50-W Push-Pull Converter Reference Design Using the UCC38085 (PR100B)

Reference Design

TEXAS
INSTRUMENTS

50-W Push-Pull Converter Reference Design Using the UCC38085 (PR100B)

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1   Introduction

The following reference design is a 50-W push-pull converter using the UCC38085, a current-mode controlled PWM with programmable slope compensation. This design controls a push-pull synchronous rectified topology which generates 15 A of current at 3.3 V from 24-V nominal input voltage. The module is designed to operate at a range between 18.5 V and 35 V and provides a 3.3 V_{DC} regulated output. The operating frequency is 200 kHz.

2   Caution

High-voltage levels are present on the evaluation module whenever it is energized. Proper precautions must be taken when working with this power module. Serious injury can occur if proper safety precautions are not followed.

3   Schematic
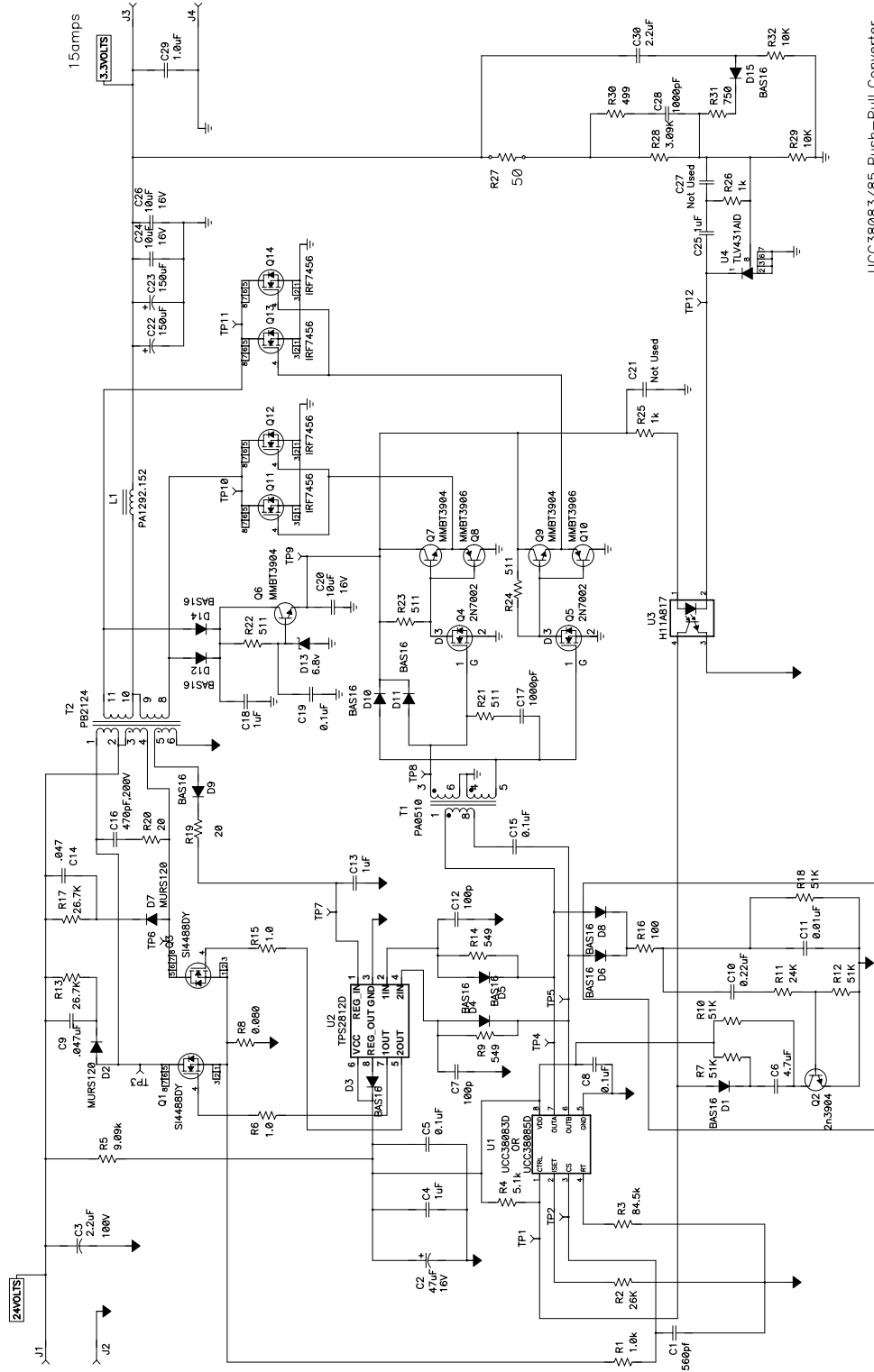
Figure 1. Reference Design Schematic

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4   List of Materials

Reference	QTY	Description	Manufacturer	Part Number
C1	1	Capacitor, ceramic, 560PF, 50 V, X7R, 0603	Yageo America	06032R561K9B20D
C2	1	Capacitor, aluminum, 47 µF, 16 V, 20%, HA series, 0.335 x 0.374	Panasonic	EEV–HA1C470P
C3	1	Capacitor, ceramic, 2.2 µF, 100 V, ST3827	ITW PAKRTON	225K100ST3827
C4	1	Capacitor, ceramic, 1.0 µF, 16 V, X7R, 1206	Panasonic	12062R105K7BB0D
C5, C8, C19	3	Capacitor, ceramic, 0.1, µF, 50 V, X7R, 0805	Panasonic	ECJ–2YB1H104K
C6	1	Capacitor, ceramic, 4.7 µF, 16 V, X5R, 1206	Kemet	C1206C475K4PACT
C7, C12	2	Capacitor, ceramic, 100 pF, 50 V, NPO, 0603	Yageo America	0603CG101J9B200
C9, C14	1	Capacitor, ceramic, 47000 pF, 50 V, X7R, 1206	muRata	C1206C473K5RACTU
C10	1	Capacitor, ceramic, 0.22 µF, 25 V, X7R, 0805	Panasonic	ECJ–2YB1E224K
C11	1	Capacitor, ceramic, 0.01 µF, 25 V, X7R, 0603	TDK	C1608X7R1H103K
C13, C18, C25	3	Capacitor, ceramic, 1.0 µF, 16 V, X7R, 0805	TDK	C2012X7R1C105J
C15	1	Capacitor, ceramic, 0.1 µF, 16 V, X7R, 10%, 0603	muRata	GRM39X7R104K16A
C16	1	Capacitor, ceramic, 470 pF, 200 V X7R, 0805	Panasonic	ECJ–2VB2D471K
C17	1	Capacitor, ceramic, 1000 pF, 50 V X7R, 0603	Yageo America	06032R102K9B20D
C21, C27	2	Capacitor, 0805		
C28	1	Capacitor, ceramic, 1000 pF, 50 V, COG, 0805	Kemet	C0805C102J5GAC
C29	1	Capacitor, ceramic, 1.0 µF, 10 V, X7R, 0805	Kemet	C0805C105K8RACTU
C30	1	Capacitor, ceramic, 2.2 µF, 6.3V X5R 0805	Panasonic	ECJ–2YB0J225K
C20, C24, C26	3	Capacitor, ceramic, 10 µF, 16V, X5R, 1210	Taiyo Yuden	EMK325BJ106MN
C22, C23	2	Capacitor, POSCAP, 150 µF, 6.3 V, 55 mΩ, 20%, 7343 (D)	Sanyo	6TPB150ML
D2, D7	2	Diode, ultra fast rectifier, 1 A, 200 V	On Semi	MURS120T3
D1, D3, D4, D5, D6, D8, D9, D10, D11, D12, D14, D15	12	Diode, switching, 10 mA, 85 V, 350 mW, SOT23	Vishay–Liteon	BAS16
D13	1	Diode, zener, 6.8 V, 350 MW, SOT23	Diodes, Inc.	BZX84C6V8–7
J1, J2, J3, J4	4	Connector, banana jack, uninsulated, 0.500 dia"	Pomona	3267
L1	1	Inductor, SMT, 1.5 µH, 21 A, 0.78 mΩ, 0.770x0.780	Pulse	PA1292.152
Q1, Q3	2	MOSFET, N-channel,150 V, 5 A, 50 mΩ, SO8	Vishay–Siliconix	SI4488DY
Q2, Q6, Q7, Q9	4	TRANS GP NPN, 40 V, 0.2 A, SOT23	Fairchild	MMBT3904FS
Q4, Q5	2	MOSFET N-channel, 60 V, 7.5 Ω, SOT23	Fairchild	2N7002
Q8, Q10	2	Bipolar, PNP, –40 V, –200 mA, SOT23	Fairchild	MMBT3906
Q11, Q12, Q13, Q14	4	MOSFET, N-channel, 20 V, 16 A, 6.5 mΩ, SO8	IR	IRF7456

Reference	QTY	Description	Manufacturer	Part Number
R1, R25, R26	3	Resistor, chip, 1.0 kΩ, 1/16 W, 1%, 0603	Std	Std
R2	1	Resistor, chip, 26 kΩ, 1/16 W, 1%, 0603	Std	Std
R3	1	Resistor, chip, 84.5 kΩ, 1/16 W, 1%, 0603	Std	Std
R4	1	Resistor, chip, 5.1 kΩ, 1/16 W, 1%, 0603	Std	Std
R5	1	Resistor, chip, 9.09 kΩ, 1/8 W, 1%, 1206	Std	Std
R6, R15	2	Resistor, chip, 1.0 Ω, 1/10 W, 1%, 0805	Std	Std
R7, R10, R12, R18	4	Resistor, chip, 51 kΩ, 1/16 W, 0603	Std	Std
R8	1	Resistor, chip, 0.08 Ω, 1 W, 1%, 2512	Dale	WSL–2512 .08 1%
R9, R14	2	Resistor, chip, 549 Ω, 1/16 W, 1%, 0603	Std	Std
R11	1	Resistor, chip, 24 kΩ, 1/16 W, 1%, 0603	Std	Std
R13, R17	2	Resistor, chip, 26.7 kΩ, 1 W, 1%, 2512	Dale	CRCW25122672F
R16	1	Resistor, chip, 100 Ω, 1/16 W, 0603	Std	Std
R19	1	Resistor, chip, 20 Ω, 1/16 W, 1%, 0603	Std	Std
R20	1	Resistor, chip, 20 Ω, 1/8 W, 1%, 1206	Std	Std
R21, R22, R23, R24	4	Resistor, chip, 511 Ω, 1/16 W, 1%, 0603	Std	Std
R27	2	Socket pins, 0.020–0.032 inch pins, quantity 2, 0.1 x 0.5	Mill–Max	0338–0–15–01–15–14–10–0
R27[3]	1	Resistor, carbon film, 51 Ω, 1/4 W, 5%, thru-hole	Yageo America	CFR–25JB–51R
R28	1	Resistor, chip, 3.09 kΩ, 1/16 W, 1%, 0603	Std	Std
R29	1	Resistor, chip, 1.87 kΩ, 1/16 W, 1%, 0603	Std	Std
R30	1	Resistor, chip, 499 Ω, 1/10 W, 1%, 0805	Std	Std
R31	1	Resistor, chip, 750 Ω, 1/16 W, 1%, 0603	Std	Std
R32	1	Resistor, chip, 10 kΩ, 1/10 W, 1%, 0805	Std	Std
T1	1	Transformer, gate drive, 3950 µH, 1500 V_{DC} isolation, 0.340 x 0355	Pulse	P0544
T2	1	Transformer, 3 primary., 2 secondary, push pull, 1160 x 1524	Pulse	PB2124
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12	12	Test point, O.050 inch hole	None	
U1[1]	1	IC, Current Mode Push-Pull PWM With Programmable Slope Compensation, SO8	Texas Instruments	UCC38085D
U1[1]	1	IC, Current Mode Push-Pull PWM With Programmable Slope Compensation, SO8	Texas Instruments	UCC38083D
U2	1	IC, MOSFET Driver, Dual Channel Buffer With Regulator, SO8	Texas Instruments	TPS2812D
U3	1	IC, Optocoupler, 5300 V, 50–600% CTR, 0.380 x 0.180	QT Optoelectronics	H11A817
U4	1	IC, Adj Shunt Regulator, 100–mA, 36–V, SO8	Texas Instruments	TLV431AID
PCB	1	PCB used for both UCC38083 and UCC38085		PR100–B

NOTES: (1) If building for UCC38083, omit C6, C10, C11, D1,D6, D8, R10, R11, R12 ,R16, R18, Q2 and install UCC38083 for U1.
(2) If building for UCC38085, include C6, C10, C11, D1,D6, D8, R10, R11, R12 ,R16, R18, Q2 and install UCC38085 for U1.
(3) Wrap R27 leads around pins.
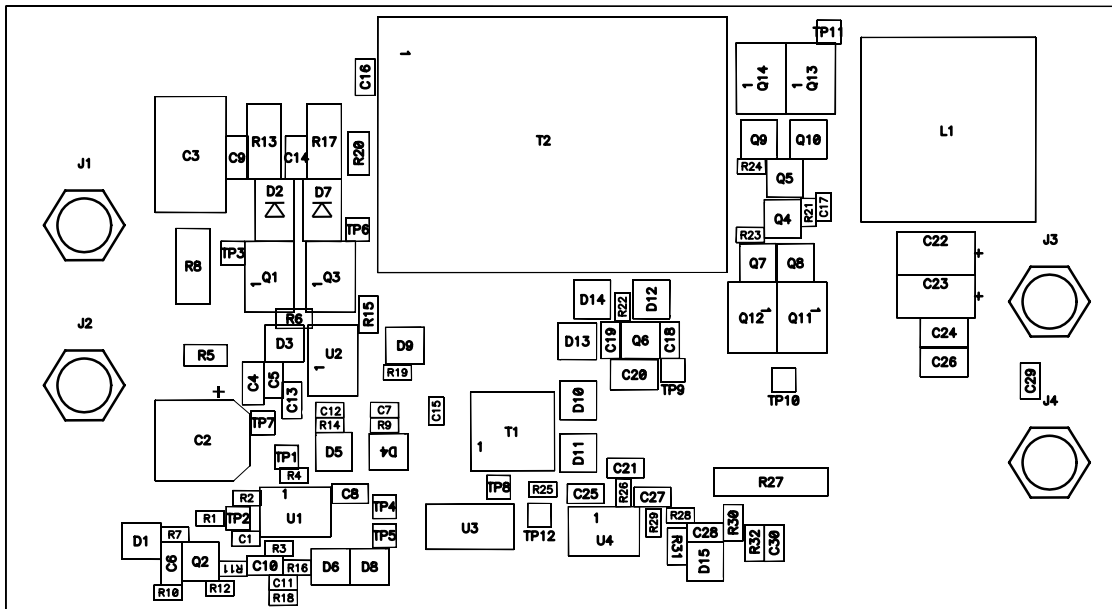
5   Reference Design Layout

Figure 2. Reference Design Layout

6   Electrical Characteristics

T$_A$ = 0°C to 70°C. All voltages are with respect to load ground unless otherwise indicated.

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNITS
V$_{IN}$, input voltage			18	24	35	V
V$_{OUT}$, output voltage			3.25	3.3	3.5	
P$_{OUT}$, output power			0	25	50	W
Turn-on overshoot voltage					0	V
Efficiency	V$_{IN}$ = 24 V,	I$_{LOAD}$ = 10 A		88.5%		
	V$_{IN}$ = 24 V,	I$_{LOAD}$ = 15 A		86.3%		

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7 Reference Design Performance

The following figures illustrate this reference design's performance.

**OUTPUT VOLTAGE
STARTUP TRAJECTORY**

CH. 1
1.0 V/div

t – Time – 400 µs/div

Figure 3

**EFFICIENCY
vs
OUTPUT POWER**

V_{IN} = 24 V

V_{IN} = 18.5 V

V_{IN} = 35 V

P_{OUT} – Output Power – W

η – Efficiency – %

Figure 4

**GAIN AND PHASE
vs
OUTPUT FREQUENCY**

V_{IN} = 18 V
Full Load

PHASE
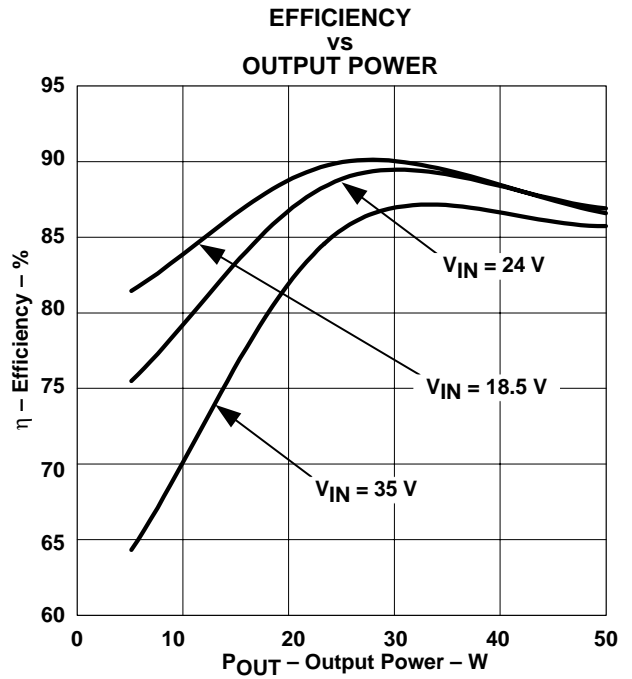
GAIN

Gain – dB

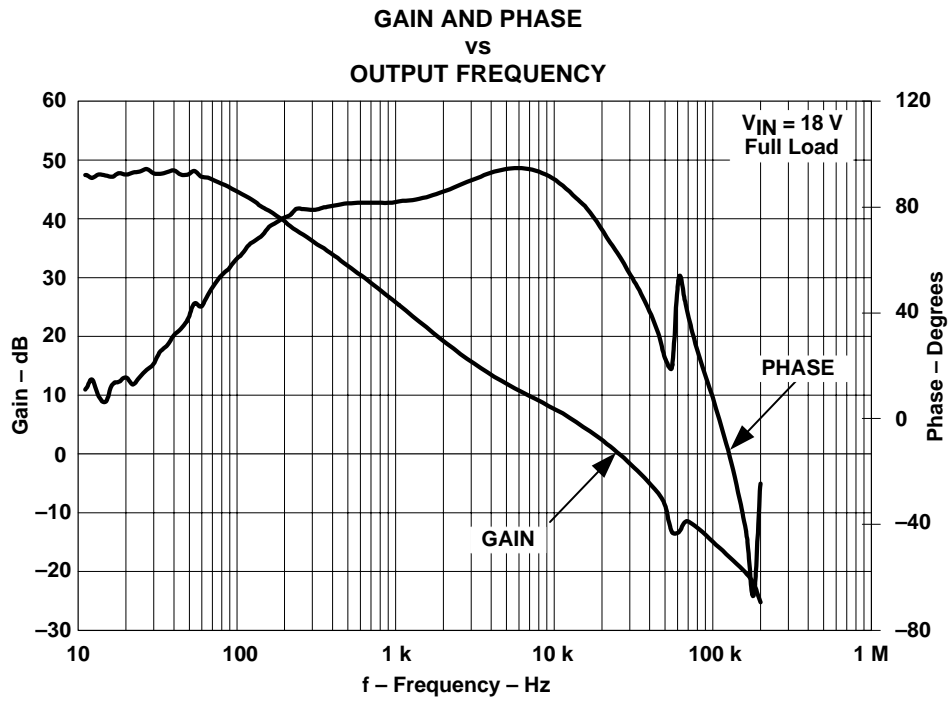Phase – Degrees

f – Frequency – Hz
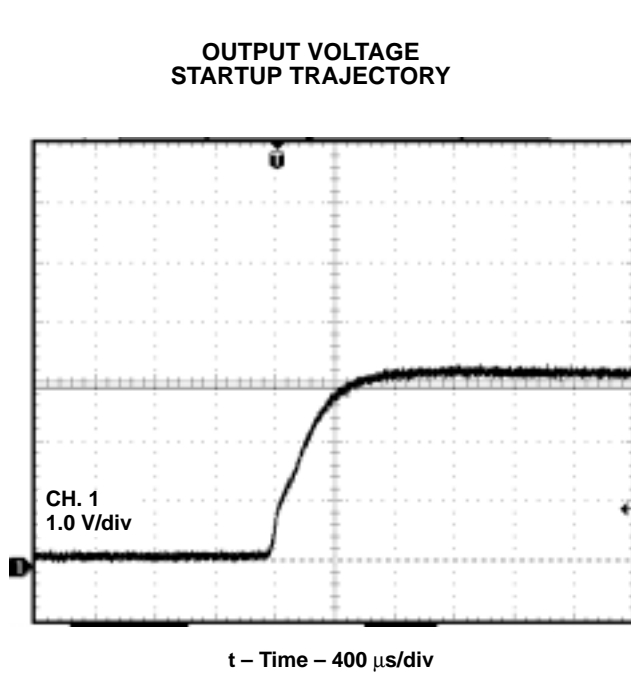
Figure 5. Phase and Gain Response

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