MBI1804

Macroblock

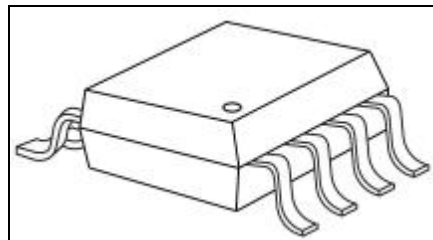# All-Ways-On^{TM} High-Power LED Driver

Features

I   4 constant-current output channels

I   Constant output current invariant to load voltage change

I   Maximum output constant current: 360 mA

I   Excellent output current accuracy:

   between channels: <±3% (max.), and

   between ICs: <±6% (max.)

I   Output current adjusted through an external resistor

I   Fast response of output current, $\overline{OE}$ (min.): 10 μs

I   Schmitt trigger input

I   5V supply voltage

I   Package type: SOP8 with thermal pad

CD: SOP8-150-1.27

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

Product Description

MBI1804 is an instant On/Off LED driver for high power LED applications and exploits PrecisionDrive™ and All-Ways-On™ technology to enhance its output characteristics. At MBI1804 output stage, four regulated current ports are designed to provide uniform and constant current sinks for driving LEDs within a large range of V_F variations.

With All-Ways-On™, MBI1804 provides users easily a consistent current source in their system design. Users may adjust the output current from 20 mA up to 360 mA through an external resistor, R_{ext}, 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 control with Pulse Width Modulation. MBI1804 also guarantees LED can be cascaded to maximum 17V at the output ports.

Additionally, to ensure the system reliability, MBI1804 is provided in the SOP8 with thermal pad for dramatically increased power dissipation capability. As a result, a large amount of current can be handled safely in one package.

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Applications

- **I** High-Flux LED Lighting
- **I** Automotive Interior Lighting
- **I** LCD Backlight
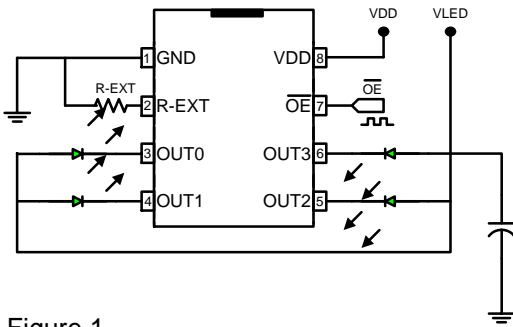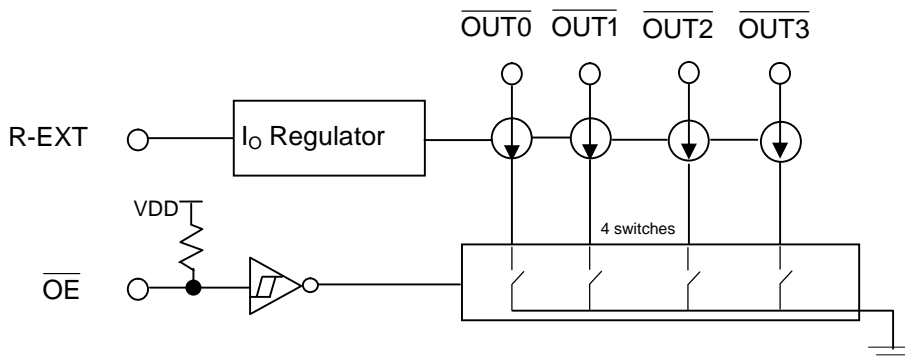- **I** Photocopier
- **I** Scanner

Typical Application Circuit

Figure 1

Block Diagram

Terminal Description

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

Pin Configuration
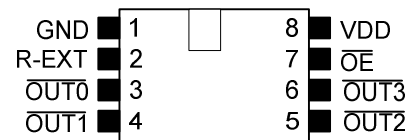
MBI1804

Maximum Ratings

All-Ways-On^{TM} High-Power LED Driver

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}	360*	mA
Output Voltage		V_{DS}	-0.5~+17.0	V
GND Terminal Current		I_{GND}	1440	mA
Power Dissipation* (On PCB, Ta=25°C)	SOP8	P_D	0.8	W
Thermal Resistance* (Under good thermal system)		$R_{th(j-a)}$	33.39**	°C/W
Thermal Resistance* (On PCB, Ta=25°C)			125	
Operating Temperature		T_{opr}	-40~+85	°C
Storage Temperature		T_{stg}	-55~+150	°C

*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 6.

** Good thermal system design can ensure that the heat management of the total system (storage temperature and operating temperature) maintains MBI1804 within the defined temperature limits ($R_{th(j-a)}$= 33.39°C/W).

Electrical Characteristics

Characteristic		Symbol	Condition		Min.	Typ.	Max.	Unit
Supply Voltage		V_{DD}	-		4.5	5.0	5.5	V
Output Voltage		V_{DS}	$\overline{OUT0}$ ~ $\overline{OUT3}$		-	-	17.0	V
Output Current		I_{OUT}	DC Test Circuit		20	-	360	mA
Input Voltage	"H" level	V_{IH}	Ta= -40~85°C		$0.7*V_{DD}$	-	V_{DD}	V
	"L" level	V_{IL}	Ta= -40~85°C		GND	-	$0.3*V_{DD}$	V
Output Leakage Current		I_{OH}	V_{OH}= 17.0V		-	-	0.5	µA
Output Current 1		I_{OUT1}	V_{DS}= 0.6V	R_{ext}= 720 Ω	-	105	-	mA
Current Skew		dI_{OUT1}	I_{OL}= 105mA V_{DS}= 0.6V	R_{ext}= 720 Ω	-	±1	±3	%
Output Current 2		I_{OUT2}	V_{DS}= 0.8V	R_{ext}= 360 Ω	-	210	-	mA
Current Skew		dI_{OUT2}	I_{OL}= 210mA V_{DS}= 0.8V	R_{ext}= 360 Ω	-	±1	±3	%
Output Current vs. Output Voltage Regulation		%/dV_{DS}	V_{DS} within 1.0V and 3.0V		-	±0.1	-	% / V
Output Current vs. Supply Voltage Regulation		%/dV_{DD}	V_{DD} within 4.5V and 5.5V		-	±1	-	% / V
Pull-up Resistor		$R_{IN}(up)$	$\overline{OE}$		250	500	800	KΩ
Supply Current	"OFF"	$I_{DD}(off)$ 1	R_{ext}=Open, $\overline{OUT0}$ ~ $\overline{OUT3}$ = Off		-	6	8	mA
		$I_{DD}(off)$ 2	R_{ext}=720 Ω, $\overline{OUT0}$ ~ $\overline{OUT3}$ = Off		-	6	8	
		$I_{DD}(off)$ 3	R_{ext}=360 Ω, $\overline{OUT0}$ ~ $\overline{OUT3}$ = Off		-	6	8	
	"ON"	$I_{DD}(on)$ 1	R_{ext}=720 Ω, $\overline{OUT0}$ ~ $\overline{OUT3}$ = On		-	9	11	
		$I_{DD}(on)$ 2	R_{ext}=360 Ω, $\overline{OUT0}$ ~ $\overline{OUT3}$ = On		-	10	12	

Test Circuit for Electrical Characteristics
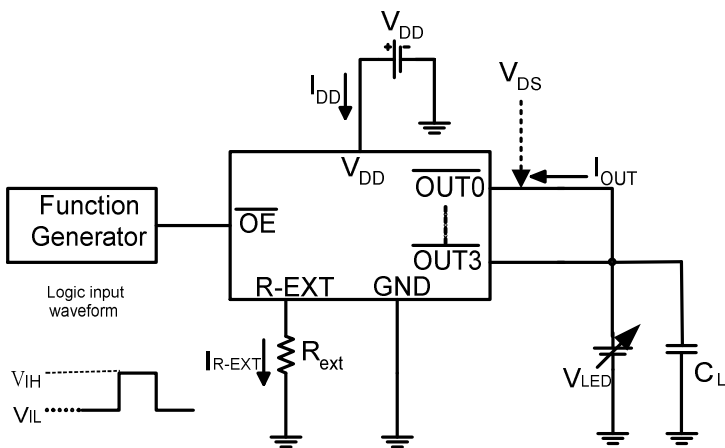
Figure 2

Switching Characteristics

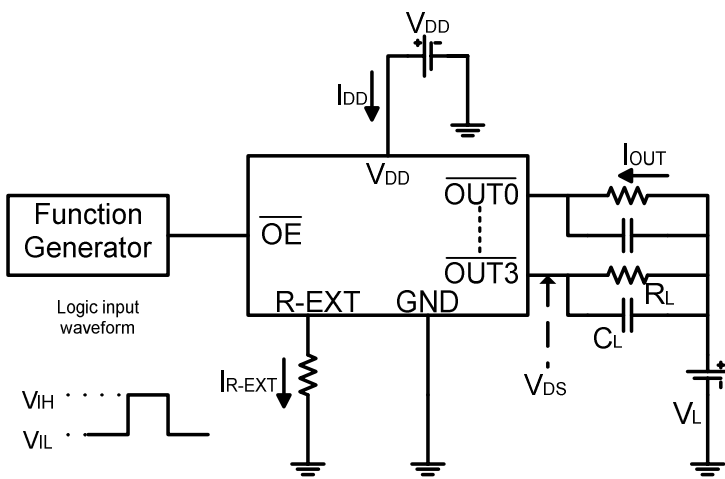| Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time ("L" to "H")	$\overline{OE}$ - $\overline{OUTn}$	t_{pLH}	V_{DD}= 5.0 V V_{DS}= 1-1.5V V_{IH}= V_{DD} V_{IL}= GND R_{ext}= 300 Ω V_L= 4.0 V R_L= 10 Ω C_L= 10 pF	1	2	3	µs
Propagation Delay Time ("H" to "L")	$\overline{OE}$ - $\overline{OUTn}$	t_{pHL}		1	2	3	µs
Pulse Width	$\overline{OE}$	$t_{w(OE)}$		10	-	-	µs
Output Rise Time of Vout (turn off)		t_{or}		1	1.7	3	µs
Output Fall Time of Vout (turn on)		t_{of}		1	1.7	3	µs

Test Circuit for Switching Characteristics

Figure 3

Application Information

Constant Current

In LED lighting applications, MBI1804 provides nearly no variations 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 performs as a perfection of load regulation.
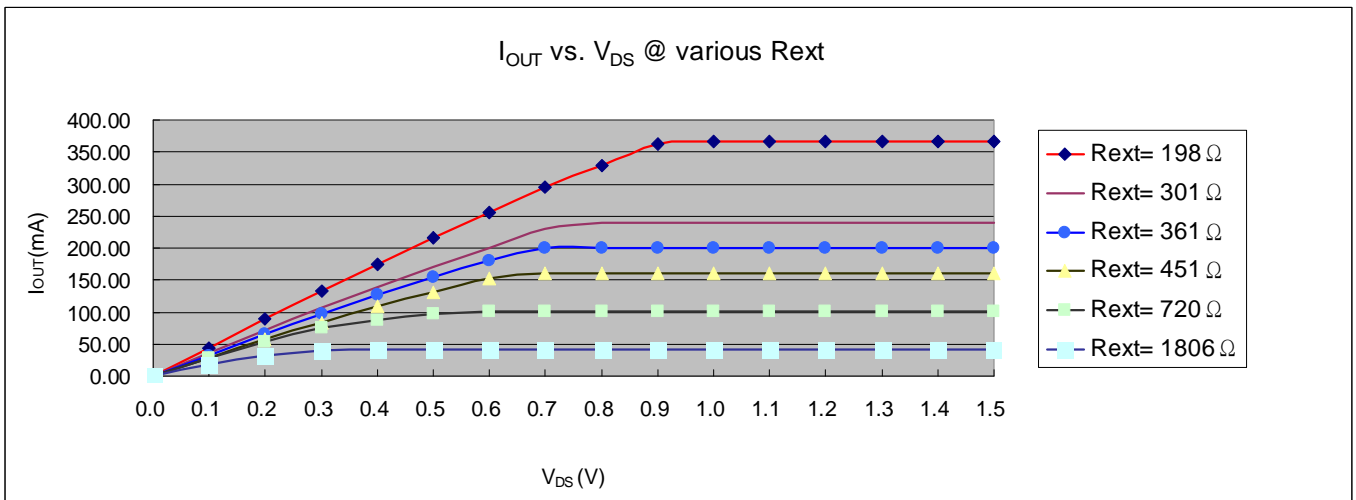
Figure 4

Adjusting Output Current

The output current of each channel (I_{OUT}) is set by an external resistor, R_{ext}. The relationship between I_{OUT} and R_{ext} is shown in the following figure.
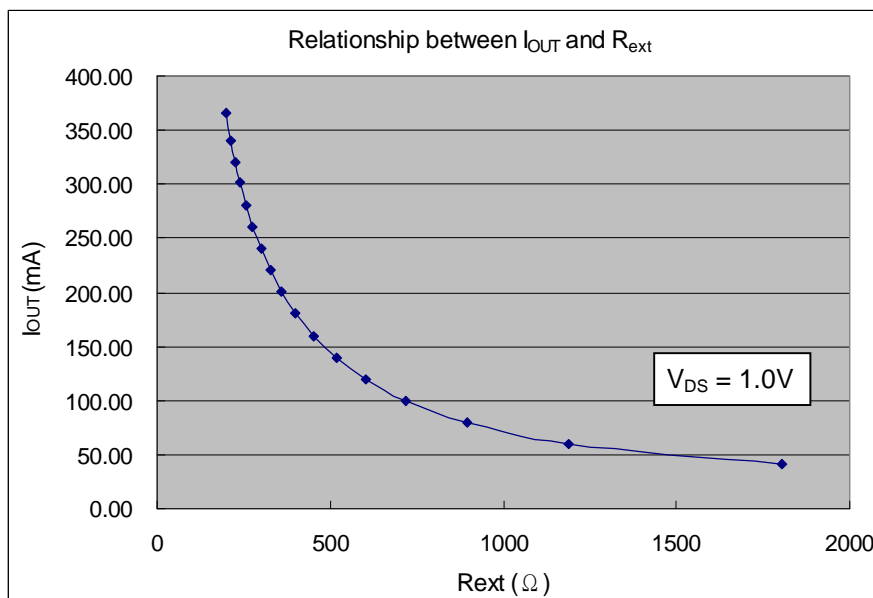
Relationship between I_{OUT} and R_{ext}

$V_{DS} = 1.0V$

Figure 5

Also, the output current can be calculated from the equation:

$V_{R-EXT} = 1.26V$; $I_{OUT} = (V_{R-EXT} / R_{ext}) \times 60 = (1.26V / R_{ext}) \times 60$

where R_{ext} is the resistance of the external resistor connected to R-EXT terminal and V_{R-EXT} is the voltage of R-EXT terminal. The magnitude of current (as a function of R_{ext}) is around 210 mA at 360Ω and 105 mA at 720Ω.

Package Power Dissipation (P_D)

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

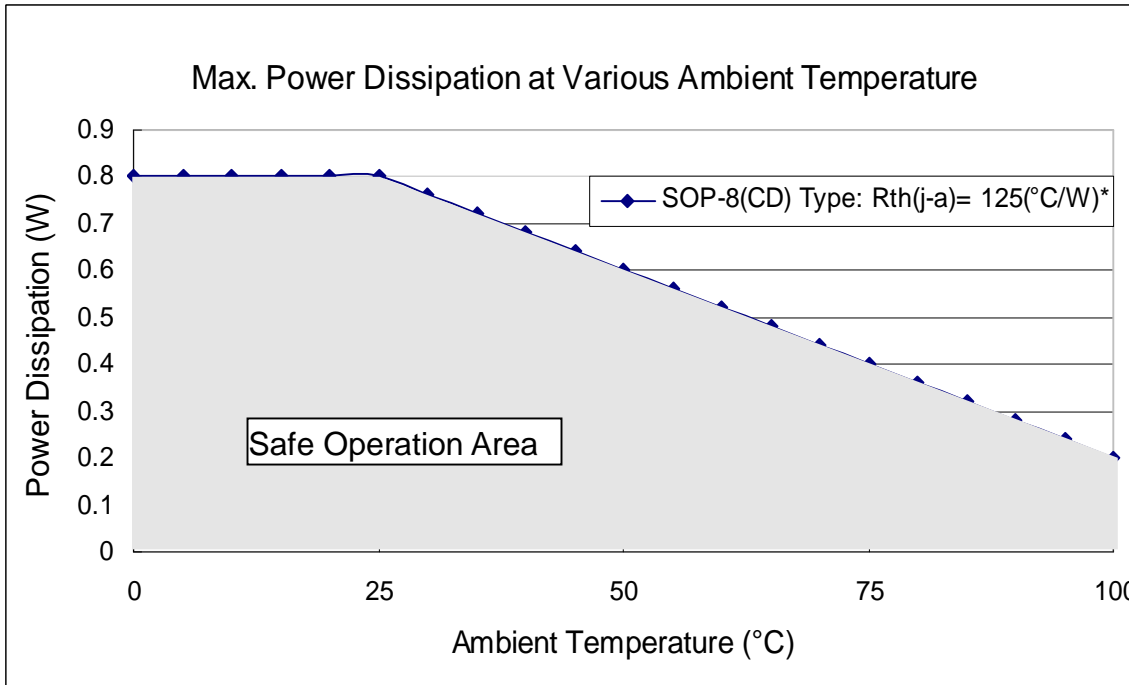## Max. Power Dissipation at Various Ambient Temperature

Figure 6

The maximum allowable package power dissipation is determined as $P_D(max) = (Tj – Ta) / R_{th(j-a)}$. 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:

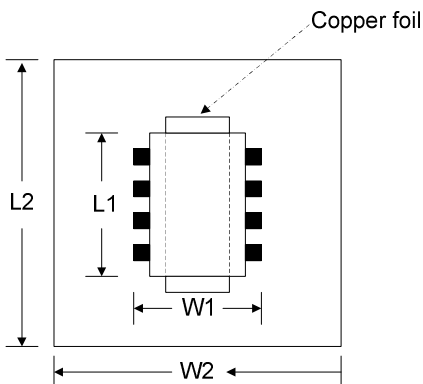$I_{OUT} = \{ [(Tj – Ta) / R_{th(j-a)}] – (I_{DD} \times V_{DD}) \} / V_{DS} / Duty / 4,$

where $Tj = 125°C$;

$Duty = t_{ON} / T$;

t_{ON}: the time of LEDs turning on; T: $\overline{OE}$ signal period
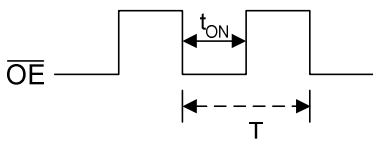
*Note1: The thermal resistor $R_{th(j-a)} = 125 \,°C/W$ is based on the following structure.

The PCB area L2xW2 is 4 times to 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.
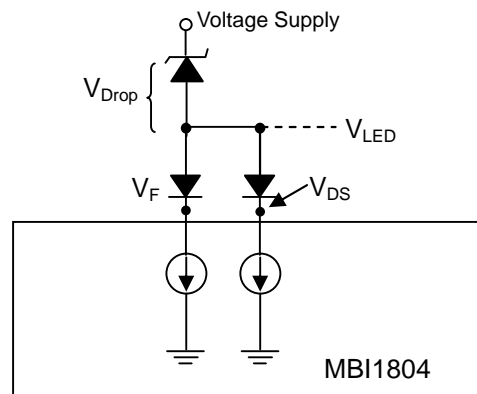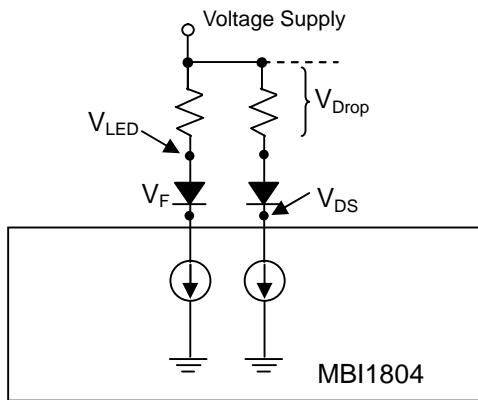
Load Supply Voltage (V_{LED})

MBI1804 are designed to operate with V_{DS} ranging from 0.4V to 1.0V considering the package power dissipating limits. V_{DS} may be higher enough to make $P_{D(act)} > P_{D(max)}$ when $V_{LED} = 5V$ and $V_{DS} = V_{LED} - V_F$, in which V_{LED} is the load supply voltage. 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 or Zener diode can be used in the applications as shown in the following figures.

Outline Drawing

SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.45	1.50	1.55	0.057	0.059	0.061
A1	0.00	---	0.10	0.000	---	0.004
A2	---	1.45	---	---	0.057	---
B	0.33	---	0.51	0.013	---	0.020
C	0.19	---	0.25	0.007	---	0.010
D	4.80	---	5.00	0.189	---	0.197
E	3.80	---	4.00	0.150	---	0.157
e	---	1.27	---	---	0.050	---
H	5.80	---	6.20	0.228	---	0.244
L	0.40	---	1.27	0.016	---	0.050
y	---	---	0.10	---	---	0.004
q	0	---	8	0	---	8