TEXAS INSTRUMENTS

Using the UCC38500EVM

User's Guide

SLUU068C

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User's Guide

February 2005 *Power Management Products*

SLUU068C

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 85 V to 265 V and the output voltage of 12 V +/− 5%.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 50°C. The EVM is designed to operate properly with certain components above 50°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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Contents

Figures

Chapter 1

General Information

This chapter details the Texas Instruments (TI) DM38500 PFC/PWM Combination Controller 100W Power Factor Correction Preregulator Evaluation Module (EVM) SLUU068. It includes a list of EVM features, a brief description of the module illustrated with a pictorial, schematic diagrams, and EVM specifications.

Topic **Page**

1.1 Features

UCC38500 PFC/PWM Combination Controller 100W Power Factor Correction Preregulator include:

- Combines PFC and 2nd Stage Down Converter Controls
- Controls Boost Preregulator to Near-unity Power Factor
- Accurate Power Limiting
- Improved Feedforward Line Regulation
- Peak Current Mode Control in Second Stage
- Programmable Oscillator
- Leading Edge/Trailing Edge Modulation for Reduced Output Ripple
- Low Startup Supply Current
- Synchronized Second Stage with Programmable Soft-start
- Programmable Second Stage Shut-down

1.2 Description

The UCC38500 provides all the functions necessary for active power factor correction and a second stage dc-to-dc converter all in one integrated circuit. The control IC uses leading edge modulation for the boost stage and trailing edge modulation for the step down converter to reduce the RMS current in the boost capacitor. The dc-to-dc controller uses peak current mode control for easy loop compensation.

The UCC38500 evaluation board is designed to illustrate the performance of the IC in a complete off-line 100W two-stage power converter using power factor correction. The demonstration board was designed to operate with a universal input voltage range (i.e. 85−265 Vac) with a regulated 12V dc output.

Caution

High-voltage levels are present on the evaluation module whenever it is energized. Proper precautions must be taken when working with the EVM. The output capacitor has high levels of energy storage and it must be discharged before the load is removed. Serious injury can occur if proper safety precautions are not followed.

1.3 Operating Guidelines

The operating guidelines for the evaluation board are provided with reference to the schematic in Figure 1−1 and the component layout in Figure 2−1.

1.3.1 Step 1. Load Connections

A resistive or electronic load can be applied to the output terminals labeled OUT− and OUT+.

Note: For safety reasons the load should be connected before power is supplied to the demonstration board.

1.3.2 Step 2. Applying Input Power

A 60 Hz AC power source not exceeding 265 V_{RMS} needs be applied across terminals AC−N and AC−L for proper operation.

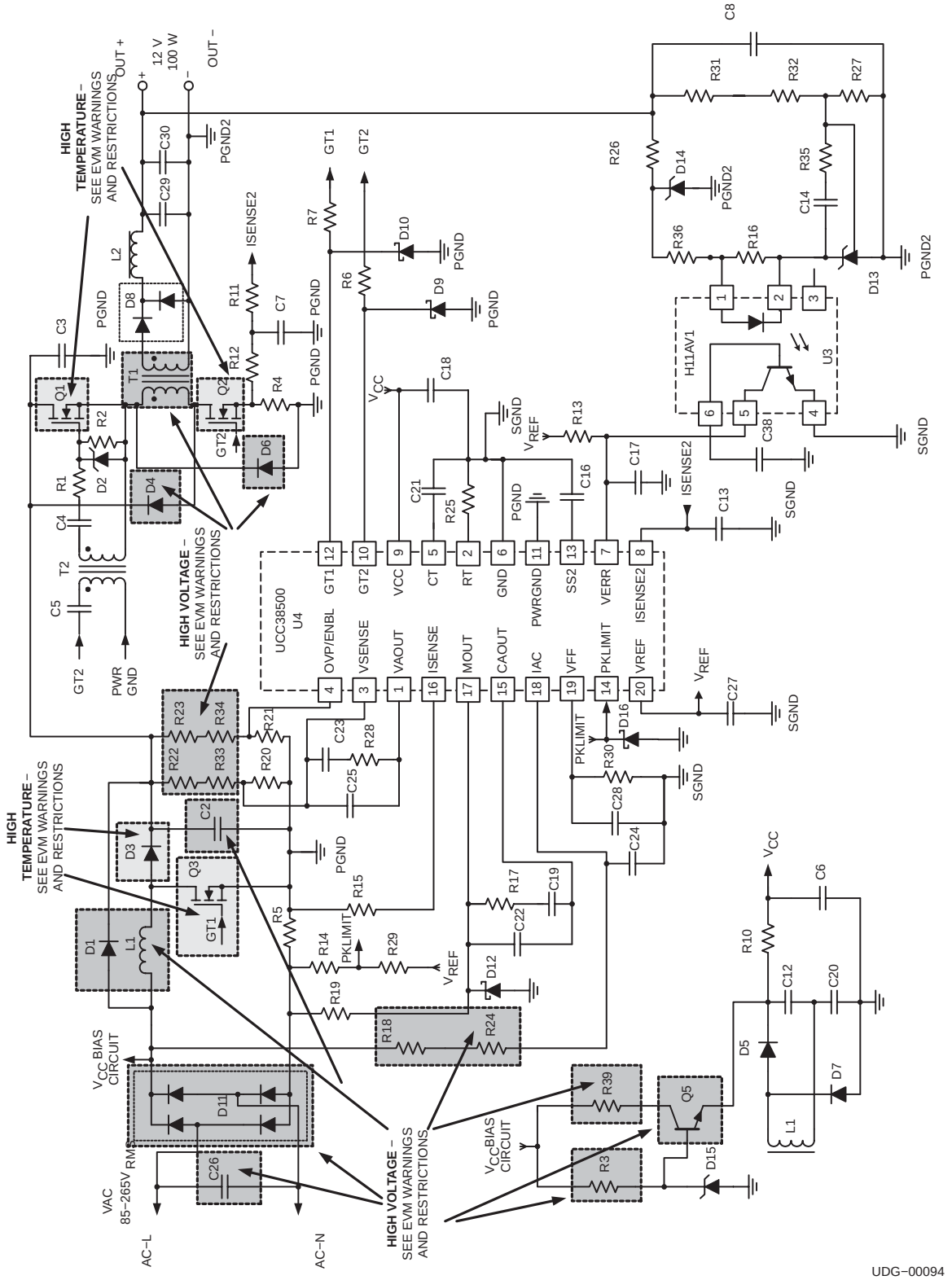
1.3.3 Step 3. Evaluating the Demonstration's Boards Performance.

With the AC source set between 85−265 V_{RMS} the output voltage should be regulated and the input current should track the input voltage shape with near unity power factor. The operation of the circuit is verified over the line and load range and shows efficiency as high as 85%. At lighter loads, there may be some distortion in the line current due to Discontinuous Conduction Mode (DCM) operation. Please refer to Figures 1−2, 1−3 and 1−4 for typical EVM performance.

1.3.4 Additional Information

For more information, pin description and specifications for the UCC38500 PFC/PWM Combination Controller, please refer to the datasheet or contact the Texas Instruments Semiconductor Product Information Center at 1-800-336-5236 or 1-972-644-5580. Product Information can also be found on the World Wide Web at www.ti.com.

Figure 1−1. DM38500 Evaluation Module Application Schematic



Note: High-Voltage component. See EVM Warnings and Restrictions at the back of this document.
Note: High-Temperature component. See EVM Warnings and Restrictions at the back of this document.

1.4 DM38500 EVM Performance

Figure 1−2 through 1−4 shows the typical evaluation module performance.

Figure 1−2. DM38500 EVM Efficiency

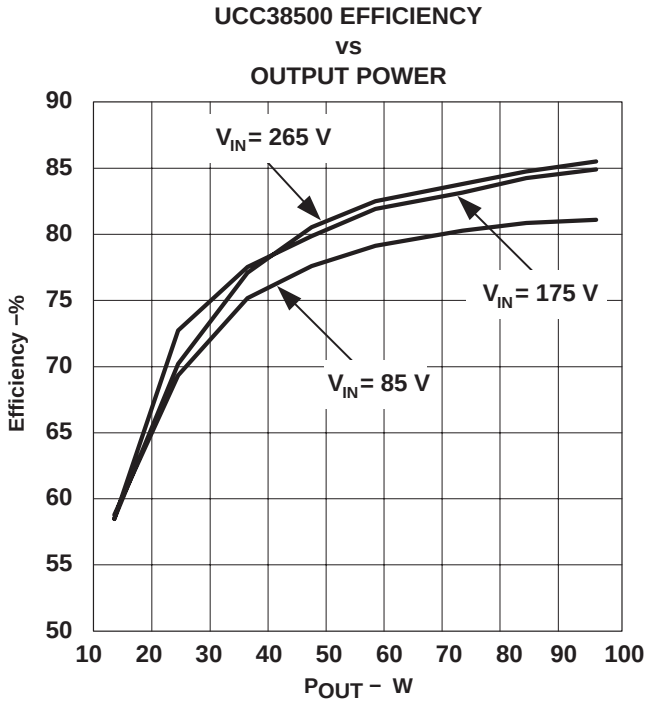


Figure 1−3. DM38500 Power Factor

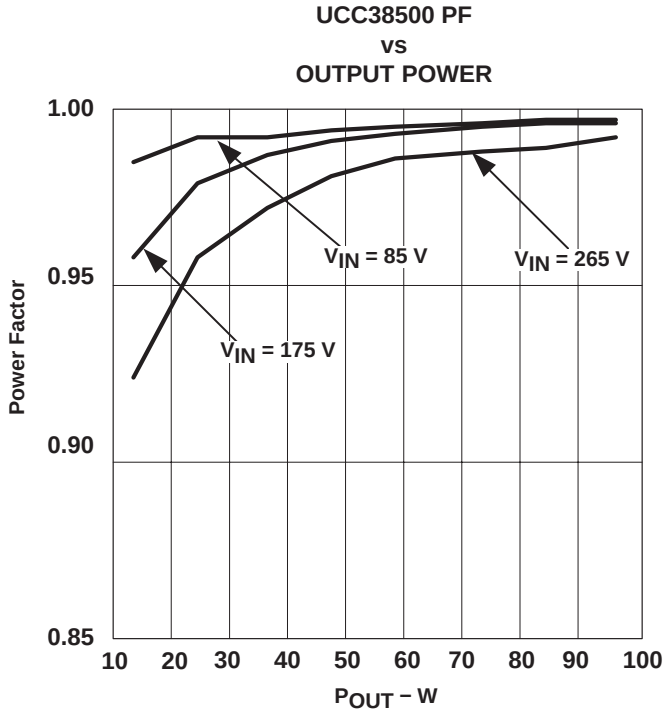
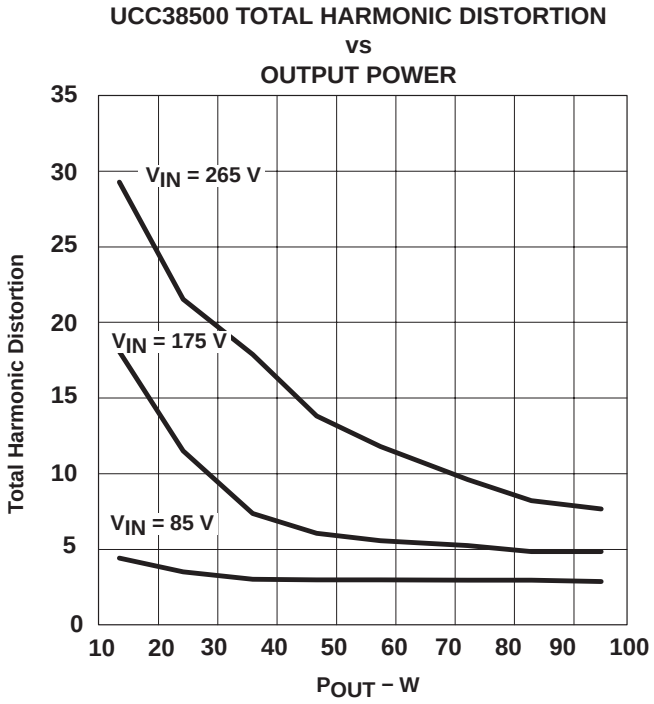


Figure 1−4. DM38500 Total Harmonic Distortion



Chapter 2

Reference

This chapter includes a parts list and PCB layout illustrations for the DM38500 EVM.

Topic **Page**

2.1 DM38500 EVM Part Descriptions

Table 2−1. DM38500 Part Descriptions

Description	Reference	Qty	Value/Type Number	Manufacturer	Part Number
Capacitors	C12, C20, C29	3	1 μF, 50 V, polypropylene	Panasonic	ECQ−V1H105JL
	C13	1	47 pF, 50 V, ceramic	Panasonic	ECU−S2A470JCA
	C7, C16, C14	3	10 nF, 50 V, ceramic	Panasonic	ECU−S1H103JCB
	C17, C38	2	100 pF, 50 V, ceramic	Panasonic	ECU−S1H101JCA
	C19	1	2.2 nF, 50 V, ceramic	Panasonic	ECU−S1H222JCB
	C2	1	470 nF, 400 V, polypropylene	Panasonic	ECQ−E4474KZ
	C21	1	680 pF, 50 V, ceramic	Panasonic	ECU−S1H681JCB
	C22	1	390 pF, 50 V, ceramic	Panasonic	ECU−S1H391JCA
	C24	1	100 pF, 50 V, ceramic	Panasonic	ECU−S1H101JCA
	C25	1	150 nF, 50 V, ceramic	Panasonic	ECU−S1H154KBB
	C26	1	47 nF, 600 V, polypropylene	Panasonic	ECQ−E6473KF
	C27, C18	2	100 pF, 50 V, ceramic	Panasonic	ECU−S1H105KBB
	C28, C23	2	2.2 μF, 50 V, ceramic	Panasonic	ECU−S1H225MEB
	C3	1	100 μF, 450 V, electrolytic	Panasonic	ECO−S2WB101BA
	C30	1	1800 μF, 25 V, electrolytic	Panasonic	ECA−IEFQ182
	C4, C5, C8	3	0.1 μF, 50 V, ceramic	Panasonic	ECU−S1H104KBB
	C6	1	100 μF, 25 V, electrolytic	Panasonic	EEU−FCIE101S
Diodes	D1	1	6 A, 600 V, GI756CT	General Inst.	GI756CT
	D11	1	6 A, 600 V, bridge rectifier, PB66	Diodes Inc.	PB66
	D12	1	1 A, 40 V, Shottky		SR103CT
	D13	1	TL431CLP	TI	TL431C
	D14	1	10 V, 1 W, Zener		1N4740
	D15, D2	2	18 V, 1 W, Zener		1N4746
	D3	1	6 A, 600 V, ultra fast	IR	HFA08TB60−ND
	D4, D6	2	1 A, 600 V, fast recovery	Philips	BYV26C
	D5,D7,D9, D10, D16	5	1 A, 40 V, Shottky		1N5819
	D8	1	6 A, 600 V, full wave rectifier	IR	HBR2045
Fuses	FH1, FH2	2	3AG Fuse clip		
	F1	1	6 A, 250 V		
Heat sinks	HS3	1	For Q3	Aavid	513201
	HS4, HS5	2	For D3 and D8	Aavid	579302 B 0 00 00
	HS1, HS2	2	For Q1 and Q2	Avid	593002 B 0 34 00
Inductors	L1	1	1.7 mH, 2.5 A, coupled	Cooper	CTX08−14730
	L2	1	35 μH, 8.3 A	Cooper	CTX08−14279
MOSFETs	Q1,Q2	2	8 A, 500 V, n−channel	IR	IRF840
	Q3	1	14 A, 500 V, n−channel	IR	IRFP450
	Q5	1	NPN transistor		MJE13005
Not used	Q4, R8, R9, C9, C15, C10	6	Not used		

Description	Reference	Qty	Value/Type Number	Manufacturer	Part Number
Resistors	R1, R12	2	Short		
	R10, R36	2	200 Ω, ¼ W		
	R25, R29, R27	3	10 kΩ, ¼ W		
	R13	1	2 kΩ, ¼ W		
	R14	1	1.5 kΩ, ¼ W		
	R15, R19	2	3.92 kΩ, ¼ W		
	R16	1	750 Ω, ¼ W		
	R17	1	7.5 kΩ, ¼ W		
	R18, R24	2	392 kΩ, ¼ W		
	R2, R11	2	1 kΩ, ¼ W		
	R20	1	22.1 kΩ, ¼ W		
	R21	1	8.25 kΩ, ¼ W		
	R22, R33	2	562 kΩ, ¼ W		
	R23	1	200 kΩ, ¼ W		
	R26	1	100 Ω, ¼ W		
	R28	1	100 kΩ, ¼ W		
	R30	1	30.1 kΩ, ¼ W		
	R31	1	33.2 kΩ, ¼ W		
	R32	1	4.75 kΩ, ¼ W		
	R34	1	221 kΩ, ¼ W		
	R35	1	16.2 kΩ, ¼ W		
	R39	1	1 kΩ, 1 W		
	R4	1	1 Ω, 1 W, ±5%		
	R5	1	0.33 Ω, 3 W, ±5%		
	R6, R7	2	20 Ω, ¼ W		
	R3	1	51 kΩ, 2 W, 400 V		
Transformers	T1	1	8 mH, 10 A, 10.8:1	Cooper	CTX08−14226
	T2	1	560−990 µH, 1:1 gate drive	Cooper	CTX08−14225
ICs	U4	1	BiCMOS PFC/PWM combination controller	Texas Instruments	UCC38500N
	U3	1	Opto-isolator		4N36
Miscellaneous	X1	3	Thermal pad TO−220 (@ Q1, Q2, D8)		
	X2	1	Thermal pad TO−247 (@ Q3)		
	X3	4	Screw pan head #4−40 X 7/16 (@Q1, Q2, Q3, D8)		
	X4	4	Nut #4x40		
	X5	3	Nylon shoulder washer #4 (@Q1, Q2, D8)		
	X6	1	Bevel washer #4 (@Q3)		
PCB	PCB	1	Bare board		UCC38500 PCB

Notes:

1) The values of these components are to be determined by the user in accordance with the application requirements.

2) Unless otherwise specified, all resistors have a tolerance of ±1%.

3) Capacitor C38 is located at reference designator R38 on the PCB.

2.2 DM38500 Board Layouts

Board layout examples of the DM38500 EVM PCB are shown in the following illustrations. They are not to scale and appear here only as a reference.

Figure 2−1. DM38500 EVM PC Board: Top Assembly