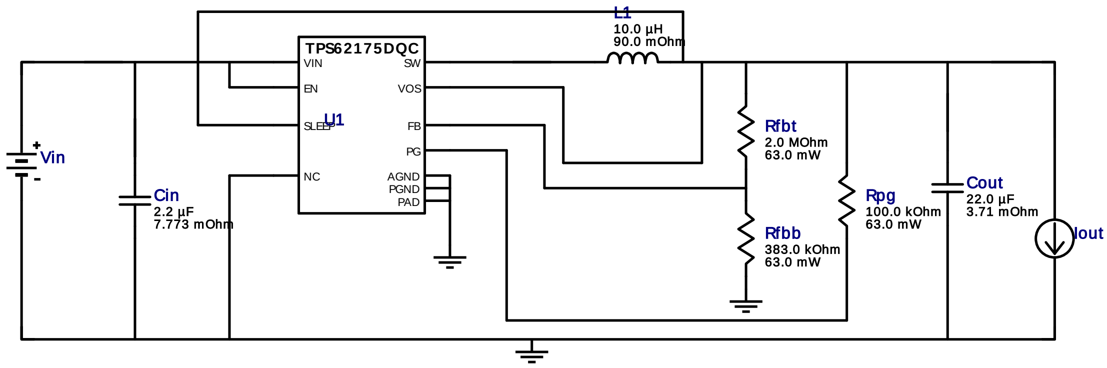
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 24.0V
VinMax = 24.0V
Vout = 5.0V
Iout = 0.25A

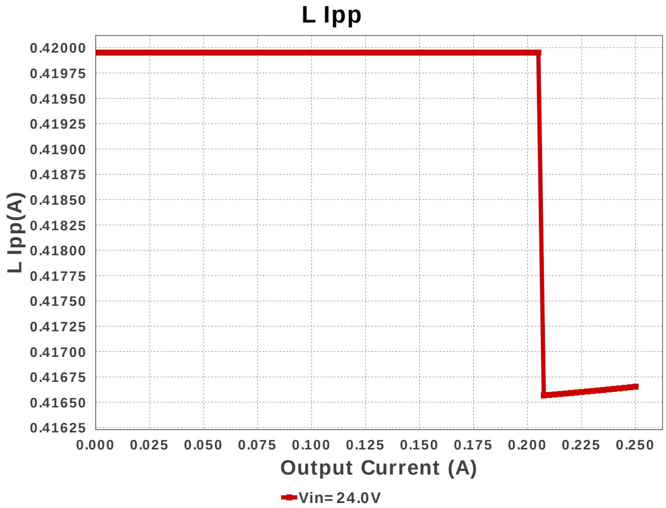
Device = TPS62175DQCR
Topology = Buck
Created = 2021-02-22 16:03:55.702
BOM Cost = $0.94
BOM Count = 7
Total Pd = 0.25W

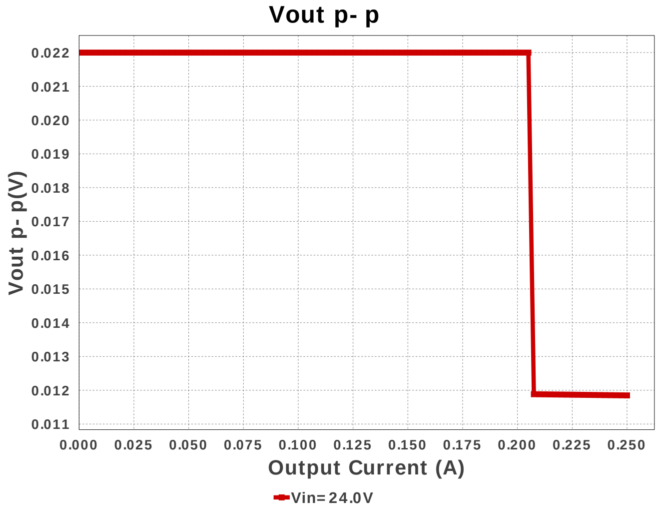
Design : 2 TPS62175DQCR
TPS62175DQCR 24V-24V to 5.00V @ 0.25A

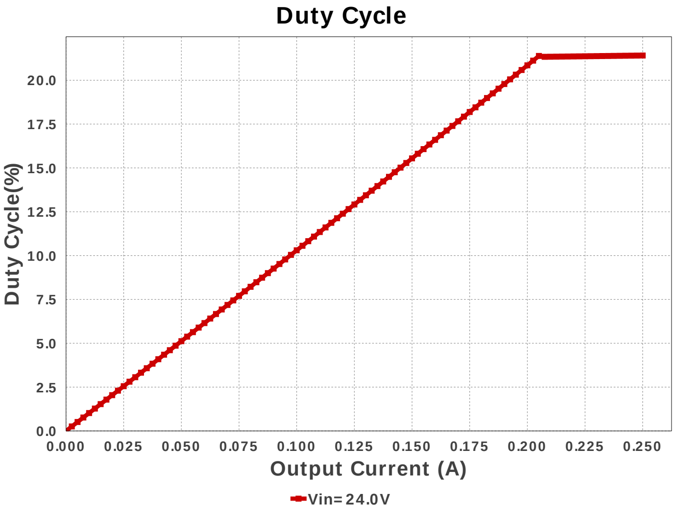


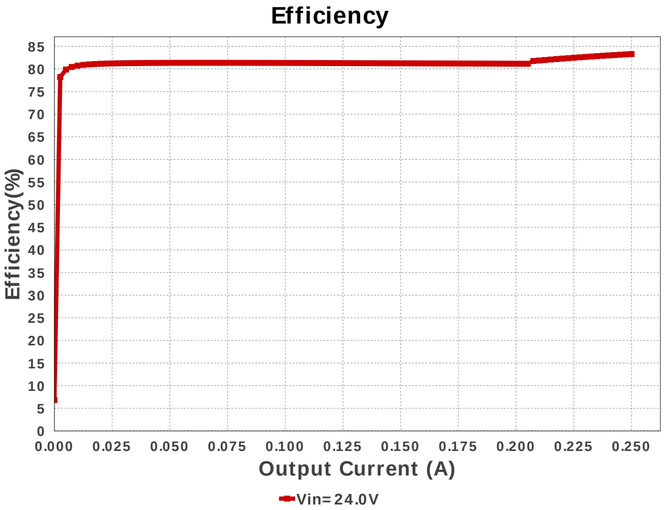
Electrical BOM

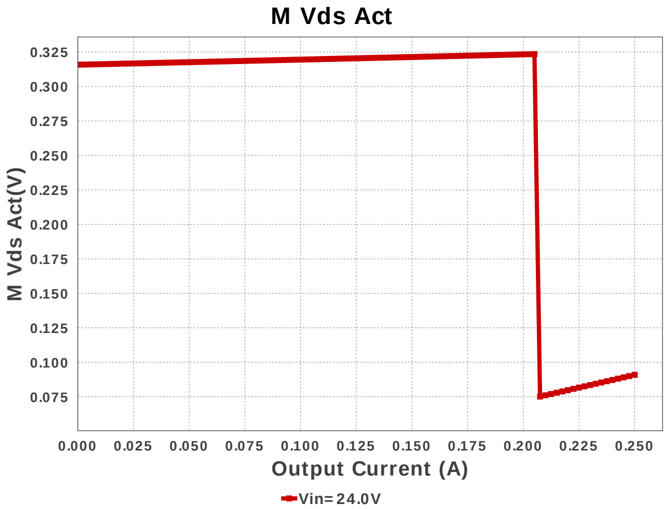
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	MuRata	GRM21BR71E225KA73L Series= X7R	Cap= 2.2 uF ESR= 7.773 mOhm VDC= 25.0 V IRMS= 1.35654 A	1	$0.13	0805 7 mm²
Cout	TDK	C1608X5R1A226M080AC Series= X5R	Cap= 22.0 uF ESR= 3.71 mOhm VDC= 10.0 V IRMS= 2.69936 A	1	$0.12	0603 5 mm²
L1	NIC Components	NPI54C100MTRF	L= 10.0 µH 90.0 mOhm	1	$0.18	IND_NPI54C 61 mm²
Rfbb	Vishay-Dale	CRCW0402383KFKED Series= CRCW..e3	Res= 383.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW04022M00FKED Series= CRCW..e3	Res= 2.0 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	TPS62175DQCR	Switcher	1	$0.48	DQC0010A 12 mm²

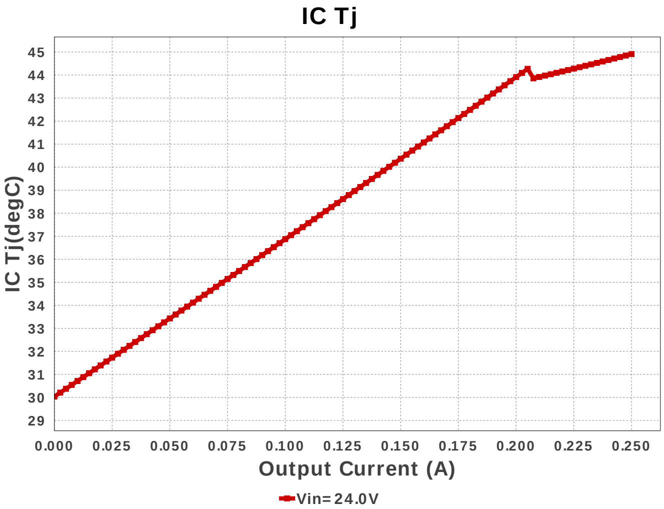

L Ipp
L Ipp(A)
0.42000
0.41975
0.41950
0.41925
0.41900
0.41875
0.41850
0.41825
0.41800
0.41775
0.41750
0.41725
0.41700
0.41675
0.41650
0.41625
0.000 0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250
Output Current (A)
Vin=24.0V


Vout p- p
Vout p- p(V)
0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.000 0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250
Output Current (A)
Vin=24.0V

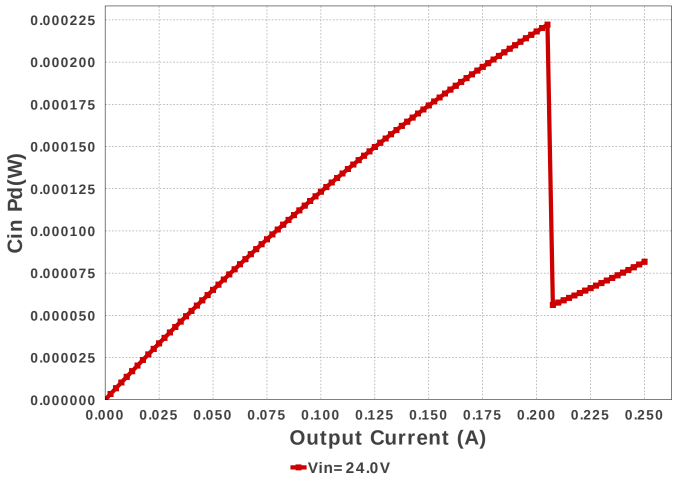

Duty Cycle
Duty Cycle(%)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
0.000 0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250
Output Current (A)
Vin=24.0V


Efficiency
Efficiency(%)
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0.000 0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250
Output Current (A)
Vin=24.0V

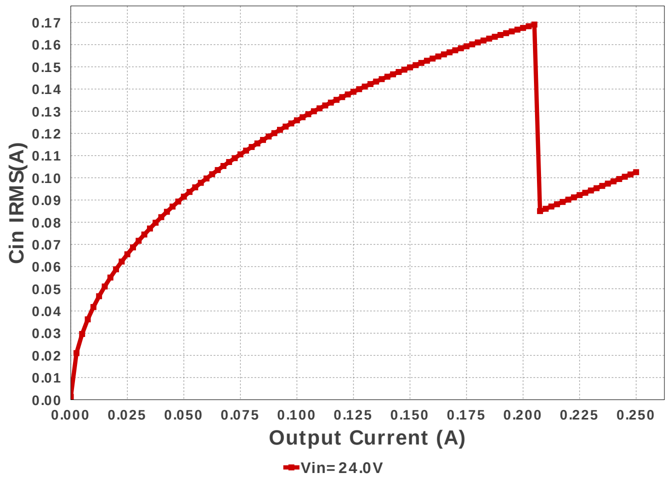

M Vds Act
M Vds Act(V)
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.000 0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250
Output Current (A)
Vin=24.0V


IC Tj
IC Tj(degC)
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
0.000 0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250
Output Current (A)
Vin=24.0V

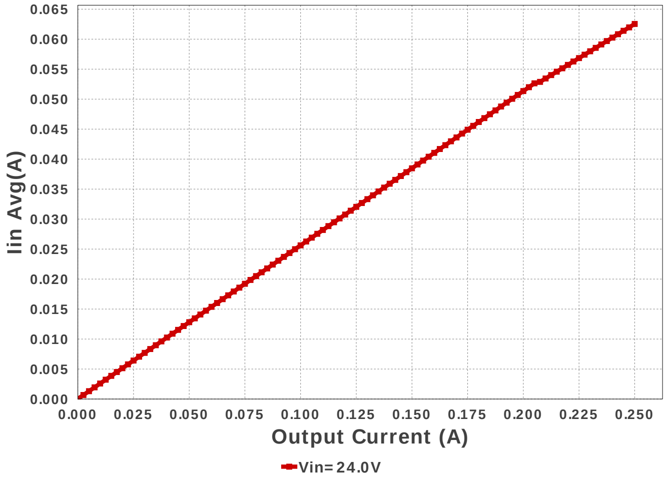
Cin Pd



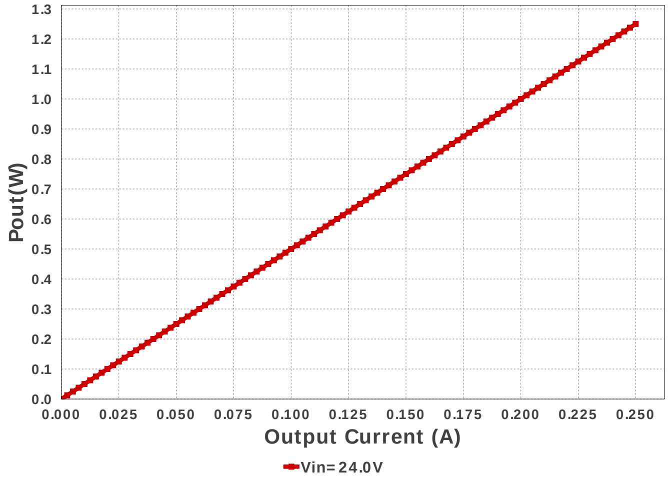
Cin IRMS



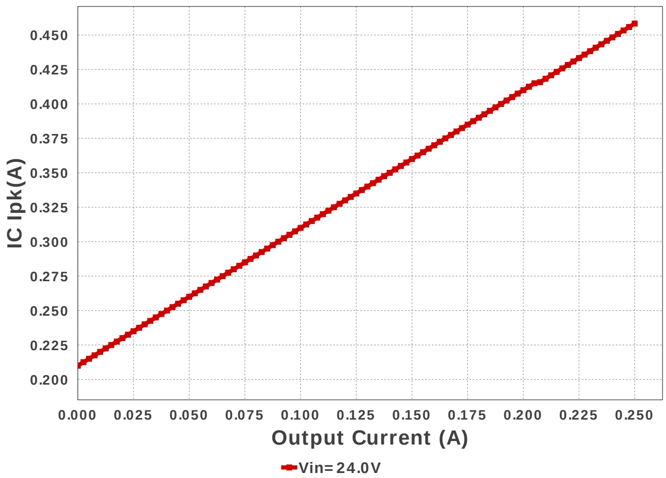
Iin Avg



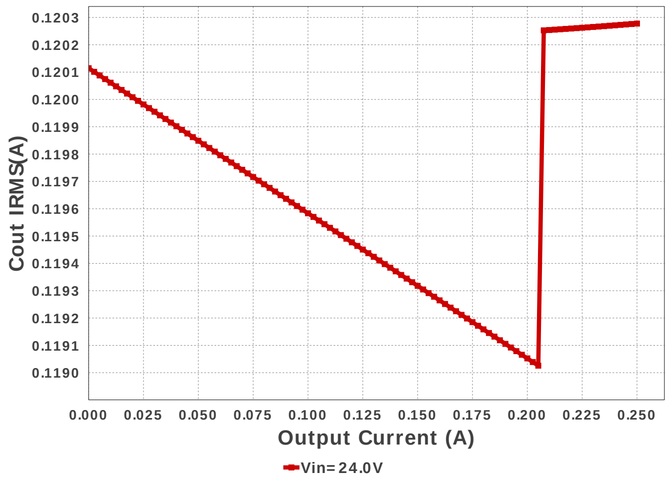
Pout

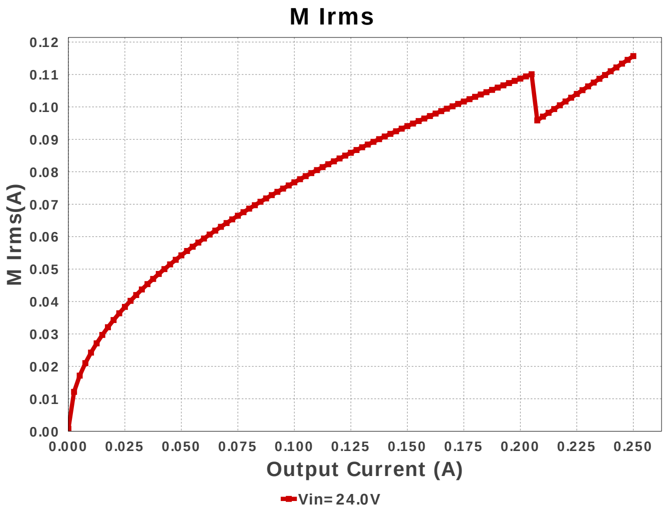


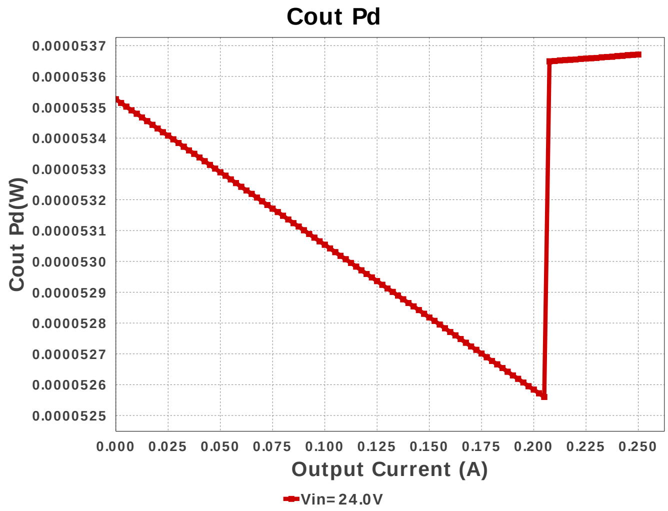
IC Ipk

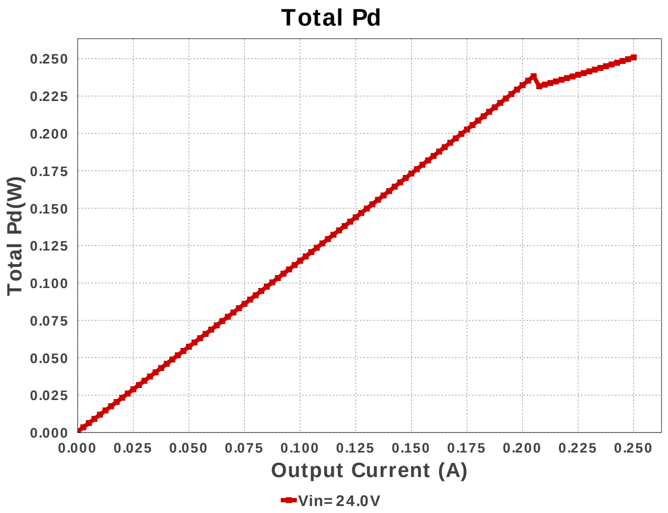


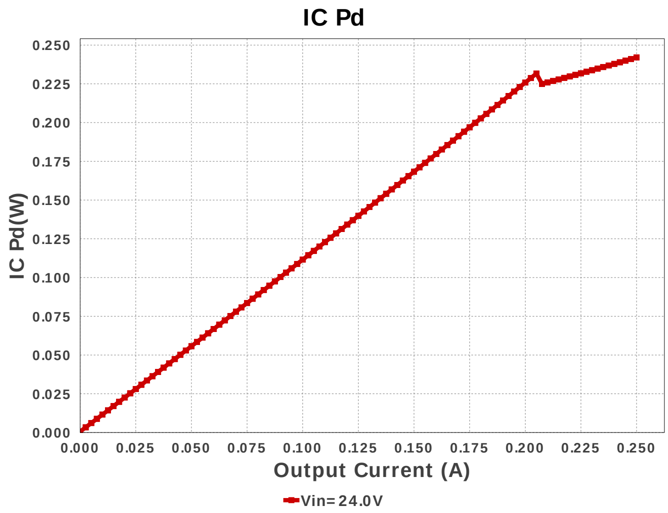
Cout IRMS

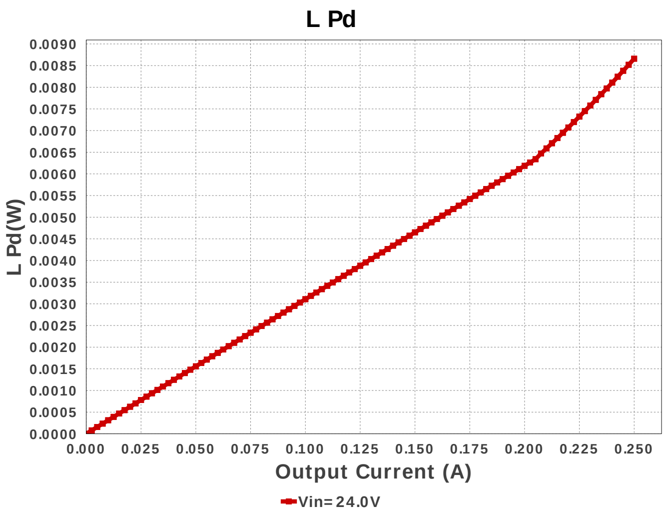












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	102.549 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	81.744 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	120.278 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	53.671 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	458.327 mA	IC	Peak switch current in IC
6.	IC Pd	242.05 mW	IC	IC power dissipation
7.	IC Tj	44.91 degC	IC	IC junction temperature
8.	IC Tolerance	14.4 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	61.6 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	62.535 mA	IC	Average input current
11.	L Ipp	416.65 mA	Inductor	Peak-to-peak inductor ripple current

#	Name	Value	Category	Description
12.	L Pd	8.659 mW	Inductor	Inductor power dissipation
13.	M1 Irms	115.678 mA	Mosfet	Q Iavg
14.	M Vds Act	90.899 mV	Mosfet	Voltage drop across the MosFET
15.	Cin Pd	81.744 µW	Power	Input capacitor power dissipation
16.	Cout Pd	53.671 µW	Power	Output capacitor power dissipation
17.	IC Pd	242.05 mW	Power	IC power dissipation
18.	L Pd	8.659 mW	Power	Inductor power dissipation
19.	Total Pd	250.835 mW	Power	Total Power Dissipation
20.	BOM Count	7	System Information	Total Design BOM count
21.	Duty Cycle	21.41 %	System Information	Duty cycle
22.	Efficiency	83.287 %	System Information	Steady state efficiency
23.	FootPrint	93.0 mm^2	System Information	Total Foot Print Area of BOM components
24.	Frequency	976.335 kHz	System Information	Switching frequency
25.	Iout	250.0 mA	System Information	Iout operating point
26.	Mode	CCM	System Information	Conduction Mode
27.	Pout	1.25 W	System Information	Total output power
28.	Total BOM	$0.94	System Information	Total BOM Cost
29.	Vin	24.0 V	System Information	Vin operating point
30.	Vout	5.0 V	System Information	Operational Output Voltage
31.	Vout Actual	4.978 V	System Information	Vout Actual calculated based on selected voltage divider resistors
32.	Vout Tolerance	3.526 %	System Information	Vout Tolerance based on IC Tolerance (full load) and voltage divider resistors if applicable
33.	Vout p-p	11.848 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	250.0 m	Maximum Output Current
VinMax	24.0	Maximum input voltage
VinMin	24.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	TPS62175	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

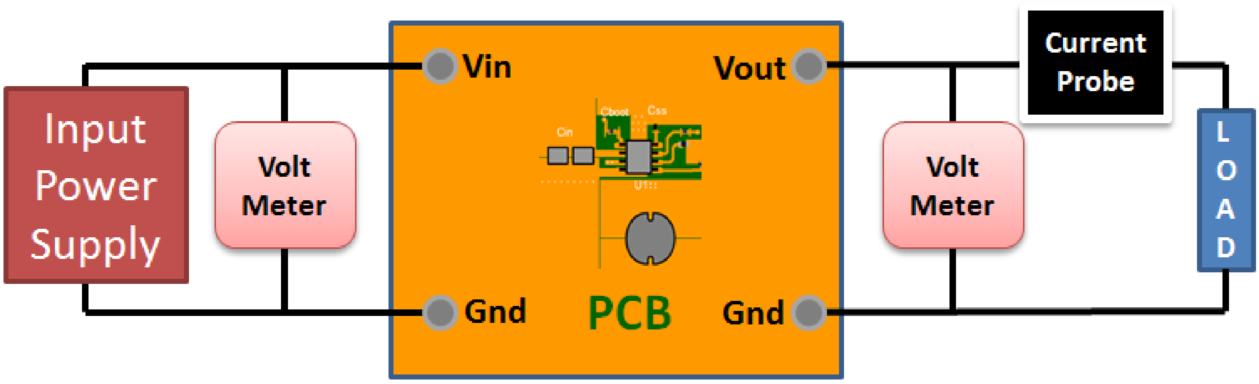
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 24.0V 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.

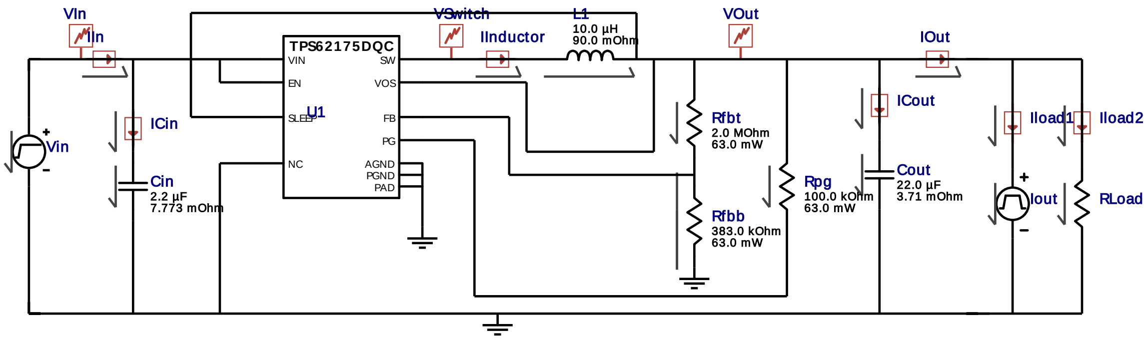


WEBENCH® Electrical Simulation Report

Design Id = 2

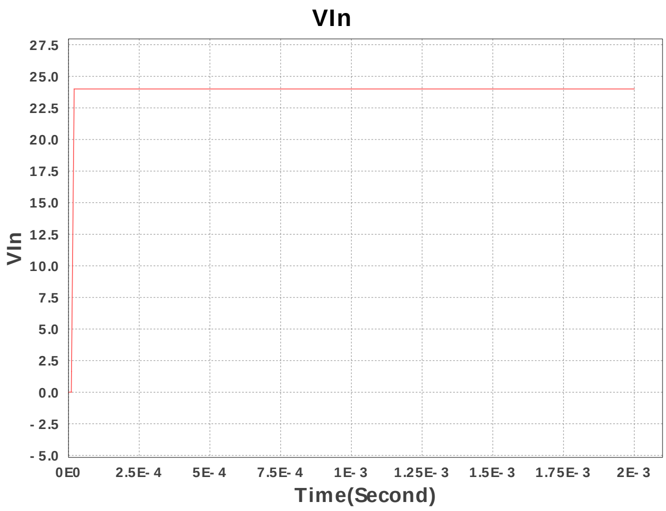
sim_id = 5

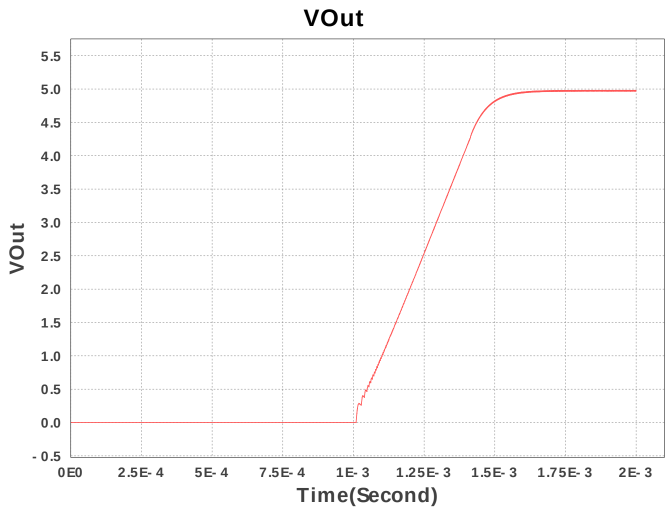
Simulation Type = 2-Step Startup

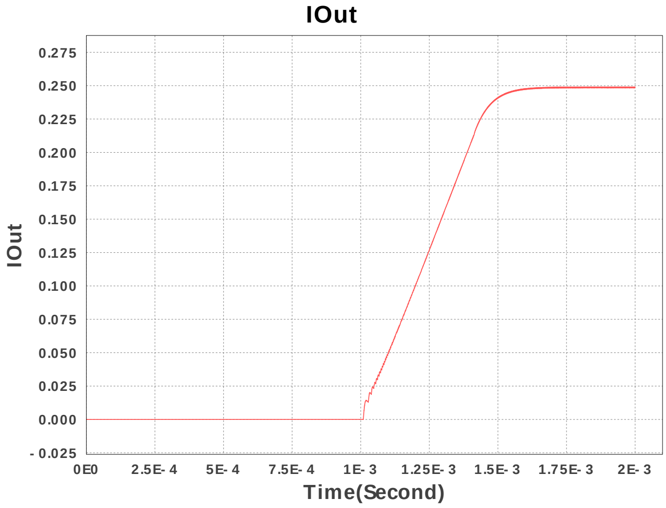


Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cout	IC	no description	0
2.	Iout	signal_type I1 I2 Td Tr	Signal Type Initial Load Current Minimum Load Current Initial Time Delay Rise Time	PULSE 0 A 0.0 A 0.0017 s 1u s
3.	RLoad	R	Load Resistance	20.0 ohm







Design Assistance

1. Master key : 9810EF8B6453D2AE[v1]
2. **TPS62175** Product Folder : http://www.ti.com/product/TPS62175 : contains the data sheet and other resources.