SKY87250: 400 mA Low-Noise Step-Down Converter in a Micro-Inductor Package

Applications

- Bluetooth® headsets
- Cellular phones
- Digital cameras
- Hard disk drives
- PDAs and handheld computers
- Portable media and MP3 players
- USB devices

Features

- V_{IN} range: 2.5 V to 5.5 V
- Adjustable output voltage: 0.6 V to V_{IN}
- Output current: 400 mA
- Up to 95% efficiency
- Low-noise, light-load architecture
- No load quiescent current: 40 μA
- Switching frequency: 2.0 MHz
- Internal soft-start control
- Over-temperature and current-limit protection
- Shutdown current: <1 μA
- Small 4.7 μF output capacitor
- Temperature range: −40 °C to +85 °C
- Compact integrated micro-inductor (μinductor) DLN (8-pin, 2.4 × 2.4 mm) package (MSL1, 260 °C per JEDEC-J-STD-020)

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Description

The SKY87250 μSwitcher™ step-down converter delivers up to 400 mA to support an adjustable 0.6 V to V_{IN} output from 2.7 V to 5.5 V input supply. Its low supply current, small size, and high switching frequency make the SKY87250 the ideal choice for portable applications.

The SKY87250 maintains a low 40 μA no-load quiescent current. The 2.0 MHz switching frequency minimizes the output capacitance requirement while keeping switching losses low. The SKY87250 feedback and control delivers excellent load regulation and transient response with a small output capacitor.

The SKY87250 maintains high efficiency throughout the load range. The unique low-noise, light-load architecture produces reduced ripple and spectral noise. Over-temperature and short-circuit protection safeguards the SKY87250 and system components from damage.

The ultra-small, 8-pin, 2.4 × 2.4 mm DLN package footprint, integrated inductor, and minimal capacitance requirements, make the SKY87250 ideal for compact designs.

Figure 1 shows the typical application circuit size comparison. A typical application circuit is shown in Figure 2. The pin configuration is shown in Figure 3. Signal pin assignments and functional pin descriptions are provided in Table 1.
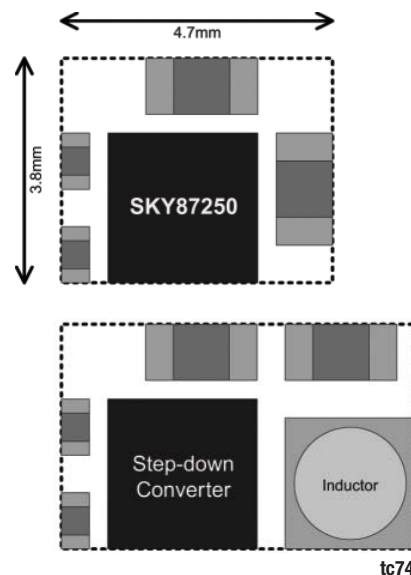

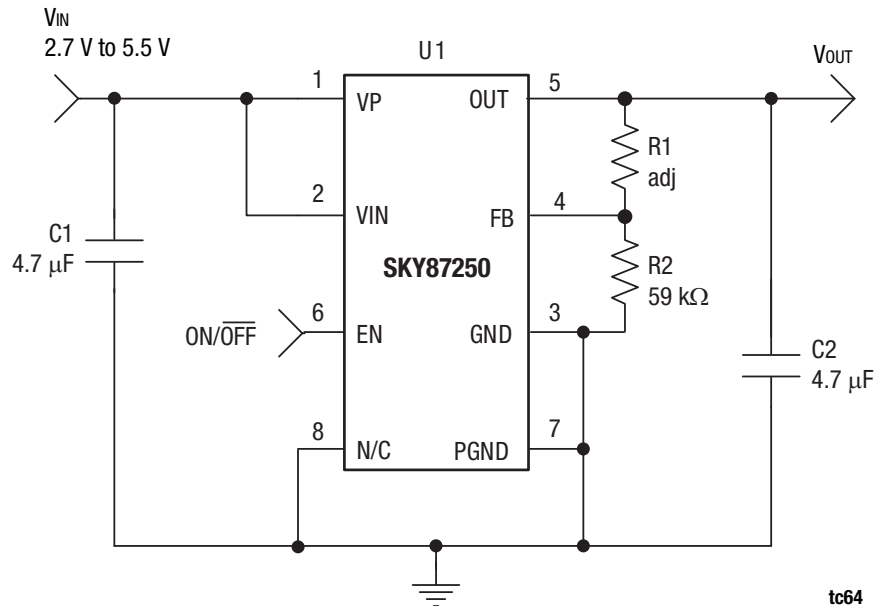**Figure 1. Typical Application Circuit Size Comparison**

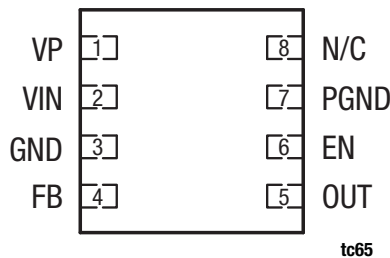Figure 2. SKY87250 Typical Application Circuit

Figure 3. SKY87250 8-Pin DLN
(Top View)

Table 1. SKY87250 Signal Descriptions

Pin	Name	Description
1	VP	Input power pin; connect to the source of the P-channel MOSFET. Connect to the input capacitor.
2	VIN	Input bias voltage for the converter.
3	GND	Non-power signal ground pin.
4	FB	Feedback input pin. Connect this pin to an external resistive divider for adjustable output.
5	OUT	DC-DC converter output.
6	EN	Enable pin. A logic high enables normal operation. A logic low shuts down the converter.
7	PGND	Power ground. Input power return pin; connect to the source of the N-channel MOSFET. Connect to the output and input capacitor return.
8	N/C	Not internally connected.

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Electrical and Mechanical Specifications

The absolute maximum ratings and thermal information of the SKY87250 are provided in Tables 2 and 3, respectively. Electrical specifications are provided in Table 4.

Typical performance characteristics of the SKY87250 are illustrated in Figures 4 through 33.

Table 2. SKY87250 Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Minimum	Typical	Maximum	Units
Input voltage and bias power to PGND	V_{IN}, V_P	−0.3		+6.0	V
FB to GND	V_{FB}	−0.3		V_{IN} + 0.3	V
EN to GND	V_{EN}	−0.3		V_{IN} + 0.3	V
AGND to PGND	V_{GND}	−0.3		+0.3	V
OUT RMS current capability	I_{OUT}		±1		A

Note 1: Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed may result in permanent damage to the device.

Table 3. SKY87250 Thermal Information

Parameter	Symbol	Minimum	Typical	Maximum	Units
Ambient temperature	T_A	−40		+85	°C
Operating junction temperature	T_J	−40		+150	°C
Maximum soldering temperature (at leads, 10 seconds)	T_{LEAD}			300	°C
Maximum power dissipation (Note 1, Note 2, Note 3)	P_D		790		mW
Maximum junction-to-ambient thermal resistance (Note 1, Note 3)	θ_{JA}		158		°C/W

Note 1: Mounted on FR4 circuit board. Two-layer, 1 ounce copper.

Note 2: Derate 6.3 mW/°C above 40 °C ambient temperature.

Note 3: The thermal resistance is measured in accordance with EIA/JESD 51 series.

CAUTION: *Although this device is designed to be as robust as possible, electrostatic discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times.*

Table 4. SKY87250 Electrical Specifications (Note 1)
(C_{IN} = 4.7 μF, C_{OUT} = 4.7 μF , V_{IN} = V_P = 3.6 V, V_{EN} = V_{IN}, GND = PGND, T_A = –40 °C to 85 °C [Typical Values are at T_A = 25 °C], Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Input voltage	V_{IN}	V_P, V_{IN}	2.7		5.5	V
Output voltage	V_{OUT}		0.6		V_{IN}	V
Maximum continuous output current capability	I_{OUT}	T_A = 25 °C		400		mA
No load supply current	I_Q	No load current; not switching		40	100	μA
Shutdown current	I_{SHDN}	EN = GND			1.0	μA
Input under-voltage lockout	V_{UVLO}	V_{CC} rising		1.8	2.5	V
FB regulation threshold	V_{FB}	V_{IN} = 2.7 V to 5.5 V, 10 mA load, T_A = 25 °C	588	600	612	mV
		V_{IN} = 2.7 V to 5.5 V, 10 mA load, T_A = –40 °C to 85 °C	582		618	mV
FB leakage current	I_{FB}	V_{FB} = 1 V			200	nA
Line regulation	$\Delta V_{OUT}/V_{OUT}$	V_{IN} = 2.7 V to 5.5 V		0.1		%
Load regulation	$\Delta V_{OUT}/V_{OUT}$	10 mA to 400 mA load		0.3		%
Oscillator frequency	f_{OSC}			2.0		MHz
On-time resistance	R_{TON}	VP to OUT resistance (high-side MOSFET on-resistance + DCR)		800		mΩ
Off-time resistance	R_{TOFF}	VP to PGND resistance (low-side MOSFET on-resistance + DCR)		650		mΩ
Soft-start period	t_{SS}	Enable rising edge to output regulation		100		μs
Over-temperature shutdown threshold	T_{SHDN}	Hysteresis = 15 °C		140		°C
EN logic level high	V_{IH}		1.4			V
EN logic level low	V_{IL}				0.4	V
EN input current	I_{EN}	V_{EN} = 0 V or V_{IN}	–1.0		+1.0	μA

Note 1: Performance is guaranteed only under the conditions listed in this table.

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Typical Performance Characteristics

(CIN = 4.7 μF, COUT = 4.7 μF , VIN = VP = 3.6 V, VEN = VIN, GND = PGND, TA = –40 °C to 85 °C [Typical Values are at TA = 25 °C], Unless Otherwise Noted)
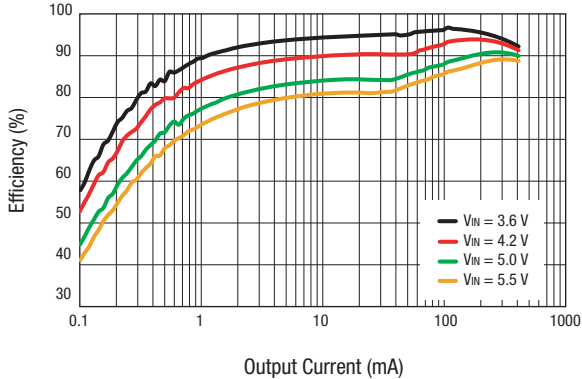
Figure 4. Efficiency vs Load
(VOUT = 3.3 V, R3 = 0 Ω, C3 = 0 pF)

Figure 5. Load Regulation
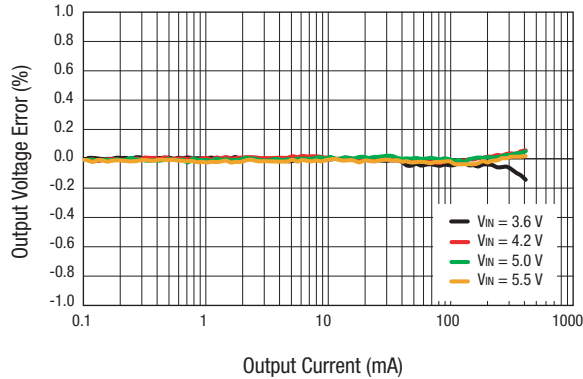(VOUT = 3.3 V, R3 = 0 Ω, C3 = 0 pF)
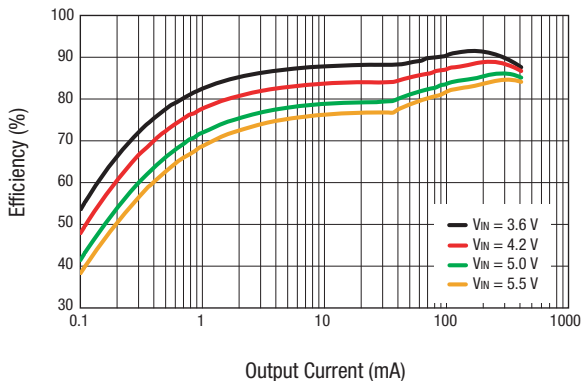
Figure 6. Efficiency vs Load
(VOUT = 2.5 V, R3 = 0 Ω, C3 = 0 pF)
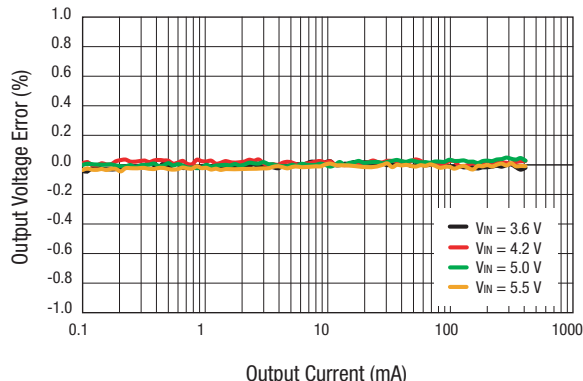
Figure 7. Load Regulation
(VOUT = 2.5 V, R3 = 0 Ω, C3 = 0 pF)
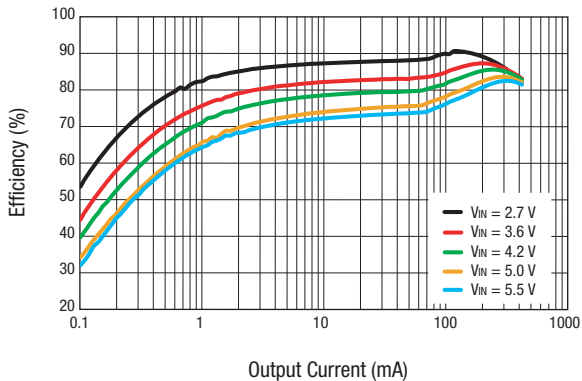
Figure 8. Efficiency vs Load
(VOUT = 1.8 V, R3 = 0 Ω, C3 = 0 pF)
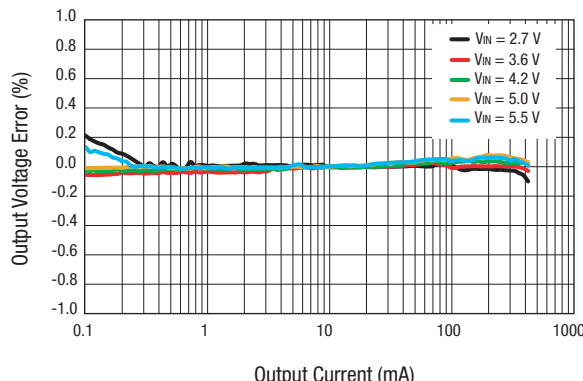
Figure 9. Load Regulation
(VOUT = 1.8 V, R3 = 0 Ω, C3 = 0 pF)
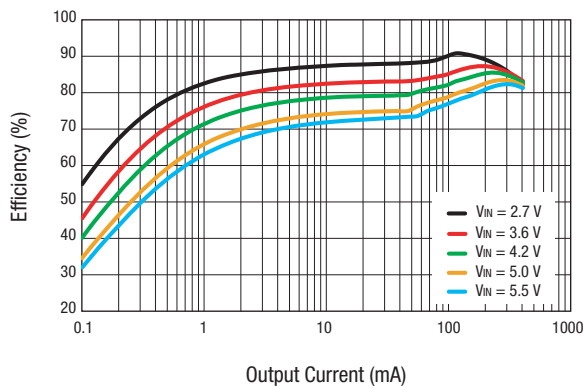
Figure 10. Efficiency vs Load
(VOUT = 1.8 V, R3 = 500 Ω, C3 = 100 pF)
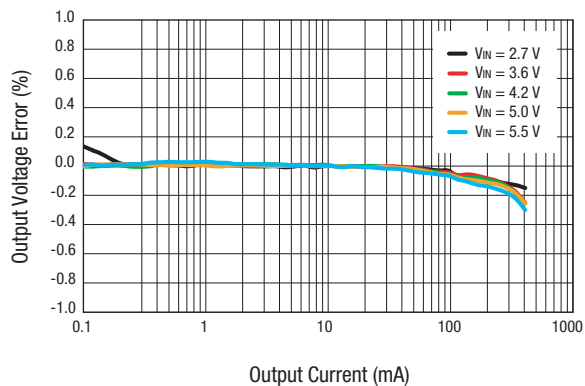
Figure 11. Load Regulation
(VOUT = 1.8 V, R3 = 500 Ω, C3 = 100 pF)
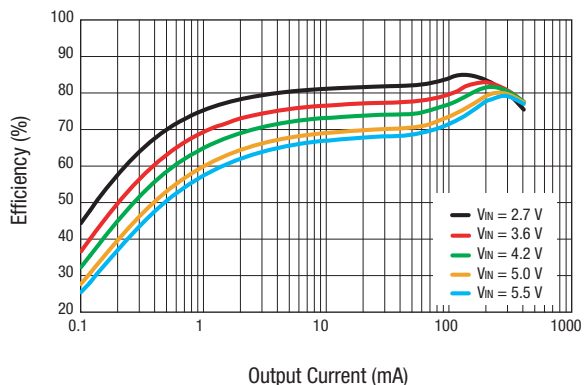
Figure 12. Efficiency vs Load
(VOUT = 1.2 V, R3 = 0 Ω, C3 = 0 pF)
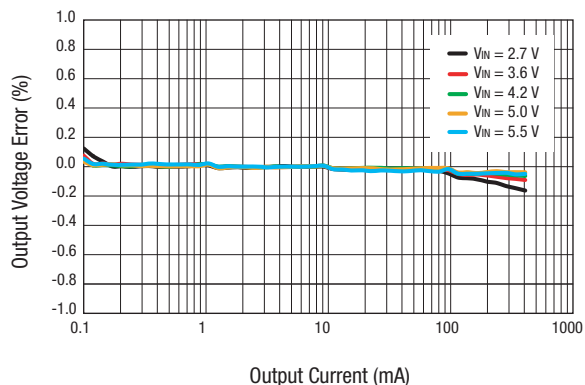
Figure 13. Load Regulation
(VOUT = 1.2 V, R3 = 0 Ω, C3 = 0 pF)
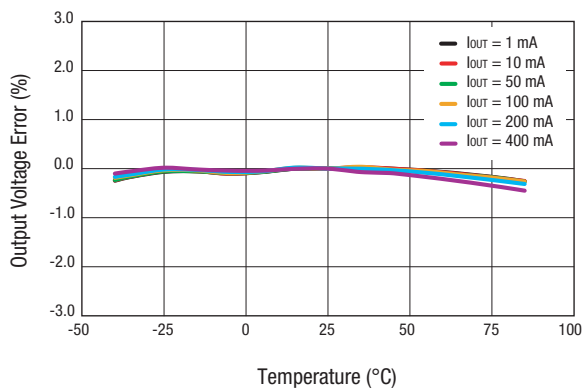
Figure 14. Output Voltage Error vs Temperature
(VIN = 3.6 V, VOUT = 1.8 V, R3 = 0 Ω, C3 = 0 pF)
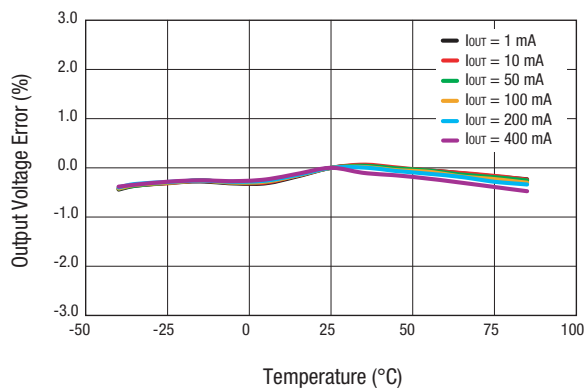
Figure 15. Output Voltage Error vs Temperature
(VIN = 3.6 V, VOUT = 1.8 V, R3 = 0 Ω, C3 = 0 pF)

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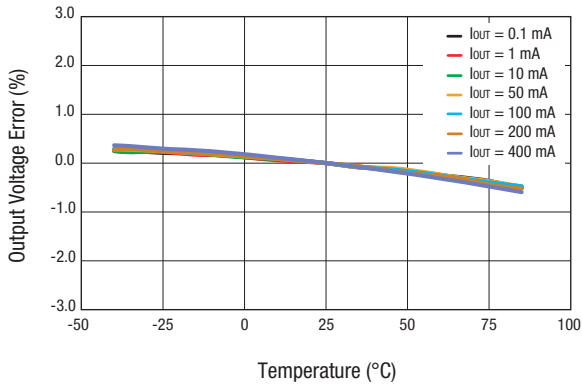
Figure 16. Output Voltage Error vs Temperature
(VIN = 3.6 V, VOUT = 2.5 V, R3 = 0 Ω, C3 = 0 pF)
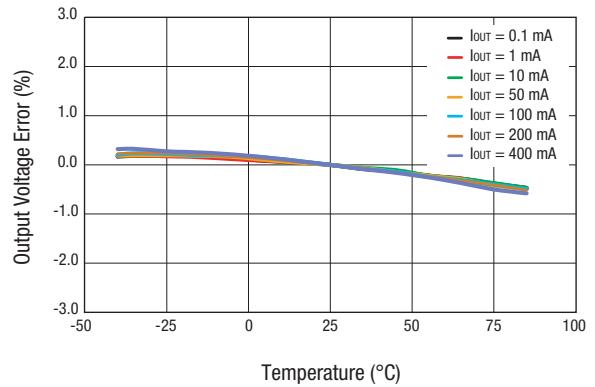
Figure 17. Output Voltage Error vs Temperature
(VIN = 4.2 V, VOUT = 3.3 V, R3 = 0 Ω, C3 = 0 pF)
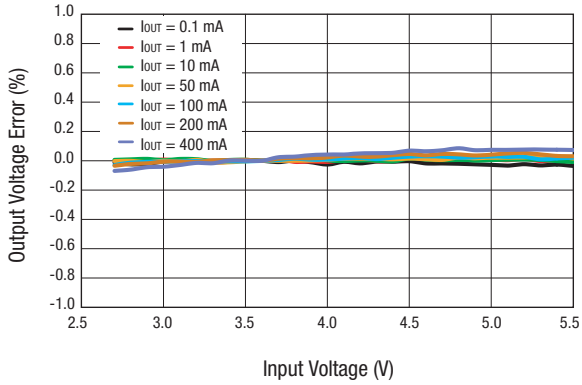
Figure 18. Line Regulation
(VOUT = 1.8 V, R3 = 500 Ω, C3 = 100 pF)
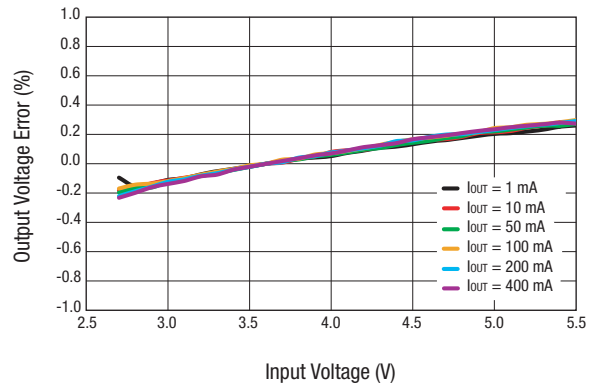
Figure 19. Line Regulation
(VOUT = 1.8 V, R3 = 0 Ω, C3 = 0 pF)
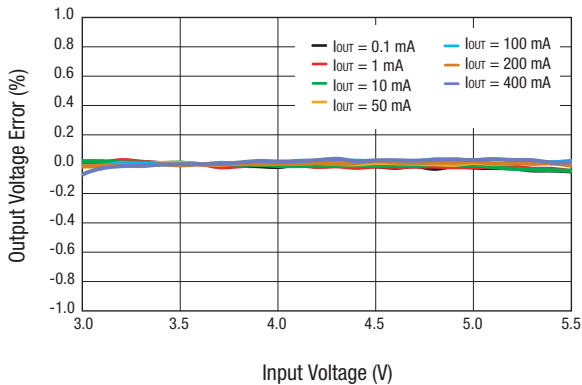
Figure 20. Line Regulation
(VOUT = 2.5 V, R3 = 0 Ω, C3 = 0 pF)
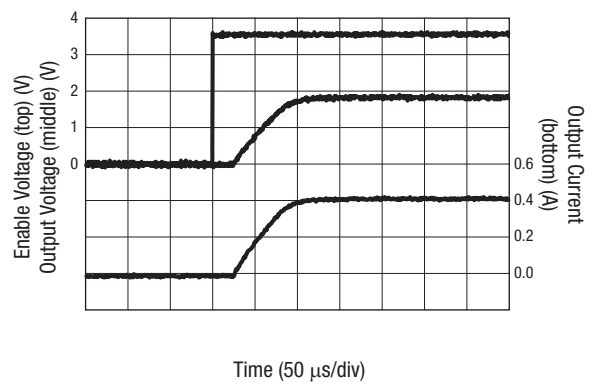
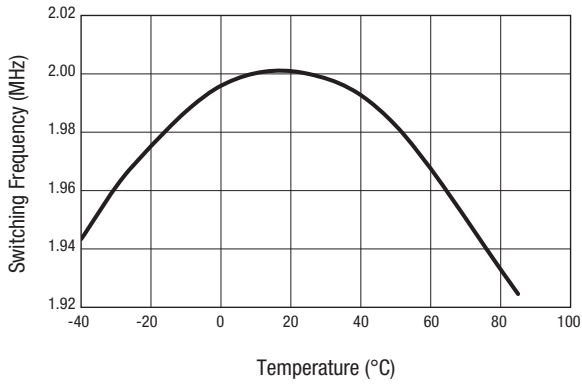**Figure 21. Soft Start**
(VIN = 3.6 V, VOUT = 1.8 V, IOUT = 400 mA)

Figure 22. Switching Frequency vs Temperature
(V$_{IN}$ = 3.6 V, V$_{OUT}$ = 1.8 V, I$_{OUT}$ = 400 mA)

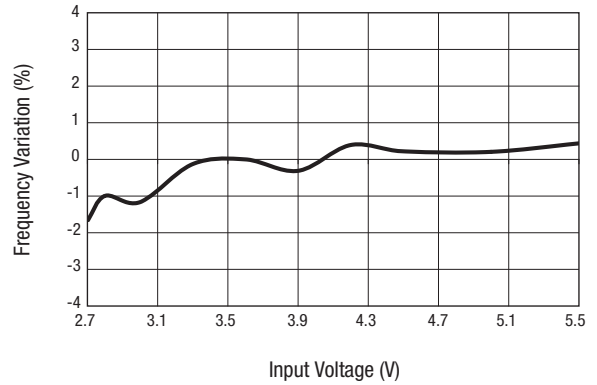**Figure 23. Switching Frequency vs Input Voltage**
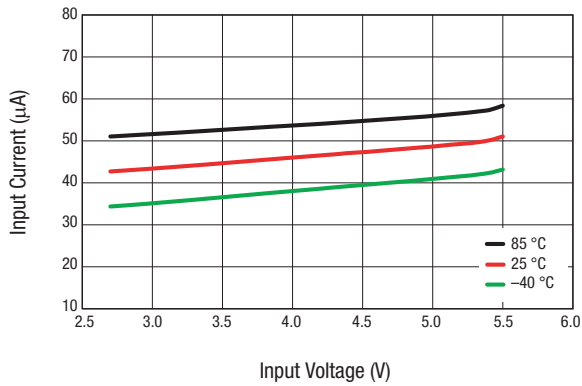(V$_{OUT}$ = 1.8 V, I$_{OUT}$ = 400 mA)
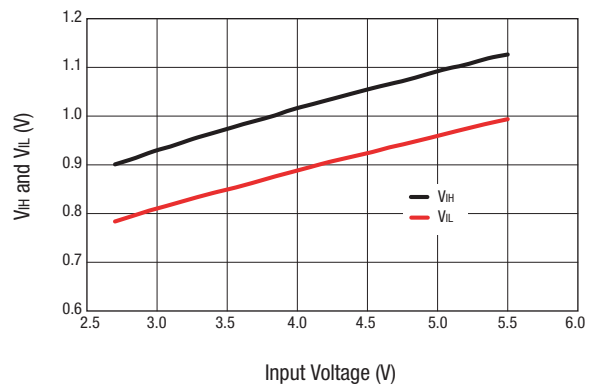
Figure 24. Input Current vs Input Voltage
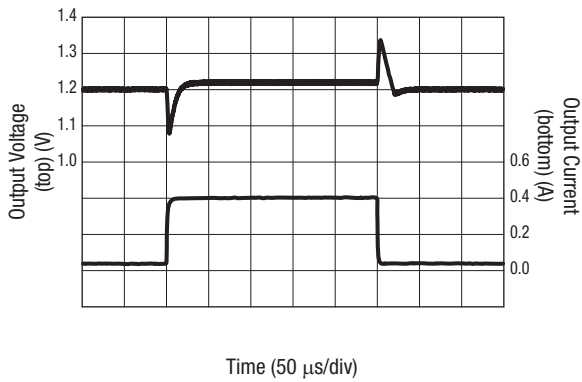
Figure 25. Enable Threshold vs Input Voltage

Figure 26. Load Transient Response
(40 mA to 400 mA, V$_{IN}$ = 3.6 V, V$_{OUT}$ = 1.2 V,
C$_{OUT}$ = 4.7 μF, C3 = 0 pF, R3 = 0 Ω)
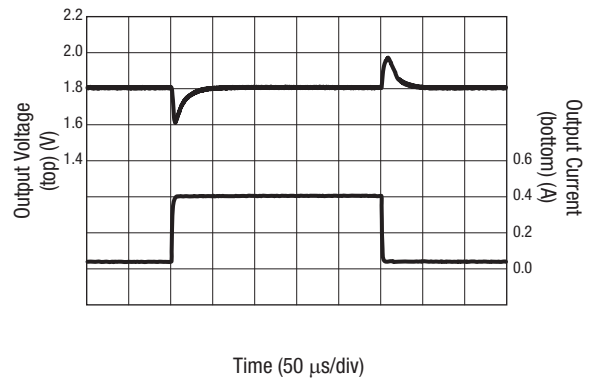
Figure 27. Load Transient Response
(40 mA to 400 mA, V$_{IN}$ = 3.6 V, V$_{OUT}$ = 1.8 V,
C$_{OUT}$ = 4.7 μF, C3 = 100 pF, R3 = 500 Ω)

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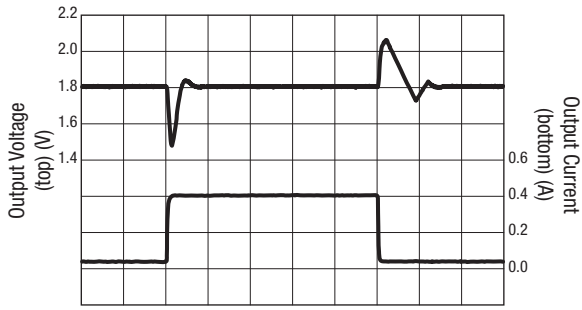
Time (50 μs/div)

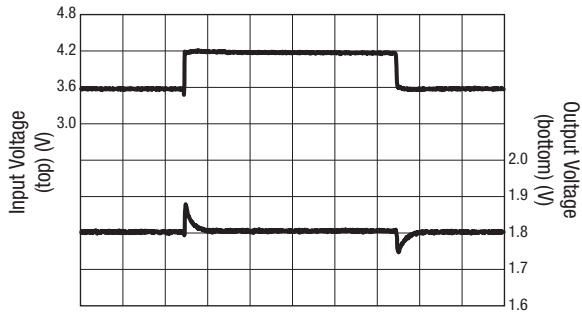**Figure 28. Load Transient Response**
(40 mA to 400 mA, V$_{IN}$ = 3.6 V, V$_{OUT}$ = 1.8 V,
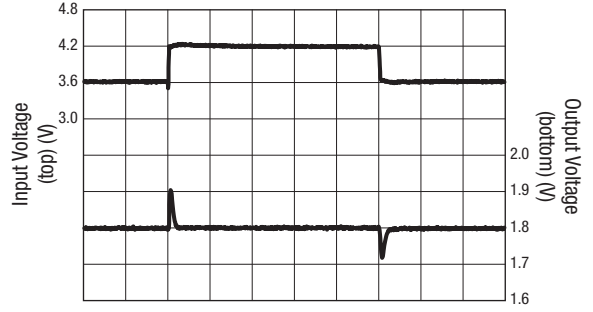**C$_{OUT}$ = 4.7 μF, C3 = 0 pF, R3 = 0 Ω)**
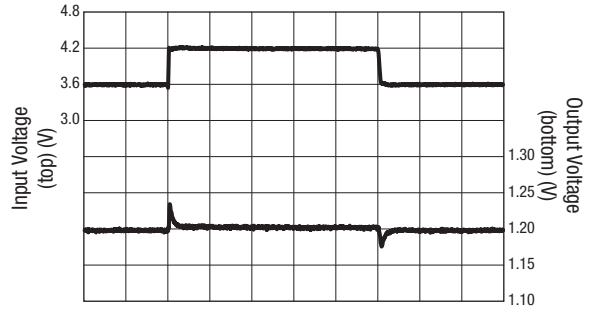
Time (100 μs/div)

Figure 29. Line Transient Response
(V$_{IN}$ = 3.6 V to 4.2 V, V$_{OUT}$ = 1.2 V, I$_{OUT}$ = 400 mA,
C$_{OUT}$ = 4.7 μF, C3 = 0 pF, R3 = 0 Ω)

Time (100 μs/div)

Figure 30. Line Transient Response
(V$_{IN}$ = 3.6 V to 4.2 V, V$_{OUT}$ = 1.8 V, I$_{OUT}$ = 400 mA,
C$_{OUT}$ = 4.7 μF, C3 = 100 pF, R3 = 500 Ω)

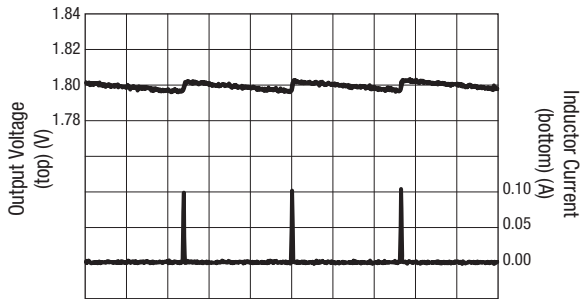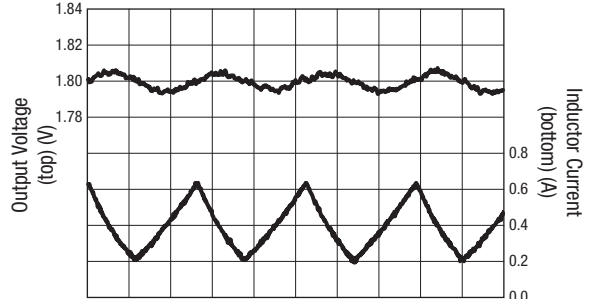

Time (100 μs/div)

Figure 31. Line Transient Response
(V$_{IN}$ = 3.6 V to 4.2 V, V$_{OUT}$ = 1.8 V, I$_{OUT}$ = 400 mA,
C$_{OUT}$ = 4.7 μF, C3 = 0 pF, R3 = 0 Ω)

Time (5 μs/div)

Figure 32. Output Ripple
(V$_{IN}$ = 3.6 V, V$_{OUT}$ = 1.8 V, I$_{OUT}$ = 1 mA)

Time (200 ns/div)

Figure 33. Output Ripple
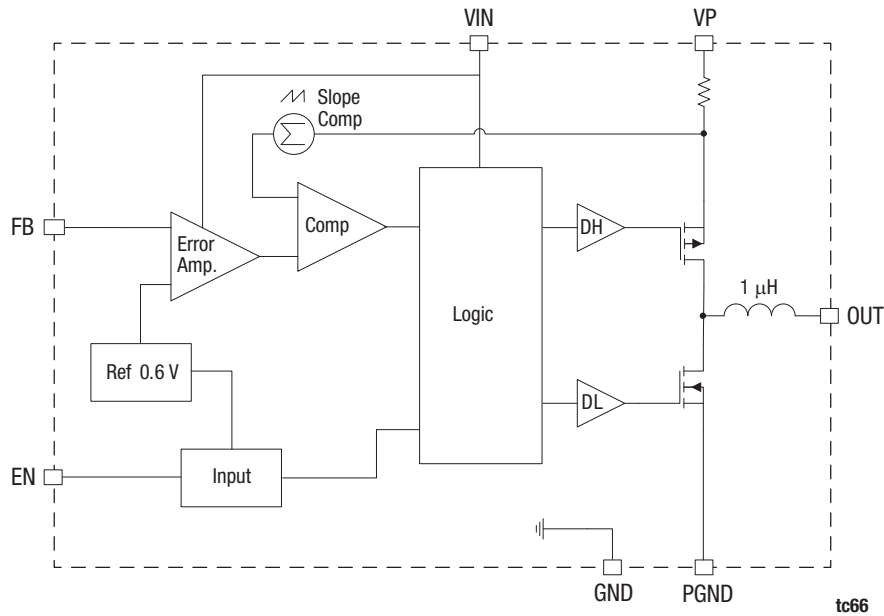**(V$_{IN}$ = 3.6 V, V$_{OUT}$ = 1.8 V, I$_{OUT}$ = 400 mA)**

Figure 34. SKY87250 Functional Block Diagram

Functional Description

The SKY87250 is a high performance 400 mA, 2.0 MHz monolithic step-down converter with an integrated micro-inductor. It is designed with the goal of minimizing external component requirements and optimizing efficiency over the complete load range. The converter operates at 2.0 MHz, which minimizes the ceramic output capacitor requirement.

The device is designed to operate with an output voltage as low as 0.6 V over an input voltage range of 2.7 V to 5.5 V. Power devices are sized for 400 mA current capability while maintaining up to 95% efficiency. At dropout, the regulator's duty cycle increases to 100% and the output voltage tracks the input voltage minus the load drop across the on-time resistance (R_{TON}).

A high-DC gain error amplifier with internal compensation controls the output. It provides excellent transient response and load/line regulation. Soft start eliminates any output voltage overshoot when the enable or the input voltage is applied.

A functional block diagram is shown in Figure 34.

Integrated Power Inductor

The SKY87250 integrates the power inductor within the package. Therefore, no external power inductor is needed.

Control Loop

The SKY87250 is a 400 mA, current mode step-down converter. The current through the P-channel MOSFET (high-side) is sensed for current loop control, as well as short-circuit and overload protection. A fixed slope compensation signal is added to the sensed current to maintain stability for duty cycles over 50%. The peak current mode loop appears as a voltage-programmed current source in parallel with the output capacitor.

The output of the voltage error amplifier programs the current mode loop for the necessary peak switch current to force a constant output voltage for all load and line conditions. Internal loop compensation terminates the transconductance voltage error amplifier output. The error amplifier reference is fixed at 0.6 V.

Soft Start/Enable

Soft start ramps the reference voltage when the input voltage and enable input are valid. The controlled output slew-rate limits the current surge seen at the input and eliminates output voltage overshoot. When the EN pin is pulled low, it forces the SKY87250 into a low-power, non-switching state. The total input current during shutdown is less than 1 μA.

Current Limit and Over-Temperature Protection

For overload conditions, the peak input current is limited. As load impedance decreases and the output voltage falls closer to zero, more power is dissipated internally, raising the device temperature. Thermal protection completely disables switching when internal dissipation becomes excessive, protecting the device from damage. The junction over-temperature threshold is 140°C with 15°C of hysteresis.

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Under-Voltage Lockout (UVLO)

Internal bias of all circuits is controlled using the V_{IN} bias supply input. UVLO guarantees sufficient V_{IN} bias and proper operation of all internal circuitry before activation.

Application Information

Input Capacitor Selection

Select a 4.7 µF to 22 µF X7R or X5R ceramic capacitor for the input. To estimate the required input capacitor size, determine the acceptable input voltage ripple level (V_{PP}) and solve for C_{IN}.

$$C_{IN} = \frac{D \times (1-D)}{\left(\frac{V_{PP}}{I_{OUT}} - ESR\right) \times f_{SW}}$$

$$D = \frac{V_{OUT}}{V_{IN}}$$

Where D is the duty cycle and f_{SW} is the switching frequency.

The peak ripple voltage occurs when $V_{IN} = 2 \times V_{OUT}$ (50% duty cycle), resulting in a minimum output capacitance recommendation:

$$C_{IN} = \frac{1}{4 \times \left(\frac{V_{PP}}{I_{OUT}} - ESR\right) \times f_{SW}}$$

The maximum input capacitor RMS current is:

$$I_{RMS} = I_{OUT} \times \sqrt{D \times (1-D)} = I_{OUT} \times \sqrt{\frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

The calculated value varies with input voltage and is a maximum when V_{IN} is twice the output voltage.

The input capacitor provides a low impedance loop for the edges of pulsed current drawn by the SKY87250. X7R and X5R ceramic capacitors are ideal for this function due to their low Equivalent Series Resistance (ESR) and Equivalent Series Inductance (ESL). To minimize stray parasitic inductance, the capacitor should be placed as closely as possible to the SKY87250. This keeps the high frequency content of the input current localized, minimizing EMI and input voltage ripple.

The proper placement of the input capacitor can be seen in the Evaluation Board layer detail (see C1 in Figure 35).

A laboratory test set-up typically consists of two long wires running from the bench power supply to the Evaluation Board input voltage pins. The inductance of these wires, along with the low-ESR ceramic input capacitor, can create a high-Q network that may affect converter performance. This problem often becomes apparent in the form of excessive ringing in the output voltage during load transients. Errors in the loop phase and gain measurements can also result.

In applications where the input power source lead inductance cannot be reduced to a level that does not affect the converter performance, a high ESR tantalum or aluminum electrolytic should be placed in parallel with the low ESR/ESL bypass ceramic. This dampens the high Q network and stabilizes the system.

Output Capacitor Selection

The output capacitor limits the output ripple and provides holdup during large load transitions. A 4.7 µF to 10 µF X5R or X7R ceramic capacitor provides sufficient bulk capacitance to stabilize the output during large load transitions and has the ESR and ESL characteristics necessary for low output ripple.

The output voltage droop due to a load transient (ΔI_{LOAD}) is dominated by the capacitance of the ceramic output capacitor. During a step increase in load current, the ceramic output capacitor alone supplies the load current until the loop responds. Within two or three switching cycles, the loop responds and the inductor current increases to match the load current demand. The relationship of the output voltage droop during the three switching cycles to the output capacitance can be estimated by:

$$C_{OUT} = \frac{3 \times \Delta I_{LOAD}}{V_{DROOP} \times f_{SW}}$$

Once the average inductor current increases to the DC load level, the output voltage recovers. The above equation establishes a limit on the minimum value for the output capacitor with respect to load transients.

The internal voltage loop compensation also limits the minimum output capacitor value to 4.7 µF. This is due to its effect on the loop crossover frequency (bandwidth), phase margin, and gain margin. Increased output capacitance reduces the crossover frequency with greater phase margin.

The maximum output capacitor RMS ripple current is given by:

$$I_{RMS(MAX)} = \frac{1}{2\sqrt{3}} \times \frac{V_{OUT} \times (V_{IN(MAX)} - V_{OUT})}{L \times f_{SW} \times V_{IN(MAX)}}$$

Where $L = 1$ µH and $f_{SW} = 2.0$ MHz.

Dissipation due to the RMS current in the ceramic output capacitor ESR is typically minimal, resulting in less than a few degrees rise in hot-spot temperature.

Feedback Resistor Selection

Resistors R1 and R2 in Figure 35 program the output to regulate at a voltage higher than 0.6 V. To limit the bias current required for the external feedback resistor string while maintaining good noise immunity, the suggested value for R2 is 59 kΩ. Decreased resistor values are necessary to maintain noise immunity on the FB pin, resulting in increased quiescent current. Table 5 summarizes the resistor values for various output voltages.

With an enhanced transient response for extreme pulsed load applications, an external feed-forward capacitor and series feedback resistor (C3 and R3 in Figure 4) can be added, and usually use 100 pF capacitor as C3 and 500 Ω resister as R3.

The feedback resistor value can be calculated using the following equation:

$$R1 = \left(\frac{V_{OUT}}{V_{REF}} - 1 \right) \times R2 = \left(\frac{1.8V}{0.6V} - 1 \right) \times 59k\Omega = 118k\Omega$$

Table 5. Adjustable Resistor Values for Step-Down Converter

V_OUT (V)	R1 (kΩ) (R2 = 59 kΩ)	R1 (kΩ) (R2 = 221 kΩ)
0.8	19.6	75
0.9	29.4	113
1.0	39.2	150
1.1	49.9	187
1.2	59	221
1.3	68.1	261
1.4	78.7	301
1.5	88.7	332
1.8	118	442
2.5	187	698
3.3	267	1000

Thermal Calculations

There are many types of losses in the internal micro-inductor including the losses in the inductor core material, losses in the inductor from skin effects, magnetic field losses of the neighboring windings, and radiation losses. To simplify the calculation, the total inductor losses can be combined into the losses in the DC winding resistance of the inductor.

There are three types of losses associated with the SKY87250 step-down converter: switching losses, conduction losses, and quiescent current losses. Conduction losses are associated with the on-resistance characteristics of the power output switching devices and the DC winding resistance (DCR) of the internal micro-inductor. Switching losses are dominated by the gate charge of the power output switching devices. At full load, assuming a Continuous Conduction Mode (CCM), a simplified form of the losses is given by:

$$P_{TOTAL} = I_{OUT}^2 \times \left(R_{TON} \times D + R_{TOFF} \times [1 - D] \right) + \left(t_{DRV} \times f_{SW} \times I_{OUT} + I_Q \right) \times V_{IN}$$

Where $D = V_{OUT}/V_{IN}$, R_{TON} is the high-side MOSFET on-resistance plus inductor DCR, R_{TOFF} is the low-side MOSFET on-resistance plus inductor DCR, I_Q is the step-down converter quiescent current, and t_{DRV} is used to estimate the full load step-down converter switching losses.

Since R_{TON}, R_{TOFF}, quiescent current, and switching losses all vary with the input voltage, the total losses should be investigated over the complete input voltage range.

Given the total losses, the maximum junction temperature can be derived from the θ_{JA} for the package which is 158 °C/W.

$$T_{J(MAX)} = P_{TOTAL} \times \theta_{JA} + T_A$$

Layout Considerations

The following guidelines should be used to help ensure a proper layout:

- The input capacitor (C1) should be connected directly between the VP and PGND pins.

- The output capacitor and analog ground should be connected together to minimize any DC regulation errors caused by ground potential differences.

- The output-sense connection to the FB pin should be separated from any power trace. Route the output-sense trace as close as possible to the load point to avoid additional load regulation errors. Sensing along a high-current load trace will degrade DC load regulation.

- Place the feedback components near the FB pin to minimize the high-impedance feedback trace length. Avoid routing the feedback trace directly under the package to avoid EMI coupled noise.

- Connect the N/C pin to the power ground plane to enhance thermal impedance, and use vias directly under the package to ground planes on the bottom or internal PCB layers to help distribute the heat.

Evaluation Board Description

The SKY87250 Evaluation Board schematic diagram is provided in Figure 35. The PCB layer details are shown in Figure 36. Component values for the SKY87250 Evaluation Board are listed in Table 6.

Package Information

The PCB layout footprint for the SKY87250 is provided in Figure 37. Package dimensions are shown in Figure 38, and tape and reel dimensions are provided in Figure 39.
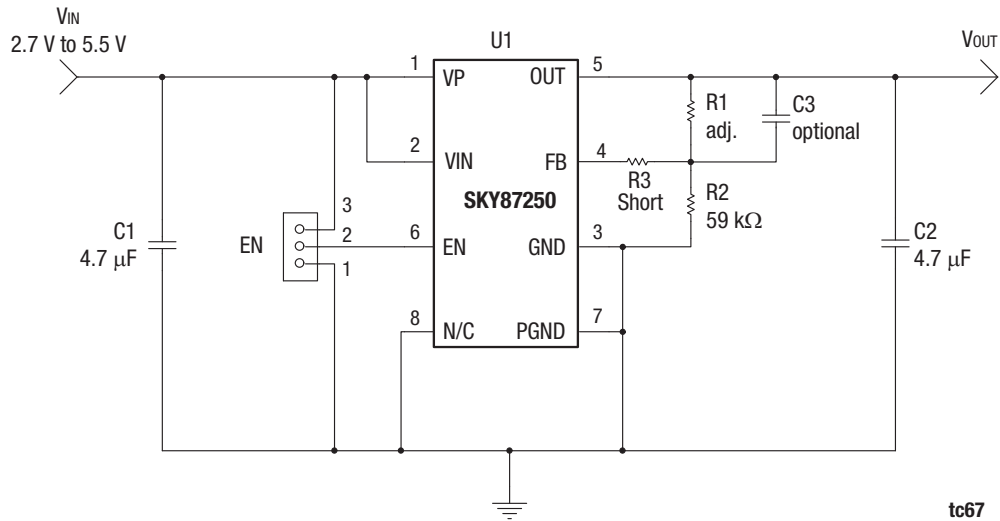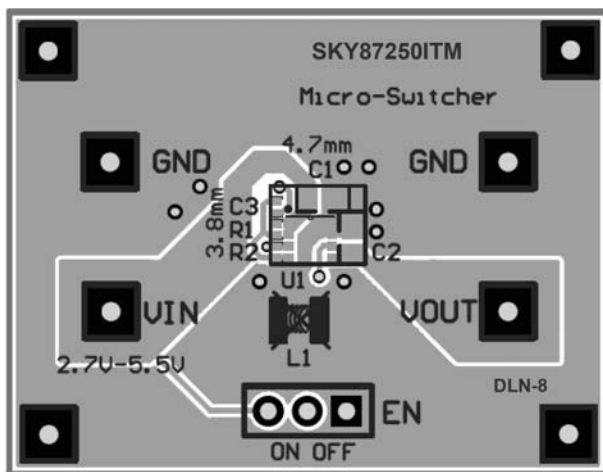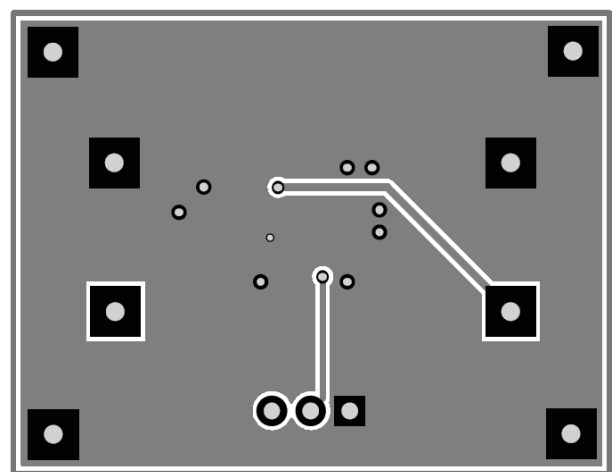
tc67

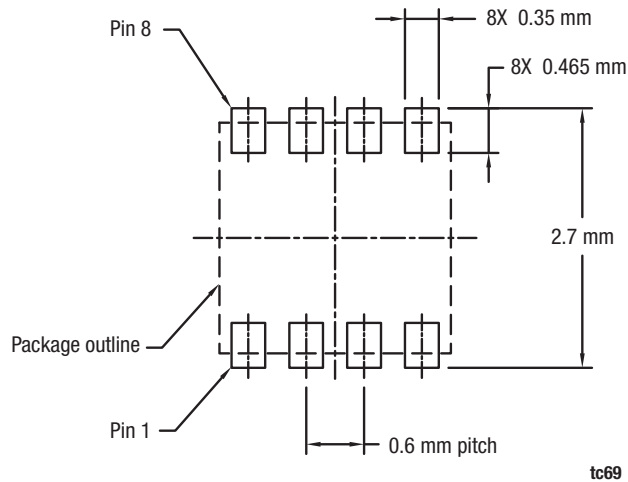**Figure 35. SKY87250 Evaluation Board Schematic**

(a)   Top Side
(L1 not required; shown for size comparison only)

(b)   Bottom Side

tc68

Figure 36. SKY87250 Evaluation Board Layer Details

Table 6. SKY87250 Evaluation Board Bill of Materials (BOM)

Component	Part Number	Description	Manufacturer
U1	SKY87250	400mA low noise step-down converter, 2.4 mm × 2.4 mm	Skyworks
C1, C2	GRM188R60J475KE19D	MLCC cap, 4.7 µF/6.3 V, 0603	Murata
C3	UMK105CG101JV-F	100 pF/50 V, 0402, optional	Taiyo Yuden
R1	Carbon film resistor	59 kΩ, 1%, 0201	
R2	Carbon film resistor	adjustable (see Table 5), 1%, 0201	Yageo
R3	Carbon film resistor	0 Ω, 1%, 0201	

Pin 8

8X 0.35 mm

8X 0.465 mm

2.7 mm

Package outline

Pin 1

0.6 mm pitch

tc69

**Figure 37. SKY87250 PCB Layout Footprint
(Top View)**

Top

2.4 → B

C

2.4

Pin 1
Indicator

⌔ 0.15 A B C

Top View

A

0.9 ± 0.1

⌔ 0.1

Side View

8x SMT pad

⊕ 0.1 Ⓜ A B C

Pin 8

C

8x 1.15

O

B   A

4X 0.3

4X 0.9

Pin 1

Bottom View

0.45 ± 0.05

2x (0.05)

0.265 ± 0.100

(0.05)

Metal pad
edge

0.35 ± 0.05

Detail A
Pad
Scale: 2x
4x this rotation
4x rotated 180º

0.525 ± 0.050

(0.125)   (0.05)

(0.05)

0.265 ± 0.100

0.35 ± 0.05

Metal pad
edge

Detail B
Pad
Scale: 2x
1x this rotation
1x rotated 180º

Metal pad
edge

0.35 ± 0.05

(0.05)

0.265 ± 0.100

0.525 ± 0.050

(0.125)

Detail C
Pad
Scale: 2x
1x this rotation
1x rotated 180º

All measurements are in millimeters.

tc70

Figure 38. SKY87250 8-pin DLN2424 Package Dimensions

Skyworks Solutions, Inc. • Phone [781] 376-3000 • Fax [781] 376-3100 • sales@skyworksinc.com • www.skyworksinc.com

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Figure 39. SKY87250 Carrier Tape Dimensions
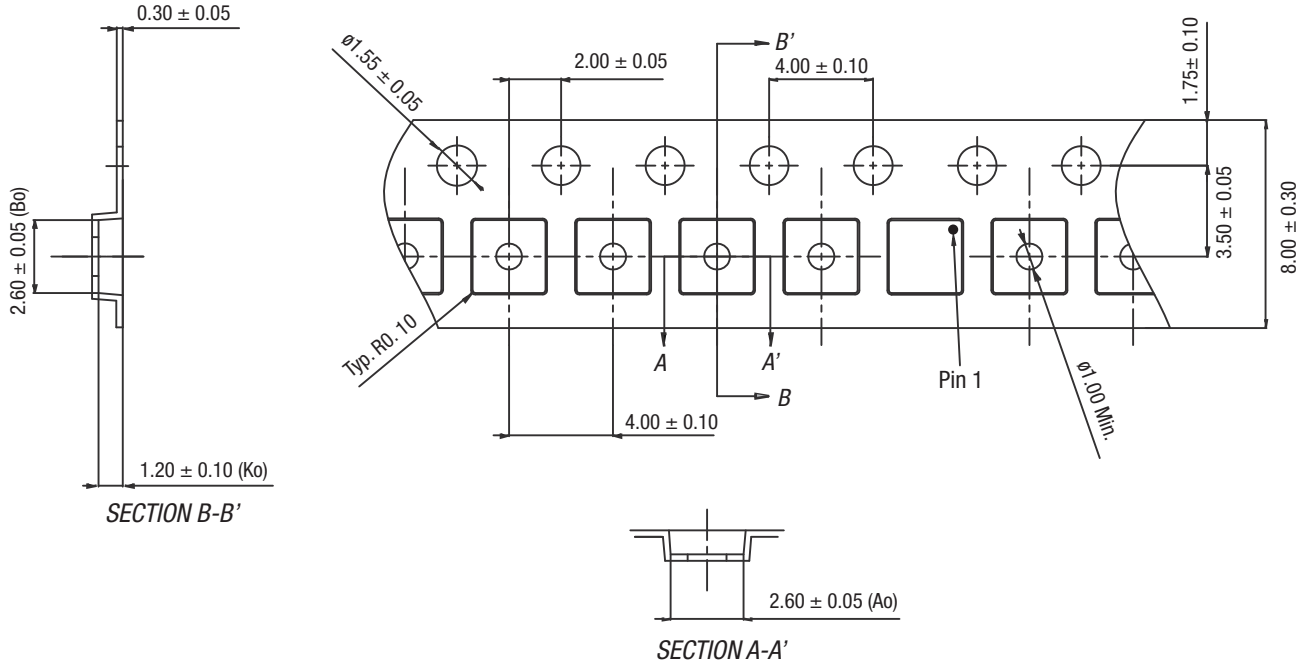
Notes:
1. Carrier tapes must meet all requirements of Skyworks GP01-D233 procurement Spec for tape and reel shipping.
2. Carrier tape shall be black conductive polystyrene.
3. Cover tape shall be transparent conductive material.
4. ESD-surface resistivity shall meet GP01-D233.
5. 10 sprocket hole pitch cumulative tolerance: ±0.20 mm.
6. Ao & Bo measured on plane 0.30 mm above the bottom of the pocket.
7. All measurements are in millimeters.
8. Part No. : 3M115401 (Please indicate on purchase order).

tc456

SKY87250 Design Example

Specifications

V_{OUT} = 1.8 V @ 400 mA

V_{IN} = 5 V

f_{SW} = 2.0 MHz

R_{TON} = 800 mΩ

R_{TOFF} = 650 mΩ

T_A = 85 °C

SKY87250 Losses

All values assume 85°C ambient temperature and thermal resistance of 158 °C/W in the package.

$$P_{TOTAL} = \frac{I_{OUT}^2 \times \left(R_{TON} \times V_{OUT} + R_{TOFF} \times \left[V_{IN} - V_{OUT}\right]\right)}{V_{IN}} + \left(t_{DRV} \times f_{SW} \times I_{OUT} + I_Q\right) \times V_{IN}$$

$$= \frac{0.4A^2 \times \left(0.8\Omega \times 1.8V + 0.65\Omega \times \left[5V - 1.8V\right]\right)}{5V} + \left(5ns \times 2MHz \times 0.4A + 45\mu A\right) \times 5V$$

$$= 120mW$$

$$T_{J(MAX)} = P_{LOSS} \times \theta_{JA} + T_A = \left(158°C/W\right) \times 120mW + 85°C = 104°C$$

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY87250: 400 mA Low-Noise Step-Down Converter in a Micro-Inductor Package	SKY87250-11	SKY87250-11-EVB