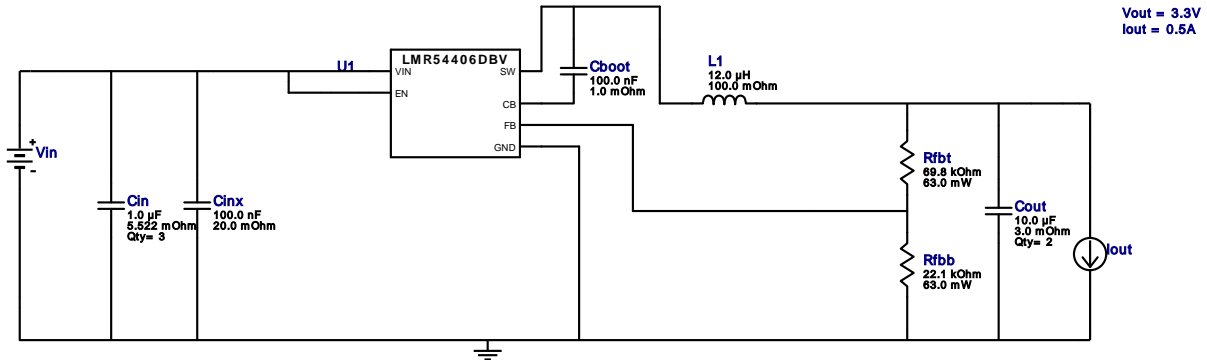


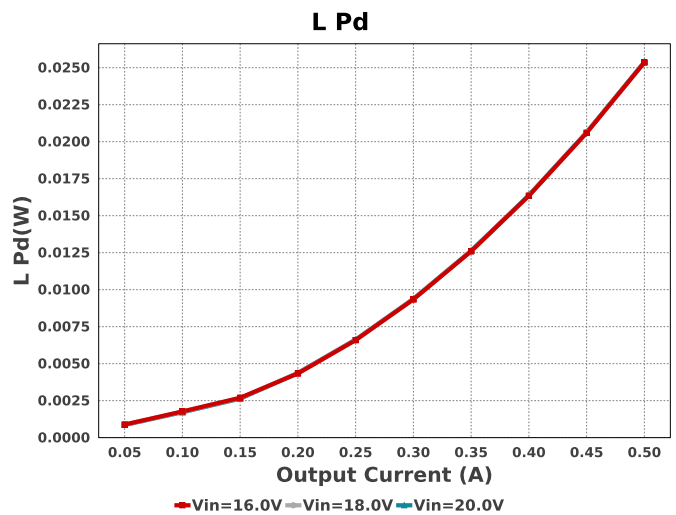
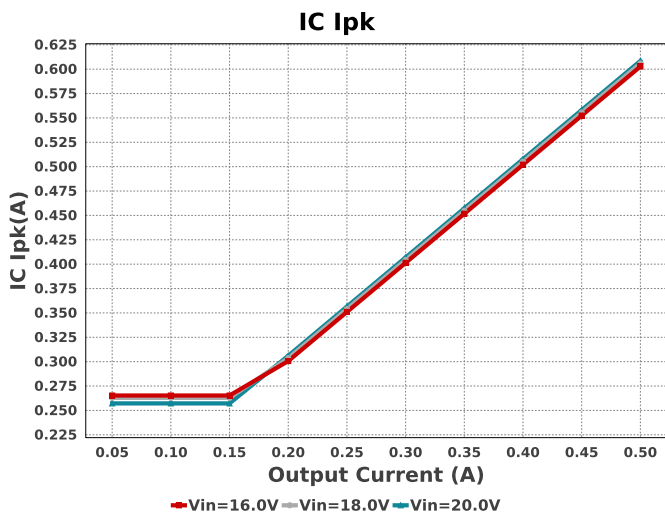
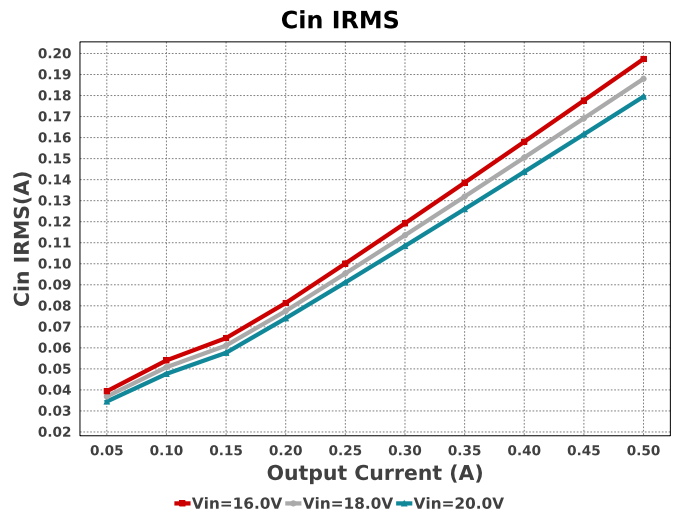
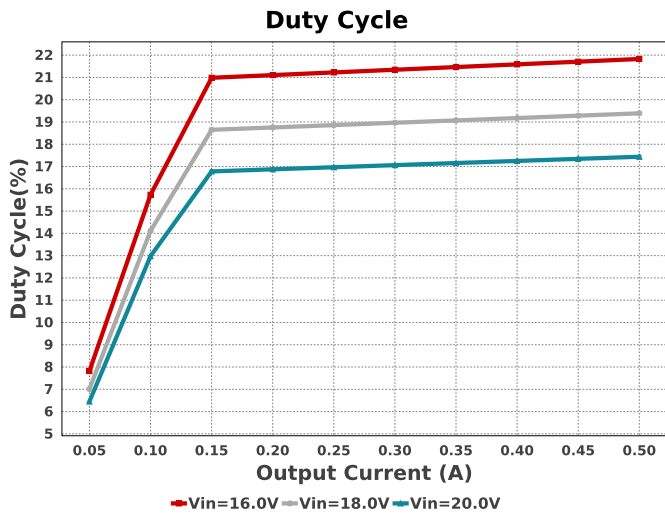
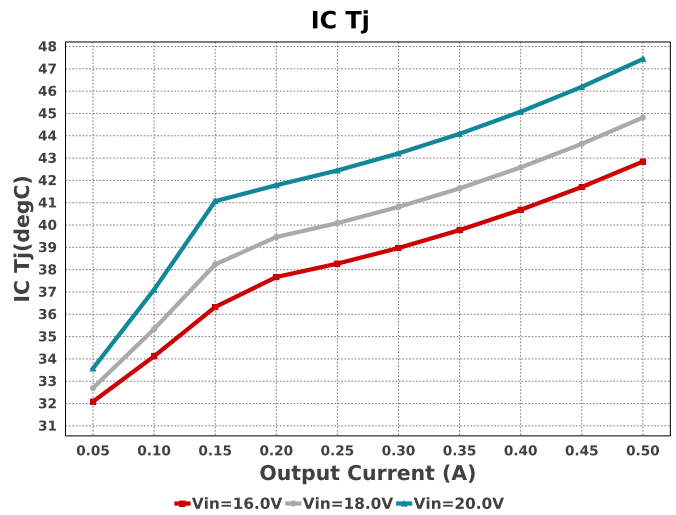
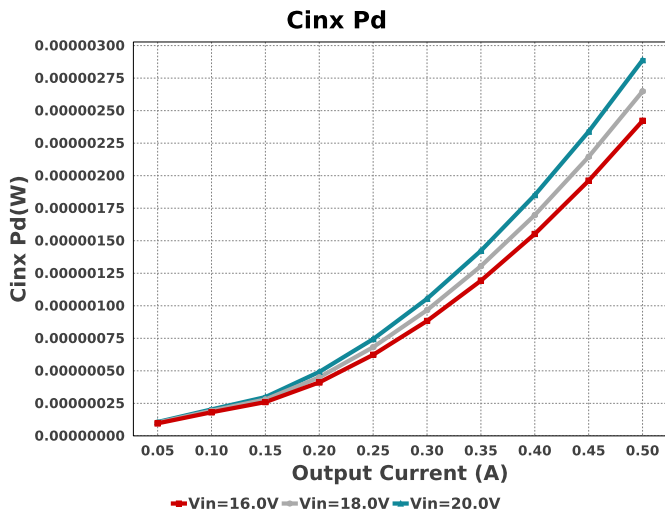
## WEBENCH® Design Report

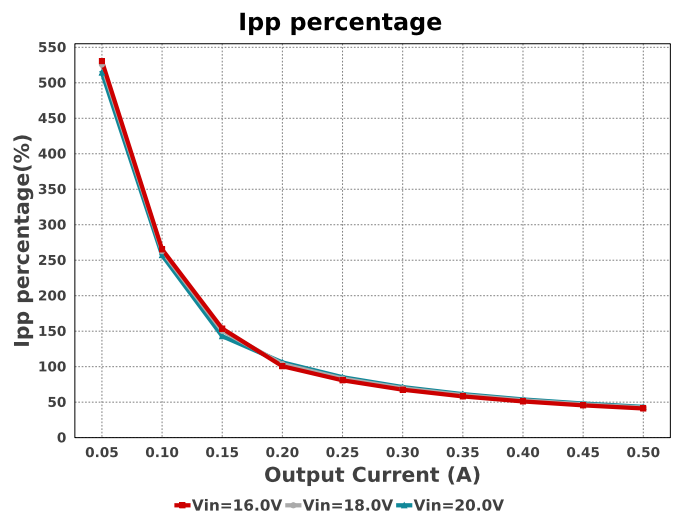
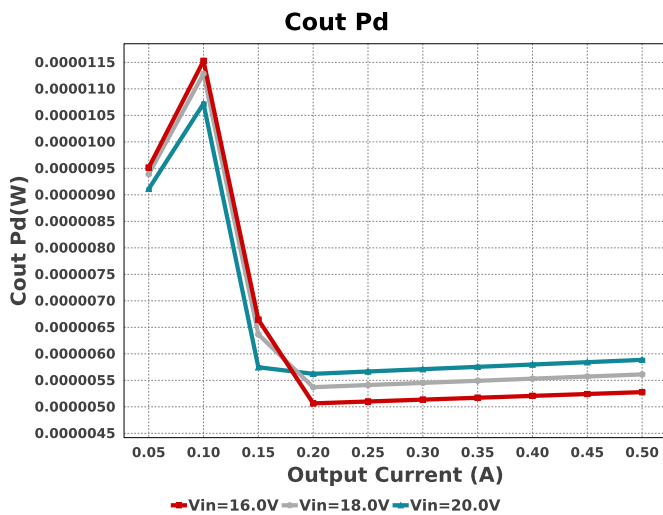
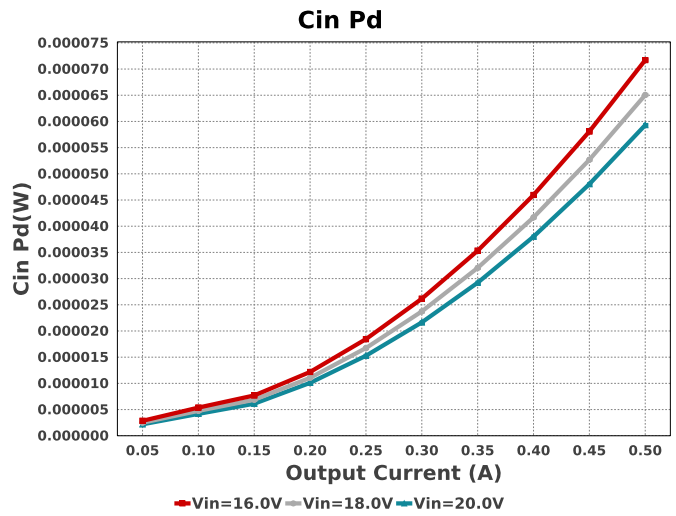
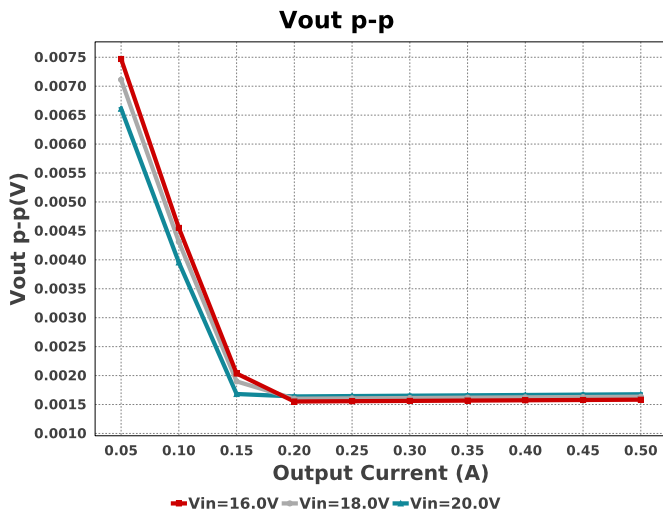
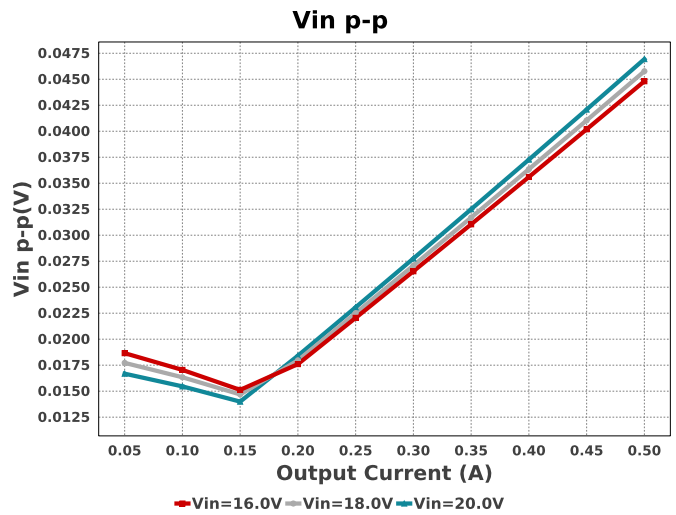
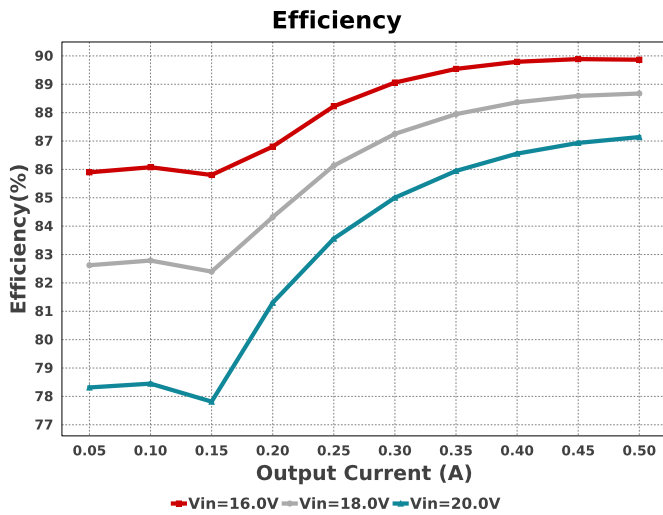
Design : 41 LMR54406DBVR  
LMR54406DBVR 16V-20V to 3.30V @ 0.5A

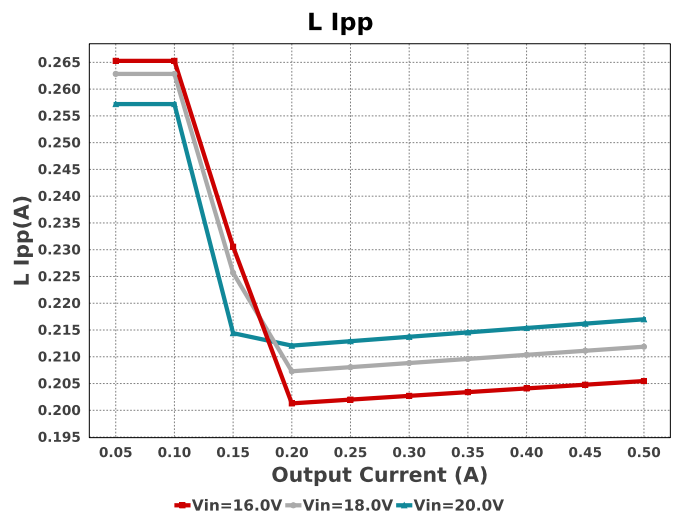
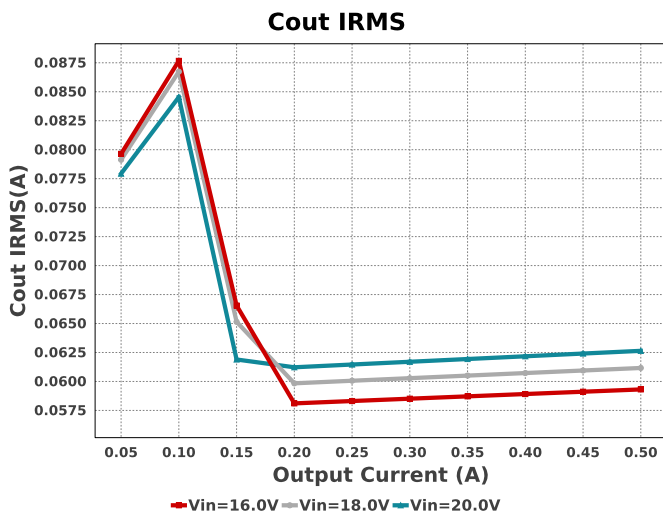
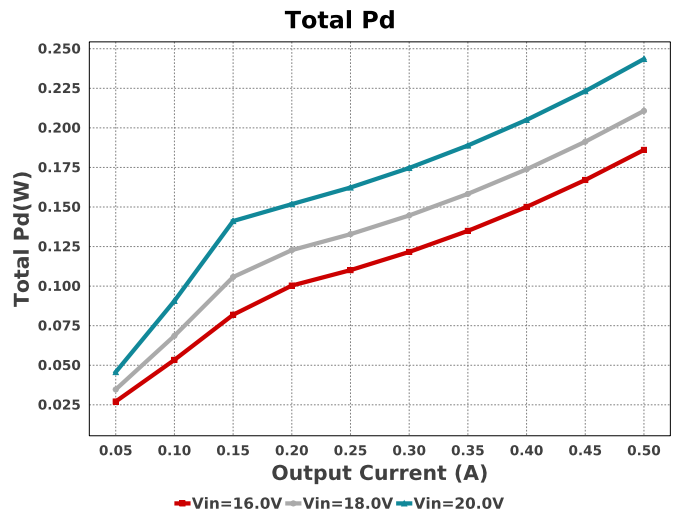
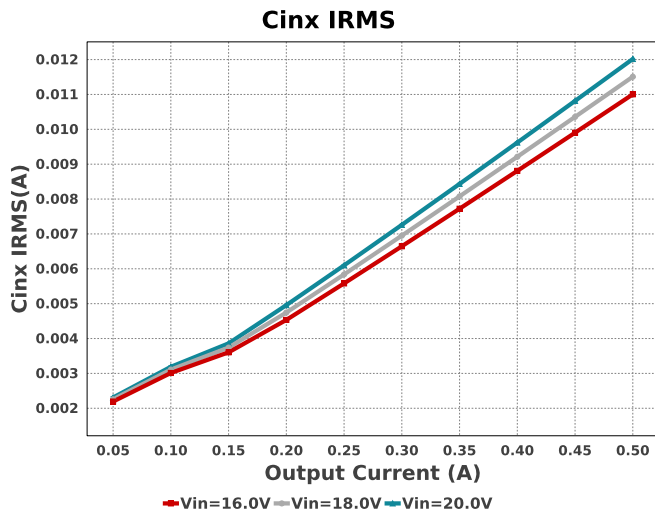
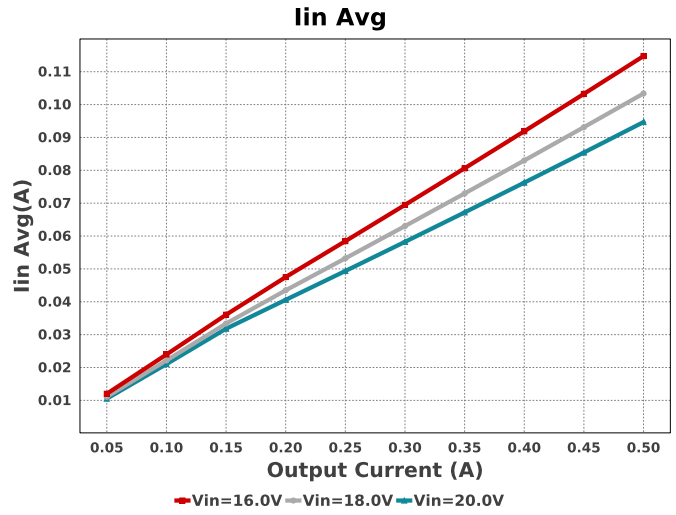
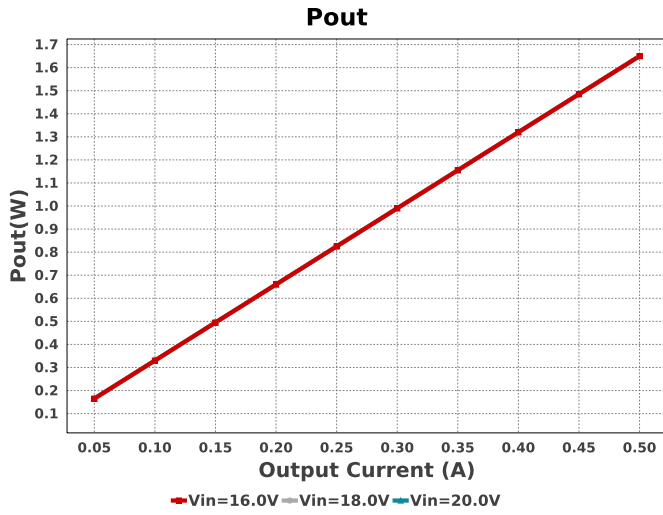


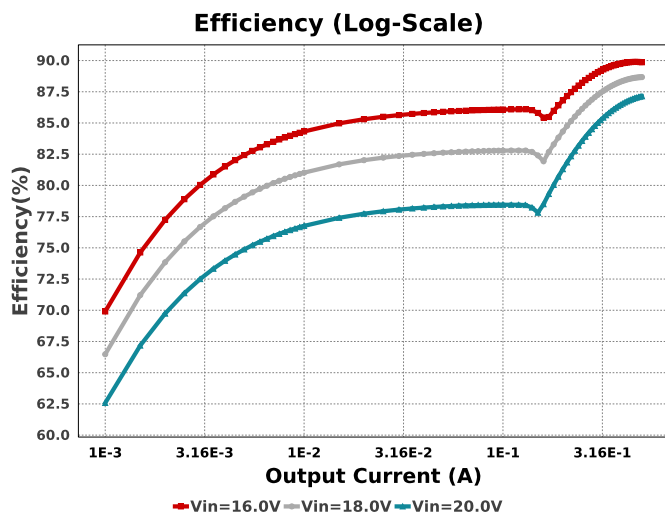
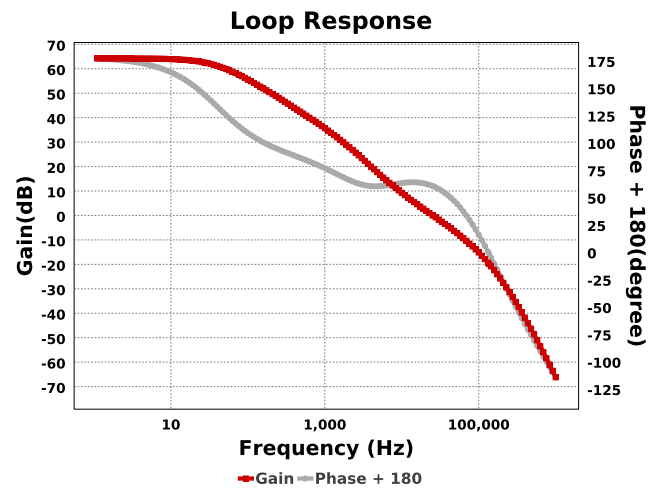
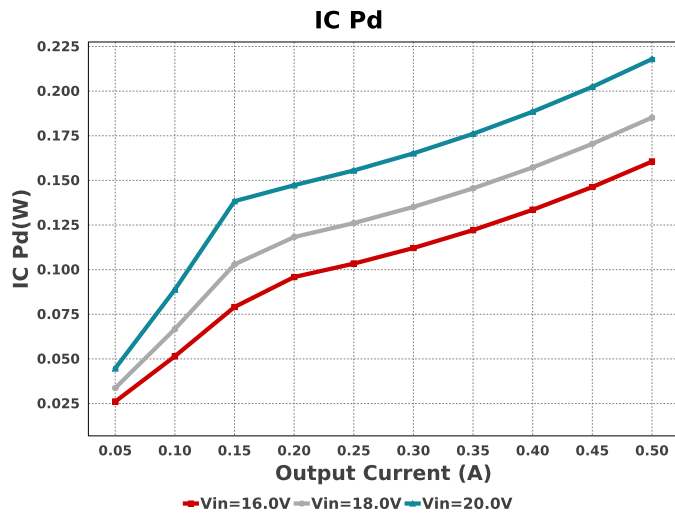
## Electrical BOM

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 mm <sup>2</sup>
Cin	TDK	C1608X7R1V105K080AC Series= X7R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 35.0 V IRMS= 2.2162 A	3	\$0.05	0603 5 mm <sup>2</sup>
Cinx	MuRata	GRM188R71H104KA93D Series= X7R	Cap= 100.0 nF ESR= 20.0 mOhm VDC= 50.0 V IRMS= 3.8 A	1	\$0.02	0603 5 mm <sup>2</sup>
Cout	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	2	\$0.03	0805 7 mm <sup>2</sup>
L1	NIC Components	NPI54C120MTRF	L= 12.0 uH 100.0 mOhm	1	\$0.09	IND_NPI54C 61 mm <sup>2</sup>
Rfbb	Vishay-Dale	CRCW040222K1FKED Series= CRCW..e3	Res= 22.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
Rfbb	Vishay-Dale	CRCW040269K8FKED Series= CRCW..e3	Res= 69.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
U1	Texas Instruments	LMR54406DBVR	Switcher	1	\$0.23	DBV0006A 15 mm <sup>2</sup>









## Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	179.501 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	59.307 $\mu$ W	Capacitor	Input capacitor power dissipation
3.	Cinx IRMS	12.017 mA	Capacitor	Bulk capacitor RMS ripple current
4.	Cinx Pd	2.888 $\mu$ W	Capacitor	Bulk capacitor power dissipation
5.	Cout IRMS	62.643 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	5.886 $\mu$ W	Capacitor	Output capacitor power dissipation
7.	IC Ipk	608.501 mA	IC	Peak switch current in IC
8.	IC Pd	217.94 mW	IC	IC power dissipation
9.	IC Tj	47.436 degC	IC	IC junction temperature
10.	IC Tolerance	20.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA Effective	80.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
12.	Iin Avg	94.676 mA	IC	Average input current
13.	Ipp percentage	43.4 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	217.0 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	25.392 mW	Inductor	Inductor power dissipation
16.	Cin Pd	59.307 $\mu$ W	Power	Input capacitor power dissipation
17.	Cinx Pd	2.888 $\mu$ W	Power	Bulk capacitor power dissipation
18.	Cout Pd	5.886 $\mu$ W	Power	Output capacitor power dissipation
19.	IC Pd	217.94 mW	Power	IC power dissipation
20.	L Pd	25.392 mW	Power	Inductor power dissipation
21.	Total Pd	243.526 mW	Power	Total Power Dissipation
22.	BOM Count	11	System	Total Design BOM count
23.	Cross Freq	25.441 kHz	System	Bode plot crossover frequency
24.	Duty Cycle	17.439 %	System	Duty cycle
25.	Efficiency	87.139 %	System	Steady state efficiency
26.	FootPrint	117.0 mm <sup>2</sup>	System	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
27.	Frequency	1.1 MHz	System Information	Switching frequency
28.	Gain Marg	-19.807 dB	System Information	Bode Plot Gain Margin
29.	Iout	500.0 mA	System Information	Iout operating point
30.	Low Freq Gain	64.22 dB	System Information	Gain at 1Hz
31.	Mode	CCM	System Information	Conduction Mode
32.	Phase Marg	61.65 deg	System Information	Bode Plot Phase Margin
33.	Pout	1.65 W	System Information	Total output power
34.	Total BOM	\$0.58	System Information	Total BOM Cost
35.	Vin	20.0 V	System Information	Vin operating point
36.	Vin p-p	46.939 mV	System Information	Peak-to-peak input voltage
37.	Vout	3.3 V	System Information	Operational Output Voltage
38.	Vout Actual	3.327 V	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Tolerance	4.073 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	1.677 mV	System Information	Peak-to-peak output ripple voltage

## Design Inputs

Name	Value	Description
Iout	500.0 m	Maximum Output Current
VinMax	20.0	Maximum input voltage
VinMin	16.0	Minimum input voltage
VinTyp	18.0	Typical input voltage
Vout	3.3	Output Voltage
base_pn	LMR54406	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  $C_{in}$  and  $C_{out}$ , 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 down 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 16.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to  $V_{in}$  and GND. Connect a digital volt meter and a load if needed to set the minimum load of the design from  $V_{out}$  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  $V_{in}$  and GND, a load is connected between  $V_{out}$  and GND and a current meter is connected in series between  $V_{out}$  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 : FC2298CE6F700CFB[v1]
2. **LMR54406** Product Folder : <http://www.ti.com/product/LMR54406> : contains the data sheet and other resources.

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