STATCON ENERGIAA

Inspire • Innovate • Implement

HBD SERIES

1- 10KVA/48V
1 PHASE

5-8 KVA/96V
1 PHASE

8-15 KVA/120V
1 PHASE

15-50 KVA/240V
1 PHASE

40-50 KVA/360V
1 PHASE

5-15 KVA/48V
3 PHASE

10-15KVA/120V
3 PHASE

15-100KVA/240V
3 PHASE

30-200KVA/360V
3 PHASE

125-250KVA/480V
3 PHASE

250 KVA/576V
3 PHASE

1P (1-50 KVA) & 3P (5-250 KVA) HYBRID MPPT PCUs

Genuine 'Hybrid' - Not just 'Off-Grid'

PRODUCT MANUAL

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Contents

1. NOTES ON THE MANUAL

1.1 SCOPE OF VALIDITY

This manual is an integral part of the PCU, and it describes the assembly, installation, commissioning, maintenance, and failure analysis/ troubleshooting of our hybrid inverters (HBD Series). List of inverters/PCUs for which this operation manual is valid have been mentioned in the list below. This manual is valid for HBD-NG inverters dispatched after 1st April 2021. This manual is not applicable for any other custom-built rating, client may contact manufacturer if they have custom-built rating PCUs.

SINGLE PHASE			
Sr. No.	Model	Sr. No.	Model
1	HBD-048-01K-1P	12	HBD-120-08K-1P
2	HBD-048-02K-1P	13	HBD-120-10K-1P
3	HBD-048-03K-1P	14	HBD-120-15K-1P
4	HBD-048-04K-1P	15	HBD-240-15K-1P
5	HBD-048-05K-1P	16	HBD-240-20K-1P
6	HBD-048-06K-1P	17	HBD-240-25K-1P
7	HBD-048-08K-1P	18	HBD-240-30K-1P
8	HBD-048-10K-1P	19	HBD-240-40K-1P
9	HBD-096-05K-1P	20	HBD-240-50K-1P
10	HBD-096-06K-1P	21	HBD-360-40K-1P
11	HBD-096-08K-1P	22	HBD-360-50K-1P

Table 1

THREE PHASE			
Sr. No.	Model	Sr. No.	Model
1	HBD-048-05K-3P	16	HBD-240-60K-3P
2	HBD-048-008K-3P	17	HBD-360-60K-3P
3	HBD-048-010K-3P	18	HBD-240-80K-3P
4	HBD-048-015K-3P	19	HBD-360-80K-3P
5	HBD-120-010K-3P	20	HBD-240-100K-3P
6	HBD-120-015K-3P	21	HBD-360-100K-3P
7	HBD-240-15K-3P	22	HBD-360-100K-3P
8	HBD-240-20K-3P	23	HBD-360-125K-3P

Sr. No.	Model	Sr. No.	Model
9	HBD-240-25K-3P	24	HBD-480-125K-3P
10	HBD-240-30K-3P	25	HBD-360-150K-3P
11	HBD-360-30K-3P	26	HBD-480-150K-3P
12	HBD-240-40K-3P	27	HBD-360-200K-3P
13	HBD-360-40K-3P	28	HBD-480-200K-3P
14	HBD-240-50K-3P	29	HBD-480-250K-3P
15	HBD-360-50K-3P	30	HBD-576-250K-3P
NOTE : This manual may be applicable for other models as well on selective basis. In case your model inverter is not mentioned in the above list, please contact manufacturer before using this manual.			

Table 2

Keep this manual close to the machine where it is easily accessible for the operator/ end-user.

1.2 TARGET AUDIENCE

The tasks described in this manual can be performed by qualified electricians or SEPL authorised electricians only. Also, they MUST follow the instructions in this manual for installation and troubleshooting, failing which, the warranty may be considered null and void in some cases.

1.3 SYMBOLS USED

Following symbols will be used throughout the manual wherever applicable:

	DANGER! "Danger" indicates a hazardous situation which, if avoided/neglected, will result in death or serious injury.		CAUTION! RISK OF ELECTRIC SHOCK! Machine is working on high voltage. Do not touch, it may burn or shock the nearest person.
	WARNING! "Warning" indicates a hazardous situation which could result in death or serious injury if neglected.		Caution!" indicates a hazardous situation which, if not followed, could result in minor or moderate injury.
	NOTE! "Note" provides tips that are valuable for the optimal operation of your product.		

VERSION: This manual is valid only for HBD-NG machines dispatched after 1st April 2021.

2. INTRODUCTION

2.1 PRODUCT DESCRIPTION

Smart Storage Solar Inverters (referred to as SSSI henceforth) are also known as HBD-NG range inverters. These machines are mechanically and electrically robust with a wide operating temperature range and hence, suitable for operation in harsh environments. These machines are a perfect fit for low maintenance, off-grid/ hybrid installations of industrial and residential nature both.

A typical block diagram is shown below in Figure 1 involving the integration of SOLAR, GRID, BATTERY and GENSETS with the site loads. Inbuilt intelligence manages all the sources selectively to provide seamless power to the loads so as incur minimum bills with optimum utilization. These HBD-NG range of inverters are available in both 1-phase and 3-phase versions under the series name of MONO-POWER and TRI-POWER respectively. MONO-POWER series has single-phase systems ranging from 1kVA to 50 kVA with same rating of MPPT charge controller in different battery voltage ranges.

Similarly, TRI-POWER series has 3-Phase inverters ranging from 10 kVA to 250 kVA in different battery voltage with same rating of MPPT charge controller. Kindly visit www.energiaa.in to know more about our products range. Custom-built ratings of inverters are also available on request and can be designed as per user requirement.

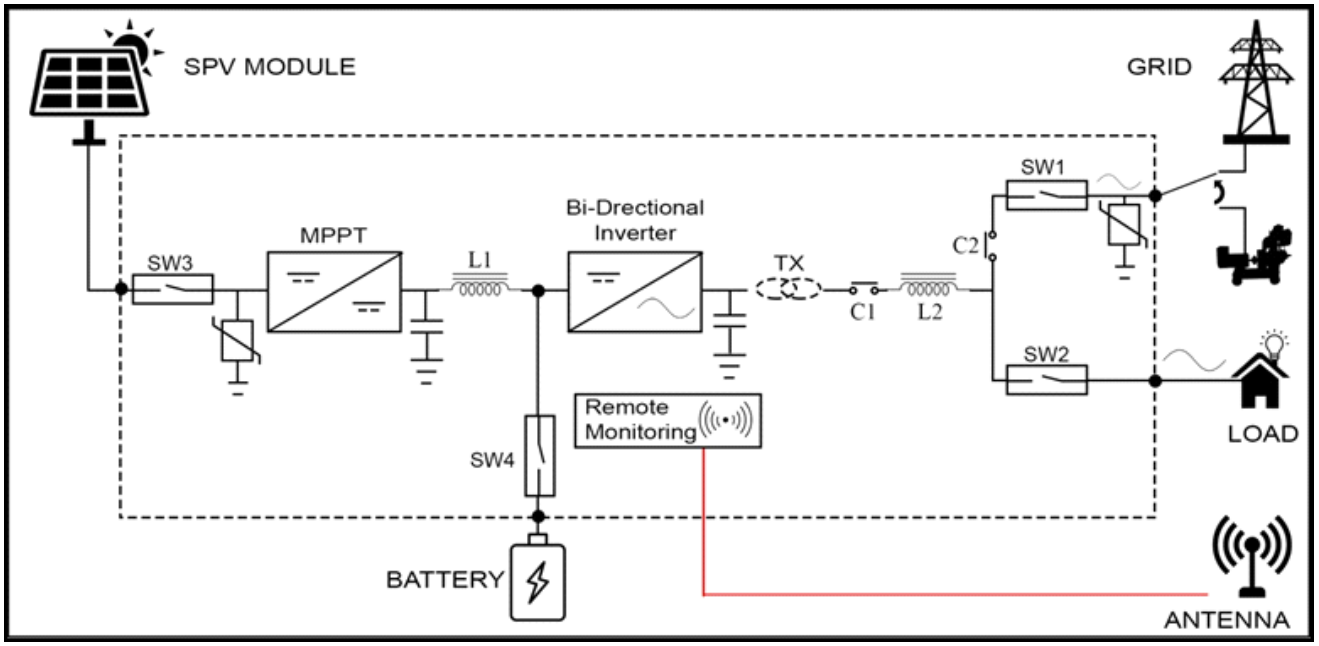

Figure 1

The SSSI can be broken down into 2 Parts – MPPT-based Solar Charge Controller and Bi-Directional Inverter. Both parts are explained in detail in the subsequent sections of this manual. On the DC side, dedicated terminals have been provided for PV and battery connections. Number of MPPT charge controllers depends on the rating of the system. Similarly, on the AC side dedicated terminals have been provided for connecting grid (EB or Mains) supply and the loads. All 4 terminations (2 on DC side and 2 on AC side) have isolators/ MCCBs for ease of operation and maintenance. All the loads connected at the load terminals will have seamless power with less than 5msec interruption time (in case of mode switching). Please be noted that either Grid supply or DG supply can be connected to the unit on AC side. Any kind of Mains/ DG changeover has to be made before the unit installation and is not in the scope of the PCU.

The sequence of power from Solar PV, Grid, DG and Battery depends on the mode of operation and has been discussed in detail later in this document. We will now discuss the key organs that comprise this HBD-NG range of Smart Storage Solar Inverters.

2.2 KEY ELEMENTS OF THE MACHINE

2.2.1 MPPT-BASED SOLAR CHARGE CONTROLLER

The unit has single/ multi MPPT-based Solar Charge Controllers to convert PV power into usable DC power as per battery and load requirements. The MPPT charger is buck type convertor such that PV voltage (under all circumstances) should be higher than the maximum battery voltage. Hence, the series-parallel arrangement of PV array is very critical for maximum power generation. The number of charge controllers depends on the rating of the system.

2.2.2 BI-DIRECTIONAL INVERTER

The heart of the system includes an Active-Front-End based Bi-directional inverter which can perform AC-DC as well as DC-AC conversion and also synchronize with Grid or DG set. The convertor can import/ export power from Grid/DG depending upon the mode of operation. Its 4-quadrant design ensures highest level of customization to perform charge/discharge functions.

The Bi-directional convertor can act as an inverter under normal mode of operation such that it converts PV and Battery power into 240V/ 415V AC 50Hz supply for the connected loads. The same convertor acts as a grid charger to charge the batteries using grid supply whenever required.

In case of three-phase systems, each phase is capable of delivering one-third power of the total inverter capacity. All the three phases have been designed for 100% power imbalance i.e., all the 3 phases need not be loaded equally for operation. This has been guaranteed using 3 independent circuits for the 3 phases and a 12 IGBT design which is perfect for imbalanced type of applications.

The inverter section has inbuilt galvanic isolation using power transformer of rated capacity which ensures rugged design under extremely fluctuating and impure grid conditions. It also provides isolation between the DC and AC sides.

2.2.3 AUTO BYPASS ARRANGEMENT

Auto Bypass Feature is an integrated part of this system such that no extra semi-conductor device is required to perform this function. Being an Active-Front-End Convertor, there is synchronization between Grid and Inverter Sine wave with a seamless transfer of power from inverter to grid with less than 5msec of changeover time. However, Anti-Islanding functionality from Grid has been achieved through an Anti-islanding Switchgear device as per IEC standards.

2.2.4 DISPLAY KEYPAD UNIT

The Display Keypad Unit (DKU) is the single point of interaction between the user and inverter. It consists of a blue colored graphical LCD, 8 push buttons and 3 LEDs in the form of stickers. DKU is used for settings change, parameter display, fault annunciation or any other indication in the machine.

2.2.5 REMOTE MONITORING SYSTEM (OPTIONAL)

HBD-NG range of inverters come with an option of Remote Monitoring System (RMS) depending upon the chosen model. For any inverter rating, three types of models are available with the suffix C00, C01 or C02, depending upon the type of communication. C00 model does not have any external communication, C01 comes with inbuilt MODBUS over RS485 communication, and C02 has GPRS based remote monitoring.

2.3 PRODUCT NOMENCLATURE

HBD-NG range of Smart Storage Solar Inverters has been named using a common nomenclature to avoid any confusion. Any part number (serial number) includes the capacity of inverter, no. of phases, battery voltage, charge controller capacity, number of charge controllers, monitoring type as well as the overload capacity. Please ensure that right from the ordering-stage to installation, reference is made to any unit using the correct part number. This part number is mentioned on datasheet, quotation, invoice, and also the actual unit post-dispatch. The warranty claim registration online also involves reference to this part number to avoid any confusion. A sample part number has been explained below for clarity:

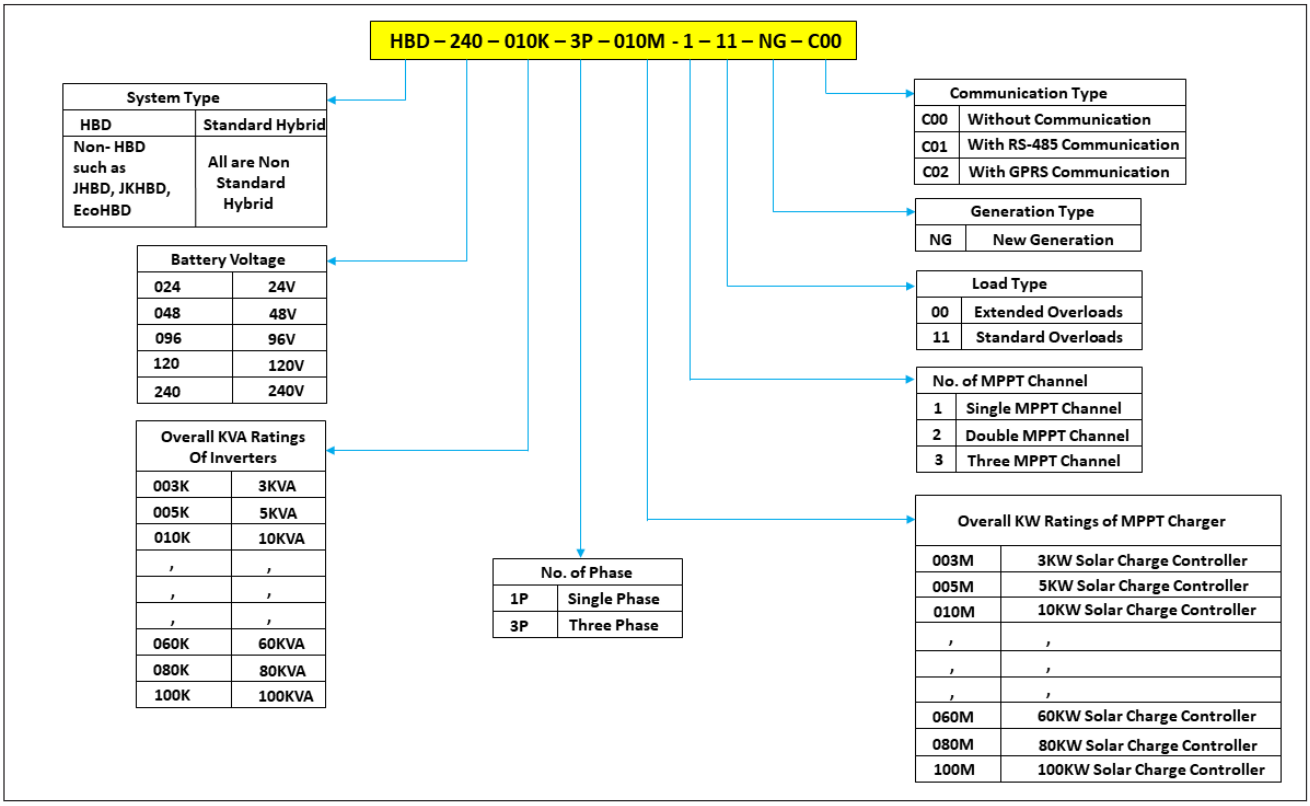

Figure 2

Note: Above nomenclature shall be valid only for Power Conditioning Unit/ Smart Storage Solar Inverter (SSSI)
(*) For HBD-NG series: As HBD-NG series is standard Power Conditioning Unit/ Smart Storage Solar Inverter, they are designed on Unit Power Factor, so kVA=kW;
(**) For Non-Standard ratings (other HBD such as JHBD, JKHBD etc.), PCU are designed on other Unity Power Factor, so kVA=kW. Inverter maximum output shall be mentioned on specs. Plate/Rating Sticker accordingly.

2.4 RATING PLATE/RATING STICKER AND ITS TERMS

For ease of usage, every HBD-NG inverter unit is provided with a rating sticker/ordering plate. This sticker can be found on the front side or the rear side of the unit depending upon the model number. It contains all the relevant technical details for ease of usage. The model no. and the serial no. are important for traceability of the unit throughout its life.

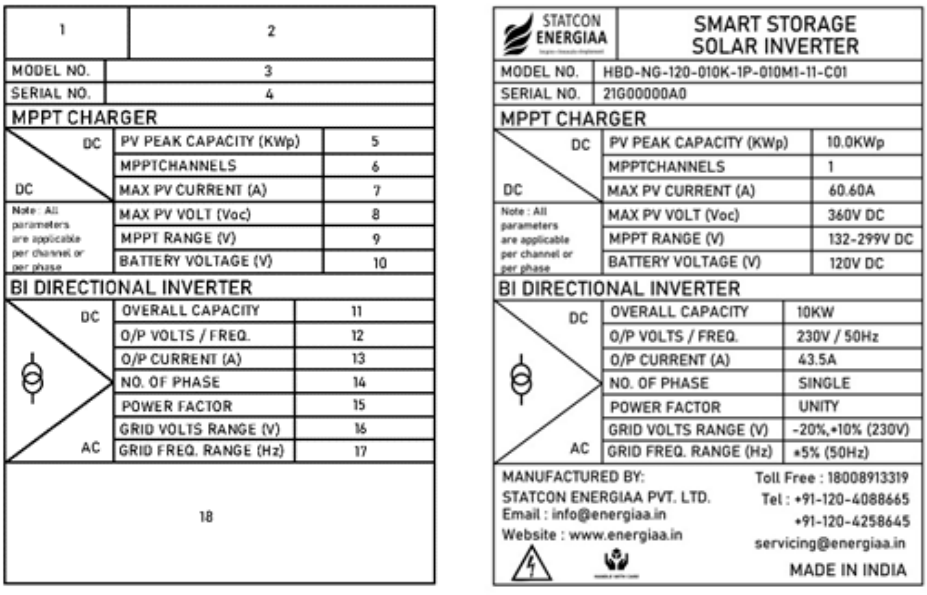

Figure 3

2.5 PHYSICAL APPEARANCE AND TERMINATION DETAILS OF INVERTERS

MONOPOWER/ TRIPOWER series of HBD-NG inverters come in sheet metal enclosures of standard sizes and color shades depending upon the size of the machine. Any machine may be either wall mounted type, tower type, floor standing, or hinged door type floor standing, depending upon the capacity of the machine. All the units are for indoor application only and should not be kept in the open. All these units are forced cooled until mentioned otherwise for any of the models supplied.

All the units have a common user interface provided on the front side of the panel for ease of access. The display unit has been explained in detail separately in this manual. All the wire connections to unit are made from the bottom side, either on the front or the rear side, depending upon the size of the machine. The terminology and sequence of terminals have been kept the same for as many models as possible for ease of understanding and has been explained below in detail.

The below chart brings out all the variants available in terms of dimensions and capacity of the machine. These machines come in 8 basic variants:

Sr. No.	Rating of Machine	Dimensions (W X D X H)	Enclosure Type	Colour Shade	Cable Entry	Wheels Available Y/N	Figure No.
1	1-3kVA Single-phase Inverters	300 X 428 X 334	Tower Type Floor Standing	RAL-9005	Rear Bottom	N	Figure-4
2	4-6kVA Single-phase Inverters	310 X 625 X 500	Tower Type Floor Standing	RAL7035/ RAL3020	Rear Bottom	N	Figure-5
3	10kVA-12.5kVA Single-phase Inverters	400X676.5X650	Sheet Metal, Floor Standing, Front/ Rear Door	RAL7035/ RAL3020	Front Bottom	N	Figure-6
4	10kVA-15kVA Three-phase/20kVA-25kVA Single-phase Inverters	530X897.4X750	Sheet Metal, Floor Standing, Front/ Rear Door	RAL7035/ RAL3020	Front Bottom	Y	Figure-7
5	20kVA-25kVA Three-phase Inverters	550X845X800	Sheet Metal, Floor Standing, Front/ Rear Door	RAL7035/ RAL3020	Front Bottom	Y	Figure-8
6	30kVA-40kVA Three-phase Inverters with Single/Three MPPT Charge Controller	650 X 965 X 900	Sheet Metal, Floor Standing, Front/ Rear Door	RAL7035/ RAL3020	Front Bottom	Y	Figure-9

Sr. No.	Rating of Machine	Dimensions (W X D X H)	Enclosure Type	Colour Shade	Cable Entry	Wheels Available Y/N	Views
7	50kVA-60kVA Three-phase Inverters with Single/ Three MPPT Charge Controller	850X1050X1650	Sheet Metal, Floor Standing, Front/ Rear Door	RAL7035/ RAL3020	Front Bottom	N	Figure-10
8	70kVA-100kVA Three-phase Inverters with Three MPPT Charge Controller	800 X 1050 X 1775	Sheet Metal, Floor Standing, Front/ Rear Door	RAL7035/ RAL3020	Front Bottom	N	Figure-11
9	Above 100kVA Three-phase Inverters with Three MPPT Charge Controller	2000X1400X1200	Sheet Metal, Floor Standing, Front/ Rear Door	RAL7035/ RAL3020	Front Bottom	N	Figure-12

Table 3

Please note that dimensions, weight, enclosure type, color shade and cable entry can be changed by the manufacturer without prior notice. This is due to technical innovations.

Now we go through the front and rear view of each of these variants in detail. The termination details of each of these variants are also provided in tabular form, after each variant drawing.

2.5.1 1kVA-3kVA SINGLE-PHASE INVERTER WITH SINGLE CHANNEL MPPT CHARGE CONTROLLER

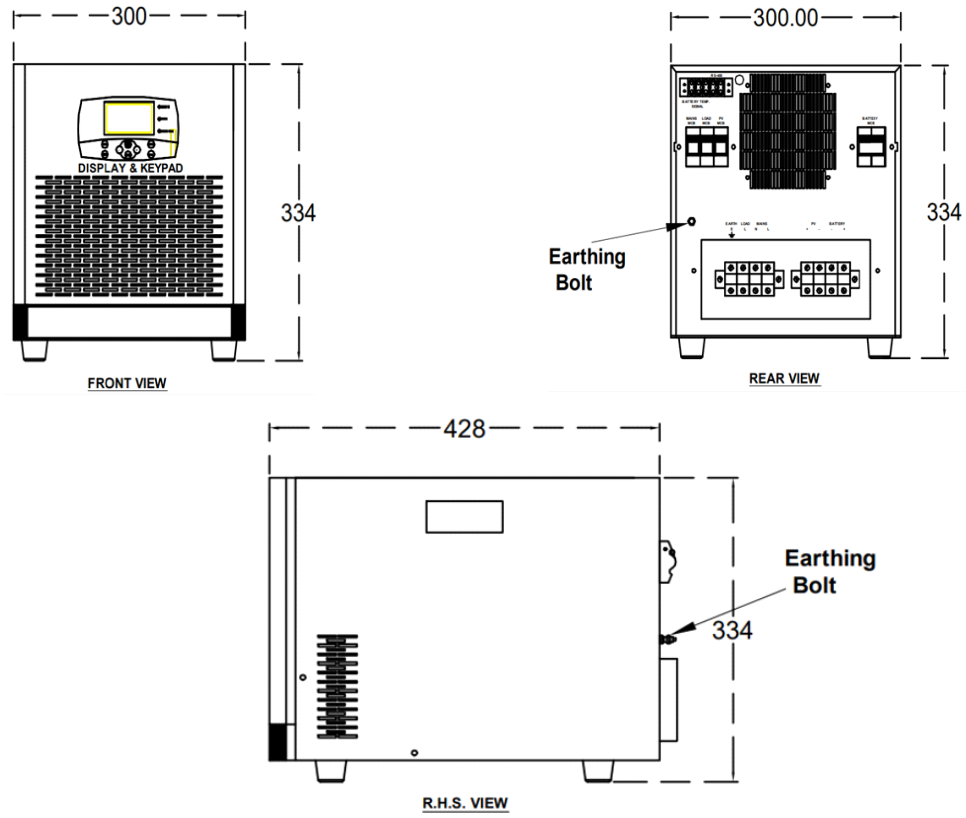

Figure 4

2.5.2 4kVA-6kVA SINGLE-PHASE INVERTER WITH SINGLE CHANNEL MPPT CHARGE CONTROLLER

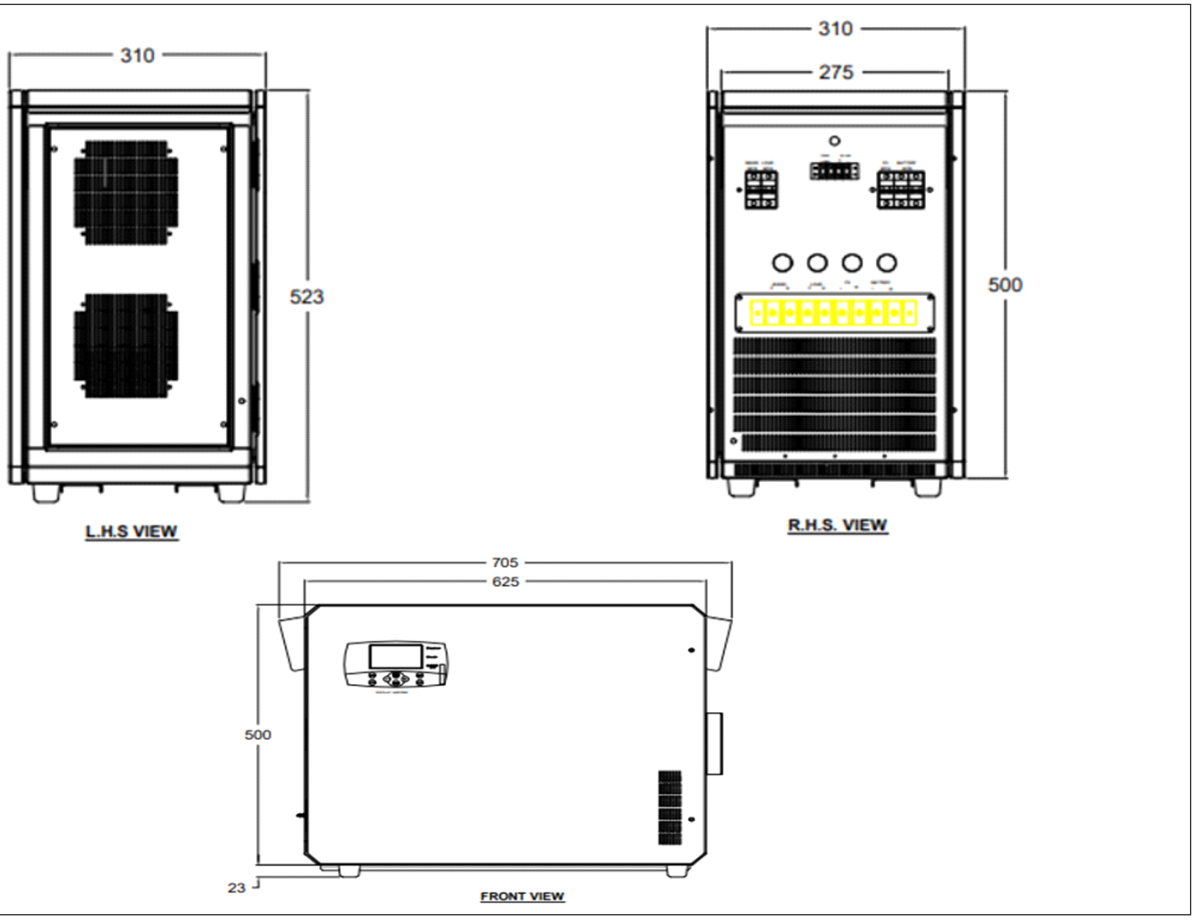

Figure 5

2.5.3 7.5kVA & 8kVA 10kVA-12.5kVA SINGLE-PHASE INVERTER WITH SINGLE CHANNEL MPPT CHARGE CONTROLLER

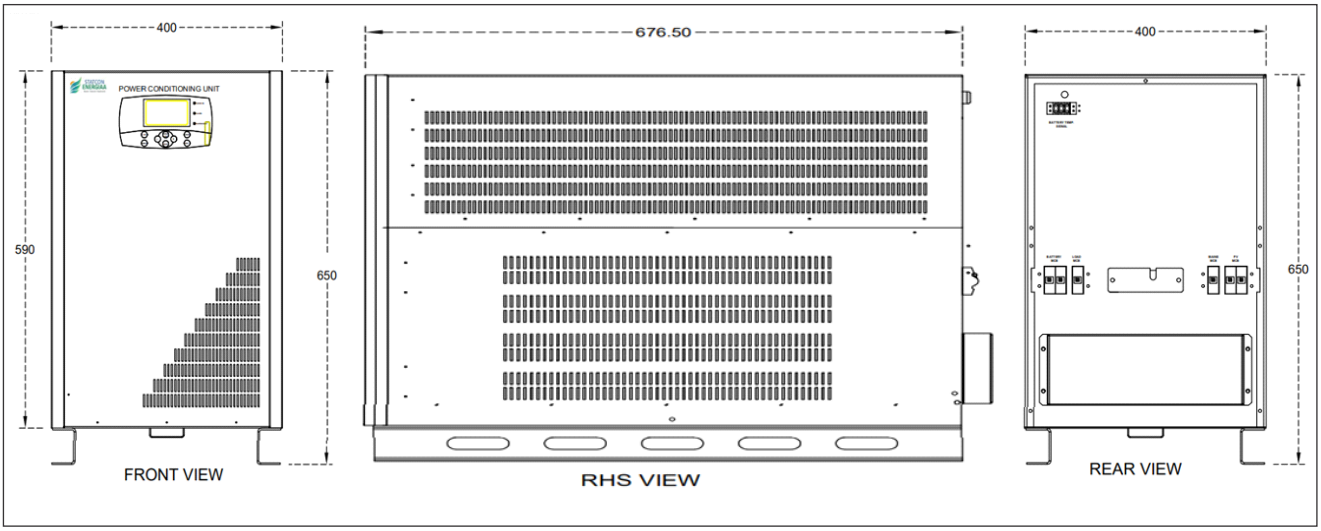

Figure 6

2.5.4 10kVA-15kVA SINGLE-PHASE/ THREE-PHASE INVERTER WITH SINGLE CHANNEL MPPT CHARGE CONTROLLER

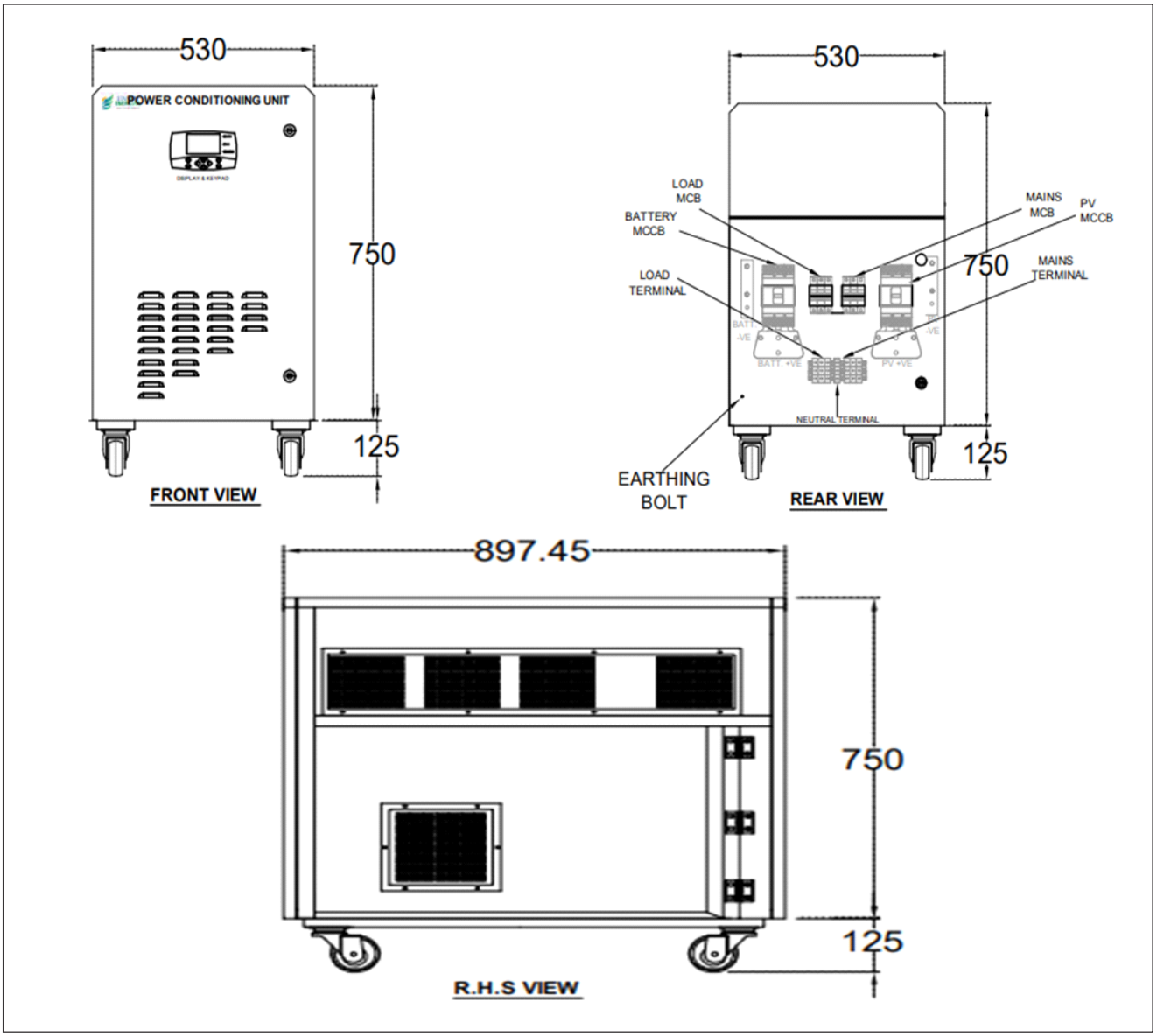

Figure 7

2.5.5 20kVA-25kVA SINGLE-PHASE INVERTER WITH SINGLE CHANNEL MPPT CHARGE CONTROLLER

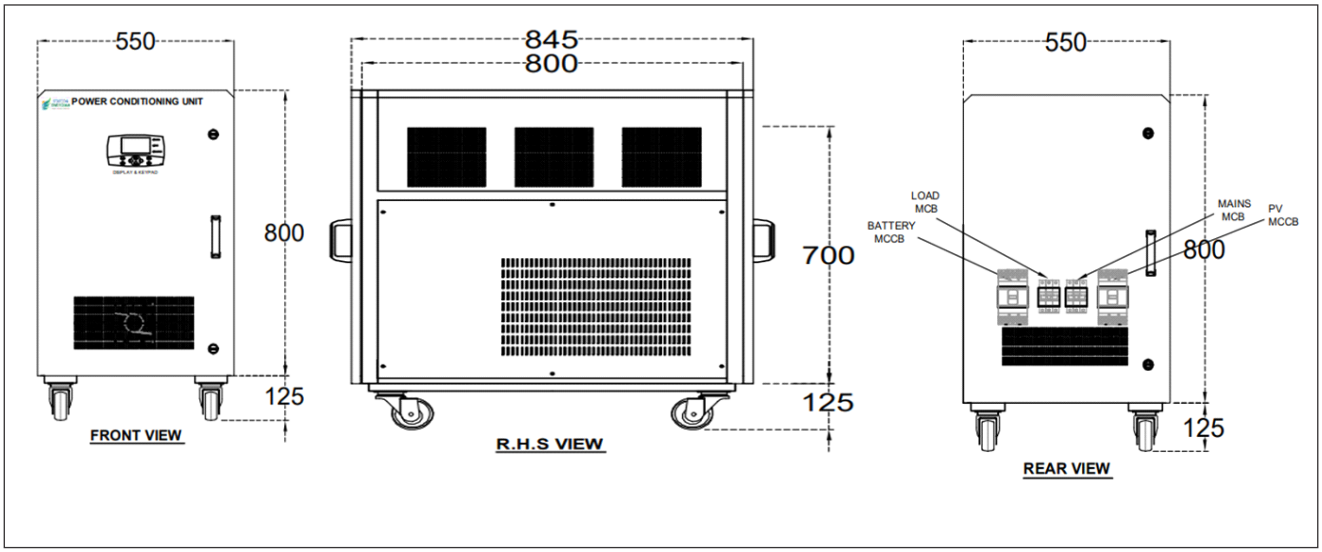

Figure 8

2.5.6 30kVA-40kVA SINGLE-PHASE/THREE-PHASE INVERTER WITH SINGLE MPPT CHARGE CONTROLLER

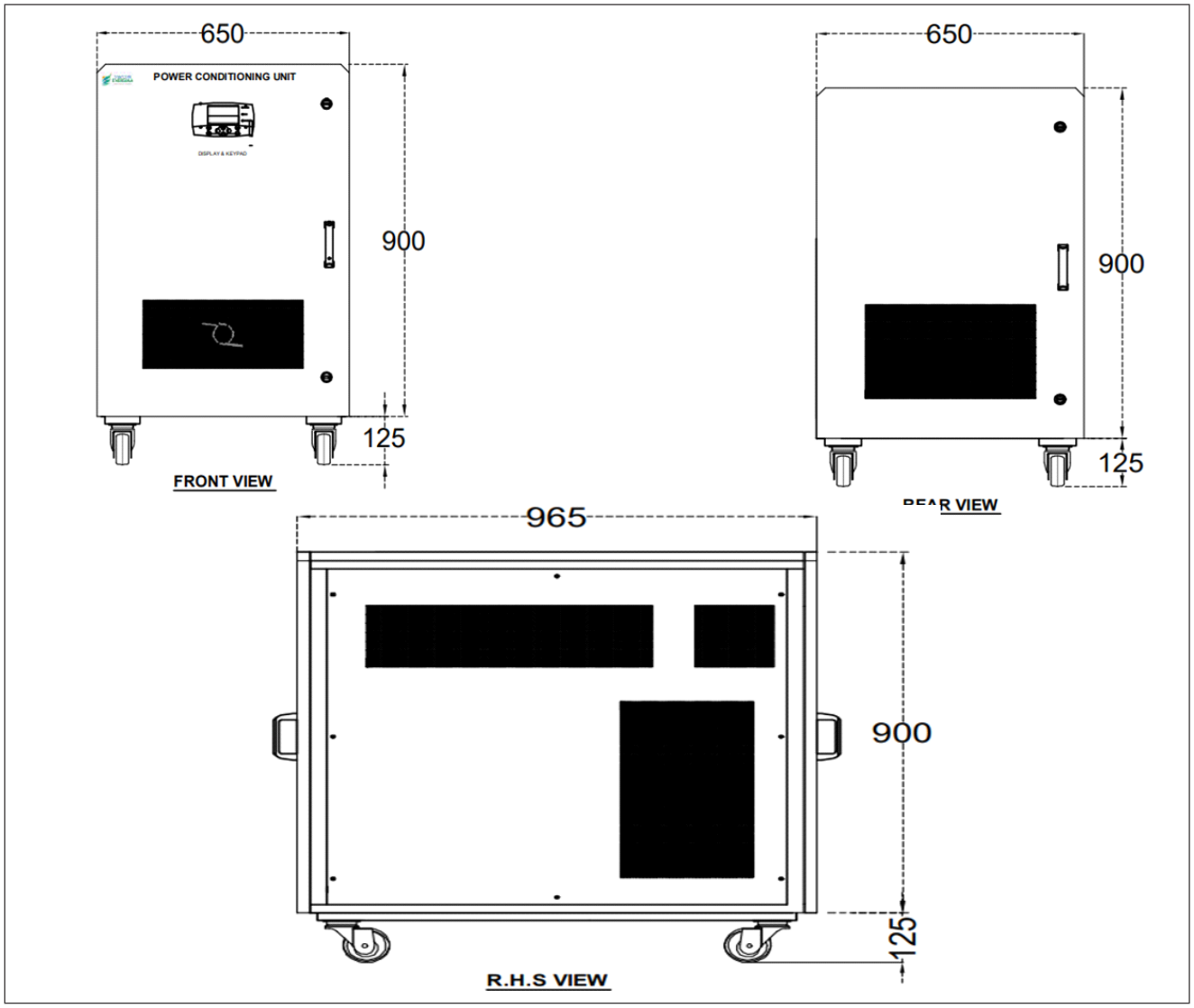

Figure 9

2.5.7 50kVA-60kVA SINGLE-PHASE/THREE-PHASE INVERTER WITH SINGLE/THREE MPPT CHARGE CONTROLLER

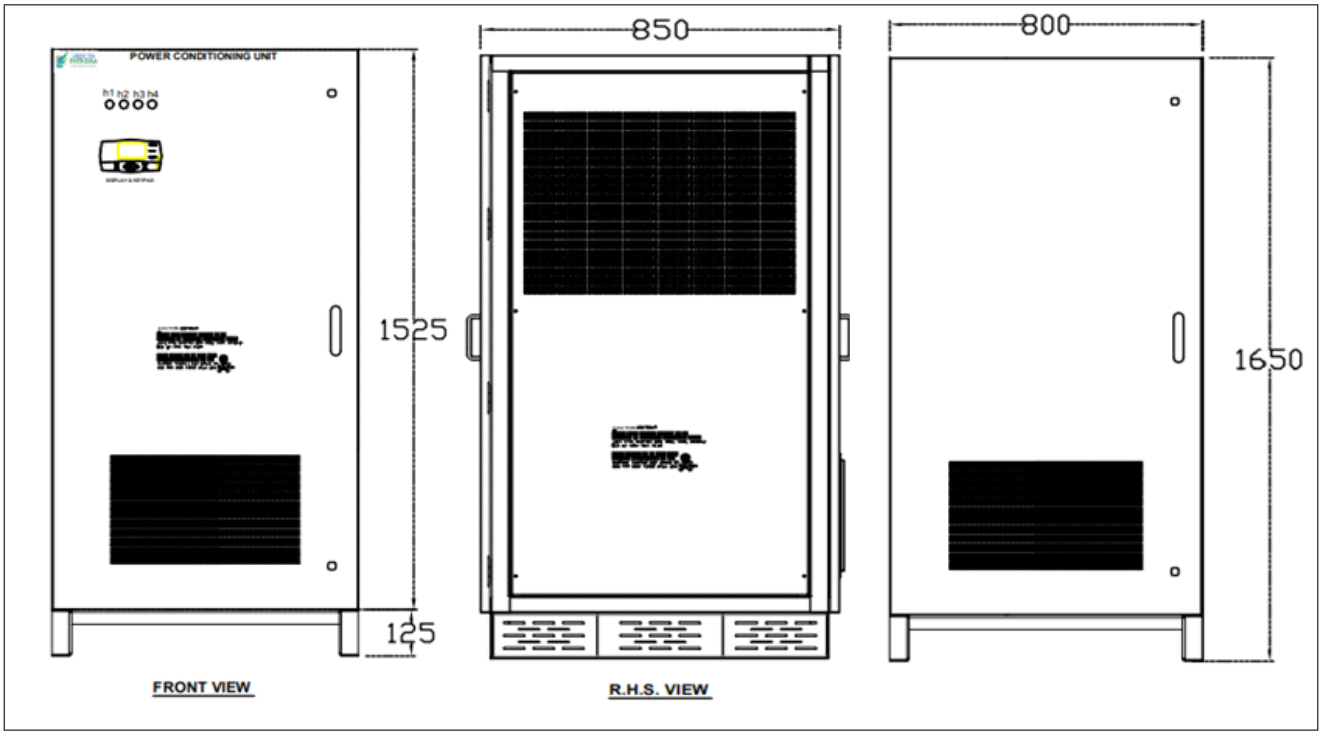

Figure 10

2.5.8 70kVA-100kVA THREE-PHASE INVERTER WITH SINGLE MPPT CHARGE CONTROLLER

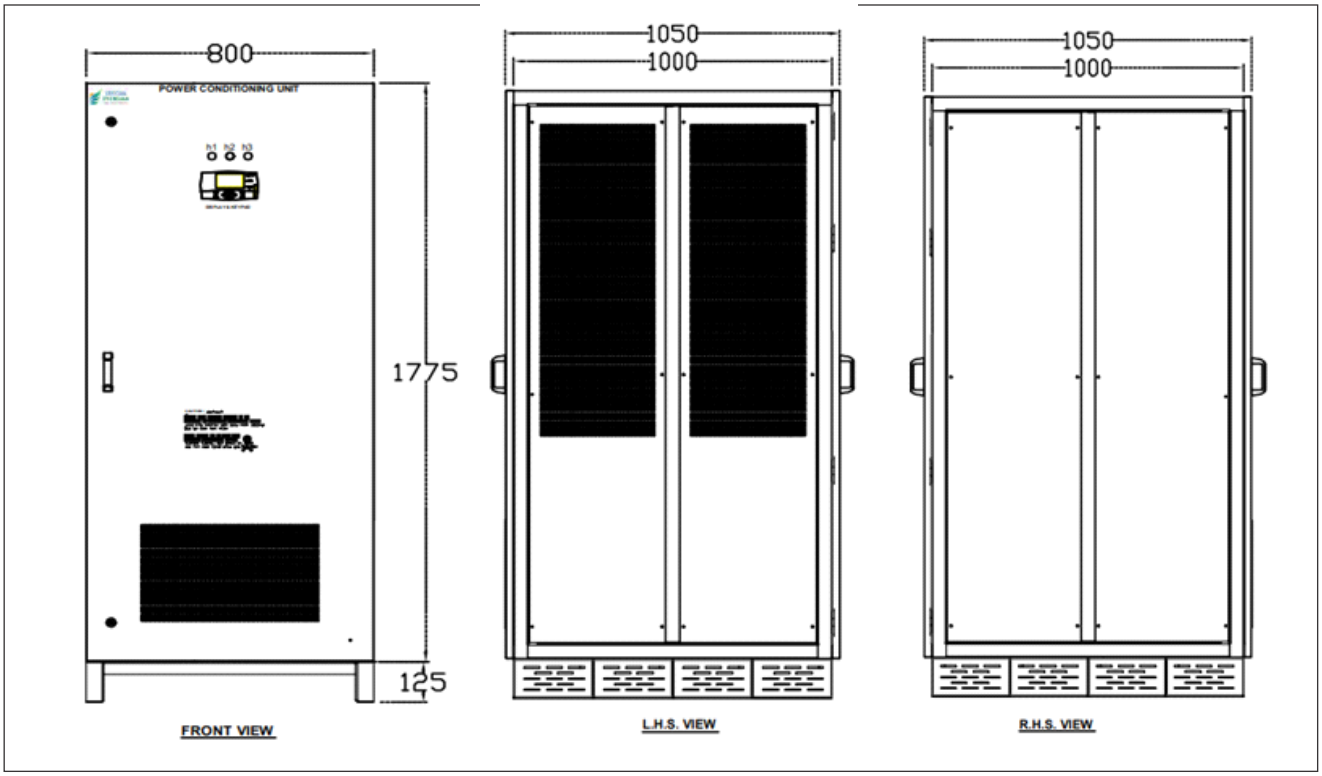

Figure 11

2.5.9 ABOVE THAN 100kVA THREE-PHASE INVERTER WITH THREE CHANNEL MPPT CHARGE CONTROLLER

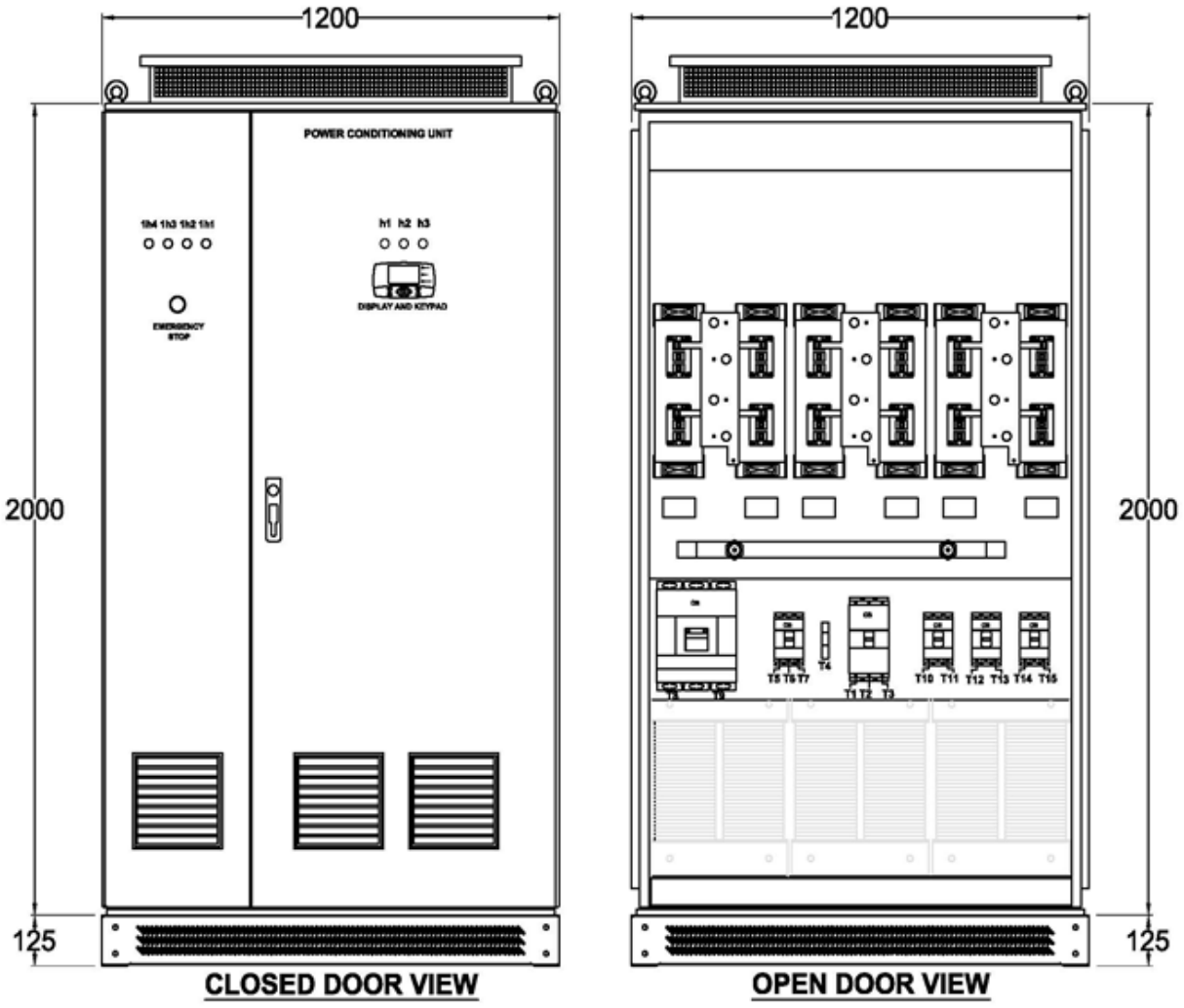

Figure 12

3. INSTALLATION

3.1 UNPACKING AND CONTENTS INSIDE

Precautions are mandatory to prevent any damage due to mishandling or water ingress. Manufacturer shall not be responsible for any such damage during transport, unloading or storage at site.

Please take a few moments to unpack your new HBD-NG range of Smart Storage Solar Inverter according to the Following steps:

1. Unpack the wooden packing carefully. Be careful as there may be sharp edges or nails. Ensure the unit does not incur any scratch during unpacking.
2. Use a crane to unload the machine in case of higher capacity machines. Proper lifting hooks have been provided to lift the machine using a crane as shown below (applicable for larger machines only).
3. Ensure the machine is always lifted vertically without tilting on any side to prevent any damage inside.
4. Check whether unloading or unpacking should be done first in case of large machines depending upon the condition.

Figure 13

5. Use always a forklift to move the inverters from one location to other location as shown in the figures above.
6. Ensure the unit is placed on a raised wooden pallet. It will ensure better cable entry through bottom and also give an increased level of insulation.
7. Verify the contents inside. It should include the SSSI unit, a hard copy of product manual for Installation and Commissioning which is also, and a warranty card. Please note that any extra accessories such as communication cable, mounting/ grouting hardware, or termination hardware, is a not a part of supply and is under the scope of customer or to be bought at extra cost.
8. Go through the rating plate/rating sticker and verify that the model no. matches the model no. that was ordered. In case of any issue related to model no. or rating, refer to the section 2 of this manual.
9. Please open the doors of the inverter to check there are no hanging wires/ connectors that may have resulted during the transport. This is just to be sure about the readiness of the unit before being powered up. In case something does not look okay, please contact the after sales/servicing department or your installer/dealer.

3.2 PLACEMENT AND LOCATION

Placement and location of the machine is very important for the machine and the plant both:

Following points should be kept in mind while placing this machine:

1. This machine has high voltages of both AC and DC nature inside and hence should be kept away from access of children, infants or pets. Proper caution marks should be displayed close by to avoid any accidental conditions. Location should be chosen accordingly.
2. This machine may be hot during operation and hence, its location should be such that any accidental, contact with it should be avoided.
3. The room where this machine is placed should be of stationary nature with firm walls, base and roof. It should be well ventilated with a proper mechanism of fresh air entry and exhaust. Air conditioned room will ensure a more reliable functioning of this machine.
4. Minimum clearances should be maintained on all four sides as per the given diagram below for ease of access. Ensure both front and rear door can easily be opened without obstruction. Sufficient space should be provided between the roof of the room and the top of this unit (atleast 2.5 feet). This is important to avoid creation of hot air column on top of the unit. Placing the PCU just below the solar panels will also damage the inverter, as the heat source is directly above it. Ventilation is mandatory.

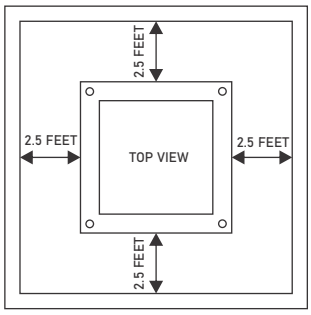

Figure 14

5. All the units have cable entry from bottom side. Proper route of cables should be envisaged before the placement of the machine. It is important that none of the wires are in tension or hinder the path of movement of people around.
6. The machine should be placed preferably on a raised platform for easy route of all incoming and outgoing cables. It is recommended also for better insulation from ground.
7. The surface used for placing the machine should be horizontal and level. Proper grouting of the panel is recommended on the holes provided on the base channels of this machine.
8. This machine is inflammable in nature and hence no high pressure items such as gas cylinders, gas pipe lines, sprays, hay etc should be close by. Please ensure presence of a fire extinguisher close by in case of emergency.

Figure 15

9. Once the machine has been firmly secured in its place, open the front and rear doors of the unit using the proper tool provided along with the machine (Optional). Remove the Silica Gel packets from inside (if any). Please check the fans for Silica Gel so that the running of fan is not hindered during operation.

3.3 WIRING PROCEDURES AND ROUTES

Before making any electrical connections to the machine, selection of wire gauge and wire type is very important. Any compromise with the wire selection will compromise with the efficiency as well as the safety of the plant. Proper color coding of cables is recommended as per IEC standards throughout the plant. However, the chart provided is only for assistance and no reference shall be made to it in case of any discrepancy later on.

Follow the procedure in below steps for making electrical connections.

1. All the connections to this machine are done through bottom cable entry only. Hence, no wires should be hanging. Proper routing of cables through trench is mandatory.
2. Open the front door and locate the gland plate at the front bottom surface of the machine. The gland plate will have several glands which can be loosened for cable entry.
3. Route all the cables through the bottom of the machine, through the glands and then into the machine.
4. Ensure too many cables are not clustered around the base or inside of the unit as it may hinder easy opening of the door when required.
5. Ensure that all the circuit breakers/ MCBs/ MCCBs/ Dis-connectors are in OFF position before any connections are made.
6. Locate the terminals provided for connecting the incoming cables. All the terminals are of bus bar type with ring type/ pin type connections. Information about the terminal sizes is part of the technical datasheet provided during ordering stage.
7. Connections of DC should be made first. In case of DC, always connect the negative first and then connect the positive side.
8. All cables should be routed through the gland located directly below that terminal. This is recommended for maintaining clearances between the cables. All the cables should be vertically aligned with their respective terminals.
9. Use proper stripping and crimping tool for the cable termination. Any loose connections or wrong hardware sizing issues may lead to lose contacts ultimately leading to fire hazards.
10. Once all the cables have been crimped properly, we can start making connections between the incoming cables and terminals.

- Refer to the figure as per enclosure as to locate the various terminals provided. A common sequence of terminals is provided in all the machines with same type of numbering.
- Always start with battery connections. Locate DC (-) terminal to make connections followed by DC (+) terminals.
- Now connect the PV (-) followed by PV (+) cables. There may be one or three nos. of MPPT chargers depending upon the capacity of system. In case of multi MPPT charger machine, repeat PV connection for all 3 MPPT sections.
- Connect the AC Line and neutral terminals now. In case of three-phase systems, ensure proper phase sequence is followed. Neutral should always be connected to Neutral terminal only.
- Lastly, connect the load terminals in proper sequence.
- Neutral of Grid and Neutral of Loads is connected to a common point to maintain the continuity of Neutral under all circumstances.

11. Use proper nut/ bolts/ washers for connecting the cables to the Terminals provided in the machine. Please be noted that use hardware of recommended sizes only. Proper contact is required between the cable, cable lugs and the terminals. Any issues may lead to heating of contacts ultimately leading to fire hazards.
12. All terminals provided are of copper material only. Hence lugs used should be of copper only for homogeneity of contact. In case of Aluminium cable, bimetallic lugs are mandatory.
13. Use proper spanners to tighten the nut/ bolts. Ensure that once tightened, all the lugs should be vertical. The conductors are carrying high currents and voltages; hence clearances between them should be maintained.
14. Double check all the connections for polarity and type to avoid any malfunction later on.
15. Double check the tightness of all the nut and bolts.
16. It is recommended to route AC and DC cables with some minimum clearances in between.

3.4 EARTHING OR GROUNDING THE MACHINE

Connecting the inverter machine to earth is not only recommended but mandatory to avoid any electrical shock as well as proper functioning of the electronics. The primary reason for earthing any equipment is to ensure that the chassis of the equipment is always at ground potential and there is no experience of shock in case of human contact. The same is valid of these inverters as well. All the inverters are provided with a proper connection point in form of an earth bus bar or a terminal. The location of this point may vary from inverter to inverter. Please note the below points with respect to the grounding of the equipment.

1. Hybrid inverters have an isolation transformer inbuilt and hence, can have a common AC side and DC side grounding.
2. Always ground the inverter using a minimum of 6mm^2 copper cables. Avoid using aluminum cable for grounding of inverters.
3. All the shields of shielded cables inside the machine are also connected to the same ground. It is important to ground these shields for the EMI/ EMC compatibility of the inverter.
4. SPD/MOV provided inside may not perform the intended function in case the inverters are not grounded properly.
5. The inverter ground should be connected to the earth potential of the site to which all the other appliances of the site are connected.
6. Inverter ground should not be connected to the PV structure ground or the lightning arrestor ground.

Avoid the contact with inverter if barefoot even if the machine is grounded properly. The body of the inverter may still be live with AC and DC voltages.

3.5 SURGE PROTECTION DEVICE (SPD)

- ✓ Surge Protections are a part of plant installations and hence, should be installed in addition to protections offered in PCU. Type and size of surge protections vary from site to site and adequate consultation should be done with a subject matter expert before selection of SPD.
- ✓ Apart from SPD in AJB used for solar panel protection, additional SPD is recommended before PCU inside the room.
- ✓ Suitable SPD on AC side (both Grid and Load) is mandatory inside the room before PCU to avoid any damage to it caused by surges. A typical such schematic drawing can be seen in figure below for single phase as well as three-phase PCU. An installer may contact some expert and use alternate scheme similar to this for reliable working of PCU and site.

See the images below for reference:

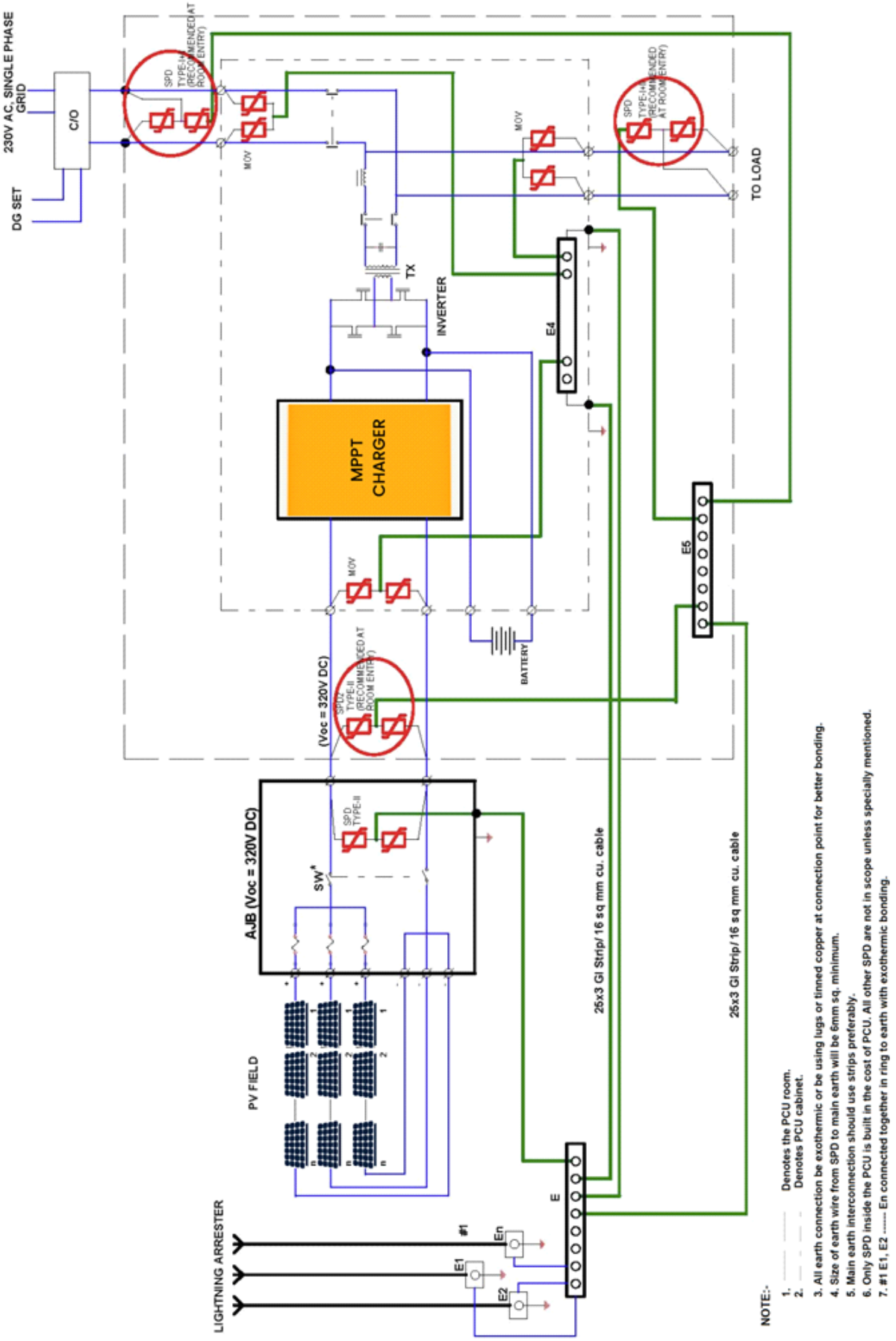

Figure 16

This image shows a typical single-line diagram showing use of SPD and earth connection thereof for single phase.

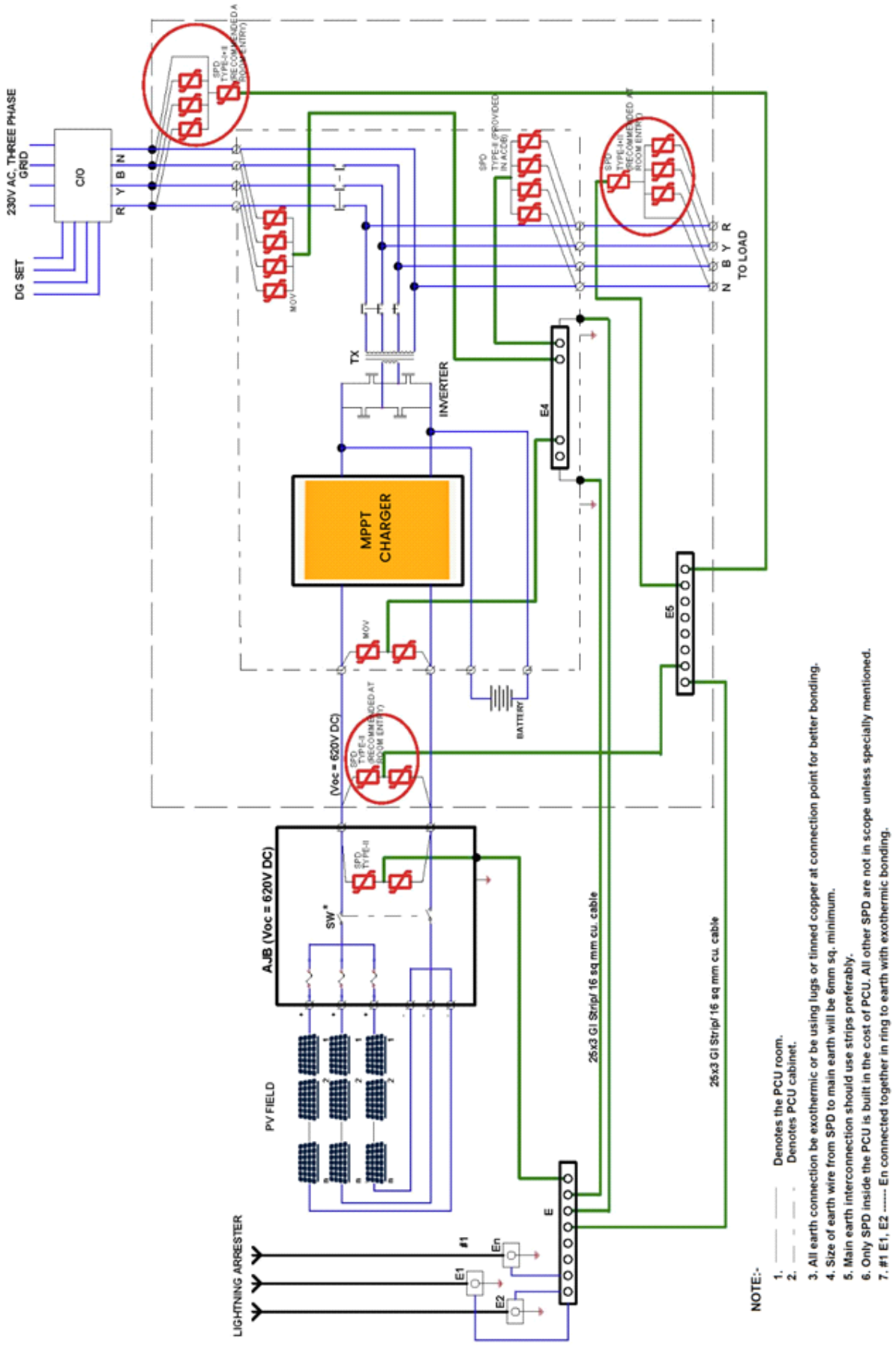

Figure 17

This image shows a typical single-line diagram showing use of SPD and earth connection thereof for three phase.

4. COMMISSIONING

Once the unit has been firmly secured and all the incoming/ outgoing cables properly connected, this machine is ready for being powered up. But before you start, please perform a couple of pre-checks which are mandatory:

4.1 PRECHECKS BEFORE ENERGIZING

Now the unit is ready to be turned on, but to be double sure, please perform the following couple of checks:

- Body machine should be firmly connected to building earth.
- Check the battery connections – both positive and negative cables should be tight.
- Check the polarity of the connections visually or preferably through a multimeter.
- Check the value of battery voltage – it should match the nominal battery voltage mentioned on the rating sticker of this machine.
- In case of discrepancy in any of the above, rectify it or refer to the troubleshooting manual.

4.2 ENERGIZING THE MACHINE FOR THE FIRST TIME

Turn on the battery breaker. With a pause of 1 second, the machine should become live. There should be a sound of contactor, and the display should light up with, possibly, a buzzer sound.

Ensure that all the other circuit breakers (PV, Load and Grid) are in OFF position only.

Before proceeding further to energize the loads, please ensure that the settings in the machine supplied are correct to suit the site conditions. Please be noted that these machines are supplied with default settings and hence, may or may not suit your requirements. The default settings are a part of this manual and discussed in the following sections.

To change any kind of settings of this machine, the user needs to interact with the Display Keypad Unit (DKU) provided on the front side of this machine. In case you are not familiar with the DKU unit, please refer to Section 5 before moving forward. Understanding the DKU unit is an essential part of the Installation and Commissioning.

4.3 SETTINGS UPLOAD

We hope that you have made yourself familiar with the DKU to feed the settings as per your requirements into the machine.

HBD-NG range of inverters are supplied with standard factory settings. These settings may or may not suit the site conditions and hence, need to be updated as per the actual site specifications. Some of the reasons why settings need to be updated and verified are as follows:

- What is the Battery Type and the Battery Ah connected?
- What are the Float, Boost and Bulk Voltage settings of the Battery connected?
- What is the Mode of Operation required – Off-Grid, Hybrid or Hybrid with Export enabled?
- When do you want to connect and disconnect the Grid supply?
- If required, how much power do you want to export?
- Do you want to set any scheduled events?

To implement the change of settings, we need to follow the below procedure in the same order:

I. Turn on the battery circuit breaker so that the unit is powered up. Ensure all the other circuit breakers – PV, Grid and load are strictly in OFF condition.
II. The display unit should be live with an active buzzer sound. Use the mute button to deactivate the buzzer sound.
III. First, update the time and date, and then press the Reset button to arrive at the home page (refer to Section 5 about the DKU, and Section 5.3 for the date and time settings procedure).
IV. Next step is to update the settings depending upon the battery type connected to this machine. So select the correct chart given below depending upon your battery type.
V. Next step is to access the DKU unit and change the battery settings inside to suit your system and depending on the battery type (for general battery settings)
VI. Press back button to Save and Exit the settings once all the changes have been made. Double check that the change of settings made has been correctly updated by reentering the settings MENU. Warranty shall be void in case there is a mismatch in the settings parameters from the actual site and the manufacturer shall not be held responsible for that.
VII. Turn off the battery circuit breaker and wait for 2 minutes for the unit to completely turn off. Restart the unit by turning the Battery Circuit breaker ON again.

4.4 POWER UP AND LOAD TRANSFER

The unit is now ready for use. All the power sources – Battery, PV and Grid – can now be used to provide seamless power to the connected loads in the following manner:

I. Turn on the battery Circuit Breaker. The unit should power up within 1-2 seconds and the display should come up. Use the front display-keypad panel to view the battery voltage and other relevant parameters. Ensure that the battery is in charged condition.

II. Within 15 seconds the inverter should start providing AC 230V/ 400V output on the load terminals. The load circuit breaker should be in OFF condition at this moment.

III. Ensure that initially only a couple of loads such as bulbs/ CFL etc. are connected. Turn on the Load circuit breaker and check that the connected loads are getting powered up. Check the display panel for the same. Now, increase the loads one by one up to a maximum load of the capacity of inverter.

IV. Turn on the PV Circuit Breaker. Ensure PV power is available during this time. Also ensure that the PV series-parallel configuration is as recommended by the inverter manufacturer. Refer to Appendix 3 for more guidance. Ensure PV panels are clean for better generation.

V. Use a clamp meter to measure the PV current and PV Voltage. Check the PV parameters on the DC kWH meter provided separately.

VI. Next step is synchronizing the inverter with the Grid/ Mains. Check the Grid supply for voltage and frequency. It should be within the permissible range mentioned on the datasheet or specs. plate/rating sticker.

VII. Turn on the Grid circuit Breaker. Wait for 15 seconds.

VIII. Grid contactor will come up with a thud sound and grid will get synchronized to the inverter. Check the mimic page of display unit to see the grid synchronized with inverter output.

IX. The machine is now connected to all the power sources and the loads connected are getting powered up. The sequence of operation will depend on the mode selected. To know more about the modes of operation read Section-7 of this manual.

X. It is recommended to keep all circuit breakers in ON position normally. The machine is intelligent enough to use the power sources only if required.

5. DISPLAY KEYPAD UNIT

This DKU has been provided on the front facing side of all machines for easy access. The graphical display is responsive to the keypad and all the scrolling, settings change and fault viewing can be done using the correct combination of these pushbuttons.

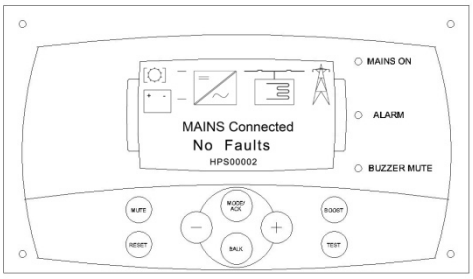

Figure 18

Disclaimer:- Due to technical innovation LCD display design or look of the PCU system can be changed by manufacturer.

Before moving forward let's go through the functions of various pushbuttons provided.

5.1 BUTTON DEFINITION

MUTE	Mute Active Alarm
MODE	Acknowledge Alarms/ Scroll to Next Display Screen
BACK	Previous Display Screen/ Move out of Sub Menu
PLUS	Increase Parameter Value/ Turn On System (if pressed for >3 sec.)
MINUS	Decrease Parameter Value/ Turn Off System (if pressed for >3 sec.)
BOOST	For internal use
TEST	For internal use
RESET	Turn off Alarm Mute/ Clear Fault/ Latch Reset Battery.
MODE+PLUS+MINUS (Press to gether for 5 seconds)	Enter Factory Settings

Table 4

5.2 DKU LED DESCRIPTION

Lable	Indications	Meanings
Mains ON	Green	Green: Mains voltage is present within acceptable limits.
Alarm	Red	No Flash: Normal condition. Red: Abnormal condition occurs. Note: Light will flash on, and a buzzer will sound. The operator can acknowledge new alarms by pressing the MODE/ACK key. The light will then remain lit until the fault has cleared, and the RESET key has been pressed to clear the latched alarms. See Appendix-1 “Display fault Analysis “for details.
Buzzer Mute	Yellow	Yellow: It lit up when the MUTE key has been pressed, indicates that the alarm is silent. Note: The muting function will cancel by itself after 24 hours, or it may be manually cancelled by pressing the RESET key.

Table 5

HOW TO IMPLEMENT OPERATIONS USING DISPLAY KEYPAD UNIT

All the operations, settings change and parameter viewing on display are performed using pushbuttons or a combination of pushbuttons. In this section, we describe some of the events that can be performed using the pushbutton keys provided on the DKU. Some of these operations include:

- Date and Time settings
- Scrolling through the various screens
- Turning ON and Turn OFF the inverter unit
- Resetting the unit in case of fault occurrence
- Change of settings

5.3 DATE AND TIME SETTINGS

To set date and time press MODE/ACK button for 10sec. A new window will be opened. Then use Mode/ACK to move next and +/- to increment and decrement. Now set the date, time, year, and hour, minute and second one by one and then accept the changes using RESET button until the display starts showing the Home Page or the Mimic page. These settings can also be changed using the Test Software only if you have been authorized or trained with its usage.

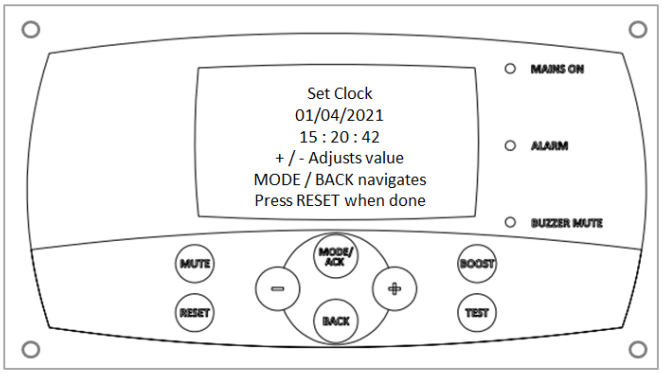

Figure 19

5.4 SCROLLING PAGES

There are a total of 12 standard display screens of the DKU displaying the various parameters of the machine. These pages have been segregated in a manner such that all the similar parameters have been displayed on a single page.

The active screen can be changed by pressing the MODE key to advance a screen and the BACK key to go back a screen. We would now explain each of the screens in details along with all the fields on any of the screen and how to toggle between various parameters on a single screen. We would start from the HOME PAGE or the MIMIC PAGE:

5.4.1 HOME PAGE

Home Page/ Mimic Page is the first page that appears after booting up of the system. It basically consists of a Mimic Single Line Diagram along with a few text lines below it.

The Mimic shows the basic circuitry and its various elements. There are arrows and dashed lines to show which of the Power sources is being used at any moment of time. On the DC side there are PV and Battery and depending upon the usage of these, arrows keep charging direction. On the AC side, there are 2 relay contacts near the Grid and the inverter output. So, the status of one of the lines shows whether the grid supply connected is available/ being used or not. The second arrow on the inverter output side disappears only when the inverter is faulty, and loads are bypassed to the grid supply (if available). The detailing of the Mimic diagram has been explained in detail in the image below:

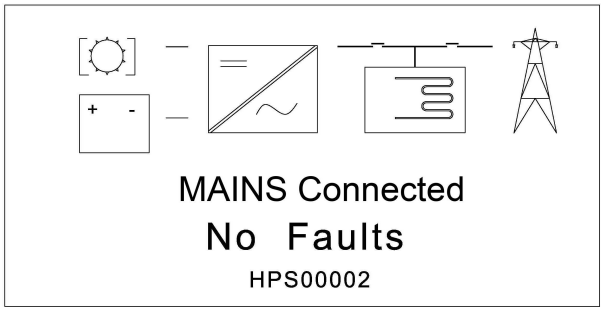

Figure 20

Basically, Mimic have three 3 lines, each of which has a specific set of data.

- The first line shows the mode of operation in which the machine is at that moment of time. The operations are mains connected, anti-islanding, standalone, boost charging, float charge, bulk charge, charge absorption, Invrt + Sync and System off. The details and understanding of all these modes have been explained later on.
- The 2nd line talks about the existing/ latched faults, if any. All the possible faults have been explained later in Appendix 1. See Appendix-1 for possible faults and their troubleshooting, otherwise it will declare that there are no faults in the system.
- The 3rd line talks about the firmware version that has been uploaded in this machine. It is relevant if the manufacturer recommends any update to the machine.

The overall Home Screen looks something as below:

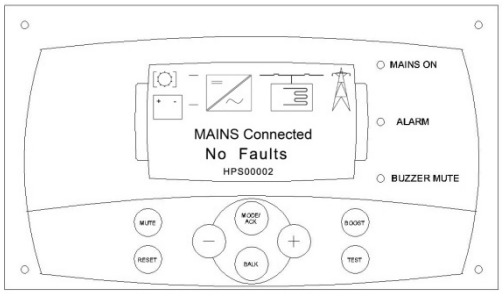

Figure 21

5.4.2 BATTERY AND PV STATUS SCREEN

This screen mainly displays the DC side parameters most of them Battery Parameters. This includes Battery Voltage, Battery Current (with sign), Solar Voltage and Solar Amps. Given figure along with the chart explains this.

The location of each of the parameters in detail:

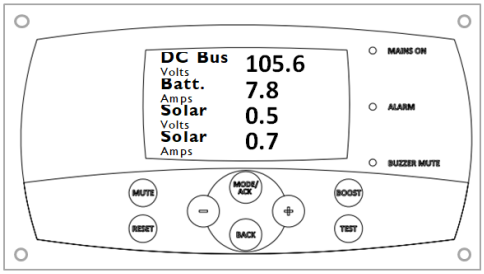

Figure 22 : BATTERY AND PV STATUS SCREEN

LABEL	SAMPLE VALUE	TEXT DISPLAYED	INFERRED PARAMETERS
B.1	105.6	DC Bus volt	Battery Instantaneous Voltage
B.2	7.8	Batt. Amps	Total current from or into the batteries (positive value indicates batteries discharging)
B.3	0.5	Solar Volts	Voltage supplied by the solar panels
B.4	0.7	Solar Amps	Current being delivered by solar charge controller
# Press +/- to check the current drawn by other MPPT channels, if they are available			

Table 6

5.4.3 TEMPERATURE STATUS SCREEN

This screen displays the temperature values of various parts of the machine. This includes the Heat Sink temperature close to each IGBT, Battery Temperature and temperature of the MPPT section device. In case of 3 phase inverters, parameters of all 3 phases are available on this screen only. Toggle using +/- buttons for other phases.

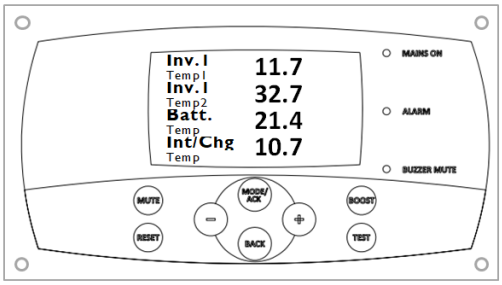

Figure 23 : TEMPERATURE STATUS SCREEN

LABEL	SAMPLE VALUE	TEXT DISPLAYED	INFERRED PARAMETERS
C.1	11.7	Inv.1 Temp1	Indicating temperature of 1st switching device of Inverter's R-Phase
C.2	32.7	Inv.1 Temp2	Indicating temperature of 2nd switching device of Inverter's R-Phase.
C.3	21.4	Batt. Temp	Indicates Battery temperature.
C.4	10.7	Int/chg1 Temp	Temperature of MPPT section.
#Press +/- to check the temperature of switch device using in Y and B phase, if they are available.			

Table 7

5.4.4 AC PARAMETERS (PHASE-NEUTRAL)

This screen displays all the AC side parameters in Phase to Neutral format. This includes Inverter Voltage (P-N), Inverter Frequency, Grid Voltage (P-N) and Grid Frequency. Default values are for master phase, Press ± to see parameter and other 2 phases in care and 3 phase systems.

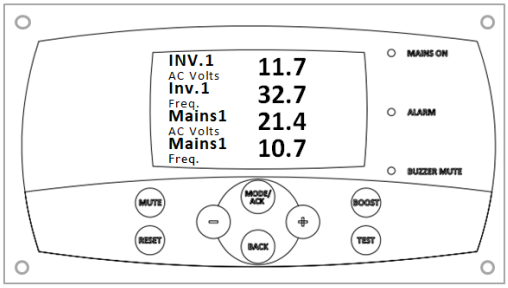

Figure 24 : AC PARAMETERS (PHASE-NEUTRAL)

LABEL	SAMPLE VALUE	TEXT DISPLAYED	INFERRED PARAMETERS
D.1	11.7	Invert.1 AC Volts	R-Phase (Inverter) voltage with respect to neutral
D.2	32.7	Invert.1 Freq	R-Phase (Inverter) frequency
D.3	21.4	Mains1 AC Volts	R-Phase (Mains) voltage with respect to neutral
D.4	10.7	Mains1 Freq	R-Phase (Mains) frequency
# Press +/-to check the voltage and frequency of other phases, if they are available			

Table 8

5.4.5 LINE TO LINE PARAMETER STATUS

Inverter and Mains phase to phase voltage appears on the same screen but on alternate cycle.

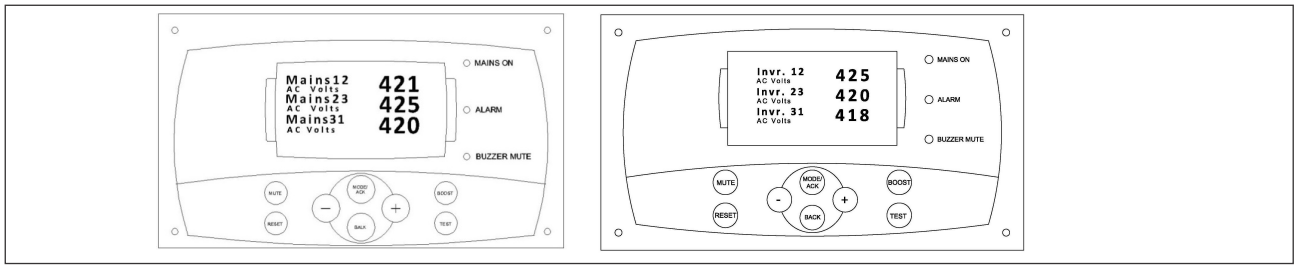

Figure 25

LABEL	SAMPLE VALUE	TEXT DISPLAYED	INFERRED PARAMETERS
E.1	425	Invr.12 AC Volts	Inverter Voltage between R-Y Phase
E.2	420	Invr.23 AC Volts	Inverter Voltage between Y-B Phase
E.3	418	Invr.31 AC Volts	Inverter Voltage between B-R Phase
E.4	421	Mains12 AC Volts	Mains/Grid Voltage between R-Y Phase
E.5	425	Mains23 AC Volts	Mains/Grid Voltage between Y-B Phase
E.6	420	Mains31 AC Volts	Mains/Grid Voltage between B-R Phase

Table 9

5.4.6 CURRENT SCREEN

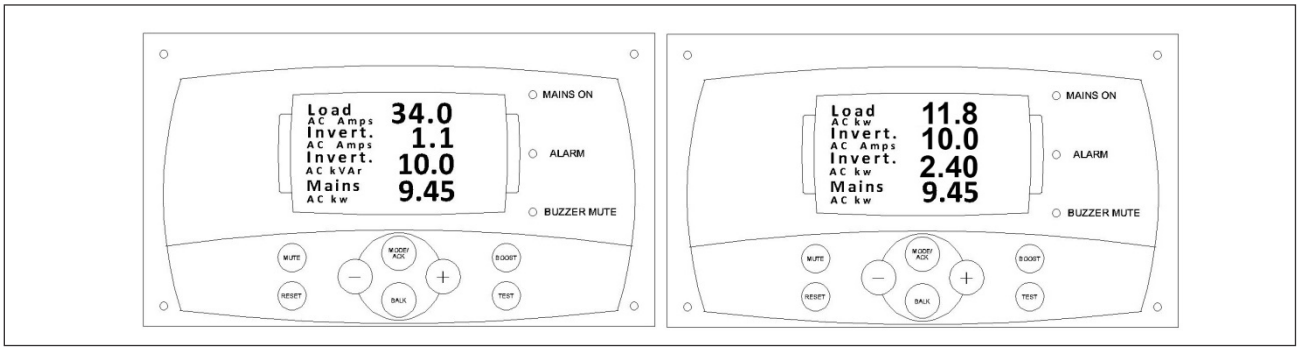

Figure 26

LABEL	SAMPLE VALUE	TEXT DISPLAYED	INFERRED PARAMETERS
F.1	34	Load AC Amps	Total current consumed by load from inverter as well as grid
F.2	1.1	Invert. AC Amps	Current delivered by inverter section
F.3	10	Invert. AC kVAR	Inverter reactive power for each phase
F.4	9.45	Mains AC kw	Total power delivered by Grid
F.5	0.94	Load AC kw	Total power consumed by load
F.6	2.40	Invert. AC kw	Total power delivered by Inverter section

Table 10

5.4.7 POWER SCREEN

This screen shows summation of load maximum power, load Avg kW, mains maximum kW, mains avg kW and PF of load and mains. It will show PF and maximum kW on same line but at alternate time.

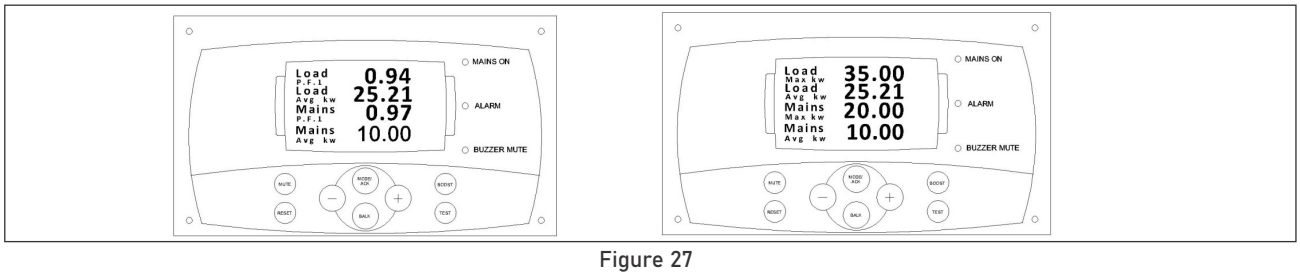

Figure 27

LABEL	SAMPLE VALUE	TEXT DISPLAYED	INFERRED PARAMETERS
G.1	35	Load Max kw	Maximum overall kW load running on three-phase.
G.2	25.21	Load Avg kw	Average load running on all three phases, and it updates in every 5 Minutes
G.3	20	Mains Max kw	Maximum kW Power is drawing from Grid/Mains.
G.4	10	Mains Avg kw	R-Phase (Mains) frequency.
G.5	0.94	Load P.F.1	Load power factor
G.6	0.97	Mains P.F.1	Mains power factor
G.7	10	Mains Avg kw	Average power delivered/taken from Grid by three phases. It will update in every 5 minutes

Table 11

5.4.8 GENERATION SCREEN

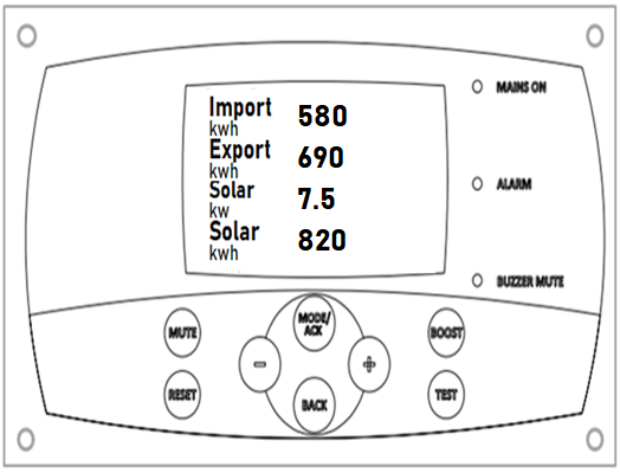

Figure 28

LABEL	SAMPLE VALUE	TEXT DISPLAYED	INFERRED PARAMETERS
H.1	580	Import kwh	Total Energy consumed from Mains/Grid
H.2	690	Export kwh	Total Energy delivered by Inverter to Load/Grid
H.3	7.5	Solar kw	Power delivered by solar charge controller
H.4	820	Solar kwh	Total energy delivered by solar

Table 12

5.4.9 SOLAR GENERATION GRAPH

The Figure shows the Solar Generation Graph and the Carbon dioxide (CO_2) saved as per solar generation.

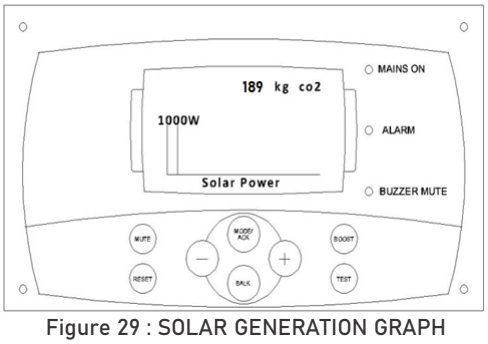

Figure 29 : SOLAR GENERATION GRAPH

LABEL	SAMPLE VALUE	TEXT DISPLAYED	INFERRED PARAMETERS
I.1	Solar Generation Graph	Import kwh	This graph shows the time-wise solar generation
I.2	CO2 Saved	Export kwh	This shows saved CO_2

Table 13

5.5.0 TURN ON AND TURN OFF THE INVERTER UNIT

Whenever any of the stable sources of power is turned on (i.e., battery or grid), the DKU immediately powers up. In case the battery is ON, the inverter mode starts with a time delay of 15 seconds. In case only the grid is on, then grid contactor connects to the load (in Bypass Mode). The machine can be turned ON or OFF using the (+) and the (-) buttons respectively for a duration of 3 seconds. Please note that this operation will TURN ON/TURN OFF only the electronics. All the DC and AC sides will be live and the status of all the circuit breakers will remain as it is.

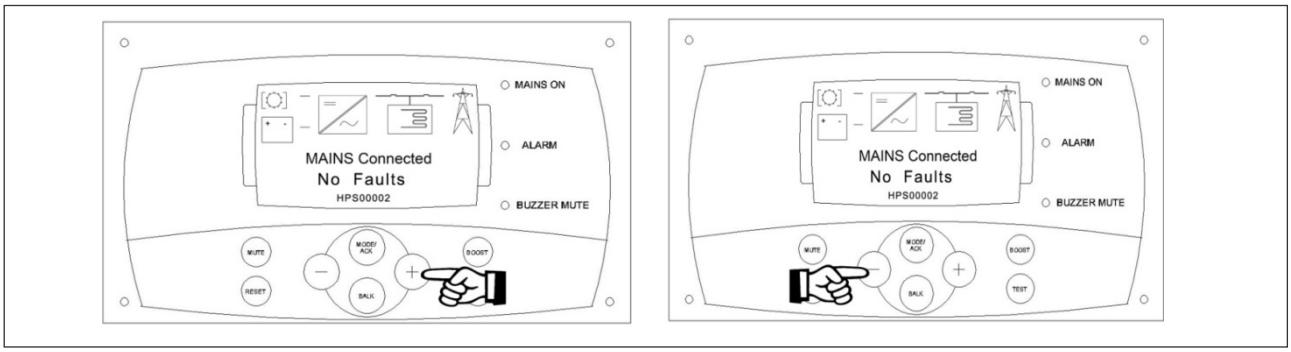

Figure 30

5.5.1 FAULT RESET OF INVERTER

These inverters have various levels of fault, and depending upon the critical nature of the fault, the reset takes place. Most of the normal category faults such as overloads, short circuit, AC UV and ACOV are auto- reset in 60 seconds. In case you want to manually reset it without waiting for 60 seconds, you can press RESET button provided on the keypad. In case of few critical faults, manual RESET has to be done using the keypad once the fault has been cleared.

5.5.2 CHANGE OF SETTINGS

Since the Display Keypad Unit is the only method to communicate between the user and the machine, hence, for any settings change you have to access the DKU unit by entering its password protected settings to make the changes as per your requirement. Please note that it is very important to learn as to how to access these settings as the user may be required to perform the settings change at various stages of its lifetime. The settings change should be performed by authorised personnel only, and whenever any such changes are made, the manufacturer should be intimated about this. In case of faulty settings, the warranty of the machine may be void. Some of the reasons why you need to access these settings are:

- At the time of installation if the site requirements are different from default settings.
- In case battery used is different from informed initially.
- If the user wants to change mode of operation and order of priority.
- In case the user wants to allow power export back to the grid.
- In case you want to set scheduled events.
- In case you want to start/stop battery charging from grid.

Here we shall just introduce how to enter the settings of Display Keypad unit.
The below 3 KEYS if pressed together for 5 seconds gives access to the settings inside the DKU:

MODE + MINUS + PLUS

The settings inside the DKU basically consist of 7 sub-settings depending upon the functionality. These include:

- FLOAT & BOOST CHARGING SETUP
- ALARM & TRIP SETTING
- BATTERY TEST SETUP
- INHIBIT & LATCH SETTINGS
- SYSTEM DEFINITION SETUP
- METER CALIBRATION
- COMMUNICATION SETUP
- AUTO-SCHEDULE SETTING
- FACTORY SETTINGS

Each of these may or may not be password protected, which can be changed whenever required. Each of these contains a bunch of set points which can be changed as per requirement. The overall list of parameters inside has been explained in the below chart for ease of explanation.

MAIN CHART

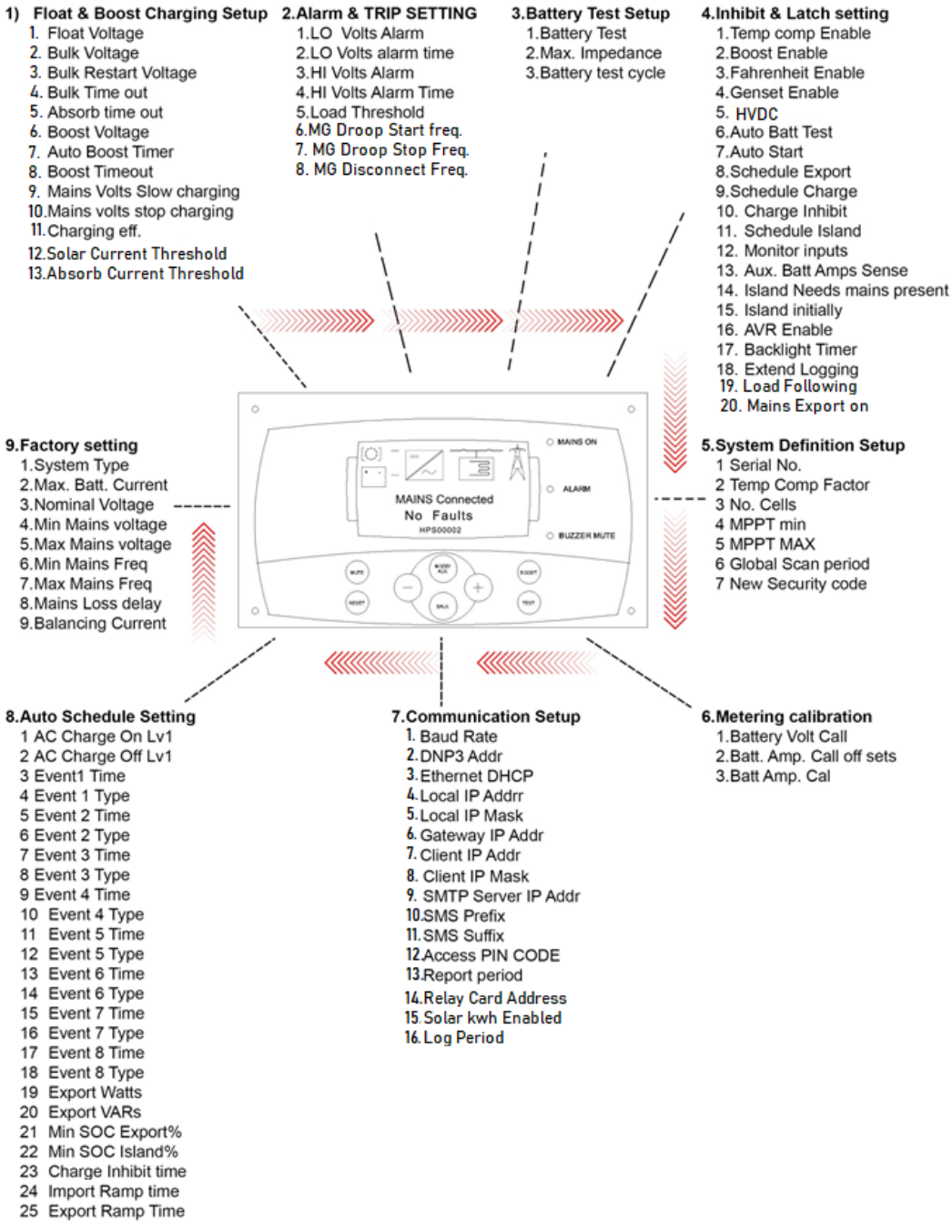

Figure 31

All the above sub-menus are accessible using the front panel and the definition of these keys has been explained in the table in above sections. However, for ease of explanation, we present the below given flow chart as to
how to set any of the values, change the values and save the settings.
Special attention is required ensure proper settings upload during initial installation and changing mode of operation
anytime in future. Special attention is required whenever settings are being changed during installation or thereafter.
Below chart of the menu settings

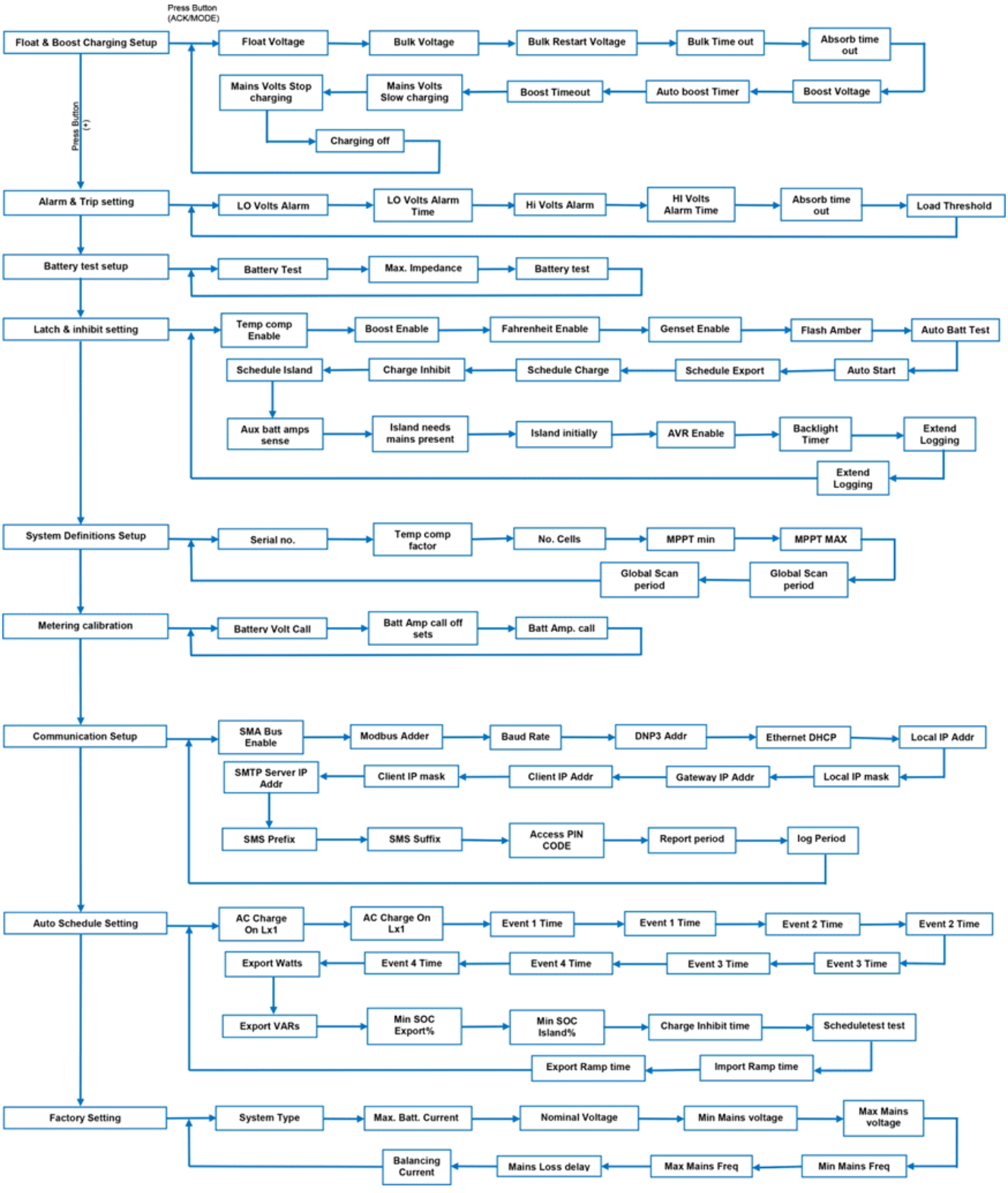

Figure 32

6. BATTERY AND BATTERY CHARGING

Although Batteries are not a part of the equipment supplied in this consignment, but since this machine works only with the Batteries connected, it's important to discuss about their selection and usage.
Please note that the SSSI range of inverters are designed for:

- Flooded LM Batteries
- Sealed Maintenance VRLA Batteries
- Sealed Maintenance Tubular Gel VRLA Batteries

All the SSSI machines supplied have been configured for a common battery type, and in case of mismatch; the settings need to be checked at the time of installation. So, it's always recommended to check the battery charging parameters at the time of installation for better performance.
Before we proceed, let's discuss a few important things about batteries and their connections in any storage-based installation. These are standard Industrial practices and inverter manufacturer shall not be responsible for any conflict in opinion with the recommendations of the battery manufacturer:

1. Never select the battery blindly as it is very important to study the application to which the battery is subjected. Main points of consideration include discharging rate, depth of discharge, rate of charging, ambient temperature, source of charging, etc.
2. Do not ignore or bypass any recommendations of the battery manufacturer as battery life is very specific to the conditions under which it can survive the said life.
3. Interconnection method of various cells is very important and preferably copper bus bars should be used for interconnections.
4. Battery bank should always be insulated to avoid an electrical shock.
5. In case of flooded batteries, regular top up of suitable (as per battery recommendation) water is very important.
6. Specific Gravity check should be a part of regular maintenance and whenever required an equalized charging cycle should be initiated.
7. Batteries should always be placed in a separate room to avoid acidic fumes.
8. Length of cables from the Battery to the PCU should be kept to minimum to avoid the losses. Cable sizing should also be done to minimize the losses.
9. Never connect more than 2 battery banks in parallel to a single system. This may lead to imbalanced charge discharge cycles of the 2 banks ultimately causing stress to one of the banks.
10. Never discharge your batteries beyond 70% DOD as it may damage your batteries permanently.
11. A battery designed to give back up of 10 hours and discharge rate D, will not give a backup of 20 hours at discharge rate of 0.5 D. The relationship is never linear.
12. Always charge the batteries at the voltages prescribed by the battery manufacturer. Always double check the charging voltages in the inverter machine during installation.
13. Battery is passive but very demanding in nature. Use battery only as recommended to get the full life of the battery.

6.1 BATTERY CHARGING TECHNIQUE IN HBD RANGE OF INVERTERS

Entire range of HBD range of inverters have inbuilt Solar Charger as well as Grid charger. These chargers can charge the battery connected at the rated voltage and current. These battery charging sources have been discussed below:

6.2 MPPT-BASED SOLAR CHARGE CONTROLLER

This is used to charge the batteries using Solar Power. This Solar Charger works on MPPT Algorithm which is better as compared to the conventional PWM charging method. Not only does it perform the MPPT (Maximum Power Point Tracking) function but also carry out the proper 3 stage charging cycle on the connected batteries.
Unlike the battery-less Inverters, here, in storage-based machines, separate power electronic switching device performs the function of charging through PV power. This has inbuilt reverse polarity protection in form of a series diode to avoid damages in case of wrong polarity connections. Input of Solar Charger also has Surge Protection device in form of Metal Oxide Varistors (MOVs).

MPPT chargers provided in these machines follow the Perturb & Observe (P&O) algorithm to track the Maximum Power Point of the solar panel curve.
In case of higher capacity inverters, the number of charge controllers is three instead of one. Please refer to the product datasheet to check the number of MPPT chargers in your machine. The purpose of providing more number of MPPT charges in bigger machines is because a single MPPT charger cannot cater to PV fields of very large sizes and hence, the generation becomes poor.
The rate at which the MPPT charger charges the battery is highly dependent on the PV power available and the loads connected. PV power can charge batteries only with the PV power available at that instant and cannot create power on its own. Similarly, in case the loads connected on the AC side demand power and PV power is available, then preference will be given to the AC loads and not the battery charging (in case of standalone mode only).
All MPPT chargers are permitted a certain degree of overload for the PV capacity that can be connected to any machine. Refer to the product datasheet for detailed specifications of MPPT charger.

6.3 GRID BASED CHARGER

All the HBD-NG machines consist of bi-directional converter modules which can act as inverter as well as battery charger. The battery charger mode of this converter is used to provide battery charging.
feature through the Grid supply. In this mode, machine bypasses Grid supply to the loads and at the same time charge the batteries using grid power.
The Input to the grid charger can be single-phase or three-phase depending upon the 1-Phase/ 3-Phase nature of the machine. Using all the phases (in case of 3-Phase machines) is very important to avoid imbalanced loading of the 3 phases at site.
Capacity of Grid charger can be changed using the set point MAX. IMPORT POWER of test software. The default power of the Grid Charger is set to the rated power of the machine. This power defines the total power imported from the grid terminals – both for the loads as well as for battery charging. Hence, batteries are charged at rated power only when the connected loads are zero. In case connected loads draw power, then only the balance power will be used to charge the batteries. This is important to avoid unnecessary loading on the Grid connection at site.
Even if the connected loads are zero, the actual power available at the battery terminals will be lesser than the import power because of the converter efficiencies as mentioned in the datasheet.
In case of weak grid areas where drawing grid power leads to dip in the voltages, Grid charging can be controlled using the same set point.
All the battery charging voltages and currents are fed through the Display-Keypad-Unit (DKU) provided on the front door. Please be noted that all these parameters are common for both the chargers and automatic priority is given to the MPPT charger as compared to the Grid charger.

6.4 COMMON FEATURES

Some of the common features of charging profile for both these chargers have been discussed as under:

6.5 BATTERY CURRENT LIMITING (BCL)

In case deep discharge batteries are put to charge, they tend to draw huge amounts of current to get charged. This often leads to very high temperatures inside the batteries and hence this current must be regulated. This feature is called Battery Current Limiting (BCL) and this is inbuilt in all the HBD-NG range of Inverters for the MPPT charger and the Grid charger both.
The value of this BCL current is a default setting value depending upon the size of the machine. It can be changed from the DKU as explained on chart on Table 5. This value is generally set at C/10 of the battery capacity that is connected and the selection of this value has been explained on Appendix 7. However, this value is generally recommended by the Battery Manufacturer and Inverter manufacturer shall not be responsible whatsoever for any mismatch of this value.

6.6 THREE STAGE CHARGING (FLOAT, BULK AND EQUALIZE)

To ensure long life of the battery and getting required back up from the battery, it is very important that we take care of battery charging procedure exactly as recommended by the battery manufacturer. Every battery manufacturer defines 3 levels of voltages to be imposed on battery bank during the battery charging process. Depending upon the state of Charge of the battery, the charger voltage changes from Float to Bulk or vice versa to ensure that proper charge has been replenished into the battery. Please refer the battery charging graph provided below for more details any particular battery manufacturer in particular. To follow the exact battery charging procedure, contact your battery manufacturer and make the changes accordingly.

6.7 TEMPERATURE COMPENSATION FOR VRLA

VRLA batteries are very temperature sensitive and in case the ambient or battery temperature drifts beyond a particular range of temperature, it requires the charging voltage to change accordingly. This is known as battery compensation feature under which, PCU must change its charging voltage as per battery temperature. The battery temperature is an external parameter which has to be supplied to the PCU as an input. Proper battery sensor terminals are provided in every PCU, and the battery sensor can be connected to this point, and the Battery Compensation feature needs to be enabled from the DKU by accessing the settings. The default mode of Battery compensation is OFF in all the machines supplied. The rating of the battery sensor can be known by contacting the manufacturer.

6.8 BOOST CYCLE ON START UP

Whenever any Hybrid PCU is started from completely OFF position, it assumes that the battery is not in fully charged condition and hence, performs a Boost Charging Cycle once. This process may take 3-4 hours depending upon the battery capacity and its state of charge. This feature is very important for the long life of battery as the machine does not know about the prior state of Battery. To avoid this again and again, it is recommended not to turn of the unit completely until it is really required.

6.9 BATTERY OVER VOLTAGE PROTECTION

All hybrid PCUs are very sensitive against over charging the battery bank, and special algorithms have been implemented in their controllers to avoid such a situation. As soon as the battery voltage reaches the pre-determined value, the charger backs off under electronic protection and in case the situation persists, there is an immediate shut down of the entire unit, considering the critical nature of the fault. This fault requires a manual reset after it has been ensured that the fault condition has been cleared.

6.10 BATTERY UNDER VOLTAGE PROTECTION

Battery under voltage protection is the most critical protection in any inverter as it prevents drainage of battery energy beyond a certain point. Hence, all hybrid inverters have an electronic shut down once this voltage is achieved. Battery undercut means there will be a blackout at site if grid/ DG is not available. To avoid this, there is a battery undercut PRE-ALARM which is an audio buzzer indicating the user that the black condition will arrive very soon.

Once the battery undercut protection is activated, inverter will remain in this condition until the battery has been revived up to a certain level. There is a hysteresis between the battery undercut voltage and the battery reconnects voltage.

As soon as any of the power sources is available such as PV/ Grid/ DG, the battery charging will start automatically and does not require any manual reset.

User is recommended not to change the battery undercut settings without consulting the battery manufacturer and inverter manufacturer as both the equipments are designed only for a certain level of battery under voltage.

GRID CHARGER START/ STOP SETTING

Grid charger Start/ Stop settings allow the user to use the Grid supply selectively. This is one of the most critical setting points in case you want to modify the MODE OF OPERATION in any hybrid inverter. These set points allow the user to select the battery voltages at which the Grid should be bypassed to the loads and charge the batteries at the same time. Please note that Grid Charger Start/ Stop settings have nothing to do with the Grid voltage Range.

6.11 BATTERY CHARGING CURVE EXPLANATION

Note: For explanation on Battery Charging Curve, refer to our web manual.

6.11 BATTERY CHARGING CURVE EXPLANATION

Below Graph explains the charging process of these inverters in detail. Also the chart below can be used to clearly understand the meaning of each of these terms. Figure Shows 4-Stage Battery Charging Curve. The 4-stage charge cycle consists of a Constant Current (Stage 1), an Absorption period (Stage 2) at a higher voltage than float, a Taper to Float (Stage 3) and a Float period (Stage 4).

➢ STAGE 1: BULK CHARGE PERIOD

This is the first stage of charge using a constant current (determined by Max._Batt._Current and Inverter Maximum current until the either the bulk voltage or equalize voltage is reached . This charge period will typically last 8-10 hours.

➢ STAGE 2: ABSORPTION OR EQUALIZE CHARGE PERIOD

This stage maintains the cells, and hence the batteries, at a constant voltage until the bulk/equalize period time has elapsed or the current into the batteries has become lower than a certain minimum value. This charge period is around 2 hours.

➢ STAGE 3: TAPER TO FLOAT PERIOD

The voltage per cell will be lowered to the float voltage per cell over a period of time no less than the number of seconds defined in the setting 'Battery Taper to Float Rate. This is achieved by lowering the current into the battery cells.

➢ STAGE 4: FLOAT TAPER CHARGE PERIOD

The current into the battery cells is reduced at a rate that allows the voltage on the cells to remain constant at the float voltage level. If an auto-start generator was used, it will turn off when this stage is reached.

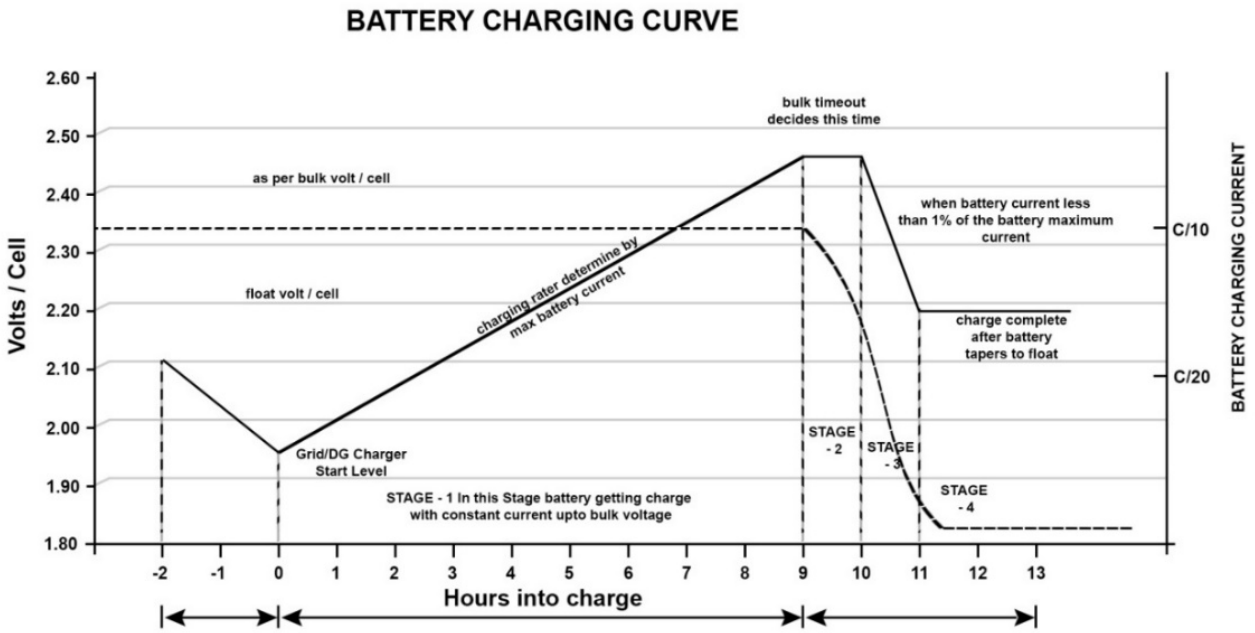

Figure 33

7. OPERATING MODES

These Smart Storage Solar Inverters have different OPERATING MODES each of which can be configured at site using the front Display keypad unit provided on the System. These different operating modes give you flexibility to prioritize various energy sources i.e. PV, Grid, Battery and DG sets in order you want to. Fundamentally there are 3 operating modes, namely:
Note : The description in this section is for reference only. For a detailed explanation of the settings, either contact our Customer Support or refer to our web manual on our website.

- Standalone Operating Mode
- HYBRID Operating Mode
- HYBRID WITH GRID EXPORT Operating Mode

To interchange between any of these Modes, there is no single set point which changes the Operating Mode. Instead, it's a combination of set points change using which any of the operating modes can be achieved. The method of switching from one Operating Mode to other has been discussed below.
The main purpose of this section is to discuss how we can switch from one OPERATING MODE to another. But first, it is very important to understand when to choose any OPERATING MODE out of the three options available. Hence, we will first discuss the pros and cons of each of the three modes:

A. STANDALONE MODE

1. Order of Priority here is PV > Battery > Grid.
2. Lesser consumption of grid power which is used only if PV and Battery are not able to meet the load demand.
3. Good for areas where grid is available all the time of the power cut is at a fixed time of the day. This is because grid should be available at the time when PV and battery are no more available.
4. Number of charge-discharge cycle of battery is high which may cause battery end-of-life to reach soon.
5. In case of weak grid availability, this may not be a good option. Grid may be available when battery is getting discharged. Once batteries are drained, grid may or may not be available. This may lead to complete blackouts.
6. Chances are high that battery may remain in shallow charge condition ultimately leading to shorter battery life.
7. In case of rainy season, grid shall charge battery and once charged, inverter shall take over and again batteries shall get discharged. Hence, the overall losses involved due to Power Electronics are double. To deliver the same units to the load, more grid units shall be consumed.

A. HYBRID MODE

1. Order of Priority is PV > Grid > Battery.
2. Grid power will be given preference over battery in case PV power is not able to meet the load demand.
3. Grid output synchronizes with inverter output and hence, shares the load demand.
4. Battery remains in top of charge as long as grid is available and hence, has a longer life.
5. Lesser number of charge discharge cycles increases the battery life.
6. Lesser chances of power blackout because battery is always the last alternative.
7. Better system efficiency because PV charges the battery and grid caters to loads and hence inverter conversion efficiencies are not involved in normal scenario.
8. In this mode, surge loads do not cause any stress on inverter or battery as the peaks of the surge is shared by the grid supply.
9. In case of widely varying Grid, load end voltage varies just like the Grid voltage. This is because the inverter voltage tracks the grid voltage for synchronization. This may not be good for some sensitive appliances. A fix to this problem is by reducing the grid window range as per requirement.
10. Grid units consumed may be high in areas where there are no power cuts and loads are also partial. The solution to this is the following discussed mode.
11. In case of partial loads and battery charged, there are chances that PV power is available but not getting utilized. This will lead to poor PV generation as power export is not allowed.

C. HYBRID MODE WITH EXPORT

1. Order of Priority is PV > Grid > Battery along with export of PV power allowed.
2. This mode is same as hybrid mode with the additional feature of allowing PV power being exported beyond the grid terminals. To explain this further, PV power will be used to charge battery and cater to loads. In case of a deficit, grid will share the burden. In case PV power is excess and not being utilized then it will be exported into the grid terminals.
3. This mode should be permitted only if net metering is allowed in the building or the overload building loads are very high as compared to the PV connected so that all the PV power is consumed within the building and no PV power is exported beyond the utility meter.
4. This mode gives excellent PV generation because of the export feature.
5. In case there are a lot of captive loads (not connected directly to PCU) then can also utilize the PV power as long as grid is available, and the PV power is excess.
6. In case of weak grid areas (where supply voltages are low), this mode tends to stabilize the Grid supply.
7. In case DG is connected and PV excess power available, then PV power may be fed through grid terminals to the Grid and may incur damages.
8. In this mode, battery power is never exported to grid unless commanded externally (available in selected models only).

Since the MODES OF OPERATION are now clear, we can discuss how the user can switch from one MODE to other MODE by using the DKU module along with a few other hardware changes.
Apart from this it is important to locate the MASTER CARD provided on the control panel which houses the necessary jumpers for change in MODE settings. The location of this MASTER CARD has been kept slightly off-the–access to avoid unwanted changes done. Please contact the manufacturer to locate this card in case of problem. It is generally hosed close to other electronics.
Please turn off Load, Grid and PV MCCB whenever changes are being made to the MODE OF OPERATION. Only battery MCB/ MCCB should be on when changes are being made in MODE OF OPERATION. This process may take a maximum of 5-10 minutes.

*Refer the below chart to implement the changes.

S. No.	Existing Mode	New Mode	Changes in DKU**
1	Hybrid mode (default mode)	Standalone	1. Need to open " Float and boost charging setup" and check the battery bulk voltage setting. 2. Open the "Auto Schedule Setting" and make AC Off Chrg lvl slightly lower than the setBattery bulk voltage volt by using – key. 3. Then press back button two time. 4.Now working made has been changed from Hybrid mode to standalone mode.
2	Hybrid mode (default mode)	Hybrid with Export	1. Need to open latch and inhibit setting. 2. Need to disable the load following option (need to make it "OFF" by using + & - key. 3. Then press back button two time. 4. Now working made has been changed from Hybrid mode to Hybrid with export mode.
3	Standalone mode	Hybrid mode	1. Need to open " Float and boost charging setup" and check the battery bulk voltage setting. 2. Open the "Auto Schedule Setting" and make AC Off Chrg lvl as Battery bulk voltage + 10volt by using + key. 3. Then press back button two time. 4. Now working made has been changed from Hybrid mode to standalone mode.

S. No.	Existing Mode	New Mode	Changes in DKU**
4	Standalone mode	Hybrid with Export mode	1. Need to open " Float and boost charging setup" and check the battery bulk voltage setting. 2. Open the "Auto Schedule Setting" and make AC Off Chrg lvl as Battery bulk voltage + 10volt by using + key. 3. Need to open latch and inhibit setting. 4. Need to disable the load following option (need to make it "OFF" by using + & - key. 5. Then press back button two time. 6. Now working made has been changed from Hybrid mode to standalone mode.
5	Hybrid with Export mode	Standalone mode	1. Need to open latch and inhibit setting. 2. Need to Enable the load following option (need to make it "ON" by using + & - key. 3. Need to open " Float and boost charging setup" and check the battery bulk voltage setting. 4. Open the "Auto Schedule Setting" and make AC Off Chrg lvl slightly lower than set Battery bulk voltage – key. 5. Then press back button two time.
6	Hybrid with Export mode	Hybrid Mode (default mode)	1.Need to open latch and inhibit setting. 2. Need to Enable the load following option (need to make it "ON" by using + & - key. 3. Then press back button two times.

Table 14

APPENDIX-1 : DISPLAY FAULT ANALYSIS

The second line of the screen shows the alarms that have been raised. If no alarms are active, the message 'No Faults' is shown. The possible faults and their meanings are as follows:

S. No.	DISPLAY FAULT	MEANS	CAUSE	ACTION
1	Low AC Volts	Low Mains Voltage.	The voltage on the grid source that was on-line was too low and out of range and the source has been disconnected.	1. Check whether Mains is available or not. 2. If fault remain persists contact our Technical personnel.
2	HI AC Volts	High Mains Voltage	The voltage from the source that was on-line was too high and out of range and the source has been disconnected.	3. Sometimes grid voltage comes out of range and cross the maximum permissible voltage. Check the voltage and wait till mains come within range.
3	HI Inverter Volts	The inverter voltage became high and out of range.	The fault could have been caused by the inverter voltage tolerance settings being narrower than the source voltage tolerance and the inverter was set up to track the source voltage.	4.Reduce your source high voltage tolerance. The inverter may not operate continuously at more than ±2% of its nominal voltage rating (at standalone mode) and +10%/-20% (In synch mode). 5. Menu/factory setting/Min Mains voltage and Max Mains Voltage. 6. Contact our Technical Support 7. Note: The inverter will attempt restart 3 times after every 1 minute to clear this fault. If fault is not cleared the inverter will shut down.
4	Inv. Trip	The Inverter current exceeded its safety limit.	Sometime system get abrupt changes in itself, it can be due to high current change during synchronization, short circuit at connected load, battery beyond to its DOD level, Overload.	8. Make sure if there is no any short circuit. It can be damage system. 9. Check DC voltage, whether it is above to its end cell voltage. 10. Press Reset button on main display. System will try to start again. 11. Contact our technical personnel, if needed. 12. Note: The inverter will attempt restart 3 times after every 1 minute to clear this fault. If fault is not cleared the inverter will shut down.
5	HI AC Load	The apparent power of the load exceeded the overload limits	The load on the inverter exceeds the inverter rating. The inverter will have stopped to prevent overheating or damage to itself.	13. Reduce Load and press Reset button. 14. If problem continue contact to our technical personnel. 15. Note: The inverter will attempt restart 3 times after every 1 minute to clear this fault. If fault is not cleared the inverter will shut down.

S. No.	DISPLAY FAULT	MEANS	CAUSE	ACTION
6	HI AC AMPS	The Inverter current exceeded beyond limit.	The system has detected a high current or dc voltage disturbance and has temporarily shut down. This fault is similar to a current limit fault except that it could not be traced to a specific line. This fault could also be caused if the battery voltage rises above the hardware protection but is still below the high dc voltage setting.	16. Carry out Fault Reset 17. Contact Technical Support. 18. Note: The inverter will attempt restart 3 times after every 1 minute to clear this fault. If fault is not cleared the inverter will shut down.
7	Low DC Volts	Battery is heavily discharged	This fault occurs when there no Solar and grid are available for a long time. Internal losses of the battery down its gravity. Then battery is not able to start the inverter.	19. Charge battery immediately to prevent permanent damage.
8	HI DC Volts	The Battery voltage sensing is reporting an invalid measurement.	The battery voltage has exceeded its safe high limit. The solar regulator will be tripped and if the fault persists the source will be masked. If the condition still persists the inverter is masked eventually.	20. Make sure that there are no external DC sources (solar/wind) that are not controlled by the HBD-NG System that could cause the battery to overcharge. 21. If fault continues contact Technical Support
9	HI Temp	Cabinet ambient temperature is high	The inverter heat sink temperature on this system is too high and the inverter has shut down to protect itself again permanent damage. System gets tripped and supply load in bypass mode.	22 . Reduce the load for 15 minutes so that temperature can lower. 23. Check for any wiring damaged. 24. Contact our Technical personnel.
10	Inv. Temp Sense	The Inverter heat sink temperature is too high to operate the Inverter	The inverter heat sink temperature on this system is too high and the inverter has shut down to protect itself again permanent damage. System gets tripped and supply load in bypass mode.	25. Reduce load and Wait 15 minutes for heat sink to cool and carry out Fault Reset. 26. If fault continues contact Technical Support 27. Note: The inverter will attempt restart 3 times after every 1 minute to clear this fault. If fault is not cleared the inverter will shut down.
11	Low AC Freq	Low AC Source Frequency	The frequency from the source that was on-line was too high and out of range and the source has been disconnected. If the source was a generator then the system will attempt to start and connect to it four times. If the fault is still present the system selects another generator as the source.	28. Repair or replace source. 29. If fault continue, contact Technical Support

S. No.	DISPLAY FAULT	MEANS	CAUSE	ACTION
12	HI AC Freq	High AC Source Frequency	The frequency from the source that was on-line was too high and out of range and the source has been disconnected. If the source was a generator then the system will attempt to start and connect to it four times. If the fault is still present the system selects another generator as the source.	30. Repair or replace source. 31. If fault continues contact Technical personnel.
13	Batt. Temp Sense	High Battery Temperature	The battery temperature is too high. The system should automatically reduce the battery voltage in an attempt to regulate the battery temperature. This requires the battery temperature compensation and charge voltages to be set up correctly. If the temperature cannot be regulated the system will trip the solar regulator in an attempt to reduce the battery temperature. If still unsuccessful the system will mask the inverter and continue running off a source.	32. Disconnect batteries 33. Wait 15 minutes for battery to cool. 34. If fault continue, contact Technical personnel.
14	COMMS Fail	Communication fails.	The Inverter controller is not communicating with the supervisory system.	35. Open front door and check the wire, FRC Cable for any loose or damage. 36. Contact our technical personnel.
15	MAINS Relay	The Mains changeover relay is not engaging	'-'	37. Contact our technical personnel.
16	Phase rotation		There might be phase difference more than 120 degree between all three phases. System will not synchronize with grid.	38. Make sure there is proper phase difference between R,Y and B. 39. Contact to our technical personnel.
17	System OFF	Inverter not delivering output	This might be issue from battery side or might be there some issue with internal circuitry.	40. Make sure all the batteries connection are tighten properly and there is no any loose connection. 41. Contact to our technical personnel

S. No.	DISPLAY FAULT	MEANS	CAUSE	ACTION
18	System Offline	Communication card /CAN communication issue.	The Inverter controller is not communicating with the supervisory system.	42. At first need to restart the inverter once then check. 43. Contact to our technical personnel.

Table 15

APPENDIX-2 : HOW TO SELECT OPERATING MODE OF YOUR CHOICE

In Section 7 of this manual, we have discussed in detail about the various OPERATING MODES available in Hybrid Inverters and their working. The three operating modes namely STANDALONE, HYBRID and HYBRID WITH EXPORT have their own advantages and disadvantages. Hence, each of them should be duly considered before setting.

APPENDIX-3 : PV MODULE ARRAY SERIES-PARALLEL ARRANGEMENT

Hybrid Inverter machines are basically DC coupled Solar inverters which have an inbuilt but separate MPPT solar Charger between the PV and the Battery. This Solar MPPT charger is of Buck type which strictly means that PV power will be extracted only when the PV voltage is higher than the battery voltage at that instant. Hence, the series parallel arrangement becomes very important for proper functioning and best generation results.

So, before we present the PV sizing chart, we would like to highlight a few points about the series-parallel arrangement of PV modules.

1. Always keep information handy about the PV module you are going to use. This includes: Open-Circuit Voltage (Voc), MPPT Voltage (Vmp), Short-Circuit Current (Isc), MPPT Current (Imp), Module Power (Pmp) and no. of cells in PV module used.
2. Always refer the Inverter datasheet while designing the series parallel arrangement. The parameters o f importance include:
   - PV Nominal Capacity (Total)
   - No of MPPT Channels
   - Per Channel PV Capacity (Nominal/ Peak)
   - Max. Open Circuit PV Volts (Voc)
   - MPPT Voltage Range
   - PV Minimum Voltage
   - Max I/P Amps per channel
3. More are the number of modules in series, higher is the plant efficiency and higher is the generation from PV modules. But there is a limit to maximum number of modules mentioned in the inverter datasheet.
4. Never exceed the Max. Open circuit Voltage permitted by the inverter datasheet. This value is mentioned as Max. Open circuit PV Volts (Voc) in the inverter datasheet
5. Open circuit voltage of PV module increases in cold season due to module characteristics and hence always keep a margin between the System Voc and permissible Voc mentioned in the datasheet.
6. The number of strings in parallel should always be kept as low as possible. Also, the summation of all the string currents should always be less than the Max I/P amps per channel mentioned in the datasheet of inverter.
7. In case of multi MPPT channel designs (above 50KVA generally) distribute the no of modules equally among all the 3 MPPT channels for better generation.
8. In case of multi MPPT channels ensure 3 separate PV fields are made. That is, do not combine all the PV modules in a single AJB and then bring 3 separate set of cables for 3 MPPT chargers in Multi MPPT inverters. This will hamper the PV generation as MPPT function will not take place at all.

9. Series parallel arrangement of PV modules is dependent on the inverter being used. It may differ from one make of inverter to other. Please consult the Inverter manufacturer before usage for proper generation.
10. Below is a general chart for series parallel arrangement depending upon the capacity of Hybrid Inverter.

PV CONFIGURATION CHART

BATTERY VOLTAGE	NOMINAL PV CAPACITY PER CHANNEL	315Wp/ 72 CELLS	
		MAX MODULES IN SERIES*	MAX. PV STRINGS IN PARALLEL*
48	1000	3	1
	2000	4	2
	3000	4	3
	4000	4	4
	5000	4	5
	8000	4	8
	10000	4	10
96	5000	7	4
	6000	8	5
	8000	8	6
120	8000	8	5
	10000	8	6
	15000	8	9
	15000	15	5
	20000	15	6
	25000	15	8
	30000	15	9
	40000	15	12
	50000	15	15
	60000	15	6
	80000	15	8
	100000	15	10
360	40000	18	8
	50000	18	10
	60000	18	4
	80000	18	5
	100000	18	6
	125000	18	8
	150000	18	10
	200000	18	13
480	125000	21	7
	150000	21	8
	200000	21	11
	250000	21	14
576	250000	23	11

Table 16

Note: In these cases it is not possible to achieve the exact kWp capacity using the said series-parallel combination. Hence the achieved kWp capacity is slightly more or slightly less than the required kWp capacity.

APPENDIX-4 : BATTERY CHARGING CURRENT AS PER BANK SIZE

Battery charging is an important feature of hybrid inverters. The charging voltage and more importantly charging current depends on the battery type and battery capacity connected.
Since all hybrid inverters are dispatched with some standard settings assuming a certain size of battery bank, it is very important to discuss these assumptions in detail. The user is requested to check if the actual battery size matches this and in case not, then change the current settings to match the size battery bank installed.
To decide the battery charging current please contact your battery manufacturer. However, as a rule of thumb, find the AH capacity of your bank and divide it by 10. The value you arrive at is the charging current you need to set on DKU.
The default setting assumes a certain battery bank size. The value of battery bank has been assumed for a 4 hour back up at 100% load for Inverter of any size. For e.g., for a 48V/ 3kVA inverter, battery bank of 400AH has been assumed because if 3kW load is connected then this bank will give a backup of 4 hours.
The calculation of how this value is reached is based on assumptions and is conditional. The manufacturer does not guarantee any such back up duration and shall not be held responsible whatsoever. The below chart lists out the battery bank capacities assumed for various inverter sizes.

SYSTEM TYPE	SYSTEM RATING	BATTERY AH
Single-phase	48V-3kVA	200AH
	96V-5kVA	200AH
	96V-6kVA	200AH
	96V-8kVA	200AH
	120V-8kVA	200AH
	120V-10kVA	200AH
	240V-10kVA	200AH
	240V-12.5kVA	200AH
	240V-15kVA	200AH
	240V-20kVA	200AH
	240V-25kVA	600AH
Three-phase	120V-10kVA	200AH
	120V-12.5kVA	200AH
	120V-15kVA	200AH
	120V-20kVA	200AH
	240V-10kVA	200AH
	240V-12.5kVA	200AH
	240V-15kVA	200AH
	240V-20kVA	200AH
	240V-25kVA	500AH
	240V-30kVA	600AH
	240V-40kVA	800AH
	240V-50kVA	1000AH
	240V-60kVA	1200AH
	240V-80kVA	1600AH
	240V-100kVA	2100AH
	360V-100kVA	1350AH
	360V-150kVA	2100AH
	360V-200kVA	2800AH

Table 17

Note: * Above battery AH just assumption for making battery charging default current setting, please set the actual battery charging current as per available at user end.
* In case your inverter is not listed in the above chart, please contact the manufacturer.

APPENDIX-5: SINGLE PHASE SMART STORAGE SOLAR INVERTER (DATA SHEET)

RATINGS	1kVA/48V	2kVA/48V	3kVA/48V	4kVA/48V	5kVA/48V	6kVA/48V	8kVA/48V	10kVA/48V
Model No.	HBD-048-01K-1P	HBD-048-23K-1P	HBD-048-03K-1P	HBD-048-04K-1P	HBD-048-05K-1P	HBD-048-06K-1P	HBD-048-08K-1P	HBD-048-10K-1P
A. SOLAR CHARGE CONTROLLER (SCC)								
Type (Buck)	MPPT							
PV Nominal Capacity (Total kWp)	1	2	3	4	5	6	8	10
Max PV Strings in Parallel	1	2	3	4	5	6	8	10
No of MPPT Channels	1							
Max. Open Circuit PV Volts (Voc)	190							
MPPT Voltage Range (Vmp)	75-160							
Max O/P Current(A)	20	40	60	80	100	120	160	200
Peak Charging Efficiency	95%							
B. SOLAR INVERTER								
Nominal Capacity	1kVA	2kVA	3kVA	4kVA	5kVA	6kVA	8kVA	10kVA
Output Current (A)	3.5	7	10	14	17	21	28	35
Battery Voltage (V)	48							
Output Voltage/ Freq/Phase	230(± 2%) / 50/1P+N							
Load Power Factor	0.8- unity							
Peak Efficiency	>86 %					>88 %		
Overloads: 60 sec/ 30 sec/ 5 sec	101-110%/111- 125%/126- 150%							
Auto Bypass Feature	Provided							
Anti-Islanding/ Power Export to Grid	Provided (As per IEC 62116 & IEC 61727)							
C. GRID CHARGER								
Grid Voltage Range	230V (+10% & -20%)							
Grid freq Range	50Hz (+5% & -5%)							
Max Grid Import Power	1.5KkVA	3kVA	4.5KVVA	6kVA	7.5kVA	9kVA	12kVA	15kVA
D. PROTECTIONS & DISPLAY PARAMETERS								
	PROTECTIONS				DISPLAY PARAMETERS			
PV Side Battery Side Grid Side Load Side System Protection	• Reverse Polarity, PV Power Limit, Surge Protection (MOV) • Reverse Polarity, O/U Voltage, Current Limit • O/U Voltage, O/U Frequency, Surge Protection (MOV) • Overloads, Short circuit, Surge Protection (MOV) • Over Temperature				• Voltage, Charger O/P Amps, Power, Cumulative Energy • Voltage, Current, Battery State • Phase Voltage, Frequency, Power, Power Factor • Voltage & Current, Frequency, Power, Export kWh. • Mode of Operation, Active Faults, Status Mimic			
E. MISCELLANEOUS								
Switchgear Protection	MCB/MCCB provided on PV, Battery, Load & Grid path.							
LED Indications	Mains On, Alarm, Buzzer Mute.							
Data Port (RS485/ RS232)	Optional (Available on Request)							
Remote Monitoring	Optional through GPRS based Modem							
Ingress Protection	IP-21(IndoorType)							
Cooling Method	Force Cooling (Temp Controlled)							
Operating Temperature	0-50 degrees (without Derating)							
Humidity	Max. 95% Non-Condensing							
Altitude	1000m above sea level							
Color Shade	RAL7035/DA GREY HEIS005							
Dimensions (H X W X D)	320X400X300		310X500X625			750X530X897.45		
Wheels Available (Y/N)	N	N	N	N	N	N	N	N
Net Weight in (Kg) Approx.	60 Kg	62 Kg	65 Kg	86 Kg	87 Kg	87 Kg	103 Kg	103 Kg

RATINGS	5kW/96V	6kW/96V	8kW/96V	8kW/120V	10kW/120V	15kW/120V	15kW/240V
Model No.	HBD-096-05K1P	HBD-096-06K1P	HBD-096-08K1P	HBD-120-08K1P	HBD-120-10K1P	HBD-120-15K1P	HBD-240-15K1P
A. SOLAR CHARGE CONTROLLER (SCC)							
Type (Buck)	MPPT						
PV Nominal Capacity (Total kWp)	5	6	8	8	10	15	15
Max PV Strings in parallel	4	5	6	5	6	9	5
No of MPPT Channel	1						
Max. Open Circuit PV Volts (Voc)	360			360			720
MPPT Voltage Range (Vmp)	140-299			165-299			330-598
Max Output Current (A)	50	60	80	64	80	120	60
Peak Charging Efficiency	94%						
B. SOLAR INVERTER							
Nominal Capacity	5kW	6kW	8kW	8kW	10kW	15kW	15kW
Output Current (A)	22	26	35	35	43	65	65
Battery Voltage (V)	96			120			240
Output Voltage/ Freq/Phase	230(± 2%) / 50/1P+N						
Load Power Factor	0.8 - Unity						
Peak Efficiency	>88 %					>90 %	
Overloads: 60 sec/ 30 sec/ 5 sec	101-110%/ 111-125%/ 126-150%						
Auto Bypass Feature	Provided						
Anti-Islanding/ Power Export to Grid	Provided (As per IEC 62116 & IEC 61727)						
C. GRID CHARGER							
Grid Voltage Range	230V (+10% & -20%)						
Grid freq Range	50Hz (+5% & -5%)						
Max Grid Import Power	7.5kW	9kW	12kW	12kW	15kW	22.5kW	22.5kW
D. PROTECTIONS & DISPLAY PARAMETERS							
	PROTECTIONS				DISPLAY PARAMETERS		
PV Side Battery Side Grid Side Load Side System Protection	• Reverse Polarity, PV Power Limit, Surge Protection (MOV) • Reverse Polarity, O/U Voltage, Current Limit • O/U Voltage, O/U Frequency, Surge Protection (MOV) • Overloads, Short circuit, Surge Protection (MOV) • Over Temperature				• Voltage, Charger O/P Amps, Power, Cumulative Energy • Voltage, Current, Battery State • Phase Voltage, Frequency, Power, Power Factor • Voltage & Current, Frequency, Power, Export kWh. • Mode of Operation, Active Faults, Status Mimic		
E. MISCELLANEOUS							
Switchgear Protection	MCB/MCCB provided on PV, Battery, Load & Grid path.						
LED Indications	Mains On, Alarm, Buzzer Mute.						
Data Port (RS485/ RS 232)	Optional (Available on Request)						
Remote monitoring	Optional through GPRS based Modem						
Ingress Protection	IP-21(IndoorType)						
Cooling Method	Force Cooling (Temp Controlled)						
Operating Temperature	0-50 degrees (without Derating)						
Humidity	Max. 95% Non-Condensing						
Altitude	1000m above sea level						
Color Shade	RAL7035/ DA GREY HEIS005						
Dimensions (H X W X D)	400X600X500			650X400X700		825X845X550	
Wheels Available (Y/N)	N	N	N	N	Y	Y	Y
Net Weight in (Kg) Approx.	86 Kg	87 Kg	87 Kg	103 Kg	118 Kg	168 Kg	168 Kg

APPENDIX-6: THREE PHASE SMART STORAGE SOLAR INVERTER (DATA SHEET)

RATINGS	5kVA/48V	8kVA/48V	10kVA/48V	15kVA/48V
Model No.	HBD-048-05K-3P	HBD-048-008K-3P	HBD-048-010K-3P	HBD-048-015K-3P
A. SOLAR CHARGE CONTROLLER (SCC)				
PV Nominal Capacity (Total kWp)	5	8	10	15
Max No. of Strings	5	8	10	15
Charge Controller Type (Buck)	MPPT			
No of MPPT Channels	3		1	
Max. Open Circuit PV Volts (Voc)	190			
MPPT Voltage Range (Vmp)	75-160			
Max SCC O/P Amps	100	160	200	300
Peak Charging Efficiency	94%			
B. SOLAR INVERTER				
Nominal Capacity (Total)	5kVA	8kVA	10kVA	15kVA
Output Amps per Phase	6	9	12	17
Nominal Battery Voltage	48			
Output Voltage/ Frequency/Phase	400(±2%) / 50/ 3P +N			
Load Power Factor	0.8- unity			
Peak Efficiency	>86 %		>88 %	
Overloads: 60 sec/ 30 sec/ 5 sec	101-110%/111- 125%/126-150%			
Auto Bypass Feature	Provided			
Anti-Islanding/ Power Export to Grid	Provided (As per IEC 62116 & IEC 61727)			
C. GRID CHARGER				
Grid Voltage Operating Range	400V (+10% & -20%)			
Grid freq Operating Range	50Hz (+5% & -5%)			
Max Import Power	7.5kVA	12kVA	15kVA	22.5kVA
D. PROTECTIONS & DISPLAY PARAMETERS				
	PROTECTIONS		DISPLAY PARAMETERS	
PV Side	· Reverse Polarity, PV Power Limit, Surge Protection (MOV)		· Voltage, Charger O/P Amps, Power, Cumulative Energy	
Battery Side	· Reverse Polarity, O/U Voltage, Current Limit		· Voltage, Current, Battery State	
Grid Side	· O/U Voltage, O/U Frequency, Surge Protection (MOV)		· Phase Voltage, Frequency, Power, Power Factor	
Load Side	· Overloads, Short circuit, Surge Protection (MOV)		· Voltage & Current, Frequency, Power, Export kWh.	
System Protection	· Over Temperature		· Mode of Operation, Active Faults, Status Mimic	
E. MISCELLANEOUS				
Switchgear Protection	MCB/MCCB provided on PV, Battery, Load & Grid path.			
LED Indications	Mains On, Alarm, Buzzer Mute.			
Data Port (RS485/ RS 232)	Optional (Available on Request)			
Remote monitoring	Optional through GPRS based Modem			
Ingress Protection	IP-21(Indoor Type)			
Cooling Method	Force Cooling (Temp Controlled)			
Operating Temperature	0-50 degrees (without Derating)			
Humidity	Max. 95% Non-Condensing			
Altitude	1000m above sea level			
Color Shade	RAL7035/ DA GREY HEIS005			
Dimensions (H X W X D)	750X530X897.45			
Wheels Available (Y/N)	N	N	Y	Y
Net Weight in (Kg) Approx.	-	-	149 Kg	149 Kg

RATINGS	10kW/120V	15kW/120V	15kW/240V	20kW/240V	25kW/240V	30kW/240V/360V	40kW/240V/360V	50kW/240V/360V
Model No.	HBD-120-010K-3P	HBD-120-015K-3P	HBD-240-15K-3P	HBD-240-20K-3P	HBD-240-25K-3P	HBD-240-30K-3P HBD-360-30K-3P	HBD-240-40K-3P HBD-360-40K-3P	HBD-240-50K-3P HBD-360-50K-3P
A. SOLAR CHARGE CONTROLLER (SCC)								
PV Nominal Capacity (Total kWp)	10	15	15	20	25	30	40	50
Max No. of Strings	6	9	5	6	8	9/6	12/8	15/10
Charge Controller Type (Buck)	MPPT							
No of MPPT Channels	1							
Max. Open Circuit PV Volts (Voc)	360		720			720 /820		
MPPT Voltage Range (Vmp)	165-299		330-598			330-598 / 495-681		
Max SCC O/P Amps	80	120	60	80	100	120/80	160/108	200/135
Peak Charging Efficiency	94%							
B. SOLAR INVERTER								
Nominal Capacity (Total)	10kW	15kW	15kW	20kW	25kW	30kW	40kW	50kW
Output Amps per Phase	14	22	22	29	36	43	58	72
Nominal Battery Voltage	120		240 / 360					
Output Voltage/ Frequency/Phase	400(±2%) / 50/ 3P+N							
Load Power Factor	0.8-Unity							
Peak Efficiency	>89 %		>90 %			>92 %		
Overloads: 60 sec/ 30 sec/ 5 sec	101-110%/111-125%/126- 150%							
Auto Bypass Feature	Provided							
Anti-Islanding/ Power Export to Grid	Provided (As per IEC 62116 & 61727)							
C. GRID CHARGER								
Grid Voltage Operating Range	400V (+10% & -20%)							
Grid freq Operating Range	50Hz (+5% & -5%)							
Max Import Power	15kW	22.5kW	22.5kW	30kW	37.5kW	45kW	60kW	75kW
D. PROTECTIONS & DISPLAY PARAMETERS								
	PROTECTIONS					DISPLAY PARAMETERS		
PV Side	• Reverse Polarity, PV Power Limit, Surge Protection (MOV)					• Voltage, Charger O/P Amps, Power, Cumulative Energy		
Battery Side	• Reverse Polarity, O/U Voltage, Current Limit					• Voltage, Current, Battery State		
Grid Side	• O/U Voltage, O/U Frequency, Surge Protection (MOV)					• Phase Voltage, Frequency, Power, Power Factor		
Load Side	• Overloads, Short circuit, Surge Protection (MOV)					• Voltage & Current, Frequency, Power, Export kWh.		
System Protection	• Over Temperature					• Mode of Operation, Active Faults, Status Mimic		

F. MISCELLANEOUS								
Switchgear Protection	MCB/MCCB provided on PV, Battery, Load & Grid path.							
LED Indications	Mains On, Alarm, Buzzer Mute.							
Data Port (RS485/ RS 232)	Optional (Available on Request)							
Remote monitoring	Optional through GPRS based Modem							
Ingress Protection	IP-21 (Indoor Type)							
Cooling Method	Force Cooling (Temp Controlled)							
Operating Temperature	0-50 degrees (without Derating)							
Humidity	Max. 95% Non-Condensing							
Altitude	1000m above sea level							
Color Shade	RAL7035/ DA GREY HEIS005							
Dimensions (H X W X D)	825X845X550				925X845X550		1040X650X965	
Wheels Available (Y/N)	Y	Y	Y	Y	Y	Y	Y	N
Net Weight in (Kg) Approx.	149 Kg	245 Kg	260 Kg	284 Kg	292 Kg	296 Kg	435 Kg	446 Kg

RATINGS	60kW/240V/360V	80kW/240V/360V	100kW/240V/360V	125kW/360V/480V	150kW/360V/480V	200kW/360V/480V	250kW/480V/576V
Model No.	HBD-240-60K-3P	HBD-240-80K-3P	HBD-240-100K-3P	HBD-360-125K-3P	HBD-360-150K-3P	HBD-360-200K-3P	HBD-480-250K-3P
	HBD-360-60K-3P	HBD-360-80K-3P	HBD-360-100K-3P	HBD-480-125K-3P	HBD-480-150K-3P	HBD-480-200K-3P	HBD-600-250K-3P
A. SOLAR CHARGE CONTROLLER (SCC)							
PV Nominal Capacity (Total kWp)	60	80	100	125	150	200	250
Max No. of Strings (per channel)	6/4	8/5	10/6	8/7	10/8	13/11	14/11
Charge Controller Type (Buck)	MPPT						
No of MPPT Channels	3						4
Max. Open Circuit PV Volts (Voc)	720/820			820/ 950			950/1050
MPPT Voltage Range (Vmp)	(330-598)/ (495-681)			(495-681)/ (560-850)			(560-850)/(750-900)
Max SCC O/P Amps	240/160	320/216	400/270	338/253	400/300	400/300	375/330
Peak Charging Efficiency	94%						
B. SOLAR INVERTER							
Nominal Capacity (Total)	60 kW	80 kW	100 kW	125kW	150kW	200kW	250kW
Output Amps per Phase	87	115	144	180	217	289	361
Nominal Battery Voltage	240/360			360/480			480/576
Output Voltage/ Frequency/Phase	400(±2%) / 50/ 3P+N						
Load Power Factor	0.8- Unity						
Peak Efficiency	>92 %			>94 %			
Overloads: 60 sec/ 30 sec/ 5 sec	101-110%/111- 125%/126- 150%					101-110%/111- 120%/121-130%	
Auto Bypass Feature	Provided						
Anti-Islanding/ Power Export to Grid	Provided (As per IEC 62116 & 61727)						
C. GRID CHARGER							
Grid Voltage Operating Range	400V (+10% & -20%)						
Grid freq Operating Range	50Hz (+5% & -5%)						
Max Import Power	90kW	120kW	150kW	188kW	225kW	250kW	300kW
D. PROTECTIONS & DISPLAY PARAMETERS							
	PROTECTIONS				DISPLAY PARAMETERS		
PV Side Battery Side Grid Side Load Side System Protection	• Reverse Polarity, PV Power Limit, Surge Protection (MOV) • Reverse Polarity, O/U Voltage, Current Limit • O/U Voltage, O/U Frequency, Surge Protection (MOV) • Overloads, Short circuit, Surge Protection (MOV) • Over Temperature				• Voltage, Charger O/P Amps, Power, Cumulative Energy • Voltage, Current, Battery State • Phase Voltage, Frequency, Power, Power Factor • Voltage & Current, Frequency, Power, Export kWh. • Mode of Operation, Active Faults, Status Mimic		
E. MISCELLANEOUS							
Switchgear Protection	MCB/MCCB provided on PV, Battery, Load & Grid path.						
LED Indications	Mains On, Alarm, Buzzer Mute.						
Data Port (RS485/ RS 232)	Optional (Available on Request)						
Remote monitoring	Optional through GPRS based Modem						
Ingress Protection	IP-21 (Indoor Type)						
Cooling Method	Force Cooling (Temp Controlled)						
Operating Temperature	0-50 degrees (without Derating)						
Humidity	Max. 95% Non-Condensing						
Altitude	1000m above sea level						
Color Shade	RAL7035/ DA GREY HEIS005						
Dimensions (H X W X D)	1040X650X965	1900X1050X800			2125X1200X1200		
Wheels Available (Y/N)	N	N	N	N	N	N	N
Net Weight in (Kg) Approx.	475 Kg	1050 Kg	1068 Kg	1135 Kg	1135 Kg	-	-

APPENDIX-7 : TERMS AND CONDITIONS OF THE WARRANTY

Statcon Energiaa Pvt. Ltd. (henceforth SEPL, the company, manufacturer, Statcon Energiaa Pvt. Ltd.) warrants to the end-purchaser, provided the purchaser is able to provide valid and legal invoice receipt as well as warranty card duly signed by the dealer/ manufacturer. If any defect(s) should be found in SEPL's manufactured PCUs within the warranty period, SEPL's only obligation is to repair or replace, at its sole discretion, any part shown to be defective, with a new part or equivalent at no cost to the owner for parts or labour. Such defective parts, which have been replaced, shall become the property of SEPL. The owner/end-customer is responsible for any repair or replacement that are not covered under this warranty. Products once sold will not be replaced or bought back.

The product warranty period will be preferred as per sales agreement with terms and conditions, the regular warranty period for the products is 27 months from the date of dispatch from manufacturer or 24 months from date of purchase, whichever is earlier, unless mentioned differently by SEPL in th signed Warranty Card (not applicable for spares or consumables). Consumables items in the products like string fuses, SPD, MOV, switches, plugs, timer, door locks, sockets etc. are excluded from warranty will be replaced on a company-defined chargeable basis. Warranty on items such as contactors, relays switchgears and circuit breakers are covered for one year only. The warranty will be valid only if the product is used within its manufacturer-advised specification, as stated in product manual supplied along with the product. The warranty for the replaced components will lapse along with that of the main instrument. SEPL reserves the right to make changes in design and specification without notice and without obligation to install changes in unit previously supplied. Repairs are performed at site for ratings ≥ 3 kVA. For ratings below 3 kVA, units will be replaced at our nearest available service centre.

Warranty for spares order will be separate. the warranty will automatically terminate upon the expiry of the warranty period, even in case of the product not being in use in the specified period. The purchaser shall intimate any change of address to the concerned authorised Service Centre and the warranty will be applicable only after the inspection of the unit and clearance of the product condition by authorised Service Centre personnel. Only authorised representative/ dealers of the company, across India, can provide free service under the terms of warranty, if found otherwise, the warranty will stand null and void. For a warranty claim to be valid, the warranty card of the respective product bearing the date of manufacturing/ purchase must be fully legible and the end customer invoice, must be available. SEPL' HBD, ECO HBD, ESS, SEOG MPPT series of PCUs are used with battery only, and SEPL shall, in no way, be responsible for cases like battery failure, poor battery back-up, poor solar generation, or an increase in electricity bills. Also SEPL will not be responsible for the poor quality of site-workmanship (installer-workmanship), plant electical wiring, load-segregation, lightning/ surge protection devices on the site (essential elements for solar site), proper earthing and earth arrangement and fluctuation and/ or voltage surge on the Grid/ Mains side.

The company will not held liable in any condition for any loss, injury or damage caused to life or property, or death and disability caused to any form of life for any reason whatsoever. In any situation whatsoever, any claims arising out of this will not exceed the basic cost of the said Inverter/PCU as per SEPL's invoice for the said serial number. In case of sale of non-manufactured items (as part of combo billing or other-wise). SEPL's liability is only limited to the extent of forwarding any warranty-related issues to the respective manufacturer of the product, who will be directly giving service and will be liable. for this, the original warranty card of the respective item's manufacturer will be supplied. The company expressly denies the right of any person to incur or assure, on behalf of it, within the warranty period, a product exhibits a defect which compromises its functioning (a warranty claim), the company will at its discretion, either repair the product at the premises, or replace its part(s) (if deemed necessary by the manufacturer) with a used or new one, of equivalent type and age.

Purely aesthetic defects which have not effect on product functionality or operability are not covered under the warranty. This includes sound, weight, lack of wheels, display brightness level, buzzer, and so on. If SEPL decides that a defective product is to be repaired at the end-customer's premises, it will arrange for the repair on a mutually decided date with the end-customer and/or Installer.
The company then sends an authorised service engineer to the customer's premises at the arrange date and time. SEPL reserves the right to decide as to whether the out of warranty repair work should be carried out at the company's service centre, at site or any other place. the freight incurred fo to end for dispatch of the defective material will have to be borne by the customer, and the transit risk for the material will rest with the purchaser. The warranty is valid only for end-customer residing in India and within a 100km radius of the

distributor purchased from, unless a written letter or email by the manufacturer is provided for longer distances. Selling in war-prone areas, hill-terrain regions without informing the manufacturer will lead to lack of servicing from the manufacturer.

Place not covered under warranty - Andaman & Nicobar Island, Kerala, Leh, Tamil Nadu, Andhra, Tripura, Mizoram, or any other place not accessible by Indian Railways or Govt. buses. Claims, if any, to this warranty shall be made only before courts having jurisdiction in Gautam Buddha Nagar, Uttar Pradesh.
The warranty will not apply if the original enclosure is found opened or tampered with, Warranty in case of defect caused by household pets, rats, cockroaches or other animals or insects in invalid. The warranty will be invalidated if defects arise, in company's assessment. due to accident, abuse, misuse, neglect, improper transport, improper installation (if not undertaken by the company or its representative), fire, flood, water seepage, other acts of God (force majeure), natural calamities and any other un-authorised repairs done. Such repair expenses will have not be borne by the purchaser, Services given for the same will be paid services. It is mandatory that said PCU is stored/kept under use a dust-free and covered area with free airflow available. It is not designed for use in open under the sun, unless very specifically deigned manual. Intimation installation so as to avoid installation-authorisation and for claiming this warranty.

Warranty of your PCU shall become null and avoid in the following cases:

- Force majeure (for example: storm damage, lightning, fire, thunderstorm, flood, Covid-19 related lockdowns, earthquakes etc.
- Incorrect use or operation/ installation and commissioning (for example: loose connection of AC and DC wires, unclean panels, fluctuating or low voltage from grid, overload at customer end, improper string connection, angle of panels, low gravity of batteries, improper maintenance of batteries etc.)
- Failure to comply with the operating, installation and /or maintenance manual.
- Heavy soiling with dirt or dust, or water/ moisture inlet into the product.
- Transportation damage, where transport has not been done by the manufacturer.
- Changes to the product or repair attempts without prior approval/ authorisation from SEPL.
- Failure to comply with the applicable safety regulations.
- The PCU is not concerned properly and/or is used incorrectly.
- The content (e.g., the date of purchase, credential etc.) of the warranty card and invoice are found to be tampered with.
- The serial number on the barcode is not same as on the PCU.

Thank you for choosing Statcon Energiaa

APPENDIX-8 SERVICING AND CUSTOMER CARE

In the unlikely event that you encounter any technical issues with one of our products, please contact our servicing customer support in one of the following ways:

1. Email us at servicing@energiaa.in
2. Call us at 1800-891-3319 (toll free)
3. Message us on Energiaa Care WhatsApp: +91-9821396421
4. Scan the QR Code below and directly message us on WhatsApp:

5. Visit us at www.energiaa.in for updated servicing contact details and to know more about our product range.

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