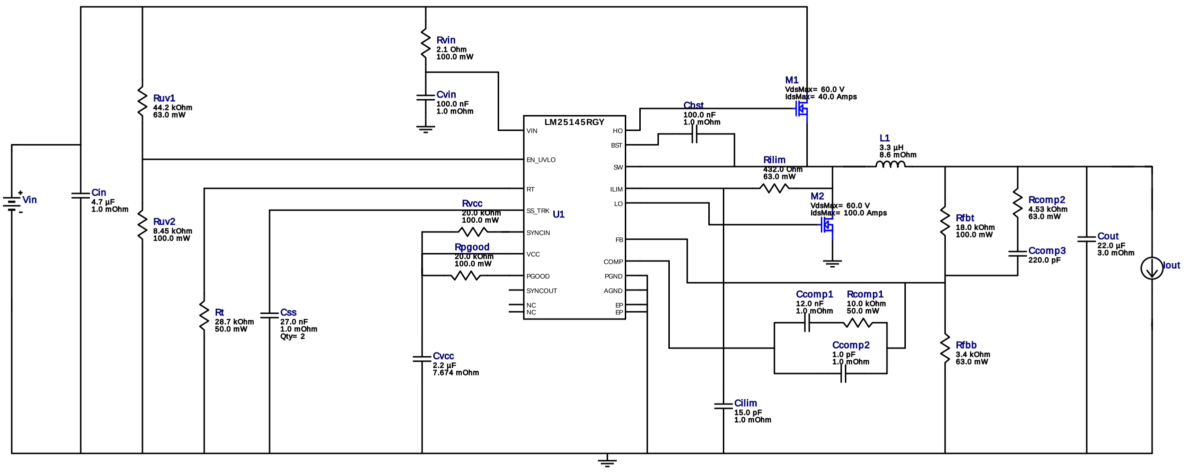
VinMin = 9.0V
VinMax = 36.0V
Vout = 5.0V
Iout = 9.0A

Device = LM25145RGYR
Topology = Buck
Created = 2018-12-17 04:54:37.870
BOM Cost = $6.99
BOM Count = 26
Total Pd = 2.47W

WEBENCH ® Design Report

Design : 114 LM25145RGYR
LM25145RGYR 9V-36V to 5.00V @ 9A

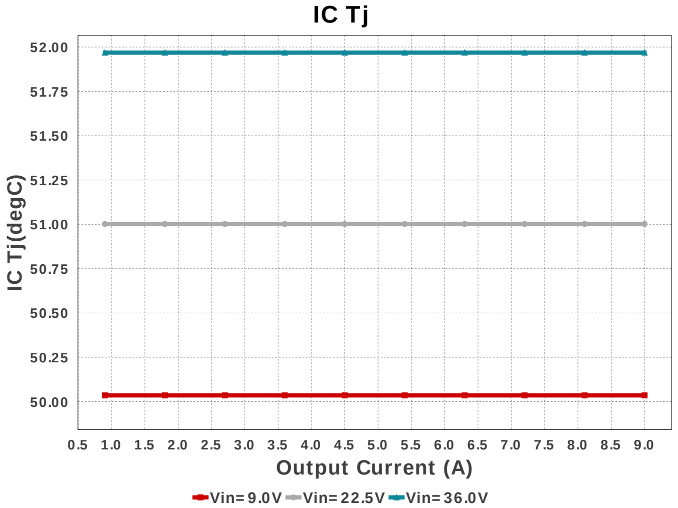


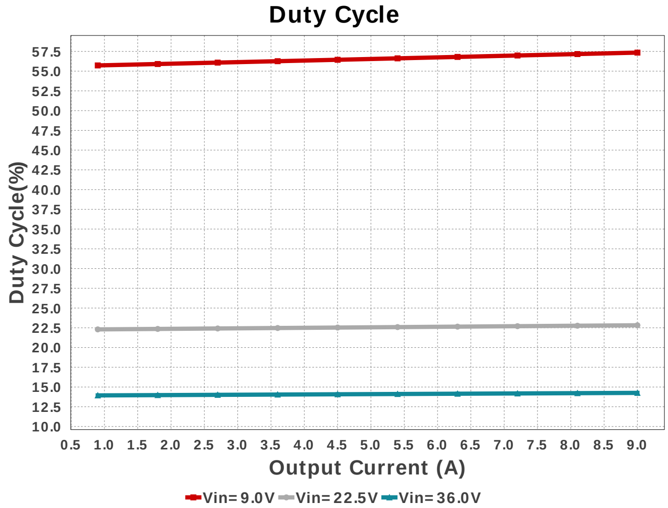
1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific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

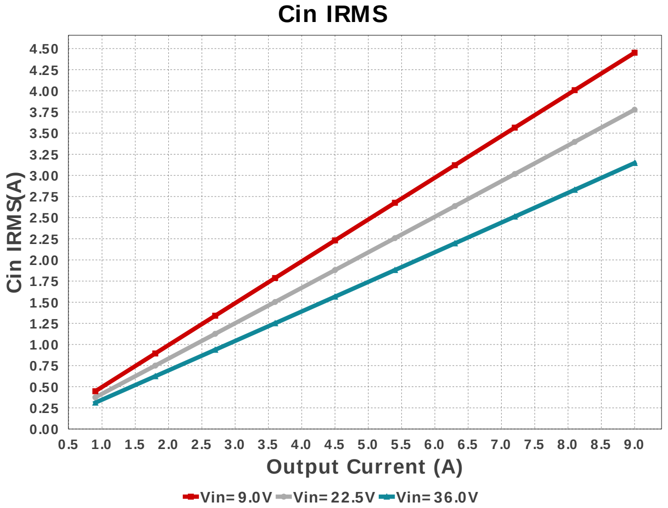
Electrical BOM

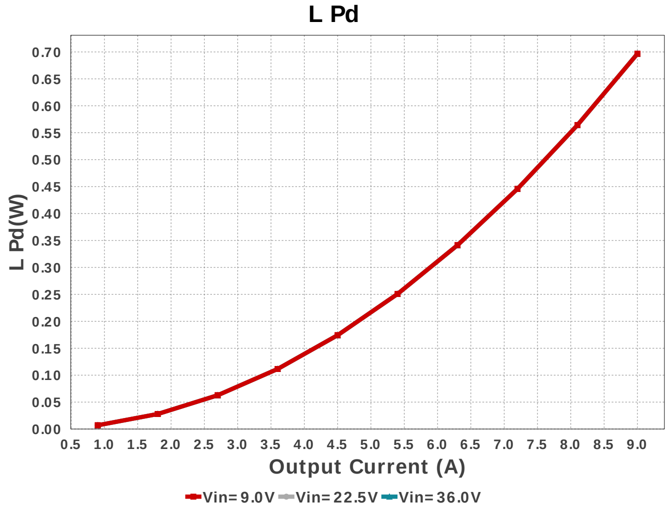
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	MuRata	~~GRM188R61E104KA01D~~ Series= X5R CC0402KRX5R9BB104 UMK105BJ104KV-F	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Ccomp1	MuRata	~~GRM155R71C123KA01D~~ Series= X7R CC0402KRX7R7BB123 CL05B123KO5NNNC	Cap= 12.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	MuRata	~~GRM1555C1H1R0CA01D~~ Series= C0G/NP0 CC0402CRNPO9BN1R0 CGA2B2C0G1H010C050BA	Cap= 1.0 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp3	Samsung Electro-Mechanics	CL05C221JA5NNNC Series= C0G/NP0 UMK105CG221JV-F	Cap= 220.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cilim	MuRata	~~GRM1885C2A150JA01D~~ Series= C0G/NP0 06031A150FAT2A 0603N150J101CT	Cap= 15.0 pF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm^2
Cin	MuRata	~~GRM32ER71H475KA88L~~ Series= X7R UMK316ABJ475KD-T C1206C475K5PACTU	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 6.0 A	1	$0.55	1210 15 mm^2
Cout	MuRata	~~GRM32ER71C226ME18L~~ Series= X7R CL21A226MOCLRNC GRM219R61C226ME15L	Cap= 22.0 uF ESR= 3.0 mOhm VDC= 16.0 V IRMS= 3.2 A	1	$2.27	1210 15 mm^2
Css	MuRata	~~GRM155R71A273KA01D~~ Series= X7R CL05B273KO5NNNC CC0402KRX7R6BB273	Cap= 27.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	2	$0.01	0402 3 mm^2

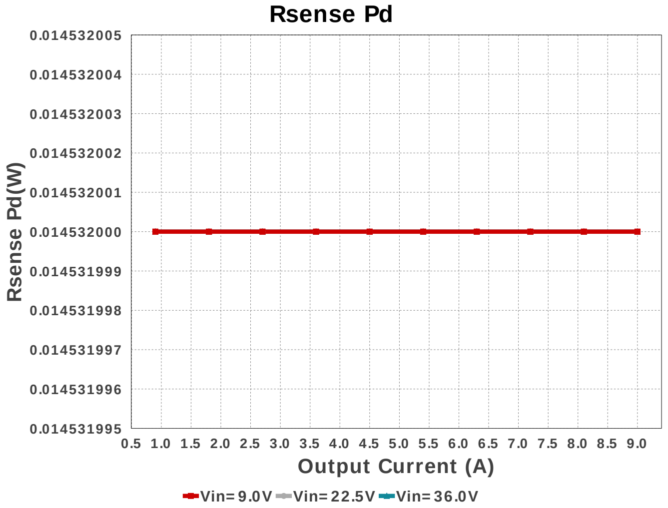
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvcc	TDK	C1608X5R1V225K080AC Series= X5R GRM188R6YA225KA12D	Cap= 2.2 uF ESR= 7.674 mOhm VDC= 35.0 V IRMS= 1.87823 A	1	$0.06	0603 5 mm²
Cvin	MuRata	GRM188R72A104KA35D Series= X7R CC0603KRX7R0BB104 CGA3E3X7S2A104K080AB	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 3.85 A	1	$0.05	0603 5 mm²
L1	Coilcraft	XAL7070-332MEB PA5005.332NLT SRP6050CA-3R3M	L= 3.3 µH DCR= 8.6 mOhm	1	$1.19	XAL7070 87 mm²
M1	Infineon Technologies	~~BSZ100N06LS3 G~~ CSD18543Q3A BSZ100N06LS3 G	VdsMax= 60.0 V IdsMax= 40.0 Amps	1	$0.40	PG-TSDSON-8 19 mm²
M2	Texas Instruments	CSD18531Q5A CSD18531Q5AT	VdsMax= 60.0 V IdsMax= 100.0 Amps	1	$0.58	TRANS_NexFET_Q5A 55 mm²
Rcomp1	Yageo	~~RC0201FR-0710KL~~ Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rcomp2	Vishay-Dale	CRCW04024K53FKED Series= CRCW..e3	Res= 4.53 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Vishay-Dale	CRCW04023K40FKED Series= CRCW..e3	Res= 3.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Yageo	RC0603FR-0718KL Series= ? ERJ-3EKF1802V	Res= 18.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rilim	Vishay-Dale	CRCW0402432RFKED Series= CRCW..e3	Res= 432.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rpgood	Yageo	~~RC0603FR-0720KL~~ Series= ? Use 20K 0.065W 0402 resistor	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rt	Yageo	~~RC0201FR-0728K7L~~ Series= ?	Res= 28.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Ruv1	Yageo	AC0402FR-0744K2L Series= ?	Res= 44.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Ruv2	Yageo	RC0603FR-078K45L Series= ? RMCF0603FT8K45	Res= 8.45 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rvcc	Yageo	RC0603FR-0720KL Series= ? ERJ-3EKF2002V	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rvin	Vishay-Dale	CRCW06032R10FKEA Series= CRCW..e3 RC0603FR-072R1L	Res= 2.1 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
U1	Texas Instruments	LM25145RGYR	Switcher	1	$1.70	RGY0020B 25 mm²

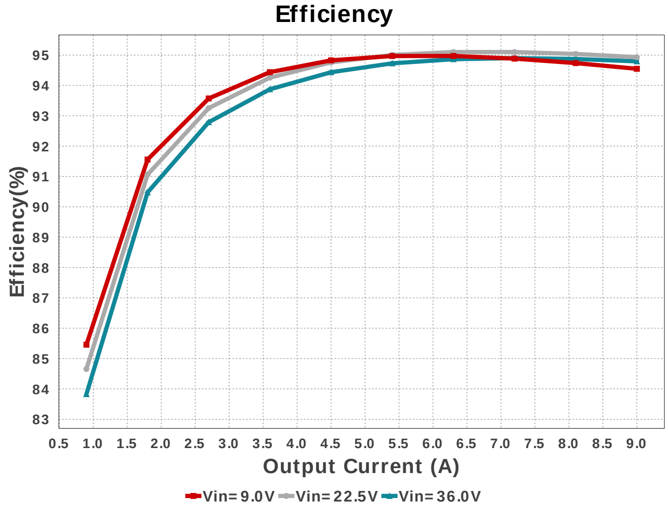

IC Tj
IC Tj(degC)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

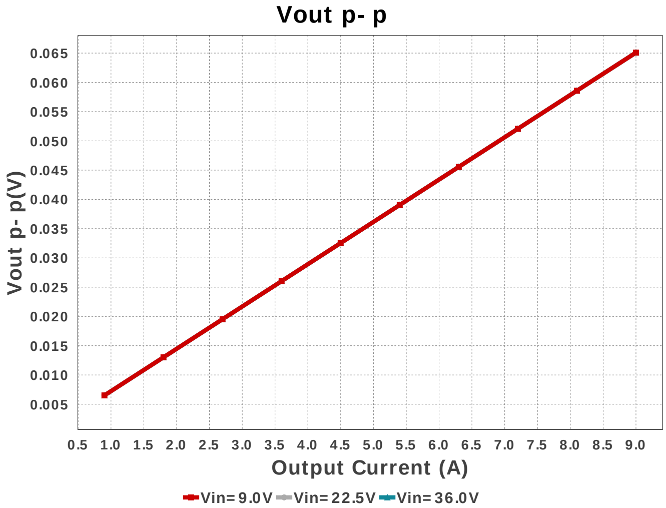

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

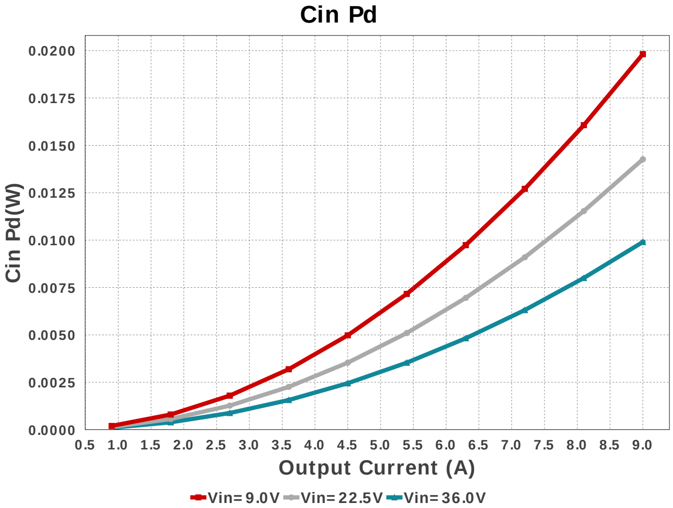

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

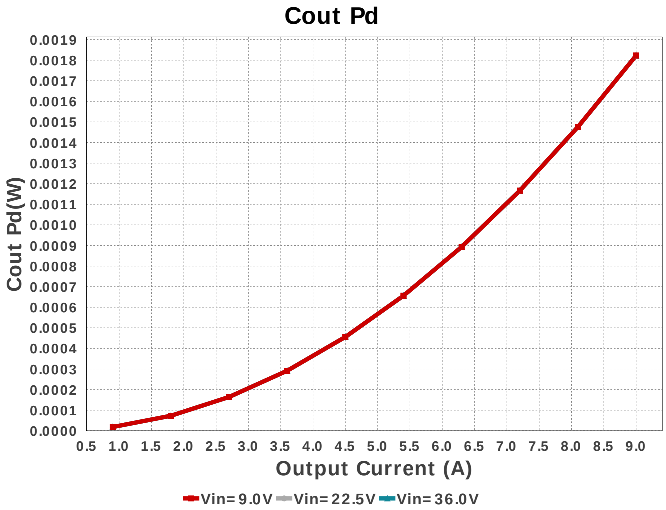

L Pd
L Pd(W)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

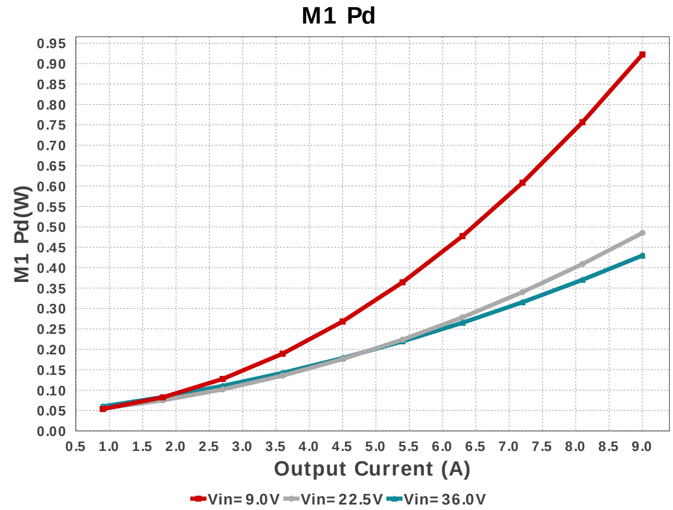

Rsense Pd
Rsense Pd(W)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

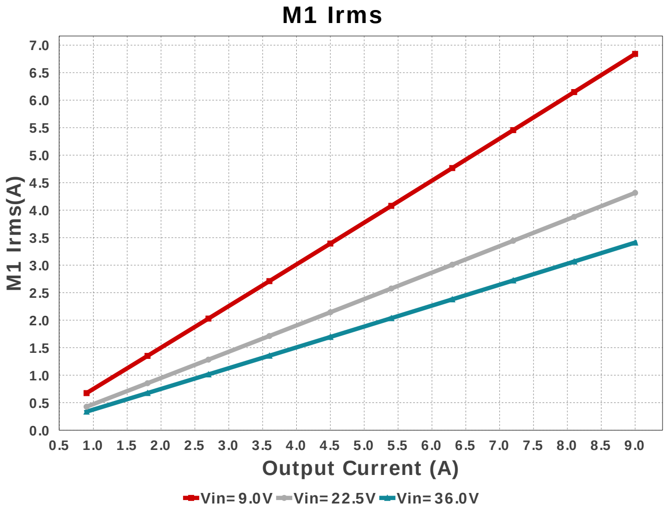

Efficiency
Efficiency(%)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

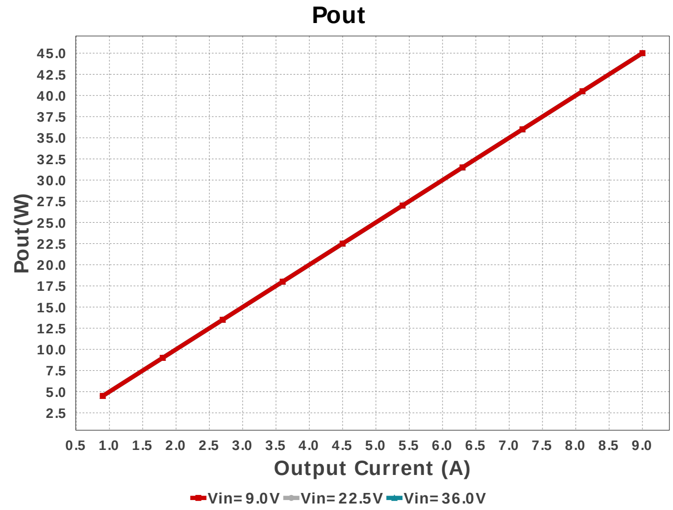

Vout p- p
Vout p- p(V)
Output Current (A)


Cin Pd
Cin Pd(W)
Output Current (A)
Vin= 9.0V Vin= 22.5V Vin= 36.0V

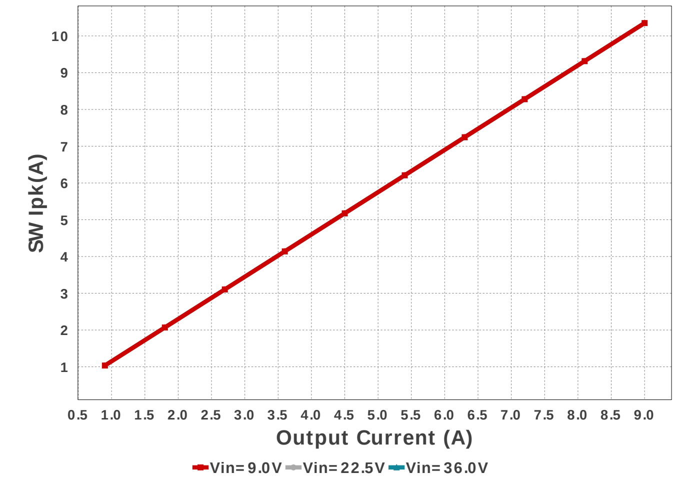

Cout Pd
Cout Pd(W)
Output Current (A)
Vin= 9.0V Vin= 22.5V Vin= 36.0V


M1 Pd
M1 Pd(W)
Output Current (A)
Vin= 9.0V Vin= 22.5V Vin= 36.0V

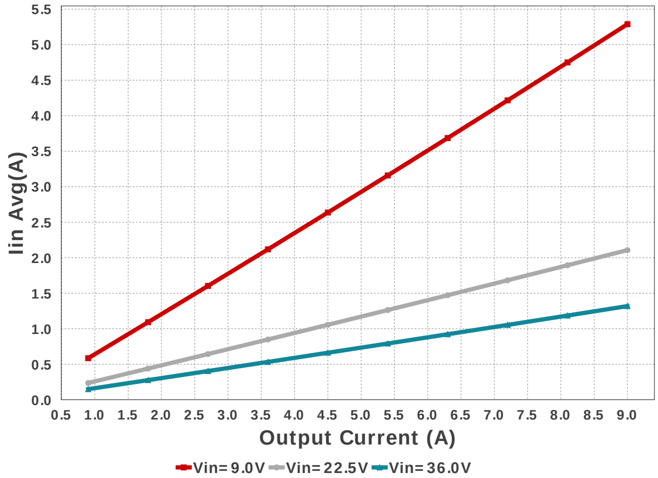

M1 Irms
M1 Irms(A)
Output Current (A)
Vin= 9.0V Vin= 22.5V Vin= 36.0V


Pout
Pout(W)
Output Current (A)
Vin= 9.0V Vin= 22.5V Vin= 36.0V

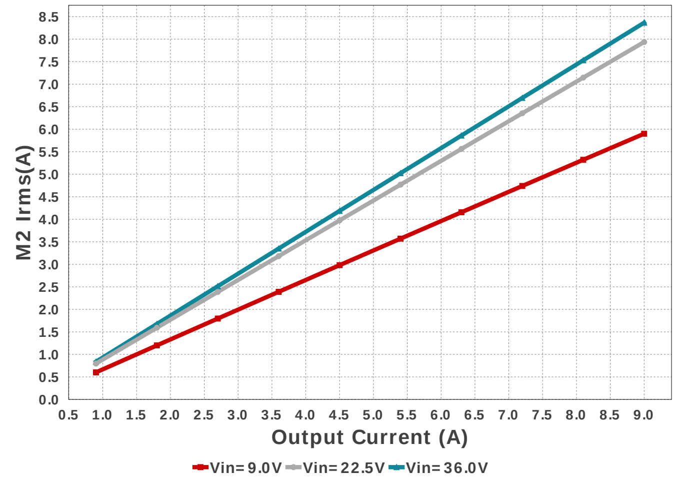
SW Ipk



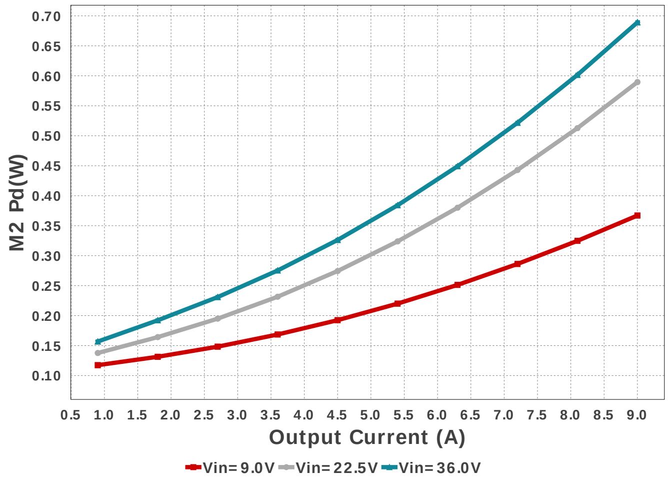
Iin Avg



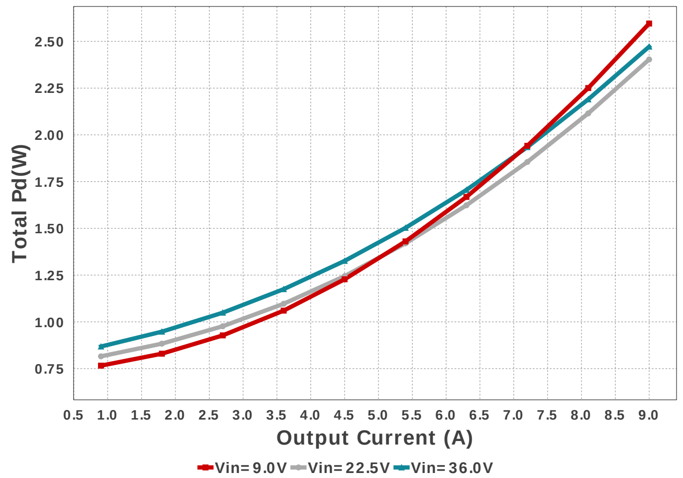
M2 Irms



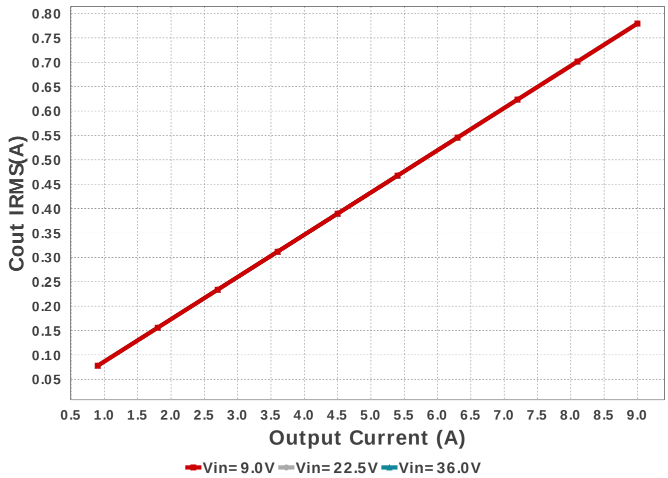
M2 Pd



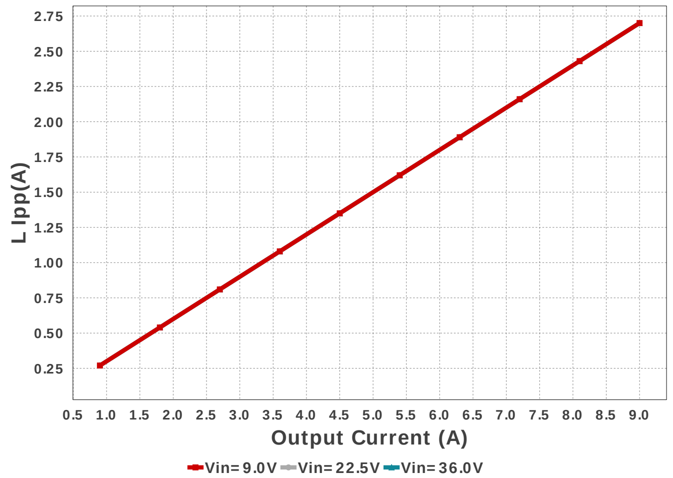
Total Pd



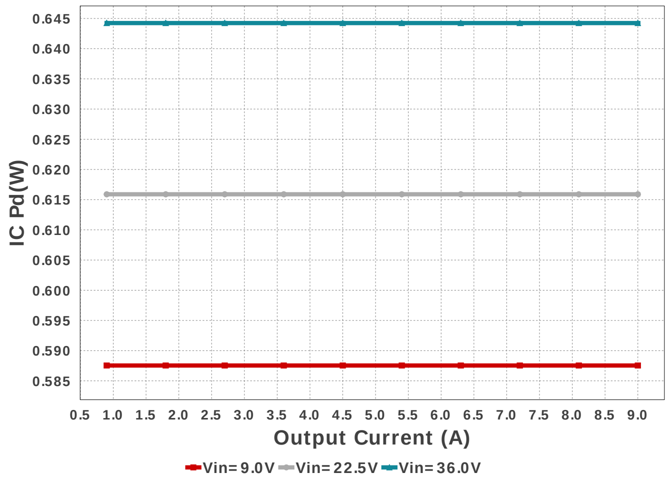
Cout IRMS



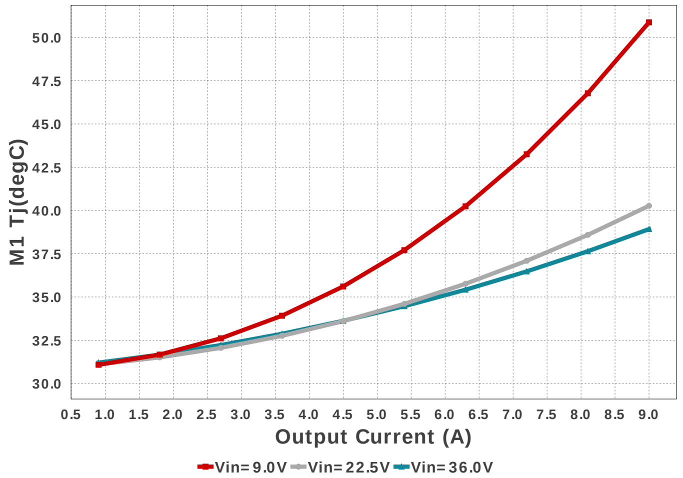
L Ipp



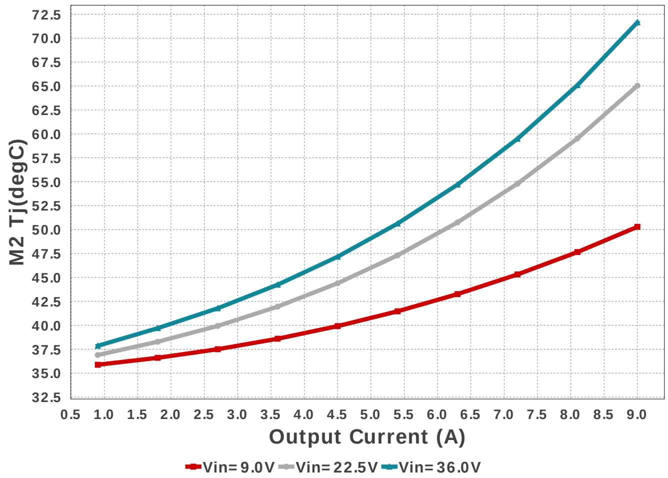
IC Pd



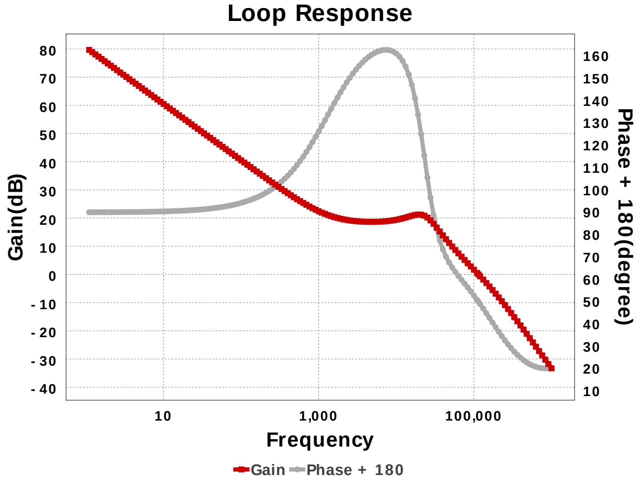
M1 Tj



M2 Tj



Loop Response



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	3.147 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	9.902 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	779.423 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	1.822 mW	Capacitor	Output capacitor power dissipation
5.	IC Pd	644.24 mW	IC	IC power dissipation
6.	IC Tj	51.969 degC	IC	IC junction temperature
7.	IC Tolerance	8.0 mV	IC	IC Feedback Tolerance
8.	Iin Avg	1.319 A	IC	Average input current
9.	L Ipp	2.7 A	Inductor	Peak-to-peak inductor ripple current
10.	L Pd	696.6 mW	Inductor	Inductor power dissipation
11.	M1 Irms	3.411 A	Mosfet	MOSFET RMS ripple current

#	Name	Value	Category	Description
12.	M1 Pd	430.73 mW	Mosfet	M1 MOSFET total power dissipation
13.	M1 Tj	38.94 degC	Mosfet	M1 MOSFET junction temperature
14.	M2 Irms	8.365 A	Mosfet	MOSFET RMS ripple current
15.	M2 Pd	690.45 mW	Mosfet	M2 MOSFET total power dissipation
16.	M2 Tj	71.729 degC	Mosfet	M2 MOSFET junction temperature
17.	Cin Pd	9.902 mW	Power	Input capacitor power dissipation
18.	Cout Pd	1.822 mW	Power	Output capacitor power dissipation
19.	IC Pd	644.24 mW	Power	IC power dissipation
20.	L Pd	696.6 mW	Power	Inductor power dissipation
21.	M1 Pd	430.73 mW	Power	M1 MOSFET total power dissipation
22.	M2 Pd	690.45 mW	Power	M2 MOSFET total power dissipation
23.	Rsense Pd	14.532 mW	Power	LED Current Rsns Power Dissipation
24.	Total Pd	2.474 W	Power	Total Power Dissipation
25.	Rsense Pd	14.532 mW	Resistor	LED Current Rsns Power Dissipation
26.	BOM Count	26	System Information	Total Design BOM count
27.	Cross Freq	113.82 kHz	System Information	Bode plot crossover frequency
28.	Duty Cycle	14.257 %	System Information	Duty cycle
29.	Efficiency	94.789 %	System Information	Steady state efficiency
30.	FootPrint	289.0 mm^2	System Information	Total Foot Print Area of BOM components
31.	Frequency	348.432 kHz	System Information	Switching frequency
32.	Gain Marg	-60.657 dB	System Information	Bode Plot Gain Margin
33.	Iout	9.0 A	System Information	Iout operating point
34.	Low Freq Gain	79.664 dB	System Information	Gain at 1Hz
35.	Mode	CCM	System Information	Conduction Mode
36.	Phase Marg	50.062 deg	System Information	Bode Plot Phase Margin
37.	Pout	45.0 W	System Information	Total output power
38.	SW Ipk	10.35 A	System Information	Peak switch current
39.	Total BOM	$6.99	System Information	Total BOM Cost
40.	Vin	36.0 V	System Information	Vin operating point
41.	Vout Actual	5.035 V	System Information	Vout Actual calculated based on selected voltage divider resistors
42.	Vout Tolerance	2.716 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
43.	Vout p-p	64.552 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	9.0	Maximum Output Current
VinMax	36.0	Maximum input voltage
VinMin	9.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM25145	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

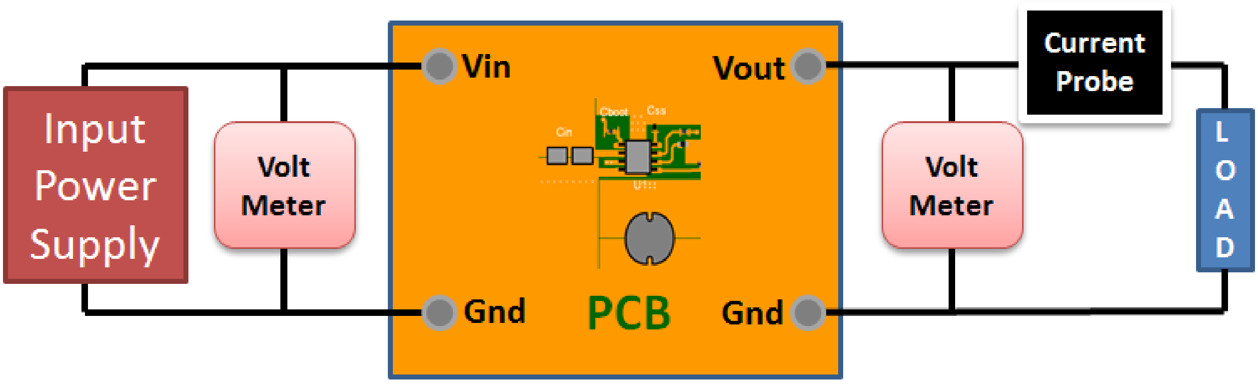
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 9.0V 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 : 0FA1F46BA1BAED1A[v1]

2. **LM25145** Product Folder : http://www.ti.com/product/lm25145 : contains the data sheet and other resources.

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