

# Different Types of Methods to Recover Regenerative Energy Replacing Conventional Dynamic Braking Of Variable Frequency Drive

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**Abstract:** These days, the most common drive in businesses is the Variable Frequency Drive (VFD). However, when dynamic braking is employed in the typical VFD, some energy is lost in it. When a motor functions as a generator, there are several ways to use and convert the regenerated energy so that it may be stored instead of evaporating as heat during dynamic braking. This paper illustrates some of the approaches.

**Keywords:** Drive Frequency Variable (VFD), Brake Dynamic (DB), and Hertz (Hz)

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## I. INTRODUCTION

The term "drive" refers to a broad concept that manages motion by precise Begin, halt, and characteristics of torque to needed by the process, minimizing losses by maintaining the highest possible efficiency while limiting input energy levels to the absolute lowest. The drive may be used alone or in conjunction with electrical, mechanical, hydraulic, or pneumatic motors as well as gearboxes, belt and throttle valves, chain drives, pulley drives, pressure regulators, and electronic systems with analog and digital controllers as control components. An asynchronous induction motor powers over 80% of industrial movements. As a result, mechanical drives are becoming simpler, and more common AC digital drives are replacing DC drives. [1].

Simply put, As a motor controller, a variable of frequency drive (VFD) works that adjusts the volt and Hz at which an electric of motor—typically a three-phase squirrel cage motor of induction is driven. Variable frequency drives, AC drives, micro-drives, inverters, variable speed drives, and adjustable speed drives are some other names for VFDs. The frequency Hz, which is proportionate the motor's speed, controls the VFD. The motor's speed rises with increasing frequency and the other way around. The Variable of Frequency Drive (VFD) market expanding quickly, making it is more crucial than ever for experts and maintenance staff to maintain the proper operation of VFD installations. VFDs, or variable frequency drives, alter speed [4].

Variable Frequency Drive's primary responsibilities are:

1. Because of their durability and low maintenance requirements, VFDs are primarily utilized in process facilities for stepless control of the speed of squirrel cage induction motors.
2. The VFD regulates the motor's speed by adjusting the output volt and Hz using the advanced microprocessor's controlled electronics of the device.
3. Units for inverters and rectifiers make up a VFD. An inverter changes DC voltage back into AC voltage, and a rectifier changes AC voltage into DC voltage.

## II. VFD AND BRAKING OPERATIONS

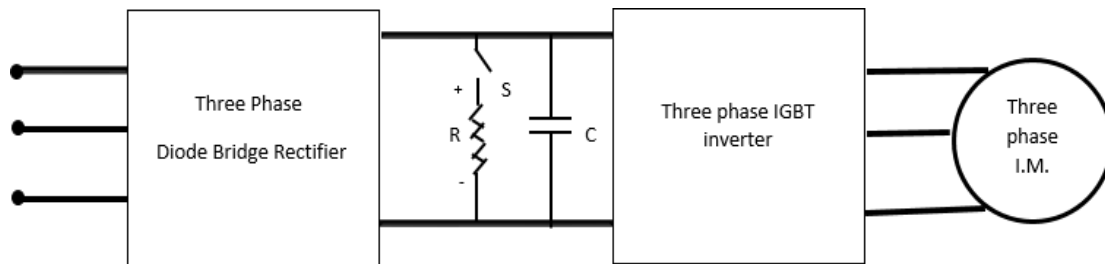


Fig 1. The drive with variable frequency (VFD)

The rectifier unit receives the three-phase AC supply and uses it to convert the AC to DC, which is typically around 650V in voltage. After that, the harmonics are eliminated and the DC voltage is filtered out. An induction motor is connected to the three-phase inverter, which converts the DC electricity to AC voltage and powers the motor. The inverter's controlling section is where frequency and speed are adjusted.

Why a motor functions as a generator?

1. accelerating the deceleration of a heavy object (a mechanical arm or flywheel)
2. Regulating a load's speed as it descends vertically (hoist, decreasing conveyor)
3. An industrial saw or machining/drilling operation causes a quick decline in load torque.
4. Repeatedly accelerating and decelerating to a stop is necessary for the procedure (indexing)
5. Managing an unwind application's speed (tension control)
6. Operating motors can be abruptly stopped without suffering any mechanical damage. Once the supply has stopped

When the motor is functioning as a generator, the inverter component permits the stator's energy to be transferred returning to the of DC bus. When the voltage in the DC bus exceeds a certain point, the braking chopper in the DC bus switches ON and the surplus energy is dispersed as heat through a resistor linked in series with the braking chopper. The motor thus stops gradually. This technique is known as VFD dynamic braking. In the modern era, industries typically employ this technique. Fig. 1 illustrates the VFD's traditional dynamic braking. Applications that need frequent or quick braking, particularly for heavy (high of inertia) of loads, usually employ dynamic braking (DB). Nevertheless, a lot of these applications might also be suitable for regenerative.

It is frequently necessary to install additional cooling and air conditioning due to the waste heat generated by DB. A regenerator that will save the client money and energy by extracting waste heat and redirecting that energy back into the AC line. By incorporating a regenerative of unit into systems, the demand on the cooling system can be decreased and the regenerative unit's upfront cost can be mitigated. This will allow for a more compact HVAC system. A single Regenerative unit is able to supply numerous drives is connected to a typical DC bus and optimize energy efficiency by gathering excess regenerative energy that the drives do not need.

## III. TECHNIQUES FOR RECOVERING RENEWABLE ENERGY

When VFD functions as a generator, there are primarily three ways to recover its regenerative energy:

1. Braking resistor snubber
2. Control of line regeneration
3. Control of synchronous rectifiers

### 3.1 Braking resistor snubber

The transistor and circuitry of Snubber Resistor Braking Kits "turn on" when the DC bus voltage is set. that less than the AC drive trip of point. The energy is transmitted to resistors, or set resistors, at this voltage level, where it is burned off as heat. Certain AC drives just need to have a resistor kit added because they already have a built-in brake transistor. Compared to synchronous rectifier controls or line regeneration controls, snubber resistor braking kits are a less expensive option. However, because they need time to cool down, snubber brake resistors are not as good for highly cyclical activities like frequent, repetitive starts and stops. For these applications, synchronous rectifier controls or line regeneration controllers are more appropriate.

### 3.2 Control of Synchronous Rectifiers

A set of transistors is pulsed "on" at a fixed DC bus voltage that is below the AC drive's trip point when Line Regeneration Controls are employed. The energy is returned straight to the AC power supply at this voltage level. Up to the transistor current rating, line regeneration controllers can run continuously[3]. They are also energy-saving devices because of their capacity to recycle electricity back into the power source. The higher expense of these measures may eventually be offset by the energy savings. The regenerative module, as depicted in Fig. 2, saves energy by converting excess DC bus energy to 3-phase AC power that returns it to of source.

We can gain some understanding of how a regenerative brake functions by returning to the three-phase bridges that were previously discussed. The IGBT bridge inside the regenerative converter and the drive's diode bridge are connected in parallel. When a diode in the diode bridge of the drive is forward biased, the of diode at the identical relative location within the IGBT bridge as well becomes forward is biased. Recall that is the DC bus and AC line terminals are essentially where the two bridges are joined. [6].

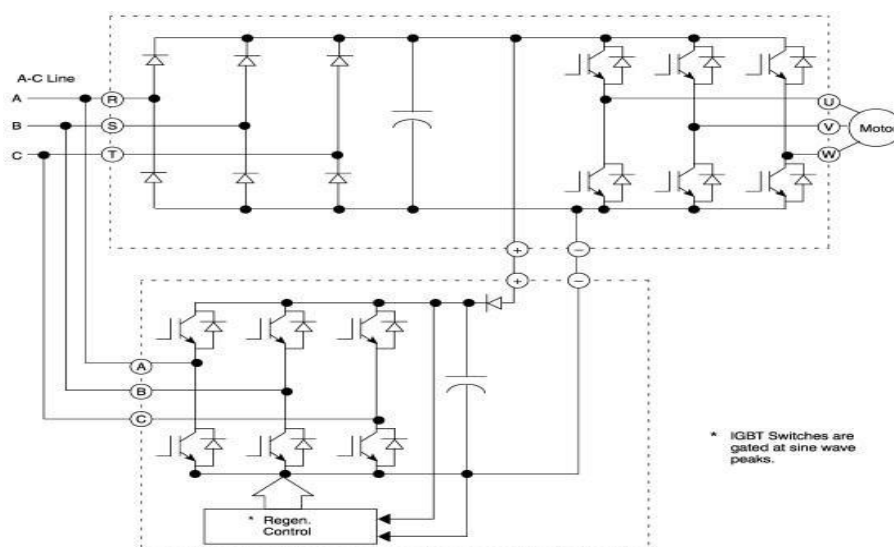


Fig 2. Control of the line Regeneration

### 3.3 Control of Synchronous Rectifiers

Rectifier Synchronous Controls is power the DC bus of an AC drive by acting as converters from AC line voltage to DC voltage or as controls for line regeneration. This is the newest technology that has the potential to be the best regenerative drive option. As seen in Fig. 3, the circuit for this comprises two IGBT bridges that are both PWM-controlled. The gating of the converter bridge is in rhythm with the A-C line. With the removal of the fifth and seventh harmonics, the resulting input currents are almost sinusoidal, as observed in diode bridge converters [3].

When the IGBT converter bridge is in driving mode, it functions as to boost converter for supplying DC bus volts by using a DC bus capacitor and a resonant-tuned input line reactor. In comparison to the voltage produced by a traditional diode bridge rectifier, this intermediate value is greater. For the purpose of optimizing input power factor When operating in the regenerative mode, the IGBT bridge supplies width-regulated bursts of the surplus C bus of voltage. A leading pf can be achieved in the system by adjusting the synchronous PWM rectifier to compensate for other trailing loads[3].

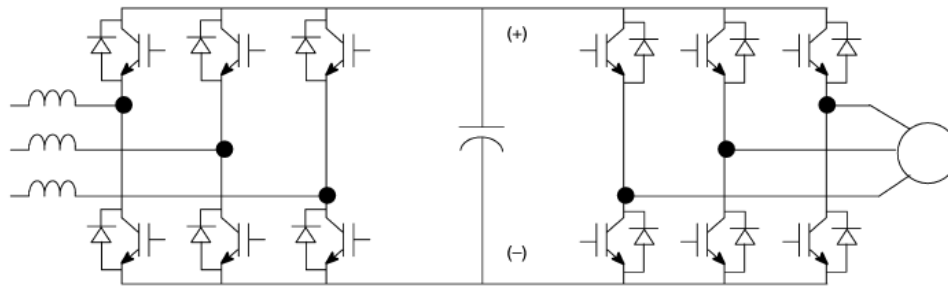


Fig 3. Control of Synchronous Rectifiers

#### IV. USES FOR REGENERATIVE AC DRIVE

- Loads that need to be overhauled
- Loads with a high moment of inertia
- Machines that need to slow down quickly
- Vacuum pumps
- Flywheels
- Cranes
- Hoists
- Locomotives
- Elevators
- Drums
- Kilns
- Injection moulding machines

#### V. CONCLUSION

According to the explanation above, there are various ways to reclaim the motor's renewable energy in place of the traditional VFD braking. The synchronous rectifier control approach is the most effective of the three because to its high efficiency and reduced cost. Moreover, this implementation can lower the cost of energy loss.

#### ACKNOWLEDGMENT

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