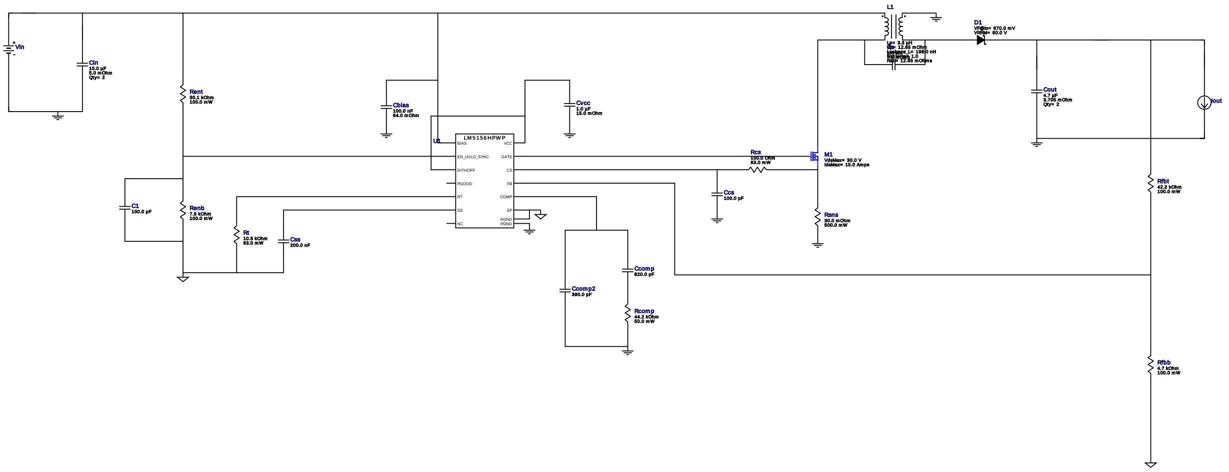
VinMin = 8.0V
VinMax = 18.0V
Vout = 10.0V
Iout = 1.0A

Device = LM5156HPWPR
Topology = SEPIC
Created = 2022-06-02 19:47:02.271
BOM Cost = NA
BOM Count = 24
Total Pd = 0.82W

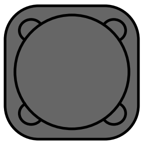
WEBENCH ® Design Report

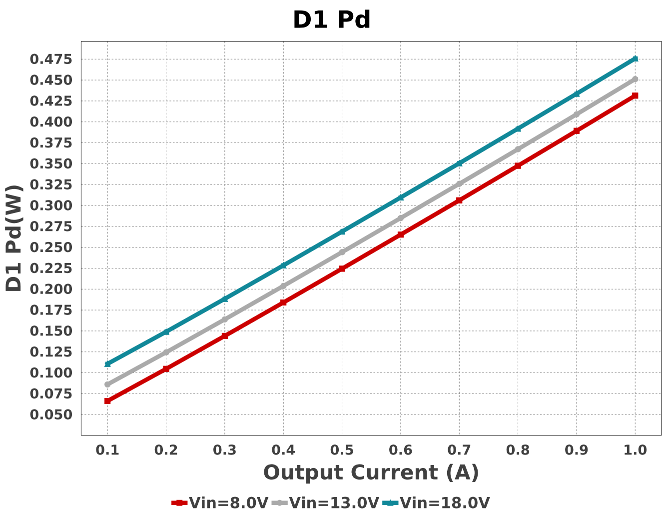
Design : 5 LM5156HPWPR
LM5156HPWPR 8V-18V to 10.00V @ 1A

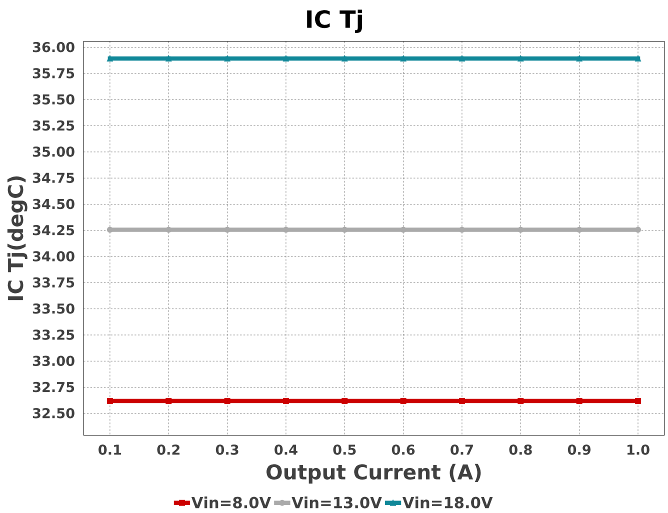


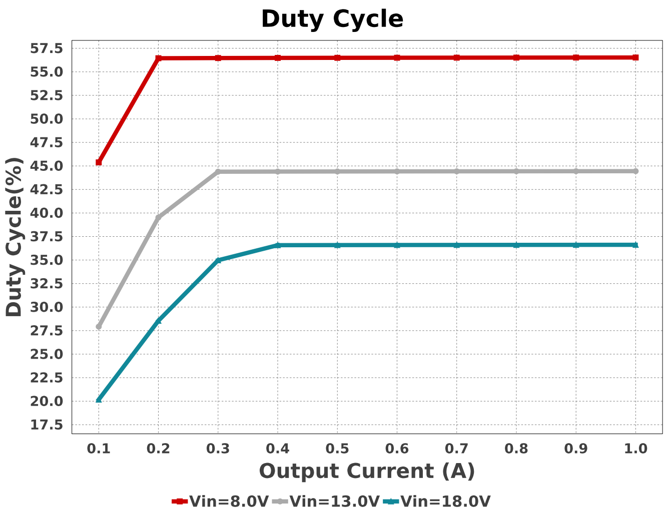
Electrical BOM

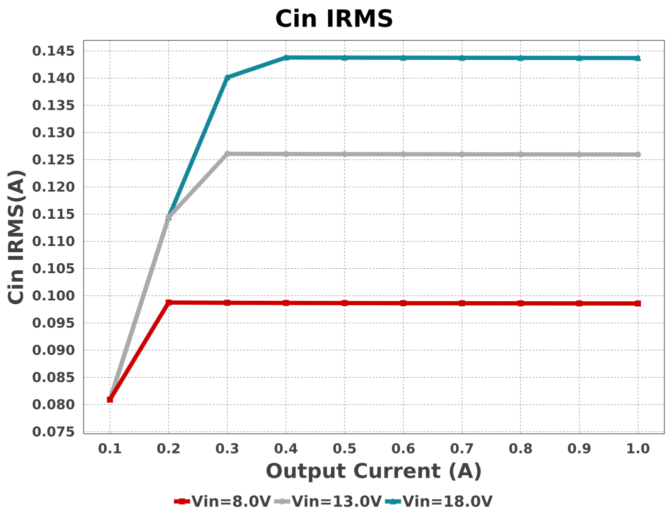
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C1	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cbias	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm²
Ccomp	Kemet	C0805C821J5GACTU Series= C0G/NP0	Cap= 820.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm²
Ccomp2	MuRata	GRM1555C1H391JA01J Series= C0G/NP0	Cap= 390.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccs	Samsung Electro-Mechanics	CL21C101JBANNNC Series= C0G/NP0	Cap= 100.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cin	Samsung Electro-Mechanics	CL32B106KBJNNWE Series= X7R	Cap= 10.0 uF ESR= 5.0 mOhm VDC= 50.0 V IRMS= 0.0 A	2	$0.17	1210_270 15 mm²
Cout	MuRata	GRM31CR71E475KA88L Series= X7R	Cap= 4.7 uF ESR= 3.705 mOhm VDC= 25.0 V IRMS= 2.8649 A	2	$0.08	1206_190 11 mm²
Cs	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	CUSTOM	CUSTOM Series= ?	Cap= 200.0 nF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 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

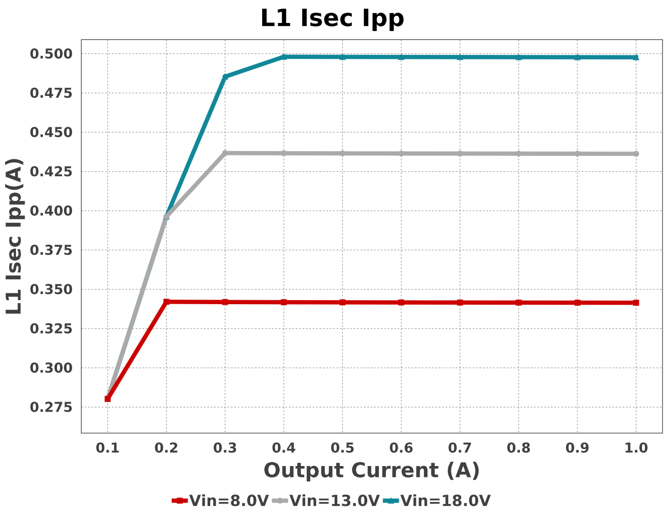
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
D1	Diodes Inc.	PDS560-13	VF@Io= 670.0 mV VRRM= 60.0 V	1	$0.42	 PowerDI5 50 mm²
L1	Coiltronics	DRQ125-3R3-R	Lp= 3.3 µH Rp= 12.65 mOhm Leakage_L= 198.0 nH Ns1toNp= 1.0 Rs1= 12.65 mOhms	1	$0.91	 DRQ125 210 mm²
M1	Texas Instruments	CSD87381P	VdsMax= 30.0 V IdsMax= 15.0 Amps	1	$0.37	MPC0005A 14 mm²
Rcomp	Vishay-Dale	CRCW020144K2FNED Series= ?	Res= 44.2 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rcs	Vishay-Dale	CRCW0402100RFKED Series= CRCW..e3	Res= 100.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Renb	Yageo	RT0603BRD077K5L Series= ?	Res= 7.5 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.04	0603 5 mm²
Rent	Yageo	RT0603BRD0730K1L Series= ?	Res= 30.1 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.04	0603 5 mm²
Rfbb	Susumu Co Ltd	RG1608P-472-B-T5 Series= RG1608	Res= 4.7 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.04	0603 5 mm²
Rfbt	Susumu Co Ltd	RG1608P-4222-B-T5 Series= RG1608	Res= 42.2 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.06	0603 5 mm²
Rsns	Stackpole Electronics Inc	CSR1206FK30L0 Series= ?	Res= 30.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.10	1206 11 mm²
Rt	Vishay-Dale	CRCW040210K5FKED Series= CRCW..e3	Res= 10.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LM5156HPWPR	Switcher	1	$0.73	DSS0012B 12 mm²

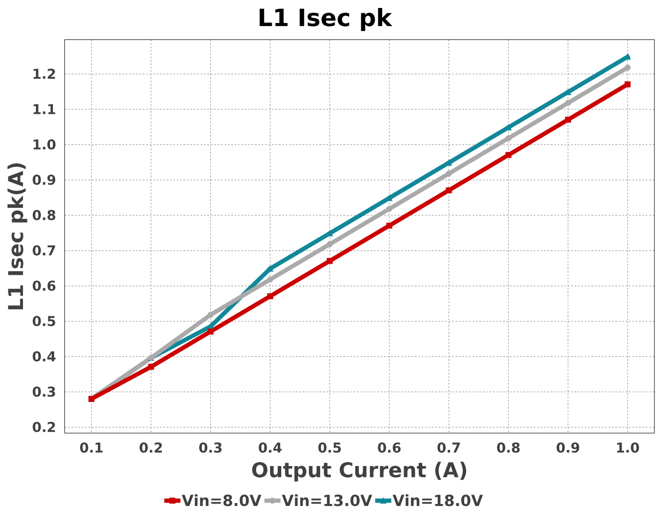


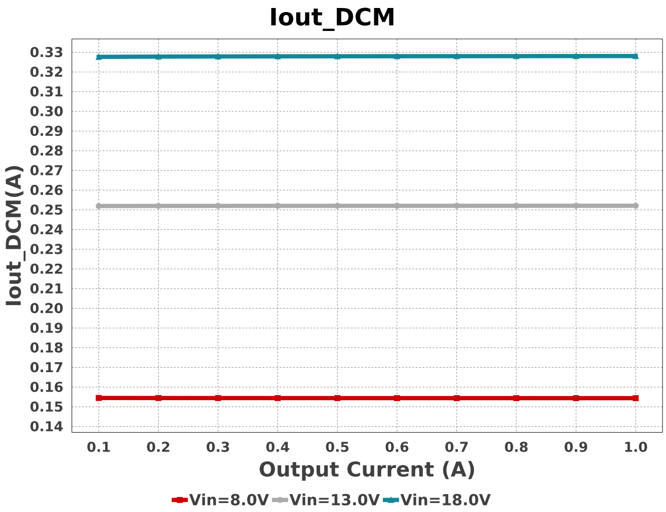


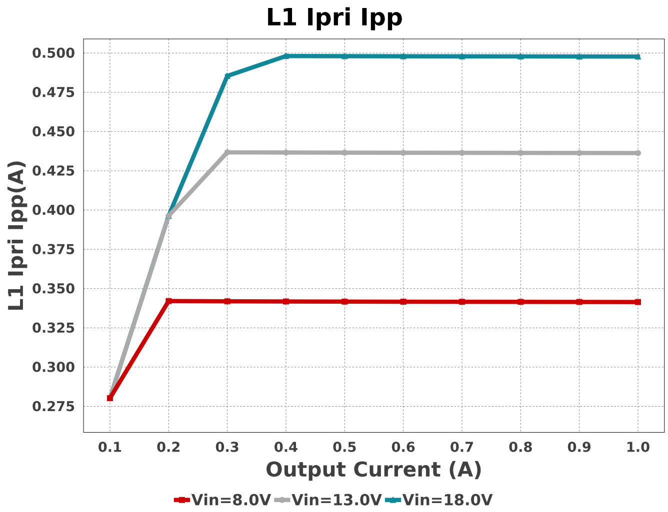

Duty Cycle
Duty Cycle(%)
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin=8.0V
Vin=13.0V
Vin=18.0V


Cin IRMS
Cin IRMS(A)
0.145
0.140
0.135
0.130
0.125
0.120
0.115
0.110
0.105
0.100
0.095
0.090
0.085
0.080
0.075
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin=8.0V
Vin=13.0V
Vin=18.0V

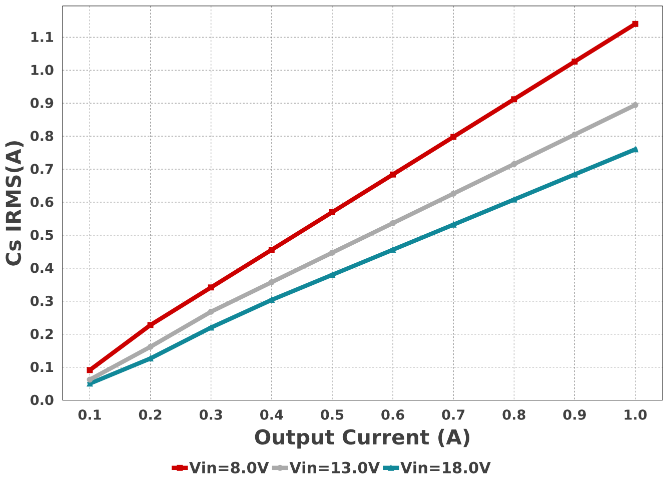

L1 Isec Ipp
L1 Isec Ipp(A)
0.500
0.475
0.450
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin=8.0V
Vin=13.0V
Vin=18.0V


L1 Isec pk
L1 Isec pk(A)
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
Output Current (A)
Vin=8.0V
Vin=13.0V
Vin=18.0V

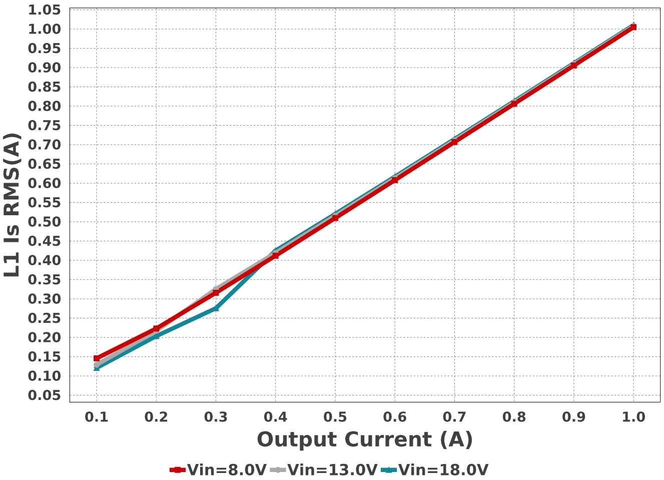

Iout_DCM
Iout_DCM(A)
0.33
0.32
0.31
0.30
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin=8.0V
Vin=13.0V
Vin=18.0V


L1 Ipri Ipp
L1 Ipri Ipp(A)
0.500
0.475
0.450
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin=8.0V
Vin=13.0V
Vin=18.0V

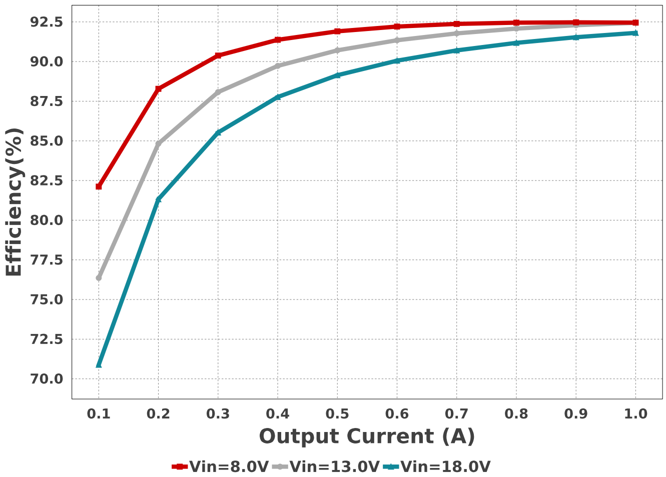
Cs IRMS



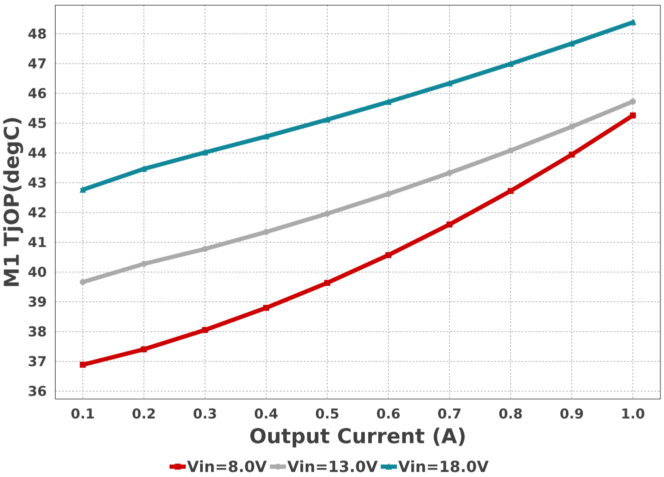
L1 Is RMS



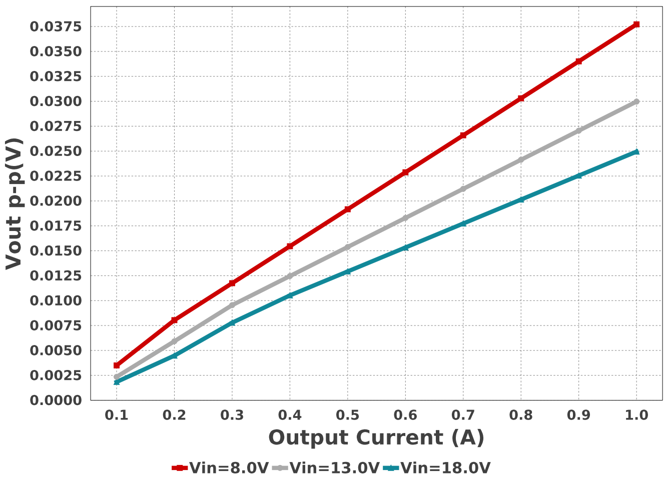
Efficiency



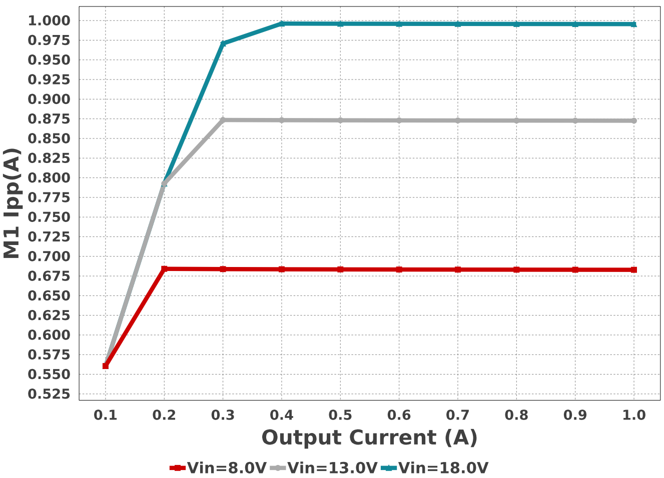
M1 TjOP

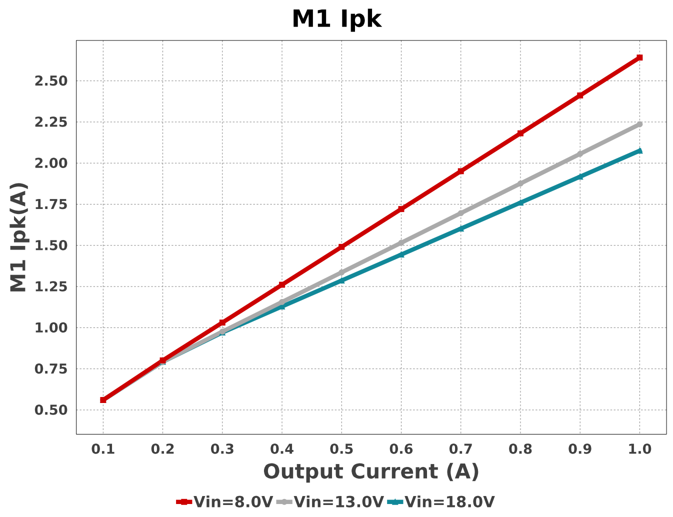


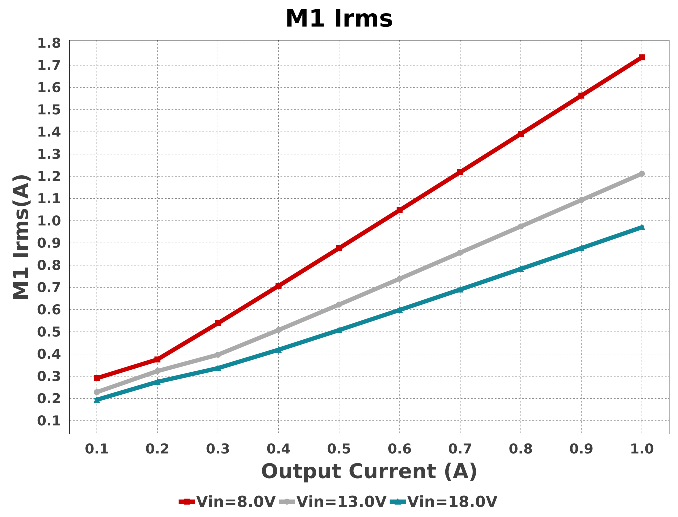
Vout p-p

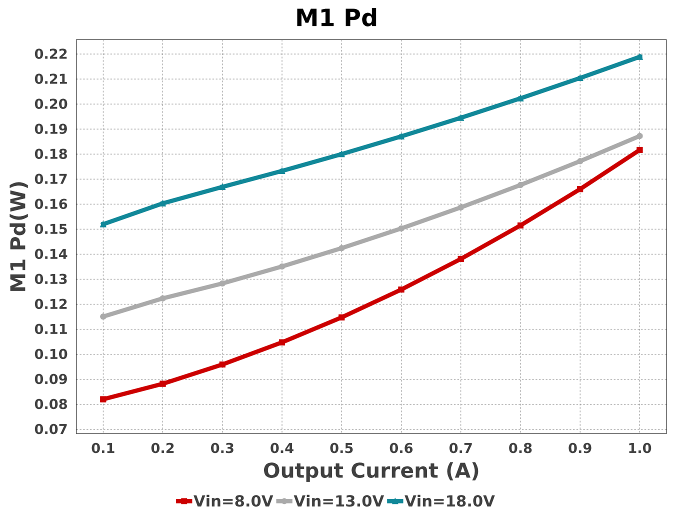


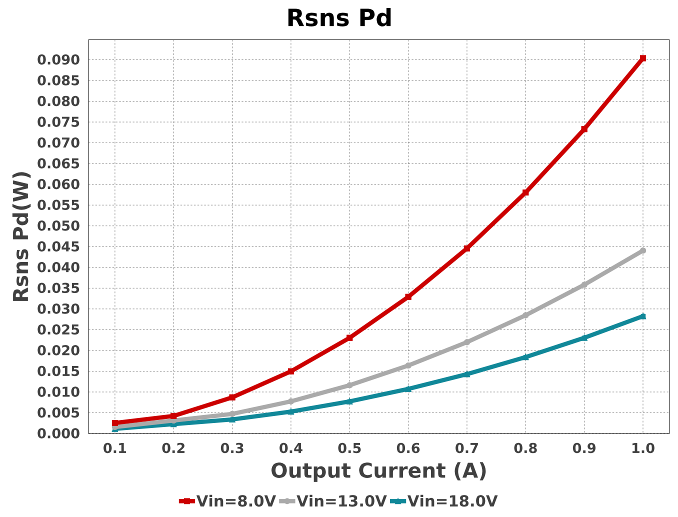
M1 Ipp

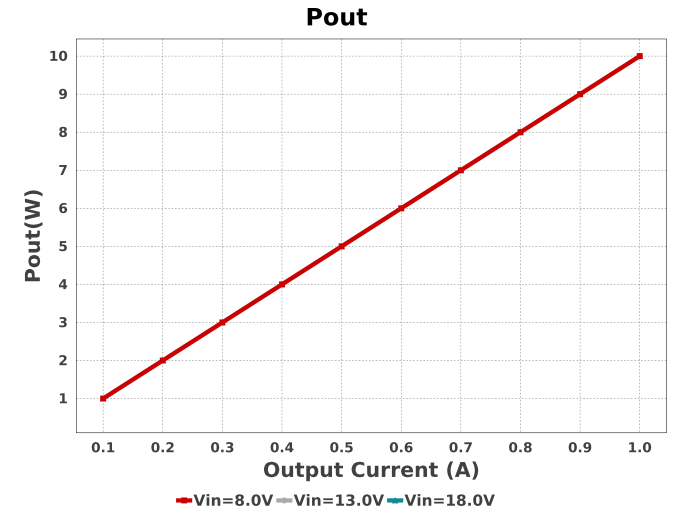


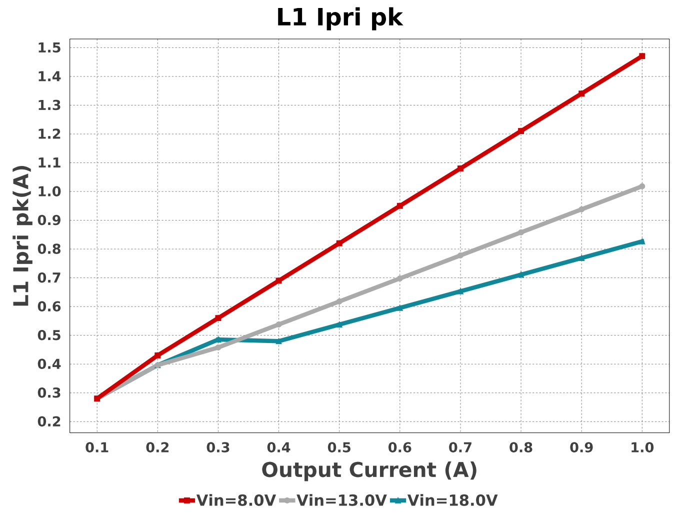

M1 Ipk
M1 Ipk(A)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

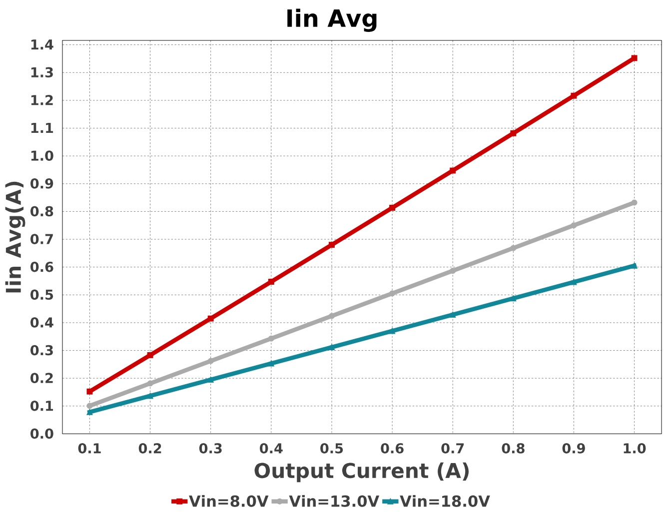

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

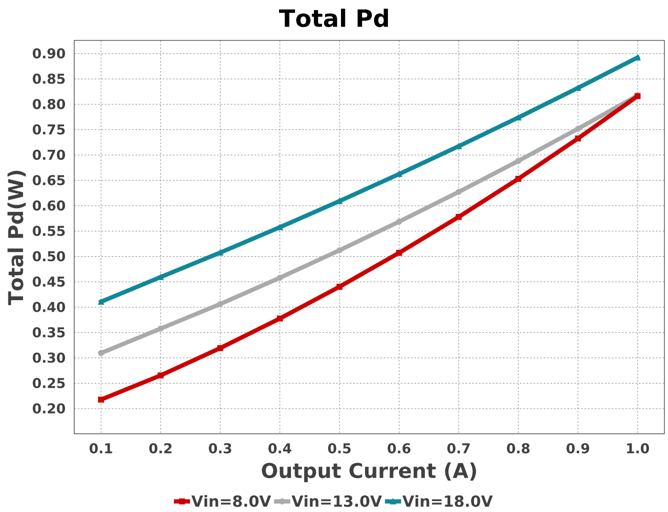

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

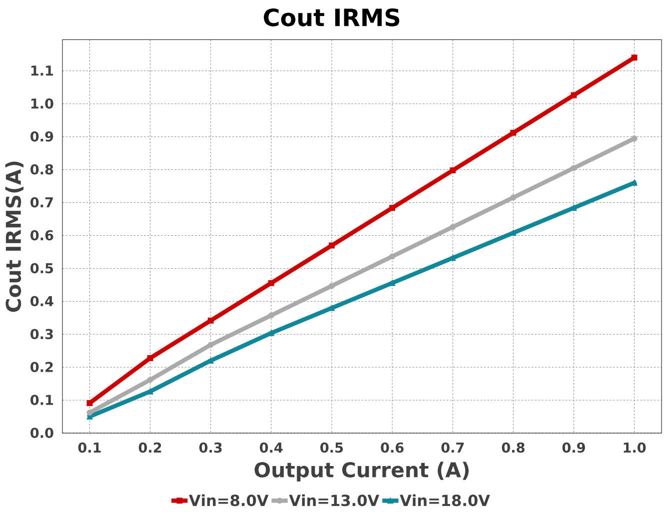

Rsns Pd
Rsns Pd(W)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

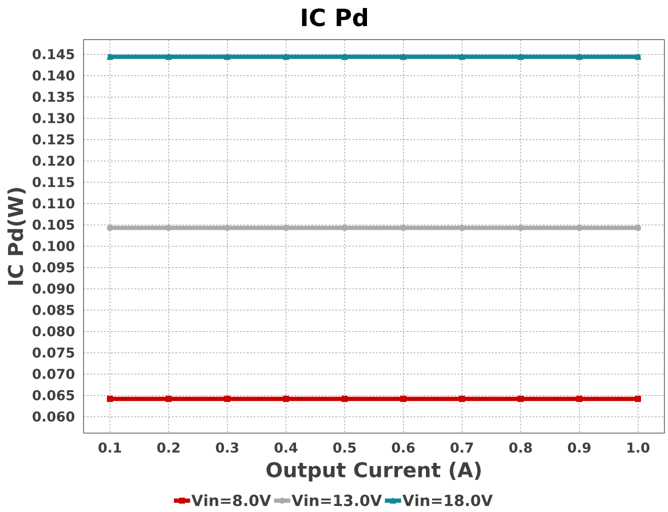

Pout
Pout(W)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

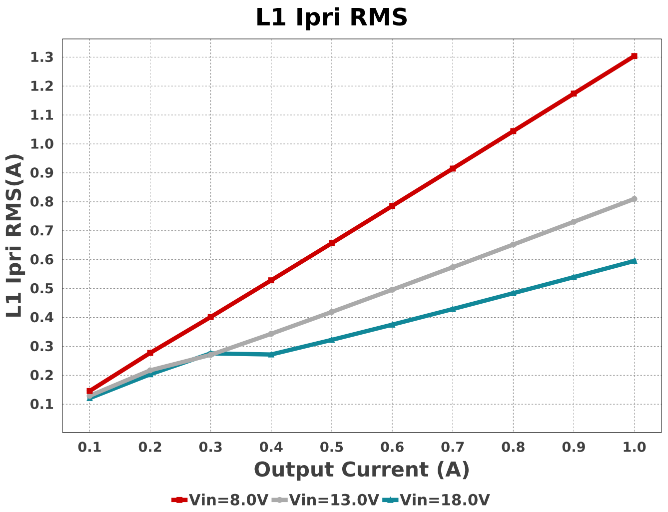

L1 Ipri pk
L1 Ipri pk(A)
Output Current (A)
Vin=8.0V Vin=13.0V Vin=18.0V

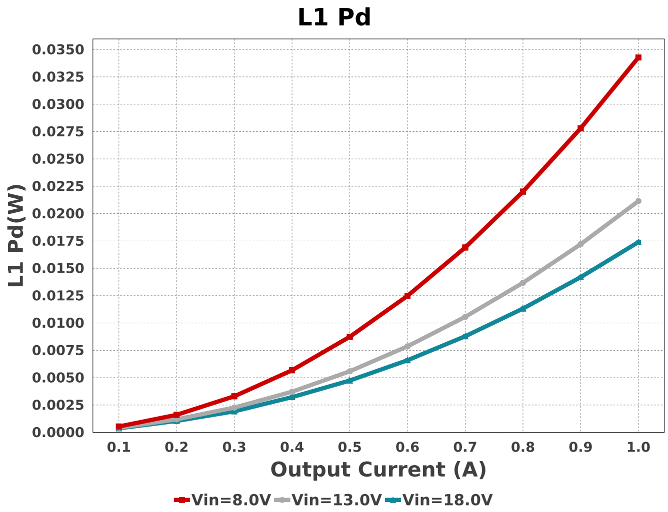












Operating Values

#	Name	Value	Category	Description
1.	BOM Count	24		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	98.568 mA	Capacitor	Input capacitor RMS ripple current
4.	Cout IRMS	1.14 A	Capacitor	Output capacitor RMS ripple current
5.	Cs IRMS	1.14 A	Capacitor	Coupling capacitor RMS ripple current
6.	M1 Ipk	2.641 A	Current	M1 peak current.
7.	D1 Pd	431.35 mW	Diode	Output Diode Power Dissipation
8.	IC Pd	64.194 mW	IC	IC power dissipation
9.	IC Tj	32.619 degC	IC	IC junction temperature
10.	ICThetaJA	40.8 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	1.352 A	IC	Average input current

#	Name	Value	Category	Description
12.	M1 Irms	1.736 A	Mosfet	M1 MOSFET Irms
13.	M1 Pd	181.66 mW	Mosfet	M1 MOSFET total power dissipation
14.	M1 TjOP	45.26 degC	Mosfet	M1 MOSFET junction temperature
15.	D1 Pd	431.35 mW	Power	Output Diode Power Dissipation
16.	IC Pd	64.194 mW	Power	IC power dissipation
17.	L1 Pd	34.275 mW	Power	Power Dissipation in the Inductor
18.	M1 Pd	181.66 mW	Power	M1 MOSFET total power dissipation
19.	Rsns Pd	90.36 mW	Power	Current Limit Sense Resistor Power Dissipation
20.	Total Pd	816.175 mW	Power	Total Power Dissipation
21.	Rsns Pd	90.36 mW	Resistor	Current Limit Sense Resistor Power Dissipation
22.	Duty Cycle	56.522 %	System Information	Duty cycle
23.	Efficiency	92.454 %	System Information	Steady state efficiency
24.	FootPrint	423.0 mm^2	System Information	Total Foot Print Area of BOM components
25.	Frequency	1.929 MHz	System Information	Switching frequency
26.	Iout	1.0 A	System Information	Iout operating point
27.	Iout_DCM	154.396 mA	System Information	Approximate Current below which DCM mode of operation will begin
28.	M1 Ipp	682.903 mA	System Information	M1 ripple pk-pk.
29.	Mode	CCM	System Information	Conduction Mode
30.	Pout	10.0 W	System Information	Total output power
31.	Vin	8.0 V	System Information	Vin operating point
32.	Vout	10.0 V	System Information	Operational Output Voltage
33.	Vout Actual	9.979 V	System Information	Vout Actual calculated based on selected voltage divider resistors
34.	Vout Tolerance	2.785 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
35.	Vout p-p	37.717 mV	System Information	Peak-to-peak output ripple voltage
36.	L1 Ipri Ipp	341.451 mA	Transformer	L1 primary side ripple pk-pk.
37.	L1 Ipri RMS	1.304 A	Transformer	L1 primary rms current.
38.	L1 Ipri pk	1.471 A	Transformer	L1 primary pk current.
39.	L1 Is RMS	1.005 A	Transformer	L1 secondary rms current
40.	L1 Isec Ipp	341.451 mA	Transformer	L1 secondary side ripple pk-pk.
41.	L1 Isec pk	1.171 A	Transformer	Peak current in L1 secondary
42.	L1 Pd	34.275 mW	Transformer	Power Dissipation in the Inductor

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	18.0	Maximum input voltage
VinMin	8.0	Minimum input voltage
Vout	10.0	Output Voltage
base_pn	LM5156H	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	1.981 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

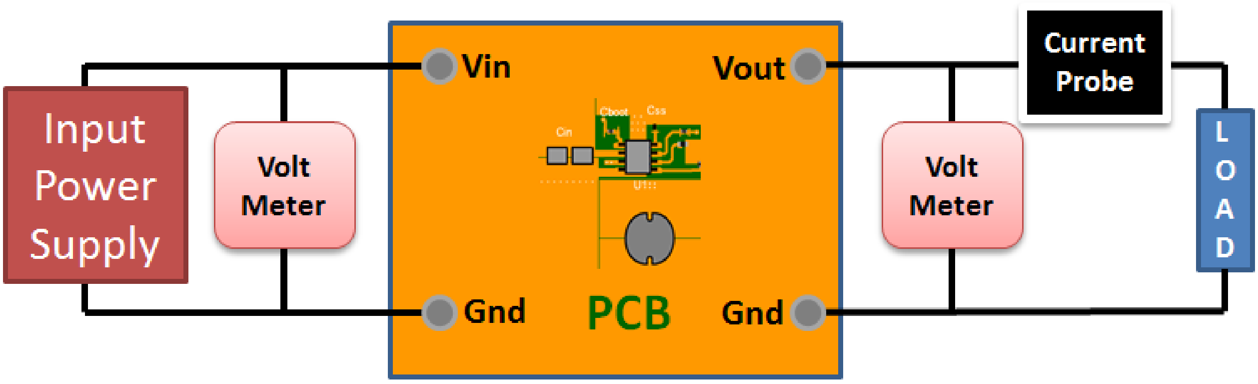
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 8.0V 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 : 02ACC1F8EF557072581E74FE8C625363[v1]

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

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