Development of "SANUPS P83C", Inverter for Photovoltaic Power Generation

Makoto Ishida Takeshi Hama Akinori Matsuzaki Hiroshi Hirata Yuuji Wada
Takashi Kobayashi Hiroshi Yamada Mitsuru Takasugi Katsutoshi Yamanaka

1. Introduction

In recent years, the "Green New Deal" policy has been taken up internationally with regard to environmental problems such as global warming and the worldwide economic downturn, and it continues to be the trend around the world.

Against this background, photovoltaic power systems have gained attention as a type of clean energy that does not emit carbon dioxide or other greenhouse gases, which are known to be among the sources of global warming. Many countries around the world are actively attempting to expand photovoltaic power systems as national projects, while still more are hoping to increase their use of these systems. There are great expectations for the spread of photovoltaic power systems around the world.

This document introduces a product overview and the features of the SANUPS P83C inverter for photovoltaic power generation that was developed for use internationally.

2. Background of the Development

Currently, photovoltaic power systems are gaining attention around the world.

In South Korea, the national energy plan (2002) published by the government states that the goal for the introduction of renewable energy is 5% by 2011 and 1300 MW by 2012. According to the results of 2008, the amount of photovoltaic power generation suddenly rose to 274 MW to exceed Japan's figure of 230 MW (statistics from the European PhotoVoltaic Industry Association (EPIA)).

Even in China, the government is moving toward a system that would guarantee purchase of renewable energy by the central government, and they plan to raise the percentage of renewable energy to 15% of the total amount of energy consumption by 2020. In other countries, there are movements to develop systems to encourage the spread of renewable energy, so photovoltaic power systems are expected to rapidly spread around the world in the future.

We have the 10 kW type SANUPS P73F inverter, which supports international systems. There is a 100 kW type SANUPS P83B, but a voltage conversion transformer external to the device must be installed. For foreign large-capacity systems, we need a more competitive product in terms of factors such as cost and installation area.

With all of this in mind, we began development of the SANUPS P83C large capacity inverter for photovoltaic power generation that supports foreign systems.

3. Features

3.1 High conversion efficiency

When using the 100 kW SANUPS P83B inverter for photovoltaic power generation, which is a Sanyo Denki model for use within Japan, support for the system of foreign countries can be added by installing a transformer for voltage conversion to the inverter AC output in addition to the insulation transformer inside the device. However, this means that there are two levels of transformers, which lowers the overall conversion efficiency.

By optimizing the commercial insulation transformer for the main circuit and the switching frequency, and by using low-loss components as the main circuit parts, the SANUPS P83C not only achieves support for foreign systems, but it also realizes the top conversion efficiency in the industry* for 100 kW at 97.8% (maximum efficiency).

Fig. 1 shows the conversion efficiency characteristics of the SANUPS P83C.

*As of September 2009. Results of Sanyo Denki inspection.

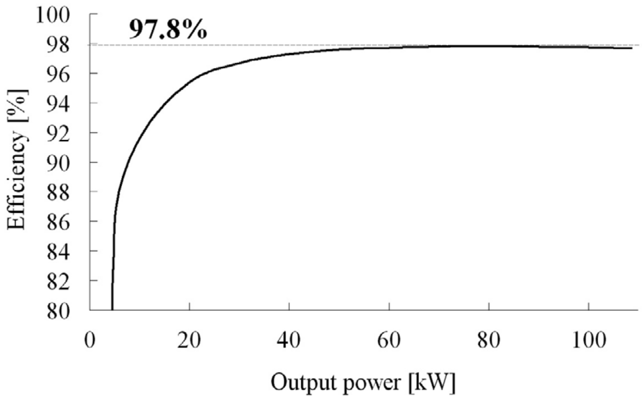


Fig. 1: Conversion efficiency characteristics of SANUPS P83C

3.2 Wide input operating voltage range

One feature of the SANUPS P83C is the wide input operating voltage range.

There are two variations of the SANUPS P83C that can operate with a wide voltage range: the high-voltage type (P83C104RH) and the low-voltage type (P83C104RL).

Fig. 2 shows the input operating voltage range for the SANUPS P83C.

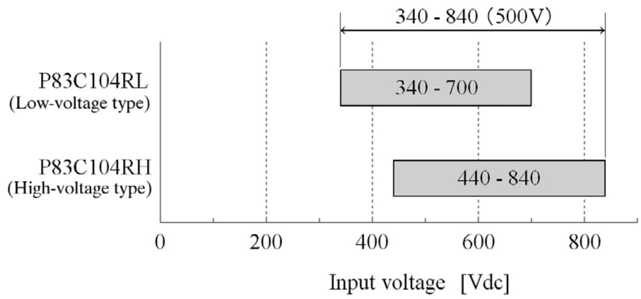


Fig. 2: Input operating voltage range

3.3 Compliance with standards

In the international market, compliance with safety standards is one of the most basic requirements when selecting equipment. Products marketed towards international customers must comply with international safety standards, and this holds true for photovoltaic inverters.

The high-voltage type SANUPS P83C104RH is designed to comply with the demands of the European directives (low voltage directive and EMC directive), and it is also a product with CE marking.

Also, the low-voltage type SANUPS P83C104RL complies with the basic South Korean accreditation tests for photovoltaic inverters.

3.4 Multiple unit control function

The multiple unit control function controls the quantity of operating inverters depending on the generation status of photovoltaic cells in generation systems where several inverters are operating in a utility-connected system.

Since the amount of power generated by photovoltaic cells depends on the weather (specifically, on the intensity of solar irradiance), on days with low intensity, the amount of power generated by photovoltaic cells falls. By controlling the number of inverters that are operating according to the amount of power generated by photovoltaic cells, we avoid operations with low output and low conversion efficiency to a very great extent. Since the system only operates with high conversion efficiency, we improved the efficiency of the entire system.

Fig. 3 shows a comparison of the efficiency characteristics with multiple unit control. During periods of low output, the number of inverters operating is relatively small compared to the number of devices, so the system efficiency during low output can be improved.

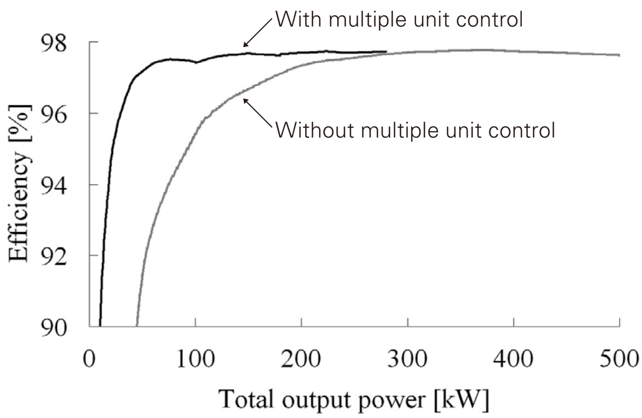
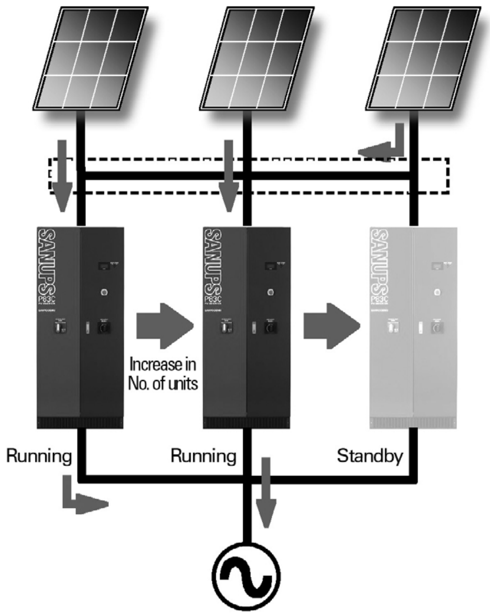


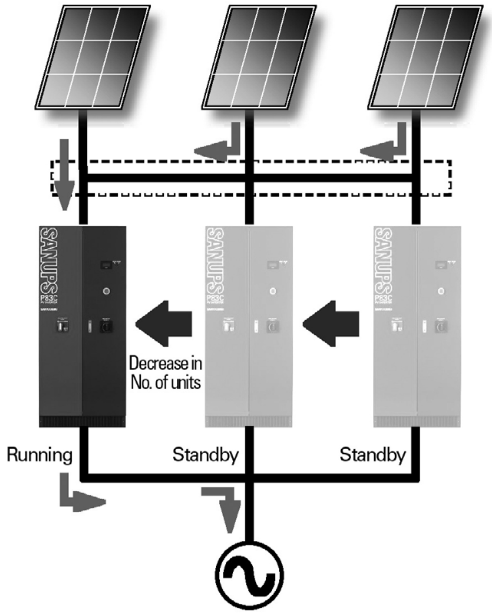
Fig. 3: Comparison of efficiency characteristics of multiple unit control

Next, Fig. 4 shows the operation of the multiple unit control when three units are used. For a 300 kW system, when the total of power generated by the photovoltaic cells is low, only one of the three units is operated and the others are kept on standby. Furthermore, when the total of power generated by the photovoltaic cells increases, the number of units operating also increases (Fig. 4(a)). When the total of power generated by the photovoltaic cells falls, the number of units operating also decreases (Fig. 4(b)).

In this way, the number of units operating, corresponding to the total amount of power generated by the photovoltaic cells, is based on the system as a whole, and system efficiency during periods of low output can be increased.



(a) When the total of power generated by the photovoltaic cells increases



(b) When the total of power generated by the photovoltaic cells decreases

Fig. 4: Operation of the multiple unit control function (Example using 3 units)

3.5 Voltage rise suppression function

In order to suppress rising voltage, the SANUPS P83C includes a function to control the reactive power and limit the active power output.

During utility-connected operations, if the AC voltage at the AC output point rises above the reactive power setting, then the reactive power is regulated and the rise in voltage that occurs due to the reverse power flow to the power line is suppressed.

Furthermore, if the AC voltage rises above the output limit, then the active power output is regulated and the voltage rise is suppressed.

3.6 Design

Fig. 5 shows a photograph of the external appearance of the SANUPS P83C.

The SANUPS P83C has been completely redesigned from the conventional model, bringing the color of Sanyo Denki power products (SANUPS Red) to the fore.

Furthermore, the display uses a touch panel, which improves both the design and usability of the product.

Fig. 5: Appearance of SANUPS P83C

4. Specifications

Table 1 shows the specifications for the SANUPS P83C.

Table 1: Main specifications for SANUPS P83C

Item \ Model		P83C104RH High-voltage type	P83C104RL Low-voltage type	Remarks
Rated output		100 kW		
Method	**Main circuit method**	Self communication voltage control type		
	Switching method	High-frequency PWM method		
	Insulating method	Commercial frequency insulation method		
DC input	**Maximum allowance input voltage**	DC 900 V	DC 750 V	
	Input operating voltage range	DC 440 to 840 V	DC 340 to 700 V	
	Rated output range	DC 450 to 840 V	DC 350 to 700 V	
	Maximum power point tracking control range	DC 440 to 840 V	DC 340 to 700 V	
AC output	**No. of phases / wires**	3-phase, 4-wire		Neutral grounding
	Rated voltage	AC 400 V	AC 380 V	Line voltage
	Rated frequency	50 / 60 Hz		
	Current distortion factor (total)	3% or less		Rated output current ratio
	Output power factor	0.99 or more		At rated output
Efficiency	**Max. efficiency**	97.8%	97.3%	
	EU efficiency	96.7%	96.1%	
Utility protection function		Over-voltage (OV), Under-voltage (UV), Over-frequency (OF), Under-frequency (UF)		
Islanding operation detection	**Passive method**	Voltage phase jump method		
	Active method	Reactive power fluctuation method		
Environment	**Installation place**	Indoor		
	Ambient temperature	-20 to 50°C		When ambient temperatures are above +40℃ , the output power is limited
	Relative humidity	15 to 90%		Non-condensing
	Altitude	2,000 m or less		
Directives	**Safety**	EN 50178 IEC 62109-1 IEC 62109-2	–	
	EMC	EN 61000-6-2 EN 61000-6-4 EN 55011	–	
	Other	DIN VDE 0126-1-1	–	
	CE marking	○	–	
	Korean general testing	–	○	
Miscellaneous		Multiple unit control function		Up to 5 units

5. Conclusion

This document introduces the main features of the SANUPS P83C.

The development of this product adds a model that can be used internationally to our line-up of inverters for photovoltaic power generation.

In the future, we plan to develop products based on the SANUPS P83C for international, large-capacity systems, with the aim of producing an inverter with even higher performance and lower cost, and to develop and design a product that can contribute to the health of the global environment.

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

Makoto Ishida
Joined Sanyo Denki in 2006.
Power Systems Division, 1st Design Dept.
Worked on the development and design of photovoltaic power systems.

Takeshi Hama
Joined Sanyo Denki in 1986.
Power Systems Division, 1st Design Dept.
Worked on the development and design of photovoltaic power systems.

Akinori Matsuzaki
Joined Sanyo Denki in 1981.
Power Systems Division, 1st Design Dept.
Worked on the development and design of photovoltaic power systems.

Hiroshi Hirata
Joined Sanyo Denki in 1985.
Power Systems Division, 1st Design Dept.
Worked on the development and design of photovoltaic power systems.

Yuuji Wada
Joined Sanyo Denki in 1988.
Power Systems Division, 1st Design Dept.
Worked on the development and design of photovoltaic power systems.

Takashi Kobayashi
Joined Sanyo Denki in 1995.
Power Systems Division, 1st Design Dept.
Worked on the development and design of photovoltaic power systems.

Hiroshi Yamada
Joined Sanyo Denki in 1994.
Power Systems Division, 1st Design Dept.
Worked on the development and design of photovoltaic power systems.

Mitsuru Takasugi
Joined Sanyo Denki in 1988.
Power Systems Division, 1st Design Dept.
Worked on the structural design of photovoltaic power systems.

Katsutoshi Yamanaka
Joined Sanyo Denki in 1996.
Power Systems Division, 1st Design Dept.
Worked on the structural design of photovoltaic power systems.