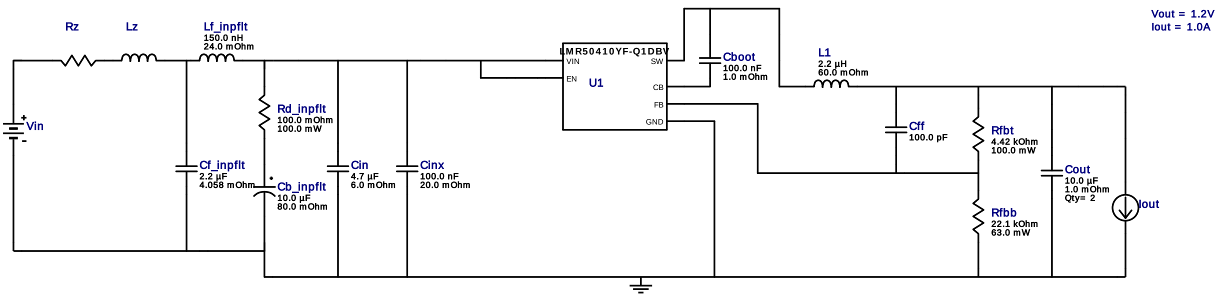
VinMin = 4.0V
VinMax = 5.5V
Vout = 1.2V
Iout = 1.0A

Device = LMR50410YFQDBVRQ1
Topology = Buck
Created = 2023-03-13 12:10:36.834
BOM Cost = $1.36
BOM Count = 14
Total Pd = 0.77W

WEBENCH ® Design Report

Design : 15 LMR50410YFQDBVRQ1
LMR50410YFQDBVRQ1 6V-36V to 5.00V @ 1A



Design Alerts

Component Selection Information

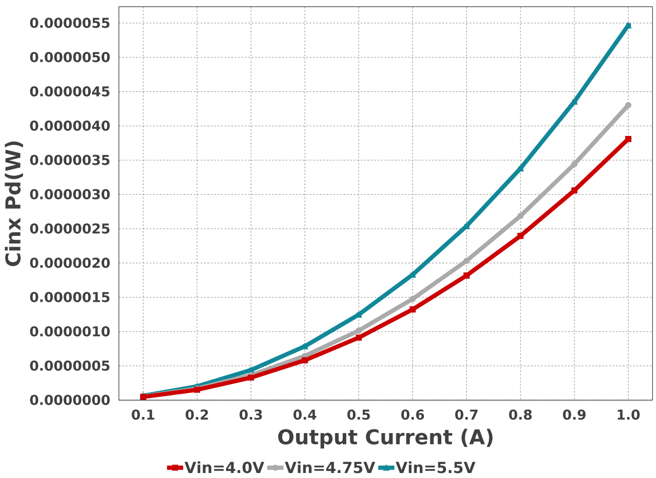
The LMR50410YF-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.

Electrical BOM

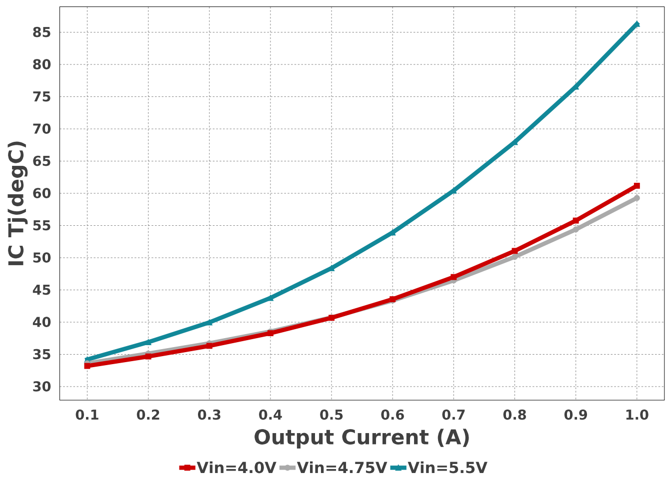
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cb_inpflt	Panasonic	12TPC10M Series= TPC	Cap= 10.0 uF ESR= 80.0 mOhm VDC= 12.5 V IRMS= 800.0 mA	1	$0.44	CAPSMT_6_B1G 17 mm^2
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cf_inpflt	TDK	C1608X7R1A225K080AC Series= X7R	Cap= 2.2 uF ESR= 4.058 mOhm VDC= 10.0 V IRMS= 2.58266 A	1	$0.03	0603 5 mm^2
Cff	Kemet	C0402C101K4GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	Kemet	C0603C475K8PACTU Series= X5R	Cap= 4.7 uF ESR= 6.0 mOhm VDC= 10.0 V IRMS= 7.24 A	1	$0.07	0603 5 mm^2
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^2
Cout	MuRata	GRM155R60J106ME15D Series= X5R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 3.52 A	2	$0.03	0402 3 mm^2
L1	NIC Components	NPI43C2R2MTRF	L= 2.2 µH 60.0 mOhm	1	$0.07	IND_NPI43C 31 mm^2
Lf_inpflt	TDK	NLCV32T-R15M-PFR	L= 150.0 nH 24.0 mOhm	1	$0.10	NLCV32 13 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rd_inpflt	Panasonic	ERJ-3RSFR10V Series= ERJ-3R	Res= 100.0 mOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.03	0603 5 mm^2
Rfbb	Vishay-Dale	CRCW040222K1FKED Series= CRCW..e3	Res= 22.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW06034K42FKEA Series= CRCW..e3	Res= 4.42 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	LMR50410YFQDBVRQ1	Switcher	1	$0.50	DBV0006A 15 mm^2

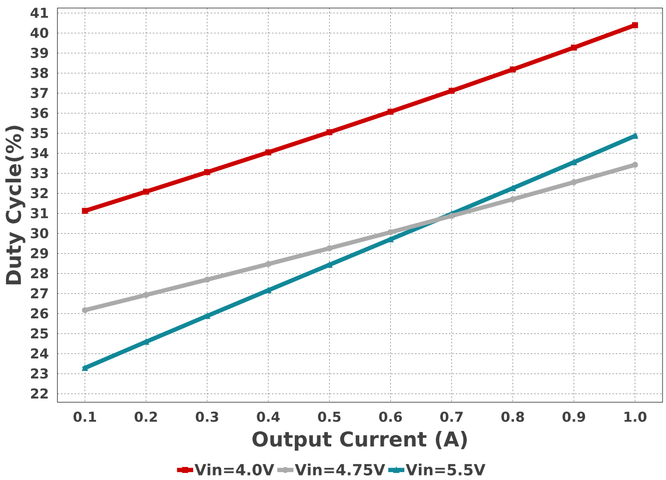
Cinx Pd



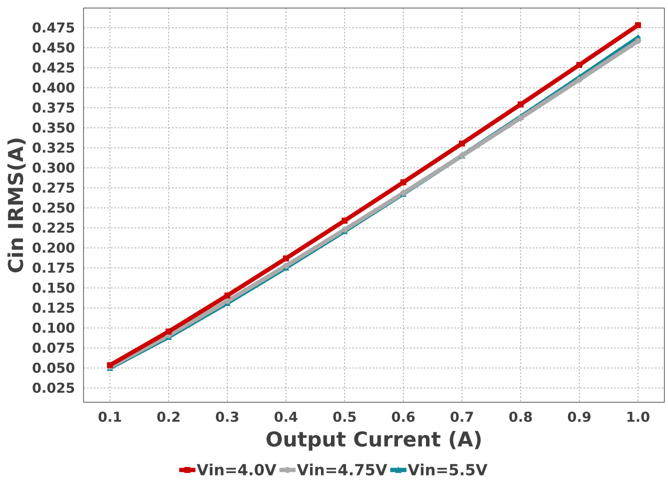
IC Tj

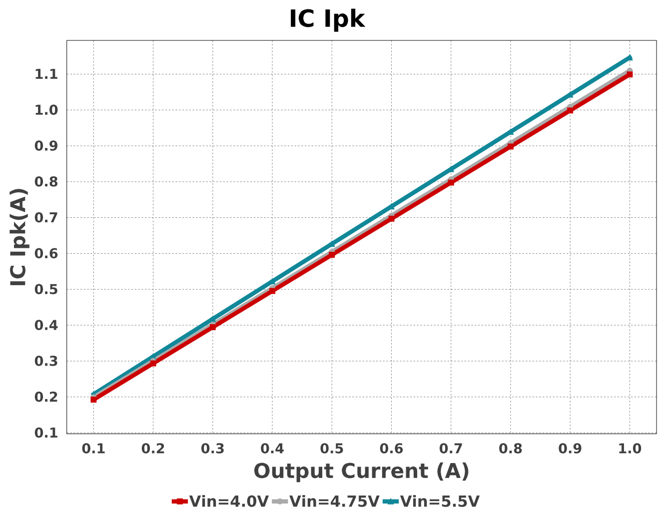


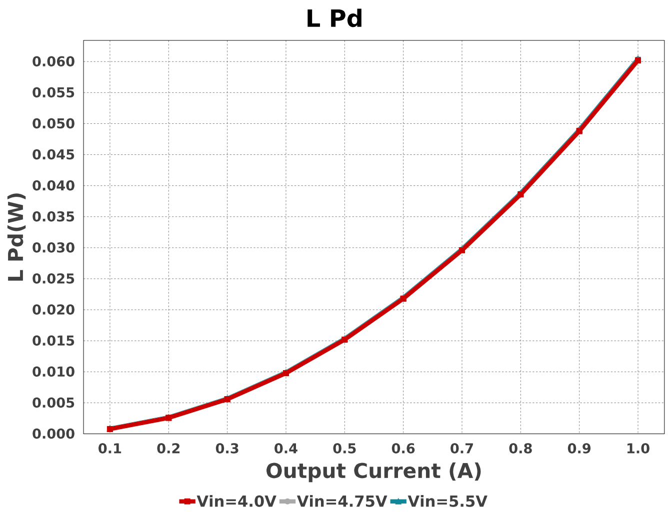
Duty Cycle

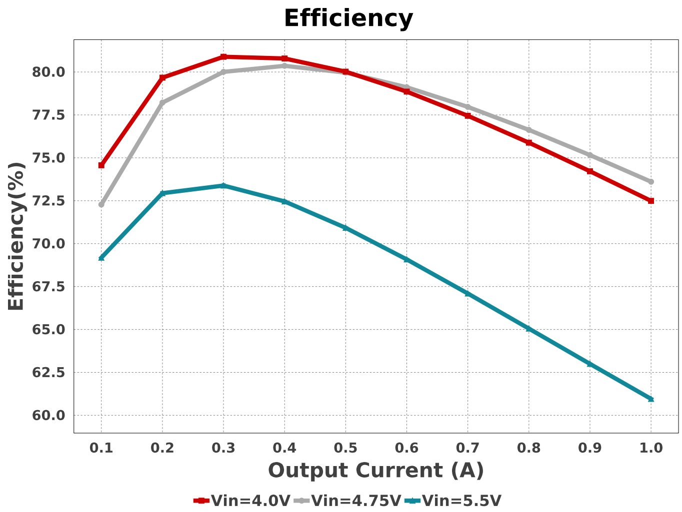


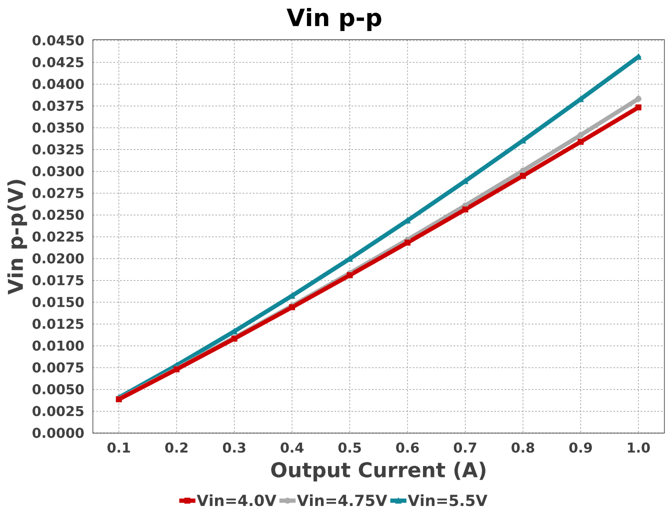
Cin IRMS

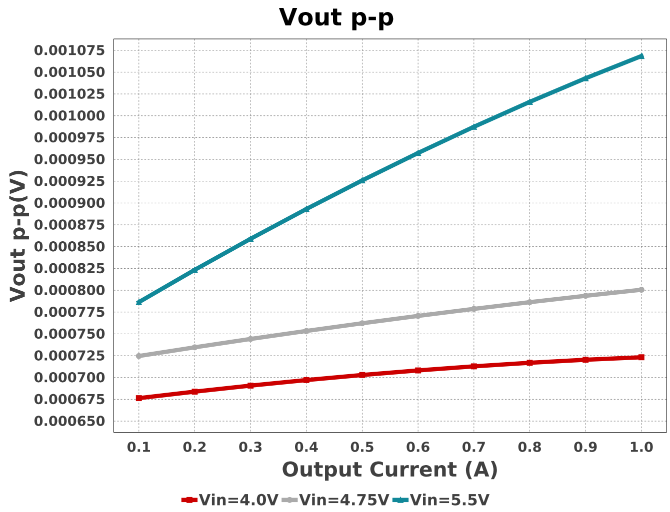


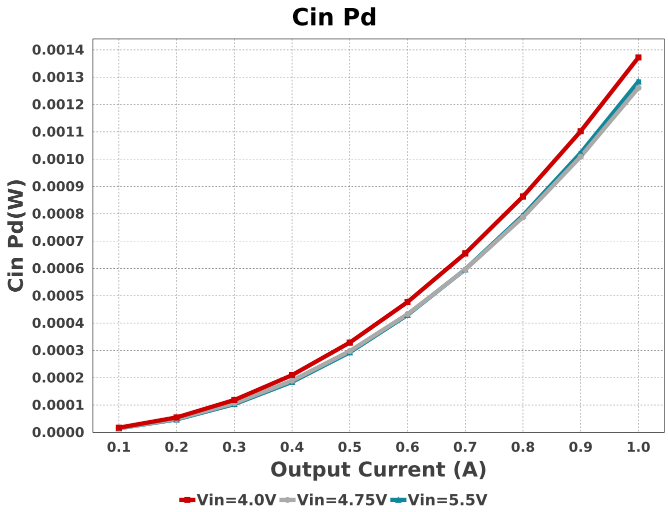

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V


L Pd
L Pd(W)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V

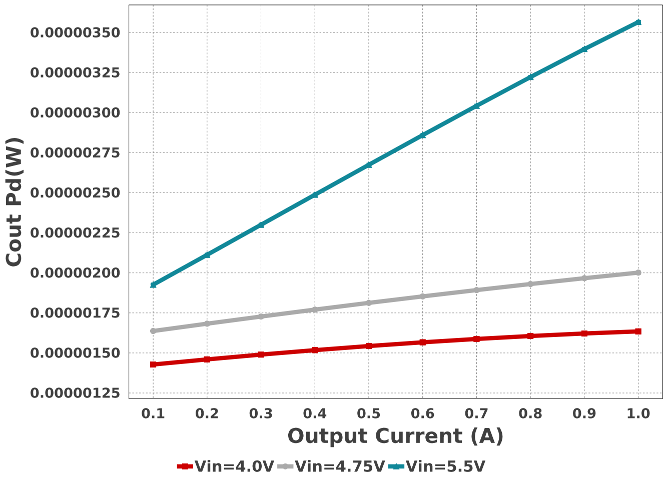

Efficiency
Efficiency(%)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V


Vin p-p
Vin p-p(V)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V

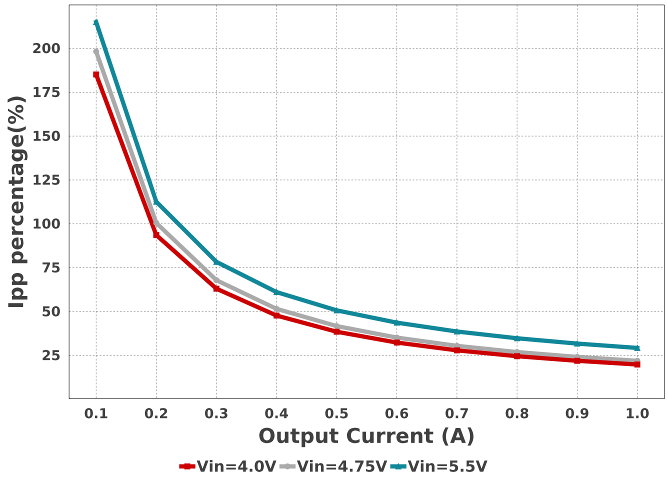

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V


Cin Pd
Cin Pd(W)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V

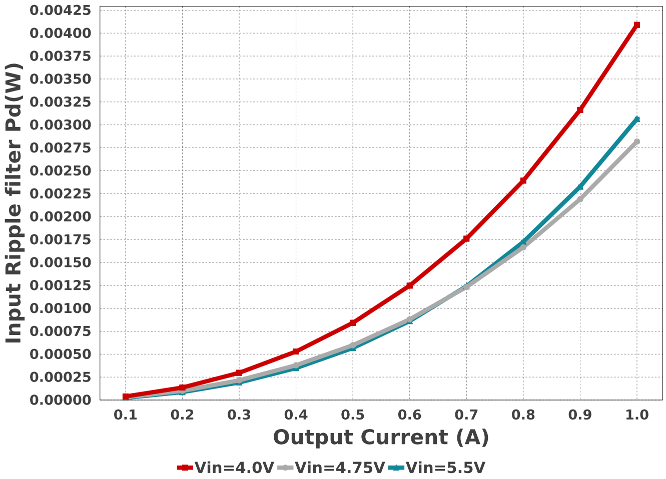
Cout Pd



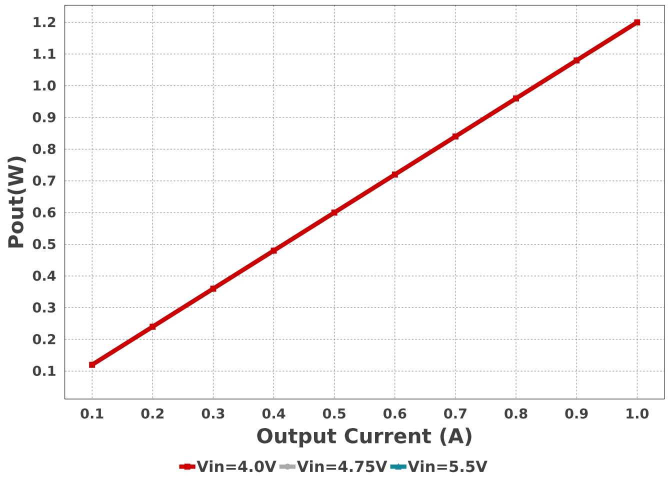
Ipp percentage



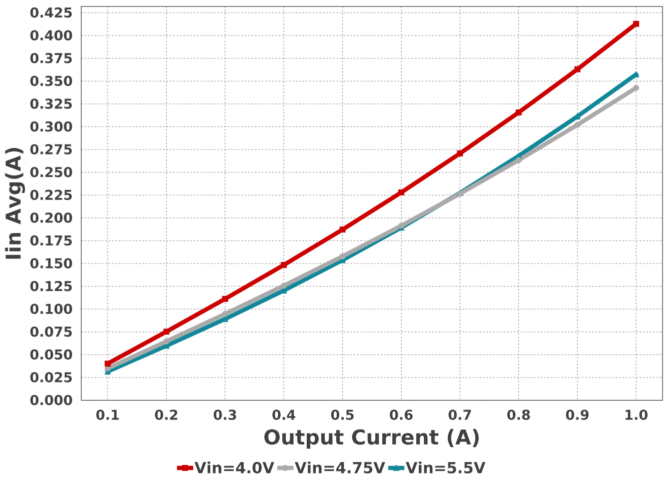
Input Ripple filter Pd



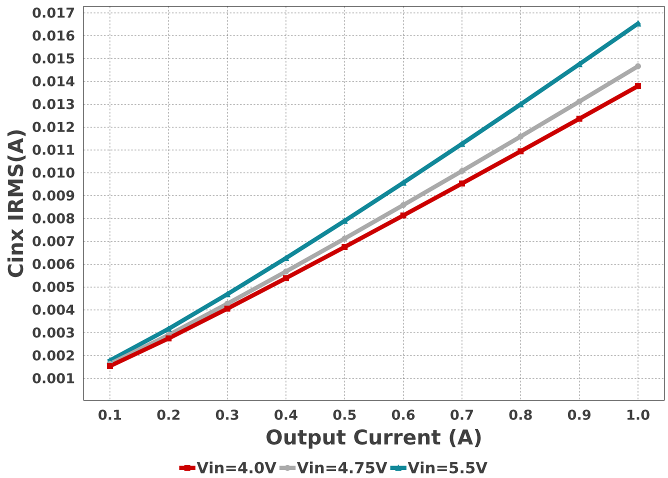
Pout

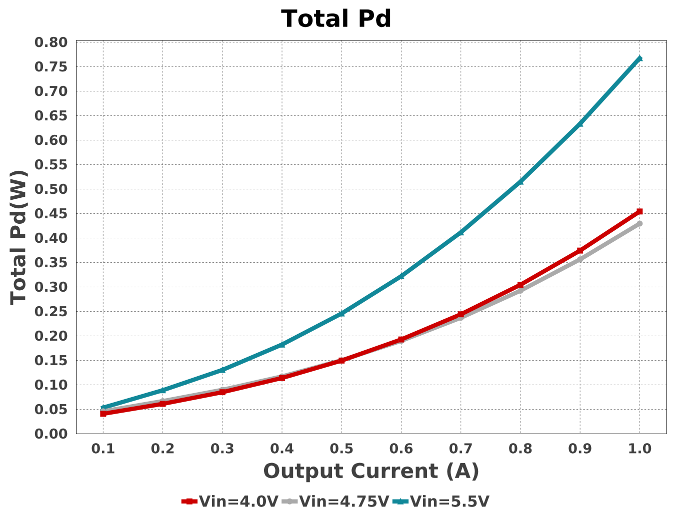


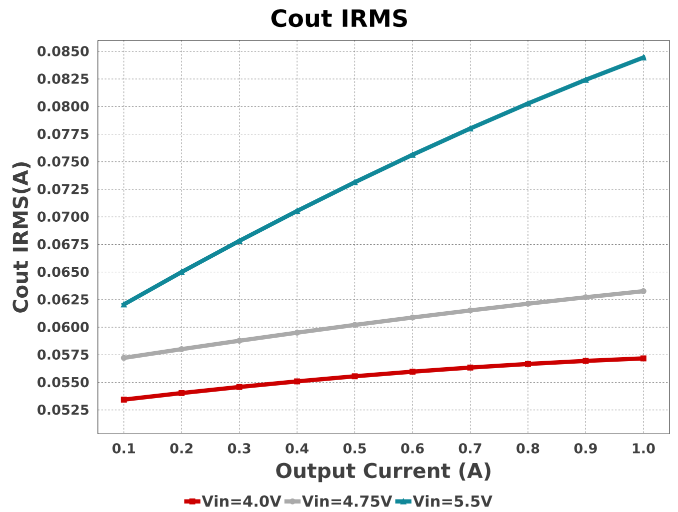
Iin Avg

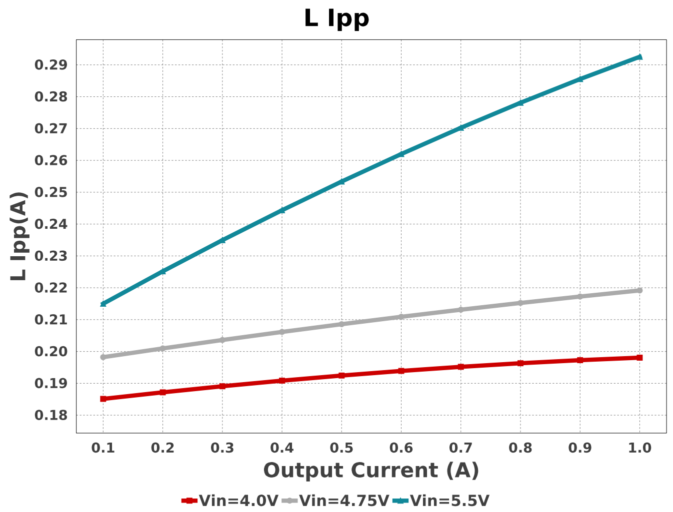


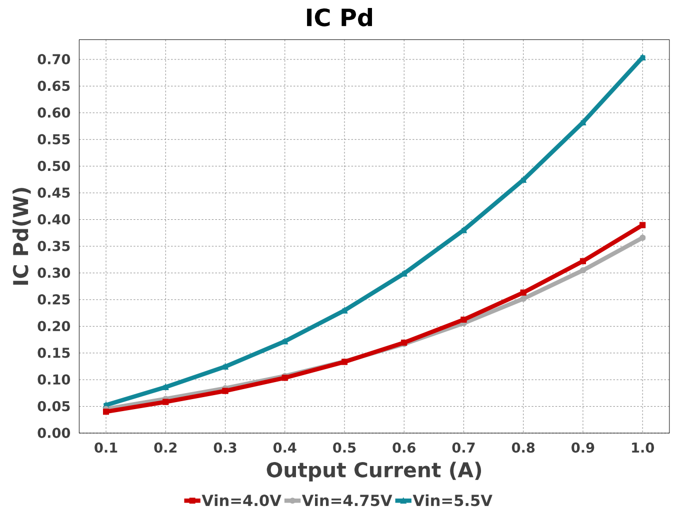
Cinx IRMS

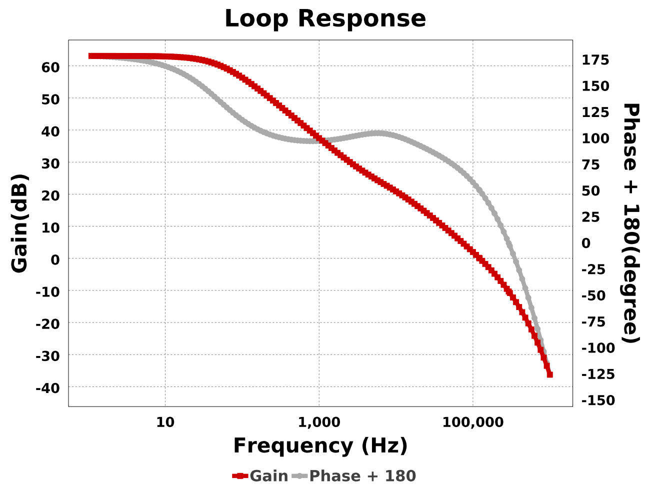


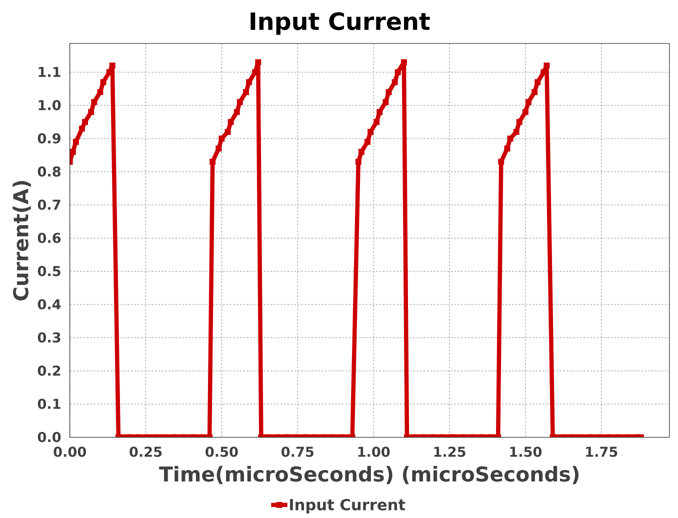

Total Pd
Total Pd(W)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V

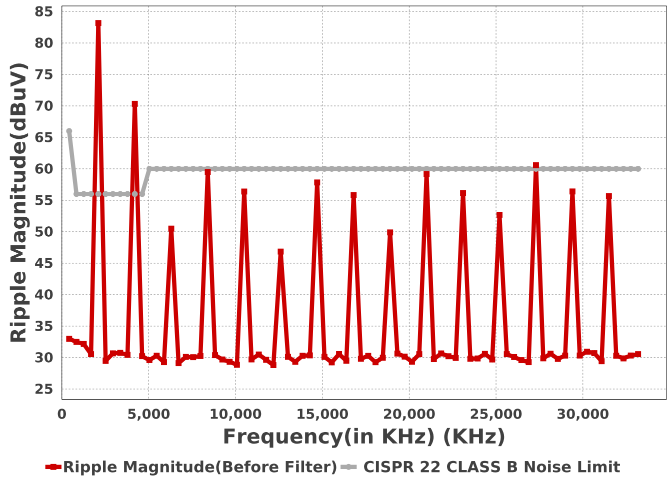

L Ipp
L Ipp(A)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V


IC Pd
IC Pd(W)
Output Current (A)
Vin=4.0V Vin=4.75V Vin=5.5V

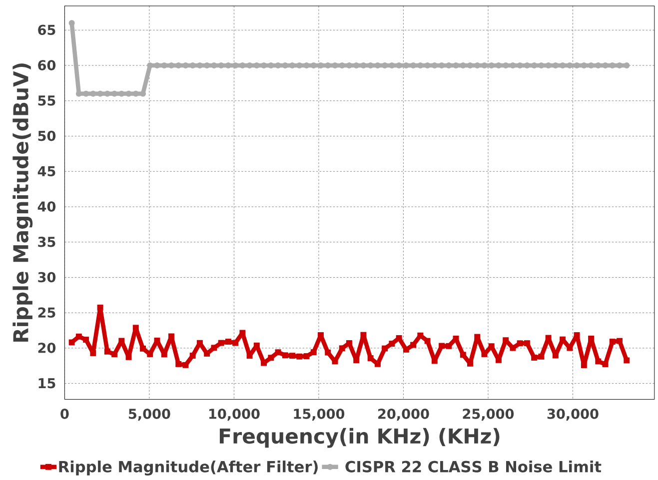

Loop Response
Gain(dB)
Phase + 180(degree)
Frequency (Hz)
Gain Phase + 180


Input Current
Current(A)
Time(microSeconds) (microSeconds)
Input Current

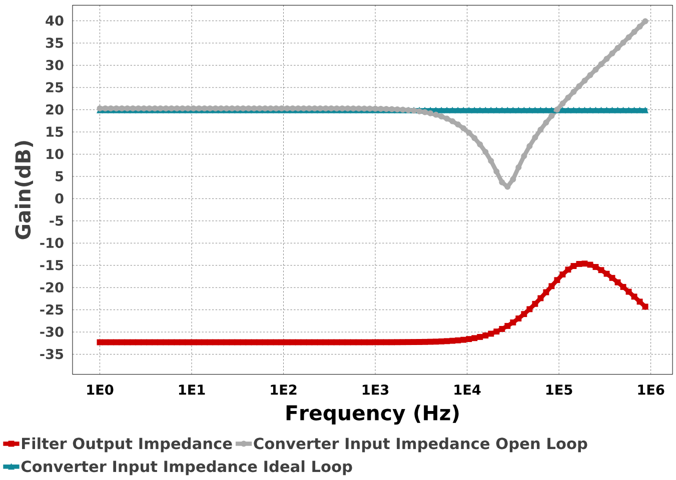
Ripple Freq Spectrum(Before Filter)



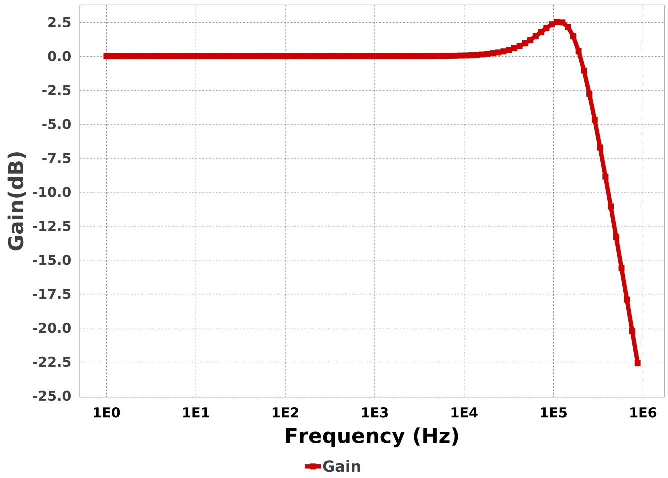
Ripple Freq Spectrum(After Filter)



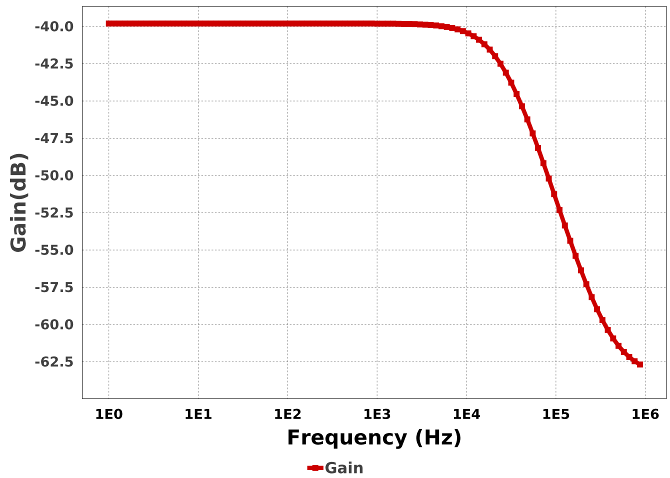
Filter vs Converter Impedance Comparison



Filter Forward Transfer Function



Input Ripple Attenuation Transfer Function



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	462.624 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	1.284 mW	Capacitor	Input capacitor power dissipation
3.	Cinx IRMS	16.533 mA	Capacitor	Bulk capacitor RMS ripple current
4.	Cinx Pd	5.467 µW	Capacitor	Bulk capacitor power dissipation
5.	Cout IRMS	84.446 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	3.566 µW	Capacitor	Output capacitor power dissipation
7.	Input Ripple Noise After input filter	27.02 dBuV	EMI Noise	Input Ripple Noise after filter at switching frequency
8.	Input Ripple Noise before input filter	83.17 dBuV	EMI Noise	Input Ripple Noise before filter at switching frequency
9.	Input Ripple filter Pd	3.065 mW	EMI Noise	Input Ripple Filter Power Dissipation

#	Name	Value	Category	Description
10.	Noise limits defined by CISPR Standards	56.0 dBuV	EMI Noise	Noise limits for CLASS B of CISPR 22 standard
11.	IC Ipk	1.146 A	IC	Peak switch current in IC
12.	IC Pd	703.79 mW	IC	IC power dissipation
13.	IC Tj	86.303 degC	IC	IC junction temperature
14.	IC Tolerance	15.0 mV	IC	IC Feedback Tolerance
15.	ICThetaJA Effective	80.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
16.	Iin Avg	357.38 mA	IC	Average input current
17.	Ipp percentage	29.253 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
18.	L Ipp	292.53 mA	Inductor	Peak-to-peak inductor ripple current
19.	L Pd	60.428 mW	Inductor	Inductor power dissipation
20.	Cin Pd	1.284 mW	Power	Input capacitor power dissipation
21.	Cinx Pd	5.467 µW	Power	Bulk capacitor power dissipation
22.	Cout Pd	3.566 µW	Power	Output capacitor power dissipation
23.	IC Pd	703.79 mW	Power	IC power dissipation
24.	Input Ripple filter Pd	3.065 mW	Power	Input Ripple Filter Power Dissipation
25.	L Pd	60.428 mW	Power	Inductor power dissipation
26.	Total Pd	767.445 mW	Power	Total Power Dissipation
27.	BOM Count	14	System Information	Total Design BOM count
28.	Cross Freq	122.16 kHz	System Information	Bode plot crossover frequency
29.	Duty Cycle	34.869 %	System Information	Duty cycle
30.	Efficiency	60.956 %	System Information	Steady state efficiency
31.	FootPrint	115.0 mm^2	System Information	Total Foot Print Area of BOM components
32.	Frequency	2.1 MHz	System Information	Switching frequency
33.	Gain Marg	-10.328 dB	System Information	Bode Plot Gain Margin
34.	Iout	1.0 A	System Information	Iout operating point
35.	Low Freq Gain	63.095 dB	System Information	Gain at 1Hz
36.	Mode	CCM	System Information	Conduction Mode
37.	Phase Marg	50.452 deg	System Information	Bode Plot Phase Margin
38.	Pout	1.2 W	System Information	Total output power
39.	Total BOM	$1.36	System Information	Total BOM Cost
40.	Vin	5.5 V	System Information	Vin operating point
41.	Vin p-p	43.141 mV	System Information	Peak-to-peak input voltage
42.	Vout	1.2 V	System Information	Operational Output Voltage
43.	Vout Actual	1.2 V	System Information	Vout Actual calculated based on selected voltage divider resistors
44.	Vout Tolerance	1.842 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
45.	Vout p-p	1.068 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	5.5	Maximum input voltage
VinMin	4.0	Minimum input voltage
Vout	1.2	Output Voltage
base_pn	LMR50410YF-Q1	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

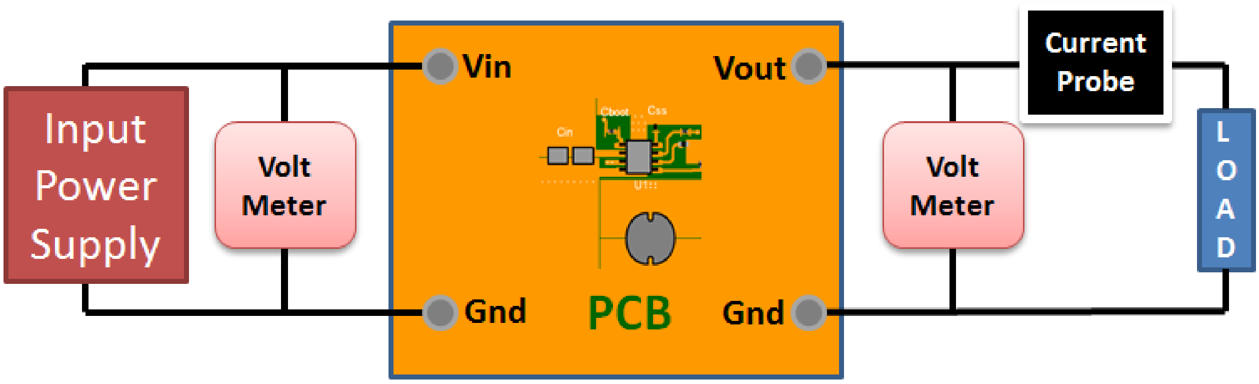
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.0V 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 : A19392E5572167559A9A1E772277F17F[v1]

2. **LMR50410YF-Q1** Product Folder : http://www.ti.com/product/LMR50410%2DQ1 : contains the data sheet and other resources.