Part + 03 _

Developing the Power Conditioner

The Highly Efficient and Fanless Power Conditioner

GS Yuasa has delivered many units of the mid-range LINE BACK α series power conditioner to public and industrial facilities such as schools, hospitals, and factories. In this article we discuss the development of our highly efficient fanless power conditioner.
The conversion efficiency of the power conditioner, i.e., the device that converts the energy obtained from a solar power system into power that can be sold, is expected to keep improving. Greater conversion efficiency means that more energy can be used with less being wasted. Power conditioners that will be installed outdoors are also required to be highly dust and waterproof. We adopted a fanless self-cooling design to commercialize power conditioners that could be installed in salt-rich environments, such as along the coast (●Fig. 1).

1. Improving Conversion Efficiency

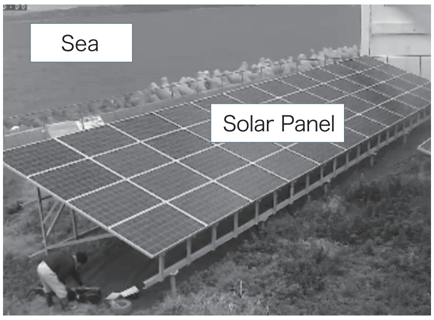
GS Yuasa was able to attain better conversion efficiency based on its invention of a revolutionary power conversion program, which made a debut in the LINE BACK α III ("Alpha Three") in 2011 (●Fig. 2).

The output of a solar panel varies depending on the amount of solar radiation reaching a given area; however, the power conditioner converts that energy to a regulated alternating current, and may sell the power back to the power company through the power line (●Fig. 3). More specifically, a boost chopper in the power conditioner takes the fluctuating voltage input from the solar panel (e.g., 200V to 550V DC), boosts it to a constant voltage (e.g., 550V DC) and inputs the constant voltage to an inverter circuit. The inverter circuit then converts the boosted direct current to the regulated alternating current (200V AC).

However, we discovered first, that there is a large variation between the direct current entering and the alternating current leaving the inverter circuit (i.e., 550V DC and 220V AC respectively); and second, that existing methods were contributing to power conversion losses in the inverter circuit. An input voltage about 330V DC is actually sufficient to produce an output voltage of 200V AC. Consequently, we proposed using the boost chopper to boost the solar panel output to 330V DC when the voltage output from solar panel was less than 330V DC, and input the result to the inverter circuit; and to input the voltage output from the solar panel as is to the inverter circuit without using the boost chopper when the voltage output from solar panel was at or greater than 330 V DC (G1 in ●Fig.4).

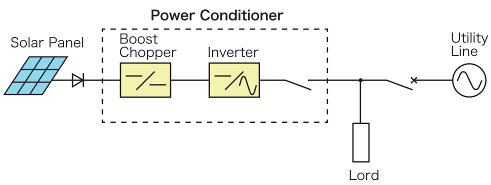
This kind of power conversion program allows us to reduce the power conversion loss in the inverter circuit compared to existing methods (G2 in ●Fig. 4). The LINE BACK αIII provides a conversion efficiency of 94.5%, a 2% increase over its predecessors.

●Fig. 1 Solar Power System in Salt-rich Environment



●Fig. 2 LINE BACK α III

●Fig. 3 The Boost Chopper and Inverter Circuit



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The LINE BACK αIII design further focuses more on waterproofing, and the device has an International Protection Rating of IP35. Note: the first digit represents protection against dust, and the second digit represents protection against water; larger numbers signify a greater degree of protection.

2. Even Greater Efficiency: Protection from Salt-rich Environments

GS Yuasa brought the LINE BACK αIV ("Alpha Four") to market in 2016. We were the first to adopt a low loss silicon carbide device (i.e., a semiconductor device constructed from a compound of silicon and carbon) in the inverter circuit to improve the device's efficiency. We were also able to cool the LINE BACK αIV, without a fan using an original enclosure cooling system.

During normal operation, the DC to AC inverter circuit in the power conditioner heats up, and therefore requires a cooling system. As a consequence, the power conditioner often includes a built-in cooling fan and the inverter circuit is cooled with the air blowing from the cooling fan. However, providing a built-in cooling fan means a larger and heavier power conditioner. The power conditioner may be installed in a salt-rich environment where the cooling fan draws salt air from the outside and the inverter circuit is cooled with this outside air. Consequently, both these components may be damaged by salt and become less durable.

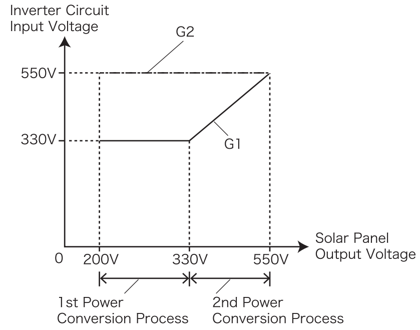
We thus created a storage chamber inside the power conditioner enclosure (i.e., the case), in the LINE BACK αIV and placed a radiator inside the storage chamber (top, ●Fig. 5). One wall of the storage chamber facing the radiator serves as a barrier, and this barrier wall is made to be thermo-conductive. The cooling passage is provided opposite of the storage chamber relative to the barrier wall (in other words, the barrier wall partitions the storage chamber and the cooling passage).

While the cooling passage (bottom, ●Fig. 5) includes an upper and a lower opening, the enclosure does not include a cooling fan. Once the radiator in the storage chamber begins to radiate heat, that heat is transmitted to the barrier wall; at that point the temperature of the air in the cooling passage on the other side of the storage chamber increases, creating rising air current in the cooling passage. The outside (cool) air drawn in from outside via the lower opening flows along the barrier wall; the air cools the radiator by way of the barrier wall and then exits via the upper opening. The radiator (inverter circuit) is isolated due to the barrier wall and thus is not subject to salted air, and thus not susceptible to salt damage.

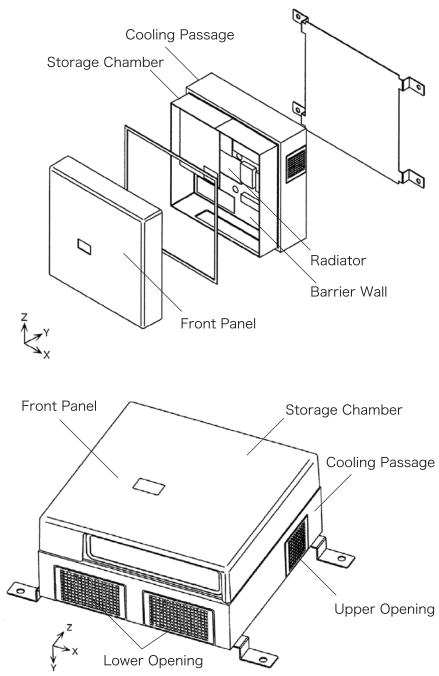
The LINE BACK αIV can attain conversion efficiencies of up to 98.0% which is the best-in-class reported in the solar photovoltaic industry. Additionally the International Protection Rating for this unit is IP56. We also placed emphasis on greater waterproofing ability, considering the environment of an island like Japan that is prone to typhoons.

These high-quality power conditioners, developed by GS Yuasa based on our advanced technical expertise and years of experience are now helping to drive the adoption of renewable technologies, which are a necessary part of the world's future.

●Fig. 4 Novel vs. Existing Power Conversion Program[1]



●Fig. 5 Enclosure Cooling System in the LINE BACK αIV[2]



1. Japan Patent No. 5953698 (Filed in 2011)
2. Japan Patent Publication No. 2017-085017 (Filed in 2015)

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