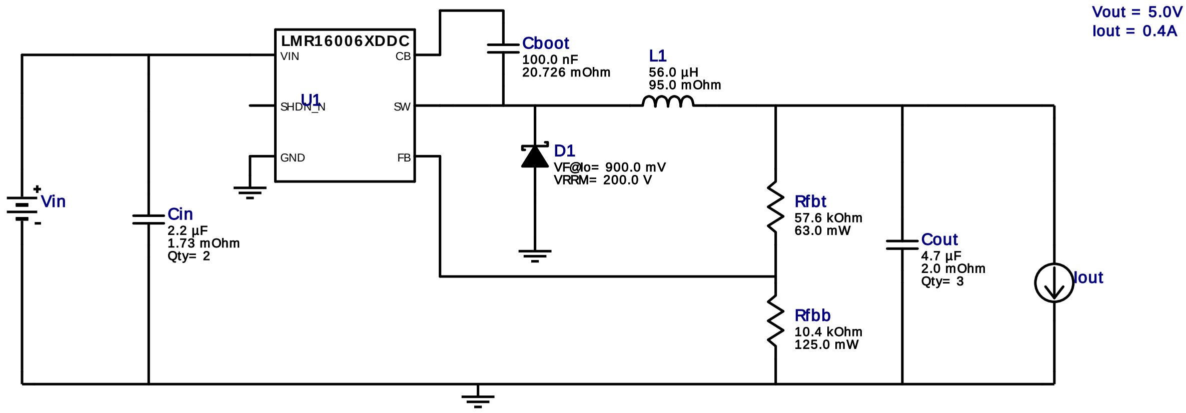
VinMin = 30.0V VinMax = 42.0V Vout = 5.0V Iout = 0.4A	Device = LMR16006XDDCR Topology = Buck Created = 2019-05-06 19:47:38.265 BOM Cost = $2.37 BOM Count = 11 Total Pd = 0.34W

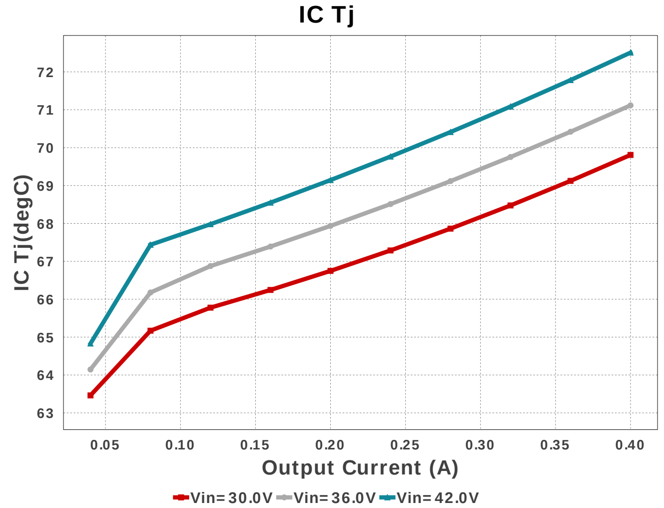
WEBENCH ® Design Report

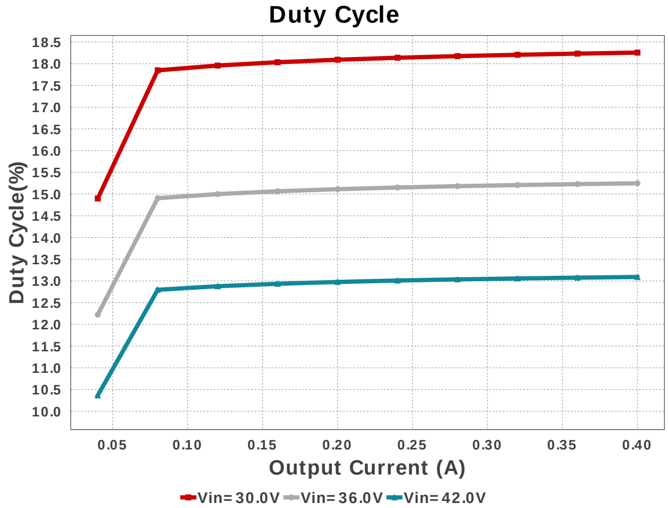
Design : 3 LMR16006XDDCR
LMR16006XDDCR 42V-42V to 5.00V @ 0.4A

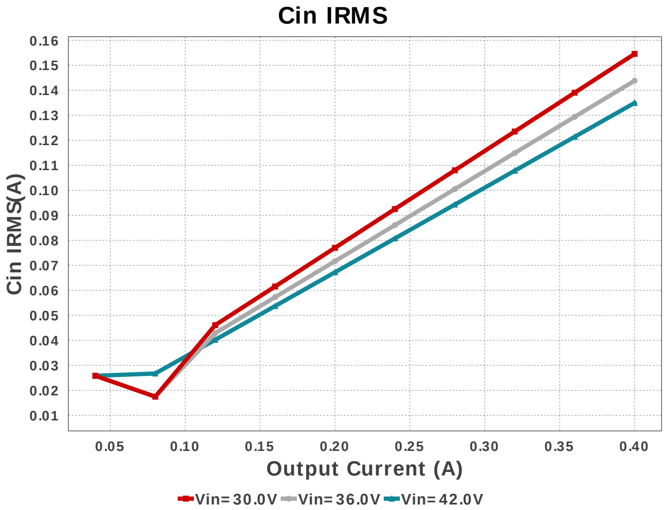


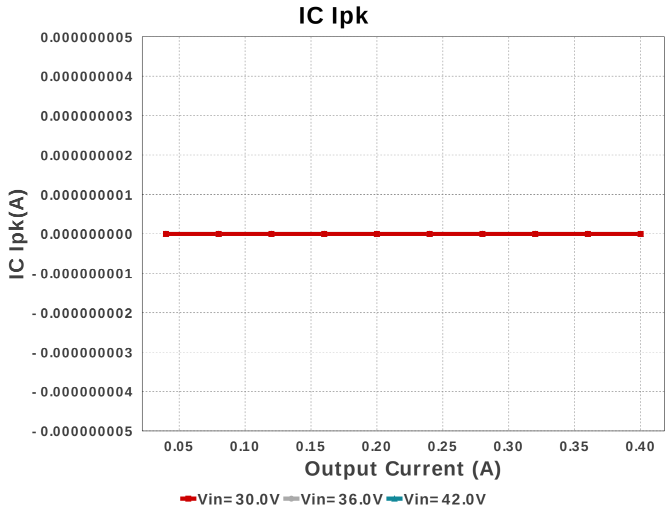
Electrical BOM

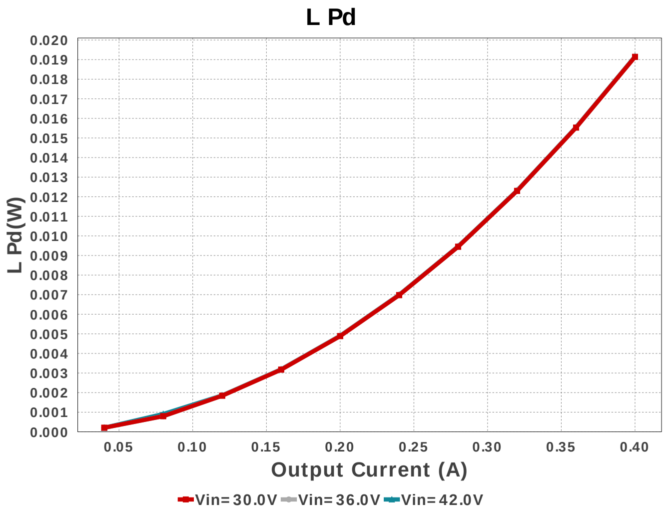
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	TDK	C2012X7R2A104K125AA Series= X7R	Cap= 100.0 nF ESR= 20.726 mOhm VDC= 100.0 V IRMS= 1.456 A	1	$0.03	0805 7 mm²
Cin	TDK	C3225X7R2A225K230AB Series= X7R	Cap= 2.2 uF ESR= 1.73 mOhm VDC= 100.0 V IRMS= 5.5932 A	2	$0.22	1210_250 15 mm²
Cout	MuRata	GRM21BR61E475MA12L Series= X5R	Cap= 4.7 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 7.29 A	3	$0.06	0805 7 mm²
D1	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.04	SMA 37 mm²
L1	Bourns	SDR1307-560KL	L= 56.0 µH 95.0 mOhm	1	$0.42	SDR1307 226 mm²
Rfbb	Yageo	RT0805BRD0710K4L Series= RT0805	Res= 10.4 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.05	0805 7 mm²
Rfbt	Vishay-Dale	CRCW040257K6FKED Series= CRCW..e3	Res= 57.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LMR16006XDDCR	Switcher	1	$1.20	DDC0006A 10 mm²

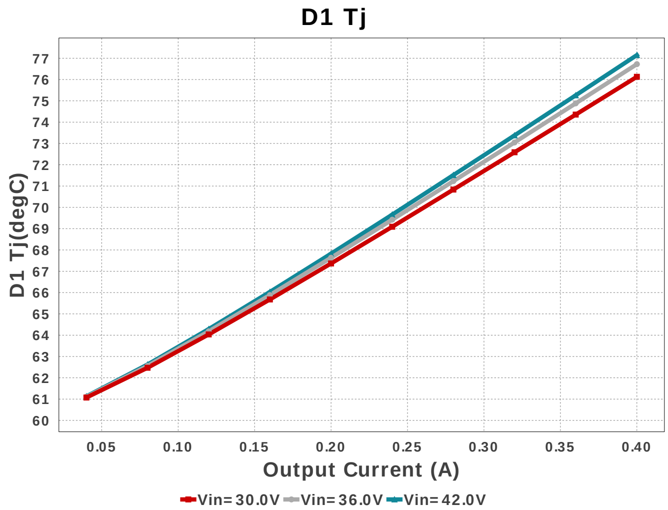

IC Tj
IC Tj(degC)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

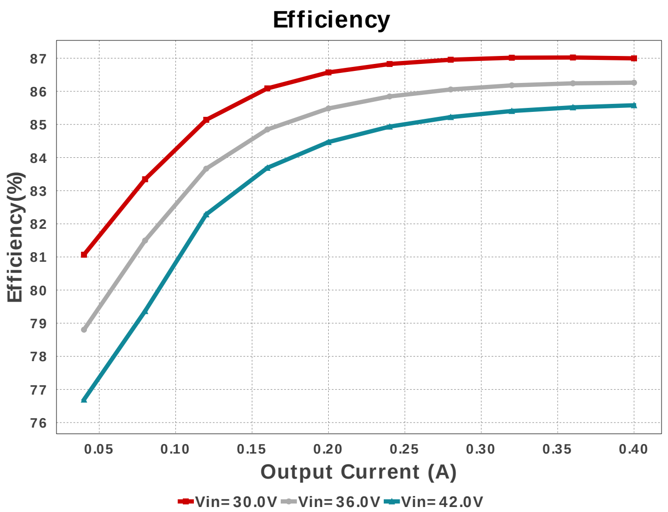

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

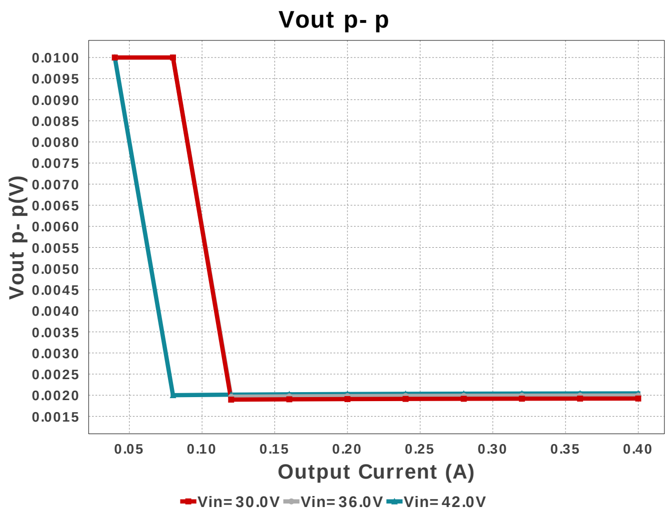

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

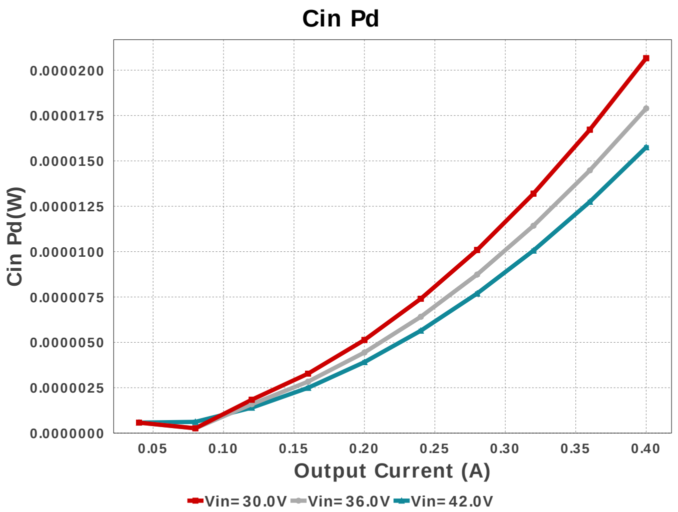

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

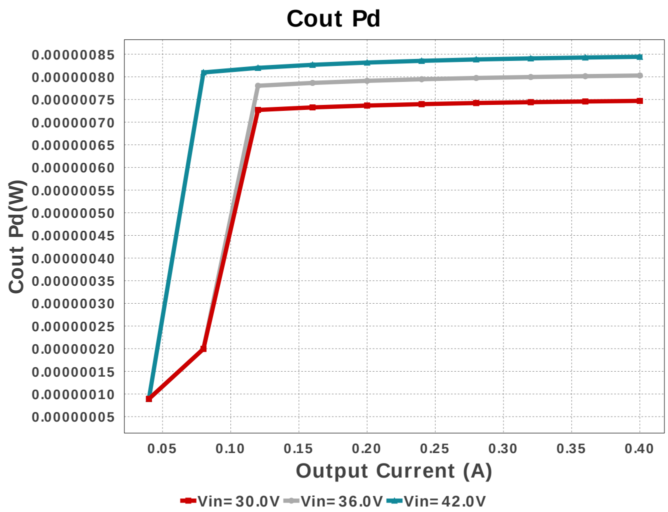

L Pd
L Pd(W)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

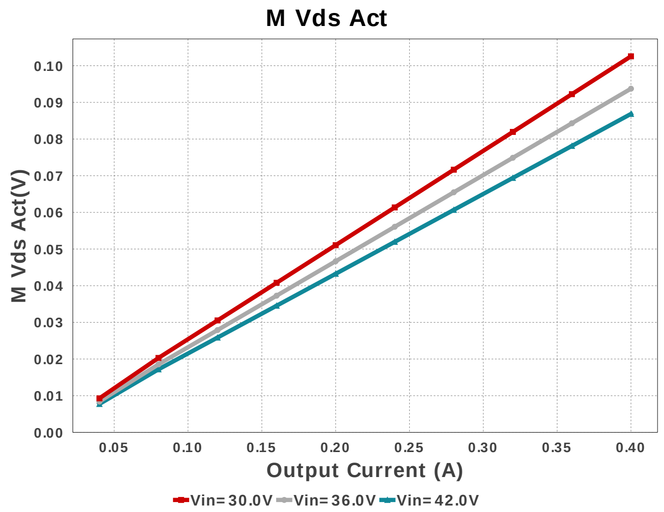

D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

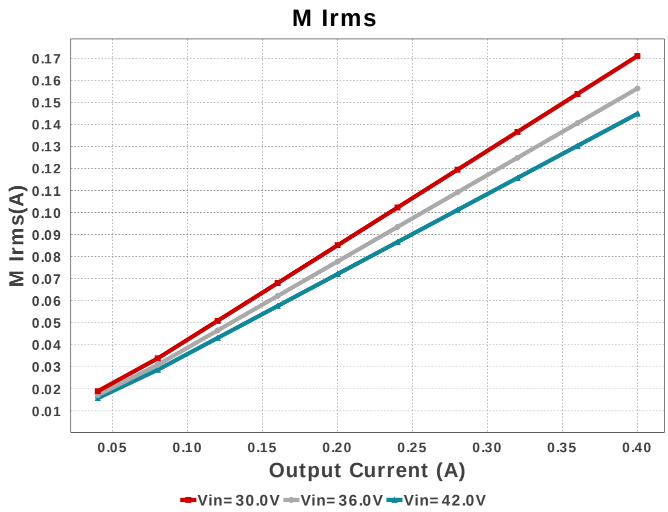

Efficiency
Efficiency(%)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

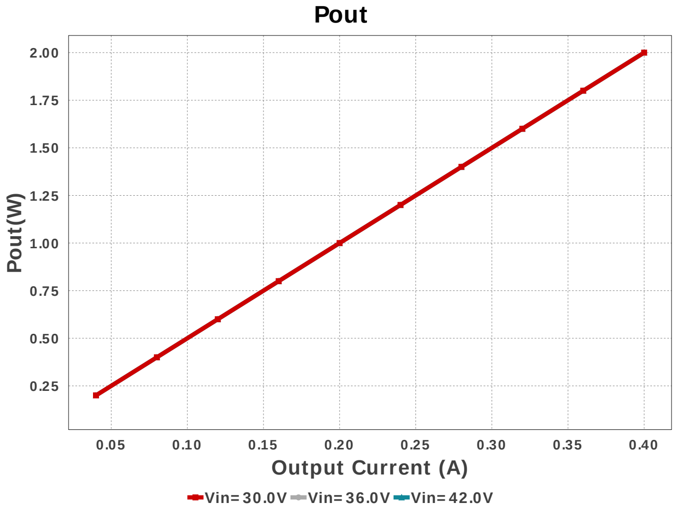

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

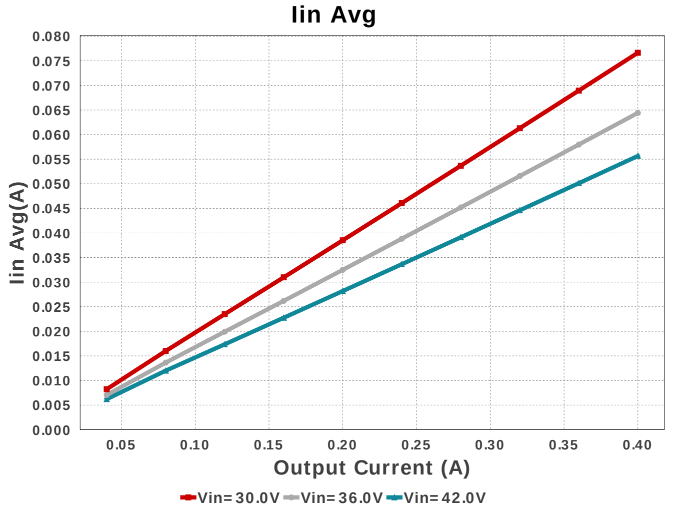

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

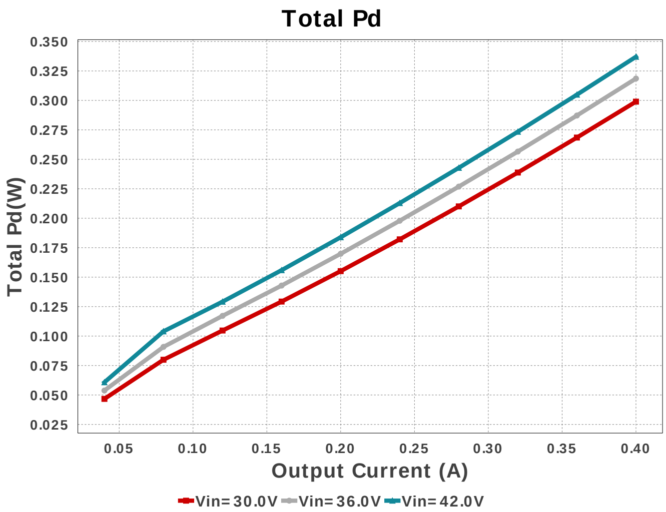

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

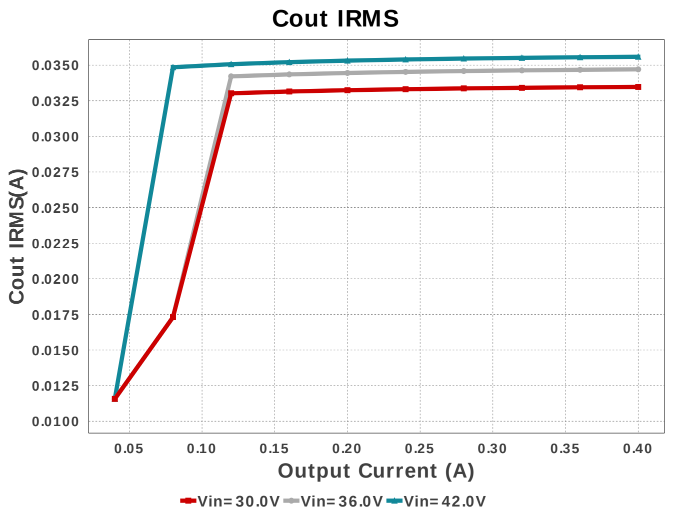

M Vds Act
M Vds Act(V)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

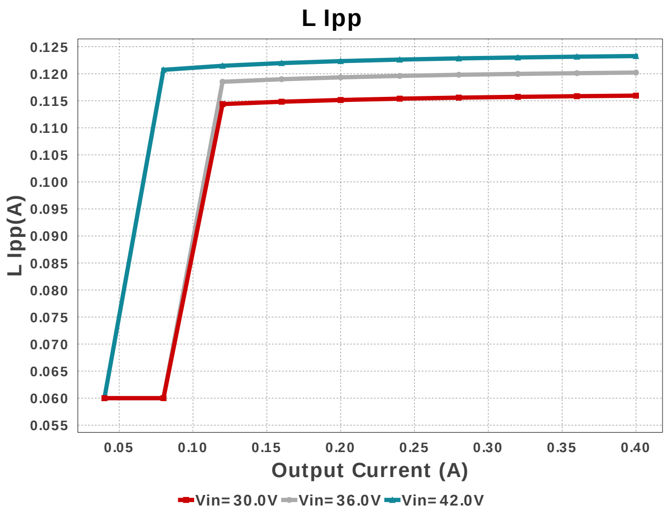

M Irms
M Irms(A)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

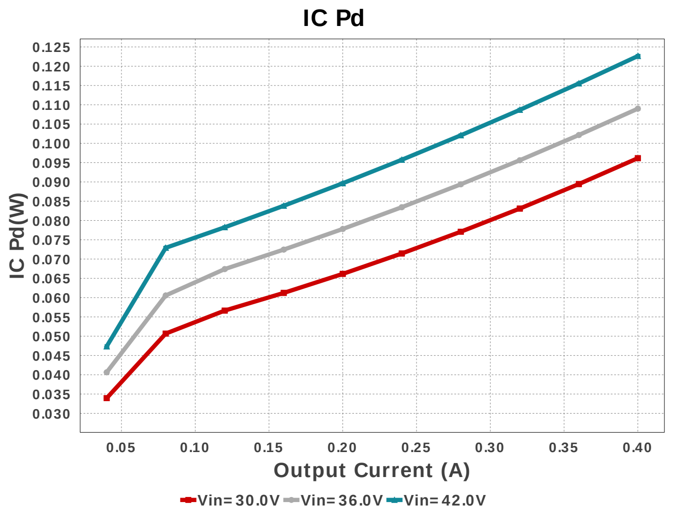

Pout
Pout(W)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

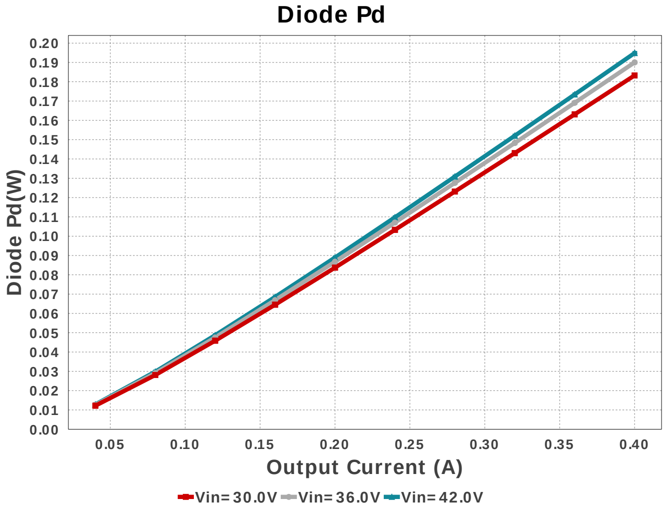

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

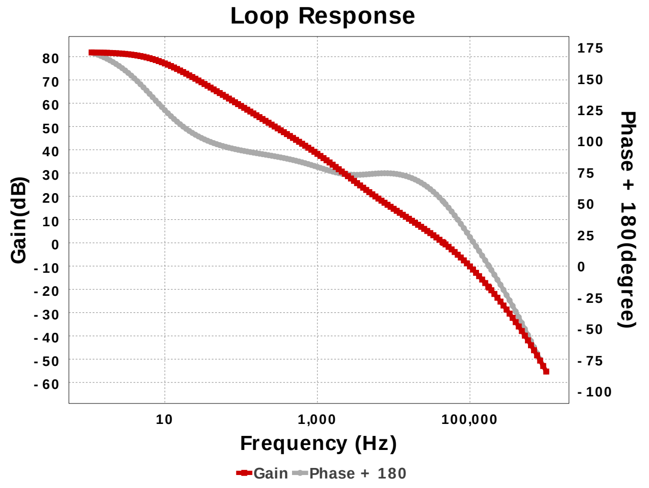

Total Pd
Total Pd(W)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V

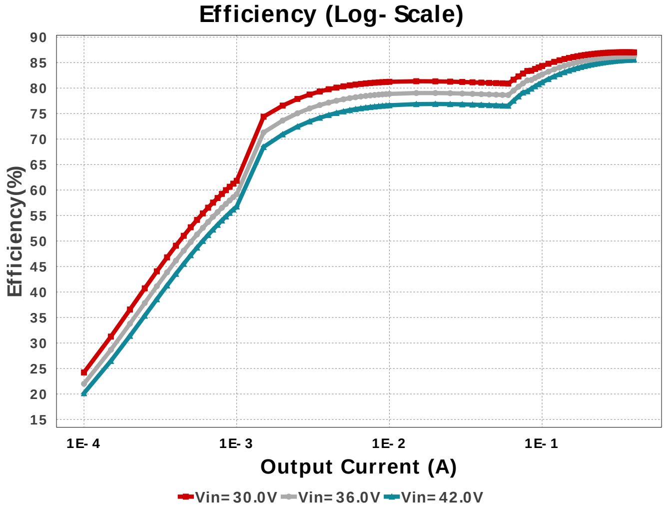

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V


L Ipp
L Ipp(A)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=30.0V Vin=36.0V Vin=42.0V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	134.948 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	15.752 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	35.587 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	844.29 nW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	77.147 degC	Diode	D1 junction temperature
6.	Diode Pd	194.85 mW	Diode	Diode power dissipation
7.	IC Ipk	0.0 A	IC	Peak switch current in IC
8.	IC Pd	122.64 mW	IC	IC power dissipation
9.	IC Tj	72.509 degC	IC	IC junction temperature
10.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	102.0 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	55.644 mA	IC	Average input current
13.	L Ipp	123.28 mA	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	19.157 mW	Inductor	Inductor power dissipation
15.	M Irms	144.847 mA	Mosfet	MOSFET RMS ripple current
16.	M Vds Act	86.853 mV	Mosfet	Voltage drop across the MosFET
17.	Cin Pd	15.752 µW	Power	Input capacitor power dissipation
18.	Cout Pd	844.29 nW	Power	Output capacitor power dissipation
19.	Diode Pd	194.85 mW	Power	Diode power dissipation
20.	IC Pd	122.64 mW	Power	IC power dissipation
21.	L Pd	19.157 mW	Power	Inductor power dissipation
22.	Total Pd	337.026 mW	Power	Total Power Dissipation
23.	BOM Count	11	System Information	Total Design BOM count
24.	Cross Freq	45.061 kHz	System Information	Bode plot crossover frequency
25.	Duty Cycle	13.091 %	System Information	Duty cycle
26.	Efficiency	85.579 %	System Information	Steady state efficiency
27.	FootPrint	340.0 mm^2	System Information	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
28.	Frequency	700.0 kHz	System Information	Switching frequency
29.	Iout	400.0 mA	System Information	Iout operating point
30.	Mode	CCM	System Information	Conduction Mode
31.	Phase Marg	51.602 deg	System Information	Bode Plot Phase Margin
32.	Pout	2.0 W	System Information	Total output power
33.	Total BOM	$2.37	System Information	Total BOM Cost
34.	Vin	42.0 V	System Information	Vin operating point
35.	Vout	5.0 V	System Information	Operational Output Voltage
36.	Vout Actual	5.002 V	System Information	Vout Actual calculated based on selected voltage divider resistors
37.	Vout Tolerance	3.308 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
38.	Vout p-p	2.043 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	400.0 m	Maximum Output Current
VinMax	42.0	Maximum input voltage
VinMin	30.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LMR16006X	Base Product Number
source	DC	Input Source Type
Ta	60.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

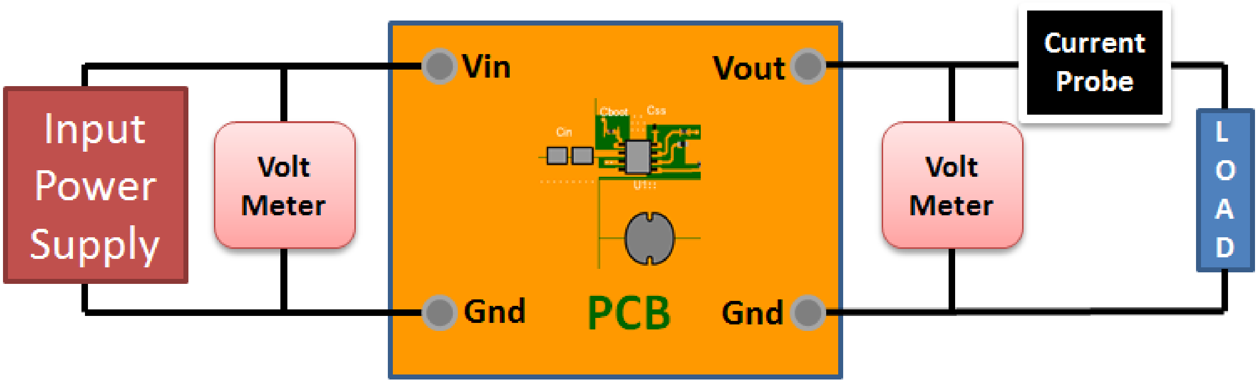
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 30.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



Design Assistance

1. Master key : CEA4B19E92263706[v1]

2. **LMR16006X** Product Folder : http://www.ti.com/product/LMR16006 : contains the data sheet and other resources.

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