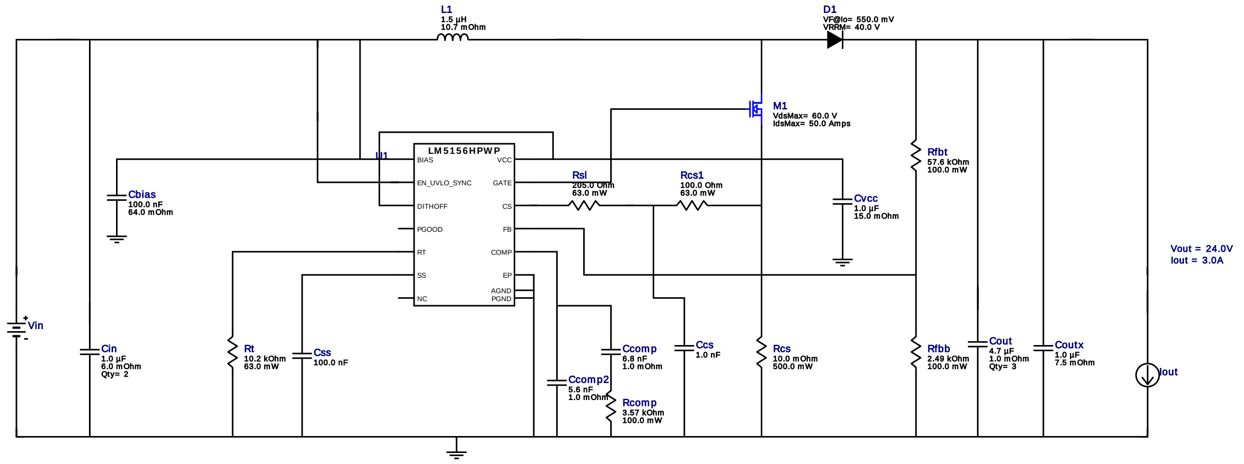
VinMin = 10.0V
VinMax = 17.0V
Vout = 24.0V
Iout = 3.0A

Device = LM5156HPWPR
Topology = Boost
Created = 2022-01-25 04:55:45.779
BOM Cost = $3.73
BOM Count = 23
Total Pd = 3.93W

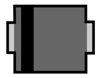
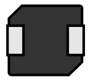
WEBENCH ® Design Report

Design : 34 LM5156HPWPR
LM5156HPWPR 10V-17V to 24.00V @ 3A

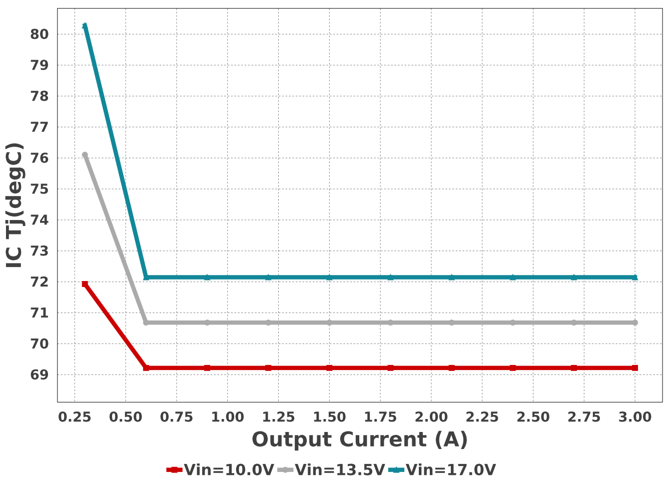


Electrical BOM

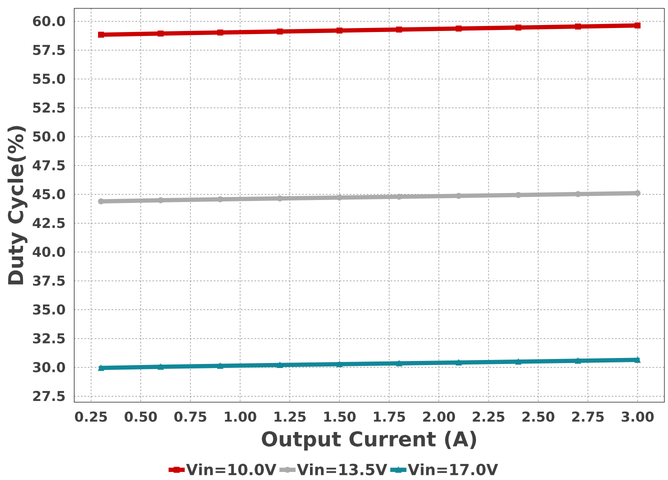
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm²
Ccomp	MuRata	GRM155R71E682KA01D Series= X7R	Cap= 6.8 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp2	MuRata	GRM155R71E562KA01D Series= X7R	Cap= 5.6 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccs	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	MuRata	GRM219R71E105KA88D Series= X7R	Cap= 1.0 uF ESR= 6.0 mOhm VDC= 25.0 V IRMS= 3.87 A	2	$0.05	0805 7 mm²
Cout	MuRata	GRM32ER71H475KA88L Series= X7R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 6.0 A	3	$0.42	1210 15 mm²
Coutx	TDK	C3216X7R2A105M160AA Series= X7R	Cap= 1.0 uF ESR= 7.5 mOhm VDC= 100.0 V IRMS= 5.9235 A	1	$0.12	1206 11 mm²
Css	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm²
Cvcc	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm²

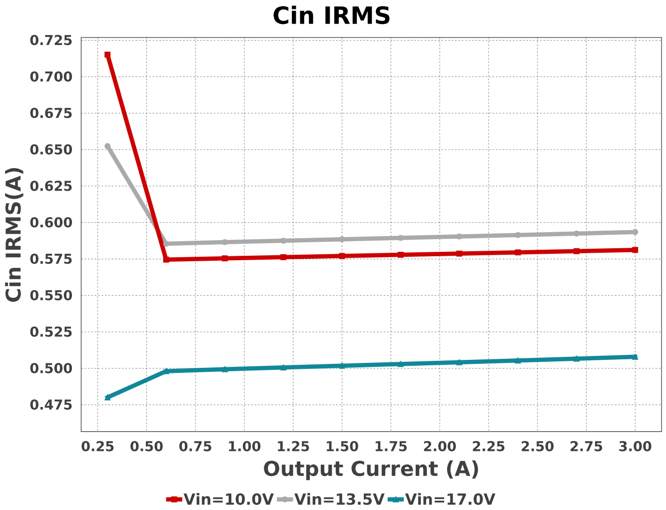
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
D1	Diodes Inc.	B540C-13-F	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.17	 SMC 83 mm²
L1	TDK	SPM6530T-1R5M100	L= 1.5 µH 10.7 mOhm	1	$0.56	 SPM6530 77 mm²
M1	ON Semiconductor	NTMFS5C673NLT1G	VdsMax= 60.0 V IdsMax= 50.0 Amps	1	$0.34	FP-NTMFS5C673NLT1G_DFN5-MFG 0 mm²
Rcomp	Susumu Co Ltd	RG1608P-3571-B-T5 Series= RG1608	Res= 3.57 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.06	0603 5 mm²
Rcs	Stackpole Electronics Inc	CSR1206FK10L0 Series= ?	Res= 10.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.12	1206 11 mm²
Rcs1	Vishay-Dale	CRCW0402100RFKED Series= CRCW..e3	Res= 100.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Susumu Co Ltd	RG1608P-2491-B-T5 Series= RG1608	Res= 2.49 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.06	0603 5 mm²
Rfbt	Susumu Co Ltd	RG1608P-5762-B-T5 Series= RG1608	Res= 57.6 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.06	0603 5 mm²
Rsl	Vishay-Dale	CRCW0402205RFKED Series= CRCW..e3	Res= 205.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rt	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LM5156HPWPR	Switcher	1	$0.73	PWP0014H 59 mm²

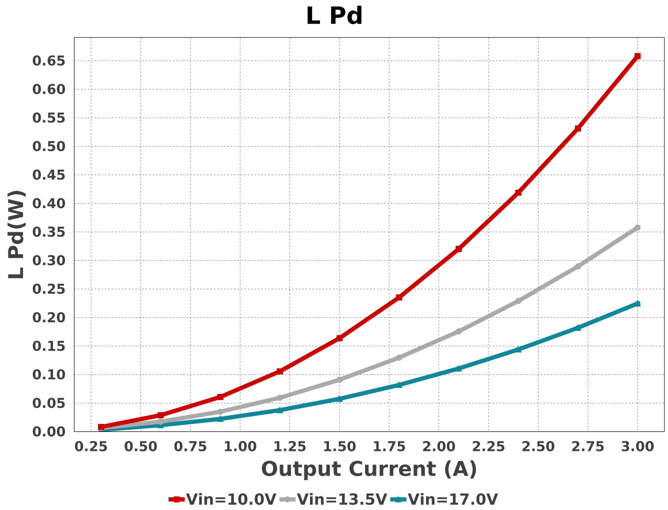
IC Tj

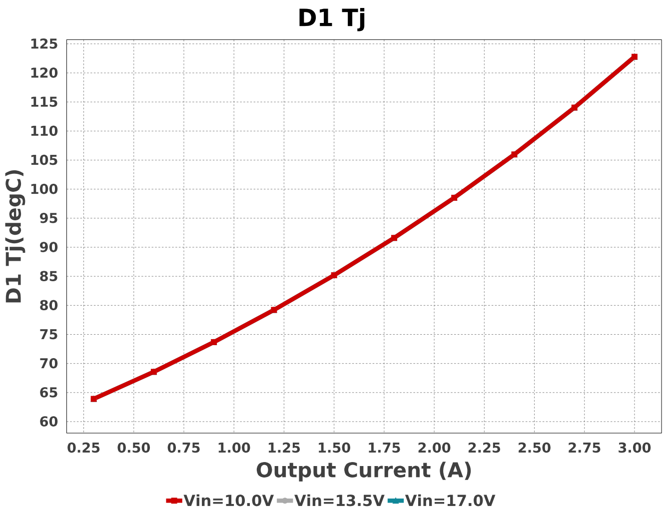


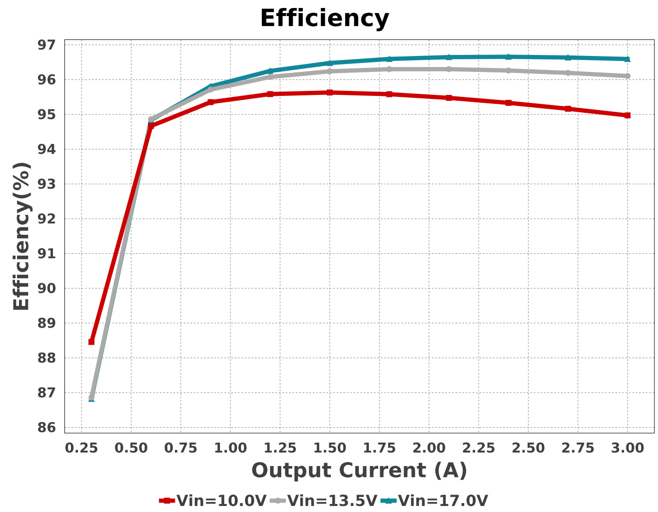
Duty Cycle

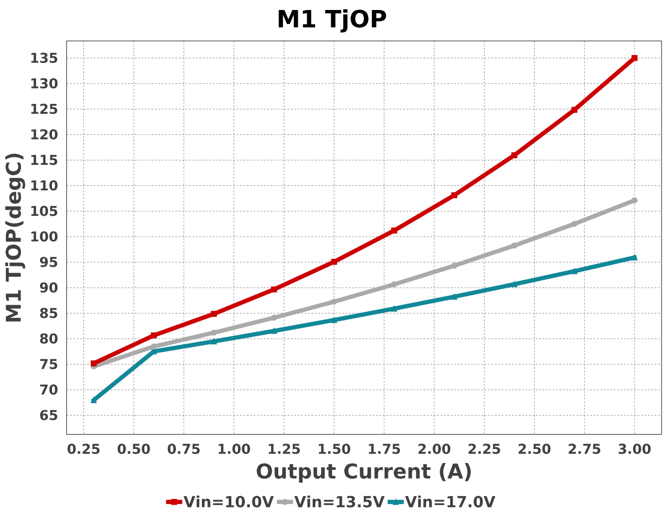


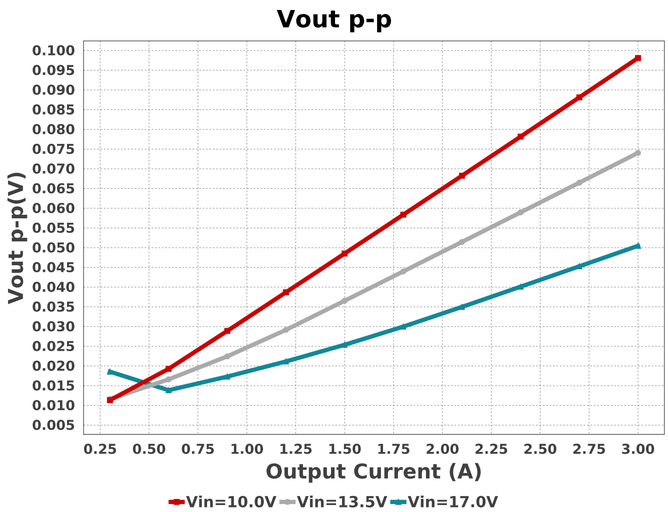

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V

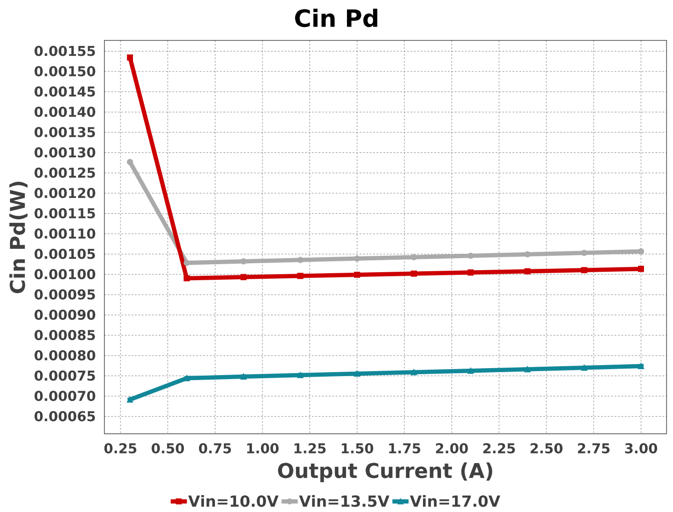

L Pd
L Pd(W)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V

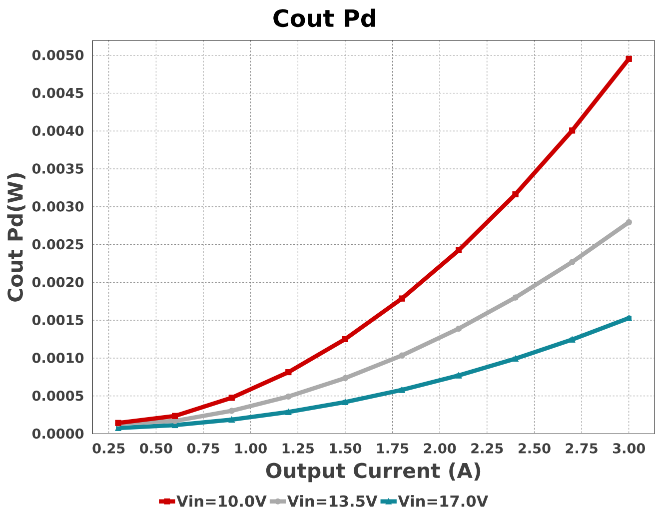

D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V

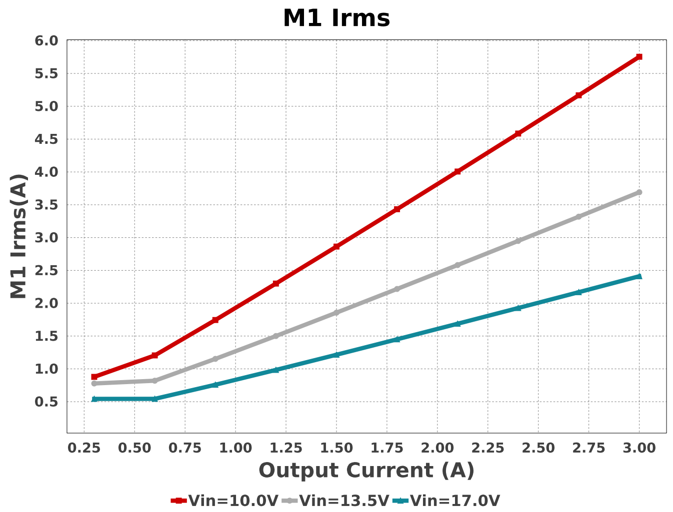

Efficiency
Efficiency(%)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V

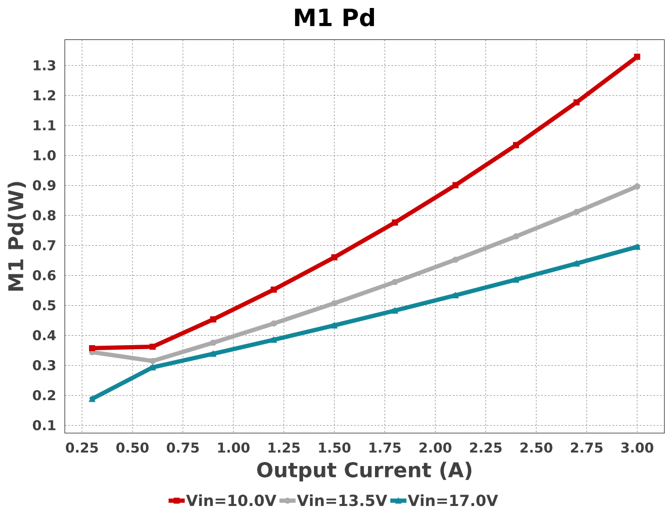

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V

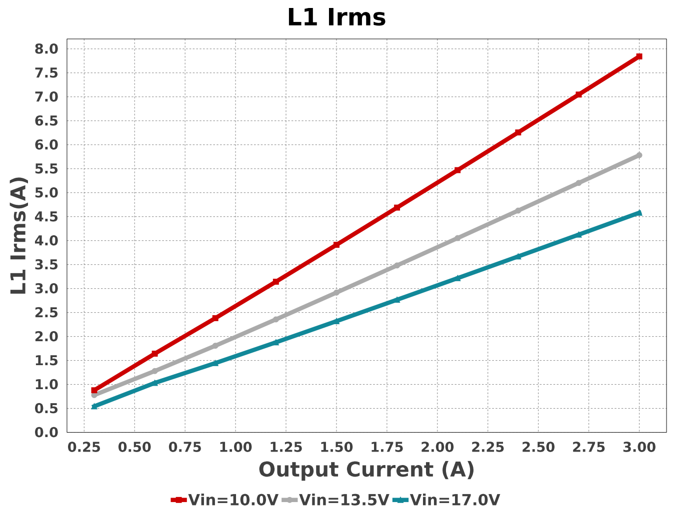

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V

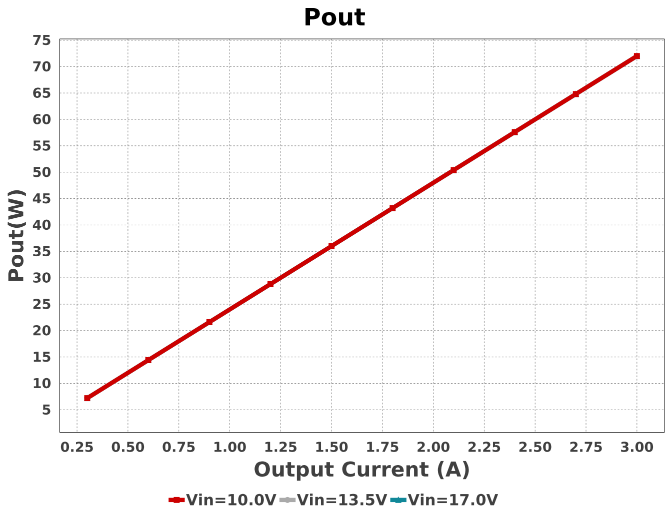

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V


Cout Pd
Cout Pd(W)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V

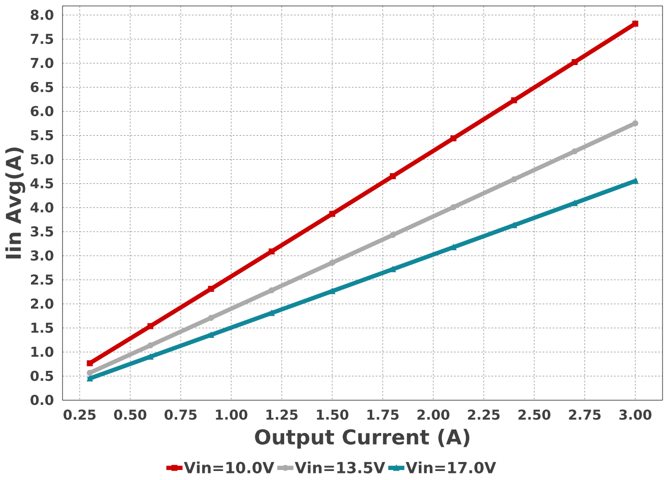

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V


M1 Pd
M1 Pd(W)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V

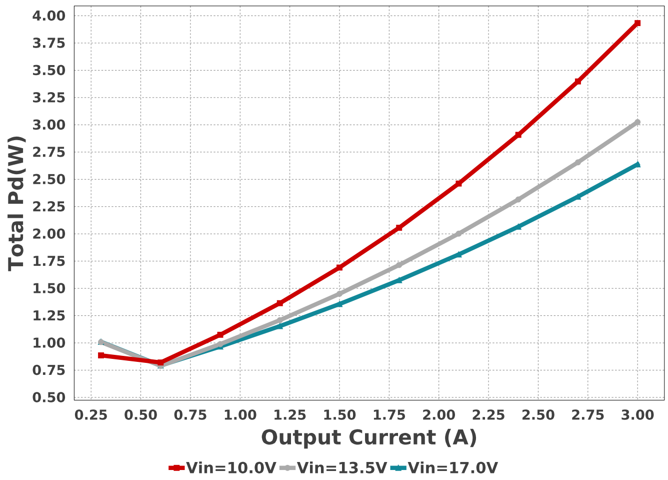

L1 Irms
L1 Irms(A)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V


Pout
Pout(W)
Output Current (A)
Vin=10.0V Vin=13.5V Vin=17.0V

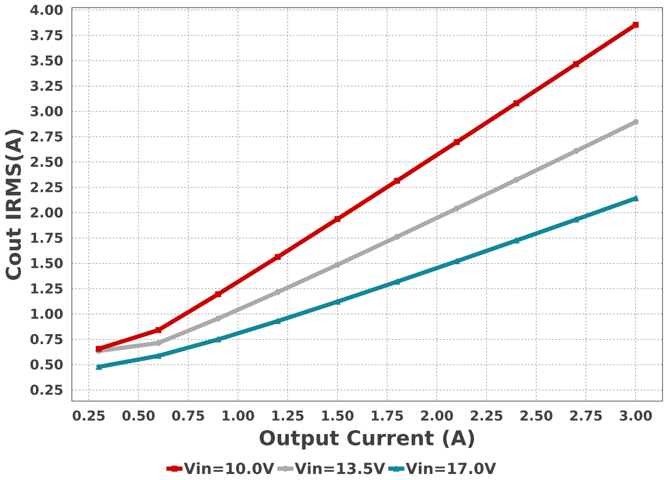
Iin Avg



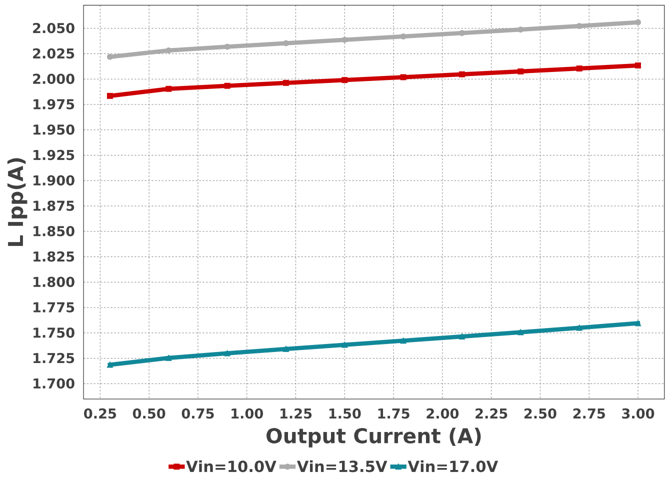
Total Pd



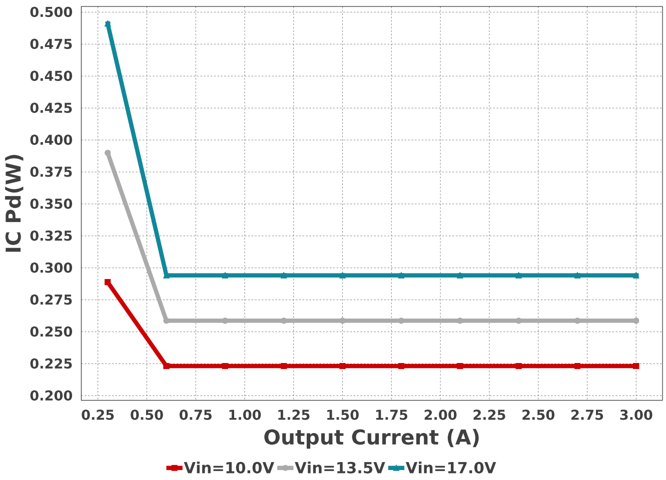
Cout IRMS



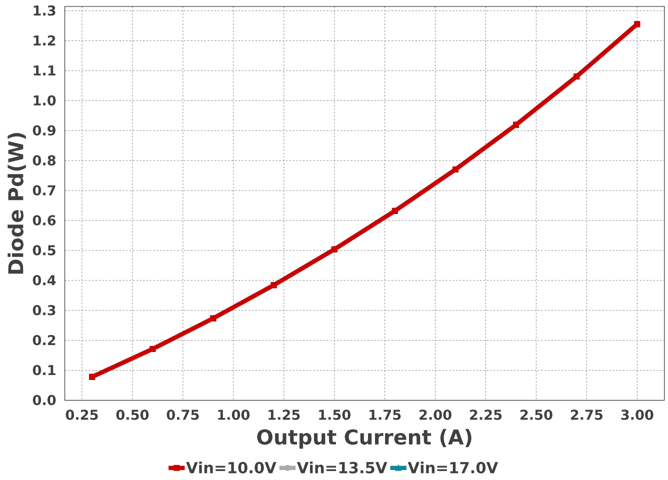
L Ipp

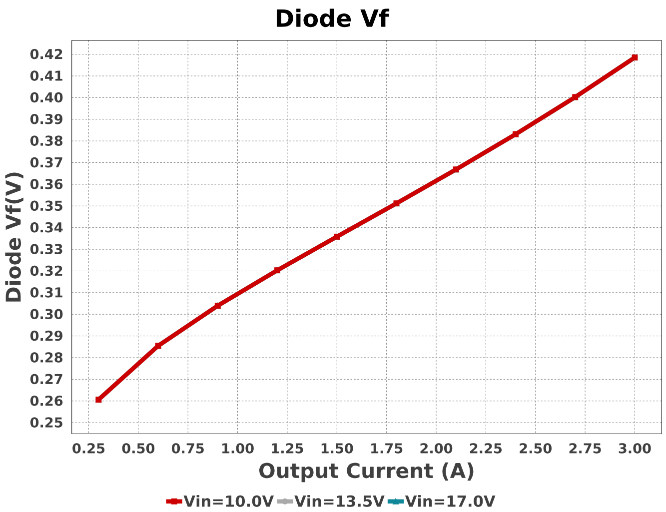


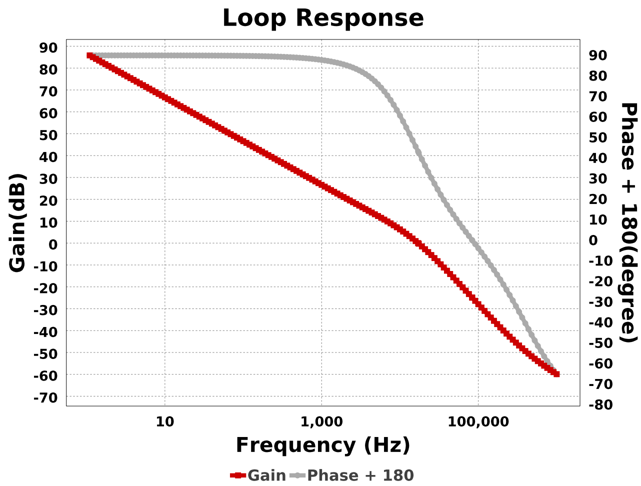
IC Pd



Diode Pd







Operating Values

#	Name	Value	Category	Description
1.	BOM Count	23		Total Design BOM count
2.	Total BOM	$3.729		Total BOM Cost
3.	Cin IRMS	581.223 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	1.014 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	3.855 A	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	4.953 mW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	122.776 degC	Diode	D1 junction temperature
8.	Diode Pd	1.256 W	Diode	Diode power dissipation
9.	Diode Vf	418.507 mV	Diode	Forward voltage drop of diode D1
10.	IC Pd	223.21 mW	IC	IC power dissipation
11.	IC Tj	69.219 degC	IC	IC junction temperature
12.	ICThetaJA	41.3 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	7.82 A	IC	Average input current
14.	L Ipp	2.013 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	658.02 mW	Inductor	Inductor power dissipation
16.	L1 Irms	7.842 A	Inductor	Inductor ripple current
17.	M1 Irms	5.754 A	Mosfet	Q Iavg
18.	M1 Pd	1.329 W	Mosfet	MOSFET power dissipation
19.	M1 TjOP	135.004 degC	Mosfet	M1 MOSFET junction temperature
20.	Cin Pd	1.014 mW	Power	Input capacitor power dissipation
21.	Cout Pd	4.953 mW	Power	Output capacitor power dissipation
22.	Diode Pd	1.256 W	Power	Diode power dissipation
23.	IC Pd	223.21 mW	Power	IC power dissipation
24.	L Pd	658.02 mW	Power	Inductor power dissipation
25.	M1 Pd	1.329 W	Power	MOSFET power dissipation
26.	Total Pd	3.933 W	Power	Total Power Dissipation
27.	Cross Freq	11.619 kHz	System Information	Bode plot crossover frequency
28.	Duty Cycle	59.638 %	System Information	Duty cycle
29.	Efficiency	94.971 %	System Information	Steady state efficiency
30.	FootPrint	351.0 mm^2	System Information	Total Foot Print Area of BOM components
31.	Frequency	1.974 MHz	System Information	Switching frequency
32.	Iout	3.0 A	System Information	Iout operating point
33.	Mode	CCM	System Information	Conduction Mode
34.	Phase Marg	53.209 deg	System Information	Bode Plot Phase Margin
35.	Pout	72.0 W	System Information	Total output power
36.	Vin	10.0 V	System Information	Vin operating point
37.	Vout Actual	24.133 V	System Information	Vout Actual calculated based on selected voltage divider resistors
38.	Vout Tolerance	1.194 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
39.	Vout p-p	98.097 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	17.0	Maximum input voltage
VinMin	10.0	Minimum input voltage
Vout	24.0	Output Voltage
base_pn	LM5156H	Base Product Number
source	DC	Input Source Type
Ta	60.0	Ambient temperature
UserFsw	2.0 M	Customer Selected Frequency

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

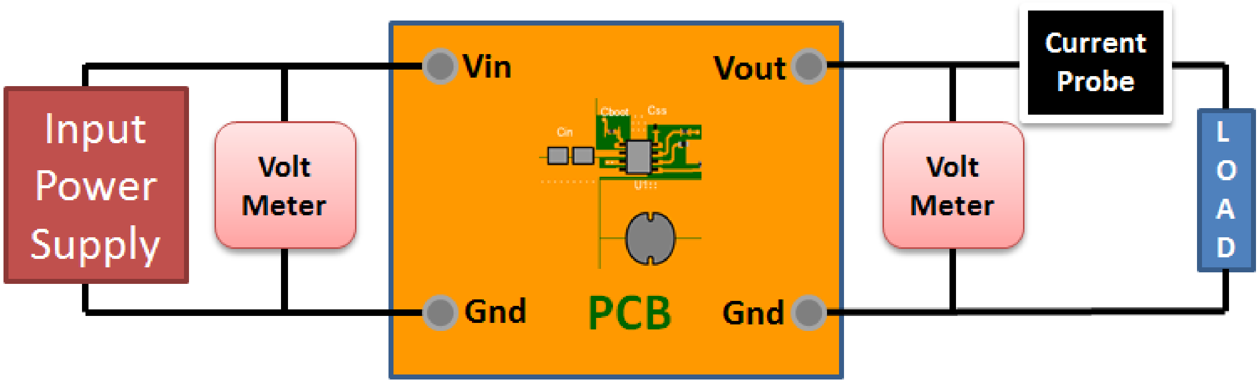
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 : EE86D21D0A9097F0[v1]

2. **LM5156H** Product Folder : http://www.ti.com/product/LM5156H : contains the data sheet and other resources.

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