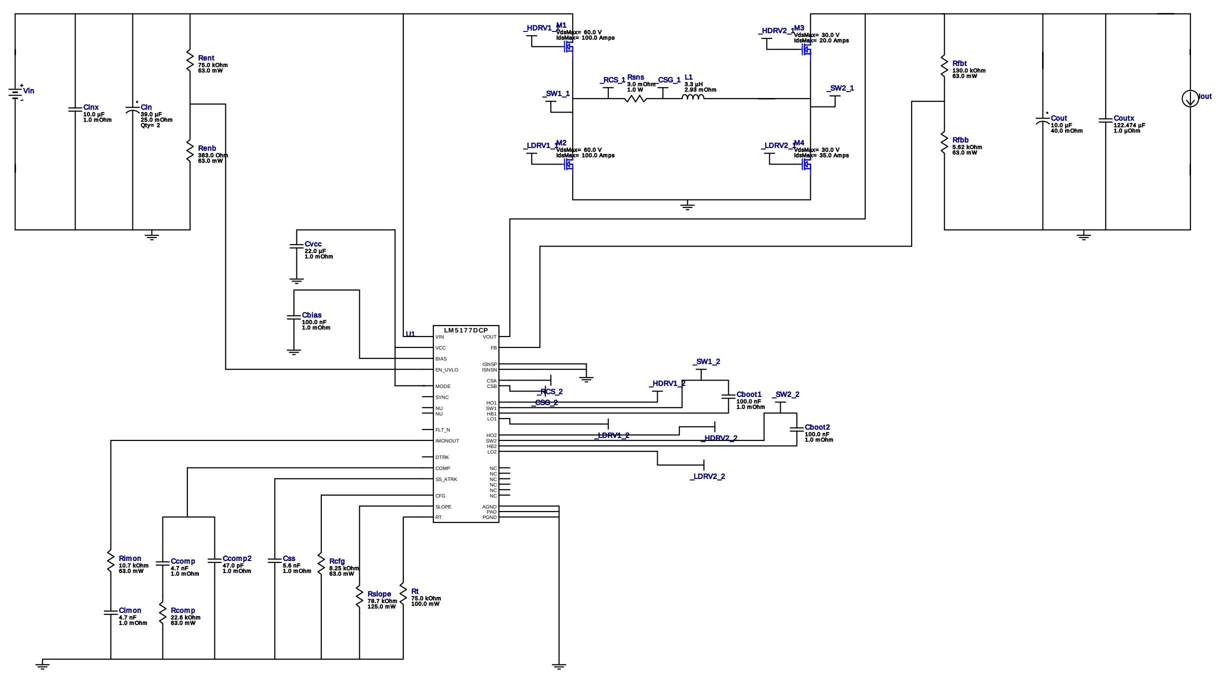
VinMin = 20.0V
VinMax = 36.0V
Vout = 24.0V
Iout = 10.0A

Device = LM5177DCPR
Topology = Buck_Boost
Created = 2024-02-01 22:47:17.269
BOM Cost = NA
BOM Count = 29
Total Pd = 3.61W

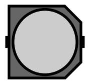
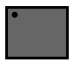
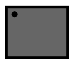
WEBENCH ® Design Report

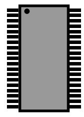
Design : 66 LM5177DCPR
LM5177DCPR 20V-36V to 24.00V @ 10A

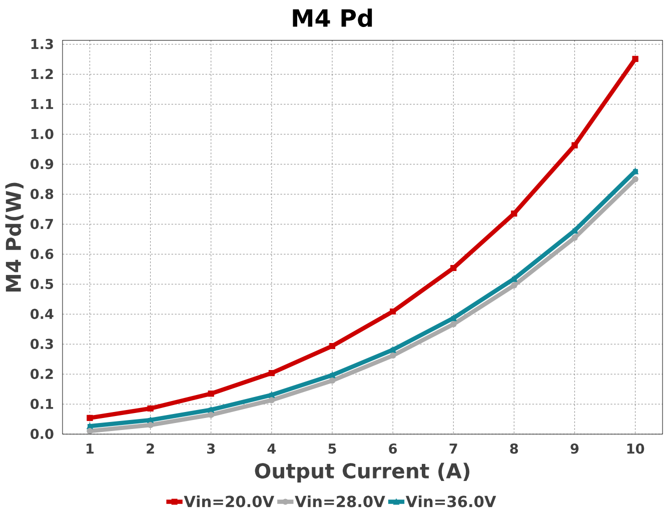


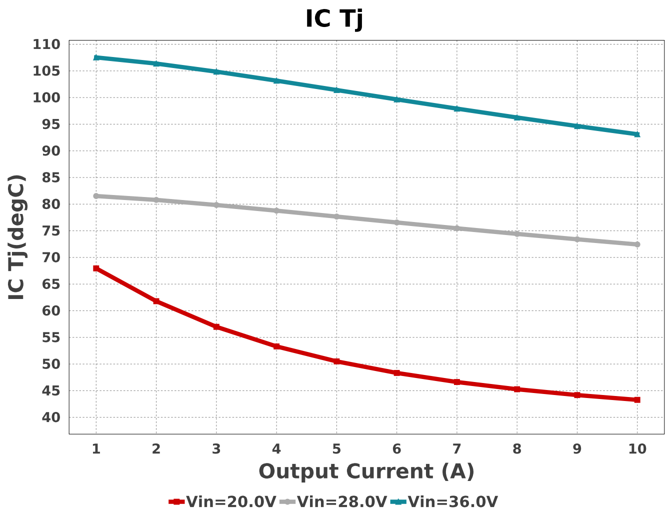
Electrical BOM

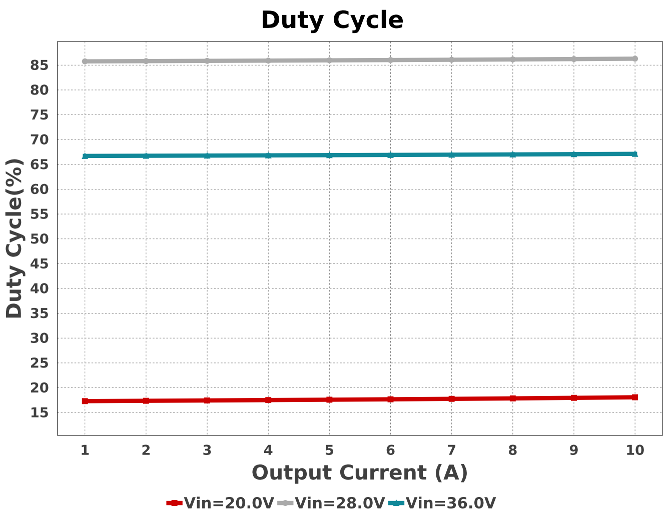
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cboot1	Taiyo Yuden	EMK107B7104KA-T Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cboot2	Taiyo Yuden	EMK107B7104KA-T Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Ccomp	MuRata	GRM155R71C472KA01D Series= X7R	Cap= 4.7 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	MuRata	GRM1555C1E470JA01D Series= C0G/NP0	Cap= 47.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cimon	MuRata	GRM155R71C472KA01D Series= X7R	Cap= 4.7 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	Panasonic	50SVPF39M Series= SVPF	Cap= 39.0 uF ESR= 25.0 mOhm VDC= 50.0 V IRMS= 3.8 A	2	$1.15	CAPSMT_62_E12 106 mm^2

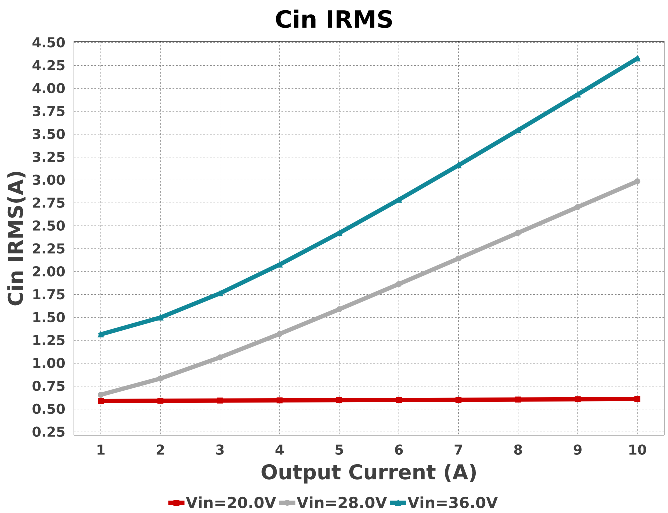
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cinx	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	1	$0.27	 1210 15 mm²
Cout	Panasonic	50SVPF10M Series= SVPF	Cap= 10.0 uF ESR= 40.0 mOhm VDC= 50.0 V IRMS= 2.5 A	1	$0.59	 CAPSMT_62_F61 74 mm²
Coutx	CUSTOM	CUSTOM Series= ?	Cap= 122.474 uF ESR= 1.0 uOhm VDC= 48.0 V IRMS= 273.349 uA	1	NA	CUSTOM 0 mm²
Css	MuRata	GRM155R71H562KA88D Series= X7R	Cap= 5.6 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cvcc	MuRata	GRM188R60J226MEA0D Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.04	0603 5 mm²
L1	Vishay-Dale	IHLP6767DZER3R3M11	L= 3.3 µH 2.93 mOhm	1	$1.98	 IHLP-6767DZ 369 mm²
M1	Texas Instruments	CSD18540Q5B	VdsMax= 60.0 V IdsMax= 100.0 Amps	1	$0.75	 DNK0008A 56 mm²
M2	Texas Instruments	CSD18540Q5B	VdsMax= 60.0 V IdsMax= 100.0 Amps	1	$0.75	 DNK0008A 56 mm²
M3	Texas Instruments	CSD17578Q3A	VdsMax= 30.0 V IdsMax= 20.0 Amps	1	$0.13	 DNH0008A 18 mm²
M4	Texas Instruments	CSD17577Q3A	VdsMax= 30.0 V IdsMax= 35.0 Amps	1	$0.15	 DNH0008A 18 mm²
Rcfg	Vishay-Dale	CRCW04028K25FKED Series= CRCW..e3	Res= 8.25 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rcomp	Vishay-Dale	CRCW040222K6FKED Series= CRCW..e3	Res= 22.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Renb	Vishay-Dale	CRCW0402383RFKED Series= CRCW..e3	Res= 383.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rent	Vishay-Dale	CRCW040275K0FKED Series= CRCW..e3	Res= 75.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Vishay-Dale	CRCW04025K62FKED Series= CRCW..e3	Res= 5.62 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW0402130KFKED Series= CRCW..e3	Res= 130.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rimon	Vishay-Dale	CRCW040210K7FKED Series= CRCW..e3	Res= 10.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

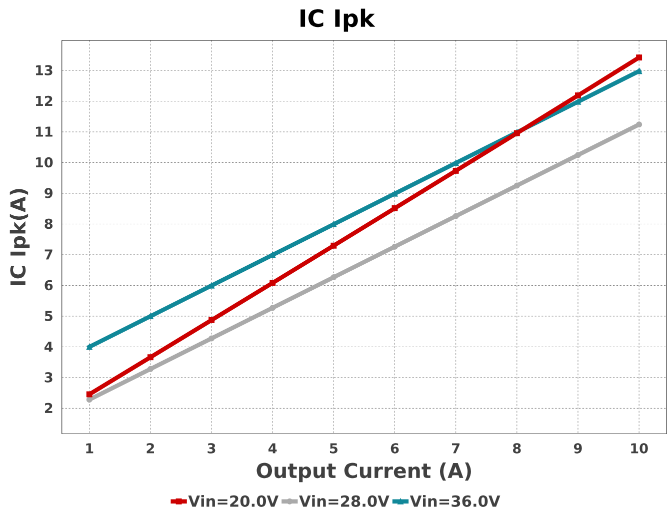
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rslope	Vishay-Dale	CRCW080578K7FKEA Series= CRCW..e3	Res= 78.7 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rsns	CTS Resistor	73M1R003F Series= 73M1	Res= 3.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.47	 2512 43 mm^2
Rt	Vishay-Dale	CRCW060375K0FKEA Series= CRCW..e3	Res= 75.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	LM5177DCPR	Switcher	1	$2.80	 DCP0038A 98 mm^2

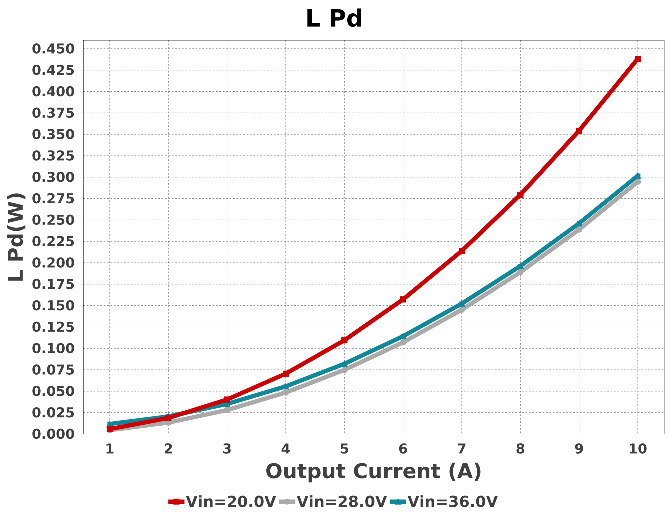


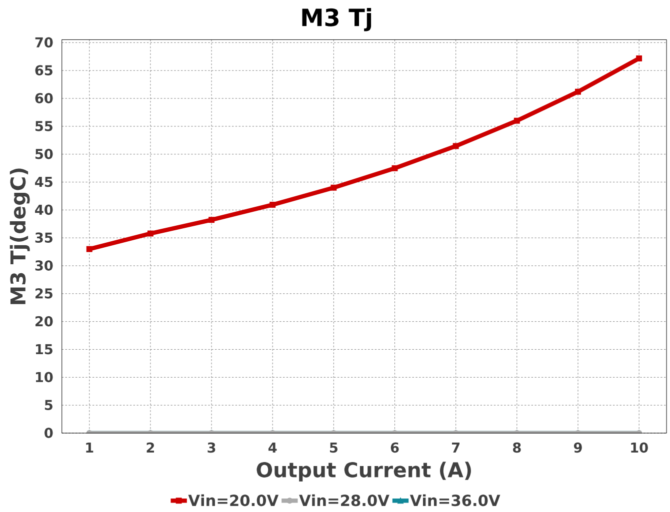


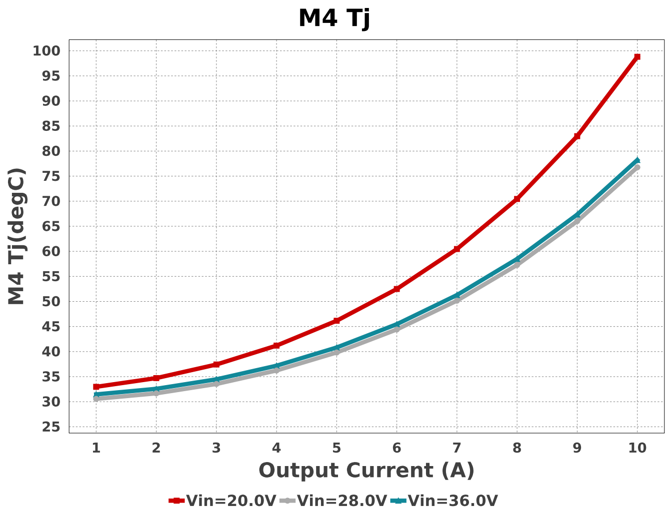


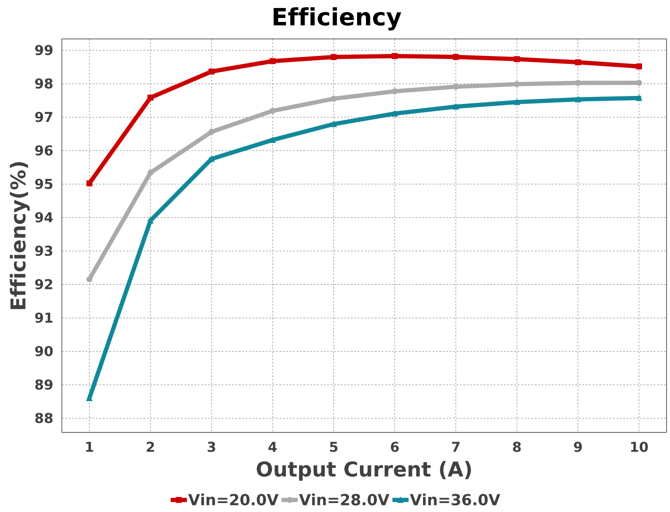


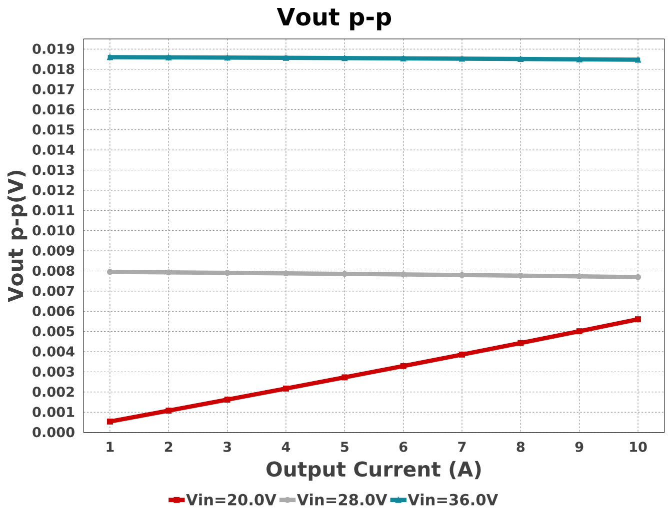

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=20.0V
Vin=28.0V
Vin=36.0V

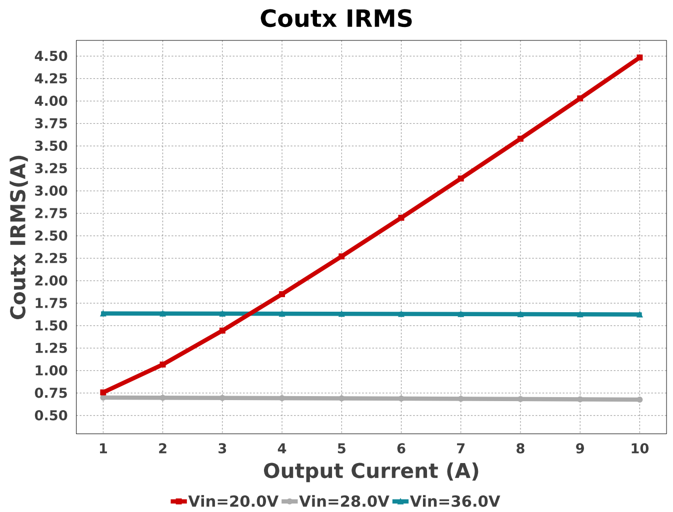

L Pd
L Pd(W)
Output Current (A)
Vin=20.0V
Vin=28.0V
Vin=36.0V

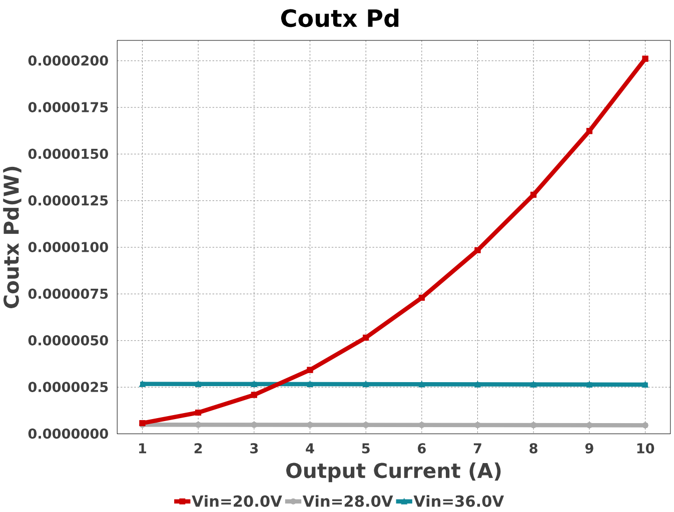

M3 Tj
M3 Tj(degC)
Output Current (A)
Vin=20.0V
Vin=28.0V
Vin=36.0V

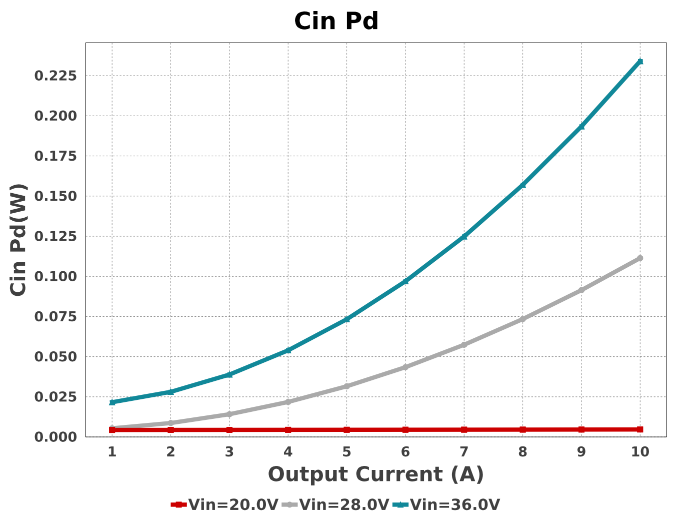

M4 Tj
M4 Tj(degC)
Output Current (A)
Vin=20.0V
Vin=28.0V
Vin=36.0V

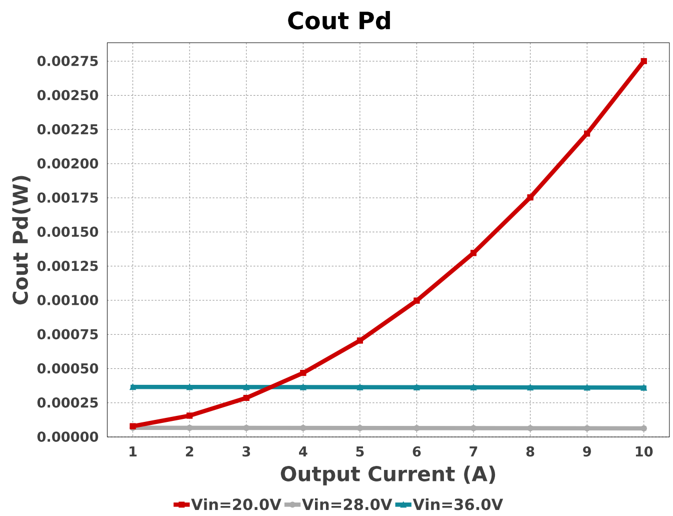

Efficiency
Efficiency(%)
Output Current (A)
Vin=20.0V
Vin=28.0V
Vin=36.0V

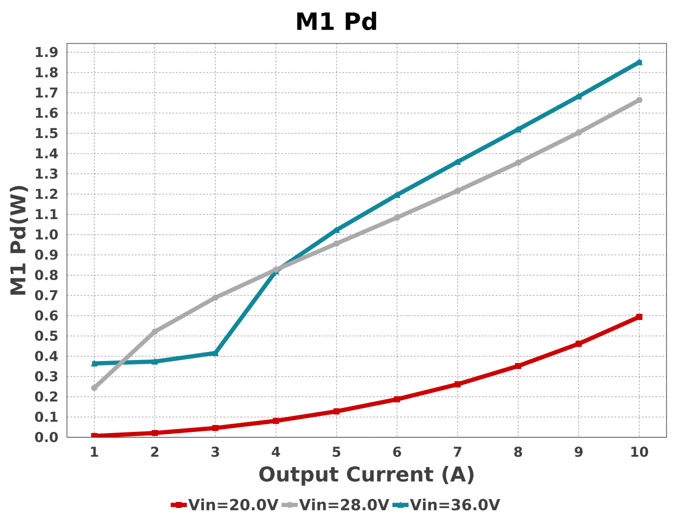

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=20.0V
Vin=28.0V
Vin=36.0V

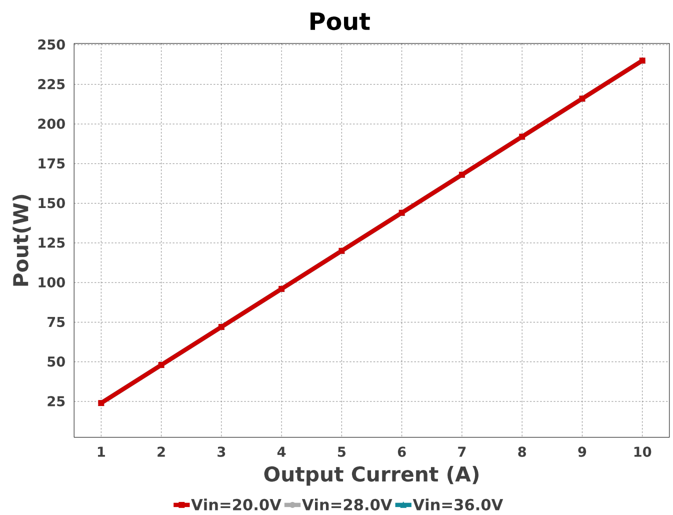

Coutx IRMS
Coutx IRMS(A)
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

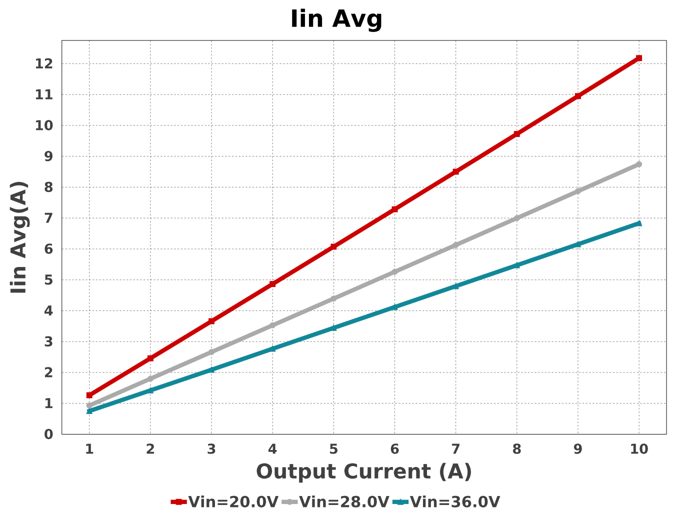

Coutx Pd
Coutx Pd(W)
0.0000200
0.0000175
0.0000150
0.0000125
0.0000100
0.0000075
0.0000050
0.0000025
0.0000000
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

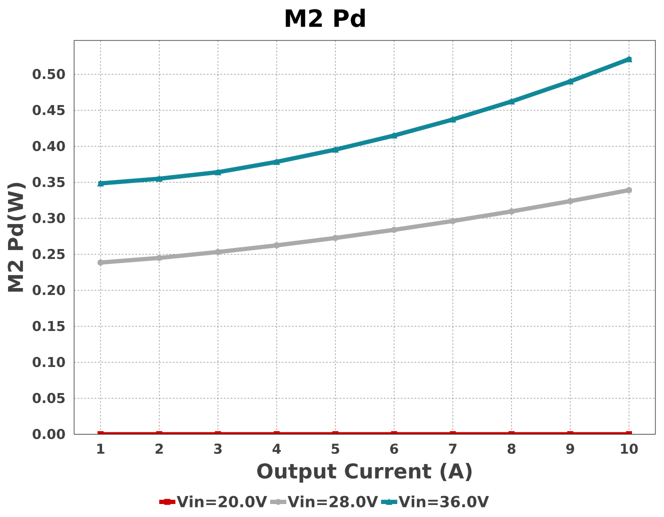

Cin Pd
Cin Pd(W)
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

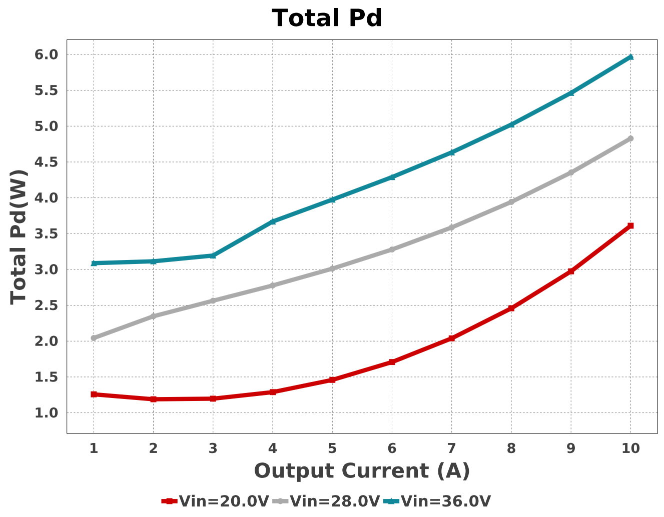

Cout Pd
Cout Pd(W)
0.00275
0.00250
0.00225
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

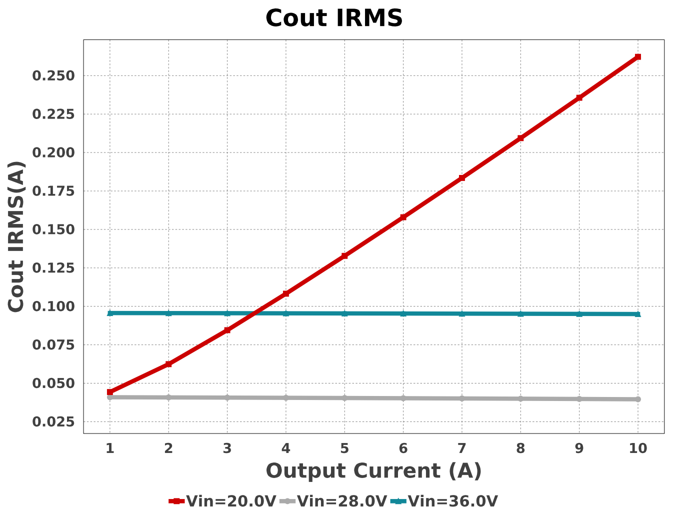

M1 Pd
M1 Pd(W)
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

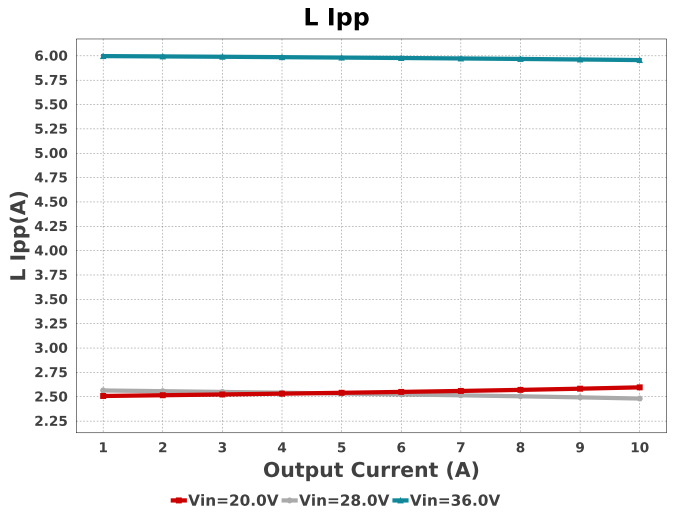

Pout
Pout(W)
250
225
200
175
150
125
100
75
50
25
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

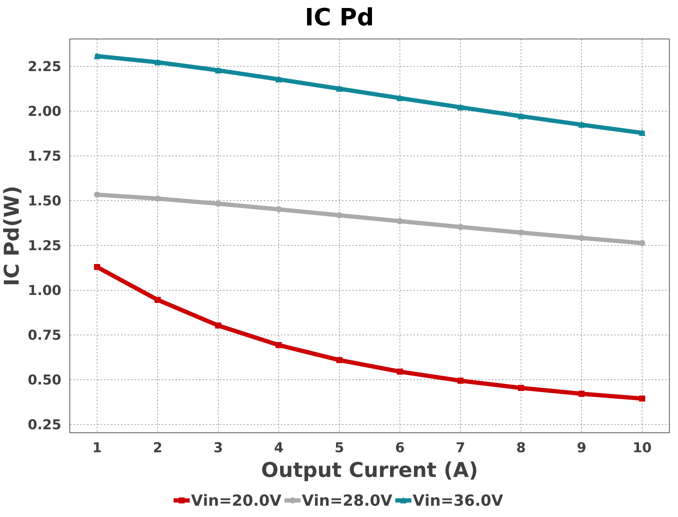

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

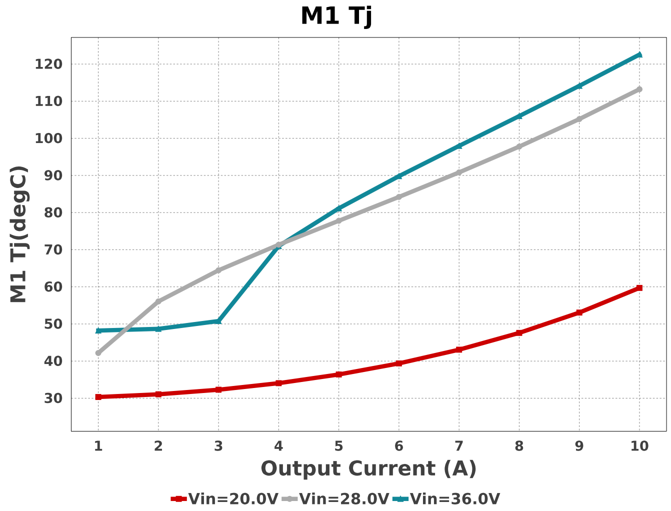

M2 Pd
M2 Pd(W)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

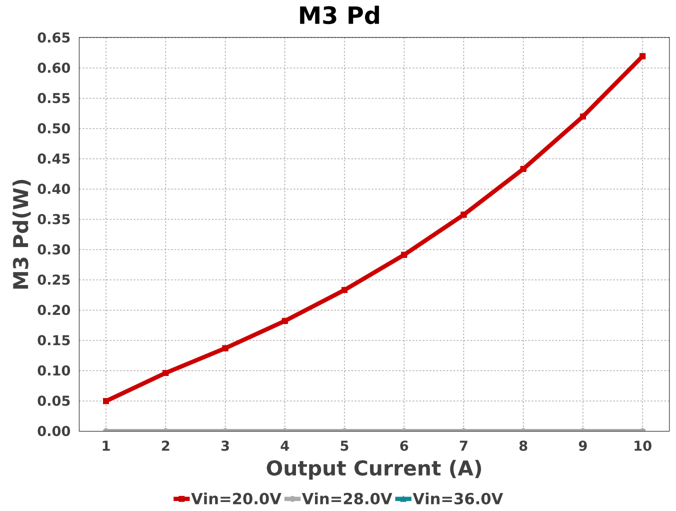

Total Pd
Total Pd(W)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

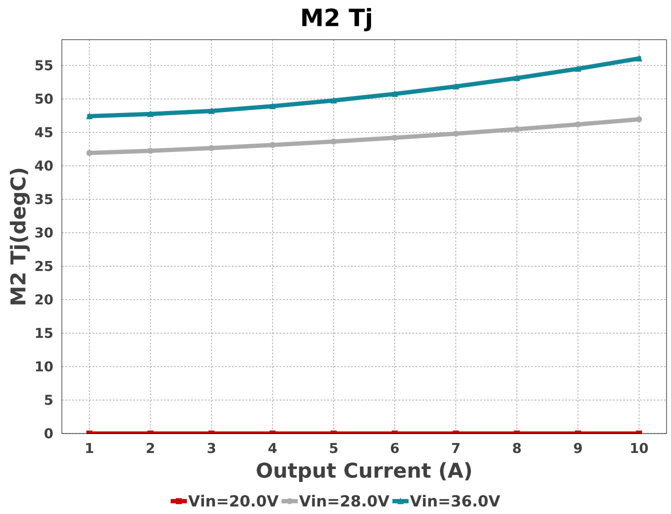

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

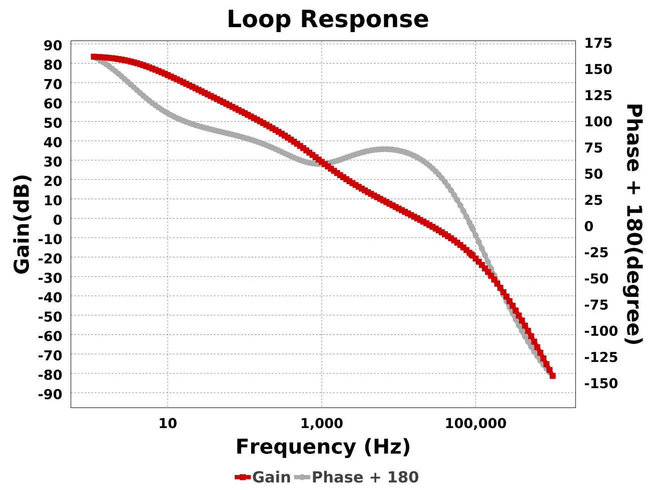

L Ipp
L Ipp(A)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V









Operating Values

#	Name	Value	Category	Description
1.	BOM Count	29		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	609.742 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	4.647 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	262.225 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	2.75 mW	Capacitor	Output capacitor power dissipation
7.	Coutx IRMS	4.484 A	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	20.11 µW	Capacitor	Output capacitor_x power loss
9.	IC Ipk	13.422 A	IC	Peak switch current in IC
10.	IC Pd	395.1 mW	IC	IC power dissipation
11.	IC Tj	43.275 degC	IC	IC junction temperature
12.	IC Tolerance	10.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA	33.6 degC/W	IC	IC junction-to-ambient thermal resistance
14.	Iin Avg	12.18 A	IC	Average input current
15.	L Ipp	2.597 A	Inductor	Peak-to-peak inductor ripple current
16.	L Pd	438.25 mW	Inductor	Inductor power dissipation
17.	M1 Pd	594.11 mW	Mosfet	M1 MOSFET total power dissipation
18.	M1 Tj	59.706 degC	Mosfet	M1 MOSFET junction temperature
19.	M2 Pd	0.0 W	Mosfet	M2 MOSFET total power dissipation
20.	M2 Tj	0.0 degC	Mosfet	M2 MOSFET junction temperature
21.	M3 Pd	619.52 mW	Mosfet	M1 MOSFET total power dissipation
22.	M3 Tj	67.171 degC	Mosfet	M1 MOSFET junction temperature
23.	M4 Pd	1.251 W	Mosfet	M2 MOSFET total power dissipation
24.	M4 Tj	98.809 degC	Mosfet	M2 MOSFET junction temperature
25.	Cin Pd	4.647 mW	Power	Input capacitor power dissipation
26.	Cout Pd	2.75 mW	Power	Output capacitor power dissipation
27.	Coutx Pd	20.11 µW	Power	Output capacitor_x power loss
28.	IC Pd	395.1 mW	Power	IC power dissipation
29.	L Pd	438.25 mW	Power	Inductor power dissipation
30.	M1 Pd	594.11 mW	Power	M1 MOSFET total power dissipation
31.	M2 Pd	0.0 W	Power	M2 MOSFET total power dissipation
32.	M3 Pd	619.52 mW	Power	M1 MOSFET total power dissipation

#	Name	Value	Category	Description
33.	M4 Pd	1.251 W	Power	M2 MOSFET total power dissipation
34.	Total Pd	3.61 W	Power	Total Power Dissipation
35.	Cross Freq	24.209 kHz	System Information	Bode plot crossover frequency
36.	Duty Cycle	18.08 %	System Information	Duty cycle
37.	Efficiency	98.518 %	System Information	Steady state efficiency
38.	FootPrint	1.122 k mm^2	System Information	Total Foot Print Area of BOM components
39.	Frequency	403.997 kHz	System Information	Switching frequency
40.	Gain Marg	-7.062 dB	System Information	Bode Plot Gain Margin
41.	Iout	10.0 A	System Information	Iout operating point
42.	Low Freq Gain	79.92 dB	System Information	Gain at 1Hz
43.	Mode	CCM	System Information	Conduction Mode
44.	Phase Marg	47.057 deg	System Information	Bode Plot Phase Margin
45.	Pout	240.0 W	System Information	Total output power
46.	Vin	20.0 V	System Information	Vin operating point
47.	Vout	24.0 V	System Information	Operational Output Voltage
48.	Vout Actual	24.132 V	System Information	Vout Actual calculated based on selected voltage divider resistors
49.	Vout Tolerance	2.956 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
50.	Vout p-p	5.607 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	10.0	Maximum Output Current
VinMax	36.0	Maximum input voltage
VinMin	20.0	Minimum input voltage
Vout	24.0	Output Voltage
base_pn	LM5177	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

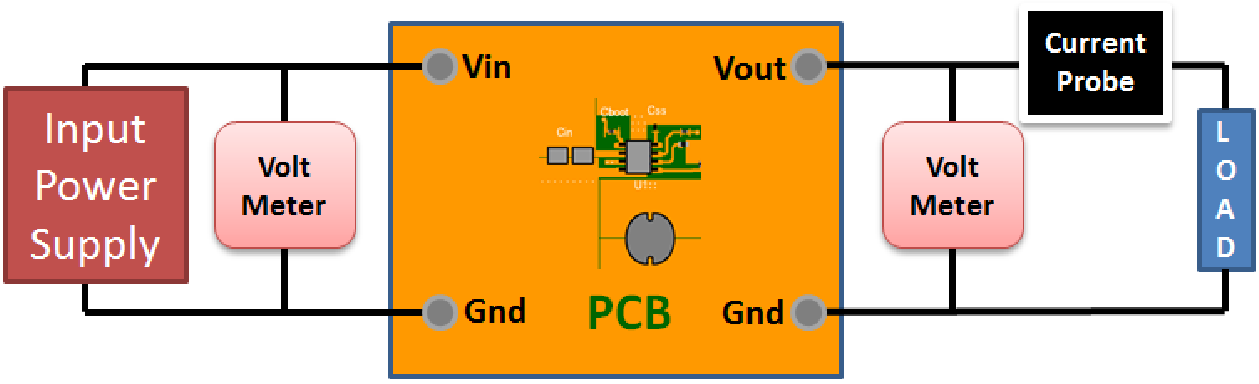
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 : A95EBBFF9A18ACFD34ABF735856AFE62[v1]

2. **LM5177** Product Folder : http://www.ti.com/product/LM5177 : contains the data sheet and other resources.

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