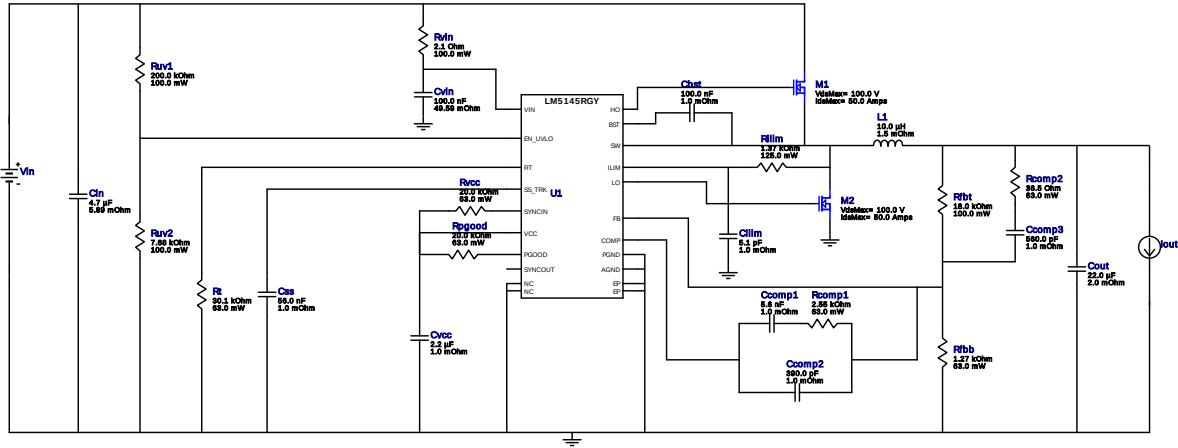


WEBENCH® Design Report

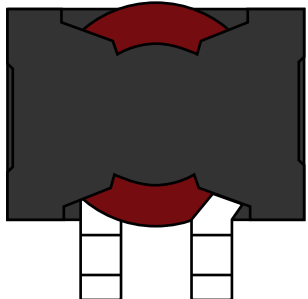
Design : 398 LM5145RGYR
LM5145RGYR 40V-60V to 12.00V @ 6.5A



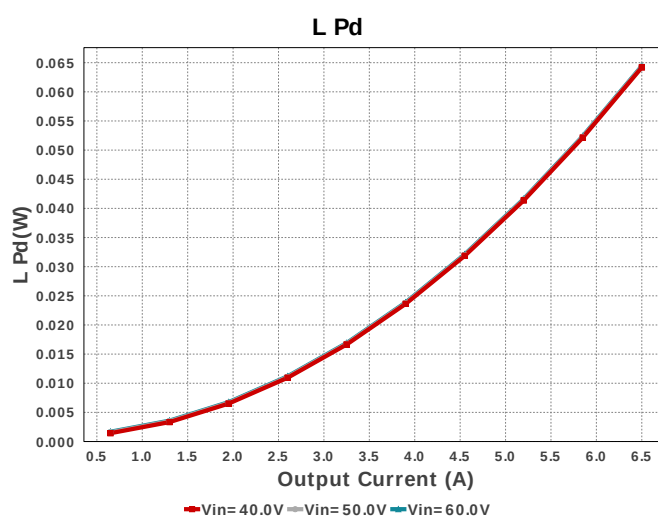
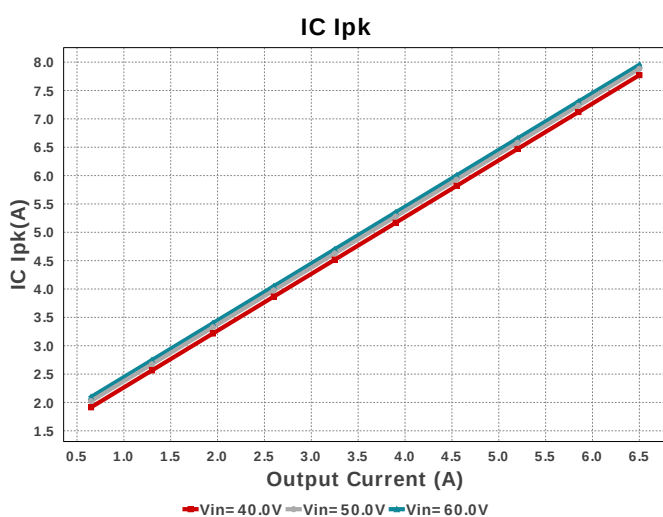
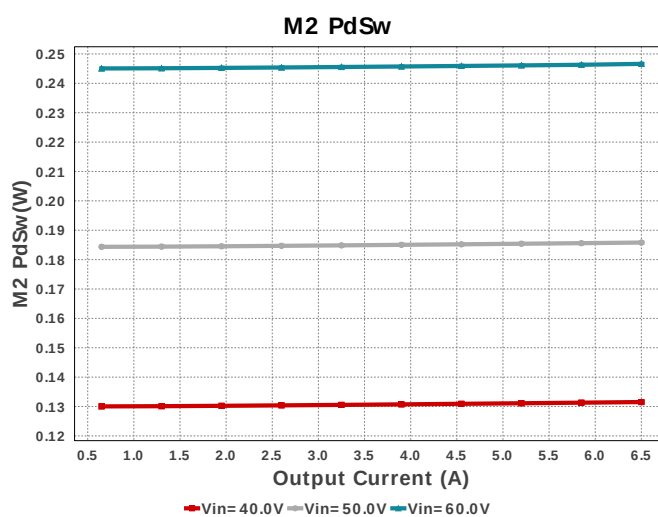
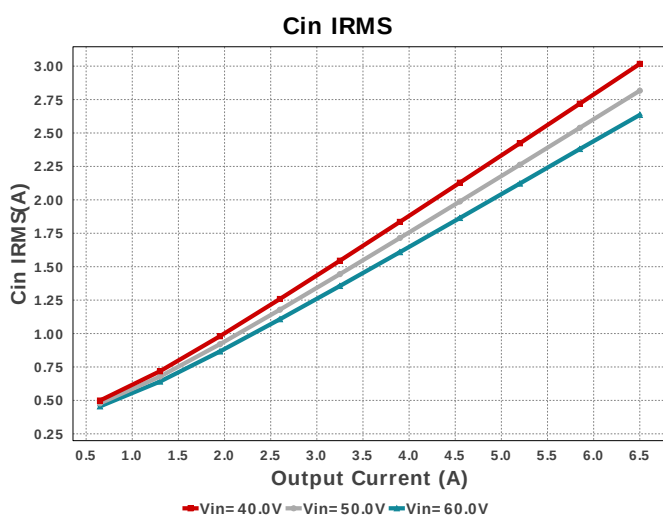
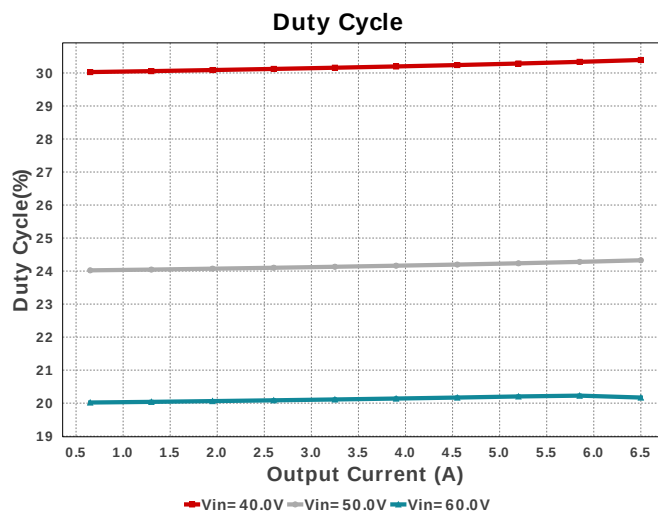
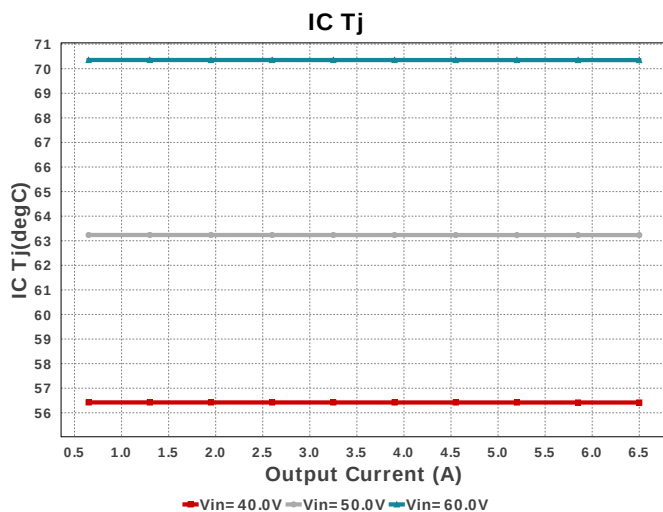
1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. View WEBENCH(R) Disclaimer.

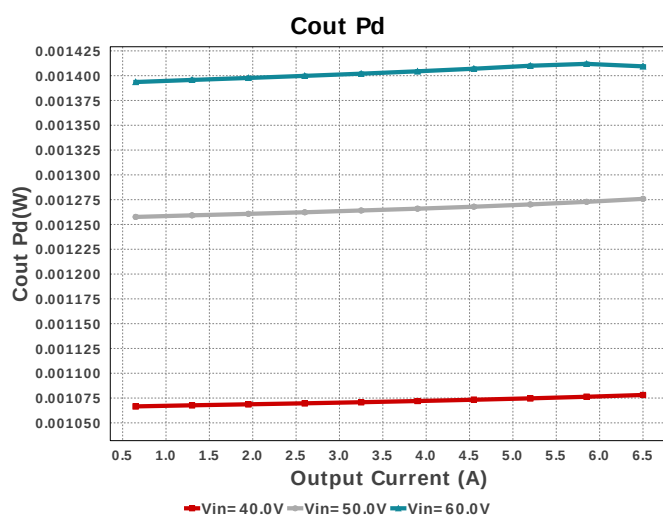
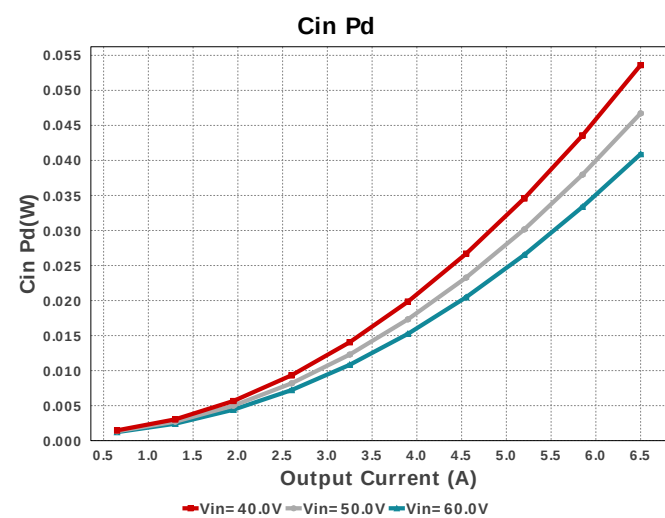
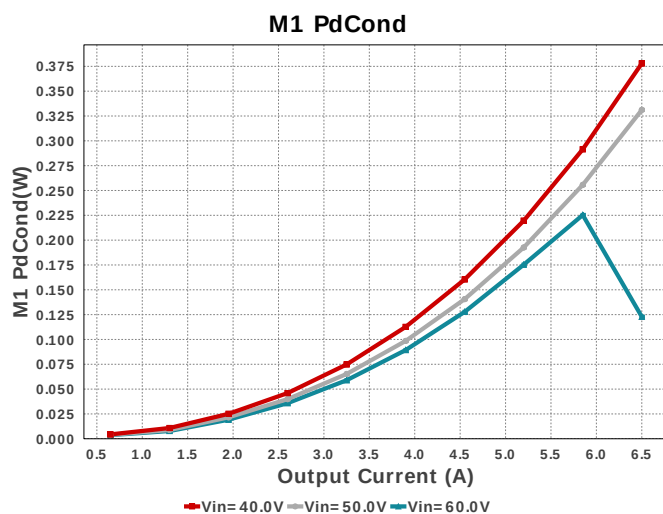
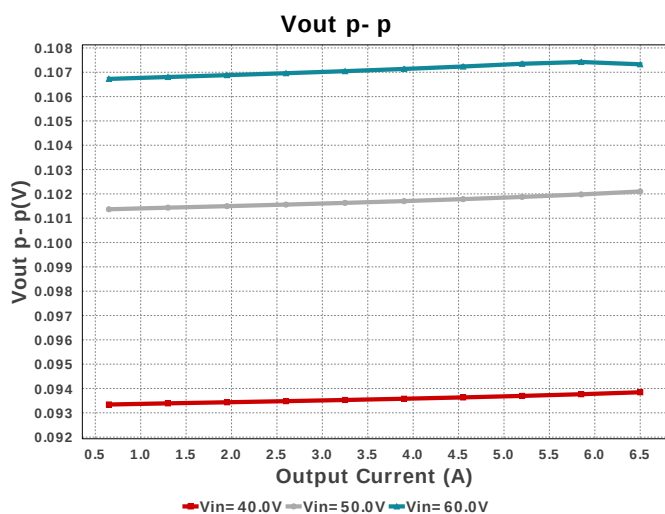
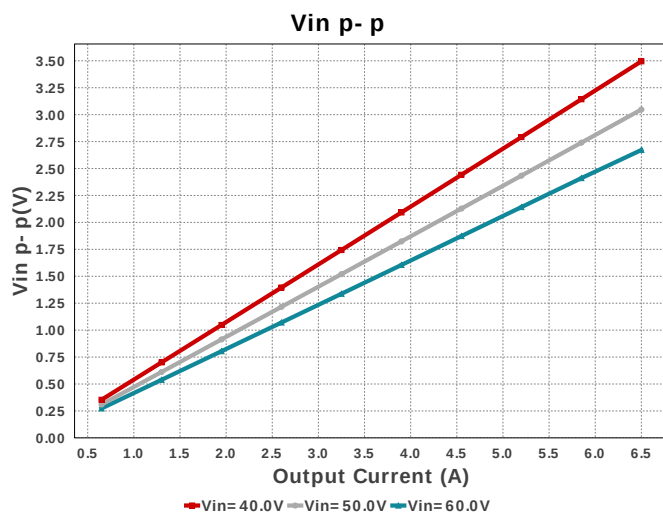
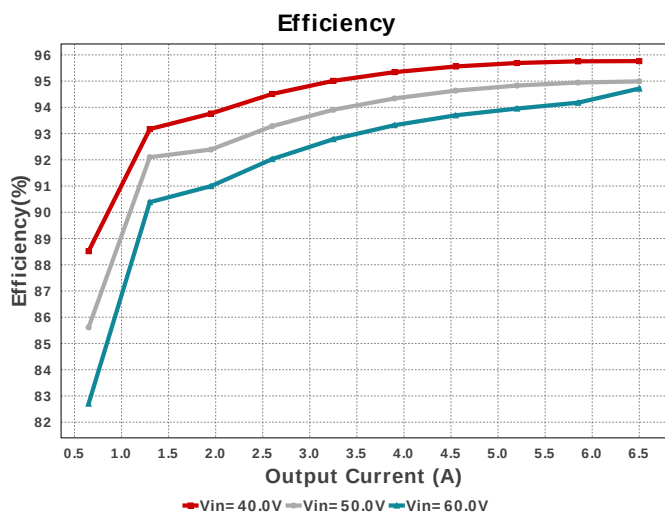
Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	Kemet	C0603C104Z3VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	0603 5 mm ²
Ccomp1	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 mm ²
Ccomp2	MuRata	GRM155R71H391KA01D Series= X7R	Cap= 390.0 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
Ccomp3	MuRata	GRM155R71H561KA01D Series= X7R	Cap= 560.0 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
Cilim	MuRata	GQM2195C2A5R1CB01D Series= C0G/NP0	Cap= 5.1 pF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	\$0.15	0805 7 mm ²
Cin	TDK	C3225X7S2A475M200AB Series= X7S	Cap= 4.7 uF ESR= 5.89 mOhm VDC= 100.0 V IRMS= 6.7739 A	1	\$0.50	1210 15 mm ²
Cout	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	1	\$0.65	1210 15 mm ²
Css	MuRata	GRM155R71C563KA88D Series= X7R	Cap= 56.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²

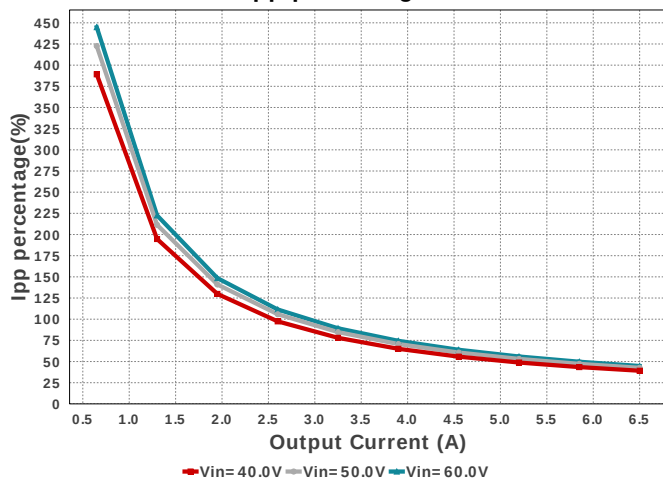
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvcc	TDK	C1005X5R1V225K050BC Series= X5R	Cap= 2.2 uF ESR= 1.0 mOhm VDC= 35.0 V IRMS= 0.0 A	1	\$0.07	 0402_065 3 mm ²
Cvin	TDK	C1608X7S2A104K080AB Series= X7S	Cap= 100.0 nF ESR= 49.59 mOhm VDC= 100.0 V IRMS= 751.62 mA	1	\$0.03	 0603 5 mm ²
L1	Coilcraft	SER2915L-103KL	L= 10.0 µH 1.5 mOhm	1	\$1.88	 SER2915L 652 mm ²
M1	Texas Instruments	CSD19534Q5A	VdsMax= 100.0 V IdsMax= 50.0 Amps	1	\$0.34	 TRANS_NexFET_Q5A 55 mm ²
M2	Texas Instruments	CSD19534Q5A	VdsMax= 100.0 V IdsMax= 50.0 Amps	1	\$0.34	 TRANS_NexFET_Q5A 55 mm ²
Rcomp1	Vishay-Dale	CRCW04022K55FKED Series= CRCW..e3	Res= 2.55 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rcomp2	Vishay-Dale	CRCW040236R5FKED Series= CRCW..e3	Res= 36.5 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rfbb	Vishay-Dale	CRCW04021K27FKED Series= CRCW..e3	Res= 1.27 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rfbt	Yageo	RC0603FR-0718KL Series= ?	Res= 18.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm ²
Rilim	Panasonic	ERJ-6ENF1371V Series= ERJ-6E	Res= 1.37 kOhm Power= 125.0 mW Tolerance= 1.0%	1	\$0.01	 0805 7 mm ²
Rpgood	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rt	Vishay-Dale	CRCW040230K1FKED Series= CRCW..e3	Res= 30.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Ruv1	Vishay-Dale	CRCW0603200KFKEA Series= CRCW..e3	Res= 200.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm ²
Ruv2	Yageo	RC0603FR-077K68L Series= ?	Res= 7.68 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm ²
Rvcc	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rvin	Vishay-Dale	CRCW06032R10FKEA Series= CRCW..e3	Res= 2.1 Ohm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm ²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	LM5145RGYR	Switcher	1	\$1.16	 RGY0020B 25 mm ²

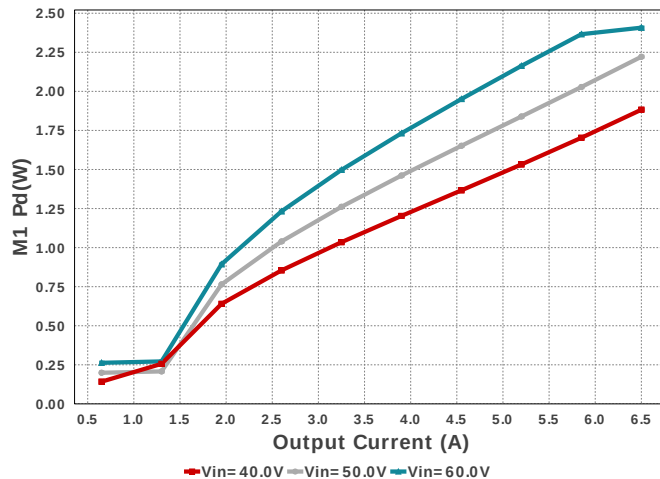




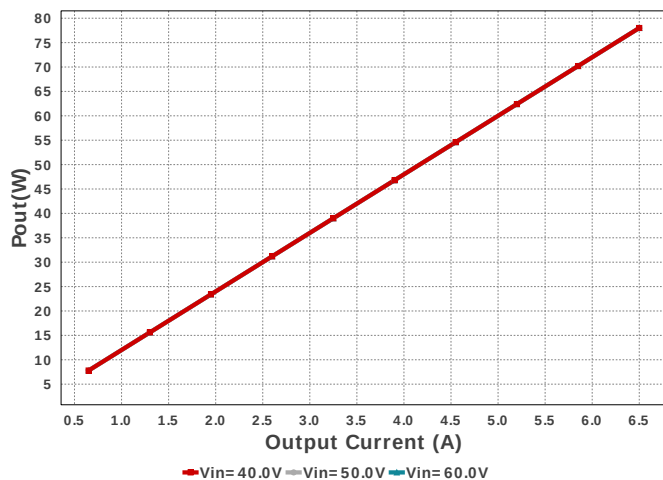
Ipp percentage



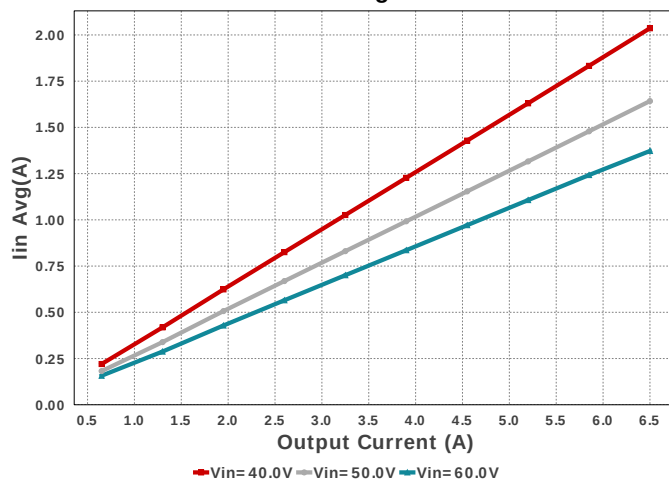
M1 Pd



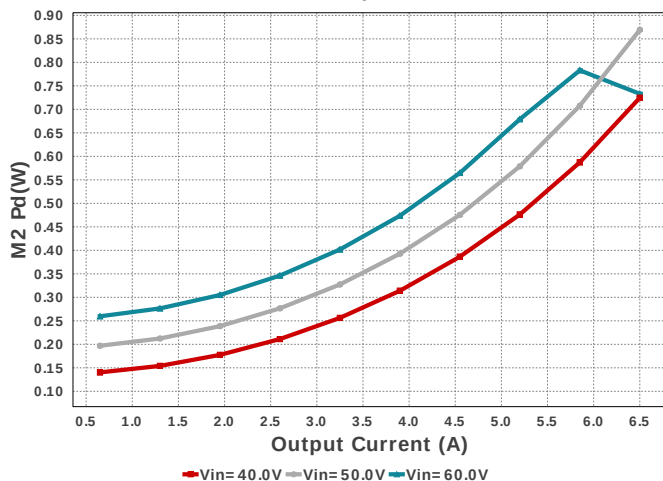
Pout



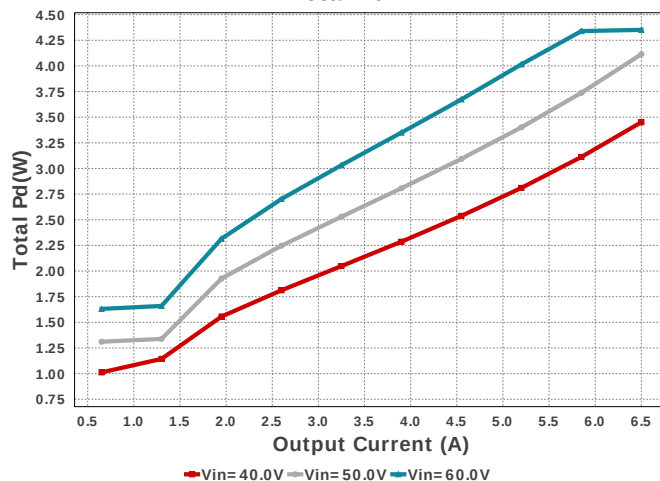
Iin Avg

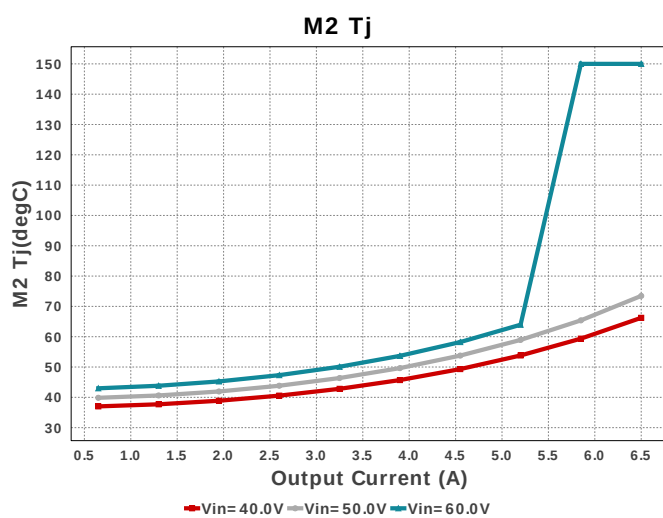
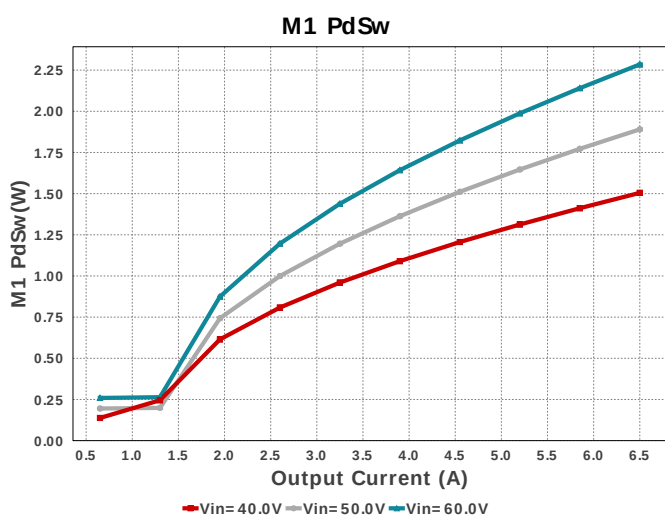
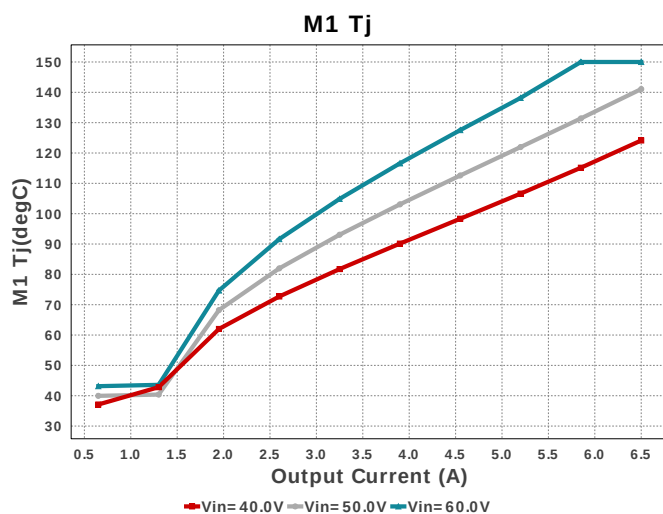
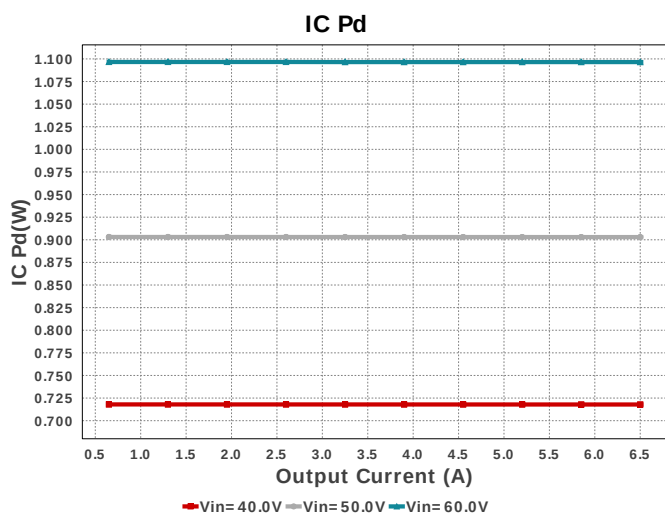
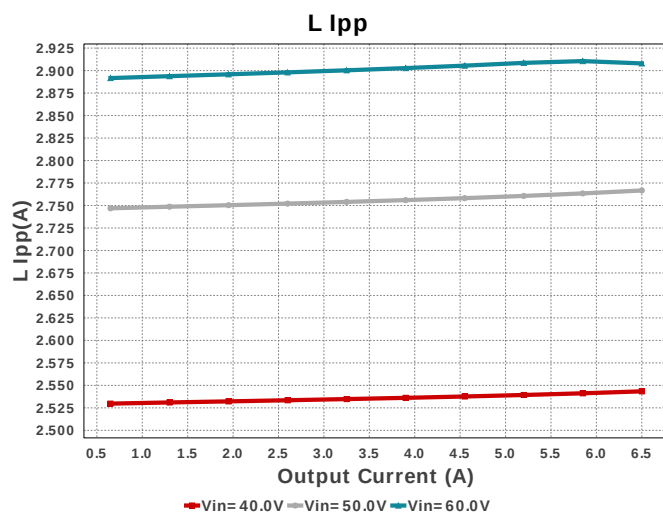
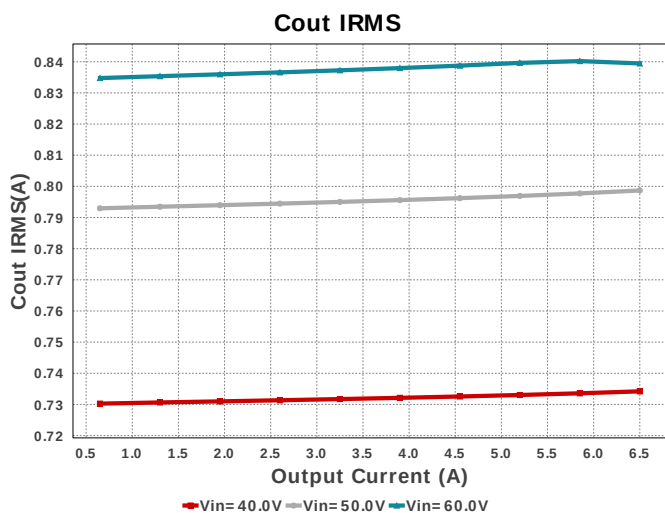


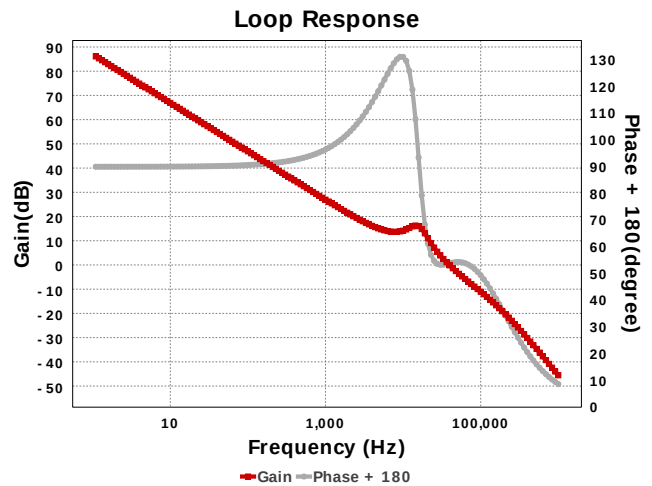
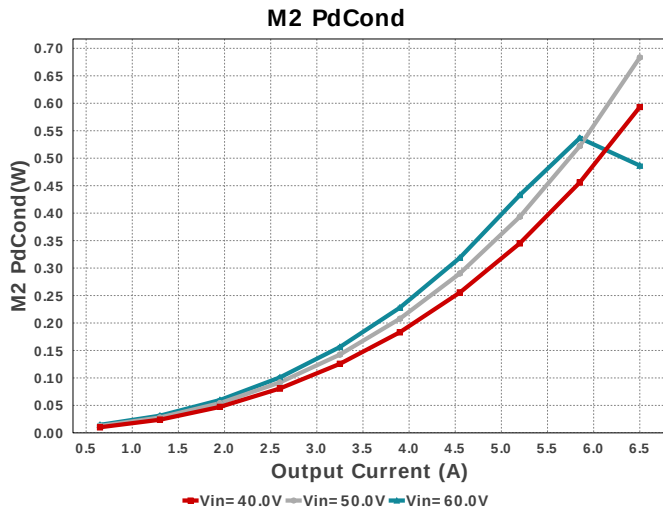
M2 Pd



Total Pd







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	2.635 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	40.907 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	839.457 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	1.409 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	7.954 A	IC	Peak switch current in IC
6.	IC Pd	1.096 W	IC	IC power dissipation
7.	IC Tj	70.351 degC	IC	IC junction temperature
8.	IC Tolerance	8.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	36.8 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	1.372 A	IC	Average input current
11.	Ipp percentage	44.738 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	2.908 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	64.432 mW	Inductor	Inductor power dissipation
14.	M1 Pd	2.408 W	Mosfet	M1 MOSFET total power dissipation
15.	M1 PdCond	122.88 mW	Mosfet	M1 MOSFET conduction losses
16.	M1 PdSw	2.285 W	Mosfet	M1 MOSFET switching losses
17.	M1 Tj	150.0 degC	Mosfet	M1 MOSFET junction temperature
18.	M2 Pd	733.18 mW	Mosfet	M2 MOSFET total power dissipation
19.	M2 PdCond	486.56 mW	Mosfet	M2 MOSFET conduction losses
20.	M2 PdSw	246.62 mW	Mosfet	M2 MOSFET switching losses
21.	M2 Tj	150.0 degC	Mosfet	M2 MOSFET junction temperature
22.	Cin Pd	40.907 mW	Power	Input capacitor power dissipation
23.	Cout Pd	1.409 mW	Power	Output capacitor power dissipation
24.	IC Pd	1.096 W	Power	IC power dissipation
25.	L Pd	64.432 mW	Power	Inductor power dissipation
26.	M1 Pd	2.408 W	Power	M1 MOSFET total power dissipation
27.	M1 PdCond	122.88 mW	Power	M1 MOSFET conduction losses
28.	M1 PdSw	2.285 W	Power	M1 MOSFET switching losses
29.	M2 Pd	733.18 mW	Power	M2 MOSFET total power dissipation
30.	M2 PdCond	486.56 mW	Power	M2 MOSFET conduction losses
31.	M2 PdSw	246.62 mW	Power	M2 MOSFET switching losses
32.	Total Pd	4.351 W	Power	Total Power Dissipation
33.	BOM Count	25	System	Total Design BOM count
34.	Cross Freq	39.37 kHz	Information	Bode plot crossover frequency
35.	Duty Cycle	20.17 %	Information	Duty cycle
36.	Efficiency	94.716 %	System	Steady state efficiency
37.	FootPrint	891.0 mm ²	Information	Total Foot Print Area of BOM components
38.	Frequency	332.226 kHz	System	Switching frequency
39.	Gain Marg	-56.913 dB	Information	Bode Plot Gain Margin
40.	Iout	6.5 A	System	Iout operating point
41.	Low Freq Gain	86.097 dB	Information	Gain at 1Hz

#	Name	Value	Category	Description
42.	Mode	CCM	System Information	Conduction Mode
43.	Phase Marg	53.833 deg	System Information	Bode Plot Phase Margin
44.	Pout	78.0 W	System Information	Total output power
45.	Total BOM	\$5.275	System Information	Total BOM Cost
46.	Vin	60.0 V	System Information	Vin operating point
47.	Vin p-p	2.672 V	System Information	Peak-to-peak input voltage
48.	Vout	12.0 V	System Information	Operational Output Voltage
49.	Vout Actual	12.139 V	System Information	Vout Actual calculated based on selected voltage divider resistors
50.	Vout Tolerance	2.906 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
51.	Vout p-p	107.327 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	6.5	Maximum Output Current
VinMax	60.0	Maximum input voltage
VinMin	40.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM5145	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 C_{in} and C_{out} , 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

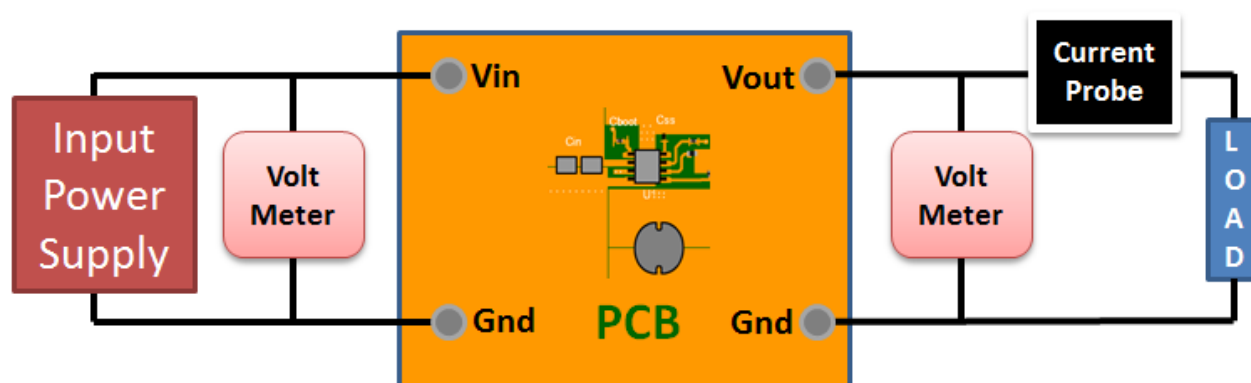
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab down 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 40.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to V_{in} and GND. Connect a digital volt meter and a load if needed to set the minimum load of the design from V_{out} 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 V_{in} and GND, a load is connected between V_{out} and GND and a current meter is connected in series between V_{out} 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 : C4B4E1E3CC7FDF8C[v1]
2. **LM5145** Product Folder : <http://www.ti.com/product/lm5145> : contains the data sheet and other resources.

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