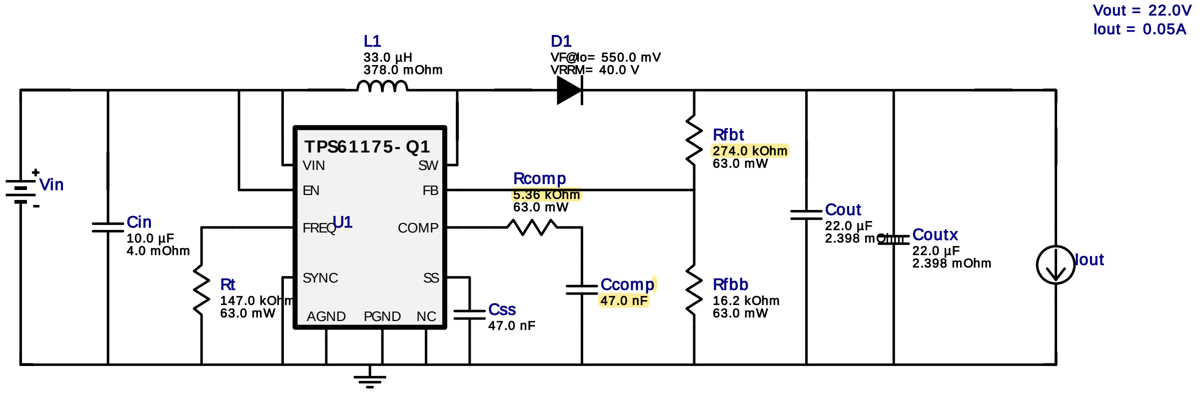
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 3.3V
VinMax = 3.7V
Vout = 22.0V
Iout = 0.05A

Device = TPS61175QPWPRQ1
Topology = Boost
Created = 2020-08-13 07:08:45.575
BOM Cost = $3.19
BOM Count = 12
Total Pd = 0.12W

Design : 3 TPS61175QPWPRQ1
TPS61175QPWPRQ1 3.3V-3.7V to 22.00V @ 0.05A



1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.View WEBENCH(R) Disclaimer.

Design Alerts

Component Selection Information

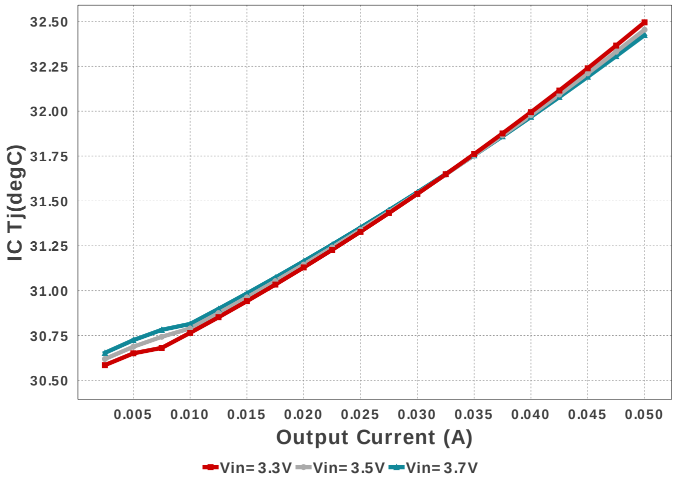
The TPS61175-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. View WEBENCH(R) Disclaimer

Electrical BOM

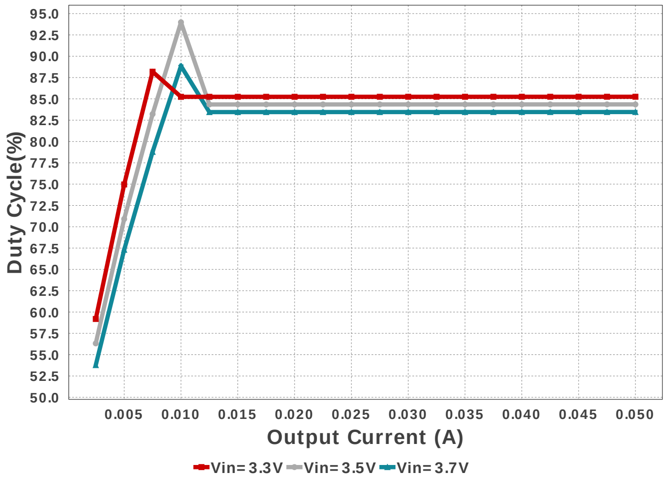
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ccomp	Kemet	C0805C473J3GACTU Series= C0G/NP0	Cap= 47.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.23	0805 7 mm²
Cin	MuRata	GRM31CR71E106KA12L Series= X7R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 6.0 A	1	$0.22	1206_180 11 mm²
Cout	TDK	C3216X5R1V226M160AC Series= X5R	Cap= 22.0 uF ESR= 2.398 mOhm VDC= 35.0 V IRMS= 4.6851 A	1	$0.35	1206_180 11 mm²
Coutx	TDK	C3216X5R1V226M160AC Series= X5R	Cap= 22.0 uF ESR= 2.398 mOhm VDC= 35.0 V IRMS= 4.6851 A	1	$0.35	1206_180 11 mm²
Css	Kemet	C0805C473J3GACTU Series= C0G/NP0	Cap= 47.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.23	0805 7 mm²
D1	ON Semiconductor	MBR140SFT1G	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.07	SOD-123FL 12 mm²
L1	Coilcraft	LPS4018-333MRB	L= 33.0 µH 378.0 mOhm	1	$0.35	LPS4018 24 mm²
Rcomp	Vishay-Dale	CRCW04025K36FKED Series= CRCW..e3	Res= 5.36 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbb	Vishay-Dale	CRCW040216K2FKED Series= CRCW..e3	Res= 16.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW0402274KFKED Series= CRCW..e3	Res= 274.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rt	Vishay-Dale	CRCW0402147KFKED Series= CRCW..e3	Res= 147.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS61175QPWPRQ1	Switcher	1	$1.35	R-PDSO-G14 61 mm^2

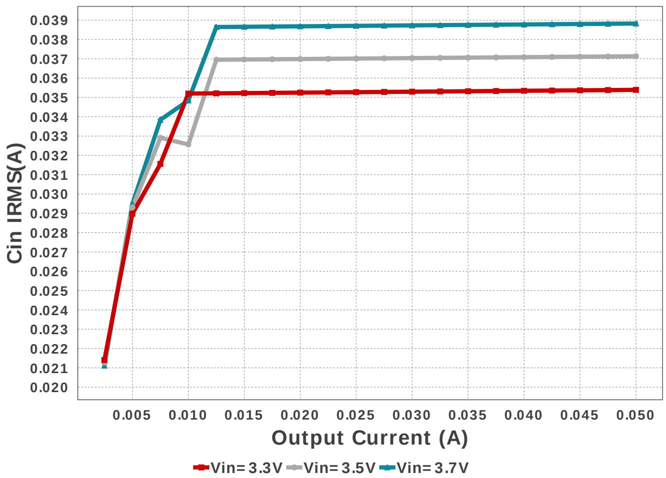
IC Tj



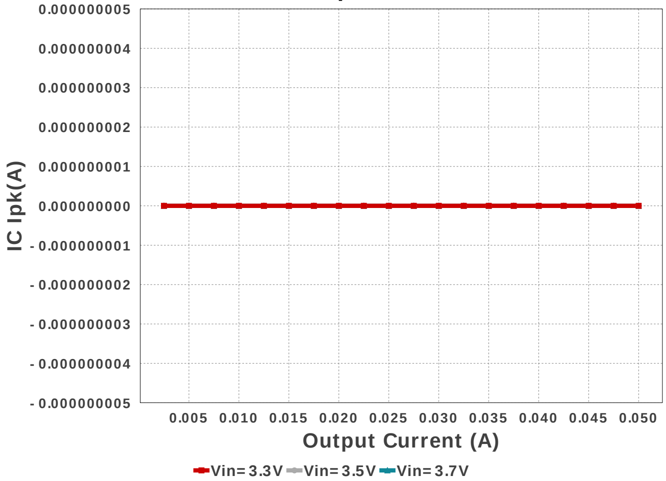
Duty Cycle

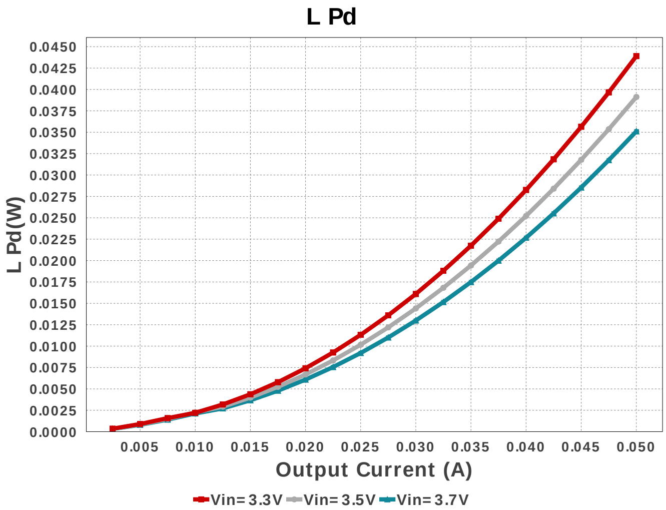


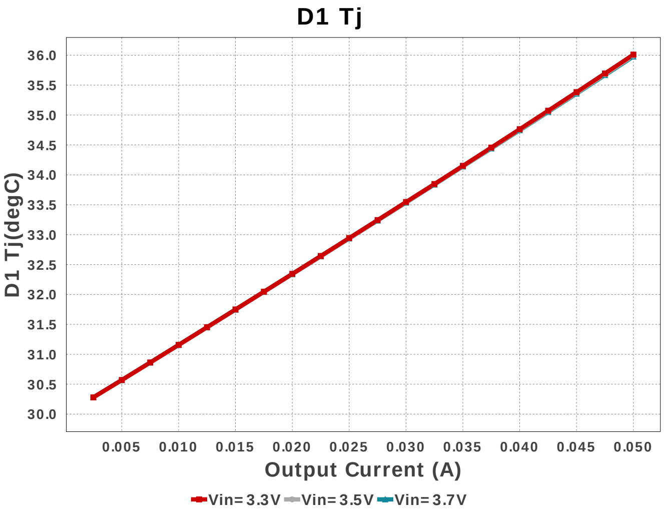
Cin IRMS

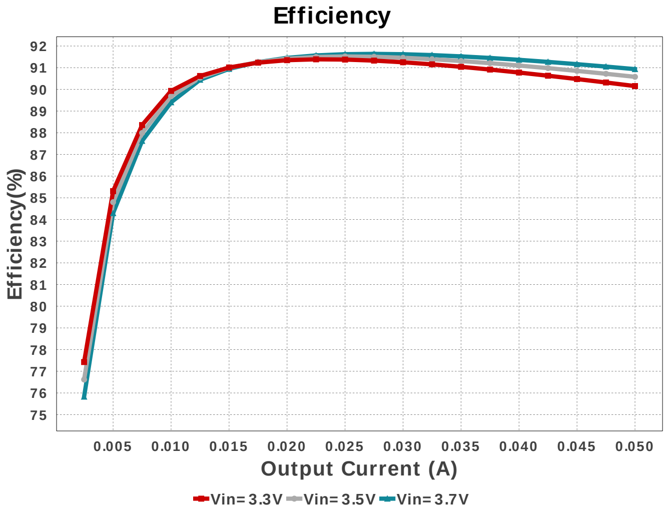


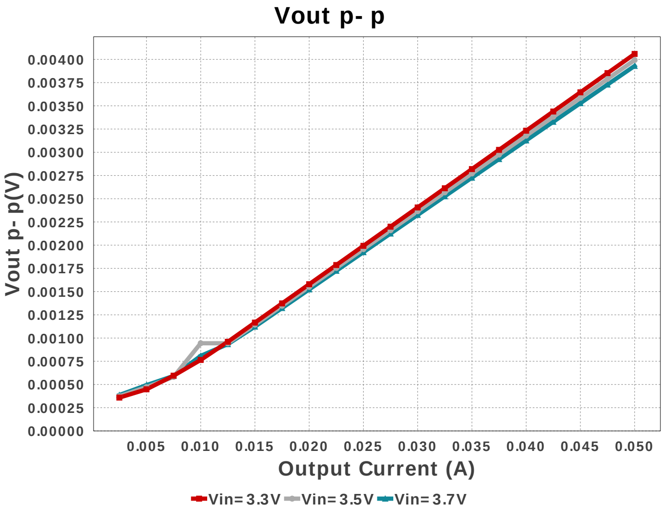
IC Ipk

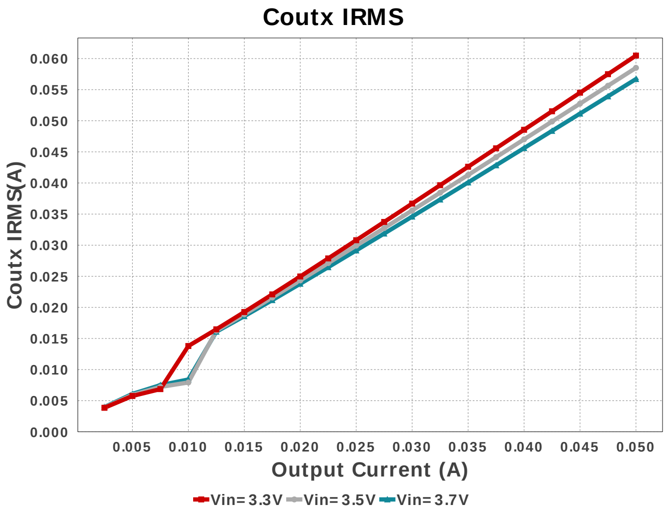


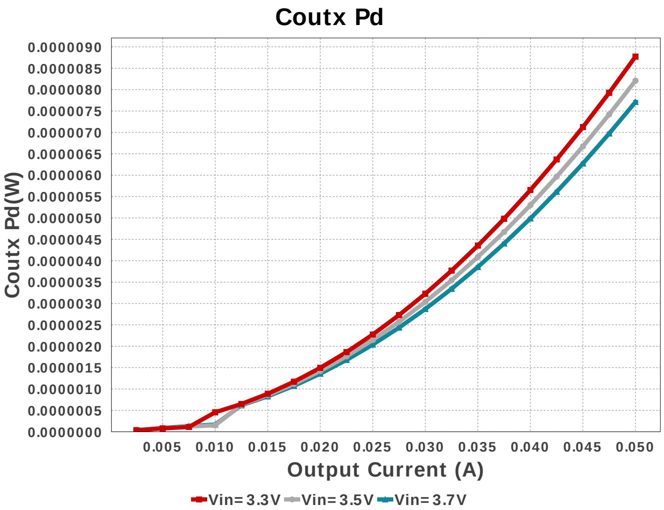

L Pd
L Pd(W)
0.0450 0.0425 0.0400 0.0375 0.0350 0.0325 0.0300 0.0275 0.0250 0.0225 0.0200 0.0175 0.0150 0.0125 0.0100 0.0075 0.0050 0.0025 0.0000
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V

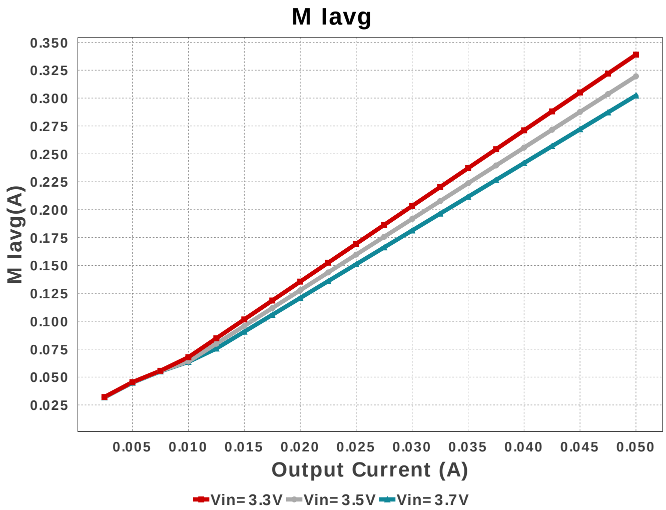

D1 Tj
D1 Tj(degC)
36.0 35.5 35.0 34.5 34.0 33.5 33.0 32.5 32.0 31.5 31.0 30.5 30.0
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V

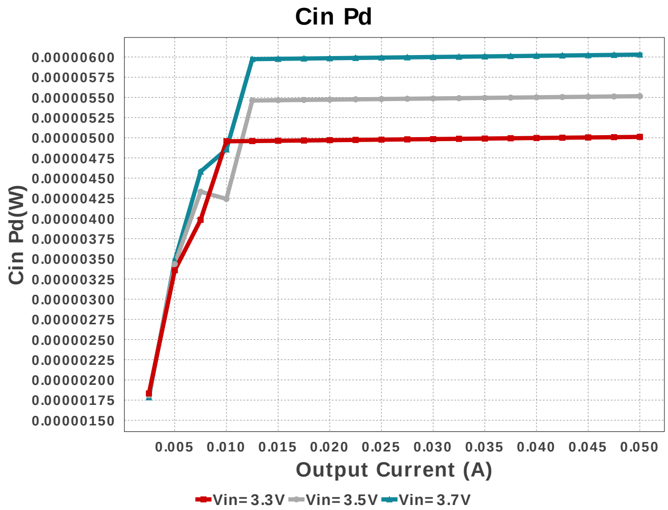

Efficiency
Efficiency(%)
92 91 90 89 88 87 86 85 84 83 82 81 80 79 78 77 76 75
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V

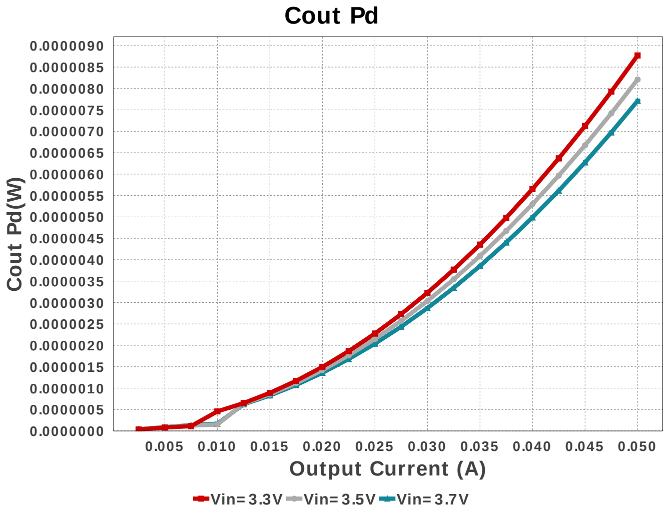

Vout p- p
Vout p- p(V)
0.00400 0.00375 0.00350 0.00325 0.00300 0.00275 0.00250 0.00225 0.00200 0.00175 0.00150 0.00125 0.00100 0.00075 0.00050 0.00025 0.00000
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V

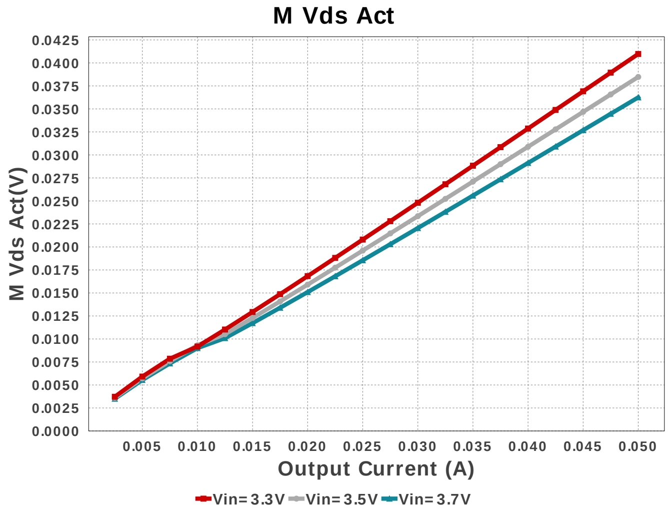

Coutx IRMS
Coutx IRMS(A)
0.060 0.055 0.050 0.045 0.040 0.035 0.030 0.025 0.020 0.015 0.010 0.005 0.000
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V

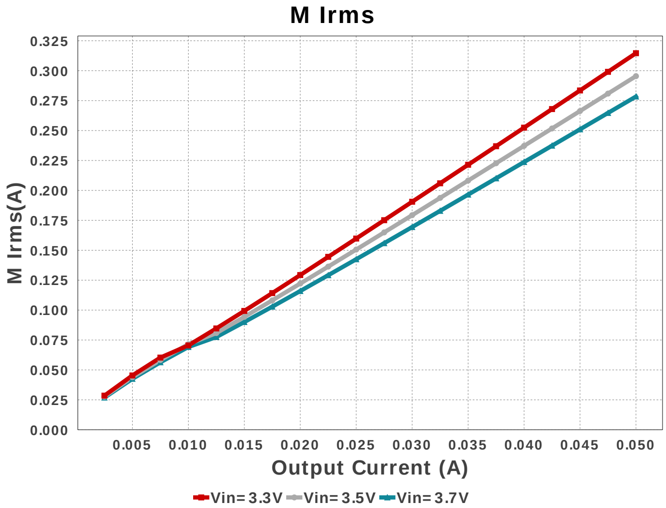

Coutx Pd
Coutx Pd(W)
0.0000090 0.0000085 0.0000080 0.0000075 0.0000070 0.0000065 0.0000060 0.0000055 0.0000050 0.0000045 0.0000040 0.0000035 0.0000030 0.0000025 0.0000020 0.0000015 0.0000010 0.0000005 0.0000000
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V

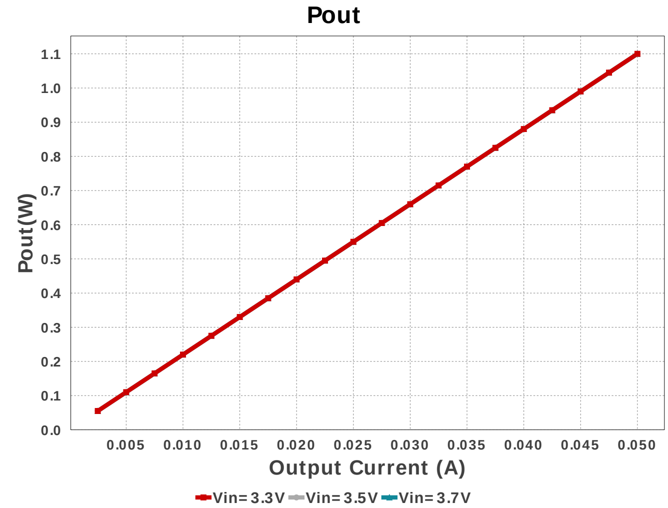

M Iavg
M Iavg(A)
Output Current (A)
Vin= 3.3V
Vin= 3.5V
Vin= 3.7V

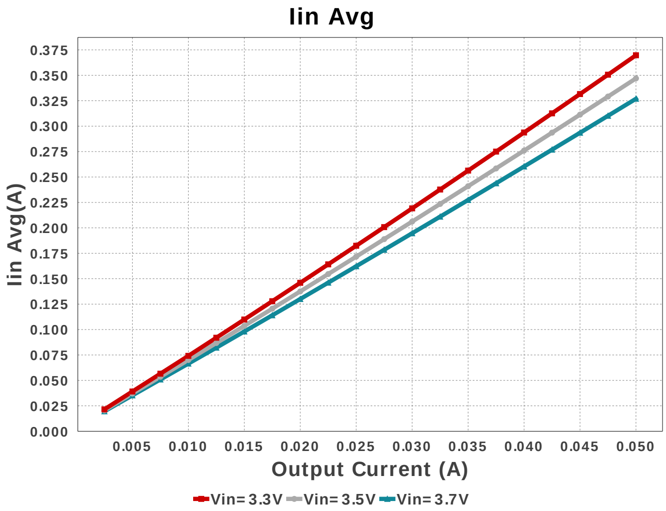

Cin Pd
Cin Pd(W)
Output Current (A)
Vin= 3.3V
Vin= 3.5V
Vin= 3.7V

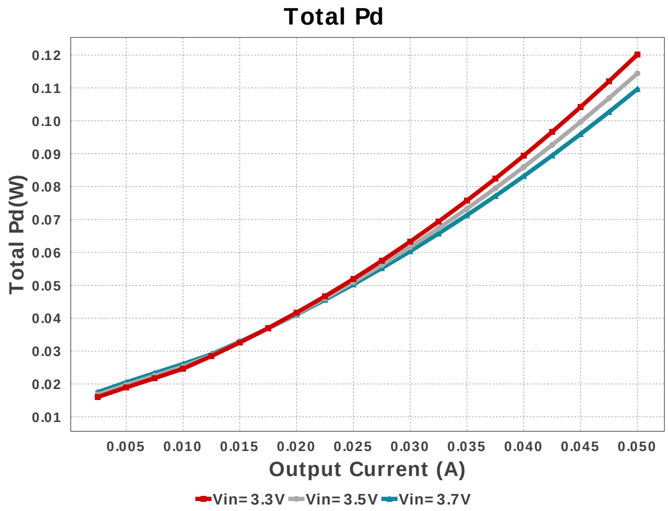

Cout Pd
Cout Pd(W)
Output Current (A)
Vin= 3.3V
Vin= 3.5V
Vin= 3.7V

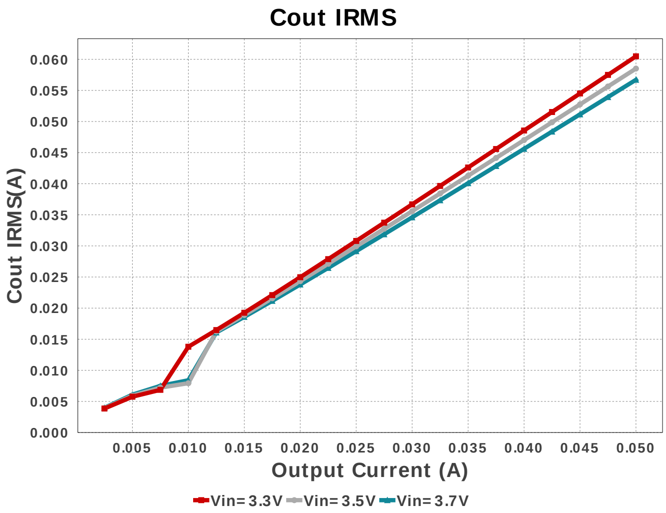

M Vds Act
M Vds Act(V)
Output Current (A)
Vin= 3.3V
Vin= 3.5V
Vin= 3.7V

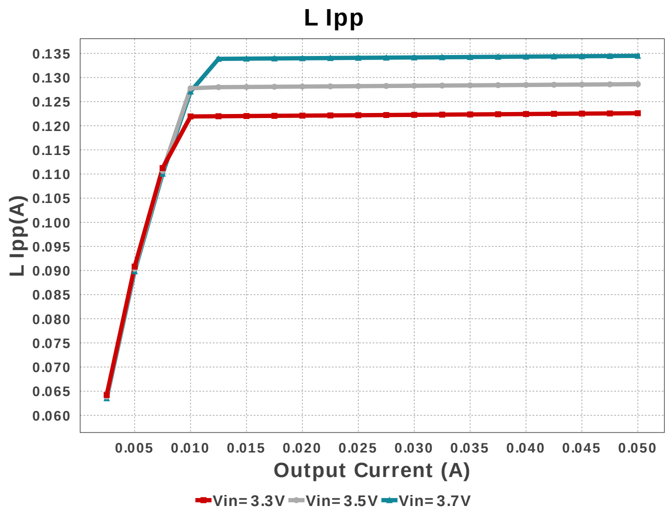

M Irms
M Irms(A)
Output Current (A)
Vin= 3.3V
Vin= 3.5V
Vin= 3.7V

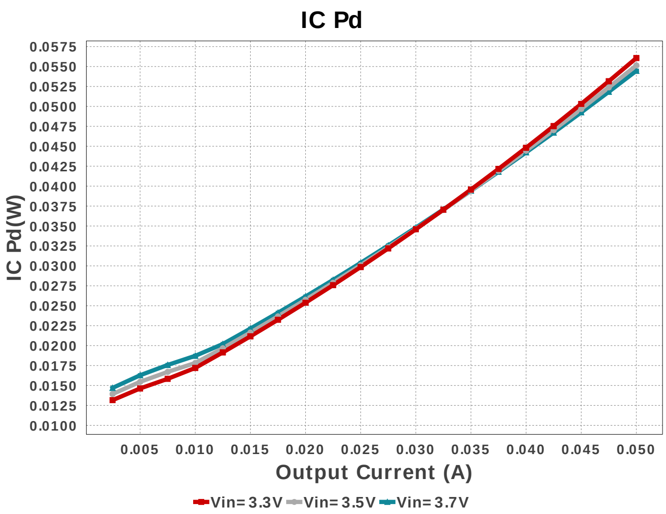

Pout
Pout(W)
Output Current (A)
Vin= 3.3V
Vin= 3.5V
Vin= 3.7V

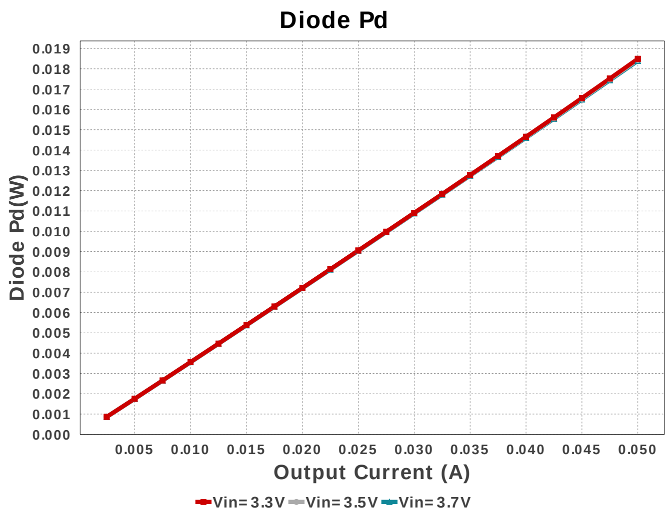

Iin Avg
Iin Avg(A)
0.375 0.350 0.325 0.300 0.275 0.250 0.225 0.200 0.175 0.150 0.125 0.100 0.075 0.050 0.025 0.000
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V

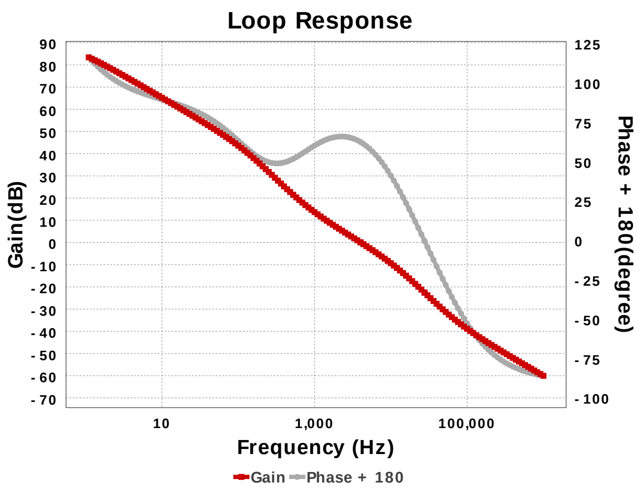

Total Pd
Total Pd(W)
0.12 0.11 0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.02 0.01
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V


Cout IRMS
Cout IRMS(A)
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
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V


L Ipp
L Ipp(A)
0.135 0.130 0.125 0.120 0.115 0.110 0.105 0.100 0.095 0.090 0.085 0.080 0.075 0.070 0.065 0.060
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V


IC Pd
IC Pd(W)
0.0575 0.0550 0.0525 0.0500 0.0475 0.0450 0.0425 0.0400 0.0375 0.0350 0.0325 0.0300 0.0275 0.0250 0.0225 0.0200 0.0175 0.0150 0.0125 0.0100
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V


Diode Pd
Diode Pd(W)
0.019 0.018 0.017 0.016 0.015 0.014 0.013 0.012 0.011 0.010 0.009 0.008 0.007 0.006 0.005 0.004 0.003 0.002 0.001 0.000
0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
Output Current (A)
Vin= 3.3V Vin= 3.5V Vin= 3.7V



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	12		Total Design BOM count
2.	Total BOM	$3.19		Total BOM Cost
3.	Cin IRMS	35.392 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	5.01 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	60.481 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	8.772 µW	Capacitor	Output capacitor power dissipation
7.	Coutx IRMS	60.481 mA	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	8.772 µW	Capacitor	Output capacitor_x power loss
9.	D1 Tj	36.01 degC	Diode	D1 junction temperature
10.	Diode Pd	18.492 mW	Diode	Diode power dissipation
11.	IC Ipk	0.0 A	IC	Peak switch current in IC
12.	IC Pd	56.067 mW	IC	IC power dissipation
13.	IC Tj	32.495 degC	IC	IC junction temperature
14.	IC Tolerance	20.0 mV	IC	IC Feedback Tolerance
15.	ICThetaJA	44.5 degC/W	IC	IC junction-to-ambient thermal resistance
16.	Iin Avg	369.74 mA	IC	Average input current
17.	L Ipp	122.601 mA	Inductor	Peak-to-peak inductor ripple current
18.	L Pd	43.897 mW	Inductor	Inductor power dissipation
19.	M Iavg	338.937 mA	Mosfet	MOSFET Average current
20.	M Irms	314.642 mA	Mosfet	MOSFET RMS ripple current
21.	M Vds Act	40.974 mV	Mosfet	Voltage drop across the MosFET
22.	Cin Pd	5.01 µW	Power	Input capacitor power dissipation
23.	Cout Pd	8.772 µW	Power	Output capacitor power dissipation
24.	Coutx Pd	8.772 µW	Power	Output capacitor_x power loss
25.	Diode Pd	18.492 mW	Power	Diode power dissipation
26.	IC Pd	56.067 mW	Power	IC power dissipation
27.	L Pd	43.897 mW	Power	Inductor power dissipation
28.	Total Pd	120.147 mW	Power	Total Power Dissipation
29.	Cross Freq	3.618 kHz	System Information	Bode plot crossover frequency
30.	Duty Cycle	85.248 %	System Information	Duty cycle
31.	Efficiency	90.153 %	System Information	Steady state efficiency
32.	FootPrint	156.0 mm^2	System Information	Total Foot Print Area of BOM components
33.	Frequency	700.0 kHz	System Information	Switching frequency
34.	Gain Marg	-21.616 dB	System Information	Bode Plot Gain Margin
35.	Iout	50.0 mA	System Information	Iout operating point
36.	Low Freq Gain	83.333 dB	System Information	Gain at 1Hz
37.	Mode	CCM	System Information	Conduction Mode
38.	Phase Marg	62.033 deg	System Information	Bode Plot Phase Margin
39.	Pout	1.1 W	System Information	Total output power
40.	Vin	3.3 V	System Information	Vin operating point

#	Name	Value	Category	Description
41.	Vout	22.0 V	System Information	Operational Output Voltage
42.	Vout Actual	22.016 V	System Information	Vout Actual calculated based on selected voltage divider resistors
43.	Vout Tolerance	3.566 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
44.	Vout p-p	4.059 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	50.0 m	Maximum Output Current
VinMax	3.7	Maximum input voltage
VinMin	3.3	Minimum input voltage
Vout	22.0	Output Voltage
base_pn	TPS61175-Q1	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

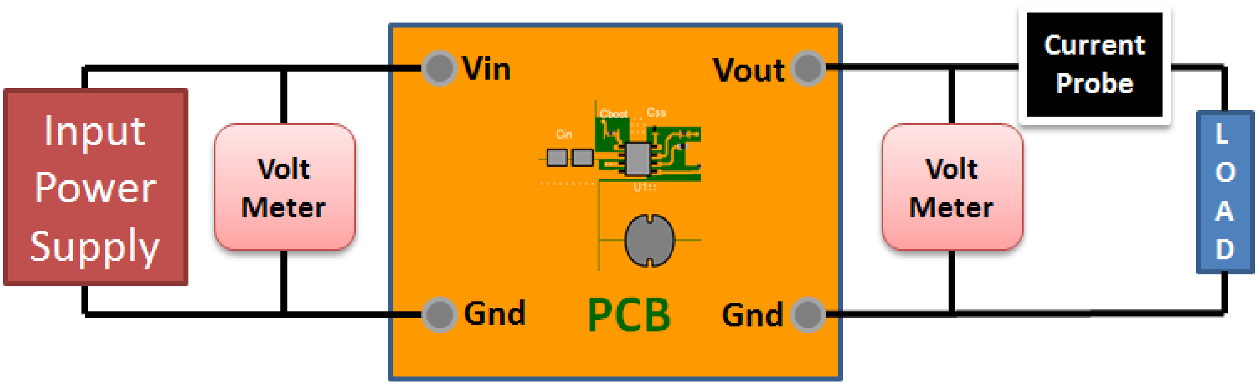
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 3.3V 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. The TPS61175-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application

2. Master key : 321D16195450476B[v1]

3. **TPS61175-Q1** Product Folder : http://www.ti.com/product/TPS61175%2DQ1 : contains the data sheet and other resources.

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