Development of the "SANUPS PMC" Power Conditioner with Peak-Cut Function

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1. Introduction

Since the Tohoku Earthquake last year, due to the effects of actual long-term power outages during the disaster, there has been an increased tendency to prepare backup emergency power for local government bodies that serve as disaster prevention bases or shelters during disasters and private companies that emphasize business continuity. Among these preparations, disaster prevention photovoltaic power generation systems that solar panels are combined with storage batteries have gained attention as backup power sources that use natural energy and yet can be used as stand-alone power sources during a disaster.

Furthermore, due to the insufficient power from the nuclear disaster caused by this particular earthquake, in addition to various energy-saving measures, there has been an emphasis on measures to suppress peak power demands.

With this in mind, Sanyo Denki developed the "SANUPS PMC" power conditioner with peak-cut function. The "SANUPS PMC" was sold previously as a disaster prevention photovoltaic power generation system that solar panels are combined with storage batteries. This model takes the "SANUPS PMC" which has function to act as backup power and adds a function that can use the storage battery to reduce the peak power to the isolated and charging operation functions. This adds the new series of "SANUPS PMC" with peak-cut function models to the lineup.

This document introduces an overview of the product and the features of the "SANUPS PMC" power conditioner with peak-cut function.

2. Overview of the "SANUPS PMC"

2.1 Circuit architecture

The "SANUPS PMC" consists of a 10 kW power conditioner unit and an I/O box, and it is a build up system that can stack up to five power conditioner units. The lineup includes models with system capacities ranging from 10 to 50 kW.

Fig. 1 shows the appearance of the "SANUPS PMC" (50 kW) and Fig. 2 shows the basic circuit architecture.

The power conditioner unit has an output circuit connected to important equipment and a charging function, therefore it can supply power to the equipment during power outages.

The I/O box has a battery input switch, a power conditioner output switch, and a special output bypass switch. By switching between operation modes, the I/O circuit can provide on and off controls for functions.

The "SANUPS PMC" power conditioner with peak-cut function has four operation modes: grid-connected operation, peak-cut operation, isolated operation, and charging operation. The operations of each operation mode are described below.

Fig. 1: Appearance of the "SANUPS PMC" (50 kW)

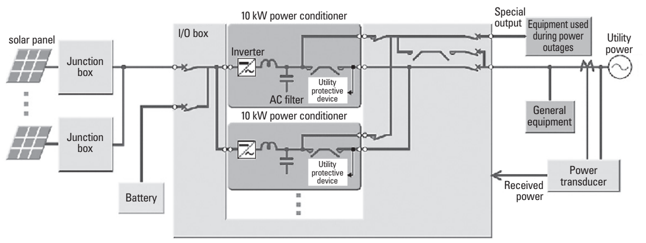


Fig. 2: Basic circuit architecture of “SANUPS PMC”

2.2 Grid-connected operation mode

Grid-connected operation mode is executed when all of the following conditions are met. Fig. 3 shows the flow of power during grid-connected operation mode.

- Power generated by the solar panels is above a certain level
- Utility grid is normal

During grid-connected operation mode, the power conditioner performs MPPT control and supplies AC power to the utility grid depending on the power generated by the solar panels. During this mode, if the AC power is more than the power required by general equipment, the surplus power is fed into the utility grid (reverse power flow).

Furthermore, the utility power can also be supplied to the equipment used during power outages via the bypass circuit.

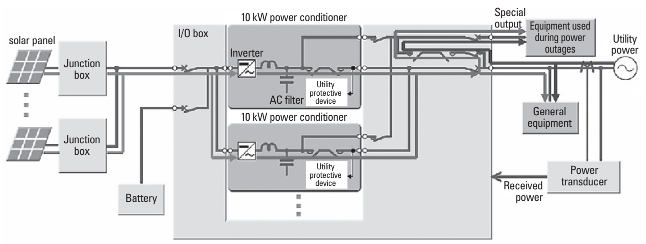


Fig. 3: Grid-connected operation mode

2.3 Peak-cut operation mode

Peak-cut operation mode is executed when all of the following conditions are met. Fig. 4 shows the flow of power during peak-cut operation mode.

- Power conditioner is in grid-connected operation or standby
- Utility grid is normal
- Power received from the utility grid is greater than the set value

During peak-cut operation mode, the power conditioner connects the DC input to the battery and the supplies AC power to the general equipment depending on the power generated by the solar panels and the discharge power from the battery.

Furthermore, the utility power can also be supplied to the equipment used during power outages via the bypass circuit.

During this mode, when the power received from the utility grid becomes less than the value specified, the power conditioner disconnects the battery and switches to grid-connected operation mode.

Since the power conditioner starts and stops peak-cut operation while monitoring the power received from the utility grid, the output power from the power conditioner does not flow back to the utility grid during peak-cut operation.

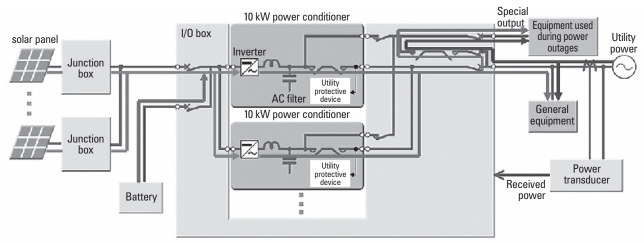


Fig. 4: Peak-cut operation mode

2.4 Isolated operation mode

Isolated operation mode is executed when all of the following conditions are met. Fig. 5 shows the flow of power during isolated operation mode.

- Power conditioner is in run or standby
- During a utility power outage

During isolated operation mode, after checking a continued power outage of a certain period of time, the power conditioner connects the DC input to the battery and supplies AC power to the equipment used during power outages with power from the solar panels and the battery.

During this mode, if the amount of power generated by the solar panels is larger than the power supplied to the equipment used during power outages, the surplus power may be used to charge the battery.

If isolated operation continues due to a long power outage, when the DC voltage falls below the set value due to battery consumption, the power conditioner stops isolated operation to conserve the battery.

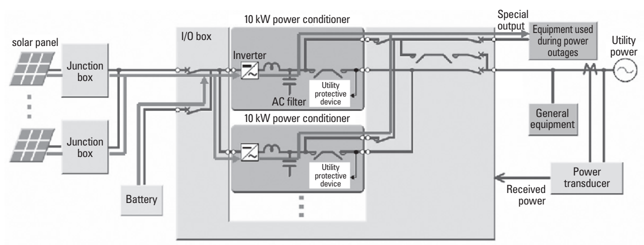


Fig. 5: Isolated operation mode

2.5 Charging operation mode

Charging operation mode is executed when all of the following conditions are met. Fig. 6 shows the flow of power during charging operation mode.

(1) Charging operation mode (night)

- Power conditioner is in run or standby
- Utility grid is normal
- Charging operation command is received from the timer in the power conditioner

In charging operation mode, the power conditioner connects the DC input to the battery and the utility power is used to charge the battery.

Furthermore, the utility power can also be supplied to the equipment used during power outages via the bypass circuit.

During charging operation, if the charging current to the battery falls below a certain value (charging complete), the power conditioner disconnects the DC input from the battery and switches to grid-connected operation mode.

(2) Charging operation mode (during recovery from power outage)

- When recovering from power outage during isolated operation

During isolated operation, if the power conditioner continues to receive the utility power for a certain period of time, it switches to charging operation mode (standby). To the equipment used during power outages, the utility power is supplied through the bypass circuit. Normally, the utility power is used to charge the battery, but if there is a constant amount of power generated by the solar panels, then it may also be used to charge the battery. Furthermore, if the power generated by the solar panels exceeds the charging power for the battery, then it is supplied to the general equipment.

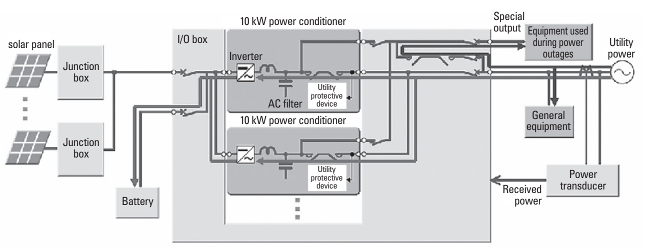


Fig. 6: Charging operation mode

2.6 Switching between each operation mode

Switching between each operation mode normally occurs automatically, but it can also be performed manually.

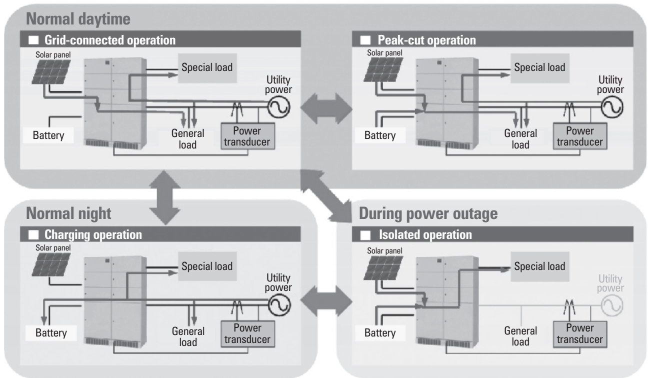


Fig. 7: Switching between each operation mode

Fig. 8 shows an image of switching between grid-connected operation, peak-cut operation, and charging operation in one day.

The load consumption power slowly increases, and when it exceeds the set peak-cut start power, the power conditioner starts peak-cut operation. In addition to the power generated by the solar panels, by discharging the battery power, peak-cut is performed on greater received power.

After this, when the load consumption power is reduced and falls below the set peak-cut end power, the power conditioner stops peak-cut operation and switches to grid-connected operation. During the day when the solar panels normally generate power, the power conditioner switches between grid-connected operation and peak-cut operation depending on the load consumption power value.

Normally, power conditioners are in standby mode during the night when the solar panels are not generating power, but when the timer reaches the set recharge start time, the power conditioner automatically starts charging operation and charges the battery consumed by peak-cut operation during the day.

When the battery is charged, the power conditioner switches to grid-connected operation mode again. With this type of operation, power-consuming peak-cut and low power consumption night power can be shifted to large amounts of daytime consumption power, which has the effect of equalizing power.

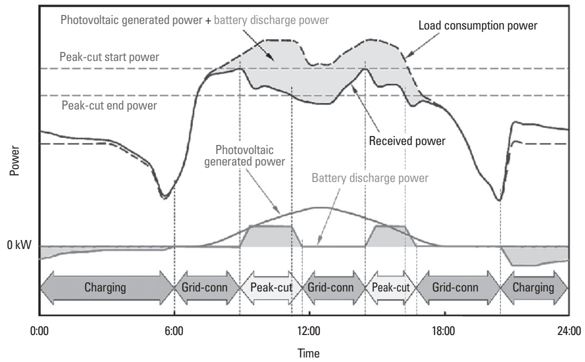


Fig. 8: Image of switching operation modes

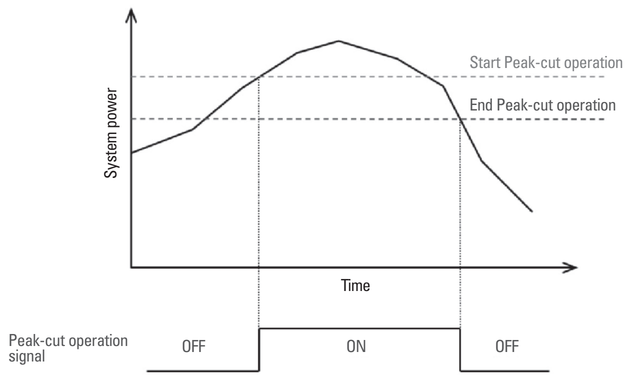


Fig. 10: Peak-cut operation signal

3. Features of Peak-Cut Operation

3.1 Setting the start and end of peak-cut operation

Starting and ending peak-cut operation is performed with the alarm setter in the I/O box.

Fig. 9 shows the operation part of the alarm setter.

Power received from the grid is converted into a 4 to 20 mA analog signal from the transducer set on the received power point and is input to the alarm setter. By monitoring the power received from the grid, starting and ending peak-cut operation can be controlled.

If the power received from the grid grows larger than the constant power value (set power for starting peak-cut operation), then the alarm setter turns on the peak-cut operation signal and starts peak-cut operation. If the value falls below the constant power value (set power for ending peak-cut operation), then the alarm setter turns off the peak-cut operation signal and ends peak-cut operation.

The received power values for starting and ending peak-cut operation are set in the alarm setter, so it can be used optionally with the system. Furthermore, after installing the power conditioner, the settings can be changed while observing changes in the setting environment.

Fig. 9: Operation part of the alarm setter

3.2 Control of discharge power from the battery

For the power discharged from the battery during peak-cut operation, the amount of usable power and discharge power during peak-cut operation is set perviously, considering the power compensated during isolated operation when there is a power outage.

For example, if the power used in peak-cut operation is set to 10 kWh and discharge power to 2 kW, 5 hours of peak-cut operation is available over the course of one day.

The power conditioner monitors the amount of power discharged from the battery during peak-cut operation, and if it exceeds the set power amount, peak-cut operation stops and it switches to grid-connected operation mode. With this, the battery power for compensating power outages can always be maintained.

Furthermore, the power conditioner output power during peak-cut operation controls the power so that the power generated by the solar panels is added onto the set discharge power from the battery. With this the power conditioner output power changes depending on the power generated by the solar panels, but a nearly constant amount of power is always discharged from the battery.

4. Specifications

Fig. 11 shows the dimensions of “SANUPS PMC” . Table 1 shows the electrical specifications.

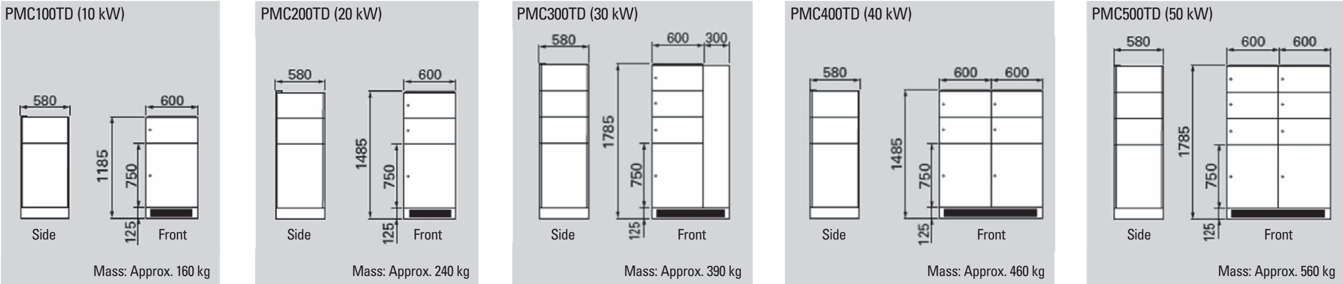


Fig. 11: Dimensions of “SANUPS PMC”

Table 1: Electrical specifications

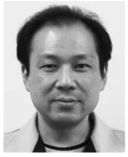
Item			PMC100TD	PMC200TD	PMC300TD	PMC400TD	PMC500TD
System capacity			10 kW	20 kW	30 kW	40 kW	50 kW
Input	Solar panel input	Rated voltage	300 V DC				
		Maximum allowable input voltage	500 V DC				
		Input operating voltage range	200 to 500 V DC				
		Maximum power point tracking control range	200 to 450 V DC				
		Max. current	45 A	90 A	135 A	180 A	225 A
	Battery input	Fluctuation range	0 to 450 V DC				
		Max. discharge current	45 A DC	90 A DC	135 A DC	180 A DC	225 A DC
Output	Charging operation	Charge output capacity	8 kW	16 kW	24 kW	32 kW	40 kW
		Charge voltage	321 V DC (Setting range: 250 to 450 V DC)				
		Drooping start current	25 A DC (Setting range: 1 to 40 A DC) Per one unit				
	Grid-connected operation	Rated voltage	200 V AC				
		Rated current	28.9 A AC	57.7 A AC	86.6 A AC	115.5 A AC	144.3 A AC
		Rated frequency	50 Hz/60 Hz				
		No. of phases/wires	Three phase, three wire				
		Output current distortion rate	5% or less of the total current, 3% or less of each next harmonic wave				
		Output power factor	0.95 min.				
	Isolated operation	Rated voltage	200 V AC				
		Rated current	28.9 A AC	57.7 A AC	86.6 A AC	115.5 A AC	144.3 A AC
		Rated frequency	50 Hz/60 Hz				
		No. of phases/wires	Three phase, three wire				
		Rated voltage precision	Within ± 8%				
		Rated frequency precision	Within ± 0.1 Hz				
		Voltage distortion rate	5% or less				
		Output power factor	1.0 to 0.8 (slow)				
Conversion efficiency			92%				
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 conversions method				
Communication method			RS-485				
Acoustic noise			60 dB max.				
Operation environment		Ambient temperature	-10 to +50°C				
		Relative humidit	30 to 90% (non-condensing)				
		Altitude	2,000 m or less				
Coating color			Munsell 5Y 7/1				
Heat generation			870 W	1740 W	2610 W	3480 W	4350 W
Operation mode			Grid-connected operation, isolated operation, charging operation, peak-cut operation				
Received power measurement function			Yes, 4 to 20 mA				

5. Conclusion

This document introduced an overview and the features of the “SANUPS PMC” power conditioner with peak-cut function.

This equipment conserves the environment through effective use of natural energy and can be used as an emergency power source during a disaster. There is great expectations for this power conditioner’s activities, because in addition to ensuring people’s safety, it also achieves improvement of the power equipment operating ratio through reduction in peak power and shift of peak power.

We will continue to realize various functions demanded of power conditioners and meet customer expectations.



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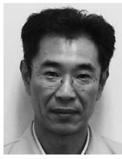

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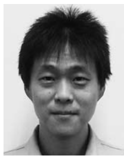

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