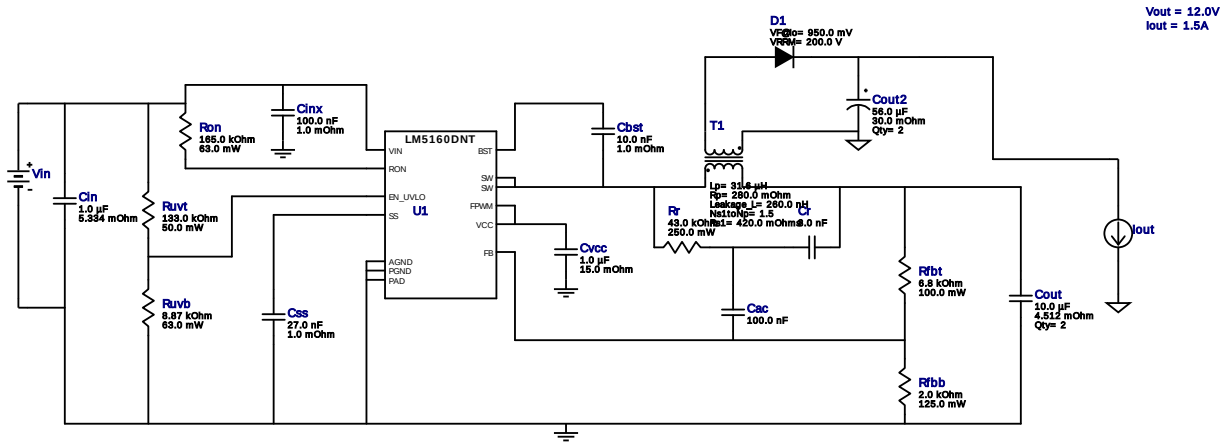
WEBENCH® Design Report

VinMin = 20.0V
VinMax = 60.0V
Vout = 12.0V
Iout = 1.5A

Device = LM5160DNTR
Topology = Flyback
Created = 2018-06-17 04:22:15.734
BOM Cost = $6.70
BOM Count = 20
Total Pd = 7.39W

Design : LM5160DNTR
LM5160DNTR 20.0V-60.0V to 12.00V @ 2.2500000989999998A



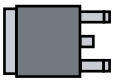
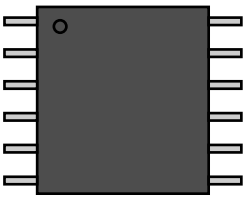
1. Feedback Resistors may need to be further adjusted to get more precise regulation as ripple injection circuit will introduce some amount of DC offset. Use simulation to help adjust.

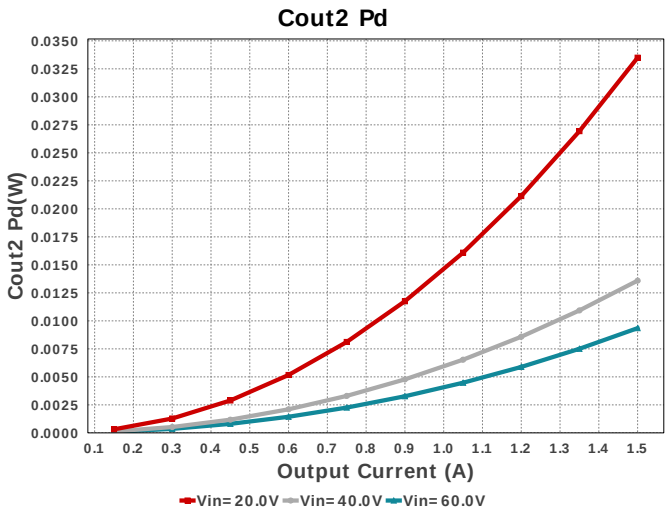
My Comments

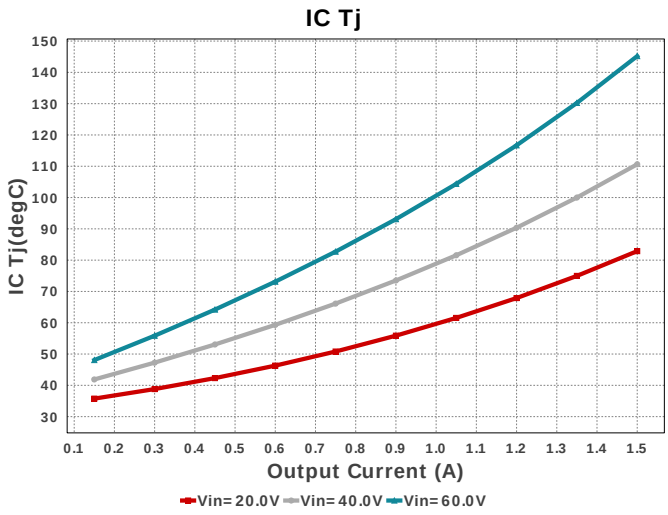
No comments

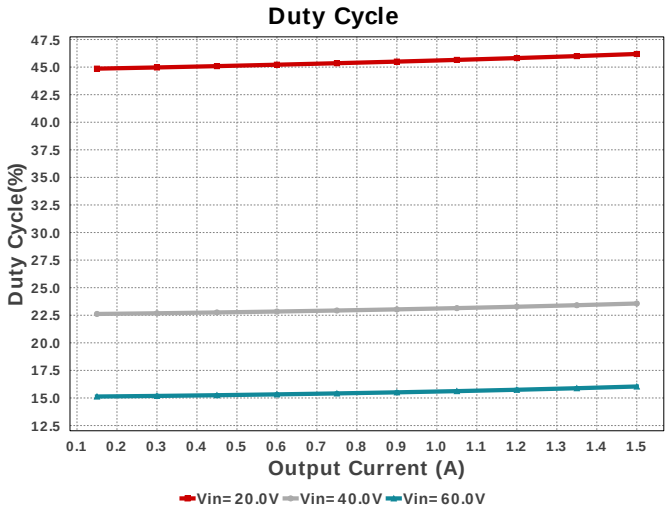
Electrical BOM

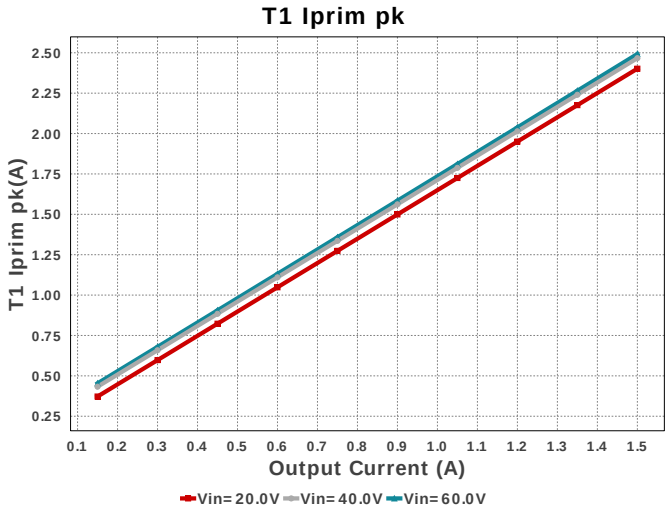
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cac	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.10	0805 7 mm²
2.	Cbst	MuRata	GRM155R71C103KA01D Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
3.	Cin	MuRata	GRM31CR72A105KA01L Series= X7R	Cap= 1.0 uF ESR= 5.334 mOhm VDC= 100.0 V IRMS= 1.55432 A	1	$0.25	1206_190 11 mm²
4.	Cinx	MuRata	GRM188R72A104KA35D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.06	0603 5 mm²
5.	Cout	MuRata	GRM31CR61E106KA12L Series= X5R	Cap= 10.0 uF ESR= 4.512 mOhm VDC= 25.0 V IRMS= 2.447 A	2	$0.07	1206_190 11 mm²
6.	Cout2	Panasonic	20SVPF56MX Series= SVPF	Cap= 56.0 uF ESR= 30.0 mOhm VDC= 20.0 V IRMS= 2.8 A	2	$0.37	CAPSMT_62_E61 53 mm²
7.	Cr	Kemet	C0603C302K5GACTU Series= C0G/NP0	Cap= 3.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.09	0603 5 mm²
8.	Css	MuRata	GRM155R71C273KA01D Series= X7R	Cap= 27.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²

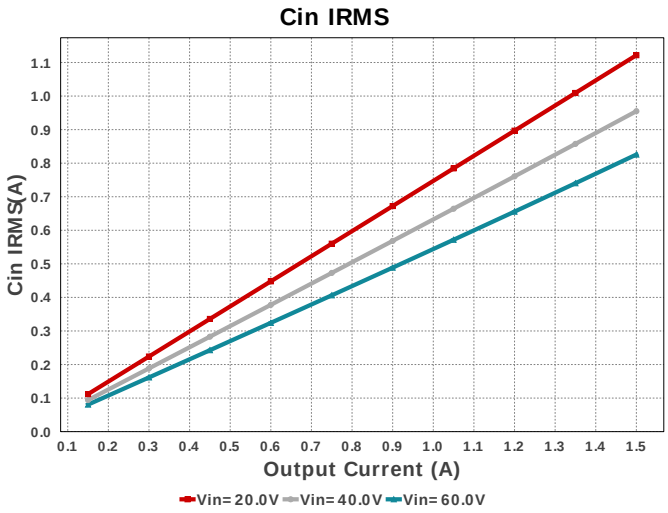
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Cvcc	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	 0805 7 mm²
10.	D1	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.12	 DPAK 102 mm²
11.	Rfbb	Panasonic	ERJ-6ENF2001V Series= ERJ-6E	Res= 2.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
12.	Rfbt	Susumu Co Ltd	RR1220P-682-D Series= RR12	Res= 6.8 kOhm Power= 100.0 mW Tolerance= 0.5%	1	$0.01	 0805 7 mm²
13.	Ron	Vishay-Dale	CRCW0402165KFKED Series= CRCW..e3	Res= 165.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
14.	Rr	Yageo	RC1206FR-0743KL Series= ?	Res= 43.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm²
15.	Ruvb	Vishay-Dale	CRCW04028K87FKED Series= CRCW..e3	Res= 8.87 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
16.	Ruvt	Yageo	RC0201FR-07133KL Series= ?	Res= 133.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm²
17.	T1	Wurth Elektronik	749196341	Lp= 31.6 µH Rp= 280.0 mOhm Leakage_L= 260.0 nH Ns1toNp= 1.5 Rs1= 420.0 mOhms	1	$3.30	 EFD15 470 mm²
18.	U1	Texas Instruments	LM5160DNTR	Switcher	1	$1.80	 DNT0012B 25 mm²

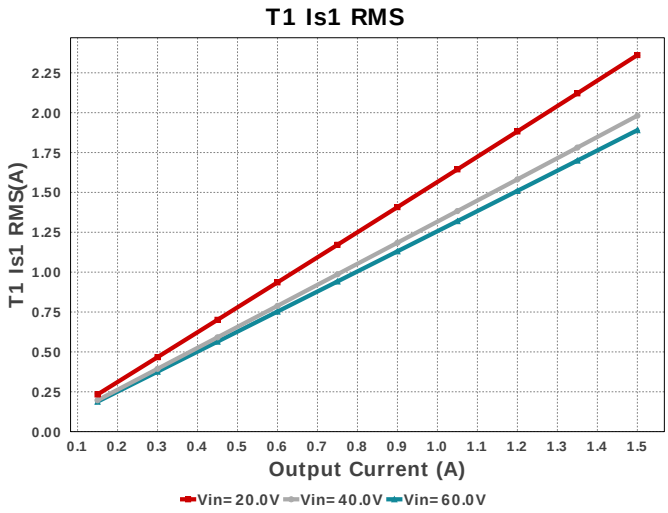


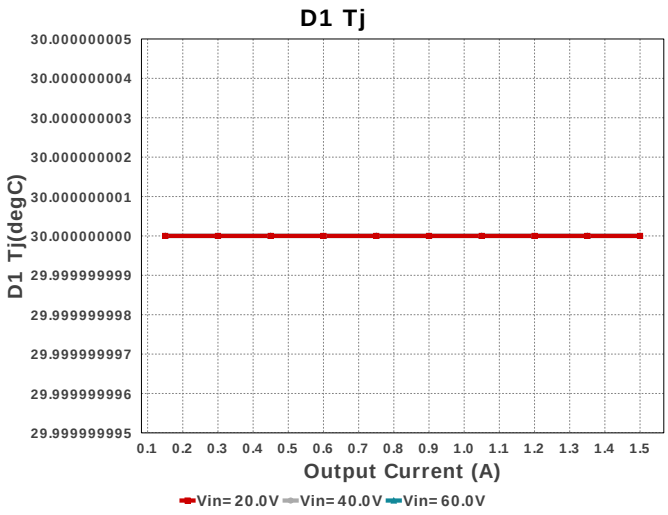


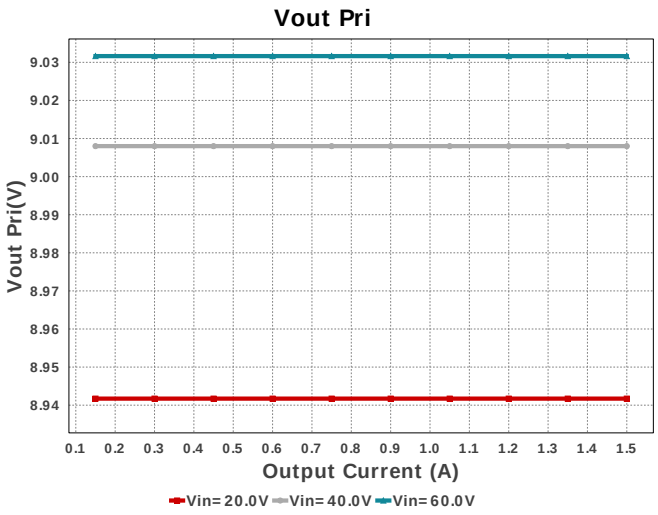


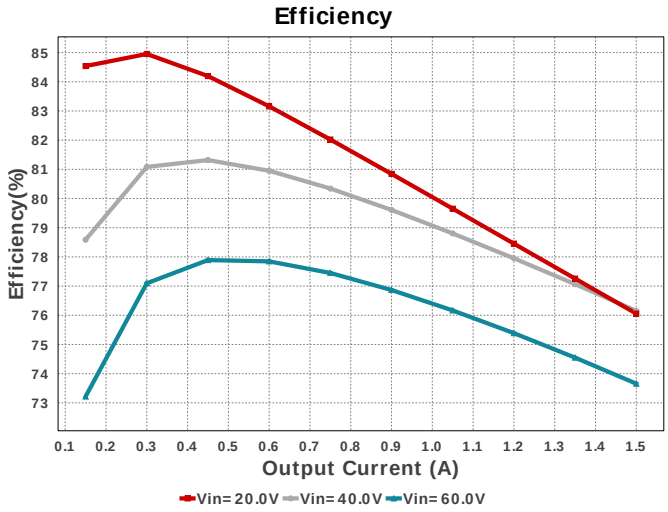


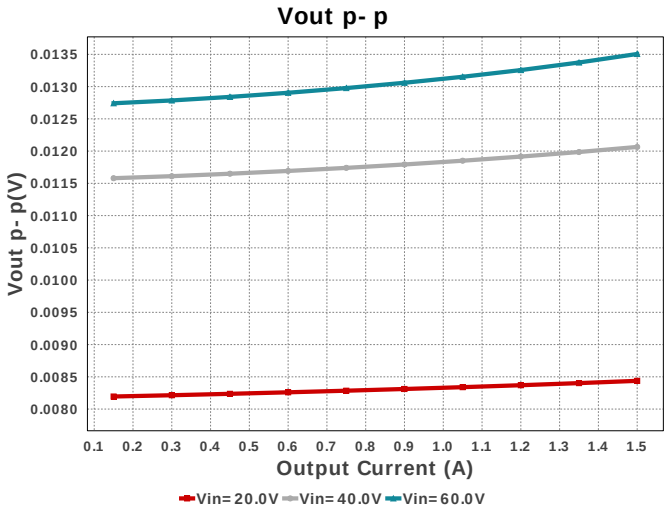


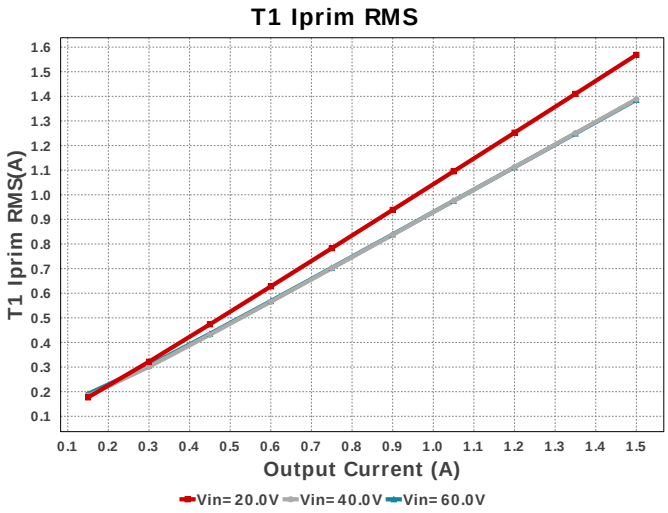


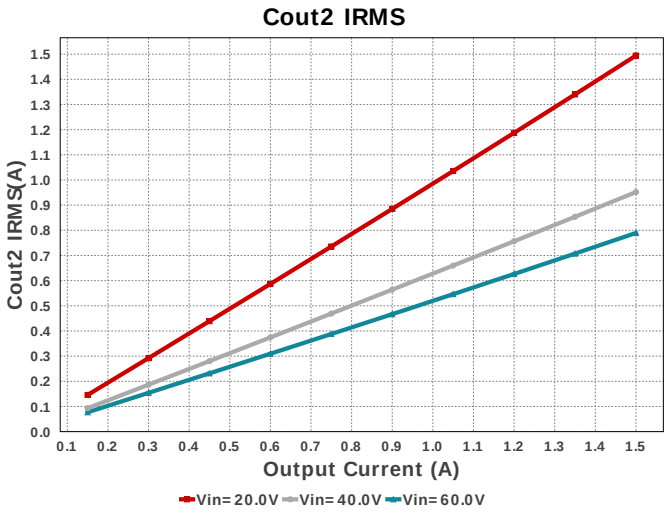


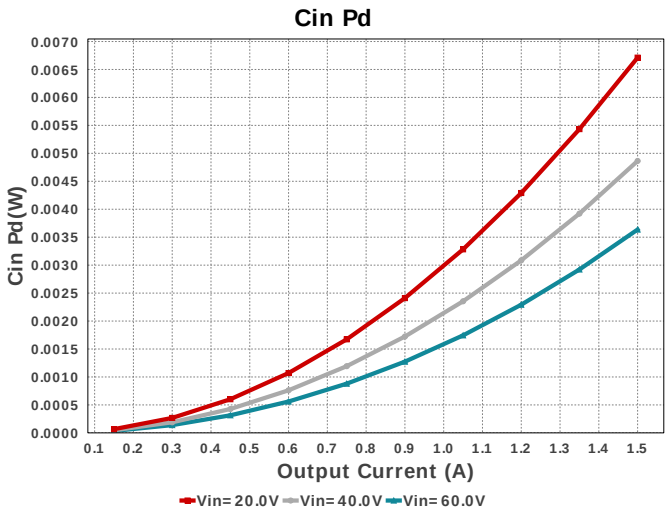


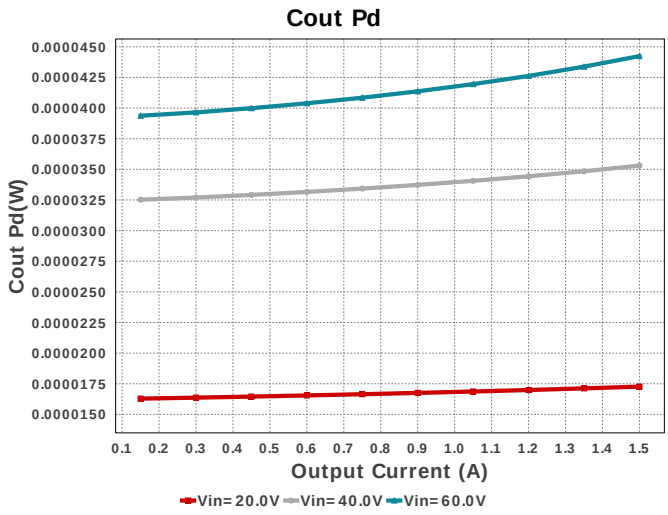


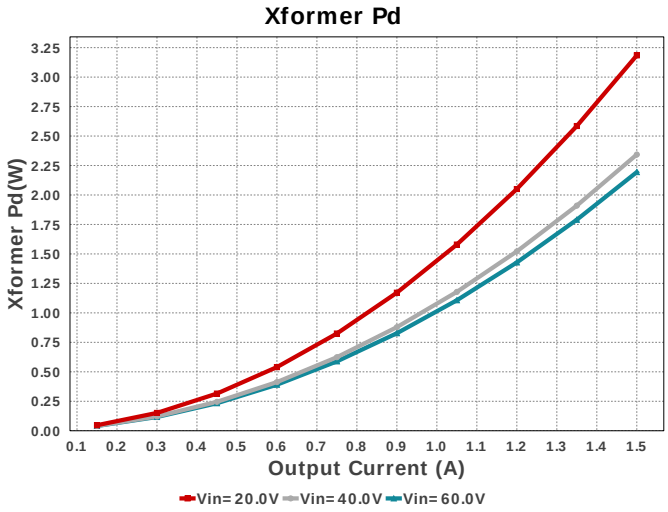


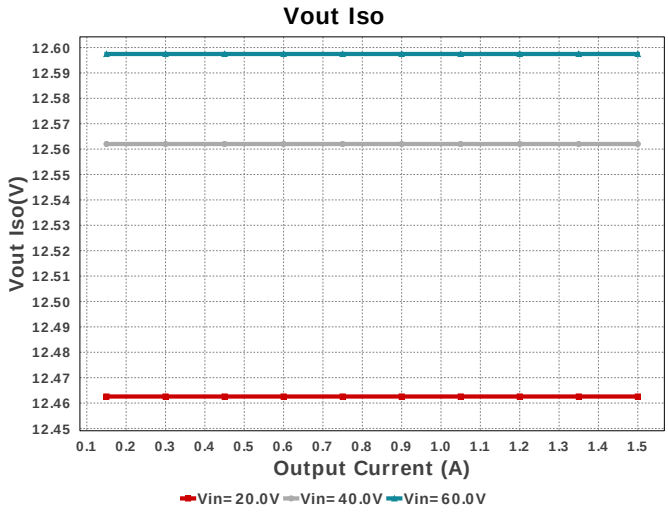


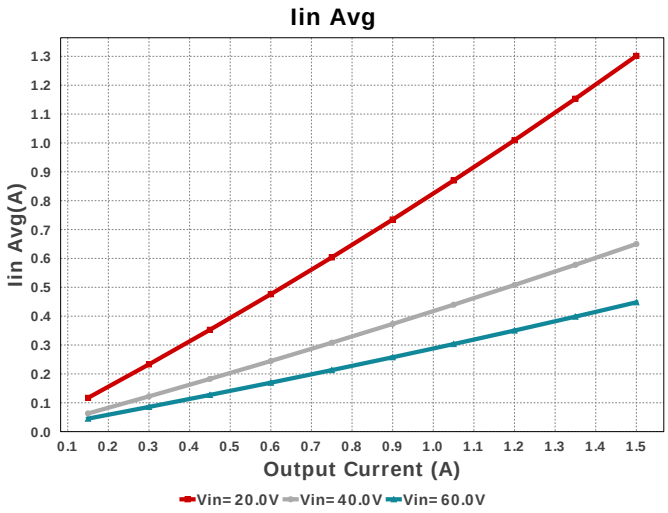


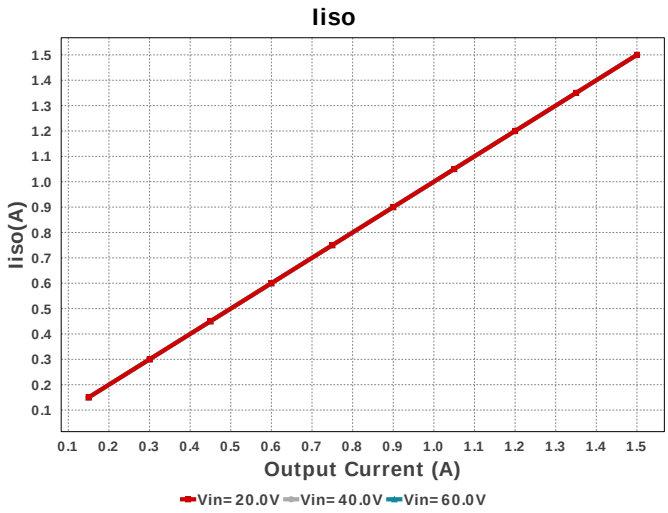


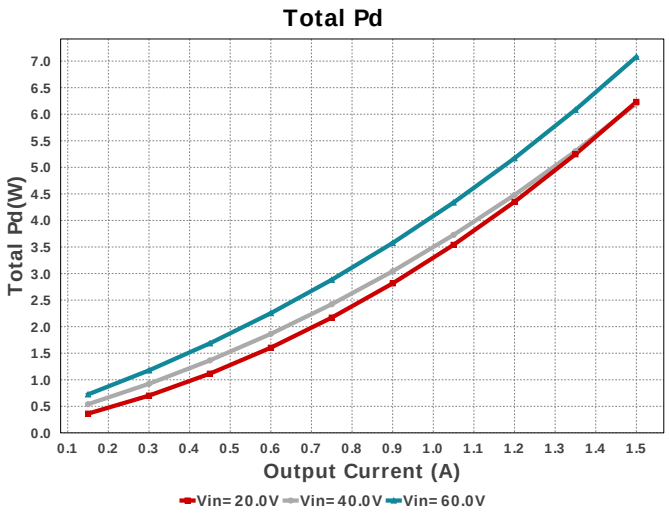


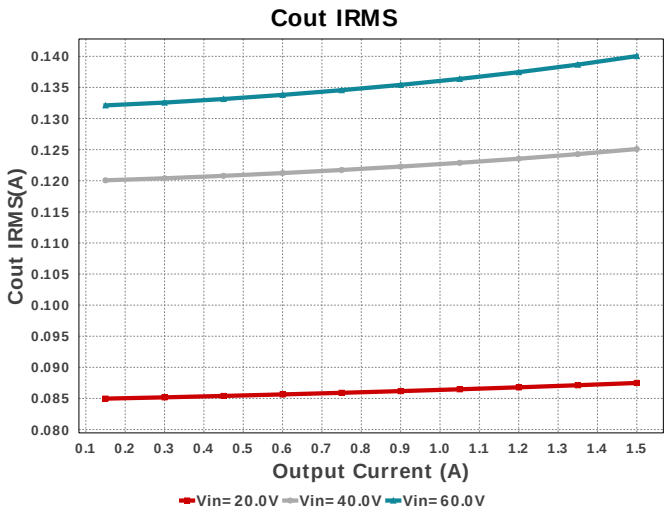


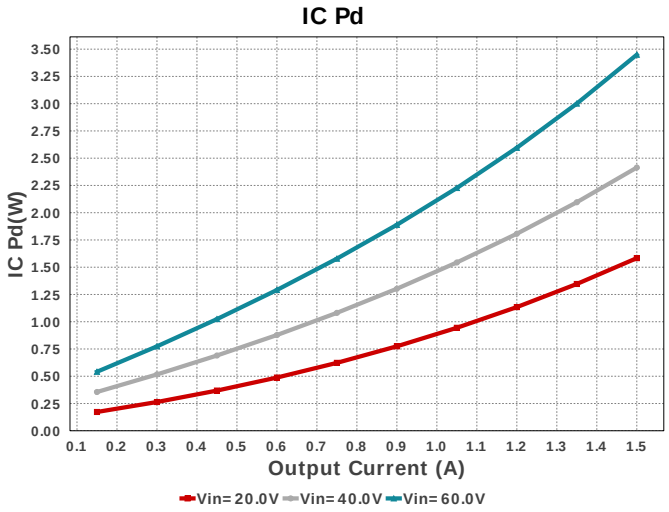


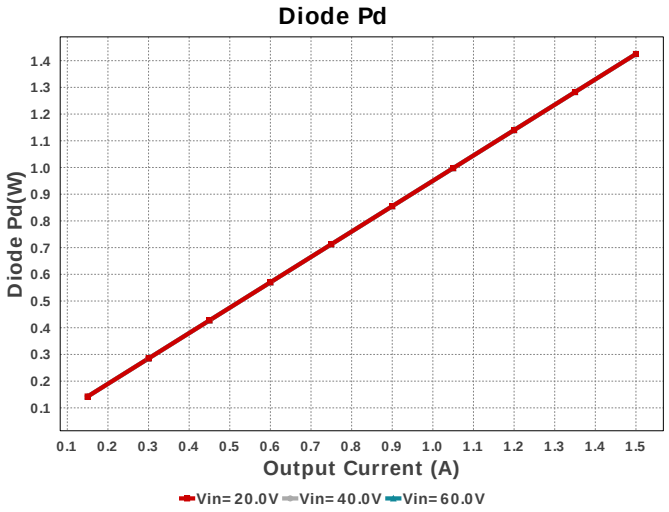












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	825.794 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	138.672 mA	Current	Output capacitor RMS ripple current
3.	Cout2 IRMS	789.562 mA	Current	Output capacitor2 RMS ripple current
4.	Iin Avg	453.24 mA	Current	Average input current
5.	Iiso	1.5 A	Current	Secondary Side Output Current
6.	T1 Iprim RMS	1.386 A	Current	Transformer Primary RMS Current
7.	T1 Iprim pk	2.49 A	Current	Transformer Primary Peak Current
8.	T1 Is1 RMS	1.89 A	Current	Transformer Secondary1 RMS Current
9.	BOM Count	20	General	Total Design BOM count
10.	FootPrint	797.0 mm^2	General	Total Foot Print Area of BOM components
11.	Frequency	538.721 kHz	General	Switching frequency
12.	Total BOM	$6.7	General	Total BOM Cost
13.	D1 Tj	30.0 degC	Op Point	D1 junction temperature
14.	Duty Cycle	16.045 %	Op Point	Duty cycle
15.	Efficiency	72.809 %	Op Point	Steady state efficiency
16.	IC Tj	146.118 degC	Op Point	IC junction temperature
17.	ICThetaJA	33.4 degC/W	Op Point	IC junction-to-ambient thermal resistance
18.	VIN_OP	60.0 V	Op Point	Vin operating point
19.	Vout Actual	8.8 V	Op Point	Vout Actual calculated based on selected voltage divider resistors
20.	Vout Iso	12.597 V	Op Point	Secondary Side Output Voltage
21.	Vout Pri	9.032 V	Op Point	Primary Side Output Voltage
22.	Vout Tolerance	2.435 %	Op Point	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
23.	Vout p-p	13.241 mV	Op Point	Peak-to-peak output ripple voltage
24.	Cin Pd	3.637 mW	Power	Input capacitor power dissipation
25.	Cout Pd	43.383 µW	Power	Output capacitor power dissipation
26.	Cout2 Pd	9.351 mW	Power	Output capacitor2 power dissipation
27.	Diode Pd	1.425 W	Power	Diode power dissipation
28.	IC Pd	3.477 W	Power	IC power dissipation
29.	Total Pd	7.394 W	Power	Total Power Dissipation
30.	Xformer Pd	2.48 W	Power	Transformer power dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	1.5	Maximum Output Current
2.	VinMax	60.0	Maximum input voltage
3.	VinMin	20.0	Minimum input voltage
4.	Vout	12.0	Output Voltage
5.	base_pn	LM5160	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. **LM5160** Product Folder : http://www.ti.com/product/LM5160 : contains the data sheet and other resources.