Development of the Small-Capacity UPS *SANUPS N11C-Li* Series

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1. Introduction

Uninterruptible Power Supplies (UPSs) are used for backing up disaster management facilities such as floodgates and warning sirens. As such, they are installed inside small unmanned buildings, cubicles, or containers, therefore must operate in extreme temperatures.

For this reason, UPSs are required to be space-saving, maintenance-free, have a wide operating temperature range, and offer prolonged backup. Moreover, these small-scale buildings often have no form of air-conditioning; therefore UPSs for these applications must be highly efficient and have reduced heat dissipation so as not to increase the temperature inside and affect equipment.

The lead-acid batteries that have conventionally been adopted in small-capacity UPSs have a limited operating temperature range, therefore requires replacement approximately every five years. Moreover, to achieve prolonged backup, more batteries are needed, which in turn requires more installation space.

Compared with UPSs with conventional lead-acid batteries, however, ones with lithium-ion batteries (LIB) can be used in a wider operating temperature range, require less space, offer long backup time, and operate without maintenance.

Our UPS products using LIB include the *SANUPS A11K-Li*, a double conversion online UPS for indoors and *SANUPS N11B-Li*, a standby UPS for outdoors. We expanded this lineup with the addition of the *SANUPS N11C-Li* that can be used inside small unmanned buildings or in other extreme temperature environments. This article introduces the features of this new model.

2. Product Overview

The *SANUPS N11C-Li* is available in three models with 1.5, 3, and 5 kVA output capacities.

Figures 1 (1) through (3) show an appearance of each model.

All the models are designed compatible with battery expansion as shown in Figure 1 (4) and mountable on a rack as shown in Figure 1 (5).

3. Features

3.1 Wide operating temperature range

Adoption of LIB has enabled a wide operating temperature range of -20 to +55°C. The *SANUPS N11C-Li* can be used in extremely hot and cold regions, inside small unmanned buildings without air-conditioning, and the like.

3.2 Maintenance-free

While our conventional UPSs with lead-acid batteries require battery replacement approximately every five years, this UPS, thanks to the employed LIB, can operate for roughly ten years without battery replacement. This maintenance-free operability reduces battery replacement costs.

3.3 Improved maintainability

Works such as battery replacement have been made easy through the modularization of the inverter. Figure 2 shows how an inverter module and battery modules are installed in the *SANUPS N11C-Li*.

All the models have a maintenance bypass circuit; therefore, module replacement and other maintenance work can be performed with the grid power supply continued.

Fig. 1 *SANUPS N11C-Li* series

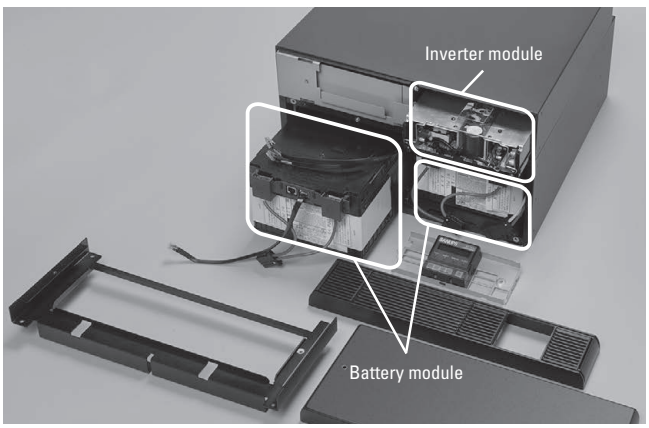


Fig. 2 Inverter module and battery modules (*SANUPS N11C-Li* 1.5 kVA)

3.4 Improved functionality

An LCD panel is used on the operation panel to improve user-friendliness and visibility.

3.5 Compact and lightweight

UPSs with LIB are around half the volume and mass of conventional UPSs with lead acid batteries, provided that both have equivalent initial backup time.

3.6 Energy saving and reduced heat dissipation

With the passive standby topology, the *SANUPS N11C-Li* suppresses power consumption and achieves a conversion efficiency of 95%. This reduces running costs and contributes to energy saving. Furthermore, because it does not generate much heat, the temperature increase in small-scale buildings with no air-conditioning can be minimized.

3.7 Extended LIB installation

By installing additional LIB, even longer backup time can be realized.

* (Max. of 400 minutes for 1.5 kVA model)

3.8 Rack-mountable

This UPS can be mounted on a 19-inch rack (EIA standard), therefore can easily be built into indoor equipment.

4. Circuit configuration

Figure 3 shows the circuit diagram for the *SANUPS N11C-Li*.

The *SANUPS N11C-Li* comprises a power supply unit consisting of a main circuit, control circuit, communication interface circuit, and other components, and battery unit consisting of a battery module, battery management unit (hereinafter BMU), and other components.

4.1 LIB monitoring circuit configuration

Equipped with a BMU, this product features a data interface between the UPS and LIB. The safety of the UPS has been increased by monitoring detailed LIB data and performing mutual protective operations and fault detections between UPS and LIB,

(1) UPS error detection

A UPS error will be notified by the UPS to BMU via CAN communication. After notified, the BMU disconnects the UPS and LIB.

(2) LIB error detection

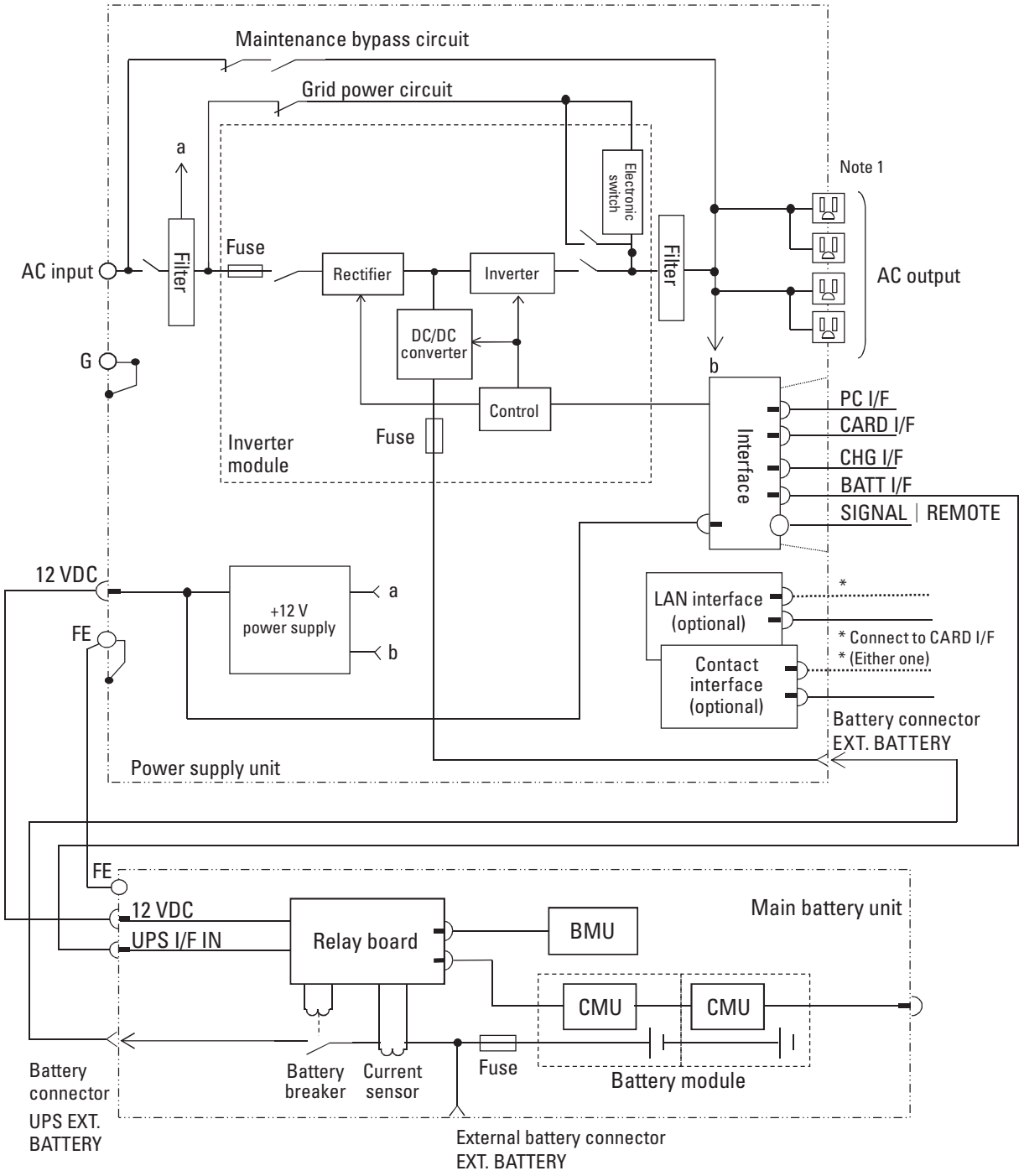
An LIB error will be notified by the BMU to the UPS via CAN communication. In response, the UPS stops the

charger's output. Moreover, if the BMU detects an LIB error, it will disconnect the UPS and LIB.

(3) Monitoring LIB cell voltage and cell temperature

Cell voltage and temperature are measured in the battery module, and the measurement values are then notified to BMU through CAN communication. If the cell becomes over-charged, over-discharged, or reaches an abnormal temperature, the BMU determines that an LIB error has occurred, and isolate the UPS from the LIB.

Users can check the measured values of battery voltage, cell temperature, and state of charge on the LCD panel.



Note 1: For the *SANUPS N11C-Li* 3 kVA and 5 kVA models, output power is available from both the output power outlet and terminal block.

Fig. 3 Circuit diagram for the *SANUPS N11C-Li* (1.5 kVA)

5. Specifications

Table 1 shows the standard specifications of the *SANUPS N11C-Li*.

Table 1 Specifications of the *SANUPS N11C-Li*

Item			Unit	Ratings and characteristics			Remarks
Model			—	N11CL152	N11CL302	N11CL502	
Rated power capacity			**kVA/kW**	1.5/1.2	3.0/2.4	5.0/4.0	Apparent power / active power
Type	**UPS topology**		—	Passive standby			
	Cooling method		—	Forced air cooling			
	Inverter system		—	High-frequency PWM method (during battery operation)			Grid synchronous double conversion online
AC input	**No. of phases/wires**		—	Single-phase 2-wire			
	Rated voltage		**V**	100, 110, 120			Same as output voltage
	Voltage range		**%**	Within ±10 of rated voltage			
	Rated frequency		**Hz**	50/60			Frequency is automatically detected
	Frequency range		**%**	Within ±1, 3, 5, or 7 of rated frequency			(The fluctuation range is the same as the selected output frequency regulation)
	Required capacity		**kVA**	2.1 max.	4.0 max.	6.7 max.	Max. capacity during battery recovery charging
AC output	**No. of phases/wires**		—	Single-phase 2-wire			
	Rated voltage		**V**	100, 110, 120			Voltage waveform: Pure sine wave
	Voltage regulation		**%**	During grid operation: Same as input voltage range			
				During battery operation: Within ±2 of rated voltage			At rated output
	Rated frequency		**Hz**	During grid operation: Same as input voltage range			
				During battery operation: 50/60			
	Frequency regulation		**%**	During grid operation: Same as input voltage range			
				During battery operation: Within ±0.5 of the rated frequency			At rated output
	Voltage harmonic distortion		**%**	3 or less / 7 or less			Linear load/rectifier load, at rated output
	Transient voltage fluctuation	**Rapid load change**	**%**	Within ±7 of rated voltage			During battery operation, for 0⇔100% load step changes / At output switch
		Loss or return of input power	**%**	Within ±5 of rated voltage			During battery operation, at rated output
	Load power factor		—	0.8 (lagging)			Variation range: 0.7 (lagging) to 1.0
	Overcurrent protection		**%**	105 or greater			Automatic transfer to bypass
	Overload capability	**Inverter**	**%**	105 or greater			200 ms
		Bypass		200/800			30 s / 2 cycles
Battery		**Type**	—	Lithium-ion battery (LIB)			
		Backup time	**Minute**	100/200/300/400	50/100/150/200	30/60/90/120	Ambient temperature 25˚C, at rated output, under factory conditions
Acoustic noise			**dB**	45 max.	46 max.	46 max.	1 m from front of device, A-weighting (Where the ambient temperature is 40˚C or lower)
				51 max.	55 max.	55 max.(1)	1 m from front of device, A-weighting (Where the ambient temperature exceeds 40˚C)
Operating environment	**Ambient temperature**		**˚C**	-20 to +55			(2)
	Relative humidity		**%**	10 to 90			Non-condensing
Storage environment	**Ambient temperature**		**˚C**	-20 to +55			(3)
	Relative humidity		**%**	10 to 90			Non-condensing

(1) 60 dB or less when battery voltage drops.
(2) Battery charging stops when battery temperature exceeds 55˚C.
(3) To extend battery life, avoid storage for extended periods of time in environments exceeding +30˚C. If the UPS is stored without being operated for a long period, the batteries may require recharging once a year.

6. Conclusion

This article has introduced the *SANUPS N11C-Li* series as a new UPS with LIB.

With the features of a wide operating temperature range, maintenance-free operability, compact size, and high-efficiency, this product can create new UPS markets such as installation in small unmanned buildings and indoor equipment without air-conditioning.

With UPSs becoming increasingly important to society and their applications and installation environments diversify, UPSs that are even more compact and have longer backup time will be required. We will expand our product lineup of UPSs with LIB to meet these market needs, aiming to develop products that can provide our customers with new value.

Reference

(1) Yuhei Shoyama and others: Development of the Small-Capacity UPS *SANUPS A11K-Li* and *SANUPS N11B-Li* Series SANYODENKI Technical Report No. 44

(2) Takeo Murai and others: Development of the *SANUPS N11B-Li (3 kVA)* Uninterruptible Power Supply SANYODENKI Technical Report No. 45

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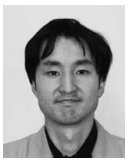

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