The Shirpur Education Society's

R. C. Patel College of Engineering and Polytechnic, Shirpur

Department of Electrical Engineering

NOTES

Programme Code: Electrical Engineering | **Year/Scheme:** EE3K | **Semester:** 3rd

Course Title: Fundamentals of Power Electronics | **Course Abbr.:** FPE | **Course Code:** 313335

Subject Teacher :- Ms. H.A.Badgujar

UNIT-05 – (08 MARKS)

Applications of Power Electronics

CO Coverage: - Use suitable power electronic circuit for given application.

Unit -05 Content (Syllabus)

5.1 Charge Controller: Concept, types, applications in Photovoltaic (PV) system with block diagram

5.2 Speed control of ceiling fan using TRIAC: Working, Block Diagram, advantages

5.3 AC to AC converter using DC link: Concept, applications in Wind Power Generation

5.4 HVDC converter station: Concept, Circuit Diagram.

* 5.1 Charge Controller :-

A charge controller is an important component in photovoltaic (solar cell) system. It regulates the voltage and current flowing from the solar panel to the battery and prevent battery overcharging.

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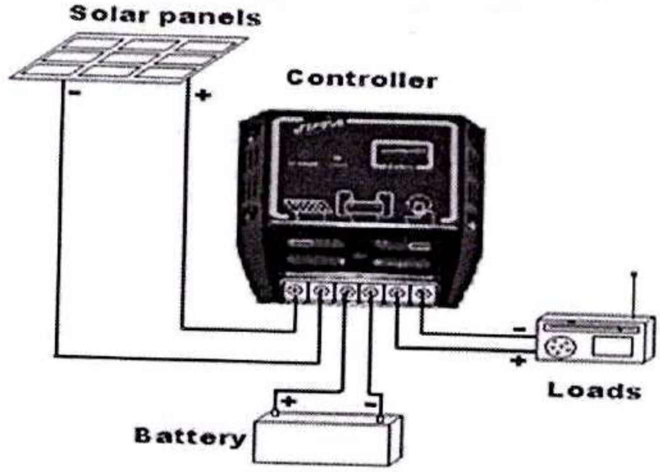

Solar Charge Controller

Fig - ① Solar charge controller.

→ As a result, the battery charges efficiently and safely, which increases it's lifespan and helps maintain the overall performance and reliability of solar energy system.

→ A solar charge controller is an electronic device used in off grid and hybrid off grid applications involving a PV array, battery, and electrical load.

→ The charge controller is used to regulate the current and voltage input.

→ Good solar charge controller can extend the life of the battery, whereas a poor quality charge controller can damage the battery and may cause the entire off grid system to fail.

* Applications in PV system :-

→ Fig-① shows applications of charge controller in PV system with block diagram.

→ In PV system, the charge controller plays an important role in regulating the flow of energy between the solar plants, ~~bat~~ (panels), battery bank and load.

* Components of PV system :-

1) Solar panels :- These PV modules convert sunlight into electrical energy.

2) Charge controller :- The charge controller is connected between the solar panels and the battery bank. It regulates the charging process to prevent overcharging or deep discharge of the battery.

3) Battery :- When sunlight is not available, the battery bank stores the energy generated by the solar panels for future use.

4) Load :- The load represents the electrical devices or equipment powered by the PV system.

* Types of charge controllers :-

There are three types of charge controller :-

i) PWM (Pulse width modulation) charge controller

ii) MPPT (Maximum Power Point Tracking) charge controller.

iii) Simple on/off or Relay charge controller.

1) PWM (Pulse Width Modulation) charge controller :-

→ This type of charge controller regulates battery charging by rapidly switching the solar panel output ON and OFF.

→ PWM controllers are generally less expensive than other types and are suitable for small systems.

→ However they are less efficient than MPPT controllers, especially in situations where the solar panel voltage is significantly higher than the battery voltage.

2) MPPT (Maximum Power Point Tracking) charge Controller :-

→ MPPT controllers are more advanced and efficient than PWM controllers.

→ They continuously track the maximum power point of the solar array and adjust the voltage and current to extract the maximum available power.

→ MPPT controllers are particularly beneficial in situations where the solar panel voltage differs significantly from the battery voltage or when there are temperature fluctuations, as they can maximize energy output under varying conditions.

3) Simple ON/OFF or Relay Charge Controllers :-

→ This type of controllers is the simplest and least expensive option. It regulates the charging process by turning the solar panel output on when the battery voltage falls below a specified limit and turning it off when the battery reaches a preset voltage level.

→ Simple charge controllers are suitable for basic applications; however, they lack the efficiency & advanced features of PWM and MPPT controllers.

→ Each type of charge controllers has it's own advantages and limitations.

→ The choice of controller depends on factors such as system size, budget and specific application requirement.

* 4.2 :- Speed Control of Ceiling fan using TRIAC :-

→ The AC fan regulator circuit diagram is as shown in fig. following components are used in the circuit :-

1) Resistors (10k) :-> Used to limit the current and set the Base resistance for the circuit.

2) Potentiometer :- Allows the user to adjust the fan speed by varying the resistance, thereby controlling the phase angle.

3) Capacitor(c) :- Works together with the potentiometer to create a phase shifting network that controls the triggering of the triac. It also provides filtering to smooth the triggering pulses.

4) DIAC (DB3) :-> Ensures that the TRIAC is triggered by providing a sudden current pulse once the capacitor voltage reaches the DIAC's breakover voltage.

5) TRIAC (BT136) :-> Acts as the main switching device that controls the power supplied to the fan motor.

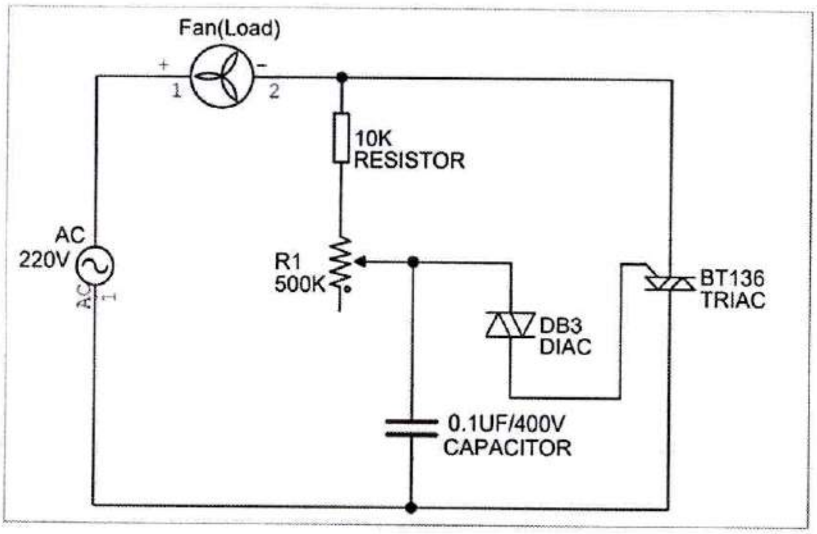

Fig. Speed control of ceiling fan using TRIAC

* Operation of the circuit :->

→ When the AC mains voltage is applied, the capacitor (c) begins charging through the potentiometer (R) and the resistor.

→ The time required for the capacitor to charge up to the DIAC's breakover voltage determines the phase delay.

→ This delay can be adjusted by changing the resistance of R_3.

→ Triggering → once capacitor voltage reaches the DIAC's breakover voltage, the DIAC delivers a pulse to the TRIAC gate, turning the TRIAC on.

→ The TRIAC remains conducting for the remainder of the AC cycle, allowing current to flow through the fan motor

→ The earlier the TRIAC is triggered within the cycle, the more power is delivered to the fan.

→ By adjusting the potentiometer, the phase delay can be continuously varied, providing smooth and continuous control of the fan speed.

* Advantages :-

1) Reduced energy ~~efficiency~~ consumption, low heat generation, hence energy efficiency improved.
2) Smooth and continuous control.
3) Simple design, so cost is less.
4) Compact and cost effective.
5) Reduces Acoustic Noise.
6) Improved Safety.

* 5.3 AC to AC Converter Using DC link :-

→ An AC-AC converter changes alternating current (AC) of one frequency, voltage or phase into another AC output with different characteristics.

→ One efficient method of doing this is through an intermediate DC link, also called an indirect AC-AC converter.

* Working Principle :-

Fig. AC to AC converter using DC link

→ Rectification stage :- (AC - DC) :- The input AC power (e.g. from a grid or generator) is first converted to DC using a rectifier.

→ Intermediate DC link :- A DC link (usually a capacitor or capacitor inductor combination) stabilizes the voltage and stores energy temporarily. Acts as an energy buffer between input and output stages.

→ Inversion stage (DC to AC) :- The stored DC power is then inverted back to AC using an inverter. The inverter can control frequency, voltage and phase of the output AC.

* Why use a DC link ?

1) Allows independent control of input and output frequencies/ voltage.
2) Offers better power quality, stability and control
3) Supports regenerative braking (energy feedback)
4) Enables bidirectional power flow in some designs.

* Applications in wind power Generation :-

1) Variable speed wind turbine system.
2) Grid Integration.
3) MPPT
4) Power quality improvement.
5) DFIG System.

* 5.4 - HVDC Converter station :-

HVDC Converter Station is a critical component in HVDC power transmission Systems. It is responsible for converting electrical energy between AC and DC. These stations are found at both ends of an HVDC transmission line. One at the sending end and one at receiving end.

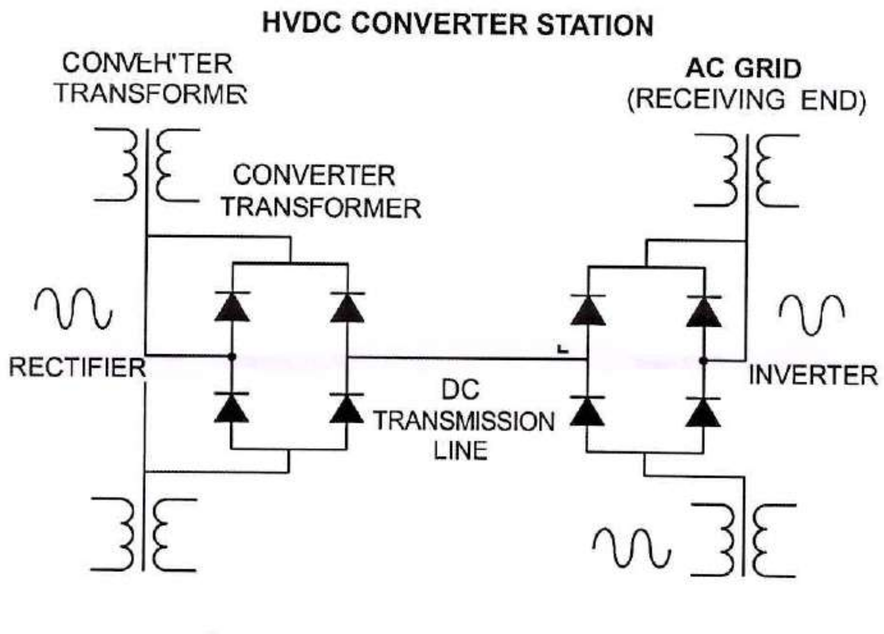

Fig. HVDC converter station

* Key Components of HVDC Converter station :-

1) Converter transformer :- Step up or step down AC voltage.
2) DC filters :- Eliminate harmonics from the DC output.
3) AC filters and Capacitors :- clean the AC input and output.

4) Smoothing reactor :- Smoothing out current ripple on the DC side.

5) Cooling System :- maintain Thermal stability of converter valves.

6) Control system :- manages conversions and protect equipments.

7) Reactive power Compensation :- Uses filters and capacitors to manage reactive power.

* Applications of HVDC converter station :-

1) long distance power transmission.
2) Remote power generation.
3) Interconnecting grids ... etc.

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ASSIGNMENT -05

Que. No.	Unit 5 Applications of Power Electronics (08 Marks)	Exam	Marks
1	State the applications of photovoltaic cell (any 2).	W-24	2
2	Describe the working of speed control of ceiling fan using TRIAC.	W-24 S-24	4
3	Describe a solar power system with block diagram.	W-24	4
4	Draw the block diagram of Solar System with Solar charge controller	W-25	4
5	Explain the function of the converter station in HVDC with circuit diagram.	W-25	4
6	Explain the speed control of ceiling fan using TRIAC.	W-25	4