Development of the Hybrid UPS "SANUPS E11A"

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1. Introduction

With the rise of information technology in recent years, the demand for reliability and maintainability among the servers, routers, and other equipment that comprise a network system has also risen sharply.

For any of these devices to be reliable, their power supply must also be reliable. This means that the demands for reliability and functionality on the uninterruptible power supplies (henceforth UPS units) that provide electricity to these devices must also be reliable and functional.

Additionally, from an environmental standpoint, products with high conversion efficiencies and thus lower power consumption are also required.

We developed the new "SANUPS E11A" with these factors in mind. In addition to the primary goal of creating a stable power supply, we also considered ease of use, improvements in maintainability, improvements in cost performance and reduced power consumption when the power source is stable.

This document outlines the "SANUPS E11A" UPS.

2. Development Background

Our previous product line, the "SANUPS ASE" series, used a continuous inverter power supply system to supply high-grade power in either 1 kVA or 1.5 kVA. Because price competition in both the domestic and international markets has been fierce, it was decided that new cost reduction measures were needed.

Additionally, global warming and other environmental problems dictate that even small capacity UPS units be designed with efficiency in mind.

It is difficult to make improvements in the efficiency and cost of the 3-arm system *(1) used in the "SANUPS ACE" series. It was thus decided that we needed to develop a new form of UPS with increased efficiency and reliability as well as decreased cost.

*(1) 3-arm system
The first arm is used for the input converter. The third arm is the output inverter. The second arm is a shared arm. This allows for high conversion efficiency.

3. Features

Figure 1 shows an exterior view of the 1 kVA "SANUPS E11A."

Figure 1 Exterior view of the 1 kVA "SANUPS E11A"

3.1 The 3-mode system

The "SANUPS E11A" uses a new system called the 3-mode system. The three available modes are power supply quality priority mode, efficiency priority mode, and active filter mode. The UPS automatically selects the best mode based on the power supply and the load power. There is no loss of output when switching between modes. Power supply quality priority mode is activated when the power supply is poor. Efficiency priority mode is activated when the power supply is good. Efficiency when operating in efficiency priority mode is approximately 4% better than the efficiency of the "SANUPS ASE," reaching 95%. The active filter mode, which is activated when the load power factor is poor, controls harmonics generated by the load and improves the input power factor.

The mode of operation can also be set by the user. There are

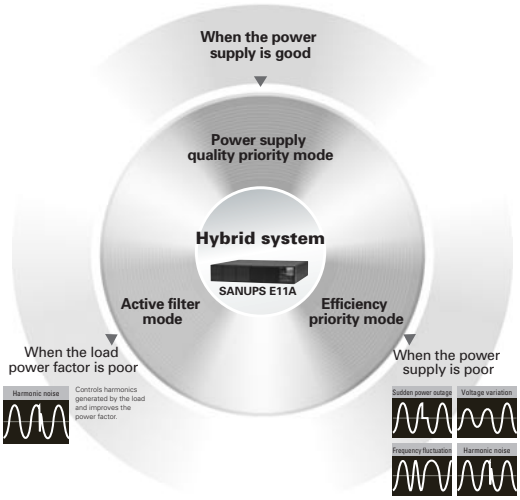

Figure 2 Operating mode diagram

three possible settings. AUTO mode automatically selects between the three available modes. Fixed power supply quality priority mode keeps the unit set on power supply quality priority mode at all times. Fixed efficiency priority mode switches between efficiency priority mode and power supply quality priority mode as needed. Figure 2 shows the three operating modes in more detail.

(1) Power supply quality priority mode

When the power source voltage varies by more than ±5% (±10% in fixed efficiency priority mode), the device switches to power supply quality priority mode. In power supply quality priority mode, stable power is supplied to the load by feeding commercial power into the rectifier to be converted to DC power. Then, that DC power is fed into the inverter to convert it back to AC power equivalent to the original commercial power. The battery is continually charged by the floating charge in case of problems (such as blackout or voltage drop) with the commercial power.

(2) Efficiency priority mode

When the power source voltage variance is ±5% (±10% in fixed efficiency priority mode) or less and the output power factor is 0.9 or more, the device switches to efficiency priority mode. Efficiency priority mode takes commercial power and supplies it directly to the load with the inverter being connected to the load. The battery is continually charged by the floating charge in case of problems (such as blackout or voltage drop) with the commercial power.

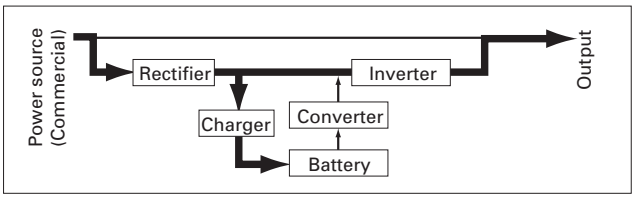

Figure 3 Power supply quality priority mode power supply circuit

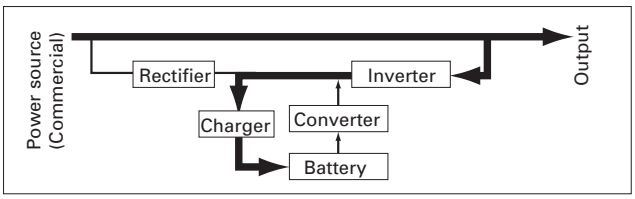

Figure 4 Efficiency priority mode power supply circuit

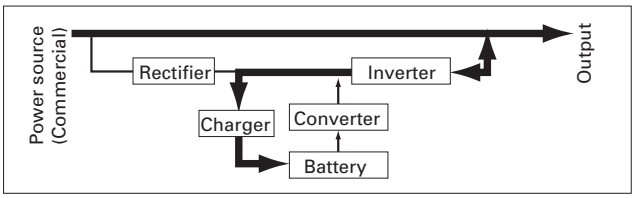

Figure 5 Active filter mode power supply circuit

(3) Active filter mode

When the voltage variance of the power supply is ±5% or less and the output power factor is less than 0.9, the device switches to active filter mode. Active filter mode takes in the commercial power and supplies it directly to the load while smoothing out harmonics at the inverter input. The battery is continually charged by the floating charge in case of problems (such as blackout or voltage drop) with the commercial power.

3.2 Automatic battery check

This UPS unit includes a function that that confirms the unit's ability to switch to battery backup in case of a power outage. Inability to provide power during an outage due to battery

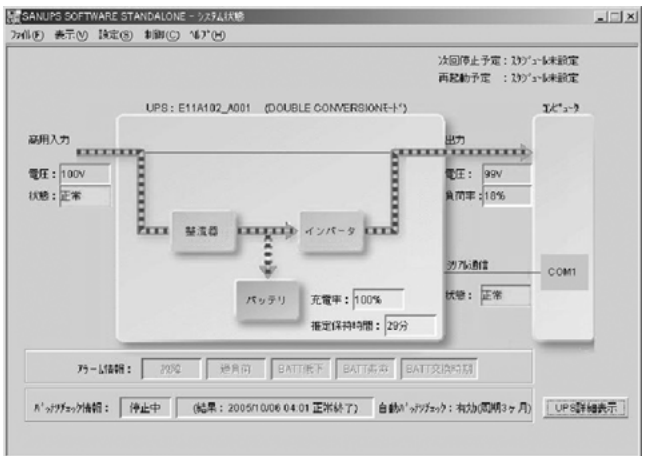

Figure 6 Power management software

deterioration is a serious problem. This function allows you to monitor the condition of the battery and be notified well in advance of any problems with the battery. The battery check function can be set for every month, every 3 months, every 6 months, or none. (The factory default is every 6 months)

3.3 Power source management software

This UPS comes standard with an RS-232C and power source management software. Use the included connector cable to connect the UPS to a computer or server. Figure 6 shows a screenshot of the included software displaying a graphic that allows you to monitor the state of the UPS at a glance. The software includes measurement, shutdown, schedule, and other features.

3.4 Maintainability

The battery for this UPS is housed in a resin tray and is thus easy to remove. This allows hot swapping for the battery, which means that the battery can be replaced while the device is operating. Additionally, there is an optional bypass unit that allows the UPS to be maintained, changed, inspected, or have its parts swapped without disrupting the flow of power to the computers and other units it is connected to. Because the battery has an expected lifetime of 5 years, the costs due to maintenance, swapping of batteries, and other battery related expenses are very low.

Figure 7 shows a view of the removable battery.

Figure 7 Changing the battery

3.5 Rack mount compliance

The UPS can be mounted either vertically or horizontally. It can also be mounted on a 19-inch rack. A molded stand for vertical mounting and metallic rack mounting brackets for mounting on a rack are included.

3.6 Wide input/output range

The input / output voltage can be set to 100 V, 110 V, 115 V, or 120 V depending on the user's needs. The input fluctuation range has also been widened from -15% to -20% to reduce the frequency of switches to battery backup.

3.7 Noise reduction

We have reduced the noise level to increase users' comfort. The number of fan rotations is controlled according to the load. Compared to "SANUPS ASE", the noise level has been reduced by 9 dB when the load factor is 20%, and 6 dB when the load factor is 50%.

3.8 Network compatibility

Our optional UPS management software "SANUPS SOFTWARE" and a LAN interface card are included to allow for UPS management over the network. These help improve the network support.

3.9 Expanded interface (High functionality type only)

One type of this UPS unit has advanced functions that enhance the interface. The supported functions are continuous operation, a remote switch, EPO, contact interface, and system control (requires optional system control box). Continuous operation uses a special cable to connect up to five devices to the UPS and start them up or shut them down on a time delay. This function can be used to prevent rush current when performing a time delayed start and can be used to start up and shut down servers and storage devices in order.

3.10 Options

This UPS device has several options that meet user demands for improved interface. The following is a list of option settings.

(1) Long duration battery
(2) LAN interface card
(3) Maintenance bypass unit
(4) Dry contact card (compatible with high function type only)
(5) System control box (compatible with high function type only)

4. Circuit Layout

The circuit block diagram for this UPS is shown in figure 8.

4.1 Major circuit architecture

This UPS is comprised of a rectifier (high power factor converter), an inverter, a charger, a DC/DC converter, and a battery.

(1) The mode system was designed for greater efficiency with fewer parts.

(2) The miniaturization was designed by having raised a battery voltage with a high frequency transformer.

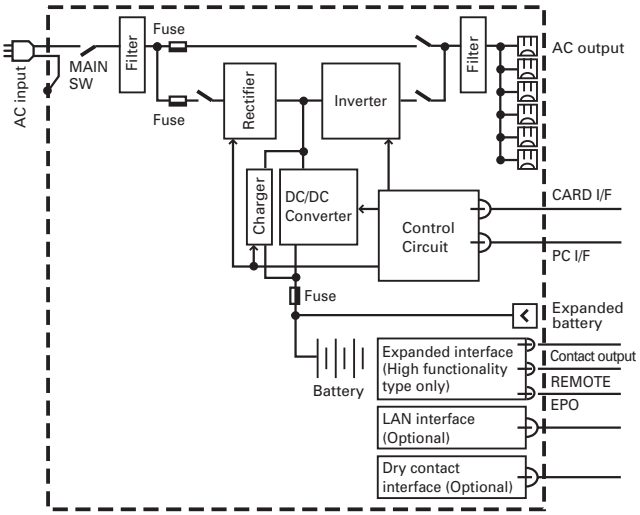

Figure 8 Block circuit diagram

To reduce manufacturing costs, we have gone out of our way to use less expensive parts made in China, to use more cost efficient materials, and to do our manufacturing overseas.

4.2 Control circuit architecture

The control circuits of previous devices were designed with the UPS waveform controller in the DSP and the sequence controller located in the CPU. This UPS has both controllers on the CPU, thus reducing the number of parts required. We have also transferred control from hardware to software to reduce the amount of hardware needed. These measures provide a 34% reduction in parts from the previous models. As with the main circuit, we are making every effort to use foreign parts.

Table 1 "SANUPS E11A" 1kVA standard specifications

Item			E11A			Remarks
			Efficiency priority mode	Active filter mode	Power supply quality priority mode	
Output			1kVA (0.7kW)			
System	Operating system		Hybrid system			
	Cooling system		Forced air cooling			
AC Input	Phases / lines		One phase, two lines			Setting can be changed
	Voltage		100,110,115,120 V			
	Voltage variation range		Between+15% / –20%			
	Frequency		50 or 60 Hz			
	Frequency variation range		Within ±1, 3 or, 5% of the rated frequency		Within ±8% of the rated frequency	Setting can be changed
	Input power factor		Same as load rate	0.9 or higher	0.95 or higher	When input voltage distortion factor is less than 1%
AC output	Phases / lines		One phase, 2 lines			
	Rated load power factor		0.7 (slow)			Fluctuation tolerance range: 0.7 (slow) to 1.0
	Rated voltage		100,110,115,120V			Setting can be changed
	Voltage setting precision		Within ±10%	Within ±5%	Within ±2%	Variance of input or load
	Rated frequency		50 or 60 Hz			Same as input frequency
	Frequency precision	When synchronized with commercial line	Within ±1, 3 or 5% of the rated frequency		Within ±1% of the rated frequency	Setting can be changed
		When using a self running oscillator	Within ±0.5%			
	Voltage waveform distortion factor	With linear load	–		3% or less	During rated operation
		With rectifier load	–		7% or less	During rated operation / When at 100% rectifier load
	Transient voltage variation	Sharp change in input voltage	Within ±5%			When changing from powered to unpowered, sharp change in input voltage
		Sharp change in load	–	–	Within ±5%	When changing between 0% and 100%
	Overload capacity		200% (30 seconds)		105% (200 mS)	Through rated load power factor / When operating at rated input
			800% (2 cycles)		–	
Overload protection			Fuse protection		Bypass no-break transfer	Auto return
Battery	Type		Small sealed lead acid battery			
	Backup time		5 minutes			Ambient temperature 25°C, output rating, initial value
Noise			40 dB or less			1 meter from unit front, A characteristics
Heat load			40W	65W	125W	
Operating Environment	Ambient temperature		0 to 40°C			
	Relative humidityN		20 to 90%			Without condensation
Overseas safety standard			UL (E226092), CE			

* Switching to battery backup in efficiency priority mode or active filter mode causes power loss for less than 3 ms

4.3 Electrical Characteristics

The standard specifications for this UPS are shown in table 1.

5. Conclusion

Information technology will continue its growth as an important part of our everyday lives and as an important part of our society. As this happens, the reliability, functionality, and affordability of UPS units will grow in importance. We forecast a growing demand for small capacity UPS units.

It is our desire to meet these growing demands with rapid development of products that satisfy users’ needs. We wish to offer our gratitude to all of the people whose cooperation and advice made the development and production of this UPS possible.

References

(1) Yoshitsugu Kashiwagi et al: “Development of the small capacity UPS SANUPS A11F”
SANYODENKI Technical Report No.19
(2) Chiaki Seki: “Power system technologies required by products in overseas markets”
SANYODENKI Technical Report No.20

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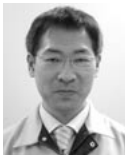

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