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Features

Development of Mid-Capacity UPS "SANUPS R"

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1. Introduction

The conditions required of the UPS that configure the power supply system are also becoming increasingly more demanding along with the development of computer systems that play important roles in today's information and communication oriented society, particularly with the growing demands for networking, size reduction, and energy saving possibilities.

Against the backdrop of this situation, we have developed "SANUPS R" to introduce as a new and reliable UPS with a focus on reliability as the critical element of UPS and on economical efficiency from the perspective of equipment investment.

Newly developed "SANUPS R" is a member of the mid-capacity UPS series based on a new method which is characterized by such features as high reliability, space saving possibilities, and low cost. It is provided with a two-way power converter from AC to DC (forward direction conversion) and DC to AC (backward direction conversion) as auxiliary equipment. The basic configuration and advantageous features of "SANUPS R" are introduced as follows.

2. Background of Development

The following requirements must be carefully observed for the development of a UPS suitable for the prospective highly information oriented society and with a focus on reliability and economic efficiency:

2.1 Reliability

(1)Ordinary UPS turns to a bypass power supply during maintenance or a system failure. However, the reliability of the power supply during such times can never be guaranteed since commercial supply sources are always in danger of power failures. Consequently, it is mandatory for a power supply system to maintain a constant supply even in the case of emergencies such as a power or equipment failure.

(2)A highly reliable system such as the parallel redundant method has always been proposed in order to meet such reliability demands as (1) above. The application, however, was mostly limited to large capacity systems (100kVA or more) due to economic reasons. In line with the recent development of high performance computers with low power consumption, however, higher reliability comparable to the parallel redundant method is now requested of systems with a small to medium capacity (1 to 100kVA) range.

2.2 Economic Efficiency

(1)One of the more important conditions of the mid-capacity UPS as compared with the large capacity UPS is the cost reduction. This is because of the advanced cost reductions of computer systems that are the intended load of this type of UPS.

(2)Important loads subject to public interest often require the provision of a long-life battery backup in preparation for commercial power failure over an extended period. Such facilities, however, result in substantial cost increases for the expansion of the rectifier capacity or for the additional installation of a separate battery charger to cope with the additional consumption of power to charge batteries.

(3)It is desirable to be able to economically increase the capacity or expand functions in response to the growth of the subject computer system.

3. Outline of "SANUPS R," the New Highly Reliable UPS

3.1 Basic System Configuration and Operation

As mentioned in Chapter 2 above, "SANPUS R" offers high reliability based on a new method to satisfy society's needs.

The basic configuration of this system is indicated in Fig. 1 below. As seen from the diagram, the system includes auxiliary equipment linked with switches unlike conventional UPS that consist of rectifiers and inverters. The auxiliary equipment has a power converter to switch between forward and backward directions to provide the system with the necessary redundancy in preparation for an inadvertent system failure.

The basic operation of the system is described as follows:

Normal operation : In a normal operation, supplies power to the load with the rectifier and inverter while the auxiliary unit waits in an inverse-transforming mode.

When the inverter fails : Should the inverter fail during normal operations the auxiliary unit immediately takes over to continue the power supply as shown in Fig. 2(b). In the meantime, the failed rectifier can be restored.

When the rectifier fails : Should the rectifier fail during normal operations the auxiliary unit waiting in the inverse-transforming mode will be shut down and switched into a forward direction conversion mode to take over the operation. In the meantime, the failed rectifier can be restored. The battery will operate the system while the auxiliary unit is being switched into the forward direction conversion mode, so that the necessary power supply to the load can be maintained.

The system also has direct circuitry in case even both the rectifier and inverter should fail.

At the time of a power failure and restoration :

In the case of a power failure while in normal operation, the system will be operated on batteries just like any other UPS. It returns to the normal operation mode if the power is restored except when the system is configured as a long haul backup system provided with large capacity batteries, where the auxiliary unit will be keep being operated in a forward direction conversion mode in parallel with the inverter until the battery is fully recharged as shown in Fig. 2(d).

3.2 Advantageous Features of "SANUPS R"

The advantageous features of "SANUPS R" compared with the conventional UPS are described as follows (refer to Table 1).

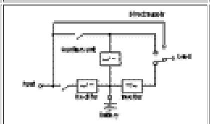
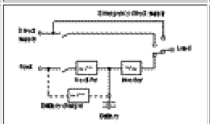
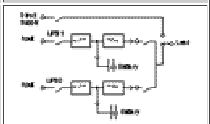
High reliability

(1)When assuming a situation where the direct supply system is rendered unusable by a maintenance service or power failure, it is necessary to evaluate the reliability of the UPS on the condition that the inverter operation will continue. With the parallel redundant system, the reliability of the power supply from the inverter will be affected by complex control functions such as the cross current control or selective shut down. On the contrary, this system offers a similar or even higher level of reliability as the parallel redundancy system because there are not any elements other than switches that should effect the system reliability. This is because the added auxiliary unit always waits in a standby mode to provide the inverter with the necessary redundancy.

(2)Should the rectifier fail, the auxiliary unit will immediately be switched into the forward direction conversion mode to substitute for the rectifier, which eliminates the possibility of wasting the battery power. Thus the system can constantly secure the time required for charging batteries to maintain its reliability during power failures.

(3)The multiplex configuration of the auxiliary system using direct circuits in preparation for the failure of more than one conversion unit helps to ensure a still higher reliability.

Table 1 Comparative review with conventional UPS

Items for comparison		New system UPS ″SANUPS R″	Conventional system UPS ″SANUPS″	Parallel redundancy UPS ″SANUPS″
Block diagram				
Basic function	Normal working condition	Power will be supplied from the inverter side to the load. Auxiliary unit is always kept in the inverter (standby) mode. Auxiliary unit can temporarily serve as an rectifier in parallel with the regular rectifier if battery maintenance continues over an extended time period.	Power will be supplied from the inverter side to the load. A separate battery charger will be required if battery maintenance should continue over an extended time period.	Power will be supplied from the inverter side to the load. UPS1 and UPS2 will be in parallel redundancy operation.
	Failure	Auxiliary unit can substitute as a rectifier when the rectifier fails and can operate as an inverter when the inverter fails.	Supply current should immediately switch to the direct supply without momentary power breaks to supply commercial power to the load when the rectifier or inverter fails.	If any of the UPS should fail, no power failure supply will be maintained from the working UPS to the load.
	During maintenance or inspection	Inverter power supply is to be maintained while the maintenance service is performed on the rectifier, inverter, and auxiliary units.	It will be switched to the direct power supply condition while the maintenance service is being performed on the rectifier and inverter.	When each UPS is under maintenance, UPS supply condition will be maintained.
Installation space requirement		1.3	1.0 (including a battery charger)	2.2
Costs		1.3	1.0 (including a battery charger)	2.2
Reliability of power supply with inverter (MTBF)		250,000 hours or longer	20,000 hours or longer	250,000 hours or longer

High cost performance

(1)When a unit fails in a conventional parallel redundancy UPS, the unit has to be dismantled from the UPS for repair, leaving the rest of the working units of the system idle with no way to contribute to the power supply operation. In the case of ″SANUPS R″, to the contrary, only the failed converter needs to be dismantled to be repaired or exchanged while the remaining working units can continue to supply power. This results in better cost performance and minimizes waste.

(2)No separate charger is required even when using a large capacity battery since the auxiliary unit can be operated as a rectifier in parallel with the working rectifier while the battery is being charged for restoration. It is, therefore, possible to keep charging batteries for an extended period of time without increasing equipment and facility costs.

(3)Requiring less components in comparison with the parallel redundancy UPS, a compact, light weight and low cost UPS can be constructed.

(4)Since the rectifier, inverter, and auxiliary unit can be produced in the same configuration, parts can be shared among them to reduce the running costs.

(5)The number of relevant repair and exchange parts can be minimized by standardizing the converter and control circuits among these devices.

3.3 Standard Specifications of "SANUPS R"

The configuration diagram for "SANUPS R" is indicated in Fig. 3 while the standard specifications are listed in Table 2.

4. Conclusion

We have introduced "SANUPS R," the high reliability UPS, in this section. "SANUPS R" was added as an innovation to our Company's mid-capacity UPS family.

"SANUPS R" has been developed as one of our Company's proposals aiming at the creation of a new market in response to the future potential demands of our advanced information oriented society.

Our aim is develop products in a timely manner in response to the changing and diversifying market demands. We will do this by expanding the above system into a distributed type of power supply system intended for application to intelligence building.

We hereby acknowledge and express our gratitude to many concerned for their guidance and cooperation in the planning, development and commercialization of the product.

Table 2 Standard Specifications of "SANUPS R"

Item			Unit	Standard specifications			Remarks
Output capacity; Apparent power/Effective power			kVA/kW	20/18	50/45	100/90	At the rated load power factor
Meth-od	System operating method		–	On-line UPS system of a type synchronized with commercial line			
	Input rectifying method		–	High power factor converter			IGBT element is implemented
	Inverter method		–	High frequency PWM, instantaneous waveform control			IGBT element is implemented
AC input	Voltage		V	200 ± 15%			3 phase, 3 wire
	Frequency		Hz	50 or 60 ± 5%			
	Current distortion factor		%	5% or lower			
	Input power factor		–	0.97 or higher			
AC output	Rated voltage		V	200			3 phase, 3 wire
	Voltage setting accuracy		%	Rated voltage within ± 2			
	Rated frequency		Hz	50 or 60			Same as the input frequency.
	Voltage wave- shape distor-tion factor	Under a linear load	%	2 or lower			For rated operation
		Under a rectifier load	%	5 or lower			For rated operation/for 100% rectifier load
	Rated load power factor		–	0.9 (delay)			Fluctuation tolerance: 0.7 to 1.0 (delay)
	Transient voltage fluctuation	For sudden change in the input voltage	%	Within ± 2			At recovery from a power failure, or a sudden variation within input voltage ± 10%
		Sudden change of load	%	Within ± 5			Sudden variation from 0% to 100%
		Output selection	%	Within ± 5			For switching from Bypass → Inverter (during rated operation)
	Setting time		ms	50 or less			
	Overload	Inverter	%	125 (10 minutes), 150 (1 minute)			With an automatic switching function without momentary power breaks
Operating noise			dB	57 or lower	60 or lower	63 or lower	At 1 m from the front side of the equipment (under linear load)
Battery	Backup time		Min.	10 to 500			Small sealed lead-acid battery
	Nominal voltage		V	336 (168 cells)			
Working environment			–	Ambient temperature: 0 to 40°C; Relative humidity: 20 to 90% (no condensation allowed)			

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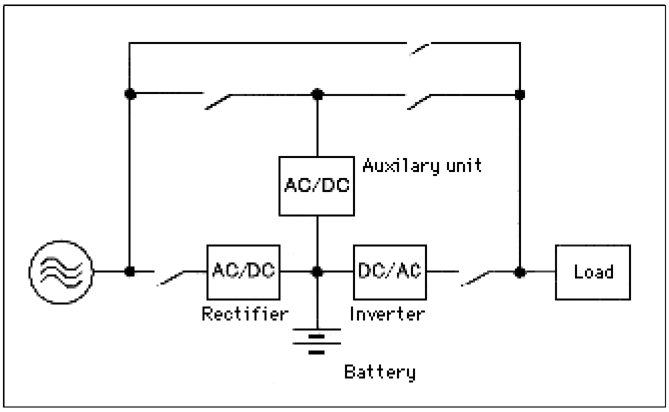

fig. 1 Basic system configuration of "SANUPS R"

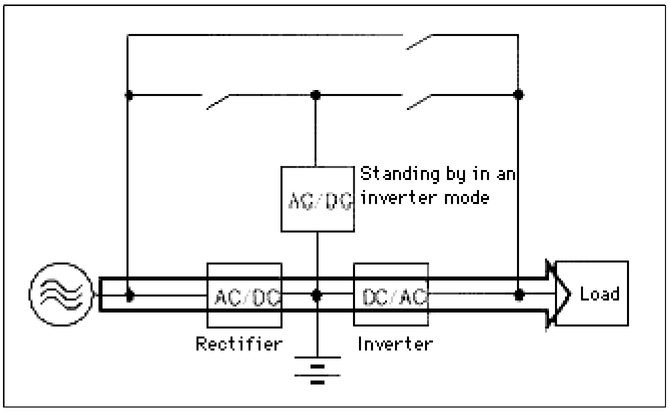

fig. 2(a) Nomal operation

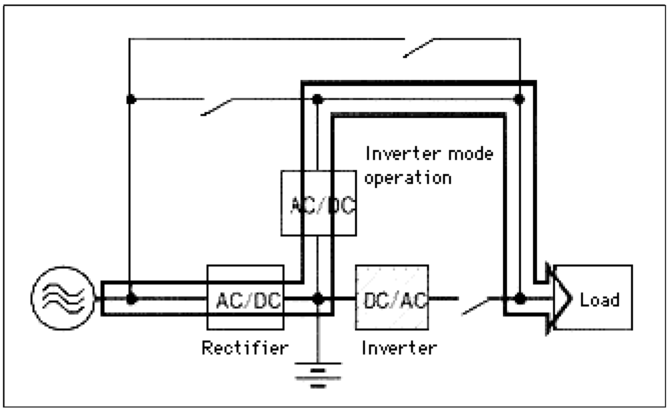

fig. 2(b) Inverter failure

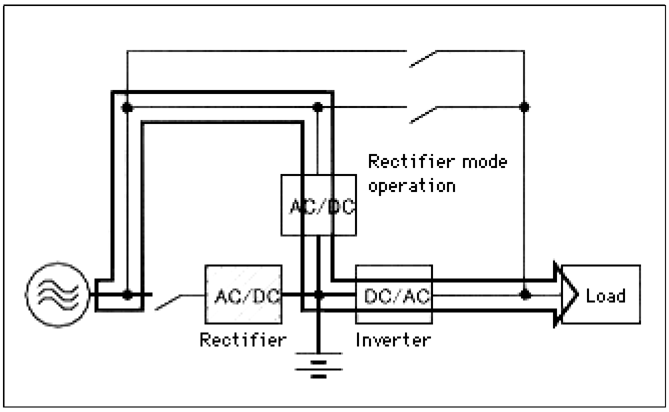

fig. 2(c) Rectifier failure

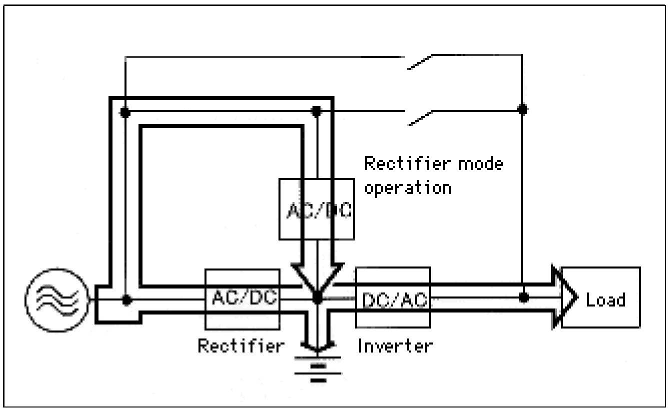

fig. 2(d) Restoration

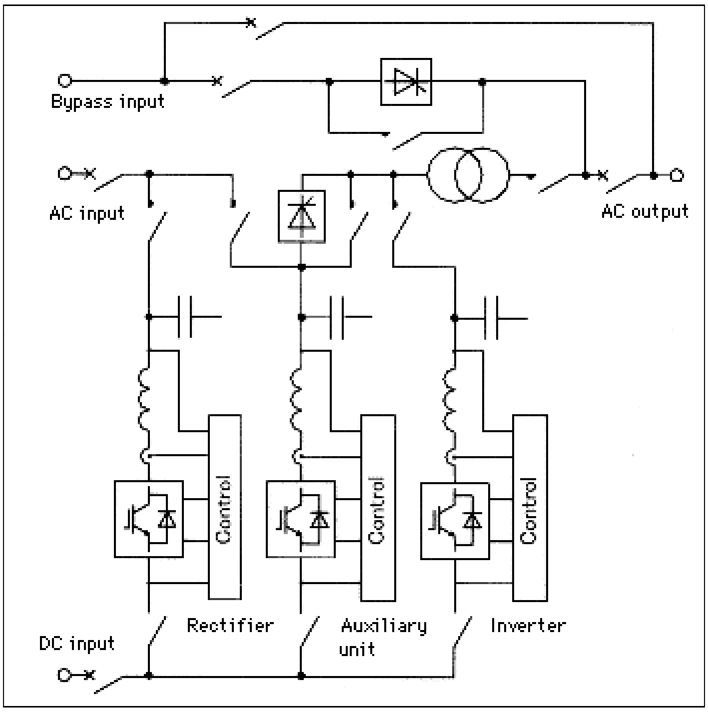

fig. 3 Configuration diagram of "SANUPS R"