Development of the Small-Capacity UPS *SANUPS A11K-Li* and *SANUPS N11B-Li* Series

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1. Introduction

Conventionally, SANYO DENKI had offered small-capacity UPSs for indoor use as backup for servers and ICT equipment or in combination with industrial devices. In recent years, there has been an increased demand for the backup power for outdoor applications such as base stations, traffic lights, planned power outages, coin-operated parking lots, and surveillance cameras.

Assuming outdoor usage will involve exposure to harsh environments, requirements include a wide operating temperature range, securing installation space, extended backup, and low maintenance.

To date, small-capacity UPSs have used lead batteries; however, these have a limited operating temperature range, short runtime towards the end of their life cycle, and require replacing. Moreover, to achieve extended backup, more batteries are needed, which in turn requires more installation space.

By adopting Lithium-ion batteries (hereinafter "LIB"), UPSs can be used in a wider operating temperature range compared to conventional lead storage batteries. Other benefits include extended backup, space-saving, and no need for battery replacement, making the UPS low maintenance.

This article will provide an overview of our new UPS series *SANUPS A11K-Li* and *SANUPS N11B-Li* which are embedded with an LIB and correlated interface functions, and effectively utilize the large-capacity charging function of the current *SANUPS A11K* UPSs.

2. Product Overview

The *SANUPS A11K-Li* is an online UPS while the *SANUPS N11B-Li* is a standby UPS. Just as the current model, the *SANUPS A11K-Li* can be used as an indoor backup for servers and the like while the *SANUPS N11B-Li* can be used as backup for equipment installed outdoors.

2.1 The *SANUPS A11K-Li*

The *SANUPS A11K-Li* lineup includes models with output capacities of 1.5, 3, and 5 kVA.

Figure 1 shows the appearance of the *SANUPS A11K-Li* series.

Fig. 1: The *SANUPS A11K-Li* series

2.2 The *SANUPS N11B-Li*

The *SANUPS N11B-Li* lineup includes models with output capacities of 1 kVA and 1.5 kVA.

Figure 2 shows the appearance of the *SANUPS N11B-Li* series.

3. Features

3.1 Common features of the *SANUPS A11K-Li* and *SANUPS N11B-Li*

3.1.1 Wide operating temperature range

Due to the adoption of an LIB, both the *SANUPS A11K-Li* and *SANUPS N11B-Li* have wide operating temperature ranges (-20 to +55°C for the former and -20 to +55°C for the latter). This means these products can be used with confidence in extremely hot or cold environments.

3.1.2 Low maintenance

The current model required battery replacement approximately every five years, but by adopting LIB, the new model can be used for up to ten years without the need for battery replacement. This reduction in maintenance work means battery replacement cost can also be reduced.

3.1.3 Improved maintainability

Tasks such as battery replacement have been made easy through the modularization of the inverter. Figure 3 shows an image of the *SANUPS N11B-Li* equipped with an inverter module and battery modules.

All series models have a maintenance bypass circuit, therefore modules can be replaced without the need to interrupt power supply from a commercial power source.

3.1.4 Enhanced functionality

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

Fig. 2: *SANUPS N11B-Li* series

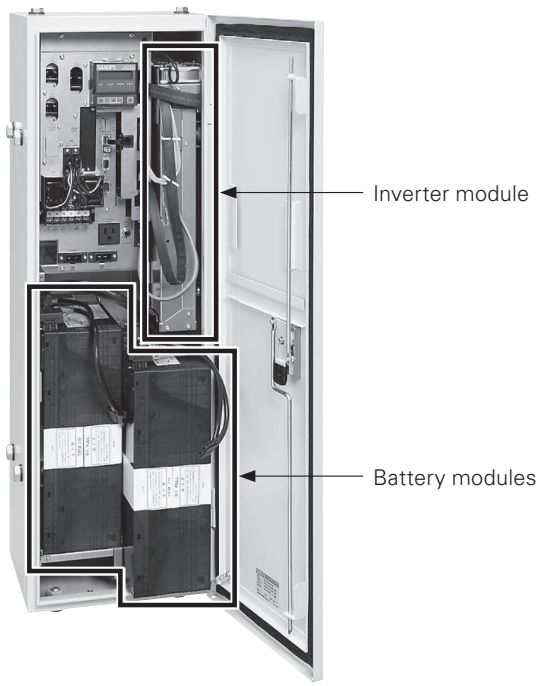

Fig. 3: Inverter module and battery modules (the *SANUPS N11B-Li*, 1 kVA)

3.2. Features of the *SANUPS A11K-Li*

3.2.1 Space-saving

Compared to the current model, which uses a lead battery, the *SANUPS A11K-Li* can be installed in approximately half the space.

Note: If the initial backup time is equivalent

3.2.2 Wide input range

Just as the current model, the allowable input voltage range is wide: -20 to +20% at a load level above 70%, and -40 to +20% at a 70% load level or below.

This wide input range makes it possible to reduce the frequency of operation switchover to battery-feed operation even when the power source is unstable, as well as minimize battery wear and deterioration.

3.2.3 High power factor

As with the current model, the *SANUPS A11K-Li* has a load power factor of 0.8, therefore can also supply electricity to high power factor equipment such as servers.

3.3. Features of the *SANUPS N11B-Li*

3.3.1 Eco-efficient

With the passive standby topology, the *SANUPS N11B-Li* suppresses power consumption and achieves a conversion efficiency of 95%. This reduces running costs and contributes to energy-saving.

3.3.2 Outdoor installation

The *SANUPS N11B-Li* uses sealed housing. As such, it can be used as outdoor power backup for base stations, traffic lights, coin-operated parking lots, and so on.

3.3.3 Water resistance and protection against solid foreign objects

This device adopts a sealed structure, therefore has excellent water resistance and protection against solid foreign objects including small insects and animals. This means it can be used outdoors with peace of mind.

The *SANUPS N11B-Li* achieves a protection rating of IP65* in protection performance tests.

* Classifications defined in "JIS C 0920: Degrees of Protection Provided by Enclosures (IP Code)"
IP65: No ingress of dust. Devices operate stably even when directly exposed to water from many directions.

4. Circuit Configuration

Figure 4 shows the circuit diagram for the *SANUPS A11K-Li*.

Figure 5 shows the circuit diagram for the *SANUPS N11B-Li*.

The *SANUPS A11K-Li* comprises a "power source unit" consisting of a main circuit, control circuit, communication interface circuit, etc., and a "battery unit" consisting of a battery module, battery management unit (hereinafter BMU), and other components.

The *SANUPS N11B-Li* integrates an "inverter module" consisting of a main circuit and a control circuit, and an "I/O portion" consisting of a communication interface circuit, input/output circuit, and BMU, etc., and a battery module.

4.1 LIB monitoring circuit configuration

Equipped with a BMU, this product features a data interface between the UPS and LIB. By monitoring detailed LIB data, and having the UPS and LIB perform mutual protection operations and fault detections, the LIB can be used safely.

(1) UPS error detection

When an UPS error occurs, notification is sent from the UPS to the BMU via CAN communication. Once the BMU receives notification, it trips the battery breaker.

(2) LIB error detection

When an LIB error occurs, notification is sent from the BMU to the UPS via CAN communication. In response, the UPS stops the charger's output. Moreover, as soon as the BMU detects an LIB error, it trips the battery breaker.

(3) Monitoring LIB cell voltage and cell temperature

Cell voltage and temperature are measured in the battery module and the BMU is notified of the measurement values 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, as mentioned in section (2) above, trips the battery breaker and separates the UPS from the LIB.

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

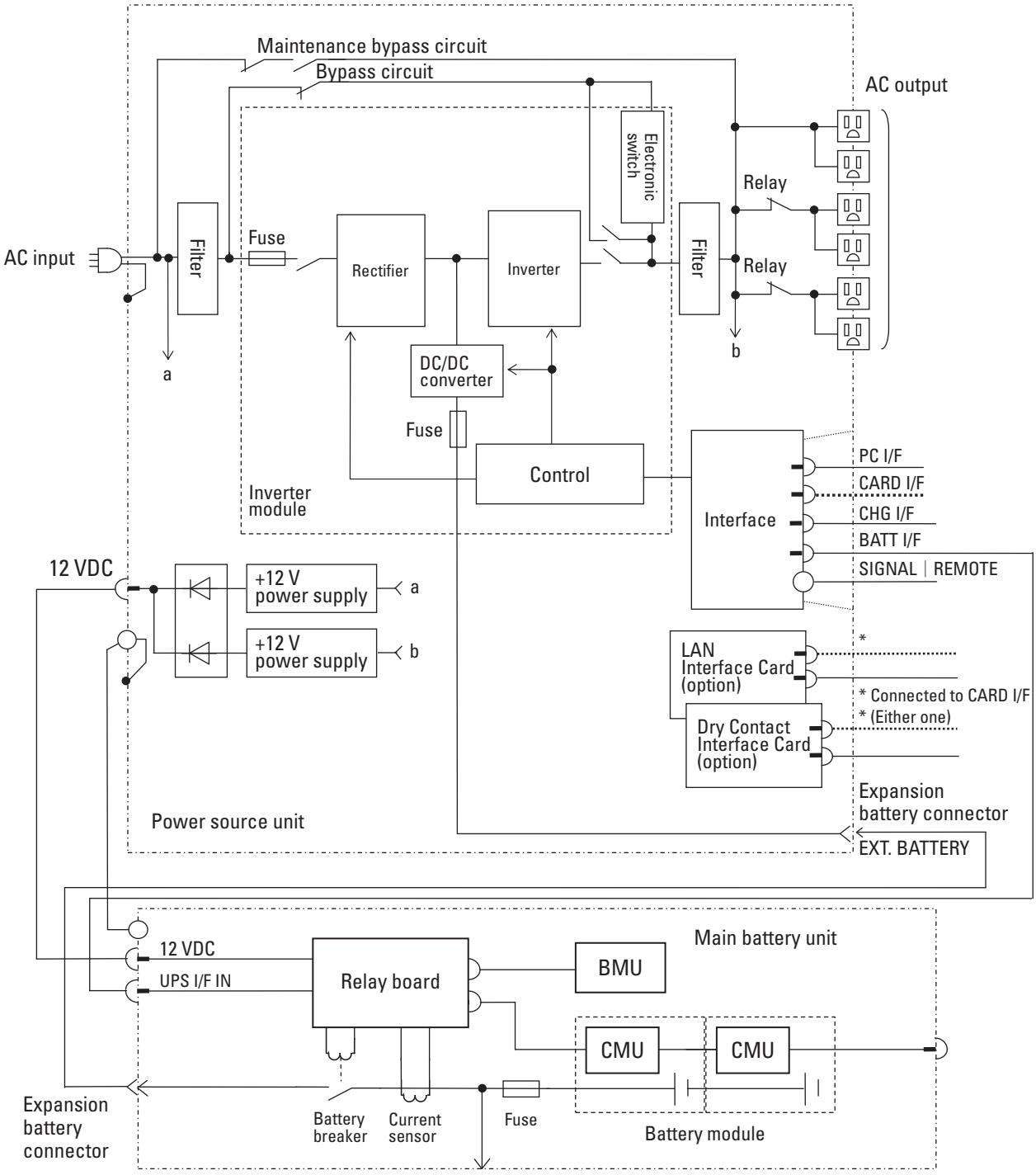

Fig. 4: Circuit diagram for the *SANUPS A11K-Li*

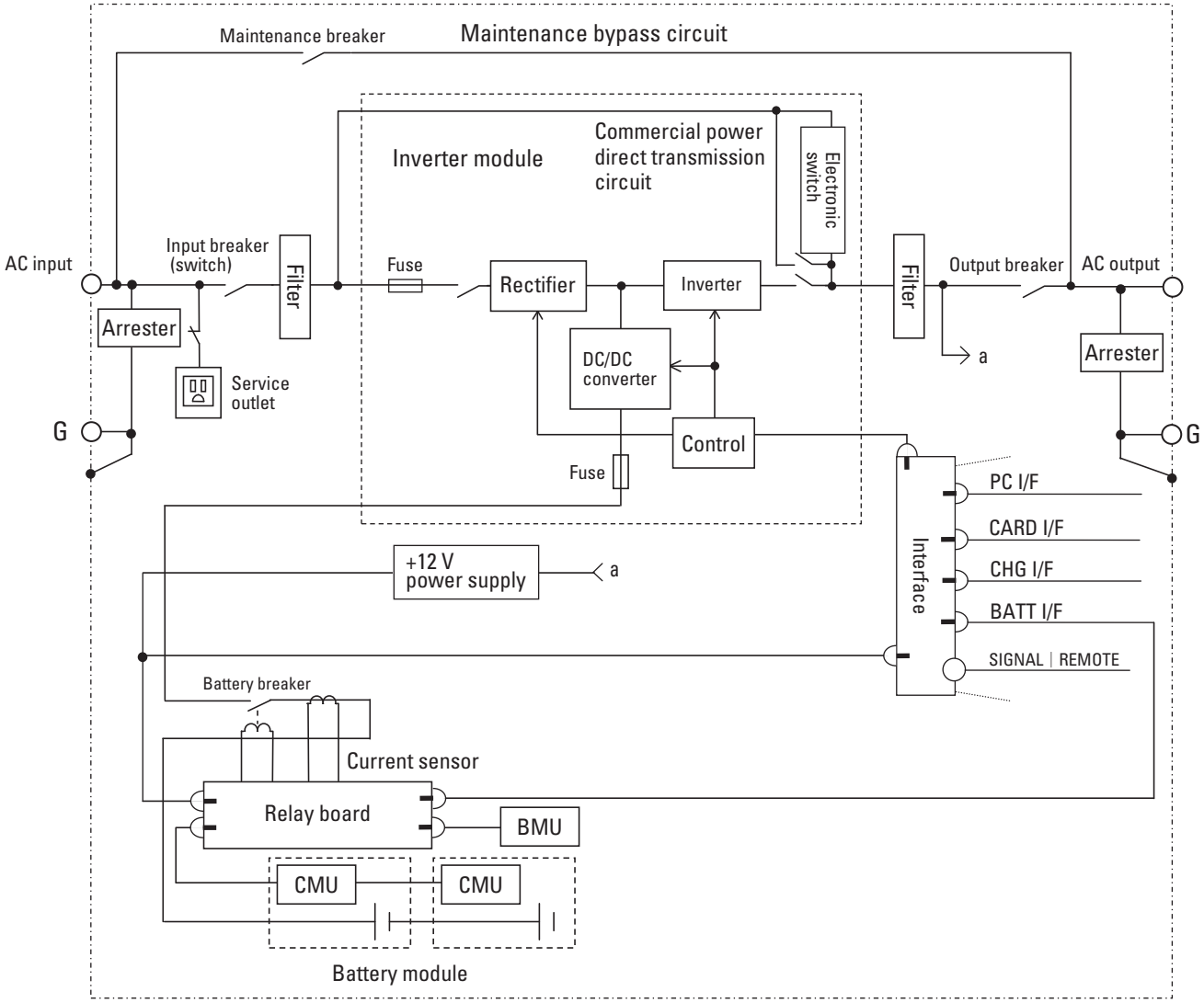

Fig. 5: Circuit diagram for the *SANUPS N11B-Li*

5. Specifications

Table 1 and Table 2 show the standard specifications of the *SANUPS A11K-Li* and *SANUPS N11B-Li*, respectively.

Table 1: The *SANUPS A11K-Li* series specifications

Item			Unit	Ratings and characteristics			Remarks
Model			—	A11KL152	A11KL302	A11KL502	
Rated output capacity			**kVA/kW**	1.5/1.2	3/2.4	5/4	(Apparent power/active power)
Type	**UPS topology**		—	Double conversion online			
	Cooling system		—	Forced air cooling			
	Inverter system		—	High-frequency PWM			Commercial synchronous online double conversion
AC input	**No. of phases/wires**		—	Single-phase 2-wire			
	Rated voltage		**V**	100, 110, 120			Same as output voltage
	Voltage range		**%**	Within ±20 of rated voltage			At a 70% load level or greater
				Within -40 to +20 of rated voltage			At a load level less than 70% Recovery voltage is -20% of rated voltage or more
	Rated frequency		**Hz**	50 or 60			Frequency is automatically detected[1]
	Frequency range		**%**	Within ±1, 3, 5, or 7 of rated frequency			(The fluctuation range is the same as the selected output frequency accuracy)
	Required capacity		**kVA**	1.5 or less	3.0 or less	5.3 or less	Max. capacity during battery recovery charging
	Power factor		—	0.95 or greater	0.97 or greater		When input voltage harmonic distortion < 1%
AC output	**No. of phases/wires**		—	Single-phase 2-wire			
	Rated voltage		**V**	100, 110, 120			Voltage waveform: Sine wave
	Voltage accuracy		**%**	Within ±2 of rated voltage			At rated output
	Rated frequency		**Hz**	50 or 60			Same as the input frequency
	Frequency accuracy		**%**	Within ±1, 3, 5, or 7 of rated frequency (Default value: ±3)			Frequency accuracy setting can be changed (±1, 3, 5, or 7%) Within ±0.5% during battery operation [1]
	Voltage harmonic distortion		**%**	3 or less/7 or less			Linear load/rectifier load, at rated output
	Transient voltage fluctuation	**Rapid load change**	**%**	Within ±5 of rated voltage			0⇔100% at transient or output switch
		During power outage, recovery	**%**				At rated output
		Input voltage during rapid change	**%**				±10% variation
		Response time	**Or less**	5 cycles			
	Power factor		—	0.8 (lag)			Variation range 0.7 (lag) to 1.0
	Overcurrent protection		**%**	105 or more			Auto switching to bypass circuit [1]
	Overload capability	**Inverter**	**%**	105 or more			200 ms
		Bypass		200/800			30-second period / 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 Default value
Acoustic noise			**dB**	45 or less	46 or less	46 or less	1 m from front of device, A-weighting (Where the ambient temperature is 40˚C or lower)
				51 or less	55 or less	55 or less [2]	1 m from front of device, A-weighting (Where the ambient temperature exceeds 40˚C)
Operating environment	**Ambient temperature**		**˚C**	-20 to +55			[3]
	Relative humidity		**%**	10 to 90			Non-condensing
Storage environment			**˚C**	-20 to +55			[4]

(1) The inverter synchronizes operation with AC input and allows switchover without interruption through a bypass circuit provided that the AC input frequency is within a range of the rated frequency ±3% (able to be switched between 1, 3, 5 and 7%), and the AC input voltage is within the rated voltage ±20% (if the load level is less than 70%: between -40% and +20%). Note that operation changes to battery operation when the AC input frequency exceeds the setting range.

(2) 60 dB or less when battery voltage drops.

(3) Battery charging stops when battery temperature exceeds 55˚C.

(4) To prolong battery life, avoid use or 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.

Table 2: The *SANUPS N11B-Li* series specifications

Item			Unit	Ratings and characteristics		Remarks
Model			—	N11BL102	N11BL152	
Rated output capacity			**kVA/kW**	1/0.8	1.5/1.2	Apparent power/active power
Type	**UPS topology**		—	Passive standby		
	Cooling system		—	Passive Forced air cooling during battery operation and high temperatures		
	Inverter system		—	High-frequency PWM method (during battery operation)		Commercial synchronous online double conversion
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 or 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 accuracy)
	Required capacity		**kVA**	1.4 or less	2.1 or less	Max. capacity during battery recovery charging
AC output	**No. of phases/wires**		—	Single-phase 2-wire		
	Rated voltage		**V**	100, 110, 120		Voltage waveform during battery operation: Sine wave
	Voltage accuracy		**%**	During commercial operation: Same as input power source		
				During battery operation: Within ±2 of rated voltage		At rated output
	Rated frequency		**Hz**	50/60		Same as the input frequency
	Frequency accuracy		**%**	During commercial operation: Same as input power source		
				During battery operation: Within ±0.5 of rated frequency		At rated output
	Voltage harmonic distortion		**%**	3 or less/7 or less		During battery operation, at rated output
	Transient voltage fluctuation	**Rapid load change**	**%**	Within ±7 of rated voltage		During battery operation, for 0⇔100% load step changes / output switch
		During power outage, recovery	**%**	Within ±5 of rated voltage		During battery operation, at rated output
	Power factor		—	0.8 (lag)		Variation range 0.7 (lag) to 1.0
	Overcurrent protection		**%**	Output breaker trip		
	Overload capability	**Inverter**	**%**	105 or more		200 ms
		Bypass		200/800		30 s / 2 cycles
Battery	**Type**		—	Lithium-ion battery (LIB)		
	Backup time		**Minute**	150		Ambient temperature 25°C, at rated output, default value
Acoustic noise			**dB**	40 or less	43 or less	1 m from front of device, A-weighting
IP rating			—	IP65		
Operating environment	**Ambient temperature**		**°C**	-20 to +50		(1)
	Relative humidity		**%**	10 to 90		Non-condensing
Storage environment			**°C**	-20 to +55		(2)

(1) Battery charging stops when battery temperature exceeds 55°C.
(2) To prolong battery life, avoid use or 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. Advantage for Customers

Below is a list of customer advantages gained by adopting this device.

(1) Common to the *SANUPS A11K-Li* and *SANUPS N11B-Li*
   1) Broader selection of applications and installation environments due to a wider operating temperature range
   2) Reduced maintenance costs thanks to low-maintenance batteries
   3) In the unlikely event of a problem, maintenance work can be performed without interrupting power supply to the load equipment.

(2) The *SANUPS A11K-Li*
   1) More freedom of installation environment due to less required installation space.
   2) Can perform backup safely even when power source is unstable thanks to its wide input voltage range.

(3) The *SANUPS N11B-Li*
   1) Backs up power for outdoor equipment.
   2) Sealed structure enables use in environments exposed to dust and rain.

7. Conclusion

Moving forward, information and communication technologies will undergo even further sophistication and play an even more important role in society. Moreover, with increased applications in a variety of environments, it is likely that the requirements for UPS will diversify.

We will continue to quickly develop products to meet these market demands and provide devices that fulfill our customers' needs.

We wish to express our deep appreciation to the many people who cooperated and offered advice in the development and production of these UPSs.

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