Specialty Technologies in *SANUPS* Power Systems Products

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1. Introduction

Stable electric power supply is essential for comfortable use of networked electronic devices such as the smartphones and tablets upon which modern-day society depends.

Our *SANUPS* Power Systems products, including uninterruptible power supplies (UPS) and renewable energy inverters, not only provide customers with the high basic performance and functionality required in normal situations, but also supply high-quality and stable power to customers' equipment in the event of unexpected power outages caused by natural disasters such as heavy rain and earthquakes. They can also be used for emergency management and BCP (business continuity planning) purposes.

This article will introduce our specialty technologies supporting the high functionality, performance, and quality of *SANUPS* Power Systems products.

2. High Efficiency Technology

High efficiency is required of UPSs and renewable energy inverters. Therefore, in addition to using high-efficiency circuit systems such as a resonance circuit, 2-phase modulation system, and 3-level inverter system, we design products using next-generation semiconductors and low-loss components. In addition, we optimize the circuit in our own unique way.

In this article, we will introduce our technologies used for achieving higher efficiency using basic UPS circuit configurations, as shown in Figure 1, as an example.

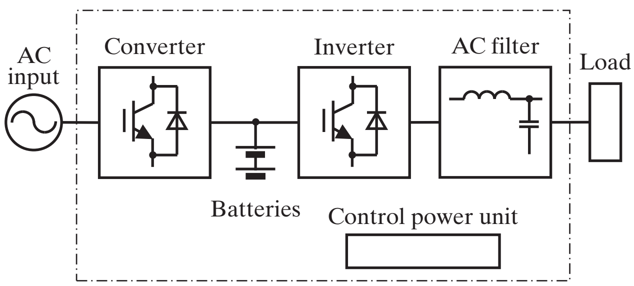

Fig. 1 Example of basic UPS circuit configuration

2.1 Achieving higher efficiency in the converter, inverter, and control power unit

2.1.1 Use of low-loss circuits

We use low-loss circuits in circuits with switching elements, such as the UPS's converter, inverter, and control power unit.

Below are examples of these circuit systems.

(1) Soft-switching system (resonance type)

Using LC resonance enables zero-voltage and zero-current switching that reduces switching loss.

(2) 3-level inverter system

Compared with typical 2-level inverter systems, 3-level inverter systems have a greater steady-state loss, but have a 1/2 switching loss, which is significantly lower.

Moreover, the switching ripple current amplitude is small, leading to a smaller iron loss of the reactor comprising the AC filter and a reduced overall loss.

(3) 2-phase modulation

This method reduces the switching loss in the 3-phase output inverter; two of the three phases perform switching with the remaining phase stopped, thus reducing switching loss by one-third.

2.1.2 Circuit optimization

In addition to using the aforementioned circuit systems, we achieve the greatest efficiency improvement by optimizing peripheral circuit configurations including gate drive circuit and gate power supply circuit, the number of used components, circuit voltage, and switching frequency.

Moreover, in the *SANUPS E11A* shown in Figure 2, by creatively reducing the number of switching elements, we successfully omitted their peripheral circuits such as a drive circuit and isolated power circuit required to activate switching elements.

This improved efficiency by the amount of the reduced circuit loss.

Fig. 2 *SANUPS E11B*

2.1.3 Use of a next-generation semiconductor

In recent years, wide-bandgap semiconductors such as SiC (Silicon Carbide) and GaN (Gallium Nitride) are attracting attention as next-generation semiconductors. We use SiC devices which can be expected to provide high-pressure resistance and low loss.

For example, the *SANUPS A22A* shown in Figure 3 uses a 3-level inverter system with a circuit configuration effective for improving efficiency. In addition, an efficiency of 94.5% was achieved by using SiC devices in peripheral circuits, which is considerably high for a double conversion online UPS.

Fig. 3 *SANUPS A22A*

2.2 Higher efficiency in the AC filter

This section will explain how we achieved higher efficiency in the AC filter.

We select the windings used in the reactor of the AC filter considering the skin effect due to harmonic current. Also, we use a core made of low-loss magnetic materials.

Furthermore, early in the design phase, we perform calculations using specification ratings and perform circuit simulation to determine which components to use. However, sometimes we cannot obtain the expected efficiency on the actual circuit due to unforeseen factors.

On such occasions, we prototype several dozen reactors using various windings and cores, and compare them in use to select the one with the highest efficiency.

2.3. Miscellaneous

High efficiency can be achieved not only by using the above-mentioned circuit systems and high-efficiency devices, but also by improving the system efficiency.

For example, our power conditioner (renewable energy inverter) for wind power and hydro power generation systems, *SANUPS W73A*, has a function to enable the DC input voltage vs. DC input power characteristics to be freely set to suit the output characteristics of the wind/hydro power generator that the power conditioner is connected to, thereby increasing efficiency of the overall system.

3. Uninterrupted Output Technology

In recent years, a wider range of increasingly complex and advanced production systems can be affected by instantaneous voltage dips; today's UPSs not only require high efficiency, but also must provide uninterrupted transfer. We offer UPSs which provide zero transfer time, such as the *SANUPS E23A* and *SANUPS E33A* shown in Figure 4.

Fig. 4 *SANUPS E23A* / *SANUPS E33A*

The *SANUPS E23A* and *SANUPS E33A* use a parallel processing topology which normally feeds grid power to the load while a bi-directional inverter connected in parallel cancels out the harmonic current generated from load equipment to make the input current sinusoidal and improve UPS input power factor.

Moreover, with this circuit system and our unique transfer technology, these UPSs can supply uninterrupted pure sine waves even during power outages, instantaneous voltage dips, and momentary outages.

Figure 5 illustrates the parallel processing topology.

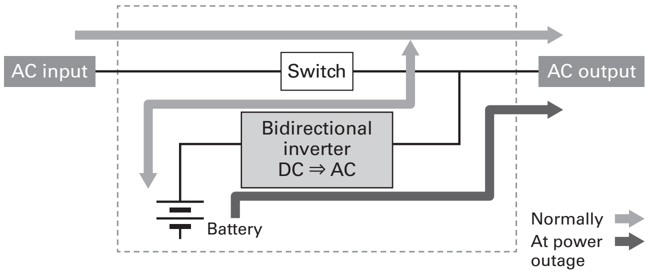

Fig. 5 Parallel processing topology

4. Technology for Improving Power Supply Reliability

Reliability is an important feature of a UPS. Our UPSs including *SANUPS A11M* and *SANUPS A22A* achieve improved reliability by using a parallel redundant configuration and our unique technology.

4.1 Use of a parallel redundant operation system

These ensure a highly reliable power supply by using a parallel redundant operation system that can continue to supply power even if one of a number of parallel-connected identical UPS units happens to fail.

Figure 6 illustrates the parallel redundant operation system.

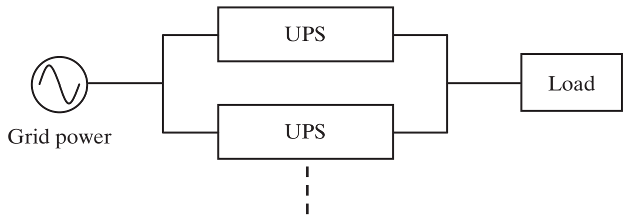

Fig. 6 Parallel redundant operation system diagram

4.2 Use of a fully autonomous control method

In general, with parallel UPS units that output AC power, it is necessary to synchronize the voltage amplitude, phase, and frequency to prevent potentially excessive high currents (known as "cross currents") from damaging the UPS.

However, if a central control unit is used to prevent this cross current, the failure of this unit may lead to the shutdown of the entire UPS system. Even with highly reliable UPS units, if the reliability of the central control unit was low, the reliability of the whole system would be low.

Therefore, we used a fully autonomous control method with a control unit on each UPS unit instead of a central control unit for parallel operation.

We successfully improved the reliability of the system by achieving parallel operation with each UPS unit independently suppressing cross current.

Figure 7 illustrates the fully autonomous control method.

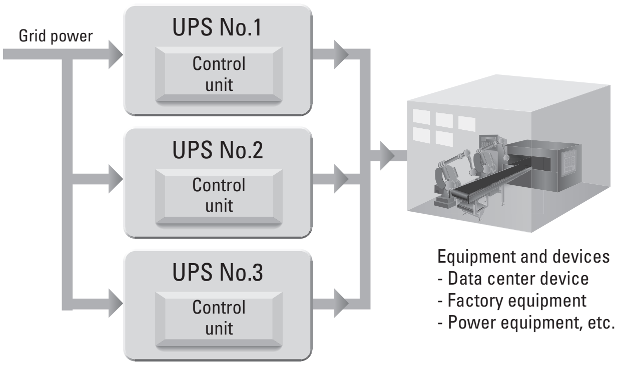

Fig. 7 Fully autonomous control method

5. Conclusion

This article has introduced our technologies to achieve higher efficiency, uninterrupted output, and improved reliability that support the high functionality, performance, and quality of *SANUPS* Power Systems products.

Moving forward, SANYO DENKI will stay committed to technological development so we can offer our customers UPSs and renewable energy inverters that can supply safe, stable power.

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