SC573

300mA Low-Noise LDO Regulator

Features

- Input voltage range — 2.3V to 5.5V
- Single 300mA (maximum) output
- Dropout at 300mA load — 180mV (Typ)
- Quiescent supply current — 50µA
- Shutdown current — 100nA
- Output noise — 100µV$_{RMS}$/V
- Over-temperature protection
- Short-circuit protection
- Under-voltage lockout
- Internal 100Ω output discharge
- SC70-5 Package

Applications

- LoRa® sensors, nodes and gateways
- IoT low power radio applications
- Consumer electronics
- Wearable & Portable electronics
- GPS devices
- Set top boxes/HDTVs
- Communication electronics
- Industrial electronics

Description

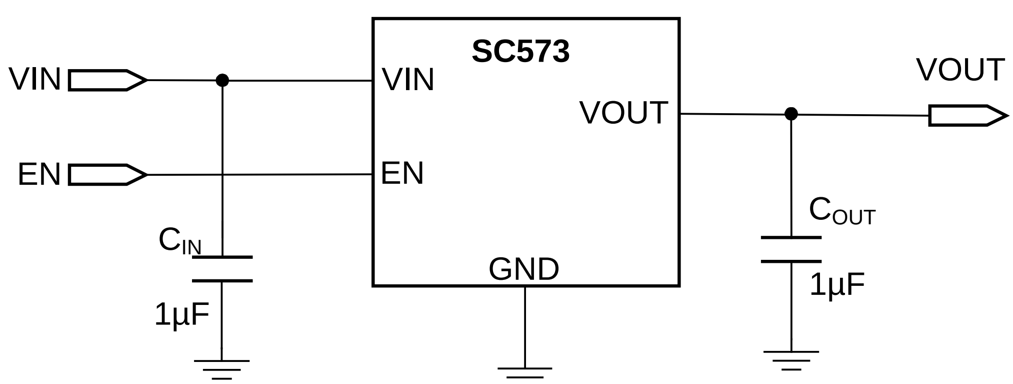
SC573 is a low dropout linear voltage regulator designed for use in applications with space constraints and low power requirements. SC573 provides fixed output voltages, delivering up to 300mA of load current. Fixed output voltage eliminates the need for external feedback resistors.

The device has an input, output and enable pin. Using the lowest possible input voltage for the output voltage reduces the power loss and improves overall package thermal performance and efficiency.

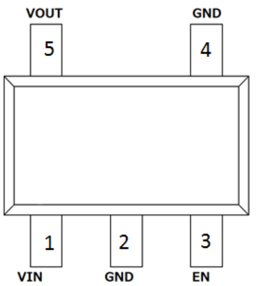
The device has fast turn-on and turn-off voltage slew rate for fast system start up and reset response. Low quiescent current extends battery life.

SC573 provides protection circuitry such as short-circuit protection, under-voltage lockout, and thermal protection to prevent device failures. Stability is maintained by using 1µF capacitors on the output pins. SC70-5 package and small ceramic bypass capacitors minimize the required PCB area.

Typical Application Circuit



Pin Configuration



Ordering Information

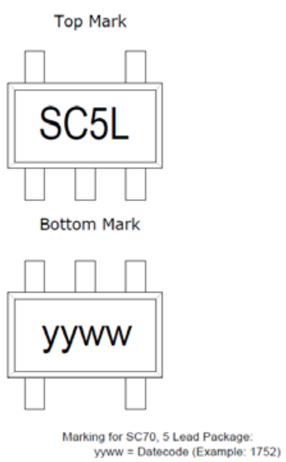
Ordering Info	Output Voltage[3]	Device Marking
SC573V33RTRC	3.3V	SC5H
SC573V18RTRC	1.8V	SC5L
SC573EVB		Evaluation Board

(1) Available in tape and reel only. A reel contains 3,000 devices.

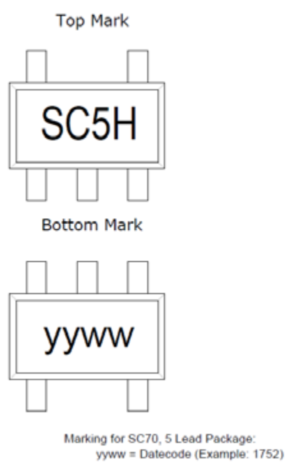
(2) Pb-free, halogen hree, RohS / WEEE compliant

(3) Voltage Options: for additional fixed output voltage options, contact Semtech marketing

Marking Information



SC573V18RTRC



SC573V33RTRC

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Absolute Maximum Ratings

VIN (V) .... -0.3 to +6.0

EN (V) .... -0.3 to +6.0

All Other Pins (V) .... -0.3 to (V_{VIN} + 0.3)

ESD [(1)] PROTECTION LEVEL (kV) 4

Recommended Operating Conditions

Ambient Temperature Range (°C) .... $-40 \le T_A \le +85$

V_{IN} (V) .... 2.3 to 5.5

EN to GND(V) .... 0 to VIN

Thermal Information

Thermal Resistance, Junction to Ambient[(2)] (°C/W) .. 262

Maximum Junction Temperature (°C) .... +125

Storage Temperature Range (°C) .... -65 to +150

Peak IR Reflow Temperature (10s to 30s) (°C) .... +260

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) Tested according to JEDEC standard JESD22-A114-B.
(2) Calculated from package in still air, mounted to 3 x 4.5 (in), 4 layer FR4 PCB with thermal vias under the exposed pad per JESD51 standards.

Electrical Characteristics

Unless otherwise noted V_{VIN} = Max[V_{OUT} + 1.0V or 2.3V], C_{IN} = 1μF, C_{OUT} = 1μF, V_{EN} = V_{VIN}, $-40\,°C \le T_j \le 125°C$. Typical values are at T_A = 25°C. All specifications apply to both LDOs unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Supply Voltage Range	V_{IN}		2.3		5.5	V
Output Voltage Accuracy [(1)]	ΔV	I_{OUT} =1mA, $V_{IN} \ge$ Max(V_{OUT} + 1.0V or 2.3V).	-3	+/- 2	3	%
Maximum Output Current	I_{MAX}		300			mA
Dropout Voltage[(2)]	V_{DROUT}	I_{OUT} = 300mA, V_{IN} = 3.0V to 3.6V		180	450	mV
		I_{OUT} = 300mA, V_{IN} = 3.0V to 3.6V, $-40°C \le T_A \le 85°C$		180	400	mV
		I_{OUT} = 300mA, V_{IN} = 2.3V to 3.0V		300	540	mV
		I_{OUT} = 300mA, V_{IN} = 2.3V to 3.0V $-40°C \le T_A \le 85°C$		300	490	mV
Shutdown Current	I_{SD}	EN=0,		0.1	1.2	μA
Quiescent Current	I_Q	I_{OUT} = 0mA, $V_{EN} = V_{IN}$		50		μA
Load Regulation	$ΔV_{LOA}$	I_{OUT} = 1mA to $I_{MAX,}$ $-40\,°C \le T_A \le 85°C$		5	40	mV
Line Regulation	$ΔV_{LIN}$	I_{OUT} = 1mA, $-40\,°C \le T_A \le 85°C$		0.02	0.1	%/V

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Electrical Characteristics (continued)

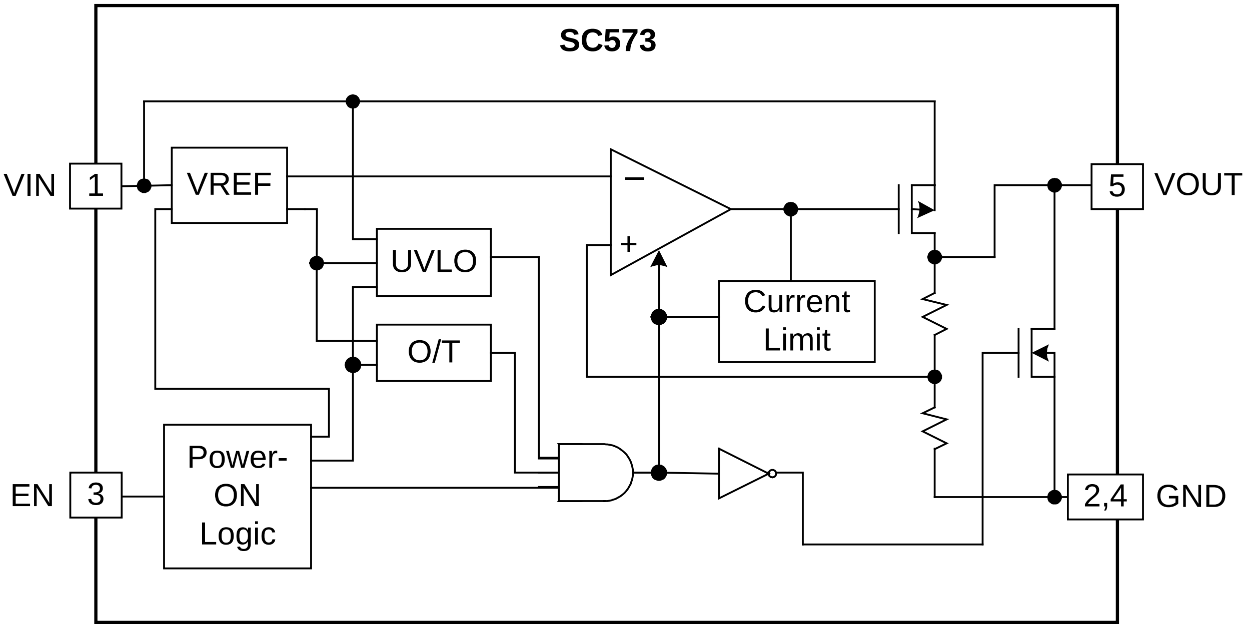
Parameter	Symbol	Conditions	Min	Typ	Max	Units
Current Limit	I_{LIM}		350	550	750	mA
Noise[3]	e_N	R_{load} = 50Ω 10Hz < f < 100kHz		100		$\mu V_{RMS}/V$
Power Supply Rejection Ratio[3]	PSRR	I_{OUT} = 5mA, f = 1kHz,		60		dB
Under Voltage Lockout	V_{UVL}	V_{IN} Rising	1.95	2.1	2.25	V
UVLO Hysteresis	$V_{UVLO-HYS}$			100		mV
Over Temperature Protection Threshold[4]	T_{OT}	Temperature Rising		150		°C
Over Temperature Threshold Hysteresis	V_{OT-HYS}			10		°C
Digital Inputs						
Logic Input High Threshold	V_{IH}	V_{IN} = 5.5V	1.2			V
Logic Input Low Threshold	V_{IL}	V_{IN} = 2.5V			0.4	V
Logic Input High Current	I_{IH}	V_{IN} = 5.5V			1.6	µA
Logic Input Low Current	I_{IL}	V_{IN} = 5.5V			1	µA

Notes:
(1) 50mV per LSB accuracy; when V_{OUT} setting is lower than approximately 1.8V, accuracy specification percentage increases accordingly
(2) Dropout voltage is defined as V_{IN} - V_{OUT}, when V_{OUT} is 100mV below the value of V_{OUT} at $V_{IN} \geq$ Max(V_{OUT} + 1.0V or 2.3V).
(3) Not tested in production, typical performance characteristic based on bench characterization
(4) Thermal shutdown does not latch LDO off. Recovery begins if the temperature drops by the hysteresis level.

Pin Configurations and Descriptions

SC573	Pin Name	Pin Function
1	VIN	Input supply for LDO – Bypass with a 1μF capacitor
2	GND	Ground
3	EN	Enable for LDO, Internal 5MΩ pull-down resistor
4	GND	Ground
5	VOUT	LDO Output -- Bypass with a 1μF capacitor

Block Diagram



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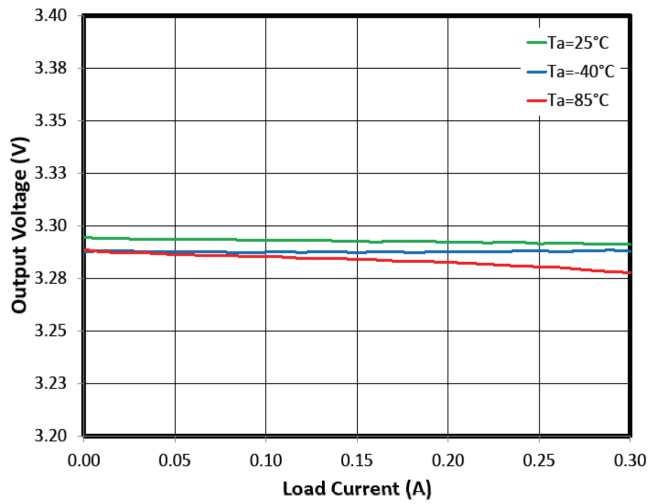
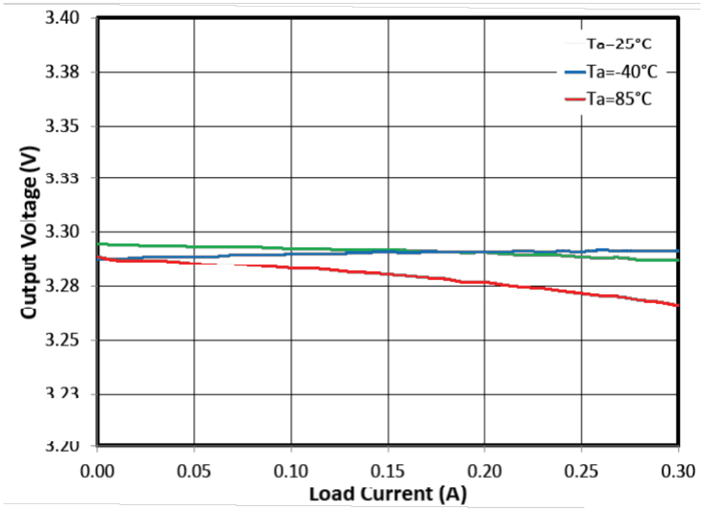
Typical Characteristics

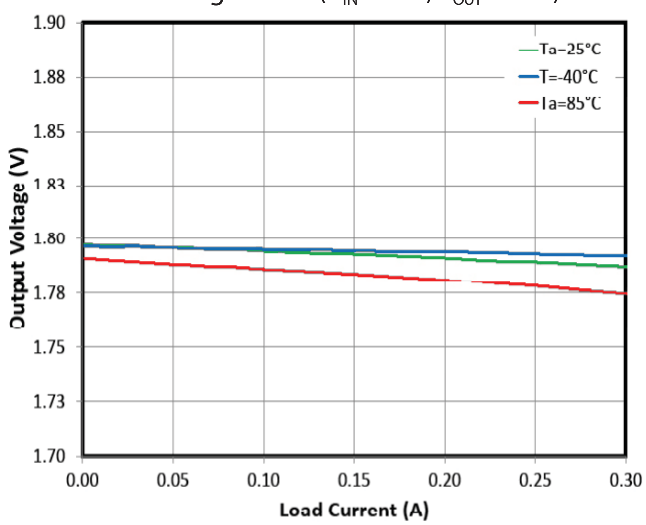
Load Regulation (V_{IN}=3.6V, V_{OUT}=3.3V)



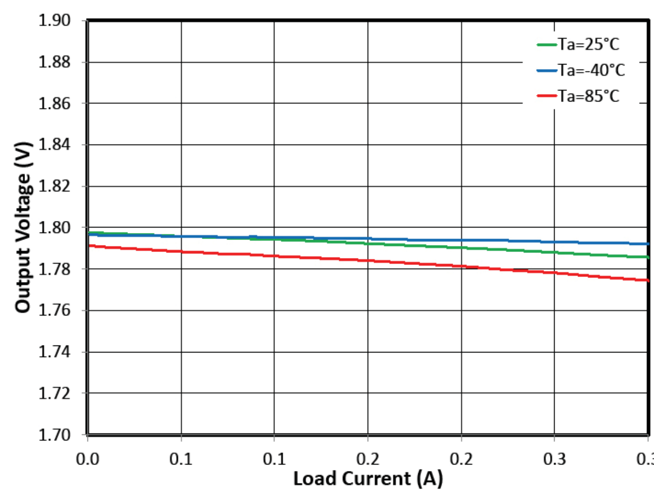
Load Regulation (V_{IN}=5.0V, V_{OUT}=3.3V)



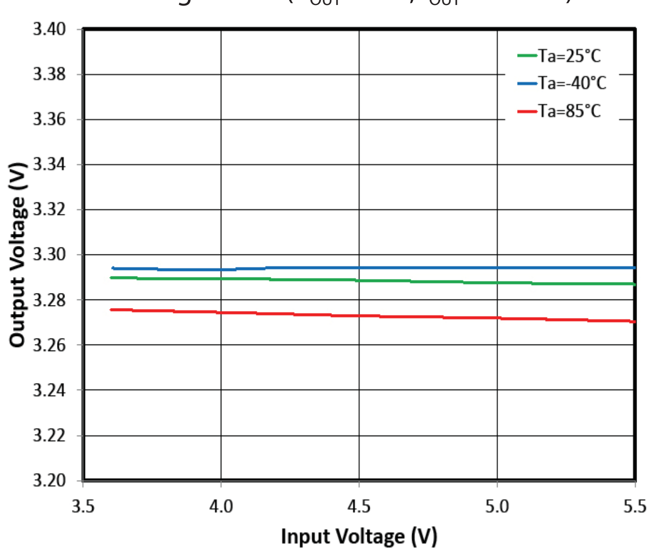
Load Regulation (V_{IN}=3.6V, V_{OUT}=1.8V)



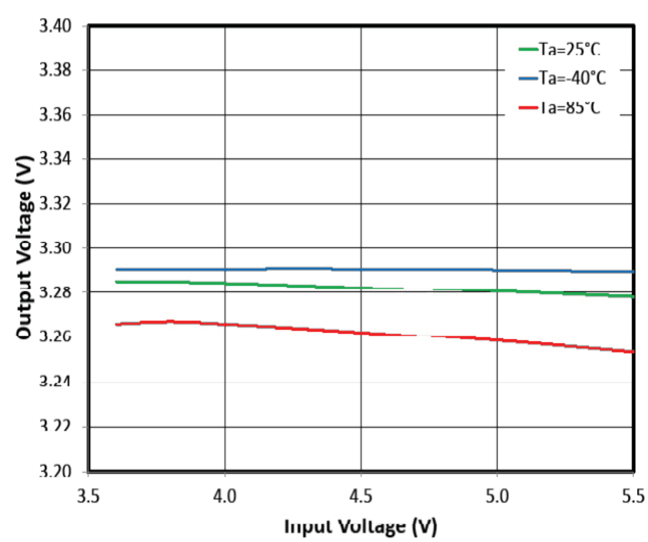
Load Regulation (V_{IN}=4.2V, V_{OUT}=1.8V)



Line Regulation (V_{OUT}=3.3V, I_{OUT}=150mA)

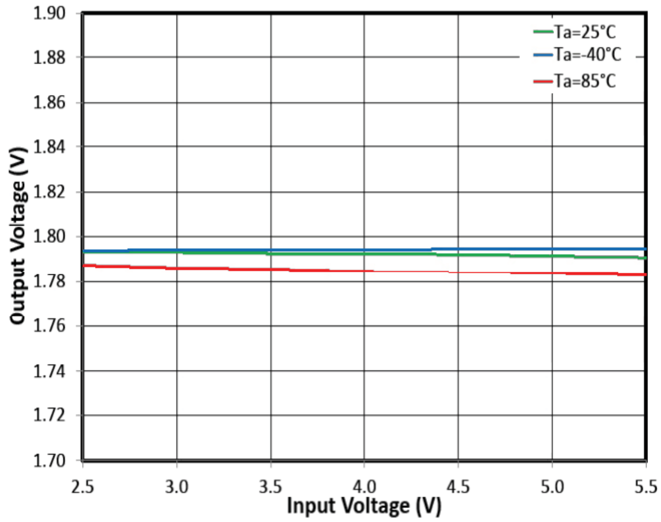


Line Regulation (V_{OUT}=3.3V, I_{OUT}=300mA)

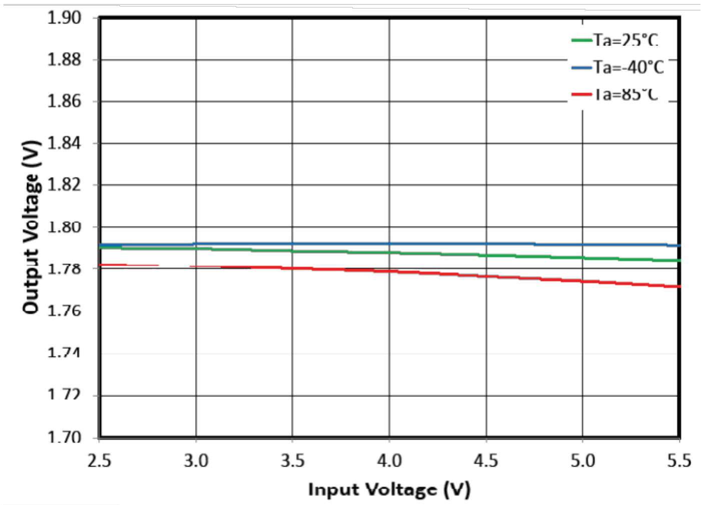


Typical Characteristics

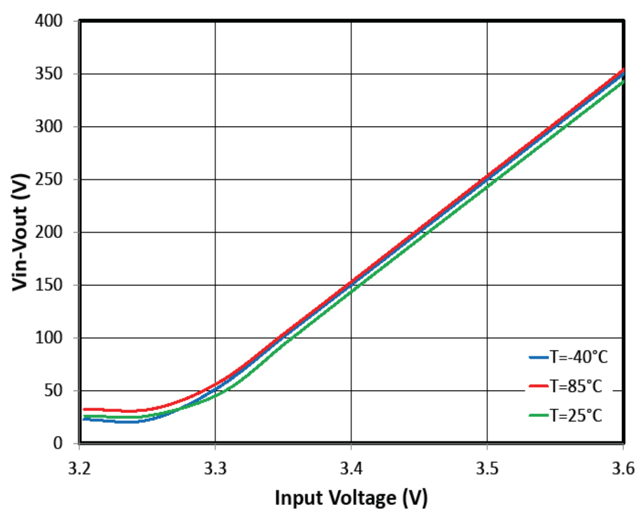
Line Regulation (V_{OUT}=1.8V, I_{OUT}=150mA)



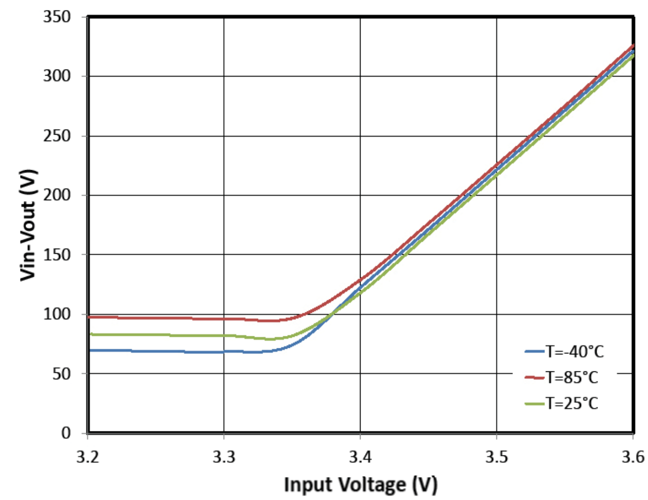
Line Regulation (V_{OUT}=1.8V, I_{OUT}=250mA)



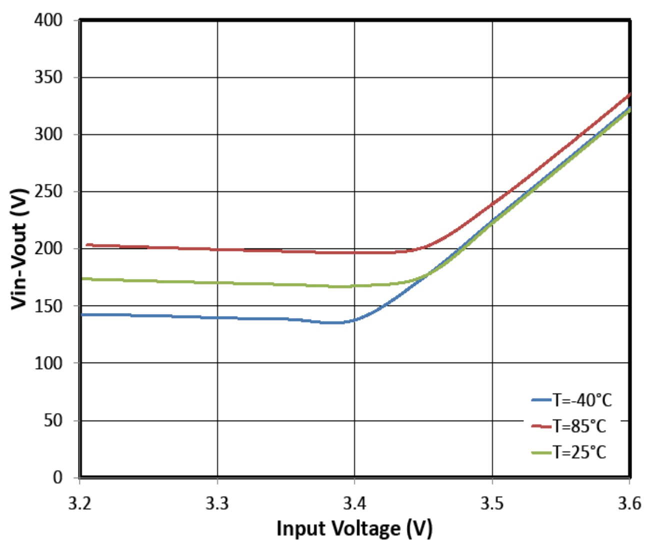
Dropout Voltage (V_{OUT}=3.3V, I_{OUT}=50mA)



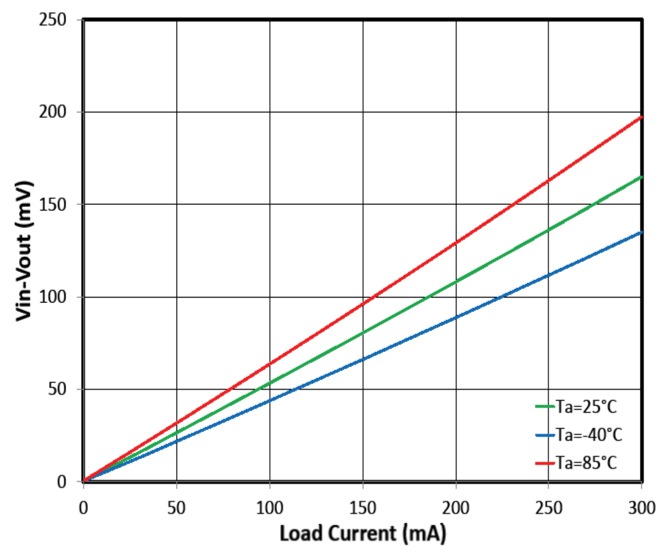
Dropout Voltage (V_{OUT}=3.3V, I_{OUT}=150mA)



Dropout Voltage (V_{OUT}=3.3V, I_{OUT}=300mA)



Dropout vs Load Current (V_{OUT}=3.3V)



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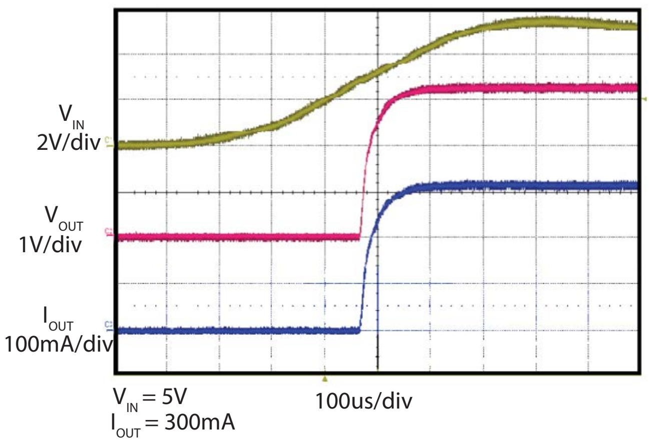
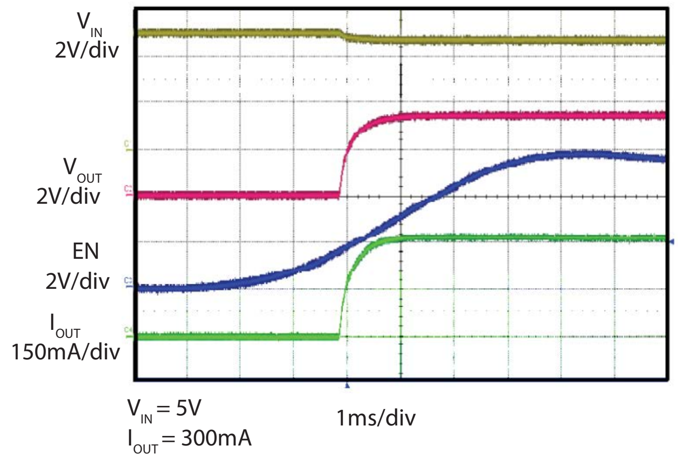
Typical Characteristics

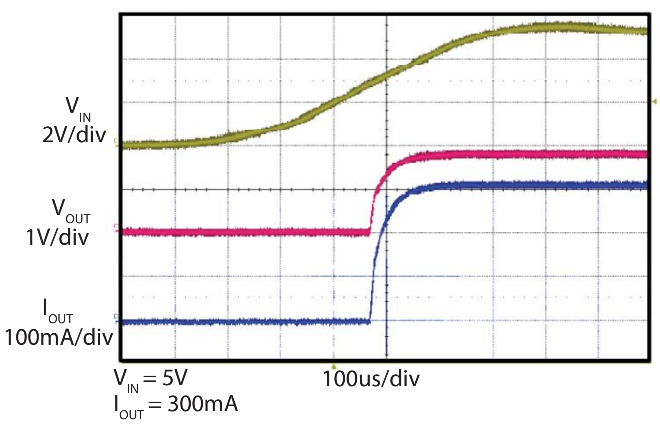
Start Up Via V_{IN} (V_{OUT}=3.3V)



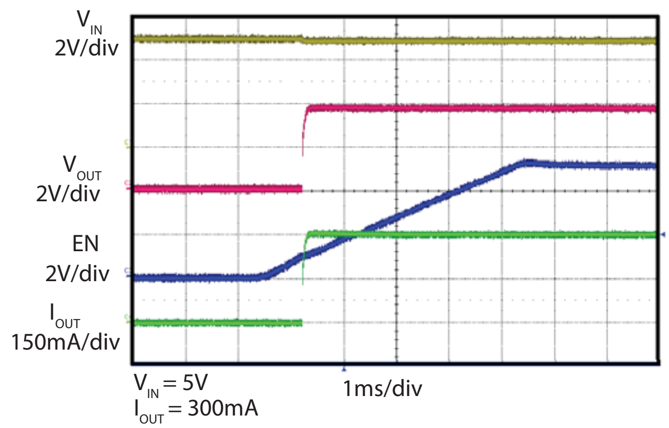
Start Up (Enable) (V_{OUT}=3.3V)



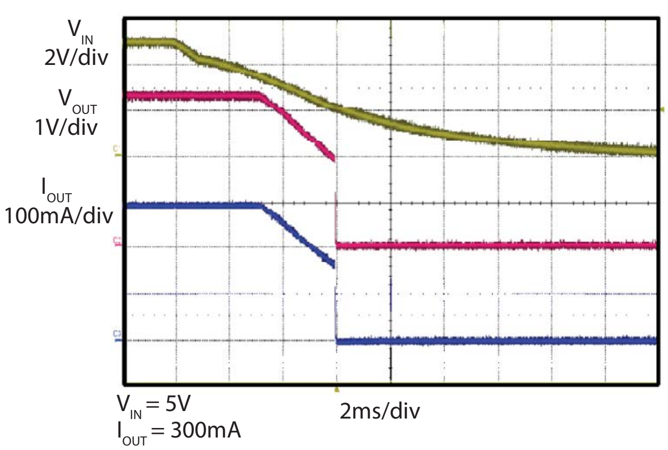
Start Up Via V_{IN} (V_{OUT}=1.8V)



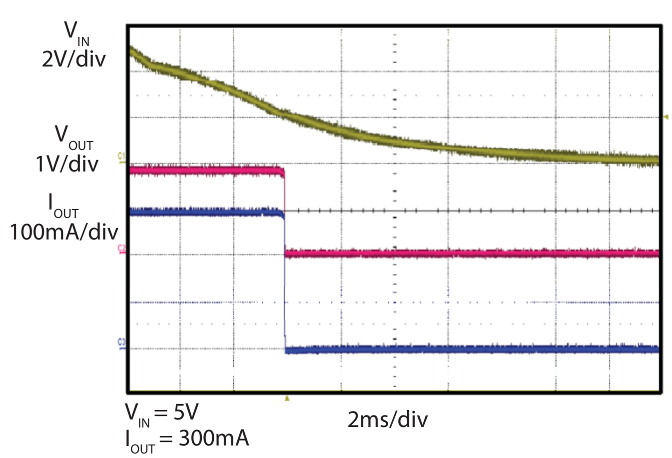
Start Up (Enable) (V_{OUT}=1.8V)



Shutdown (V_{OUT}=3.3V)

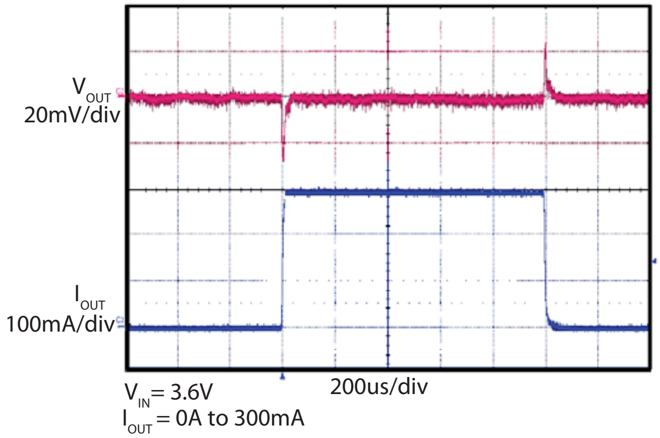


Shutdown (V_{OUT}=1.8V)

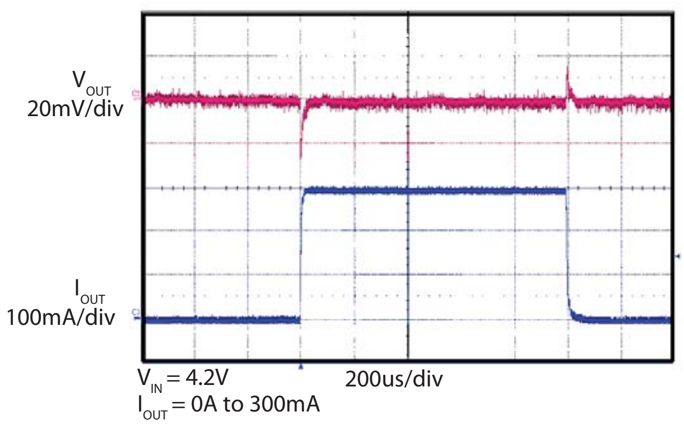


Typical Waveforms

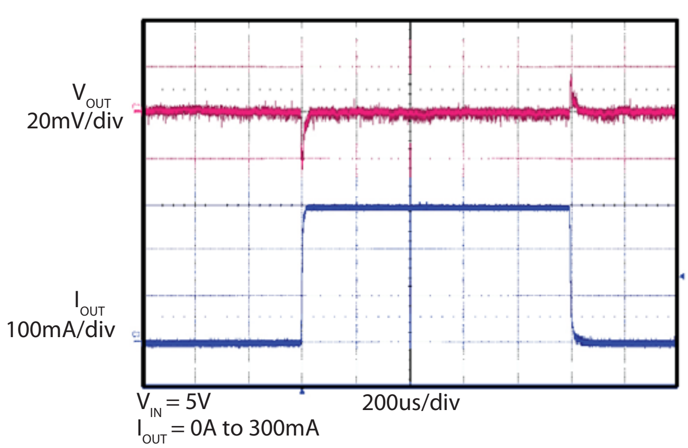
V_{OUT}=3.3V, 0 to 300mA Load Transient



V_{OUT}=3.3V, 0 to 300mA Load Transient

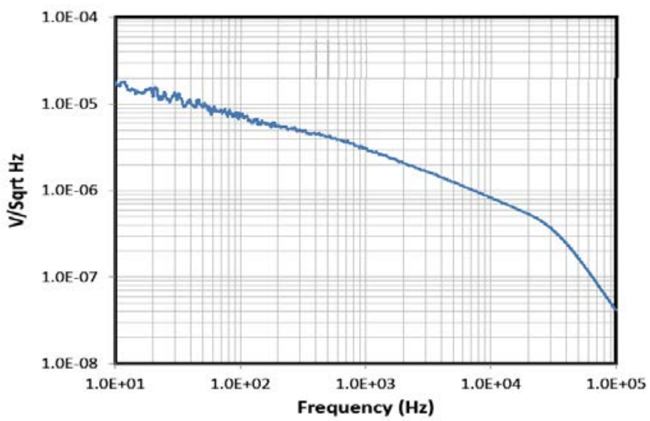


V_{OUT}=3.3V, 0 to 300mA Load Transient



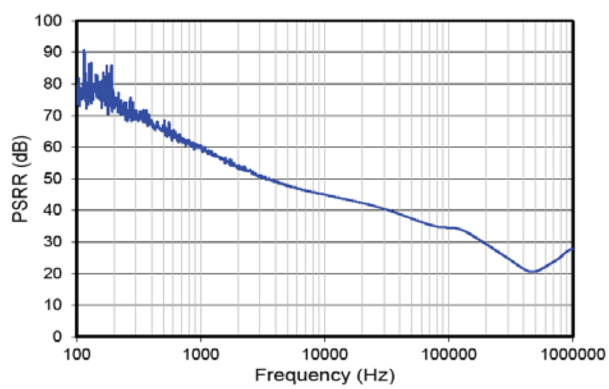
Typical Waveforms

V_{OUT}=3.3V Noise Spectral Density



V_{IN} = 5.4V, V_{OUT} = 3.3V, Load 50 Ohms

V_{OUT}=1.8V, PSRR, Iout=30mA



Applications Information

General Description

SC573 is a linear regulator with low dropout voltage, low supply current, and low output noise. The device provides a simple, low cost solution with minimal PCB area. It has a miniature package size and needs two 1μF 0402 size external capacitors for its input and output.

The LDO provides up to 300mA output current.

Power On and Off Control and Turn-on Delay

SC573 device has an enable pin (EN) that controls the LDO output. Pulling the enable pin high will enable the device when V_{IN} is above its UVLO level at about 2.4V. Pulling this pin low causes the device to shutdown where it typically draws 100nA from the input supply.
When the enable pin is connected to the input voltage supply, the device turn-on and turn-off has two voltage thresholds to overcome. At the turn-on event, the enable pin voltage needs to be greater than the enable threshold and the V_{IN} voltage needs to be higher than the UVLO. The higher of the two voltages, which is the UVLO, determines the turn on time. At turn-off, the first condition of either enable threshold low or the V_{IN} UVLO will determine the turn-off event.

After the enable goes high, the IC has a delay time before the output voltage ramps up. The delay is typically between 120μs to 510μs. The 510μs is related to the lower V_{IN} condition.

With a 1μF output capacitor (capacitor part number: GRM155R61A105kE15) at no load conditions, the output voltage ramp time is typically at 15μs. The device has an internal discharge MOSFET to discharge the output voltage when the enable pin is asserted low; the typical discharge time is at 2ms. The enable and disable waveforms are illustrated in Figure 1, and the Oscilloscope waveform is shown in the Typical Characteristics.

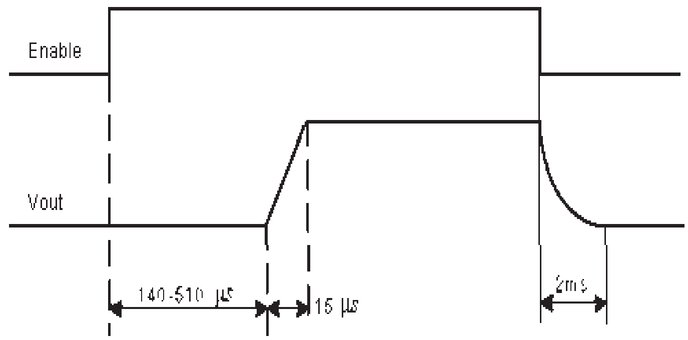


Figure 1: Timing Diagram

The Output Noise

LDO noise generally is characterized through noise spectral density (NSD) and total RMS value in the frequency band between 10Hz to 100kHz. The noise spectral density can be measured using a network analyzer with active probes. The RMS noise value is obtained from the noise spectral density curve by taking the square root of the area within the frequency range from 10Hz to 100kHz.

The normalized output noise for SC573 is at a typical value of $100\mu V_{RMS}/V$. The generalized output voltage noise can be approximated by: $V_{RMS}=V_{OUT}*100\ \mu V$.

Protection Features

SC573 provides protection features to ensure that no damage is incurred in the event of a fault condition. These functions include:

- Under-Voltage Lockout
- Over-Temperature Protection
- Short-Circuit Protection with peak and fold-back current limit

Applications Information (continued)

Under-Voltage Lockout

The Under-Voltage Lockout (UVLO) circuit protects the device from operating in an unknown state if the input voltage supply is too low.

When either V_{IN} drops below the UVLO threshold, as defined in the Electrical Characteristics section, the LDO is disabled. The LDO is re-enabled when V_{IN} is increased above the hysteresis level. When powering up with V_{IN} below the UVLO threshold, the LDO remains disabled.

Over-Temperature Protection

An internal Over-Temperature (OT) protection circuit monitors the internal junction temperature. When the temperature exceeds the OT threshold as defined in the Electrical Characteristics section, the OT protection disables the corresponding LDO output. When the temperature drops below its hysteresis value, the LDO output will resume.

Short-Circuit Protection

The output has short-circuit protection with peak current limit and fold back current limit. If the output current exceeds the peak current limit, the output voltage will drop and the output current will be limited to its fold back current limit value. See the waveforms in the typical operation section. If the short circuit is removed or the load current reduces to below the fold back current limit, the LDO output will rise back into regulation.

Component Selection

SC573 is designed to minimize the PCB solution area. The recommended input and output capacitors are 1µF with 0402 package, part number GRM155R61A105kE15.

Although there is no maximum value of output capacitor specified, very large values may increase the rise time of the output voltages without affecting stability. It is recommended that the value of output capacitance be restricted to a maximum of 10µF. Ceramic capacitors of type X5R or X7R should be used because of their low ESR and stable temperature coefficients. Tantalum capacitors and Y5V capacitors are not recommended.

Thermal Considerations

Although SC573 can provide 300mA of output current, the maximum power dissipation in the device is restricted by the miniature package size. The graph in Figure 2 can be used as a first-order guideline to determine whether the input voltage, output voltage, output current, and ambient temperature of the system result in power dissipation within operating limits.

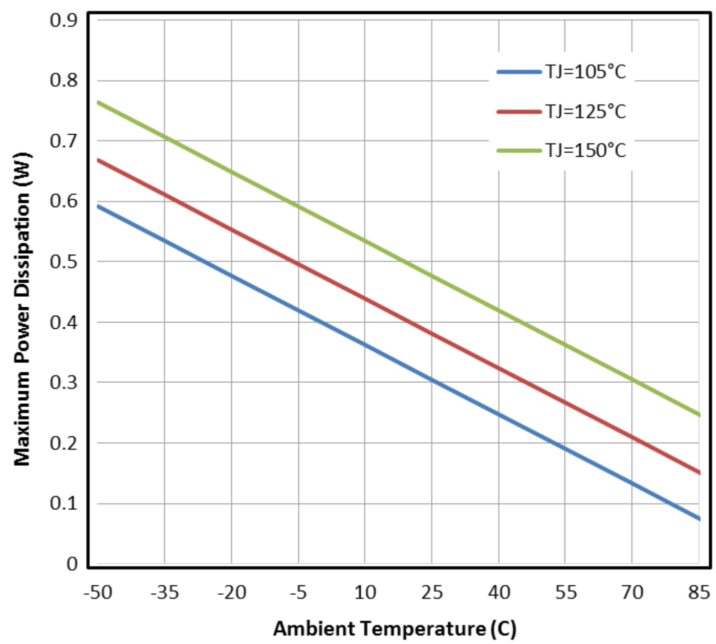


Figure 2: Maximum P_D vs. T_A

The following procedure can be followed to determine if the thermal design of the system is adequate. The junction temperature of the SC573 can be determined in known operating conditions using the following equation:

$$T_J = T_A + (P_D \times \theta_{JA})$$

where

T_J = Junction Temperature (°C)

T_A = Ambient Temperature (°C)

θ_{JA} = Thermal Resistance Junction to Ambient (°C/W)

P_D = Power Dissipation (W)

Applications Information (continued)

Example

A SC573LH is used to provide an output voltage of 3.3V at 150mA. The input voltage is 4.2V, and the ambient temperature of the system is 60°C.

$$P_D = 0.15 \text{ X } (4.2 - 3.3)$$

$$= 0.135\text{W}$$

and

$$T_J = 60°\text{C} + (0.135\text{W x } 262°\text{C/W*}) = 95.4°\text{C}$$

This calculation shows that the junction temperature is about 95°C and is well below the allowed maximum junction temperature of 125°C for this power dissipation.

Layout Considerations

The diagram in Figure 3 below illustrates proper layout of a circuit. The layout considerations are listed below:

- Attach pin 2 (GND) of the device to a copper pad with vias connected to the GND plane. This enables better heat transfer from the device to the PCB.
- Place the input and output capacitors close to the device for optimal transient response and device behavior. Extra copper trace length between the device input and output to the capacitor soldering pad introduces parasitic inductance.
- Connect all ground connections of the input and output capacitors directly to the ground plane whenever possible to minimize ground potential differences on the PCB. Shown in the evaluation board layout below, the SC573 ground pins, input and output capacitors are all connected to the ground plane through vias.

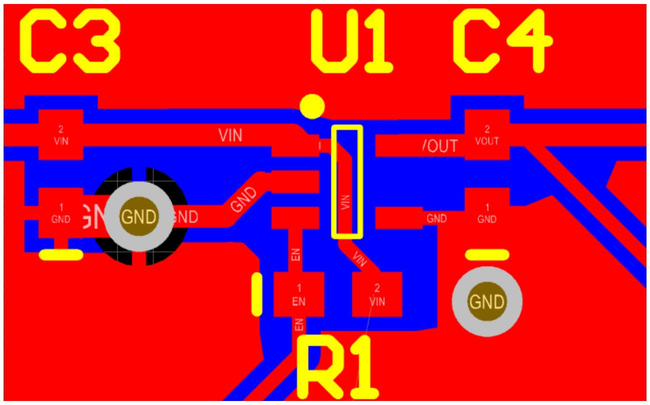
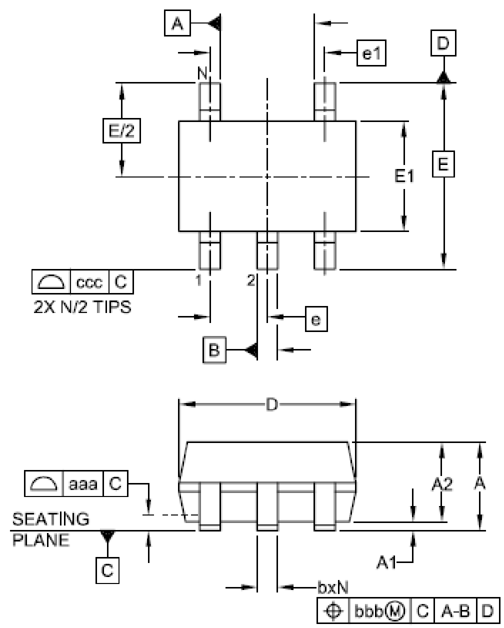
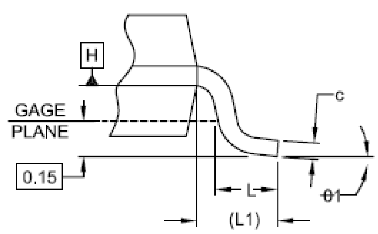


Figure 3 — SC573 Layout Example

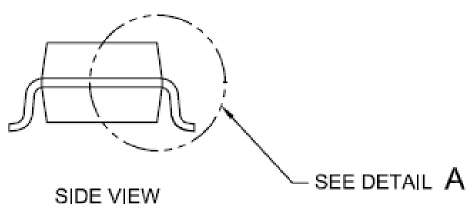
Outline Drawing — SC70-5



DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	.043	-	-	1.10
A1	.000	-	.004	0.00	-	0.10
A2	.028	.035	.039	0.70	0.90	1.00
b	.006	-	.012	0.15	-	0.30
c	.003	-	.009	0.08	-	0.22
D	.071	.079	.087	1.80	2.00	2.20
E1	.045	.049	.053	1.15	1.25	1.35
E	.083 BSC			2.10 BSC		
e	.026 BSC			0.65 BSC		
e1	.051			1.30 BSC		
L	.010	.014	.018	0.26	0.36	0.46
L1	(.017)			(0.42)		
N	5			5		
θ1	0°	-	8°	0°	-	8°
aaa	.004			0.10		
bbb	.004			0.10		
ccc	.012			0.30		



DETAIL A

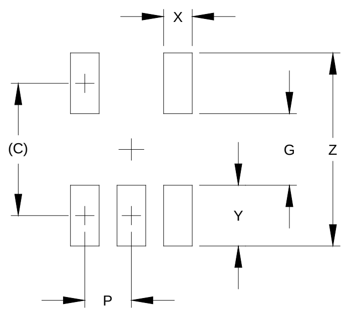


SIDE VIEW

NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-
3. DIMENSIONS "E1" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
4. REFERENCE JEDEC STD MO-203, VARIATION AA.

Land Pattern — SC70-5



DIMENSIONS		
DIM	INCHES	MILLIMETERS
C	(.073)	(1.85)
G	.039	1.00
P	.026	0.65
X	.016	0.40
Y	.033	0.85
Z	.106	2.70

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.

SEMTECH

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