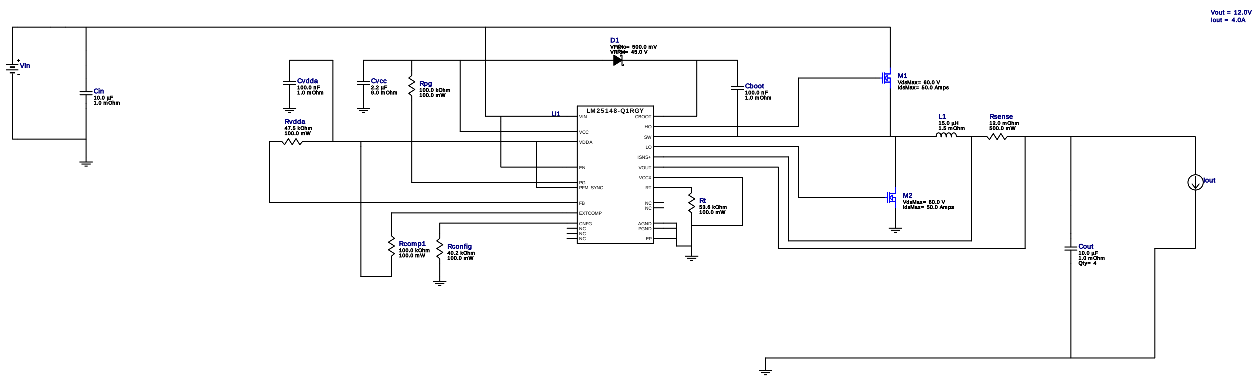
VinMin = 24.0V
VinMax = 35.0V
Vout = 12.0V
Iout = 4.0A

Device = LM25148QRGYRQ1
Topology = Buck
Created = 2023-08-09 03:28:50.025
BOM Cost = $5.40
BOM Count = 19
Total Pd = 1.23W

WEBENCH ® Design Report

Design : 8 LM25148QRGYRQ1
LM25148QRGYRQ1 24V-35V to 12.00V @ 4A



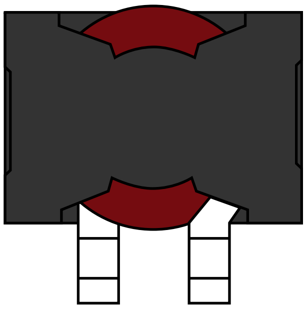
Design Alerts

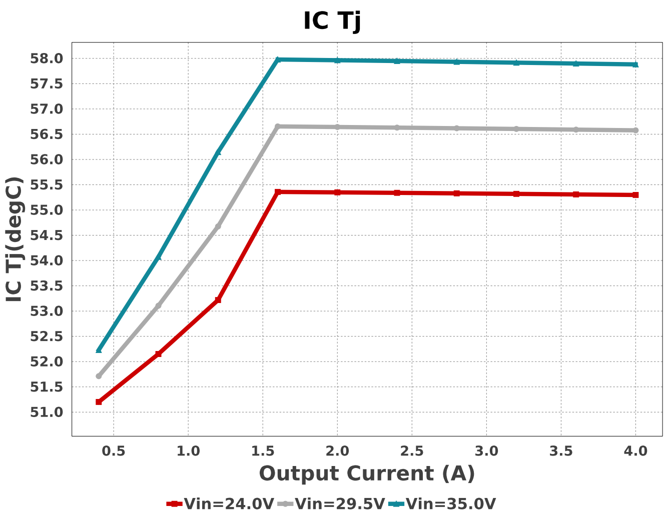
Component Selection Information

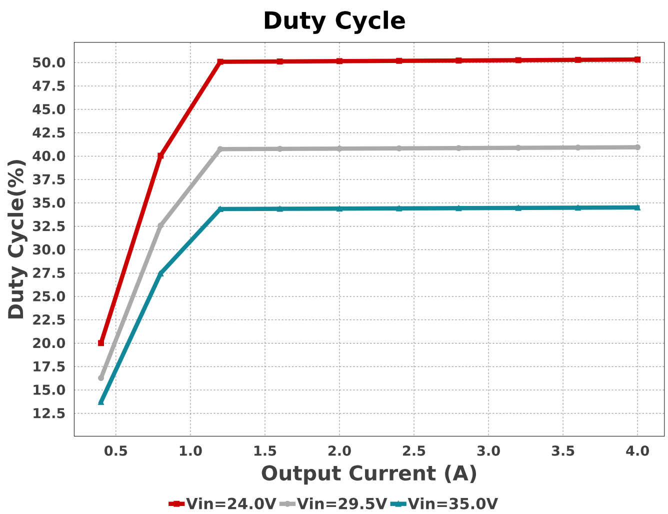
The LM25148-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.

Electrical BOM

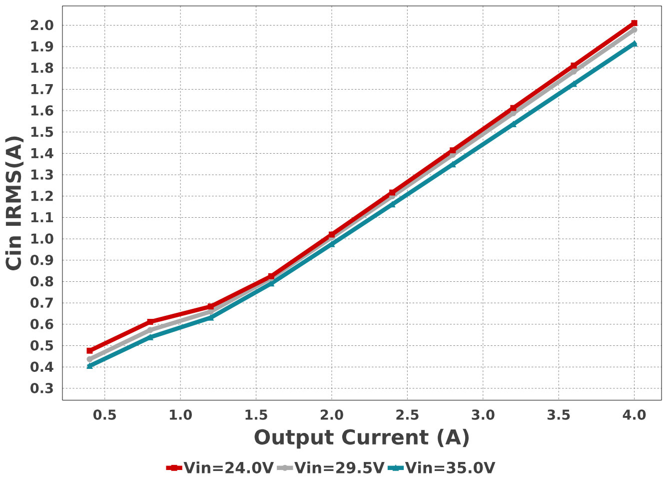
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	MuRata	GRM32ER71J106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 63.0 V IRMS= 6.0 A	1	$0.30	1210_280 15 mm²
Cout	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	4	$0.27	1210 15 mm²
Cvcc	MuRata	GRM188R71A225KE15D Series= X7R	Cap= 2.2 uF ESR= 9.0 mOhm VDC= 10.0 V IRMS= 3.3 A	1	$0.02	0603 5 mm²
Cvdda	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
D1	Vishay-Semiconductor	BYS10-45-E3/TR	VF@Io= 500.0 mV VRRM= 45.0 V	1	$0.11	SMA 37 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Coilcraft	SER2915L-153KL	L= 15.0 µH 1.5 mOhm	1	$1.88	 SER2915L 652 mm²
M1	Texas Instruments	CSD18534Q5A	VdsMax= 60.0 V IdsMax= 50.0 Amps	1	$0.31	 DQJ0008A 55 mm²
M2	Texas Instruments	CSD18534Q5A	VdsMax= 60.0 V IdsMax= 50.0 Amps	1	$0.31	 DQJ0008A 55 mm²
Rcomp1	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rconfig	Vishay-Dale	CRCW060340K2FKEA Series= CRCW..e3	Res= 40.2 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rpg	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rsense	Stackpole Electronics Inc	CSR1206FK12L0 Series= ?	Res= 12.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.11	 1206 11 mm²
Rt	Vishay-Dale	CRCW060353K6FKEA Series= CRCW..e3	Res= 53.6 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rvdda	Vishay-Dale	CRCW060347K5FKEA Series= CRCW..e3	Res= 47.5 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
U1	Texas Instruments	LM25148QRGYRQ1	Switcher	1	$1.21	RGY0024E-MFG 48 mm²

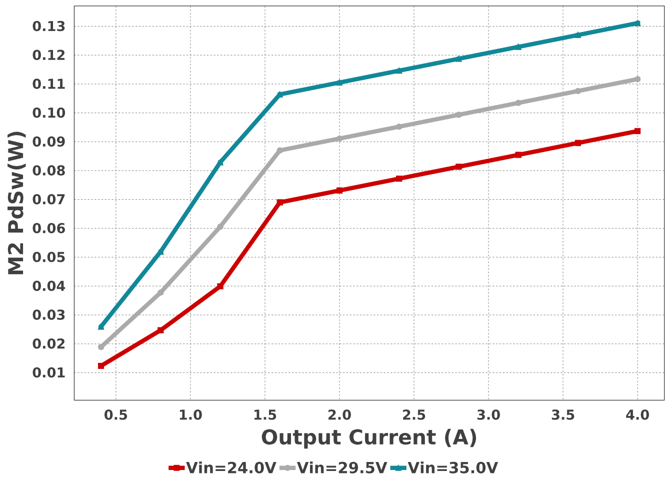




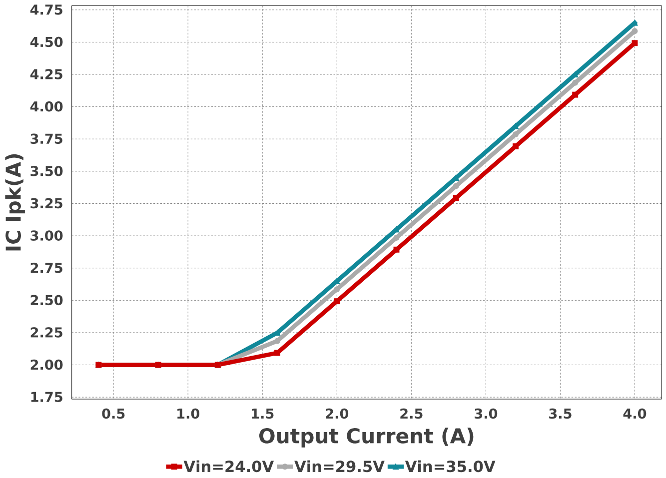
Cin IRMS



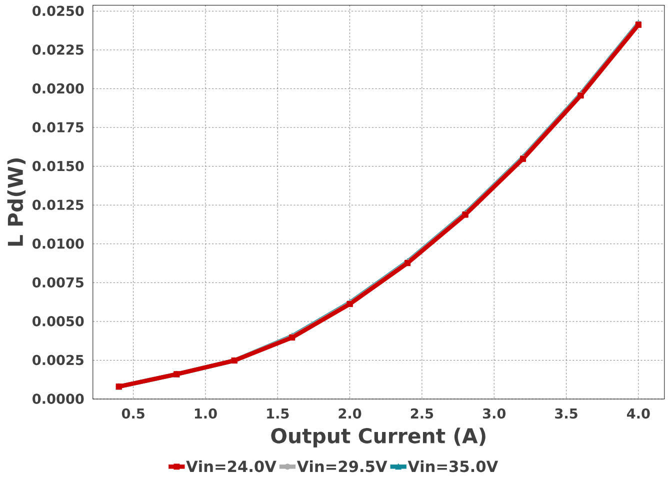
M2 PdSw



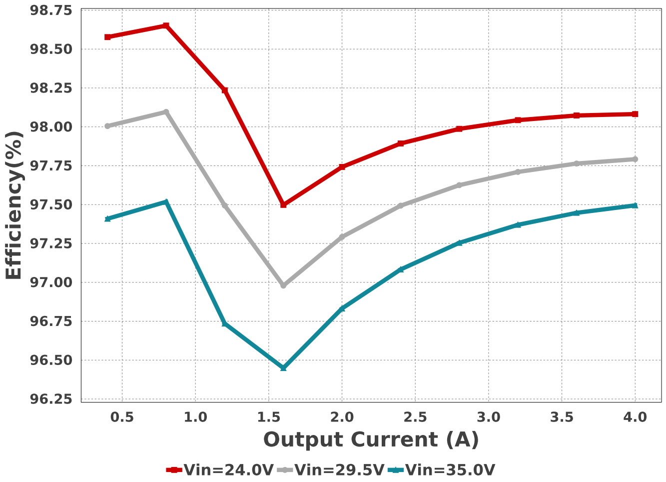
IC Ipk



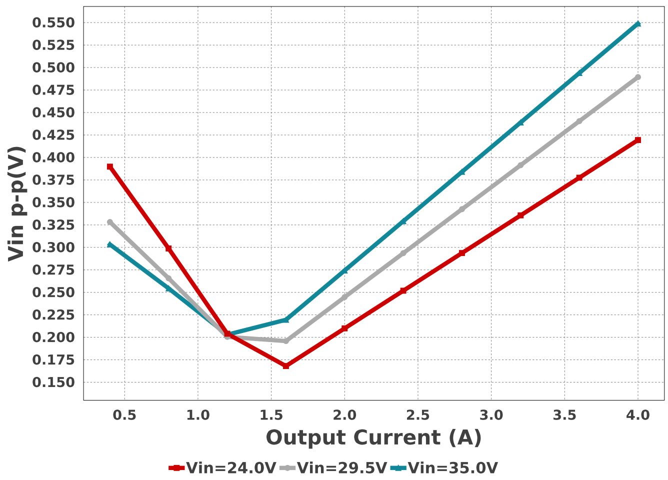
L Pd



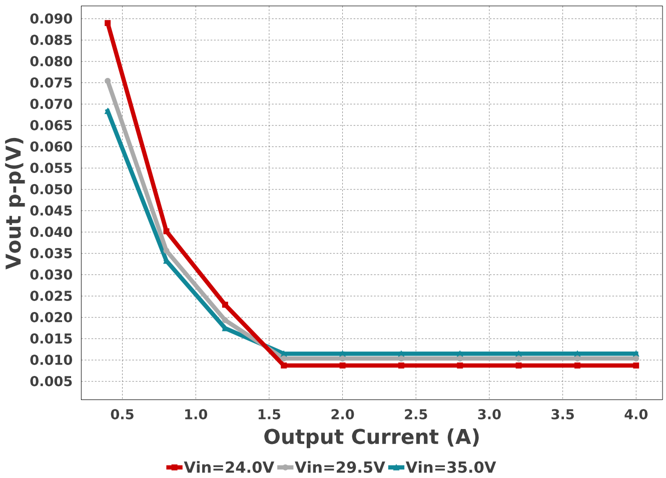
Efficiency



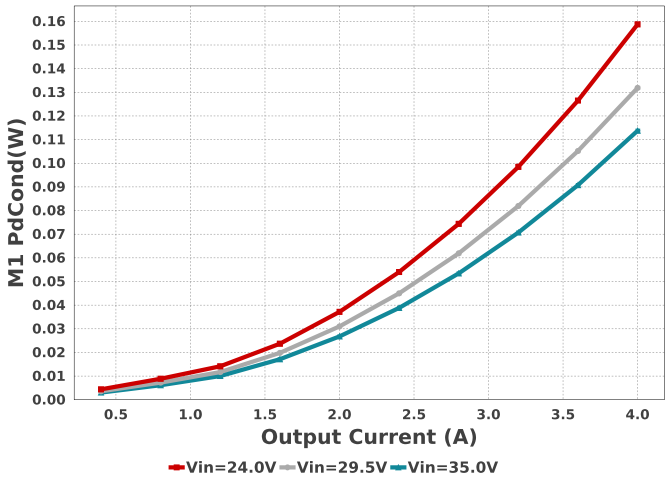
Vin p-p



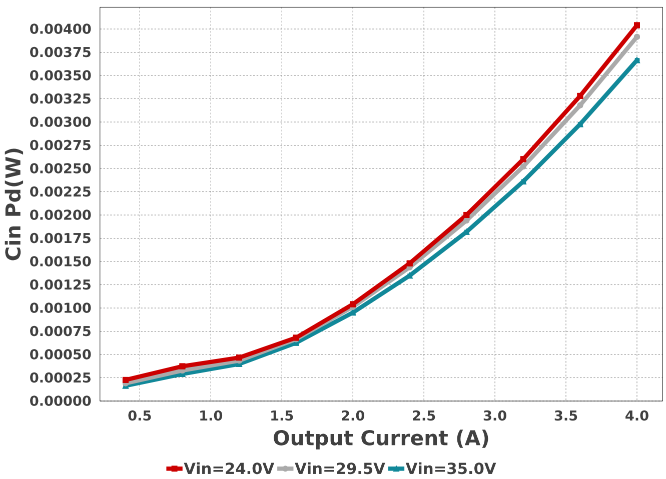
Vout p-p



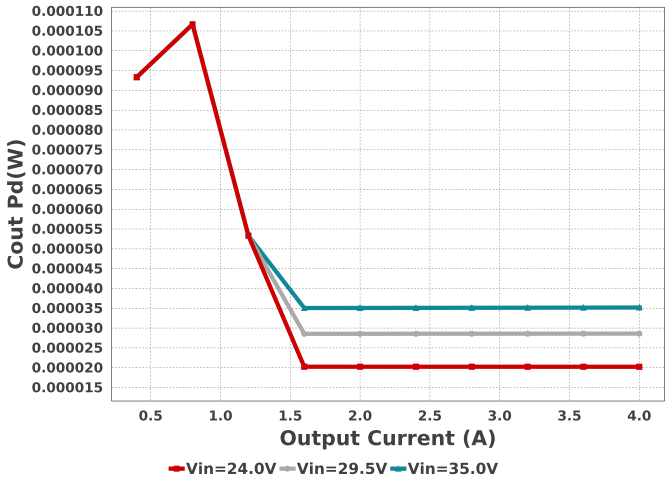
M1 PdCond



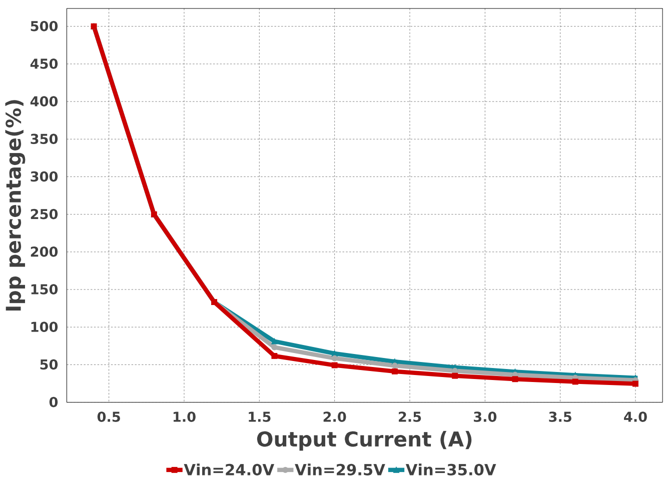
Cin Pd



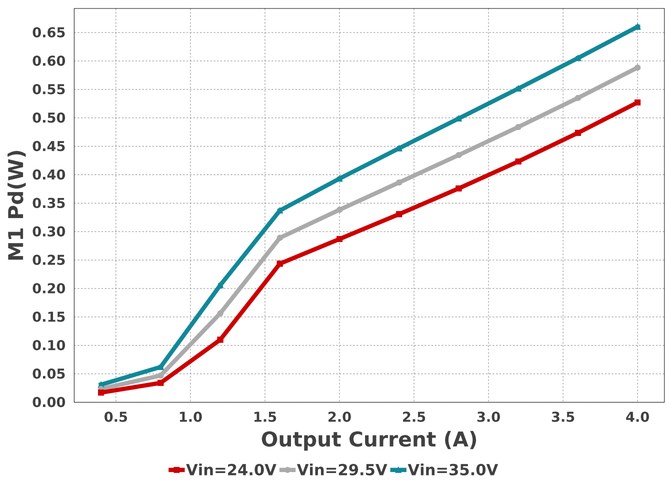
Cout Pd



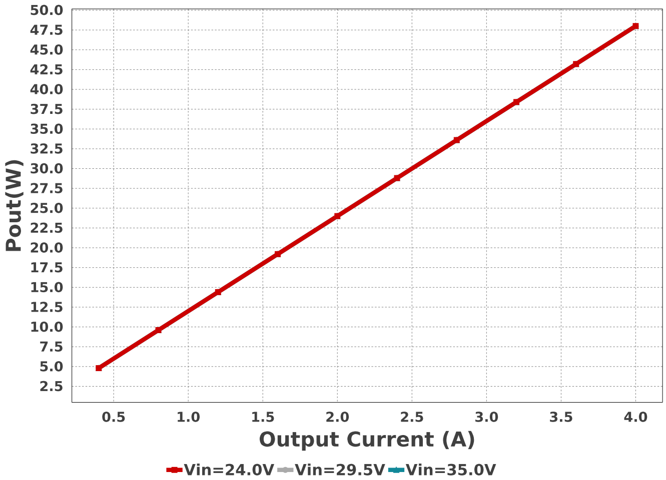
Ipp percentage



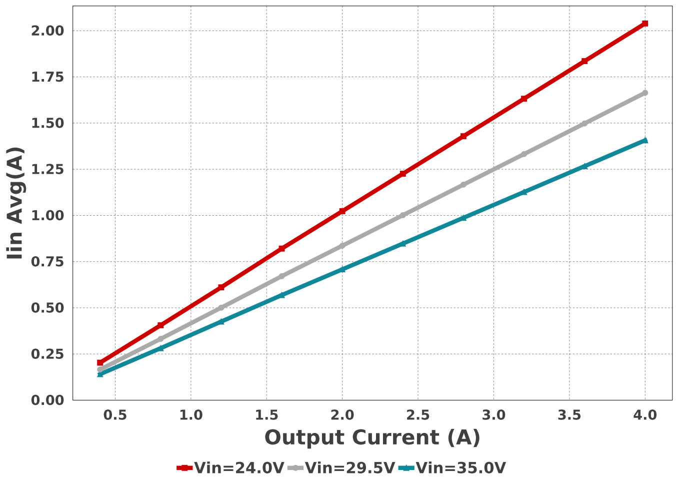
M1 Pd



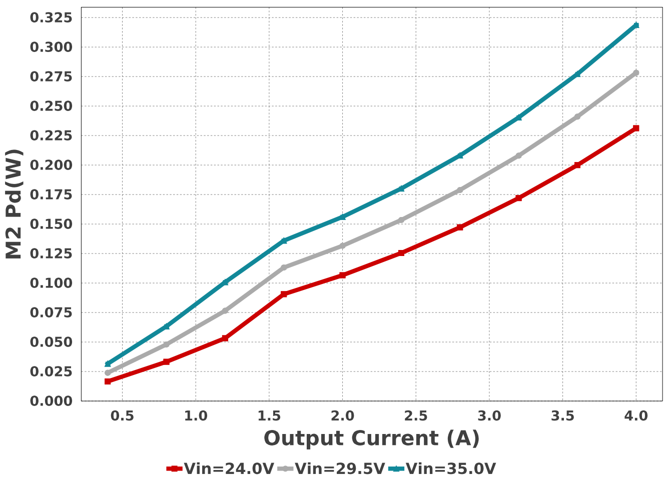
Pout



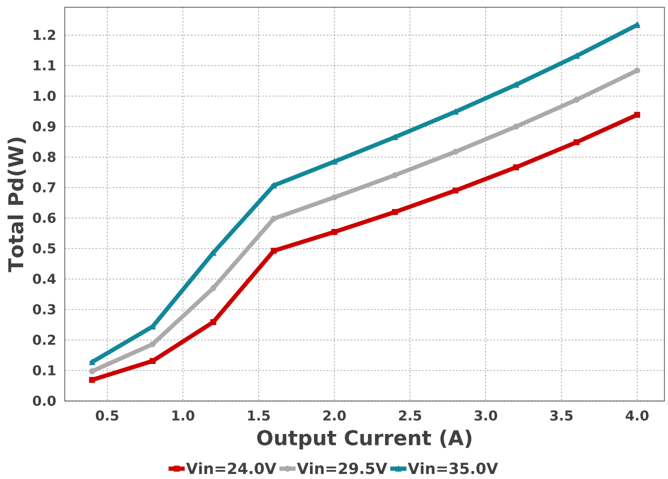
Iin Avg



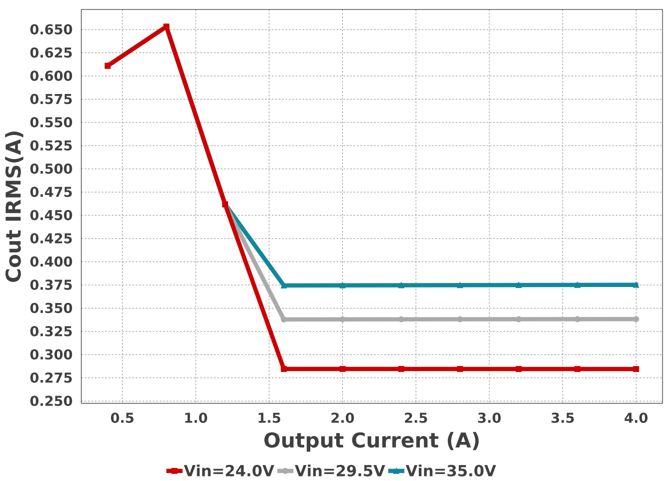
M2 Pd



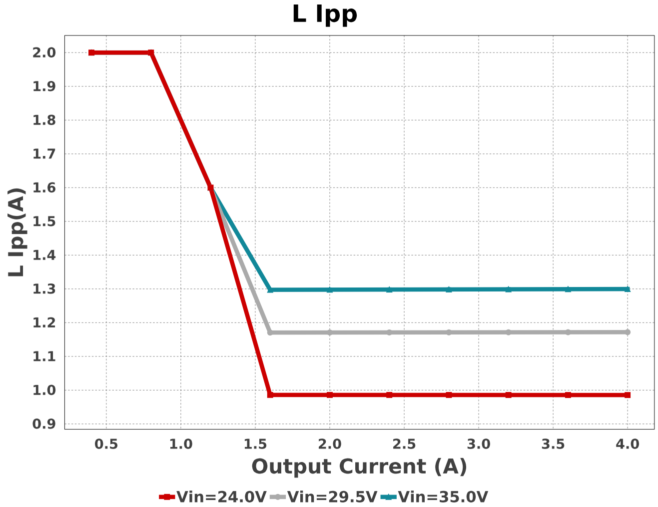
Total Pd

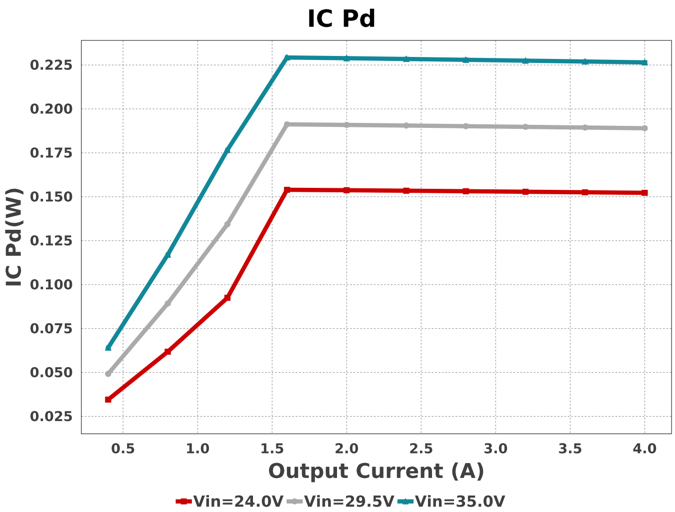


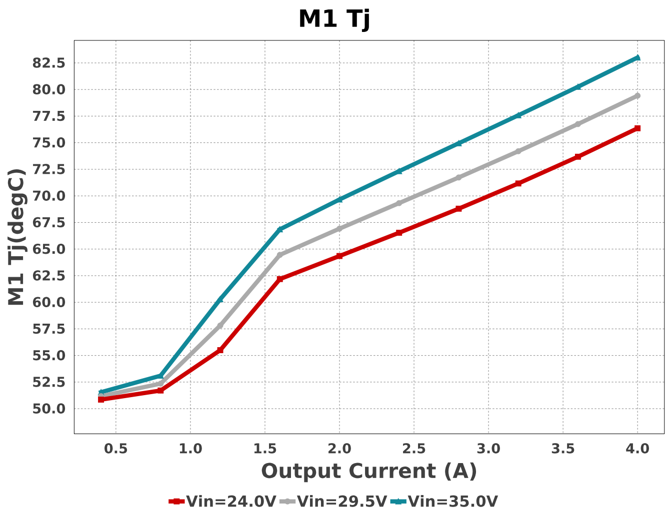
Cout IRMS

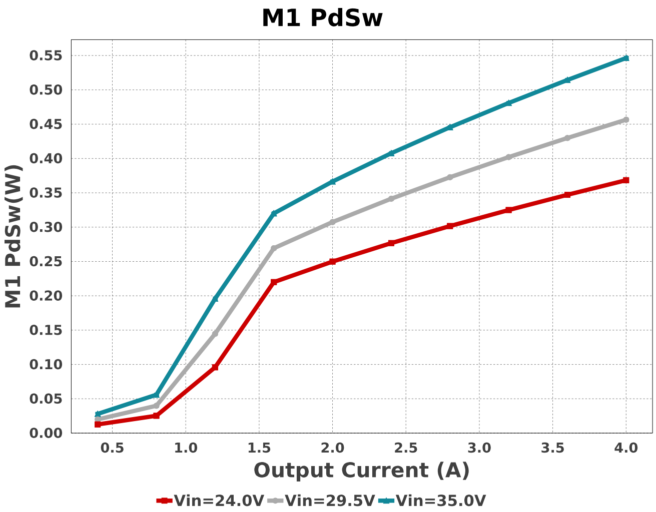


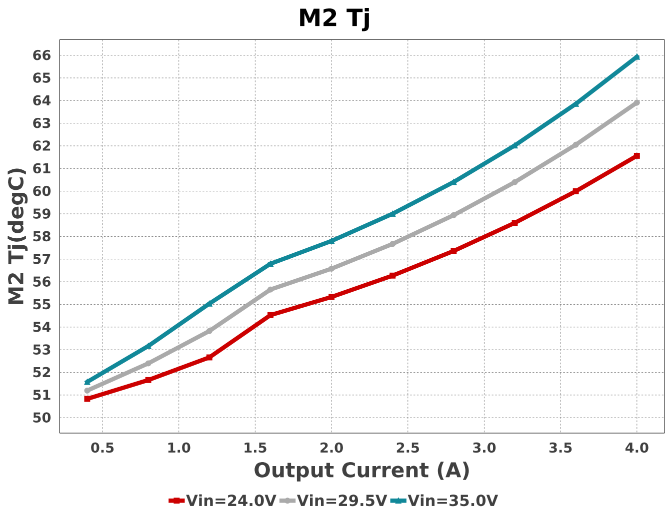
L Ipp

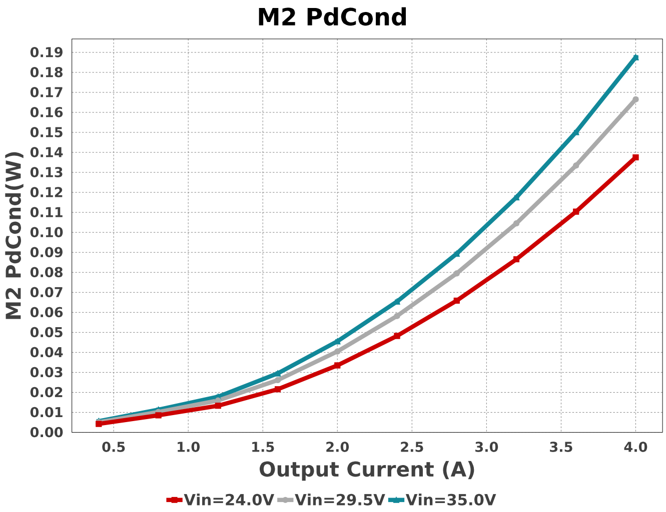


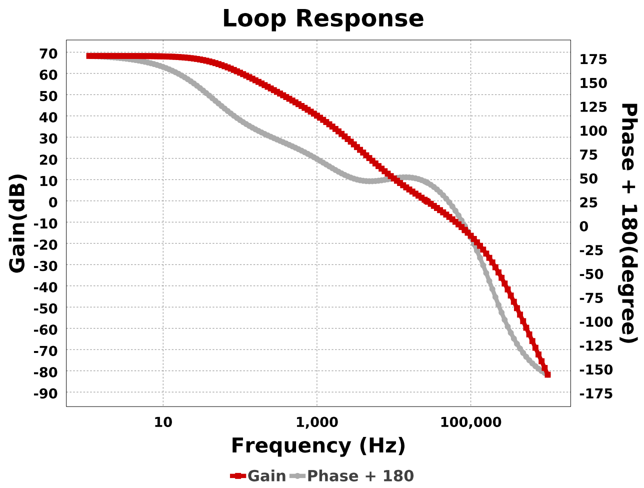

IC Pd
IC Pd(W)
Output Current (A)
Vin=24.0V Vin=29.5V Vin=35.0V

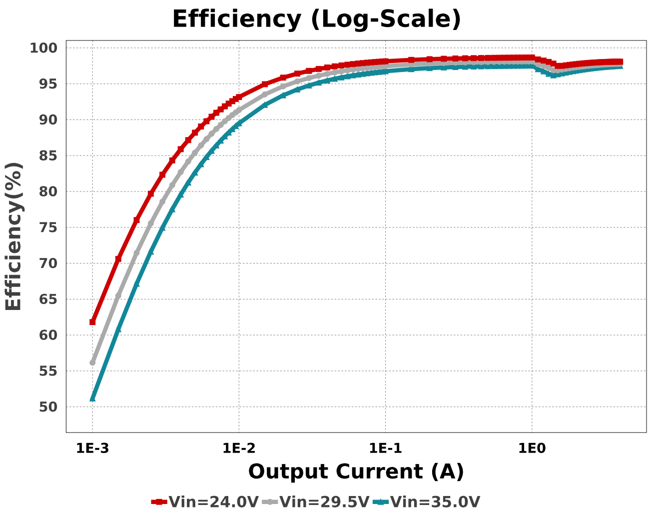

M1 Tj
M1 Tj(degC)
Output Current (A)
Vin=24.0V Vin=29.5V Vin=35.0V


M1 PdSw
M1 PdSw(W)
Output Current (A)
Vin=24.0V Vin=29.5V Vin=35.0V


M2 Tj
M2 Tj(degC)
Output Current (A)
Vin=24.0V Vin=29.5V Vin=35.0V


M2 PdCond
M2 PdCond(W)
Output Current (A)
Vin=24.0V Vin=29.5V Vin=35.0V


Loop Response
Gain(dB)
Phase + 180(degree)
Frequency (Hz)
Gain Phase + 180



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.914 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	3.665 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	375.169 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	35.188 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	4.65 A	IC	Peak switch current in IC
6.	IC Pd	226.48 mW	IC	IC power dissipation
7.	IC Tj	57.881 degC	IC	IC junction temperature
8.	IC Tolerance	120.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA Effective	34.8 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	1.407 A	IC	Average input current
11.	Ipp percentage	32.491 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	1.3 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	24.211 mW	Inductor	Inductor power dissipation
14.	M1 Pd	660.14 mW	Mosfet	M1 MOSFET total power dissipation
15.	M1 PdCond	113.75 mW	Mosfet	M1 MOSFET conduction losses
16.	M1 PdSw	546.39 mW	Mosfet	M1 MOSFET switching losses
17.	M1 Tj	83.007 degC	Mosfet	M1 MOSFET junction temperature
18.	M2 Pd	318.67 mW	Mosfet	M2 MOSFET total power dissipation
19.	M2 PdCond	187.56 mW	Mosfet	M2 MOSFET conduction losses
20.	M2 PdSw	131.11 mW	Mosfet	M2 MOSFET switching losses
21.	M2 Tj	65.934 degC	Mosfet	M2 MOSFET junction temperature
22.	Cin Pd	3.665 mW	Power	Input capacitor power dissipation
23.	Cout Pd	35.188 µW	Power	Output capacitor power dissipation
24.	IC Pd	226.48 mW	Power	IC power dissipation
25.	L Pd	24.211 mW	Power	Inductor power dissipation
26.	M1 Pd	660.14 mW	Power	M1 MOSFET total power dissipation
27.	M1 PdCond	113.75 mW	Power	M1 MOSFET conduction losses
28.	M1 PdSw	546.39 mW	Power	M1 MOSFET switching losses
29.	M2 Pd	318.67 mW	Power	M2 MOSFET total power dissipation
30.	M2 PdCond	187.56 mW	Power	M2 MOSFET conduction losses
31.	M2 PdSw	131.11 mW	Power	M2 MOSFET switching losses
32.	Total Pd	1.233 W	Power	Total Power Dissipation
33.	BOM Count	19	System Information	Total Design BOM count
34.	Cross Freq	26.49 kHz	System Information	Bode plot crossover frequency
35.	Duty Cycle	34.516 %	System Information	Duty cycle
36.	Efficiency	97.495 %	System Information	Steady state efficiency
37.	FootPrint	966.0 mm^2	System Information	Total Foot Print Area of BOM components
38.	Frequency	405.68 kHz	System Information	Switching frequency
39.	Gain Marg	-13.788 dB	System Information	Bode Plot Gain Margin
40.	Iout	4.0 A	System Information	Iout operating point
41.	Iout transient step used for Cout calculations	2.0 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).

#	Name	Value	Category	Description
42.	Low Freq Gain	68.231 dB	System Information	Gain at 1Hz
43.	Mode	CCM	System Information	Conduction Mode
44.	Overshoot Value	71.766 mV	System Information	Theoretical Vout Overshoot Value
45.	Phase Marg	46.29 deg	System Information	Bode Plot Phase Margin
46.	Pout	48.0 W	System Information	Total output power
47.	Total BOM	$5.4	System Information	Total BOM Cost
48.	Undershoot Value	130.444 mV	System Information	Theoretical Vout Undershoot Value
49.	Vin	35.0 V	System Information	Vin operating point
50.	Vin p-p	548.885 mV	System Information	Peak-to-peak input voltage
51.	Vout	12.0 V	System Information	Operational Output Voltage
52.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
53.	Vout Tolerance	1.0 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
54.	Vout p-p	11.498 mV	System Information	Peak-to-peak output ripple voltage
55.	Vout transient requirement used for Cout calculations	3.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

Name	Value	Description
Iout	4.0	Maximum Output Current
VinMax	35.0	Maximum input voltage
VinMin	24.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM25148-Q1	Base Product Number
source	DC	Input Source Type
Ta	50.0	Ambient temperature
UserFsw	2.075 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

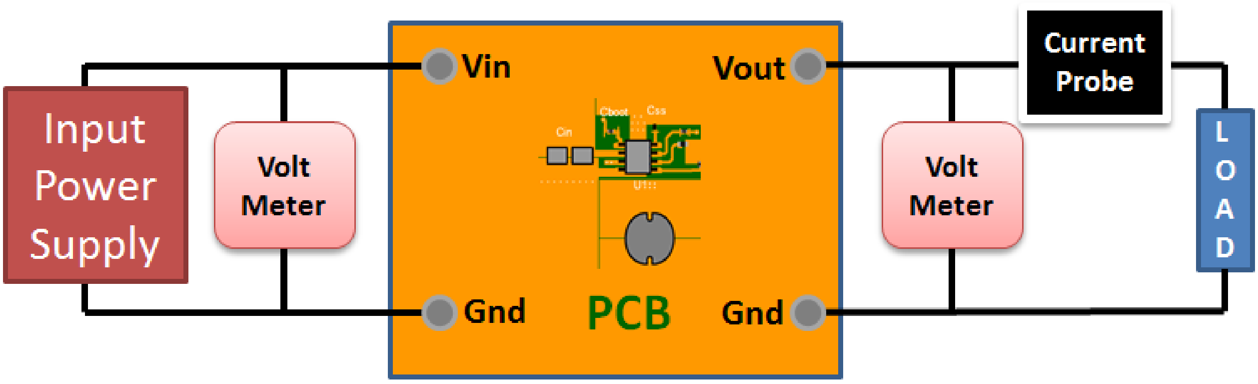
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 24.0V 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 : 18357C3A6FC010F679187DF770631ECB[v1]

2. **LM25148-Q1** Product Folder : http://www.ti.com/product/LM25148%2DQ1 : contains the data sheet and other resources.