Development of the Small Capacity UPS "SANUPS" MODEL TYPE ASE-H

Toshifumi Nishizawa Hiroyuki Hanaoka Narumi Yanagisawa
Hiroshi Sakaba Kenji Ishiguro Tetsuya Yamazaki

1. Introduction

As IT technology develops remarkably, the reliability of Internet related communications equipment such as servers is highly demanded. In general, communications equipment, including the computer, is sensitive to changes in the power supply, and requires a steady and high quality power source. Therefore, the reliability of the uninterruptible power supply (UPS) providing the power is extremely important, and the development of a highly reliable UPS is demanded. Additionally, environmental concerns have increased the demand for a highly effective product that limits its excessive power consumption.

We have developed a new product, the UPS "SANUPS" MODEL TYPE ASE-H. The ASE-H makes parallel operation easy and features a small size, easy operation, network compatibility, and increased capacity while ensuring high reliability. Additionally, the ASE-H boasts improvements in maintenance and cost performance.

2. Background of the Development

2.1 Reliability

As demand for small capacity UPS devices increases to match the downsizing and networking of computers, small-capacity UPS devises require improvements in reliability. In a large-capacity UPS, the current/spare switching method and the parallel redundant method are already adopted and are widely used to provide a reliable system.

A parallel redundant method is an effective way to configure a highly reliable system with small-capacity UPS devices. It offers the benefits of a smaller size, ease of maintenance, individual control of each device, and lower costs. In addition, it is preferable to decrease the common parts of the main circuit and the control circuit as much as possible.

2.2 Economy

There are many competitors in the small capacity UPS market, each offering a number of products. Price competition is severe. Therefore, it is necessary to satisfy the demands of high reliability and increased capacity at a low price. A system that excels in maintainability and extendibility, with the ability to increase the power supply capacity easily with little capital investment, is preferable.

2.3 Environmental Consideration

In response to growing concern about global warming, there is a growing demand for a UPS with environmental considerations reflected in its design and energy efficiency.

ASE-H has been developed to meet such a demand.

3. Features

ASE-H is a system that makes 1kVA as a basic unit, and can drive up to five units in parallel, for an output capacity of 5kVA. Fig. 1 shows externals of ASE-H at 5kVA.

Fig.1 "SANUPS" MODEL TYPE ASE-H 5kV Rack Mount

3.1 High Reliability/Economy

(1) Parallel operation by individual control

It is necessary to match the amplitude, the phase, and the frequency of the voltage of each unit when the inverter is controlled in parallel. Also, cross-flow and load division between units must be managed. In order to meet these requirements, there are methods such as sharing a control part, master-slave method, and controlling amplitude and phase by comparing the current of a machine with another machine.

The master-slave method and the method of sharing a control part are suitable to add capacity to a system. However, because the system is influenced by a common part or the master machine, these methods are not suitable for a parallel redundant method. Detecting the current of another machine is also unsuitable for a small-capacity UPS, because the complexity of the cur-

rent detection circuit increases in proportion to the number of devices, causing the circuit to become too expensive.

To overcome these problems, ASE-H did not install the common control part, but rather adopted the individual control method by installing a parallel control circuit in each individual unit.

Units are linked together with serial communications, and each unit transmits startup/shutdown and measurement data to the other units. The operation and the display can be assumed to be the same with all units in ASE-H, and the operation of startup/shutdown can be performed from any unit. Moreover, there is no limitation to the connection of LAN interface card; any unit can be connected.

(2) Improvement in cost performance

The 3-arm system has been adopted for a main circuit. The circuit configuration was simplified by reviewing the circuit, and a reduction in the number of parts was achieved. Additionally, all the control circuits are digitalized, Digital Signal Processors (DSP) were adopted, and a further reduction in the number of parts was achieved in the control circuit. The number of parts has been reduced by about 50% compared with the conventional model, and an improvement of MTBF (Mean Time Between Failure) was attained.

1kVA is the basic unit for each UPS unit, and the production cost can be suppressed because the device is composed of the same unit.

3.2 High Efficiency/High Power Factor

In order to achieve high efficiency, the ASE-H has adopted a 3-arm on-line UPS system, which the "SANUPS" MODEL ASE has already adopted and has made available on the market. It can achieve 91% efficiency, and can supply a steady sine wave power output to the load equipment for an abnormal commercial power without the switching time.

The rectifier of the input adopts a high power converter, and greatly controls the higher harmonics of the input. Because the input voltage and the input current are always controlled in the same phase, the ineffective power is lost and the input capacitance is decreased, allowing use of the power-receiving equipment.

3.3 Substantial Lineup

Because 1kVA is a basic unit, and it is possible to drive up to five units in parallel, the output capacity can be 2, 3, 4, and 5kVA according to the load equipment.

Fig. 2 shows the system configuration.

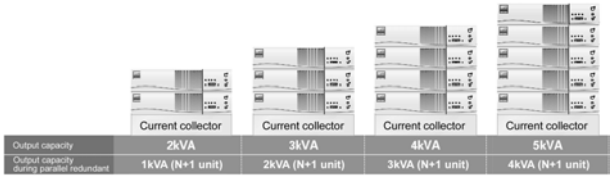

Fig. 2 System Configuration

3.4 Compact/Light Weight and Rack-Mountable

The number of parts is only about 50% of the conventional model by full digitalization of the control part of a main circuit. This achieved a reduction in size and weight. The ASE-H measures only 410mm width × 435mm depth × 86mm height, making it the industry leading on-line UPS system in its class.

Because it can be installed in both an upward sitting position and 19-inch rack-mounting (2U), it can be installed in any location.

3.5 Supporting Network

To support UPS control in a network environment, communications with computers are required.

The ASE-H comes with RS-232C as a standard feature, as opposed to conventional models that offer it as an option. This allows the Windows NT UPS service or similar software to communicate with the UPS via the connector cable provided as a standard accessory.

The ring signal send function enables a PC to be activated by modem's ring signal.

Also, using the optional LAN interface card in conjunction with the UPS management software "SAN GUARD IV Lite" enables strong support in the network environment. Its features are as follows:

(1) Capable of safely controlling via network up to 10 computers connected to one UPS.
(2) Capable of controlling the status of a UPS from a Web browser.
(3) No need to install UPS management software in WS (UNIX, Linux).
(4) Applicable to sophisticated server systems such as clustering configurations.
(5) Relieves the network manager's workload, thanks to the significant improvement on the UPS management capability.
(6) Scheduled operations cut down on power consumption ,and automated operations provide effective power supply.

Fig. 3 shows the interface card, and Fig. 4 shows a sample network connection.

Fig. 3 LAN Interface Card

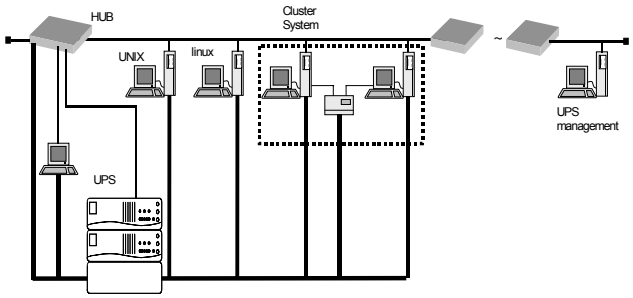

Fig. 4 Sample Network Connection

3.6 Ease of Maintenance/Reducing Maintenance Cost

The ASE-H consists of the UPS unit and the 1kVA current collector unit. Each UPS unit and current collector unit are connected with the electric power cable on the back of the device as shown in Fig. 5. Also, each UPS unit is linked to the other UPS units with the communication cable to provide control. By setting the equipment upward or installing it on the 19-inch rack-mount, the UPS unit can be detached or changed easily by only disconnecting the electric power cable for collecting current and the communications cable between units.

It uses a five year battery, to reduce the maintenance cost of exchange. Moreover, the battery was built into the resin tray, enabling the battery to be removed easily. As a result, hot swapping the battery is now possible.

Fig. 6 shows the internal of the UPS unit.

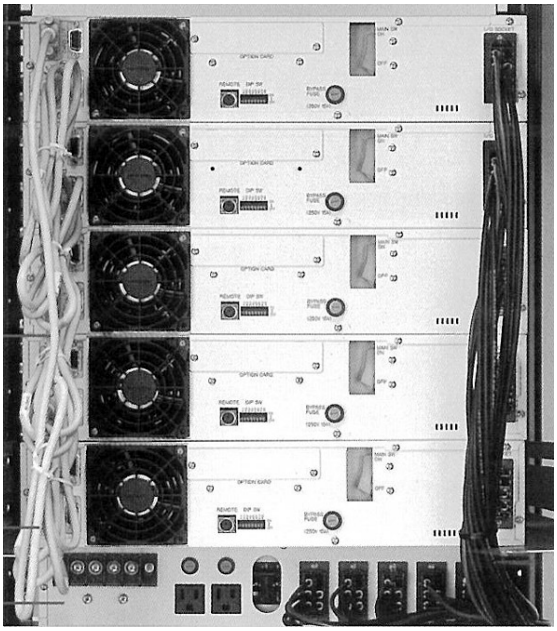

Fig. 5 Back of "SANUPS" MODEL TYPE ASE-H

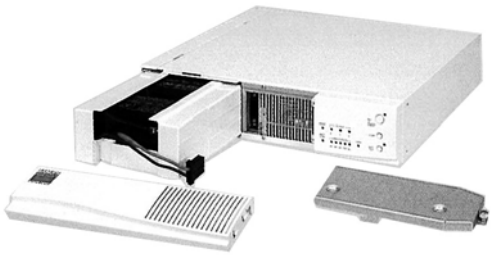

Fig. 6 Internal of UPS unit

3.7 Wide I/O Voltage Range

Four types (100V, 110V, 115V, and 120V) are available based on the input/output voltage to be used.

3.8 Options

Various options are available to meet specific user needs. Such options are as follows:

(1) Long discharging time battery
(2) Rack mount tools
(3) LAN interface card
(4) Maintenance bypass unit

4. Circuit Configuration

Fig. 7 shows the block diagram of ASE-H unit circuit.

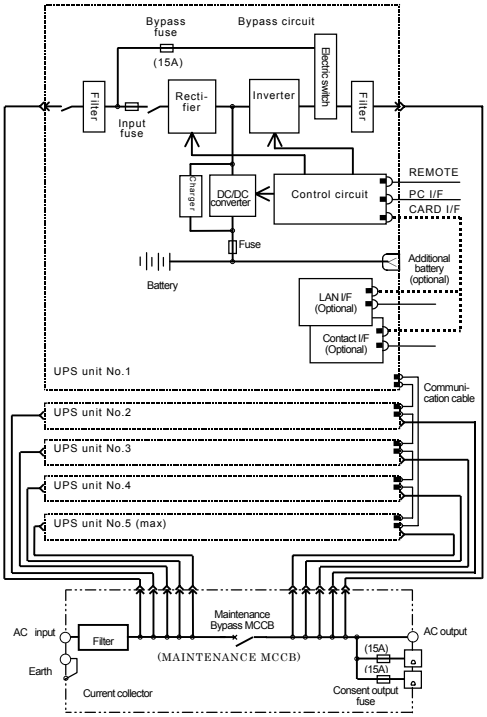

Fig. 7 System Circuit Block Diagram

4.1 Main Circuit Configuration

The ASE-H consists of a high power factor converter, inverter, charger, battery voltage part output selector switch, bypass circuit, and battery.

(1) The 3-arm on-line UPS is introduced to achieve high efficiency and a reduction in the number of components used.

(2) Battery voltage is boosted via high frequency transformer, which reduces size.

4.2 Control Circuit Configuration

The basic control and the parallel operation control of the UPS are done with a DSP, and the sequence and communication controls are done by the CPU in the ASE-H.

(1) Parallel Operation Control

It is necessary to match the amplitude, phase, and frequency of the output voltage to operate UPS units in parallel. The ASE-H adopted the individual control method.

① Some amplitude differences arise in the output voltage value of each UPS due to the error margin of initialization and secular distortion. On the other hand, it is basically impossible to know the current difference with another machine and the allotment rate of the load by using only current detection inside the self-machine. Then, the inverter current is fed back and controls a cross-flow from the voltage difference by selecting the control gain. [1]

② The idea of zero-cross reinforced synchronous signal of digital PLL used with UPS conventionally was applied to the phase control, and it was adopted as "Advance reinforced synchronization" which made to interactive and shared the synchronized signal of each UPS.

③ About the frequency, PLL usually synchronizes commercially, and at power failure, there are few differences between each UPS because of a highly accurate self-running oscillator.

(2) Communication Between Units

The information between units is transmitted by serial communication. As for the communication between units, one unit becomes the master station, which controls all data transfers with other slave stations.

An identification number is given to each unit. The identification number is used for the decision-making in the master and the slave station, and for the discernment of other party of transmission under the transmission control procedure. If the master station breaks down, another unit automatically becomes the master station, and the control of the communication between units is continued.

The number of signals used by serial communications between units has decreased about 75% compared to the conventional model, speeding up the transmission rate of serial communications.

Table 1 Specifications of the "SANUPS" MODEL TYPE ASE-H

Item			2		3		4		5		Note
Configuration of Specification Operation			N configuration	N+1 configuration	N configuration	N+1 configuration	N configuration	N+1 configuration	N configuration	N+1 configuration	
Output Capacity (active power/apparent power)			2kVA/1.4kW	1kVA/0.7kW	3kVA/2.1kW	2kVA/1.4kW	4kVA/2.8kW	3kVA/2.1kW	5kVA/3.5kW	4kVA/2.8kW	
System	Operating System		Synchronized with commercial line inverter power supply								
	Input Rectifier System		High power factor converter								
	Cooling System		Forced air cooling								
	Inverter System		High frequency PWM control								
AC Input	Number of phases/lines		Single phase 2-wire								
	Rated Voltage		100/110/115/120V±15%								Same as output voltage
	Rated Frequency		50Hz/60Hz(Same rated range and output frequency accuracy)								
	Required Capacity		1.8kVA or less	1.8kVA or less	2.7kVA or less	2.7kVA or less	3.6kVA or less	3.6kVA or less	4.5kVA or less	4.5kVA or less	
	Power Factor		0.95 or more								
AC Output	Number of phases/lines		Single phase 2-wire								
	Rated Voltage		100/110/115/120V(100V at the time of shipment)								Setting changeable
	Voltage Setting Precision		Rated voltage within±5%								
	Rated Frequency		50Hz/60Hz								Automated selection
	Frequency Accuracy		Rated frequency ±1,3,5%(±3% at the time of shipment)								Setting changeable
	Voltage Wave Form Distortion factor	Linear Load	3% or less								
		Wave Rectifier Load	8% or less								
	Rated Load Power Factor	Rated	0.7(delay)								
		Fluctuation Range	0.7(delay)-1.0								
	Transient Voltage Fluctuation	Load Sharp Change	Within ±10% 0⇔100% change or output transfer								
		Power Outage/Return	Within ±10% at rated operation								
		Input Voltage Sharp Change	Within ±10% ±10% change								
	Over-current Protection Action		Switches automatically to bypass circuit								
	Overload Capacity	Inverter	105%(200ms)								
		Bypass	200%(30 sec.) 800%(2 cycles)								
Battery	Type		Small seal lead storage battery								Expected life 5yrs
	Backup Time		5min.	15min.	5min.	10min.	5min.	9min.	5min.	8min.	For rated load at 25℃ ambient temp
Noise(Front of equipment 1m, A characteristics)			40dB or less				45dB or less				
Heating Value			185W	92W	280W	185W	377W	280W	475W	377W	
Input Linkage Current			4.5mA or less		6mA or less		7.5mA or less		9mA or less		
Ambient Condition			Ambient Temp: 0～40℃, RH: 30～90%(no dew)								

5. Conclusion

With highly reliable and more network-oriented computers, it is demanded that UPS devices deliver higher reliability, higher performance, lower cost, and compactness.

We are determined and ready to respond to such demands swiftly by developing products that meet these demands to the greatest satisfaction of our customers.

Finally, we would like to express our heartfelt gratitude to many for their assistance in our developing and producing ASE-H.

Reference

(1) Hanaoka, others: "Analysis of Parallel Operation of UPS in Consideration of the Influence of Line Resistance" SANYODENKI Technical Report No.10 Nov.-2000

Toshifumi Nishizawa

Joined company in 1997
Power Systems Division, 2nd Design Dept.
Worked on the development and the design of uninterruptible power supply units

Hiroyuki Hanaoka

Joined company in 1989
Power Systems Division, 2nd Design Dept.
Worked on the development and the design of uninterruptible power supply units

Narumi Yanagisawa

Joined company in 1992
Power Systems Division, 2nd Design Dept.
Worked on the development and the design of uninterruptible power supply units

Hiroshi Sakaba

Joined company in 1990
Power Systems Division, 2nd Design Dept.
Worked on the development and the design of uninterruptible power supply units

Kenji Ishiguro

Joined company in 1996
Power Systems Division, 2nd Design Dept.
Worked on the development and the design of uninterruptible power supply units

Tetsuya Yamazaki

Joined company in 1983
Power Systems Division, 2nd Design Dept.
Worked on the development and the design of uninterruptible power supply units