TOSHIBA Bi-CMOS Digital Integrated Circuit   Silicon Monolithic

TB62734FMG

Step-Up Type DC-DC Converter for White LED's

The TB62734FMG is a high-efficiency step-up type DC-DC converter   the design of which has been optimized for driving white LED's.

It is possible to drive two to six white LED's connected in series by the lithium ion battery. This IC contains the N-ch MOS transistor required for switching of external inductors.

The LED forward current is set up using an external resistor. PWM brightness control is possible through the use of analog voltage input and pulse input.

The switching frequency is fixed at around 1.0 MHz.

This IC is most suitable for use as a white LED backlighting driver for color LCD's in PDA's, cellular phones and handy terminal devices.

The suffix (G) appended to the part number represents a Lead (Pb) -Free product.

SON8-P-0.65
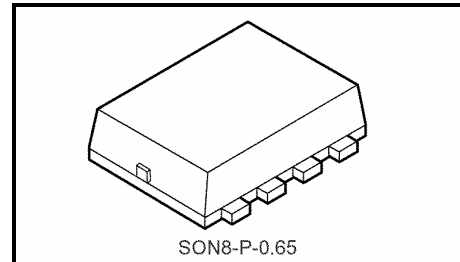
Weight: 0.02 g (typ.)

Features

- Brightness control function: LED forward current 30~100%
- Maximum output voltage: 24 V
  (supporting 2 to 6 LED's in series)
- LED current variable through external resistance:
  20 mA (typ.) @ RSENS = 7.5 Ω
- Output power: 500 mW
- Package: SON8-P-0.65 (typical height: 0.8 mm)
- High efficiency: 85% (recommended parts in use)
- Low-resistance power MOS included:
  Ron = 0.7 Ω (typ.) @ V_{IN} = 2.8 to 5.5 V
- Overvoltage detection included:
  Protection voltage: OVD pin = 20 V (typ.)

Pin Assignment (top view)

	B36	
V_{CC}		K
CTL		RSENS
OVD		GND
A		PGND
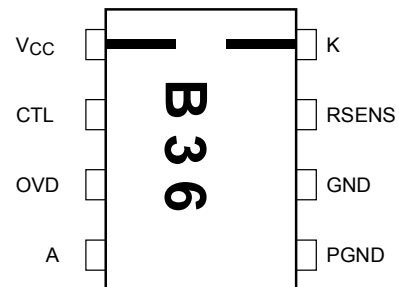
Note 1: The pins of this IC are sensitive to electrostatic discharge (3 pin: HBM spec < ±1.5 kV). Handle with care. Be sure to install the device in the correct orientation. Make sure that the positive and negative terminals of the power supplies are connected correctly. Misconnections may cause breakdown of the IC.

Note 2: Leaving the control pin open may cause output instability. Be sure to fix this control pin to a definite logic level. Be sure to fix this control pin to a definite logic level.
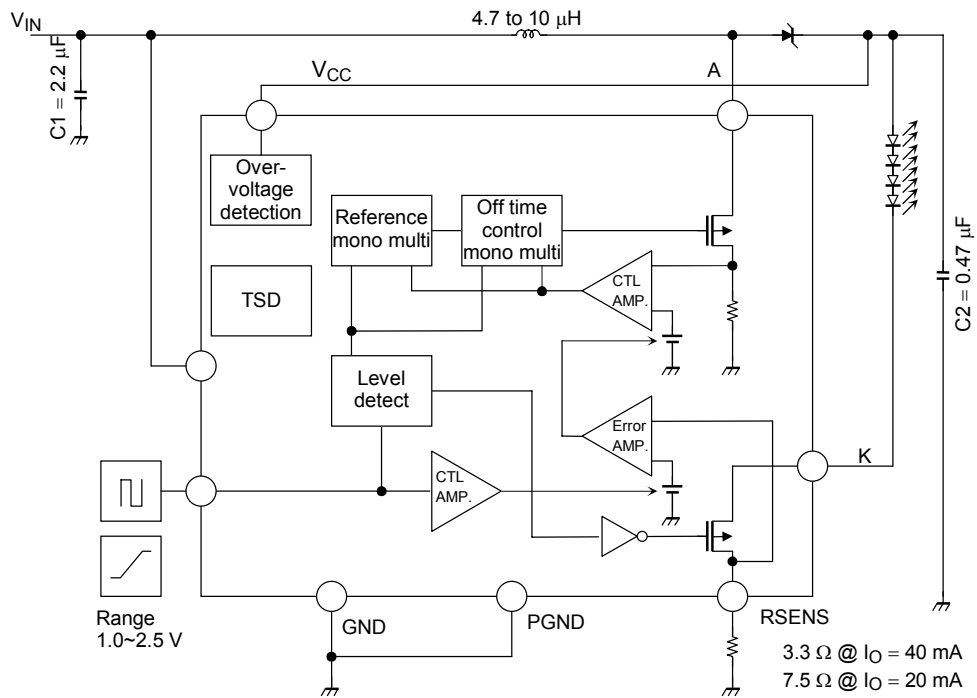
Note 3: Regarding solderability, the following conditions have been confirmed:

- Solderability

(1) Use of Sn-37Pd 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

Block Diagram

Pin Description

No.	Symbol	Function
1	V_{CC}	Supply voltage pin. Supply voltage range: 2.8 V to 5.5 V
2	CTL	Input pin for IC ON/OFF control and variable LED I_O. 0 to 0.4 V: Shutdown mode (IC shutdown) 1.0 V to 2.5 V: I_O = 30 to 100% variable (linear control) Over 2.6 V: I_O = 100%
3	OVD	Feedback pin for output voltage
4	A	Sink driver pin for step-up DC-DC converter
5	PGND	Ground pin for power line
6	GND	Ground pin
7	RSENS	Pin for connecting the resistance for LED current Io setup.
8	K	Connected to the LED cathode

Note: Connect the PGND and GND pins to the ground.

Absolute Maximum Ratings (T_{opr} = 25°C if not specified)

Characteristic	Symbol	Ratings	Unit
Power supply voltage	V_{CC}	−0.3 to 6.0	V
Input voltage	V_{IN}	−0.3 to V_{CC} + 0.3	V
Switching terminal voltage	$V_{O (A)}$	−0.3 to 24	V
OVD voltage	V_{OVD}	−0.3 to 23	V
Power dissipation	P_D	0.41 (device)	W
		0.47 (with PCB) (Note)	
Thermal resistance	$R_{th (j\text{-}a) 1}$	300 (device)	°C/W
	$R_{th (j\text{-}a) 2}$	260 (with PCB)	
Operating temperature range	T_{opr}	−40 to 85	°C
Storage temperature	T_{stg}	−40 to 150	°C
Maximum junction temperature	T_j	125	°C

Note: For every rise in ambient temperature by 1°C above the 25°C, the allowable loss must be reduced by 3.8 mW/°C relative to the maximum rated value (when the device is mounted on a PCB).

Recommended Operating Condition (T_{opr} = −40 to 85°C if not specified)

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V_{CC}	—	2.8	—	5.5	V
CTL terminal H level input voltage	$V_{CTL (H)}$	—	V_{CC} − 0.5	—	V_{CC}	V
CTL terminal L level input voltage	$V_{CTL (L)}$	—	0	—	0.4	V
LED current (average value)	I_{O1}	V_{CC} = 3.6 V, V_{CTL} > 2.6 V RSENS = 7.5 Ω, six (6) LED's T_{opr} = 25°C	—	20	—	mA
	I_{O2}	V_{CC} = 3.6 V, V_{CTL} > 2.6 V RSENS = 7.5 Ω, four (4) LED's T_{opr} = 25°C	—	20	—	mA
	I_{O3}	V_{CC} = 3.6 V, V_{CTL} > 2.6 V RSENS = 3.3 Ω, three (3) LED's T_{opr} = 25°C	—	40	—	mA

Electrical Characteristics ($T_{opr} = -40 \sim 85°C$ $V_{CC} = 2.8 \sim 5.5$ V if not specified)

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Operating consumption current	$I_{CC (ON)}$	V_{CC} = 3.6 V, RSENS = 8.2 Ω	—	0.9	1.5	mA
Quiescent consumption current	$I_{CC (OFF)}$	V_{CC} = 3.6 V, V_{CTL} = 0 V	—	0.5	1.0	μA
CTL terminal current	I_{CTL}	V_{CC} = 3.0 V, V_{CTL} = 3.0 V	7	12	21	μA
Integrated MOS-Tr ON resistance	Ron	$I_{O (A)}$ = greater than 400 mA	—	0.7	1.5	Ω
Integrated MOS-Tr switching frequency	f_{OSC}	V_{CC} = 3.6 V, V_{CTL} = 3.0 V T_{opr} = 25°C	0.75	1.0	1.39	MHz
A terminal protection voltage	$V_{O (A)}$	Six (6) white LED's connected in series are supported	24	—	—	V
Switching terminal current	$I_{O (A)}$	—	—	600	—	mA
Switching terminal leakage current	$I_{OZ (A)}$	$V_{O (A)}$ = 22 V	—	0.5	1	μA
OVD terminal voltage	V_{OVD}	—	19	21	23	V
OVD terminal leakage current	I_{OVDZ}	V_{OVD} = 18 V	—	0.5	1	μA
LED current (average value)	I_{O2}	V_{CC} = 3.6 V, V_{CTL} > 2.6 V RSENS = 7.5 Ω, L = 6.8 μH illumination of four (4) LED's, T_{opr} = 25°C	18	20	22	mA

Setting the Output Side Capacitance

A C2 of 0.47 (μF) or greater is recommended.

Setting the External Inductor Size

Reference: According to the number of LED's, select an inductor size greater than the corresponding value
indicated in the table below.

Number of LED's	V_{IN} = 2.8V to 5.5V	Note
2	4.7	I_O = 20 mA Unit: μH
3	6.8	
4		
5		
6	10	

Setting of I_O

Connect the RSENS resistor between the RSENS pin and GND. The RSENS resistor (K terminal and Ground) is used for setting the output current (I_O).
   Average currents set by this RSENS value are obtained using the following equations. (Choose the equation corresponding to the number of LED's.)

$$2 \text{ LED's: } I_O = 119.16 \times RSENS^{-0.8399}$$
$$3 \text{ LED's: } I_O = 115.32 \times RSENS^{-0.854}$$
$$4 \text{ LED's: } I_O = 113.08 \times RSENS^{-0.8614}$$
$$5 \text{ LED's: } I_O = 108.02 \times RSENS^{-0.8534}$$
$$6 \text{ LED's: } I_O = 106.71 \times RSENS^{-0.836}$$

The equations above apply only to the inductor sizes we recommend, i.e., they cannot be used to calculate average current if the inductor sizes used differ from those recommended.
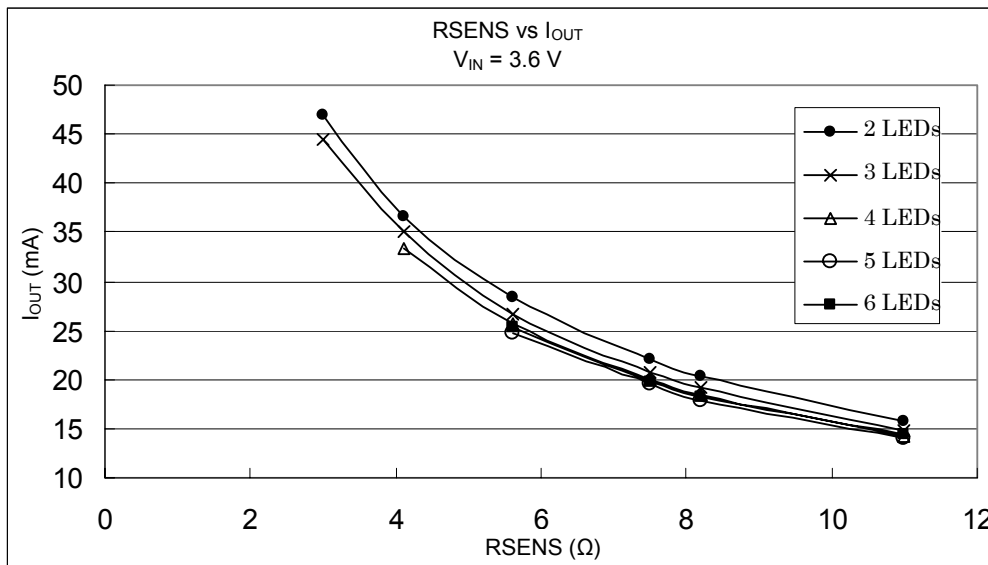
Current Control through the CTL Pin

With this IC it is possible to vary the I_O current through the external resistance. Variable range: 30 to 100%.

CTL voltage	V_{CTL} = 0 V to 0.4 V	V_{CTL} = 1 V to 2.5 V	V_{CTL} > 2.6 V	Note
I_O valuable rate	0	30 to 100	100	Unit: %

The linearity tolerance during V-A conversion is ±10%.

CTL input – Output rate / Output current
V_{IN} = 3.0V
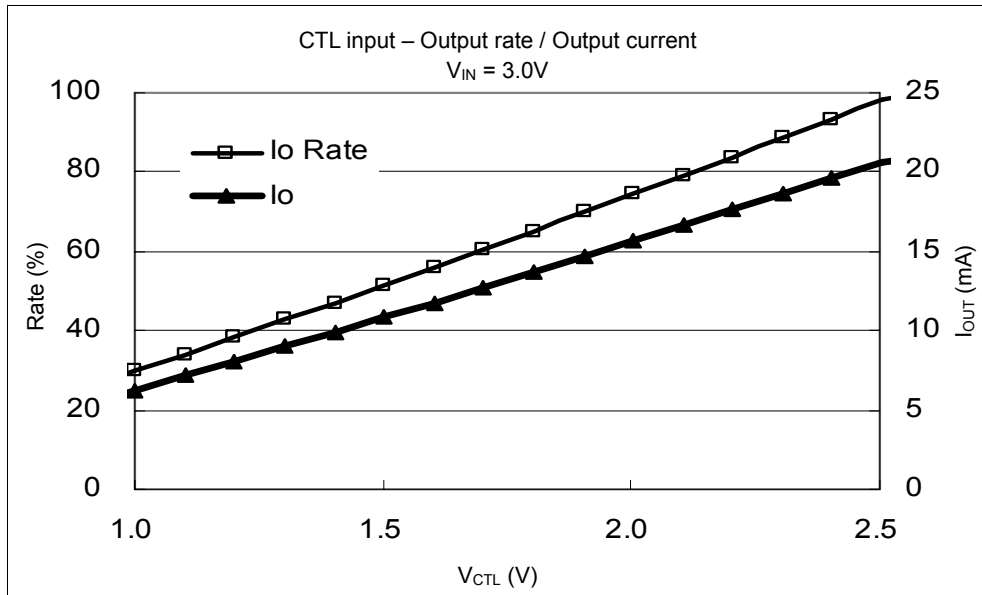
Timing Chart
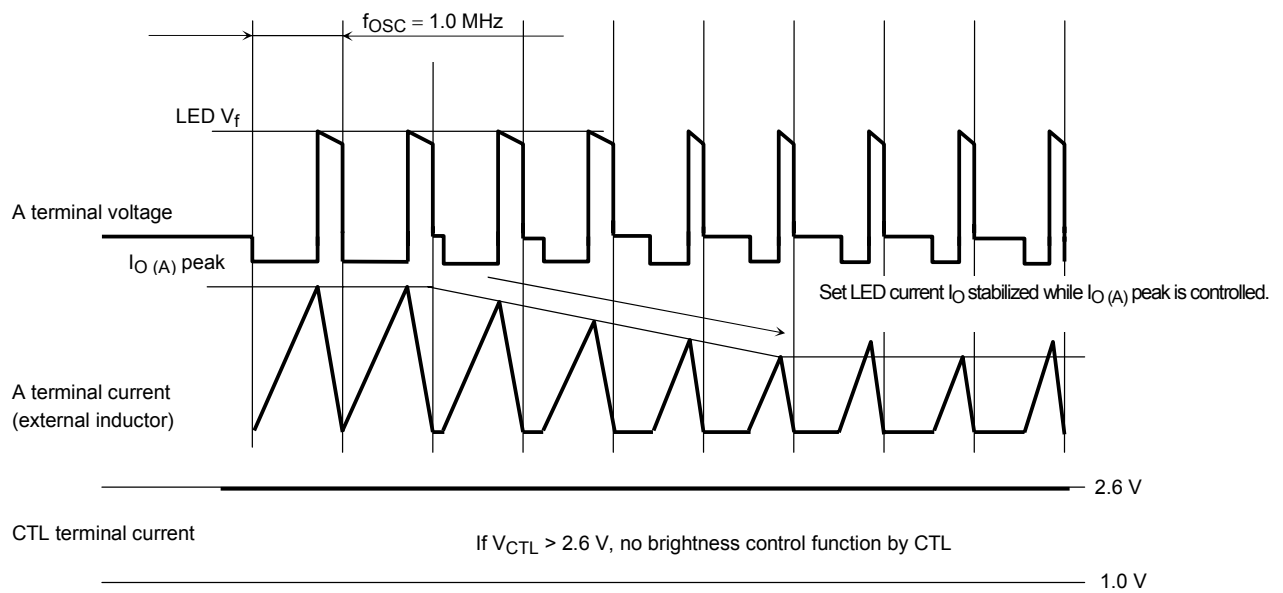
1. Example of Application Circuit and Measurement Data: Inductor 1001AS Series (Toko)
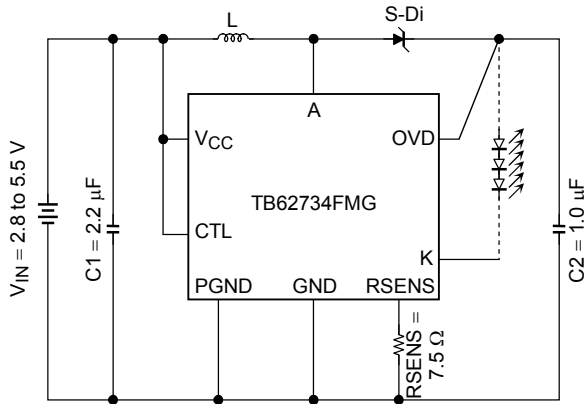
L : 1001AS series (Size: $3.8 \times 3.8 \times 1.2$ mm)
S-Di : CUS02 1 A/30 V (TOSHIBA)
LED : NSCW215T (NICHIA)
C1 : C2012JB1E225K (TDK)
C2 : C2012JB1E105K (TDK)

2 LED drive : L = 4.7 μH
3 to 5 LED drive : L = 6.8 μH
6 LED drive : L = 10 μH

Input - Efficiency / Output Current
5 LED Drive

Input - Efficiency / Output Current
2 LED Drive

Input - Efficiency / Output Current
6 LED Drive

Input - Efficiency / Output Current
3 LED Drive

<Measurement Data>
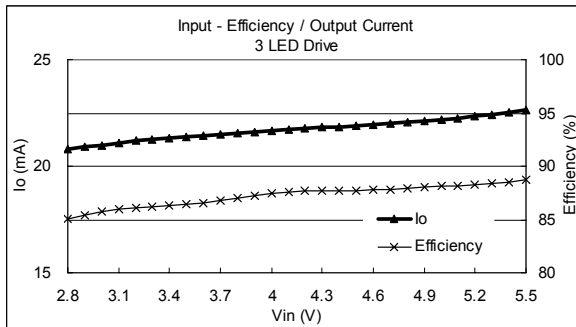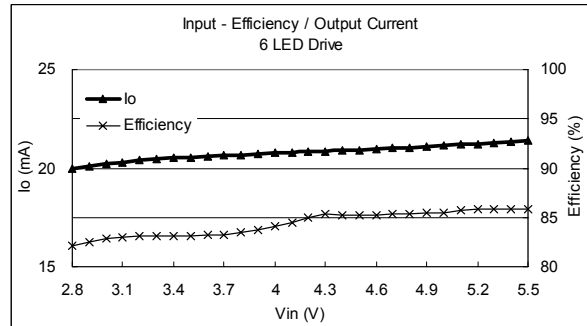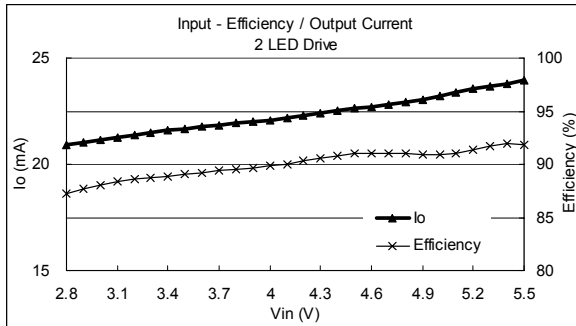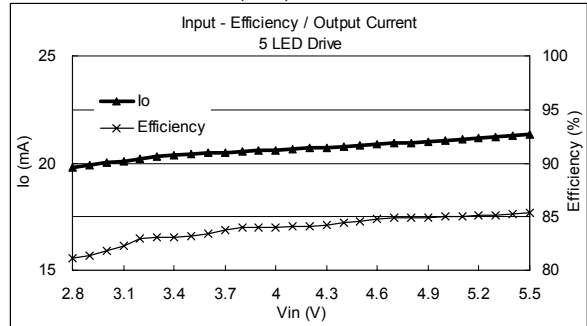
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

	Efficiency (%)	Average Efficiency (%)
2 LED	87.25 to 91.90	90.00
3 LED	85.04 to 88.75	87.24
4 LED	83.18 to 86.95	85.50
5 LED	81.15 to 85.36	83.93
6 LED	82.11 to 85.87	84.35

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

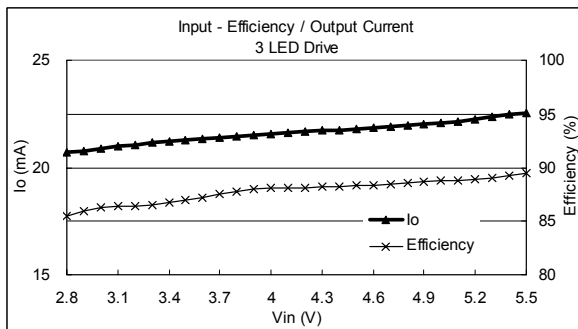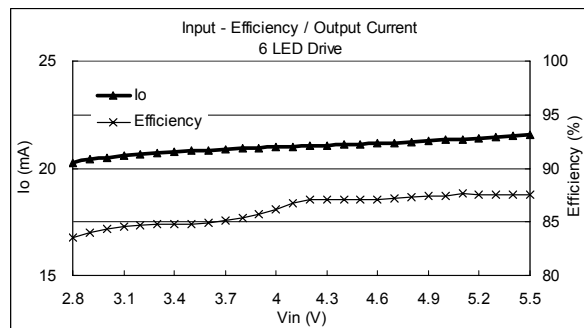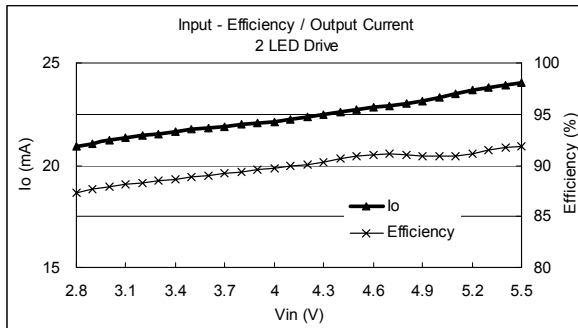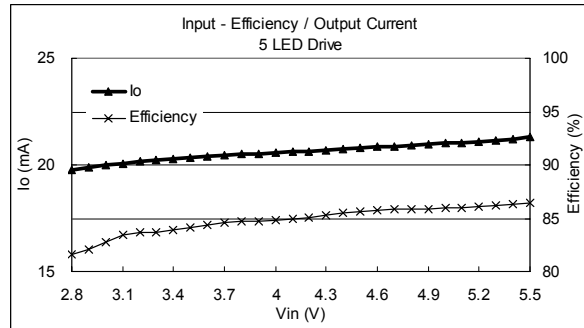|	Output Current (mA)	Tolerance (%)
2 LED	20.90 to 23.96	14.65 (5.87)
3 LED	20.80 to 22.62	8.77 (3.88)
4 LED	20.18 to 21.78	7.89 (3.66)
5 LED	19.82 to 21.34	7.67 (3.47)
6 LED	19.95 to 21.40	7.26 (3.22)

( ): Range of V_{IN} = 3.0 to 4.3 V

2. Example of Application Circuit and Measurement Data: Inductor CXLD120 Series (Sumitomo)
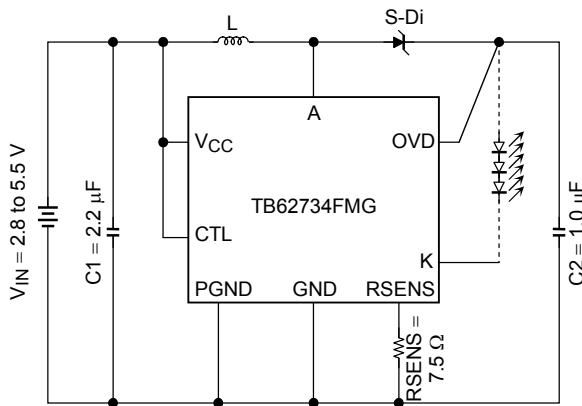
L : 1001AS series (Size: 3.0 × 2.65 × 1.20 mm)
S-Di : CUS02 1 A/30 V (TOSHIBA)
LED : NSCW215T (NICHIA)
C1 : C2012JB1E225K (TDK)
C2 : C2012JB1E105K (TDK)

2 LED drive : L = 4.7 µH
3 to 5 LED drive : L = 6.8 µH
6 LED drive : L = 10 µH

<Measurement Data>
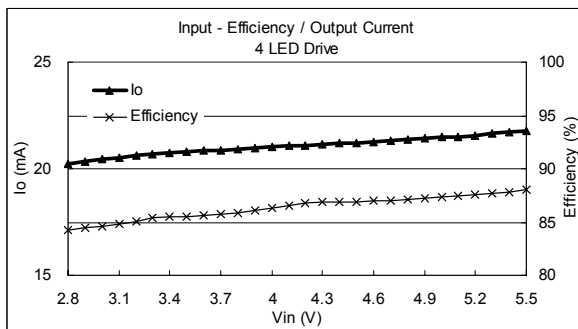
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

	Efficiency (%)	Average Efficiency (%)
2 LED	87.34 to 91.82	89.87
3 LED	85.46 to 89.50	87.81
4 LED	84.22 to 87.99	86.33
5 LED	81.65 to 86.49	84.84
6 LED	83.53 to 87.63	86.15

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

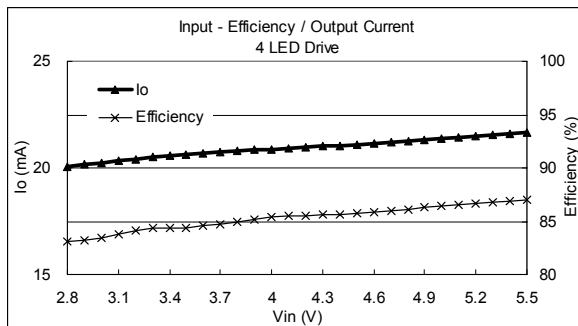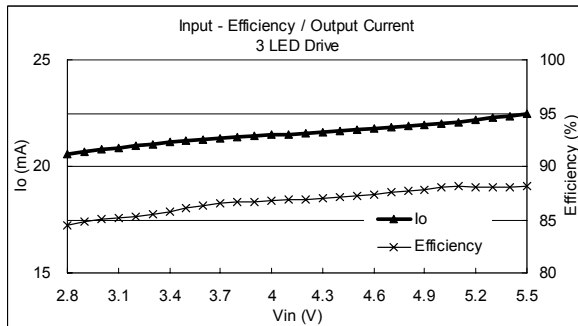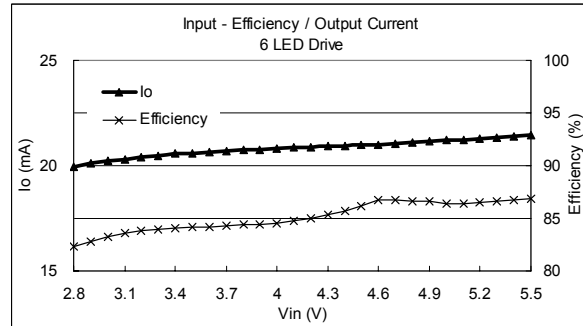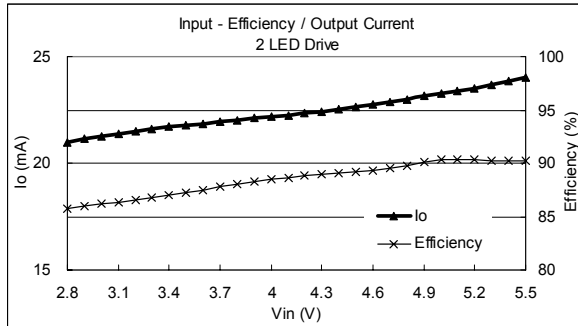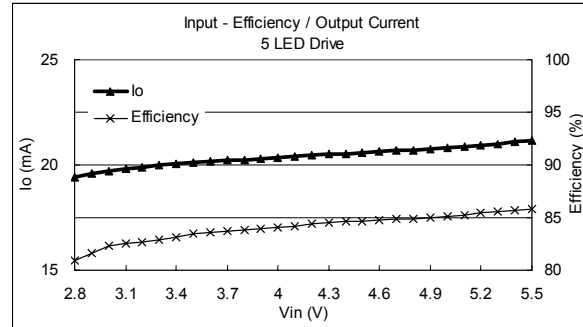|	Output Current (mA)	Tolerance (%)
2 LED	20.93 to 24.06	14.95 (6.01)
3 LED	20.69 to 22.56	9.02 (3.96)
4 LED	20.22 to 21.77	7.66 (3.49)
5 LED	19.78 to 21.30	7.69 (3.51)
6 LED	20.28 to 21.55	6.28 (2.71)

( ): Range of V_{IN} = 3.0 to 4.3 V

3. Example of Application Circuit and Measurement Data: Inductor VLF3010 Series (TDK)
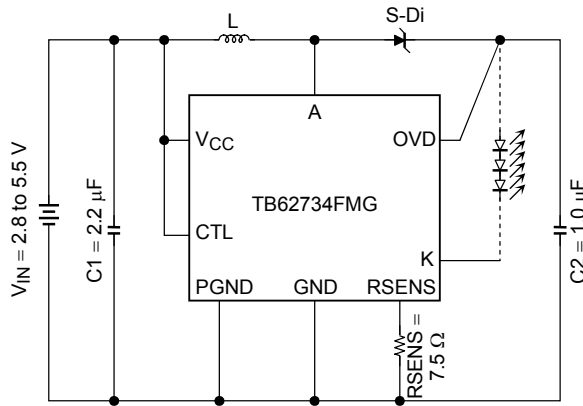
L   : VLF3010 series (Size: $3.0 \times 3.0 \times 1.0$ mm)
S-Di : CUS02 1 A/30 V (TOSHIBA)
LED   : NSCW215T (NICHIA)
C1   : C2012JB1E225K (TDK)
C2   : C2012JB1E105K (TDK)

2 LED drive   : L = 4.7 μH
3 to 5 LED drive : L = 6.8 μH
6 LED drive   : L = 10 μH

Circuit diagram

V_{IN} = 2.8 to 5.5 V, C1 = 2.2 μF, C2 = 1.0 μF, RSENS = 7.5 Ω

TB62734FMG — pins: V_{CC}, CTL, PGND, GND, RSENS, A, OVD, K

Input - Efficiency / Output Current 5 LED Drive

Input - Efficiency / Output Current 2 LED Drive

Input - Efficiency / Output Current 6 LED Drive

Input - Efficiency / Output Current 3 LED Drive

Input - Efficiency / Output Current 4 LED Drive

<Measurement Data>

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

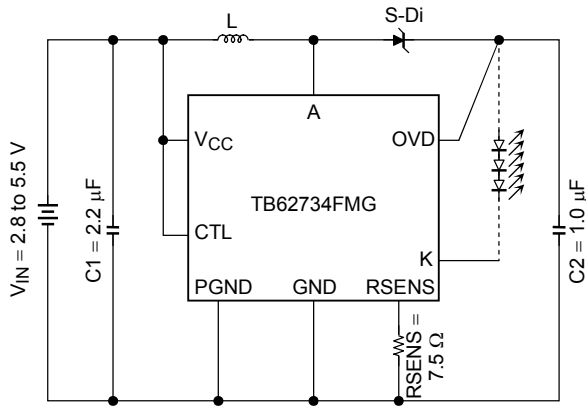|	Efficiency (%)	Average Efficiency (%)
2 LED's	85.70 to 90.39	88.47
3 LED's	84.51 to 88.15	86.76
4 LED's	83.06 to 86.97	85.30
5 LED's	80.94 to 85.78	84.07
6 LED's	82.28 to 86.85	85.11

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

|	Output Current (mA)	Tolerance (%)
2 LED's	21.00 to 24.01	14.35(5.53)
3 LED's	20.57 to 22.48	9.27(4.06)
4 LED's	20.03 to 21.69	8.24(3.74)
5 LED's	19.44 to 21.14	8.75(4.07)
6 LED's	19.96 to 21.46	7.52(3.40)

(   ): Range of V_{IN} = 3.0 to 4.3 V

4. Example of Application Circuit and Measurement Data: Inductor CXML322509-150 (Sumitomo)

2 to 6 LED drive: L = 15 μH

L : CXML322509-150 (Size 3.2 × 2.5 × 0.9 mm)
S-Di : CUS02 1 A/30 V (TOSHIBA)
LED : NSCW215T (NICHIA)
C1 : C2012JB1E225K (TDK)
C2 : C2012JB1E105K (TDK)

<Measurement Data>
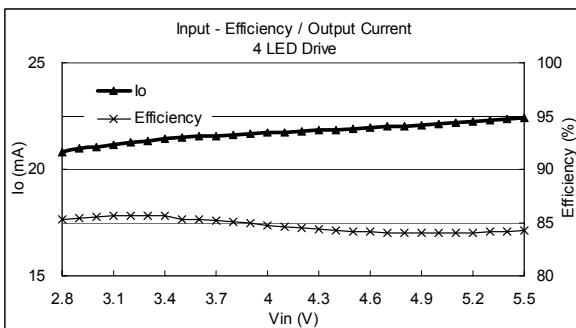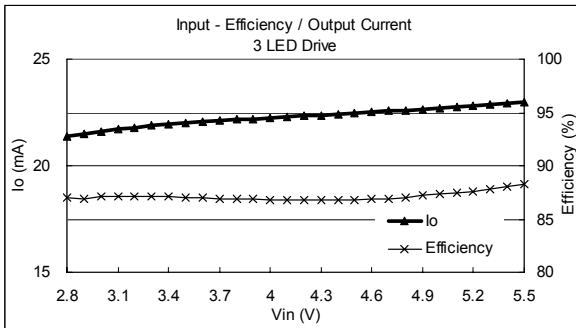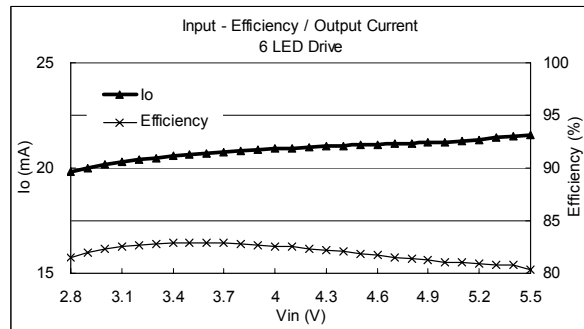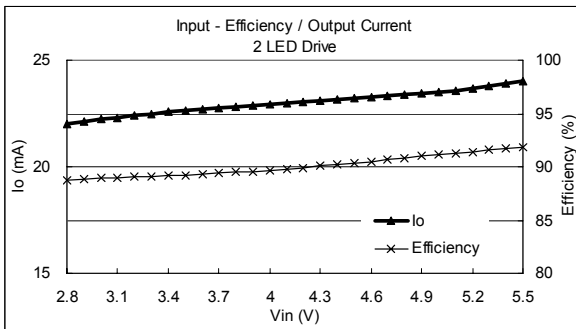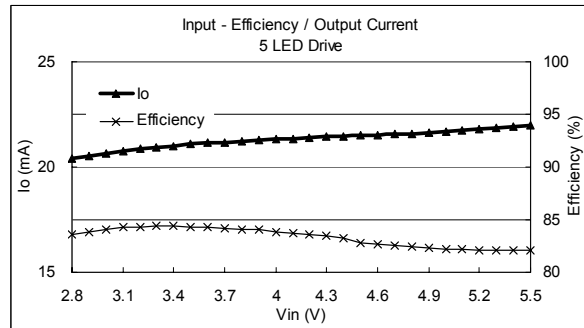
Efficiency in the range of V_{IN} = 2.8 to 5.5 V

	Efficiency (%)	Average Efficiency (%)
2 LED's	88.75 to 91.85	90.07
3 LED's	86.77 to 88.22	87.13
4 LED's	84.00 to 85.65	84.71
5 LED's	82.13 to 84.38	83.34
6 LED's	80.39 to 82.92	81.98

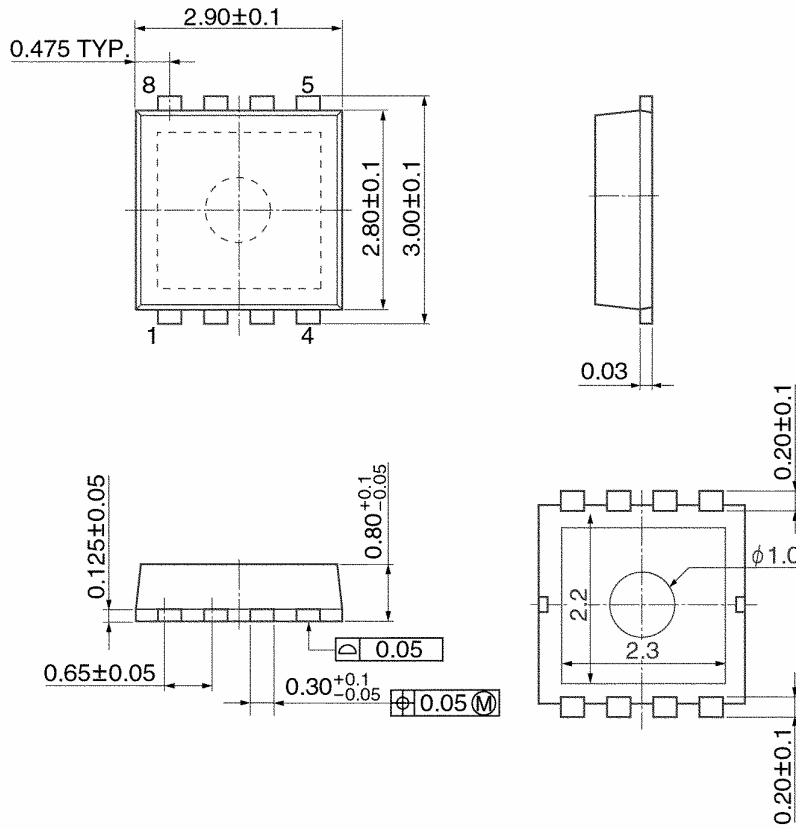Output current in the range of V_{IN} = 2.8 to 5.5 V

	Output Current (mA)	Tolerance (%)
2 LED's	22.00 to 24.04	9.30 (3.85)
3 LED's	21.39 to 23.00	7.49 (3.56)
4 LED's	20.82 to 22.41	7.61 (3.65)
5 LED's	20.39 to 21.99	7.82 (3.75)
6 LED's	19.84 to 21.57	8.69 (4.26)

( ): Range of V_{IN} = 3.0 to 4.3 V

2006-06-14

Package Dimensions

SON8-P-0.65   Unit: mm

Weight: 0.02 g (typ.)

Marking

1st Half of Year
(1st to 26th week)

2nd Half of Year
(27th to 53rd week)

B36 ← Product name
XXX
1PIN → Weekly code Ass'ly code

B36 ← Product name
XXX
1PIN → Weekly code Ass'ly code
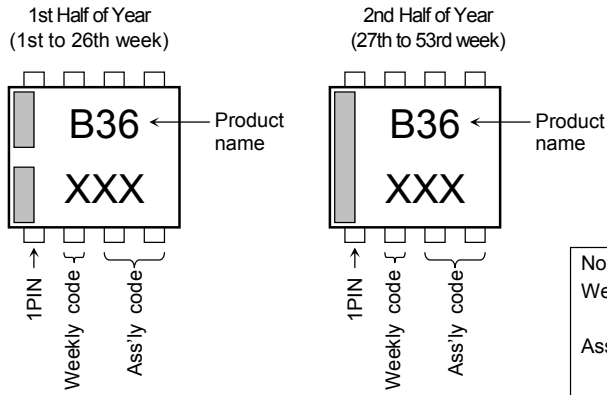
Note:
Weekly code: Code indicating the week of manufacture .
            A (1st week) to Z (26th week)
Ass'ly code: Lot code for the week of manufacture
            A1 (1st lot), A2 (2nd lot), and … A9, A0,
            B1 … Z0, 21 … 90

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 (Tj) 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 absolute maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

About solderability, following conditions were confirmed

• Solderability

(1) Use of Sn-37Pb   solder Bath
    · solder bath temperature = 230°C
    · dipping time = 5 seconds
    · the 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
    · the number of times = once
    · use of R-type flux

RESTRICTIONS ON PRODUCT USE

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