Speed Control of Induction Motor

Exp No: **Date:**

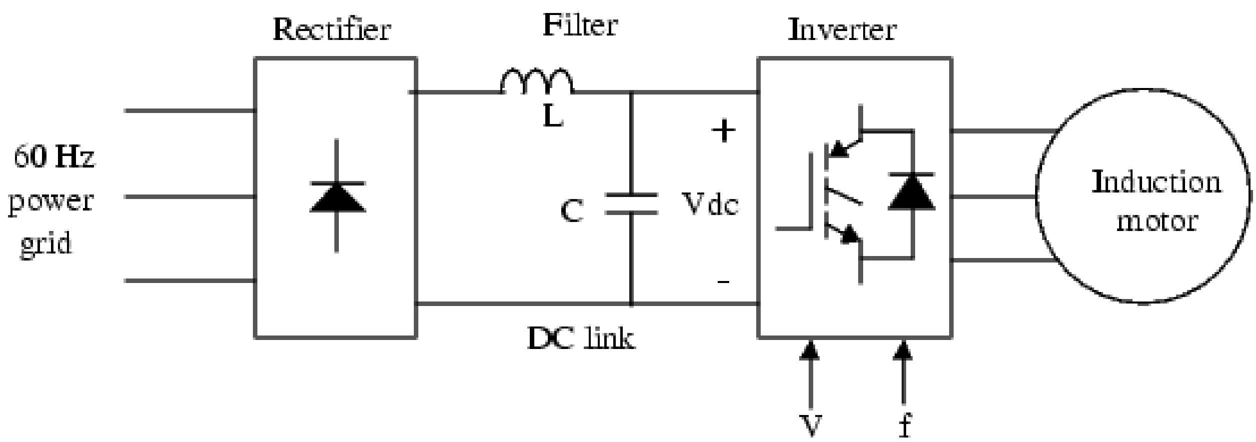
Aim: To perform speed control of induction motor using variable frequency drive (VFD) with SPWM.

VFD is a power electronics based device which converts a basic fixed frequency , fixed voltage sine wave power (line power) to a variable frequency , variable output voltage used to control speed of induction motor. It regulates the speed of a three phase induction motor by controlling the frequency and voltage of the power supplied to the motor.

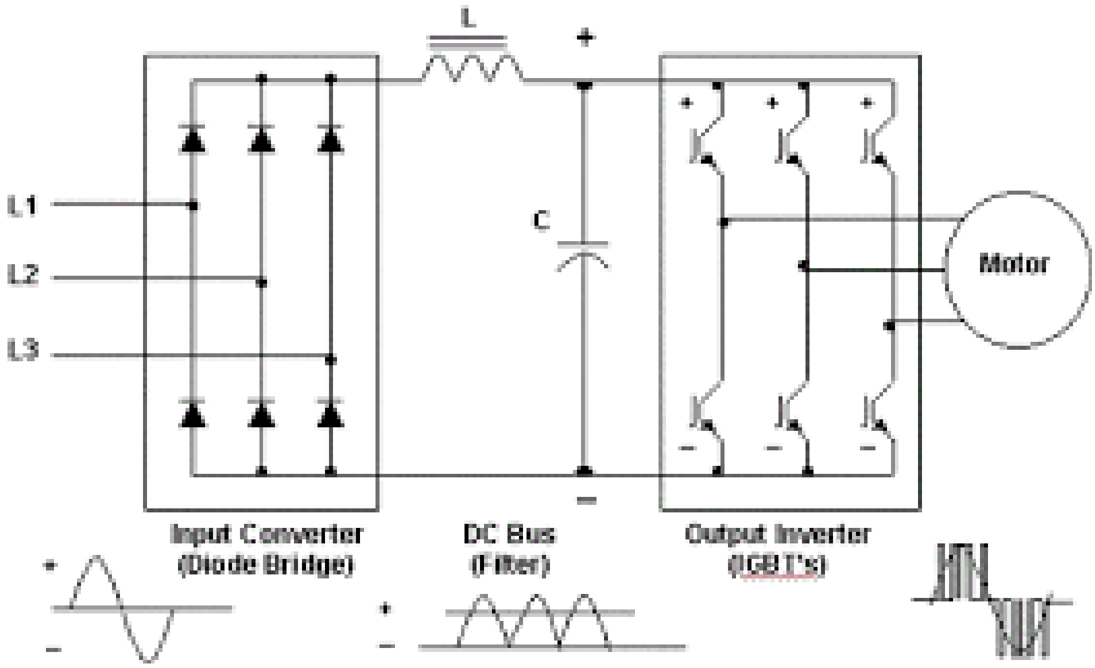
$$Ns = \frac{120f}{P}$$

Since the number of pole is constant the speed N , can be varied by continuously changing frequency.

Block Diagram:



Circuit Diagram:



Working of Variable Frequency Drive

Any variable frequency drive or VFD incorporates following three stages for controlling a three phase induction motor.

Rectifier Stage

A full-wave power diode based solid-state rectifier converts three-phase 50 Hz power from a standard 220, 440 or higher utility supply to either fixed or adjustable DC voltage. The system may include transformers for high voltage system.

Inverter Stage

Power electronic switches such as IGBT, GTO or SCR switch the DC power from rectifier on and off to produce a current or voltage waveform at the required new frequency. Presently most of the voltage source inverters (VSI) use pulse width modulation (PWM) because the current and voltage waveform at output in this scheme is approximately a sine wave. Power Electronic switches such as IGBT; GTO etc. switch DC voltage at high speed, producing a series of short-width pulses of constant amplitude. Output voltage is varied by varying the gain of the inverter. Output frequency is adjusted by changing the number of pulses per half cycle or by varying the period for each time cycle.

The resulting current in an induction motor simulates a sine wave of the desired output frequency.

The high speed switching action of a PWM inverter results in less waveform distortion and hence decreases harmonic losses.

Control System

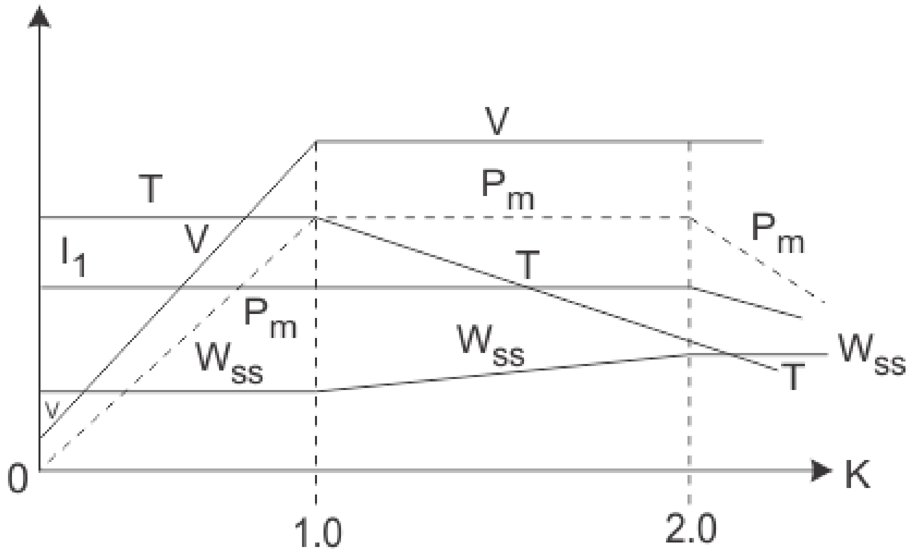
Its function is to control output voltage i.e. voltage vector of inverter being fed to motor and maintain a constant ratio of voltage to frequency (V/Hz). It consists of an electronic circuit which receives feedback information from the driven motor and adjusts the output voltage or frequency to the desired values. Control system may be based on SPWM (Sine Wave PWM), SVPWM (Space Vector modulated PWM) or some soft computing based algorithm.

Induction Motor Characteristic under Variable Frequency Drive

In an induction motor induced in stator, E is proportional to the product of the slip frequency and the air gap flux. The terminal voltage can be considered proportional to the product of the slip frequency and flux, if stator drop is neglected. Any reduction in the supply frequency without a change in the terminal voltage causes an increase in the air gap flux which will cause magnetic saturation of motor. Also the torque capability of motor is decreased. Hence while controlling a motor with the help of VFD or Variable Frequency Drive we always keep the V/f ratio constant. Now define variable 'K' as,

$$K = \frac{f}{f_{rated}}$$

For operation below K < 1 i.e. below rated frequency we have constant flux operation. For this we maintain constant magnetization current Im for all operating points. For K > 1 i.e. above rated frequency we maintain terminal voltage Vrated constant. In this field is weakened in the inverse ratio of per unit frequency 'K'. ratio of per unit frequency 'K'.



V(Terminal Voltage), T(Torque), P_m(Power), I_1(Stator Current) and W_{ss} vs. K plot

Procedure:

Connect the circuit as shown in the figure.

Give the A.C. supply to the drive.

Take the reading at different values of frequency.

Note down the reading of modulation index,stator speed,rotor speed,phase voltage,line voltage at the different values of frequency.

Observation Table

Sr.No.	Ma	Freq.	Ns	N	Vin	Vdc	Vph	V_L	Vph/f

Conclusion: