TOSHIBA BiCD Digital Integrated Circuit Silicon Monolithic

TB62737FPG

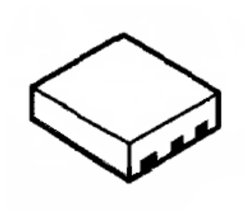
Step Up Type DC-DC Converter for White LED

The TB62737FPG 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.



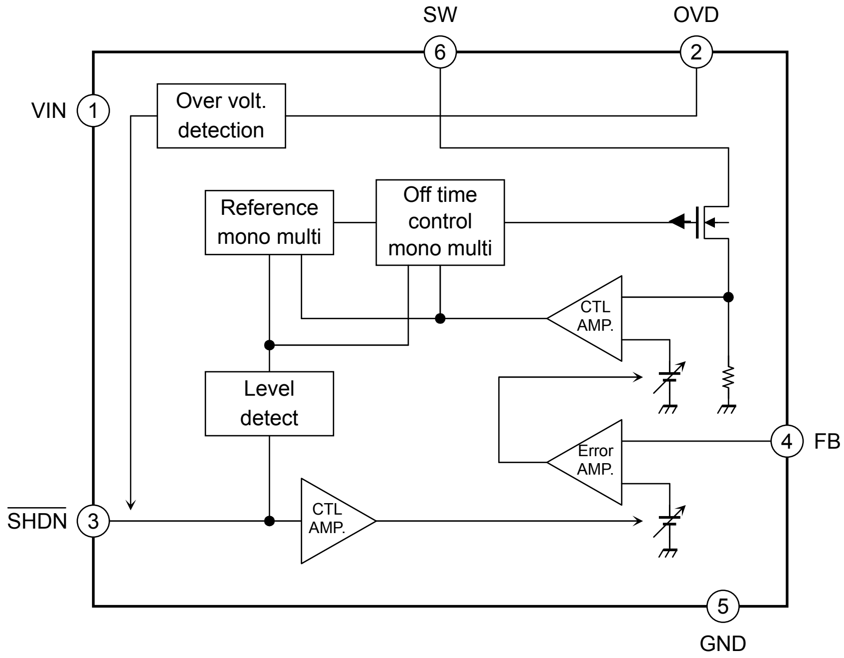
SON6-P-0202-0.50

Weight: 0.005 g (typ.)

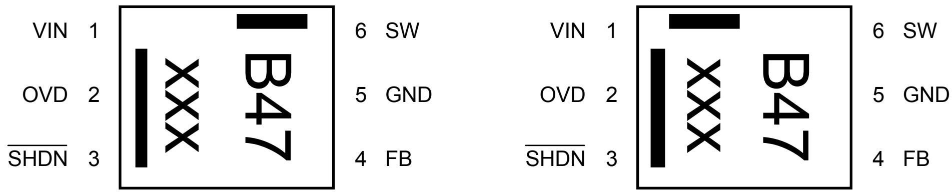
Features

- Brightness control function with changing drive current:
  LED current I_F = 25% to 100% (analog input)
  For the control in range of 25% or less, refer 5 page.
- Can drive 2-6 white LEDs connected series
- Built-in output over voltage detection circuit:
  When an OVD terminal becomes more than 22V (typ.), switching of in inductor is stopped.
- Variable LED current I_F is set with a external resistor:
  20 mA (typ.) @R_{SENS} = 16 Ω
- Output power: Available for 400 mW LED loading
- High efficiency: 87% @maximum (using recommended external parts)
- IC package: SON6-P-0202-0.50
- Switching frequency: 1.1 MHz (typ.)

Block Diagram



Pin Assignment (top view)



Week 1 to 26 Week 27 to 53

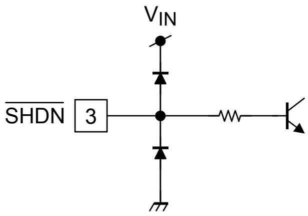
Note: This IC could be destroyed in some case if amounted in 180° inverse direction.
Please be careful about IC direction in mounting.

Pin Function

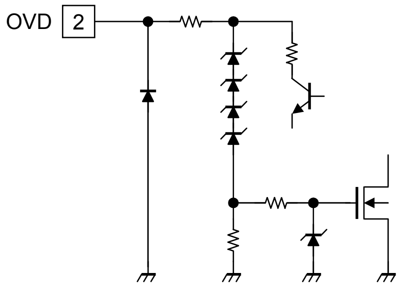
Pin No.	Symbol	Function Description
1	VIN	Supply voltage input terminal. (Voltage of operation is 2.8 to 5.5 V.)
2	OVD	Over voltage detection terminal. IC switching operation is disabled with detection over voltage. If the voltage returns to detection level or less, operation is enabled again.
3	$\overline{\text{SHDN}}$	Voltage-input terminal for IC-enable/setting LED-I_F. 0 V to 0.5 V: Shutdown (Power saving) mode, IC operation is disabled. 1.0 V to 2.5 V: I_F = 25% to 100% Over 2.5 V: I_F = 100% I_F adjustment with PWM input signal is also available.
4	FB	LED I_F setting resistor connecting terminal.
5	GND	Ground terminal.
6	SW	Switch terminal for DC-DC converter. Nch MOSFET built-in.

I/O Equivalent Pin Circuits

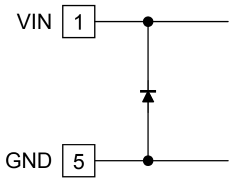
1. $\overline{\text{SHDN}}$ Terminal



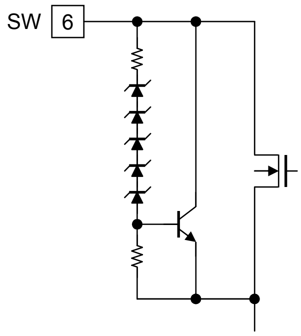
2. OVD Terminal



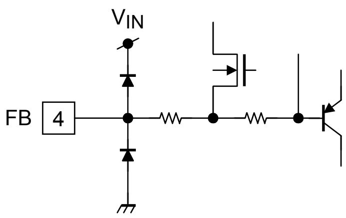
3. VIN Terminal to GND Terminal



4. SW Terminal



5. FB Terminal



Setting of External Capacitor

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

In case with PWM signal to $\overline{SHDN}$ terminal for brightness control, recommended values are C_1 = Over 4.7 (μF), C_2 = Under 0.1 (μF).

The recommended capacitor values depend on the Brightness Control Method.

<Please refer the next page or later>

The capacitor value must be considered for gain enough accuracy of brightness with reduction of noise from Input current changing.

Setting of External Inductor Size

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

Recommendation

LEDs	Indictor Size	Note
2	4.7 μH	LED current I_F = 20 mA
3		
4	6.8 μH	
5	8.1 μH	
6	10 μH	

LED Current IF Setting

The resistance between the FB pin and GND, R_{SENS} (Ω) is the resistance for the setting the output current.
Depending on the resistance value, it is possible to set the average output current I_F (mA).
The average output current I_F (mA) can be approximated with the following equation:

$$I_F = (325\ [mV]/R_{SENS}\ [\Omega])$$

The current value error is ± 5%.

Protection in LED Opened Condition

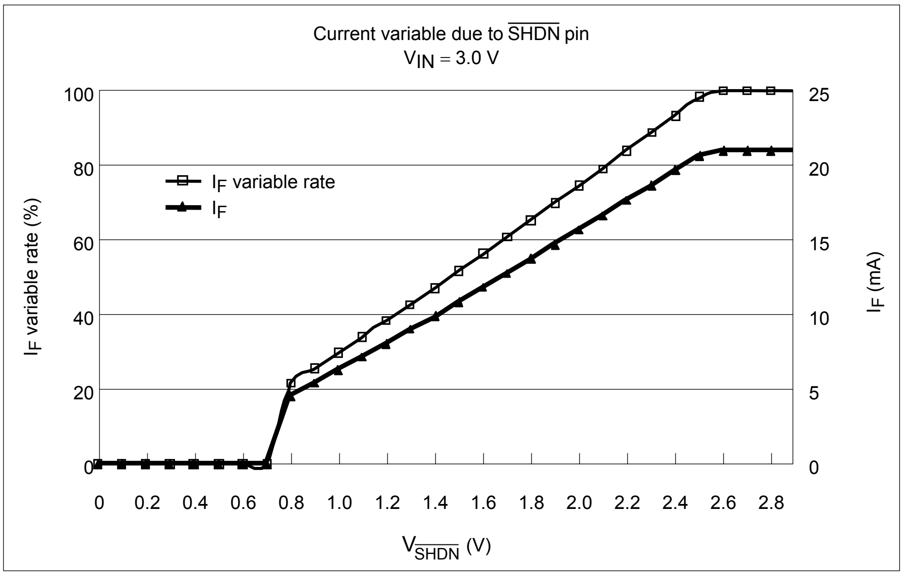
The operation with OVD terminal is available for the protection in case LED Circuit opened.
In the case of LED open circuit, Overvoltage output is detected and switching operation of NchMOS is stopped.
(*If the voltage returns to detection level or less, operation is enabled again.)

Current Dimming Control

Recommended Brightness Control Circuits are 5 types.

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

$\overline{SHDN}$ Voltage	$V_{\overline{SHDN}}$ = 0 V to 0.5 V	$V_{\overline{SHDN}}$ = 1 V to 2.5 V	$V_{\overline{SHDN}}$ > 2.5 V	Note
I_F Valuable Rate	0	25 to 100	100	Unit: %



2) Input PWM signal to $\overline{\text{SHDN}}$ terminal
I_F can be adjusted with PWM signal by inputting it to $\overline{\text{SHDN}}$ terminal.

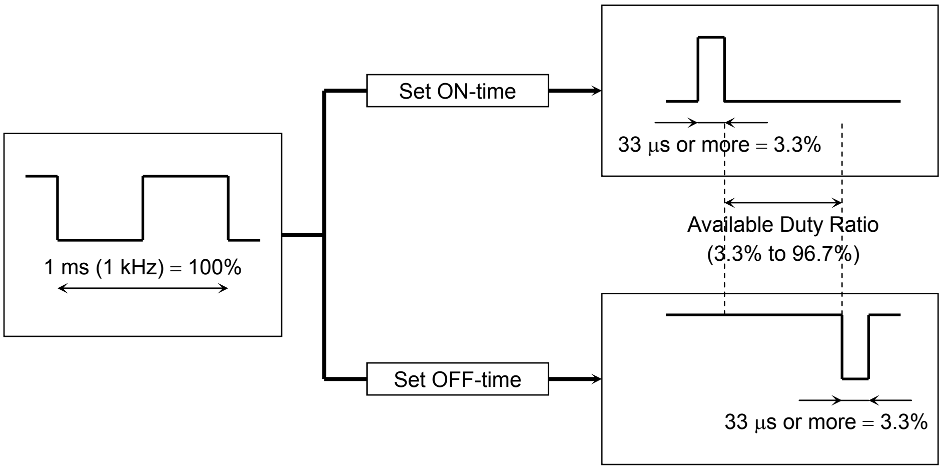
[Notice]

<<Minimum ON-time of PWM signal input>>

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

Ex) In case PWM Frequency is 1 kHz,
1 kHz is 1 ms (PWM width = 100%) and it takes 10 μs per 1%.
To set the pulse width 33 μs or more, necessary ON-or-OFF-time is calculated below.
33 μs ÷ 10 μs = 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 100 Hz to 10 kHz. 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 (μF) or more , C_2 = 0.1 (μF) 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 $\overline{\text{SHDN}}$ terminal specification.

<<Rush current in inputting>>

- In case dimming by inputting the PWM signal to the $\overline{\text{SHDN}}$ 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.

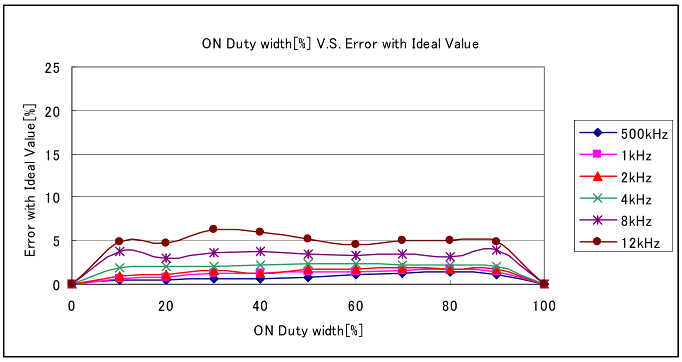
<<Current value in Control with PWM: Ideal Equation>>

$$I_F[\text{mA}] = \frac{325[\text{mV}] \times \text{ONDuty}[\%]}{R_{SENS}[\Omega]}$$

<Reference Data>

Condition: V_{IN} = 3.6 V, L = 6.8 μH, 4LEDs, R_{SENS} = 16 Ω @I_F = 20 mA

(1) C_1 = 4.7 μF, C_2 = 0.1 μF

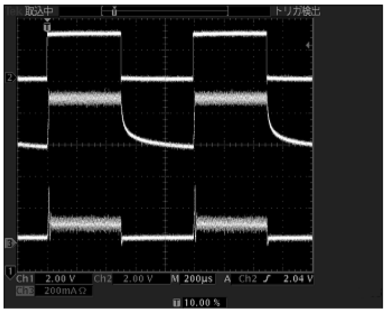


Wave Form

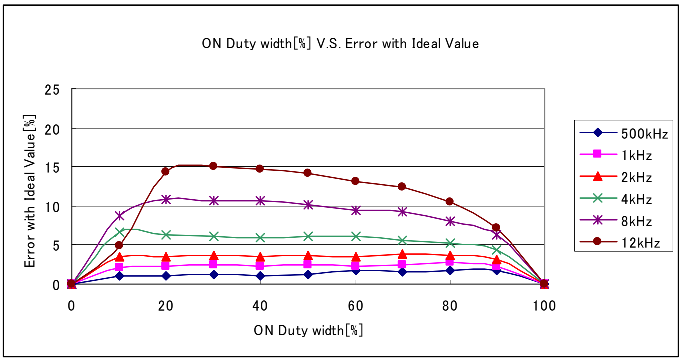
$\overline{SHDN}$

VOUT

I_{IN}



(2) C_1 = 4.7 μF, C_2 = 0.47 μF

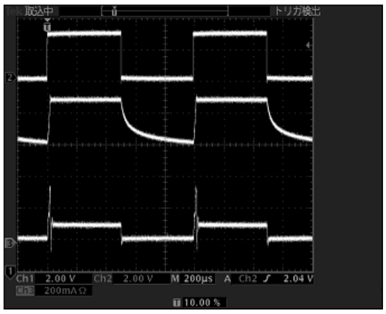


Wave Form

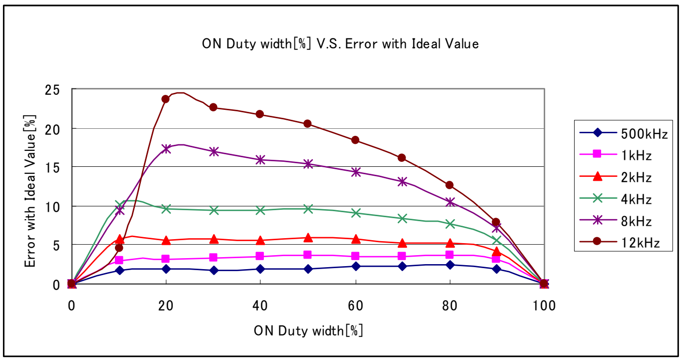
$\overline{SHDN}$

VOUT

I_{IN}



(3) C_1 = 4.7 μF, C_2 = 1.0 μF

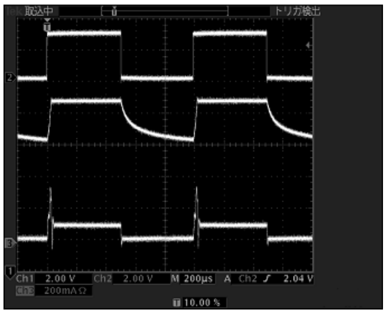


Wave Form

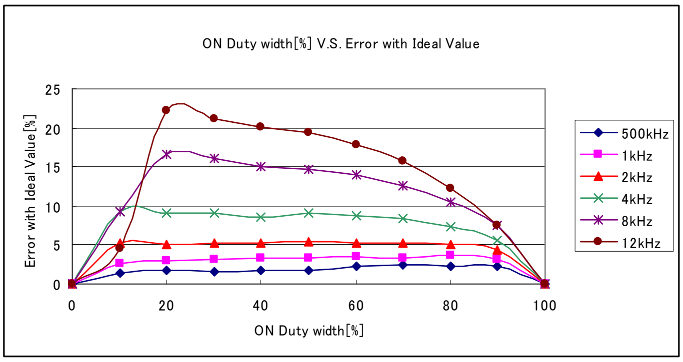
$\overline{SHDN}$

VOUT

I_{IN}



(4) C_1 = 2.2 μF, C_2 = 1.0 μF



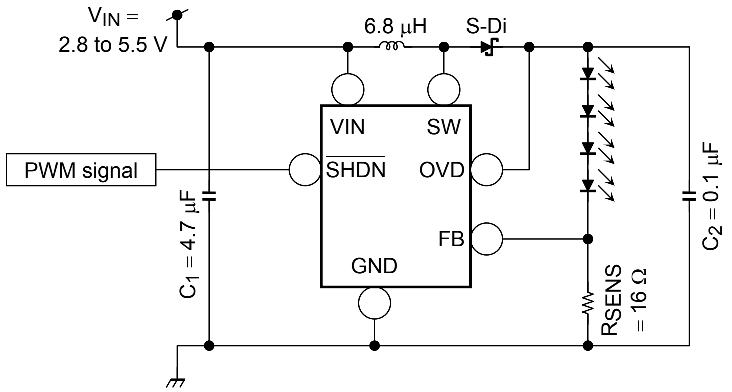
Wave Form

$\overline{SHDN}$

VOUT

I_{IN}

<Recommended application>

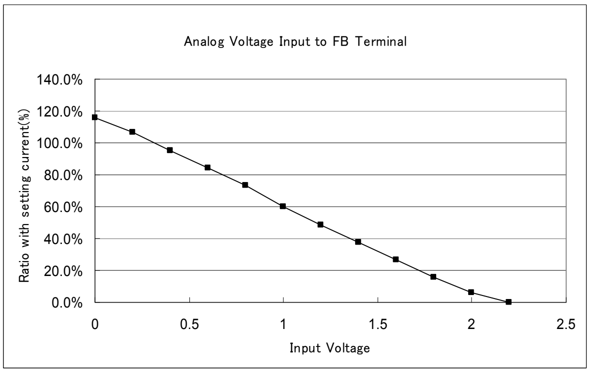


3) Input analog voltage to FB terminal
   I_F can be adjusted with Analog voltage input to FB terminal.
   This method is without repeating IC ON/OFF, and no need to consider holding rash current.

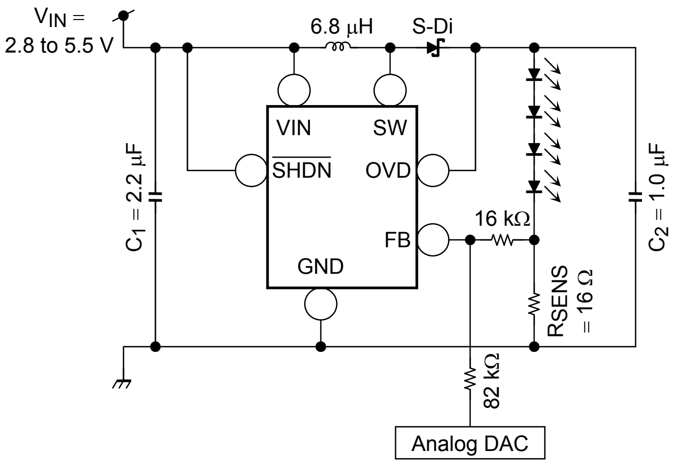
   [Notice]
   - LED current value goes over 100% of the current set with R_{SENS}, if the input analog voltage is between 0 V to 325 mV (typ.).

   (Reference data) Analog voltage = 0 to 2.2 V
   About external parts value, please see recommended circuit.

Supply Voltage (V)	Ratio with Setting Current
No connect (OFF)	100%
0	116.0%
0.2	106.5%
0.4	95.4%
0.6	84.5%
0.8	73.6%
1	59.9%
1.2	48.4%
1.4	37.4%
1.6	26.6%
1.8	15.9%
2	5.8%
2.2	0.0%



<Recommended application>



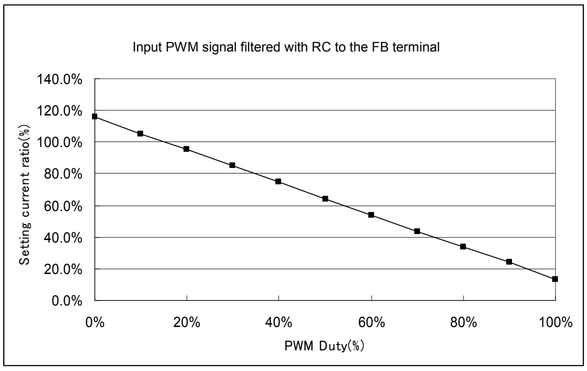
4) Input PWM signal with filtering to FB terminal
I_F can be adjusted with filtering PWM signal using RC filter indicated in recommended circuit, because the PWM signal can be regard as analog voltage after filtering.
This method is without repeating IC ON/OFF, and no need to consider holding rash current.

[Notice]

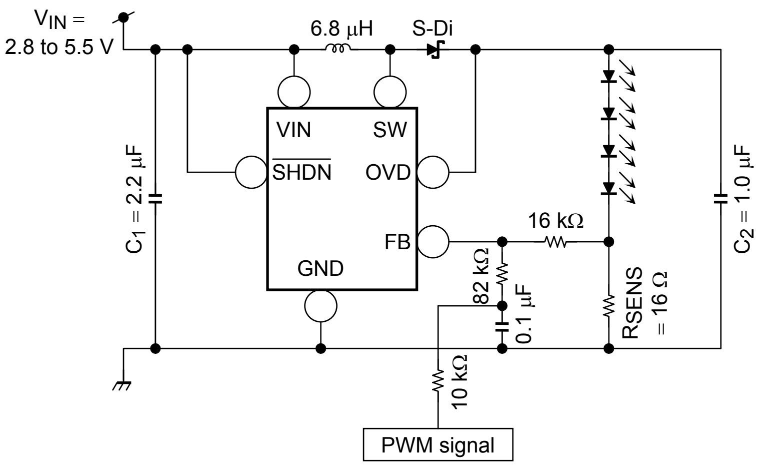
- LED current value goes over 100% of the current set with R_{SENS}, if the input voltage after filtering is between 0 V to 325 mV (typ.).

(Reference data) Voltage during PWM Signal-ON = 2 V
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>



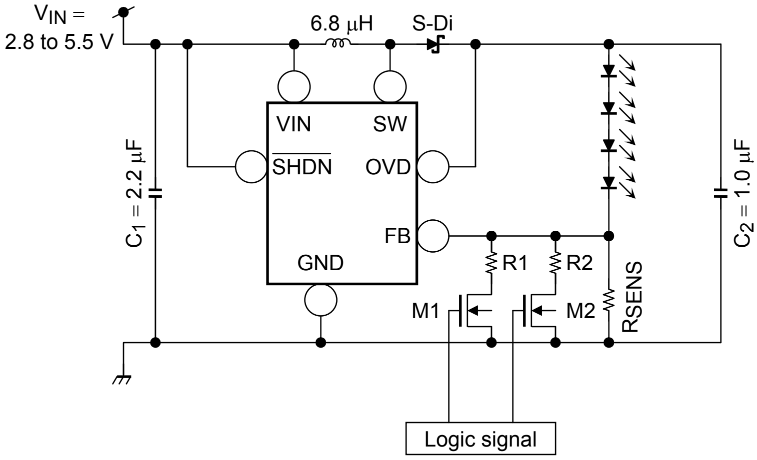
5) Input Logic signal

I_F can be adjusted with Logic signal input as indicated in recommended circuit.
The resistor connected the ON-State Nch MOS Drain and R_{SENS} determines I_F.

Average of setting current I_F (mA) is next, approximately.

I_F = (325 [mV]/Sum of resistor value [Ω])

<Recommended application>



M1	M2	I_F (LED Current)
OFF	OFF	$\frac{325[mV]}{R_{SENS}[\Omega]}$
ON	OFF	$325[mV] \times \frac{R_{SENS}[\Omega] + R_1[\Omega]}{R_{SENS}[\Omega] \times R_1[\Omega]}$
OFF	ON	$325[mV] \times \frac{R_{SENS}[\Omega] + R_2[\Omega]}{R_{SENS}[\Omega] \times R_2[\Omega]}$
ON	ON	$325[mV] \times \frac{R_{SENS}[\Omega] \times R_1[\Omega] + R_{SENS}[\Omega] \times R_2[\Omega] + R_1[\Omega] \times R_2[\Omega]}{R_{SENS}[\Omega] \times R_1[\Omega] \times R_2[\Omega]}$

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{IN}	−0.3 to + 6.0	V
Input terminal voltage	$V_{\overline{SHDN}}$	−0.3 to +V_{IN} + 0.3 (Note 3)	V
Switching terminal voltage	V_o (SW)	−0.3 to 24	V
Power dissipation (On PCB)	P_D	2.4 (Note1) (Note2) With Exposed Pad mounting	W
Thermal resistance (On PCB)	$R_{th\ (j\text{-}a)}$	52 (Note1) With Exposed Pad mounting	°C/W
Operation temperature range	T_{opr}	−40 to + 85	°C
Storage temperature range	T_{stg}	−55 to + 150	°C
Maximum junction temperature	T_j	150	°C

Note 1: PCB Condition : 76.4×114.3×1.6mm, JEDEC (4 layers)

Note 2: Power dissipation is reduced by 19.2mW/°C from the maximum rating for every 1°C exceeding ambient temperature of 25°C.

Note 3: Ensure that the supply voltage never exceeds 6.0 V.

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

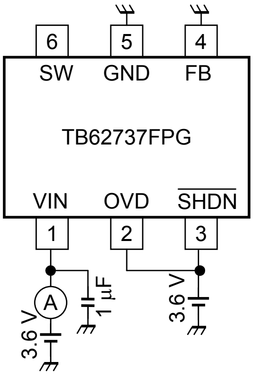
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Power supply voltage	V_{IN}	—	2.8	—	5.5	V
$\overline{SHDN}$ terminal “H” level input voltage	$V_{\overline{SHDN}H}$	—	2.7	—	V_{IN}	V
$\overline{SHDN}$ terminal “L” level input voltage	$V_{\overline{SHDN}L}$	—	0	—	0.5	V
$\overline{SHDN}$ terminal input pulse width	t_{pw}	Both “H” and “L” pulse	33	—	—	μs
LED current setting	I_{F1}	V_{IN} = 3.6 V, R_{SENS} = 16 Ω 4 White LEDs, T_{opr} = 25°C	—	20	—	mA

Electrical Characteristics (Ta = 25°C, V_{IN} = 2.8 to 5.5V if without notice)

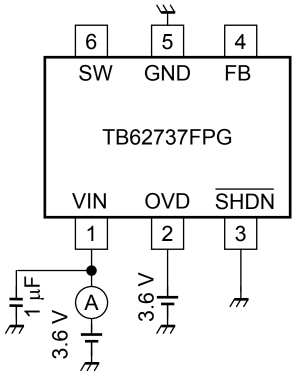
Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Power supply voltage	V_{IN}	-	—	2.8	—	5.5	V
Operating consumption current	I_{IN} (On)	1	V_{IN} = 3.6 V, R_{SENS} = 16 Ω	—	0.9	1.5	mA
Quiescent consumption current	I_{IN} (Off)	2	V_{IN} = 3.6 V, $V_{\overline{SHDN}}$ = 0 V	—	0.5	1.0	μA
$\overline{SHDN}$ terminal “H” level input voltage	$V_{\overline{SHDN}H}$	3	—	2.7	—	V_{IN}	V
$\overline{SHDN}$ terminal “L” level input voltage	$V_{\overline{SHDN}L}$	3	—	0	—	0.5	V
Integrated MOS-Tr switching frequency	f_{OSC}	6	V_{IN} = 3.6 V, $V_{\overline{SHDN}}$ = 3.6 V	0.77	1.1	1.43	MHz
Switching terminal protection voltage	V_o (SW)	4	—	—	25	—	V
Switching terminal current	I_o (SW)	-	—	—	400	—	mA
Switching terminal leakage current	I_{oz} (SW)	5	—	—	0.5	1	μA
FB terminal feedback voltage	V_{FB}	6	V_{IN} = 3.6 V, R_{SENS} = 16 Ω T_{opr} = 25°C, L = 6.8 μH	308	325	342	mV
FB terminal line regulation	ΔV_{FB}	6	V_{IN} = 3.6 V (typ.) V_{IN} = 3.0 to 5.0 V	−5	—	5	%
OVD terminal operating voltage	V_{OVD}	7	—	19	22	23.5	V
OVD terminal leakage current	I_{OVD}	8	V_{OVD} = 16 V	—	0.5	1	μA

Test circuit

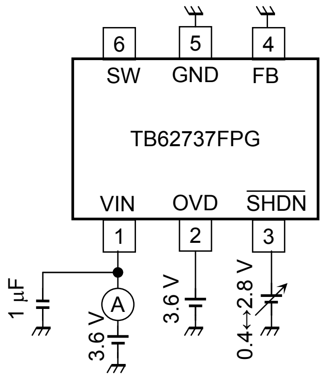
1. I_{IN} (On)



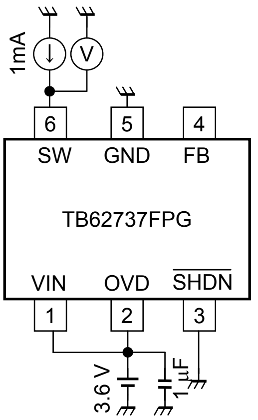
2. I_{IN} (Off)



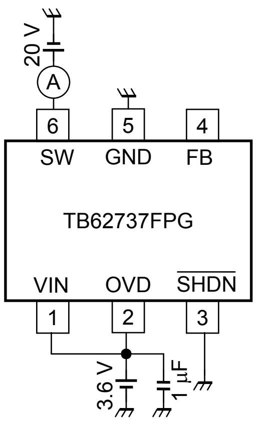
3. $V_{\overline{SHDN}H}$, $V_{\overline{SHDN}L}$



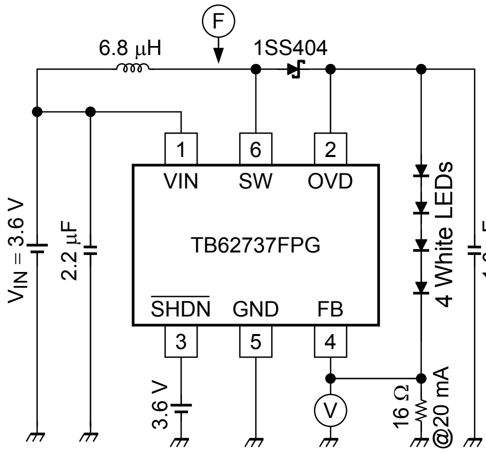
4. V_O (SW)



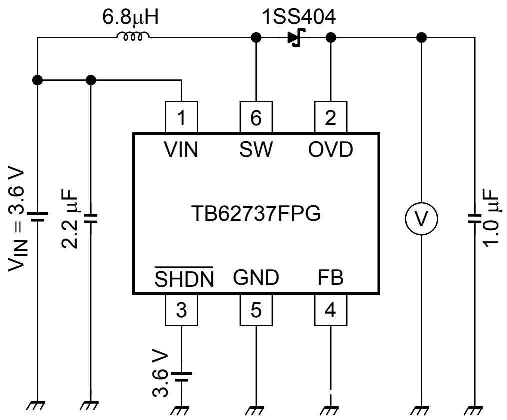
5. I_{OZ} (SW)



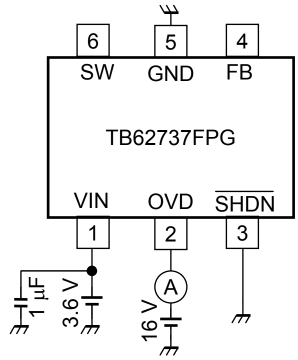
6. f_{OSC}, V_{FB}, ΔV_{FB} *1



7. V_{OVD}*1

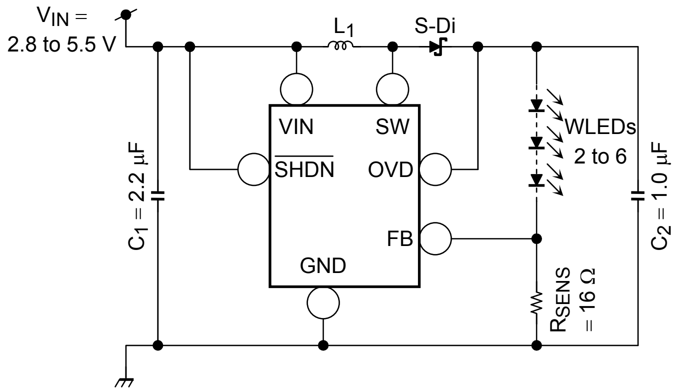


8. I_{OVD}



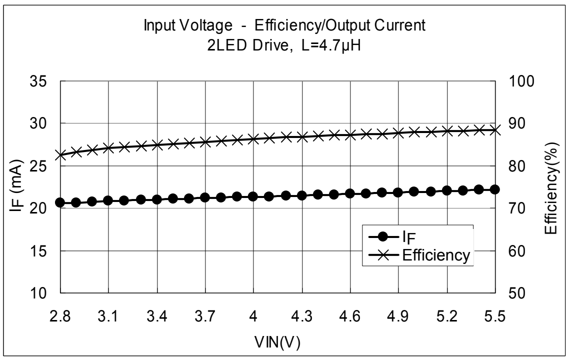
*1:The locations of the pins differ from the actual ones to simplify the diagram. See page 2 for the actual pin locations.

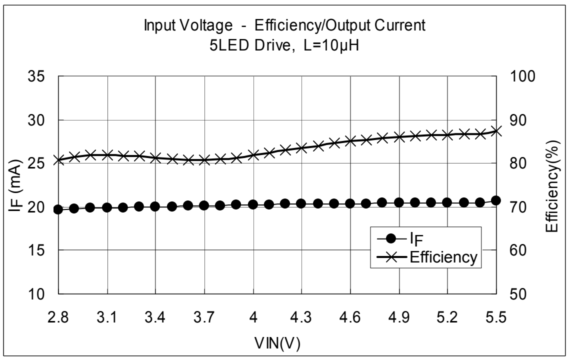
1. Application Circuit Example and Measurement Data (reference data)

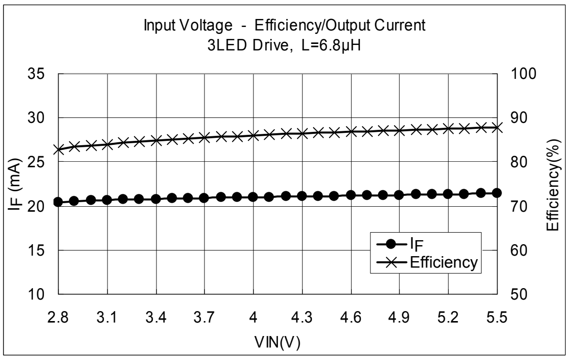


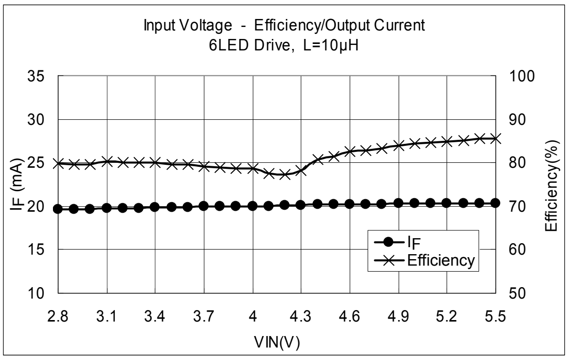
- Evaluation conditions (Ta = 25°C)

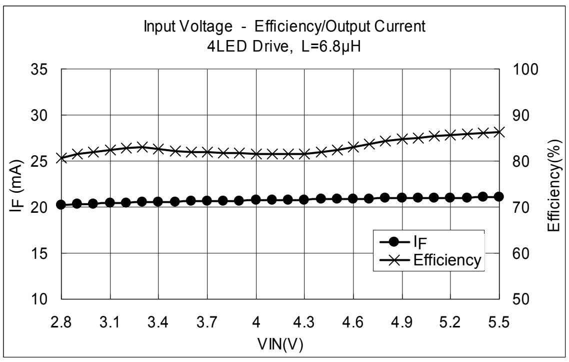
L_1 : CXLD120 series (NEO MAX CO.,Ltd.)
(Size: 2.5 mm × 3.0 mm × 1.2 mm)
C_1 : C2012JB1E225K (TDK Corp.)
C_2 : C2012JB1E105K (TDK Corp.)
S-Di : CUS02 1 A/30 V (TOSHIBA Corp.)
WLEDs: NSCW215T (NICHIA Corp.)
R_{SENS} : RK73B1ETBK (KOA Corp.)











<Measurement Data>

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

	Efficiency (%)	Average Efficiency (%)
2 LEDs	82.60 to 88.46	86.29
3 LEDs	82.69 to 87.78	85.95
4 LEDs	80.73 to 86.22	83.05
5 LEDs	80.73 to 87.28	83.45
6 LEDs	79.78 to 85.55	81.15

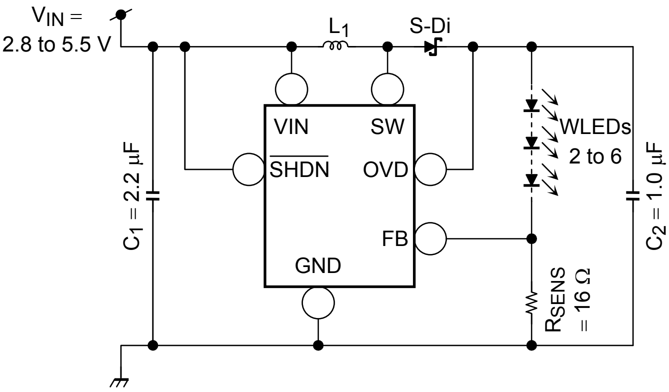
Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.13	−3.50	1.77
3 LEDs	20.60	−1.95	1.38
4 LEDs	20.87	−1.75	1.11
5 LEDs	20.06	−1.81	1.15
6 LEDs	19.90	−1.95	1.28

* V_{OUT} voltage in driving 5 or 6 LEDs must be lower than OVD detection level. (V_{OUT} < 19 V)

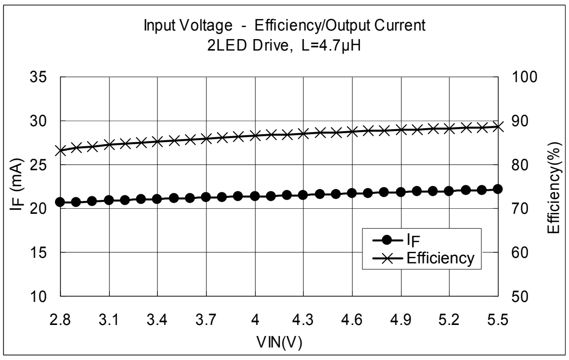
Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

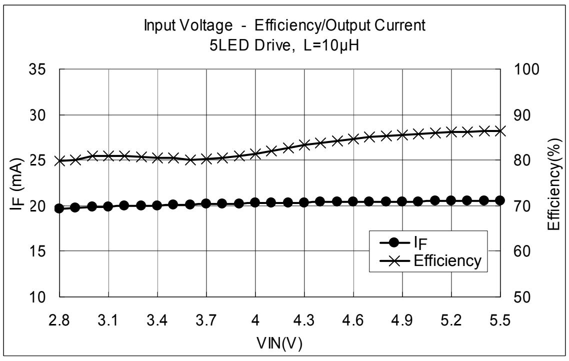
2. Application Circuit Example and Measurement Data (reference data)

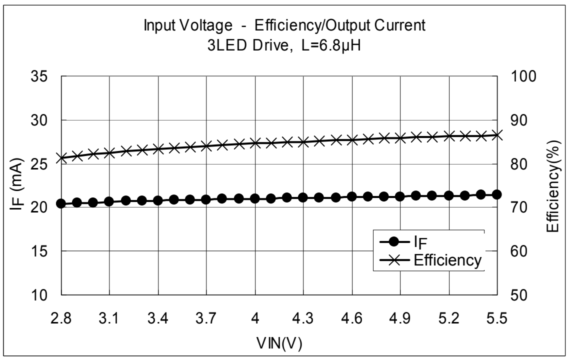


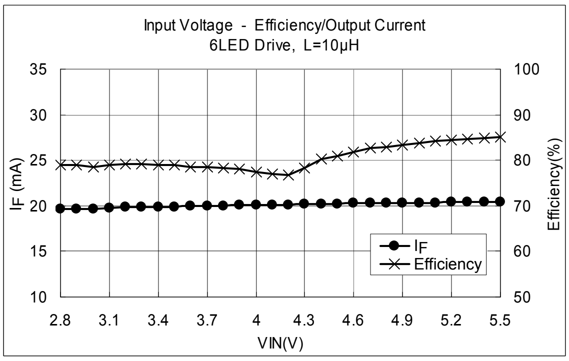
- Evaluation conditions (Ta = 25°C)

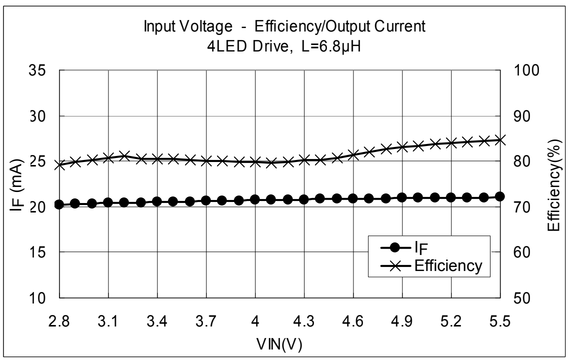
L_1	: 1001AS series (TOKO, INC) (Size: 3.6 mm × 3.6 mm × 1.2 mm)
C_1	: C2012JB1E225K (TDK Corp.)
C_2	: C2012JB1E105K (TDK Corp.)
S-Di	: CUS02 1 A/30 V (TOSHIBA Corp.)
WLEDs	: NSCW215T (NICHIA Corp.)
R_{SENS}	: RK73B1ETBK (KOA Corp.)











<Measurement Data>

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

	Efficiency (%)	Average Efficiency (%)
2 LEDs	83.10 to 88.60	86.55
3 LEDs	81.32 to 86.47	84.54
4 LEDs	79.15 to 84.63	81.30
5 LEDs	79.72 to 86.39	82.87
6 LEDs	78.91 to 85.10	80.47

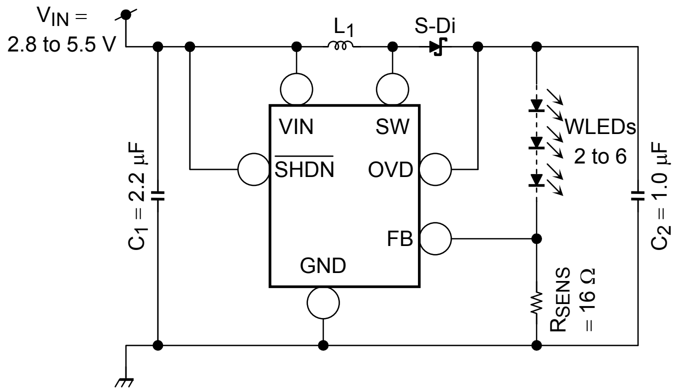
Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.17	−3.32	1.73
3 LEDs	20.85	−1.95	1.38
4 LEDs	20.56	−1.79	1.15
5 LEDs	20.10	−1.82	1.22
6 LEDs	19.95	−1.94	1.26

* V_{OUT} voltage in driving 5 or 6 LEDs must be lower than OVD detection level. (V_{OUT} < 19 V)

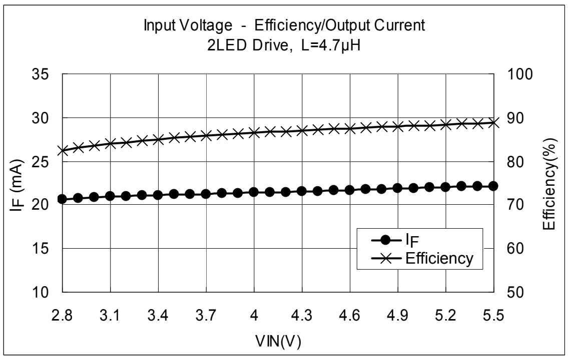
Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

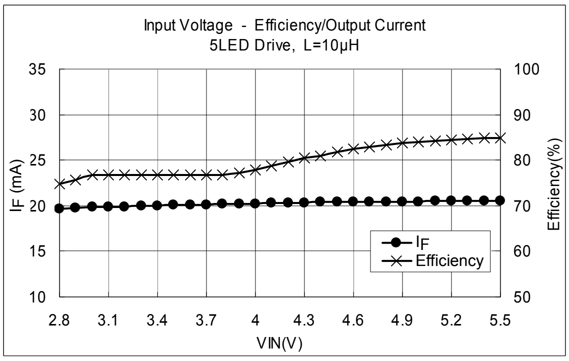
3. Application Circuit Example and Measurement Data (reference data)

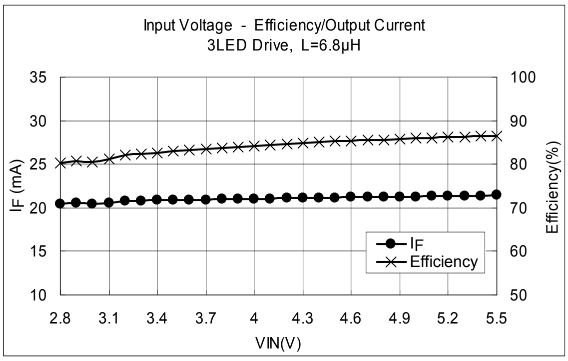


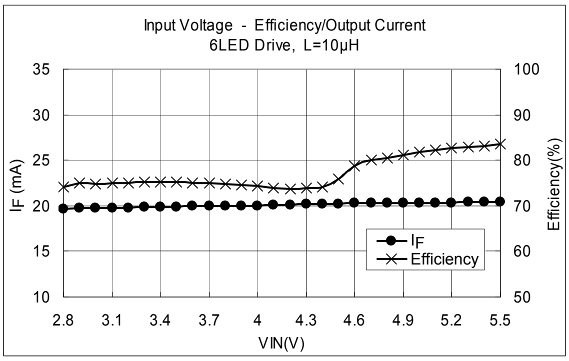
- Evaluation conditions (Ta = 25°C)

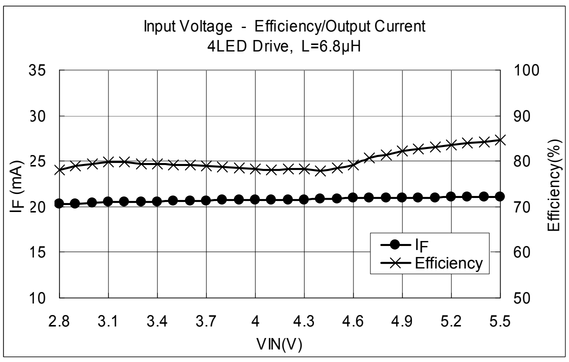
L_1	: LQH2M series (Murata Manufacturing Co.,Ltd.) (Size: 2.0 mm × 1.6 mm × 0.95 mm)
C_1	: C2012JB1E225K (TDK Corp.)
C_2	: C2012JB1E105K (TDK Corp.)
S-Di	: CUS02 1 A/30 V (TOSHIBA Corp.)
WLEDs	: NSCW215T (NICHIA Corp.)
R_{SENS}	: RK73B1ETBK (KOA Corp.)











<Measurement Data>

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

	Efficiency (%)	Average Efficiency (%)
2 LEDs	82.37 to 88.70	86.38
3 LEDs	80.19 to 86.55	84.12
4 LEDs	78.11 to 84.54	80.16
5 LEDs	74.79 to 84.94	79.94
6 LEDs	74.14 to 83.47	77.17

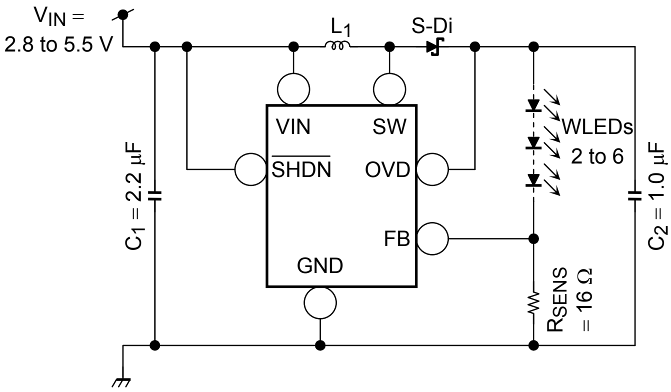
Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.19	−3.26	1.69
3 LEDs	20.90	−1.87	2.17
4 LEDs	20.63	−1.78	1.01
5 LEDs	20.09	−1.88	1.25
6 LEDs	19.93	−1.99	1.07

* V_{OUT} voltage in driving 5 or 6 LEDs must be lower than OVD detection level. (V_{OUT} < 19 V)

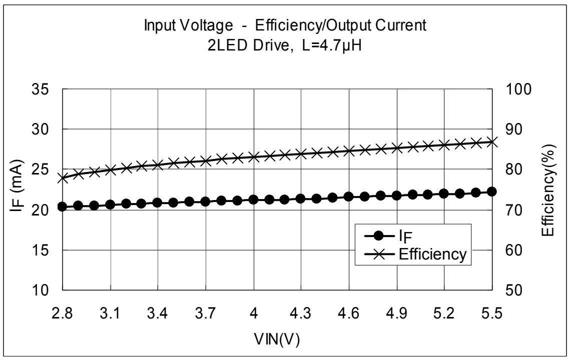
Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

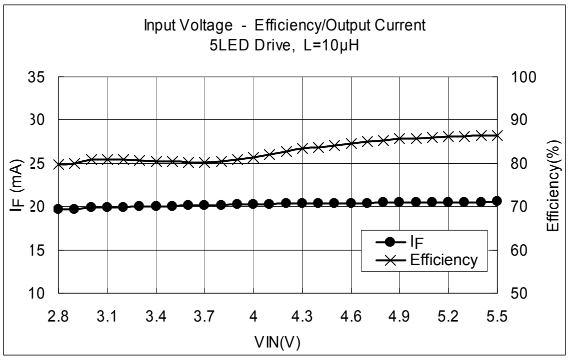
4. Application Circuit Example and Measurement Data (reference data)

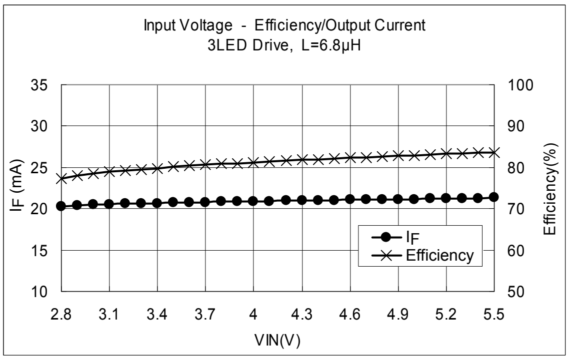


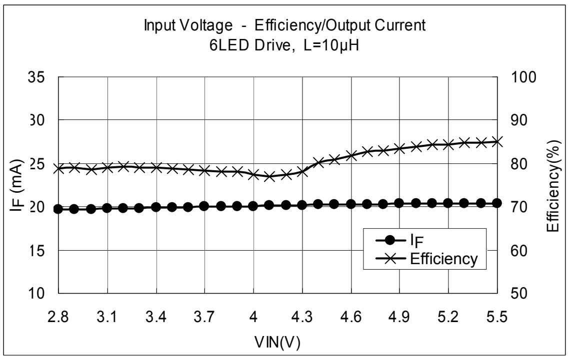
- Evaluation conditions (Ta = 25°C)

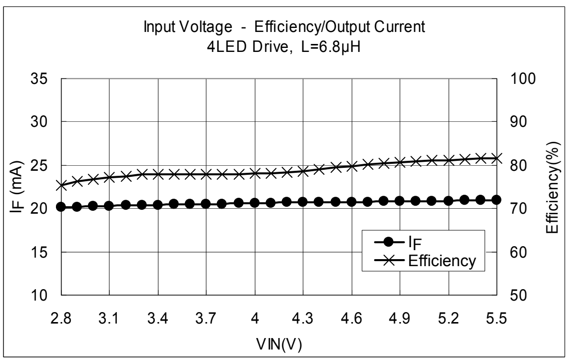
L_1	: VLF3010A series (TDK Corp.) (Size: 3.0 mm × 3.0 mm × 1.0 mm)
C_1	: C2012JB1E225K (TDK Corp.)
C_2	: C2012JB1E105K (TDK Corp.)
S-Di	: CUS02 1 A/30 V (TOSHIBA Corp.)
WLEDs	: NSCW215T (NICHIA Corp.)
R_{SENS}	: RK73B1ETBK (KOA Corp.)











<Measurement Data>

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

	Efficiency (%)	Average Efficiency (%)
2 LEDs	79.85 to 86.97	84.02
3 LEDs	80.19 to 85.32	83.39
4 LEDs	78.77 to 83.60	80.69
5 LEDs	79.72 to 86.39	82.87
6 LEDs	78.91 to 85.10	80.49

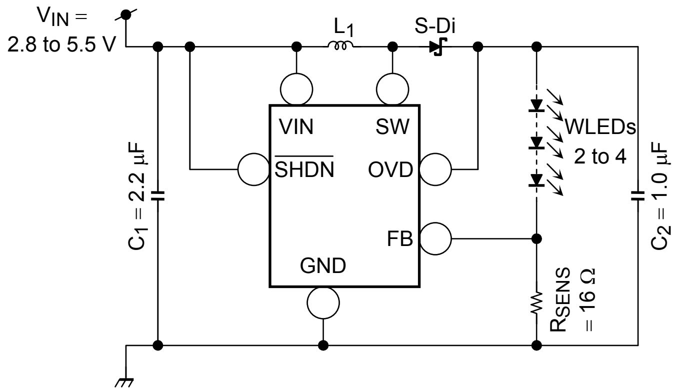
Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.19	−3.08	1.67
3 LEDs	20.89	−1.86	1.33
4 LEDs	20.64	−1.68	1.11
5 LEDs	20.10	−1.82	1.22
6 LEDs	19.95	−1.94	1.26

* V_{OUT} voltage in driving 5 or 6 LEDs must be lower than OVD detection level. (V_{OUT} < 19 V)

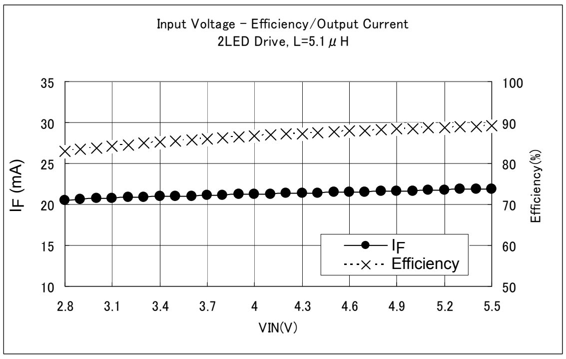
Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

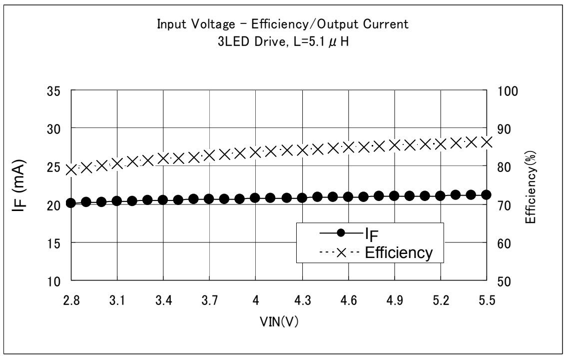
5. Application Circuit Example and Measurement Data (reference data)

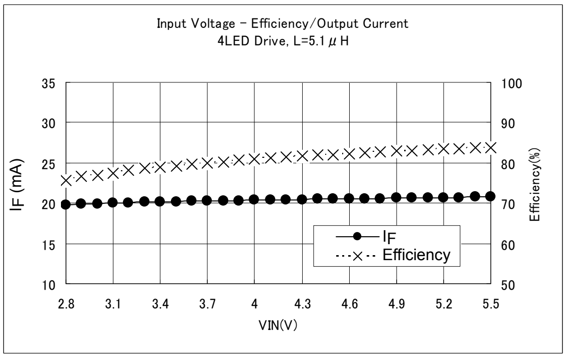


- Evaluation conditions (Ta = 25°C)

L_1	: 32R51 (KOA Corp.) (Size: 3.2 mm × 2.5 mm × 0.6 mm)
C_1	: C2012JB1E225K (TDK Corp.)
C_2	: C2012JB1E105K (TDK Corp.)
S-Di	: CUS02 1 A/30 V (TOSHIBA Corp.)
WLEDs	: NSCW215T (NICHIA Corp.)
R_{SENS}	: RK73B1ETBK (KOA Corp.)







<Measurement Data>

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

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

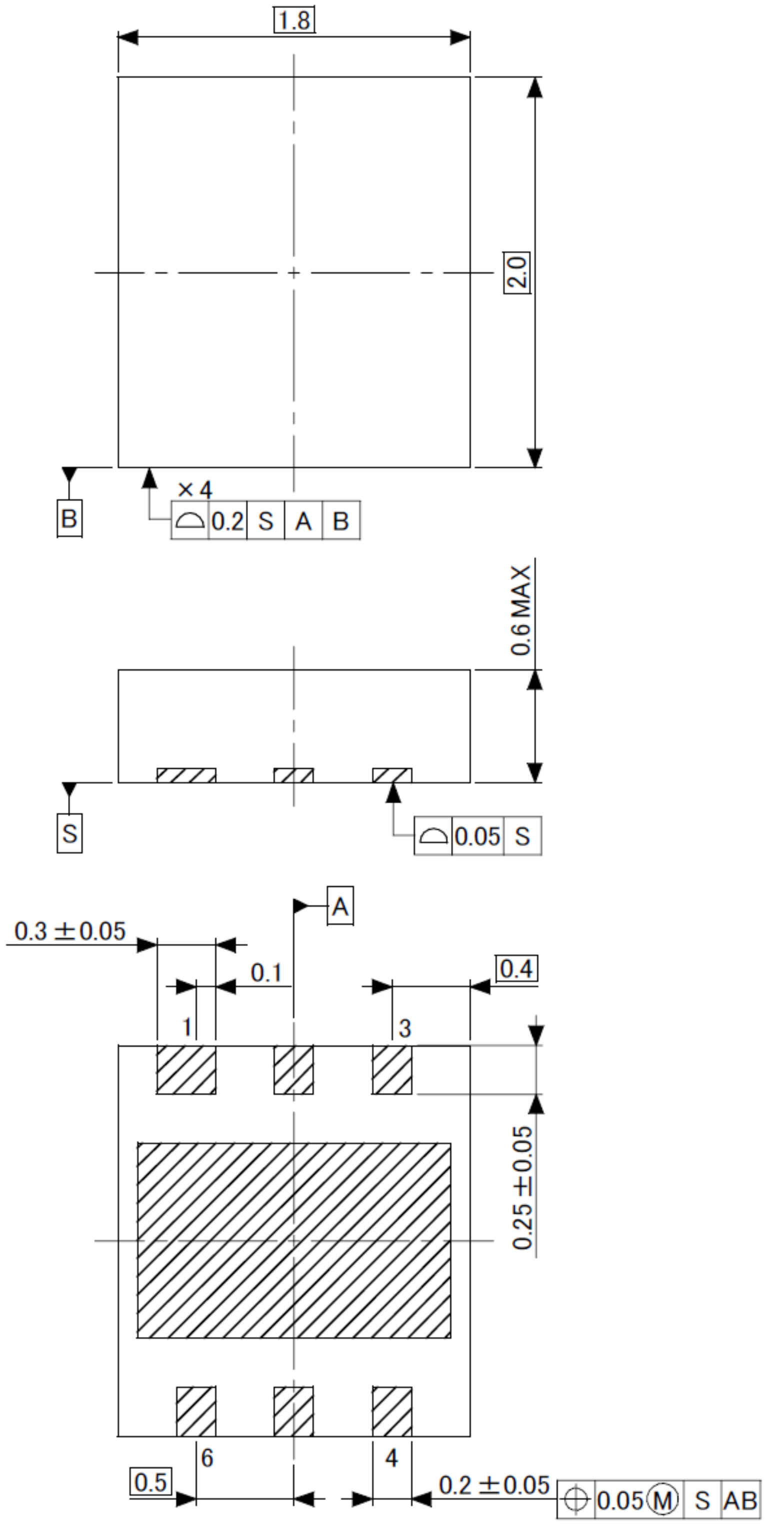
Output current in the range of V_{IN} = 3.0 to 5.0 V (V_{IN} = 3.6 V typ.)

	Output Current (mA) V_{IN} = 3.6 V	Tolerance (%)	
		Min	Max
2 LEDs	21.06	−2.46	4.02
3 LEDs	20.57	−2.39	2.94
4 LEDs	20.22	−2.28	2.65

Note: These application examples are provided for reference only. Thorough evaluation and testing should be implemented when designing your application's mass production design.

Package Dimensions

SON6-P-0202-0.50 Rev01 "Unit : mm"



Weight: 0.005 g (typ.)

Notes on Contents

1. Block Diagrams
Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

2. Equivalent Circuits
The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

3. Timing Charts
Timing charts may be simplified for explanatory purposes.

4. Application Circuits
The application circuits shown in this document are provided for reference purposes only. Thorough evaluation is required, especially at the mass production design stage.
Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

5. Test Circuits
Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

IC Usage Considerations
Notes on handling of ICs

[1] The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings.
Exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.

[2] Use an appropriate power supply fuse to ensure that a large current does not continuously flow in case of over current and/or IC failure. The IC will fully break down when used under conditions that exceed its absolute maximum ratings, when the wiring is routed improperly or when an abnormal pulse noise occurs from the wiring or load, causing a large current to continuously flow and the breakdown can lead smoke or ignition. To minimize the effects of the flow of a large current in case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.

[3] If your design includes an inductive load such as a motor coil, incorporate a protection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. IC breakdown may cause injury, smoke or ignition.
Use a stable power supply with ICs with built-in protection functions. If the power supply is unstable, the protection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.

[4] Do not insert devices in the wrong orientation or incorrectly.
Make sure that the positive and negative terminals of power supplies are connected properly.
Otherwise, the current or power consumption may exceed the absolute maximum rating, and exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
In addition, do not use any device that is applied the current with inserting in the wrong orientation or incorrectly even just one time.

[5] Carefully select external components (such as inputs and negative feedback capacitors) and load components (such as speakers), for example, power amp and regulator.
If there is a large amount of leakage current such as input or negative feedback condenser, the IC output DC voltage will increase. If this output voltage is connected to a speaker with low input withstand voltage, overcurrent or IC failure can cause smoke or ignition. (The over current can cause smoke or ignition from the IC itself.) In particular, please pay attention when using a Bridge Tied Load (BTL) connection type IC that inputs output DC voltage to a speaker directly.

Points to remember on handling of ICs

(1) Heat Radiation Design
In using an IC with large current flow such as power amp, regulator or driver, please design the device so that heat is appropriately radiated, not to exceed the specified junction temperature (T_J) at any time and condition. These ICs generate heat even during normal use. An inadequate IC heat radiation design can lead to decrease in IC life, deterioration of IC characteristics or IC breakdown. In addition, please design the device taking into considerate the effect of IC heat radiation with peripheral components.

(2) Back-EMF
When a motor rotates in the reverse direction, stops or slows down abruptly, a current flow back to the motor’s power supply due to the effect of back-EMF. If the current sink capability of the power supply is small, the device’s motor power supply and output pins might be exposed to conditions beyond maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

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