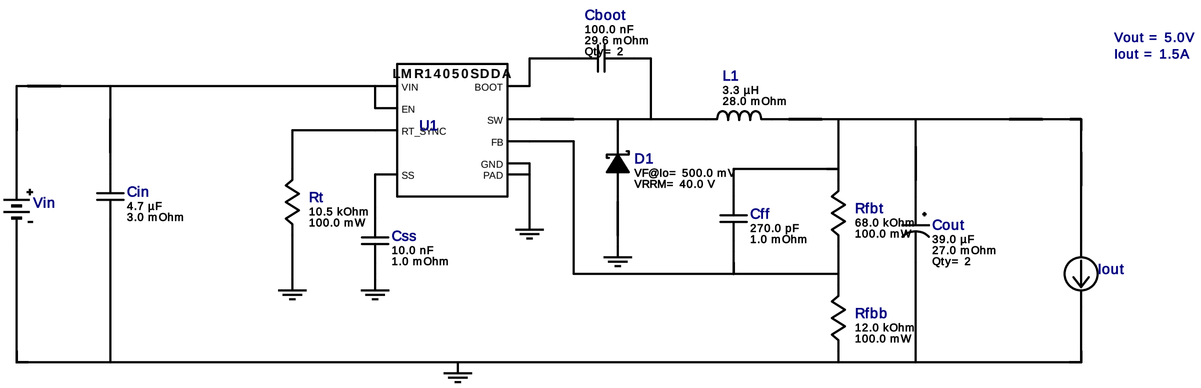
TEXAS INSTRUMENTS

VinMin = 10.0V
VinMax = 26.0V
Vout = 5.0V
Iout = 1.5A

Device = LMR14050SDDAR
Topology = Buck
Created = 2024-09-24 08:33:03.699
BOM Cost = $2.93
BOM Count = 13
Total Pd = 1.56W

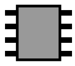
WEBENCH ® Design Report

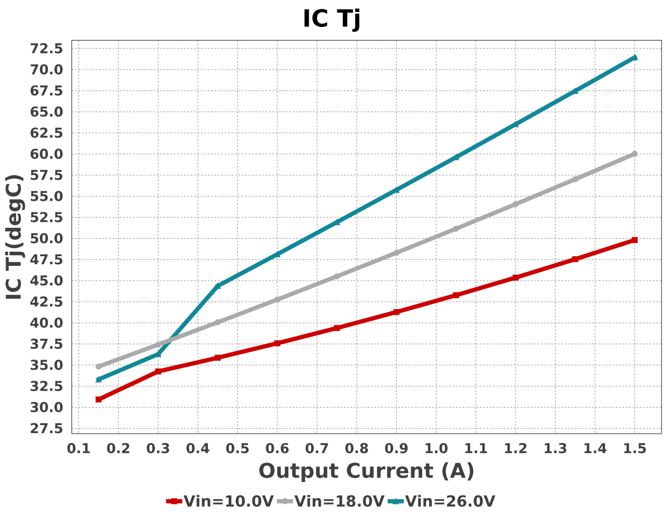
Design : 5 LMR14050SDDAR
LMR14050SDDAR 10V-26V to 5.00V @ 1.5A

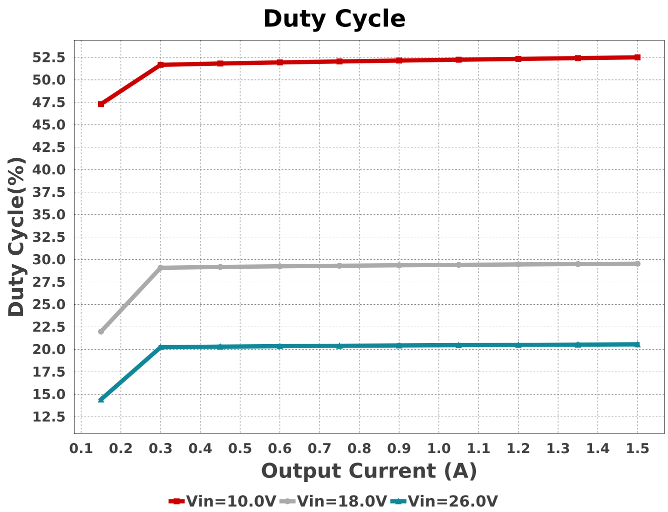


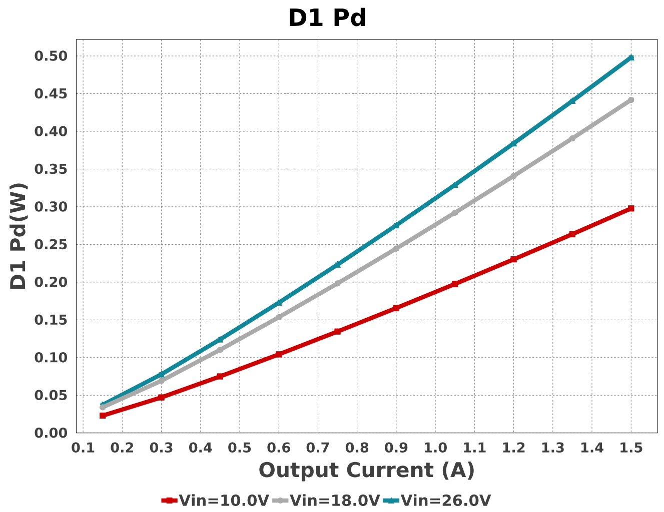
Electrical BOM

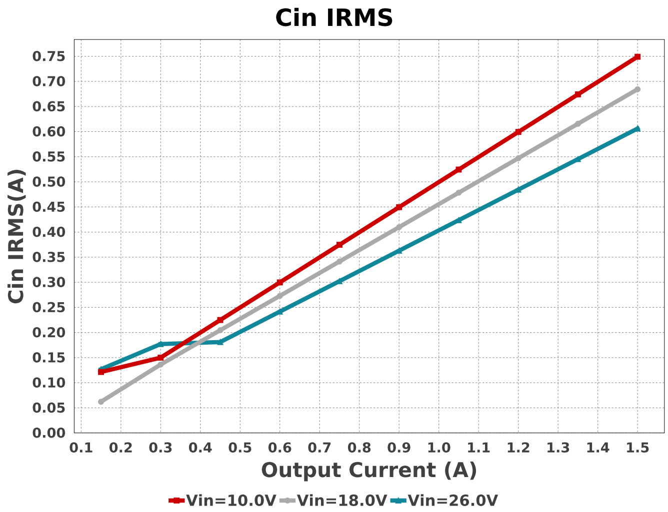
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	2	$0.01	0603 5 mm²
Cff	MuRata	GRM1885C1H271JA01D Series= C0G/NP0	Cap= 270.0 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm²
Cin	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
Cout	Panasonic	16SVPC39MV Series= SVPC	Cap= 39.0 uF ESR= 27.0 mOhm VDC= 16.0 V IRMS= 2.35 A	2	$0.44	SM_RADIAL_5MM 58 mm²
Css	MuRata	GRM188R71H103KA01D Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
D1	Diodes Inc.	B240-13-F	VF@Io= 500.0 mV VRRM= 40.0 V	1	$0.10	SMB 44 mm²
L1	Vishay-Dale	IHLP2525CZER3R3M01	L= 3.3 µH 28.0 mOhm	1	$0.61	IHLP-2525CZ 75 mm²
Rfbb	Yageo	RC0603FR-0712KL Series= ?	Res= 12.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbt	Yageo	RC0603FR-0768KL Series= ?	Res= 68.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rt	Vishay-Dale	CRCW060310K5FKEA Series= CRCW..e3	Res= 10.5 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²

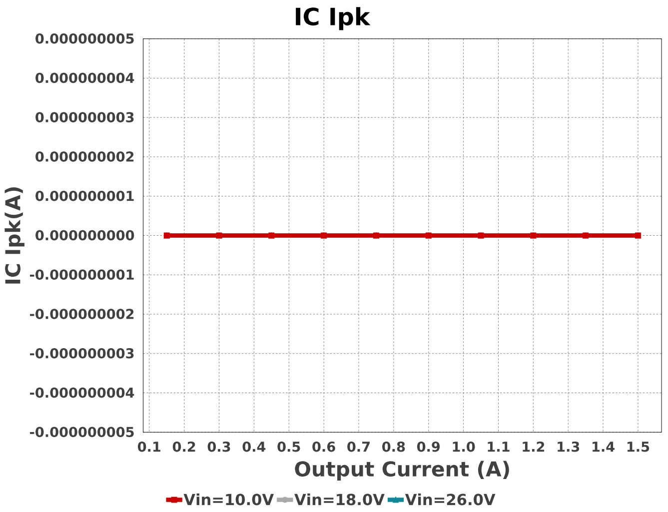
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	LMR14050SDDAR	Switcher	1	$1.16	 DDA0008E_N 55 mm²

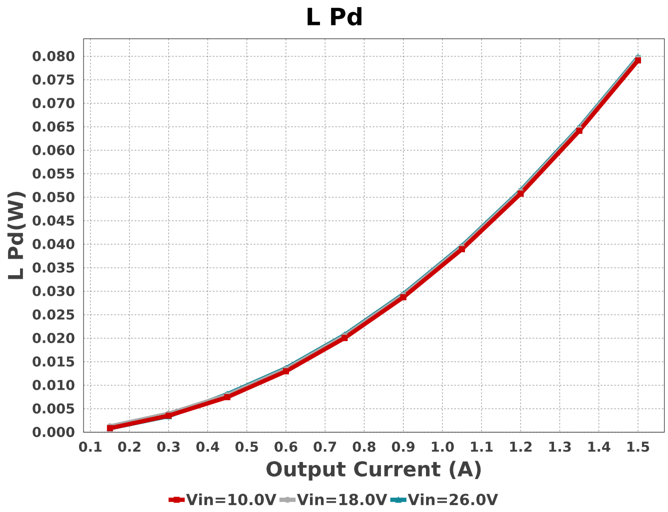


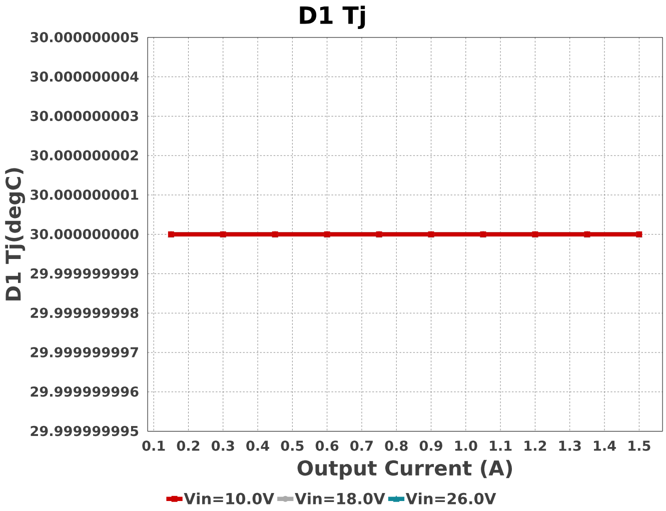


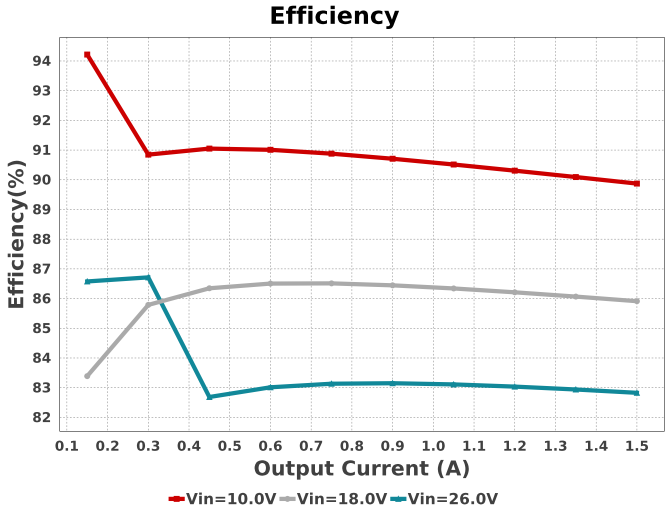


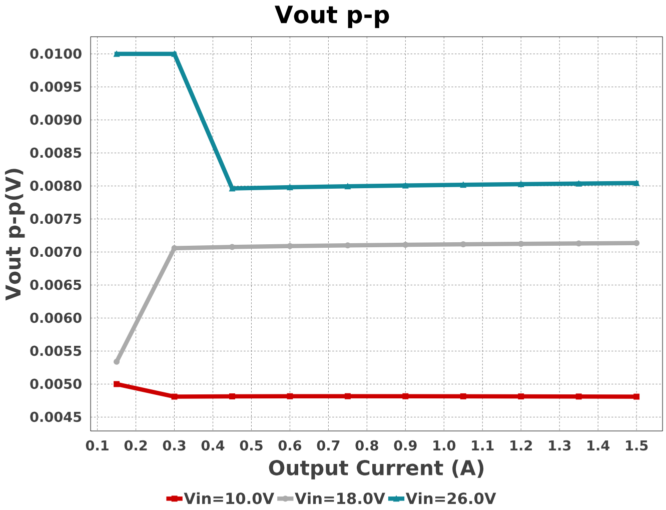


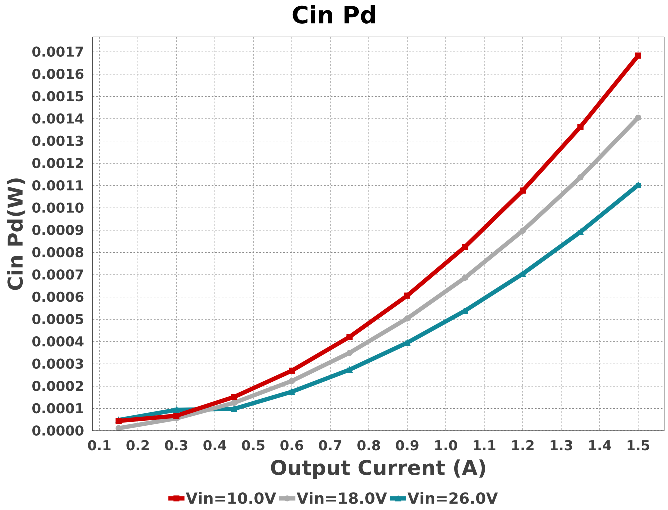


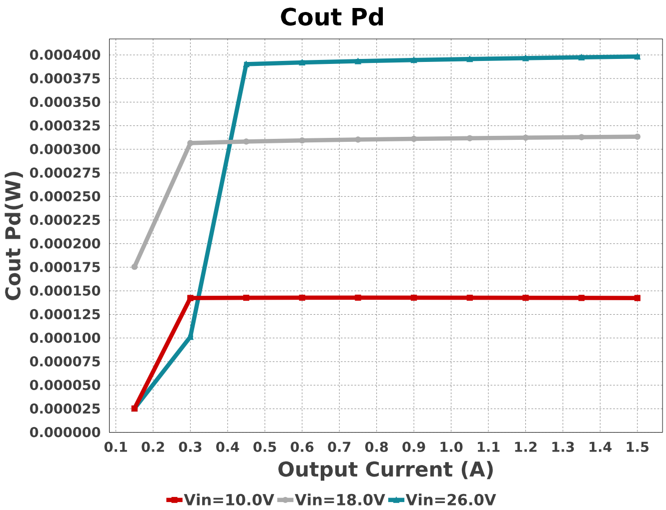


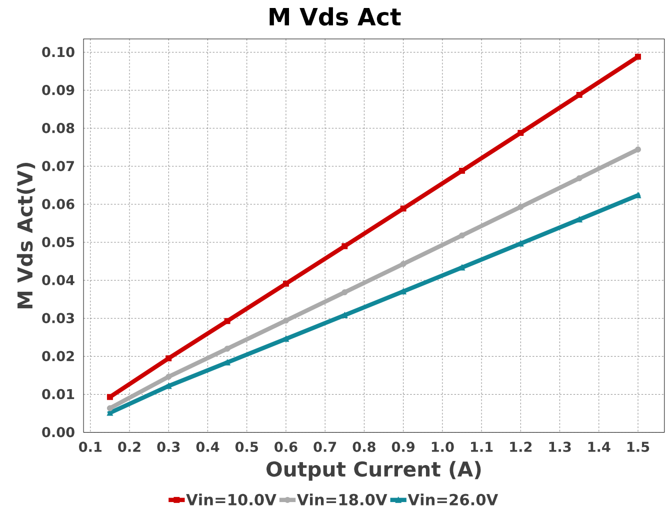

D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=10.0V
Vin=18.0V
Vin=26.0V

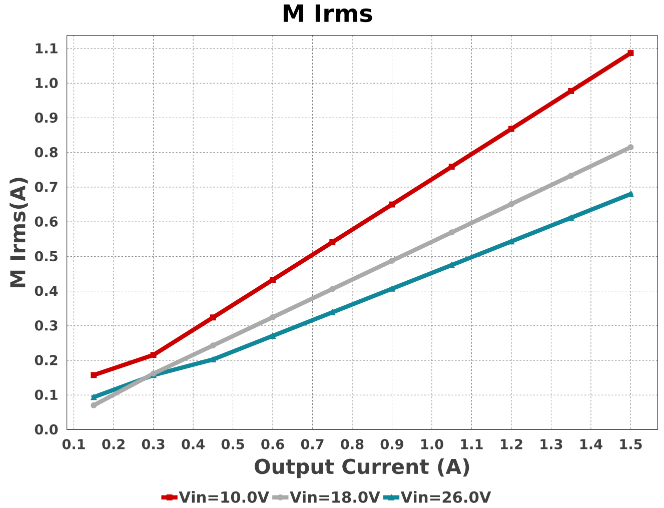

Efficiency
Efficiency(%)
Output Current (A)
Vin=10.0V
Vin=18.0V
Vin=26.0V

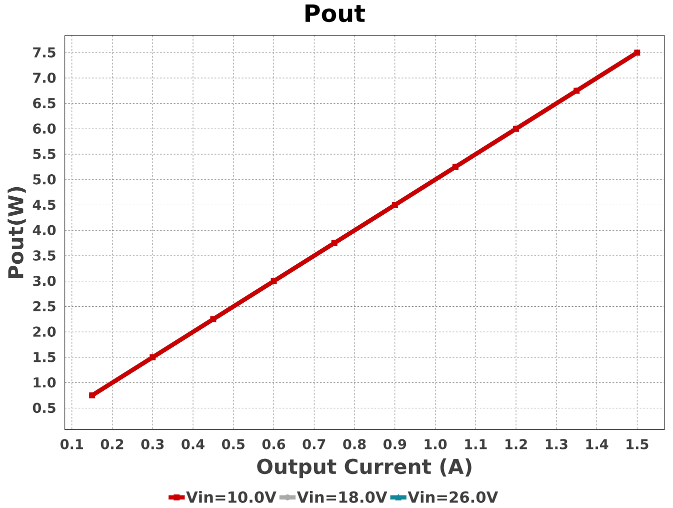

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=10.0V
Vin=18.0V
Vin=26.0V

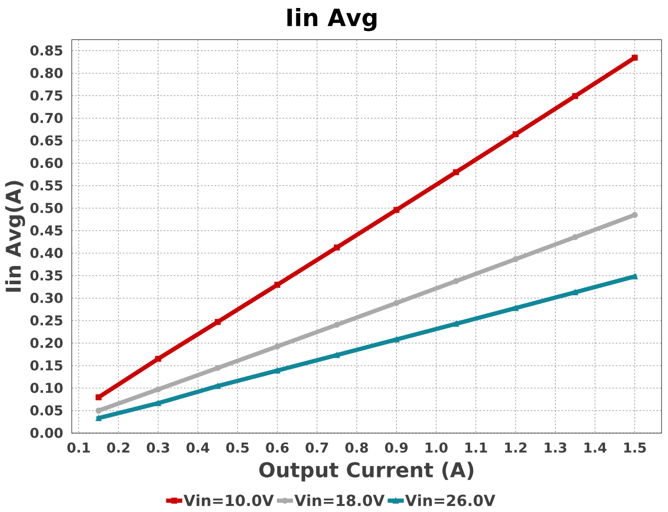

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=10.0V
Vin=18.0V
Vin=26.0V

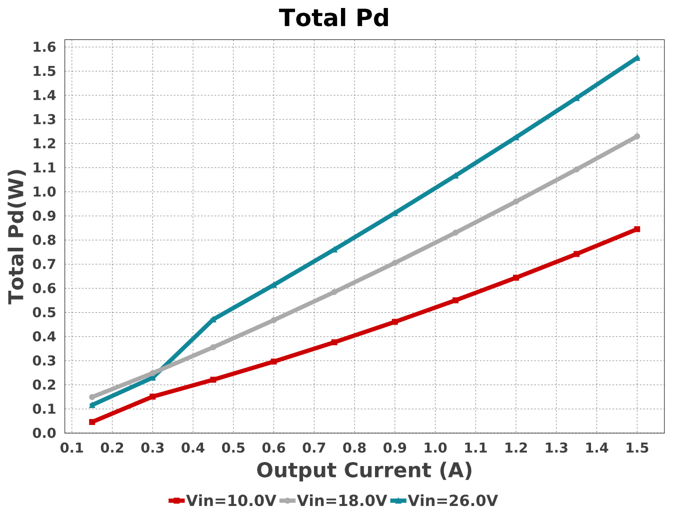

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=10.0V
Vin=18.0V
Vin=26.0V

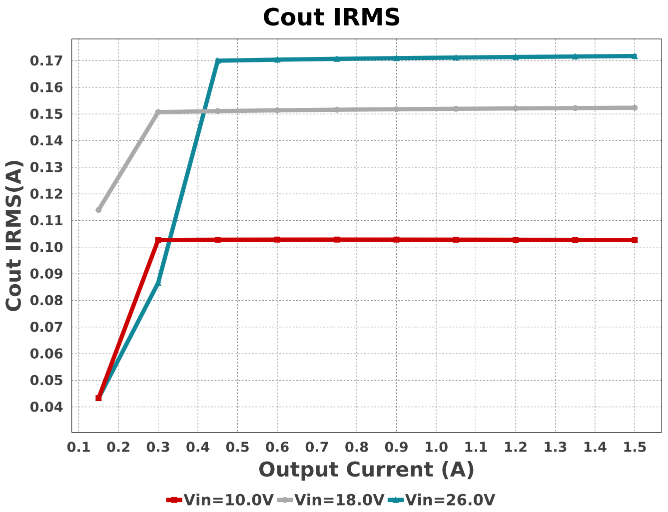

M Vds Act
M Vds Act(V)
Output Current (A)
Vin=10.0V
Vin=18.0V
Vin=26.0V

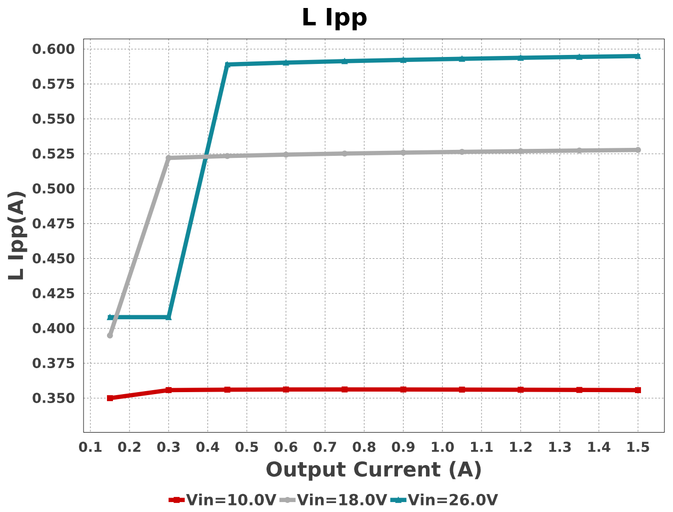

M Irms
M Irms(A)
Output Current (A)
Vin=10.0V Vin=18.0V Vin=26.0V

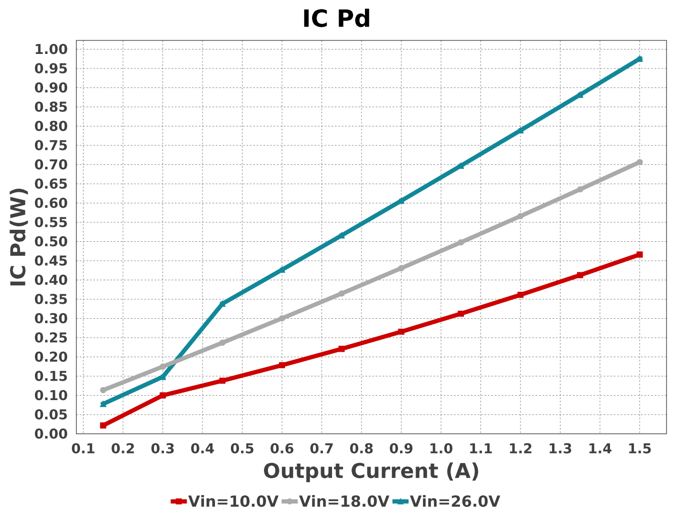

Pout
Pout(W)
Output Current (A)
Vin=10.0V Vin=18.0V Vin=26.0V

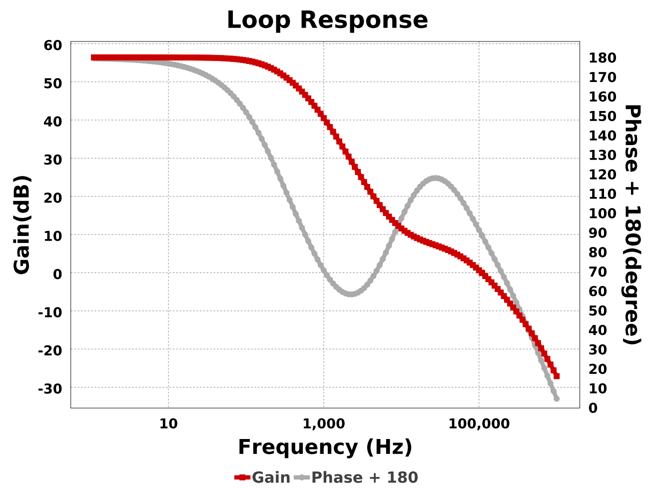

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=10.0V Vin=18.0V Vin=26.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=10.0V Vin=18.0V Vin=26.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.0V Vin=18.0V Vin=26.0V


L Ipp
L Ipp(A)
Output Current (A)
Vin=10.0V Vin=18.0V Vin=26.0V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	13		Total Design BOM count
2.	Total BOM	$2.932		Total BOM Cost
3.	Cin IRMS	606.178 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	1.102 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	171.765 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	398.3 µW	Capacitor	Output capacitor power dissipation
7.	D1 Pd	498.05 mW	Diode	Output Diode Power Dissipation
8.	D1 Tj	30.0 degC	Diode	D1 junction temperature
9.	IC Ipk	0.0 A	IC	Peak switch current in IC
10.	IC Pd	975.32 mW	IC	IC power dissipation
11.	IC Tj	71.451 degC	IC	IC junction temperature
12.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA	42.5 degC/W	IC	IC junction-to-ambient thermal resistance
14.	Iin Avg	348.27 mA	IC	Average input current
15.	L Ipp	595.013 mA	Inductor	Peak-to-peak inductor ripple current
16.	L Pd	79.783 mW	Inductor	Inductor power dissipation
17.	M Irms	680.1 mA	Mosfet	MOSFET RMS ripple current
18.	M Vds Act	62.378 mV	Mosfet	Voltage drop across the MosFET
19.	Cin Pd	1.102 mW	Power	Input capacitor power dissipation
20.	Cout Pd	398.3 µW	Power	Output capacitor power dissipation
21.	D1 Pd	498.05 mW	Power	Output Diode Power Dissipation
22.	IC Pd	975.32 mW	Power	IC power dissipation
23.	L Pd	79.783 mW	Power	Inductor power dissipation
24.	Total Pd	1.555 W	Power	Total Power Dissipation
25.	Cross Freq	108.34 kHz	System Information	Bode plot crossover frequency
26.	Duty Cycle	20.557 %	System Information	Duty cycle
27.	Efficiency	82.827 %	System Information	Steady state efficiency
28.	FootPrint	335.0 mm^2	System Information	Total Foot Print Area of BOM components
29.	Frequency	2.192 MHz	System Information	Switching frequency
30.	Gain Marg	-28.852 dB	System Information	Bode Plot Gain Margin
31.	Iout	1.5 A	System Information	Iout operating point
32.	Low Freq Gain	56.41 dB	System Information	Gain at 1Hz
33.	Mode	CCM	System Information	Conduction Mode
34.	Phase Marg	88.942 deg	System Information	Bode Plot Phase Margin
35.	Pout	7.5 W	System Information	Total output power
36.	Vin	26.0 V	System Information	Vin operating point
37.	Vout	5.0 V	System Information	Operational Output Voltage

#	Name	Value	Category	Description
38.	Vout Actual	5.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Tolerance	4.158 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	8.044 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.5	Maximum Output Current
VinMax	26.0	Maximum input voltage
VinMin	10.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LMR14050S	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

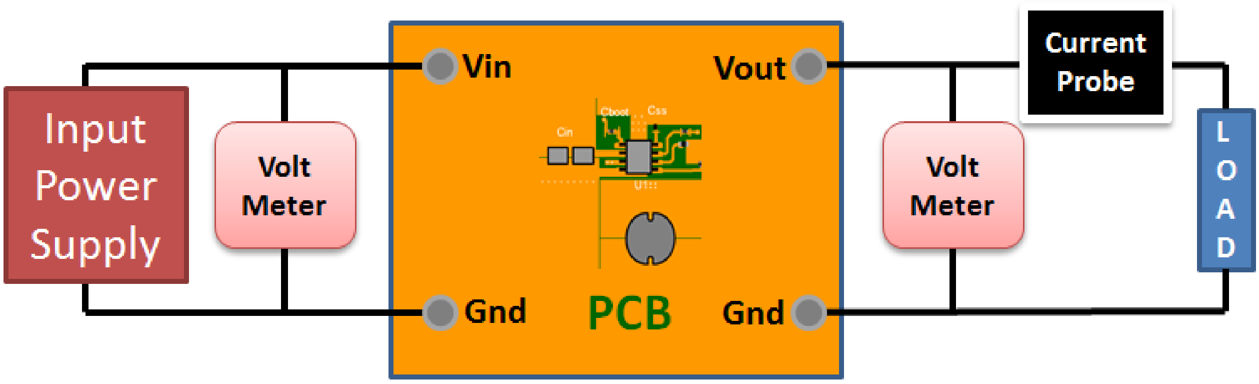
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.0V 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 : CA78D03292776F866BBADADDBD4D840C[v1]

2. **LMR14050S** Product Folder : http://www.ti.com/product/LMR14050 : contains the data sheet and other resources.

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