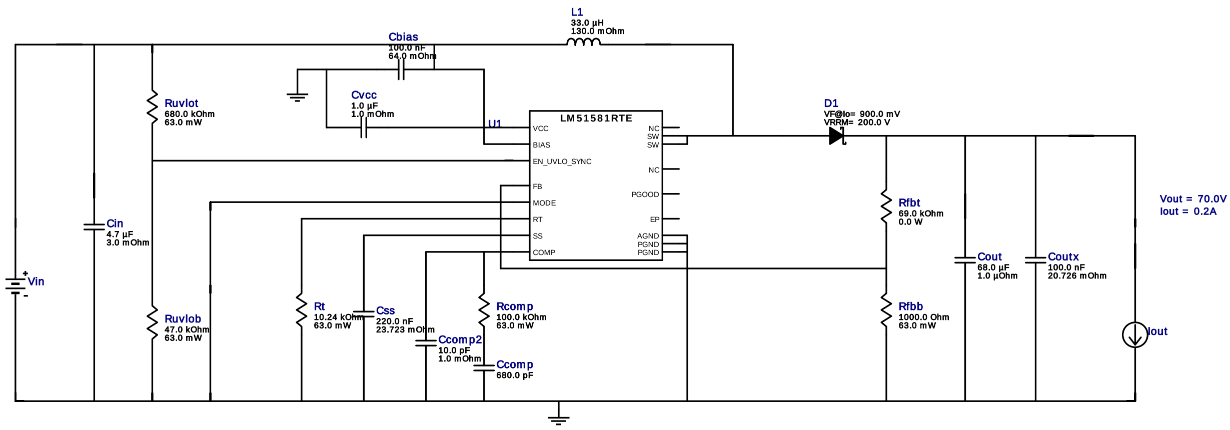
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 20.0V
VinMax = 30.0V
Vout = 70.0V
Iout = 0.2A

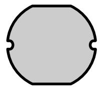
Device = LM51581RTER
Topology = Boost
Created = 2024-10-03 10:17:44.852
BOM Cost = NA
BOM Count = 17
Total Pd = 1.42W

Design : 16 LM51581RTER
LM51581RTER 20V-30V to 70.00V @ 0.2A

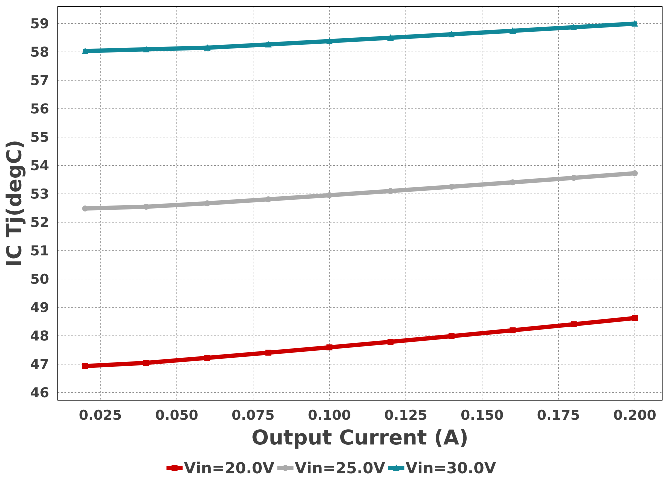


Electrical BOM

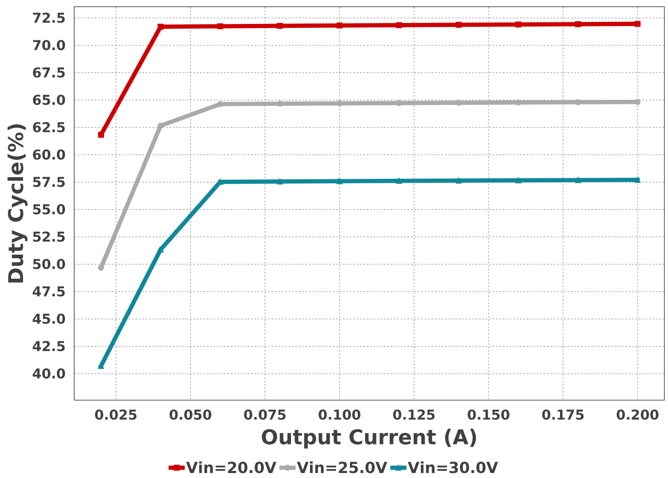
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm^2
Ccomp	Samsung Electro-Mechanics	CL05C681JB5NNNC Series= C0G/NP0	Cap= 680.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	CUSTOM	CUSTOM Series= ?	Cap= 10.0 pF ESR= 1.0 mOhm VDC= 140.0 V IRMS= 200.0 mA	1	NA	CUSTOM 0 mm^2
Cin	MuRata	GRM31CR71H475KA12L Series= X7R	Cap= 4.7 uF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 4.98 A	1	$0.10	1206 11 mm^2
Cout	CUSTOM	CUSTOM Series= X7S	Cap= 68.0 uF ESR= 1.0 uOhm VDC= 100.0 V IRMS= 6.7739 A	1	NA	1210 0 mm^2
Coutx	TDK	C2012X7R2A104K125AA Series= X7R	Cap= 100.0 nF ESR= 20.726 mOhm VDC= 100.0 V IRMS= 1.456 A	1	$0.03	0805 7 mm^2
Css	CUSTOM	CUSTOM Series= X5R	Cap= 220.0 nF ESR= 23.723 mOhm VDC= 50.0 V IRMS= 1.35424 A	1	NA	0805 0 mm^2
Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
D1	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.06	SMA 37 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	NIC Components	NPI75C330MTRF	L= 33.0 µH 130.0 mOhm	1	$0.14	 IND_NPI75C 94 mm²
Rcomp	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	CUSTOM	CUSTOM Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	NA	0402 0 mm²
Rfbt	CUSTOM	CUSTOM Series= ?	Res= 69.0 kOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rt	CUSTOM	CUSTOM Series= CRCW..e3	Res= 10.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	NA	0402 0 mm²
Ruvlob	CUSTOM	CUSTOM Series= CRCW..e3	Res= 47.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	NA	0402 0 mm²
Ruvlot	CUSTOM	CUSTOM Series= CRCW..e3	Res= 680.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	NA	0402 0 mm²
U1	Texas Instruments	LM51581RTER	Switcher	1	$1.60	RTE0016K-IPC_A 16 mm²

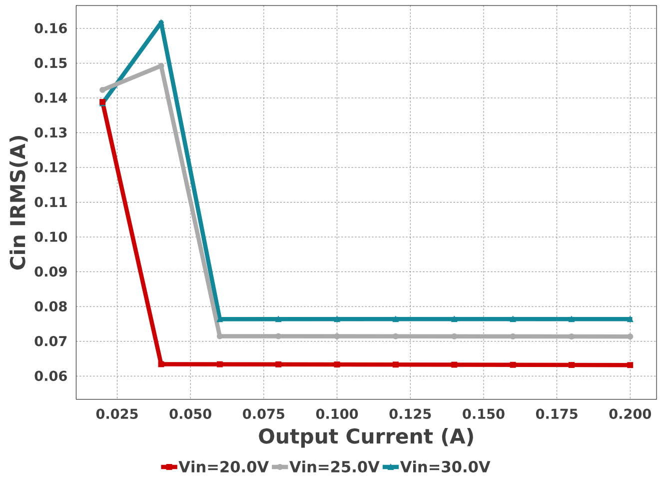
IC Tj



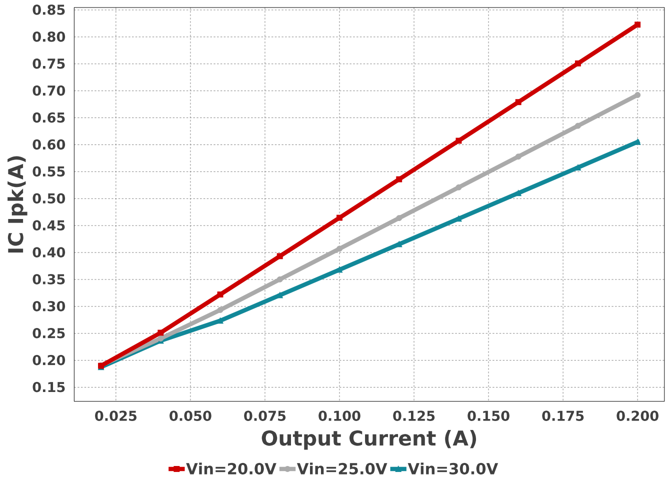
Duty Cycle



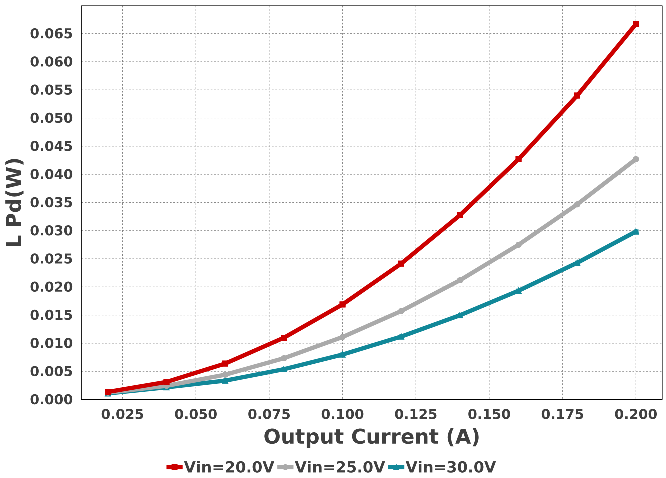
Cin IRMS



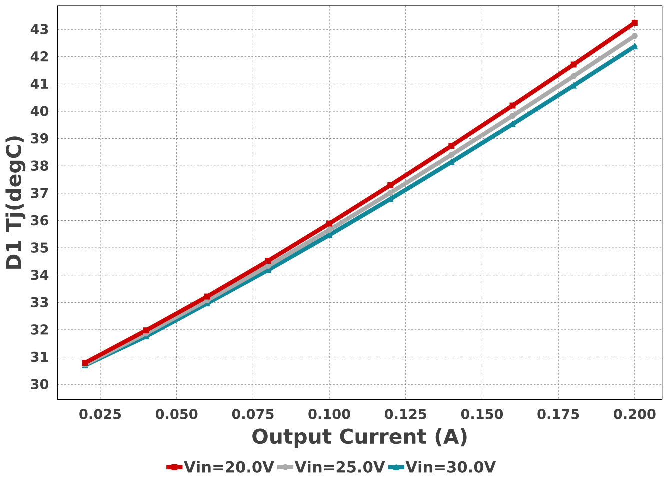
IC Ipk



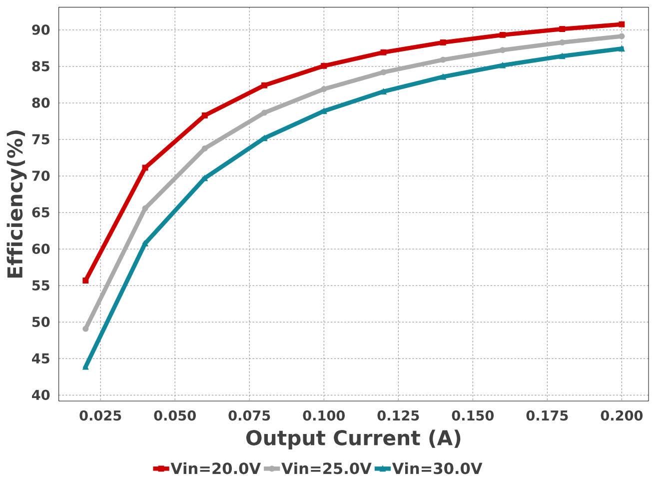
L Pd



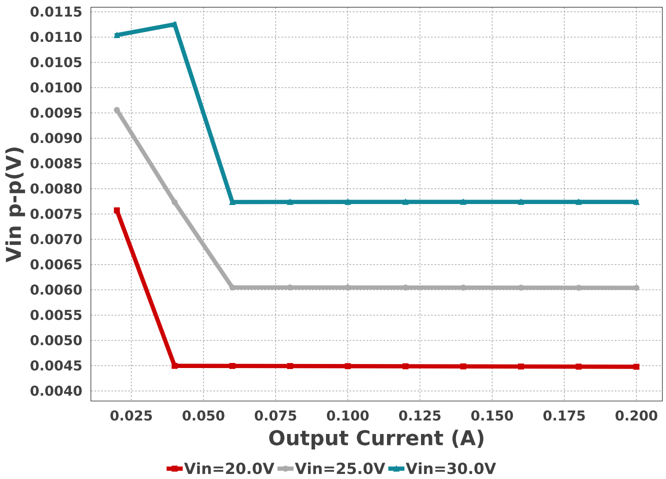
D1 Tj



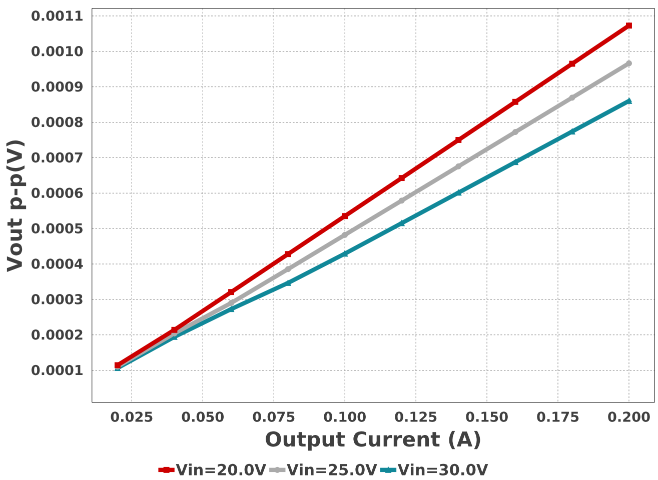
Efficiency



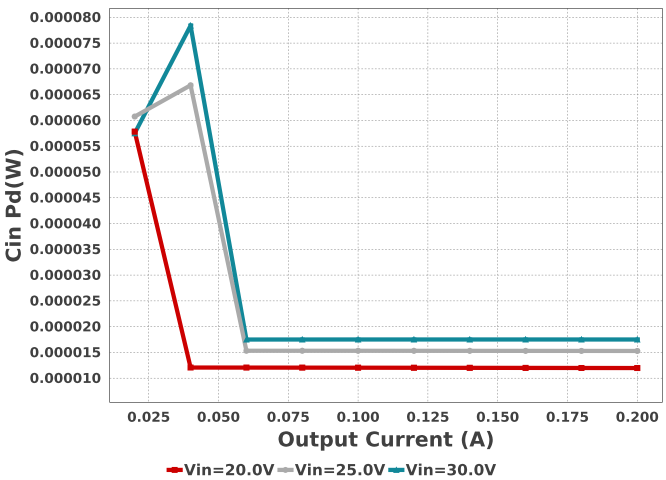
Vin p-p



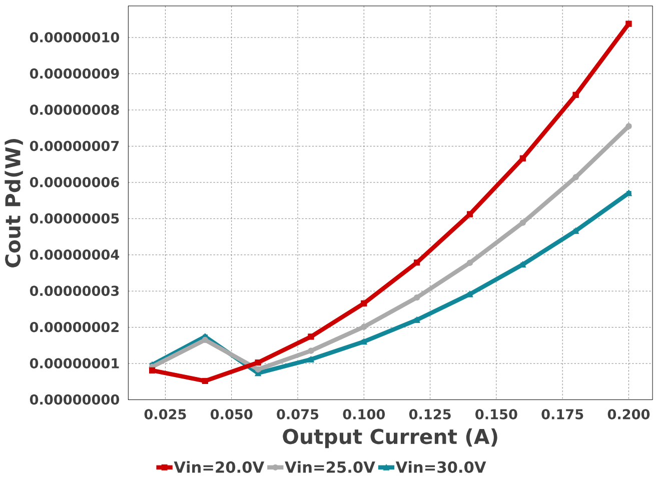
Vout p-p



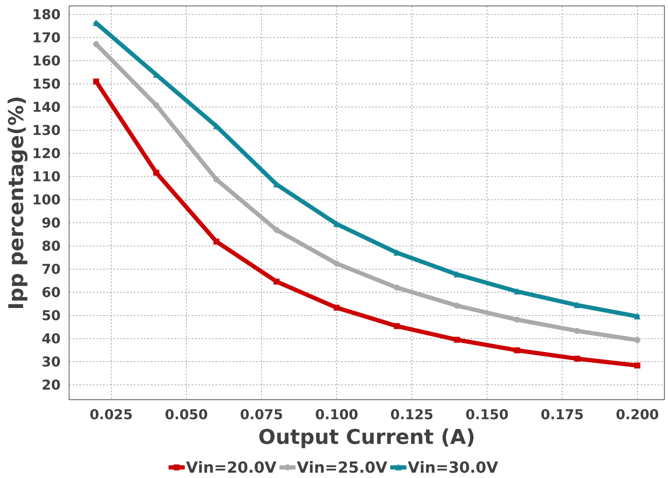
Cin Pd



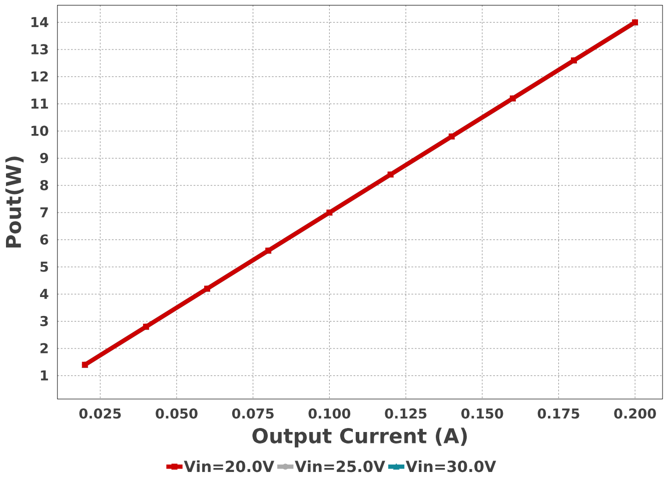
Cout Pd



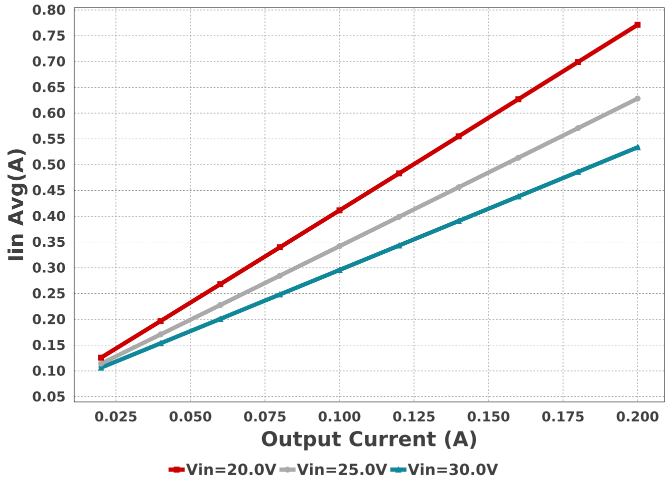
Ipp percentage



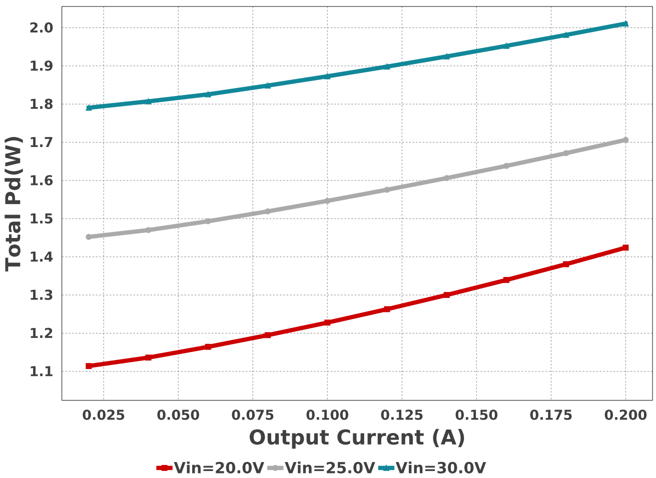
Pout



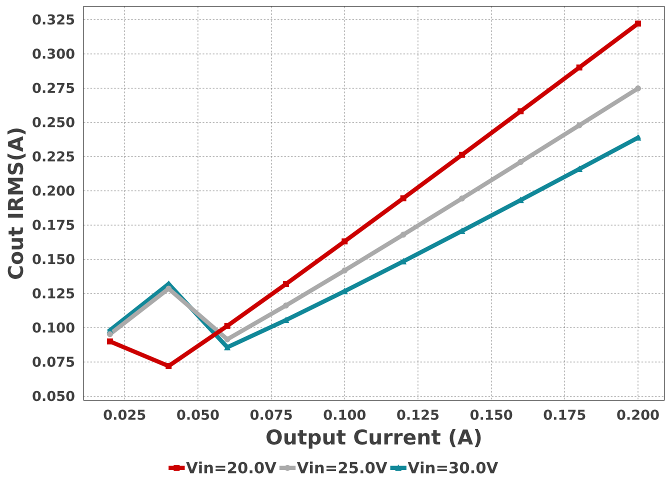
Iin Avg

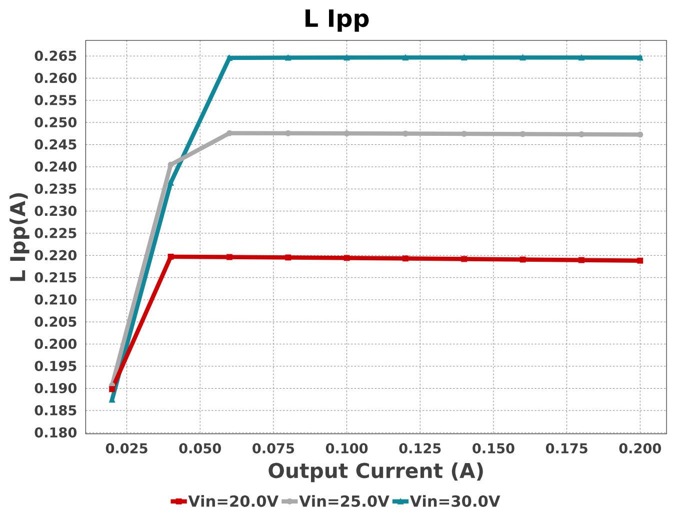


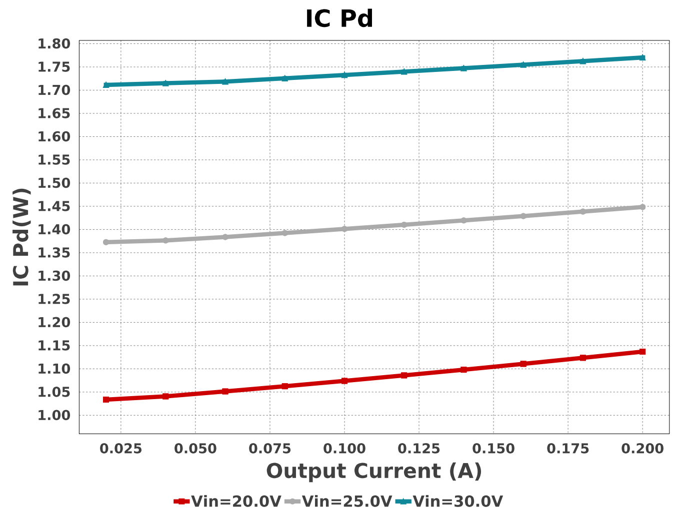
Total Pd

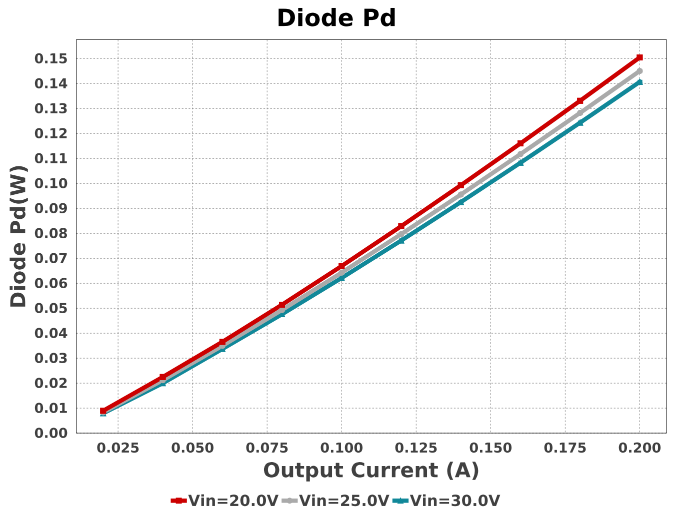


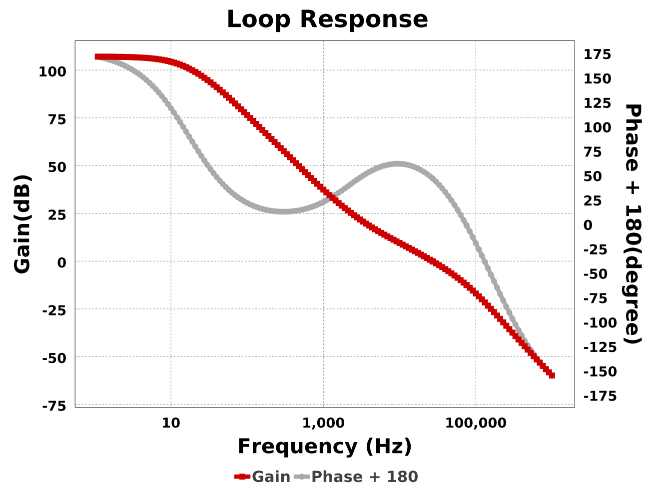
Cout IRMS











Operating Values

#	Name	Value	Category	Description
1.	BOM Count	17		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	63.168 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	11.971 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	322.165 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	103.79 nW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	43.238 degC	Diode	D1 junction temperature
8.	Diode Pd	150.44 mW	Diode	Diode power dissipation
9.	IC Ipk	822.767 mA	IC	Peak switch current in IC
10.	IC Pd	1.137 W	IC	IC power dissipation
11.	IC Tj	48.624 degC	IC	IC junction temperature
12.	IC Tolerance	10.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA Effective	16.38 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
14.	Iin Avg	771.21 mA	IC	Average input current
15.	Ipp percentage	28.374 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
16.	L Ipp	218.821 mA	Inductor	Peak-to-peak inductor ripple current
17.	L Pd	66.673 mW	Inductor	Inductor power dissipation
18.	Cin Pd	11.971 µW	Power	Input capacitor power dissipation
19.	Cout Pd	103.79 nW	Power	Output capacitor power dissipation
20.	Diode Pd	150.44 mW	Power	Diode power dissipation
21.	IC Pd	1.137 W	Power	IC power dissipation
22.	L Pd	66.673 mW	Power	Inductor power dissipation
23.	Total Pd	1.424 W	Power	Total Power Dissipation
24.	Cross Freq	19.045 kHz	System Information	Bode plot crossover frequency
25.	Duty Cycle	71.964 %	System Information	Duty cycle
26.	Efficiency	90.767 %	System Information	Steady state efficiency
27.	FootPrint	226.0 mm^2	System Information	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
28.	Frequency	1.974 MHz	System Information	Switching frequency
29.	Gain Marg	-12.4 dB	System Information	Bode Plot Gain Margin
30.	Iout	200.0 mA	System Information	Iout operating point
31.	Low Freq Gain	103.504 dB	System Information	Gain at 1Hz
32.	Mode	CCM	System Information	Conduction Mode
33.	Phase Marg	52.586 deg	System Information	Bode Plot Phase Margin
34.	Pout	14.0 W	System Information	Total output power
35.	Vin	20.0 V	System Information	Vin operating point
36.	Vin p-p	4.479 mV	System Information	Input Source ripple voltage
37.	Vout	70.0 V	System Information	Operational Output Voltage
38.	Vout Actual	70.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Tolerance	2.006 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	1.073 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	200.0 m	Maximum Output Current
SoftStart	10.0 ms	Soft Start Time (ms)
VinMax	30.0	Maximum input voltage
VinMin	20.0	Minimum input voltage
Vout	70.0	Output Voltage
base_pn	LM51581	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	2.017 M	Customer Selected Frequency

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

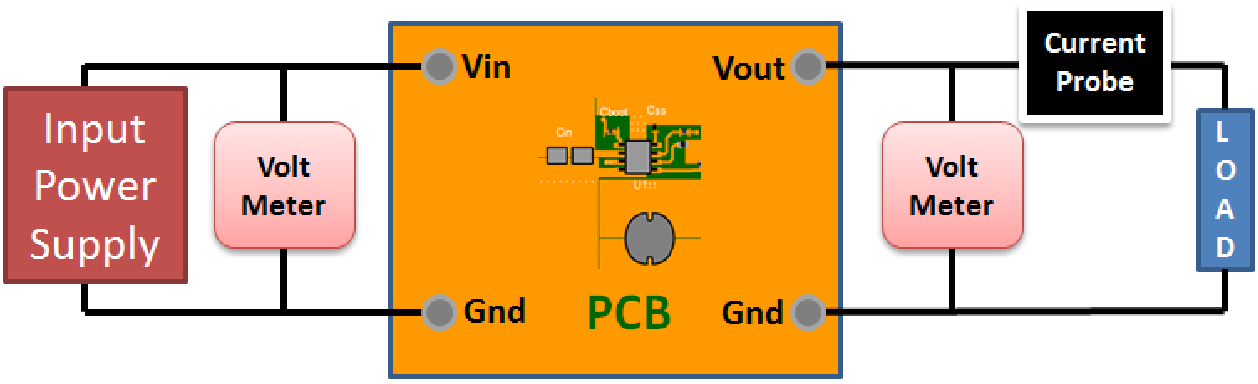
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 20.0V 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.

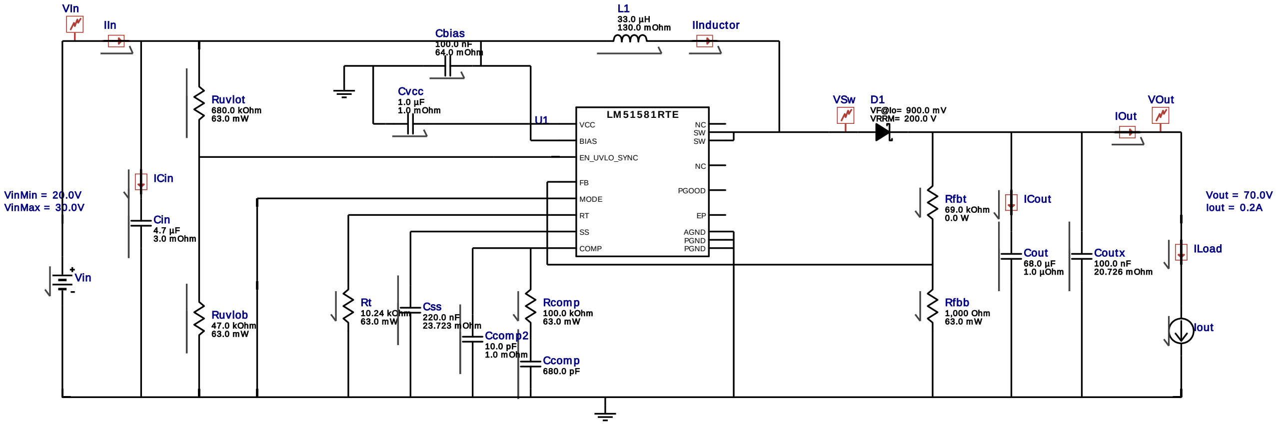


WEBENCH® Electrical Simulation Report

Design Id = 16

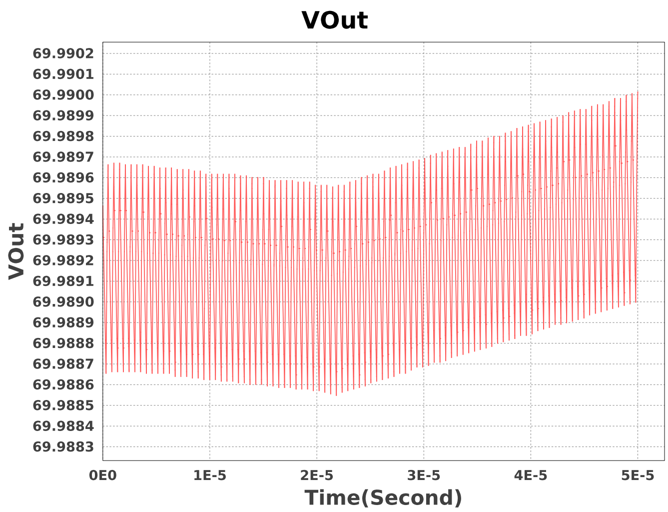
sim_id = 3

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cout	IC	Initial Condition	70.0 V
2.	Css	IC	Initial Condition	1
3.	Cin	IC	Initial Condition	25.0
4.	Iout	I	Load current	0.2 A



Design Assistance

1. Master key : 5C7E25139A496A37BD41B9ACC0467E77[v1]

2. **LM51581** Product Folder : http://www.ti.com/product/LM51581 : contains the data sheet and other resources.