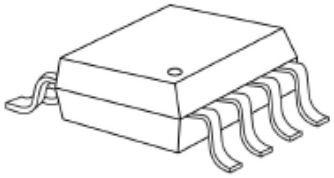
HIGH-POWER LED DRIVER

IK2804

FEATURES

- 4 constant-current output channels
- Constant output current invariant to load voltage change
- Maximum output constant current per channel: 240mA
- Excellent output current accuracy:
  between channels: <±3% (max.), and
  between ICs: <±6% (max.)
- Output current adjusted through an external resistor
- Schmitt trigger input
- 5V supply voltage
- Package type: Pb-free SOP8 with thermal pad

Small Outline Package



SOP8

ORDERING INFORMATION

Device	Operating Temperature Range	Package	Shipping
IK2804DT	T_A = - 40 ... + 85 °C	SOP-8	Tape& Reel

Current Accuracy		Conditions
Between Channels	Between ICs	
<±3%	<±6%	I_{OUT} = 40 ~ 240 mA

PRODUCT DESCRIPTION

IK2804 is an instant On/Off LED driver for high power LED applications and exploits to enhance its output characteristics. At IK2804 output stage, four regulated current ports are designed to provide uniform and constant current sinks for driving LEDs within a large range of VF variations.

IK2804 provides users 4-channel constant current ports. Users may adjust the output current from 40 mA up to 240mA through an external resistor, Rext, which gives users flexibility in controlling the light intensity of LEDs. In addition, users can precisely adjust LED brightness from 0% to 100% via output enable ($\overline{OE}$) with Pulse Width Modulation.

Additionally, to ensure the system reliability, IK2804 is built with TP (Thermal Protection) function and thermal pad. The TP function protects IC from over temperature (165°C). Also, the thermal pad enhances the power dissipation. As a result, a large amount of current can be handled safely in one package.

APPLICATIONS

- High-flux LED lighting
- Automotive interior lighting
- LCD backlight
- Photocopier
- Scanner

TYPICAL APPLICATION CIRCUIT

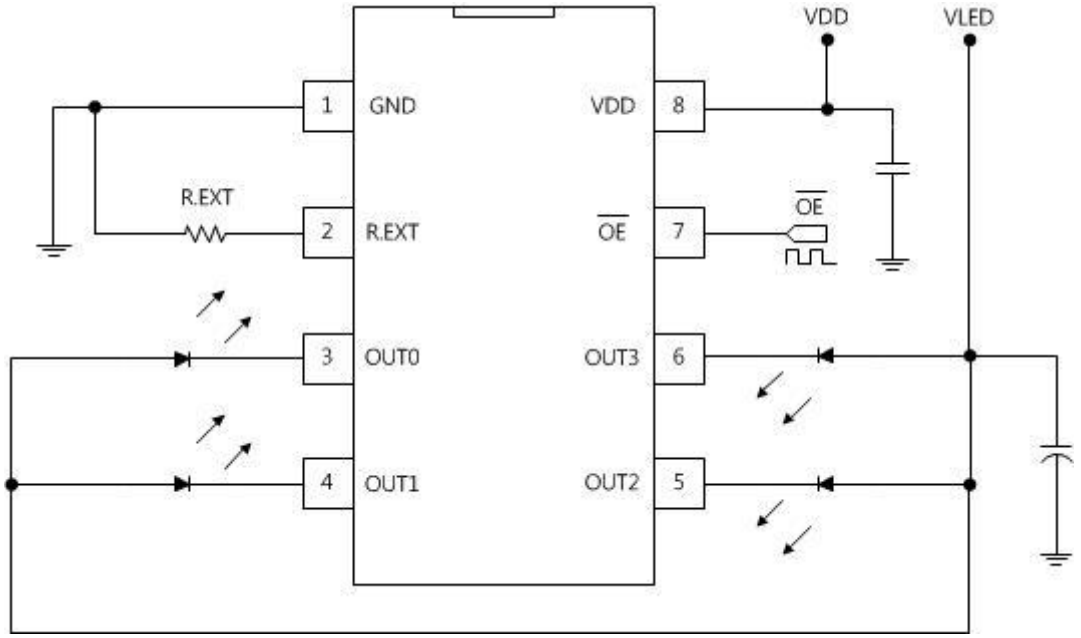
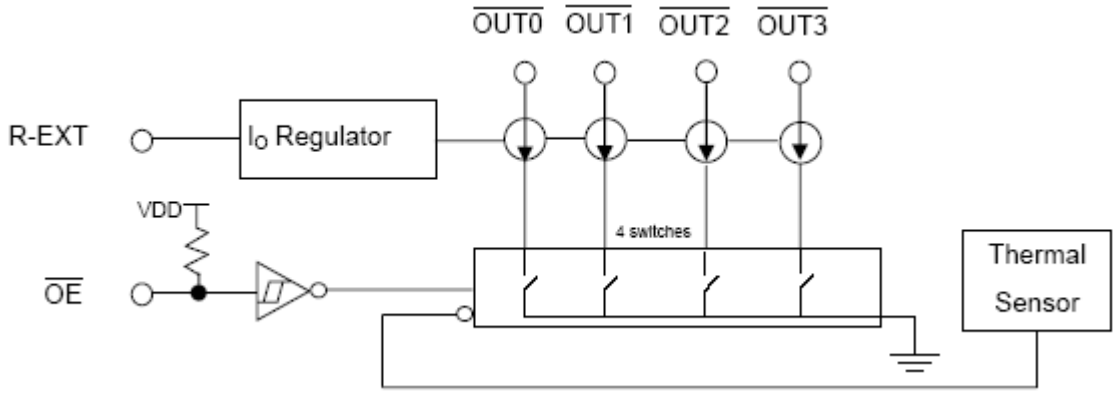
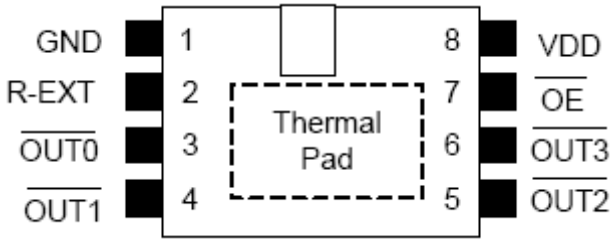


Figure 1

FUNCTIONAL DIAGRAM



PIN CONFIGURATION



PIN DESCRIPTION

Pin No.	Pin Name	Function
1	GND	Ground terminal for control logic and current sink
3,4,5,6	$\overline{OUT0}$~$\overline{OUT3}$	Constant current output terminals
7	$\overline{OE}$	Output enable terminal When $\overline{OE}$ is active (low), the output pins are enabled; when $\overline{OE}$ is inactive (high), all output pins are turned OFF (blanked).
2	R-EXT	Terminal used to connected an external resistor (R_{ext}) for setting up output current for all output channels
8	VDD	5V supply voltage terminal
-	Thermal Pad	Power dissipation terminals connected to GND*

*To eliminate the noise influence, the thermal pad is suggested to be connected to GND on PCB.
In addition, desired thermal conductivity will be improved, if a heat-conducting copper foil on PCB is soldered with thermal pad.

MAXIMUM RATINGS

Characteristic		Symbol	Rating	Unit
Supply Voltage		V_{DD}	0~7.0	V
Input Voltage		V_{IN}	-0.4~V_{DD} + 0.4	V
Output Current		I_{OUT}	320*	mA
Sustaining Voltage		V_{DS}	27.0	V
GND Terminal Current		I_{GND}	1000	mA
Power Dissipation* (On PCB, Ta=25 ºC)	SOP8	P_D	0.8	W
Thermal Resistance** (By simulation)	SOP8	$R_{th(j-a)}$	33.39	ºC/W
Empirical Thermal Resistance* (On PCB, Ta=25 ºC)	SOP8	$R_{th(j-a)}$	125	ºC/W
Operating Junction Temperature		$T_{j,max}$	125	ºC
Operating Temperature		T_{opr}	-40~+85	ºC
Storage Temperature		T_{stg}	-55~+150	ºC

*Users must notice that the power dissipation (almost equaling to I_{OUT} x V_{DS}) should be within the Safe Operation Area shown in Figure 7.
** Provided by factory.
*** Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device.
These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied.
Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

Characteristics		Symbol	Condition		Min.	Typ.	Max.	Unit
Supply Voltage		V_{DD}	·		4.5	5.0	5.5	V
Sustaining Voltage at OUT pin		V_{DS}	OUT0~OUT15		·	·	27.0	V
Output Current		I_{OUT}	DC Test Circuit		40	·	240*	mA
Input Voltage	"H" level	V_{IH}	Ta=-40~85 ºC		1.6		V_{DD}	V
	"L" level	V_{IL}	Ta=-40~85 ºC		GND		0.6	V
Output Leakage Current		I_{OH}	V_{OH}=27V		·	·	0.5	uA
Output Current 1		I_{OUT1}	V_{DS}=0.6V	R_{ext}=2.4kOhm	·	120	·	mA
Current Skew 1		$dI_{OUT/IOUT}$	I_{OL}=120mA V_{DS}=0.6V	R_{ext}=2.4kOhm	·	±1	±3	%
Output Current 2		I_{OUT2}	V_{DS}=0.8V	R_{ext}=1.3kOhm	·	220	·	mA
Current Skew 2		$dI_{OUT/IOUT}$	I_{OL}=220mA V_{DS}=0.8V	R_{ext}=1.3kOhm	·	±1	±3	%
Regulation of Output Current vs. Sustaining Voltage		$\%/dV_{DS}$	V_{DS} within 1.0V and 3.0V		·	±0.1	·	%/V
Regulation of Output Current vs. Supply Voltage		$\%/dV_{DD}$	V_{DD} within 4.5V and 5.5V		·	±1	·	%/V
Pull-up Resistor		$R_{N(up)}$	OE		300	700	800	kOhm
Thermal Shutdown temperature		T_{XI}	Shutdown Temp.increasing		·	165	·	ºC
		T_{XD}	Reset Temp.decreasing		·	150	·	ºC
Supply Current	"OFF"	I_{DD}(off) 1	R_{ext}=Open, OUT0~OUT15=Off		·	5	9	mA
		I_{DD}(off) 2	R_{ext}=2.4kOhm, OUT0~OUT15=Off		·	7	10	
		I_{DD}(off) 3	R_{ext}=1.3kOhm, OUT0~OUT15=Off		·	8	12	
	"ON"	I_{DD}(on) 1	R_{ext}=2.4kOhm, OUT0~OUT15=On		·	4	10	
		I_{DD}(on) 2	R_{ext}=1.3kOhm, OUT0~OUT15=On		·	5	10	

* Each output current, I_{OUT}, can be driven up to 240mA, but the total output current should be smaller than 1A.

TEST CIRCUIT FOR ELECTRICAL CHARACTERISTICS

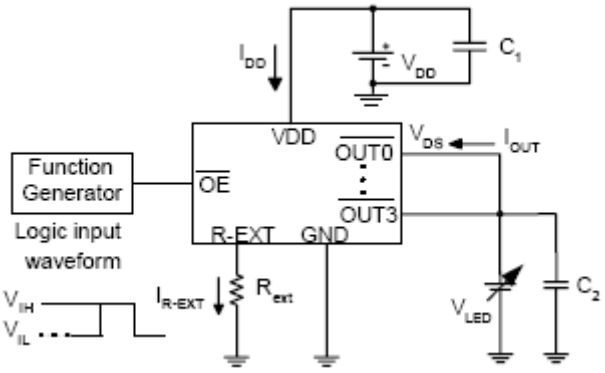


Figure 2

SWITCHING CHARACTERISTICS

Characteristics		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time("L" to "H")	$\overline{OE}$-$\overline{OUTn}$	t_{pLH}	V_{DD}=5.0V V_{DS}=1.0V V_{IH}=V_{DD} V_{IL}=GND R_{ext}=1226Ohm (I_{OUTn}=240mA) V_L=4.0V R_L=12.5Ohm C_L=10pF	0.3	0.5	1	us
Propagation Delay Time("H" to "L")	$\overline{OE}$-$\overline{OUTn}$	t_{pHL}		0.3	0.5	1	us
Pulse width	OE	$t_{w(OE)}$		1	-	-	us
Output Rise Time of OUT (turn off)		t_{or}		0.3	0.5	1	us
Output Rise Time of OUT (turn on)		t_{of}		0.3	0.5	1	us

TEST CIRCUIT FOR SWITCHING CHARACTERISTICS

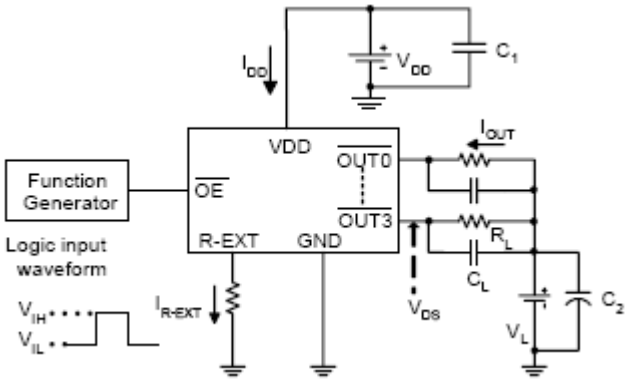
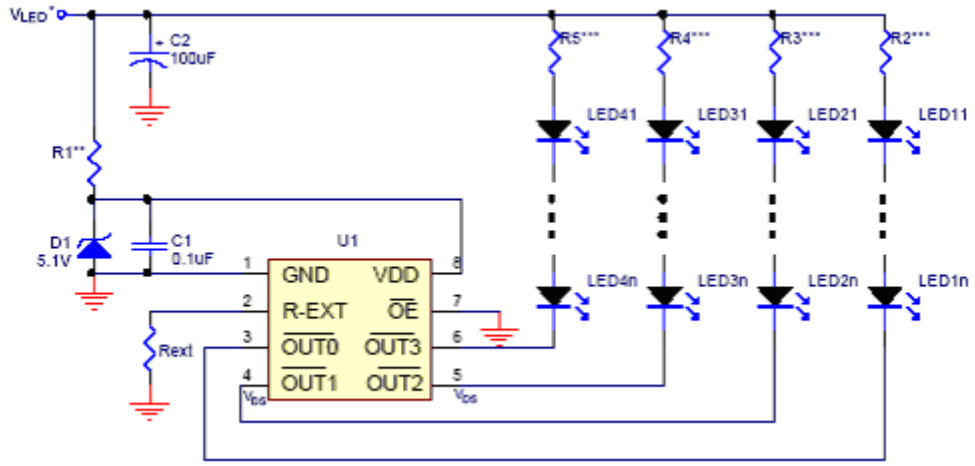


Figure 3

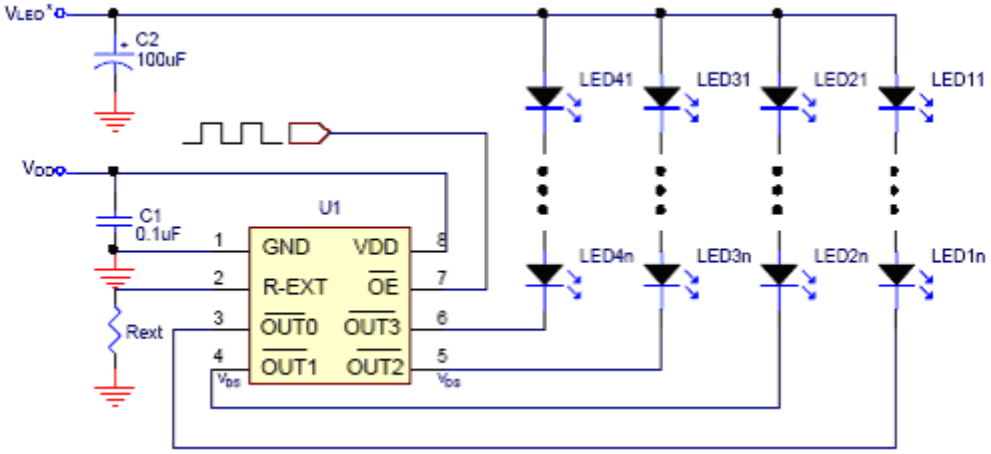
APPLICATION CIRCUITS

(a) IK2804 application circuit, where V_{LED} and V_{DD} share a single voltage source.



* $V_{LED} > V_{DS} + V_{F,LED}$ x n; $V_{F,LED}$: Forward voltage of LED; n: LED count
** R1 = (V_{LED} - 5.1V) / I_{DD}; refer to Electrical Characteristics for I_{DD}
*** R2~R5 = [V_{LED} –V_{DS} – ($V_{F,LED}$ x n)] / I_{LED}

(b) IK2804 application circuit with dimming control by PWM signal, where V_{LED} and V_{DD} use voltage sources separately.



*V_{LED} = V_{DS} + $V_{F,LED}$ x n; $V_{F,LED}$: Forward voltage of LED; n: LED count

Figure 4

Constant Current

In LED lighting applications, IK2804 provides nearly no variation in current from channel to channel and from IC to IC. This can be achieved by:
1) The maximum current variation between channels is less than ±3%, and that between ICs is less than ± 6%.

2) In addition, the current characteristic of output stage is flat and users can refer to the figure as shown below. The output current can be kept constant regardless of the variations of LED forward voltages (V_F). This guarantees LED to be performed on the same brightness as user's specification.

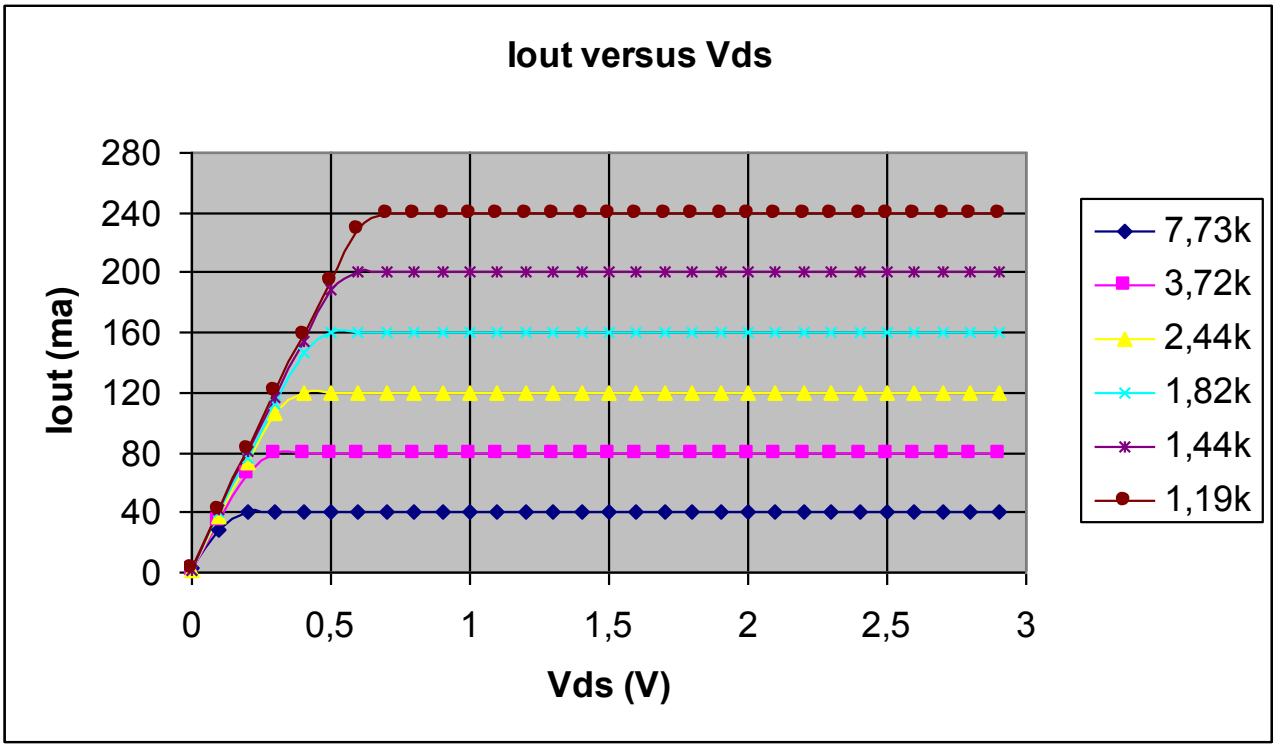


Figure 5

Setting Output Current

The output current of each channel (Iout) is set by an external resistor, Rext. The relationship between Iout and Rext is shown in the following figure and Table.

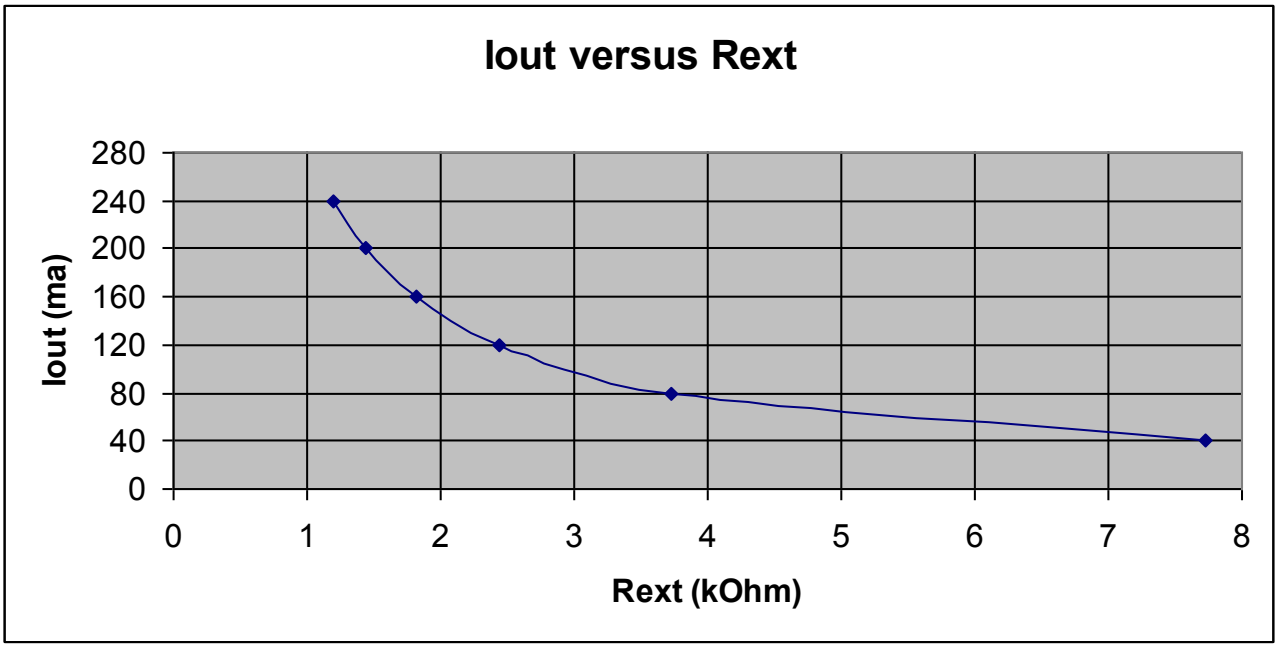


Figure 6

Iout ma	Rext kOhm
240	1,19
200	1,44
160	1,82
120	2,44
80	3,72
40	7,73

The output current can be calculated from the equation:
$V_{R\text{-}EXT}$ = 1.24V;
Rext = ($V_{R\text{-}EXT}$ / Iout) × 236 = (1.24V / Iout) × 236,
Iout = ($V_{R\text{-}EXR}$ / Rext) × 236 = (1.24V / Rext) × 236 within ± 6% chip skew
Where Rext is the resistance of the external resistor connected to R-EXT terminal and $V_{R\text{-}EXT}$ is the voltage of R-EXT terminal. The magnitude of current (as a function of Rext) is around 225mA at 1.3kΩ and 122mA at 2.4kΩ.

Package Power Dissipation (PD)

The maximum power dissipation, $P_D(max) = (T_{j,max} – T_a) / R_{th(j-a)}$, decreases as the ambient temperature increases.

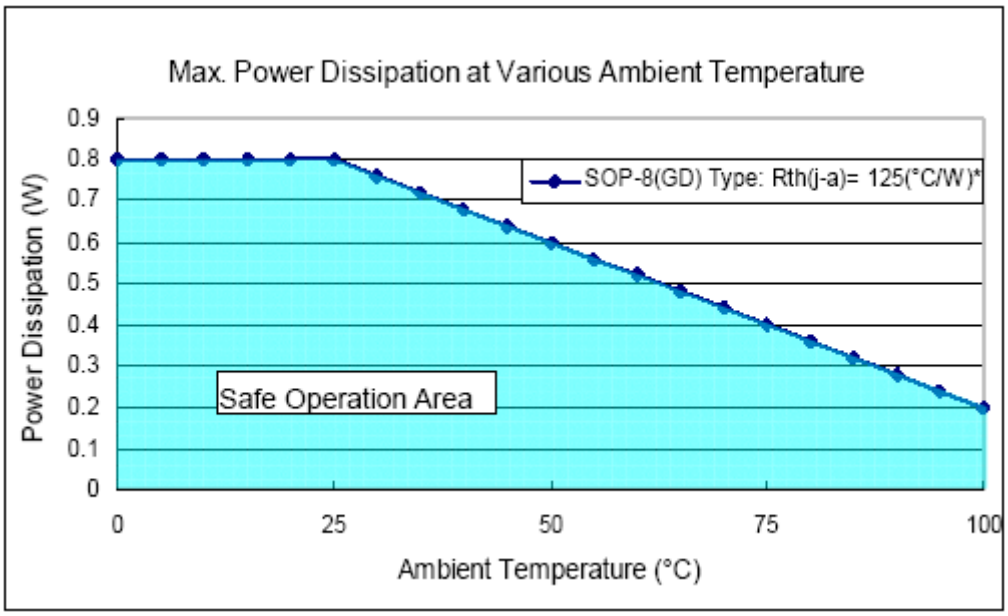
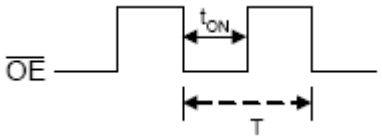
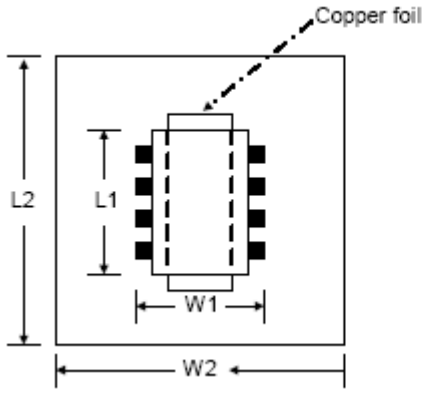


Figure 7

The maximum allowable package power dissipation is determined as $P_D(max) = (T_{j,max} – T_a) / R_{th(j-a)}$. When 4 output channels are turned on simultaneously, the actual package power dissipation is:
$P_D(act) = (I_{DD} \times V_{DD}) + (I_{OUT} \times Duty \times V_{DS} \times 4)$.
Therefore, to keep $P_D(act) \leq P_D(max)$, the allowable maximum output current as a function of duty cycle is:
$I_{OUT} = \{ [(T_j – T_a) / R_{th(j-a)}] – (I_{DD} \times V_{DD}) \} / V_{DS} / Duty / 4$,
where $T_j = 125°C$;
$Duty = t_{ON} / T$;
t_{ON}: the time of LEDs turning on; T: $\overline{OE}$ signal period



*Note: The empirical thermal resistor $R_{th(j-a)}$ =125 °C/W is based on the following structure.



The PCB area L2xW2 is 4 times of the IC's area L1xW1.
The thickness of the PCB is 1.6mm, copper foil 1 Oz. The thermal pad on the IC's bottom has to be mounted on the copper foil.

TP Function (Thermal Protection)

Thermal protection turns off the output current when the junction temperature rises to approximately 165°C, allowing the device to cool. When the junction temperature cools to approximately 150°C, the output current is turned on again. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This limits the dissipation of the driver, protecting it from damage due to overheating.

Load Supply Voltage (VLED)

IK2804 is designed to operate with adequate V_{DS} to achieve constant current. V_{DS} together with I_{OUT} should not exceed the package power dissipation limit, $P_{D(max)}$.
As in Figure 8, $V_{DS} = V_{LED} – V_F$, and V_{LED} is the load supply voltage. $P_{D(act)}$ will be greater than $P_{D(max)}$, if V_{DS} drops too much voltage on the driver. In this case, it is recommended to use the lowest possible supply voltage or to set an external voltage reducer, V_{DROP}.
A voltage reducer lets $V_{DS} = (V_{LED} – V_F) – V_{DROP}$.
Resistors can be used in the applications as shown in Figure 8.

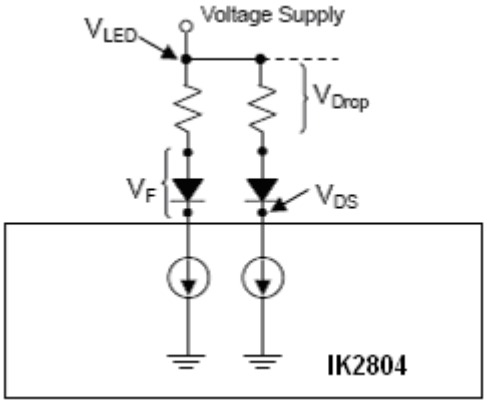
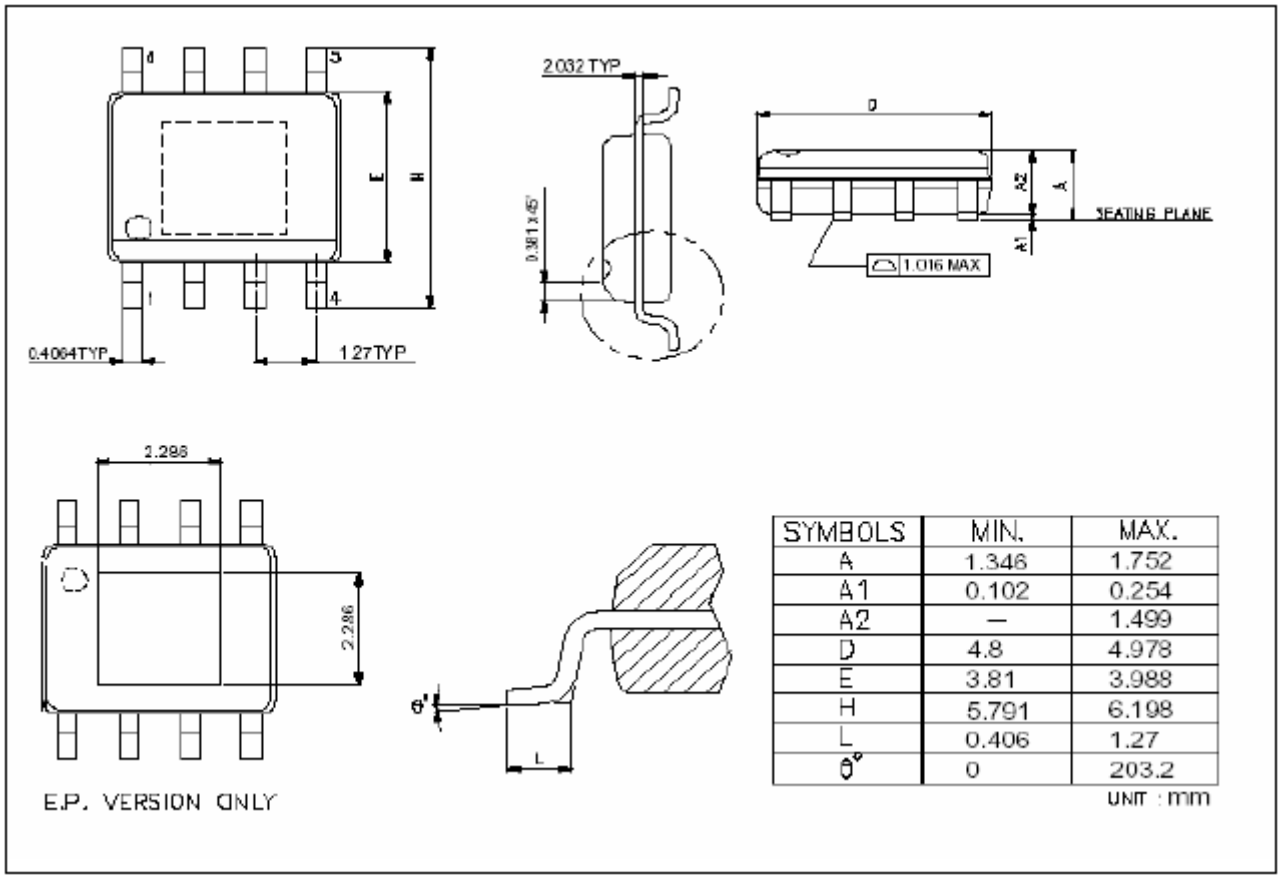


Figure 8

PACKAGE DIMENSIONS

SOP 8



SYMBOLS	MIN.	MAX.
A	1.346	1.752
A1	0.102	0.254
A2	—	1.499
D	4.8	4.978
E	3.81	3.988
H	5.791	6.198
L	0.406	1.27
θ°	0	203.2

UNIT : mm

Note: The unit for the outline drawing is mm.