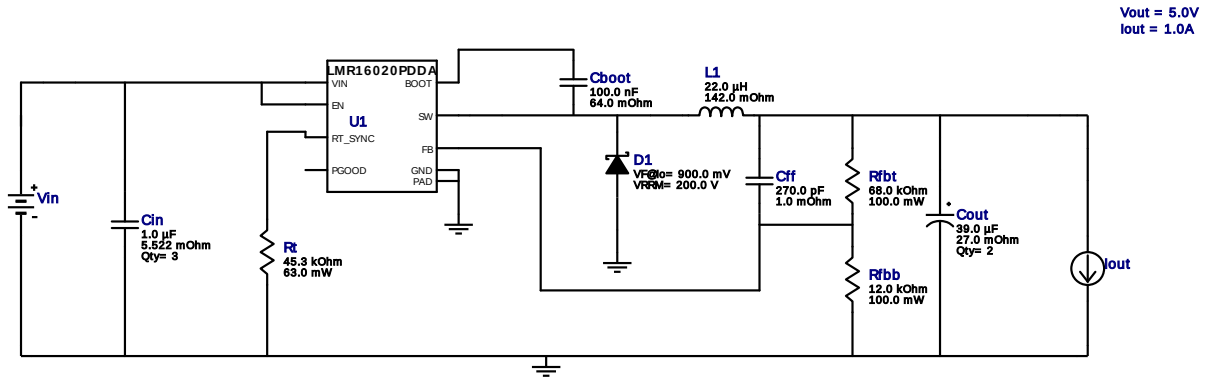
WEBENCH® Design Report

VinMin = 20.0V
VinMax = 34.0V
Vout = 5.0V
Iout = 1.0A

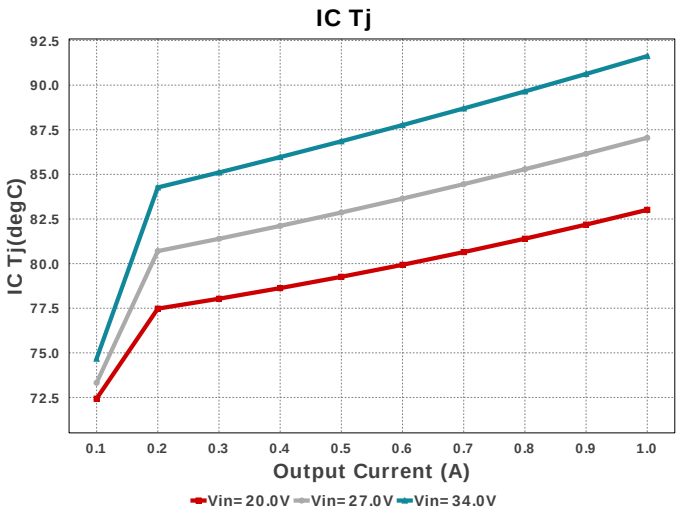
Device = LMR16020PDDAR
Topology = Buck
Created = 2019-03-28 03:33:06.567
BOM Cost = $2.85
BOM Count = 13
Total Pd = 1.23W

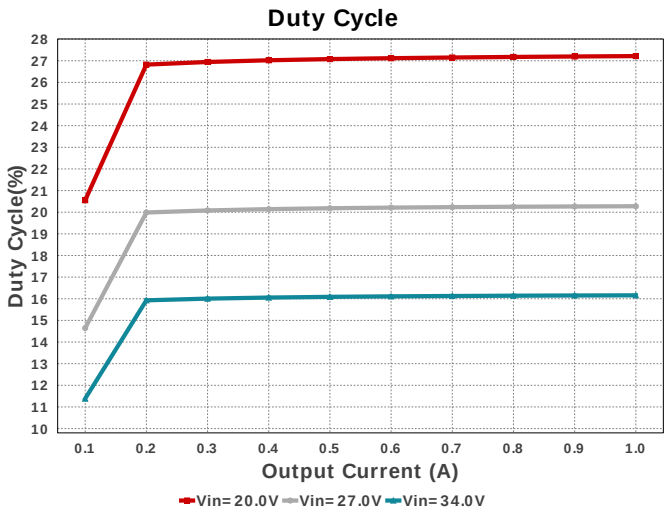
Design : 6020 LMR16020PDDAR
LMR16020PDDAR 20V-34V to 5.00V @ 1.000188A

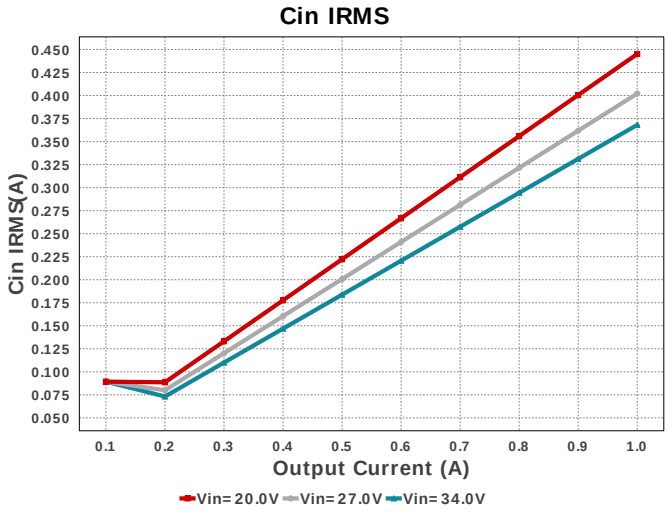


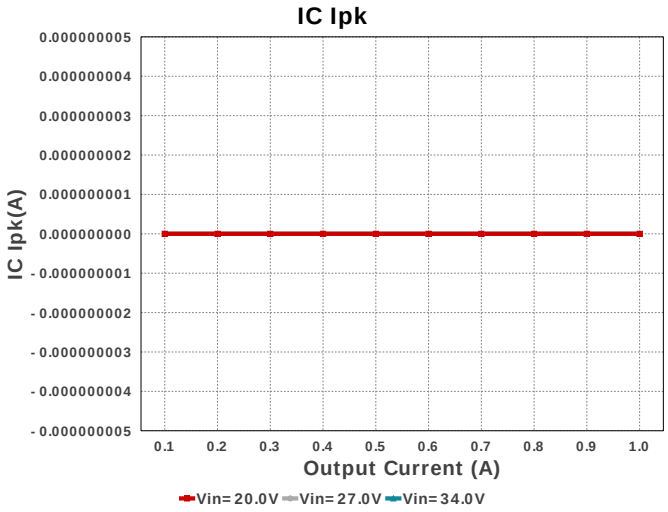
Electrical BOM

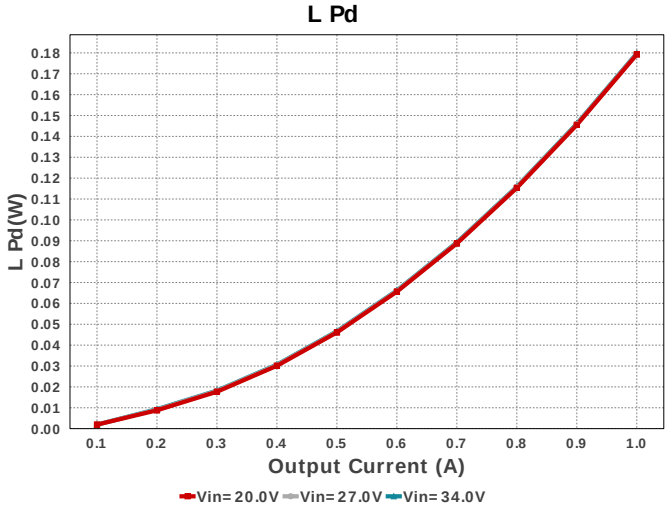
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm²
Cff	MuRata	GRM033R71C271KA01D Series= X7R	Cap= 270.0 pF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cin	TDK	C1608X5R1H105K080AB Series= X5R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	3	$0.04	0603 5 mm²
Cout	Panasonic	16SVPC39MV Series= SVPC	Cap= 39.0 uF ESR= 27.0 mOhm VDC= 16.0 V IRMS= 2.35 A	2	$0.31	SM_RADIAL_5MM 58 mm²
D1	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.04	SMA 37 mm²
L1	Bourns	SRN6045-220M	L= 22.0 µH 142.0 mOhm	1	$0.20	SRN6045 64 mm²
Rfbb	Yageo	RC0603FR-0712KL Series= ?	Res= 12.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbt	Yageo	RC0603FR-0768KL Series= ?	Res= 68.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rt	Vishay-Dale	CRCW040245K3FKED Series= CRCW..e3	Res= 45.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LMR16020PDDAR	Switcher	1	$1.82	DDA0008E_N 55 mm²

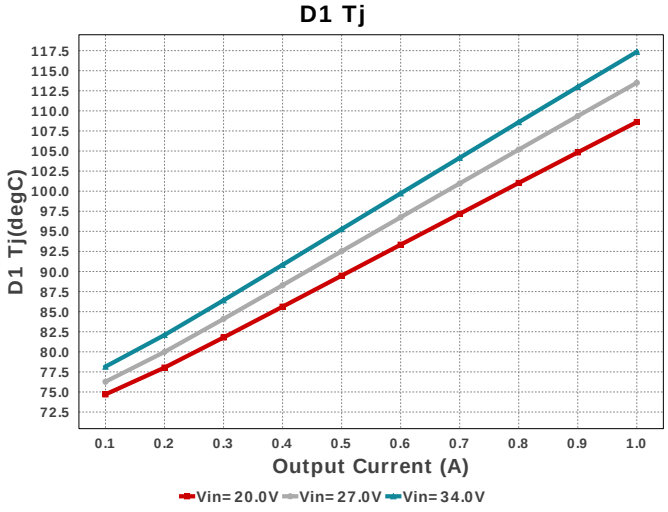


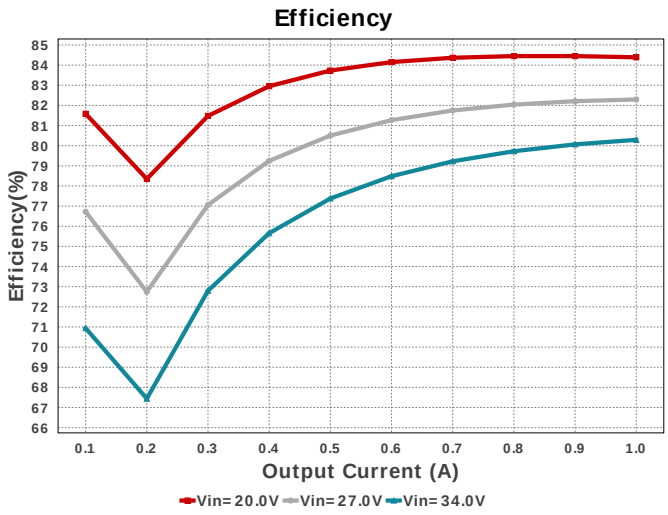


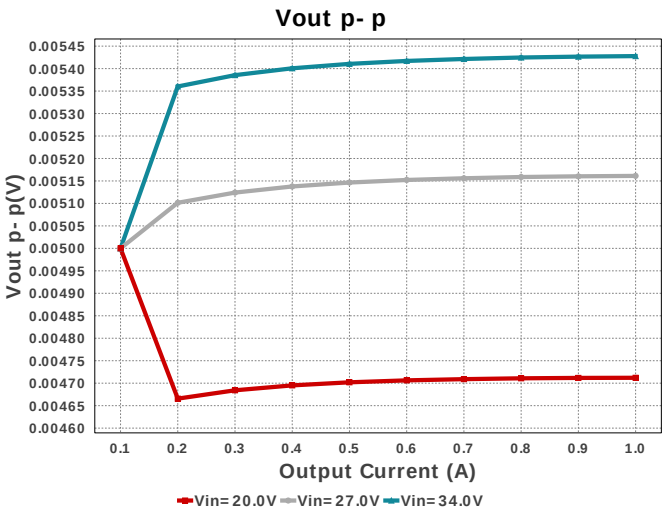


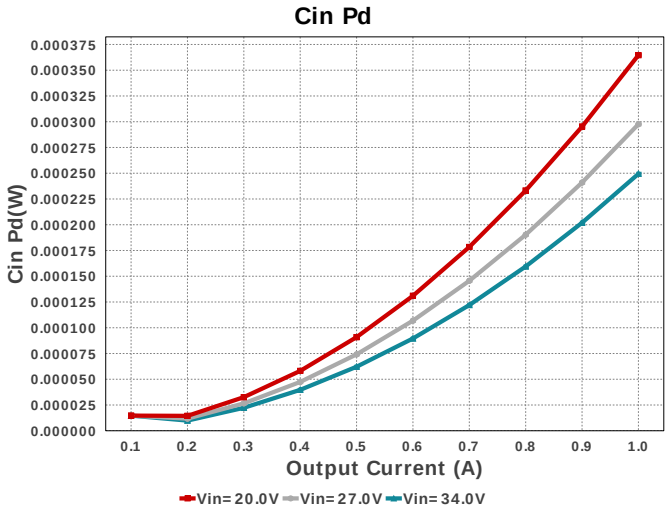


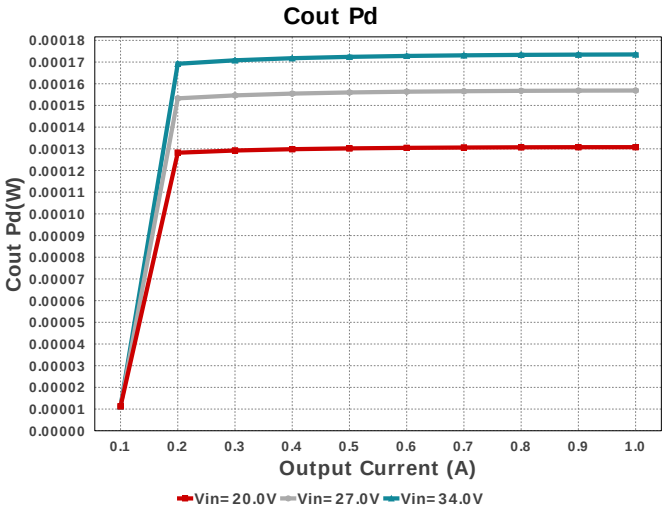


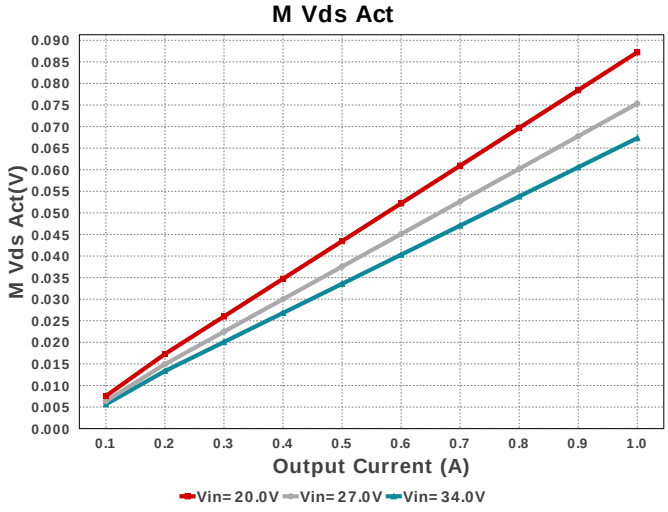


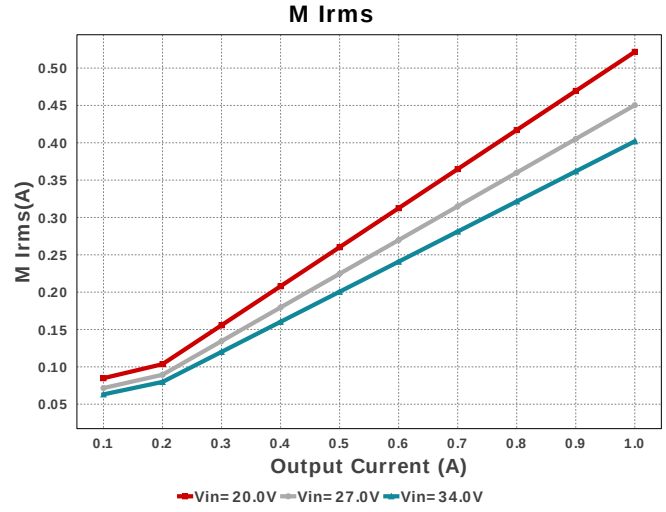


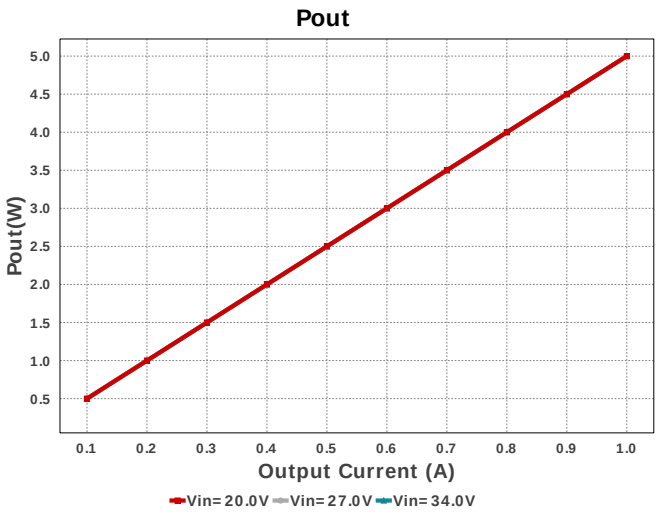


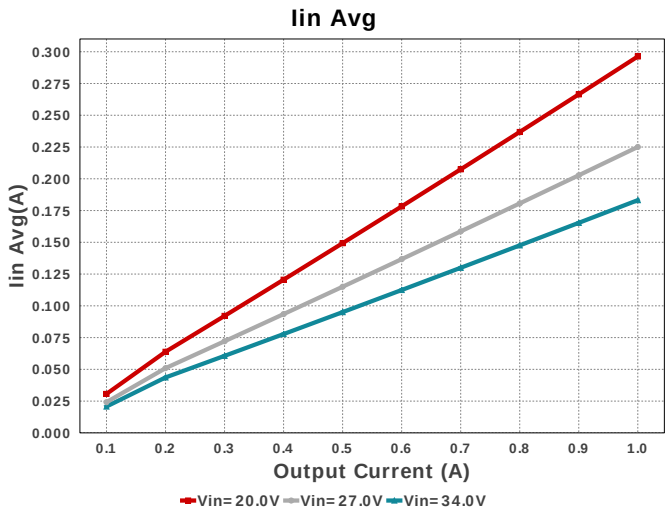


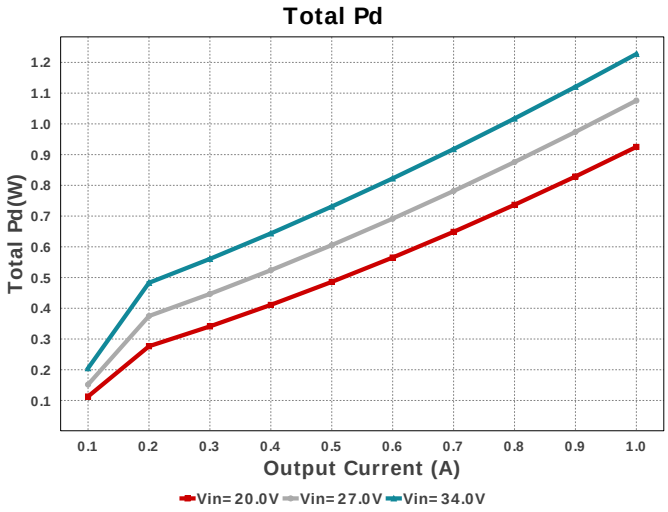


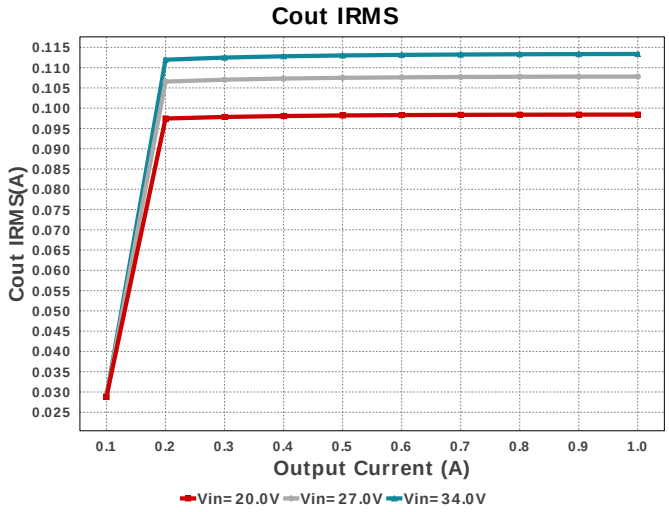


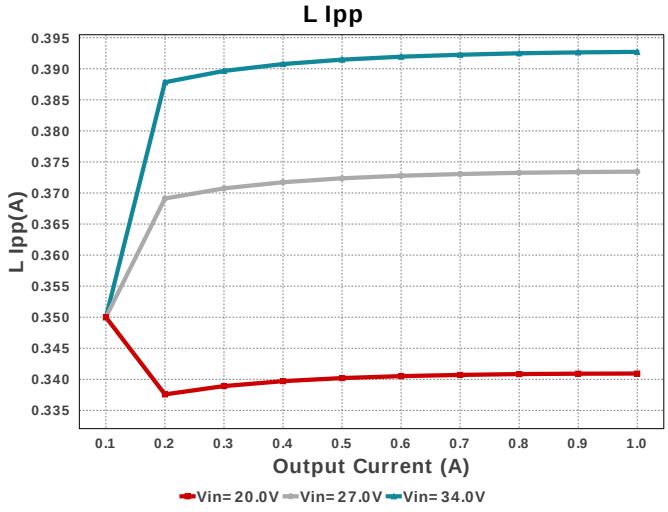


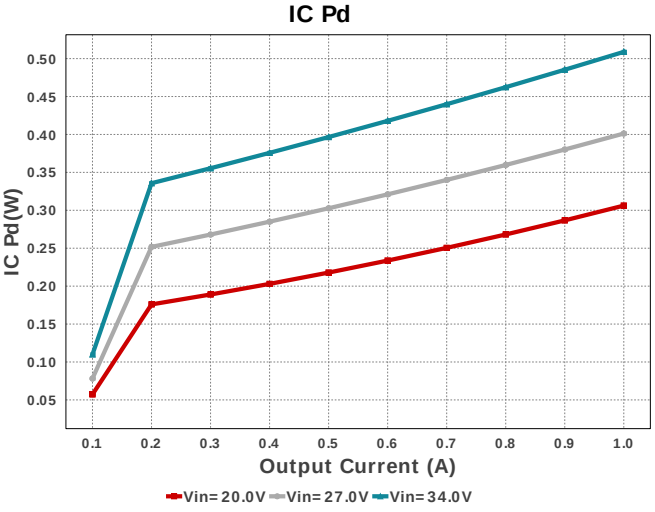


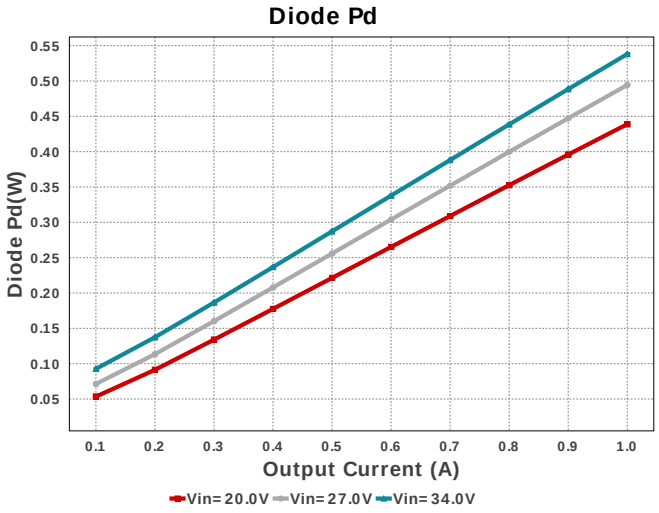


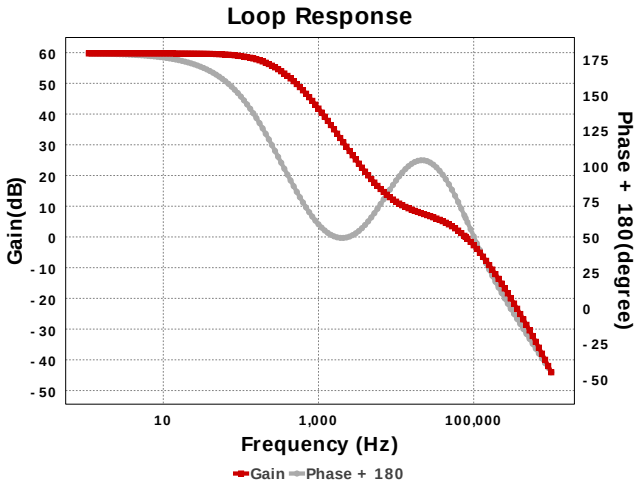












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	368.092 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	249.4 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	113.369 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	173.51 µW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	117.35 degC	Diode	D1 junction temperature
6.	Diode Pd	538.02 mW	Diode	Diode power dissipation
7.	IC Ipk	0.0 A	IC	Peak switch current in IC
8.	IC Pd	508.88 mW	IC	IC power dissipation
9.	IC Tj	91.373 degC	IC	IC junction temperature
10.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	42.0 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	183.17 mA	IC	Average input current
13.	L Ipp	392.72 mA	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	179.8 mW	Inductor	Inductor power dissipation
15.	M Irms	402.001 mA	Mosfet	MOSFET RMS ripple current
16.	M Vds Act	67.317 mV	Mosfet	Voltage drop across the MosFET
17.	Cin Pd	249.4 µW	Power	Input capacitor power dissipation
18.	Cout Pd	173.51 µW	Power	Output capacitor power dissipation
19.	Diode Pd	538.02 mW	Power	Diode power dissipation
20.	IC Pd	508.88 mW	Power	IC power dissipation
21.	L Pd	179.8 mW	Power	Inductor power dissipation
22.	Total Pd	1.227 W	Power	Total Power Dissipation
23.	BOM Count	13	System Information	Total Design BOM count
24.	Cross Freq	78.699 kHz	System Information	Bode plot crossover frequency
25.	Duty Cycle	16.158 %	System Information	Duty cycle
26.	Efficiency	80.291 %	System Information	Steady state efficiency
27.	FootPrint	309.0 mm^2	System Information	Total Foot Print Area of BOM components
28.	Frequency	541.105 kHz	System Information	Switching frequency
29.	Gain Marg	-19.917 dB	System Information	Bode Plot Gain Margin
30.	Iout	1.0 A	System Information	Iout operating point
31.	Low Freq Gain	59.734 dB	System Information	Gain at 1Hz
32.	Mode	CCM	System Information	Conduction Mode
33.	Phase Marg	63.667 deg	System Information	Bode Plot Phase Margin
34.	Pout	5.0 W	System Information	Total output power
35.	Total BOM	$2.85	System Information	Total BOM Cost
36.	Vin	34.0 V	System Information	Vin operating point

#	Name	Value	Category	Description
37.	Vout	5.0 V	System Information	Operational Output Voltage
38.	Vout Actual	5.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Tolerance	4.158 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	5.428 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	34.0	Maximum input voltage
VinMin	20.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LMR16020P	Base Product Number
source	DC	Input Source Type
Ta	70.0	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

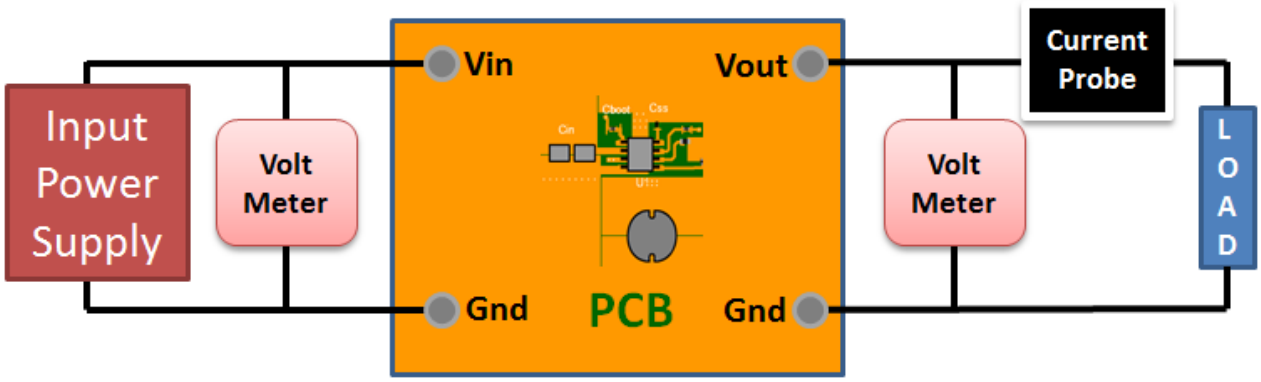
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins.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

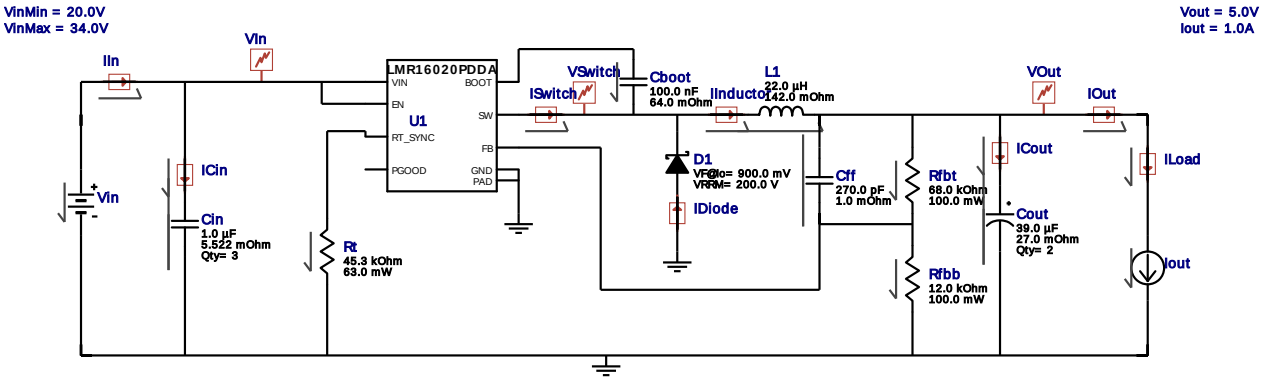


WEBENCH® Electrical Simulation Report

Design Id = 6020

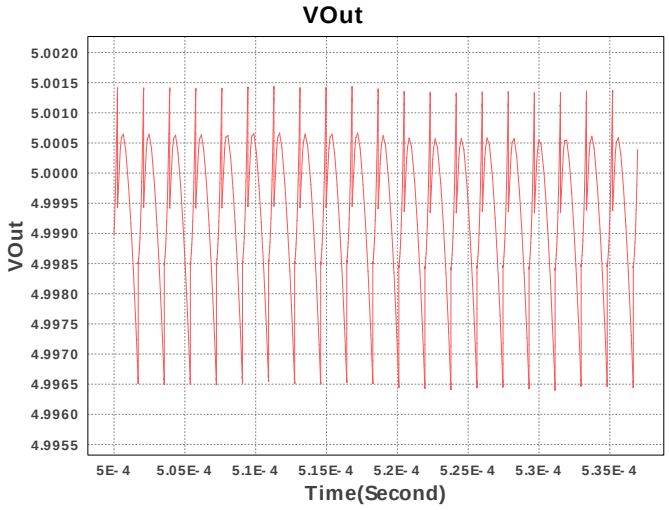
sim_id = 1

Simulation Type = Steady State



Simulation Parameters

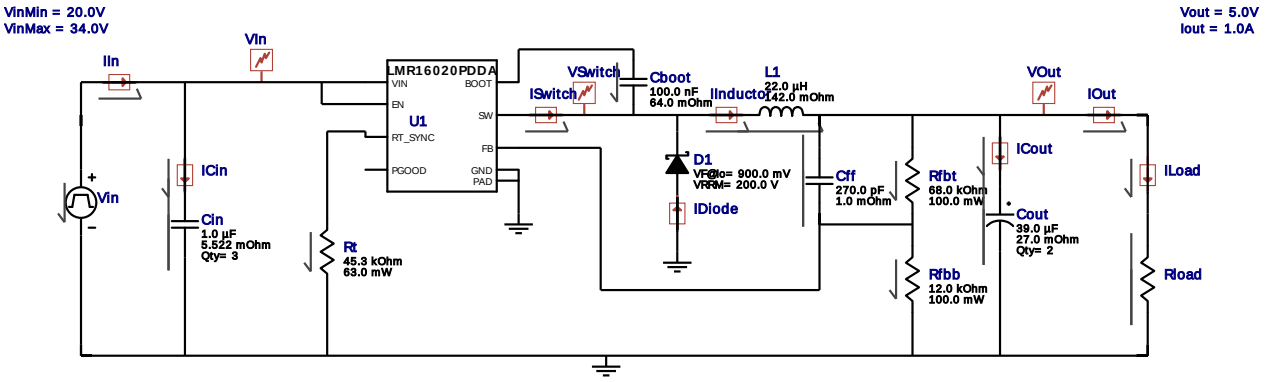
#	Name	Parameter Name	Description	Values
1.	Iout	I	Load Current	1.0 A



Design Id = 6020

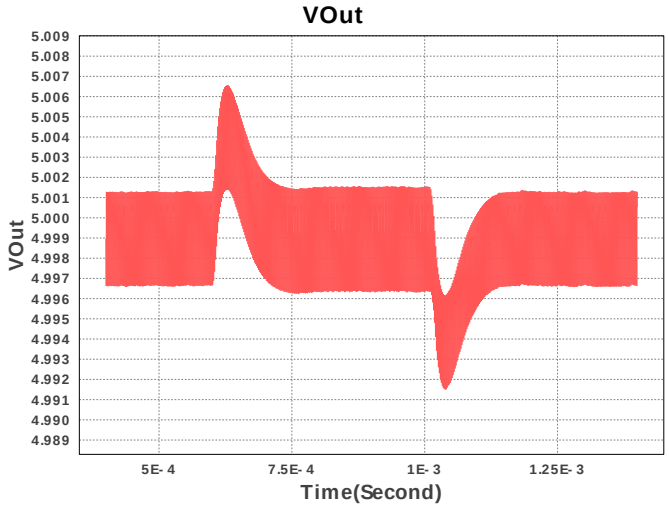
sim_id = 2

Simulation Type = Input Transient



Simulation Parameters

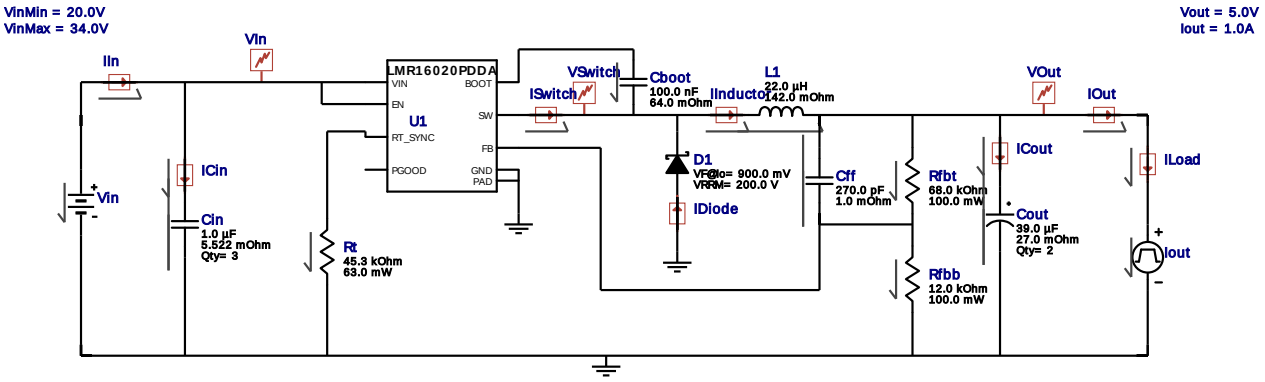
#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	5.0 Ohm



Design Id = 6020

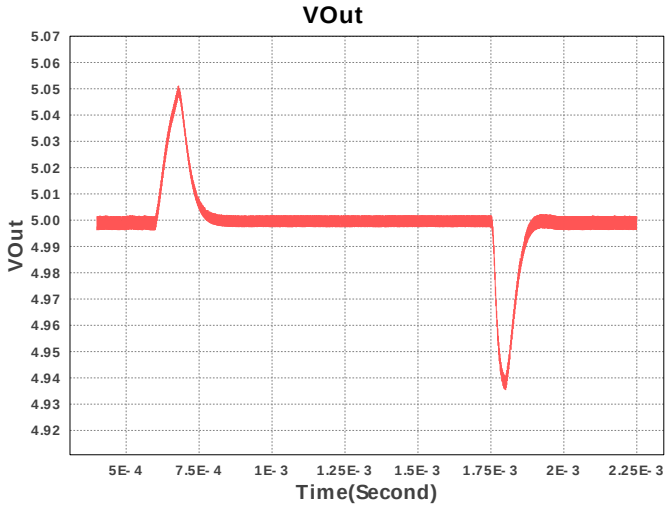
sim_id = 3

Simulation Type = Load Transient



Simulation Parameters

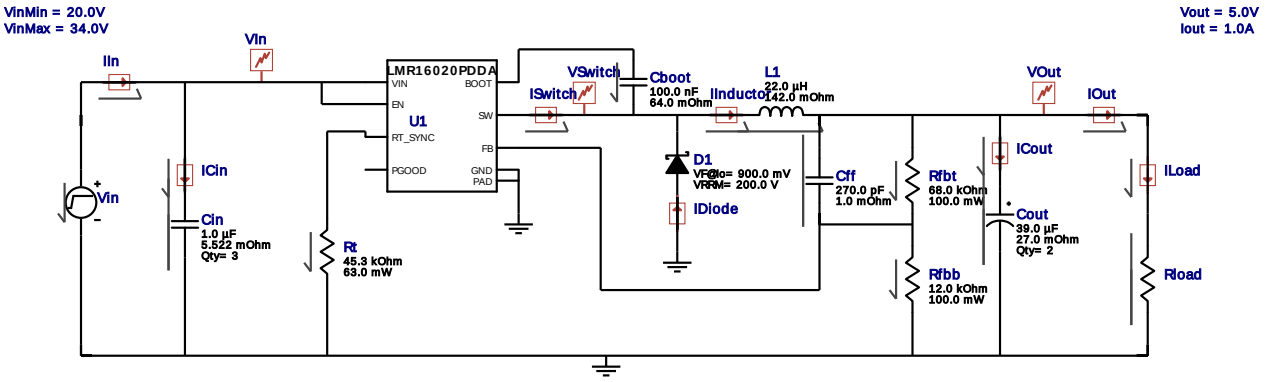
#	Name	Parameter Name	Description	Values
1.	ILoad	I	Load Current	ILoad1 A
2.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	1.0 A
		I2	Minimum Load Current	0.1 A
		Td	Initial Time Delay	6.000000000000001E-4 s
		Tf	Fall Time	50u s
		Tr	Rise Time	50u s
		Pw	Pulse Width	0.0011 s



Design Id = 6020

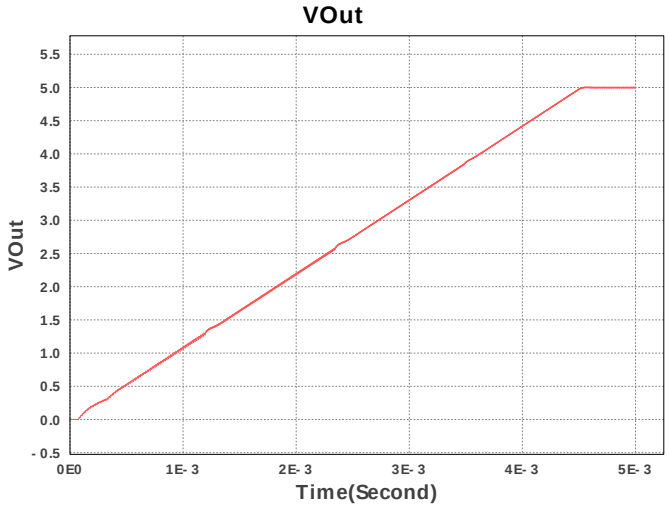
sim_id = 4

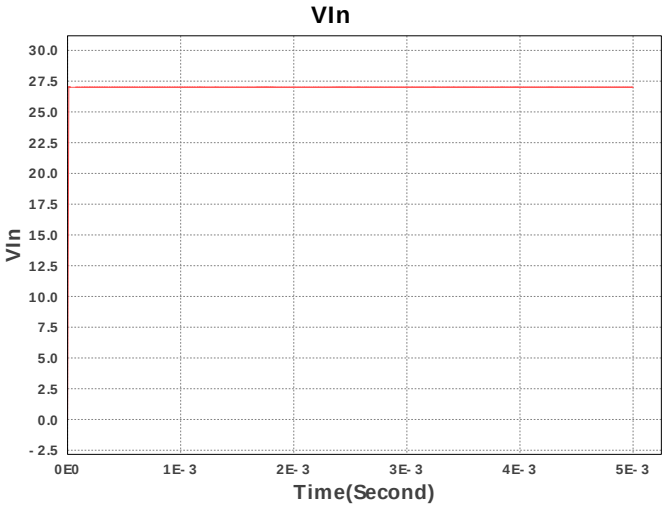
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	5.0 Ohm





Design Assistance

1. Master key : B9C964572EBB957B[v1]
2. **LMR16020P** Product Folder : http://www.ti.com/product/LMR16020 : contains the data sheet and other resources.