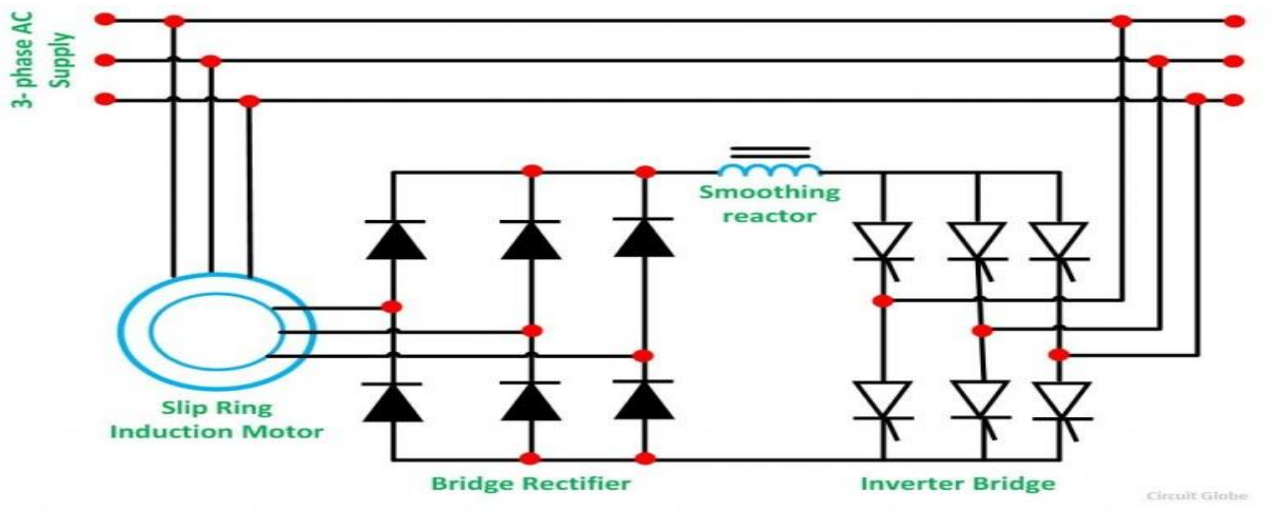
Slip Power Recovery of an Induction Motor

Slip Energy Recovery is one of the methods of controlling the speed of an **Induction motor.** This method is also known as **Static Scherbius Drive**. In the rotor resistance control method, the slip power in the rotor circuit is wasted as I^2R losses during the low-speed operation. The efficiency is also reduced. The slip power from the rotor circuit can be recovered and fed back to the AC source so as to utilize it outside the motor. Thus, the overall efficiency of the drive system can be increased.

The figure below shows the connection and method for recovering the **slip energy** and **power recovery** of an Induction Motor.



The **basic principle** of the **slip power recovery** is to connect an external source of the EMF of the slip frequency of the rotor circuit. The slip energy recovery method provides the speed control of a **slip ring induction motor** below its synchronous speed. A portion of rotor AC power (slip power) is converted into DC by a diode bridge. The **smoothing reactor** is provided to **smoothen** the rectified current. The output of the rectifier is then connected to the DC terminals of the inverter. The inverter inverts the DC power to the AC power and feeds it back to the AC source. The inverter is a controlled rectifier operated in the **inversion mode**.

This method of speed control is used in large power applications where the variation of speed over a wide range involves a large amount of slip power.

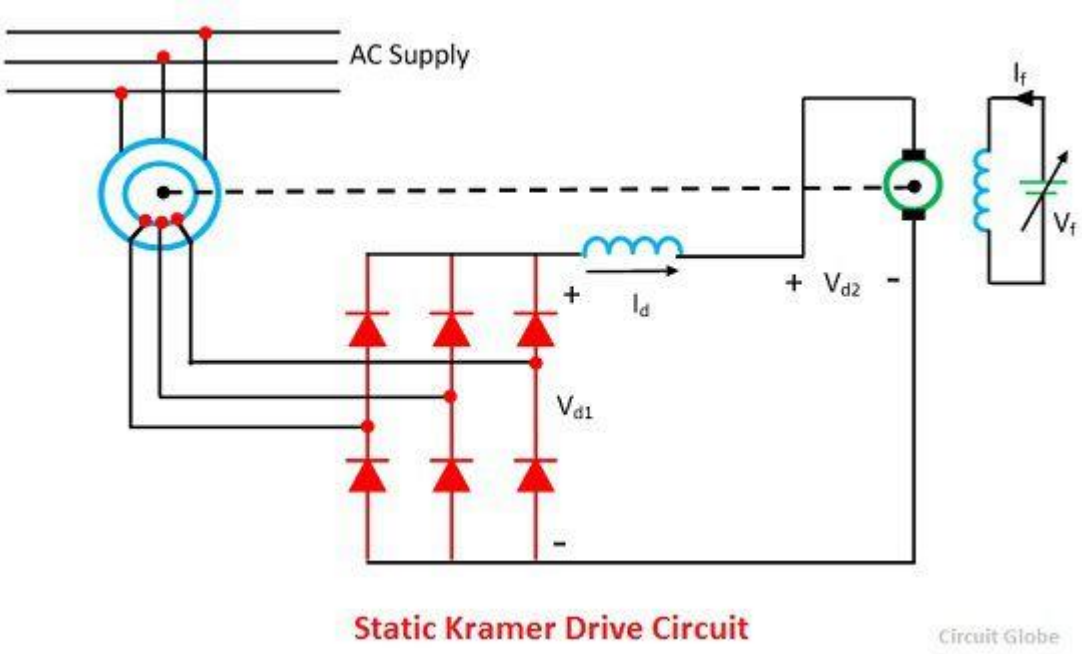
There are two types of Slip power recovery scheme:

1.Static Karmer Drive

2. Static Scherbius Drive

Static Kramer Drive

Definition: The static Kramer-drive is the method of controlling the speed of an induction motor by injecting the opposite-phase voltage in the rotor circuit. The injected voltage increases the resistance of the rotor, thus controlled the speed of the motor. By changing the injected voltage, the resistance and speed of an induction motor are controlled.



Static Kramer Drive Circuit

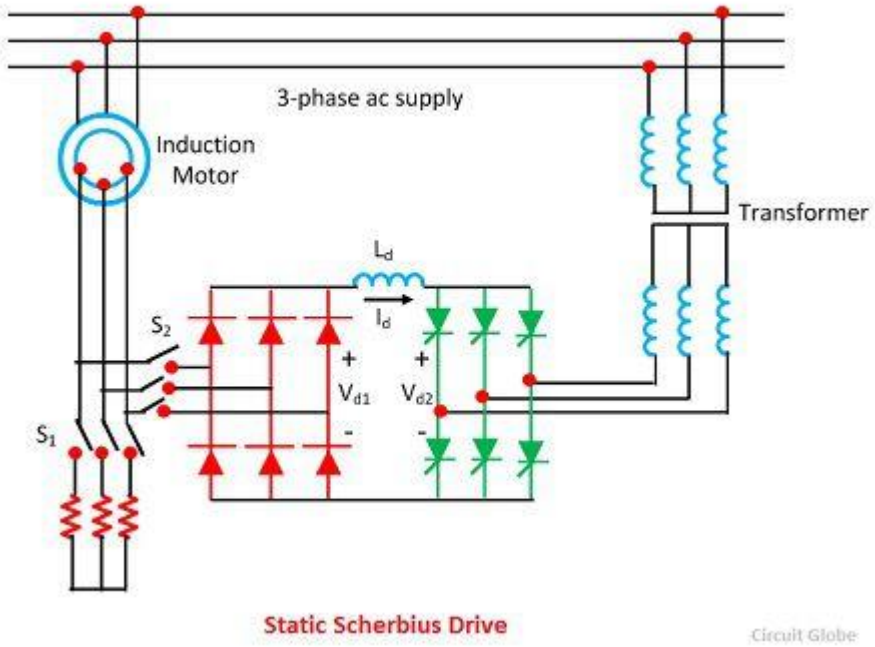
The static Kramer-drive converts the slip power of an induction motor into AC power and supply back to the line. The slip power is the air gap power between the stator and the rotor of an induction motor which is not converted into mechanical power. Thus, the power is getting wasted. The static Kramer drives fed back the wasted power into the main supply. This method is only applicable when the speed of the drive is less than the synchronous speed.

The speed control is possible only when speed is less or half of the synchronous speed. When the large range speed is required, the diode bridge is replaced by the thyristor bridge. The relationship between the V_{d1} and the speed can be altered by controlling the firing angle of thyristor amplifier. Speed can now be controlled up to stand still.

Static Scherbius Drive

The Static Scherbius Drive provides the speed control of a wound rotor motor below synchronous speed. The portion of rotor AC power is converted into DC by a diode bridge.

The controlled rectifier works as an inverter and converts the DC power back into AC and feeds it back to the AC source. This drive has the ability of flow the power both in the positive as well as the negative direction of the injected voltage. This increases the operating condition of the drive.



The drive input power is the difference of the DC input power and the power fed back. Reactive input power is the sum of the motor and input reactive power.Thus, the drive has poor power factor throughout the range of its operation.

Operating Modes of Static Scherbius Drives

The following are the operating modes of Static Scherbius Drives.

Sub-synchronous Motoring – In this mode of operation the slip and torque both are positive and hence the injected voltage is in phase with rotor current. The power flows into the stator and feedback into the rotor circuit.

Super-synchronous Motoring – When the speed of the motor is above the synchronous speed, then the slip is negative. Thus, the voltage and current are out of phase with each other.The power feeds into the rotor from the drive circuit along with input power flowing into the stator.

Sub-synchronous Generating – For sub-synchronous speed, the torque is required to be positive, although the slip is positive. The power is fed into the rotor through the slip ring.

Super-synchronous Generating – When the speed of the motor above the synchronous speed, then the slip and torque becomes negative. Thus, the injecting voltage is in phase with the rotor.

The mechanical power is injected by the shaft and the output power is obtained from the stator and rotor circuit