Keywords: switch-mode, bipolar output, +/-15V power supply.

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APPLICATION NOTE 3843

±15V Switch-Mode Power Supply Has Wide Input-Voltage Range

Abstract: This switch-mode power supply provides ±15V at 0.5A output from a 4.5V to 12V input-voltage range. The wide input-voltage range allows this power supply the flexibility to be powered from a regulated DC voltage, or even an unregulated DC voltage such as the rectified output from an inexpensive AC step-down transformer.

The power supply consists of a MAX668 boost circuit and a MAX1846 inverting circuit. Each circuit operates at a 300kHz switching frequency as a compromise among cost, size, and performance. Both circuits limit the maximum switch current, which ultimately limits the output current for a given input voltage. However, the maximum output current increases as the input voltage increases.

The MAX668 circuit in **Figure 1** contains a few components in addition to the minimum circuit implementation. C7 adds a pole to compensate for the ESR-zero of the output capacitor. R5 and C8 filter the current-sense voltage to prevent high-frequency switching noise from tripping the current limit. This is in addition to the internal 60ns current-sense blanking time.

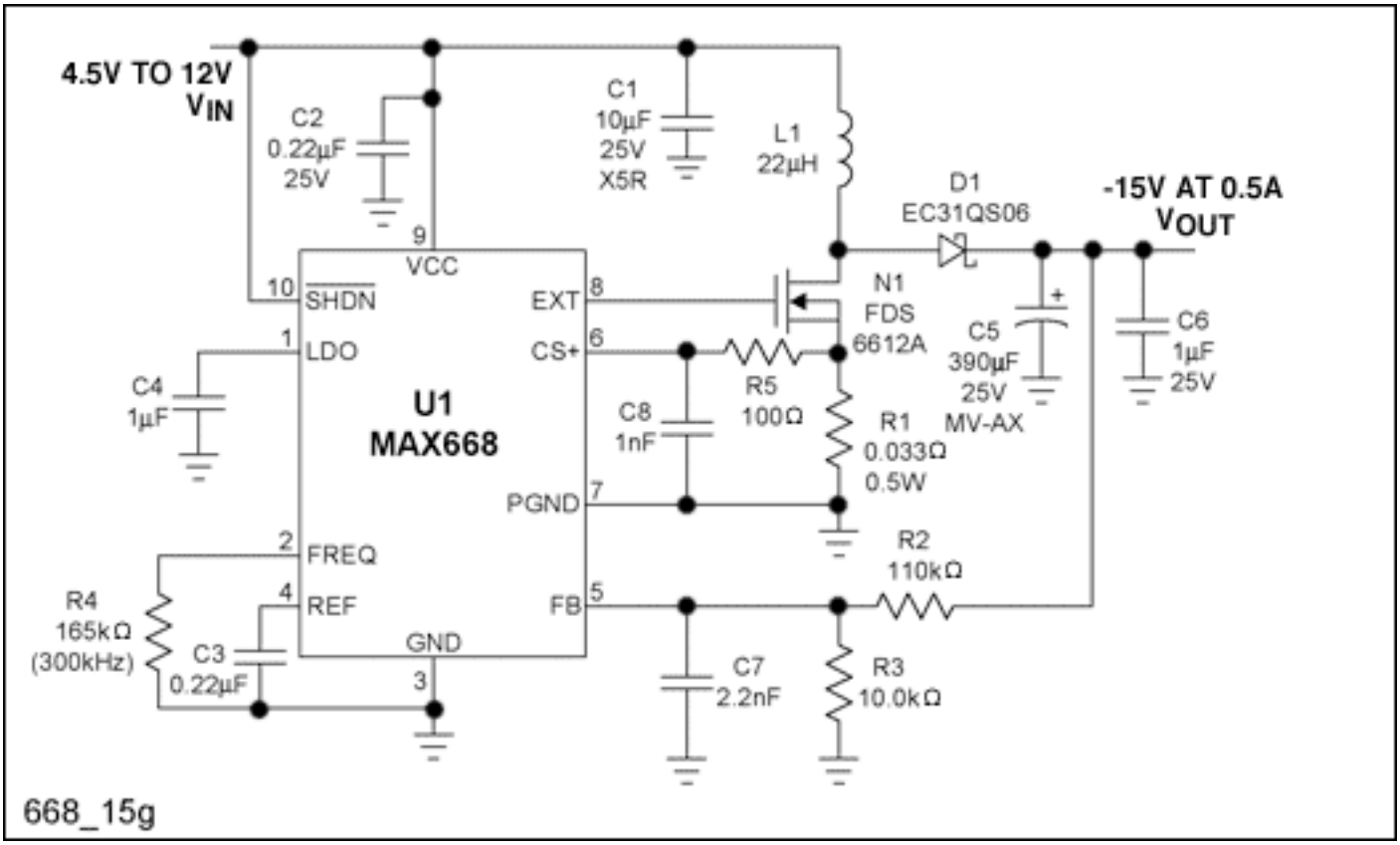

Figure 1. MAX668 Boost circuit for +15V at 0.5A.

The MAX668 output voltage can be changed to +12V by changing R2 to 86.6kΩ. The minimum input voltage then decreases to approximately 10V. No other changes are required because the MAX668 has internal compensation.

The output ripple voltage caused by switching can be reduced an order of magnitude with a secondary output filter set to one-tenth of the switching frequency. A 1Ω, 0.5W resistor placed in series with a 10µF 25V capacitor with less than 100mΩ ESR is sufficient. This introduces an additional 0.5V decrease in output voltage for a 0.5A

load. The feedback voltage must be sensed before the secondary filter for the MAX668 to work properly.

The MAX1846 circuit (**Figure 2**) also contains a few components in addition to the minimum circuit implementation. Like the C7 for the MAX668, C20 adds a pole to compensate for the ESR-zero of the output capacitor. As with the MAX668, R16 and C22 filter the current-sense voltage to prevent high-frequency switching noise from tripping the current limit. This is in addition to the internal 100ns current-sense blanking time. The MAX1846 EXT pin has a controlled slew rate that inherently limits the high-frequency switching noise.

Table 1. MAX668 Application Circuit Capabilities

V_{IN}	I_{IN}	V_{OUT}	I_{OUT}	Efficiency
5.00	0.0007	15.11	0	
5.00	1.597	14.81	0.50	0.927
6.00	1.318	14.85	0.50	0.939
8.00	0.981	14.91	0.50	0.950
10.00	0.781	14.96	0.50	0.958
11.00	0.708	14.98	0.50	0.962
12.00	0.648	15.01	0.50	0.965
4.47	1.800	14.78	0.50	0.918
20MHz BW		$240mV_{P-P}$		
4.46	2.556	14.70	0.70	0.903
Current limit			~0.71	

BILL OF MATERIALS
4.5V to 10V Input
15V at 0.5A Output
668_15g

DESIGNATION	QTY	DESCRIPTION
C1	1	10µF, 25V X5R ceramic capacitor (1210) Taiyo Yuden TMK325BJ106MM
C2	1	0.22µF, 25V ceramic capacitor (0805) Taiyo Yuden UMK212BJ224MG
C3	1	0.22µF, 10V ceramic capacitor (0603) Taiyo Yuden EMK107BJ224MA
C4	1	1µF, 10V X5R ceramic capacitor (0603) Taiyo Yuden LMK107BJ105MA
C5	1	390µF, 25V aluminum electrolytic capacitor Sanyo 25MV390AX
C6	1	1µF, 25V X5R ceramic capacitor (1206)
C7	1	2.2nF ceramic capacitor (0603)
C8	1	1nF ceramic capacitor (0603)
D1	1	3A, 60V Schottky diode Nihon EC31QS06
L1	1	22µH, 6A power inductor Coilcraft DO5022P-223
N1	1	30mΩ, 30V n-channel MOSFET (SO-8) Fairchild FDS6612A
R1	1	0.033Ω, 0.5W, 5% resistor (2012)
R2	1	110kΩ, 1% resistor (0603)
R3	1	10.0kΩ, 1% resistor (0603)
R4	1	165kΩ, 1% resistor (0603)
R5	1	100Ω, 5% resistor (0603)
U1	**1**	**MAX668EUB (10-µMAX®)**

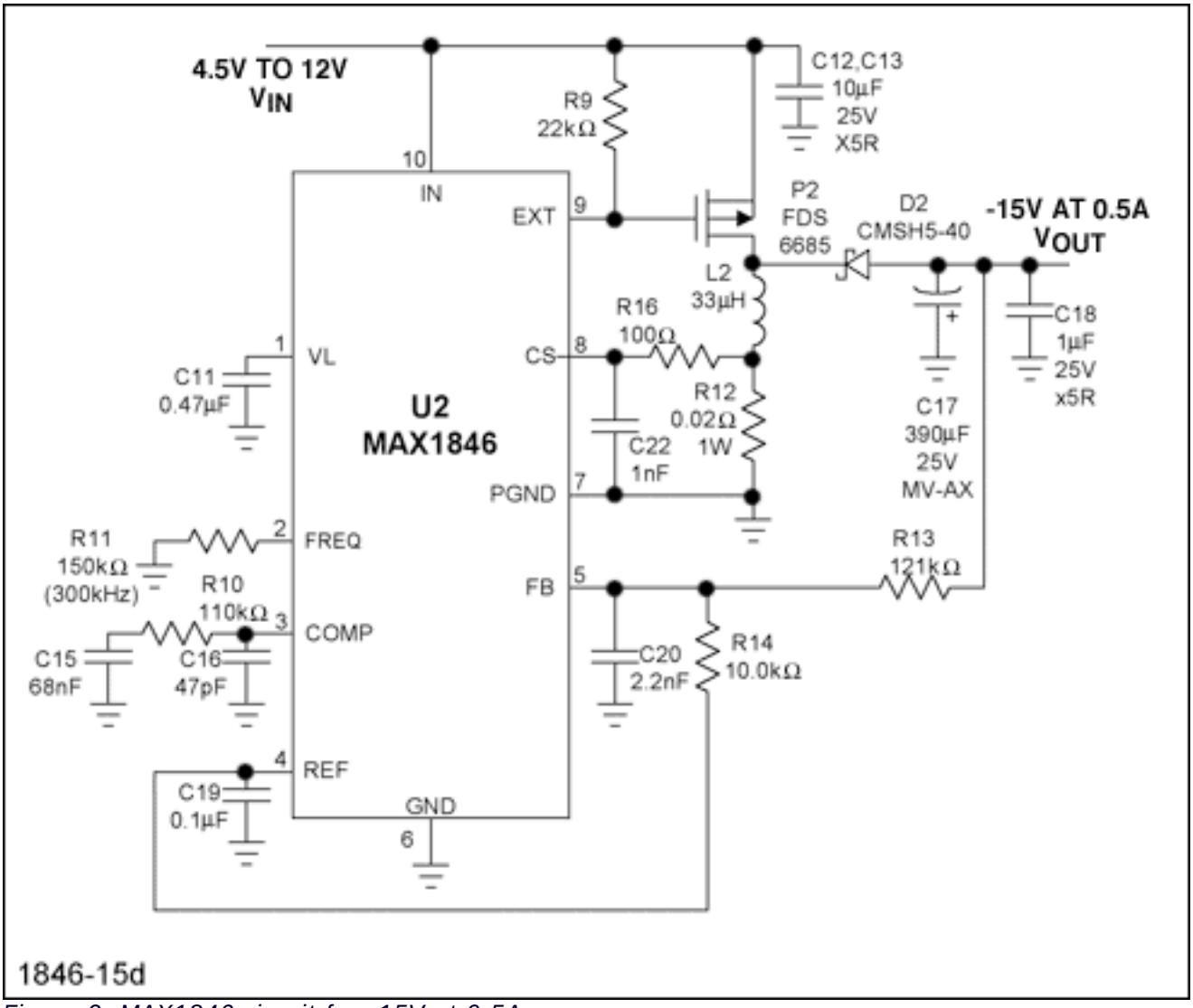

Figure 2. MAX1846 circuit for -15V at 0.5A.

The MAX1846 output voltage can be changed to -12V by changing R13 to 97.6kΩ and R10 to 91kΩ. The maximum input voltage does not decrease, though duty cycle jitter increases somewhere between 10V and 12V input. Again, the output ripple voltage caused by switching can be reduced an order of magnitude with the same secondary filter described for the MAX668. The feedback voltage must be sensed before the secondary filter for the MAX1846 to work properly.

Table 2. MAX1846 Application Circuit Capabilities

V_{IN}	I_{IN}	V_{OUT}	I_{OUT}	Efficiency
5.00	0.0077	-15.15	0	
5.00	1.76	-15.15	0.50	0.861
6.01	1.42	-15.15	0.50	0.888
8.01	1.05	-15.15	0.50	0.901
10.00	0.84	-15.15	0.50	0.902
12.00	0.70	-15.15	0.50	0.902
4.48	2.04	-15.15	0.50	0.829
20MHz BW		$360mV_{P-P}$		
4.48	3.63	-15.15	0.80	0.745
Current limit			~0.81	

BILL OF MATERIALS
4.5V to 12V Input
-15V at 0.5A Output
1846-15d

DESIGNATION	QTY	DESCRIPTION
C11	1	0.47µF ceramic capacitor (0603)
C12,C13	2	10µF, 25V X5R ceramic capacitor (1210) Taiyo Yuden TMK325BJ106MM
C15	1	68nF ceramic capacitor (0603)
C16	1	100pF ceramic capacitor (0603)
C17	1	390µF, 25V aluminum electrolytic capacitor Sanyo 25MV390AX
C18	1	1µF, 25V X5R ceramic capacitor (1206)
C19	1	0.1µF ceramic capacitor (0603)
C20	1	2.2nF ceramic capacitor (0603)
C22	1	1nF ceramic capacitor (0603)
D2	1	5A, 40V Schottky diode Central Semi CMSH5-40
L2	1	33µH, 5A inductorCoilcraft DS5022P-333
P2	1	35mΩ, -30V p-channel MOSFET (SO-8) Fairchild FDS6685
R9	1	22kΩ, 5% resistor (0603)
R10	1	110kΩ, 5% resistor (0603)
R11	1	150kΩ, 5% resistor (0603)
R12	1	0.02Ω, 1W, 1% resistor (2512) Dale WSL-2512-R020-F
R13	1	121kΩ, 1% resistor (0603)
R14	1	10.0kΩ, 1% resistor (0603)
R16	1	100Ω, 5% resistor (0603)
U2	**1**	**MAX1846EUB (10-µMAX)**

Application Note 3843: www.maxim-ic.com/an3843

More Information
For technical support: www.maxim-ic.com/support
For samples: www.maxim-ic.com/samples
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Related Parts

MAX1846: QuickView -- Full (PDF) Data Sheet -- Free Samples

MAX668: QuickView -- Full (PDF) Data Sheet -- Free Samples

AN3843, AN 3843, APP3843, Appnote3843, Appnote 3843