Three-Phase Uninterruptible Power System

Configuration Details:

UPS System, connected in standalone operational mode, shall be provided to supply uninterrupted power for the Server/ Network loads. Battery banks to give total 15 minutes back up on the above mentioned UPS system shall be provided for the units feeding to Server/Network loads.

1.0 General
1.1 Summary

The units will have state-of-the-art technology with high degree of reliability in operation for continuous operation, i.e. 24 hrs, 365 days an year. This specification defines the electrical and mechanical characteristics and requirements for a continuous duty, highly reliable stand alone type **true on-line double conversion UPS system using PWM IGBT technology** i.e. the Rectifier of the UPS system converts the input AC power to DC and then the inverter converts the DC into clean AC power. The UPS must use the most advanced Microprocessor technology. The UPS shall provide high quality AC power for sensitive electronic equipment loads. It should also supply clean power automatically without any break in the supply in the absence of raw power. Under no conditions will the protected system get direct supply from the raw mains unless there is fault in the protected system. The Block diagram of the UPS system should be as shown in Block Schematic Fig. 1.

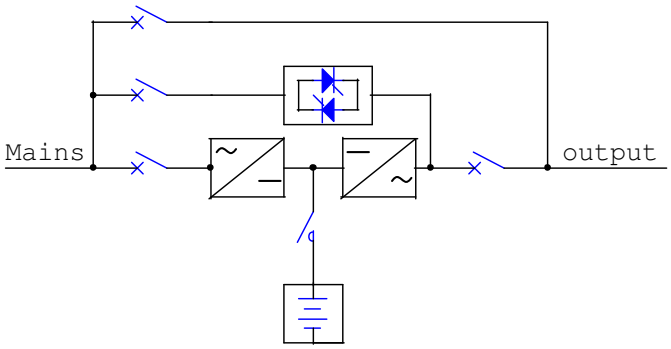

Fig-1

The major items constituting of the blocks of the above schematic Fig.-1 are shown as below in Fig-1(A).

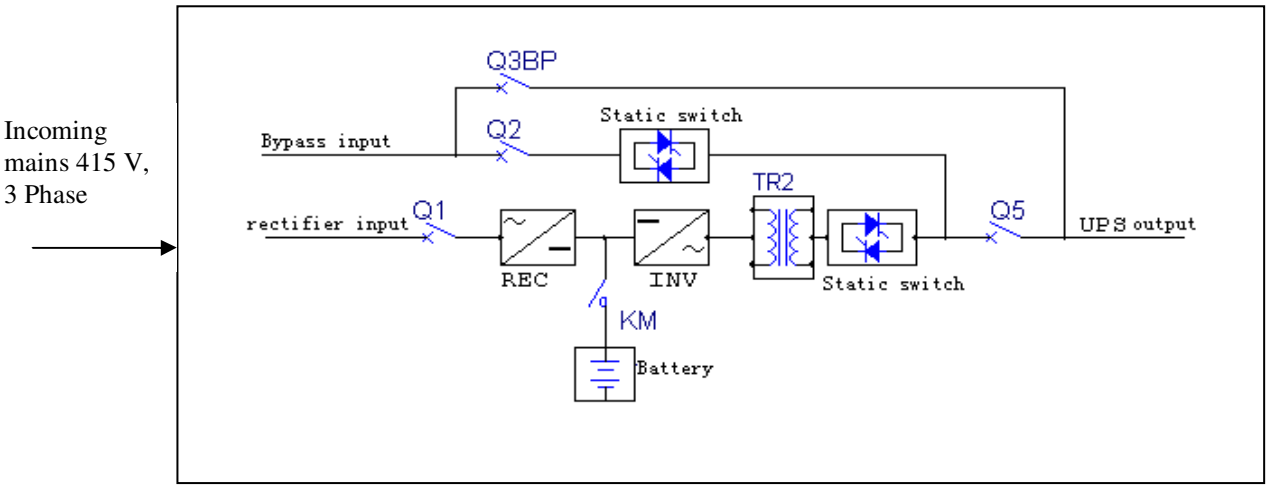

Fig.-1(A)

The main circuit and the bypass can use the same or different sources as per the discretion of customer. The details of the above schematic are as given below:

Q1: Connects rectifier to Utility source

Q2: Connects bypass to Utility source

Q5: Connects UPS output to the Load

Q3BP: Connects bypass input source to the load switch

KM: Battery Circuit Breaker

TR2: Galvanic Output Isolation Transformer (Delta- Zigzag)

REC: Rectifier Module

INV: Inverter Module

System Configuration and operation in normal conditions:

The utility source should be input at Q1 and should pass through the fuse, and inductor and into the high frequency rectifier, which will convert the AC power into DC power. The rectifier should have PFC and charger function and should make use of soft start and microprocessor based control to improve the system immunity against surge, improve the stability of the DC bus voltage, reduce the charging current ripple and prolongs the battery life.

The output should be isolated from the load by Delta-Zigzag transformer, static switch, fuse and isolators.
The bypass source should be input at Q2 and output through the bypass static switch as mentioned in above Fig-1(A).

The main elements of the configurations are:

- Fully Microprocessor Controlled SCR Based, **6 pulse** Rectifier
- Fully Microprocessor Controlled PWM IGBT Based Inverter
- Delta / Zig Zag Isolation Transformer at the O/P of the Inverter to provide Galvanic isolation and separating the I/P and O/P Neutral.
- Full Capacity Static Switch at the O/P of the Inverter
- Full Capacity Static Switch in the Bypass path
- Full Capacity Manual Bypass Switch

Please note that all the above mentioned elements should form a part of the UPS system and are to be in the same sequence as mentioned in the Fig.-1 (A) along with all the Isolators etc. within a Single Cabinet.

2.0 Modes of Operation

The UPS shall be able to operate as an on-line reverse transfer system in the following modes:

2.1. Normal mode

When the utility is normal, the UPS powers the load through the rectifier and inverter and charges the batteries at the same time, as shown in Bold Lines in Fig-2 (A).

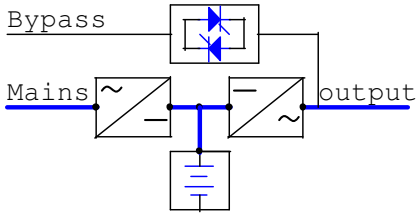

Fig-2 (A)

2.2. Emergency/ Battery Mode - When the utility fails, the UPS system shall switch to battery mode without interruption and the battery will power the load through the inverter.

The UPS shall return to normal mode automatically when the utility returns to normal, shown in Bold Lines in Fig-2(B).

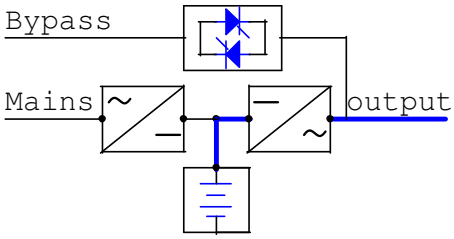

Fig.-2(B)

2.3. Recharge - Upon restoration of AC input power, during the 'Emergency' mode of operation, the rectifier/charger shall automatically restart, walk-in, and gradually assume the inverter and battery recharge loads.

2.4. Bypass - In the event of an inverter overload which last longer than the typical time, an output short circuit or a fault on the inverter, the UPS will transfer the load to bypass. There should be two kinds of bypass modes. In the first kind, the UPS can be set to return to normal mode automatically when the fault is cleared. In the second kind, the UPS is set to return to normal mode only with a manual transfer.
When the main UPS circuit fails, the battery is depleted or a severe fault occurs, the inverter shall be shut down and the system will remain in the bypass mode. The system can return to normal mode only with a manual reset after the fault is cleared, shown in Bold Lines in Fig-2(C).

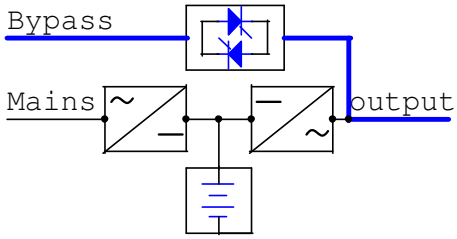

Fig.-2(C)

2.5. Maintenance Mode

When the UPS has to undergo routine maintenance, the UPS shall be set to maintenance mode by switching on the maintenance bypass circuit breaker. The load will be powered from the maintenance bypass supply without interruption.

During maintenance, the circuit breakers Q1, Q2, QF1 and Q5 should be switched off to ensure the safety of maintenance personnel. As shown in Bold Lines in Fig-2 (D).

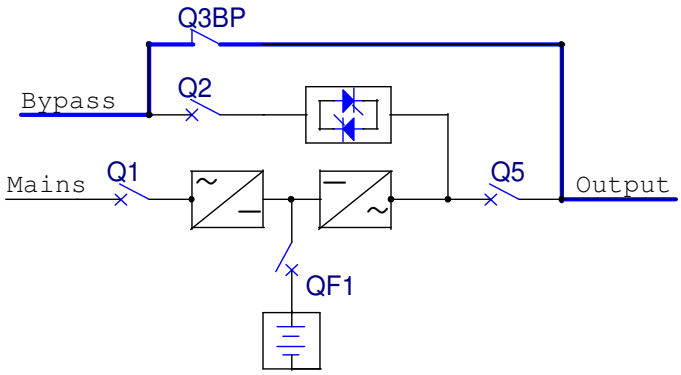

Fig. –2(D)

2.6 Basic Functions

Battery Management Function - The UPS has advanced battery management functions including battery fault detection and backup time forecast.

Soft Start Function - Complete delay soft start function can reduce the surge to the UPS unit and utility source.

Alarm and Protection Function - The UPS can generate audible and visual alarm through LCD, input/output contacts and network transmission. It can help maintenance personnel to locate and clear the faults that are sent out in time, accurately and in detail.

Automatic Re-start when Utility returns – On failure of the input mains supply the UPS goes to battery mode. After the batteries are completely discharged the UPS system shuts down. It must automatically restart on the resumption of the input supply.

1.2 SYSTEM DESCRIPTION

1.2.1 Design Requirements - UPS Module

A. Voltage.

Input/Out voltage specifications of the UPS shall be:

Rectifier Input: (380) (400) (415) volts, three-phase 4-wire-plus-ground.
Bypass Input (if used): (380) (400) (415) volts, three-phase, 4-wire-plus-ground.
Output: (380) (400) (415) volts, three phase, 4-wire-plus-ground.

B. OUTPUT LOAD CAPACITY

Specified output load capacity of the UPS shall be rated kVA at 0.8 lagging power factor.

1.2.3 PERFORMANCE REQUIREMENTS

1. AC Input to UPS

A. Voltage Configuration: three-phase, 4-wire plus ground.
B. Voltage: (380) (400) (415) V
C. Voltage Range: +/-15% of nominal.
D. Frequency: Field selectable 50Hz or 60 Hz

E. Frequency: Nominal frequency + 5%
F. Voltage distortion The harmonic content introduced into the mains supply shall comply with IEC 61000-3-4 / AS2279 Part 2 for harmonic voltage distortion at the Point of Common Coupling (PCC) with other loads. Where higher impedance Mains or Generator supplies are present, the manufacturer shall offer reduced current distortion options to ensure IEC 61000-3-4 / AS2279 Part 2 requirements are complied to when interfaced with the proposed UPS system.

2. AC Output, UPS Inverter

A. To isolate the input disturbances from the output side a **Galvanic Isolation Transformer** is mandatory to be included in the design at the output of the Inverter.

B. Voltage: (380) (400) (415) V

C. Voltage Configuration: three-phase, 4-wire plus ground.

C. Voltage Regulation: ± 1% steady state.

D. Frequency: Field selectable 50 Hz or 60Hz, (+ 0.5 or 2Hz adjustable).

E. Frequency Slew Rate: 0.1 to 1Hz /sec adjustable

F. Phase Displacement: ± 1 degree for balanced load.

± 1 degree for 100% unbalanced load.

G. Voltage Distortion: 1% Typical 2% maximum for liner loads

<5% total harmonic distortion (THD) for 100% non-linear loads with 3:1 crest factor.

H. Output Power Rating: Rated kVA at 0.8 lagging power factor.

I. Overload Capability: 110% for 60 minutes
125% for 10 minutes
150% for 1 minute
200% single phase for 30 secs

J. VOLTAGE TRANSIENT RESPONSE: ±5%

K. Transient Recovery Time: to within ±1% of output voltage within 20 milli secs

L. Voltage Unbalance: Balanced load 1%

100% unbalanced load 2%

M. Inverter Short Circuit Current Limit:
150% full load current for 5 seconds
220% single phase for 5 seconds

1.3 ENVIRONMENTAL CONDITION

1.3.1 The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

A. Operating Ambient temperature
UPS Module: 0ºC to 40ºC
Battery: 25 ± 5ºC

B. Storage/Transport Ambient Temperature
-25ºC to 70ºC

C. Relative Humidity: <90% at 20ºC

D. Altitude Operating: to 1000 meters above mean Sea Level de-rated for higher altitude applications. 1% per 100m between 1000 & 2000

E. Audible Noise
Noise generated by the UPS under any condition or normal operation shall not exceed 60 dbA measured 1.5 meters from surface of the UPS.

1.3.2 Design Requirements - Matching Battery

A. Battery Cells: Sealed, lead-acid, valve-regulated.

B. Reserve Time: 15 minutes at full load, 0.8 power factor, with ambient temperature between 20 and 30ºC.

1.4 UPS Delivery Submittals

Submittal upon UPS delivery shall include:

One instruction manual: Manual shall include a functional description of the equipment with block diagrams, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.5 Quality Assurance

1.5.1 Manufacturer Qualifications
A minimum of five year's experience in the design, manufacture, and testing of solid-state UPS systems is required. Standards ISO90001, CE certified to level A of EN55022.

1.5.2 Factory Testing
Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification.

2.0 PRODUCT

2.1 Fabrication

2.1.1 Materials
All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.

2.1.2 Construction and Mounting
The UPS unit, comprised of input isolator, rectifier/charger, inverter, static transfer switch, maintenance bypass switch, and static bypass input switch should be housed in a freestanding steel enclosure with key-lockable doors. Front access only shall be required for expedient servicing, adjustments, and installation. The enclosure will be built to comply with IP20 when the doors are open. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color. The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug-in. Like assemblies and like components shall be interchangeable.

2.1.3 Cooling
Cooling of the UPS shall be forced-air. Low velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output. Temperature will be monitored by thermal sensors.

2.2 Components

2.2.1 Rectifier/Charger

A. General
The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be **12 Pulse three phase-controlled thyristor bridge type** with constant voltage/current limiting control circuitry. Input Current harmonic has to be < 10 %

B. Input Current Walk-In
The rectifier/charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 10-second time interval after input voltage is applied.

C. Fuse Failure Protection
Power semiconductors in the rectifier/charger shall be fused with fast-acting fuses, so that loss of any one-power semiconductor shall not cause cascading failures.

D. DC Filter
The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 1% RMS. The filter shall be adequate to insure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.

E. Battery Recharge
In addition to supplying power for the inverter load, the rectifier/charger shall be capable of producing battery-charging current to recharge the battery. After the battery is recharged the rectifier/charger shall maintain the battery at full charge until the next emergency operation. The charging shall be an automatic cycle per DIN 41772 characteristic I -U (boost to floating charge switching, with current measuring criteria and control during recharge). Both float and recharge voltages shall be adjustable. The charge voltage can also be manually controlled. The use of the inverter is inhibited during manual charging.

2.2.2 Inverter

A. General
The term inverter shall denote the solid-state equipment and controls to convert DC power from the rectifier/charger or battery to regulated AC power for supporting the critical load. The inverter shall be an **Insulated Gate Bipolar Transistor, phase-controlled, pulse width modulated (PWM)** design capable of proving the specified AC output.

B. Overload Capability
The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 150%

of full load current. A status indicator and audible alarm shall indicate overload operation. The UPS shall

transfer the load to bypass when overload capacity is exceeded.

C. Fault Clearing and Current Limit
Without bypass supply available to the inverter shall be capable of supplying an overload current of **200% of its full-load rating in excess of Thirty Seconds**. For greater currents or longer time duration, the inverter shall have electronic greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The inverter shall be self-protecting against any magnitude of connected output overload (Vce Trip). Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement **to clear protective fuses**.

D. Output Frequency

The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to + .01% for steady state and transient conditions.

E. Isolation Transformer: To isolate the input disturbances from the output side a double wound delta-zigzag transformer to galvanically isolate the input from output is mandatory to be included in the design at the output of the inverter as shown the Figure 3 below. The isolation transformer will be connected as shown in the Fig 1(a). The combination of the inverter and Output isolation transformer shall form a **separately derived source** wherein the Input neutral and the three Phases are completely isolated from the output neutral and the three phases.

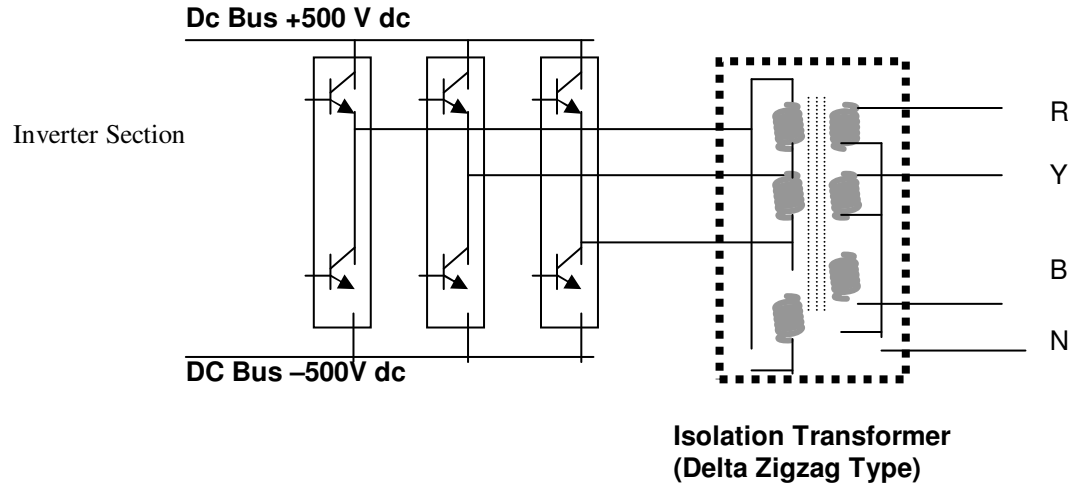

Fig. - 3

2.2.3 Display and Controls

A. Monitoring and Control
The UPS shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. A system controls section designed for convenient and reliable user operation. A system power flow diagram, a percentage load and battery time remaining display shall be provided as part of the monitoring and controls sections, which depicts a single-line diagram of the UPS. Illuminated visual indicators shall be of the long-life light-emitting diode (LED) type. All of the operator controls and monitors shall be located on the front of the UPS cabinet. The monitoring functions such as metering, and alarms shall be displayed on an alphanumeric LCD display. Additional features of the monitoring system shall include:
Menu-driven display with test format selectable in five (5) languages (English,
German, French, Spanish, or Italian).

B. Metering

The following parameters shall be displayed:
Battery voltage
Battery charge/discharge current
Input voltage and frequency
Output AC voltage line-to-line and line to neutral and % load used of nominal capacity for each phase.
Output AC current for each phase and neutral
Output frequency
Active Power (kW) Apparent Power (kVA)
Temperature - Ambient, battery, inverter assembly module

C. Warning and Alarm Messages

Normal Operation Input breaker open
Output breaker open Rect. breaker open
Battery breaker open On Manual bypass
Bypass absent Bypass over limits
Bypass under limits Bypass freq. over limit
Bypass Phase Rotation Bypass SCR fail
Bypass inhibit Local Bypass inhibit remote
Load on bypass on bypass due to over temperature
Rectifier off Local Rect. off remotely
Rectifier Block Rectifier overload
Rectifier over temp Rectifier Fuse fail
Inverter off local. Inverter off remotely
Inverter block Inverter overload
Inverter over temperature. Inverter out of sync
Inverter over voltage Inverter under voltage
Inverter fuse fail D.C Volts High
D.C Volts low Inverter no voltage
Inverter Peak Volts low Battery under test
Battery test fail Discharge battery
Battery E.O.D. Boost Charge
DC Bus over volt Battery Low
Battery Fuse Fail Bat. Fast over volt
Bypass overuse Cut-off overload
Cut-off overtemp Cut-off emergency stop
Overload Cut-off max overload

Software Warnings

Bad EPROM program Err. LRC param. Pag 1
Err. LRC Param Pag 2 Err. LRC Param Pag 3
Err. LRC Alarm Hist Err. LRC Even Hist
Back-up battery low Error LRC table
Error LRC Panel Modem Wrong Config
Modem no response Modem false command
Modem time-out trasm Can bus no response
Autonomy XXXX min

D. Controls

Four pushbuttons shall be located on the operator control panel.

Enter
Escape
Up
Down

The push buttons shall permit the operator either to select options from a menu for display on the LCD winder or to change the value of some parameters. One push-button and alarm silence switch.

E. Power Status Diagram

A mimic panel shall be provided to depict a single line diagram of the UPS.
Indicating lights shall be integrated within the single line diagram to illustrate the status of the UPS. The three LEDs shall indicate the following status.

Bypass voltage OK
Load on bypass
Load on inverter

Included in the power status diagram shall be an LED bar graph indicating % load with amber overload indication. Also an LED bar graph indicating % battery time remaining shall be included.
Ethernet Connectivity Interface Port
An Ethernet Connectivity based interface port shall be provided for remote display of UPS status information on a computer terminal (by others).

2.2.4 Static Transfer Switch

A. General
Static transfers switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously and shall have a contactor in the output of the inverter circuit to enable the critical load to be connected to the inverter output or bypass power source. the static transfer switch control logic shall contain and automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.

B. Uninterrupted Transfer

The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:
Inverter overload capacity exceeded
Critical AC load over voltage or under-voltage
UPS fault condition.
The transfer control logic shall inhibit and automatic transfer of the critical load to the bypass source if any of the following conditions are present:

- Inverter/bypass voltage difference exceeding pre-set limits
- Bypass frequency out of limits
- Bypass out-of-synchronization range with inverter output.

C. Uninterrupted Retransfer
Retransfer of the critical AC load from the bypass source to the invert output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:

- Bypass out of synchronization range with inverter output
- Inverter/bypass voltage difference exceeding pre-set limits
- Overload condition exists in excess of inverter full load rating
- UPS fault condition present.

2.2.5 Maintenance Bypass Isolator

A. General
A manually operated maintenance bypass isolator shall be incorporated into the UPS cabinet to directly connect the critical load to the input AC power source, bypassing the rectifier/charger, inverter, and static transfer switch.

B. Maintenance Capability
With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, invert, battery, and static transfer switch.

C. Wall Mounted Battery Circuit Breaker (BCB)
A battery circuit breaker shall be provided to isolate the battery from the UPS. This breaker together with battery circuit breaker controller board shall be in a separate wall mounted enclosure. The battery breaker provides a manual disconnecting means, short circuit protection, and over-current protection for the battery system. When opened, there shall be no battery voltage in the UPS enclosure.

D. Split Bypass standard feature
UPS shall have both a rectifier input and bypass input. Two separate input sources must be provided. An internal bypass circuit breaker shall be provided for connection to the bypass source.

3.0 FIELD ENGINEERING SUPPORT
The UPS manufacturer shall directly employ a national field service network staffed by factory trained field service engineers to provide start up, maintenance and repair of the UPS equipment.

TECHNICAL SPECIFICATIONS OF 30 KVA UPS SYSTEM

	UPS TOPOLOGY	True on-line double conversion PWM IGBT based.
A	**INPUT**	
1	Input voltage	415V, 3 phase, 4 wires
2	Input voltage tolerance	+10 % , -15%
3	Input frequency	50 Hz
4	Input frequency tolerance	+/- 5 %
5	Input current limit	115% (Adjustable between 100 - 125%)
6	Power walk - in period	30 seconds
7	Input circuit	IGBT rectifier. Input current harmonics <10%.
8	Inbuilt Input & Bypass Isolator with SFU	Required, Isolator with fuse unit.

B	**OUTPUT**	
1	Module full load rating KVA/ KW	100 kVA/ 80 kW
2	Rated voltage	415 V 3 PH, N
3	Rated current	Vendor to specify
4	Phase Voltage asymmetry (For Three Phase output UPS only) a] Balance load b] 100% unbalanced load	 1% 2%
5	Voltage Phase shift (In case of three phase Output UPS) - with balanced load - With Unbalanced laod	 120 +/- 1 deg 120 +/- 1 deg
6	Output voltage adjustment range	+/- 5%
7	Phase displacement (In case of three phase Output UPS) a] Balance load b] 100% unbalanced load	 120 deg. +/- 1 deg 120 deg. +/- 1 deg
8	Output power factor range	0.7 to unity
9	Internal oscillator stability	+/- 0.2 %
10	Mains synchronization tracking	+/- 1 Hz (settable to +/-2)
11	Max. rate of change of frequency	1 Hz. Per second
12	Output voltage harmonics a] Linear load b] Non-linear load (Crest factor of 3:1)	 < 1% < 5 %
13	Crest Factor	3 : 1
14	Overload rating	110% for 60 minutes 125% for 10 minutes 150% for 60 seconds
15	Overload trip	10 min at 125% reducing to 60 seconds at 150%
16	Inverter Efficiency	> 92 %
17	Current limit short	Set at 150% of the output power
18	Transient Response a] 100% load change b) Manual transfer of load from UPS to bypass and vice-versa C] Automatic transfer of load form UPS to bypass	 < +/- 5% 0 msecs. when in sync 0 msecs. in sync

19	Transient recovery time	Recovery to +/- 3 % in < 4 msec.
20	Manual Bypass Isolator	One with each UPS Module

C	**DC CHARACTERISTICS**	
1	Nominal DC bus voltage	408 V
2	Battery isolation	Manually closed circuit breaker with under voltage release and over current trip
3	Battery fully discharge voltage	326V
4	Allowable voltage drop in battery cables	3 volts at end of discharge voltage.
5	Battery float voltage	459 V
6	Battery end voltage	340 V
7	DC Bus voltage ripple	< 1 RMS
8	Battery recharge current limit	Amps, Vendor to specify
9	No. of cells	Vendor to specify

D	**CONTROLS**
1	Charger input Isolator
2	Battery circuit breaker (mounted separately in its own enclosure)
3	Inverter output Isolator
4	Bypass line Isolator
5	Maintenance Bypass Isolator
6	Alarm acknowledge / Reset button
7	Inverter On-Off Pushbutton for Manually switching of the Inverter
8	Emergency off push button
E	**MEASURING INSTRUMENTS**
1	LCD panel for Measuring Input Voltage, Output voltages, Output currents and Frequency, Battery Voltage and Charging / Discharging current.
2	LCD panel should display status of the Battery capacity and backup Time in minutes.
E	**PROTECTIONS**
1	RC surge suppressor.
2	Sustained under voltage on input side
3	Phase loss on input side.
4	Negative sequence on input side
5	Semiconductor fuses in the lines for thyristor
6	Snubber circuit for device dv/ dt protection
7	Charger input current limit
8	HRC fuses for filter capacitors
9	Battery current limit
10	DC over voltage
11	Low battery
12	Semiconductor fuses at inverter output
13	Overload
14	Over temperature for the inverter
15	HRC fuses in the control circuit
F	**INDICATIONS (ALARMS)**
1	Inverter Failure
2	Overload (if load exceeds 100%)
3	Overload shutdown
4	Emergency shutdown
5	Equipment over temperature

6	Maintenance Bypass ON
7	DC over voltage
8	Low battery
9	Battery circuit breaker open
10	Battery on load
11	Mains failure
12	Rectifier Failed or Off
13	Inverter Unsynchronized
14	Load on bypass
15	Output voltage error

G. DC link characteristic for total 15 Min. battery run on 30 KVA KVA UPS System	
No. of SMF lead acid batteries	Vendor to Specify rating and no.
AH rating of one 15 Mins. Bank	Vendor to Specify rating and no.
Model / Make	G & Y/ Panasonic/ Rocket
Float voltage	459 V
Final discharge voltage	340 V
Voltage tolerance	+/- 1 %
DC ripple	< 1 %
Charging current limit	10 %
Battery Isolation	With U/V release type Battery Circuit Breaker

Mechanical Dimensions:

Weight of UPS – Kg	Vendor to specify
Dimension of UPS (L x D x H) in mm	Vendor to specify
Ventilation	Forced air cooled with internal fans
Protection Level : * with enclosure closed * with front doors open	 IP 20 IP 20

Environmental:

Operating temperature	0 – 40 deg.C.
Relative humidity	< 90 % (20 deg. C.)
Altitude	1000 m
Storage temp.	from -25 to + 70 deg. C.