

Topic3 / Design1

Designing mixed operation mode transformer, 230V/115V, 10A in autotransformer and 230V/115V, 10A galvanic separated connection

Input parameters

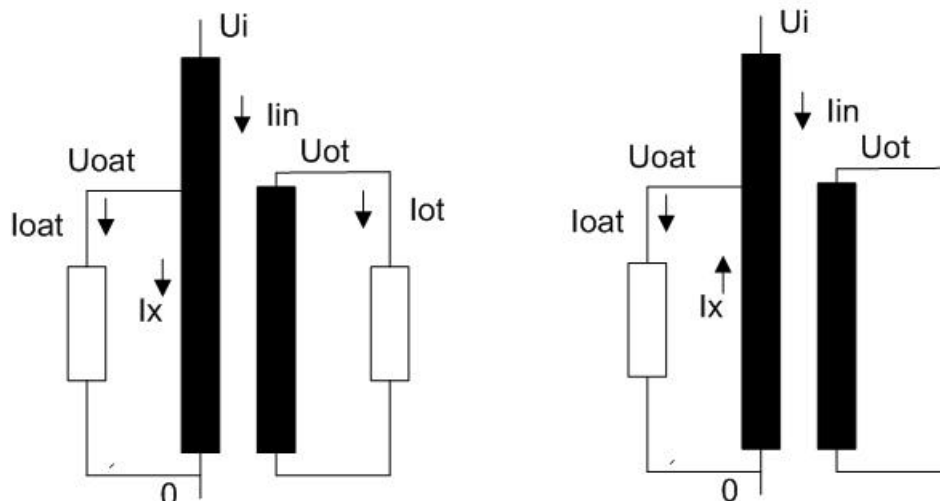
Input	Voltage	230V, +-10%, 50/60Hz, sine wave
	Wire	Cu, round, single insulated
Output	Nominal output voltage	115V, in autotransformer connection 115V, galvanic separated connection
	Nominal output current	10A, in autotransformer connection 10A, galvanic separated connection
	Wire	Cu, round, single insulated
Core	Steel	M19, alternate stacking, not annealed
Bobbin	Type	Single section
Design	Insulation class	B, max. operating temperature 120C,
	Ambient temperature	40C

Modifying the wire size from thermal point of view

Due to the fact that the program supports only the full load operation mode we need to compare the currents in both, full load and partial load operation mode (disconnected one of both 10A loads) and modify the wire size by hand in the segment Uoat-0.

In the full load operation mode the current I_x has amount of 0.348A (view 3. design page). If you disconnect the load of the galvanic separated winding the amount of the current I_x changes to 4.188A and the temperature rise from 60K to 112K (view design page 4)

Changing the wire size in the segment Uoat-0 from AWG 26 to AWG 20.5 the temperature rise can be set back to the amount of approx. 50K (view the last 2 design pages)



Design page 1

08-07-2008/18:07:31/14.43		Input and Circuit		Page 1	
PRIMARY U(U) I(A) Circuit--:1 115. 10. Overvlt*:1.00 230. Wire :0.0 . I/L. mil:0. . I/E. mil:5. . Formfac.:1.11 . Fre.Hz:50 . dI/Io :100 .		SECOND. 1--- 2--- 3--- 4--- 5--- 6--- 7--- 8--- Circuit--:11 Volta. U:115. Curre. A:10. Wire :0 I/L mil:0.0 I/E mil:0.0			
Regulat. %:50.0	Steel -:22	Cooling *:1.00	Bobbin -:1		
Udiode U:0.8	Induction T:1.30	Force ft/s:0.00	P/S-Order -:1		
dUdiode U:.1	Remanence *:0.35	Bracket -:1	Rac/Rdc *:1.05		
Ripple %:5.	W/kg *:1.00	Radiator -:0	Space *:0.95		
Tmp. Amb. °C:40	UAr/kg *:1.00	Chassis -:1.00	Vertical -:1		
Tmp. rise °K:60	Gap *:1.00	Channel in:0.00	Horizontal -:1		
Time 1 Min:30.0	Annealed -:0	Cu-Surface*:1.00	Impregnat. -:2		
Load 1 *:1.0	Stacking *:1.00	Rth-uarni.*:1.00	Spread %:0		
Time 2 Min:30.0	Hole -:1	Rth-comp. *:1.00	Selection -:0		
Load 2 *:1.0	Assembly -:1	Case -:0	Criterion -:0		
CIRCUIT:					
230. U	A			U	
115. U	10. A			A	
				U	
				A	
				U	
				A	
				U	
				A	
				U	
				A	
				U	
				A	

Design page 2

08-07-2008/18:07:31 CORE / BOBBIN / STEEL / CASE													Page 2	
Name : 1XEI 200/(2) R /EI 2HW/(2) Steel : M19 Gauge 24 / 0.0250"													Weight lb: 19.52	
													/25.59	
													Gap total in: 0.000	
													A-Limb in: 2.00	
													B-Width in: 1.50	
													C-Height in: 3.74	
													D-Stack in: 2.02	
													E-Yoke 1 in: 1.25	
													F-Yoke 2 in: 1.25	
													G-Hole in: 0.31	
													Radiator Fin : 0	
													Radiator Chan. : 0	
													a1 cm: 2.18	
													a2 cm: 4.94	
													d1 cm: 2.18	
													d2 cm: 4.94	
													l cm: 3.60	
													lp cm:	
													ls cm:	
													Margin cm: 0.07	
													X- Length 1 in:	
													Y- Width 1 in:	
													Z- Height 1 in:	
													x- Length 2 in:	
													y- Width 2 in:	
													z- Height 2 in:	
													w- Thickness in:	
													Material :	
													Potted :	
	Typ	Windun	MTI	DN	DN	Par	D/φ mil	B/φ mil	W/L	L	I/L mil	I/E mil	Weight lb	RWH %
1	1	154.8	C00	26.0	26.0	1	15.9	15.9	205	.76	.	5.	.086	1.3
2	1	308.1	C00	12.5	12.5	1	76.3	76.3	44	3.5	.	5.	2.206	24.
3														
4														
5														
6														
7														
8														
1	11	161.6	C00	11.0	11.0	1	90.7	90.7	37	4.3	.	.	4.179	36.
2														
3														
4														
5														
6														
7														
8														
TOTAL													6.471 63.	

Design page 3

08-07-2008/18:07:31	General Data	Page 3
<p>NOMINAL OPERATION at Temperature °C 100.3 and Overvoltage 1.00</p> <p>Output Power on Load W:2299. Output Power of Transform. W:2299. Cu Losses W:61.88 Fe-Losses active W:14.29 Short-Circuit-Volt. cold %:2.03 Regulation %:2.68 Instantaneous pow. .5/95& W:950. Efficiency of Transformer %:96.79 dT Fe average Surface °K:48. dT primary °K:60.9 dT Case aver. Surface °K:.. dT secondary °K:59.8</p>		
<p>DUTY CYCLE OPERATION at Amb. Temperature °C 40. and Overvoltage 1.00</p> <p>dT Fe average Surface °K:48. dT primary °K:60.9 dT Gehäuse av. Surface °K:.. dT secondary °K:59.8</p>		
<p>NO LOAD OPERATION at Amb. Temperature °C 40. and Overvoltage 1.00</p> <p>Losses active W:14.33 Losses reactive UAr:22.78 Current factor %:1.13 Induction T:1.328 dT Fe average Surface °K:13.2 dT primary °K:11.7 dT Gehäuse av. Surface °K:.. Resonance frequency kHz:1.9</p>		
<p>SHORT-CIRCUIT OPERATION at Amb. Temperature °C 40. and Overvoltage 1.00</p> <p>Losses active W:10843 Losses reactive UAr:44587 Current factor cold %:4933. Induction T:1.206 dT Fe average Surface °K:3264. dT primary °K:4278. dT Gehäuse av. Surface °K:.. dT secondary °K:3943.</p>		
<p>PRIMARY (Tap:2) 1---- 2---- 3---- 4---- 5---- 6---- 7---- 8----</p> <p>Voltage Input/Output U:115. 230. Out. Voltage no load U:115.7 Current Input/Output A:10. 10.33 Load on output Ω:11.5 Power factor of load :1.000 Current in segment A:0.348 10.33 Current density A/in²:1752. 2259. Icc-Current cold A:530.6 509.7 Io -Current A: 0.117 Inrush Current peak ^A: 47.65 Inrush Current rms A: 18.71 Cu-Losses W: 33.2 Resistance cold Ω:4.709 4.938 Reactance Ω:.091 .0893 Eddy-Current Factor :1. 1.</p>		
<p>SECONDARY 1---- 2---- 3---- 4---- 5---- 6---- 7---- 8----</p> <p>Output Voltage U:114.9 Output Current A:10. Out. Voltage no load U:120.4 Sec. Voltage U:114.9 Sec. Current A:10. Current density A/in²:1547. Sec. Voltage cold U:116.2 Load on output Ω:11.5 Power factor of load :1.000 Icc cold A:463.7 Cu-Losses warm W:28.71 Resistance cold Ω:.2168 Reactance Ω:.0992 Eddy-Current Factor :1. Capacitor mF:..</p>		

Design page 4

08-07-2008/18:14:58	General Data	Page 3
<p>NOMINAL OPERATION at Temperature °C 147.4 and Overvoltage 1.00</p> <p>Output Power on Load W:884.6 Output Power of Transform. W:884.6 Cu Losses W:133.3 Fe-Losses active W:16.28 Short-Circuit-Volt. cold %:0.88 Regulation %:15.23 Instantaneous pow. .5/958 W:1671. Efficiency of Transformer %:85.53 dT Fe average Surface °K:81.5 dT primary °K:112.8 dT Case aver. Surface °K:.. dT secondary °K:102.1</p>		
<p>Diagram parameters: -6.26Ω -0.85Ω 258.5V 13.27Ω 1.053Ω 199.6 V -0.65 ° -12.2% -1.67% 112.4% 26.02% 2.06 % 86.78 % 51.01 Ω 230. V 4103 Ω 33769 Ω 920 Ω 45.03 Ω 100 % 8043. % .943 nF . 1803. % 45.03 Ω 4.509 A 1.495T 100 % 4.432 A</p>		
<p>DUTY CYCLE OPERATION at Amb. Temperature °C 40. and Overvoltage 1.00</p> <p>dT Fe average Surface °K:81.5 dT primary °K:112.8 dT Gehäuse av. Surface °K:.. dT secondary °K:102.1</p>		
<p>NO LOAD OPERATION at Amb. Temperature °C 40. and Overvoltage 1.00</p> <p>Losses active W:14.33 Losses reactive UAr:22.77 Current factor %:2.59 Induction T:1.328 dT Fe average Surface °K:13.2 dT primary °K:11.7 dT Gehäuse av. Surface °K:.. Resonance frequency kHz:3.</p>		
<p>SHORT-CIRCUIT OPERATION at Amb. Temperature °C 40. and Overvoltage 1.00</p> <p>Losses active W:10846 Losses reactive UAr:44602 Current factor cold %:11309 Induction T:1.206 dT Fe average Surface °K:3266. dT primary °K:4280. dT Gehäuse av. Surface °K:.. dT secondary °K:3945.</p>		
<p>PRIMARY (Tap:2) 1---- 2---- 3---- 4---- 5---- 6---- 7---- 8----</p> <p>Voltage Input/Output U:99.8 230. Out. Voltage no load U:115.7 Current Input/Output A:8.679 4.509 Load on output Ω:11.5 Power factor of load :1.000 Current in segment A:4.188 4.509 Current density A/in²:21077 986.2 Icc-Current cold A:530.7 509.9 Io -Current A: 0.117 Inrush Current peak ^A: 49.01 Inrush Current rms A: 19.53 Cu-Losses W: 133.3 Resistance cold Ω:4.710 4.939 Reactance Ω:.0911 .0893 Eddy-Current Factor :1. 1.</p>		
<p>SECONDARY 1---- 2---- 3---- 4---- 5---- 6---- 7---- 8----</p> <p>Output Voltage U:135.5 Output Current A:0.136 Out. Voltage no load U:120.4 Sec. Voltage U:135.5 Sec. Current A:0.136 Current density A/in²:20.99 Sec. Voltage cold U:130.9 Load on output Ω:999. Power factor of load :1.000 Icc cold A:463.6 Cu-Losses warm W:.006 Resistance cold Ω:.2168 Reactance Ω:.0992 Eddy-Current Factor :1. Capacitor mF:..</p>		

Design page 5

08-07-2008/18:16:47 CORE / BOBBIN / STEEL / CASE										Page 2				
Name : 1XEI 200/(2) R /EI 2HW/(2) Steel : M19 Gauge 24 / 0.0250"										Weight lb: 19.52 Gap total in: 0.000 A-Limb in: 2.00 B-Width in: 1.50 C-Height in: 3.74 D-Stack in: 2.02 E-Yoke 1 in: 1.25 F-Yoke 2 in: 1.25 G-Hole in: 0.31 Radiator Fin : 0 Radiator Chan. : 0				
										a1 cm: 2.18 a2 cm: 4.94 d1 cm: 2.18 d2 cm: 4.94 l cm: 3.60 lp cm: ls cm: Margin cm: 0.07				
										X- Length 1 in: Y- Width 1 in: Z- Height 1 in: x- Length 2 in: y- Width 2 in: z- Height 2 in: w- Thickness in: Material : Potted :				
	Typ	Windun	MTI	DN	DN	Par	D/φ mil	B/φ mil	W/L	L	I/L mil	I/E mil	Weight lb	RWH %
1	1	154.8	C00	20.5	20.5	1	30.2	30.2	111	1.4	.	5.	.315	4.8
2	1	308.1	C00	12.5	12.5	1	76.3	76.3	44	3.5	.	5.	2.273	24.
3														
4														
5														
6														
7														
8														
1	11	161.6	C00	11.0	11.0	1	90.7	90.7	37	4.3	.	.	4.104	36.
2														
3														
4														
5														
6														
7														
8														
TOTAL													6.693	60.

Design page 6

08-07-2008/18:16:47	General Data	Page 3
<p>NOMINAL OPERATION at Temperature °C 88.4 and Overvoltage 1.00</p> <p>Output Power on Load W:1083. Output Power of Transform. W:1083.</p> <p>Cu Losses W:44.65 Fe-Losses active W:14.22</p> <p>Short-Circuit-Volt. cold %:0.94 Regulation %:4.15</p> <p>Instantaneous pow. .5/958 W:3466. Efficiency of Transformer %:94.85</p> <p>dT Fe average Surface °K:40.3 dT primary °K:50.4</p> <p>dT Case aver. Surface °K:. dT secondary °K:46.4</p>		
<p>Diagram parameters: -1.29Ω -0.06Ω 236.4V 3.179Ω 0.242Ω 220.8 V -0.25 ° -2.79% -0.15% 102.8% 6.87 % 0.52 % 96.01 % 46.28 Ω 44.99 Ω 230. V 3932 Ω 42347 Ω 2152 Ω 100 % 8496. % .752 nF .4650. % 4.97 A 4.908 A 101.3 % 1.367T 100 %</p>		
<p>DUTY CYCLE OPERATION at Amb. Temperature °C 40. and Overvoltage 1.00</p> <p>dT Fe average Surface °K:40.3 dT primary °K:50.4</p> <p>dT Gehäuse av. Surface °K:. dT secondary °K:46.4</p>		
<p>NO LOAD OPERATION at Amb. Temperature °C 40. and Overvoltage 1.00</p> <p>Losses active W:14.28 Losses reactive UAr:22.45</p> <p>Current factor %:2.33 Induction T:1.329</p> <p>dT Fe average Surface °K:13.2 dT primary °K:11.7</p> <p>dT Gehäuse av. Surface °K:. Resonance frequency kHz:2.2</p>		
<p>SHORT-CIRCUIT OPERATION at Amb. Temperature °C 40. and Overvoltage 1.00</p> <p>Losses active W:11360 Losses reactive UAr:43744</p> <p>Current factor cold %:10650 Induction T:1.111</p> <p>dT Fe average Surface °K:3334. dT primary °K:4413.</p> <p>dT Gehäuse av. Surface °K:. dT secondary °K:3987.</p>		
<p>PRIMARY (Tap:2) 1---- 2---- 3---- 4---- 5---- 6---- 7---- 8----</p> <p>Voltage Input/Output U:110.8 230.</p> <p>Out. Voltage no load U:115.6</p> <p>Current Input/Output A:9.639 4.97</p> <p>Load on output Ω:11.5</p> <p>Power factor of load :1.000</p> <p>Current in segment A:4.671 4.97</p> <p>Current density A/in²:6521. 1087.</p> <p>Icc-Current cold A:599.5 529.3</p> <p>Io -Current A: 0.116</p> <p>Inrush Current peak ^A: 86.87</p> <p>Inrush Current rms A: 39.01</p> <p>Cu-Losses W: 44.6</p> <p>Resistance cold Ω:1.329 1.565</p> <p>Reactance Ω:.0898 .0881</p> <p>Eddy-Current Factor :1. 1.</p>		
<p>SECONDARY 1---- 2---- 3---- 4---- 5---- 6---- 7---- 8----</p> <p>Output Voltage U:123.9</p> <p>Output Current A:0.124</p> <p>Out. Voltage no load U:120.5</p> <p>Sec. Voltage U:123.9</p> <p>Sec. Current A:0.124</p> <p>Current density A/in²:19.2</p> <p>Sec. Voltage cold U:123.3</p> <p>Load on output Ω:999.</p> <p>Power factor of load :1.000</p> <p>Icc cold A:435.6</p> <p>Cu-Losses warm W:.004</p> <p>Resistance cold Ω:.2129</p> <p>Reactance Ω:.0979</p> <p>Eddy-Current Factor :1.</p> <p>Capacitor mF:.</p>		