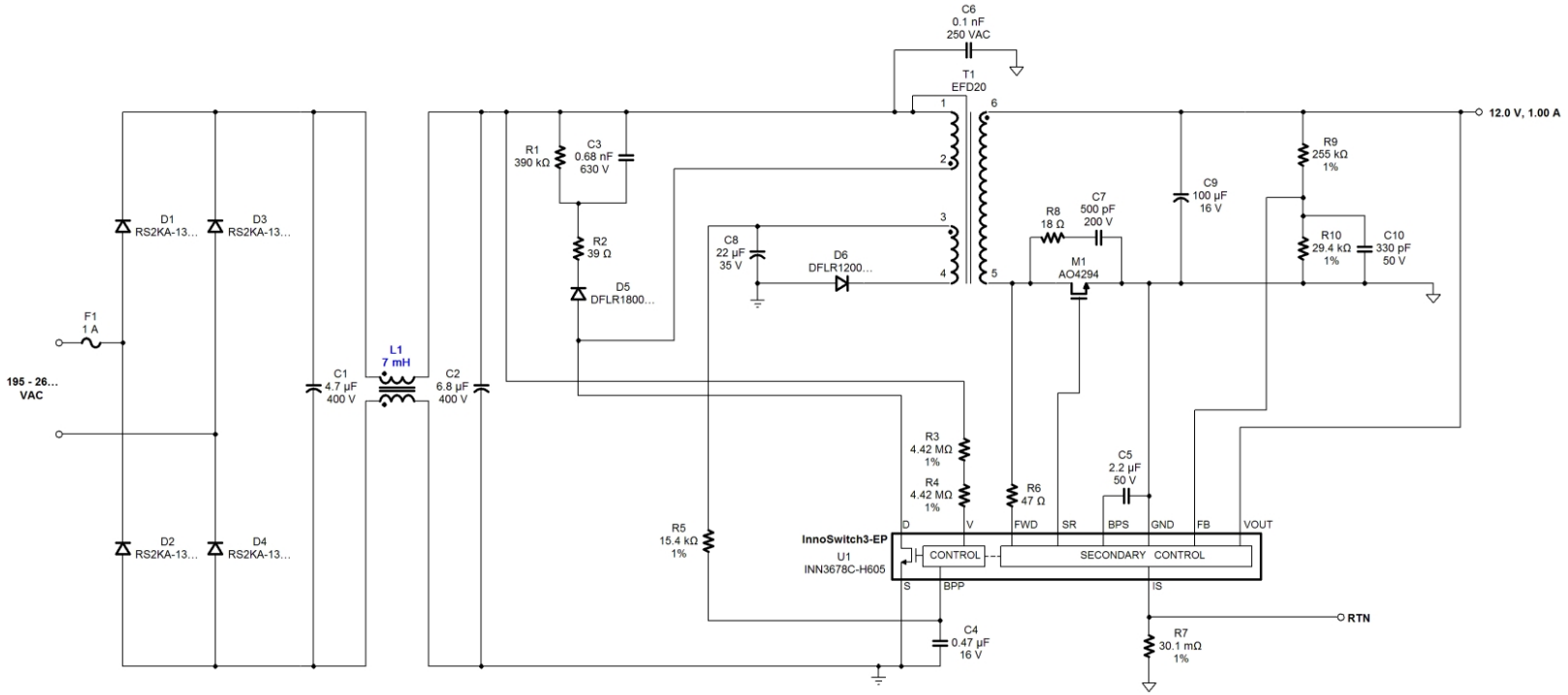


Schematic components that have been frozen by the user will appear with blue reference designators.

For any information regarding user added Shield or Screen and additional EMI features implemented in the Transformer, review Magnetics Designer.

Power Supply Input

Var	Value	Units	Description
VACMIN	195	V	Minimum Input AC Voltage
VACNOM	230	V	Nominal AC Voltage (For universal designs low line nominal voltage is displayed)
VACMAX	265	V	Maximum Input AC Voltage
FL	50	Hz	Line Frequency
η	89.0	%	Efficiency Estimate (Target)
TC	1.76	ms	Input Rectifier Conduction Time
Z	0.46		Loss Allocation Factor
VMIN	238.9	V	Minimum DC Input Voltage
VMAX	374.8	V	Maximum DC Input Voltage
ENCLOSURE	Adapter		Enclosure
TAMB	60	°C	Maximum Operating Ambient air Temperature

Input Section

Var	Value	Units	Description
Fuse	1.00	A	Input Fuse Rated Current
IAVG	0.05	A	Average Diode Bridge Current (DC Input Current)

Device Variables

Var	Value	Units	Description
Device	INN3678C-H605		PI Device Name
Current Limit Mode	Standard		Device Current Limit Mode
BVDSS	750	V	Drn-Src Bkdn Voltage
ILIMITMIN	1.581	A	Minimum Current Limit
ILIMITTYP	1.700	A	Typical Current Limit
ILIMITMAX	1.819	A	Maximum Current Limit
RDSON	0.78	Ω	PI Device RDSON (100°C)
RDSON_25C	0.52	Ω	PI Device RDSON (25°C)
PO	12.00	W	Total Output Power
VOR	66.55	V	Reflected Output Voltage
VDS	0.04	V	On state Drain to Source Voltage
FS	40409	Hz	Switching Frequency (at VMIN and Full Load)
KP	3.223		Continuous/Discontinuous Operating Ratio (at VMIN and Full Load)
DMAX	0.080		Maximum Duty Cycle (at VMIN and Full Load)
TIME_OFF	22.81	µs	Expected Device Off-time (at VMIN and Full Load)
TIME_ON	2.28	µs	Primary controller on-time
IP	1.481	A	Peak Primary Current (at VMIN and Full Load)
IR	1.481	A	Primary Ripple Current (at VMIN and Full Load)
IRMS	0.229	A	Primary RMS Current (at VMIN and Full Load)
UVOV_PRIORITY	Undervoltage		Input Undervoltage/Overvoltage Priority type
RTH_DEVICE	274.95	°C/W	PI Device Heatsink Maximum Thermal Resistance
DEV_HSINK_TYPE	2 Oz (70 µ) 2-Sided Copper PCB		PI Device Heatsink Type
DEV_HSINK_AREA	104	mm²	PI Device Heatsink Area

Clamp Circuit

Var	Value	Units	Description

Clamp Type	**RCD Clamp**		*Clamp Circuit Type*
VCLAMP_ESTIMATED	**271.22**	*V*	*Estimated Clamping Voltage above VMAX*
VDRAIN Estimated	**645.99**	*V*	*Estimated Drain Voltage*

Primary Bias Variables

Var	*Value*	*Units*	*Description*
VB	**12.0**	*V*	*Bias Voltage*
VBMIN	**12.4**	*V*	*Minimum Bias Voltage*
VBMAX	**31.7**	*V*	*Maximum Bias Voltage*
Circuit Type	**Simple Resistor**		*Bias Circuit Type*
PIVB	**112**	*V*	*Bias Rectifier Maximum Peak Inverse Voltage*
NB	**13**		*Primary Bias Winding Number of Turns*

Transformer Construction Parameters

Var	*Value*	*Units*	*Description*
Core Type	**EFD20**		*Core Type*
Core Material	**3F3**		*Core Material*
Bobbin Reference	**EFD20 -1 (P4+ S4)**		*Bobbin Reference*
Bobbin Orientation	**Horizontal**		*Bobbin type*
LP_nom	**358**	*µH*	*Nominal Primary Inductance*
LP_Tol	**5.0**	*%*	*Primary Inductance Tolerance*
NP	**61.0**		*Calculated Primary Winding Total Number of Turns*
NSM	**11**		*Secondary Main Number of Turns*
CMA	**219.35**	*Cmils/A*	*Primary Winding Current Capacity*
BW	**13.50**	*mm*	*Bobbin Winding Width*
ML	**0.00**	*mm*	*Safety Margin on Left Width*
MR	**0.00**	*mm*	*Safety Margin on Right Width*
FF	**69.32**	*%*	*Actual Transformer Fit Factor. 100% signifies fully utilized winding window*
AE	**31.00**	*mm²*	*Core Cross Sectional Area*
ALG	**96**	*nH/T²*	*Gapped Core Specific Inductance*
BM	**2883**	*Gauss*	*Maximum Flux Density*
BP	**3700**	*Gauss*	*Peak Flux Density*
BAC	**1441**	*Gauss*	*AC Flux Density for Core Loss*
LG	**0.373**	*mm*	*Estimated Gap Length*
L_LKG	**11.27**	*µH*	*Estimated primary leakage inductance*
LSEC	**20**	*nH*	*Secondary Trace Inductance*

Primary Winding Section 1

Var	*Value*	*Units*	*Description*
NP1	**61**		*Number of Primary Winding Turns in the First Section of Primary*
Wire Size	**33**	*AWG*	*Primary Winding - Wire Size*
Winding Type	**Single (x1)**		*Primary Winding - Number of Parallel Wire Strands*
L	**0.98**		*Primary Winding - Number of Layers*

Output 1

Var	*Value*	*Units*	*Description*
VO	**12.00**	*V*	*Typical Output Voltage*

IO	**1.00**	*A*	*Output Current*
VOUT_ACTUAL	**12.00**	*V*	*Actual Output Voltage*
Cable Drop Compensation	**0**	*mV*	*Cable Drop Compensation*
NS	**11**		*Secondary Number of Turns*
Wire Size	**20**	*AWG*	*Wire size of secondary winding*
Winding Type	**Single (x1)**		*Output winding number of parallel strands*
L_S_OUT	**0.92**		*Secondary Output Winding Layers*
PIVS	**79.58**	*V*	*Output Rectifier Maximum Peak Inverse Voltage*
ISP	**8.215**	*A*	*Peak Secondary Current*
ISRMS	**2.405**	*A*	*Secondary RMS Current*
ISRMS_WINDING	**2.405**	*A*	*Secondary Winding RMS Current*
CMAS	**426**	*Cmils/A*	*Secondary Winding Current Capacity*
RTH_RECTIFIER	**273.06**	*°C/W*	*Output Rectifier Heatsink Maximum Thermal Resistance*
OR_HSINK_TYPE	**2 Oz (70 µ) 2-Sided Copper PCB**		*Output Rectifier Heatsink Type*
OR_HSINK_AREA	**104**	*mm²*	*Output Rectifier Heatsink Area*
OSR_RDSON	**15.50**	*mΩ*	*Synchronous Rectifier RDSON*
CO	**100 x 1**	*µF*	*Output Capacitor - Capacitance*
IRIPPLE	**2.188**	*A*	*Output Capacitor - RMS Ripple Current*
Expected Lifetime	**17093**	*hr*	*Output Capacitor - Expected Lifetime*

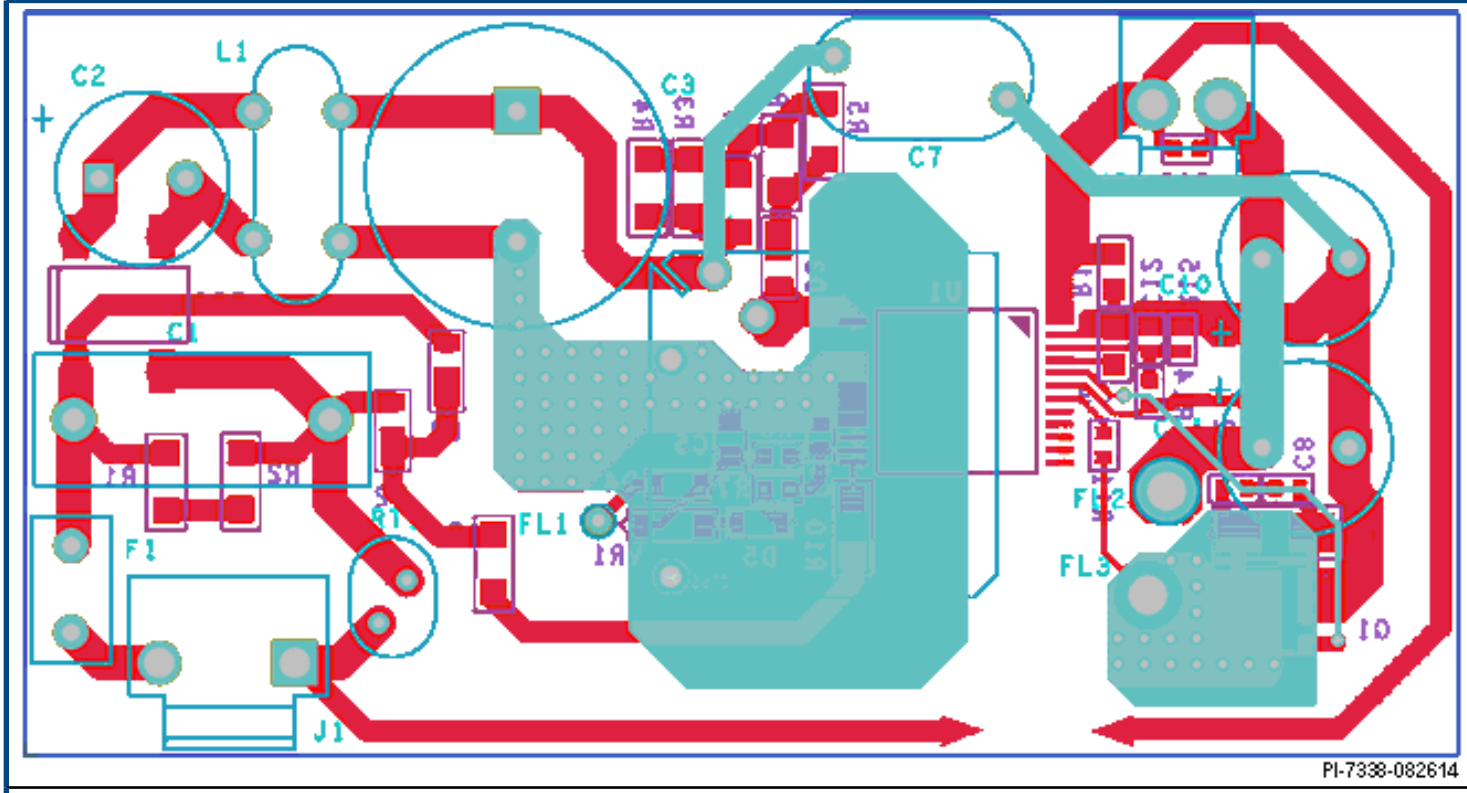
Feedback Circuit

Var	***Value***	***Units***	***Description***
DUAL_OUTPUT_FB_FLAG	**NO**		*Get feedback from 2 outputs*

The regulation and tolerances do not account for thermal drifting and component tolerance of the output diode forward voltage drop and voltage drops across the LC post filter. The actual voltage values are estimated at full load only.

Please verify cross regulation performance on the bench.

Board Layout Recommendations



Click on the "Show me" icon to highlight relevant areas on the sample layout.

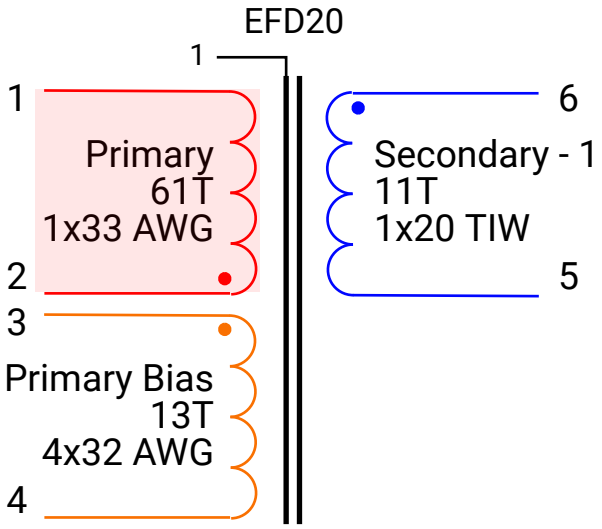
	Description	Show Me
1	*Minimize loop area formed by secondary winding, the output rectifier and the output filter capacitor*	
2	*Y-capacitor connected directly to the DC pin of the primary and secondary GND*	
3	*Minimize loop area formed by drain, clamp and transformer*	
4	*Maximize hatched area for heat-sinking*	
5	*Minimize loop area formed by drain, input capacitor and transformer*	
6	*Spark gaps with adequate creepage help in steering away the destructive energy created during an ESD event through the protection components such as the Y-cap.*	
7	*The BYPASS pin capacitor should be located as close as possible to the BYPASS and SOURCE pins*	

Bill Of Materials

Item #	Quantity	Part Ref	Value	Description	Mfg	Mfg Part Number
1	1	C1	4.7 µF	4.7 µF, 400 V, High Voltage Al Electrolytic, (16 mm x 10 mm)	Nippon Chemi-Con	ESMG401ELL4R7MJ16S
2	1	C2	6.8 µF	6.8 µF, 400 V, High Voltage Al Electrolytic, (16 mm x 10 mm)	United Chemi-Con	EKXG401ELL6R8MJ16S
3	1	C3	0.68 nF	0.68 nF, 630 V, High Voltage Ceramic	Murata	GRM31A7U2J681JW31D
4	1	C4	0.47 µF	0.47 µF, 16 V, Ceramic, X7R	Murata	GRM219R71C474KA01D
5	1	C5	2.2 µF	2.2 µF, 50 V, Ceramic, X7R	Kemet	C1206C225K5RACTU
6	1	C6	0.1 nF	0.1 nF, 250 VAC, Ceramic, Y Class	Murata	GA342QR7GF101KW01L
7	1	C7	500 pF	500 pF, 200 V, High Voltage Ceramic	AVX Corp	08052C501KAT2A
8	1	C8	22 µF	22 µF, 35 V, Electrolytic, Gen Purpose, 100 mΩ, (5 mm x 5.8 mm)	Panasonic	EEH-ZA1V220R
9	1	C9	100 µF	100 µF, 16 V, Al Organic Polymer, 35 mΩ, (10 mm x 5 mm)	Nichicon	RNE1C101MDS1PX
10	1	C10	330 pF	330 pF, 50 V, Ceramic, C0G	TDK	FK18C0G1H331J
11	4	D1, D2, D3, D4	RS2KA-13-F	800 V, 1.5 A, Standard Recovery, DO-214AC	Diodes Inc.	RS2KA-13-F
12	1	D5	DFLR1800-7	800 V, 1 A, Standard Recovery, POWERDI123	Diodes Inc.	DFLR1800-7
13	1	D6	DFLR1200-7	200 V, 1 A, Standard Recovery, POWERDI123	Diodes Inc.	DFLR1200-7
14	1	F1	1 A	250 VAC, 1 A, Radial TR5, Time Lag Fuse	Littelfuse / Wickmann(R)	37411000410
15	1	L1	7 mH	7 mH, 3.5 A	Wurth Elektronik	744834407
16	1	M1	AO4294	MOSFET, N-Channel, 100 V, 9 A, SOIC-8	Alpha & Omega Semiconductor Inc.	AO4294
17	1	R1	390 kΩ	390 kΩ, 5 %, 0.25 W, Thick Film	Generic	
18	1	R2	39 Ω	39 Ω, 5 %, 0.125 W, Thick Film	Generic	
19	2	R3, R4	4.42 MΩ	4.42 MΩ, 1 %, 0.25 W, Thick Film	Generic	
20	1	R5	15.4 kΩ	15.4 kΩ, 1 %, 0.125 W, Thick Film	Generic	
21	1	R6	47 Ω	47 Ω, 5 %, 0.125 W, Thick Film	Generic	
22	1	R7	30.1 mΩ	30.1 mΩ, 1 %, 0.125 W, Metal Film	Generic	
23	1	R8	18 Ω	18 Ω, 5 %, 0.25 W, Thick Film	Generic	
24	1	R9	255 kΩ	255 kΩ, 1 %, 0.125 W, Thick Film	Generic	
25	1	R10	29.4 kΩ	29.4 kΩ, 1 %, 0.125 W, Thick Film	Generic	
26	1	T1	EFD20	Core Material See Transformer Construction's Materials List for complete information	Ferroxcube	EFD20-3F3
27	1	U1	INN3678C-H605	InnoSwitch3-EP, INN3678C-H605, inSOP-24D	Power Integrations	INN3678C-H605
28	1			104 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Device U1.	Custom	
29	1			104 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier M1.	Custom	

TRANSFORMER CONSTRUCTION REPORT

Electrical Diagram



Winding info

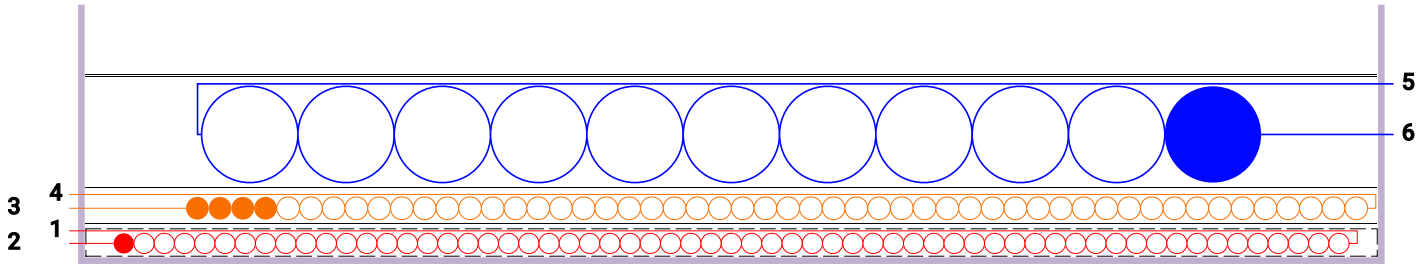
Stack Fill Factor: 69.32%;
Total Copper Weight: 2.67g
Copper Loss: 0.337W; Total Transformer Loss: 0.374W

47.07%H; Secondary - 1; IRMS = 2.41A;
0.92L; 11T; 1x20 TIW; CMA = 425.93 Cmils/A; LENw = 46.3 cm;
RDC = 19.64 mΩ; RAC = 30.26 mΩ; WeightCU = 2.15 g; Pw = 30.26 mW;

11.7%H; Primary Bias;
1L; 13T; 4x32 AWG; LENw = 39 cm;

10.55%H; Primary; IRMS = 0.23A;
0.98L; 61T; 1x33 AWG; CMA = 219.35 Cmils/A; LENw = 178.1 cm;
RDC = 1541.1 mΩ; RAC = 1532.43 mΩ; WeightCU = 0.41 g; Pw = 1532.43 mW;

Mechanical diagram



Building Instructions

LIST OF MATERIALS

Item	Description
[1]	Core: EFD20, 3F3, gapped for ALG of 96 nH / T^2
[2]	Bobbin: Generic, 4 pri. + 4 sec.
[3]	Tinned copper wire 0.5mm
[4]	Varnish
[5]	Single core wire: 33 AWG (0.21 mm), insulation Heavy Build
[6]	Separation Tape: Polyester film [1 mil (25.4 micrometers) base thickness], 13.5 mm wide
[7]	Single core wire: 32 AWG (0.24 mm), insulation Heavy Build
[8]	Triple Insulated Wire: 20 AWG (1 mm)

WINDING INSTRUCTIONS

1. Primary

Start with 1 lead(s) of Item [5] from Pin 2, and wind 61 turns in Clockwise direction in total of 1 layer(s).Wind one layer from left to right. Finish this winding on Pin 1. Add 1 layer(s) of tape, Item [6], on the top.

2. Primary Bias

Start with 4 lead(s) of Item [7] from Pin 3, and wind 13 turns in Clockwise direction in total of 1 layer(s).Wind one layer from left to right. Finish this winding on Pin 4. Add 1 layer(s) of tape, Item [6], on the top.

3. Secondary - 1

Start with 1 lead(s) of Item [8] from Pin 6, and wind 11 turns in Clockwise direction in total of 1 layer(s).Wind one layer from right to left. Finish this winding on Pin 5. Add 2 layer(s) of tape, Item [6], on the top.

BUILDING PREPARATIONS

1. Gap the core halves to get 358 uH +- 5.0%.

FINISHING INSTRUCTIONS

1. Using a piece of wire, Item [3], connect the core to Pin 1.

2. Varnish with Item [4]

ELECTRICAL PARAMETERS

Parameter	Condition	Spec
Electrical Strength	60 Hz 1 second, from pins 1,2,3,4 to pins 5,6.	3000 VAC
Nominal Primary Inductance	Measured at 1 V pk-pk, typical switching frequency, between pin 2 to pin 1, with all other Windings open.	358 uH +- 5.0%

Maximum Primary Leakage	Measured between Pin 2 to Pin 1, with all other Windings shorted.	11.27 uH

Comments:

Achieving compliance to applicable safety standard may require additional considerations for transformer construction, manufacturing and methods used for termination of wires.
It is the responsibility of the user to verify that all applicable safety requirements are met and make additional changes as applicable.

Winding Parameters

Type	Power	Bias	Power
Name	Secondary - 1	Primary Bias	Primary
Turns	11	13	61
Layers	0.92	1	0.98
Color	Blue	Orange	Red
Wire Type	Single Core	Single Core	Single Core
Wire Size, AWG	20	32	33
Wire Grade	TIW	Heavy Build	Heavy Build
Filar	1	4	1
Wire Tolerance, %	0	0	0
Split	False	False	False
Spread	NO	NO	NO
Arrangement	Independent	Independent	Independent
Direction	Clockwise	Clockwise	Clockwise
Z winding	NO	NO	NO
Opposite start	NO	NO	NO
Winding Start	Pin	Pin	Pin
Winding End	Pin	Pin	Pin
Start Pin	6	3	2
End Pin	5	4	1
Sleeving	None	None	None
Connection	Floating	Floating	Floating
Margin Left, mm	0	0	0
Margin Right, mm	0	0	0
Tape Between Layers	NO	NO	NO
Tape Between Lead & Winding	NO	NO	NO
Tape on top	2	1	1
Tape Thickness, mm	0.0254	0.0254	0.0254
Wire CMA	425.93	25549.63	219.35

Core/Coil Former Parameters

Core	EFD20
Core Part Number	EFD20-3F3
Ferrite Material	3F3
Coil Former Part Number	EFD20 -1 (P4+ S4)
Orientation	1
Available Pins	8
Bobbin Window Length, mm	13.5
X-Tolerance, %	0
Maximum Stack Height, mm	2.26
Y-Tolerance, %	0
External Shielding	Core Connection
Connect To	1

Design Specifications

Magnetizing Inductance Tolerance (LP_Tol), %	5.0
Frequency (FS), Hz	40409
Reflected Output Voltage (VOR), V	66.55
Main Turns (NSM)	11

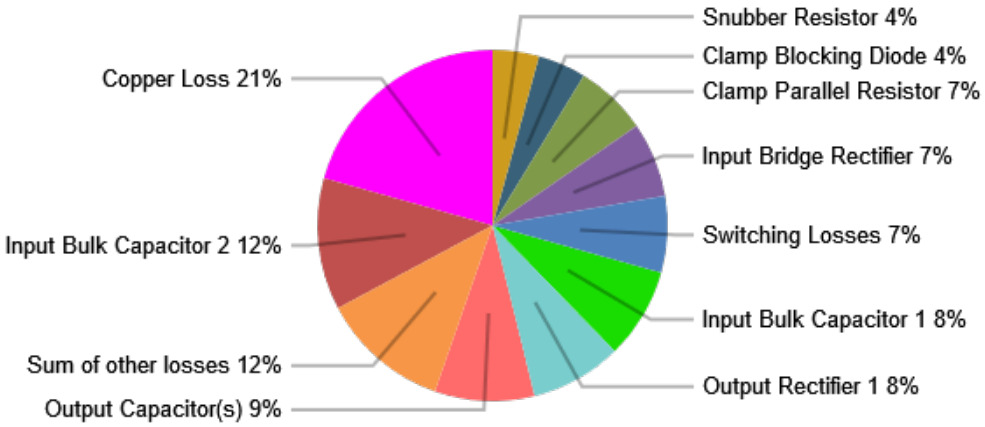
Set-Point	1
ILIMIT Tolerance	Min
LP Tolerance	Min
VACMIN [V]	195
VMIN [V]	238.9
INDUCTANCE [uH]	339.98
ILIMIT [A]	1.58
PO [W]	12.00
VO [V]	12.00
IO [A]	1.00
FS [Hz]	40409
VOR [V]	66.55
DMAX	0.078
KP	3.287
TIME_ON [µs]	1.93
TIME_OFF [µs]	22.81
IAVG [A]	0.05
IP [A]	1.358
IRMS [A]	0.219
ISP [A]	7.533
IRIPPLE [A]	2.075
BM [Gauss]	2442
BP [Gauss]	2909
BAC [Gauss]	1221
ISRMS [A]	2.303
NP	61.0
N_ACTUAL [%]	88.00

Design Evaluation

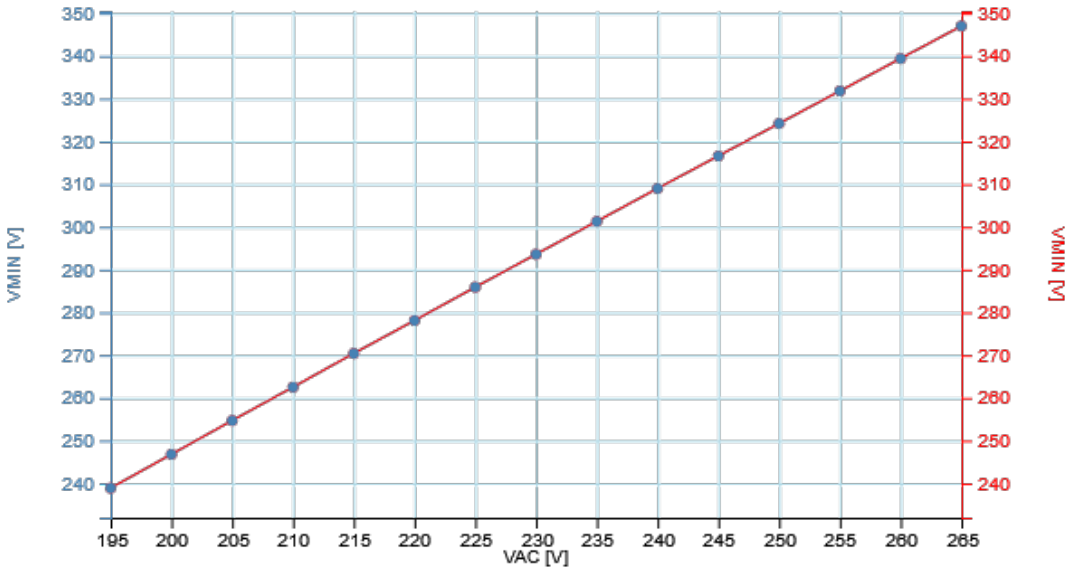
LOAD [%]	100
VAC [V]	195
Set-Point	1
ILIMIT Tolerance	MIN
LP Tolerance	MIN

Components	Loss (W)	Rth (C/W)	Temp. Rise (C)
Total Losses	1.638		
INPUT STAGE	0.452		
Common Mode Choke	0.003		
Input Bridge Rectifier	0.113		
Input Bulk Capacitor 1	0.137		
Input Bulk Capacitor 2	0.199		
PI DEVICE	0.182		
Switching Losses	0.115		
Conduction Losses	0.035		
Self Consumption	0.032		
PRIMARY CLAMP CIRCUIT	0.202		
Clamp Parallel Resistor	0.109		
Clamp Series Resistor	0.020		
Clamp Blocking Diode	0.073		
PRIMARY BIAS	0.030		
Diode	0.001		
Resistor	0.028		
CONTROLLER CIRCUIT	0.038		
Line Sense Resistor 1	0.004		
Line Sense Resistor 2	0.004		
Current Sense Resistor	0.030		
Upper Feedback Resistor	0.000		
Lower Feedback Resistor	0.000		
TRANSFORMER	0.375		
Copper Loss	0.338		
Core Loss	0.037		
SECONDARY RECTIFIER	0.208		
Output Rectifier 1	0.138		
Snubber Resistor	0.070		
OUTPUT CAP	0.151		
Output Capacitor(s)	0.151		

PIE Chart



Line Chart



Note: Design parameters shown in the tool are based on calculations and approximations. Actual results will vary. Power supply designed using the tool should be tested to verify actual parameter values.