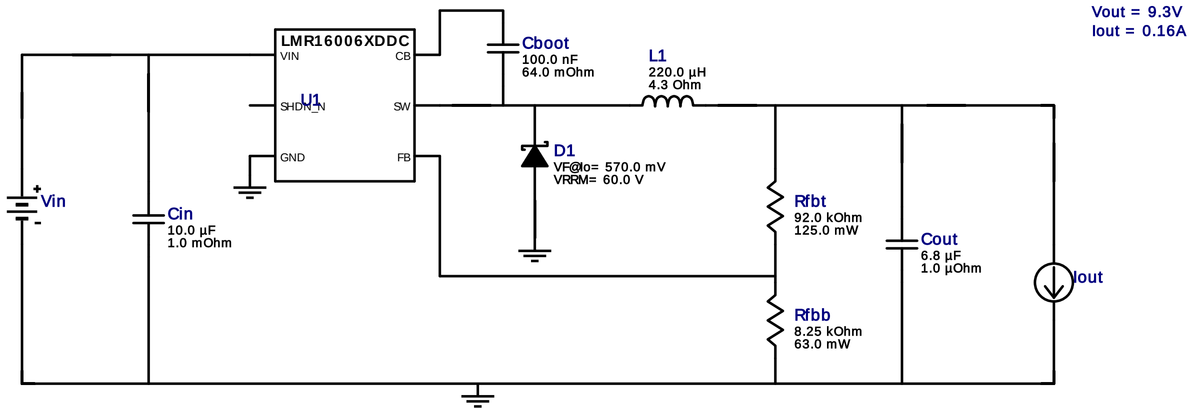
WEBENCH® Design Report

VinMin = 10.0V
VinMax = 34.0V
Vout = 9.3V
Iout = 0.16A

Device = LMR16006XDDCR
Topology = Buck
Created = 2021-07-28 08:37:26.375
BOM Cost = NA
BOM Count = 8
Total Pd = 0.26W

Design : 4 LMR16006XDDCR
LMR16006XDDCR 10.3V-24V to 9.30V @ 0.165A

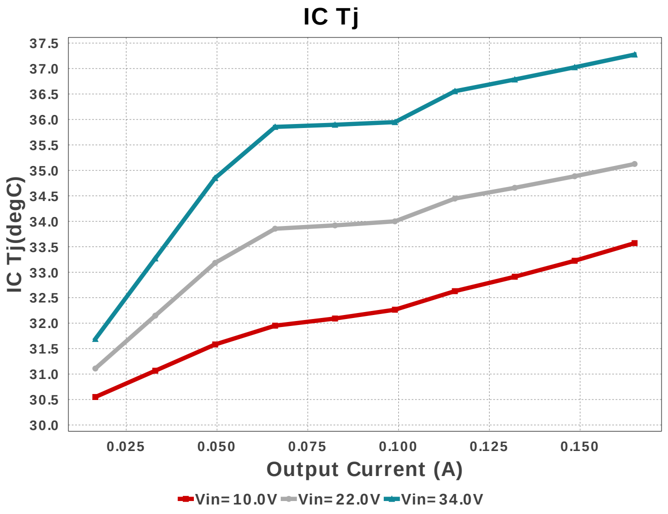


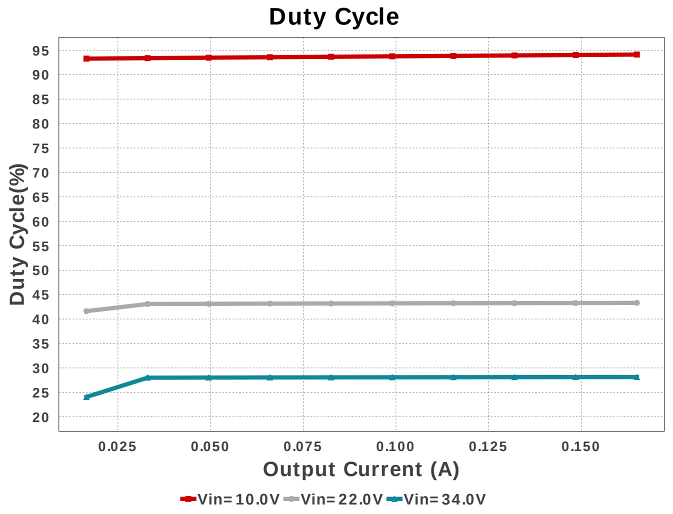
Design Alerts

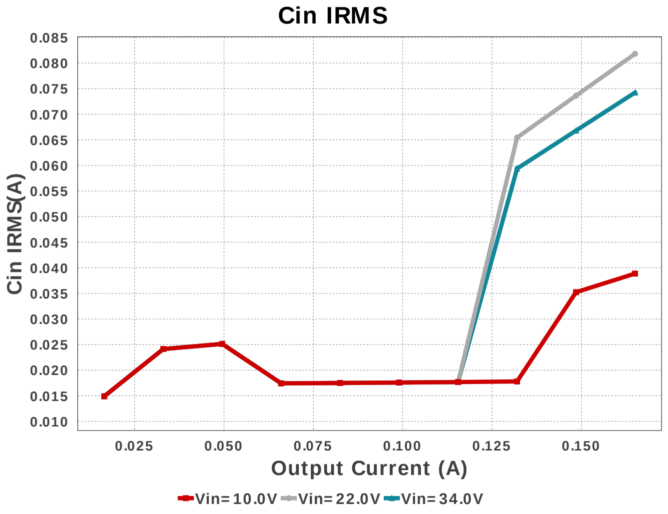
Phase margin is too low
Phase margin: 33.08deg < Specification 35.0deg
This may lead to unstable design.
Sorry, we do not have auto compoensation enabled for this device. You may still manually update compensation conponents or optimize the design

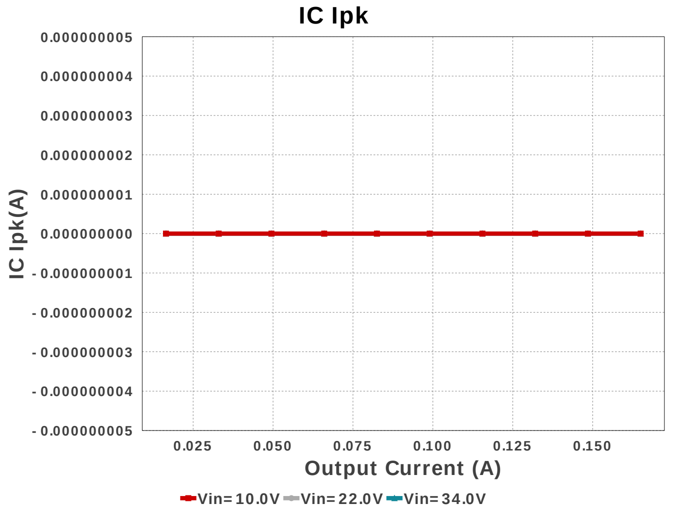
Electrical BOM

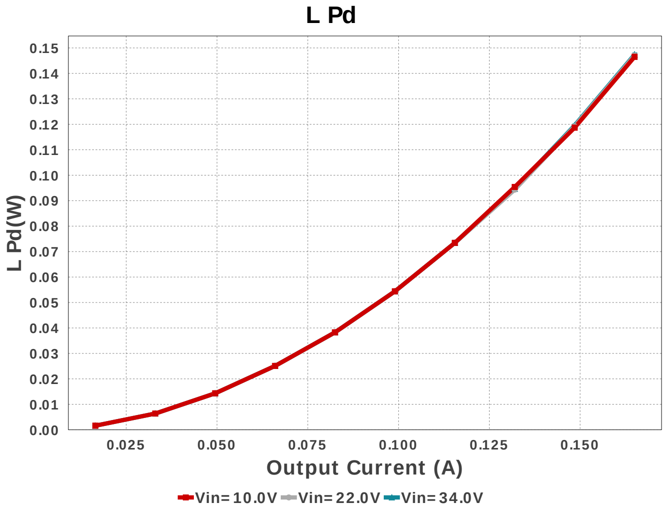
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm²
Cin	MuRata	GRM32ER71J106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 63.0 V IRMS= 6.0 A	1	$0.30	1210_280 15 mm²
Cout	CUSTOM	CUSTOM Series= X6S	Cap= 6.8 uF ESR= 1.0 uOhm VDC= 50.0 V IRMS= 4.5415 A	1	NA	1210_280 0 mm²
D1	Nexperia	PMEG6010CEH,115	VF@Io= 570.0 mV VRRM= 60.0 V	1	$0.04	SOD-123F 12 mm²
L1	CUSTOM	CUSTOM	L= 220.0 µH 4.3 Ohm	1	NA	CUSTOM 0 mm²
Rfbb	Vishay-Dale	CRCW04028K25FKED Series= CRCW..e3	Res= 8.25 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Yageo	RT0805BRD0792KL Series= RT0805	Res= 92.0 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.06	0805 7 mm²
U1	Texas Instruments	LMR16006XDDCR	Switcher	1	$1.16	DDC0006A 10 mm²

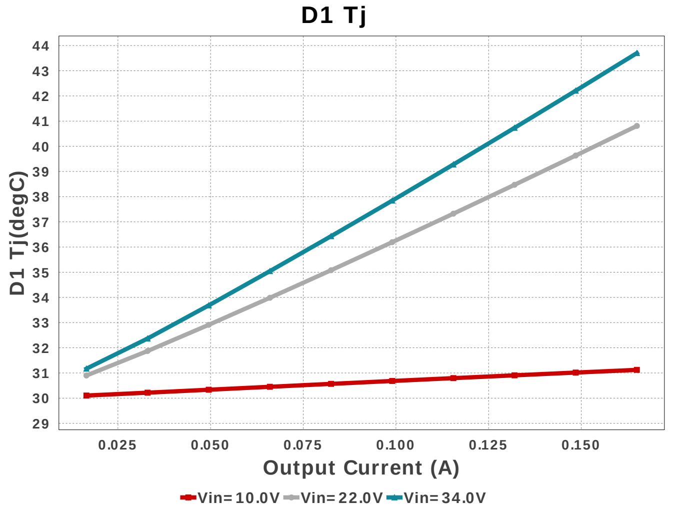

IC Tj
IC Tj(degC)
Output Current (A)
Vin=10.0V
Vin=22.0V
Vin=34.0V


Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=10.0V
Vin=22.0V
Vin=34.0V

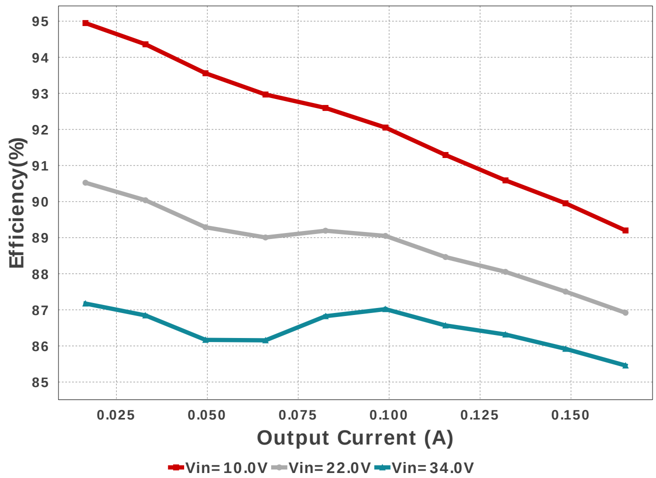

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=10.0V
Vin=22.0V
Vin=34.0V


IC Ipk
IC Ipk(A)
Output Current (A)
Vin=10.0V
Vin=22.0V
Vin=34.0V

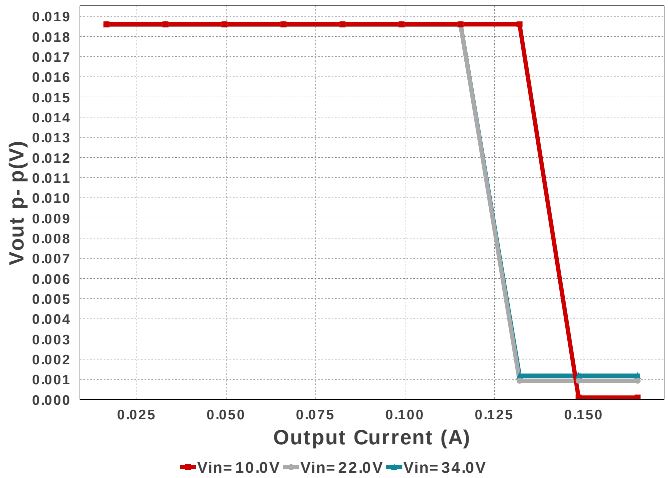

L Pd
L Pd(W)
Output Current (A)
Vin=10.0V
Vin=22.0V
Vin=34.0V


D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=10.0V
Vin=22.0V
Vin=34.0V

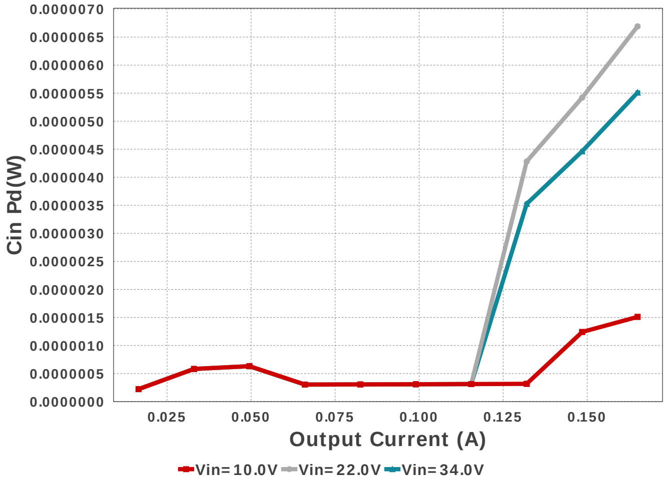
Efficiency



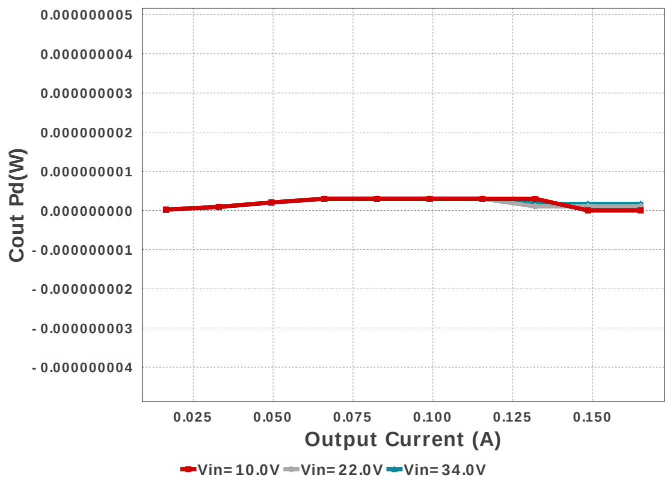
Vout p-p



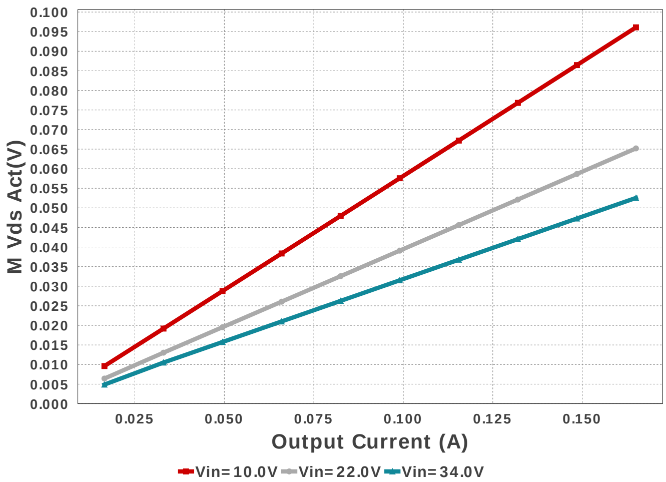
Cin Pd



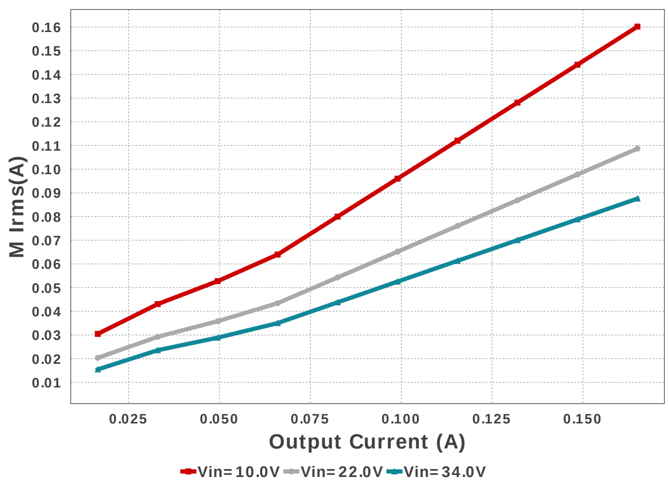
Cout Pd

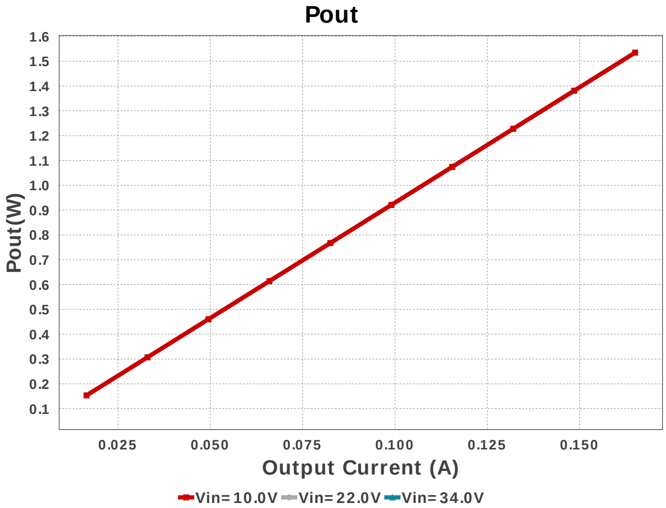


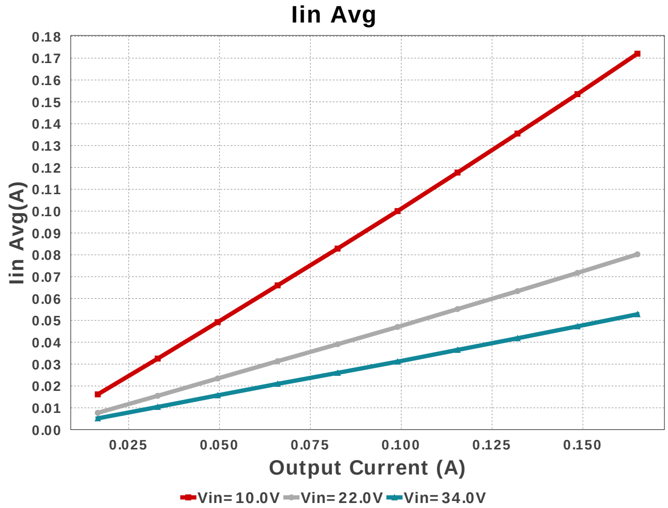
M Vds Act

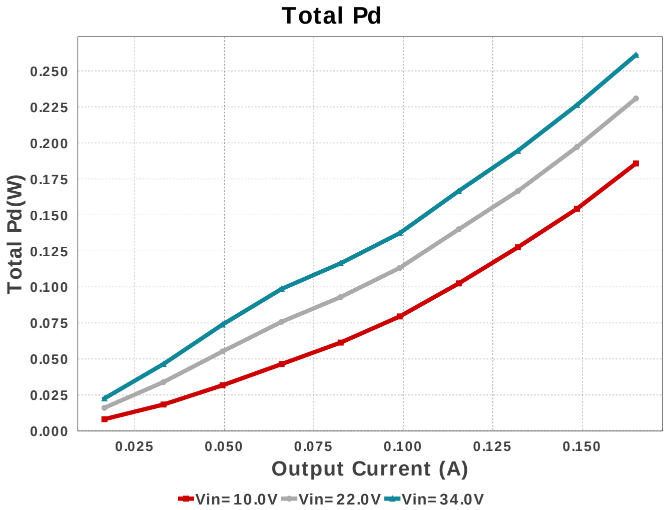


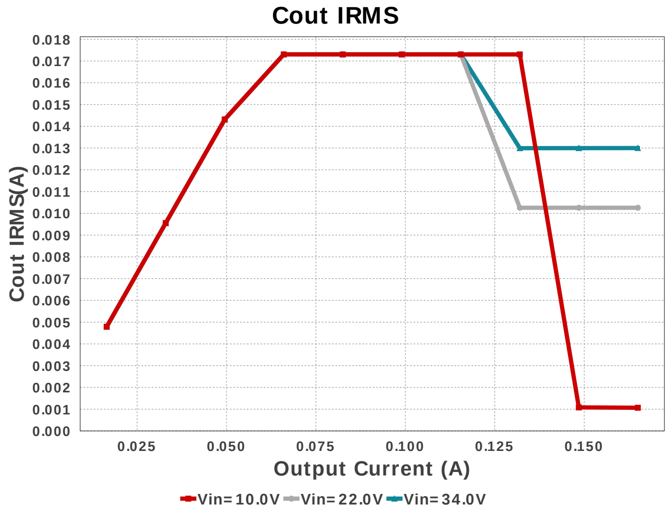
M Irms

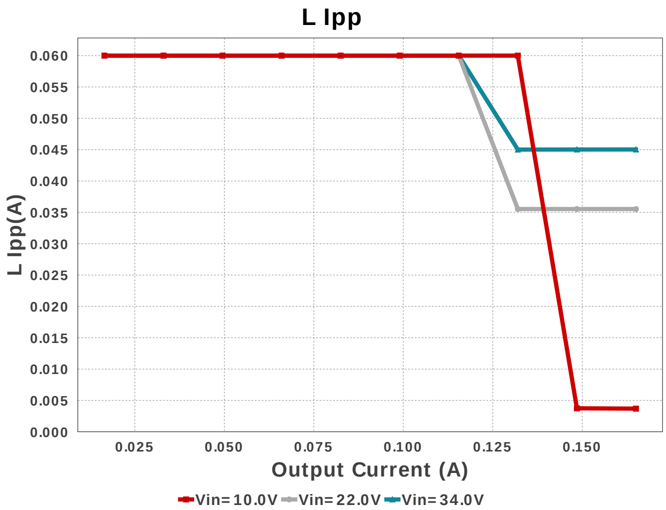


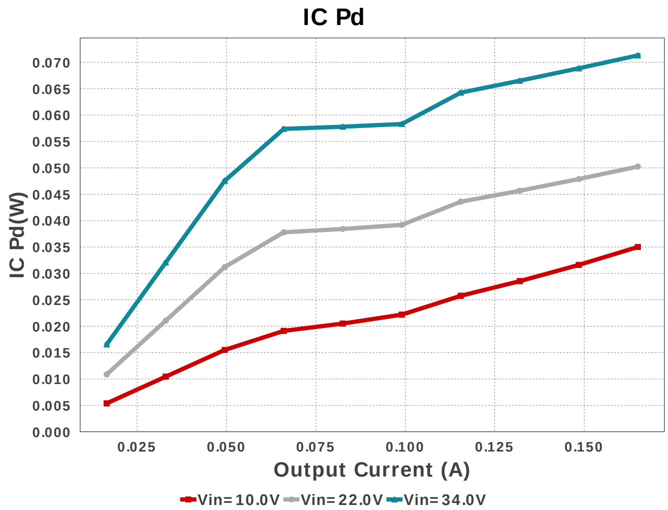

Pout
Pout(W)
Output Current (A)
Vin=10.0V Vin=22.0V Vin=34.0V

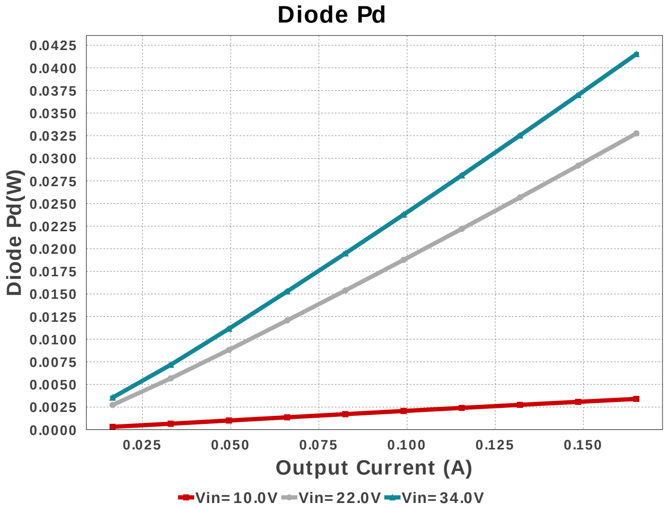

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=10.0V Vin=22.0V Vin=34.0V

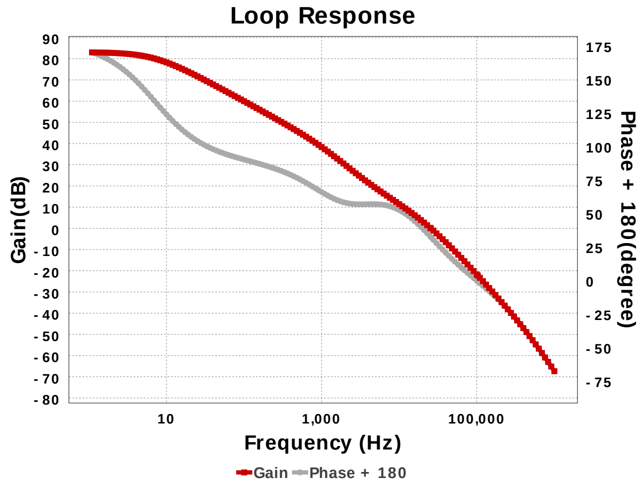

Total Pd
Total Pd(W)
Output Current (A)
Vin=10.0V Vin=22.0V Vin=34.0V

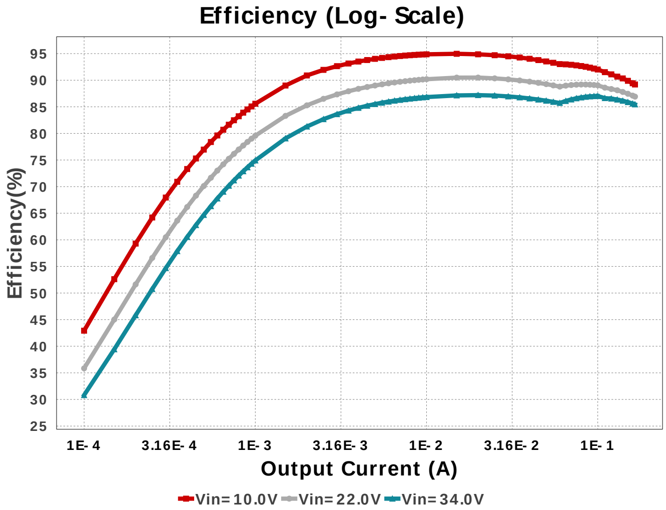

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.0V Vin=22.0V Vin=34.0V


L Ipp
L Ipp(A)
Output Current (A)
Vin=10.0V Vin=22.0V Vin=34.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=10.0V Vin=22.0V Vin=34.0V







Operating Values

#	Name	Value	Category	Description
1.	BOM Count	8		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	74.236 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	5.511 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	12.999 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	168.99 pW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	43.701 degC	Diode	D1 junction temperature
8.	Diode Pd	41.517 mW	Diode	Diode power dissipation
9.	IC Ipk	0.0 A	IC	Peak switch current in IC
10.	IC Pd	71.319 mW	IC	IC power dissipation
11.	IC Tj	37.275 degC	IC	IC junction temperature
12.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA	102.0 degC/W	IC	IC junction-to-ambient thermal resistance
14.	Iin Avg	52.812 mA	IC	Average input current
15.	L Ipp	45.031 mA	Inductor	Peak-to-peak inductor ripple current
16.	L Pd	147.41 mW	Inductor	Inductor power dissipation
17.	M Irms	87.578 mA	Mosfet	MOSFET RMS ripple current
18.	M Vds Act	52.543 mV	Mosfet	Voltage drop across the MosFET
19.	Cin Pd	5.511 µW	Power	Input capacitor power dissipation
20.	Cout Pd	168.99 pW	Power	Output capacitor power dissipation
21.	Diode Pd	41.517 mW	Power	Diode power dissipation
22.	IC Pd	71.319 mW	Power	IC power dissipation
23.	L Pd	147.41 mW	Power	Inductor power dissipation
24.	Total Pd	261.117 mW	Power	Total Power Dissipation
25.	Cross Freq	25.571 kHz	System Information	Bode plot crossover frequency
26.	Duty Cycle	28.136 %	System Information	Duty cycle
27.	Efficiency	85.458 %	System Information	Steady state efficiency
28.	FootPrint	423.0 mm^2	System Information	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
29.	Frequency	700.0 kHz	System Information	Switching frequency
30.	Iout	165.0 mA	System Information	Iout operating point
31.	Mode	CCM	System Information	Conduction Mode
32.	Phase Marg	33.076 deg	System Information	Bode Plot Phase Margin
33.	Pout	1.535 W	System Information	Total output power
34.	Vin	34.0 V	System Information	Vin operating point
35.	Vout	9.3 V	System Information	Operational Output Voltage
36.	Vout Actual	9.296 V	System Information	Vout Actual calculated based on selected voltage divider resistors
37.	Vout Tolerance	3.397 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
38.	Vout p-p	1.183 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	165.0 m	Maximum Output Current
VinMax	34.0	Maximum input voltage
VinMin	10.0	Minimum input voltage
Vout	9.3	Output Voltage
base_pn	LMR16006X	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

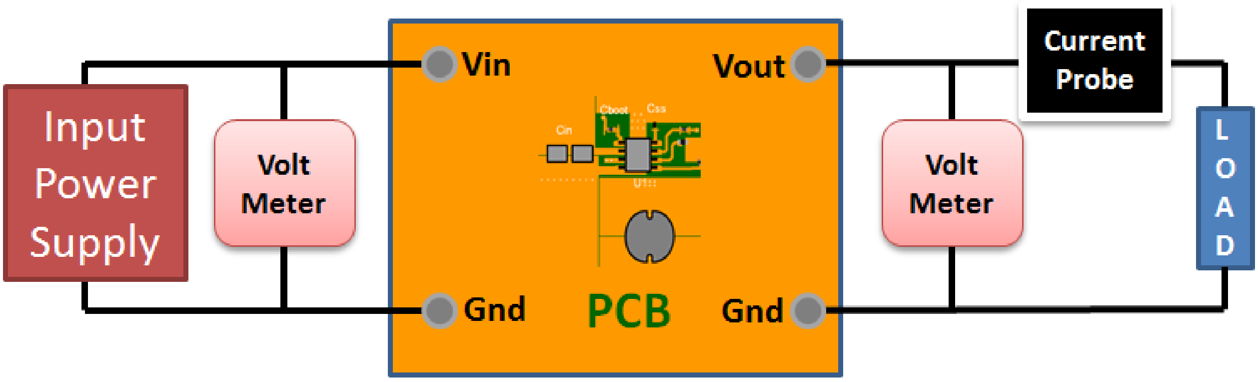
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.0V 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.

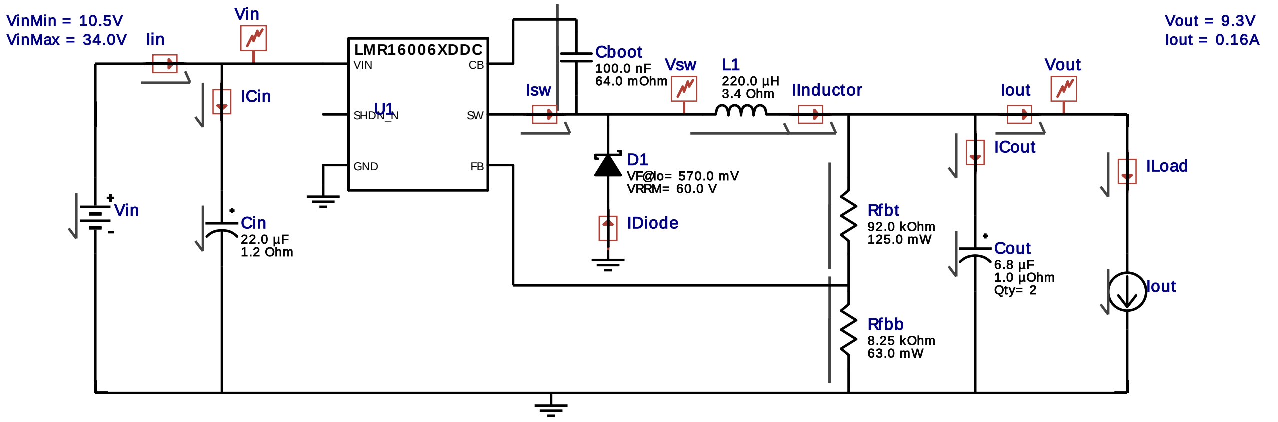


WEBENCH® Electrical Simulation Report

Design Id = 4

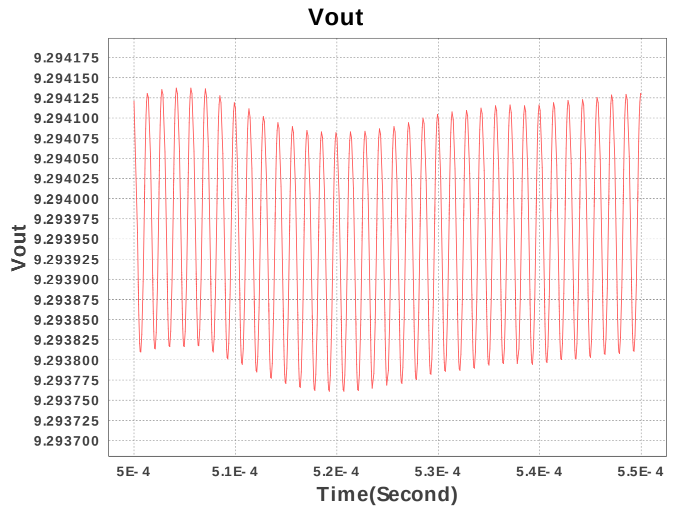
sim_id = 6

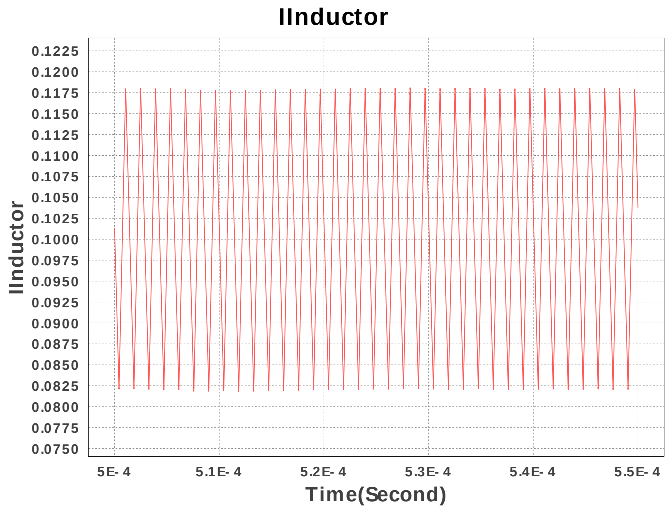
Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cboot	IC	Initial Voltage	-5.0 V
2.	L1	IC	Initial Current	-0.165 A
3.	Iout	I	Output Current	0.1 A





Design Assistance

1. Master key : E8892D3CB43864FE[v1]

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