Welcome to

TECHNICAL PRESENTATION OF FLOAT CUM BOOST BATTERY CHARGER FOR STAND BY APPLICATION
WHAT IS A FLOAT CUM BOOST BATTERY CHARGER?
1) Float cum Boost Battery Charger (FCBC) for stand by application is a part of the un-interruptible “DC POWER SUPPLY SYSTEM”.

2) It may be called a DC UPS (Un-interruptible Power Supply)
DC power supply system

- FCBC along with a Battery and a DC Distribution Board completes a DC Power Supply System.
- DC Power Supply system provides 100% no-break supply to critical and sensitive load.
Role of FCBC in a battery back-up DC UPS

❖ Float cum Boost Battery Charger steps down & converts incoming AC supply to DC system voltage.
❖ It feeds load as well as trickle charges the battery up to its rated current rating.
❖ On overload excess current (mostly of momentary in nature) is delivered by the battery.
During power outage battery feeds the load without interruption as battery floats across the load.

On resumption of power FCBC charges the battery ( may be in boost mode ) and also feeds the load.
COMMON FLOAT CHARGER

APPLICATIONS

- SUBSTATION BATTERY CHARGER
- BATTERY CHARGER OF ON-LINE UPS SYSTEM
- CHARGER (DC-DC) OF GRID CONNECTED SOLAR INVERTER
- LAPTOP ADAPTER etc.
TYPICAL SCHEMATIC OF DC BACK-UP SYSTEM
NORMAL OPERATION

AC INPUT

Float cum Boost Battery Charger

CRITICAL & SENSITIVE DC LOAD

BATTERY BANK

FCBC feeds the load as well as trickle charges the Battery

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During power outage Battery feeds the load instantly without any change over.
TYPICAL SCHEMATIC OF DC BACK-UP SYSTEM

RESTORATION OF BATTERY AH

FLOAT CUM BOOST BATTERY CHARGER

CRITICAL & SENSITIVE DC LOAD

BATTERY BANK

Float Charger feeds the load as well as trickle charges the Battery

AC INPUT
TOPOLOGIES OF FLOAT cum BOOST BATTERY CHARGER FOR STAND BY APPLICATION
A review of FLOAT CHARGER definition

➢ Float Charger or Float rectifier feeds the critical load as well as charges the battery.

➢ In the event of mains power outage battery feeds the load without any break in supply to the load.

➢ When mains power supply resumes Float rectifier charges the discharged battery and feeds the load.
In most of the applications loads are not only critical to supply interruption but also sensitive to voltage fluctuation and ac superimposed ripple.

There are various topologies of Float Battery Chargers (commonly called float-cum-boost charger):
1) *Float cum boost battery charger with one rectifier.*

2) *Float and boost battery charger with two rectifiers.*

3) *Dual Float cum boost battery charger for more critical application with larger load.*
Power flow scheme of a popular & typical Float and Boost Battery Charger (two rectifiers)
STAGE-1: NORMAL OPERATION

Float rectifier feeds the load and trickle charges the Battery. Boost charger remains in stand by OFF position.
STAGE-2: POWER OUTAGE

BATTERY BACK UP PERIOD
Battery feeds the Load

AC INPUT

K1

FLOAT RECTIFIER [NO SUPPLY]

DC1 - CLOSED
K1, K2-OPEN

BOOST CHARGER [NO SUPPLY]

DC DISTRIBUTION BOARD

BATTERY BANK

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BOOST CHARGING OF BATTERY AFTER DEEP DISCHARGE

Boost charger charges Battery when Float rectifier feeds load
STAGE-4: BATTERY CHARGED

Back to NORMAL operation. Float rectifier feeding the load and trickle charging the Battery. Boost charger remains in stand by OFF position

AC INPUT

K1

K1, DC1 - CLOSED
K2-OPEN

FLOAT RECTIFIER [ON]

BOOST CHARGER [OFF]

DC DISTRIBUTION BOARD

BATTERY BANK

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EMERGENCY FLOAT MODE
Boost charger acts as Float rectifier feeding the load and charging the Battery

STAGE-5
FLOAT RECT. FAILED

AC INPUT

K1

K1, K2 -CLOSED
DC1-OPEN

K2

FLOAT RECTIFIER
UNDER SERVICE

BOOST CHARGER
[ON IN FLOAT MODE]

DC DISTRIBUTION BOARD

BATTERY BANK

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At ESI we design and manufacture Thyristor controlled Float and Boost Battery Chargers up to 250V DC, 300KW of each rectifier.
Dual Float cum Boost Battery Charger
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SCHEMATIC OF DUAL FLOAT CUM BOOST CHARGER
Both the chargers FCBC – 1 and FCBC – 2 are identical.

Float / Boost change-over of both the chargers will be either Automatic or Manual.

In position–1 of the switch SW1, FCBC - 1 is selected to feed the load and FCBC – 2 is selected to charge the Battery.

In position – 2 of SW1, FCBC – 1 is selected for charging the Battery, where as FCBC – 2 will be connected to the load.
DC Contactor DC1 is normally de-energized and Battery is not connected to the load as DC1 ‘NO’ contact is open.

In the event of power outage at input supply DC1 coil will be energized from the Battery through NC contacts of K1 and K2 contactors.

Eventually load current will be supplied from the Battery.

In order to provide absolute no-break dc power to critical load (connected across the DC output) D3 diode is connected at 80% tap of the Battery Bank, which will conduct during milli-second making period of the DC1 contact of the contactor.
RL1 and RL2 are activated when charger fails. That is when charger output (before the blocking diode D1 & D2) goes beyond the specified output voltage range despite of availability of input supply to charger, we assign that is fail-condition of the charger. RL1 is activated when FCBC-1 fails and RL2 is activated when FCBC-2 fails.

Eventually DC–1 will be energized and DC1 contact will close to put the load or the battery automatically to the circuit of the healthy FCBC.
SINGLE LINE CIRCUIT DIAGRAM OF FCBC and FNBC
Write up of Float-cum-Boost Battery Charger

- Normally charger feeds the load at constant voltage (CV) and trickle charges the battery. DC contactor DC1 is normally energised to provide a shorted path across series dropper diode network D1......Dn. This mode of operation is known as “FLOAT” mode of operation.

- During power failure battery feeds the load without any break since battery is floating parallerly across the load. At this stage also DC1 remains closed.
Write up of Float-cum-Boost Battery Charger

☐ When power comes back normal operation resumes. That is system goes back to “Float mode”.

☐ But, if battery is drained out heavily then it is necessary to restore the discharged battery quickly. That is “BOOST” mode of operation must be switched ON.
Boost mode of operation can be switched ON manually or automatically. Automatic selection of “Boost mode” and switching back to “Float mode” is achieved by sensing battery voltage level.

Generally in “Boost mode” charger charges battery at a constant current (CC) and battery voltage increases gradually.
In order to restrict high battery voltage to appear across load a series dropper diode network D1.....Dn is provided, which comes in the circuit when DC1 is de-energised that is DC1 path becomes open.

This DC contactor DC1 is de-energised by relay RL1. This “battery over voltage relay RL1” is activated at a preset battery voltage level (that is the maximum permitted voltage level which a load may normally withstand).

On completion of boost charging, system swings back to float mode.
SINGLE LINE DIAGRAM OF THYRISTOR
CONTROLLED FLOAT AND BOOST BATTERY CHARGER

AC INPUT [1PH/3PH]

SW1

BOOST CUM FLOAT RECTIFIER

ANNUNCIATION

V1

ANNUNCIATION CIRCUIT

FLOAT RECTIFIER

K1

ANNUNCIATION

FLOAT RECT

CHOKE

SHUNT

CAP

DC OUTPUT TO LOAD

V2

ANNUNCIATION

BOOST RECT

K2

ANNUNCIATION

TRIGGER CUM CONTROL PCB

VOLTAGE CONTROL

CURRENT CONTROL

BATTERY BANK

TRIGGER CUM CONTROL PCB

VOLTAGE CONTROL

CURRENT CONTROL

DC1

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Write up of Float-and-Boost Battery Charger

- Normally float rectifier feeds load and trickle charges the battery through DC contactor contact DC1 since DC contactor is energized by battery bank. Float rectifier operates in constant voltage mode and maintains a constant voltage across load terminal (settable between 2.0 and 2.3 V / cell).

- During power outage battery feeds load through the same path (closed DC1) and maintains uninterrupted supply at DC output terminal.
 Normally boost rectifier (or boost cum float rectifier) remains OFF. If battery voltage goes down after heavy discharge, then boost rectifier contactor K2 is switched ON by battery under voltage relay and boost rectifier charges battery in constant current/voltage mode.

- When boost rectifier is switched ON by K2, DC contactor DC1 is de-energised by K2 interlock thus eliminating the possibility of appearance of high DC voltage of battery (when charged beyond 2.3 V / cell) across the sensitive load.
Write up of Float-and-Boost Battery Charger

- Now float rectifier feeds load in constant voltage mode and boost charger charges battery. At this stage if power fails, battery feeds the load as soon as DC contactor picks up. But total no break supply is maintained at the load through tap cell diode, connected at 80% cell of the battery bank.

- Battery voltage increases with charge and when it reaches a preset level, the battery over voltage relay is activated, which consequently switches OFF K2. The system goes back to normal mode of operation, that is float rectifier feeds the load and trickle charges the battery while boost rectifier remains OFF.
Boost rectifier can also be switched ON manually for initial and equalizing charging.

In the event of failure of float rectifier, boost rectifier can be converted as spare float rectifier (interlock not shown in diagram).
TECHNICAL SPECIFICATION OF ESI MAKE SCR FLOAT CHARGER
(Common to both FCBC & FNBC)
### Standard technical specification of SCR based Battery Charger used in switch gear back-up

<table>
<thead>
<tr>
<th></th>
<th>Single phase, 230V or Three phase 415V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Voltage</strong></td>
<td>Single phase, 230V or Three phase 415V</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>50Hz.± 5%</td>
</tr>
<tr>
<td><strong>Input voltage variation</strong></td>
<td>±10%</td>
</tr>
<tr>
<td><strong>Battery voltage</strong></td>
<td>As per customer’s requirement</td>
</tr>
</tbody>
</table>
### Standard technical specification of SCR based Battery Charger continues-------

| Rectifier configuration | Full wave half control in 1 phase  
|-------------------------|-----------------------------------
|                         | Full wave fully control in 3 phase |
| Control mode            | Constant voltage, current limiting  
|                         | OR                                 
|                         | Constant current, voltage limiting |
| Specification of Battery Charger continues--------
|-----------------------------------------------
| Voltage regulation | ±1% |
| Current regulation | ±2% |
| Ripple voltage | 1-3% RMS (normally) |
Protection:

a) Electronic trip against input phase fail/sequence reversal
b) Gate pulse inhibit against AC under voltage
c) High speed semiconductor fuse/MCB at rectifier input
d) HRC fuse at output and filter circuit
e) Snubber across each semiconductor device
f) Soft start with current limiting circuitry against over load and short circuit
g) Device over temperature shut down (optional)
h) Surge suppressor network at input (optional)
### Specification of Battery Charger continues---------

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annunciation</strong></td>
<td>Audio-visual annunciation with flashing LEDs and piezzo buzzer.</td>
</tr>
<tr>
<td><strong>Termination of charging</strong></td>
<td>Automatic by sensing battery voltage/charging current/state of charge/ $dV/dT$/duration of charge</td>
</tr>
<tr>
<td><strong>Trickle/boost change over</strong></td>
<td>Automatic/Manual (whenever applicable)</td>
</tr>
<tr>
<td>Construction</td>
<td>Folded construction with 2mm CRCA sheet steel</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Degrees of protection</td>
<td>IP-42</td>
</tr>
<tr>
<td>Cooling</td>
<td>Air natural or forced cooling</td>
</tr>
<tr>
<td>Finish</td>
<td>Epoxy powder coated paint. Normally RAL 7032, Siemens grey OR as per client’s requirement</td>
</tr>
</tbody>
</table>
SCR BASED CONTROLLED RECTIFIER
Closed loop feedback control
SIX PULSE TRIGGER CUM CONTROL PCB [MOTHER BOARD]

USER CONTROL POTS

OUTPUT TO 6-PULSE TRAFEO

INP FROM POWER SUPPLY

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Salient features of ESI make Thyristor controlled Battery Charger

➢ Full wave fully controlled rectifier configuration in three phase version for better reliability and low inherent ripple.

➢ Separate P & I Controller for precise adjustment of transient response.

➢ Status indicating and self diagnostic LEDs are provided on each PCB.

➢ Test points provided on PCB to enable easy troubleshooting
Salient features of ESI make Thyristor controlled Battery Charger

➢ Temperature compensation in the control loop for SMF VRLA Battery charging.

➢ Current sharing loop for parallel redundant operation.

➢ Soft start with current limiting protects the charger from dead short circuit.

➢ Microcontroller based multi stage charging profile (optional)
All supervisory fault sensing circuits are IC based with built-in hysteresis and delay, which eliminates false alarm and hunting.

Automatic commencement and termination of battery charging protects battery from deep discharge and over charging.

LEDs are used in place of indicating panel mounting lamps.

Edge connectors and plug-in type relays are used for fast replacement.
➢ Isolated base thermostats are used on heat sinks for protection of semiconductor device from thermal runaway in large chargers.

➢ All components within the panel are laid out with sufficient space for easy maintenance and better ventilation.

➢ Comprehensive user’s manual with trouble shooting chart and detailed drawings are furnished to end user for easy maintenance.
SIZING AND SELECTION OF BATTERY & BATTERY CHARGER
❖ In stand by application Battery functions in full float operation.

❖ Battery will deliver current only when load exceeds charger output current rating.
A varying continuous load from a SCADA system

Continuously energized coils in switchgear and indicating lights

A non-continuous load from emergency lighting.

Random momentary operations of switchgear
### 125VDC Load Description

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Current (A)</th>
<th>Subtotal (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>69kV circuit switchers</td>
<td>2</td>
<td>15.0</td>
<td>30.0</td>
</tr>
<tr>
<td>69kV substation relays</td>
<td>8</td>
<td>0.2</td>
<td>1.6</td>
</tr>
<tr>
<td>5kV vacuum breakers</td>
<td>9</td>
<td>7.0</td>
<td>63.0</td>
</tr>
<tr>
<td>5kV switchgear relays</td>
<td>8</td>
<td>0.2</td>
<td>1.6</td>
</tr>
<tr>
<td>5kV switchgear indicating lights</td>
<td>Ignore</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>96.2A</strong></td>
<td></td>
</tr>
</tbody>
</table>
Table 5. Required Ampere-hour rate for a hypothetical 69kV substation load.

<table>
<thead>
<tr>
<th>125VDC Load Description</th>
<th>Quantity</th>
<th>Current (A)</th>
<th>Hours (h)</th>
<th>Subtotal (Ah)</th>
</tr>
</thead>
<tbody>
<tr>
<td>69kV circuit switchers</td>
<td>2</td>
<td>15.0</td>
<td>0.016*</td>
<td>0.5</td>
</tr>
<tr>
<td>69kV substation relays</td>
<td>8</td>
<td>0.2</td>
<td>8.0</td>
<td>12.8</td>
</tr>
<tr>
<td>5kV vacuum breakers</td>
<td>9</td>
<td>7.0</td>
<td>0.016*</td>
<td>1.0</td>
</tr>
<tr>
<td>5kV switchgear relays</td>
<td>8</td>
<td>0.2</td>
<td>8.0</td>
<td>12.8</td>
</tr>
<tr>
<td>5kV switchgear indicating lights</td>
<td>Ignore</td>
<td>0.0</td>
<td>8.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>27.1 Ah</strong></td>
</tr>
</tbody>
</table>

*0.016 hours = 1 minute
Charging Characteristics with CP Charging
Charge Voltage 2.3 Volts/Cell; Current limit 0.2 C₁₀Amps

Current in % of Rated Capacity vs Time in Hrs

Voltage

% Recharge

Cell voltage in Volts
Performance Curves at Different Rates of Discharge

CCV in Volts

Time in Minutes

C1, C2, C3, C5, C8, C10
12 Volt Lead Acid Battery State of Charge (SOC) vs. Voltage while battery is under charge.
PRESENT TREND IN CONVERTER TECHNOLOGY
Battery Charging is a complex electro technical process, in which the discharged electrical energy must be replenished from the electrical network.

Quality of the charging process is critical to the health & longevity of the battery.

As a whole battery charger plays a vital role in life & performance of today’s industrial batteries.
THYRISTOR CHARGERS ARE LOOSING GROUND TO SMPS CHARGERS

SMPS CHARGERS ARE VERY POPULAR IN TELECOM APPLICATION AS WELL AS IN UPS INDUSTRY

IN HIGH POWER REGION MEDIUM FREQUENCY (Around 20KHz) CONVERTERS ARE USED WITH PERMALLOY, METGLASS AND POWDER CORE MAGNETICS.
A typical Switched Mode Power Supply incorporates a front end AC-DC rectifier to generate an unregulated DC input voltage.

A high frequency chopper (MOSFET/IGBT) then chops the input DC Voltage.

After that a high frequency transformer isolates, steps down and converts this square wave DC to square wave AC output.
It is then rectified & filtered to generate a smooth ripple free output voltage.

Pulse Width Modulation technique is generally employed to regulate the charger output of a SMPS Charger.
TYPICAL SCHEMATIC OF SMPS CONVERTER

AC INPUT

RECTIFIER

SMPS

TRANSFORMER

HF RECTIFIER & FILTER

DC OUTPUT

13 March 2016
SMPS Advantage

☞ COMPACT & LIGHT
☞ HIGH EFFICIENCY
☞ LOW RIPPLE
☞ EXCELLENT REGULATION
☞ VERY WIDE INPUT VOLTAGE WINDOW (150-270V IN 1 PH)
☞ MODULAR & EASILY REPLACEABLE
☞ AT LEAST 40% LOWER COST COMPARED TO SCR CHARGERS
QUALITY ASSURANCE
Quality process begins from screening of raw materials till the packing of the finished goods.

ESI has predefined and streamlined QAP.

We have dedicated engineers at our QA lab.
We test each & every finished goods and issue routine test certificate

All the Test Instruments are calibrated in NABL accredited Laboratory

Product Type Tests are carried out at ERTL, National Test House and SAMEER
Salient Quality Features

- Magnetics are of class-F insulation and vacuum impregnated
- Transformers are tested as per IS2026/11171
- PCBs are soak tested at 65 deg C
- Current sensed fan cooling (redundant to AN)
- Enclosure with 2mm CRCA sheet metal
- Pretreatment in 8-tank process before painting
- Epoxy resin based powder coating
- Drawing, BOM, TC & WC are furnished with each Equipments

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Routine Inspection & Testing

- Enclosures are inspected both during fabrication as well as painting as per our internal QAP-ISO9001
- Transformers are tested as per IS2026/11171
- Continuous full load run is done for 8 hours to observe temperature rise (one from each lot/type)
Routine Electrical Tests are carried out on each Transformer for:

- Insulation resistance
- High Voltage Test
- No load current & loss
- Full load efficiency
- Output voltage regulation of both line & load
- Each transformer is tested for No load loss, Winding loss, Voltage ratio, High voltage & Insulation resistance
Routine Electrical Tests are carried out on each Battery Charger for:

- Insulation resistance
- Voltage/current regulation
- Test of load limiting feature
- Measurement of ripple
- Full load efficiency
- Test of protection circuits by fault simulation
- Test of change over & annunciation circuits
We would look forward to your association with us.

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Thank you