Development of the Inverter "SANUPS D11A"

Toshifumi Nishizawa Satoru Shimizu Hideaki Yoda Yoshinori Kaneko

Kenichi Nakamura Kouji Kurumisawa Chiaki Seki

1. Introduction

With the advance of the information society, computers and other IT and communications devices that require AC power are sometimes forced to rely on stable power from DC power supply systems.

Additionally, the need for efficient inverters is particularly strong from the standpoint of both effective use of energy and the reduction of the electric power charge.

On top of that, such devices are often mounted on the standard 19-inch rack, meaning that customers require the efficient use of rack space. Thus the devices must be smaller, as must the inverters that power them. Finally, light weight is required to reduce work during installation and maintenance.

With this background, we have developed "SANUPS D11A" DC-AC inverter, aimed at achieving the high-reliability, high-efficiency, and reduced size and reducing maintenance installation labor.

This document introduces an overview of the features of the "SANUPS D11A" .

2. Product Overview

The "SANUPS D11A" is based on a 1 kVA (1 kW) inverter unit. By connecting this unit to a cabinet for parallel operation, parallel redundant operation is achieved. Fig. 1 shows the external dimensions of the inverter unit.

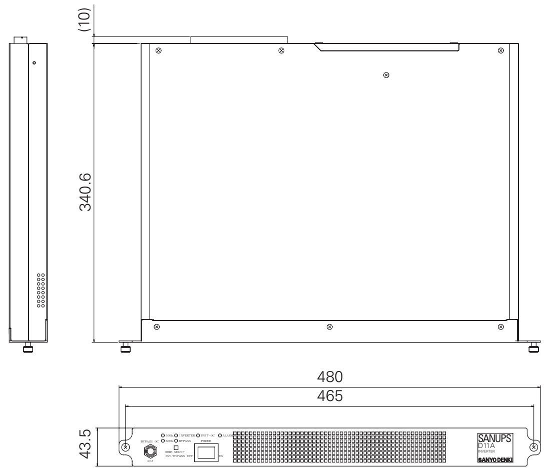

Fig. 1: External dimensions of the inverter unit

A parallel operation cabinet comes in a 3-connection and a 6-connection type. Installing an inverter on a 6-connection cabinet allows 5 kVA parallel redundant operations. Fig. 2 shows the image of a parallel operation cabinet (6 units).

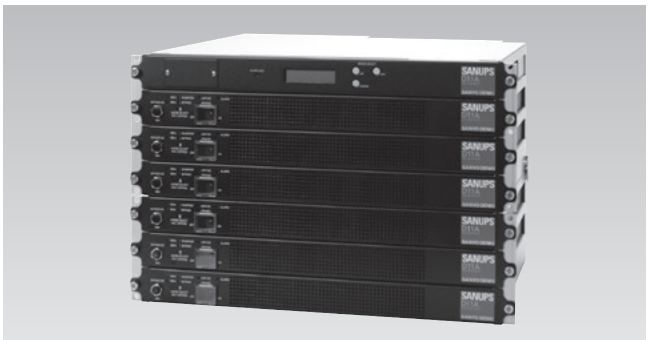

Fig. 2: Image of a parallel operation cabinet (6 units)

Additionally, the inverter is a basic unit, meaning that it can be connected to cabinet for single device to make a stand alone inverter. Stand alone inverters can be used to disperse loads of less than 1 kVA. Fig. 3 shows the external dimensions of a stand alone inverter.

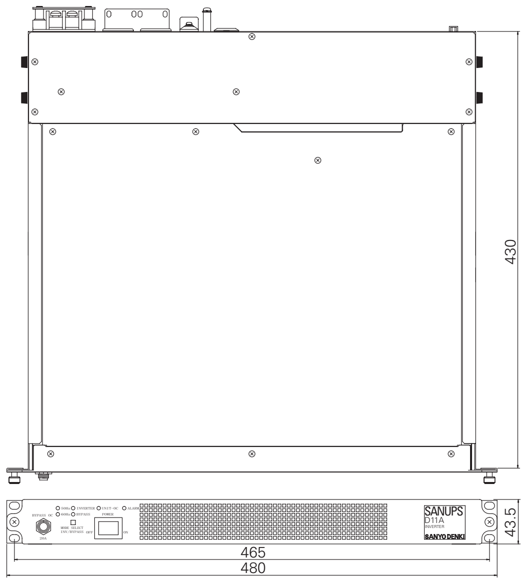

Fig. 3: External dimensions of a stand alone inverter

Finally, the bypass power supply function is available for both parallel and stand alone inverters.

3. Product Features

3.1. High Efficiency

Our previous model, the “SANUPS DA10SR” has an 80% inverter efficiency. The newly developed “SANUPS D11A” reaches 86% efficiency.

The first step in achieving this improved efficiency was to perform a loss analysis on the “SANUPS DA10SR.”

Fig. 4 shows the circuit architecture of the inverter equipment. The device includes an insulated converter (DC/DC conversion), an inverter (DC/AC conversion) and a control unit.

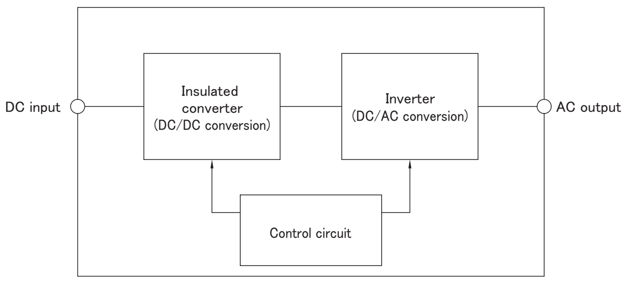

Fig.4:Circuit architecture of the inverter equipment

The results of the analysis indicated that there was significant loss from the insulated converter and that most of this was due to a specific semiconductor element used in conversion. Thus, we researched the control system and a circuit to reduce switching loss from the insulated converter, resulting in the use of a partial resonant converter.

Additionally, the main semiconductor and several other circuits now use low-loss components, reducing overall loss and increasing efficiency.

Fig. 5 compares the loss ratio of the “SANUPS D11A” and the previous model. The new model shows a 50% improvement in efficiency in the insulated converter circuit.

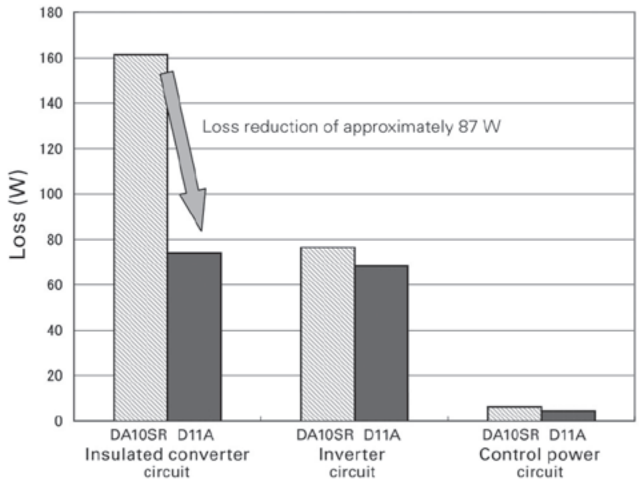

Fig. 5: Loss comparison

3.2 High reliability

1. Complete individual control

To use the previous model, the “SANUPS DA10SR,” for parallel operation, the phase of the inverter unit AC power had to be synchronized with other inverter units, so a synchronization signal was shared by all units. Each inverter unit applied synchronization control to the phase signal to ensure synchronized operation. This required a circuit dedicated to share the phase signal.

On the other hand, the “SANUPS D11A” uses phase information from the general output voltage to synchronize each machine, resulting in complete individual control. There is thus no need for the phase control circuit, thus improving overall reliability.

2. High reliability operation for all types

The “SANUPS D11A” can use both parallel redundant mode and bypass power function mode. Thus, even if direct current is completely stopped, power can still be supplied to load equipment using AC power.

Using a bypass power supply function in an inverter unit allows the unit to switch current/spare method. Fig. 6 shows a block diagram of each method.

A parallel redundant operation system with a bypass power supply function is a parallel redundant operation system with a bypass power supply function added, meaning that irregularities in direct current or dropping of inverter output due to overload can be handled by automatically switching to the bypass circuit, keeping power flowing smoothly.

Current/spare method is achieved by changing the connection of cabinets of a parallel redundant operation system with a bypass power supply function using the optional copper bar. The top 3 units and the bottom 3 units of the cabinet are divided into current and spare devices, with the output of the spare units connected to the AC input of the current units. This means that, when 6 units are installed in the cabinet, 3 kVA current/spare method is possible.

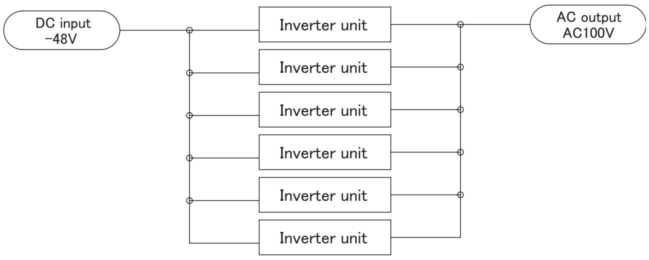

Fig. 6-1: Parallel redundant method block diagram

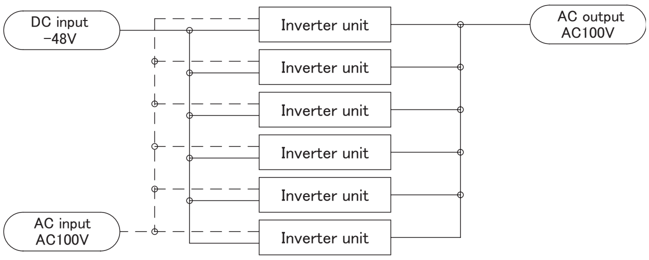

Fig. 6-2: Parallel redundant method with bypass power supply function

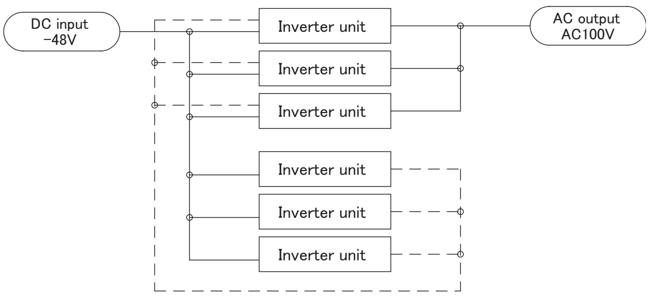

Fig. 6-3: Current/spare method

3.3 Small size and low mass

By increasing the efficiency of the conversion unit, selected parts have been reduced in size compared to the “SANUPS DA10SR.” The “SANUPS D11A” is thus significantly smaller and lighter than its predecessor. Table 1 compares the volume and mass of the “SANUPS D11A” and the previous model. The maximum device output has been increased 200 W, but the volume has decreased 39% and the mass has decreased 21%, resulting in a smaller, lighter device. Additionally, because it has reached 1U size, it helps in making efficient use of rack space.

Table 1: Volume and Mass comparison

Item	D11A	DA10SR	Remarks
Output capacity	1 kVA/1 kW	1 kVA/0.8 kW	200 W increase
Volume	6,360 cm^3	10,406 cm^3	Reduced approximately 39%
Mass	7.5 kg	9.5 kg	Reduced approximately 21%

3.4 Installation and maintainability

The “SANUPS D11A” weights approximately 2 kg less than its predecessor, the “SANUPS DA10SR,” reducing the load on maintenance and installation personnel.

Additionally, the inverter unit and the input/output unit of the previous device were connected by a cable, meaning that maintenance work required reaching behind the machine. The “SANUPS D11A” uses a simple plug-in connection to connect the inverter unit and the cabinet, meaning that all maintenance can be performed from the front of the unit. This represents large improvement in ease of maintenance and installation. Fig. 7 shows inverter unit mounting.

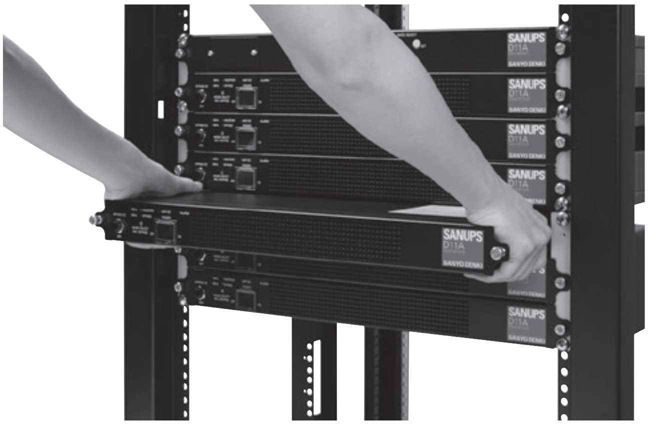

Fig. 7: Inverter unit mounting

4. Specifications

Table 2 shows the specifications of the inverter unit. Table 3 shows the specifications of the parallel operating cabinet.

5. Conclusion

As information communication technology becomes more sophisticated, its social importance will continue to grow. Thus, demand for more reliable and efficient inverters is likely to increase.

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

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

Table 2: Inverter unit specifications

Item		Rating or characteristics		Remarks
Series name		D11A102		DC/AC inverter for parallel operation
Rated capacity		1 kVA (1 kW)		Apparent power (effective power)
Bypass circuit		No	Yes	
Rating type		Continuous		
Cooling method		Forced air cooling		
Device life		15 years		
Acoustic noise		55 dB or less		1 m from the front of the device, A characteristics
Operating environment		5˚C to 40˚C		Short term: 0˚C to 50˚C (72 hours at a time/ 15 days per year)
		5 % to 85 %		Short term: 5% to 90% (72 hours at a time/ 15 days per year)
DC input	Rated voltage	48 V		
	Fluctuation range	40.5 V to 57 V		
AC output	Number of phase	Single-phase, 2-wire		
	Rated voltage	100 V/120 V		Sine wave output, voltage by setting switch
	Voltage precision	±2%		
	Rated frequency	50/60 Hz		Frequency by setting switch
	Frequency precision	±1%		
	Waveform distortion factor	Within 8%		
	Transient voltage fluctuation	Within ±10%		Variation between 0% and 100% or sudden change in input voltage
	Response time	100 ms or less		
	Load power factor	1		Range of variation: 0.7 (lag) to 1.0 *Does not exceed 1 kVA even when PF = 0.7.
	Overcurrent protection	105% or higher		
AC input for bypass operation	Rated voltage	—	100 V / 120 V	
	Fluctuation range	—	100 V ±15%	
		—	120 V ±15%	

Table 3: Parallel operation cabinet specifications

Item		Rating or characteristics		Remarks
Series name		PD-D11A		
DC input	Rated voltage	48 V		
	Fluctuation range	40.5 V to 57 V		
AC output	Inverter connections	Maximum 3	Maximum 6	
	Rated voltage	100 V/120 V		
	Load power factor	1		Same as inverter unit
AC input for bypass operation	Rated voltage	100 V/120 V		Only with bypass function included
	Fluctuation range	100 V ±15%		Only with bypass function included
		120 V ±15%		Only with bypass function included
Display	Voltage/current display Unit status display	Overall voltage/current display Standby / inverter operation / bypass operation / error		LCD indicator
External transfer signals		Operating, overload, DC input irregularity, unit failure, cabinet failure		

Toshifumi Nishizawa
Joined Sanyo Denki in 1997.
Power Systems Division, 2nd Design Dept.
Worked on the development and design of UPS and inverter.

Satoru Shimizu
Joined Sanyo Denki in 1990.
Power Systems Division, 2nd Design Dept.
Worked on the development and design of UPS and inverter.

Hideaki Yoda
Joined Sanyo Denki in 1991.
Power Systems Division, 2nd Design Dept.
Worked on the development and design of UPS and inverter.

Yoshinori Kaneko
Joined Sanyo Denki in 1992.
Power Systems Division, 2nd Design Dept.
Worked on the structural design of UPS and inverter.

Kenichi Nakamura
Joined Sanyo Denki in 2002.
Power Systems Division, 2nd Design Dept.
Worked on the development and design of UPS and inverter.

Kouji Kurumisawa
Joined Sanyo Denki in 2006.
Power Systems Division, 2nd Design Dept.
Worked on the development and design of UPS and inverter.

Chiaki Seki
Joined Sanyo Denki in 1987.
Power Systems Division, 2nd Design Dept.
Worked on the development and design of UPS and inverter.