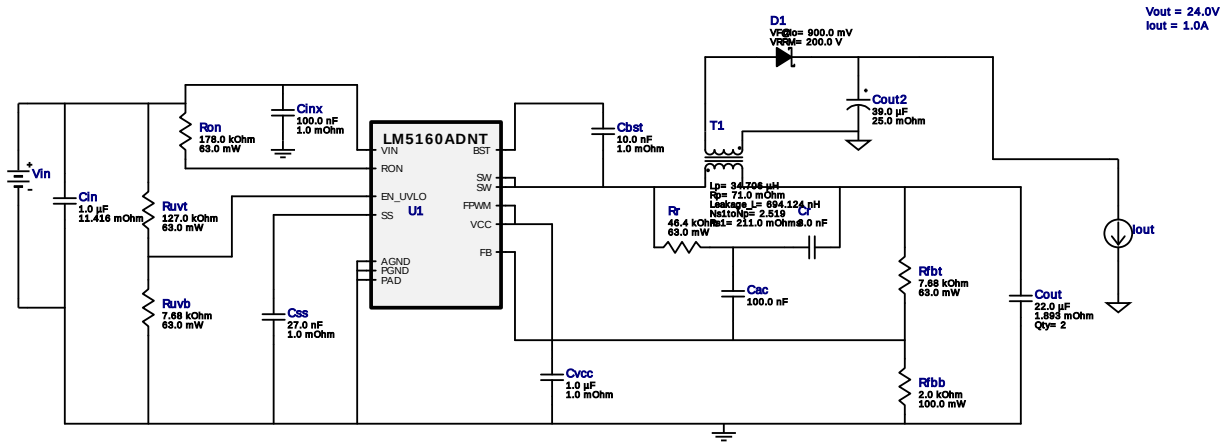
WEBENCH® Design Report

VinMin = 22.0V
VinMax = 26.0V
Vout = 24.0V
Iout = 1.0A

Device = LM5160ADNTR
Topology = Flyback
Created = 2018-03-29 17:17:46.896
BOM Cost = $0.00
BOM Count = 19
Total Pd = 3.78W

Design : 4808195/25 LM5160ADNTR
LM5160ADNTR 22.0V-26.0V to 24.00V @ 2.5186114575550222A



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.

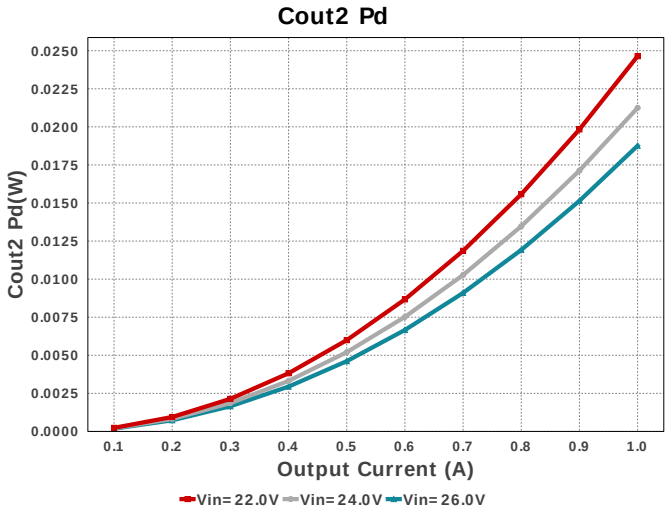
My Comments

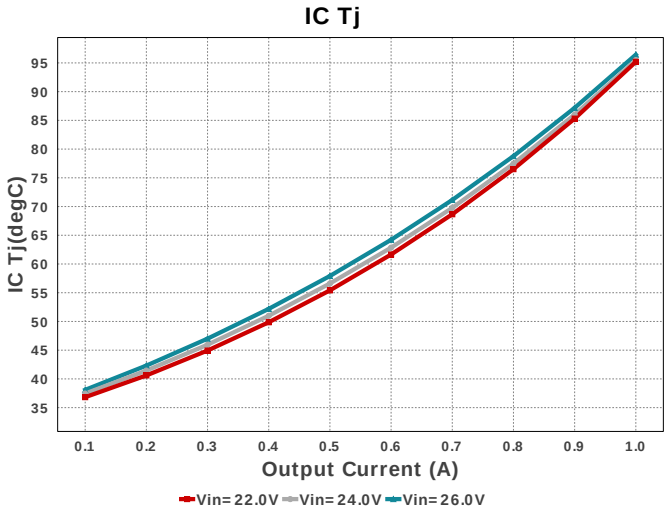
No comments

Electrical BOM

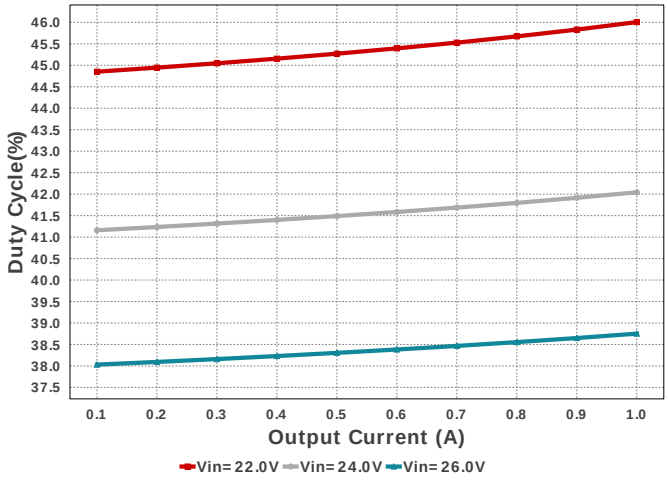
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cac	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.09	0805 7 mm²
2.	Cbst	MuRata	GRM155R61C103KA01D Series= X5R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
3.	Cin	TDK	C1005X5R1V105K050BC Series= X5R	Cap= 1.0 uF ESR= 11.416 mOhm VDC= 35.0 V IRMS= 1.483 A	1	$0.03	0402 3 mm²
4.	Cinx	Kemet	C0603C104K5RACTU Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
5.	Cout	TDK	CGA9P2X7R1E226M250KA Series= X7R	Cap= 22.0 uF ESR= 1.893 mOhm VDC= 25.0 V IRMS= 6.635 A	2	$1.02	2220_280 54 mm²
6.	Cout2	Panasonic	50SVPF39M Series= SVPF	Cap= 39.0 uF ESR= 25.0 mOhm VDC= 50.0 V IRMS= 3.8 A	1	$0.76	CAPSMT_62_E12 106 mm²
7.	Cr	Kemet	C0603C302K5GACTU Series= C0G/NP0	Cap= 3.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.08	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

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
10.	D1	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.04	SMA 37 mm²
11.	Rfbb	Susumu Co Ltd	RR1220P-202-D Series= RR12	Res= 2.0 kOhm Power= 100.0 mW Tolerance= 0.5%	1	$0.01	0805 7 mm²
12.	Rfbt	Vishay-Dale	CRCW04027K68FKED Series= CRCW..e3	Res= 7.68 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
13.	Ron	Vishay-Dale	CRCW0402178KFKED Series= CRCW..e3	Res= 178.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
14.	Rr	Vishay-Dale	CRCW040246K4FKED Series= CRCW..e3	Res= 46.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
15.	Ruvb	Vishay-Dale	CRCW04027K68FKED Series= CRCW..e3	Res= 7.68 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
16.	Ruvt	Vishay-Dale	CRCW0402127KFKED Series= CRCW..e3	Res= 127.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
17.	T1	CUSTOM	CUSTOM	Lp= 34.706 µH Rp= 71.0 mOhm Leakage_L= 694.124 nH Ns1toNp= 2.519 Rs1= 211.0 mOhms	1	NA	CUSTOM 0 mm²
18.	U1	Texas Instruments	LM5160ADNTR	Switcher	1	$1.80	DNT0012B 25 mm²

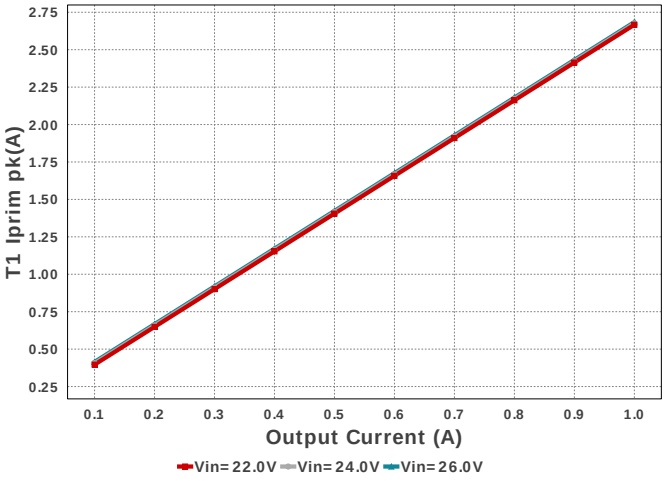




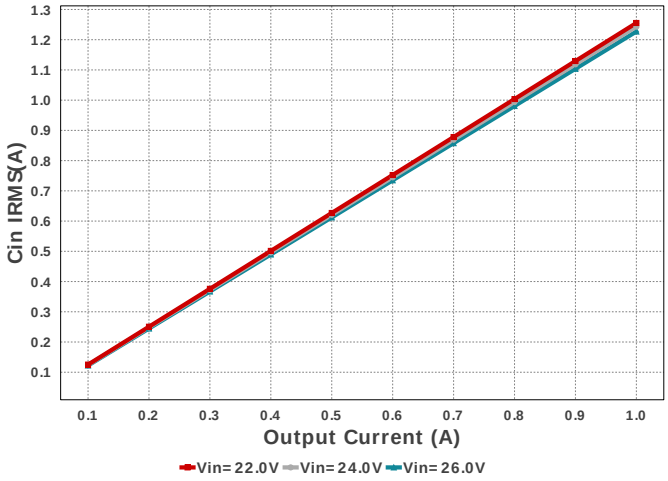
Duty Cycle



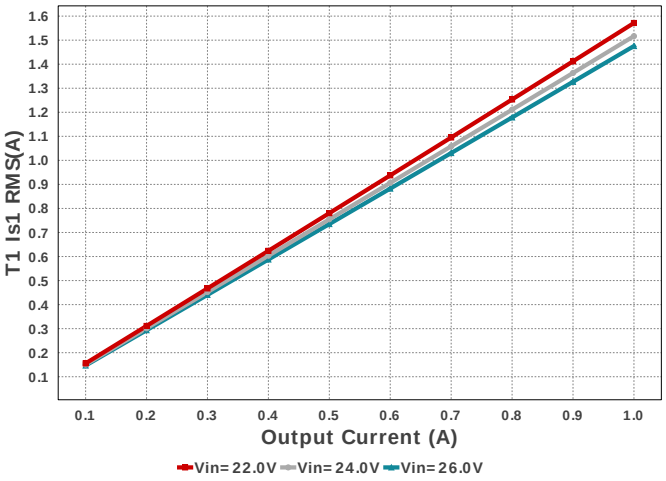
T1 Iprim pk



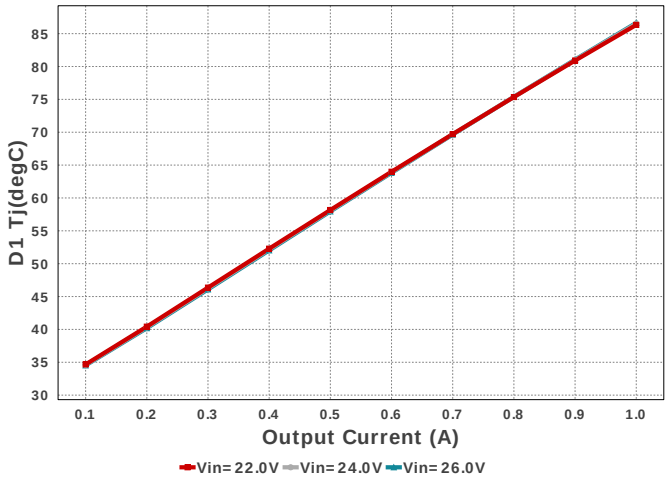
Cin IRMS



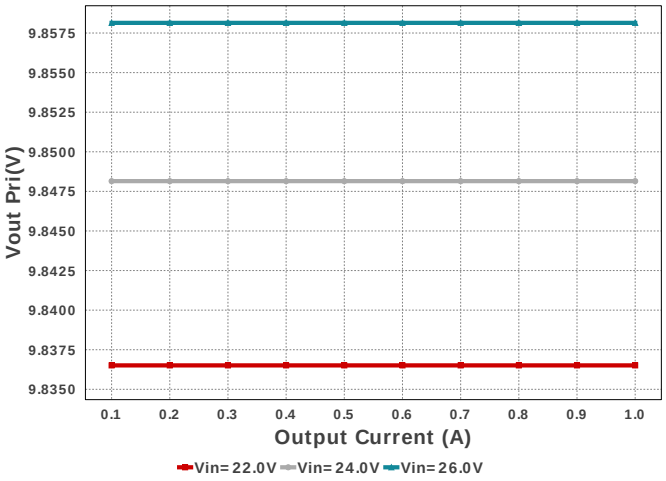
T1 Is1 RMS

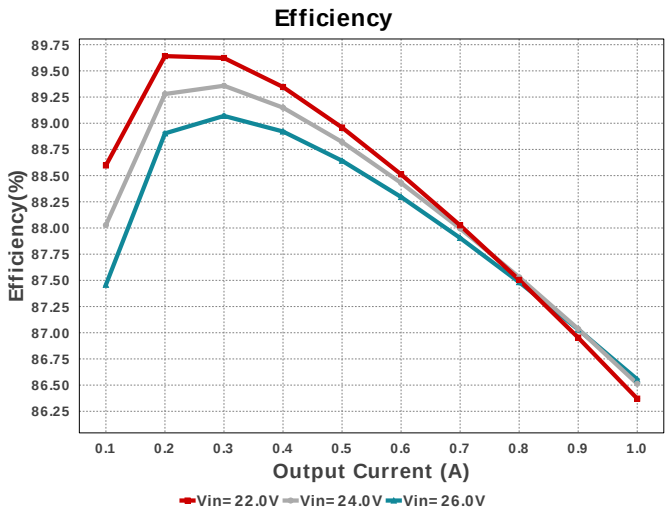


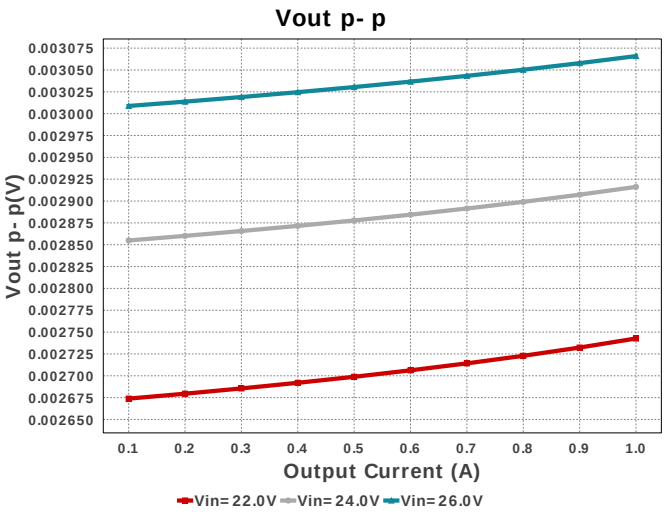
D1 Tj

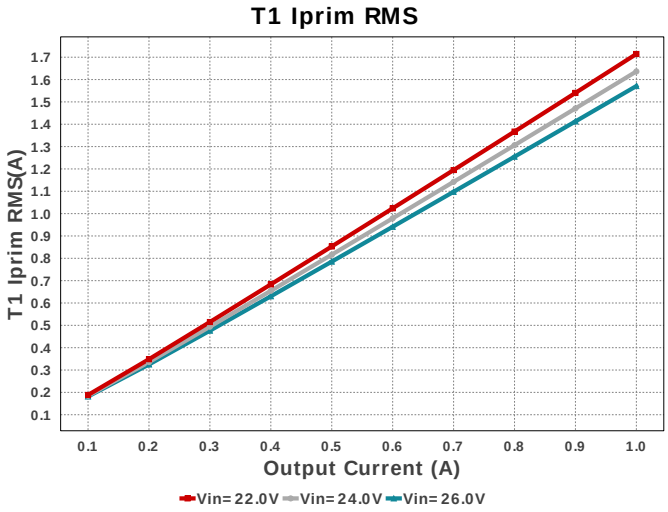


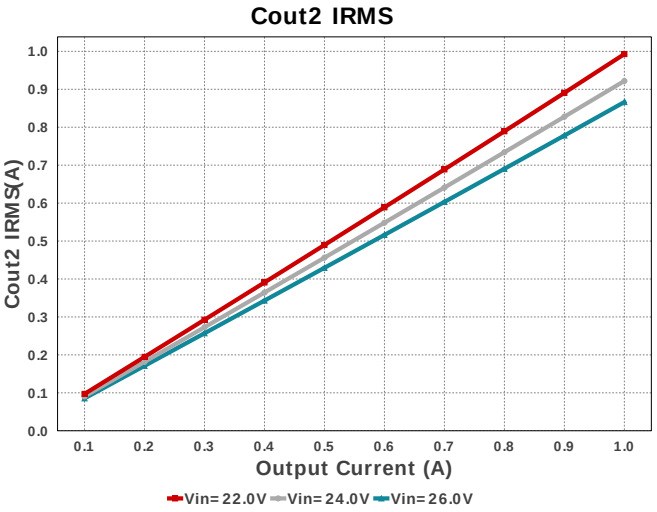
Vout Pri

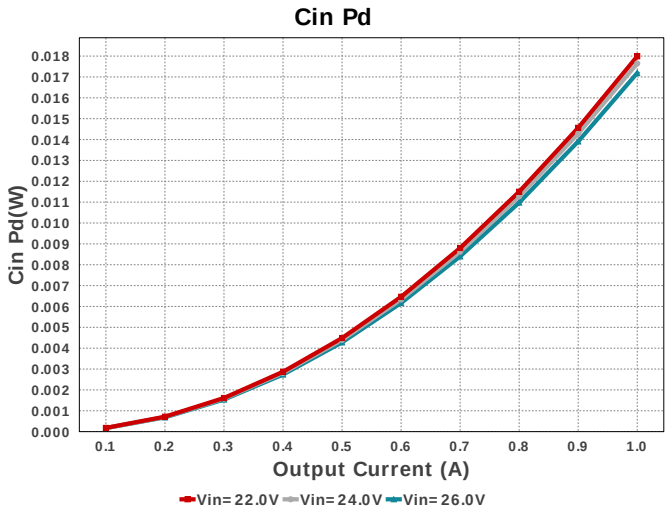


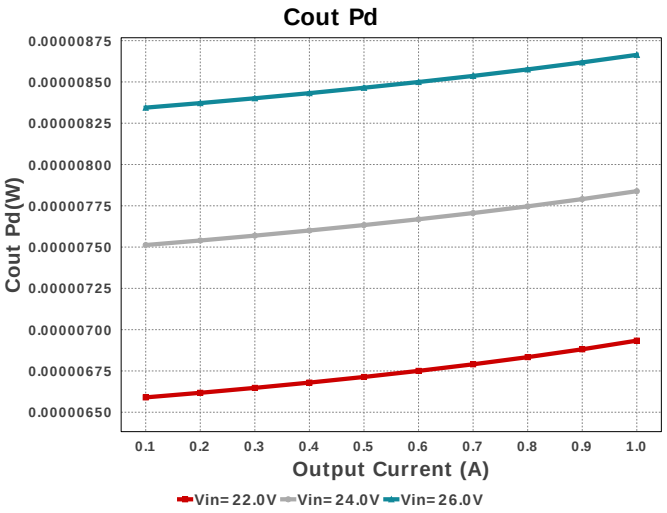


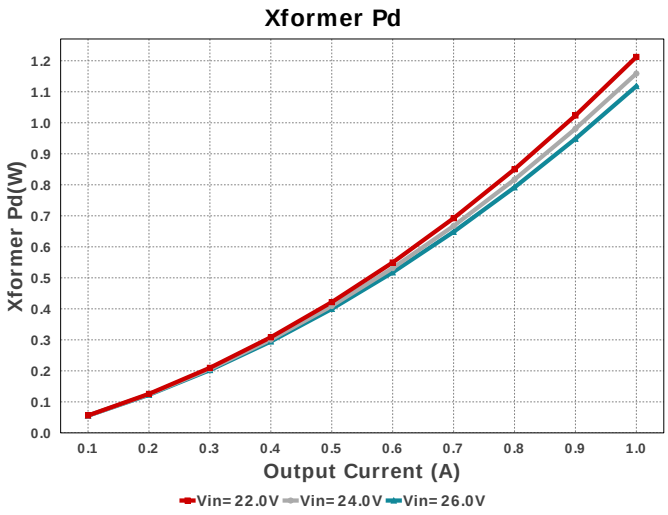


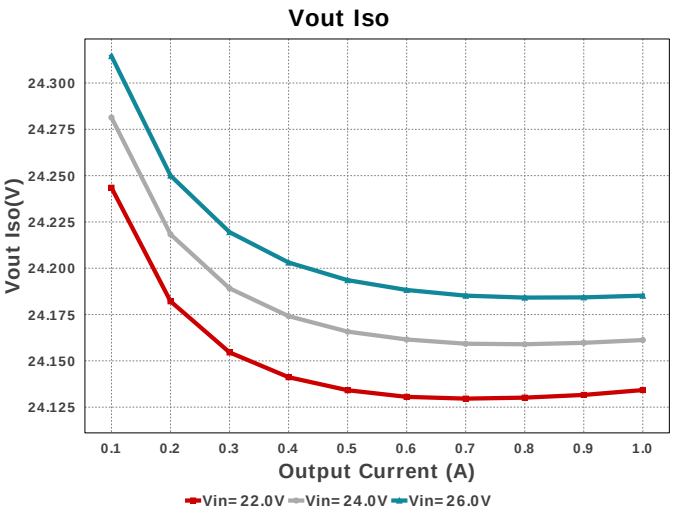


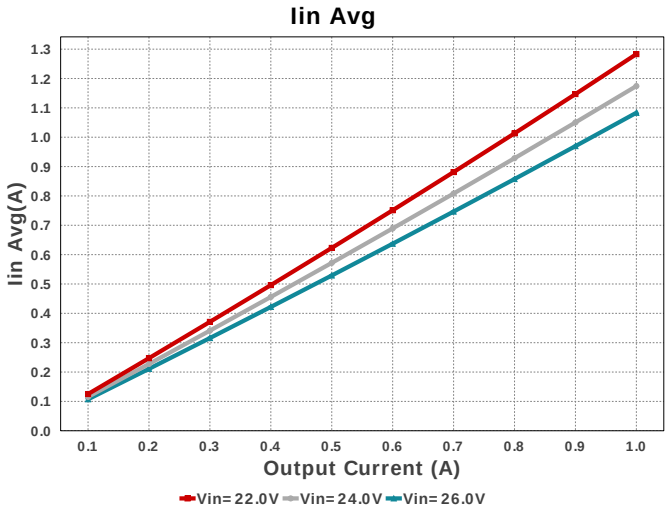


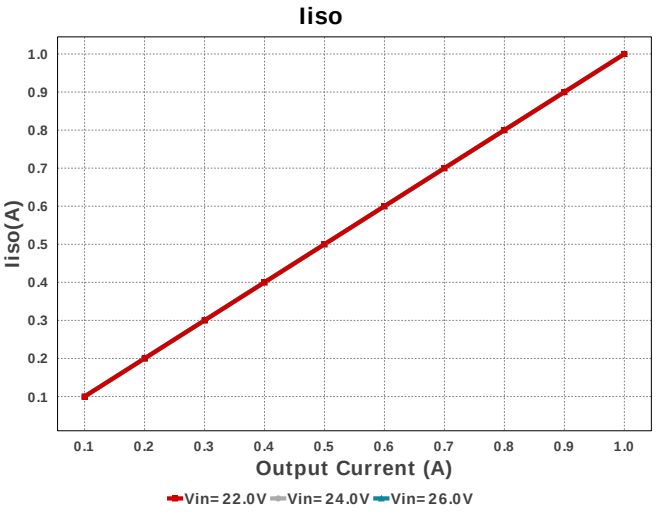


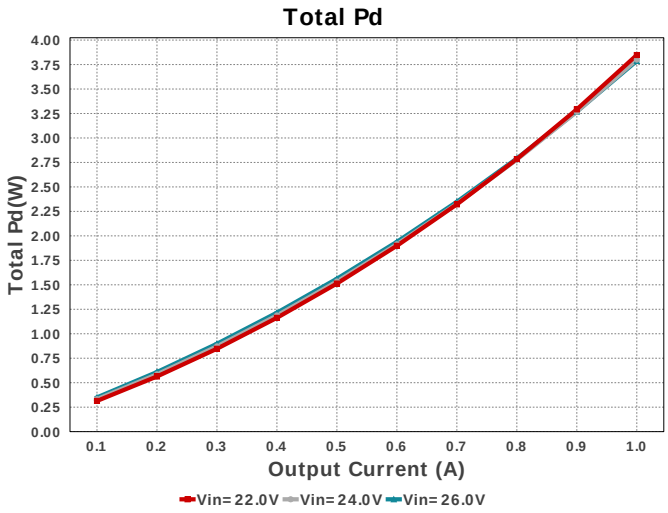


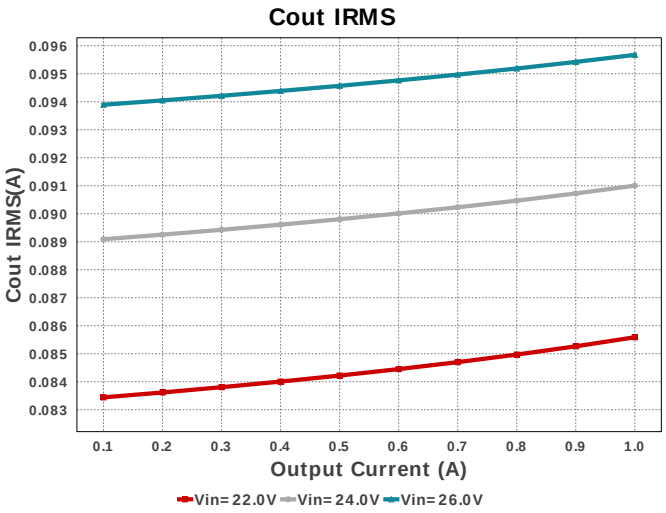


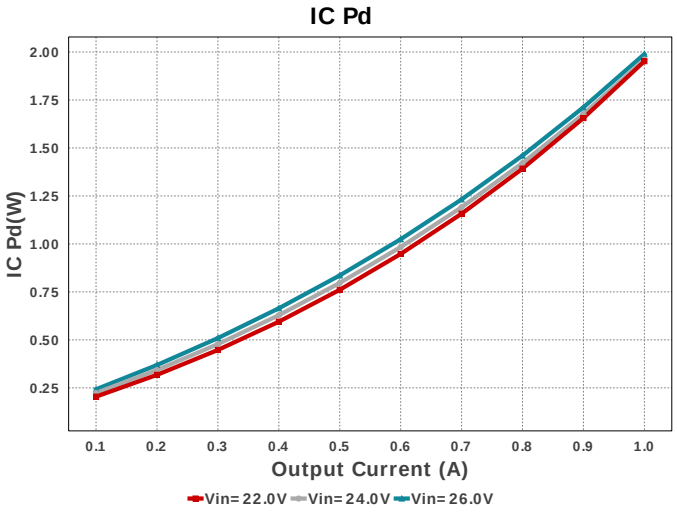


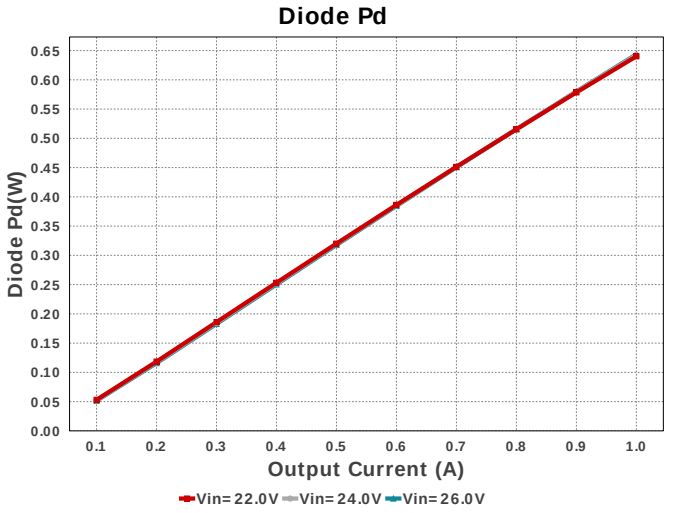












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.227 A	Current	Input capacitor RMS ripple current
2.	Cout IRMS	94.719 mA	Current	Output capacitor RMS ripple current
3.	Cout2 IRMS	866.343 mA	Current	Output capacitor2 RMS ripple current
4.	Iin Avg	1.083 A	Current	Average input current
5.	Iiso	1.0 A	Current	Secondary Side Output Current
6.	T1 Iprim RMS	1.571 A	Current	Transformer Primary RMS Current
7.	T1 Iprim pk	2.683 A	Current	Transformer Primary Peak Current
8.	T1 Is1 RMS	1.475 A	Current	Transformer Secondary1 RMS Current
9.	BOM Count	19	General	Total Design BOM count
10.	FootPrint	333.0 mm^2	General	Total Foot Print Area of BOM components
11.	Frequency	549.313 kHz	General	Switching frequency
12.	Total BOM	$0.0	General	Total BOM Cost
13.	D1 Tj	85.125 degC	Op Point	D1 junction temperature
14.	Duty Cycle	38.752 %	Op Point	Duty cycle
15.	Efficiency	86.568 %	Op Point	Steady state efficiency
16.	IC Tj	96.859 degC	Op Point	IC junction temperature
17.	ICThetaJA	33.4 degC/W	Op Point	IC junction-to-ambient thermal resistance
18.	VIN_OP	26.0 V	Op Point	Vin operating point
19.	Vout Actual	9.68 V	Op Point	Vout Actual calculated based on selected voltage divider resistors
20.	Vout Iso	24.202 V	Op Point	Secondary Side Output Voltage
21.	Vout Pri	9.858 V	Op Point	Primary Side Output Voltage
22.	Vout Tolerance	2.461 %	Op Point	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
23.	Vout p-p	3.005 mV	Op Point	Peak-to-peak output ripple voltage
24.	Cin Pd	17.188 mW	Power	Input capacitor power dissipation
25.	Cout Pd	8.492 µW	Power	Output capacitor power dissipation
26.	Cout2 Pd	18.764 mW	Power	Output capacitor2 power dissipation
27.	Diode Pd	626.42 mW	Power	Diode power dissipation
28.	IC Pd	2.002 W	Power	IC power dissipation
29.	Total Pd	3.783 W	Power	Total Power Dissipation
30.	Xformer Pd	1.119 W	Power	Transformer power dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	1.0	Maximum Output Current
2.	VinMax	26.0	Maximum input voltage
3.	VinMin	22.0	Minimum input voltage
4.	Vout	24.0	Output Voltage
5.	base_pn	LM5160A	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. **LM5160A** Product Folder : http://www.ti.com/product/LM5160A : contains the data sheet and other resources.