TOSHIBA BiCD Digital Integrated Circuit Silicon Monolithic

TB62737FUG

Step Up Type DC/DC Converter for White LED

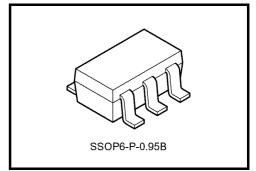
Features

The TB62737FUG is a high efficient Step-Up Type DC/DC Converter specially designed for constant current driving of White LED. This IC can drive 2-6 white LEDs connected series using a Li-ion battery.

This IC contains N-ch MOS-FET Transistor for Coil-Switching, and LED Current (I_F) is set with an external resistor.

This IC is especially for driving back light white LEDs in LCD of PDA, Cellular Phone, or Handy Terminal Equipment.

Characteristics

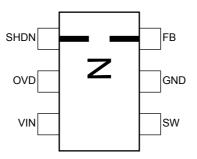


Weight: 0.016 g (Typ.)

- Brightness Control Function with changing drive current : LED Current I_F = 25% to 100% (Analog Input to SHDN terminal) For the control in range of 25% or less, refer 7-page.
- Maximum output voltage : V₀ = 24 V
 Can drive 2 6 white LEDs connected 4
- Can drive 2-6 white LEDs connected series (Typ. 4LEDs)

 Variable LED Current I_F is set with a external resistor :
 - 20 mA (Typ.) @RSENS = 16 Ω
- Output Power : Available for 480mW LED loading
- High Efficiency : 87% @Maximum (Using recommended external parts: Typ. 4LEDs)
- Output Over Voltage Shutdown Function :
 - Switching Operation is shut downed when OVD terminal Voltage is over 19 V (typ.).
- IC Package : SOT23-6
- Switching Frequency : 1.1 MHz (Typ.)

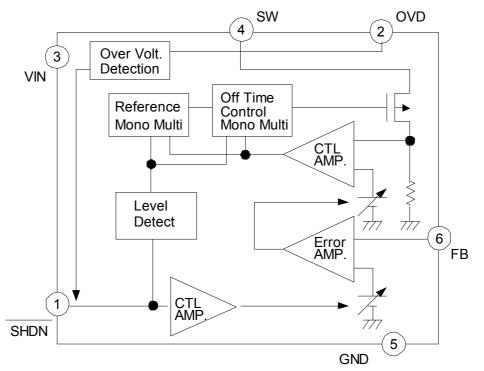
Pin Assignment (Top view)



Caution 1: This IC could be destroyed in some case if amounted in 180° inverse direction. Please be careful about IC direction in mounting.

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Block Diagram



Pin Function

Pin No.	Symbol	Function Description
1	SHDN	Voltage-Input Terminal for IC-Enable / Setting LED-I _F . 0V to 0.5V : Shutdown (PS) Mode, IC operation is disabled. 1.0V to 2.5V : I _F = 25% to 100% Over 2.5V : I _F = 100% I _F adjustment with PWM input signal is also available.
2	OVD	Over Voltage Detection Terminal. IC Switching Operation is disabled with detection over voltage. If the voltage returns to detection level or less, Operation is enabled again.
3	VIN	Supply Voltage Input Terminal. (2.8V to 5.5V)
4	SW	Switch Terminal for DC/DC Converter. Nch MOSFET Built-In.
5	GND	Ground Terminal.
6	FB	LED I _F Setting Resister Connecting Terminal.

Absolute Maximum Ratings (Topr = 25 °C if without notice)

Characteristics	Symbol	Ratings	Unit	
Power Supply Voltage	V _{IN}	-0.3 to +6.0	V	
Input Voltage	V _{SHDN}	-0.3 to $+V_{IN} + 0.3$	V	
Switching Terminal Voltage	V _o (SW)	-0.3 to 24	V	
Switching Terminal Current	I _o (SW)	380	mA	
Dewar Dissinction	Pp	0.41 (Device)	W	
Power Dissipation	ГD	0.47 (on PCB) Caution 2	vv	
T I I D I <i>I</i>	D	300 (Device)	°C 1.1/	
Thermal Resistance	R _{th (j-a)}	260 (on PCB)	°C/W	
Operation Temperature Range	T _{opr}	-40 to +85	°C	
Storage Temperature Range	T _{stg}	-55 to +150	°C	
Maximum Junction Temperature	Tj	150	°C	

Caution 2: Power Dissipation must be calculated with subtraction of 3.8 mW/°C from Maximum Rating with every 1°C if T_{opr} is upper 25°C. (on PCB)

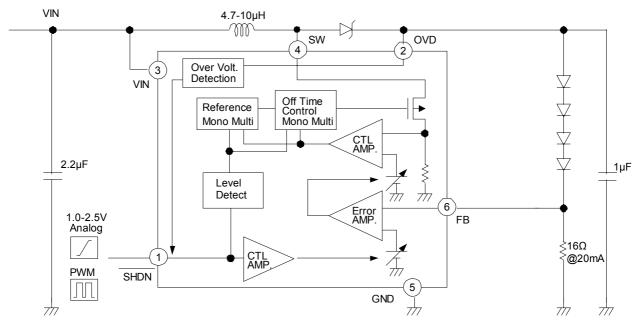
Recommended Operating Condition (Ta = -40°C to 85°C if without notice)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Тур	Max	Unit
Power Supply Voltage	V _{IN}	-		2.8	-	5.5	V
SHDN terminal 'H' level input voltage	V _{SHDN} H	-		2.5	-	V _{IN}	V
SHDN terminal 'L' level input voltage	V _{SHDN} L	-		0	-	0.5	V
SHDN terminal input Pulse Width	tpw	-	ON duty width OFF duty width	33	-	-	μs
LED Current (Average Value)	I _{o1}	-	$\label{eq:VIN} \begin{array}{l} V_{IN} = 3.6 \; V, \; R_{SENS} \texttt{=} 16 \Omega \\ \texttt{4LEDs}, \; T_{opr} \texttt{=} 25^{\circ} \texttt{C} \end{array}$	-	20	-	mA

Electrical Characteristics (Ta = -40° C to 85° C if without notice)

Characteristics	Symbol	Test Condition	Min	Тур	Max	Unit
Input Voltage Range	V _{IN}		2.8	-	5.5	V
Operating Consumption Current	I _{IN} (On)	VIN=3.6V, RSENS=16Ω	-	0.9	1.5	mA
Quiescent Consumption Current	I _{IN} (Off)	VIN=3.6V,V _{SHDN} =0V	-	0.5	1.0	μA
SHDN Terminal Current	I _{SHDN}	VIN=3.6V,V _{SHDN} =3.6V	-10	0	10	μA
Integrated MOS-Tr Switching Frequency	f _{osc}	VIN=3.6V,V _{SHDN} =3.6V	0.77	1.1	1.43	MHz
SW Terminal Protection Voltage	V _o (SW)	-	-	25	-	V
Switching Terminal Current	I _{oZ} (SW)	-	-	400	-	mA
Switching Terminal Leakage Current	I _{oz} (SW)	-	-	0.5	1	μA
FB Terminal Feedback Voltage (VFB)	V_{FB}	V _{IN} =3.6V, RSENS=16Ω T _{opr} =25°C, L=6.8μH	308	325	342	mV
FB Terminal Line Regulation	ΔV_{FB}	V_{IN} =3.6V center V_{IN} =3.0 to 5.0V	-5	-	5	%
OVD Terminal Voltage	V _{OVD}	-	19	22	23.5	V
OVD Terminal Leakage Current	I _{OVDZ}	V _{OVD} =16V	-	0.5	1	μA

Application Note



Protection in LED opened condition

The operation with OVD terminal is available for the protection in case LED Circuit opened.

Please see the example of application circuit.

If load of LED is detached, Nch MOS switching operation is disabled with detection of boost circuit voltage.

Setting of external Capacitor

In case not using PWM signal to \overline{SHDN} terminal for brightness control, recommended values are $C_1=Over~2.2~(\mu F),~C_2=Over~1.0~(\mu F)$

In case with PWM signal to \overline{SHDN} terminal for brightness control, recommended values are $C_1 = Over 4.7 \ (\mu F), C_2 = Under 0.1 \ (\mu F)$ to reduce fluctuation of input current and up accuracy of brightness.

The recommended capacitor values depend on the Brightness Control Method. <Please see after page-8> The capacitor value must be considered for gain enough accuracy of brightness with reduction of noise from

Setting of external Inductor size

Input current changing.

Please select the inductor size with referring this table corresponding to each number of LEDs.

Recommendation for the case that LED current I_F =20mA

LEDs	Indictor size	Note	
2	4 7.111	LED Current I _F =20mA	
3	4.7µH		
4	6.8µH		
5	8.1µH		
6	10µH		

Setting of Io

Resistance connects between RSENS pin and GND.

The average current is set by this RSENS value and average current are obtained by the following equation.

$$I_{F}[mA] = \frac{325[mV]}{RSENS [\Omega]}$$

Current Value error is within ±5%.

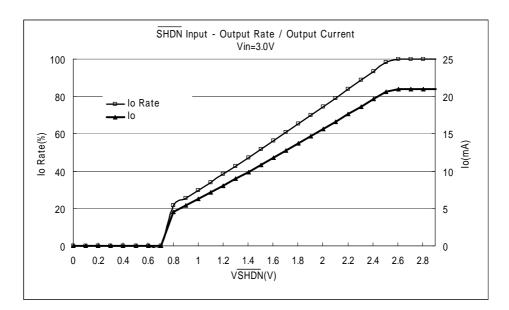
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Current Dimming Control

Recommended Brightness Control Circuits are 5 types.

- 1) Input analog voltage to SHDN terminal
 - I_F can be adjusted in range of 25% to 100% after set with external resistor connected RSENS terminal. Linearity error in V-A Conversion is within +/-10%.

SHDN Voltage	$V_{\overline{SHDN}} = 0V \sim 0.5V$	V _{SHDN} = 1V ~ 2.5V	V _{SHDN} > 2.5V	Note
lo Valuable Rate	0	25 ~ 100	100	Unit : %



2) Input PWM signal to SHDN terminal

 I_F can be adjusted with PWM signal by inputting it to \overline{SHDN} terminal.

[Notice]

《 Minimum ON-time of PWM signal input **》**

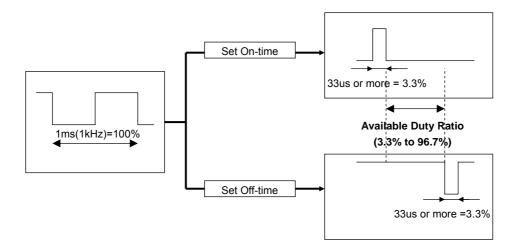
- Set the minimum ON-time or OFF-time 33µs or more in inputting the PWM signal.
- Set the Duty ratio satisfying the condition above.

Ex) In case PWM Frequency is 1kHz,

1kHz is 1ms (PWM Width = 100%) and it takes 10µs per 1%.

To set the pulse width 33us or more, necessary ON-or-OFF-time is calculated below. $33\mu s \div 10\mu s = 3.3\%$ (Under the condition that 10 μs equals 1%.)

Finally, the Duty Ratio can be set in range of 3.3% to 96.7%.



PWM signal frequency >

• The recommended PWM signal frequency is from 100Hz to 10kHz. There is a possibility to arise the audible frequency in mounting to the board because it is within the auditory area.

Constant number of external condenser >

- To reduce the fluctuation of input current and increase the accuracy of brightness, the values that $C_1 = 4.7$ (μ F) or more , $C_2 = 0.1$ (μ F) or less are recommended.
- When the PWM signal is off, the time to drain C_2 of charge depends on the constant number. And so, the actual value is little different from the theoretical value.

〈 PWM input signal **〉**

• Set the amplitude of PWM signal within the range of SHDN terminal specification.

• In case dimming by inputting the PWM signal to the SHDN terminal, this IC turns on and off repeatedly. And the rush current, which provides the charge to C_2 , arises in turning on. Take care in selecting the condenser.

《 Current value in Control with PWM : Ideal Equation **》**

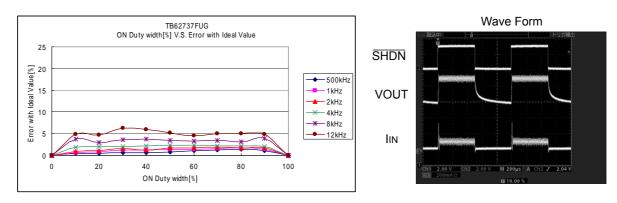
 $I_{F}[mA] = \frac{325[mV] \times ON \text{ Duty } [\%]}{\text{RSENS } [\Omega]}$

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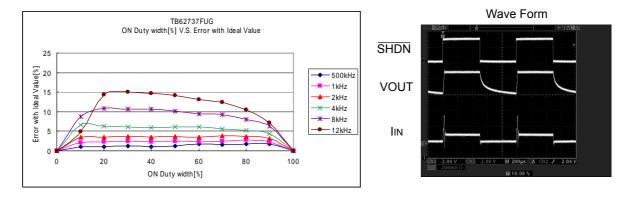
<Reference Data>

Condition: VIN=3.6V, L=6.8µH, 4LEDs, RSENS=16mΩ@lo=20mA

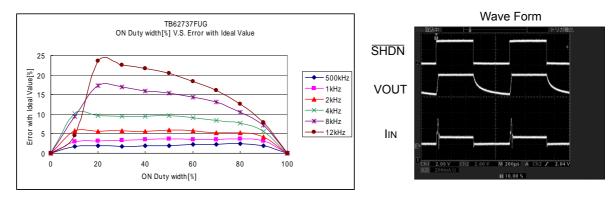
(1) C1=4.7µF, C2=0.1µF



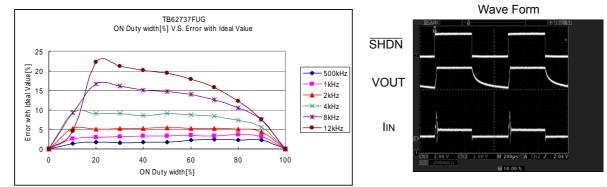
(2) C1=4.7µF, C2=0.47µF



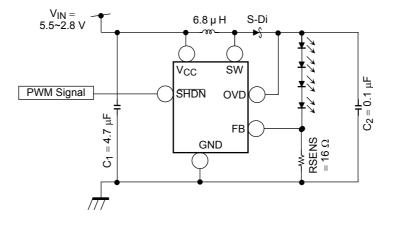
(3) C1=4.7µF, C2=1.0µF



(4) C1=2.2μF, C2=1.0μF



{Recommended application }



3) Input analog voltage to FB terminal

IF can be adjusted with Analog voltage input to FB terminal.

This method is without repeating IC ON/OFF, and no need to consider holding rash current.

<< Notice >>

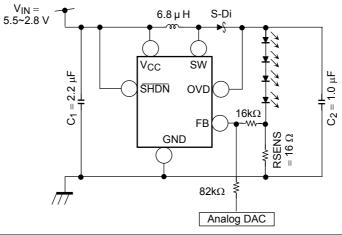
- \cdot LED current value goes over 100% of the current set with RSENS,
- if the input analog voltage is between 0V to 325mV(TYP.).

for ref.) Analog voltage = 0 to 2.2V

About external parts value, please see recommended circuit.

Supply Voltage[V]	Ratio with]
	Setting Current	TB62737FUG Analog Voltage Input to FB Terminal
No Connect(OFF)	100%	140.0%
0	116.0%	
0.2	106.5%	₩ 120.0% ₩ 100.0%
0.4	95.4%	€ 120.0% E 100.0% B 80.0% E 60.0%
0.6	84.5%	
0.8	73.6%	
1	59.9%	ti 40.0% ti 40
1.2	48.4%	
1.4	37.4%	0 0.5 1 1.5 2 2.5
1.6	26.6%	Input Voltage
1.8	15.9%	
2	5.8%	
2.2	0.0%]

{Recommended application}



4) Input PWM signal with filtering to FB terminal

IF can be adjusted with filtering PWM signal using RC filter indicated in recommended circuit, because the PWM signal can be regard as analog voltage after filtering. This method is without repeating IC ON/OFF, and no need to consider holding rash current.

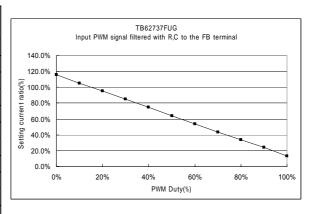
<< Notice >>

• LED current value goes over 100% of the current set with RSENS, if the input voltage after filtering is between 0V to 325mV(TYP.).

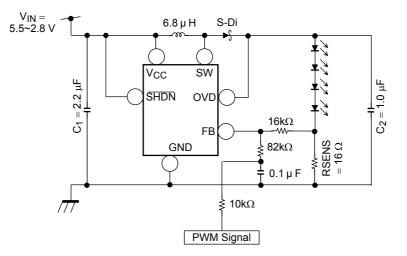
for ref.) Voltage during PWM Signal-ON = 2V

About external parts value, please see recommended circuit.

Supply Voltage[V]	Ratio with
	Setting Current
No Connect(OFF)	100%
0	116.1%
10%	105.3%
20%	95.1%
30%	84.8%
40%	74.6%
50%	64.0%
60%	53.8%
70%	43.7%
80%	34.0%
90%	24.2%
100%	13.3%



{Recommended application}

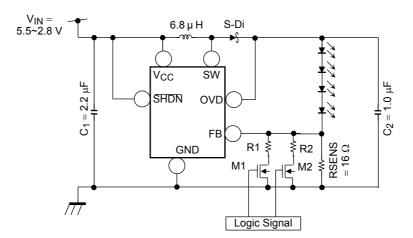


5) Input Logic signal

IF can be adjusted with Logic signal input as indicated in recommended circuit. The Resistor connected the ON-State Nch MOS Drain and RSENS determines IF.

 $\label{eq:linear} \begin{array}{l} \mbox{Average of Setting Current lo(mA) is next, approximately.} \\ I_F = (\ 325[mV] \ / \ Sum \ of \ Resistor \ Value[\Omega] \) \end{array}$

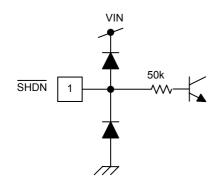
{Recommended application }



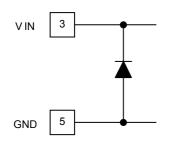
M1	M2	LED Current	
OFF	OFF	325[mV] RSENS [Ω]	
ON	OFF	325 [mV] × RSENS [Ω]+R1 [Ω]	
OFF	ON	325 [mV] × RSENS [Ω]×R2 [Ω] RSENS [Ω]+R2 [Ω]	
ON	ON	325 [mV] ×	

I/O Equivalent Pin Circuits

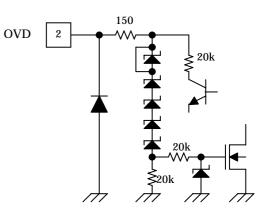
1. SHDN Terminal



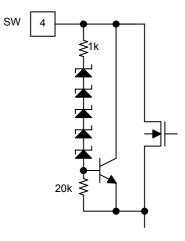
3. VIN terminal to GND terminal



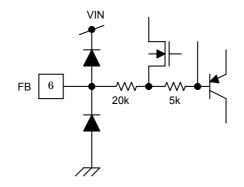
2. OVD Terminal

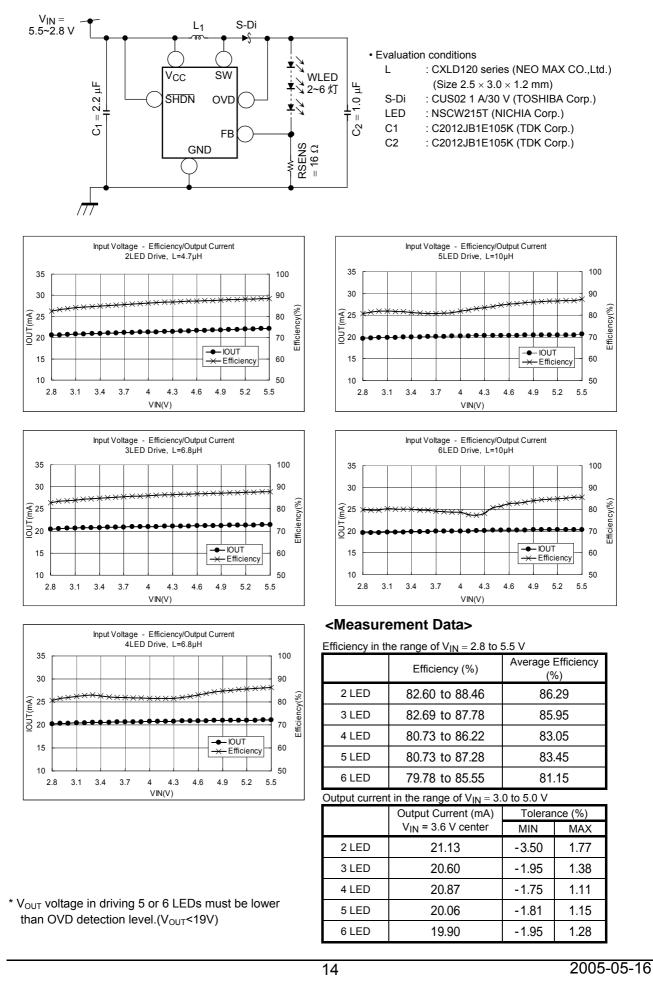


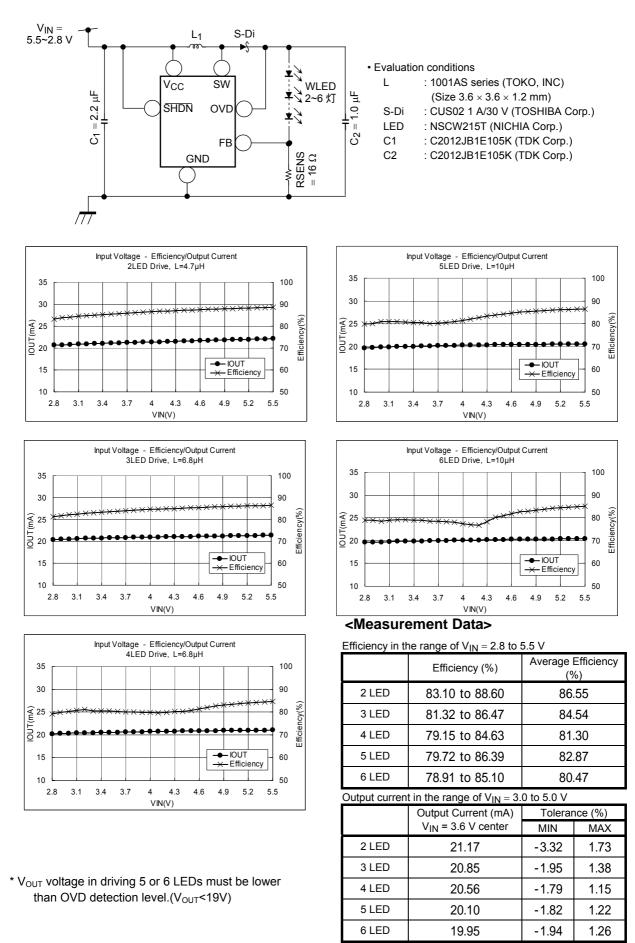
4. SW Terminal

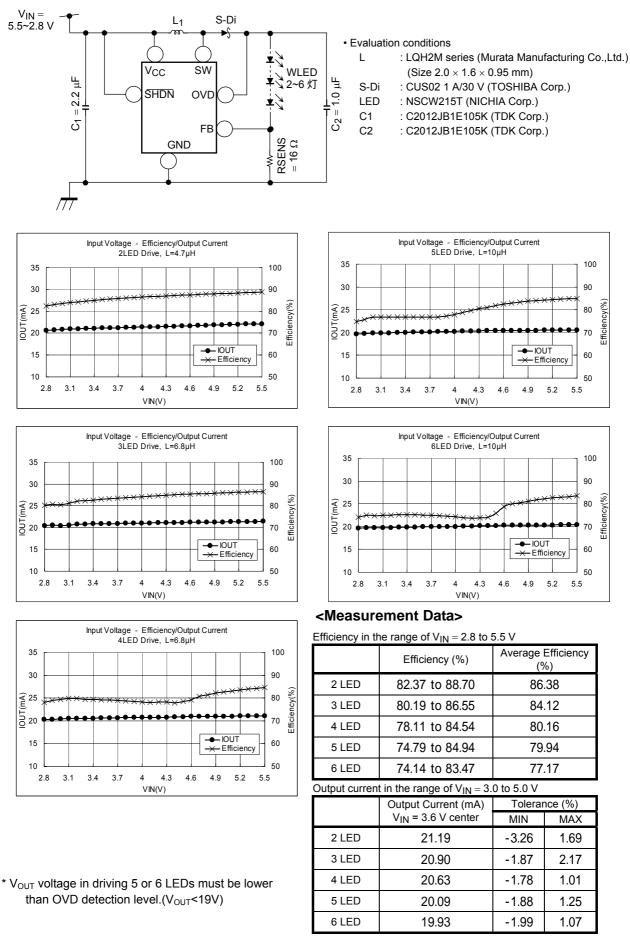


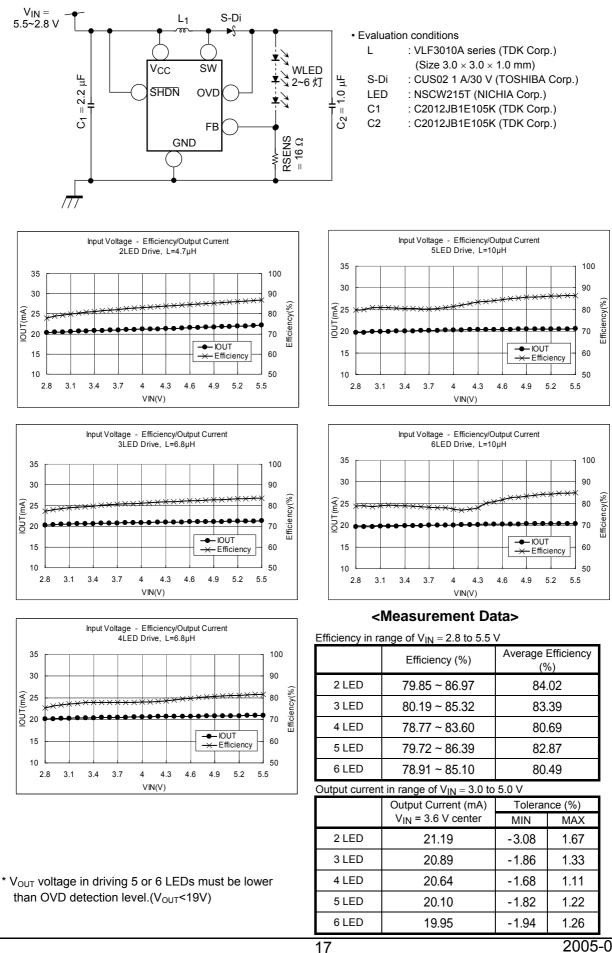
5. FB Terminal

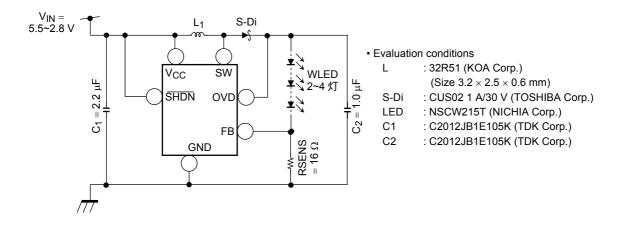


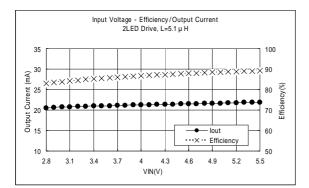


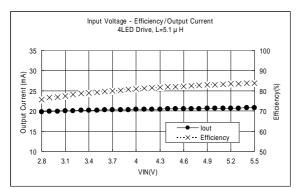


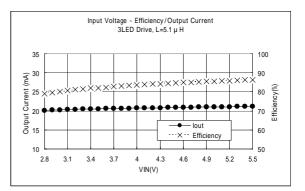












<Measurement Data>

Efficiency in the range of $V_{IN} = 2.8$ to 5.5 V

	Efficiency (%)	Average Efficiency (%)
2 LED	83.08 ~ 89.23	86.73
3 LED	79.02 ~ 86.30	83.52
4 LED	75.75 ~ 83.83	80.78

Output current in the range of V_{IN} = 3.0 to 5.0 V

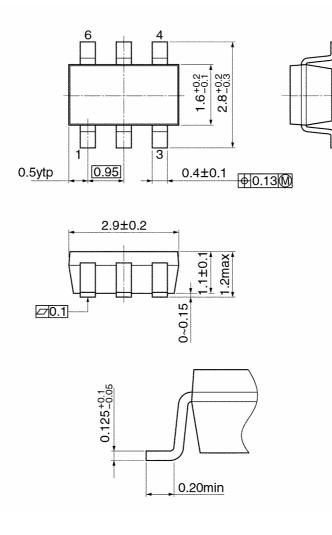
	Output Current (mA)	Tolerance (%)		
	V _{IN} = 3.6 V center	MIN	MAX	
2 LED	21.06	-2.46	4.02	
3 LED	20.57	-2.39	2.94	
4 LED	20.22	-2.28	2.65	

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Package Dimensions

SSOP6-P-0.95B

Unit: mm



Weight : 0.016 g (Typcal)

Regarding solder ability

Regarding solder ability, the following conditions have been confirmed.

- Solder ability
 - (1) Use of Sn-63Pb solder bath
 - solder bath temperature = 230°C, dipping time = 5 seconds, number of times = once, use of R-type flux (2) Use of Sn-3.0Ag-0.5Cu solder bath
 - solder bath temperature = 245°C, dipping time = 5 seconds, number of times = once, use of R-type flux

NOTES

- Utmost care is necessary in the design of the output line, VCC, COMMON and GND line since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.
- Do not insert devices in the wrong orientation. Make sure that the positive and negative terminals of power supplies are connected correctly. Otherwise, the rated maximum current of power dissipation may be exceeded and the device may break down or undergo performance degradation, causing it to catch fire or explode and resulting in injury.
- Please take care that IC might be destroyed in case external components were destroyed or not connected exactly.

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