Battery and Chargers

Mid-South Meterman's School Substation Class

MICHAEL ARCHIE

5/10/18

- The Alpha Group represents an alliance of independent companies sharing a common goal:

- *Create world-class power solutions*

- Over $600 million in annual sales
- Over 1,200 employees
- Over 3 million powering solutions in operation globally
- Over 40 years of powering solutions expertise

Alpha Group

Common Technologies, Diverse Industries

- Cable TV/Broadband
- Industrial
- Utilities
- Renewable Energy
- Telecom
- Security
- Parking
- Traffic Control






Alpha Group

CORPORATE OFFICE

- Bellingham, WA
- Over 170,000 square feet
- R & D Labs
- Production facilities
- Circuit board design and prototypes
- Custom and final assembly

- Suwanee, GA
- Over 150,000 square feet
- Manufacturing
- Sales
- Technical support

AC vs. DC Power

Direct current (**DC**), the electric charge (current) only flows in one direction. **(Thomas Edison).**

Alternating current (**AC**), current changes direction. Switches back and forth. **(Nikola Tesla)**

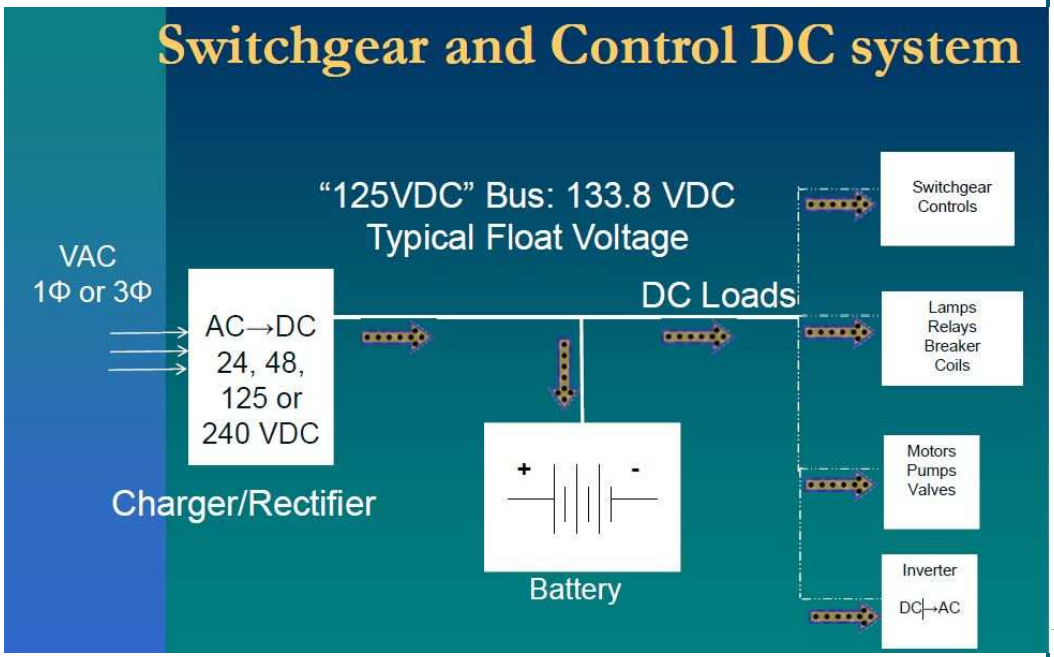
Advantage of AC - The major **advantage** that **AC** electricity has **over DC** electricity is that **AC** voltages can be readily transformed to higher or lower voltage levels, while it is difficult to do that with **DC** voltages. Since high voltages are more efficient for sending electricity great distances, **AC** electricity has an **advantage over DC.**

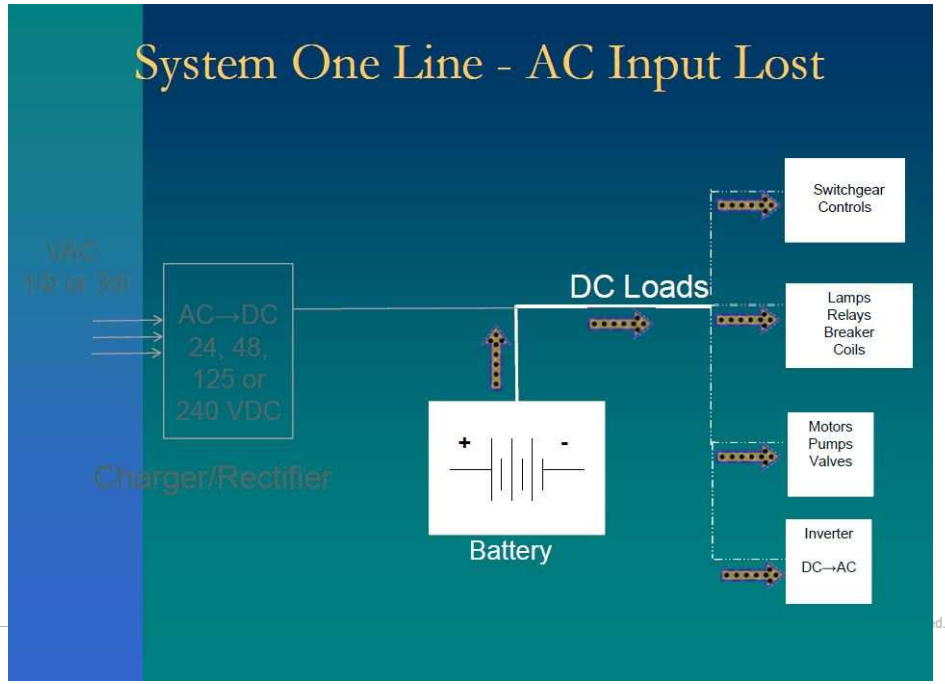
Advantage of DC -**You cannot store ac potential** (power) but you can store dc potential (power) in batteries. This is a very big advantage over ac. Almost all portable electronics need dc.

Why is DC Power Needed in a Substation?

DC distribution is needed in Sub-station to provide **power supply to Control & Protection** equipment situated in Substation in case of outages/faults.

In sub stations we get AC supply but in the case of a fault in the incoming supply ,then we will not have AC supply to power the protective equipment and Isolation switches. **Unlike AC supply DC supply can be stored in batteries.**



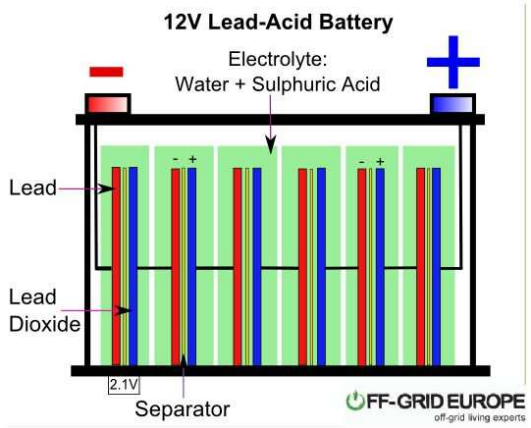


Batteries

Alessandro Volta invented the first battery. The first actual battery was invented by a man in Italy named **Alessandro Volta** in 1800.

A container consisting of one or more cells, in which chemical energy is converted into electricity and used as a source of power.

Batteries have three parts, **an *anode* (-)**, a ***cathode* (+)**, and the ***electrolyte***. The cathode and anode (the positive and negative sides at either end of a traditional battery) are hooked up to an electrical circuit



Types of Batteries (Substation)

Lead Acid Batteries: A **lead-acid battery** is an electrochemical **battery** that uses **lead** and **lead** oxide for electrodes and sulfuric **acid** for the electrolyte.

The lead–acid battery was invented in **1859** by French physicist **Gaston Planté** and is the oldest type of rechargeable battery

Nickel–cadmium battery: (NiCd battery or NiCad battery) is a type of rechargeable battery using nickel oxide hydroxide and metallic cadmium as electrodes. **(Used for harsh environments).**

Batteries

CELL: A unit consisting two dissimilar electrodes immersed in an electrolyte.

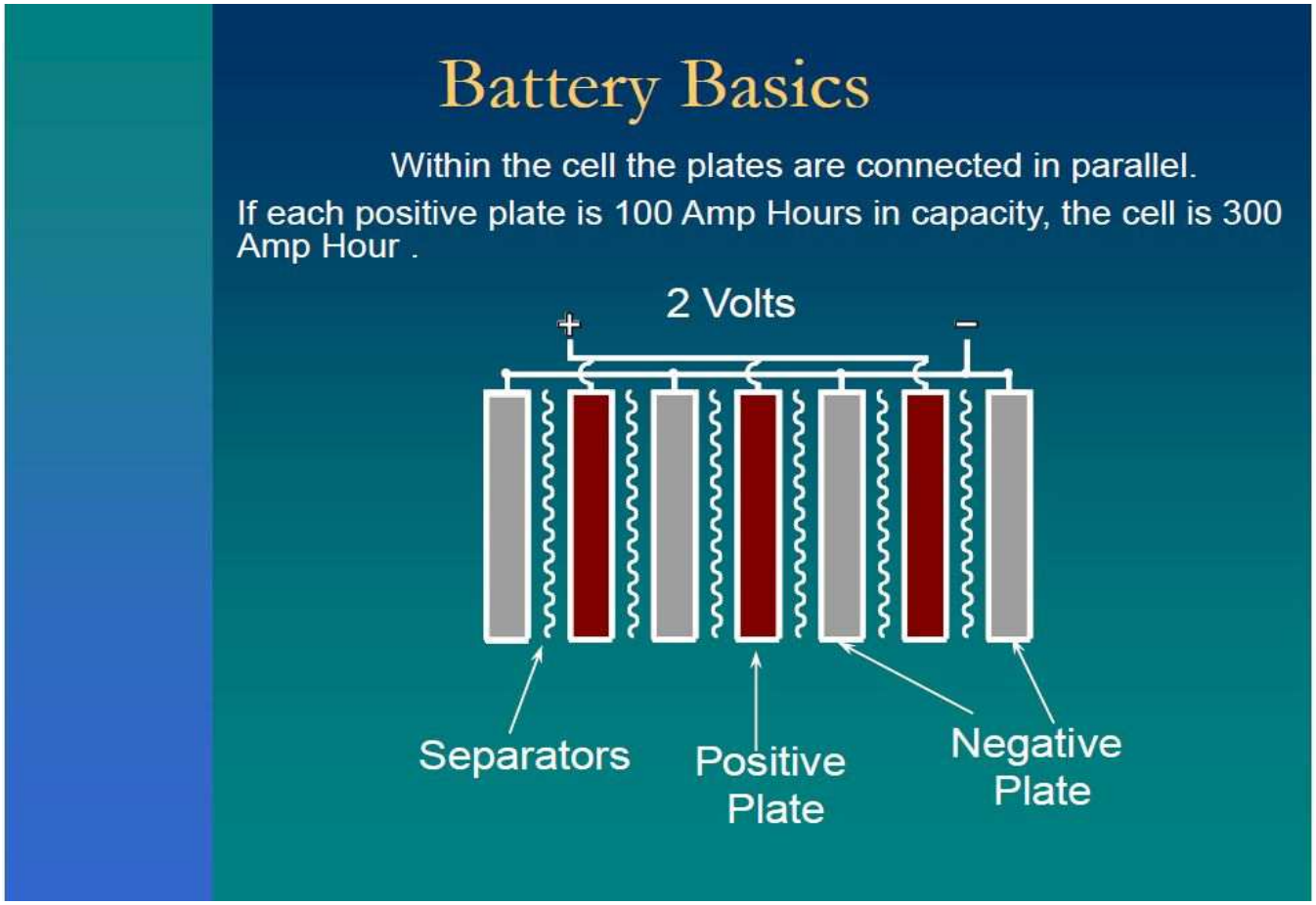
One lead acid cell is **2 volts** nominal.

One nickel cadmium cell is **1.2 volts** nominal.

STRING: An energy storage system consisting of two or more series connected cells up to the required system voltage.

Lead Acid
"**125 Vdc**" = **58-60** cells
Typical Float = 130-134Vdc

Nickle Cadmium
"**125 Vdc**" = **90-96** cells
Typical Float = 130-134Vdc



Amp-Hour: this is a unit of measurement for **battery** capacity, obtained by multiplying a current flow in **amperes** by the time in **hours** of discharge.

Lead Acid Batteries

Lead dioxide Positive plate, PbO_2

Metallic sponge lead Negative plate, Pb

Immersed into an electrolyte of Water & Sulfuric Acid, H_2SO_4

Grid

Positive Plate

Negative Plate

Separators

SEPARATOR: PREVENTS ELECTRICAL CONTACT BETWEEN THE POSITIVE AND NEGATIVE PLATES WHILE MAINTAINING SUFFICIENT ELECTROLYTE TO SUSTAIN CAPACITY

- **FLOODED:** MICRO POROUS SEPARATOR
  - GROOVED DESIGN TO ALLOW FREE LIQUID AND GAS MOVEMENT WITHIN CELL
  - PROVIDES PREVENTION FROM SHORTS
  - GLASS MAT MAY BE USED

- **VRLA:** "ABSORBENT GLASS MAT" WRAPS POSITIVE AND NEGATIVE PLATES
  - AGM
  - GEL

Lead Acid Cell Components

Post

Vent

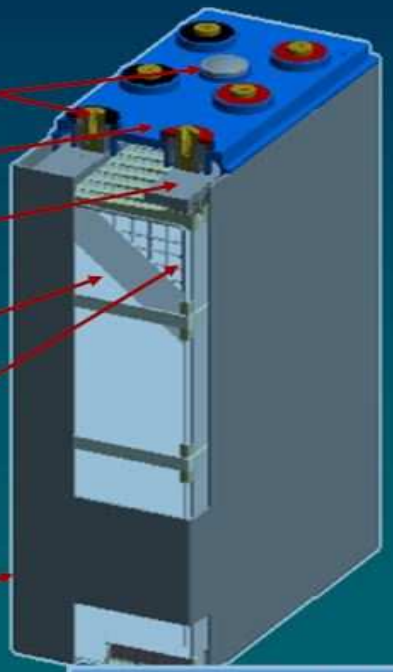
Cover

Strap

Separator

Plate

Container



VLA (Flooded)

2 Volt VRLA

Types of Lead Acid Batteries

Vented Lead Acid (“VLA”) Flooded or Wet Cell

- Lead Antimony
- Lead Calcium
- Lead Selenium

Valve Regulated Lead Acid (“VRLA”)

– Also called Sealed *(not maintenance free)*
– Lead Calcium
– Pure Lead
– AGM Design (Absorbed Glass Mat)
– Gel Design

Battery

Lead Acid Battery Construction – 3 alloys

Lead Antimony *(6-13%)*

1. Ability to withstand repeated deep discharge cycles *(1800 Typical)*
2. Minimum 15 years of reliable service
3. Subject to Antimonial poisoning *(watering becomes excessive as battery ages)*

Lead Calcium

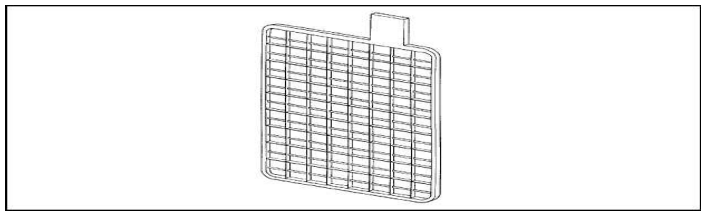
1. Good stability of float voltage Requires less watering
2. Poor cycling *(capacity likely to exhibit a marked reduction after 50 cycles*
3. **Positive grid growth** *(Positive post seal problems)*
4. Subject to Passivity (Sudden Death). Requires regular testing

Lead-selenium ***(Low >1.5%Ca and Low Antimony >1.5 %)*** **has characteristics common to both: Lead-Calcium and Lead-Antimony.**

1. Elimination of Antimony poisoning
2. Stable float charge characteristics over the life of the Battery
3. Good cycling *(800 to 1000 cycles typical)*

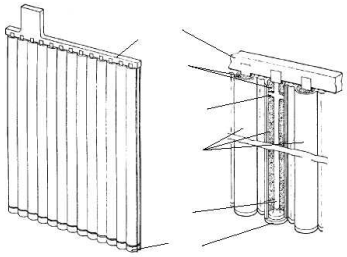
Tubular vs. Flat Plate

Lead Acid Battery Construction



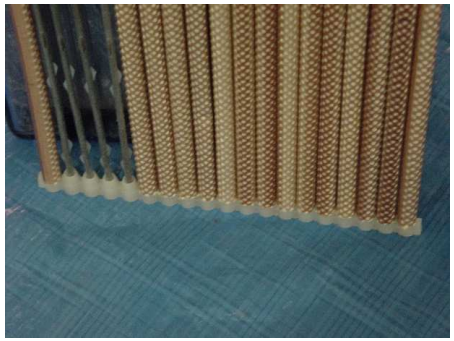
Flat Plate

1. Low cost
2. High Performance
3. Good energy density
4. Good mechanical strength
5. Limited Life
6. Limited cycling capability



Tubular Plate

1. Excellent energy density
2. Superior cycling capability
3. Excellent Long-Rate performance
4. **Tubular design prevents shedding of active material (mechanical encapsulating)**



Advantages of Tubular vs. Flat Plate

1. Tubular Plate construction deploys frame structure consisting of **series of vertical spines** connected to a common current carrying bus.

2. Paste is held in micro-porous, non-conductive tubes placed over the individual spines.

3. AIP's stationary OPzS flooded type batteries are manufactured in translucent top & transparent base chemical resistant containers of Styrene-Acrylonitrile (SAN) type in accordance with DIN 40736 & ISO standards.

4. Batteries are characterized by proven long life, low water consumption, and low self discharge rate. Under normal operating conditions, only distilled water is added every 2-3 years.

5. Longer life in comparison with Flat Plate. The tubes in the Tubular design prevents shedding of active material (mechanical encapsulating)

6. Field proven service life of 18-22 years

History of Battery Chargers

- Before 1900, DC motor generator sets were the only electrical way to generate dc power.
- Early 1900's, mercury arc rectifier vacuum tubes were introduced; ac current was rectified through an electrical arc created between electrodes in very low pressure mercury vapor glass bulb.
- 1920's the Thyratron was introduced; an electrical switch controlled rectifier vacuum tube using Argon for higher power applications. By the end of World War II, solid state germanium and silicon diodes emerged and so did the Mag-amp and Ferroresonant chargers.
- 1960's SCR chargers were introduced.
- 1970's Field Effect Transistors (MOSFET) and isolated gate bipolar transistors (IGBT) were developed.
- 1990's that more reliable higher power and frequency MOSFETs and IGBTs were commercially available thus allowing the emergence of SMR chargers.

Battery Chargers

Charger Technologies

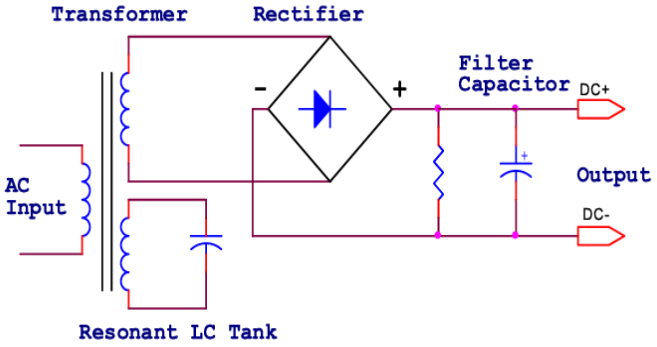
1. Ferro resonant
2. Mag Amp
3. Silicone Controlled Rectifiers (SCR)
4. Insulated Gate Bipolar Transistors (IGBT)
5. Switch Mode Rectifiers (SMR)

Charger technology

TYPE-1: FERRO RESONANT

- Ferro resonant design

Introduced more than 60 years ago to regulate AC voltage & rectify AC to DC. It consists of primary, secondary, resonant LC tank, rectifying Diode & Filtering.

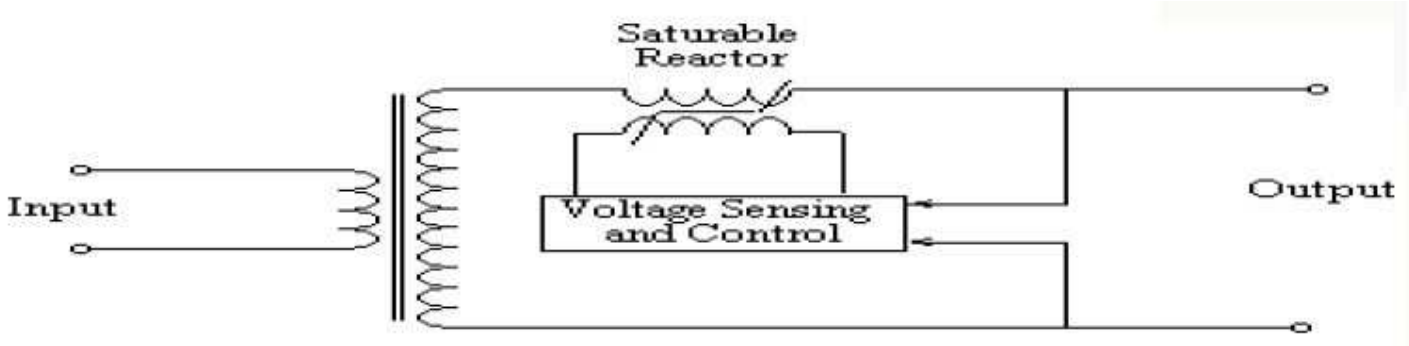


Charger technology

TYPE-2: MAG AMP

- Saturable Core Reactors

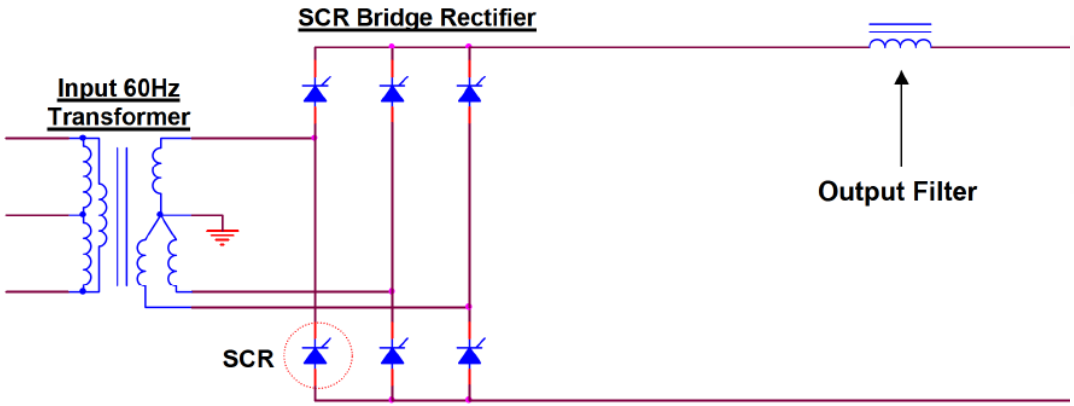
Introduced as an alternative to the ferro resonnate design to prevent using capacitors. The magnetic-core reactor has its reactance controlled by changing the permeability through a control coil and a DC variable current source.



Charger Technology

TYPE-3: SILICONE CONTROLLED RECTIFIERS (SCR)

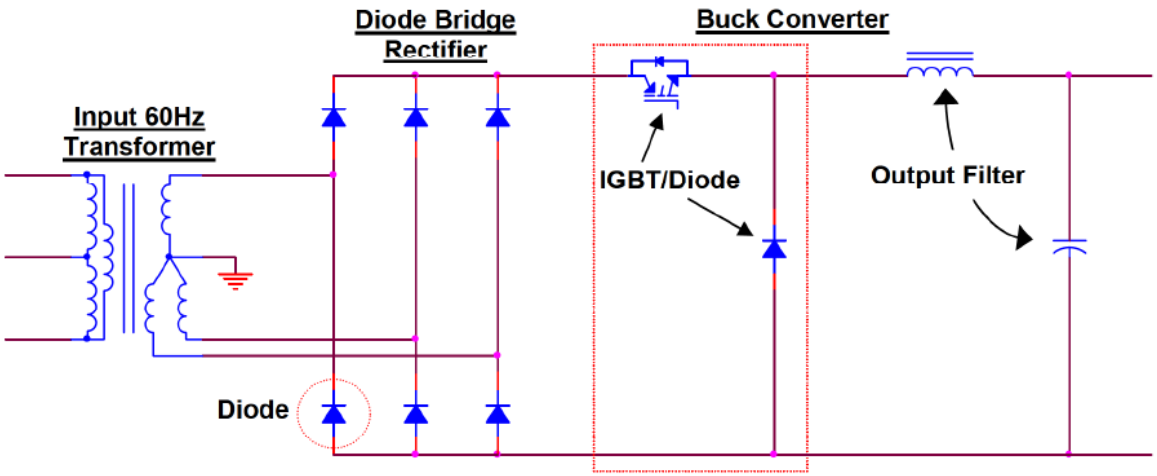
- Thyristors were introduced in the 70's to replace the earlier gas-filled devices. One single conversion stage to convert AC to DC through an isolation transformer and bridge rectifier.



Charger Technology

TYPE-4: HIGH FREQ. IGBT CHARGER

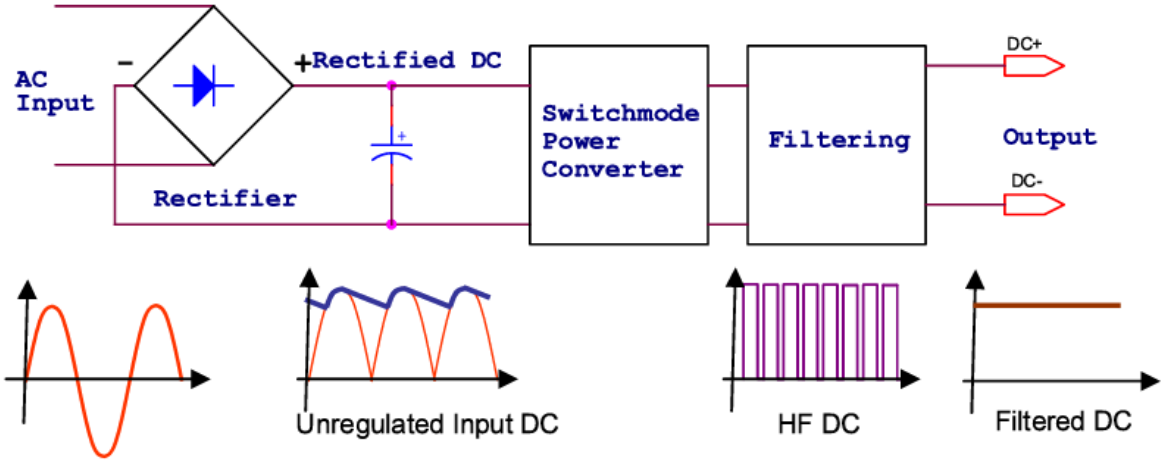
Introduced to ease output filter design using MODULAR, COMPACT and more economical components.



Charger Technology

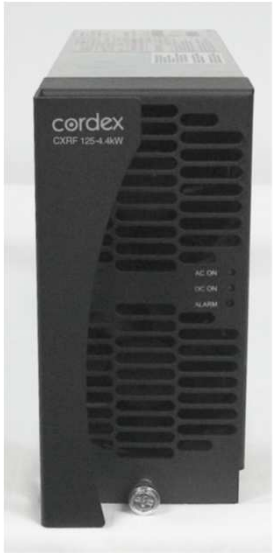
Type 5-Switch Mode Charger

Switch Mode charger design implements a high frequency switching isolation transformer & Pulse Width Modulation (PWM) process to rectify AC power into DC power to have an ultimate DC output regulation with negligible AC ripple & compact in physical footprint.



Cordex ™ modular switch-mode technology

- The main advantage switched mode technology is greater efficiencies than older magnetic based architectures.
- Dissipates very little heat or wasted energy when switching.
- Smaller size and weight with greater power densities.
- 4.4kW provides **35Amps** at 125Vdc
- 4.4kW provides **20 Amps** at 230Vdc
- 1.2kW provides **25Amps** at 48Vdc
- 1.1kW provides **8 Amps** at 125Vdc



Switch Mode Rectifiers

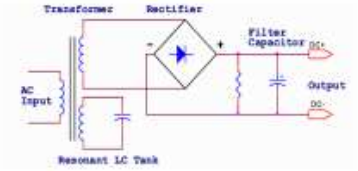
- Commercially available for over 30 years.
- Dominant technology in Telecom, Laboratories and Medical industries.
- SMR technology used in utilities in Europe and Australia for 15 years.

- **Main Advantages:**
  - Compact Size (Smaller Footprint)
  - Modularity (Hot Swappable Power Modules)
  - Cost Effective especially when N+1 redundancy is needed.
  - Easier and shorter repair times. (Just swap out power modules).

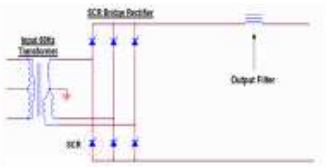
AIP Products

COMPARISON BATTERY CHARGER TECHNOLOGY

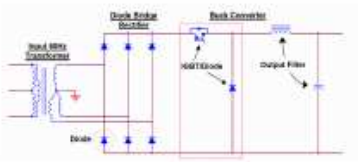
No.	COMPARISON CATEGORY	BATTERY CHARGER TYPE			
		FERRORESONANT CHARGER	SILICON CONTROL RECTIFIER(SCR) CHARGER	NON-ISOLATED SWITCHMODE IGBT CHARGER	ISOLATED HIGH FREQUENCY TRANSFORMER SWITCHMODE CHARGER
1	Efficiency	Medium at full load &low at light load (70-75%). Ferroresonant transformer dissipates more heat than a conventional transfromer	Medium(75-85%). Conventional transfromer used	High(85-95%): Low frequency transformer used at input.	Very High(95-99%)
2	Response	Very slow	Medium	Fast	Very Fast
3	Control	Minimal	Medium	Medium to high	Very High
4	Physical dimensions	Very large/Heavy	Very large/Heavy	Large/Heavy: Due to low frequency transfromer used at input	Very small/light
5	Noise	Very Audible	Audible	Less Audible	Non Audible
6	Complexity	Low	Medium	Medium	High
7	Power Quality	Medium	Poor	Medium	High
8	THD Back-Feed	Medium	Poor	Medium	Very low
9	Communication fearure	Low	Medium to High	Medium to High	Very High
10	Cost	Very High	High	Medium	Low
	Example of 100A/125VDC output/480VAC input Cost in US$	**$15,979.20**	**$13,316.00**	**$9,328.20**	**$8,180.00**



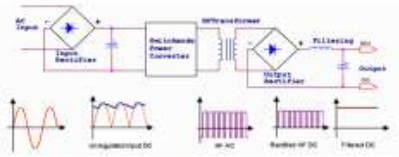
FERRORESONANT CHARGER



SCR CHARGER



NON ISOLATED SWITCHMODE IGBT CHARGER



ISOLATED SWITCHMODE CHARGER

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