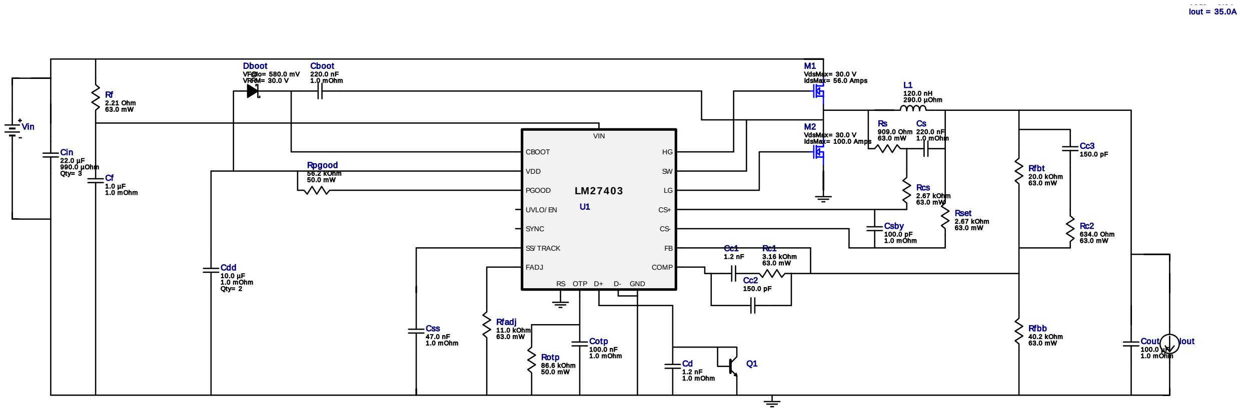
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 12.0V
VinMax = 12.1V
Vout = 0.9V
Iout = 35.0A

Device = LM27403SQ/NOPB
Topology = Buck
Created = 2019-12-30 10:42:19.480
BOM Cost = NA
BOM Count = 33
Total Pd = 3.7W

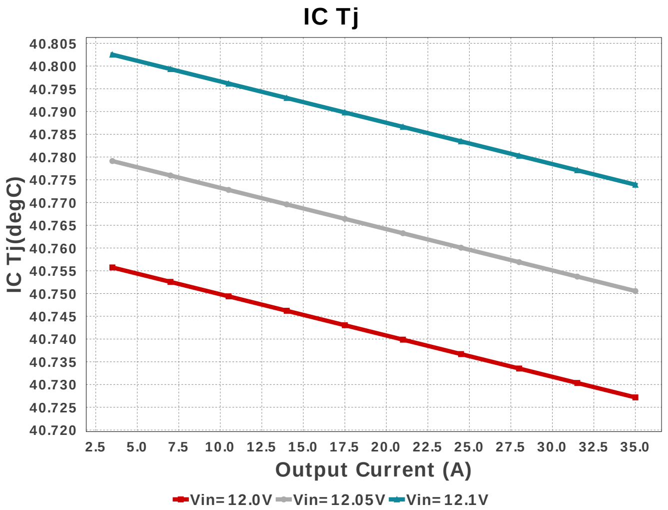
Design : 351 LM27403SQ/NOPB
LM27403SQ/NOPB 12V-12.1V to .90V @ 35A

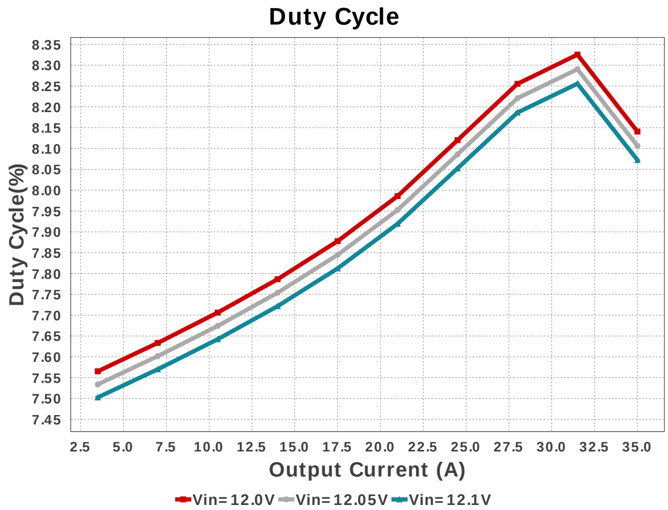


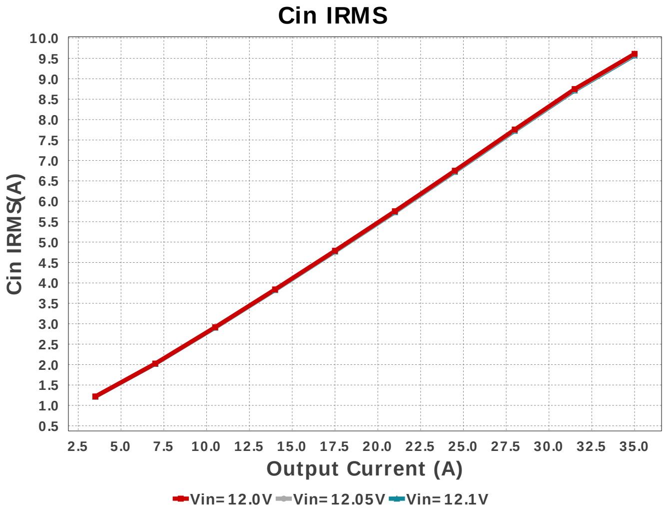
Electrical BOM

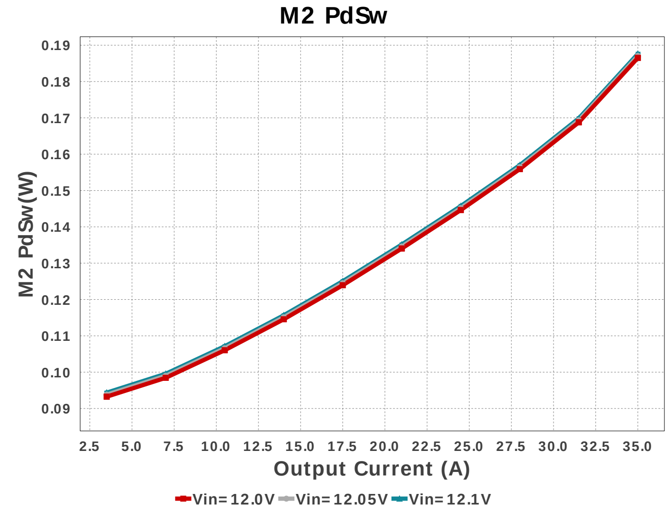
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM188R61E224KA88D Series= X5R	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.03	0603 5 mm²
Cc1	Samsung Electro-Mechanics	CL21C122JBFNNNE Series= C0G/NP0	Cap= 1.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Cc2	Samsung Electro-Mechanics	CL21C151JBANNNC Series= C0G/NP0	Cap= 150.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cc3	Samsung Electro-Mechanics	CL21C151JBANNNC Series= C0G/NP0	Cap= 150.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cd	MuRata	GRM033R71A122KA01D Series= X7R	Cap= 1.2 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cdd	TDK	C2012X7R1A106M125AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	2	$0.09	0805 7 mm²
Cf	Taiyo Yuden	TMK212B7105KG-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Cin	CUSTOM	CUSTOM Series= ?	Cap= 22.0 uF ESR= 990.0 uOhm VDC= 16.093 V IRMS= 0.0 A	3	NA	CUSTOM 0 mm²
Cotp	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
Cout	MuRata	GRM32ER60J107ME20L Series= X5R	Cap= 100.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.52	1210_270 15 mm²

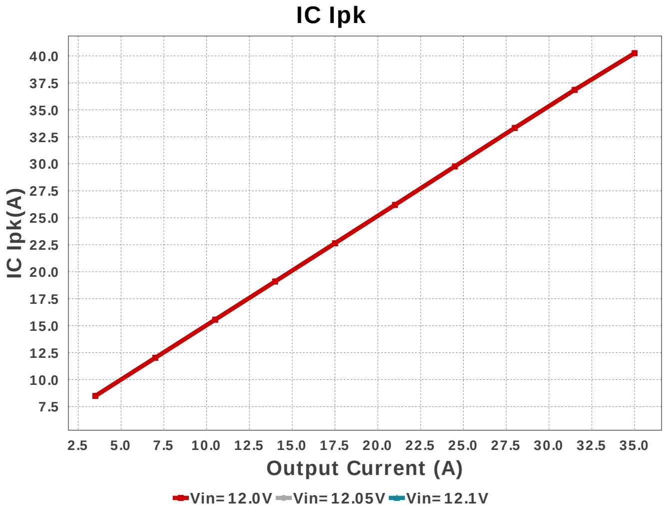
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cs	Kemet	C0603C224Z4VACTU Series= Y5V	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Csby	MuRata	GRM033R71C101KA01D Series= X7R	Cap= 100.0 pF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Css	MuRata	GRM155R71E473KA88D Series= X7R	Cap= 47.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Dboot	Diodes Inc.	SBR0230T5-7-F	VF@Io= 580.0 mV VRRM= 30.0 V	1	$0.10	SOD-523 5 mm^2
L1	Coilcraft	SLR1070-121KE	L= 120.0 nH 290.0 µOhm	1	$0.37	CUSTOM 80 mm^2
M1	Texas Instruments	CSD17304Q3	VdsMax= 30.0 V IdsMax= 56.0 Amps	1	$0.29	DQG0008A 18 mm^2
M2	Texas Instruments	CSD17573Q5B	VdsMax= 30.0 V IdsMax= 100.0 Amps	1	$0.60	DNK0008A 56 mm^2
Q1	Diodes Inc.	MMBT3904T	Bipolar Transistor	1	$0.06	SOT-523 7 mm^2
Rc1	Vishay-Dale	CRCW04023K16FKED Series= CRCW..e3	Res= 3.16 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rc2	Vishay-Dale	CRCW0402634RFKED Series= CRCW..e3	Res= 634.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcs	Vishay-Dale	CRCW04022K67FKED Series= CRCW..e3	Res= 2.67 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rf	Vishay-Dale	CRCW04022R21FKED Series= CRCW..e3	Res= 2.21 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfadj	Vishay-Dale	CRCW040211K0FKED Series= CRCW..e3	Res= 11.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW040240K2FKED Series= CRCW..e3	Res= 40.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rotp	Yageo	RC0201FR-0786K6L Series= ?	Res= 86.6 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rpgood	Yageo	RC0201FR-0756K2L Series= ?	Res= 56.2 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rs	Vishay-Dale	CRCW0402909RFKED Series= CRCW..e3	Res= 909.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rset	Vishay-Dale	CRCW04022K67FKED Series= CRCW..e3	Res= 2.67 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	LM27403SQ/NOPB	Switcher	1	$0.95	WQFN-24 25 mm^2

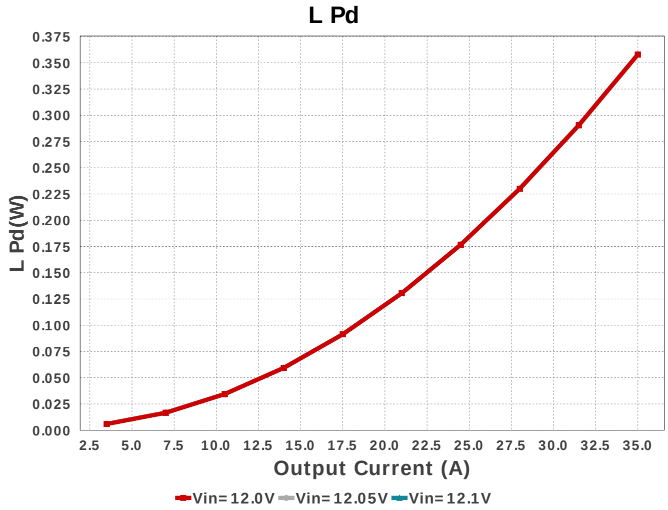

IC Tj
IC Tj(degC)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

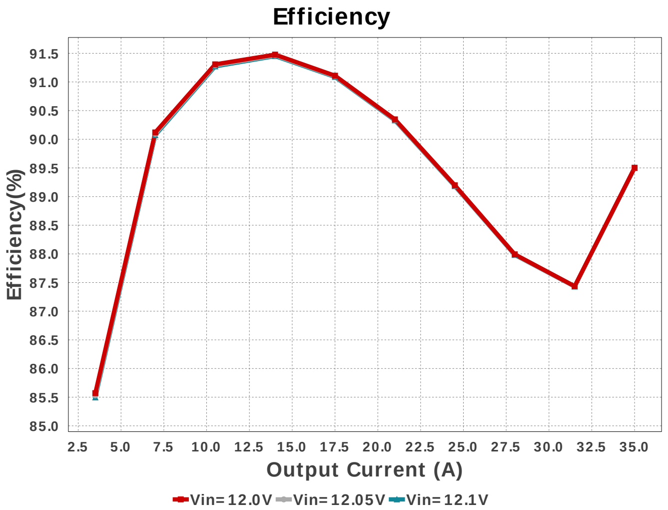

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

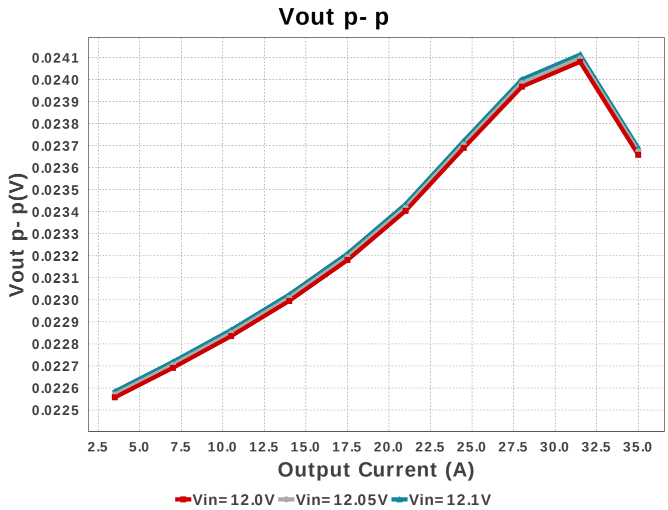

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

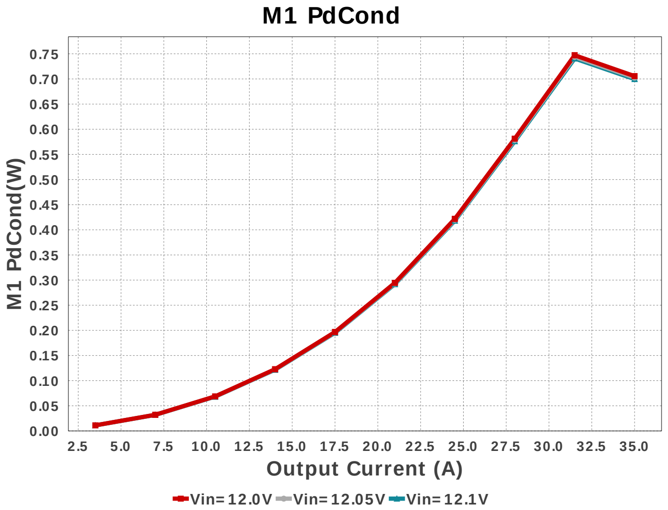

M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

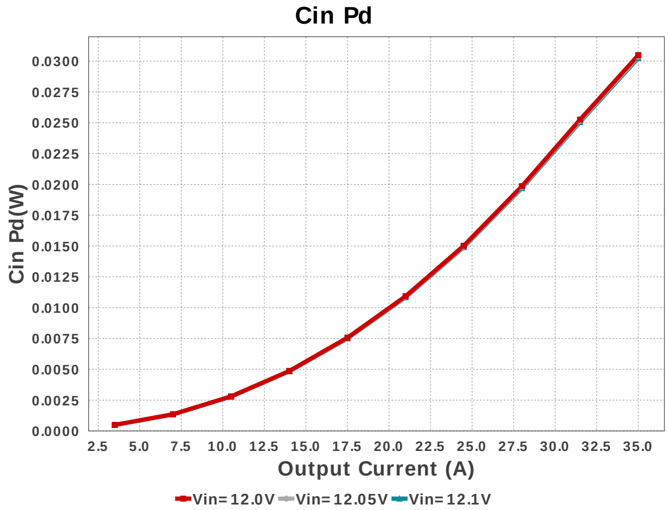

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

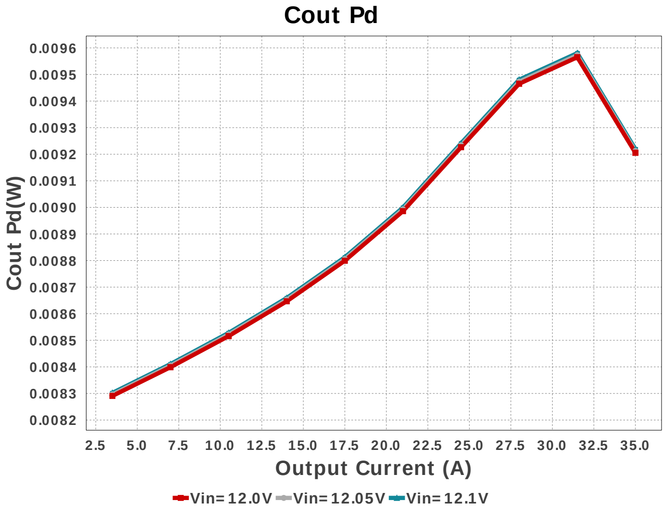

L Pd
L Pd(W)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

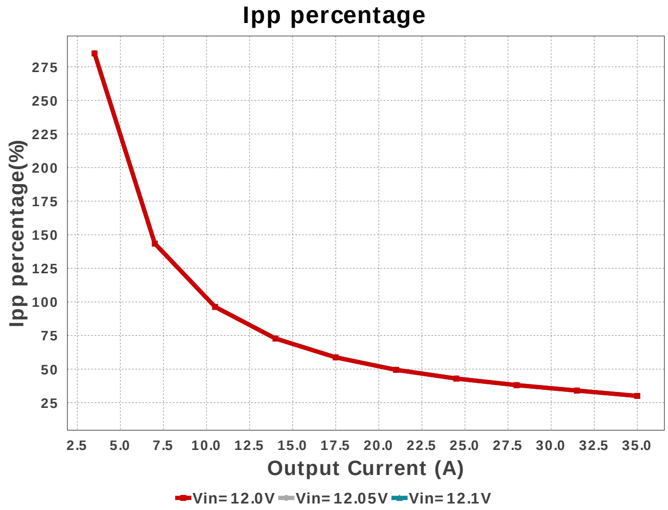

Efficiency
Efficiency(%)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

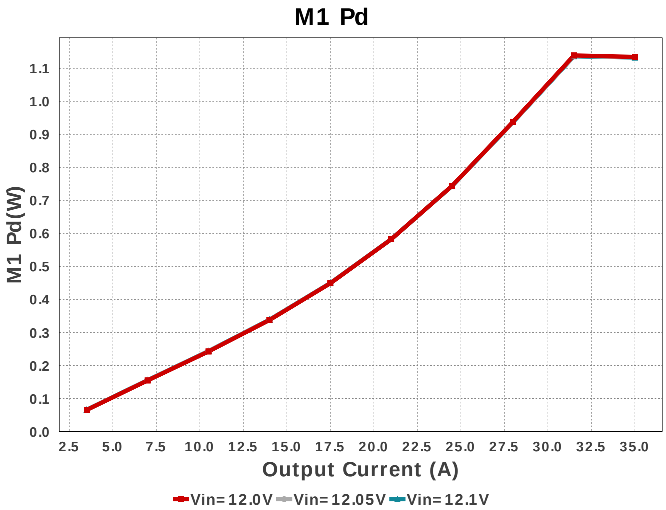

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

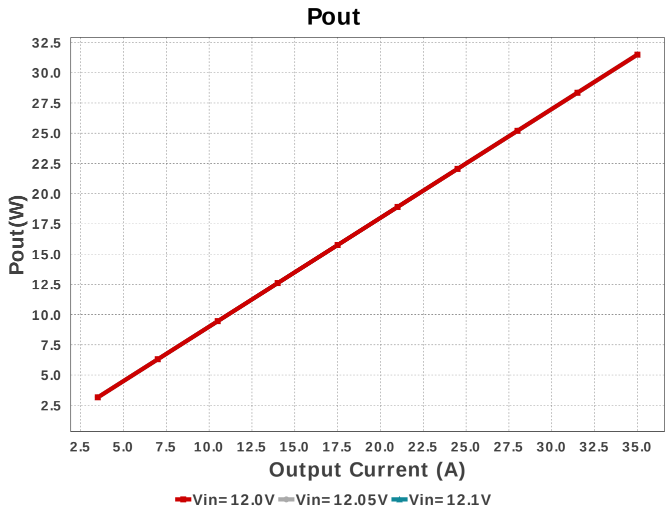

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

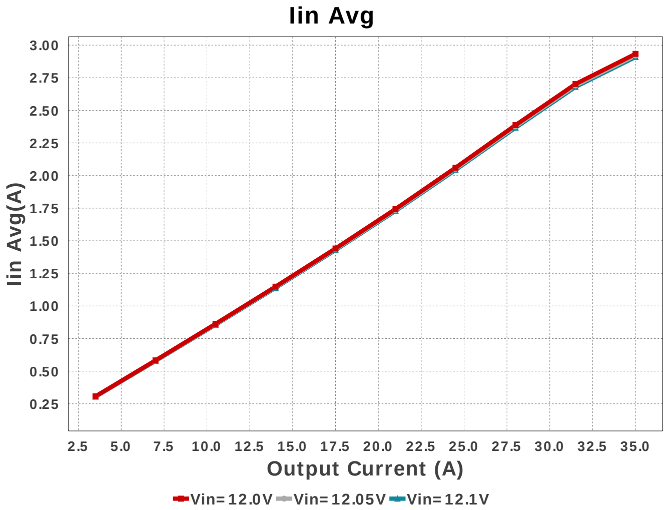

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

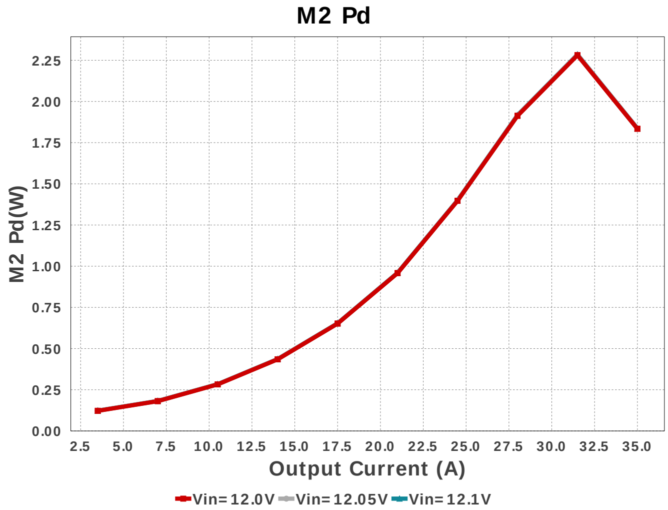

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

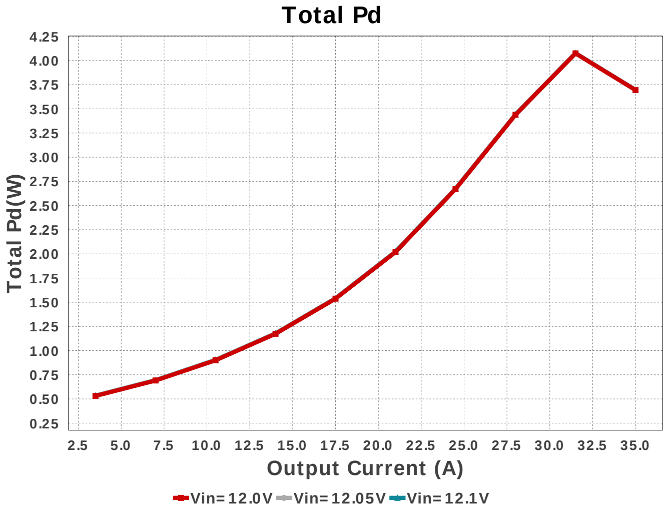

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=12.0V Vin=12.05V Vin=12.1V

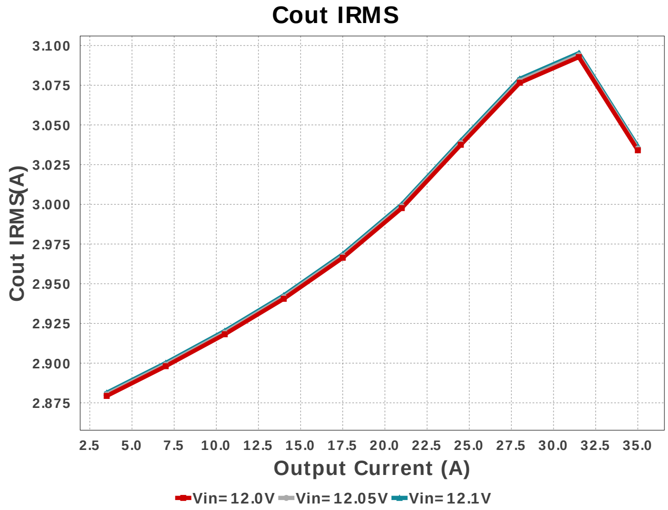

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=12.0V
Vin=12.05V
Vin=12.1V


Pout
Pout(W)
Output Current (A)
Vin=12.0V
Vin=12.05V
Vin=12.1V

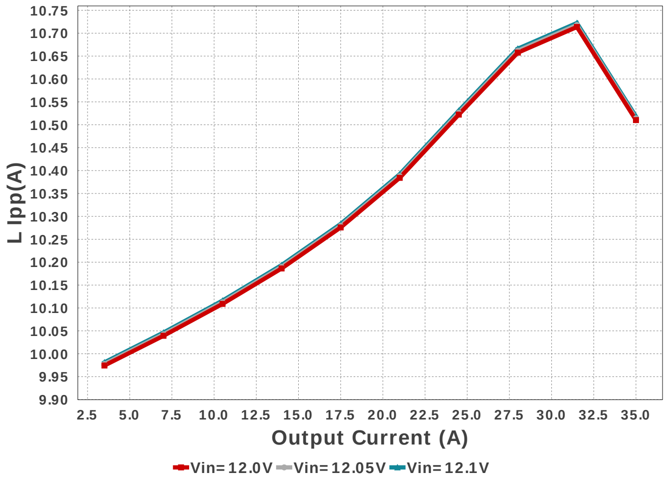

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=12.0V
Vin=12.05V
Vin=12.1V


M2 Pd
M2 Pd(W)
Output Current (A)
Vin=12.0V
Vin=12.05V
Vin=12.1V

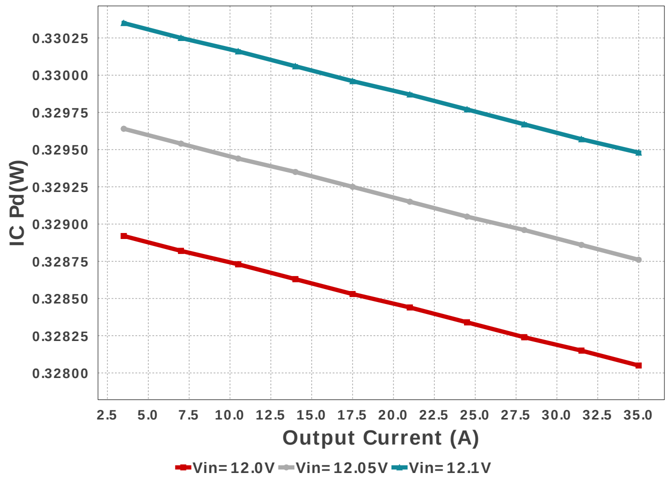

Total Pd
Total Pd(W)
Output Current (A)
Vin=12.0V
Vin=12.05V
Vin=12.1V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=12.0V
Vin=12.05V
Vin=12.1V

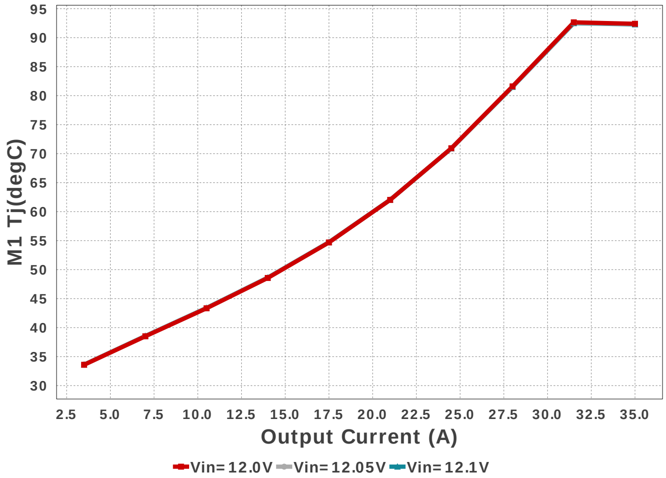
L Ipp



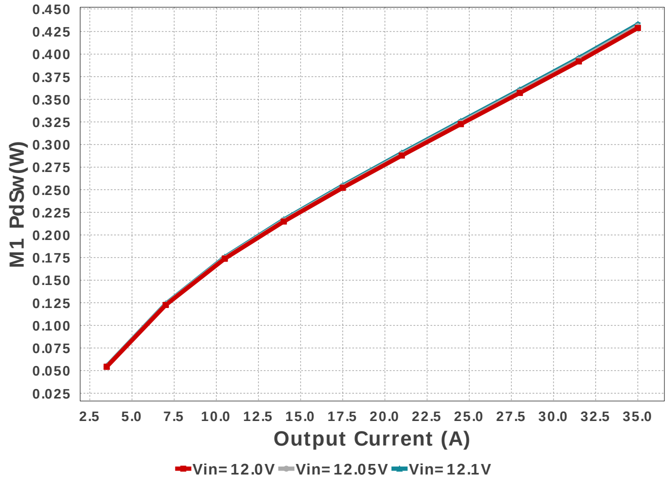
IC Pd



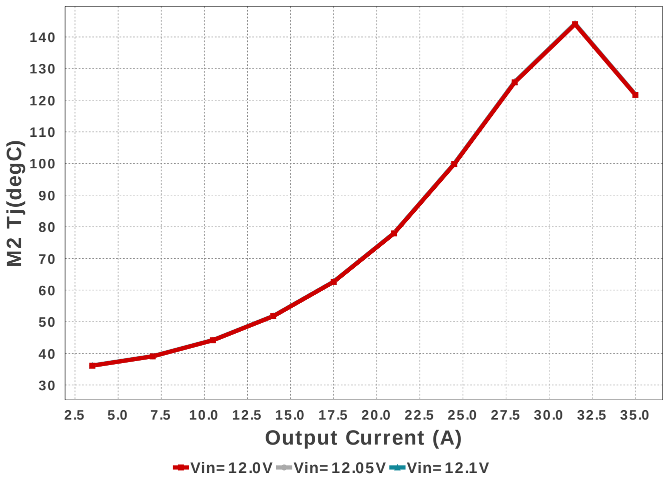
M1 Tj



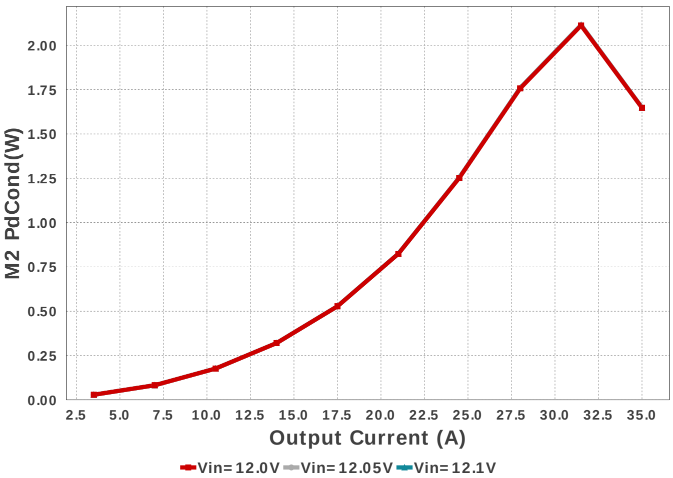
M1 PdSw

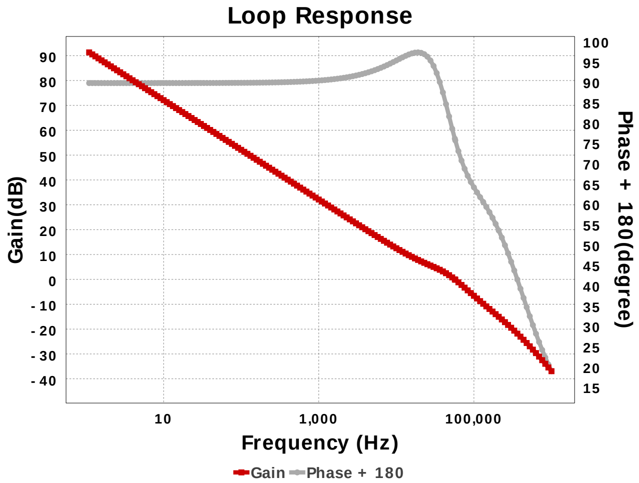


M2 Tj



M2 PdCond





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	33		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	9.573 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	30.244 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	3.036 A	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	9.219 mW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	40.259 A	IC	Peak switch current in IC
8.	IC Pd	329.48 mW	IC	IC power dissipation
9.	IC Tj	40.774 degC	IC	IC junction temperature
10.	IC Tolerance	6.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	32.7 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	2.909 A	IC	Average input current
13.	Ipp percentage	30.052 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	10.518 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	357.92 mW	Inductor	Inductor power dissipation
16.	M1 Pd	1.133 W	Mosfet	M1 MOSFET total power dissipation
17.	M1 PdCond	699.72 mW	Mosfet	M1 MOSFET conduction losses
18.	M1 PdSw	432.94 mW	Mosfet	M1 MOSFET switching losses
19.	M1 Tj	92.297 degC	Mosfet	M1 MOSFET junction temperature
20.	M2 Pd	1.836 W	Mosfet	M2 MOSFET total power dissipation
21.	M2 PdCond	1.649 W	Mosfet	M2 MOSFET conduction losses
22.	M2 PdSw	187.61 mW	Mosfet	M2 MOSFET switching losses
23.	M2 Tj	121.827 degC	Mosfet	M2 MOSFET junction temperature
24.	Cin Pd	30.244 mW	Power	Input capacitor power dissipation
25.	Cout Pd	9.219 mW	Power	Output capacitor power dissipation
26.	IC Pd	329.48 mW	Power	IC power dissipation
27.	L Pd	357.92 mW	Power	Inductor power dissipation
28.	M1 Pd	1.133 W	Power	M1 MOSFET total power dissipation
29.	M1 PdCond	699.72 mW	Power	M1 MOSFET conduction losses
30.	M1 PdSw	432.94 mW	Power	M1 MOSFET switching losses
31.	M2 Pd	1.836 W	Power	M2 MOSFET total power dissipation
32.	M2 PdCond	1.649 W	Power	M2 MOSFET conduction losses
33.	M2 PdSw	187.61 mW	Power	M2 MOSFET switching losses
34.	Total Pd	3.696 W	Power	Total Power Dissipation
35.	Cross Freq	56.738 kHz	System Information	Bode plot crossover frequency
36.	Duty Cycle	8.072 %	System Information	Duty cycle
37.	Efficiency	89.499 %	System Information	Steady state efficiency
38.	FootPrint	342.0 mm^2	System Information	Total Foot Print Area of BOM components
39.	Frequency	699.939 kHz	System Information	Switching frequency
40.	Gain Marg	-48.794 dB	System Information	Bode Plot Gain Margin
41.	Iout	35.0 A	System Information	Iout operating point
42.	Low Freq Gain	91.316 dB	System Information	Gain at 1Hz

#	Name	Value	Category	Description
43.	Mode	CCM	System Information	Conduction Mode
44.	Phase Marg	76.332 deg	System Information	Bode Plot Phase Margin
45.	Pout	31.5 W	System Information	Total output power
46.	Vin	12.1 V	System Information	Vin operating point
47.	Vout	900.0 mV	System Information	Operational Output Voltage
48.	Vout Actual	898.507 mV	System Information	Vout Actual calculated based on selected voltage divider resistors
49.	Vout Tolerance	1.678 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
50.	Vout p-p	23.689 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	35.0	Maximum Output Current
VinMax	12.1	Maximum input voltage
VinMin	12.0	Minimum input voltage
Vout	900.0 m	Output Voltage
base_pn	LM27403	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

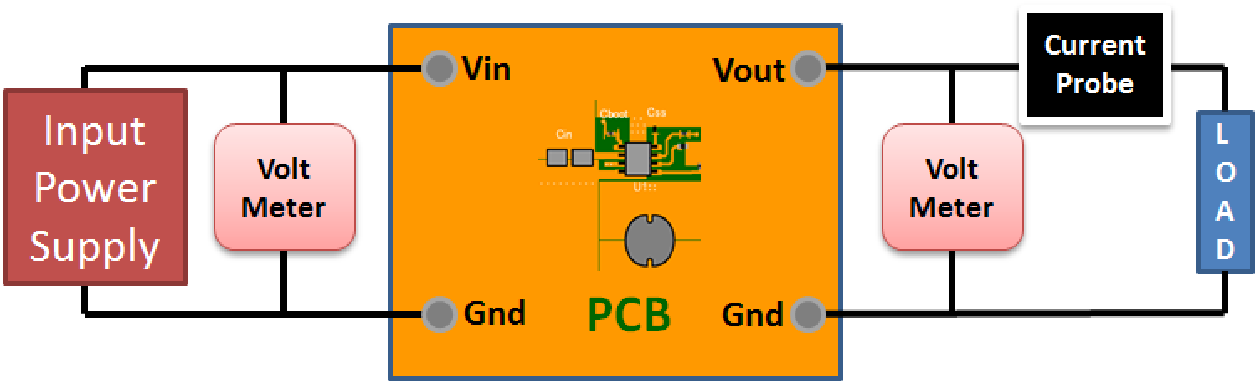
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 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. Tip: LM27403 High Current PCB Layout Design Guidance For higher current designs, please take care in designing the PCB layout. Consider good thermal management practices and proper routing of traces. Please see the following for more guidelines. Best Layout Practices for Switching Power Supplies http://sva.ti.com/assets/en/appnotes/national_power_designer114.pdf SIMPLE SWITCHER Layout Guidelines http://www.ti.com/lit/an/snva054c/snva054c.pdf Thermal Design by Insight, not Hindsight http://www.ti.com/lit/an/snva419c/snva419c.pdf

2. General Description: The LM27403 is a synchronous voltage mode buck controller with inductor DCR current sense capability. Sensing the inductor current eliminates the need to add resistive powertrain elements which increases overall efficiency and allows for accurate continuous current limit sensing. A 0.6V +/-1% voltage reference permits high accuracy and low voltage capability at the output. An operating voltage range of 3V to 20V makes the LM27403 suitable for a large variety of input rails. The LM27403 voltage mode control loop incorporates input voltage feed-forward to maintain stability throughout the entire input voltage range. The switching frequency is adjustable from 200 kHz to 1.2 MHz allowing a flexible design space. A power good indicator provides power rail sequencing capability and output fault detection. Programmable external softstart capability limits inrush current and provides monotonic output control at startup. Other features include external tracking of other power supplies, integrated LDO bias supply, and synchronization capability.

3. Master key : C4B4E1E3CC7FDF8C[v1]

4. **LM27403** Product Folder : http://www.ti.com/product/LM27403 : contains the data sheet and other resources.