AN-1935 LM3445 Off-Line TRIAC Dimmer LED Driver Demo Board

1 Introduction

The demonstration board included in this shipment converts $90V_{AC}$ to $135V_{AC}$ input, and drives seven, or eight series connected LED's at 350 mA average current. The LM3445 switching frequency is set at a nominal 225 kHz. 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 below 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. Please refer to the *LM3445 Triac Dimmable Offline LED Driver* (SNVS570 data sheet for detailed information regarding the LM3445 device, and the application circuit

2 Operating Conditions

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

Seven or eight series connected LEDs

I_{LED} = 350 mA

3 Simplified LM3445 Schematic and Efficiency Plot

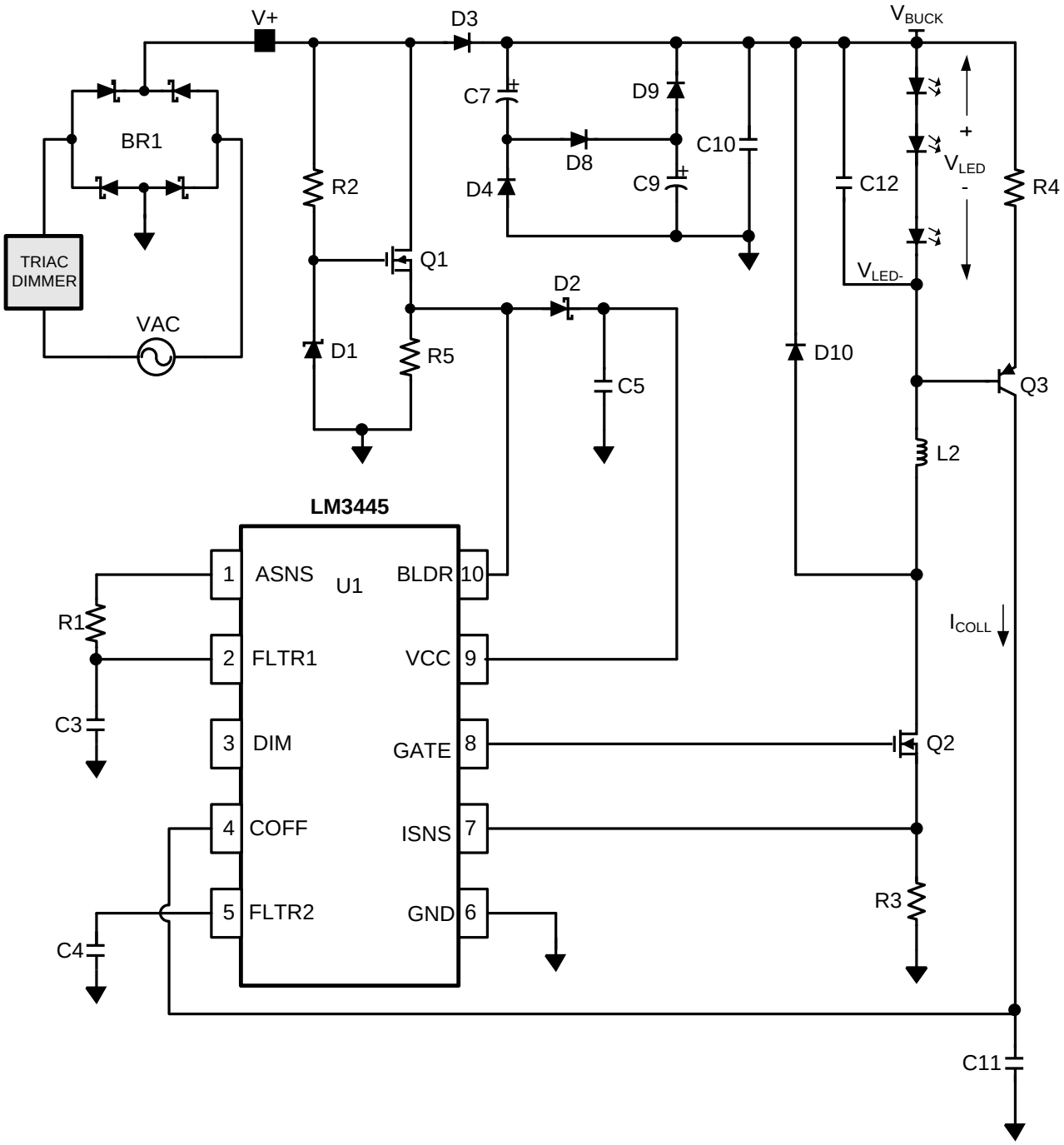

Figure 1. Simplified LM3445 Schematic

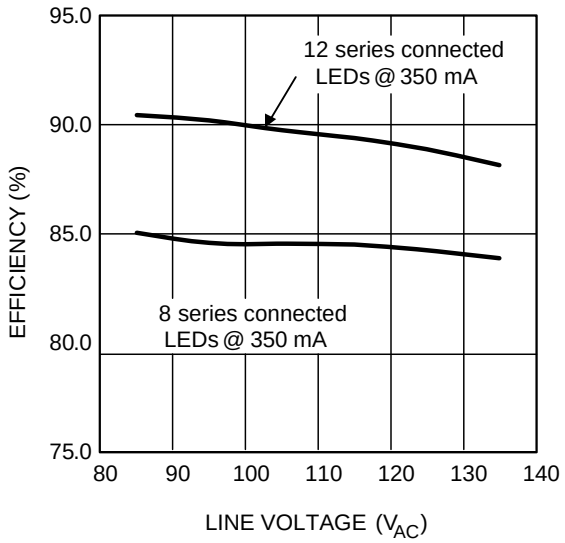

Figure 2. Efficiency Plot

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.

4 Pin-Out

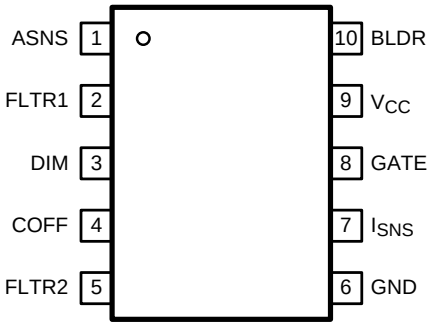

Figure 3. 10-Pin VSSOP

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.

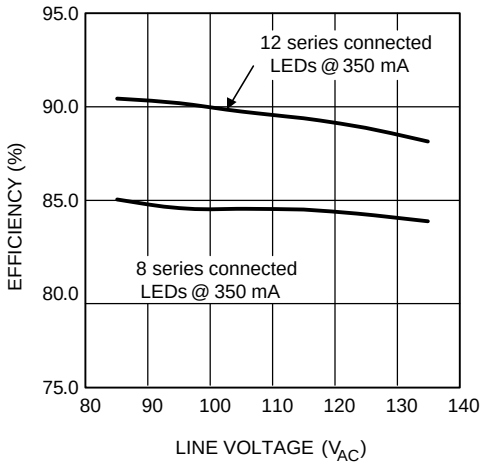

Figure 4. LM3445 Efficiency vs Input Voltage
8 and 12 Series connected LEDs @ 350 mA

5 LM3445 Evaluation Board Schematic

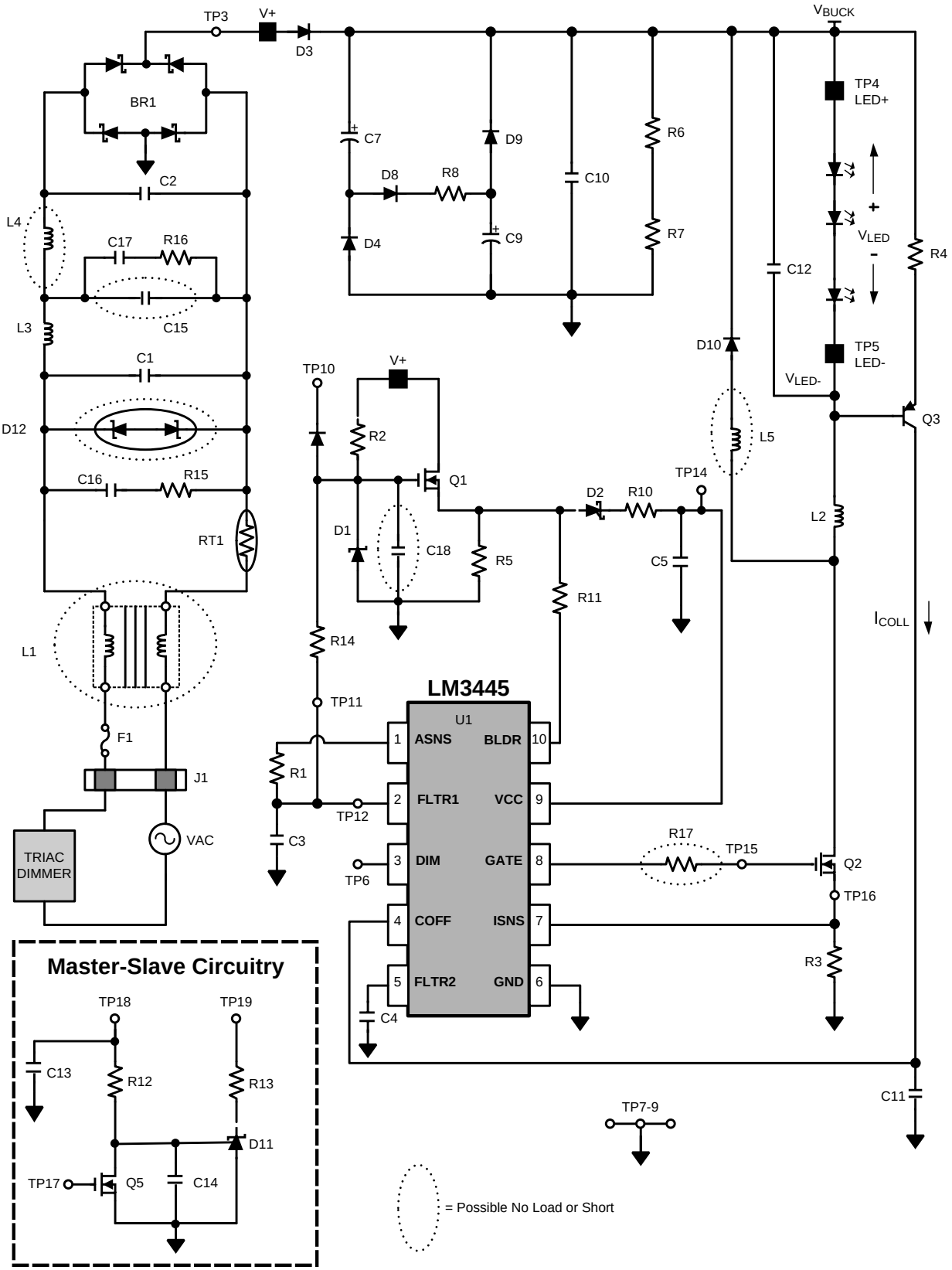

Table 2. Bill of Materials LM3445 Evaluation Board

REF DES	Description	MFG	MFG Part Number
U1	IC, CTRLR, DRVR-LED, VSSOP10	TI	LM3445
BR1	Bridge Rectifier, SMT, 400V, 800 mA	Diodes Inc	HD04-T
L1 (no load, short pad)	Common mode filter DIP4NS, 900 mA, 700 µH	Panasonic	ELF11M090E
L2	Inductor, SHLD, SMT, 1A, 470 µH	Coilcraft	MSS1260-474KLB
L3	Diff mode inductor, 500 mA 1 mH	Coilcraft	MSS1260-105KL-KLB
L4 (no Load, short pad)	Diff mode inductor, 500 mA 1 mH	Coilcraft	MSS1260-105KL-KLB
L5	Bead Inductor, 160Ω, 6A	Steward	HI1206T161R-10
C1, C2	Cap, Film, X2Y2, 12.5MM, 250VAC, 20%, 10nF	Panasonic	B32921C3103M(K)
C3	Cap, X7R, 0603, 16V, 10%, 470 nF	MuRata	GRM188R71C474KA88D
C4	Cap, X7R, 0603, 16V, 10%, 100 nF	MuRata	GRM188R71C104KA01D
C5, C6	Cap, X5R, 1210, 25V, 10%, 22 µF	MuRata	GRM32ER61E226KE15L
C7, C9	Cap, AL, 200V, 105C, 20%, 33 µF	UCC	EKXG201ELL330MK20S
C10	Cap, Film, 250V, 5%, 10 nF	Epcos	B32521C3103J
C12	Cap, X7R, 1206, 50V, 10%, 1.0 µF	MuRata	C1206F105K5RACTU
C11	Cap, C0G, 0603, 100V, 5%, 120 pF	MuRata	GRM1885C2A121JA01D
C13	Cap, X7R, 0603, 50V, 10%, 1.0 nF	Kemet	C0603C102K5RACTU
C14	Cap, X7R, 0603, 50V, 10%, 22 nF	Kemet	C0603C223K5RACTU
C15 (no load)	Cap, Film, X2Y2, 12.5MM, 250VAC, 20%, 10nF	Panasonic	B32921C3103M(K)
C16, C17	Cap, X7R, 1206, 250V, 10%, 0.047 µF	TDK	C3216X7R2E473K
C18 (no load)	Cap, X7R, 0603, 50V, 10%, 1.0 nF	Kemet	C0603C102K5RACTU
D1	Diode, ZNR, SOT23, 15V, 5%	On Semi	BZX84C15LT1G
D2, D3, D4, D8, D9	Diode, FR, SOD123, 200V, 1A	Rohm	RF071M2S
D10	Diode, FR, SMB, 400V, 1A	On Semi	MURS140T3G
D11	IC, SHNT, ADJ, SOT23, 2.5V, 0.5%	TI	TL431BIDBZR
D12 (No Load)	TVS	Littelfuse	
D13	Diode, SCH, SOD123, 40V, 120 mA	NXP	BAS40H
R1	Resistor, 0603, 1%, 280 kΩ	Panasonic	ERJ-3EKF2803V
R2	Resistor, 1206, 1%, 100 kΩ	Panasonic	ERJ-8ENF1003V
R3	Resistor, 1210, 5%, 1.8Ω	Panasonic	ERJ-14RQJ1R8U
R4	Resistor, 0603, 1%, 576 kΩ	Panasonic	ERJ-3EKF5763V
R5	Resistor, 1206, 1%, 1.00 kΩ	Panasonic	ERJ-8ENF1001V
R6, R7	Resistor, 0805, 1%, 1.00 MΩ	Rohm	MCR10EZHF1004
R8, R10, R17, R18, R19, R21	Resistor, 1206, 0.0Ω	Yageo	RC1206JR-070RL
R20 (No Load)	Resistor, 1206, 0.0Ω		
R9	Resistor, 1210, 0.0Ω	Vishay	CRCW12100000Z0EA
R11	Resistor, 0603, 0.0Ω	Yageo	RC0603JR-070RL
R12	Resistor, 0603, 1%, 33.2kΩ	Panasonic	ERJ-3EKF3322V
R13	Resistor, 0603, 1%, 2.0kΩ	Panasonic	ERJ-3EKF2001V
R14	Resistor, 0805, 1%, 3.3 MΩ	Rohm	MCR10EZPJ335
R15, R16	Resistor, 2210, 820Ω	Vishay	CRCW2010820RJNEF
RT1	Thermistor, 120V, 1.1A, 50Ω @ 25C	CL-140	KC014L-ND
Q1, Q2	XSTR, NFET, DPAK, 300V, 4A	Fairchild	FQD7N30TF
Q3	XSTR, PNP, SOT23, 300V, 500 mA	Fairchild	MMBTA92
Q5	XSTR, NFET, SOT23, 100V, 170 mA	Fairchild	BSS123
J1	Terminal Block 2 pos	Phoenix Contact	1715721
F1	Fuse, 125V, 1,25A	bel	SSQ 1.25

LM3445 Loads and No Load components: This LM3445 evaluation PCB has been built to allow the end user to add or delete EMI circuitry, and an input over-voltage TVS. The input common mode choke (L1), both differential chokes (L3 and L4) solder pads are created so that 0 ohm 1206 resistors (R18, R19, R20, and R21) can short the components circuit path if necessary.

6 PCB Layout

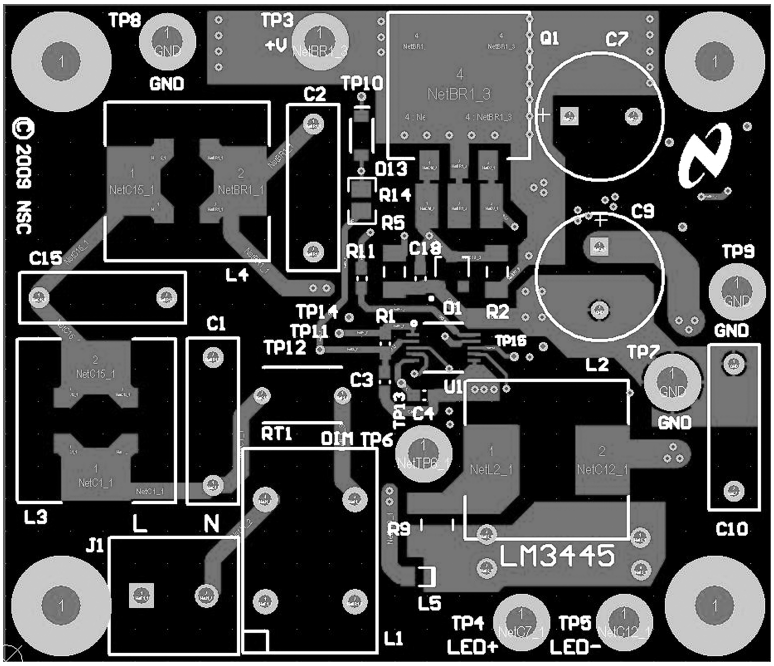

Figure 5. Top Layer

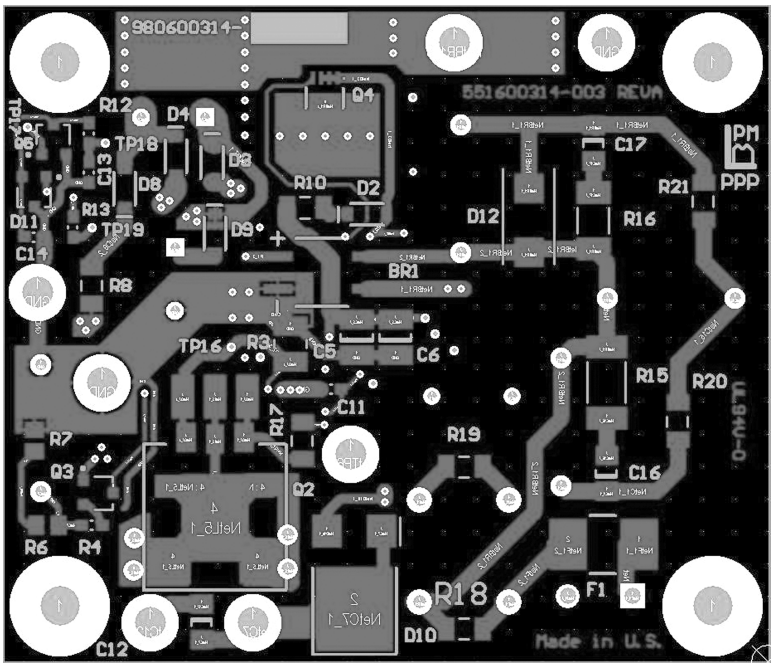

Figure 6. Bottom Layer

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