SC1551
1.5 Amp Low Dropout Regulator With Reset And Enable

POWER MANAGEMENT

Description

The SC1551 high performance positive voltage regulator is designed for use in applications requiring low dropout performance at up to 1.5A. Additionally, the SC1551 provides excellent regulation over variations in line, load and temperature.

Similar to Semtech's popular EZ1086, the SC1551 includes extra features for maximum flexibility - a low power shutdown mode and a power-on reset output. The active high enable pin, when pulled low, shuts the regulator down so that it draws less than 10µA from the input supply. The power-on reset output remains asserted low until 175ms (typical) after the output voltage rises above the reset threshold. When the output drops below the reset threshold, reset asserts low within 20µs (typical).

Outstanding features include low dropout performance at rated current, fast transient response, internal current limiting and thermal shutdown protection of the output device.

The SC1551 is available with two standard output voltage options, 2.5V and 3.3V. It comes in the popular 5 pin TO-263 surface mount package.

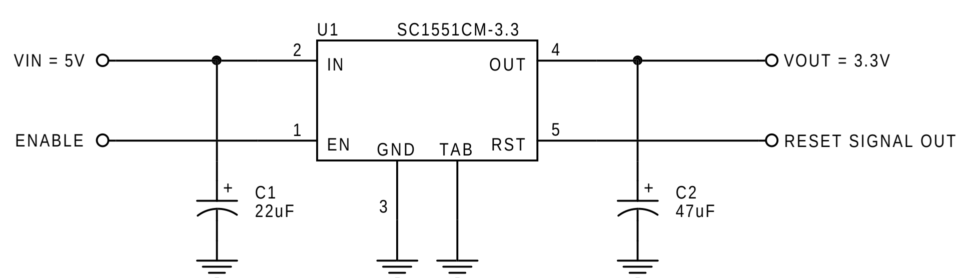
Features

- Low dropout voltage: 1.4V maximum
- Full current rating over line and temperature
- Fast transient response
- ±3% total output regulation over line, load and temperature
- Active high enable input
- Power-on reset output with 175ms (typical) delay
- Line regulation typically 0.015%
- Load regulation typically 0.05%
- TO-263-5 surface mount package

Applications

- Microcontroller power supplies
- Battery chargers
- Post regulators
- Battery chargers

Typical Application Circuit



Absolute Maximum Ratings

Parameter	Symbol	Maximum	Units
Maximum Input Pin Voltage	V_{IN}, V_{EN}	7	V
Power Dissipation	P_D	Internally Limited	W
Thermal Impedance Junction to Ambient	θ_{JA}	60	°C/W
Thermal Impedance Junction to Case	θ_{JC}	3	°C/W
Operating Ambient Temperature Range	T_A	0 to +70	°C
Operating Junction Temperature Range	T_J	0 to +125	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C
Lead Temperature (Soldering) 10 Seconds	T_{LEAD}	300	°C

Electrical Characteristics

Unless specified: 3.9V ≤ V_{IN} ≤ 7.0V (2.5V option, 4.7V ≤ V_{IN} ≤ 7.0V for the 3.3V option), V_{EN} = V_{IN}, 0A ≤ I_{OUT} ≤ 1.5A, T_A = 25°C.
Values in **bold** apply over full operating temperature range.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
IN						
Supply Voltage (2.5V option)	V_{IN}		**3.9**		**7.0**	V
Supply Voltage (3.3V option)	V_{IN}		**4.7**		**7.0**	V
Quiescent Current	I_Q			15	20	mA
					25	
Off State Quiescent Current	$I_{Q(OFF)}$	V_{IN} = 5V, V_{EN} = 0V		5	10	µA
					15	
OUT						
Output Voltage[1]	V_{OUT}	V_{IN} = 5V, I_{OUT} = 0mA	-1%	V_{OUT}	+1%	V
			-3%		**+3%**	
Line Regulation[1]	REG_{LINE}	V_{IN} = ($V_{OUT(NOM)}$ + 1.4V) to 7V, I_{OUT} = 0mA		0.015	0.100	%
					0.150	
Load Regulation[1]	REG_{LOAD}	V_{IN} = 5V, I_{OUT} = 0A to 1.5A		0.05	0.20	%
					0.30	
Dropout Voltage[1][2]	V_D	I_{OUT} = 1.5A		1.3	**1.4**	V

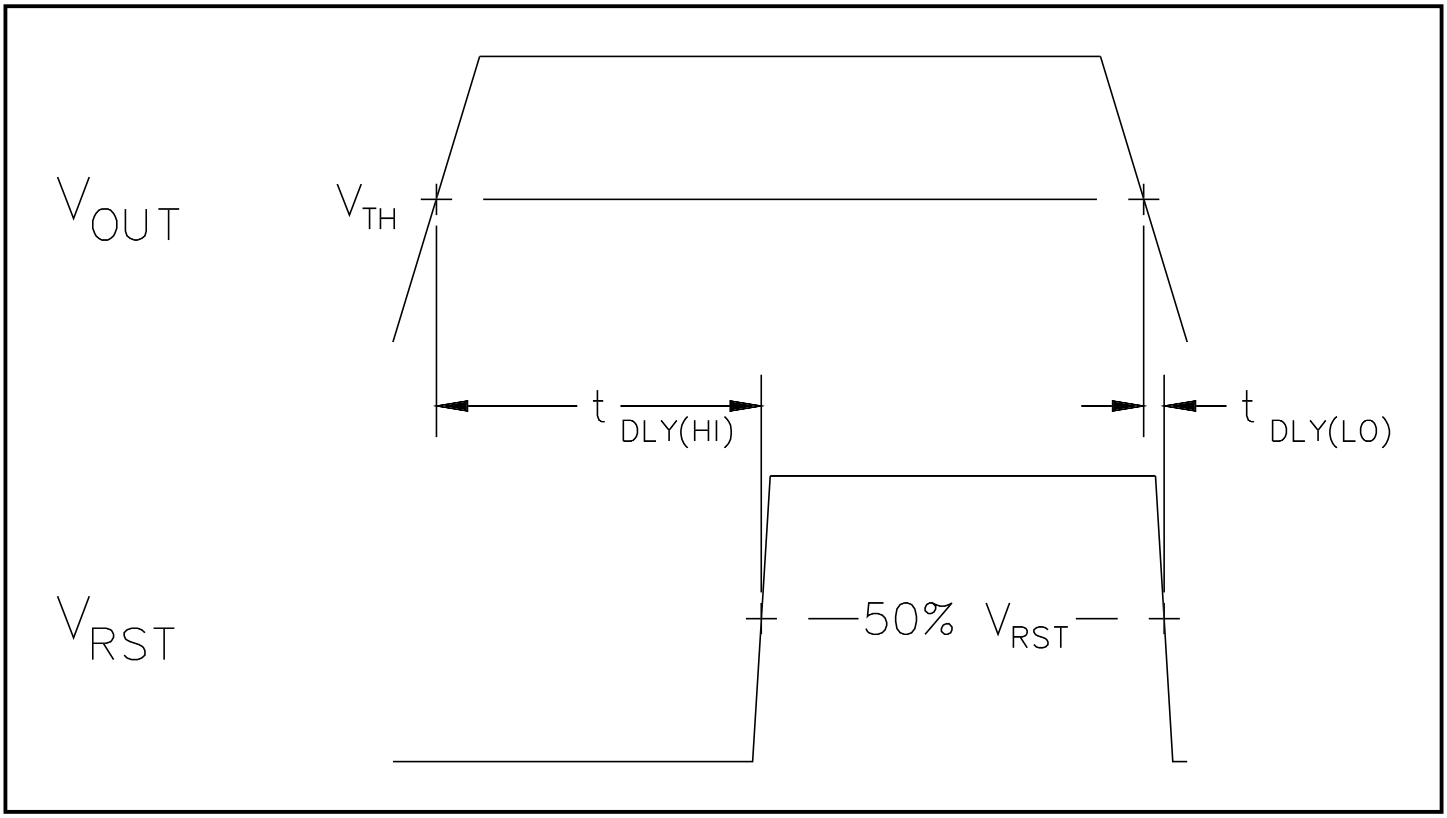
Electrical Characteristics (Cont.)

Unless specified: 3.9V ≤ V_{IN} ≤ 7.0V (2.5V option, 4.7V ≤ V_{IN} ≤ 7.0V for the 3.3V option), V_{EN} = V_{IN}, 0A ≤ I_{OUT} ≤ 1.5A, T_A = 25°C.
Values in **bold** apply over full operating temperature range.

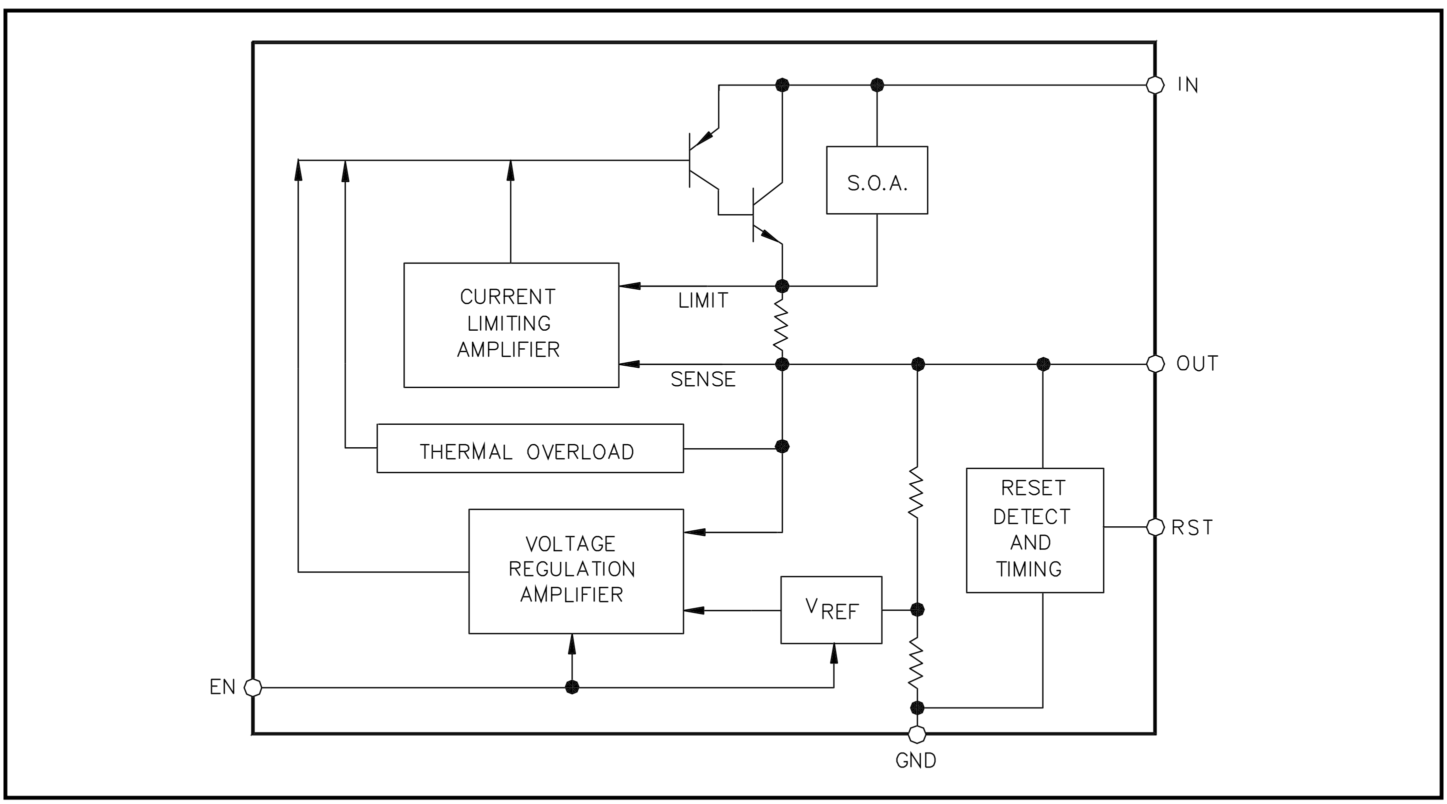
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
OUT (Cont.)						
Current Limit[1]	I_{CL}		**1.5**	2.5		A
Temperature Coefficient	T_C			**0.005**		%/°C
Temperature Stability	T_S	V_{IN} = 5V, I_{OUT} = 0.5A		**0.5**		%
RMS Output Noise	e_n	f = 10Hz to 10kHz		0.003		%V_{OUT}
Ripple Rejection Ratio	R_A	V_{IN} = 5V, f = 120Hz	**60**	**72**		dB
EN						
Enable Pin Control Voltage	V_{IL}	Device OFF			**0.4**	V
	V_{IH}	Device ON	**1.6**			
Enable Pin Current	I_{EN}	V_{EN} = 0V, V_{IN} = 5V (OFF)		0.15	**1.00**	µA
		V_{EN} = V_{IN} = 5V (ON)		35	**100**	
RST						
Reset Threshold	V_{TH}	V_{OUT} falling		93		%V_{OUT}
		V_{OUT} rising		94		
Reset Delay[3]	$t_{DLY(LO)}$	V_{OUT} falling		20		µs
	$t_{DLY(HI)}$	V_{OUT} rising	**140**	175	**560**	ms
Reset Output Voltage	V_{OL}	V_{OUT} ≤ V_{TH}, I_{RST} = -1.2mA		0.1	**0.2**	V
	V_{OH}	V_{OUT} = $V_{OUT(NOM)}$, I_{RST} = 500µA	**0.8V_{IN}**			V
OVER TEMPERATURE PROTECTION						
High Trip Level	T_{HI}			170		°C
Hysteresis	T_{HYST}			10		°C

Notes:
(1) Low duty cycle pulse testing with Kelvin connections required.
(2) ΔV_{OUT}, ΔV_{REF} = 1%.
(3) Reset delay is measured from (V_{OUT} = V_{TH}) to (V_{RST} = 50%) - see Timing Diagram on page 4.

Timing Diagram

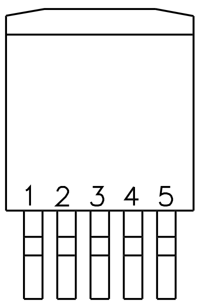


Block Diagram



Pin Configurations

Top View



TO-263-5

Pin	Function
1	EN
2	IN
3/TAB	GND
4	OUT
5	RST

Ordering Information

Part Number[(1)(2)]	Package
SC1551CM-X.XTR	TO-263-5

Notes:

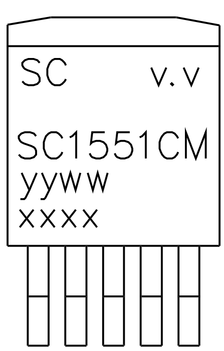
(1) Where X.X denotes voltage options. Available voltages are: 2.5V and 3.3V. Contact factory for additional voltage options.

(2) Only available in tape and reel packaging. A reel contains 800 devices.

Pin Descriptions

Pin	Pin Name	Pin Function
1	EN	Active high enable pin. Pulling this pin high will enable the output. While the device will be turned off if this pin is left open, it is recommended to pull it low to turn the device off for noise immunity. Connect to IN if not being used.
2	IN	Input supply pin.
3	GND	Ground pin. Electrically connected to the device tab.
4	OUT	Regulated output pin, sourcing up to 1.5A.
5	RST	Reset pin. Remains low while V_{OUT} is below the reset threshold, and for 175ms (typical) after V_{OUT} rises above the threshold. When V_{OUT} drops below the threshold, RST pulls low within 20µs (typical).

Marking Information



Top View

v.v = Voltage Option (Example: 2.5)

yyww = Datecode (Example: 0015)

xxxx = Semtech Lot No. (Example: 00101)

Theory Of Operation

The SC1551 is intended for applications requiring a regulated voltage capable of sourcing up to 1.5A. It has an enable input and power-on reset making it a "one chip solution" for microcontroller power supplies and other applications where a low power shutdown mode and output voltage monitoring might be required.

The SC1551 contains a bandgap reference trimmed for optimal temperature coefficient. The output voltage of the regulator is divided down internally using a resistor divider and compared to the bandgap voltage using an internal error amplifier. The error amplifier drives the base of a PNP transistor which in turn drives the base of the NPN pass device.

An active high enable pin (EN) allows the regulator to be shut down. Pulling this pin low causes the device to enter a very low power shutdown mode, where it will draw typically 1µA from the input supply. The enable pin is connected to the base of an NPN transistor, so when pulled low draws almost no current. If this pin is left open, the device will be disabled, however for better noise immunity it should be pulled low rather than left floating. Connect this pin to IN if the enable function is not being used.

A power-on reset pin (RST) is provided to indicate to the load that the output voltage is within specification. As the output voltage rises at turn-on, the reset pin will remain low until approximately 175ms after the output voltage rises above the Reset Threshold (V_{TH}, typically 94% of specified output voltage). After this Reset Delay, the reset pin will pull high to greater than 80% of the input voltage value. As the output voltage starts to fall, the reset pin will pull low within 20µs (typ.) once the Reset Threshold voltage (93% for V_{OUT} falling) is crossed. If the output voltage rises above the Reset Threshold once more, the Reset Delay timer will start again. The reset pin pulls high and low, therefore does not require any external pull-up or pull-down resistors. Leave this pin floating if the reset function is not being used. When the device is disabled, the reset pin function is disabled.

The regulator has its own current limit circuitry to ensure that the output current will not damage the device during output short, overload or start-up. The current limit is guaranteed to be greater than 1.5A to permit full current operation under all specified operating conditions.

The SC1551 includes thermal shutdown circuitry to turn off the device if T_J exceeds 170°C (typical), with the device remaining off until T_J drops by 10°C (typical).

Component Selection - General

Output capacitor - Semtech recommends a minimum capacitance of 10µF at the output with an equivalent series resistance (ESR) of > 50mΩ over temperature. If larger capacitors are used, the minimum ESR can be reduced to 25 mΩ with 100µF or greater. Ceramic capacitors should not be used. Increasing the bulk capacitance will improve the overall transient response.

Input capacitor - Semtech recommends the use of a minimum capacitance of 10µF at the output with an equivalent series resistance (ESR) of > 50mΩ over temperature. 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 overall load transient response.

Thermal Considerations

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

$$P_{D(MAX)} = \left(V_{IN(MAX)} - V_{OUT(MIN)}\right) \bullet I_{OUT(MAX)} + V_{IN(MAX)} \bullet I_{Q(MAX)} \qquad (1)$$

Looking at a typical application, 5V to 3.3V at 1A:
$V_{IN(MAX)}$ = 5 + 5% = 5.25V
$V_{OUT(MIN)}$ = 3.3V - 3% = 3.201V
$I_{Q(MAX)}$ = 25mA
I_{OUT} = 1A
T_A = 50°C

Inserting these values into equation (1) gives us:

$$P_{D(MAX)} = (5.25 - 3.201) \bullet 1 + 5.25 \bullet 0.025 = 2.18W$$

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

Applications Information (Cont.)

$$\theta_{JA(MAX)} = \frac{\left(T_{J(MAX)} - T_{A(MAX)}\right)}{P_{D(MAX)}} = \frac{(125-50)}{2.18} = 34°C/W$$

This thermal impedance can be achieved by attaching a copper area approximately 1.75” x 1.75” to the tab of the device on a single sided PCB.

The use of multi layer boards with internal ground/power planes will lower the junction temperature from the above example and improve overall output voltage accuracy. Forced air cooling of 100lfm or better will also decrease the total thermal impedance. For extreme power dissipation or very high ambient temperatures, surface mount heat sinks are available for the TO-263 package from suppliers such as Aavid.

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.

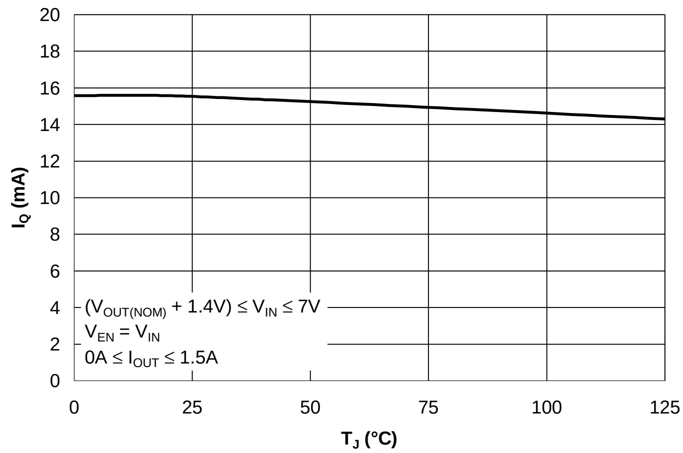
2) Place the input and output capacitors close to the device for optimal transient response and device behaviour.

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.

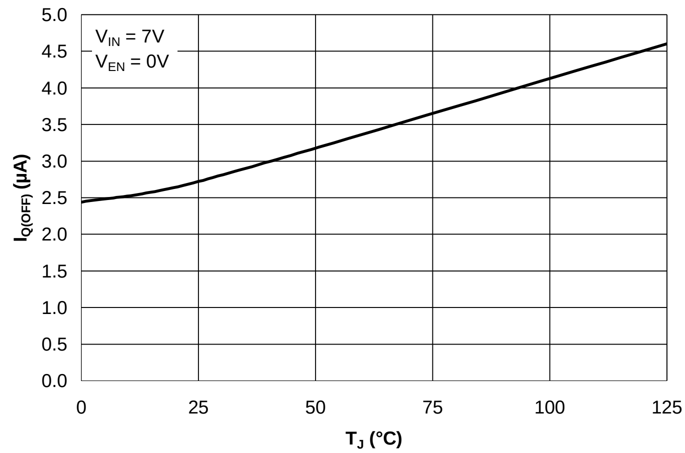
POWER MANAGEMENT

Typical Characteristics

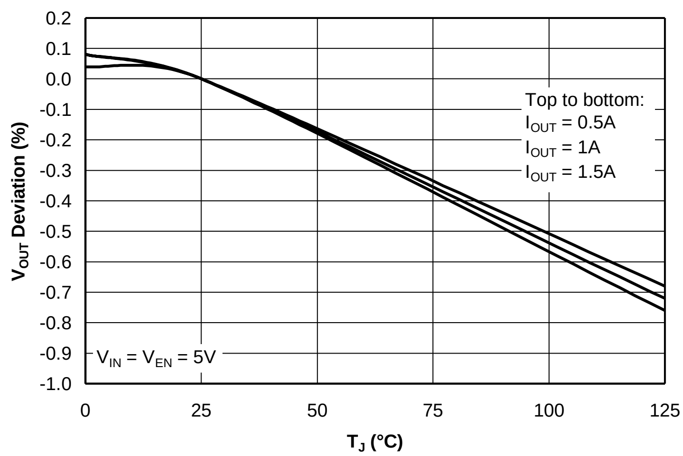
Quiescent Current vs. Junction Temperature



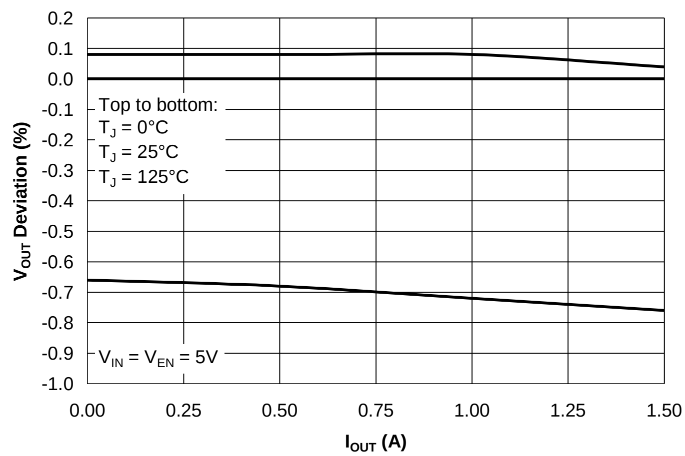
Off-State Quiescent Current vs. Junction Temperature



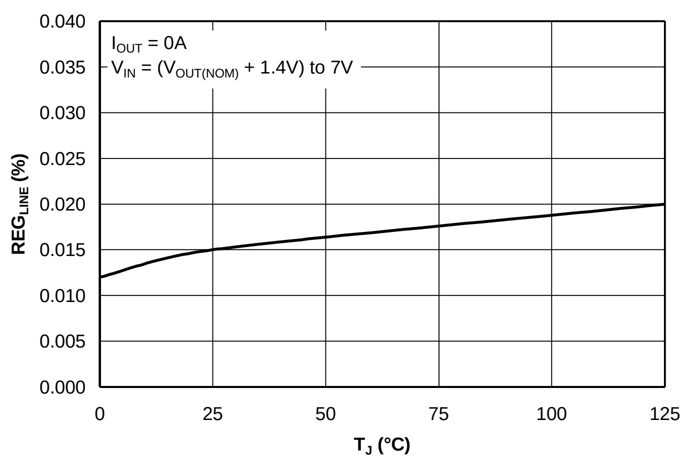
Output Voltage vs. Junction Temperature vs. Output Current



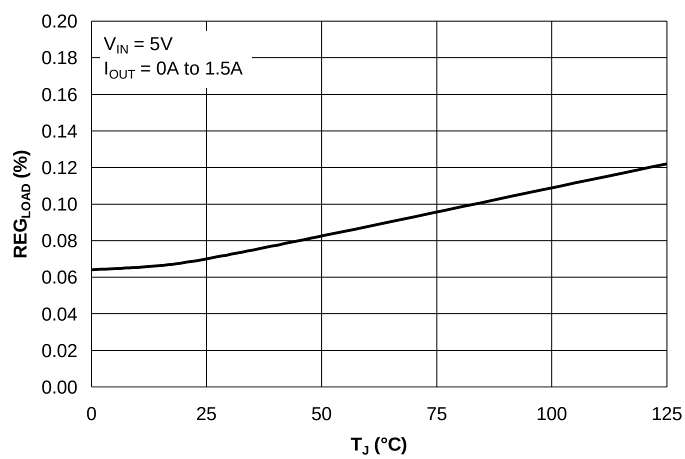
Output Voltage vs. Output Current vs. Junction Temperature



Line Regulation vs. Junction Temperature

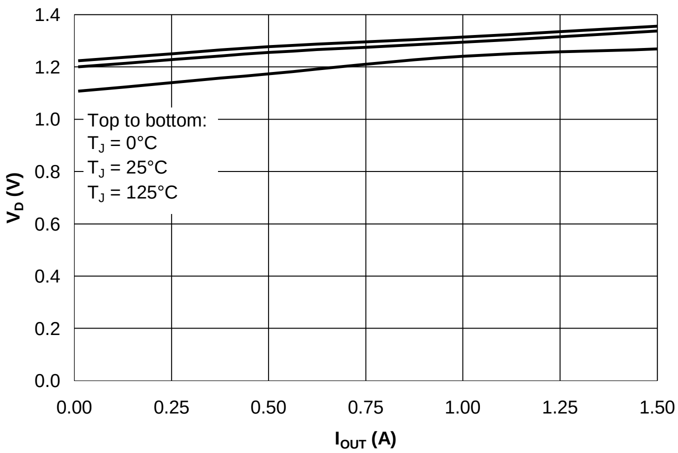


Load Regulation vs. Junction Temperature

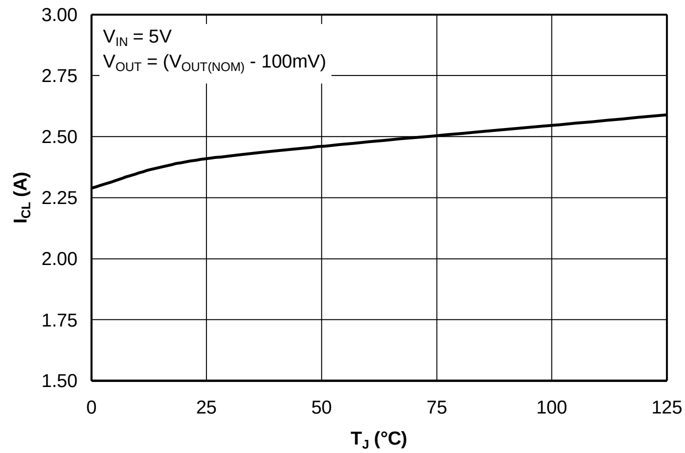


Typical Characteristics (Cont.)

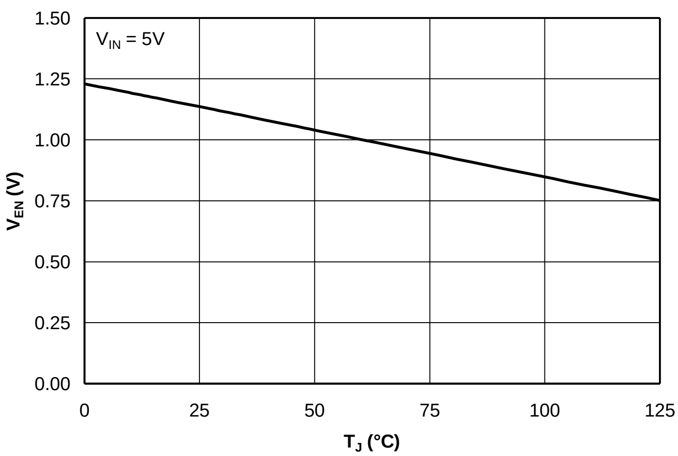
Dropout Voltage vs. Output Current vs. Junction Temperature



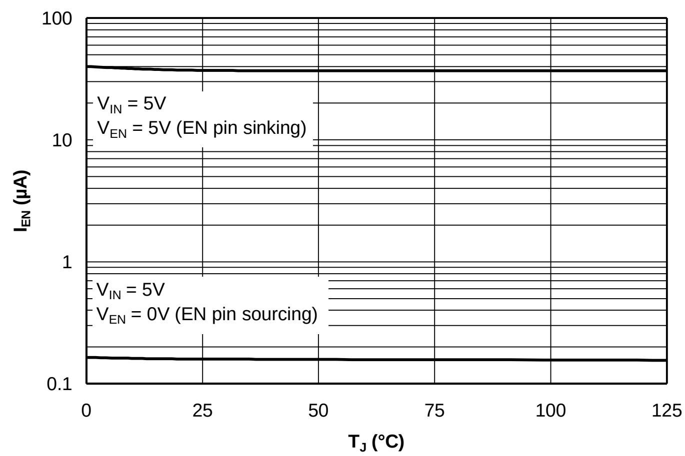
Current Limit vs. Junction Temperature



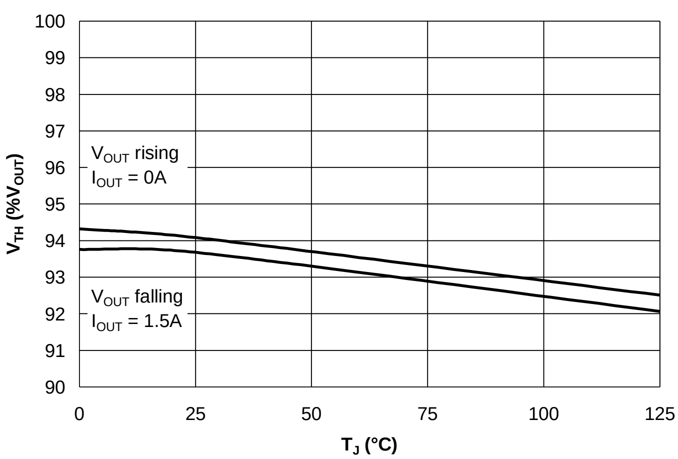
Enable Pin Control Voltage vs. Junction Temperature



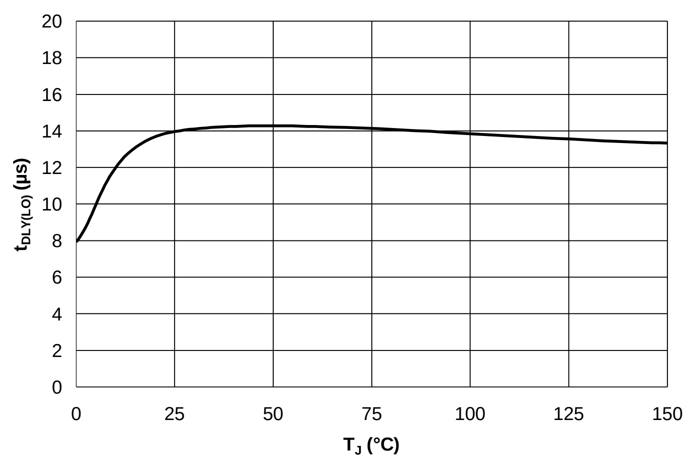
Enable Pin Current vs. Junction Temperature



Reset Threshold vs. Junction Temperature

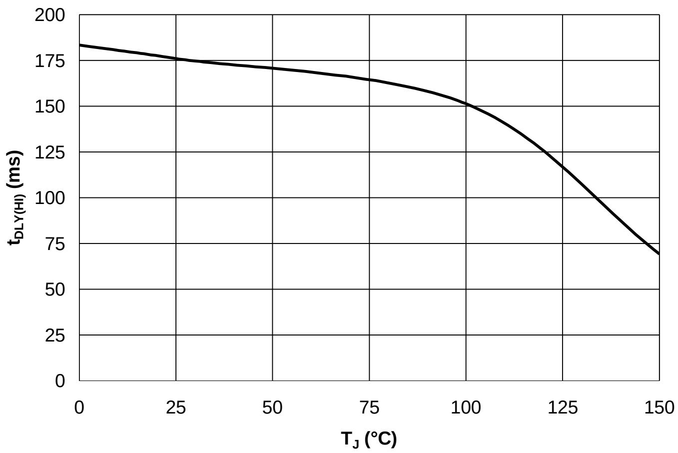


Reset Delay (V_{OUT} falling) vs. Junction Temperature

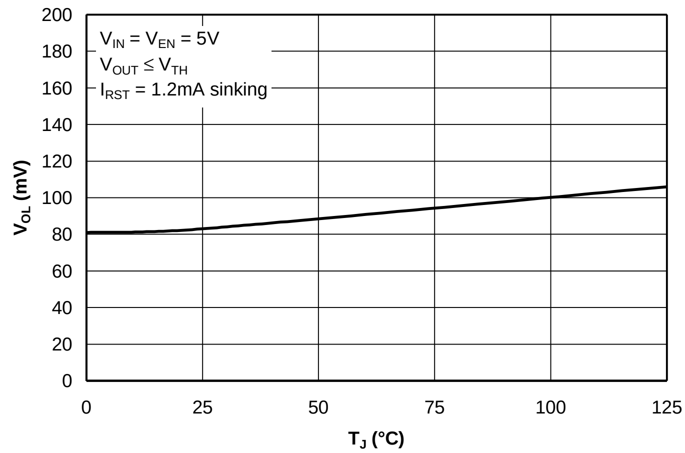


Typical Characteristics (Cont.)

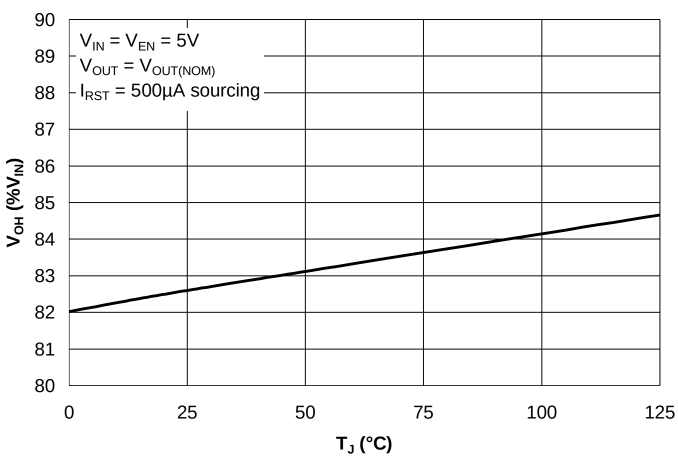
Reset Delay (V_{OUT} rising) vs. Junction Temperature



Reset Low Output Voltage vs. Junction Temperature

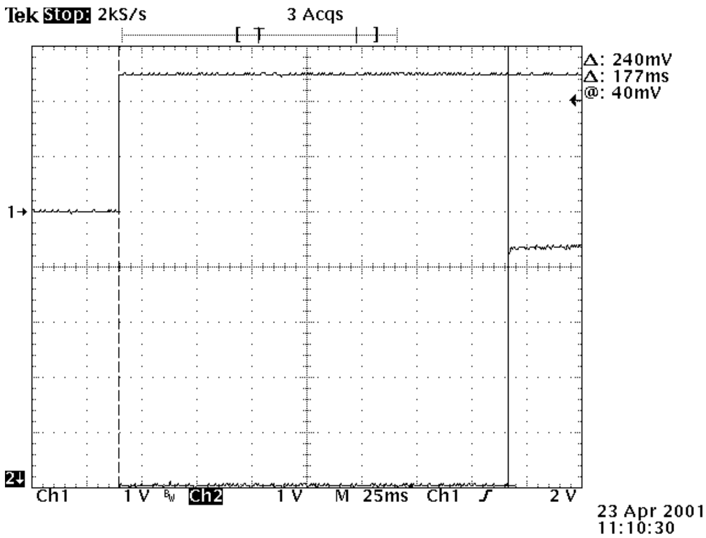


Reset High Output Voltage vs. Junction Temperature



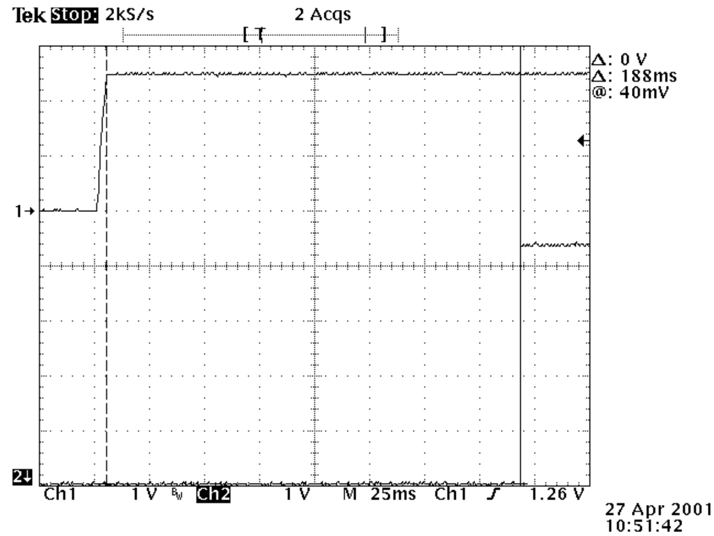
Typical Characteristics (Cont.)

Reset Delay, V_{OUT} Rising, $t_{DLY(HI)}$



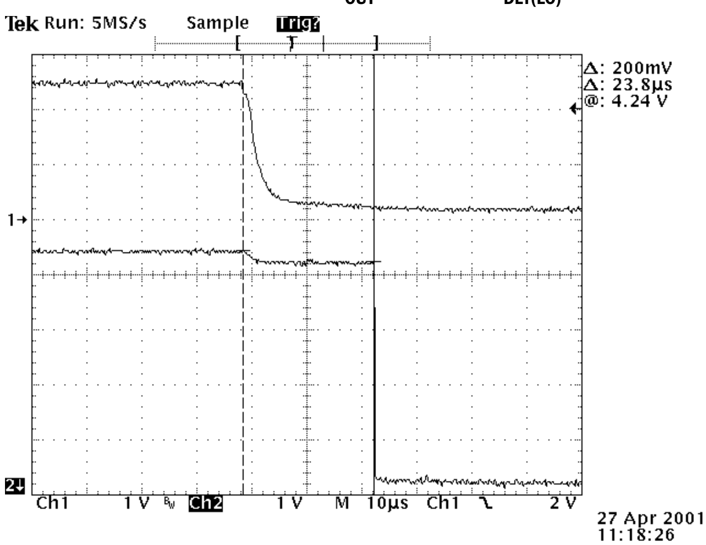
Trace 1: V_{OUT}, 1V/div., 2.5V option shown
Trace 2: V_{RST}, 1V/div.
Timebase: 25ms/div
V_{IN} = 5V, EN stepping from 0V to V_{IN}
$t_{DLY(HI)} \approx$ 177ms

Reset Delay, V_{OUT} Rising, $t_{DLY(HI)}$



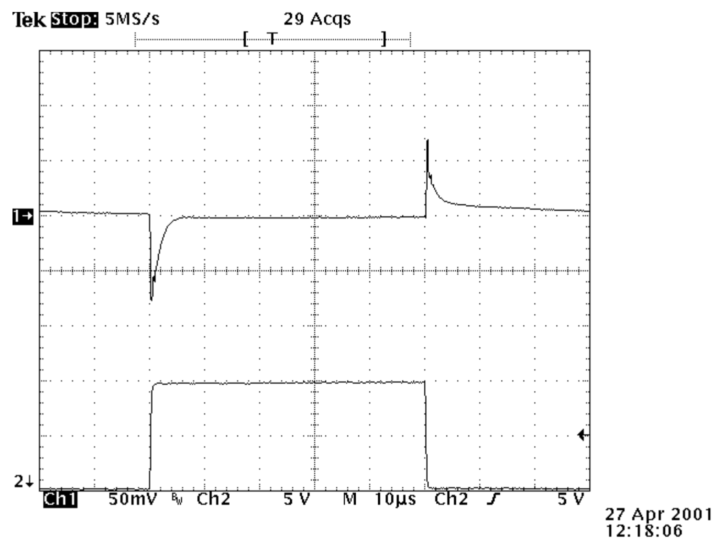
Trace 1: V_{OUT}, 1V/div., 2.5V option shown
Trace 2: V_{RST}, 1V/div.
Timebase: 25ms/div
V_{IN} = V_{EN}, ramping from 0V to 5V in 10ms
$t_{DLY(HI)} \approx$ 188ms

Reset Delay, V_{OUT} Falling, $t_{DLY(LO)}$



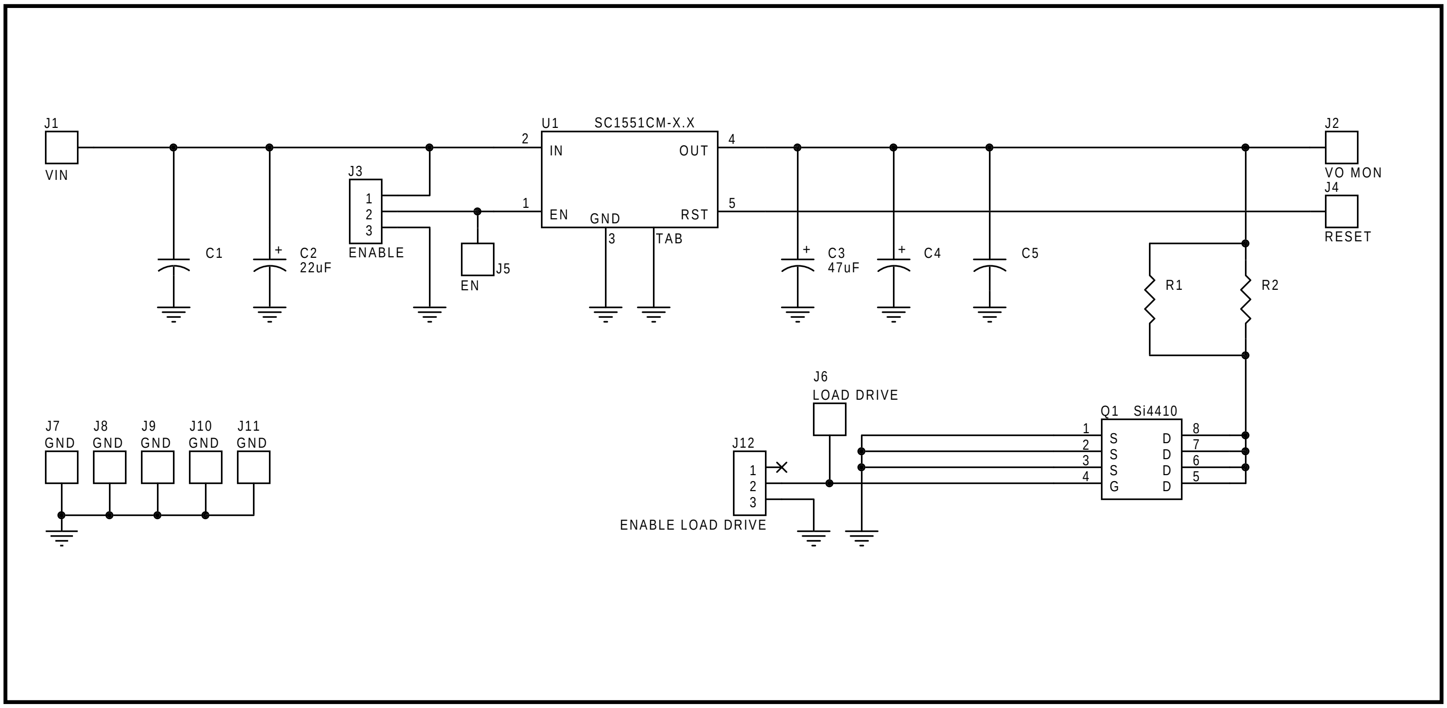
Trace 1: V_{OUT}, 1V/div., 2.5V option shown
Trace 2: V_{RST}, 1V/div.
Timebase: 10μs/div
V_{OUT} shorted to pull output below V_{TH}
$t_{DLY(LO)} \approx$ 24μs
Note: 0.2V droop in V_{RST} due to drop in input voltage when output is shorted

Transient Load Response



Trace 1: V_{OUT}, 50mV/div., dc coupled, offset 2.5V
Trace 2: load FET gate drive, 5V/div.
Timebase: 10μs/div
I_{OUT} stepping from 10mA to 1.51A at 10kHz, 50% duty cycle
C_{IN} = 33μF tantalum, C_{OUT} = 100μF tantalum + 1μF ceramic

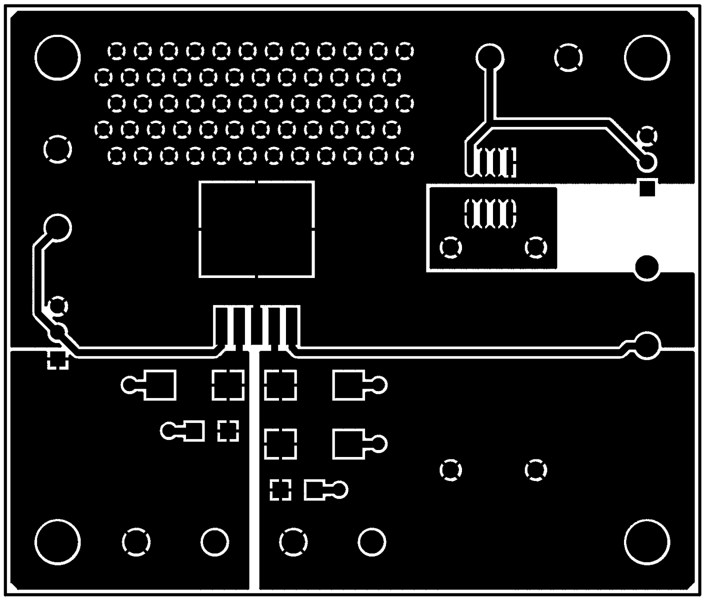
Evaluation Board Schematic



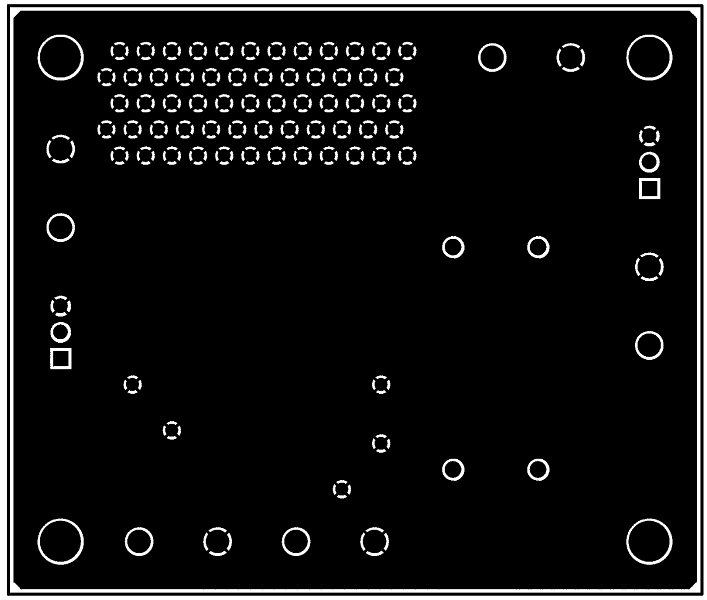
Evaluation Board Bill of Materials

Quantity	Reference	Part/Description	Vendor	Notes
3	C1, C4, C5	Not placed		
1	C2	22µF, 10V tantalum	Various	
1	C3	47µF, 6.3V tantalum	Various	
2	J1, J2	Test pin	Various	Red
2	J3, J12	Header, 3 pin	Various	
1	J4	Test pin	Various	Yellow
1	J5	Test pin	Various	White
1	J6	Test pin	Various	Orange
5	J7 - J11	Test pin	Various	Black
1	Q1	Si4410	Vishay	
2	R1, R2	See next page	Various	
1	U1	**SC1551CM-X.X**	Semtech	

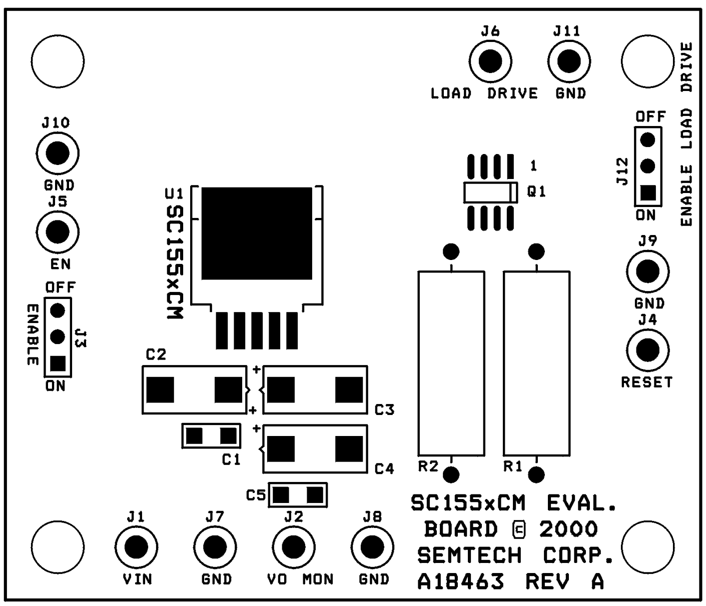
Evaluation Board Gerber Plots



Top Copper



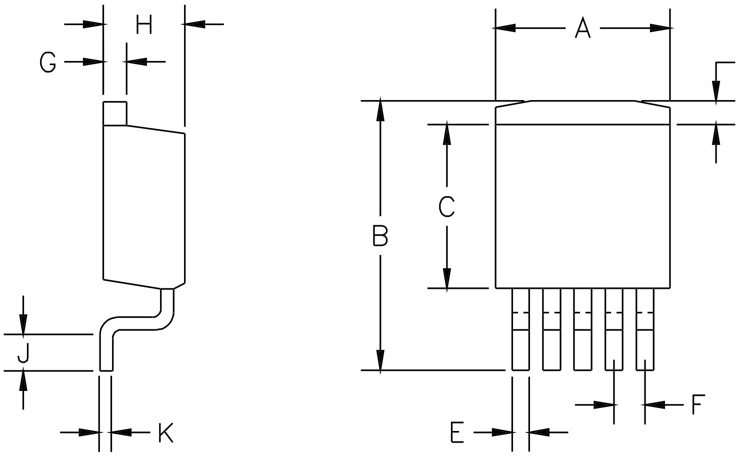
Bottom Copper



Top Silk Screen

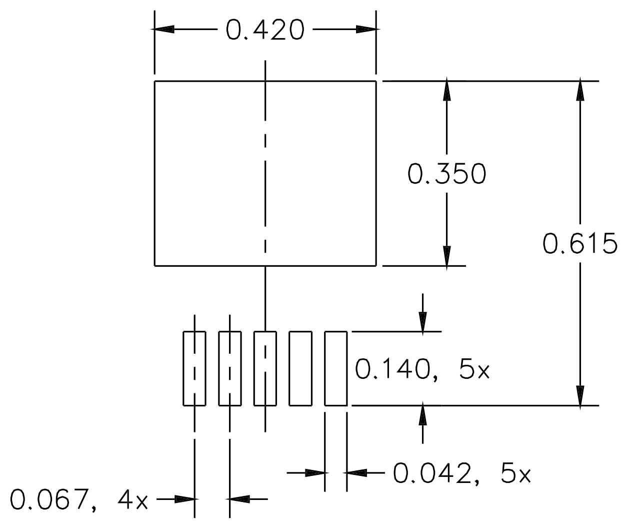
Output Voltage Option (V)	R1, R2 Value / Size
2.5	3.3Ω / 3W
3.3	4.3Ω / 3W

Outline Drawing - TO-263-5



DIM	DIMENSIONS INCHES MIN	INCHES MAX	MM MIN	MM MAX	NOTE
A	.380	.405	9.65	10.29	–
B	.575	.625	14.60	15.88	–
C	.325	.380	8.25	9.66	–
D	–	.055	–	1.40	–
E	.020	.039	.50	.99	–
F	.060	.072	1.52	1.83	–
G	.045	.055	1.14	1.40	–
H	.160	.190	4.06	4.83	–
J	.090	.110	2.28	2.80	–
K	.018	.029	.457	.736	–

Minimum Land Pattern - TO-263-5



NOTE: ALL DIMENSIONS ARE IN INCHES

Contact Information

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