Introduction

élantec

The EL7564 is a full featured Buck (Step Down) DC:DC controller with integrated synchronous MOSFETs. With very few external components, a 4A step-down DC:DC converter can be very easily built, resulting in saved board space, minimal design effort, and improved design time.

This demo board is operated at about 350kHz switching frequency. The input voltages are 4.5V to 5.5V. This document outlines the design consideration and lists the bill of materials and the layout. Please also refer to the advanced data sheet of EL7564 for detailed applications of the features.

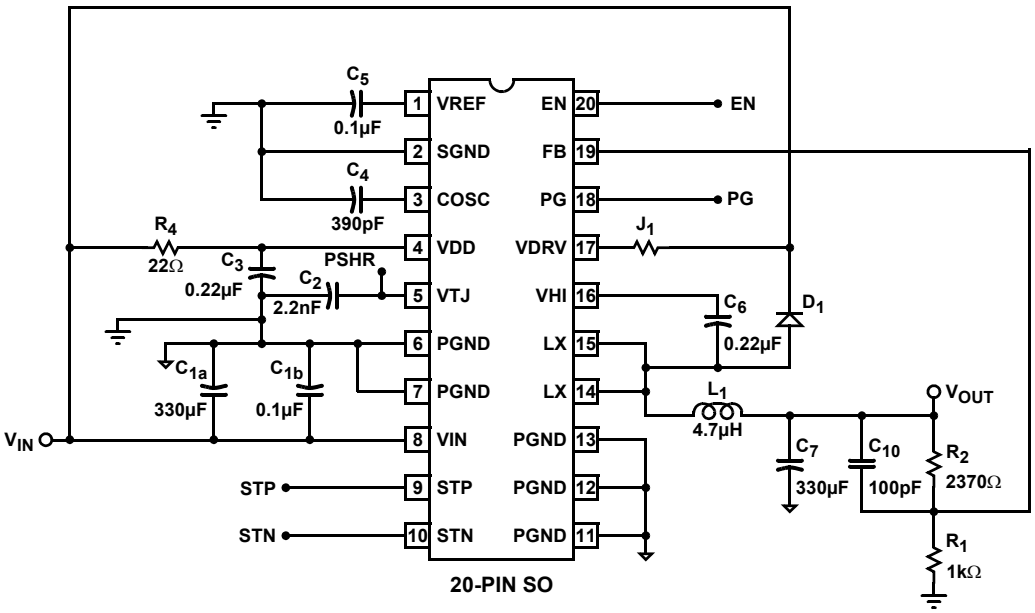

FIGURE 1. EL7564CM DEMO BOARD CIRCUIT SCHEMATIC

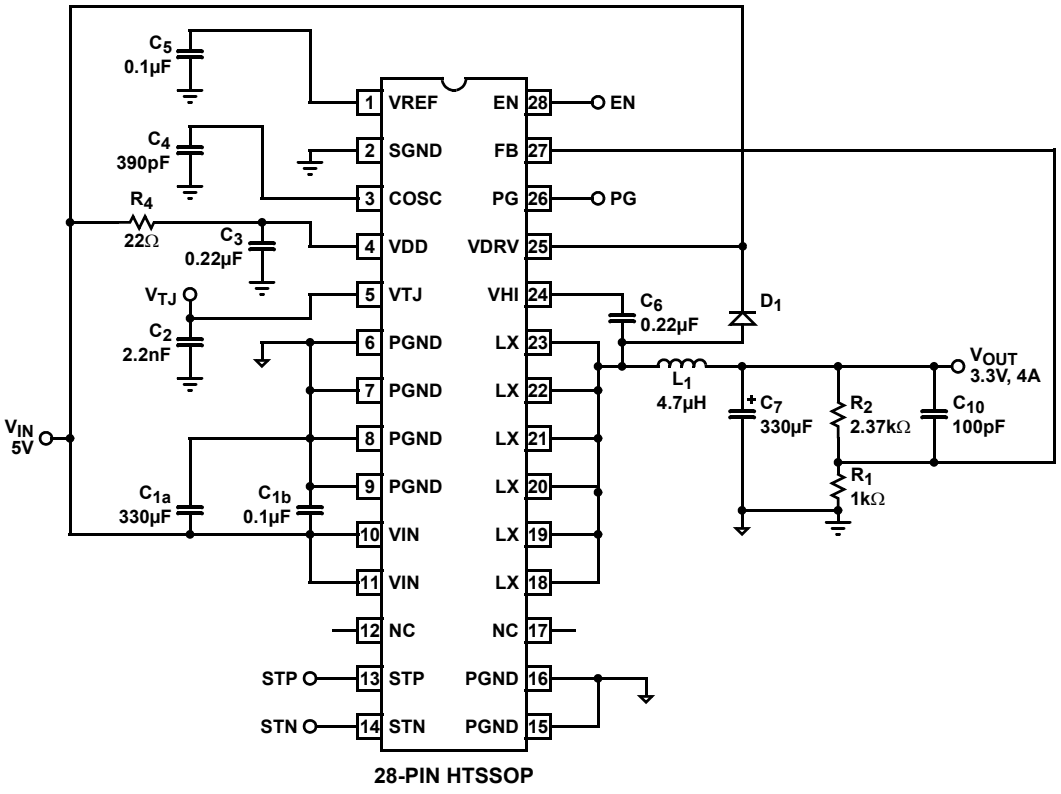

FIGURE 2. EL7564CRE DEMO BOARD SCHEMATIC

EL7564 Demo Board Bill of Material

V_{IN} = 5V, V_{OUT} = 3.3V

COMPONENT	LABEL	VALUE	MANUFACTURER	MANUFACTURER'S PHONE NUMBER	PART NUMBER
Capacitor	C1a	330µF	Sprague	207-324-4140	293D337X96R3
Capacitor	C1b	0.1µF	Vitramon	203-268-6261	VJ0805Y104KXXA
Capacitor	C2	2.2nF	Vitramon	203-268-6261	VJ0805Y222KXXA
Capacitor	C10	100pF	Vitramon	203-268-6261	VJ0805Y100KXXA
Capacitor	C3, C6	0.22µF	Vitramon	203-268-6261	VJ0805Y224KXXA
Capacitor	C4	390pF	Vitramon	203-268-6261	VJ0805A391KXXA
Capacitor	C5	0.1µF	Vitramon	203-268-6261	VJ0805Y104KXXA
Capacitor	C7	330µF	Sprague	207-324-4140	293D337X96R3
Diode	D1		Telefunken	1-800-554-5565	BAT42W
Inductor	L1	4.7µH	Dale	605-665-9301	IDC-5020 4.7µF
			Coilcraft	847-639-6400	D03316P-472
Resistor	R1	1kΩ	Dale	402-563-6506	CRCW08051001
Resistor	R2	2370Ω	Dale	402-563-6506	CRCW08052371
Resistor	R4	22.1Ω	Dale	402-563-6506	CRCW080522R1

Design Considerations

Choosing the Component Values

The following requirements are specified for a DC:DC converter:

Input voltage range: V_{IN} = 4.5V-5.5V

Output voltage: V_O = 3.3V

Max output voltage ripple: ΔV_O = 50mV

Output max current: I_O = 4A

The following steps briefly outline the steps to choose components. For a detailed design discussion, please refer to Elantec Application #18 “Designing a High Efficiency DC:DC Converter with the EL75XX.”

1. Choose the feedback resistor divider.

   The output voltage is decided by:

   EL7564CM: $V_O = 0.975 \times \left(1 + \frac{R_2}{R_1}\right)$

   EL7564CRE: $V_O = 0.992 \times \left(1 + \frac{R_2}{R_1}\right)$

   If R_1 is chosen to be 1kΩ, then:

   $R_2 = 2.37k\Omega$

2. Choose the converter switching frequency F_S.

   F_S, inductor L_1, output capacitor C_7, and EL7564’s switching loss are closely related. many iterations (or thermal measurements) may be required before a final value can be decided.

   Please refer to the EL7564 data sheet for the F_S vs C_{OSC} curve.

3. Inductor L_1.

   The EL7564 is internally ramp-compensated. For optimal operation, the inductor current ripple range should be less than 0.8A.

   If ΔI_L = 0.8A, then:

   $$L = \frac{(1 - D) \times V_O}{\Delta I_L \times F_S}$$

   when:

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

   Choosing L_1 = 4.7µH yields ΔI_{LMAX} = 0.72 and ΔI_{LMIN} = 0.64A. L_1 should also be able to handle DC current of 4A and peak current of 4.4A at temperature range.

4. Output capacitor C_7.

   ΔV_O and ΔI_L normally decide C_7 value. ΔV_O requires ESR of C_7 be less than:

   $$ESR = \frac{\Delta V_O}{\Delta I_{LMAX}} = 70m\Omega$$

   Double-check the RMS current requirement of the output capacitor:

   $$\Delta I_{C7} = \frac{\Delta I_{LMAX}}{\sqrt{12}}$$

   which is 0.21A. For a capacitor or combination of capacitors with 70mΩ parallel ESR, it is more than enough to handle this current.

5. Input capacitor C_{1a}.

   If all the AC current is handled by the input capacitor C_{1a}, its RMS current is calculated as:

   $$I_{IN,rms} = \sqrt{[D \times (1 - D)]} \times I_O$$

   This gives almost 1.97A when D = D_{MAX}. Therefore a cap with 1.97A current handling capability should be chosen. However, in case some other capacitor is sharing current with it, C_{1a}’s current requirement can be reduced.

Layout Considerations

The layout is very important for the converter to function properly. Power Ground (⏚) and Signal Ground (⏚) should be separated to ensure that the high pulse current in the Power Ground never interferes with the sensitive signals connected to Signal Ground. They should only be connected at one point (normally at the negative side of either the input or output capacitor.)

The trace connected to the FB pin is the most sensitive trace. It needs to be as short as possible and in a “quiet” place, preferably with the PGND or SGND traces surrounding it.

In addition, the bypass capacitor connected to the V_{DD} pin needs to be as close to the pin as possible.

The heat of the chip is mainly dissipated through the PGND pins for the CM package, and through the heat pad at the bottom for the CRE package. Maximizing the copper area around these PGND pins or the heat pad is preferable. In addition, a solid ground plane is always helpful for the EMI performance.

Performance

The waveforms and thermal performance curves of this demo board are shown on the next pages. The junction temperature of the chip can be determined by:

$$T_J = 75 + \frac{1.2 + VTJ}{0.00384}$$

Typical Performance Curves

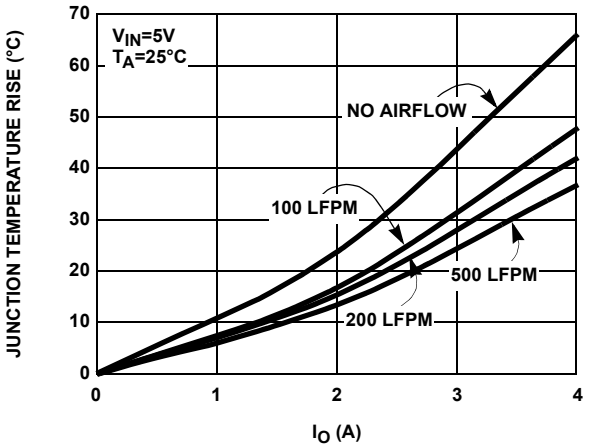

FIGURE 3. EL7564CM JUNCTION TEMPERATURE RISE ON DEMO BOARD

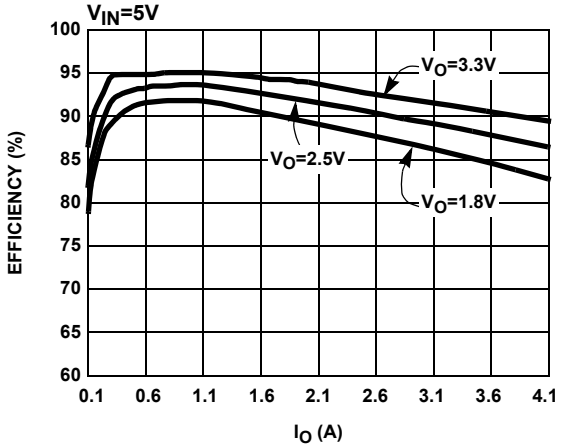

FIGURE 4. EL7564CRE EFFICIENCY

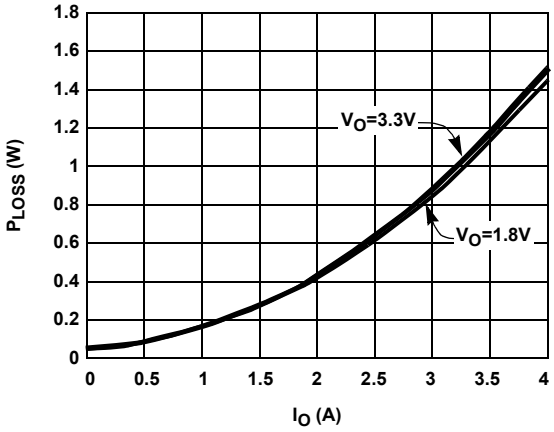

FIGURE 5. TOTAL CONVERTER POWER LOSS - EL7564CRE

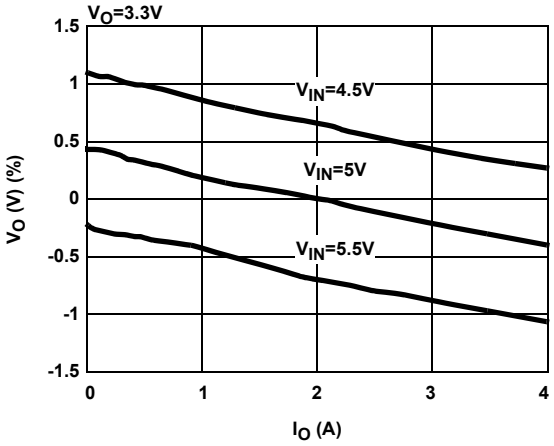

FIGURE 6. EL7564CRE LOAD REGULATION

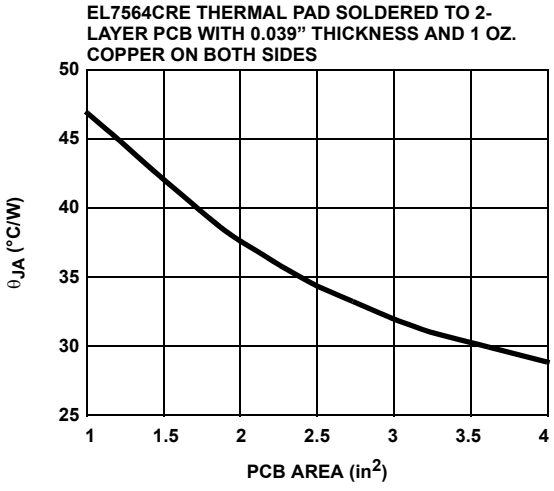

FIGURE 7. EL7564CRE THERMAL RESISTANCE VS PCB AREA - NO AIRFLOW

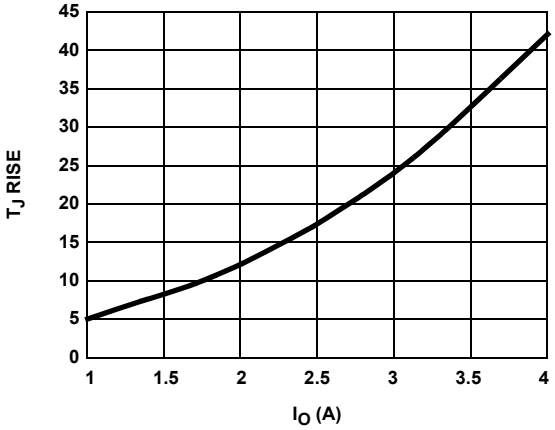

FIGURE 8. EL7564CRE JUNCTION TEMPERATURE RISE ON DEMO BOARD - NO AIRFLOW

Demo Board Waveforms

V_{IN}=5V, V_O=3.3V, I_O=4A

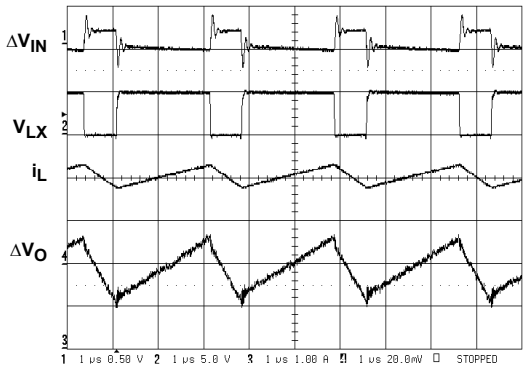

FIGURE 9. SWITCHING WAVEFORMS

V_{IN}=5V, V_O=3.3V, I_O=0.2A-4A

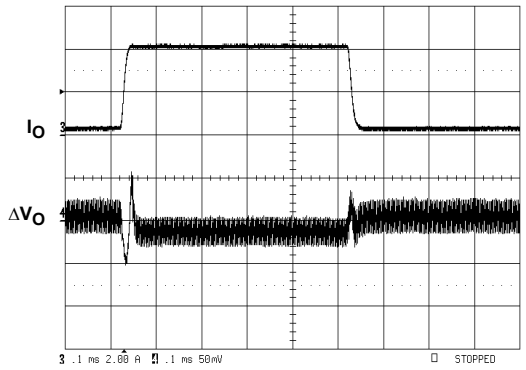

FIGURE 10. TRANSIENT RESPONSE

V_{IN}=5V, V_O=3.3V, I_O=2A

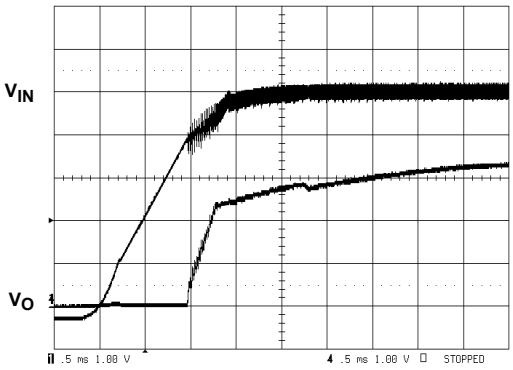

FIGURE 11. POWER-UP

V_{IN}=5V, V_O=3.3V, I_O=4A

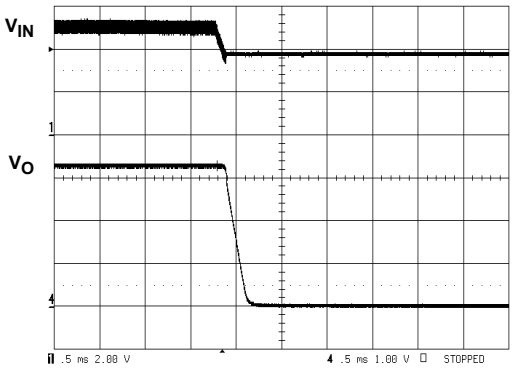

FIGURE 12. POWER-DOWN

V_{IN}=5V, V_O=3.3V, I_O=2A

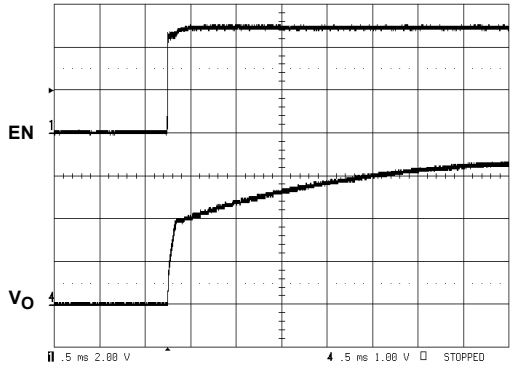

FIGURE 13. RELEASING EN

V_{IN}=5V, V_O=3.3V, I_O=4A

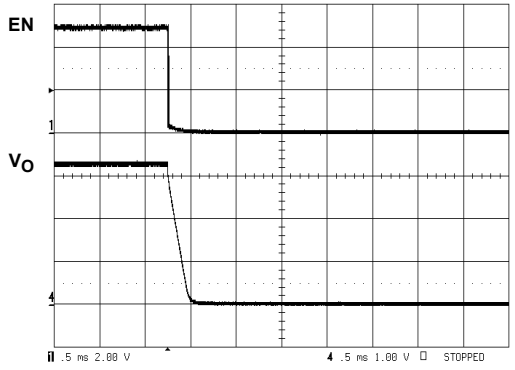

FIGURE 14. SHUT-DOWN

Demo Board Waveforms (Continued)

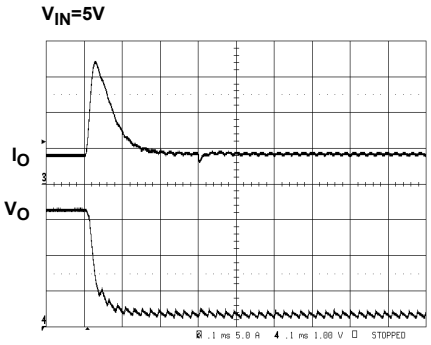

FIGURE 15. SHORT-CIRCUIT PROTECTION

Demo Board Layout (EL7564CM)

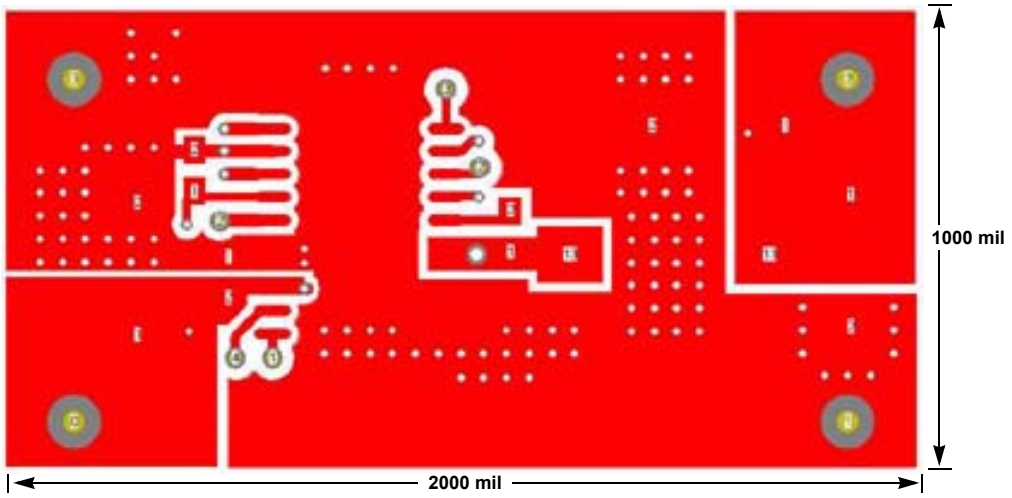

FIGURE 16. TOP LAYER

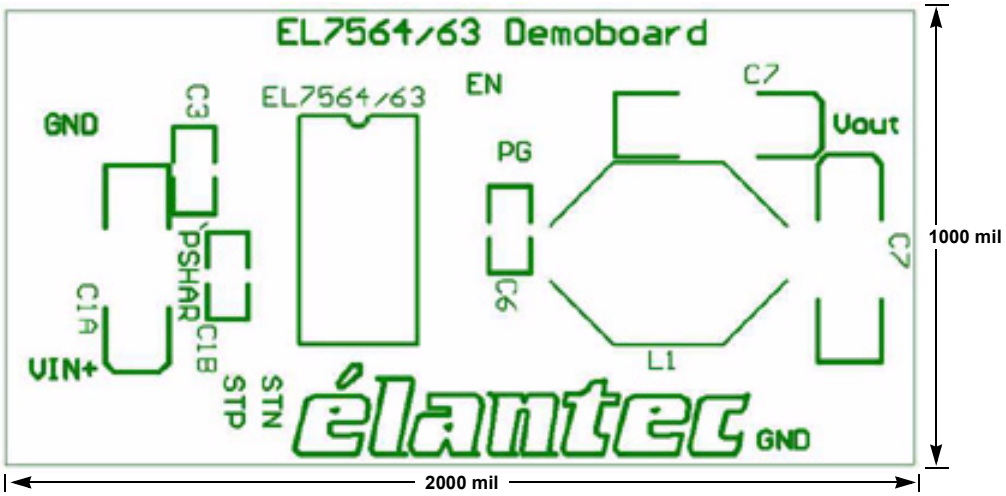

FIGURE 15. TOP SILKSCREEN

Demo Board Layout (EL7564CM) (Continued)

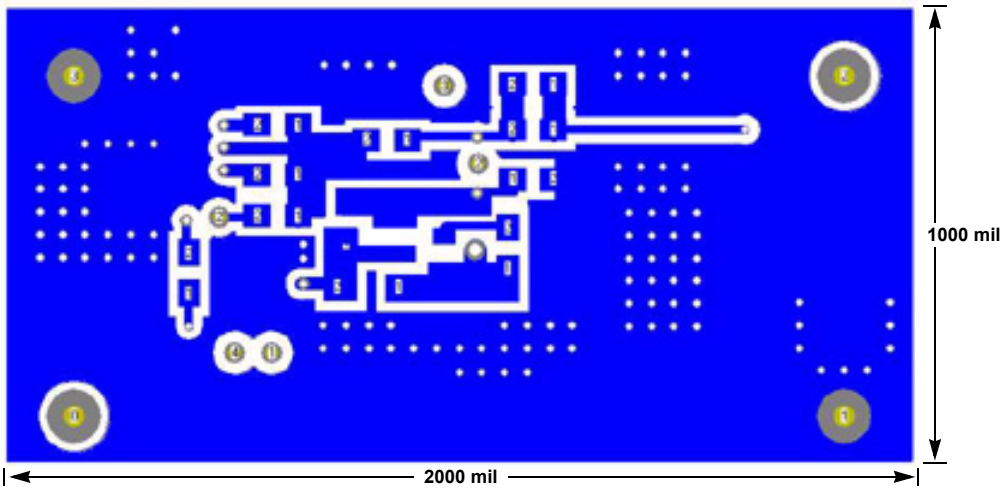

FIGURE 17. BOTTOM LAYER

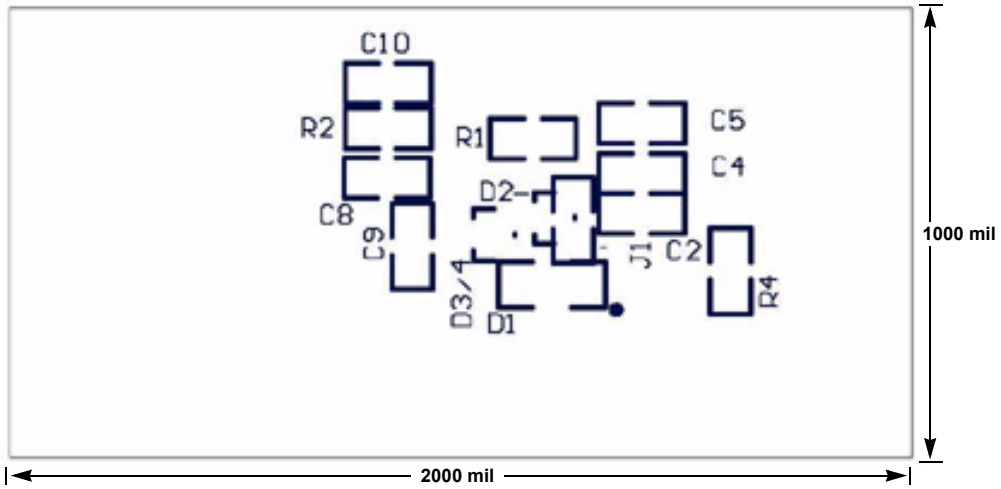

FIGURE 16. BOTTOM SILKSCREEN

Demo Board Layout (EL7564CRE) (Continued)

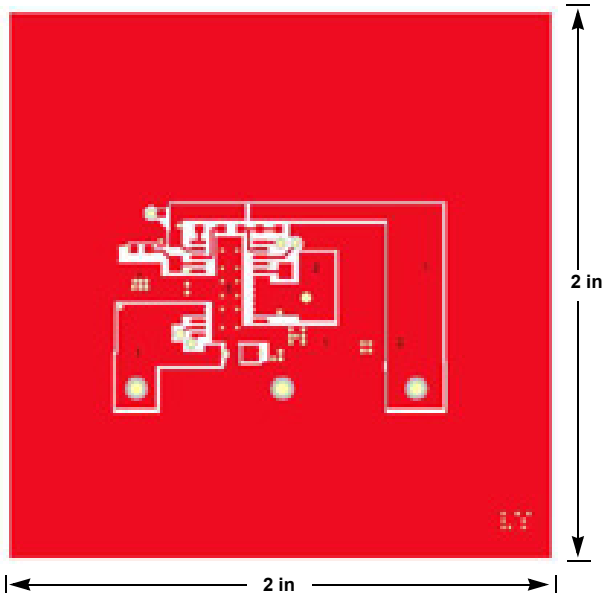

FIGURE 18. TOP LAYER

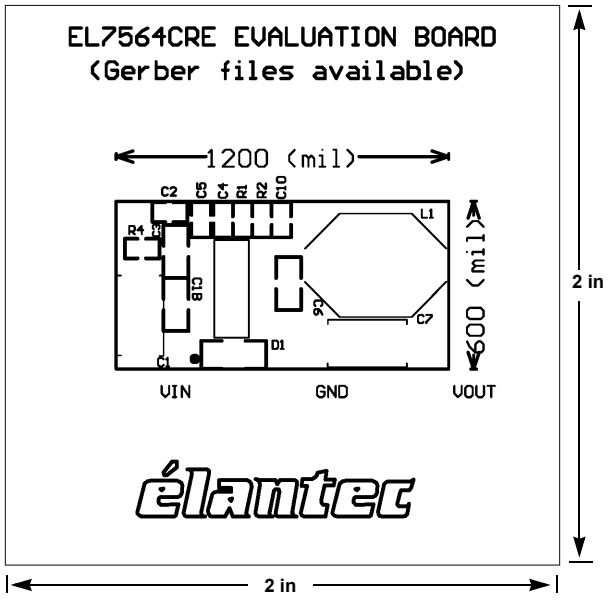

FIGURE 17. TOP SILKSCREEN

Demo Board Layout (EL7564CRE) (Continued)

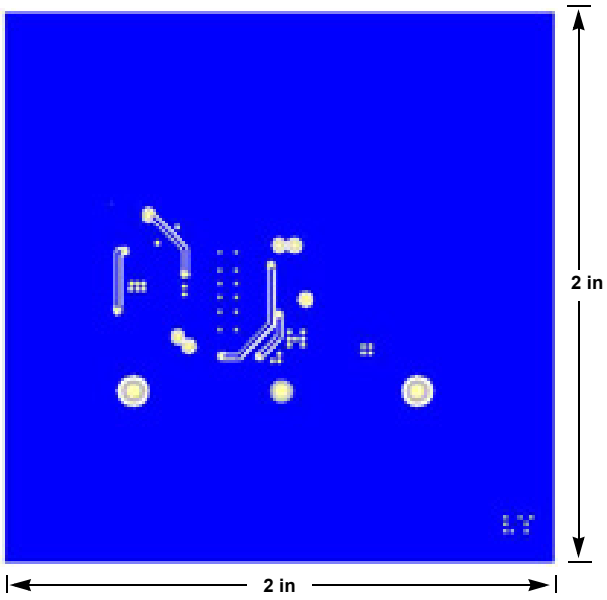

FIGURE 19. BOTTOM LAYER

FIGURE 18. BOTTOM SILKSCREEN

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