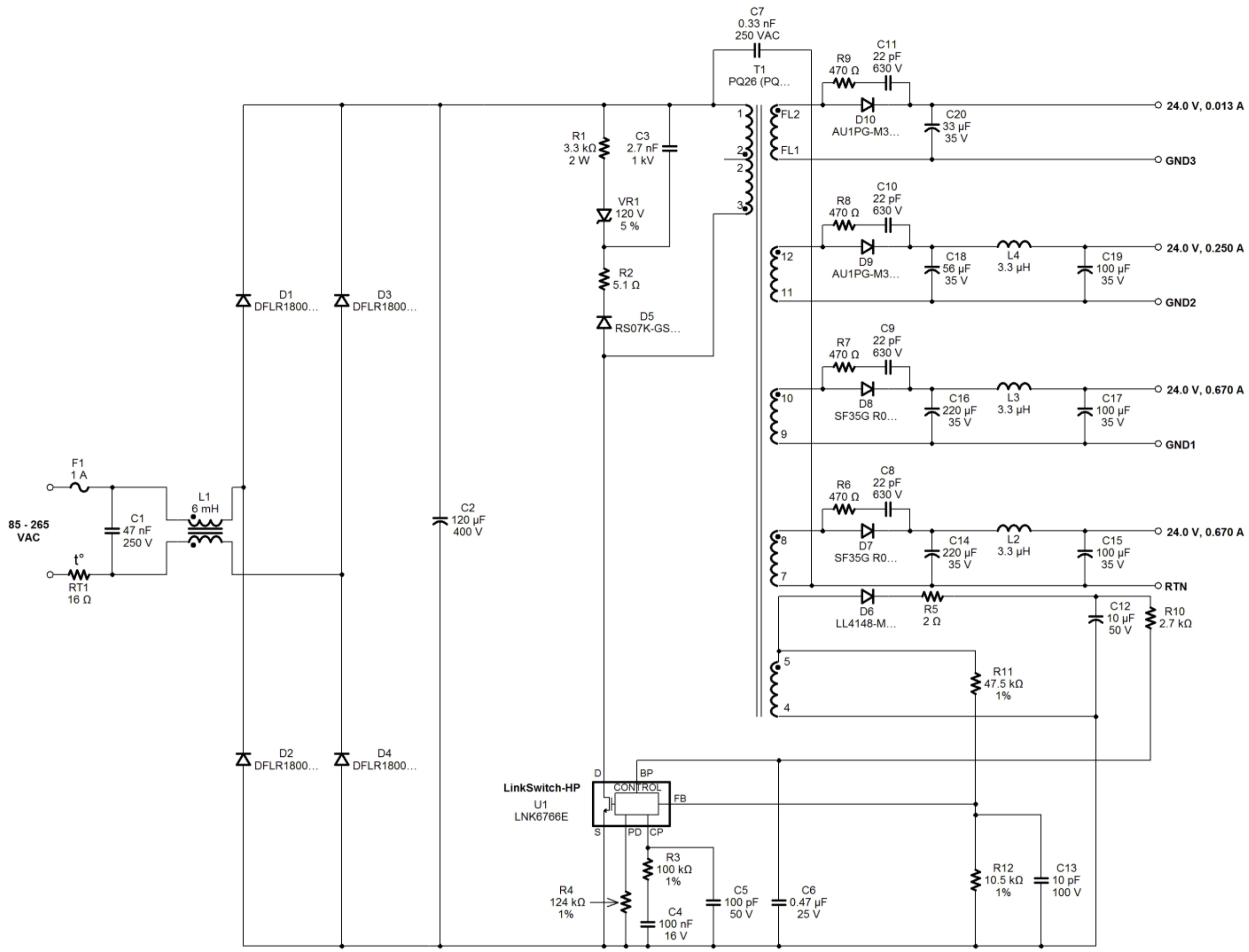


Schematic components that have been frozen by the user will appear with blue reference designators.

A primary side-regulated design requires a pre-load to ensure regulation. The designer should add an appropriate pre-load based on the expected minimum load.

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	**2.36**	*ms*	*Input Rectifier Conduction Time*
Z	**0.55**		*Loss Allocation Factor*
η	**81.0**	*%*	*Efficiency Estimate (Target)*
VMIN	**91.6**	*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	**0.52**	*A*	*Average Diode Bridge Current (DC Input Current)*
Thermistor	**16.00**	*Ω*	*Input Thermistor*

Device Variables

Var	*Value*	*Units*	*Description*
Device	**LNK6766E**		*PI Device Name*
BVDSS	**650**	*V*	*Drn-Src Bkdn Voltage*
Current Limit Mode	**Default**		*Device Current Limit Mode*
PO	**38.47**	*W*	*Total Output Power*
VDRAIN Estimated	**544.29**	*V*	*Estimated Drain Voltage*
VDS	**6.89**	*V*	*On state Drain to Source Voltage*
FS	**132000**	*Hz*	*Switching Frequency (at VMIN and Full Load)*
FMIN_OTE	**120601**	*Hz*	*Minimum Switching Frequency During On-Time Extension*
FMAX_OTE	**136163**	*Hz*	*Maximum Switching Frequency During On-Time Extension*
TSAMPLE_FULL_LOAD	**3.28**	*μs*	*Auxiliary Winding Sample Time at Full Load*
TSAMPLE_NO_LOAD	**1.65**	*μs*	*Auxiliary Winding Sample Time at No Load*
KP	**0.700**		*Continuous/Discontinuous Operating Ratio (at VMIN and Full Load)*
DMAX	**0.541**		*Maximum Duty Cycle (at VMIN and Full Load)*
KI	**1.00**		*Current Limit Reduction Factor*
ILIMITEXT	**1.81**	*A*	*Programmed Current Limit*
ILIMITMIN	**1.814**	*A*	*Minimum Current Limit*
ILIMITMAX	**2.087**	*A*	*Maximum Current Limit*
AROTE_FLAG	**NO**		*Auto Restart On-Time Extension Enable*
AROTE_ACT	**1**	*ms*	*Actual Auto Restart On-Time Extension*
IP	**1.473**	*A*	*Peak Primary Current (at VMIN and Full Load)*
IRMS	**0.738**	*A*	*Primary RMS Current (at VMIN and Full Load)*

RTH_DEVICE	**25.85**	*°C/W*	*PI Device Heatsink Maximum Thermal Resistance*
DEV_HSINK_TYPE	**Custom Aluminum**		*PI Device Heatsink Type*
DEV_HSINK_AREA	**1838**	*mm²*	*PI Device Heatsink Area*

Clamp Circuit

Var	*Value*	*Units*	*Description*
Clamp Type	**RCDZ Clamp**		*Clamp Circuit Type*
VCLAMP	**69.57**	*V*	*Average Clamping Voltage*
Estimated Clamp Loss	**2.653**	*W*	*Clamp total power loss*
VC_MARGIN	**75.28**	*V*	*Clamp Voltage Safety Margin*
TPRIMARY	**0.95**	*µs*	*Primary Drain Voltage Ring Decay Time*

Primary Bias Variables

Var	*Value*	*Units*	*Description*
VB	**10.0**	*V*	*Bias Voltage*
IB	**0.001**	*A*	*Bias Current*
PIVB	**57**	*V*	*Bias Rectifier Maximum Peak Inverse Voltage*

Feedback Winding

Var	*Value*	*Units*	*Description*
NFB	**4**		*Feedback Winding Number of Turns*
VFB	**11.88**		*Feedback pin voltage*
Layers	**0.90**		*Feedback Winding Layers*

Transformer Construction Parameters

Var	*Value*	*Units*	*Description*
Core Type	**PQ26 (PQ26/20-3F3)**		*Core Type*
Core Material	**3F3**		*Core Material*
Primary Pins	**5**		*Number of Primary pins used*
Secondary Pins	**6**		*Number of Secondary pins used*
USE_SHIELDS	**NO**		*Use shield Windings*
LP_nom	**405**	*µH*	*Nominal Primary Inductance*
LP_Tol	**10.0**	*%*	*Primary Inductance Tolerance*
NP	**31.6**		*Calculated Primary Winding Total Number of Turns*
NSM	**8**		*Secondary Main Number of Turns*
CMA	**434.31**	*Cmils/A*	*Primary Winding Current Capacity*
VOR	**99.95**	*V*	*Reflected Output Voltage*
BW	**9.00**	*mm*	*Bobbin Winding Width*
FF	**98.35**	*%*	*Actual Transformer Fit Factor. 100% signifies fully utilized winding window*
TSAMPLE_FULL_LOAD	**3.28**	*µs*	*Auxiliary Winding Sample Time at Full Load*
TSAMPLE_NO_LOAD	**1.65**	*µs*	*Auxiliary Winding Sample Time at No Load*
AE	**121.00**	*mm²*	*Core Cross Sectional Area*
ALG	**406**	*nH/T²*	*Gapped Core Specific Inductance*
BM	**1561**	*Gauss*	*Maximum Flux Density*

BP	**2433**	Gauss	Peak Flux Density
BAC	**546**	Gauss	AC Flux Density for Core Loss
LG	**0.346**	mm	Estimated Gap Length
L_LKG	**8.11**	µH	Estimated primary leakage inductance
LSEC	**20**	nH	Secondary Trace Inductance

Primary Winding Section 1

Var	Value	Units	Description
NP1	**16**		Number of Primary Winding Turns in the First Section of Primary
L	**0.90**		Primary Winding - Number of Layers
DC Copper Loss	**0.06**	W	Primary Section 1 DC Losses

Primary Winding Section 2

Var	Value	Units	Description
NP2	**16**		Rounded (Integer) Number of Primary winding turns in the second section of primary
L2	**0.90**		Primary Number of Layers in 2nd split winding

Output 1

Var	Value	Units	Description
VO	**24.00**	V	Typical Output Voltage
IO	**0.670**	A	Output Current
VOUT_ACTUAL	**24.00**	V	Actual Output Voltage
NS	**8**		Secondary Number of Turns
L_S_OUT	**0.53**		Secondary Output Winding Layers
DC Copper Loss	**0.10**	W	Secondary DC Losses
VD	**1.30**	V	Output Winding Diode Forward Voltage Drop
VD	**1.30**	V	Output Winding Diode Forward Voltage Drop
PIVS	**117.69**	V	Output Rectifier Maximum Peak Inverse Voltage
ISP	**2.433**	A	Peak Secondary Current
ISRMS	**1.122**	A	Secondary RMS Current
ISRMS_WINDING	**1.122**	A	Secondary Winding RMS Current
CMAS	**225**	Cmils/A	Secondary Winding Current Capacity
RTH_RECTIFIER	**62.56**	°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	**82**	mm²	Output Rectifier Heatsink Area
CO	**220 x 1**	µF	Output Capacitor - Capacitance
IRIPPLE	**0.900**	A	Output Capacitor - RMS Ripple Current
Expected Lifetime	**27230**	hr	Output Capacitor - Expected Lifetime

Output 2

Var	Value	Units	Description
VO	**24.00**	V	Typical Output Voltage
IO	**0.670**	A	Output Current

VOUT_ACTUAL	**24.00**	*V*	*Actual Output Voltage*
NS	**8**		*Secondary Number of Turns*
L_S_OUT	**0.53**		*Secondary Output Winding Layers*
DC Copper Loss	**0.11**	*W*	*Secondary DC Losses*
VD	**1.30**	*V*	*Output Winding Diode Forward Voltage Drop*
VD	**1.30**	*V*	*Output Winding Diode Forward Voltage Drop*
PIVS	**117.69**	*V*	*Output Rectifier Maximum Peak Inverse Voltage*
ISP	**2.433**	*A*	*Peak Secondary Current*
ISRMS	**1.122**	*A*	*Secondary RMS Current*
ISRMS_WINDING	**1.122**	*A*	*Secondary Winding RMS Current*
CMAS	**225**	*Cmils/A*	*Secondary Winding Current Capacity*
RTH_RECTIFIER	**62.56**	*°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	**82**	*mm²*	*Output Rectifier Heatsink Area*
CO	**220 x 1**	*µF*	*Output Capacitor - Capacitance*
IRIPPLE	**0.900**	*A*	*Output Capacitor - RMS Ripple Current*
Expected Lifetime	**27230**	*hr*	*Output Capacitor - Expected Lifetime*

Output 3

Var	***Value***	***Units***	***Description***
VO	**24.00**	*V*	*Typical Output Voltage*
IO	**0.250**	*A*	*Output Current*
VOUT_ACTUAL	**23.80**	*V*	*Actual Output Voltage*
NS	**8**		*Secondary Number of Turns*
L_S_OUT	**0.40**		*Secondary Output Winding Layers*
DC Copper Loss	**0.04**	*W*	*Secondary DC Losses*
VD	**1.50**	*V*	*Output Winding Diode Forward Voltage Drop*
VD	**1.50**	*V*	*Output Winding Diode Forward Voltage Drop*
PIVS	**117.49**	*V*	*Output Rectifier Maximum Peak Inverse Voltage*
ISP	**0.908**	*A*	*Peak Secondary Current*
ISRMS	**0.419**	*A*	*Secondary RMS Current*
ISRMS_WINDING	**0.419**	*A*	*Secondary Winding RMS Current*
CMAS	**239**	*Cmils/A*	*Secondary Winding Current Capacity*
RTH_RECTIFIER	**146.79**	*°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	**56 x 1**	*µF*	*Output Capacitor - Capacitance*
IRIPPLE	**0.336**	*A*	*Output Capacitor - RMS Ripple Current*
Expected Lifetime	**19873**	*hr*	*Output Capacitor - Expected Lifetime*

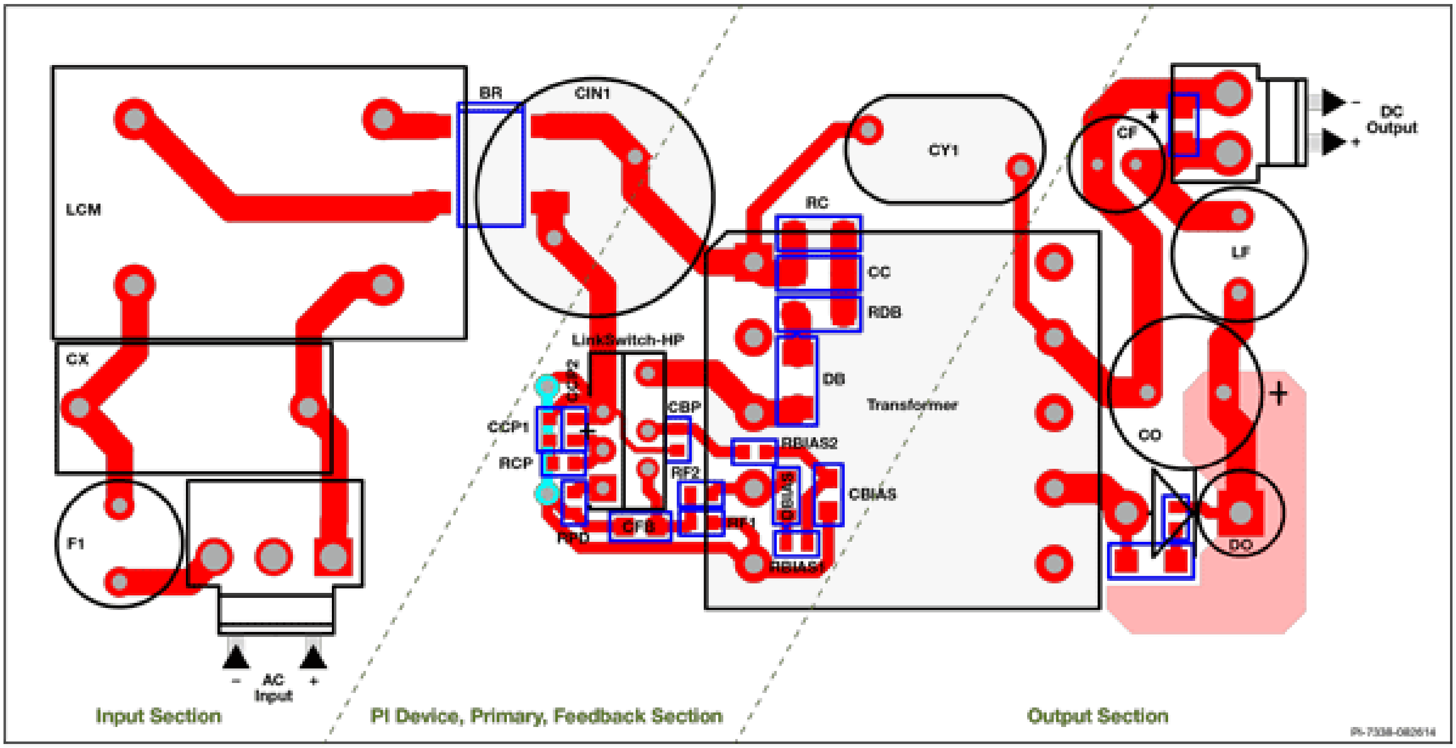
Output 4

Var	Value	Units	Description
VO	**24.00**	V	Typical Output Voltage
IO	**0.013**	A	Output Current
VOUT_ACTUAL	**23.80**	V	Actual Output Voltage
NS	**8**		Secondary Number of Turns
L_S_OUT	**0.36**		Secondary Output Winding Layers
DC Copper Loss	**0.00**	W	Secondary DC Losses
VD	**1.50**	V	Output Winding Diode Forward Voltage Drop
VD	**1.50**	V	Output Winding Diode Forward Voltage Drop
PIVS	**117.49**	V	Output Rectifier Maximum Peak Inverse Voltage
ISP	**0.045**	A	Peak Secondary Current
ISRMS	**0.021**	A	Secondary RMS Current
ISRMS_WINDING	**0.021**	A	Secondary Winding RMS Current
CMAS	**3058**	Cmils/A	Secondary Winding Current Capacity
RTH_RECTIFIER	**3109.02**	°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	**33 x 1**	µF	Output Capacitor - Capacitance
IRIPPLE	**0.017**	A	Output Capacitor - RMS Ripple Current
Expected Lifetime	**31900**	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



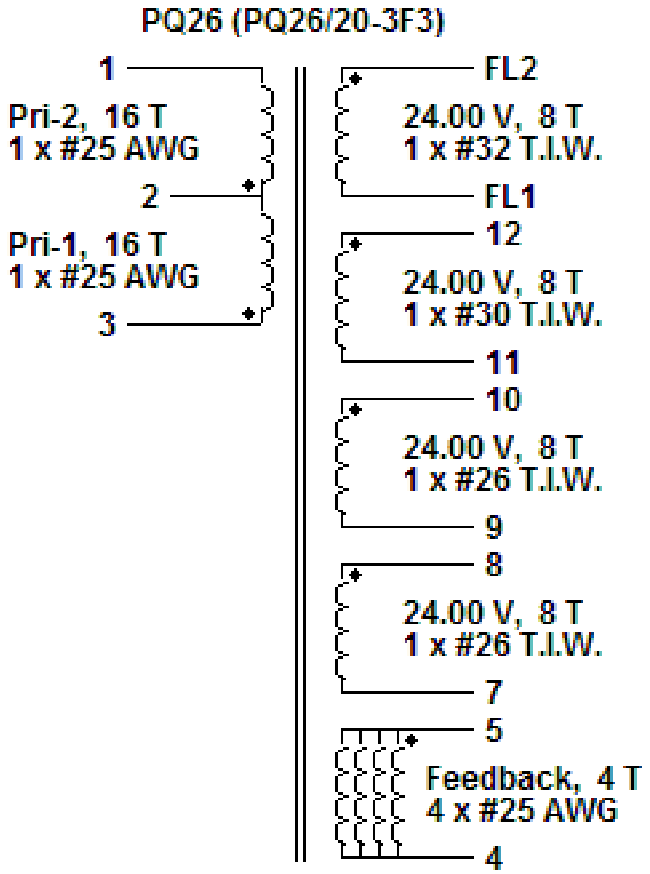
Click on the "Show me" icon to highlight relevant areas on the sample layout.		
	Description	*Show Me*
1	*Minimize loop area formed by drain, input capacitor and transformer*	
2	*Minimize loop area formed by secondary winding, the output rectifier and the output filter capacitor*	
3	*Minimize the loop area formed by the clamp blocking diode, the damping resistor and the snubber capacitor*	
4	*Place the FB/BP/CP pin components as close to the pin as possible. These signal traces should be routed separately from the power traces. Use of kelvin connection for this purpose is highly recommended.*	
5	*A large copper area on the cathode of the secondary rectifier is acceptable since this is a quiet node and the larger copper area actually provides heatsinking to the rectifier*	
6	*The Y capacitor should be placed directly from the primary input filter capacitor positive terminal to the common/return terminal of the transformer secondary*	

Bill Of Materials

Item #	Quantity	Part Ref	Value	Description	Mfg	Mfg Part Number
1	1	C1	47 nF	47 nF, 250 V, Film, X Class	Murata	GA355ER7GB473KW01L
2	1	C2	120 µF	120 µF, 400 V, High Voltage Al Electrolytic, (35.5 mm x 18 mm)	Nichicon	UPT2G121MHD6
3	1	C3	2.7 nF	2.7 nF, 1 kV, High Voltage Ceramic	Kemet	C1210H272JDGACTU
4	1	C4	100 nF	100 nF, 16 V, Ceramic, X7R	AVX Corp	0603YC104K4T4A
5	1	C5	100 pF	100 pF, 50 V, Ceramic, C0G	Wurth Elektronik	885012009011
6	1	C6	0.47 µF	0.47 µF, 25 V, Ceramic, X7R	Kemet	C0805C474K3RAC7800
7	1	C7	0.33 nF	0.33 nF, 250 VAC, Ceramic, Y Class	Murata	GA342DR7GF331KW02L
8	4	C8, C9, C10, C11	22 pF	22 pF, 630 V, High Voltage Ceramic	Murata	GRM31A5C2J220JW01D
9	1	C12	10 µF	10 µF, 50 V, Electrolytic, Gen Purpose, 1000 mΩ, (6.1 mm x 6.3 mm)	Rubycon	50TRV10M6.3X6.1
10	1	C13	10 pF	10 pF, 100 V, Ceramic, C0G	Kemet	K100J15C0GH5TL2
11	2	C14, C16	220 µF	220 µF, 35 V, Electrolytic, Super Low ESR, 56 mΩ, (15 mm x 8 mm)	United Chemi-Con	EKZE350ELL221MH15D
12	3	C15, C17, C19	100 µF	100 µF, 35 V, Electrolytic, Low ESR, 80 mΩ, (10.2 mm x 8 mm)	Panasonic	EEE-FP1V101AP
13	1	C18	56 µF	56 µF, 35 V, Electrolytic, Super Low ESR, 130 mΩ, (11 mm x 6.3 mm)	United Chemi-Con	EKZE350ELL560MF11D
14	1	C20	33 µF	33 µF, 35 V, Electrolytic, Super Low ESR, 300 mΩ, (11 mm x 5 mm)	United Chemi-Con	EKZE350ELL330ME11D
15	4	D1, D2, D3, D4	DFLR1800-7	800 V, 1 A, Standard Recovery, POWERDI123	Diodes Inc.	DFLR1800-7
16	1	D5	RS07K-GS08	800 V, 1.4 A, Fast Recovery, 300 ns, DO-219AB	Vishay	RS07K-GS08
17	1	D6	LL4148-M-08	100 V, 0.15 A, Fast Recovery, 8 ns, SOD-80	Vishay	LL4148-M-08
18	2	D7, D8	SF35G R0G	300 V, 3 A, Ultrafast Recovery, 35 ns, DO-201AD	Taiwan Semiconductor Corporation	SF35G R0G
19	2	D9, D10	AU1PG-M3/84A	400 V, 1 A, Ultrafast Recovery, 75 ns, DO-220AA	Vishay	AU1PG-M3/84A
20	1	F1	1 A	250 VAC, 1 A, Radial TR5, Time Lag Fuse	Littelfuse / Wickmann(R)	37411000410
21	1	HS1		45.9 mm x 20 mm. Aluminum Alloy (3003 OR 5052), 1.6 mm thickness. Heatsink for use with Device U1.	Custom	
22	1	L1	6 mH	6 mH, 1.6 A	Panasonic	ELF18N016
23	3	L2, L3, L4	3.3 µH	3.3 µH, 2.6 A	Murata	LQH66SN3R3M03L
24	1	R1	3.3 kΩ	3.3 kΩ, 5 %, 2 W, Metal Oxide Film	Generic	
25	1	R2	5.1 Ω	5.1 Ω, 5 %, 0.25 W, Thick Film	Generic	
26	1	R3	100 kΩ	100 kΩ, 1 %, 0.25 W, Thick Film	Generic	
27	1	R4	124 kΩ	124 kΩ, 1 %, 0.125 W, Thick Film	Generic	
28	1	R5	2 Ω	2 Ω, 5 %, 0.125 W, Thick Film	Generic	
29	4	R6, R7, R8, R9	470 Ω	470 Ω, 5 %, 0.25 W, Thick Film	Generic	
30	1	R10	2.7 kΩ	2.7 kΩ, 5 %, 0.125 W, Thick Film	Generic	
31	1	R11	47.5 kΩ	47.5 kΩ, 1 %, 0.25 W, Thick Film	Generic	

32	*1*	*R12*	*10.5 kΩ*	*10.5 kΩ, 1 %, 0.125 W, Thick Film*	*Generic*	
33	*1*	*RT1*	*16 Ω*	*NTC Thermistor 16 Ω, 1.7 A*	*Thermometrics*	*CL-180*
34	*1*	*T1*	*PQ26 (PQ26/20-3F3)*	*3F3 Core Material* *Refer to Manufacturer datasheet for a number of parts to purchase*	*Ferroxcube*	*PQ26/20-3F3*
35	*1*	*T1 Bobbin*	*PQ26/20 - 2 (P6-S6)*	*Bobbin Material : Polyethylene terephtalate (PET)*	*Ferroxcube*	*CPV-PQ26/20-1S-12P-Z*
36	*1*	*T1 Core Acc.1*	*CLM/P-PQ26/20*	*Clamp . Phosphorbronze, Sn plated*	*Ferroxcube*	*CLM/P-PQ26/20*
37	*1*	*U1*	*LNK6766E*	*LinkSwitch-HP, LNK6766E, eSIP-7C*	*Power Integrations*	*LNK6766E*
38	*1*	*VR1*	*P6SMB120CA*	*120 V, 5 W, 5 %, DO-214AA, TVS*	*Vishay*	*P6SMB120CA*
39	*1*			*52 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier D9.*	*Custom*	
40	*1*			*52 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier D10.*	*Custom*	
41	*1*			*82 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier D7.*	*Custom*	
42	*1*			*82 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier D8.*	*Custom*	

Electrical Diagram



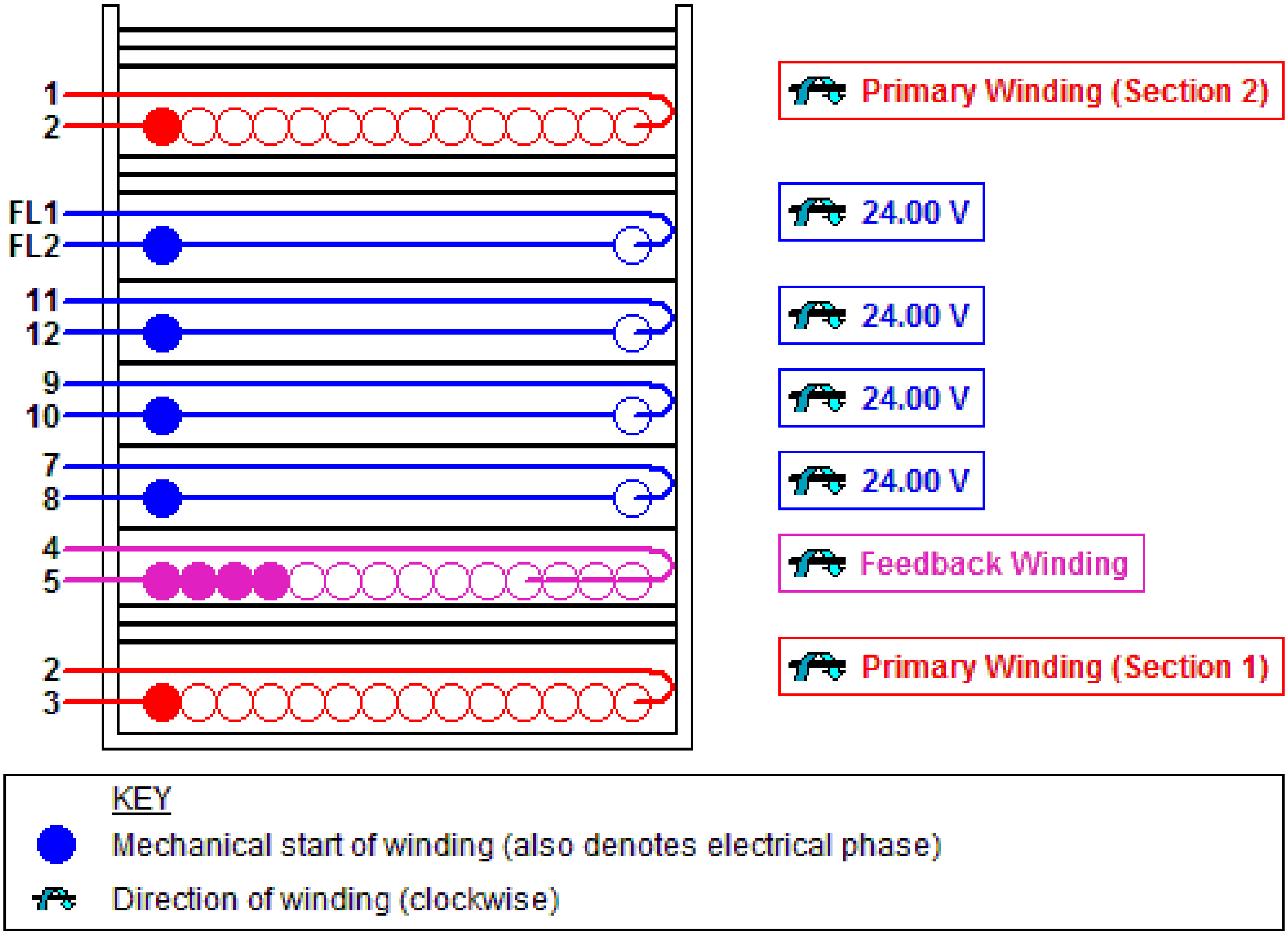
KEY

Pri-1 = Primary Winding (Section 1)

Pri-2 = Primary Winding (Section 2)

T.I.W. = Triple Insulated Wire

Mechanical Diagram



Winding Instruction

Primary Winding (Section 1)

Start on pin(s) 3 and wind 16 turns (x 1 filar) of item [5]. in 1 layer(s) from left to right. Winding direction is clockwise. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 2.

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

Feedback Winding

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

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

Secondary Winding

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

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

Start on pin(s) 10 and wind 8 turns (x 1 filar) of item [6]. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Finish this winding on pin(s) 9.

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

Start on pin(s) 12 and wind 8 turns (x 1 filar) of item [7]. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Finish this winding on pin(s) 11.

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

Take (x 1 filar) of item [8]. Mark FL2 at the start and wind 8 turns. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Mark finish lead(s) as FL1.

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

Primary Winding (Section 2)

Start on pin(s) 2 and wind 16 turns (x 1 filar) of item [5]. in 1 layer(s) from left to right. Winding direction is clockwise. 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.

Core Assembly

Assemble and secure core halves. Item [1].

Varnish

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

Comments

1. Each Flying Lead insulation length measured from core or any 'connected to primary' winding is at least 6.4 mm or as long as needed to
2. Use of a grounded flux-band around the core may improve the EMI performance.
3. For non margin wound transformers use triple insulated wire for all secondary windings.

Materials

Item	*Description*
[1]	**Core: PQ26 (PQ26/20-3F3), 3F3, gapped for ALG of 406 nH/T²**
[2]	**Bobbin: Generic, 6 pri. + 6 sec.**
[3]	**Barrier Tape: Polyester film [1 mil (25 µm) base thickness], 9.00 mm wide**
[4]	**Varnish**
[5]	**Magnet Wire: 25 AWG (0.45 mm), Solderable Double Coated**
[6]	**Triple Insulated Wire: 26 AWG (0.4 mm)**
[7]	**Triple Insulated Wire: 30 AWG (0.25 mm)**
[8]	**Triple Insulated Wire: 32 AWG (0.2 mm)**

Electrical Test Specifications

Parameter	*Condition*	*Spec*
Electrical Strength, VAC	**60 Hz 1 second, from pins 1,2,3,4,5 to pins 7,8,9,10,11,12 & FL1,FL2.**	**3000**
Nominal Primary Inductance, µH	**Measured at 1 V pk-pk, typical switching frequency, between pin 1 to pin 3, with all other Windings open.**	**405**
Tolerance, ±%	**Tolerance of Primary Inductance**	**10.0**
Maximum Primary Leakage, µH	**Measured between Pin 1 to Pin 3, with all other Windings shorted.**	**8.11**

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.