Push Pull Parameter and Transformer Design

:Given parameter

:Calculated parameter

:Notice or Check Point

Parameter:

Minimum Input Voltage $Vin\_min := 8$

Maximum Input Voltage $Vin\_max := 30$

Frequency $fs := 53 \cdot 10^{3}$

Maximum Duty Cycle $Dmax := 0.48$

Output Voltage (DC) $Vo := 12$

Output Current (A) $Io := 4$

Wire Current Density (A/cm2) $J := 700$

Maximum Flux Density (A) $Bmax := 2500$

Efficiency $Eff := 0.85$

Calculation:

Ts $Ts := \frac{1}{fs}$ $Ts = 1.887 \times 10^{-5}$

Ton $ton := \frac{Dmax}{fs}$ $ton = 9.057 \times 10^{-6}$

Secondary Voltage $Vob := Vo + 0.5 + 0.2$ $Vob = 12.7$

Output Power $Po := Vo \cdot Io$ $Po = 48$

Input Power $Pin := \frac{Po}{Eff}$ $Pin = 56.471$

Auusume Ip rms $Ip\_rms := \frac{Pin}{Vin\_min}$ $Ip\_rms = 7.059$

Maximum Turns $Nmax := \frac{(2Vin\_min \cdot Dmax)}{Vob}$ $Nmax = 0.605$

Turns $N := 0.6$

Ture Turn On Duty

$$Don\_hiin := \frac{(N \cdot Vob)}{2 \cdot Vin\_max} \qquad Don\_hiin = 0.127$$

$$Don\_loin := \frac{(N \cdot Vob)}{2 \cdot Vin\_min} \qquad Don\_loin = 0.476$$

BCM Inductance

$$LoB\_hiin := \frac{Vo}{(2 \cdot Io)}(0.5 - Don\_hiin) \cdot Ts \qquad LoB\_hiin = 1.056 \times 10^{-5}$$

$$LoB\_loin := \frac{Vo}{(2 \cdot Io)}(0.5 - Don\_loin) \cdot Ts \qquad LoB\_loin = 6.722 \times 10^{-7}$$

Set Output Inductaor $Lo := 23 \cdot 10^{-6}$

Set Output Capactor $Co := 470 \cdot 10^{-6}$

Output Ripple Voltage

$$\Delta Vo\_hiin := \frac{Ts^2 \cdot Vo}{16 \cdot Co \cdot Lo} \cdot (0.5 - Don\_hiin) \qquad \Delta Vo\_hiin = 9.213 \times 10^{-3}$$

$$\Delta Vo\_loin := \frac{Ts^2 \cdot Vo}{16 \cdot Co \cdot Lo} \cdot (0.5 - Don\_loin) \qquad \Delta Vo\_loin = 5.866 \times 10^{-4}$$

Output Ripple Current

$$\Delta I\_hiin := \frac{\left(\frac{Vin\_max}{N} - 0.7 - Vo\right)}{Lo} \cdot Don\_hiin \cdot Ts \qquad \Delta I\_hiin = 3.886$$

$$\Delta I\_loin := \frac{\left(\frac{Vin\_min}{N} - 0.7 - Vo\right)}{Lo} \cdot Don\_loin \cdot Ts \qquad \Delta I\_loin = 0.247$$

Output Peak Current

$IDpk := Io + \frac{1}{2} \cdot \Delta I\_hiin \qquad IDpk = 5.943$

Primary Peak Current

$IQpk := \frac{IDpk}{N} \qquad IQpk = 9.905$

Current Sensor Resistor

$Rs := \frac{0.52}{IQpk} \qquad Rs = 0.052$

$PRs := IQpk^{2} \cdot Rs \cdot Don\_hiin \qquad PRs = 0.654$

Frequency of UCC38084

$RT := 649 \cdot 10^{3}$

$Fr := \frac{1}{28.7 \cdot 10^{-12} \cdot RT + \left(2.0 \cdot 10^{-7}\right)} \qquad Fr = 5.312 \times 10^{4}$

Choose Core Type of XFMR

Choose PQ2620 as XFMR Core $\qquad Ac := 1.19$

Ac=Iron area

Wa=Windows area

STANDARD PRODUCTS

Part No.	Maximum external dimensions (mm)			Rated output power (W) max.			Core sectional area (mm²)	No. of terminal
	W	D	H	25KHz	50KHz	100KHz		
PQ-20/16	23.0	23.0	18.5	-	41	63	62.0	14
PQ-20/20	23.0	23.0	22.5	-	55	80	62.0	14
PQ-26/20	26.5	29.5	22.5	-	95	136	119.0	12
PQ-26/25	26.5	29.5	29.5	-	107	160	118.0	12
PQ-32/20	32.0	34.0	22.5	-	133	190	170.0	12
PQ-32/30	32.0	34.0	32.5	-	186	261	161.0	12
PQ-35/35	35.0	39.0	37.5	-	267	357	196.0	12
PQ-40/40	40.0	42.0	42.5	-	386	525	201.0	12
PQ-50/50	51.0	51.0	52.0	-	524	980	328.0	12

Primary Turns of XFMR

Set the Bmax of XFMR

$Bmax := 2.5 \cdot 10^{3}$

Tuning the Bmax for Optimum Primary Turns $\quad Bt\_max := 2.01 \cdot 10^{3}$

$$Np := \frac{(Vin\_min \cdot Don\_loin) \cdot 10^{8}}{(Ac \cdot Bt\_max) \cdot fs} \qquad Np = 3.005$$

Secondary Turns of XFMR

$N = 0.6$

Tuning the N for Optimum Secondary Turns $\quad Nt := 0.6$

$$Ns := \frac{Np}{Nt} \qquad Ns = 5.009$$

Skin Depth (cm) $\quad Dep := \frac{6.61}{\sqrt{fs}} \qquad Dep = 0.029$

Primary Wire Area (cm2) $\quad Wpri := \frac{Ip\_rms}{J} \qquad Wpri = 0.01$ sq. cm

Secondary Wire Area (cm2) $\quad Wsec := \frac{Io}{J} \qquad Wsec = 5.714 \times 10^{-3}$ sq. cm

Choose Primary Wire AWG#31 x 28

Ture Primary Wire Area $\quad WApri := 0.593 \cdot 10^{-3} \cdot 28 \qquad WApri = 0.017$ sq. cm

Current Density in Primary $\quad Jpri := \frac{Ip\_rms}{WApri} \qquad Jpri = 425.128$ Amp / sq. cm

Choose Secondary Wire AWG#31 x 16

Ture Sencondary Wire Area $\quad WAsec := 0.593 \cdot 10^{-3} \cdot 16 \qquad WAsec = 9.488 \times 10^{-3}$ sq. cm

Current Density in Secondary $\quad Jsec := \frac{Io}{WAsec} \qquad Jsec = 421.585$ Amp / sq. cm

Choose 3rd Wire AWG#31 x 2

Ture 3rd Wire Area $WA3rd := 0.593 \cdot 10^{-3} \cdot 2$ $WA3rd = 1.186 \times 10^{-3}$ sq. cm

Current Density in 3rd $J3rd := \frac{0.5}{WA3rd}$ $J3rd = 421.585$ Amp / sq. cm

Wire Table

AWG Wire Size	Resistance Ω/meter (x.305=Ω/ft)	Wire O.D. (cm) Heavy Build	Wire Area		Current Capacity, Amps (listed by columns of amps/sq.cm.)			
			Circ. Mils	sq. cm (x0.001)	200	400	600	800
8	.00207	.334	18,000	91.2	16.5	33.0	49.5	66.0
9	.00259	.298	14,350	72.7	13.1	26.2	39.3	52.4
10	.00328	.267	11,500	58.2	10.4	20.8	31.2	41.6
11	.00413	.238	9,160	46.4	8.23	16.4	24.6	32.8
12	.00522	.213	7,310	37.0	6.53	13.1	19.6	26.1
13	.00656	.1902	5,850	29.6	5.18	10.4	15.5	20.8
14	.00827	.1714	4,680	23.7	4.11	8.22	12.3	16.4
15	.01043	.1529	3,760	19.1	3.26	6.52	9.78	13.0
16	.01319	.1369	3,000	15.2	2.58	5.16	7.74	10.3
17	.01657	.1224	2,420	12.2	2.05	4.10	6.15	8.20
18	.0210	.1095	1,940	9.83	1.62	3.25	4.88	6.50
19	.0264	.0980	1,560	7.91	1.29	2.58	3.87	5.16
20	.0332	.0879	1,250	6.34	1.02	2.05	3.08	4.10
21	.0420	.0785	1,000	5.07	.812	1.63	2.44	3.25
22	.0531	.0701	810	4.11	.640	1.28	1.92	2.56
23	.0666	.0632	650	3.29	.511	1.02	1.53	2.04
24	.0843	.0566	525	2.66	.404	.808	1.21	1.62
25	.1063	.0505	425	2.15	.320	.641	.962	1.28
26	.1345	.0452	340	1.72	.253	.506	.759	1.01
27	.1686	.0409	270	1.37	.202	.403	.604	.806
28	.214	.0366	220	1.11	.159	.318	.477	.636
29	.266	.0330	180	.912	.128	.255	.382	.510
30	.341	.0295	144	.730	.100	.200	.300	.400
31	.430	.0267	117	.593	.0792	.158	.237	.316
32	.531	.0241	96.0	.487	.0640	.128	.192	.256
33	.676	.0216	77.4	.392	.0504	.101	.152	.202
34	.856	.01905	60.8	.308	.0397	.0794	.119	.159

Total Wire Area $WA := WApri \cdot Np + WAsec \cdot Ns + WA3rd \cdot Ns$

$WA = 0.103$ sq. cm