Clean Energy Technology

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Abstract

Enabling anyone to communicate freely at any time and from any place requires highly reliable communication systems. Consequently, there is a demand for a clean and powerful backup power supply. Here, we introduce i) a high-performance backup power supply system that employs nickel metal hydride batteries for use in the communication infrastructure and ii) Solar Card Power, a power supply for ubiquitous mobile devices.

1. High-performance backup power supply system

1.1 What is a backup power supply system?

A backup power supply system supplies continuous 48 V DC and l00 V AC to telecommunication equipment from storage batteries when the public power supply is interrupted by a serious disaster.

1.2 Why is a new power supply system needed?

For over half a century, lead-acid batteries have been used for backup storage batteries, but they are heavy and take up a lot of space. Furthermore, the power consumed by communication equipment has tended to increase with increases in the speed and functionality of data communication services, so the demand for a small, lightweight power supply system to replace lead-acid batteries has also increased. As one step toward meeting that demand, NTT Energy and Environment Systems Laboratories has developed a power supply system based on large-capacity nickel metal hydride (NiMH) batteries, which have a higher energy density than lead-acid batteries [1].

1.3 Overview of the new power supply system

The configuration of the new high-performance backup power supply system and its basic operation are illustrated in **Fig. 1**. An example of a high-performance backup power supply system is shown in **Fig. 2**. This power supply system stores 10 kWh of energy, so it can provide about three hours of backup power at the power output of 3 kW during a commercial power outage. It is therefore suitable as the power supply system for wireless base stations, ADSL remote subscriber stations, and other such access systems.

1.4 Technological key points

One feature of our system is that it is divided into a battery module and a power supply module. NiMH batteries can tolerate hot summer environments and have long stand-by times under full charge. However, we had to develop new large-capacity NiMH batteries because there were none suitable for use in a backup system. We started with the cycling NiMH batteries used in electric automobiles as a base and improved the charging and discharging characteristics, the self-discharging characteristics, and the lifetime characteristics for a wide range of use environments at temperatures between –10°C and 65°C by optimizing the electrode composition, the electrolyte concentration, and the electrolyte ratios (KOH, NaOH, and LiOH).

For the power supply module, we developed a special charging device, discharging device, and control device as well as a new recharging control method to

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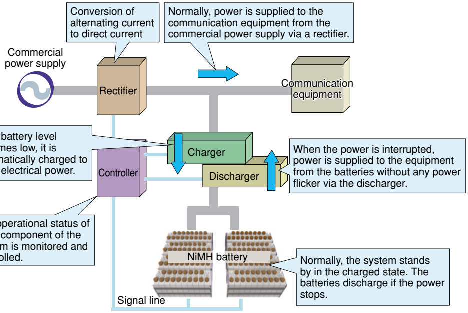
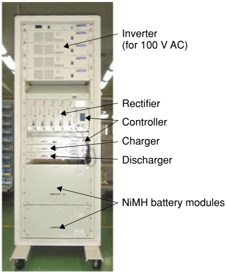


Fig. 1. Components and basic operation of backup power supply system.



Dimensions: W600 × D685 × H1600 mm
Weight: 300 kg

Fig. 2. High-performance backup power supply system.

extract the full potential of NiMH batteries. Specifically, the controller regularly computes the remaining capacity of the battery and begins supplementary charging automatically when the capacity falls to a prescribed value. Furthermore, the charging is done by a constant current charging method, which is the most desirable method for NiMH batteries. A full charge is detected by measuring the increase in heat per unit time (dT/dt), utilizing the characteristic of NiMH batteries that heat is generated when the battery is fully charged. The discharger incorporates a highly efficient dropper and step-up converter for matching the voltage change range of the battery and the operating voltage range of the load. It can supply power to the load without any power flicker when commercial power is interrupted.

Considering outdoor use, we conducted field trials in a harsh summer environment. Those tests confirmed that this new system can maintain the same safety and reliability levels as lead-acid battery systems or even exceed them. Furthermore, this system received a model certification based on the Fire Services Act, which is the first time this certification has been granted to a storage battery facility using NiMH batteries in Japan.

1.5 Results

The battery module of the developed power supply system is two-thirds the volume of a conventional system using lead-acid batteries and half the weight, so the floor load weight and installation footprint can both be reduced. The battery lifetime is also at least twice that of lead-acid batteries and the batteries are maintenance-free. Therefore, the total cost, including replacement and maintenance costs, is lower than that for lead-acid batteries. Furthermore, the completely lead-free battery module makes this a very environmentally friendly system, so companies that use it should benefit from a positive boost to their corporate images.

2. Solar cell input type mobile power supply: Solar Card Power

2.1 Power supply for mobile devices that is friendly to the global environment

In recent years, the popularity of mobile phones, PDAs (personal digital assistants), digital cameras, and other mobile devices has risen sharply. The overall energy consumption of these devices has also greatly increased. We have developed a power supply for such devices that is more convenient than existing ones and only a slight burden on the environment. We call it Solar Card Power. It features:

- Clean power generation from sunlight
- Applicability to various types of mobile devices
- Compact design and high power output

It is thus useful as a mobile power supply for travelers and as a backup power supply in times of emergency.

2.2 System configuration

As shown in **Fig. 3**, the system comprises a generating unit and a main unit. The main unit has a storage part that accumulates the electrical energy generated by the generating unit and a converter for supplying that energy at various voltages and currents. The prototype is shown in **Fig. 4**. The generating unit and the main unit are separate and detachable for convenience and ease in carrying. The storage battery built into the main unit has about twice the capacity of a built-in mobile phone battery and provides about 5 Wh of energy in an easily carried form. The battery has a lifetime of over 500 recharging cycles, so it can provide clean energy equivalent to more than 1000 AA alkaline batteries.

2.3 Technological key points

Solar Card Power features two technologies developed by NTT: (i) an electric-power generating module with a single solar cell and (ii) automatic setting of the output power.

(1) Generating module

The solar cell conveniently generates electricity when illuminated. However, the output voltage of a cell is only about 0.5 V. Conventionally, from 10 to 12 cells are connected in series to increase the output to about 5 V, as shown in **Fig. 5**. Thus, this setup suffers from the problem that if even one of the cells is shaded from the sunlight or breaks, the electricity-generating system cannot function correctly. The ultralow-

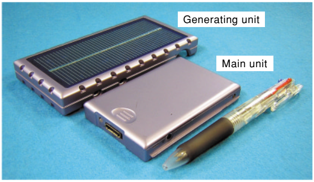


Fig. 4. External appearance of the prototype device.

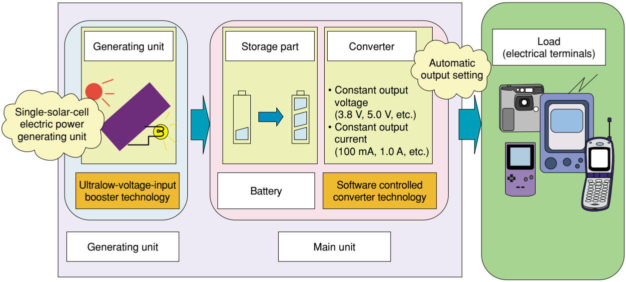


Fig. 3. Configuration of Solar Card Power.

voltage-input booster technology that we have developed can raise a voltage of about 0.1 V to about 5 V. That eliminates the need to connect multiple solar cells in series and allows the use of a single solar cell, thus reducing the manufacturing cost. This technology can eliminate the problem of partial shading and increase the amount of electricity generated, while maintaining a stable output.

(2) Main unit

Conventional converters change the output voltage or current by a switch or other switching mechanism, which could allow excessive voltage to be applied to the load equipment if a mistake were made in the switch setting. Our newly developed software controlled converter technology can output the voltage and current at the values set for various types of cables according to the type of cable connected (cell phone cable, 5-V cable, etc.) as shown in **Fig. 6**. This is more convenient for the user. The output specifications for the prototype are 3.8 V to 8.5 V with a maximum output power of 10 W, so one of these devices can be used for many types of portable devices from PDAs to digital cameras and video cameras, but not for notebook PCs.

3. Future plans

We will proceed with our efforts to increase the capacity of the high-performance backup power supply system and with plans to support power systems ranging in size up to the main power supply systems of communication buildings and data centers. Our goal is to construct a clean energy system that can reduce the cost of electricity as well as the emission of CO_2 by coordinated use of the commercial power supply and fuel cell facilities (electric power generators).

We plan to continue our work on increasing the

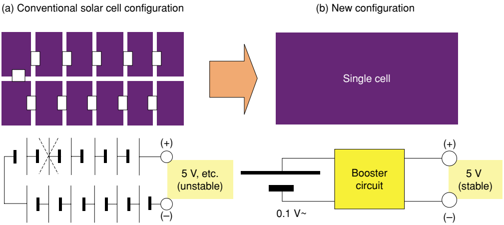


Fig. 5. Configurations of conventional solar panel and our new solar cell.

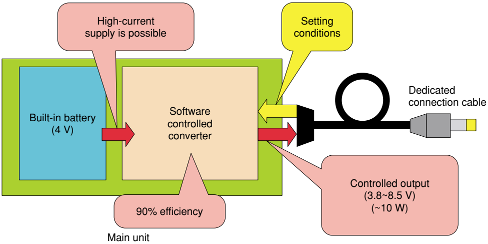


Fig. 6. Configuration of the main unit with built-in software controlled converter.

capacity of Solar Card Power as a solar cell electric power generation system and to expand the application to the field of telemetry, including remote monitoring equipment. Like solar cells, fuel cells produce low-voltage output and must be connected in series in a power system. We also plan to develop the ultralow-voltage booster technology for use in micro-fuel-cell batteries and other small generation systems, thus promoting the use of clean energy.

Reference

[1] K. Saito, T. Shodai, A. Yamashita, and H. Wakaki, "High Performance Backup Power Supply System," Proceedings of Intelec'03, Yokohama, Japan, p. 261, Oct. 2003.

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