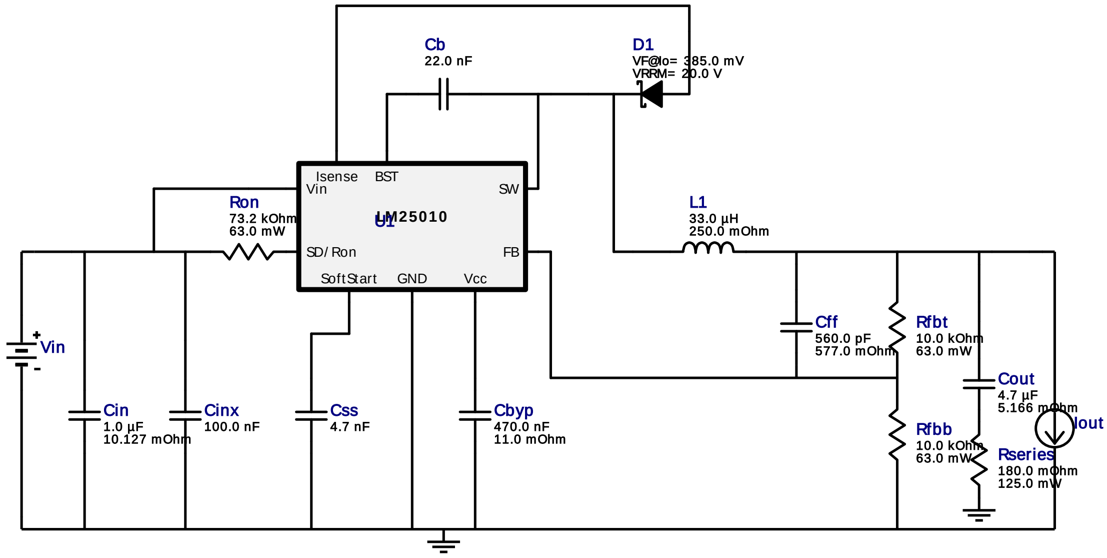
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 10.0V
VinMax = 12.0V
Vout = 5.0V
Iout = 0.5A

Device = LM25010MH/NOPB
Topology = Buck
Created = 7/21/16 7:28:31 PM
BOM Cost = $1.41
BOM Count = 14
Total Pd = 0.5W

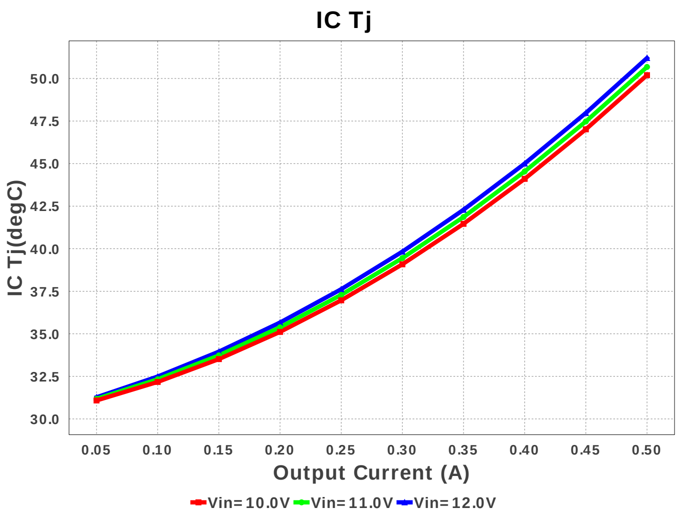
Design : 4742013/244 LM25010MH/NOPB
LM25010MH/NOPB 10.0V-12.0V to 5.00V @ 0.5A

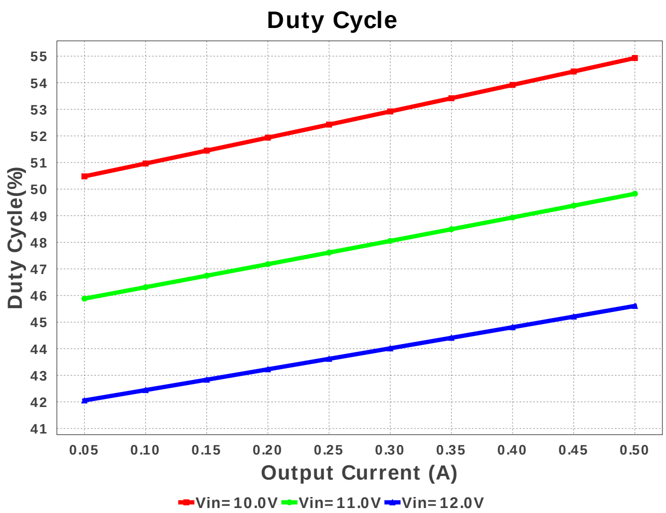


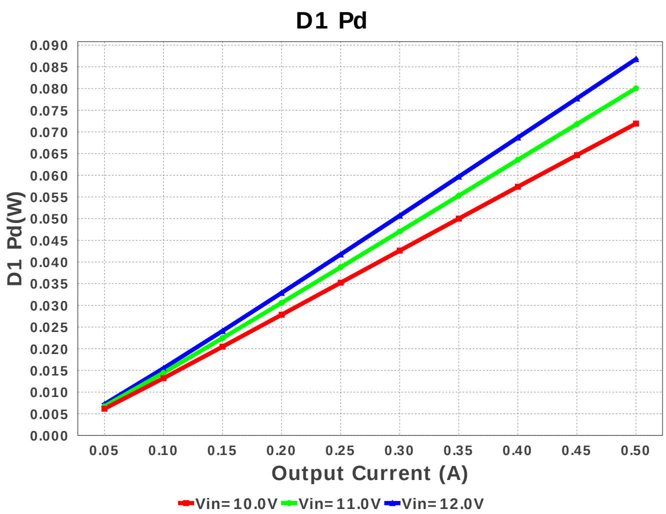
Electrical BOM

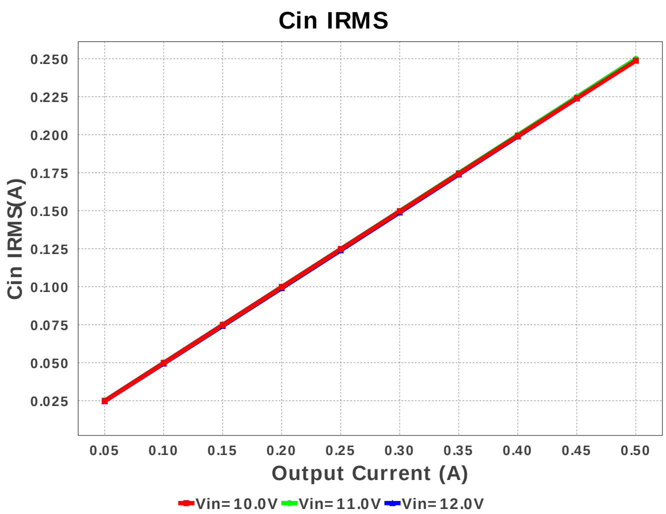
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cb	MuRata	GRM155R61C223KA01D Series= X5R	Cap= 22.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
2.	Cbyp	AVX	0805YC474KAT2A Series= X7R	Cap= 470.0 nF ESR= 11.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
3.	Cff	Kemet	C0805C561K5RACTU Series= X7R	Cap= 560.0 pF ESR= 577.0 mOhm VDC= 50.0 V IRMS= 234.0 mA	1	$0.05	0805 7 mm²
4.	Cin	MuRata	GRM188R61C105KA93D Series= X5R	Cap= 1.0 uF ESR= 10.127 mOhm VDC= 16.0 V IRMS= 994.63 mA	1	$0.01	0603 5 mm²
5.	Cinx	MuRata	GRM155R61C104KA88D Series= X5R	Cap= 100.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
6.	Cout	MuRata	GRM21BC81E475KA12L Series= X6S	Cap= 4.7 uF ESR= 5.166 mOhm VDC= 25.0 V IRMS= 2.03531 A	1	$0.02	0805 7 mm²
7.	Css	MuRata	GRM155R61C472KA01D Series= X5R	Cap= 4.7 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
8.	D1	ON Semiconductor	MBR0520LT1G	VF@Io= 385.0 mV VRRM= 20.0 V	1	$0.06	SOD-123 13 mm²
9.	L1	Bourns	SDR0604-330KL	L= 33.0 µH DCR= 250.0 mOhm	1	$0.18	SDR0604 61 mm²

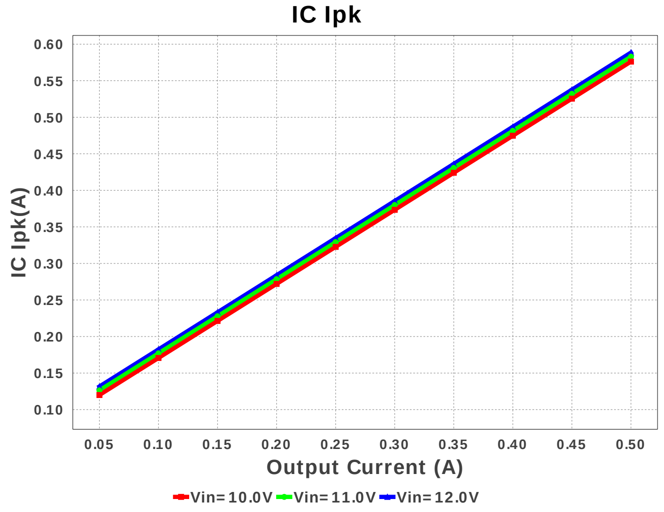
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	Rfbb	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
11.	Rfbt	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
12.	Ron	Vishay-Dale	CRCW040273K2FKED Series= CRCW..e3	Res= 73.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
13.	Rseries	Panasonic	ERJ-2BSFR18X Series= ERJ-2B	Res= 180.0 mOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.06	0402 3 mm²
14.	U1	Texas Instruments	LM25010MH/NOPB	Switcher	1	$0.95	PWP0014A 59 mm²

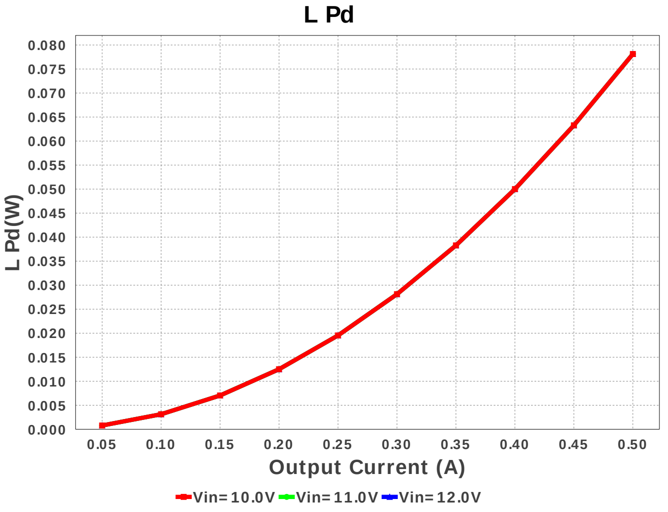


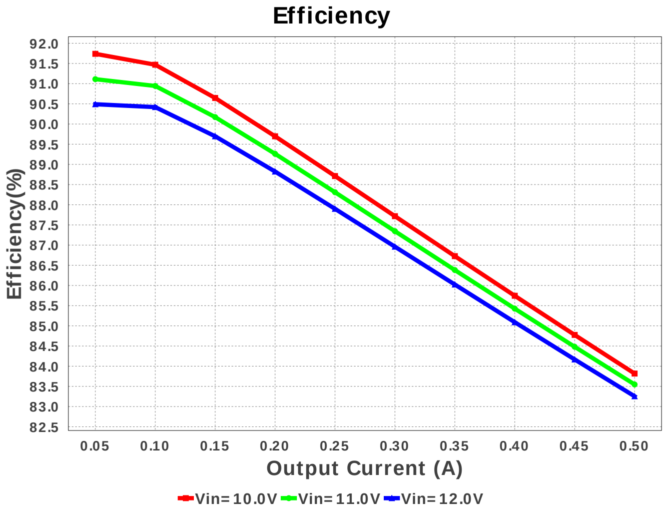


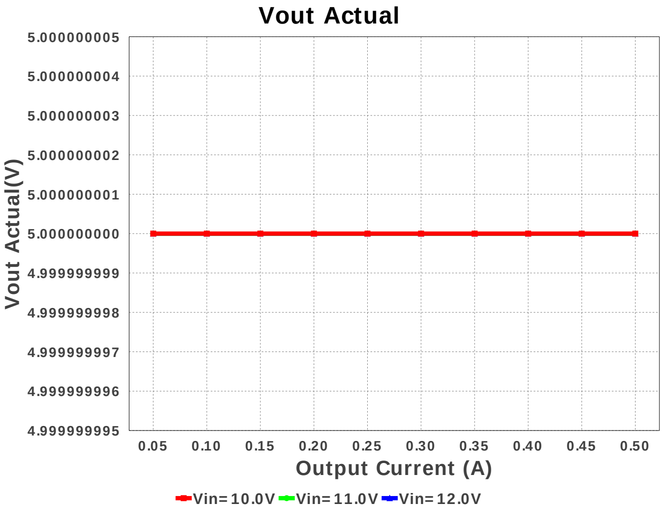


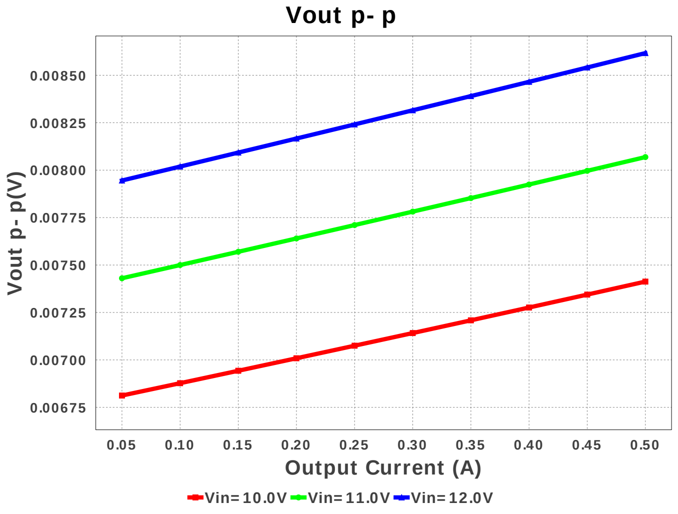


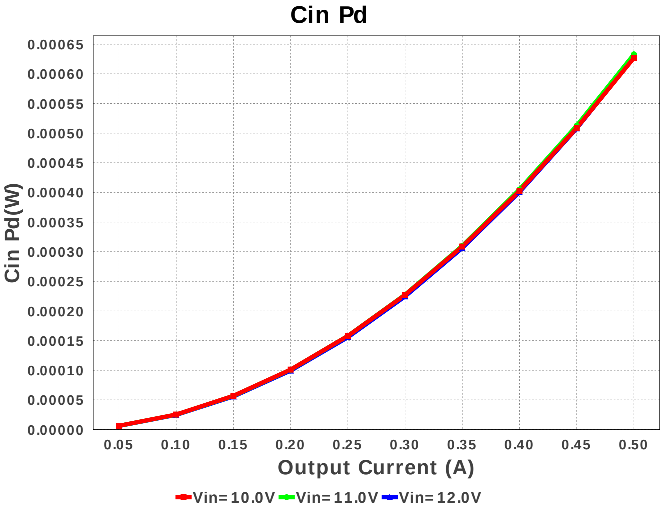

IC Ipk
IC Ipk(A)
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V


L Pd
L Pd(W)
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

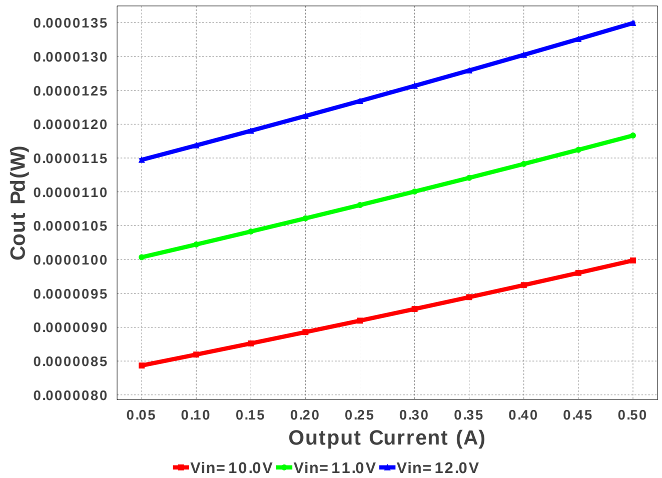

Efficiency
Efficiency(%)
92.0
91.5
91.0
90.5
90.0
89.5
89.0
88.5
88.0
87.5
87.0
86.5
86.0
85.5
85.0
84.5
84.0
83.5
83.0
82.5
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V


Vout Actual
Vout Actual(V)
5.000000005
5.000000004
5.000000003
5.000000002
5.000000001
5.000000000
4.999999999
4.999999998
4.999999997
4.999999996
4.999999995
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

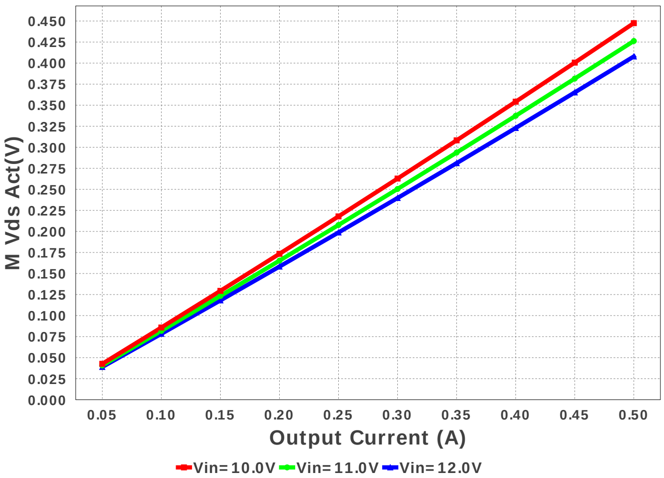

Vout p-p
Vout p-p(V)
0.00850
0.00825
0.00800
0.00775
0.00750
0.00725
0.00700
0.00675
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V


Cin Pd
Cin Pd(W)
0.00065
0.00060
0.00055
0.00050
0.00045
0.00040
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=10.0V Vin=11.0V Vin=12.0V

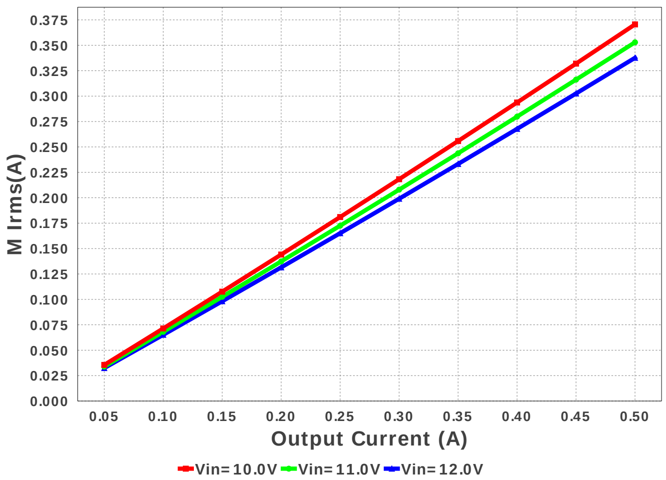
Cout Pd



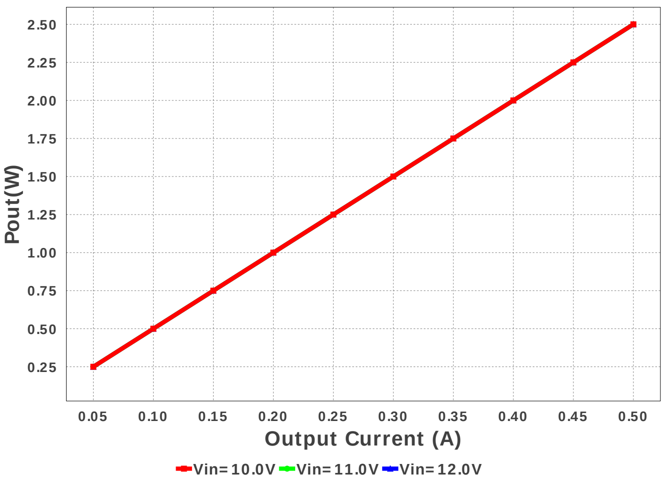
M Vds Act



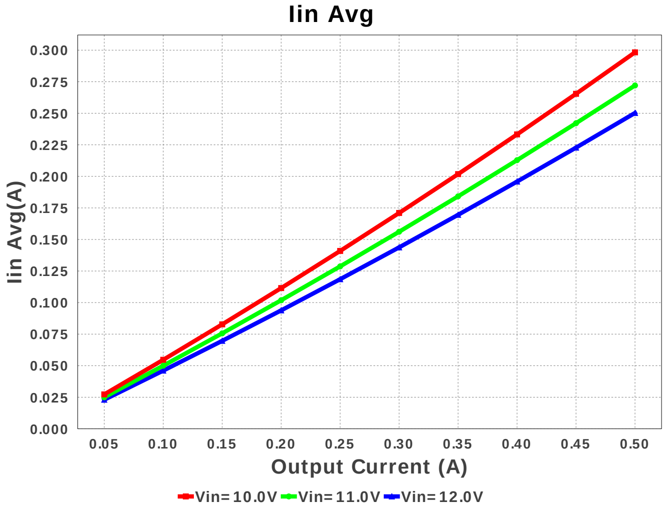
M Irms



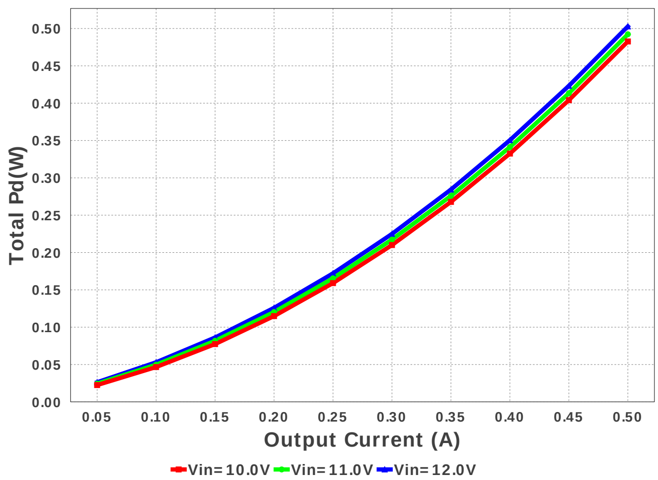
Pout

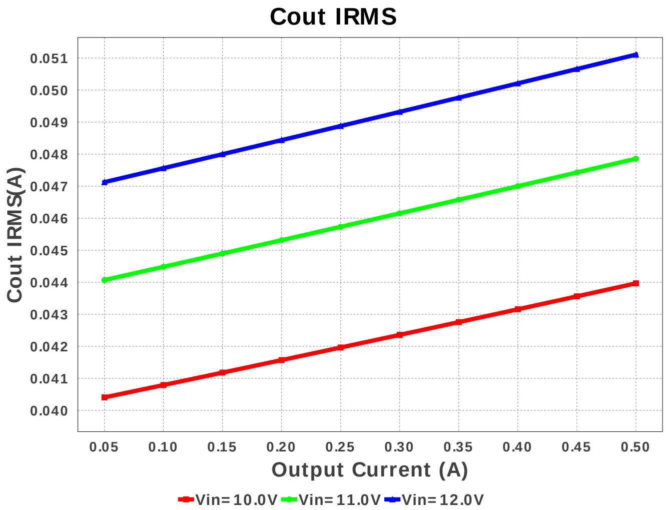


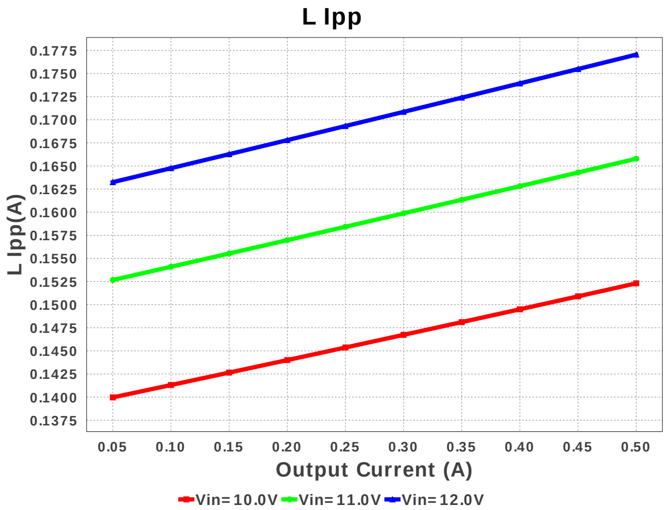
Iin Avg

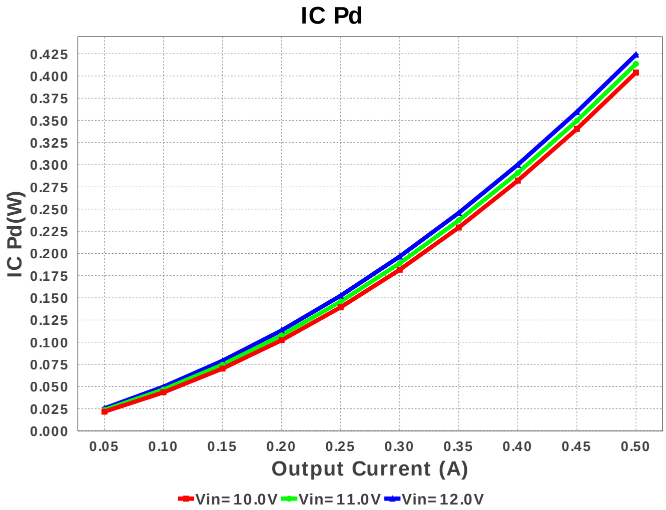


Total Pd









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	249.034 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	51.108 mA	Current	Output capacitor RMS ripple current
3.	IC Ipk	588.522 mA	Current	Peak switch current in IC
4.	Iin Avg	250.24 mA	Current	Average input current
5.	L Ipp	177.04 mA	Current	Peak-to-peak inductor ripple current
6.	M1 Irms	337.671 mA	Current	Q Iavg
7.	BOM Count	14	General	Total Design BOM count
8.	FootPrint	179.0 mm^2	General	Total Foot Print Area of BOM components
9.	Frequency	546.448 kHz	General	Switching frequency
10.	IC Tolerance	50.0 mV	General	IC Feedback Tolerance
11.	M Vds Act	407.86 mV	General	Voltage drop across the MosFET
12.	Pout	2.5 W	General	Total output power
13.	Total BOM	$1.41	General	Total BOM Cost
14.	Vout Actual	5.0 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
15.	Vout OP	5.0 V	Op_Point	Operational Output Voltage
16.	Duty Cycle	45.609 %	Op_point	Duty cycle
17.	Efficiency	83.255 %	Op_point	Steady state efficiency
18.	IC Tj	51.203 degC	Op_point	IC junction temperature
19.	ICThetaJA	50.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
20.	IOUT_OP	500.0 mA	Op_point	Iout operating point
21.	VIN_OP	12.0 V	Op_point	Vin operating point
22.	Vout p-p	8.617 mV	Op_point	Peak-to-peak output ripple voltage
23.	Cin Pd	628.056 µW	Power	Input capacitor power dissipation
24.	Cout Pd	13.494 µW	Power	Output capacitor power dissipation
25.	D1 Pd	86.781 mW	Power	Output Diode Power Dissipation
26.	IC Pd	424.066 mW	Power	IC power dissipation
27.	L Pd	78.125 mW	Power	Inductor power dissipation
28.	Total Pd	502.832 mW	Power	Total Power Dissipation
29.	Vout Tolerance	3.03 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	500.0 m	Maximum Output Current
2.	VinMax	12.0	Maximum input voltage
3.	VinMin	10.0	Minimum input voltage
4.	Vout	5.0	Output Voltage
5.	base_pn	LM25010	Base Product Number
6.	source	DC	Input Source Type
7.	Ta	30.0	Ambient temperature

Design Assistance

1. For a Constant On Time device to be stable, we need to provide a ripple at the feedback comparator. There are various methods to implement the ripple. Depending on the circuit complexity vs. the allowable ripple, we have three options to choose from. The simplest option, 'Low Complexity', would require only a high ESR cap at the output. This means that the BOM count will be small, but the output voltage ripple will be quite large. The 'Optimal Solution' would require a feed-forward cap in parallel with the upper feedback resistor to AC couple the ripple to the feedback node. This increases the BOM count slightly, but now we have more control over the output voltage ripple. If the output voltage requirement is very tight, then the best option is to go for the 'Low Output Ripple' solution. In this option we can go with very low ESR output caps and have very good control over the output voltage ripple.

2. **LM25010** Product Folder : http://www.ti.com/product/LM25010 : contains the data sheet and other resources.