

## CHAPTER 8

### HARDWARE DESIGN

#### 8.1 Inverter Design

##### 8.1.1 Construction of a Three Phase Bridge Inverter

Specifications:

1. Voltage rating 54Vdc input.
2. Current rating 1.0A.
3. Switching frequency  $> 50\text{KHz}$ .
4. Number of outputs= 2.
5. The top and bottom devices in each leg of the inverter should be isolated.

Assumptions:

1. It is inferred that for this particular case, short circuit protection and overload protection are not mandatory.
2. The control signals for this inverter are through an external source like DSP or micro-controller or any other PWM generation IC.

Tasks:

In meeting the above requirements it was necessary to build:

1. Construction of Power Stage.
2. Strong base drive circuit.

### 8.1.2 Construction of Power Stage

The total output wattage of the system is 50W. Since the switching frequency should be  $>50\text{KHz}$  the choice of device could be an IGBT or MOSFET's.

One would preferably go for the MOSFET due to following reasons:

1. Now considering the cost MOSFET is much cheaper than an IGBT module.
2. The power stage becomes modular, so that in any case if one of the devices is damaged, replacement becomes easy. Whereas in case if an IGBT module gets damaged, the whole module has to be replaced. This adds to the cost for repairs.

### 8.1.3 Selection of Devices (MOSFET's)

1. Considering a safety factor of three for the voltage, the voltage rating of the device should be 150V.
2. Considering a safety factor of 1.5 for the voltage, the current rating of the device should be 3A.
3. The switching frequency of this MOSFET should be greater than 50KHz.

Referring to the IRF device selection manual, select the IRF540 MOSFET (refer datasheet attached).

$V = 100\text{V}$ ,  $I_d = 5\text{A}$ . But due to the availability of IRF 350 ( $V_d = 400\text{V}$ ,  $I_d = 15\text{A}$ ) go for these MOSFETS.

### 8.1.4 Design of Snubber Circuit for these MOSFET

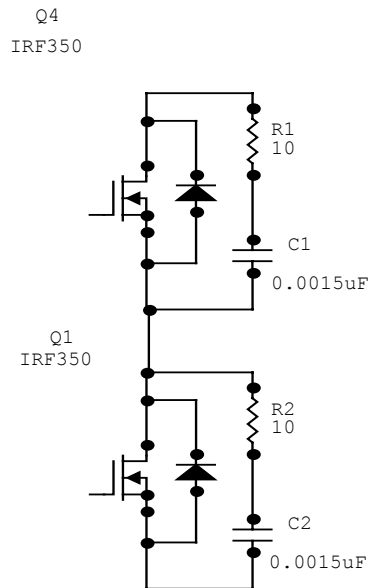
Due to the switching characteristics of the MOSFET, a snubber circuit has to be considered to suppress the ringing of the MOSFET during turn ON and turn OFF.

This design concentrates on using a RC snubber.

Let the minimum switching time constant is  $T = \frac{1}{67\text{KHz}} = 0.015\text{msec}$ .

Hence the RC should satisfy this time constant i.e  $RC=0.015\text{msec}$ .

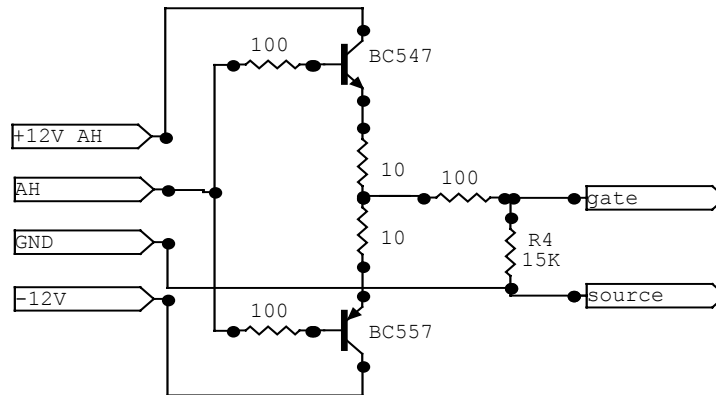
Let  $C = 0.0015\mu\text{F}$ , then  $R = 10\text{ohm}$ .



**Figure 8.1 Single leg of an inverter using MOSFET**

### 8.1.5 Design of Gate Drive Circuit for these MOSFET

The threshold gate voltage is 4V. But to ensure switching ON and OFF of the devices at these high frequencies, the gate voltage range is between +12V and -12V.



**Figure 8.2 Gate Drive buffers**

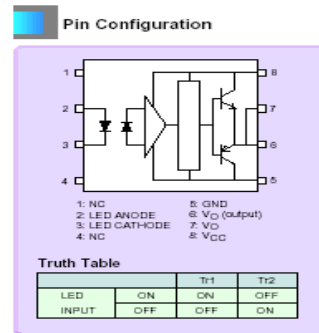
In order to provide a sufficient gate drive current a BC547-BC557 push-pull pair is used.

These transistors are operated in saturation region.

It should be noted that the power supply to each drive circuit should be isolated

The signals, AH, AL, BH, BL, CH, CL, DH, DL to these push pull stages is given through an opto-isolator driver IC TLP250.

### 8.1.6 Design of Opto-isolator Circuit



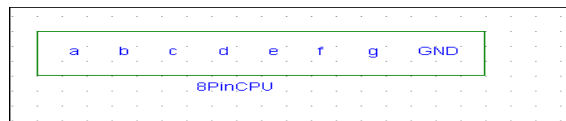
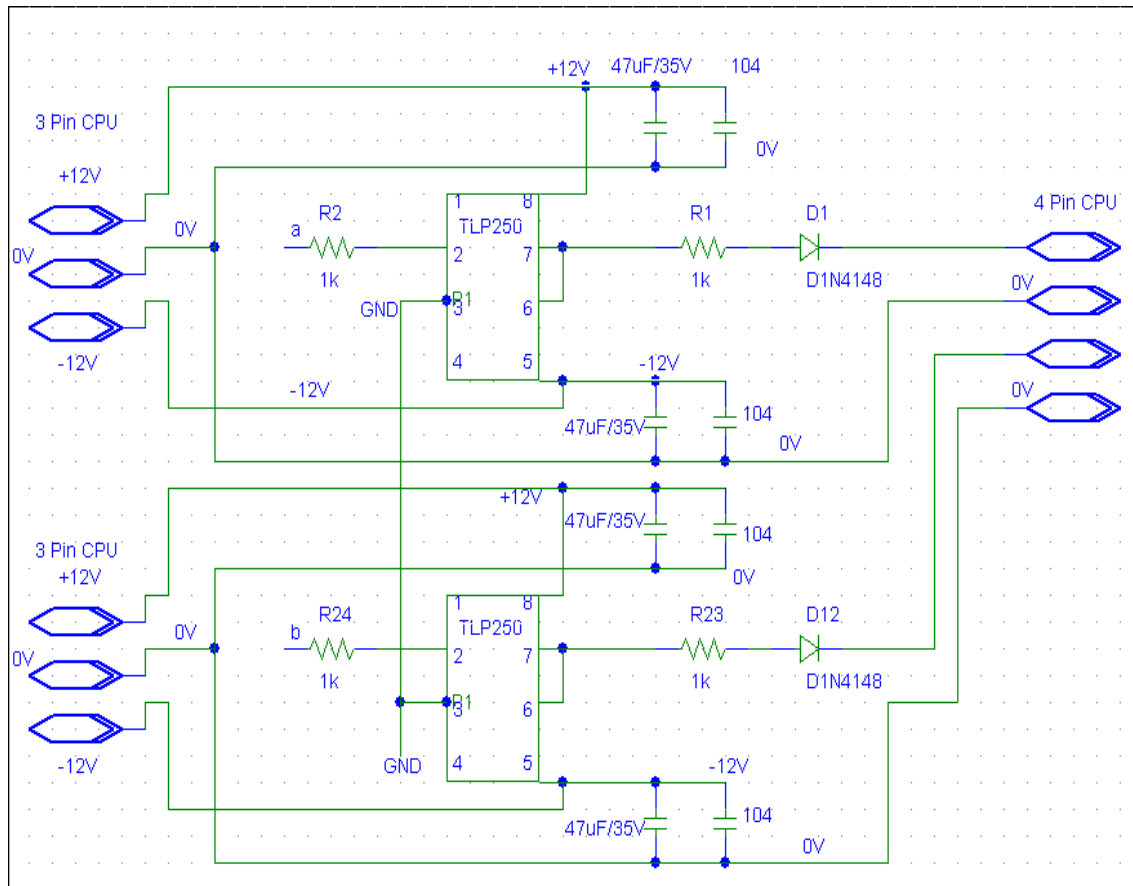
**Figure 8.3 TLP 250 Opto-Isolator**

For providing opto-isolation between the power stage and the drive signal stage, the opto-isolator driver IC TLP 250 is used.

Following reasons justify the advantages of using TLP 250.

1. Input threshold voltage current  $I_f = 5\text{mA}$  (max)
2. Supply Voltage 10V-35V
3. Output Peak current 2A
4. Response speed 0.5us

Isolation voltage 2500Vrms



**Figure 8.4 Complete schematic of the driver circuit**