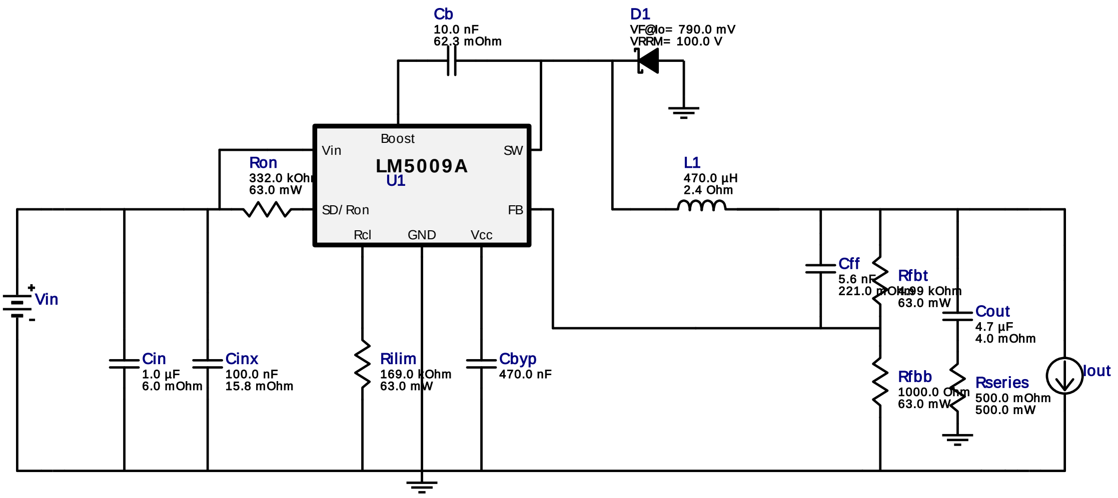
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 30.0V
VinMax = 65.0V
Vout = 15.0V
Iout = 0.1A

Device = LM5009MM/NOPB
Topology = Buck
Created = 2/9/14 3:59:49 PM
BOM Cost = $1.82
Footprint = 210.0 mm^2
BOM Count = 14
Total Pd = 0.15W

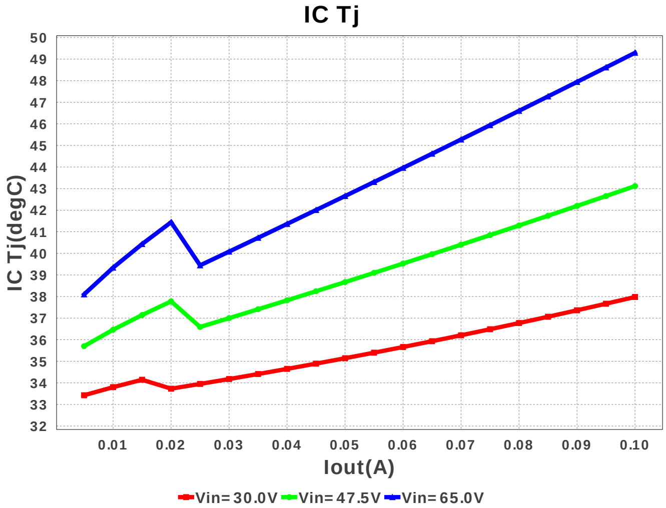
Design : 1231947/58 LM5009MM/NOPB
LM5009MM/NOPB 30.0V-65.0V to 15.0V @ 0.1A

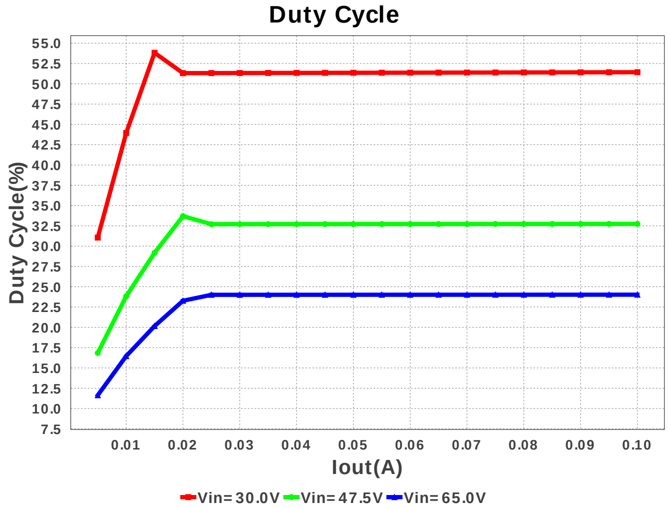


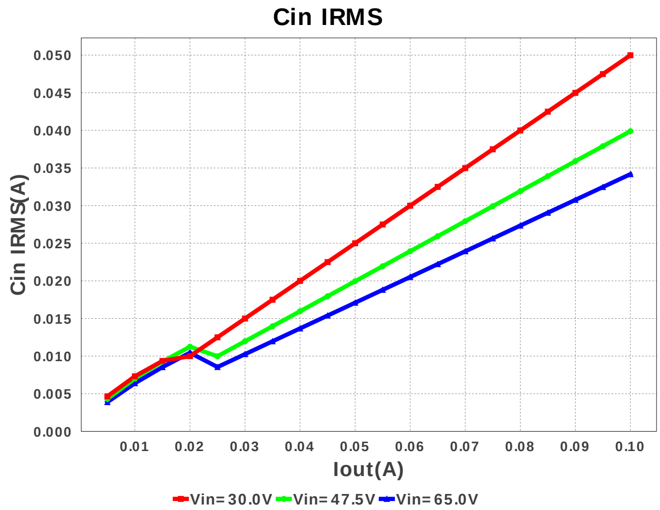
Electrical BOM

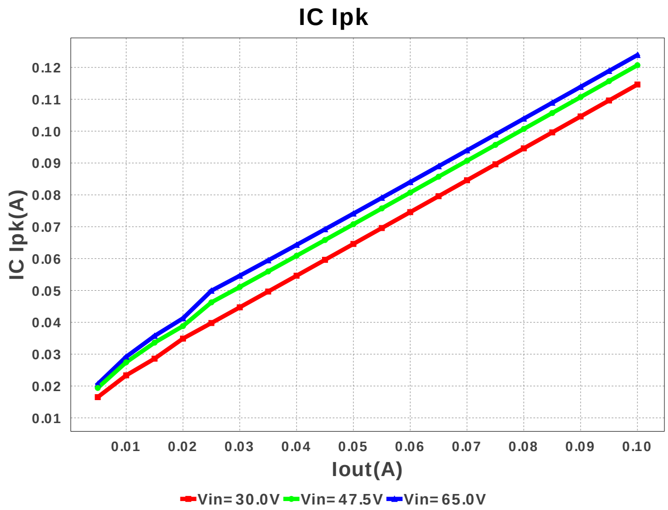
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cb	TDK	C1005X7R1C103K Series= X7R	Cap= 10.0 nF ESR= 62.3 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
2.	Cbyp	Taiyo Yuden	EMK212B7474KD-T Series= X7R	Cap= 470.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm^2
3.	Cff	Kemet	C1206C562K5RACTU Series= X7R	Cap= 5.6 nF ESR= 221.0 mOhm VDC= 50.0 V IRMS= 326.0 mA	1	$0.06	1206 11 mm^2
4.	Cin	TDK	C3216X7R2A105M Series= 285	Cap= 1.0 uF ESR= 6.0 mOhm VDC= 100.0 V IRMS= 4.5 A	1	$0.11	1206 11 mm^2
5.	Cinx	TDK	C2012X7R2A104K Series= X7R	Cap= 100.0 nF ESR= 15.8 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2
6.	Cout	MuRata	GRM21BR61E475KA12L Series= X5R	Cap= 4.7 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.05	0805 7 mm^2
7.	D1	Diodes Inc.	B1100-13-F	VF@Io= 790.0 mV VRRM= 100.0 V	1	$0.10	SMA 37 mm^2
8.	L1	Bourns	SRR7032-471M	L= 470.0 µH DCR= 2.4 Ohm	1	$0.25	SRR7032 81 mm^2
9.	Rfbb	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

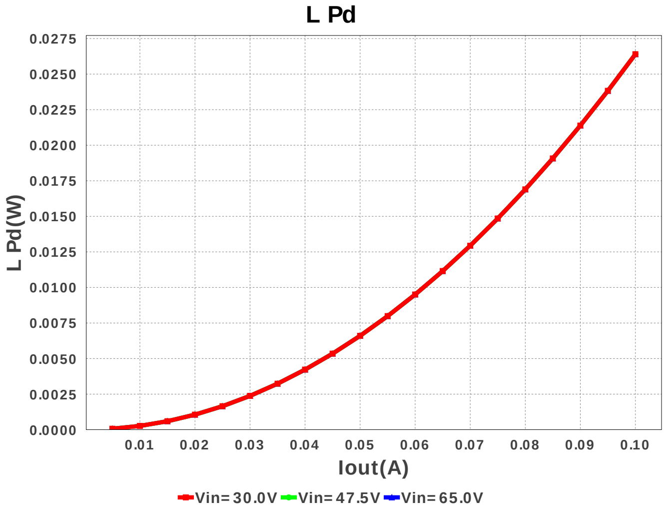
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	Rfbt	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
11.	Rilim	Vishay-Dale	CRCW0402169KFKED Series= CRCW..e3	Res= 169.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
12.	Ron	Vishay-Dale	CRCW0402332KFKED Series= CRCW..e3	Res= 332.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
13.	Rseries	Stackpole Electronics Inc	CSR1206FKR500 Series= ?	Res= 500.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.05	1206 11 mm^2
14.	U1	Texas Instruments	LM5009MM/NOPB	Switcher	1	$1.10	MUA08A 24 mm^2

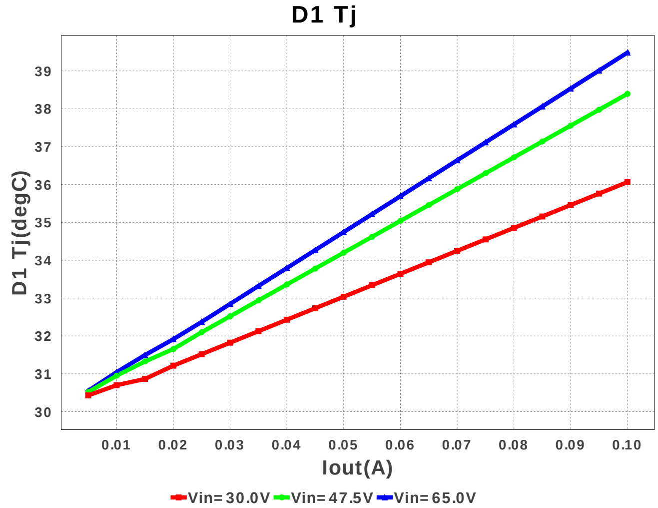


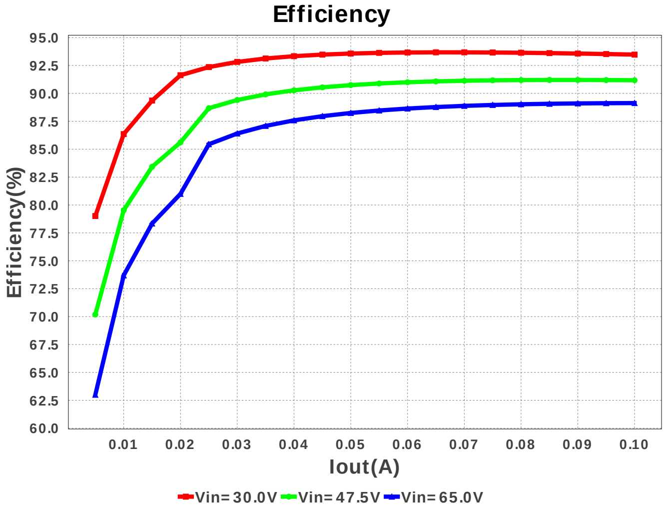


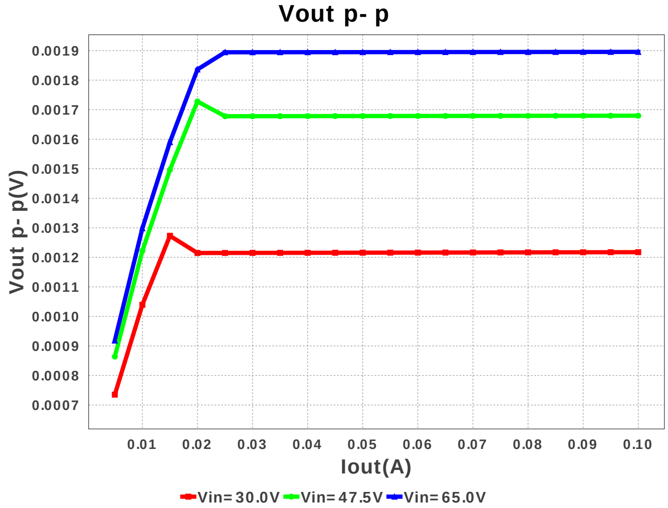


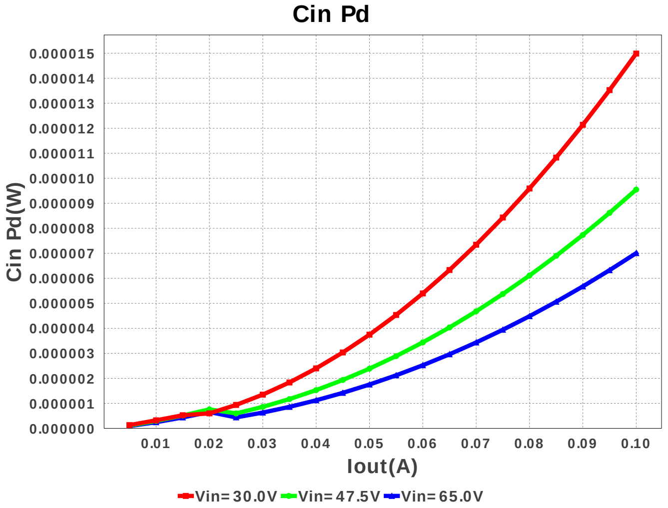


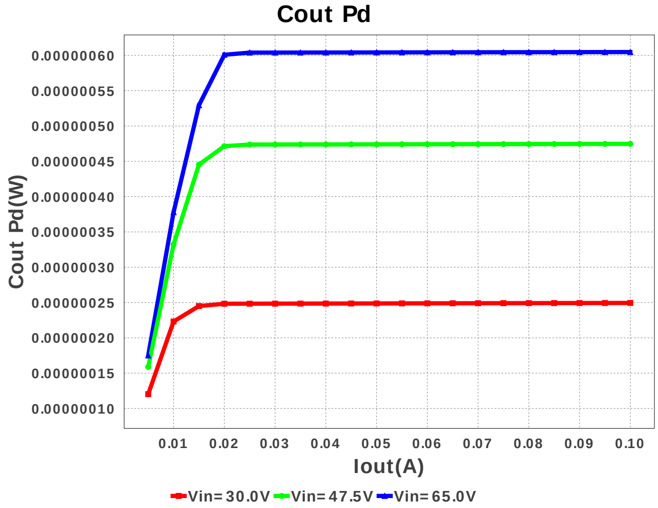

L Pd
L Pd(W)
Iout(A)
Vin=30.0V Vin=47.5V Vin=65.0V


D1 Tj
D1 Tj(degC)
Iout(A)
Vin=30.0V Vin=47.5V Vin=65.0V

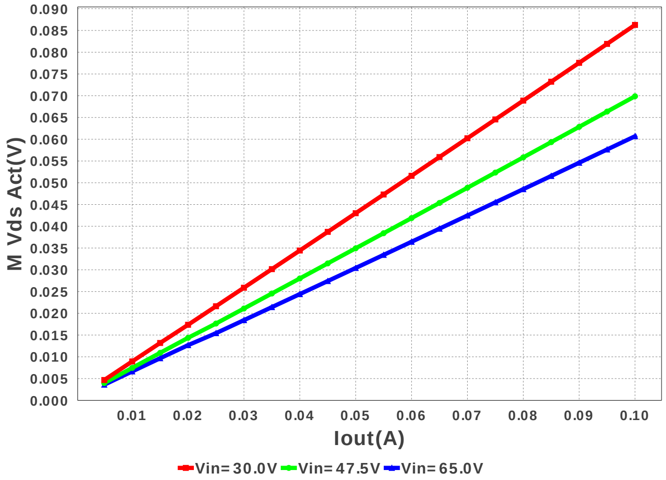

Efficiency
Efficiency(%)
Iout(A)
Vin=30.0V Vin=47.5V Vin=65.0V


Vout p-p
Vout p-p(V)
Iout(A)
Vin=30.0V Vin=47.5V Vin=65.0V

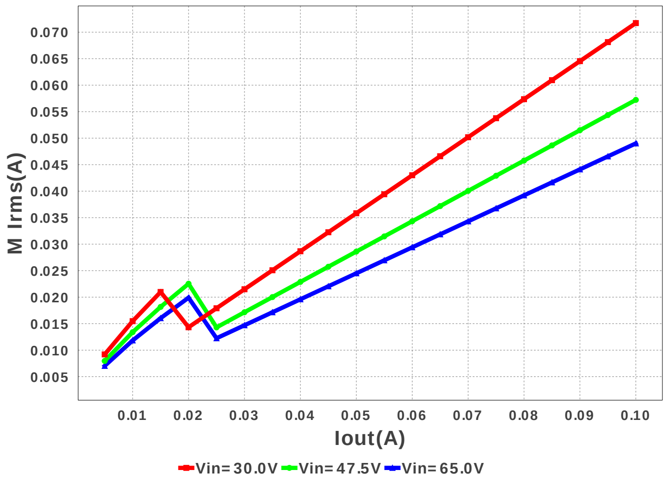

Cin Pd
Cin Pd(W)
Iout(A)
Vin=30.0V Vin=47.5V Vin=65.0V


Cout Pd
Cout Pd(W)
Iout(A)
Vin=30.0V Vin=47.5V Vin=65.0V

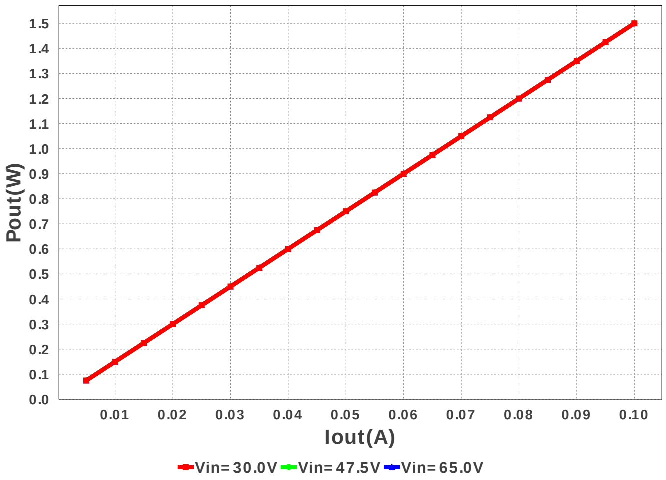
M Vds Act



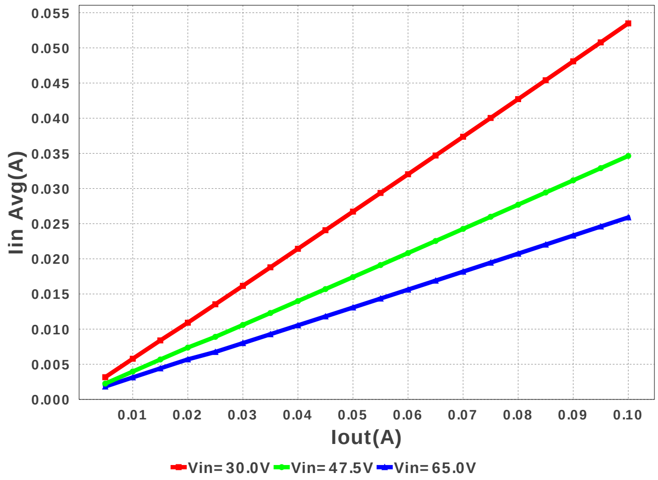
M Irms



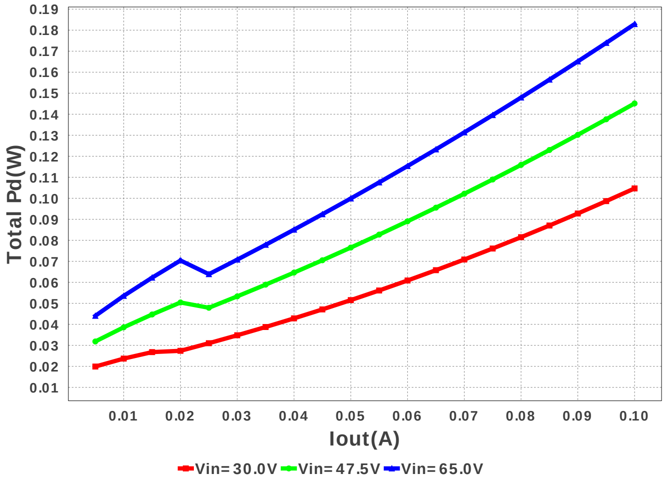
Pout



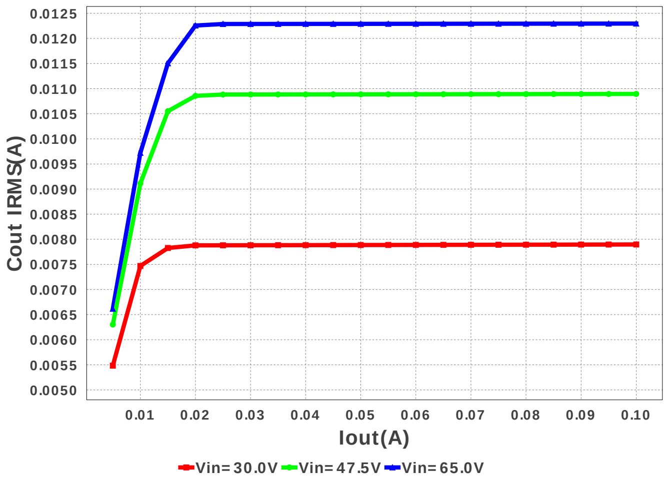
Iin Avg

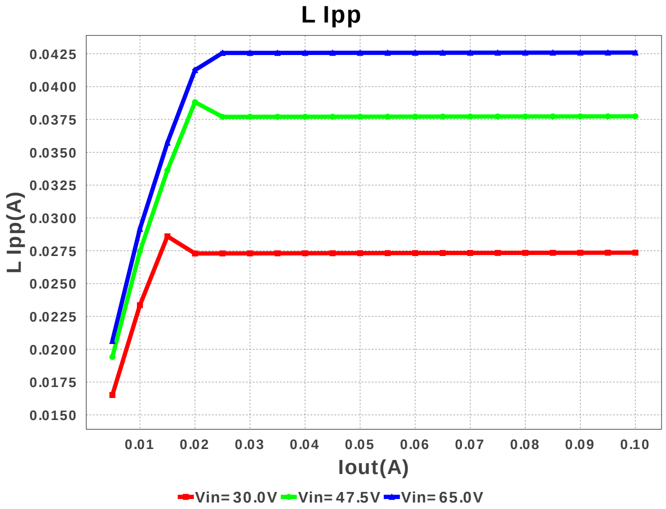


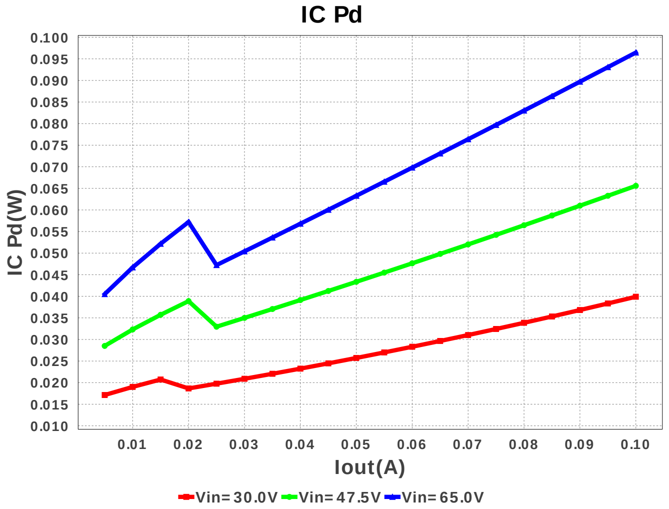
Total Pd

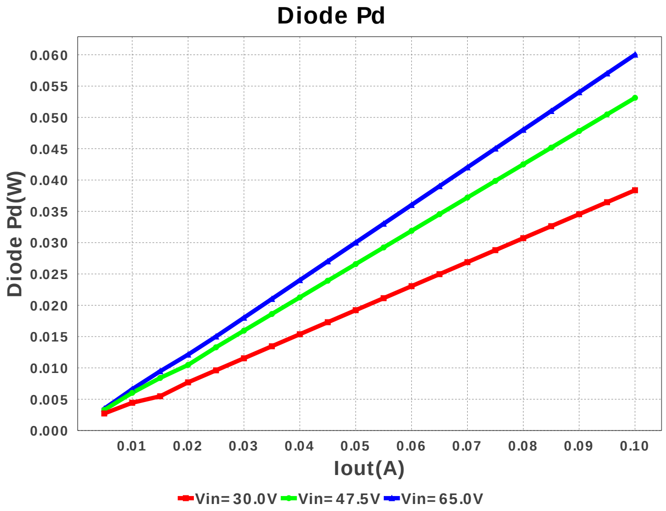


Cout IRMS









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	34.175 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	22.7 mA	Current	Output capacitor RMS ripple current
3.	IC Ipk	139.317 mA	Current	Peak switch current in IC
4.	Iin Avg	25.452 mA	Current	Average input current
5.	L Ipp	78.634 mA	Current	Peak-to-peak inductor ripple current
6.	M1 Irms	49.013 mA	Current	Q Iavg
7.	BOM Count	14	General	Total Design BOM count
8.	FootPrint	210.0 mm^2	General	Total Foot Print Area of BOM components
9.	Frequency	325.0 kHz	General	Switching frequency
10.	IC Tolerance	50.0 mV	General	IC Feedback Tolerance
11.	M Vds Act	60.06 mV	General	Voltage drop across the MosFET
12.	Pout	1.5 W	General	Total output power
13.	Total BOM	$1.82	General	Total BOM Cost
14.	D1 Tj	39.484 degC	Op_Point	D1 junction temperature
15.	Vout OP	15.0 V	Op_Point	Operational Output Voltage
16.	Duty Cycle	24.023 %	Op_point	Duty cycle
17.	Efficiency	90.667 %	Op_point	Steady state efficiency
18.	IC Tj	43.596 degC	Op_point	IC junction temperature
19.	ICThetaJA	200.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
20.	IOUT_OP	100.0 mA	Op_point	Iout operating point
21.	VIN_OP	65.0 V	Op_point	Vin operating point
22.	Vout p-p	6.443 mV	Op_point	Peak-to-peak output ripple voltage
23.	Cin Pd	7.007 µW	Power	Input capacitor power dissipation
24.	Cout Pd	2.061 µW	Power	Output capacitor power dissipation
25.	Diode Pd	60.022 mW	Power	Diode power dissipation
26.	IC Pd	67.978 mW	Power	IC power dissipation
27.	L Pd	26.4 mW	Power	Inductor power dissipation
28.	Total Pd	154.403 mW	Power	Total Power Dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	100.0 m	Maximum Output Current
2.	Iout1	100.0 m	Output Current #1
3.	VinMax	65.0	Maximum input voltage
4.	VinMin	30.0	Minimum input voltage
5.	Vout	15.0	Output Voltage
6.	Vout1	15.0	Output Voltage #1
7.	base_pn	LM5009A	Base Product Number
8.	source	DC	Input Source Type
9.	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. **LM5009A** Product Folder : http://www.ti.com/product/lm5009 : contains the data sheet and other resources.