

POWER MANAGEMENT

Features

- Input to linear regulator (VIN): 1.0V to 3.6V
- Output (VTT): 0.5V to 1.8V
- Bias Voltage (VDD): 2.35V to 3.6V
- Up to 3A sink or source from VTT for DDR through DDR4
- $\pm 1\%$ over temperature (with respect to VDDQ/2, including internal resistor divider variation) VREF and VTT
- Logic-level enable input
- Built in soft-start
- Thermal shutdown with auto-restart
- Over current protection
- Minimal output capacitance
- Package: SOIC8-EDP

Applications

- DDR Memory Termination

Description

The SC2597 is designed to meet the latest JEDEC specification for low power DDR3 and DDR4, while also supporting DDR and DDR2. The SC2597 regulates up to $\pm 3A$ for VTT and up to $\pm 40mA$ for VREF.

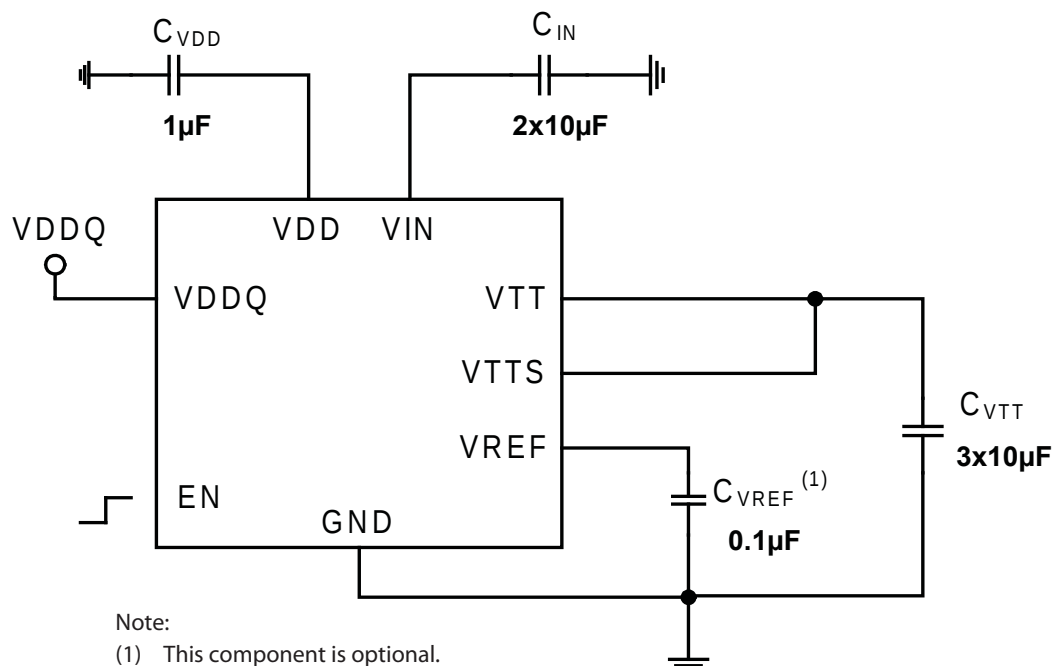
The SC2597 also provides an accuracy of $\pm 1\%$ over temperature (which takes into account the internal resistor divider) for VREF and VTT for the memory controller and DRAM.

SC2597 protection features include thermal shutdown with auto-restart for VTT and over-current limit for both VTT and VREF.

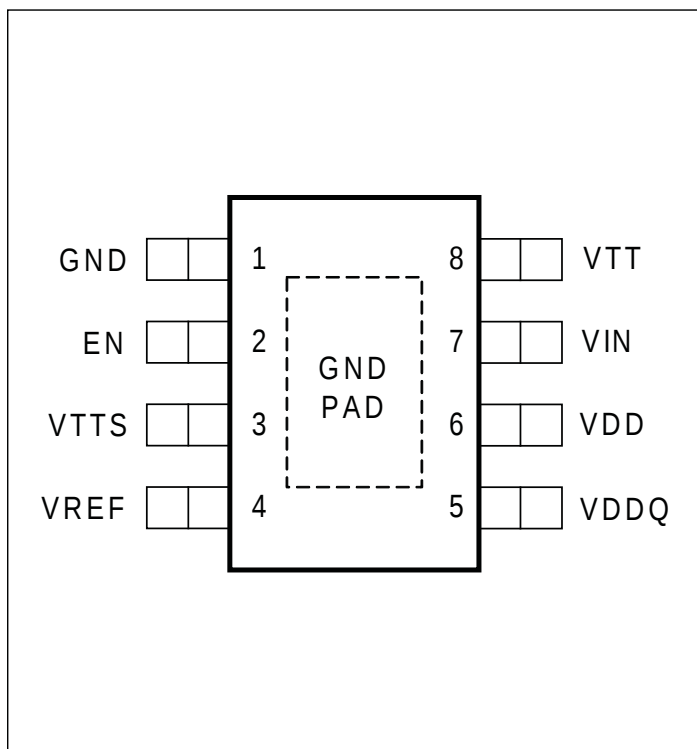
Under-Voltage-Lock-Out circuits are included to ensure that the output is off when the bias voltage falls below its threshold, and that the part behaves elegantly in power-up or power-down.

The low external parts count combined with industry leading specifications make SC2597 an attractive solution for DDR through DDR4 termination.

Typical Application Circuit



Pin Configuration



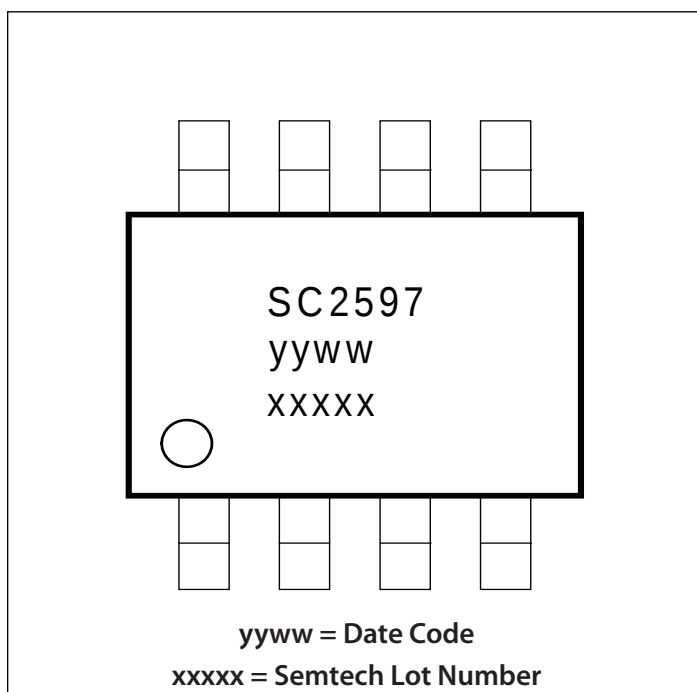
Ordering Information

Device	Package
SC2597SETRC ⁽¹⁾⁽²⁾	SOIC8-EDP
SC2597EVB	Evaluation Board

Notes:

- (1) Available in tape and reel only. A reel contains 2500 devices.
- (2) Lead-free packaging only. Device is WEEE and RoHS compliant and halogen-free.

Marking Information



Absolute Maximum Ratings

V _{IN} (V).....	-0.3 to 4.3
V _{DD} to GND (V).....	-0.3 to 4.3
V _{TT} to GND (V)	-0.3 to V _{DD}
EN (V)	-0.3 to 6.0
Other pins	-0.3 to 4.3
ESD Protection Level ⁽¹⁾ (kV)	2.5

Recommended Operating Conditions

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

Thermal Information

Thermal Resistance, Junction to Ambient⁽²⁾ (°C/W) ... 46

Thermal Resistance, Junction to Ambient⁽³⁾ (°C/W) ... 38

Maximum Junction Temperature (°C) +150

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.

(3) Based upon lab measurement on EVB board: 3 x 2 (in), 4 layer FR4 PCB with thermal vias under the exposed pad.

Electrical Characteristics

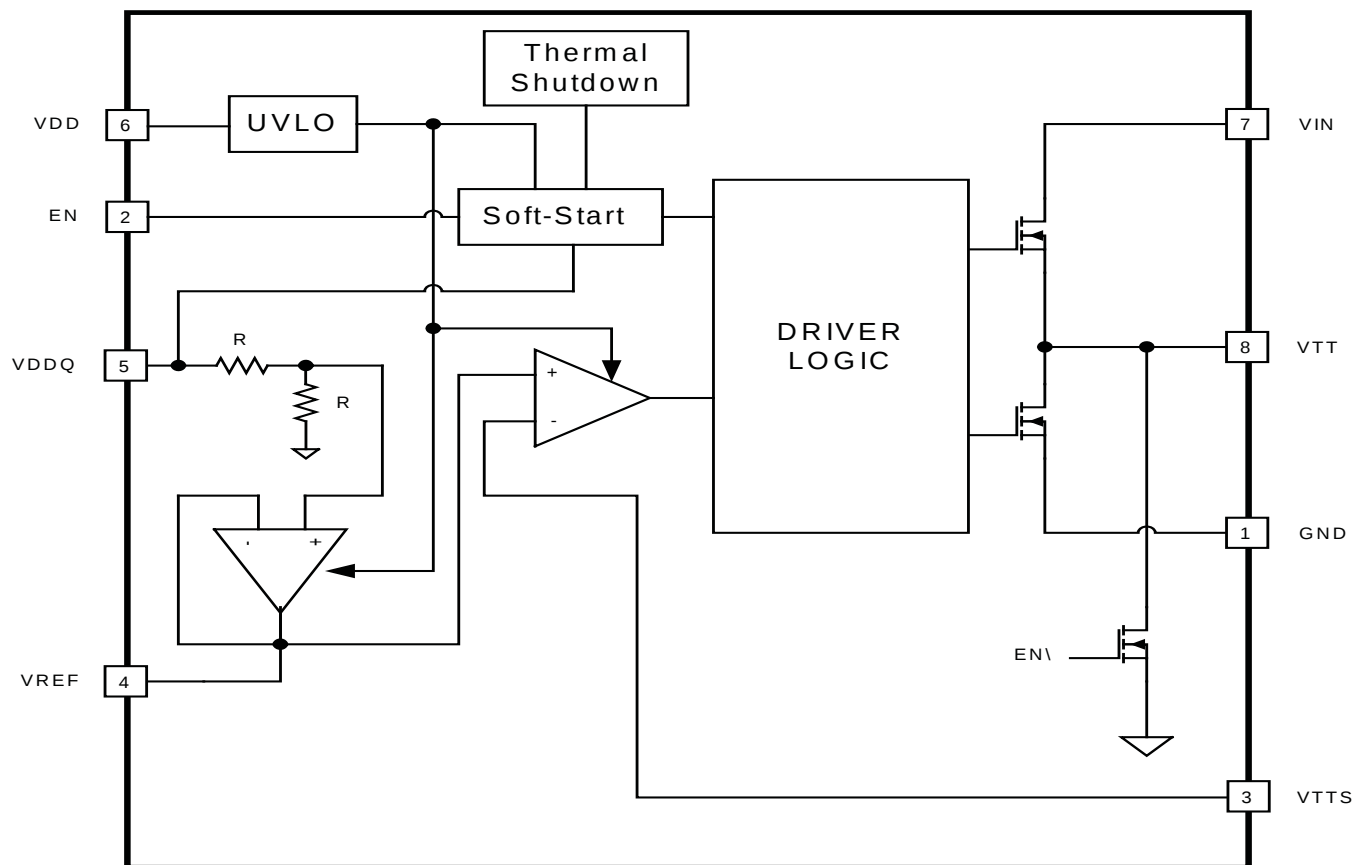
Unless otherwise noted $T_J = -40$ to $+125^\circ\text{C}$, $V_{IN} = 1.2\text{V}$, $V_{DD} = 3.3\text{V}$. Typical values are at $T_A = 25^\circ\text{C}$.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Supplies						
LDO Supply Voltage	V_{IN}		1		3.6	V
VDD Supply Voltage	V_{DD}		2.35		3.6	V
VDD UVLO Threshold		Measured at VDD pin, rising edge	2.0		2.25	V
		Measured at VDD pin, falling edge	1.95		2.15	
VDD UVLO Hysteresis				0.1		V
Quiescent Current for VDD	I_Q	Load = 0A, EN = High, $V_{VDDQ} \geq 1\text{V}$		415	700	μA
Shutdown Current for VDD	I_{QSD}	Load = 0A, EN = Low, $V_{VDDQ} \geq 1\text{V}$, $I_{REF} = 0\text{A}$		160	400	μA
		Load = 0A, EN = Low, $V_{VDDQ} = 0\text{V}$, $I_{REF} = 0\text{A}$		100	160	μA
Quiescent Current for V_{IN}	I_{IN}	Load = 0A, EN = High		3	30	μA
Shutdown Current for V_{IN}	I_{INSD}	Load = 0A, EN = Low		3	20	μA
VTT Output						
Output Voltage Range	VTT		0.5		1.8	V
Output Voltage Tolerance with respect to VDDQ/2		Load = 0A, VTT = 0.5V to 1.8V	-1		+1	%

Electrical Characteristics (continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Load Regulation		-2A ≤ Load ≤ 2A	-25		+25	mV
On-Resistance		High-Side MOSFET (source), Load = 0.1A	50	100	150	mΩ
		Low-Side MOSFET (sink), Load = 0.1A	90	140	190	
Discharge MOSFET On-Resistance		EN = Low		8		Ω
Reference Input/Output						
VDDQ Voltage Range			1		3.6	V
VDDQ Input Bias Current			0		10	μA
Tolerance with respect to VDDQ/2		Load = 0A, VREF = 0.5V to 1.8V	-1		1	%
VREF Source Current Limit			40			mA
VREF Sink Current Limit			- 40			
Protection						
Thermal Shutdown Threshold				160		°C
Thermal Restart Hysteresis				20		°C
Output Current Limit Threshold		Ambient Temperature: -40 °C to 85 °C	3.7	4.3		A
Soft-Start						
VTT Soft-Start Time		From EN = High to V _{TT} = 90% VREF		40		μs
Logic						
EN Logic Threshold		EN = High	1.7			V
		EN = Low			0.3	
EN Input Current			-1		1	μA

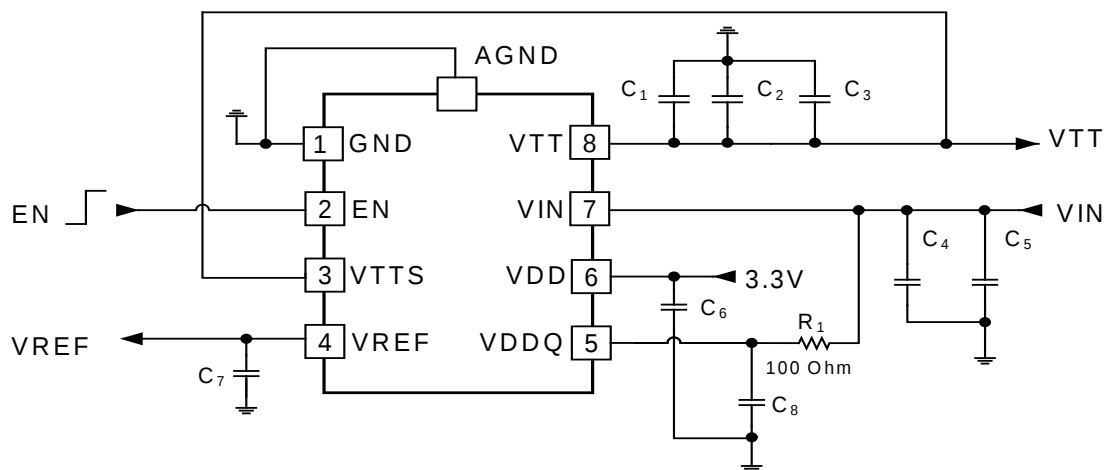
Block Diagram



Pin Descriptions

Pin #	Pin Name	Pin Function
1, PAD	GND	Ground reference for the IC.
2	EN	Logic input to enable or disable the VTT output. If EN pin is grounded to shut down the linear regulator, VREF remains active.
3	VTTS	VTT output sense input. Connect VTTS to the output at the output capacitor to implement remote sense.
4	VREF	The reference output, equal to one half of VDDQ. Connect a 100nF capacitor from this pin to GND.
5	VDDQ	External reference input; range 1V to 3.6V.
6	VDD	Input bias voltage — 2.35V to 3.6V. Connect a ceramic capacitor from this pin to GND.
7	VIN	LDO input range — 1V to 3.6V. Connect ceramic capacitors from this pin to GND.
8	VTT	Output of the linear regulator. Connect ceramic capacitors from this pin to GND.

Detailed Application Circuit



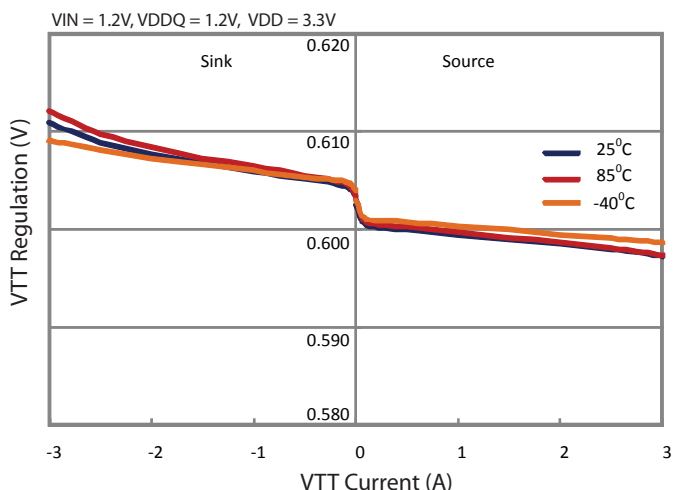
Bill Of Materials

Reference Designator	Description	Value	Part Number	Manufacture
C_1, C_2, C_3, C_4, C_5	Ceramic Capacitor	10uF/0805/X7R	GRM21BR71A106KE51	Murata
C_6	Ceramic Capacitor	1uF/0603/X7R	GRM188R71A105KA61D	Murata
C_7, C_8	Ceramic Capacitor	0.1uF/0603/X7R	GRM188R71H104KA93D	Murata

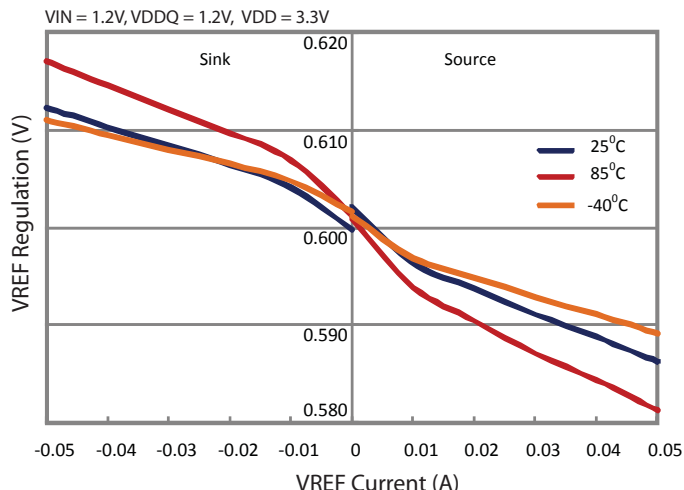
Typical Characteristics

Characteristics in this section are based upon the detailed application circuit on page 6.

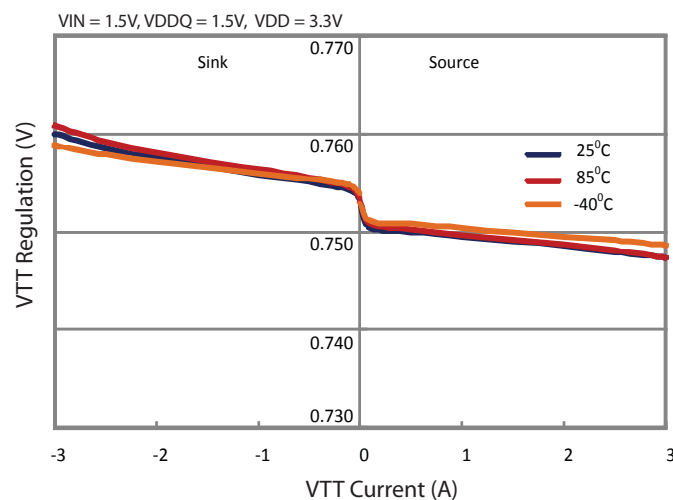
0.6V VTT Regulation Sink/Source



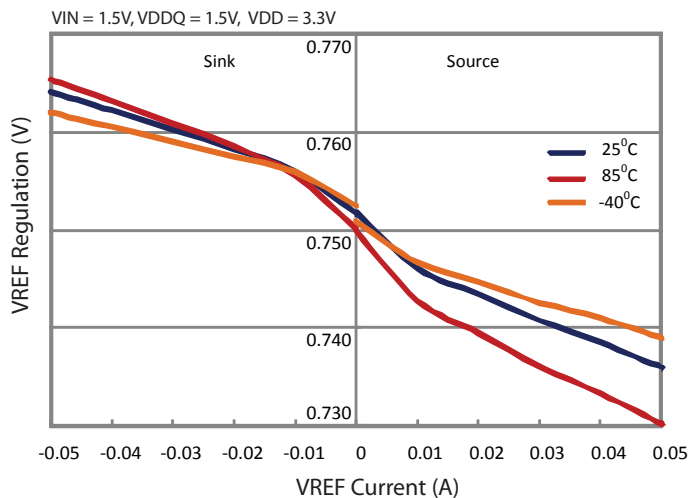
0.6V VREF Regulation Sink/Source



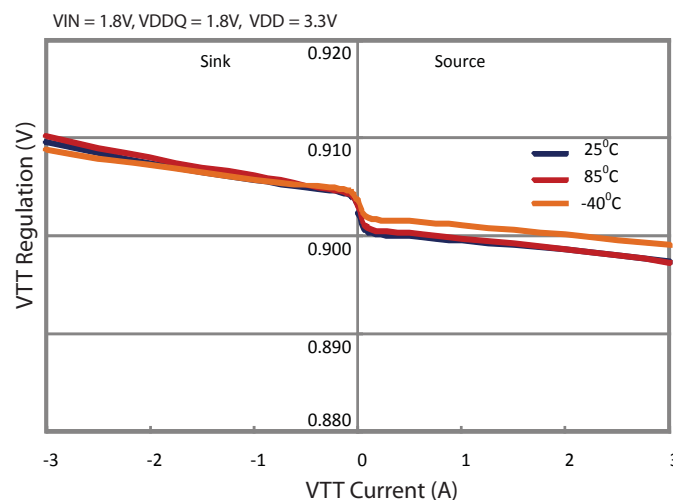
0.75V VTT Regulation Sink/Source



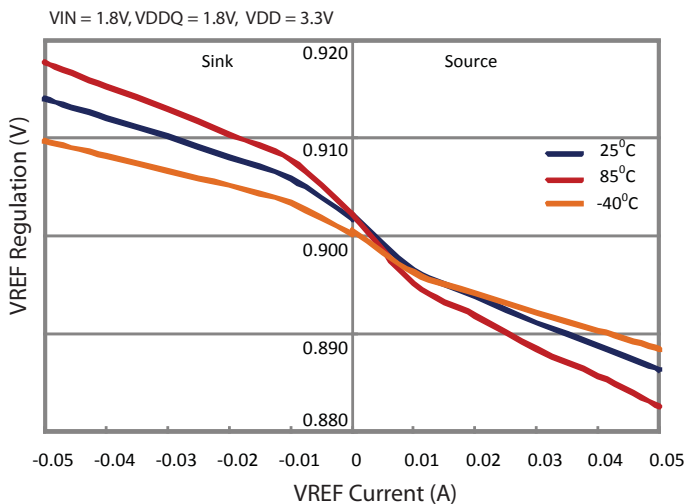
0.75V VREF Regulation Sink/Source



0.9V VTT Regulation Sink/Source



0.9V VREF Regulation Sink/Source

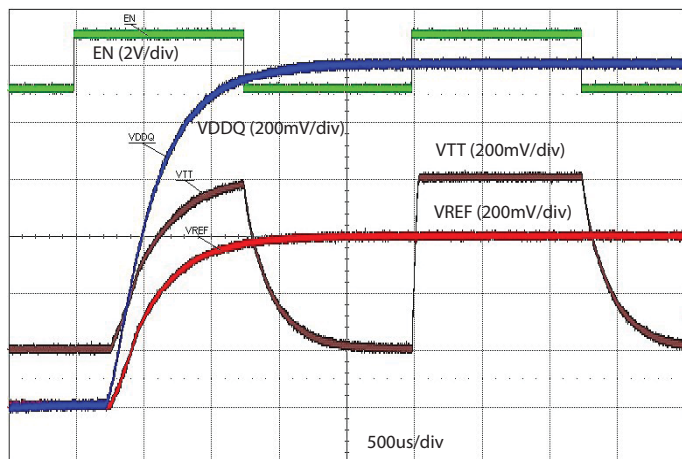


Typical Characteristics

Characteristics in this section are based upon the detailed application circuit on page 6.

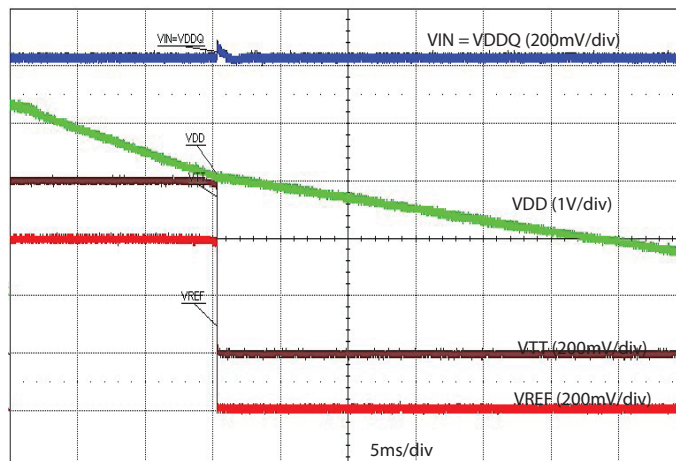
Start-Up and Shutdown Using EN

VIN = 1.2V, VDD = 3.3V, VREF = 0A, VTT = 0A



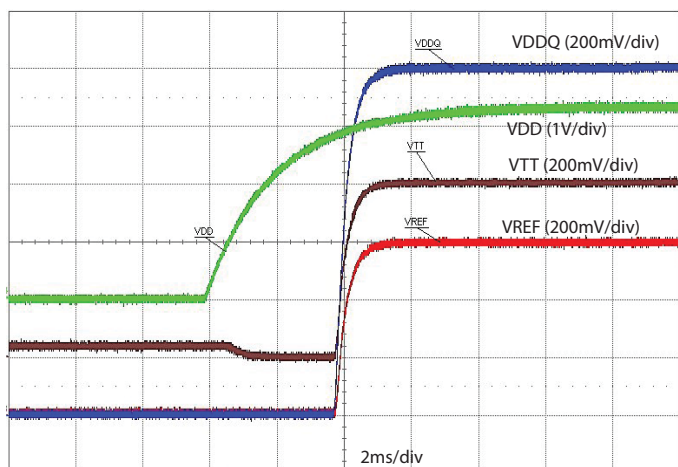
Shutdown Using VDD

VREF = 40mA, VTT = 1A



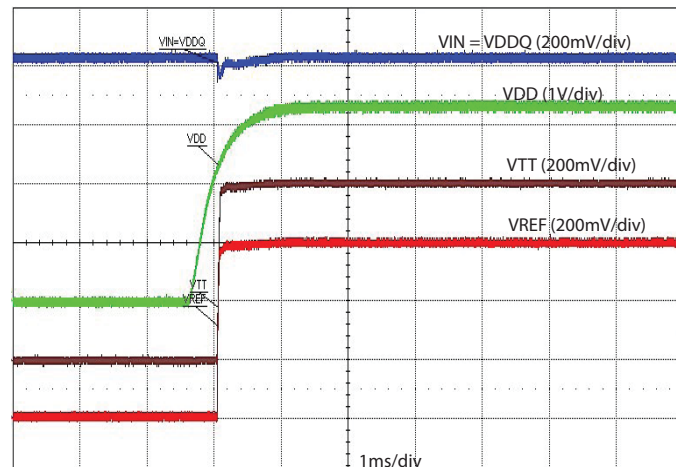
Start-Up Using VDDQ

VREF = 0A, VTT = 0A, VIN = 1.2V



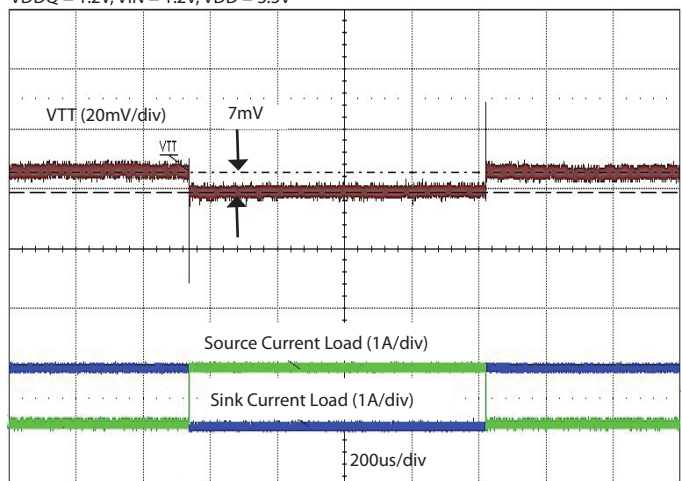
Start-Up Using VDD

VREF = 40mA, VTT = 1A



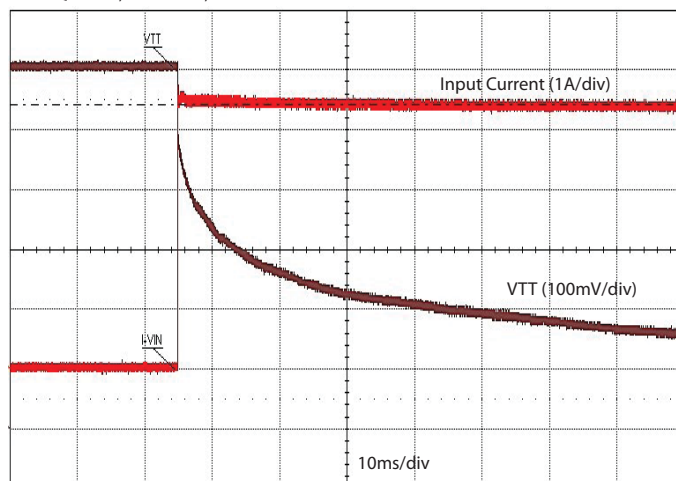
Load Transient Source and Sink: -1A to +1A

VDDQ = 1.2V, VIN = 1.2V, VDD = 3.3V



Current Limit with VTT Shorted

VDDQ = 1.2V, VIN = 1.2V, VDD = 3.3V



Applications Information

VTT Output

VTT starts to ramp up when EN and VDD meet their startup thresholds. SC2597 regulates VTT to the voltage at VREF and can support up to 3A for sourcing or sinking capability.

To achieve tight regulation and fast dynamic response at VTT, it is recommended to connect the VTTS sense signal to VTT at the ceramic output capacitors.

VREF Output

VREF starts to ramp up when VDD meets the UVLO threshold. SC2597 regulates VREF to one-half of VDDQ. To reduce the component count and provide a good accuracy reference for VTT, SC2597 includes an internal resistor divider network. SC2597 is capable of sinking or sourcing up to 60mA at VREF. To reduce the component count further, SC2597 does not require the user to have a local ceramic capacitor at the VREF pin - but it is recommended to layout with a capacitor place holder.

EN Input

The EN pin is used to enable and disable VTT only; it does not control VREF. When EN is pulled low, the VTT output is discharged internally to ground through an 8Ω FET.

Protection

SC2597 has thermal protection with auto-restart. When the junction temperature is above the thermal shutdown threshold (160°C), SC2597 disables VTT, while VREF remains present. When the junction temperature drops below the hysteretic window, typically at 140°C, SC2597 will be enabled again.

SC2597 has a built-in current limit feature to prevent damage to the sink and source FETs. If VTT is shorted to VDD or ground, SC2597 will sink or source current up to the current limit threshold.

Input Capacitor

The primary purpose of input capacitance is to provide the charge to the VTT output capacitor when there is a load transient at VTT. In the typical application circuit, VDDQ equals VIN, and VTT equals one-half of VDDQ. As a result,

theory tells us that the input capacitance can be chosen to be half of the output capacitance.

Ceramic capacitors have a capacitance value that degrades with temperature, DC and AC bias, and their chemistry. Usually, ceramic capacitors need to be derated by 50% when operated at their rated DC voltage. Therefore, it is recommended to use capacitors with a voltage rating of 6.3V or higher for 3.3V or lower applications.

Stability and VTT Capacitor

Figure 1 shows the small signal model for the sourcing current loop stability. The low frequency pole is formed by C_{OUT} and R_L . Since this pole depends on those variables, it is recommended to have a minimum of 10μF C_{OUT} for stable condition. SC2597 has an internal compensation network to ensure the stability as the load changes. Figure 2 shows the bode plot with the crossover frequency at around 0.8MHz and 36 degree phase margin. Another parameter effecting to the loop stability is parasitic inductance in PCB layout and output capacitor ESL. The gain plot shows that a peaking rising after the crossing frequency is due to ESL effect. Minimizing the ESL reduces this peaking.

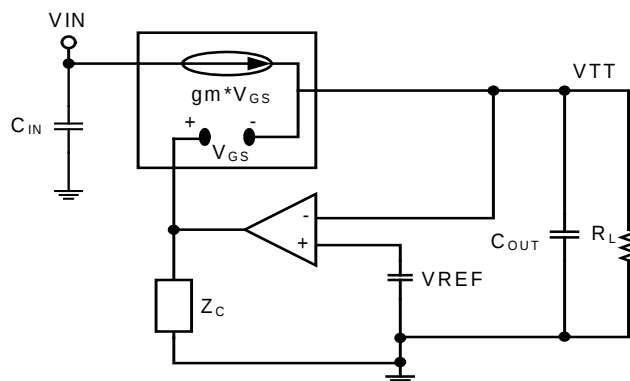


Figure 1 — Small Signal Model

PCB Layout

The SC2597 requires minimal external components to provide a VTT solution. Figure 3 shows the component placement and layout for the application circuit on page 6.



Figure 2 — Gain and Phase Bode Plot

$F_c = 810\text{KHz}$, $PM = 36$ degree at 1A Source

Critical Layout Guidelines

Bias and Reference Capacitors:

A $1\mu\text{F}$ capacitor must be placed as close as possible to the IC and connected between pin 6 (VDD) and the ground plane.

A $0.1\mu\text{F}$ capacitor must be placed as close as possible to the IC and connected between pin 4 (VREF) and the ground plane. The user has an option to add this capacitor to the circuit but it is recommended to layout with a capacitor place holder.

VDDQ Reference Capacitor:

An R-C filter from the supply used for VDDQ consisting of a 100Ω resistor and a $0.1\mu\text{F}$ capacitor should be placed as close as possible to the IC and connected between pin 5 (VDDQ) and the ground plane, as shown on page 6.

VTT and VIN Capacitors:

Since SC2597 provides both sink and source capabilities, the loop impedance through the input and VTT capacitors plays an important role in circuit stability. Figure 4 shows both sink and source current loops. Close attention to board layout is needed to reduce ESL in these loops. During a bode plot measurement for the sourcing current loop, an injected small AC signal flows around the loop from C_{IN} to Q_T through C_{VTT} and then returns to C_{VIN} through the ground plane. Therefore, it is recommended to keep the C_{IN} and C_{VTT} capacitors as close as possible to reduce the ESL impedance between them. Similarly in the sinking

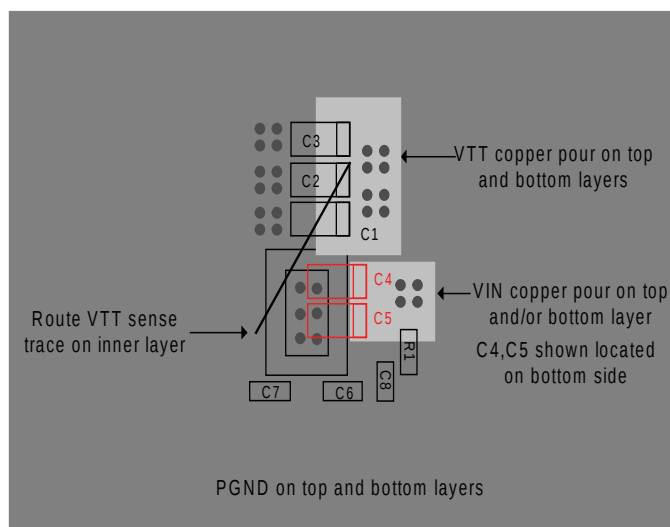


Figure 3 — Component Placement and Layout

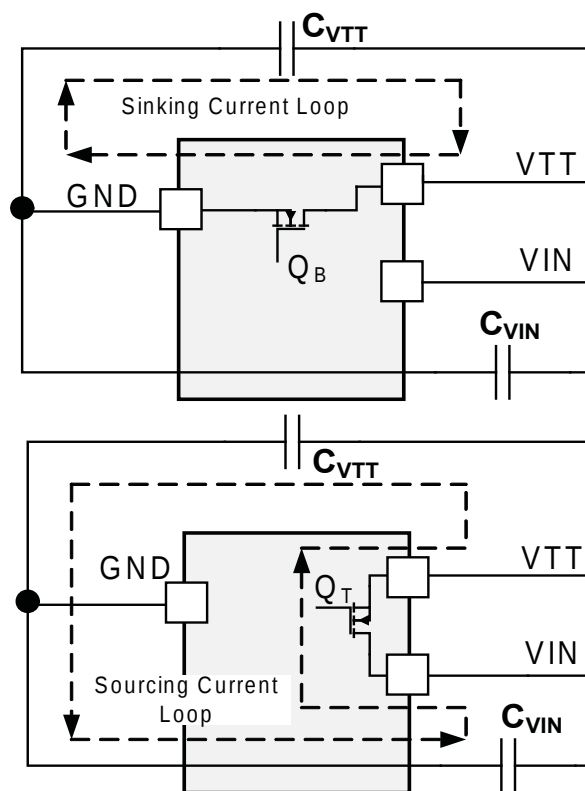
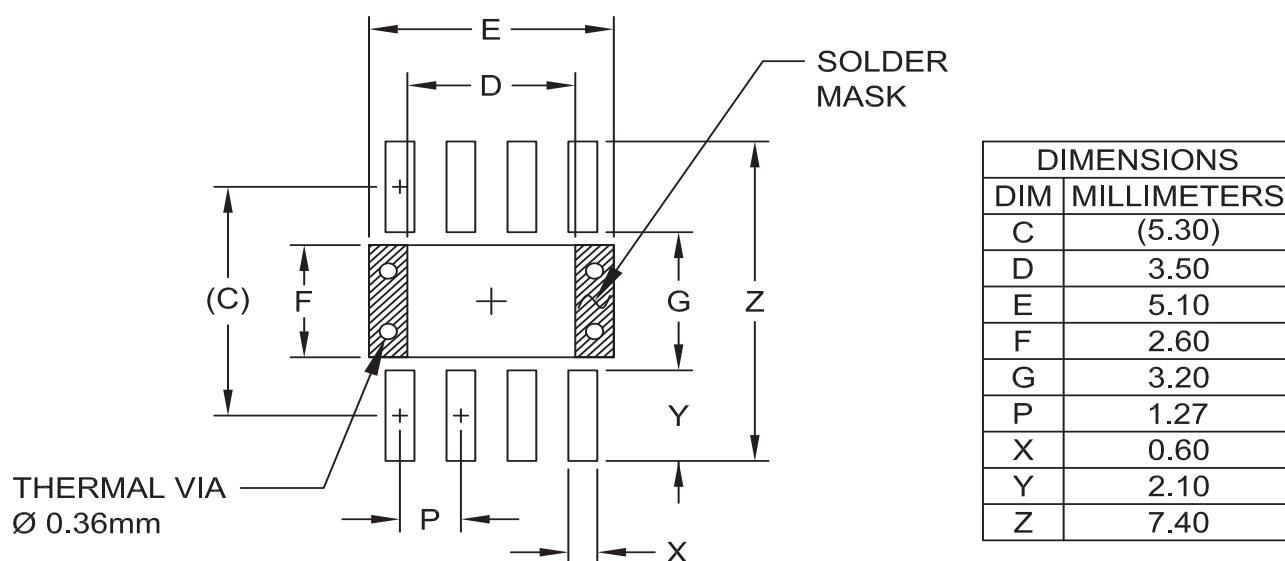


Figure 4 — Small AC Signal Current Loops

current loop, an injected small AC signal flows from C_{VTT} through Q_B and then returns to C_{VTT} through the GND plane. Therefore, it is recommended to keep ESL small for this loop. Balancing the ESL of those loops gives the best case for stability.

Land Pattern — SOIC8-EDP

NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. THIS LAND PATTERN IS FOR REFERENCE PURPOSE 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.
4. REFERENCE IPC-SM-782A, SECTION 9.1, RLP NO. 300A.

© Semtech 2014

All rights reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner. The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent or other industrial or intellectual property rights. Semtech assumes no responsibility or liability whatsoever for any failure or unexpected operation resulting from misuse, neglect improper installation, repair or improper handling or unusual physical or electrical stress including, but not limited to, exposure to parameters beyond the specified maximum ratings or operation outside the specified range.

SEMTECH PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF SEMTECH PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE UNDERTAKEN SOLELY AT THE CUSTOMER'S OWN RISK. Should a customer purchase or use Semtech products for any such unauthorized application, the customer shall indemnify and hold Semtech and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs damages and attorney fees which could arise.

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

Contact Information

Semtech Corporation
Power Mangement Products Division
200 Flynn Road, Camarillo, CA 93012
Phone: (805) 498-2111 Fax: (805) 498-3804

www.semtech.com