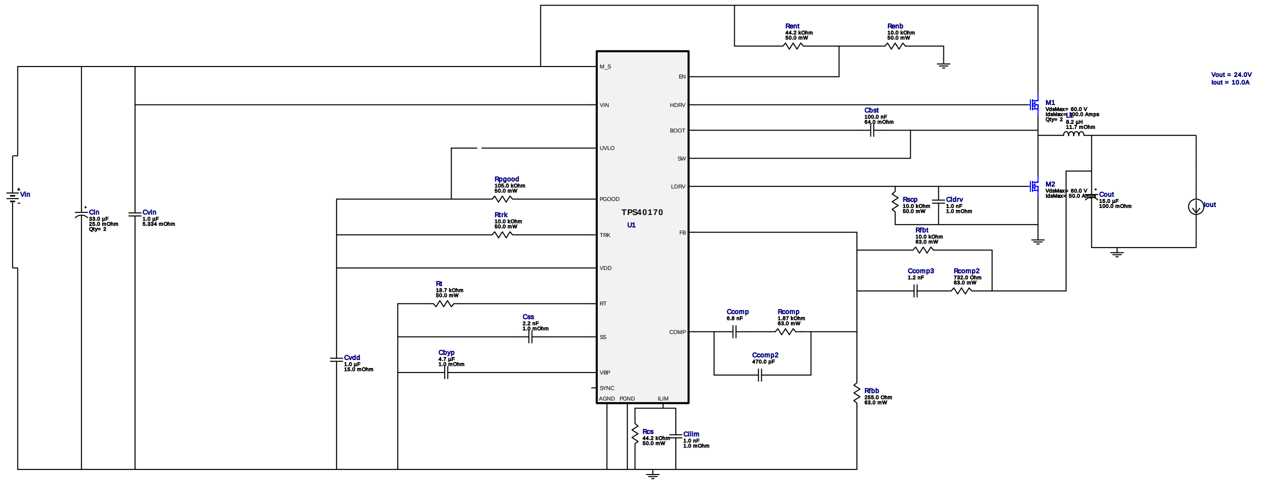
VinMin = 26.0V
VinMax = 42.0V
Vout = 24.0V
Iout = 10.0A

Device = TPS40170RGYR
Topology = Buck
Created = 2021-05-12 09:58:43.560
BOM Cost = $8.10
BOM Count = 30
Total Pd = 4.38W

WEBENCH ® Design Report

Design : 6 TPS40170RGYR
TPS40170RGYR 26V-42V to 24.00V @ 10A



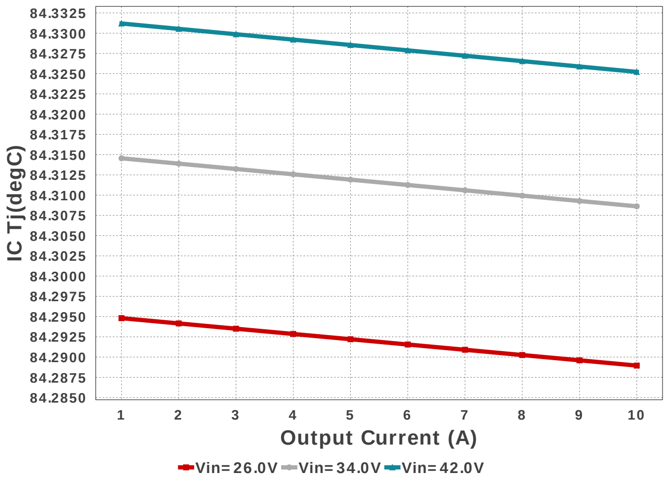
Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	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
Cbyp	Taiyo Yuden	EMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.05	0805 7 mm²
Ccomp	TDK	C2012C0G1H682J060AA Series= C0G/NP0	Cap= 6.8 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm²
Ccomp2	Samsung Electro-Mechanics	CL21C471KBANNNC Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Ccomp3	Samsung Electro-Mechanics	CL21C122JBFNNNE Series= C0G/NP0	Cap= 1.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Cilim	MuRata	GRM216R71E102KA01D Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cin	Panasonic	63SXV33M Series= SXV	Cap= 33.0 uF ESR= 25.0 mOhm VDC= 63.0 V IRMS= 2.95 A	2	$1.18	CAPSMT_62_E12 106 mm²
Cldrv	Yageo	CC0805KRX7R9BB102 Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cout	Panasonic	25TQC15MYFB Series= TQC	Cap= 15.0 uF ESR= 100.0 mOhm VDC= 25.0 V IRMS= 900.0 mA	1	$0.42	3528-21 17 mm²

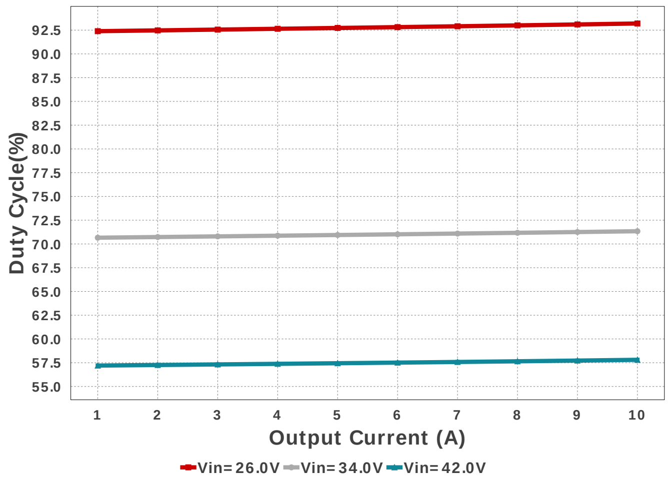
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Css	MuRata	GRM033R70J222KA01D Series= X7R	Cap= 2.2 nF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Cvdd	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm^2
Cvin	MuRata	GRM31CR72A105KA01L Series= X7R	Cap= 1.0 uF ESR= 5.334 mOhm VDC= 100.0 V IRMS= 1.55432 A	1	$0.24	1206_190 11 mm^2
L1	Coilcraft	XAL1010-822MEB	L= 8.2 µH 11.7 mOhm	1	$1.71	XAL1010 160 mm^2
M1	Texas Instruments	CSD18534Q5A	VdsMax= 60.0 V IdsMax= 100.0 Amps	2	$0.31	DQJ0008A 55 mm^2
M2	ON Semiconductor	NTMFS5C673NLT1G	VdsMax= 60.0 V IdsMax= 50.0 Amps	1	$0.34	FP- NTMFS5C673NLT1G_DFN5- MFG 0 mm^2
Rcomp	Vishay-Dale	CRCW04021K87FKED Series= CRCW..e3	Res= 1.87 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcomp2	Vishay-Dale	CRCW0402732RFKED Series= CRCW..e3	Res= 732.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcs	Vishay-Dale	CRCW020144K2FNED Series= ?	Res= 44.2 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Renb	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rent	Vishay-Dale	CRCW020144K2FNED Series= ?	Res= 44.2 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbb	Vishay-Dale	CRCW0402255RFKED Series= CRCW..e3	Res= 255.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpgood	Yageo	RC0201FR-07105KL Series= ?	Res= 105.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rscp	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rt	Yageo	RC0201FR-0718K7L Series= ?	Res= 18.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rt	Yageo	RC0201FR-0718K7L Series= ?	Res= 18.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rtrk	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	TPS40170RGYR	Switcher	1	$2.11	RGY0020A 25 mm^2

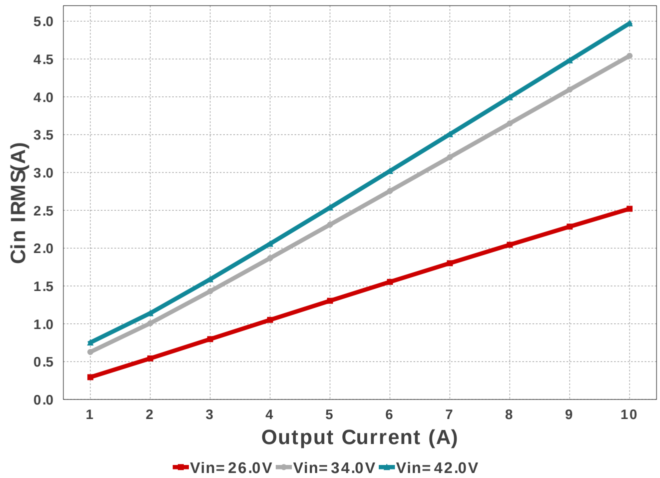
IC Tj



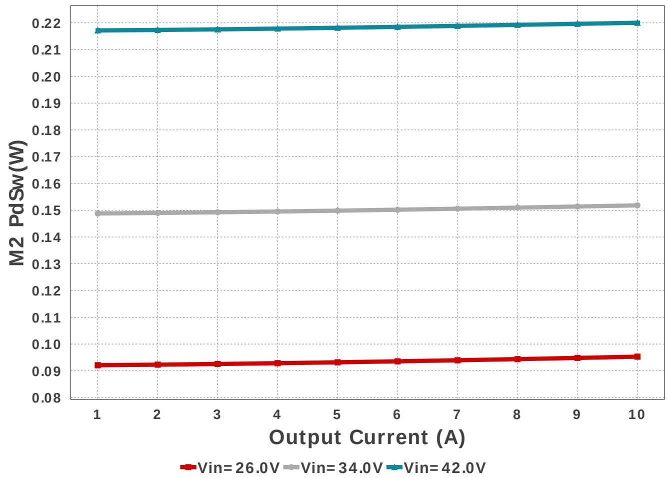
Duty Cycle



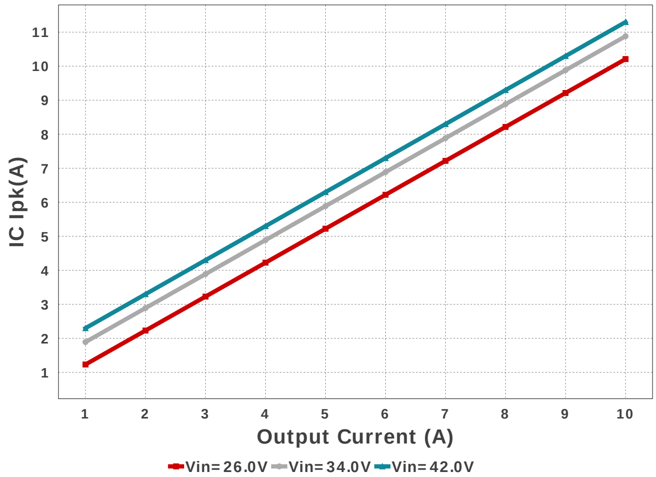
Cin IRMS



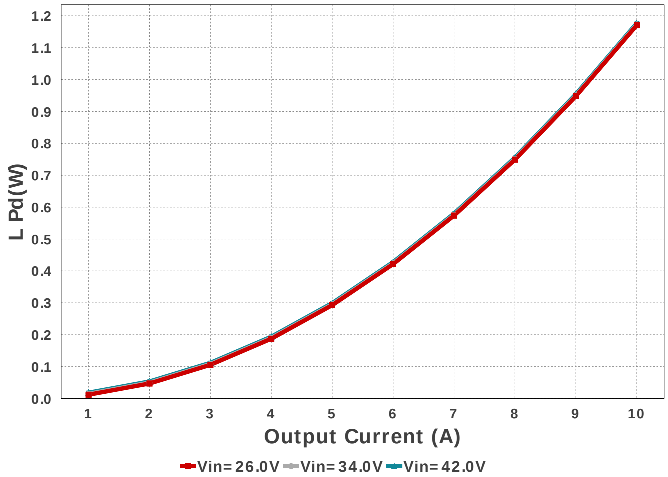
M2 PdSw

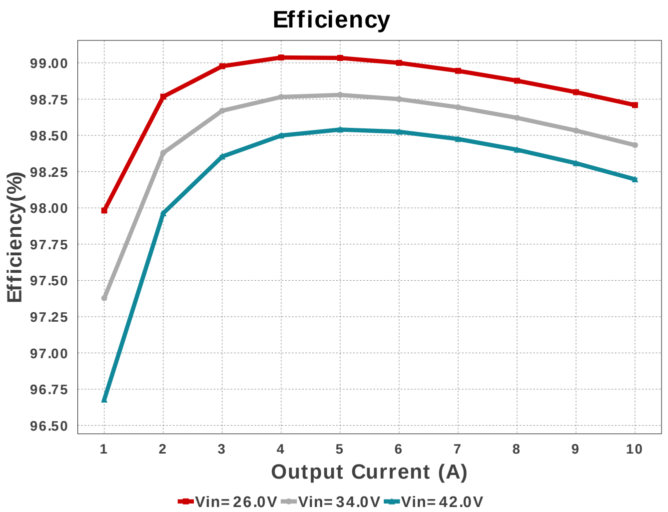


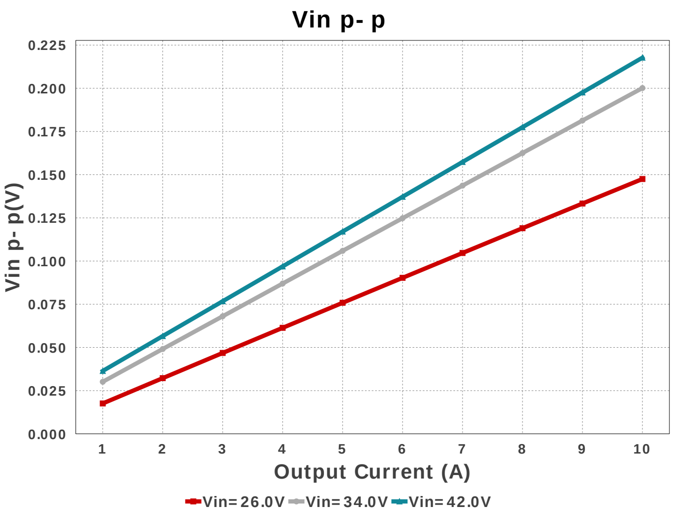
IC Ipk

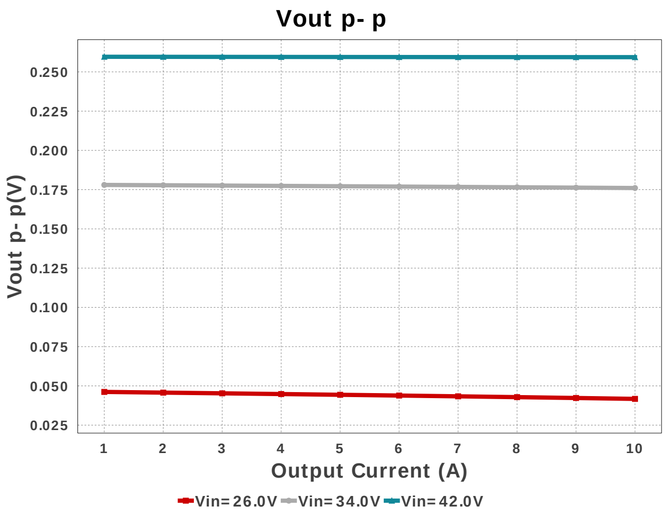


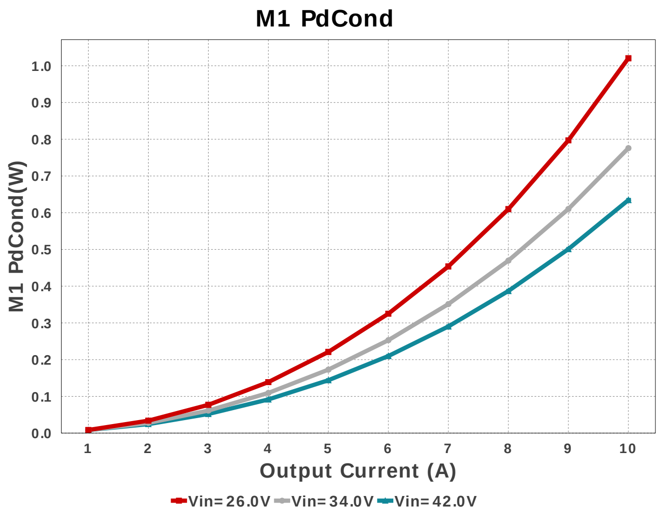
L Pd

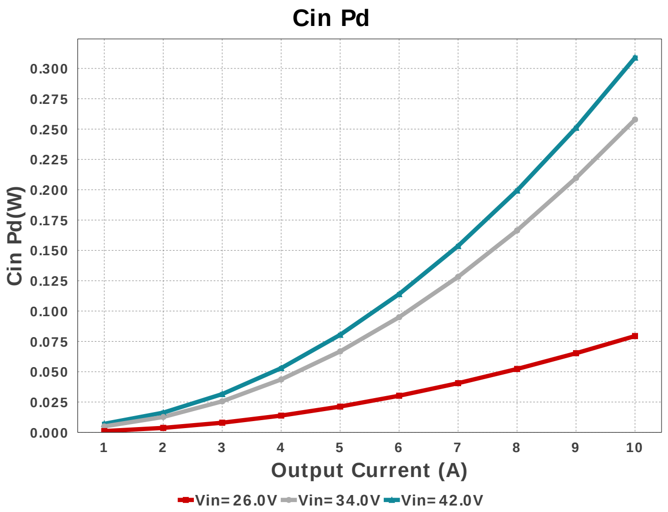


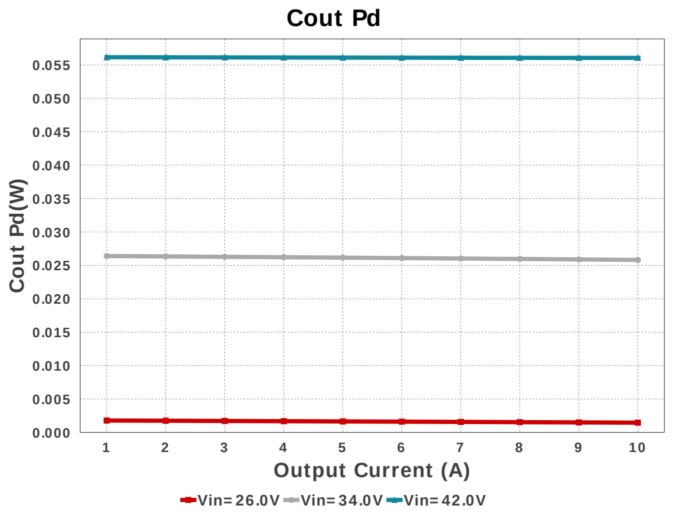

Efficiency
Efficiency(%)
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V

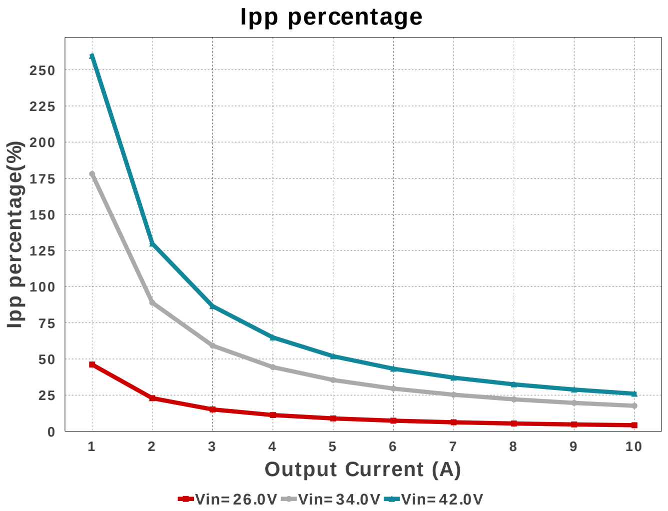

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V

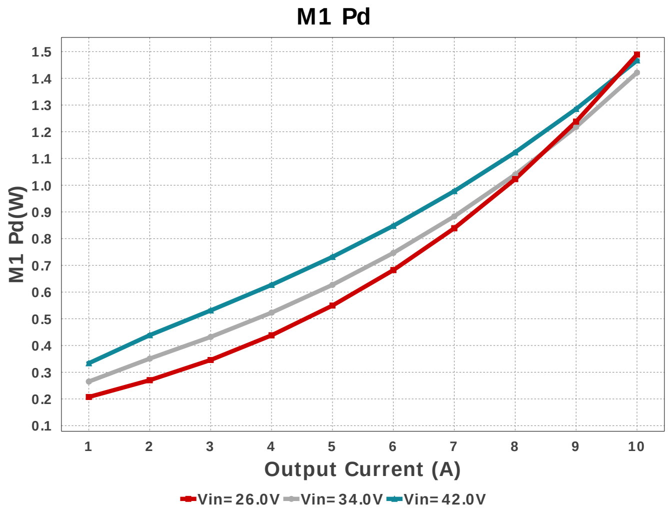

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V

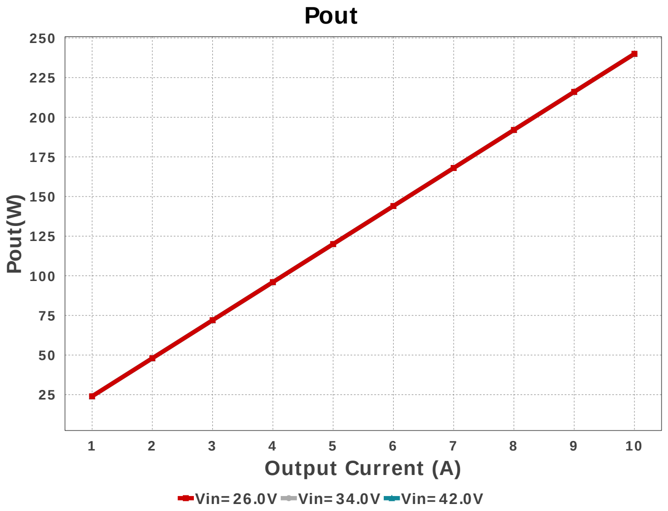

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V

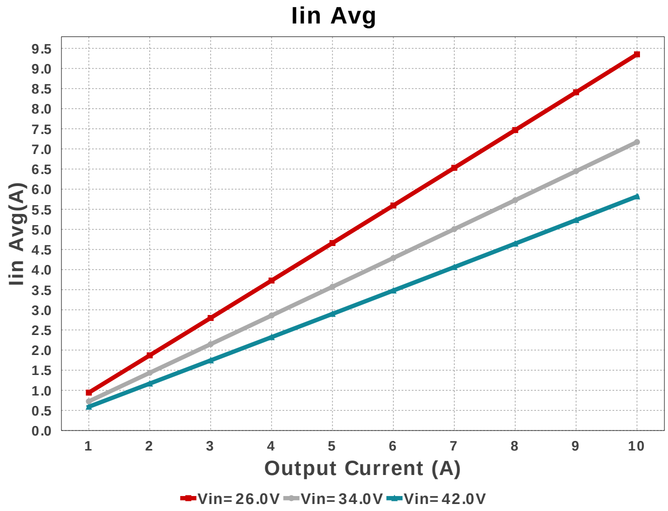

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V

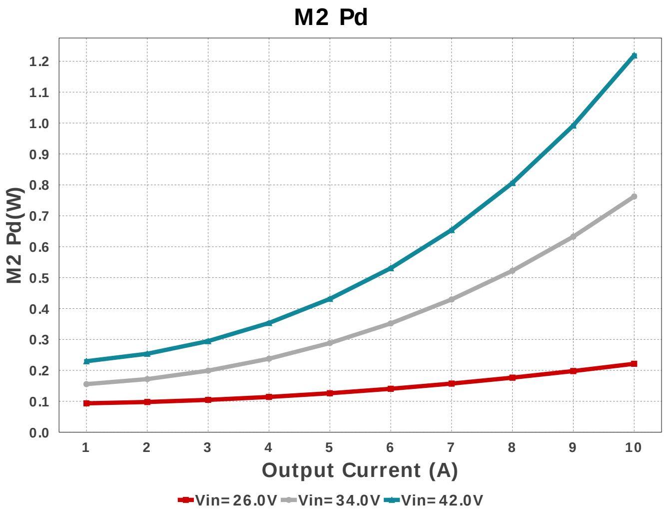

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V

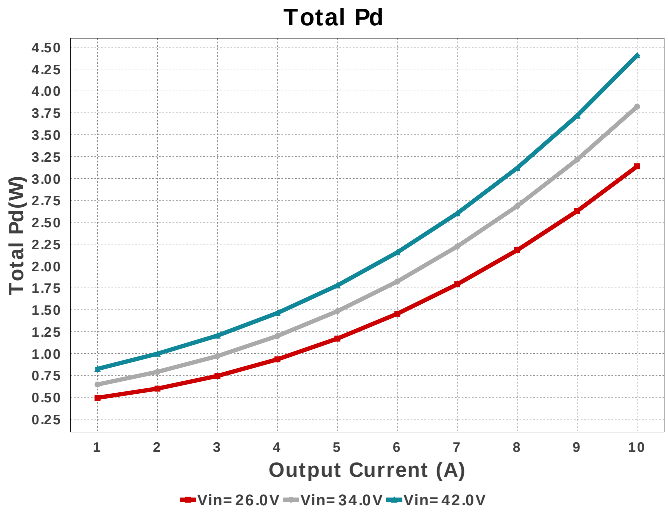

Ipp percentage
Ipp percentage(%)
250
225
200
175
150
125
100
75
50
25
0
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin= 26.0V Vin= 34.0V Vin= 42.0V

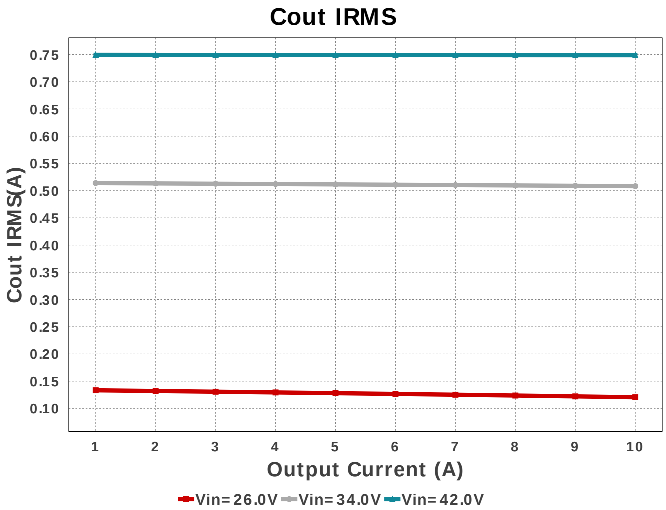

M1 Pd
M1 Pd(W)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin= 26.0V Vin= 34.0V Vin= 42.0V

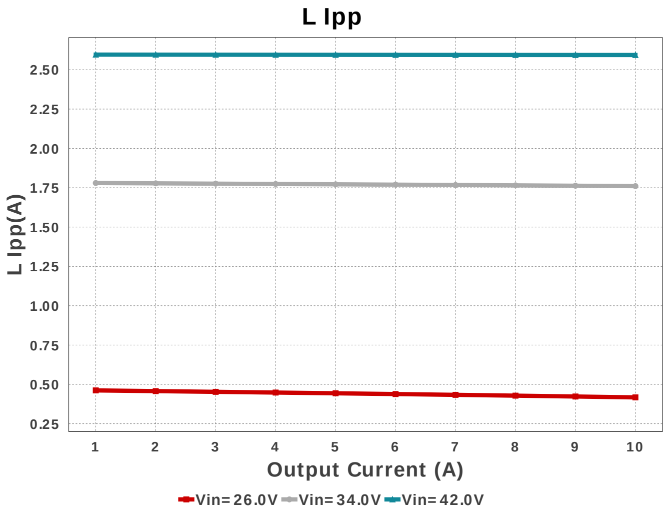

Pout
Pout(W)
250
225
200
175
150
125
100
75
50
25
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin= 26.0V Vin= 34.0V Vin= 42.0V

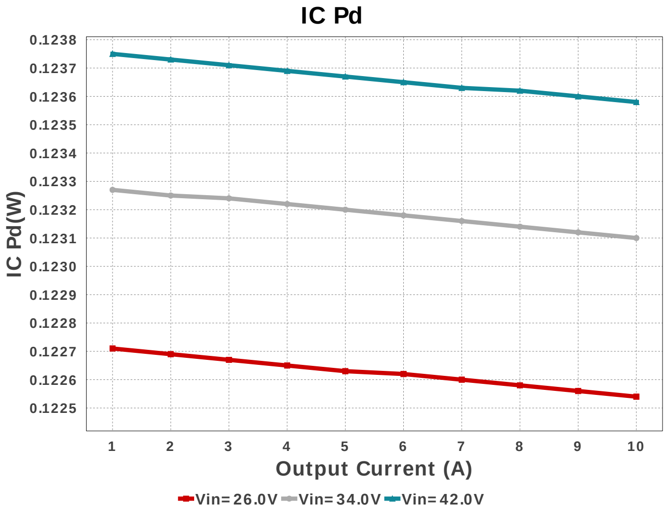

Iin Avg
Iin Avg(A)
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin= 26.0V Vin= 34.0V Vin= 42.0V

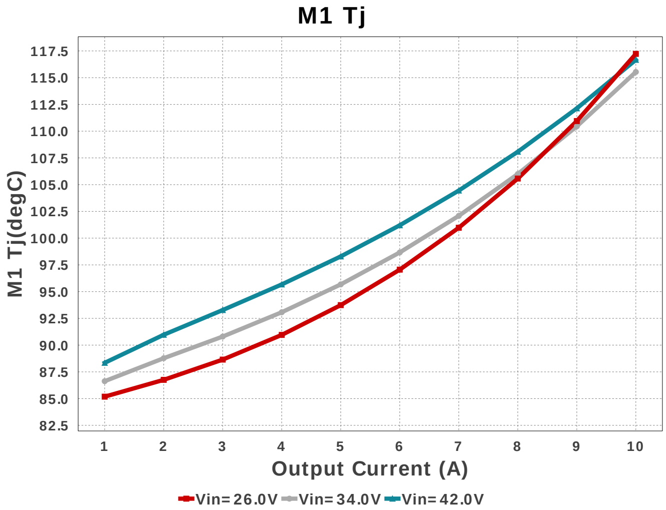

M2 Pd
M2 Pd(W)
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin= 26.0V Vin= 34.0V Vin= 42.0V

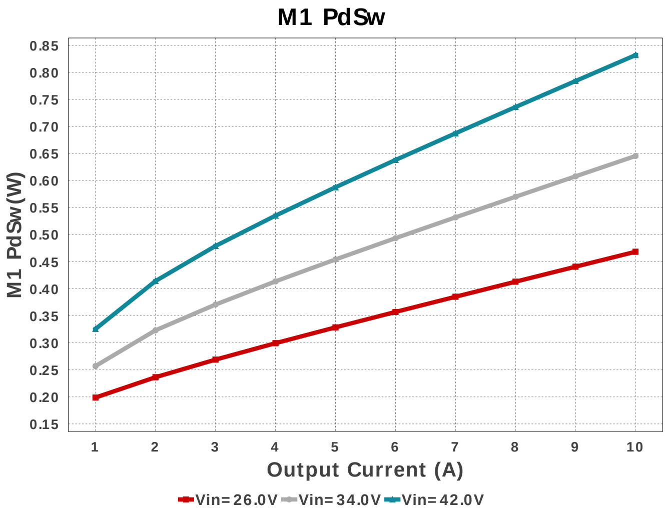

Total Pd
Total Pd(W)
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin= 26.0V Vin= 34.0V Vin= 42.0V

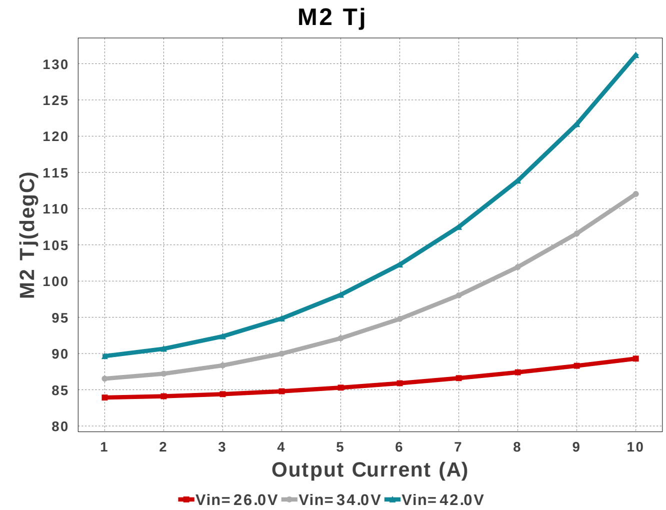

Cout IRMS
Cout IRMS(A)
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V

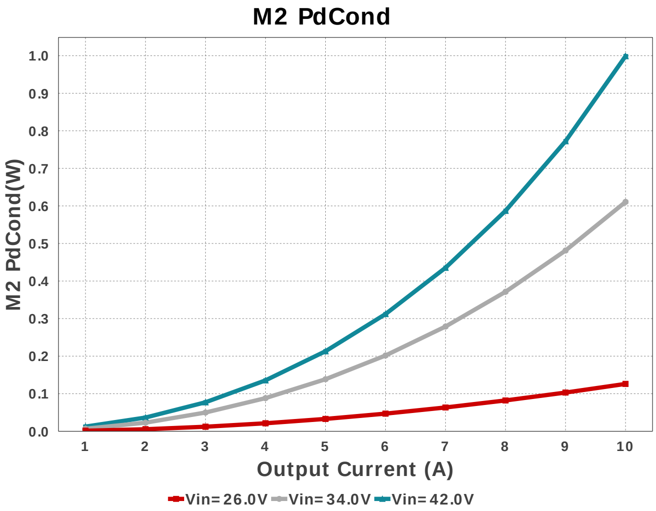

L Ipp
L Ipp(A)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V

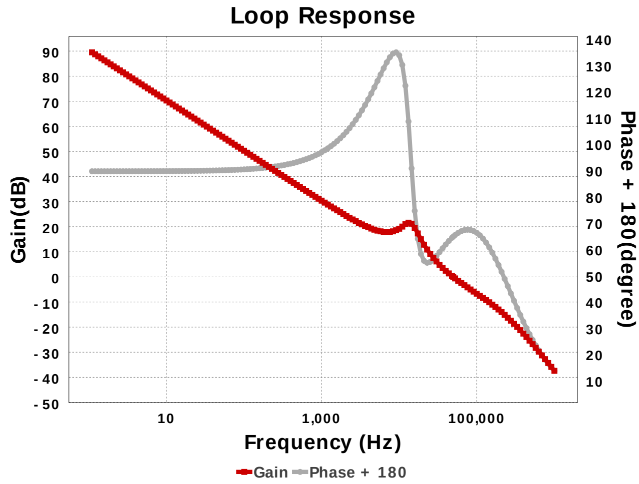

IC Pd
IC Pd(W)
0.1238
0.1237
0.1236
0.1235
0.1234
0.1233
0.1232
0.1231
0.1230
0.1229
0.1228
0.1227
0.1226
0.1225
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V


M1 Tj
M1 Tj(degC)
117.5
115.0
112.5
110.0
107.5
105.0
102.5
100.0
97.5
95.0
92.5
90.0
87.5
85.0
82.5
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V


M1 PdSw
M1 PdSw(W)
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V


M2 Tj
M2 Tj(degC)
130
125
120
115
110
105
100
95
90
85
80
1 2 3 4 5 6 7 8 9 10
Output Current (A)
Vin=26.0V Vin=34.0V Vin=42.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	4.97 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	308.74 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	730.66 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	53.386 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	11.266 A	IC	Peak switch current in IC
6.	IC Pd	126.64 mW	IC	IC power dissipation
7.	IC Tj	84.432 degC	IC	IC junction temperature
8.	IC Tolerance	6.0 µV	IC	IC Feedback Tolerance
9.	ICThetaJA	35.0 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	5.819 A	IC	Average input current
11.	Ipp percentage	25.311 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	2.531 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	1.176 W	Inductor	Inductor power dissipation
14.	M1 Pd	1.489 W	Mosfet	M1 MOSFET total power dissipation
15.	M1 PdCond	636.32 mW	Mosfet	M1 MOSFET conduction losses
16.	M1 PdSw	852.77 mW	Mosfet	M1 MOSFET switching losses
17.	M1 Tj	117.23 degC	Mosfet	M1 MOSFET junction temperature
18.	M2 Pd	1.225 W	Mosfet	M2 MOSFET total power dissipation
19.	M2 PdCond	999.86 mW	Mosfet	M2 MOSFET conduction losses
20.	M2 PdSw	225.47 mW	Mosfet	M2 MOSFET switching losses
21.	M2 Tj	131.46 degC	Mosfet	M2 MOSFET junction temperature
22.	Cin Pd	308.74 mW	Power	Input capacitor power dissipation
23.	Cout Pd	53.386 mW	Power	Output capacitor power dissipation
24.	IC Pd	126.64 mW	Power	IC power dissipation
25.	L Pd	1.176 W	Power	Inductor power dissipation
26.	M1 Pd	1.489 W	Power	M1 MOSFET total power dissipation
27.	M1 PdCond	636.32 mW	Power	M1 MOSFET conduction losses
28.	M1 PdSw	852.77 mW	Power	M1 MOSFET switching losses
29.	M2 Pd	1.225 W	Power	M2 MOSFET total power dissipation
30.	M2 PdCond	999.86 mW	Power	M2 MOSFET conduction losses
31.	M2 PdSw	225.47 mW	Power	M2 MOSFET switching losses
32.	Total Pd	4.379 W	Power	Total Power Dissipation
33.	BOM Count	30	System Information	Total Design BOM count
34.	Cross Freq	49.645 kHz	System Information	Bode plot crossover frequency
35.	Duty Cycle	57.809 %	System Information	Duty cycle
36.	Efficiency	98.208 %	System Information	Steady state efficiency
37.	FootPrint	721.0 mm^2	System Information	Total Foot Print Area of BOM components
38.	Frequency	495.05 kHz	System Information	Switching frequency
39.	Gain Marg	-48.784 dB	System Information	Bode Plot Gain Margin
40.	Iout	10.0 A	System Information	Iout operating point
41.	Low Freq Gain	89.446 dB	System Information	Gain at 1Hz

#	Name	Value	Category	Description
42.	Mode	CCM	System Information	Conduction Mode
43.	Phase Marg	65.406 deg	System Information	Bode Plot Phase Margin
44.	Pout	240.0 W	System Information	Total output power
45.	Total BOM	$8.1	System Information	Total BOM Cost
46.	Vin	42.0 V	System Information	Vin operating point
47.	Vin p-p	215.468 mV	System Information	Peak-to-peak input voltage
48.	Vout	24.0 V	System Information	Operational Output Voltage
49.	Vout Actual	24.129 V	System Information	Vout Actual calculated based on selected voltage divider resistors
50.	Vout Tolerance	1.971 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
51.	Vout p-p	253.108 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	10.0	Maximum Output Current
VinMax	42.0	Maximum input voltage
VinMin	26.0	Minimum input voltage
Vout	24.0	Output Voltage
base_pn	TPS40170	Base Product Number
source	DC	Input Source Type
Ta	80.0	Ambient temperature
UserFsw	500.0 k	Customer Selected Frequency

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

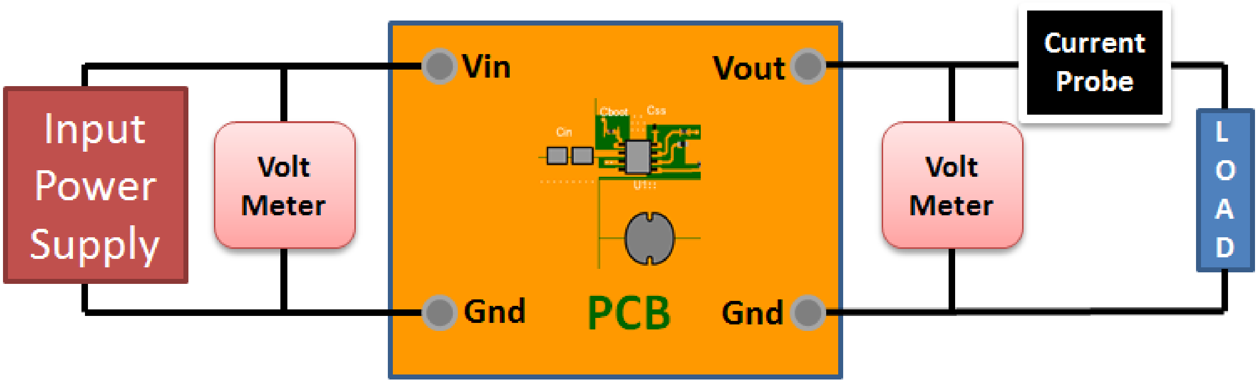
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 26.0V 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 : 553AF4EFC9030A83[v1]

2. **TPS40170** Product Folder : http://www.ti.com/product/TPS40170 : contains the data sheet and other resources.

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