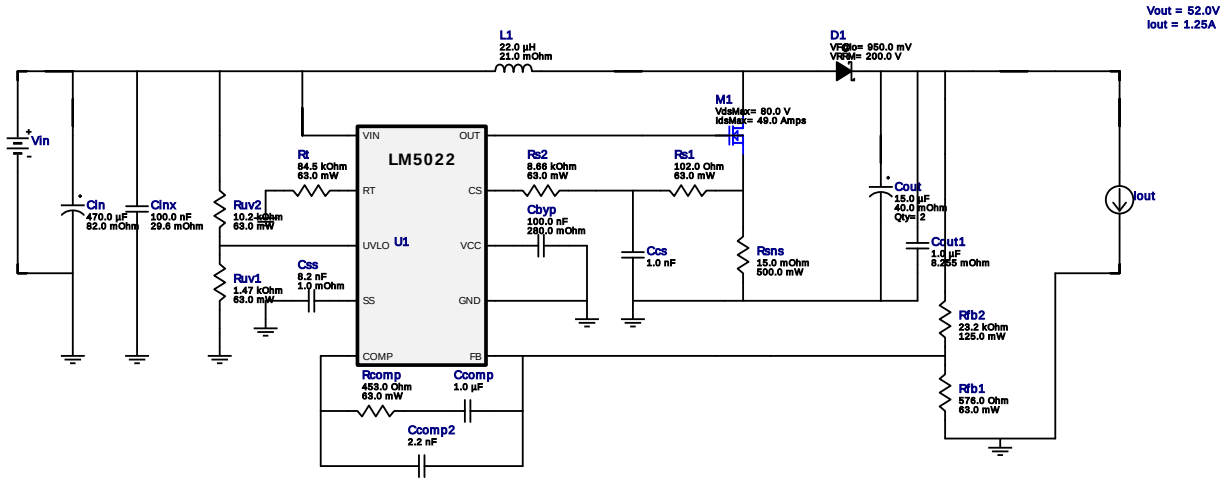
WEBENCH® Design Report

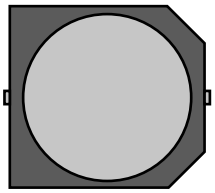
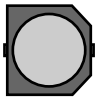
VinMin = 12.0V
VinMax = 36.0V
Vout = 52.0V
Iout = 1.25A

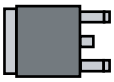
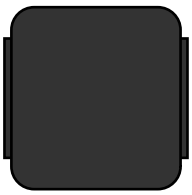
Device = LM5022MM/NOPB
Topology = Boost
Created = 2018-03-30 18:47:43.523
BOM Cost = NA
BOM Count = 1
Total Pd = 3.45W

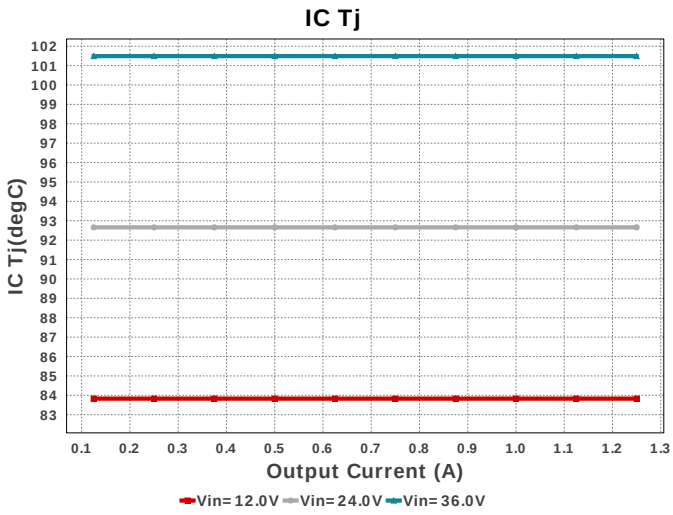
Design : 36 LM5022MM/NOPB
LM5022MM/NOPB 12.0V-36.0V to 52.00V @ 1.25A

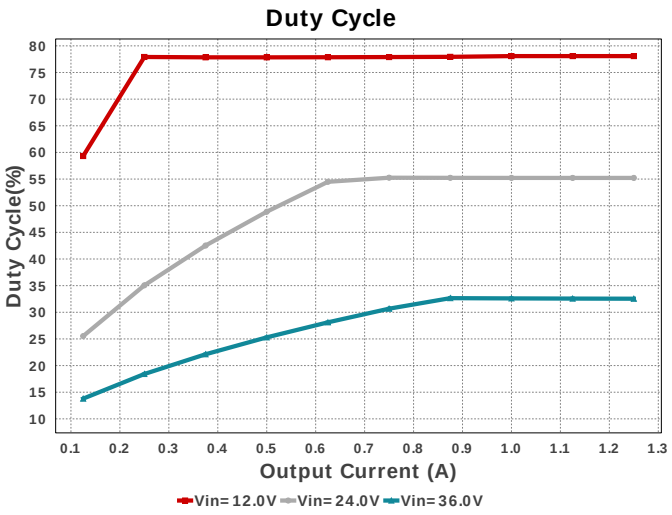


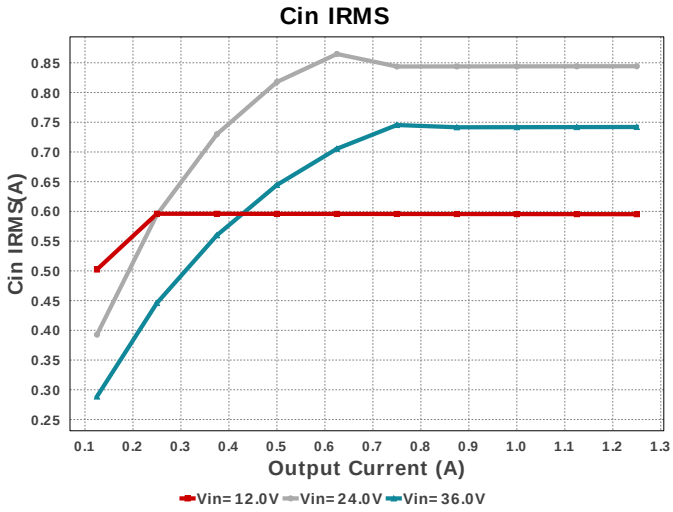
Electrical BOM

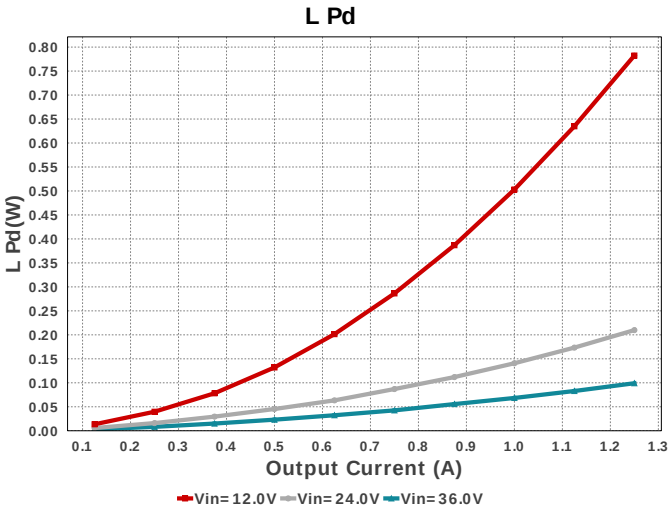
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbyp	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm²
Ccomp	Panasonic	ECPU1C105MA5 Series= ECPU(A)	Cap= 1.0 uF VDC= 16.0 V IRMS= 0.0 A	1	NA	 1210 15 mm²
Ccomp2	MuRata	GRM1885C1H222JA01J Series= C0G/NP0	Cap= 2.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0603 5 mm²
Ccs	Samsung Electro-Mechanics	CL05C102JB5NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
Cin	Panasonic	EEV-FK1J471M Series= FK	Cap= 470.0 uF ESR= 82.0 mOhm VDC= 63.0 V IRMS= 1.41 A	1	$0.78	 SM_RADIAL_J16 399 mm²
Cinx	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 mm²
Cout	Panasonic	100SXV15M Series= SXV	Cap= 15.0 uF ESR= 40.0 mOhm VDC= 100.0 V IRMS= 2.35 A	2	$1.20	 CAPSMT_62_E12 106 mm²
Cout1	TDK	C2012X7S2A105K125AB Series= X7S	Cap= 1.0 uF ESR= 8.255 mOhm VDC= 100.0 V IRMS= 2.27442 A	1	$0.12	 0805 7 mm²

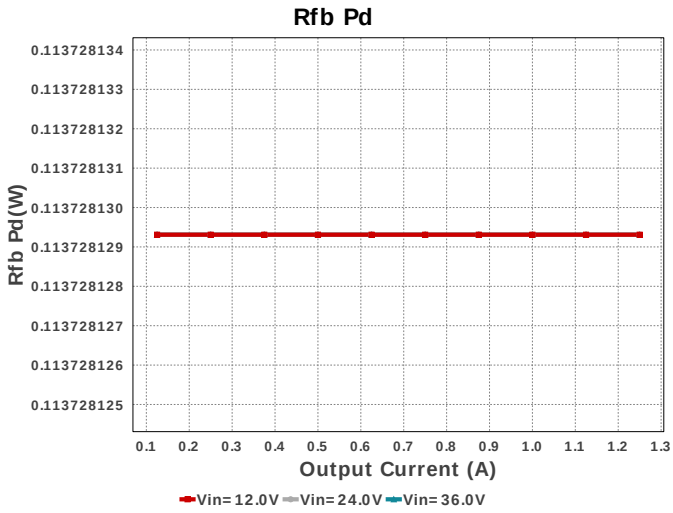
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Css	MuRata	GRM155R71E822KA01D Series= X7R	Cap= 8.2 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
D1	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm²
L1	Vishay-Dale	IHLP6767GZER220M11	L= 22.0 µH 21.0 mOhm	1	$2.55	 IHLP-6767GZ 367 mm²
M1	Infineon Technologies	BSC117N08NS5ATMA1	VdsMax= 80.0 V IdsMax= 49.0 Amps	1	$0.50	 PG-TDSON-8 55 mm²
Rcomp	Vishay-Dale	CRCW0402453RFKED Series= CRCW..e3	Res= 453.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rfb1	Vishay-Dale	CRCW0402576RFKED Series= CRCW..e3	Res= 576.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rfb2	Panasonic	ERJ-6ENF2322V Series= ERJ-6E	Res= 23.2 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rs1	Vishay-Dale	CRCW0402102RFKED Series= CRCW..e3	Res= 102.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rs2	Vishay-Dale	CRCW04028K66FKED Series= CRCW..e3	Res= 8.66 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rsns	Stackpole Electronics Inc	CSR1206FK15L0 Series= ?	Res= 15.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.12	 1206 11 mm²
Rt	Vishay-Dale	CRCW040284K5FKED Series= CRCW..e3	Res= 84.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Ruv1	Vishay-Dale	CRCW04021K47FKED Series= CRCW..e3	Res= 1.47 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Ruv2	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
U1	Texas Instruments	LM5022MM/NOPB	Switcher	1	$0.90	 MUB10A 24 mm²

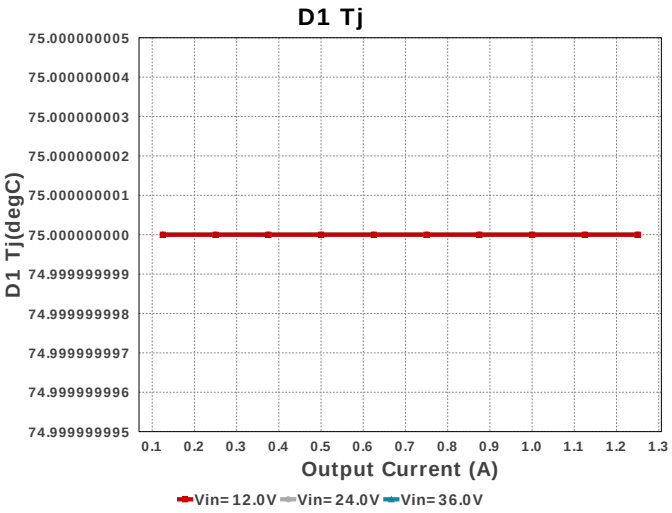


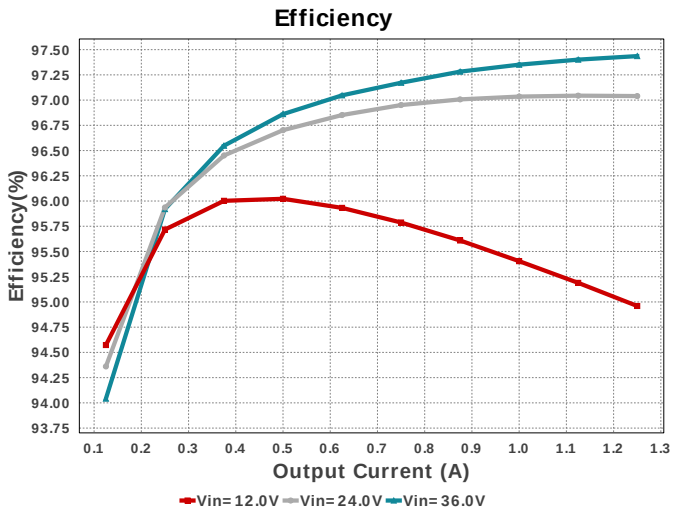


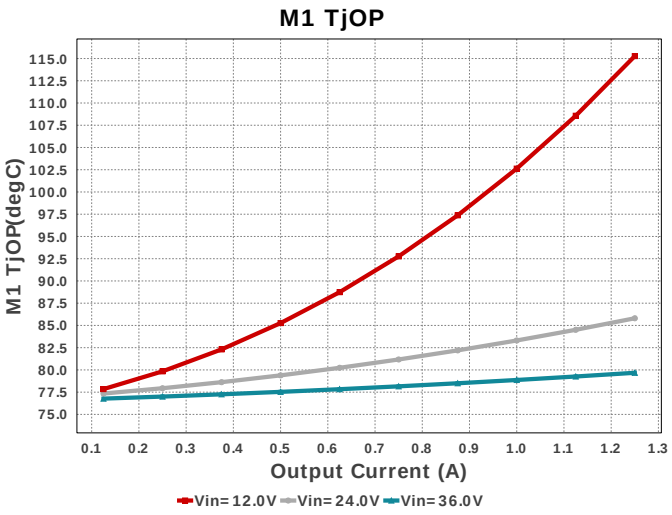


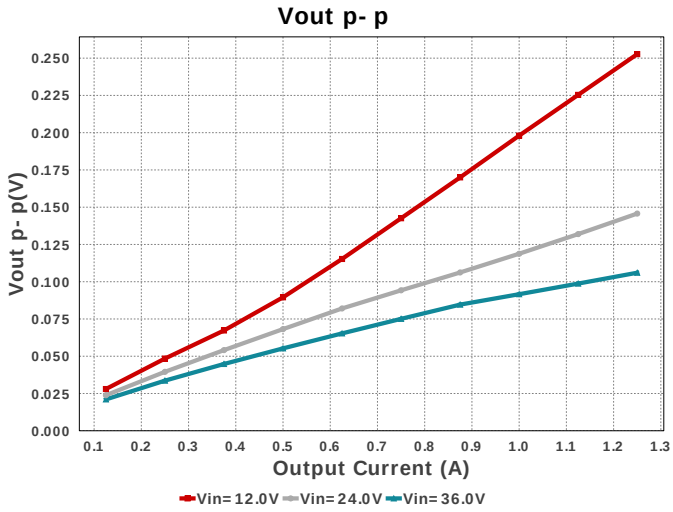


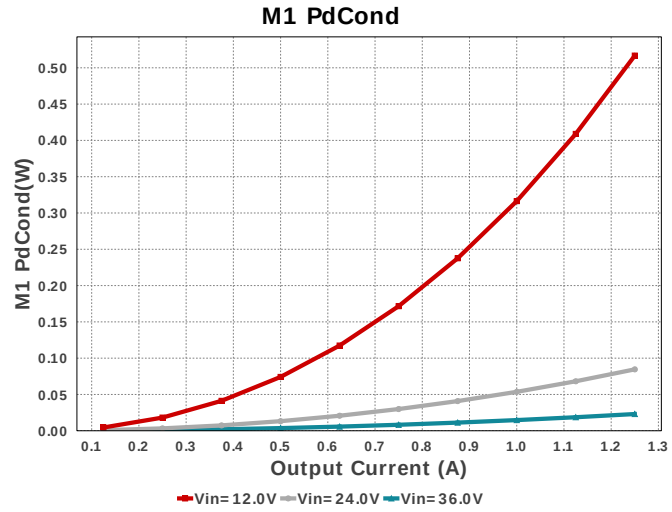


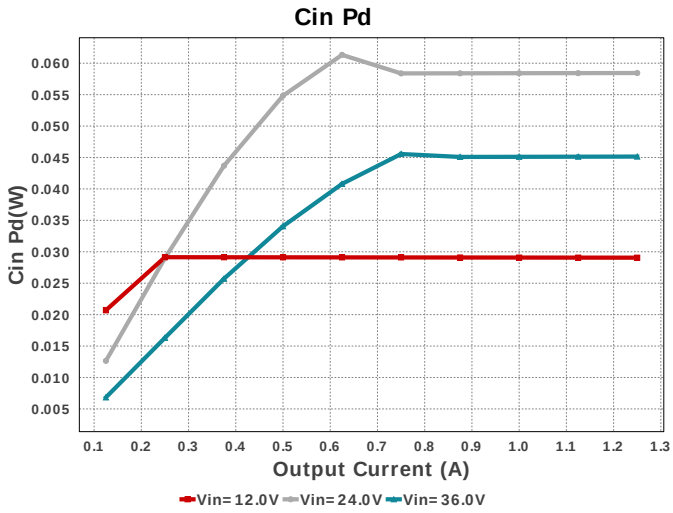


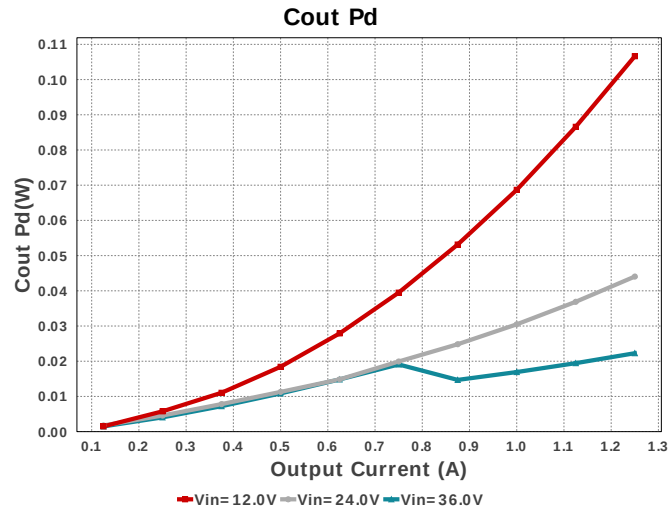


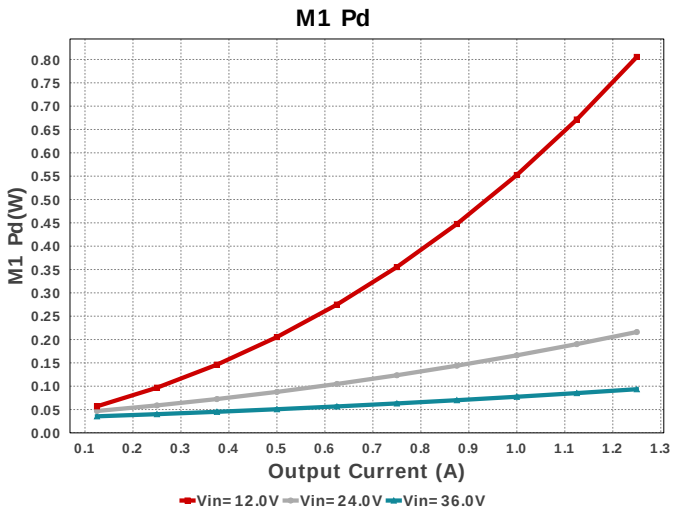


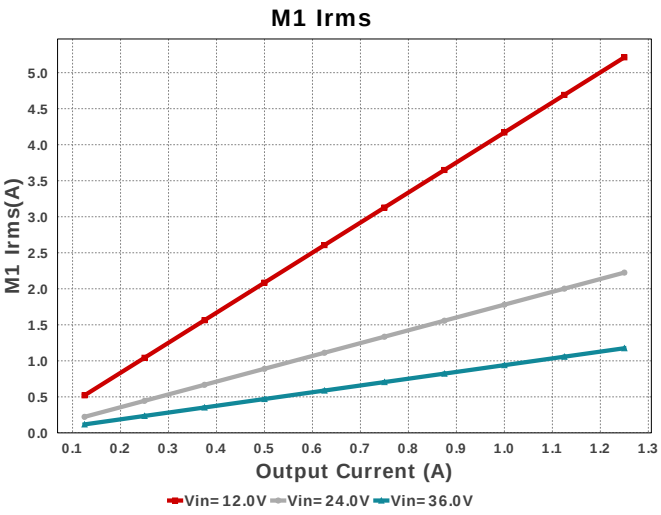


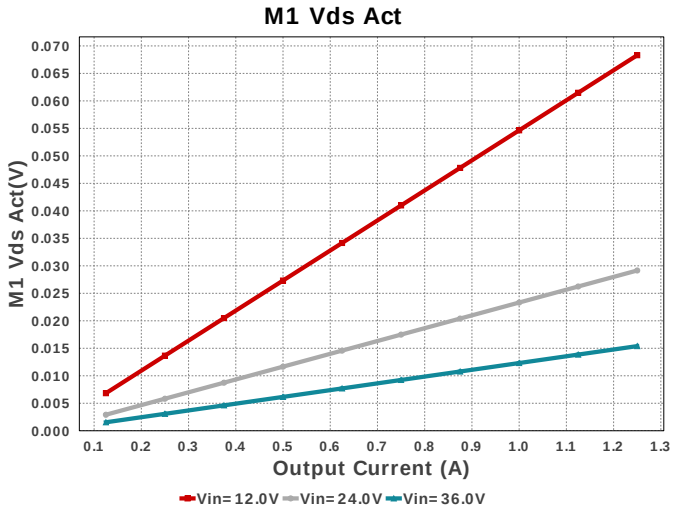


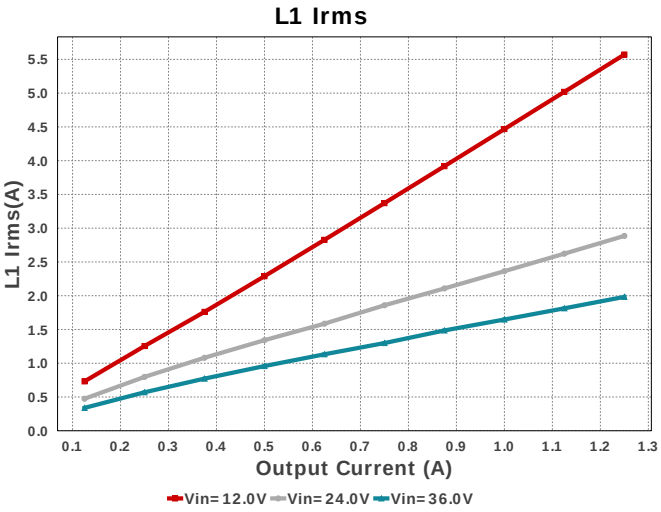


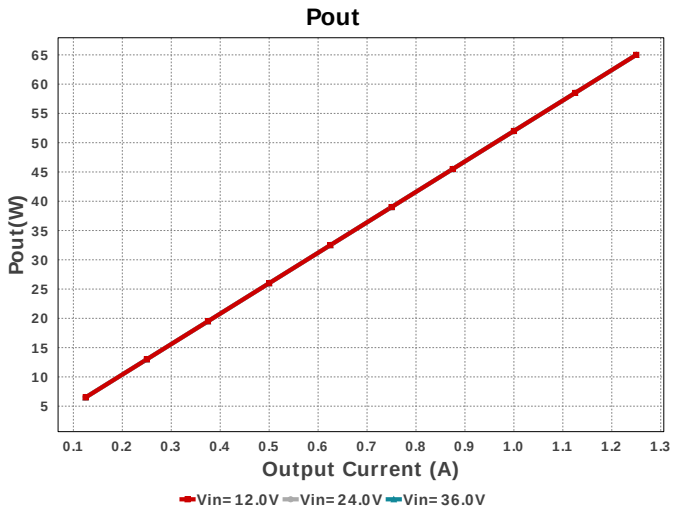


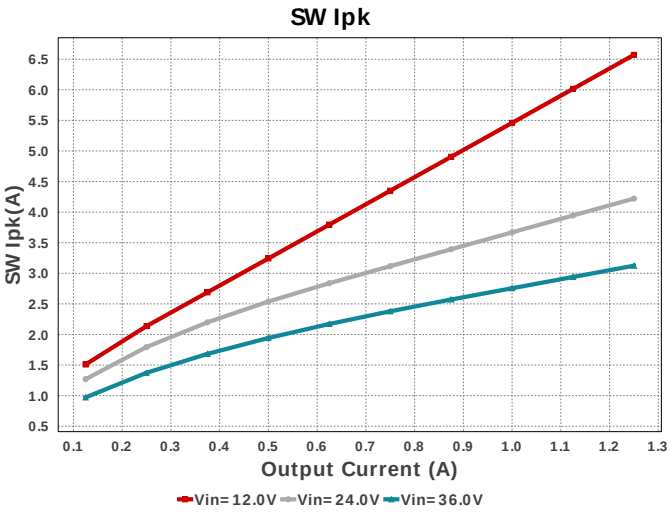


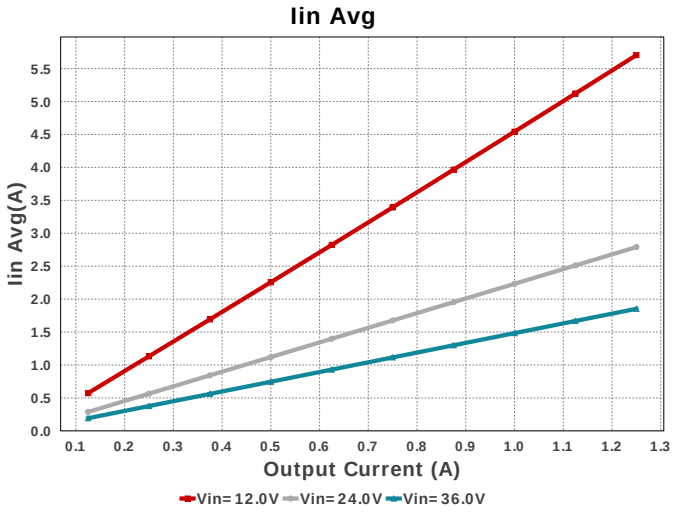


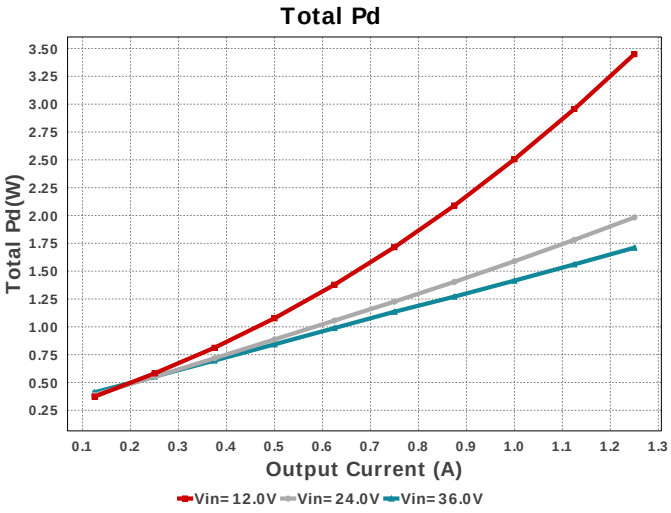


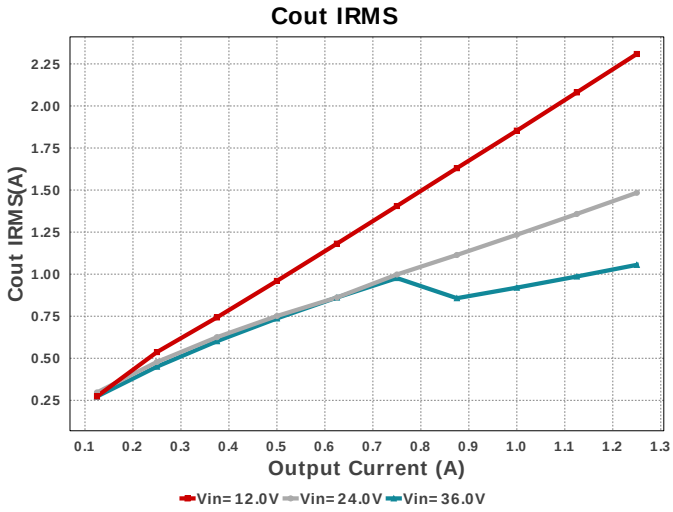


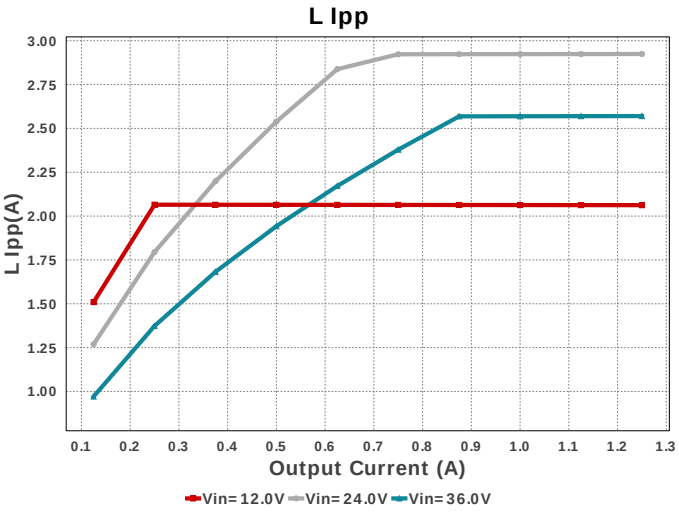


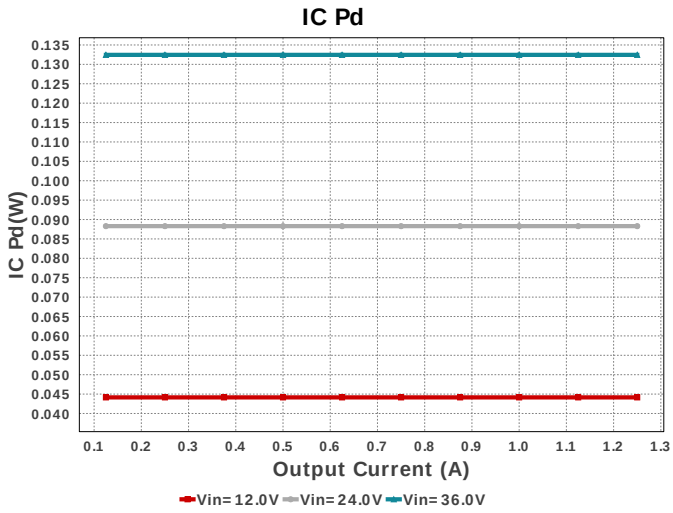


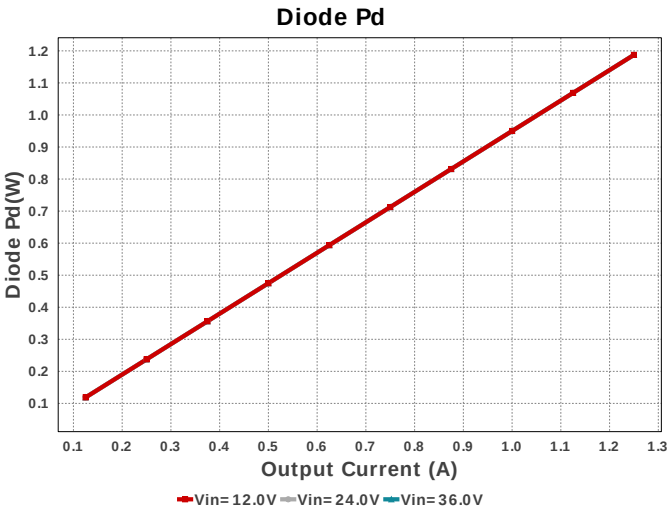


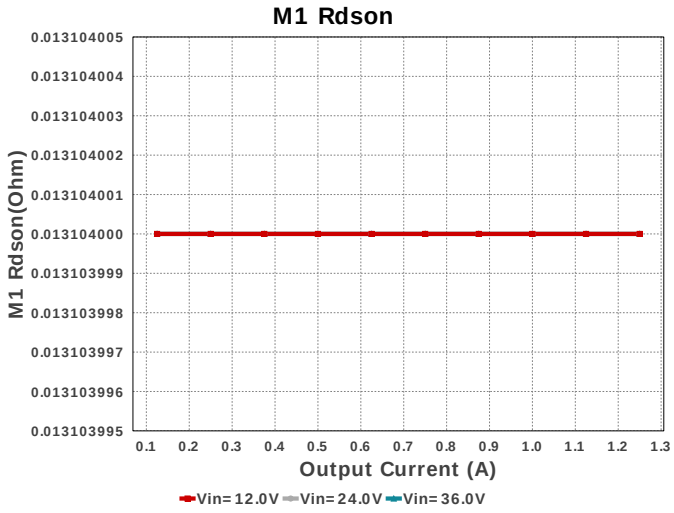


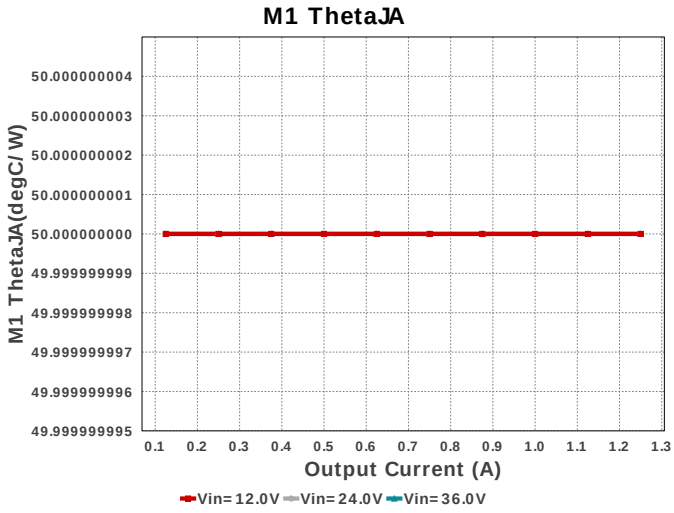


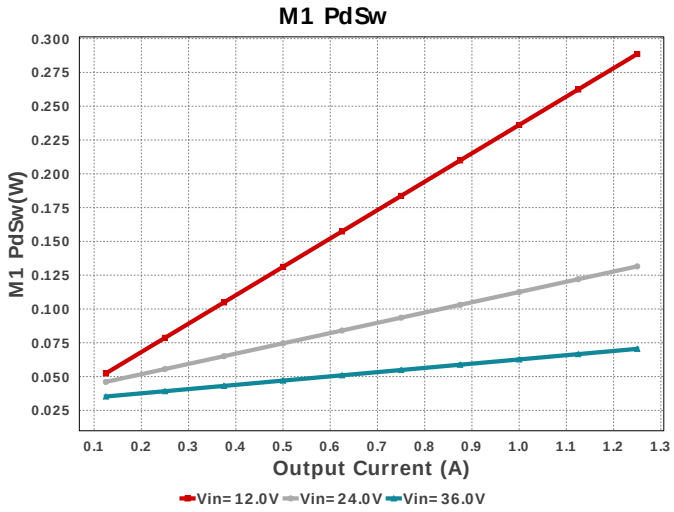


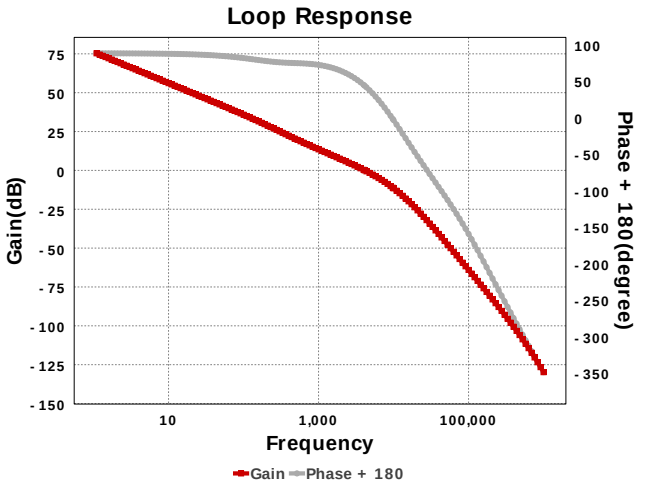












Operating Values

#	Name	Value	Category	Description
1.	Total BOM	NA		Total BOM Cost
2.	Cin IRMS	595.326 mA	Current	Input capacitor RMS ripple current
3.	Cout IRMS	2.309 A	Current	Output capacitor RMS ripple current
4.	Iin Avg	5.704 A	Current	Average input current
5.	L Ipp	2.062 A	Current	Peak-to-peak inductor ripple current
6.	L1 Irms	5.572 A	Current	Inductor ripple current
7.	M1 Irms	5.213 A	Current	M1 MOSFET Irms
8.	SW Ipk	6.571 A	Current	Peak switch current
9.	BOM Count	1	General	Total Design BOM count
10.	FootPrint	1.241 k mm^2	General	Total Foot Print Area of BOM components
11.	Frequency	204.228 kHz	General	Switching frequency
12.	IC Tolerance	25.0 mV	General	IC Feedback Tolerance
13.	M1 Rdson	13.104 mOhm	General	Drain-Source On-resistance
14.	M1 ThetaJA	50.0 degC/W	General	MOSFET junction-to-ambient thermal resistance
15.	Mode	CCM	General	Conduction Mode
16.	Pout	65.0 W	General	Total output power
17.	Cross Freq	1.521 kHz	Op Point	Bode plot crossover frequency
18.	D1 Tj	75.0 degC	Op Point	D1 junction temperature
19.	Duty Cycle	78.077 %	Op Point	Duty cycle
20.	Efficiency	94.96 %	Op Point	Steady state efficiency
21.	Gain Marg	-15.35 dB	Op Point	Bode Plot Gain Margin
22.	IC Tj	83.83 degC	Op Point	IC junction temperature
23.	ICThetaJA	200.0 degC/W	Op Point	IC junction-to-ambient thermal resistance
24.	IOUT_OP	1.25 A	Op Point	Iout operating point
25.	Low Freq Gain	65.565 dB	Op Point	Gain at 1Hz
26.	M1 TjOP	115.272 degC	Op Point	M1 MOSFET junction temperature
27.	Phase Marg	67.437 deg	Op Point	Bode Plot Phase Margin
28.	VIN_OP	12.0 V	Op Point	Vin operating point
29.	Vout Actual	52.01 V	Op Point	Vout Actual calculated based on selected voltage divider resistors
30.	Vout OP	52.0 V	Op Point	Operational Output Voltage

#	Name	Value	Category	Description
31.	Vout Tolerance	3.994 %	Op Point	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
32.	Vout p-p	252.706 mV	Op Point	Peak-to-peak output ripple voltage
33.	Cin Pd	29.062 mW	Power	Input capacitor power dissipation
34.	Cout Pd	106.624 mW	Power	Output capacitor power dissipation
35.	Diode Pd	1.188 W	Power	Diode power dissipation
36.	IC Pd	44.149 mW	Power	IC power dissipation
37.	L Pd	782.372 mW	Power	Inductor power dissipation
38.	M1 Pd	805.44 mW	Power	M1 MOSFET total power dissipation
39.	M1 PdCond	516.803 mW	Power	M1 MOSFET conduction losses
40.	M1 PdSw	288.637 mW	Power	M1 MOSFET switching losses
41.	Rfb Pd	113.728 mW	Power	Rfb Power Dissipation
42.	Total Pd	3.45 W	Power	Total Power Dissipation
43.	M1 Vds Act	68.309 mV		M Vds

Design Inputs

Name	Value	Description
Iout	1.25	Maximum Output Current
VinMax	36.0	Maximum input voltage
VinMin	12.0	Minimum input voltage
Vout	52.0	Output Voltage
base_pn	LM5022	Base Product Number
source	DC	Input Source Type
Ta	75.0	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

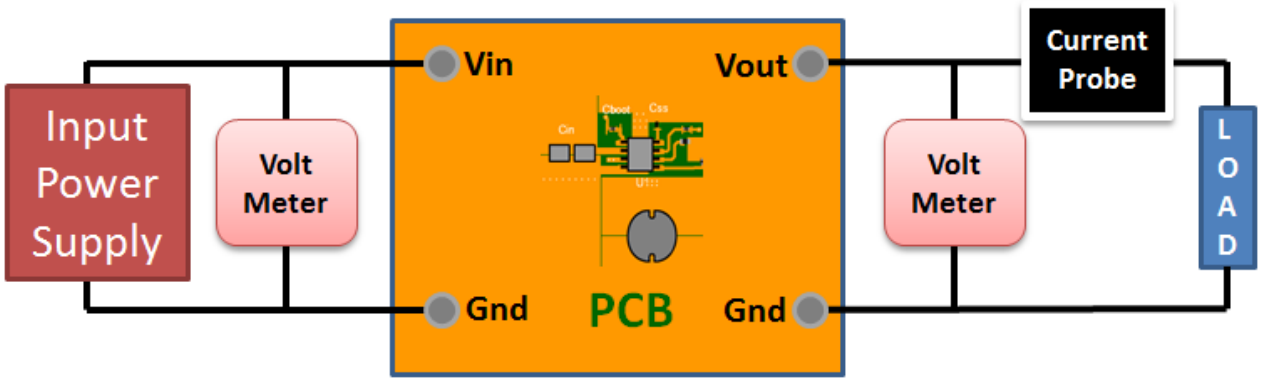
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 12.0V 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 : 17D39C88EB2C3A63[v1]
2. **LM5022** Product Folder : http://www.ti.com/product/LM5022 : contains the data sheet and other resources.