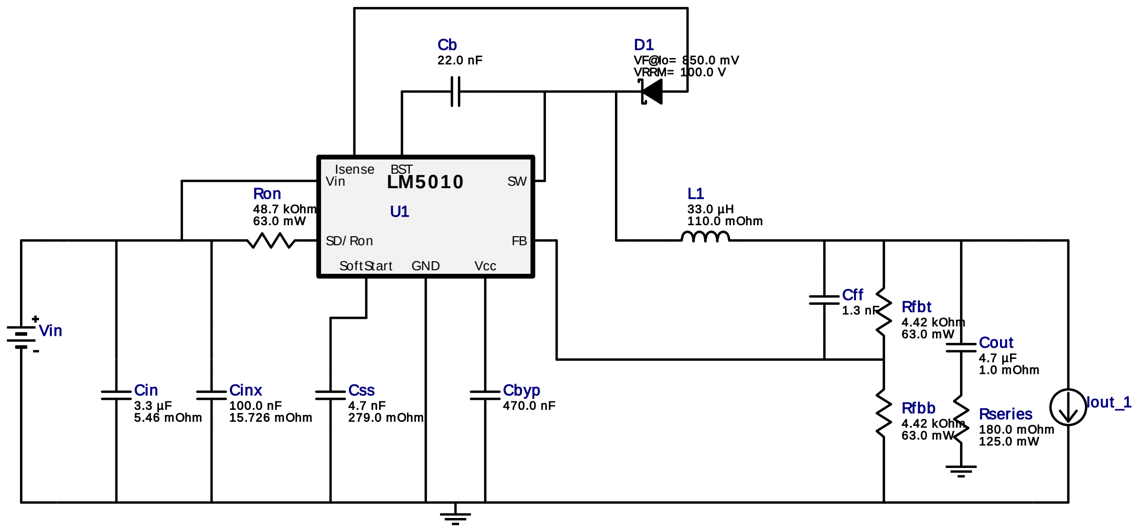
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 10.0V
VinMax = 50.0V
Vout = 5.0V
Iout = 1.0A

Device = LM5010MHX/NOPB
Topology = Buck
Created = 6/27/14 7:51:23 AM
BOM Cost = $2.22
Footprint = 267.0mm2
BOM Count = 14
Total Pd = 1.18W

Design : 2020184/23 LM5010MHX/NOPB
LM5010MH/NOPB 10.0V-50.0V to 5.0V @ 1.0A

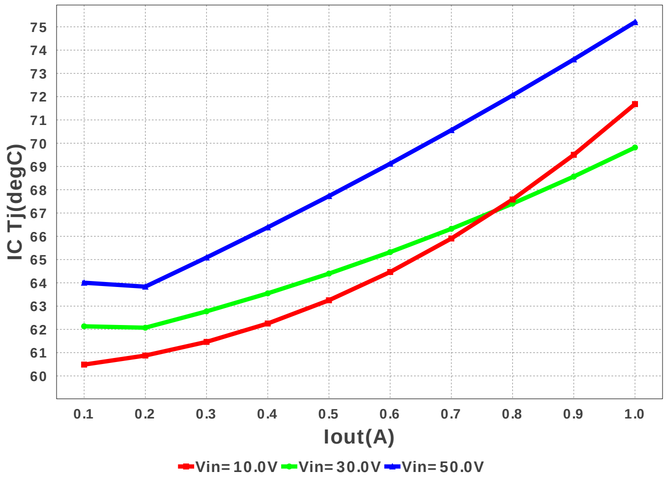


Electrical BOM

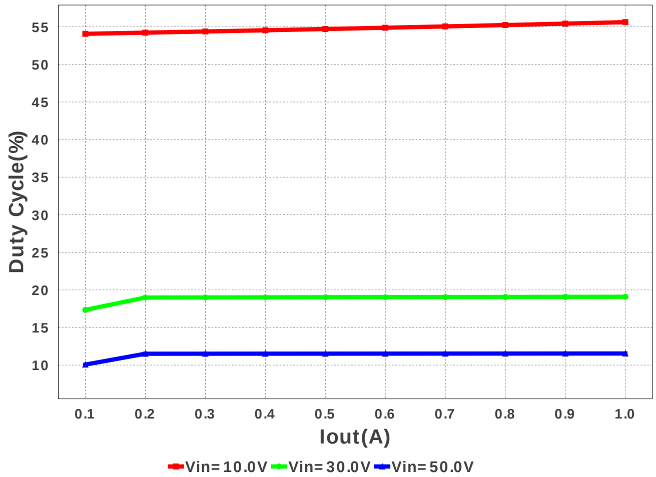
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cb	MuRata	GRM155R61C223KA01D Series= X5R	Cap= 22.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3mm2
2.	Cbyp	Taiyo Yuden	EMK212B7474KD-T Series= X7R	Cap= 470.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0805 7mm2
3.	Cff	AVX	0402YC132KAT2A Series= X7R	Cap= 1.3 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.05	0402 3mm2
4.	Cin	TDK	C3225X7S2A335K200AB Series= X7R	Cap= 3.3 µF ESR= 5.46 mOhm VDC= 100.0 V IRMS= 7.036 A	1	$0.24	1210 15mm2
5.	Cinx	TDK	C2012X7R2A104K Series= 285	Cap= 100.0 nF ESR= 15.726 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.03	0805 7mm2
6.	Cout	MuRata	GRM188R60J475ME19D Series= X5R	Cap= 4.7 µF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.02	0603 5mm2
7.	Css	Kemet	C0805C472K5RACTU Series= X7R	Cap= 4.7 nF ESR= 279.0 mOhm VDC= 50.0 V IRMS= 321.0 mA	1	$0.01	0805 7mm2
8.	D1	Micro Commercial Components	SK310A-TP	VF@Io= 850.0 mV VRRM= 100.0 V	1	$0.10	SMA 37mm2
9.	L1	TDK	VLP8040T-330M	L= 33.0 µH DCR= 110.0 mOhm	1	$0.22	VLP8040 113mm2

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	Rfbb	Vishay-Dale	CRCW04024K42FKED Series= CRCW..e3	Res= 4.42 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3mm2
11.	Rfbt	Vishay-Dale	CRCW04024K42FKED Series= CRCW..e3	Res= 4.42 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3mm2
12.	Ron	Vishay-Dale	CRCW040248K7FKED Series= CRCW..e3	Res= 48.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3mm2
13.	Rseries	Panasonic	ERJ-2BSFR18X Series= 226	Res= 180.0 mOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.06	0402 3mm2
14.	U1	Texas Instruments	LM5010MHX/NOPB	Switcher	1	$1.43	PWP0014A 59mm2

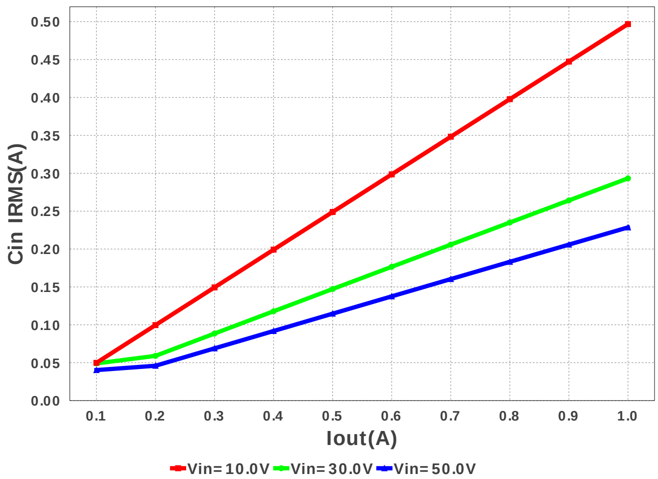
IC Tj



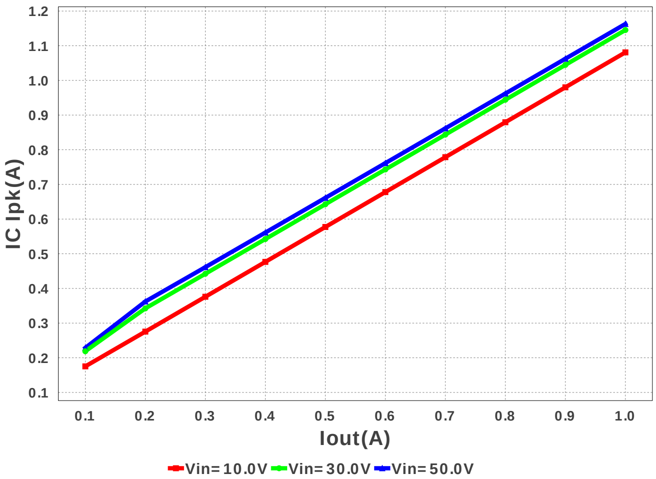
Duty Cycle

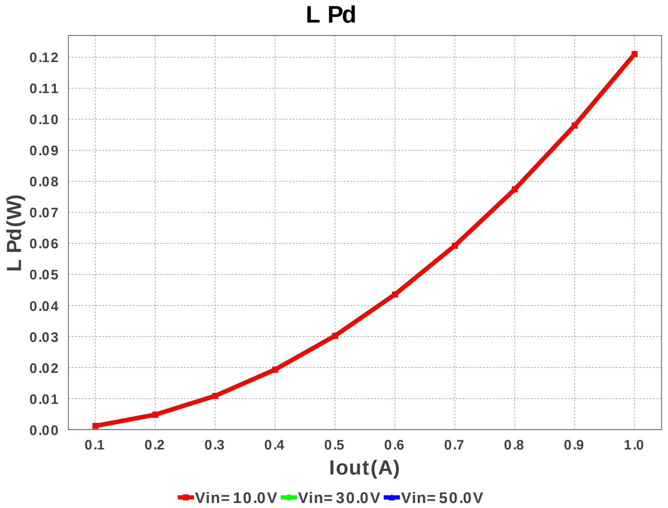


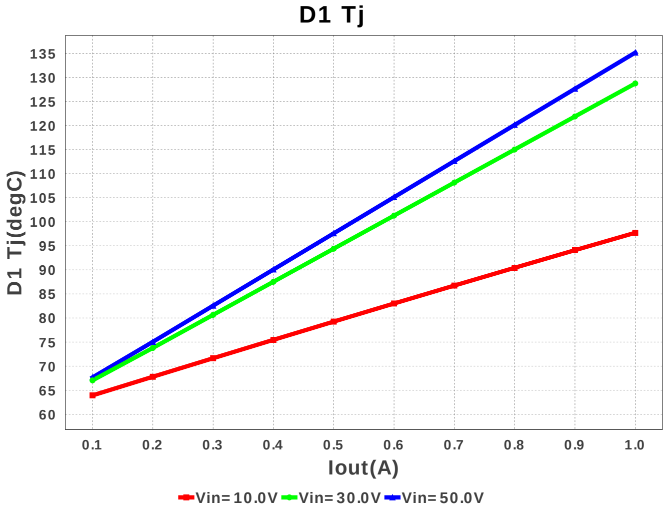
Cin IRMS

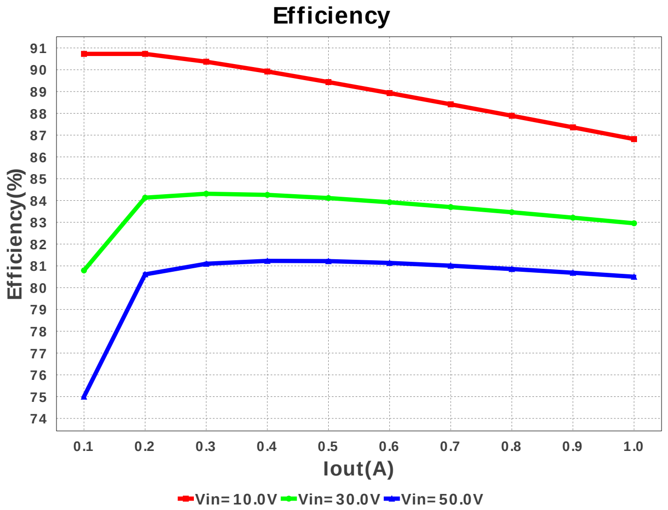


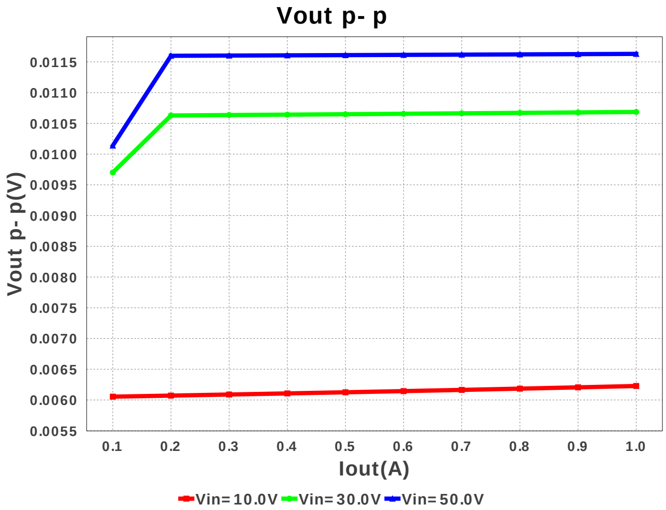
IC Ipk

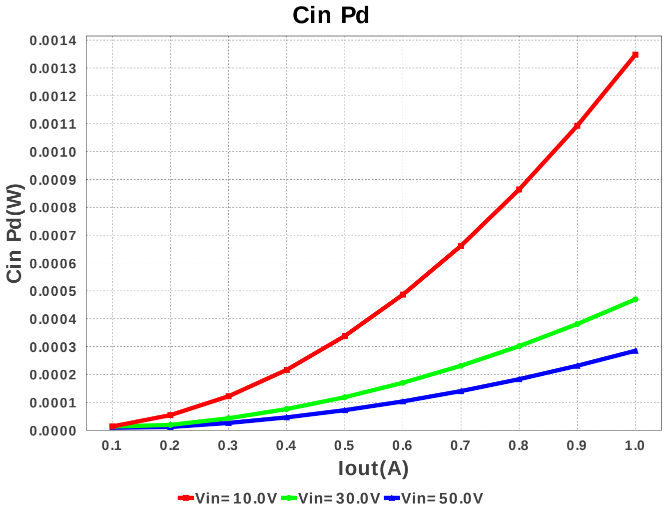


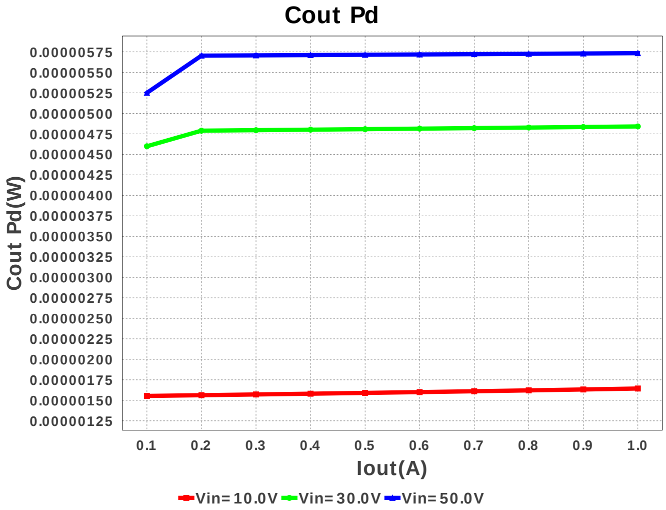

L Pd
L Pd(W)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

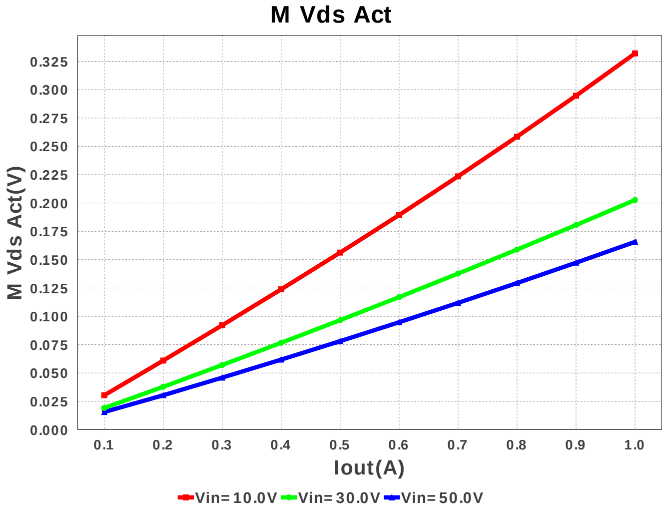

D1 Tj
D1 Tj(degC)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

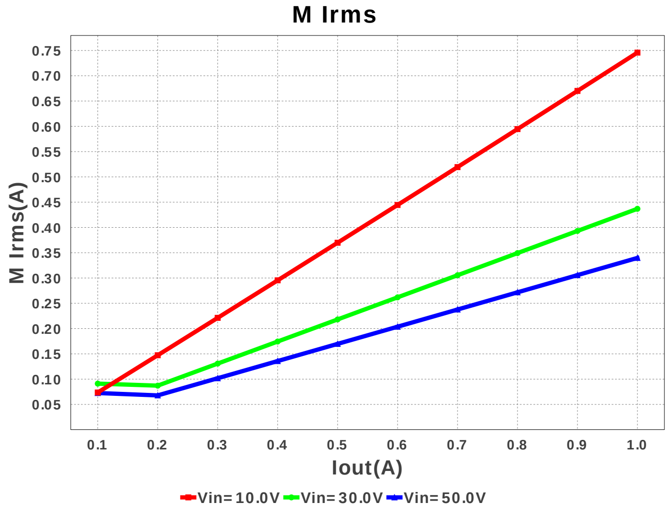

Efficiency
Efficiency(%)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

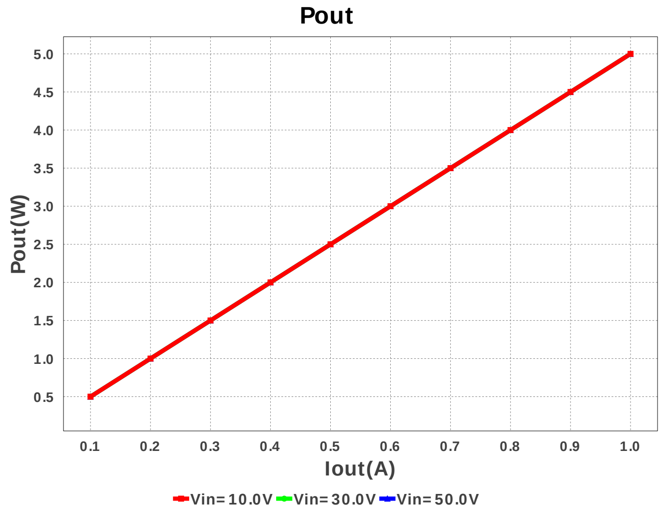

Vout p-p
Vout p-p(V)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

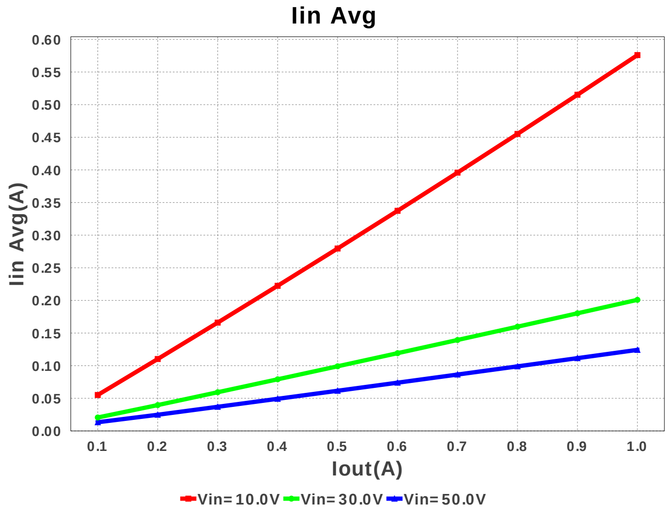

Cin Pd
Cin Pd(W)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

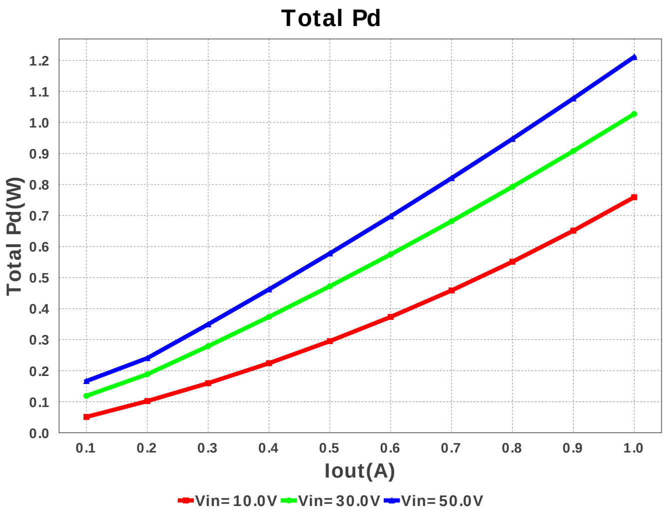

Cout Pd
Cout Pd(W)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

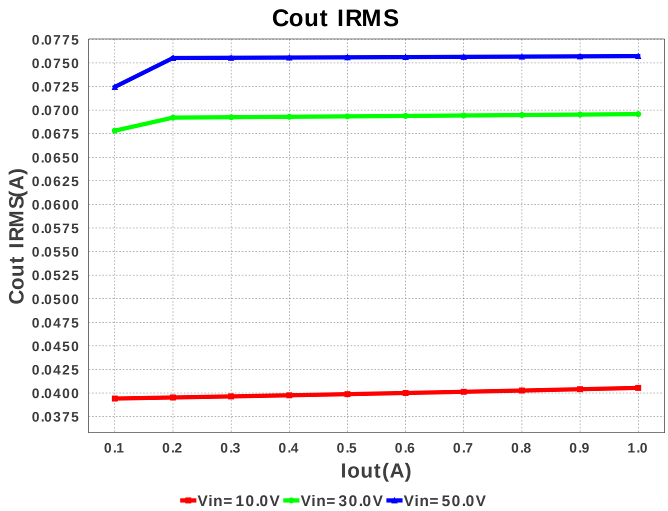

M Vds Act
M Vds Act(V)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

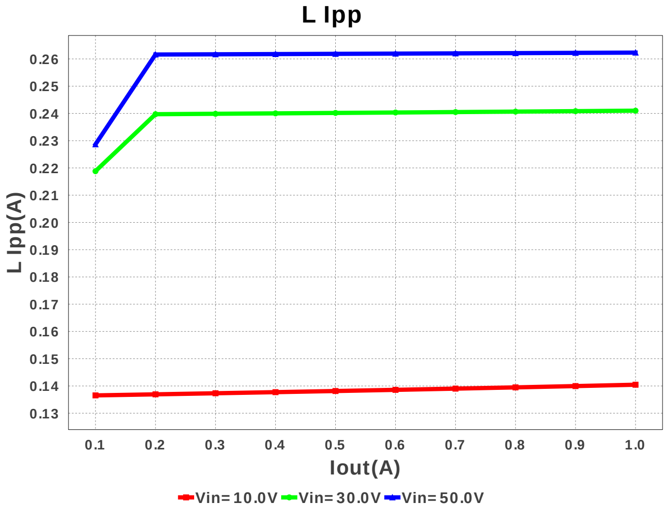

M Irms
M Irms(A)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

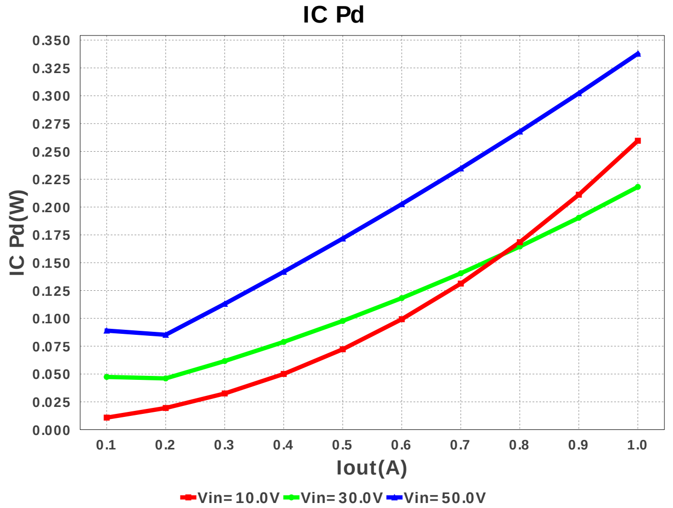

Pout
Pout(W)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

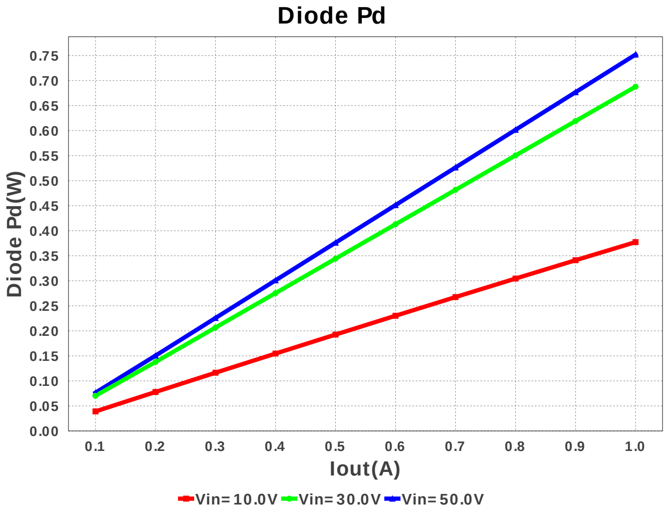

Iin Avg
Iin Avg(A)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V

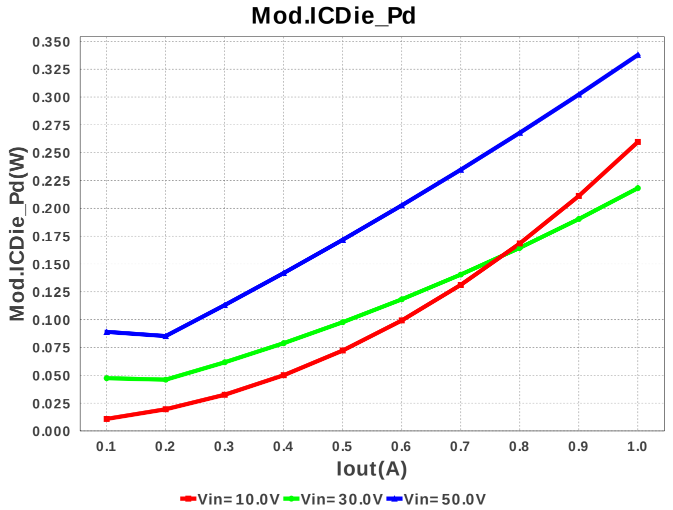

Total Pd
Total Pd(W)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V


Cout IRMS
Cout IRMS(A)
Iout(A)
Vin=10.0V Vin=30.0V Vin=50.0V









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	228.57 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	86.536 mA	Current	Output capacitor RMS ripple current
3.	IC Ipk	1.15 A	Current	Peak switch current in IC
4.	Iin Avg	123.56 mA	Current	Average input current
5.	L Ipp	299.769 mA	Current	Peak-to-peak inductor ripple current
6.	M1 Irms	339.722 mA	Current	Q Iavg
7.	BOM Count	14	General	Total Design BOM count
8.	FootPrint	267.0 mm2	General	Total Foot Print Area of BOM components
9.	Frequency	525.0 kHz	General	Switching frequency
10.	IC Tolerance	50.0 mV	General	IC Feedback Tolerance
11.	M Vds Act	161.592 mV	General	Voltage drop across the MosFET
12.	Pout	5.0 W	General	Total output power
13.	Total BOM	$2.22	General	Total BOM Cost
14.	D1 Tj	135.19 degC	Op_Point	D1 junction temperature
15.	Vout OP	5.0 V	Op_Point	Operational Output Voltage
16.	Duty Cycle	11.541 %	Op_point	Duty cycle
17.	Efficiency	80.932 %	Op_point	Steady state efficiency
18.	IC Tj	72.193 degC	Op_point	IC junction temperature
19.	ICThetaJA	40.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
20.	IOUT_OP	1.0 A	Op_point	Iout operating point
21.	VIN_OP	50.0 V	Op_point	Vin operating point
22.	Vout p-p	15.189 mV	Op_point	Peak-to-peak output ripple voltage
23.	Cin Pd	285.252 µW	Power	Input capacitor power dissipation
24.	Cout Pd	7.488 µW	Power	Output capacitor power dissipation
25.	Diode Pd	751.901 mW	Power	Diode power dissipation
26.	IC Pd	304.837 mW	Power	IC power dissipation
27.	L Pd	121.0 mW	Power	Inductor power dissipation
28.	Total Pd	1.178 W	Power	Total Power Dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	1.0 A	Maximum Output Current
2.	Iout1	1.0 Amps	Output Current #1
3.	VinMax	50.0 V	Maximum input voltage
4.	VinMin	10.0 V	Minimum input voltage
5.	Vout	5.0 V	Output Voltage
6.	Vout1	5.0 Volt	Output Voltage #1
7.	base_pn	LM5010	Base Product Number
8.	source	DC	Input Source Type
9.	Ta	60.0 degC	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. **LM5010** Product Folder : http://www.ti.com/product/lm5010 : contains the data sheet and other resources.