

EXECUTIVE SUMMARY

0.1 NEED FOR UPS

Electronic equipment, process control, medical equipment and computers often require highly reliable power supply. Also the supply should be without fluctuations. Even a well designed power supply system cannot ensure a level of reliability.

In India, the electric power projections depict a shortfall in power generation. The quality of power is also not as desired. Therefore, a suitable power conditioning system is needed to buffer the equipment from electric utility supply variations and fluctuations.

UPS (Uninterrupted Power Supply) is a power conditioning equipment that allows for a smooth changeover to mains operation on resumption of power. It also has the capability of taking care of the following problems :

- brownouts
- voltage sags
- voltage surges.
- transient surges
- impulses
- noise
- harmonic distortion

0.2 COMPONENTS OF UPS

A UPS normally consists of a battery charger/converter and an inverter. The battery charger has an input isolation/step-down transformer whose output is rectified to get a required DC output which is used to charge the battery. The same output is used, in most cases, as input for the inverter which converts DC into AC output.

When the mains are on, battery is charged by the converter, which also supplies input to the inverter. When the mains fail, the charged battery acts as the input source for the inverter.

In India, a new trend seems to be emerging *i.e* the introduction of a solar battery charger. The cost of this charger is about 6-7 times that of an ordinary charger. This is because the solar batteries are right now being produced in very small quantities. The mass production of these batteries is bound to reduce the cost of production.

The reverse process of conversion is inversion. Various snubber and damper networks can be added to the basic inverter circuit to increase the residual spikes that prevail, despite appropriate considerations given to the transformer and feedback base drive.

Batteries constitute a vital subsystem of the UPS. The UPS unit may use lead acid or Ni-Cd batteries of various capacities. Batteries are characterized by the type, voltage and capacity in Ampere Hour (AH).

0.3

USES OF UPS

The application areas of UPS include mini and micro computers, large computers, computer peripherals, electronic cash registers, numerical control systems, programmable controller, process control equipment, electronic medical equipment, constant voltage and constant frequency sources.

In India, some of the major users of UPS are railways, telecom, textile and glass industry.

In railways, UPS are used for stationary applications *e.g.* signalling, mobile applications *e.g.* carriages and wagons, railway reservations.

In telecom, UPS are mainly being used for computers, though, some inverters are used in the telephone exchanges.

All processes which are continuous and not batch processes require continuous quality power supply. A reliable power supply is essential in all the three phases of textiles, manufacturing — spinning, weaving and printing.

A continuous power supply is most critical in synthetic spinning. The molten polymers are forced through the extruder which is power driven. Fluctuations can lead to variable speeds of extrusion. This will effect the viscosity of the polymers, thickness & length of the polymers and, lead to unevenness in the final fabric.

The process control equipment is very expensive. They are also sensitive to temperature and pressure. These are in turn dependent on quality of power supplied. Any power fluctuation can damage the instruments.

0.4. TYPE OF UPS

There are essentially two types of UPS; Online UPS which are also called true UPS and the offline UPS which are also called standby UPS.

The on-line UPS is in operation constantly. It also compensates power discrepancies, if any.

Off-line UPS are normally on standby status and are manually or automatically switched on. The mains are fed directly to the load through a transfer switch.

A Triport UPS can be similar to either Online or Offline. It combines the capability of the inverter and the efficiency of the power line to produce a low cost product.

0.5. TECHNOLOGY OF UPS

Technology of UPS can be of three different types-rotary power source, standby power source and solid state power source.

A rotary power source consists of a battery driven DC motor that is mechanically connected to an AC generator. The battery is kept in a charged state by a battery charger that is connected to the commercial power line.

A standby power is the technology used in Off-line UPS. It consists of a battery connected to a DC-to-AC static inverter.

A solid state system has the general configuration of standby power system. The sensitive load operates continually from the output of the static inverter.

0.6 FEATURES DESIRED IN UPS

A number of supervisory and protection features are desired and normally provided in the UPS. The output should not give an over voltage, under voltage or over load trip. In addition, battery-related indications, are also desired.

A parallel redundant system is essential for Online systems where preservation of data is necessary. It refers to the connection of two UPSs in parallel so that they share the load. In case of the failure of one, the other takes over the entire load.

A UPS system should also provide for either manual or static bypass, so that the load may be serviced by the mains in the event of UPS failure or shutdown for maintenance.

0.7 MAJOR CAPITAL EQUIPMENT IN USE

Most of the large UPS manufacturing units surveyed have installed a computer for all CAD/CAM operations at their works. Colour plotters, Flow soldering units, Programmed multiple drilling machines are also installed at all big UPS manufacturing units. All units have installed Wave soldering equipment, Winding machines, Variable frequency meters, Variable voltage generators, Load testers.

0.8. PERFORMANCE OF THE INDUSTRY

The total Indian UPS market in the organized sector is estimated to be Rs. 60—70 crores. The demand for UPS is largely dependant on the computer market. The UPS market has not grown commensurate with the growth in the computer market due to high costs and lack of availability of reliable indigenous components. The industry is expected to register an increase of 20 to 25 %.

UPS can be conveniently classified into two segments; those systems with power output greater than 1 kVA and those with less than 1 kVA. The former finds applications in mainframes, hospitals, defence, process industry, telephone exchanges, remote microwave relays and so on, the latter largely caters to single PC users. Manufacturers of low capacity UPS had a setback last year as compared to manufacturers of high capacity UPS.

0.9 UPS MARKET

The UPS market has not grown commensurate with the growth of the computer industry due to the lack of availability of reliable indigenous components/subassemblies. Also, the cost of a UPS system can be as high as the cost of a PC.

The UPS market in India has increased only because of the undependable and unreliable AC mains power supply in the country.

At present, the major UPS manufacturers in the organized sector are NELCO, KELTRON and Aplab. The estimates show that NELCO commands about 80% of the market in the range of 55—400 kVA. It has a share of 60% in 15—35 kVA. KELTRON AND Aplab are major competitors in the range of 2—10 kVA. Companies like Aplab, KELTRON, NELCO and Instrumentation Ltd. cater to the high-capacity or the high end of the market, like applications in banks, hospitals, defence and other Government sectors.

The increase in low-capacity UPS systems is an offshoot of the growth of the personal computer industry in the country since 1985.

0.10 EXPORT POTENTIAL

The export potential of UPS is high. But the manufacturers have not been able to exploit it because of :

- high cost
- bulky nature
- lack of availability of add-on features
- high component cost
- lack of aesthetics

If the manufacturers are able to supply international quality systems at low prices, the market will be very large. There are isolated cases of exports by Aplab and a few other leading manufacturers to European and Middle-East countries. Some small scale units like Universal, have sold machines abroad but with some difficulty.

0.11 COMPONENTS/SUBASSEMBLIES

Production of most of the professional grade components is very low as they are material intensive and require electronic grade material which are imported. The manufacturing units operate at an uneconomic level with obsolete processes and are not able to match the prices of imported components.

According to estimates of the Department of Electronics, the raw materials constitute nearly 50% of the value of production of components. About 70% of the raw materials in value for producing components are imported and only the balance 30% are indigenous.

A study by Electronic Components Industries Association (EL-CINA), reveals that the indigenous components are priced 50 to 150% higher than the imported components, the average being around 80%.

The components industry is also characterized by absence of quality control, standardization and poor economies of scale. To produce international quality components automated plants, quality control equipment and good technology is essential.

The main components/subassemblies of the UPS are similar to any industrial electronic equipment which include.

- Integrated Circuits
- Transistors like Bipolar-Junction-Transistors, Metal Oxide Semiconductor Field Effect Transistors.
- Printed Circuit Boards
- Rectifier/Charger
- Inverter Circuits
- Capacitors
- Special cooling fans
- Microprocessor/Microcontroller
- Filtering Circuits
- Display Electronics
- Battery

0.12 FOREIGN COLLABORATIONS

It is interesting to note that all large scale units surveyed in the area of UPS manufacturing have a collaboration. About 55% of the respondents in the organized sector had foreign tie-up for supply of technology, while others had sourced the technology from within the country, for e.g. Maxx Systems had got the technology developed from IIT, Delhi. Among the organisations having foreign collaborations, 60% had only technical tie-up whereas 40% had both technical and financial tie-ups. Out of the units surveyed, only 20% of these organisations had collaborations valid during 1992. The small scale units surveyed did not have any collaboration.

Table 2.7 lists out all the major foreign collaborations in the field of UPS.

0.13

USER INTERACTION

The major users of UPS are either medical electronics or computer users or process control or PABX users. In India, the major users of UPS are Telecommunications, Railways and the Defence services.

The basic problems faced by the users seem to be lack of after-sales service and the fact that the response time is as high as 24 hours. This becomes a major problem because of :

- unstable power conditions
- non-availability of technical staff for maintenance from the user's side
- non-availability of spares from the open market.

Other major problems faced by the users are :

- battery does not get charged properly
- inverter breakdown
- maintenance charges are very high
- equipment is proprietary and maintenance contract cannot be given to anybody else.
- adaptability of UPS is very low.

0.14.

PROBLEMS OF THE INDUSTRY

The import duty on components is high making the final product very expensive. The quality of indigenous components/subassemblies is poor and needs to be improved. The manufacture of components/subassemblies is difficult because economies of scale are not present.

Despite the availability of technology for manufacture of high frequency UPS, the size of the UPS remains large and does not offer add-on features.

The low market growth is due to lack of awareness in the consumers. Though a small section of consumers are aware of the additional features of UPS, they are not willing to pay higher price for them. The low product quality and poor workmanship from the unorganized sector are competing with products from the high end of the market. Also there are no ISI standards.

0.15 INTERNATIONAL SCENARIO

In USA and Europe, most systems are on-line, therefore preservation of data is critical. Any power disturbance can render the entire data useless. Experts are of the view that 62 % of all computer problems are due to power disturbances. To avoid this, a UPS is a necessity in all these countries.

International Computer Power, USA is manufacturing rotary power conditioners. They are offered under the brand name of Roto-Plus. The basic features of this machine are that it has the capability of recharging the battery from full discharge to 90 % charge in less than 8 times the discharge time. The inverter is based on transistor technology. A fan cooled heat exchanger maintains the power devices at safe operating temperatures. The options available vary between automatic bypass switch, remote control panel, weather protective enclosure and 400 Hz output.

Liebert was founded in 1965, and has subsequently been merged with Emerson Electric. The Emerson Electric have proprietary right over the latest Application Specific Integrated Circuits (ASIC) technology. This technology has the advantage that the system can be matched to the application requirement. This has greatly reduced the number of components and interconnects. They are also using Very Large Scale Integration (VLSI). This has helped in achieving a reduction of 41% in the number of discrete components.

Precise Power Corporation is the only organisation which is manufacturing a UPS that performs without electro-chemical batteries. This machine uses a synchronous M-G set which has a relatively low output impedance. In this machine, the rotor has a continuous layer of high coercive magnetic material on the surface. This continuous magnetic layer can be written into any desired pole pattern by the exciter pole. One limitation of the PPC machine is that the UPS has a full ride through of 18—20 seconds as compared to 5—15 minutes for a typical battery system.

General Power UPS incorporates the latest semiconductor technology and circuit design. The output is not a simple version of what is on the utility, but it is completely new and contains none of the prior abnormalities.

Fiskars is manufacturing the 9000 series UPS which uses Insulated Gate Bipolar Transistors (IGBT), in a three phase inverter bridge, giving a higher operating frequency and thus lower losses and a higher power factor than in designs using bipolar transistors or thyristors.

Philips has introduced a new UPS which can supply a 200% overload current for short periods (around 1 sec) for starting loads such as disk drives, motors and laser printers. The UPS has a power factor of 99% using a switch conversion which acts as an active rectifier, producing the corrected sinusoidal input current and a pre-regulated output voltage.

SOCOMEC was founded in 1922, the rectifier supplies DC from the mains to the inverter and compensates the self discharge of the battery by supplying a constant voltage to the terminal plugs called the floating voltage. The rectifier recharges the battery after the UPS operation while mains are absent. Charging current is limited and voltage regulated in order to avoid any battery damage.

Holec is an Australia based organisation and has a separate Electro Magnetic Interference to filter out the noise and prevent alteration of data.

The microprocessor based Sola 45 UPS provides undisturbed power regardless of poor quality mains power. This UPS range has the additional feature of an output isolation transformer. Messages like 'Battery not charged', 'No phase lock' and 'Inverter overload' can also be flashed.

0.16 LATEST DEVELOPMENTS AT THE INTERNATIONAL LEVEL

Software features have been incorporated in the UPS to make it more efficient. The features offered vary. The software available can diagnose system crashes and other power related problems. Certain software can even track down output voltage, maximum and minimum voltage and UPS temperature. Some manufacturers have developed software which uses Artificial Intelligence to switch off the equipment connected to the UPS system in case of a major problem.

The latest UPS are incorporating the concept of an alarm system. Digital displays continuously show critical voltages and frequency. A front panel illustrates the power flow, indicating operation in the UPS mode or on bypass

A battery based system requires regular maintenance as batteries are sources of fumes/emissions and acid spillage. The manufacturers abroad are looking for alternatives. One such alternative developed in USA is a system in which energy is stored in the machine's rotating mass and when momentary power interruptions occur, the motor-generator set rides through without disturbing the load. The advantages of this technology are:

- absence of harmonic distortion which are introduced by the battery charger
- is very safe especially in applications like oil platforms and industrial processing where a normal battery based UPS is prone to explosion

- adequate ride through time to a standby generator
- full electrical isolation to protect sensitive loads.
- constant frequency output to protect the performance
- unity power factor and low input harmonics
- modularity and ease of paralleling
- solid state controls.

0.17 R&D EFFORTS

The basic UPS manufacturing technology available in the country is of an international quality, but constraints in availability of components like power semiconductors and magnetic devices reduce the chances of the Indian UPS to be able to compete in the international market. As a result of R&D being undertaken by large manufacturers, some companies have been able to develop UPS working on low cost indigenous semiconductors, instead of high cost imported components.

About 77% of the units surveyed, in the organised sector, have a R&D cell for development of newer and more efficient models. The expenses on R&D is in the range of 1—10% of the turnover. These manufacturers have about 10 technical personnel in their R&D division. Despite spending this effort on R&D, there have been very few components/ assemblies/sub-assemblies patented in the country.

The industry is carrying out R&D in a large number of areas like :

- regulated manual by-pass,
- active-reactive genset synchronising with the power loads,

- microprocessor based controls,
- fault indication and self diagnostic panel coupled with a PC and/or a printer,
- reduction in size.
- special batteries for UPS systems

0.18 TECHNOLOGY AVAILABLE

While Indian manufacturers have the capability to manufacture high frequency UPS, they are constrained due to non-availability of components like power semiconductors and magnetic devices . The production of such components in India, to international standards should increase.

0.19 FUTURE TRENDS

The future trends in UPS are towards

- indgenisation of the components
- compact noiseless UPS
- high efficiency systems
- fuseless systems

The R&D work carried out by educational institutions and organisations such as IIT, IISC, ETDC, SAMEER are in the following areas:

- extinction type phase angle controlled as against conventional phase control techniques for converter circuits to maintain the input power factor close to unity
- secondary break-down characteristics of bipolar transistors and the paralleling of bipolar transistors

- usage of MOSFETs especially at high frequencies with special reference to the higher voltage clamping device across gate-source and drain-source terminals
- incorporating GTOs as power devices in inverter circuits.

0.20 TESTING FACILITIES AVAILABLE

Large scale organizations which are manufacturing UPS have installed efficient equipment to provide testing and calibration facilities. They have installed harmonic distortion analyzers, storage and triggered oscilloscopes for waveform studying, function generators, frequency meters, multimeters, test jigs and loading systems for testing. Some of these equipment in use are imported but most of them are indigenously manufactured.

Small scale units have installed Transistors, Variable frequency generators, Variable voltage generators, Oscilloscopes and LED displays. All equipment used is locally manufactured.

DoE has established a countrywide infrastructure for testing and calibration. The facilities are provided under the STQC scheme. The infrastructure consists of, at present, four Regional Electronic Testing Labs (ERTL), and several state level Electronic Test and Development Centres (ETDC).

ERTLs are equipped with state-of-the art testing and calibration equipment. Some of the automatic test equipment and systems available are Multiprogrammer, Oscilloscope Measurement System, Data Generator/Data Analyzer, Impedance Meter, Programmable Pulse Generator, Sweep Oscillator, etc., besides some other specialized facilities like dynamic build-in facility for testing of LSI/VLSI devices, etc. The facilities available for environmental testing include Low and High Temperature, Humidity, Mould Growth, Corrosion, Dust and Sand, Shock, Vibration Bump and Leak Detection (Gross and Fine for hermetically sealed devices) etc. Details on the STQC scheme are given in Chapter 2.

0.21. INDIAN UNITS WITH RECOGNISED R&D

Continuous work is being undertaken to have a link between the work in the national laboratories and the industry to ensure effective utilisation of research inputs. Various units like Instrumentation Ltd., DB Electronics, etc., have been recognized by the Department of Scientific and Industrial Research for their R&D activities in the country.

0.22 LEVEL OF INDIGENIZATION

The industry claims that most of them have attained a level of indigenisation of nearly 80—90%. Even though the user industry is growing at a fast rate, the reason for slow growth in the UPS industry is that the component industry is not equipped to meet the requirements of high quality, high performance components of the UPS industry. The indigenisation of the UPS industry is largely dependant on the level of indigenisation in the component industry.

0.23. CONCLUSIONS

Based on the study, the following conclusions are arrived at :

The number of units manufacturing UPS is high, especially in the tiny sector which is dominated by kit assemblers who manufacture low quality products. They offer practically no after-sales service.

The basic technology for manufacture of UPS is available in the country though it is at a medium level. The peculiarity of this industry is that despite availability of technology it is not put to use, because of lack of an adequate component base.

The number of collaborations especially for UPS in the range of less than 1 kVA are not very high, technical and financial collaborations have been interred into in the higher kVA ratings.

Component base is almost nonexistent, the industry is heavily dependent on imports for critical electronic components.

In the case of electro mechanical and mechanical components, the gaps in the technical know-how and production expertise, exist in the areas of lower micron engineering and precision toolings.

There is lack of standardization, making it difficult to cater to the large variety and small quantity requirements.

There is a gap in respect of development of UPS which do not use batteries, or those which use software extensively. All the latest UPS abroad are incorporating the concept of an alarm system wherein a user specified telephone number can be dialled and the user can be informed about the inherent risk.

There is difference also in aesthetics. The models available abroad are sleek and light. They are better than their Indian counterparts in appearance and display electronics.

UPS manufacturers do not have any separate association.

The Indian manufacturers are carrying out R&D, but lack of funds inhibit development of international quality products.

0.24. RECOMMENDATIONS

A long term strategy for development of trained manpower should be formulated by the industry.

The industry should innovate and manufacture UPS which are sleeker. The UPS should use newer technologies like battery less UPS, incorporation of self diagnostic system, etc.

The units may collaborate, especially in the field of software usage, alarm monitoring and battery less UPS.

The manufacturers should form an association for experience sharing as well as to encourage the advent of latest technology within the country.

The component industry should produce international quality components. They should automate plants and import quality control equipment and good technology.

The Bureau of Indian Standards should encourage formulation of standards commensurate with ISO 9000. This industry in turn should facilitate the process.

The industry should make efforts to educate the client on advantages of UPS.