Unit 5: Converters

Module 16: Single Phase Half controlled Bridge rectifier with Resistive load and Inductive load

Introduction:

Single phase fully controlled bridge converters are two quadrant converters having unidirectional current with both positive and negative voltage polarity. Thus, they can be operated either as a controlled rectifier or an inverter. But for some applications that do not utilize the inverter mode operation, a fully controlled converter with four thyristors and their associated control and gate drive circuit makes the system unnecessarily complicated. In such situations, two of the thyristors of a single phase fully controlled converter has to be replaced by diodes as shown in figure 1. The resulting converters are called single phase half-controlled converters. Half controlled convertors are single quadrant converters having one polarity of voltage and current at the DC terminals. Input and output behaviour of both circuits fig.1(a) and 1(b) are identical although the device designs differ. In Fig. 1 (b) the diodes carry current for a considerably longer duration than the thyristors. However, in Fig. 1 (a) both the thyristors and the diodes carry current for half the input cycle.

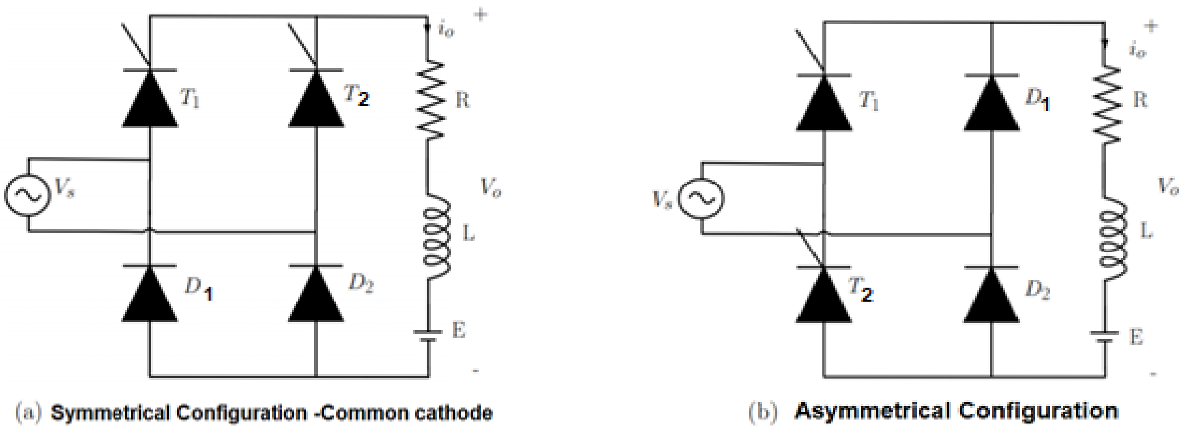
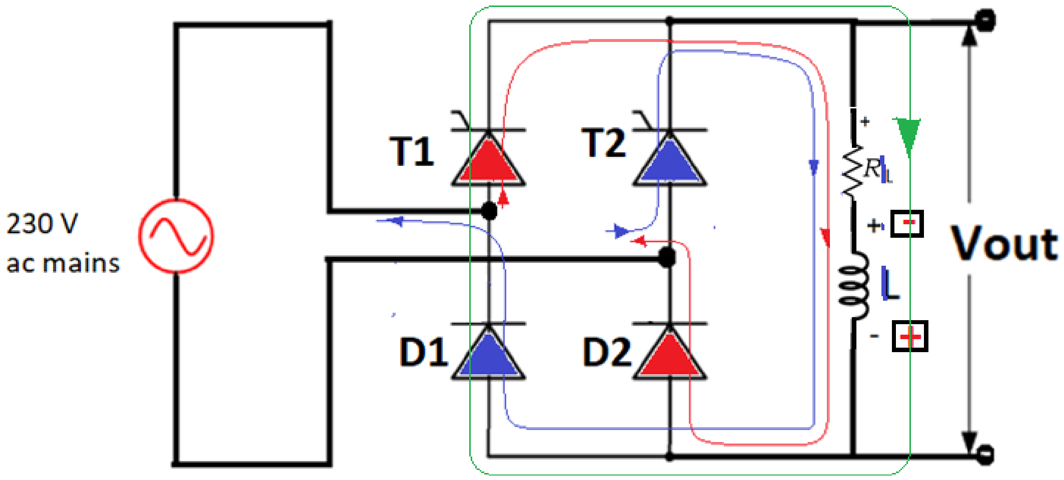


Fig: Half Controlled Bridge Rectifiers

Features of Half controlled Bridge rectifier or Semi-converters

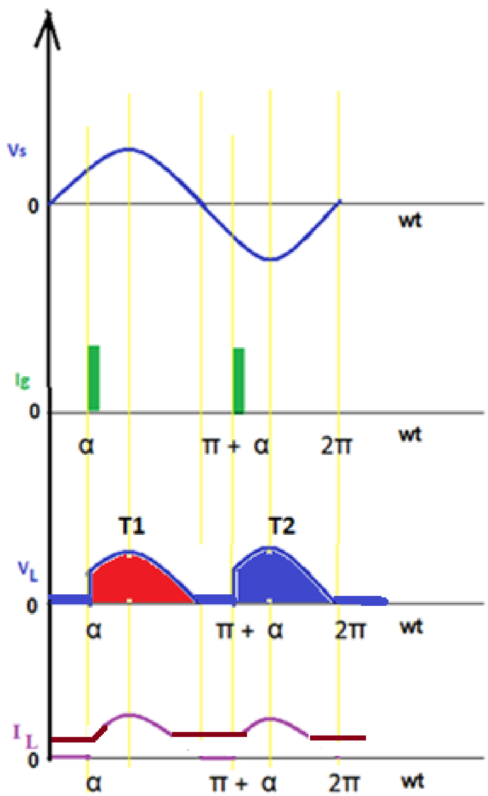
- Provides continuous control of mean DC terminal voltage to virtually Zero volts.
- It operates only as a Rectifier and not as a Inverter.
- Makes use of 2 SCRs and 2 diodes; thus the cost is reduced
- The reactive power consumption is Less
- The ratio of the power drawn from the input to the power consumed in the load approaches unity. (improvement in power factor)

Converter operation

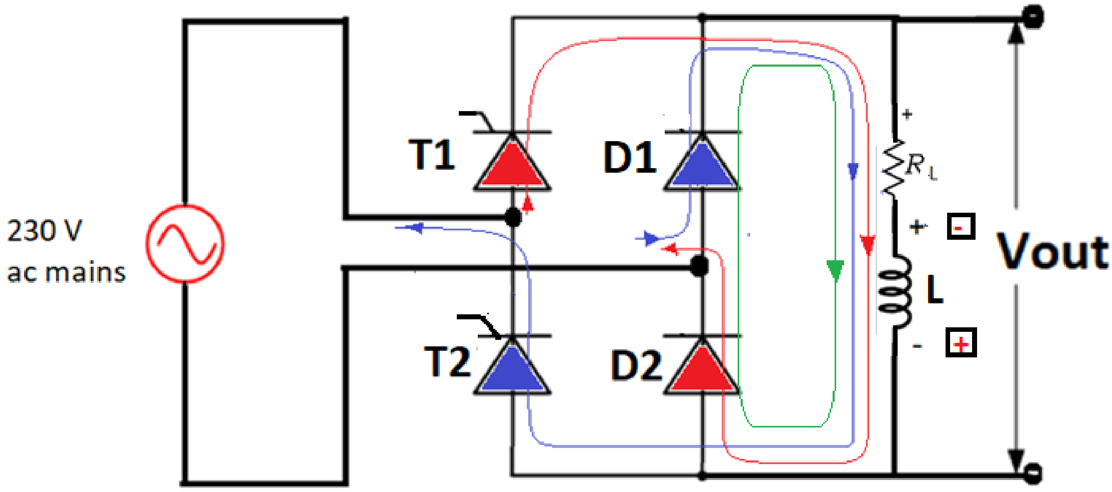


- During the positive half cycle T_1 is triggered into conduction, current flows through the path T_1-R_L-L-D_2 upto 180^0.
- After 180^0 the load current still flows in the circuit, but is transferred from diode D_2 to diode D_1, without including reverse supply voltage across the load.
- When T_2 is fired in the negative half cycle, T_1 turns off and the load current flows from the supply through thyristor T_2 and diode D_1, through the path T_2-R_L-L-D_1.
- Thyristor T_1 is triggered in the next positive half-cycle and the cycle is repeated.

Waveforms

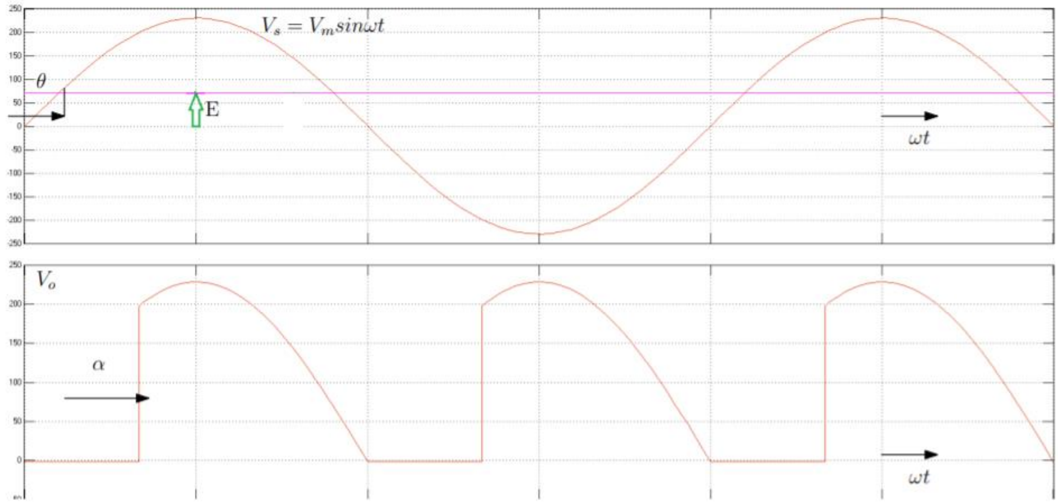


Single Phase Half controlled Bridge rectifier with Inductive Load (Asymmetrical Configuration)



Converter Operation

Since diodes can block only negative voltage, it can be concluded that diodes D1 and D2 conducts for positive and negative half cycle of the input voltage respectively. For the positive half cycle, when thyristor T1 is fired at its firing angle α, load current flows through T1 and D2. When diode D1 starts conduction in the negative half cycle, T1 is reverse biased and is turned off. Then load current is transferred to diodes D2 and D1 as observed in the waveforms. Thyristor T2 will come in once it is fired, which turns off diode D2. Thus, load current is continuous throughout and this mode of operation is known as continuous mode of operation. If load current becomes zero for some time, then it is known as discontinuous mode of operation. The circuit diagram and the waveforms of a single-phase half-controlled converter supplying an R-L-E load is shown in figure 2. The device currents are shown in figure 3. Since the output voltage is periodic over half the input cycle, Voav = 1 π R π 0 vodωt = Vm π (1 + cosα). Thus by varying the firing angle α, average output voltage from the converter can be controlled and that is applied in most of the dc drives as a variable voltage dc source for the motor speed control. Both armature voltage control and field control requires a variable voltage dc source. If a fixed dc source is available, by using rheostats , variable voltage can be applied to the armature and field terminals. But this results in poor efficiency due to high copper loss. So nowadays power electronic controllers (half controlled converters) are used in dc drives to obtain efficient, smooth and flexible speed control.



(b)

Figure 2: Half controlled converter in continuous mode of operation a) Circuit diagram b) Waveforms

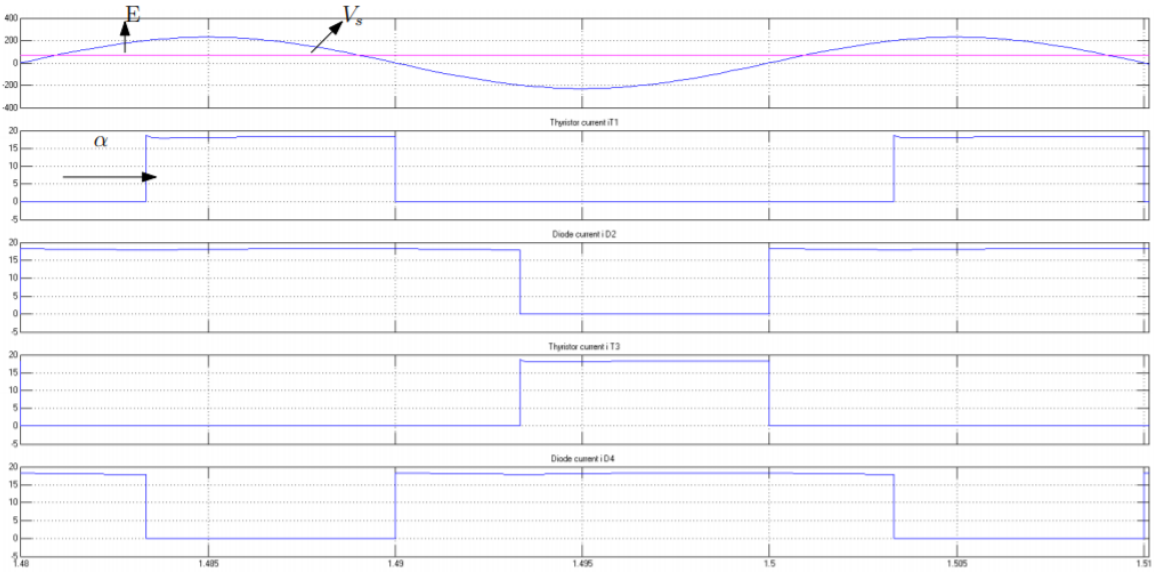


Figure 3: Device currents of a half controlled converter in continuous mode