PUSH PULL CONVERTER DESIGN AND CIRCUIT

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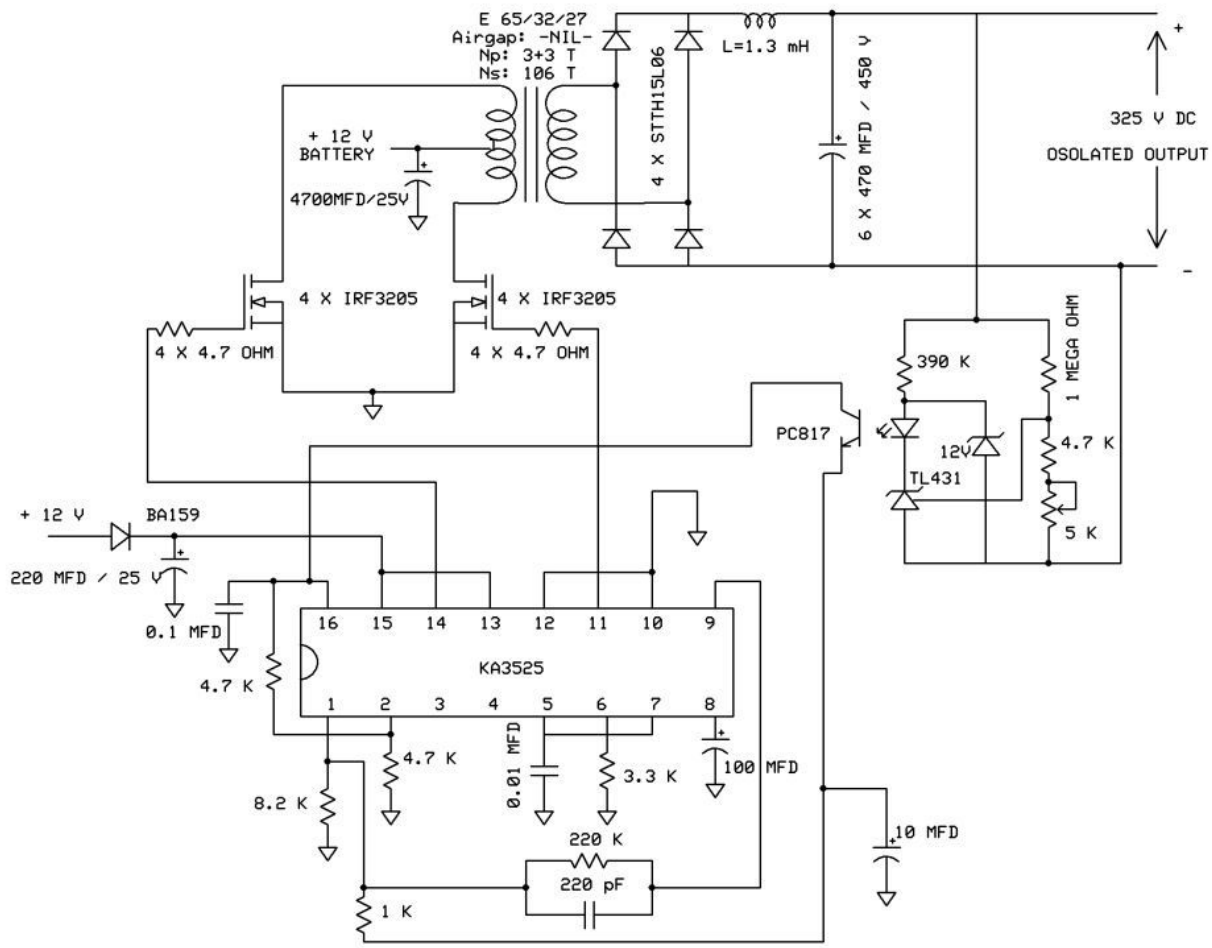
The circuit and calculation given are to step up 12V DC supply to 325V DC to deliver 1KW Power. KA3525 push-pull SMPS controller is used. If the output is used for pure sine wave inverter then output filter capacitor should be 2.5 times output power. Use 16 Sq mm copper cable of length less than 1m each to connect battery with converter.



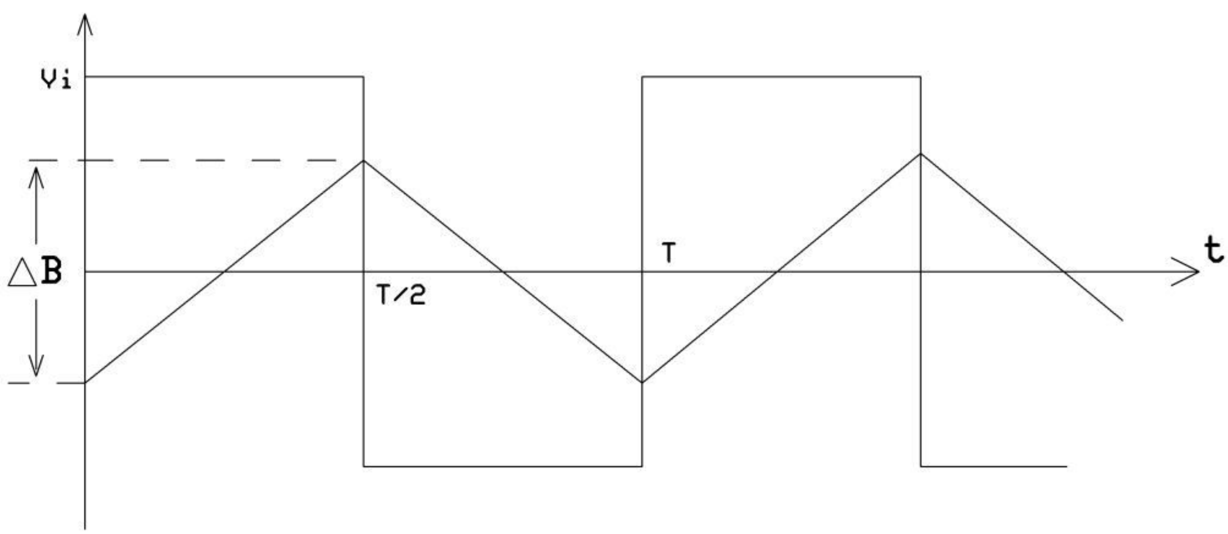
Ferrite core selected for Transformer: **E 65/32/27**

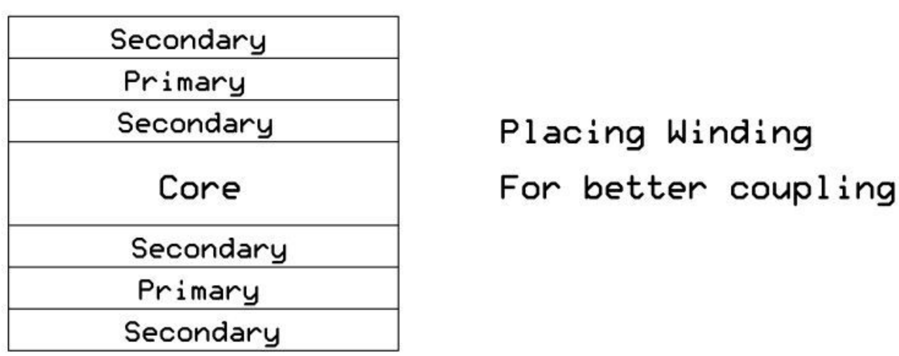
Area of ferrite core Ae = 540 mm^2

Max flux density Bm = 0.1 Wb/m^2 (for push-pull configuration)

Air gap = 0

Timing resistor R_T = 3.3 KΩ
Timing capacitor C_T = 0.01 µF
Dead time resistor R_D = 0 Ω
Maximum duty cycle Dmax = 49 %
Frequency of oscillator $F_{OSC} = 1 / (C_T (0.7 \times R_T + 3 \times R_D))$
$= 1 / (0.01\times10^{-6} \times (0.7 \times 3.3\times10^3 + 3 \times 0))$
= 43.2 KHz
Switching frequency $Fs = F_{OSC} / 2$
= 43.2 / 2
= 21.6 KHz
Switching time period T = 1 / Fs
$= 1 / 21.6\times10^3$
= 46.2 µS
T/2 = 23.1 µS
Minimum input voltage Vmin = 10.5V
Drain source on voltage V_{DS} (on) = 1V





Primary turns Np (min) = $\frac{Vi \times T/2}{\Delta B \times Ae}$

$$Np(min) = \frac{(10.5-1) \times 23.1\times10^{-6}}{2 \times 0.1 \times 540\times10^{-6}}$$

Np(min) = 2.03 T

Take primary turns Np as 3 Turns per limb.

Output Voltage Vo = 325V

Diode voltage drop Vf = 1V

Secondary Voltage Vs = (Vo + 2 x Vf) / (2 x Dmax)

= (325 + 2 x 1) / (2 x 0.49)

= 334 V

Secondary Turns Ns = Np x Vs / Vi

= 3 x 334 / 9.5

Secondary Turns Ns = 106 Turns

Selection of wire gauge

Output Power = 1000 W

Output Current Io = 1000 / 325

= 3.1 A

Take current density of 5 A/mm^2

Secondary wire cross section area = 3.1 / 5 = 0.62 mm^2

So 20 SWG wire selected for secondary winding.

Assume efficiency = 85%

Input power = 1000 / 0.85 = 1176 W

Input current = Pi / (Vmin x 2 x Dmax) = 114 A

Per limb Input Current = 114 / 2 = 57 A

As primary turns are only 3, higher current density may be allowed (9 A/mm^2).

Primary wire cross section area = 57 / 9 = 6.3 mm^2

So 2 x 14 SWG wire selected for primary winding / Limb.

Design of Output Inductor L

Assume the maximum input voltage of 12 V under fully loaded condition

Secondary voltage Vs = Ns x Vi / Np

= 106 x (12-1) / 3

= 389 V

MOSFET on Time Ton = 23.1 X 325 / (389 - 2)

= 19.7 µS

Voltage applied across Output inductor V_L = Vs - 2 x Vf - Vo

$V_L = 389 - 2 - 325$

$V_L = 62$ V

Assume Maximum allowed current ripple $\Delta Io = 0.3 \times Io$

$= 0.93$ A

Inductance L = e x dt / di

Output Inductor $L = 62 \times 19.7 \times 10^{-6} / 0.93$

Output Inductor L = 1.3 milli Henry

Peak Inductor current $Ipeak = Io + \Delta Io / 2$

$= 3.1 + 0.93 / 2$

$Ipeak = 3.6$ A

Ferrite core selected for Output Inductor: **E 42/21/15**

Cross section area $Ae = 178\ mm^2$

Saturation flux density $Bsat = 0.35\ Wb/m^2$

From datasheet of core $A_L = 3600\ nH/T^2$

Minimum Inductor Turns N = L x Ipeak / (Bsat x Ae)

$= 1.3 \times 10^{-3} \times 3.6 / (0.35 \times 178 \times 10^{-6})$

Inductor Turns N = 76 Turns

Air gap required $= \mu_o \times Ae \times ((N^2/L) – (1/A_L))$

$= 4 \times \pi \times 10^{-7} \times 178 \times 10^{-6} \times ((76^2 / 1.3 \times 10^{-3}) – (1/3600 \times 10^{-9}))$

$= 0.93$ mm

Per limb Air gap = 0.93 / 2 = 0.465 mm

Same secondary current flows through this inductor also, so the same 20 SWG wire may be used.