# BASICS OF SELF GENERATING COACHES

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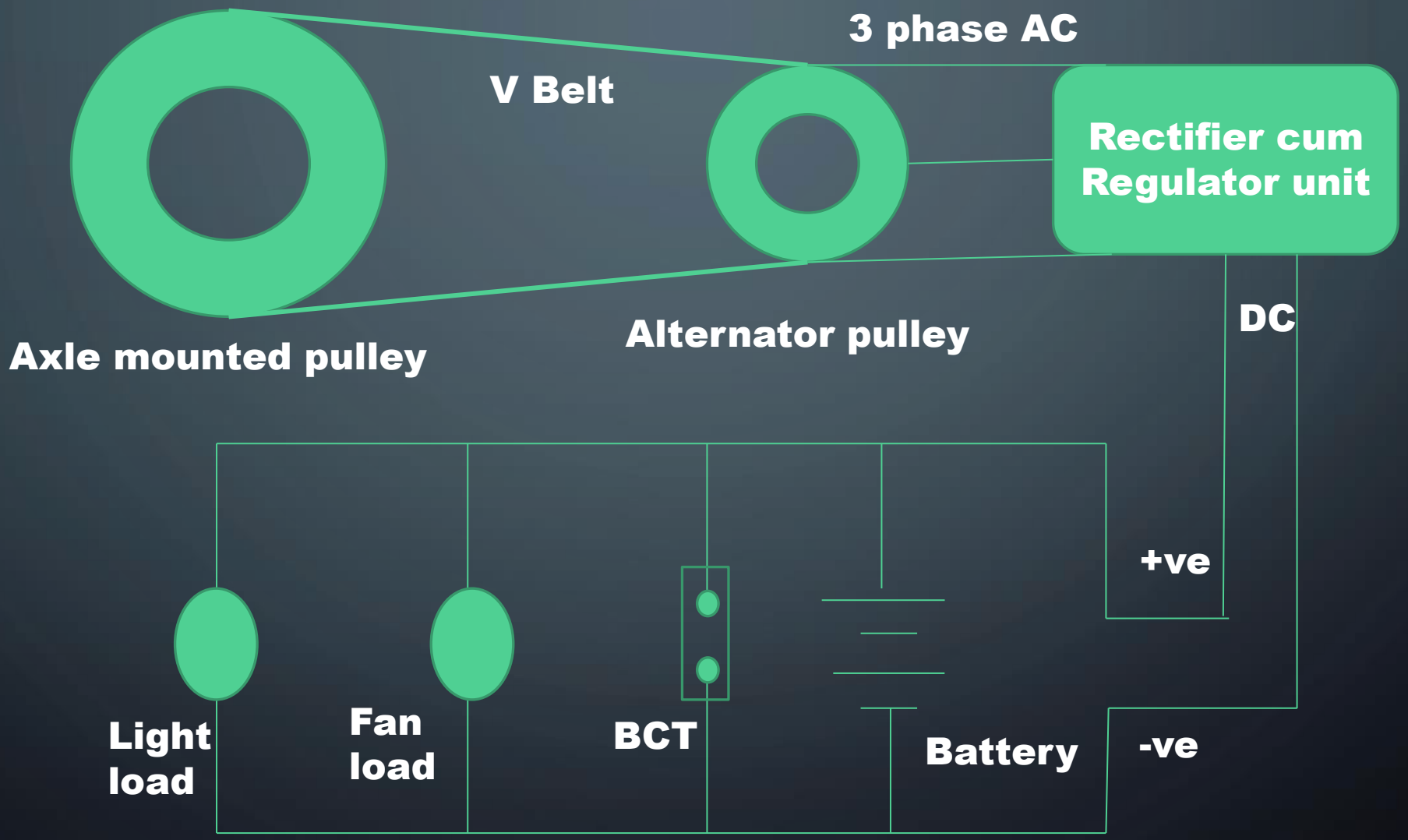
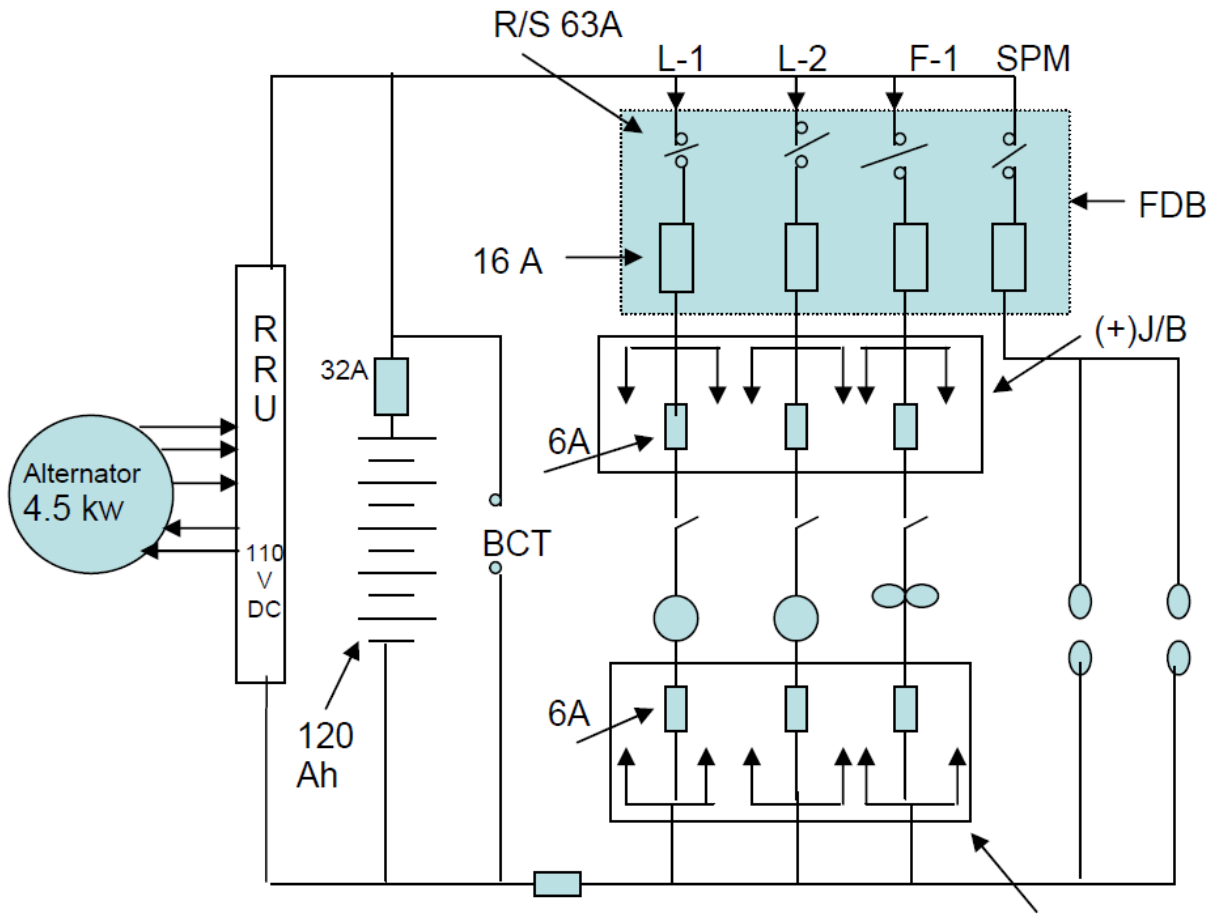
# TRAIN LIGHTING

- It is a basic passenger amenity in railway systems.
- Train lighting not only include lighting of coaches but also the electrical circuitry and equipment involved.
- Initially train lighting done through candles and lamps.
- Replaced by electrical lighting in 1897 over Indian Railways.
- 24 V DC Self generating lighting system was used till 1996 mostly employing DC Dynamos. This system required high maintenance and was subsequently replaced due to lesser KW/weight and poor quality of lighting.
- 110 V DC Self generating lighting system supplied by axle driven brushless alternator.
- Further End on Generation and Head on Generation systems have been utilized.

# SELF GENERATING SYSTEM



# SCHEMATIC OF 110 V DC SYSTEM



# SG NON-AC COACH

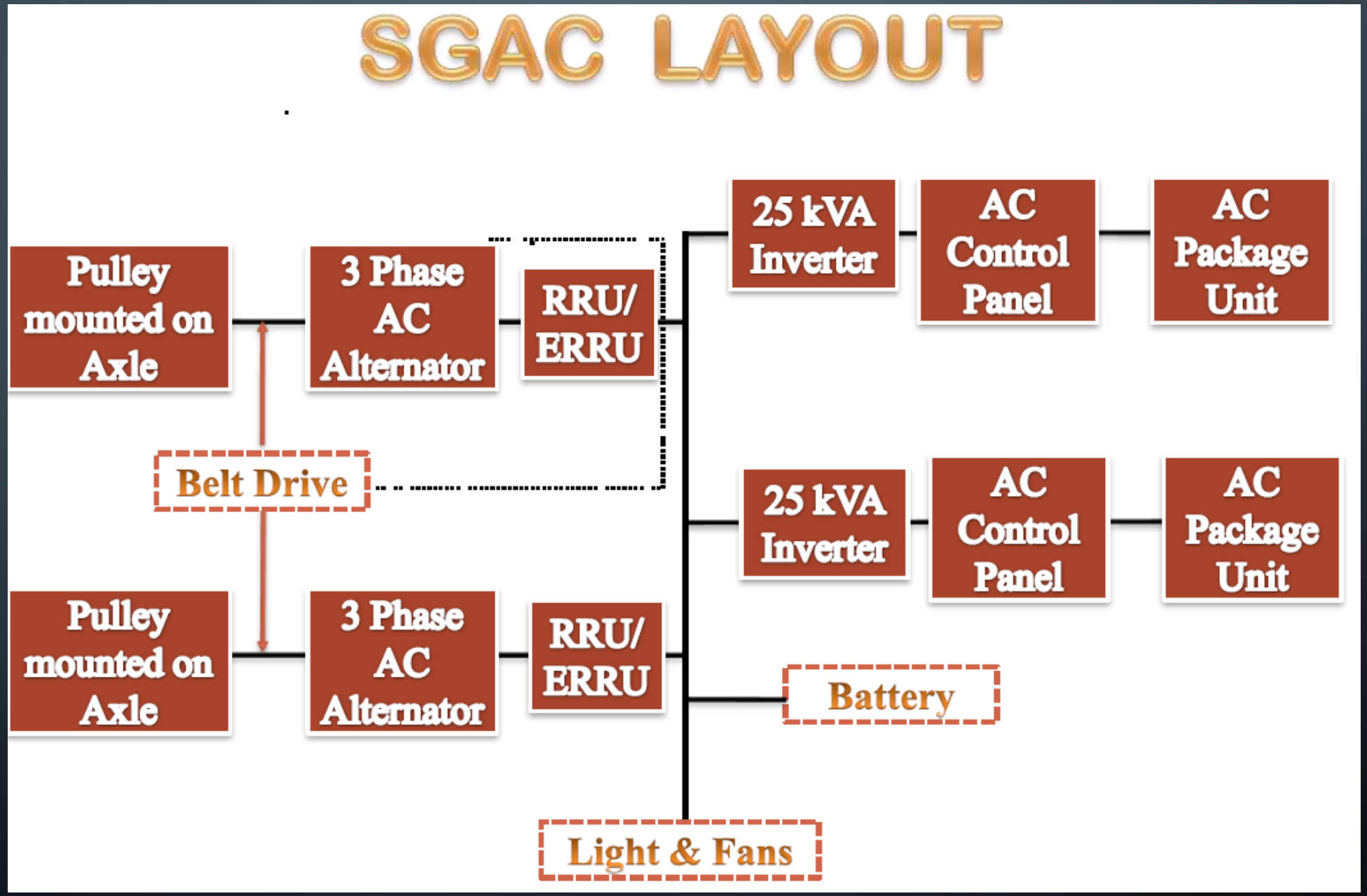
- Under slung alternator of 4.5 Kw, 37.5 Amp is driven by V-belts through axle and alternator pullies.
- Alternator generates 3 phase AC which is rectified and regulated through rectifier and regulator unit (RRU).
- Output of this RRU is given to electrical load through junction box. Lead acid batteries 110 V, 120 Ah arranged from 3 cell monoblock units are in parallel with the alternator and feeds electrical loads when the alternator is not generating.
- For charging this battery, there is provision for battery charging terminal on the under frame of the coach. Fuses are provided for safety against excessive current for each component.
- 4 Emergency feeding terminals, located at each coach end, to give/take electrical power supply to/from adjoining coach in emergency through temporary connections (TC).

- At a junction box, rotary switches and MCBs are provided to switch ON and OFF power supply to light/fan and emergency feeding terminals (EFT).
- The load is fed through four rotating switches (RSW) and fuses connecting circuits L1, L2, F and SPM.
- L1 feeds the essential lighting load like lavatories, gangways, doorways and up-to 50% of light in each compartment/ bays corridor lights and night-lights.
- L2 feeds remaining lighting loads.
- F feeds the fan load and SPM feeds emergency feed terminals (EFT).

# SG AC COACH

- For B.G AC coaches, 18 KW/25 KW brushless alternators are used, primarily to appropriately power the RMPUs and inverter.
- Two such alternators are used in AC-2T/AC-3T/chair cars and only an alternator is used in First AC Coach.
- Batteries of 800/1100 Ah capacity at 10 hour rating are used in I AC/AC-2T/AC-3T/chair car of B.G coaches.
- Inverter

# SGAC LAYOUT


Pulley mounted on Axle
3 Phase AC Alternator
RRU/ ERRU
Belt Drive
Pulley mounted on Axle
3 Phase AC Alternator
RRU/ ERRU
25 kVA Inverter
AC Control Panel
AC Package Unit
25 kVA Inverter
AC Control Panel
AC Package Unit
Battery
Light & Fans

# SELF GENERATION SYSTEM- EQUIPMENTS

- Alternator
- RRU/ERRU
- Battery
- Inverter (AC coach)
- Pre-cooling cum battery charging unit
- RMPU (AC coach)
- Light and fans

# Alternator

- Bi-directional and interchangeable
- Rating
  - 3/4.5 kW for Non-AC coaches
  - 12 kW for MG AC/Jan shatabdi Non-ac
  - 18 kW for under slung SG AC coaches
  - 25 kW for RMPU SG AC coaches (2 no.s)

Output voltage - 97V, 3 phase AC

Current 140/193 A (Max)

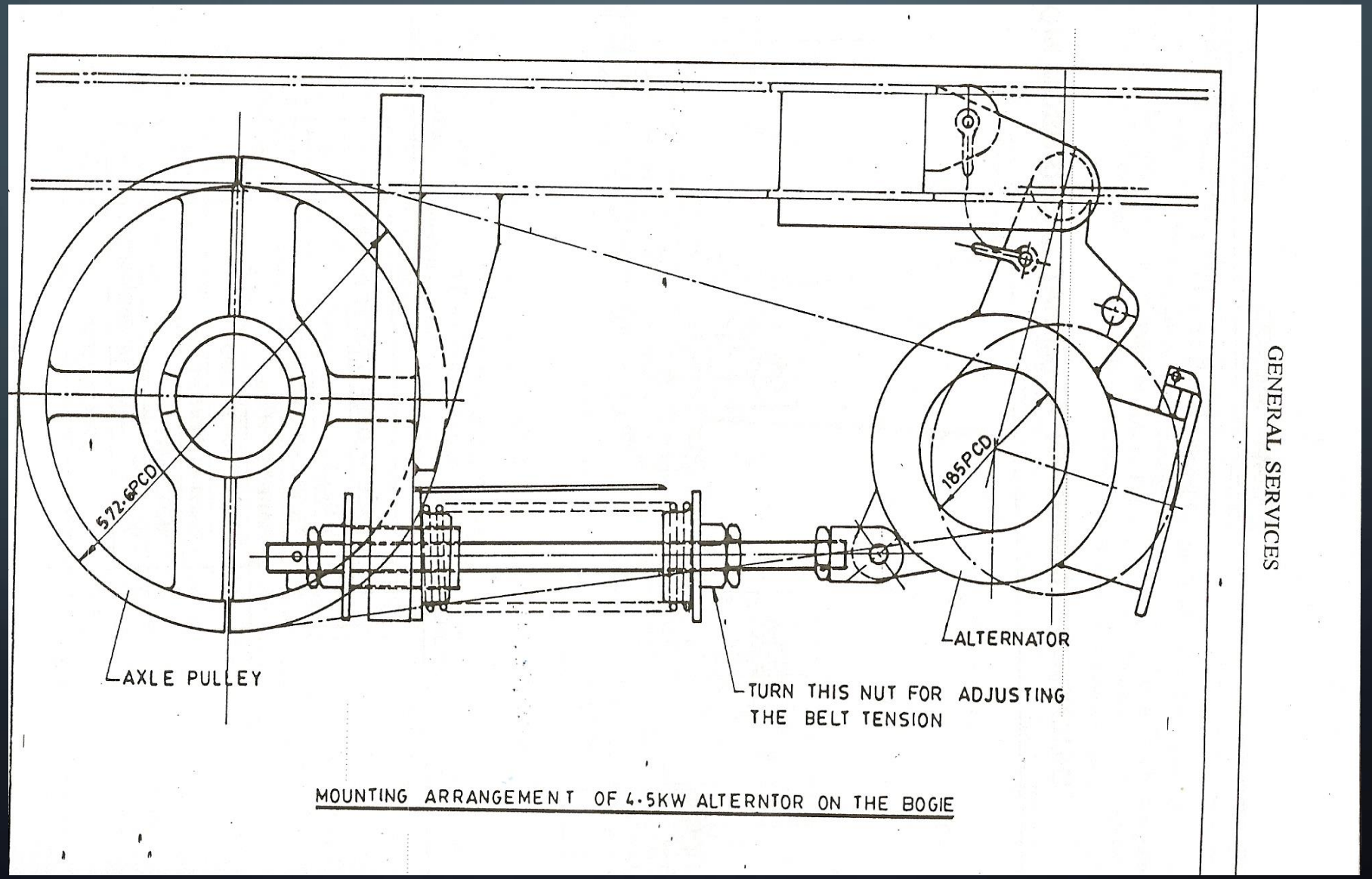
Cut in speed - 550 rpm (30 KMPH with half worn wheels )

Maxm. speed for full output 930 rpm for 135 A at 135 V- 51 KMPH

Maxm. speed - 2800 rpm (156 KMPH)

Class of Insulation - F

# MOUNTING ARRANGEMENT OF ALTERNATOR



# NAC Coach Alternator 4.5 kw

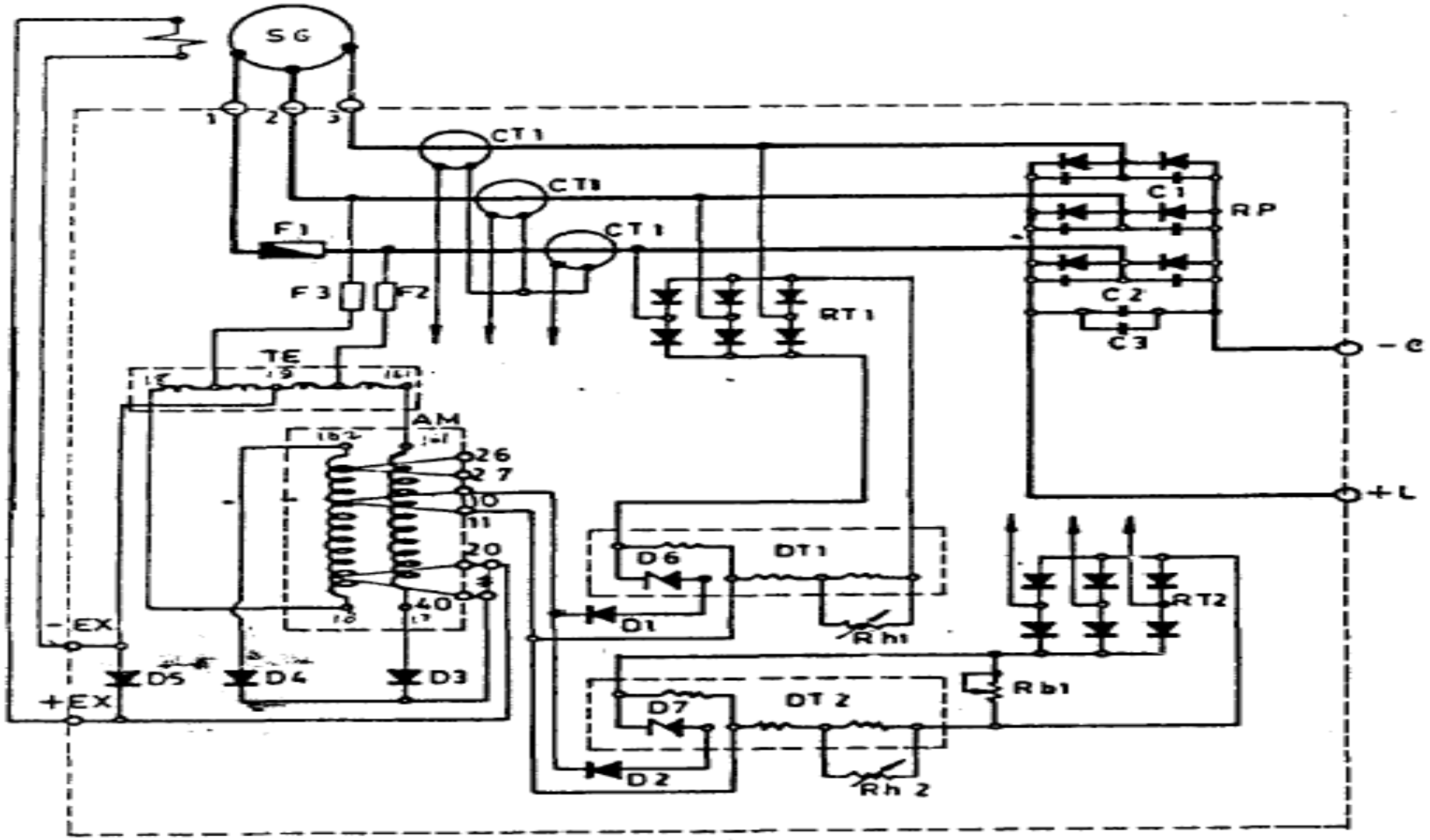
# AC Coach Alternator- 25 kw

# RRU – RECTIFIER CUM REGULATOR UNIT

- Functions
  - Rectification of 3 phase AC output of Alternator using full wave rectifier bridge
  - Regulation of voltage at set value for variable loads and speed
  - Regulating output current at set value for variable loads and speed

**RRU**

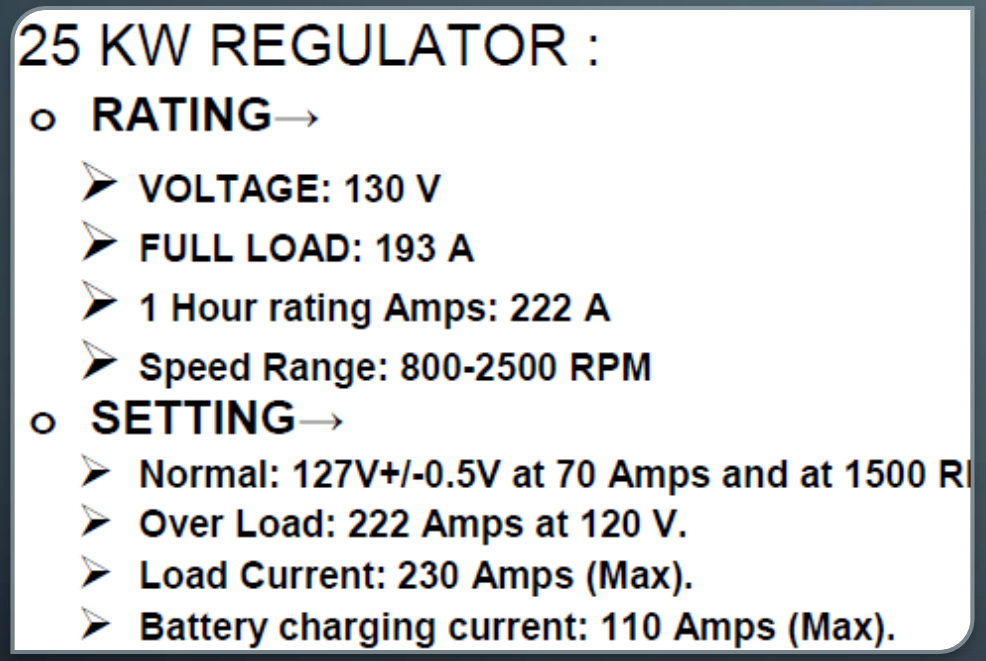
- POWER RECTIFIER
  - consists of six silicon diodes connected in three phase full wave bridge. three phase output of the alternator is rectified by to give a DC output
- CURRENT TRANSFORMER
  - The current transformers are used to sense the load current for the current limiter
- MAGNETIC AMPLIFIER
  - The magnetic amplifier forms the nucleus of the regulator circuit. It works on the principle of saturation of magnetic core
- VOLTAGE DETECTORS
  - These voltage detectors serve the function of providing necessary "error signal" for voltage regulator and current limiting.


SG
1
2
3
CT1
CT1
CT1
F1
F3
F2
TE
AM
26
27
D
11
20
40
RT1
C1
RP
C2
C3
-C
+L
D6
DT1
D1
Rh1
RT2
Rb1
D7
DT 2
D2
Rh 2
-EX
+EX
D5
D4
D3

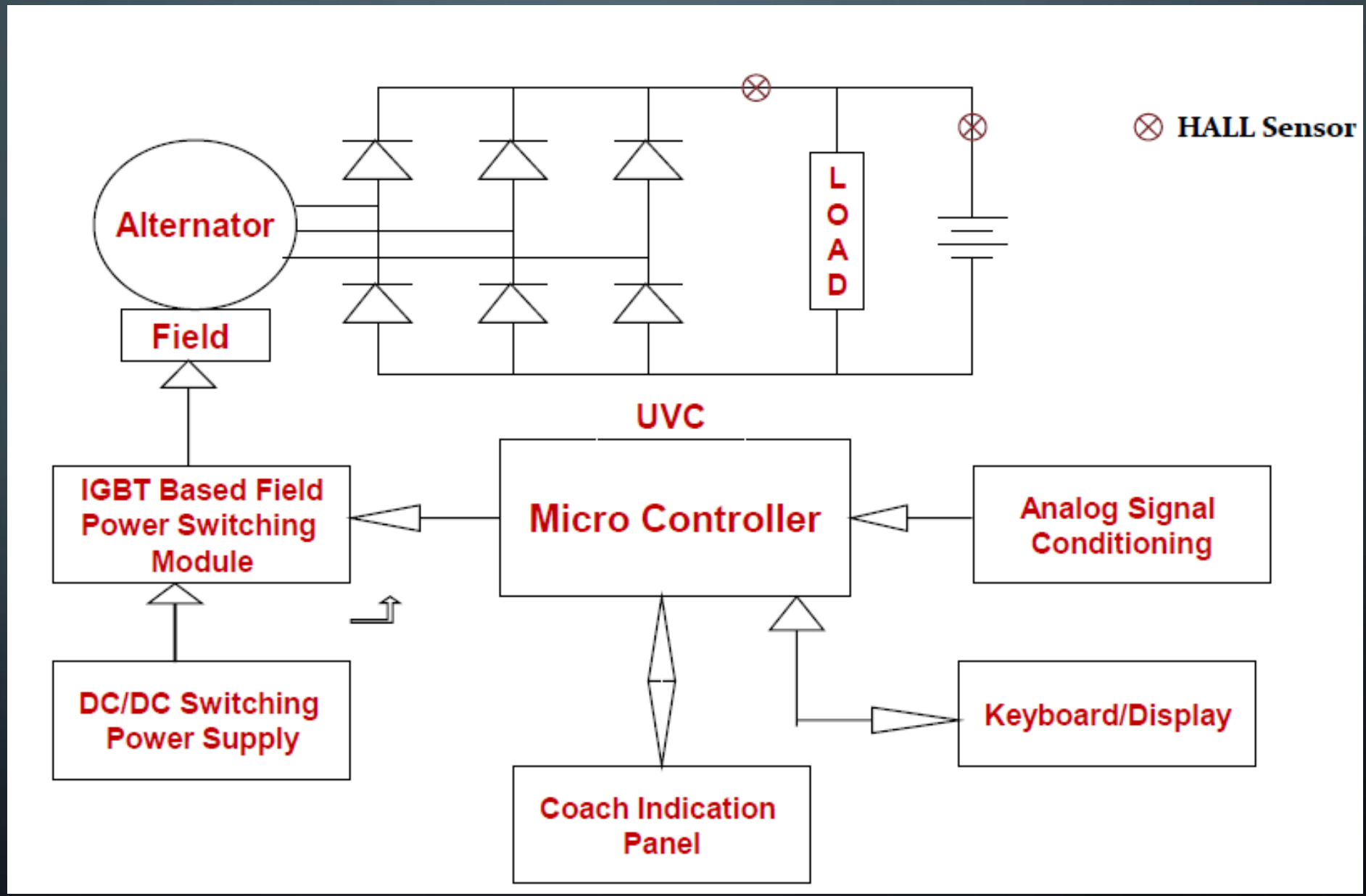
# RRU

# ELECTRONIC RECTIFIER AND REGULATOR UNIT WITH UNIVERSAL VOLTAGE CONTROLLER (ERRU/UVC)

- Microcontroller based regulator
- Hall Effect sensors are used for sensing the output load current and battery charging current and further sets current limit.
- Modular construction
- Fast and reliable switching devices.
- Less voltage and current ripple on Battery Charging current.
- Controlled Battery charging current to have longer life of batteries.
- Alternator identifying facilities (4.5, 18 or 25 KVA)
- Auto setting of parameters such as output DC voltage, battery current, load current, which in turn increase the life of battery and the alternator itself.
- Monitoring real time value of alternator voltage, load current, battery AH (IN), AH (OUT) etc. through interface fitted inside. Data logger and downloading unit available.
- This interface also has Emergency unit. In case of failure of one control unit, the other control unit will take care of both regulators




The various data and characteristics of 4.5kw, 18kw and 25kw alternators are fed to the controller and stored. As the train start moving or as the alternator is driven, the micro controller automatically gets the information from the alternator and identifies the same. As the alternator is identified, the setting of various parameters for the particular rating of the alternator is set and starts working as per the set parameters.


HALL Sensor
Alternator
Field
LOAD
UVC
IGBT Based Field Power Switching Module
Micro Controller
Analog Signal Conditioning
DC/DC Switching Power Supply
Keyboard/Display
Coach Indication Panel

- High performance 16 bit microcontroller used to ensure real time response.
- Use of intelligent control algorithm for improved performance.
- Reduction of the ripple content in the controlled DC output (less than 1% ripple content as compared to the
15% in conventional system).
- Better current regulation and current ripple (less than 10% compared to typically 25% in conventional system)

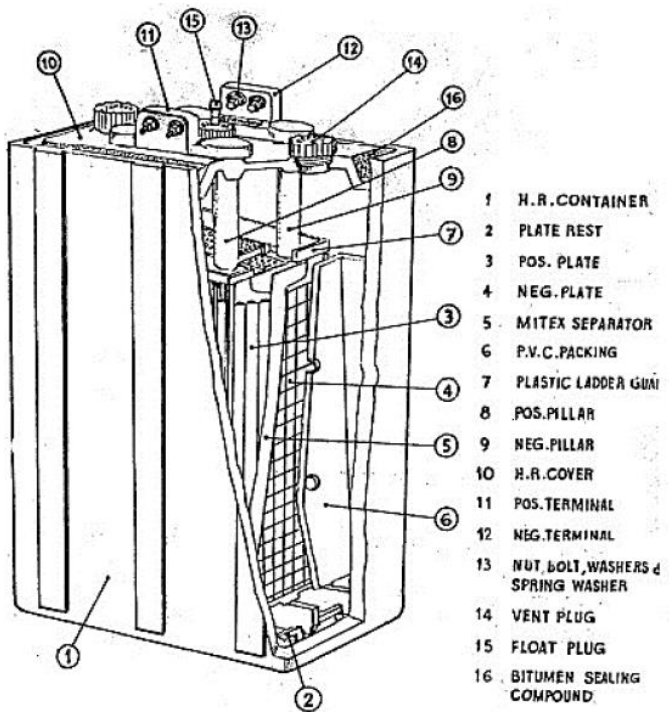
# INVERTER

- 25 KVA, 3 phase underslung inverter
- IGBT based power circuit
- Converts 110 DC from battery to 415V, 3 phase AC at 50 Hz.
- Output used to feed air conditioning load of coaches
- Supplies power to RMPUs

# Battery

Ratings:

- 120 Ah for BG non-ac coaches.
- 800  Ah for under slung SG AC coaches.
- 1100 Ah (VRLA) for RMPU  AC coaches.




**Conventional lead acid battery**

- Needs frequent top up with distilled water
- Higher maintenance required
- Corrosion of positive plate grids
- Increased self discharge

Low maintenance Lead acid battery (LMLA)

- Replaced the conventional batteries
- These batteries don’t require topping earlier than 9 months
- In Low maintenance battery,  antimony is reduced to 1.8 % , which helps in reducing loss of water.

***At the negative electrode***

$$Pb + H_2SO_4 \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} PbSO_4 + 2H^+ + 2e^- \qquad E° = 0.356V$$

***At the positive electrode***

$$PbO_2 + 2H^+ + H_2SO_4 + 2e^- \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} PbSO_4 + 2\,H_2O \qquad E° = 1.685V$$

***Overall Reaction***:

$$PbO_2 + Pb + 2\,H_2SO_4 \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} PbSO_{4\,(+ve\ Plate)} + PbSO_{4\,(-ve\ Plate)} + 2\,H_2O$$

$$E° = 2.041V$$

# VRLA/SMF BATTERY

- To overcome problems of frequent topping up and leakage of electrolyte scaled maintenance free lead acid batteries termed as SMF (VRLA) batteries have been developed and now used in most of the ac coaches.
- It works on oxygen recombination principle due to which prevents water loss.
- Electrolyte in these batteries is in immobilized form and these can be used in any position- horizontal or vertical.
- Manufacturers duly charged supply the batteries and no initial charging is required. Such a battery requires no topping up and maintenance except periodic cleaning of terminals.
- It has self-sealing vent plug, which normally does not open out in service.
- These batteries are also called Scaled Maintenance Free (SMF) Batteries.

# Valve Regulated Lead Acid Battery (VRLA)

**AGM – Electrolyte absorbed within glass mat**

**GEL - Electrolyte jellified**

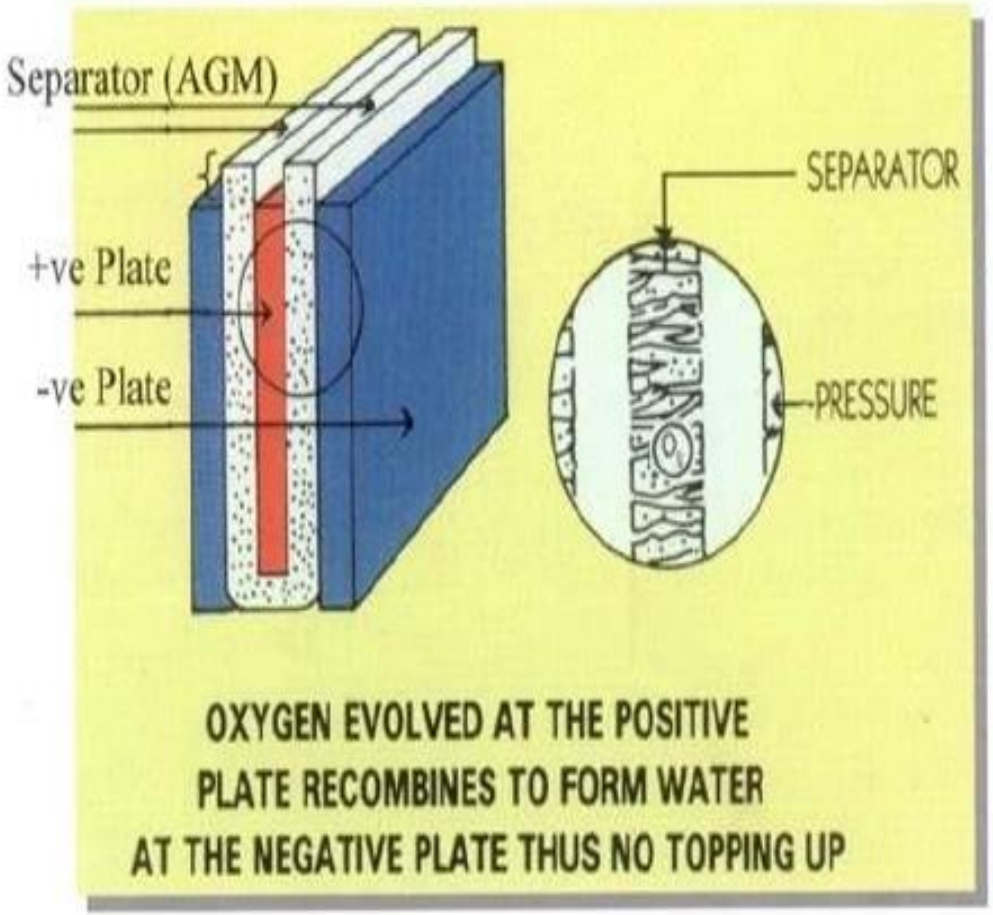
## *Recombination Reaction*

### At Positive Plate

$H_2O \rightarrow 2H^+ + \frac{1}{2} O2 + 2e^-$

### At Negative Plate

$\frac{1}{2} O2 + Pb \longrightarrow PbO$




$PbO + H_2SO_4 + 2e^- + 2H^+ \longrightarrow 2PbSO_4 + 2H_2O + Heat$

# Carriage Fan

- One of the important passenger amenity item
- Conforms to IS: 6680 with RDSO's Annexure H
- Sweeps in use: 400 mm (non-ac coaches/Ist class)
  : 300 mm (AC 2T,3T)
  : 225 mm (AC coach toilets)
- Type : Fixed/Swivel
  : dc (with or without brush)/ac
- Motor (dc): Series wound
- Accessories
  - Regulator (fan to work in min position with 85% V).
  - Gimbal ring (for swivel type)
  - Fuse protection

BLDC(Brushless DC fans) being used off late

# CARRIAGE LIGHTING

- The coaches are fitted with FTL, CFL or incandescent light fittings.
- The fluorescent light fittings consists of 2 feet long, 20 watt, CFL of 11w x 2, incandescent lamps 25w/40w are working on 110 V DC supply.
- Level of illumination (Ref: RDSO spec. no.EL/TL/48(Rev’1’) –2005).

***The level of illumination to be attained in various types of coaches shall be as given below***

| *Class of coach* | *Min. illumination level* |
|---|---|
| Ist class compartments | 30 lux |
| 2nd class compartments | 30 lux |
| Postal compartments | 40 lux |
| Pantry compartments | 30 lux |
| Lavatories and corridor | 16 lux |
| Luggage compartment of SLR coaches | 20 lux |

# Battery Charging Terminal

***Battery Charging Terminal*** (BCT) is provided centrally at the both sides of the under-frame of the coaches for external charging of the batteries at stations or maintenance lines

# UNDER FRAME TERMINAL BOX

All the cables coming from under-frame equipment like regulator-rectifier, batteries and battery charging sockets are terminated at the *terminal board* mounted inside this box. Supply to the junction box inside the coach is taken from this box

# ROTARY JUNCTION BOX

Rotary Junction Box is provided inside the coach. It is used to arrange and control the power supply to various circuits of the coach (e.g. light, fan etc.) with the help of rotary switches

# EMERGENCY FEED TERMINAL (EFT)

Each coach is provided with four emergency feed terminal boards on end panels, one each at the four corners of the coach at lower level to enable emergency connection to be made between adjacent coaches

# Self Generation System- Advantages

- Flexibility in rake formation
- Independent of mode of traction
- No separate power car required
- Failure in one coach does not affect other coach
- Feed extension is possible in emergency from adjacent coach

# Self Generation System- Disadvantages

- Load restricted to 2X25 kW per coach
- Bulky 1100AH (AC)/120AH (Non-AC) battery required during stationery / slow movement
- No standby alternator/battery
- Extensive maintenance due to under-slung alternator, battery, axle-pulley, belt etc
- Poor overall system efficiency of 54%

# THANK YOU