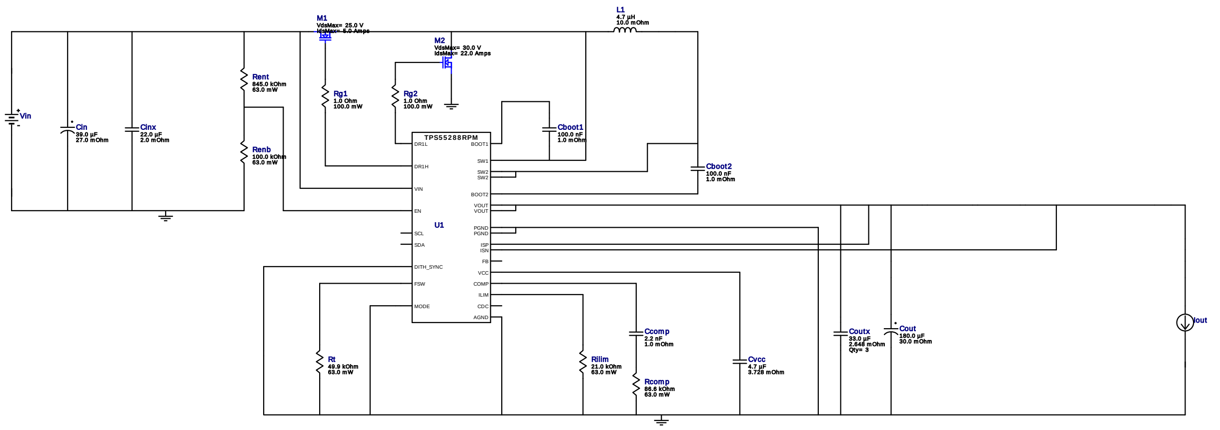
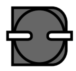
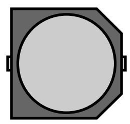
VinMin = 11.5V VinMax = 12.5V Vout = 5.0V Iout = 3.5A	Device = TPS55288RPMR Topology = Buck_Boost Created = 2022-03-22 01:57:34.136 BOM Cost = $5.56 BOM Count = 21 Total Pd = 0.72W

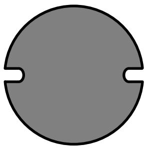
WEBENCH ® Design Report

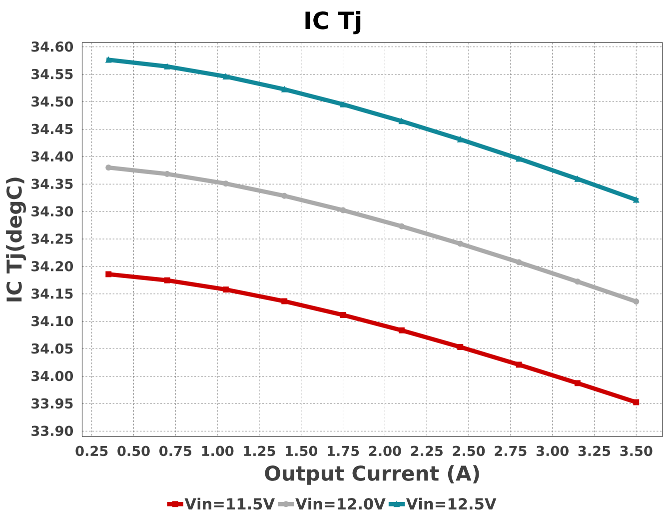
Design : 155 TPS55288RPMR
TPS55288RPMR 11.5V-12.5V to 5.00V @ 3.5A

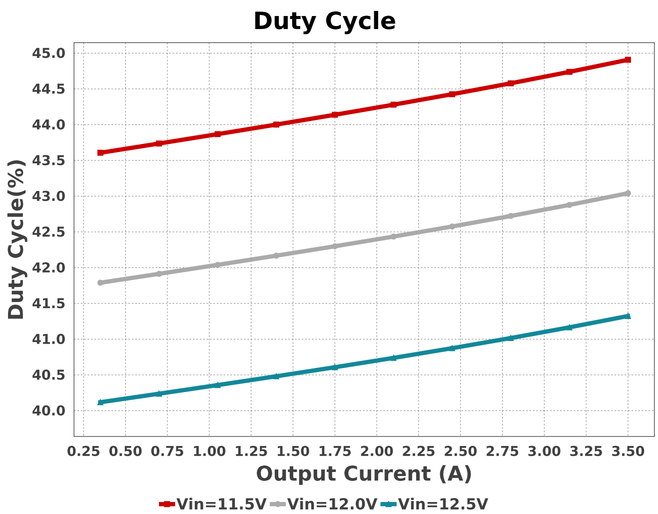


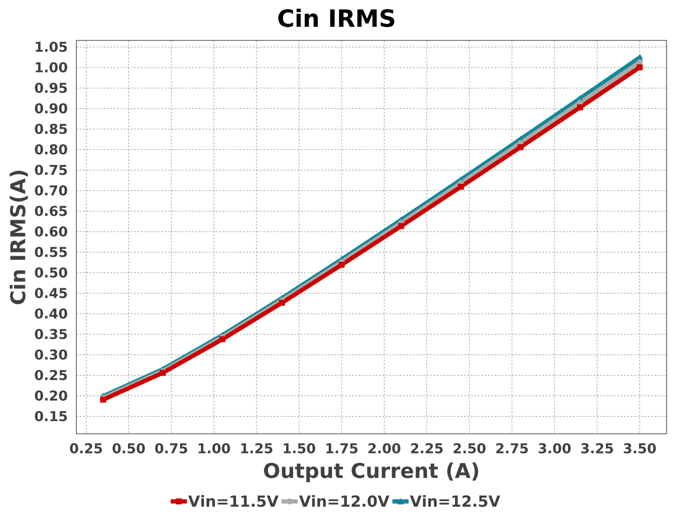
Electrical BOM

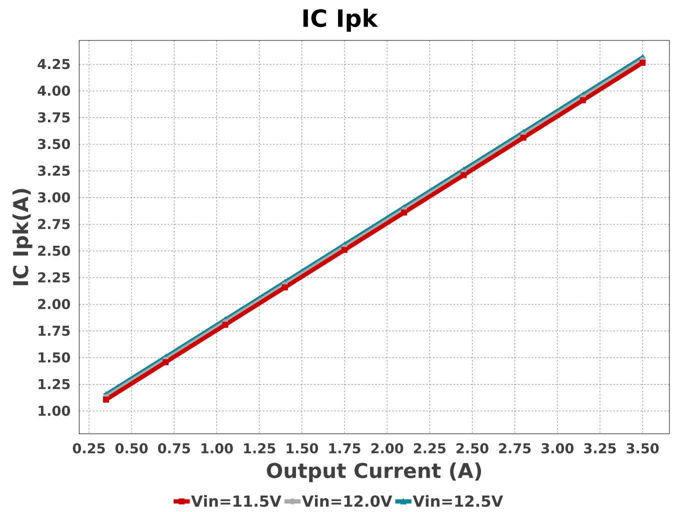
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot1	Taiyo Yuden	EMK107B7104KA-T Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cboot2	Taiyo Yuden	EMK107B7104KA-T Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Ccomp	MuRata	GRM155R71C222KA01D Series= X7R	Cap= 2.2 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	Panasonic	16SVPC39MV Series= SVPC	Cap= 39.0 uF ESR= 27.0 mOhm VDC= 16.0 V IRMS= 2.35 A	1	$0.29	 SM_RADIAL_5MM 58 mm^2
Cinx	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	1	$0.65	1210 15 mm^2
Cout	Panasonic	16SVP180MX Series= SVP	Cap= 180.0 uF ESR= 30.0 mOhm VDC= 16.0 V IRMS= 3.02 A	1	$0.30	 SM_RADIAL_10AMM 160 mm^2
Coutx	TDK	C3216X6S1A336M160AC Series= X6S	Cap= 33.0 uF ESR= 2.648 mOhm VDC= 10.0 V IRMS= 4.4586 A	3	$0.32	1206_180 11 mm^2
Cvcc	TDK	C1608X6S1C475K080AC Series= X6S	Cap= 4.7 uF ESR= 3.728 mOhm VDC= 16.0 V IRMS= 2.69359 A	1	$0.08	0603 5 mm^2

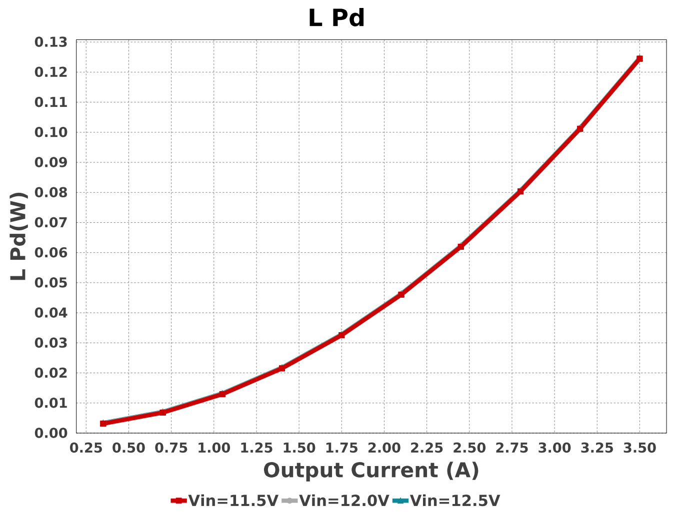
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Bourns	SDR1307-4R7ML	L= 4.7 µH 10.0 mOhm	1	$0.42	 SDR1307 226 mm^2
M1	Texas Instruments	CSD16301Q2	VdsMax= 25.0 V IdsMax= 5.0 Amps	1	$0.13	DQK0006C 9 mm^2
M2	Texas Instruments	CSD17571Q2	VdsMax= 30.0 V IdsMax= 22.0 Amps	1	$0.11	DQK0006C 9 mm^2
Rcomp	Yageo	AC0402FR-0786K6L Series= ?	Res= 86.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Renb	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rent	Vishay-Dale	CRCW0402845KFKED Series= CRCW..e3	Res= 845.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rg1	Vishay-Dale	CRCW06031R00FKEA Series= CRCW..e3	Res= 1.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rg2	Vishay-Dale	CRCW06031R00FKEA Series= CRCW..e3	Res= 1.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rilim	Vishay-Dale	CRCW040221K0FKED Series= CRCW..e3	Res= 21.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rt	Vishay-Dale	CRCW040249K9FKED Series= CRCW..e3	Res= 49.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS55288RPMR	Switcher	1	$2.52	RPM0026A 22 mm^2

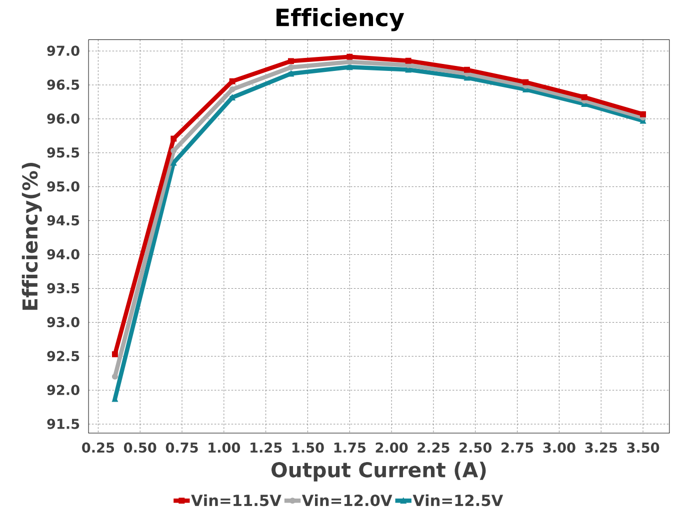


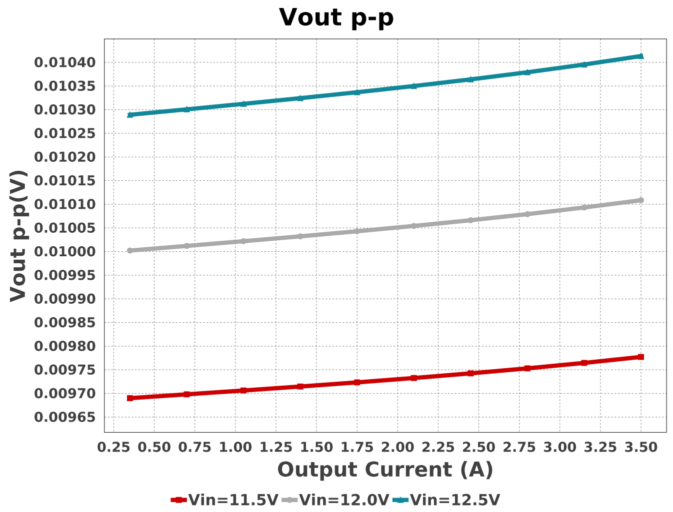


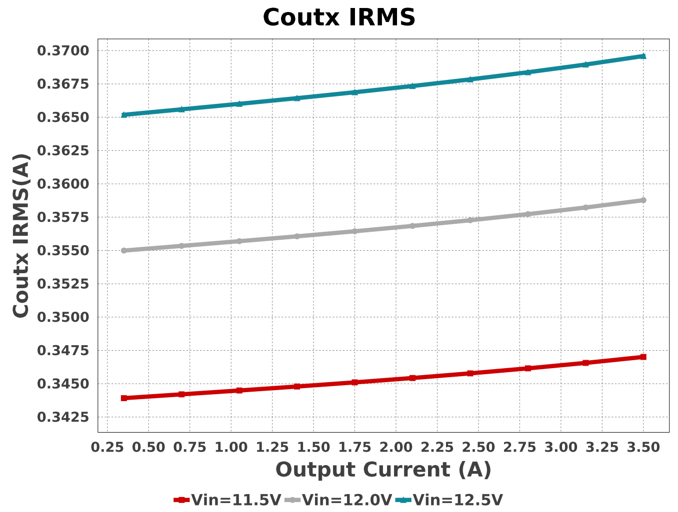

Cin IRMS
Cin IRMS(A)
1.05 1.00 0.95 0.90 0.85 0.80 0.75 0.70 0.65 0.60 0.55 0.50 0.45 0.40 0.35 0.30 0.25 0.20 0.15
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V


IC Ipk
IC Ipk(A)
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
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V

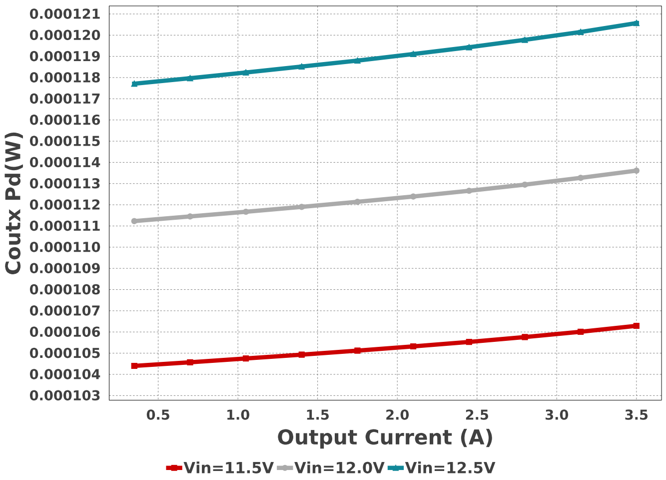

L Pd
L Pd(W)
0.13 0.12 0.11 0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.02 0.01 0.00
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V


Efficiency
Efficiency(%)
97.0 96.5 96.0 95.5 95.0 94.5 94.0 93.5 93.0 92.5 92.0 91.5
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V

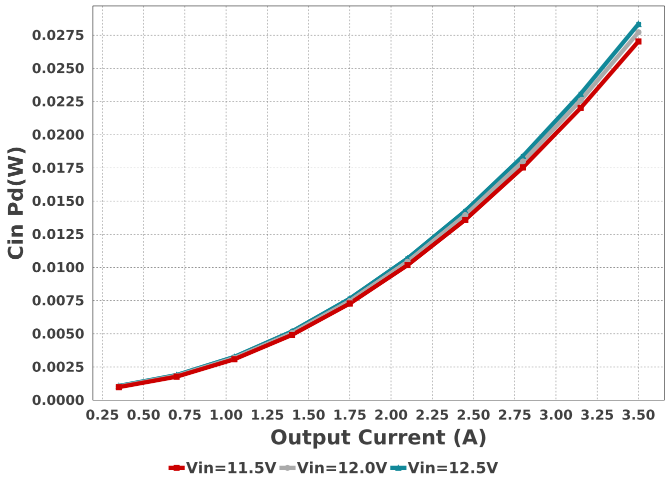

Vout p-p
Vout p-p(V)
0.01040 0.01035 0.01030 0.01025 0.01020 0.01015 0.01010 0.01005 0.01000 0.00995 0.00990 0.00985 0.00980 0.00975 0.00970 0.00965
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V


Coutx IRMS
Coutx IRMS(A)
0.3700 0.3675 0.3650 0.3625 0.3600 0.3575 0.3550 0.3525 0.3500 0.3475 0.3450 0.3425
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V

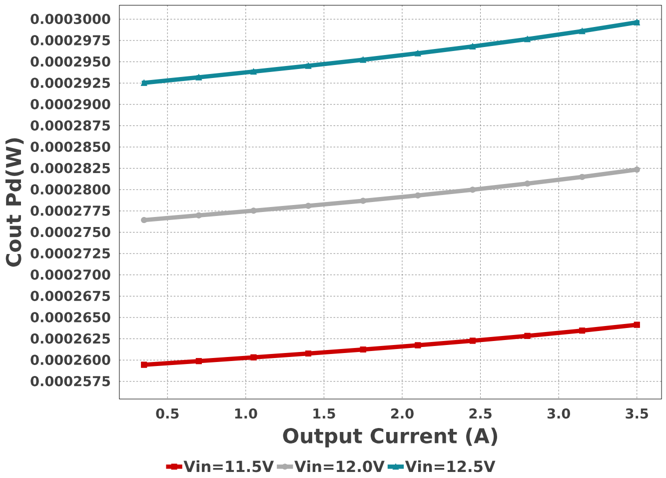
Coutx Pd



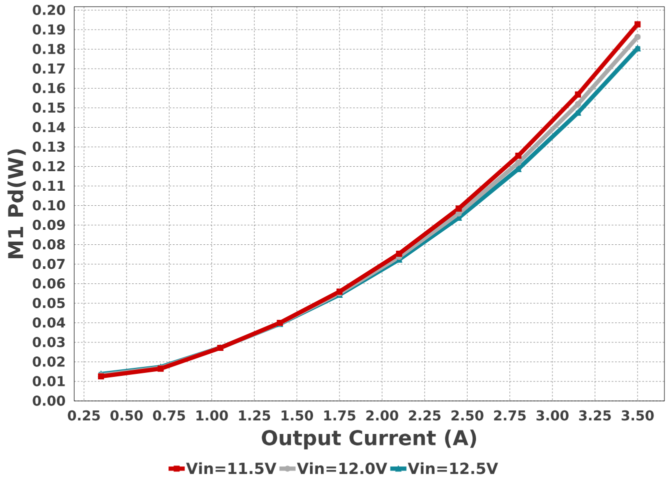
Cin Pd



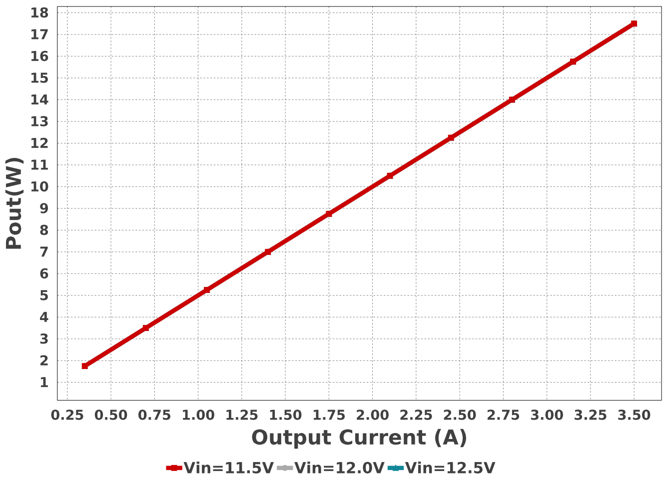
Cout Pd



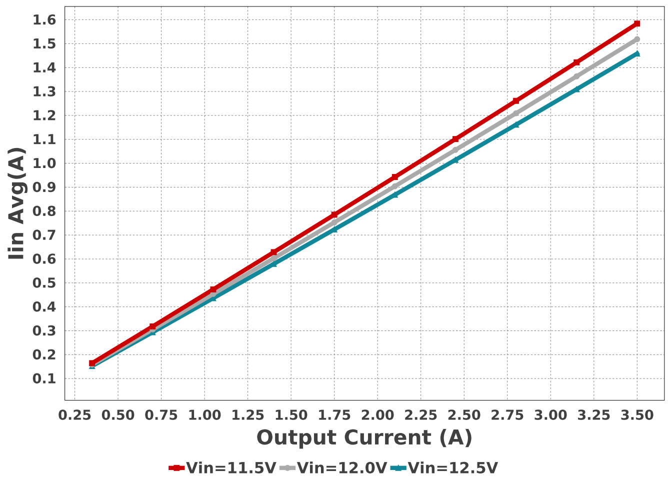
M1 Pd

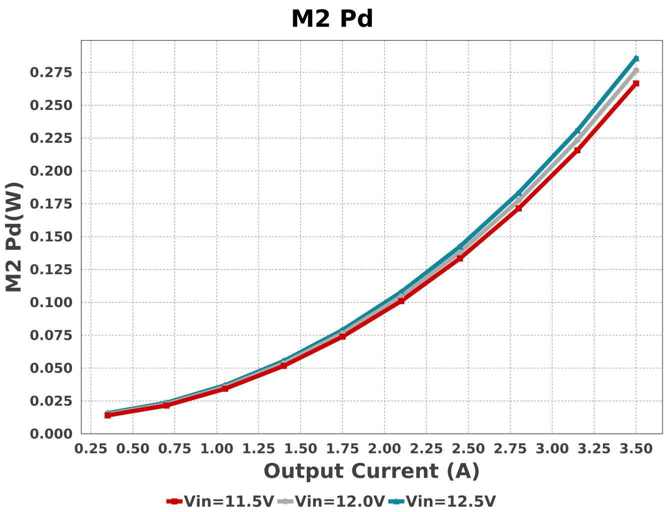


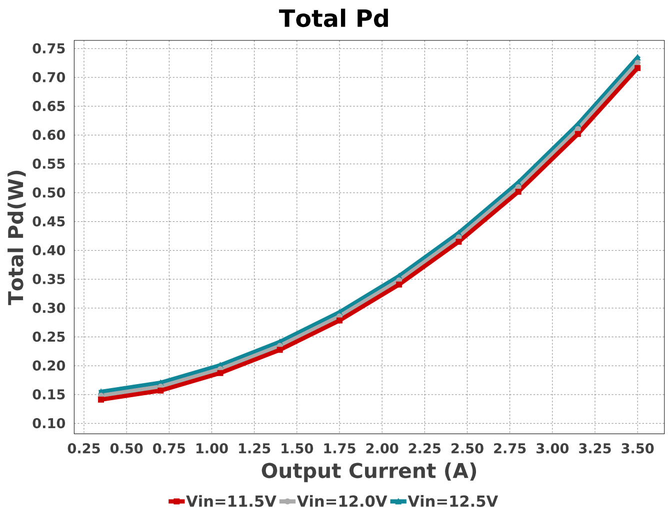
Pout

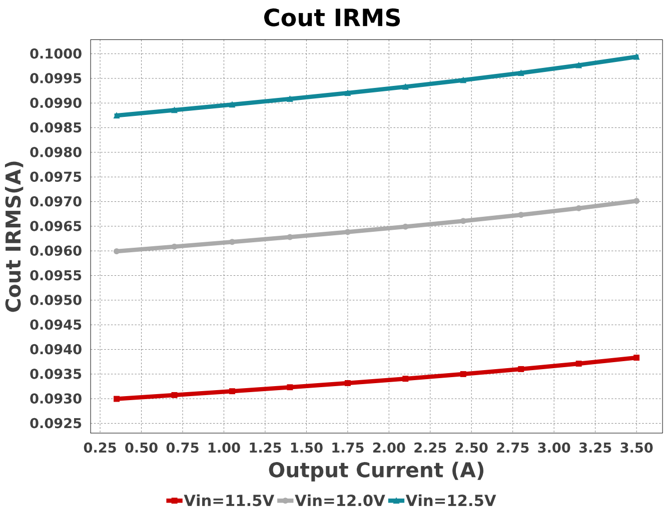


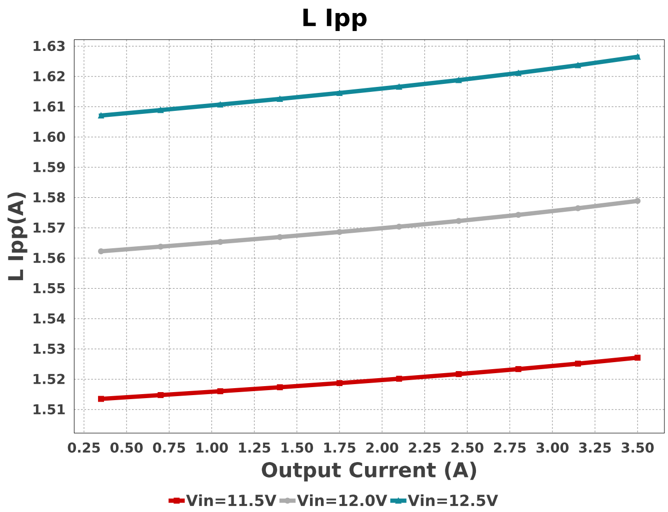
Iin Avg

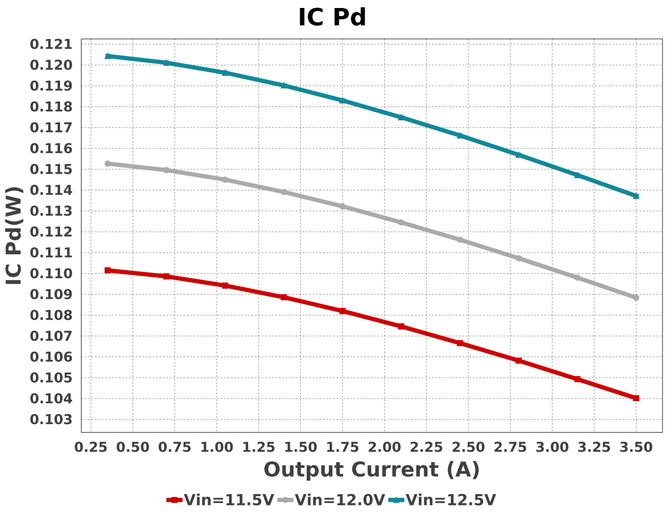


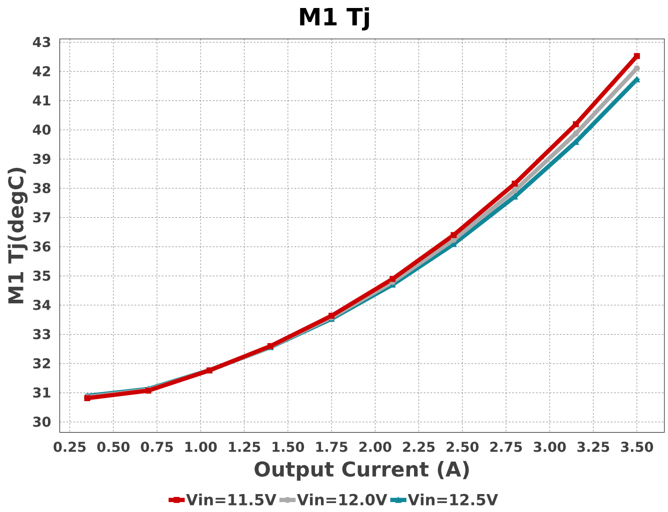

M2 Pd
M2 Pd(W)
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V

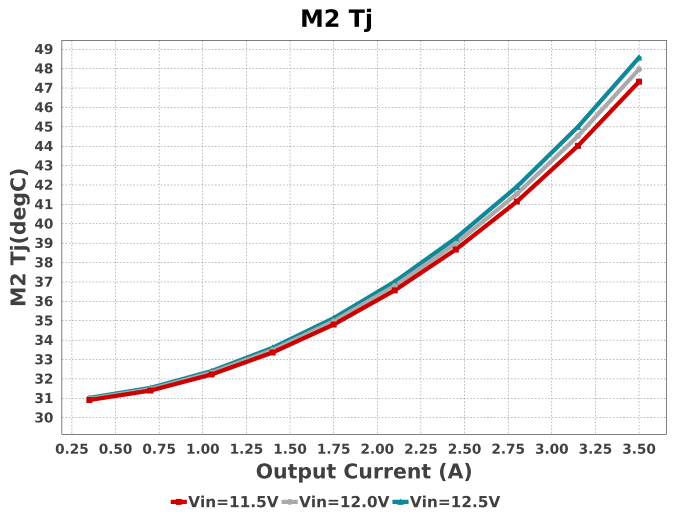

Total Pd
Total Pd(W)
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V

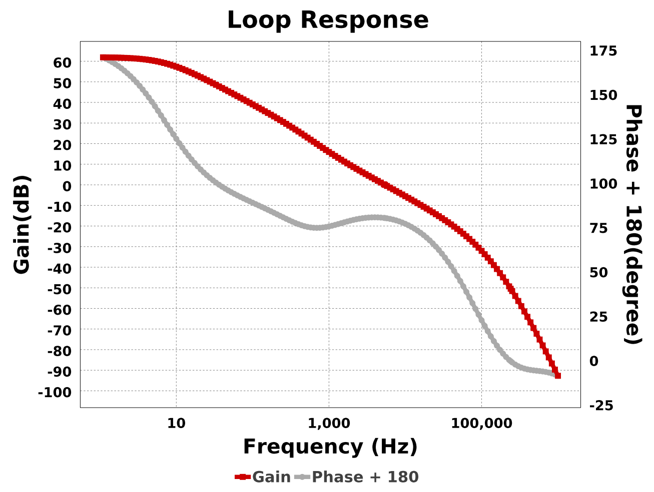

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V

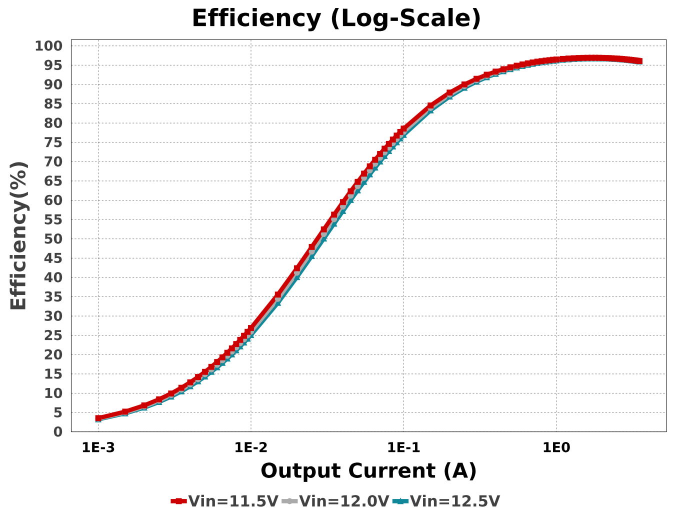

L Ipp
L Ipp(A)
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V


IC Pd
IC Pd(W)
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V


M1 Tj
M1 Tj(degC)
Output Current (A)
Vin=11.5V Vin=12.0V Vin=12.5V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.001 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	27.033 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	93.833 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	264.14 µW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	347.01 mA	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	106.29 µW	Capacitor	Output capacitor_x power loss
7.	IC Ipk	4.264 A	IC	Peak switch current in IC
8.	IC Pd	104.02 mW	IC	IC power dissipation
9.	IC Tj	33.953 degC	IC	IC junction temperature
10.	IC Tolerance	12.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	38.0 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	1.584 A	IC	Average input current
13.	L Ipp	1.527 A	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	124.44 mW	Inductor	Inductor power dissipation
15.	M1 Pd	192.74 mW	Mosfet	M1 MOSFET total power dissipation
16.	M1 Tj	42.528 degC	Mosfet	M1 MOSFET junction temperature
17.	M2 Pd	266.57 mW	Mosfet	M2 MOSFET total power dissipation
18.	M2 Tj	47.327 degC	Mosfet	M2 MOSFET junction temperature
19.	Cin Pd	27.033 mW	Power	Input capacitor power dissipation
20.	Cout Pd	264.14 µW	Power	Output capacitor power dissipation
21.	Coutx Pd	106.29 µW	Power	Output capacitor_x power loss
22.	IC Pd	104.02 mW	Power	IC power dissipation
23.	L Pd	124.44 mW	Power	Inductor power dissipation
24.	M1 Pd	192.74 mW	Power	M1 MOSFET total power dissipation
25.	M2 Pd	266.57 mW	Power	M2 MOSFET total power dissipation
26.	Total Pd	716.253 mW	Power	Total Power Dissipation
27.	BOM Count	21	System Information	Total Design BOM count
28.	Cross Freq	5.41 kHz	System Information	Bode plot crossover frequency
29.	Duty Cycle	44.907 %	System Information	Duty cycle

#	Name	Value	Category	Description
30.	Efficiency	96.068 %	System Information	Steady state efficiency
31.	FootPrint	574.0 mm^2	System Information	Total Foot Print Area of BOM components
32.	Frequency	397.614 kHz	System Information	Switching frequency
33.	Gain Marg	-55.048 dB	System Information	Bode Plot Gain Margin
34.	Iout	3.5 A	System Information	Iout operating point
35.	Low Freq Gain	61.884 dB	System Information	Gain at 1Hz
36.	Mode	CCM	System Information	Conduction Mode
37.	Phase Marg	80.726 deg	System Information	Bode Plot Phase Margin
38.	Pout	17.5 W	System Information	Total output power
39.	Total BOM	$5.56	System Information	Total BOM Cost
40.	Vin	11.5 V	System Information	Vin operating point
41.	Vout	5.0 V	System Information	Operational Output Voltage
42.	Vout Tolerance	240.0 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
43.	Vout p-p	9.777 mV	System Information	Peak-to-peak output ripple voltage
44.	Vref	d2	System Information	Register VREF

Design Inputs

Name	Value	Description
Iout	3.5	Maximum Output Current
VinMax	12.5	Maximum input voltage
VinMin	11.5	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	TPS55288	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

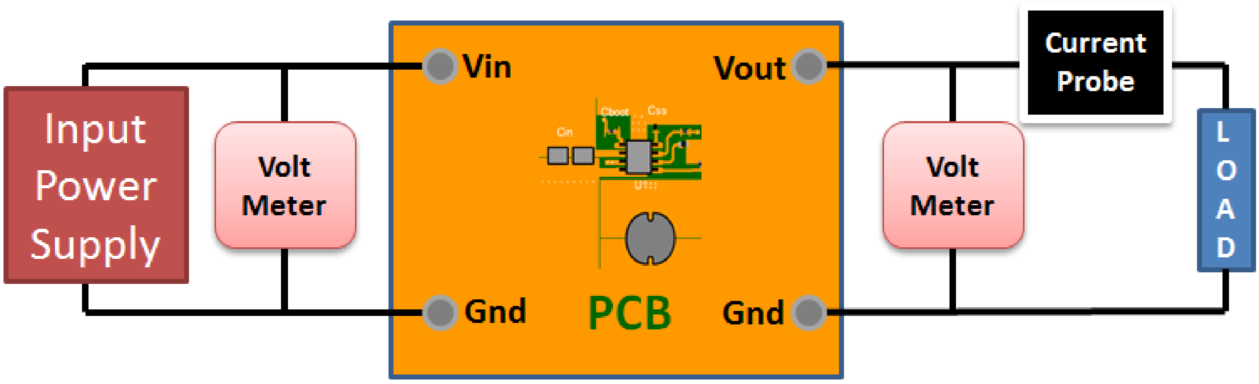
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 11.5V 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 : 08753044EC99A9F1[v1]

2. **TPS55288** Product Folder : http://www.ti.com/product/TPS55288 : contains the data sheet and other resources.

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