

# LM3404/04HV

## 1.0A Constant Current Buck Regulator for Driving High Power LEDs

### General Description

The LM3404/04HV are monolithic switching regulators designed to deliver constant currents to high power LEDs. Ideal for automotive, industrial, and general lighting applications, they contain a high-side N-channel MOSFET switch with a current limit of 1.5A (typical) for step-down (Buck) regulators. Hysteretic controlled on-time and an external resistor allow the converter output voltage to adjust as needed to deliver a constant current to series and series-parallel connected LED arrays of varying number and type. LED dimming via pulse width modulation (PWM), broken/open LED protection, low-power shutdown and thermal shutdown complete the feature set.

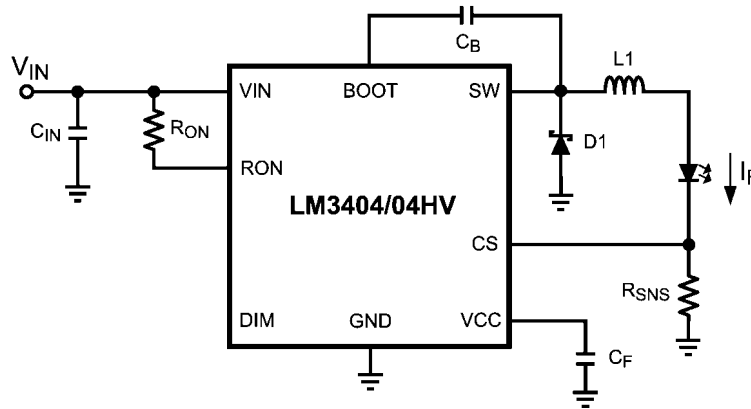
### Features

- Integrated 1.0A MOSFET
- $V_{IN}$  Range 6V to 42V (LM3404)
- $V_{IN}$  Range 6V to 75V (LM3404HV)
- 1.2A Output Current Over Temperature
- Cycle-by-Cycle Current Limit
- No Control Loop Compensation Required
- Separate PWM Dimming and Low Power Shutdown
- Supports all-ceramic output capacitors and capacitor-less outputs
- Thermal shutdown protection
- SO-8 Package, PSOP-8 Package

### Applications

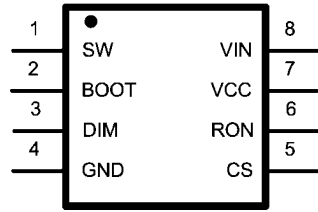
- LED Driver
- Constant Current Source
- Automotive Lighting
- General Illumination
- Industrial Lighting

### Typical Application

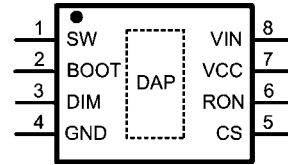


20205401

## Connection Diagrams



20205402  
8-Lead Plastic SO-8 Package  
NS Package Number M08A



20205456  
8-Lead Plastic PSOP-8 Package  
NS Package Number MRA08B

## Ordering Information

Order Number	Package Type	NSC Package Drawing	Supplied As
LM3404MA	SO-8	M08A	95 units in anti-static rails
LM3404MAX			2500 units on tape and reel
LM3404HVMA			95 units in anti-static rails
LM3404HVMAX			2500 units on tape and reel
LM3404MR	PSOP-8	MRA08B	95 units in anti-static rails
LM3404MRX			2500 units on tape and reel
LM3404HVMR			95 units in anti-static rails
LM3404HVMRX			2500 units on tape and reel

## Pin Descriptions

Pin(s)	Name	Description	Application Information
1	SW	Switch pin	Connect this pin to the output inductor and Schottky diode.
2	BOOT	MOSFET drive bootstrap pin	Connect a 10 nF ceramic capacitor from this pin to SW.
3	DIM	Input for PWM dimming	Connect a logic-level PWM signal to this pin to enable/disable the power MOSFET and reduce the average light output of the LED array.
4	GND	Ground pin	Connect this pin to system ground.
5	CS	Current sense feedback pin	Set the current through the LED array by connecting a resistor from this pin to ground.
6	RON	On-time control pin	A resistor connected from this pin to VIN sets the regulator controlled on-time.
7	VCC	Output of the internal 7V linear regulator	Bypass this pin to ground with a minimum 0.1 $\mu$ F ceramic capacitor with X5R or X7R dielectric.
8	VIN	Input voltage pin	Nominal operating input range for this pin is 6V to 42V (LM3404) or 6V to 75V (LM3404HV).
DAP	GND	Thermal Pad	Connect to ground. Place 4-6 vias from DAP to bottom layer ground plane.

## Absolute Maximum Ratings

**(LM3404)** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

VIN to GND	-0.3V to 45V
BOOT to GND	-0.3V to 59V
SW to GND	-1.5V to 45V
BOOT to VCC	-0.3V to 45V
BOOT to SW	-0.3V to 14V
VCC to GND	-0.3V to 14V
DIM to GND	-0.3V to 7V
CS to GND	-0.3V to 7V
RON to GND	-0.3V to 7V
Junction Temperature	150°C

Storage Temp. Range	-65°C to 125°C
ESD Rating (Note 2)	2kV
Soldering Information	
Lead Temperature (Soldering, 10sec)	260°C
Infrared/Convection Reflow (15sec)	235°C

## Operating Ratings (LM3404)

(Note 1)

V <sub>IN</sub>	6V to 42V
Junction Temperature Range	-40°C to +125°C
Thermal Resistance $\theta_{JA}$ (SO-8 Package)	155°C/W
Thermal Resistance $\theta_{JA}$ (PSOP-8 Package) (Note 5)	50°C/W

**Electrical Characteristics**  $V_{IN} = 24V$  unless otherwise indicated. Typicals and limits appearing in plain type apply for  $T_A = T_J = +25^\circ C$ . (Note 4) Limits appearing in **boldface type** apply over full Operating Temperature Range. Datasheet min/max specification limits are guaranteed by design, test, or statistical analysis.

## LM3404

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>SYSTEM PARAMETERS</b>						
$t_{ON-1}$	On-time 1	$V_{IN} = 10V, R_{ON} = 200 k\Omega$	<b>2.1</b>	2.75	<b>3.4</b>	$\mu s$
$t_{ON-2}$	On-time 2	$V_{IN} = 40V, R_{ON} = 200 k\Omega$	<b>515</b>	675	<b>835</b>	ns

## LM3404HV

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>SYSTEM PARAMETERS</b>						
$t_{ON-1}$	On-time 1	$V_{IN} = 10V, R_{ON} = 200 k\Omega$	<b>2.1</b>	2.75	<b>3.4</b>	$\mu s$
$t_{ON-2}$	On-time 2	$V_{IN} = 70V, R_{ON} = 200 k\Omega$	<b>325</b>	415	<b>505</b>	ns

## LM3404/LM3404HV

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>REGULATION AND OVER-VOLTAGE COMPARATORS</b>						
$V_{REF-REG}$	CS Regulation Threshold	CS Decreasing, SW turns on	<b>194</b>	200	<b>206</b>	mV
$V_{REF-0V}$	CS Over-voltage Threshold	CS Increasing, SW turns off		300		mV
$I_{CS}$	CS Bias Current	CS = 0V		0.1		$\mu A$
<b>SHUTDOWN</b>						
$V_{SD-TH}$	Shutdown Threshold	$R_{ON} / SD$ Increasing	<b>0.3</b>	0.7	<b>1.05</b>	V
$V_{SD-HYS}$	Shutdown Hysteresis	$R_{ON} / SD$ Decreasing		40		mV
<b>OFF TIMER</b>						
$t_{OFF-MIN}$	Minimum Off-time	CS = 0V		270		ns
<b>INTERNAL REGULATOR</b>						
$V_{CC-REG}$	$V_{CC}$ Regulated Output		<b>6.4</b>	7	<b>7.4</b>	V
$V_{IN-DO}$	$V_{IN} - V_{CC}$	$I_{CC} = 5 mA, 6.0V < V_{IN} < 8.0V$		300		mV
$V_{CC-BP-TH}$	$V_{CC}$ Bypass Threshold	$V_{IN}$ Increasing		8.8		V
$V_{CC-BP-HYS}$	$V_{CC}$ Bypass Hysteresis	$V_{IN}$ Decreasing		230		mV
$V_{CC-Z-6}$	$V_{CC}$ Output Impedance (0 mA < $I_{CC}$ < 5 mA)	$V_{IN} = 6V$		55		$\Omega$
$V_{CC-Z-8}$		$V_{IN} = 8V$		50		
$V_{CC-Z-24}$		$V_{IN} = 24V$		0.4		
$V_{CC-LIM}$	$V_{CC}$ Current Limit (Note 3)	$V_{IN} = 24V, V_{CC} = 0V$		16		mA
$V_{CC-UV-TH}$	$V_{CC}$ Under-voltage Lock-out Threshold	$V_{CC}$ Increasing		5.3		V
$V_{CC-UV-HYS}$	$V_{CC}$ Under-voltage Lock-out Hysteresis	$V_{CC}$ Decreasing		150		mV
$V_{CC-UV-DLY}$	$V_{CC}$ Under-voltage Lock-out Filter Delay	100 mV Overdrive		3		$\mu s$
$I_{IN-OP}$	$I_{IN}$ Operating Current	Non-switching, CS = 0.5V		625	<b>900</b>	$\mu A$
$I_{IN-SD}$	$I_{IN}$ Shutdown Current	$R_{ON} / SD = 0V$		95	<b>180</b>	$\mu A$
<b>CURRENT LIMIT</b>						
$I_{LIM}$	Current Limit Threshold		<b>1.2</b>	1.5	<b>1.8</b>	A

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>DIM COMPARATOR</b>						
$V_{IH}$	Logic High	DIM Increasing	<b>2.2</b>			V
$V_{IL}$	Logic Low	DIM Decreasing			<b>0.8</b>	V
$I_{DIM-PU}$	DIM Pull-up Current	DIM = 1.5V		80		$\mu$ A
<b>MOSFET AND DRIVER</b>						
$R_{DS-ON}$	Buck Switch On Resistance	$I_{SW} = 200mA$ , BST-SW = 6.3V		0.37	<b>0.75</b>	$\Omega$
$V_{DR-UVLO}$	BST Under-voltage Lock-out Threshold	BST-SW Increasing	<b>1.7</b>	3	<b>4</b>	V
$V_{DR-HYS}$	BST Under-voltage Lock-out Hysteresis	BST-SW Decreasing		400		mV
<b>THERMAL SHUTDOWN</b>						
$T_{SD}$	Thermal Shutdown Threshold			165		$^{\circ}$ C
$T_{SD-HYS}$	Thermal Shutdown Hysteresis			25		$^{\circ}$ C
<b>THERMAL RESISTANCE</b>						
$\theta_{JA}$	Junction to Ambient	SOIC-8 Package		155		$^{\circ}$ C/W
		PSOP-8 Package (Note 5)		50		

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see Electrical Characteristics.

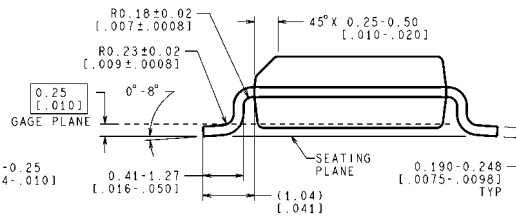
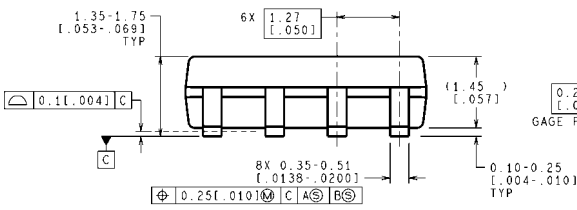
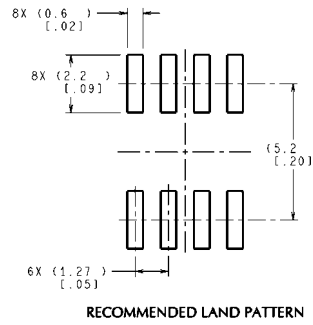
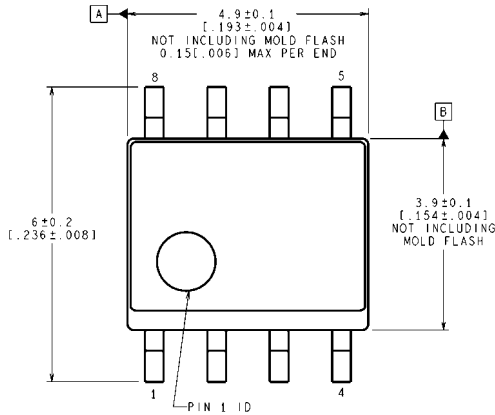
**Note 2:** The human body model is a 100 pF capacitor discharged through a 1.5 k $\Omega$  resistor into each pin.

**Note 3:** VCC provides self bias for the internal gate drive and control circuits. Device thermal limitations limit external loading.

**Note 4:** Typical specifications represent the most likely parametric norm at 25 $^{\circ}$ C operation.

**Note 5:**  $\theta_{JA}$  of 50 $^{\circ}$ C/W with DAP soldered to a minimum of 2 square inches of 1oz. copper on the top or bottom PCB layer.

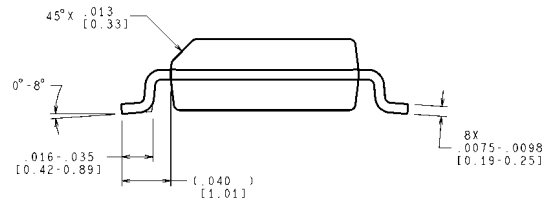
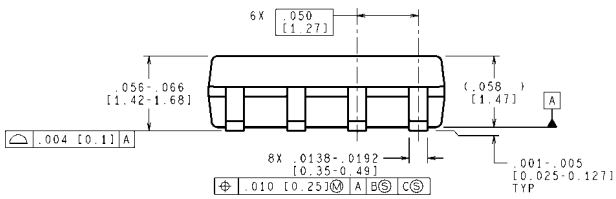
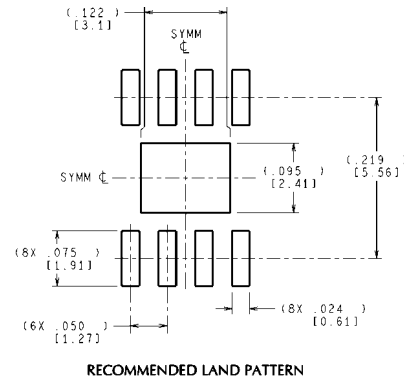
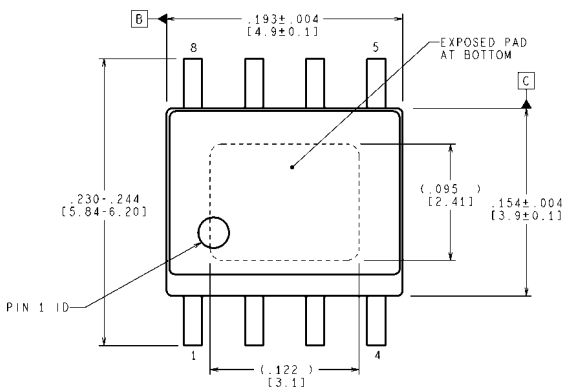
**Physical Dimensions** inches (millimeters) unless otherwise noted



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M08A (Rev L)

**SO-8 Package  
NS Package Number M08A**



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MRA08B (Rev B)

**PSOP-8 Package  
NS Package Number MRA08B**