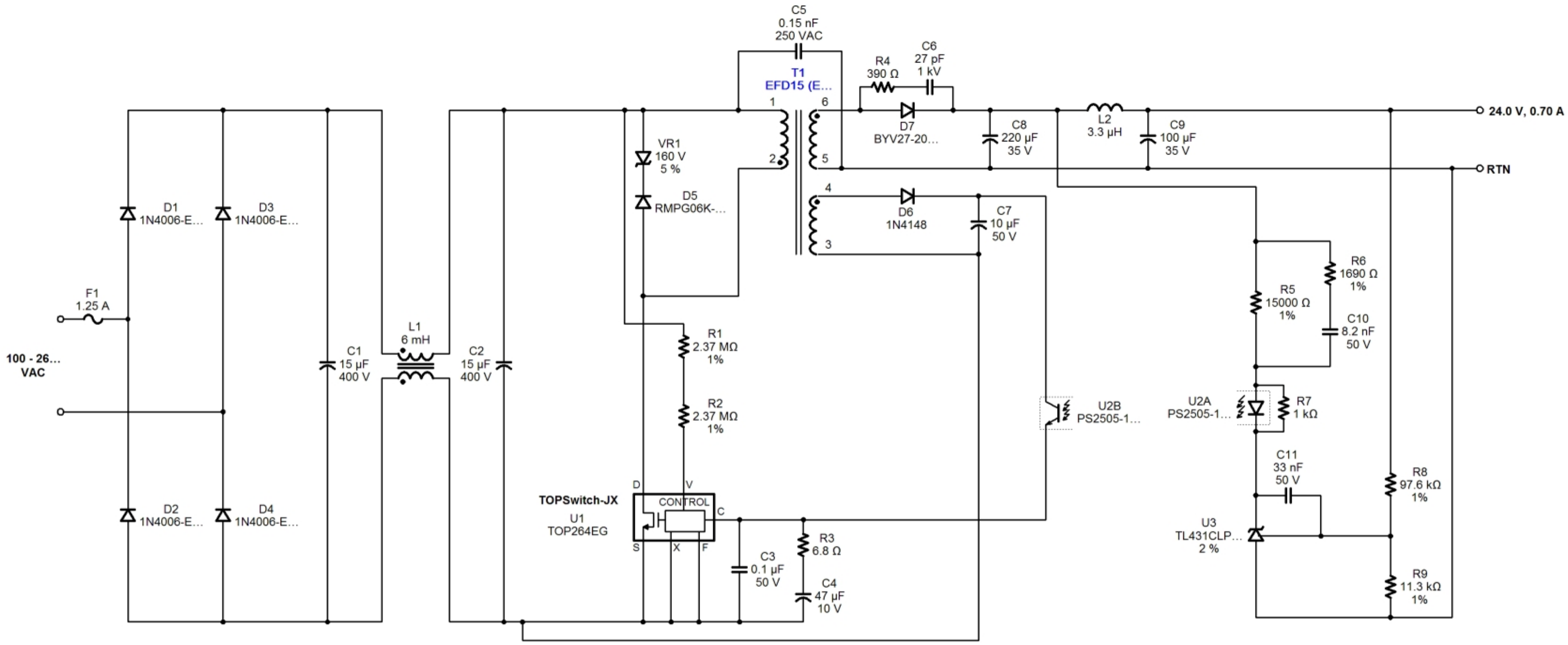


Schematic components that have been frozen by the user will appear with blue reference designators.

Power Supply Input

Var	Value	Units	Description
VACMIN	100	V	Minimum Input AC Voltage (Manual Overwrite)
VACMAX	265	V	Maximum Input AC Voltage (Manual Overwrite)
FL	50	Hz	Line Frequency (Manual Overwrite)
TC	2.52	ms	Input Rectifier Conduction Time
Z	0.47		Loss Allocation Factor
η	85.0	%	Efficiency Estimate (Target)
VMIN	100.5	V	Minimum DC Input Voltage
VMAX	374.8	V	Maximum DC Input Voltage

Input Section

Var	Value	Units	Description
Fuse	1.25	A	Input Fuse Rated Current
IAVG	0.20	A	Average Diode Bridge Current (DC Input Current)

Device Variables

Var	Value	Units	Description
Device	TOP264EG		PI Device Name
BVDSS	725	V	Drn-Src Bkdn Voltage
Current Limit Mode	Default		Device Current Limit Mode
OVP_FLAG	NO		Output Overvoltage Protection Enabled
PO	16.87	W	Total Output Power
VDRAIN Estimated	534.77	V	Estimated Drain Voltage
VDS	5.38	V	On state Drain to Source Voltage
FS	132000	Hz	Switching Frequency (at VMIN and Full Load)
KP	0.527		Continuous/Discontinuous Operating Ratio (at VMIN and Full Load)
DMAX	0.587		Maximum Duty Cycle (at VMIN and Full Load)
KI	1.00		Current Limit Reduction Factor
ILIMITEXT	1.21	A	Programmed Current Limit
ILIMITMIN	1.209	A	Minimum Current Limit
ILIMITMAX	1.391	A	Maximum Current Limit
PLIM_FLAG	NO		Enable Overload Power Limiting
IP	0.457	A	Peak Primary Current (at VMIN and Full Load)
IRMS	0.263	A	Primary RMS Current (at VMIN and Full Load)
RTH_DEVICE	82.63	°C/W	PI Device Heatsink Maximum Thermal Resistance
DEV_HSINK_TYPE	Custom Aluminum		PI Device Heatsink Type
DEV_HSINK_AREA	400	mm^2	PI Device Heatsink Area

Clamp Circuit

Var	Value	Units	Description
Clamp Type	Zener Clamp		Clamp Circuit Type

VCLAMP	**25.00**	*V*	*Average Clamping Voltage*
Estimated Clamp Loss	**0.000**	*W*	*Clamp total power loss*
VC_MARGIN	**115.23**	*V*	*Clamp Voltage Safety Margin*

Primary Bias Variables

Var	*Value*	*Units*	*Description*
VB	**12.0**	*V*	*Bias Voltage*
IB	**0.006**	*A*	*Bias Current*
PIVB	**51**	*V*	*Bias Rectifier Maximum Peak Inverse Voltage*
NB	**9**		*Primary Bias Winding Number of Turns*

Transformer Construction Parameters

Var	*Value*	*Units*	*Description*
Core Type	**EFD15 (EFD15/8/5-3F3-S)**		*Core Type (Manual Overwrite)*
Core Material	**3F3**		*Core Material*
Primary Pins	**4**		*Number of Primary pins used*
Secondary Pins	**2**		*Number of Secondary pins used*
USE_SHIELDS	**NO**		*Use shield Windings*
LP_nom	**1829**	*μH*	*Nominal Primary Inductance*
LP_Tol	**10.0**	*%*	*Primary Inductance Tolerance*
NP	**86.2**		*Calculated Primary Winding Total Number of Turns*
NSM	**16**		*Secondary Main Number of Turns*
Primary Current Density	**5.33**	*A/mm²*	*Primary Winding Current Density*
VOR	**135.00**	*V*	*Reflected Output Voltage*
BW	**8.85**	*mm*	*Bobbin Winding Width*
FF	*127.04*	*%*	*Actual Transformer Fit Factor. 100% signifies fully utilized winding window. See Warnings section for detail*
AE	**15.00**	*mm²*	*Core Cross Sectional Area*
ALG	**222**	*nH/T²*	*Gapped Core Specific Inductance*
BM	*582*	*mT*	*Maximum Flux Density. See Errors section for detail*
BP	*1953*	*mT*	*Peak Flux Density. See Errors section for detail*
BAC	**154**	*mT*	*AC Flux Density for Core Loss*
LG	*0.061*	*mm*	*Estimated Gap Length. See Information section for detail*
L_LKG	**54.87**	*μH*	*Estimated primary leakage inductance*
LSEC	**20**	*nH*	*Secondary Trace Inductance*

Primary Winding Section 1

Var	*Value*	*Units*	*Description*
NP1	**87**		*Number of Primary Winding Turns in the First Section of Primary*
L	**2.90**		*Primary Winding - Number of Layers*
DC Copper Loss	**0.06**	*W*	*Primary Section 1 DC Losses*

Output 1

Var	*Value*	*Units*	*Description*

VO	**24.00**	*V*	*Typical Output Voltage*
IO	**0.70**	*A*	*Output Current*
VOUT_ACTUAL	**24.00**	*V*	*Actual Output Voltage*
NS	**16**		*Secondary Number of Turns*
L_S_OUT	**1.08**		*Secondary Output Winding Layers*
DC Copper Loss	**0.13**	*W*	*Secondary DC Losses*
VD	**1.07**	*V*	*Output Winding Diode Forward Voltage Drop*
VD	**1.07**	*V*	*Output Winding Diode Forward Voltage Drop*
PIVS	**92.92**	*V*	*Output Rectifier Maximum Peak Inverse Voltage*
ISP	**2.452**	*A*	*Peak Secondary Current*
ISRMS	**1.185**	*A*	*Secondary RMS Current*
ISRMS_WINDING	**1.185**	*A*	*Secondary Winding RMS Current*
Secondary Current Density	**9**	*A/mm²*	*Secondary Winding Current Density*
RTH_RECTIFIER	**72.26**	*°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	**52**	*mm²*	*Output Rectifier Heatsink Area*
CO	**220 x 1**	*µF*	*Output Capacitor - Capacitance*
IRIPPLE	**0.956**	*A*	*Output Capacitor - RMS Ripple Current*
Expected Lifetime	**25301**	*hr*	*Output Capacitor - Expected Lifetime*

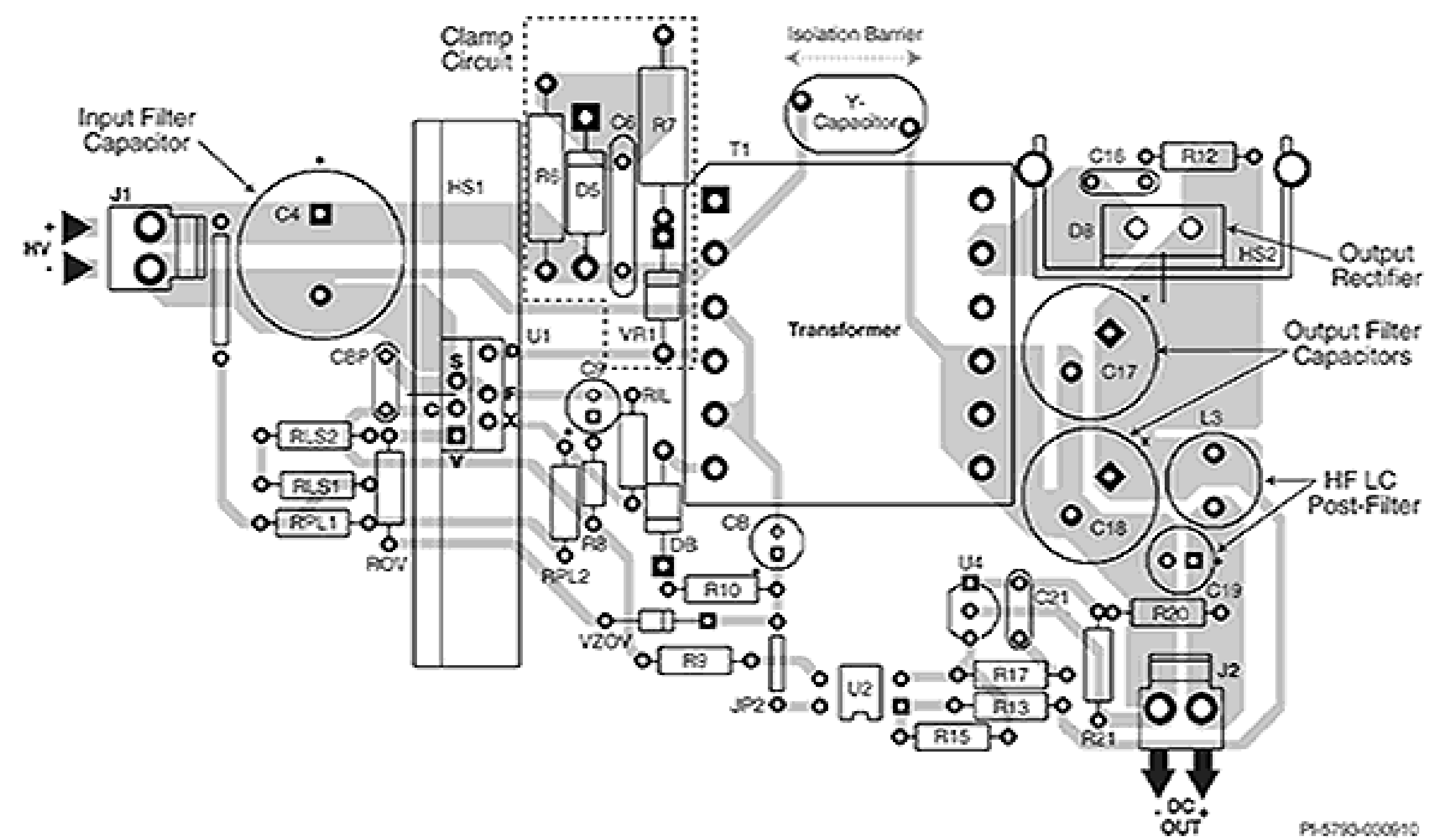
Feedback Circuit

Var	***Value***	***Units***	***Description***
DUAL_OUTPUT_FB_FLAG	**NO**		*Get feedback from 2 outputs*
SF_FLAG	**NO**		*Soft Finish Circuits use flag*
TYPE_3CTRL_FLAG	**YES**		*Phase Boost Network flag*

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



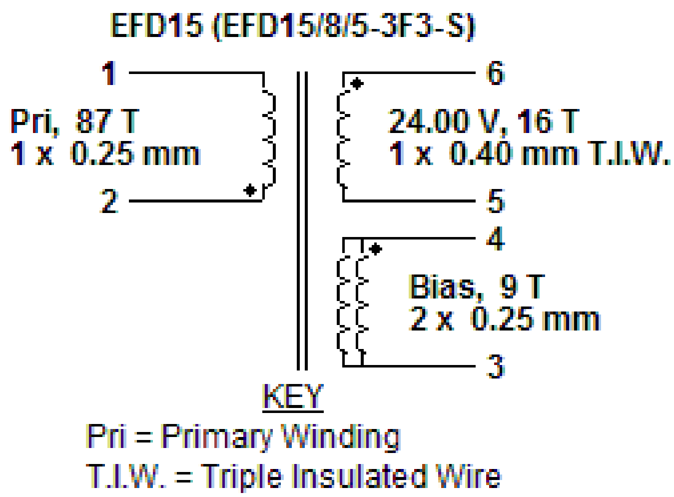
Click on the "Show me" icon to highlight relevant areas on the sample layout.		
	Description	*Show Me*
1	*Minimize loop area formed by drain, clamp and transformer*	
2	*Bias winding and bias capacitor are a power connection and therefore returned to Kelvin connection at SOURCE pin*	
3	*V and X pin node areas minimized, line sensing (R1 & R2) and power limiting (R3 & R4) close to device. Connections to V and X pin nodes should be away from noisy switching nodes (drain, clamp and bias)*	
4	*Place CONTROL pin decoupling capacitor directly across CONTROL and SOURCE pins*	
5	*Y capacitor connected between output RTN and B+*	
6	*Minimize loop area formed by secondary winding, the output rectifier and the output filter capacitor*	
7	*Kelvin connection at SOURCE pins: power and signal currents kept separate*	
8	*B+ connection of RLS or RPL resistor should be on input side of capacitor to prevent switching noise injection*	

Bill Of Materials

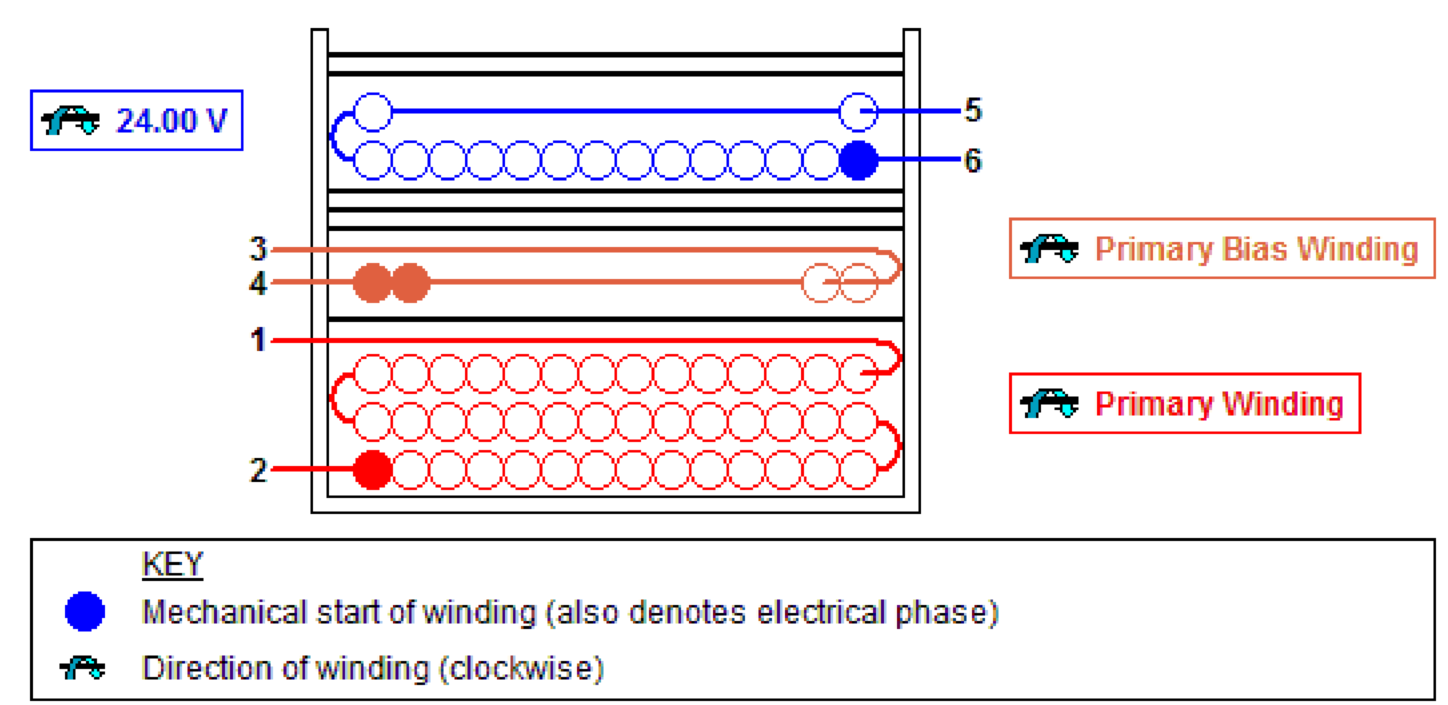
Item #	Quantity	Part Ref	Value	Description	Mfg	Mfg Part Number
1	2	C1, C2	15 μF	15 μF, 400 V, High Voltage Al Electrolytic, (22 mm x 12.5 mm)	Nichicon	UCS2G150MHD1TO
2	1	C3	0.1 μF	0.1 μF, 50 V, Ceramic, X7R	Kemet	C322C104K5R5TA
3	1	C4	47 μF	47 μF, 10.0 V, Electrolytic, Gen Purpose, 2300 mΩ, (11 mm x 4 mm)	Nichicon	UPW1A470MDD6
4	1	C5	0.15 nF	0.15 nF, 250 VAC, Ceramic, Y Class	TDK	CD70-B2GA151KYNS
5	1	C6	27 pF	27 pF, 1 kV, High Voltage Ceramic	Vishay	S270K25SL0N63L6R
6	1	C7	10 μF	10 μF, 50 V, Electrolytic, Gen Purpose, 1050 mΩ, (11.5 mm x 5 mm)	Panasonic	ECA-1HHG100
7	1	C8	220 μF	220 μF, 35 V, Electrolytic, Super Low ESR, 56 mΩ, (15 mm x 8 mm)	United Chemi-Con	EKZE350ELL221MH15D
8	1	C9	100 μF	100 μF, 35 V, Electrolytic, Low ESR, 180 mΩ, (15 mm x 6.3 mm)	United Chemi-Con	ELXZ350ELL101MF15D
9	1	C10	8.2 nF	8.2 nF, 50 V, Ceramic, X7R	Kemet	C315C822K5R5TA
10	1	C11	33 nF	33 nF, 50 V, Ceramic, X7R	Kemet	C315C333K5R5TA
11	4	D1, D2, D3, D4	1N4006-E3/54	800 V, 1 A, Standard Recovery, DO-41	Vishay	1N4006-E3/54
12	1	D5	RMPG06K-E3/54	800 V, 1 A, Fast Recovery, 250 ns, MPG06	Vishay	RMPG06K-E3/54
13	1	D6	1N4148	100 V, 0.15 A, Fast Recovery, 8 ns, DO-35	Vishay	1N4148
14	1	D7	BYV27-200-TR	200 V, 2 A, Ultrafast Recovery, 25 ns, SOD57	Vishay	BYV27-200-TR
15	1	F1	1.25 A	250 VAC, 1.25 A, Radial TR5, Time Lag Fuse	Littelfuse / Wickmann(R)	37411250410
16	1	HS1		10 mm x 20 mm. Aluminum Alloy (3003 OR 5052), 1.6 mm thickness. Heatsink for use with Device U1.	Custom	
17	1	L1	6 mH	6 mH, 1.6 A	Panasonic	ELF18N016
18	1	L2	3.3 μH	3.3 μH, 2.66 A	Bourns Inc.	RL822-3R3K-RC
19	2	R1, R2	2.37 MΩ	2.37 MΩ, 1 %, 0.25 W, Metal Film	Generic	
20	1	R3	6.8 Ω	6.8 Ω, 5 %, 0.125 W, Carbon Film	Generic	
21	1	R4	390 Ω	390 Ω, 5 %, 0.25 W, Carbon Film	Generic	
22	1	R5	15000 Ω	15000 Ω, 1 %, 0.125 W, Metal Film	Generic	
23	1	R6	1690 Ω	1690 Ω, 1 %, 0.125 W, Metal Film	Generic	
24	1	R7	1 kΩ	1 kΩ, 5 %, 0.125 W, Carbon Film	Generic	
25	1	R8	97.6 kΩ	97.6 kΩ, 1 %, 0.125 W, Metal Film	Generic	
26	1	R9	11.3 kΩ	11.3 kΩ, 1 %, 0.125 W, Metal Film	Generic	
27	1	T1	EFD15 (EFD15/8/5-3F3-S)	3F3 Core Material Refer to Manufacturer datasheet for a number of parts to purchase	Ferroxcube	EFD15/8/5-3F3-S
28	1	T1 Bobbin	EFD15/8/5 - 2 (P4-S4)	Bobbin Material : Phenolformaldehyde (PF)	Ferroxcube	CSH-EFD15-1S-8P
29	1	T1 Core Acc.1	B66414	Yoke . Stainless spring steel (0.25 mm)	EPCOS (TDK)	B66414
30	1	T1 Core Acc.2	CLM-EFD15	Clamp . Stainless steel (CrNi)	Ferroxcube	CLM-EFD15

31	*1*	*T1 Core Acc.3*	*CLI-EFD15*	*Clip . Stainless steel (CrNi)*	*Ferroxcube*	*CLI-EFD15*
32	*1*	*U1*	*TOP264EG*	*TOPSwitch-JX, TOP264EG, eSIP-7C*	*Power Integrations*	*TOP264EG*
33	*1*	*U2*	*PS2505-1-A*	*Optocoupler PS2505-1-A, 80 V, CTR 300 - 600 %, 4-DIP*	*Renesas*	*PS2505-1-A*
34	*1*	*U3*	*TL431CLPM*	*2.495 V, Shunt Regulator IC, 2 %, TO-92*	*Texas Instruments*	*TL431CLPM*
35	*1*	*VR1*	*P6KE160A-E3/54*	*160 V, 5 W, 5 %, DO-204AC, TVS*	*Vishay*	*P6KE160A-E3/54*
36	*1*			*52 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier D7.*	*Custom*	

Electrical Diagram



Mechanical Diagram



Winding Instruction

Primary Winding

Start on pin(s) 2 and wind 87 turns (x 1 filar) of item [5]. in 3 layer(s) from left to right. Winding direction is clockwise. At the end of 1st layer, continue to wind the next layer from right to left. At the end of 2nd layer, continue to wind the next layer from left to right. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 1.

Add 1 layer of tape, item [3], for insulation.

Primary Bias Winding

Start on pin(s) 4 and wind 9 turns (x 2 filar) of item [5]. Winding direction is clockwise. Spread the winding evenly across entire bobbin. Finish this winding on pin(s) 3.

Add 3 layers of tape, item [3], for insulation.

Secondary Winding

Start on pin(s) 6 and wind 16 turns (x 1 filar) of item [6]. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Finish this winding on pin(s) 5.

Add 2 layers of tape, item [3], for insulation.

Core Assembly

Assemble and secure core halves. Item [1].

Varnish

Dip varnish uniformly in item [4]. Do not vacuum impregnate.

Comments

1. For non margin wound transformers use triple insulated wire for all secondary windings.

Materials

Item	*Description*
[1]	**Core: EFD15 (EFD15/8/5-3F3-S), 3F3, gapped for ALG of 222 nH/T²**
[2]	**Bobbin: Generic, 4 pri. + 4 sec.**
[3]	**Barrier Tape: Polyester film [1 mil (25 µm) base thickness], 8.85 mm wide**
[4]	**Varnish**
[5]	**Magnet Wire: 0.25 mm, Solderable Double Coated**
[6]	**Triple Insulated Wire: 0.4 mm**

Electrical Test Specifications

Parameter	*Condition*	*Spec*
Electrical Strength, VAC	**60 Hz 1 second, from pins 1,2,3,4 to pins 5,6.**	**3000**
Nominal Primary Inductance, µH	**Measured at 1 V pk-pk, typical switching frequency, between pin 1 to pin 2, with all other Windings open.**	**1829**
Tolerance, ±%	**Tolerance of Primary Inductance**	**10.0**
Maximum Primary Leakage, µH	**Measured between Pin 1 to Pin 2, with all other Windings shorted.**	**54.87**

Although the design of the software considered safety guidelines, it is the user's responsibility to ensure that the user's power supply design meets all applicable safety requirements of user's product.

	Description	Fix	Ref. #
	Maximum flux density limit exceeded.	*Increase transformer size, increase secondary turns (NS), increase reflected output voltage (VOR), increase KP, increase efficiency estimate (N).*	*203*
	Peak flux density limit exceeded.	*Increase transformer size, increase secondary turns (NS), reduce size of device (ILIM MIN), increase reflected output voltage (VOR), increase KP, reduce KI (TOPGX/HX only).*	*215*
	Transformer windings do not fit in the winding window	*Use a larger transformer*	*712*
	Gap length too small.	*Increase core size, increase secondary turns (NS), increase reflected output voltage (VOR), increase KP. Verify minimum size with magnetics vendor.*	*216*