Development of the Small Capacity UPS "SANUPS A11J"

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1. Introduction

Due to advancement in information communication technology, IT equipment has recently become more high density, and therefore, there are demands for the power supply equipment to be smaller and to have greater output. As networks become more essential, network outages can greatly affect society. Therefore, the reliability demanded from power supplies has become higher than ever.

Furthermore, more people are becoming concerned with conservation of the environment, particularly in the reduction of CO_2 in order to prevent global warming, and therefore power supplies are expected to have even higher efficiency.

This document introduces the small capacity UPS "SANUPS A11J" that was developed to meet these demands.

2. Background of the Development

An increasing number of servers and other IT equipment are constructed as blade systems with extremely high density. This type of equipment needs a much larger amount of power compared to conventional models, even for models of the same size. In order to deal with this situation, we planned for a basic unit with a capacity of 5 kVA to be miniaturized and redesigned in the size of our conventional 3.5 kVA product.

We adopted the CVCF system (Constant Voltage Constant Frequency: power supplies that always provide both constant output voltage and frequency) in order to supply higher quality power while simultaneously meeting the expectations of high efficiency for power supplies, and we aimed to have the top efficiency in the industry with 93% or higher for models with the same method.

Furthermore, we developed the parallel redundant system that was used in conventional models even further in order to improve the reliability even more.

3. Product Overview

Fig. 1 shows the "SANUPS A11J" series 5 kVA single unit model, and Fig. 2 shows the model stacked in parallel. The basic unit of this system is a 5 kVA device. By stacking up to four units in parallel, a structure of up to 20 kVA can be constructed. The I/O voltage can be selected from single-phase 200 V, 208 V, 220 V, 230 V, or 240 V. This

Fig. 1: "SANUPS A11J" 5 kVA unit

Fig. 2: Stacked in parallel (20 kVA structure)

system was made for use in America, Asia, and Europe as well, not just for use within Japan. By using transformers on the input and output sides, this system can support 100 V I/O and single-phase three-wire output.

In consideration of the power supply quality, the double-conversion system was adopted, and it achieves high efficiency while using the CVCF system that is not affected by input voltage and frequency.

The operation panel uses an LCD display, for providing the device with an easy-to-use user interface.

4. Features

4.1 High efficiency

Although the UPS is the CVCF system, because the three-level inverter is used in the DC/AC conversion circuit, it achieves an efficiency of 93% that is the top efficiency in the UPS trade. This efficiency enables the system to reduce running costs and contribute to energy conservation. Fig. 3 shows a comparison of the Sanyo Denki conventional model and a similar model from another company.

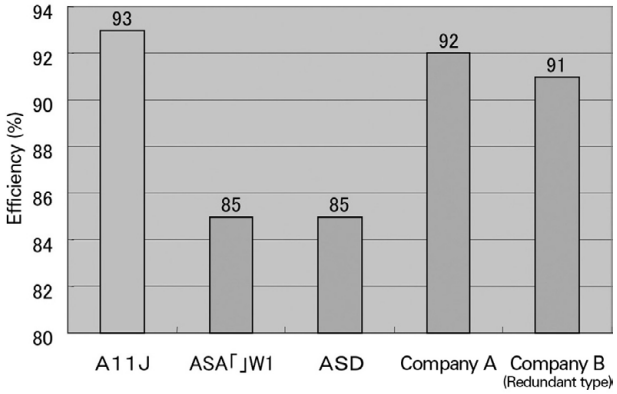

Fig. 3: Efficiency comparison

4.2 Output power factor 0.9

In recent years, many types of control power supplies built into servers have gained the power factor correction function of the input current. This tends to raise the load power factor. In order to handle this situation, the new model has achieved an output power factor 0.9. This allows the new model to supply sufficient power even when there is an increasingly high input power factor.

4.3 Realizing high reliability with parallel redundancy

In the new model, up to four 5 kVA UPS units can be connected in parallel. Therefore, if the UPS output capacity has a margin of one unit (5 kVA) or more, even if malfunction happens with one unit, the remaining units can continue to supply power. This parallel redundancy function allows the UPS to realize high reliability.

Furthermore, there are not any common wires to perform synchronization on the voltage phase between the UPS units during parallel operations. Since the reliability does not depend upon the reliability of any common parts, high reliability can be maintained.

4.4 Battery management function

During a power outage, in order to reliably provide power from the battery, the automatic battery test function is included. Furthermore, a variety of battery management functions, including life warning, total battery operating time, state of charge, and estimated backup time, are included in order to improve reliability.

4.5 Space saving and light weight

The new model uses a larger board for the main circuit compared to conventional models. By reducing the wiring as much as possible and mounting the internal components with high density, the device height can be kept to 3U (about 130 mm) and the mass to 61 kg (including the battery).

4.6 Improved maintainability

As shown in Fig. 4, by using modules for the battery and the power converter, the maintainability in terms of exchanging parts can be improved. The modules use a plug-in method, so even if a malfunction occurs during parallel redundant operations, the power module can be replaced quickly while supplying inverter power, ensuring high availability. Furthermore, the maintenance bypass is built-in, so even if the device is not running redundantly, the modules can be maintained or replaced while continuing to supply power from the commercial power supply.

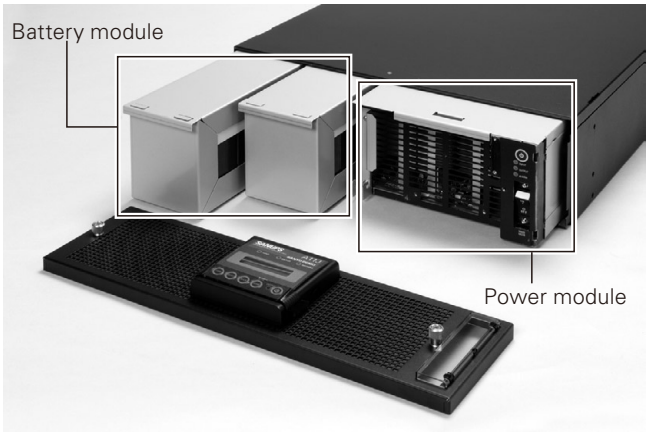

Fig. 4: Battery and power module

The mass for the power module and the battery module for the new model was kept at maximum 18 kg each. This was designed to help reduce the risk of injury for the service personnel.

4.7 Operation panel

A module is also used for the operation panel, so it can be removed. Fig. 5 shows a photograph of the operation panel.

Fig. 5: Operation panel

During parallel operations, this panel can be connected to any unit. So if one unit must be detached due to malfunction, the panel can be connected to another unit in order to obtain system information. In addition, the panel also has the benefit where it can be placed in any position for easy operation depending on the state of the installation.

Furthermore, a 16 character, 2 line LCD display is used as the display device, so the device information can be displayed in a clear manner.

4.8 Support for rack mounting and vertical mounting

The supported mounting methods include a 19-inch rack, vertical mounting, or horizontal mounting. Fig. 6 shows rack mounting and vertical mounting.

Fig. 6: Rack mounted and vertical mounted state (5 kVA model)

4.9 Network compatibility

The optional UPS management software “SANUPS SOFTWARE” and the LAN interface card are included in order to perform UPS management in a network environment. By using these options, a flexible and powerful network environment can be constructed.

4.10 High performance interface

The new model includes the following interfaces standard.

(a) Dry contact signal interface
(b) Remote switch connector
(c) EPO (Emergency Power Off) connector

In particular, (a) and (b) are included for compatibility with the conventional model, so that the new model can replace the conventional model in any system.

4.11 Wide range input

The system can operate on normal mode during the input voltage is -20% to +15% of the nominal input voltage for the nominal output capacity. If the load can be reduced the system can operate with -40% to +15% of the nominal input voltage. Furthermore, during set to I/O asynchronous mode, output of 50/60 Hz can be supplied even with an input frequency in the range 40 Hz to 120 Hz.

5. Circuit Architecture

Fig. 7 shows the circuit block diagram for “SANUPS A11J” .

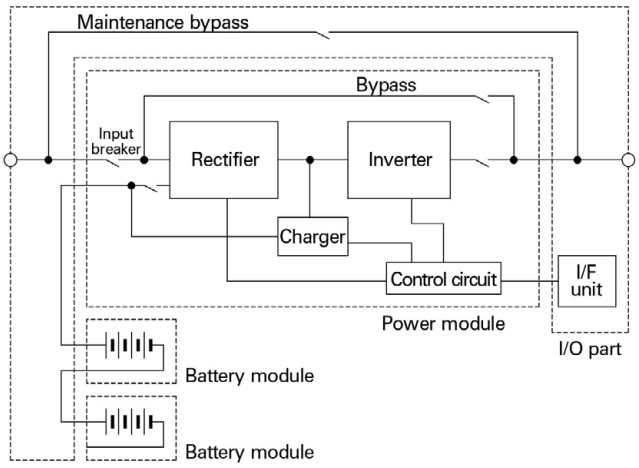

Fig. 7: Circuit block diagram (5 kVA single units)

5.1 Main circuit architecture

The new model is composed of a rectifier, inverter, charger, and battery, and it includes the following improvements.

(1) By using high input power factor chopper in the rectifier, the UPS input power factor can be improved and it can support a wide range. Furthermore, the chopper method can also be used in common with the battery boost, which reduces the number of parts.

(2) The inverter uses a three-level method, thus improving the efficiency. The three-level method has the following features.

(a) The switching frequency is halved compared to the half-bridge method.

(b) It can use a low-voltage switching device.

(c) The ripple current through the AC filter is halved compared to the half-bridge method.

(3) The charger can control the charge current with the CPU, so even when the optional long discharging time battery is used, the battery holds appropriate

Table 1: "SANUPS A11J" standard specifications (single 5 kVA unit)

Item			Units	Rating or characteristic	Remarks
Model	Model No.		–	A11J502A002T	Input: Terminal block. Output: Terminal block, L6-30x1, IEC C-13x2
	Charging method		–	True on-line, double conversion	
	Cooling method		–	Forced air cooling	
	INV method		–	High-frequency PWM method	
AC input	Rated voltage		V	200, 220, 230, 240, 208 (Default: 200)	Depends on the setting Allowable voltage: -40% to +15%*1
	Rate frequency		Hz	50 / 60	Can select from automatic or fixed. *2 (Default: Automatic)
	No. of phases		–	Single-phase, two-wire	
	Max. capacity		kVA	5.5	Max. capacity during battery charging
AC output	Rated capacity		kVA / kW	5 / 4.5	Apparent power / effective power
	No. of phases		–	Single-phase, two-wire	
	Rated voltage		V	200, 220, 230, 240, 208 (Default: 200)	Same as input voltage setting
	Voltage regulation		Within %	±2	
	Rated frequency		Hz	50 / 60	Same as input frequency setting
	Frequency regulation		Within %	±1, 3, 5	Within ±0.5% with an internal oscillator
	Waveform distortion rate		Max. %	3 / 8	Linear load / rectifier load during rated operations
	Transient voltage variation	Rapid load change	Within %	±5	Transient between 0% and 100%
		Power outage, recovery	Within %		
		Rapid input voltage change	Within %		±10% variation
	Response time		Max.	5 cycles	
	Load power factor		–	0.9 (lag)	Variation range 0.7(lag) to 1.0
	Overcurrent protection		Min. %	110	Automatic switching to bypass circuit
	Overload capacity	Inverter	%	110 / 200	1 min. / instantaneous
		Bypass		200 / 800	30 sec. / 2 cycles
Battery		Type	–	Small-sized valve regulated lead-acid battery	
		Backup time	Minutes	5	Ambient temperature 25˚C, load power factor 0.8, initial value
		Life	Years	5	Ambient temperature 25˚C
Acoustic noise			Max. dB	45	1 m from UPS front panel, A characteristics
Environment	Ambient temperature		˚C	0 to 40	
	Relative humidity		%	20 to 90	No condensation
Dimensions	W		mm	435	
	D		mm	700	
	H		mm	130	
Miscellaneous	Coating color		–	Black	
	External IF position		–	Rear	
	Mass		kg	61	

*1 The allowable voltage range for AC input changes depending on the load factor. If the load factor is 70% or less: -40% to +15%. If it exceeds 70%: -20% to +15%.

*2 During automatic, the frequency following range can be selected from ±1%, ±3%, and ±5%. (Default: ±3%) Also, the allowable frequency range during automatic is ±8%. During fixed frequency, the output frequency is fixed to 50 Hz or 60 Hz, regardless of the input frequency. At this time, the allowable frequency range is 40 Hz to 120 Hz.

*3 The synchronous switching conditions for the bypass circuit are automatic for the frequency setting, with the synchronous following range for the input frequency, and within the rated variable range for input voltage.

*4 When first starting up, the output is supplied from the inverter. (Inverter start-up type)

amounts of charge.

5.2 Control circuit architecture

By using surface mounting for the control circuit parts, the mounting area was reduced for the new model. Furthermore, CAN bus (Controller Area Network: a highly reliable communication method developed for LAN in a vehicle) is used for communication between units or between the unit and the LCD display, so communication can be performed at high speeds and with high reliability.

5.3 Electrical characteristics

Table 1 and Table 2 show the standard specifications for SANUPS A11J.

Table 2: "SANUPS A11J" standard specifications (Large capacity and parallel operation composition, with PDU)

Item			Units	Rating or characteristic				Remarks
Model No.			—	A11J502SA002	A11J103SA002	A11J153SA002	A11J203SA002	With PDU, supports add-on capacity
Output rated capacity (for N units)			kVA / kW	5 / 4.5	10 / 9	15 / 13.5	20 / 18	Apparent power / effective power
Output rated capacity (for N+1 units)			kVA / kW	—	5 / 4.5	10 / 9	15 / 13.5	Apparent power / effective power
Method	Charging method		—	True on-line, double conversion				
	Cooling method		—	Forced air cooling				
	INV method		—	High-frequency PWM method				
AC input	Rated voltage		V	200, 220, 230, 240, 208 (Default: 200)				Depends on the setting Allowable voltage: -40% to +15%*1
	Rated frequency		Hz	50 / 60				Can select from automatic or fixed.*2 (Default: Automatic)
	No. of phases		—	Single-phase, two-wire				
	Max. capacity		kVA	5.5	11	16.5	22	Max. capacity during battery charging
AC output	No. of phases		—	Single-phase, two-wire				
	Rated voltage		V	200, 220, 230, 240, 208 (Default: 200)				Same as input voltage setting
	Voltage regulation		Within %	±2				
	Rated frequency		Hz	50 / 60				Same as input frequency setting
	Frequency regulation		Within %	±1, 3, 5				Within ±0.5% with an internal oscillator
	Waveform distortion rate		Max. %	3 / 8				Linear load / rectifier load during rated operations
	Transient voltage variation	Rapid load change	Within %	±5				Transient between 0% and 100%
		Power outage, recovery	Within %					
		Rapid input voltage change	Within %					±10% variation
	Response time		Max.	5 cycles				Except when load is open
	Load power factor		—	0.9 (lag)				Variation range 0.7(lag) to 1.0
	Overcurrent protection		Min. %	110				Automatic switching to bypass circuit
	Overload capacity	Inverter	%	110 / 200				1 min. / instantaneous
		Bypass		200 / 800				30 sec. / 2 cycles
Battery		Type	—	Small-sized valve regulated lead-acid battery				
		Backup time	Minutes	5				Ambient temperature 25˚C, load power factor 0.8, initial value
		Life	Years	5				Ambient temperature 25˚C
Acoustic noise			Max. dB	45	50	50	50	1 m from UPS front panel, A characteristics
Environment		Ambient temperature	˚C	0 to 40				
		Relative humidity	%	20 to 90				No condensation
Dimensions		W	mm	435	435	435	435	
		D	mm	700	700	700	700	
		H	mm	408	539	671	803	Including PDU and caster
Miscellaneous		Coating color	—	Black	←	←	←	
		External IF position	—	Rear	←	←	←	
		Mass	kg	101	163	223	283	Including PDU and caster

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6. Conclusion

As information communication technology becomes more sophisticated, its social importance will continue to grow. Furthermore, the demand for energy conservation is likely to grow due to an increase in environmental awareness. Therefore, people will likely want UPS with higher reliability, higher efficiency, and lower cost.

We will continue to quickly develop products to meet these market demands and provide products that fulfill our customers' needs.

We sincerely thank the many people involved in the development and realization of this UPS product for their advice and support.

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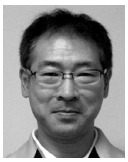

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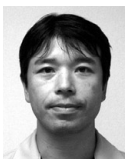

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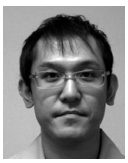

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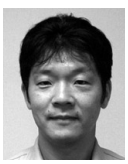

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