AN-1978 LM3445 120VAC Small Evaluation Board

1 Introduction

The demonstration board included in this shipment converts $90V_{AC}$ to $135V_{AC}$ input, and drives six, to thirteen series connected LED's at 350 mA average current. The LM3445 switching frequency ranges from about 70 kHz with six series connected LEDS, to about 110 kHz with thirteen series connected LEDs. The switching frequency can be modified to optimize performance,. This is a four-layer board using the bottom and top layer for component placement. The demonstration board can be modified to adjust the LED forward current, the number of series connected LEDs and switching frequency.. .

A bill of materials included describes the parts used on this demonstration board. A schematic and layout have also been included below along with measured performance characteristics. The above restrictions for the input voltage are valid only for the demonstration board as shipped with the schematic below. The board is currently set up to drive six to thirteen series connected LEDs, but the evaluation board may be modified to accept fewer series LEDs. Please refer to the *LM3445 Triac Dimmable Offline LED Driver* (SNVS570) data sheet for further explanation, instruction, and details.

2 Evalution Board Operating Conditions

V_{IN} = $90V_{AC}$ to $135V_{AC}$

Six to thirteen series connected LEDs

I_{LED} = 350 mA

3 Simplified LM3445 Schematic and Efficiency Plot

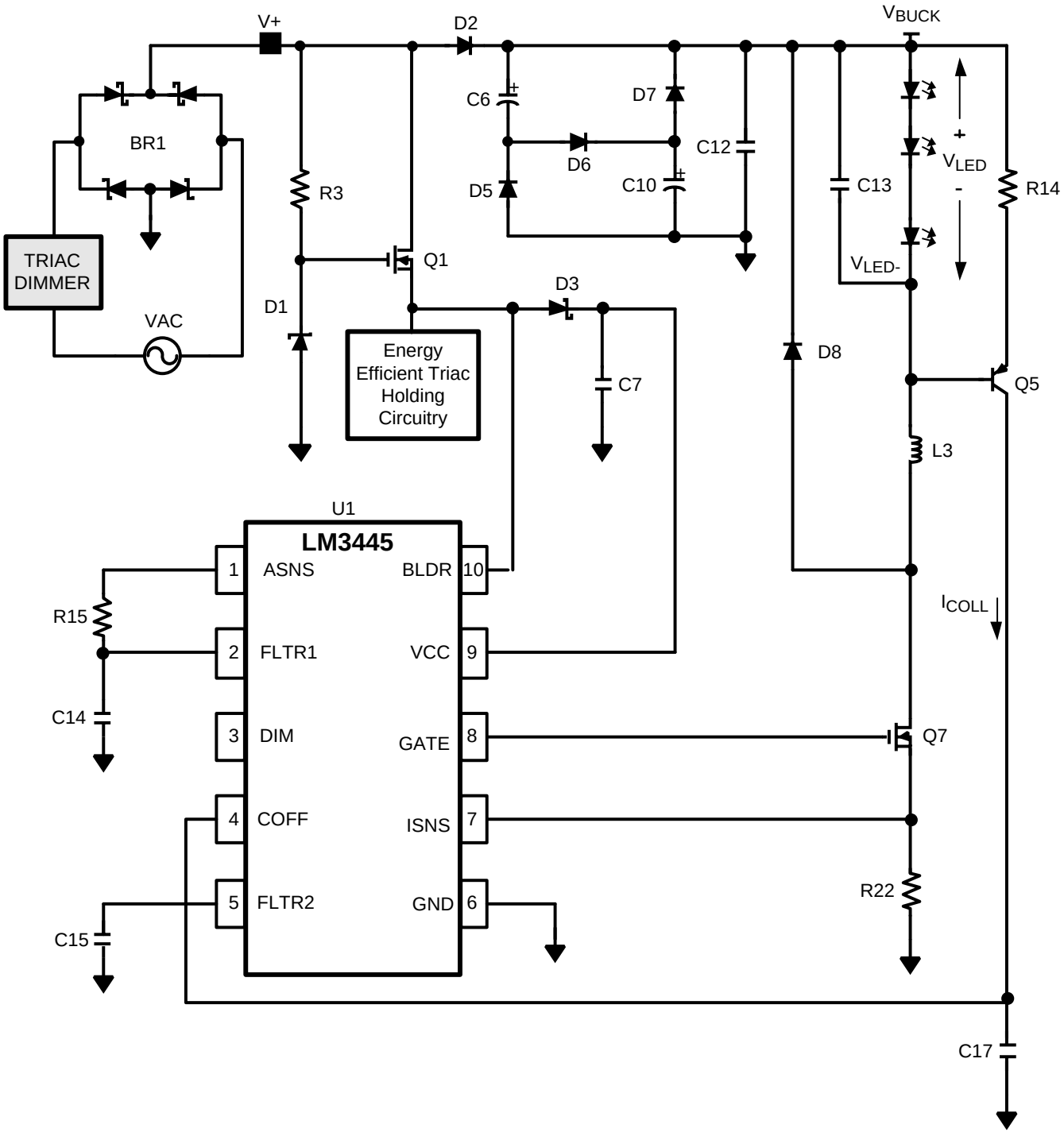

Figure 1. LM3445 Schematic

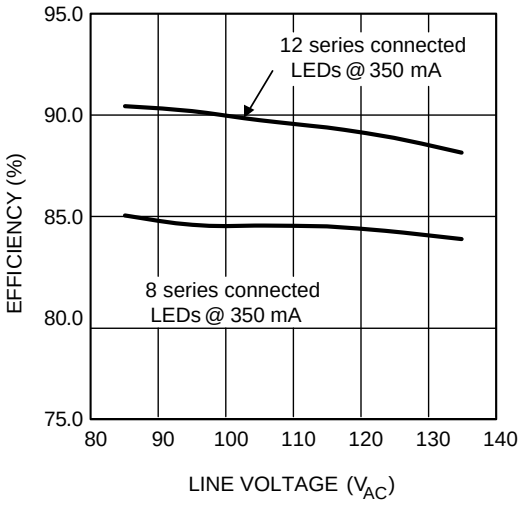

Figure 2. Efficiency Plot

WARNING

The LM3445 evaluation boards have no isolation or any type of protection from shock. Caution must be taken when handling evaluation board. Avoid touching evaluation board, and removing any cables while evaluation board is operating. Isolating the evaluation board rather than the oscilloscope is highly recommended.

WARNING

This LM3445 evaluation PCB is a non-isolated design. The ground connection on the evaluation board is NOT referenced to earth ground. If an oscilloscope ground lead is connected to the evaluation board ground test point for analysis, and AC power is applied, the fuse (F1) will fail open. The oscilloscope should be powered via an isolation transformer before an oscilloscope ground lead is connected to the evaluation board.

4 Pin-Out

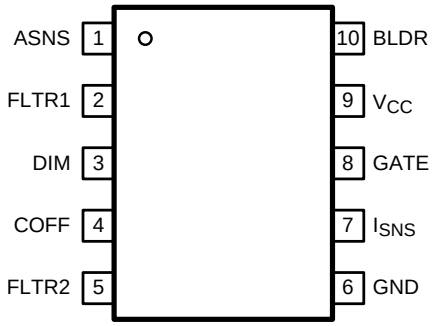

Figure 3. 10-Pin VSSOP

Table 1. Pin Description 10 Pin VSSOP

Pin #	Name	Description
1	ASNS	PWM output of the triac dim decoder circuit. Outputs a 0 to 4V PWM signal with a duty cycle proportional to the triac dimmer on-time.
2	FLTR1	First filter input. The 120Hz PWM signal from ASNS is filtered to a DC signal and compared to a 1 to 3V, 5.85 kHz ramp to generate a higher frequency PWM signal with a duty cycle proportional to the triac dimmer firing angle. Pull above 4.9V (typical) to tri-state DIM.
3	DIM	Input/output dual function dim pin. This pin can be driven with an external PWM signal to dim the LEDs. It may also be used as an output signal and connected to the DIM pin of other LM3445 or LED drivers to dim multiple LED circuits simultaneously.
4	COFF	OFF time setting pin. A user set current and capacitor connected from the output to this pin sets the constant OFF time of the switching controller.
5	FLTR2	Second filter input. A capacitor tied to this pin filters the PWM dimming signal to supply a DC voltage to control the LED current. Could also be used as an analog dimming input.
6	GND	Circuit ground connection.
7	ISNS	LED current sense pin. Connect a resistor from main switching MOSFET source, ISNS to GND to set the maximum LED current.
8	GATE	Power MOSFET driver pin. This output provides the gate drive for the power switching MOSFET of the buck controller.
9	V_{CC}	Input voltage pin. This pin provides the power for the internal control circuitry and gate driver.
10	BLDR	Bleeder pin. Provides the input signal to the angle detect circuitry as well as a current path through a switched 230Ω resistor to ensure proper firing of the triac dimmer.

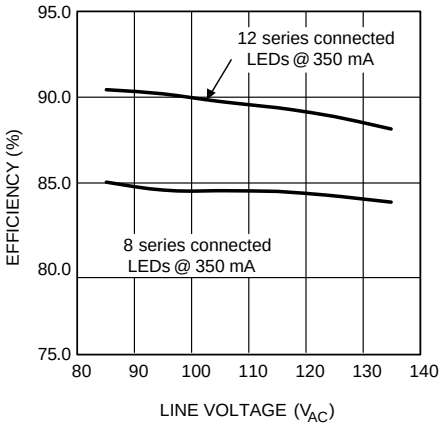

Figure 4. LM3445 Efficiency vs Input Voltage
8 and 12 Series connected LEDs @ 350 mA

5 LM3445 Evaluation Board Schematic

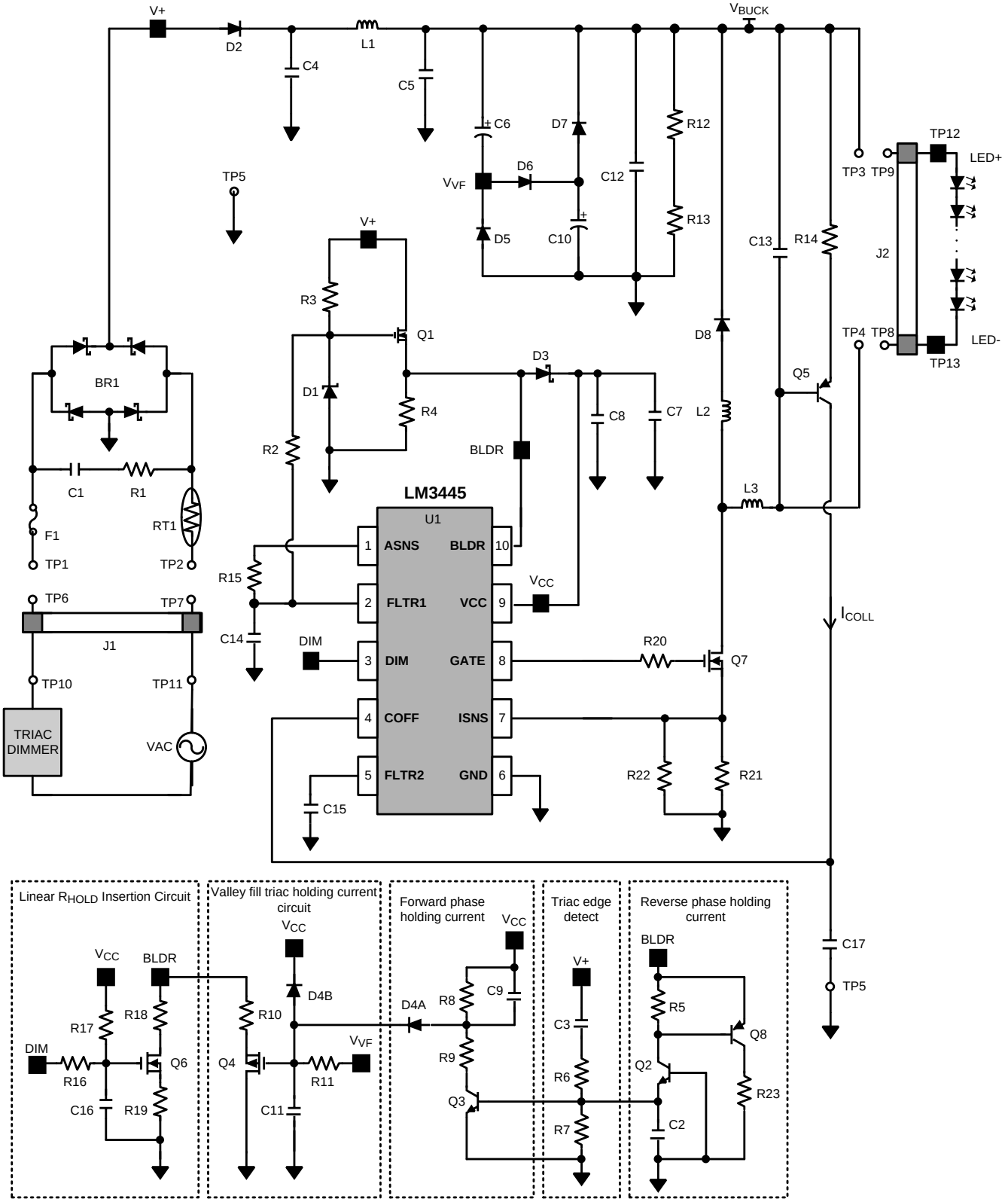

Figure 5. Evaluation Board Schematic

6 Bill of Materials LM3445 Evaluation Board

Table 2. Bill of Materials LM3445 Evaluation Board

REF DES	Description	MFG	MFG Part Number
U1	IC DRIVER LED W/TRIAC DIM 10VSSOP	Texas Instruments	LM3445
BR1	Bridge Rectifier Vr = 400V, Io = 0.8A, Vf = 1V	Diodes Inc.	HD04-T
C1	Ceramic .10uF 250V X7R 1210	Taiyo Yuden	QMK325B7104KN-T
C2	Ceramic, 0.01uF, X7R, 25V, 10%	MuRata	GRM188R71E103KA01D
C3	Ceramic, 1000pF 500V X7R 1206	Kemet	C1206C102KCRACTU
C4, C5, C12	.01uF	KEMIT	C1808C103KDRACTU
C6, C10	CAP 33uF 100V ELECT NHG RADIAL	Panasonic-ECG	ECA-2AHG330
C7, C8	22uF, Ceramic, X5R, 25V, 10%	MuRata	GRM32ER61E226KE15L
C9	4.7uF		C3216X7R1E475K
C11	No Load		
C13	Ceramic, 1.0 uF 100V X7R 1206	Murata	GRM31CR72A105KA01
C14	Ceramic, X7R, 16V, 10%	MuRata	GRM188R71C474KA88D
C15	Ceramic, 0.1uF, X7R, 16V, 10%	MuRata	GRM188R71C104KA01D
C16	Ceramic, 0.22uF, X7R, 16V, 10%	Murata	GRM188R71E224KA88D
C17	Ceramic, 330pF 100V C0G 0603	Murata	GCM1885C2A331JA16D
D1	DIODE ZENER 225MW 15V SOT23	ON Semiconductor	BZX84C15LT1G
D2, D3, D5, D6, D7	DIODE FAST REC 200V 1A	Rohm Semiconductor	RF071M2STR
D4	DIODE SWITCH SS DUAL 70V SOT323	Fairchild	BAV99WT1G
D8	DIODE SUPER FAST 200V 1A SMB	Diodes Inc	MURS120-13-F
F1	FUSE 1A 125V FAST	Cooper/Bussman	6125FA1A
J1, J2	Conn, Term Block 2POS	Phoenix Contact	1715721
L1	INDUCTOR 1000UH .27A SMD SHIELD	Murata Power sol	46105C
L2	10mH, FERRITE CHIP POWER 160 OHM	Steward	HI1206T161R-10
L3	1mH, Shielded Drum Core,	Coilcraft Inc.	MSS1260-105
Q1	MOSFET N-CHAN 250V 4.4A DPAK	Fairchild	FDD6N25
Q2, Q3	TRANS NPN 350MW 40V SMD SOT23	Diodes Inc	MMBT4401-7-F
Q4	MOSFET P-CH 50V 130MA SOT-323	Diodes Inc	BSS84W-7-F
Q5	TRANS HIVOLT PNP AMP SOT-23	Fairchild	MMBTA92
Q6	MOSFET N-CHANNEL 100V SOT323	Diodes Inc	BSS123W-7-F
Q7	MOSFET N-CH 200V POWERPAK 8-SOIC	Vishay/Siliconix	Si7464DP
Q8	TRANS PNP LP 100MA 30V SOT23	ON Semiconductor	BC858CLT1G
R1	330ohm 2512 5% Resistor	Vishay/Dale	CRCW2512330RJNEG
R2	4.75M, 0805, 1%, 0.125W	Vishay-Dale	CRCW08054M75FKEA
R3	1%, 0.25W	Vishay-Dale	CRCW1206332kFKEA
R4	(No Load) 0805		
R5, R16	RES 49.9K OHM, 0.1W, 1% 0603	Vishay-Dale	CRCW060349k9FKEA
R6	RES 100K OHM, 0.25W1%, 1206	Vishay-Dale	CRCW1206100kFKEA
R7	RES 7.50K OHM, 0.1W, 1% 0603	Vishay-Dale	CRCW06037k50FKEA
R8	RES 10.0K OHM, 0.1W, 1% 0603	Vishay-Dale	CRCW060310k0FKEA
R9	RES 100 OHM, 0.25W1%, 1206	Vishay-Dale	CRCW1206100RFKEA
R10	RES 124 OHM, 0.25W1%, 1206	Vishay-Dale	CRCW1206124RFKEA
R11	RES 200K OHM, 0.125W, 1%, 0805	Vishay-Dale	CRCW0805200kFKEA
R12, R13	RES 1.0M OHM, 0.125W, 1%, 0805	Vishay-Dale	CRCW08051M00FKEA
R14	RES 576K OHM, 1/10W 1% 0603	Vishay-Dale	CRCW0603576kFKEA
R15	RES 280K OHM, 1/10W 1% 0603	Vishay-Dale	CRCW0603280kFKEA

Table 2. Bill of Materials LM3445 Evaluation Board (continued)

REF DES	Description	MFG	MFG Part Number
R17	(No Load) 0603		
R18	RES 301 OHM, 0.25W1%, 1206	Vishay-Dale	CRCW1206301RFKEA
R19	RES 49.9 OHM, 0.125W, 1%, 0805	Vishay-Dale	CRCW080549R9FKEA
R20	RES 4.99 OHM 1/8W 1% 0805	Vishay-Dale	CRCW08054R99FKEA
R21	RES 12.1 OHM, 0.25W1%, 1206	Vishay-Dale	CRCW120612R1FKEA
R22	RES 1.8 OHM 1/3W 5% 1210	Vishay-Dale	CRCW12101R80JNEA
R23	RES 499 OHM, 0.25W1%, 1206	Vishay-Dale	CRCW1206499RFKEA
RT1	CURRENT LIM INRUSH 60OHM 20%	Canterm	MF72-060D5
TP10-TP13	Terminal, Turret, TH, Double	Keystone Electronics	1503-2

7 PCB Layout

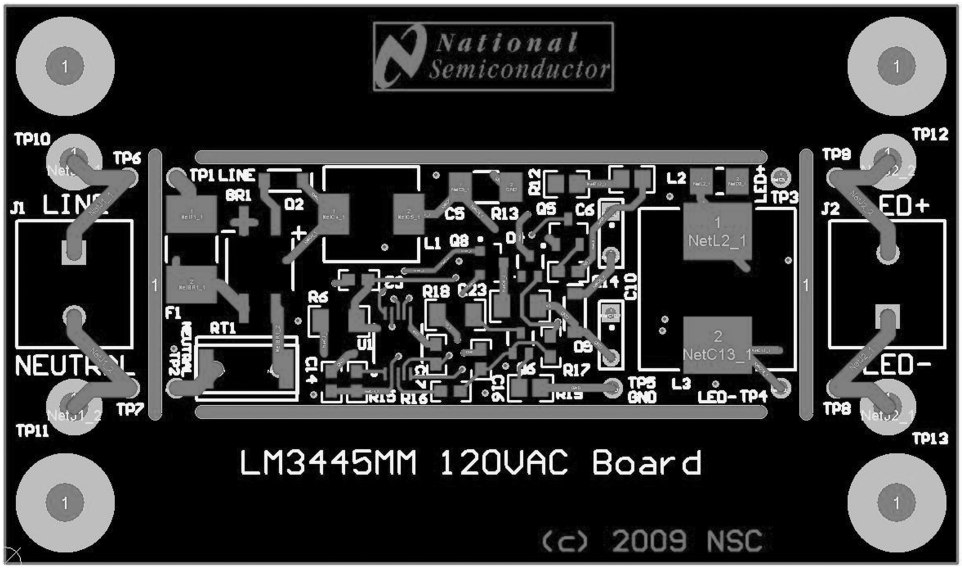

Figure 6. Top Layer

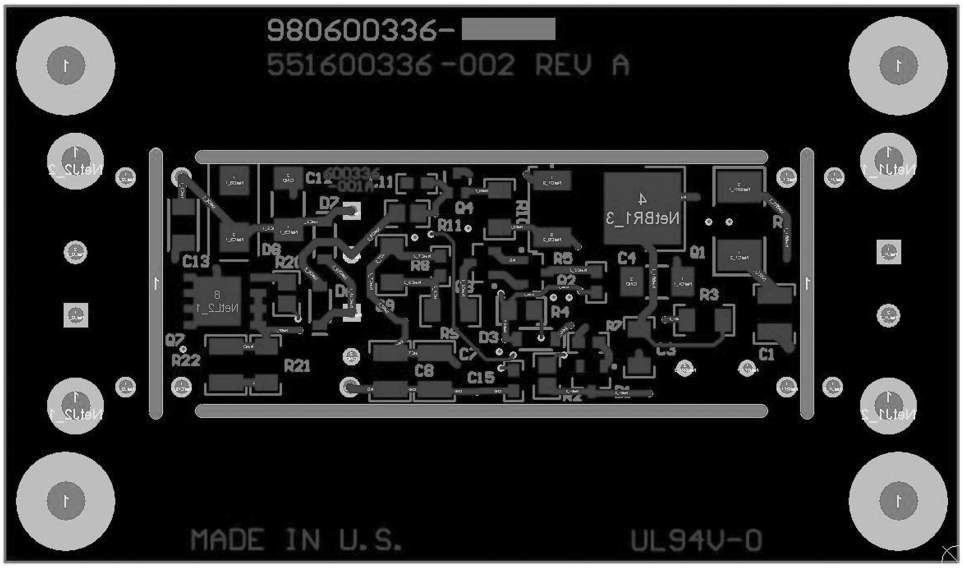

Figure 7. Bottom Layer

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