SP6213/14

Data Sheet

Micropower 100mA CMOS LDO Regulator

General Description

The SP6213/14 is a 100mA CMOS linear voltage regulator offered in an SC70 package that reduces board space requirements by 50% over a SOT-23 package. The SP6213/14 features low dropout voltage (250mV at 100mA), low ground current (135µA at full load) and low, 65µA quiescent current. Designed specifically for hand-held, battery-powered devices, the device includes an enable/shutdown pin. The regulator ground current increases only slightly in dropout to extend battery life. The SP6213/14 is offered in an industry standard SC70-5 package.
The SP6213/14 is available in a 3.3V fixed output voltage.

SP6213 available, SP6214 obsolete

Features

- Guaranteed 100mA output
- 2.5% output voltage accuracy
- Low dropout voltage: 250mV at 100mA
- Low quiescent current: 65µA
- Low ground current: 135µA at I_L = 100mA
- Low shutdown current: 1µA max
- Current limit: 190mA
- Thermal shutdown: 168°C
- Good load and line regulation
- Fast transient response: T_{ON}/T_{OFF} = 80µs
- Low temperature coefficient
- Unconditionally stable with 1µF ceramic
- Fixed output: 3.3V
- 100mA replacement for 80mA MIC5213 and TC1016 (SP6213)
- 100mA replacement for 80mA NCP512 (SP6214)
- Tiny SC70-5 package

Applications

- Digital cordless phones
- Cellular phones
- PDAs
- Digital still cameras
- MP3 players
- Battery-powered equipment
- Medical devices
- Data cable

Typical Application

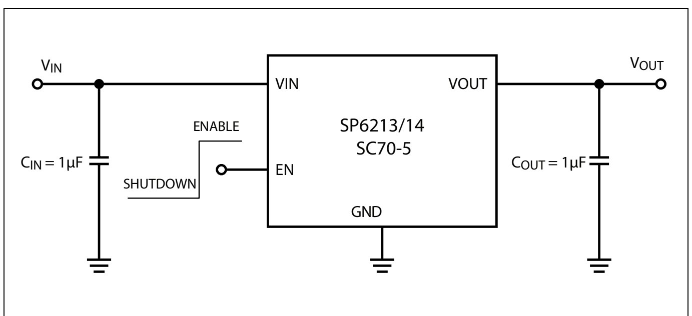

Figure 1: Typical Application

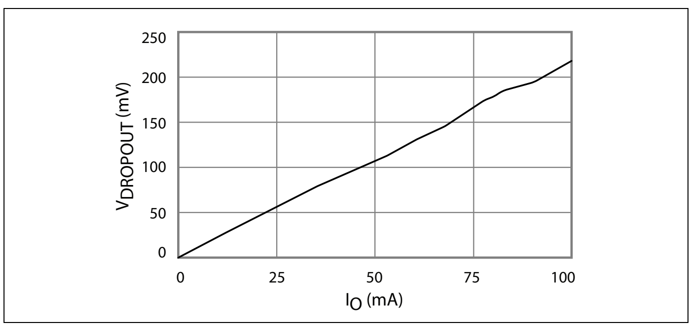

Figure 2: Dropout Voltage vs Output Current

Revision History

Revision	Release Date	Change Description
241DSR00	July 28, 2023	**Updated:** ■ New template applied, contents rewriting, and obsolete packages highlighted. ■ Subtitle of the document. ■ "General Description" section. ■ "Features" section. ■ "Specifications" section. ■ "Mechanical Dimensions—SC70-5" figure. ■ "Ordering Information" section. **Added:** ■ "Typical Application" section. ■ "Pin Configuration" section.
--	December 13, 2005	Legacy Sipex data sheet.

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Specifications

SP6213 available, SP6214 obsolete

Absolute Maximum Ratings

Important: The stresses above what is listed under the following table may cause permanent damage to the device. This is a stress rating only—functional operation of the device above what is listed under the following table or any other conditions beyond what MaxLinear recommends is not implied. Exposure to conditions above the recommended extended periods of time may affect device reliability. Solder reflow profile is specified in the *IPC/JEDEC J-STD-020C* standard. Devices are electrostatic discharge (ESD) sensitive. Handling precautions are recommended.

Table 1: Absolute Maximum Ratings

Parameter	Min	Max	Units
Supply Input Voltage	–2	7	V
Ouptut Voltage	–0.6	(V_{IN} + 1V)	V
Enable Input Voltage	–2	7	V
Power Dissipation	Internally Limited (1)		-
Lead Temperature (soldering 5s)	-	260	°C
Storage Temperature	–65	150	°C

1. The maximum allowable power dissipation at any T_A (ambient temperature) is $P_{D\ (MAX)} = (T_{J\ (MAX)} - T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation results in excessive die temperature and the regulator goes into thermal shutdown. The θ_{JA} of the SP6213/14 (SC70-5) is 330°C/W mounted on a PC board with minimum copper area (for more information, see “Thermal Considerations” on page 6).

Operating Conditions (1)

Table 2: Operating Conditions

Parameter	Min	Max	Units
Input Voltage	2.5	6	V
Enable Input Voltage	0	6	V
Junction Temperature	–40	125	°C

1. The maximum allowable power dissipation at any T_A (ambient temperature) is $P_{D\ (MAX)} = (T_{J\ (MAX)} - T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation results in excessive die temperature and the regulator goes into thermal shutdown. The θ_{JA} of the SP6213/14 (SC70-5) is 330°C/W mounted on a PC board with minimum copper area (for more information, see “Thermal Considerations” on page 6).

Thermal Specifications

Table 3: Thermal Performance

Symbol	Parameter	Package	Typ	Units
θ_{JA}	Junction to Ambient	SC70-5	330	°C/W

Electrical Characteristics

Electrical characteristics at $V_{IN} = V_{OUT} + 0.5V$, $I_L = 100\mu A$, $C_{IN} = 1\mu F$, $C_{OUT} = 1\mu F$, $T_J = 25°C$, unless otherwise specified. The • denotes the specifications that apply over the full temperature range of –40°C to 125°C, unless otherwise specified.

Table 4: Electrical Characteristics

Parameter	Conditions		Min	Typ	Max	Units
Output Voltage Accuracy	Variation from specified V_{OUT}		–2.5	-	2.5	%
		•	–4	-	4	%
Output Voltage Temperature Coefficient ($\Delta V_{OUT}/\Delta T$) (1)	-		-	60	-	ppm/°C
Minimum Supply Voltage	$I_{OUT} = 100\mu A$		-	2.50	2.70	V
	$I_{OUT} = 50mA$		-	2.55	2.85	V
	$I_{OUT} = 100mA$		-	2.75	3.00	V
Line Regulation ($\Delta V_{OUT}/V_{IN}$)	$V_{IN} = (V_{OUT} + 0.5V)$ to 6V	•	-	0.05	0.2	%/V
SP6213 – 1.8V Line Regulation	$V_{IN} = 2.8V$ to 6V	•	-	0.05	0.2	%/V
Load Regulation (2)	$I_L = 0.1mA$ to 100mA, $V_{IN} = V_{OUT} + 1V$	•	-	0.4	0.8	%
SP6213 – 1.8V Load Regulation	$I_L = 0.1mA$ to 100mA, $V_{IN} = 3.0V$	•	-	0.4	0.8	%
Dropout Voltage ($V_{IN} – V_{OUT}$) (3)	$I_L = 100\mu A$	•	-	0.25	4	mV
	$I_L = 50mA$	•	-	130	250	mV
	$I_L = 100mA$	•	-	250	500	mV
Quiescent Current	$V_{EN} \leq 0.4V$ (shutdown)	•	-	0.01	1	µA
	$V_{EN} \geq 1.6V$ (operating), $I_L = 0\mu A$	•	-	65	125	µA
Ground Pin Current (4)	$V_{EN} \geq 1.6V$, $I_L = 100\mu A$	•	-	65	125	µA
	$V_{EN} \geq 1.6V$, $I_L = 50mA$	•	-	100	175	µA
	$V_{EN} \geq 1.6V$, $I_L = 100mA$	•	-	135	250	µA
Power Supply Rejection Ratio (PSRR)	Frequency = 100Hz, $I_L = 10mA$		-	74	-	dB
	Frequency = 400Hz, $I_L = 10mA$		-	40	-	dB
Current Limit	-	•	120	190	350	mA
Thermal Limit	Turns on		-	168	-	°C
	Turns off		-	153	-	°C
Thermal Regulation ($\Delta V_{OUT}/\Delta P_D$) (5)	-		-	0.05	-	%/W
Output Noise	$I_L = 50mA$, $C_L = 1\mu F$, 10Hz to 100kHz		-	250	-	μV_{RMS}

Table 4: Electrical Characteristics (Continued)

Parameter	Conditions		Min	Typ	Max	Units
Enable Input						
Enable Input Logic-Low Voltage	Regulator shutdown	●	-	-	0.4	V
Enable Input Logic-High Voltage	Regulator enabled	●	1.6	-	-	V
Enable Input Current	$V_{IL} \leq 0.4V$	●	-	0.01	1	µA
	$V_{IH} \geq 1.6V$	●	-	0.01	1	µA
Turn-on Time	I_{OUT} = 50mA		-	80	165	µS
Turn-off Time	I_{OUT} = 100µA		-	80	175	µS
	I_{OUT} = 100mA		-	30	35	µS

1. Output voltage temperature coefficient is defined as the worst-case voltage change divided by the total temperature range.

2. Load regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

3. Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal value measured at 0.5V differential. Not applicable to output voltages less than 2.7V.

4. Ground pin current is the regulator quiescent current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

5. Thermal regulation is defined as the change in output voltage at a time t after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 100mA load pulse at V_{IN} = 6V for t = 10ms.

Pin Information

SP6213 available, SP6214 obsolete

Pin Configuration

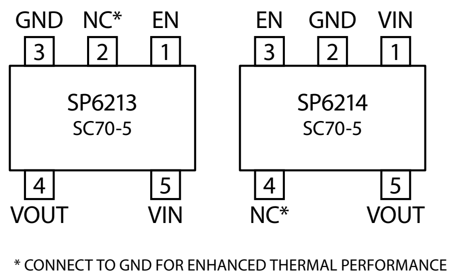


Figure 3: SP6213/14 Pinout (Top View)—SC70-5 Package

Pin Description

Table 5: Pin Description

Pin Number	Pin Name	Description
		SP6213
1	EN	Enable/shutdown (logic high = enable, logic low = shutdown).
2	NC	No connection.
3	GND	Ground connection.
4	VOUT	Regulator output.
5	VIN	Supply input.
		SP6214
1	VIN	Supply input.
2	GND	Ground connection.
3	EN	Enable/shutdown (logic high = enable, logic low = shutdown).
4	NC	No connection.
5	VOUT	Regulator output.

Block Diagram

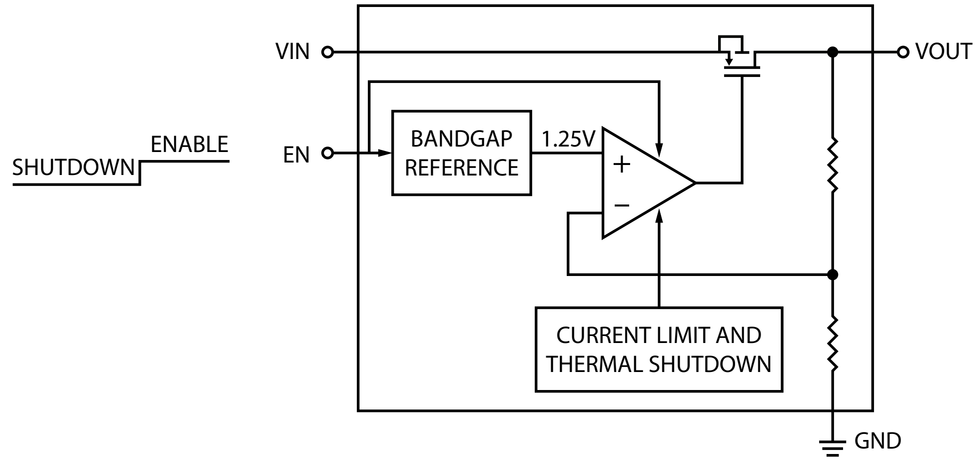


Figure 4: Functional Block Diagram

Application Information

SP6213 available, SP6214 obsolete

Enable/Shutdown Operation

The SP6213/14 is turned off by pulling the EN pin low and turned on by pulling it high. If this enable/shutdown feature is not required, EN should be tied to V_{IN} to keep the regulator output on at all times.

Input Capacitor

You can use any good quality ceramic or tantalum capacitor at the input. A small capacitor of about 1μF is required from V_{IN} to GND if, for instance, a battery is used as the input.

Output Capacitor

An output capacitor is required between V_{OUT} and GND to prevent oscillation. The minimum size of the output capacitor is a 0.47μF ceramic. The values given in the data sheet relate to an IC with a ceramic output capacitor of 1μF. Larger values make the IC more stable, which means an improvement of the regulator's transient response.
For a lower output current, the output capacitance can be chosen smaller in order to have the same output stability.

No Load Stability

The SP6213/14 remains stable and in regulation with no external load (other than the internal voltage driver), unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications.

Thermal Considerations

The SP6213/14 is designed to provide 100mA of continuous current in a very tiny package. Maximum power dissipation can be calculated based on the output current and the voltage drop across the part. To determine the maximum power dissipation of the package, use the junction-to-ambient thermal resistance of the device and the following basic equation:

$$P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$$

$T_{J(MAX)}$ is the maximum junction temperature of the die and is 125°C. T_A is the ambient operating temperature. θ_{JA} is the junction-to-ambient thermal resistance for the regulator and is layout-dependent. The actual power dissipation of the regulator circuit can be determined using one simple equation:

$$P_D = (V_{IN} - V_{OUT})^*I_{OUT} + V_{IN}^*I_{GND}$$

Substituting $P_{D(MAX)}$ for P_D and solving for the operating conditions that are critical to the application gives the maximum operating conditions for the regulator circuit. For example, if you are operating the SP6213/14 at 3.0V output at room temperature, with a minimum footprint layout, the maximum input voltage for a set output current can be determined as follows:

$$P_{D(MAX)} = [(125°C - 25°C)/(330°C/W)] = 303mW$$

To prevent the device from entering thermal shutdown, the maximum power dissipation cannot be exceeded. Using the output voltage of 3.0V and an output current of 100mA, the maximum input voltage can be determined. You can find the ground pin current values in "Electrical Characteristics" on page 2 (0.135mA at 100mA load current).

The maximum input voltage is determined as follows:

$$303mW = (V_{IN} - 3.0V)^*100mA \text{ load current} + V_{IN}^*0.135mA$$

Calculations show that the maximum input voltage of a 3.0V application at 100mA of output current in an SC70-5 package is 6.02V.

Typical Performance Characteristics

27°C, V_{IN} = 4V, I_L = 100µA, C_{IN} = C_{OUT} = 1µF, unless otherwise specified.

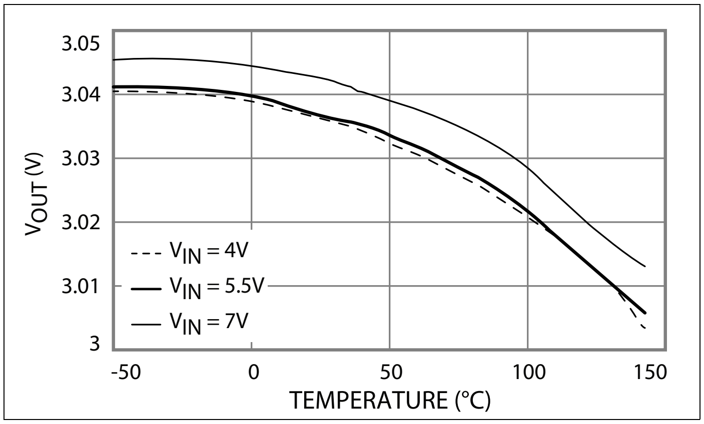


Figure 5: Output Voltage vs Temperature (I_{OUT} = 0.1mA)

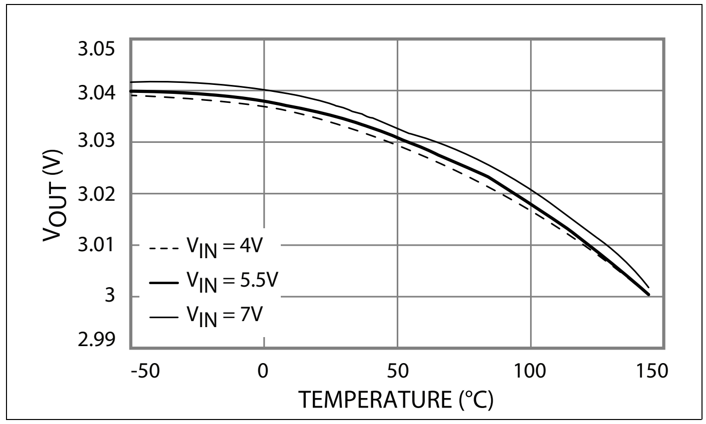


Figure 6: Output Voltage vs Temperature (I_{OUT} = 10mA)

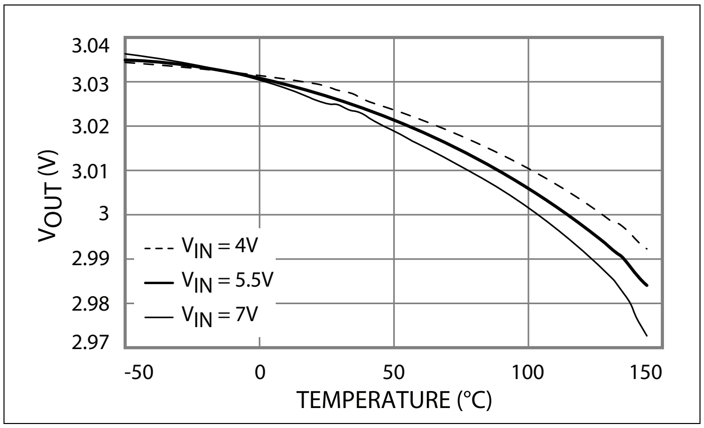


Figure 7: Output Voltage vs Temperature (I_{OUT} = 50mA)

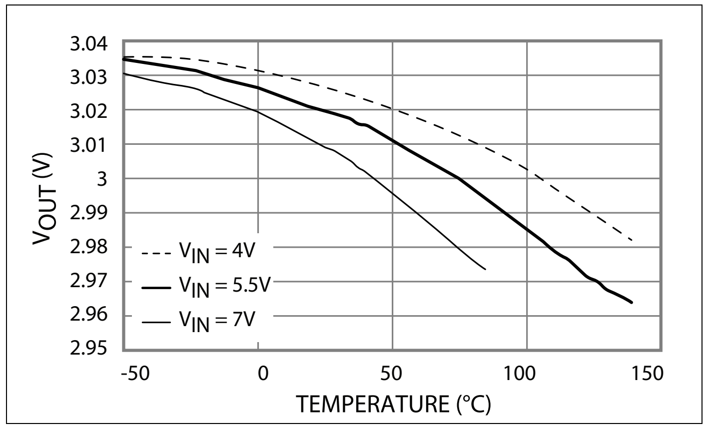


Figure 8: Output Voltage vs Temperature (I_{OUT} = 100mA)

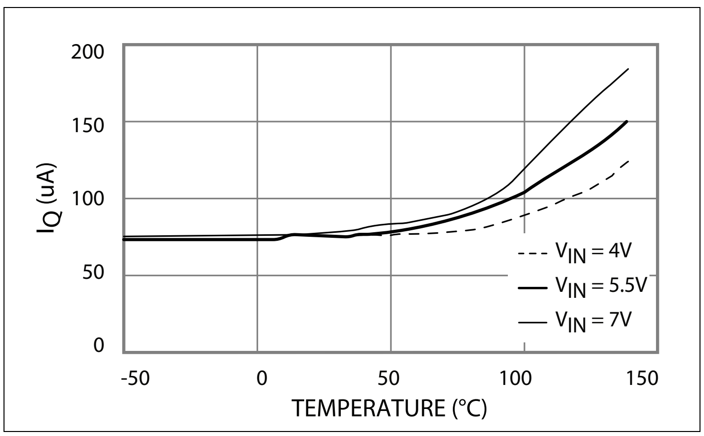


Figure 9: Quiescent Current vs Temperature (I_{OUT} = 0A)

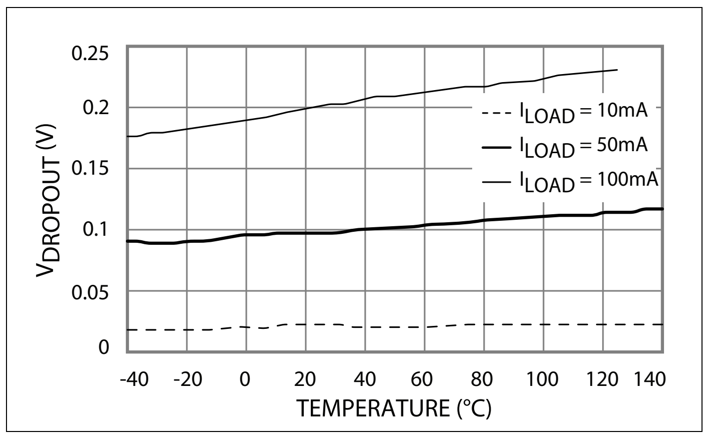


Figure 10: Dropout Voltage vs Temperature

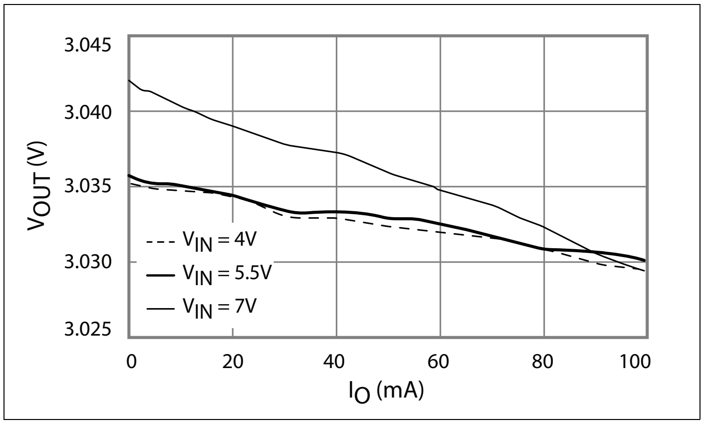


Figure 11: Output Voltage vs Output Current

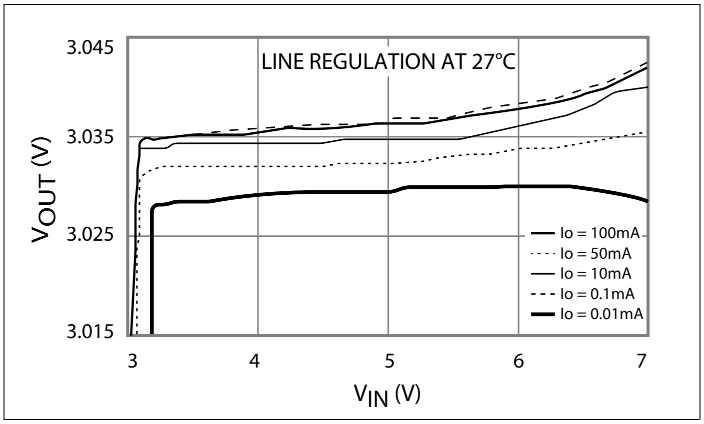


Figure 12: Output Voltage vs Input Voltage

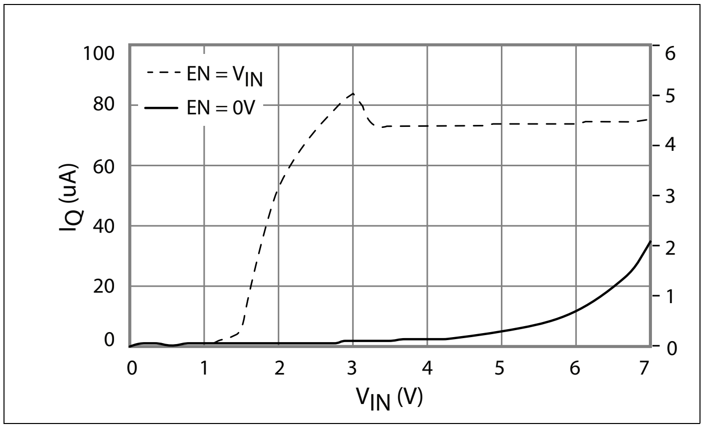


Figure 13: Quiescent Current vs Input Voltage

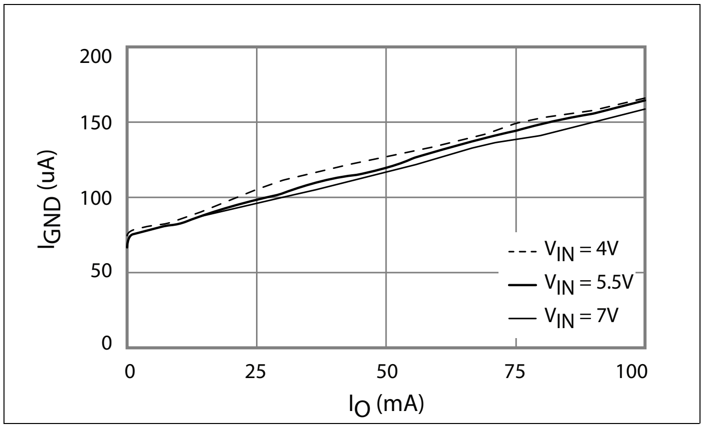


Figure 14: Ground Current vs Output Current

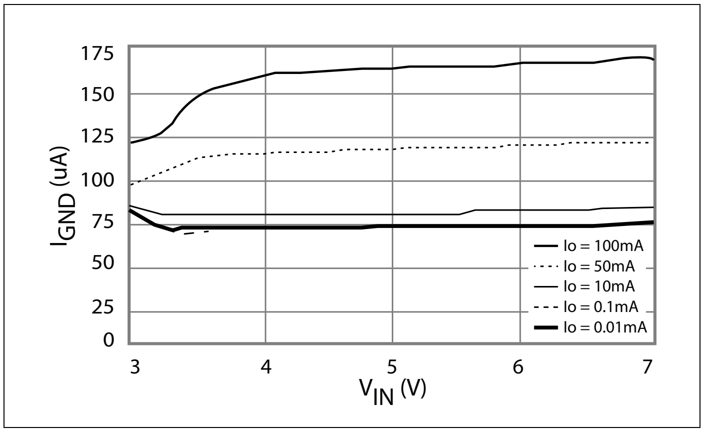


Figure 15: Ground Current vs Input Voltage

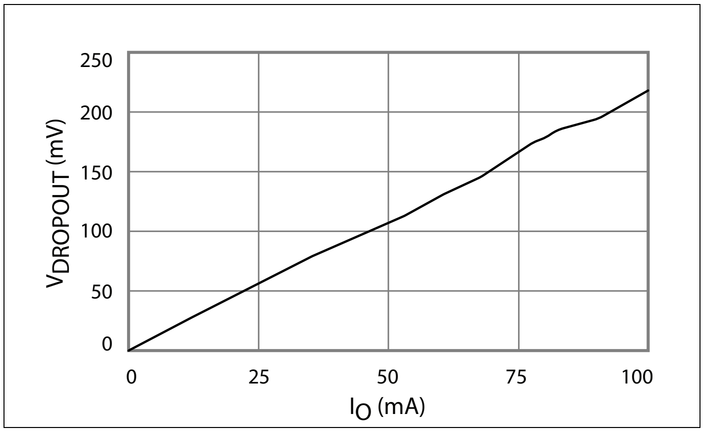


Figure 16: Dropout Voltage vs Output Current

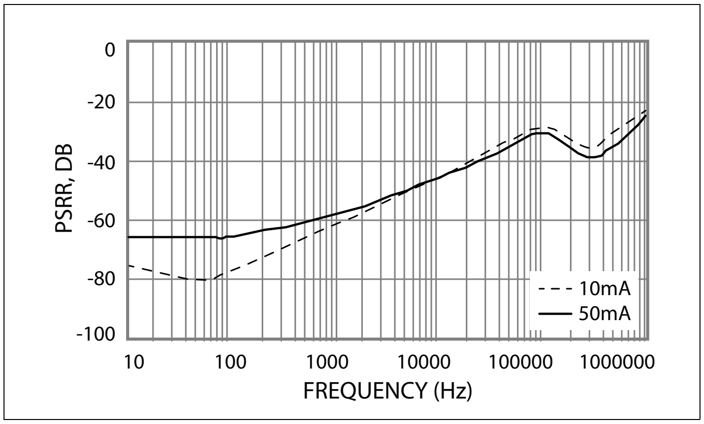


Figure 17: Power Supply Rejection Ratio (V_O = 3V)

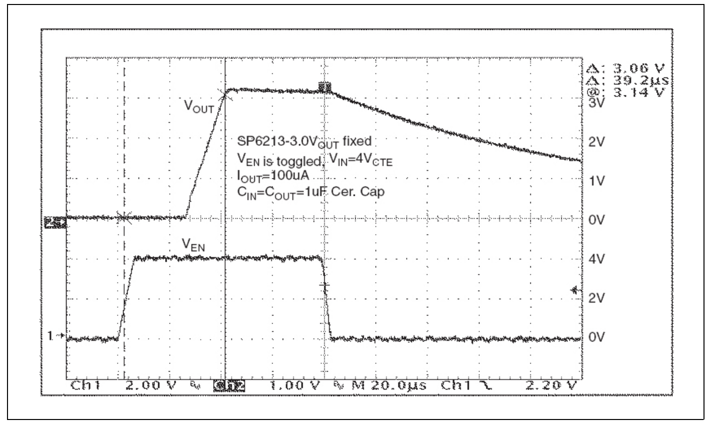


Figure 18: Turn-on Characteristic (V_{IN} = 4V, I_{OUT} = 100µA)

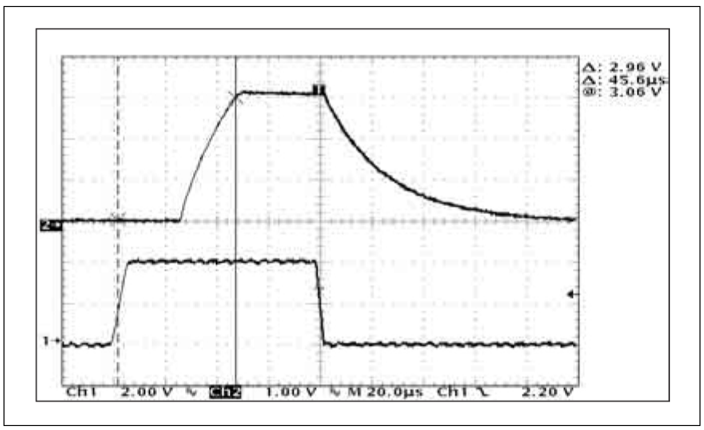


Figure 19: Turn-on Characteristic (V_{IN} = 4V, I_{OUT} = 100mA)

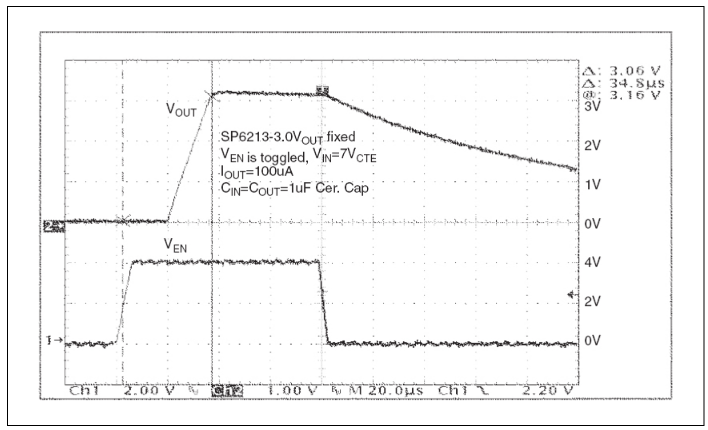


Figure 20: Turn-on Characteristic (V_{IN} = 7V, I_{OUT} = 100µA)

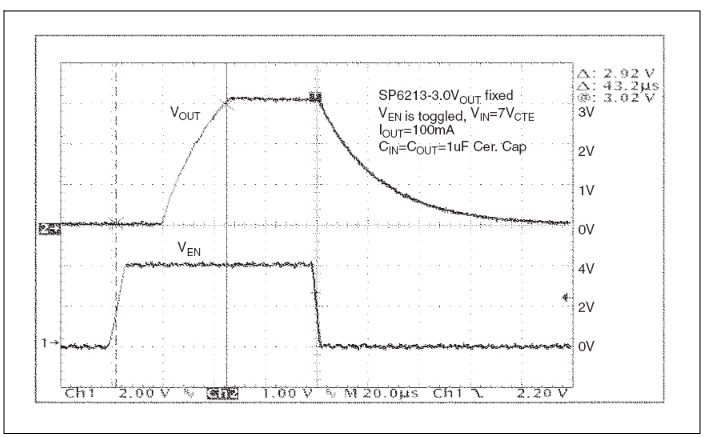


Figure 21: Turn-on Time (V_{IN} = 7V, I_{OUT} = 100mA)

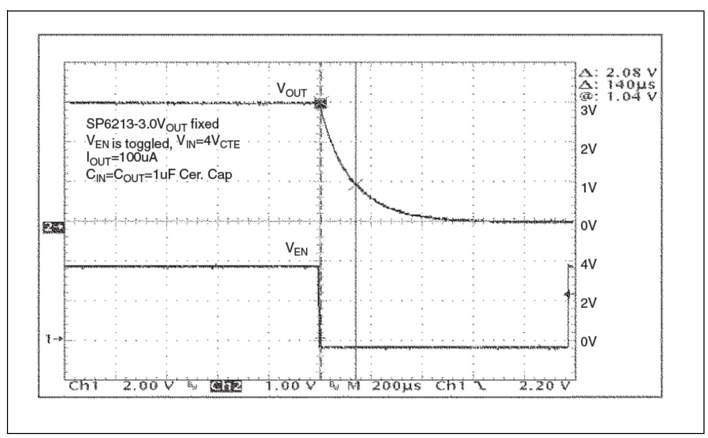


Figure 22: Turn-off Time (V_{IN} = 4V, I_{OUT} = 100µA)

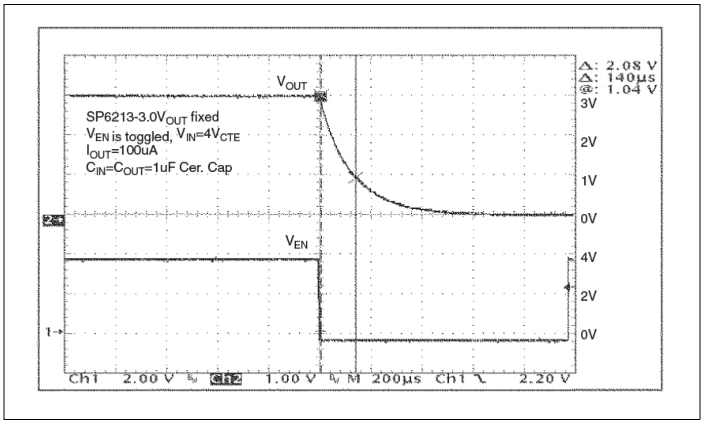


Figure 23: **Turn-off Time (V_{IN} = 4V, I_{OUT} = 100mA)**

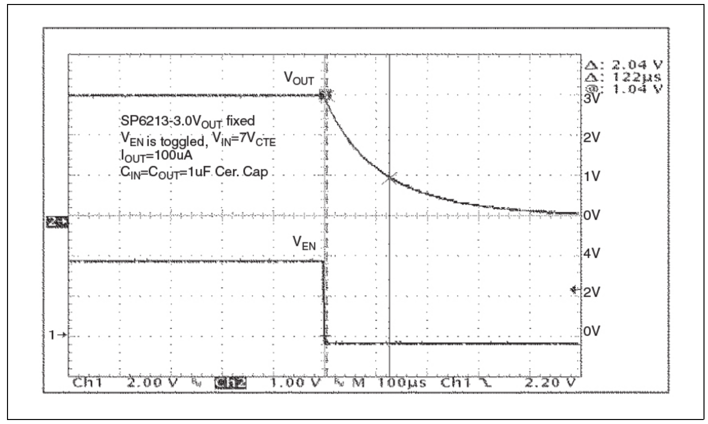


Figure 24: **Turn-off Time (V_{IN} = 7V, I_{OUT} = 100µA)**

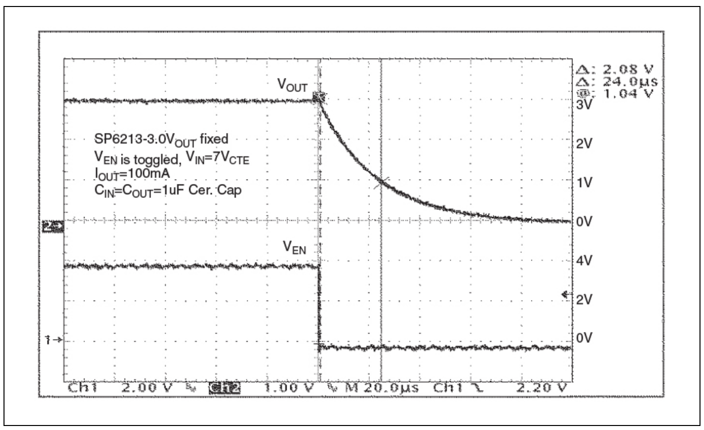


Figure 25: **Turn-off Time (V_{IN} = 7V, I_{OUT} = 100mA)**

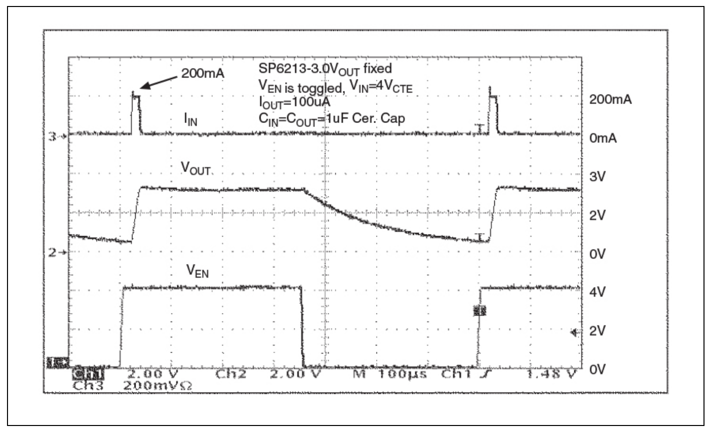


Figure 26: **Inrush Current (V_{IN} = 4V, I_{OUT} = 100µA)**

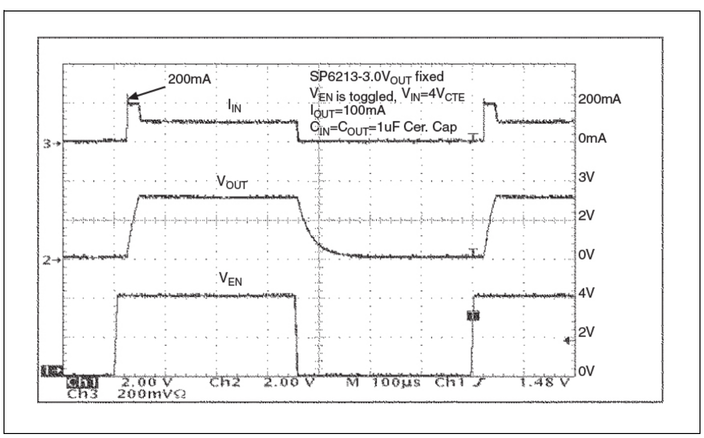


Figure 27: **Inrush Current (V_{IN} = 4V, I_{OUT} = 100mA)**

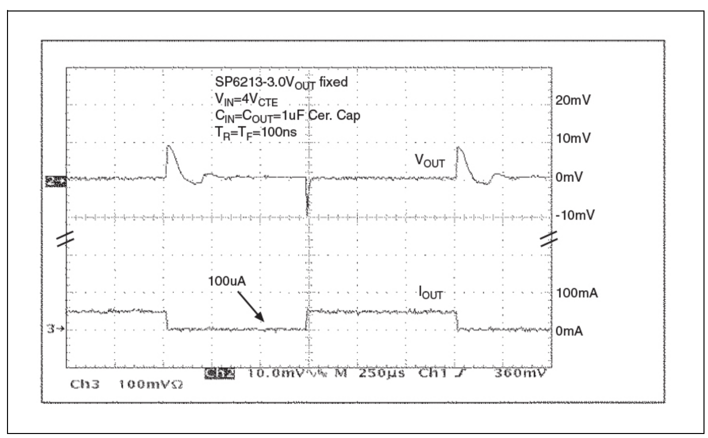


Figure 28: **Load Transient Response (V_{IN} = 4V)**

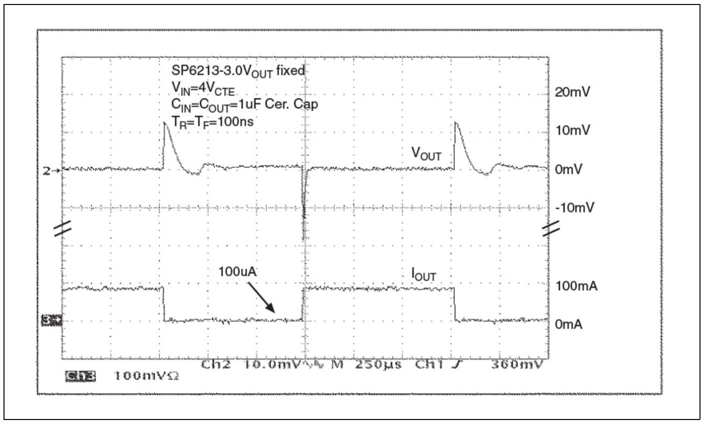


Figure 29: Load Transient Response (V_{IN} = 4V)

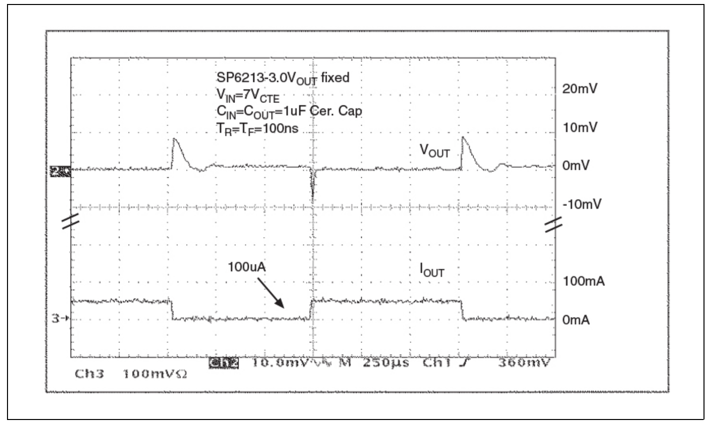


Figure 30: Load Transient Response (V_{IN} = 7V)

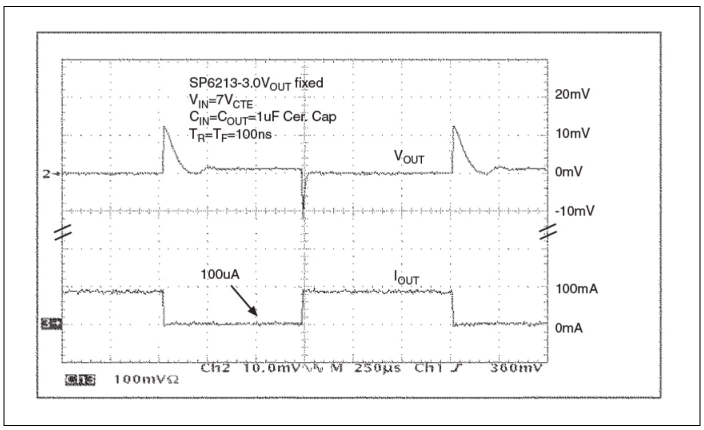


Figure 31: Load Transient Response (V_{IN} = 7V)

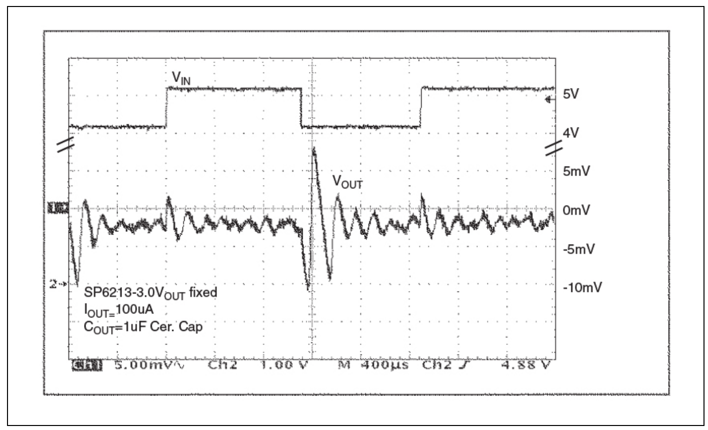


Figure 32: Line Transient Response (V_{IN} = 4V, I_{OUT} = 100µA)

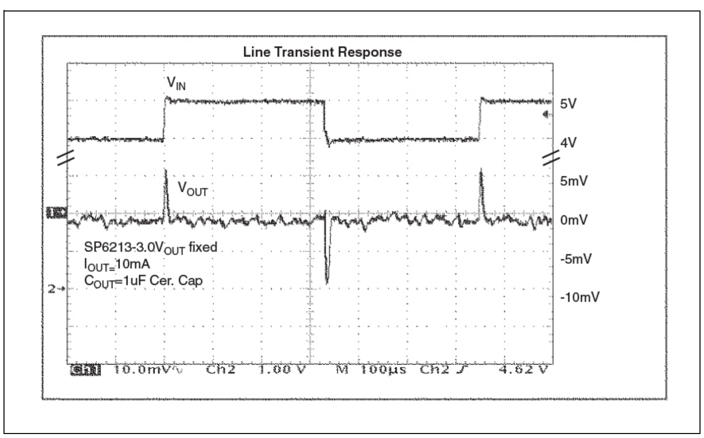


Figure 33: Line Transient Response (V_{IN} = 4V, I_{OUT} = 10mA)

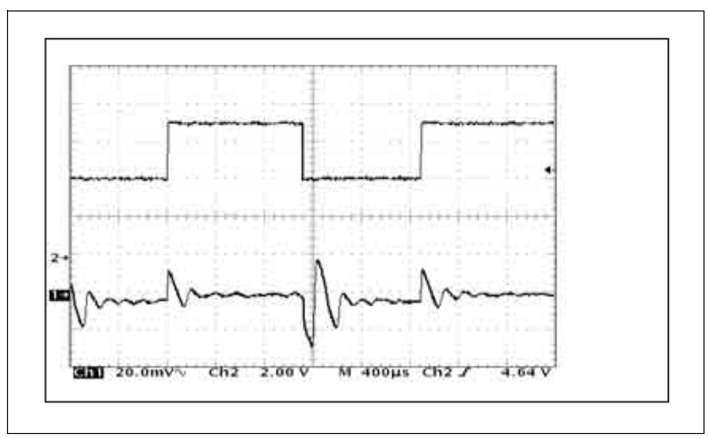


Figure 34: Line Transient Response (V_{IN} = 7V, I_{OUT} = 100µA)

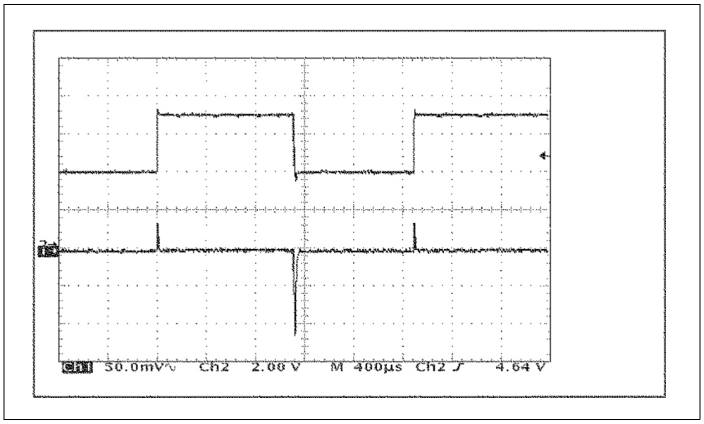
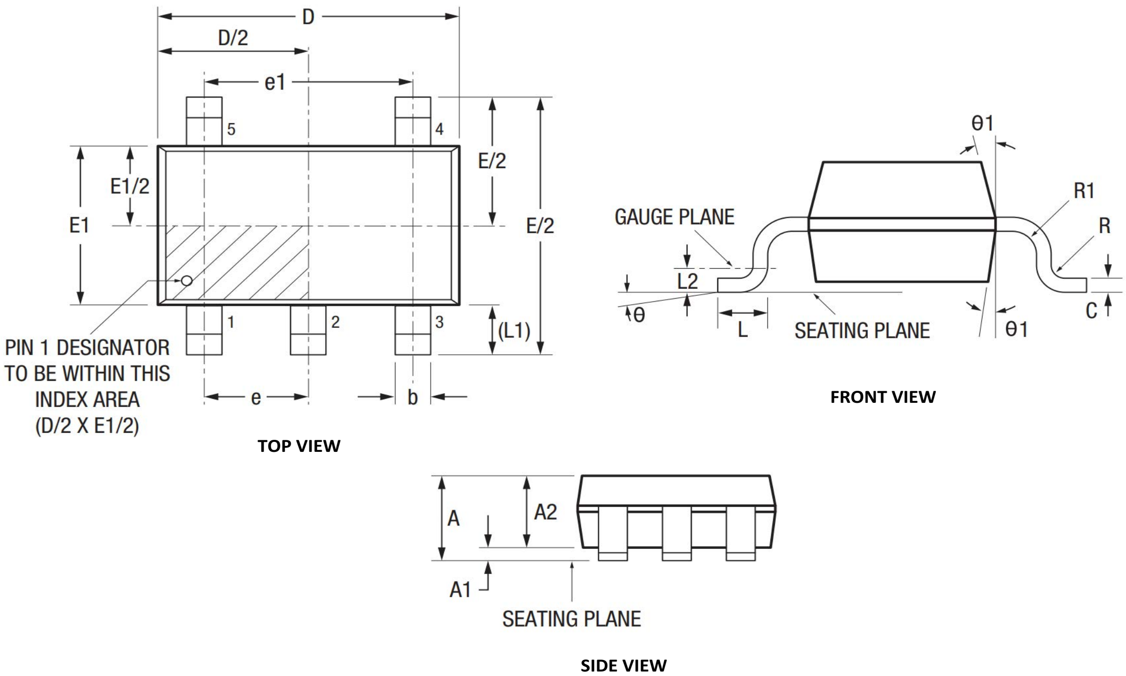


Figure 35: **Line Transient Response (V_{IN} = 7V, I_{OUT} = 10µA)**

Mechanical Dimensions

SC70-5

SP6213 available, SP6214 obsolete



5-Pin SC70 (JEDEC MO-203) Variation AA						
Symbols	Dimension in mm (Control Unit)			Dimension in inches (1 inch = 25.40mm)		
	Min	Nom	Max	Min	Nom	Max
A	-	-	1.10	-	-	0.043
A1	0.00	-	0.10	0.000	-	0.004
A2	0.70	0.90	1.00	0.028	0.036	0.039
c	0.08	-	0.22	0.004	-	0.009
D	2.00 BSC			0.079 BSC		
E	2.10 BSC			0.083 BSC		
E1	1.25 BSC			0.049 BSC		
L	0.26	0.36	0.46	0.011	0.014	0.018
L1	0.42 Ref			0.017 Ref		
L2	0.15 BSC			0.006 BSC		
R	0.10	-	-	0.004	-	-
R1	0.10		0.25	0.004	-	0.01
θ	0°	4°	8°	0°	4°	8°
θ1	4°	-	12°	4°	-	12°
b	0.15	-	0.30	0.006	-	0.012
e	0.65 BSC			0.026 BSC		
e1	1.30 BSC			0.051 BSC		

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Figure 36: Mechanical Dimensions—SC70-5