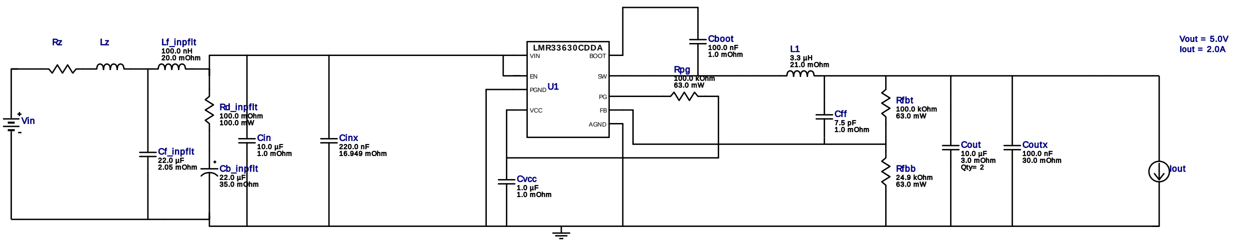
VinMin = 18.0V
VinMax = 30.0V
Vout = 5.0V
Iout = 2.0A

Device = LMR33630CDDAR
Topology = Buck
Created = 2020-07-23 01:02:17.481
BOM Cost = $2.36
BOM Count = 17
Total Pd = 1.96W

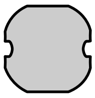
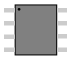
WEBENCH ® Design Report

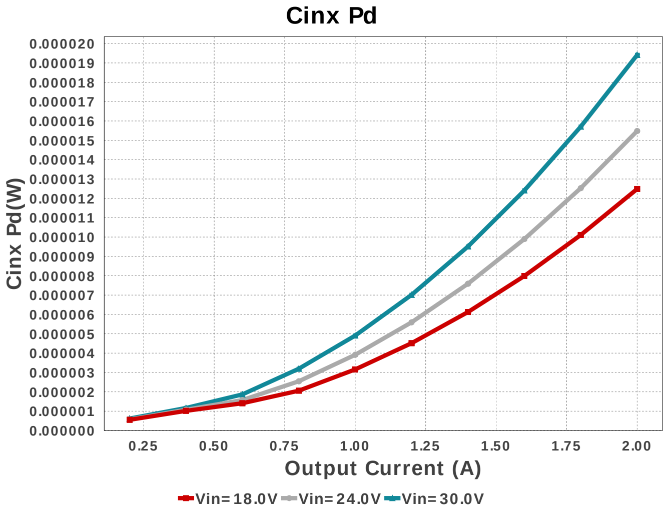
Design : 83 LMR33630CDDAR
LMR33630CDDAR 18V-30V to 5.00V @ 2A

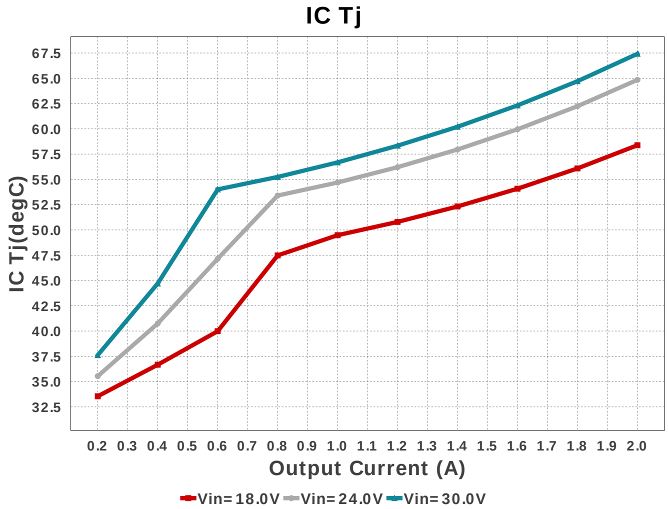


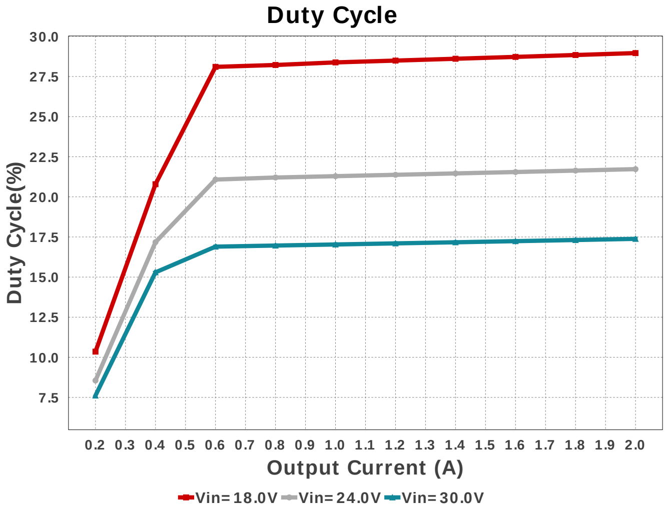
Electrical BOM

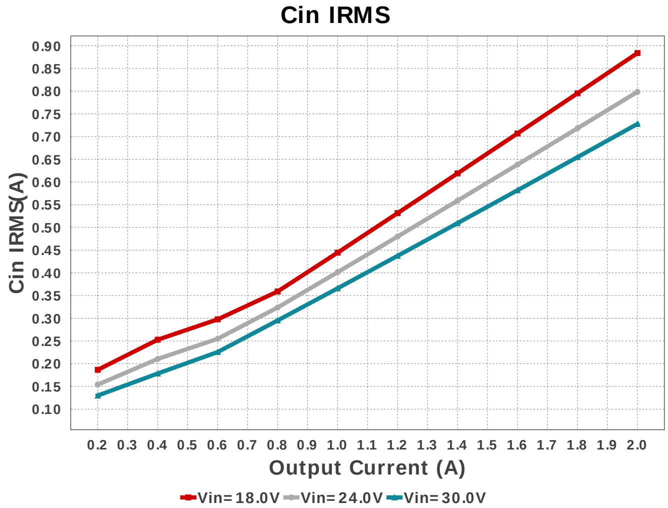
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cb_inpflt	Panasonic	35SVPF22M Series= SVPF	Cap= 22.0 uF ESR= 35.0 mOhm VDC= 35.0 V IRMS= 2.6 A	1	$0.44	CAPSMT_62_F61 74 mm^2
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cf_inpflt	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	1	$0.33	0805 7 mm^2
Cff	MuRata	GRM1555C1H7R5CA01D Series= C0G/NP0	Cap= 7.5 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cff	MuRata	GRM1555C1H7R5CA01D Series= C0G/NP0	Cap= 7.5 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	1	$0.28	1210 15 mm^2
Cinx	TDK	C2012X7R1H224K125AA Series= X7R	Cap= 220.0 nF ESR= 16.949 mOhm VDC= 50.0 V IRMS= 1.5961 A	1	$0.03	0805 7 mm^2
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^2
Coutx	MuRata	GRM188R71E104KA01D Series= X7R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 25.0 V IRMS= 1.51 A	1	$0.01	0603 5 mm^2
Cvcc	Kemet	C0603C105K8PACTU Series= X5R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2

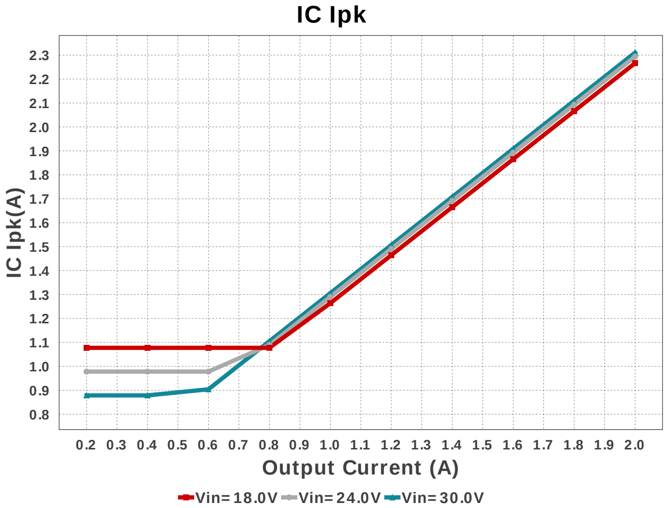
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Bourns	SRN8040-3R3Y	L= 3.3 µH 21.0 mOhm	1	$0.27	 SRN8040 100 mm²
Lf_inpflt	TDK	NLCV32T-R10M-PFR	L= 100.0 nH 20.0 mOhm	1	$0.10	 NLCV32 13 mm²
Rd_inpflt	Panasonic	ERJ-3RSFR10V Series= ERJ-3R	Res= 100.0 mOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.03	0603 5 mm²
Rfbb	Vishay-Dale	CRCW040224K9FKED Series= CRCW..e3	Res= 24.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LMR33630CDDAR	Switcher	1	$0.75	 DDA0008J 55 mm²

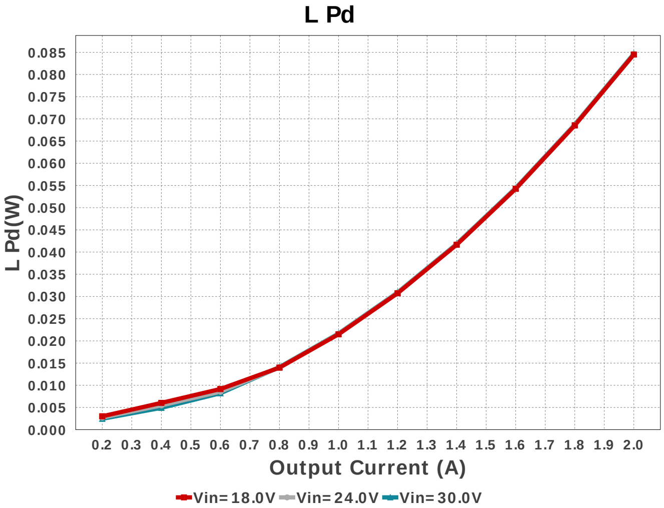


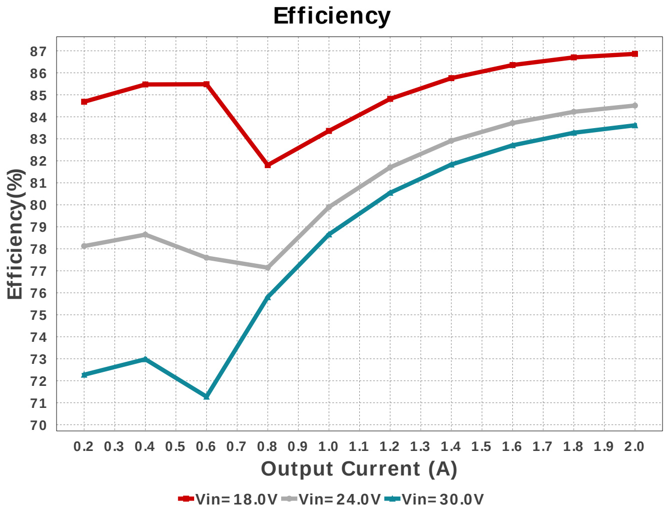


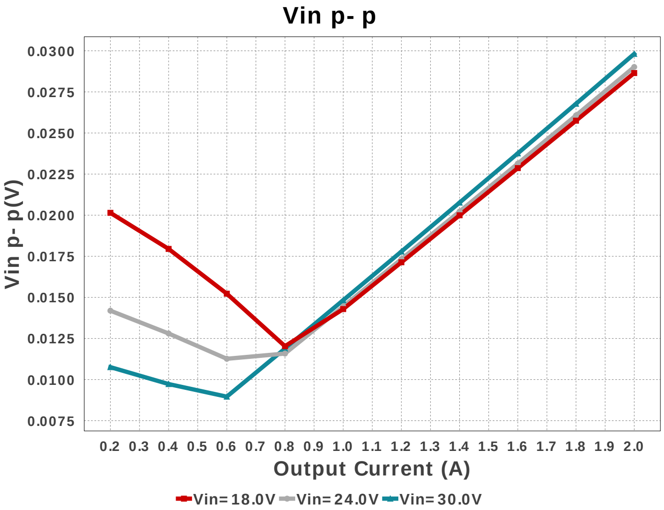


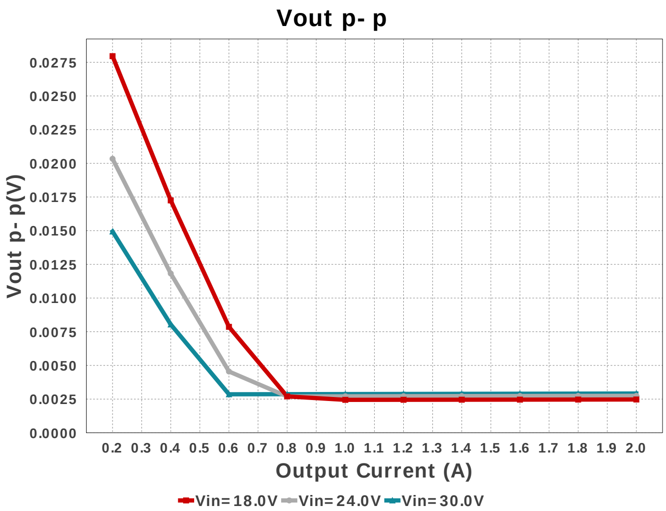


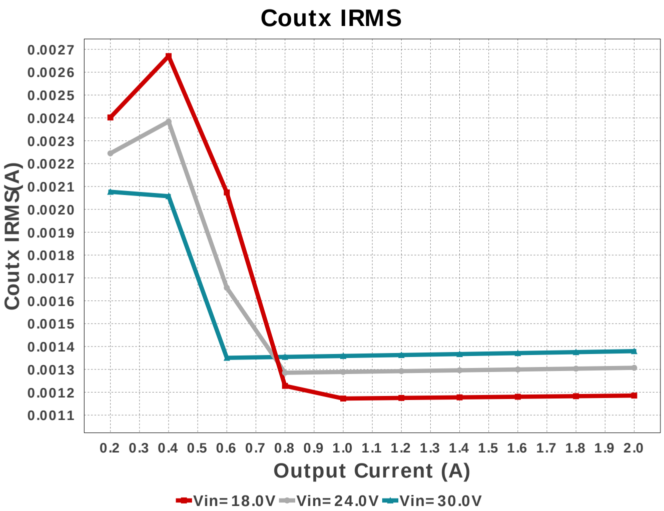

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V


L Pd
L Pd(W)
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V

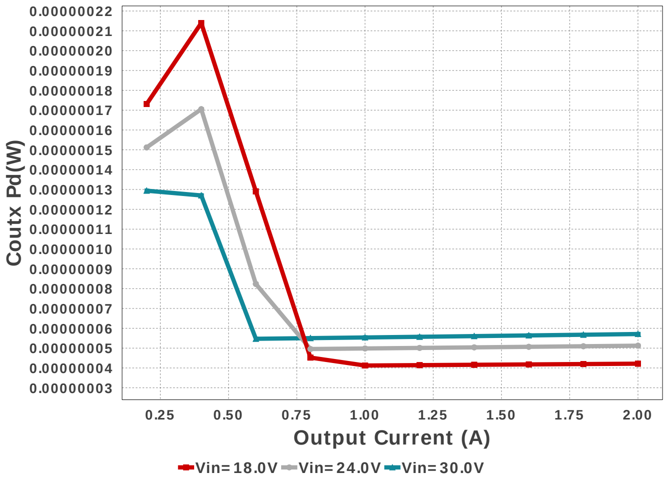

Efficiency
Efficiency(%)
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V


Vin p- p
Vin p- p(V)
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V

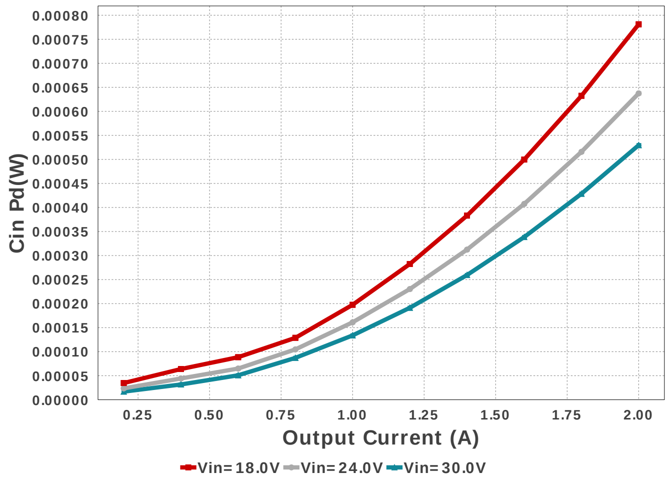

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V


Coutx IRMS
Coutx IRMS(A)
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V

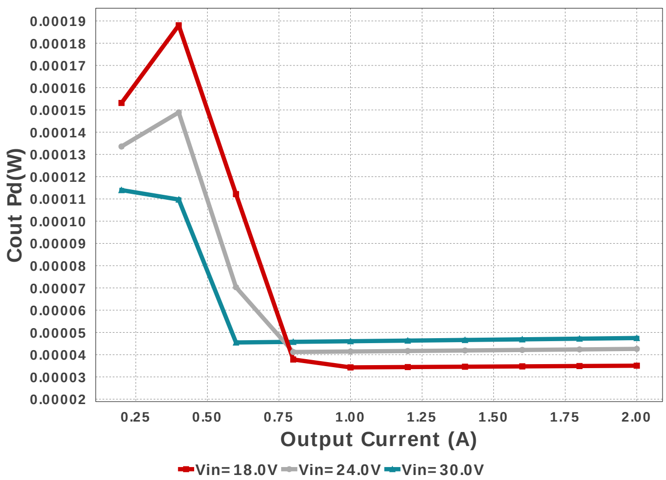
Coutx Pd



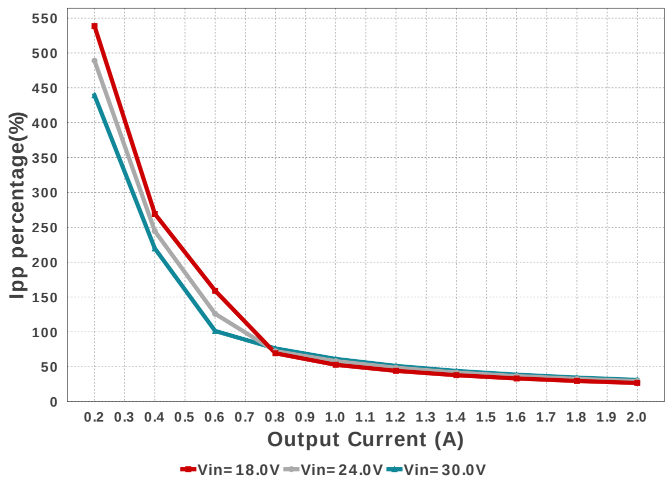
Cin Pd



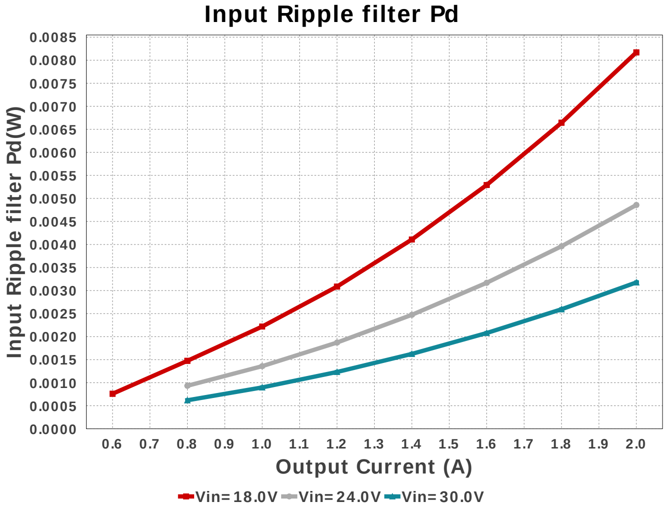
Cout Pd



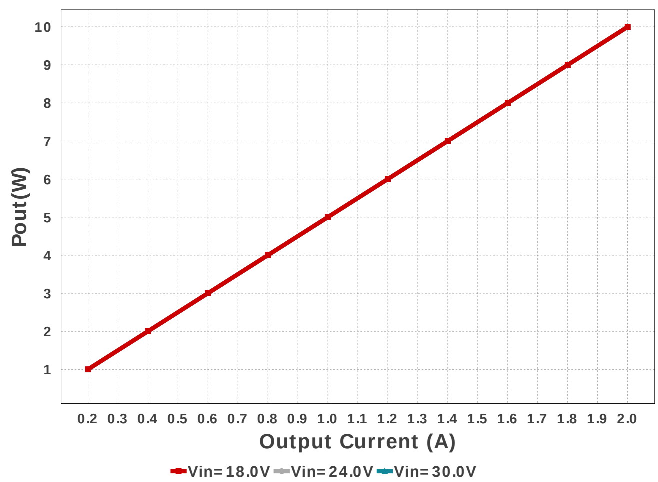
Ipp percentage

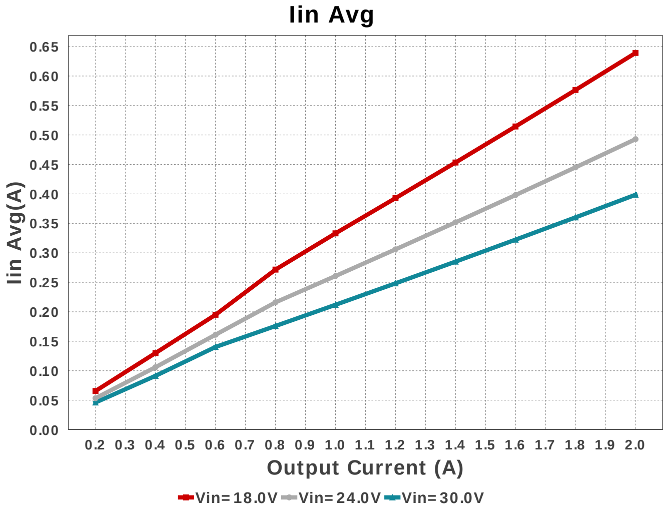


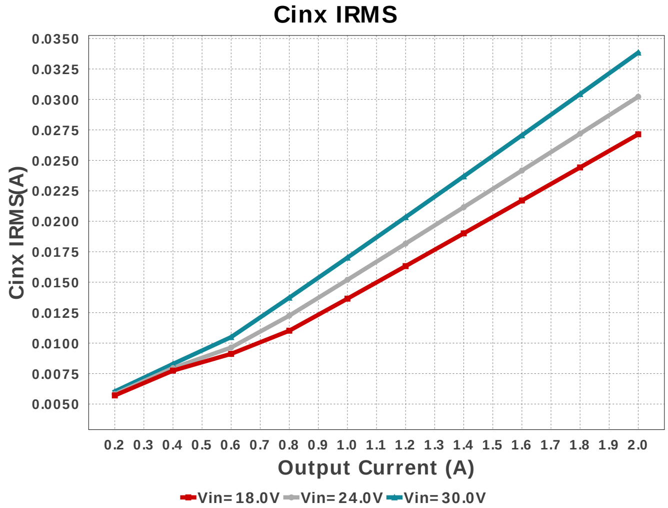
Input Ripple filter Pd

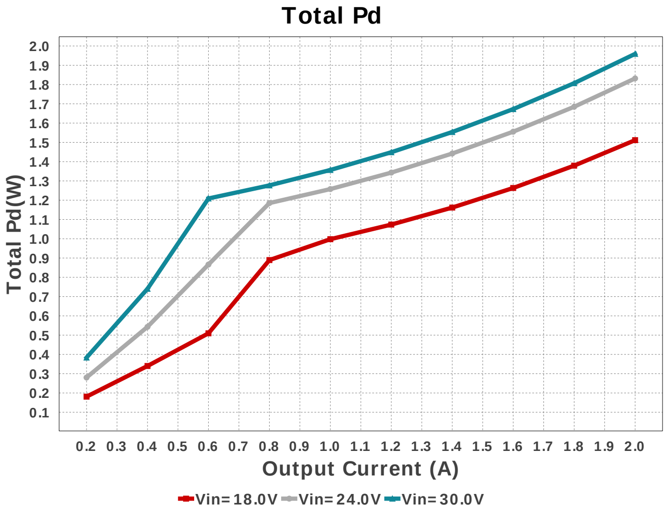


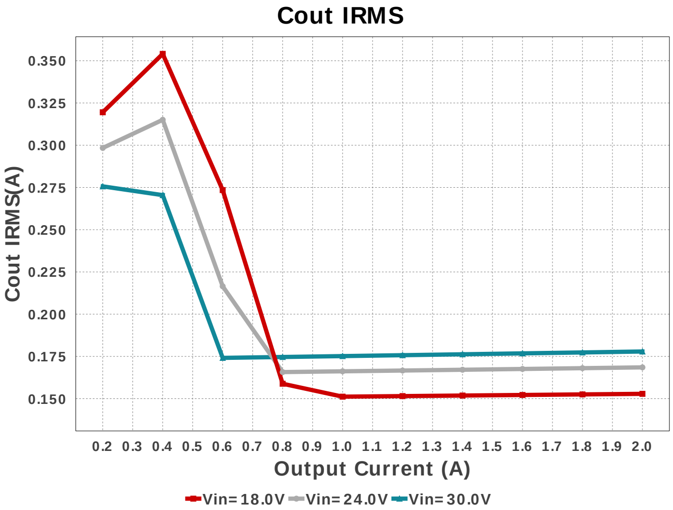
Pout

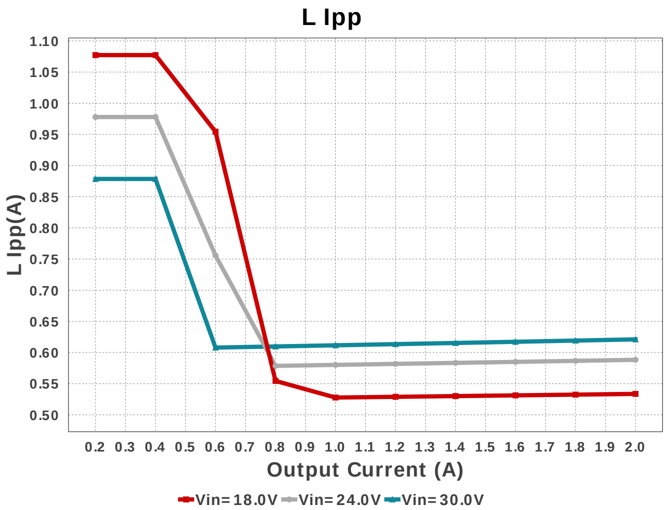


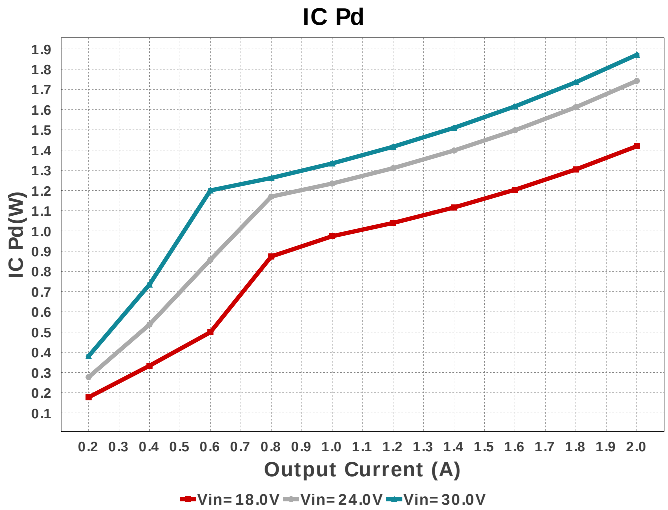

Iin Avg
Iin Avg(A)
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V


Cinx IRMS
Cinx IRMS(A)
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V

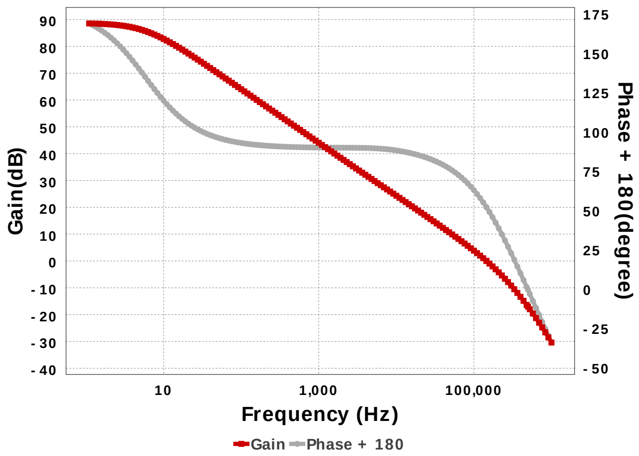

Total Pd
Total Pd(W)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V


Cout IRMS
Cout IRMS(A)
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V

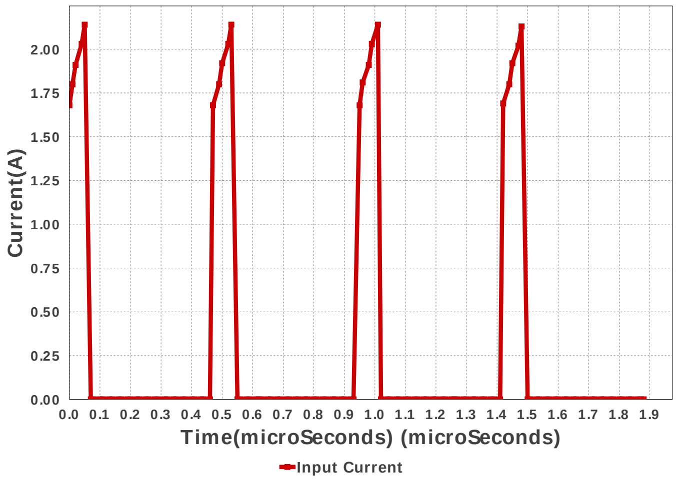

L Ipp
L Ipp(A)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V


IC Pd
IC Pd(W)
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Output Current (A)
Vin=18.0V Vin=24.0V Vin=30.0V

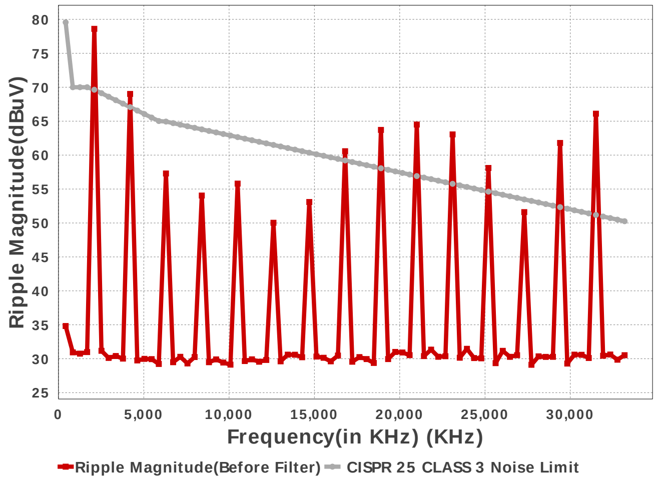
Loop Response



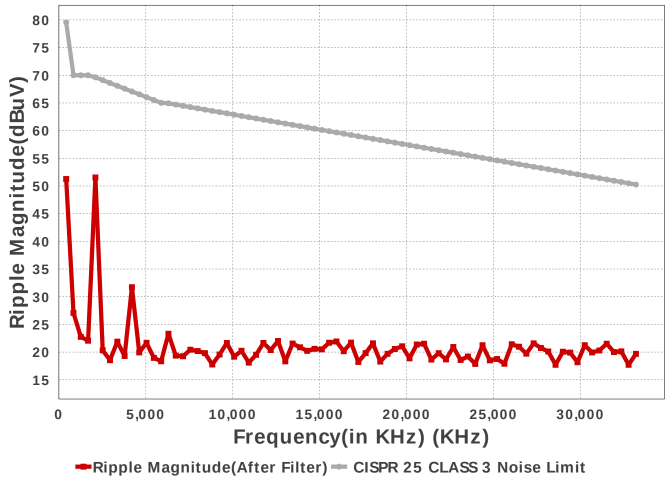
Input Current



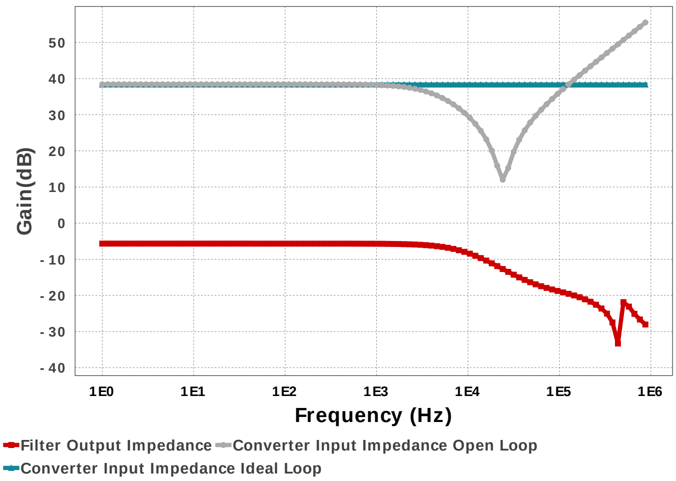
Ripple Freq Spectrum(Before Filter)



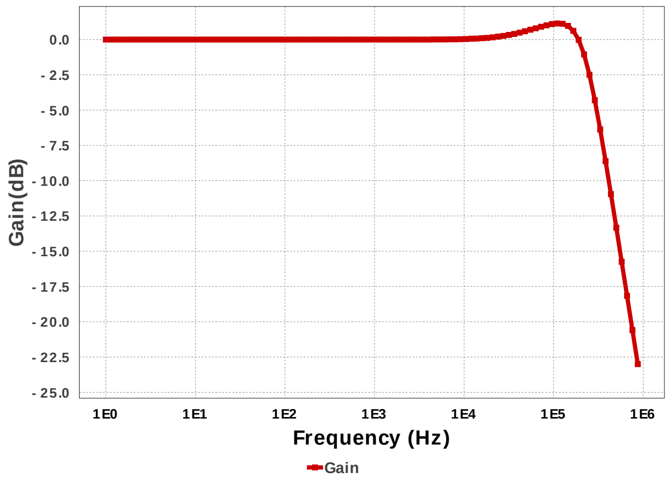
Ripple Freq Spectrum(After Filter)

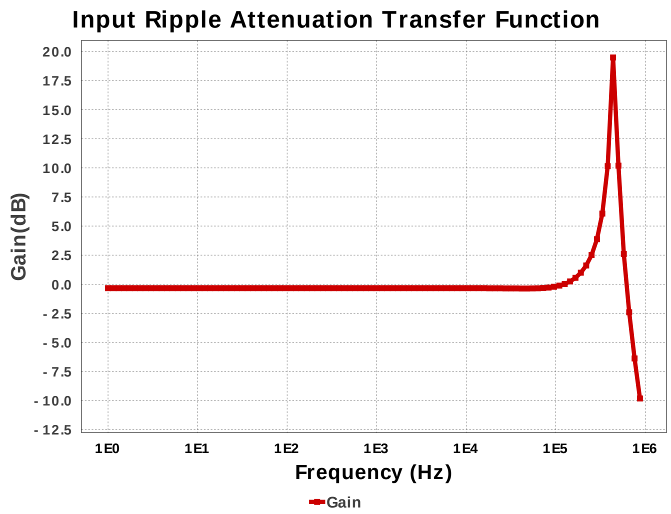


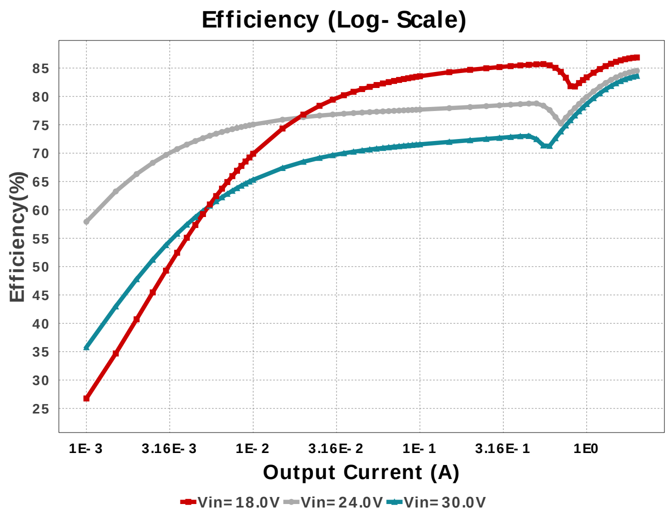
Filter vs Converter Impedance Comparison



Filter Forward Transfer Function







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	727.74 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	529.61 µW	Capacitor	Input capacitor power dissipation
3.	Cinx IRMS	33.844 mA	Capacitor	Bulk capacitor RMS ripple current
4.	Cinx Pd	19.413 µW	Capacitor	Bulk capacitor power dissipation
5.	Cout IRMS	177.918 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	47.482 µW	Capacitor	Output capacitor power dissipation
7.	Coutx IRMS	1.38 mA	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	57.111 nW	Capacitor	Output capacitor_x power loss
9.	Input Ripple Noise After input filter	51.67 dBuV	EMI Noise	Input Ripple Noise after filter at switching frequency
10.	Input Ripple Noise before input filter	78.61 dBuV	EMI Noise	Input Ripple Noise before filter at switching frequency
11.	Input Ripple filter Pd	3.177 mW	EMI Noise	Input Ripple Filter Power Dissipation
12.	Noise limits defined by CISPR Standards	69.63 dBuV	EMI Noise	Noise limits for CLASS 3 of CISPR 25 standard
13.	IC Ipk	2.311 A	IC	Peak switch current in IC
14.	IC Pd	1.871 W	IC	IC power dissipation
15.	IC Tj	67.419 degC	IC	IC junction temperature
16.	IC Tolerance	15.0 mV	IC	IC Feedback Tolerance
17.	ICThetaJA Effective	20.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
18.	Iin Avg	398.55 mA	IC	Average input current
19.	Ipp percentage	31.055 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
20.	L Ipp	621.11 mA	Inductor	Peak-to-peak inductor ripple current
21.	L Pd	84.675 mW	Inductor	Inductor power dissipation
22.	Cin Pd	529.61 µW	Power	Input capacitor power dissipation
23.	Cinx Pd	19.413 µW	Power	Bulk capacitor power dissipation
24.	Cout Pd	47.482 µW	Power	Output capacitor power dissipation
25.	Coutx Pd	57.111 nW	Power	Output capacitor_x power loss
26.	IC Pd	1.871 W	Power	IC power dissipation
27.	Input Ripple filter Pd	3.177 mW	Power	Input Ripple Filter Power Dissipation
28.	L Pd	84.675 mW	Power	Inductor power dissipation
29.	Total Pd	1.959 W	Power	Total Power Dissipation
30.	BOM Count	17	System Information	Total Design BOM count
31.	Cross Freq	145.168 kHz	System Information	Bode plot crossover frequency
32.	Duty Cycle	17.382 %	System Information	Duty cycle
33.	Efficiency	83.615 %	System Information	Steady state efficiency
34.	FootPrint	313.0 mm^2	System Information	Total Foot Print Area of BOM components
35.	Frequency	2.1 MHz	System Information	Switching frequency
36.	Gain Marg	-17.026 dB	System Information	Bode Plot Gain Margin
37.	Iout	2.0 A	System Information	Iout operating point
38.	Low Freq Gain	88.562 dB	System Information	Gain at 1Hz

#	Name	Value	Category	Description
39.	Mode	CCM	System Information	Conduction Mode
40.	Phase Marg	52.441 deg	System Information	Bode Plot Phase Margin
41.	Pout	10.0 W	System Information	Total output power
42.	Total BOM	$2.36	System Information	Total BOM Cost
43.	Vin	30.0 V	System Information	Vin operating point
44.	Vin p-p	29.814 mV	System Information	Peak-to-peak input voltage
45.	Vout	5.0 V	System Information	Operational Output Voltage
46.	Vout Actual	5.016 V	System Information	Vout Actual calculated based on selected voltage divider resistors
47.	Vout Tolerance	3.142 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
48.	Vout p-p	2.916 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	30.0	Maximum input voltage
VinMin	18.0	Minimum input voltage
VinTyp	24.0	Typical input voltage
Vout	5.0	Output Voltage
base_pn	LMR33630C-SOIC	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

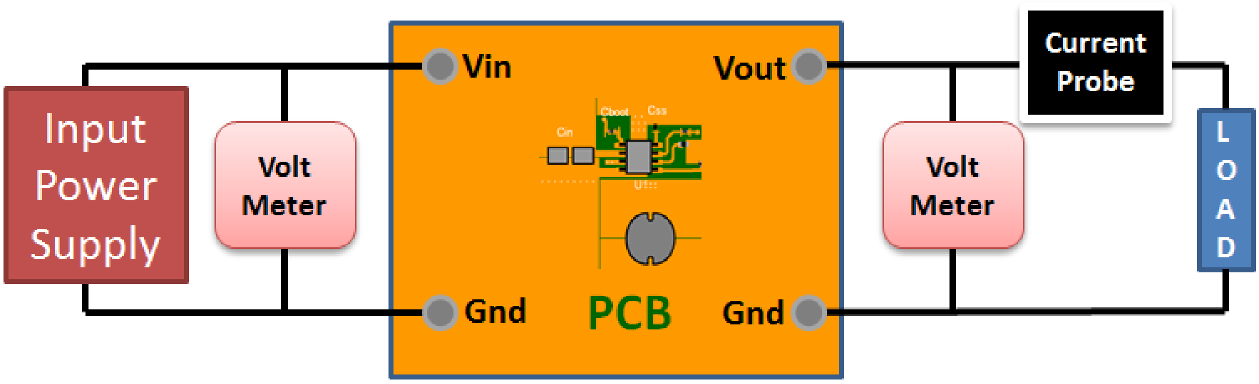
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 18.0V 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 : D92E1EB0221A07D6[v1]

2. **LMR33630C-SOIC** Product Folder : http://www.ti.com/product/LMR33630 : contains the data sheet and other resources.

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