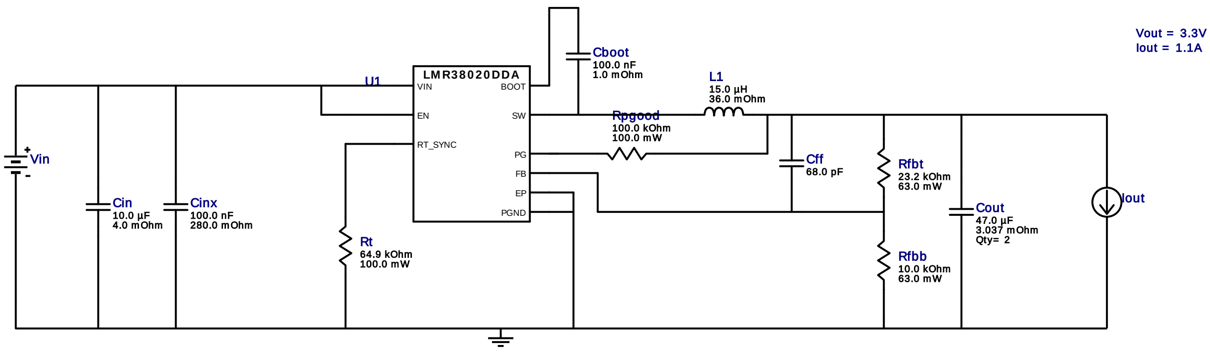
VinMin = 6.0V
VinMax = 10.0V
Vout = 3.3V
Iout = 1.1A

Device = LMR38020DDAR
Topology = Buck
Created = 2023-04-21 14:07:52.100
BOM Cost = $1.33
BOM Count = 12
Total Pd = 0.4W

WEBENCH ® Design Report

Design : 27 LMR38020DDAR
LMR38020DDAR 6V-10V to 3.30V @ 1.1A

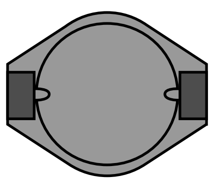


Design Alerts

Component Selection Information

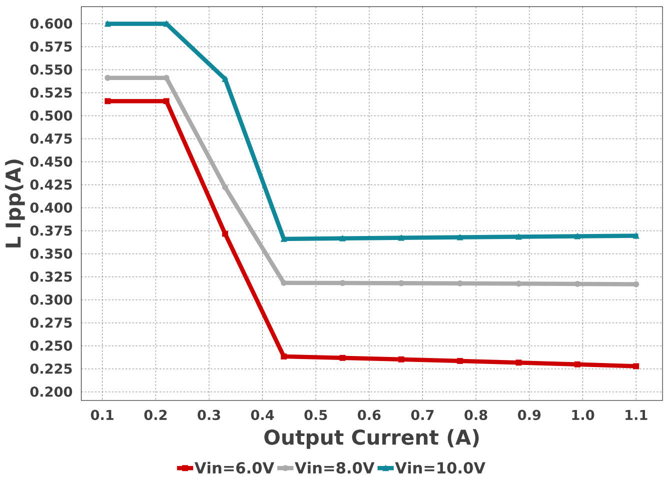
This device can work in steady state at Vin = 4.2V. However, needs a minimum of 4.5V during start up. See datasheet for details.

Electrical BOM

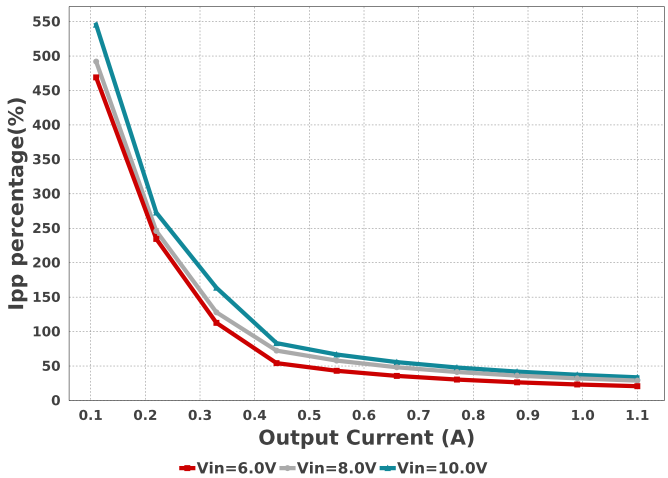
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cff	TDK	CGA1A2C0G1E680J030BA Series= C0G/NP0	Cap= 68.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cin	MuRata	GRM31CR71E106KA12L Series= X7R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 6.0 A	1	$0.06	1206_180 11 mm²
Cinx	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cout	MuRata	GRM32ER61C476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	2	$0.17	1210_280 15 mm²
L1	NIC Components	NPI52W150MTRF	L= 15.0 µH 36.0 mOhm	1	$0.26	 IND_NPI52W 358 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	CRCW040223K2FKED Series= CRCW..e3	Res= 23.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rpgood	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rt	Vishay-Dale	CRCW060364K9FKEA Series= CRCW..e3	Res= 64.9 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	LMR38020DDAR	Switcher	1	$0.60	DDA0008E_N 55 mm^2

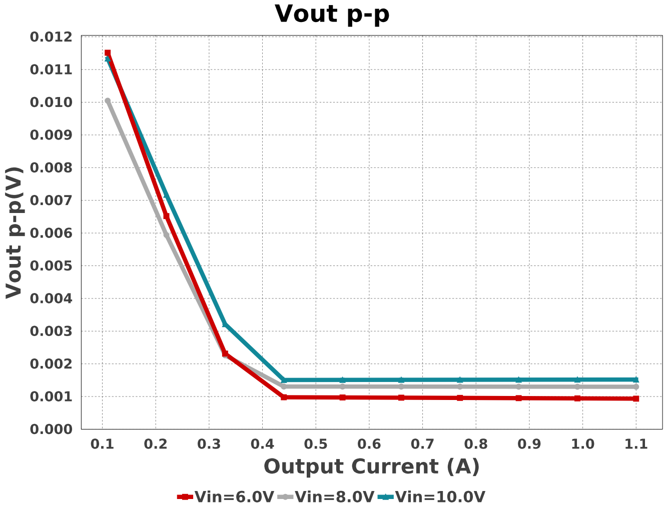
L Ipp



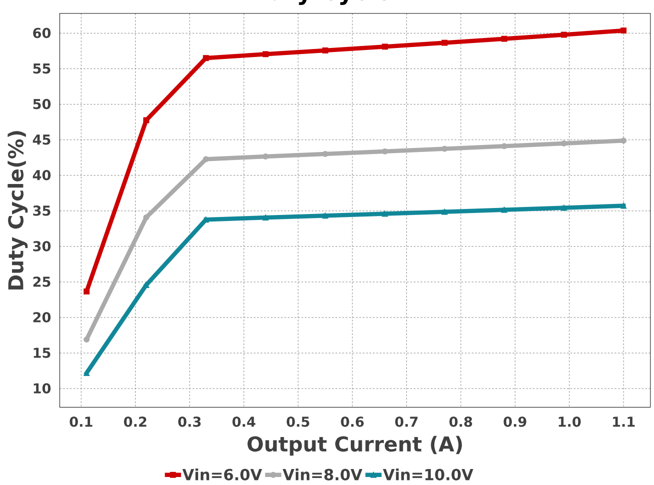
Ipp percentage



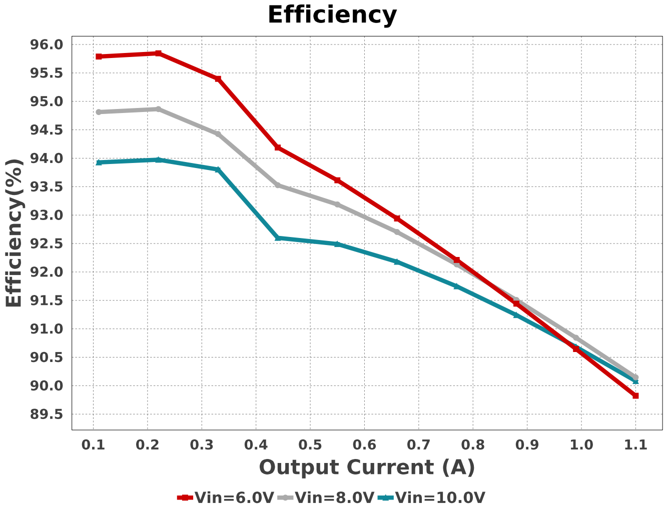
Vout p-p



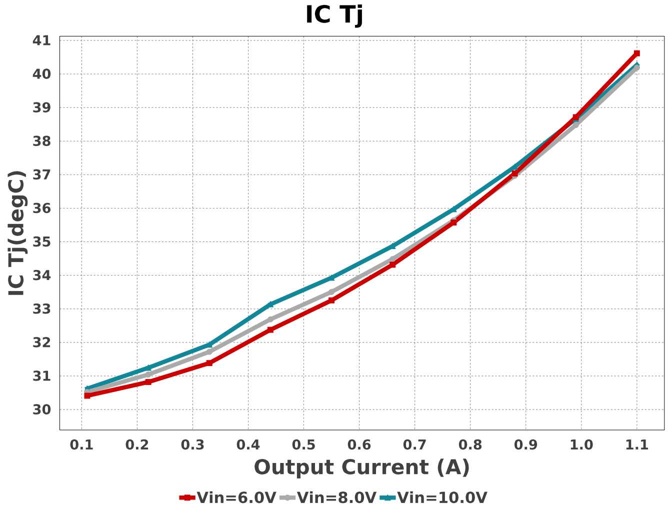
Duty Cycle



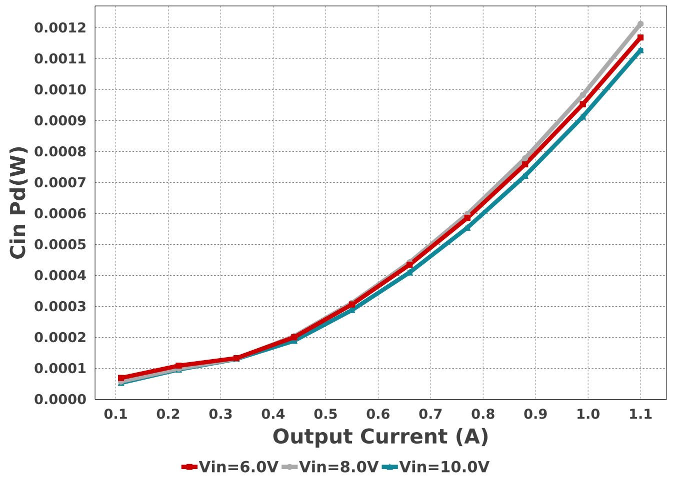
Efficiency



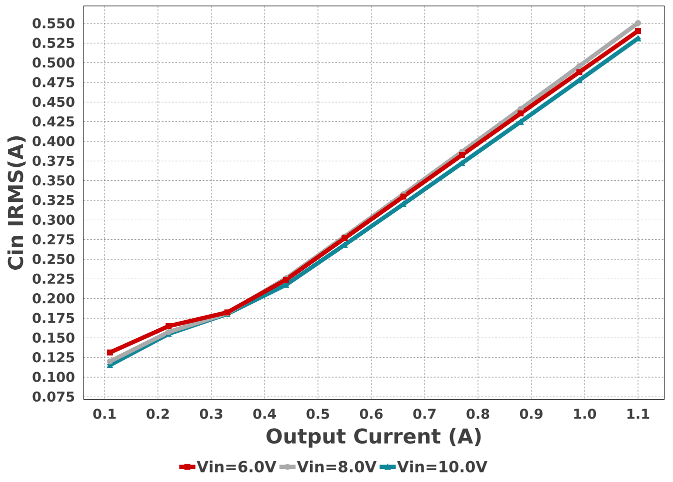
IC Tj



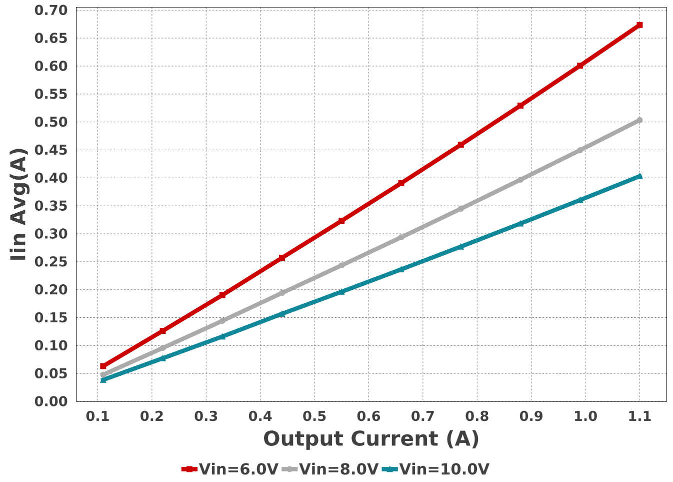
Cin Pd



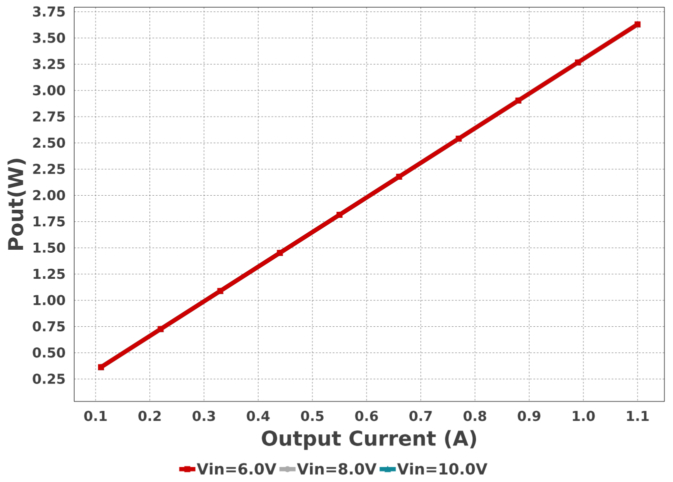
Cin IRMS



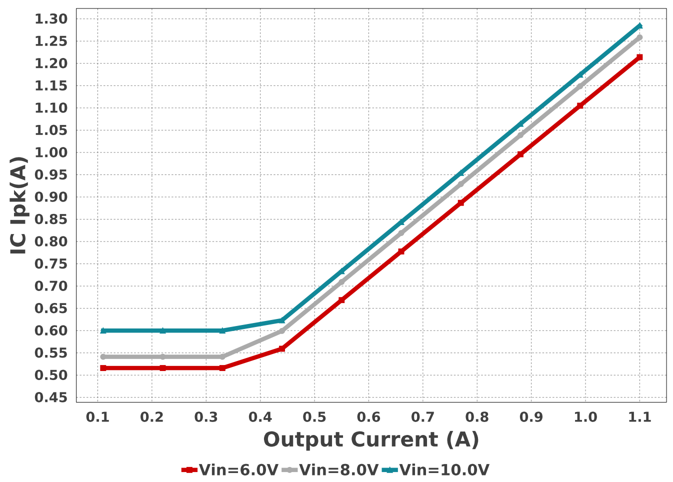
Iin Avg



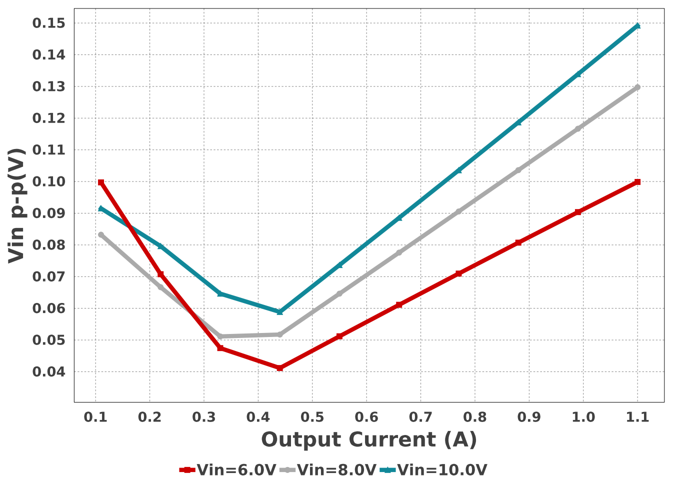
Pout

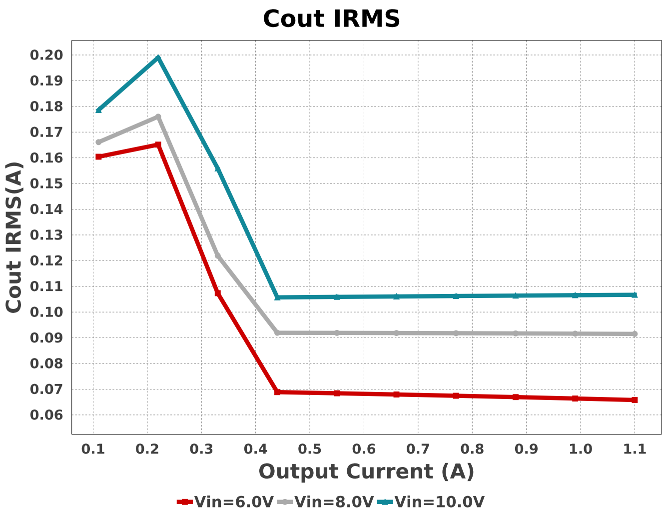


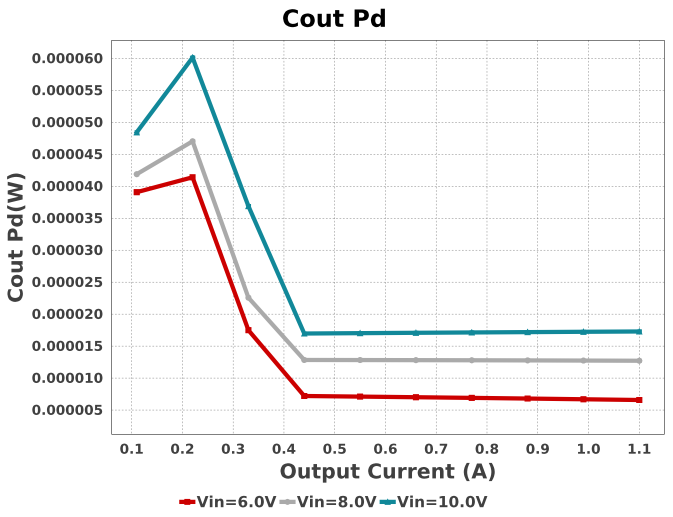
IC Ipk

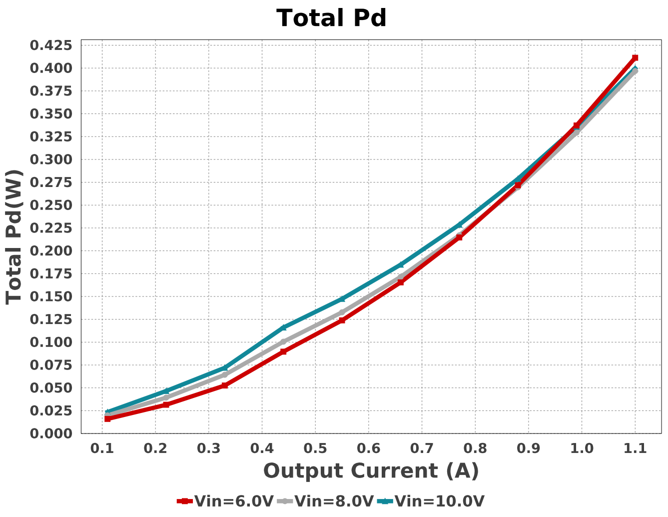


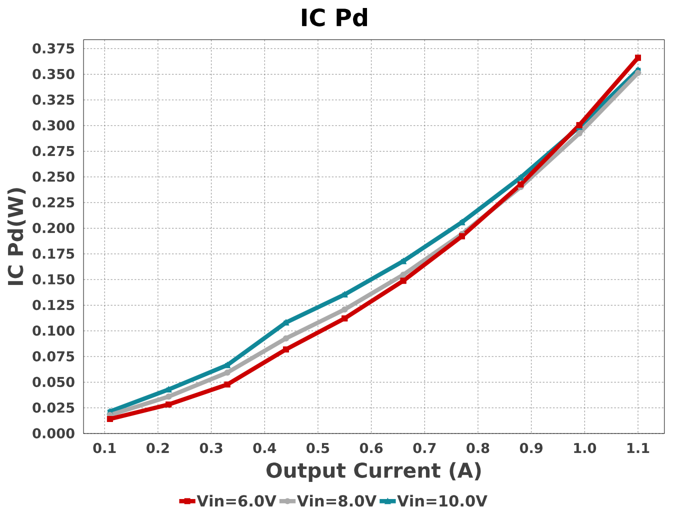
Vin p-p

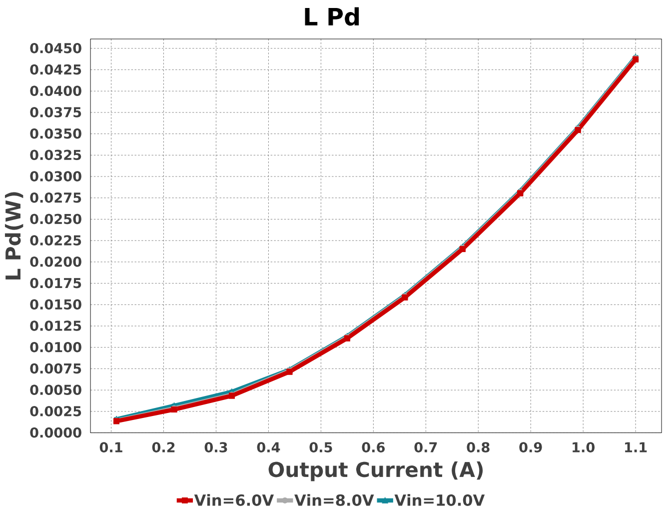


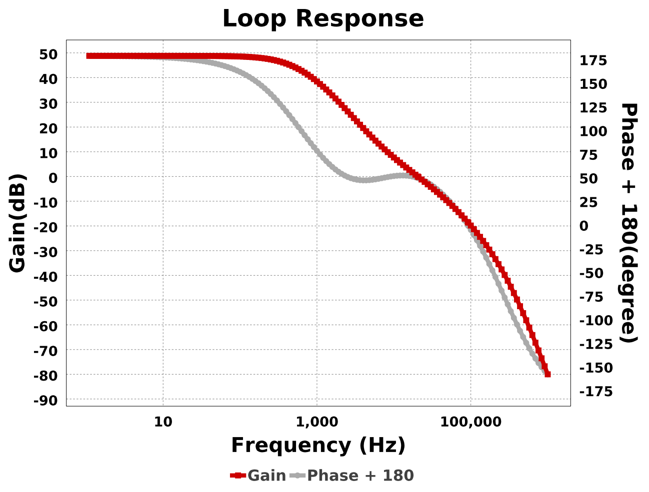

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=6.0V Vin=8.0V Vin=10.0V

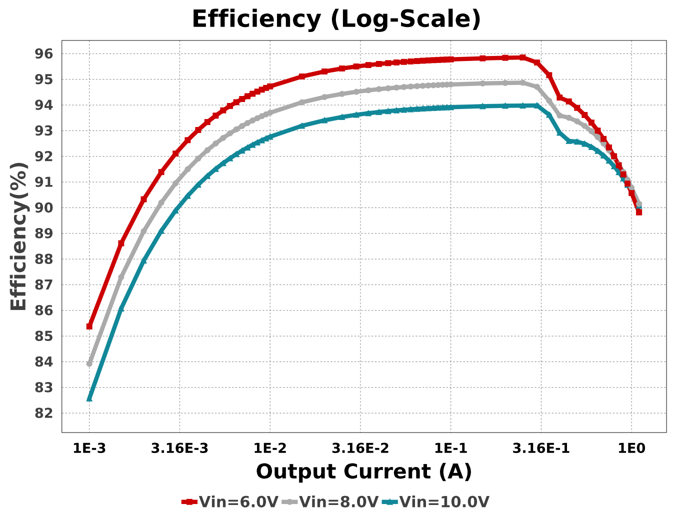

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=6.0V Vin=8.0V Vin=10.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=6.0V Vin=8.0V Vin=10.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=6.0V Vin=8.0V Vin=10.0V


L Pd
L Pd(W)
Output Current (A)
Vin=6.0V Vin=8.0V Vin=10.0V


Loop Response
Gain(dB)
Phase + 180(degree)
Frequency (Hz)
Gain Phase + 180



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	530.949 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	1.128 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	106.714 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	17.292 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	1.285 A	IC	Peak switch current in IC
6.	IC Pd	354.2 mW	IC	IC power dissipation
7.	IC Tj	40.272 degC	IC	IC junction temperature
8.	IC Tolerance	5.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA Effective	29.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	402.96 mA	IC	Average input current
11.	Ipp percentage	33.606 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	369.67 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	43.97 mW	Inductor	Inductor power dissipation
14.	Cin Pd	1.128 mW	Power	Input capacitor power dissipation
15.	Cout Pd	17.292 µW	Power	Output capacitor power dissipation
16.	IC Pd	354.2 mW	Power	IC power dissipation
17.	L Pd	43.97 mW	Power	Inductor power dissipation
18.	Total Pd	399.656 mW	Power	Total Power Dissipation
19.	BOM Count	12	System Information	Total Design BOM count
20.	Cross Freq	20.424 kHz	System Information	Bode plot crossover frequency
21.	Duty Cycle	35.724 %	System Information	Duty cycle
22.	Efficiency	90.082 %	System Information	Steady state efficiency
23.	FootPrint	481.0 mm^2	System Information	Total Foot Print Area of BOM components
24.	Frequency	405.78 kHz	System Information	Switching frequency
25.	Gain Marg	-18.662 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	1.1 A	System Information	Iout operating point
28.	Iout transient step used for Cout calculations	550.0 mA	System Information	Custom Transient current step requirement that was used for Cout selection (A).
29.	Low Freq Gain	48.78 dB	System Information	Gain at 1Hz
30.	Mode	CCM	System Information	Conduction Mode
31.	Overshoot Value	8.817 mV	System Information	Theoretical Vout Overshoot Value
32.	Phase Marg	50.703 deg	System Information	Bode Plot Phase Margin
33.	Pout	3.63 W	System Information	Total output power
34.	Total BOM	$1.33	System Information	Total BOM Cost

#	Name	Value	Category	Description
35.	Undershoot Value	15.99 mV	System Information	Theoretical Vout Undershoot Value
36.	Vin	10.0 V	System Information	Vin operating point
37.	Vin p-p	149.193 mV	System Information	Peak-to-peak input voltage
38.	Vout	3.3 V	System Information	Operational Output Voltage
39.	Vout Actual	3.32 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	1.919 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Vout p-p	1.519 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	1.1	Maximum Output Current
VinMax	10.0	Maximum input voltage
VinMin	6.0	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	LMR38020	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

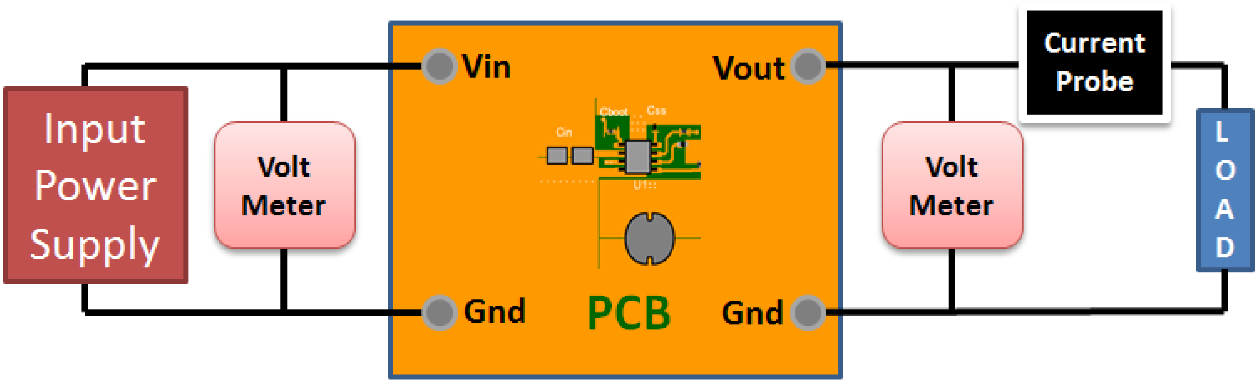
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 6.0V 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 : 2987CECD7190F5F83249B689B90B3C5B[v1]

2. **LMR38020** Product Folder : http://www.ti.com/product/LMR38020 : contains the data sheet and other resources.