Interpion Semiconductor

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The Design method for Gate Pulse Transformer of IP3102

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The IP3102 is a driver IC for ballasts of fluorescent lamp. Generally, ballast for fluorescent lamp using the IP3102 is composed of half bridge inverter. Most of half bridge inverter has high side and low side MOSFET. For the high side MOSFET, the IP3102 needs pulse transformer.

This application note provides the design procedure and the analysis for optimal pulse transformer.

Figure 13 shows the equivalent circuit of the pulse transformer. The main purpose of the pulse transformer is to transfer the signal without distortion. The normal transformer has air gap for the energy store but on the other hand the pulse transformer should not have the air gap. The most important design consideration is the pulse transformer should have very small leakage inductance and very big coupling constant of the primary and the secondary wires.

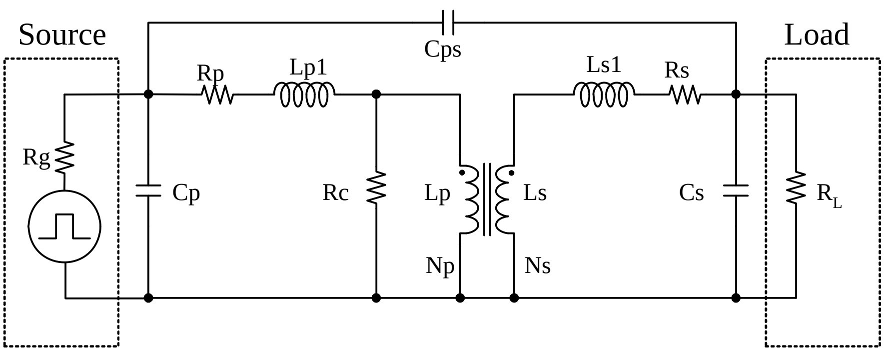

Figure 1. The equivalent circuit of the pulse transformer

R_g = Internal resistance of the driving source

R_P = DC Resistance of the primary winding

R_S = DC Resistance of the secondary winding

R_L = Load Resistance on the secondary winding

R_C = Core losses expressed as a shunt resistance in parallel with the primary windings

C_P = Primary shunt and distributed capacitance

C_S = Secondary shunt and distributed capacitance

C_{PS} = Primary-to-Secondary inter winding capacitance.

L_P = Primary inductance that is mutually coupled to the Secondary

L_S = Secondary inductance that is mutually coupled to the primary

L_{P1} =Primary leakage inductance.

L_{S1} = Secondary leakage inductance

N_P = Number of turns on the primary

N_S = Number of turns on the secondary

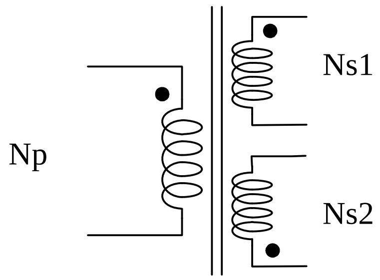

Figure 2. Pulse transformer

The figure 2 shows the pulse transformer for IP3102. The design procedure of the pulse transformer is as follows:

Step1. **Select the primary input voltage.**

: The 1st stage voltage depends on the Vcc of the IP3102. Since, the output voltage of the IP3102 is clamped at 14[V]. Therefore, the 1st stage input voltage Vin is 14[V].

Step2. **Calculate primary turns**

$$N_p = \frac{V_{in} \cdot T_{on}}{B_{\max} \cdot A} \tag{11}$$

Where the T_{on} is MOSFET Turn on time[μSec], B_{max} is maximum flux density[T], the ferrite core case

Bmax=0.3 [T], A is cross-sectional area [mm^2].

Step3. **Calculate secondary turns**

:The secondary turns has very closed relationship with MOSFET V_{TH} (Threshold Voltage) and primary turns N_p. If we defined the desired secondary output is V_{gs}, the equation for Ns is calculated as follows;.

$$N_s = \frac{V_{gs}}{V_{in}} N_p \qquad (12)$$

Example: Design the pulse transformer with IP3102. The conditions are Vcc=18[V], Vgs=15[V], oscillation frequency is 40[KHz]

Step1. Vin=14[V]

Step2. Select EI core (ferrite) EE1614, the area of core is 18.4[mm^2], $T_{on} + T_{off} = \frac{1}{40K} = 25[\mu\sec]$, $T_{on} \cong 12.5[\mu\sec]$ so that

$$N_p = \frac{V_{in} \cdot T_{on}}{B_{\max} \cdot A} = \frac{14 \times 12.5 \times 10^{-6}}{0.3 \times 18.4 \times 10^{-6}} \approx 32[Turn] \qquad (13)$$

Step3. $N_s = \frac{V_{gs}}{V_{in}} N_p = \frac{15}{14} \times 32 = 34[Turn]$

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