SCY99226

Ultra-Low I_Q 150 mA CMOS LDO Regulator

The SCY99226 series of CMOS low dropout regulators are designed specifically for portable battery-powered applications which require ultra-low quiescent current. The ultra-low consumption of typ. 500 nA ensures long battery life and dynamic transient boost feature improves device transient response for wireless communication applications. The device is available in small 1 × 1 mm xDFN4 package.

Features

- Operating Input Voltage Range: 2.2 V to 5.5 V
- Output Voltage: 1.2 V, 1.8 V, 3.3 V
- Ultra-Low Quiescent Current Typ. 0.5 μA
- Low Dropout: 170 mV Typ. at 150 mA
- High Output Voltage Accuracy ±1%
- Stable with Ceramic Capacitors 1 μF
- Over-Current Protection
- Thermal Shutdown Protection
- Active Discharge
- Available in Small 1 × 1 mm xDFN4 Package
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Typical Applications

- Battery Powered Equipments
- Portable Communication Equipments
- Cameras, Image Sensors and Camcorders

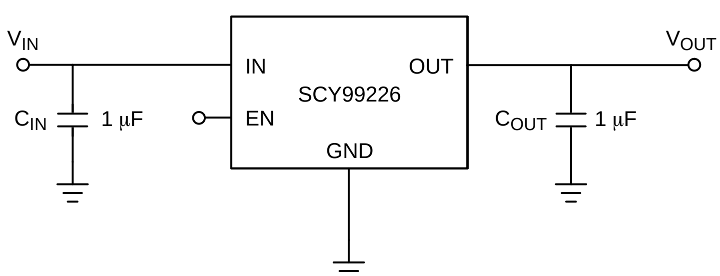
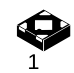


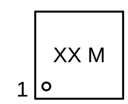
Figure 1. Typical Application Schematics



XDFN4
MX SUFFIX
CASE 711AJ

MARKING DIAGRAM

XDFN4



XX = Specific Device Code
M = Date Code

ORDERING INFORMATION

See detailed ordering, marking and shipping information on page 11 of this data sheet.

PIN FUNCTION DESCRIPTION

Pin No. XDFN4	Pin Name	Description
4	IN	Power Supply Input Voltage
2	GND	Power Supply Ground
3	EN	Chip Enable Pin (Active "H")
1	OUT	Output Pin
EPAD	EPAD	Internally Connected to GND

ABSOLUTE MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_{IN}	Input Voltage (Note 1)	6.0	V
V_{OUT}	Output Voltage	−0.3 to V_{IN} + 0.3	V
V_{CE}	Chip Enable Input	−0.3 to 6.0	V
$T_{J(MAX)}$	Maximum Junction Temperature	150	°C
T_{STG}	Storage Temperature	−55 to 150	°C
ESD_{HBM}	ESD Capability, Human Body Model (Note 2)	2000	V
ESD_{MM}	ESD Capability, Machine Model (Note 2)	200	V

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Refer to ELECTRICAL CHARACTERISTIS and APPLICATION INFORMATION for Safe Operating Area.
2. This device series incorporates ESD protection and is tested by the following methods:
   ESD Human Body Model tested per AEC-Q100-002 (EIA/JESD22-A114)
   ESD Machine Model tested per AEC-Q100-003 (EIA/JESD22-A115)
   Latchup Current Maximum Rating tested per JEDEC standard: JESD78

THERMAL CHARACTERISTICS

Symbol	Rating	Value	Unit
$R_{\theta JA}$	Thermal Characteristics, Thermal Resistance, Junction-to-Air XDFN4 1 × 1 mm	250	°C/W

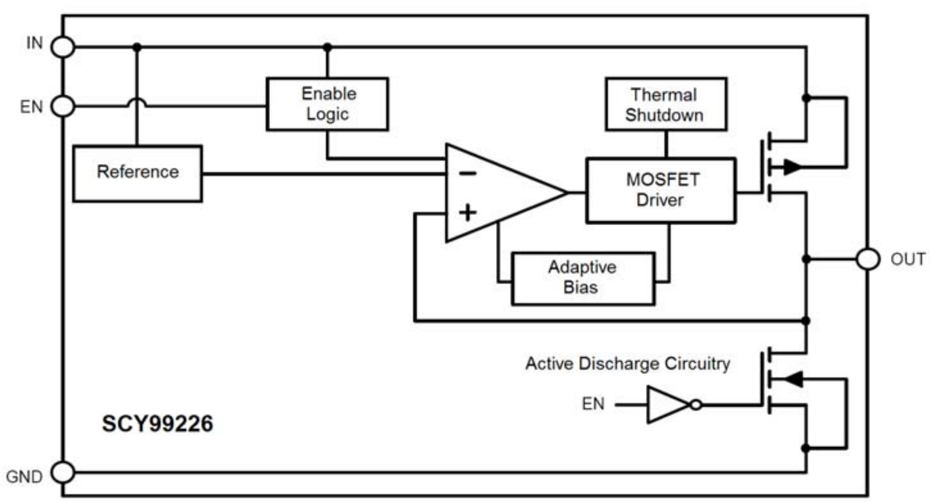


Figure 2. Simplified Block Diagram

ELECTRICAL CHARACTERISTICS − VOLTAGE VERSION 1.2 V

(−40°C ≤ T_J ≤ 85°C; V_{IN} = 2.5 V; I_{OUT} = 1 mA, C_{IN} = C_{OUT} = 1.0 μF, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 3)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Operating Input Voltage		2.2	−	5.5	V
V_{OUT}	Output Voltage	T_A = +25°C	1.188	1.2	1.212	V
		−40°C ≤ T_J ≤ 85°C	1.176	1.2	1.224	
$Line_{Reg}$	Line Regulation	2.5 V < V_{IN} ≤ 5.5 V, I_{OUT} = 1 mA	−	0.05	0.20	%/V
$Load_{Reg}$	Load Regulation	0 mA < I_{OUT} ≤ 150 mA, V_{IN} = 2.5 V	−20	1	20	mV
V_{DO}	Dropout Voltage	(Note 4)	−	−	−	mV
I_{OUT}	Output Current	(Note 5)	150	−	−	mA
I_{SC}	Short Circuit Current Limit	V_{OUT} = 0 V	−	225	−	mA
I_Q	Quiescent Current	I_{OUT} = 0 mA	−	0.5	0.9	μA
I_{STB}	Standby Current	V_{EN} = 0 V, T_J = 25°C	−	0.1	0.5	μA
V_{ENH}	EN Pin Threshold Voltage	EN Input Voltage “H”	1.2	−	−	V
V_{ENL}	EN Pin Threshold Voltage	EN Input Voltage “L”	−	−	0.4	V
I_{EN}	EN Pin Current	V_{EN} ≤ V_{IN} ≤ 5.5 V (Note 6)	−	10	−	nA
PSRR	Power Supply Rejection Ratio	f = 1 kHz, V_{IN} = 2.2 V + 200 mVpp Modulation I_{OUT} = 150 mA I_{OUT} = 10 mA	 − −	 57 63	 − −	dB
V_{NOISE}	Output Noise Voltage	V_{IN} = 5.5 V, I_{OUT} = 1 mA, f = 100 Hz to 1 MHz, C_{OUT} = 1 μF	−	85	−	μVrms
R_{LOW}	Active Output Discharge Resistance (A option only)	V_{IN} = 5.5 V, V_{EN} = 0 V (Note 6)	−	100	−	Ω
T_{SD}	Thermal Shutdown Temperature	Temperature Increasing from T_J = +25°C (Note 6)	−	175	−	°C
T_{SDH}	Thermal Shutdown Hysteresis	Temperature Falling from T_{SD} (Note 6)	−	25	−	°C

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. Performance guaranteed over the indicated operating temperature range by design and/or characterization production tested at T_J = T_A = 25°C. Low duty cycle pulse techniques are used during testing to maintain the junction temperature as close to ambient as possible.
4. Not Characterized at V_{IN} = 2.2 V, V_{OUT} = 1.2 V, I_{OUT} = 150 mA.
5. Respect SOA.
6. Guaranteed by design and characterization.

ELECTRICAL CHARACTERISTICS − VOLTAGE VERSION 1.8 V

(−40°C ≤ T_J ≤ 85°C; V_{IN} = 2.8 V; I_{OUT} = 1 mA, C_{IN} = C_{OUT} = 1.0 μF, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 7)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Operating Input Voltage		2.2	−	5.5	V
		I_{OUT} < 30 mA	2.0	−	5.5	
V_{OUT}	Output Voltage	T_A = +25°C	1.782	1.8	1.818	V
		−40°C ≤ T_J ≤ 85°C	1.764	1.8	1.836	
$Line_{Reg}$	Line Regulation	2.8 V < V_{IN} ≤ 5.5 V, I_{OUT} = 1 mA	−	0.05	0.20	%/V
$Load_{Reg}$	Load Regulation	0 mA < I_{OUT} ≤ 150 mA, V_{IN} = 2.8 V	−20	1	20	mV
V_{DO}	Dropout Voltage	I_{OUT} = 150 mA (Note 8)	−	350	480	mV
I_{OUT}	Output Current	(Note 9)	150	−	−	mA
I_{SC}	Short Circuit Current Limit	V_{OUT} = 0 V	−	225	−	mA
I_Q	Quiescent Current	I_{OUT} = 0 mA	−	0.5	0.9	μA
I_{STB}	Standby Current	V_{EN} = 0 V, T_J = 25°C	−	0.1	0.5	μA
V_{ENH}	EN Pin Threshold Voltage	EN Input Voltage “H”	1.2	−	−	V
V_{ENL}	EN Pin Threshold Voltage	EN Input Voltage “L”	−	−	0.4	V
I_{EN}	EN Pull Down Current	V_{EN} ≤ V_{IN} ≤ 5.5 V (Note 10)	−	10	−	nA
PSRR	Power Supply Rejection Ratio	f = 1 kHz, V_{IN} = 2.8 V + 200 mVpp Modulation I_{OUT} = 150 mA	−	57	−	dB
V_{NOISE}	Output Noise Voltage	V_{IN} = 5.5 V, I_{OUT} = 1 mA f = 100 Hz to 1 MHz, C_{OUT} = 1 μF	−	95	−	μVrms
R_{LOW}	Active Output Discharge Resistance (A option only)	V_{IN} = 5.5 V, V_{EN} = 0 V (Note 10)	−	100	−	Ω
T_{SD}	Thermal Shutdown Temperature	Temperature Increasing from T_J = +25°C (Note 10)	−	175	−	°C
T_{SDH}	Thermal Shutdown Hysteresis	Temperature Falling from T_{SD} (Note 10)	−	25	−	°C

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

7. Performance guaranteed over the indicated operating temperature range by design and/or characterization production tested at T_J = T_A = 25°C. Low duty cycle pulse techniques are used during testing to maintain the junction temperature as close to ambient as possible.
8. Characterized when V_{OUT} falls 54 mV below the regulated voltage and only for devices with V_{OUT} = 1.8 V.
9. Respect SOA.
10. Guaranteed by design and characterization.

ELECTRICAL CHARACTERISTICS − VOLTAGE VERSION 3.3 V

($-40°C \le T_J \le 85°C$; V_{IN} = 4.3 V; I_{OUT} = 1 mA, C_{IN} = C_{OUT} = 1.0 μF, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 11)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Operating Input Voltage		2.2	−	5.5	V
V_{OUT}	Output Voltage	T_A = +25°C	3.267	3.3	3.333	V
		$-40°C \le T_J \le 85°C$	3.234	3.3	3.366	
$Line_{Reg}$	Line Regulation	4.3 V < $V_{IN} \le$ 5.5 V, I_{OUT} = 1 mA	−	0.05	0.20	%/V
$Load_{Reg}$	Load Regulation	0 mA < $I_{OUT} \le$ 150 mA, V_{IN} = 4.3 V	−20	1	20	mV
V_{DO}	Dropout Voltage	I_{OUT} = 150 mA (Note 12)	−	180	250	mV
I_{OUT}	Output Current	(Note 13)	150	−	−	mA
I_{SC}	Short Circuit Current Limit	V_{OUT} = 0 V	−	195	−	mA
I_Q	Quiescent Current	I_{OUT} = 0 mA	−	0.5	0.9	μA
I_{STB}	Standby Current	V_{EN} = 0 V, T_J = 25°C	−	0.1	0.5	μA
V_{ENH}	EN Pin Threshold Voltage	EN Input Voltage “H”	1.2	−	−	V
V_{ENL}	EN Pin Threshold Voltage	EN Input Voltage “L”	−	−	0.4	V
I_{EN}	EN Pull Down Current	$V_{EN} \le V_{IN} \le$ 5.5 V (Note 14)	−	10	−	nA
PSRR	Power Supply Rejection Ratio	f = 1 kHz, V_{IN} = 4.3 V + 200 mVpp Modulation I_{OUT} = 150 mA	−	41	−	dB
V_{NOISE}	Output Noise Voltage	V_{IN} = 5.5 V, I_{OUT} = 1 mA f = 100 Hz to 1 MHz, C_{OUT} = 1 μF	−	125	−	μVrms
R_{LOW}	Active Output Discharge Resistance (A option only)	V_{IN} = 5.5 V, V_{EN} = 0 V (Note 14)	−	100	−	Ω
T_{SD}	Thermal Shutdown Temperature	Temperature Increasing from T_J = +25°C (Note 14)	−	175	−	°C
T_{SDH}	Thermal Shutdown Hysteresis	Temperature Falling from T_{SD} (Note 14)	−	25	−	°C

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

11. Performance guaranteed over the indicated operating temperature range by design and/or characterization production tested at $T_J = T_A$ = 25°C. Low duty cycle pulse techniques are used during testing to maintain the junction temperature as close to ambient as possible.
12. Characterized when V_{OUT} falls 99 mV below the regulated voltage and only for devices with V_{OUT} = 3.3 V.
13. Respect SOA.
14. Guaranteed by design and characterization.

TYPICAL CHARACTERISTICS

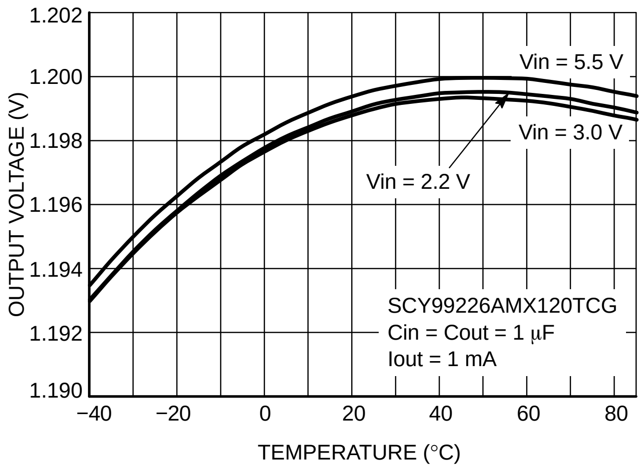


Figure 3. Output Voltage vs. Temperature, Vout = 1.2 V

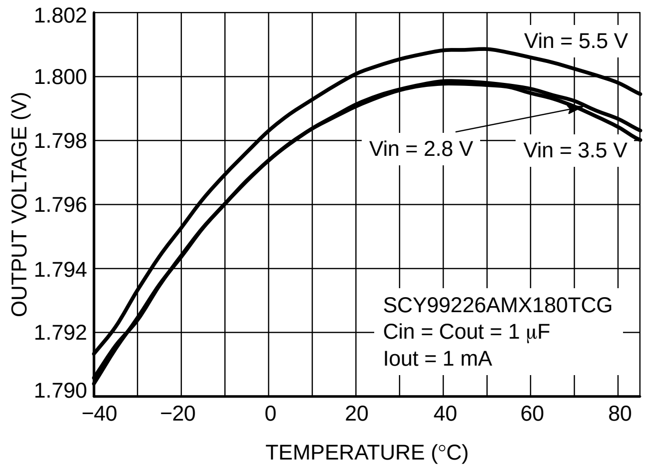


Figure 4. Output Voltage vs. Temperature, Vout = 1.8 V

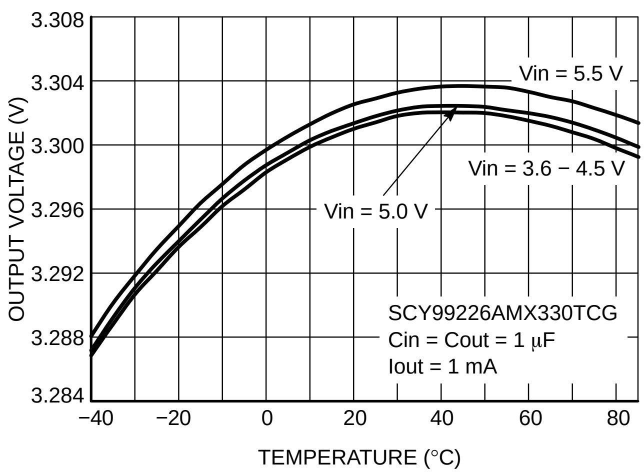


Figure 5. Output Voltage vs. Temperature, Vout = 3.3 V

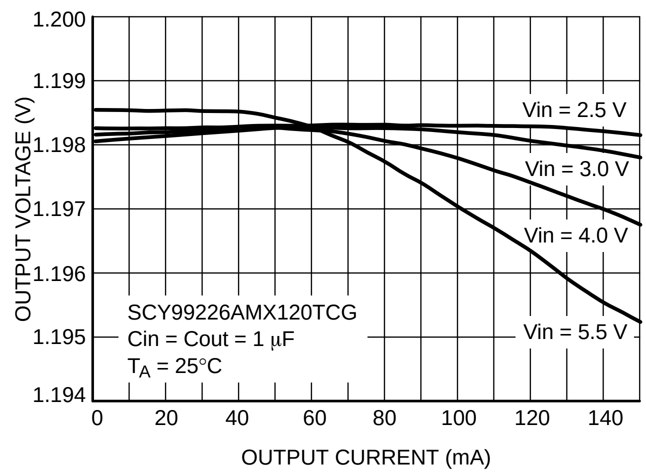


Figure 6. Output Voltage vs. Output Current, Vout = 1.2 V

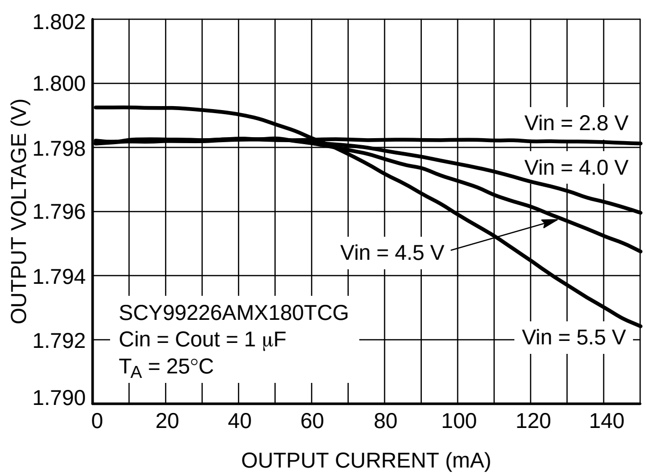


Figure 7. Output Voltage vs. Output Current, Vout = 1.8 V

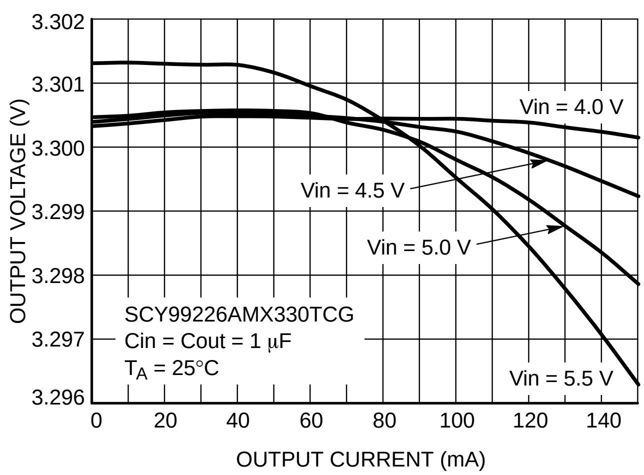


Figure 8. Output Voltage vs. Output Current, Vout = 3.3 V

TYPICAL CHARACTERISTICS

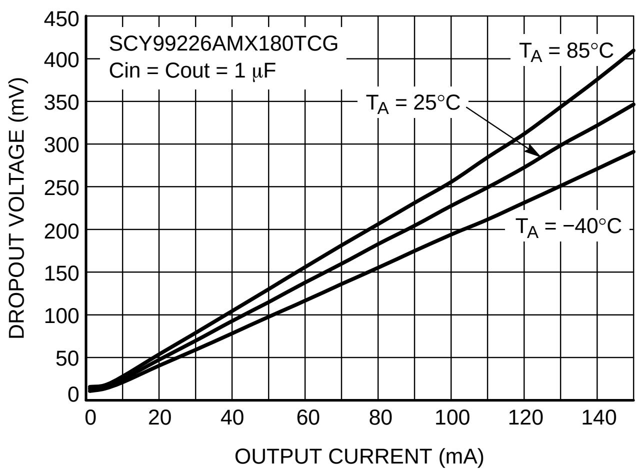


Figure 9. Dropout Voltage vs. Output Current, Vout = 1.8 V

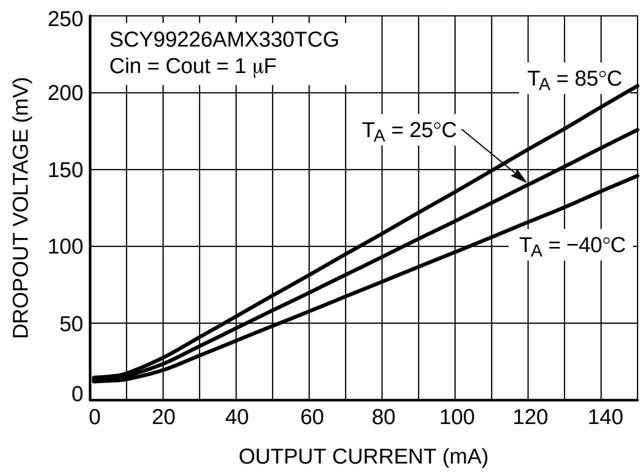


Figure 10. Dropout Voltage vs. Output Current, Vout = 3.3 V

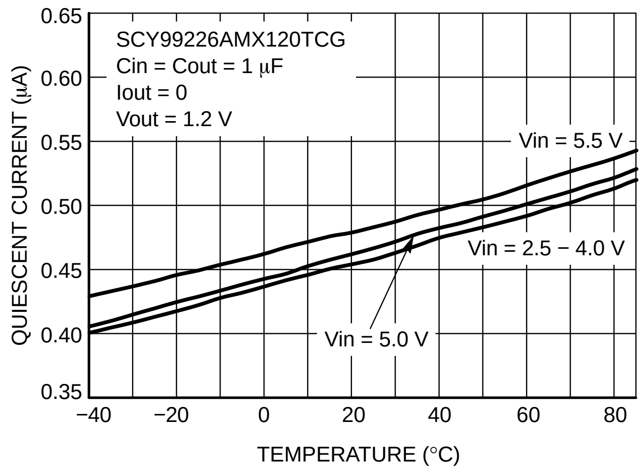


Figure 11. Quiescent Current vs. Temperature, Vout = 1.2 V

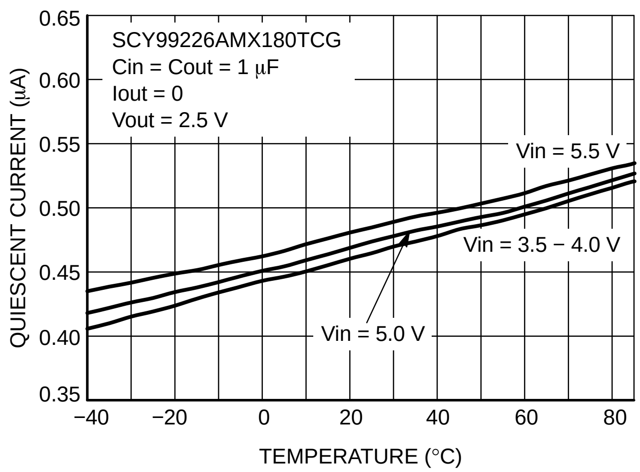


Figure 12. Quiescent Current vs. Temperature, Vout = 1.8 V

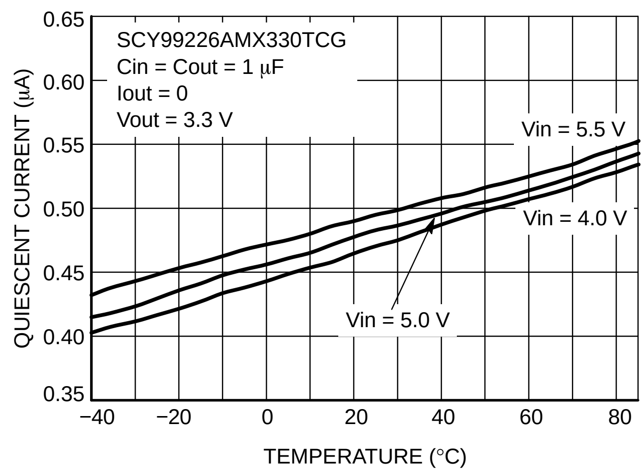


Figure 13. Quiescent Current vs. Temperature, Vout = 3.3 V

TYPICAL CHARACTERISTICS

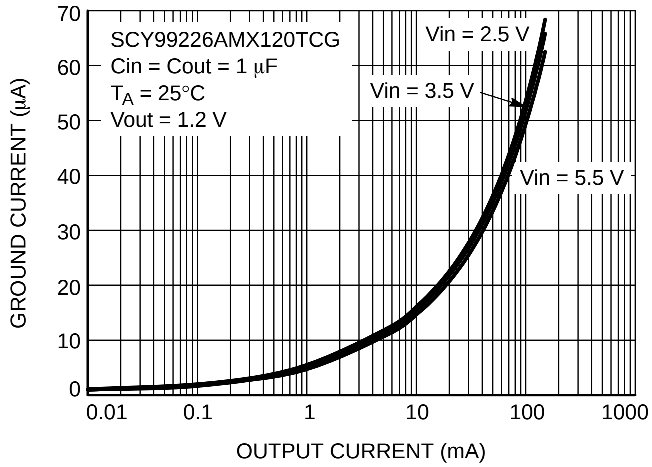


Figure 14. Ground Current vs. Output Current, Vout = 1.2 V

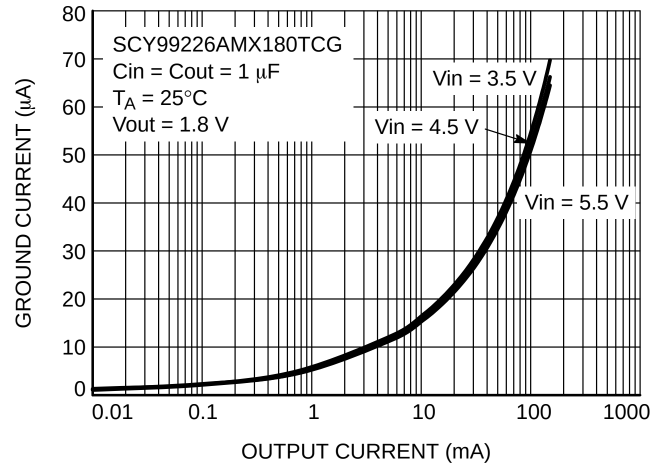


Figure 15. Ground Current vs. Output Current, Vout = 1.8 V

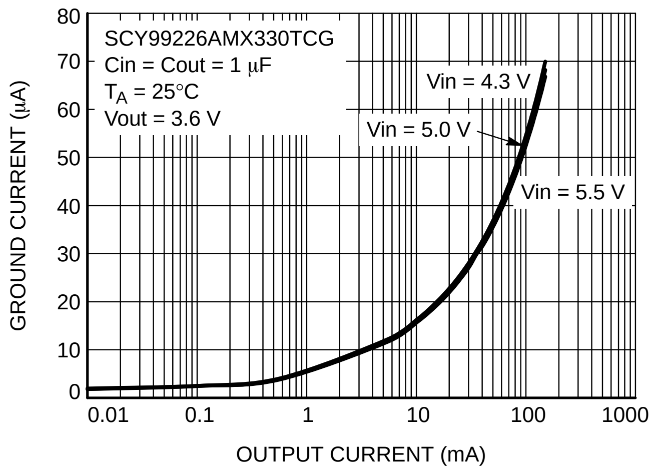


Figure 16. Ground Current vs. Output Current, Vout = 3.3 V

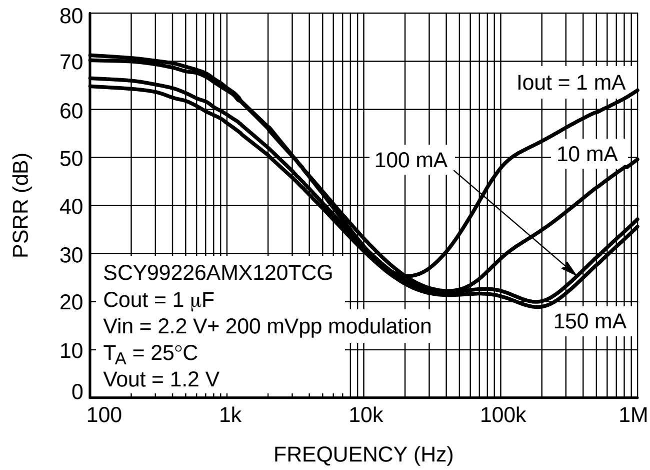


Figure 17. PSRR vs. Frequency, Vout = 1.2 V

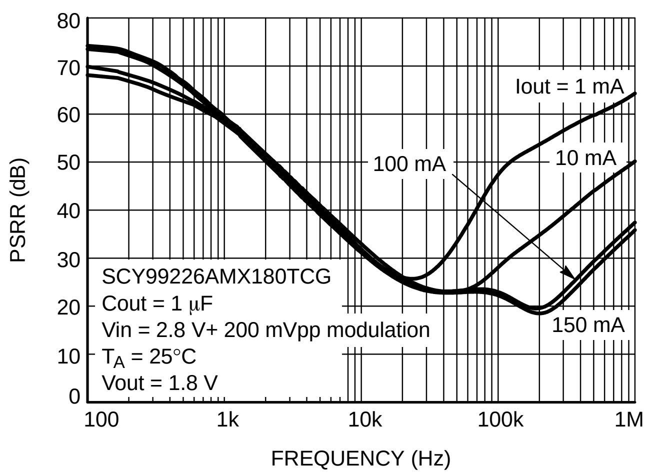


Figure 18. PSRR vs. Frequency, Vout = 1.8 V

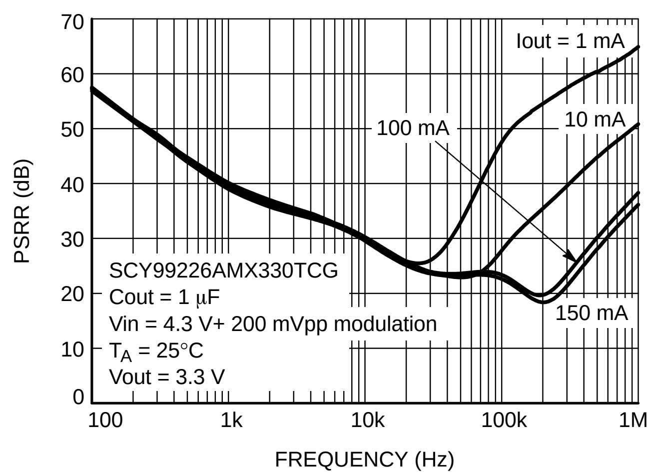


Figure 19. PSRR vs. Frequency, Vout = 3.3 V

TYPICAL CHARACTERISTICS

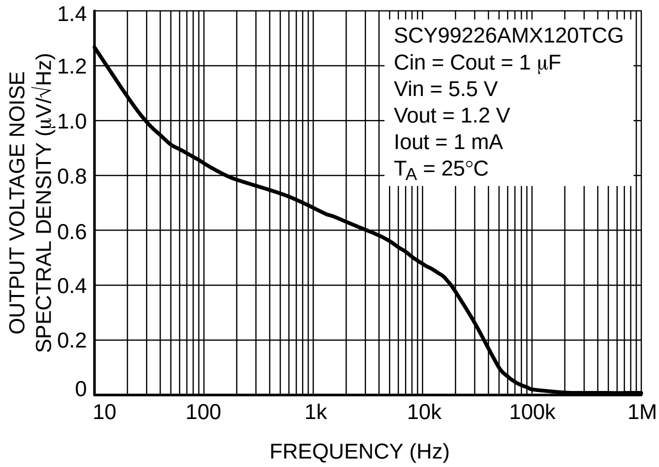


Figure 20. Output Voltage Noise Spectral Density, Vout = 1.2 V

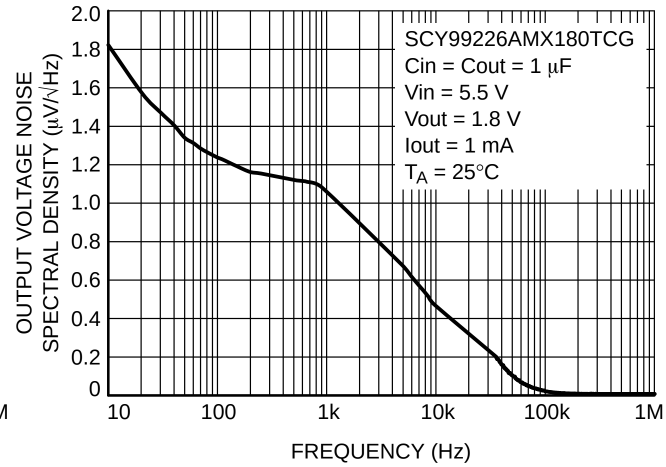


Figure 21. Output Voltage Noise Spectral Density, Vout = 1.8 V

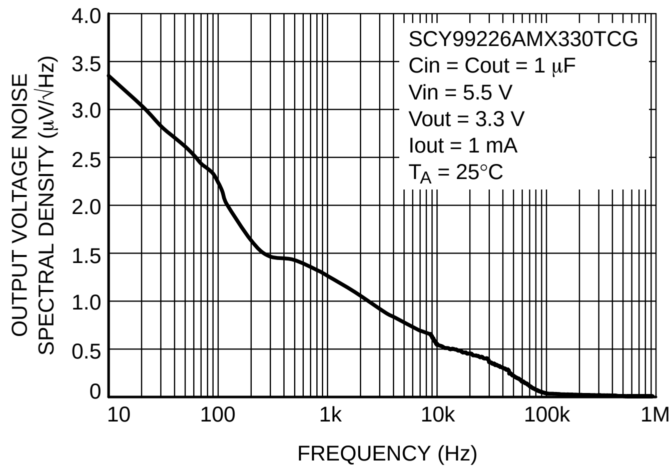


Figure 22. Output Voltage Noise Spectral Density, Vout = 3.3 V

TYPICAL CHARACTERISTICS

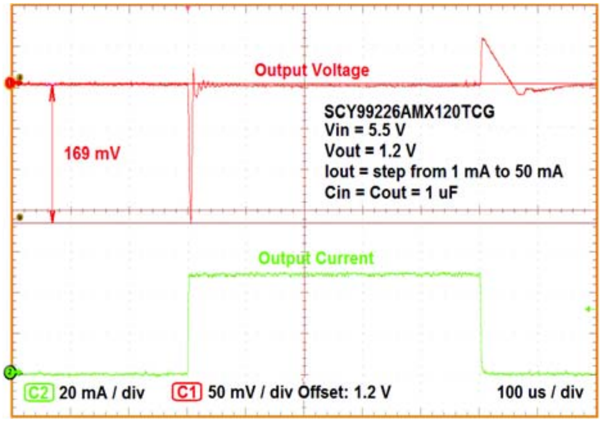


Figure 23. Load Transient Response at Load Step from 1 mA to 50 mA, Vout = 1.2 V

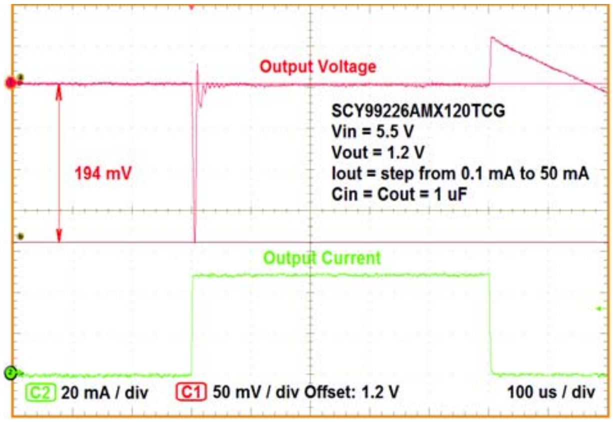


Figure 24. Load Transient Response at Load Step from 0.1 mA to 50 mA, Vout = 1.2 V

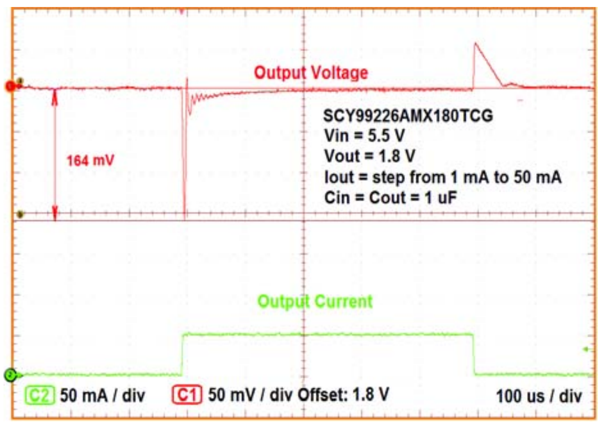


Figure 25. Load Transient Response at Load Step from 1 mA to 50 mA, Vout = 1.8 V

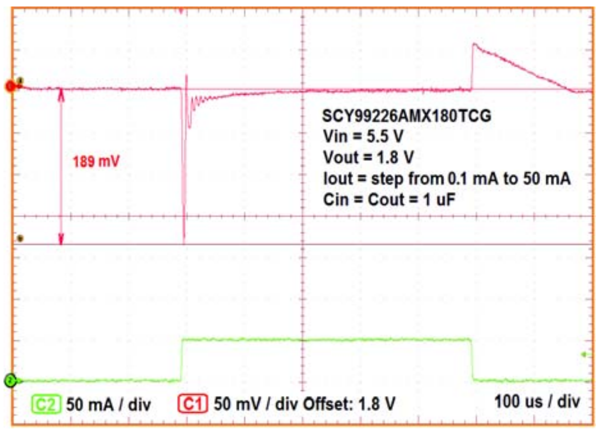


Figure 26. Load Transient Response at Load Step from 0.1 mA to 50 mA, Vout = 1.8 V

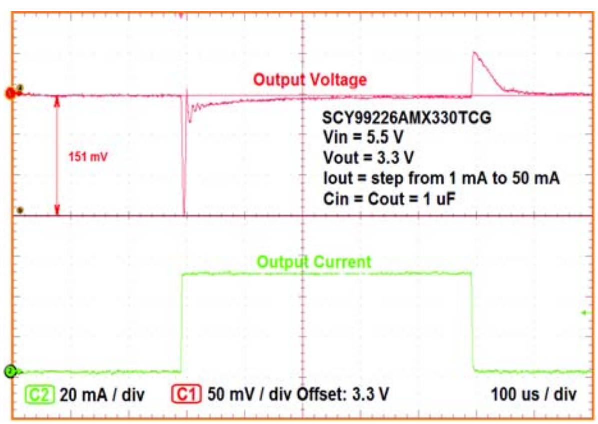


Figure 27. Load Transient Response at Load Step from 1 mA to 50 mA, Vout= 3.3 V

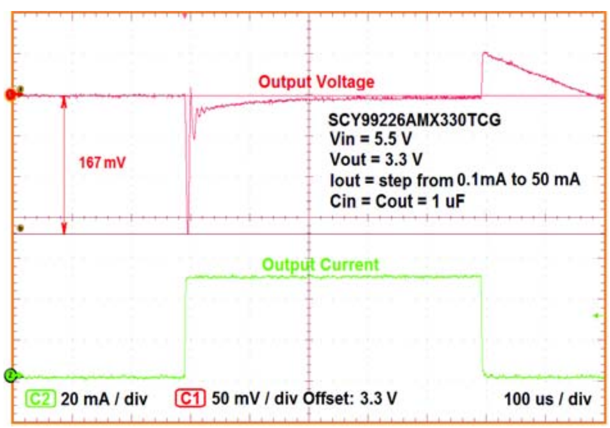


Figure 28. Load Transient Response at Load Step from 0.1 mA to 50 mA, Vout = 3.3 V

APPLICATIONS INFORMATION

General

The SCY99226 is a high performance 150 mA Linear Regulator with Ultra Low IQ. This device delivers low Noise and high Power Supply Rejection Ratio with excellent dynamic performance due to employing the Dynamic Quiescent Current adjustment which assure ultra low I_Q consumption at no – load state. These parameters make this device very suitable for various battery powered applications.

Input Decoupling (C_{IN})

It is recommended to connect at least a 1 μF Ceramic X5R or X7R capacitor between IN and GND pins of the device. This capacitor will provide a low impedance path for any unwanted AC signals or Noise superimposed onto constant Input Voltage. The good input capacitor will limit the influence of input trace inductances and source resistance during sudden load current changes.

Higher capacitance and lower ESR Capacitors will improve the overall line transient response.

Output Decoupling (C_{OUT})

The SCY99226 does not require a minimum Equivalent Series Resistance (ESR) for the output capacitor. The device is designed to be stable with standard ceramics capacitors with values of 1.0 μF or greater up to 10 μF. The X5R and X7R types have the lowest capacitance variations over temperature thus they are recommended. There is recommended connect the output capacitor as close as possible to the output pin of the regulator.

Enable Operation

The SCY99226 uses the EN pin to enable /disable its device and to activate /deactivate the active discharge function at devices with this feature. If the EN pin voltage is pulled below 0.4 V the device is guaranteed to be disable. The active discharge transistor at the devices with Active Discharge Feature is activated and the output voltage VOUT is pulled to GND through an internal circuitry with effective resistance about 100 ohms.

If the EN pin voltage is higher than 1.2 V the device is guaranteed to be enabled. The internal active discharge circuitry is switched off and the desired output voltage is available at output pin. In case the Enable function is not required the EN pin should be connected directly to input pin.

Thermal Shutdown

When the die temperature exceeds the Thermal Shutdown point (TSD = 175°C typical) the device goes to disabled state and the output voltage is not delivered until the die temperature decreases to 150°C. The Thermal Shutdown feature provides a protection from a catastrophic device failure at accidental overheating. This protection is not intended to be used as a substitute for proper heat sinking.

Power Dissipation and Heat sinking

The maximum power dissipation supported by the device is dependent upon board design and layout. Mounting pad configuration on the PCB, the board material, and the ambient temperature affect the rate of junction temperature rise for the part. For reliable operation, junction temperature should be limited to +125°C. The maximum power dissipation the SCY99226 device can handle is given by:

$$P_{D(MAX)} = \frac{\left[T_{J(MAX)} - T_A\right]}{R_{\theta JA}} \qquad \text{(eq. 1)}$$

The power dissipated by the SCY99226 device for given application conditions can be calculated from the following equations:

$$P_D \approx V_{IN}\left(I_{GND}(I_{OUT})\right) + I_{OUT}\left(V_{IN} - V_{OUT}\right) \qquad \text{(eq. 2)}$$

or

$$V_{IN(MAX)} \approx \frac{P_{D(MAX)} + \left(V_{OUT} \times I_{OUT}\right)}{I_{OUT} + I_{GND}} \qquad \text{(eq. 3)}$$

Hints

VIN and GND printed circuit board traces should be as wide as possible. When the impedance of these traces is high, there is a chance to pick up noise or cause the regulator to malfunction. Place external components, especially the output capacitor, as close as possible to the SCY99226, and make traces as short as possible.

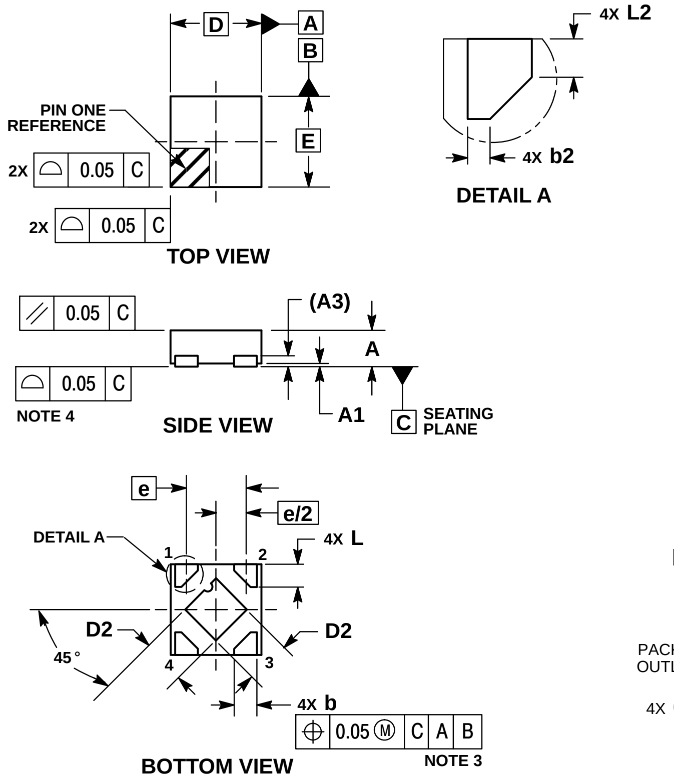
ORDERING INFORMATION

Device	Nominal Output Voltage	Marking	Active Discharge	Package	Shipping†
SCY99226AMX120TCG	1.2	AC	Yes	XDFN4 1.0 × 1.0 (Pb-Free)	3000 / Tape & Reel
SCY99226AMX180TCG	1.8	AD			
SCY99226AMX330TCG	3.3	AG			

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

PACKAGE DIMENSIONS

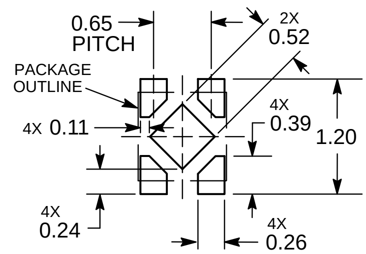
XDFN4 1.0x1.0, 0.65P
MX SUFFIX
CASE 711AJ
ISSUE A



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.20 mm FROM THE TERMINAL TIPS.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	MILLIMETERS	
DIM	MIN	MAX
A	0.33	0.43
A1	0.00	0.05
A3	0.10 REF	
b	0.15	0.25
b2	0.02	0.12
D	1.00 BSC	
D2	0.43	0.53
E	1.00 BSC	
e	0.65 BSC	
L	0.20	0.30
L2	0.07	0.17

RECOMMENDED MOUNTING FOOTPRINT*



DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PUBLICATION ORDERING INFORMATION

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