ACDC_TOPSwitchJX_032514; Rev.1.6; Copyright Power Integrations 2014	INPUT	INFO	OUTPUT	UNIT	TOP_JX_032514: TOPSwitch-JX Continuous/Discontinuous Flyback Transformer Design Spreadsheet
ENTER APPLICATION VARIABLES					Design title
VACMIN	195			Volts	Minimum AC Input Voltage
VACMAX	265			Volts	Maximum AC Input Voltage
fL	50			Hertz	AC Mains Frequency
VO	5.00			Volts	Output Voltage (main)
PO_AVG	80.00			Watts	Average Output Power
PO_PEAK			80.00	Watts	Peak Output Power
Heatsink Type	External		External		Heatsink Type
Enclosure	Open Frame				Open Frame enclosure assumes sufficient airflow, while Adapter means a sealed enclosure.
n	0.85			%/100	Efficiency Estimate
Z	0.50				Loss allocation factor
VB	12			Volts	Bias Voltage - Verify that VB is > 8 V at no load and VMAX
tC	3.00			ms	Bridge Rectifier Conduction Time Estimate
CIN	82.0		82.0	uFarads	Input Filter Capacitor
ENTER TOPSWITCH-JX VARIABLES					
TOPSwitch-JX	TOP267V			Universal / Peak	115 Doubled/230V
Chosen Device		TOP267V	Power Out	137 W / 137 W	137W
KI	0.77				External Ilimit reduction factor (KI=1.0 for default ILIMIT, KI <1.0 for lower ILIMIT)
ILIMITMIN_EXT			2.156	Amps	Use 1% resistor in setting external ILIMIT
ILIMITMAX_EXT			3.197	Amps	Use 1% resistor in setting external ILIMIT. Includes tolerance over temperature. See Fig 37 of datasheet
Frequency (F)=132kHz, (H)=66kHz	F		F		Select 'H' for Half frequency - 66kHz, or 'F' for Full frequency - 132kHz
fS			132000	Hertz	TOPSwitch-JX Switching Frequency: Choose between 132 kHz and 66 kHz
fSmin			119000	Hertz	TOPSwitch-JX Minimum Switching Frequency
fSmax			145000	Hertz	TOPSwitch-JX Maximum Switching Frequency
High Line Operating Mode			FF		Full Frequency, Jitter enabled
VOR	120.00			Volts	Reflected Output Voltage
VDS			10.00	Volts	TOPSwitch on-state Drain to Source Voltage
VD	0.50			Volts	Output Winding Diode Forward Voltage Drop
VDB	0.70			Volts	Bias Winding Diode Forward Voltage Drop
KP	0.70				Ripple to Peak Current Ratio (0.3 < KRP < 1.0 : 1.0< KDP<6.0)
PROTECTION FEATURES					
LINE SENSING					V pin functionality
VUV_STARTUP			217.83	Volts	Minimum DC Bus Voltage at which the power supply will start-up
VOV_SHUTDOWN			1050	Volts	Typical DC Bus Voltage at which power supply will shut-down (Max)

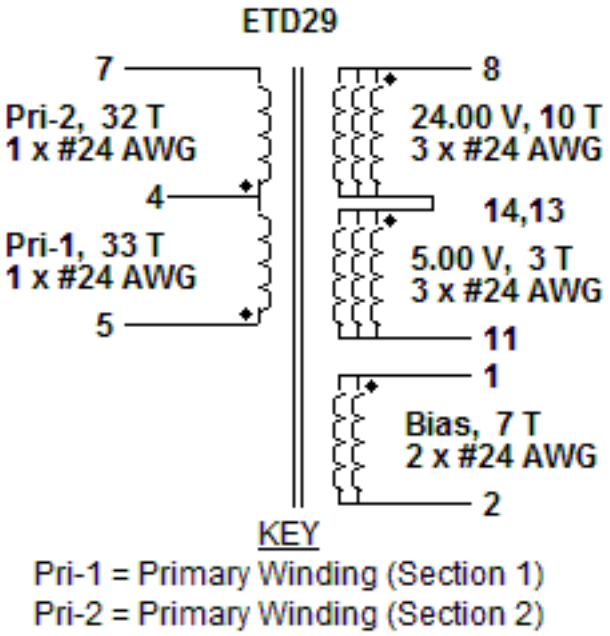
RLS			9.4	M-ohms	Use two standard, 4.7 M-Ohm, 5% resistors in series for line sense functionality.
OUTPUT OVERVOLTAGE					
VZ			22	Volts	Zener Diode rated voltage for Output Overvoltage shutdown protection
RZ			5.1	k-ohms	Output OVP resistor. For latching shutdown use 20 ohm resistor instead
OVERLOAD POWER LIMITING					X pin functionality
Overload Current Ratio at VMAX			1.20		Enter the desired margin to current limit at VMAX. A value of 1.2 indicates that the current limit should be 20% higher than peak primary current at VMAX
Overload Current Ratio at VMIN			1.18		Margin to current limit at low line.
ILIMIT_EXT_VMIN			1.75	A	Peak primary Current at VMIN
ILIMIT_EXT_VMAX			1.77	A	Peak Primary Current at VMAX
RIL			8.15	k-ohms	Current limit/Power Limiting resistor.
RPL			N/A	M-ohms	Resistor not required. Use RIL resistor only
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES					
Core Type	ETD29		ETD29		Core Type
Custom Core (Optional)					If Custom core is used - Enter Part number here
Bobbin		ETD29_BOBBIN		P/N:	*
AE			0.7360	cm^2	Core Effective Cross Sectional Area
LE			7.0600	cm	Core Effective Path Length
AL			2500.0	nH/T^2	Ungapped Core Effective Inductance
BW			19.4	mm	Bobbin Physical Winding Width
M				mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	1.30				Number of Primary Layers
NS			3		Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS					
VMIN			245	Volts	Minimum DC Input Voltage
VMAX			375	Volts	Maximum DC Input Voltage
CURRENT WAVEFORM SHAPE PARAMETERS					
DMAX			0.34		Maximum Duty Cycle (calculated at PO_PEAK)
IAVG			0.38	Amps	Average Primary Current (calculated at average output power)
IP			1.75	Amps	Peak Primary Current (calculated at Peak output power)
IR			1.22	Amps	Primary Ripple Current (calculated at average output power)
IRMS			0.69	Amps	Primary RMS Current (calculated at average output power)
TRANSFORMER PRIMARY DESIGN PARAMETERS					
LP			506	uHenries	Primary Inductance

LP Tolerance			10		Tolerance of Primary Inductance
NP			65		Primary Winding Number of Turns
NB			7		Bias Winding Number of Turns
ALG			118	nH/T^2	Gapped Core Effective Inductance
BM			1838	Gauss	Maximum Flux Density at PO, VMIN (BM<3000)
BP			3697	Gauss	Peak Flux Density (BP<4200) at ILIMITMAX and LP_MAX. Note: Recommended values for adapters and external power supplies <=3600 Gauss
BAC			643	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur			1908		Relative Permeability of Ungapped Core
LG			0.75	mm	Gap Length (Lg > 0.1 mm)
BWE			25.22	mm	Effective Bobbin Width
OD			0.39	mm	Maximum Primary Wire Diameter including insulation
INS			0.06	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			0.33	mm	Bare conductor diameter
AWG			28	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM			161	Cmils	Bare conductor effective area in circular mils
CMA			233	Cmils/Amp	Primary Winding Current Capacity (200 < CMA < 500)
Primary Current Density (J)			8.60	Amps/mm^2	Primary Winding Current density (3.8 < J < 9.75)
TRANSFORMER SECONDARY DESIGN PARAMETERS (SINGLE OUTPUT EQUIVALENT)					
Lumped parameters					
ISP			38.15	Amps	Peak Secondary Current
ISRMS			21.13	Amps	Secondary RMS Current
IO_PEAK			16.00	Amps	Secondary Peak Output Current
IO			16.00	Amps	Average Power Supply Output Current
IRIPPLE			13.80	Amps	Output Capacitor RMS Ripple Current
CMS			4225	Cmils	Secondary Bare Conductor minimum circular mils
AWGS			13	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
DIAS			1.83	mm	Secondary Minimum Bare Conductor Diameter
ODS			6.47	mm	Secondary Maximum Outside Diameter for Triple Insulated Wire
INSS			2.32	mm	Maximum Secondary Insulation Wall Thickness
VOLTAGE STRESS PARAMETERS					
VDRAIN			611	Volts	Maximum Drain Voltage Estimate (Includes Effect of Leakage Inductance)
PIVS			22	Volts	Output Rectifier Maximum Peak Inverse Voltage
PIVB			52	Volts	Bias Rectifier Maximum Peak Inverse Voltage

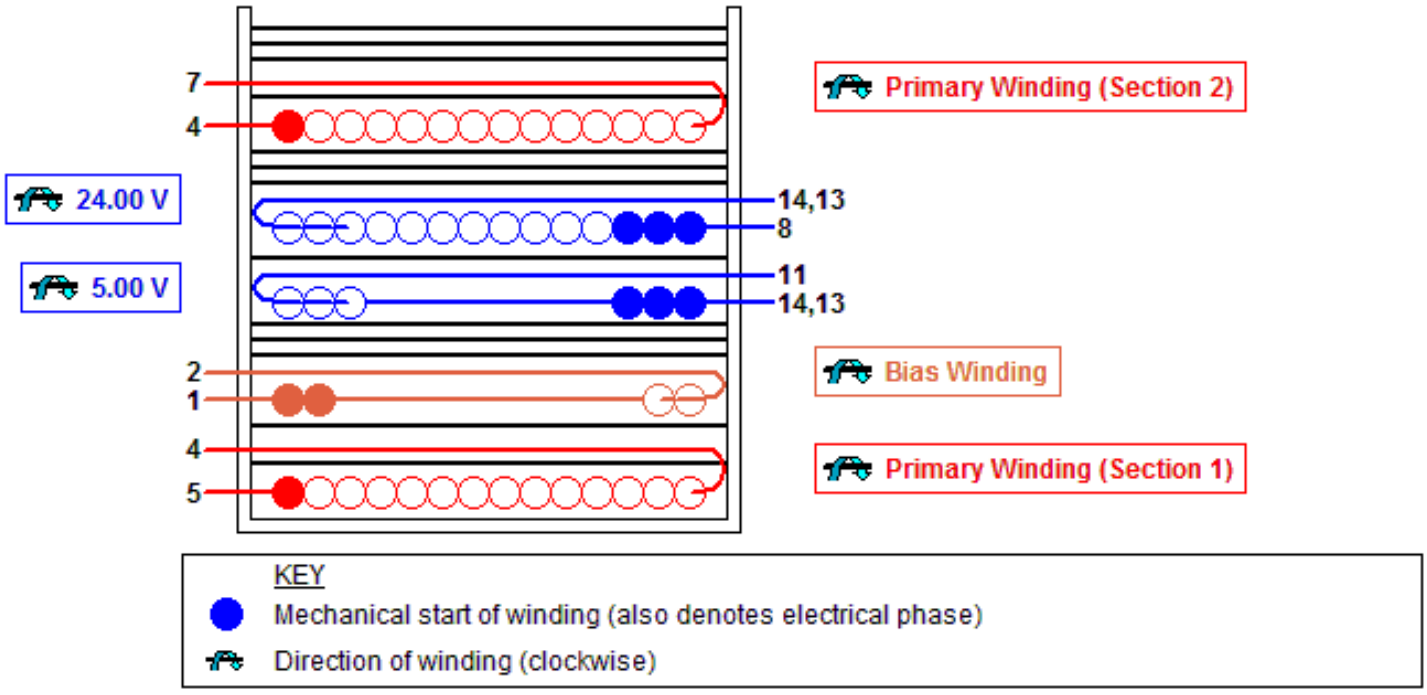
TRANSFORMER SECONDARY DESIGN PARAMETERS (MULTIPLE OUTPUTS)					
1st output					
VO1	*5.00*		*5.00*	*Volts*	*Output Voltage*
IO1_AVG	*0.50*		*0.50*	*Amps*	*Average DC Output Current*
PO1_AVG			*2.5*	*Watts*	*Average Output Power*
VD1			*0.50*	*Volts*	*Output Diode Forward Voltage Drop*
NS1			*3.00*		*Output Winding Number of Turns*
ISRMS1			*0.66*	*Amps*	*Output Winding RMS Current*
IRIPPLE1			*0.43*	*Amps*	*Output Capacitor RMS Ripple Current*
PIVS1			*22*	*Volts*	*Output Rectifier Maximum Peak Inverse Voltage*
CMS1			*132*	*Cmils*	*Output Winding Bare Conductor minimum circular mils*
AWGS1			*28*	*AWG*	*Wire Gauge (Rounded up to next larger standard AWG value)*
DIAS1			*0.32*	*mm*	*Minimum Bare Conductor Diameter*
ODS1			*6.47*	*mm*	*Maximum Outside Diameter for Triple Insulated Wire*
2nd output					
VO2	*24.00*			*Volts*	*Output Voltage*
IO2_AVG	*3.33*			*Amps*	*Average DC Output Current*
PO2_AVG			*79.92*	*Watts*	*Average Output Power*
VD2	*0.50*		*0.50*	*Volts*	*Output Diode Forward Voltage Drop*
NS2			*13.36*		*Output Winding Number of Turns*
ISRMS2			*4.397*	*Amps*	*Output Winding RMS Current*
IRIPPLE2			*2.87*	*Amps*	*Output Capacitor RMS Ripple Current*
PIVS2			*101*	*Volts*	*Output Rectifier Maximum Peak Inverse Voltage*
CMS2			*879*	*Cmils*	*Output Winding Bare Conductor minimum circular mils*
AWGS2			*20*	*AWG*	*Wire Gauge (Rounded up to next larger standard AWG value)*
DIAS2			*0.81*	*mm*	*Minimum Bare Conductor Diameter*
ODS2			*1.45*	*mm*	*Maximum Outside Diameter for Triple Insulated Wire*
3rd output					
VO3				*Volts*	*Output Voltage*
IO3_AVG				*Amps*	*Average DC Output Current*
PO3_AVG			*0*	*Watts*	*Average Output Power*
VD3			*0.70*	*Volts*	*Output Diode Forward Voltage Drop*
NS3			*0.38*		*Output Winding Number of Turns*
ISRMS3			*0*	*Amps*	*Output Winding RMS Current*
IRIPPLE3			*0.00*	*Amps*	*Output Capacitor RMS Ripple Current*
PIVS3			*2*	*Volts*	*Output Rectifier Maximum Peak Inverse Voltage*
CMS3			*0*	*Cmils*	*Output Winding Bare Conductor minimum circular mils*

AWGS3			*N/A*	*AWG*	*Wire Gauge (Rounded up to next larger standard AWG value)*
DIAS3			*N/A*	*mm*	*Minimum Bare Conductor Diameter*
ODS3			*N/A*	*mm*	*Maximum Outside Diameter for Triple Insulated Wire*
Total Continuous Output Power			*82.42*	*Watts*	*Total Continuous Output Power*
Negative Output	*N/A*		*N/A*		*If negative output exists enter Output number; e.g.: If VO2 is negative output, enter 2*

Electrical Diagram



Mechanical Diagram



Winding Instruction

Primary Winding (Section 1)

Start on pin(s) 5 and wind 33 turns (x 1 filar) of item [6]. in 1 layer(s) from left to right. Winding direction is clockwise. Add 1 layer of tape, item [4], in between each primary winding layer. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 4.

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

Bias Winding

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

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

Secondary Winding

Start on pin(s) 14,13 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) 11.

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

Start on pin(s) 8 and wind 10 turns (x 3 filar) of item [6]. Spread the winding evenly across entire bobbin. Winding direction is clockwise. Finish this winding on pin(s) 14,13.

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

Primary Winding (Section 2)

Start on pin(s) 4 and wind 32 turns (x 1 filar) of item [6]. in 1 layer(s) from left to right. Winding direction is clockwise. Add 1 layer of tape, item [4], in between each primary winding layer. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 7.

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

Core Assembly

Assemble and secure core halves. Item [1].

Varnish

Dip varnish uniformly in item [5]. Do not vacuum impregnate.

Comments

1. Pins 13 and 14 are electrically shorted to each other on the PCB via a copper trace.
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: ETD29, PC95, gapped for ALG of 118 nH/T²**
[2]	**Bobbin: Generic, 7 pri. + 7 sec.**
[3]	**Barrier Tape: Polyester film [1 mil (25 µm) base thickness], 19.40 mm wide**
[4]	**Separation Tape: Polyester film [1 mil (25 µm) base thickness], 19.40 mm wide**
[5]	**Varnish**
[6]	**Magnet Wire: 24 AWG, Solderable Double Coated**

Electrical Test Specifications

Parameter	*Condition*	*Spec*
Electrical Strength, VAC	**60 Hz 1 second, from pins 1,2,4,5,7 to pins 8,11,13,14.**	**3000**
Nominal Primary Inductance, µH	**Measured at 1 V pk-pk, typical switching frequency, between pin 5 to pin 7, with all other Windings open.**	**506**
Tolerance, ±%	**Tolerance of Primary Inductance**	**10.0**
Maximum Primary Leakage, µH	**Measured between Pin 5 to Pin 7, with all other Windings shorted.**	**7.60**

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.

Transformer Construction Parameters

Var	Value	Units	Description
Core Type	**ETD29**		Core Type
Core Material	**PC95**		Core Material
Bobbin Reference	**Generic, 7 pri. + 7 sec.**		Bobbin Reference
Bobbin Orientation	**Horizontal**		Bobbin type
Primary Pins	**7**		Number of Primary pins used
Secondary Pins	**7**		Number of Secondary pins used
LP	**506**	µH	Nominal Primary Inductance
ML	**0.00**	mm	Safety Margin on Left Width
MR	**0.00**	mm	Safety Margin on Right Width
LG	**0.745**	mm	Estimated Gap Length

Bias Variables

Var	Value	Units	Description
NB	**7**		Bias Winding Number of Turns
Wire Size	**24**	AWG	Wire size of Bias windings (Manual Overwrite)
Winding Type	**Bifilar (x2)**		Wire type of Bias windings (Manual Overwrite)
Layers	**0.41**		Bias Winding Layers
Start Pin(s)	**1**		Starting pin(s) for Bias winding (Manual Overwrite)
Termination Pin(s)	**2**		Termination pin(s) for Bias winding (Manual Overwrite)

Primary Winding Section 1

Var	Value	Units	Description
NP1	**33**		Number of Primary Winding Turns in the First Section of Primary
Wire Size	**24**	AWG	Primary Winding - Wire Size
Winding Type	**Single (x1)**		Primary Winding - Number of Parallel Wire Strands
L	**0.96**		Primary Winding - Number of Layers
Start Pin(s)	**5**		Starting pin(s) for first section of primary winding (Manual Overwrite)
Termination Pin(s)	**4**		Termination pin(s) for first section of primary winding (Manual Overwrite)

Primary Winding Section 2

Var	Value	Units	Description
NP2	**32**		Rounded (Integer) Number of Primary winding turns in the second section of primary
Wire Size	**24**	AWG	Primary Winding - Wire Size
Winding Type	**Single (x1)**		Primary Winding - Number of Parallel Wire Strands
L2	**0.93**		Primary Number of Layers in 2nd split winding
Start Pin(s)	**4**		Starting pin(s) for the second section of primary winding (Manual Overwrite)
Termination Pin(s)	**7**		Termination pin(s) for the second section of primary winding (Manual Overwrite)

Output 1

Var	Value	Units	Description
VO	**5.00**	V	Typical Output Voltage
IO	**0.50**	A	Output Current
VOUT_ACTUAL	**5.00**	V	Actual Output Voltage

NS	**3**		*Secondary Number of Turns*
Wire Size	**24**	*AWG*	*Wire size of secondary winding (Manual Overwrite)*
Winding Type	**Trifilar (x3)**		*Output winding number of parallel strands (Manual Overwrite)*
L_S_OUT	**0.26**		*Secondary Output Winding Layers*
Start Pin(s)	**14,13**		*Starting pin(s) for Output winding (Manual Overwrite)*
Termination Pin(s)	**11**		*Termination pin(s) for Output winding (Manual Overwrite)*

Output 2

Var	***Value***	***Units***	***Description***
VO	**24.00**	*V*	*Typical Output Voltage*
IO	**3.33**	*A*	*Output Current*
VOUT_ACTUAL	**23.33**	*V*	*Actual Output Voltage*
NS	**10**		*Secondary Number of Turns*
Wire Size	**24**	*AWG*	*Wire size of secondary winding (Manual Overwrite)*
Winding Type	**Trifilar (x3)**		*Output winding number of parallel strands (Manual Overwrite)*
L_S_OUT	**0.88**		*Secondary Output Winding Layers*
Start Pin(s)	**8**		*Starting pin(s) for Output winding (Manual Overwrite)*
Termination Pin(s)	**14,13**		*Termination pin(s) for Output winding (Manual Overwrite)*