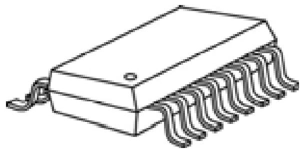
8-Channel All-Ways-On™ Constant Current LED Driver

Features

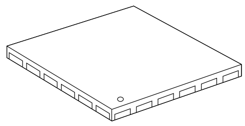
- Maximum 50V output sustaining voltage
- 8 constant-current output channels
- Adjustable 5 - 60mA output current per channel through an external resistor
- Constant output current invariant to load voltage change
- Excellent output current accuracy:
  between channels: <±3% (max.), and
  between ICs: <±6% (max.)
- Open-circuit detection mode to detect LED errors
- Integrated voltage regulator for 8 - 40V supply voltage
- Voltage feedback for DC/DC controller
- Package Type: “Pb-free & Green” package with thermal pad

Thin Shrink SOP



GTS: TSSOP16-173-0.65

Quad Flat No-Lead



GFN: QFN24-4*4-0.5

Current Accuracy		Conditions
Between Channels	Between ICs	
< ±3%	< ±6%	I_{OUT} = 5 ~ 60mA

Product Description

MBI1828 is an instant On/Off LED driver for lighting applications and exploits PrecisionDrive™ technology to enhance its output characteristics. At MBI1828 output stage, 8 regulated current ports are designed to provide uniform and constant current sinks for driving LEDs within a large range of V_F variations.

MBI1828 provides users 8-channel constant current ports to match LEDs with equal current. Users may adjust the output current from 5mA to 60mA 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 enable (OE) with Pulse Width Modulation.

Additionally, to ensure the system reliability, MBI1828 is built with thermal pad. The thermal pad enhances the power dissipation. As a result, a large amount of current can be handled safely in one package.

Applications

- Automotive lighting
- Channel letter
- Decorative LED lighting

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Typical Application Circuit

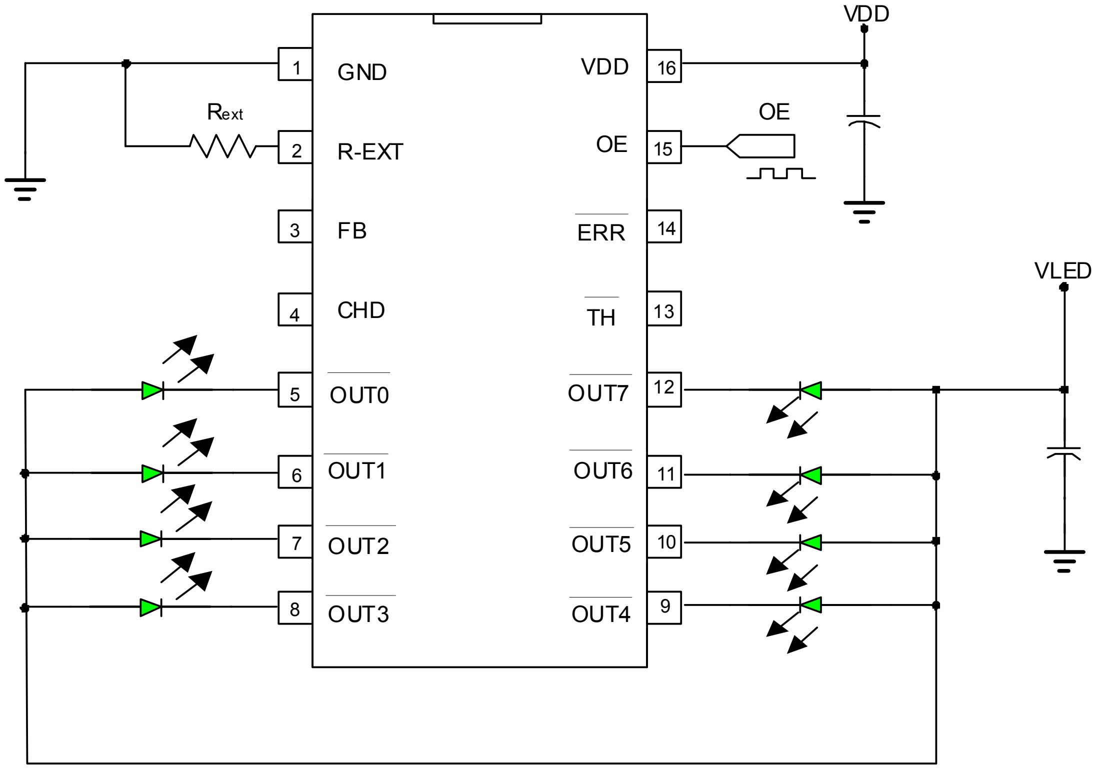


Figure 1

Functional Diagram

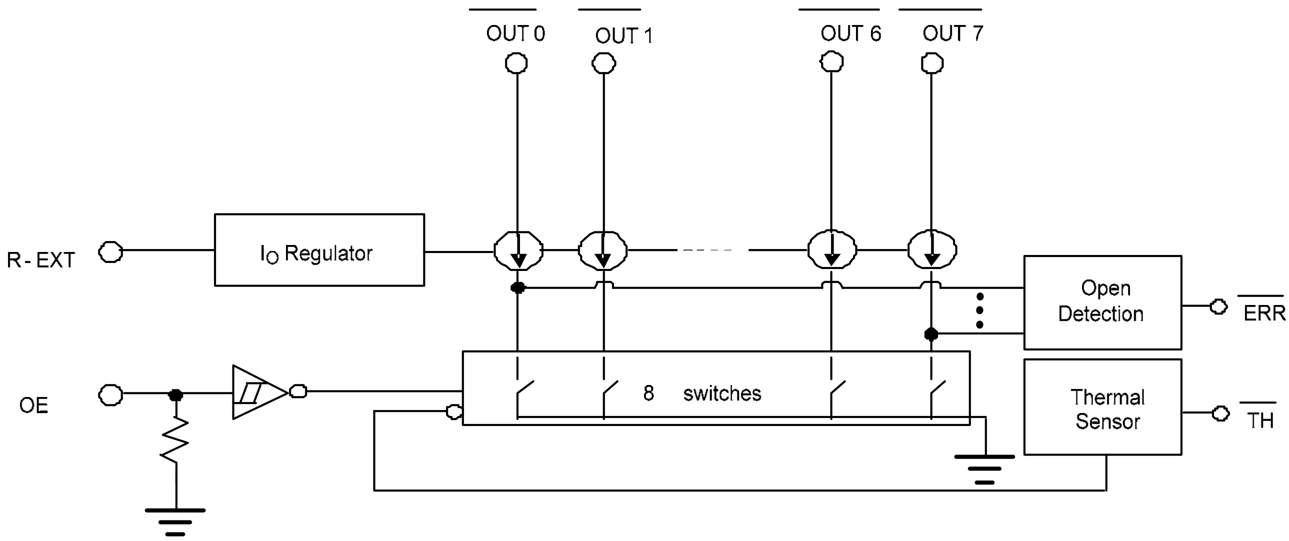
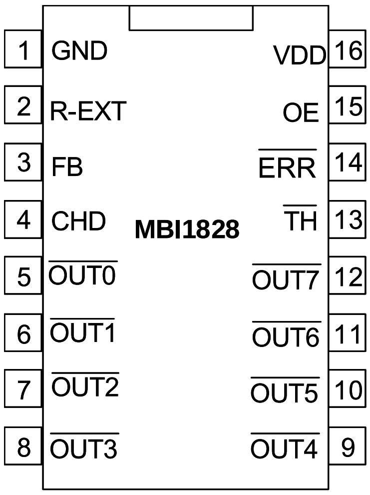
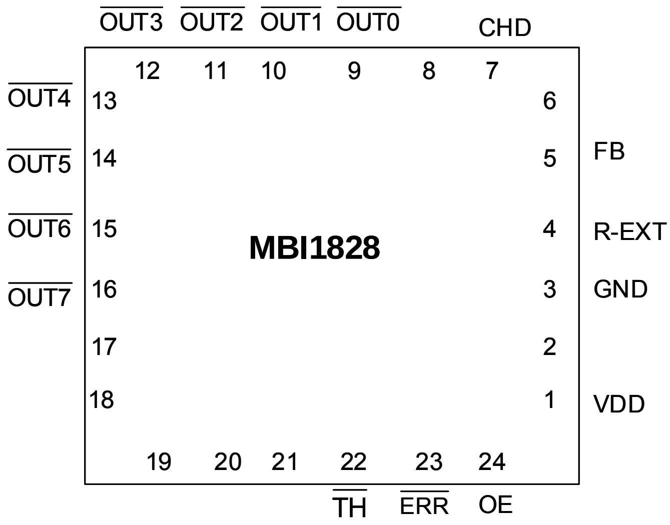


Figure 2

Pin Configuration



MBI1828 GTS



Pin Description

Pin Name	Function
VDD	Supply voltage terminal
GND*	Ground terminal for control logic and current sink
$\overline{OUT0}$ ~ $\overline{OUT7}$	Constant current output terminals
OE	Output enable terminal When OE is active (High), the output pins are enabled; when OE is inactive (Low), all output pins are turned off (blanked).
$\overline{ERR}$	When any single output channel is open, $\overline{ERR}$ is going to low.
R-EXT	The terminal used to connect an external resistor for setting up output current for output channel
$\overline{TH}$	When Tj is over 155 ºC, $\overline{TH}$ is going to low.
CHD	Channel disable terminal. Non-used channels can be connected to the port for preventing wrong open-circuit detection result.
FB	Feedback control voltage to DC/DC controller. The relationship between FB and minimum output voltage is V_{FB}=1.56 x minimum output voltage($V_{DS,\ min}$)

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

Maximum Ratings

Characteristic		Symbol	Rating	Unit
Supply Voltage		V_{DD}	0~40.0	V
Input Voltage		V_{IN}	-0.4~V_{DD} + 0.4	V
Output Current		I_{OUT}	66*	mA
Sustaining Voltage		V_{DS}	-0.5~+50.0	V
GND Terminal Current		I_{GND}	520	mA
Power Dissipation* (On PCB, Ta=25°C)	GTS	P_D	1.29	W
	GFN			
Thermal Resistance (By simulation)	GTS	$R_{th(j-a)}$	97.15	°C/W
	GFN		42.37	
Empirical Thermal Resistance** (On PCB, Ta=25°C)	GTS		103.15	
	GFN		99.73	
Operating Junction Temperature		T_j	125	°C
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 9。

**The PCB size is 4 times larger than that of IC and without extra heat sink.

Electrical Characteristics

VDD=12V, GND =0 V, Ta=25°C, unless otherwise specified.

Characteristic		Symbol	Condition		Min.	Typ.	Max.	Unit
Supply Voltage		V_{DD}	-		8	-	40	V
Sustaining Voltage at $\overline{OUT}$ pin		V_{DS}	$\overline{OUT0}$ ~ $\overline{OUT7}$		-	-	50	V
Output Current		I_{OUT}	DC Test Circuit		5	-	60*	mA
Input Voltage	"H" level	V_{IH}	T_a= -40~85ºC		2.8	-	V_{DD}	V
	"L" level	V_{IL}	T_a= -40~85ºC		GND	-	0.7	V
Output Leakage Current		I_{OH}	V_{OH}= 40.0V		-	-	0.5	µA
Output Voltage of $\overline{ERR}$ and $\overline{TH}$		V_{OL}, V_{OH}	I_{OL}= 1.0mA, I_{OH} =1.0mA		4.2	-	0.5	V
Output Current 1		I_{OUT1}	V_{DS}= 0.6V	R_{ext}= 2.4kΩ	-	30.75	-	mA
Current Skew 1		dI_{OUT1}	I_{OL}= 30.7mA V_{DS}= 0.6V	R_{ext}= 2.4kΩ	-	±1	±3	%
Output Current 2		I_{OUT2}	V_{DS}= 0.8V	R_{ext}= 1.3kΩ	-	56.7	-	mA
Current Skew 2		dI_{OUT2}	I_{OL}= 56.7mA V_{DS}= 0.8V	R_{ext}= 1.3kΩ	-	±1	±3	%
Current Chip Skew			-			-	±6	%
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 8.0V and 40V		-	±0.1	-	% / V
Pull-down Resistor		R_{IN}(down)			280	400	520	KΩ
V_{OUT} Feedback Report Voltage		V_{FB}	Min(V_{OUT})		-	1.25		V
Supply Current	"OFF"	I_{DD}(off) 1	R_{ext}= Open, $\overline{OUT0}$ ~ $\overline{OUT7}$ = Off		-	0.57	1	mA
		I_{DD}(off) 2	R_{ext}= 2.4kΩ, $\overline{OUT0}$ ~ $\overline{OUT7}$ = Off		-	0.57	1	
		I_{DD}(off) 3	R_{ext}= 1.3kΩ, $\overline{OUT0}$ ~ $\overline{OUT7}$ = Off		-	0.57	1	
	"ON"	I_{DD}(on) 1	R_{ext}= 2.4kΩ, $\overline{OUT0}$ ~ $\overline{OUT7}$ = On		2.5	3.17	5	
		I_{DD}(on) 2	R_{ext}= 1.3kΩ, $\overline{OUT0}$ ~ $\overline{OUT7}$ = On		3.0	3.55	5	
Junction Temperature Threshold of Thermal flag		T_j			-	155	-	°C
The Hysteresis Temperature of Thermal Flag		T_{hys}			-	35	-	°C
Standby Current		I_{DD}(shdn)	The OFF time of OE exceeds t_{shdn}		-	0.57	1	mA
$\overline{ERR}$ Delay Time		t_{err}	After VDD builds up		-	-	1000	mS

* Each output current, I_{OUT}, can be driven up to 60mA.

Test Circuit for Electrical Characteristics

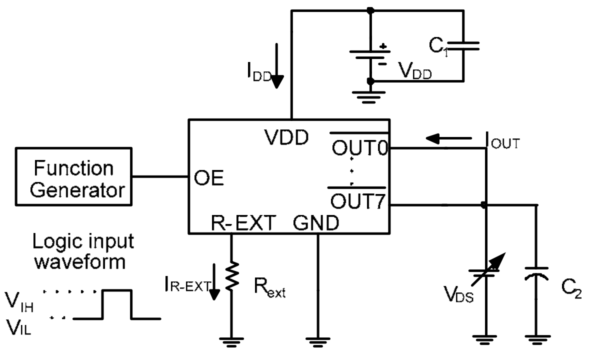


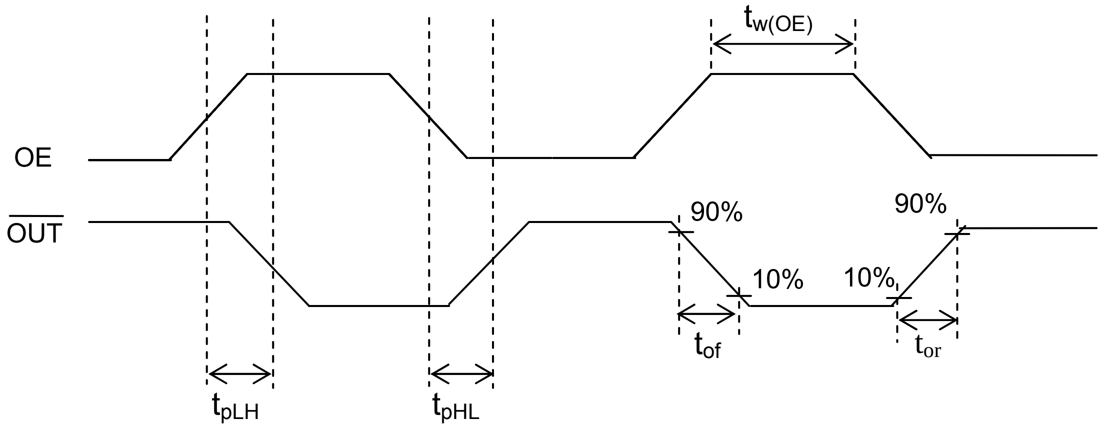
Figure 3

Switching Characteristics

Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time ("L" to "H")	OE - $\overline{OUTn}$	t_{pLH}	V_{DD}= 12.0 V V_{DS}= 1.0V V_{IH}= 5V V_{IL}= GND R_{ext}= 1227Ω (I_{OUTn}=60mA) V_{LED}= 4.2 V R_L= 51 Ω C_L= 10 pF	-	1.88	2.5	μs
Propagation Delay Time ("H" to "L")	OE - $\overline{OUTn}$	t_{pHL}		-	1.3	2.5	μs
Pulse Width	OE	$t_{w(OE)}$		5	-	-	μs
Output Rise Time of $\overline{OUT}$ (turn off)		t_{or}		-	1.5	2.5	μs
Output Fall Time of $\overline{OUT}$ (turn on)		t_{of}		-	1.8	2.5	μs
Shutdown Time		t_{shdn}	OE disable time	491	-	825	us

Note: Where the "n" of $\overline{OUTn}$ refers to 0~7.

Timing Waveform



Test Circuit for Switching Characteristics

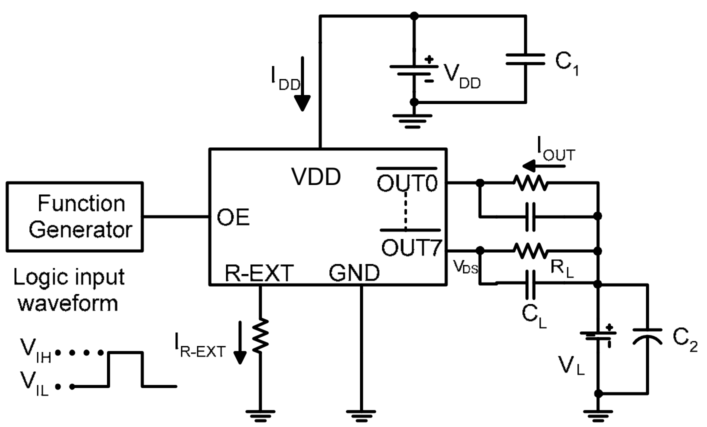


Figure 4

Constant Current

In LED lighting applications, MBI1828 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 Figure 5. 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.

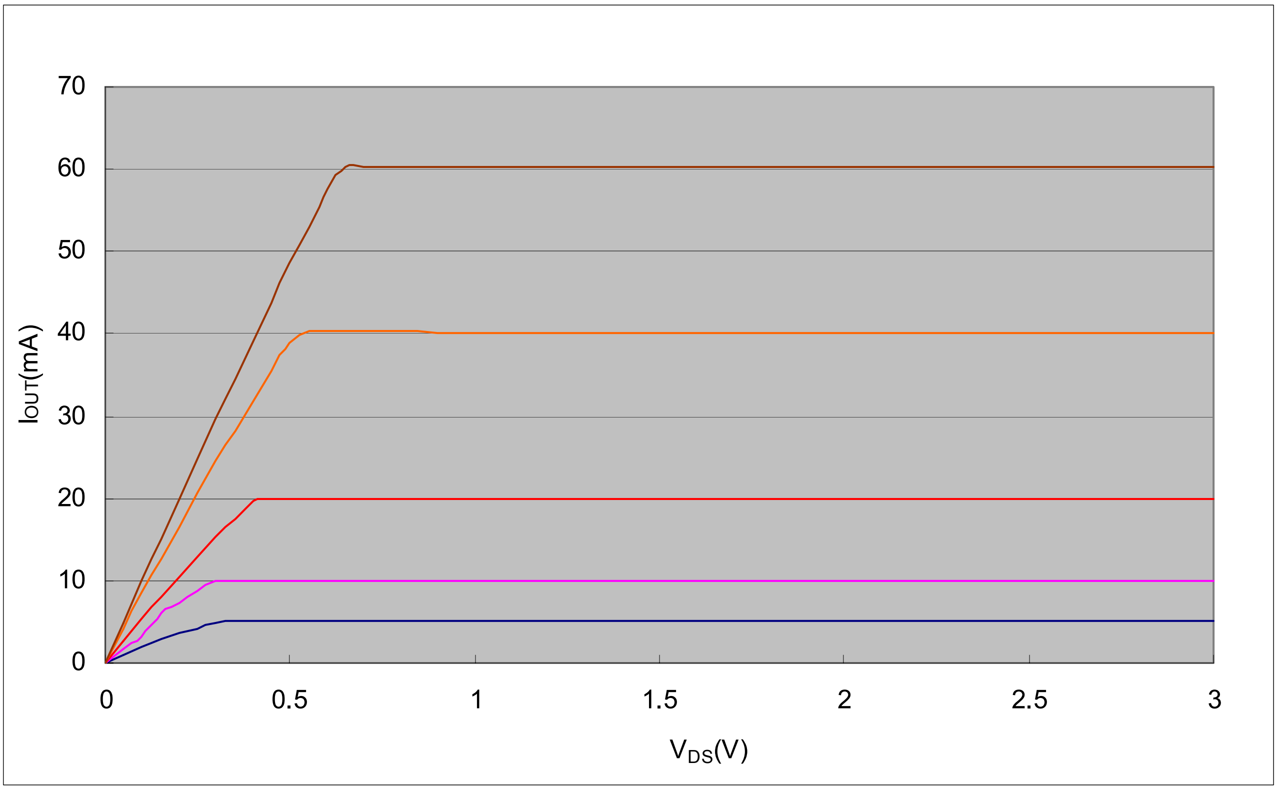


Figure 5

Setting Output Current

The output current of each channel (I_{OUT}) is set by an external resistor, R_{ext}. The relationship between I_{OUT} and R_{ext} is shown in Figure 6.

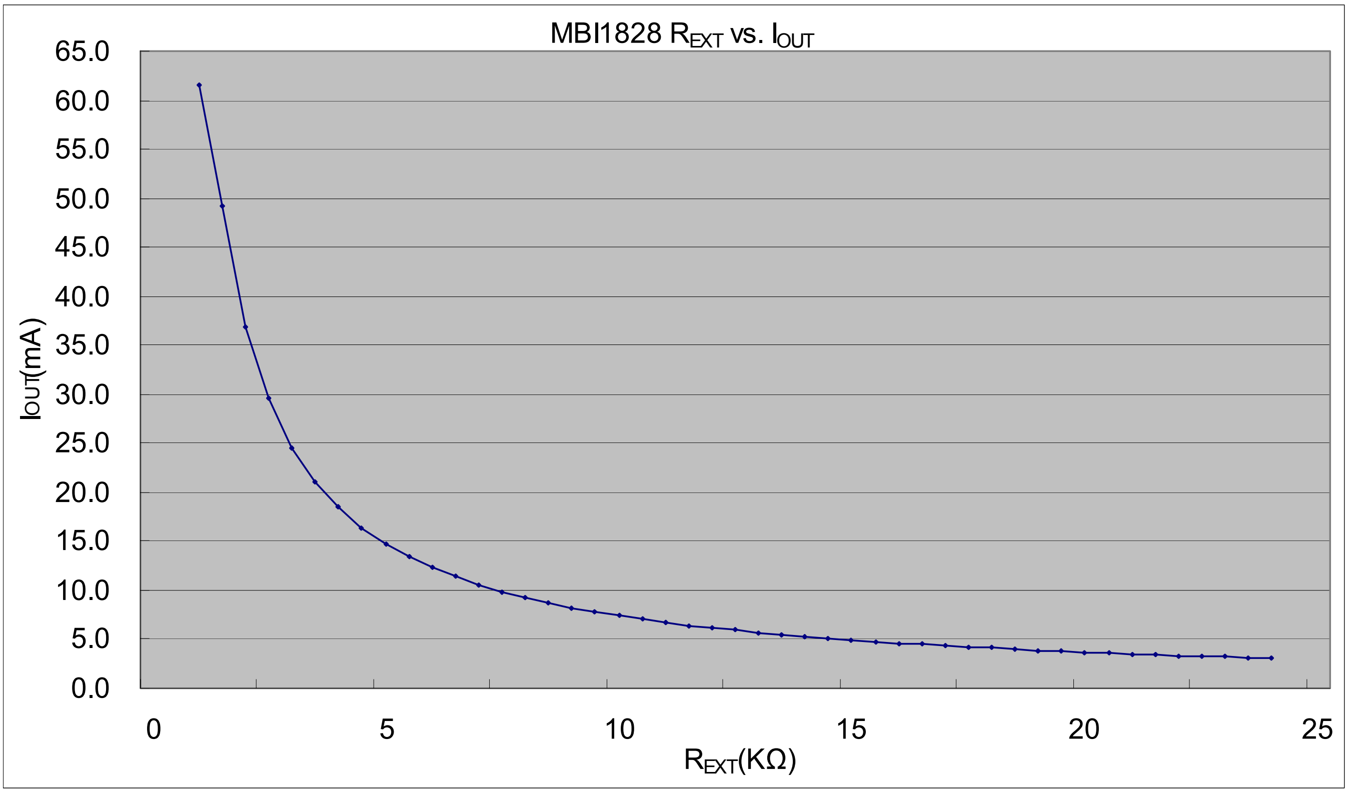


Figure 6

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

V_{R-EXT} = 1.23V;

$R_{ext} = (V_{R-EXT} / I_{OUT}) \times 60 = (1.23V / I_{OUT}) \times 60$;

$I_{OUT} = (V_{R-EXT} / R_{ext}) \times 60 = (1.23V / R_{ext}) \times 60$ within $\pm$6% chip skew;

where R_{ext} is the resistance of the external resistor connecting 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 56.7mA at 1.3kΩ and 30.75mA at 2.4kΩ.

Open-Circuit Detection

The principle of LED open-circuit detection is based on the fact that when output voltage (V_{DS}) is lower than 0.3V. The $\overline{ERR}$ pin will become low. Before activating open-circuit detection, MBI1828 will check CHD pin first. Once it confirms, the open-circuit detection will bypass those non-used pins which are connected to CHD.

Thermal Detection

When the junction temperature exceeds the threshold, Tj (155°C), the thermal flag would be enabled. The $\overline{TH}$ pin will become low. As soon as the temperature is below 155°C, the $\overline{TH}$ will go high again.

Principle to Cooperate with DC/DC Converter

MBI1828 can co-work with DC/DC converter through FB terminal. The voltage of FB terminal is V_{FB}=1.56 x ($V_{DS,\ min}$) to make V_{DS} reaching 0.8V. When the minimum V_{DS} of MBI1828 in any single channel is lower than 0.8V, the V_{FB} will force DC/DC controller to boost V_{LED} as shown in Figure 7.

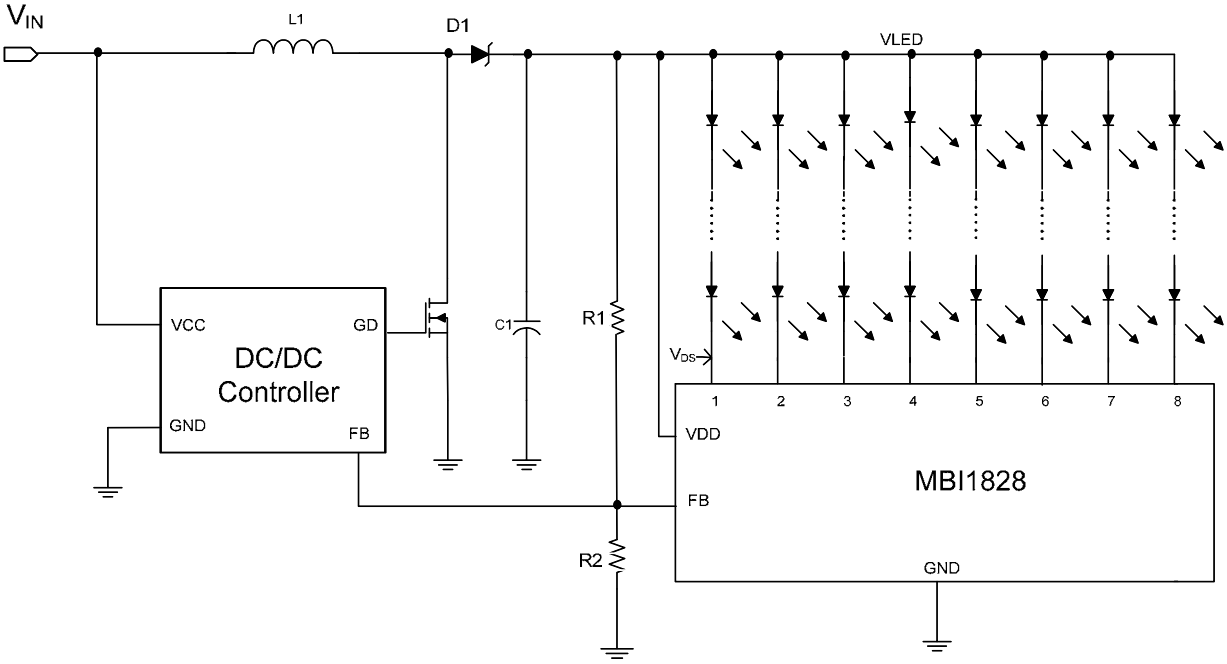
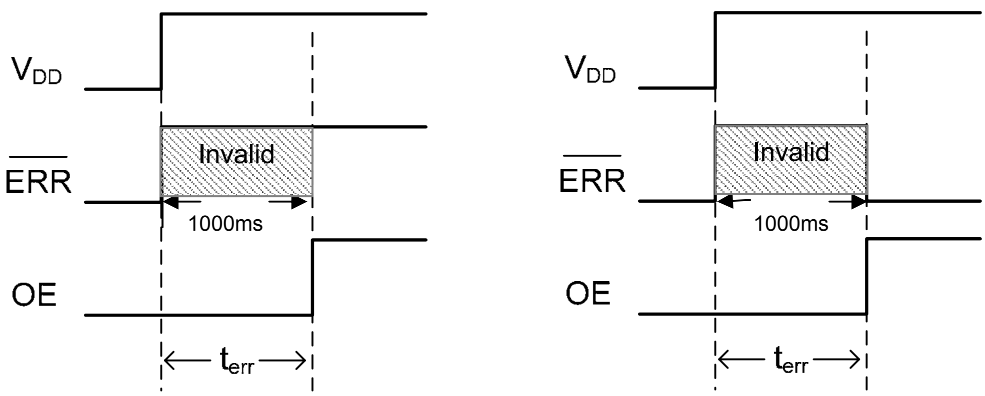


Figure 7

As noted previously, MBI1828 reports open-circuit event and results in $\overline{ERR}$ signal change. To avoid false alarm of error report, there should be a 1000ms delay time (t_{err}) after V_{DD} builds up. In Figure 8 (a), the $\overline{ERR}$ is invalid during this delay period and remains high level after the delay time. However, if IC detects the real open-circuit event after the delay time, the $\overline{ERR}$ goes low and the error report shows open-circuit event as shown in Figure 8 (b). However, there are 2 points of power on sequence should be aware when applying DC/DC controller:

1. OE pin cannot directly connect to $\overline{ERR}$, $\overline{TH}$, and VDD pins. OE should be addressed after 1000ms delay time of V_{DD}.
2. The output voltage of DC/DC converter is decided by a voltage divider, $V_{LED}=V_{FB}(1+(R1/R2))$. This output voltage of DC/DC converter should be 1V higher than maximum LED forward voltage.



(a) If there is no open-circuit event, the $\overline{ERR}$ remains high after the delay time.

(b) If IC detects the real open-circuit event after the delay time, the $\overline{ERR}$ goes low and report open-circuit event.

Figure 8 The waveform of power on sequence

Package Power Dissipation (P_D)

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

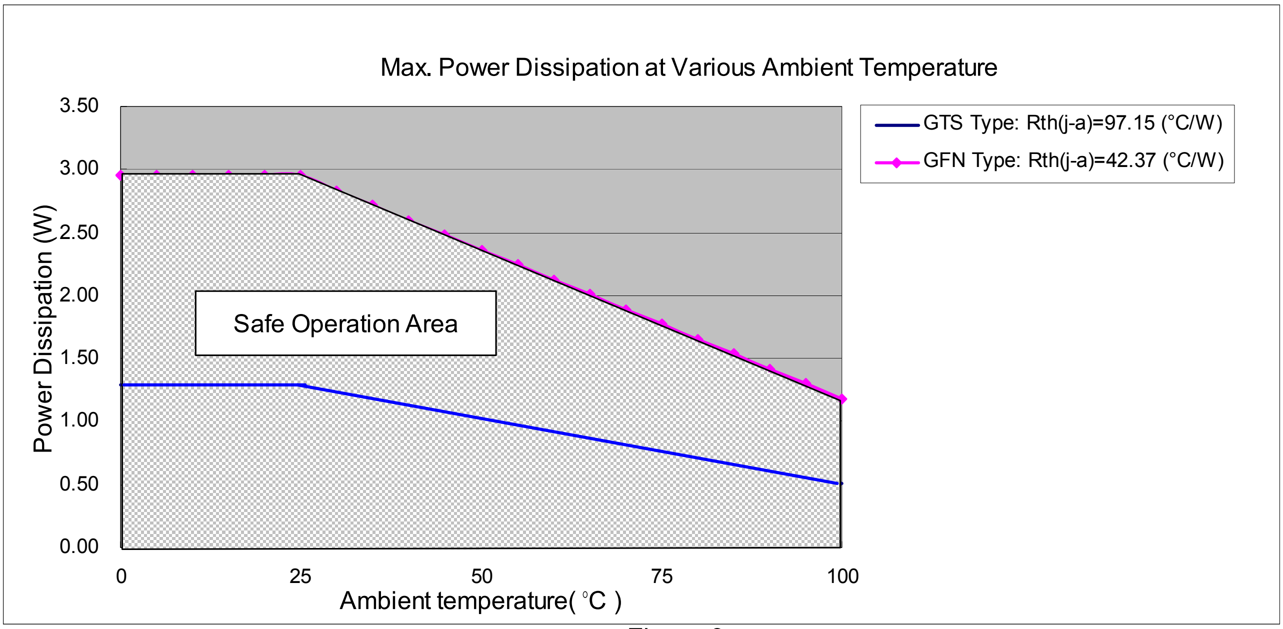


Figure 9

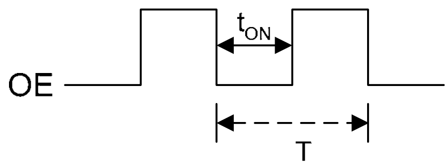
The maximum allowable package power dissipation is determined as $P_D(max) = (T_{j,max} – T_a) / R_{th(j-a)}$. When 8 output channels are turned on simultaneously, the actual package power dissipation is $P_D(act) = (I_{DD} \times V_{DD}) + (I_{OUT} \times Duty \times V_{DS} \times 8)$. Therefore, to keep $P_D(act) \le P_D(max)$, the allowable maximum output current as a function of duty cycle is:

$I_{OUT} = \{ [(T_j – T_a) / R_{th(j-a)}] – (I_{DD} \times V_{DD}) \} / V_{DS} / Duty / 8$,

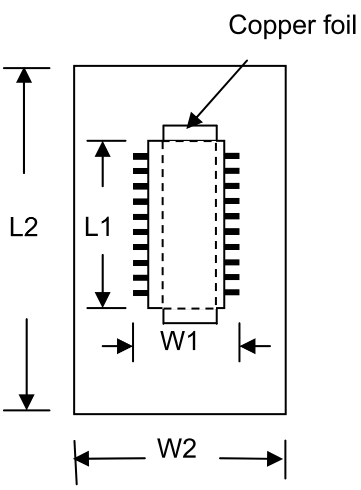
where T_j = 125°C;

Duty= t_{ON} / T;

t_{ON}: the time of LEDs turning on; T: OE signal period



*Note: The empirical thermal resistor $R_{th(j-a)}$ =125 °C/W; it 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 1.6 mm, 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})

MBI1828 is designed to operate with adequate V_{DS} to achieve constant current. V_{DS} and I_{OUT} should not exceed the package power dissipation limit, PD(max).

$V_{DS} = V_{LED} – V_F$, and V_{LED} is the load supply voltage. If V_{DS} drops too much voltage on the driver, PD(act) will be greater than PD(max). In this case, it is recommended to use supply voltage as low as possible or to set an external voltage reducer, V_{DROP}.

A voltage reducer allows $V_{DS} = (V_{LED} – V_F) – V_{DROP}$.

Resistors can be used in the applications as shown in Figure10.

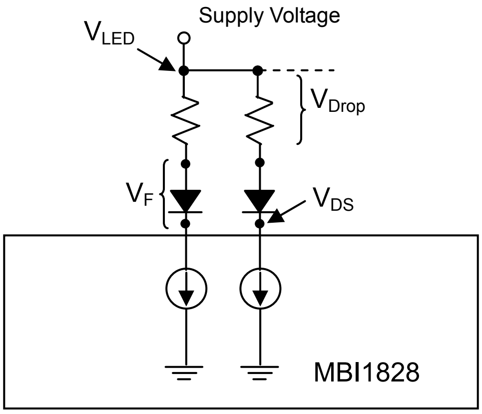
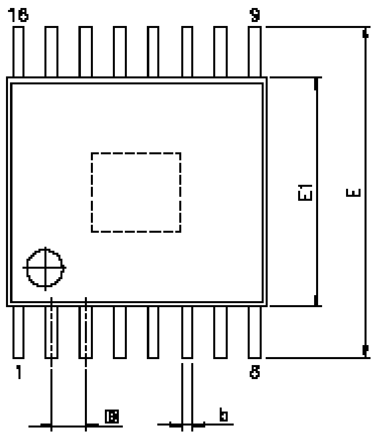
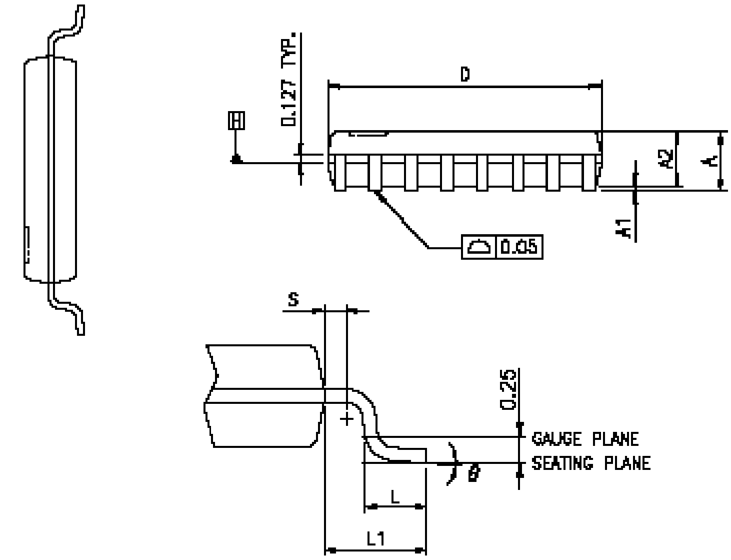
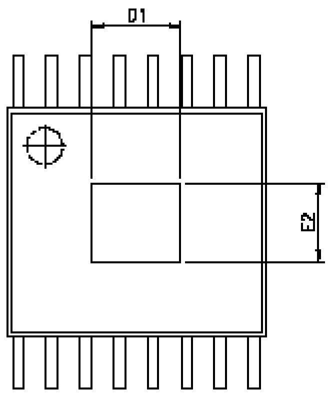


Figure 10

Outline Drawing







THERMALLY ENHANCED VARIATIONS ONLY

VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

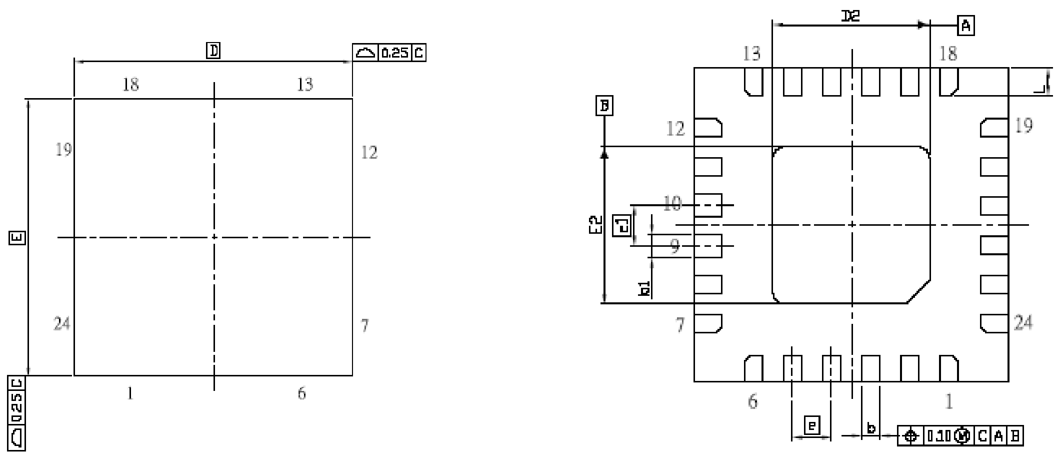
SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.20
A1	0.00	–	0.15
A2	0.80	1.00	1.05
b	0.19	–	0.30
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.40 BSC		
e	0.65 BSC		
L1	1.00 REF		
L	0.45	0.60	0.75
S	0.20	–	–
θ	0°	–	8°

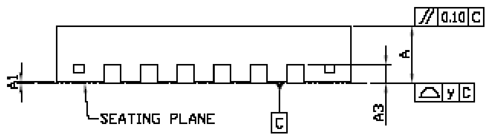
4 THERMALLY ENHANCED DIMENSIONS(SHOWN IN MM)

PAD SIZE	E2		D1	
	MIN.	MAX.	MIN.	MAX.
118X11E	2.40	3.00	2.40	3.00

MBI1828 GTS Outline Drawing

Note: The unit for the outline drawing is mm. Please use the maximum dimensions for the thermal pad layout. To avoid the short circuit risk, the vias or circuit traces shall not pass through the maximum area of thermal pad.



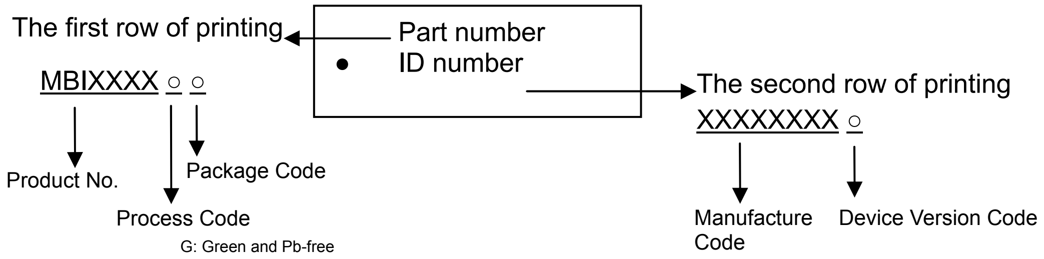


SYMBOL	DIMENSION (MM)			DIMENSION (MIL)		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	27.6	29.5	31.5
A1	0	0.02	0.05	0	0.79	1.97
A3	0.203 REF			8 REF		
b	0.18	0.23	0.28	7.1	9.0	11.0
D	3.90	4.00	4.10	153.5	157.5	161.4
D2	1.90	2.00	2.10	74.8	78.7	82.7
E	3.90	4.00	4.10	153.5	157.5	161.4
E2	1.90	2.00	2.10	74.8	78.7	82.7
e	0.50 BSC			19.69 BSC		
L	0.25	0.35	0.45	9.8	13.7	17.7
y	0.08			3.15		
b1	0.25	0.30	0.35	9.8	11.8	13.7
e1	0.52 REF.			20.5 REF.		

MBI1828 GFN Outline Drawing

Note: Please use the maximum dimensions for the thermal pad layout. To avoid the short circuit risk, the vias or circuit traces shall not pass through the maximum area of thermal pad.

Product Top-Mark Information



Product Revision History

Datasheet Version	Device Version Code
V1.00	A

Product Ordering Information

Part Number	Package Type	Weight (g)
MBI1828GTS	TSSOP16-173-0.65	0.067
MBI1828GFN	QFN24-4*4- 0.5	0.0379

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