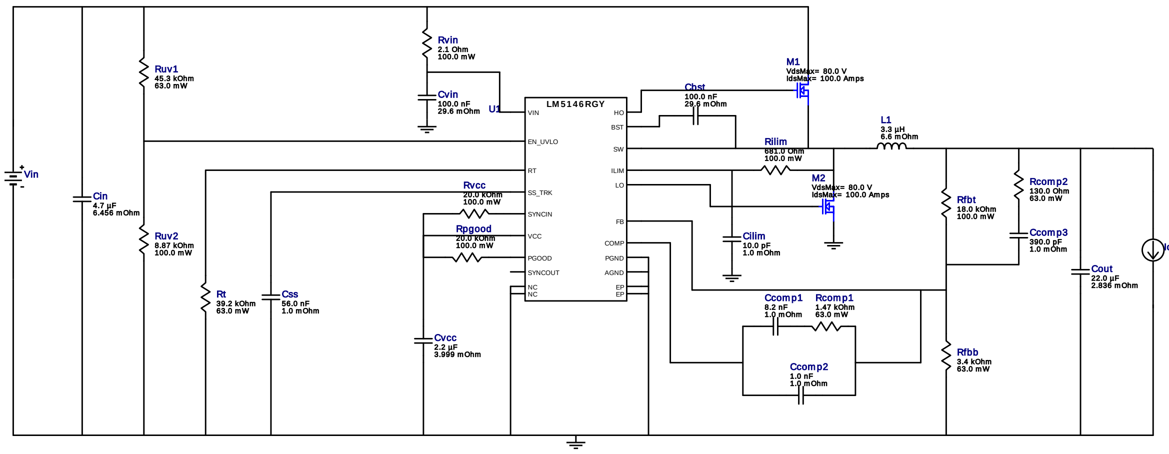
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 9.0V
VinMax = 36.0V
Vout = 5.0V
Iout = 11.0A

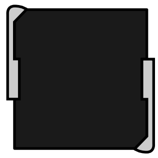
Device = LM5146RGYR
Topology = Buck
Created = 2025-10-21 03:42:05.797
BOM Cost = $4.60
BOM Count = 25
Total Pd = 4.54W

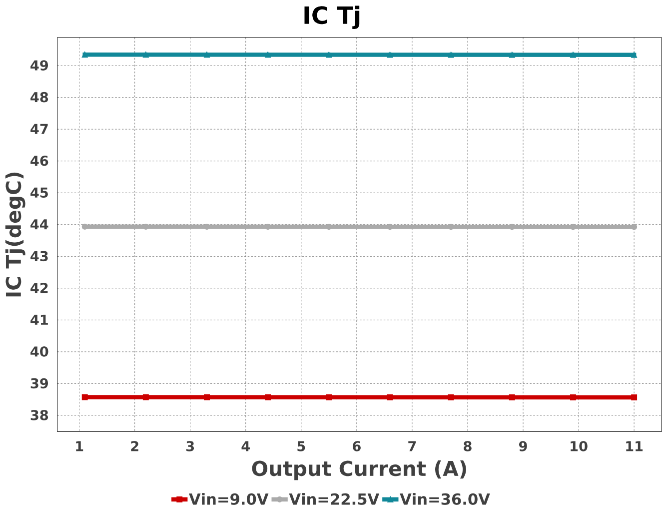
Design : 15 LM5146RGYR
LM5146RGYR 9V-36V to 5.00V @ 11A

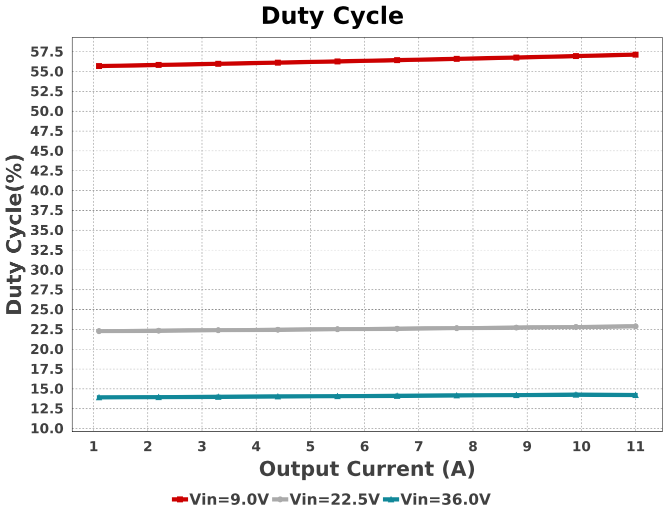


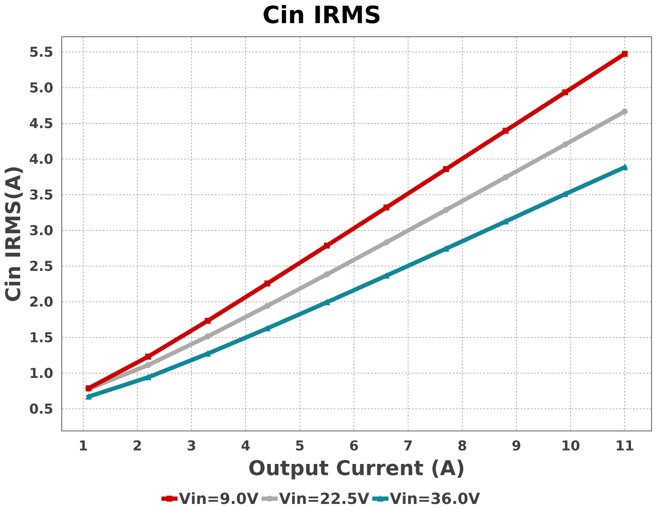
Electrical BOM

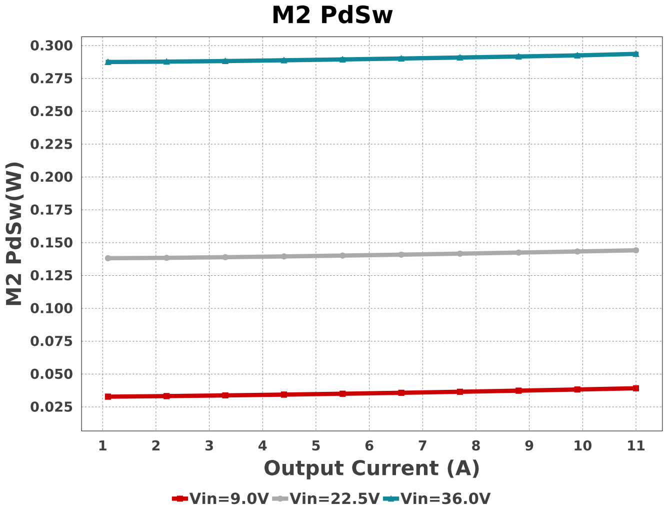
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	$0.01	0603 5 mm^2
Ccomp1	MuRata	GRM155R71C822KA01D Series= X7R	Cap= 8.2 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	MuRata	GRM155R71C102KA01D Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp3	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
Cilim	MuRata	GRM1885C2A100JA01D Series= C0G/NP0	Cap= 10.0 pF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm^2
Cin	Taiyo Yuden	MSASU32MSB7475MPNA01 Series= X7R	Cap= 4.7 uF ESR= 6.456 mOhm VDC= 50.0 V IRMS= 3.147 A	1	$0.15	1210 15 mm^2
Cout	Taiyo Yuden	MCASL32MSB5226MPNA01 Series= X5R	Cap= 22.0 uF ESR= 2.836 mOhm VDC= 10.0 V IRMS= 4.1463 A	1	$0.21	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
Cvcc	TDK	CGA5L2X7R1E225K160AA Series= X7R	Cap= 2.2 uF ESR= 3.999 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.08	1206 11 mm^2

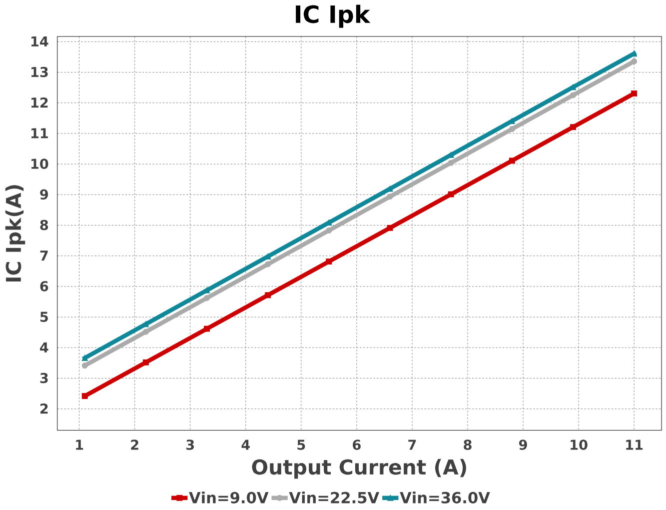
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvin	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	$0.01	0603 5 mm^2
L1	Bourns	SRP1270-3R3M	L= 3.3 µH 6.6 mOhm	1	$0.83	 SRP1270 246 mm^2
M1	Texas Instruments	CSD19502Q5B	VdsMax= 80.0 V IdsMax= 100.0 Amps	1	$0.74	DQK0006C 9 mm^2
M2	Texas Instruments	CSD19502Q5B	VdsMax= 80.0 V IdsMax= 100.0 Amps	1	$0.74	DQK0006C 9 mm^2
Rcomp1	Vishay-Dale	CRCW04021K47FKED Series= CRCW..e3	Res= 1.47 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcomp2	Vishay-Dale	CRCW0402130RFKED Series= CRCW..e3	Res= 130.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW04023K40FKED Series= CRCW..e3	Res= 3.4 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	Vishay-Dale	CRCW0603681RFKEA Series= CRCW..e3	Res= 681.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rpgood	Yageo	RC0603FR-0720KL Series= ?	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rt	Vishay-Dale	CRCW040239K2FKED Series= CRCW..e3	Res= 39.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ruv1	Vishay-Dale	CRCW040245K3FKED Series= CRCW..e3	Res= 45.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ruv2	Yageo	RC0603FR-078K87L Series= ?	Res= 8.87 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rvcc	Yageo	RC0603FR-0720KL Series= ?	Res= 20.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 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
U1	Texas Instruments	LM5146RGYR	Switcher	1	$1.66	RGY0020B 25 mm^2

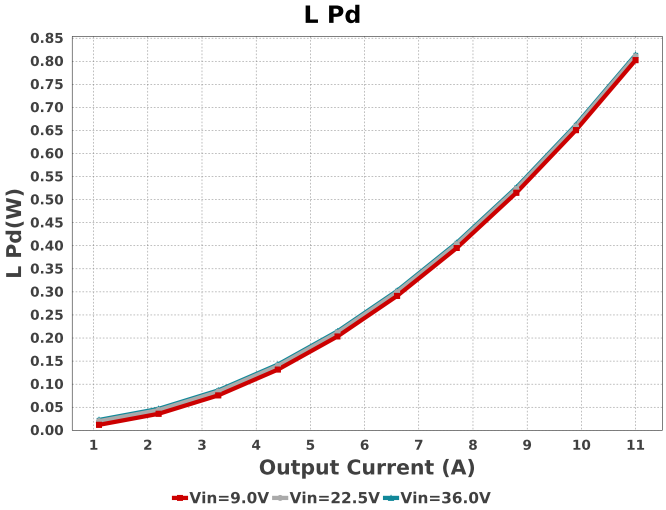

IC Tj
IC Tj(degC)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

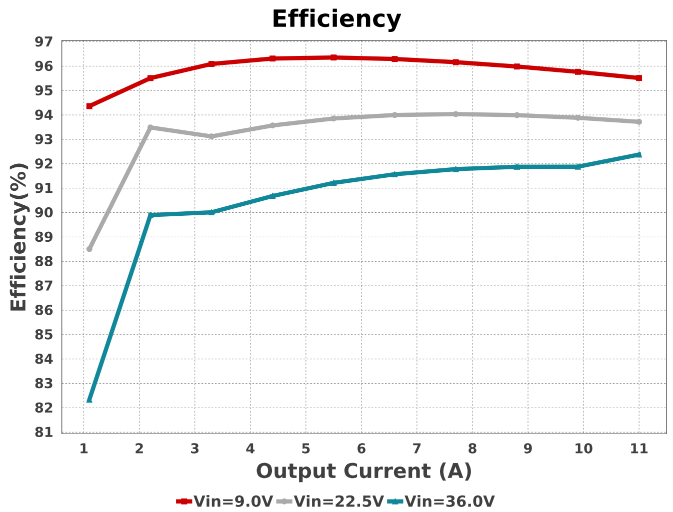

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

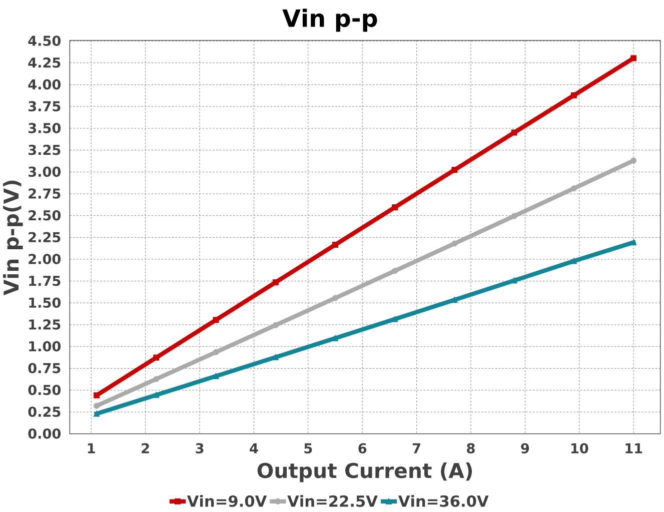

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

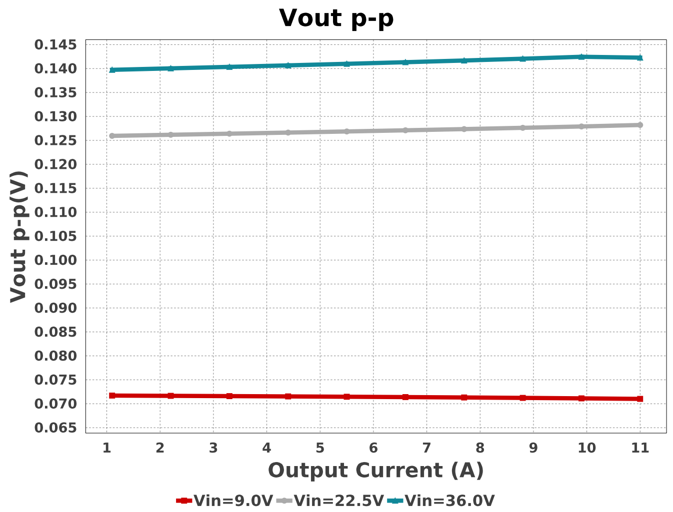

M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

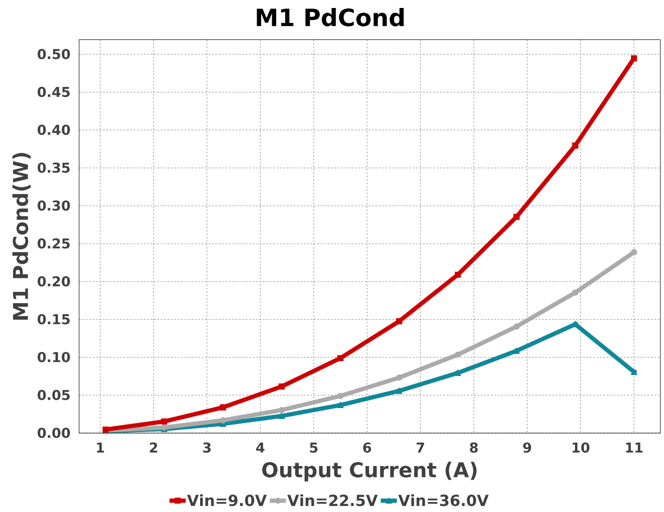

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

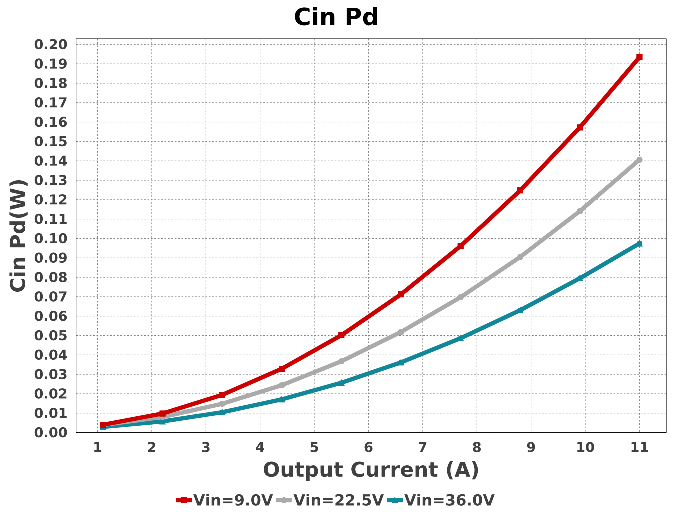

L Pd
L Pd(W)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

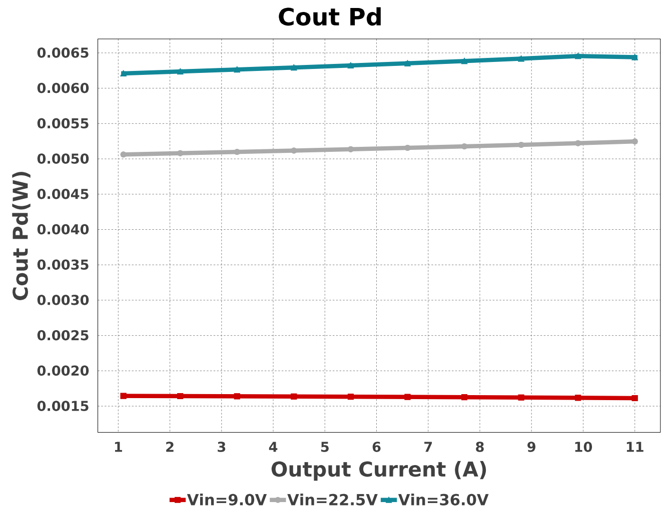

Efficiency
Efficiency(%)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V


Vin p-p
Vin p-p(V)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

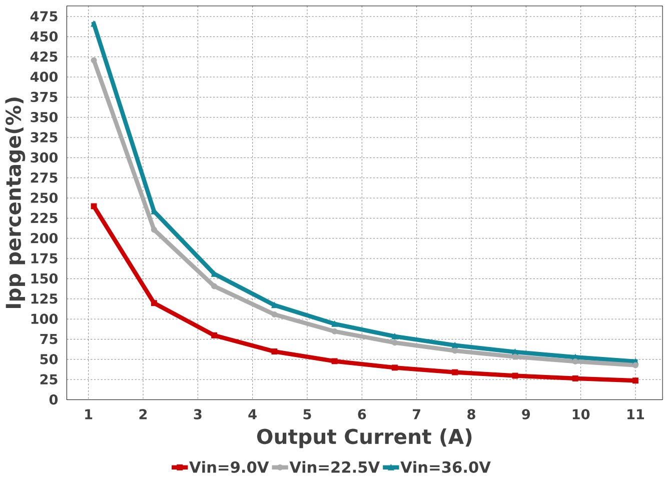

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V


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

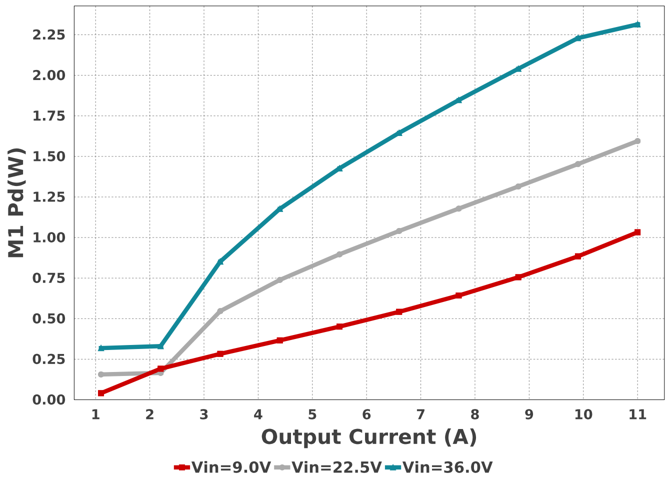

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V


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

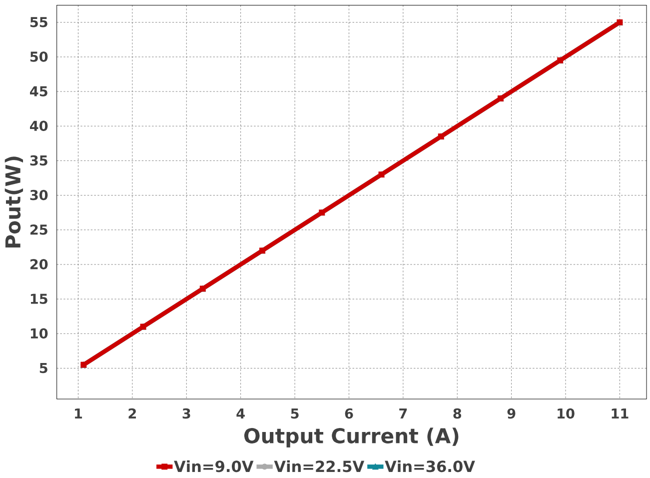
Ipp percentage



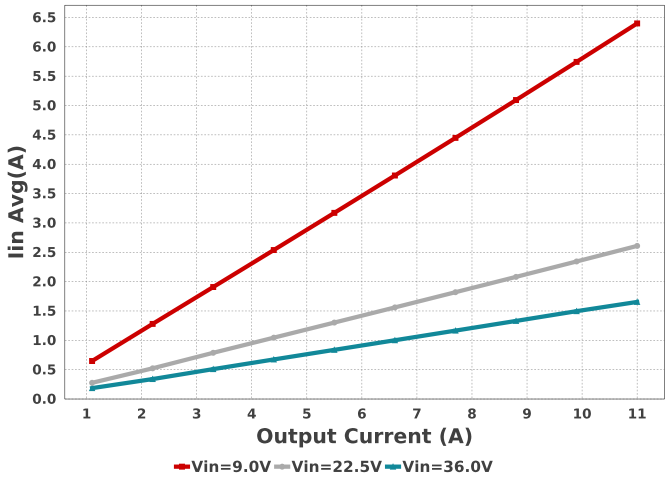
M1 Pd



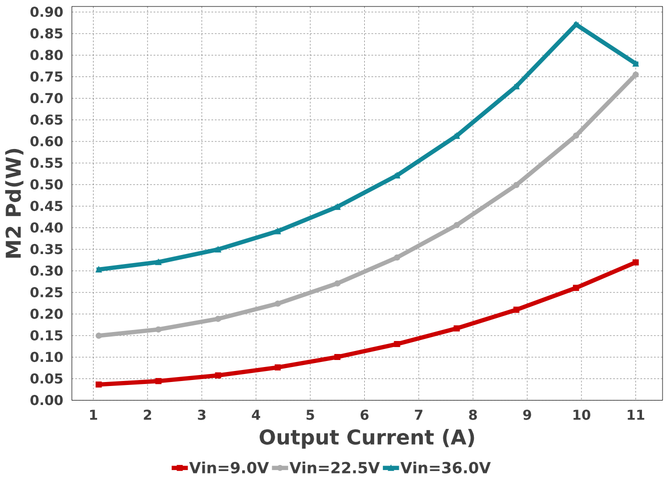
Pout



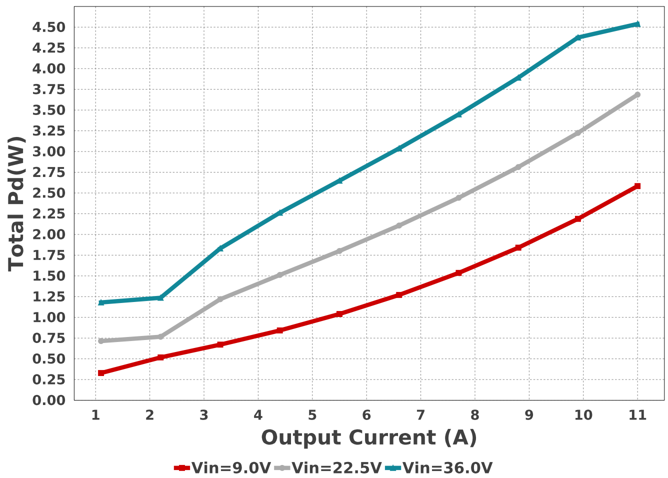
Iin Avg



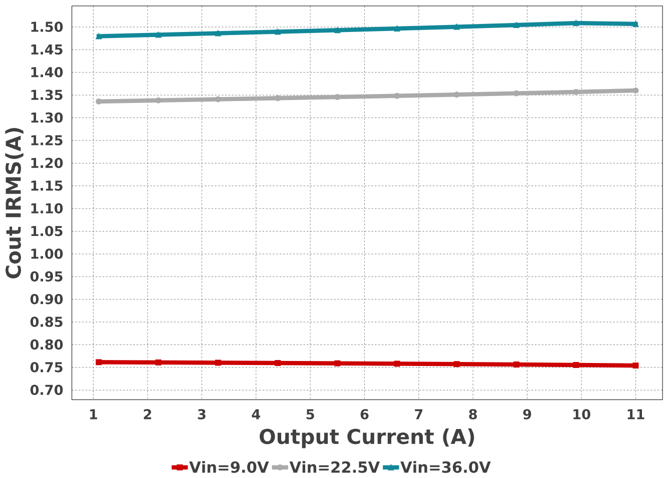
M2 Pd



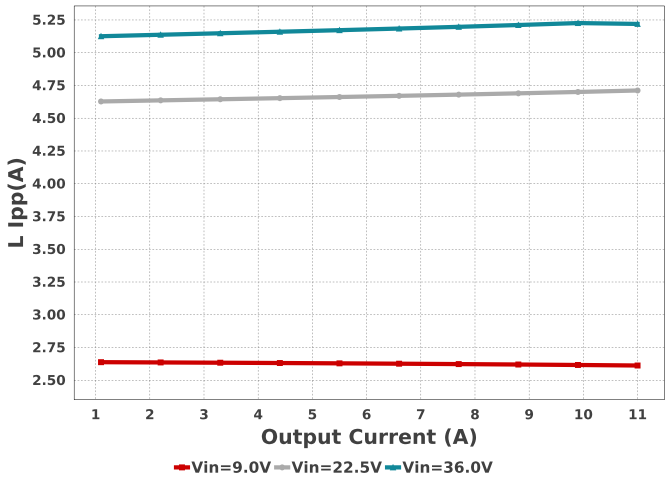
Total Pd



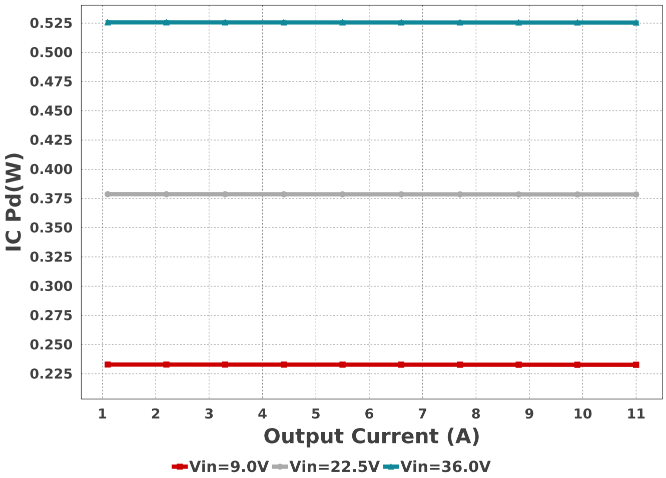
Cout IRMS



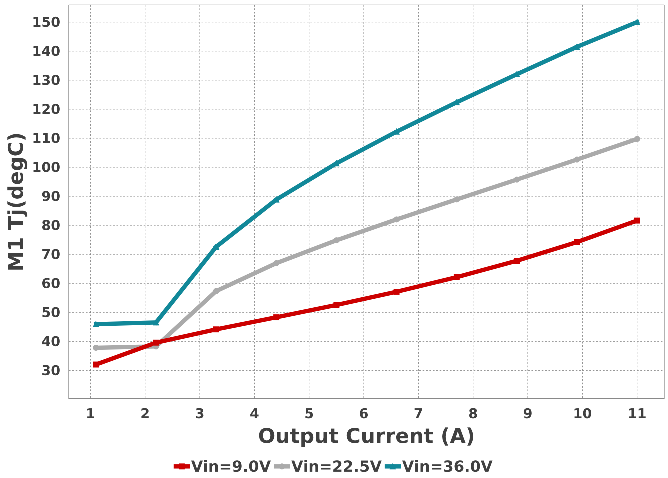
L Ipp



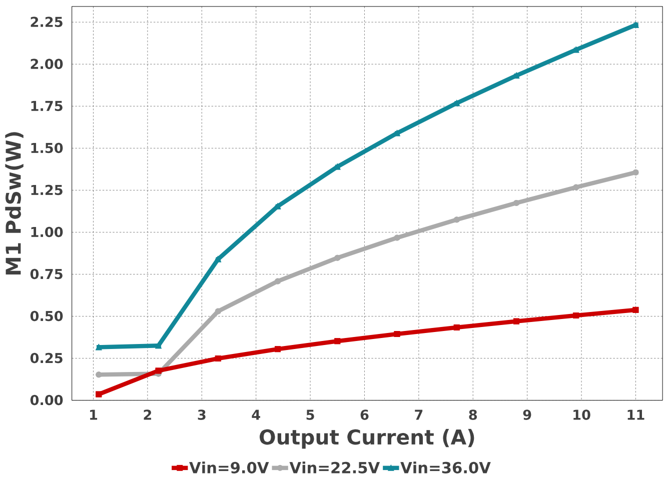
IC Pd



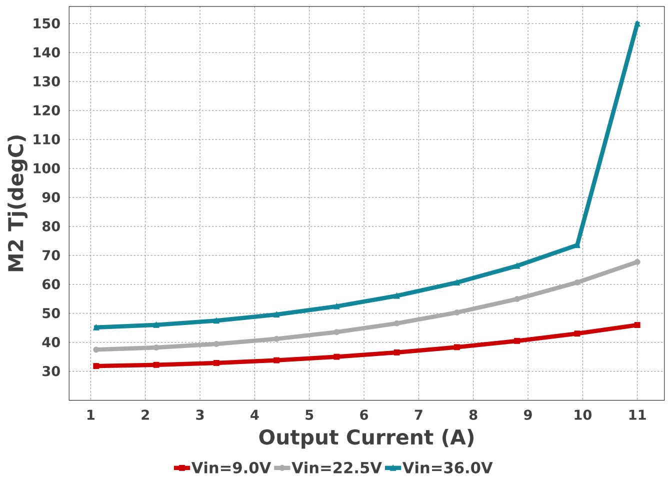
M1 Tj

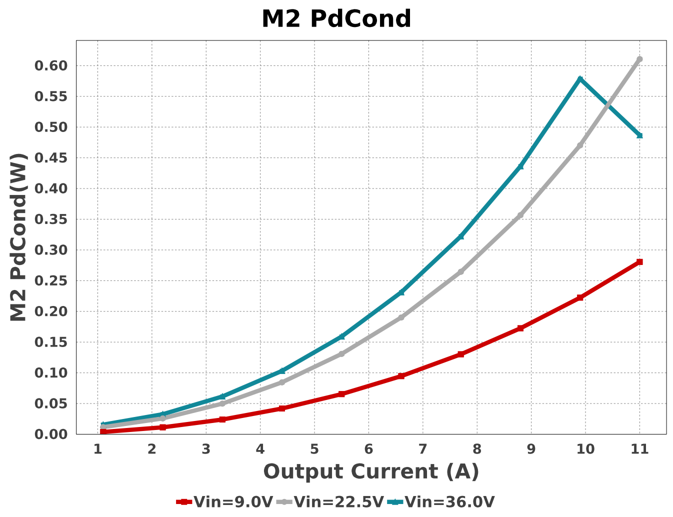


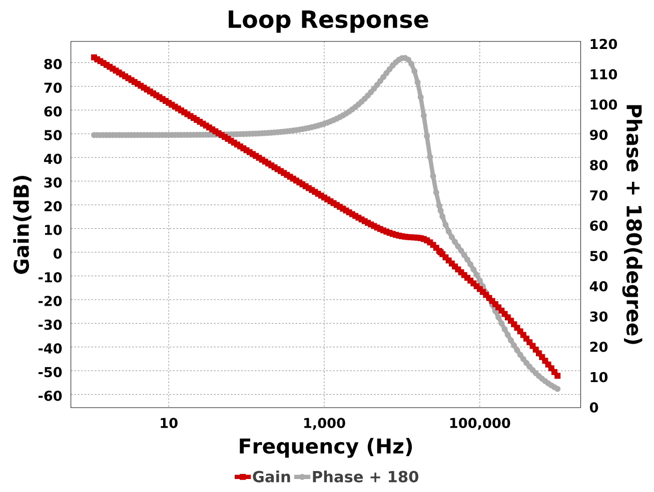
M1 PdSw



M2 Tj







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	3.885 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	97.436 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	1.507 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	6.439 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	13.61 A	IC	Peak switch current in IC
6.	IC Pd	525.46 mW	IC	IC power dissipation
7.	IC Tj	48.286 degC	IC	IC junction temperature
8.	IC Tolerance	8.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	34.8 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	1.654 A	IC	Average input current
11.	Ipp percentage	47.452 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	5.22 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	813.58 mW	Inductor	Inductor power dissipation
14.	M1 Pd	2.314 W	Mosfet	M1 MOSFET total power dissipation
15.	M1 PdCond	80.732 mW	Mosfet	M1 MOSFET conduction losses
16.	M1 PdSw	2.233 W	Mosfet	M1 MOSFET switching losses
17.	M1 Tj	150.0 degC	Mosfet	M1 MOSFET junction temperature
18.	M2 Pd	780.48 mW	Mosfet	M2 MOSFET total power dissipation
19.	M2 PdCond	486.77 mW	Mosfet	M2 MOSFET conduction losses
20.	M2 PdSw	293.71 mW	Mosfet	M2 MOSFET switching losses
21.	M2 Tj	150.0 degC	Mosfet	M2 MOSFET junction temperature
22.	Cin Pd	97.436 mW	Power	Input capacitor power dissipation
23.	Cout Pd	6.439 mW	Power	Output capacitor power dissipation
24.	IC Pd	525.46 mW	Power	IC power dissipation
25.	L Pd	813.58 mW	Power	Inductor power dissipation
26.	M1 Pd	2.314 W	Power	M1 MOSFET total power dissipation
27.	M1 PdCond	80.732 mW	Power	M1 MOSFET conduction losses
28.	M1 PdSw	2.233 W	Power	M1 MOSFET switching losses
29.	M2 Pd	780.48 mW	Power	M2 MOSFET total power dissipation
30.	M2 PdCond	486.77 mW	Power	M2 MOSFET conduction losses
31.	M2 PdSw	293.71 mW	Power	M2 MOSFET switching losses
32.	Total Pd	4.539 W	Power	Total Power Dissipation
33.	BOM Count	25	System Information	Total Design BOM count
34.	Duty Cycle	14.231 %	System Information	Duty cycle
35.	Efficiency	92.377 %	System Information	Steady state efficiency
36.	FootPrint	399.0 mm^2	System Information	Total Foot Print Area of BOM components
37.	Frequency	255.102 kHz	System Information	Switching frequency
38.	Iout	11.0 A	System Information	Iout operating point
39.	Mode	FCCM	System Information	Conduction Mode
40.	Pout	55.0 W	System Information	Total output power
41.	Total BOM	$4.6	System Information	Total BOM Cost

#	Name	Value	Category	Description
42.	Vin	36.0 V	System Information	Vin operating point
43.	Vin p-p	2.204 V	System Information	Peak-to-peak input voltage
44.	Vout	5.0 V	System Information	Operational Output Voltage
45.	Vout Actual	5.035 V	System Information	Vout Actual calculated based on selected voltage divider resistors
46.	Vout Tolerance	2.716 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
47.	Vout p-p	142.282 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	11.0	Maximum Output Current
VinMax	36.0	Maximum input voltage
VinMin	9.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM5146	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

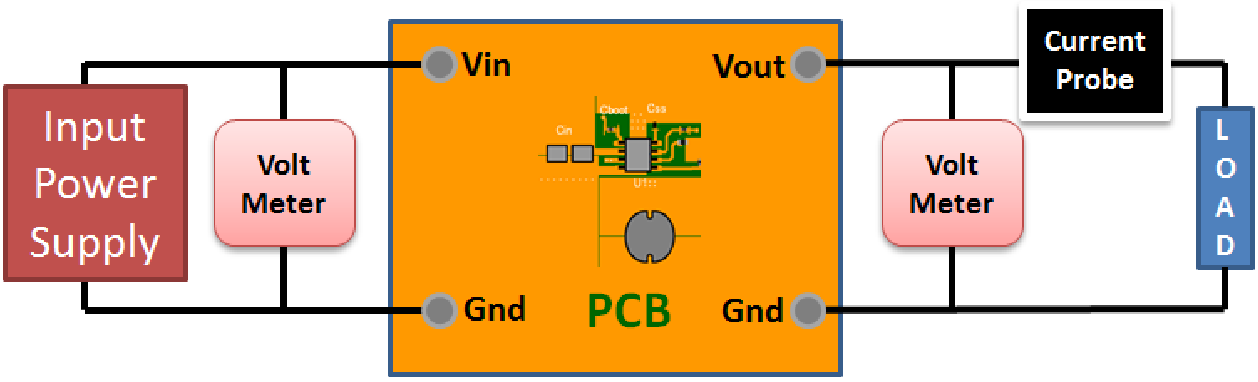
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 : 299619673AB5314E09B0C840216210C8[v1]

2. **LM5146** Product Folder : http://www.ti.com/product/lm5146 : contains the data sheet and other resources.