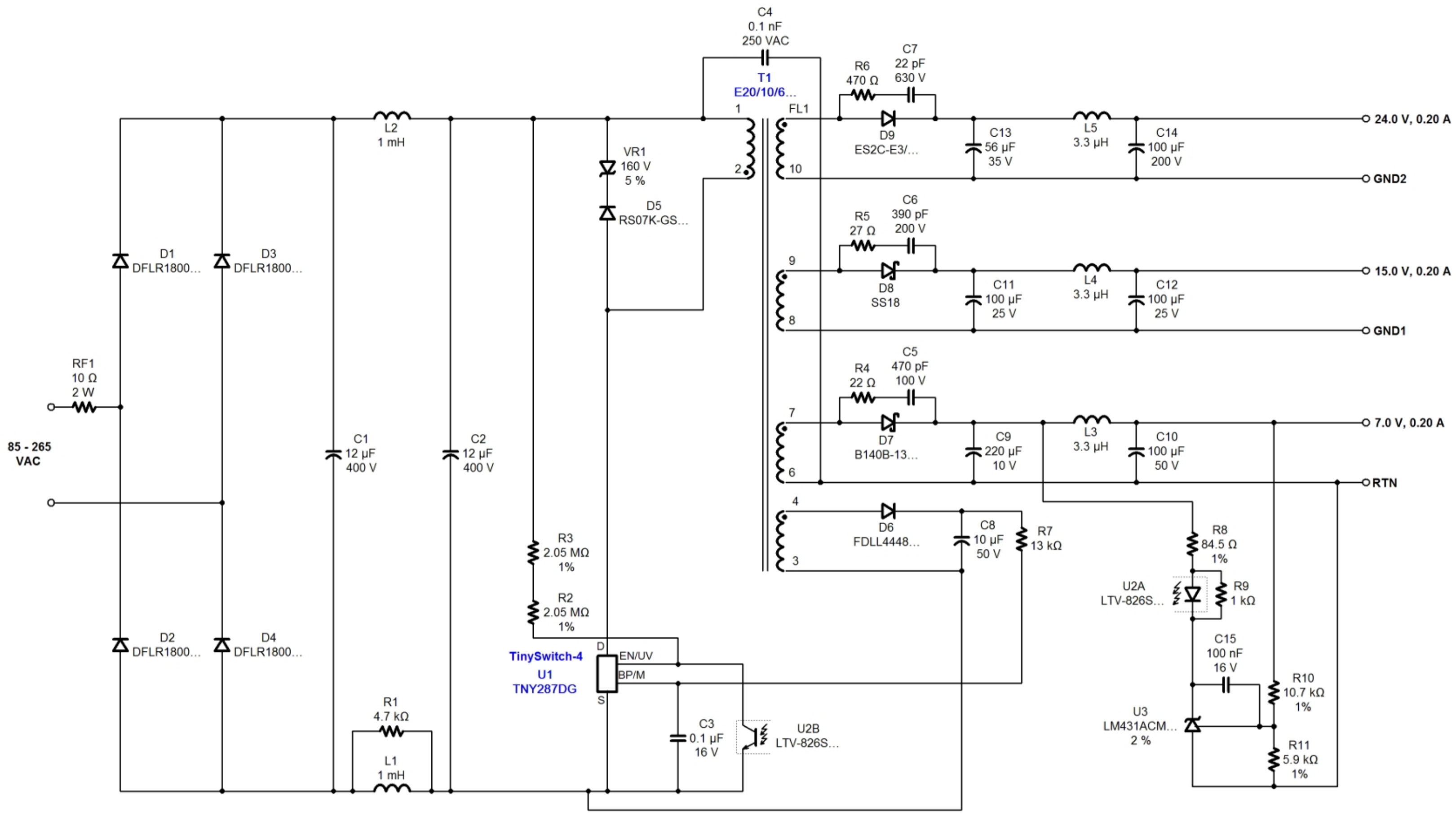


Schematic components that have been frozen by the user will appear with blue reference designators.

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	0.49		Loss Allocation Factor
η	73.0	%	Efficiency Estimate (Target)
VMIN	81.9	V	Minimum DC Input Voltage
VMAX	374.8	V	Maximum DC Input Voltage

Input Section

Var	Value	Units	Description
RFUSE	10.00	Ω	**Fusible Resistor.**
IAVG	0.16	A	Average Diode Bridge Current (DC Input Current)

Device Variables

Var	Value	Units	Description
Device	TNY287DG		PI Device Name (Manual Overwrite)
BVDSS	700	V	Drn-Src Bkdn Voltage
Current Limit Mode	Standard		Device Current Limit Mode (Manual Overwrite)
OVP_FLAG	NO		Output Overvoltage Protection Enabled
PO	9.27	W	Total Output Power
VDRAIN Estimated	534.77	V	Estimated Drain Voltage
VDS	5.47	V	On state Drain to Source Voltage
I2F_MIN	24.06	A^2kHz	Minimum I2F
I2F_MAX	29.94	A^2kHz	Maximum I2F
FS_AT_ILIMMIN	137029	Hz	Switching Frequency at Current Limit Minimum
KP	0.808		Continuous/Discontinuous Operating Ratio (at VMIN and Full Load)
KP_TRANSIENT	0.72		Transient Ripple to Peak Current Ratio
DMAX	0.638		Maximum Duty Cycle (at VMIN and Full Load)
ILIMITMIN	0.419	A	Minimum Current Limit
ILIMITMAX	0.481	A	Maximum Current Limit
IRMS	0.220	A	Primary RMS Current (at VMIN and Full Load)
RTH_DEVICE	87.20	°C/W	PI Device Heatsink Maximum Thermal Resistance
DEV_HSINK_TYPE	2 Oz (70 µ) 2-Sided Copper		PI Device Heatsink Type
DEV_HSINK_AREA	52	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

Primary Bias Variables

Var	Value	Units	Description
VB	12.0	V	Bias Voltage

IB	**0.001**	A	Bias Current
PIVB	**49**	V	Bias Rectifier Maximum Peak Inverse Voltage
NB	**9**		Primary Bias Winding Number of Turns

Transformer Construction Parameters

Var	Value	Units	Description
Core Type	**E20/10/6 (EF20)**		Core Type (Manual Overwrite)
Core Material	**3F3**		Core Material
Bobbin Reference	**Generic, 5 pri. + 5 sec.**		Bobbin Reference
Bobbin Orientation	**Horizontal**		Bobbin type
Primary Pins	**4**		Number of Primary pins used
Secondary Pins	**5**		Number of Secondary pins used
USE_SHIELDS	**NO**		Use shield Windings
LP_nom	**1049**	µH	Nominal Primary Inductance
LP_Tol	**10.0**	%	Primary Inductance Tolerance
NP	**90.0**		Calculated Primary Winding Total Number of Turns
NSM	**5**		Secondary Main Number of Turns
Primary Current Density	**5.76**	A/mm²	Primary Winding Current Density
VOR	**135.00**	V	Reflected Output Voltage
BW	**12.50**	mm	Bobbin Winding Width
ML	**3.00**	mm	**Safety Margin on Left Width (Manual Overwrite).**
MR	**3.00**	mm	**Safety Margin on Right Width (Manual Overwrite). See Warnings section for detail**
FF	**92.99**	%	Actual Transformer Fit Factor. 100% signifies fully utilized winding window
AE	**32.10**	mm²	Core Cross Sectional Area
ALG	**117**	nH/T²	Gapped Core Specific Inductance
BM	**162**	mT	Maximum Flux Density
BAC	**57**	mT	AC Flux Density for Core Loss
LG	**0.315**	mm	Estimated Gap Length
L_LKG	**31.46**	µH	Estimated primary leakage inductance
LSEC	**15**	nH	Secondary Trace Inductance

Primary Winding Section 1

Var	Value	Units	Description
NP1	**90**		Number of Primary Winding Turns in the First Section of Primary
Wire Size	**0.22**	mm	Primary Wire Inner Diameter Actual (Manual Overwrite)
Winding Type	**Single (x1)**		Primary Winding - Number of Parallel Wire Strands (Manual Overwrite)
L	**3.69**		Primary Winding - Number of Layers
DC Copper Loss	**0.08**	W	Primary Section 1 DC Losses

Output 1

Var	Value	Units	Description
VO	**15.00**	V	Typical Output Voltage
IO	**0.20**	A	Output Current
VOUT_ACTUAL	**15.65**	V	Actual Output Voltage
NS	**11**		Secondary Number of Turns

Wire Size	**0.25**	*mm*	*Secondary Wire Inner Diameter Actual*
Winding Type	**Single (x1)**		*Output winding number of parallel strands*
L_S_OUT	**0.50**		*Secondary Output Winding Layers*
DC Copper Loss	**0.04**	*W*	*Secondary DC Losses*
VD	**0.85**	*V*	*Output Winding Diode Forward Voltage Drop*
VD	**0.85**	*V*	*Output Winding Diode Forward Voltage Drop*
PIVS	**61.45**	*V*	*Output Rectifier Maximum Peak Inverse Voltage*
ISP	**1.139**	*A*	*Peak Secondary Current*
ISRMS	**0.438**	*A*	*Secondary RMS Current*
ISRMS_WINDING	**0.438**	*A*	*Secondary Winding RMS Current*
Secondary Current Density	**9**	*A/mm²*	*Secondary Winding Current Density*
RTH_RECTIFIER	**312.39**	*°C/W*	*Output Rectifier Heatsink Maximum Thermal Resistance*
OR_HSINK_TYPE	**2 Oz (70 µ) 2-Sided Copper**		*Output Rectifier Heatsink Type*
OR_HSINK_AREA	**52**	*mm²*	*Output Rectifier Heatsink Area*
CO	**100 x 1**	*µF*	*Output Capacitor - Capacitance*
IRIPPLE	**0.390**	*A*	*Output Capacitor - RMS Ripple Current*
Expected Lifetime	**16831**	*hr*	*Output Capacitor - Expected Lifetime*

Output 2

Var	*Value*	*Units*	*Description*
VO	**7.00**	*V*	*Typical Output Voltage*
IO	**0.20**	*A*	*Output Current*
VOUT_ACTUAL	**7.00**	*V*	*Actual Output Voltage*
NS	**5**		*Secondary Number of Turns*
Wire Size	**0.25**	*mm*	*Secondary Wire Inner Diameter Actual*
Winding Type	**Single (x1)**		*Output winding number of parallel strands*
L_S_OUT	**0.23**		*Secondary Output Winding Layers*
DC Copper Loss	**0.02**	*W*	*Secondary DC Losses*
VD	**0.50**	*V*	*Output Winding Diode Forward Voltage Drop*
VD	**0.50**	*V*	*Output Winding Diode Forward Voltage Drop*
PIVS	**27.82**	*V*	*Output Rectifier Maximum Peak Inverse Voltage*
ISP	**1.139**	*A*	*Peak Secondary Current*
ISRMS	**0.438**	*A*	*Secondary RMS Current*
ISRMS_WINDING	**0.438**	*A*	*Secondary Winding RMS Current*
Secondary Current Density	**9**	*A/mm²*	*Secondary Winding Current Density*
RTH_RECTIFIER	**569.71**	*°C/W*	*Output Rectifier Heatsink Maximum Thermal Resistance*
OR_HSINK_TYPE	**2 Oz (70 µ) 2-Sided Copper**		*Output Rectifier Heatsink Type*
OR_HSINK_AREA	**52**	*mm²*	*Output Rectifier Heatsink Area*
CO	**220 x 1**	*µF*	*Output Capacitor - Capacitance*
IRIPPLE	**0.390**	*A*	*Output Capacitor - RMS Ripple Current*
Expected Lifetime	**16831**	*hr*	*Output Capacitor - Expected Lifetime*

Output 3

Var	*Value*	*Units*	*Description*
VO	**24.00**	*V*	*Typical Output Voltage*

IO	**0.20**	*A*	*Output Current*
VOUT_ACTUAL	**24.60**	*V*	*Actual Output Voltage*
NS	**17**		*Secondary Number of Turns*
Wire Size	**0.25**	*mm*	*Secondary Wire Inner Diameter Actual*
Winding Type	**Single (x1)**		*Output winding number of parallel strands*
L_S_OUT	**0.77**		*Secondary Output Winding Layers*
DC Copper Loss	**0.07**	*W*	*Secondary DC Losses*
VD	**0.90**	*V*	*Output Winding Diode Forward Voltage Drop*
VD	**0.90**	*V*	*Output Winding Diode Forward Voltage Drop*
PIVS	**95.39**	*V*	*Output Rectifier Maximum Peak Inverse Voltage*
ISP	**1.139**	*A*	*Peak Secondary Current*
ISRMS	**0.438**	*A*	*Secondary RMS Current*
ISRMS_WINDING	**0.438**	*A*	*Secondary Winding RMS Current*
Secondary Current Density	**9**	*A/mm²*	*Secondary Winding Current Density*
RTH_RECTIFIER	**275.17**	*°C/W*	*Output Rectifier Heatsink Maximum Thermal Resistance*
OR_HSINK_TYPE	**2 Oz (70 µ) 2-Sided Copper**		*Output Rectifier Heatsink Type*
OR_HSINK_AREA	**52**	*mm²*	*Output Rectifier Heatsink Area*
CO	**56 x 1**	*µF*	*Output Capacitor - Capacitance*
IRIPPLE	**0.390**	*A*	*Output Capacitor - RMS Ripple Current*
Expected Lifetime	**16831**	*hr*	*Output Capacitor - Expected Lifetime*

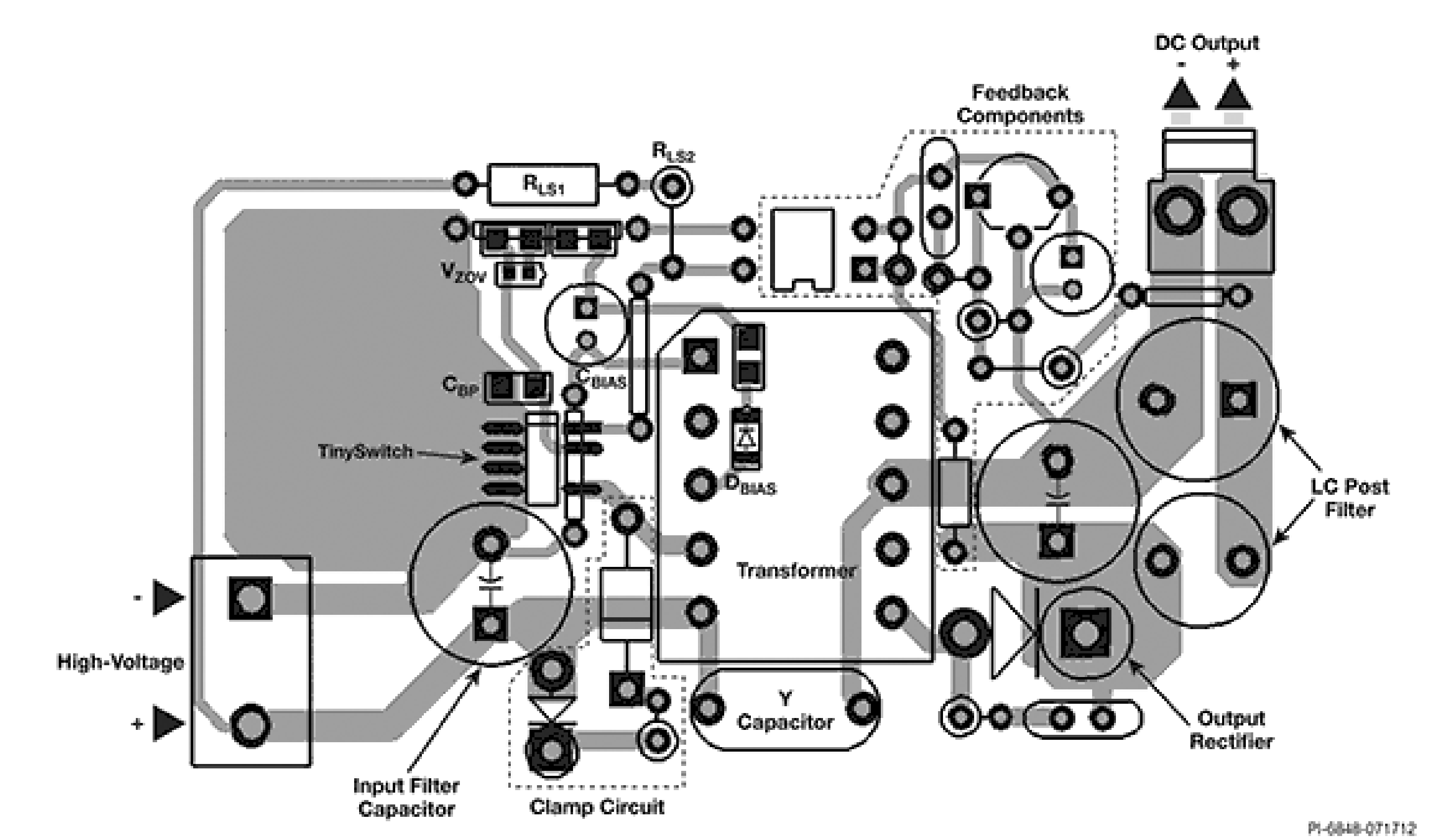
Feedback Circuit

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	**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.

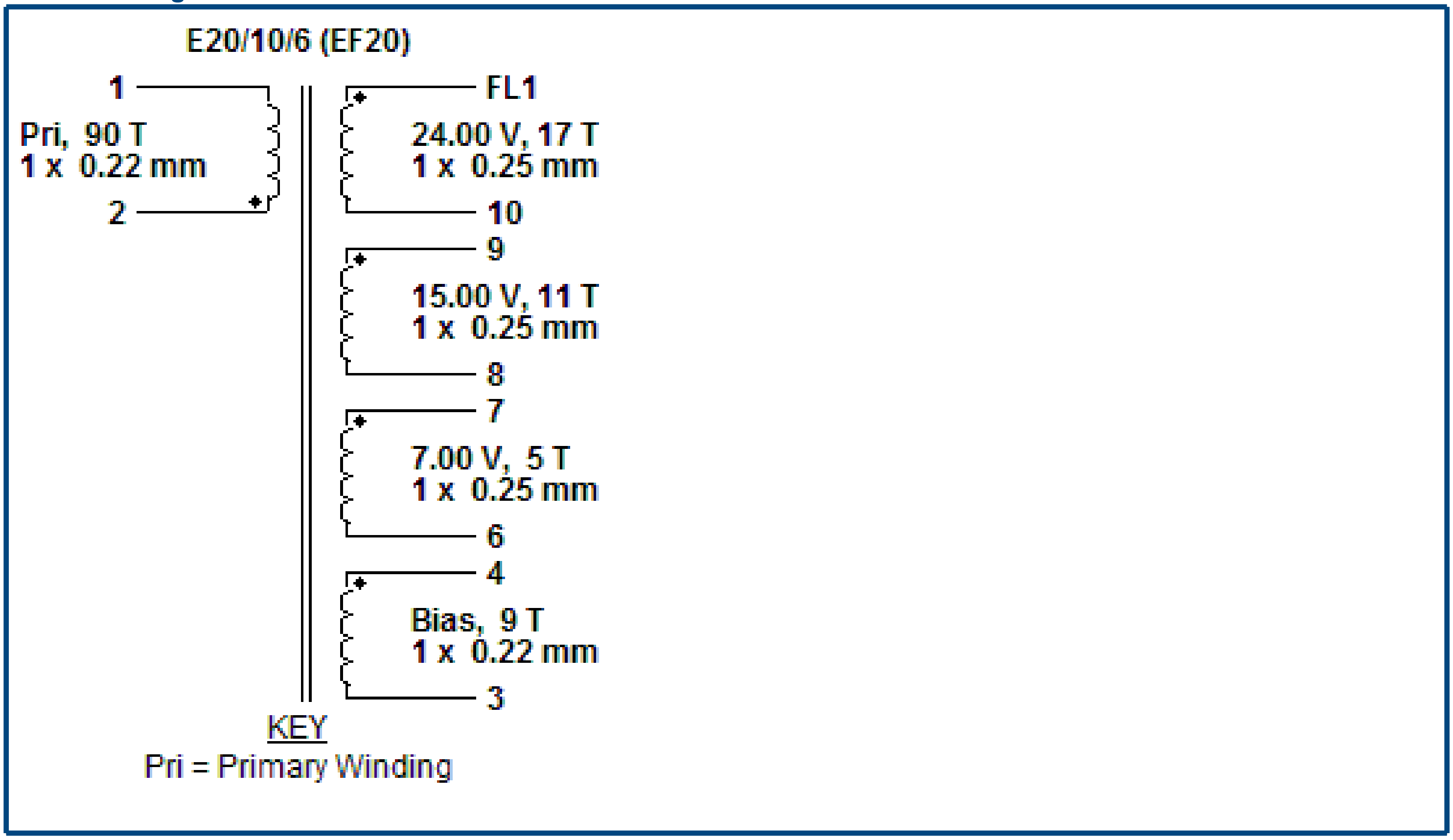
	Description	*Show Me*
1	*Maximize source area for good heat-sinking*	
2	*Keep drain trace short*	
3	*The BYPASS pin capacitor should be located as close as possible to the BYPASS and SOURCE pins*	
4	*Keep noisy traces away from EN/UV pin*	
5	*Route bias winding currents back to the bulk cap*	
6	*Keep 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 rectifier and the output filter capacitor should be minimized*	

Bill Of Materials

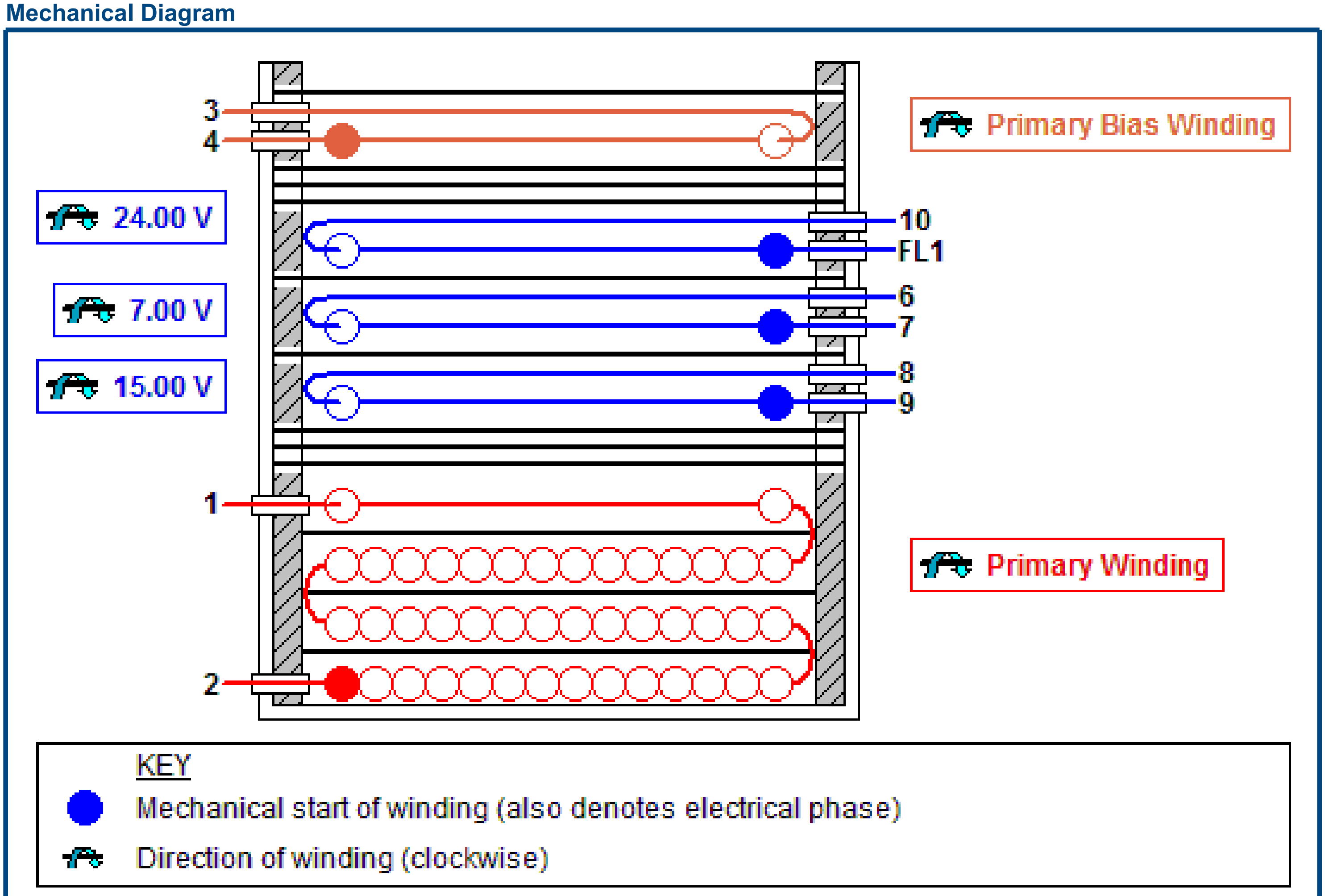
Item #	Quantity	Part Ref	Value	Description	Mfg	Mfg Part Number
1	2	C1, C2	12 µF	12 µF, 400 V, High Voltage Al Electrolytic, (17.5 mm x 10 mm)	Rubycon	400BXF12MCT10X16
2	2	C3, C15	0.1 µF	0.1 µF, 16 V, Ceramic, X7R	AVX Corp	0603YC104K4T4A
3	1	C4	0.1 nF	0.1 nF, 250 VAC, Ceramic, Y Class	Murata	GA342QR7GF101KW01L
4	1	C5	470 pF	470 pF, 100 V, Ceramic, C0G	AVX Corp	08051A471JAT2A
5	1	C6	390 pF	390 pF, 200 V, High Voltage Ceramic	AVX Corp	08052C391KAT2A
6	1	C7	22 pF	22 pF, 630 V, High Voltage Ceramic	Murata	GRM31A5C2J220JW01D
7	1	C8	10 µF	10 µF, 50 V, Electrolytic, Gen Purpose, 1000 mΩ, (6.1 mm x 6.3 mm)	Rubycon	50TRV10M6.3X6.1
8	1	C9	220 µF	220 µF, 10.0 V, Electrolytic, Super Low ESR, 130 mΩ, (11 mm x 6.3 mm)	United Chemi-Con	EKZE100ELL221MF11D
9	1	C10	100 µF	100 µF, 50 V, Electrolytic, Low ESR, 200 mΩ, (10.3 mm x 10 mm)	Nichicon	UCX1H101MCS1GS
10	1	C11	100 µF	100 µF, 25 V, Electrolytic, Super Low ESR, 130 mΩ, (11 mm x 6.3 mm)	United Chemi-Con	EKZE250ELL101MF11D
11	1	C12	100 µF	100 µF, 25 V, Electrolytic, Low ESR, 260 mΩ, (8 mm x 6.2 mm)	Panasonic	EEEFK1E101AP
12	1	C13	56 µF	56 µF, 35 V, Electrolytic, Super Low ESR, 130 mΩ, (11 mm x 6.3 mm)	United Chemi-Con	EKZE350ELL560MF11D
13	1	C14	100 µF	100 µF, 200 V, Electrolytic, Low ESR, 1900 mΩ, (21.5 mm x 18 mm)	Panasonic	EEVEB2D101M
14	4	D1, D2, D3, D4	DFLR1800-7	800 V, 1 A, Standard Recovery, POWERDI123	Diodes Inc.	DFLR1800-7
15	1	D5	RS07K-GS08	800 V, 1.4 A, Fast Recovery, 300 ns, DO-219AB	Vishay	RS07K-GS08
16	1	D6	FDLL4448	100 V, 0.3 A, Fast Recovery, 4 ns, SOD-80	ON Semiconductor	FDLL4448
17	1	D7	B140B-13-F	40 V, 1 A, Schottky, DO-214AA	Diodes Inc.	B140B-13-F
18	1	D8	SS18	80 V, 1 A, Schottky, DO-214AC	ON Semiconductor	SS18
19	1	D9	ES2C-E3/52T	150 V, 2 A, Ultrafast Recovery, 30 ns, DO-214AA	Vishay	ES2C-E3/52T
20	2	L1, L2	1 mH	1 mH, 0.33 A	Bourns Inc.	B82464A4105K000
21	3	L3, L4, L5	3.3 µH	3.3 µH, 2.6 A	Murata	LQH66SN3R3M03L
22	1	R1	4.7 kΩ	4.7 kΩ, 5 %, 0.25 W, Thick Film	Generic	
23	2	R2, R3	2.05 MΩ	2.05 MΩ, 1 %, 0.25 W, Thick Film	Generic	
24	1	R4	22 Ω	22 Ω, 5 %, 0.25 W, Thick Film	Generic	
25	1	R5	27 Ω	27 Ω, 5 %, 0.25 W, Thick Film	Generic	
26	1	R6	470 Ω	470 Ω, 5 %, 0.25 W, Thick Film	Generic	
27	1	R7	13 kΩ	13 kΩ, 5 %, 0.125 W, Thick Film	Generic	
28	1	R8	84.5 Ω	84.5 Ω, 1 %, 0.125 W, Thick Film	Generic	
29	1	R9	1 kΩ	1 kΩ, 5 %, 0.125 W, Thick Film	Generic	
30	1	R10	10.7 kΩ	10.7 kΩ, 1 %, 0.125 W, Thick Film	Generic	
31	1	R11	5.9 kΩ	5.9 kΩ, 1 %, 0.125 W, Thick Film	Generic	
32	1	RF1	10 Ω	10 Ω, 2 W, Flameproof Wire-Wound Resistor	Vitrohm	CRF253-4 10R

33	1	T1	E20/10/6 (EF20)	3F3 Core Material See Transformer Construction's Materials List for complete information	Epcos	B66311-G-X127
34	1	U1	TNY287DG	TinySwitch-4, TNY287DG, SO-8C	Power Integrations	TNY287DG
35	1	U2	LTV-826S	Optocoupler LTV-826S , 80 V, CTR 300 - 600 %, 4-SMD	Liteon	LTV-826S
36	1	U3	LM431ACM/NOPB	2.495 V, Shunt Regulator IC, 2 %, SOIC-8	Texas Instruments	LM431ACM/NOPB
37	1	VR1	P6SMB160A-E3/52	160 V, 5 W, 5 %, DO-214AA, TVS	Vishay	P6SMB160A-E3/52
38	1			52 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier D8.	Custom	
39	1			52 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier D7.	Custom	
40	1			52 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Device U1.	Custom	
41	1			52 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Rectifier D9.	Custom	

Electrical Diagram



Mechanical Diagram



Winding Instruction

Use 3.00 mm margin (item [3]) on the left side. Use 3.00 mm margin (item [3]) on the right side.

Primary Winding

Start on pin(s) 2 using item [6] at the start leads and wind 90 turns (x 1 filar) of item [8]. in 4 layer(s) from left to right. Winding direction is clockwise. Add 1 layer of tape, item [5], in between each primary winding layer. 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. Continue the same way as in previous 2 layers. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 1 using item [6] at the finish leads.

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

Secondary Winding

Start on pin(s) 9 using item [6] at the start leads and wind 11 turns (x 1 filar) of item [9]. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Finish this winding on pin(s) 8 using item [6] at the finish leads.

Add 1 layer of tape, item [4], for insulation.

Start on pin(s) 7 using item [6] at the start leads and wind 5 turns (x 1 filar) of item [9]. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Finish this winding on pin(s) 6 using item [6] at the finish leads.

Add 1 layer of tape, item [4], for insulation.

Take (x 1 filar) of item [9]. Mark FL1 at the start, apply item [6] and wind 17 turns. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Finish this winding on pin(s) 10 using item [6] at the finish leads.

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

Primary Bias Winding

Start on pin(s) 4 using item [6] at the start leads and wind 9 turns (x 1 filar) of item [8]. Winding direction is clockwise. Spread the winding evenly across entire bobbin. Finish this winding on pin(s) 3 using item [6] at the finish leads.

Add 1 layer of tape, item [4], for insulation.

Core Assembly

Assemble and secure core halves. Item [1].

Varnish

Dip varnish uniformly in item [7]. 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. The sleeving length must comply with 6.40 mm safety margins required.

Materials

Item	*Description*
[1]	**Core: E20/10/6 (EF20), 3F3, gapped for ALG of 117 nH/T²**
[2]	**Bobbin: Generic, 5 pri. + 5 sec.**
[3]	**Tape: Polyester web 3.00 mm wide**
[4]	**Barrier Tape: Polyester film [1 mil (25 µm) base thickness], 12.50 mm wide**
[5]	**Separation Tape: Polyester film [1 mil (25 µm) base thickness], 6.50 mm wide**
[6]	**Teflon Tubing # 22**
[7]	**Varnish**
[8]	**Magnet Wire: 0.22 mm, Solderable Double Coated**
[9]	**Magnet Wire: 0.25 mm, Solderable Double Coated**

Electrical Test Specifications

Parameter	*Condition*	*Spec*
Electrical Strength, VAC	**60 Hz 1 second, from pins 1,2,3,4 to pins 6,7,8,9,10 & FL1.**	**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.**	**1049**
Tolerance, ±%	**Tolerance of Primary Inductance**	**10.0**
Maximum Primary Leakage, µH	**Measured between Pin 1 to Pin 2, with all other Windings shorted.**	**31.46**

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. #
	You have selected to use a magnet wire for at least one output. This is a non-margin, non safety compliant bobbin.	It is recommended to use triple insulated wire for such designs.	574
	Fusible Resistor is used.	Make sure to use a wire-wound, flameproof, fusible resistor for RF1.	165