DC to AC Conversion (INVERTER)

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DEFINITION: Converts DC to AC power by switching the DC input voltage (or current) in a pre-determined sequence so as to generate AC voltage (or current) output.

• TYPICAL APPLICATIONS:
  – Un-interruptible power supply (UPS), Industrial (induction motor) drives, Traction.
General block diagram
Types of inverter

- Voltage Source Inverter (VSI)
- Current Source Inverter (CSI)
Voltage source inverter (VSI) with variable DC link

- DC link voltage is varied by a DC-to DC converter or controlled rectifier.
- Generate “square wave” output voltage.
- Output voltage amplitude is varied as DC link is varied.
- Frequency of output voltage is varied by changing the frequency of the square wave pulses.
VSI with fixed DC link

- DC voltage is held constant.
- Output voltage amplitude and frequency are varied simultaneously using Pulse-width modulation (PWM) technique.
- Good harmonic control, but at the expense of complex waveform generation.
Operation of simple square wave inverter

- To illustrate the concept of AC waveform generation
Operation of simple square wave inverter
Waveforms and harmonics of square-wave inverter
Filtering

Output of the inverter is “chopped AC voltage with zero DC component. In some applications such as UPS, “high purity” sine wave output is required. An LC section low-pass filter is normally fitted at the inverter output to reduce the high frequency harmonics. In some applications such as AC motor drive, filtering is not required.
“Notching” of square wave

- Notching results in controllable output voltage magnitude (compare Figures above).
- Limited degree of harmonics control is possible.
Pulse-width modulation (PWM)

• A better square wave notching is shown below - this is known as PWM technique.
• Both amplitude and frequency can be controlled independently. Very flexible.
PWM - output voltage and frequency control
Three-phase inverter

• Each leg (Red, Yellow, Blue) is delayed by 120 degrees.
• A three-phase inverter with star connected load is shown below.
Sinusoidal normal three phase supply voltages
Square-wave inverter waveforms

(a) Three phase pole switching waveforms

(b) Line voltage waveform

(c) Phase voltage waveform (six-step)

Interval
1  2  3  4  5  6
Positive device(s) on 3  3.5  3  5  4  6
Negative device(s) on 2  4  4  6  1  2

Quasi-square wave operation voltage waveforms
Three-phase inverter waveform relationship

- $V_{RG}$, $V_{YG}$, $V_{BG}$ are known as “pole switching waveform” or “inverter phase voltage”.
- $V_{RY}$, $V_{RB}$, $V_{BG}$ are known as “line to line voltage” or simply “line voltage”.
MODULATION: Pulse Width Modulation (PWM)

- Triangulation method (Natural sampling)
  - Amplitudes of the triangular wave (carrier) and sine wave (modulating) are compared to obtain PWM waveform. Simple analogue comparator can be used.
  - Basically an analogue method. Its digital version, known as REGULAR sampling is widely used in industry.