# Expansion of the *SANUPS A11K-Li* Small-Capacity UPS Lineup

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## 1. Introduction

General servers, compact ICT equipment, and FA equipment often require an uninterruptible power supply (UPS) that can provide backup power for around 10 minutes.

We already offer *SANUPS A11K-Li* series equipped with lithium-ion batteries (LIB) that are capable of providing 30 to 400 minutes of backup time. These models use large-capacity LIBs to provide a long backup time, and are bigger than lead-acid battery-equipped models that provide 10 minutes of backup time. As such, there is a demand for UPSs that are equivalent in size to the *SANUPS A11K* series, which use lead-acid batteries, but are equipped with LIBs to offer benefits such as a long service life, maintenance-free, and a wide operating temperature range.

Furthermore, with hyper-converged infrastructure (HCI) systems becoming increasingly popular as next-generation virtualization platforms, servers need more time to shut down than before. To shut down safely during power outages, UPSs are required to provide at least 15 minutes backup time even at the end of the battery life.

To satisfy these requirements, we developed the two UPSs models described below.

- Short backup time (around 10 minutes) models with a compact LIB built into the UPS main unit that is equivalent in size to and lighter than the lead-acid battery-equipped *SANUPS A11K* series.
- Intermediate backup time models with 19 minutes of backup time suited to new-generation servers.

This article introduces the new model lineup, as well as their main specifications and appearance. The following section will explain the features of the new models, as well as techniques for LIB monitoring and protective operations.

## 2. Main Specifications of the New Models

This time, we enhanced our *SANUPS A11K-Li* series with models offering around 10 minutes of backup time in 1 kVA, 1.5 kVA, 2 kVA, 3 kVA, and 5 kV output capacities (short backup time models) and models offering 19 minutes of backup time in 1.5 kVA and 3 kVA output capacities (intermediate backup time models). Table 1 shows the main specifications of the new models.

Figure 1 (1) through (3) shows the appearance of the new models. These are *SANUPS A11K-Li* short backup time models with output capacities of 1 kVA, 3 kVA, and 5 kVA.


Fig. 1 *SANUPS A11K-Li* series

Table 1 Main specifications of the *SANUPS A11K-Li* series new models

| Item | | | Unit | Ratings and characteristics | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Model** | | | — | A11KL102 | A11KL152 | A11KL202 | A11KL302 | A11KL502 | A11KL152 (19 min) | A11KL302 (19 min) | |
| **Rated output capacity** | | | **kVA/kW** | 1/0.8 | 1.5/1.2 | 2/1.6 | 3/2.4 | 5/4 | 1.5/1.2 | 3/2.4 | Apparent power / Active power |
| **Technology** | **Topology** | | — | Double conversion online | | | | | | | |
| | **Cooling system** | | — | Forced air cooling | | | | | | | |
| | **Inverter system** | | — | High-frequency PWM | | | | | | | Grid synchronous |
| **AC input** | **Number 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 load level ≥ 70% |
| | | | | Within -40 to +20 of rated voltage | | | | | | | At load level < 70%<br>The -40% becomes -20% for recovery voltage(1) |
| | **Rated frequency** | | **Hz** | 50/60 | | | | | | | Auto-sensing(2) |
| | **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** | 1.1 or less | 1.5 or less | 2.0 or less | 3.0 or less | 5.3 or less | 1.5 or less | 3.0 or less | Max. capacity during battery recovery charging |
| | **Power factor** | | — | 0.95 or more | | 0.97 or more | | | 0.95 or more | 0.97 or more | When input voltage harmonic distortion is less than 1% |
| **AC output** | **Number of phases/wires** | | — | Single-phase 2-wire | | | | | | | |
| | **Rated voltage** | | **V** | 100, 110, 120 | | | | | | | Factory setting.<br>Voltage waveform: pure sine wave |
| | **Voltage regulation** | | **%** | Within ±2 of rated voltage | | | | | | | At rated output |
| | **Rated frequency** | | **Hz** | 50/60 | | | | | | | Same as input frequency |
| | **Frequency regulation** | | **%** | Within ±1, 3, 5, or 7 of rated frequency<br>(Default setting: ±3) | | | | | | | Frequency regulation setting can be changed (±1, 3, 5, or 7%).<br>Within ±0.5% during battery operation(2) |
| | **Voltage harmonic distortion** | | **%** | 3 or less / 7 or less | | | | | | | Linear load / rectifier load, at rated output |
| | **Transient voltage fluctuation** | **For abrupt load change** | **%** | Within ±5 of rated voltage | | | | | | | For 0⇔100% load step changes or at output switching |
| | | **Loss or return of input power** | **%** | | | | | | | | At rated output |
| | | **For abrupt input voltage change** | **%** | | | | | | | | For ±10% changes |
| | | **Response time** | **Or less** | 5 cycles | | | | | | | |
| | **Load power factor** | | — | 0.8 (lagging) | | | | | | | Variation range: 0.7 (lagging) to 1.0 |
| | **Overcurrent protection** | | **%** | 105 or greater | | | | | | | Automatic transfer to bypass(2) |
| | **Overload capability** | **Inverter** | **%** | 105 or greater | | | | | | | 200 ms |
| | | **Bypass** | | 200/800 | | | | | | | 30 s / 2 cycles |
| **Battery** | | **Type** | — | Lithium-ion battery (LIB) | | | | | | | |
| | | **Backup time** | **min** | 13 | 8 | 15 | 9 | 11 | 19 | 19 | Ambient temperature 25°C, at rated output, using new, fully charged batteries |
| **Acoustic noise** | | | **dB** | 41 max. | 45 max. | | 46 max. | | 45 max. | 46 max. | 1 m from front of device, A-weighting<br>(Where the ambient temperature is 40°C or lower) |
| | | | | 51 max. | | 55 max. | | | 51 max. | 55 max. | 1 m from front of device, A-weighting<br>(Where the ambient temperature exceeds 40°C) |
| **Operating environment** | **Ambient temperature** | | **°C** | -20 to +55 | | | | | | | (3) |
| | **Relative humidity** | | **%** | 10 to 90 | | | | | | | Non-condensing |

(1) When the low input voltage detection value setting is variable (setting can be changed). Fixed setting is ±20% of rated voltage.
(2) The inverter synchronizes operation with AC input and allows uninterrupted transfer to a bypass circuit provided that the AC input frequency is within ±3% of the rated frequency (1, 3, 5, or 7% selectable) and the AC input voltage is within ±20% of the rated voltage (if the setting of the low input voltage detection value is variable and the load level is less than 70%: within -40% to +20% of the rated voltage).
Note that operation changes to battery operation when the AC input frequency exceeds the setting range.
(3) Charging stops when battery temperature exceeds 55°C.

## 3. Features

### 3.1 Maintainability and backup time after aging deterioration

While *SANUPS A11K* series UPSs with lead-acid batteries require battery replacement approximately every five years, the new models, thanks to the LIB, can operate for roughly ten years without battery replacement. This maintenance-free operability reduces maintenance work and battery replacement costs.

Furthermore, an LIB has less capacity reduction due to aging deterioration compared to a lead-acid battery. This means that, when we compare the backup time at the end of battery life, the backup time for the lead-acid battery is approximately half the initial value. By contrast, the backup time for LIBs only drops 10%, meaning that the change in backup time due to aging deterioration for the latter is extremely minimal.

### 3.2 Operating temperature range

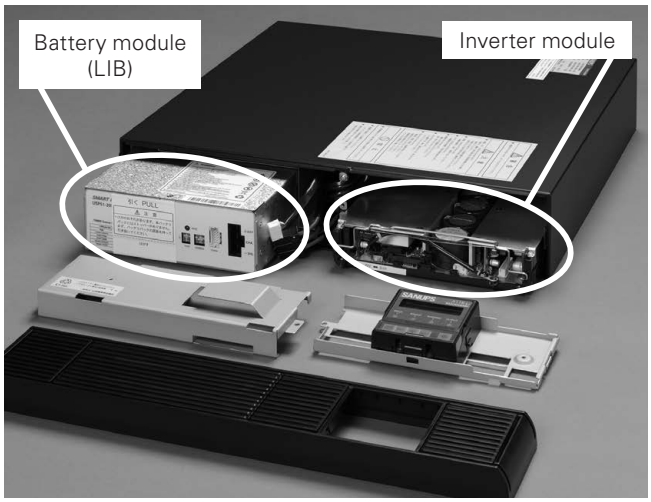
The operating temperature range of the *SANUPS A11K* series equipped with lead-acid batteries is -10˚C to +55˚C (charging stops at +40˚C to protect the battery). By contrast, the operating temperature range of the new models is -20˚C to +55˚C, making them suitable for both extremely cold and extremely hot environments.

### 3.3 Equipment size and mass

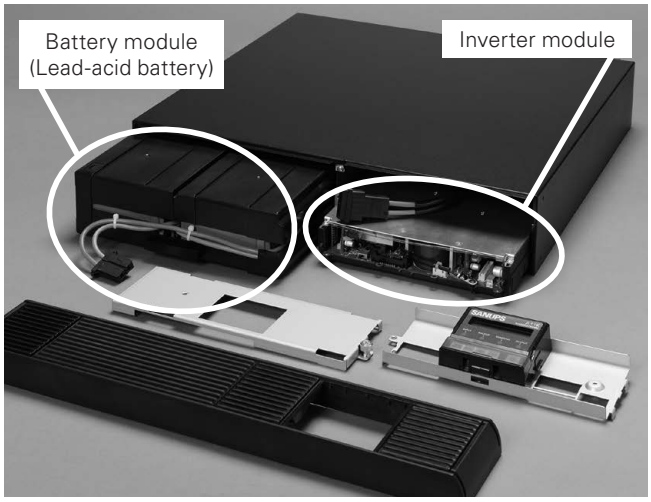
Figure 2 (1) and (2) show the interiors of *SANUPS A11K-Li* (1 kVA) and *SANUPS A11K* (1 kVA), respectively. Table 2 shows a comparison of the volume and mass for the new short backup time models and the current models.

Figure 2 (1) shows that, for the new short backup time models, we were able to fit the LIB in the space occupied by the lead-acid battery without changing the size or shape of the current housing. LIBs are lighter than lead-acid batteries, therefore, as demonstrated in Table 2, the new short backup time models are up to 44.8% lighter than current models of equivalent size.

Table 3 shows a comparison of the volume and mass for the new intermediate backup time models and the current models. As Table 3 shows, the new intermediate backup time models are smaller and lighter than the current models. On the current models, an external battery unit is necessary to provide 19 minutes of backup time. Therefore, volume, mass, and space occupied on a rack are all greater. For the new intermediate backup time models, the depth of the main unit has been extended, so the battery can be contained internally and an external battery unit is not required.




(1) New model *SANUPS A11K-Li* (1 kVA)




(2) Current model *SANUPS A11K* (1 kVA)

Fig. 2 Interior of new model and current model

Table 2 Volume and mass comparison between *A11K-Li* and *A11K* series short backup time models

| Output capacity | Model | Backup time | Dimensions (Width × depth × height) | Volume ratio | Mass | Mass ratio |
|---|---|---|---|---|---|---|
| 1 kVA | **A11KL102 (new model)** | 13 min (0.8 kW/power factor 0.8) | 435 mm × 440 mm × 86 mm | ±0% | 17 kg | -22.7% |
| | A11K102 (current model) | 10 min (0.8 kW/power factor 0.8) | | — | 22 kg | — |
| 1.5 kVA | **A11KL152 (new model)** | 8 min (1.2 kW/power factor 0.8) | 435 mm × 440 mm × 86 mm | ±0% | 18 kg | -37.9% |
| | A11K152 (current model) | 10 min (1.2 kW/power factor 0.8) | | — | 29 kg | — |
| 2 kVA | **A11KL202 (new model)** | 15 min (1.6 kW/power factor 0.8) | 435 mm × 625 mm × 86 mm | ±0% | 27 kg | -32.5% |
| | A11K202 (current model) | 8 min (1.6 kW/power factor 0.8) | | — | 40 kg | — |
| 3 kVA | **A11KL302 (new model)** | 9 min (2.4 kW/power factor 0.8) | 435 mm × 625 mm × 131 mm | ±0% | 32 kg | -44.8% |
| | A11K302 (current model) | 8 min (2.4 kW/power factor 0.8) | | — | 58 kg | — |
| 5 kVA | **A11KL502 (new model)** | 11 min (4 kW/power factor 0.8) | 435 mm × 690 mm × 175 mm | ±0% | 49 kg | -38.7% |
| | A11K502 (current model) | 8 min (4 kW/power factor 0.8) | | — | 80 kg | — |

Table 3 Volume and mass comparison between *A11K-Li* and *A11K* series 19-minute backup time models

| Output capacity | Model | Backup time | Dimensions (Width × depth × height) | Volume ratio | Mass | Mass ratio |
|---|---|---|---|---|---|---|
| 1.5 kVA | **A11KL152 (new model)** | 19 min (1.2 kW/power factor 0.8) | 435 mm × 625 mm × 86 mm | -35.9% | 27 kg | -60.8% |
| | A11K152 (current model) | 30 min (1.2 kW/power factor 0.8) (1) | 435 mm × 488 mm × 86 mm<br>435 mm × 488 mm × 86 mm<br>External battery unit | — | 69 kg | — |
| 3 kVA | **A11KL302 (new model)** | 19 min (2.4 kW/power factor 0.8) | 435 mm × 690 mm × 175 mm | -10.9% | 47 kg | -56.0% |
| | A11K302 (current model) | 30 min (2.4 kW/power factor 0.8) (1) | 435 mm × 625 mm × 131 mm<br>435 mm × 625 mm × 86 mm<br>External battery unit | — | 108 kg | — |

(1) When used in an ambient temperature of 25˚C, the backup time at the end of the lead-acid battery life (after 5 years) is 19 minutes. LIBs maintain 90% or more backup time after 5 years.

## 4. Technique for Monitoring LIB

Figure 3 shows the circuit diagram for the new models. The new models comprise a main circuit, control circuit, communication interface circuit, LIB, and a battery management system (or BMS) that monitors the LIB.

### 4.1 LIB monitoring circuit configuration

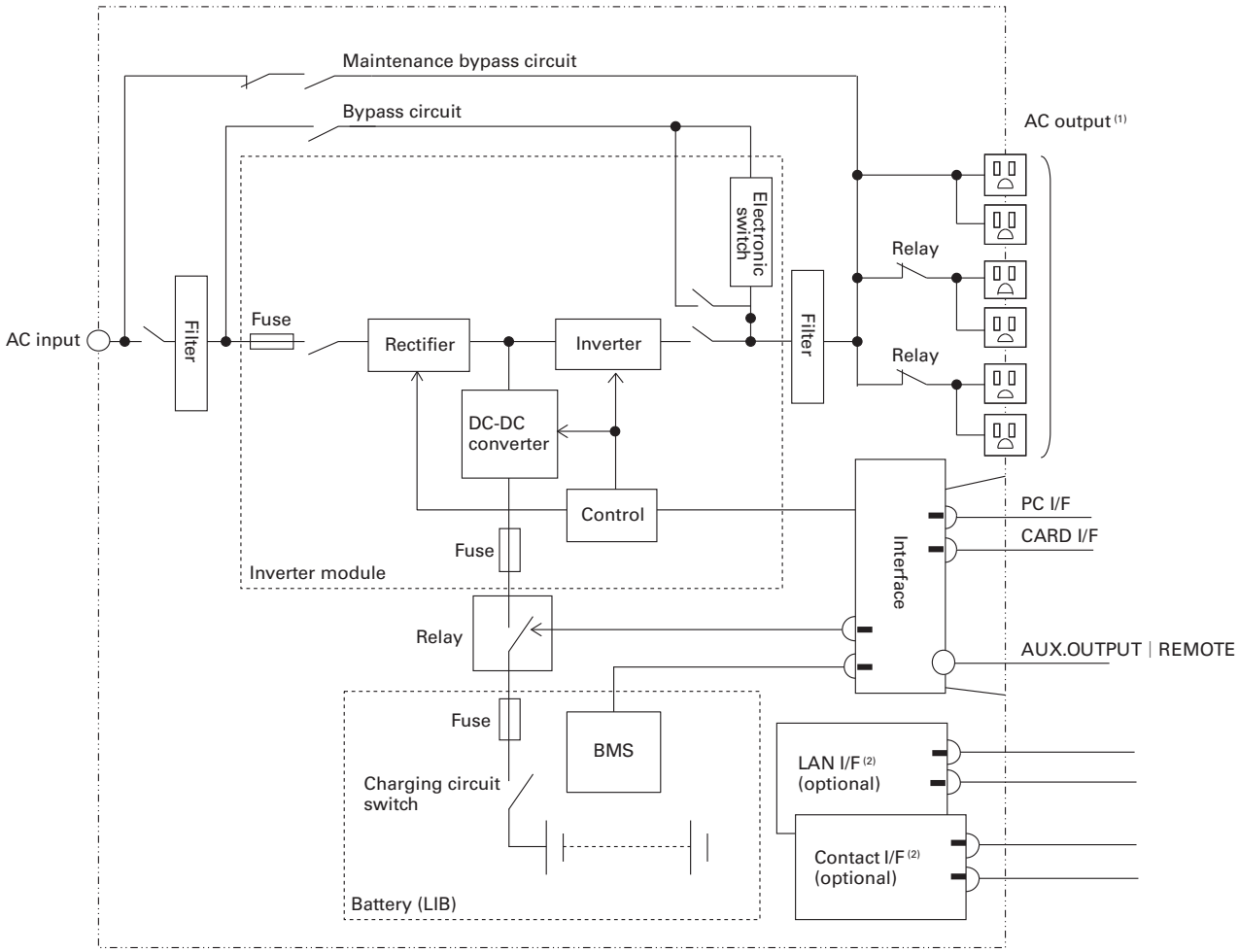
The BMS is installed inside the LIB and manages the battery's status. The UPS communicates with the BMS and gathers information on the LIB. As such, both the BMS and UPS monitor the LIB and improve safety through their respective roles of fault detection and protection.

(1)Protection by BMS

The BMS monitors cell voltage, battery current, and cell temperature. If it detects overcharging, overcurrent, or excessive temperature rise, it will disconnect the LIB from the charging circuit for protection.

(2)Protection by UPS

The UPS stops charging to protect the LIB when a fault occurs on the BMS, or a communication fault occurs between the UPS and BMS. The UPS stops charging if the LIB's charging voltage or cell voltage increases. The UPS stops charging and discharging if the cell temperature becomes too high.




(1) For the *SANUPS A11K-Li* 2 kVA, 3 kVA, and 5 kVA models, output power is available from both the outlet and terminal block.
(2) Connect to CARD I/F connector (either one).

Fig. 3 Circuit diagram for the *SANUPS A11K-Li* (1 kVA)

## 5. Conclusion

This article introduced the new lineup for the LIB-equipped *SANUPS A11K-Li* series.

The newly-developed UPS has the following advantages over a conventional UPS using lead-acid batteries.

(1) Maintenance-free, requiring no battery replacement
(2) Wide operating temperature range enables use in extremely hot and cold environments
(3) Weight reduction achieved for the short backup time models, and the 19-minute backup time models are more compact and lightweight

Moreover, we designed an LIB monitoring system by the UPS and BMS for fault detection and protection.

UPSs are becoming increasingly important to society. As their applications and installation environments diversify, it is likely that demand will grow for models with various specifications. 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.

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