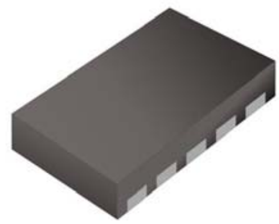
60V/2A, Common Anode Step-Down LED Driver

Features

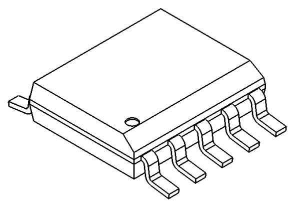
- Maximum 2A constant output current
- >95% efficiency @ input voltage 36V, load condition: 2A, 10 LEDs
- 4.5V~60V wide input voltage range
- Common anode connection
- Adaptive hysteretic PFM with adjustable fixed frequency operation
- Tunable output current
- Integrated power switch with 0.2Ω on-resistance
- Full protections: UVLO/OCP/ Thermal/ LED Open-/ LED Short- Circuited

Dual Flat No-lead



GDF: DFN-10L 3*3

Small Outline Package



GD: SOP-10L-150

Product Description

MBI6662 is a high efficiency, constant current and step-down DC/DC converter. It is designed to deliver constant current to light up high power LEDs. With the adaptive hysteretic PFM control scheme, MBI6662 can achieve constant frequency operation under common anode connection.

The output current of MBI6662 can be set by an external resistor, and LED brightness can be controlled via a pulse width modulation (PWM) signal through DIM pin. In addition, the soft-start function limits the inrush current while the power is turned on. MBI6662 also features under voltage lock out (UVLO), over temperature protection (OTP), and over current protection (OCP) to ensure system robustness and prevent IC and LEDs from being damaged once any abnormal condition occurs.

To ensure system reliability, MBI6662 is equipped with thermal shutdown protection (TSD), which protects IC from overheating by turning off the internal MOSFET. MBI6662 is available in thermal-enhanced DFN-10 and SOP-10 package to handle power dissipation more efficiently.

Applications

- Stage Lighting
- High Power LED Wall-Washer
- Automotive LED Lighting
- Parallel Lighting Fixtures Connected by Common-Anode Scheme

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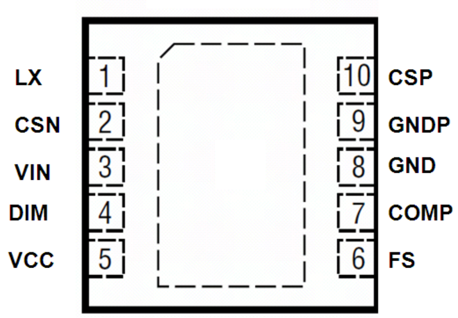
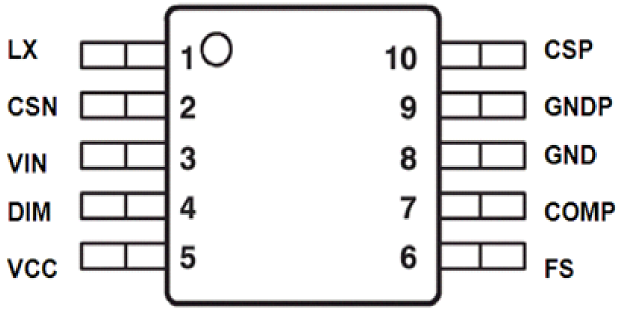
Pin Configuration



MBI6662GDF



MBI6662GD

Fig.1 Pin Configuration of MBI6662

Pin Description

Pin Name	Function
LX	Terminal of the drain node of the internal N-MOSFET
CSN	Terminal to sense schottky diode current
VIN	Terminal of the supply voltage
DIM	Terminal of the PWM dimming input
VCC	Terminal of the Internal regulator output
FS	Terminal of the swtiching frequency setting resistor
COMP	Terminal of the compensator
GND	Terminal of the analog signal ground
GNDP	Terminal of the power signal ground
CSP	Terminal of the current sensing resistor

*To improve the noise immunity, the thermal pad is suggested to connect to GND on PCB. In addition, when a heat-conducting copper foil on PCB is soldered with thermal pad, the desired thermal conductivity will be improved.

Typical Application Circuit

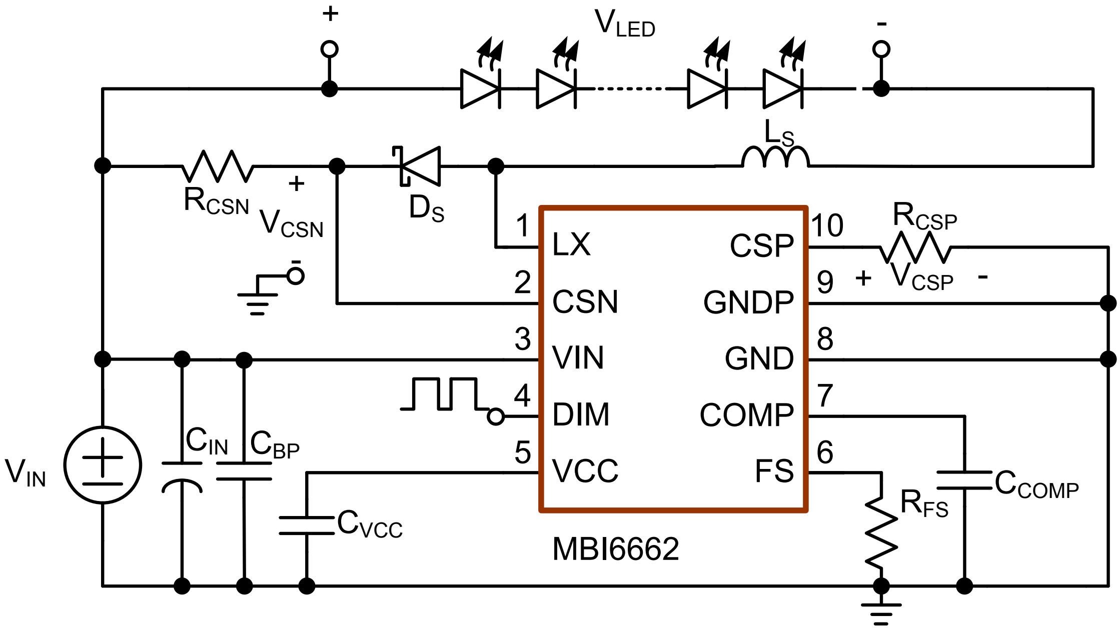


Fig.2 Typical application circuit of MBI6662

Functional Diagram

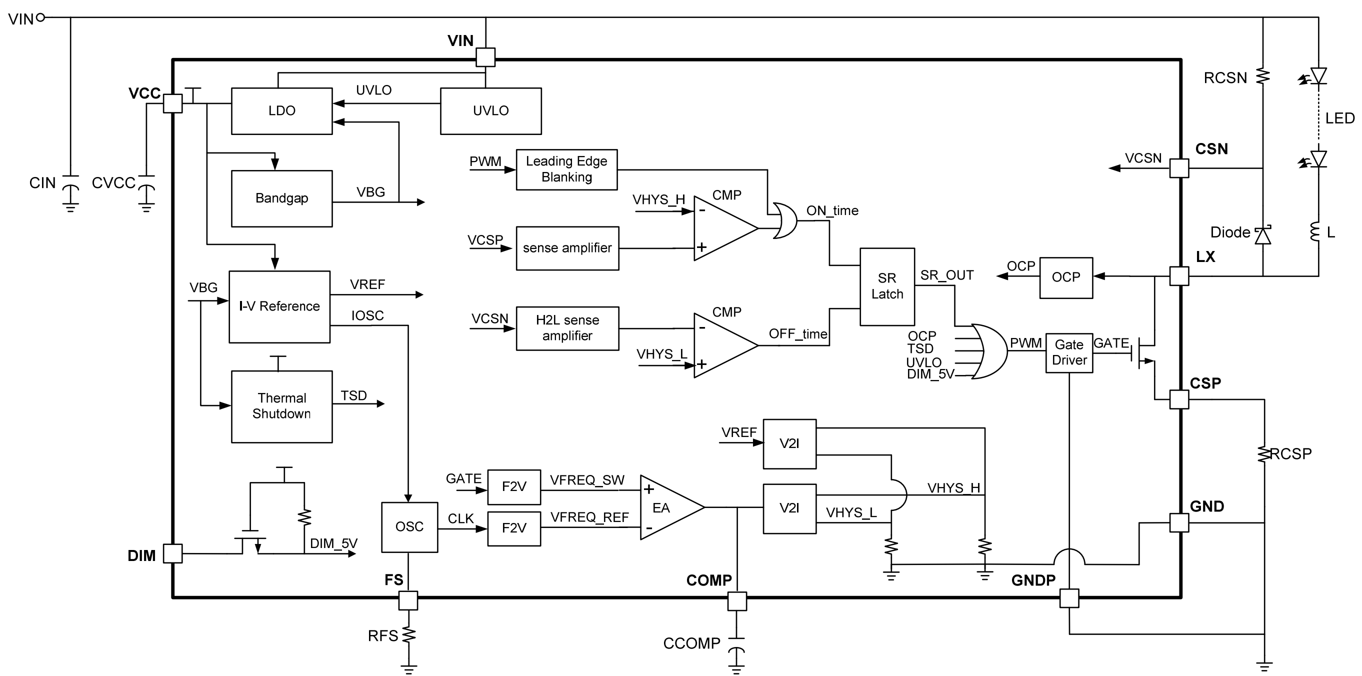


Fig. 3 Functional diagram of MBI6662

Maximum Ratings

Operation above the maximum ratings may cause device failure.

Characteristic		Symbol	Rating	Unit
Supply Voltage		V_{IN}	-0.3~75	V
Sustaining Voltage at DIM pin		V_{DIM}	-0.3~75	V
Sustaining Voltage at LX pin		V_{LX}	-0.3~75	V
Sustaining Voltage at CSN pin		V_{CSN}	-0.3~75	V
Sustaining Voltage at CSP pin		V_{CSP}	-0.3~7	V
Sustaining Voltage at VCC pin		V_{CC}	-0.3~7	V
Sustaining Voltage at COMP pin		V_{COMP}	-0.3~7	V
Sustaining Voltage at FS pin		V_{FS}	-0.3~7	V
Power Dissipation (On 4 Layer PCB, Ta=25°C)*	GDF Type	P_D	2.67	W
Thermal Resistance (By simulation, on 4 Layer PCB)*		$R_{th(j-a)}$	47.85	°C/W
Power Dissipation (On 4 Layer PCB, Ta=25°C)*	GD Type	P_D	3.13	W
Thermal Resistance (By simulation, on 4 Layer PCB)*		$R_{th(j-a)}$	40	°C/W
Junction Temperature		$T_{j,max}$	150***	°C
Operating Ambient Temperature		T_{opr}	-40~+85	°C
Storage Temperature		T_{stg}	-55~+150	°C

*The PCB size is 76.2mm*114.3mm in simulation. Please refer to JEDEC JESD51.

** Operation at the maximum rating for extended periods may reduce the device reliability; therefore, the suggested operation temperature of the device (T_{opr}) is under 125°C.

Note: The performance of thermal dissipation is strongly related to the size of thermal pad, thickness and layer numbers of the PCB. The empirical thermal resistance may be different from simulative value. Users should plan for expected thermal dissipation performance by selecting package and arranging layout of the PCB to maximize the capability.

Electrical Characteristics

Test condition: V_{IN}=12V, V_{OUT}=3.6V, L1=68μH, C_{IN}=C_{OUT}=10μF, C_{VCC}=1μF, T_A=25°C; unless otherwise specified.

Characteristics	Symbol	Condition	Min.	Typ.	Max.	Unit
DC Characteristics						
Supply Voltage	V_{IN}	-	4.5	-	60	V
Supply Current	I_{DD}	V_{IN}=4.5V~60V, F_{SW}=100kHz	-	1.5	2.5	mA
Output Current	I_{OUT}	Refer to page 19 for derating.	-	-	2.0	A
Output Current Accuracy	dI_{OUT}/I_{OUT}	0.35A≤I_{OUT}≤2A	-	±2	±5	%
MOSFET On-Resistance	$R_{DS,ON}$	I_{OUT}=350mA	-	0.2	0.5	Ω
MOSFET Leakage	I_{LEAK}	V_{LX}=60V	-	0.1	1.0	μA
Efficiency	-	V_{IN}=36V, I_{OUT}=2A, 10LEDs	-	95	-	%
Switching Characteristics						
LX Rise Time	T_{R_LX}	-	-	-	20	ns
LX Fall Time	T_{F_LX}	-	-	-	20	ns
Recommended Duty Cycle	D_{LX}	-	10		90	%
Operating Frequency	F_{SW}	-	0.1	-	1.0	MHz
Current Sense						
Mean Sense Voltage	V_{CS}	-	95	100	105	mV
Low Side Hysteresis	V_{CSP}	Normalize to average current	5	-	80	%
High Side Hysteresis	$V_{IN}-V_{CSN}$	Normalize to average current	5	-	80	%
CSP Propagation Delay	T_{PPD}	LX tights to V_{IN}	-	100	-	ns
CSN Propagation Delay	T_{NPD}	LX tights to GND	-	100	-	ns
High Side Blanking Time	T_{LEB_H}	-	-	280	-	ns
Low Side Blanking Time	T_{LEB_L}	-	-	180	-	ns
Thermal Shutdown (TSD)						
Thermal Shutdown Threshold*	T_{SD}	-	145	155	175	°C
Thermal Shutdown Hysteresis*	T_{SD-HYS}	-	20	30	40	°C
Under Voltage Lock-out (UVLO)						
UVLO Voltage	V_{UVLO}	T_A=-40~85°C	-	4.1	-	V
Start Up Voltage	V_{STUP}	-	-	4.4	-	V
Over Current Protection (OCP)						
Over Current Threshold*		-	-	3.0	-	A
PWM Dimming						
PWM Duty Cycle Range	D_{DIM}	PWM frequency:0.1kHz~1kHz	1	-	100	%
PWM Signal High Level	V_{IH_DIM}	V_{IN}=4.5V~60V	2.5	-	-	V
PWM Signal Low Level	V_{IL_DIM}	V_{IN}=4.5V~60V	-	-	0.8	V
Regulator						
Regulated Voltage	V_{CC}	V_{IN}=4.5V,I_{LOAD}=2mA	-	4.2	-	V
	V_{CC}	V_{IN}=6V~60V, I_{LOAD}=2mA	4.5	5.0	5.5	V

*Parameters are not tested at production. Parameters are guaranteed by design.

Typical Performance Characteristics

Efficiency for Series LED Load/Input Voltage

R_{CSP}=R_{CSN}=100mΩ(1A)/66mΩ(1.5A)/50mΩ(2A), R_{FS}=300kΩ, L=68μH, C_{COMP}=4.7nF, C_{VCC}=1μF, C_{IN}=10μF.

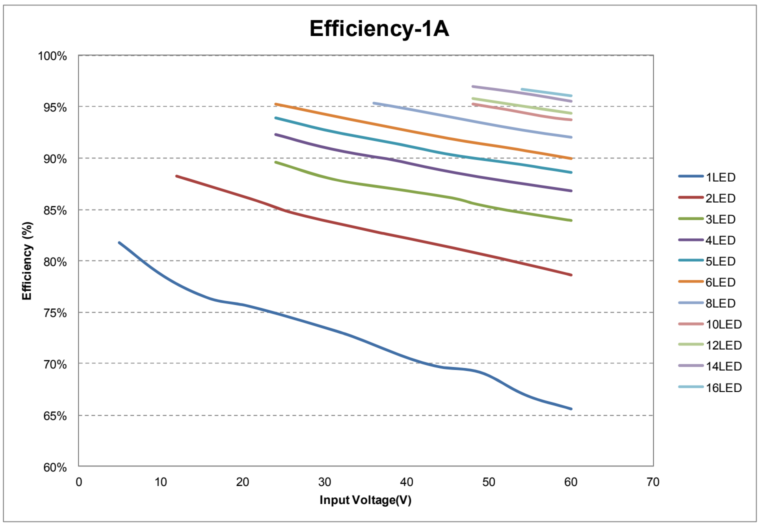


Fig.4 Efficiency of MBI6662: 1A output current

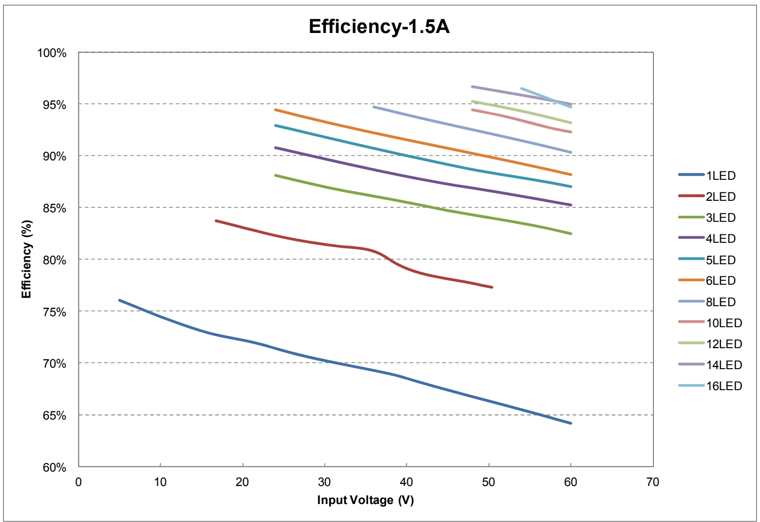


Fig.5 Efficiency of MBI6662: 1.5A output current

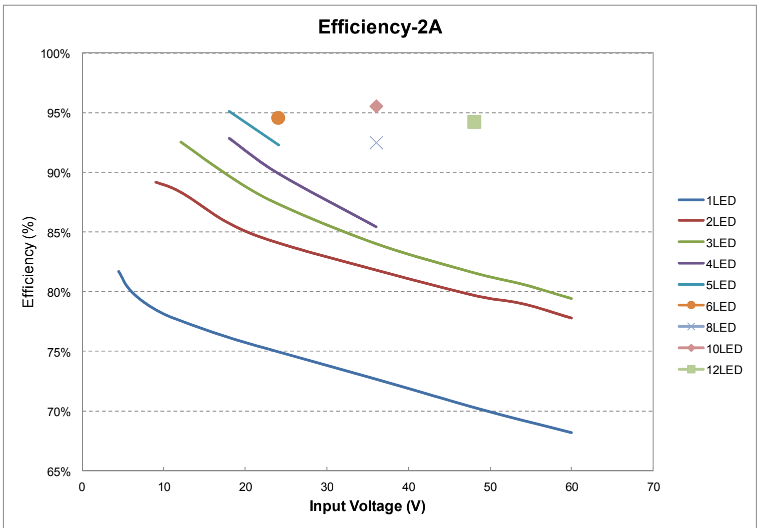


Fig.6 Efficiency of MBI6662: 2A output current

Output Current vs. Input Voltage (Line Regulation)

$R_{CSP}=R_{CSN}=100m\Omega(1A)/66m\Omega(1.5A)/50m\Omega(2A)$, $R_{FS}=300k\Omega$, $L=68\mu H$, $C_{COMP}=4.7nF$, $C_{VCC}=1\mu F$, $C_{IN}=10\mu F$.

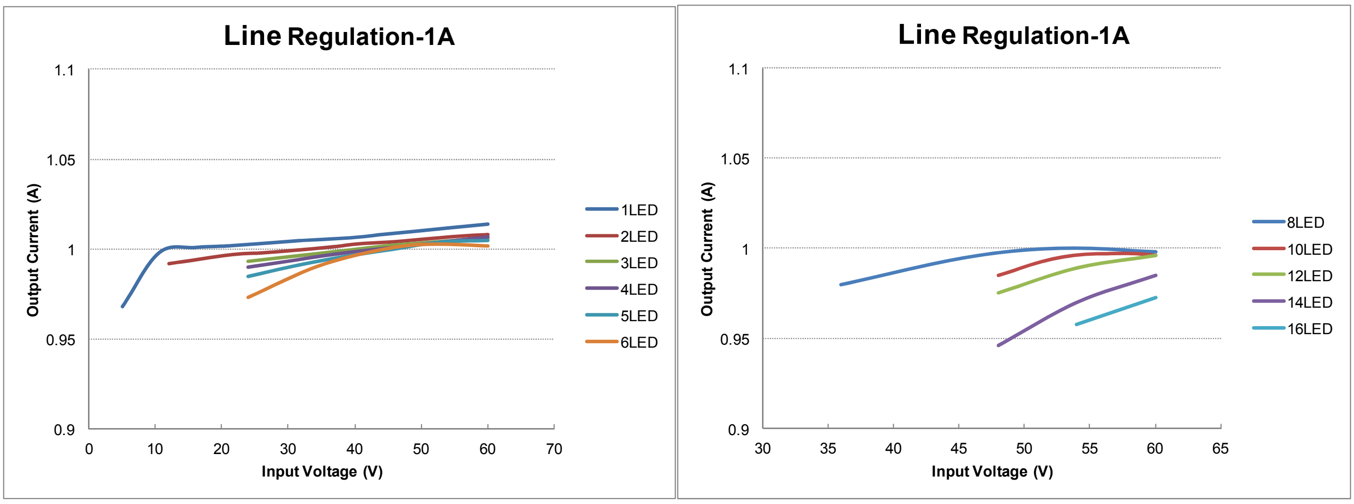


Fig.7 Line regulation of MBI6662: 1A output current

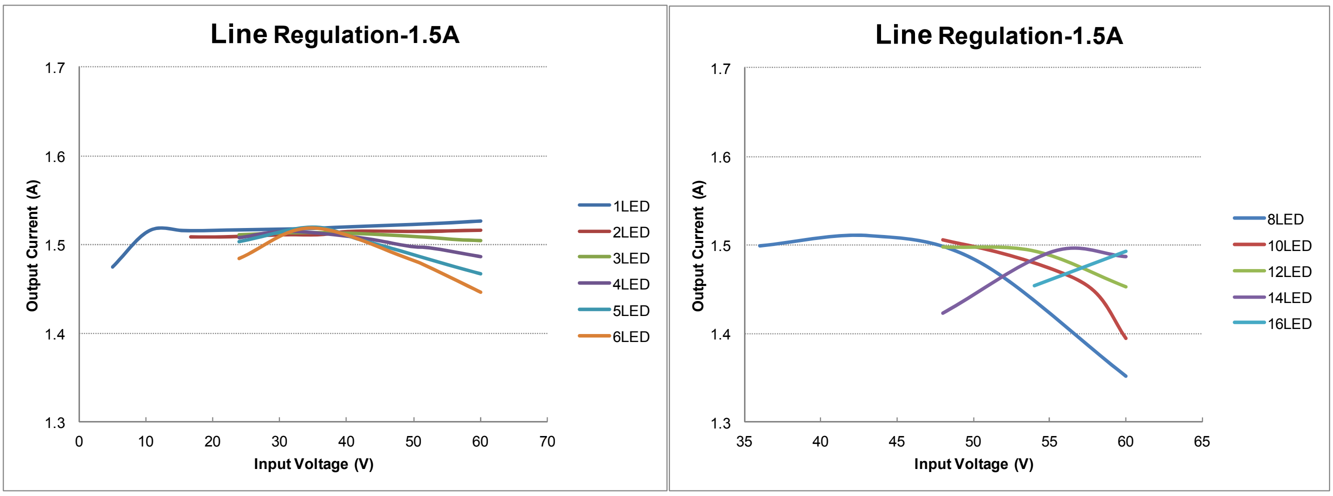


Fig.8 Line regulation of MBI6662: 1.5A output current

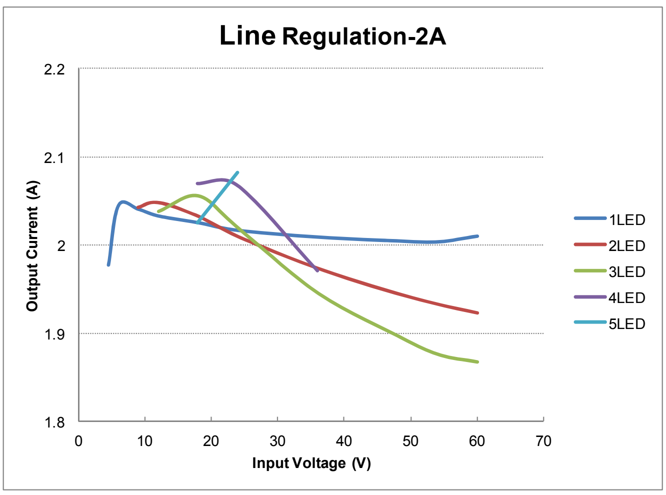


Fig.9 Line regulation of MBI6662: 2A output current

Output Current vs. Temperature Variation

V_{IN}=12V, 1 LED, R_{CSP}=R_{CSN}=50mΩ, R_{FS}=300kΩ, L=68μH, C_{COMP}=4.7nF, C_{VCC}=1μF, C_{IN}=10μF.

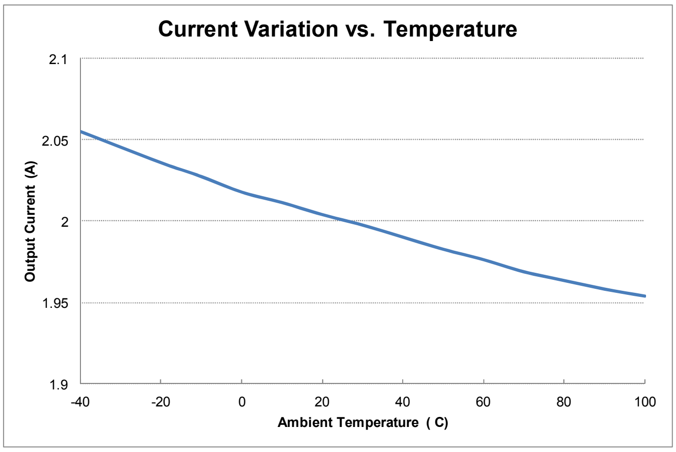


Fig.10 Output current variation with respect to temperature

Output Current vs. Inductor Variation

V_{IN}=12V, 1 LED, R_{CSP}=R_{CSN}=50mΩ, R_{FS}=300kΩ, L=4.7μH~100μH, C_{COMP}=4.7nF, C_{VCC}=1μF, C_{IN}=10μF.

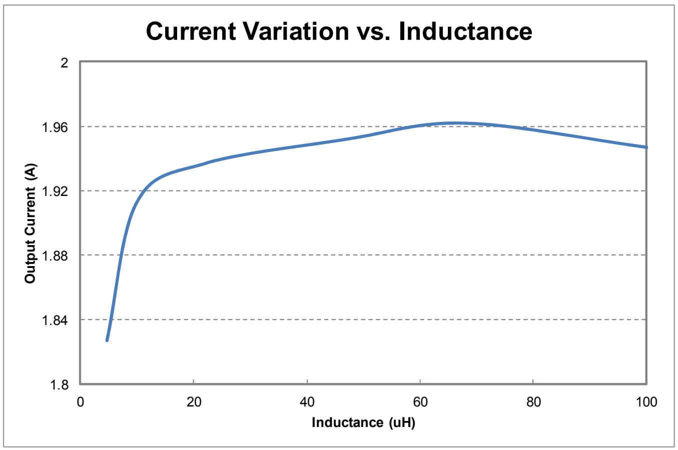


Fig.11 Output current variation with respect to inductance

Dimming Linearity

V_{IN}=12V, 1 LED, R_{CSP}=R_{CSN}=50mΩ, R_{FS}=300kΩ, C_{COMP}=4.7nF, C_{VCC}=1μF, C_{IN}=10μF.

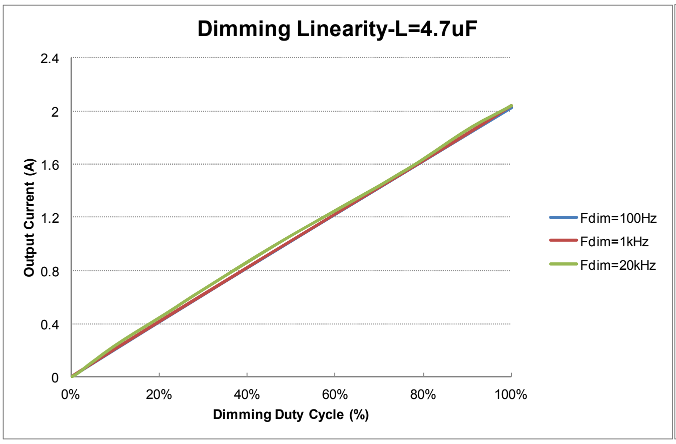


Fig.12 Dimming Linearity of MBI6662: L=4.7μH

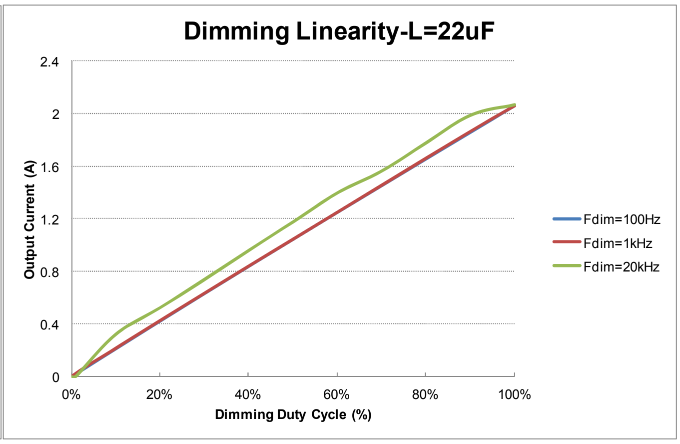


Fig.13 Dimming Linearity of MBI6662: L=22μH

Typical Switching Waveforms

V_{IN}=12V, V_{LED}=3.5V, R_{CSP}=R_{CSN}=50mΩ(I_{LED}=2A), R_{FS}=300kΩ, L=4.7μ~100μH, C_{COMP}=4.7nF, C_{VCC}=1μF, C_{IN}=10μF.

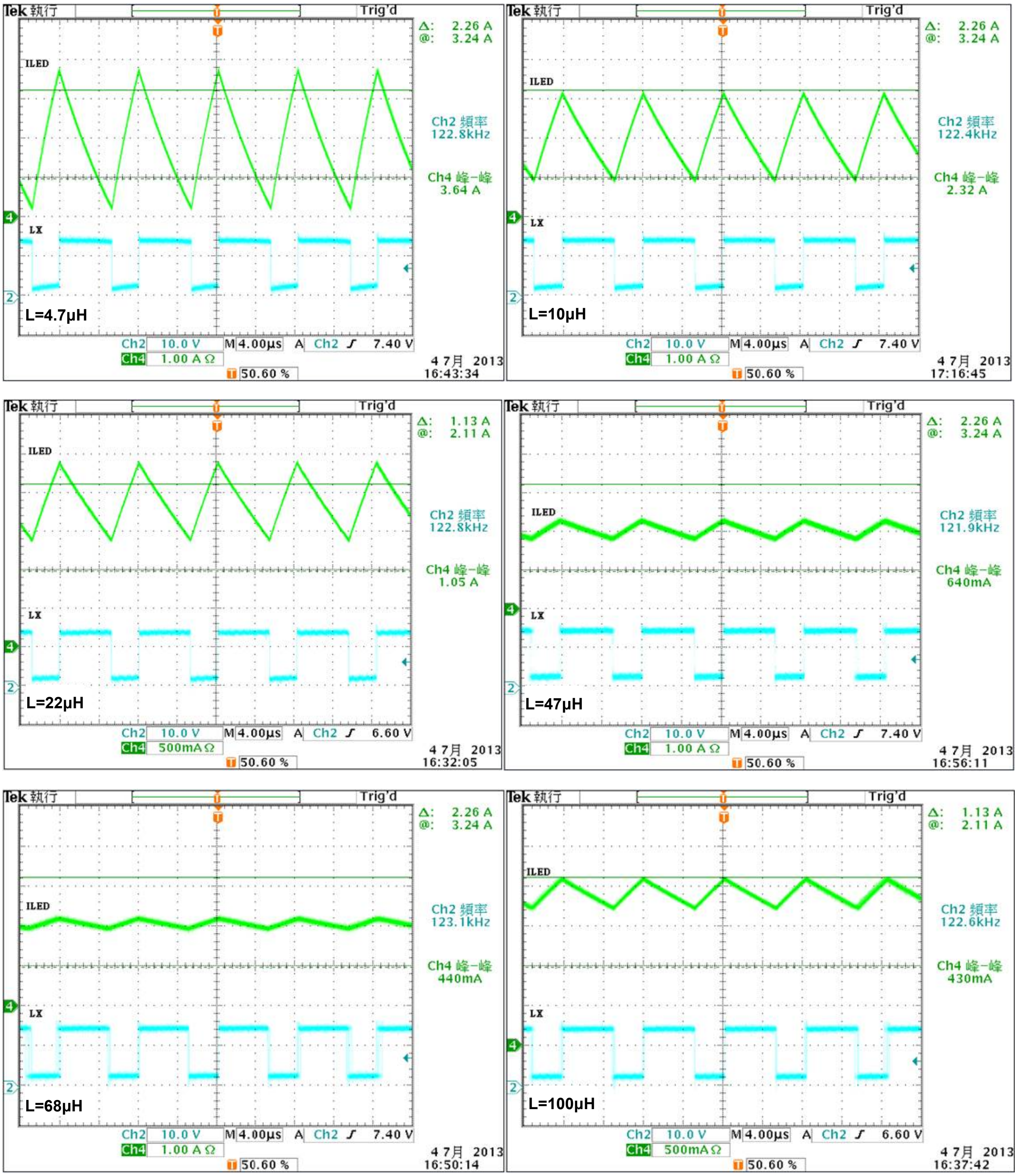


Fig.14 Typical switching waveforms of MBI6662: L=4.7μH~100μH

Power On/Off Waveforms

V_{IN}=6V, V_{LED}=3.5V, R_{CSP}=R_{CSN}=50mΩ(I_{LED}=2A), R_{FS}=300kΩ, L=22μH, C_{COMP}=4.7nF, C_{VCC}=1μF, C_{IN}=10μF.

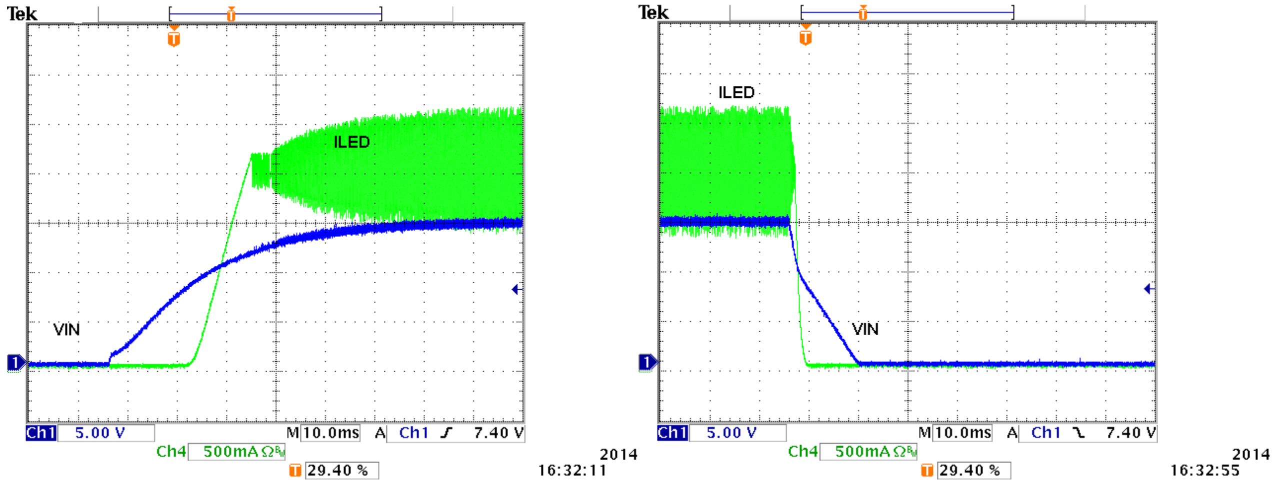


Fig.15 Power on/off waveforms of MBI6662

Constant Switching Frequency Operation

R_{CSP}=R_{CSN}=50mΩ(I_{LED}=2A), R_{FS}=300kΩ, L=22μH/68μH, C_{COMP}=4.7nF, C_{VCC}=1μF, C_{IN}=10μF.

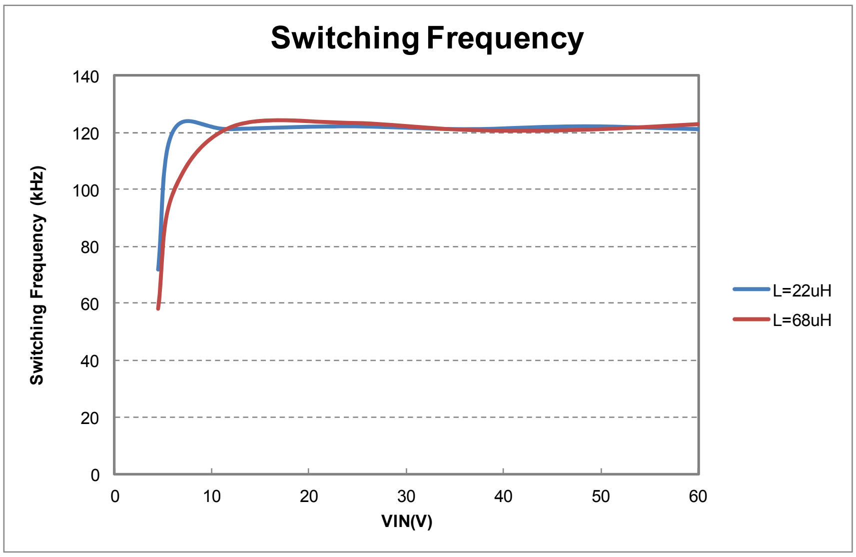


Fig.16 Constant switching frequency over wide input voltage range

Application Information

MBI6662 is a simple and high-efficiency buck converter with the capability of driving up to 2A current load. The adaptive hysteretic PFM control topology simplifies external circuit design to achieve constant frequency operation while possessing fast load transient response. The common-anode connection effectively reduces necessary wires in applications of multiple power modules in parallel. MBI6662 also equips with Under Voltage Lock-Out (UVLO), Over Temperature Protection (OTP), and Over Current Protection (OCP) to prevent the convertor from being damaged under abnormal operations.

Setting Output Current

In conventional hysteretic PFM topology, the switching frequency varies with input voltage and output loading. MBI6662 provides an innovative constant frequency technique to alleviate the sensitivity of switching frequency. From equation (1), ΔHYS must be adjustable to achieve constant frequency under various input voltage supposed inductance L_S, V_{LED} and I_{LED} are fixed. In other words, MBI6662 dynamically adjusts the hysteretic window, ΔHYS, from 5% to 80% to achieve constant switching frequency.

$$f_S = \frac{(V_{IN} - V_{LED})\frac{V_{LED}}{V_{IN}}}{\Delta HYS \times L \times I_{LED}} \quad \text{.......... (1)}$$

where f_S is the switching frequency and $\Delta HYS=\Delta I_{HYS}/I_{LED}$, and ΔI_{HYS} is the current variation in hysteretic control as shown in Fig.17.

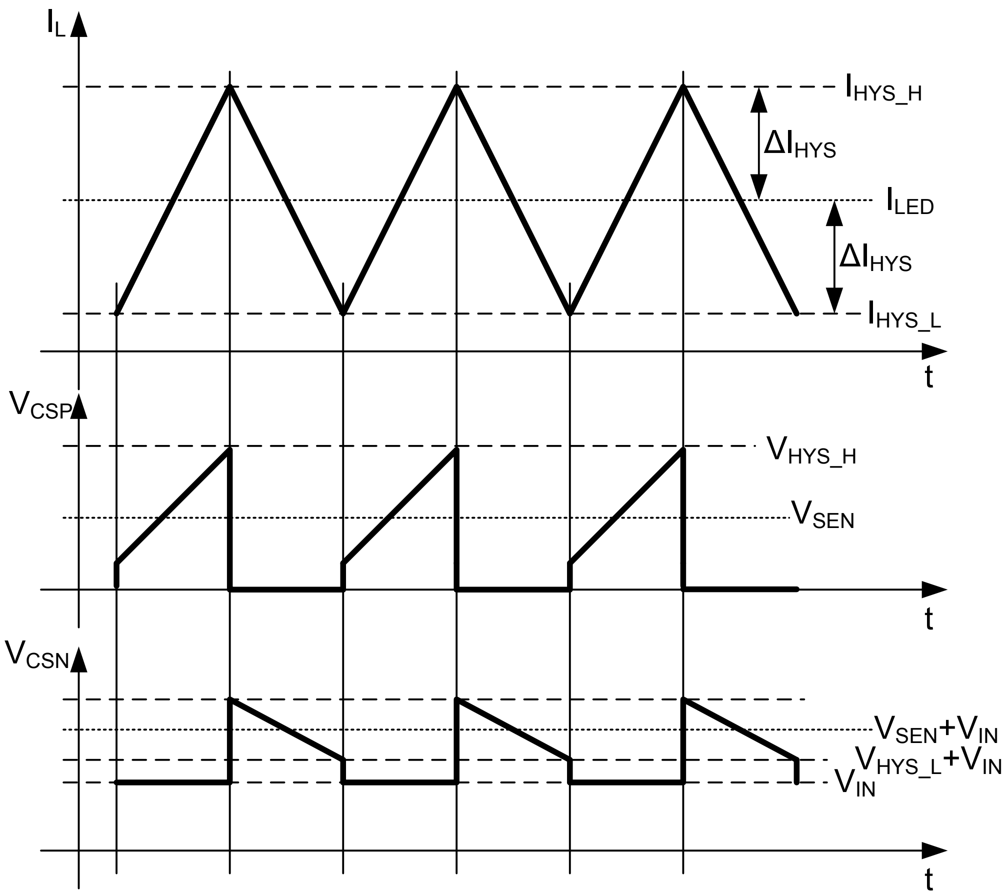


Fig.17 Typical switching waveforms of MBI6662

Fig.2 illustrates a typical application circuit of MBI6662. When the internal MOSFET is turned on, the inductor is charged by the dc power supply V_{IN}. The current flows through the loop composed of LED load, inductor L_S, internal MOSFET of MBI6662 and then return to GND through R_{CSP}. The voltage across R_{CSP}, i.e. V_{CSP}, increases with the charging inductor current, and the charging half cycle ends once V_{CSP} exceeds the upper threshold V_{HYS_H}. The internal MOSFET will be turned off, and the inductor starts to discharge. The current circulates in loop of inductor L_S, freewheel diode D_S, R_{CSN}, and the LED load. V_{CSN} decreases with the discharging inductor current, and the discharging half cycle ends when V_{CSN} is lower than V_{HYS_L}+V_{IN}, as depicted Fig.17.

From Fig.2 and Fig.17, the average output current I_{LED} can be calculated as

$$I_{LED} = \frac{1}{2}(I_{HYS\_H} + I_{HYS\_L}) = \frac{1}{2}(\frac{V_{HYS\_H}}{R_{CSP}} + \frac{V_{HYS\_L}}{R_{CSN}}) \quad \text{.......... (2)}$$

where

$$V_{HYS\_H} = (1+\Delta HYS)\times V_{SEN}$$
$$V_{HYS\_L} = (1-\Delta HYS)\times V_{SEN} \quad \text{.......... (3)}$$

And, therefore, the output LED current is calculated as

$$I_{LED} = \frac{V_{SEN}}{2}(\frac{(1+\Delta HYS)}{R_{CSP}} + \frac{(1-\Delta HYS)}{R_{CSN}}) \quad \text{.......... (4)}$$

In order to simplify equation (4), replace R_{CSP} and R_{CSN} with R_{SEN}, and then the output current would be

$$I_{LED} = \frac{V_{SEN}}{R_{SEN}} \quad \text{.......... (5)}$$

where V_{SEN} is the reference voltage 100mV, and R_{CSP}=R_{CSN}=R_{SEN}.

Constant Frequency Control Scheme

The switching frequency is set by an external resistor, R_{FS}, through pin FS. The internal control black compares the switching frequency to the preset reference frequency, and the hysteretic window is adjusted accordingly to achieve constant switching frequency, as Fig.18 shows. Please refer to the "*MBI6662 Application Note*" and "*MBI6662 Design Tool*" of MBI6662 for detailed guidelines to properly set up the switching frequency for different applications.

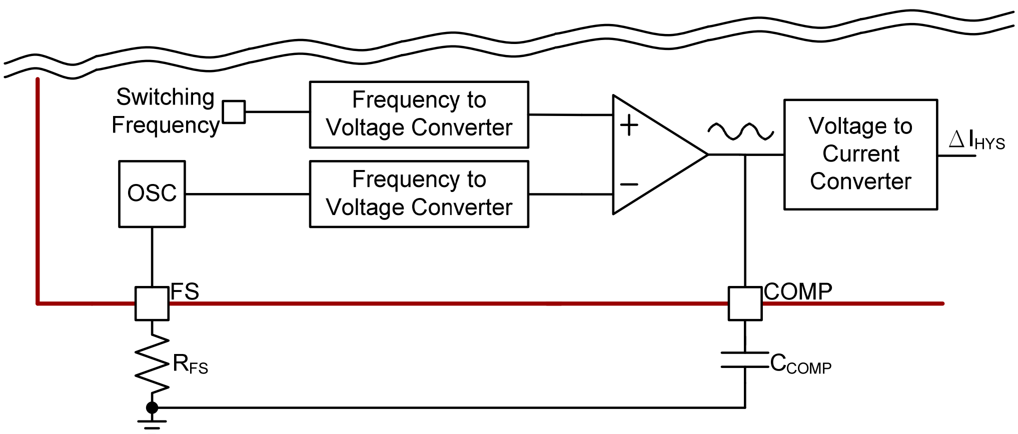


Fig.18 Constant frequency control scheme of MBI6662

Common Anode Connection

For conventional high-side sensing and low-side switching buck converters, the output LED string is not connected directly to the input power supply but through a sensing resistor. Therefore, when N such power modules work in parallel, each LED string possesses its unique anode voltage potential, and a total of 2N wires are necessary for theses LED strings to be properly driven. MBI6662 supports common-anode connection, in which LED strings of the N parallel power modules share the same anode voltage potential, apparently the input voltage V_{IN}, and only N+1 wires are necessary to complete the wiring scheme.

Dimming

The dimming of LEDs can be performed by applying PWM signals at DIM pin. A logic low (below 0.8V) at DIM will disable the internal MOSFET and shut off the current flow to the LED array, whereas a logic high (above 2.5V) at DIM will resume the normal switching. An internal pull-up circuit ensures that MBI6662 is ON when DIM pin is unconnected. Fig.12 and Fig.13 illustrate comparisons of dimming performance for different inductor selections under various dimming frequency. Please refer to "*MBI6662 Application Note*" and "*MBI6662 Design Tool*" for proper setup of the dimming design.

Under Voltage Lock Out Protection

When the voltage at V_{IN} of MBI6662 is below 4.1V (typ.), the output current of MBI6662 is turned off. When the V_{IN} voltage of MBI6662 resumes to above 4.4V (typ.), the output current of MBI6662 is turned on again.

LED Open-Circuit Protection

When any LED connected to MBI6662 is open-circuited, the output current of MBI6662 will be terminated to protect the output capacitor from voltage over-stress, as shown in Fig.19. Once the open-circuit failure is removed, MBI6662 will resume normal operation as depicted in Fig.20.

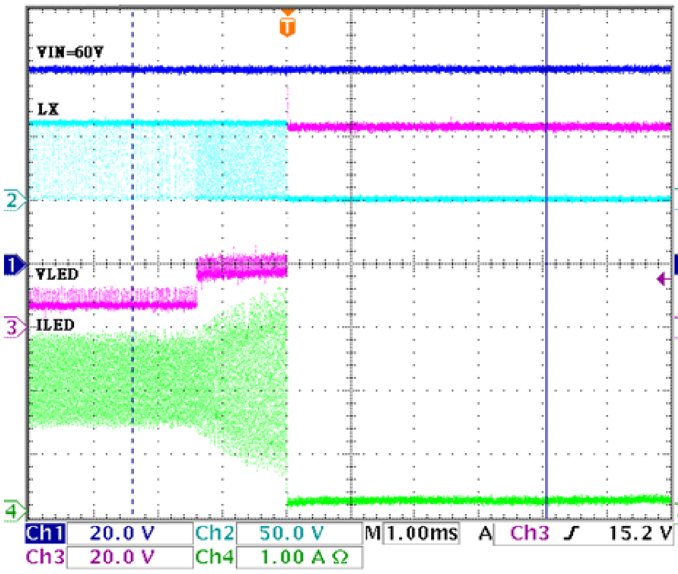


Fig.19 LED Open-Circuit Protection

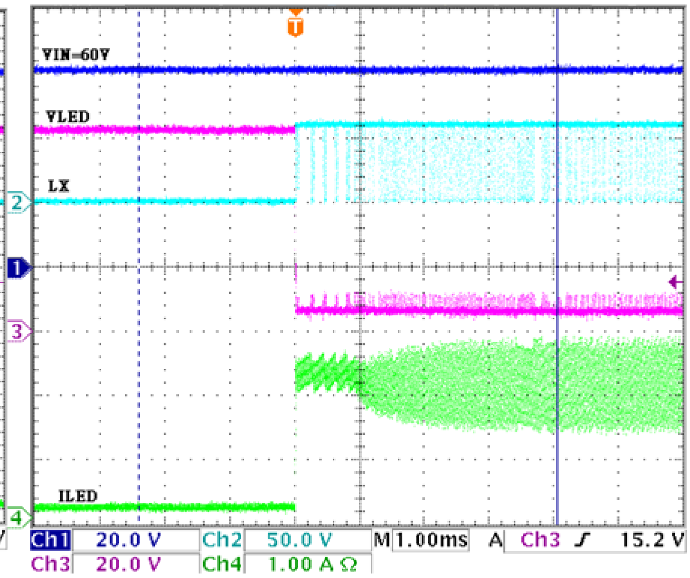


Fig.20 Open-circuit protection auto recovery

LED Short-Circuit Protection

When any LED connected to the MBI6662 is short-circuited, the output current of MBI6662 will be unaltered. If the whole LED string is short-circuited, which is equivalent that the pins VIN and LX are short, MBI6662 will turn off the MOSFET to protect the LEDs from being damaged by over-stress current. As depicted in Fig.21, the loop current is still in regulation at the preset level, and therefore the internal MOSFET keeps switching with minimum required on-time. Once the VIN-LX short condition is removed, MBI6662 resumes normal operation illustrated in Fig.22.

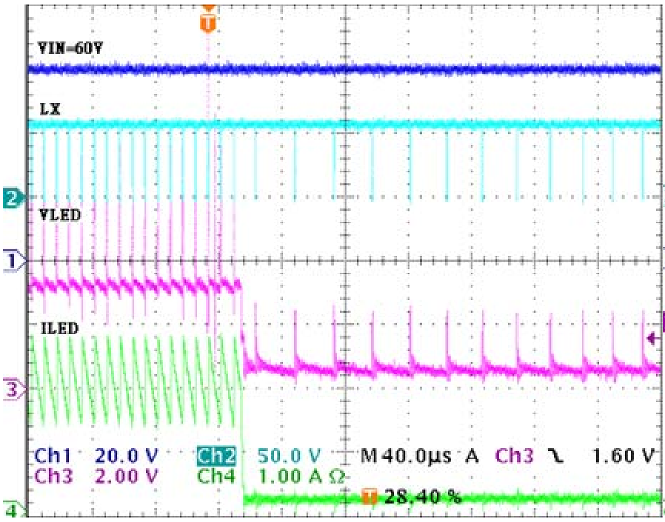


Fig.21 LED Short-Circuit Protection

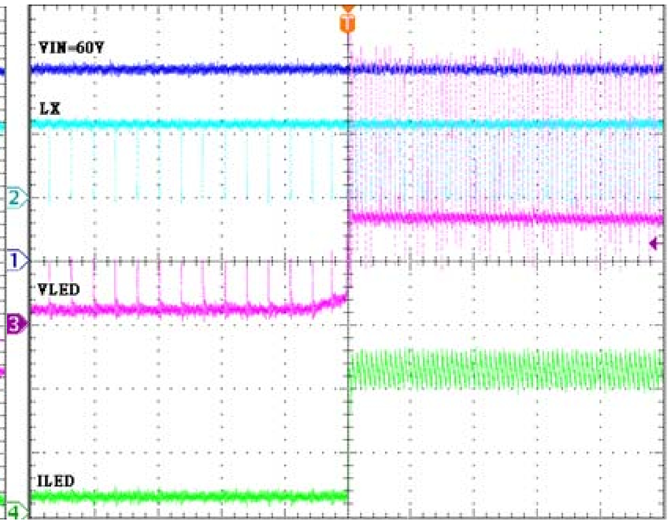


Fig.22 Short-circuit protection auto recovery

Over Current Protection

MBI6662 offers over current protection to eliminate irrecoverable damage resulting from abnormal excessive current, such as thermal runaway of the freewheel diode. The function is activated when the LED current reaches the threshold of 3A. The integrated MOSFET of MBI6662 will be turned off, and it will only resume normal operation when the input power supply is reset.

Thermal Shutdown (TSD)

When the junction temperature, T_j, exceeds the threshold of 155°C, TSD function turns off the output current by disabling the internal MOSFET. The junction temperature starts to decrease accordingly, and once the temperature drops below 125°C, the internal MOSFET turns on again and the converter resumes normal operation.

Design Consideration

The minimum inductance can be calculated by substituting an appropriate ΔHYS in equation (1). To prevent the inductor current from exceeding the over current protection threshold (I_{OCP}), as shown in Fig.24, it is recommended to set the ΔHYS to be lower than half of the over current protection threshold, as illustrated in Fig.23. If the inductor peak current exceeds the I_{OCP}, OCP function will be triggered as stated in the previous section. Once the inductor valley current is under zero, as illustrated in Fig.25, the system operates in discontinuous conduction mode (DCM), in which the output current accuracy is degraded.

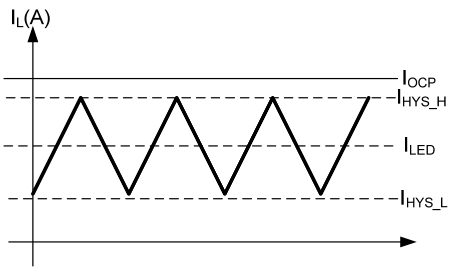


Fig.23 Normal setting ($\Delta HYS<0.5xI_{OCP}$)

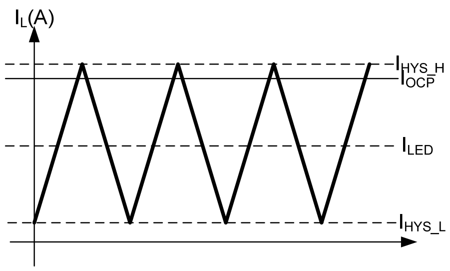


Fig.24 OCP trigger ($I_{HYS\_H}<I_{OCP}$)

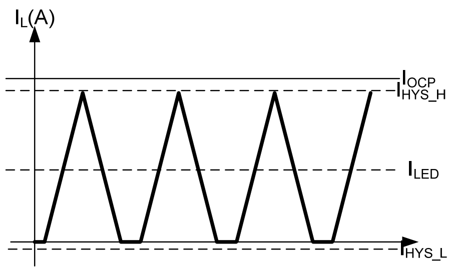


Fig.25 DCM ($I_{HYS\_L}<0$)

Component Selection

Output Current Setup

As shown in equation (5), the resistance of R_{SEN} is equal to V_{SEN} divided by I_{LED}, in which $R_{SEN}=R_{CSP}=R_{CSN}$. R_{CSP} and R_{CSN} are suggested to be implemented with resistors of 1% tolerance for better output current accuracy. The power dissipations of R_{SCP} and R_{CSN} are equal to $P_{RSEN}=(V_{SEN}{}^2/R_{SEN})$, where V_{SEN} is equal to 100mV. To prevent the sustainable power from decreasing with the rising temperature, the rating of R_{CSP} and R_{CSN} is recommended to be 2.5 times of P_{RSEN}.

Switching Frequency Setup

The switching frequency is set by R_{FS} as illustrated in Fig.26. System efficiency and dimming resolution must be taken into consideration when setting the switching frequency. Given a high power application of 2A LED current, the recommended switching frequency is 100kHz considering the switching loss.

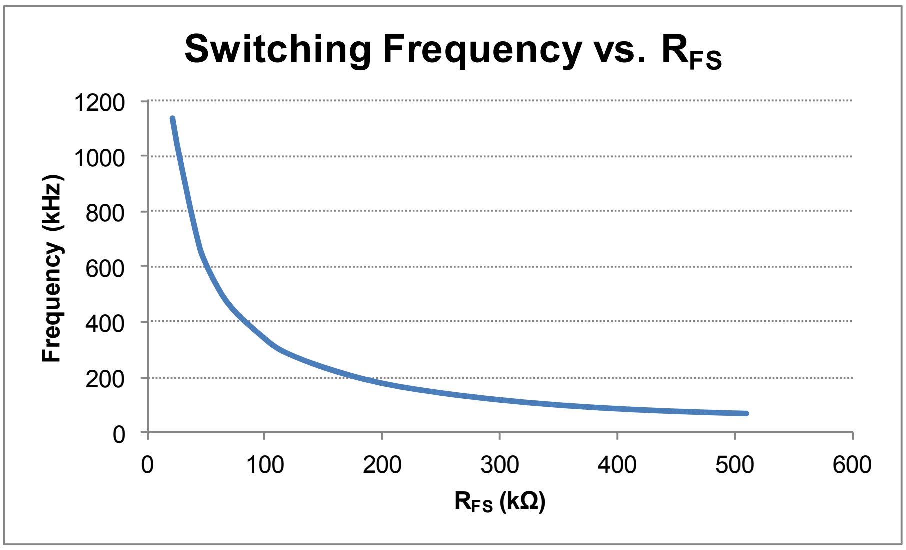


Fig.26 Switching frequency vs. R_{FS}

Inductor Selection

After the switching frequency is determined, the inductance can be calculated by substituting the desired ΔHYS in equation (1). However, inductance is not only a concern of inductance but also the saturation current. The recommended saturation current should be at least 1.25 times of the inductor peak current I_{HYS_H}. Moreover, the larger inductance results in better line and load regulations with the trade-off of smaller saturation current of the same size of inductor cores. Furthermore, the inductor with shielding is highly recommended for EMI consideration.

Input Capacitor Selection

Input capacitor provides instantaneous current to the converter when the internal MOSFET turns on, and also it is recharged by the input power supply when the internal MOSFET turns off. A capacitor of 10μF is preferred and the capacitance can be adjusted by applications. The rating voltage of the input capacitor is 1.5 times of the input voltage.

The advantages of electrolytic capacitor are cheap and easily accessible; on the other hand, the relatively short life time under high ambient temperature is its disadvantage. Small size, low ESR and good high frequency characteristic are the advantages of ceramic capacitor, but the need of supplementary transient voltage suppressor (TVS) to suppress the surge current during hot plug is its major drawback. Please refer to the "*MBI6662 Application Note*" for detailed guideline for choices of the appropriate type of capacitors.

Schottky Diode Selection

When the internal MOSFET turns off, the inductor discharges through the free-wheeling diode and LED to form a current loop. The Schottky diode with low forward voltage and fast response time is recommended for the choice of the free-wheeling diode. One consideration for the choice of an appropriate Schottky diode is the maximum reverse voltage, of which rating is 1.5 times of the input voltage; the other is the maximum forward current, and empirically 1.25 times of inductor peak current (I_{peak}) is recommended.

C_{COMP} Selection

MBI6662 only needs a compensation capacitor to adjust the response of the converter. The larger capacitance results in slower response time, and the smaller capacitance results in more obvious jitter-like transient response. The recommended C_{COMP} capacitance is 4.7nF for most applications.

C_{VCC} Selection

C_{VCC} provides the transient current to the gate driver and the recommended capacitance is 1μF. The capacitance can be increased in low input voltage applications to prevent the VCC from dropping below UVLO and the accompanying undesirable restarting of the converter.

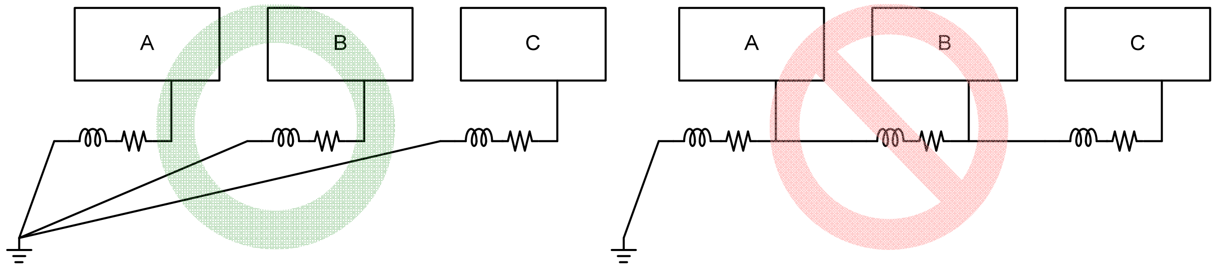
Output Capacitor Selection (Optional)

The output capacitor is used for reduction of the output ripple current. The larger capacitance results in smaller ripple current. The recommended capacitance is 10μF and the rating voltage is 1.5 times of the output voltage. The output capacitor also influences on the dimming resolution. In applications of high dimming resolution, the output capacitor is prohibited.

PCB Layout Consideration

Good PCB layout is helpful to enhance system performance. The guidelines are listed as follows.

1. Connect the pins of GND and GNDP to the negative terminal of input capacitor by a shortest possible trace. Keep the ground plane complete and DO NOT separate it into smaller portions.
2. To enhance the output current accuracy, R_{CSN} and R_{CSP} should be placed as close as possible to the CSN and CSP of IC through wider traces.
3. The input capacitor should be placed to the VIN pin as close as possible. If a close placement is not allowed, a 0.1μF ceramic capacitor should be paralleled to the VIN and GND to serve as a bypass capacitor.
4. To prevent the noise interference originated from the internal MOSFET, reduce the PCB area which consists of SW pin, Schottky diode and the inductor.
5. In order to alleviate parasitic phenomena, the path with lager current flowing through should be short and wide.
6. When several LED modules work in parallel, the single-point grounding in parallel is recommended to prevent the interference to each others. Fig.27(a) shows the connection and the ground traces should be short and wide. The PCB layout of a multi-module application is shown in Fig.28.



(a) Parallel Connection (b) Series Connection

Fig.27 Single-point grounding methods

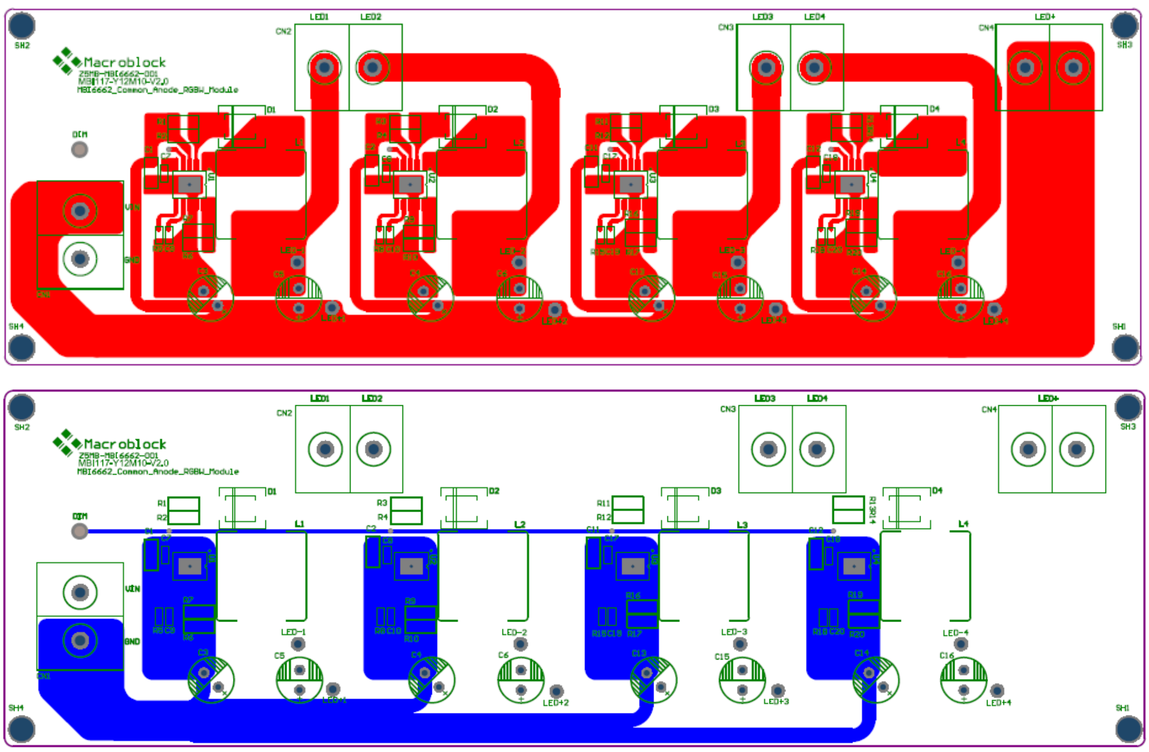
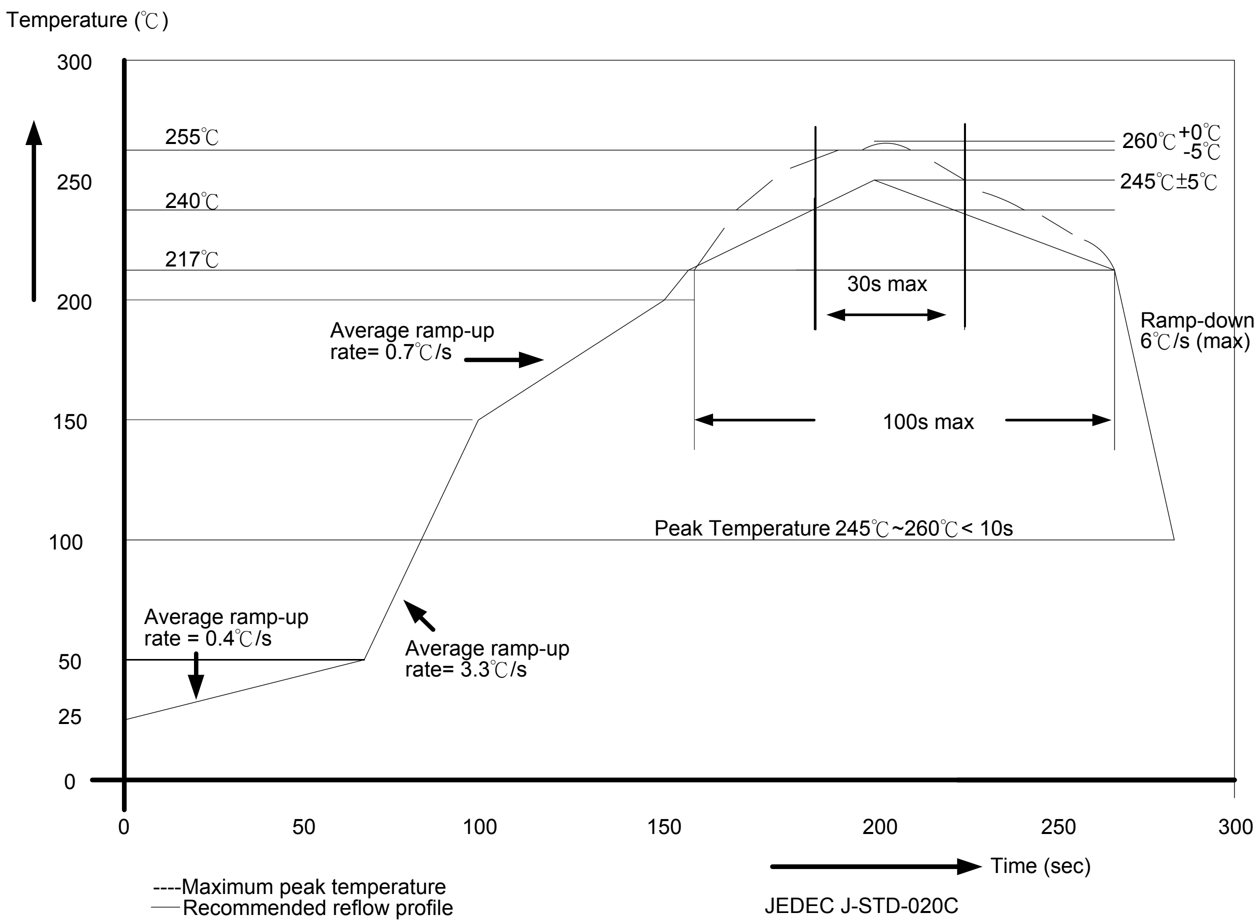


Fig.28 Sample layout of multi-module application of MBI6662

Soldering Process of "Pb-free" Package Plating*

Macroblock has defined "Pb-Free & Green" to mean semiconductor products that are compatible with the current RoHS requirements and selected 100% pure tin (Sn) to provide forward and backward compatibility with both the current industry-standard SnPb-based soldering processes and higher-temperature Pb-free processes. Pure tin is widely accepted by customers and suppliers of electronic devices in Europe, Asia and the US as the lead-free surface finish of choice to replace tin-lead. Also, it adopts tin/lead (SnPb) solder paste, and please refer to the JEDEC J-STD-020C for the temperature of solder bath. However, in the whole Pbfree soldering processes and materials, 100% pure tin (Sn) will all require from 245°C to 260°C for proper soldering on boards, referring to JEDEC J-STD-020C as shown below.

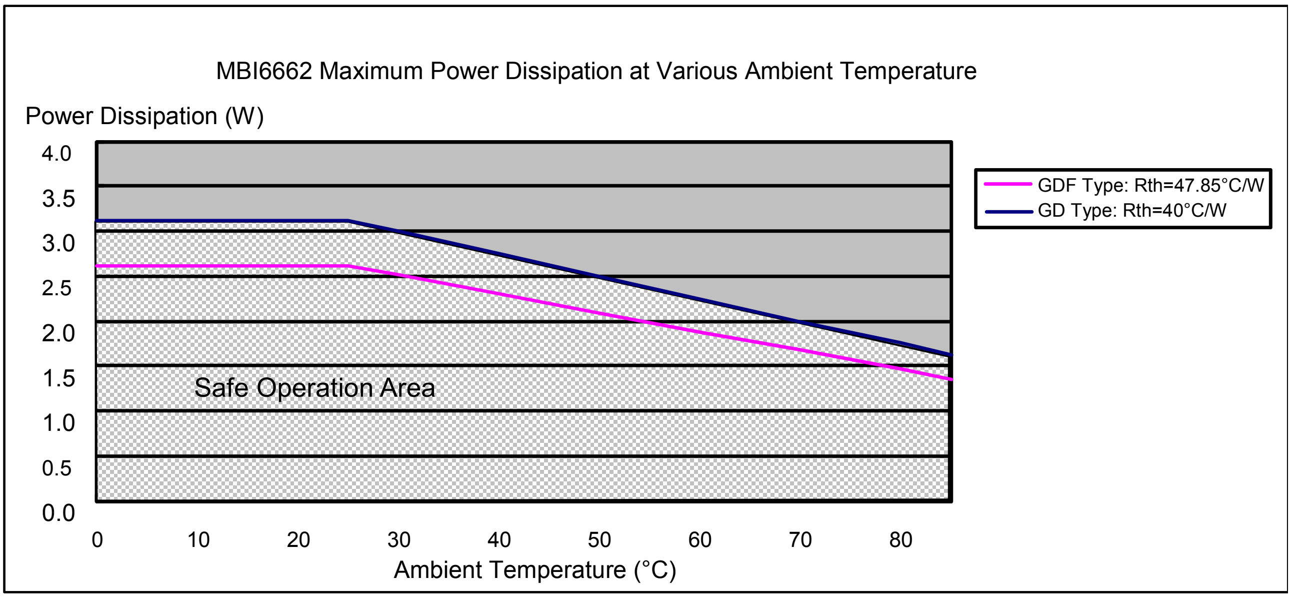


Package Thickness	Volume mm³ <350	Volume mm³ 350-2000	Volume mm³ ≧2000
<1.6mm	260 +0 °C	260 +0 °C	260 +0 °C
1.6mm – 2.5mm	260 +0 °C	250 +0 °C	245 +0 °C
≧2.5mm	250 +0 °C	245 +0 °C	245 +0 °C

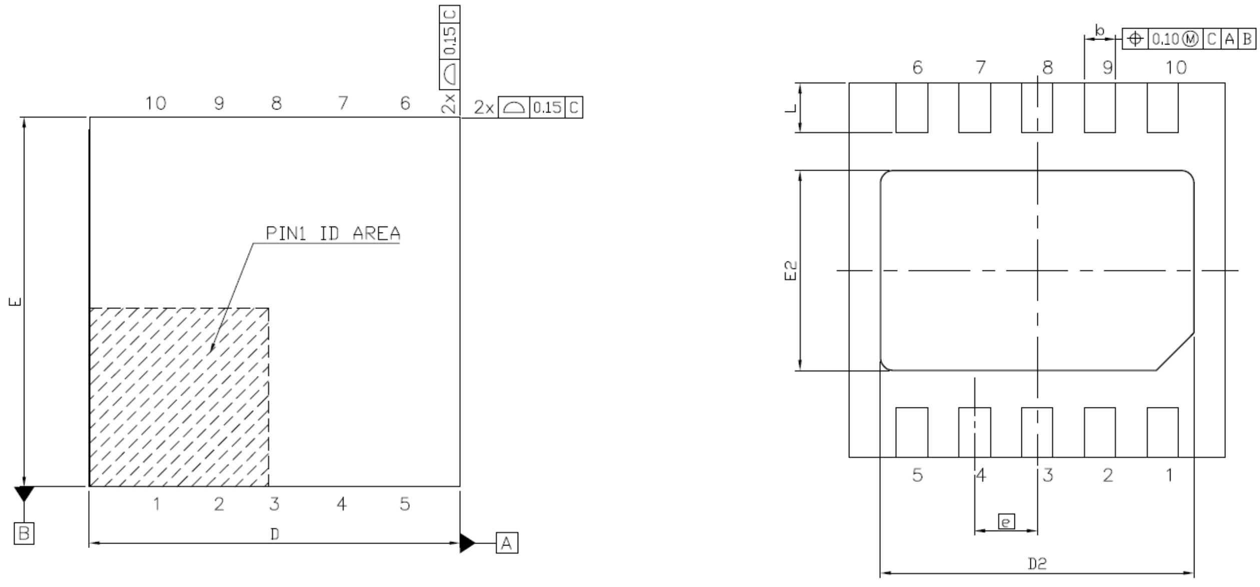
* For details, please refer to Macroblock's "Policy on Pb-free & Green Package".

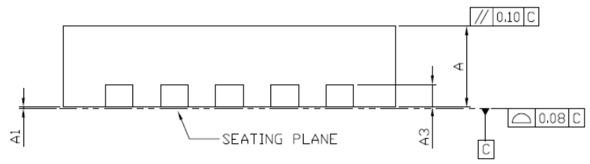
Package Power Dissipation (PD)

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



Outline Drawing

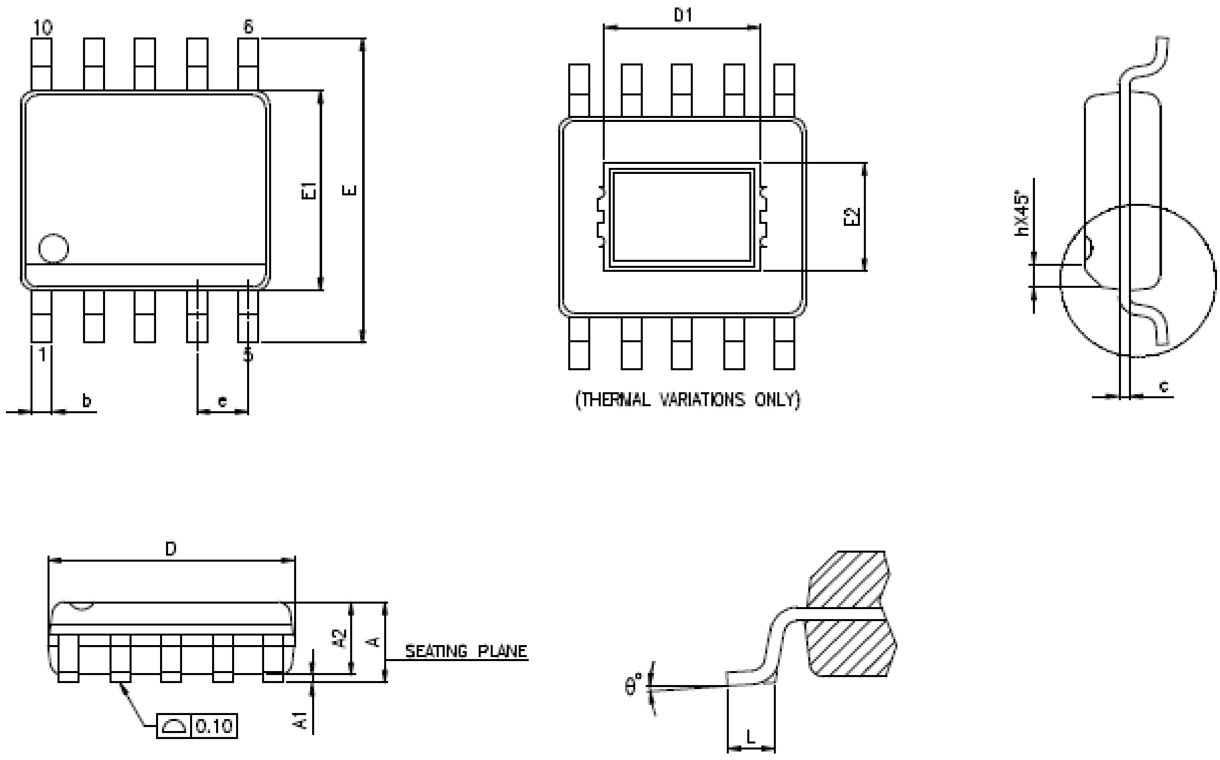




SYMBOL	DIMENSION (MM)			DIMENSION (MIL)		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	28	30	32
A1	0.00	0.02	0.05	0	0.8	2
A3	0.203 REF			8 REF		
b	0.18	0.25	0.30	7	10	12
D	2.90	3.00	3.10	114	118	122
D2	2.40	2.50	2.60	94	98	102
E	2.90	3.00	3.10	114	118	122
E2	1.50	1.60	1.70	59	63	67
L	0.35	0.40	0.45	14	16	18
e	0.45	0.50	0.55	18	20	22

MBI6662GDF 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.



VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	STANDARD		THERMAL	
	MIN.	MAX.	MIN.	MAX.
A	-	1.75	-	1.70
A1	0.10	0.25	0.00	0.15
A2	1.25	-	1.25	-
b	0.30	0.45	0.30	0.45
c	0.10	0.25	0.10	0.25
D	4.90 BSC		4.90 BSC	
E	6.00 BSC		6.00 BSC	
E1	3.90 BSC		3.90 BSC	
e	1.00 BSC		1.00 BSC	
L	0.40	1.27	0.40	1.27
h	0.25	0.50	0.25	0.50
θ°	0	8	0	8

THERMALLY ENHANCED DIMENSIONS (SHOWN IN MM)

PAD SIZE	D1		E2	
	MIN.	MAX.	MIN.	MAX.
94*X12*	2.59	3.05	1.81	2.13

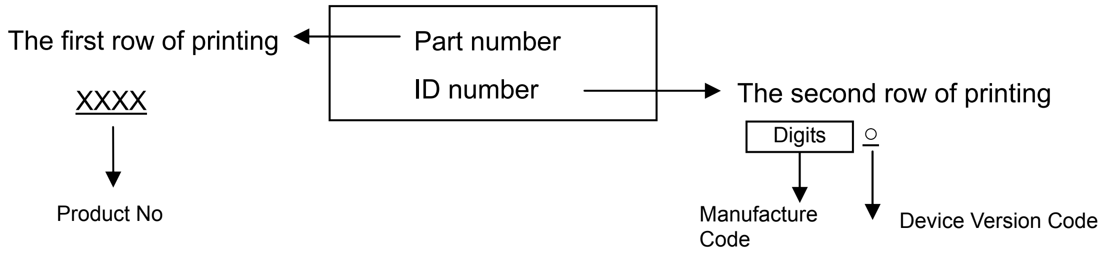
* is an universal character, which means maybe replaced by specific character, the actual character refers to the bonding diagram.

MBI6662GD Outline Drawing

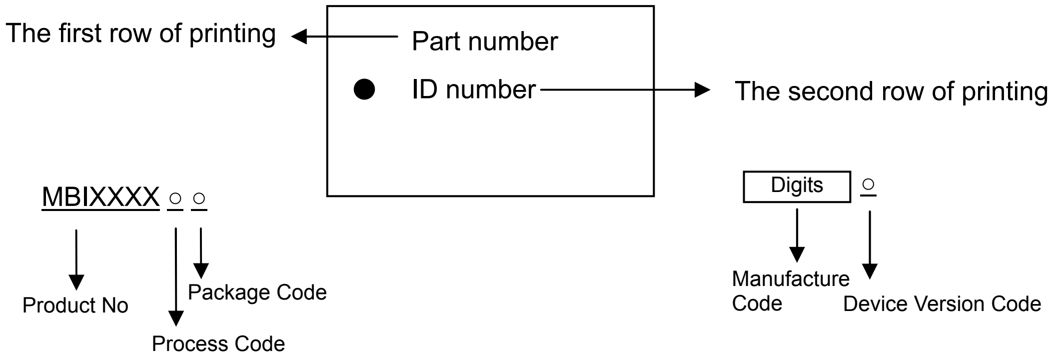
Note: Please use the maximum dimensions for the thermal pad layout. To avoid the short circuit risk, the vias or circuit traces shall not pass through the maximum area of thermal pad.

Product Top Mark Information

GDF (DFN-10L)



GD(SOP-10L)



Product Revision History

Datasheet version	Device Version Code
V1.00	A
V1.01	A

Product Ordering Information

Product Ordering Number*	**RoHS Compliant Package Type**	**Weight (g)**
MBI6662GDF-A	DFN-10L 3*3	0.02165
MBI6662GD-A	SOP-10L-150	0.0768

*Please place your order with the “product ordering number” information on your purchase order (PO).

Disclaimer