

TOSHIBA Bi-CMOS INTEGRATED CIRCUIT SILICON MONOLITHIC TB62733FTG

Charge Pump type DC/DC Converter for White LED Driver

■ Application

Charge Pump type DC/DC Converter / White LED Driver

■ Features

TB62733FTG is charge pump type DC to DC Converter that is accept from 2.8 up to 4.2V input and continue to up converting operation until FB terminal is equal to 0.4V. (1.5 times up converting)

This device provides over 190mA at $V_{in}=3.9V$ as the maximum current, and two outputs structure may help to design the backlighting system such as the system having two displays that are main and sub LCD displays.

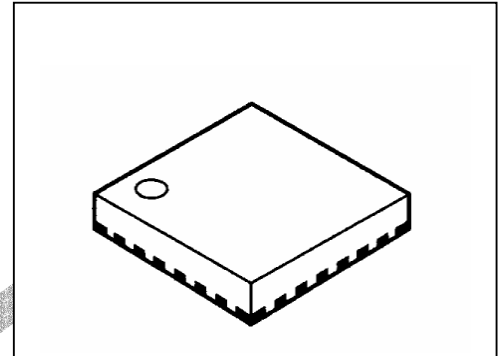
Also, this is used for the power supply of flash lighting by using two outputs At the same time.

■ Function

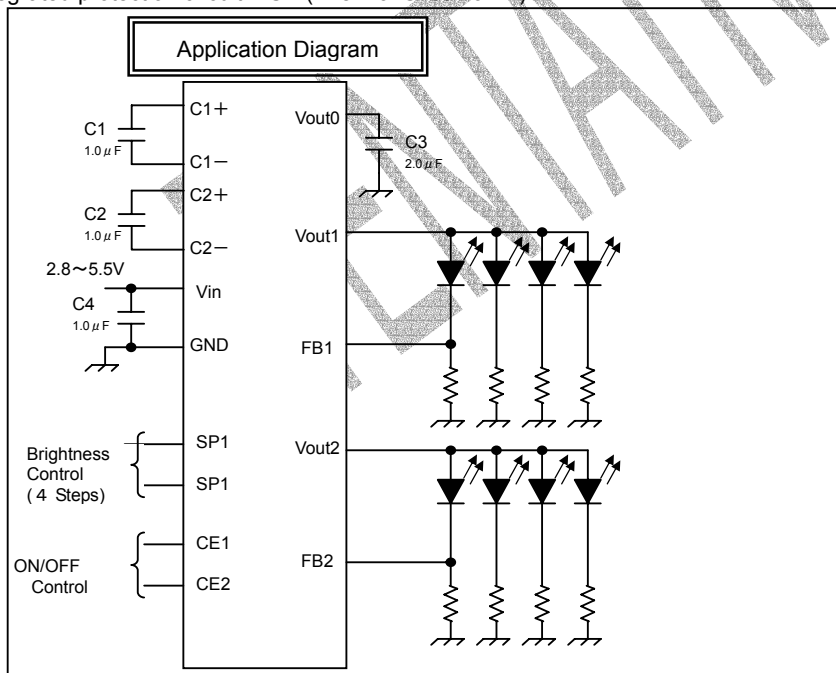
1.5 times Charge Pump type step up DC to DC converter

■ Features

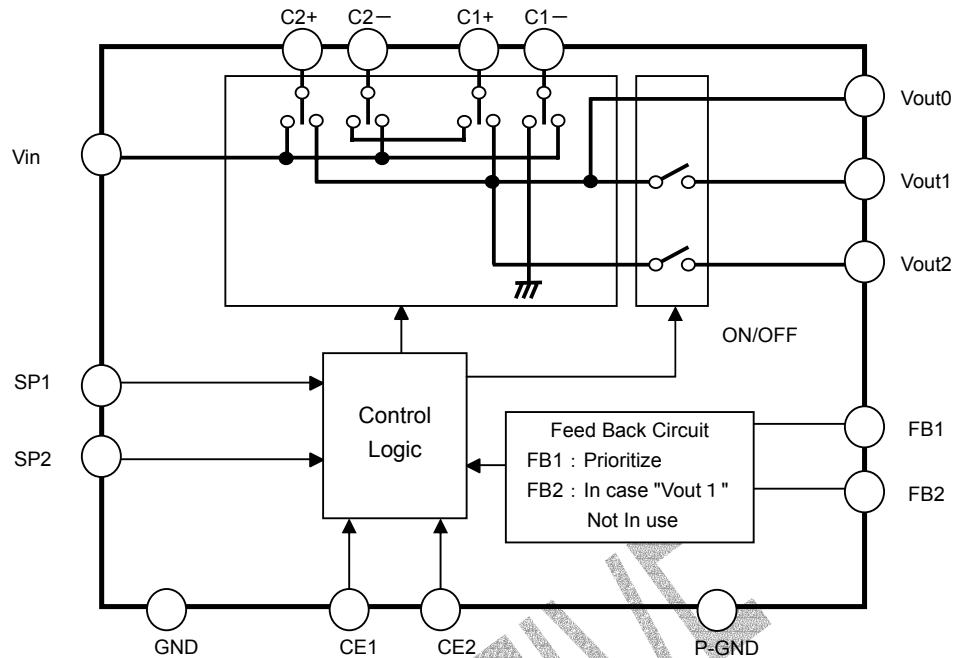
- Utilize Bi-CMOS Process
- Package : VQON24(Leadless type)
- Input Voltage : 2.8V (Min)
- Output Voltage : 4.0V (Min)
- Output Current Ability : Greater than 190mA (Usual State)
- 4 Steps Brightness Control (25%, 50%, 75%, 100%)
- Auto Discharge function equipped
- Integrated protection circuit TSD (Thermal Shut Down)



(VQON24-)
Weight : 0.0g (Typ.)



■ Block Diagram



■ Explanation of Terminals

Terminal Number	Terminal Name	Function	Comments
1	NC		
2	Vout 1	Output 1 Terminal	
3	C1+	Capacitance Terminal for Charge Pump	Capacitance for Charge Pump
4	C1-	Capacitance Terminal for Charge Pump	Capacitance for Charge Pump
5	VIN	Power supply terminal	
6	NC		
7	NC		
8	FB1	Feed Back Control Terminal	Setting feed back voltage by SP terminal (SP1,SP2)
9	NC		
10	FB2	Feed Back Control Terminal	Setting feed back voltage by SP terminal (SP1,SP2)
11	NC		
12	NC		
13	NC		
14	GND	Ground	
15	C2-	Capacitance Terminal for Charge Pump	Capacitance for Charge Pump
16	C2-	Capacitance Terminal for Charge Pump	Capacitance for Charge Pump
17	Vout2	Output 2 Terminal	
18	NC		
19	SP2	Logic Input	Setting of feed back voltage
20	SP1	Logic Input	Setting of feed back voltage
21	Vout0	Output 0	Terminal for output Capacitor
22	NC		
23	CE1	Logic Input	On/ Off Control Terminal for Vout 1
24	CE2	Logic Input	On/ Off Control Terminal for Vout 2

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■ Absolute Maximum Ratings

Item	Symbol	Conditions	Ratings	Unit
Power Supply	Vin	—	-0.3~6.0	V
Input Voltage	Vin2	FB/CE/SP Terminal	-0.3~Vin+0.3	V
Output Current	Iout	—	250	mA
Power Dissipation	P D	Without PCB With PCB	357 TBD	mW
Operating Temperature	TOPR	—	-25~85	°C
Storage Temperature	TSTG	—	-55~150	°C
Junction Temperature	Tj	—	150	°C

※When the ambient temperature is excess 25 degree C, it should be derating with 1.24mW/degree C.

■ Recommended Operating Conditions (Topr = -25 – 85 Degree C)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power Supply	Vin	—	2.8		5.5	V
Logic Input Voltage	VCE		0	—	Vin	V
Input Ripple Voltage	Vin(ripple)	—	—	—	40	mVpp
Capacitance for Charge Pump	C1/2		0.8	1.0	4.0	μ F

TENTATIVE

■ Electrical Characteristics (Vin=3.6V, TOPR=25°C, if it is not specified.)

Item	Symbol	Measurement Circuit	Measurement Condition	Min.	Typ.	Max.	Unit
Input Voltage	Vin			2.8		5.5	V
Maximum Output Voltage	Vout		Vin=3.0V, Iout=100mA	4.0	—	—	V
Feed Back Terminal Voltage (Tolerance of Current Setting)	VFB1 VFB2		SP1="L", SP2="L" Iout=0mA	(94)	100	(106)	mV
			SP1="L", SP2="H" Iout=0mA	(188)	200	(212)	mV
			SP1="H", SP2="L" Iout=0mA	(282)	300	(318)	mV
			SP1="H", SP2="H" Iout=0mA	(376)	400	(424)	mV
Feed Back Terminal Input Current	IFB			—	—	0.5	μA
Output Current Ability	Iout1/2		Vin=3.2V, Vout=4.2V VFB1=0.4V	90	110	—	mA
	Iout(MAX)		Vin=3.2V, Vout=4.2V VFB1=0.4V CE1="H", CE2="H",	180	—	—	mA
Consumption Current	IDD		Vin=2.8~4.2V Iout=100mA	—	—	5	mA
Stand By Consumption Current	IDDSTB		Iout=0mA CE1/2="L"	—	—	1	μA
Logic Input Voltage	High	VIH	Logic Inputs	0.7 × Vin	—	—	V
	Low	VIL	Logic Inputs	—	—	0.3 × Vin	V
Logic Input Current	Ileak		Logic Inputs	—	—	0.5	μA
Auto Discharging	Iauto		CE1/CE2="L⇔H" Vin=3.6V Vout=4.0V	—	7	—	mA
Vout Rise Time			Vin=2.8V, Iout=10mA The transition time when Vout from 0V to 4V	—	—	500	μs
Clock Frequency	fOSC			0.85	1.2	1.55	MHz
Rush Current	IRUSH		Rush Current at CE = "H"	—	—	500	mA

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■ Explanation of Operations

1.5 times Up converting operation

This device performs up converting to output voltage (Vout) that is converted 1.5 times from input voltage. (Vin)
The input voltage will be allowed from 2.8V to 4.2V.

The actual output (Vout) will be differ by the conditions of output current, external parts, application circuit and so on, because the feed back voltage will be hold at the constant voltage.

The ripple voltage of the output will be approximately 100mV peak to peak.

【Principle of Basic Operation】

The following is the explanation for basic operation of 1.5 time up converting

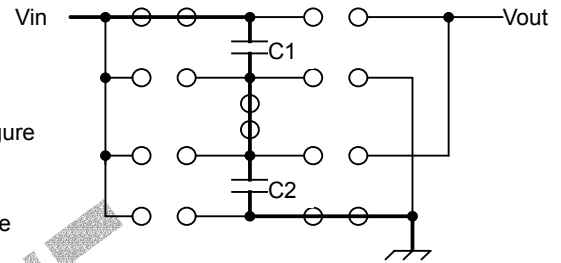
1. Charging to C1 and C2

By connecting C1 and C2 through internal Switch as shown in the figure

C1 and C2 is charged. In this case, the C1 is charged up to around the half of Vin. ($V_{c1} = 1/2 V_{in}$)

Actually, the voltage is slightly lower than $1/2 V_{in}$ due to on resistance of internal switch and equivalent resistance of C1.

Thus, C2 is also charged up to $1/2 V_{in}$ as well.

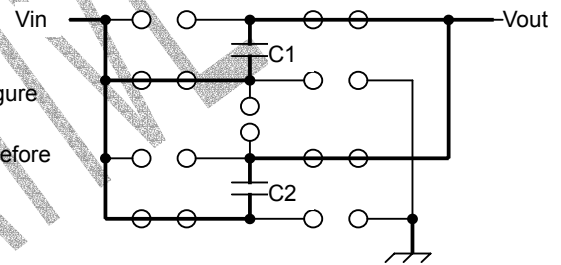


2. Out put from C1 and C2 yjat are charged

By connecting C1 and C2 through internal switch as shown in the figure

The charged energy of C1 and C2 output to Vout.

At this time, Vout is added by the voltage charged to C1 and C2, therefore Vout voltage is approximately $3/2 V_{in}$.



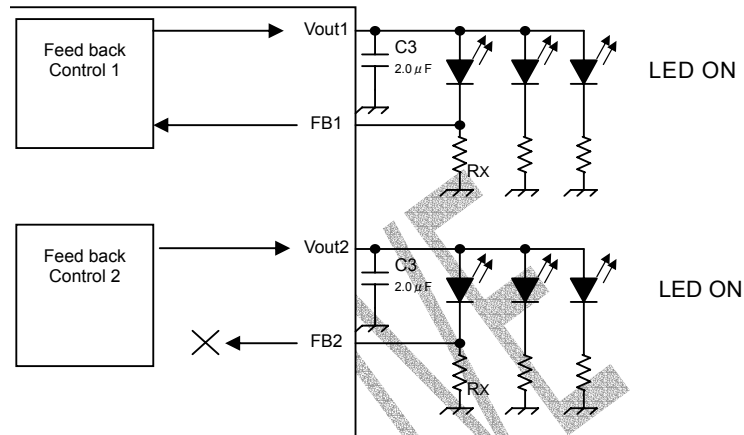
3. By repeating the operation 1 and 2 described above, the voltage is supplied to Vout around 1.5 times of Vin.

■ Feed Back Voltage Control

This device has a capability of variable control for feed back voltage by using two input such as SP1 and SP2. Two kind of feed back terminal exist and the following feed back control is performed.

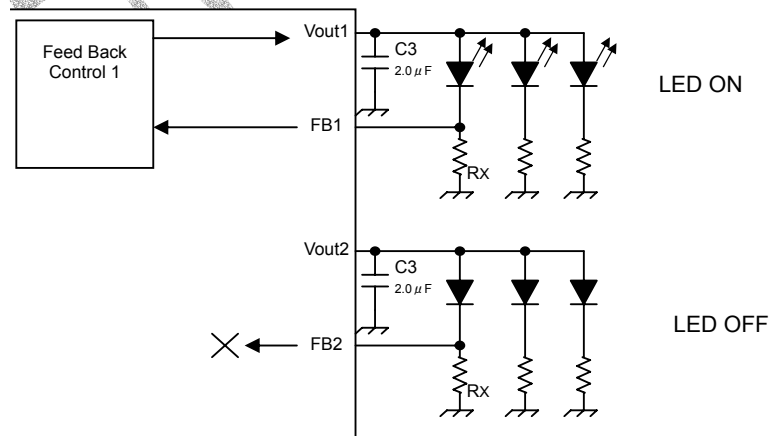
1. Operating both Vout1 and Vout2 : Out1 is controlled by feed back terminal 1. (FB1)
No feed back operation for Out2
2. Operate Vout1 only : Operation by feed back terminal 1 (FB1)
3. Operate Vout2 only : Operation by feed back terminal 2 (FB2)

1. Operate both Vout1 and Vout2

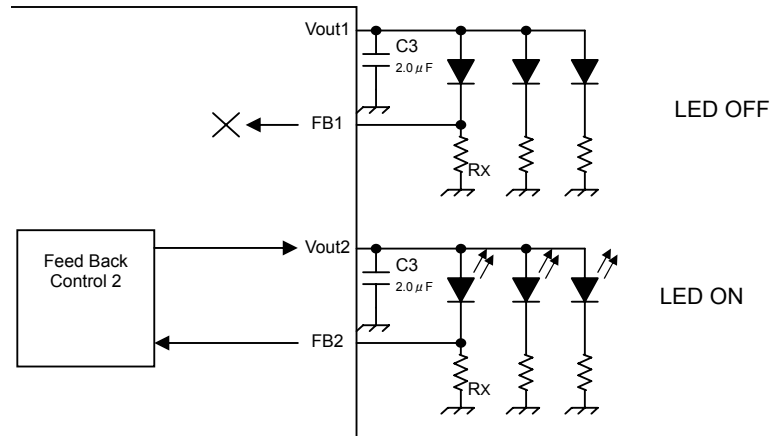


- In case of output capacitance C3 is connected to Vout0, capacitance C3 connecting to Vout1 and Vout2 May be omitted. However, if you have to care about output ripple, it is better C3 connect to each Vout1 and Vout2.

2. Vout 1 operating



3. Vout 2 Operating



Truth Table (CE1 and CE2)

CE1	CE2	Output Terminal	Feed Back Control
L	L	None	None
H	L	Vout1	FB1
L	H	Vout2	FB2
H	H	Vout1,Vout2	FB1/FB2

The feed back voltage is set by input signal (SP1 and SP2)
 As shown in the following table, the current value of LED is obtained by the following equation.
 $I_{LED} = V_{FB} / R_X$

The brightness control is available with feed back voltage control.

Truth Table for Current Control

SP1	SP2	FB Control Voltage	LED Current at Resistor(Rx)=20Ω
L	L	0.1V	5mA
L	H	0.2V	10mA
H	L	0.3V	15mA
H	H	0.4V	20mA

■ Soft Start Function

This device is integrated Soft start function. When the power supply is ON or output is started to operate, the transition time is controlled in order to decrease the rush current.

■ Thermal Shut Down Function

This device has Thermal Shutdown Function to protect from thermal damage when the output is shorted. The temperature to operate this function is set around from 120 to 160 degree C. (This is not guaranteed Value.)

■ The selection of Capacitor for Charge Pump, input and output

The input capacitor is effective to decrease the impedance of power supply and also input current is averaged. The input capacitor should be selected by impedance of power supply, it is better to choose with lower ESR (Equivalent Series Resistor). (i.e. ceramic capacitor etc.) Regarding to the capacitance values, it is recommended to choose in the range from 0.8 uF to 10 uF, however larger than 1 uF should be better. The output capacitor is effective to decrease the ripple noise of the output line. Also, it is better to choose the capacitor. Regarding to the capacitance values, it is recommended to choose in the range from 0.8 uF to 10 uF, however larger than 2 uF should be better. The capacitor for charge pump operation is also selected the capacitor with low ESR.) Regarding to the capacitance values, it is recommended to choose in the range from 0.8 uF to 10 uF, however larger than 1 uF should be better.

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Application Example

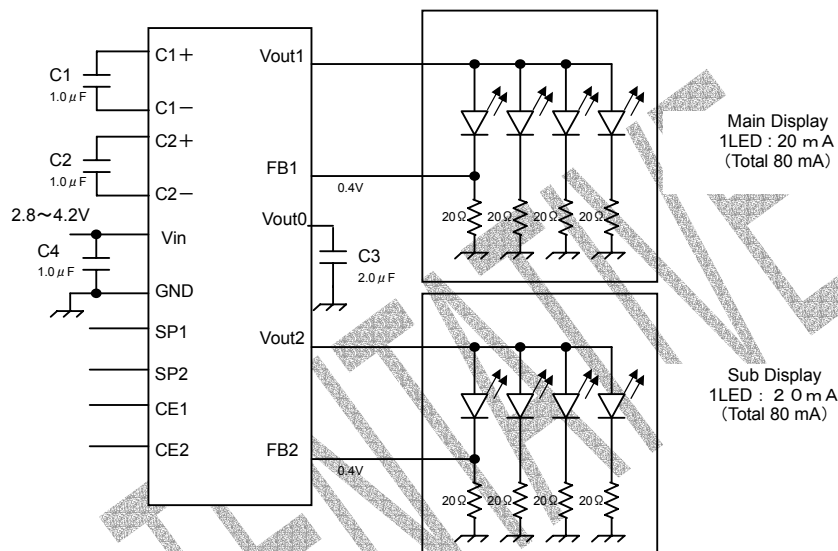
This device has a large drive capability (Iout Max : Larger than 190mA), if in case of driving LED at 20mA each, this device can drive up to 9 LEDs max.

1. In use of LCD backlighting (Main and Sub Displays)

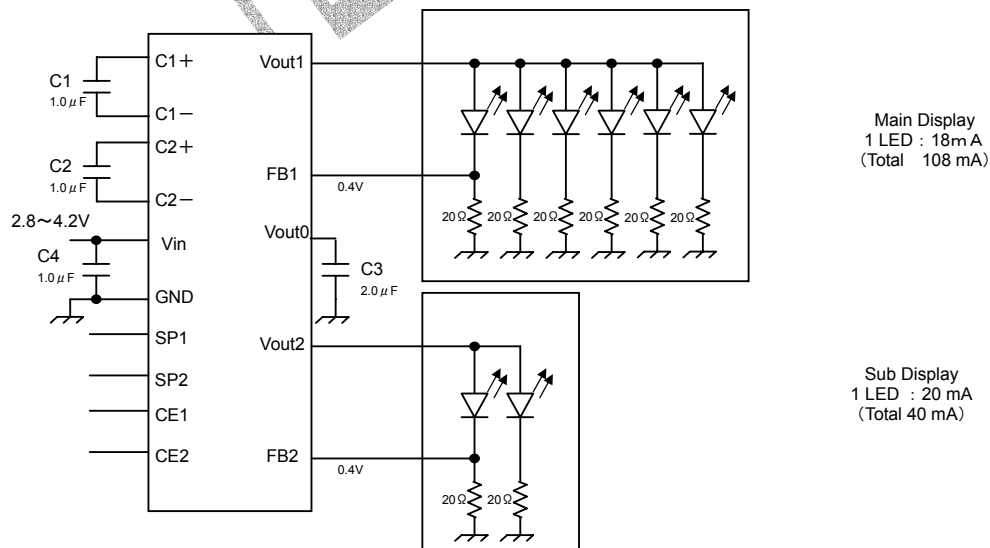
In case of driving the back light system both for main display and sub display, this device can be used for this application With securing the output current of maximum 190mA.

Also, Vout 1 has a drive capability up to 110mA, so it is allowed to change the system that Vout 1 can drive 6 LEDs (backlight for main display), then Vout 2 drives 2LEDs for the backlight of sub display as showing in Application Figure 2. The LED brightness balance is adjusted by using FB1 and FB2.

Application Figure 1



Application Figure 2



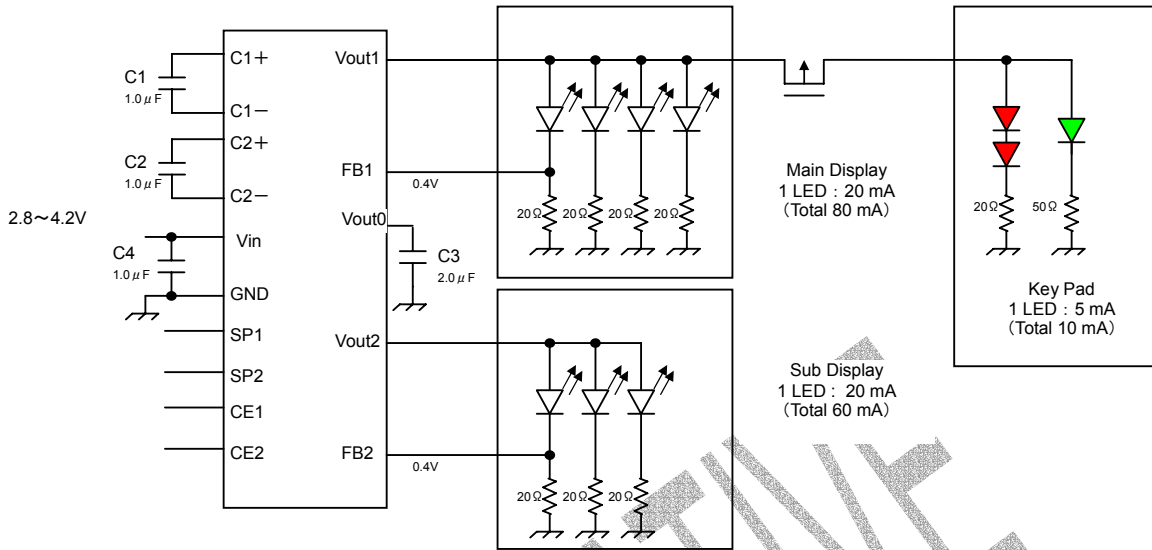
These figures are showing as the standard application example. The current values or so are considered whenever it is designed.

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2. In case of driving both Backlighting (Main/Sub Displays) and Key pad Illumination

By using external MOS FET, the system of driving for main , sub display and Key pad Illumination is also composed.

Application Figure 3



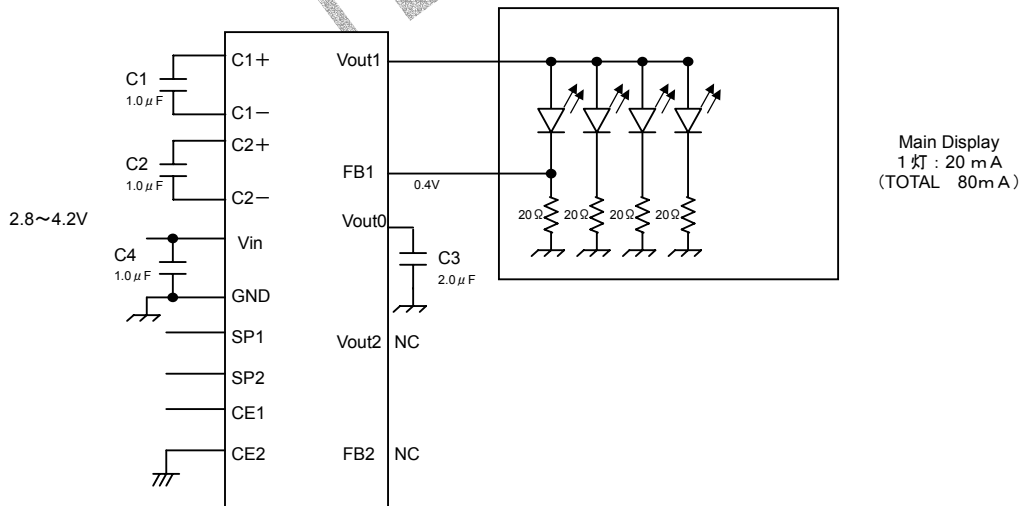
These figures are showing as the standard application example. The current values or so are considered whenever it is designed.

3. LCD Backlight system (Only Main Display)

In case sub display is not connected, Vout 2 is terminated when CE2 terminal fix to the ground, then only Vout 1 can be operated. In case of this application, Vout2 and FB2 should be open connection.

In case of using this device with 190mA of total output current, as shown application figure 5, Vout 1 and Vout 2 are connected as common output. In this case, CE1 and CE2 are applied with common signal, and FB2 should be open connection.

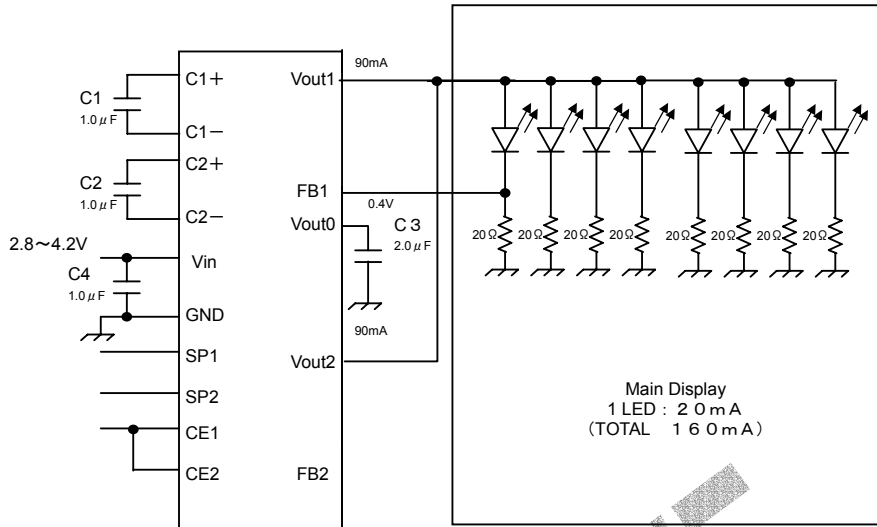
Application Figure 4



These figures are showing as the standard application example. The current values or so are considered whenever it is designed.

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Application Figure 5

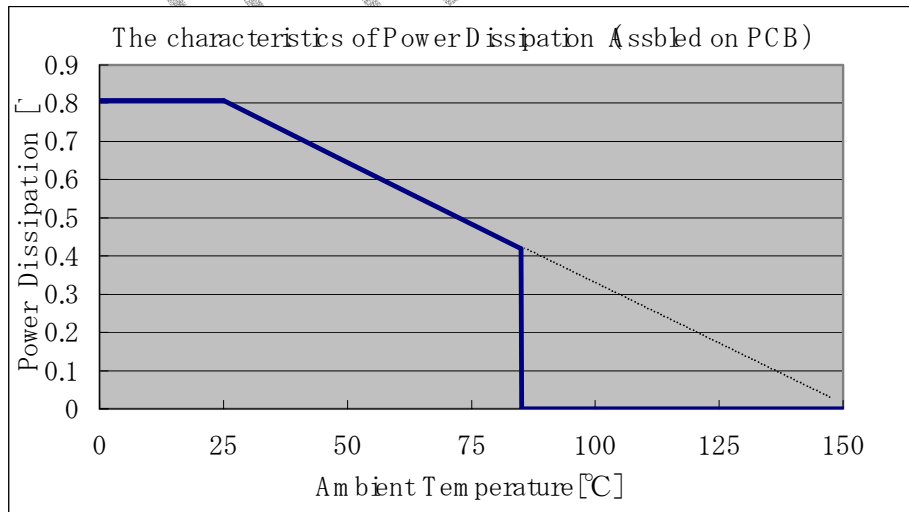


These figures are showing as the standard application example. The current values or so are considered whenever it is designed. In case of output capacitance C3 is connected to Vout0, capacitance C3 connecting to Vout1 and Vout2 may be omitted.

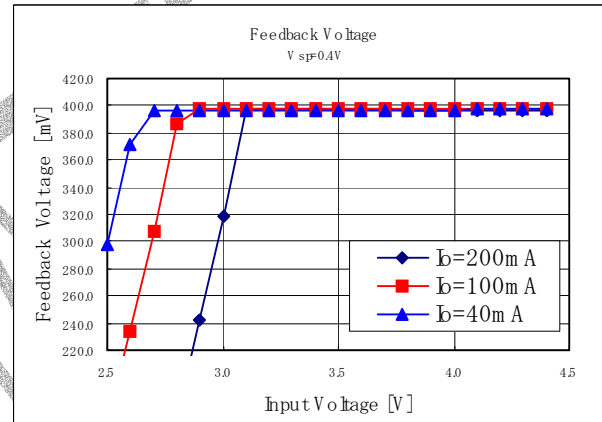
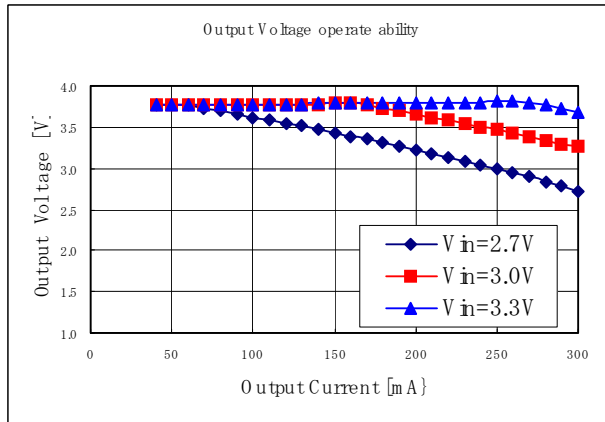
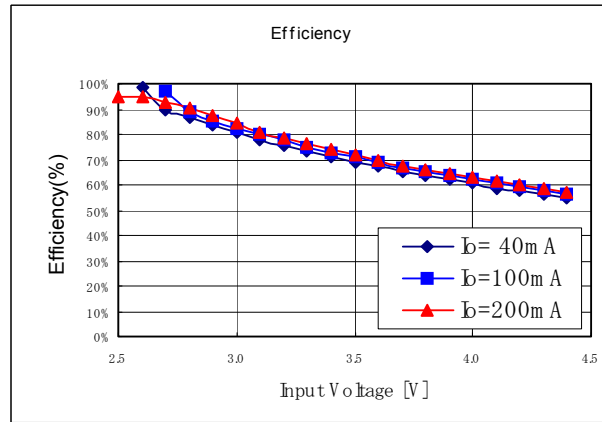
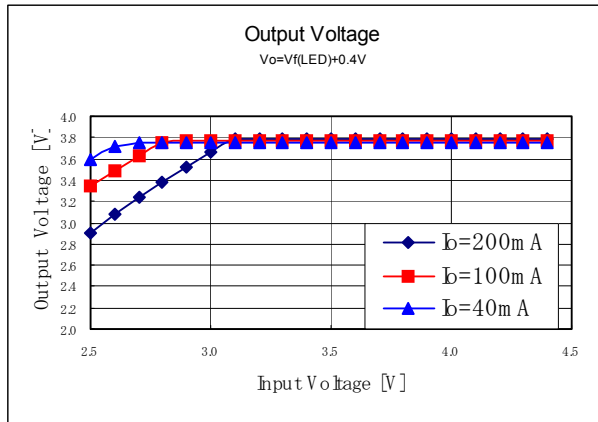
The current value is just example for the explanation of this device function, please note that power dissipation should be taken care when the system is designed or define the current value.

■ Power Dissipation

If the ambient temperature is exceed than 25 degree C , it is derated with derating factor of 1.24mW/Degree C. <In case of assembled SEMI PCB((75 mm x 114 mm) ; 155 degree C/W)>



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