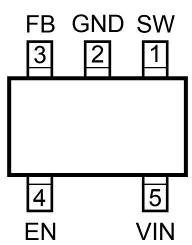
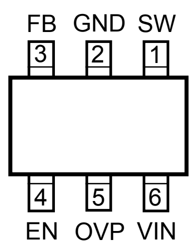
Ordering Information

Part Number	Marking Code	Overvoltage Protection	Junction Temp. Range	Package	Lead Finish
MIC3287YD5	WGAA	N/A	-40°C to +125°C	Thin SOT-23-5	Lead Free
MIC3287-24YD6	WHAA	24V	-40°C to +125°C	Thin SOT-23-6	Lead Free
MIC3287-24YML	WLA	24V	-40°C to +125°C	8-Pin 2mm x 2mm MLF	Lead Free

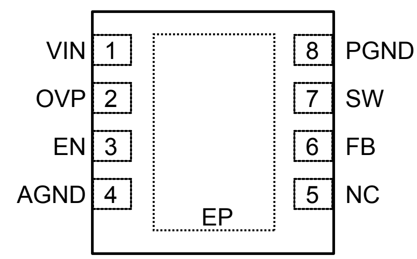
Pin Configuration



TSOT-23-5 (YD5)



TSOT-23-6 (YD6)



8-Pin 2mm x 2mm MLF™ (YML)

Pin Description

Pin Number TSOT-23-5	Pin Number TSOT-23-6	Pin Number 8-Pin MLF	Pin Name	Pin Function
1	1	7	SW	Switch Node (Input): Internal power bipolar collector.
2	2	4	AGND	Analog Ground (Return): Ground.
2	2	8	PGND	Power Ground (Return): Ground.
3	3	6	FB	Feedback (Input): Output voltage sense node. Connect the cathode of the LED to this pin. A resistor from this pin to ground sets the LED current.
4	4	3	EN	Enable (Input): Logic high enables regulator. Logic low shuts down regulator.
5	6	1	VIN	Supply (Input): 2.8V to 6.5V for internal circuitry.
—	5	2	OVP	Overvoltage Protection (Input): Connect to the output.
—	—	5	NC	Not Connected
—	—	EP	EP	Exposed Backside Pad: Connect to ground.

Absolute Maximum Ratings[1]

Supply Voltage (V_{IN}) 7V
Switch Voltage (V_{SW}) .... –0.3V to 40V
Enable Pin Voltage (V_{EN}) .... –0.3 to V_{IN}
FB Voltage (V_{FB}) 6V
Switch Current (I_{SW}) 1.2A
Ambient Storage Temperature (T_S) .... –65°C to +150°C
ESD Rating[3] 2kV

Operating Ratings[2]

Supply Voltage (V_{IN}) .... 2.8V to 6.5V
Output Voltage (V_{OUT}) .... V_{IN} to 36V
Output Voltage (V_{OUT})[4] .... V_{IN} to V_{OVP}
Junction Temperature Range (T_J) .... –40°C to +125°C
Package Thermal Impedance
Thin SOT-23-5 (θ_{JA})[5] .... 207°C/W
Thin SOT-23-6 (θ_{JA})[5] .... 134°C/W
8-Pin MLF (θ_{JA}) .... 90°C/W

Electrical Characteristics[6]

T_A = 25°C, V_{IN} = V_{EN} = 3.6V, V_{OUT} = 10V, I_{OUT} = 10mA, unless otherwise noted. **Bold** values indicate –40°C ≤ T_J ≤125°C.

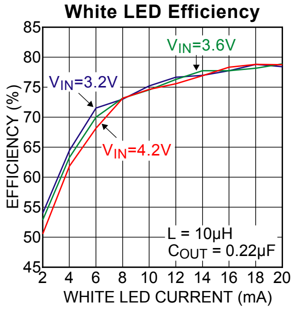
Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{IN}	Supply Voltage Range		**2.8**		**6.5**	V
V_{UVLO}	Under Voltage Lockout		1.8	2.1	2.4	V
I_{VIN}	Quiescent Current	V_{FB} > 500mV, (not switching)		2.1	5	mA
I_{SD}	Shutdown Current	V_{EN} = 0V[7]		0.04	**1**	µA
V_{FB}	Feedback Voltage	(±7.5%)	231	250	269	mV
I_{FB}	Feedback Input Current	V_{FB} = 250mV		–450		nA
	Line Regulation	3V ≤ V_{IN} ≤ 5V[8]		0.4	1	%
	Load Regulation	5mA ≤ I_{OUT} ≤ 20mA[8]		0.5		%
D_{MAX}	Maximum Duty Cycle		**85**	90		%
I_{SW}	Switch Current Limit	V_{IN} = 3.6V	350			mA
V_{SW}	Switch Saturation Voltage	V_{IN} = 3.6V, I_{SW} = 300mA		250		mV
I_{SW}	Switch Leakage Current	V_{EN} = 0V, V_{SW} = 10V		0.01	**1**	µA
V_{EN}	Enable Threshold	TURN ON TURN OFF	**1.5**		 **0.4**	V V
I_{EN}	Enable Pin Current	V_{EN} = 10V		21	40	µA
f_{SW}	Oscillator Frequency		1	1.2	1.4	MHz
V_{OVP}	Overvoltage Protection	MIC3287-24YD6 MIC3287-24YML	17	19	24	V
T_J	Overtemperature Threshold Shutdown	 Hysteresis		150 10		°C °C

Notes:

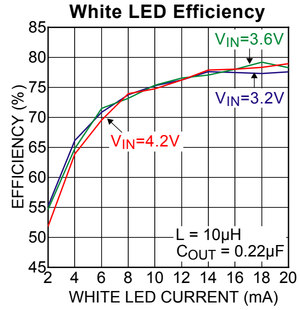
1. Absolute maximum ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside of its operating ratings. The maximum allowable power dissipation is a function of the maximum junction temperature, T_J(max), the junction-to-ambient thermal resistance, θ_{JA}, and the ambient temperature, T_A. The maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.
2. This device is not guaranteed to operate beyond its specified operating ratings.
3. Devices are inherently ESD sensitive. Handling precautions required. Human body model.
4. For options with OVP.
5. Using 4 layer PCB.
6. Specification for packaged product only.
7. I_{SD} = I_{VIN}.
8. Guaranteed by design.

Typical Characteristics

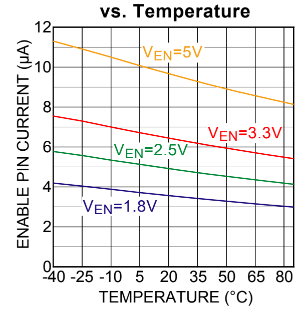
3 Series White LED Efficiency



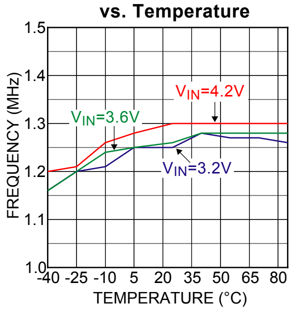
4 Series White LED Efficiency



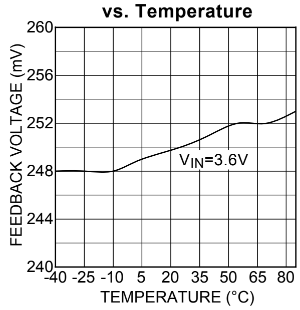
Enable Pin Current vs. Temperature



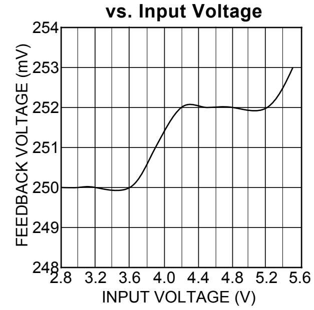
Frequency vs. Temperature



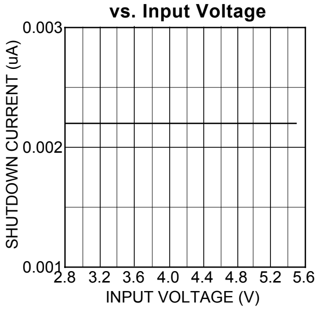
Feedback Voltage vs. Temperature



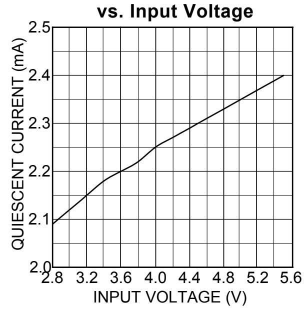
Feedback Voltage vs. Input Voltage



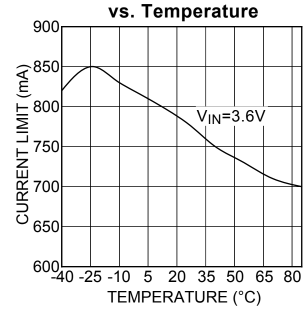
Shutdown Current vs. Input Voltage



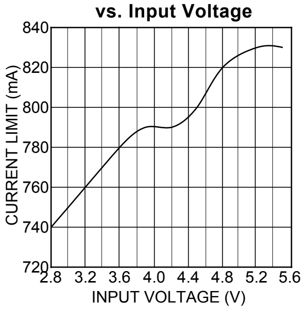
Quiescent Current vs. Input Voltage



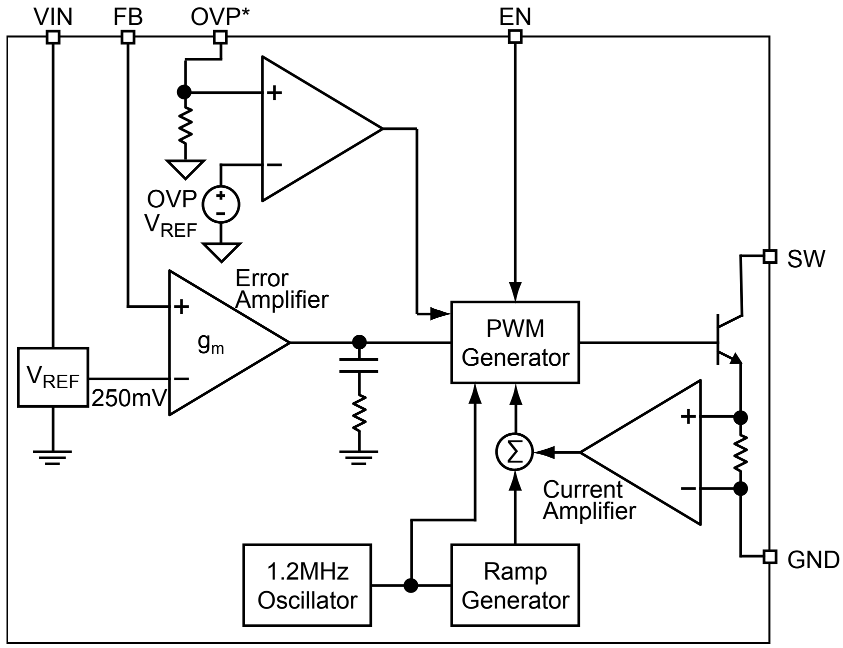
Curremt Limit vs. Temperature



Current Limit vs. Input Voltage



Functional Diagram



* OVP available on TSOP-23-6 and MLF™ package options only.

MIC3287 Block Diagram

Functional Description

The MIC3287 is a constant frequency pulse width modulated (PWM) current-mode step-up regulator. The block diagram is shown above. The MIC3287 is composed of an oscillator, slope compensation ramp generator, current amplifier, g_m error amplifier, PWM generator, and a 350mA minimum bipolar output transistor. The oscillator generates a 1.2MHz clock. The clock's two functions are to trigger the PWM generator that turns on the output transistor and to reset the slope compensation ramp generator. The current amplifier is used to measure the switch current by amplifying the voltage signal from the internal sense resistor. The output of the current amplifier is summed with the output of the slope compensation ramp generator. This summed current-loop signal is fed to one of the inputs of the PWM generator.

The g_m error amplifier measures the LED current through the external sense resistor and amplifies the error between the detected signal and the internal 250mV reference voltage. The output of the g_m error amplifier provides the voltage-loop signal that is fed to the other input of the PWM generator. When the current-loop signal exceeds the voltage-loop signal, the PWM generator turns off the bipolar output transistor. The next clock period initiates the next switching cycle, thus maintaining the constant frequency current-mode PWM control. The LED current is set by the feedback resistor:

$$I_{LED} = \frac{250mV}{R_{FB}}$$

The enable pin shuts down the internal power bipolar transistor and disables the control circuitry to reduce input current-to-leakage levels. Enable pin input current is zero at zero volts.

External Component Selection

The table below shows recommended inductor and output capacitor combinations for optimal performance.

Series LEDs	L	Min C_{OUT}
2	22µH	2.2µF
	15µH	1µF
	10µH	0.22µF
	6.8µH	0.22µF
	4.7µH	0.22µF
3	22µH	2.2µF
	15µH	1µF
	10µH	0.22µF
	6.8µH	0.22µF
	4.7µH	0.27µF
4	22µH	1µF
	15µH	1µF
	10µH	0.22µF
	6.8µH	0.27µF
	4.7µH	0.27µF

Dimming Control

There are two techniques for dimming control. One is PWM dimming, and the other is continuous dimming.

1. PWM dimming control is implemented by applying a PWM signal to the EN pin, as shown in Figure 1. The MIC3287 is turned on and off by the PWM signal. With this method, the LEDs operate with either zero or full current. The average LED current is increased proportionally to the duty-cycle of the PWM signal. This technique has high-efficiency because the IC and the LEDs consume no current during the off time of the PWM signal. Typical PWM frequency should be between 100Hz and 10kHz.
2. Continuous dimming control is implemented by applying a DC control voltage to the FB pin of the MIC3287 through a series resistor, as shown in Figure 2. The LED intensity (current) can be dynamically varied with the applied DC control voltage. The DC voltage can come from a DAC signal, or a filtered PWM signal. The advantage of the filtered PWM signal approach is a high frequency PWM signal (>10kHz) can be used to control LED intensity (current).

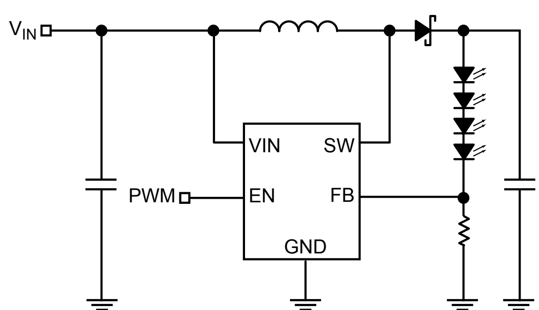


Figure 1. PWM Dimming Method

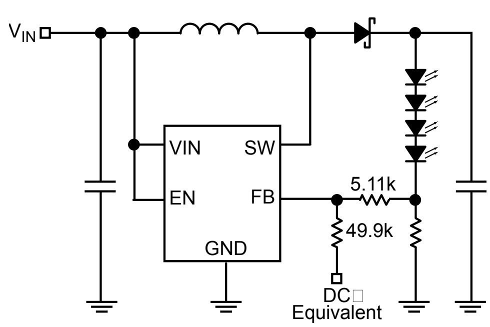


Figure 2. Continuous Dimming

Open-Circuit Protection

If the LEDs are disconnected from the circuit, or in the case that an LED fails, the sense resistor will then pull the FB pin to ground. This will cause the MIC3287 to switch with a high duty-cycle, resulting in output over-voltage. This may cause the SW pin voltage to exceed its maximum voltage rating, damaging the IC and the external components. To ensure the highest level of protection, the MIC3287 has buit-in 24V over-voltage protection functionality in the TSOT-23-6 pin and 8-pin MLF™ package options. The OVP will clamp the output voltage to within the specified limits.

Start-Up and Inrush Current

If the inrush current needs to be limited, a soft-start circuit, similar to Figure 3, could be implemented. The soft-start capacitor, C_{SS}, provides overdrive to the FB pin at start-up, resulting in gradual increase of switch duty cycle and limited in rush current.

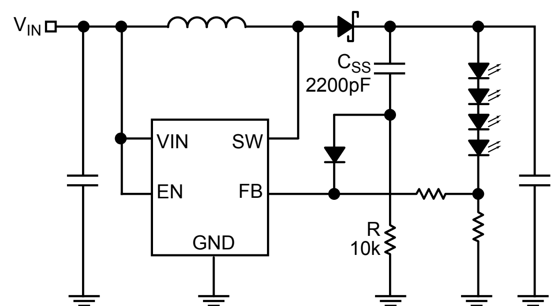
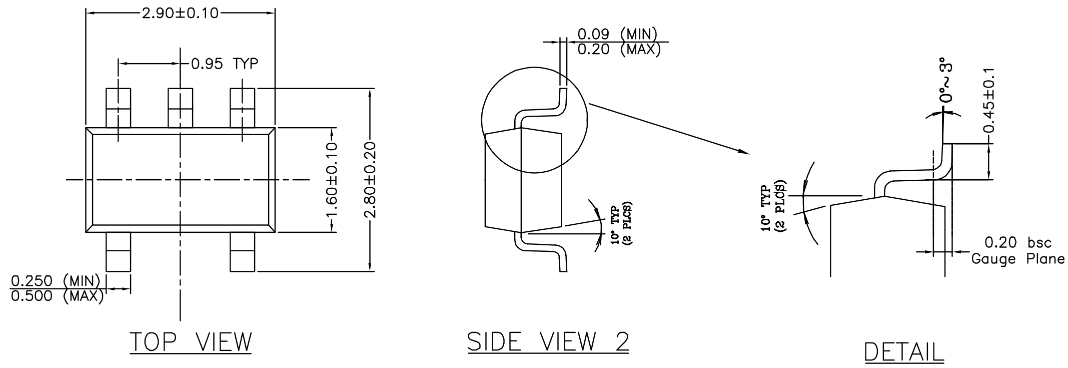
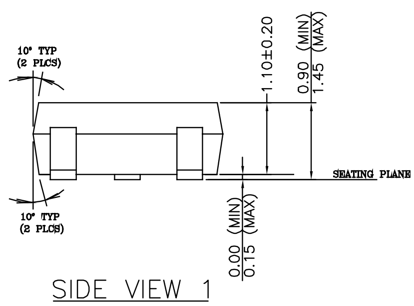


Figure 3. Soft-Start Circuit

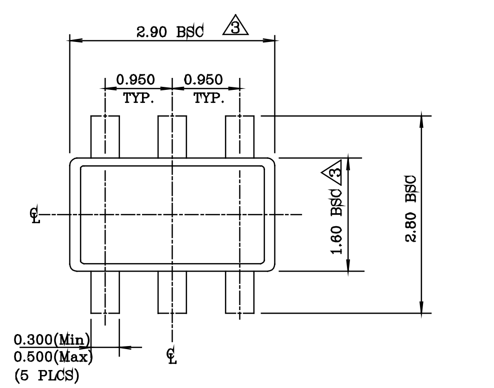
Package Information



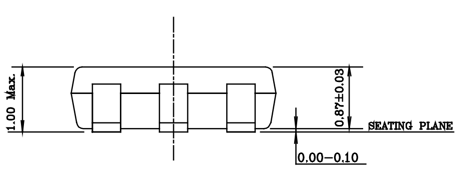


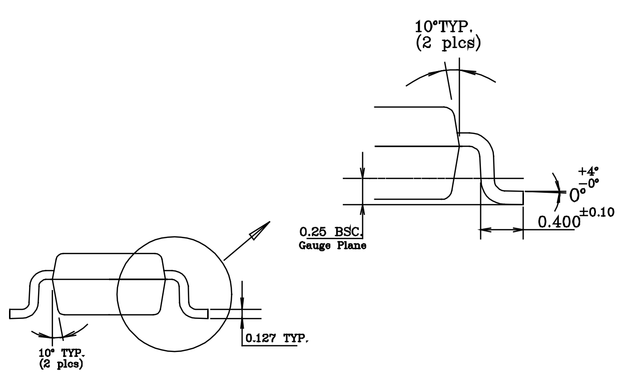
NOTE:
1. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & BURR.
2. PACKAGE OUTLINE INCLUSIVE OF SOLER PLATING.
3. DIMENSION AND TOLERANCE PER ANSI Y14.5M, 1982.
4. FOOT LENGTH MEASUREMENT BASED ON GAUGE PLANE METHOD.
5. DIE FACES UP FOR MOLD, AND FACES DOWN FOR TRIM/FORM.

5-Pin TSOT (YD5)

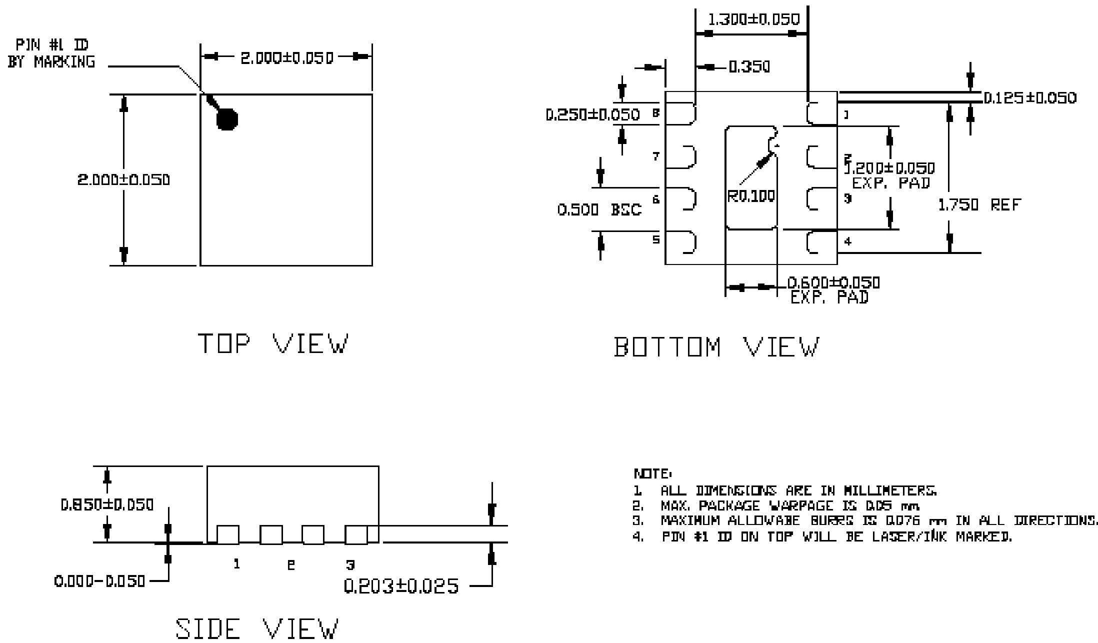


NOTE:
1. Dimensions and tolerances are as per ANSI Y14.5M, 1994.
2. Die is facing up for mold. Die is facing down for trim/form, ie. reverse trim/form.
3. Dimensions are exclusive of mold flash and gate burr.
4. The footlength measuring is based on the gauge plane method.
5. All specification comply to Jedec Spec MO193 Issue C.
6. All dimensions are in millimeters.





6-Pin TSOT (YD6)



8-Pin 2mm x 2mm MLF® (ML)

MICREL INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA
TEL + 1 (408) 944-0800 FAX + 1 (408) 474-1000 WEB http://www.micrel.com