Keywords: SEPIC, print head power supply

REFERENCE DESIGN 4361 INCLUDES: √Tested Circuit √Schematic √BOM √Description √Test Data

Reference Design Ensures Dynamic Output Voltages for a Print-Head Power Supply

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Abstract: This article describes some important design parameters for managing power in a printer. The reference design shows how to use a MAX15005 power-supply controller as a SEPIC circuit to obtain a high-variable output voltage for a print-head power supply. The circuit schematics, bill of materials (BOM), test measurements, and results are provided.

Introduction

This reference design is a solution for obtaining a high-variable output voltage for a printer-head power supply. The design includes the complete circuit schematic, bill of materials (BOM), efficiency measurements, and test results.

Some Basics of Printer Design

The increasing speed of printers has led to higher power dissipation and higher temperatures in the print head. If the temperature in the printer becomes sufficiently high, the ink will smudge. When the temperature is low, the ink becomes illegible. Consequently, thermal management of the print head is critical to ensuring high-quality printing. A microcontroller is required to adjust the printing speed and thus maintain the operating temperature between these two limits. The printer's motor speed is adjusted by applying variable DC voltages.

Reference Design Overview

This reference design features the MAX15005 power-supply controller and provides a dynamic DC voltage (up to 45V) to the printer's motor. The output voltage can be varied by applying a PWM signal from the microcontroller to the SS pin of MAX15005 through a RC filter. During startup, the printer's motor draws more current to magnetize its field. The MAX15005A is particularly useful now because it offers hiccup-mode protection. The MAX15005 can enter hiccup mode and supply power at a reduced rate to protect all circuit components. Once magnetization is over, the motor draws normal current and the converter operates in regulation mode.

Specifications and Design Setup

The reference design meets the following specifications:

- Input voltage: 32V to 45V
- Output voltage: 25V to 45V (varied externally from the microcontroller)
- Output current: 0 to 2A
- Output ripple: ±0.5V

Input ripple: ±100mV

- Efficiency: > 93% with full load
- Switching frequency: 400kHz

The schematic for the above specifications is shown in **Figure 1**. In this design the MAX15005 is used in the SEPIC configuration when output is below or above the input voltage.

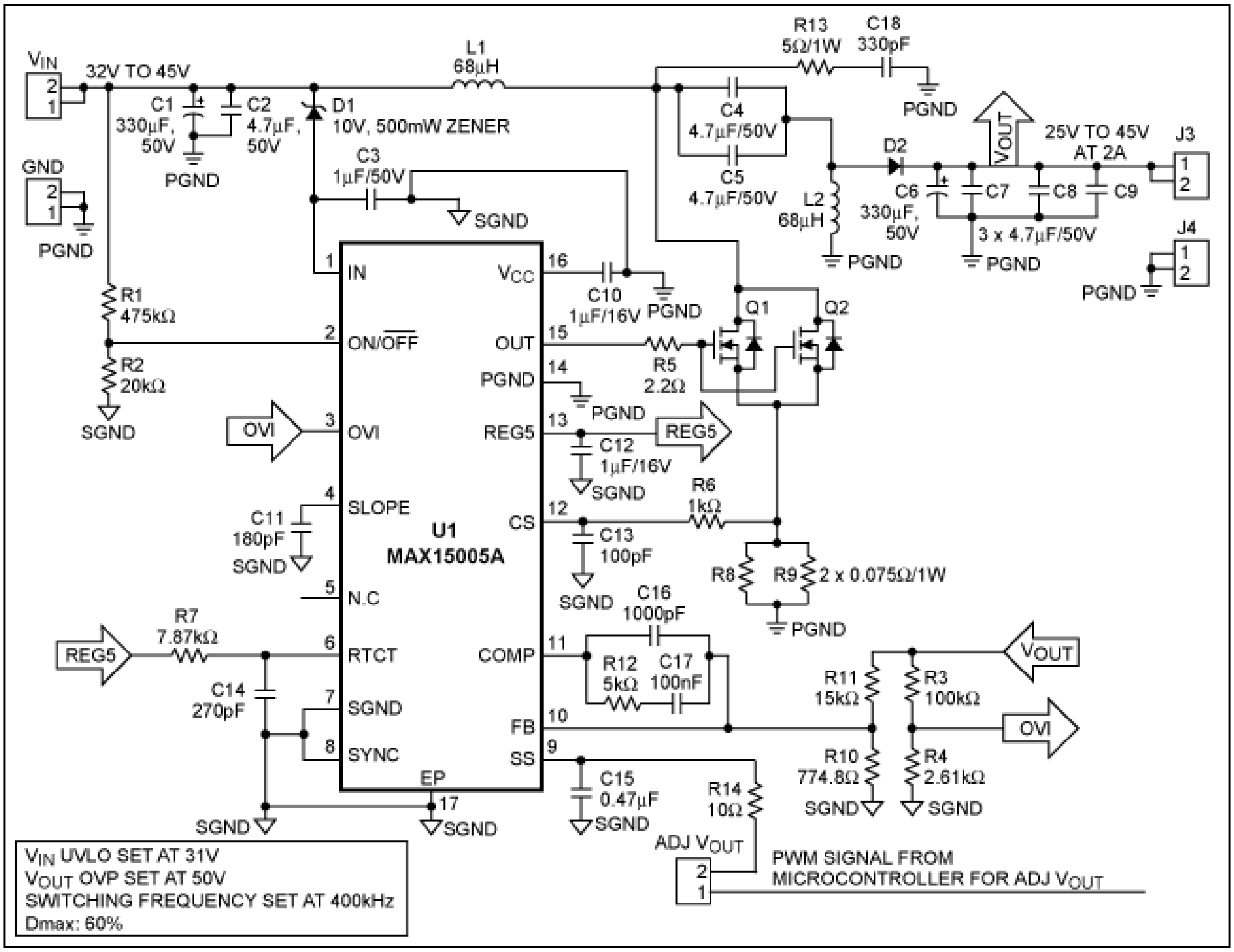


Figure 1. Schematic of the MAX15005A SEPIC converter for F_{SW} = 400kHz.

The bill of materials (BOM) for this reference design is given in **Table 1**.

Table 1. BOM for Print-Head Power Supply

Designator	Description	Comment	Footprint	Manufacturer	Quantity	Value
C1, C6	Electrolytic capacitor	EEVFK1H331Q	12.5mm x 13.5mm	Panasonic®	2	330µF/50V
C2, C4, C5, C7, C8, C9	Capacitor	GRM32ER71H475KA88L	1210	Murata®	6	4.7µF/50V
C3	Capacitor	GRM31MR71H105KA88L	1206	Murata	1	1µF/50V
C10, C12	Capacitor	GRM188R71C105KA12D	603	Murata	2	1µF/16V
C11	Capacitor	GRM1885C1H181JA01D	603	Murata	1	180pF
C13	Capacitor	GRM1885C1H101JA01D	603	Murata	1	100pF

C14	Capacitor	GRM1885C1H271JA01D	603	Murata	1	270pF
C15	Capacitor	GRM188R71E474KA12D	603	Murata	1	0.47µF
C16	Capacitor	GRM188R71H102KA01D	603	Murata	1	1000pF
C17	Capacitor	GRM188R71H104KA93D	603	Murata	1	100nF
C18	Capacitor	GRM1885C1H331JA01D	603	Murata	1	330pF
D1	Zener diode	MMSZ10T1	SOD-123	ON Semiconductor®	1	10V, 500mW Zener
D2	Schottky rectifier	FEPB6BT	D^{2}PAK	Vishay®	1	100V/6A Schottky
L1, L2	Inductor	D05040H-683MLD	D05040	Coil Craft	2	68µH
Q1, Q2	n-Channel MOSFET	HUF76609D3S	DPAK	Fairchild Semiconductor®	2	100V/10A MOSFET
R1	Resistor	SMD 1% Resistor	603	Vishay	1	475kΩ
R2	Resistor	SMD 1% Resistor	603	Vishay	1	20kΩ
R3	Resistor	SMD 1% Resistor	603	Vishay	1	100kΩ
R4	Resistor	SMD 1% Resistor	603	Vishay	1	2.61kΩ
R5	Resistor	SMD 1% Resistor	603	Vishay	1	2.2Ω
R6	Resistor	SMD 1% Resistor	603	Vishay	1	1kΩ
R7	Resistor	SMD 1% Resistor	603	Vishay	1	7.87kΩ
R8, R9	Resistor	LRCLR201001R075F	2010	IRC	2	0.075Ω/1W
R10	Resistor	SMD 1% Resistor	603	Vishay	1	774.8Ω
R11	Resistor	SMD 1% Resistor	603	Vishay	1	15kΩ
R12	Resistor	SMD 1% Resistor	603	Vishay	1	5kΩ
R13	Resistor	ERJ-1TYJ5R0	2512	Panasonic	1	5Ω/1W
R14	Resistor	SMD 1% Resistor	603	Vishay	1	10Ω
U1	**PWM controller**	**MAX15005A**	**TSSOP-16-EP**	**Maxim®**	**1**	**–**

Efficiency Plots

Efficiency V_S load-current plots are given in **Figures 2** and **3**. The input voltage was V_{OUT} = 25V in Figure 2 and V_{OUT} = 45V in Figure 3.

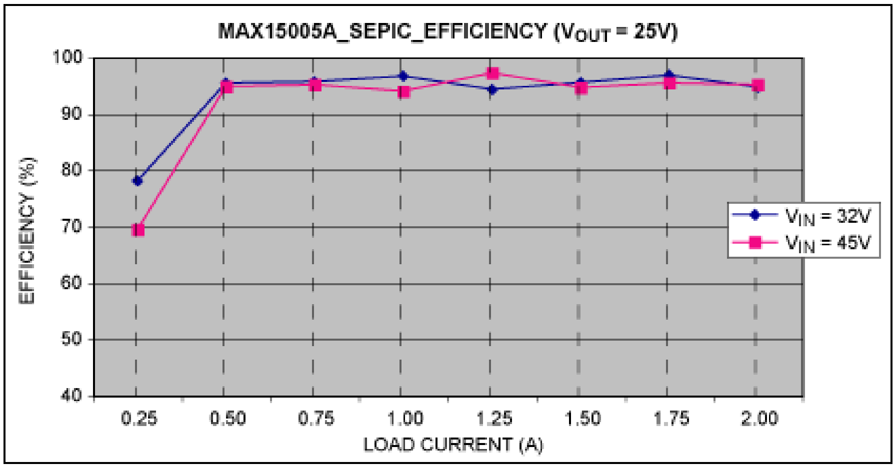


Figure 2. Load current vs. converter efficiency for V_{OUT} = 25V.

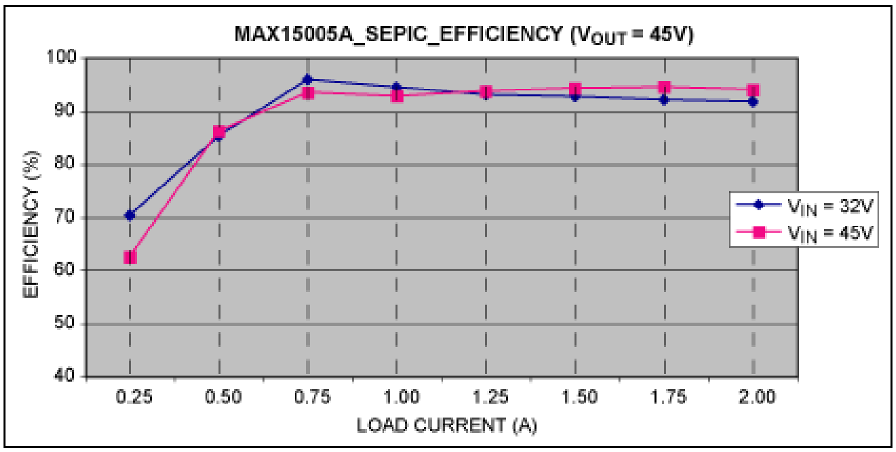
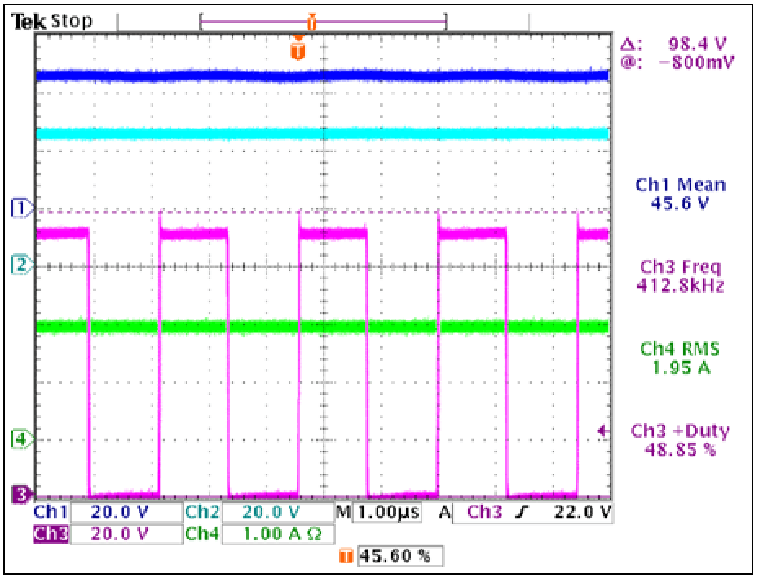


Figure 3. Load current vs. converter efficiency for V_{OUT} = 45V.

Experimental Results

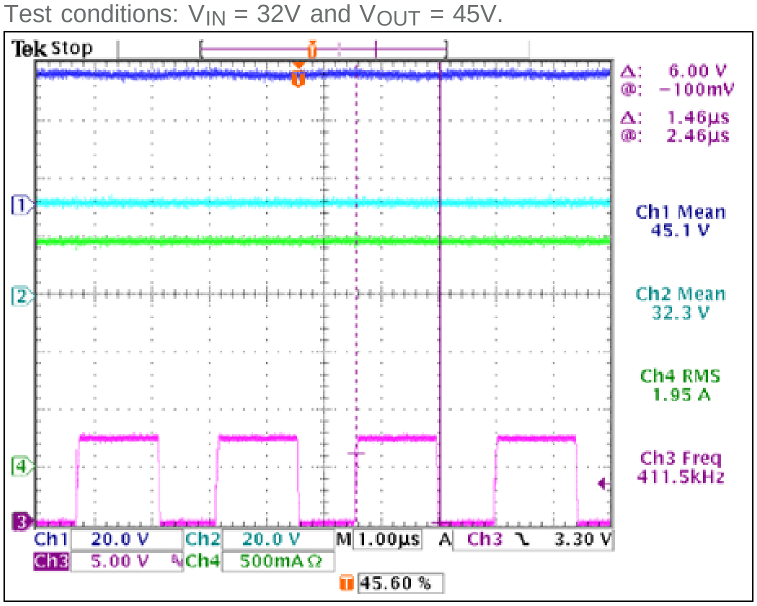
Converter output voltage and load current are shown in following figures for different input excitations.

Test conditions: V_{IN} = 45V and V_{OUT} = 45V.



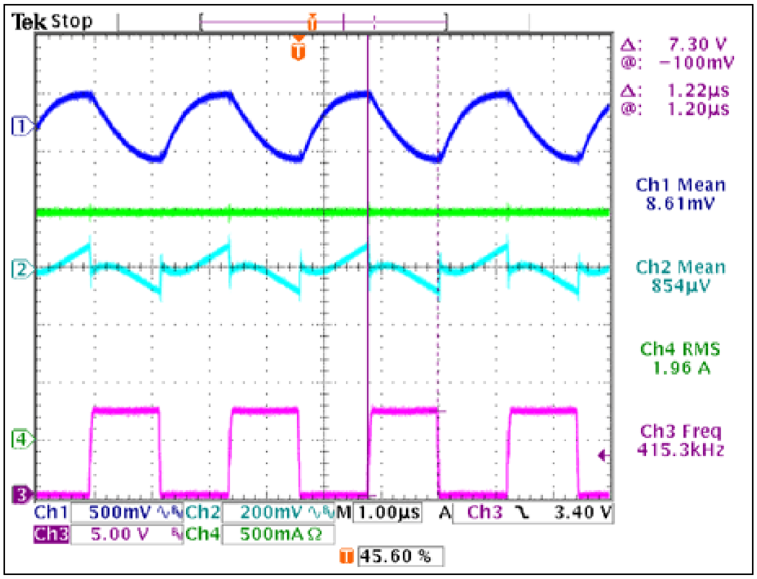
Ch1: output voltage; Ch2: input voltage; Ch3: MOSFET drain voltage; Ch4: output current.

Test conditions: V_{IN} = 32V and V_{OUT} = 45V.



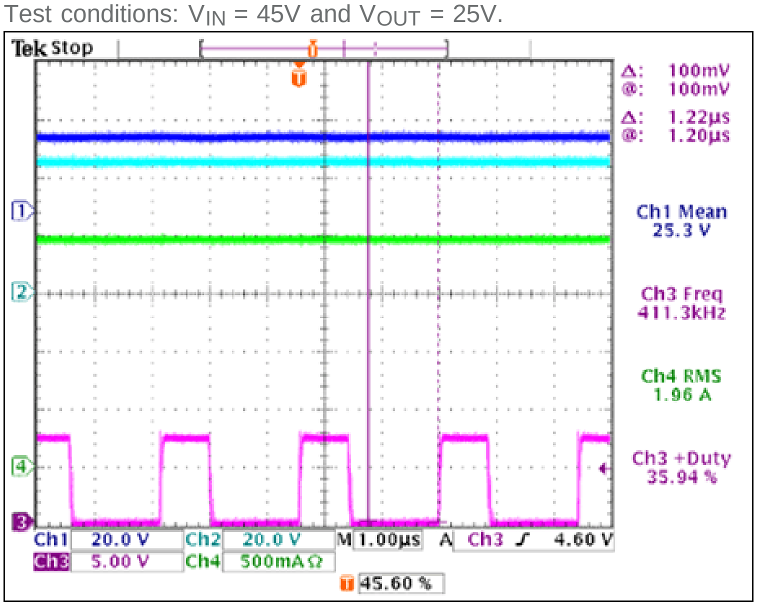
Ch1: output voltage; Ch2: input voltage; Ch3: MOSFET gate voltage; Ch4: output current.

Test conditions: V_{IN} = 45V and V_{OUT} = 45V.



Ch1: output voltage; Ch2: input voltage; Ch3: MOSFET gate voltage; Ch4: output current.

Test conditions: V_{IN} = 45V and V_{OUT} = 25V.



Ch1: output voltage; Ch2: input voltage; Ch3: MOSFET gate voltage; Ch4: output current.

More Information

For Technical Support: http://www.maximintegrated.com/support

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Application Note 4361: http://www.maximintegrated.com/an4361
REFERENCE DESIGN 4361, AN4361, AN 4361, APP4361, Appnote4361, Appnote 4361