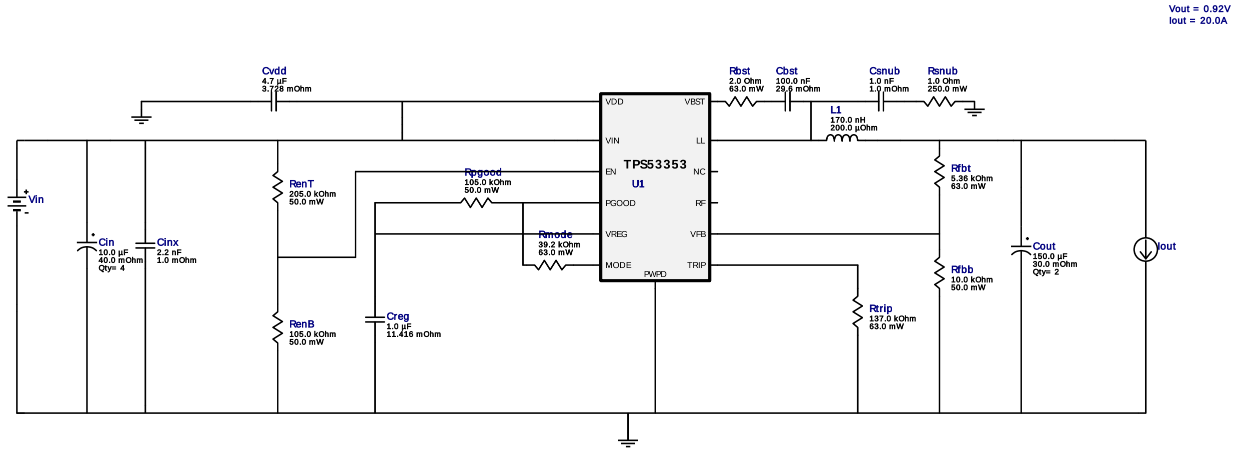
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 12.0V
VinMax = 12.0V
Vout = 0.92V
Iout = 20.0A

Device = TPS53353DQPR
Topology = Buck
Created = 2020-03-02 00:03:07.391
BOM Cost = $6.44
BOM Count = 22
Total Pd = 2.98W

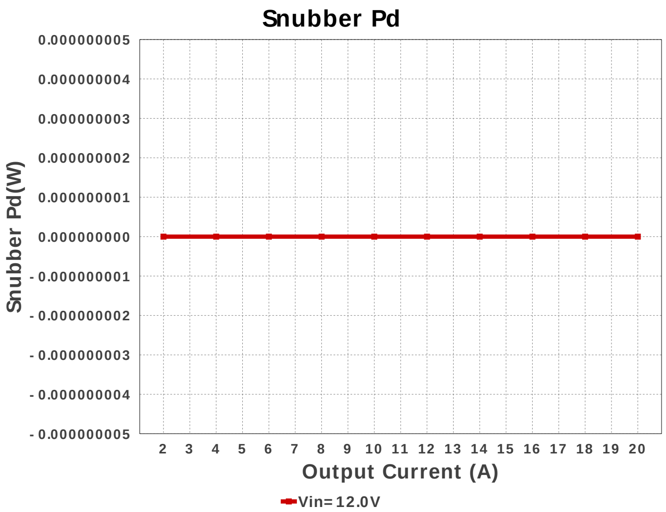
Design : 8080 TPS53353DQPR
TPS53353DQPR 12V-12V to .92V @ 20A

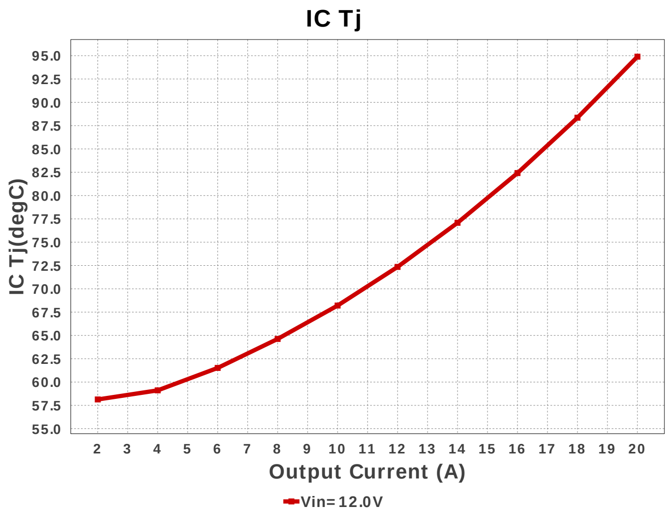


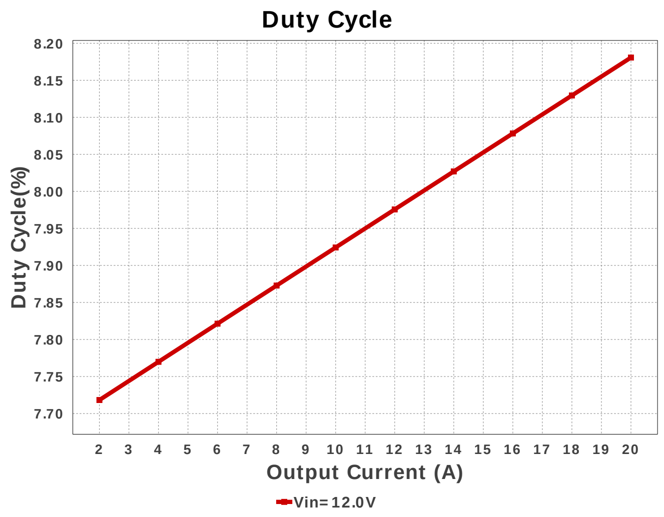
Electrical BOM

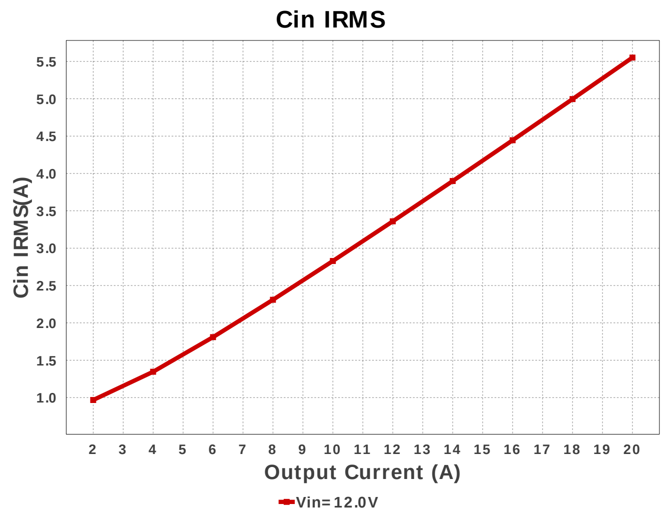
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	$0.01	0603 5 mm²
Cin	Panasonic	50SVPF10M Series= SVPF	Cap= 10.0 uF ESR= 40.0 mOhm VDC= 50.0 V IRMS= 2.5 A	4	$0.41	CAPSMT_62_F61 74 mm²
Cinx	MuRata	GRM155R71H222KA01D Series= X7R	Cap= 2.2 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cout	Panasonic	4SVPC150M Series= SVPC	Cap= 150.0 uF ESR= 30.0 mOhm VDC= 4.0 V IRMS= 1.97 A	2	$0.51	SM_RADIAL_5MM 58 mm²
Creg	TDK	C1005X5R1V105K050BC Series= X5R	Cap= 1.0 uF ESR= 11.416 mOhm VDC= 35.0 V IRMS= 1.483 A	1	$0.03	0402 3 mm²
Csnub	Kemet	C0603C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Cvdd	TDK	C1608X5R1V475K080AC Series= X5R	Cap= 4.7 uF ESR= 3.728 mOhm VDC= 35.0 V IRMS= 2.69359 A	1	$0.10	0603 5 mm²
L1	Coilcraft	SLC1175-171MEB	L= 170.0 nH 200.0 µOhm	1	$0.48	SLC1175 125 mm²
Rbst	Vishay-Dale	CRCW04022R00FKED Series= CRCW..e3	Res= 2.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

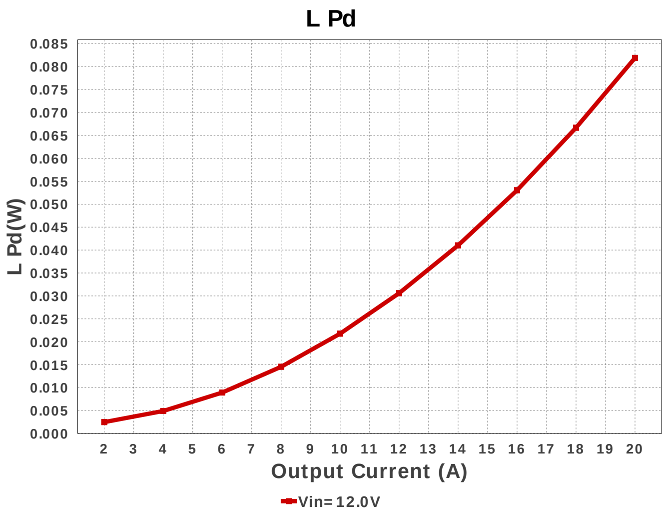
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
RenB	Yageo	RC0201FR-07105KL Series= ?	Res= 105.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
RenT	Yageo	RC0201FR-07205KL Series= ?	Res= 205.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbb	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbt	Vishay-Dale	CRCW04025K36FKED Series= CRCW..e3	Res= 5.36 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rmode	Vishay-Dale	CRCW040239K2FKED Series= CRCW..e3	Res= 39.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpgood	Yageo	RC0201FR-07105KL Series= ?	Res= 105.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rsnub	Vishay-Dale	CRCW12061R00FKEA Series= CRCW..e3	Res= 1.0 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rtrip	Vishay-Dale	CRCW0402137KFKED Series= CRCW..e3	Res= 137.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS53353DQPR	Switcher	1	$3.05	DQP0022A 56 mm^2

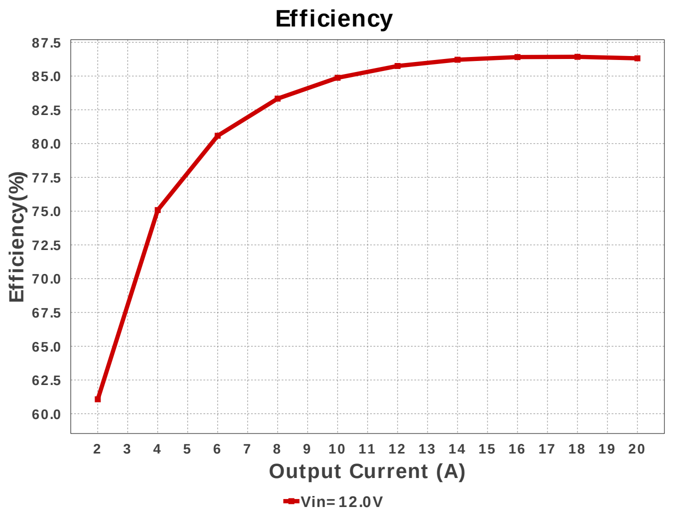


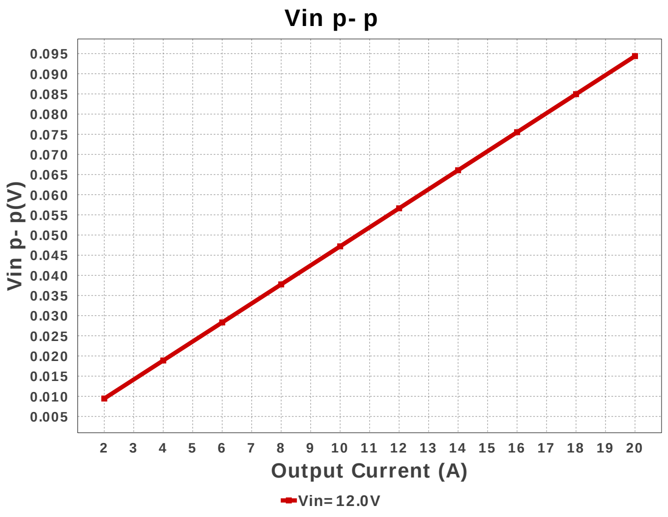


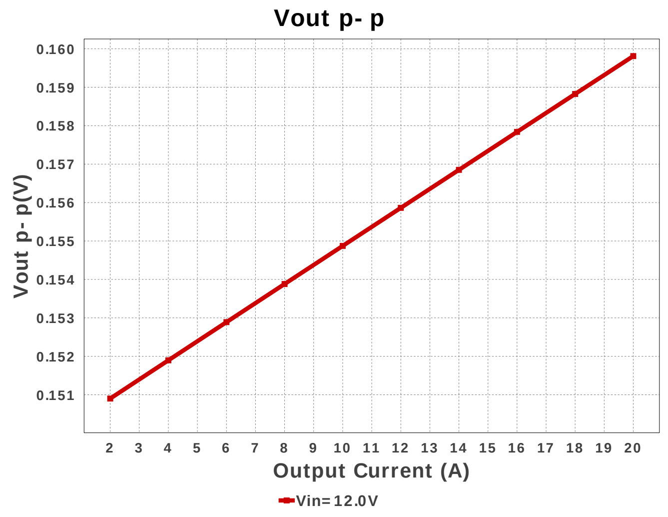

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=12.0V

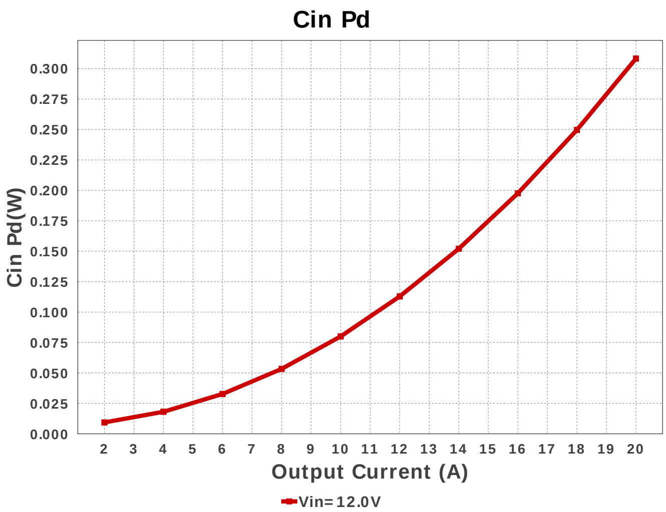

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=12.0V

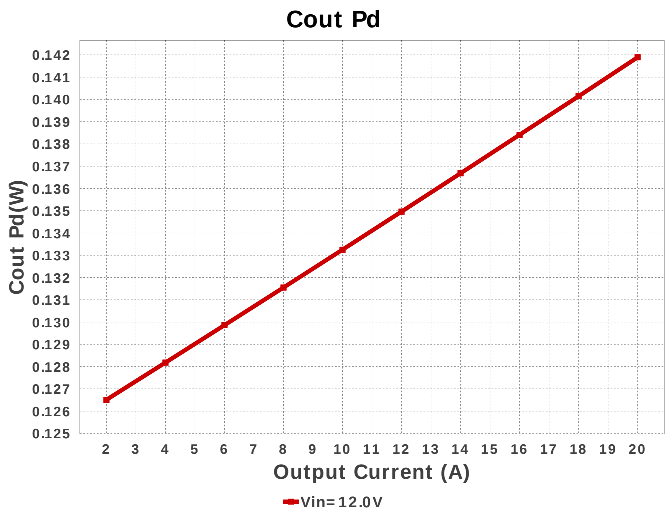

L Pd
L Pd(W)
Output Current (A)
Vin=12.0V

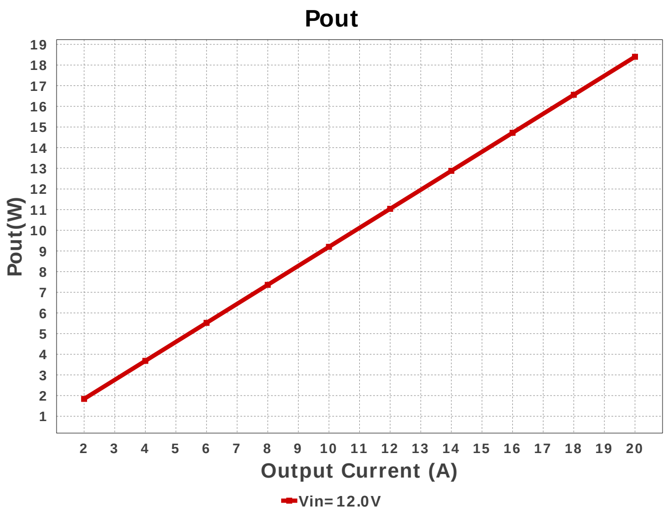

Efficiency
Efficiency(%)
Output Current (A)
Vin=12.0V

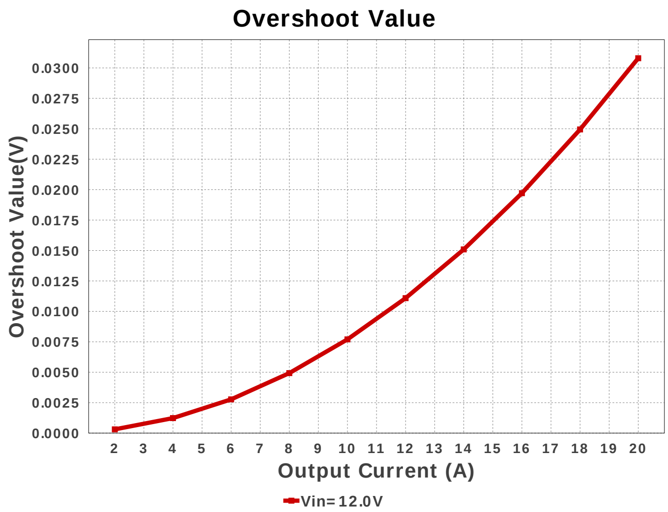

Vin p- p
Vin p- p(V)
Output Current (A)
Vin=12.0V

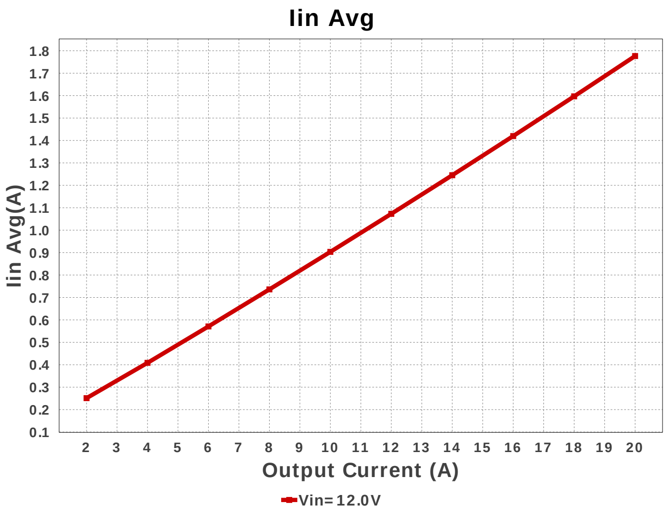

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=12.0V

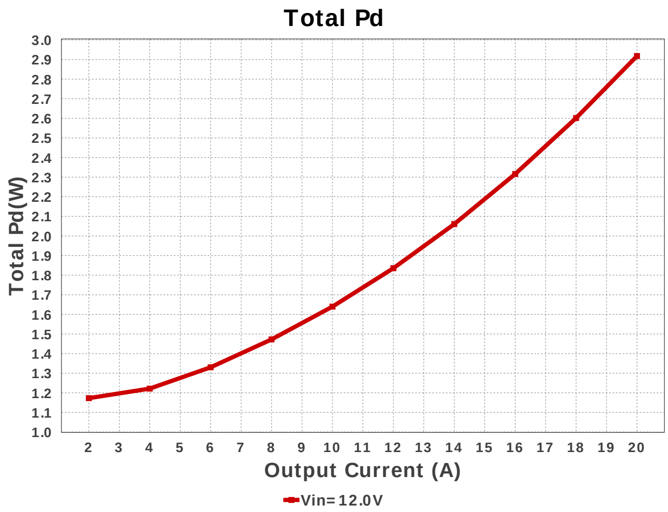

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=12.0V

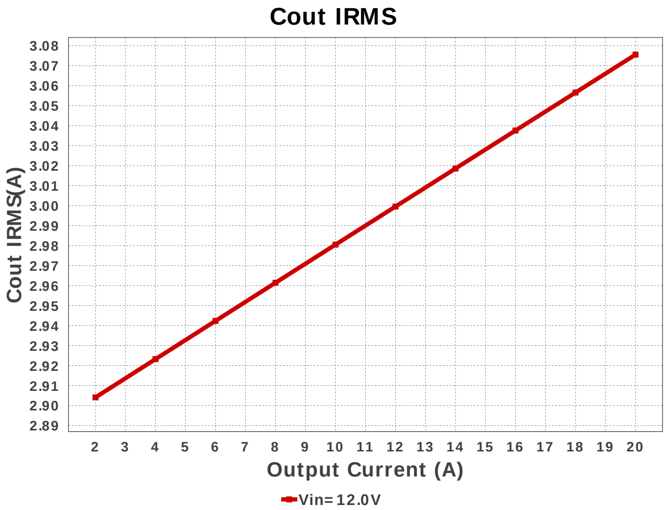

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=12.0V

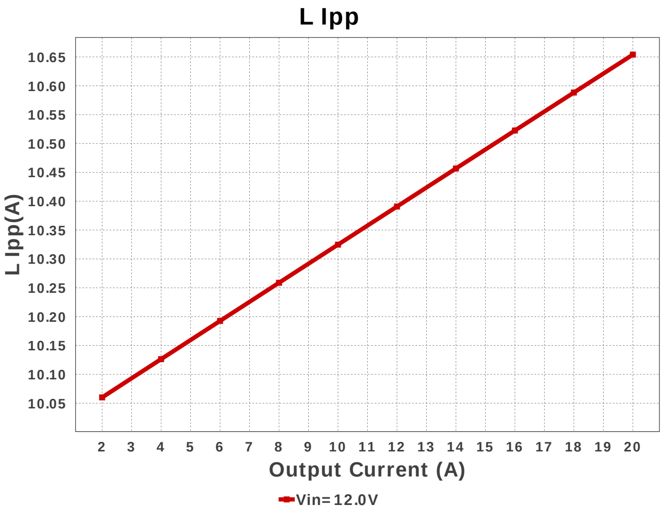

Pout
Pout(W)
Output Current (A)
Vin=12.0V

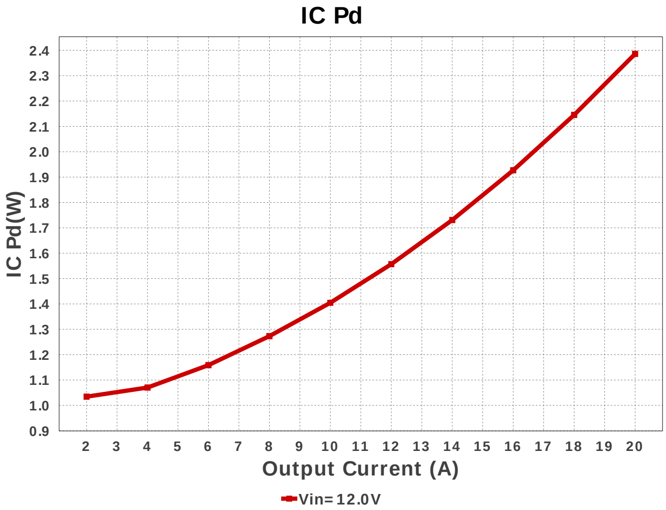

Overshoot Value
Overshoot Value(V)
Output Current (A)
Vin=12.0V

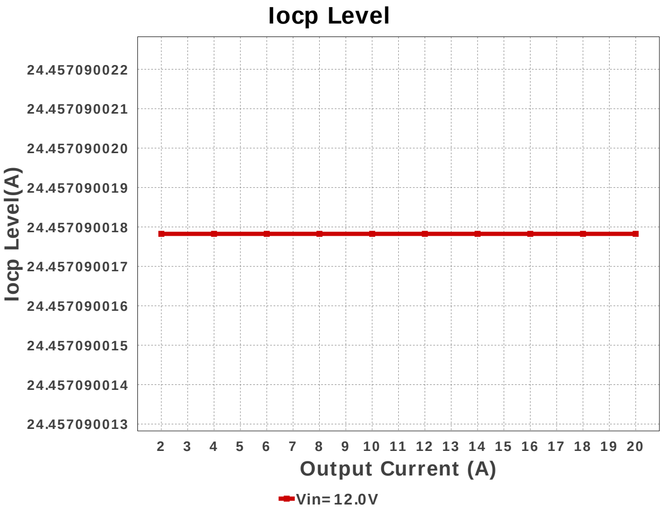

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=12.0V

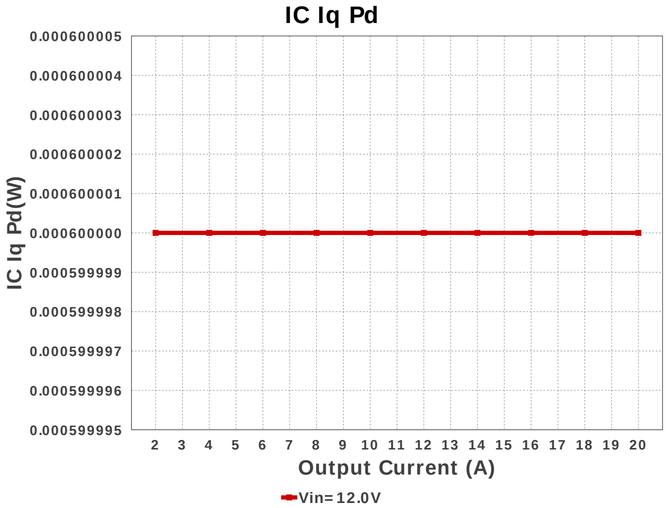

Total Pd
Total Pd(W)
Output Current (A)
Vin=12.0V

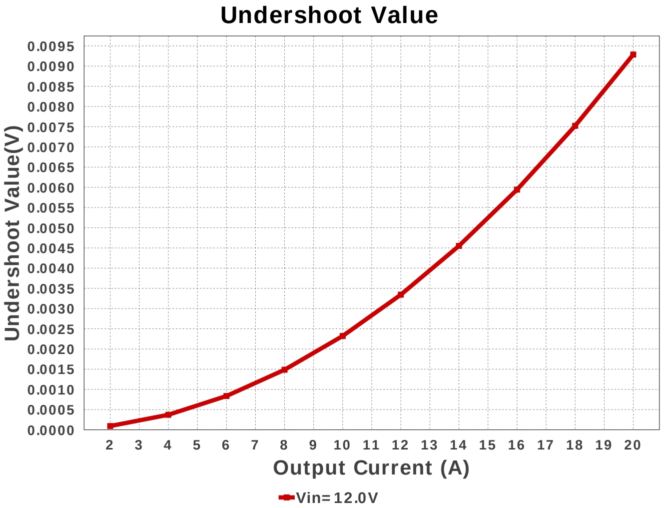












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	5.552 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	308.2 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	3.076 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	141.89 mW	Capacitor	Output capacitor power dissipation
5.	IC Iq Pd	600.0 µW	IC	IC Iq Pd
6.	IC Pd	2.386 W	IC	IC power dissipation
7.	IC Tj	94.895 degC	IC	IC junction temperature
8.	ICThetaJA	27.2 degC/W	IC	IC junction-to-ambient thermal resistance
9.	Iin Avg	1.776 A	IC	Average input current
10.	L Ipp	10.654 A	Inductor	Peak-to-peak inductor ripple current
11.	L Pd	81.892 mW	Inductor	Inductor power dissipation

#	Name	Value	Category	Description
12.	Cin Pd	308.2 mW	Power	Input capacitor power dissipation
13.	Cout Pd	141.89 mW	Power	Output capacitor power dissipation
14.	IC Pd	2.386 W	Power	IC power dissipation
15.	L Pd	81.892 mW	Power	Inductor power dissipation
16.	Snubber Pd	72.0 mW	Power	Snubber Power Dissipation
17.	Total Pd	2.98 W	Power	Total Power Dissipation
18.	BOM Count	22	System Information	Total Design BOM count
19.	Duty Cycle	8.181 %	System Information	Duty cycle
20.	Efficiency	86.022 %	System Information	Steady state efficiency
21.	FootPrint	645.0 mm^2	System Information	Total Foot Print Area of BOM components
22.	Frequency	500.0 kHz	System Information	Switching frequency
23.	Iocp Level	24.457 A	System Information	Over current protection threshold
24.	Iout	20.0 A	System Information	Iout operating point
25.	Mode	CCM	System Information	Conduction Mode
26.	Overshoot Value	30.797 mV	System Information	Theoretical Overshoot Value
27.	Pout	18.4 W	System Information	Total output power
28.	Total BOM	$6.44	System Information	Total BOM Cost
29.	Undershoot Value	9.286 mV	System Information	Theoretical Undershoot Value
30.	Vin	12.0 V	System Information	Vin operating point
31.	Vin p-p	94.38 mV	System Information	Peak-to-peak input voltage
32.	Vout	920.0 mV	System Information	Operational Output Voltage
33.	Vout Actual	921.6 mV	System Information	Vout Actual calculated based on selected voltage divider resistors
34.	Vout Tolerance	1.712 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
35.	Vout p-p	159.81 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	20.0	Maximum Output Current
VinMax	12.0	Maximum input voltage
VinMin	12.0	Minimum input voltage
Vout	920.0 m	Output Voltage
base_pn	TPS53353	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

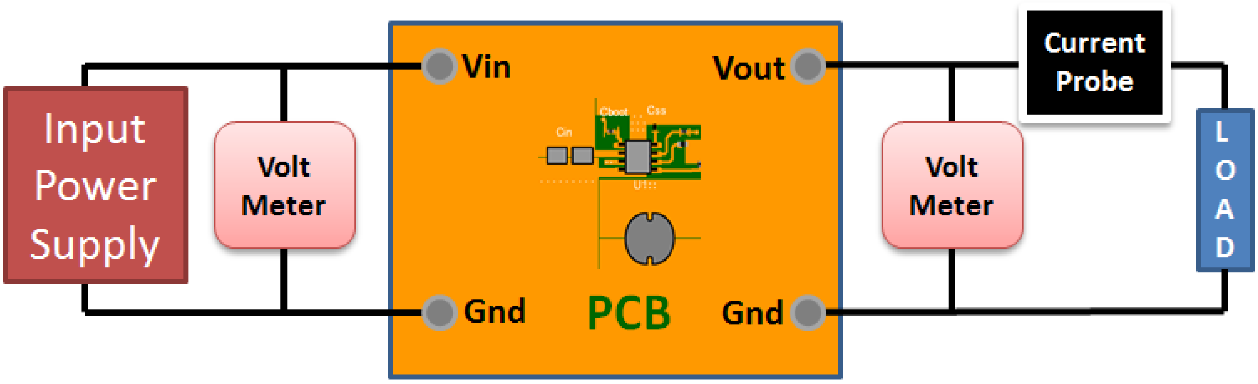
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 12.0V 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 : B9C964572EBB957B[v1]

2. **TPS53353** Product Folder : http://www.ti.com/product/TPS53353 : contains the data sheet and other resources.