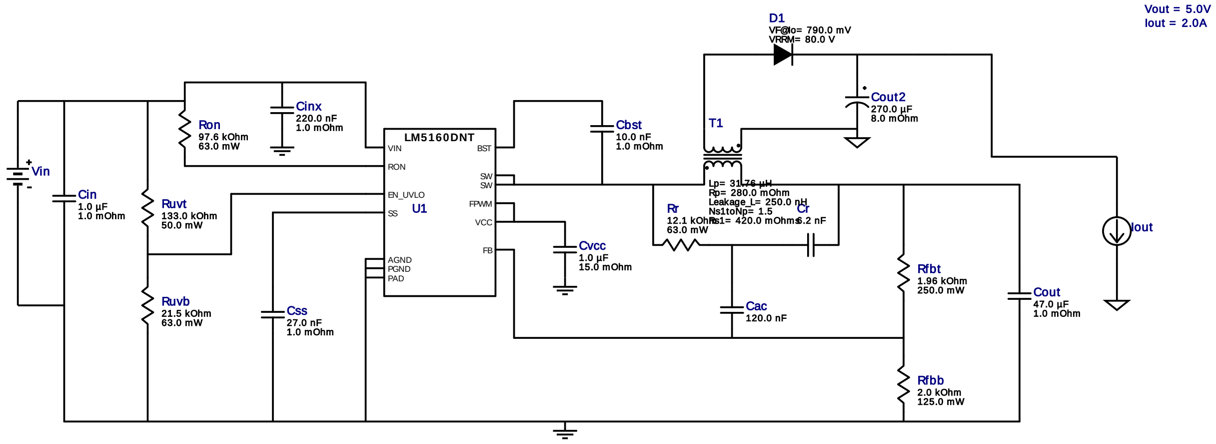
![Texas Instruments]

VinMin = 9.0V VinMax = 36.0V Vout = 5.0V Iout = 2.0A	Device = LM5160DNTR Topology = Flybuck Created = 2018-06-11 09:08:03.020 BOM Cost = $8.24 BOM Count = 18 Total Pd = 8.13W

WEBENCH ® Design Report

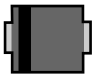
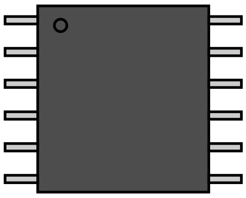
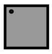
Design : LM5160DNTR
Design 31frompuja.langalia@gmail.com

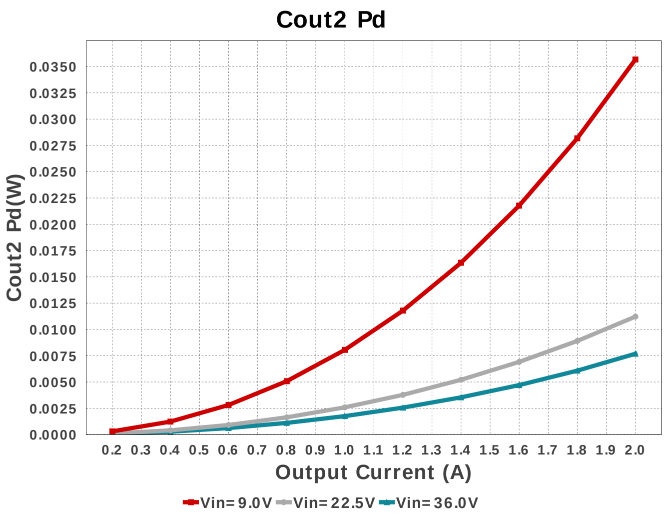


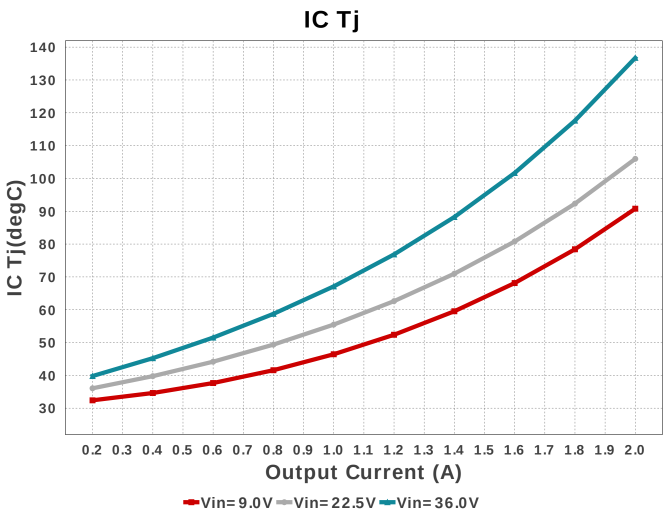
1. Feedback Resistors may need to be further adjusted to get more precise regulation as ripple injection circuit will introduce some amount of DC offset. Use simulation to help adjust.

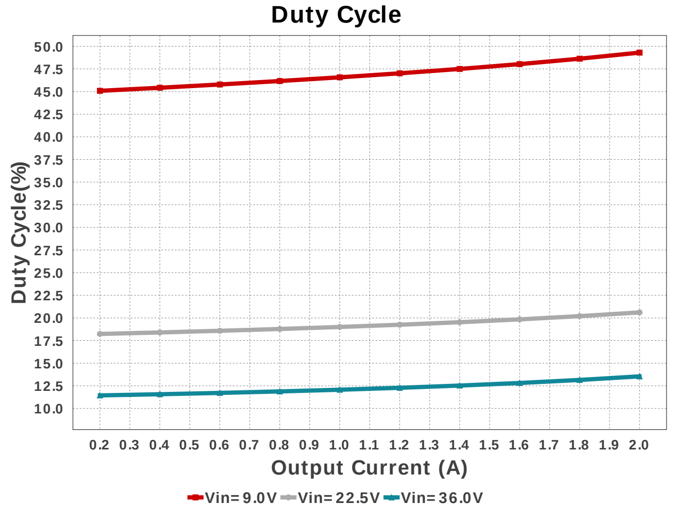
Electrical BOM

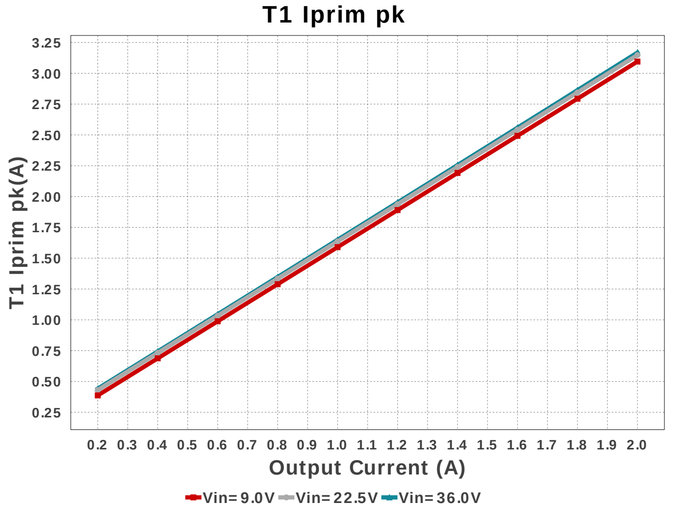
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cac	Samsung Electro-Mechanics	CL31C124JOHNNNE Series= C0G/NP0	Cap= 120.0 nF VDC= 5.0 V IRMS= 0.0 A	1	$0.35	1206 11 mm²
2.	Cbst	MuRata	GRM155R71C103KA01D Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
3.	Cin	AVX	08055C105KAT2A Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm²
4.	Cinx	MuRata	GRM21BR71H224MA01L Series= X7R	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.08	0805 7 mm²
5.	Cout	MuRata	GRM32ER60J476ME20L Series= X5R	Cap= 47.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	1	$0.36	1210_270 15 mm²
6.	Cout2	Panasonic	16SVPG270M Series= SVPG	Cap= 270.0 uF ESR= 8.0 mOhm VDC= 16.0 V IRMS= 5.8 A	1	$0.68	CAPSMT_62_C10 74 mm²
7.	Cr	Kemet	C0603C622J5GAC7867 Series= C0G/NP0	Cap= 6.2 nF VDC= 5.0 V IRMS= 0.0 A	1	$0.11	0603 5 mm²
8.	Css	MuRata	GRM155R61C273KA01D Series= X5R	Cap= 27.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
9.	Cvcc	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm²

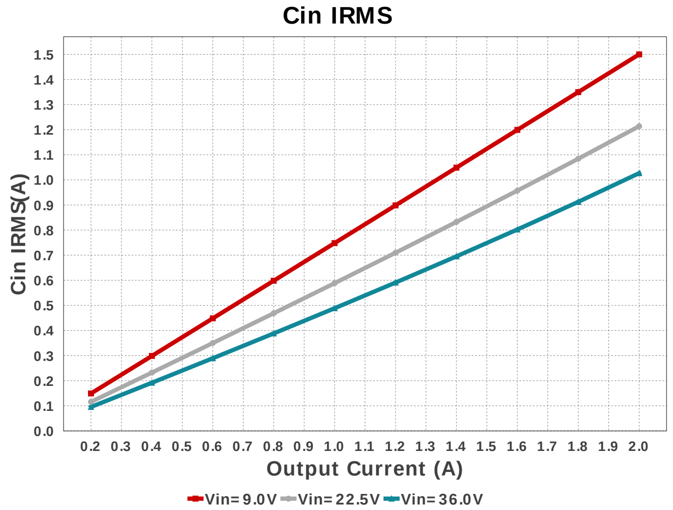
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	D1	Diodes Inc.	B380-13-F	VF@Io= 790.0 mV VRRM= 80.0 V	1	$0.32	 SMC 83 mm^2
11.	Rfbb	Panasonic	ERJ-6ENF2001V Series= ERJ-6E	Res= 2.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
12.	Rfbt	Vishay-Dale	CRCW12061K96FKEA Series= CRCW..e3	Res= 1.96 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
13.	Ron	Vishay-Dale	CRCW040297K6FKED Series= CRCW..e3	Res= 97.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
14.	Rr	Yageo	AC0402FR-0712K1L Series= ?	Res= 12.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
15.	Ruvb	Vishay-Dale	CRCW040221K5FKED Series= CRCW..e3	Res= 21.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
16.	Ruvt	Yageo	RC0201FR-07133KL Series= ?	Res= 133.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
17.	T1	Coiltronics	VPH3-0047-R	Lp= 31.76 µH Rp= 280.0 mOhm Leakage_L= 250.0 nH Ns1toNp= 1.5 Rs1= 420.0 mOhms	1	$4.37	 VP3 464 mm^2
18.	U1	Texas Instruments	LM5160DNTR	Switcher	1	$1.80	 DNT0012B 25 mm^2

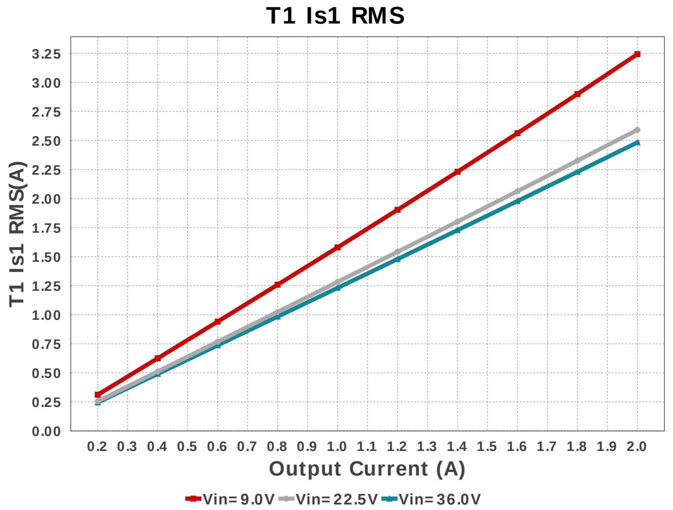


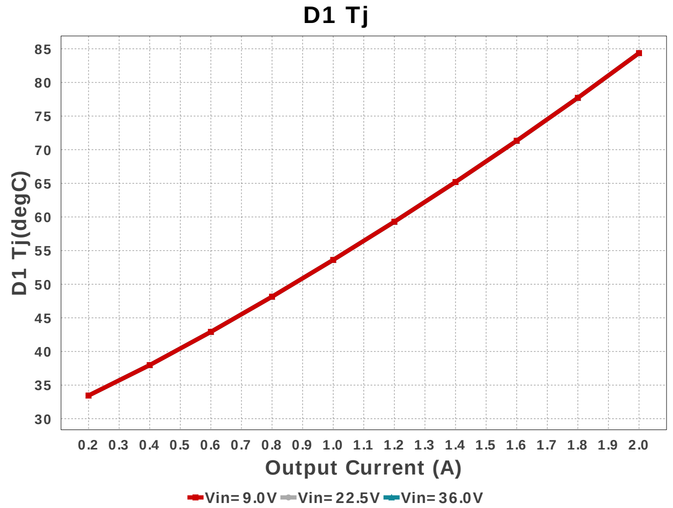


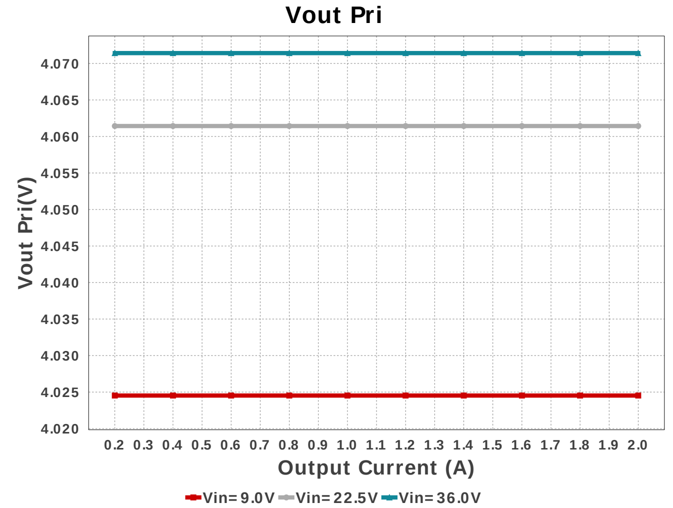

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V


T1 Iprim pk
T1 Iprim pk(A)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

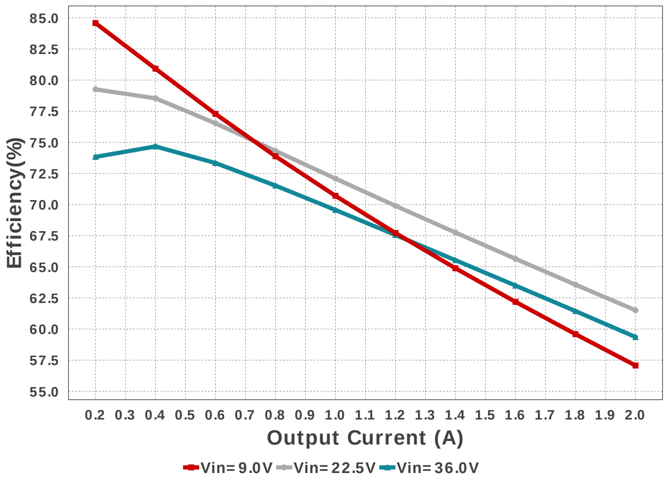

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V


T1 Is1 RMS
T1 Is1 RMS(A)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

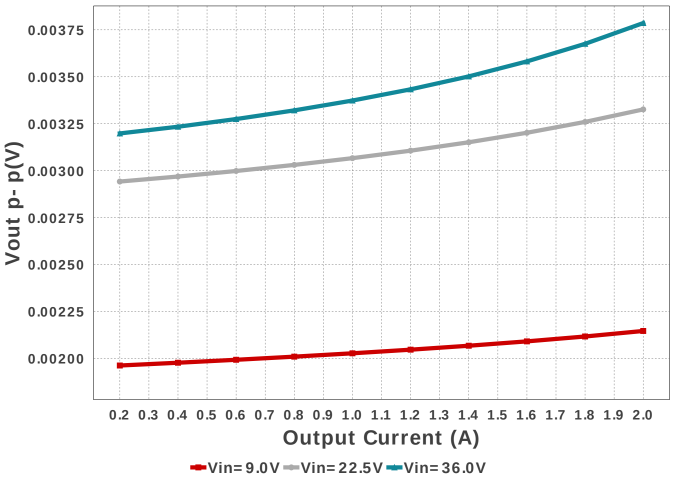

D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V


Vout Pri
Vout Pri(V)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

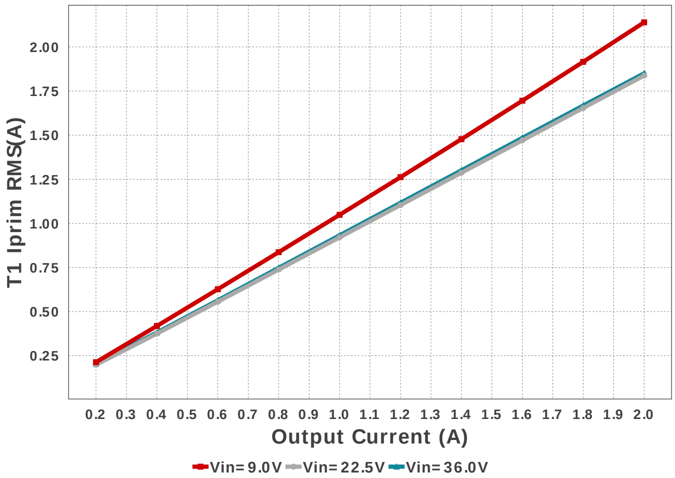
Efficiency



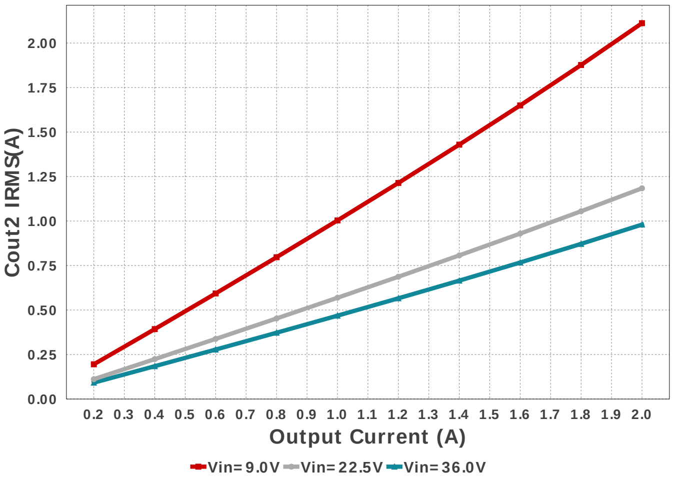
Vout p- p



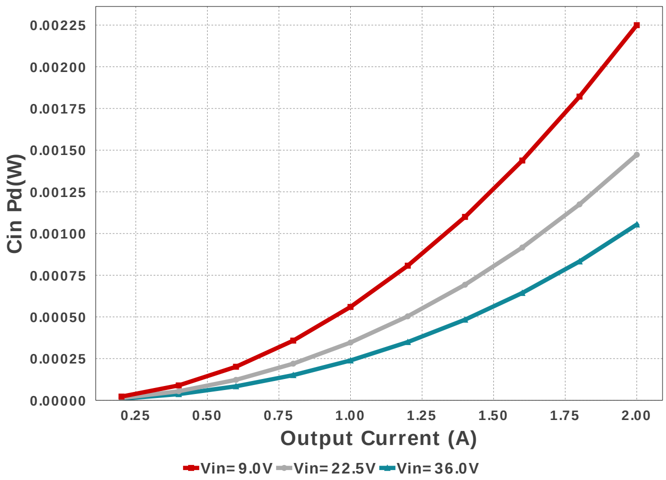
T1 Iprim RMS



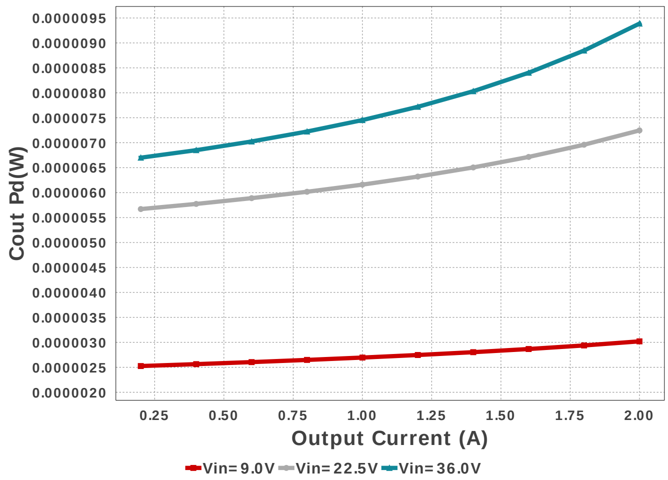
Cout2 IRMS

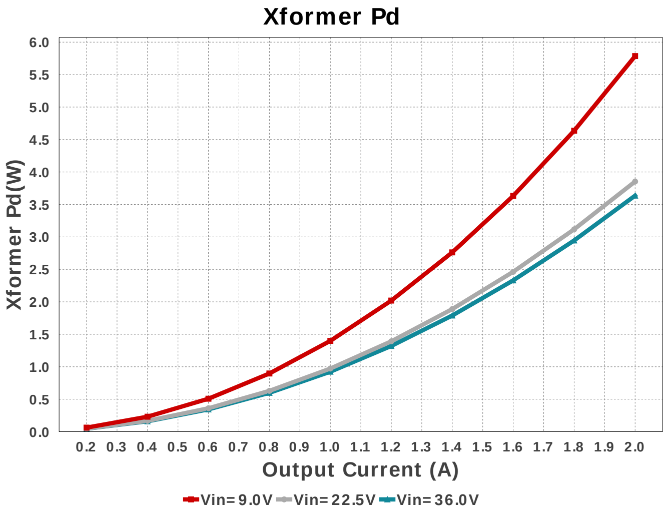


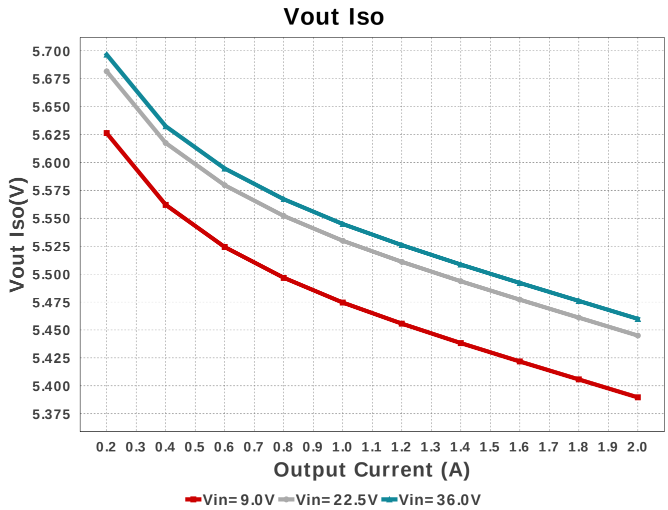
Cin Pd

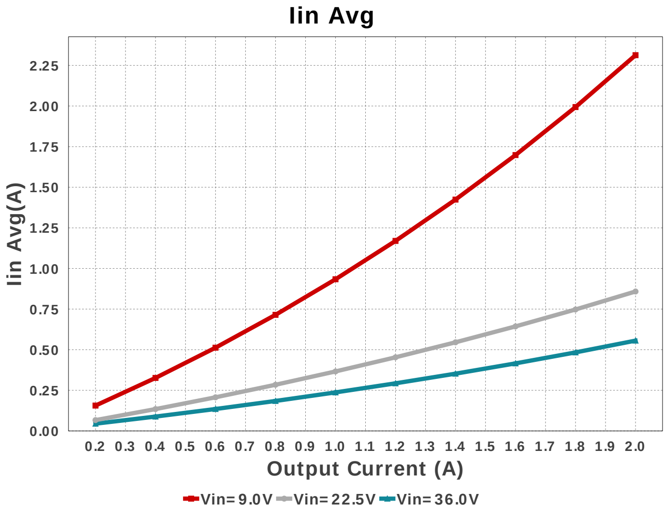


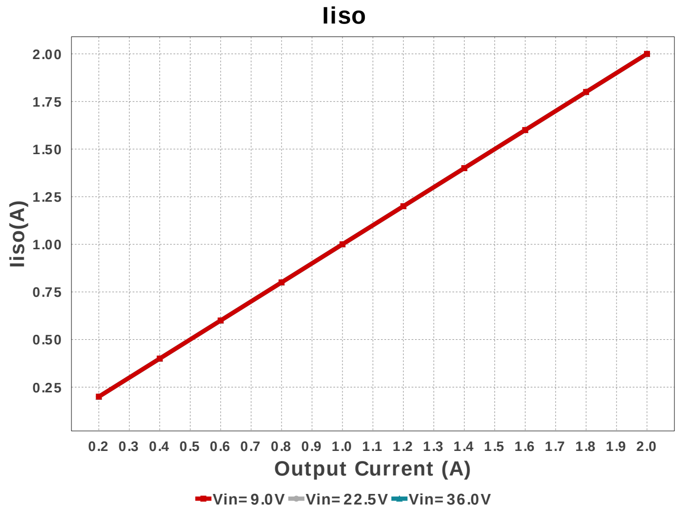
Cout Pd

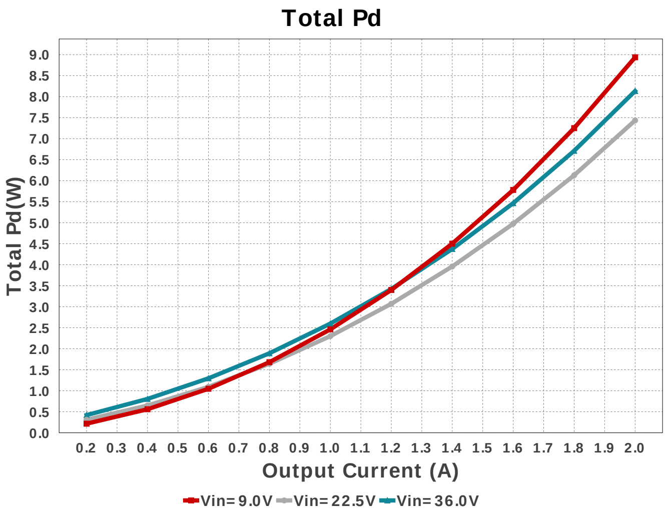


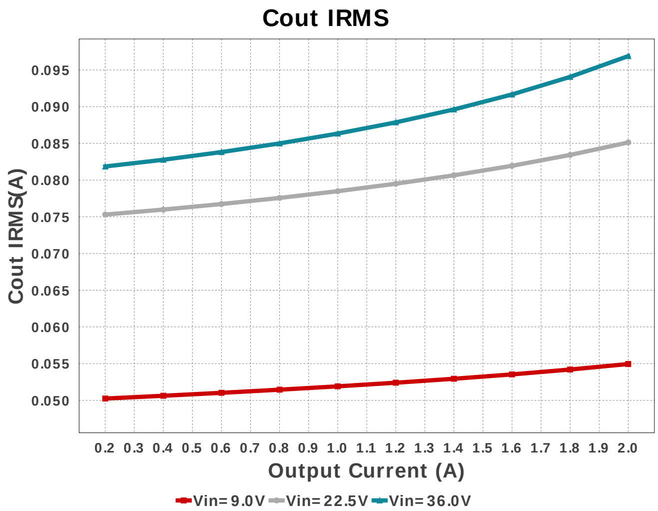

Xformer Pd
Xformer Pd(W)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

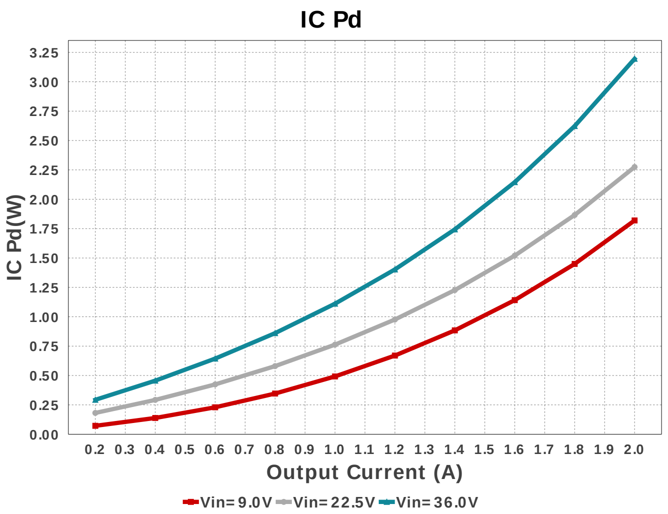

Vout Iso
Vout Iso(V)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V

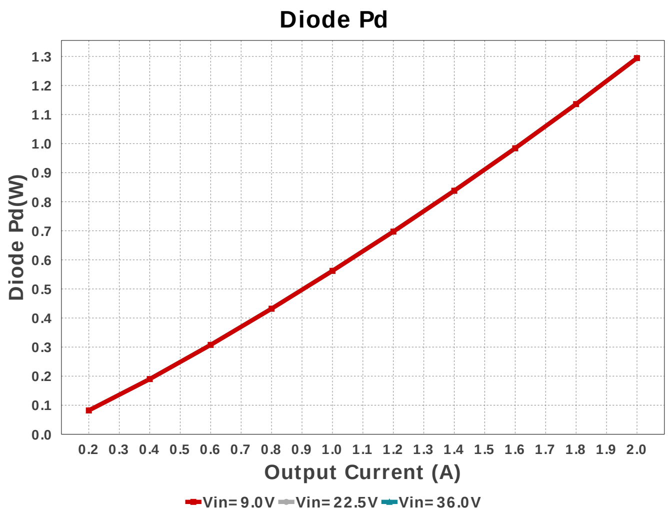

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V


Iiso
Iiso(A)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=9.0V Vin=22.5V Vin=36.0V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	18		Total Design BOM count
2.	Total BOM	$8.24		Total BOM Cost
3.	Cin IRMS	1.027 A	Current	Input capacitor RMS ripple current
4.	Cout IRMS	96.889 mA	Current	Output capacitor RMS ripple current
5.	Cout2 IRMS	980.126 mA	Current	Output capacitor2 RMS ripple current
6.	Iin Avg	555.95 mA	Current	Average input current
7.	Iiso	2.0 A	Current	Secondary Side Output Current
8.	T1 Iprim RMS	1.85 A	Current	Transformer Primary RMS Current
9.	T1 Iprim pk	3.168 A	Current	Transformer Primary Peak Current
10.	T1 Is1 RMS	2.484 A	Current	Transformer Secondary1 RMS Current
11.	FootPrint	732.0 mm^2	General	Total Foot Print Area of BOM components
12.	Frequency	405.738 kHz	General	Switching frequency
13.	D1 Tj	84.364 degC	Op Point	D1 junction temperature
14.	Duty Cycle	13.546 %	Op Point	Duty cycle
15.	Efficiency	59.358 %	Op Point	Steady state efficiency
16.	IC Tj	136.729 degC	Op Point	IC junction temperature
17.	ICThetaJA	33.4 degC/W	Op Point	IC junction-to-ambient thermal resistance
18.	VIN_OP	36.0 V	Op Point	Vin operating point
19.	Vout Actual	3.96 V	Op Point	Vout Actual calculated based on selected voltage divider resistors
20.	Vout Iso	5.46 V	Op Point	Secondary Side Output Voltage
21.	Vout Pri	4.071 V	Op Point	Primary Side Output Voltage
22.	Vout Tolerance	2.262 %	Op Point	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
23.	Vout p-p	3.786 mV	Op Point	Peak-to-peak output ripple voltage
24.	Cin Pd	1.054 mW	Power	Input capacitor power dissipation
25.	Cout Pd	9.388 µW	Power	Output capacitor power dissipation
26.	Cout2 Pd	7.685 mW	Power	Output capacitor2 power dissipation
27.	Diode Pd	1.294 W	Power	Diode power dissipation
28.	IC Pd	3.195 W	Power	IC power dissipation
29.	Total Pd	8.134 W	Power	Total Power Dissipation
30.	Xformer Pd	3.636 W	Power	Transformer power dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	2.0	Maximum Output Current
2.	SoftStart	5.0 ms	Soft Start Time (ms)
3.	VinMax	36.0	Maximum input voltage
4.	VinMin	9.0	Minimum input voltage
5.	Vout	5.0	Output Voltage
6.	acFrequency	0.0	AC Frequency
7.	base_pn	LM5160	Base Product Number
8.	source	DC	Input Source Type
9.	Ta	30.0	Ambient temperature
10.	UserFsw	409.836 k	Customer Selected Frequency

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. **LM5160** Product Folder : http://www.ti.com/product/LM5160 : contains the data sheet and other resources.