DC/AC Converter

Part-1

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DC/AC Converter: Inverter

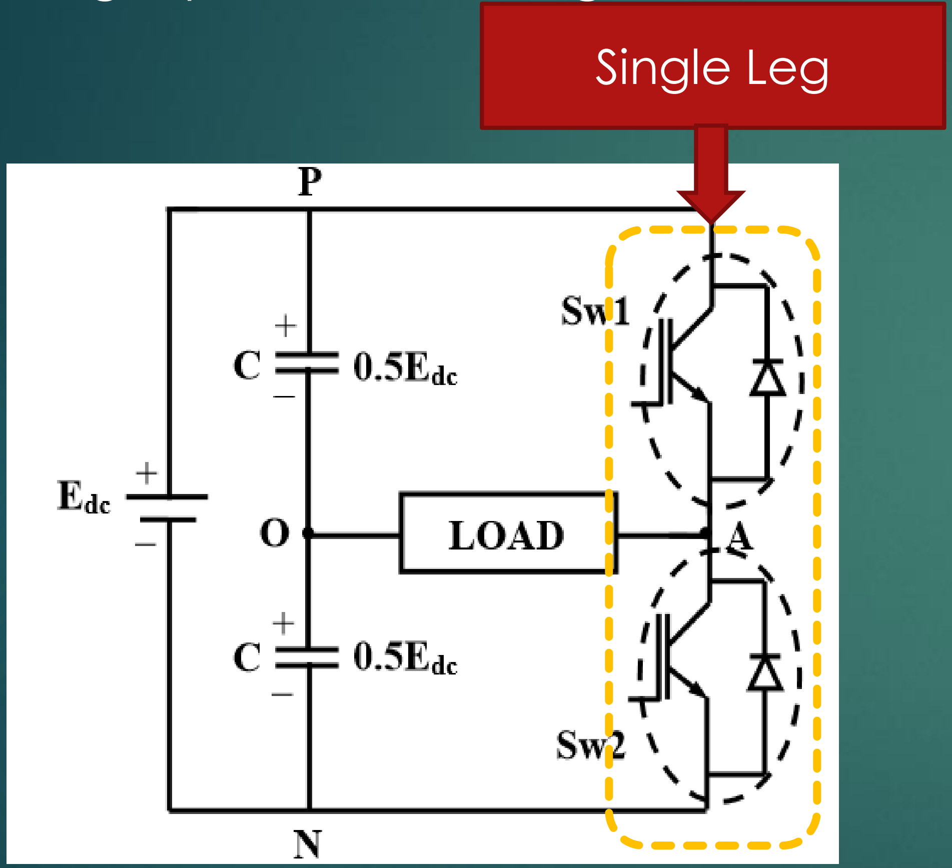
- A device that converts dc power into ac power at a desired output voltage and frequency
- The DC source may be in the form of batteries, generators, solar cells or for large power applications, controlled or uncontrolled ac-dc rectifier circuits.
- The configuration of AC/DC converter and DC/AC converter is called a dc-link converter.
- Applications:
  - Emergency lighting systems
  - Uninterrupted power supplies
  - AC motor drives

Classifications

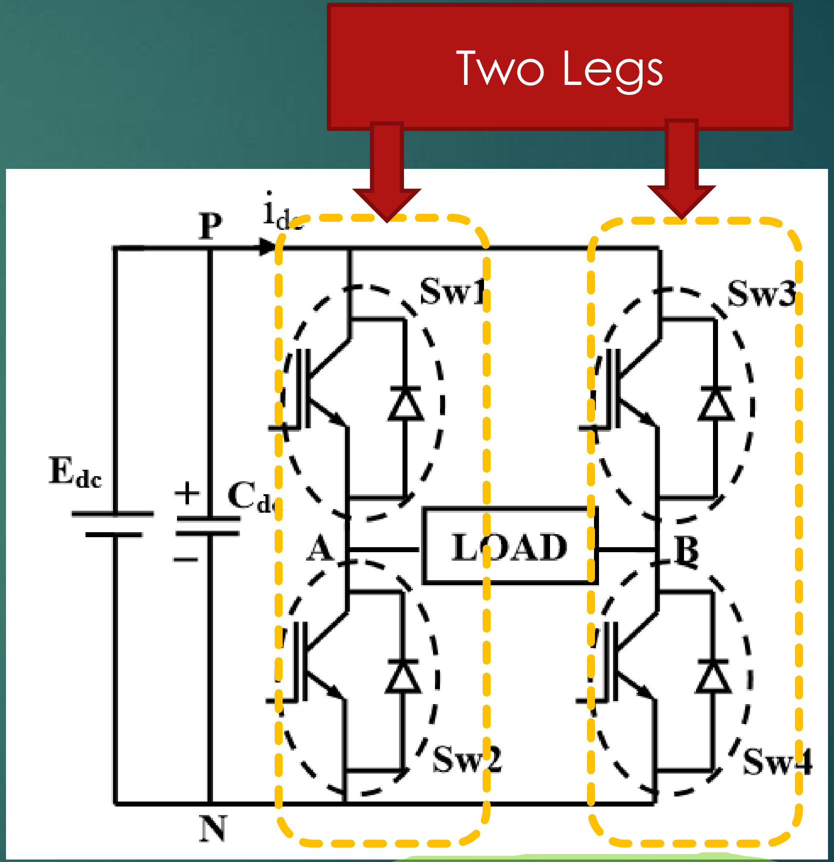
- **On the basis of input source**
  - Voltage Source Inverter (VSI) : Have stiff dc voltage source at the input, in other words it have dc voltage source with negligible impedance.
  - Current Source Inverter (CSI): Have stiff current source at the input in other words dc source have high impedance.
- **On the basis of Commutation**
  - Line commutated Inverters: Can't function as isolated ac voltage source or as a variable frequency generator with dc power at the input.
  - Forced commutated Inverters: Can provide an independent ac output voltage of adjustable voltage and adjustable frequency.
- **On the basis of output**
  - Single phase Inverters
  - Three phase Inverters

Single phase VSIs

- Single phase half bridge



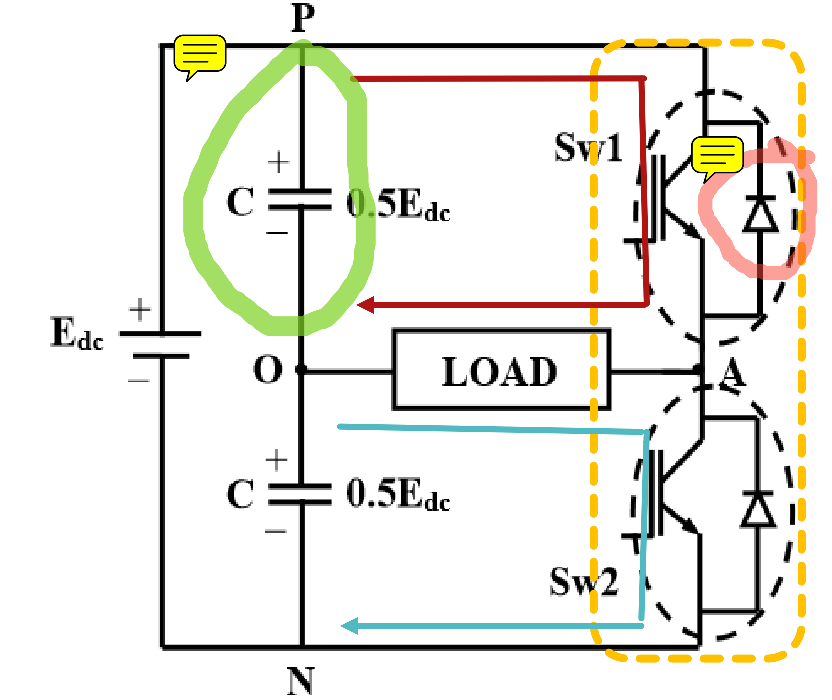
- Single phase full bridge



First generation inverters, using thyristor switches, were almost invariably square wave inverters because thyristor switches could be switched on and off only a few hundred times in a second

Single phase half bridge VSI

- In half bridge topology the input dc voltage is split in two equal parts through an ideal and loss-less capacitive potential divider.
- Each leg of the inverter consists of two series connected electronic switches
- Each of these switches consists of an IGBT type controlled switch across which an uncontrolled diode is put in anti-parallel manner
- These switches are capable of conducting bi-directional current but they need to block only one polarity of voltage
- In half bridge topology the single-phase load is connected between the mid-point of the input dc supply and the junction point of the two switches
- the switches should neither be simultaneously on nor be simultaneously off. Simultaneous turn-on of both the switches will amount to short circuit across the dc bus and will cause the switch currents to rise rapidly.



For Resistive load

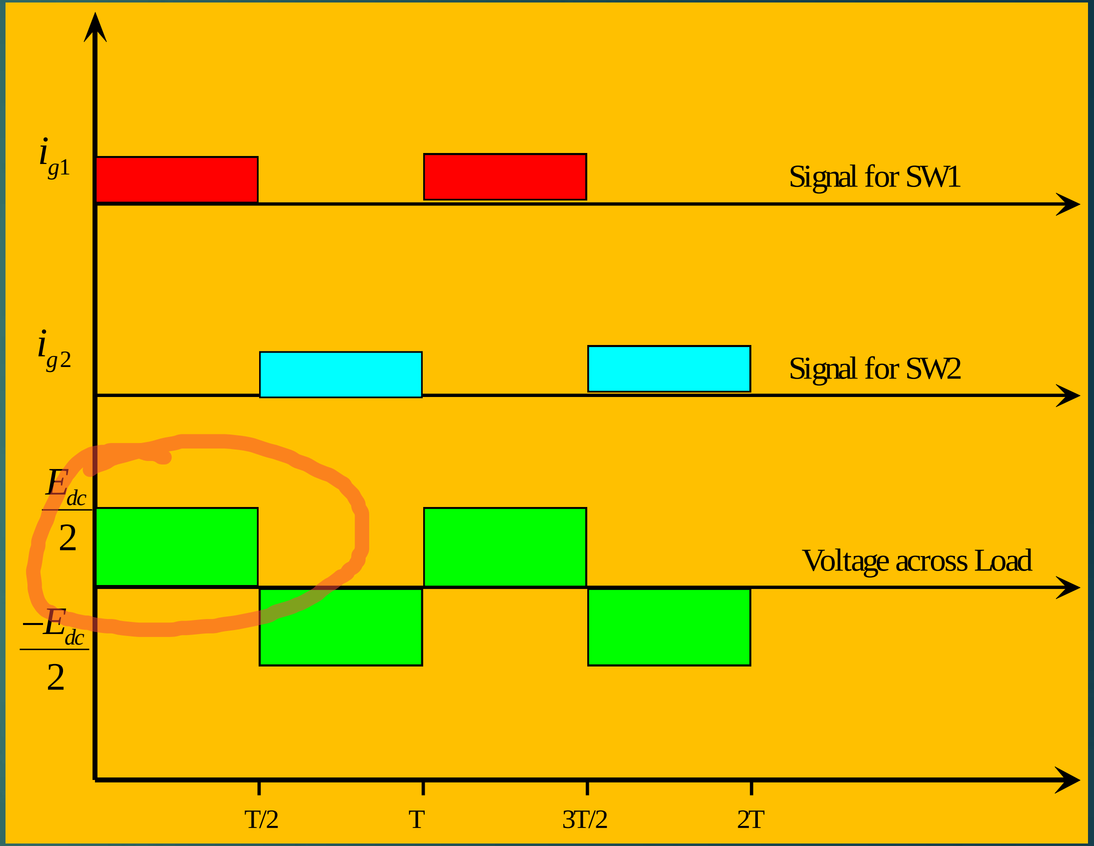
- The switching sequence is to design that switch SW_1 is on for the time duration $0 \leq t \leq T_1$ and the switch SW_2 is on for the time duration $T_1 \leq t \leq T_2$.
- When switch SW_1 is turned **ON**, the instantaneous voltage across the load is

  $V_o = +E_{dc}/2$

- When the switch SW_2 is only turned **ON**, the voltage across the load is

  $V_o = -E_{dc}/2$

- The waveform of the output voltage and the switch currents for a resistive load is shown in Fig.



The r.m.s. value of output voltage vo is given by : $V_o, rms = \frac{1}{T_1}\int_0^{T_1} \frac{E_{dc}}{4}^2 dt = \frac{E_{dc}}{2}$

The instantaneous output voltage (vo) is rectangular in shape. The instantaneous output can be expressed in Fourier series as:

$$v_o = \frac{a_o}{2} + \sum_{n=1}^{\infty} a_n \cos(n\omega t) + b_n \sin(n\omega t)$$

Due to the quarter wave symmetry along the time axis (Figure 3), the values of a_0 and a_n are zero. The value of b_n is given by:

$$b_n = \frac{1}{\pi}\left[\int_{-\frac{\pi}{2}}^{0} \frac{-E_{dc}}{2} d(\omega t) + \int_{0}^{\frac{\pi}{2}} \frac{E_{dc}}{2} d(\omega t)\right] = \frac{2E_{dc}}{n\pi}$$

Substituting the value of bn:

Output voltage

$$v_o = \sum_{n=1,3,5,\dots}^{\infty} \frac{2E_{dc}}{n\pi} \sin(n\omega t)$$

Output current

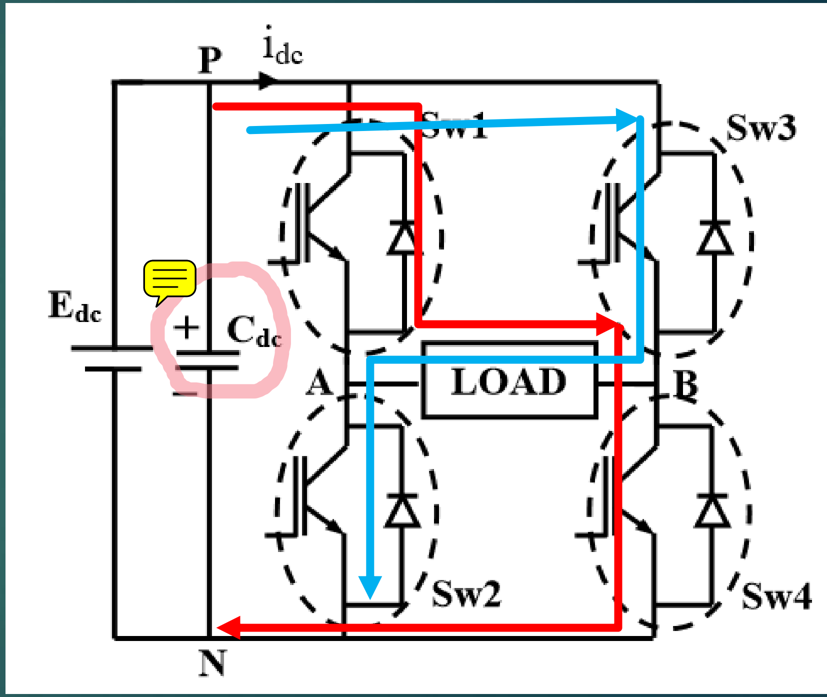
$$i_o = \sum_{n=1,3,5,\dots}^{\infty} \frac{1}{R} \frac{2E_{dc}}{n\pi} \sin(n\omega t)$$

For n=1

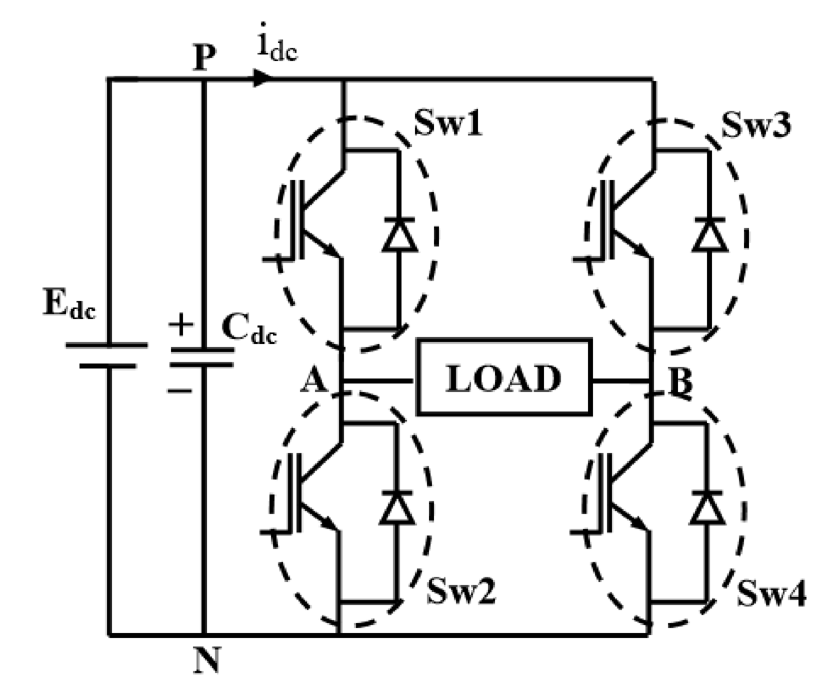
$$v_{o1} = \sum \frac{2E_{dc}}{\sqrt{2}\pi} \approx 0.45E_{dc}$$

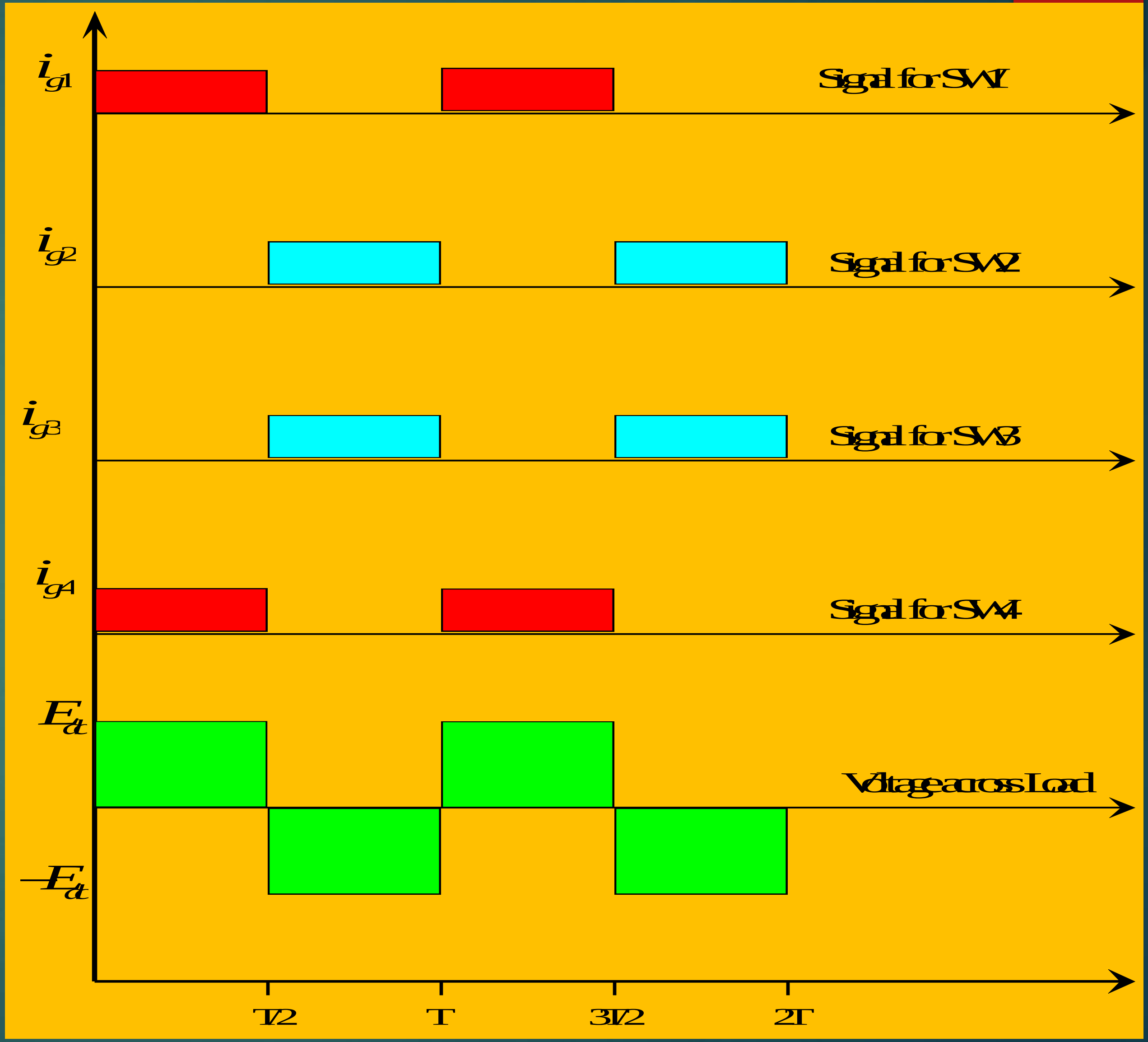
Single phase full bridge VSI with R Load

- **Operation**
- Switch SW1 and SW4 are turned ON simultaneously for half of the time period
  - Path of current flow is marked with red color line arrow
- Switch SW2 and SW3 are turned ON simultaneously for the remaining half cycle.
  - Path of the current flow is marked with blue color line arrow.



Firing Scheme





Thank You