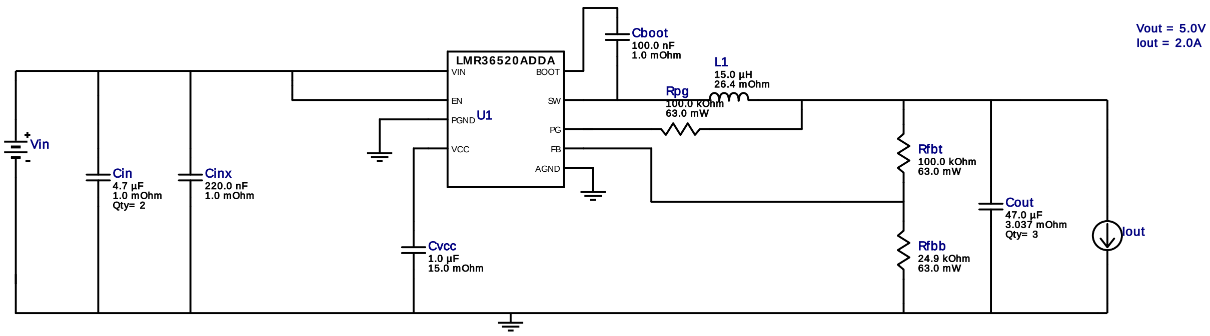
TEXAS INSTRUMENTS

WEBENCH ® Design Report

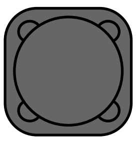
VinMin = 20.0V
VinMax = 30.0V
Vout = 5.0V
Iout = 2.0A

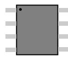
Device = LMR36520ADDAR
Topology = Buck
Created = 2020-10-12 17:52:28.558
BOM Cost = $3.09
BOM Count = 13
Total Pd = 1.15W

Design : 95 LMR36520ADDAR
LMR36520ADDAR 20V-30V to 5.00V @ 2A

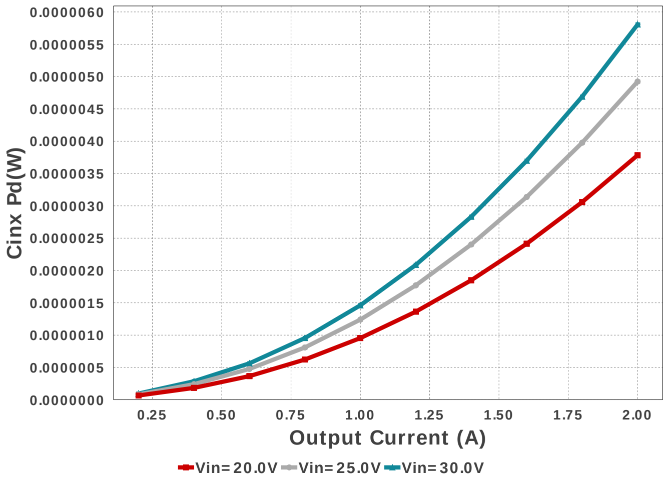


Electrical BOM

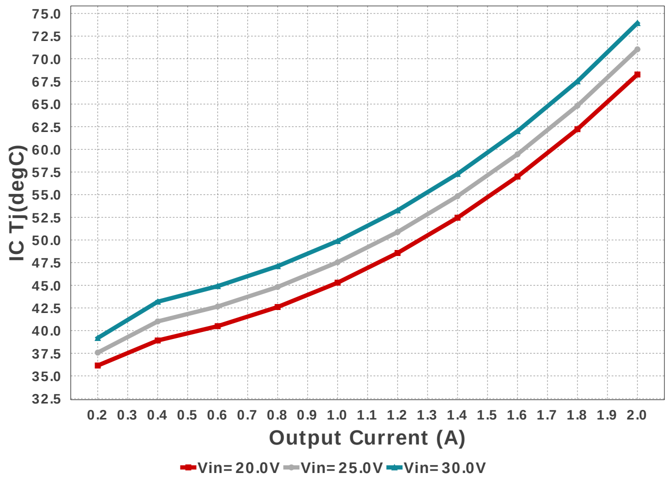
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	2	$0.18	0805 7 mm²
Cinx	MuRata	GRM21BR71H224MA01L Series= X7R	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm²
Cout	MuRata	GRM32ER61C476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	3	$0.38	1210_280 15 mm²
Cvcc	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm²
L1	Sumida	CDRH127/LDNP-150MC	L= 15.0 µH 26.4 mOhm	1	$0.61	 CDRH127 196 mm²
Rfbb	Vishay-Dale	CRCW040224K9FKED Series= CRCW..e3	Res= 24.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	LMR36520ADDAR	Switcher	1	$0.85	 DDA0008J 55 mm²

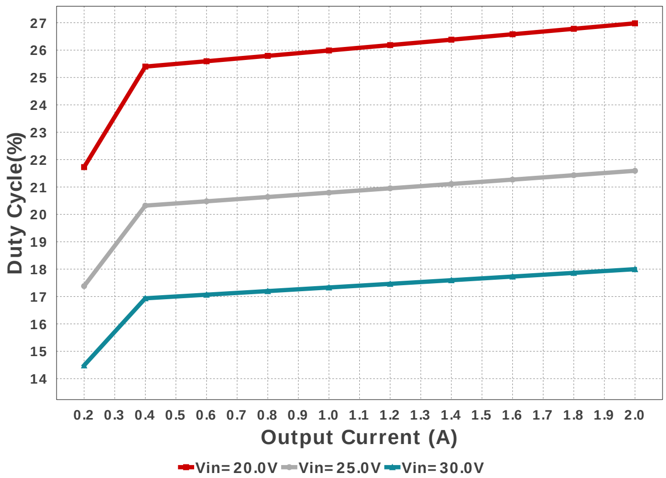
Cinx Pd



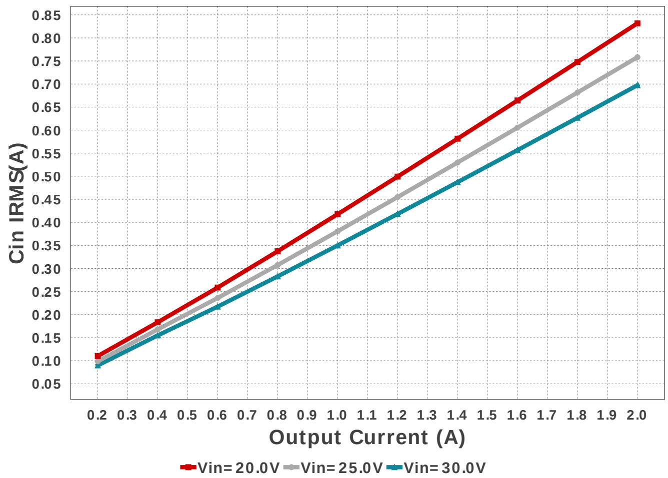
IC Tj



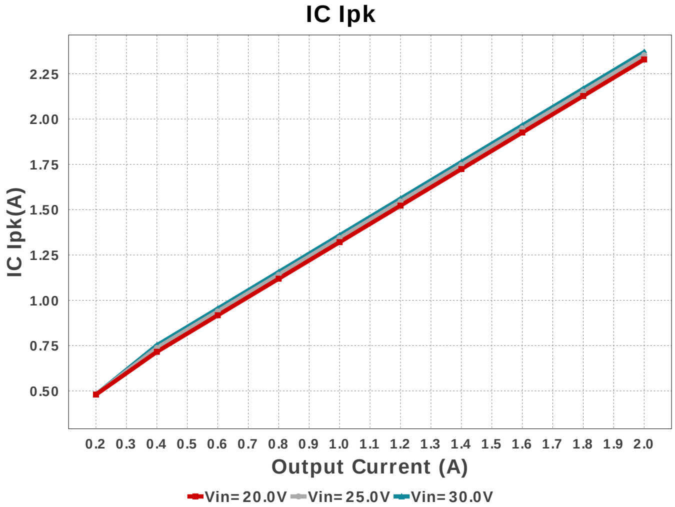
Duty Cycle



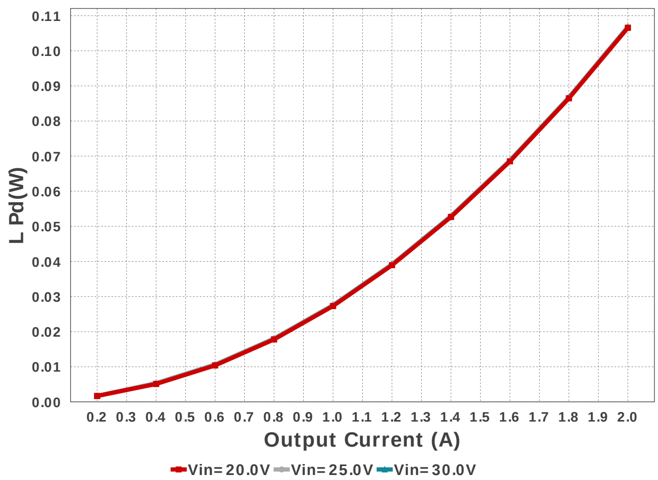
Cin IRMS

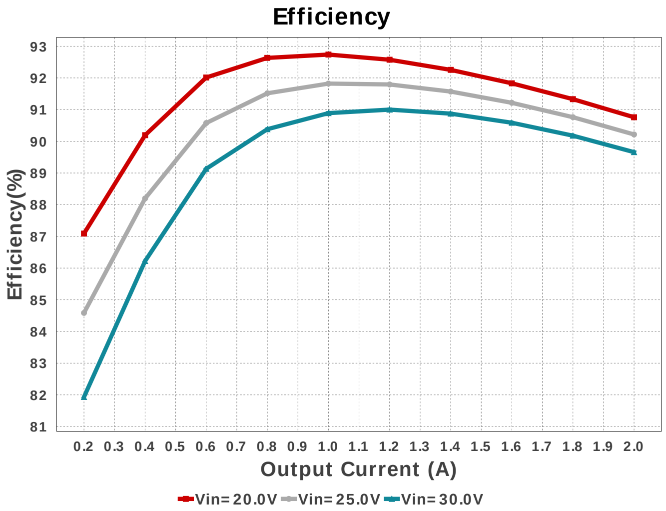


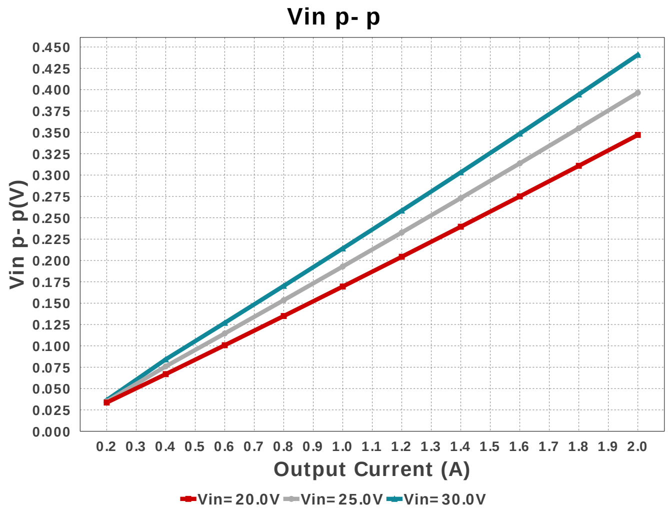
IC Ipk

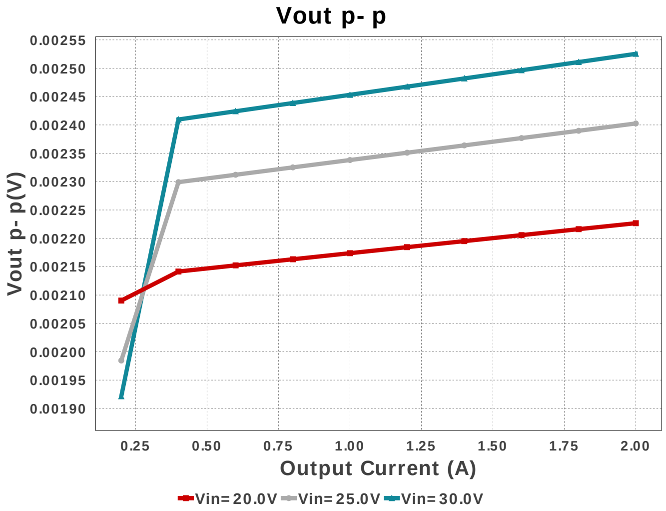


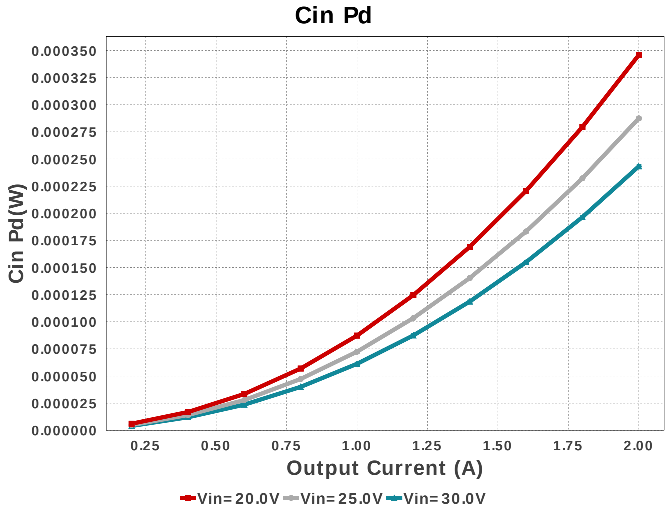
L Pd

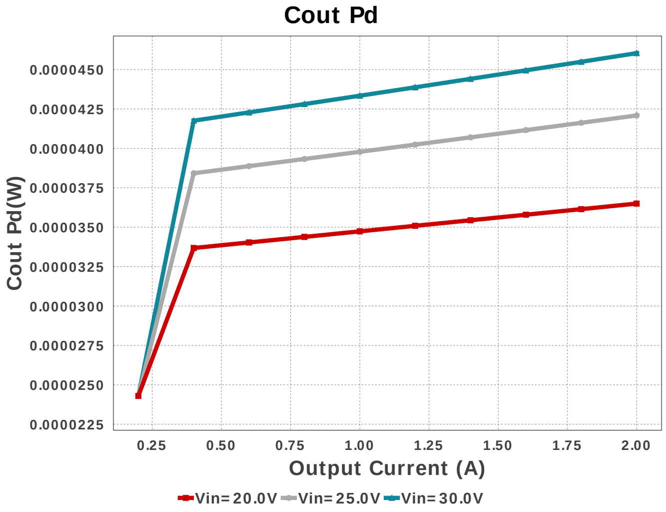


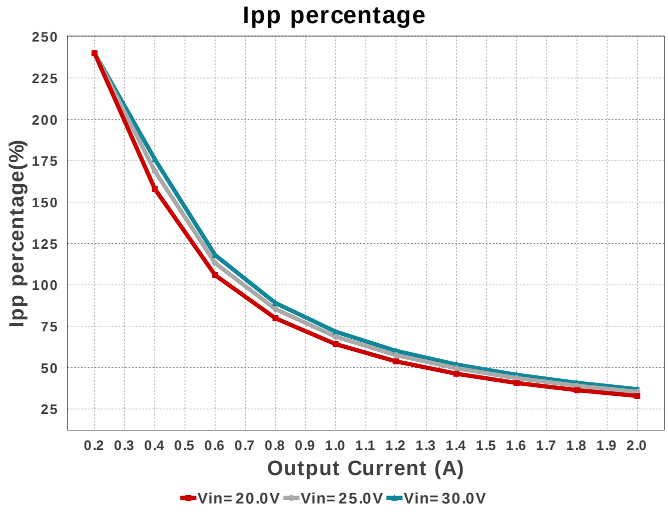

Efficiency
Efficiency(%)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V

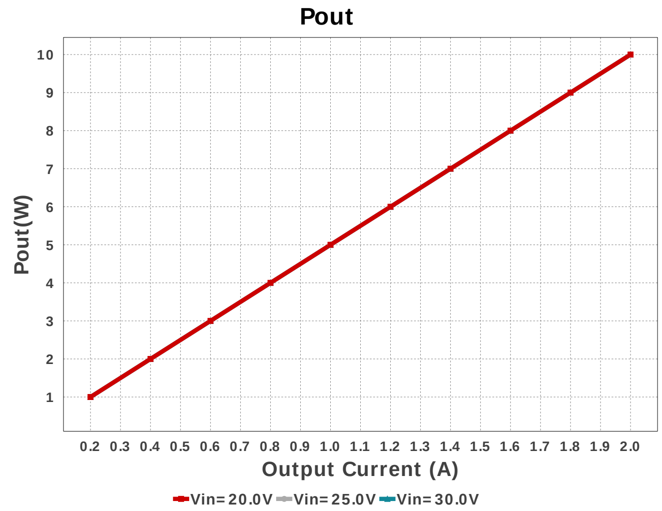

Vin p- p
Vin p- p(V)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V

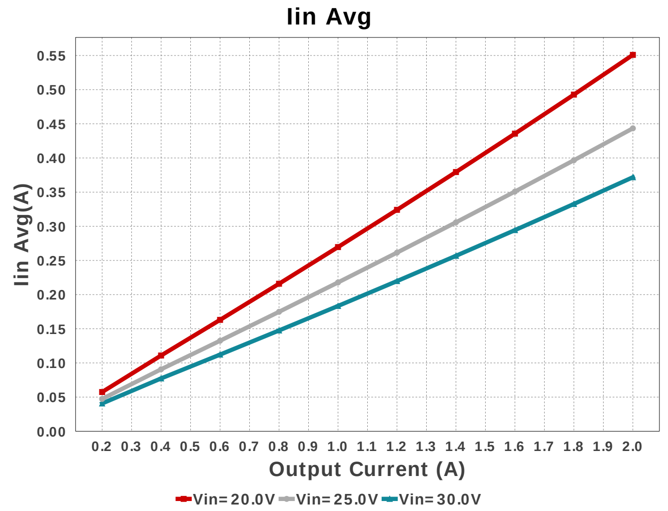

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V

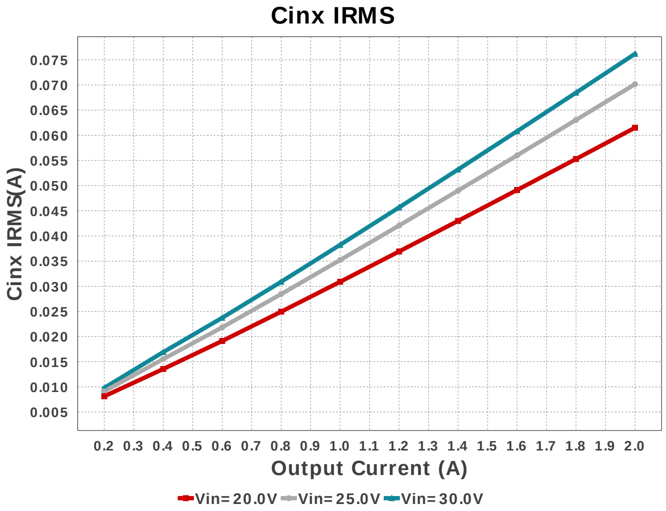

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V

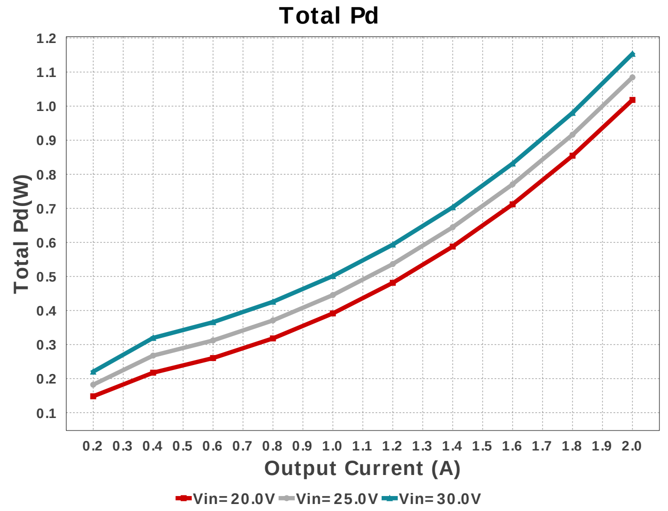

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V

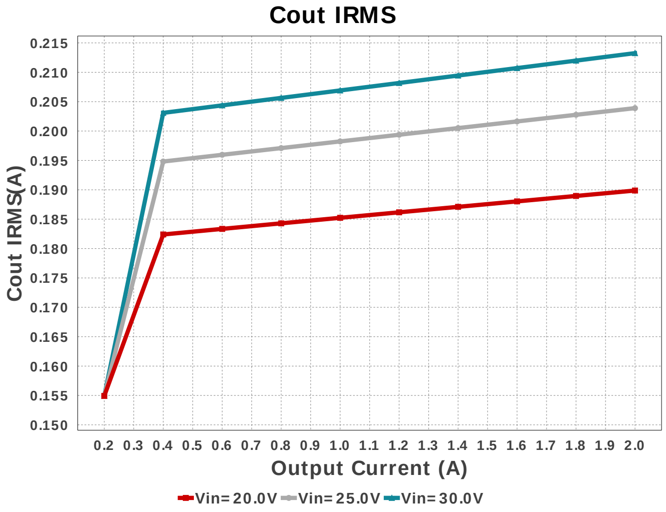

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V

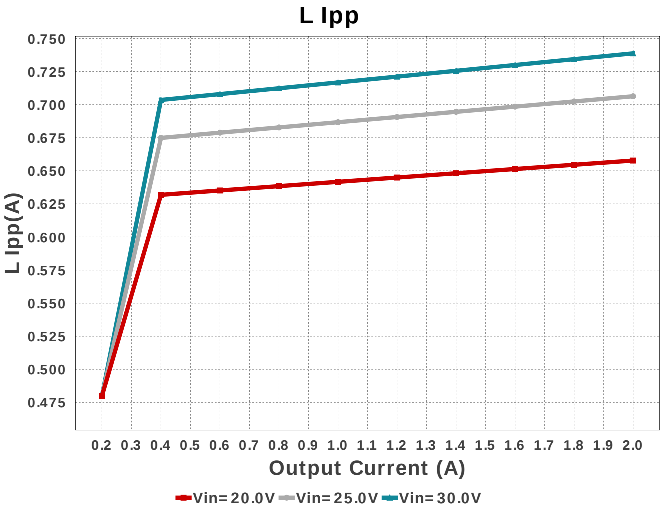

Pout
Pout(W)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V

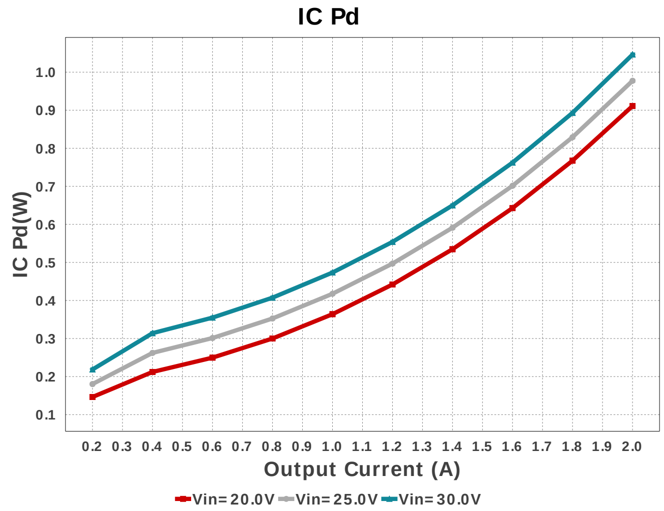

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V

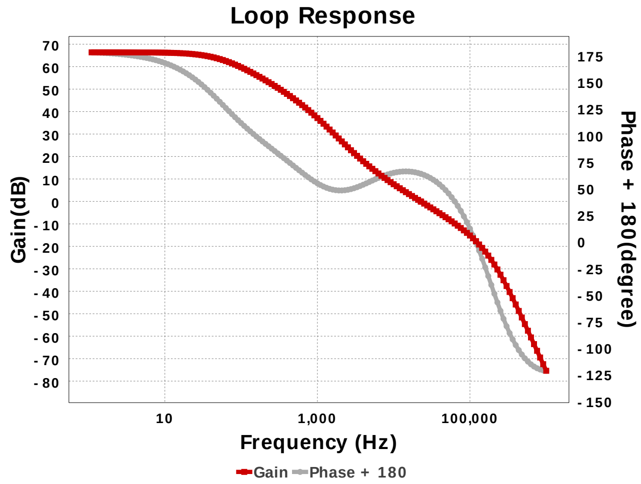

Cinx IRMS
Cinx IRMS(A)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V

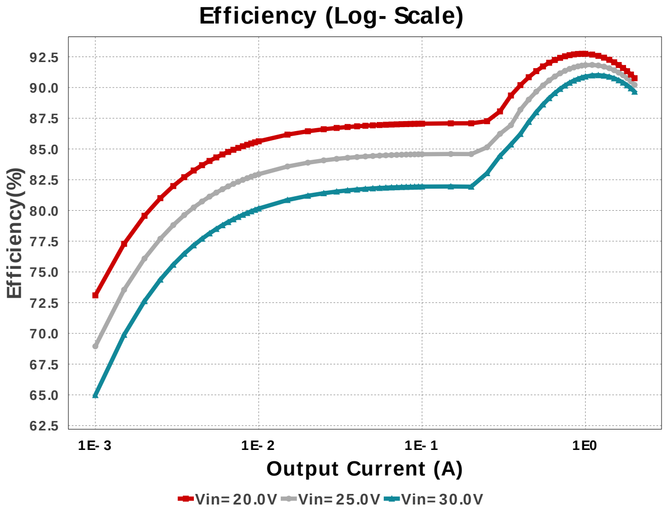

Total Pd
Total Pd(W)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V


L Ipp
L Ipp(A)
Output Current (A)
Vin=20.0V Vin=25.0V Vin=30.0V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	697.462 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	243.23 µW	Capacitor	Input capacitor power dissipation
3.	Cinx IRMS	76.193 mA	Capacitor	Bulk capacitor RMS ripple current
4.	Cinx Pd	5.805 µW	Capacitor	Bulk capacitor power dissipation
5.	Cout IRMS	213.258 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	46.04 µW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	2.369 A	IC	Peak switch current in IC
8.	IC Pd	1.046 W	IC	IC power dissipation
9.	IC Tj	73.939 degC	IC	IC junction temperature
10.	IC Tolerance	15.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA Effective	42.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
12.	Iin Avg	371.78 mA	IC	Average input current
13.	Ipp percentage	36.937 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	738.75 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	106.8 mW	Inductor	Inductor power dissipation
16.	Cin Pd	243.23 µW	Power	Input capacitor power dissipation
17.	Cinx Pd	5.805 µW	Power	Bulk capacitor power dissipation
18.	Cout Pd	46.04 µW	Power	Output capacitor power dissipation
19.	IC Pd	1.046 W	Power	IC power dissipation
20.	L Pd	106.8 mW	Power	Inductor power dissipation
21.	Total Pd	1.153 W	Power	Total Power Dissipation
22.	BOM Count	13	System Information	Total Design BOM count
23.	Cross Freq	22.604 kHz	System Information	Bode plot crossover frequency
24.	Duty Cycle	17.998 %	System Information	Duty cycle
25.	Efficiency	89.658 %	System Information	Steady state efficiency
26.	FootPrint	334.0 mm^2	System Information	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
27.	Frequency	400.0 kHz	System Information	Switching frequency
28.	Gain Marg	-17.671 dB	System Information	Bode Plot Gain Margin
29.	Iout	2.0 A	System Information	Iout operating point
30.	Low Freq Gain	66.369 dB	System Information	Gain at 1Hz
31.	Mode	CCM	System Information	Conduction Mode
32.	Phase Marg	64.569 deg	System Information	Bode Plot Phase Margin
33.	Pout	10.0 W	System Information	Total output power
34.	Total BOM	$3.09	System Information	Total BOM Cost
35.	Vin	30.0 V	System Information	Vin operating point
36.	Vin p-p	440.811 mV	System Information	Peak-to-peak input voltage
37.	Vout	5.0 V	System Information	Operational Output Voltage
38.	Vout Actual	5.016 V	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Tolerance	3.142 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	2.525 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	30.0	Maximum input voltage
VinMin	20.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LMR36520A	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

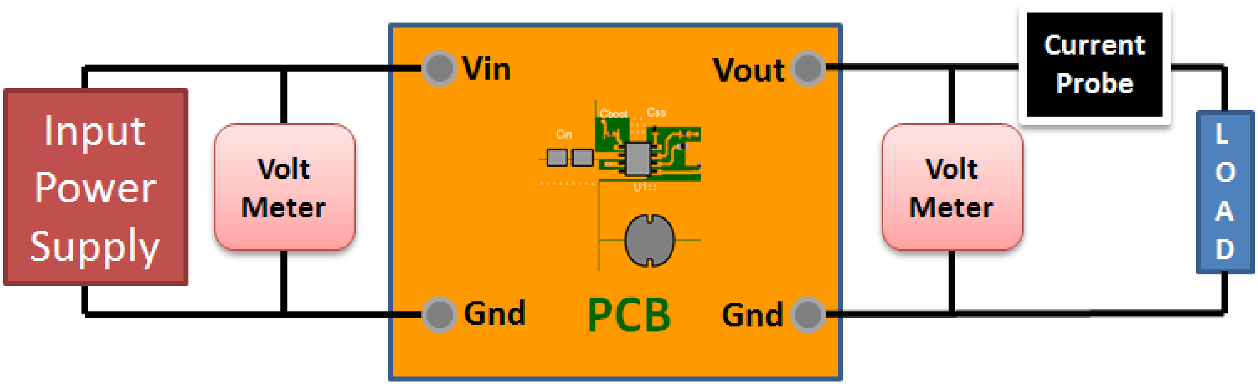
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 20.0V 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 : D06CA397F9C398D8[v1]

2. **LMR36520A** Product Folder : http://www.ti.com/product/LMR36520 : contains the data sheet and other resources.

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