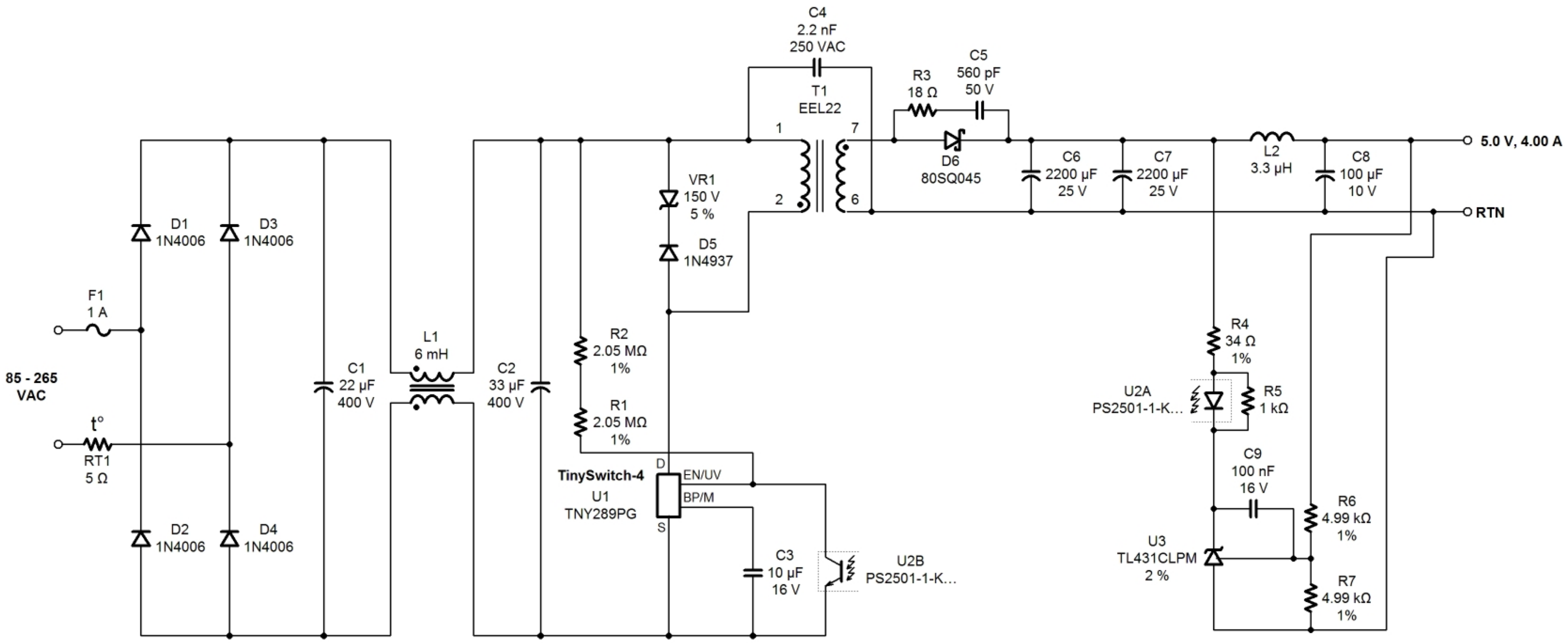


C4
2.2 nF
250 VAC
T1
EEL22
R3
18 Ω
C5
560 pF
50 V
1
7
2
6
D6
80SQ045
C6
2200 µF
25 V
C7
2200 µF
25 V
L2
3.3 µH
C8
100 µF
10 V
5.0 V, 4.00 A
RTN
VR1
150 V
5 %
D5
1N4937
D1
1N4006
D3
1N4006
F1
1 A
85 - 265
VAC
t°
RT1
5 Ω
D2
1N4006
D4
1N4006
C1
22 µF
400 V
L1
6 mH
C2
33 µF
400 V
R2
2.05 MΩ
1%
R1
2.05 MΩ
1%
TinySwitch-4
U1
TNY289PG
D
EN/UV
BP/M
S
C3
10 µF
16 V
U2B
PS2501-1-K…
R4
34 Ω
1%
U2A
PS2501-1-K…
R5
1 kΩ
C9
100 nF
16 V
R6
4.99 kΩ
1%
U3
TL431CLPM
2 %
R7
4.99 kΩ
1%

Power Supply Input

Var	*Value*	*Units*	*Description*
VACMIN	**85**	V	Minimum Input AC Voltage
VACMAX	**265**	V	Maximum Input AC Voltage
FL	**50**	Hz	Line Frequency
TC	**2.69**	ms	Diode Conduction Time
Z	**0.58**		Loss Allocation Factor
η	**71.0**	%	Efficiency Estimate
VMIN	**83.5**	V	Minimum DC Input Voltage
VMAX	**374.8**	V	Maximum DC Input Voltage

Input Section

Var	*Value*	*Units*	*Description*
Fuse	**1.00**	A	Input Fuse Rated Current
IAVG	**0.34**	A	Average Diode Bridge Current (DC Input Current)
Thermistor	**5.00**	Ω	Input Thermistor

Device Variables

Var	*Value*	*Units*	*Description*
Device	**TNY289PG**		PI Device Name
BVDSS	**700**		Drn-Src Bkdn Voltage
Device Mode	**Increased**		Current Limit mode for device
PO	**20.00**	W	Total Output Power
VDRAIN Estimated	**524.77**	V	Actual Estimated Drain Voltage
VDS	**5.86**	V	On state Drain to Source Voltage
I2F_MIN	**66.83**	A^2kHz	Minimum I2F
I2F_MAX	**86.13**	A^2kHz	Maximum I2F
FS_AT_ILIMMIN	**137160**	Hz	Switching Frequency at Current Limit Minimum
KP	**0.34**		Continuous/Discontinuous Operating Ratio
KP_TRANSIENT	**0.26**		Transient Ripple to Peak Current Ratio
ILIMITMIN	**0.70**	A	Minimum Current Limit
ILIMITMAX	**0.83**	A	Maximum Current Limit
IRMS	**0.46**	A	Primary RMS Current (at VMIN)
DMAX	**0.60**		Maximum Duty Cycle
RTH_DEVICE	**39.49**	°C/W	PI Device Maximum Thermal Resistance
DEV_HSINK_TYPE	**2 Oz (70 µ) Copper PCB**		PI Device Heatsink Type
DEV_HSINK_AREA	**482**	mm^2	PI Device Heatsink Area

Clamp Circuit

Var	*Value*	*Units*	*Description*
Clamp Type	**Zener Clamp**		Clamp Circuit Type
VCLAMP	**35**	V	Estimated average clamping voltage
Estimated Clamp Loss	**1.67**	W	Clamp Dissipation

Transformer Construction Parameters

Var	*Value*	*Units*	*Description*
Core Type	**EEL22**		Core Type
Core Material	**NC-2H (Nicera) or Equivalent**		Core Material
Bobbin Reference	**Generic, 5 pri. + 5 sec.**		Bobbin Reference

Bobbin Orientation	**Vertical**		Bobbin type
Primary Pins	**4**		Number of Primary pins used
Secondary Pins	**2**		Number of Secondary pins used
USE_SHIELDS	**NO**		Use shield Windings
LP_nom	**1440**	µH	Nominal Primary Inductance
LP_Tol	**10.0**	%	Primary Inductance Tolerance
NP	**105.5**		Calculated Primary Winding Total Number of Turns
NSM	**5**		Secondary Main Number of Turns
CMA	**279**	Cmils/A	Primary Winding Current Capacity
VOR	**114.8**	V	Reflected Output Voltage
BW	**18.20**	mm	Bobbin Winding Width
ML	**3.20**	mm	Safety Margin on Left Width
MR	**3.20**	mm	Safety Margin on Right Width
FF	**65**	%	Actual Transformer Fit Factor. 100% signifies fully utilized winding window
AE	**35.80**	mm²	Core Cross Sectional Area
ALG	**117**	nH/T²	Gapped Core Effective Inductance
BM	**2932**	Gauss	Maximum Flux Density
BAC	**422**	Gauss	AC Flux Density for Core Loss
LG	**0.354**	mm	Estimated Gap Length
L_LKG	**43.20**	µH	Estimated primary leakage inductance
LSEC	**15**	nH	Secondary Trace Inductance

Primary Winding Section 1

Var	***Value***	***Units***	***Description***
NP1	**106**		Rounded (Integer) Number of Primary winding turns in the first section of primary
Wire Size	**29**	AWG	Wire size of primary winding
Winding Type	**Single (x1)**		Primary winding number of parallel wire strands
L	**2.97**		Primary Number of Layers
DC Copper Loss	**0.24**	W	Primary 1 DC Losses

Output 1

Var	***Value***	***Units***	***Description***
VO	**5.00**	V	Output Voltage
IO	**4.00**	A	Output Current
VOUT_ACTUAL	**5.00**	V	Actual Output Voltage
NS	**5**		Secondary Number of Turns
Foil Thickness	**5**	mil	Wire size of secondary winding
Winding Type	**Foil**		Output winding number of parallel strands
L_S_OUT	**5.00**		Secondary Output Winding Layers
DC Copper Loss	**0.10**	W	Secondary DC Losses
VD	**0.44**	V	Output Winding Diode Forward Voltage Drop
PIVS	**23**	V	Output Rectifier Maximum Peak Inverse Voltage
ISP	**14.72**	A	Peak Secondary Current
ISRMS	**7.80**	A	Secondary RMS Current
RTH_DIODE	**32.73**	°C/W	Output Diode Maximum Thermal Resistance
OD_HSINK_TYPE	**Custom Aluminum**		Output Diode Heatsink Type

OD_HSINK_AREA	**1106**	mm²	Output Diode Heatsink Area
CO	**2200 x 2**	µF	Output Capacitor
IRIPPLE	**6.69**	A	Output Capacitor RMS Ripple Current
Expected Lifetime	**40883**	hr	Expected Lifetime of Output Capacitor

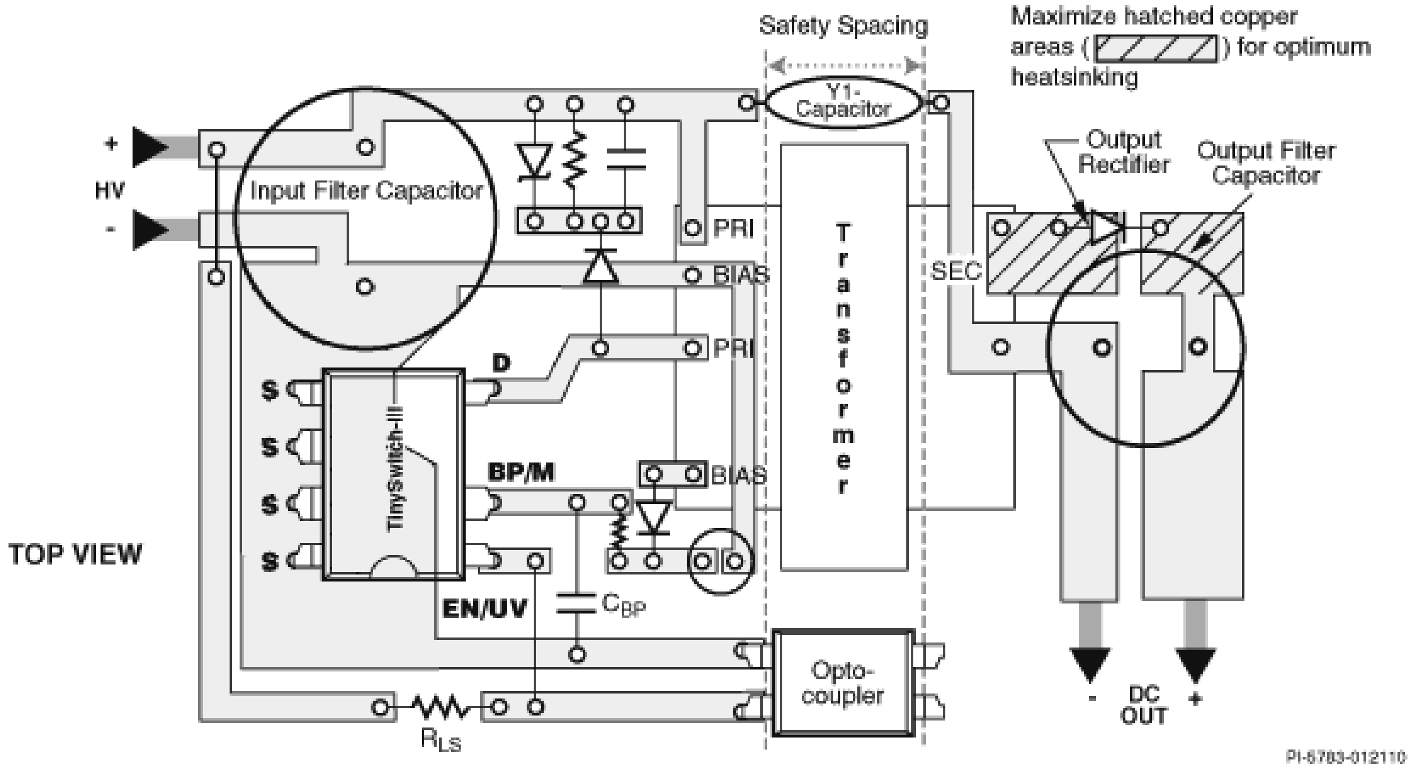
Feedback Circuit

Var	***Value***	***Units***	***Description***
DUAL_OUTPUT_FB_FLAG	**NO**		Dual Output Feedback regulations use flag
SF_FLAG	**NO**		Soft Finish Circuits use flag
TYPE_3CTRL_FLAG	**NO**		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



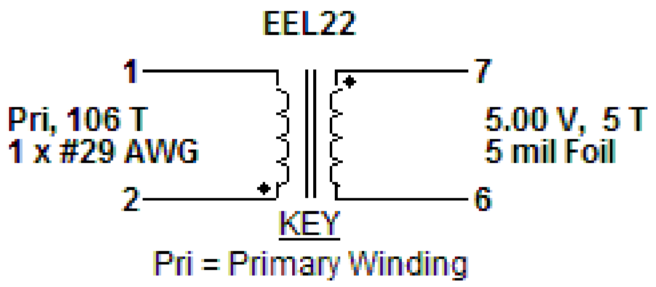
Click on the "Show me" icon to highlight relevant areas on the sample layout.

	Description	Show Me
1	Maximize source area for good heat-sinking	
2	Keep drain trace short	
3	The BYPASS pin capacitor should be located as close as possible to the BYPASS and SOURCE pins	
4	Keep noisy traces away from EN/UV pin	
5	Route bias winding currents back to the bulk cap	
6	Keep clamp loop short	
7	Connect Y capacitor to the B+ rail on the primary side for better surge immunity. Keep Y capacitor traces short	
8	The area of the loop connecting the secondary winding, the output diode and the output filter capacitor should be minimized	

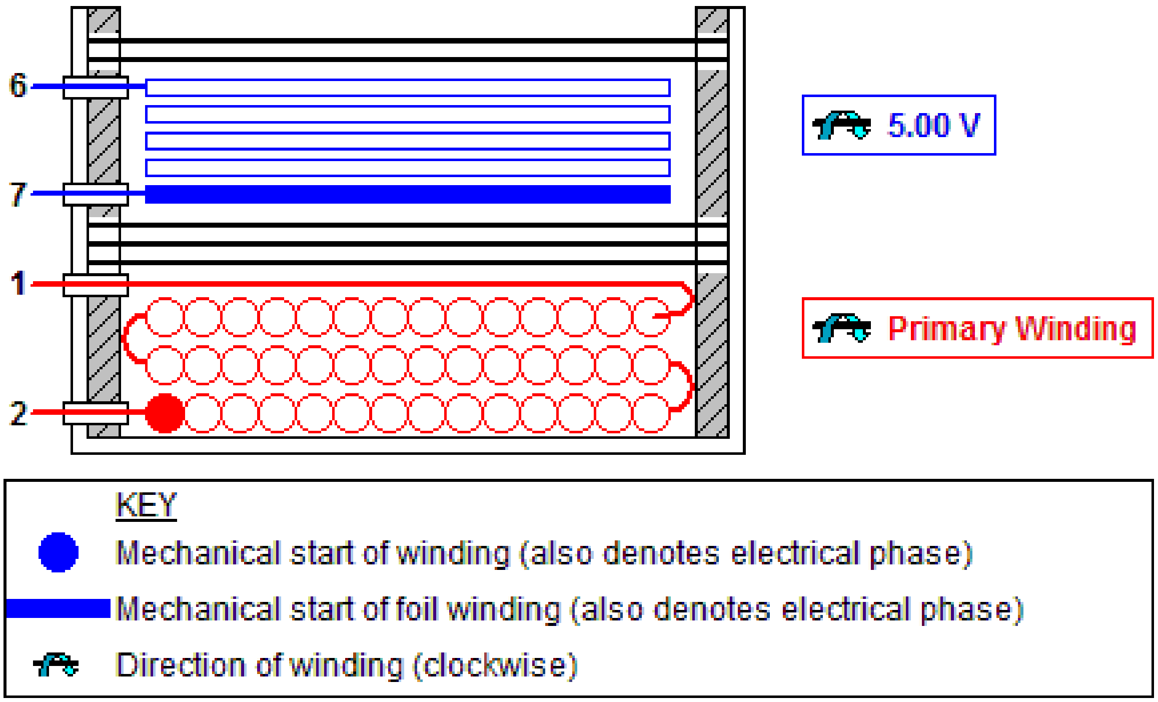
Bill Of Materials

Item #	*Quantity*	*Part Ref*	*Value*	*Description*	*Mfg*	*Mfg Part Number*
1	1	C1	22 µF	22 µF, 400 V, High Voltage Al Electrolytic, (20 mm x 16 mm)	United Chemi-Con	EKMX400VB22RM16X20LL
2	1	C2	33 µF	33 µF, 400 V, High Voltage Al Electrolytic, (35 mm x 10 mm)	United Chemi-Con	EPAG400VB33RM10X35LL
3	1	C3	10 µF	10 µF, 16 V, Ceramic, X7R	TDK	C3216X7R1C106K
4	1	C4	2.2 nF	2.2 nF, 250 VAC, Ceramic, Y Class	TDK	CD12-E2GA222MYNS
5	1	C5	560 pF	560 pF, 50 V, Ceramic, C0G	TDK	FK18C0G1H561J
6	2	C6, C7	2200 µF	2200 µF, 25 V, Electrolytic, Super Low ESR, 15 mΩ, (35 mm x 12.5 mm)	United Chemi-Con	EKZE250ELL222MK35S
7	1	C8	100 µF	100 µF, 10 V, Electrolytic, Low ESR, 500 mΩ, (11.5 mm x 5 mm)	United Chemi-Con	ELXZ100ELL101MEB5D
8	1	C9	100 nF	100 nF, 16 V, Ceramic, X7R	TDK	C1005X7R1C104K
9	4	D1, D2, D3, D4	1N4006	800 V, 1 A, Standard Recovery, DO-41	Vishay	1N4006
10	1	D5	1N4937	600 V, 1 A, Fast Recovery, 200 ns, DO-41	Vishay	1N4937
11	1	D6	80SQ045	45 V, 8 A, Schottky, DO-204AR	International Rectifier	80SQ045
12	1	F1	1 A	250 VAC, 1 A, Radial TR5, Time Lag Fuse	Littelfuse / Wickmann(R)	37411000410
13	1	HS1		27.7 mm x 20 mm. Aluminum Alloy (3003 OR 5052), 1.6 mm thickness. Heatsink for use with Diode D6.	Custom	
14	1	L1	6 mH	6 mH, 1.6 A	Panasonic	ELF18N016
15	1	L2	3.3 µH	3.3 µH, 5.5 A	Bourns Inc.	RL622-3R3K-RC
16	2	R1, R2	2.05 MΩ	2.05 MΩ, 1 %, 0.25 W, Metal Film	Generic	
17	1	R3	18 Ω	18 Ω, 5 %, 0.25 W, Carbon Film	Generic	
18	1	R4	34 Ω	34 Ω, 1 %, 0.125 W, Metal Film	Generic	
19	1	R5	1 kΩ	1 kΩ, 5 %, 0.125 W, Carbon Film	Generic	
20	2	R6, R7	4.99 kΩ	4.99 kΩ, 1 %, 0.125 W, Metal Film	Generic	
21	1	RT1	5 Ω	NTC Thermistor 5 Ω, 2.8 A	Thermometrics	CL160
22	1	T1	EEL22	NC-2H (Nicera) or Equivalent Core Material See Transformer Construction's Materials List for complete information	TDK	PC40EE22/29/6-Z
23	1	U1	TNY289PG	TinySwitch-4, TNY289PG, DIP-8	Power Integrations	TNY289PG
24	1	U2	PS2501-1-K-A	Optocoupler PS2501-1-K-A, 80 V, CTR 300 - 600 %, 4-DIP	CEL	PS2501-1-K-A
25	1	U3	TL431CLPM	2.495 V, Shunt Regulator IC, 2 %, TO-92	Texas Instruments	TL431CLPM
26	1	VR1	P6KE150A	150 V, 5 W, 5 %, DO-204AC, TVS	Vishay	P6KE150A
27	1			482 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Device U1.	Custom	

Electrical Diagram



Mechanical Diagram



Winding Instruction

Use 3.20 mm margin (item [3]) on the bottom. Use 3.20 mm margin (item [3]) on the top.

Primary Winding

Start on pin(s) 2 using item [5] at the start leads and wind 106 turns (x 1 filar) of item [7]. in 3 layer(s) from left to right. 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 using item [5] at the finish leads.

Add 3 layers of tape, item [4], for insulation.

Secondary Winding

Start on pin(s) 7 using item [5] at the start leads and wind 5 turns of item [8]. Wind in same rotational direction as primary winding. Finish this winding on pin(s) 6 using item [5] at the finish leads.

Add 2 layers of tape, item [4], for insulation.

Core Assembly

Assemble and secure core halves. Item [1].

Varnish

Dip varnish uniformly in item [6]. Do not vacuum impregnate.

Materials

Item	***Description***
[1]	**Core: EEL22, NC-2H (Nicera) or Equivalent, gapped for ALG of 117 nH/T^2**

[2]	**Bobbin: Generic, 5 pri. + 5 sec.**
[3]	**Tape: Polyester web 3.20 mm wide**
[4]	**Barrier Tape: Polyester film [1 mil (25 µm) base thickness], 18.20 mm wide**
[5]	**Teflon Tubing # 22**
[6]	**Varnish**
[7]	**Magnet Wire: 29 AWG, Solderable Double Coated**
[8]	**Copper Foil: 5 mil thick, 11.80 mm wide, covered with 1 layer of lapped tape. Terminations to foil: 2 x 23 AWG magnet wire**

Electrical Test Specifications

Parameter	***Condition***	***Spec***
Electrical Strength, VAC	**60 Hz 1 second, from pins 1,2 to pins 6,7.**	**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.**	**1440**
Tolerance, ±%	**Tolerance of Primary Inductance**	**10.0**
Maximum Primary Leakage, µH	**Measured between Pin 1 to Pin 2, with all other Windings shorted.**	**43.20**

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.

1 Design Passed (Optimization Done)