Development of "SANUPS P73J" , Power Conditioner for Photovoltaic Power Generation

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1. Introduction

In recent years, anticipation of renewable energy has risen from the viewpoint of compatibility with economic growth and global warming countermeasure. Particularly, photovoltaic power generation has a large potential available power supply and is expected to be effective in creating jobs for all industries. As a result, it is expanding through government supportive measures and there is great anticipation that its diffusion to spread further.

In particular, in order to support the introduction of renewable energy, ever since the Feed-in Tariff system for Renewable Energy was implemented in July of 2012, the introduction of photovoltaic power generation equipment has increased and the total module shipment of FY 2013 was 8,625 MW which is 205% compared with the previous year. [*1]

Under these circumstances, the market demands a high-efficiency and highly reliable power conditioner for photovoltaic power systems.

Here we introduces the newly developed the "SANUPS P73J" power conditioner and its features.

2. Background of the Development

In line with the diversification of photovoltaic modules in recent years, there are cases when DC ground is required, however in the case of non-insulation type power conditioners, an insulation transformer must be added externally to respond to DC ground.

Moreover, in low voltage grids with a power generation capacity of less than 50 kW, there are an increasing number of cases in which insulation transformers are required due to differences in the grounding methods of the grid side.

In order to solve issues such as these, Sanyo Denki has developed the "SANUPS P73J", 9.9 kW and 10 kW power conditioners for photovoltaic power generation which adopts a high frequency insulation method and enables interconnection without the use of an insulation transformer in both the case when DC circuits are grounded and when the grounding method of the grid differs.

3. Features

3.1 High conversion efficiency

In order to achieve high conversion efficiency, we optimized the transformer and switching frequency used in the insulation converter.

As a result, the "SANUPS P73J" has achieved top class conversion efficiency in the industry[*2] at 93.5%[*3].

3.2 Dustproof and waterproof performance

Due to its sealed structure with dustproof and waterproof, as an outdoor power conditioner, the "SANUPS P73J" prevents from rain, dust, and also entry of small insects, etc. This enables it a highly reliable product.

Moreover, the "SANUPS P73J" achieved a protection grade IP65[*4] in the external performance test from the Research Institute of Marine Engineering.

3.3 Power factor modification function

In order to countermeasure the voltage rises in distribution systems associated with large-scale introduction of photovoltaic power generation, the "SANUPS P73J" is standardly equipped with a power factor modification function for grid-connected operation as standard.

This function enables the output power factor to modify within 0.8 to 1.0 range during grid-connected operation, and so making it possible to suppress system voltage rises without installing specialized equipment or enhanced distribution line.

3.4 Response to the FRT requirement*5

In the case of an introduction of distributed power sources are increased, and are interconnected to electric power system at a wide area and large volume, it occurs the disturbance of electric power system, and so it will have a large effect on the power quality if disconnecting all at once. FRT (Fault Ride Through) means the continuing operation in order to prevent problems such as those caused by this kind of simulataneous disconnection.

Since April, 2014 it has been an interconnection condition of low voltage grids that to satisfy FRT. As such, the “SANUPS P73J” responds to FRT.

3.5 The 9.9 kW output capacity lineup

In addition to the 10 kW output capacity, the “SANUPS P73J” also features a 9.9 kW in its lineup.

By combining the two output capacities of 10 kW and 9.9 kW, it is possible to select a power generation capacity of 49.9 kW against the power generation capacity less than 50 kW, which is a standard of low voltage grids.

3.6 Isolated operation function

“SANUPS P73J” enables an isolated operation by switching to isolated operation mode manually.

The output electric mode at isolated operation is 202 V AC of 3-phase 3-wire with a maximum output of 10 kVA, so it enables the power supply to emergency equipment if occurs power outage.

Due to an isolated operation function is expected to be used at power outage caused by disasters, it adopted the manually mode switching in order to use with switched after confirmed the system safety.

Fig. 1 gives an example of an isolated operation.

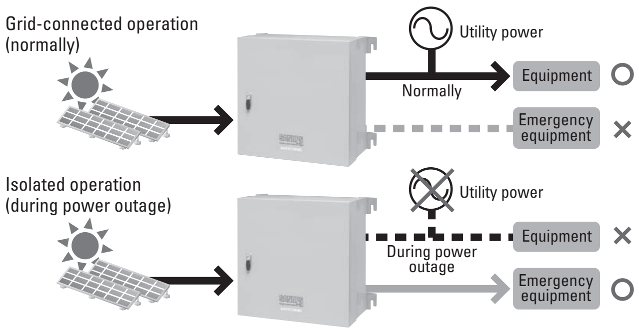


Fig. 1: Isolated operation image

4. Circuit Configuration

4.1 Circuit block diagram

Fig. 2 shows the circuit block diagram of the “SANUPS P73J”.

The “SANUPS P73J” consists of main circuit unit (including an insulated converter circuit, inverter circuit, and filter circuit) and a control circuit unit (including the utility protective circuit, external communication circuit, and the control circuit that controls the main circuits).

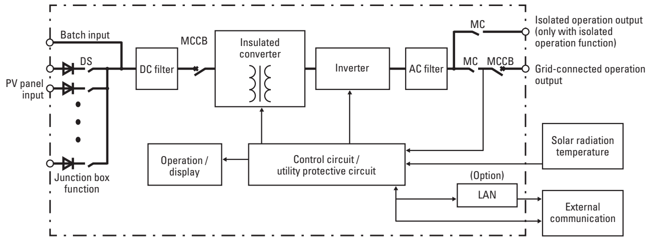
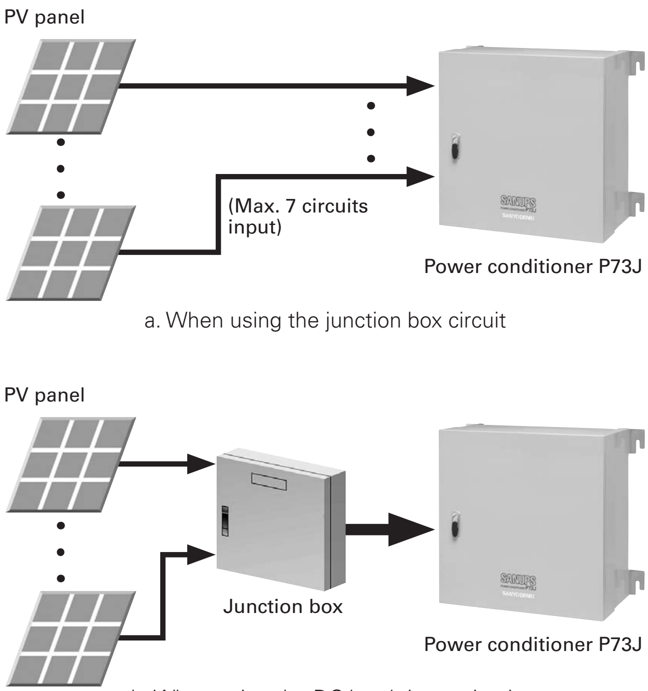


Fig. 2: Circuit block diagram

4.2 Flexible DC input circuit

The “SANUPS P73J” includes both a junction box circuit (max. 7 circuit input) and a DC batch input circuit as standard equipments, and therefore it can be used for a variety of DC input specifications.

Fig. 3 shows the DC input method.



a. When using the junction box circuit

b. When using the DC batch input circuit

Fig. 3: DC input circuit

4.3 Transducer circuit

The "SANUPS P73J" includes a built-in transducer (signal converter) circuit that can connect directly to the pyranometer and temperature transmitter, without an external transducer.

Furthermore, it can be connected to 4 to 20 mA DC signals of an external transducer.

4.4 External communication circuit

The "SANUPS P73J" uses the same interface (RS-485) and communication protocol for external communications circuits with conventional models, so it can be used in common with the "SANUPS P" series.

As a result, it can communicate with conventional models, which gives more flexibility of current system expansion and output capacity configurations.

5. Options

The "SANUPS P73J" has a wealth of options to meet the need of customer's request.

5.1 Photovoltaic panel multi-input measuring function

With the "SANUPS P73J", a current measurement per each photovoltaic panel (maximum of 7 circuits) is available as an option.

A PV system is a structure where multiple modules are connected in serial-parallel and the early detection of drops in power generation capacity due to module errors is an important issue, as this leads to significant financial loss.

5.2 Visualization of the photovoltaic power system

By connecting the "SANUPS P73J" to our "SANUPS PV Monitor" enables to collect and analyze the pyranometer and temperature transmitter's data, and also perform remote monitoring via the network.

Furthermore, by using the state monitoring service, "SANUPS NET" enables to perform remote monitoring the photovoltaic power system through an internet by PC and smartphone.

Moreover, by monitoring the current of photovoltaic panel with multi-input measuring function, it enables to monitor the drop in power generation of photovoltaic panel.

Customers can choose either a service for the visualization of power or a system information management service with the "SANUPS NET", depending on their needs.

Fig. 4 shows the connection image of remote monitoring when using the "SANUPS PV Monitor" and the "SANUPS NET".

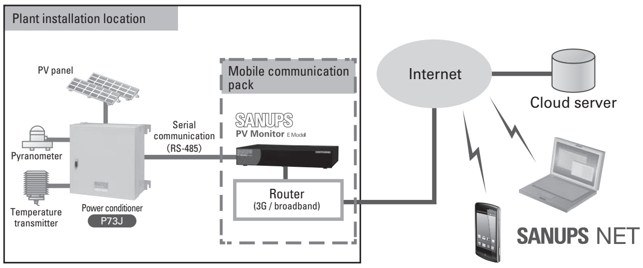


Fig. 4: Connection image of remote monitoring

5.3 Weather shelter

A weather shelter is optional equipment that provides thermal insulation for power conditioners in direct sunlight. By installing the weather shelter to the "SANUPS P73J", the power conditioner can be used even in locations exposed to direct sunlight.

The weather shelter is an on-site assembling and is the structure that is unnecessary to install to power conditioner, thus it will not affect the protection grade IP65 of "SANUPS P73J".

Fig. 5 and 6 show the weather shelter installation images.

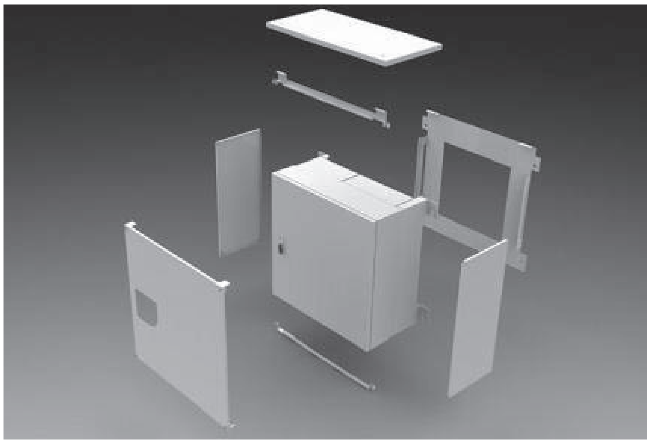


Fig. 5: Weather shelter installation image

Fig. 6 Installed weather shelter installation image

5.4 Stand-type fittings

The stand-type fittings are used when the “SANUPS P73J” cannot be wall-mounted or installed to a support structure for photovoltaic panel. It is the free-standing support that enables to install outdoors independently.

Fig. 7 shows an usage image of the stand-type fittings.

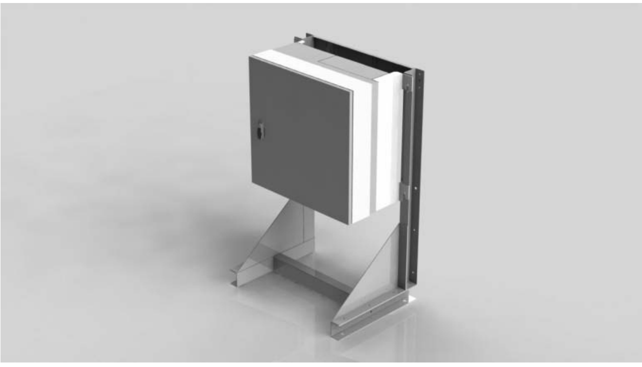


Fig. 7: Usage image of stand-type fittings

6. Specifications

Fig. 8 shows the external view of “SANUPS P73J”, and Table 1 shows the main specifications.

Fig. 8: “SANUPS P73J” external view

Table 1: Main specifications of the “SANUPS P73J”

Item			Utility connected system type		Isolated operation function type	Remarks
Output capacity			9.9 kW	10 kW	10 kW	
Main circuit method			Self-commutation voltage type			
Switching method			High frequency PWM			
Insulation method			High frequency insulation method			
Cooling method			Forced air cooling			
Utility connected system operation	DC input	Rated voltage	400 V DC			
		Maximum allowable input voltage	570 V DC			
		Input operating voltage range	150 to 570 V DC			Rated output range 250 to 540 V DC
		Maximum power point tracking control range	190 to 540 V DC			
		No. of input circuits	7 circuits (max. 11 A/circuit) 1 circuit (for batch input)			In the case of batch input, an external junction box is required.
	AC output	No. of phases/wires	Three phase, three wire			
		Rated voltage	202 V AC			
		Rated frequency	50 Hz / 60 Hz			
		Rated output current	28.3 A AC	28.6 A AC		
		AC output current distortion rate	5% or less of the total current, 3% or less of each next harmonic wave			Rated output current ratio
		Output power factor	0.95 or higher			At rated output with a power factor setting of 1.0 Power factor setting range: 0.8 to 1.0 (0.01 step)
Isolated operation	DC input	Rated voltage	-		400 V DC	
		Maximum allowable input voltage	-		570 V DC	
		Input operating voltage range	-		150 to 570 V DC	Rated output range 250 to 540 V DC
	AC output	Rated output	-		10 kVA	Load power factor 1.0
		No. of phases/wires	-		Three phase, three wire	By using the optimal transformer panel an output of 100 V AC (single phase, 2 wires) is possible.
		Rated voltage	-		202 V AC	
		Voltage precision	-		Rated voltage ± 5%	
		Rated frequency	-		50 Hz / 60 Hz	
		Frequency precision	-		Rated frequency within ± 0.1 Hz	
		AC output voltage distortion rate	-		Linear load: 5% or less	
		Overload capacity	-		100% continuous	
Efficiency			93.5% (excluding junction box function)			Efficiency measurement method based on JIS C 8961
Utility protection function			Over-voltage (OVR), under-voltage (UVR), over-frequency (OFR), under-frequency (UFR)			The OVGR is attached externally and the normally-closed dry contact input is the standard
Islanding operation detection		Passive method	Voltage phase jump detection			
		Active method	Reactive power fluctuation method			
Communication method			RS-485			
Acoustic noise			50 dB or less			A-weighting, front 1 m
Operating environment		Ambient temperature	-25 to +60°C			Operate with output limit when exceeds 40°C
		Relative humidity	90% or less (non-condensing)			
		Altitude	2000 m or lower			
Coating color			Munsell 5Y 7/1 (Semi-glossy)			
Heat generation			688 W	695 W		
Transducer function			Yes			For pyranometer, for temperature transmitter
Mass			64 kg		66 kg	

7. Benefits for Our Customers

- Interconnection is available without insulation transformer in both cases that grounding the DC circuit and differing the ground method with grids.
- It is possible to change the output power factor during grid-connected operation.
- It is possible to select below the power generation capacity of less than 50 kW which is the standard of low voltage grids.

These features enable customers to minimize the cost of photovoltaic power system installation as there is no need for additional transformer or equipment reinforcement.

8. Conclusion

This document described the overview of the "SANUPS P73J".

The development of this product has enhanced our lineup with a 9.9 kW and 10 kW power conditioners that adopts a high frequency insulation method.

With the expected future growth of photovoltaic power generation, we believe that the demand will increase for power conditioners that are high efficiency, high performance and high reliability with low cost. We will continue to develop products quickly that can handle market demands and supply products that satisfy customers, and contribute to achieve a low carbon society.

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

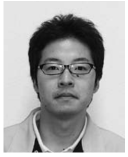
*1: "Statistics for photovoltaic panel shipments in Japan Q4 2013 and 2013"
Japan Photovoltaic Energy Association News release June 11, 2014

*2: As of August 2014. As a power conditioner for photovoltaic power generation of equivalent capacity adopting the high frequency insulation method.
Results from Sanyo Denki inspection. At rated output with a power factor setting of 1.0.

*3: Rated load efficiency based on "JIS C 8961 Measuring procedure of power conditioner efficiency for photovoltaic systems" . Excluding junction box circuit.

*4: Classification defined in "JIS C 0920 protection grade (IP Code) provided by enclosures of an electric machinery and apparatus" .
IP65: No dust penetration and no impact from jet flows from all directions.

*5: The requirement for distributed power sources to continue operation in order to secure power quality during grid disturbance.



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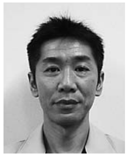

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