LM25088 Evaluation Board

National Semiconductor
Application Note 1931
Ajay Hari
December 8, 2008

Introduction

The LM25088 evaluation board is designed to provide the design engineer with a fully functional power converter based on Emulated Current Mode Control to evaluate the LM25088 controller IC. The LM25088 evaluation board is available in two versions (like the LM25088 controller): the LM25088-1

evaluation board provides ±5% oscillator frequency dithering to reduce EMI and the LM25088-2 evaluation board provides hiccup mode restart to reduce over load stress. Both the evaluation boards share the same layout except for silkscreen. The printed circuit board consists of 2 layers, 2 ounce of copper top and bottom and the board size is 2.55x1.5x0.5 inches.

Specification	LM25088-1	LM25088-2
Input Voltage Range	5.5V to 36V	5.5V to 36V
Output Voltage	5.0V	5.0V
Max. Average Load Current	7A	7A
Load Regulation	2%	2%
Current Limit Type	Cycle-by-cycle current limit	Hiccup Mode Restart
Frequency	250 kHz (±5% Oscillator Dithering)	250 kHz
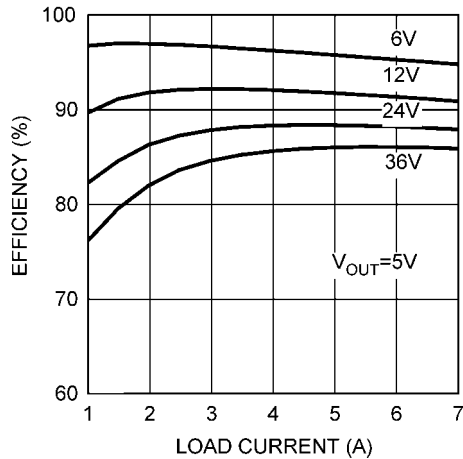
30087701

FIGURE 1. Typical Efficiency Curves of LM25088-1 and LM25088-2 Evaluation Boards

Powering and Loading Considerations

Read this entire page prior to attempting to power the evaluation board.

QUICK SETUP PROCEDURE

Step 1: Set the power supply current limit to 10A. Turn off the power supply. Connect the power supply to the VIN terminals.

Step 2: Connect the load, with a 7A capability, to the VOUT terminals.

Step 3: Slowly increase the load while monitoring the output, VOUT should be in regulation with a nominal 5V output.

Step 4: Slowly sweep the input voltage from 5.5V to 36V, VOUT should remain in regulation with a nominal 5V output.

Step 5: Temporarily short the EN pin to check the shutdown function, Also, EN pin can be set between 0.4V and 1.2V, for example, by shorting EN pin to ground with a diode, to check the standby function.

Step 6: Increase the load beyond the rated current to check the current limiting. The output current should limit at approximately 10A. The LM25088-1 board will enter cycle-by-cycle current limiting, while LM25088-2 is configured for a hiccup mode restart. Cooling is critical in this step.

AIR FLOW

Prolonged operation with high input voltage (>24V) at full load will cause the LM25088 and MOSFETs to overheat and could potentially result in thermal shutdown. A fan with a minimum of 100LFM should always be used to cool the LM25088 evaluation board.

POWERING UP

It is suggested that the load be kept low during the first power up. Set the current limit of the source supply to provide about 1.5 times the anticipated wattage of the load. A quick efficiency check is the best way to confirm that everything is operating properly. If something is amiss one can be reasonably sure that it will affect the efficiency adversely. Few parameters can be correct in a switching power supply without creating losses and potentially damaging heat.

OVER CURRENT PROTECTION

The LM25088-1 and LM25088-2 evaluation boards are both configured with over-current protection schemes. The LM25088-1 employs a cycle-by-cycle current limiting, while the LM25088-2 is configured for a hiccup mode restart. Please refer the LM25088 datasheet for more information on RES pin.

SYNCHRONIZATION

A Sync pin has been provided on the evaluation board. This pin can be used to synchronize the LM25088 to an external clock. It is recommended not to exceed 500 kHz while synchronizing. Refer the LM25088 datasheet for complete information.

ACTIVE LOADS

When using electronic load, it is strongly recommended to power up the evaluation board at light load and then slowly increase the load. This is necessary as most of the electronic loads do not draw any current till the output reaches an internally set point; this can result in soft-start function to not work as desired and can trip the current sense comparator. Electronic loads, in general, are best suited for monitoring steady state waveforms. If it is desired to power up the evaluation board at maximum load, resistor banks can be used. This will ensure a soft-start and evaluation board will perform as desired. Ensure that there is sufficient cooling for both the resistor banks and the LM25088 evaluation board, while running at full load.
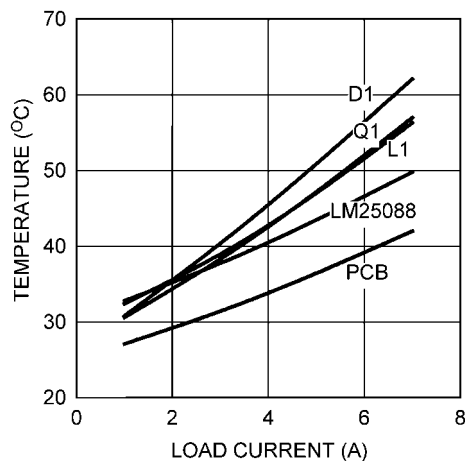
30087702

FIGURE 2. Typical Thermal Profile at 48VIN

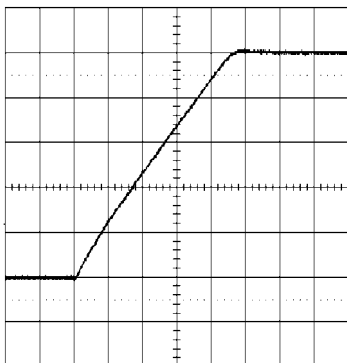# Typical Performance Waveforms of LM25088-1 and LM25088-2 Evaluation Boards
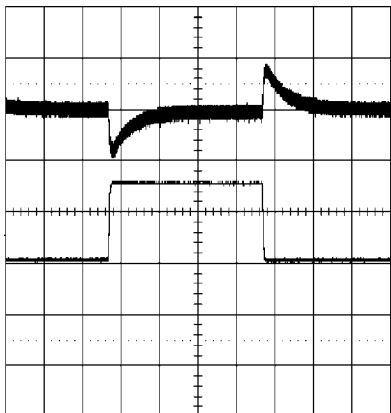
30087703

Conditions:
Input Voltage = 24VDC
Output Current = 4A to 7A
Bandwidth Limit = 20 MHz
Traces:
Bottom Trace: Output Current
Amps/div = 2A
Top Trace: Output Voltage response
Volts/div = 100 mV
Horizontal Resolution = 500 µs/div
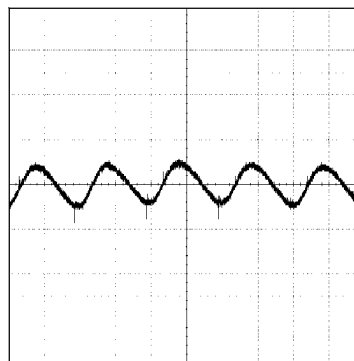
FIGURE 3. Transient Response

30087704

Conditions:
Input Voltage = 24VDC
Output Current = 7A
Trace:
Output Voltage
Volts/div = 1V

FIGURE 4. Soft-Start

30087705

Conditions:
Input Voltage = 24VDC
Output Current = 7A
Bandwidth Limit = 20 MHz
Trace:
Output Ripple
Volts/div = 50 mV
Horizontal Resolution = 5.0 µs/div

FIGURE 5. Output Voltage Ripple
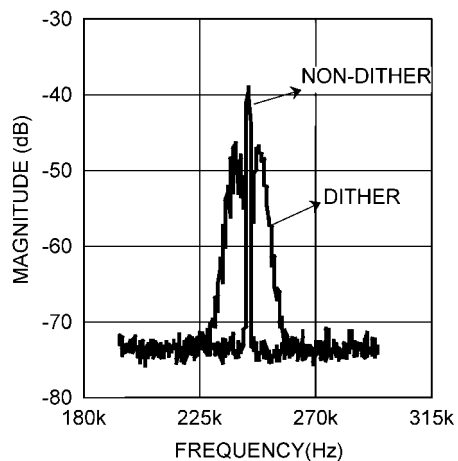
30087706

FIGURE 6. Conducted Emissions Measured at the Input of a LM25088-1 Evaluation Board
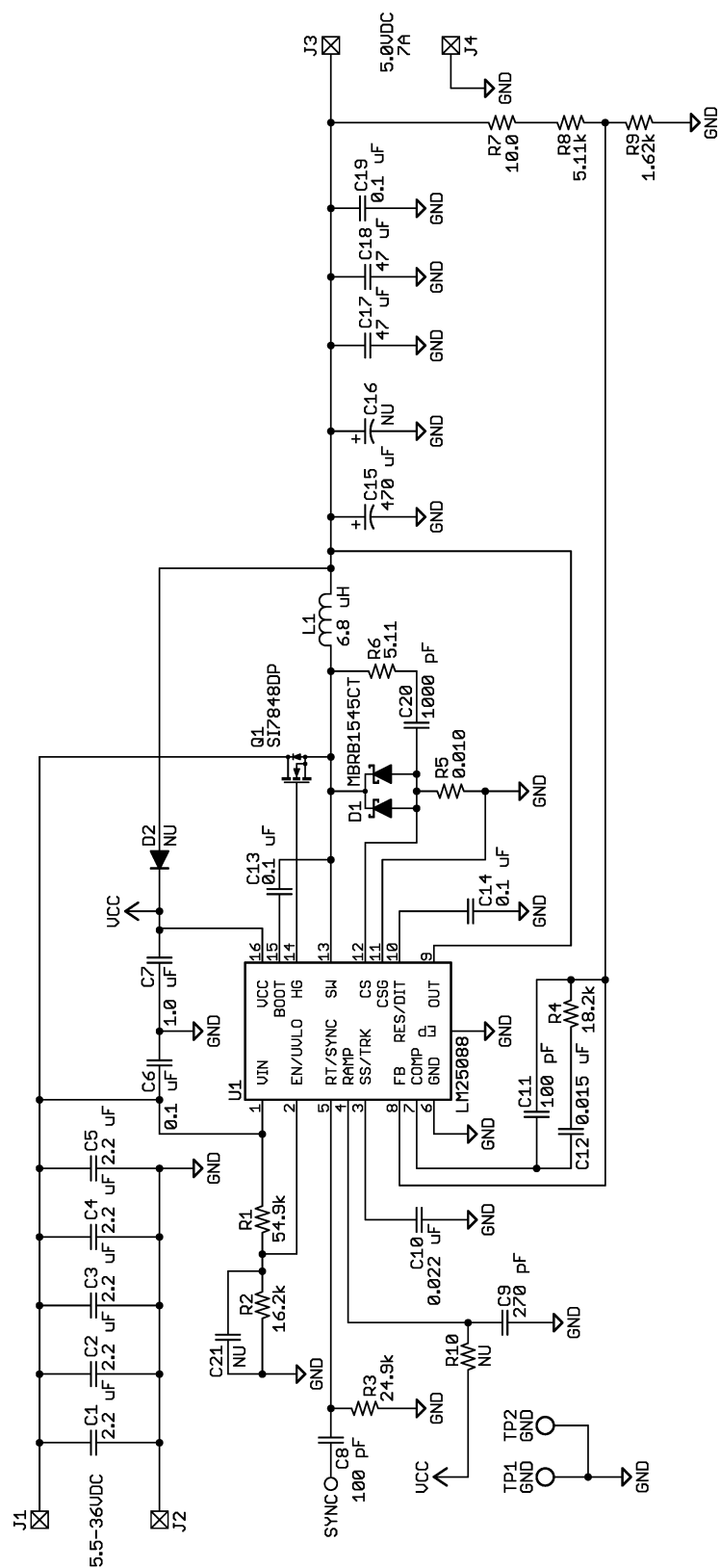
FIGURE 7. LM25088-1 W/Dithering Schematic
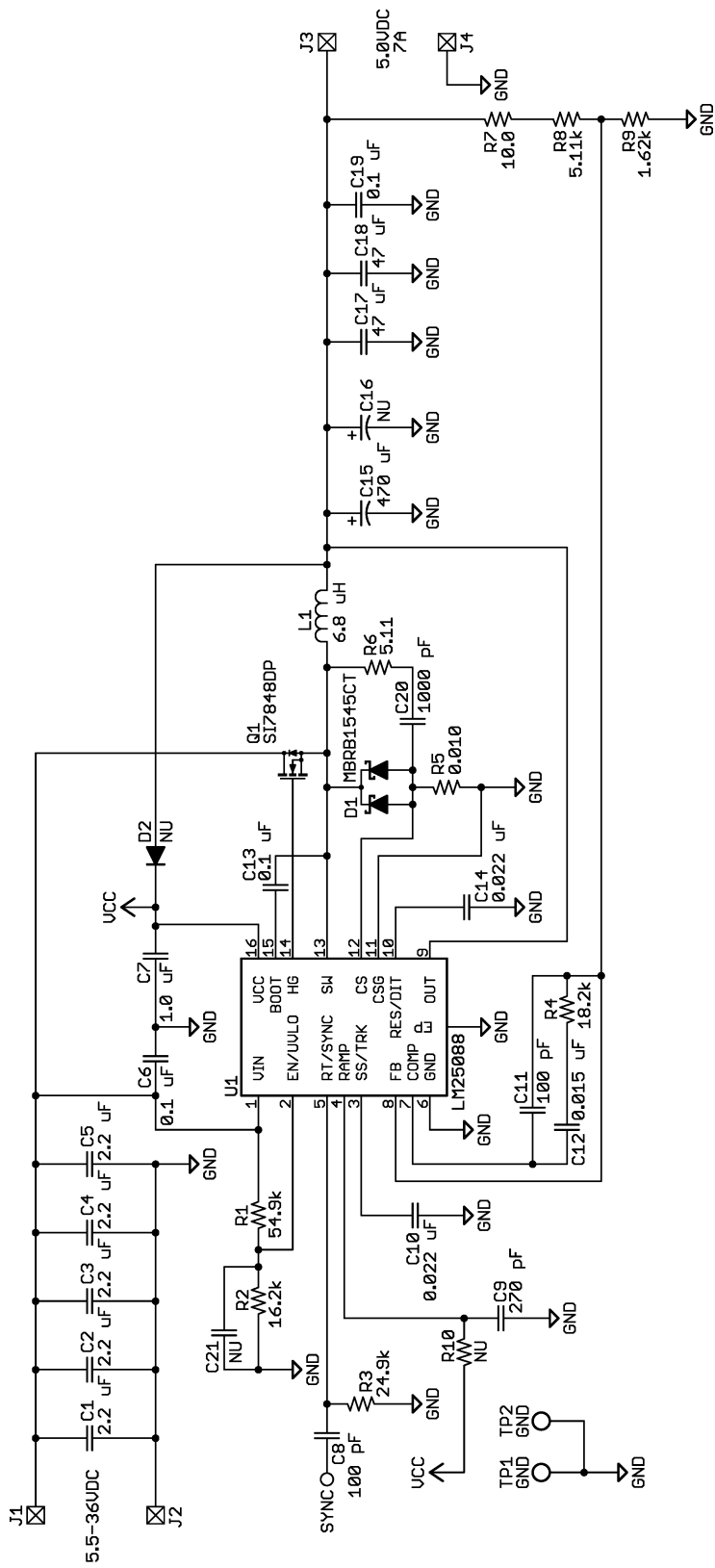
30087707

FIGURE 8. LM25088-2 W/Restart Schematic

30087708

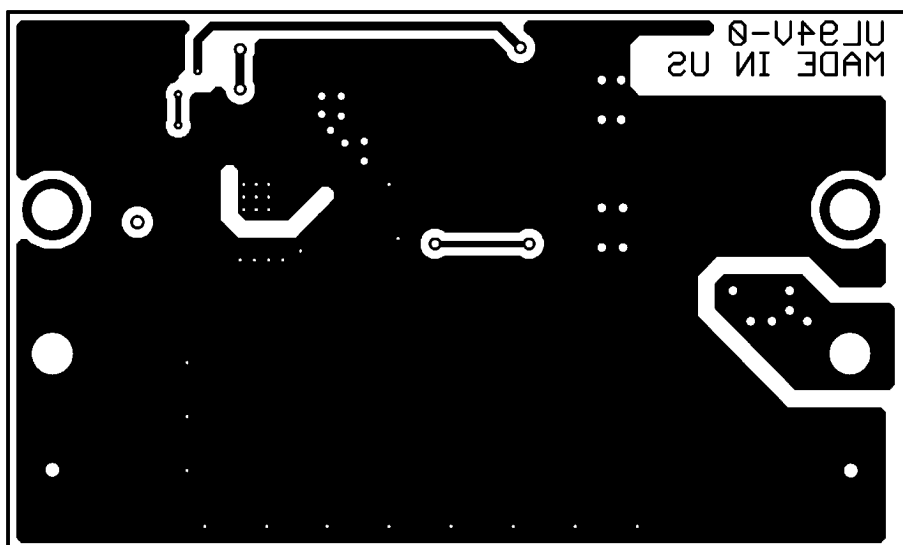## Bill of Materials for LM25088-1 and LM25088-2 Evaluation Boards

| Part	Value	Package	Manufacturer	Manufacturer Part Number	Description
C1,C2,C3, C4,C5	2.2 µF	C1210	Murata	GRM32ER72A225KA35L	CAP CER 2.2 µF 100V X7R 1210
C6,C19	0.1 µF	C0805	TDK Corporation	C2012X7R2A104K	CAP CER .10 µF 100V X7R 10% 0805
C7	1 µF	C0603	Murata	GRM188R71C105KA12D	CAP CER 1 µF 16V X7R 0603
C8,C11	100 pF	C0603	AVX Corporation	06031A101FAT2A	CAP CERM 100 pF 1% 100V NP0 0603
C9	270 pF	C0603	Murata	GRM1885C2A271JA01D	CAP CER 270 pF 100V 5% C0G 0603
C13	0.1 µF	C0603	Murata	GRM188R72A104KA35D	CAP CER .1 µF 100V X7R 0603
C10	0.022 µF	C0603	Murata	GRM188R71C223KA01D	CAP CER 22000 pF 16V 10% X7R 0603
C12	0.015 µF	C0603	Murata	GRM188R71H153KA01D	CAP CER 15000 pF 50V 10% X7R 0603
C15	470 µF	0.327x0.327x0.303	Nippon-Chemicon	APXF6R3ARA471MH80G	CAP 470 µF 6.3V ELECT POLY SMD
C17,C18	47 µF	C1210	Murata	GRM32ER61A476KE20L	CAP CER 47 µF 10V X5R 1210
C20	1000 pF	C0805	Murata	GRM2195C2A102JA01D	CAP CER 1000 pF 100V 5% C0G 0805
C16	NU	0.327x0.327x0.303	NU	NU	NU
C21	NU	C0603	NU	NU	NU
C14 (LM25088-1)	0.1 µF	C0603	Murata	GRM188R72A104KA35D	CAP CER .1 µF 100V X7R 0603
C14 (LM25088-2)	0.022 µF	C0603	Murata	GRM188R71C223KA01D	CAP CER 22000 pF 16V 10% X7R 0603
D1	Schottky Diode	D2PAK	On Semi	MBRB1545CT	Schottky Rectifiers 15A 45V
D2	NU	SOD123	NU	NU	NU
L1	6.8 µH	HC9 series	Coiltronics	HC9-6R8-R	INDUCTOR HIGH CURRENT 6.8 µH
Q1	MOSFET	SO-8	Vishay IR	SI7848DP	MOSFET N-CH 40V PWR PAK SO8
R1	54.9 kΩ	R0805	Rohm	MCR10EZHF5492	RES 54.9 kΩ 1/8W 1% 0805 SMD
R2	16.2 kΩ	R0603	Rohm	MCR03EZPFX1622	RES 16.2 kΩ 1/10W 1% 0603 SMD
R3	24.9 kΩ	R0603	Rohm	MCR03EZPFX2492	RES 24.9 kΩ 1/10W 1% 0603 SMD
R4	18.2 kΩ	R0603	Rohm	MCR03EZPFX1822	RES 18.2 kΩ 1/10W 1% 0603 SMD
R5	10 mΩ	R0815	Susumu Co Ltd	RL3720WT-R010-F	RES .01Ω 1W 1% 0815 SMD
R6	5.1Ω	R2512	Panasonic - ECG	ERJ-1TRQF5R1U	RES 5.1Ω 1W 1% 2512 SMD
R7	10Ω	R0805	Rohm	MCR10EZHF10R0	RES 10.0Ω 1/8W 1% 0805 SMD
R8	5.11 kΩ	R0603	Rohm	MCR03EZPFX5111	RES 5.11 kΩ 1/10W 1% 0603 SMD
R9	1.62 kΩ	R0603	Rohm	MCR03EZPFX1621	RES 1.62 kΩ 1/10W 1% 0603 SMD
R10	NU	R0603	NU	NU	NU
J1,J2,J3, J4	Terminal_ Turret		Keystone	1509	Terminal, Turret
TP1,TP2	Slotted test point		Keystone	1040	Terminal test point slotted
U1	PWM IC	TSSOP16_EP	National	LM25088-1/LM25088-2	ECM Buck Controller

PCB Layout
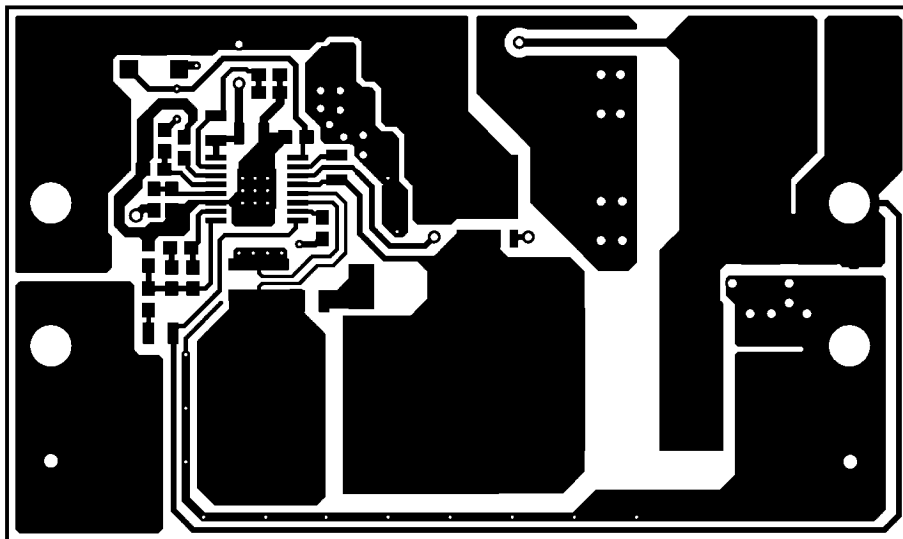
30087709

LM25088-1 and LM25088-2 Top Layer

30087710

LM25088-1 and LM25088-2 Bottom Layer

LM25088 EVAL BD.   P/N 551600288-001
W/RESTART   REV A
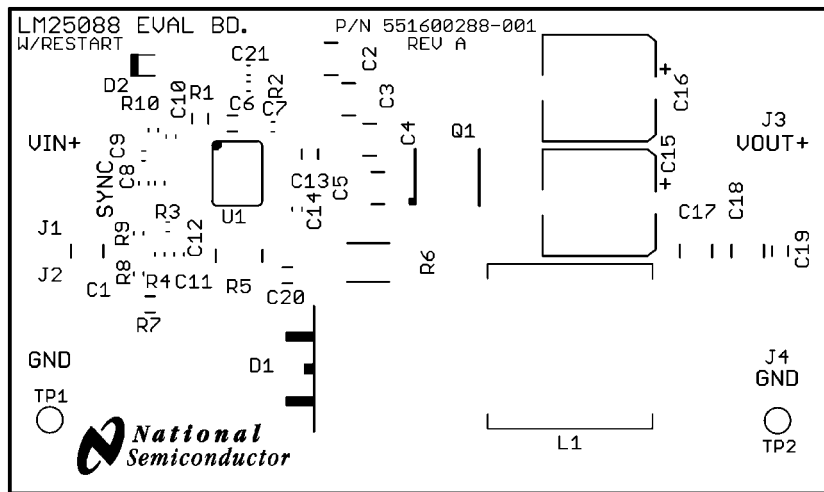
LM25088-2 Silk Screen

30087711

LM25088 EVAL BD.   P/N 551600287-001
W/DITHER   REV A
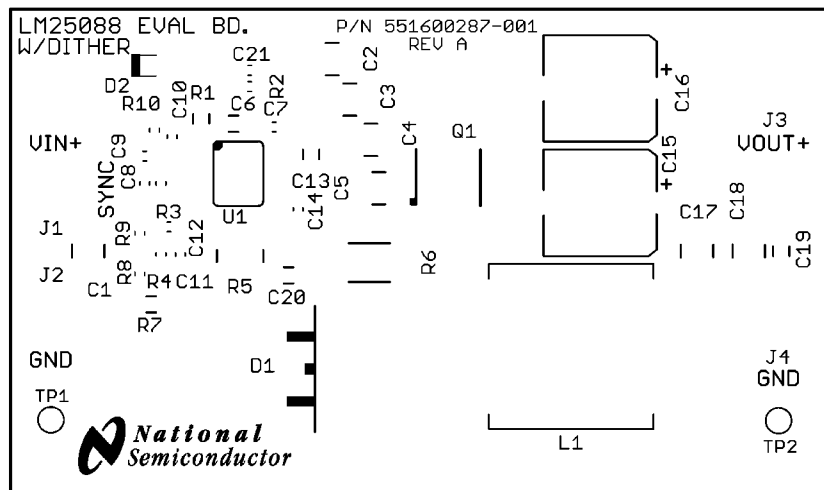
LM25088-1 Silk Screen

30087712

Notes

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:

Products		Design Support	
Amplifiers	www.national.com/amplifiers	WEBENCH® Tools	www.national.com/webench
Audio	www.national.com/audio	App Notes	www.national.com/appnotes
Clock and Timing	www.national.com/timing	Reference Designs	www.national.com/refdesigns
Data Converters	www.national.com/adc	Samples	www.national.com/samples
Interface	www.national.com/interface	Eval Boards	www.national.com/evalboards
LVDS	www.national.com/lvds	Packaging	www.national.com/packaging
Power Management	www.national.com/power	Green Compliance	www.national.com/quality/green
Switching Regulators	www.national.com/switchers	Distributors	www.national.com/contacts
LDOs	www.national.com/ldo	Quality and Reliability	www.national.com/quality
LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback
Voltage Reference	www.national.com/vref	Design Made Easy	www.national.com/easy
PowerWise® Solutions	www.national.com/powerwise	Solutions	www.national.com/solutions
Serial Digital Interface (SDI)	www.national.com/sdi	Mil/Aero	www.national.com/milaero
Temperature Sensors	www.national.com/tempsensors	Solar Magic®	www.national.com/solarmagic
Wireless (PLL/VCO)	www.national.com/wireless	Analog University®	www.national.com/AU

National Semiconductor Americas Technical Support Center	National Semiconductor Europe Technical Support Center	National Semiconductor Asia Pacific Technical Support Center	National Semiconductor Japan Technical Support Center
Email: support@nsc.com Tel: 1-800-272-9959	Email: europe.support@nsc.com German Tel: +49 (0) 180 5010 771 English Tel: +44 (0) 870 850 4288	Email: ap.support@nsc.com	Email: jpn.feedback@nsc.com