Keywords: cold crank, boost, step up

REFERENCE DESIGN 4329 INCLUDES: √Tested Circuit √Schematic √BOM √Test Data

How to Use the MAX15005 Current-Mode Controller as a Boost Circuit for an Automotive Cold-Crank Condition

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Abstract: This reference design shows how to use a MAX15005 automotive power-supply controller as a boost circuit to maintain a constant voltage during an automotive cold-crank condition.

Introduction

When an automotive engine remains in a cold climate or is subjected to freezing temperatures for a long time, the engine oil becomes very viscous. In cold temperatures the battery's internal resistance also increases from its normal value. If the engine is started during that time, the starter motor needs more torque, which draws more current from the battery. Due to transients in the current requirement and high-series resistance, the battery voltage can drop as low as 2.5V. This is known as the cold-crank condition in automotives.

The MAX15005 is a current-mode controller that operates from 4.5V to 40V. The device can manage cold-crank conditions and a load-dump condition as well. Once powered, the MAX15005 operates down to 2.5V, thus accommodating a further drop in the battery voltage.

This reference design shows a solution for a cold crank in automotive applications. The design includes the complete schematic, bill of materials (BOM), efficiency measurements, and test results.

Specifications and Design Setup

The design uses the following specifications:

- Input voltage: 2.5V to 18V
- Output voltage: 12V
- Output current: 1A
- Output ripple: ±0.6V
- Input ripple: ±15mV
- Efficiency: 75% with cold crank > 90% for normal operation
- Switching frequency: 200kHz

The schematic for the above specifications is shown in **Figure 1**.

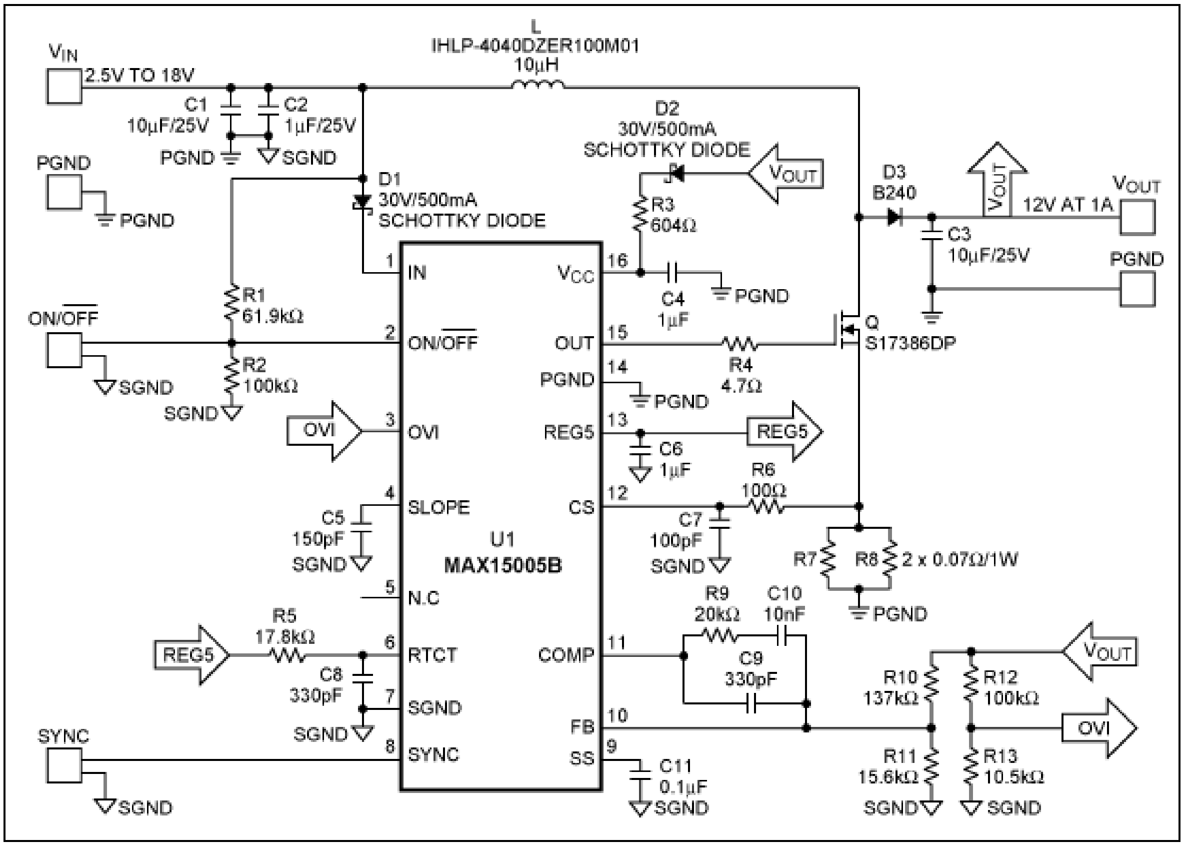

Figure 1. Schematic of the MAX15005B boost converter for F_{SW} = 200kHz.

The BOM for this reference design is given in **Table 1**.

Table 1. Bill of Materials

Designator	Value	Description	Part	Footprint	Manufacturer	Quantity
C1	10µF/25V	Capacitor	GRM32DR71E106KA12L	1210	Murata®	1
C2	1µF/25V	Capacitor	GRM219R71E105KA88D	805	Murata	1
C3	10µF/25V	Capacitor	GRM32DR71E106KA12L	1210	Murata	1
C4, C6	1µF/16V	Capacitor	GRM188R71C105KA12D	603	Murata	2
C5	150pF	Capacitor	GRM1885C1H151JA01D	603	Murata	1
C7	100pF	Capacitor	GRM1885C1H101JA01D	603	Murata	1
C8, C9	330pF	Capacitor	GRM1885C1H331JA01D	603	Murata	2
C10	10nF	Capacitor	GRM188R71H103KA01D	603	Murata	1
C11	0.1µF	Capacitor	GRM188R71H104KA93D	603	Murata	1
D1	30V/500mA Schottky	Schottky diode	MBR0530T1	SOD123	On Semiconductor®	1
D2	30V/500mA Schottky	Schottky diode	MBR0530T1	SOD123	On Semiconductor	1
D3	40V/2A Schottky	Default diode	B240	SMB	Diodes Incorporated	1
L	10µH	Inductor	IHLP-4040DZER100M01	IHLP-4040EZ	Vishay®	1

Q	30V, 17A n-channel MOSFET	n-channel MOSFET	SI7386DP	Power PAKSO-8	Vishay	1
R1	61.9K	Resistor	SMD 1% Resistor	603	Vishay	1
R2, R12	100K	Resistor	SMD 1% Resistor	603	Vishay	2
R3	604Ω	Resistor	SMD 1% Resistor	603	Vishay	1
R4	4.7	Resistor	SMD 1% Resistor	603	Vishay	1
R5	17.8K	Resistor	SMD 1% Resistor	603	Vishay	1
R6	100	Resistor	SMD 1% Resistor	603	Vishay	1
R7, R8	0.07Ω/1W	Resistor	LRCLR2010LF01R070J	2010	IRC	2
R9	20K	Resistor	SMD 1% Resistor	603	Vishay	1
R10	137K	Resistor	SMD 1% Resistor	603	Vishay	1
R11	15.6K	Resistor	SMD 1% Resistor	603	Vishay	1
R13	10.5K	Resistor	SMD 1% Resistor	603	Vishay	1
U1	4.5V to 40V input, automotive flyback/boost/SEPIC, power-supply controller	PWM controller	MAX15005BAUE+	TSSOP-16	Maxim	1

Performance Data

The efficiency vs. load current plots for this design are given in **Figure 2**. Input voltage was the test parameter.

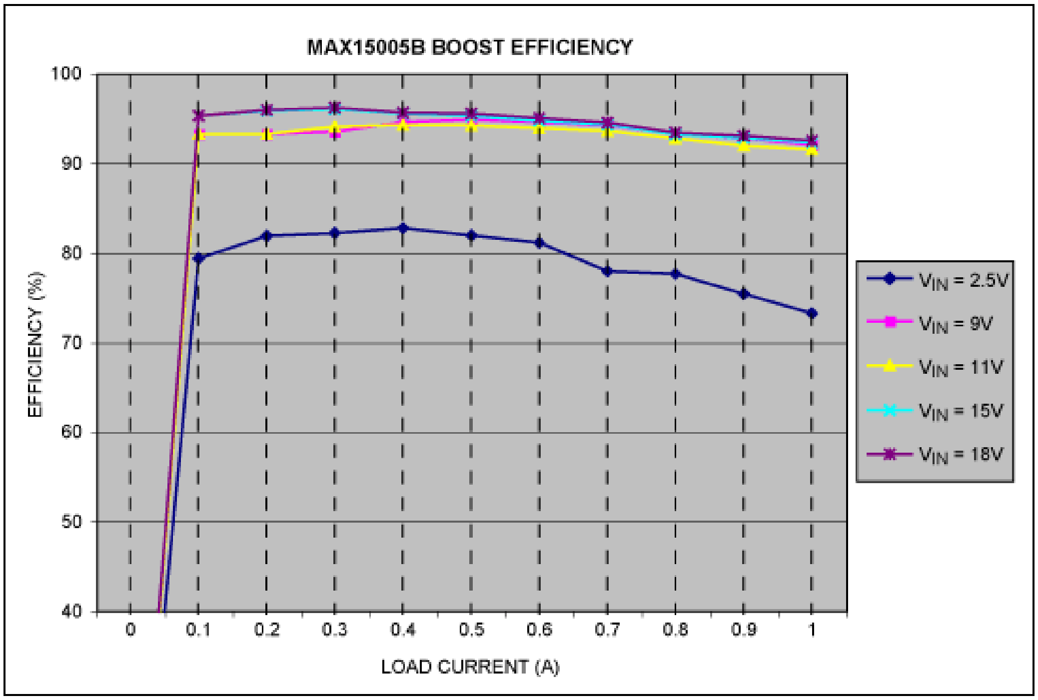

Figure 2. Load current vs. converter efficiency.

Converter output voltage and load current are shown in **Figure 3** and **Figure 4** with V_{IN} = 2.5V and V_{IN} = 11V, respectively.

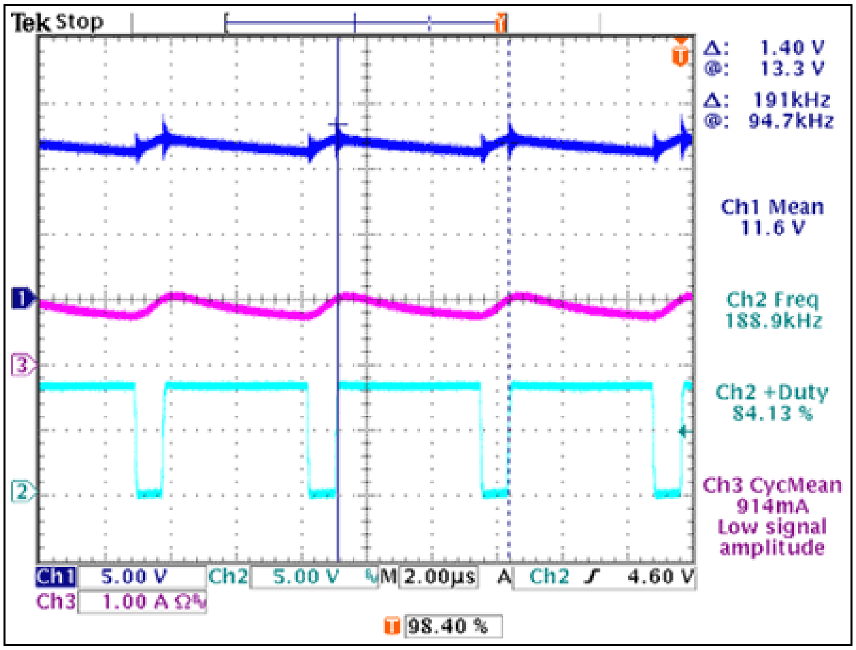

Figure 3. Converter output voltage and load current with V_{IN} = 2.5V.
CH1: output voltage; CH2: MOSFET gate voltage; CH3: output current.

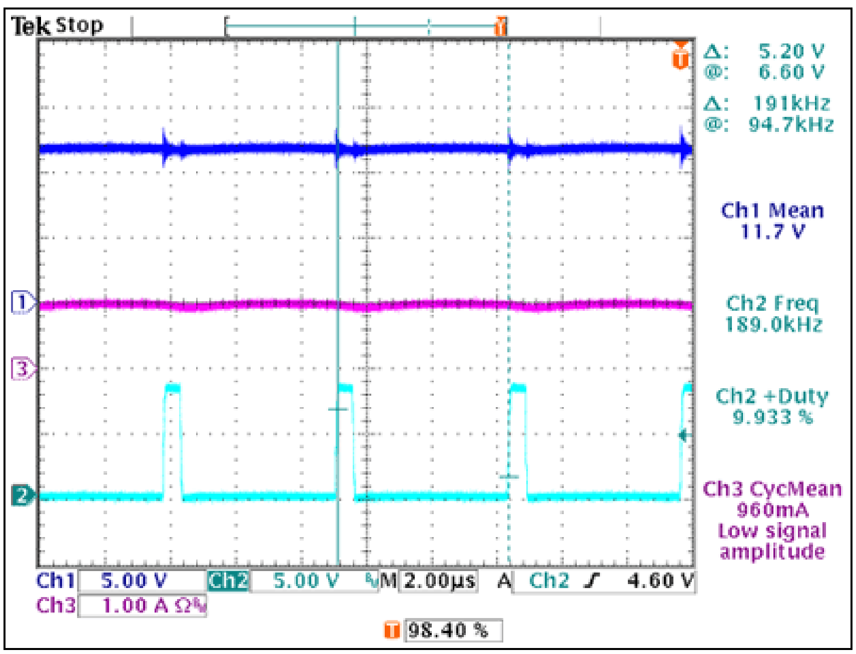

Figure 4. Converter output voltage and load current with V_{IN} = 11V.
CH1: output voltage; CH2: MOSFET gate voltage; CH3: output current.

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Related Parts

MAX15005	4.5V to 40V Input Automotive Flyback/Boost/SEPIC Power-Supply Controllers	Free Samples

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