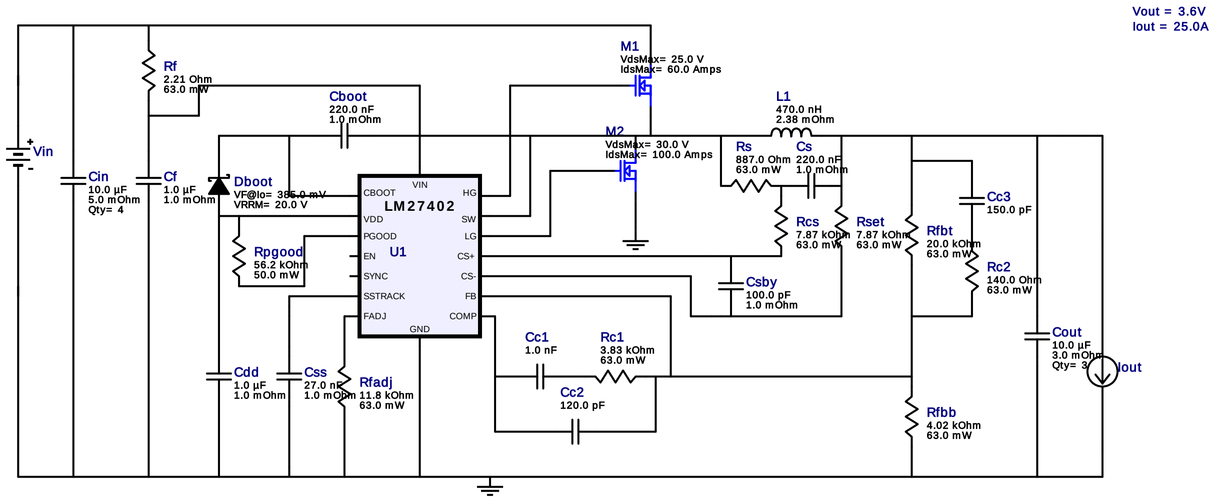
VinMin = 11.0V
VinMax = 13.0V
Vout = 3.6V
Iout = 25.0A

Device = LM27402SQ/NOPB
Topology = Buck
Created = 2023-11-25 22:37:02.520
BOM Cost = $4.46
BOM Count = 31
Total Pd = 5.87W

WEBENCH ® Design Report

Design : 9 LM27402SQ/NOPB
LM27402SQNOPB 8V-20V to 3.60V @ 30A

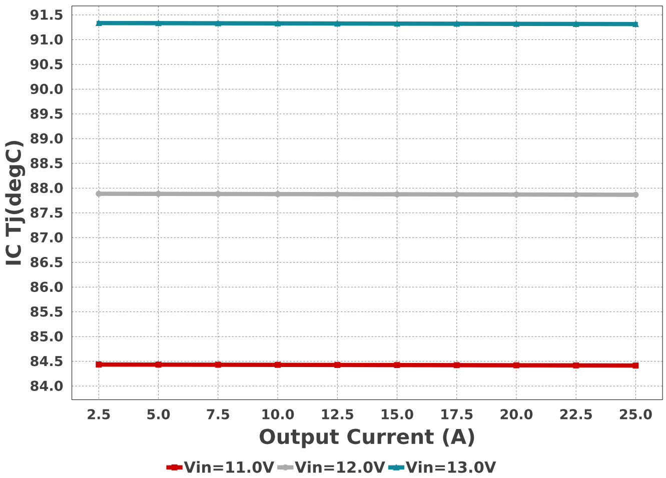


Electrical BOM

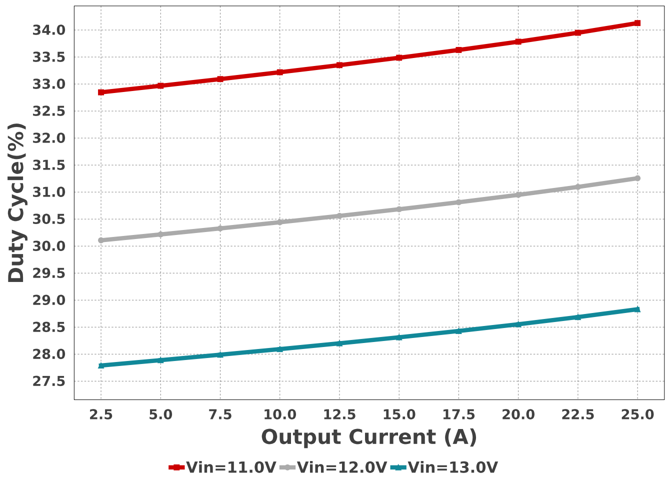
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM188R61C224KA88D Series= X5R	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.03	0603 5 mm^2
Cc1	Samsung Electro-Mechanics	CL21C102JBCNNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cc2	MuRata	GRM0335C1H121JA01D Series= C0G/NP0	Cap= 120.0 pF VDC= 5.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Cc3	Taiyo Yuden	UMK105CG151JV-F Series= C0G/NP0	Cap= 150.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cdd	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	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	Samsung Electro-Mechanics	CL32A106KBJNNNE Series= X5R	Cap= 10.0 uF ESR= 5.0 mOhm VDC= 50.0 V IRMS= 0.0 A	4	$0.15	1210_270 15 mm^2
Cout	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	3	$0.03	0805 7 mm^2
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

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
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	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	Comchip Technology	CDBK0520L-HF	VF@Io= 385.0 mV VRRM= 20.0 V	1	$0.07	SOD-123F 12 mm^2
L1	Wurth Elektronik	744373580047	L= 470.0 nH 2.38 mOhm	1	$1.40	WE-LHMI_8040 123 mm^2
M1	Texas Instruments	CSD16340Q3	VdsMax= 25.0 V IdsMax= 60.0 Amps	1	$0.33	DQG0008A 18 mm^2
M2	Texas Instruments	CSD17573Q5B	VdsMax= 30.0 V IdsMax= 100.0 Amps	1	$0.52	DNK0008A 56 mm^2
Rc1	Vishay-Dale	CRCW04023K83FKED Series= CRCW..e3	Res= 3.83 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rc2	Vishay-Dale	CRCW0402140RFKED Series= CRCW..e3	Res= 140.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcs	Vishay-Dale	CRCW04027K87FKED Series= CRCW..e3	Res= 7.87 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	CRCW040211K8FKED Series= CRCW..e3	Res= 11.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW04024K02FKED Series= CRCW..e3	Res= 4.02 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
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	CRCW0402887RFKED Series= CRCW..e3	Res= 887.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rset	Vishay-Dale	CRCW04027K87FKED Series= CRCW..e3	Res= 7.87 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	LM27402SQ/NOPB	Switcher	1	$1.22	SQB16A 25 mm^2

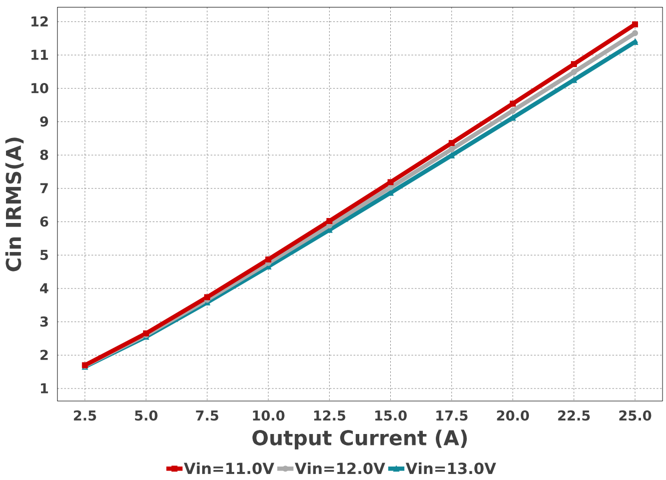
IC Tj



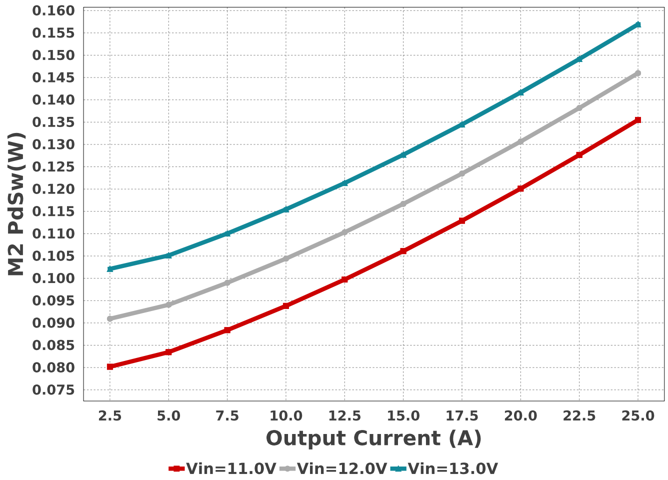
Duty Cycle



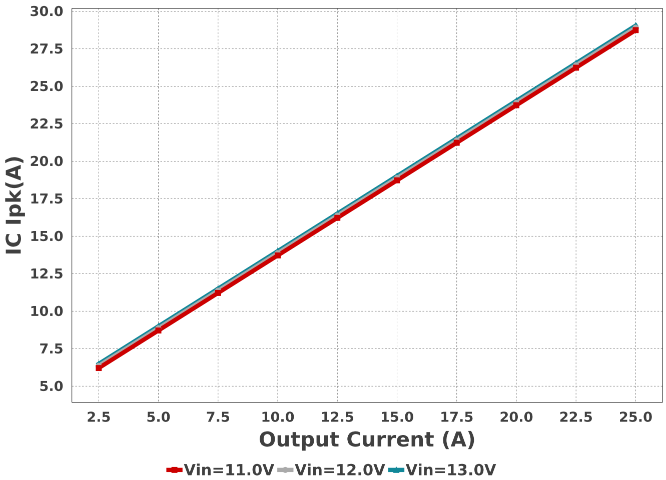
Cin IRMS



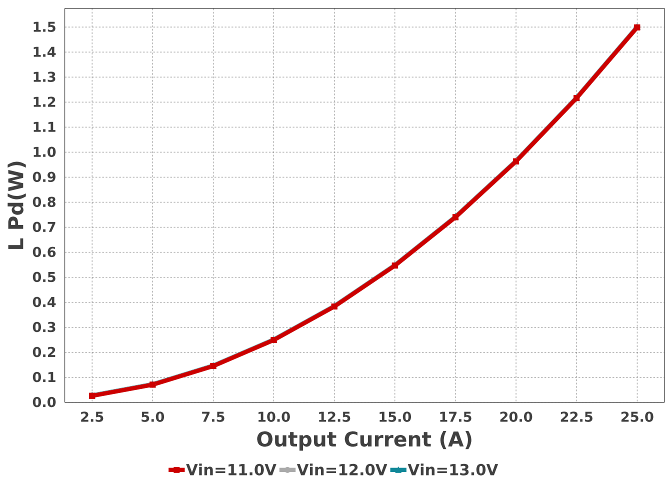
M2 PdSw



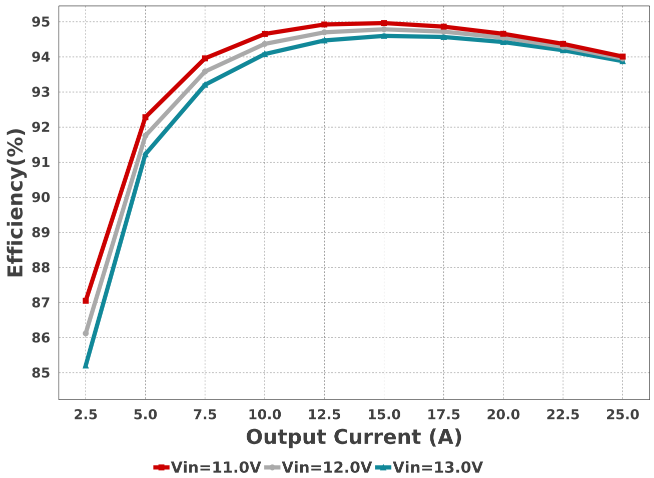
IC Ipk



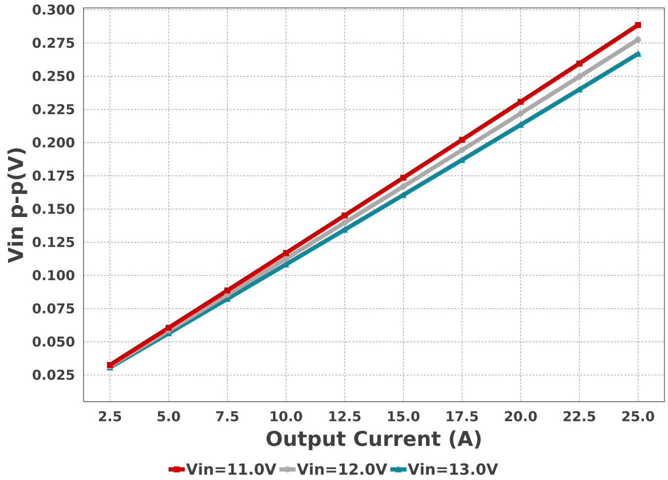
L Pd



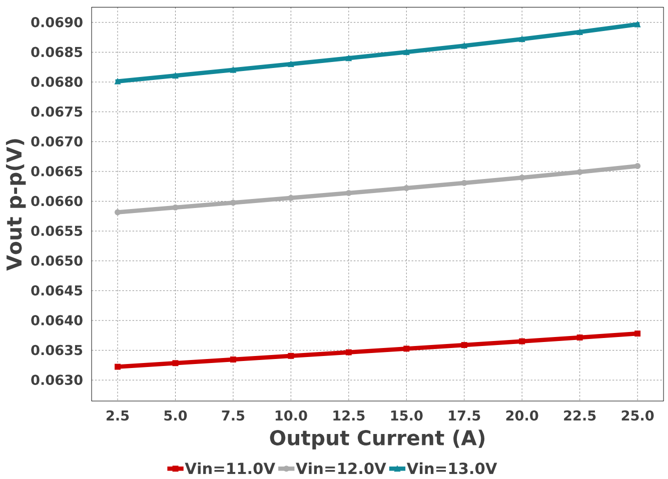
Efficiency



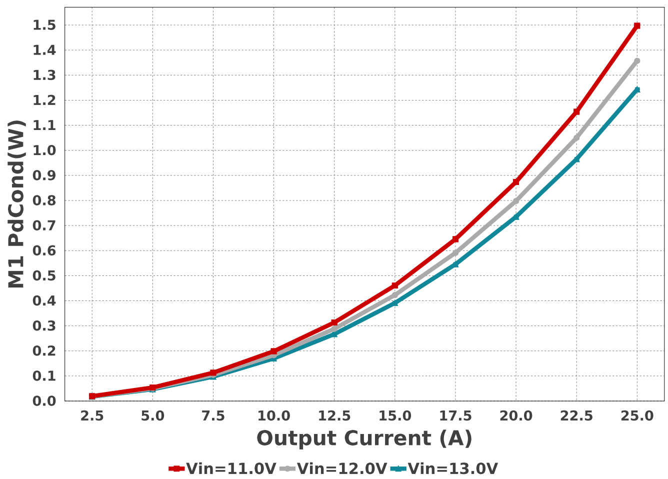
Vin p-p



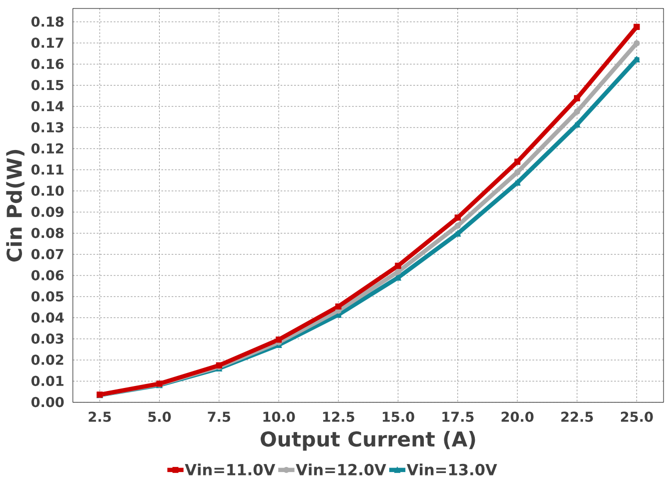
Vout p-p



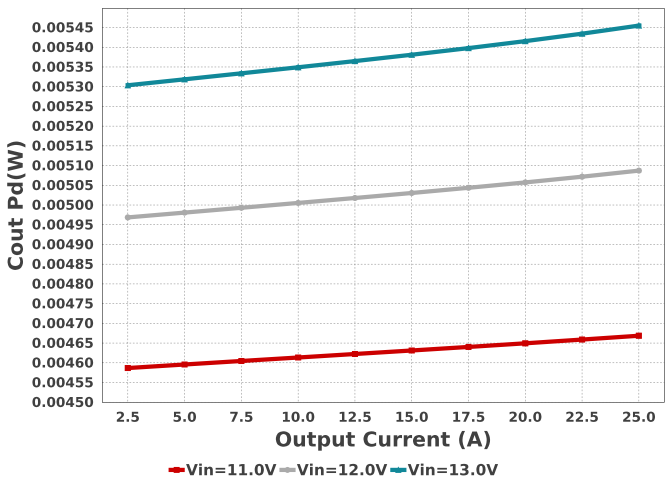
M1 PdCond

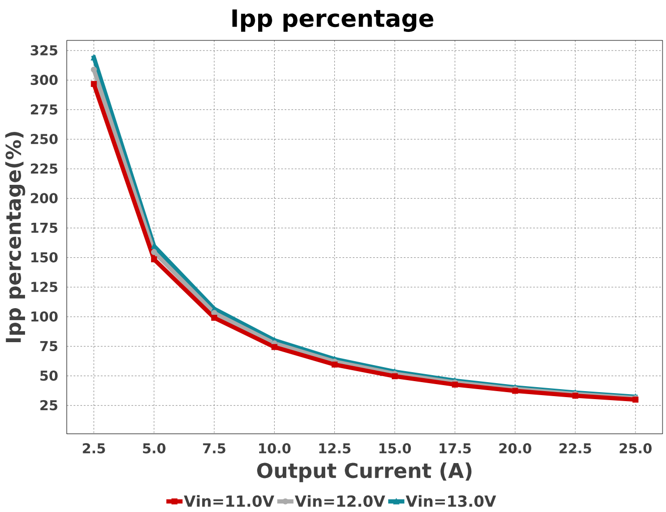


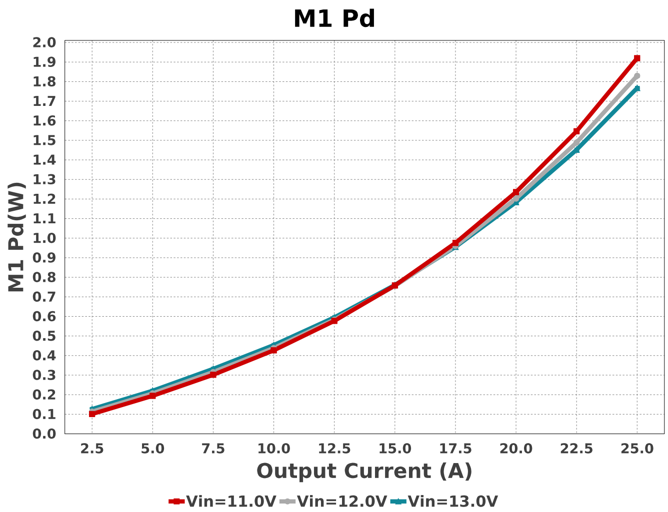
Cin Pd

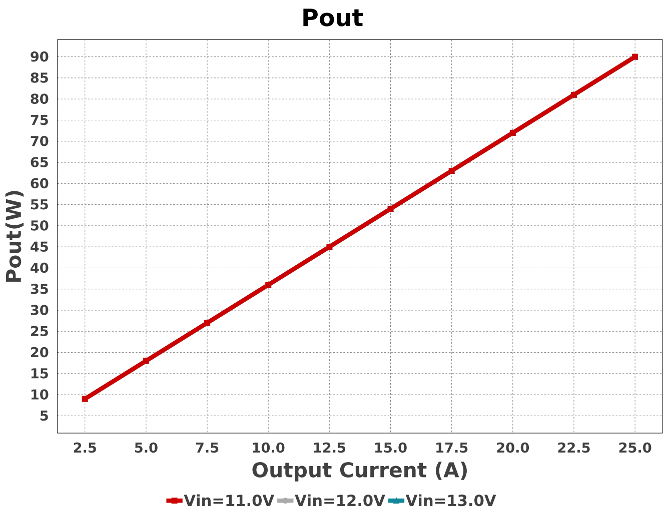


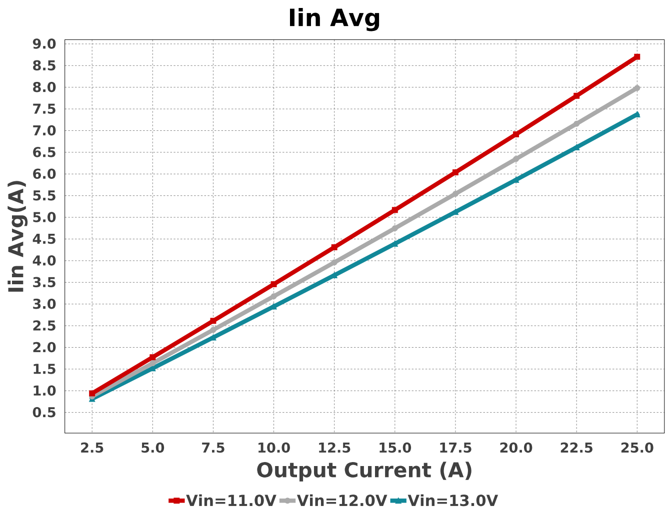
Cout Pd

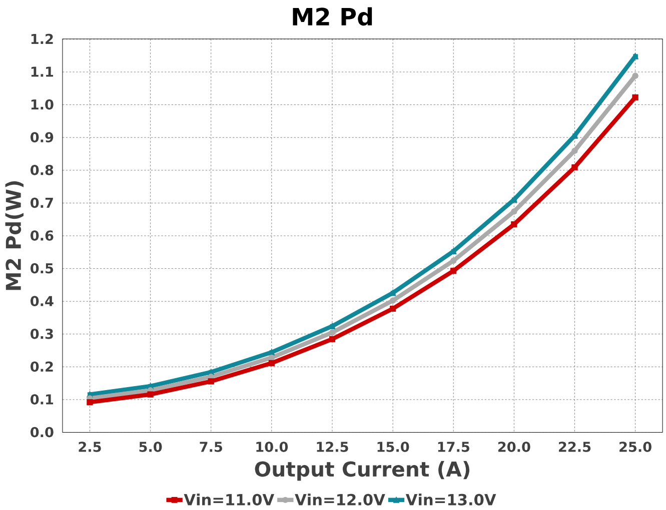


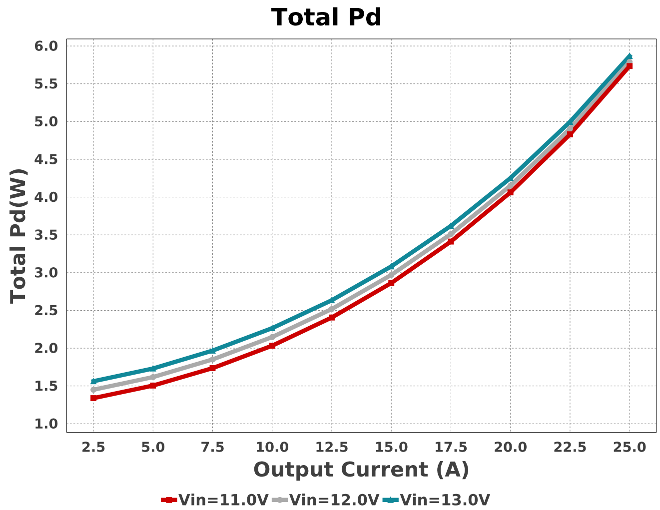

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V

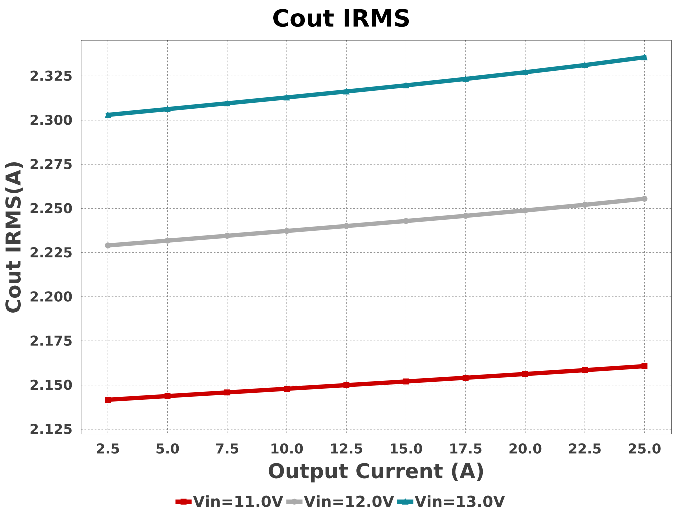

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V

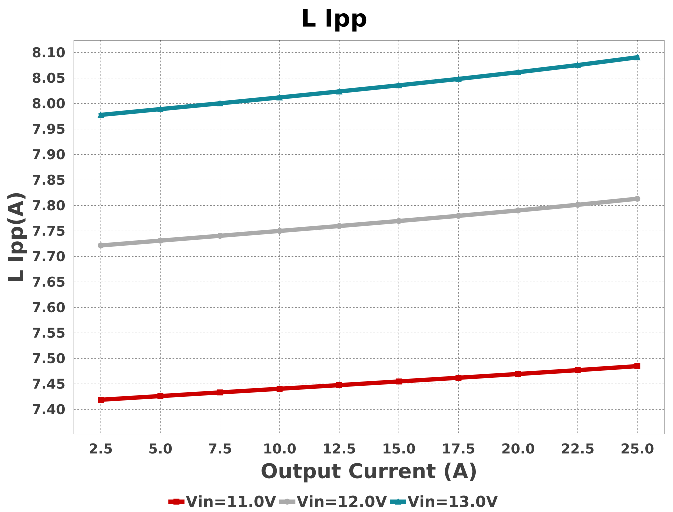

Pout
Pout(W)
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V

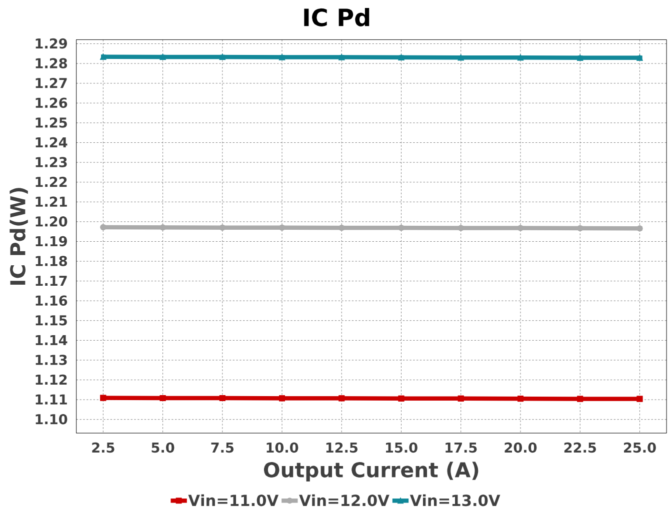

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V

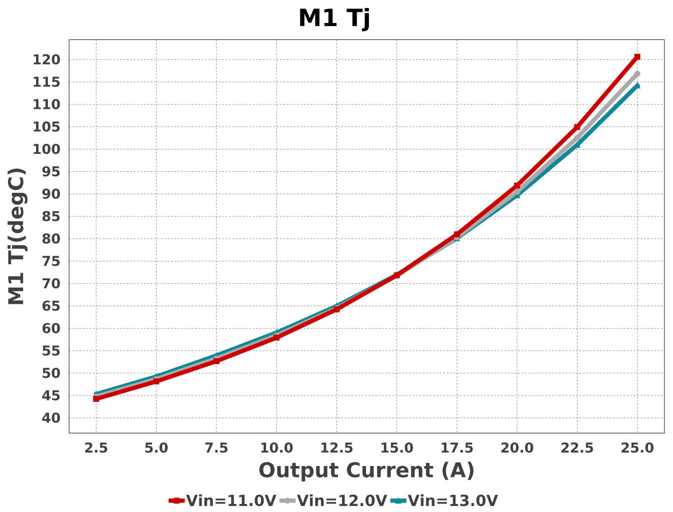

M2 Pd
M2 Pd(W)
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V

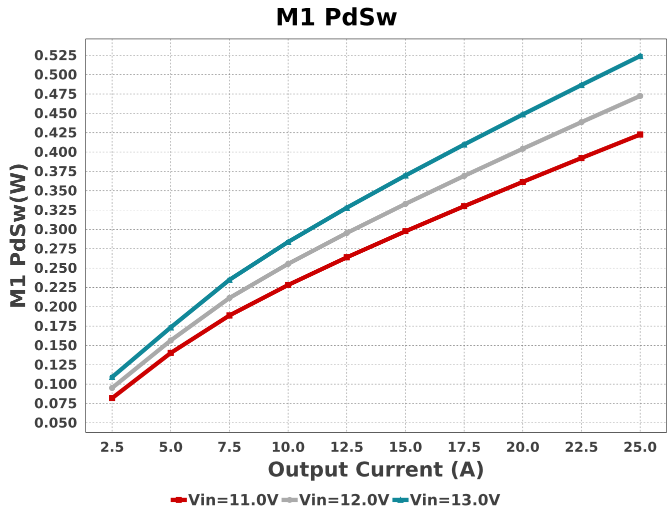

Total Pd
Total Pd(W)
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V

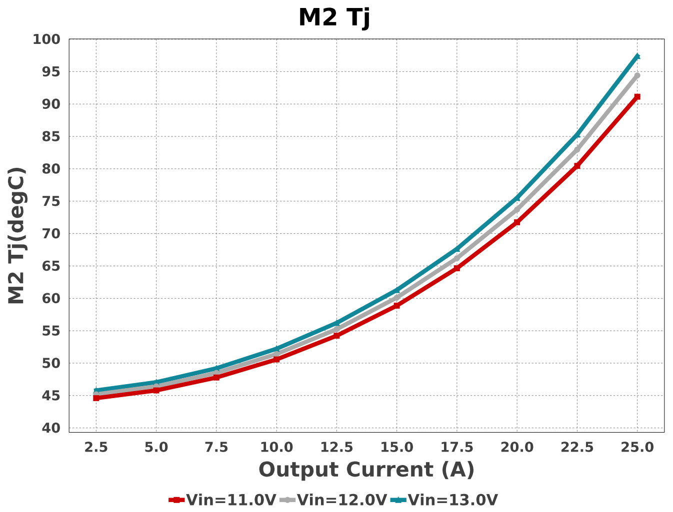

Cout IRMS
Cout IRMS(A)
2.325
2.300
2.275
2.250
2.225
2.200
2.175
2.150
2.125
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V

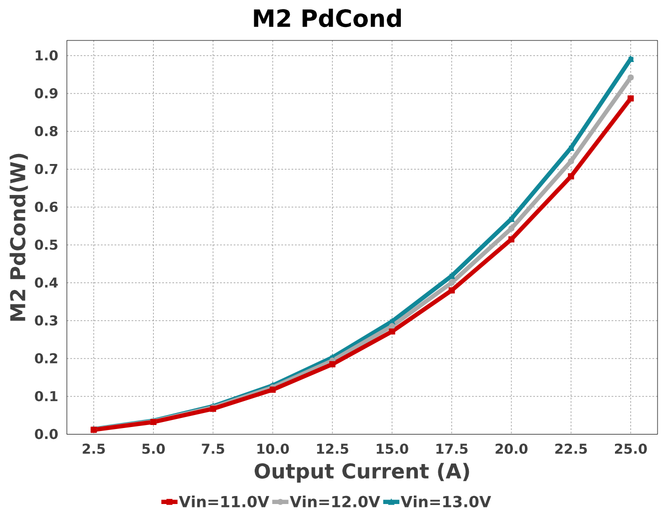

L Ipp
L Ipp(A)
8.10
8.05
8.00
7.95
7.90
7.85
7.80
7.75
7.70
7.65
7.60
7.55
7.50
7.45
7.40
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V

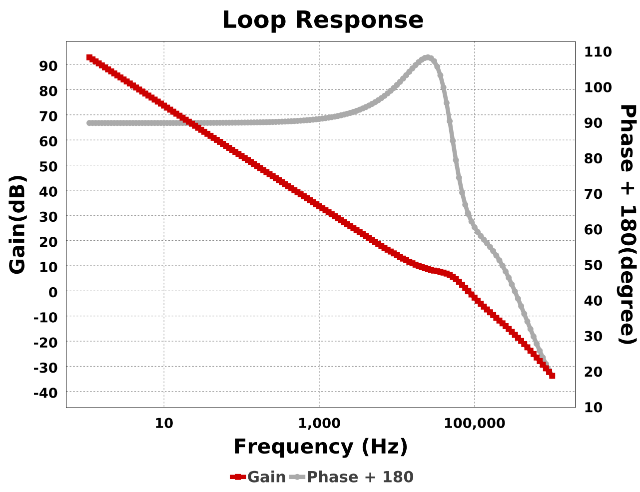

IC Pd
IC Pd(W)
1.29
1.28
1.27
1.26
1.25
1.24
1.23
1.22
1.21
1.20
1.19
1.18
1.17
1.16
1.15
1.14
1.13
1.12
1.11
1.10
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V


M1 Tj
M1 Tj(degC)
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V


M1 PdSw
M1 PdSw(W)
0.525
0.500
0.475
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
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V


M2 Tj
M2 Tj(degC)
100
95
90
85
80
75
70
65
60
55
50
45
40
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=11.0V Vin=12.0V Vin=13.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	11.394 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	162.27 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	2.336 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	5.455 mW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	29.045 A	IC	Peak switch current in IC
6.	IC Pd	1.283 W	IC	IC power dissipation
7.	IC Tj	91.315 degC	IC	IC junction temperature
8.	IC Tolerance	6.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	40.0 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	7.374 A	IC	Average input current
11.	Ipp percentage	32.363 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	8.091 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	1.5 W	Inductor	Inductor power dissipation
14.	M1 Pd	1.767 W	Mosfet	M1 MOSFET total power dissipation
15.	M1 PdCond	1.243 W	Mosfet	M1 MOSFET conduction losses
16.	M1 PdSw	524.09 mW	Mosfet	M1 MOSFET switching losses
17.	M1 Tj	114.22 degC	Mosfet	M1 MOSFET junction temperature
18.	M2 Pd	1.148 W	Mosfet	M2 MOSFET total power dissipation
19.	M2 PdCond	991.13 mW	Mosfet	M2 MOSFET conduction losses
20.	M2 PdSw	156.92 mW	Mosfet	M2 MOSFET switching losses
21.	M2 Tj	97.402 degC	Mosfet	M2 MOSFET junction temperature
22.	Cin Pd	162.27 mW	Power	Input capacitor power dissipation
23.	Cout Pd	5.455 mW	Power	Output capacitor power dissipation
24.	IC Pd	1.283 W	Power	IC power dissipation
25.	L Pd	1.5 W	Power	Inductor power dissipation
26.	M1 Pd	1.767 W	Power	M1 MOSFET total power dissipation
27.	M1 PdCond	1.243 W	Power	M1 MOSFET conduction losses
28.	M1 PdSw	524.09 mW	Power	M1 MOSFET switching losses
29.	M2 Pd	1.148 W	Power	M2 MOSFET total power dissipation
30.	M2 PdCond	991.13 mW	Power	M2 MOSFET conduction losses
31.	M2 PdSw	156.92 mW	Power	M2 MOSFET switching losses
32.	Total Pd	5.867 W	Power	Total Power Dissipation
33.	BOM Count	31	System Information	Total Design BOM count
34.	Cross Freq	79.456 kHz	System Information	Bode plot crossover frequency
35.	Duty Cycle	28.831 %	System Information	Duty cycle
36.	Efficiency	93.88 %	System Information	Steady state efficiency
37.	FootPrint	377.0 mm^2	System Information	Total Foot Print Area of BOM components
38.	Frequency	695.238 kHz	System Information	Switching frequency
39.	Gain Marg	-46.054 dB	System Information	Bode Plot Gain Margin
40.	Iout	25.0 A	System Information	Iout operating point
41.	Low Freq Gain	92.055 dB	System Information	Gain at 1Hz

#	Name	Value	Category	Description
42.	Mode	CCM	System Information	Conduction Mode
43.	Phase Marg	67.743 deg	System Information	Bode Plot Phase Margin
44.	Pout	90.0 W	System Information	Total output power
45.	Total BOM	$4.46	System Information	Total BOM Cost
46.	Vin	13.0 V	System Information	Vin operating point
47.	Vin p-p	267.855 mV	System Information	Peak-to-peak input voltage
48.	Vout	3.6 V	System Information	Operational Output Voltage
49.	Vout Actual	3.585 V	System Information	Vout Actual calculated based on selected voltage divider resistors
50.	Vout Tolerance	2.699 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
51.	Vout p-p	68.968 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	25.0	Maximum Output Current
VinMax	13.0	Maximum input voltage
VinMin	11.0	Minimum input voltage
Vout	3.6	Output Voltage
base_pn	LM27402	Base Product Number
source	DC	Input Source Type
Ta	40.0	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

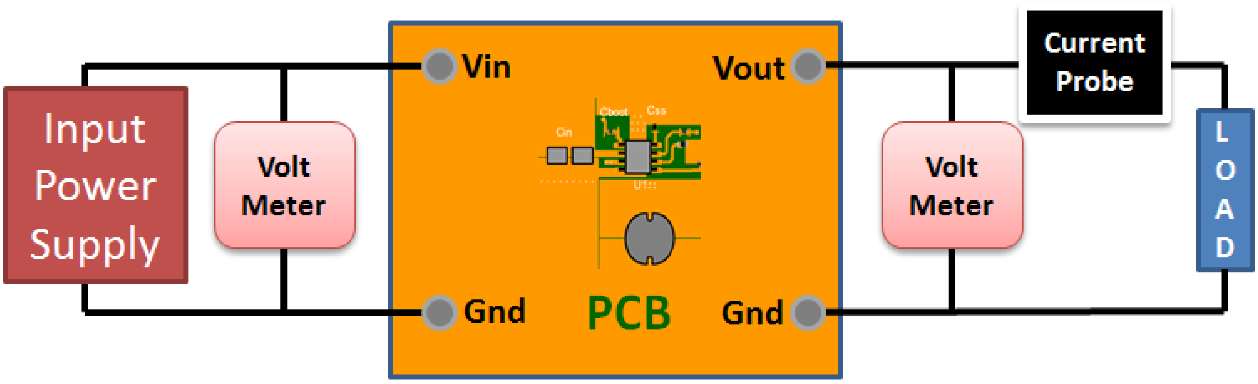
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 11.0V 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: LM27402 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 LM27402 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 LM27402 suitable for a large variety of input rails. The LM27402 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. General Description: The LM27402 is offered in a 16 pin eTSSOP package and a 4mm x 4mm 16 pin exposed LLP.

4. Master key : 330B248541F6394ED110965082F3CA95[v1]

5. **LM27402** Product Folder : http://www.ti.com/product/LM27402 : contains the data sheet and other resources.