SC1456

Dual 150mA Ultra Low Dropout, Low Noise Regulator

POWER MANAGEMENT

Description

The SC1456 contains two low dropout linear regulators that operate from a +2.5V to +6V input range and deliver up to 150mA. PMOS pass transistors allow a low 110μA supply current per device to remain independent of load, making these devices ideal for battery operated portable equipment such as cellular phones, cordless phones and personal digital assistants.

Each device can be powered from a separate supply voltage or the same supply voltage for maximum flexibility. The output voltage of each device can be preset or adjusted with an external resistor divider. Other features include independant low powered shutdown, short circuit protection, thermal shutdown protection and reverse battery protection for each regulator. The SC1456 comes in the tiny 10 lead MSOP package.

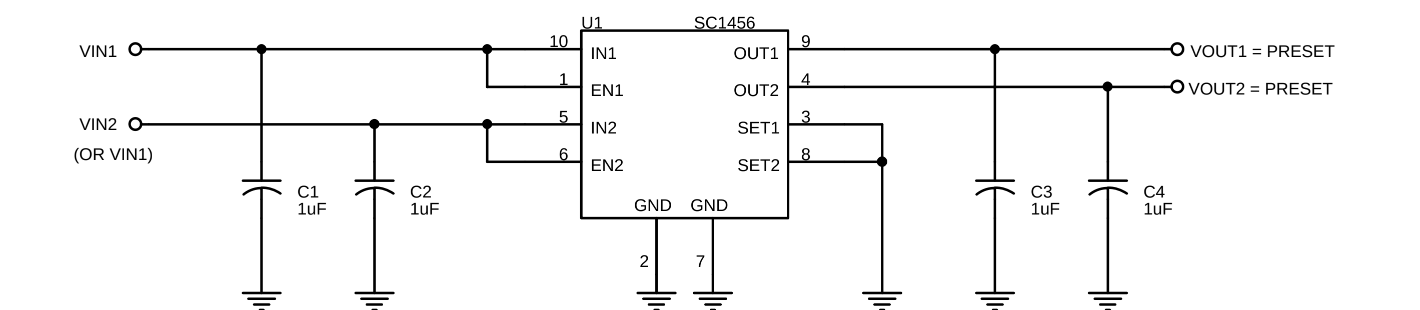
Features

- Two guaranteed 150 mA outputs
- Designed to operate with ceramic capacitors
- Fixed or adjustable outputs
- Very small external components
- Low 75μV_{RMS} output noise
- Very low supply currents
- Thermal overload protection
- Reverse battery protection
- Individual low power shutdown
- Full industrial temperature range
- Surface mount packaging (10 pin MSOP)

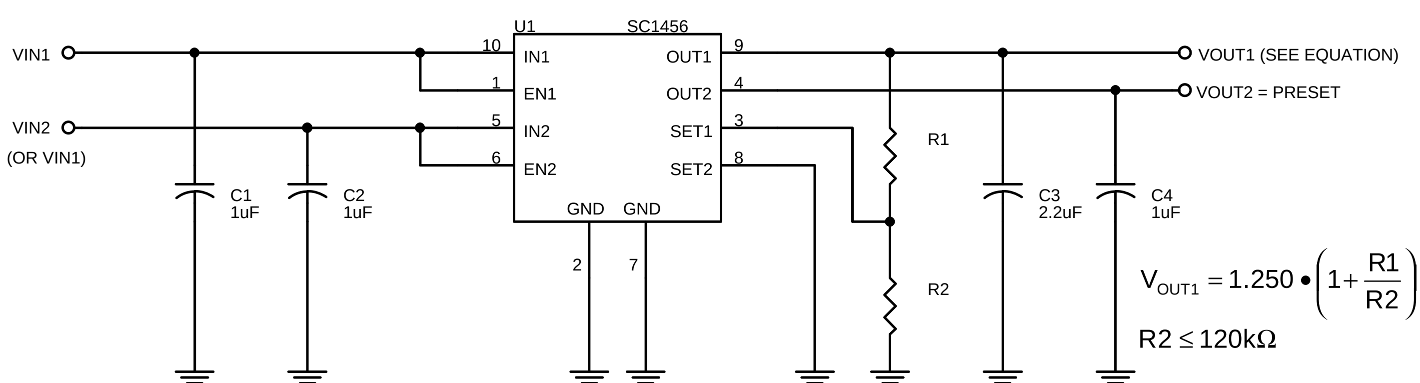
Applications

- Battery Powered Systems
- Cellular Telephones
- Cordless Telephones
- Personal Digital Assistants
- Portable Instrumentation
- Modems
- PCMCIA cards

Typical Application Circuits



Output Voltages Set Internally



$$V_{OUT1} = 1.250 \bullet \left(1 + \frac{R1}{R2}\right)$$

$R2 \leq 120k\Omega$

Output 1 Set Externally and Output 2 Set Internally

Absolute Maximum Ratings

Parameter	Symbol	Maximum	Units
Input Supply Voltage	V_{IN}	-0.3 to +7	V
Thermal Resistance, Junction to Ambient	θ_{JA}	113	°C/W
Thermal Resistance, Junction to Case	θ_{JC}	42	°C/W
Operating Ambient Temperature Range	T_A	-40 to +85	°C
Operating Junction Temperature Range	T_J	-40 to +125	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C
Lead Temperature (Soldering) 10 sec	T_{LEAD}	300	°C
ESD Rating	V_{ESD}	1.25	kV

Electrical Characteristics(1)

Unless specified: V_{INx} = 3.6V, V_{SETx} = GND, V_{ENx} = 3.6V, T_A = 25°C. Values in **bold** apply over full operating ambient temperature range.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
IN1, IN2						
Supply Voltage Range	V_{IN}		**2.5**		**6.0**	V
Supply Current	I_Q	I_{OUT} = 0mA		90	130	µA
					160	
		50mA ≤ I_{OUT} ≤ 150mA		110	160	µA
					200	
		V_{EN} = 0V		0.0001	1	µA
					2	
OUT1, OUT2						
Output Voltage(2)	V_{OUT}	I_{OUT} = 1mA	-2.0%	V_{OUT}	+2.0%	V
		1mA ≤ I_{OUT} ≤ 150mA, V_{OUT} + 1V ≤ V_{IN} ≤ 5.5V	**-3.5%**		**+3.5%**	
Line Regulation(2)	$REG_{(LINE)}$	2.5V ≤ V_{IN} ≤ 5.5V, V_{SET} = V_{OUT}, I_{OUT} = 1mA		5	10	mV
					12	
Load Regulation(2)	$REG_{(LOAD)}$	I_{OUT} = 0mA to 50mA		-10	-15	mV
					-20	
		I_{OUT} = 0mA to 100mA		-15	-20	mV
					-25	

Electrical Characteristics (Cont.)(1)

Unless specified: V_{INx} = 3.6V, V_{SETx} = GND, V_{ENx} = 3.6V, T_A = 25°C. Values in **bold** apply over full operating ambient temperature range.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Load Regulation (Cont.)(2)	$REG_{(LOAD)}$	I_{OUT} = 0mA to 50mA, V_{SET} = V_{OUT}		-2.5	-7.5	mV
					-15.0	
		I_{OUT} = 0mA to 100mA, V_{SET} = V_{OUT}		-5	-15	mV
					-30	
Dropout Voltage(2)(3)	V_D	I_{OUT} = 1mA		1.1		mV
		I_{OUT} = 50mA		55	90	mV
					120	
		I_{OUT} = 100mA		110	180	mV
					240	
Current Limit	I_{LIM}		**150**	240	**350**	mA
Output Voltage Noise	e_n	10Hz to 99kHz, I_{OUT} = 50mA, C_{OUT} = 1µF		90		$µV_{RMS}$
		10Hz to 99kHz, I_{OUT} = 50mA, C_{OUT} = 100µF		75		
Power Supply Rejection Ratio	PSRR	f = 120Hz		55		dB
EN1, EN2						
EN Input Threshold	V_{IH}		**1.8**			V
	V_{IL}				**0.4**	
EN Input Bias Current(4)	I_{EN}	V_{EN} = V_{IN}		0	100	nA
					200	
SET1, SET2						
Sense/Select Threshold	V_{TH}		**20**	55	**80**	mV
SET Reference Voltage(2)	V_{SET}	I_{OUT} = 1mA	1.225	1.250	1.275	V
		1mA ≤ I_{OUT} ≤ 150mA, 2.5V ≤ V_{IN} ≤ 5.5V	**1.206**		**1.294**	
SET Input Leakage Current(4)	I_{SET}	V_{SET} = 1.3V		0.015	2.500	nA
					5.000	
Over Temperature Protection						
High Trip Level	T_{HI}			170		°C
Hysteresis	T_{HYST}			10		°C

Notes:

(1) This device is ESD sensitive. Use of standard ESD handling precautions is required.

(2) Low duty cycle pulse testing with Kelvin connections required.

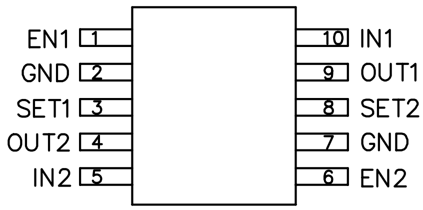
(3) Defined as the input to output differential at which the output voltage drops 100mV below the value measured at a differential of 2V.

(4) Guaranteed by design.

POWER MANAGEMENT

Pin Configuration

Top View



MSOP-10

Ordering Information

Part Number	Package
SC1456XIMSTR(1)(2)	MSOP-10

Notes:

(1) Where X denotes voltage options - see table below. Consult factory for other voltage options.

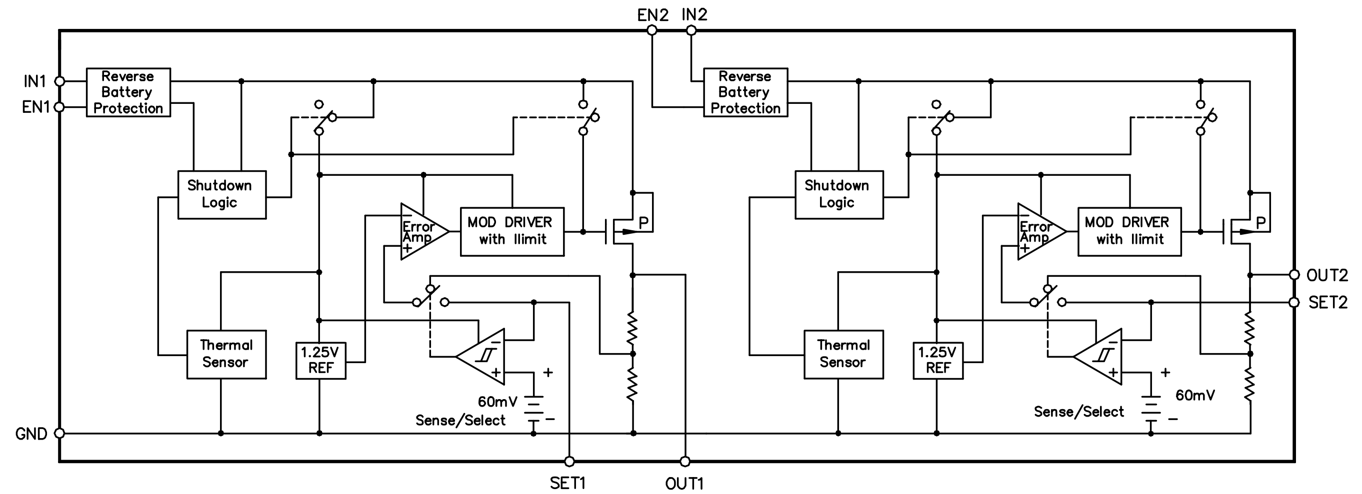
(2) Only available in tape and reel packaging. A reel contains 2500 devices.

Voltage Options

Replace X in the part number (SC1456XIMSTR) by the letter shown below for the corresponding voltage options:

X	V_{OUT1} (V)	V_{OUT2} (V)
A	2.5	2.5
B	2.8	2.8
C	3.0	3.0
D	3.3	3.3

Block Diagram

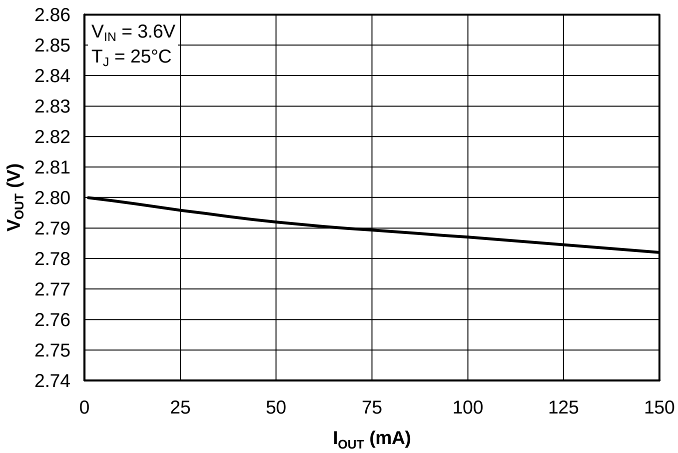


Pin Descriptions

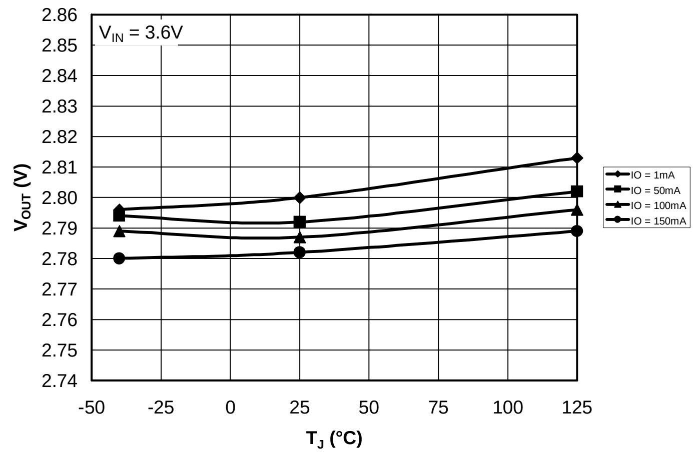
Pin	Pin Name	Pin Function
1	EN1	Active high enable pin for device 1. Connect to V_{IN1} if not being used.
2	GND	Ground pin. Can be used for heatsinking if needed. Electrically connected to pin 7.
3	SET 1	Connecting this pin to ground results in the internally preset value for V_{OUT1}. Connecting to an external resistor divider changes V_{OUT1} to: $V_{OUT1} = 1.250 \bullet \left(1 + \frac{R1}{R2}\right)$
4	OUT2	Regulator output for device 2, sourcing up to 150mA.
5	IN2	Supply input pin for device 2.
6	EN2	Active high enable pin for device 2. Connect to V_{IN2} if not being used.
7	GND	Ground pin. Can be used for heatsinking if needed. Electrically connected to pin 2.
8	SET2	Connecting this pin to ground results in the internally preset value for V_{OUT2}. Connecting to an external resistor divider changes V_{OUT2} to: $V_{OUT2} = 1.250 \bullet \left(1 + \frac{R1}{R2}\right)$
9	OUT1	Regulator output for device 1, sourcing up to 150mA
10	IN1	Supply input pin for device 1.

Typical Characteristics

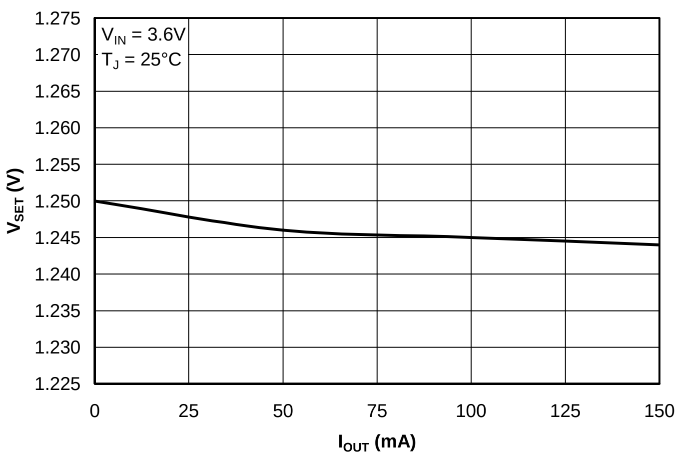
Output Voltage (2.8V) vs. Output Current



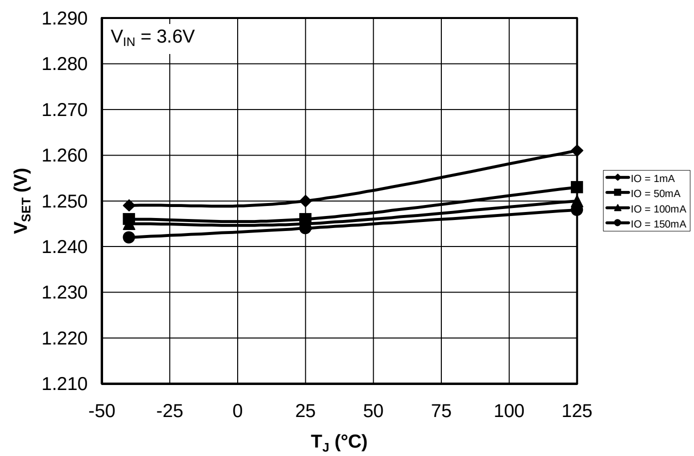
Output Voltage (2.8V) vs. Junction Temperature vs. Output Current



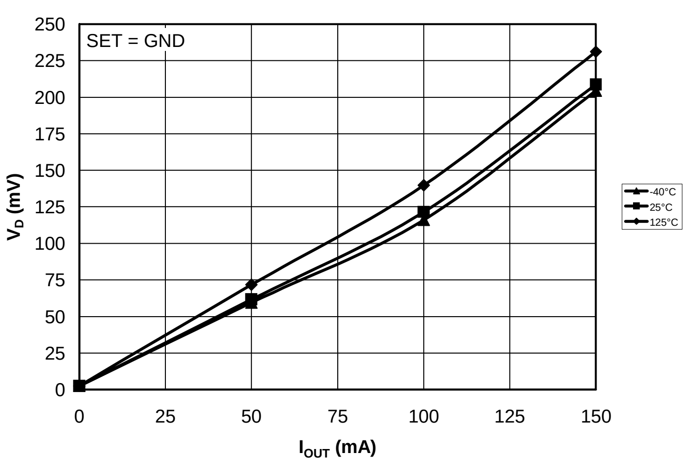
SET Reference Voltage vs. Output Current



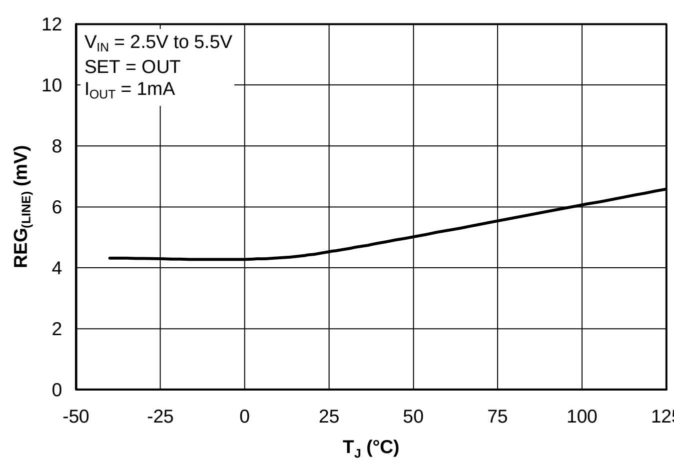
SET Reference Voltage vs. Junction Temperature vs. Output Current



Dropout Voltage vs. Output Current vs. Junction Temperature

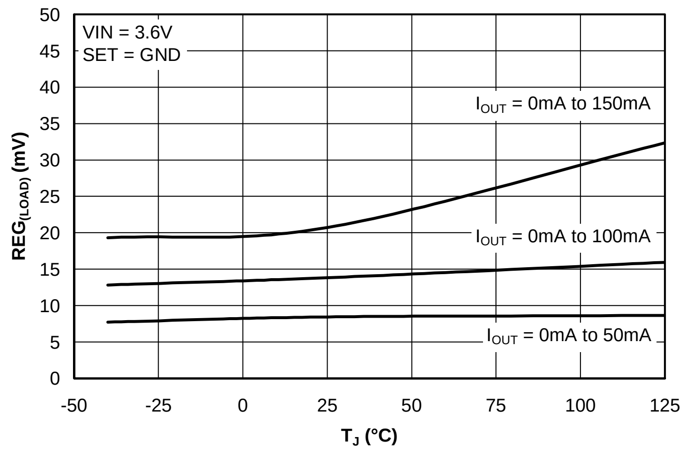


Line Regulation vs. Junction Temperature

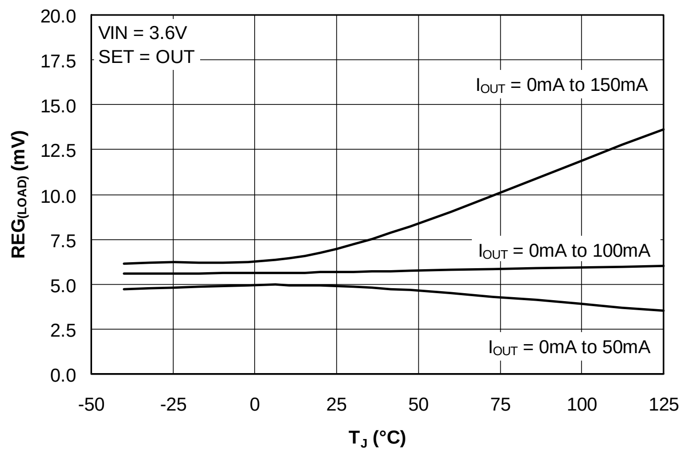


Typical Characteristics (Cont.)

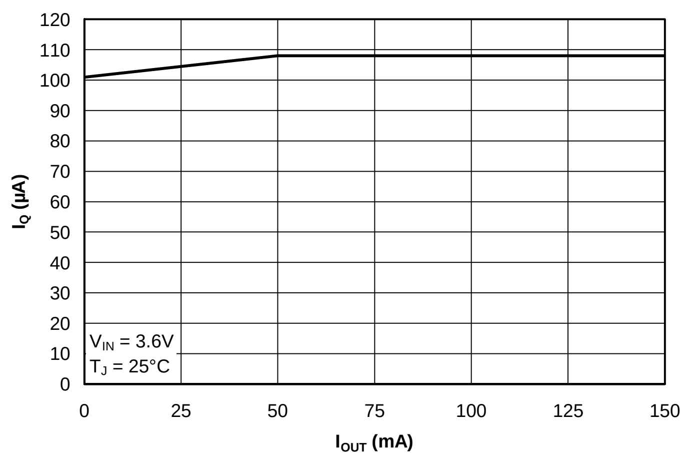
Load Regulation (V_{SET} = GND) vs. Junction Temperature



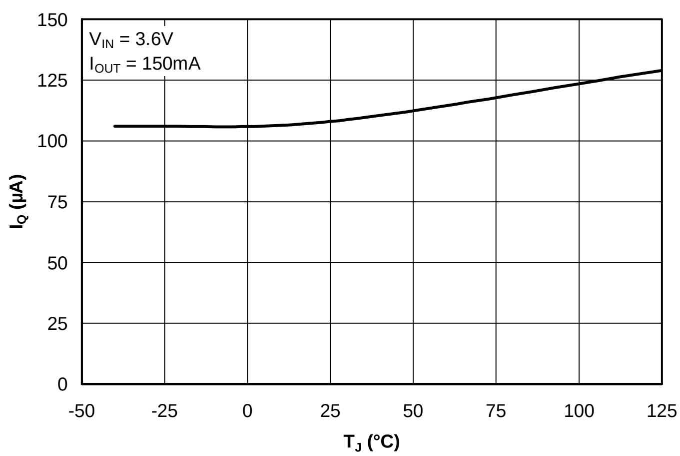
Load Regulation (V_{SET} = V_{OUT}) vs. Junction Temperature



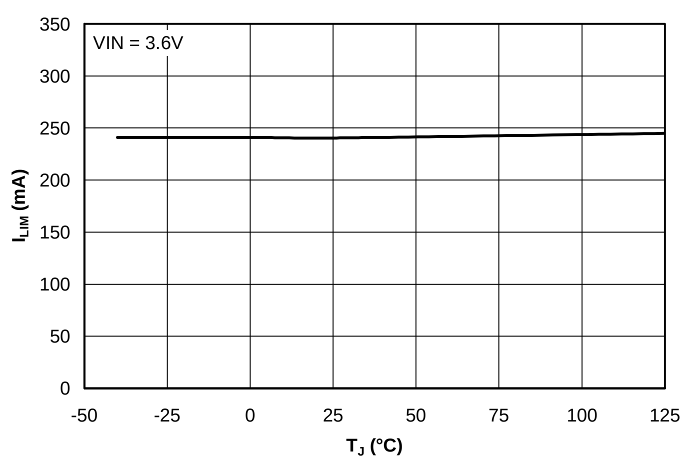
Supply Current vs. Output Current



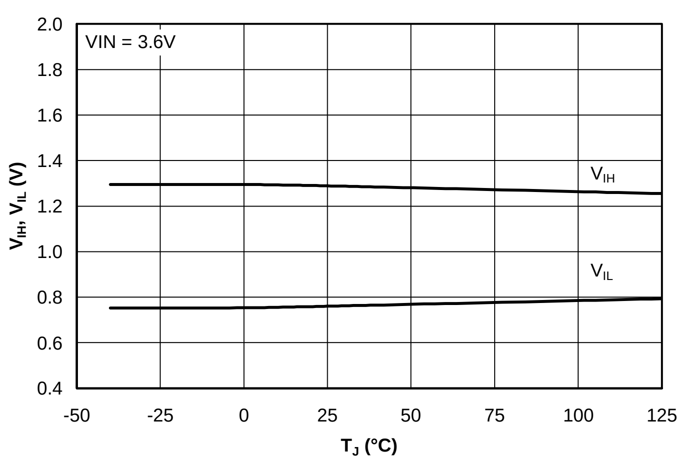
Supply Current vs. Junction Temperature



Current Limit vs. Junction Temperature

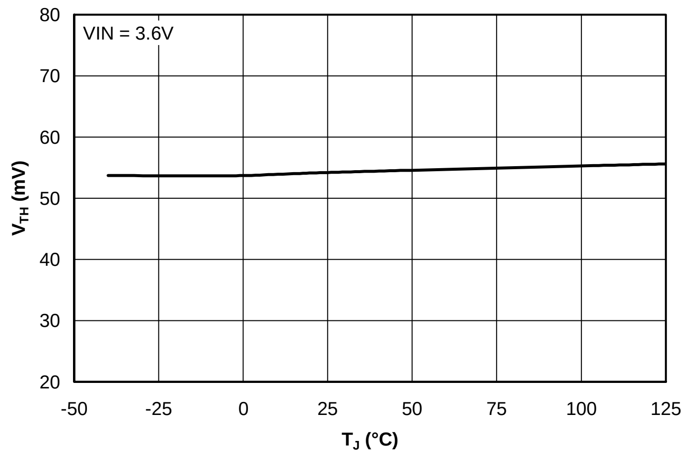


Enable Input Threshold vs. Junction Temperature

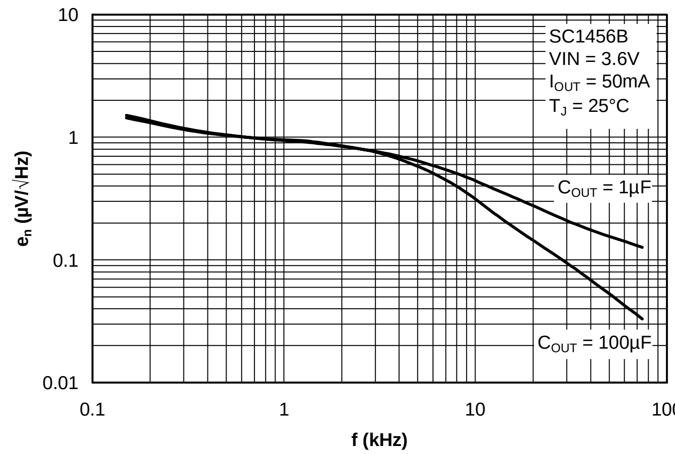


Typical Characteristics (Cont.)

Sense/Select Threshold vs. Junction Temperature



Output Spectral Noise Density vs. Frequency



Applications Information

Theory Of Operation

The SC1456 is intended for applications where very low dropout voltage, low supply current, low output noise and pcb real estate are critical. It provides a very simple, low cost solution for two seperate regulated outputs. Internally preset output voltage options require the use of only four external capacitors for operation.

Each regulator has both fixed and adjustable output voltage modes. Grounding the SET pin (pulling it below the Sense/Select threshold of 55mV) will connect the internal resistor divider of that regulator to the error amplifier resulting with the internally preset output voltage. If SET is pulled above this threshold, then the Sense/Select switch will connect the SET pin to the error amplifier. The output will be regulated such that the voltage at SET will equal V_{SET}, the SET reference voltage (typically 1.250V).

An active high enable pin (EN) is provided for each output to allow the customer to shut down that regulator and enter an extremely low power Off-state. A logic Low signal will reduce the regulator’s supply current to 0.1nA.

Component Selection - General

Output capacitor: Semtech recommends a minimum capacitance of 1µF at each output with an equivalent series resistance (ESR) of <1Ω over temperature. Ceramic capacitors are ideal for this application. Increasing the bulk capacitance will further reduce output noise and improve the overall transient response.

Input capacitor: Semtech recommends the use of a 1µF ceramic capacitor at each input. This allows for the device being some distance from any bulk capacitance on the rail. Additionally, input droop due to load transients is reduced, improving load transient response.

Component Selection - Externally Set Output

Please refer to Figure 1 on page 9. The output voltage of both outputs (OUT1 shown here) can be externally adjusted anywhere within the range from 1.25V to ($V_{IN(MIN)}$ - $V_{D(MAX)}$). The output voltage will be in accordance with the following equation:

$$V_{OUT} = 1.250 \bullet \left(1 + \frac{R1}{R2}\right)$$

1% tolerance resistors are recommended. The values of R1 and R2 should be selected such that the current flow through them is ≥ 10µA (thus R2 ≤ 120kΩ). At high input voltages and/or high output currents, stability may be improved by increasing C2 to 2.2µF and reducing R2 to 10kΩ. See “Component Selection - General” for input capacitor requirements.

Applications Information (Cont.)

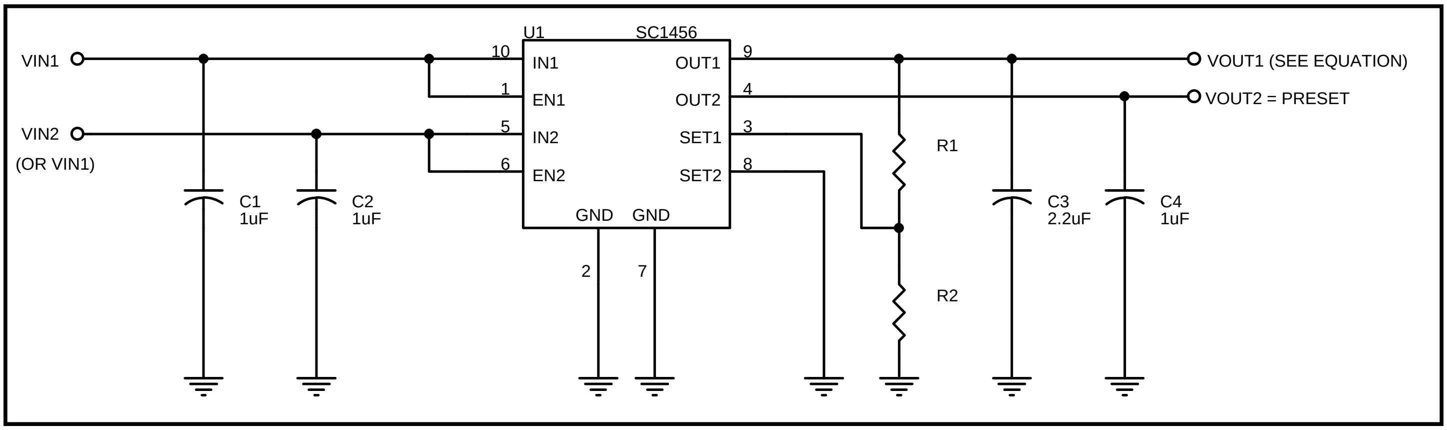


Figure 1: Output 1 Set Externally and Output 2 Set Internally

Thermal Considerations

The worst-case power dissipation for this part is given by:

$$P_{D(MAX)} = \left(V_{IN1(MAX)} - V_{OUT1(MIN)}\right) \bullet I_{OUT1(MAX)} + V_{IN1(MAX)} \bullet I_{Q1(MAX)}$$
$$+ \left(V_{IN2(MAX)} - V_{OUT2(MIN)}\right) \bullet I_{OUT2(MAX)}$$
$$+ V_{IN2(MAX)} \bullet I_{Q2(MAX)}$$

For all practical purposes, it can be reduced to:

$$P_{D(MAX)} = \left(V_{IN1(MAX)} - V_{OUT1(MIN)}\right) \bullet I_{OUT1(MAX)}$$
$$+ \left(V_{IN2(MAX)} - V_{OUT2(MIN)}\right) \bullet I_{OUT2(MAX)}$$

Looking at a typical application:

$V_{IN1(MAX)} = V_{IN2(MAX)} = 4.2V$
$V_{OUT1(MIN)} = V_{OUT2(MIN)} = (2.8V - 3.5\%) = 2.702V$ worst-case
$I_{OUT1} = I_{OUT2} = 100mA$
$T_A = 85°C$

This gives us:

$$P_{D(MAX)} = 2 \bullet (4.2 - 2.702) \bullet 0.100 = 300mW$$

Using this figure, we can calculate the maximum thermal impedance allowable to maintain $T_J \leq 125°C$:

$$\theta_{(J-A)(MAX)} = \frac{\left(T_{J(MAX)} - T_{A(MAX)}\right)}{P_{D(MAX)}} = \frac{(125 - 85)}{0.300} = 133°C/W$$

With the standard MSOP-10 Land Pattern shown at the end of this datasheet, and minimum trace widths, the thermal impedance junction to ambient for SC1456 is 113°C/W. Thus with no additional heatsinking, $T_{J(MAX)} = 119°C$.

The junction temperature can be reduced further by the use of larger trace widths, and connecting pcb copper area to the GND pins (pins 2 and 7), which connect directly to the device substrate. Lower junction temperatures improve overall output voltage accuracy.

Layout Considerations

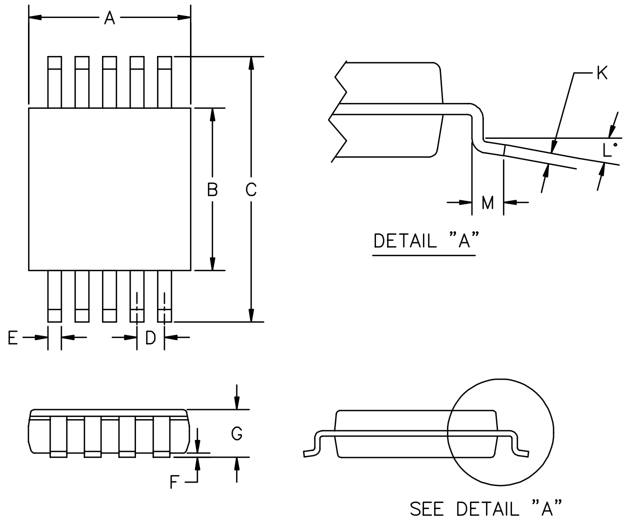
While layout for linear devices is generally not as critical as for a switching application, careful attention to detail will ensure reliable operation.

1) Attaching the part to a larger copper footprint will enable better heat transfer from the device, especially on PCBs where there are internal ground and power planes.

2) Place the input and output capacitors close to the device for optimal transient response and device behavior.

3) Connect all ground connections directly to the ground plane. If there is no ground plane, connect to a common local ground point before connecting to board ground.

Outline Drawing - MSOP-10

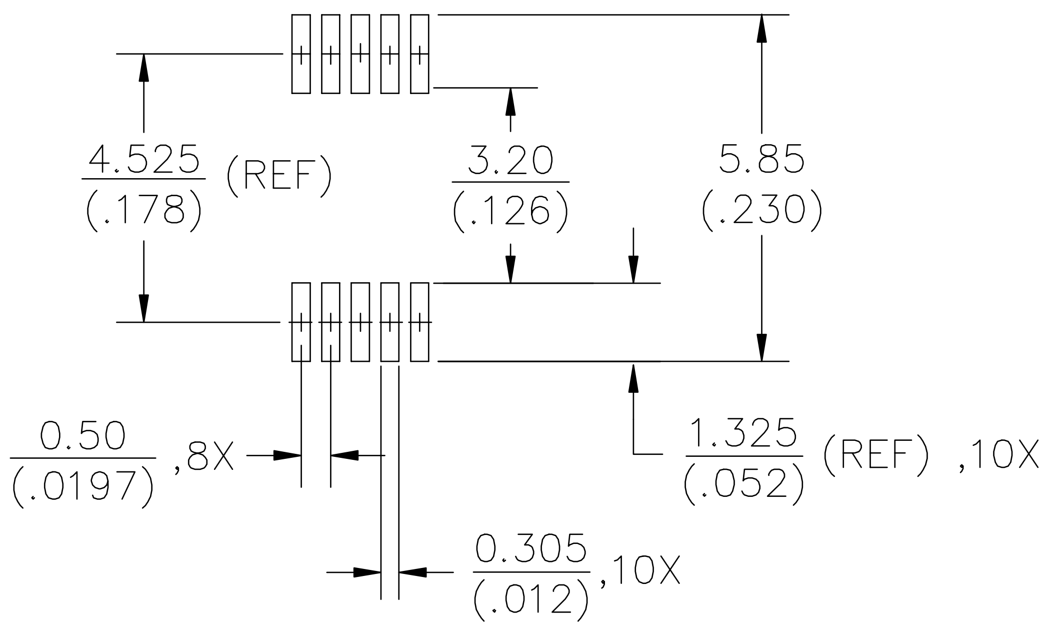


DIM	INCHES MIN	INCHES MAX	MM MIN	MM MAX	NOTE
A	.114	.122	2.90	3.10	
B	.114	.122	2.90	3.10	
C	.187	.199	4.75	5.05	
D	.020 BSC		.50 BSC		
E	.006	.012	.15	.30	
F	.002	.006	.05	.15	
G	–	.043	–	1.10	
K	.005	.009	.13	.23	
L	0°	6°	0°	6°	
M	.016	.028	.40	.70	

2 PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH AND METAL BURR.

1 CONTROLLING DIMENSIONS: MILLIMETERS.

Land Pattern - MSOP-10



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