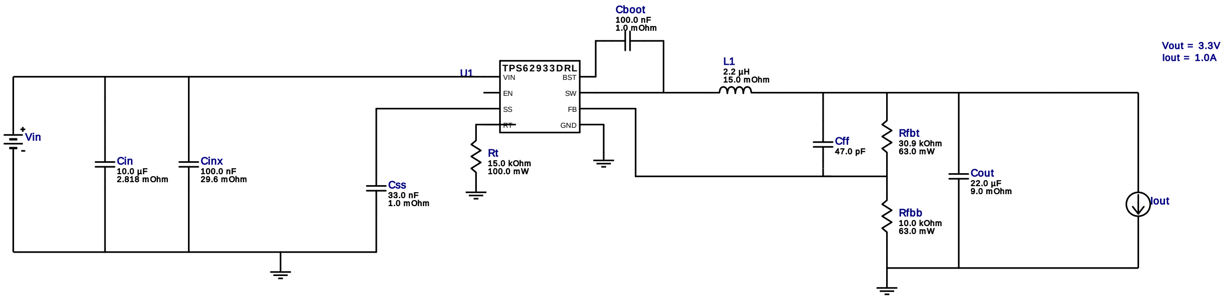
VinMin = 22.0V
VinMax = 26.0V
Vout = 3.3V
Iout = 1.0A

Device = TPS62933DRLR
Topology = Buck
Created = 2023-12-06 06:18:31.653
BOM Cost = $0.70
BOM Count = 11
Total Pd = 0.53W

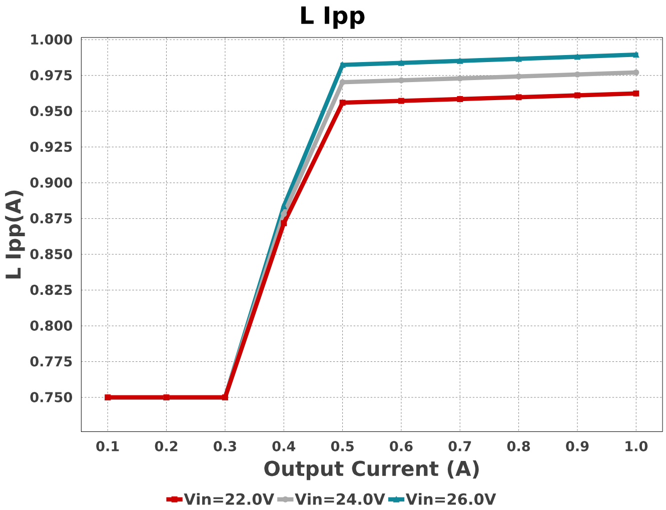
WEBENCH ® Design Report

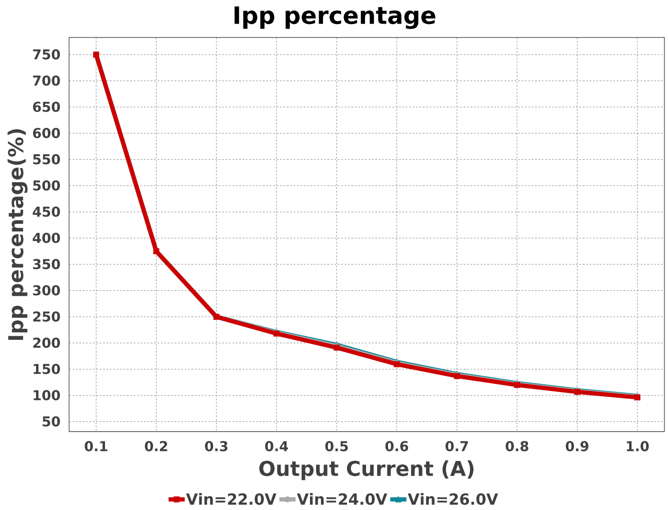
Design : 6 TPS62933DRLR
TPS62933DRLR 22V-26V to 3.30V @ 1A

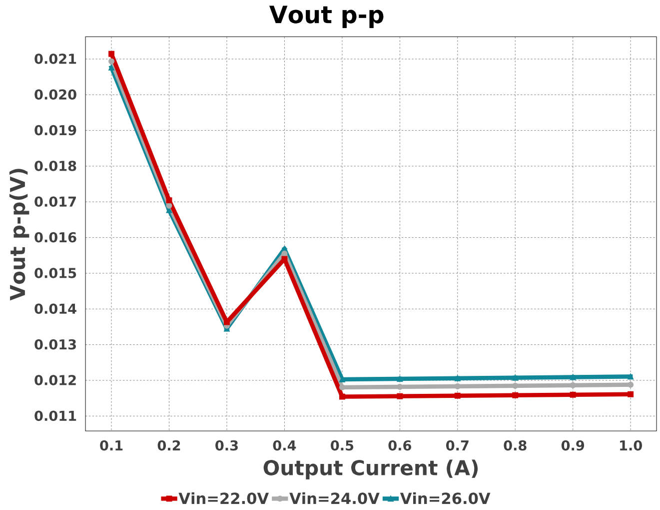


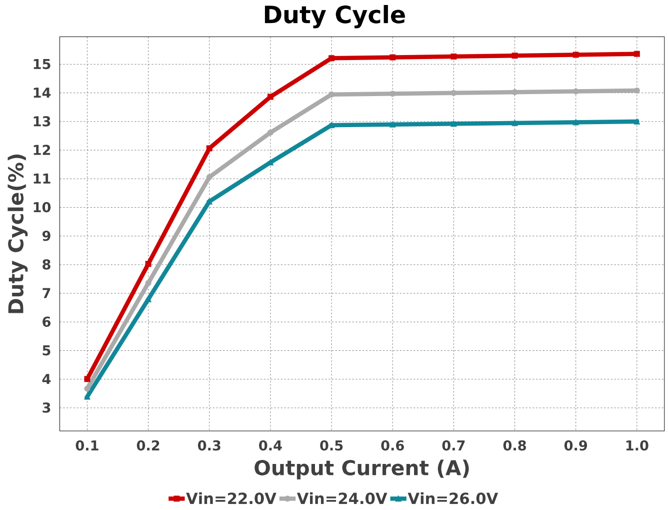
Electrical BOM

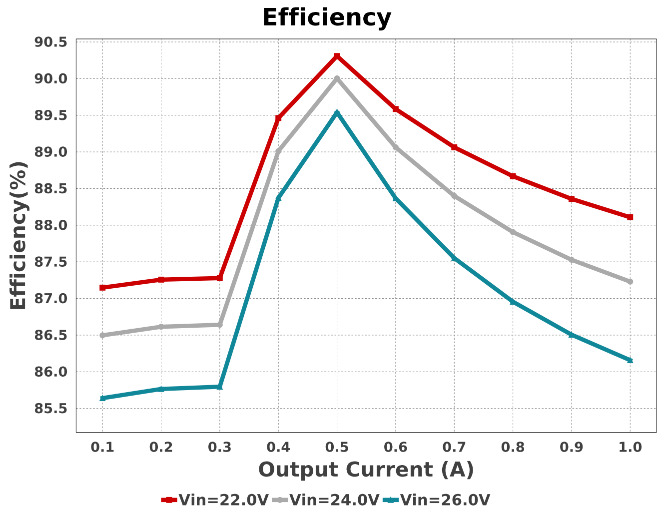
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cff	MuRata	GRM0335C1E470JA01D Series= C0G/NP0	Cap= 47.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cin	TDK	C2012X5R1V106K085AC Series= X5R	Cap= 10.0 uF ESR= 2.818 mOhm VDC= 35.0 V IRMS= 3.8868 A	1	$0.12	0805 7 mm²
Cinx	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	$0.01	0603 5 mm²
Cout	MuRata	GRM21BR60J226ME39L Series= X5R	Cap= 22.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 3.5 A	1	$0.09	0805 7 mm²
Css	MuRata	GRM155R71A333KA01D Series= X7R	Cap= 33.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
L1	TDK	VLP8040T-2R2N	L= 2.2 µH 15.0 mOhm	1	$0.22	VLP8040 113 mm²
Rfbb	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW040230K9FKED Series= CRCW..e3	Res= 30.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rt	Yageo	RC0603FR-0715KL Series= ?	Res= 15.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
U1	Texas Instruments	TPS62933DRLR	Switcher	1	$0.20	DRL0008A-MFG 9 mm²

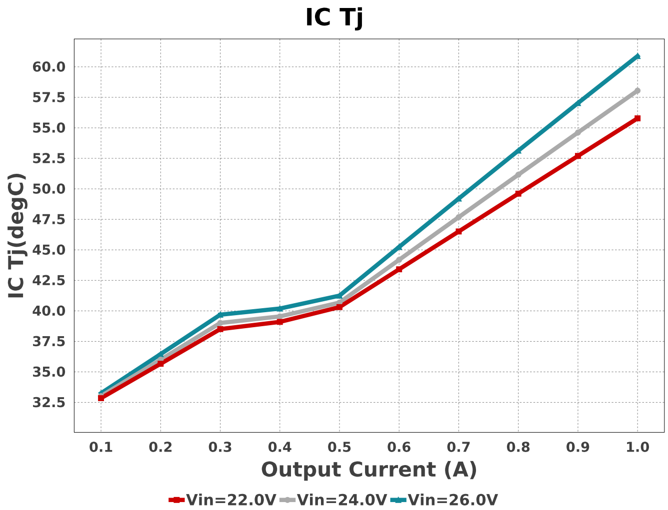

L Ipp
L Ipp(A)
1.000
0.975
0.950
0.925
0.900
0.875
0.850
0.825
0.800
0.775
0.750
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V


Ipp percentage
Ipp percentage(%)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V

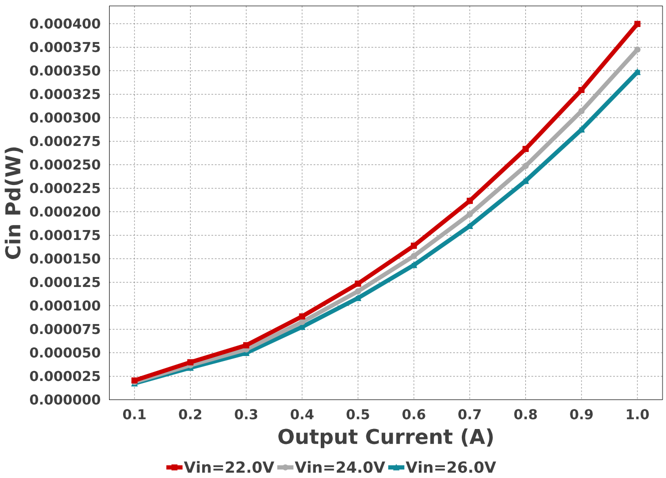

Vout p-p
Vout p-p(V)
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V


Duty Cycle
Duty Cycle(%)
15
14
13
12
11
10
9
8
7
6
5
4
3
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V

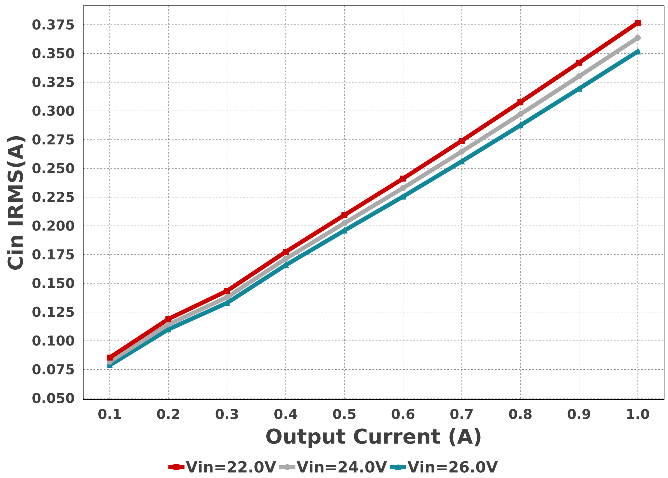

Efficiency
Efficiency(%)
90.5
90.0
89.5
89.0
88.5
88.0
87.5
87.0
86.5
86.0
85.5
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V


IC Tj
IC Tj(degC)
60.0
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V

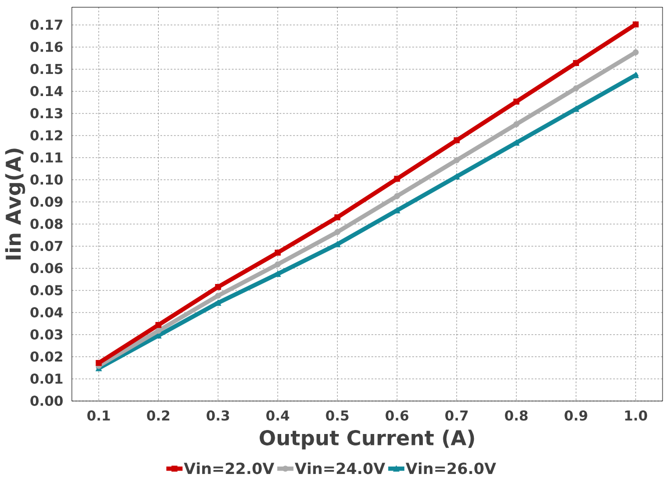
Cin Pd



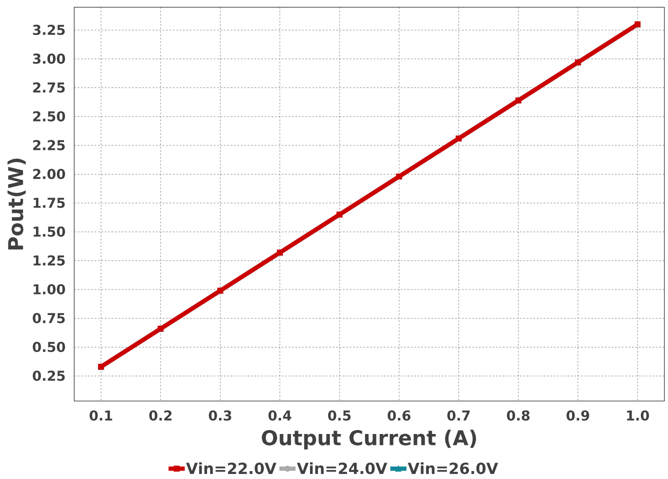
Cin IRMS



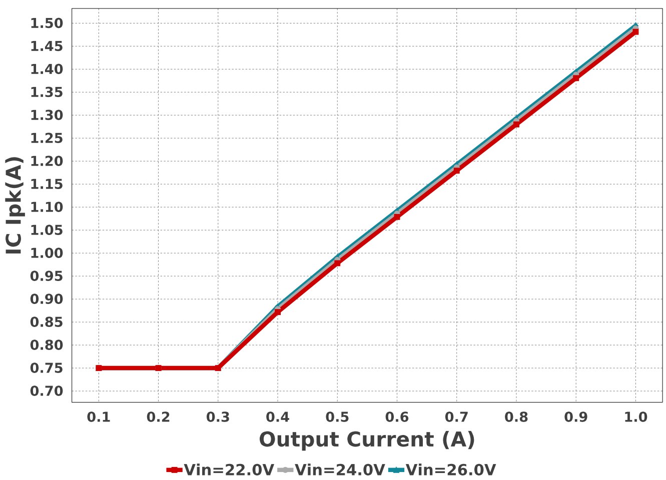
Iin Avg



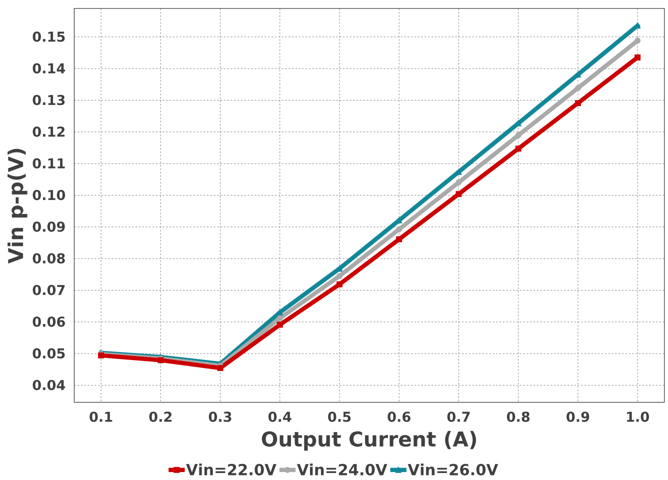
Pout

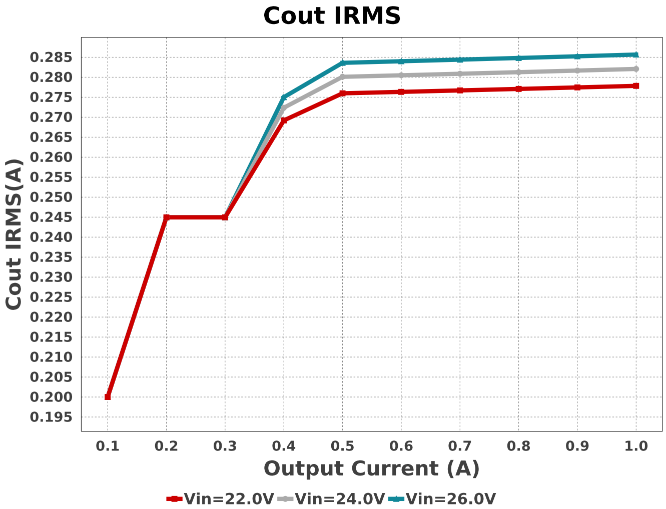


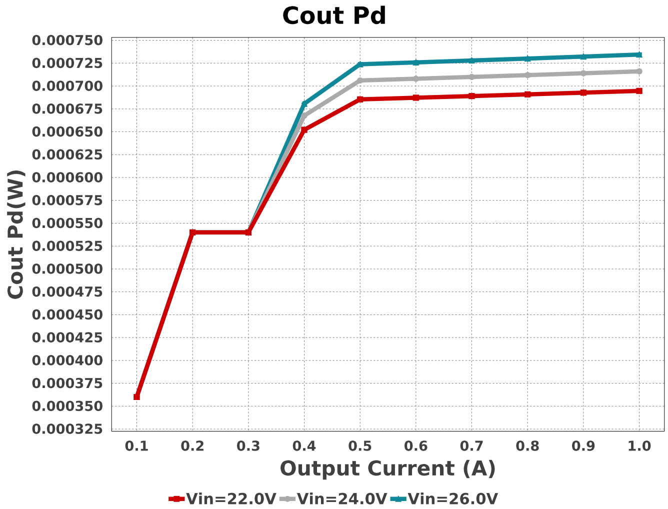
IC Ipk

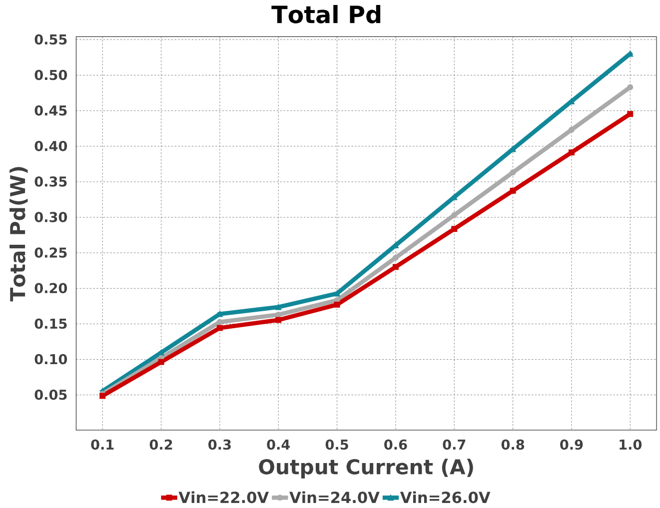


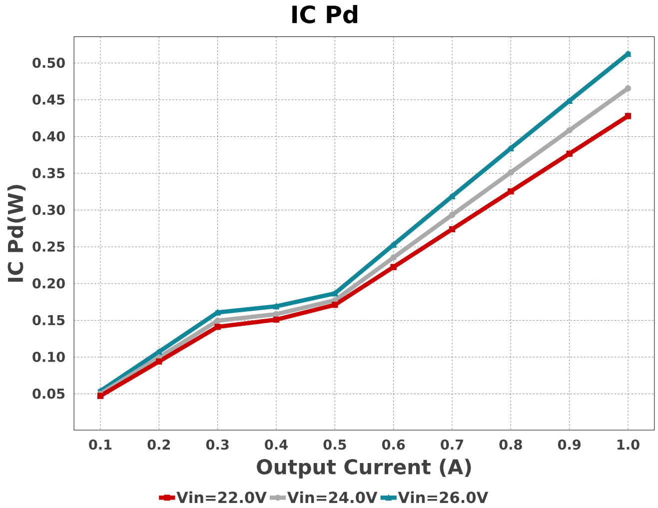
Vin p-p

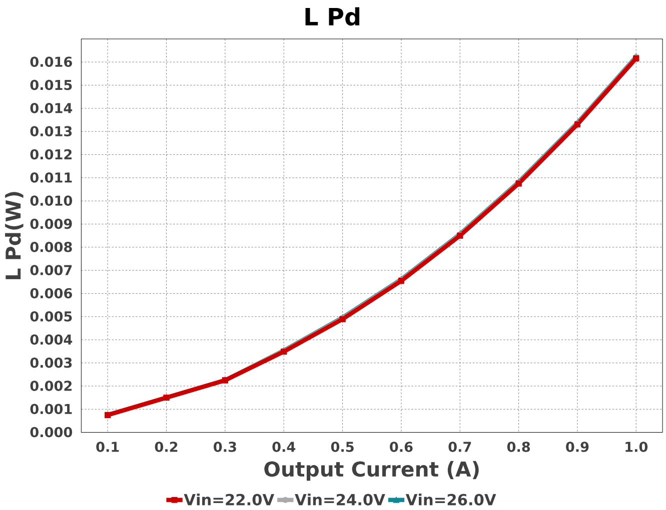


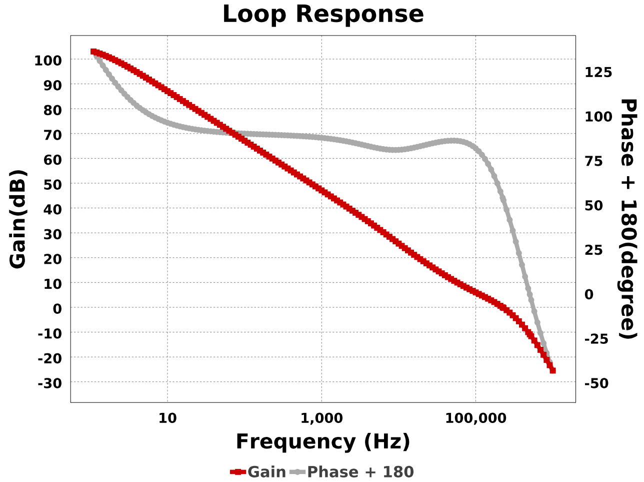

Cout IRMS
Cout IRMS(A)
0.285
0.280
0.275
0.270
0.265
0.260
0.255
0.250
0.245
0.240
0.235
0.230
0.225
0.220
0.215
0.210
0.205
0.200
0.195
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V

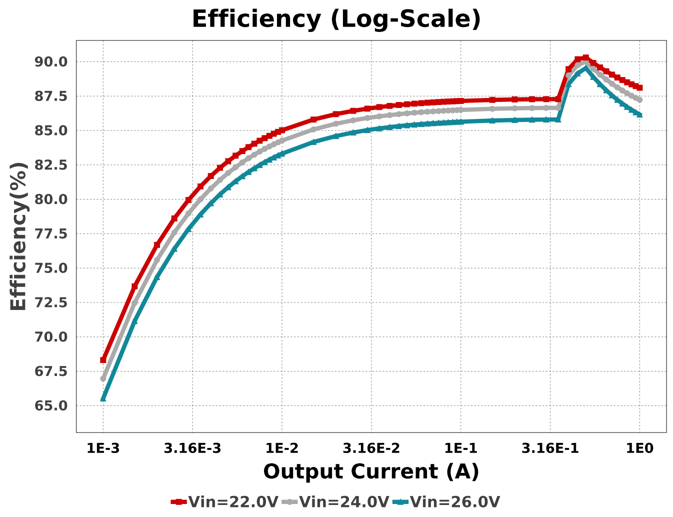

Cout Pd
Cout Pd(W)
0.000750
0.000725
0.000700
0.000675
0.000650
0.000625
0.000600
0.000575
0.000550
0.000525
0.000500
0.000475
0.000450
0.000425
0.000400
0.000375
0.000350
0.000325
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V


Total Pd
Total Pd(W)
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V


IC Pd
IC Pd(W)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V


L Pd
L Pd(W)
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
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=22.0V Vin=24.0V Vin=26.0V


Loop Response
Gain(dB)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
Phase + 180(degree)
125
100
75
50
25
0
-25
-50
10 1,000 100,000
Frequency (Hz)
Gain Phase + 180



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	351.725 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	348.62 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	285.662 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	734.42 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	1.495 A	IC	Peak switch current in IC
6.	IC Pd	512.6 mW	IC	IC power dissipation
7.	IC Tj	60.884 degC	IC	IC junction temperature
8.	IC Tolerance	16.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA Effective	60.25 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	147.31 mA	IC	Average input current
11.	Ipp percentage	98.956 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	989.562 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	16.224 mW	Inductor	Inductor power dissipation
14.	Cin Pd	348.62 µW	Power	Input capacitor power dissipation
15.	Cout Pd	734.42 µW	Power	Output capacitor power dissipation
16.	IC Pd	512.6 mW	Power	IC power dissipation
17.	L Pd	16.224 mW	Power	Inductor power dissipation
18.	Total Pd	530.157 mW	Power	Total Power Dissipation
19.	BOM Count	11	System Information	Total Design BOM count
20.	Cross Freq	223.412 kHz	System Information	Bode plot crossover frequency
21.	Duty Cycle	13.0 %	System Information	Duty cycle
22.	Efficiency	86.158 %	System Information	Steady state efficiency
23.	FootPrint	159.0 mm^2	System Information	Total Foot Print Area of BOM components
24.	Frequency	1.349 MHz	System Information	Switching frequency
25.	Gain Marg	-10.865 dB	System Information	Bode Plot Gain Margin
26.	Inductor ripple current requirement used for Inductor selection	40.0 %	System Information	Custom Inductor ripple current (% of average inductor current) requirement used for Inductor selection
27.	Iout	1.0 A	System Information	Iout operating point
28.	Iout transient step used for Cout calculations	500.0 mA	System Information	Custom Transient current step requirement that was used for Cout selection (A).
29.	Low Freq Gain	103.053 dB	System Information	Gain at 1Hz
30.	Mode	CCM	System Information	Conduction Mode
31.	Overshoot Value	7.248 mV	System Information	Theoretical Vout Overshoot Value
32.	Phase Marg	54.419 deg	System Information	Bode Plot Phase Margin
33.	Pout	3.3 W	System Information	Total output power
34.	Total BOM	$0.698	System Information	Total BOM Cost

#	Name	Value	Category	Description
35.	Undershoot Value	29.202 mV	System Information	Theoretical Vout Undershoot Value
36.	Vin	26.0 V	System Information	Vin operating point
37.	Vin p-p	153.573 mV	System Information	Peak-to-peak input voltage
38.	Vout	3.3 V	System Information	Operational Output Voltage
39.	Vout Actual	3.272 V	System Information	Vout Actual calculated based on selected voltage divider resistors
40.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
41.	Vout Tolerance	3.557 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Vout p-p	12.107 mV	System Information	Peak-to-peak output ripple voltage
43.	Vout transient requirement used for Cout calculations	3.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	26.0	Maximum input voltage
VinMin	22.0	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	TPS62933	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

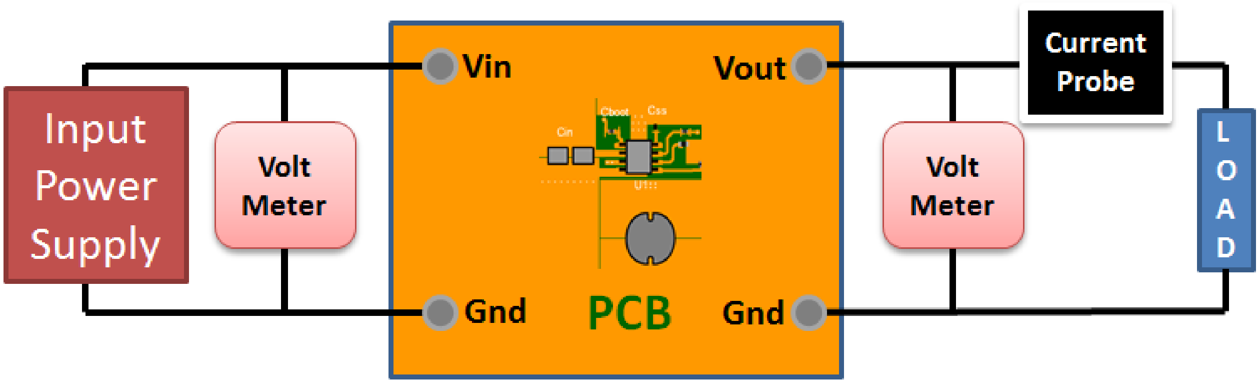
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 22.0V 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.



Design Assistance

1. Master key : F04D01DEACD168FBA2D6D8E65C251146[v1]
2. **TPS62933** Product Folder : http://www.ti.com/product/TPS62933 : contains the data sheet and other resources.

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