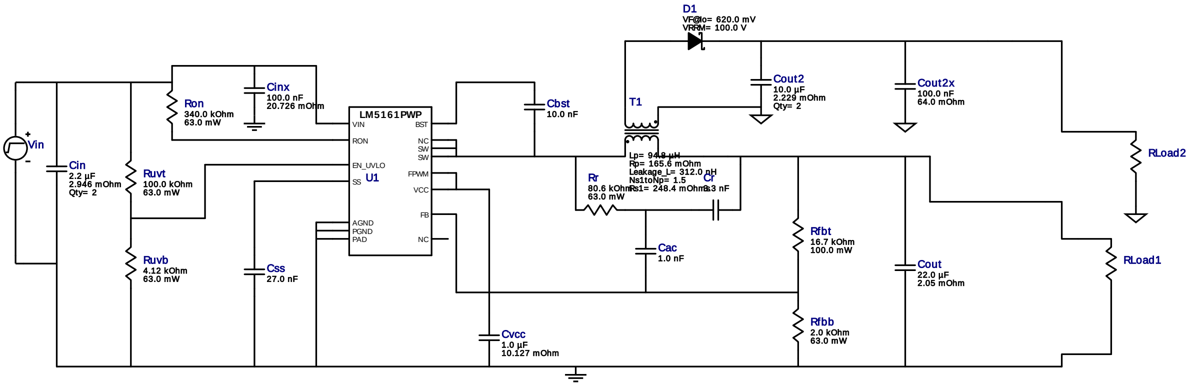
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 42.0V
VinMax = 50.0V
Vout = 24.0V
Iout = 0.75A

Device = LM5161PWPR
Topology = Flybuck
Created = 1/19/17 4:25:10 PM
BOM Cost = $9.09
BOM Count = 21
Total Pd = 1.61W

Design : 4441883/119 LM5161PWPR
LM5161PWPR 42.0V-50.0V to 18.67V @ 1.125A



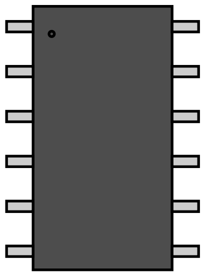
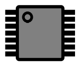
1. Feedback Resistors may need to be further adjusted to get more precise regulation as ripple injection circuit will introduce some amount of DC offset. Use simulation to help adjust.

My Comments

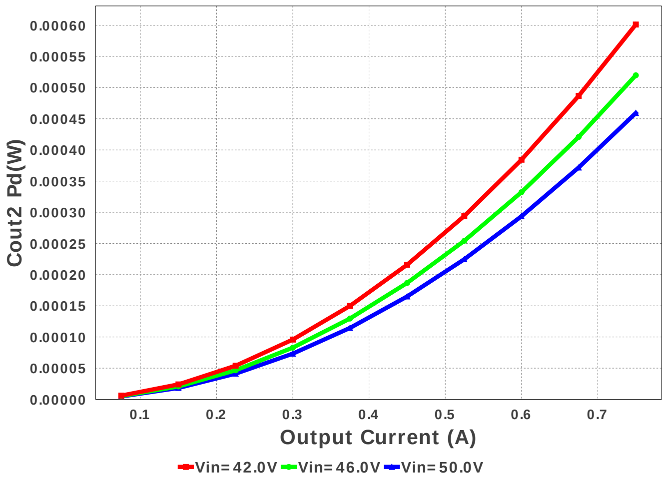
LM5161, 24V, 0.75A, VPH4-0140R Transformer

Electrical BOM

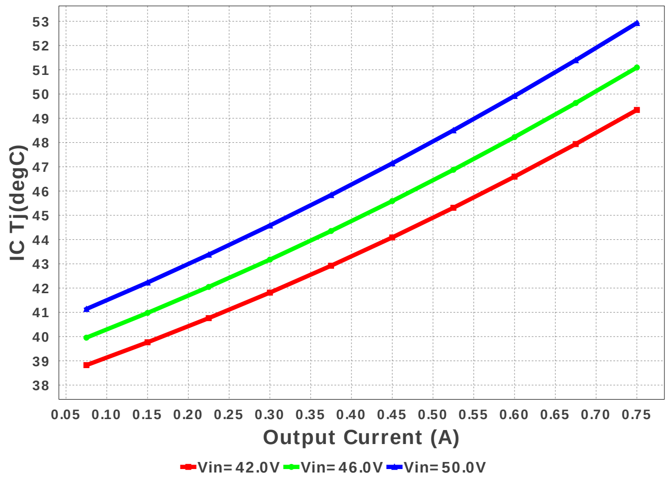
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cac	Kemet	C0603C102G5GACTU Series= C0G/NP0	Cap= 1.0 nF VDC= 2.0 V IRMS= 0.0 A	1	$0.16	0603 5 mm²
2.	Cbst	MuRata	GRM155R61C103KA01D Series= X5R	Cap= 10.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
3.	Cin	TDK	C3225JB2A225K Series= JB	Cap= 2.2 uF ESR= 2.946 mOhm VDC= 100.0 V IRMS= 0.0 A	2	$0.14	1210 15 mm²
4.	Cinx	TDK	C2012X5R2A104K125AA Series= X5R	Cap= 100.0 nF ESR= 20.726 mOhm VDC= 100.0 V IRMS= 1.456 A	1	$0.03	0805 7 mm²
5.	Cout	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	1	$0.30	0805 7 mm²
6.	Cout2	TDK	C3216X5R1H106K160AB Series= X5R	Cap= 10.0 uF ESR= 2.229 mOhm VDC= 50.0 V IRMS= 4.8593 A	2	$0.26	1206_180 11 mm²
7.	Cout2x	Kemet	C0805C104K5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm²
8.	Cr	AVX	04023A331JAT2A Series= C0G/NP0	Cap= 3.3 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.10	0402 3 mm²
9.	Css	MuRata	GRM155R61C273KA01D Series= X5R	Cap= 27.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	Cvcc	MuRata	GRM188R61C105KA93D Series= X5R	Cap= 1.0 uF ESR= 10.127 mOhm VDC= 16.0 V IRMS= 994.63 mA	1	$0.01	0603 5 mm^2
11.	D1	Vishay-Semiconductor	SS2PH10-M3	VF@Io= 620.0 mV VRRM= 100.0 V	1	$0.14	DO-220AA 14 mm^2
12.	Rfbb	Vishay-Dale	CRCW04022K00FKED Series= CRCW..e3	Res= 2.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
13.	Rfbt	Yageo America	RT0603BRD0716K7L Series= ?	Res= 16.7 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.04	0603 5 mm^2
14.	Ron	Vishay-Dale	CRCW0402340KFKED Series= CRCW..e3	Res= 340.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
15.	Rr	Vishay-Dale	CRCW040280K6FKED Series= CRCW..e3	Res= 80.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
16.	Ruvb	Vishay-Dale	CRCW04024K12FKED Series= CRCW..e3	Res= 4.12 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
17.	Ruvt	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
18.	T1	Coiltronics	VPH4-0140-R	Lp= 94.8 µH Rp= 165.6 mOhm Leakage_L= 312.0 nH Ns1toNp= 1.5 Rs1= 248.4 mOhms	1	$5.63	 VP4 532 mm^2
19.	U1	Texas Instruments	LM5161PWPR	Switcher	1	$1.80	 PWP0014A_N 59 mm^2

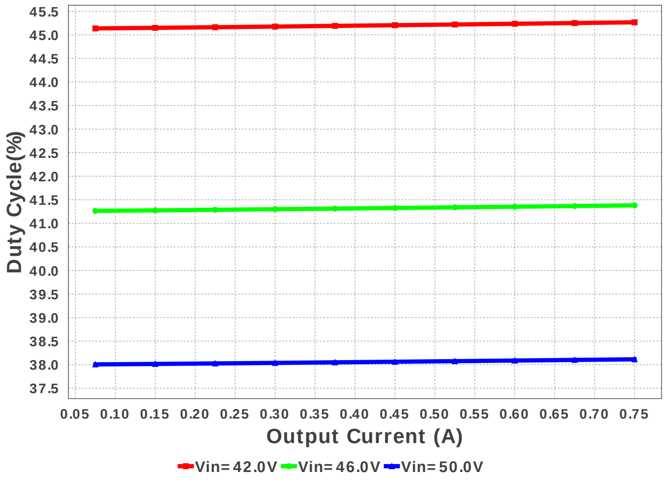
Cout2 Pd



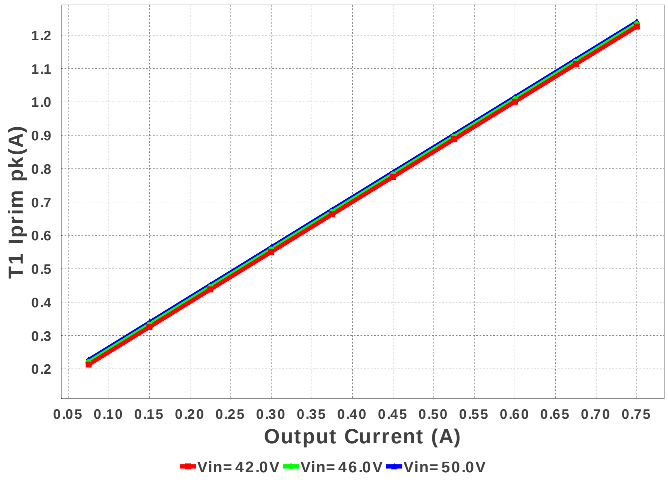
IC Tj



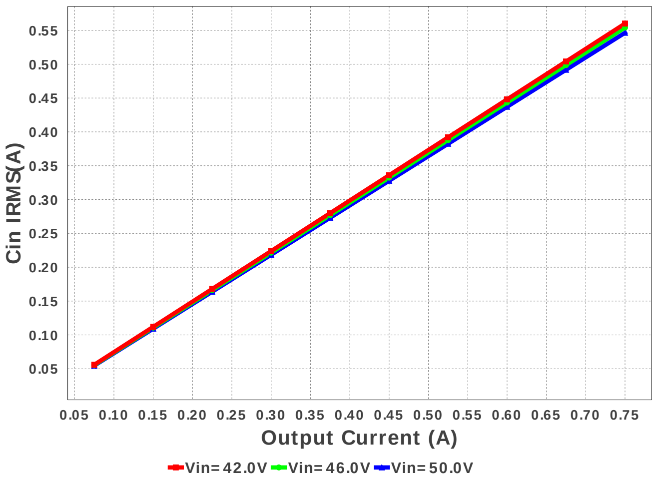
Duty Cycle



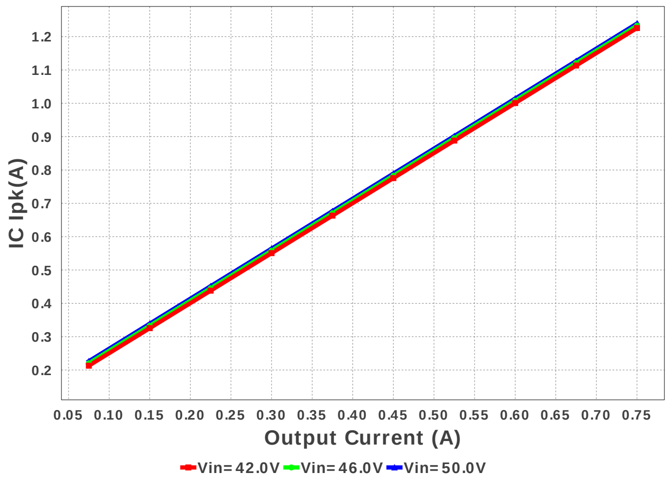
T1 Iprim pk



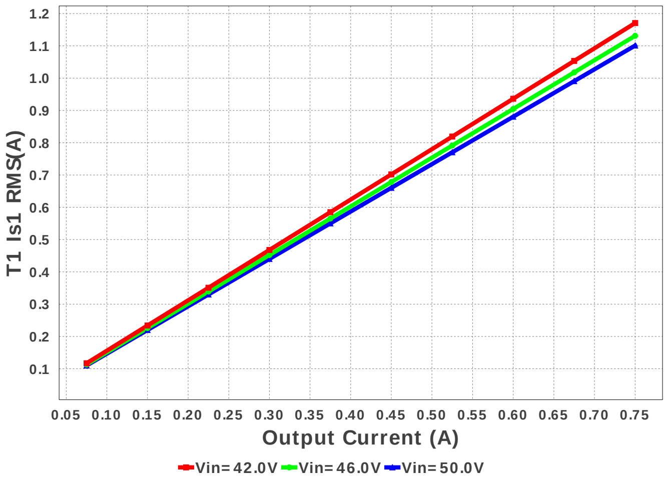
Cin IRMS



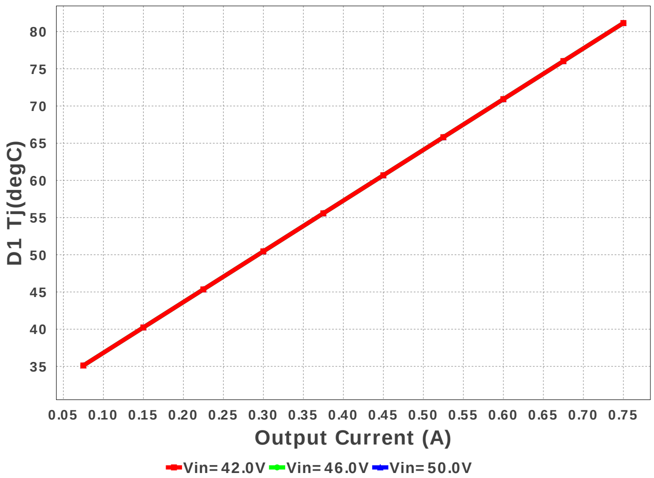
IC Ipk



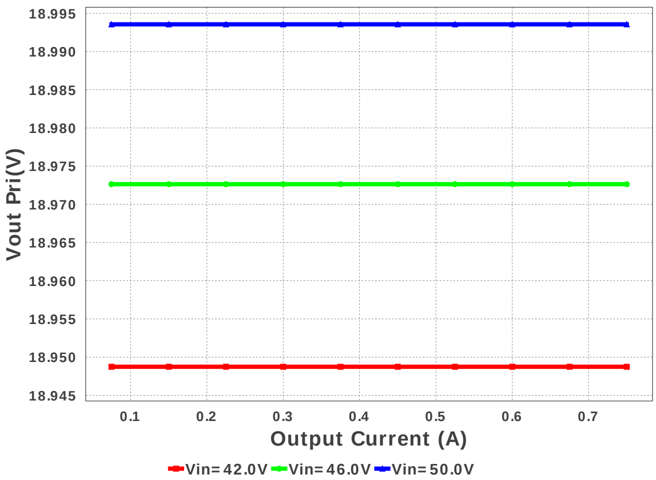
T1 Is1 RMS



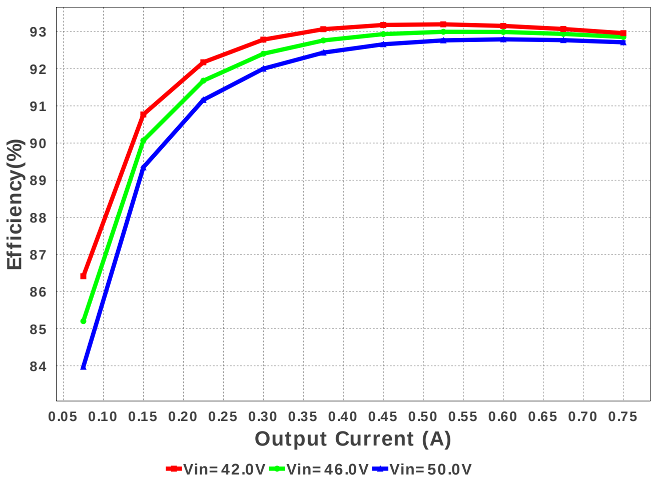
D1 Tj



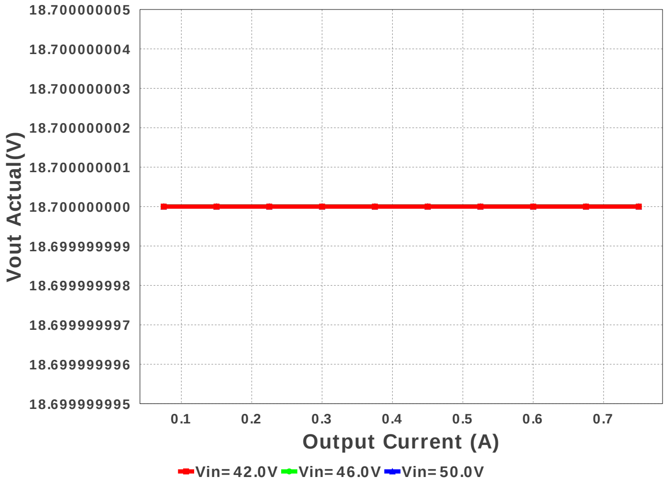
Vout Pri



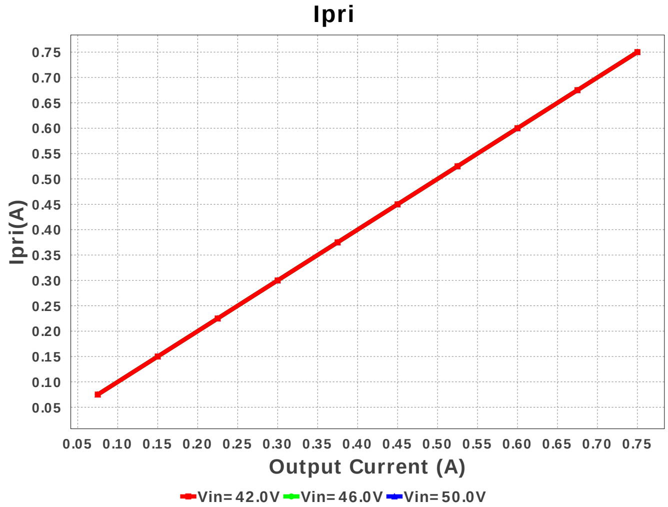
Efficiency



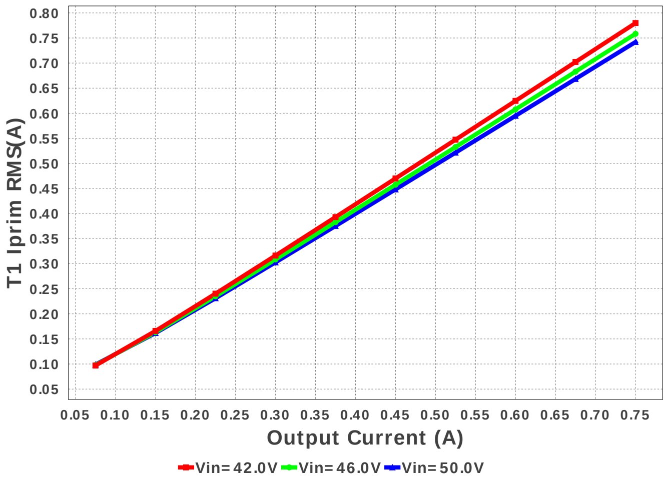
Vout Actual



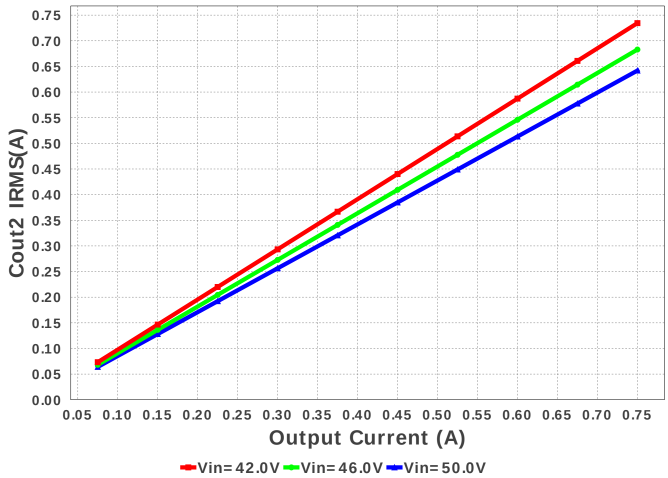
Ipri



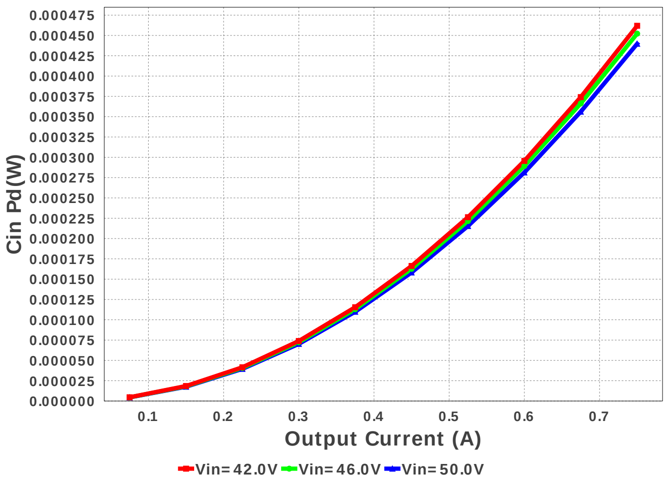
T1 Iprim RMS



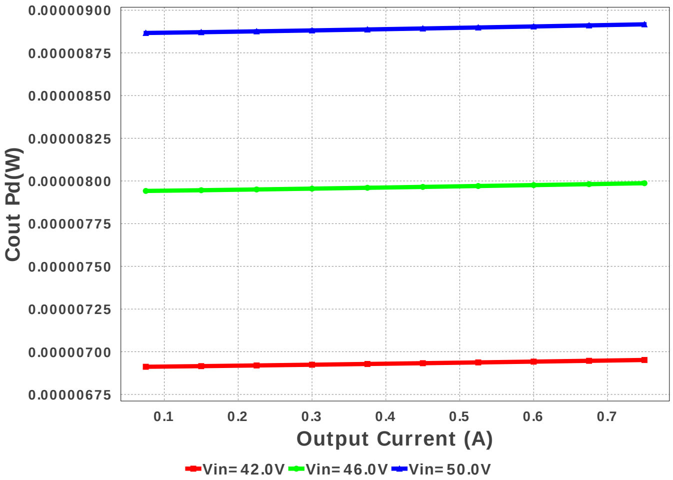
Cout2 IRMS



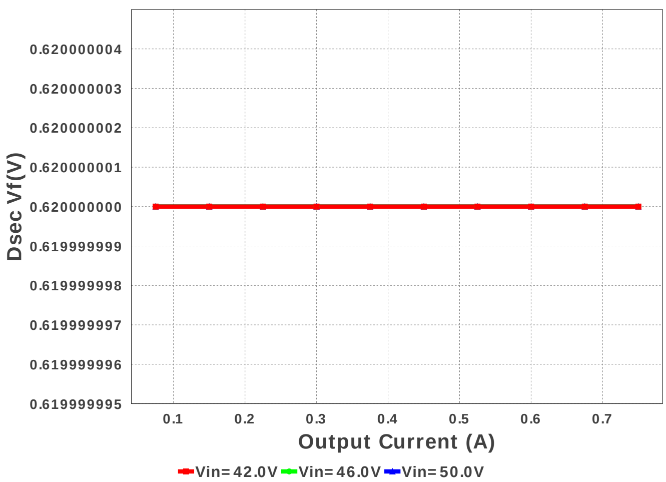
Cin Pd



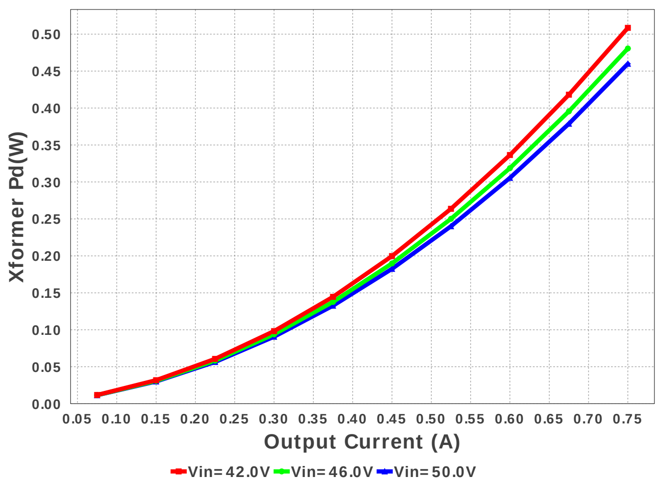
Cout Pd

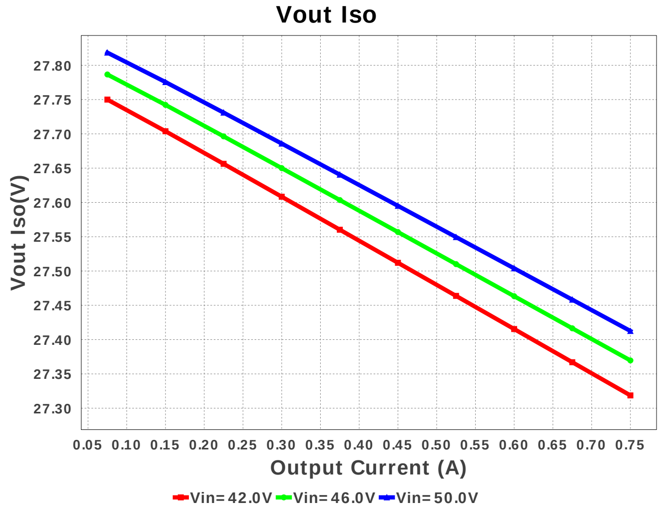


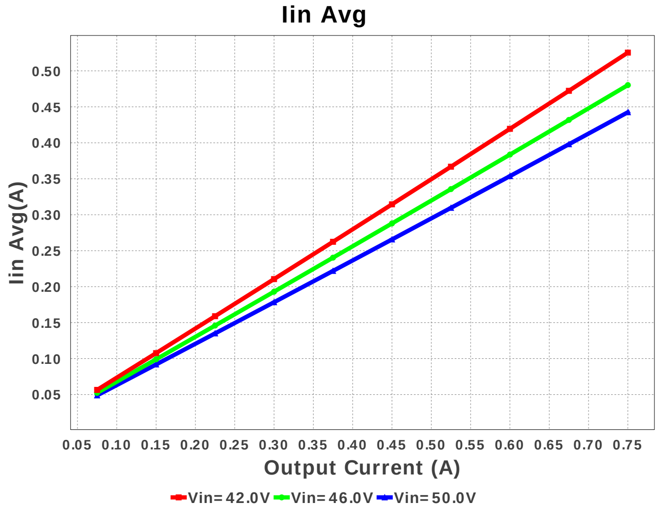
Dsec Vf

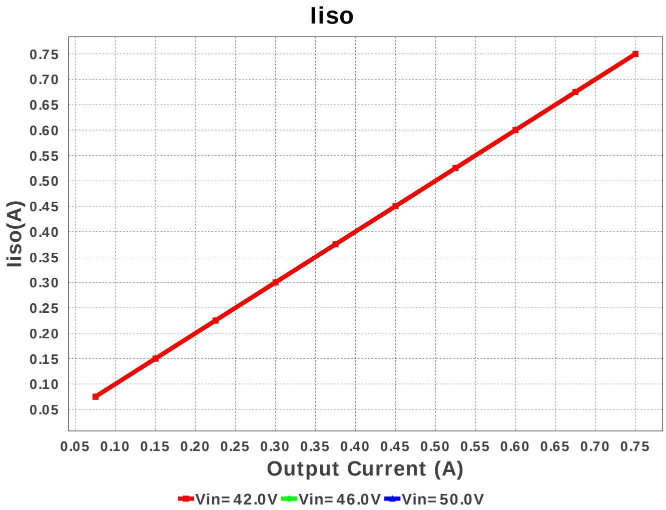


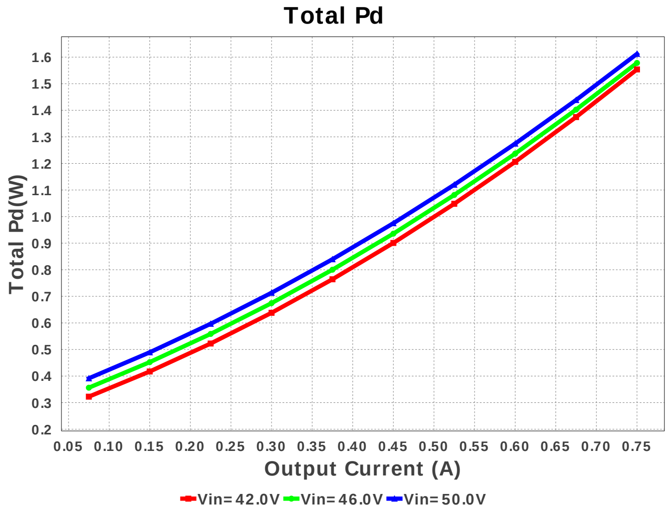
Xformer Pd

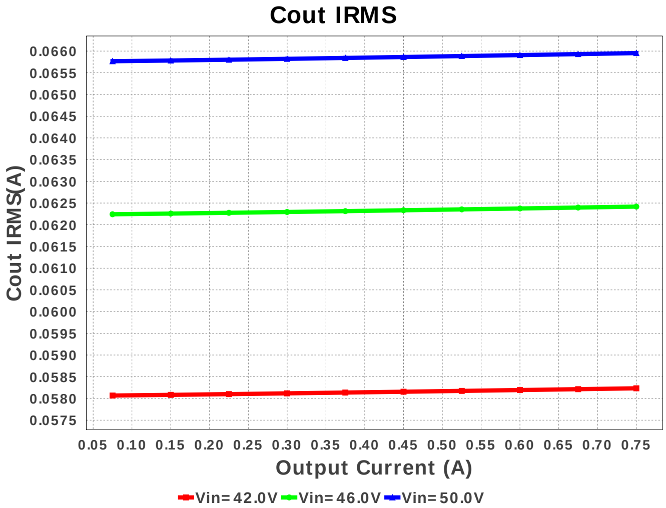


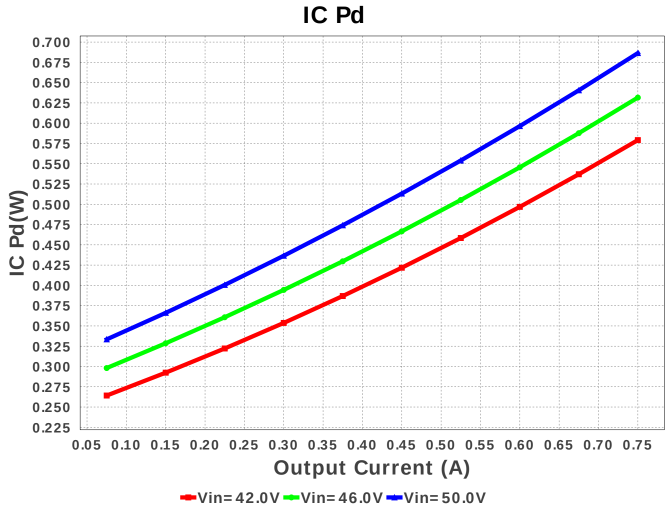

Vout Iso
Vout Iso(V)
Output Current (A)
Vin=42.0V Vin=46.0V Vin=50.0V

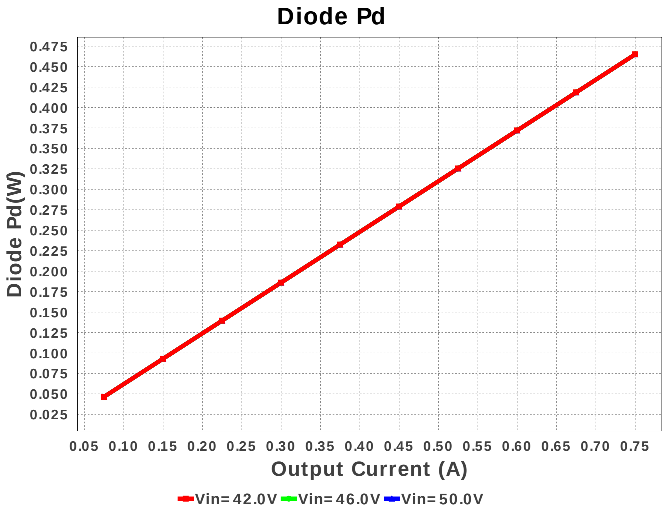

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=42.0V Vin=46.0V Vin=50.0V


Iiso
Iiso(A)
Output Current (A)
Vin=42.0V Vin=46.0V Vin=50.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=42.0V Vin=46.0V Vin=50.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=42.0V Vin=46.0V Vin=50.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=42.0V Vin=46.0V Vin=50.0V



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	21		Total Design BOM count
2.	Total BOM	$9.086		Total BOM Cost
3.	Cin IRMS	546.376 mA	Current	Input capacitor RMS ripple current
4.	Cout IRMS	65.953 mA	Current	Output capacitor RMS ripple current
5.	Cout2 IRMS	641.894 mA	Current	Output capacitor2 RMS ripple current
6.	IC Ipk	1.239 A	Current	Peak switch current in IC
7.	Iin Avg	442.49 mA	Current	Average input current
8.	Iiso	750.0 mA	Current	Secondary Side Output Current
9.	Ipri	750.0 mA	Current	Primary Side Output Current
10.	T1 Iprim RMS	742.014 mA	Current	Transformer Primary RMS Current
11.	T1 Iprim pk	1.239 A	Current	Transformer Primary Peak Current
12.	T1 Is1 RMS	1.101 A	Current	Transformer Secondary1 RMS Current
13.	Dsec Vf	620.0 mV	General	Effective Forward Voltage Drop at the Operating Current
14.	FootPrint	715.0 mm²	General	Total Foot Print Area of BOM components
15.	Frequency	545.635 kHz	General	Switching frequency
16.	D1 Tj	81.15 degC	Op_Point	D1 junction temperature
17.	Vout Actual	18.7 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
18.	Duty Cycle	38.114 %	Op_point	Duty cycle
19.	Efficiency	92.713 %	Op_point	Steady state efficiency
20.	IC Tj	52.927 degC	Op_point	IC junction temperature
21.	ICThetaJA	33.4 degC/W	Op_point	IC junction-to-ambient thermal resistance
22.	IOUT_OP	1.125 A	Op_point	Iout operating point
23.	VIN_OP	50.0 V	Op_point	Vin operating point
24.	Vout Iso	27.413 V	Op_point	Secondary Side Output Voltage
25.	Vout Pri	18.994 V	Op_point	Primary Side Output Voltage
26.	Cin Pd	439.729 µW	Power	Input capacitor power dissipation
27.	Cout Pd	8.917 µW	Power	Output capacitor power dissipation
28.	Cout2 Pd	459.204 µW	Power	Output capacitor2 power dissipation
29.	Diode Pd	465.0 mW	Power	Diode power dissipation
30.	IC Pd	686.428 mW	Power	IC power dissipation
31.	Total Pd	1.612 W	Power	Total Power Dissipation
32.	Xformer Pd	459.879 mW	Power	Transformer power dissipation
33.	Vout Tolerance	2.255 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	750.0 m	Maximum Output Current
2.	VinMax	50.0	Maximum input voltage
3.	VinMin	42.0	Minimum input voltage
4.	Vout	24.0	Output Voltage
5.	base_pn	LM5161	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. **LM5161** Product Folder : http://www.ti.com/product/LM5161 : contains the data sheet and other resources.