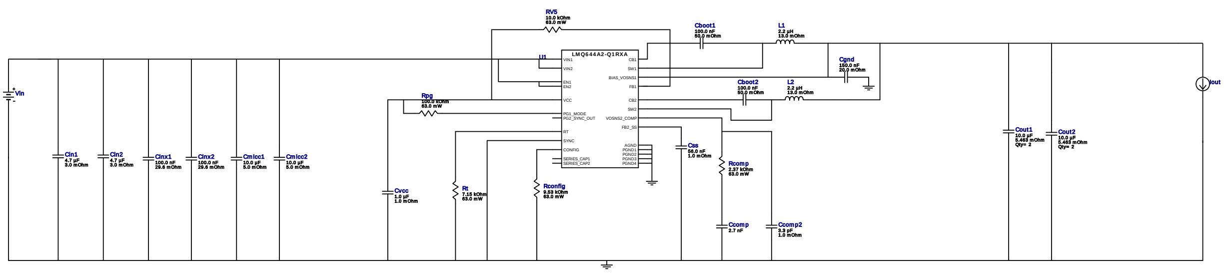
VinMin = 20.0V
VinMax = 36.0V
Vout = 5.0V
Iout = 8.0A

Device = LMQ644A2QRXARQ1
Topology = Buck
Created = 2025-09-30 07:44:47.549
BOM Cost = $4.73
BOM Count = 25
Total Pd = 2.67W

WEBENCH ® Design Report

Design : 15 LMQ644A2QRXARQ1
LMQ644A2QRXARQ1 20V-36V to 5.00V @ 8A



Design Alerts

Component Selection Information

The LMQ644A2-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application

Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot1	AVX	06033C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 50.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Cboot2	AVX	06033C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 50.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Ccomp	TDK	C2012C0G1H272J060AA Series= C0G/NP0	Cap= 2.7 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm²
Ccomp2	MuRata	GRM1555C1H3R3CA01D Series= C0G/NP0	Cap= 3.3 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cgnd	MuRata	GRM188R71E154KA01D Series= X7R	Cap= 150.0 nF ESR= 20.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.03	0603 5 mm²
Cin1	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 mm²
Cin2	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 mm²
Cinx1	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
Cinx2	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

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cmlcc1	Samsung Electro-Mechanics	CL32A106KBJNNNE Series= X5R	Cap= 10.0 uF ESR= 5.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.15	1210_270 15 mm^2
Cmlcc2	Samsung Electro-Mechanics	CL32A106KBJNNNE Series= X5R	Cap= 10.0 uF ESR= 5.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.15	1210_270 15 mm^2
Cout1	Taiyo Yuden	MSAST21GBB5106MTNA01 Series= X5R	Cap= 10.0 uF ESR= 5.463 mOhm VDC= 25.0 V IRMS= 2.36768 A	2	$0.04	0805 7 mm^2
Cout2	Taiyo Yuden	MSAST21GBB5106MTNA01 Series= X5R	Cap= 10.0 uF ESR= 5.463 mOhm VDC= 25.0 V IRMS= 2.36768 A	2	$0.04	0805 7 mm^2
Css	MuRata	GRM188R71C563KA01D Series= X7R	Cap= 56.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm^2
Cvcc	Kemet	C0603C105Z8VACTU Series= Y5V	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
L1	Bourns	SRN8040-2R2Y	L= 2.2 µH 13.0 mOhm	1	$0.33	SRN8040 100 mm^2
L2	Bourns	SRN8040-2R2Y	L= 2.2 µH 13.0 mOhm	1	$0.33	SRN8040 100 mm^2
RV5	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcomp	Vishay-Dale	CRCW04022K37FKED Series= CRCW..e3	Res= 2.37 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rconfig	Vishay-Dale	CRCW04029K53FKED Series= CRCW..e3	Res= 9.53 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rt	Vishay-Dale	CRCW04027K15FKED Series= CRCW..e3	Res= 7.15 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	LMQ644A2QRXARQ1	Switcher	1	$3.22	RXA0024A-MFG 51 mm^2

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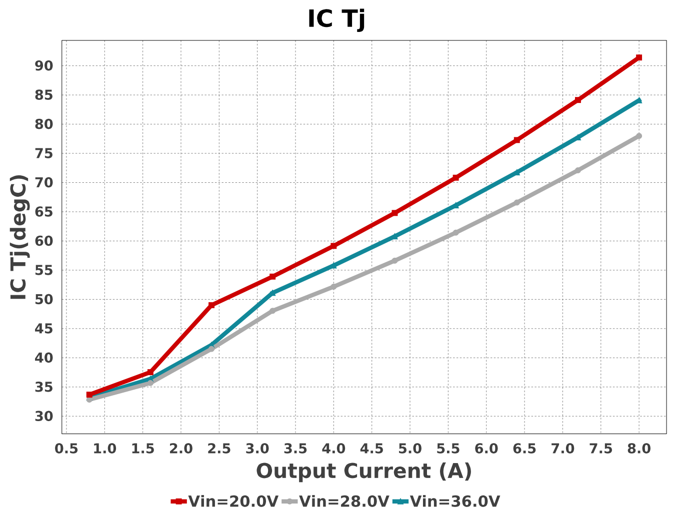

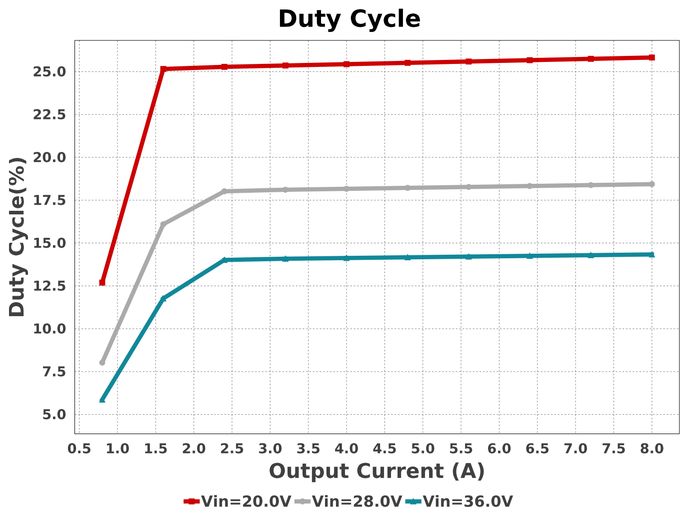

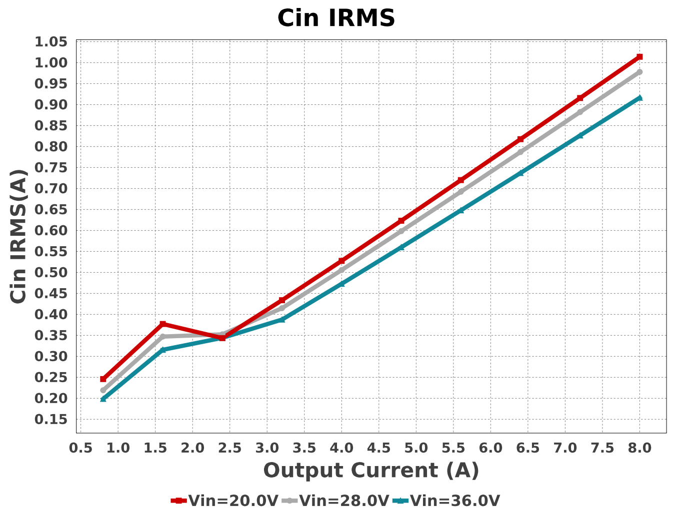

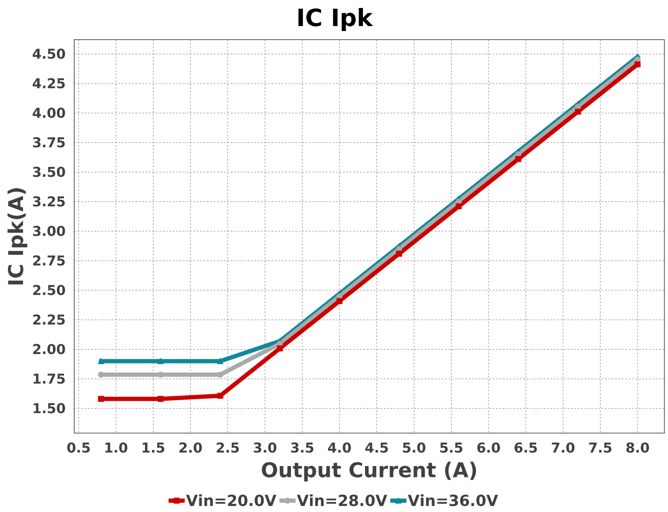

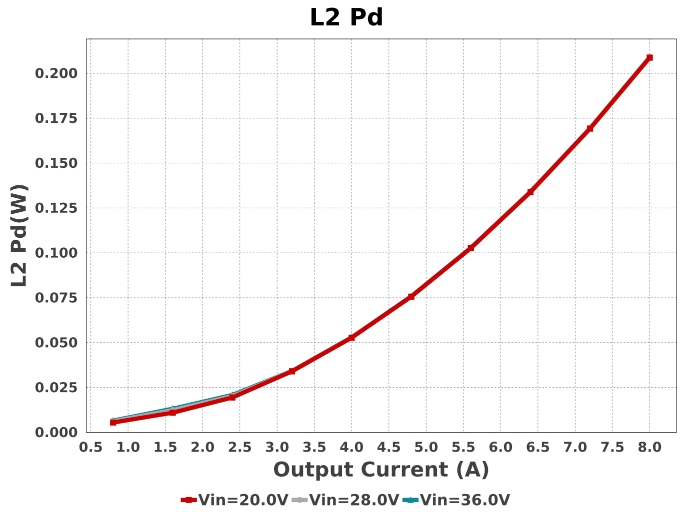

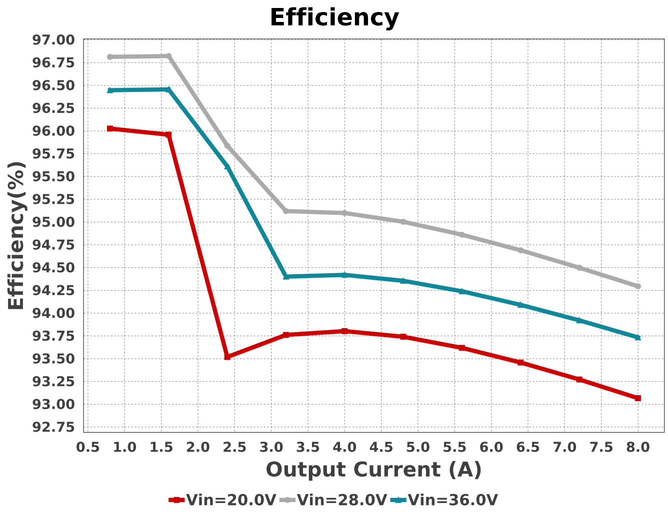

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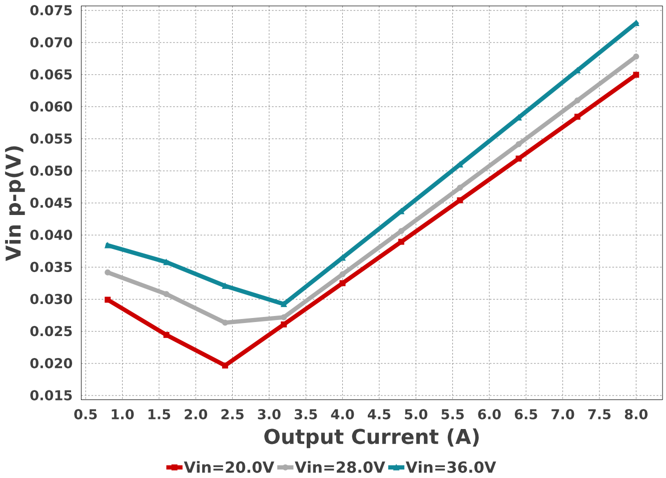
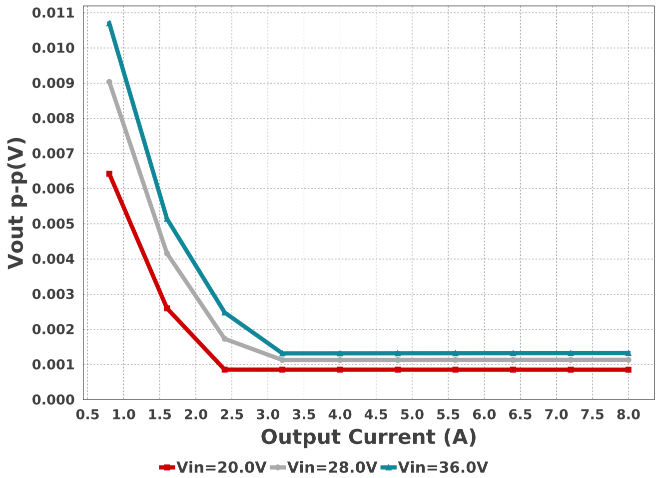
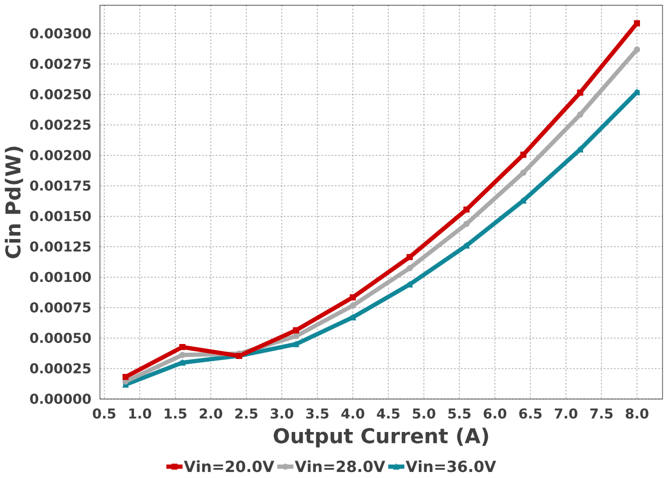
Vin p-p



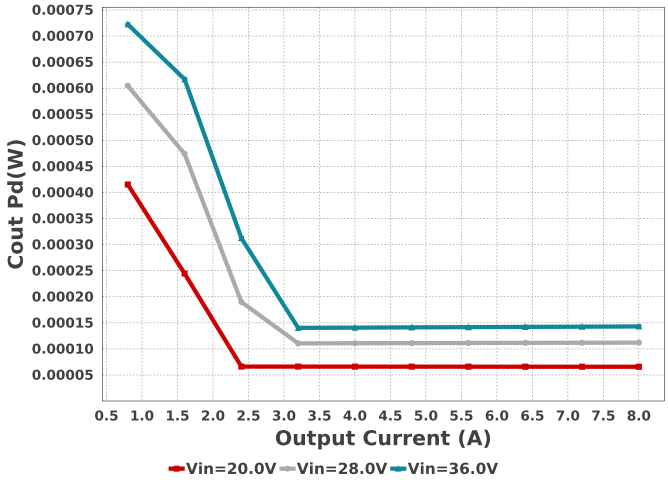
Vout p-p



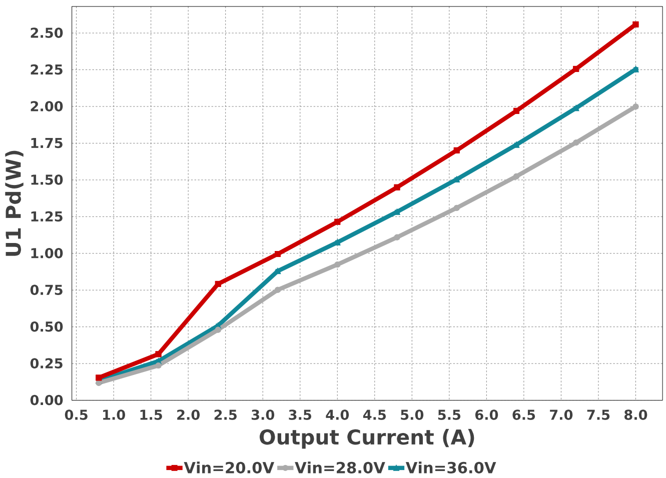
Cin Pd



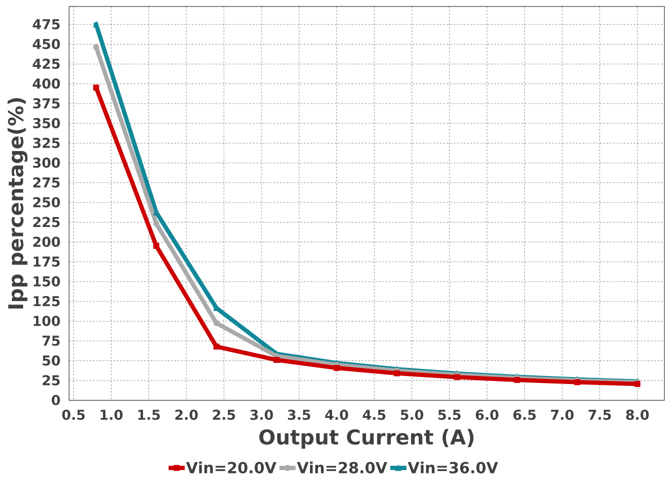
Cout Pd

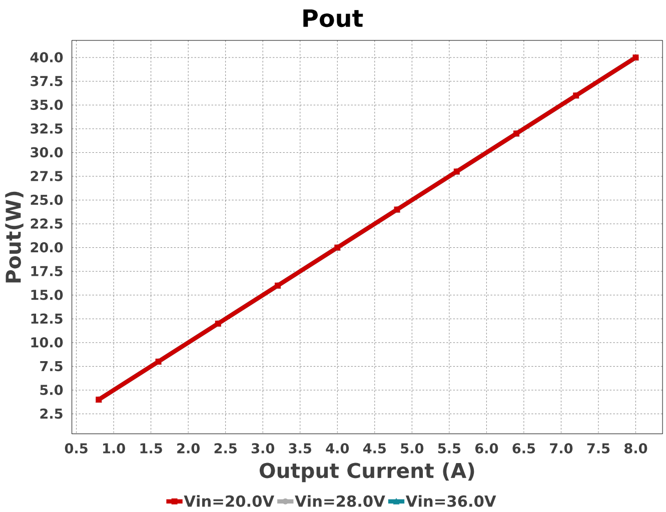


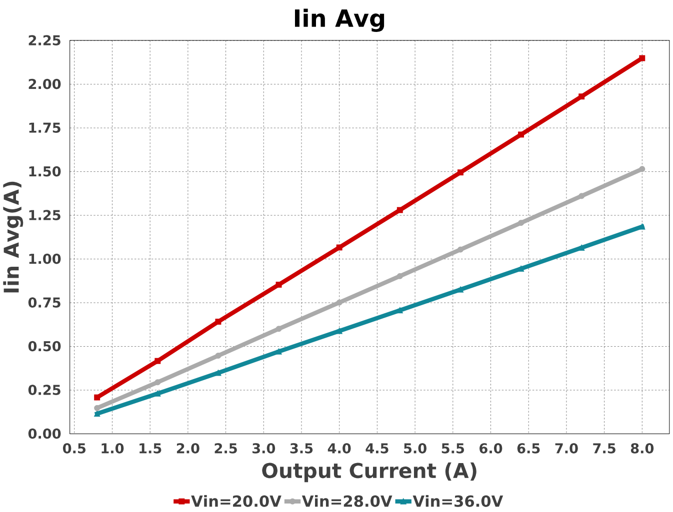
U1 Pd

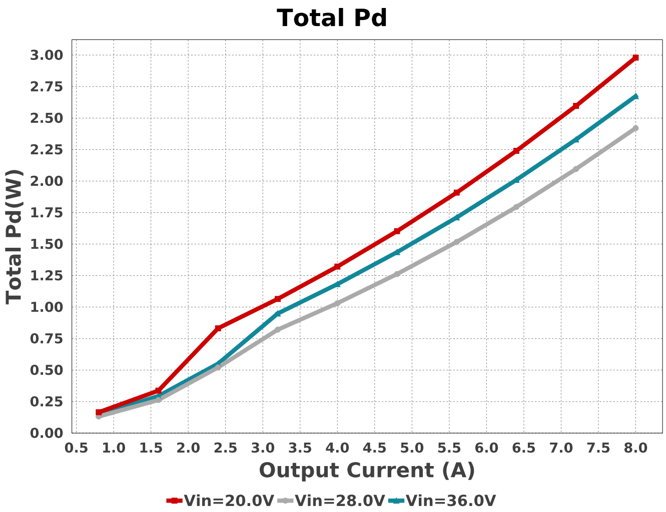


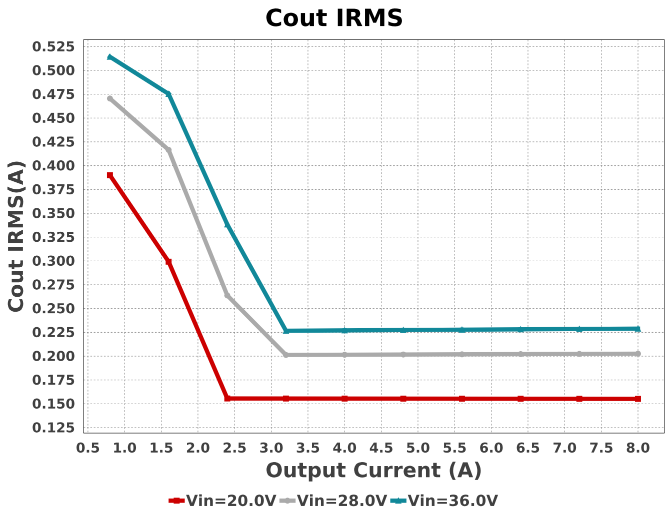
Ipp percentage

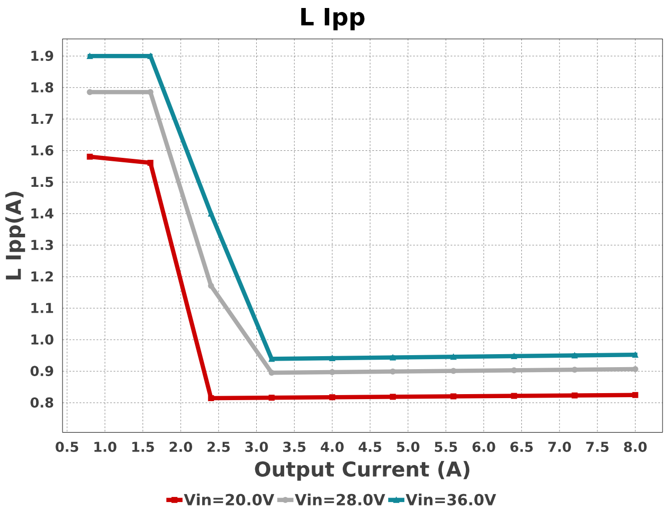


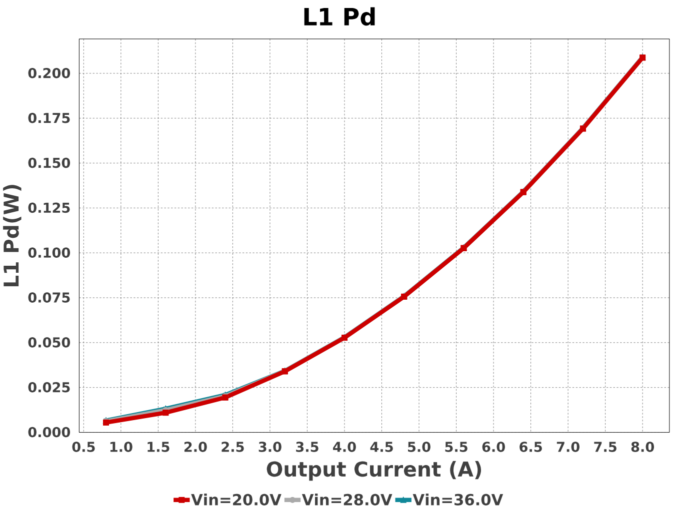

Pout
Pout(W)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

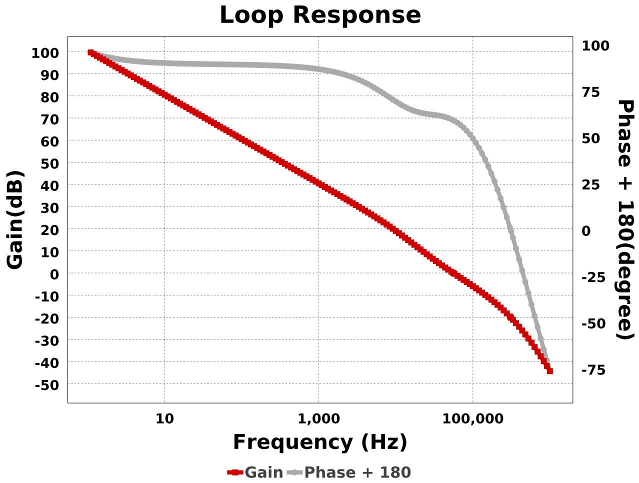

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V

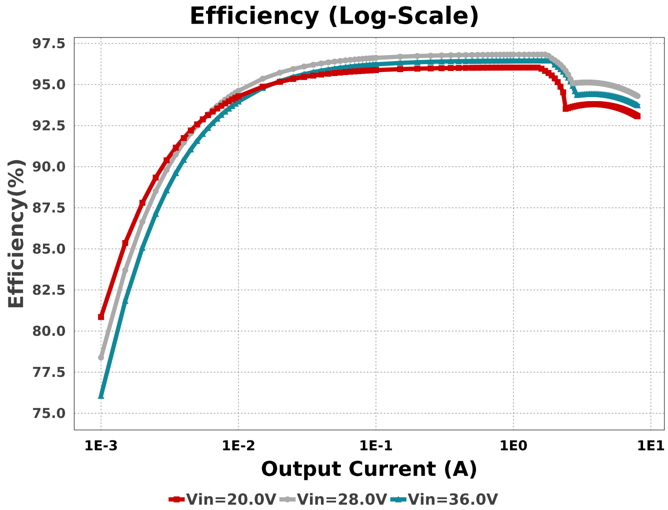

Total Pd
Total Pd(W)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V


L Ipp
L Ipp(A)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V


L1 Pd
L1 Pd(W)
Output Current (A)
Vin=20.0V Vin=28.0V Vin=36.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	916.329 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	2.519 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	228.908 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	143.13 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	4.476 A	IC	Peak switch current in IC
6.	IC Tj	84.079 degC	IC	IC junction temperature
7.	ICThetaJA Effective	24.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
8.	Iin Avg	1.185 A	IC	Average input current
9.	U1 Pd	2.253 W	IC	IC power dissipation
10.	Ipp percentage	23.808 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
11.	L Ipp	952.31 mA	Inductor	Peak-to-peak inductor ripple current
12.	L1 Pd	208.98 mW	Inductor	Inductor power dissipation
13.	L2 Pd	208.98 mW	Inductor	Inductor power dissipation
14.	Cin Pd	2.519 mW	Power	Input capacitor power dissipation
15.	Cout Pd	143.13 µW	Power	Output capacitor power dissipation
16.	L1 Pd	208.98 mW	Power	Inductor power dissipation
17.	L2 Pd	208.98 mW	Power	Inductor power dissipation
18.	Total Pd	2.674 W	Power	Total Power Dissipation
19.	U1 Pd	2.253 W	Power	IC power dissipation
20.	BOM Count	25	System Information	Total Design BOM count
21.	Cross Freq	55.632 kHz	System Information	Bode plot crossover frequency
22.	Duty Cycle	14.334 %	System Information	Duty cycle
23.	Efficiency	93.734 %	System Information	Steady state efficiency
24.	FootPrint	386.0 mm^2	System Information	Total Foot Print Area of BOM components
25.	Frequency	2.108 MHz	System Information	Switching frequency
26.	Gain Marg	-20.183 dB	System Information	Bode Plot Gain Margin
27.	Iout	8.0 A	System Information	Iout operating point
28.	Low Freq Gain	99.63 dB	System Information	Gain at 1Hz
29.	Mode	CCM	System Information	Conduction Mode
30.	Phase Marg	59.82 deg	System Information	Bode Plot Phase Margin
31.	Pout	40.0 W	System Information	Total output power
32.	Total BOM	$4.73	System Information	Total BOM Cost
33.	Vin	36.0 V	System Information	Vin operating point
34.	Vin p-p	73.034 mV	System Information	Peak-to-peak input voltage
35.	Vout	5.0 V	System Information	Operational Output Voltage

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#	Name	Value	Category	Description
36.	Vout	5.0 V	System Information	Operational Output Voltage
37.	Vout Tolerance	240.0 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
38.	Vout p-p	1.328 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	8.0	Maximum Output Current
VinMax	36.0	Maximum input voltage
VinMin	20.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LMQ644A2-Q1	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

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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

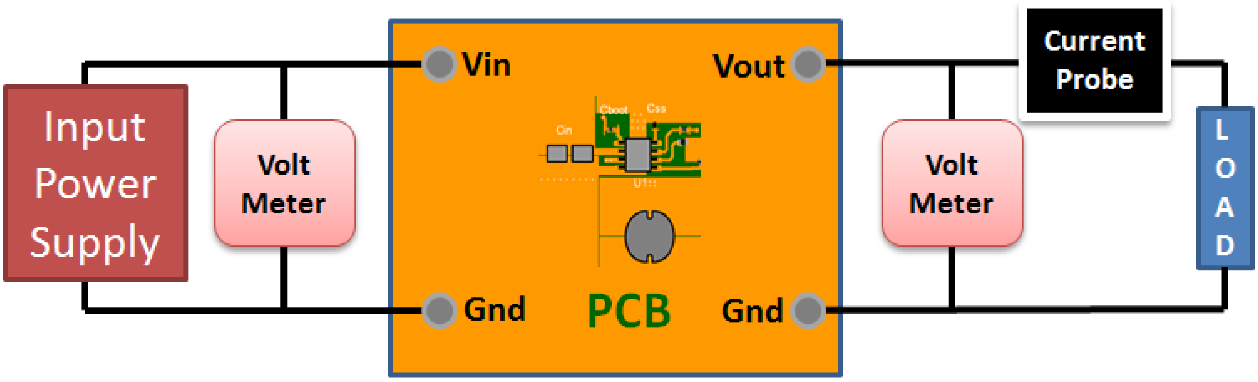
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins.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



Design Assistance

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2. Master key : E11CD5DD0136C8F37538F20AD8412EA8[v1]

3. **LMQ644A2-Q1** Product Folder : http://www.ti.com/product/LMQ644A2%2DQ1 : contains the data sheet and other resources.

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