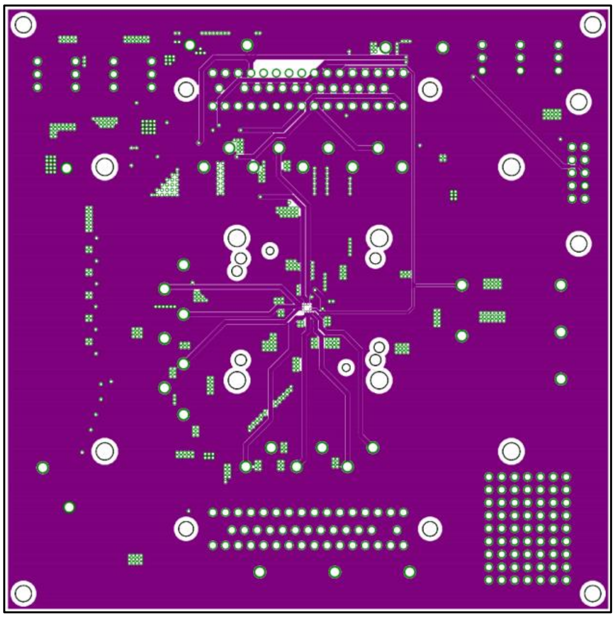


Figure 6. Middle1 Layer Layout
(Top View)

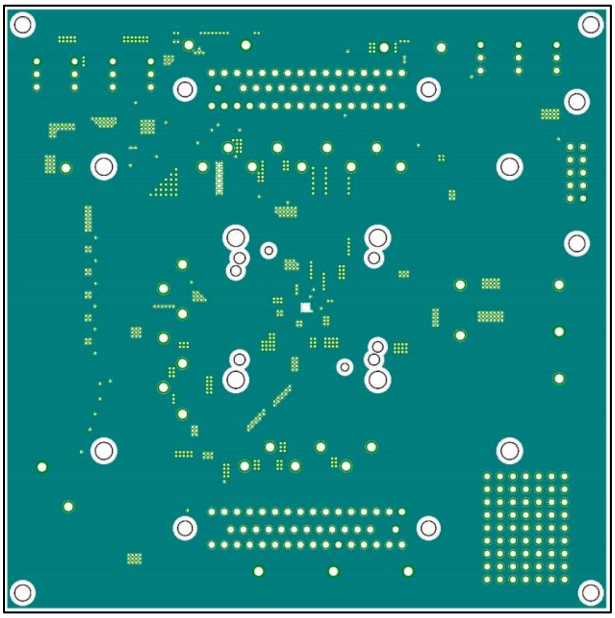


Figure 7. Middle2 Layer Layout
(Top View)

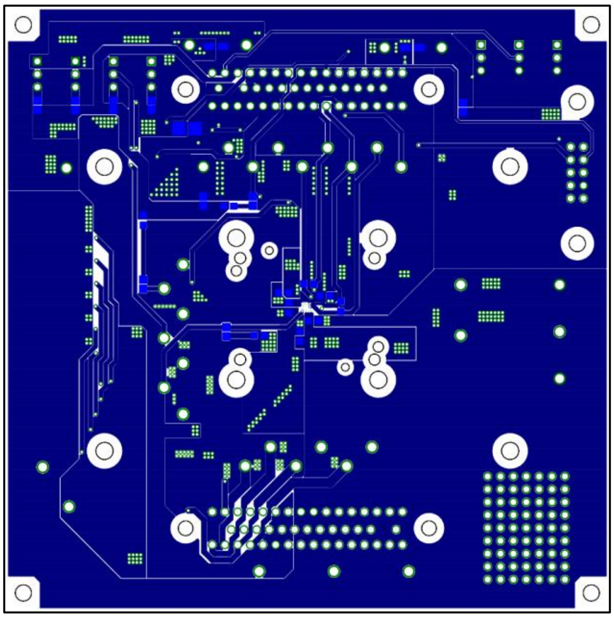


Figure 8. Bottom Layer Layout
(Top View)

I2C BUS Format

The writing operation is based on the I2C slave standard.

・Slave address:

	A7	A6	A5	A4	A3	A2	A1	R/W
ADDSEL = L	0	0	1	1	0	1	0	1/0
ADDSEL = H	0	0	1	1	0	1	1	1/0

The slave address can be changed with the external terminal ADDSEL.

Register Map

Table 6. Register Map

Address	W/R	Register data								Function
		D7	D6	D5	D4	D3	D2	D1	D0	
00h	R/W	SLPMD	FSEL	CLKMD	CLKEN	-	-	-	SFTRST	Soft Reset DC/DC driver function
01h	R/W	-	RGB2MEL	RGB2OS	RGB2EN	-	RGB1MEL	RGB1OS	RGB1EN	RGB LED control
02h	W	SFRGB1(1)	SFRGB1(0)	SRRGB1(1)	SRRGB1(0)	-	TRGB1(2)	TRGB1(1)	TRGB1(0)	RGB1 time setup
03h	W	-	IR11(6)	IR11(5)	IR11(4)	IR11(3)	IR11(2)	IR11(1)	IR11(0)	R1 current 1 setup
04h	W	-	IR12(6)	IR12(5)	IR12(4)	IR12(3)	IR12(2)	IR12(1)	IR12(0)	R1 current 2 setup
05h	W	-	-	-	-	PR1(3)	PR1(2)	PR1(1)	PR1(0)	R1 Wave pattern setup
06h	W	-	IG11(6)	IG11(5)	IG11(4)	IG11(3)	IG11(2)	IG11(1)	IG11(0)	G1 current 1 setup
07h	W	-	IG12(6)	IG12(5)	IG12(4)	IG12(3)	IG12(2)	IG12(1)	IG12(0)	G1 current 2 setup
08h	W	-	-	-	-	PG1(3)	PG1(2)	PG1(1)	PG1(0)	G1 Wave pattern setup
09h	W	-	IB11(6)	IB11(5)	IB11(4)	IB11(3)	IB11(2)	IB11(1)	IB11(0)	B1 current 1 setup
0Ah	W	-	IB12(6)	IB12(5)	IB12(4)	IB12(3)	IB12(2)	IB12(1)	IB12(0)	B1 current 2 setup
0Bh	W	-	-	-	-	PB1(3)	PB1(2)	PB1(1)	PB1(0)	B1 Wave pattern setup
0Ch	W	SFRGB2(1)	SFRGB2(0)	SRRGB2(1)	SRRGB2(0)	-	TRGB2(2)	TRGB2(1)	TRGB2(0)	RGB2 time setup
0Dh	W	-	IR21(6)	IR21(5)	IR21(4)	IR21(3)	IR21(2)	IR21(1)	IR21(0)	R2 current 1 setup
0Eh	W	-	IR22(6)	IR22(5)	IR22(4)	IR22(3)	IR22(2)	IR22(1)	IR22(0)	R2 current 2 setup
0Fh	W	-	-	-	-	PR2(3)	PR2(2)	PR2(1)	PR2(0)	R2 Wave pattern
10h	W	-	IG21(6)	IG21(5)	IG21(4)	IG21(3)	IG21(2)	IG21(1)	IG21(0)	G2 current 1 setup
11h	W	-	IG22(6)	IG22(5)	IG22(4)	IG22(3)	IG22(2)	IG22(1)	IG22(0)	G2 current 2 setup
12h	W	-	-	-	-	PG2(3)	PG2(2)	PG2(1)	PG2(0)	G2 Wave pattern setup
13h	W	-	IB21(6)	IB21(5)	IB21(4)	IB21(3)	IB21(2)	IB21(1)	IB21(0)	B2 current 1 setup
14h	W	-	IB22(6)	IB22(5)	IB22(4)	IB22(3)	IB22(2)	IB22(1)	IB22(0)	B2 current 2 setup
15h	W	-	-	-	-	PB2(3)	PB2(2)	PB2(1)	PB2(0)	B2 Wave pattern setup
16h ～ 3Fh	-	Reserved								-
40h	R/W	VOUT(1)	VOUT(0)	DCDCMD	DCDCFON	-	-	-	-	DC/DC driver function
41h	R/W	-	-	-	-	RGB2PW (1)	RGB2PW (0)	RGB1PW (1)	RGB1PW (0)	LED pin function

(Note)

Input "0” for "-".

(Note)

Vacant address may be used for test.

It is prohibited to access the address that isn’t included on the above table because they might be used for test.

Please refer to datasheet p.10 to 19 about the Register Map description.

RGB Waveform Setting

Various kinds of RGB control can be implemented by designating waveform cycles, waveform patterns, current settings 1, 2 and rising/falling slope times. To activate an RGB waveform, a continuous operation via RGB*EN or a single-shot operation via RGB*OS can be selected. In addition, when control via the external terminal, RGB*CNT, is enabled via RGB*MEL, the corresponding LED can be lit in synchronization with the external signal.

1. Waveform cycle
   - A single cycle time is set for a waveform pattern.
   - This setting can be made independently for RGB1 and RGB2.
2. Waveform pattern
   - A pattern in a waveform cycle is set.
   - Sixteen types of waveform patterns can be set in units of waveform patterns.
   - For concrete waveform patterns, refer to the timing diagram shown on the next page.
3. Current settings 1 and 2 (I1, I2)
   - Two currents (I1, I2) in a waveform pattern are set.
   - When the maximum current value is 25.4mA, it is possible to set the current ranging from 0 to 25.4mA with an increment of 0.2mA (128 steps).
   - The polarity of the waveform is determined by the current setting of each terminal.
   - The current value can be set to each terminal.
4. Rising/falling slope time
   - The transition time between current settings I1 and I2 can be set.
   - The time per current step (0.2mA) is calculated based on the difference between the currents selected in current settings I1, I2 and the set slope time.
     For this reason, the time per step (0.2mA) is short when the difference between setting currents I1 and I2 is large.
     In contrast, it is long when a difference between setting currents I1 and I2 is small.
   - Regardless of the current settings I1 and 2, a rising slope time applies at current increase and a falling slope time applies at current decrease. For concrete waveform images, refer to the timing diagram shown on the next page.
5. External terminal synchronization control

   When control via the external terminal, RGB*CNT, is enabled via RGB*MEL, lighting is enabled if the input external signal goes "H". In contrast, it is disabled if the external input signal goes "L". In this way, synchronization with the external signal is enabled so that the LED can be blinked in conjunction with a ringing tone (a melody signaling a ring tone).

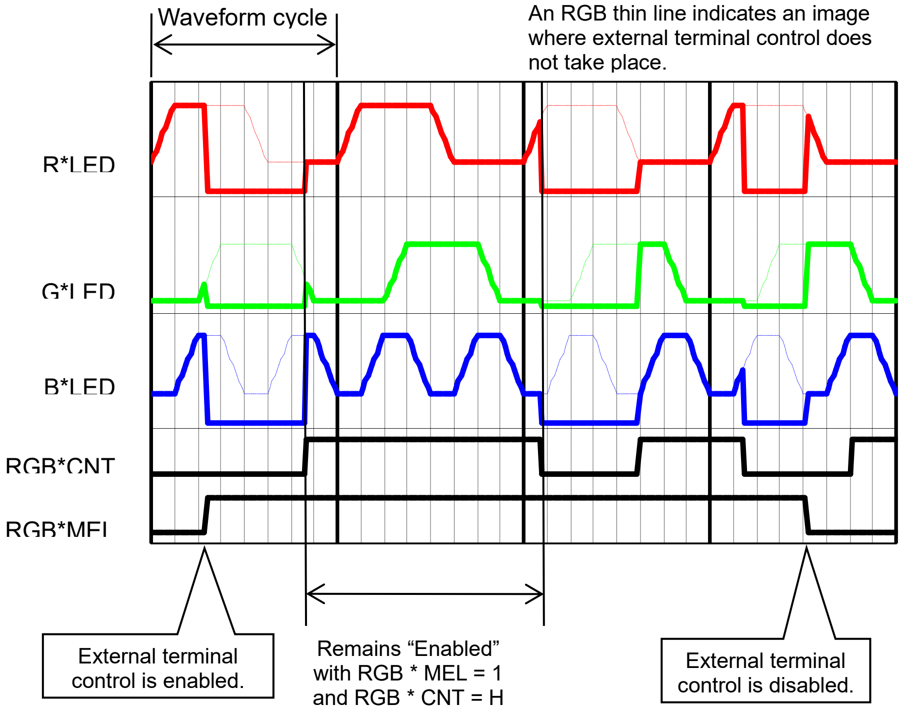


Figure 9. RGB Waveform Setting

RGB Waveform Setting - continued

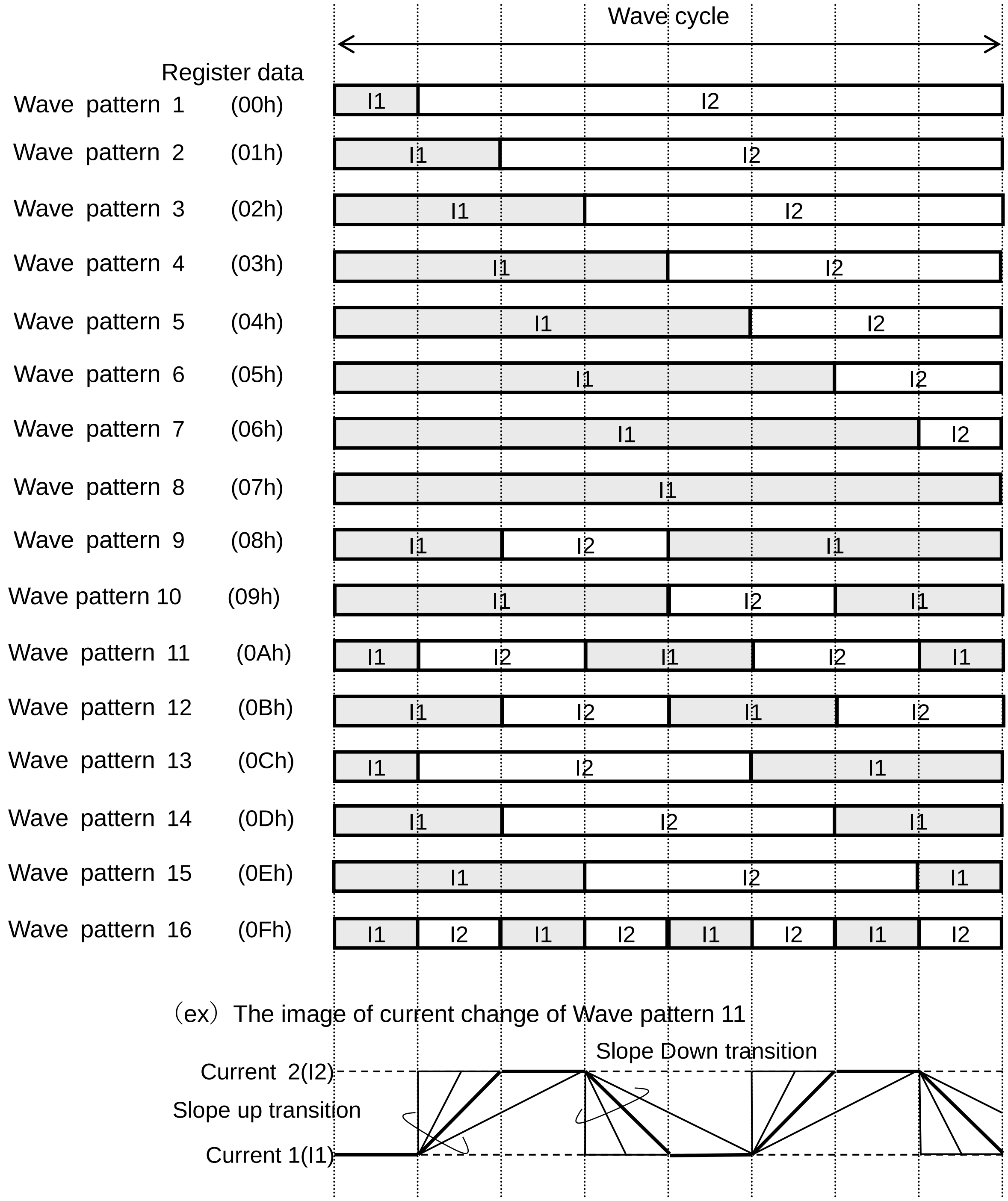
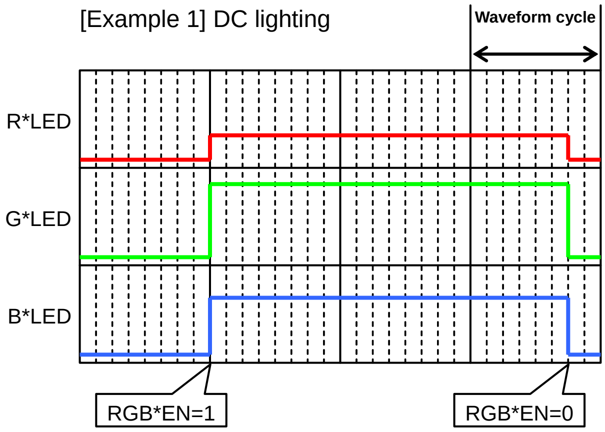


Figure 10. RGB wave setting timing diagram

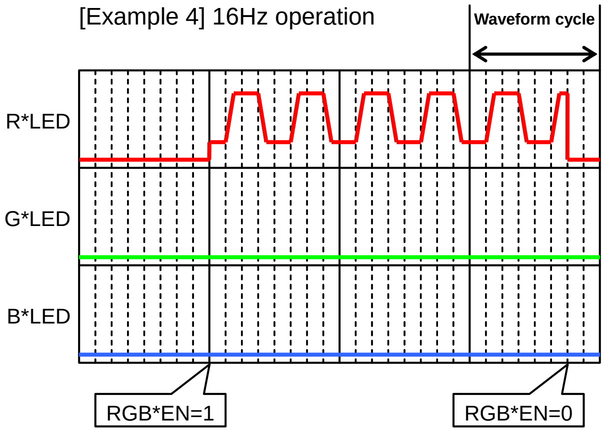
RGB Waveform Setting Examples

[Example 1] DC lighting



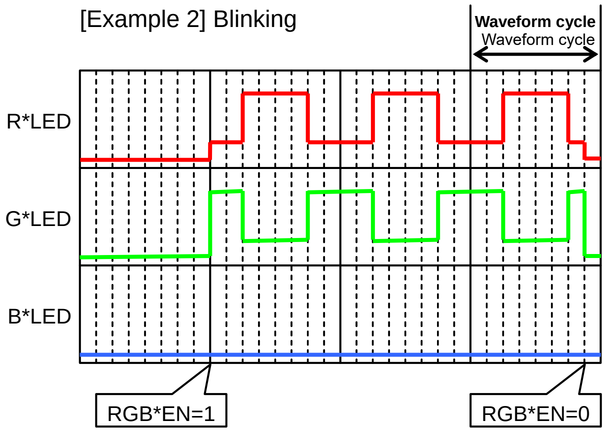
Selecting waveform pattern 8 causes a continuous normal operation to take place through the setting current 1.

[Example 4] 16Hz operation



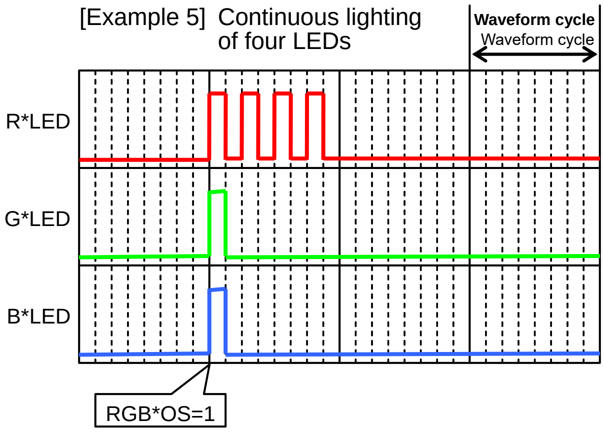
Combining the settings of a waveform pattern 11 and a waveform cycle 131ms causes blinking at a rate of 15.3Hz (approx. 16Hz).

[Example 2] Blinking

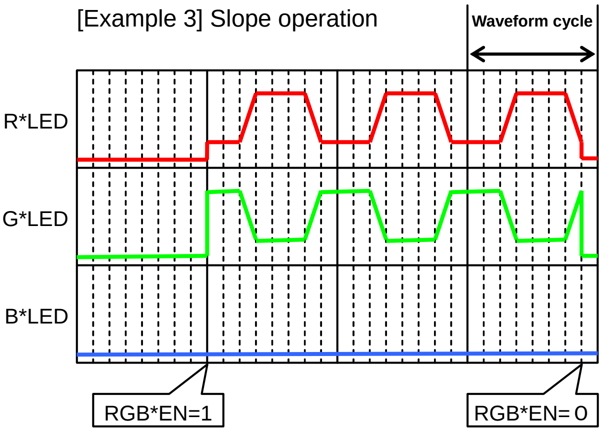


Setting a rising/falling slope time to "0" causes blinking to take place. Phase switching takes place via the setting currents of R and G.

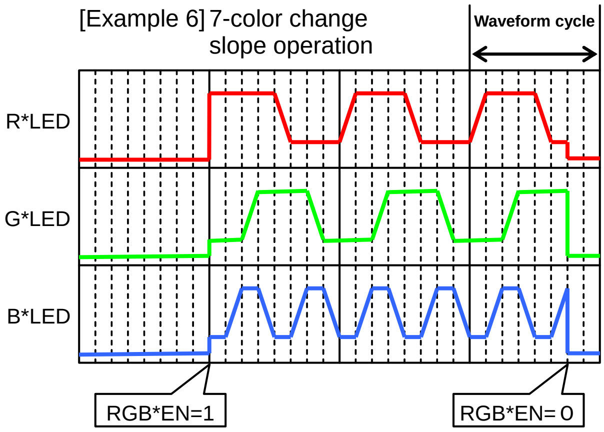
[Example 5] Continuous lighting of four LEDs



This example shows that lighting occurs continuously in the order of white, red, red and red. To achieve this, waveform patterns 16, 1 and RGB*OS single cycle operation need to be combined.



When a rising/falling slope time is longer than the setting made in example 2, a continuous color change is made by slope operation.



R, G and B waveform patterns are set in a way that any of R, G and B changes constantly.

Figure 11. RGB waveform setting examples

Activation

The DC/DC circuit is activated when any LED is subjected to lighting control (DCDCFON = 0).

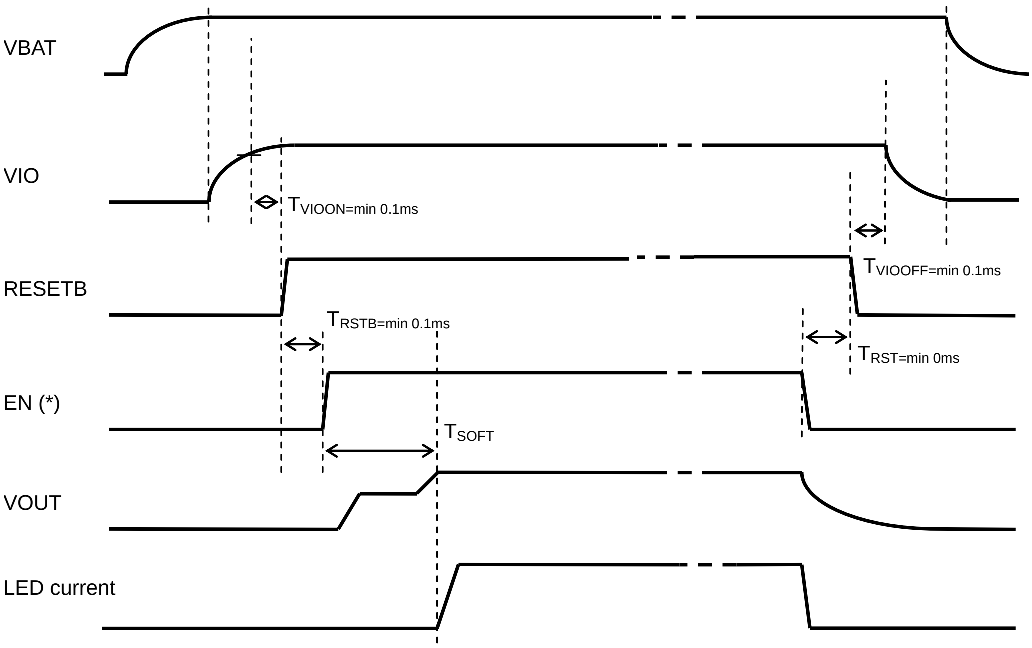
(However, this is limited when the output of the DC/DC circuit (VOUT) is connected to an active/lighted LED.)

A soft start function is available to prevent the rush current during the DC/DC circuit activation.

Please note that the voltage should be applied to both VBAT and VIO as follows.

DCDCMD = 1 must be set in the fixed voltage mode.

If the DCDC output is active, regardless of the LEDs’ connection, please set DCDCMD = DCDCFON = 1.



(*) In the above figure, the EN signal means the following:
①EN = “MLEDEN” or “W*EN” or “RGB*EN” or “RGB*OS” (=LED lighting control with LED connected to VOUT)
But EN is disabled when Ta > T_{TSD} (Typ: 195° C) due to the activated TSD protection.
②T_{SOFT} typical value is 200μs when the output capacitor of VOUT =1.0μF, T_{SOFT} changes depending on the value of the capacitor connected to VOUT and the characteristics of the internal OSC block.

Figure 12. DC/DC Starting Sequence

Mode Transition

The mode of the charge pump is automatically changed depending on the conditions of the VBAT voltage and VOUT terminal voltage.

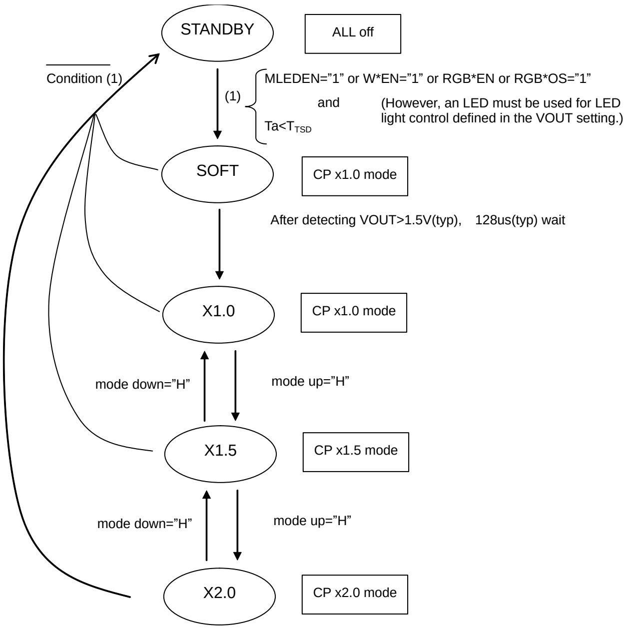


Figure 13. DC/DC State Transition Diagram

The charge pump’s mode transition is as follows.

<Mode transition: x1.0 → x1.5 → x2.0>

VBAT and VOUT values are monitored and mode transition is allowed only when the following conditions are satisfied:

Mode transition from x1.0 to x1.5

VBAT ≤ VOUT + (Ron10×Iout)

(LED terminal feedback: VOUT = Vf+0.2(Typ))

Mode transition from x1.5 to x2.0

VBAT×1.5 ≤ VOUT + (Ron15×Iout)

(LED terminal feedback: VOUT = Vf+0.2(Typ))

Where, Ron10 and Ron15 represent the ON resistances of the charge pump.

Ron10 = 1Ω (Typ), Ron15 = 5Ω (Typ) (design value)

<Mode transition: x2.0 → x1.5 → x1.0>

1. VOUT and VBAT levels are monitored and mode transition is performed only when a prescribed condition is exceeded. The conditions are as follows.

Mode transition from x1.5 to x1.0

VBAT/VOUT = 1.07 (design value)

Mode transition from x2.0 to x1.5

VBAT/VOUT = 0.96 (design value)

2. If DCDCMD (register40h) ’1’→’0’ (switch from output voltage fixed mode to LED pin return mode) is operated, the mode down will continue until the conditions of mode up is satisfied.

Power On/Off Sequence

Voltage shall be applied as follows at driver activation. When a delay element is connected to the VIO voltage source and a reset cancel signal is input to the RESETB terminal, there should be enough time between VIO stable high voltage and RESETB signal to prevent power on failure.

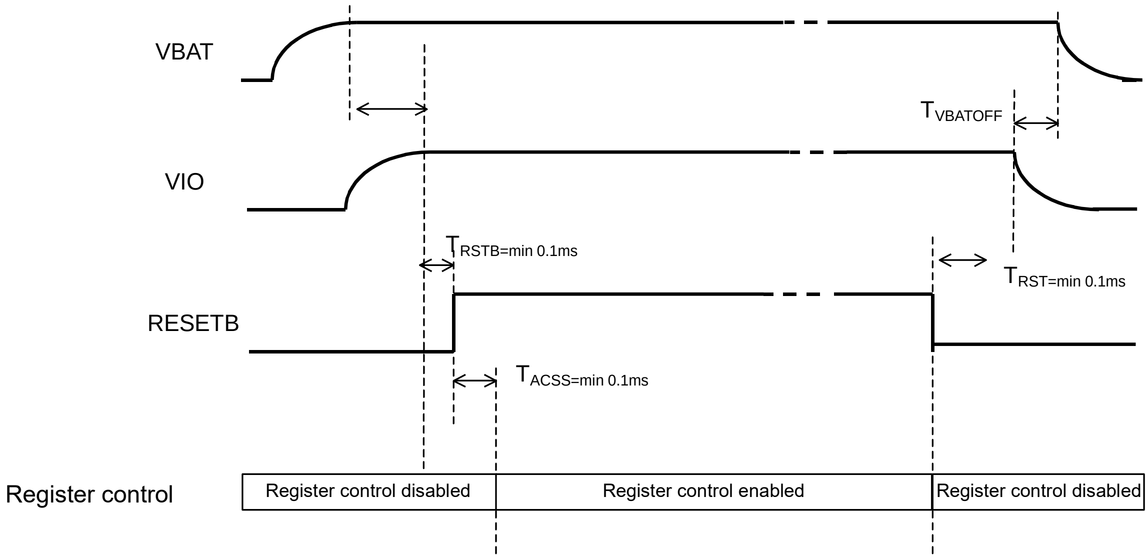


Figure 14. Power On/Off Sequence

Revision History

Date	Revision Number	Description
26.Sep.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.

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

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