SANYO DENKI TECHNICAL REPORT No.11 May-2001

Feature

Development of Power Conditioner "PMC-TD" for Photovoltaic Power System

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1. Introduction

These days, demand is rising for effectively using solar energy as an eco-friendly, pollution-free source of energy to help prevent global warming. Under these circumstances, industrial-purpose medium-scale photovoltaic power systems lag a little behind housing-purpose photovoltaic power systems. There is, therefore, demand for corrective action, such as cost cuts by introducing standardization.

To meet these needs, we reduced the cost, size, and weight of power conditioners designed to convert the DC power of solar batteries to AC power and to be linked with a system of commercial power. The power conditioners were designed as 10kW standard units that can be installed outdoors and can be stacked on top of another.

Here is a description of the Power Conditioner, "PMC-TD", which we newly developed.

2. Background of development

The conventional model, the "PMB", was on a rack-mount system consisting of a 10kW unit incorporating no control unit and a rack-type cabinet on which a plurality of such units can be mounted.

However, this system had some problems: products varied with capacity and incurred costs for control, and they were of the unit type but still had much in common, resulting in limited effects of mass-production.

In addition, there has been user demand for improving the conversion efficiency of the conventional model, enhancing and adding functions of external communications for status information by serial communications and functions of automatically identifying frequencies.

It is also to be noted that some of the commercially available power conditioners are of the complete unit type without any common portion. However, these models require footprint additions when capacity add-ons are made.

To address these problems and demands, we developed the "PMC-TD".

3. Features

3.1 Standard unit of 10kW

The "PMC-TD" consists of only one standard model with an output capacity of 10kW.

This standard unit contains everything that a power conditioner needs, such as power converter, control power supply, system utility protective device, and display functions. A single unit of this model can be used as a power conditioner of 10kW.

To obviate the need for modification for each variation in specifications, standalone output and various control signals (such as those for contact input and output and external communications) are available.

Requirements for special specifications that cannot be fully met only by a "PMC-TD" are met not by remodelling the equipment, but by adding an input/output box, which is described later.

Fig. 1 is an external view of the "PMC-TD". Fig. 2 is a circuit system diagram of the "PMC-TD".

3.2 Low cost

The "PMC-TD" has been subjected to such measures as (1) cutting the number of parts by reviewing the conditions for functions, circuits, and parts, (2) mass-producing the product by using a single configuration (the standard configuration only), and (3) having the product accredited by the Electrical Safety Environment Institute, in an attempt to cut the total costs, including administrative expenses for power negotiations, order intake, order placement and other operations.

Efforts are also being made to cut maintenance costs by means such as eliminating some of the parts to be replaced periodically.

3.3 Small-size and lightweight

The "PMC-TD" has a volume of 0.1m^3 and a weight of 65kg. Thus, it is 74% smaller in volume and 64% lower in weight than the 10kW outdoor type of the conventional "PMB".

3.4 High conversion efficiency

The "PMC-TD" achieves a conversion efficiency of 92% (in rated load efficiency as per JIS C 8961) as a result of its optimized main circuit and carrier frequency.

3.5 Ease of capacity add-ons

(1) Ease of electrical capacity add-ons

In conventional models, connecting their DC side directly resulted in the cross-flow becoming deviated, resulting in the inability to take out power efficiency, because action points based on the maximum power point control of each 10kW unit vary.

We recently designed such a system where the action voltages between "PMC-TD" are set to identical settings by communications to enable up to two to five units to be run in parallel without installing a common unit for control. This equalizes the system to a system having a single-unit capacity of 20k to 50kW in total. Fig. 3 is a system diagram of capacity add-ons.

(2) Ease of structural capacity add-ons

The "PMC-TD" is based on a build-up system where a system can be built up by piling a "PMC-TD" up on an input/output box incorporating various breakers, terminals and other components as standard equipment.

The build-up system can be composed of one to five "PMC-TD" and an input/output box. A system of 10k to 50kW (note 1) can be easily built up with a reduced footprint.

Fig. 4 is an external view of equipment built up (in the case of a 30kW configuration).

In the case of a general pile-up system, there was a problem that the second and lower devices from the top could not be maintained.

However, the "PMC-TD" is so designed that an external box of the outdoor type is rack-shaped to enable the internal unit to be taken out. It is therefore maintainable even when piled up.

Fig. 5 is a descriptive diagram of the build-up system.

Note 1): In the case of 40kW (with four "PMC-TD") or 50kW (with five "PMC-TD"), another panel is used in addition to the input/output box.

3.6 External communications

External communications, which was not incorporated in conventional units, has now been added to the "PMC-TD" to allow information about the equipment status, fault, and measurement of the entire power conditioner to be output by serial communications.

The interface of external communications is ensured by RS-485 to allow a plurality of systems to communicate on a common line and reduce the number of wires and tasks.

3.7 Automatic frequency identification

Users of conventional units made settings of system frequency manually by destination. Automatic identification is now incorporated to obviate the need for bothersome frequency settings.

3.8 Flexible system expandability

The "PMC-TD" is expandable in standalone and recharging functions. Combining a build-up configuration with an input/output box and equipping the input/output box with an optional standalone automatic switchover circuit and accumulator connection circuit, along with other equipment has been performed to achieve the following functions:

①Standalone operation (including disaster-prevention types)

②Recharged operation

③Reverse power output for thawing operation

④Rated output operation for peak-cut operation.

3.9 Outdoor installation

The "PMC-TD" is equipped with a drip-proof cover and can be installed outdoors (under an array of solar batteries or other places not exposed to direct sunlight).

In case the "PMC-TD" needs to be installed in a place exposed to direct sunlight, it comes with an optional "Weather Shelter," which is designed for simple covering.

If the build-up system is used aswell, this system can be installed outdoors under the same conditions.

4. Specifications

Table 1 shows the main specifications of the "PMC-TD."

Table 1 Main specifications of the "PMC-TD"

Item		PMC-TD	Remark
Output capacity		10 to 50kW (10k to 50kW Buildup system)	
System	Inverter system	Voltage type current control system	During continuous operation
	Switching system	High frequency PWM system	
DC input	Rated voltage	300V	
	Fluctuation range	0 to 500V	
	Operating voltage	200 to 500V	
	Maximum power point Control range	200 to 450V	
AC output	Number of phases, number of wires	3-phase, 3-wire	
	Rated voltage	200V	
	Rated frequency	Automatic identification of 50/60Hz (Lock-in is possible)	
	High harmonics leak-out current	Total 5%, 3% or less each	
	Output power factor	0.95 or more	
	Linkage classification	Low/high voltage	
Conversion efficiency		92%	Rated load efficiency as per JIS C 8961
Utility protection		Overvoltage (OV) Undervoltage (UV) Over-frequency (OF) Under-frequency (UF) DC detection DC ground fault detection Ground fault overvoltage (OVGR) (OVGR is an external type)	
Independent operation detection	Passive system	Voltage phase jump detection	
	Active system	Reactive power fluctuation system	
Standalone, recharging operation		Optional	
Operating environment	Ambient temperature	-10 to 40 °C	
	Relative humidity	30 to 90%	Non-condensing

5. Conclusion

We have so far presented the main functions, structure, and other features of the "PMC-TD".

This unit actively uses functions and a structure designed for standardization to allow major cuts in cost, size, and weight compared with conventional units.

Sufficient consideration is given to make this unit adaptable to delicate differences in specifications that tend to be sacrificed in standardization. The unit is thus finished as a product flexibly applicable to diverse customer needs.

Without being content with these accomplishments, we are determined to develop power conditioners that are inexpensive and that achieve high conversion efficiencies, while being eco-friendly, in an attempt to spread photovoltaic power systems even further.

We wish to express our heart-felt thanks to all personnel concerned for their cooperation and advice in developing the "PMC-TD."

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Fig. 1 External view of the "PMC-TD"

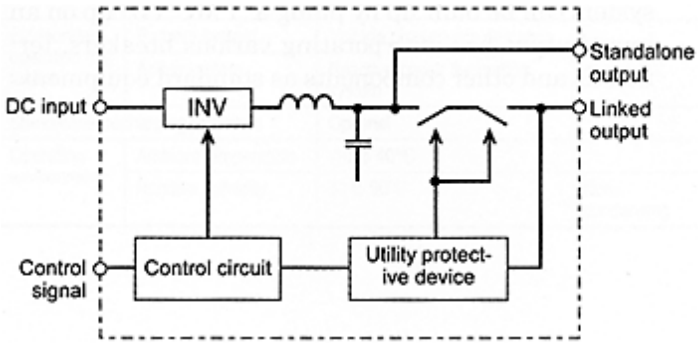

Fig. 2 Circuit diagram of the "PMC-TD"

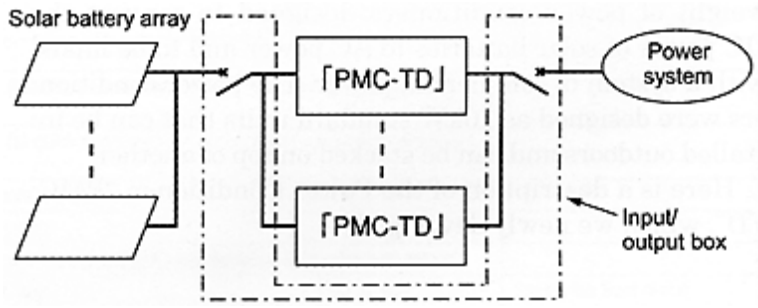

Fig. 3 System diagram of capacity add-ons

Fig. 4 External of a built-up installation (in the case of 30kW)

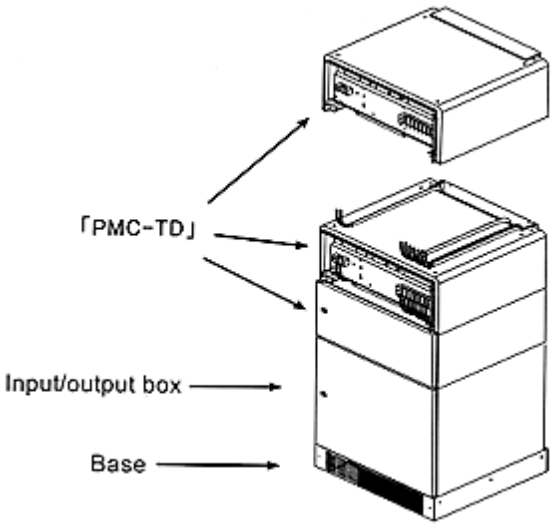

Fig. 5 Descriptive diagram of the buildup system