Project Seminar on:

ELECTRIC DRIVES

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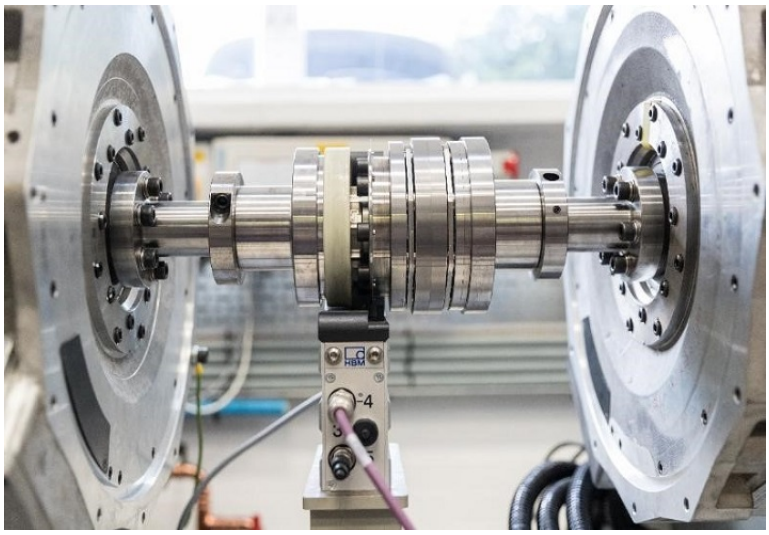
Content

What are Electric Drives?

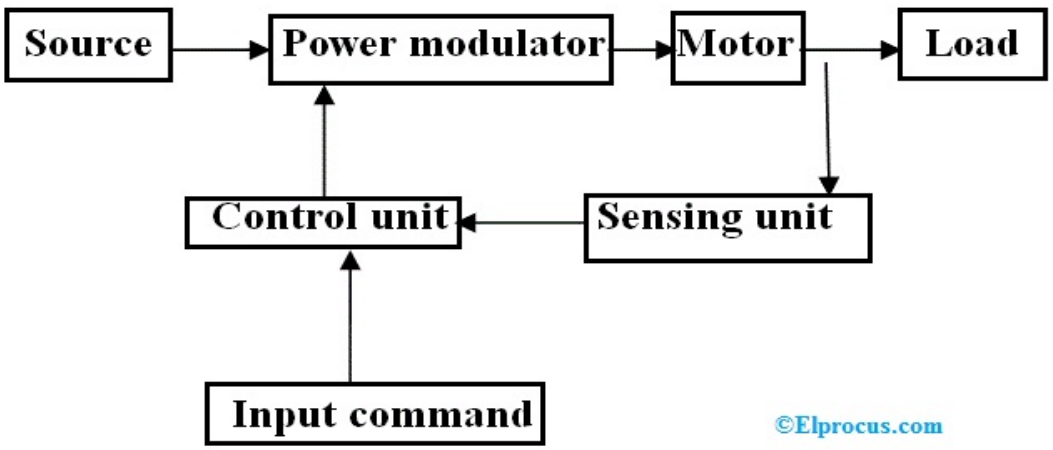


Whenever the term electric motor or electrical generator is used, we tend to think that the speed of rotation of these machines is totally controlled only by the applied voltage and frequency of the source current. But the speed of rotation of an electrical machine can be controlled precisely also by implementing the concept of drive.

An Electric Drive can be defined as a system which is used to control the motion of an electrical machine. The electrical drive uses any of the prime movers like diesel or a petrol engine, gas or steam turbines, steam engines, hydraulic motors and electrical motors as a primary source of energy. This prime mover supplies the mechanical energy to the drive for motion control.

The main advantage of this concept is, the motion control is easily optimized with the help of drive. In very simple words, the systems which control the motion of the electrical machines, are known as electrical drives**.** A typical drive system is assembled with a electric motor (may be several) and a sophisticated control system that controls the rotation of the motor shaft.
Now coming to the history of electrical drives, this was first designed in Russia in the year 1838 by B.S.Iakobi, when he tested a DC electric motor supplied from a storage battery and propelled a boat. Even though the industrial adaptation occurred after many years as around 1870. Today almost everywhere the application of electric drives is seen.

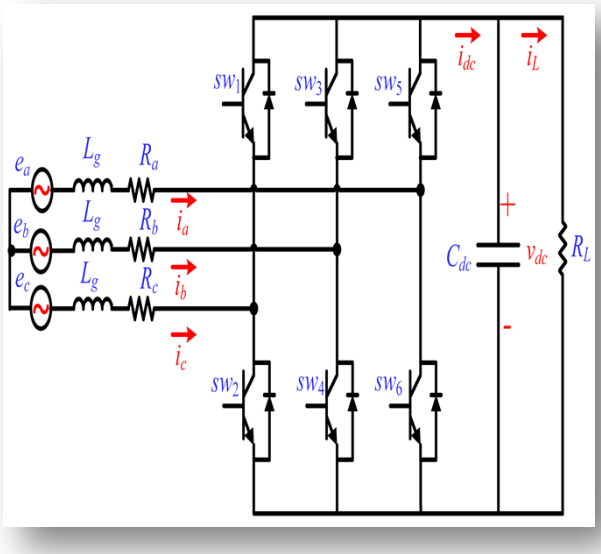
Parts of an Electric Drive System



The source provides the energy for the drive to operate. Most of the drives are fed from ac sources either directly or through a converter link. The power modulator modifies the energy from the source and provides to the motor such that the speed torque characteristics required by the load is met. The motor

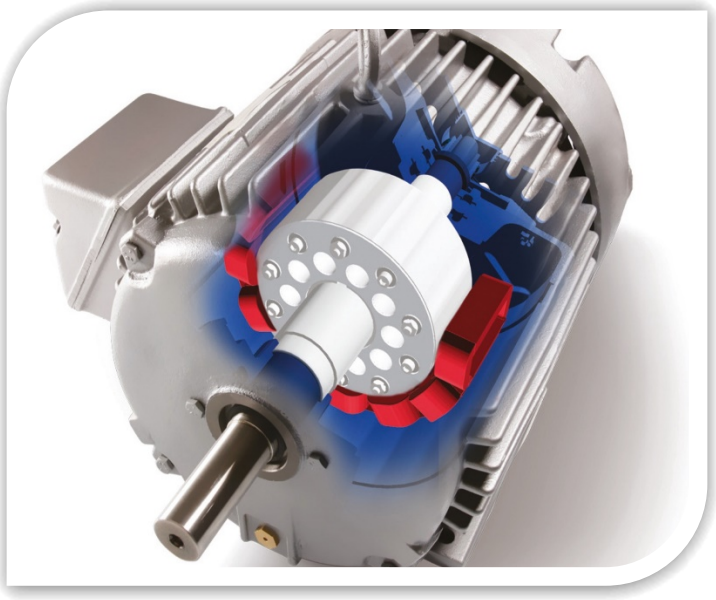
converts electrical energy into mechanical energy an provides it to the load. The sensing unit senses a particular drive factor like motor current, speed, voltage etc,. The control unit controls the power modulator in such a way that the reference value given from the user is attained. Load is a machinery designed to accomplish a given task for example fans, pumps, robots, washing machine and so on.

Power Modulator



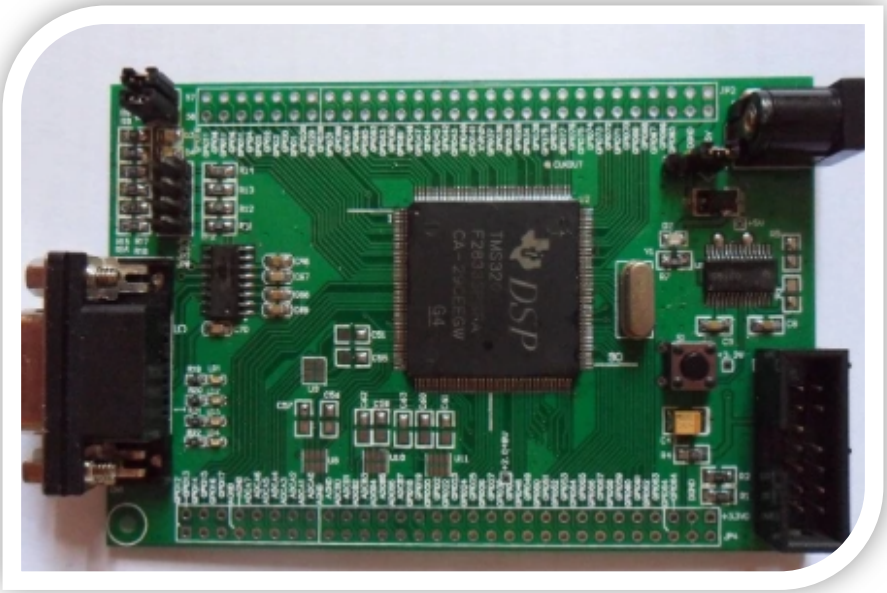
- This is used to control the supply from source to the motor so that the speed-torque characteristics required by the load is met. They can be made of thyristors, mosfets, IGBTs, etc.
- It restricts the excessive current drawn from the source during transient operation.
- It converts the electrical energy from the source into a form suitable for the motor to operate. For example if the source is dc and induction motor is used then the power modulator converts the dc into variable frequency ac and provides it to the motor.
- It selects the mode of operation of the motor that is either motoring or braking.

Electric Motors



- Electrical motors used in the electric drives can be DC Motors(they can shunt, series, compound or permanent magnet motors) or AC Motors like Induction Motor(Squirrel-cage motors, wound rotors or linear motors) , Synchronous Motor.
- The electric motor is chosen based on various features such as price, performance, requirements by the load, efficiency etc.
- AC Motors are now being employed in variable speed drives because of various developments in variable speed drive . DC motors have a number of disadvantages like high cost, weight, volume, for the same rating, unsuitable in explosive and contaminated environments, restrictions on maximum power , voltage and so on.

Control Unit



- The control unit controls the power modulator.
- It generates command for the protection of power modulator and motor.
- If semiconductor converters are used then the control unit can consists of firing circuits and microprocessor for a more sophisticated control.
- When control of switching circuits is required then the function of control circuit will be to provide sequencing and interlocking. Sequencing ensures that all the drive operations are carried in a pre-planned sequence so that the load is driven in a desired manner and drive capabilities are put into optimum use. Interlocking prevents the system from any abnormal or unsafe operation.

Sensing Unit

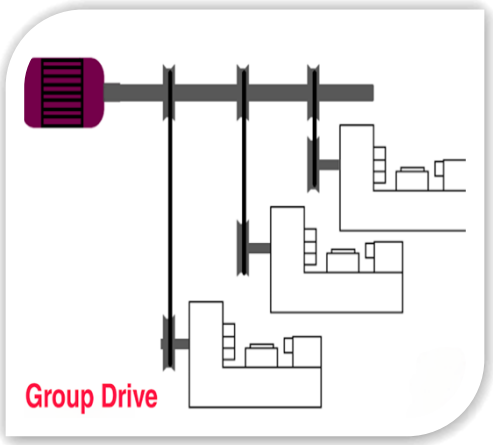
- The sensing unit in the electric drive is used to sense the particular drive factor such as speed, motor current or voltage.
- This unit is mainly used for closed loop operation otherwise protection.
- They can be used for following sensing operation:

- Speed sensing (Tachometer is used to sense speed. For wind speed sensing anemometer is used. Similarly to sense both speed and velocity speedometer is used).
- Torque sensing (Magnetoelastic torque sensor is used in various vehicle application like race cars, automobiles, aircrafts)
- Position sensing (Position can be sensed through GPS, vibrometer, and rotary encoder.)
- Current sensing and Voltage sensing (Hall Effect Sensors are used)
- Temperature sensing (Thermistor is a device used to sense temperature)

Classification of Electric Drives

Electric Drives are classified into three types: Group Drives, Individual drives, multi-motor drives.

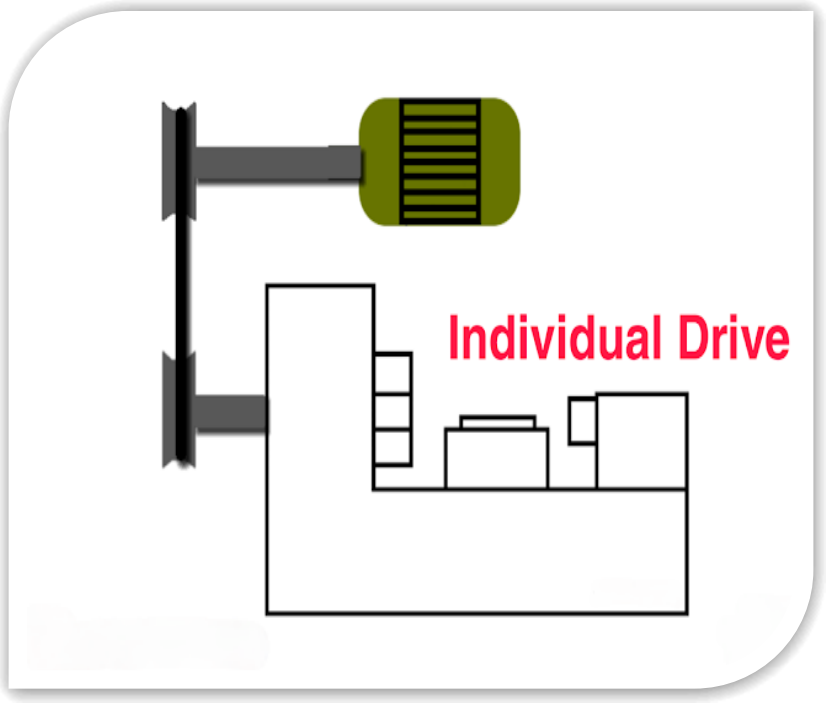
1. Group Drives



- When one prime mover or motor is used for a number of machine tools on common shaft then the drive is called as group drive.
- They are the most economical.
- Any fault in the driving motor renders all other driving component idle.
- They are less flexible since transportation of machines from one part to another is hardly possible.

- Noise level is high.

2. Individual Drives



- If a single motor is used to drive or actuate a given mechanism and it does all the jobs connected with this load, the drive is called individual drive.
- Each operator has complete control of its machines.
- It has flexibility in layouts since fault in any one machine does not affect the operation of other parts of the system.
- Since each machine operates to its near rated capacity so efficiency and power factor is better.
- But it has high initial cost and there is power loss during transmission.

3. Multi-motor Drives

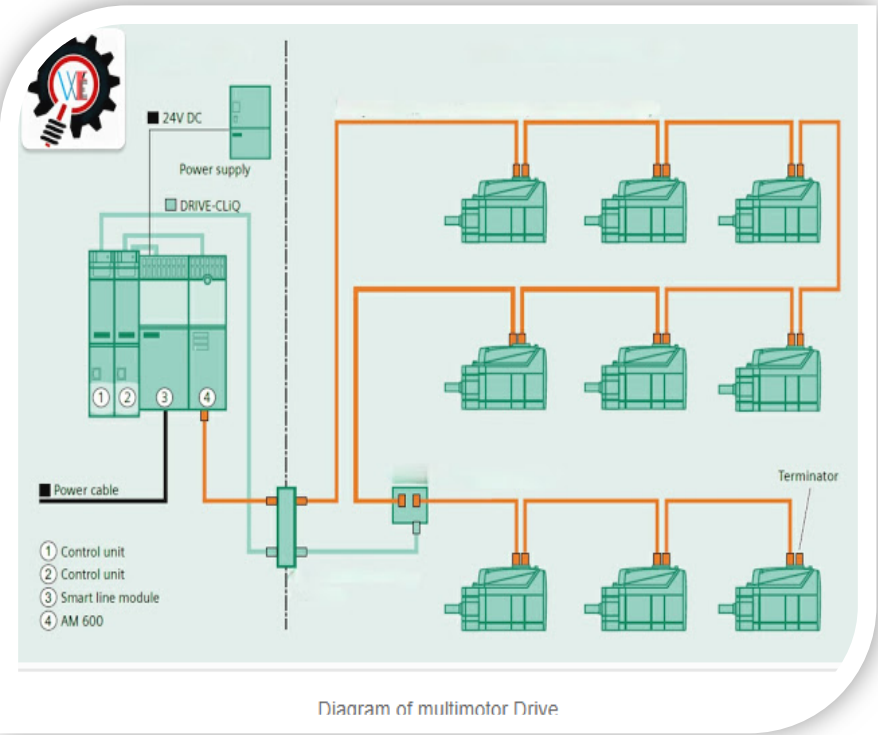


Diagram of multimotor Drive

- In multi motor drive, separate motors are used for operating different parts of same mechanism. The system contains several drives each of which is used to operate its own mechanism
- a group of electric motors that are interconnected by a common control system and drive the working members of a machine or installation (for example, rolling mills, paper machines, composite metalworking machin es, and walking excavators).
- Since each machine is driven by a separated motor, it can be run and stopped as desired.
- In case of motor fault only its connected machine will stop whereas others will continue to work.
- Machines not required can be shut down and also replaced with a minimum of dislocation.
- It has high initial cost.

Control of Electric Drives

It can be said that electric drives control every aspect of an elect4ric motor or generator. It controls the starting, braking and speed of a motor.

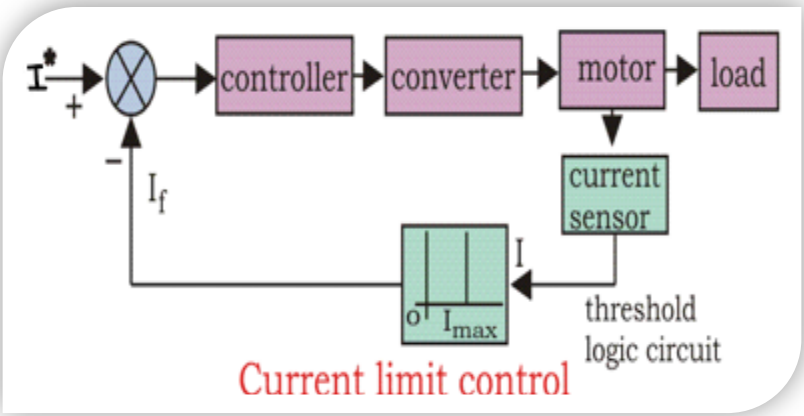
In a control system, there are two types of systems, one is open loop and the other is closed loop control system. In open loop control system the output has no effect on the input, i.e the controlling phenomenon is independent of the output, on the other hand closed loop control system is much more advanced and scientific, here the output is fed back to the input terminal which determines the amount of input to the system, for example if the output is more than predetermined value the input is reduced and vice-versa. Control of electric drives is necessary since all the functions accomplished by the drives are mainly transient operations that is the change in terminal voltage, current, are huge which may damage the motor either temporarily or permanently.

In electric drives feedback loops or closed loop control satisfy the following requirements:

- Protection
- Enhancement of speed of response
- Improvement in steady-state accuracy

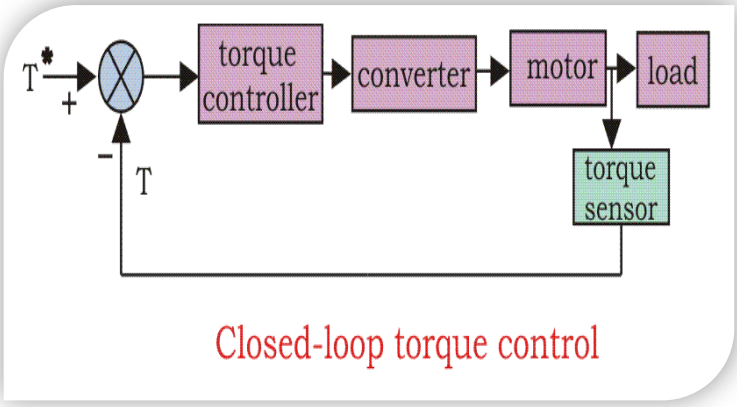
Different closed loop configurations used in control of electric drives are:

1.Current Limit Control



During the starting, we know if precautionary measures are not taken there is a chance of huge current flow through the motor circuit. To limit the current and sense the current fed to the motor, current limit controller is installed. The feedback loop does not effect the normal operation of the drive but if the current exceeds the predetermined safe limit, the feedback loop activates and the current is brought down below the safe limit. Once the current is brought down below the safe limit the feedback loop again deactivates and in this way the control of current takes place.

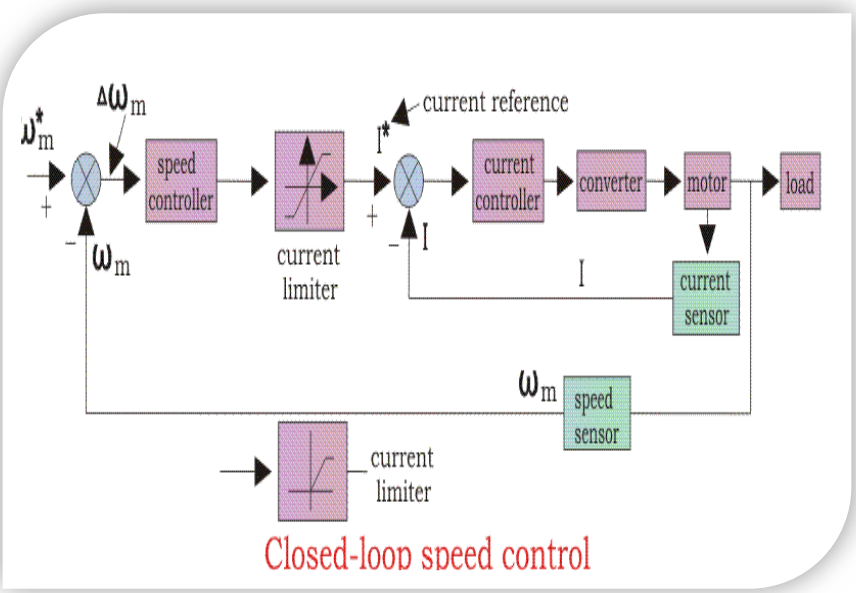
2.Closed Loop Torque Control



Such types of loop are used in battery powered vehicles, rails, and electric trains. The reference torque T* is set through the accelerator, and this T*

follows by the loop controller and the motor. The speed of the drive is controlled by putting pressure on the accelerator.

3.Closed Loop Speed Control



- This is a cascade control system where speed is indirectly controlled by current sensors.
- There are two control loops, which are inner loop and outer loop.
- Consider a reference speed ω*m which produces a positive error Δ ω*m. The speed error is operated through a speed controller and applied to a current limiter which is overloaded even for a small speed error. The current limiter set current for the inner current control loop. Then, the drive accelerates, and when the speed of the drive is equal to the desired speed, then the motor torque is equal to the load torque. This, decrease the reference speed and produces a negative speed error.When the current limiter saturates, then the drive becomes de-accelerate in a braking mode. When the current limiter becomes desaturated, then the drive is transferred from braking to motoring.

- During speed controlling the function transfers from motoring to braking and from braking to motoring continuously for the smooth operation and running of the motor.

Choice of Electric Drives

Factors affecting the choice of electric drives are:

- Steady state operation requirements – Like nature of speed-torque characteristics, speed regulation, efficiency, etc.
- Transient operation requirements – It can be values of acceleration, deceleration, starting, braking and so on.
- Requirements related to source – Type of source, magnitude of voltage, frequency, capacity, efficiency.
- Capital cost, maintenance, etc.
- Environment and location
- Reliability

Advantages of Electric Drives

The advantages of electrical drives include the following.

- These dries are obtainable with an extensive range of speed, power & torque.
- Not like other main movers, the requirement of refuel otherwise heat up the motor is not necessary.
- They do not contaminate the atmosphere.
- Changeable speed drives utilize a dc motor.

- They have flexible manage characteristics due to the utilization of electric braking.
- At present, the AC motor is used within variable speed drives because of semiconductor converters development.

Disadvantages of Electric Drives

The disadvantages of electrical drives include the following.

- This drive cannot be used where the power supply is not accessible.
- The power breakdown totally stops the entire system.
- The primary price of the system is expensive.
- The dynamic response of this drive is poor.
- The drive output power which is obtained is low.

Application of Electric Drives

The applications of electrical drives include the following.

- The main application of this drive is electric traction. Electric traction is basically a type of locomotion where the driving force comes from an electric motor. The different types of electric tractions mainly include electric trains, buses, trolleys, trams, and solar-powered vehicles inbuilt with battery.
- Electrical drives are extensively used in the huge number of domestic as well as industrial applications which includes motors, transportation systems, factories, textile mills, pumps, fans, robots, etc.
- These are used as main movers for petrol or diesel engines, turbines like gas otherwise steam, motors like hydraulic & electric.

Conclusion

Thus, this is all about the fundamentals of electrical drives. From the above information, finally, we can conclude that a drive is one kind of electrical device used to control the energy which is sent to the electrical motor. The drive supplies energy to the motor in unstable amounts and at unstable frequencies, thus ultimately controls the speed and torque of the motor.

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