



# **DT3007A/B/C**

4 Channels AC LED Driver IC

Rev1.0 – 18 Dec, 2014



## **1. General Description**

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The DT3007A/B/C is AC LED drivers with four internal current sources for AC LED light applications. The DT3007A/B/C drives the LEDs directly through the Bridge rectifier supply without AC-DC conversion circuit. It uses an external resistor to set the LED current with a high accuracy. The DT3007A/B/C provides protection against over temperature. The DT3007A/B/C is available in 12-pin QFN Package.

## **2. Features**

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- High power Factor > 0.97
- Low Total Harmonic Distortion < 15%
- Adjustable LED driving current with external resistors
- TRIAC Dimmable
- Analog Dimming Function
- Including Bleeder Current
- Power Compensation within  $\pm 5\%$
- Regulation output supply for biasing the external device
- Over Temperature Protection
- Under Voltage Protection
- Thermally Enhanced 12 Pin QFN

## **3. Applications**

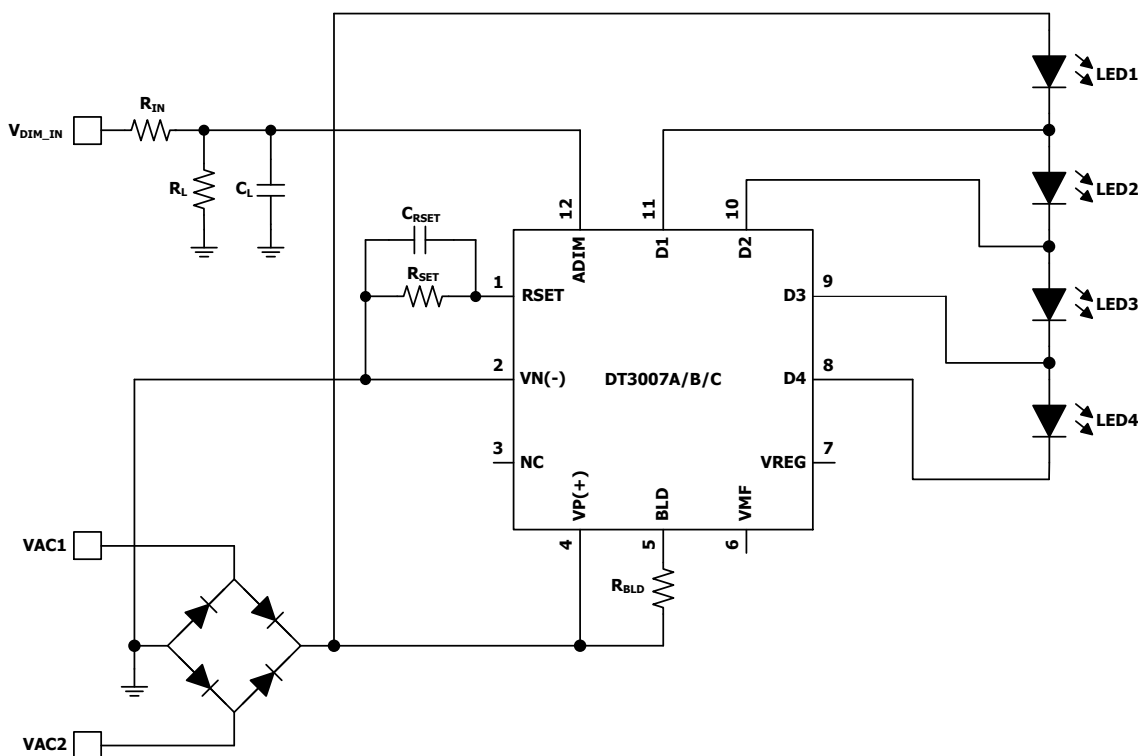
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- AC LED light Applications

### 4. Package Information

Type number	Package		
	Name	Description	Marking
DT3007A	12 QFN	12 QFN	DT3007A
DT3007B	12 QFN	12 QFN	DT3007B
DT3007C	12 QFN	12 QFN	DT3007C

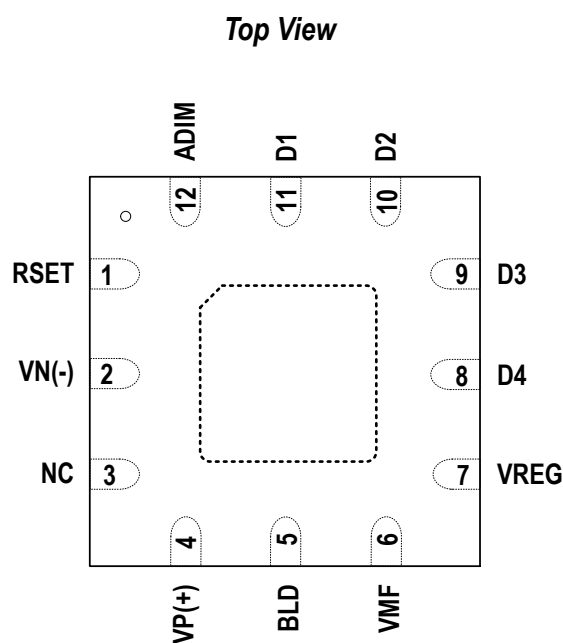
### 5. Typical Application



Typical VAC	Recommend Typical $V_F$			
	LED1	LED2	LED3	LED4
120V	43V	43V	21.5V	21.5V
220V	64.5V	64.5V	64.5V	64.5V



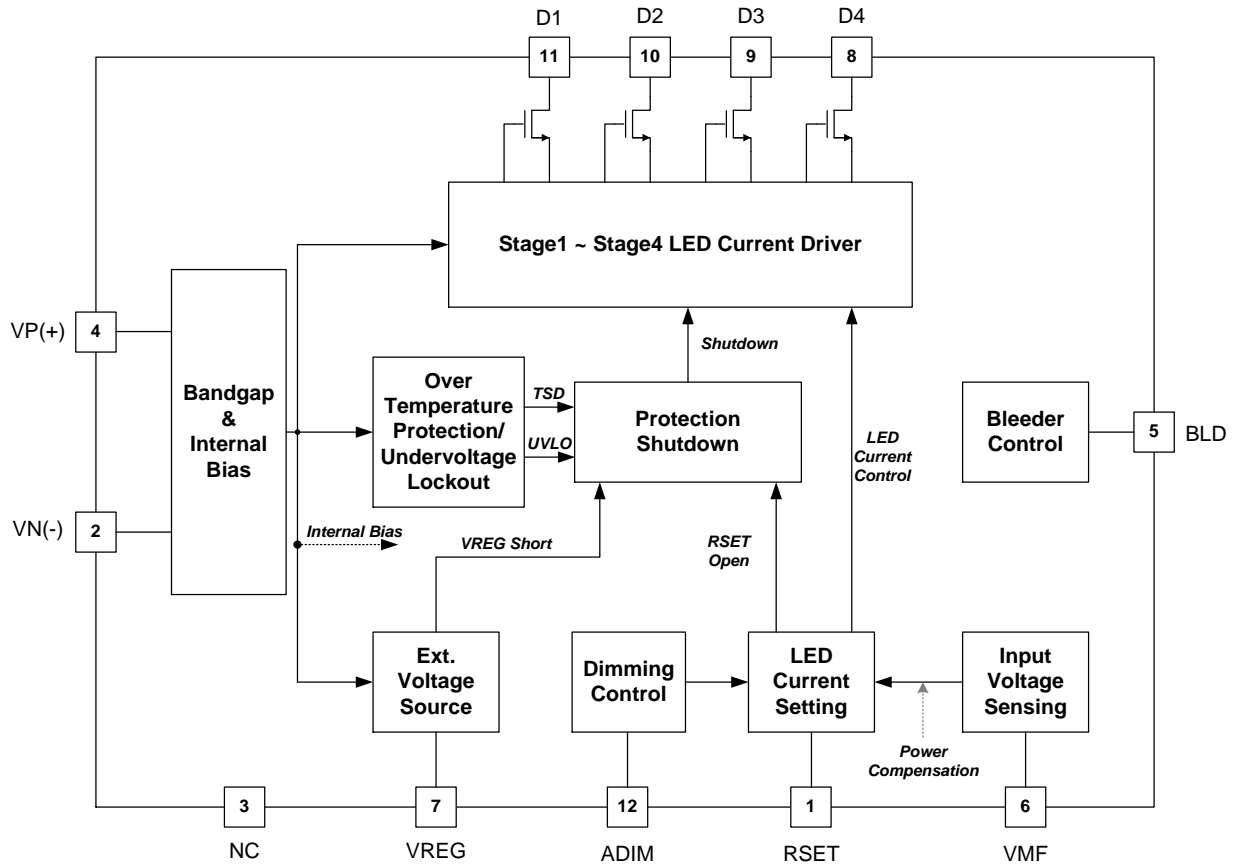
## 6. Pin Information



Pin	Symbol	I/O	Description
1	RSET	I	Resistor Connection for Driver Current Setting
2	VN(-)	I	Voltage Input (-)
3	NC	-	No Connection
4	VP(+)	I	Voltage Input (+)
5	BLD	O	Bleeder Current Output
6	VMF	I	Voltage Input for Multi-Function
7	VREG	O	Reference Voltage Output
8	D4	O	Driver output – 4
9	D3	O	Driver output – 3
10	D2	O	Driver output – 2
11	D1	O	Driver output – 1
12	ADIM	I	Analog Dimming Input



### 7. Block Diagram



## 8. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
VP(+) to VN(-), BLD, D1~D4	$V_{HV}$	-0.3 ~ +450	V
VREG to VN(-)	$V_{CC}$	-0.3 ~ +9	V
Other Pins to VN(-)	$V_{LV}$	-0.3 ~ +6.5	V
Maximum Junction Temperature	$T_{JMAX}$	+150	°C
Storage Temperature	$T_{STG}$	-65 ~ +150	°C
ESD (HBM)	$V_{HBMV}$	1.5	kV
Power Dissipation <sup>(Note1)</sup>	$P_D$	3	W
Maximum Driver Stage Current <sup>(Note2)</sup>	$I_{D4}$	240 ( $V_{AC}=100V$ condition)	mA
		110 ( $V_{AC}=220V$ condition)	mA

### Note 1)

- Package power dissipation is dependent on the PCB board type, size, layout, pattern and thermal heat sink. Therefore, the board material is recommended the use of metal PCB.

### Note 2)

- The maximum drive current means the guaranteed operating current.
- The maximum drive current is not the DC current.
- It is the maximum peak current of the fourth stage for guaranteeing normal operation in AC direct drive method.
- The operating current must be used within the allowed package dissipation.
- The operating drive current must be determined within the maximum drive current with margin.

## 9. Package Thermal Characteristics

Parameter	Symbol	Value	Unit
Junction to ambient thermal resistance	$\Theta_{JA}$	34.65	°C/W
Junction to case thermal resistance	$\Theta_{JC}$	11.25	°C/W

### \*Test conditions

- $\Theta_{JA}$  : The package thermal impedance is calculated in accordance with JESD 51-7
- $\Theta_{JC}$  : The package thermal impedance is calculated in accordance with JESD 51-14

## 10. Electrical Characteristics

$T_A = 80^\circ\text{C}$ ,  $V_{AC} = 100/120/220\text{V}$ , unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
<b>General</b>						
Supply Voltage	$V_{IN}$		90		270	VAC
Bias Current	$I_{BIAS}$			2		mA
Power Factor	PF		0.97			-
Total Harmonic Distortion	$I_{THD}$				15	%
<b>Driver Stage Current for DT3007A</b>						
Driver Stage Current <sup>(Note 3)</sup>	$I_{D1}$	VP(+)=40V, VN(-)=0V, D1=40V, R <sub>SET</sub> =6.04kΩ		15.00		mA
	$I_{D2}$	VP(+)=40V, VN(-)=0V, D2=40V, R <sub>SET</sub> =6.04kΩ		26.25		mA
	$I_{D3}$	VP(+)=40V, VN(-)=0V, D3=40V, R <sub>SET</sub> =6.04kΩ		33.75		mA
	$I_{D4}$	VP(+)=40V, VN(-)=0V, D4=40V, R <sub>SET</sub> =6.04kΩ		37.50		mA
<b>Driver Stage Current for DT3007B</b>						
Driver Stage Current <sup>(Note 3)</sup>	$I_{D1}$	VP(+)=40V, VN(-)=0V, D1=40V, R <sub>SET</sub> =6.04kΩ		30.00		mA
	$I_{D2}$	VP(+)=40V, VN(-)=0V, D2=40V, R <sub>SET</sub> =6.04kΩ		52.50		mA
	$I_{D3}$	VP(+)=40V, VN(-)=0V, D3=40V, R <sub>SET</sub> =6.04kΩ		67.50		mA
	$I_{D4}$	VP(+)=40V, VN(-)=0V, D4=40V, R <sub>SET</sub> =6.04kΩ		75.00		mA
<b>Driver Stage Current for DT3007C</b>						
Driver Stage Current <sup>(Note 3)</sup>	$I_{D1}$	VP(+)=40V, VN(-)=0V, D1=40V, R <sub>SET</sub> =6.01kΩ		60.00		mA
	$I_{D2}$	VP(+)=40V, VN(-)=0V, D2=40V, R <sub>SET</sub> =6.01kΩ		105.00		mA
	$I_{D3}$	VP(+)=40V, VN(-)=0V, D3=40V, R <sub>SET</sub> =6.01kΩ		135.00		mA
	$I_{D4}$	VP(+)=40V, VN(-)=0V, D4=40V, R <sub>SET</sub> =6.01kΩ		150.00		mA
<b>VREG</b>						
VREG Voltage	$V_{REG\_H}$	No load		7		V
<b>ADIM</b>						
ADIM Operating Voltage Limit	$ADIM_{LM}$			2.00		V
ADIM Turn Off Threshold	$ADIM_{OFF\_TH}$	Falling		0.40		V
ADIM Turn On Threshold	$ADIM_{ON\_TH}$	Rising, With $C_{VREG}$		0.44		V
ADIM Turn On Hysteresis	$ADIM_{ON\_HYS}$	Rising, With $C_{VREG}$		40		mV

Note 3)

- Driver stage current is based on the simulation results.

## 10. Electrical Characteristics (Continued)

$T_A = 80^\circ\text{C}$ ,  $V_{AC} = 100/120/220\text{V}$ , unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
<b>Protection</b>						
VP(+) Under-voltage Lockout Threshold	$V_{UVLO}$			10		V
VP(+) Turn On Threshold	$V_{IN\_TH}$			15		V
Over Temperature Threshold	$T_{OTP}$			160		$^\circ\text{C}$

## 11. Functional Description

### LED Current and Power Setting

The LED current can be set by using the RSET pin. Therefore LED power dissipation can be set by adjusting the LED current. The resistor connected between RSET pin and VN(-). Use the table 1 below to choose the value of  $R_{SET}$  for the desired power dissipation. Also, for a more stable operation in DT3007A/B/C, it is recommended to connect the capacitor of 1~10nF in parallel with  $R_{SET}$ .

VAC	Type	Power Dissipation	$R_{SET} \pm 1\%$
100V	A	4W	8.11 k $\Omega$
	B	8W	8.40 k $\Omega$
	C	12W	6.28 k $\Omega$
	C	16W	8.61 k $\Omega$
120V	A	4W	6.45 k $\Omega$
	B	8W	6.69 k $\Omega$
	C	12W	5.30 k $\Omega$
	C	16W	7.31 k $\Omega$
220V	A	4W	3.20 k $\Omega$
	A	8W	6.96 k $\Omega$
	B	12W	5.28 k $\Omega$
	B	16W	7.20 k $\Omega$

Table 1.  $R_{SET}$  Setting for Power Dissipation

\* The  $R_{SET}$  values are based on the simulation results.

\* The actual  $R_{SET}$  values must be determined by the actual LED arrays and board condition for given input power requirement.

### $R_{SET}$ Open

When RSET Pin is opened, the DT3007A/B/C becomes LED off, that is, all the LED output currents become zero. When RSET Pin is shorted to VN(-), all the output currents have its extremely low current level below a few hundreds of  $\mu$ A determined by the offset voltages of the amplifiers consisting the LED current sources.

### Over Temperature Protection

The DT3007A/B/C becomes LED off when the temperature exceeds 160°C and restarts when the junction temperature falls. If a capacitor is connected to VREG, the DT3007A/B/C is restarts by the VREG reset.

### VREG

VREG pin supplies regulated 7V (Typ.) for biasing the peripheral device. When VREG is shorted to VN(-) DT3007A/B/C becomes LED off.





**Bleeder Current**

The Bleeder current is the internal current source. Their maximum output current can be adjusted by the resistor value connected between the BLD pin and VP(+). The bleeder current is 0~35mA.

**Analog Dimming**

The LED brightness can be adjusted by applying DC voltage to ADIM Pin. When  $0.40V < \text{ADIM pin voltage} < 2.0V$ , DT3007A/B/C operates in positive polarity mode as shown in figure 1. When the ADIM DC voltage becomes over 2.0V, the LED brightness is clamped at their maximum flux. When ADIM DC voltage is decreased to 0.40V, LED current becomes off. For a more stable ADIM function in DT3007A/B/C, that is, for obtaining non-flickering operation in LED light at the minimum ADIM voltage, it is recommended to use the 40mV hysteresis by connecting a capacitor in VREG.

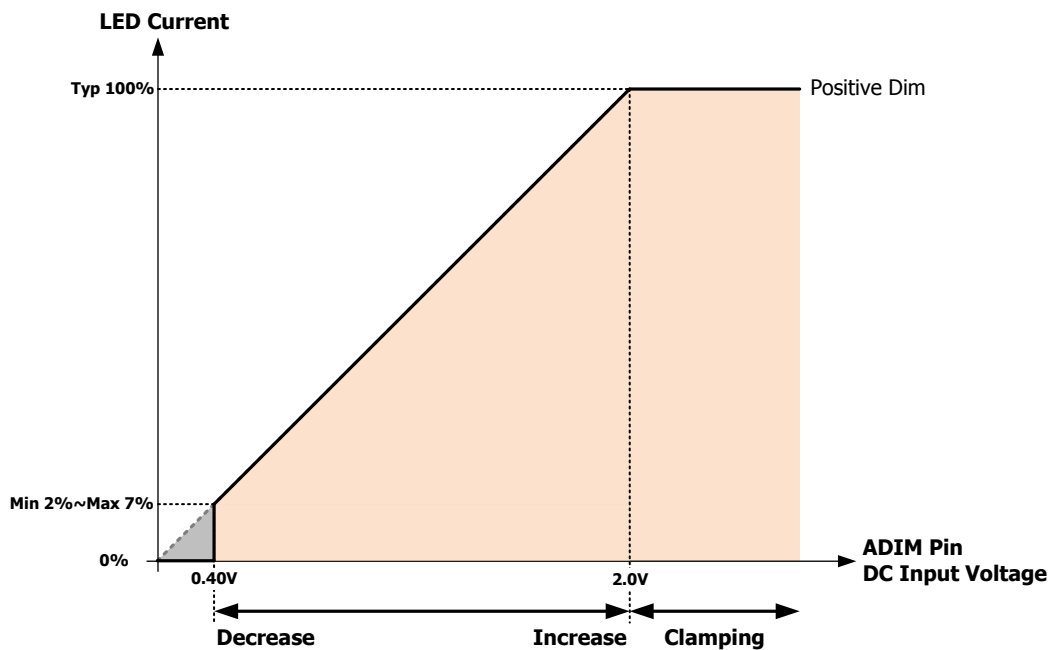


Figure 1. ADIM Operation Ranges

**Multi-Functions Setting**

The DT3007/B/C has a multi-functional operation. The following table 2 shows the multi-functional operation mode and each operation mode is divided by the VMF pin voltage that is set by the external components.

VMF Ranges	Mode Section	Remarks
$0.00 \leq VMF \leq 0.36V$	TRIAC Dimming Control Mode - Phase Cut	LED current=OFF
$0.36 < VMF \leq 3.00V$	TRIAC Dimming Control Mode	- Min current=Max.10% in comparison with typ.100% of the normal mode - Max current=Depends on the max angle of the dimmer.
$3.50 \leq VMF < 5.00V$	Power Compensation Mode	
OPEN (Internal Pull-up)	Normal Mode	LED current=Typ. 100%

Table 2. VMF Ranges for Multi-Functions

**TRIAC Dimming Control**

The DT3007A/B/C can be used with different types of TRIAC dimming control switches. The DT3007A/B/C has phase cut off function to prevent misfiring which can be happened at narrow dimming angle. When phase cut off function initiates, the DT3007A/B/C turns off the LED output. The angle of phase cut off can be adjustable by the external component as shown in figure 2. The VMF pin voltage for phase cut off is 0.36V.

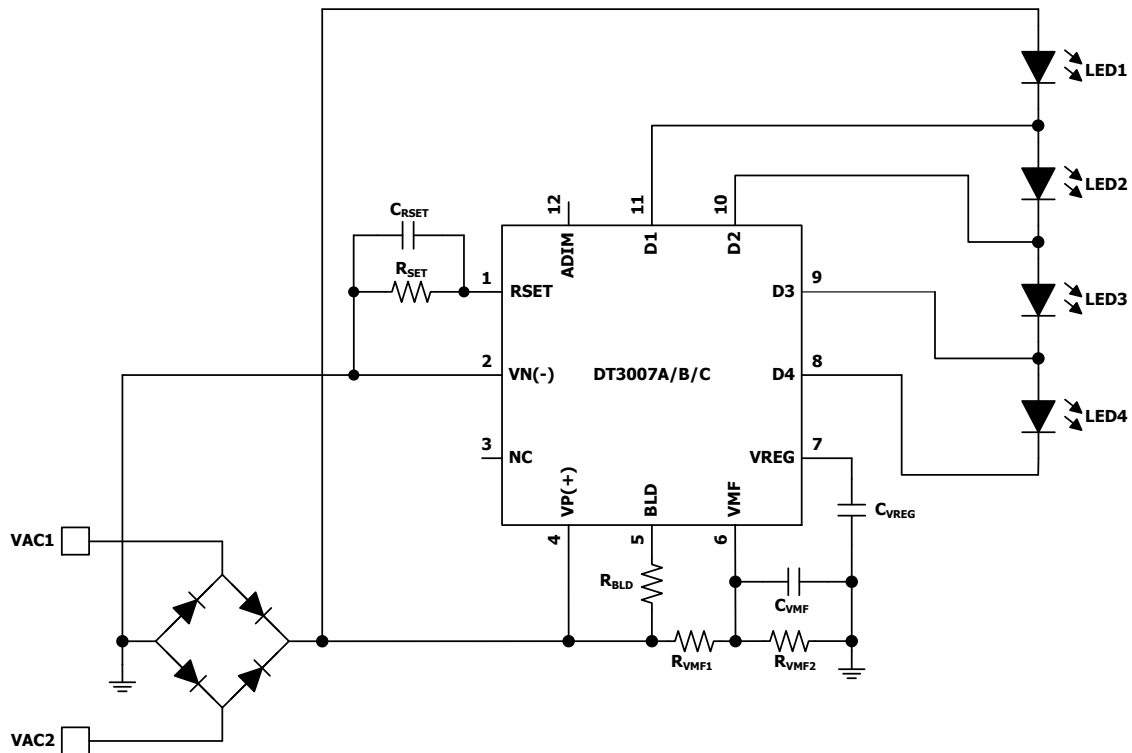


Figure 2. Typical Application for TRIAC Dimming Control

**Power Compensation**

The DT3007A/B/C has power compensation function to minimize power variation. The power compensation function make the input power to within  $\pm 5\%$  of its nominal input power. The power compensation works only when the AC input voltage is increased from its nominal value up to  $+20\%$  as shown below table 3. If the VMF pin voltage is increasing more than 3.5V, then the DT3007A/B/C begins to control the LED driving current to regulate the input power to within  $\pm 5\%$  of its nominal input power. If the VMF pin voltage is decreasing less than 3.5V, then no input power compensation operation occurs. Do set the VMF pin voltage to 3.5V by using external components at the nominal AC input voltage as shown in figure 3. When the VMF pin is opened, no power compensation is operated.

Typical VAC	VAC range for Power Compensation	Power Variation
100V	100~120V	$\pm 5\%$
120V	120~144V	$\pm 5\%$
220V	220~264V	$\pm 5\%$

Table 3. Power Compensation Specification

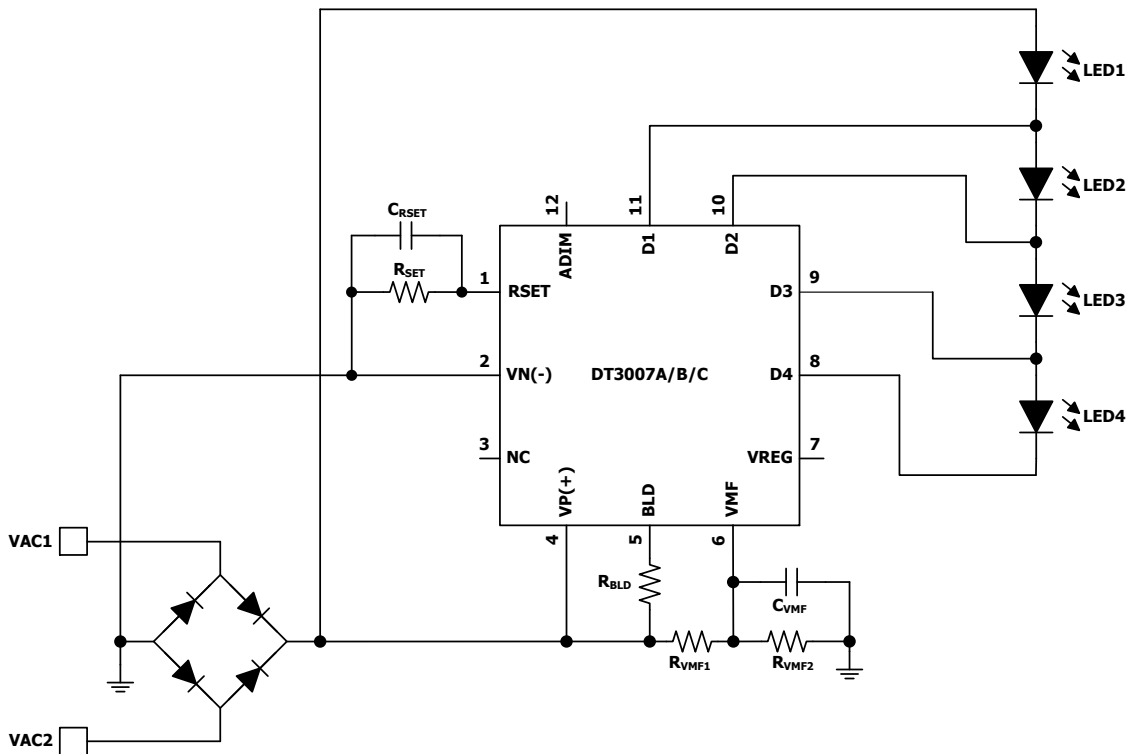
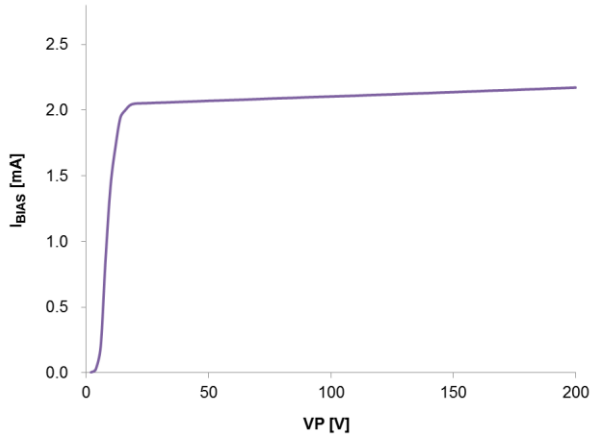


Figure 3. Typical Application for Power Compensation

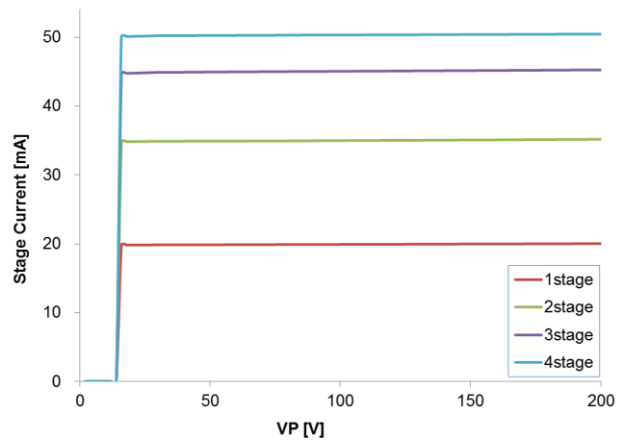


## 12. Typical Performance Characteristics

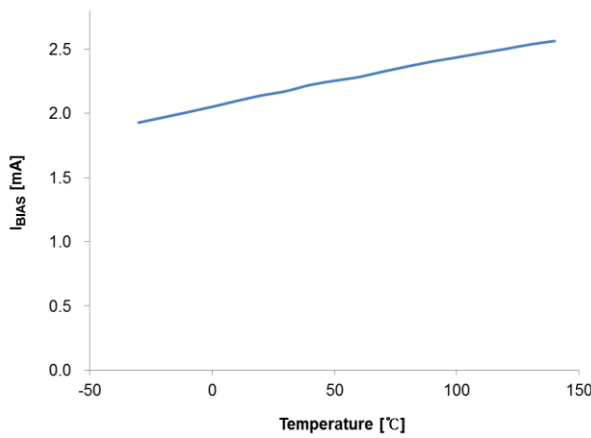
VP Range : 0~200V, Temperature Range : -30~140°C, R<sub>SET</sub> : 2.02kΩ, Unless otherwise noted.



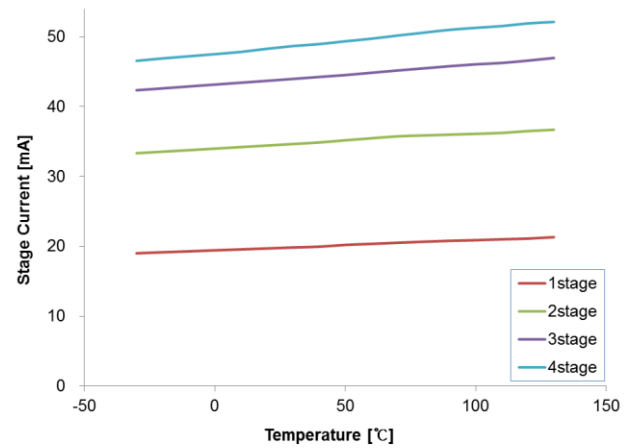
Bias Current vs. Input Voltage



LED Driving Current vs. Input Voltage



Bias Current vs. Temperature



LED Driving Current vs. Temperature



### 13. Package Marking Information

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1'st row : Acrich3 logo

***Acrich 3***

2'nd row : DMBT product code

- . DT3007A
- . DT3007B
- . DT3007C

3'rd row : Original wafer lot no.

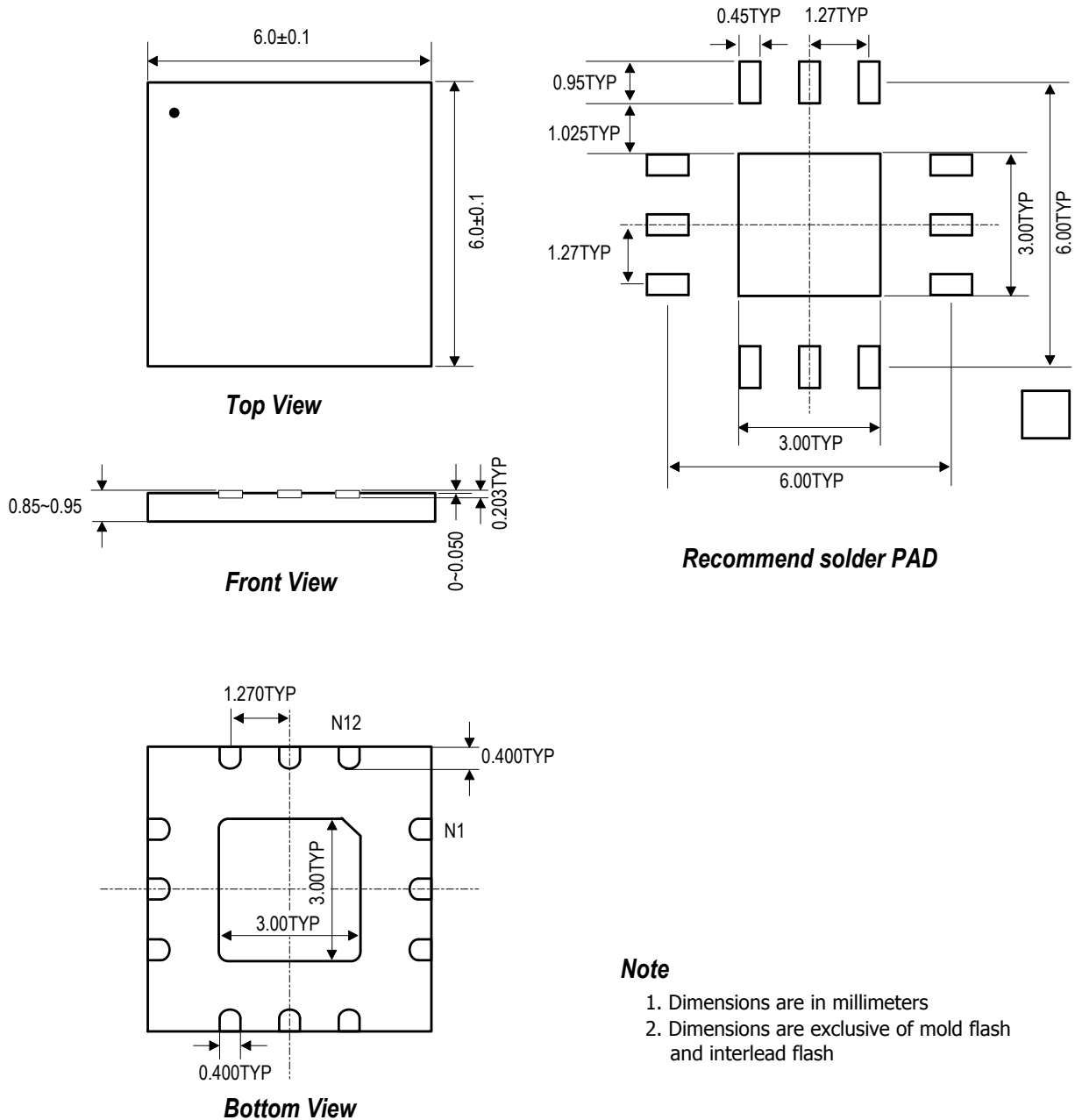
4'th row : PKG ass'y house code + Manufacturing Work Week

- . "A" means that PKG Ass'y site code
- . "YY" is a year code / "WW" is a weekly code



### 14. Package Outline Dimensions

#### QFN 12Pin





## 15. Important notices

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## 16. Contact information

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<i>For technical information</i>	techinfo@dmbtech.com
<i>For sales information</i>	snm@dmbtech.com
<i>For additional information</i>	<a href="http://www.dmbtech.com">http://www.dmbtech.com</a>