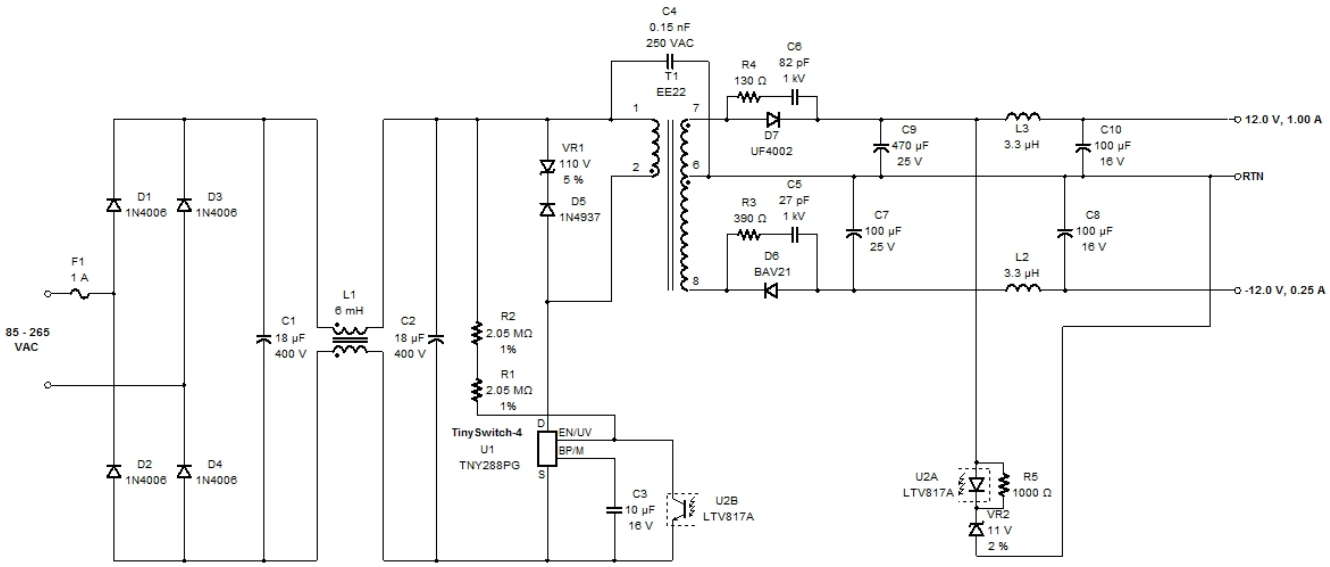

C4
0.15 nF
250 VAC
T1
EE22
R4
130 Ω
C6
82 pF
1 kV
D7
UF4002
C9
470 µF
25 V
L3
3.3 µH
C10
100 µF
16 V
12.0 V, 1.00 A
RTN
VR1
110 V
5 %
D5
1N4937
C5
27 pF
1 kV
R3
390 Ω
D6
BAV21
C7
100 µF
25 V
C8
100 µF
16 V
L2
3.3 µH
-12.0 V, 0.25 A
D1
1N4006
D3
1N4006
F1
1 A
85 - 265
VAC
C1
18 µF
400 V
L1
6 mH
C2
18 µF
400 V
R2
2.05 MΩ
1%
R1
2.05 MΩ
1%
TinySwitch-4
U1
TNY288PG
D
EN/UV
BP/M
S
C3
10 µF
16 V
U2B
LTV817A
U2A
LTV817A
R5
1000 Ω
VR2
11 V
2 %
D2
1N4006
D4
1N4006

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	Input Rectifier Conduction Time
Z	0.47		Loss Allocation Factor
η	79.0	%	Efficiency Estimate (Target)
VMIN	82.1	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	0.23	A	Average Diode Bridge Current (DC Input Current)

Device Variables

Var	Value	Units	Description
Device	TNY288PG		PI Device Name
BVDSS	700	V	Drn-Src Bkdn Voltage
Current Limit Mode	Increased		Device Current Limit Mode
PO	15.00	W	Total Output Power
VDRAIN Estimated	484.77	V	Estimated Drain Voltage
VDS	7.03	V	On state Drain to Source Voltage
I2F_MIN	50.19	A²kHz	Minimum I2F
I2F_MAX	64.69	A²kHz	Maximum I2F
FS_AT_ILIMMIN	137129	Hz	Switching Frequency at Current Limit Minimum
KP	0.57		Continuous/Discontinuous Operating Ratio (at VMIN and full load)
KP_TRANSIENT	0.37		Transient Ripple to Peak Current Ratio
DMAX	0.55		Maximum Duty Cycle (at VMIN and full load)
ILIMITMIN	0.605	A	Minimum Current Limit
ILIMITMAX	0.721	A	Maximum Current Limit
IRMS	0.34	A	Primary RMS Current (at VMIN and full load)
RTH_DEVICE	56.71	°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	119	mm²	PI Device Heatsink Area

Clamp Circuit

Var	Value	Units	Description
Clamp Type	Zener Clamp		Clamp Circuit Type
VCLAMP	19	V	Average Clamping Voltage
Estimated Clamp Loss	0.45	W	Clamp Dissipation

Transformer Construction Parameters

Var	Value	Units	Description
Core Type	EE22		Core Type
Core Material	3F3		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	3		Number of Secondary pins used
USE_SHIELDS	NO		Use shield Windings
LP_nom	919	µH	Nominal Primary Inductance
LP_Tol	10.0	%	Primary Inductance Tolerance
NP	48.9		Calculated Primary Winding Total Number of Turns
NSM	7		Secondary Main Number of Turns
CMA	379	Cmils/A	Primary Winding Current Capacity
VOR	90.8	V	Reflected Output Voltage
BW	8.45	mm	Bobbin Winding Width
ML	0.00	mm	Safety Margin on Left Width
MR	0.00	mm	Safety Margin on Right Width
FF	82	%	Actual Transformer Fit Factor. 100% signifies fully utilized winding window
AE	42.00	mm²	Core Cross Sectional Area
ALG	346	nH/T²	Gapped Core Specific Inductance
BM	2996	Gauss	Maximum Flux Density
BAC	709	Gauss	AC Flux Density for Core Loss
LG	0.131	mm	Estimated Gap Length
L_LKG	27.58	µH	Estimated primary leakage inductance

LSEC	15	nH	Secondary Trace Inductance

Primary Winding Section 1

Var	Value	Units	Description
NP1	49		Number of Primary Winding Turns in the First Section of Primary
Wire Size	29	AWG	Primary Winding - Wire Size
Winding Type	Single (x1)		Primary Winding - Number of Parallel Wire Strands
L	1.91		Primary Winding - Number of Layers
DC Copper Loss	0.06	W	Primary Section 1 DC Losses

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
NS	7		Secondary Number of Turns
Wire Size	27	AWG	Wire size of secondary winding
Winding Type	Bifilar (x2)		Output winding number of parallel strands
L_S_OUT	0.91		Secondary Output Winding Layers
DC Copper Loss	0.08	W	Secondary DC Losses
OD_VD	1.00	V	Output Winding Diode Forward Voltage Drop
PIVS	66	V	Output Rectifier Maximum Peak Inverse Voltage
ISP	3.38	A	Peak Secondary Current
ISRMS	1.67	A	Secondary RMS Current
RTH_RECTIFIER	54.76	°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	136	mm²	Output Rectifier Heatsink Area
CO	470 x 1	µF	Output Capacitor - Capacitance
IRIPPLE	1.34	A	Output Capacitor - RMS Ripple Current
Expected Lifetime	34813	hr	Output Capacitor - Expected Lifetime

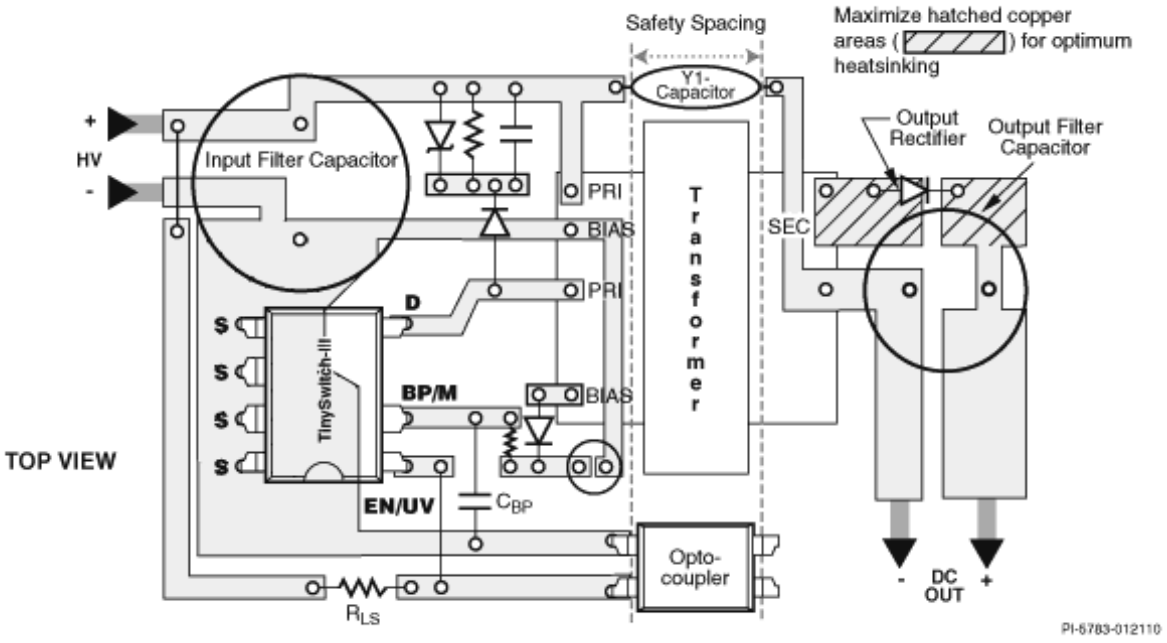
Output 2

Var	Value	Units	Description
VO	-12.00	V	Typical Output Voltage
IO	0.25	A	Output Current
VOUT_ACTUAL	-12.00	V	Actual Output Voltage
NS	7		Secondary Number of Turns
Wire Size	30	AWG	Wire size of secondary winding
Winding Type	Single (x1)		Output winding number of parallel strands
L_S_OUT	0.37		Secondary Output Winding Layers
DC Copper Loss	0.02	W	Secondary DC Losses
OD_VD	1.00	V	Output Winding Diode Forward Voltage Drop
PIVS	66	V	Output Rectifier Maximum Peak Inverse Voltage
ISP	0.85	A	Peak Secondary Current
ISRMS	0.42	A	Secondary RMS Current
RTH_RECTIFIER	219.03	°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	100 x 1	µF	Output Capacitor - Capacitance
IRIPPLE	0.34	A	Output Capacitor - RMS Ripple Current
Expected Lifetime	19911	hr	Output Capacitor - Expected Lifetime

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



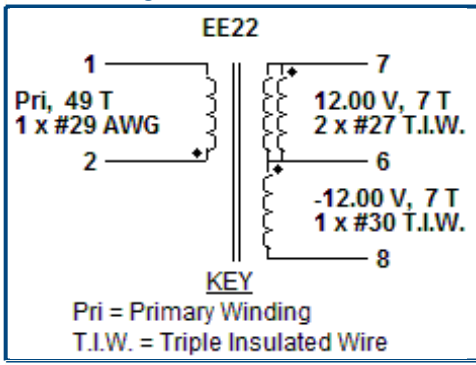
Click on the "Show me" icon to highlight relevant areas on the sample layout.

	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 rectifier and the output filter capacitor should be minimized	

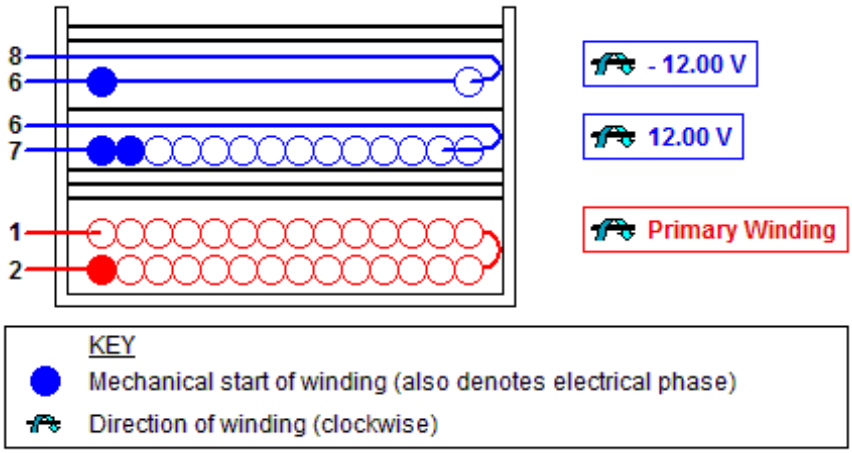
Bill Of Materials

Item #	Quantity	Part Ref	Value	Description	Mfg	Mfg Part Number
1	2	C1, C2	18 µF	18 µF, 400 V, High Voltage Al Electrolytic, (20 mm x 10 mm)	Nichicon	UCY2G180MPD
2	1	C3	10 µF	10 µF, 16 V, Ceramic, X7R	TDK	C3216X7R1C106K
3	1	C4	0.15 nF	0.15 nF, 250 VAC, Ceramic, Y Class	TDK	CD70-B2GA151KYNS
4	1	C5	27 pF	27 pF, 1 kV, High Voltage Ceramic	Panasonic	ECC-D3A270JGE
5	1	C6	82 pF	82 pF, 1 kV, High Voltage Ceramic	Panasonic	ECC-D3A820JGE
6	1	C7	100 µF	100 µF, 25 V, Electrolytic, Super Low ESR, 130 mΩ, (11 mm x 6.3 mm)	United Chemi-Con	EKZE250ELL101MF11D
7	2	C8, C10	100 µF	100 µF, 16 V, Electrolytic, Low ESR, 250 mΩ, (11.5 mm x 6.3 mm)	United Chemi-Con	ELXZ160ELL101MFB5D
8	1	C9	470 µF	470 µF, 25 V, Electrolytic, Super Low ESR, 38 mΩ, (16 mm x 10 mm)	United Chemi-Con	EKZE250ELL471MJ16S
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	BAV21	250 V, 0.25 A, Fast Recovery, 50 ns, DO-35	Vishay	BAV21
12	1	D7	UF4002	100 V, 1 A, Ultrafast Recovery, 50 ns, DO-41	Vishay	UF4002
13	1	F1	1 A	250 VAC, 1 A, Radial TR5, Time Lag Fuse	Littelfuse / Wickmann(R)	37411000410
14	1	L1	6 mH	6 mH, 1.6 A	Panasonic	ELF18N016
15	2	L2, L3	3.3 µH	3.3 µH, 2.66 A	Bourns Inc.	RL822-3R3K-RC
16	2	R1, R2	2.05 MΩ	2.05 MΩ, 1 %, 0.25 W, Metal Film	Generic	
17	1	R3	390 Ω	390 Ω, 5 %, 0.25 W, Carbon Film	Generic	
18	1	R4	130 Ω	130 Ω, 5 %, 0.25 W, Carbon Film	Generic	
19	1	R5	1000 Ω	1000 Ω, 5 %, 0.125 W, Carbon Film	Generic	
20	1	T1	EE22	3F3 Core Material See Transformer Construction's Materials List for complete information	TDK	PC40EI22-Z
21	1	U1	TNY288PG	TinySwitch-4, TNY288PG, DIP-8	Power Integrations	TNY288PG
22	1	U2	LTV817A	Optocoupler LTV817A, 35 V, CTR 80 - 160 %, 4-DIP	Liteon	LTV817A
23	1	VR1	P6KE110A	110 V, 5 W, 5 %, DO-204AC, TVS	Vishay	P6KE110A
24	1	VR2	BZX79-B11	11 V, 500 mW, 2 %, DO-204AC, General Purpose	Vishay	BZX79-B11
25	1			52 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier D6.	Custom	
26	1			119 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Device U1.	Custom	
27	1			136 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 49 turns (x 1 filar) of item [5]. in 2 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. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 1.

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

Secondary Winding

Start on pin(s) 7 and wind 7 turns (x 2 filar) of item [6]. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Finish this winding on pin(s) 6.

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

Start on pin(s) 6 and wind 7 turns (x 1 filar) of item [7]. Spread the winding evenly across entire bobbin. Finish this winding on pin(s) 8.

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: EE22, 3F3, gapped for ALG of 346 nH/T²
[2]	Bobbin: Generic, 5 pri. + 5 sec.
[3]	Barrier Tape: Polyester film [1 mil (25 µm) base thickness], 8.45 mm wide
[4]	Varnish
[5]	Magnet Wire: 29 AWG, Solderable Double Coated
[6]	Triple Insulated Wire: 27 AWG
[7]	Triple Insulated Wire: 30 AWG

Electrical Test Specifications

Parameter	*Condition*	*Spec*
Electrical Strength, VAC	60 Hz 1 second, from pins 1,2 to pins 6,7,8.	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.	919
Tolerance, ±%	Tolerance of Primary Inductance	10.0
Maximum Primary Leakage, µH	Measured between Pin 1 to Pin 2, with all other Windings shorted.	27.58

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.

The products and applications illustrated herein (including circuits external to the products and transformer construction) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations' patents may be found at www.power.com.

Design Passed (Optimization Done)