Products Supporting the Globalization of the Power Systems Division

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1. Introduction

Compared to Japan, the power situation of other countries involve large voltage fluctuations, momentary power outages, frequent voltage drops and other issues, which all have a negative impact on quality. This document will introduce the functions of power supply products developed by Power Systems Division which respond to this kind of power situations. In order to sell power supply products overseas, an important issue is being able to carry out installation and maintenance of such equipment both easily and quickly, therefore it is required that design to be considered of field service in overseas countries.

We will describe the basic outline and features of uninterruptible power supply (UPS), instantaneous voltage drop compensator and peak-cut device as products which will support globalization in the future.

2. Small Capacity UPS

2.1 "SANUPS A11H" series

With the global development of IT, there is a demand for the high reliable power supply products which supply power to IT devices, and UPS plays an important role. However, in regions with unstable power situations, backup operations using the power stored in batteries are performed frequently, and as a result, the battery cannot maintain the necessary charged state, meaning that it may not be possible to perform sufficient backup when required. Due to this fact, a growing demand has emerged for UPS which respond to the unstable power supply environments.

The A11H series are UPS based on the conventional E11A but developed with an optimized design enabling them to respond to these environment.

Specially for rectifier which configures UPS shows in Fig.1, to be able to continue operation in a wider input voltage range, A11H series optimized the control program.

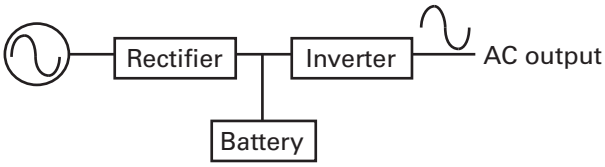


Fig. 1: Circuit block

Below is a description of the main features of A11H. Fig. 2 is an external view of A11H.

(1) Responds to wide range input
AC input voltage range: 55 V to 150 V
AC input frequency range: 40 Hz to 120 Hz

(2) Responds to fluctuations in engine generator voltage and frequency
As both the voltage and frequency of an engine generator experience significant momentarily fluctuation when a load is applied, the standard UPS switches over to battery operation. However our newly developed UPS continues AC input operation.

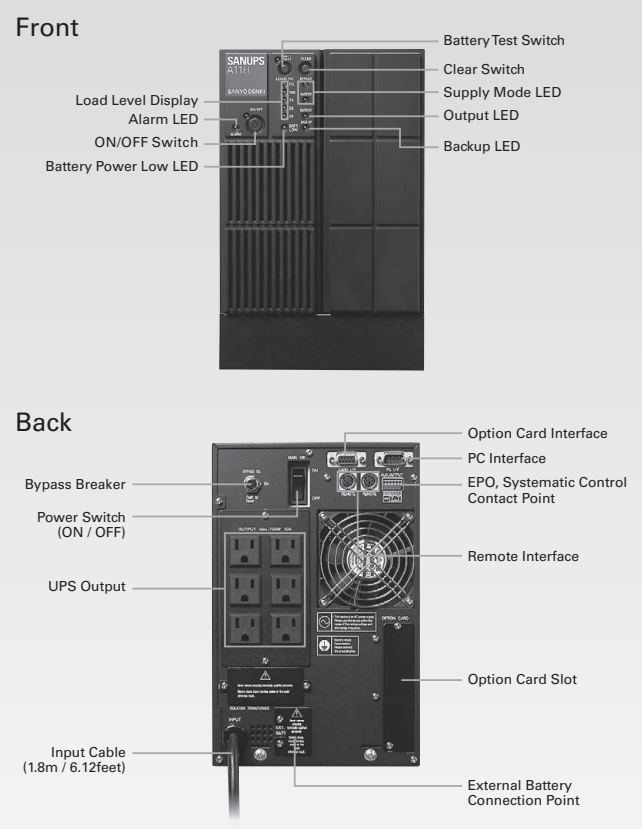
(3) Setting of the tower type and 19 inch rack mounting type

As described above, this UPS continues to provide a stable power supply to the connected devices to even if input power is unstable with large fluctuation. Moreover, because a wide input range makes it difficult to switch to battery operation, this make it possible to reduce battery usage and minimize early-stage deterioration of the battery.

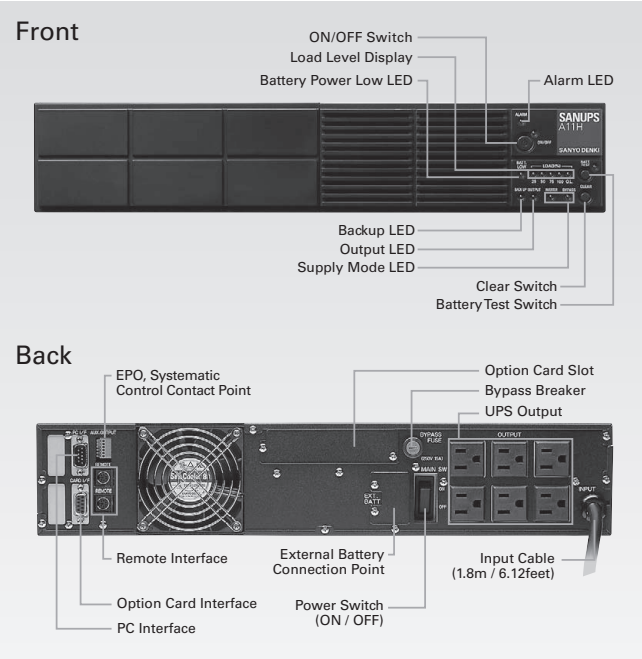
2.2 "SANUPS A11J" three-phase, four-wire model

While globalization of the world economy is prevalent, economic development of Southeast Asia is receiving particular attention.

Many Japanese companies have taken up presences in this region and maintenance of the power infrastructure, which is the foundation of business activities, has become



Tower type (in the case of 1 kVA)



19 inch rack mounting type (in the case of 1 kVA)

Fig. 2: External view of device

a central issue, therefore we strongly anticipate an increase in the demand for UPS.

Predicting an increase in demand for mid-capacity UPS in the Southeast Asian region, in addition to the single-phase, two-wire 5 kVA to 20 kVA of the "SANUPS A11J" series, we have developed a new three-phase, four-wire 15 kVA to 45 kVA UPS. This product is described in detail in the "Development of Uninterruptible Power Supply SANUPS A11J Three-phase, Four-wire model" section of this book.

Three-phase, four-wire AC systems are the mainstream indoor AC systems used in overseas. Extracting a neutral wire from the neutral point provides the advantage of being able to use both the voltages between the wires and between the phases. In Southeast Asia, voltages such as 380 V / 220 V (three-phase/single phase), are used for power distribution of both three-phase power (R, S, T) and single phase lights (R-N, etc.). By using the existing single-phase technology of our "SANUPS A11J" series, we were able to develop a three-phase, four-wire UPS in a short period of time and respond to globalization.

Moreover, it is possible to select and set the phase voltage/wire-to-wire voltage from the options of 220 V / 380 V, 230 V / 398 V and 240 V / 415 V, making our UPS capable of responding to power environments of not only the Asian region, but also European countries.

This device comprises of an inverter unit, current collector and battery unit, and can be equipped on a versatile 19 inch rack (hereinafter "rack"), making it a mid-capacity class UPS which can be implemented on commercially available racks, thus significantly reducing costs involved in installation and maintenance. Moreover, a plug connection structure and weight reduction was achieved by grouping each unit into a module by block. As per the modularization, it makes excellent maintainability of replacement, etc. So without sending technicians from Japan, it is able to replace the units and modules in the field. This enables the quick maintenance and system recovery. Fig. 3 shows each structural unit and an example of rack mounting.

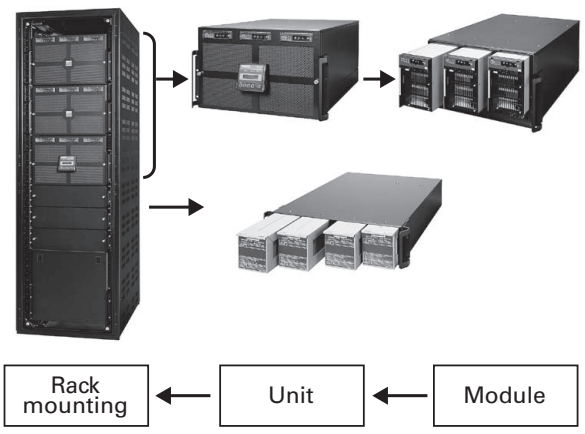


Fig. 3: An example of structural units and rack mounting

Each module is a plug-in system, therefore during parallel redundant operation, even if an error has occurred, replacement can be carried out quickly with maintaining the inverter power feeding, hence obtaining high availability. Moreover, there is a built-in maintenance bypass circuit, therefore it is possible to perform module maintenance, replacement and other tasks while continuing to feed power from a utility power supply.

(1) Responds to wide range input

Allowable range of the input voltage:

- If load factor exceeds 70%: -20% to +15%
- If load factor is 70% or less: -40% to +15%

Allowable range of the input frequency:

- Feeding of power with an output frequency of 50/60 Hz is possible within a range of 40 Hz to 120 Hz

In the above way, the new UPS responds to wide range input and constantly supplies stable power to the connected devices. Moreover, this UPS can respond to fluctuations in engine generator voltage and frequency.

This wide range response also makes it possible to reduce the frequency of switching to battery power feeding and minimize battery deterioration.

3. Mid/Large-capacity UPS, Instantaneous Voltage Drop Compensator, Peak-cut Device

3.1 "SANUPS E33A" series

As a trend of the UPS market, in addition to markets focused on computer devices and communications infrastructure, the demand is growing in the field of datacenters and plant production equipment. Particularly in regards to datacenters, cloud computing is spreading on a global scale and UPS designed for application in datacenters are becoming increasingly more in demand. This market is characterized by a high amount of 500 kVA class large-capacity UPS and due to the requirement to reduce current in order to achieve high efficiency, 400 V power distribution systems are mainstream as they can reduce wiring loss.

Figures 4 and 5 show the "SANUPS E33A", a 400 V large-capacity UPS of the parallel processing type. The "SANUPS E33A" offers both high efficiency and high quality, and achieves complete individual parallel operation control by the parallel processing type.

Parallel processing type UPS is a hybrid UPS with a simple structure which has combined active filter, charger and inverter functions all in one bidirectional inverter.

The inverter is connected in parallel to a utility power supply, and during normal operation, it feeds power from the utility power supply via only an AC switch to the load while suppressing the harmonic current which the load creates a harmonic current with the active filter function, as well as charging the battery simultaneously using the charger function. Because only the suppressed harmonic current pass through the power converter during normal operation, there is less power loss compared with the continuous inverter power supply system type, thus higher efficiency is achieved. Moreover, In the case of a utility power supply at abnormal situation, immediately isolate the utility power and continue inverter feeding. This will enable it to supply to load with no instantaneous interruptions, this is a highly reliable type.

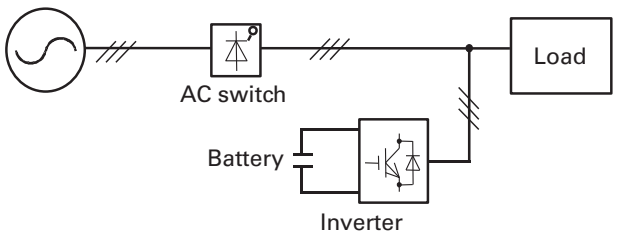


Fig. 4: Circuit configuration of the parallel processing type

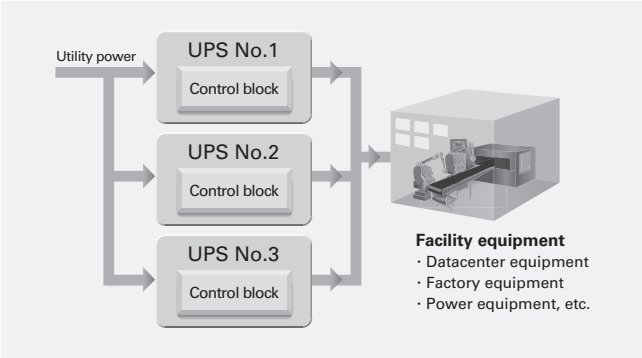


Fig. 5: Parallel operation of the parallel processing type

The main features of E33A are shown below. Fig. 6 is an external view of the device.

(1) 98% of high efficiency

(2) Responds to both three-phase, three-wire type and three-phase, four-wire type

(3) Responds to 380 V / 400 V / 415 V / 420 input

(4) Responds to parallel type and parallel redundant type of UPS units

This UPS is based on the 100 kVA UPS, the lineup of parallel type is from 100 kVA to 600 kVA, and parallel redundant type is up to 500 kVA. This series was developed as expandable UPS for datacenters both in Japan and

overseas as they grow in scale, however is also expected to be installed for production plant's equipment as backup power both at home and abroad. As the majority of power devices for this kind of production equipment require a large volume of power for backup, by applying this system that units can easily be connected in parallel so it enables to respond flexibly to the increased capacity of equipment.

Fig. 6: External view of device

3.2 Instantaneous voltage drop compensator "SANUPS C23A" series

Due to production systems becoming increasingly more complex and sophisticated in recent years, the impact of instantaneous voltage drops (hereinafter referred to as "instant voltage drops") and instantaneous power outages (hereinafter referred to as "instant outages") caused by lightning strike to power lines, etc., is increasing in scale and there are many cases of significant damage caused by instant voltage drops at plants that manufacture goods such as semiconductors and LCD. Due to machine's emergency stop by instant voltage drops, the equipment and product being manufactured or transferred can be damaged.

As such it is essential that countermeasures are implemented against instant voltage drops and instant outages of manufacturing plants, and this is a particularly critical issue in overseas plants where the power quality is not as high as Japan. In order to address this issue, there are many cases of instantaneous voltage drop compensators and UPS being installed.

Moreover, in production equipment such as these areas, there is an increasing number of cases with excessive power consumption at the time motors and other power equipment are started up (peak current) as well as regenerative electric power occurring when the motor is stopped. On such occasions, the flicker phenomenon which occurs on utility power supplies (voltage drops or flickering) and voltage rises can affect the performance deterioration of other equipment or stopping the operation. In the past, the main way to countermeasure peak current was to select different power-receiving equipment or increasing wiring capacity however this incurs surplus installation costs. Meanwhile, to countermeasure regenerative electric power, additional equipment (large-capacity condensers or resistors) is required in order to expel unwanted power, and this requires considerable equipment investment.

In response, we have developed the "SANUPS C23A" as an instantaneous voltage drop compensator with short-time rating specifications by combining a long life, maintenance-free Electric Double Layer Capacitor (hereinafter refferred to as "EDLC") with the above mentioned "SANUPS E23A" , the parallel processing type UPS suitable for use on this kind of production equipment. Below is an explanation of C23A and its features.

Fig. 7 gives the circuit configuration, and Fig. 8 shows an external view of the device.

Because the device is able to feed power to the load at a high efficiency through an AC switch in the same way as the standby power type, and simultaneously provide an active filter function with the bidirectional inverter and charge the capacitor, C23A isolates the utility power

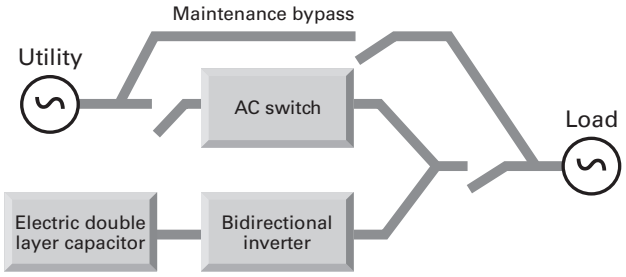


Fig. 7: Circuit configuration

Fig. 8: External view of device

supply during abnormalities such as instant voltage drops and instant outages, enabling a power supply with no instataneous interruption to production equipment from the EDLC. Also, in regards to the issue of adverse effects on equipment due to peak current and regenerative electric power, the excess power can be absorbed on the power supply side without the need to review equipment.

Furthermore, due to the built-in maintenance bypass circuit, it is possible to carry out service and replacement of internal parts locally.

3.3 Peak-cut device "SANUPS K33A" series

When running the motors mounted into large pressing machines and transport equipment, a large amount of power is required momentarily, and therefore there were cases that the power receiving equipment should be reinforced with a capacity higher than the actual consumption power. In the pressing industry in particular, they are switching from hydraulic presses to servo presses in order to improve controllability and maintainability. These servo pressing machines improve the speed, position, and controllability of welding pressure. But on the other hand, a large amount of power is required momentarily when powering the motor, and therefore the power equipment has to be reinforced. Failure to reinforce power equipment causes voltage flicker to occur, which affects other facility equipment. As a result, a peak-cut function to reduce the large power required when powering the motor is essential in servo pressing machines and transport equipment, and a peak-cut device that uses an electrolytic capacitor has been suggested. However, the energy density is low as a stand-alone electrolytic capacitor therefore the equipment must be made bigger as several electrolytic capacitors are required to be installed to generate a high volume of power. Moreover, in the future it will be necessary for the power supplies of large motor drives to respond to not only voltage flicker but also the issue of harmonics, however a highly-functional power source suitable for this does not exist. In light of these circumstances, the peak-cut function and regenerative electric power processing function of the C23A, C33A series was applied to develop the "SANUPS K33A" as a peak-cut device for large motor drives which uses an EDLC with high energy density able to charge and discharge large current. The "SANUPS K33A" is mainly used in overseas pressing plants.

This section describes the features of the "SANUPS K33A".

Fig. 9 shows a comparison between the "SANUPS K33A" and the conventional electrolytic capacitor type. Conventional systems initially required a inrush current control panel (in order to minimize inrush current) for charging the electrolytic capacitor however the "SANUPS K33A" is capable of charging the battery element via a DC/DC converter, thus a large initial charging circuit such as an inrush current control panel will be unnecessary.

Furthermore, in the conventional system, the electrolytic capacitor is directly connected to the DC output, so the power is smoothed when powering and regenerating by the electrolytic capacitors. In the case of this system, the received power increases and effects to peak-cut performance when the electrolytic capacitor is detriorated compare to an initial installation.

Meanwhile, the "SANUPS K33A" adopts a long life EDLC which does not deteriorate easily and even if it did, EDLC voltage fluctuation would be absorbed to a certain degree due to the fact that it passes through a DC/DC converter. As a result, the peak-cut performance is not affected.

For servo pressing systems at emergency stop situation, the electrical circuit is physically disconnected as a power shutoff. In conventional systems where electrolytic capacitors are used, the electrolytic capacitor is connected to the DC output, so operations are performed with the DC circuit breaker, but a special DC circuit breaker is required as the DC voltage is high and a large amount of current must be cut off. In contrast, the "SANUPS K33A" uses a semiconductor switch of an AC/DC and DC/DC converter to release the magnet switch after the large current is isolated at high-speed thereby achieving power isolation by a common magnet switch. Moreover, conventional AC/DC converter require large AC reactor panel to be mounted externally to countermeasure harmonics. However with the "SANUPS K33A" the active filter function of the AC/DC converter converts the input current to a sine wave at the time of both powering up and regeneration, and controls so that the input power factor is virtually 1, eliminating the need for an external reactor panel.

Fig. 10 shows a circuit block of the "SANUPS K33A", and Fig. 11 gives an example of its basic operation waveform. Fig. 12 is an external view of the device.

By peak-cut of the utility power at the time of powering, and supplying power from the EDLC, the "SANUPS K33A" is able to respond to large power capacity of the motor. Furthermore, the regenerative electric power from the motor is used to charge the EDLC rapidly through the bidirectional DC/DC converter, battery to be in a standby state for the next powering.

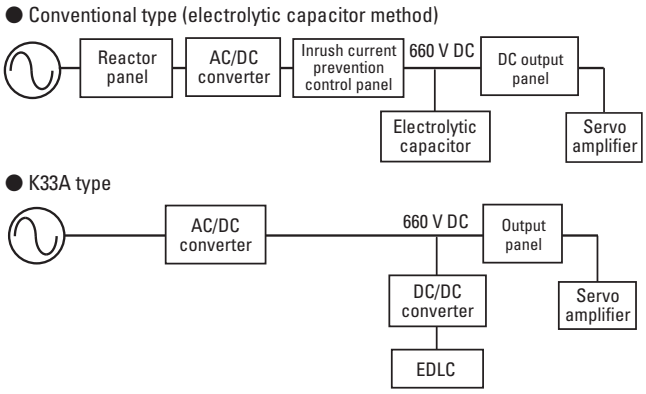


Fig. 9: Comparison of a peak-cut device

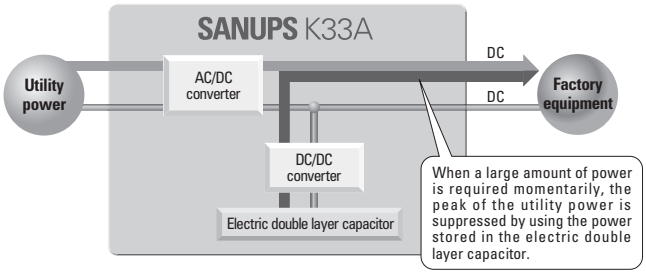


Fig. 10: Circuit block

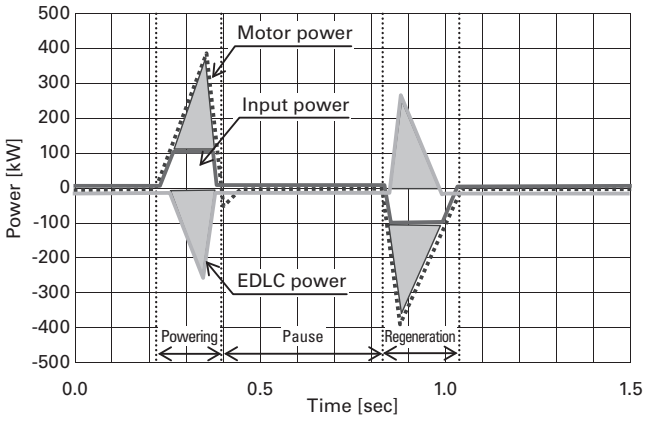


Fig. 11: An example of a basic operation waveform

Fig. 12: External view of device

5. Conclusion

This document has explained the functions and technologies of products for application in environments and markets with poor power supply environments as technologies supporting Sanyo Denki's globalization.

It has also explained about module-system UPS which features a simple unit configuration to allow local response at overseas.

The importance of UPS and other power supply products for use with production equipment will continue to grow with the sophistication of information communication technology and economic development of the Asian region in particular. In the future, we plan to propose products that meet customers' needs and contribute to customer success.

Reference

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UPS Suitable for Production Equipment Field, "SANUPS E"
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(3) SANYO DENKI Technical Report No. 24
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(4) SANYO DENKI Technical Report No. 27
Development of the High Performance Voltage Dip Compensator "SANUPS C23A"
(5) SANYO DENKI Technical Report No. 32
Development of the Peak Power Cut Device "SANUPS K33A"

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