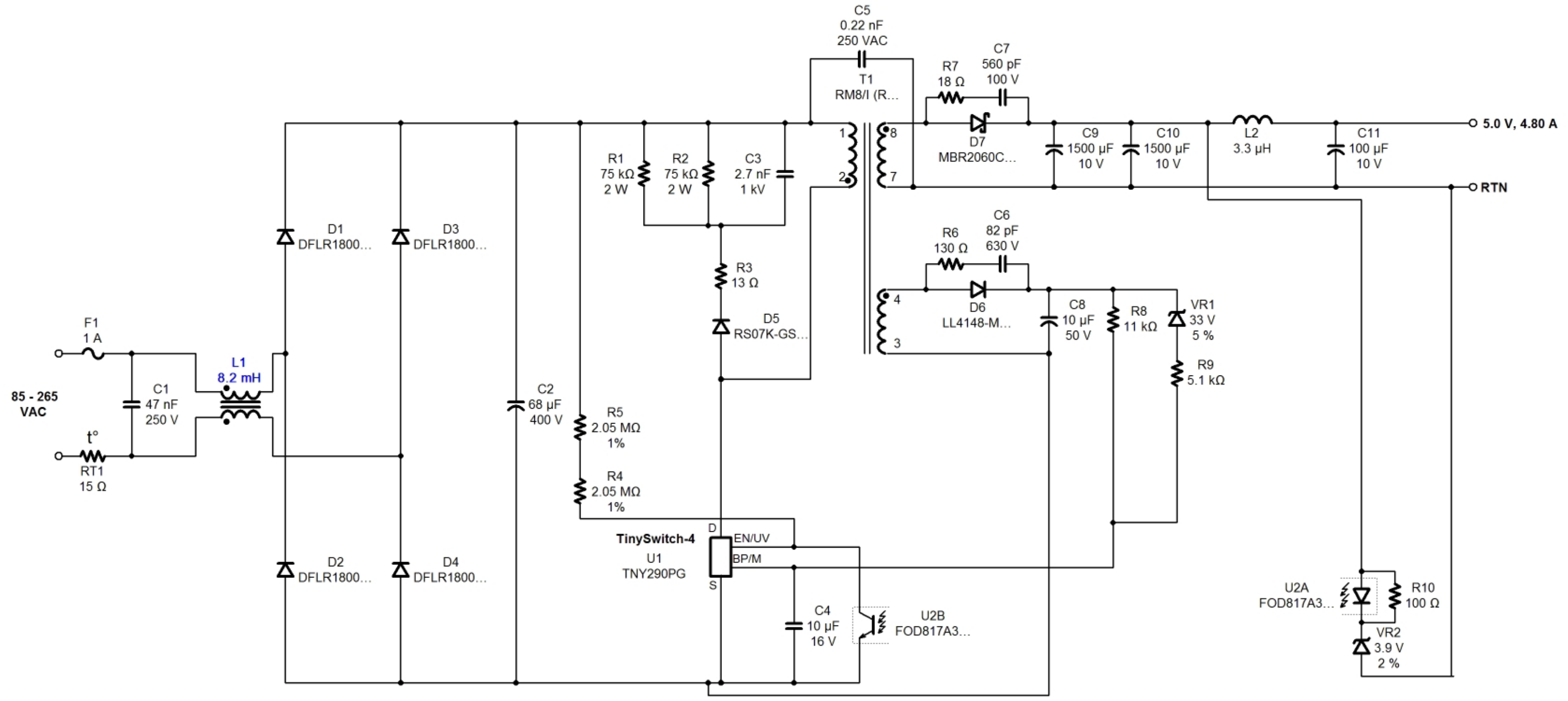


Schematic components that have been frozen by the user will appear with blue reference designators.

Power Supply Input

Var	Value	Units	Description
VACMIN	85	V	Minimum Input AC Voltage (Manual Overwrite)
VACMAX	265	V	Maximum Input AC Voltage (Manual Overwrite)
FL	60	Hz	Line Frequency (Manual Overwrite)
TC	2.25	ms	Input Rectifier Conduction Time
Z	0.61		Loss Allocation Factor
η	70.0	%	Efficiency Estimate (Target)
VMIN	90.0	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	0.39	A	Average Diode Bridge Current (DC Input Current)
Thermistor	15.00	Ω	Input Thermistor

Device Variables

Var	Value	Units	Description
Device	TNY290PG		PI Device Name
BVDSS	700	V	Drn-Src Bkdn Voltage
Current Limit Mode	Increased		Device Current Limit Mode
OVP_FLAG	YES		Output Overvoltage Protection Enabled (Manual Overwrite)
PO	24.80	W	Total Continuous Output Power
PO_PEAK	24.80	W	Total Peak Output Power
PO_AVG	24.80	W	Total Average Output Power
VDRAIN Estimated	607.60	V	Estimated Drain Voltage
VDS	4.21	V	On state Drain to Source Voltage
I2F_MIN	85.83	A^2kHz	Minimum I2F
I2F_MAX	110.63	A^2kHz	Maximum I2F
FS_AT_ILIMMIN	137183	Hz	Switching Frequency at Current Limit Minimum
KP	0.339		Continuous/Discontinuous Operating Ratio (at VMIN and Full Load)
KP_TRANSIENT	0.27		Transient Ripple to Peak Current Ratio
DMAX	0.611		Maximum Duty Cycle (at VMIN and Full Load)
ILIMITMIN	0.791	A	Minimum Current Limit
ILIMITMAX	0.943	A	Maximum Current Limit
IRMS	0.528	A	Primary RMS Current (at VMIN and Full Load)
RTH_DEVICE	42.54	°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	361	mm^2	PI Device Heatsink Area

Clamp Circuit

Var	Value	Units	Description

Clamp Type	**RCD Clamp**		*Clamp Circuit Type*
VCLAMP	**97.83**	*V*	*Average Clamping Voltage*
Estimated Clamp Loss	**1.446**	*W*	*Clamp total power loss*

Primary Bias Variables

Var	*Value*	*Units*	*Description*
VB	**16.0**	*V*	*Bias Voltage (Manual Overwrite)*
IB	**0.050**	*A*	*Bias Current (Manual Overwrite)*
PIVB	**65**	*V*	*Bias Rectifier Maximum Peak Inverse Voltage*
NB	**9**		*Primary Bias Winding Number of Turns*

Transformer Construction Parameters

Var	*Value*	*Units*	*Description*
Core Type	**RM8/I (RM8/I-3F3)**		*Core Type*
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	**1437**	*µH*	*Nominal Primary Inductance*
LP_Tol	**10.0**	*%*	*Primary Inductance Tolerance*
NP	**69.2**		*Calculated Primary Winding Total Number of Turns*
NSM	**3**		*Secondary Main Number of Turns*
Primary Current Density	**6.52**	*A/mm²*	*Primary Winding Current Density*
VOR	**135.00**	*V*	*Reflected Output Voltage*
BW	**8.60**	*mm*	*Bobbin Winding Width*
FF	**76.55**	*%*	*Actual Transformer Fit Factor. 100% signifies fully utilized winding window*
AE	**63.00**	*mm²*	*Core Cross Sectional Area*
ALG	**270**	*nH/T²*	*Gapped Core Specific Inductance*
BM	**287**	*mT*	*Maximum Flux Density*
BAC	**41**	*mT*	*AC Flux Density for Core Loss*
LG	**0.267**	*mm*	*Estimated Gap Length*
L_LKG	**43.12**	*µH*	*Estimated primary leakage inductance*
LSEC	**15**	*nH*	*Secondary Trace Inductance*

Primary Winding Section 1

Var	*Value*	*Units*	*Description*
NP1	**70**		*Number of Primary Winding Turns in the First Section of Primary*
L	**2.98**		*Primary Winding - Number of Layers*
DC Copper Loss	**0.18**	*W*	*Primary Section 1 DC Losses*

Output 1

Var	*Value*	*Units*	*Description*
VO	**5.00**	*V*	*Typical Output Voltage*
IO	**4.80**	*A*	*Output Current (Continuous Load)*
IO_PEAK	**4.80**	*A*	*Output Current at Peak Load*
VOUT_ACTUAL	**5.00**	*V*	*Actual Output Voltage*

NS	**3**		*Secondary Number of Turns*
L_S_OUT	**0.94**		*Secondary Output Winding Layers*
DC Copper Loss	**0.25**	*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	**21.06**	*V*	*Output Rectifier Maximum Peak Inverse Voltage*
ISP	**17.665**	*A*	*Peak Secondary Current*
ISRMS	**9.208**	*A*	*Secondary RMS Current*
ISRMS_WINDING	**9.208**	*A*	*Secondary Winding RMS Current*
Secondary Current Density	**8**	*A/mm²*	*Secondary Winding Current Density*
RTH_RECTIFIER	**14.42**	*°C/W*	*Output Rectifier Heatsink Maximum Thermal Resistance*
OR_HSINK_TYPE	**Custom Aluminum**		*Output Rectifier Heatsink Type*
OR_HSINK_AREA	**6444**	*mm²*	*Output Rectifier Heatsink Area*
CO	**1500 x 2**	*µF*	*Output Capacitor - Capacitance*
IRIPPLE	**7.858**	*A*	*Output Capacitor - RMS Ripple Current*
Expected Lifetime	**20493**	*hr*	*Output Capacitor - Expected Lifetime*

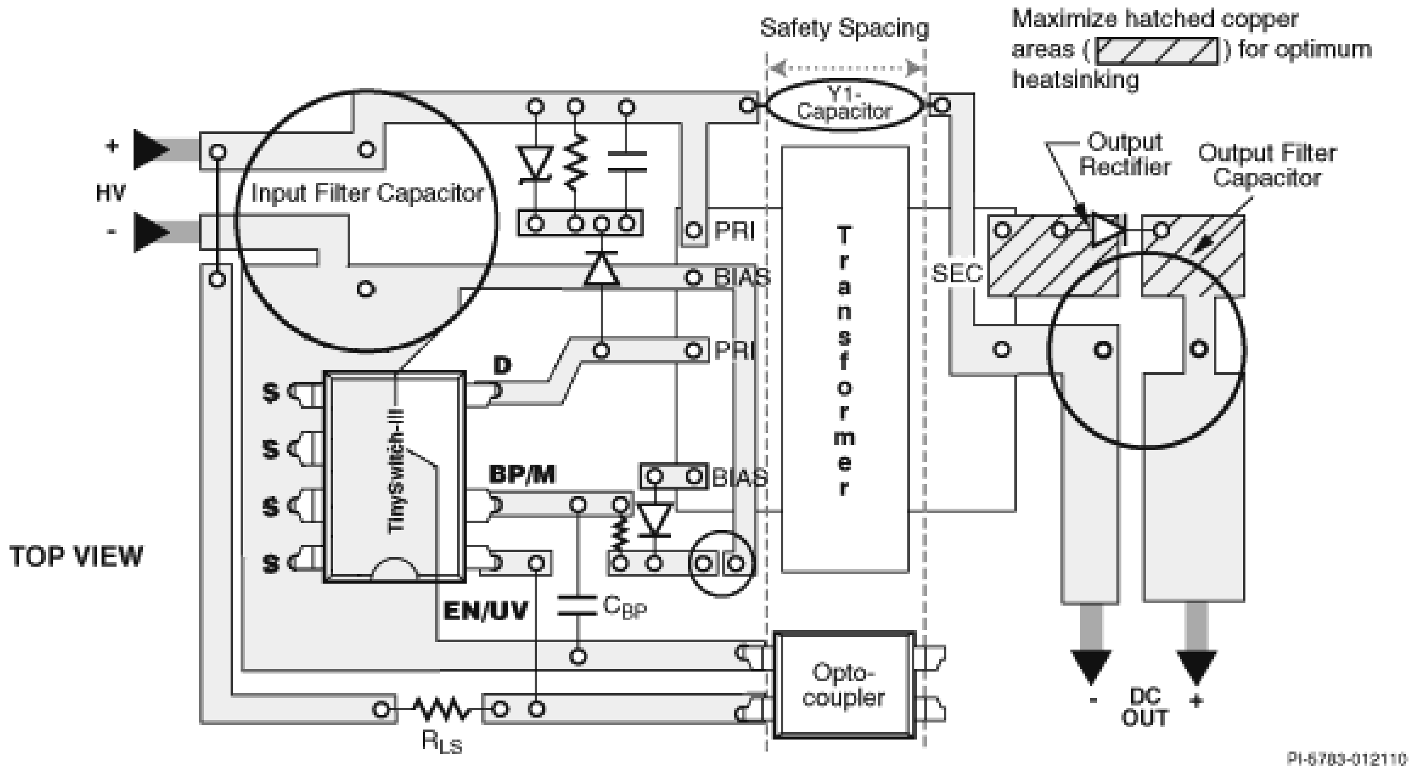
High output current Flyback design.

Use parallel low ESR output capacitors, reduce secondary ripple currents by reducing VOR and KP.

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.

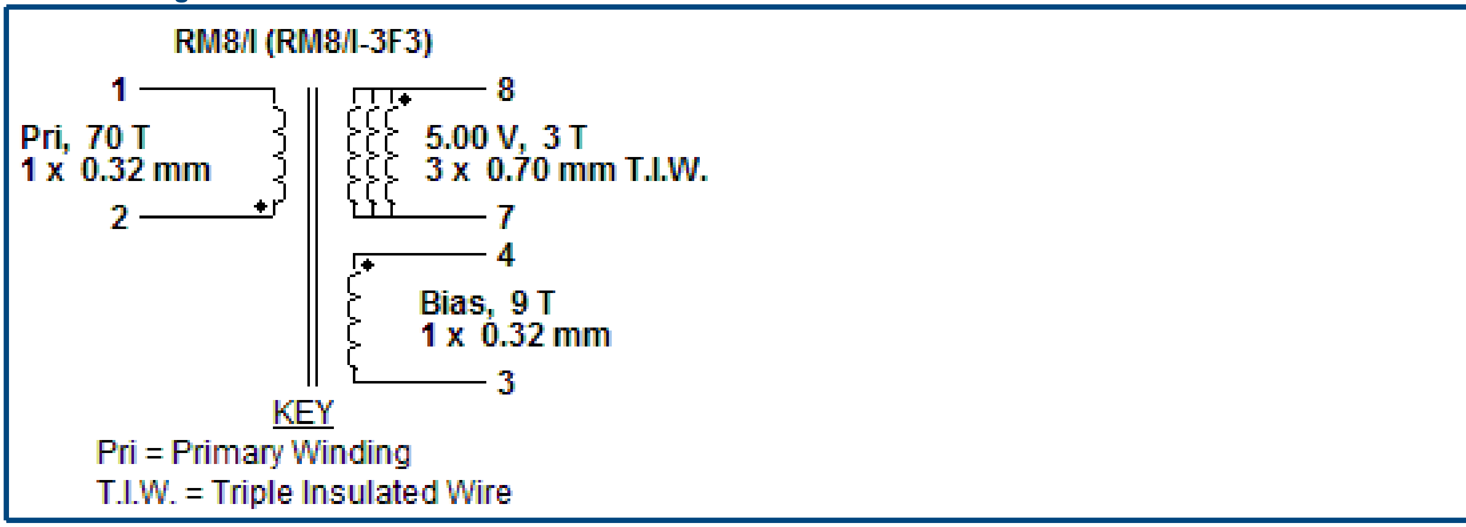
	Description	*Show Me*
1	*Maximize source area for good heat-sinking*	
2	*Keep drain trace short*	
3	*The BYPASS pin capacitor should be located as close as possible to the BYPASS and SOURCE pins*	
4	*Keep noisy traces away from EN/UV pin*	
5	*Route bias winding currents back to the bulk cap*	
6	*Keep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

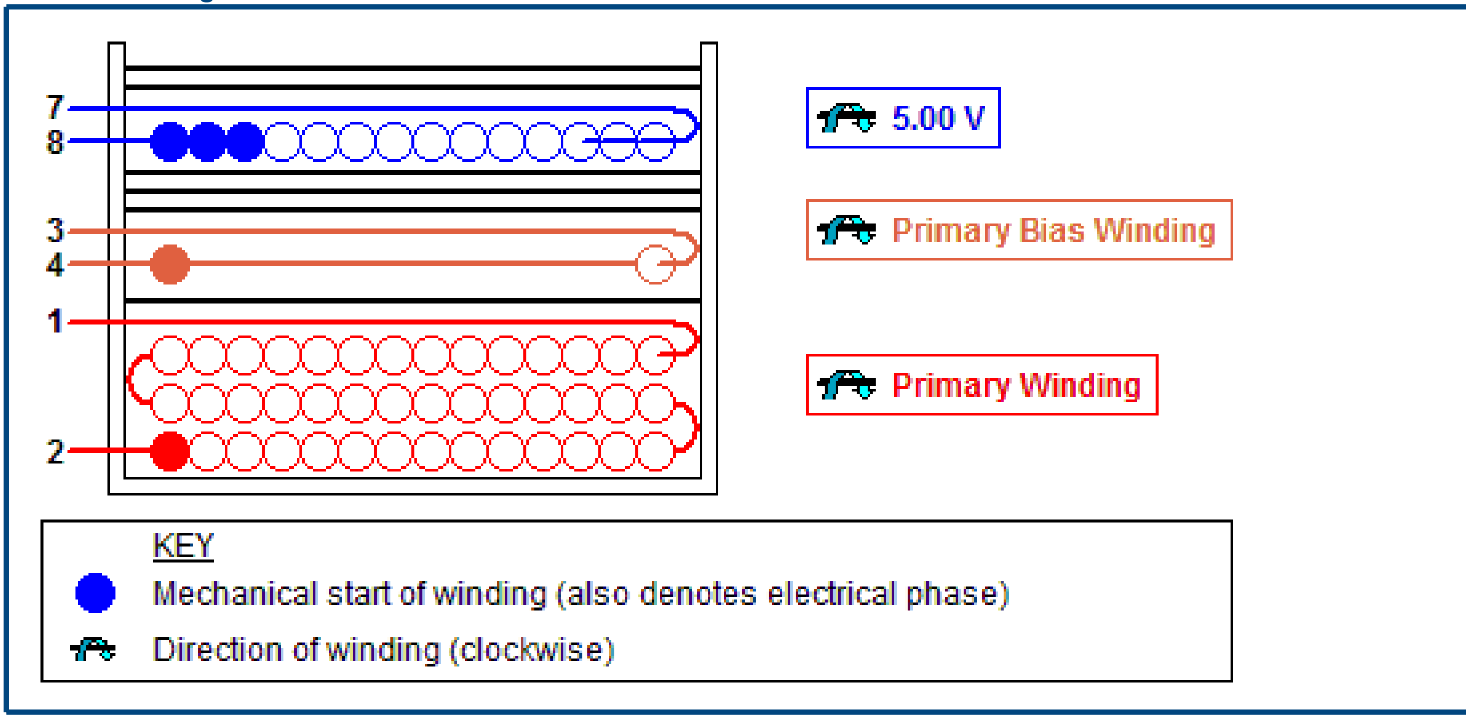
Item #	Quantity	Part Ref	Value	Description	Mfg	Mfg Part Number
1	1	C1	47 nF	47 nF, 250 V, Film, X Class	Murata	GA355ER7GB473KW01L
2	1	C2	68 µF	68 µF, 400 V, High Voltage Al Electrolytic, (30 mm x 20 mm)	Nichicon	LGU2G680MELY
3	1	C3	2.7 nF	2.7 nF, 1 kV, High Voltage Ceramic	Kemet	C1210H272JDGACTU
4	1	C4	10 µF	10 µF, 16 V, Ceramic, X7R	Kemet	C1206C106K4RACTU
5	1	C5	0.22 nF	0.22 nF, 250 VAC, Ceramic, Y Class	Vishay	VJ2008A221JXUSTX1
6	1	C6	82 pF	82 pF, 630 V, High Voltage Ceramic	Murata	GRM31A5C2J820JW01D
7	1	C7	560 pF	560 pF, 100 V, Ceramic, C0G	AVX Corp	08051A561JAT2A
8	1	C8	10 µF	10 µF, 50 V, Electrolytic, Gen Purpose, 1000 mΩ, (6.1 mm x 6.3 mm)	Rubycon	50TRV10M6.3X6.1
9	2	C9, C10	1500 µF	1500 µF, 10.0 V, Electrolytic, Super Low ESR, 13 mΩ, (12.7 mm x 10 mm)	Nichicon	PCG1A152MCL1GS
10	1	C11	100 µF	100 µF, 10.0 V, Electrolytic, Low ESR, 500 mΩ, (3.5 mm x 2.8 mm)	Kemet	T495B107M010ATE500
11	4	D1, D2, D3, D4	DFLR1800-7	800 V, 1 A, Standard Recovery, POWERDI123	Diodes Inc.	DFLR1800-7
12	1	D5	RS07K-GS08	800 V, 1.4 A, Fast Recovery, 300 ns, DO-219AB	Vishay	RS07K-GS08
13	1	D6	LL4148-M-08	100 V, 0.15 A, Fast Recovery, 8 ns, SOD-80	Vishay	LL4148-M-08
14	1	D7	MBR2060CTG	60 V, 10 A, Schottky, TO-220AB	ON Semiconductor	MBR2060CTG
15	1	F1	1 A	250 VAC, 1 A, Radial TR5, Time Lag Fuse	Littelfuse / Wickmann(R)	37411000410
16	1	HS1		161.1 mm x 20 mm. Aluminum Alloy (3003 OR 5052), 1.6 mm thickness. Heatsink for use with Rectifier D7.	Custom	
17	1	L1	8.2 mH	8.2 mH, 0.5 A	Wurth Elektronik	744862082
18	1	L2	3.3 µH	3.3 µH, 7.6 A	Bourns Inc.	PM5022-3R3M-RC
19	2	R1, R2	75 kΩ	75 kΩ, 5 %, 2 W, Metal Oxide Film	Generic	
20	1	R3	13 Ω	13 Ω, 5 %, 0.25 W, Thick Film	Generic	
21	2	R4, R5	2.05 MΩ	2.05 MΩ, 1 %, 0.25 W, Thick Film	Generic	
22	1	R6	130 Ω	130 Ω, 5 %, 0.25 W, Thick Film	Generic	
23	1	R7	18 Ω	18 Ω, 5 %, 0.25 W, Thick Film	Generic	
24	1	R8	11 kΩ	11 kΩ, 5 %, 0.125 W, Thick Film	Generic	
25	1	R9	5.1 kΩ	5.1 kΩ, 5 %, 0.125 W, Thick Film	Generic	
26	1	R10	100 Ω	100 Ω, 5 %, 0.125 W, Thick Film	Generic	
27	1	RT1	15 Ω	NTC Thermistor 15 Ω, 1 A	EPCOS (TDK)	B59860C0120A570
28	1	T1	RM8/I (RM8/I-3F3)	3F3 Core Material Refer to Manufacturer datasheet for a number of parts to purchase	Ferroxcube	RM8/I-3F3
29	1	T1 Bobbin	RM8/I - 1 (P6-S6)	Bobbin Material : Polybutyleneterephthalate (PBT)	Ferroxcube	CPV-RM8/I-1S-12PD
30	1	T1 Core Acc.1	CLI/P-RM8/I	Mounting clip with earth pin . Stainless steel (CrNi)	Ferroxcube	CLI/P-RM8/I
31	1	T1 Core Acc.2	CLI-RM8/I	Mounting clip without earth pin . Stainless steel (CrNi)	Ferroxcube	CLI-RM8/I

32	*1*	*U1*	*TNY290PG*	*TinySwitch-4, TNY290PG, DIP-8*	*Power Integrations*	*TNY290PG*
33	*1*	*U2*	*FOD817A3SD*	*Optocoupler FOD817A3SD , 70 V, CTR 80 - 160 %, 4-SMD*	*ON Semiconductor*	*FOD817A3SD*
34	*1*	*VR1*	*MMSZ33T1G*	*33 V, 500 mW, 5 %, SOD-123, General Purpose*	*ON Semiconductor*	*MMSZ33T1G*
35	*1*	*VR2*	*BZT55B3V9-GS08*	*3.9 V, 500 mW, 2 %, SOD-80, General Purpose*	*Vishay*	*BZT55B3V9-GS08*
36	*1*			*361 mm² area on Copper PCB. 2 oz (70 µm) thickness. Heatsink for use with Device U1.*	*Custom*	

Electrical Diagram



Mechanical Diagram



Winding Instruction

Primary Winding

Start on pin(s) 2 and wind 70 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 1 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) 8 and wind 3 turns (x 3 filar) of item [6]. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Finish this winding on pin(s) 7.

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: RM8/I (RM8/I-3F3), 3F3, gapped for ALG of 270 nH/T²**
[2]	**Bobbin: Generic, 6 pri. + 6 sec.**
[3]	**Barrier Tape: Polyester film [1 mil (25 µm) base thickness], 8.60 mm wide**
[4]	**Varnish**
[5]	**Magnet Wire: 0.32 mm, Solderable Double Coated**
[6]	**Triple Insulated Wire: 0.7 mm**

Electrical Test Specifications

Parameter	*Condition*	*Spec*
Electrical Strength, VAC	**60 Hz 1 second, from pins 1,2,3,4 to pins 7,8.**	**3900**
Nominal Primary Inductance, µH	**Measured at 1 V pk-pk, typical switching frequency, between pin 1 to pin 2, with all other Windings open.**	**1437**
Tolerance, ±%	**Tolerance of Primary Inductance**	**10.0**
Maximum Primary Leakage, µH	**Measured between Pin 1 to Pin 2, with all other Windings shorted.**	**18.9**

Design Notepad

7508112110

https://www.we-online.com/en/components/products/MID-OLRM
https://www.we-online.com/components/products/datasheet/7508112110.pdf

https://www.fks-tech.com/products/73-OLRM-RM-Style-Offline-Flyback-Transformers.html
https://www.fks-tech.com/pic/other/15749260231267484.pdf

1 *Design Passed (Optimization Done)*

	Description	***Fix***	***Ref. #***
	Wire size thicker than 0.55 mm not recommended.	*Consider paralleling wires or using copper foil.*	*506*