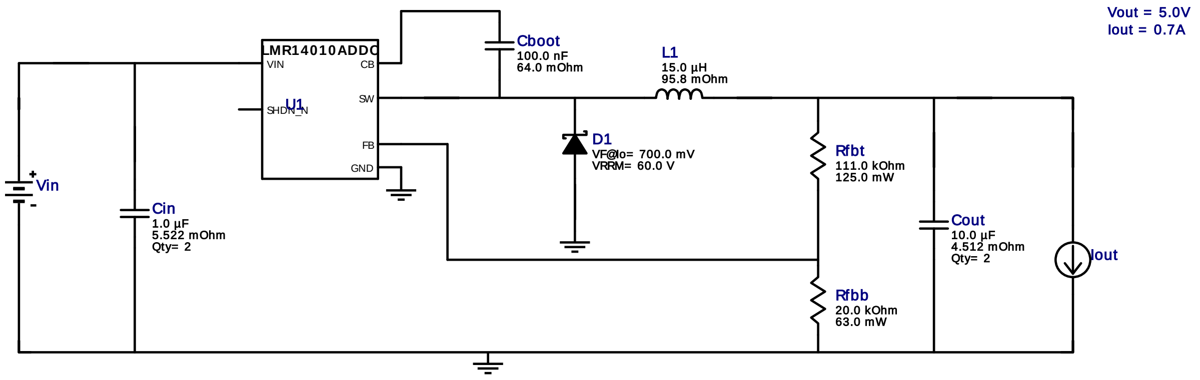
TEXAS INSTRUMENTS

WEBENCH® Design Report

VinMin = 9.0V
VinMax = 30.0V
Vout = 5.0V
Iout = 0.7A

Device = LMR14010ADDCR
Topology = Buck
Created = 2019-04-07 16:56:42.867
BOM Cost = NA
BOM Count = 10
Total Pd = 0.74W

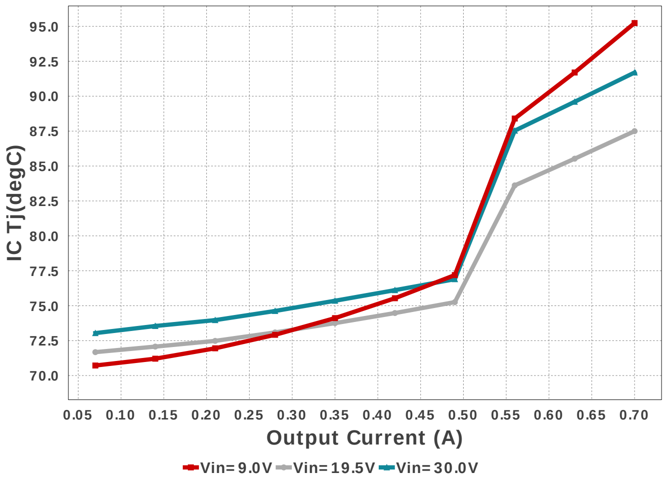
Design : 17 LMR14010ADDCR
LMR14010ADDCR 9V-30V to 5.01V @ 0.7A



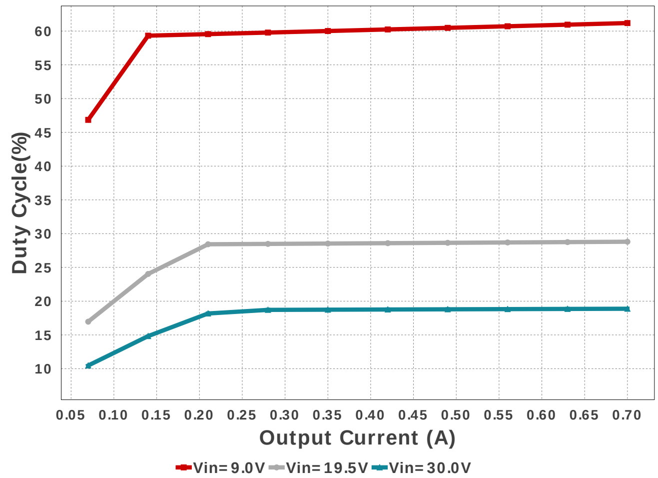
Electrical BOM

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 mm^2
Cin	TDK	C1608X5R1H105K080AB Series= X5R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	2	$0.04	0603 5 mm^2
Cout	MuRata	GRM31CR61E106KA12L Series= X5R	Cap= 10.0 uF ESR= 4.512 mOhm VDC= 25.0 V IRMS= 2.447 A	2	$0.12	1206_190 11 mm^2
D1	Fairchild Semiconductor	SS26FL	VF@Io= 700.0 mV VRRM= 60.0 V	1	$0.10	SOD-123F 12 mm^2
L1	CUSTOM	CUSTOM	L= 15.0 µH 95.8 mOhm	1	NA	SRU8043 0 mm^2
Rfbb	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Yageo	RT0805BRD07111KL Series= RT0805	Res= 111.0 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.05	0805 7 mm^2
U1	Texas Instruments	LMR14010ADDCR	Switcher	1	$1.00	DDC0006A_N 10 mm^2

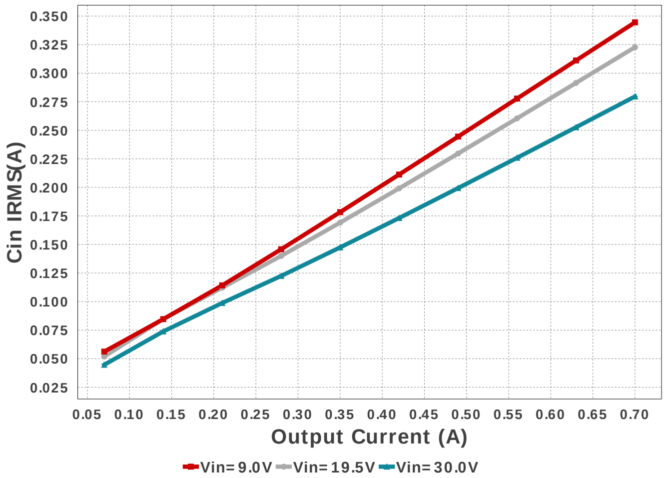
IC Tj



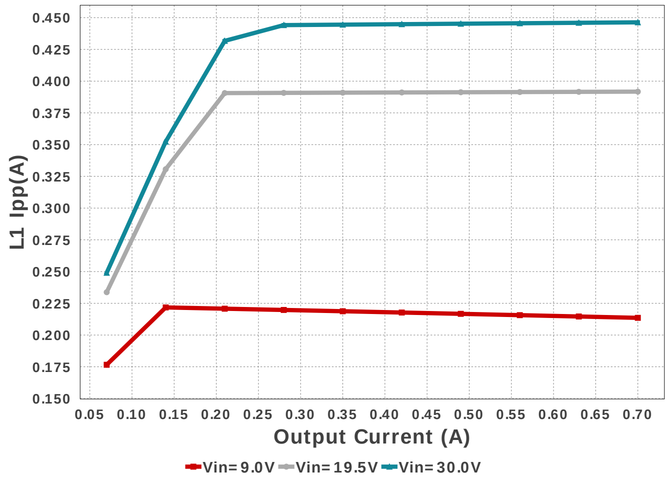
Duty Cycle



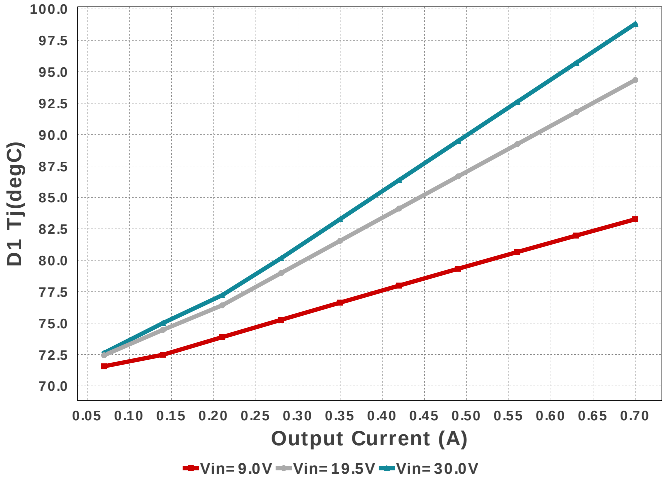
Cin IRMS



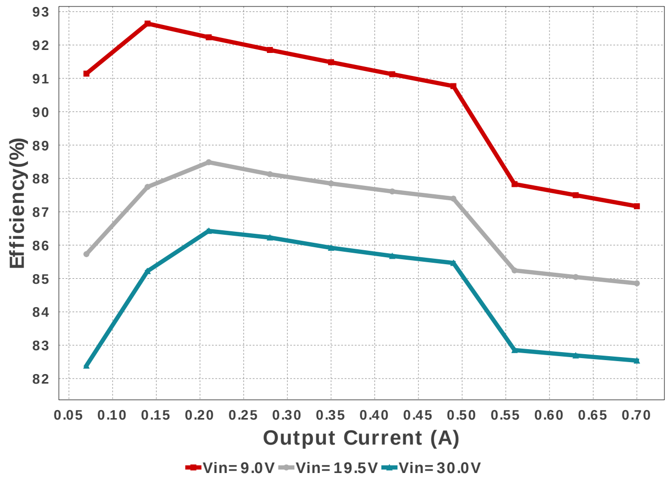
L1 Ipp



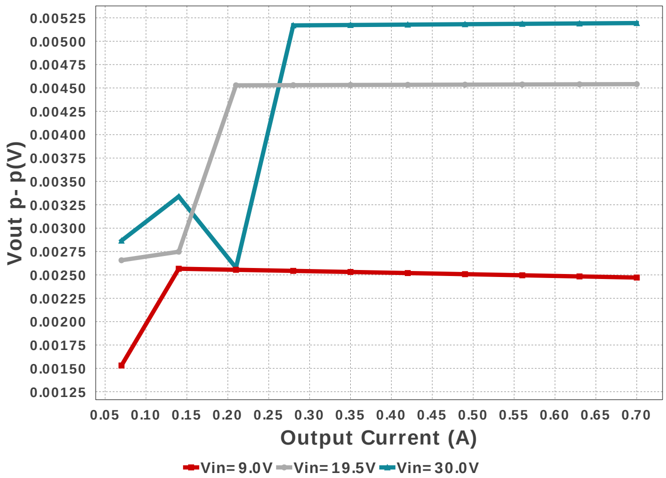
D1 Tj



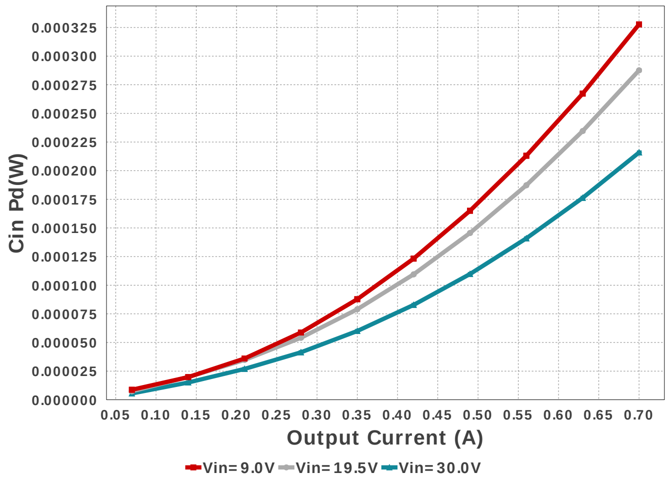
Efficiency



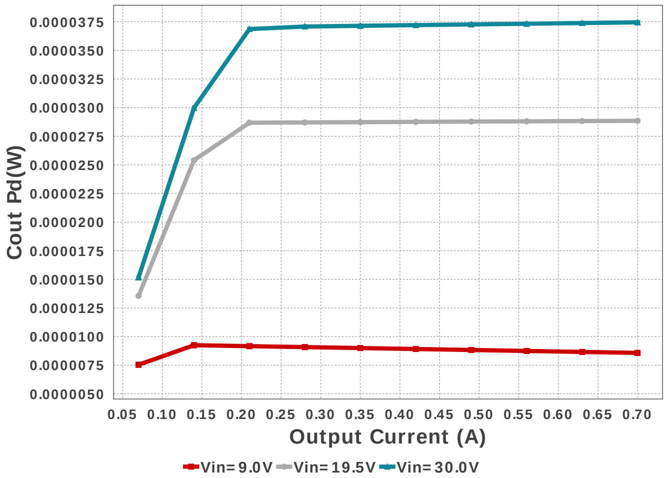
Vout p- p



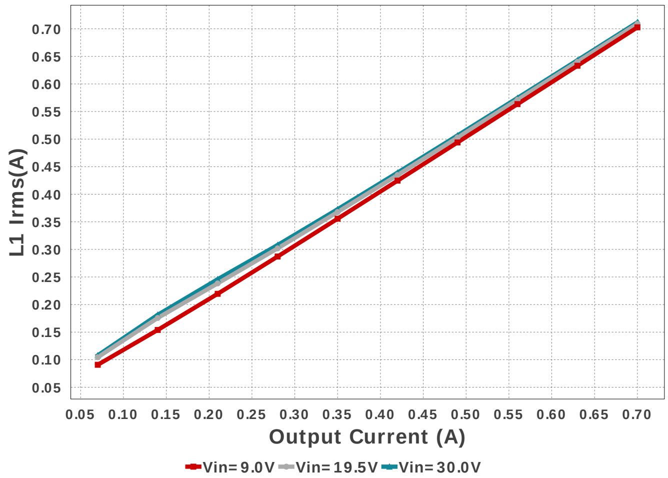
Cin Pd



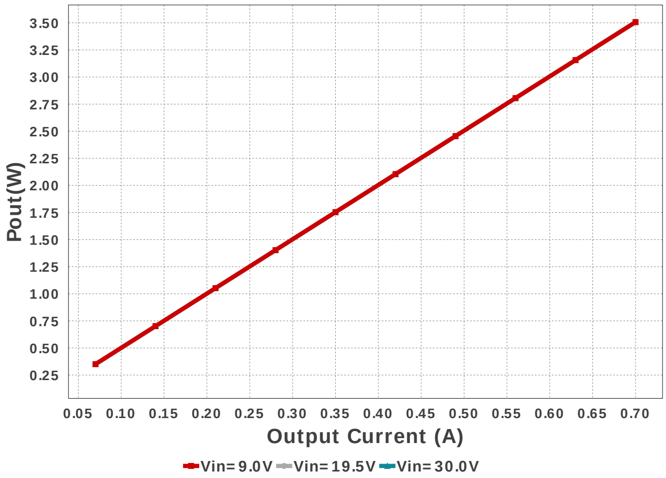
Cout Pd



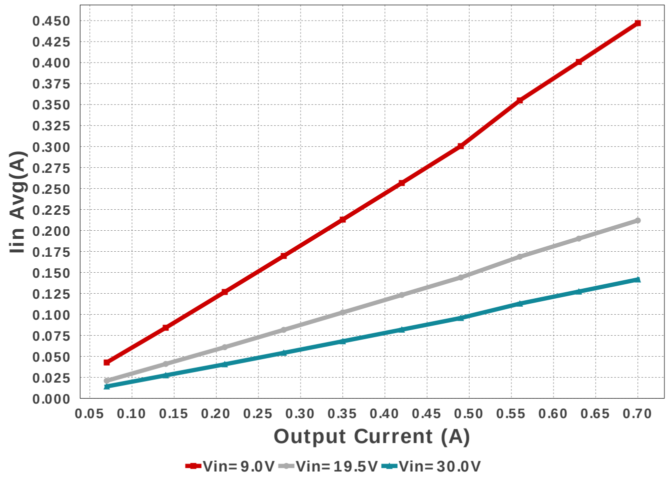
L1 Irms

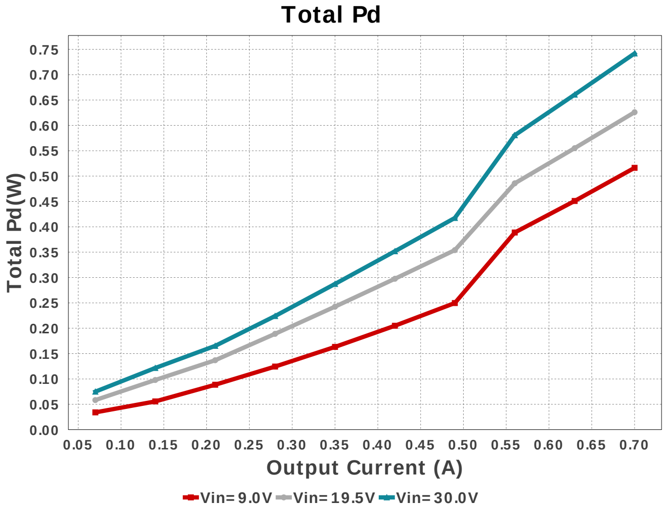


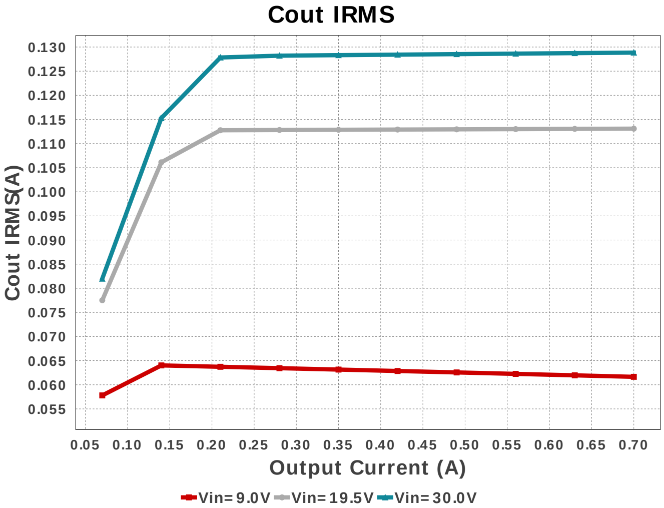
Pout

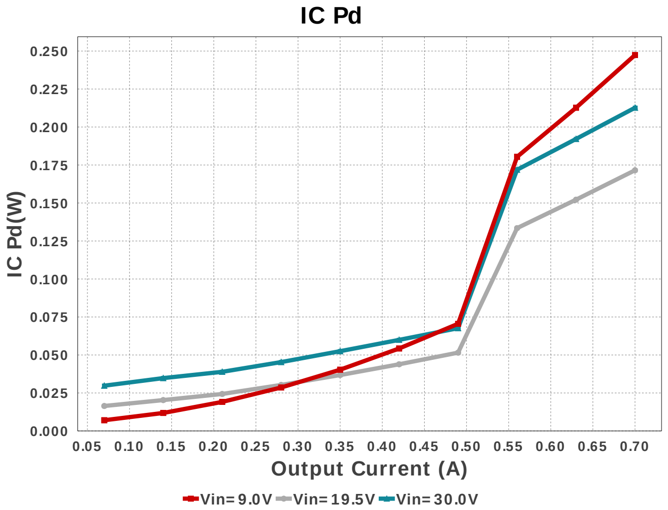


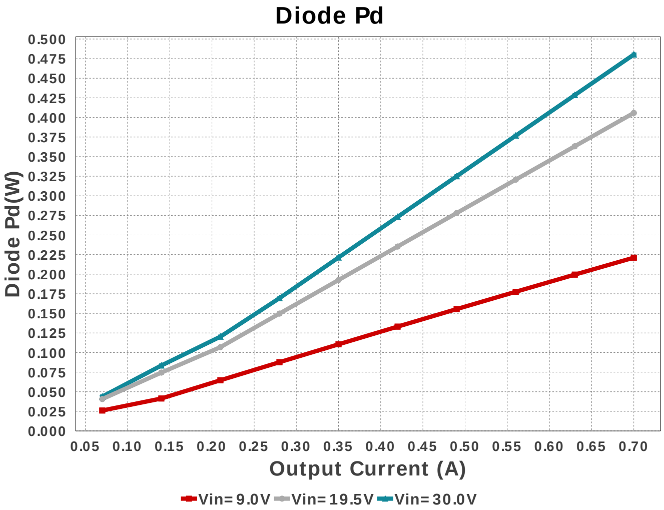
Iin Avg

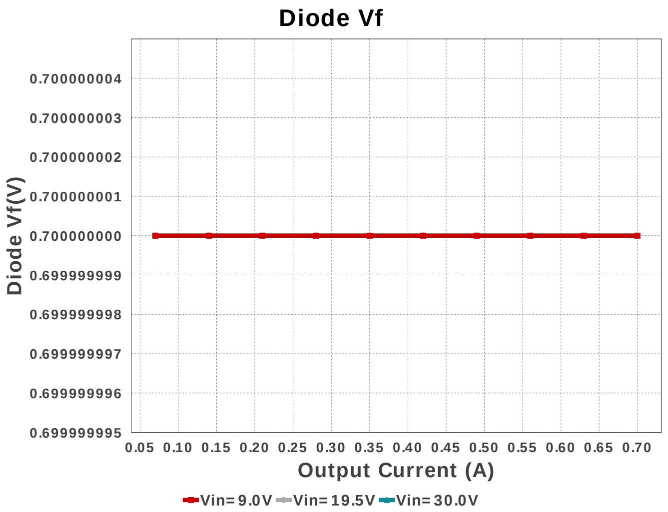


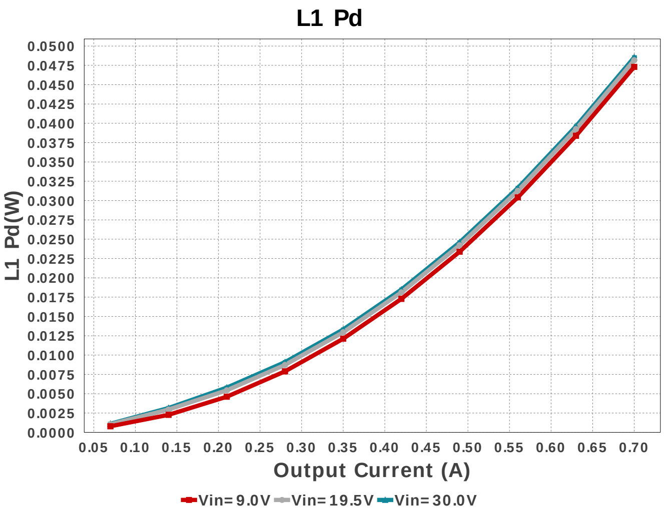

Total Pd
Total Pd(W)
Output Current (A)
Vin=9.0V Vin=19.5V Vin=30.0V

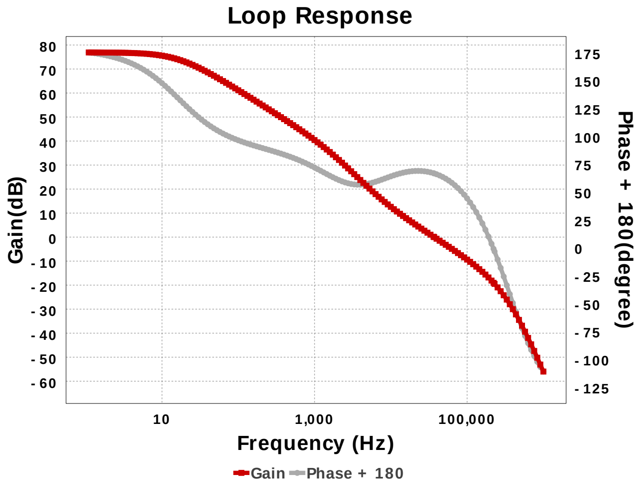

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=9.0V Vin=19.5V Vin=30.0V

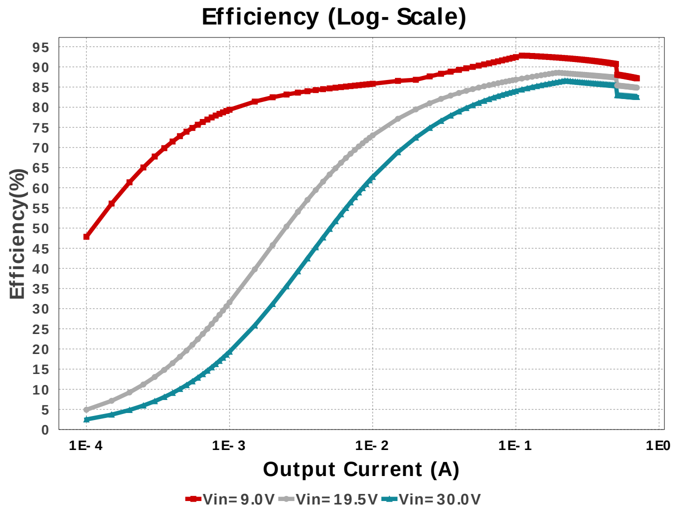

IC Pd
IC Pd(W)
Output Current (A)
Vin=9.0V Vin=19.5V Vin=30.0V


Diode Pd
Diode Pd(W)
Output Current (A)
Vin=9.0V Vin=19.5V Vin=30.0V


Diode Vf
Diode Vf(V)
Output Current (A)
Vin=9.0V Vin=19.5V Vin=30.0V


L1 Pd
L1 Pd(W)
Output Current (A)
Vin=9.0V Vin=19.5V Vin=30.0V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	10		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	279.596 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	215.84 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	128.844 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	37.451 µW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	98.813 degC	Diode	D1 junction temperature
8.	Diode Pd	480.21 mW	Diode	Diode power dissipation
9.	Diode Vf	700.0 mV	Diode	Forward voltage drop of diode D1
10.	IC Pd	212.69 mW	IC	IC power dissipation
11.	IC Tj	91.694 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	141.63 mA	IC	Average input current
15.	L1 Irms	711.759 mA	Inductor	Inductor ripple current
16.	L1 Pd	48.532 mW	Inductor	Inductor power dissipation
17.	Cin Pd	215.84 µW	Power	Input capacitor power dissipation
18.	Cout Pd	37.451 µW	Power	Output capacitor power dissipation
19.	Diode Pd	480.21 mW	Power	Diode power dissipation
20.	IC Pd	212.69 mW	Power	IC power dissipation
21.	L1 Pd	48.532 mW	Power	Inductor power dissipation
22.	Total Pd	741.9 mW	Power	Total Power Dissipation
23.	Cross Freq	37.025 kHz	System Information	Bode plot crossover frequency
24.	Duty Cycle	18.878 %	System Information	Duty cycle
25.	Efficiency	82.539 %	System Information	Steady state efficiency
26.	FootPrint	170.0 mm²	System Information	Total Foot Print Area of BOM components
27.	Frequency	700.0 kHz	System Information	Switching frequency
28.	Gain Marg	-19.017 dB	System Information	Bode Plot Gain Margin
29.	Iout	700.0 mA	System Information	Iout operating point
30.	L1 Ipp	446.33 mA	System Information	
31.	Low Freq Gain	76.905 dB	System Information	Gain at 1Hz
32.	Mode	CCM	System Information	Conduction Mode
33.	Phase Marg	67.678 deg	System Information	Bode Plot Phase Margin
34.	Pout	3.507 W	System Information	Total output power
35.	Vin	30.0 V	System Information	Vin operating point
36.	Vout	5.0 V	System Information	Operational Output Voltage
37.	Vout Actual	5.011 V	System Information	Vout Actual calculated based on selected voltage divider resistors

#	Name	Value	Category	Description
38.	Vout Tolerance	3.317 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
39.	Vout p-p	5.194 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	700.0 m	Maximum Output Current
VinMax	30.0	Maximum input voltage
VinMin	9.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LMR14010A	Base Product Number
source	DC	Input Source Type
Ta	70.0	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

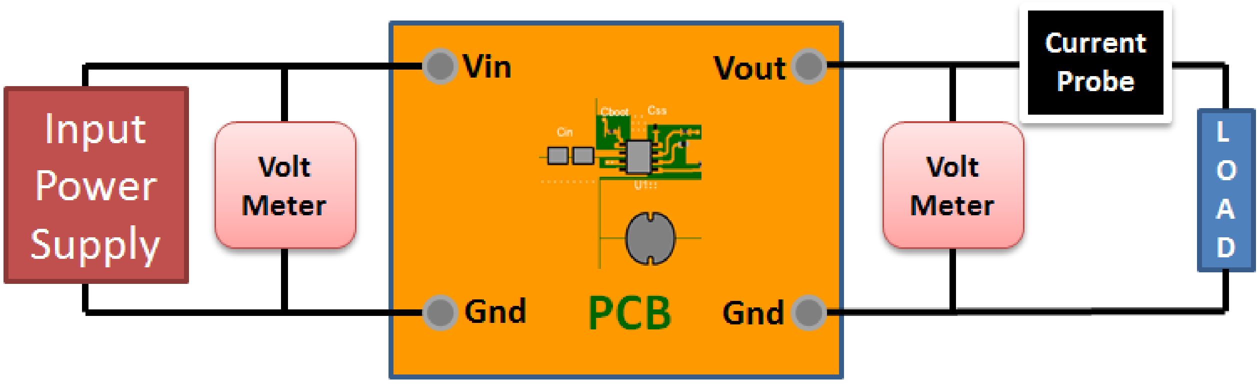
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 9.0V 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 : EAB86B6E95819668[v1]

2. **LMR14010A** Product Folder : http://www.ti.com/product/LMR14010A : contains the data sheet and other resources.

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