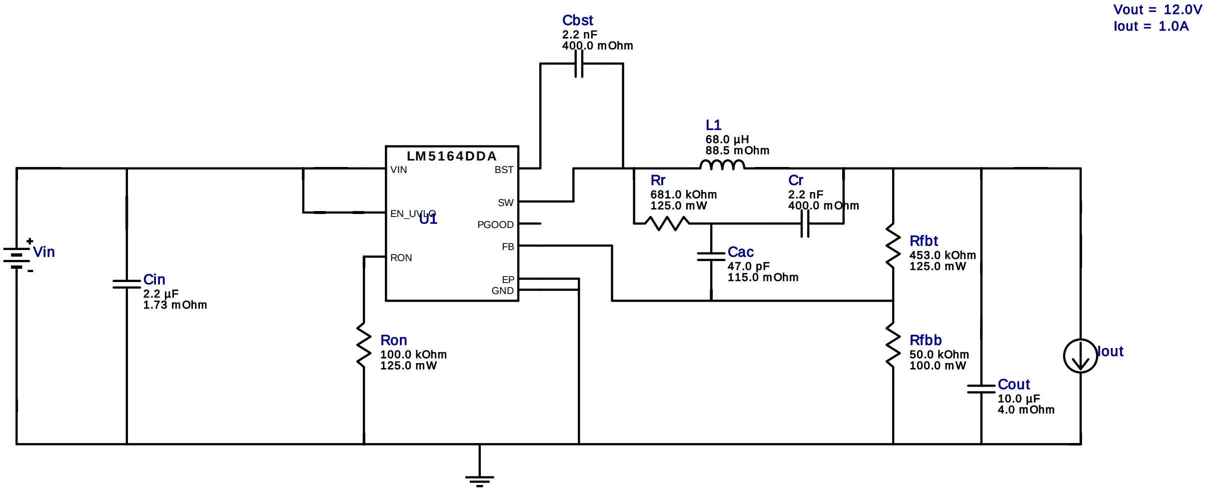
WEBENCH ® Design Report

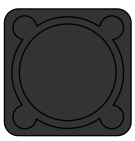
VinMin = 48.0V
VinMax = 51.6V
Vout = 12.0V
Iout = 1.0A

Device = LM5164DDAR
Topology = Buck
Created = 2025-01-14 11:34:04.276
BOM Cost = $3.27
BOM Count = 11
Total Pd = 0.99W

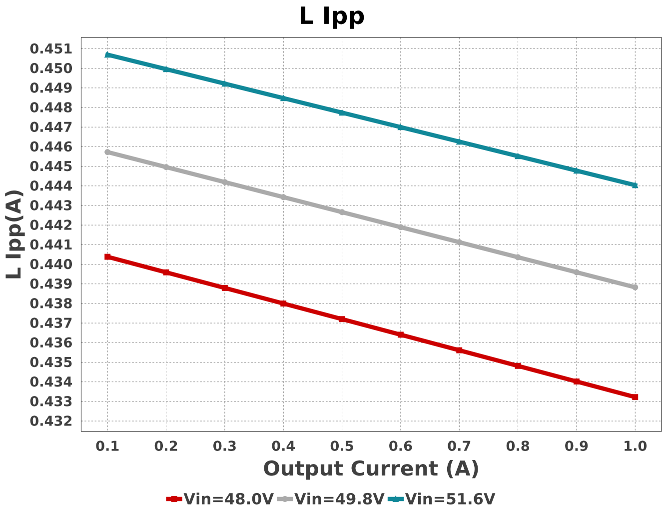
Design : 16 LM5164DDAR
LM5164DDAR 48V-51.6V to 12.00V @ 1A

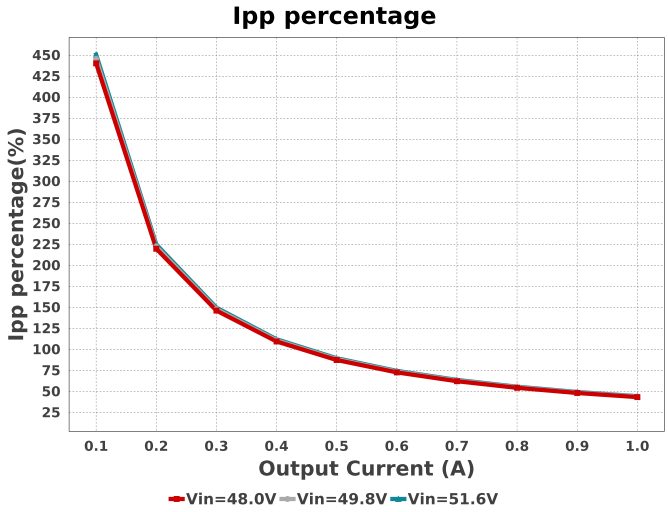


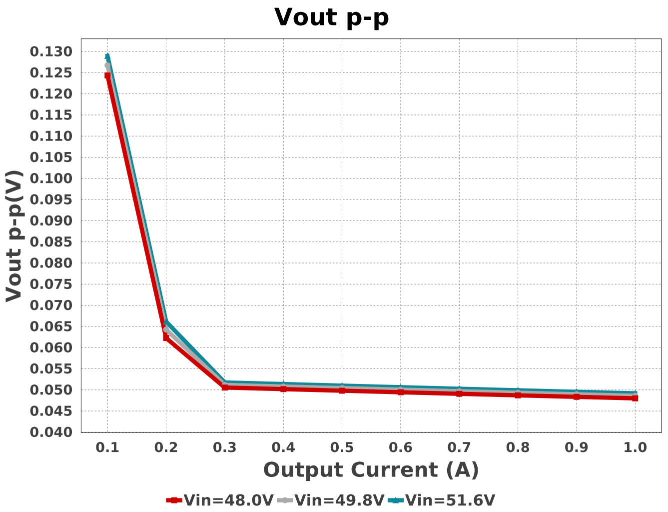
Electrical BOM

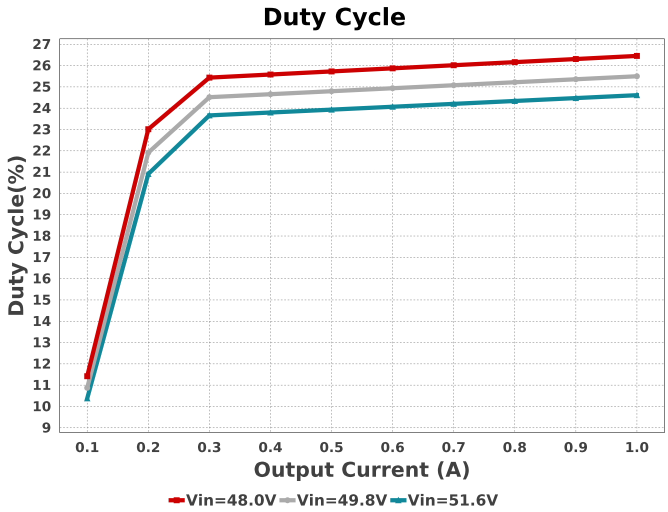
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cac	Kemet	C0805C470J5GACTU Series= C0G/NP0	Cap= 47.0 pF ESR= 115.0 mOhm VDC= 50.0 V IRMS= 505.0 mA	1	$0.01	0805 7 mm²
Cbst	Kemet	C0805C222K5RACTU Series= X7R	Cap= 2.2 nF ESR= 400.0 mOhm VDC= 50.0 V IRMS= 251.0 mA	1	$0.01	0805 7 mm²
Cin	TDK	C3225X7R2A225K230AB Series= X7R	Cap= 2.2 uF ESR= 1.73 mOhm VDC= 100.0 V IRMS= 5.5932 A	1	$0.21	1210_250 15 mm²
Cout	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
Cr	Kemet	C0805C222K5RACTU Series= X7R	Cap= 2.2 nF ESR= 400.0 mOhm VDC= 50.0 V IRMS= 251.0 mA	1	$0.01	0805 7 mm²
L1	Wurth Elektronik	7447709680	L= 68.0 µH 88.5 mOhm	1	$1.48	 WE-PD_1210 196 mm²
Rfbb	Yageo	RT0603BRD0750KL Series= 0603	Res= 50.0 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.05	0603 5 mm²
Rfbt	Panasonic	ERJ-6ENF4533V Series= ERJ-6E	Res= 453.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Ron	Vishay-Dale	CRCW0805100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²

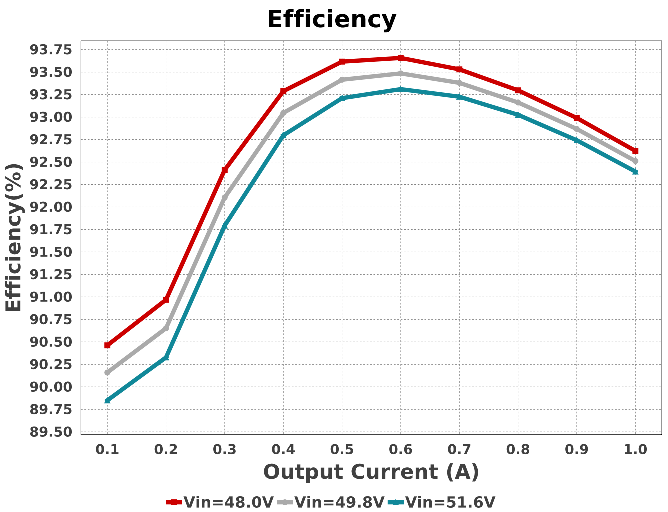
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rr	Vishay-Dale	CRCW0805681KFKEA Series= CRCW..e3	Res= 681.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
U1	Texas Instruments	LM5164DDAR	Switcher	1	$1.41	DDA0008E-MFG 55 mm^2

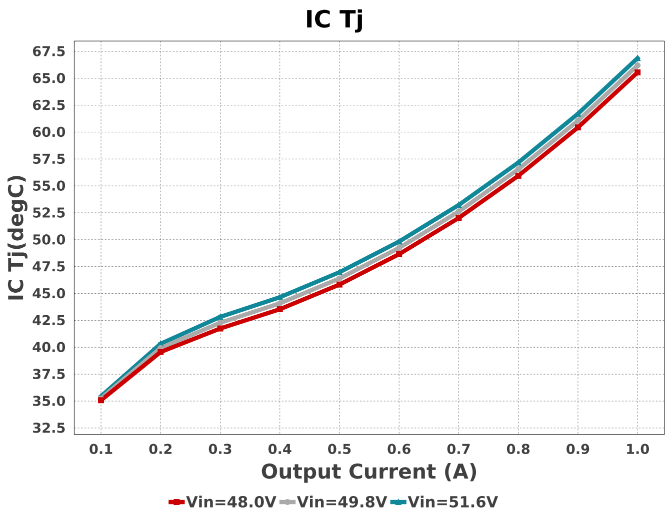


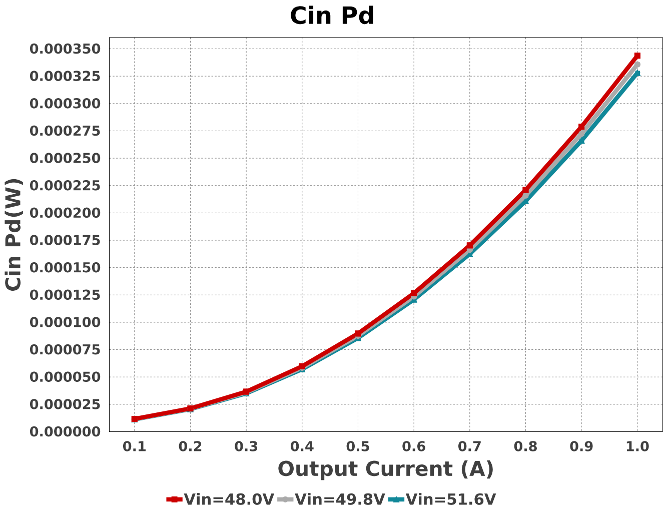


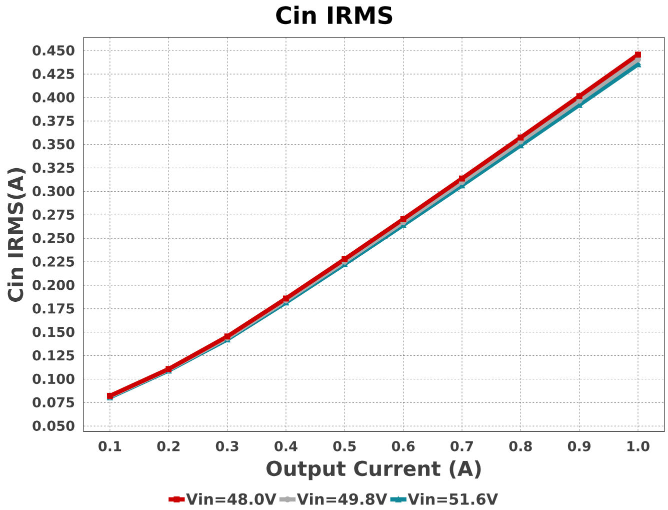


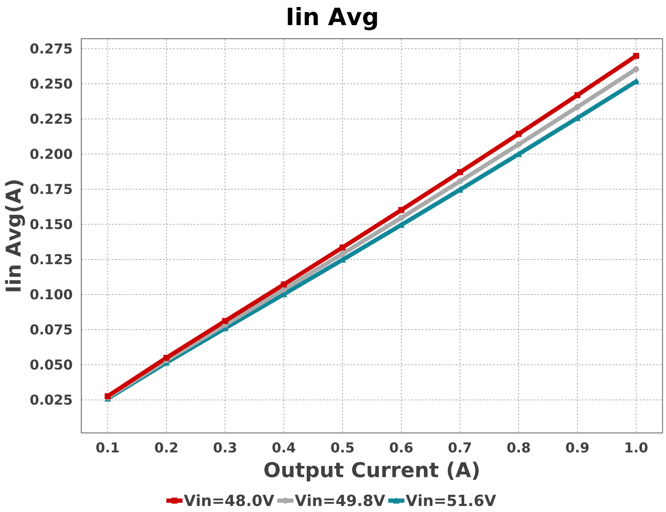


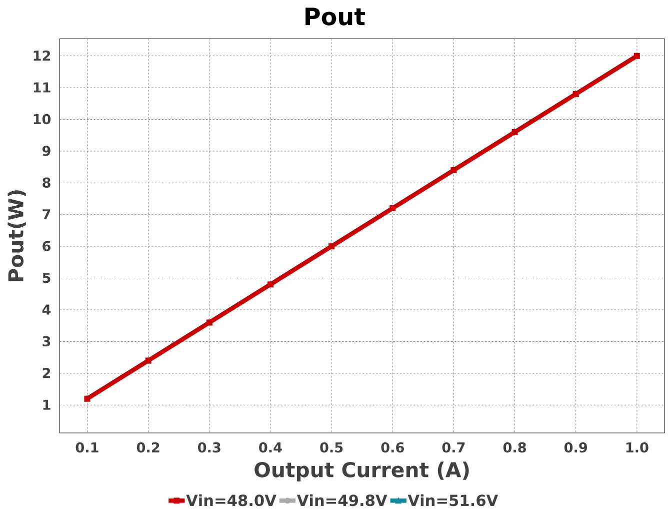


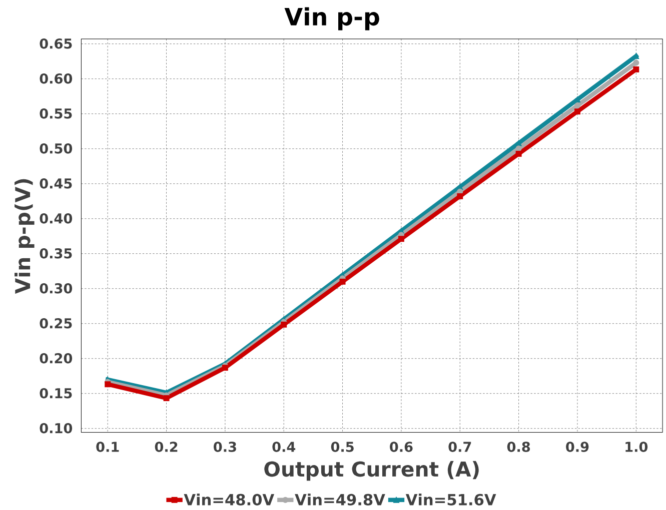


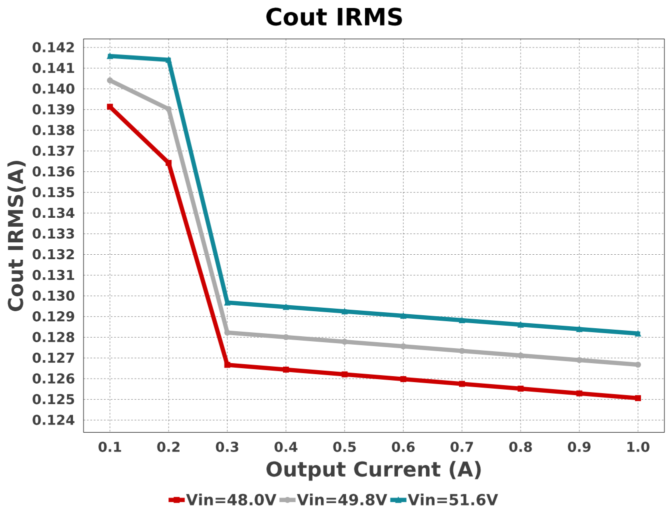

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=48.0V Vin=49.8V Vin=51.6V

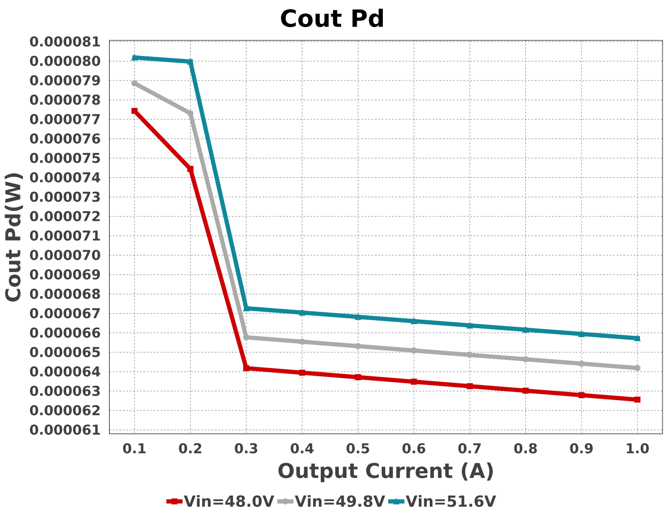

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=48.0V Vin=49.8V Vin=51.6V

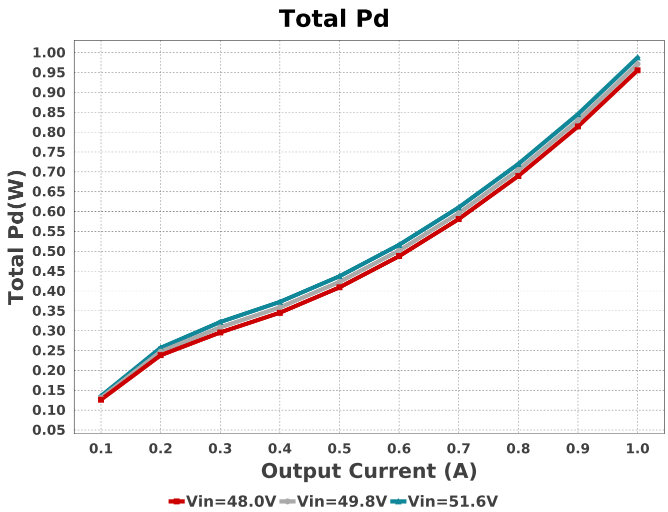

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=48.0V Vin=49.8V Vin=51.6V

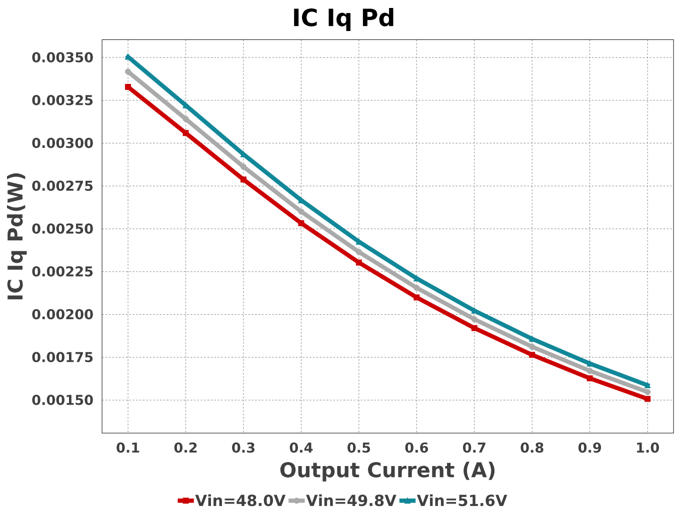

Pout
Pout(W)
Output Current (A)
Vin=48.0V Vin=49.8V Vin=51.6V

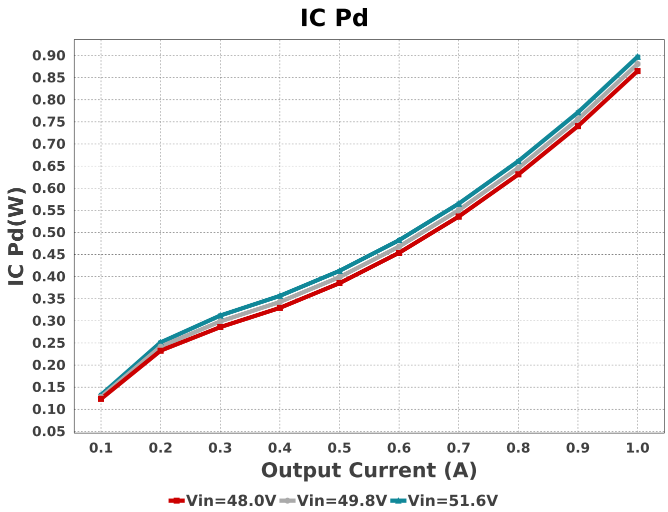

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=48.0V Vin=49.8V Vin=51.6V

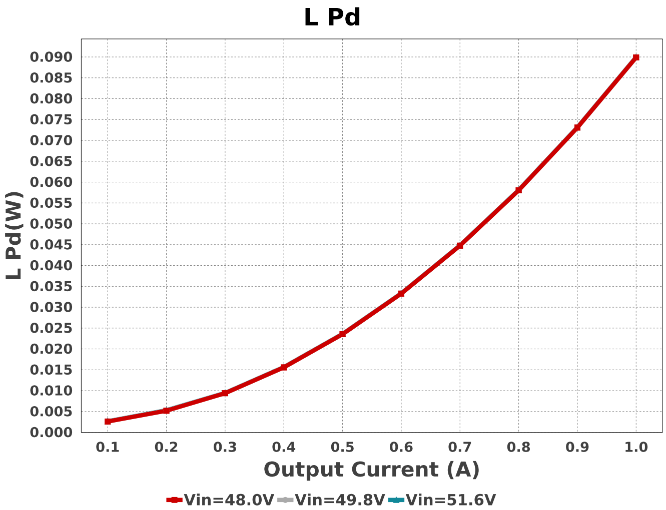

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=48.0V Vin=49.8V Vin=51.6V

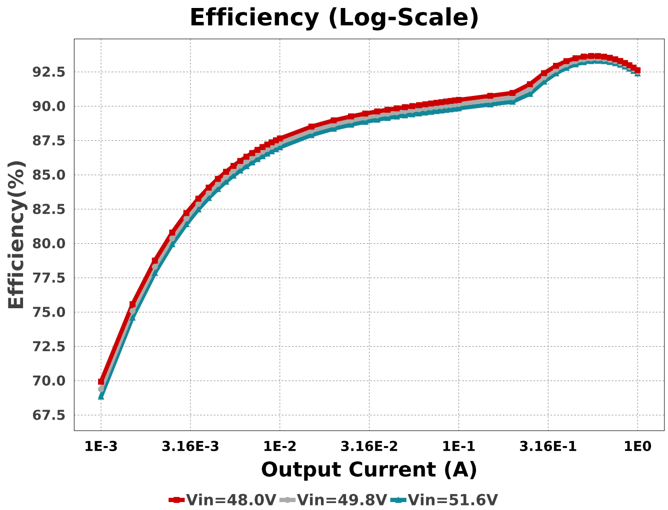












Operating Values

#	Name	Value	Category	Description
1.	BOM Count	11		Total Design BOM count
2.	Total BOM	$3.273		Total BOM Cost
3.	Cin IRMS	435.408 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	327.97 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	128.182 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	65.723 µW	Capacitor	Output capacitor power dissipation
7.	IC Iq Pd	1.587 mW	IC	IC Iq Pd
8.	IC Pd	897.17 mW	IC	IC power dissipation
9.	IC Tj	66.874 degC	IC	IC junction temperature
10.	ICThetaJA	41.1 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	251.7 mA	IC	Average input current

#	Name	Value	Category	Description
12.	Ipp percentage	44.404 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
13.	L Ipp	444.036 mA	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	89.954 mW	Inductor	Inductor power dissipation
15.	Cin Pd	327.97 µW	Power	Input capacitor power dissipation
16.	Cout Pd	65.723 µW	Power	Output capacitor power dissipation
17.	IC Pd	897.17 mW	Power	IC power dissipation
18.	L Pd	89.954 mW	Power	Inductor power dissipation
19.	Total Pd	987.846 mW	Power	Total Power Dissipation
20.	Duty Cycle	24.61 %	System Information	Duty cycle
21.	Efficiency	92.394 %	System Information	Steady state efficiency
22.	FootPrint	322.0 mm^2	System Information	Total Foot Print Area of BOM components
23.	Frequency	317.473 kHz	System Information	Switching frequency
24.	Iout	1.0 A	System Information	Iout operating point
25.	Mode	CCM	System Information	Conduction Mode
26.	Pout	12.0 W	System Information	Total output power
27.	Vin	51.6 V	System Information	Vin operating point
28.	Vin p-p	632.562 mV	System Information	Peak-to-peak input voltage
29.	Vout	12.0 V	System Information	Operational Output Voltage
30.	Vout Actual	12.072 V	System Information	Vout Actual calculated based on selected voltage divider resistors
31.	Vout Tolerance	2.591 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
32.	Vout p-p	49.185 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	51.6	Maximum input voltage
VinMin	48.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM5164	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

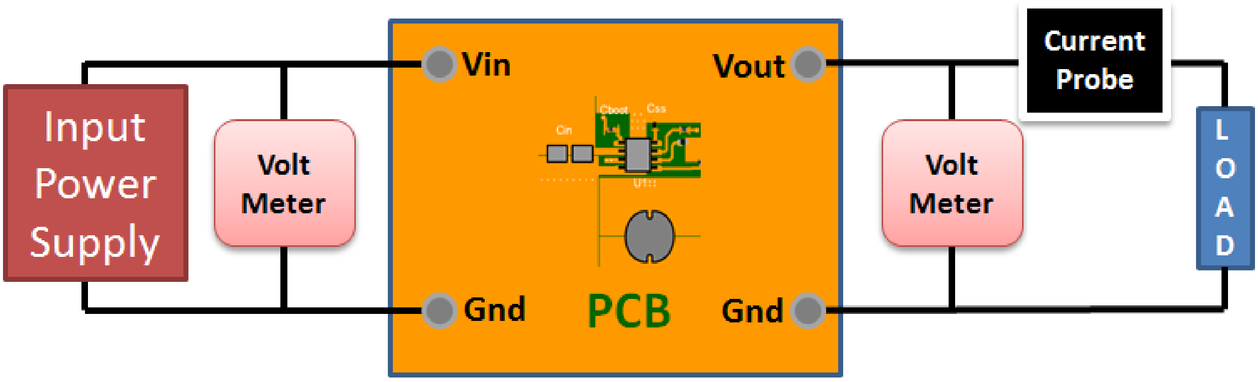
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 48.0V 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 : 8D46410E296FCE97B33F99C6313555A5[v1]

2. **LM5164** Product Folder : http://www.ti.com/product/lm5164 : contains the data sheet and other resources.

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