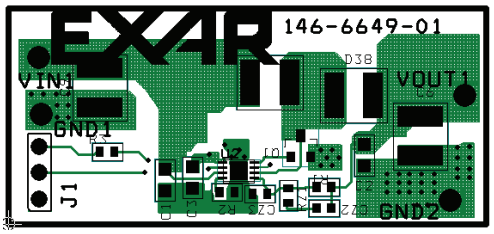
SP7606

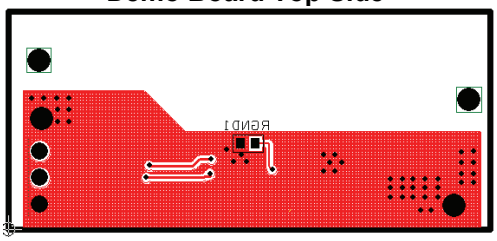
Wide Input Voltage Boost Controller

FEATURES

- Voltage-Mode PWM Operation
- Adjustable Output Voltage up to 38V
- Up to 85% Efficiency
- Low Supply Current:
- Require Tiny Inductors and Capacitors
- 8-pin 2x3 DFN package
- Internal Compensation
- Built in current limit



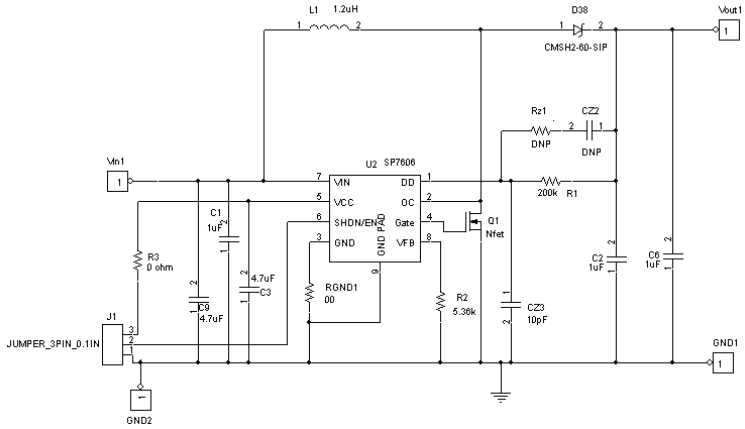
Demo Board Top Side



Demo Board Bottom Side

GENERAL DESCRIPTION

The SP7606 is a fixed frequency boost controller designed to drive loads up to 38V output voltage. The SP7606 was developed to be used in conjunction with the SP7616 to drive a wide range of led chains that require high anode voltages. The ability to disconnect the output voltage feedback resistors (DD Pin) reduces shutdown current. The high switching frequency allows the use of tiny external components and saves layout space and cost. The SP7606 is packaged in a space-saving 8-pin 2x3 DFN.



TYPICAL APPLICATION SCHEMATIC
Boost converter 12V to 30V

Using the Demo board.
Connect the source voltage to the input pins of the demo board. The load needs to be connected to Vout pins. The SP7606 is enabled when the pin 7 (SHDN) pin is high. The demo board can deliver 400mA of output current at 30Vout from a 12V input.

Design procedure for the SP7606 in DCM mode of operation.
The primary mode of operation for the SP7606 is in Discontinuous Conduction mode (DCM). Below is the general procedure that was used to design the SP7606 demo board. 146-6649-01 part number.

Vin 12V, 500mVp-p ripple, Vout30V, Iout 400mA. The FET requirements are a SOT-23 package for small foot print.

Setting the output voltage
The output voltage of the SP7606 can be set by using an output voltage divider. The internal reference of this part is set to 0.8V. Due to the internal compensation, resistor R1 might need to be chosen according to the desired gain of the compensation loop. This resistor is typically between 100K and 1M ohms. Resistor R2 can be determined by using the following equation:

$$Vout = Vfb\left[1 + \frac{R1+200}{R2}\right]$$

Vfb=800mV
R1=Top Voltage divider resistor
R2=Bottom Voltage divide resistor
200=the typical impedance of the DD FET

R1 Chosen value of 200K
R2 Value is 5.36K

Calculate the on time and inductor value.

$$Ton = \frac{Kr\left[\frac{1}{fsw}\right][Vo - Vinmin]}{Vo}$$
$$Ton = 4 \times 10^{-7}$$

Kr is a constant that sets the maximum on time to off time. A value of .8 should be used this will assure that the inductor value is chosen such that the converter runs in DCM mode.

$$L_{DCM} = \frac{K\left[\frac{Vo}{1.5\cdot 10}\right]T_{on}}{2\left[\frac{Vo}{V_{inmin}}\right]^2}$$

Where

K is .8 ratio of MOSFET and diode conduction time to T (T=1/fsw)
$\frac{Vo}{Io}$= output impedance at full load this should be multiplied by 1.5 for current limit variations
Vo is the output voltage
V_{inmin} is the minimum input voltage
T_{on} is the maximum on time

$L_{DCM} = 1.28uH$ is the maximum calculated value to satisfy discontinuous mode of operation at full load. A value of 1.2 uH was chosen.

The peak current is given by

$$Ip_{DCM} = Ton\left[\frac{Vinmin}{L_{DCM}}\right]$$

The calculated peak current is 4.0A

Once the peak current is known for the current limit the value needs to be checked to make sure it will not trip during normal operation.

Over current protection

The boost regulator topology inherently does not have short circuit protection. The SP7606 converter uses a simple comparator circuit to check for an over current condition on a pulse by pulse basis. The Vset voltage threshold for the over-current (OC) pin is worst case set 0.2V.

$$I_{limit} = \frac{Vset}{RDSON}$$

RDSON is the FET RDSON. The RDSON of the Si2318 is 0.058 ohms
Vset is 0.25V
I_{limit} is the current limit peak current or I_{pDCM}

I_{limit} is 4.31A. Since I limit is greater than I_{pDCM} the inductor value is ok. If this value was smallerthan the calculated I_{pDCM} then a different FET needs to be chosen with a different Rdson.

Input capacitor selection

For both continuous and discontinuous mode of operation the input capacitor needs to be chosen based on maximum input voltage rating and the RMS ripple current and minimum input capacitance. For DCM mode the RMS current is given by:

$$Irms_{DCM} = Ip_{DCM}\sqrt{\frac{K}{3}}$$

Where K is the conduction time constant
Ip is the peak inductor current calculated from equation.

The RMS current is 1.65A

The minimum input capacitance that is required is:

$$Cin_{DCM} = Irms_{DCM}\left[\frac{T-Ton}{0.2Vin}\right]$$

Ton is the calculated on time
Vin is the minimum input voltage

The minimum amount of capacitance required is 0.34uF a value of 4.7uF was used to give good decoupling also at higher input voltage the capacitance of a ceramic capacitor can be half of the actual specified value.

Calculate the Output capacitor.
The minimum required output capacitor ESR is given by:

$$ESR = \frac{\Delta Vo}{Ip}$$

The ΔVo is the output ripple Voltage.
Ip is the peak current.
The minimum required value of ESR is 0.31 ohms.
The minimum output capacitance required in CCM and DCM mode is approximated by

$$Cout \approx \frac{Ip[D_{DCM}]}{Fsw[\Delta Vo]}$$

Where D_{DCM}= duty cycle
fsw=switching frequency

The minimum output capacitance is 1.25uF. 2 1uF capacitors were used.

Duty Cycle in discontinuous conduction mode (DCM)

$$D_{DCM} = \sqrt{\frac{2L}{\left[\frac{Re}{fsw}\right]}}$$

Where fsw is the switching frequency
L is the inductor
Re is the effective resistance of the small signal model

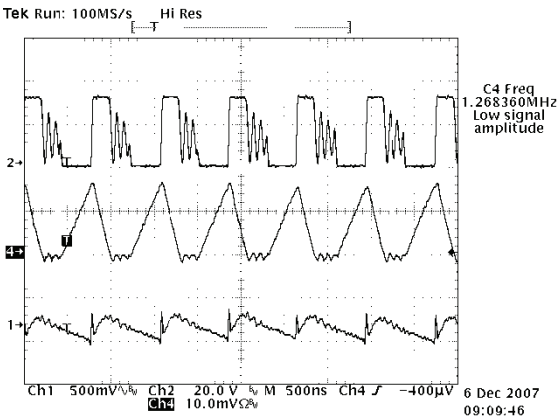
Re can be found by using as follows:

$$Re = \frac{Vin^2}{Iout(Vout - Vin)}$$

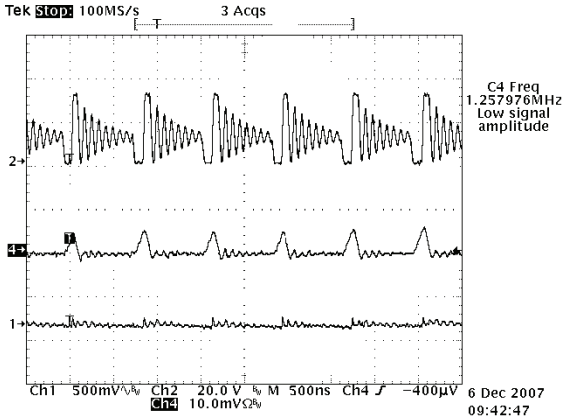
Compensation

When the board is operating in DCM mode of operation Type 2 compensation should be sufficient. Please refer to the SP7606 data sheet for more compensation information.

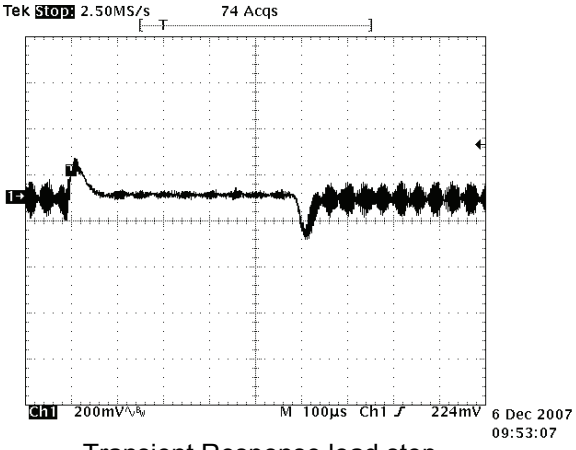
Oscilloscope shots of the demo board design. Note that the oscillations observed after the current in the inductor reaches zero are normal in nearly all switching topologies and represents normal DCM operation.

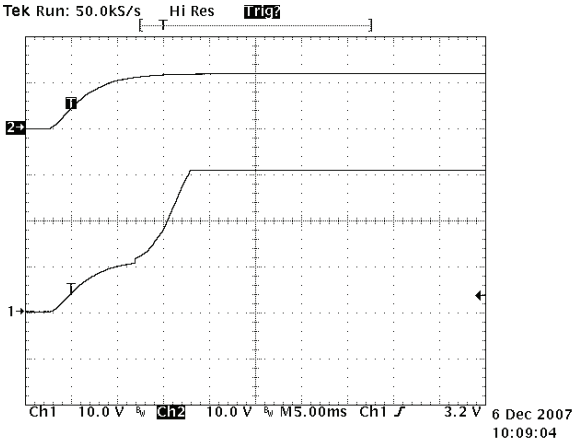


400mA Load switching characteristics 12Vin 30Vout
Channel 1 Vout Ripple
Channel 2 LX node
Channel 3 Inductor Current 2A/Div



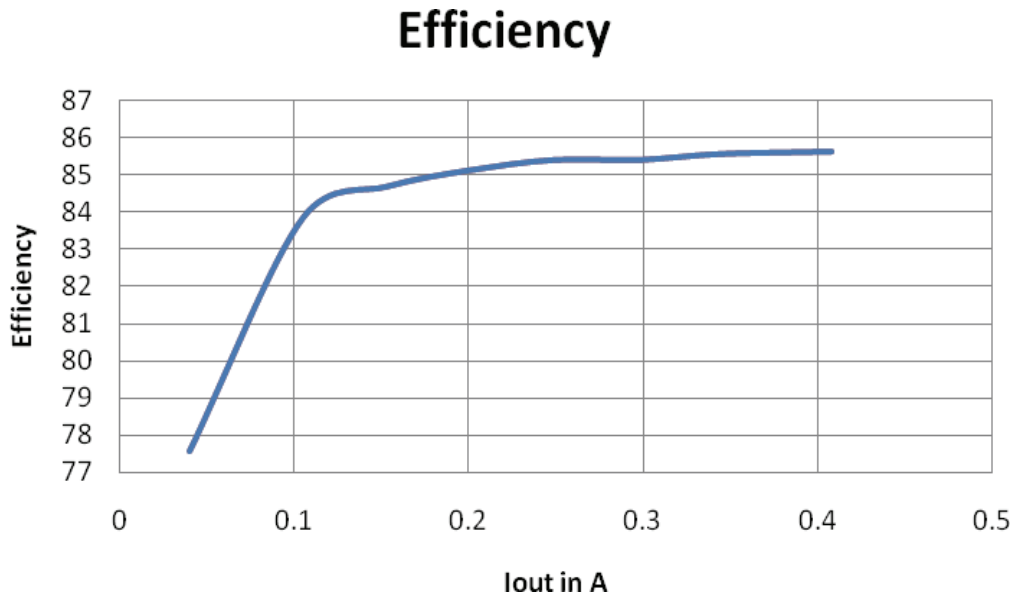
Light Load switching characteristics 12Vin 30Vout
Channel 1 Vout Ripple
Channel 2 LX node
Channel 3 Inductor Current 2A/Div





Transient Response load step
100mA to 400mA

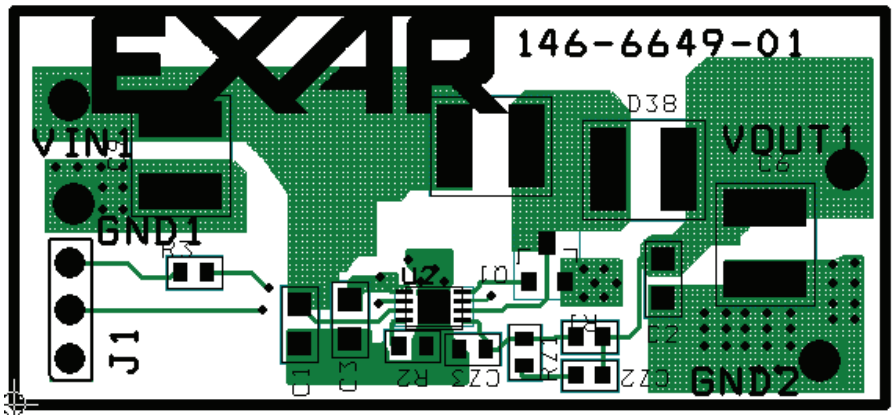
Startup characteristics into 400mA load
Channel 1 Vout Channel 2 Vin



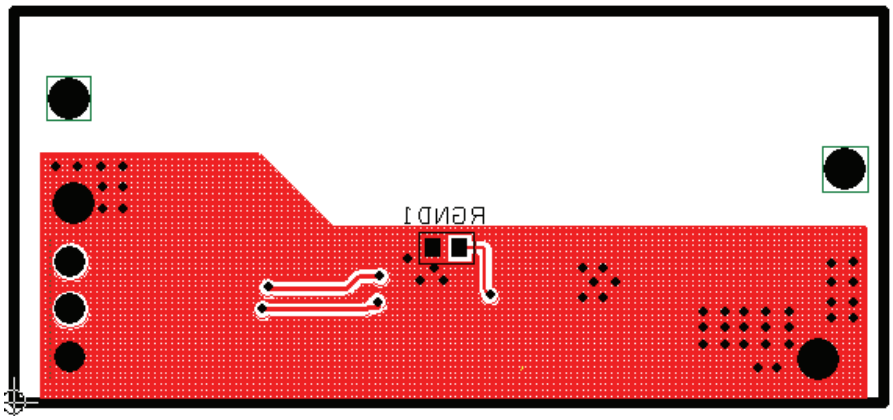
BOM

Reference Designator	QTY	Component Description	Footprint	Manufacturer	Manufacturer Part-number
U2	1	SP7606	2x3 DFN	Exar	SP7606
C2 C6 C1	3	1uF 50V capacitor	0805	Murata	GRM21BR71H105K
C3	1	4.7uF 25V capacitor	0805	Murata	GRM21BR61E475K
C9		4.7uF 10V capacitor	0805	Murata	GRM21BR61A475K
D38	1	60 Volt Schottky diode	SIP	Central Semi	CMSH2-60-SIP
Q1	1	40V N FET	SOT-23	Vishay	SI2318
L1	1	1.2uH Inductor	5.2x5.8x2	Würth	7447745017
J1	1	3 Pin Header		Würth	
R3 RGDN1	2	0 ohm jumper	0603		
R2	1	5.36K resistor	0805		
R1	1	200K resistor	0805		
	4	Test Post		Digikey	
	1	Demo Board PCB	N/A	Exar	146-6649-01

Layout



Demo Board Top Side



Demo Board Bottom Side

Board ordering information

ORDERING INFORMATION

Model	**Temperature Range**	**Package Type**
SP7606EB	-40°C to +85°C	SP7606Evaluation Board