1.10 Isolation of Gate and Base Drives

Answer following questions after reading this topic.

1. *Write a short note on methods of isolating control and power circuits in power converters.* **[Marks[6], May-2004, 2005, 2008]**
2. *Why isolation between driver circuit and power circuit is necessary ?* **[Marks [4], May-2001]**

Most likely and **asked in** previous University Exam

1.10.1 Necessity of Isolation

We know that driver circuits operate at very low power levels. Normally the signal levels are 3 to 12 volts. Sometimes digital circuits and microprocessors are also used in the triggering circuits. The gate and base drives are connected to power devices which operate at high power levels. Fig. 1.10.1 shows this situation. Observe that collector of BJT can have voltages of 200 V. But base is connected to trigger circuit that have voltages of 5 V. If BJT is damaged and collector-base gets shorted, then high voltage will get connected to trigger circuit. This will damage the trigger circuit also. This means trigger circuit is damage due to device damage. Therefore there must be some electric isolation between control and power circuit. There is one more reason for isolation. Consider that the trigger circuit is deriving the two devices as shown in Fig. 1.10.2. Here observe that T_1 is given the drive between a-b. And T_2 is given the drive between c-d. The trigger circuit must isolate the two drives. If there is no electric

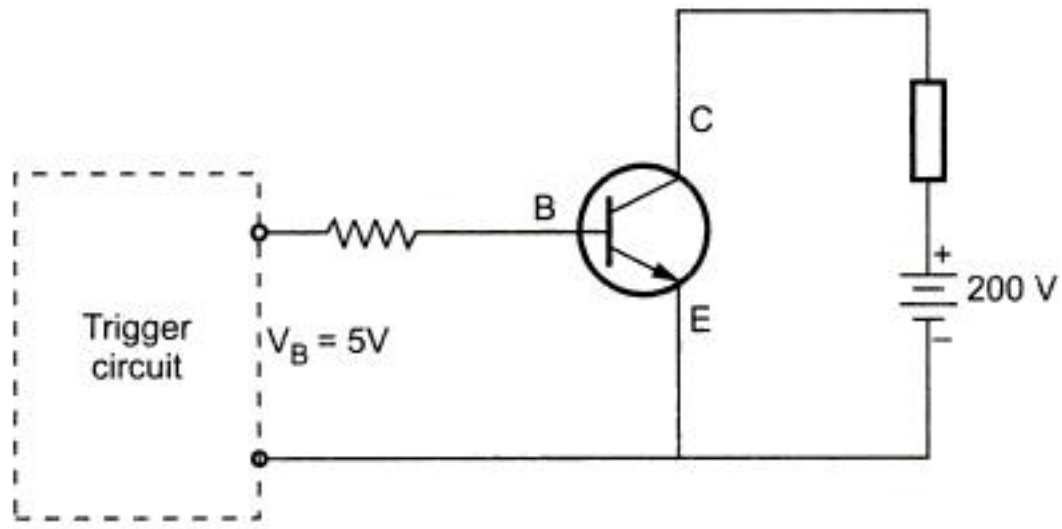

Fig. 1.10.1 Control / power levels

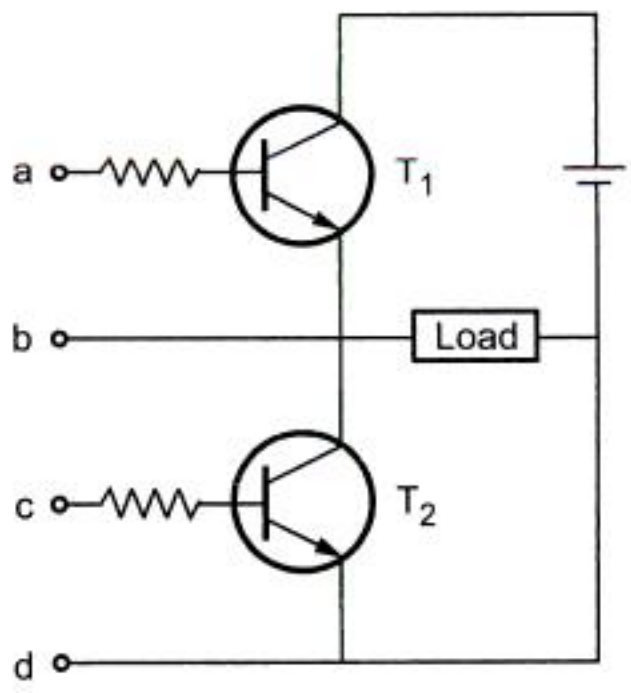

Fig. 1.10.2 Isolation of grounds

isolation, the points 'b' and 'd' may be shorted due to common ground of the trigger circuit. Isolation can be obtained with the help of pulse transformers and optocouplers.

1.10.2 Isolation using Pulse Transformer

Pulse transformer has one primary and one or more secondary windings. It is normally used for pulsed mode of triggering. Fig. 1.10.3 shows the isolation using pulse transformer.

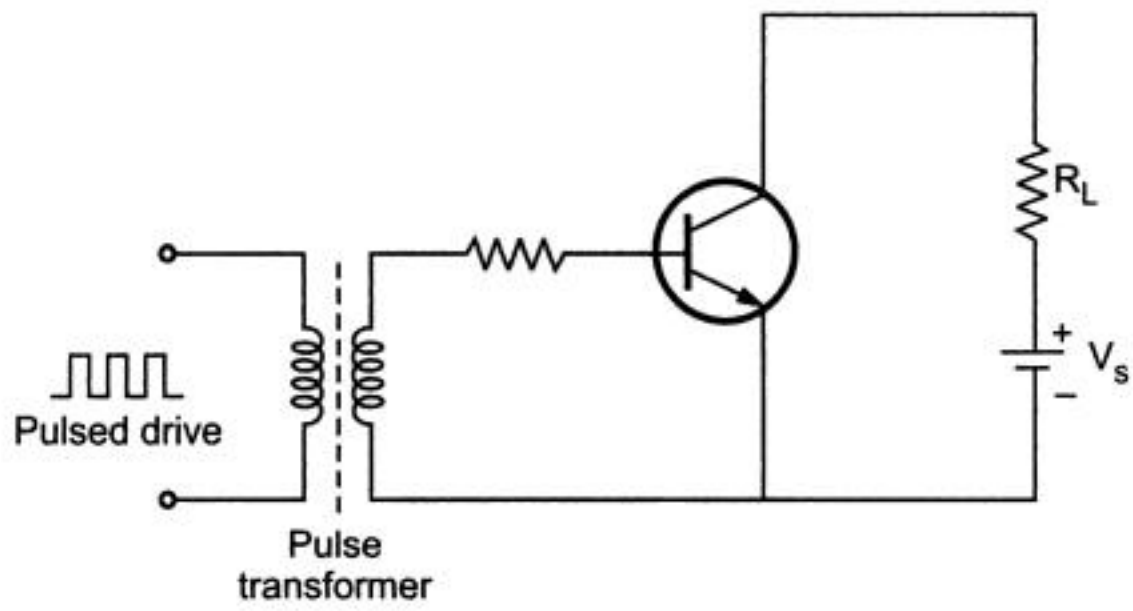

Fig. 1.10.3 Electric isolation using pulse transformer

In the above circuit, observe that triggering circuit is electrically isolated from BJT. Hence if there is any electric damage to BJT, there will be no effect on triggering circuit.

Advantages

i) Pulse transformer does not need external power for its operation.

ii) It is very simple to use.

Disadvantages

i) Pulse transformer saturates at low frequencies hence it can be used only for high frequencies.

ii) Due to magnetic coupling, the signal is distorted.

1.10.3 Isolation using Optocouplers

Optocoupler consists of a pair of infrared LED and phototransistor. Fig. 1.10.4 shows the symbol of optocoupler. When the signal is applied to the infrared LED, it turns-on. It's light falls on phototransistor. Therefore phototransistor also starts conducting. There is no electric connection between LED and phototransistor.

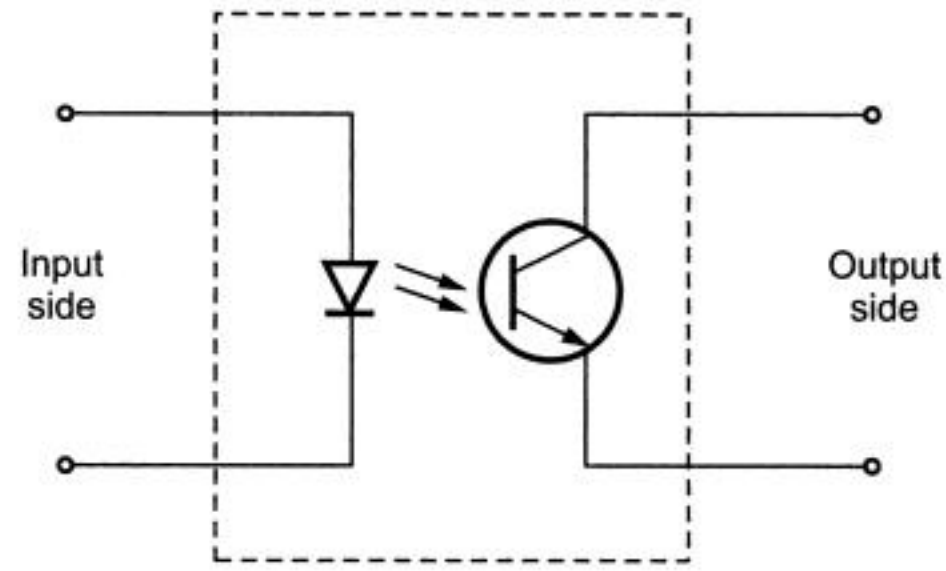

Fig. 1.10.4 Optocoupler

Fig. 1.10.5 shows the triggering circuit that uses optocoupler. In this circuit the triggering pulses are given to the input (LED) of optocoupler. When 'V_g' is positive, LED turns-on. It's light falls on phototransistor. Hence it turns-on. Therefore base of T_1 is connected to zero volts through phototransistor. Due to this, T_1 turns-on. Therefore the voltage V_{CC} is applied to gate of the MOSFET. Hence MOSFET turns-on. When $V_g = 0$, the LED turns-off, therefore phototransistor also turn-off. Therefore base drive of T_1 goes to V_{CC} and it turn-off. When T_1 turns-off, MOSFET gate voltage becomes zero. Therefore MOSFET turns-off. Thus gate drive circuit using optocoupler works.

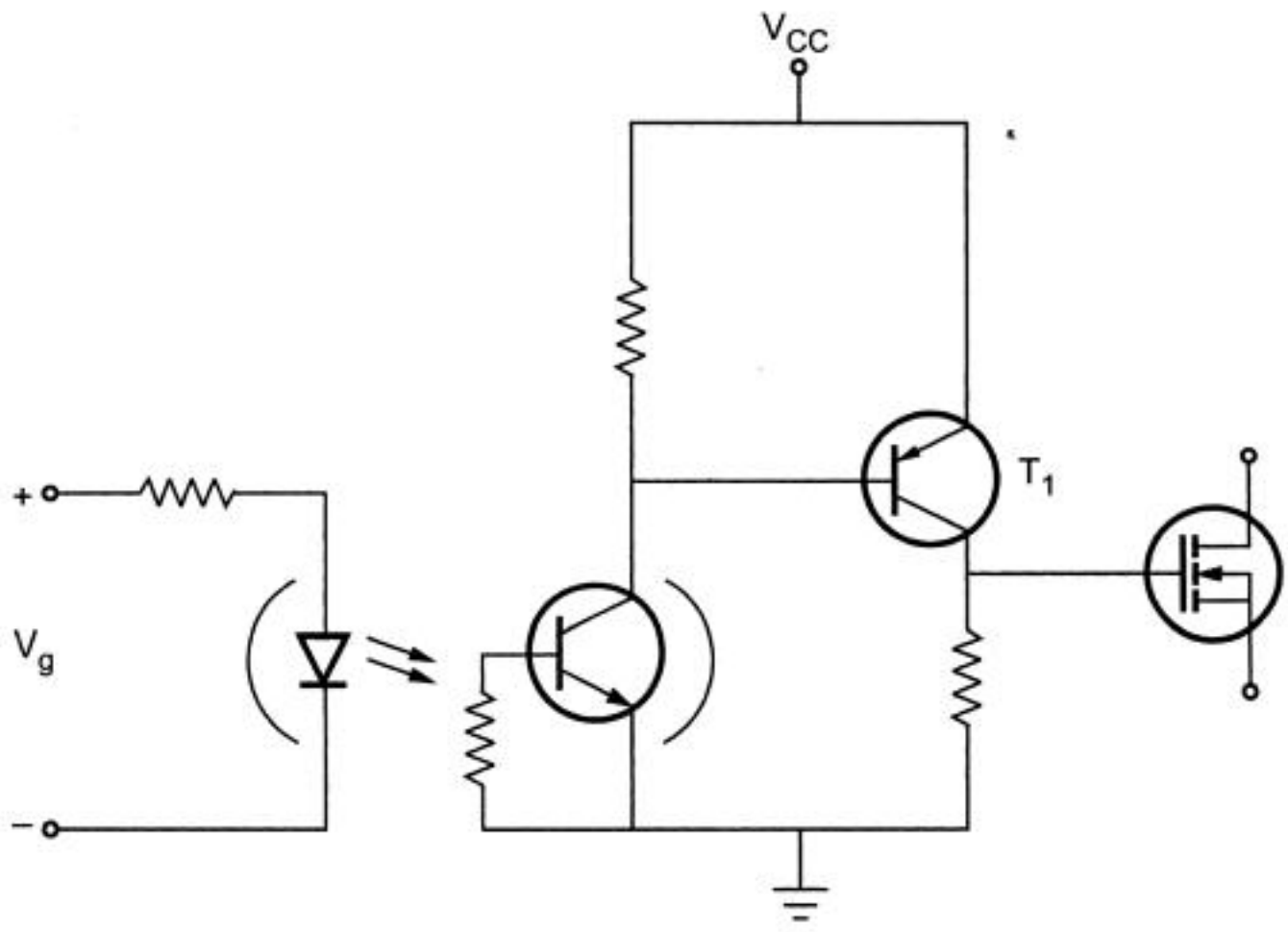

Fig. 1.10.5 MOSFET triggering circuit using optocoupler

Advantages

1) Very good response at low frequencies.
2) Compact and cheaper optocoupler devices are available.

Disadvantages

1) Optocoupler need, external biasing voltage for their operation.
2) High frequency response is poor.

Applications

Inverters, SMPS, Choppers, AC motor drives use optocouplers.

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