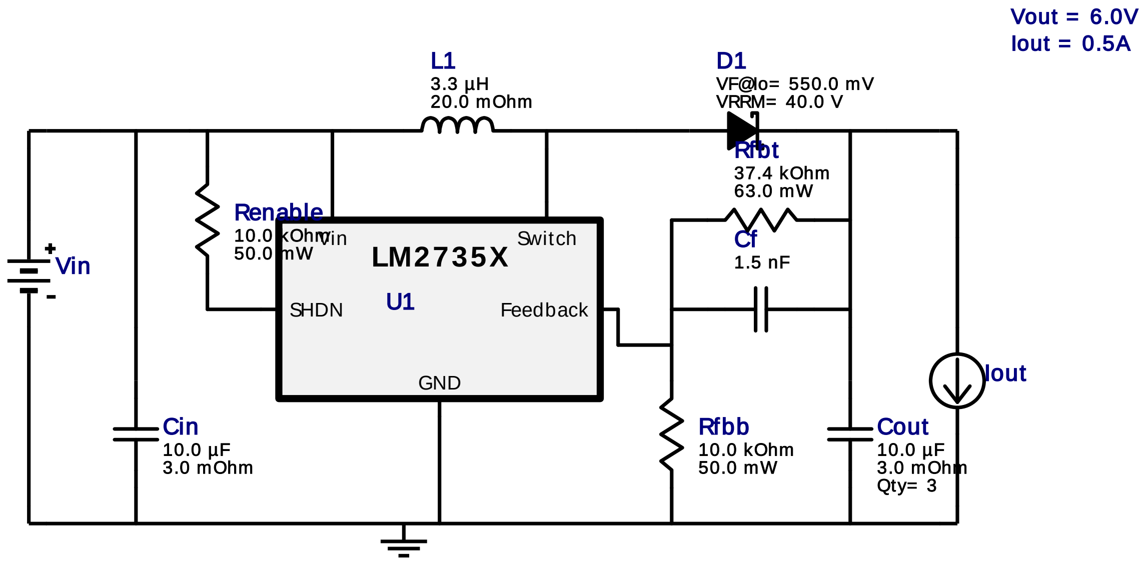
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 3.0V
VinMax = 4.2V
Vout = 6.0V
Iout = 0.5A

Device = LM2735XMF/NOPB
Topology = Boost
Created = 2021-09-14 10:51:51.334
BOM Cost = $1.47
BOM Count = 11
Total Pd = 0.5W

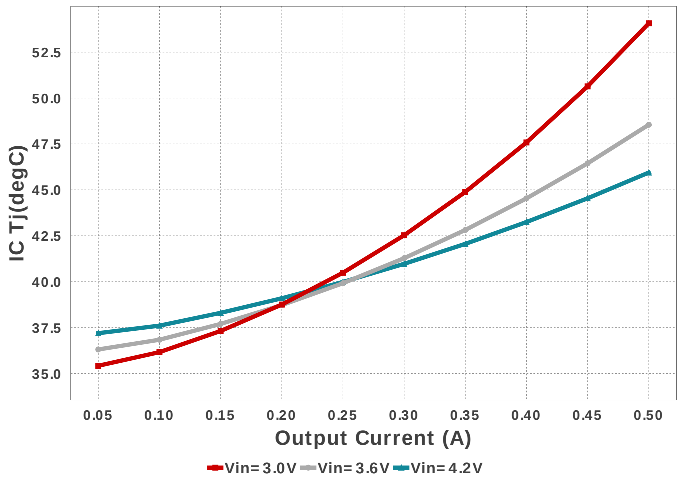
Design : 8 LM2735XMF/NOPB
LM2735XMF/NOPB 3V-4.2V to 6.00V @ 0.5A



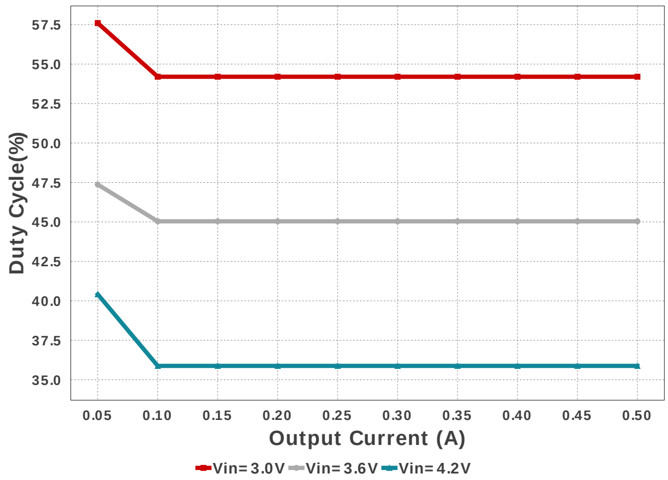
Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cf	TDK	C2012C0G1H152J060AA Series= C0G/NP0	Cap= 1.5 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Cin	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	1	$0.03	0805 7 mm²
Cout	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	3	$0.03	0805 7 mm²
D1	Fairchild Semiconductor	SS24FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.05	SOD-123F 12 mm²
L1	TDK	SLF7045T-3R3M2R5-PF	L= 3.3 µH 20.0 mOhm	1	$0.45	SLF7045 81 mm²
Renable	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rfbb	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rfbt	Vishay-Dale	CRCW040237K4FKED Series= CRCW..e3	Res= 37.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LM2735XMF/NOPB	Switcher	1	$0.80	MF05A 15 mm²

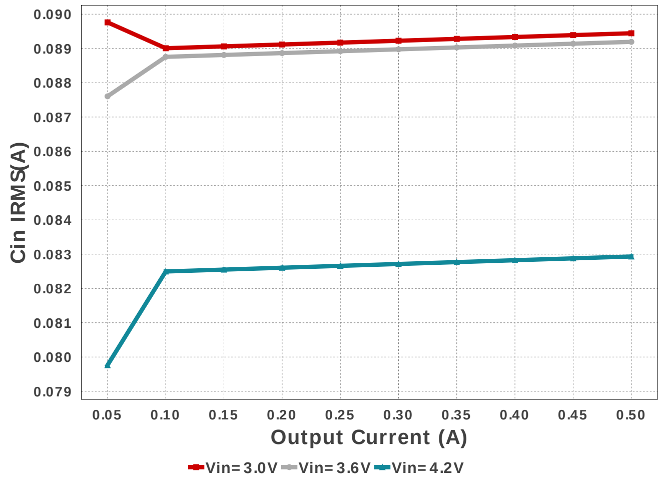
IC Tj



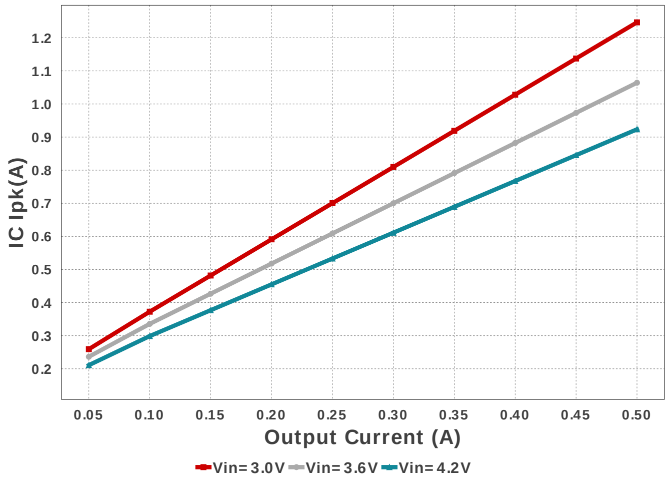
Duty Cycle



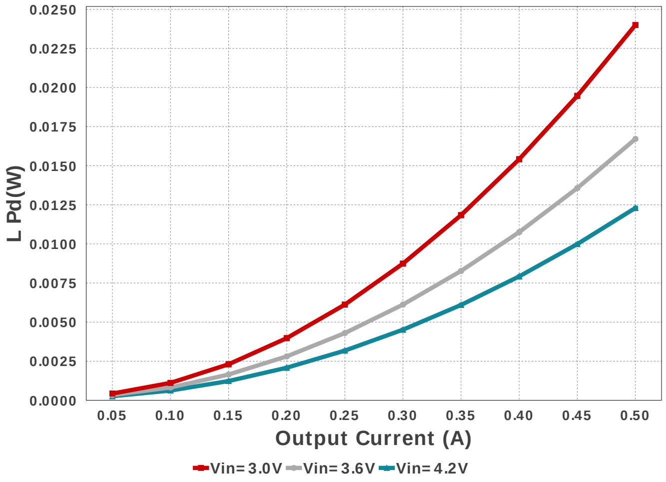
Cin IRMS



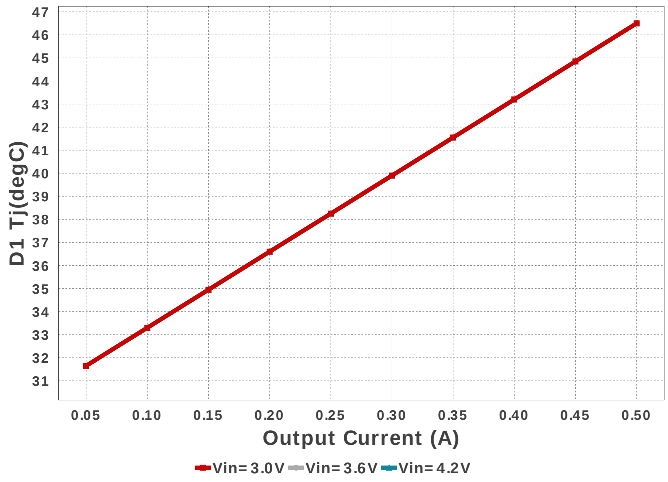
IC Ipk

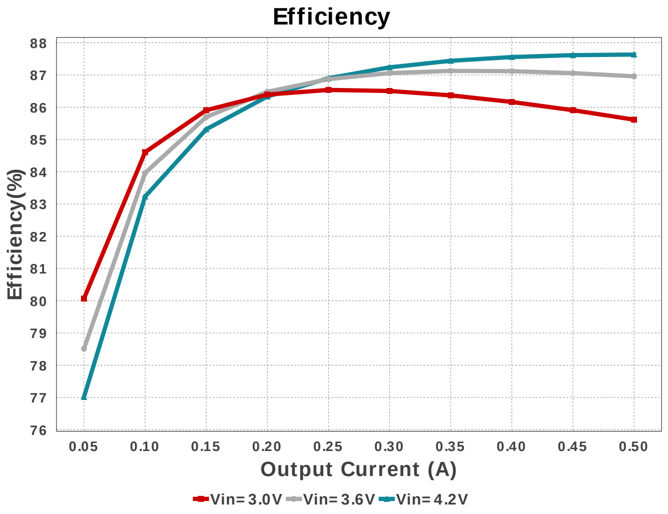


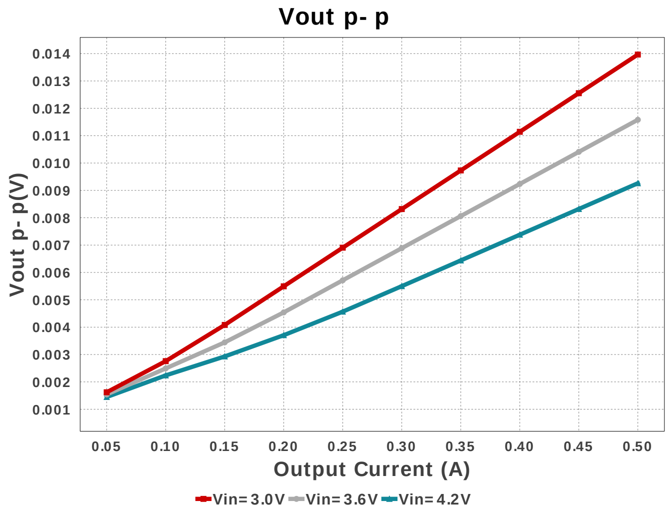
L Pd

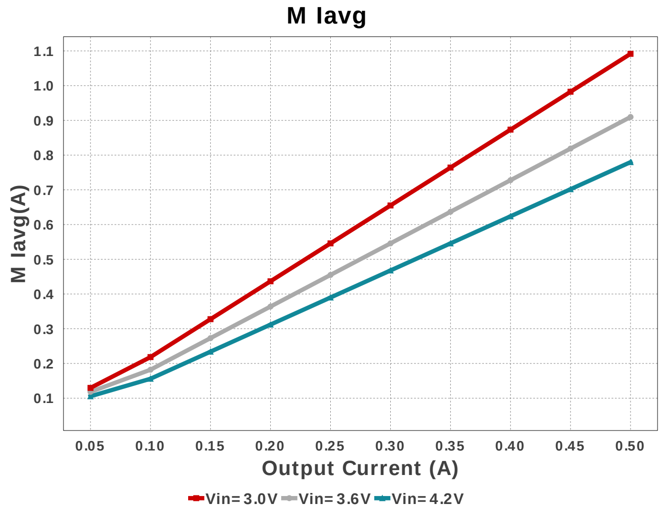


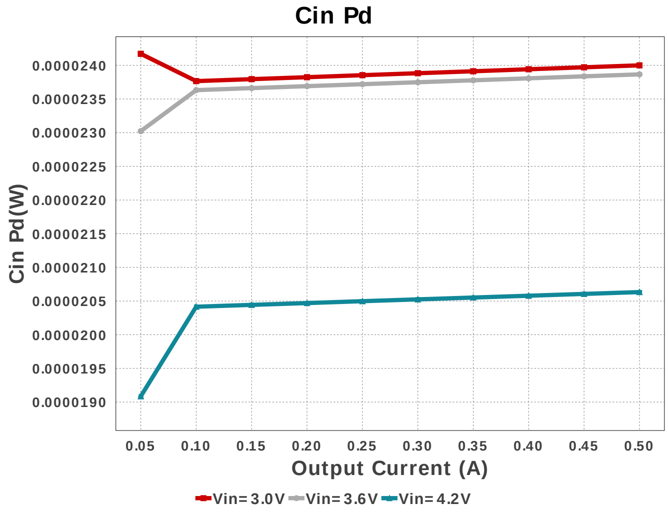
D1 Tj

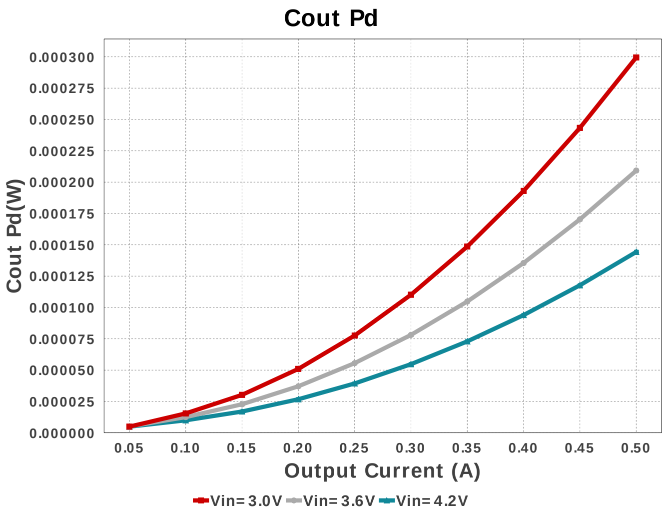


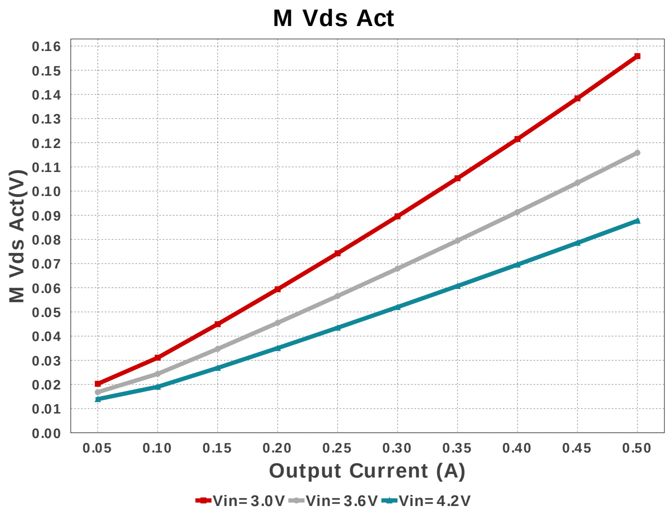

Efficiency
Efficiency(%)
88
87
86
85
84
83
82
81
80
79
78
77
76
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V

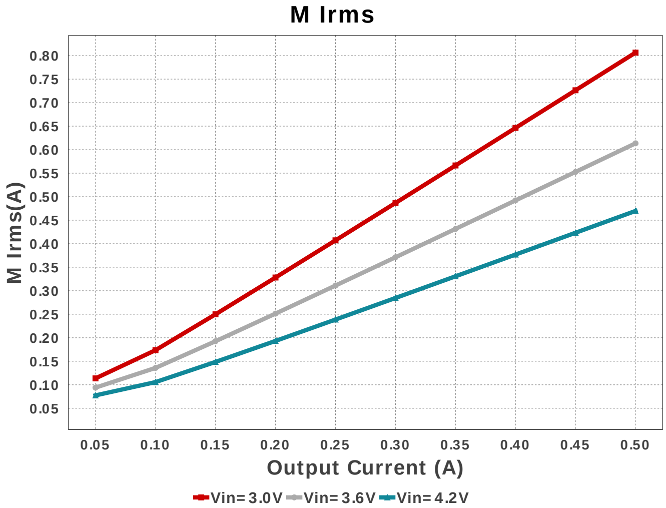

Vout p- p
Vout p- p(V)
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V

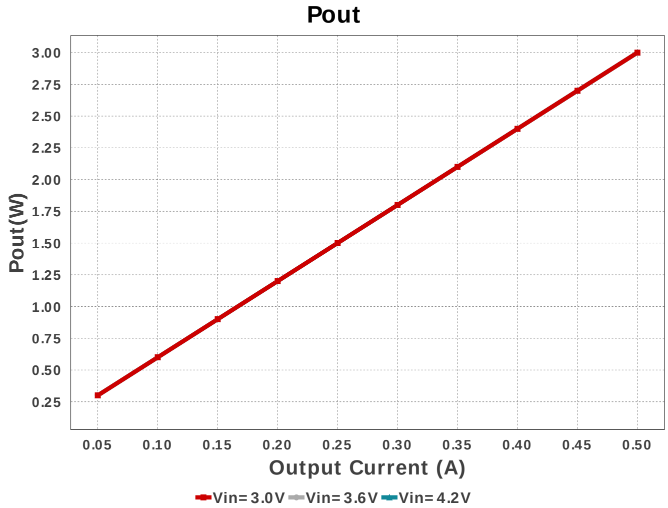

M Iavg
M Iavg(A)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V

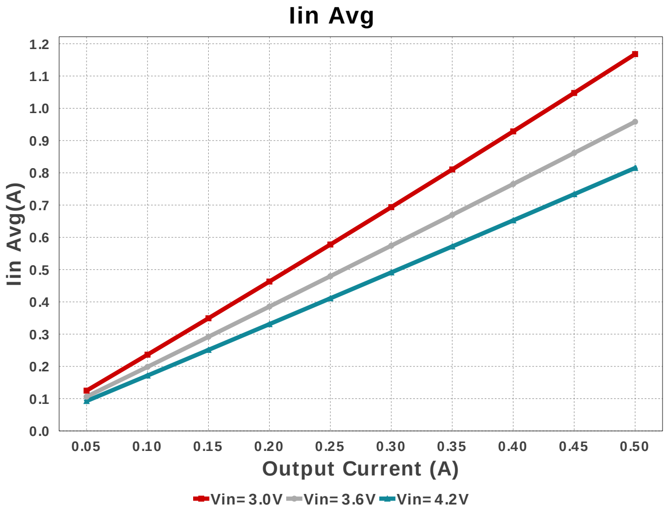

Cin Pd
Cin Pd(W)
0.0000240
0.0000235
0.0000230
0.0000225
0.0000220
0.0000215
0.0000210
0.0000205
0.0000200
0.0000195
0.0000190
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V

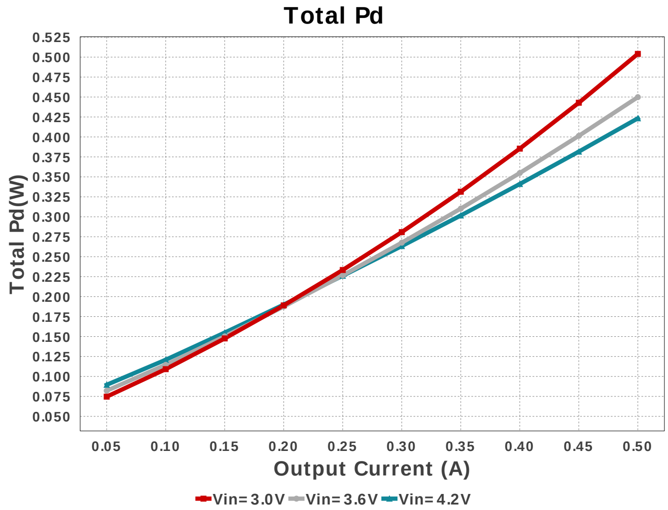

Cout Pd
Cout Pd(W)
0.000300
0.000275
0.000250
0.000225
0.000200
0.000175
0.000150
0.000125
0.000100
0.000075
0.000050
0.000025
0.000000
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V

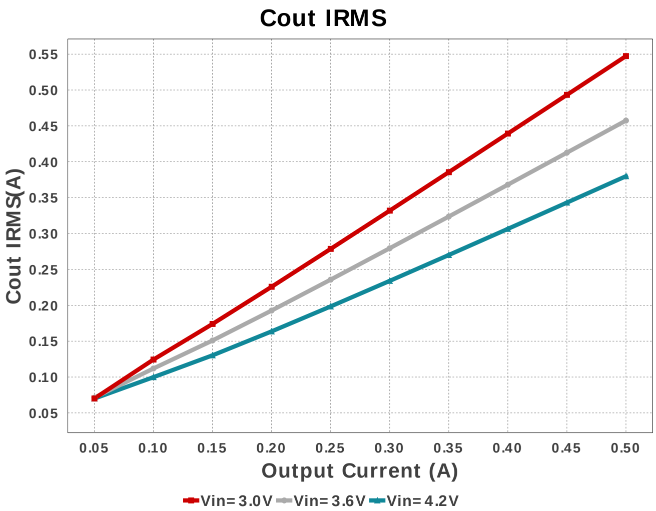

M Vds Act
M Vds Act(V)
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V

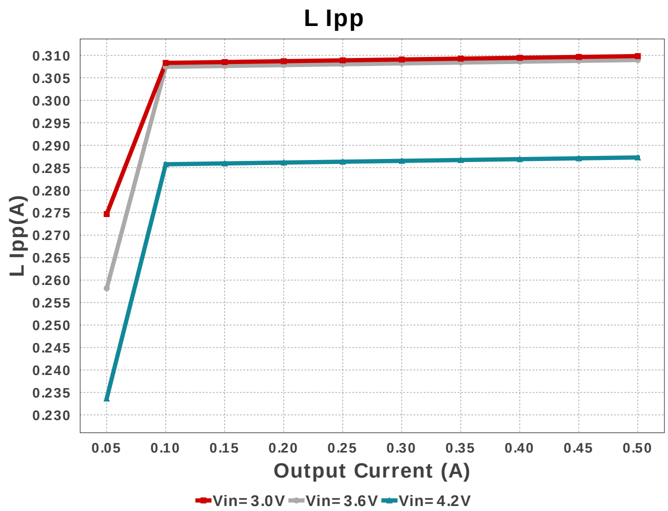

M Irms
M Irms(A)
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V

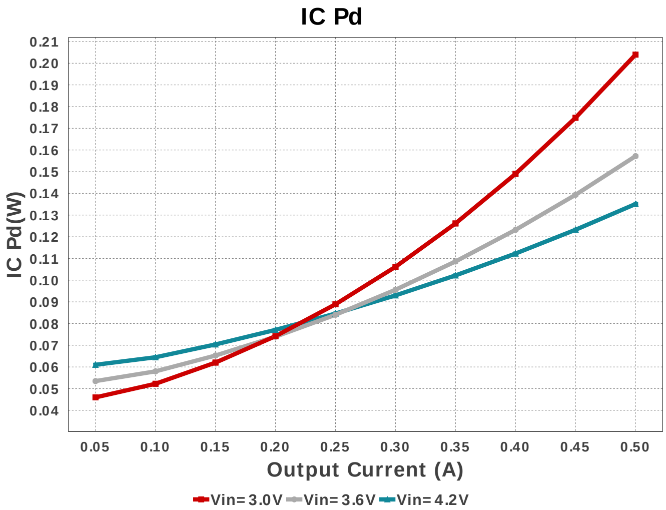

Pout
Pout(W)
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V

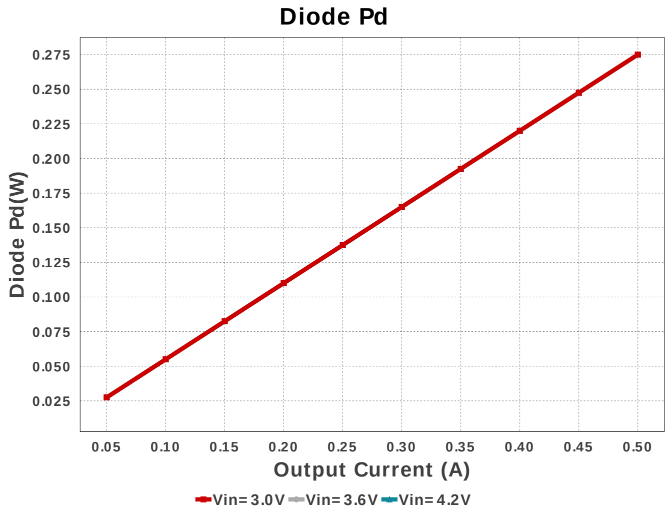

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V

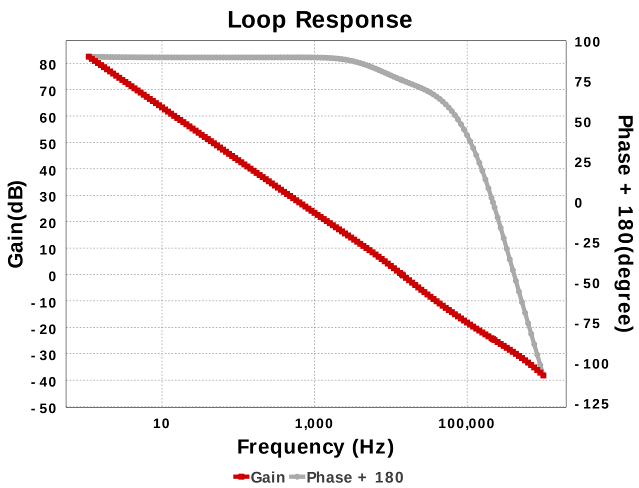

Total Pd
Total Pd(W)
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V


L Ipp
L Ipp(A)
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	89.443 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	24.0 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	547.264 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	299.5 µW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	46.5 degC	Diode	D1 junction temperature
6.	Diode Pd	275.0 mW	Diode	Diode power dissipation
7.	IC Ipk	1.247 A	IC	Peak switch current in IC
8.	IC Pd	203.96 mW	IC	IC power dissipation
9.	IC Tj	54.067 degC	IC	IC junction temperature
10.	IC Tolerance	25.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	118.0 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	1.168 A	IC	Average input current
13.	L Ipp	309.84 mA	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	23.995 mW	Inductor	Inductor power dissipation
15.	M Iavg	1.092 A	Mosfet	MOSFET Average current
16.	M Irms	806.374 mA	Mosfet	MOSFET RMS ripple current
17.	M Vds Act	155.835 mV	Mosfet	Voltage drop across the MosFET
18.	Cin Pd	24.0 µW	Power	Input capacitor power dissipation
19.	Cout Pd	299.5 µW	Power	Output capacitor power dissipation
20.	Diode Pd	275.0 mW	Power	Diode power dissipation
21.	IC Pd	203.96 mW	Power	IC power dissipation
22.	L Pd	23.995 mW	Power	Inductor power dissipation
23.	Total Pd	504.05 mW	Power	Total Power Dissipation
24.	BOM Count	11	System Information	Total Design BOM count
25.	Cross Freq	10.317 kHz	System Information	Bode plot crossover frequency
26.	Duty Cycle	54.198 %	System Information	Duty cycle
27.	Efficiency	85.615 %	System Information	Steady state efficiency

#	Name	Value	Category	Description
28.	FootPrint	149.0 mm^2	System Information	Total Foot Print Area of BOM components
29.	Frequency	1.6 MHz	System Information	Switching frequency
30.	Gain Marg	-22.366 dB	System Information	Bode Plot Gain Margin
31.	Iout	500.0 mA	System Information	Iout operating point
32.	Low Freq Gain	81.304 dB	System Information	Gain at 1Hz
33.	Mode	CCM	System Information	Conduction Mode
34.	Phase Marg	73.437 deg	System Information	Bode Plot Phase Margin
35.	Pout	3.0 W	System Information	Total output power
36.	Total BOM	$1.47	System Information	Total BOM Cost
37.	Vin	3.0 V	System Information	Vin operating point
38.	Vout	6.0 V	System Information	Operational Output Voltage
39.	Vout Actual	5.949 V	System Information	Vout Actual calculated based on selected voltage divider resistors
40.	Vout Tolerance	3.618 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
41.	Vout p-p	13.681 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	500.0 m	Maximum Output Current
VinMax	4.2	Maximum input voltage
VinMin	3.0	Minimum input voltage
Vout	6.0	Output Voltage
base_pn	LM2735X	Base Product Number
source	DC	Input Source Type
Ta	30.0	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

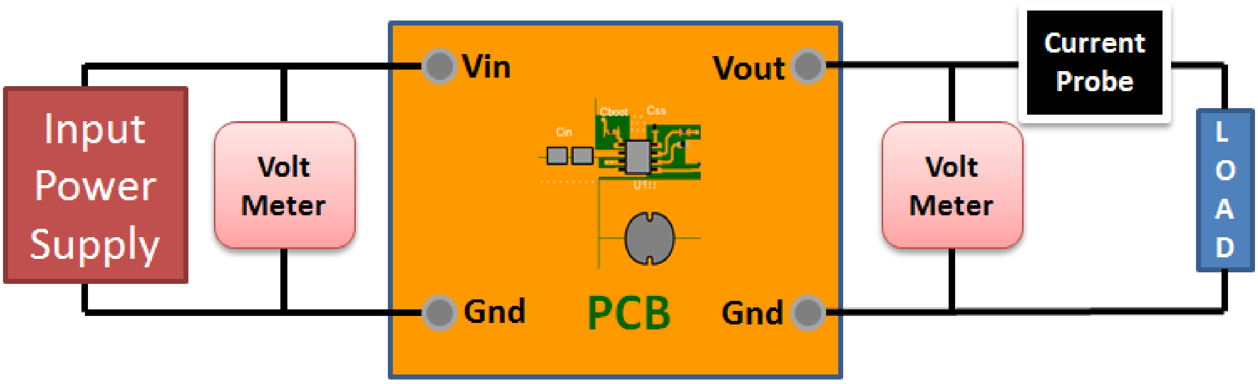
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 3.0V 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 : 189A33F35518BB3C[v1]

2. **LM2735X** Product Folder : http://www.ti.com/product/LM2735 : contains the data sheet and other resources.