

# Low Dropout 600mA Linear Regulator in 3mm x 3mm Package

## POWER MANAGEMENT

### Features

- $V_{IN}$  range: 2.7V to 5.5V
- Fixed 1.5V or adjustable output voltage
- 600mA output current
- Operate with ceramic capacitors
- 2 $\mu$ A quiescent current in shutdown
- No minimum load current requirement
- Over-current and over-temperature protection
- Reverse voltage protection
- 3mm x 3mm x 1mm MLPD-8 package ( WEEE and RoHS compliant )

### Applications

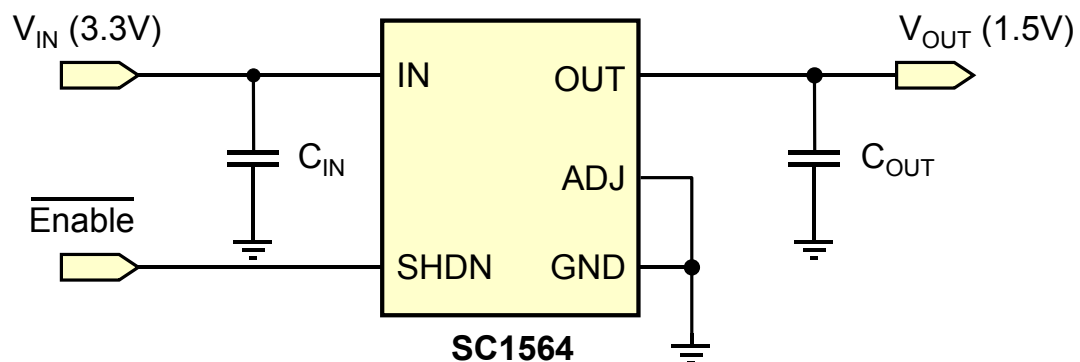
- Personal digital assistants
- Battery powered systems
- Motherboards
- Peripheral cards
- PCMCIA cards

### Description

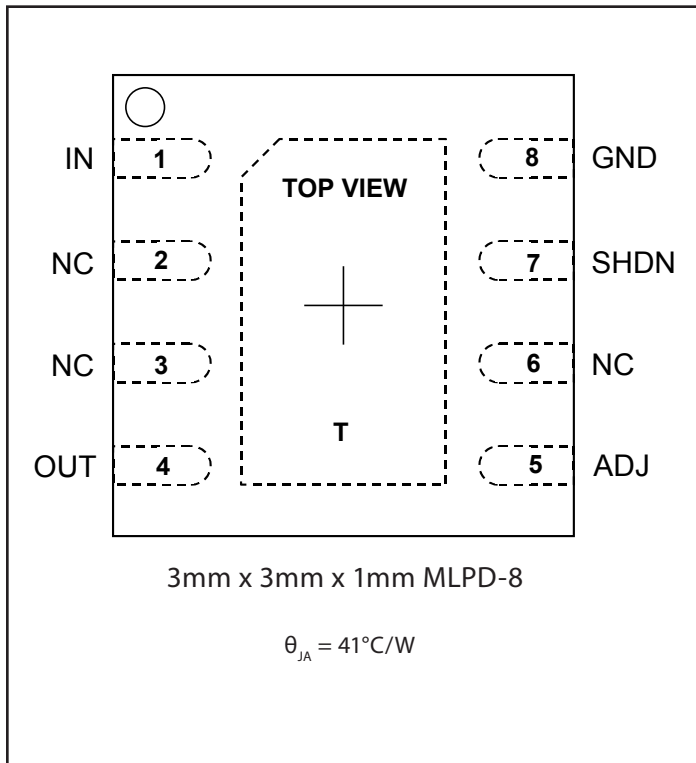
The SC1564 is a high performance positive voltage regulator designed for use in applications requiring low dropout voltages up to 600mA. Since it has superior dropout characteristics compared to regular LDOs, it can be used to supply 2.5V on motherboards, or 2.8V on peripheral cards from the 3.3V supply with no heatsink. Additionally, the SC1564 has a shutdown pin to further reduce power dissipation while in shut down mode. The SC1564 provides excellent regulation in line, load and temperature variations.

The output voltage of every device can be selected to be 1.5V or adjusted between 1.2V and 4.55V. The SC1564 comes in a space-saving 3mm x 3mm x 1mm MLPD-8 package.

## Typical Application Circuit



### Pin Configuration



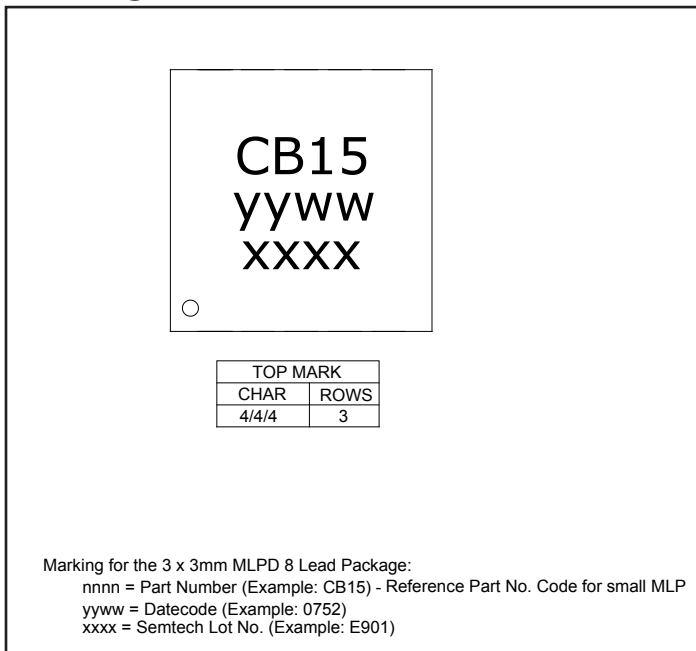
### Ordering Information

Part Number	Package
SC1564ML-1.5TRT <sup>(1)(2)(3)</sup>	3mm x 3mm x 1mm MLPD-8
SC1564-1.5EVB	Evaluation Board

Notes:

- (1) Output voltage can be adjusted using external resistors, see Pin Descriptions.
- (2) Only available in tape and reel packaging. A reel contains 3000 devices.
- (3) Available in lead-free package only. Device is WEEE and RoHS compliant.

### Marking Information



## Absolute Maximum Ratings

IN Voltage .....	-0.3V to +7V
OUT Voltage .....	-0.3V to $V_{IN}$
ADJ Voltage .....	-0.3V to $V_{IN}$
SHDN Voltage .....	-0.3V to $V_{IN}$

## Recommended Operating Conditions

IN Voltage Range .....	2.7 to 5.5V
Maximum Output Current .....	600mA
Junction Temperature .....	-40 to 150°C

## Thermal Information

Thermal Resistance, Junction to Ambient <sup>(1)</sup> ....	41°C/W
Storage Temperature .....	-65 to +150°C
Peak IR Reflow Temperature (10s to 30s) .....	+260°C

Exceeding the above specifications may result in permanent damage to the device or device malfunction. Operation outside of the parameters specified in the Electrical Characteristics section is not recommended.

### NOTES:

- (1) Calculated from package in still air, mounted to 3" x 4.5", 4 layer FR4 PCB with thermal vias under the exposed pad per JEDEC standards.
- (2) This device is ESD sensitive. Use of standard ESD handling precautions is required.

## Electrical Characteristics

Unless specified:  $V_{SHDN} = 0V$ , Adjustable mode: ( $V_{ADJ} = V_{REF}$ ), Fixed mode: ( $V_{ADJ} = GND$ ),  $V_{IN} = 2.7V$  to 5.5V and  $I_{OUT} = 10mA$  to 600mA. Values in **bold** apply over full operating temperature range..  $T_J = -40^\circ C$  to 150°C, typical value are at  $T_J = 25^\circ C$ .

Parameter	Symbol	Conditions	Min	Typ	Max	Units
<b>Input Supply</b>						
IN Voltage Range	$V_{IN}$		<b>2.7</b>		<b>5.5</b>	V
Quiescent Current	$I_Q$	$V_{IN} = 3.3V$		85	<b>170</b>	$\mu A$
		$V_{IN} = V_{SHDN} = 5.5V$		0.01	<b>2.00</b>	
<b>Output</b>						
OUT Voltage <sup>(1)</sup> (Internal Fixed Voltage)	$V_{OUT}$	$V_{IN} = 3.3V, I_{OUT} = 10mA, T_A = 25^\circ C$	1.482	1.500	1.518	V
			<b>1.467</b>		<b>1.533</b>	
Line Regulation <sup>(1)(2)</sup>	$REG_{(LINE)}$	$V_{IN} = 2.7V$ to 5.5V, $I_{OUT} = 10mA, T_J \geq 0^\circ C$		0.10	<b>0.40</b>	%
Load Regulation <sup>(1)</sup>	$REG_{(LOAD)}$	$V_{IN} = 2.7V$		0.15	<b>0.40</b>	%
Current Limit <sup>(1)(3)</sup>	$I_{LM}$		<b>0.65</b>		<b>1.10</b>	A
Dropout Voltage <sup>(2)</sup>	$V_D$	$I_{OUT} = 10mA$		1		mV
		$I_{OUT} = 100mA$		70	115	mV
		$I_{OUT} = 300mA$		210	300	mV
		$I_{OUT} = 600mA$		420	600	mV
					<b>835</b>	

**Electrical Characteristics (continued)**

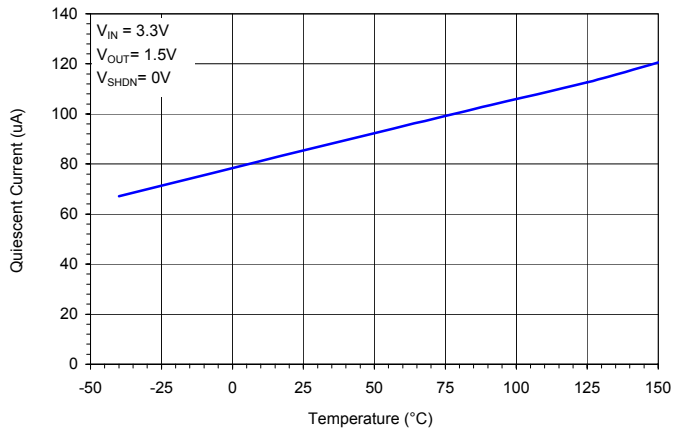
Parameter	Symbol	Conditions	Min	Typ	Max	Units
<b>Reference</b>						
Reference Voltage <sup>(1)</sup>	$V_{REF}$	$V_{IN} = 3.3V, V_{ADJ} = V_{OUT}, I_{OUT} = 10mA$	1.186	1.200	1.214	V
			<b>1.174</b>		<b>1.226</b>	
ADJ Pin Current <sup>(4)</sup>	$I_{ADJ}$	$V_{IN} = 3.3V, V_{ADJ} = V_{REF}$		65	<b>150</b>	nA
ADJ Pin Threshold <sup>(5)</sup>	$V_{ADJ-TH}$	$V_{IN} = 3.3V, V_{ADJ} = V_{REF}$	<b>0.10</b>	0.25	<b>0.40</b>	V
<b>Shutdown</b>						
SHDN Pin Current	$I_{SHDN}$	$V_{SHDN} = 0V, V_{IN} = 3.3V$		1.5	<b>5.0</b>	$\mu A$
SHDN Pin Threshold	$V_{IH}$	$V_{IN} = 3.3V$	<b>1.8</b>			V
	$V_{IL}$	$V_{IN} = 3.3V$			<b>0.4</b>	
<b>Over Temperature Protection</b>						
High Trip Level	$T_{HI}$			170		$^{\circ}C$
Hysteresis	$T_{HYST}$			10		$^{\circ}C$

**Notes:**

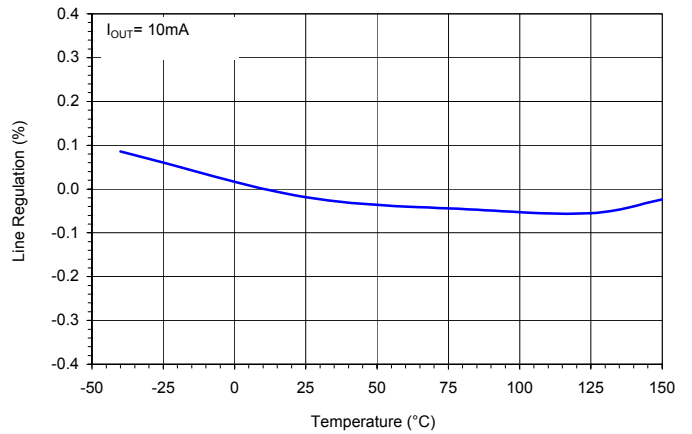
- (1) Low duty cycle pulse testing with Kelvin connections required.
- (2) Defined as the input to output differential at which the output voltage drops to 1% below the value measured at a differential of 0.95V for  $2.2V \leq V_{OUT} \leq 4.55V$  at adjustable mode configuration. Not measurable on outputs less than 2.2V due to minimum  $V_{IN}$  constraints. See typical characteristics curves.
- (3) Defined as the output current at which the output voltage drops to 2% below the value measured at output current of 10mA.
- (4) Guaranteed by design.
- (5) When  $V_{ADJ}$  exceeds this threshold, the "Sense Select" switch disconnects the internal feedback chain from the error amplifier and connects  $V_{ADJ}$  instead.

## Typical Characteristics

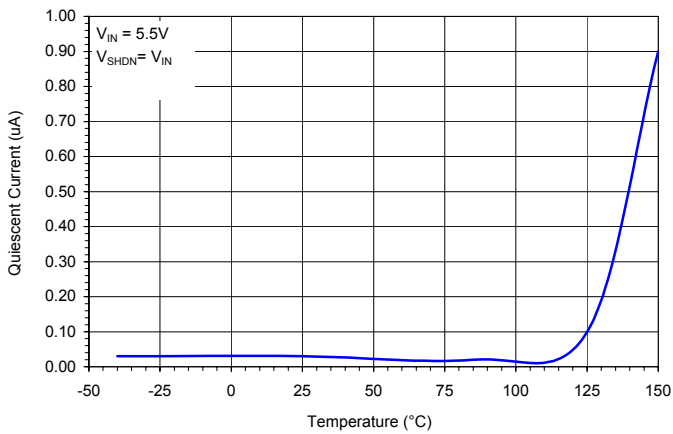
Quiescent Current vs Junction Temperature



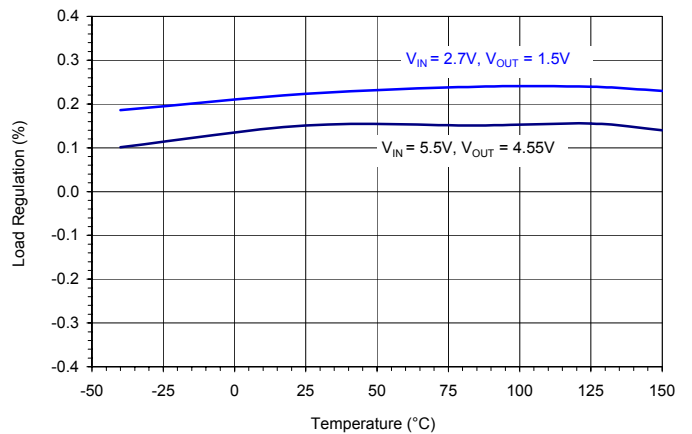
Line Regulation vs Junction Temperature



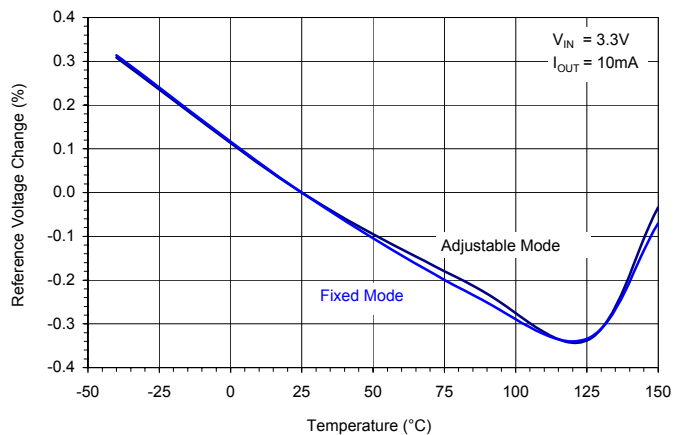
Quiescent Current at Shutdown



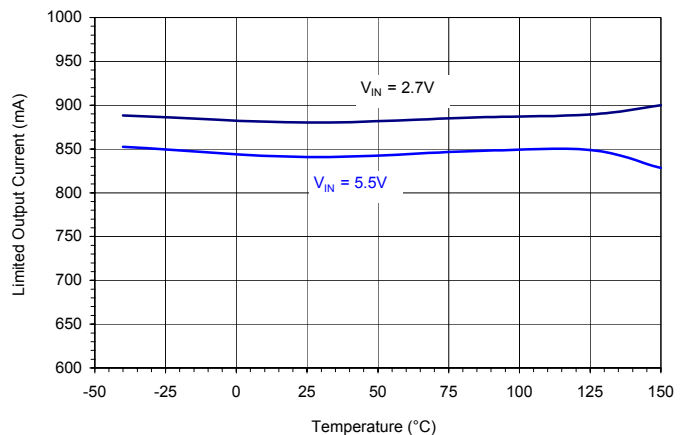
Load Regulation vs Junction Temperature



Output Voltage vs Junction Temperature

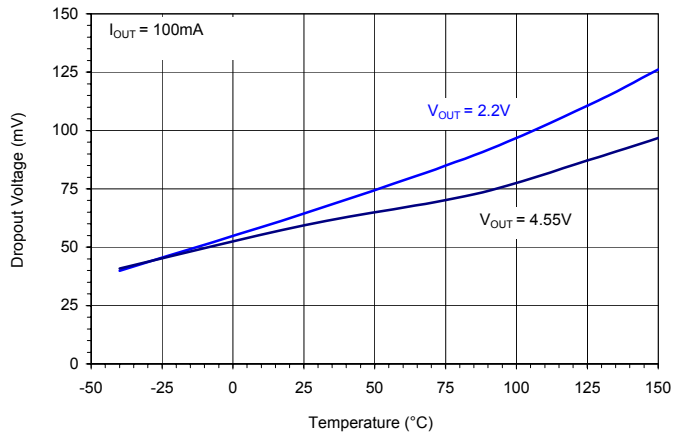


Current Limit vs Junction Temperature

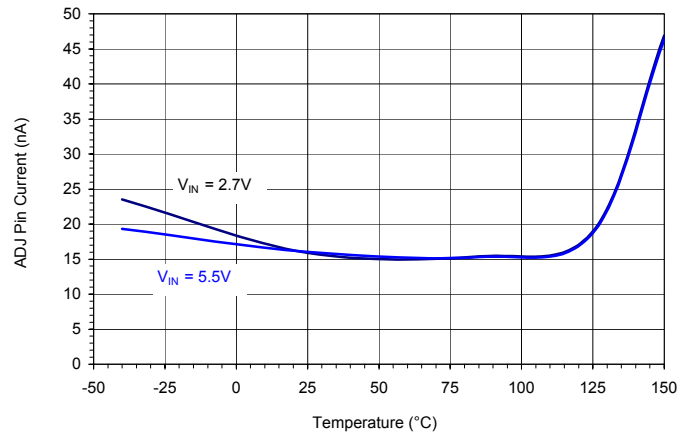


## Typical Characteristics

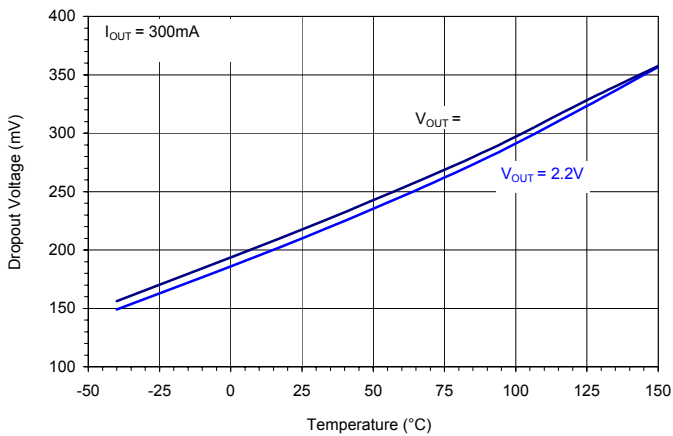
Dropout Voltage vs Output Voltage  
@  $I_{OUT} = 100\text{mA}$



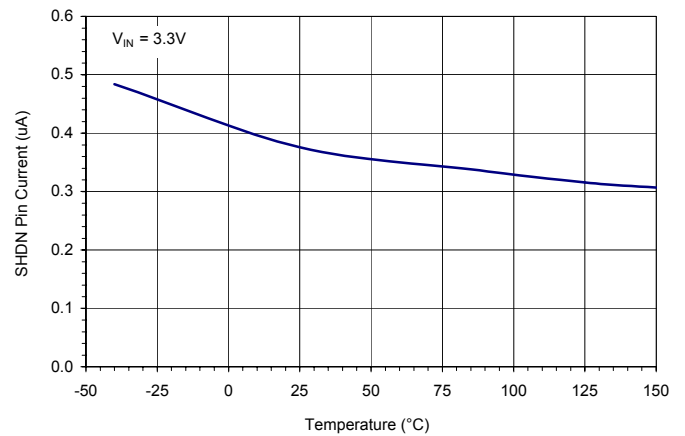
ADJ Pin Current vs Junction Temperature



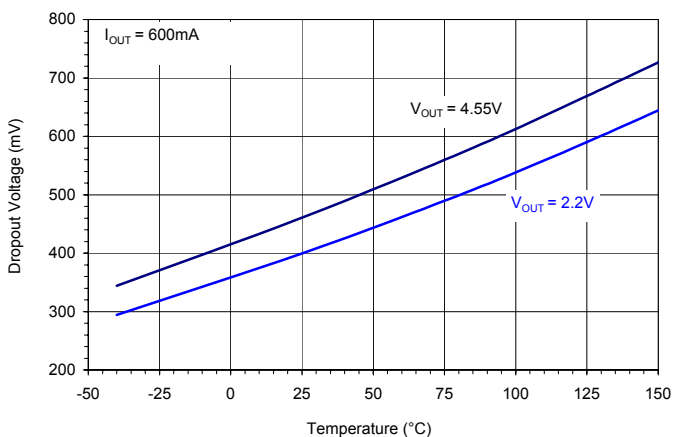
Dropout Voltage vs Output Voltage  
@  $I_{OUT} = 300\text{mA}$



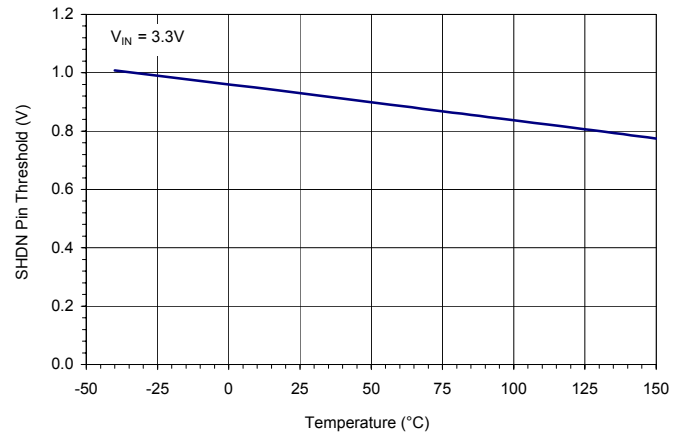
SHDN Pin Current vs Junction Temperature



Dropout Voltage vs Output Voltage  
@  $I_{OUT} = 600\text{mA}$

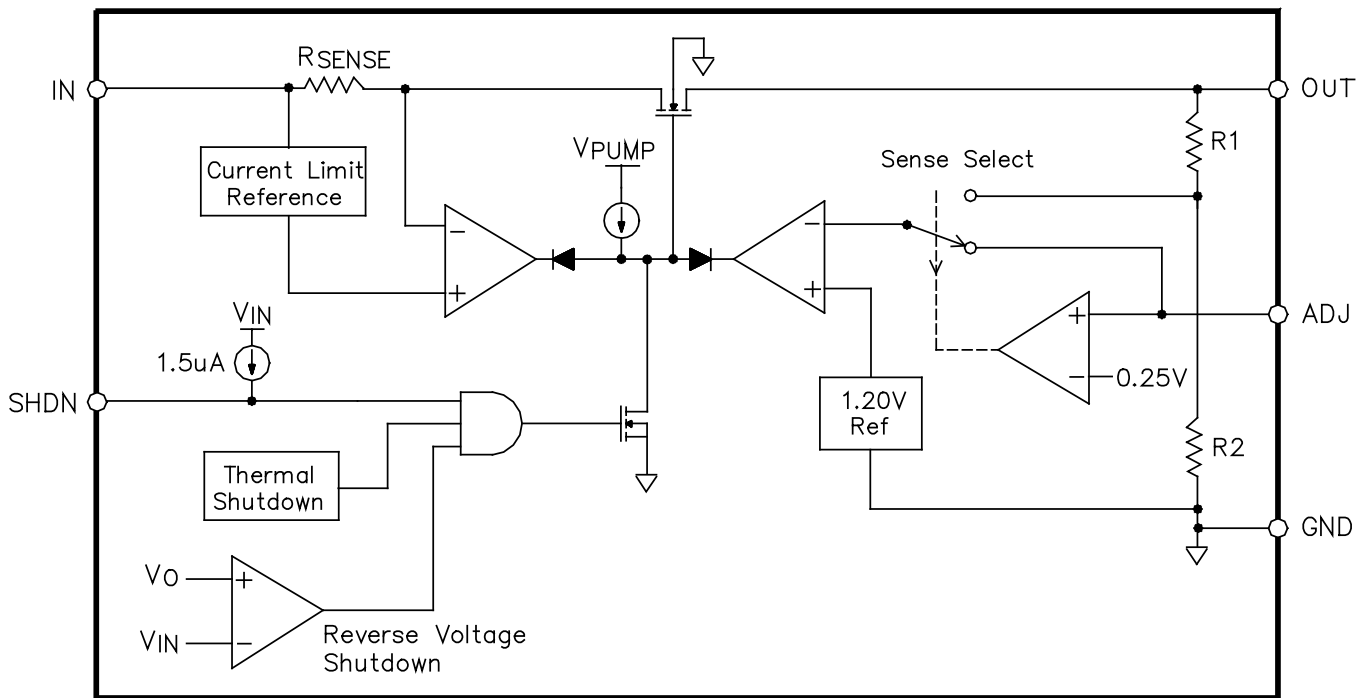


SHDN Pin Threshold vs Junction Temperature



## Pin Descriptions

Pin #	Pin Name	Pin Function
1	IN	Input voltage. For regulation at full load, the input to this pin must be between ( $V_{OUT} + 0.95V$ ) and 5.5V. Minimum $V_{IN} = 2.7V$ .
2	NC	No connect
3	NC	No connect
4	OUT	This pin is the power output of this device, sourcing up to 600mA.
5	ADJ	<p>This pin sets the output voltage when grounded by the set of internal feedback resistors. If external feedback resistors are used, the output voltage will be:</p> $V_{OUT} = \frac{1.200 \cdot (R_1 + R_2)}{R_2} \cdot V$ <p><math>R_1</math>: The resistor connected from OUT to ADJ.  <math>R_2</math>: The resistor connected from ADJ to GND.</p>
6	NC	No connect
7	SHDN	Shutdown Input. Pulling this pin high turns the regulator off, reducing the quiescent current to a fraction of its operating value (typically < 300nA). The device will be enabled if this pin is pulled below 0.4V. Connect to GND if not being used.
8	GND	Reference ground.
T	Thermal Pad	Thermal pad for heatsinking purposes. Not connected internally

**Block Diagram**




## Applications Information

### Introduction

The SC1564 is intended for applications such as graphics cards where high current capability and low drop-out voltage are required. It provides a very simple, low cost solution that uses little PCB real estate. Additional features include a shutdown pin to allow for a very low power consumption standby mode, and a fully adjustable output.

### Component Selection

**Input capacitor:** A 1 $\mu$ F ceramic capacitor is recommended. This allows for the device some distance from any bulk capacitance on the rail. Additionally, input droop due to load transients is reduced, improving load transient response. Additional capacitance may be added if required by the application.

**Output capacitor:** A minimum bulk capacitance of 1 $\mu$ F, along with a 0.1 $\mu$ F ceramic decoupling capacitor, is recommended. Increasing the bulk capacitance will improve the overall transient response. The use of multiple lower value ceramic capacitors in parallel to achieve the desired bulk capacitance will not cause stability issues. Although designed for use with ceramic output capacitors, the SC1564 is extremely tolerant of output capacitor ESR values and thus will also work comfortably with tantalum output capacitors.

**Noise immunity:** In very electrically noisy environments, it is recommended that 0.1 $\mu$ F ceramic capacitors be placed from IN to GND and OUT to GND as close to the device pins as possible.

**External voltage selection resistors:** the use of 1% resistors, designed for a current flow  $\geq 10\mu$ A is recommended to ensure a well-regulated output (tus, R2  $\leq 120k\Omega$ ).

### Thermal Considerations

The power dissipation in the SC1564 is approximately equal to the product of the output current and the input to output voltage differential:

$$P_O = (V_{IN} - V_{OUT}) \cdot I_{OUT}$$

The absolute worst-case dissipation is given by:

$$P_{O(MAX)} = (V_{IN(MAX)} - V_{OUT(MIN)}) \cdot I_{OUT(MAX)} + V_{IN(MAX)} \cdot I_{Q(MAX)}$$

For a typical scenario,  $V_{IN} = 3.3V \pm 5\%$ ,  $V_{OUT} = 1.5V$  and  $I_{OUT} = 600mA$ , therefore:

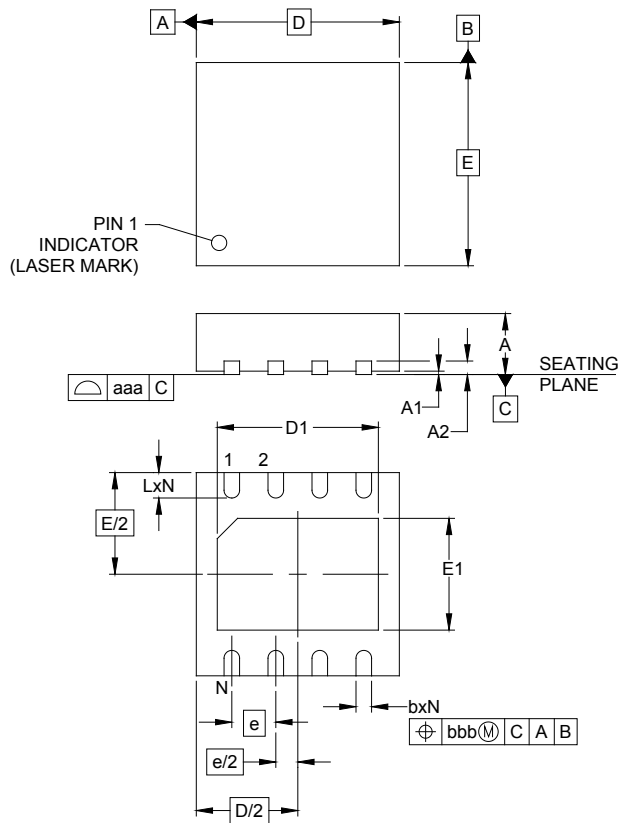
$$\begin{aligned} V_{IN(MAX)} &= 3.465V, \\ V_{OUT(MIN)} &= 1.47V \text{ and} \\ I_{Q(MAX)} &= 170\mu A, \end{aligned}$$

Thus  $P_{D(MAX)} = 1.1976W$ .

Using this figure, and assuming  $T_{A(MAX)} = 85^\circ C$ , we can calculate the maximum thermal impedance allowable to maintain  $T_j \leq 150^\circ C$ :

$$R_{TH(J-A)(MAX)} = \left( \frac{T_{J(MAX)} - T_{A(MAX)}}{P_{O(MAX)}} \right) = \left( \frac{150^\circ C - 85^\circ C}{1.1976W} \right) = 54.3^\circ C/W$$

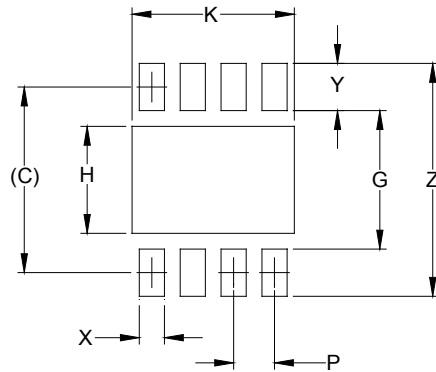
This should be achievable with the 3mm x 3mm MLPD-8 package using PCB copper area to aid in conducting the heat away from the device. Internal ground/power planes and air flow will also assist in removing heat.

**Outline Drawing — 3mm x 3mm MLPD-8**


DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	.031	.035	.039	0.80	0.90	1.00
A1	.000	.001	.002	0.00	0.02	0.05
A2	-	(.008)	-	-	(0.20)	-
b	.010	.012	.014	0.25	0.30	0.35
D	.114	.118	.122	2.90	3.00	3.10
D1	.085	-	.098	2.15	-	2.48
E	.114	.118	.122	2.90	3.00	3.10
E1	.053	-	.069	1.35	-	1.75
e	.026 BSC			0.65 BSC		
L	.012	.016	.020	0.30	0.40	0.50
N	8			8		
aaa	.003			0.08		
bbb	.004			0.10		

**NOTES:**

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS TERMINALS.

**Land Pattern — 3mm x 3mm MLPD-8**


DIMENSIONS		
DIM	INCHES	MILLIMETERS
C	(.116)	(2.95)
G	.087	2.20
H	.067	1.70
K	.102	2.58
P	.026	0.65
X	.016	0.40
Y	.030	0.75
Z	.146	3.70

**NOTES:**

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.
3. THERMAL VIAS IN THE LAND PATTERN OF THE EXPOSED PAD SHALL BE CONNECTED TO A SYSTEM GROUND PLANE. FAILURE TO DO SO MAY COMPROMISE THE THERMAL AND/OR FUNCTIONAL PERFORMANCE OF THE DEVICE.

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