Development of a 100 kW Power Conditioner "SANUPS P83E"

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1. Introduction

In recent years, anticipation of renewable energy has risen as a solution to achieving both the goals of economic growth and combating global warming. Amidst this, photovoltaic power generation has a large potential available supply and is expected to be effective in creating jobs for all industries. As a result, it is expanding through governmental supportive measures and there is great anticipation that its utilization will popularize further.

In particular, to support the introduction of renewable energy, since the feed-in tariff system for renewable energy was made effective from July of 2012, photovoltaic power generation equipment is being introduced at an accelerated rate.

As of the end of October 2013, the equivalent of 5.85 million kW in renewable energy generation equipment had been installed, with photovoltaic power generation equipment accounting for 5.66 million kW's of the total. [*1]

With these conditions, the market demands a high-efficiency, easy-to-use, highly reliable power conditioner for photovoltaic power systems.

This paper introduces the newly developed "SANUPS P83E" 100 kW power conditioner and its features.

2. Background of the Development

In addition to power conditioners being required to have better conversion efficiency to obtain more power as a photovoltaic power system, in recent years a growing demand has emerged for power conditioners to support a wider voltage range for DC input in line with the diversification of photovoltaic modules.

Moreover, after the Great East Japan Earthquake there was an extremely high demand for power conditioners with an isolated operation function allowing use of power generated by photovoltaic power systems even during power failures.

To respond to market demands such as these, Sanyo Denki has developed the "SANUPS P83E" 100 kW power conditioner which has high conversion efficiency, supports a wide DC input voltage range and features an isolated operation function.

3. Features

3.1 High conversion efficiency

The "SANUPS P83E" adopts a utility frequency link type main circuit which uses a utility insulation transformer. Moreover, in order to achieve high conversion efficiency, we investigated methods to reduce switching loss, as well as optimized the utility insulation transformer and switching frequency of the main circuit.

As a result, the "SANUPS P83E" has achieved top class conversion efficiency in the industry[*2] at 95%[*3].

3.2 Wide DC input voltage range

In order to respond to the diversification of photovoltaic modules in recent years, the "SANUPS P83E" has an expanded maximum DC input voltage of 600 V.

This enables a wider input operating voltage range than conventional Sanyo Denki models and makes it possible to respond to a diversity of photovoltaic module specifications.

Fig. 1 compares the input operating voltage ranges of the "SANUPS P83E" and conventional models.

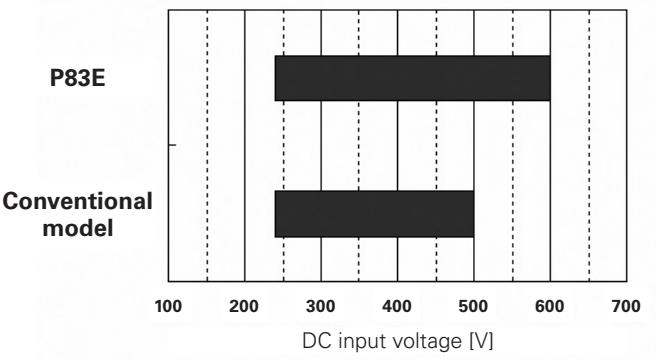


Fig. 1: Comparison of input operating voltage range

3.3 Isolated operation function

By adding a function which switches over to isolated operation mode, the “SANUPS P83E” isolated operation function type (the P83E104S) can be made to supply power to load for isolated operation during power failures in times of disaster, etc.

The output power method during isolated operation is three phase three wire 202 V AC with a maximum output of 100 kVA.

The new model also adopts manual mode switchover as it is necessary to switch after confirming the system is safe.

Fig. 2 shows a block diagram of an isolated operation circuit of the “SANUPS P83E” isolated operation function type.

Normally, grid-connected operation is possible in the same way as the utility connected system type. During power failures, isolated operation mode is entered and the output MCCB switches from grid-connected output to isolated output, making it possible to supply power to load for isolated operation.

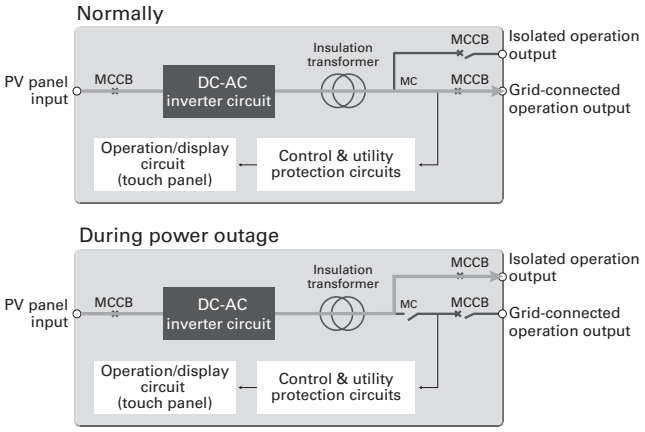


Fig. 2: A block diagram of an isolated operation circuit

3.4 Power factor variation function

In order to countermeasure voltage rises in distribution lines, which has emerged as an issue due to the large volume of photovoltaic power generation being introduced, the “SANUPS P83E” is standardly equipped with a power factor variation function for grid-connected operation.

This function enables the output power factor to vary within a range of 0.8 and 1.0 during grid-connected operation, making it possible to countermeasure system voltage rises without installing specialized equipment or strengthening the distribution line.

3.5 Visualization of the photovoltaic power system

By connecting the “SANUPS P83E” to another Sanyo Denki-made product, the “SANUPS PV Monitor” , it is possible to perform remote monitoring or collect and analyze actinometer or thermometer data via the network.

Additionally, by using the status monitoring service, “SANUPS NET” , remote monitoring of the photovoltaic power system is available from a PC or smartphone.

With the “SANUPS NET” customers can choose either a service for the visualization of power or a system information management service, depending on their needs.

Fig. 3 shows an example of the connections when using the “SANUPS PV Monitor” and the “SANUPS NET” for remote monitoring.

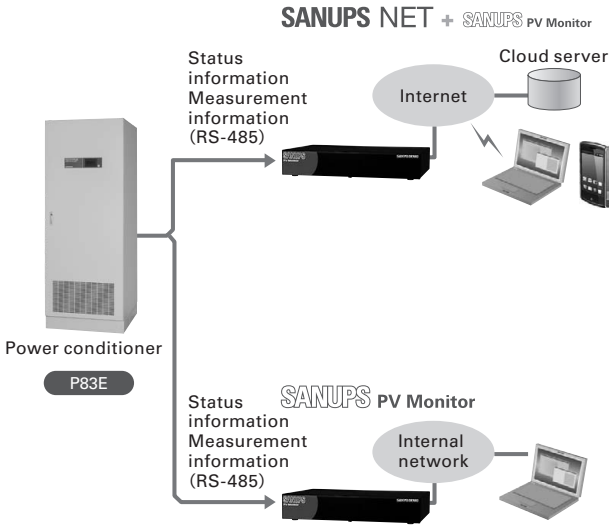


Fig. 3: An example of remote monitoring

4. Circuit Architecture

4.1 Circuit block diagram

Fig. 4 shows the circuit block diagram for the “SANUPS P83E”.

The “SANUPS P83E” utility connected system type (the P83E104R) consists of the main circuit portion including the DC-AC inverter circuit and insulation transformer, a control circuit which controls the main circuit, a utility protective circuit and a control circuit portion with operation/display circuits, etc.

The “SANUPS P83E” isolated operation function type (the P83E104S) is the same as the P83E104R but with an MCCB added for isolated operation output.

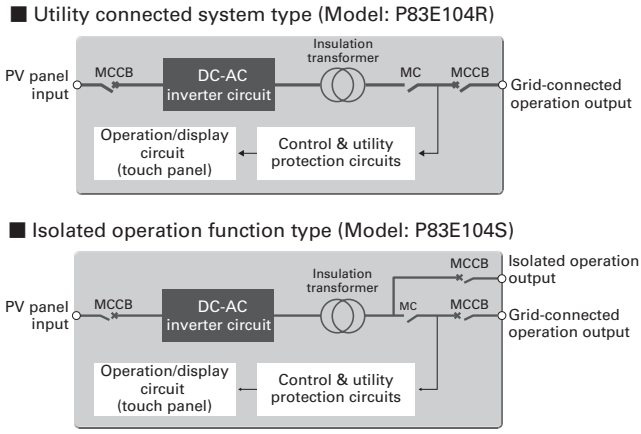


Fig. 4: Circuit block diagram of the “SANUPS P83E”

4.2 Operational section

On the “SANUPS P83E”, the status of the power conditioner is displayed on the touch panel, where a variety of settings can be made.

By making the operational section a touch panel, it is possible to externally change settings which could only be changed on conventional models by opening the door and operating a switch.

Fig. 5 shows the touch panel menu screen of the “SANUPS P83E” while Fig. 6 shows the utility protective function setting screen.

Table 1 shows an example of touch panel setting items.

Fig. 5: Menu screen of the “SANUPS P83E” touch panel

Fig. 6: Utility protective function setting screen of the “SANUPS P83E” touch panel

Table 1: Example of setting items on the “SANUPS P83E” touch panel

Item		Available settings (Underlined values are factory settings)
Utility protection function Function settings	**UV settings**	Detection values/detection times of system undervoltage Detection values: 160 V, 165 V, 170 V, 175 V, 180 V Detection times: 0.5 sec, 1.0 sec, 1.5 sec, 2.0 sec
	OV settings	Detection values/detection times of system overvoltage Detection values: 225 V, 230 V, 235 V, 240 V Detection times: 0.5 sec, 1.0 sec, 1.5 sec, 2.0 sec
	UF settings	Detection values/detection times of system under-frequency Detection values (50 Hz): 47.5 Hz, 48.0 Hz, 48.5 Hz, 49.0 Hz, 49.5 Hz Detection values (60 Hz): 57.0 Hz, 57.6 Hz, 58.2 Hz, 58.8 Hz, 59.4 Hz Detection times: 0.5 sec, 1.0 sec, 1.5 sec, 2.0 sec
	OF settings	Detection values/detection times of system over-frequency Detection values (50 Hz): 50.5 Hz, 51.0 Hz, 51.5 Hz Detection values (60 Hz): 60.6 Hz, 61.2 Hz, 61.8 Hz Detection times: 0.5 sec, 1.0 sec, 1.5 sec, 2.0 sec
	Passive setting	Passive method of the isolated operation detection function Detection values: ±3°, ±5°, ±8°, ±10°
	Recovery time	Input prevention time after power recovery 5 sec, 150 sec, 200 sec, 300 sec
Output power factor setting		Power conditioner output power factor Setting range: 0.8 -1.0 (0.01 step)

* The above are only some examples of available settings.

5. Specifications

Fig. 7 shows the “SANUPS P83E”, while Table 2 lists its main specifications.

Fig. 7: A “SANUPS P83E” utility connected system

Table 2: Main specifications of the “SANUPS P83E”

Item \ Model			P83E104R (Utility connected system type)	P83E104S (Isolated operation function type)	Remarks
Output capacity			100 kW		For a power factor of 1.0
Method		**Main circuit method**	Self-commutation voltage type		
		Switching method	High frequency PWM		
		Insulation method	Utility frequency link type		
		Cooling method	Forced air cooling		
Utility connected system Operation	**DC input**	**Rated voltage**	300 V DC		
		Maximum allowable input voltage	600 V DC		
		Input operating voltage range	240 to 600 V DC (Rated output range of 270 to 550 V DC)		
		Maximum power point tracking control range	240 to 550 V DC		
	AC output	**No. of phases/wires**	Three phase, three wire		S phase ground
		Rated voltage	202 V AC		
		Rated frequency	50 or 60 Hz		
		Rated output current	286 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)
	Efficiency		95%		Efficiency measurement method based on JIS C 8961 For a power factor of 1.0
Isolated operation	**DC input**	**Rated voltage**	–	300 V DC	
		Maximum allowable input voltage	–	600 V DC	
		Input operating voltage range	–	240 to 600 V DC (Rated output range: 270 to 550 V DC)	
	AC output	**Rated output**	–	100 kVA	Load power factor 1.0
		No. of phases/wires	–	Three phase, three wire	Conversion to single phase output is possible with the optional single phase output transformer.
		Rated voltage	–	202 V AC	
		Voltage precision	–	Rated voltage within ±8%	
		Rated frequency	–	50 or 60 Hz	
		Frequency precision	–	Rated frequency within ±0.1 Hz	
		AC output voltage distortion rate	–	Linear load: Max. 5%	
		Overload capacity	–	100% continuous	
	Efficiency		–	95%	
Utility protection function			Over-voltage (OVR), under-voltage (UVR), over-frequency (OFR), under-frequency (UFR)		
Islanding operation detection		**Passive method**	Voltage phase jump detection		
		Active method	Reactive power fluctuation method		
Communication method			RS-485		
Acoustic noise			63 dB or less		1 m from the front of the device, A characteristics
Operation environment		**Ambient temperature**	-10 to +60˚C		Limited output operations when the temperature exceeds 40˚C
		Relative humidity	30 to 90% (non-condensing)		
		Altitude	2000 m or lower		
Coating color			Munsell 5Y 7/1 (Semi-glossy)		
Heat generation			5263 W		

6. Conclusion

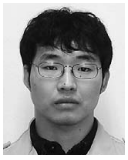
This paper gave a brief introduction of the “SANUPS P83E”.

The development of this product enhances our power conditioner lineup with a model that can flexibly address the specifications of various photovoltaic modules.

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, high reliability and low cost. We will continue to speedily develop products that can handle market demands, 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 “Disclosing the installation status of renewable energy generation equipment”
News release issued by the Agency for Natural Resources and Energy, January 10, 2014
*2 As of March 2014. As a power conditioner for domestic use of equivalent capacity.
Results from Sanyo Denki inspection.
*3 Rated load efficiency based on “JIS C 8961 Measuring procedure of power conditioner efficiency for photovoltaic systems”. Excluding junction box circuit.



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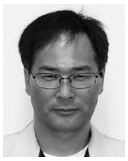

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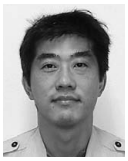

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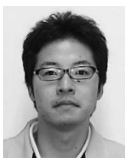

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