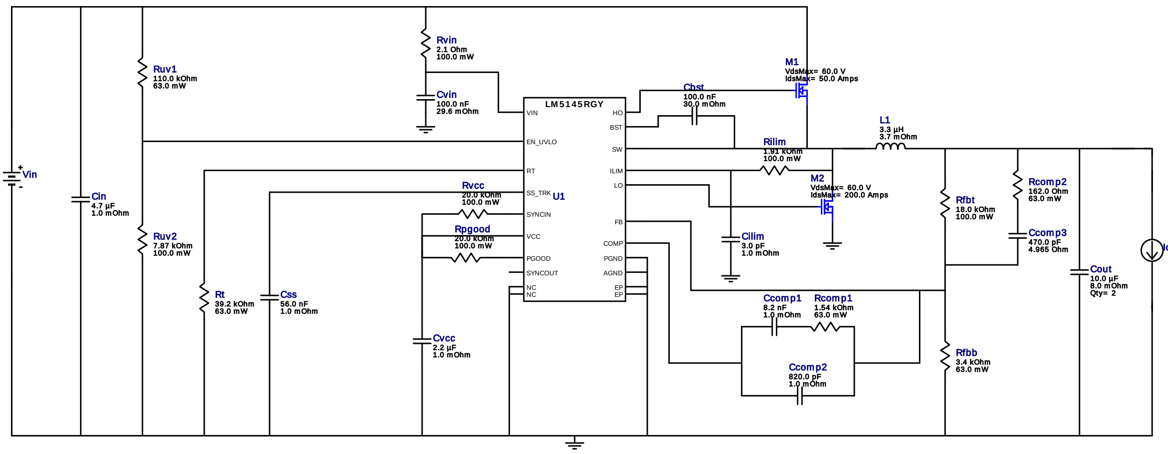
TEXAS INSTRUMENTS

VinMin = 22.0V
VinMax = 36.0V
Vout = 5.0V
Iout = 13.0A

Device = LM5145RGYR
Topology = Buck
Created = 2024-06-11 13:05:13.501
BOM Cost = $6.17
BOM Count = 26
Total Pd = 3.62W

WEBENCH ® Design Report

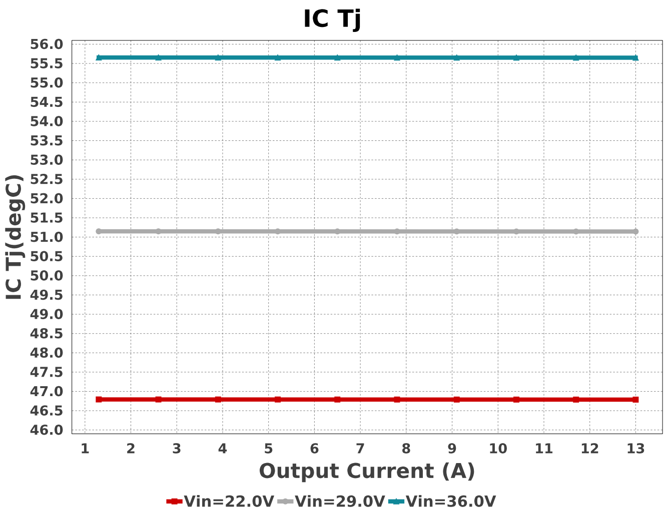
Design : 182 LM5145RGYR
LM5145RGYR 22V-36V to 5.00V @ 13A

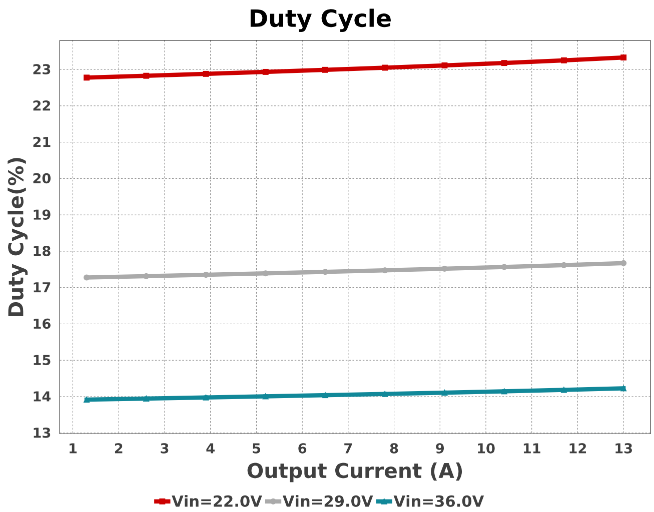


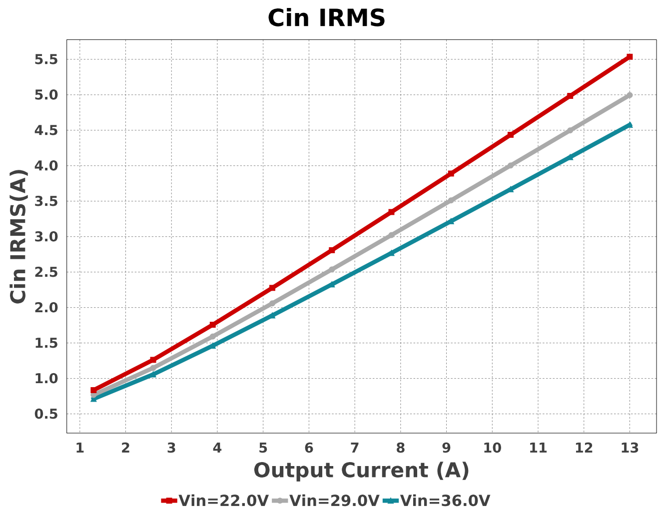
Electrical BOM

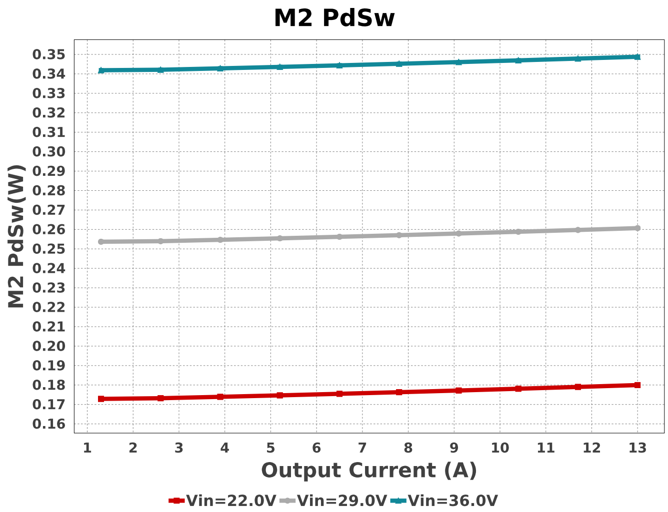
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	MuRata	GRM188R61E104KA01D Series= X5R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Ccomp1	MuRata	GRM155R71C822KA01D Series= X7R	Cap= 8.2 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	MuRata	GRM155R71H821KA01D Series= X7R	Cap= 820.0 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp3	TDK	CGA2B2X7R1H471K050BA Series= X7R	Cap= 470.0 pF ESR= 4.9649 Ohm VDC= 50.0 V IRMS= 228.41 mA	1	$0.01	0402 3 mm^2
Cilim	MuRata	GQM2195C2A3R0CB01D Series= C0G/NP0	Cap= 3.0 pF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.17	0805 7 mm^2
Cin	MuRata	GRM32ER71H475KA88L Series= X7R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 6.0 A	1	$0.16	1210 15 mm^2
Cout	Kemet	C1210C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 8.0 mOhm VDC= 10.0 V IRMS= 6.9 A	2	$0.22	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	C1005X5R1V225K050BC Series= X5R	Cap= 2.2 uF ESR= 1.0 mOhm VDC= 35.0 V IRMS= 0.0 A	1	$0.06	0402_065 3 mm^2

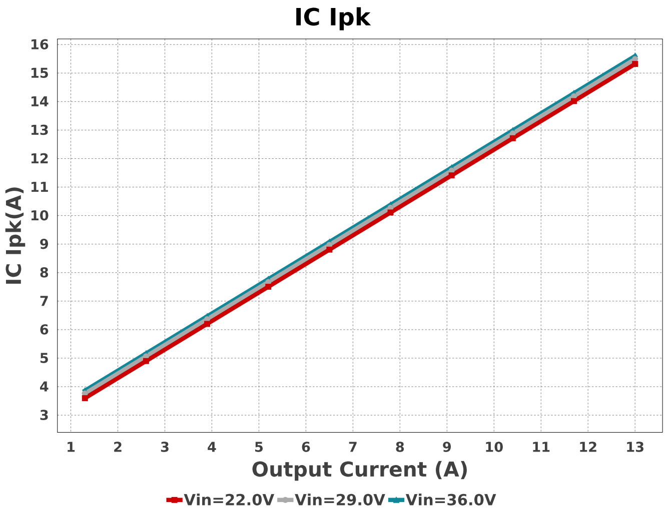
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvin	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	$0.01	0603 5 mm^2
L1	Coilcraft	XAL1010-332MEB	L= 3.3 µH 3.7 mOhm	1	$1.71	XAL1010 160 mm^2
M1	ON Semiconductor	NTMFS5C673NLT1G	VdsMax= 60.0 V IdsMax= 50.0 Amps	1	$1.06	FP-NTMFS5C673NLT1G_DFN5-MFG 0 mm^2
M2	Texas Instruments	CSD18535KTT	VdsMax= 60.0 V IdsMax= 200.0 Amps	1	$1.08	KTT0002A 198 mm^2
Rcomp1	Vishay-Dale	CRCW04021K54FKED Series= CRCW..e3	Res= 1.54 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcomp2	Vishay-Dale	CRCW0402162RFKED Series= CRCW..e3	Res= 162.0 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	CRCW06031K91FKEA Series= CRCW..e3	Res= 1.91 kOhm 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	CRCW0402110KFKED Series= CRCW..e3	Res= 110.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ruv2	Yageo	RC0603FR-077K87L Series= ?	Res= 7.87 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	LM5145RGYR	Switcher	1	$1.32	RGY0020B 25 mm^2

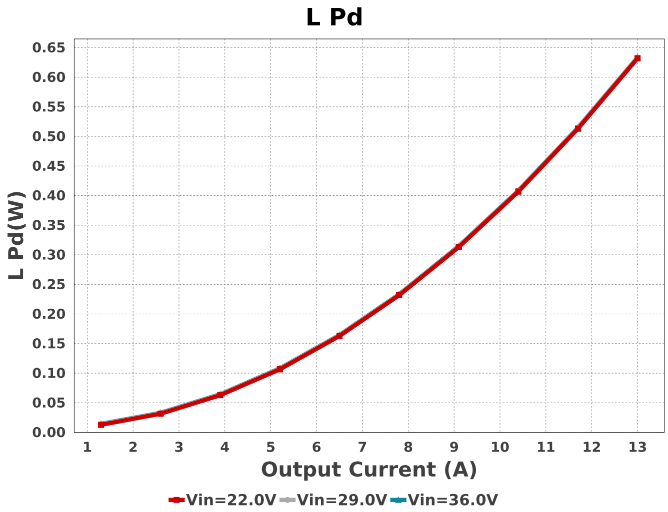

IC Tj
IC Tj(degC)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

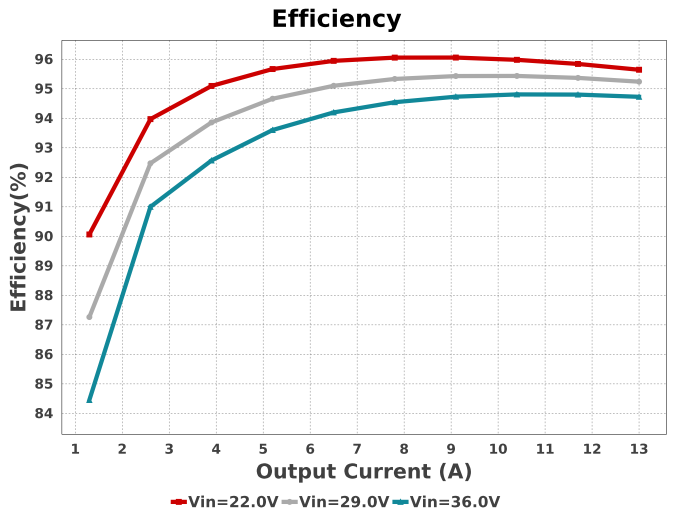

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

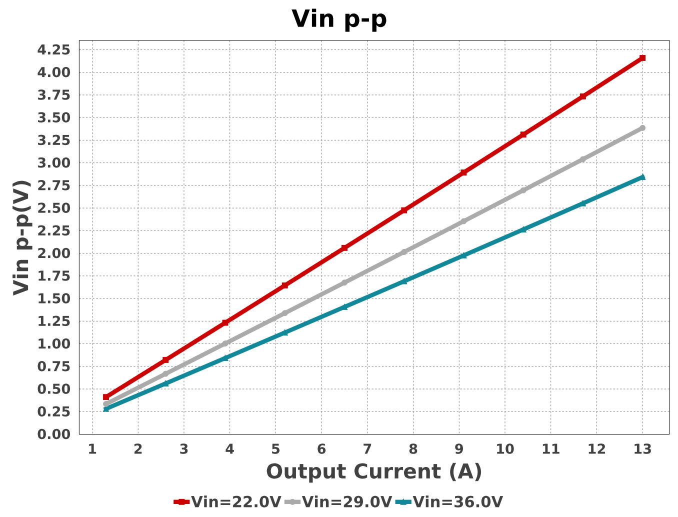

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

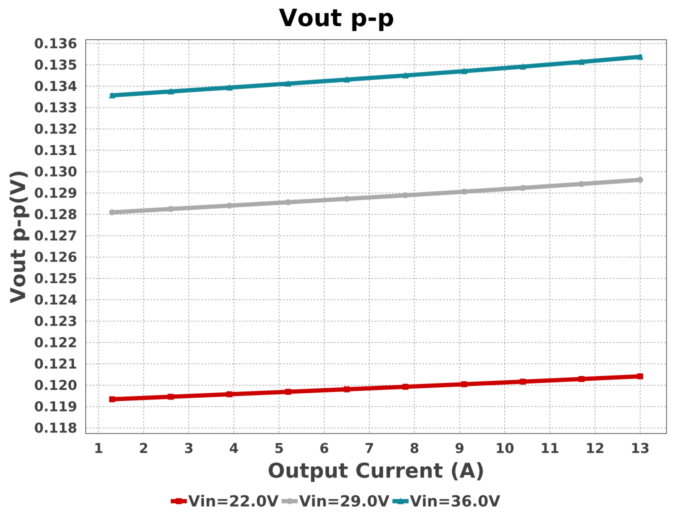

M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

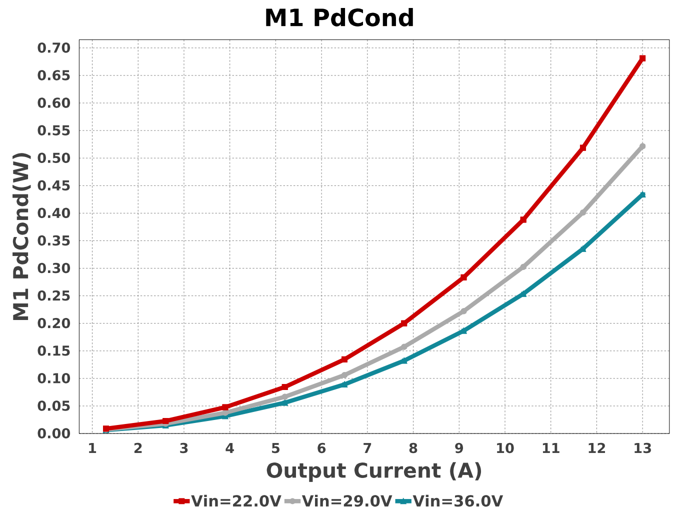

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

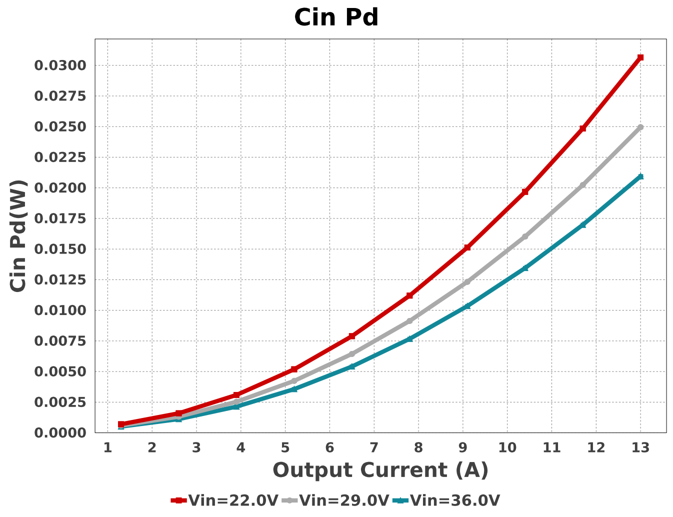

L Pd
L Pd(W)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

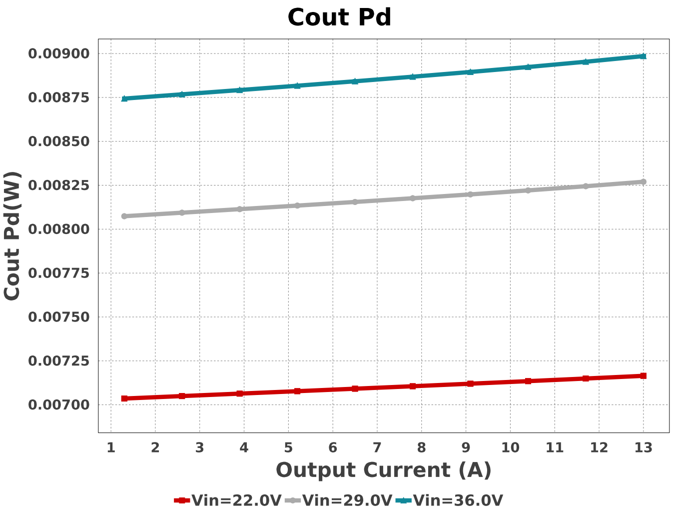

Efficiency
Efficiency(%)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

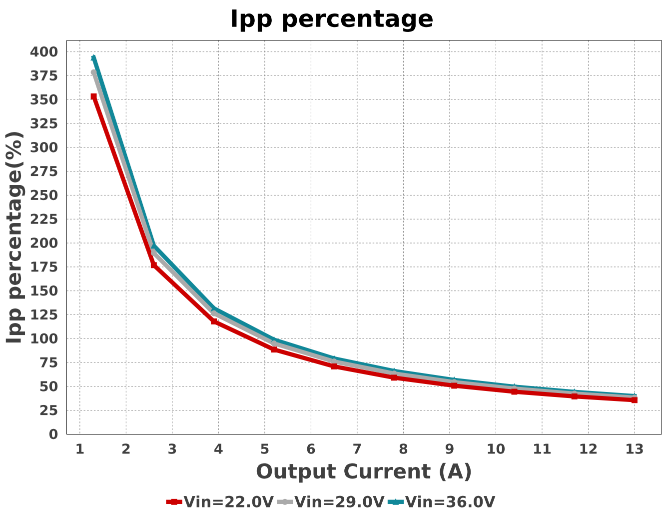

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

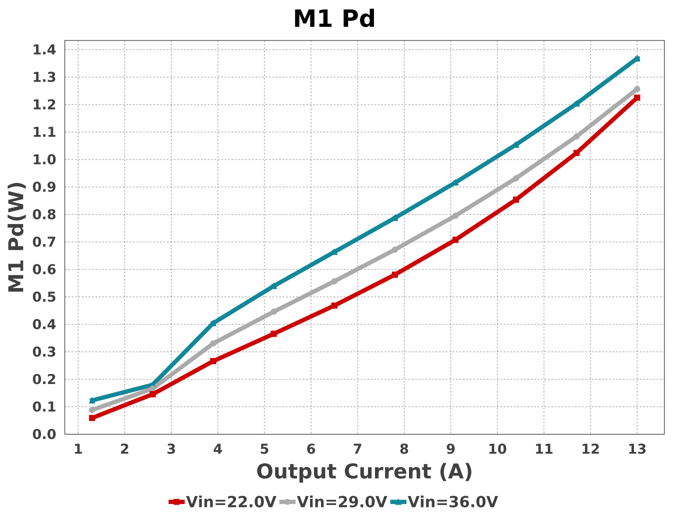

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

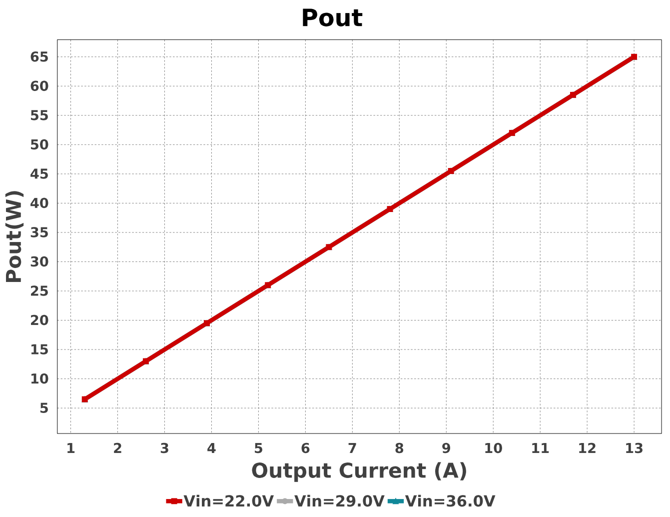

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

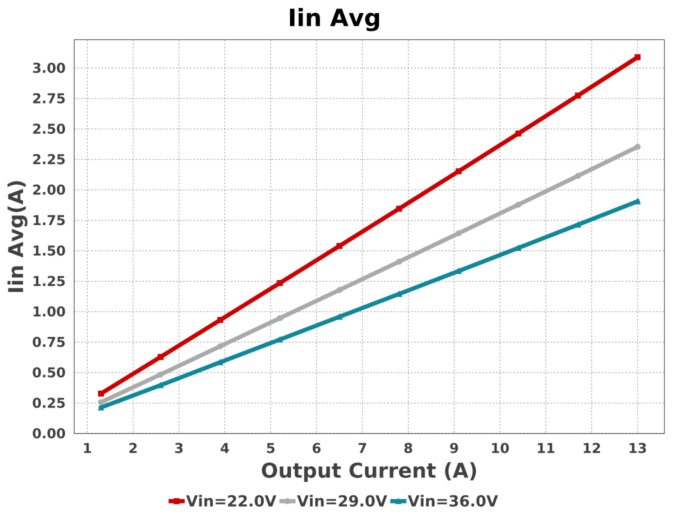

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

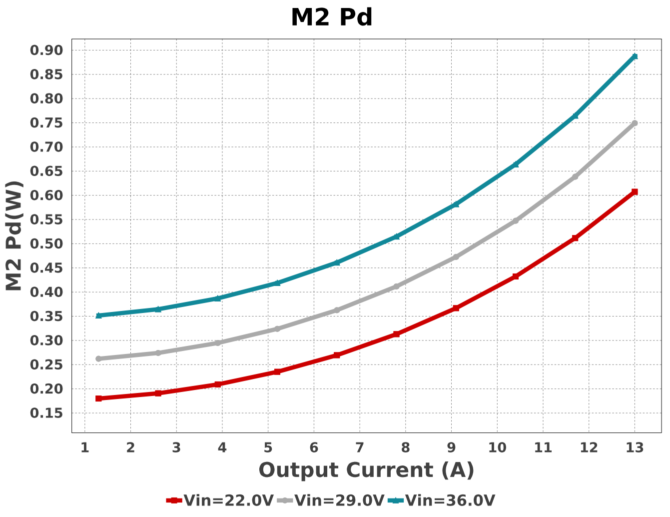

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

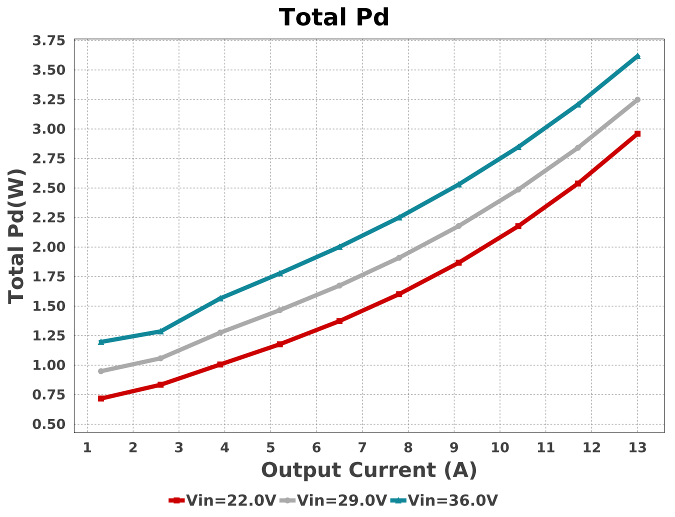

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V


M1 Pd
M1 Pd(W)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

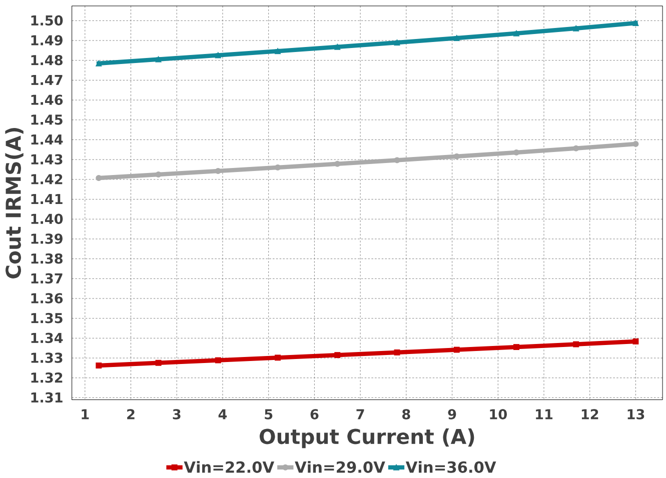

Pout
Pout(W)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V


Iin Avg
Iin Avg(A)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

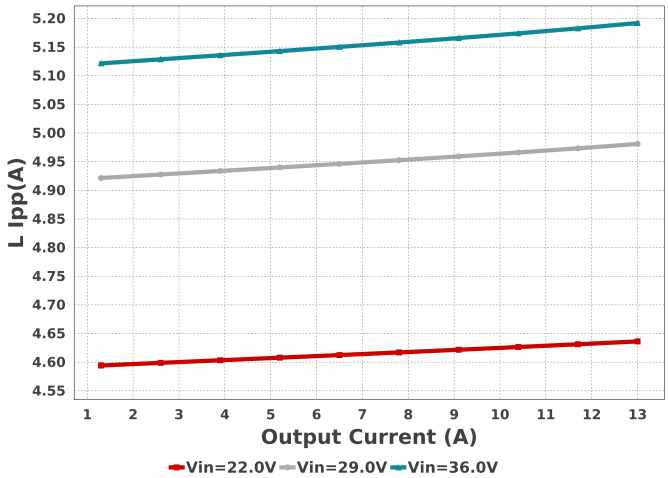

M2 Pd
M2 Pd(W)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=22.0V Vin=29.0V Vin=36.0V

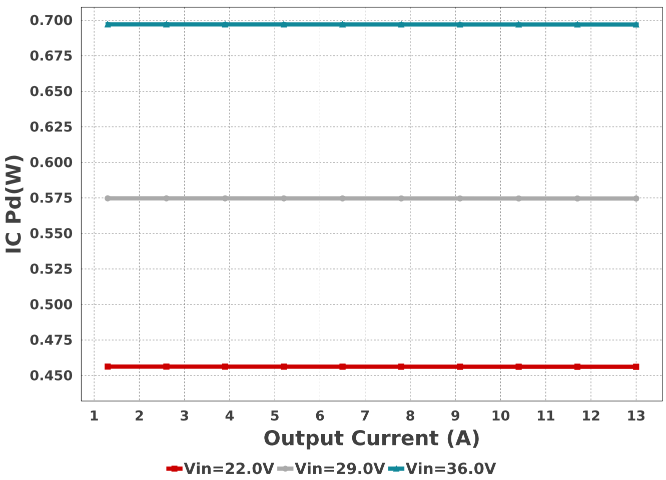
Cout IRMS



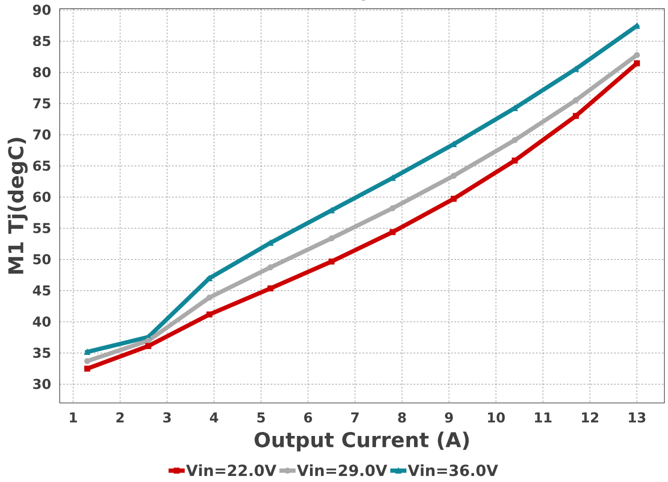
L Ipp



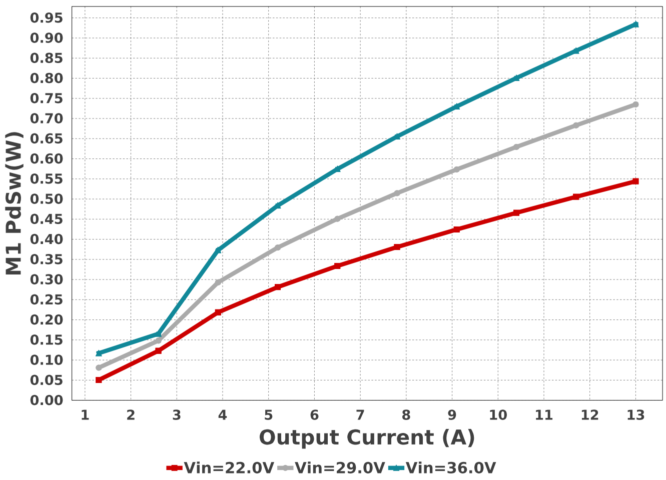
IC Pd



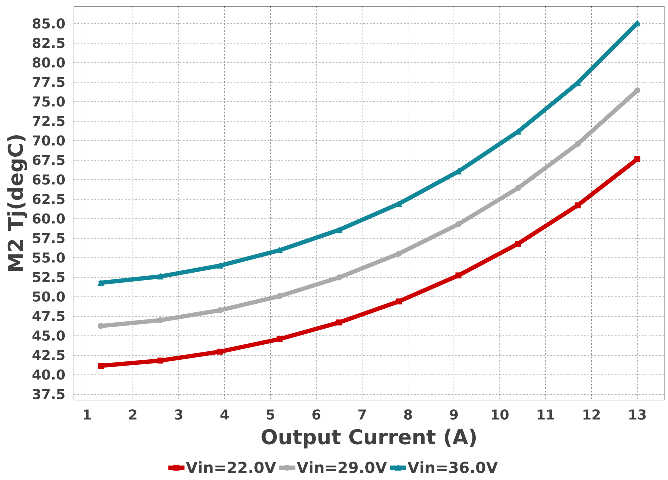
M1 Tj

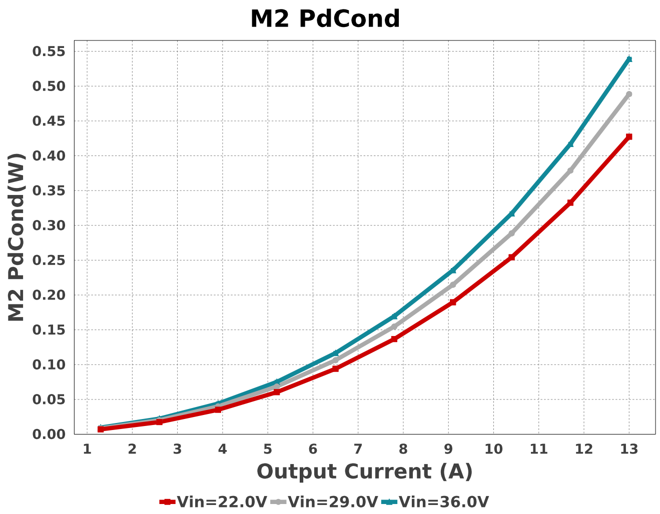


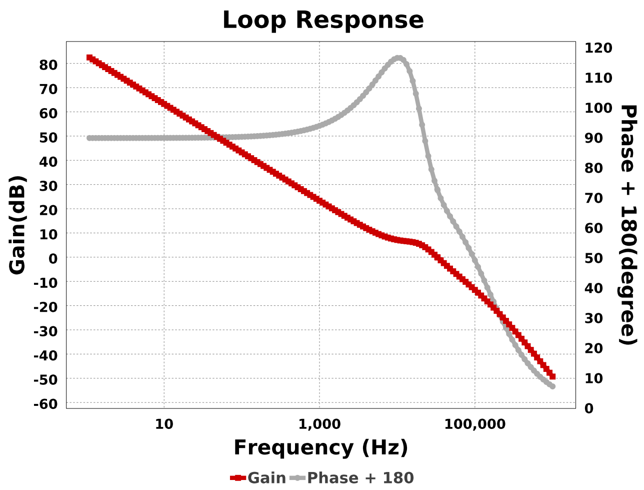
M1 PdSw



M2 Tj







Operating Values

#	Name	Value	Category	Description
1.	BOM Count	26		Total Design BOM count
2.	Total BOM	$6.168		Total BOM Cost
3.	Cin IRMS	4.576 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	20.943 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	1.499 A	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	8.986 mW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	15.596 A	IC	Peak switch current in IC
8.	IC Pd	697.01 mW	IC	IC power dissipation
9.	IC Tj	55.65 degC	IC	IC junction temperature
10.	IC Tolerance	8.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	36.8 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	1.906 A	IC	Average input current
13.	Ipp percentage	39.938 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	5.192 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	633.61 mW	Inductor	Inductor power dissipation
16.	M1 Pd	1.368 W	Mosfet	M1 MOSFET total power dissipation
17.	M1 PdCond	433.98 mW	Mosfet	M1 MOSFET conduction losses
18.	M1 PdSw	934.13 mW	Mosfet	M1 MOSFET switching losses
19.	M1 Tj	87.461 degC	Mosfet	M1 MOSFET junction temperature
20.	M2 Pd	887.82 mW	Mosfet	M2 MOSFET total power dissipation
21.	M2 PdCond	539.03 mW	Mosfet	M2 MOSFET conduction losses
22.	M2 PdSw	348.79 mW	Mosfet	M2 MOSFET switching losses
23.	M2 Tj	85.045 degC	Mosfet	M2 MOSFET junction temperature
24.	Cin Pd	20.943 mW	Power	Input capacitor power dissipation
25.	Cout Pd	8.986 mW	Power	Output capacitor power dissipation
26.	IC Pd	697.01 mW	Power	IC power dissipation
27.	L Pd	633.61 mW	Power	Inductor power dissipation
28.	M1 Pd	1.368 W	Power	M1 MOSFET total power dissipation
29.	M1 PdCond	433.98 mW	Power	M1 MOSFET conduction losses
30.	M1 PdSw	934.13 mW	Power	M1 MOSFET switching losses
31.	M2 Pd	887.82 mW	Power	M2 MOSFET total power dissipation
32.	M2 PdCond	539.03 mW	Power	M2 MOSFET conduction losses
33.	M2 PdSw	348.79 mW	Power	M2 MOSFET switching losses
34.	Total Pd	3.617 W	Power	Total Power Dissipation
35.	Duty Cycle	14.228 %	System Information	Duty cycle
36.	Efficiency	94.728 %	System Information	Steady state efficiency
37.	FootPrint	501.0 mm^2	System Information	Total Foot Print Area of BOM components
38.	Frequency	255.102 kHz	System Information	Switching frequency
39.	Iout	13.0 A	System Information	Iout operating point
40.	Mode	FCCM	System Information	Conduction Mode
41.	Pout	65.0 W	System Information	Total output power
42.	Vin	36.0 V	System Information	Vin operating point

#	Name	Value	Category	Description
43.	Vin p-p	2.842 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	135.376 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	13.0	Maximum Output Current
SoftStart	4.0 ms	Soft Start Time (ms)
VinMax	36.0	Maximum input voltage
VinMin	22.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM5145	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	250.0 k	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

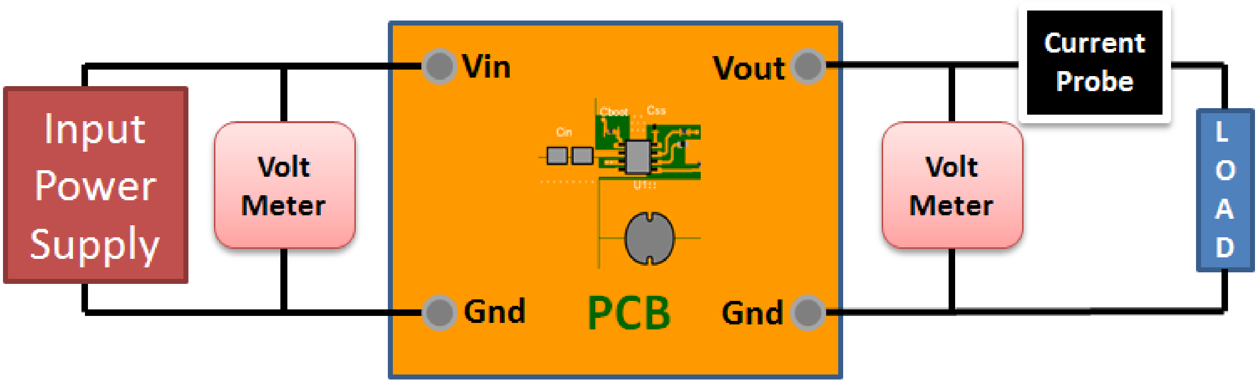
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 22.0V 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 : C5BEBEF5D4C5F4F8[v1]

2. **LM5145** Product Folder : http://www.ti.com/product/lm5145 : contains the data sheet and other resources.

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