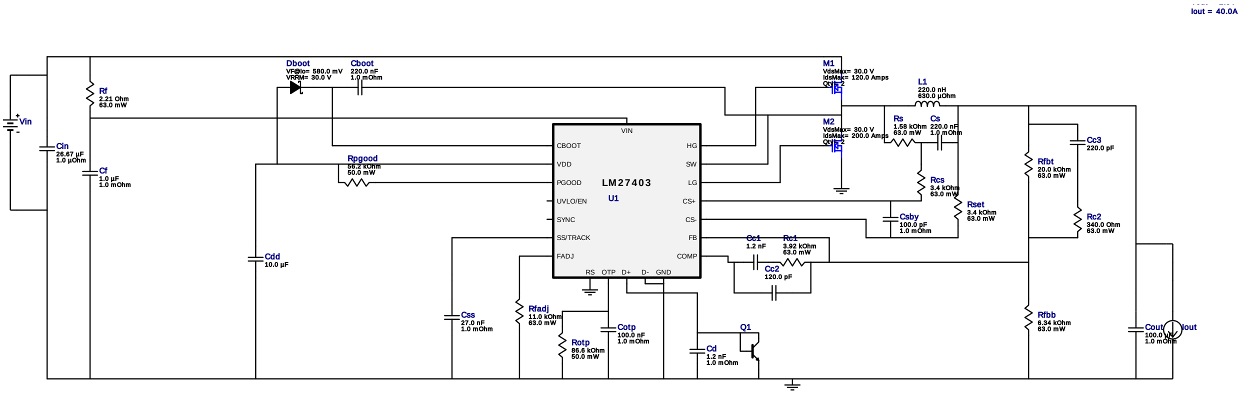
TEXAS INSTRUMENTS

VinMin = 9.0V
VinMax = 15.0V
Vout = 2.5V
Iout = 40.0A

Device = LM27403SQ/NOPB
Topology = Buck
Created = 2025-04-15 11:26:27.168
BOM Cost = NA
BOM Count = 32
Total Pd = 5.23W

WEBENCH ® Design Report

Design : 7 LM27403SQ/NOPB
LM27403SQ/NOPB 9V-15V to 2.50V @ 40A



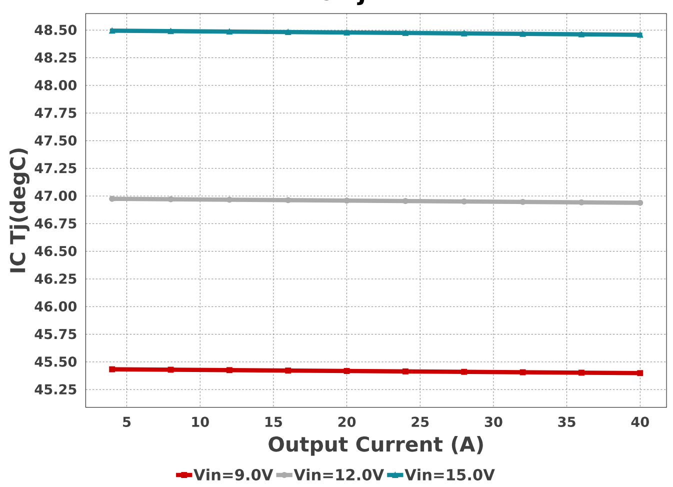
Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM188R61C224KA88D Series= X5R	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.03	0603 5 mm^2
Cc1	TDK	C2012C0G1H122J060AA Series= C0G/NP0	Cap= 1.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm^2
Cc2	MuRata	GRM0335C1H121JA01D Series= C0G/NP0	Cap= 120.0 pF VDC= 5.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Cc3	Samsung Electro-Mechanics	CL21C221JBANNNC Series= C0G/NP0	Cap= 220.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
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 mm^2
Cdd	TDK	C1608X5R1A106M080AC Series= X5R	Cap= 10.0 uF VDC= 10.0 V IRMS= 0.0 A	1	$0.11	0603 5 mm^2
Cf	Taiyo Yuden	TMK212BJ105KG-T Series= X5R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2
Cin	CUSTOM	CUSTOM Series= ?	Cap= 26.67 uF ESR= 1.0 uOhm VDC= 19.95 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm^2
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 mm^2
Cout	MuRata	GRM32EC80J107ME20L Series= X6S	Cap= 100.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.17	1210_270 15 mm^2

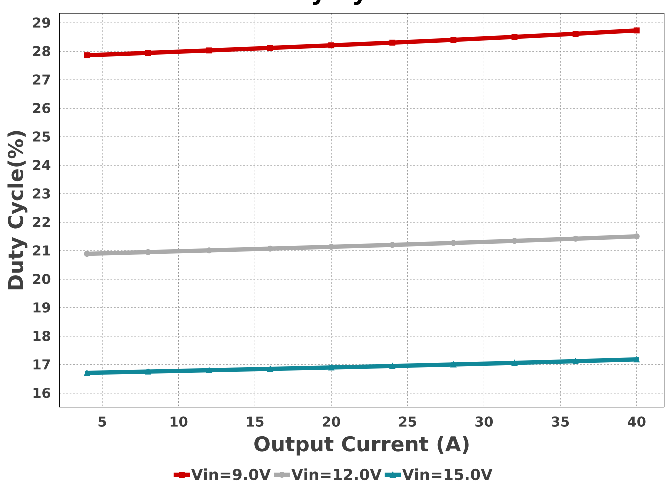
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cs	MuRata	GRM155R61A224KE19D Series= X5R	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Csby	MuRata	GRM033R71E101KA01D Series= X7R	Cap= 100.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Css	MuRata	GRM033R60J273KE01D Series= X5R	Cap= 27.0 nF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Dboot	Diodes Inc.	SBR0230T5-7-F	VF@Io= 580.0 mV VRRM= 30.0 V	1	$0.16	SOD-523 5 mm^2
L1	Vishay-Dale	IHLP6767GZERR22M01	L= 220.0 nH 630.0 µOhm	1	$2.32	IHLP-6767GZ 367 mm^2
M1	Texas Instruments	CSD17309Q3	VdsMax= 30.0 V IdsMax= 120.0 Amps	2	$0.33	DQG0008A 18 mm^2
M2	Texas Instruments	CSD17573Q5B	VdsMax= 30.0 V IdsMax= 200.0 Amps	2	$0.48	DNK0008A 56 mm^2
Q1	Diodes Inc.	MMBT3904T	Bipolar Transistor	1	$0.02	SOT-523 7 mm^2
Rc1	Vishay-Dale	CRCW04023K92FKED Series= CRCW..e3	Res= 3.92 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rc2	Vishay-Dale	CRCW0402340RFKED Series= CRCW..e3	Res= 340.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcs	Vishay-Dale	CRCW04023K40FKED Series= CRCW..e3	Res= 3.4 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	CRCW04026K34FKED Series= CRCW..e3	Res= 6.34 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	CRCW04021K58FKED Series= CRCW..e3	Res= 1.58 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rset	Vishay-Dale	CRCW04023K40FKED Series= CRCW..e3	Res= 3.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LM27403SQ/NOPB	Switcher	1	$1.21	WQFN-24 25 mm²

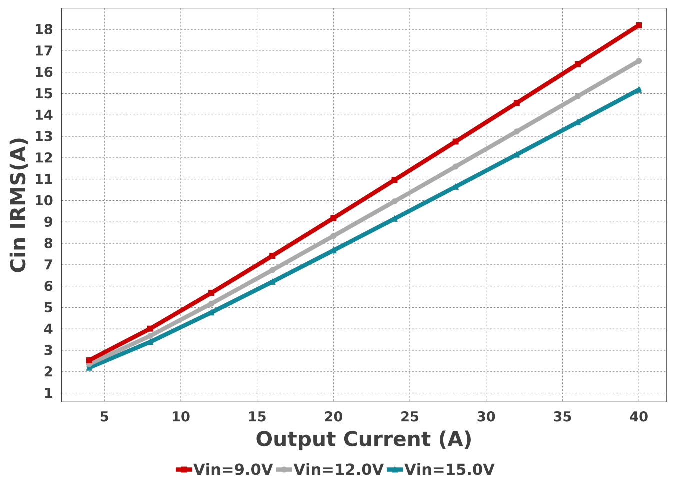
IC Tj



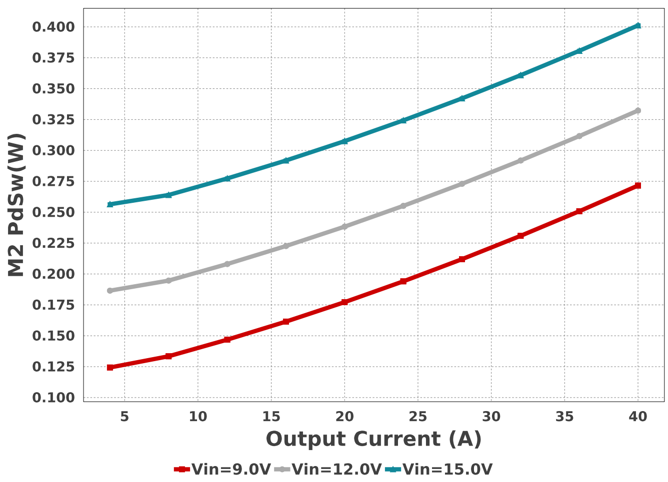
Duty Cycle



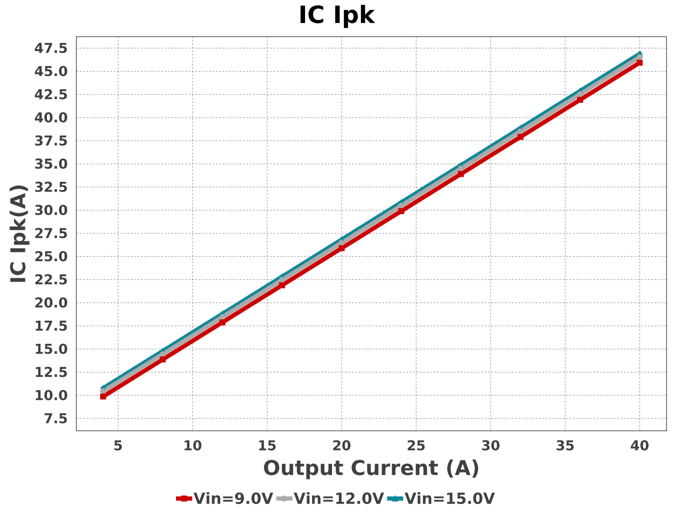
Cin IRMS



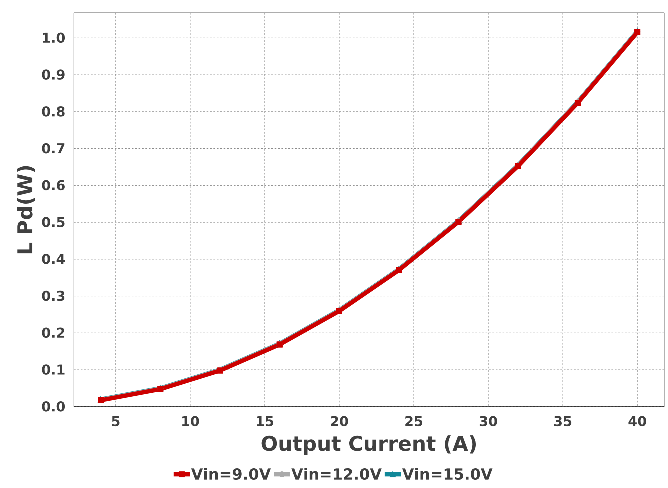
M2 PdSw

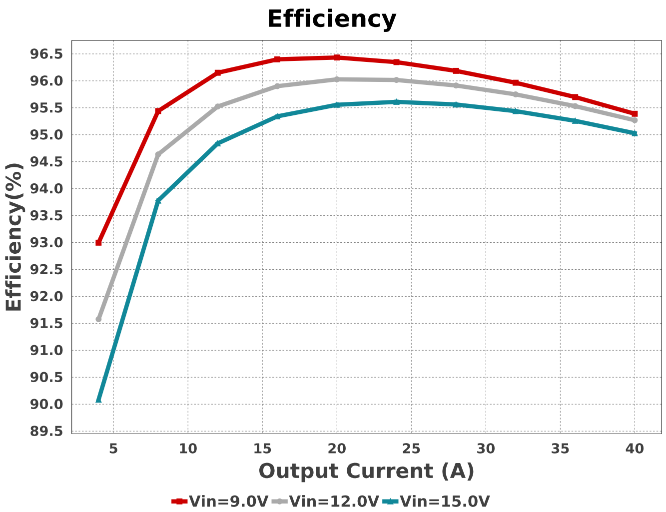


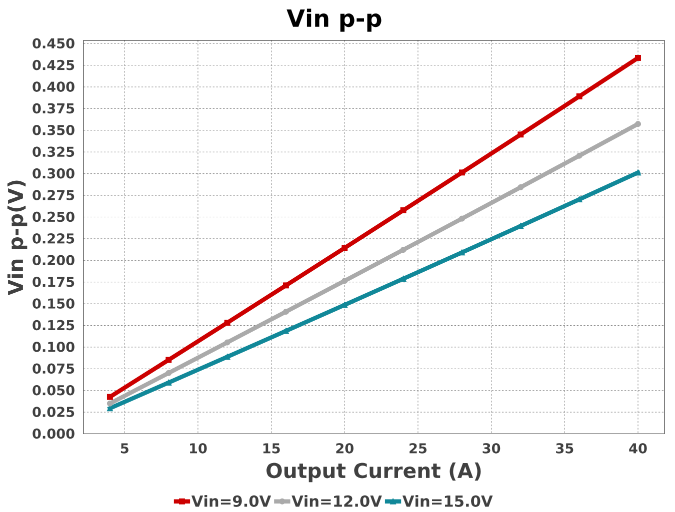
IC Ipk

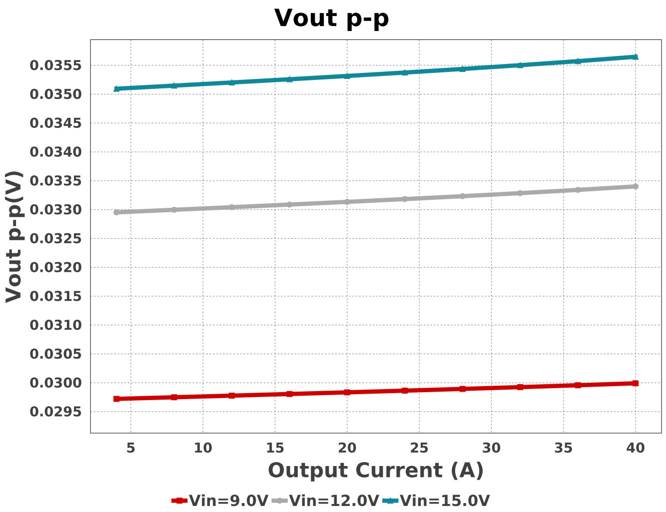


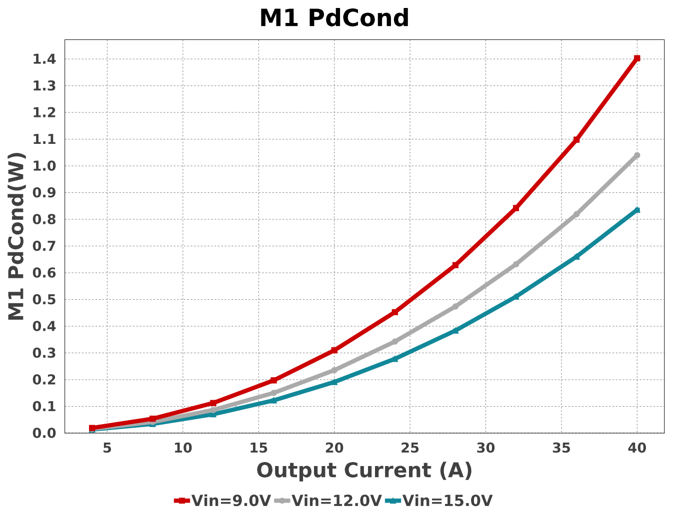
L Pd

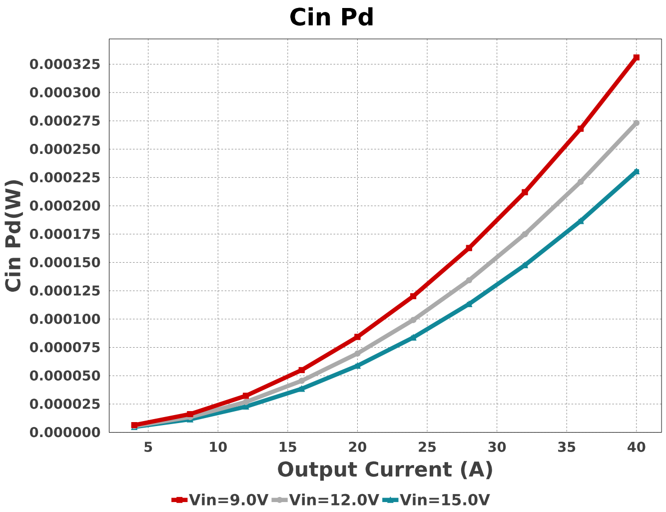


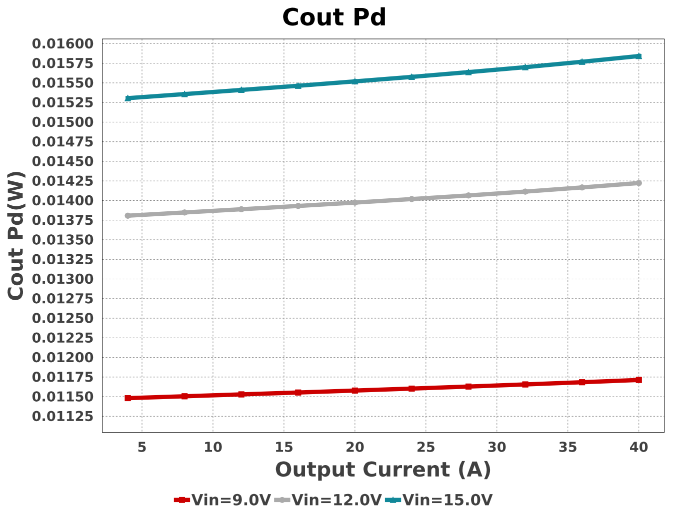

Efficiency
Efficiency(%)
96.5
96.0
95.5
95.0
94.5
94.0
93.5
93.0
92.5
92.0
91.5
91.0
90.5
90.0
89.5
5
10
15
20
25
30
35
40
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V


Vin p-p
Vin p-p(V)
0.450
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
5
10
15
20
25
30
35
40
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V

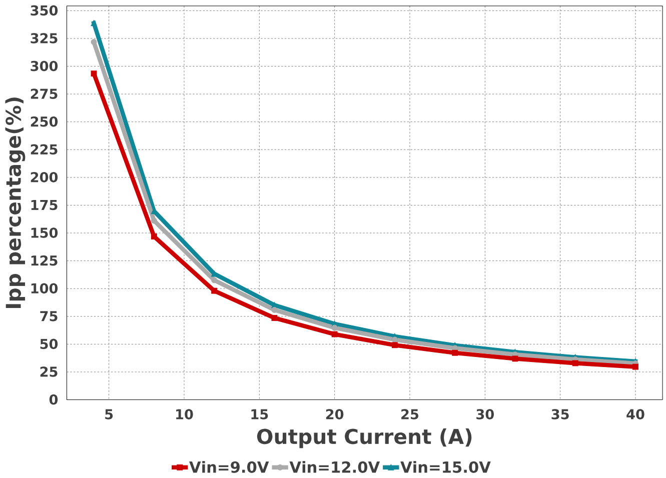

Vout p-p
Vout p-p(V)
0.0355
0.0350
0.0345
0.0340
0.0335
0.0330
0.0325
0.0320
0.0315
0.0310
0.0305
0.0300
0.0295
5
10
15
20
25
30
35
40
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V


M1 PdCond
M1 PdCond(W)
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
5
10
15
20
25
30
35
40
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V

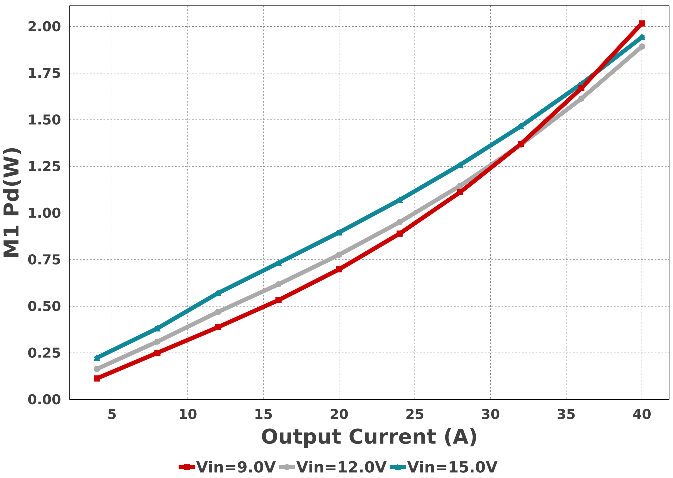

Cin Pd
Cin Pd(W)
0.000325
0.000300
0.000275
0.000250
0.000225
0.000200
0.000175
0.000150
0.000125
0.000100
0.000075
0.000050
0.000025
0.000000
5
10
15
20
25
30
35
40
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V


Cout Pd
Cout Pd(W)
0.01600
0.01575
0.01550
0.01525
0.01500
0.01475
0.01450
0.01425
0.01400
0.01375
0.01350
0.01325
0.01300
0.01275
0.01250
0.01225
0.01200
0.01175
0.01150
0.01125
5
10
15
20
25
30
35
40
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V

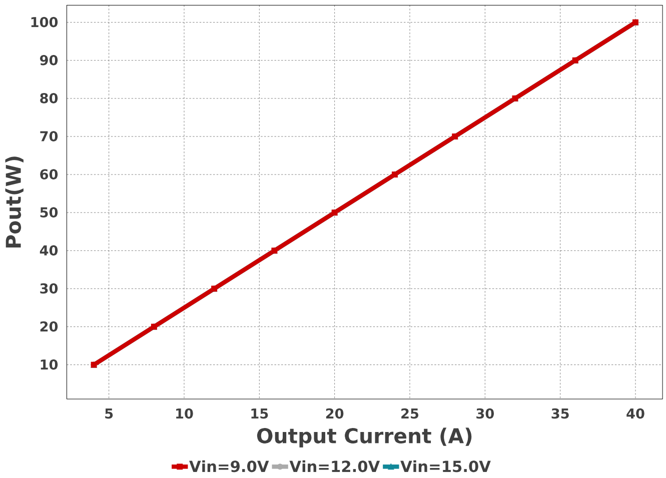
Ipp percentage



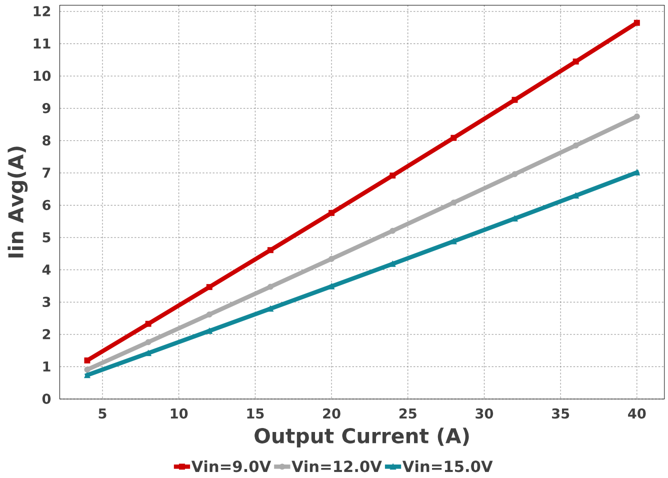
M1 Pd



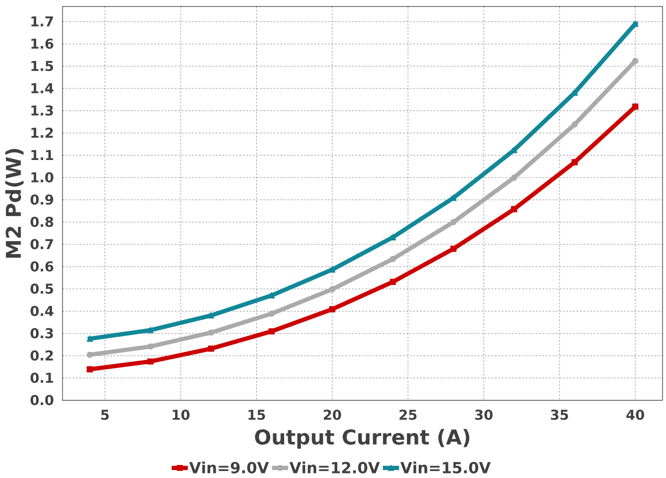
Pout



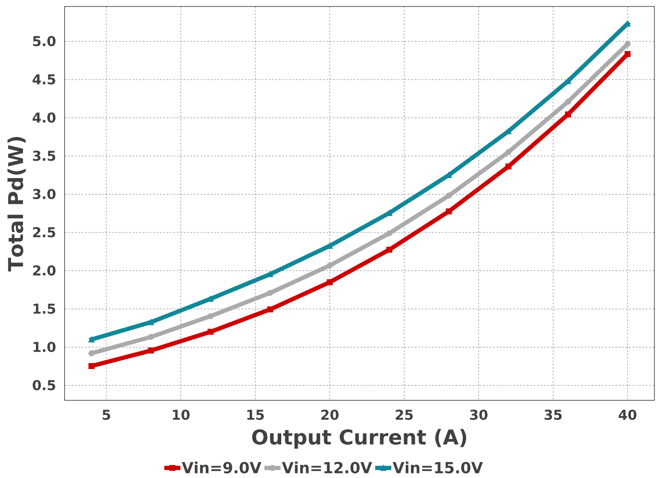
Iin Avg

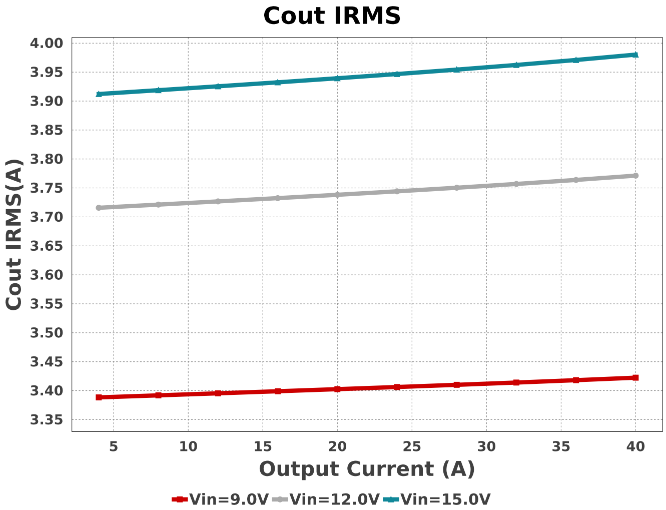


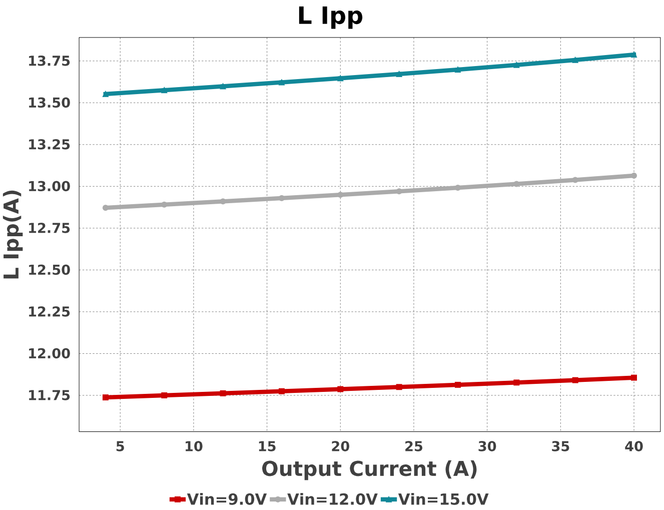
M2 Pd

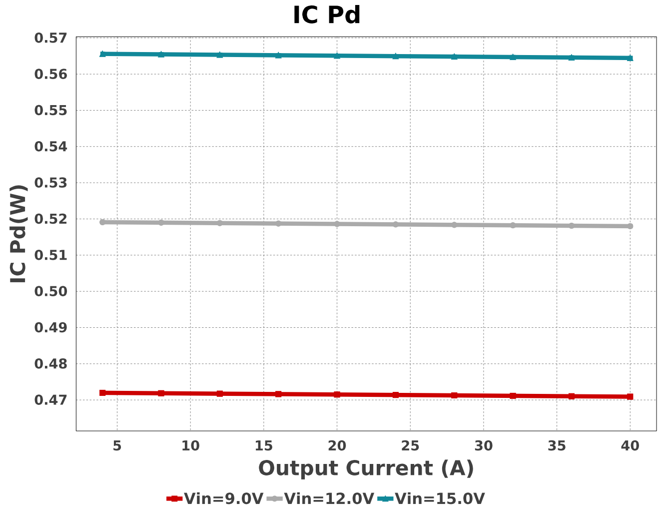


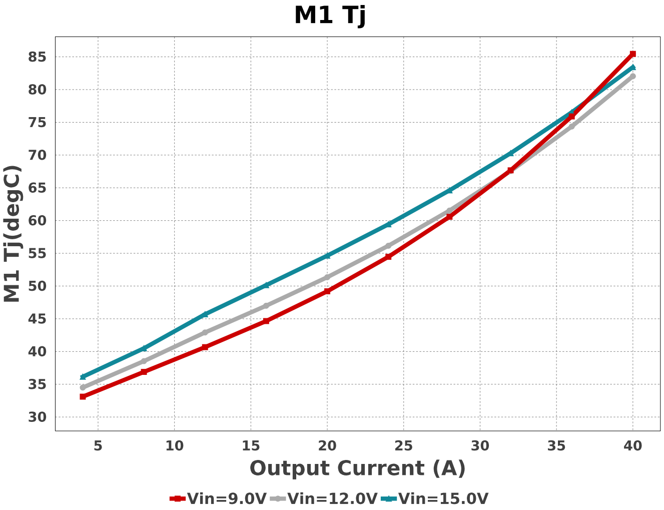
Total Pd

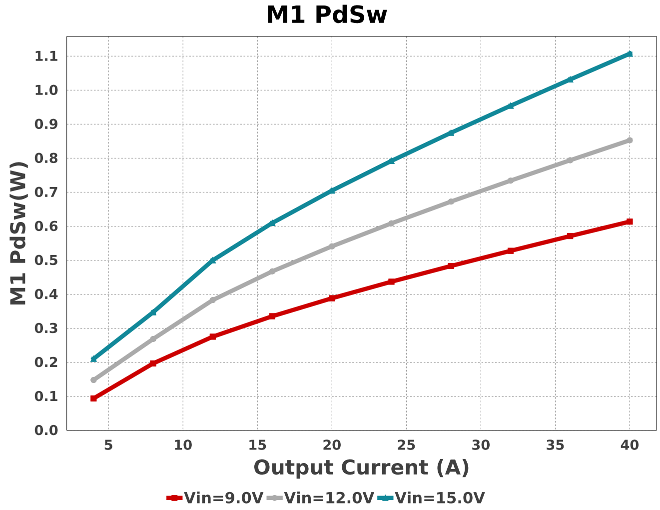


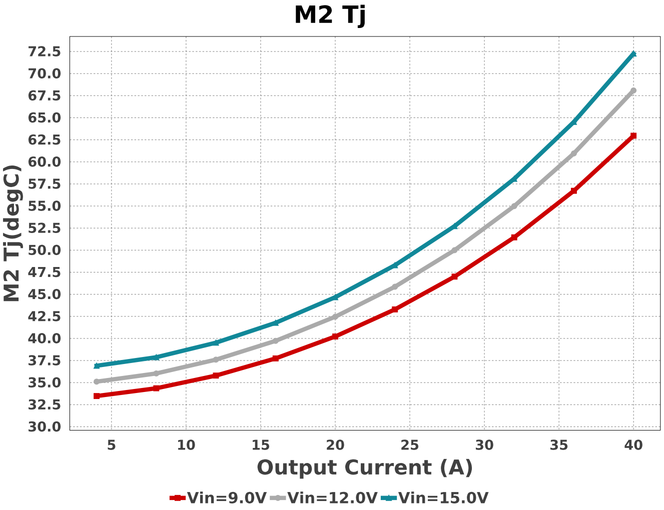

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V

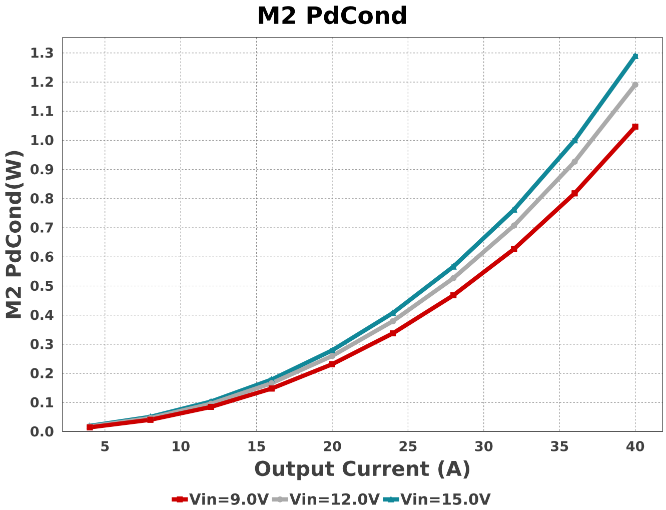

L Ipp
L Ipp(A)
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V

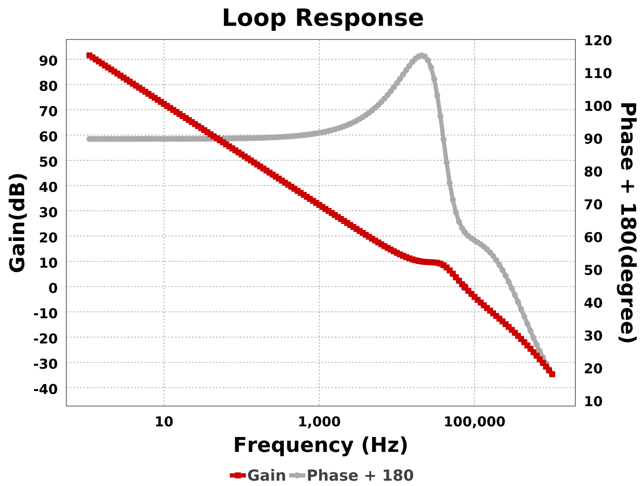

IC Pd
IC Pd(W)
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V


M1 Tj
M1 Tj(degC)
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V


M1 PdSw
M1 PdSw(W)
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V


M2 Tj
M2 Tj(degC)
Output Current (A)
Vin=9.0V
Vin=12.0V
Vin=15.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	15.18 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	230.43 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	3.98 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	15.842 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	46.894 A	IC	Peak switch current in IC
6.	IC Pd	564.46 mW	IC	IC power dissipation
7.	IC Tj	48.458 degC	IC	IC junction temperature
8.	IC Tolerance	6.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	32.7 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	7.016 A	IC	Average input current
11.	Ipp percentage	34.47 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	13.788 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	1.018 W	Inductor	Inductor power dissipation
14.	M1 Pd	1.943 W	Mosfet	M1 MOSFET total power dissipation
15.	M1 PdCond	835.67 mW	Mosfet	M1 MOSFET conduction losses
16.	M1 PdSw	1.107 W	Mosfet	M1 MOSFET switching losses
17.	M1 Tj	83.427 degC	Mosfet	M1 MOSFET junction temperature
18.	M2 Pd	1.69 W	Mosfet	M2 MOSFET total power dissipation
19.	M2 PdCond	1.289 W	Mosfet	M2 MOSFET conduction losses
20.	M2 PdSw	401.18 mW	Mosfet	M2 MOSFET switching losses
21.	M2 Tj	72.263 degC	Mosfet	M2 MOSFET junction temperature
22.	Cin Pd	230.43 µW	Power	Input capacitor power dissipation
23.	Cout Pd	15.842 mW	Power	Output capacitor power dissipation
24.	IC Pd	564.46 mW	Power	IC power dissipation
25.	L Pd	1.018 W	Power	Inductor power dissipation
26.	M1 Pd	1.943 W	Power	M1 MOSFET total power dissipation
27.	M1 PdCond	835.67 mW	Power	M1 MOSFET conduction losses
28.	M1 PdSw	1.107 W	Power	M1 MOSFET switching losses
29.	M2 Pd	1.69 W	Power	M2 MOSFET total power dissipation
30.	M2 PdCond	1.289 W	Power	M2 MOSFET conduction losses
31.	M2 PdSw	401.18 mW	Power	M2 MOSFET switching losses
32.	Total Pd	5.232 W	Power	Total Power Dissipation
33.	BOM Count	32	System Information	Total Design BOM count
34.	Cross Freq	71.541 kHz	System Information	Bode plot crossover frequency
35.	Duty Cycle	17.185 %	System Information	Duty cycle
36.	Efficiency	95.028 %	System Information	Steady state efficiency
37.	FootPrint	676.0 mm^2	System Information	Total Foot Print Area of BOM components
38.	Frequency	699.939 kHz	System Information	Switching frequency
39.	Gain Marg	-46.751 dB	System Information	Bode Plot Gain Margin
40.	Iout	40.0 A	System Information	Iout operating point
41.	Low Freq Gain	90.724 dB	System Information	Gain at 1Hz

#	Name	Value	Category	Description
42.	Mode	CCM	System Information	Conduction Mode
43.	Phase Marg	64.469 deg	System Information	Bode Plot Phase Margin
44.	Pout	100.0 W	System Information	Total output power
45.	Total BOM	NA	System Information	Total BOM Cost
46.	Vin	15.0 V	System Information	Vin operating point
47.	Vin p-p	305.005 mV	System Information	Peak-to-peak input voltage
48.	Vout	2.5 V	System Information	Operational Output Voltage
49.	Vout Actual	2.493 V	System Information	Vout Actual calculated based on selected voltage divider resistors
50.	Vout Tolerance	2.549 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
51.	Vout p-p	35.648 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	40.0	Maximum Output Current
VinMax	15.0	Maximum input voltage
VinMin	9.0	Minimum input voltage
Vout	2.5	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

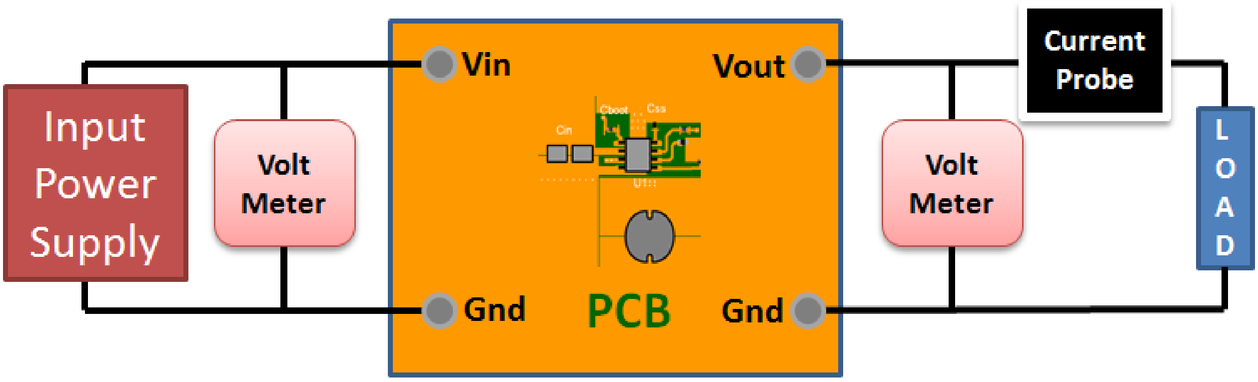
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 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. 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 : 16D2CED4A3A6B35A2959E2030665F69F[v1]

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