

# Introduction

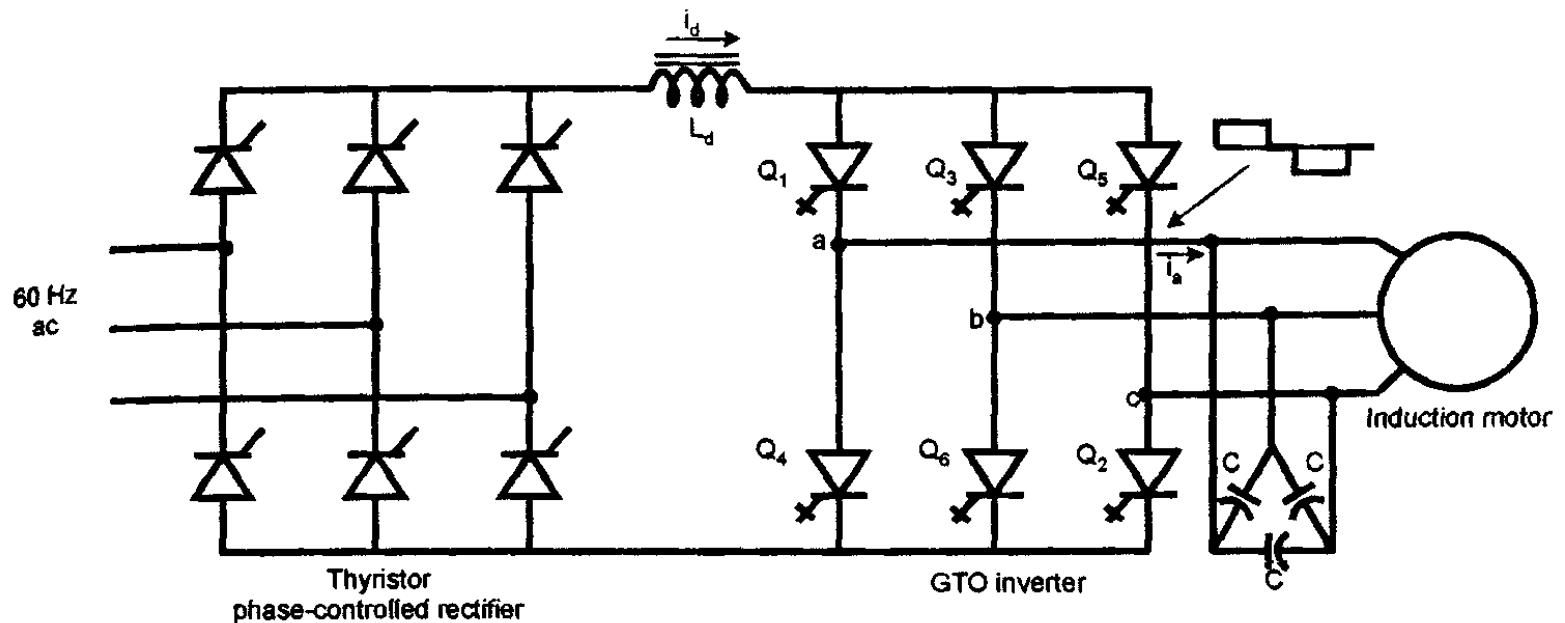
Power semiconductor devices used in CSI inverters must be able to withstand large reverse voltages. Therefore, power MOSFETs, BJTs, IGBTs, MCTs, IGCTs and GTOs.

Symmetric blocking GTOs and thyristors can be used in CSI inverters.

Generally CSI inverters are now used in very high power applications.

# Six-Step CSI with Self-Commutated Devices

Self-controlled symmetric blocking devices, e.g. GTO's can be turned on and off by gate current pulses. This allows the 6-step waveform to be directly controlled.



**Figure 6.18** Six-step GTO current-fed inverter with induction motor load

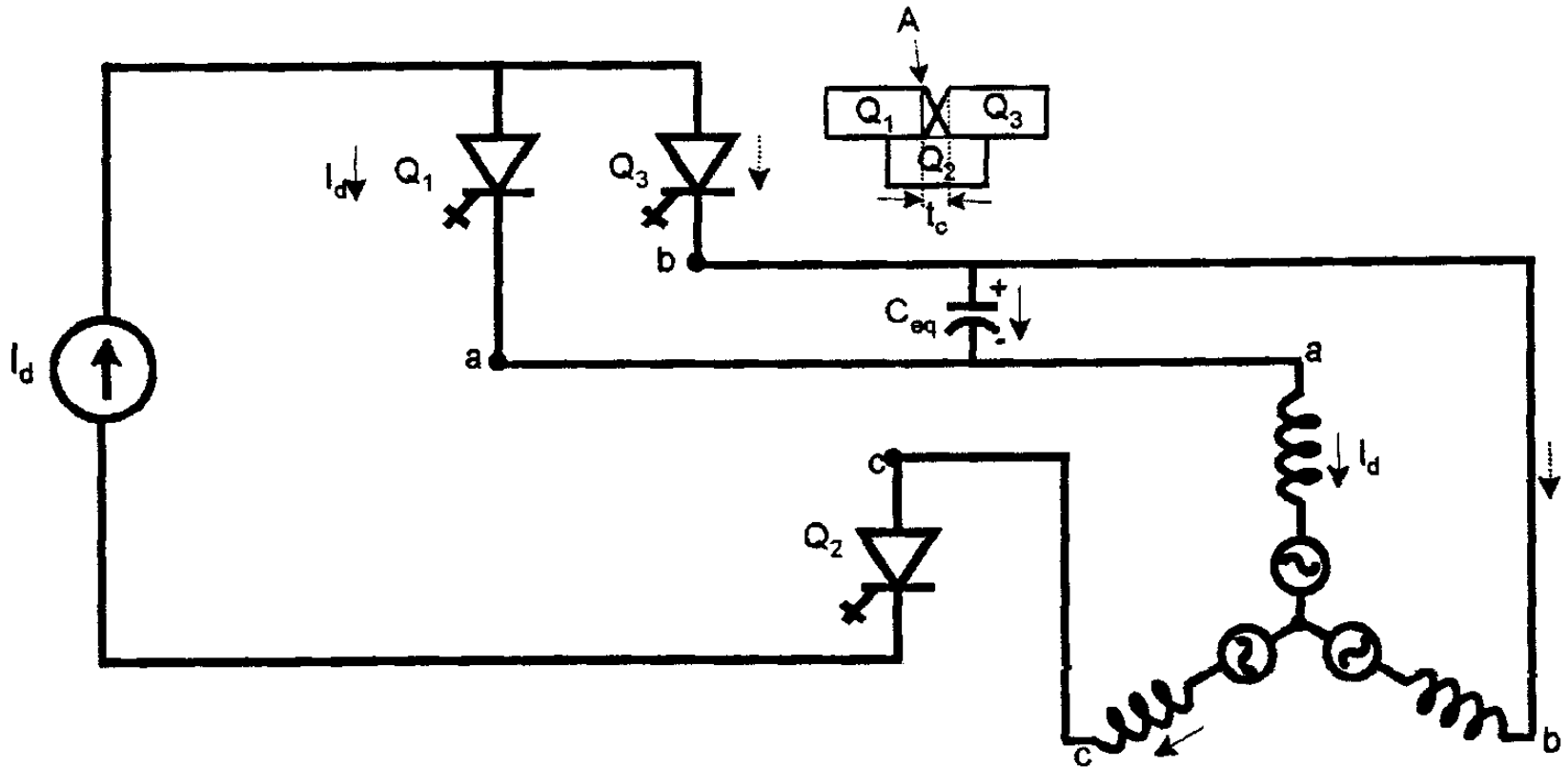
# Six-Step CSI with Self-Commutated Devices (cont'd)

In this circuit, the capacitors are freed from their commutating requirement and are simply placed across the terminals of the induction motor. These capacitors are much smaller and serve two roles:

- 1) primarily, to allow commutation from the outgoing GTO to the incoming GTO,
- 2) secondarily, to load filter higher harmonics

# Six-Step CSI with Self-Commutated Devices (cont'd)

Example: Commutation from  $Q_1$  to  $Q_3$ .



**Figure 6.19** Equivalent circuit during commutation from  $Q_1$  to  $Q_3$

# Six-Step CSI with Self-Commutated Devices (cont'd)

Initially current flows through  $Q_1$ , phase a, phase c, and  $Q_2$ . The equivalent capacitance  $C_{eq}$  and polarity of  $v_{ba}$  are as shown.

Next,  $Q_3$  is turned on at time A. But because of voltage across  $C_{eq}$ ,  $Q_1$  does not automatically turn off.

Next,  $Q_1$  is turned off. The current  $I_d$  transfers to  $Q_3$  and through  $C_{eq}$ .

$C_{eq}$  charges up overcoming the motor back emf b/w phases a and b. Gradually the current transfers to phase b. Commutation is completed when  $i_b = I_d$ .

# Six-Step CSI with Self-Commutated Devices (cont'd)

Total commutation time is  $t_c$ .

Once commutation is complete, current can be commutated back to  $Q_1$ . This back and forth current commutation can be used to create a PWM current wave and with suitable selection of notch angles, can be used to suppress higher harmonics (just as in the VSI inverter).

# Six-Step CSI with Self-Commutated Devices (cont'd)

A major disadvantage of this scheme is the potential for resonance between the capacitors and the motor inductance. Care must be taken to avoid impressing current harmonics into the motor/capacitor network which will excite one of the system resonance frequencies. This can be avoided by careful use of PWM. However, since the motor parameters must be known to implement such an approach, this drive is not popular for general-purpose applications.