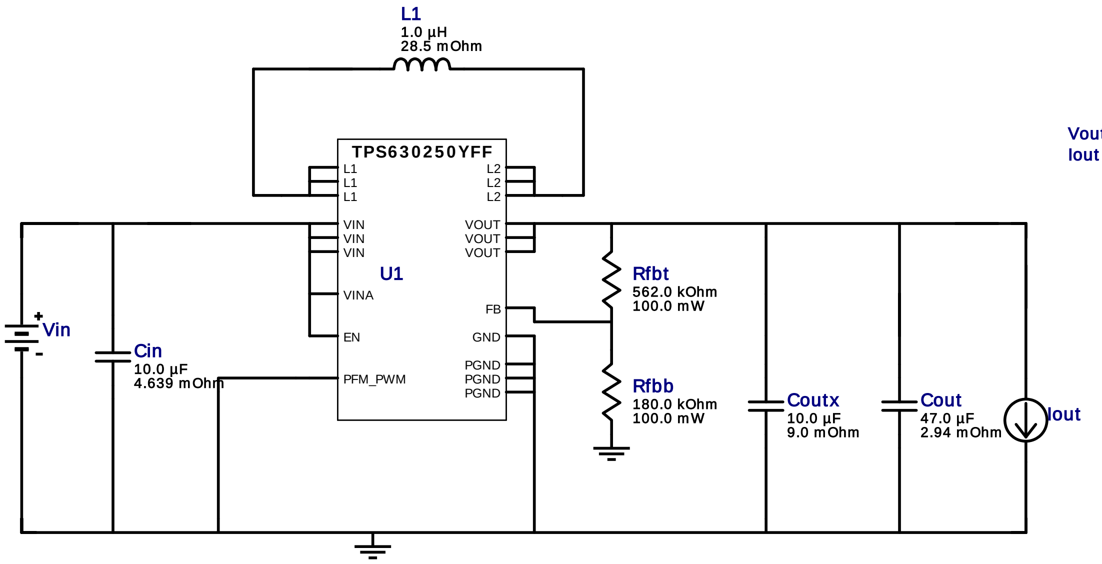
Texas Instruments

WEBENCH® Design Report

VinMin = 2.7V
VinMax = 5.5V
Vout = 3.3V
Iout = 2.0A

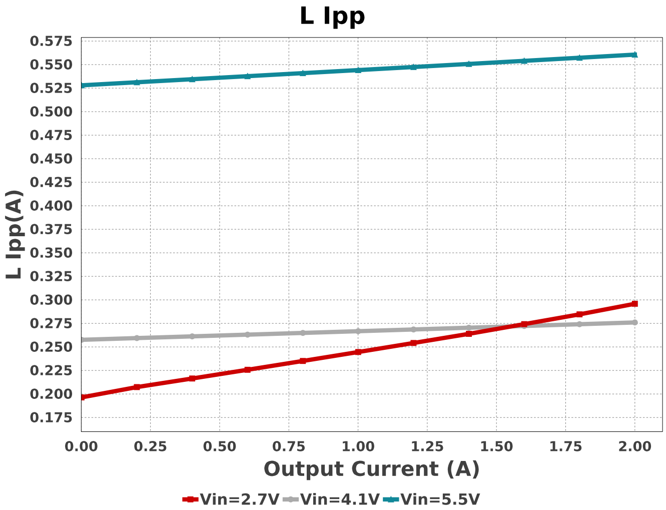
Device = TPS630250YFFR
Topology = Buck_Boost
Created = 2025-01-11 12:17:54.314
BOM Cost = $2.16
BOM Count = 7
Total Pd = 0.56W

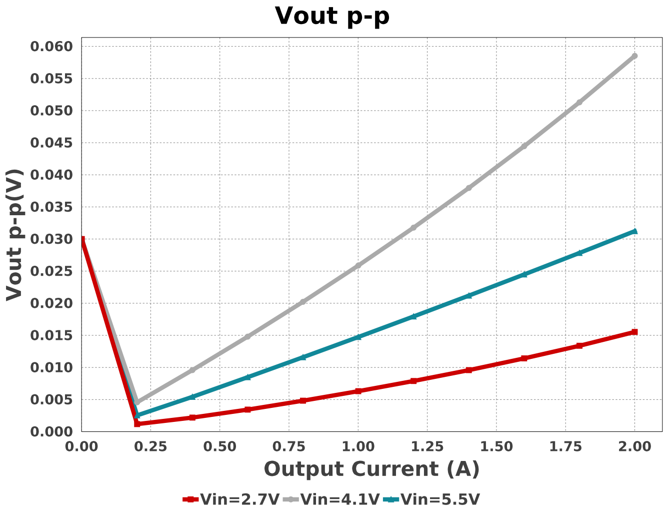
Design : 7 TPS630250YFFR
TPS630250YFFR 2.7V-5.5V to 3.30V @ 2A

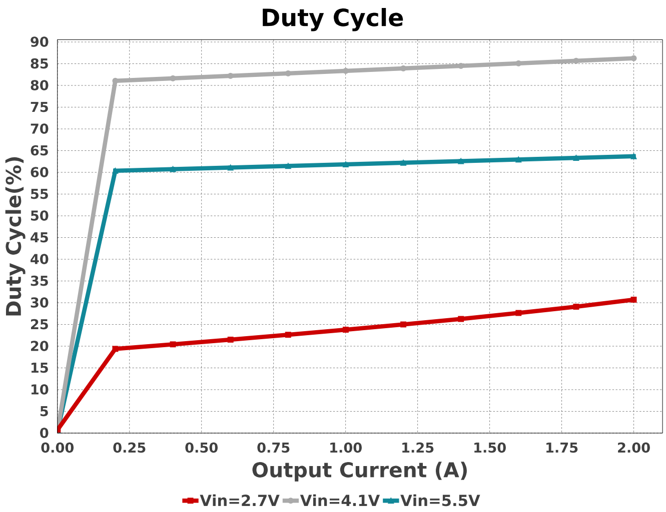


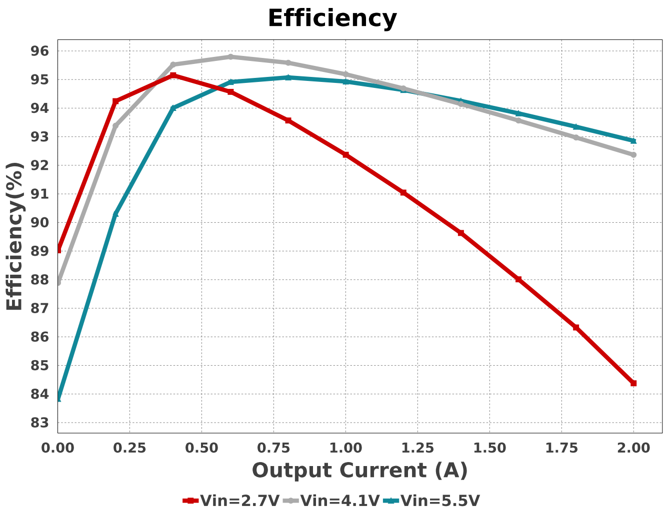
Electrical BOM

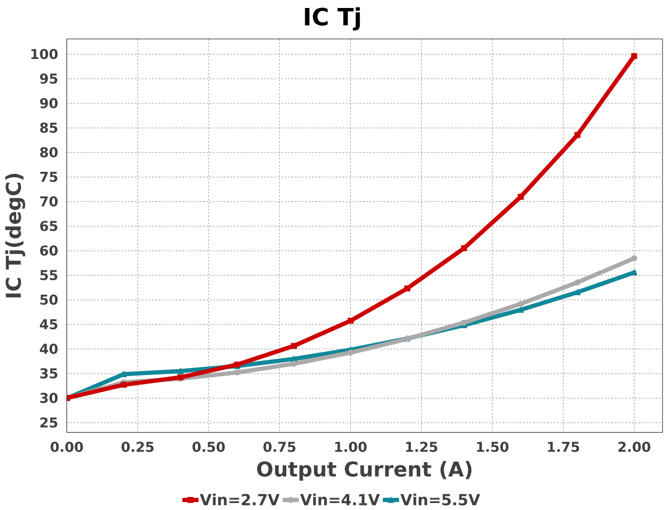
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	TDK	C1608X5R1A106K080AC Series= X5R	Cap= 10.0 uF ESR= 4.639 mOhm VDC= 10.0 V IRMS= 2.4141 A	1	$0.09	0603 5 mm²
Cout	TDK	C2012X5R1A476M125AC Series= X5R	Cap= 47.0 uF ESR= 2.94 mOhm VDC= 10.0 V IRMS= 3.80451 A	1	$0.28	0805 7 mm²
Coutx	MuRata	GRM188R60J106ME47D Series= X5R	Cap= 10.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 2.74 A	1	$0.03	0603 5 mm²
L1	Wurth Elektronik	74438336010HT	L= 1.0 µH 28.5 mOhm	1	$0.94	WE-MAPI_3020 16 mm²
Rfbb	Yageo	RC0603FR-07180KL Series= ?	Res= 180.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbt	Vishay-Dale	CRCW0603562KFKEA Series= CRCW..e3	Res= 562.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
U1	Texas Instruments	TPS630250YFFR	Switcher	1	$0.80	YFF0020AJAF 9 mm²

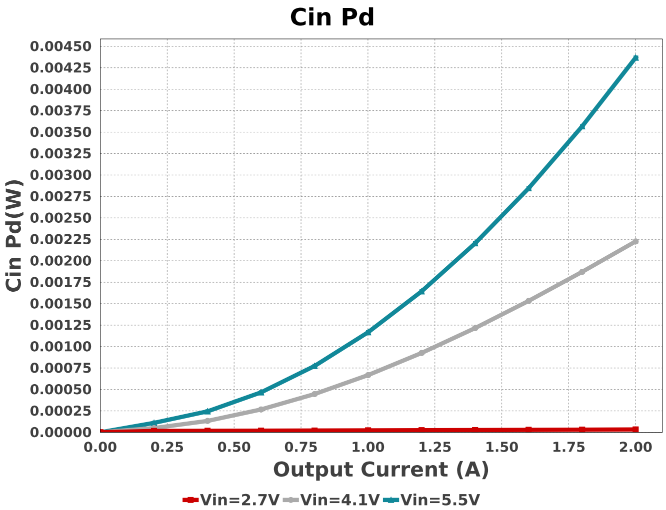

L Ipp
L Ipp(A)
0.575
0.550
0.525
0.500
0.475
0.450
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

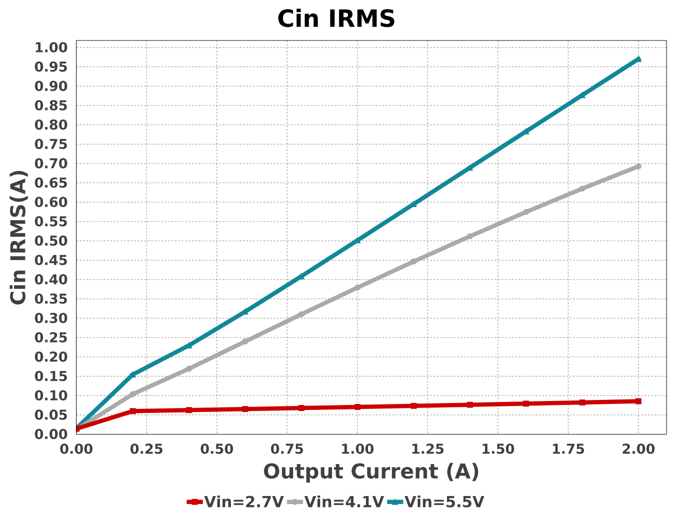

Vout p-p
Vout p-p(V)
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

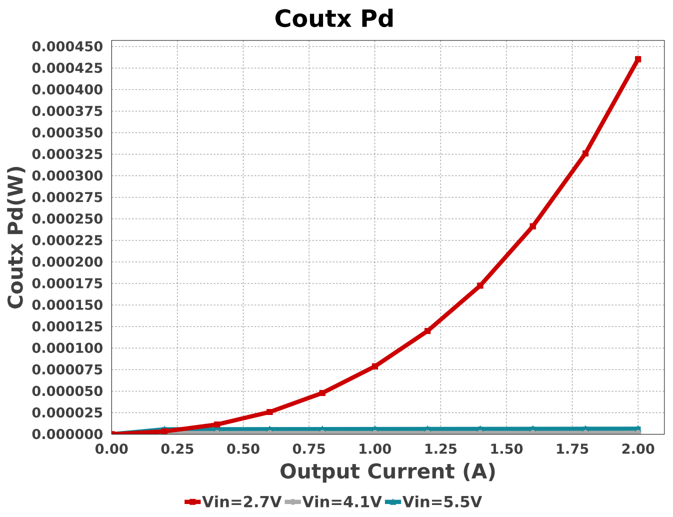

Duty Cycle
Duty Cycle(%)
90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

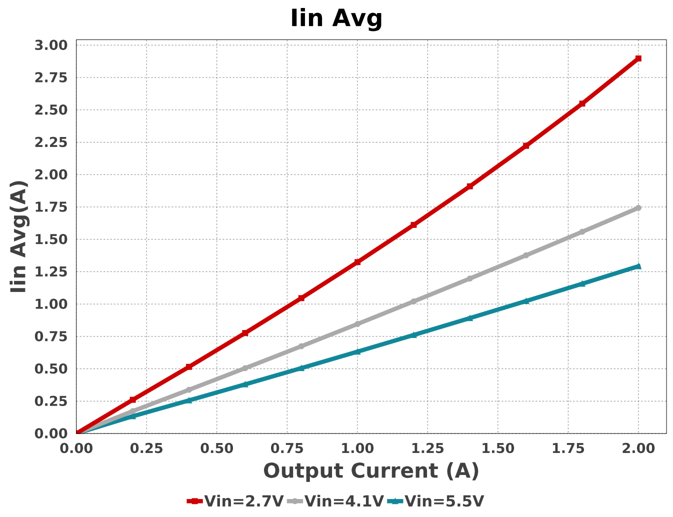

Efficiency
Efficiency(%)
96 95 94 93 92 91 90 89 88 87 86 85 84 83
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

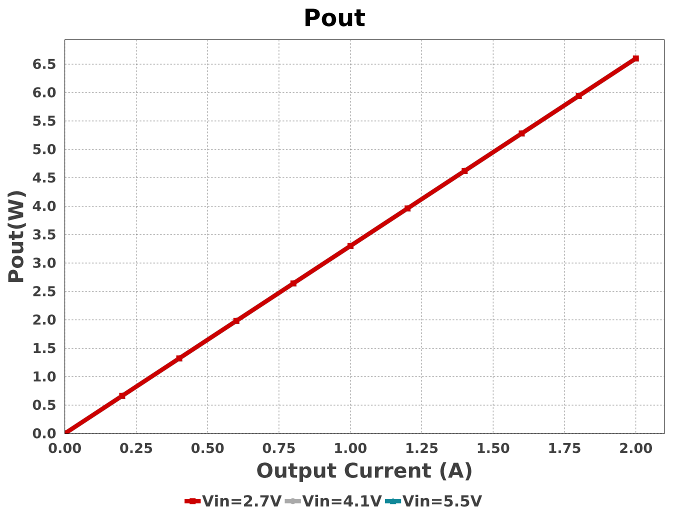

IC Tj
IC Tj(degC)
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

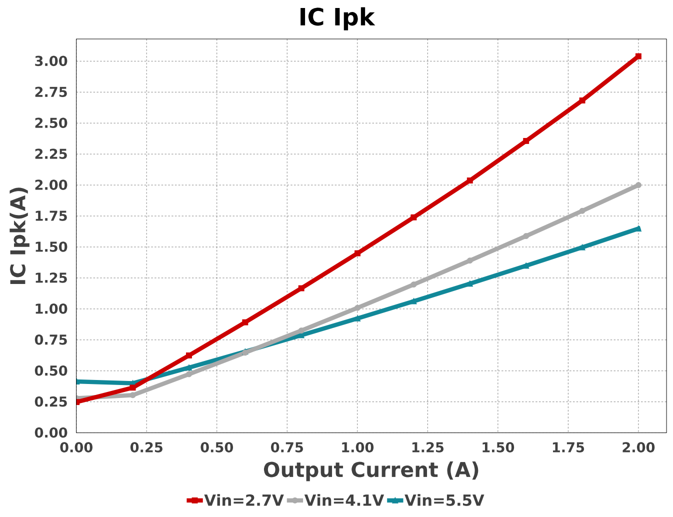

Cin Pd
Cin Pd(W)
0.00450
0.00425
0.00400
0.00375
0.00350
0.00325
0.00300
0.00275
0.00250
0.00225
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

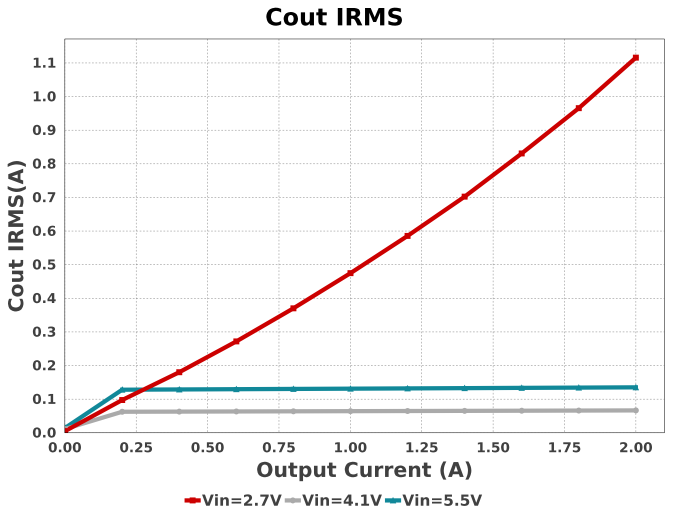

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

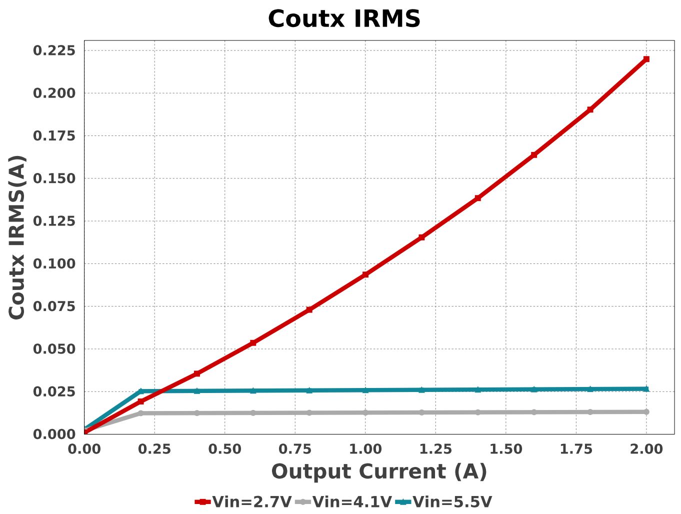

Coutx Pd
Coutx Pd(W)
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

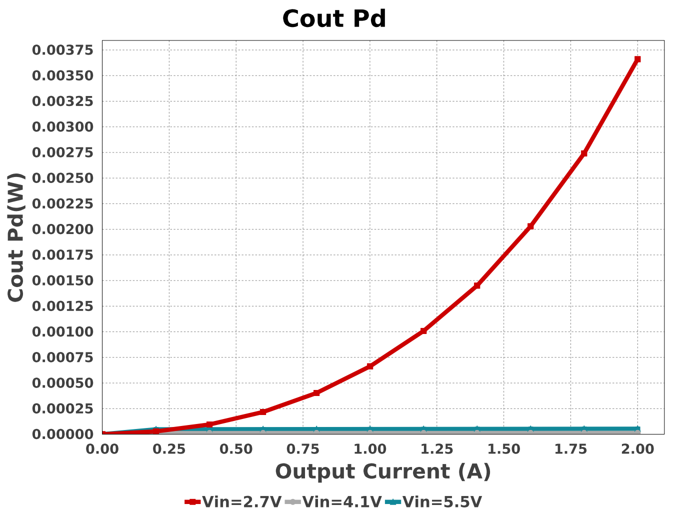

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

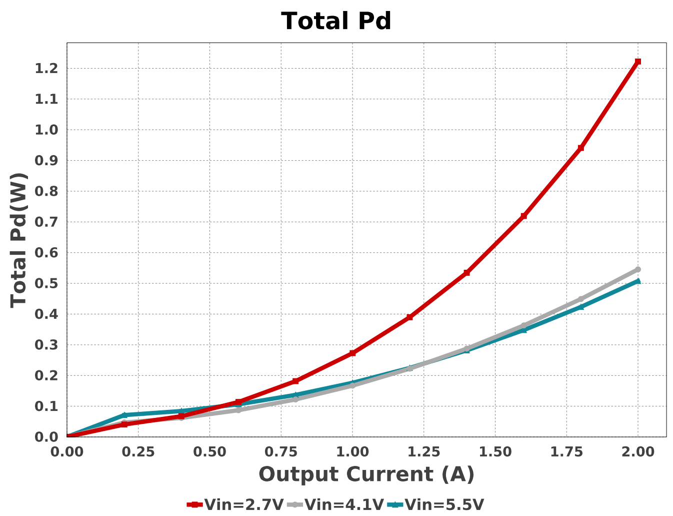

Pout
Pout(W)
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

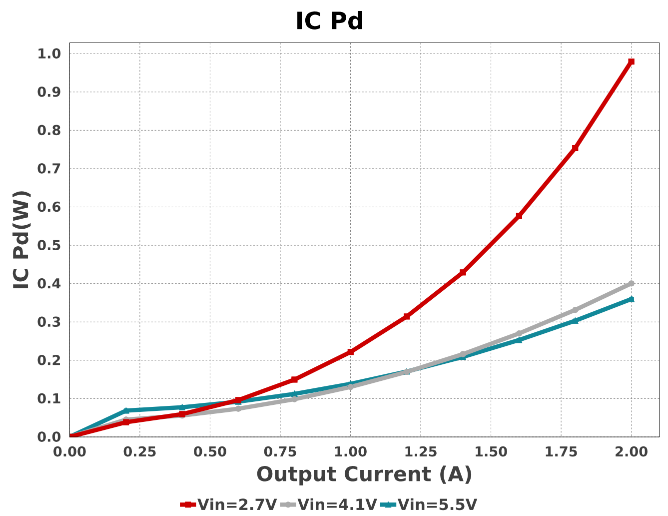

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

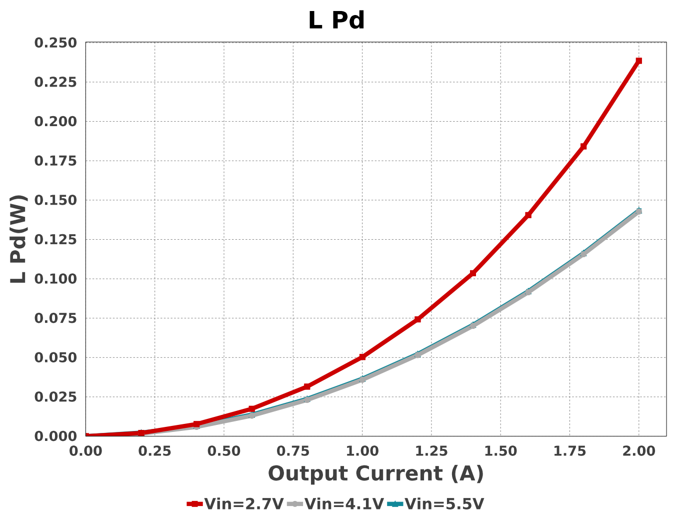

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=2.7V Vin=4.1V Vin=5.5V

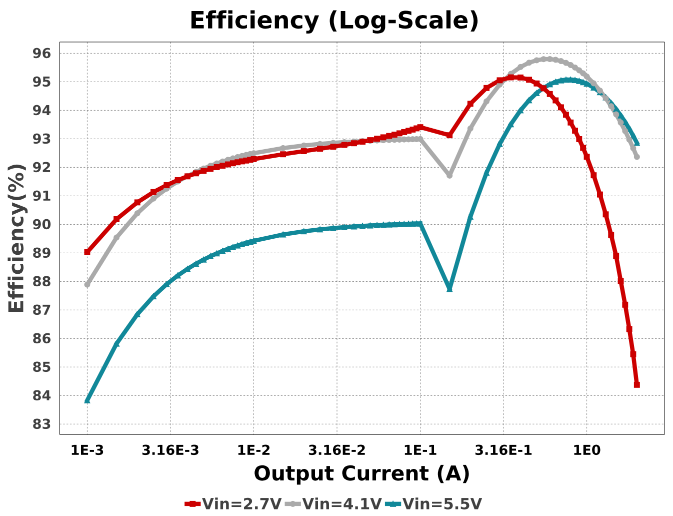












Operating Values

#	Name	Value	Category	Description
1.	BOM Count	7		Total Design BOM count
2.	Total BOM	$2.156		Total BOM Cost
3.	Cin IRMS	398.578 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	736.97 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	37.004 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	4.026 µW	Capacitor	Output capacitor power dissipation
7.	Coutx IRMS	7.294 mA	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	478.79 nW	Capacitor	Output capacitor_x power loss
9.	IC Ipk	2.151 A	IC	Peak switch current in IC
10.	IC Pd	418.85 mW	IC	IC power dissipation
11.	IC Tj	59.78 degC	IC	IC junction temperature

#	Name	Value	Category	Description
12.	ICThetaJA	71.1 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	1.936 A	IC	Average input current
14.	L Ipp	153.453 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	142.57 mW	Inductor	Inductor power dissipation
16.	Cin Pd	736.97 µW	Power	Input capacitor power dissipation
17.	Cout Pd	4.026 µW	Power	Output capacitor power dissipation
18.	Coutx Pd	478.79 nW	Power	Output capacitor_x power loss
19.	IC Pd	418.85 mW	Power	IC power dissipation
20.	L Pd	142.57 mW	Power	Inductor power dissipation
21.	Total Pd	562.152 mW	Power	Total Power Dissipation
22.	Duty Cycle	95.908 %	System Information	Duty cycle
23.	Efficiency	92.151 %	System Information	Steady state efficiency
24.	FootPrint	50.0 mm^2	System Information	Total Foot Print Area of BOM components
25.	Frequency	2.5 MHz	System Information	Switching frequency
26.	Iout	2.0 A	System Information	Iout operating point
27.	Mode	BUCK PWM CCM	System Information	PWM/PFM Mode
28.	Pout	6.6 W	System Information	Total output power
29.	Vin	3.7 V	System Information	Vin operating point
30.	Vout Actual	3.298 V	System Information	Vout Actual calculated based on selected voltage divider resistors
31.	Vout Tolerance	1.53 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
32.	Vout p-p	137.708 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	5.5	Maximum input voltage
VinMin	2.7	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	TPS630250	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

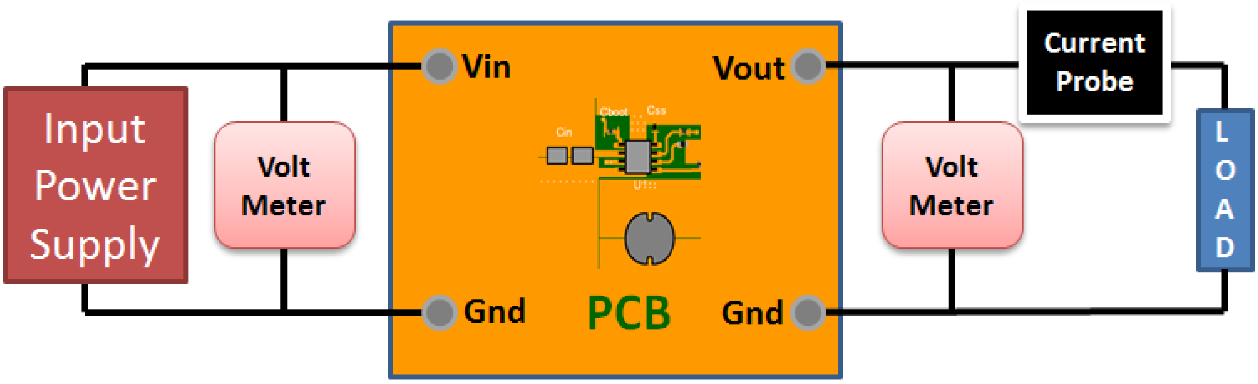
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 2.7V 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.

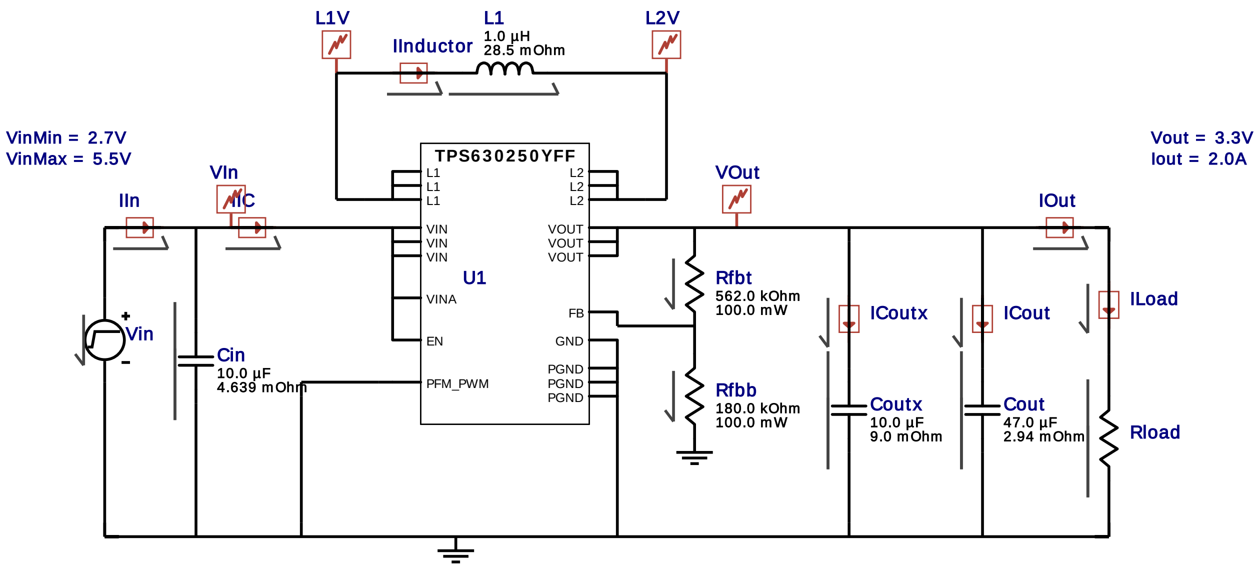


WEBENCH® Electrical Simulation Report

Design Id = 7

sim_id = 1

Simulation Type = Startup



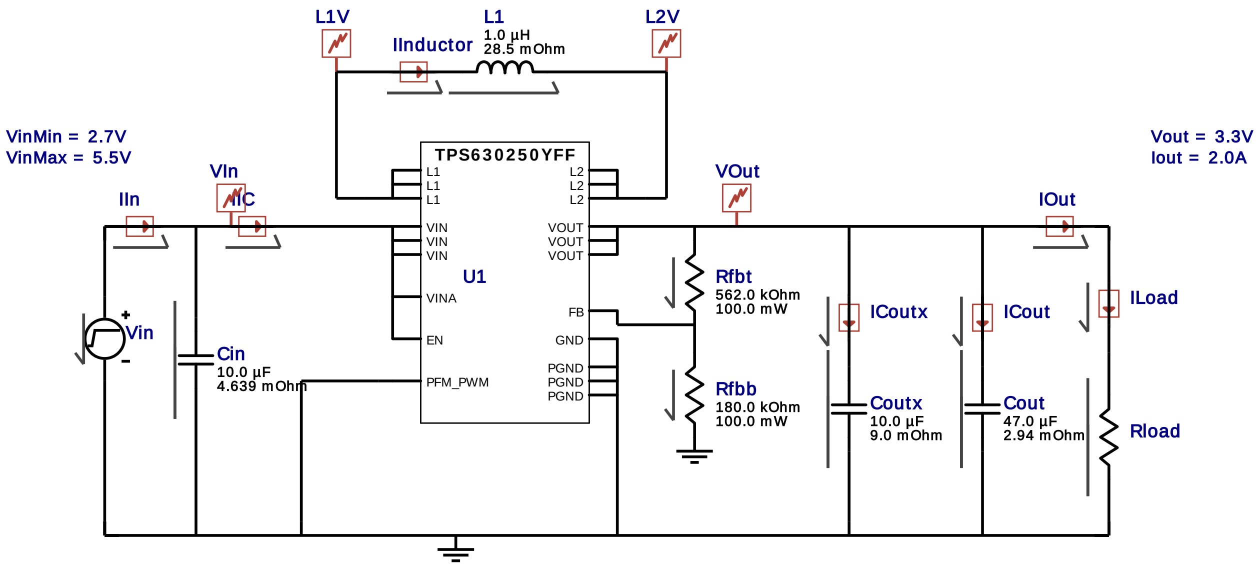
Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	1.65 Ohm

Design Id = 7

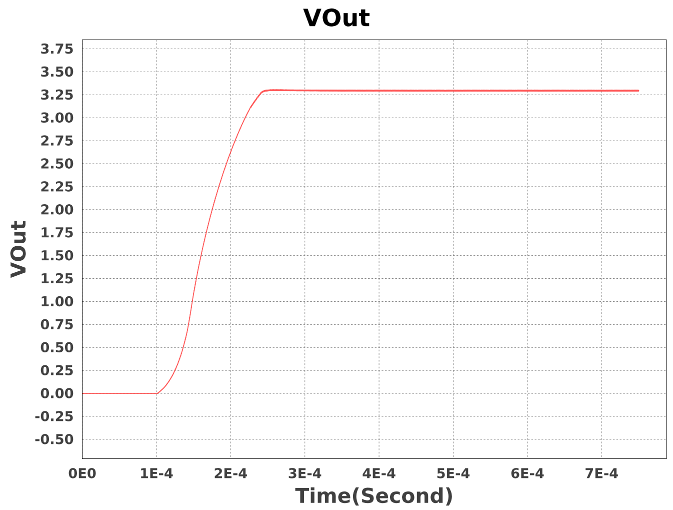
sim_id = 2

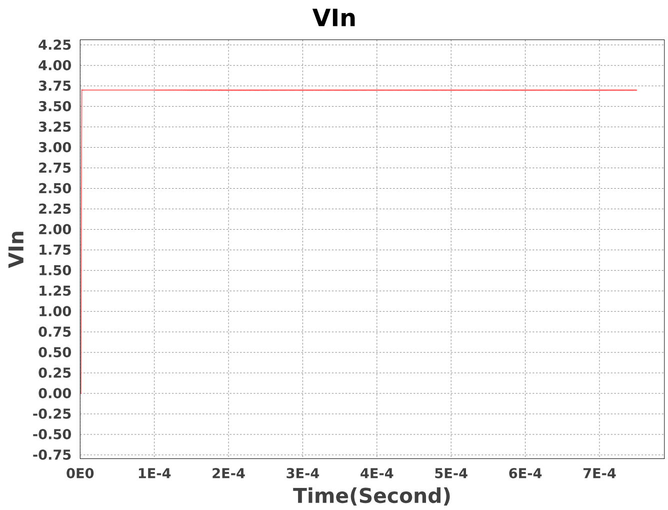
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	1.65 Ohm





Design Assistance

1. Master key : A7B5E7C219908AD5209AF22DDF147F08[v1]

2. **TPS630250** Product Folder : http://www.ti.com/product/TPS630250 : contains the data sheet and other resources.