John Danison

ECET 32900 – Lab 8

03/28/2025

Goal:

The goal of this lab was to learn via hands-on methods, how to design a power system for a given embedded system application using Texas Instruments' WEBENCH product.

Output:

WEBENCH report including the schematic, the graphs, the BOM, and other information is attached at the end of this report.

Conclusion:

I learned that designing a custom power system is **significantly** easier to do than I ever knew about. This portion of embedded system hardware design is one that I struggle to get correct on every single personal project that I have ever done. I will absolutely be using this for my own future use in power design. I love the instant ability to have the schematic, BOM, and output graphs all for free.

References

Texas Instruments. (n.d.). *WEBENCH® power designer*. Retrieved March 28, 2025, from https://webench.ti.com/power-designer/

Purdue University. (2025). *ECET 32900 Lab 8 instructional documents*. Purdue University.

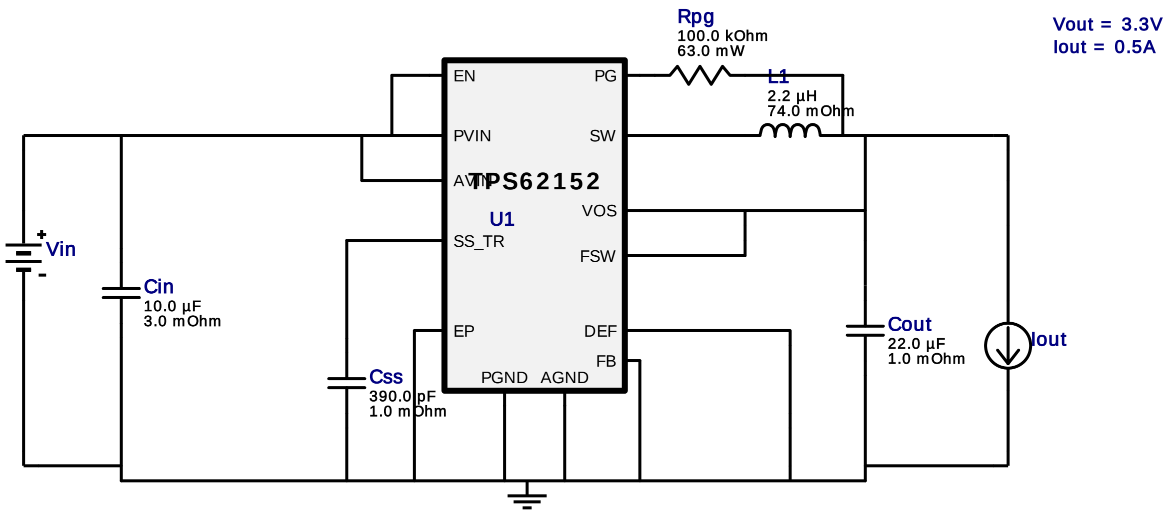
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 4.0V
VinMax = 6.0V
Vout = 3.3V
Iout = 0.5A

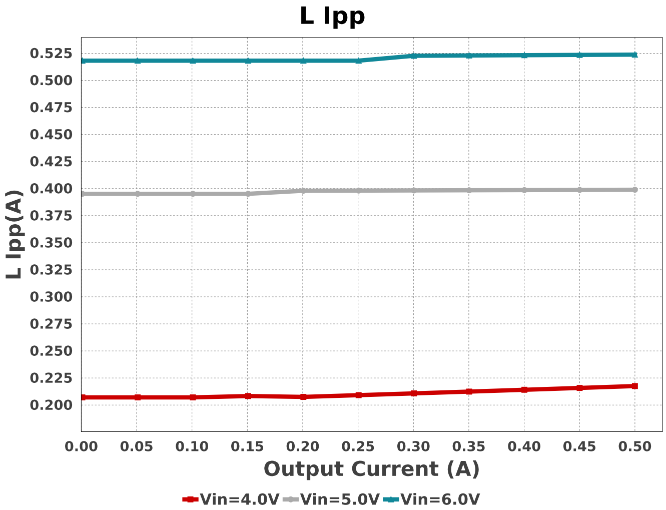
Device = TPS62152RGTR
Topology = Buck
Created = 2025-03-14 14:51:27.361
BOM Cost = $0.73
BOM Count = 6
Total Pd = 0.1W

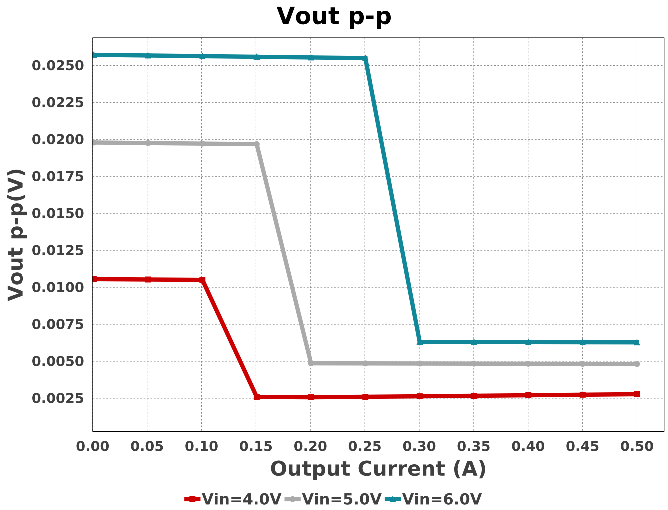
Design : 1 TPS62152RGTR
TPS62152RGTR 4V-6V to 3.30V @ 0.5A

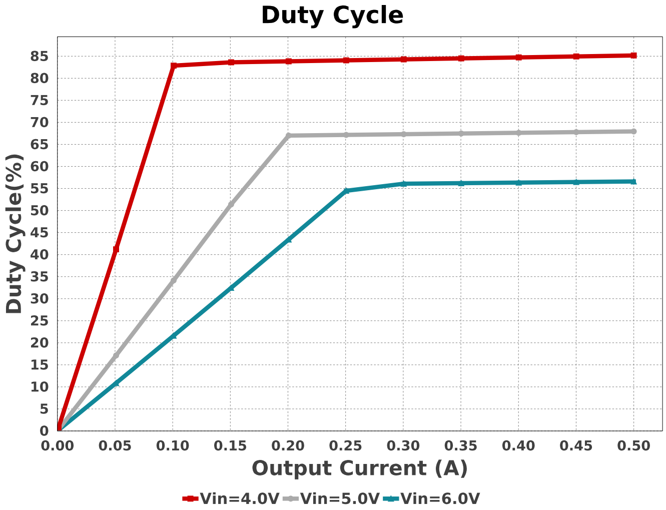


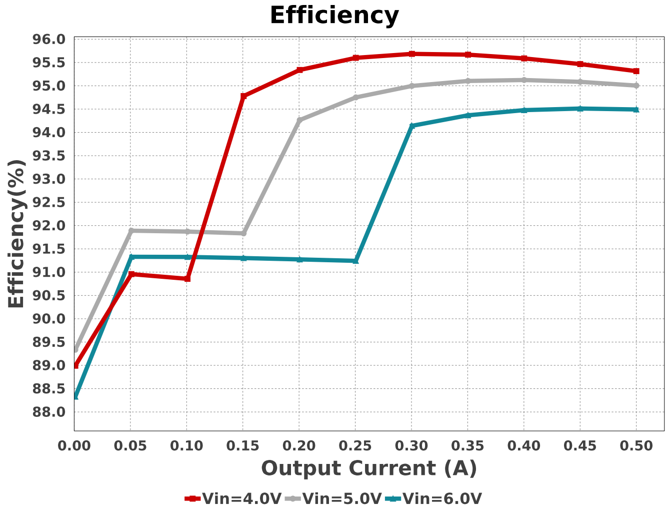
Electrical BOM

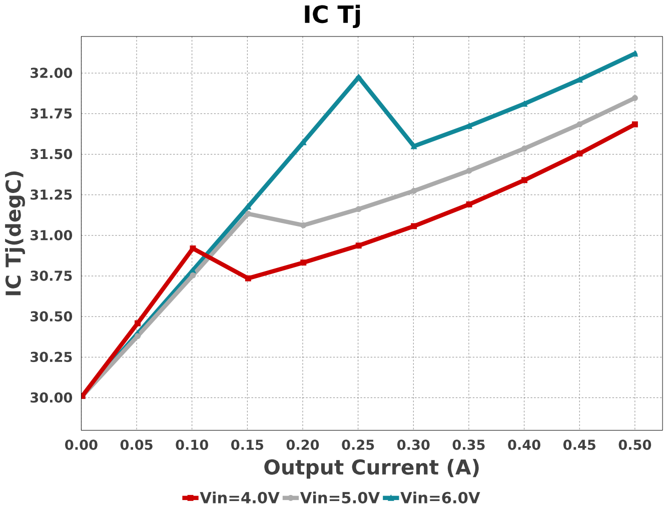
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	1	$0.03	0805 7 mm^2
Cout	MuRata	GRM188R60J226MEA0D Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.04	0603 5 mm^2
Css	MuRata	GRM033R71C391KA01D Series= X7R	Cap= 390.0 pF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
L1	TDK	VLS3012CX-2R2M-1	L= 2.2 µH 74.0 mOhm	1	$0.14	VLS3012 16 mm^2
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS62152RGTR	Switcher	1	$0.50	RGT0016C 16 mm^2

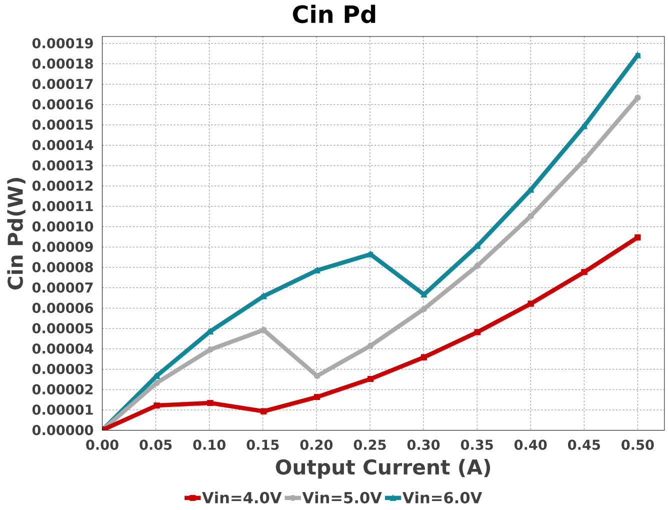

L Ipp
L Ipp(A)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

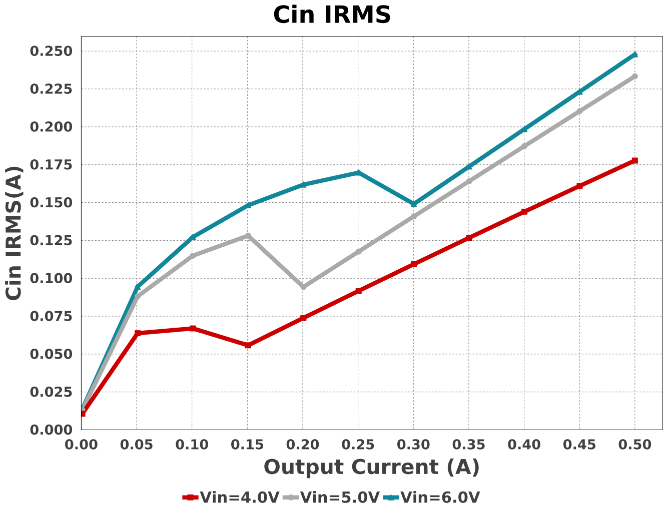

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V


Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

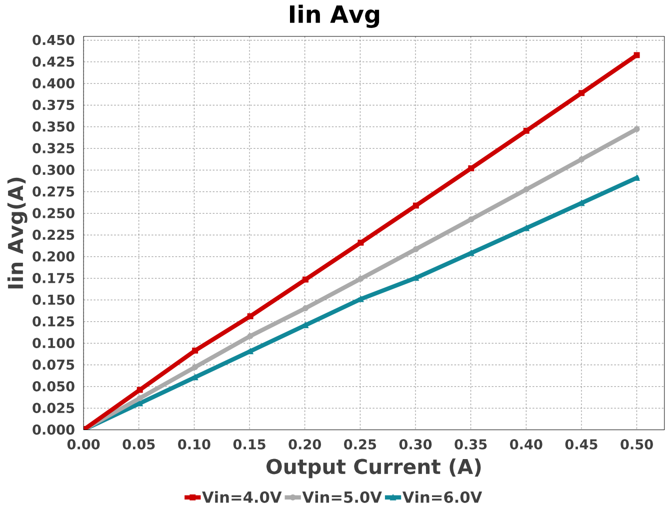

Efficiency
Efficiency(%)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V


IC Tj
IC Tj(degC)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

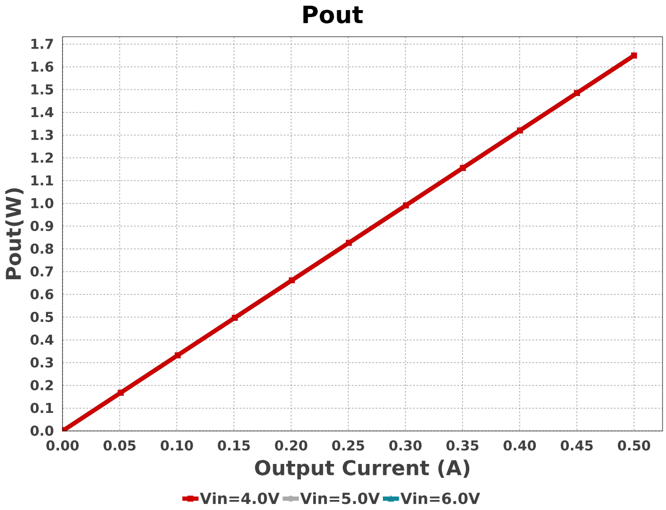

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V



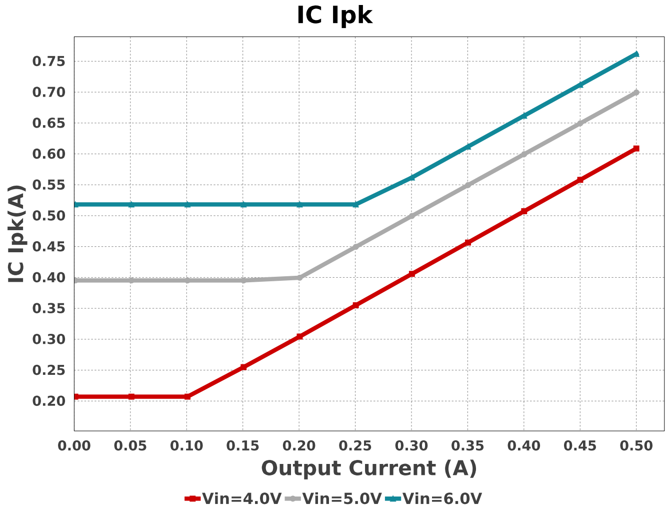
Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V



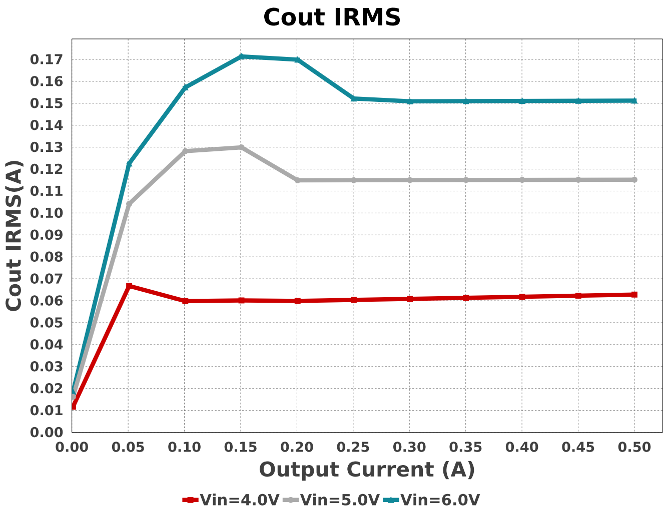
Iin Avg
Iin Avg(A)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V



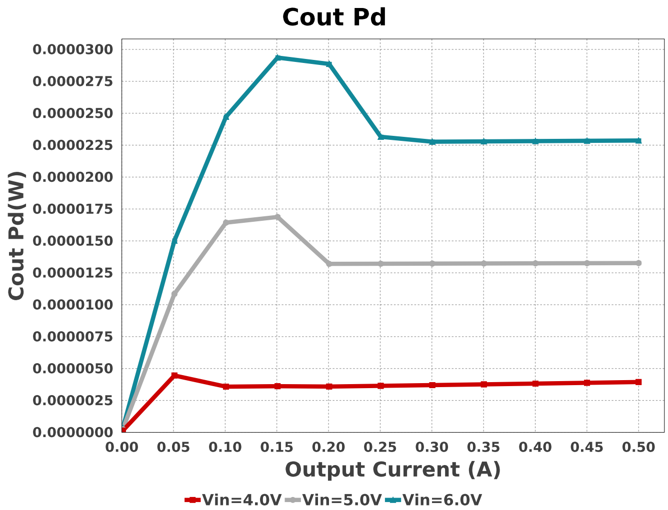
Pout
Pout(W)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V



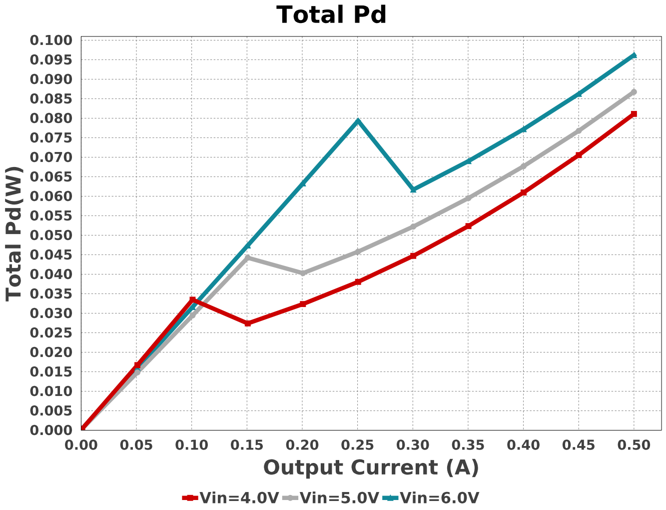
IC Ipk
IC Ipk(A)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

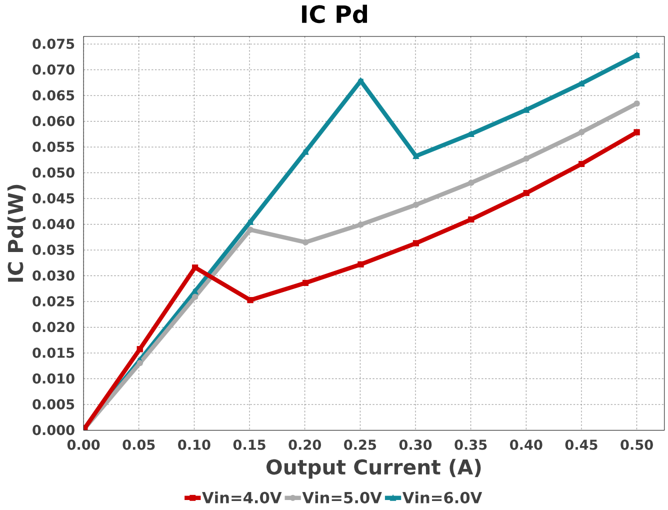


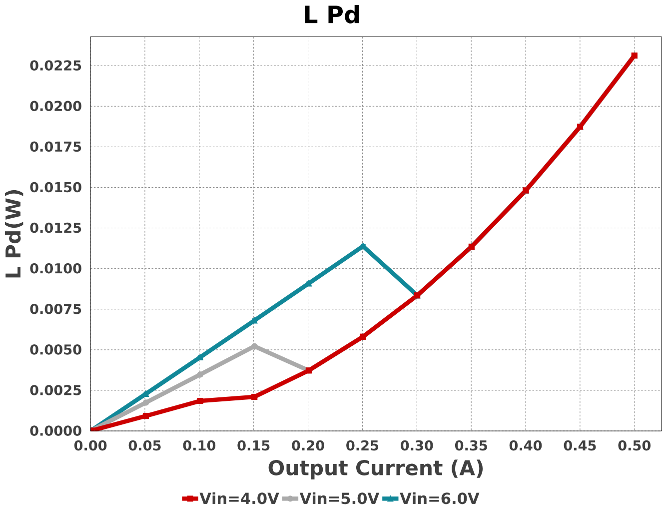
Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

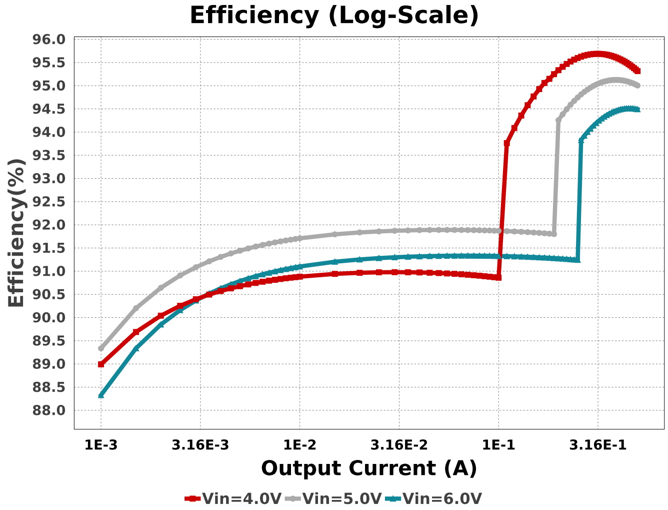


Cout Pd
Cout Pd(W)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	247.82 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	184.24 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	151.209 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	22.864 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	761.902 mA	IC	Peak switch current in IC
6.	IC Pd	72.855 mW	IC	IC power dissipation
7.	IC Tj	32.12 degC	IC	IC junction temperature
8.	ICThetaJA	29.1 degC/W	IC	IC junction-to-ambient thermal resistance
9.	Iin Avg	291.03 mA	IC	Average input current
10.	L Ipp	523.8 mA	Inductor	Peak-to-peak inductor ripple current
11.	L Pd	23.125 mW	Inductor	Inductor power dissipation
12.	Cin Pd	184.24 µW	Power	Input capacitor power dissipation
13.	Cout Pd	22.864 µW	Power	Output capacitor power dissipation
14.	IC Pd	72.855 mW	Power	IC power dissipation
15.	L Pd	23.125 mW	Power	Inductor power dissipation
16.	Total Pd	96.18 mW	Power	Total Power Dissipation
17.	BOM Count	6	System Information	Total Design BOM count
18.	Duty Cycle	56.589 %	System Information	Duty cycle
19.	Efficiency	94.492 %	System Information	Steady state efficiency
20.	FootPrint	49.0 mm²	System Information	Total Foot Print Area of BOM components
21.	Frequency	1.326 MHz	System Information	Switching frequency
22.	Iout	500.0 mA	System Information	Iout operating point
23.	Mode	CCM	System Information	Conduction Mode
24.	Pout	1.65 W	System Information	Total output power

#	Name	Value	Category	Description
25.	Total BOM	$0.73	System Information	Total BOM Cost
26.	Vin	6.0 V	System Information	Vin operating point
27.	Vout	3.3 V	System Information	Operational Output Voltage
28.	Vout Tolerance	1.8 %	System Information	Vout Tolerance based on IC Tolerance (full load) and voltage divider resistors if applicable
29.	Vout p-p	6.278 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	500.0 m	Maximum Output Current
VinMax	6.0	Maximum input voltage
VinMin	4.0	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	TPS62152	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

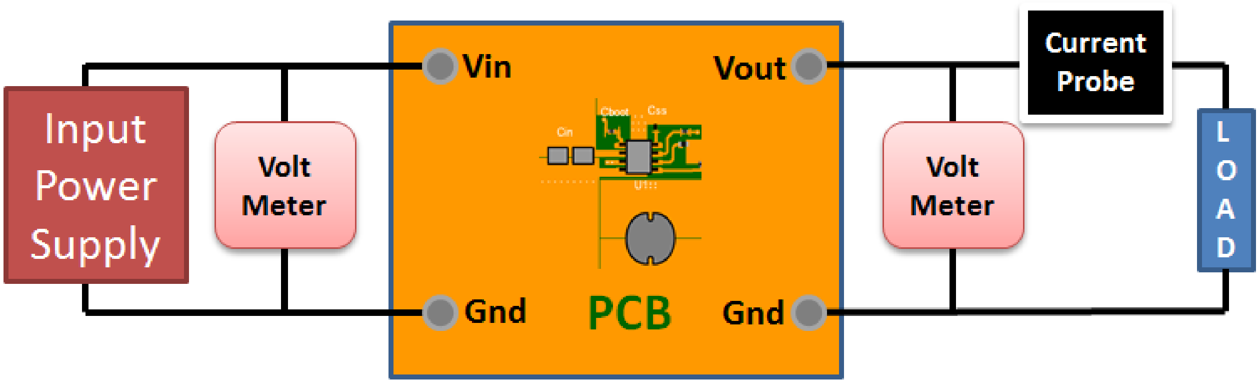
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.0V 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.

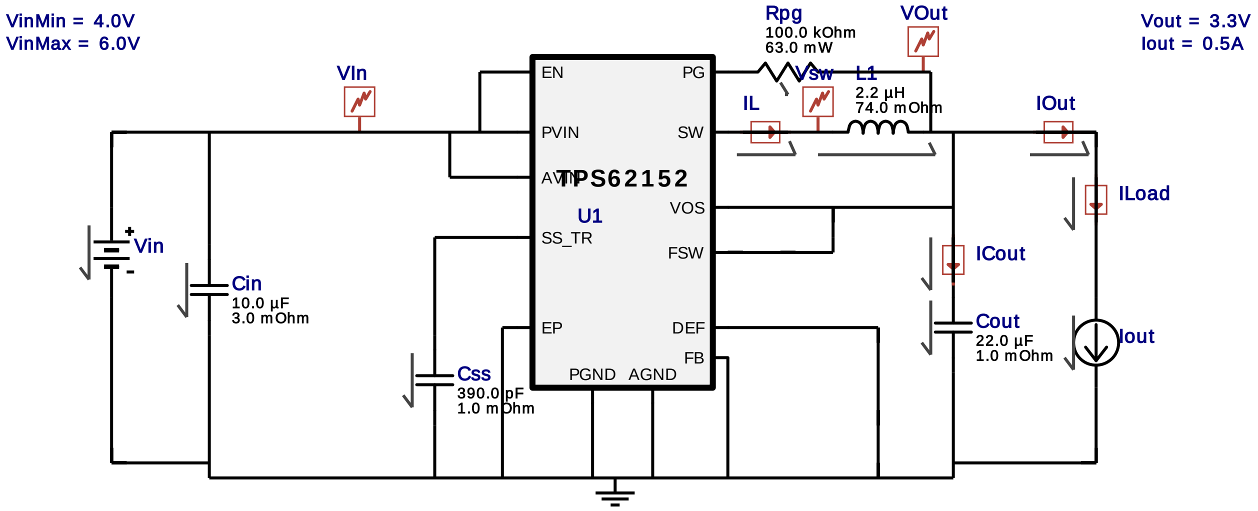


WEBENCH® Electrical Simulation Report

Design Id = 1

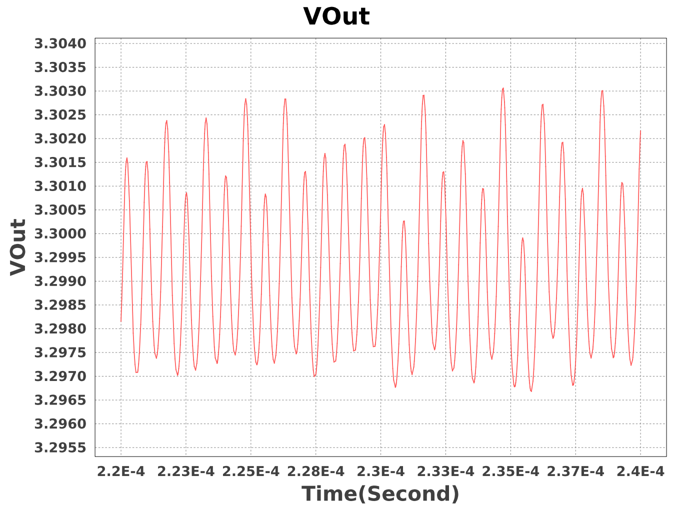
sim_id = 1

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Iout	I	Load Current	0.5 A



Design Assistance

1. Feature Highlights: DCS-Control(TM) Architecture with upto 1A output current, 3V to 17V Input Voltage Range, 3.3V Fixed Output voltageSelectable operating frequency, Optional Softstart Capacitor for slow startup, Tracking,Pin selectable output voltage (nominal, +5%) Seamless Power Save Mode for Light Load Efficiency, Power Good Output, 100% Duty Cycle mode, Short Circuit Protection, Thermal Shutdown

2. Master key : 3B1EC955F3A3AF9BB76B7EF2215CD094[v1]

3. **TPS62152** Product Folder : http://www.ti.com/product/TPS62152 : contains the data sheet and other resources.

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