Development of the Peak Power Cut Device “SANUPS K33A”

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1. Introduction

When running the motors built into large pressing machines and transport equipment, a large amount of power is required momentarily, and therefore there are cases where the power receiving equipment needs to be reinforced with a capacity higher than the actual consumption power. In the pressing industry in particular, the industry is 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, while elimination of the use of oil leads to excellent maintainability. But on the other hand, a large amount of power is required momentarily when powering the motor, and therefore the power equipment needs to be reinforced.

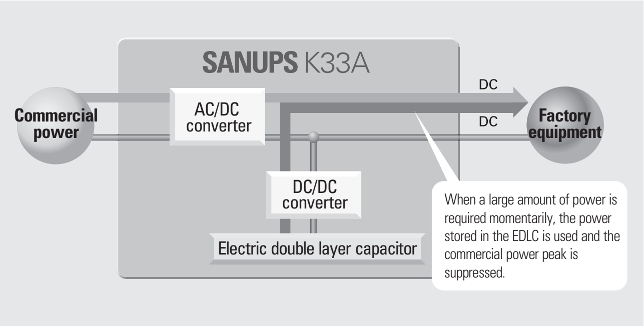
As a result, failure to reinforce power equipment causes a voltage dip phenomenon known as voltage flicker to occur, which affects other equipment. Furthermore, reinforcing the power equipment can cause problems by forcing large costs upon the end user. As a result, a peak-cut function to reduce the large power that occurs when powering the motor is essential in servo pressing machines and transport equipment, and a peak power cut device that uses an electrolytic capacitor is suggested. However, the energy density of electrolytic capacitors is low, so the device must be made bigger. Furthermore, in terms of the power supply for driving the motor, the inverter technology used for driving the motor has been improved, but in addition to voltage flicker, harmonic problems can also occur in the interface with the commercial power. In other words, a highly functional power source for driving large motors does not exist in the current market.

In this situation, we applied the C33A series peak-cut and regenerative functions to develop the “SANUPS K33A” as a peak power cut device for driving large motors using an EDLC (electric double layer capacitor) as a storage device. This document introduces the characteristics of the “SANUPS K33A” .

2. Structure and Operations of “SANUPS K33A”

2.1 Basic structure

Fig. 1 shows the basic circuit structure of this device. This device is primarily composed of an AC/DC converter, DC/DC converter, and an electric double layer capacitor (EDLC). The AC/DC converter is a rectifier that keeps the sine wave and power factor for the input current at about 1.0 when powering to drive the motor or when regenerating power as the motor reduces speed. As a result, large reactors or other devices do not need to be installed externally. The DC/DC converter is included to reduce the input power supplied from the commercial power by assisting (discharging) power from the EDLC while powering (peak cut) and to absorb (charge) the EDLC with some power during regeneration (use of regenerative power). When DC output is directly connected to the storage device without using this DC/DC converter, the storage device must be made quite large, but by using the DC/DC converter, the rate of utilization for the storage device can be increased and a smaller storage device can be realized. For the storage device, an EDLC is used, as it has high energy density compared to an electrolytic capacitor and large charge/discharge current compared to lead storage batteries. The device output is direct current, and the device is planned to supply a large amount of power to the inverter for driving the motor and to provide effective use of regenerative electric power.



When a large amount of power is required momentarily, the power stored in the EDLC is used and the commercial power peak is suppressed.

Fig. 1: Basic circuit structure of “SANUPS K33A”

2.2 Basic operations

Fig. 2 shows the operation waveform diagram for the “SANUPS K33A”.

The power generated for powering the motor is assisted from the EDLC for the amount that exceeds the maximum input capacity of the set device, thus providing peak cut for the input power of the device. If all of the power for powering the motor is supplied from the commercial power, then a voltage dip phenomenon known as voltage flicker occurs due to the large current and impedance of the commercial power. With the peak-cut operations as shown in the figure, flicker on the commercial power can be suppressed and the cost of reinforcing power systems can be reduced.

Furthermore, the regenerative power generated when the motor decelerates charges the EDLC and is used when next powering the motor. In conventional methods, this regenerative power is consumed by regeneration resistance, but by absorbing it into the EDLC with the DC/DC converter and using it when next powering the motor, wasteful power consumption can be eliminated, realizing power saving.

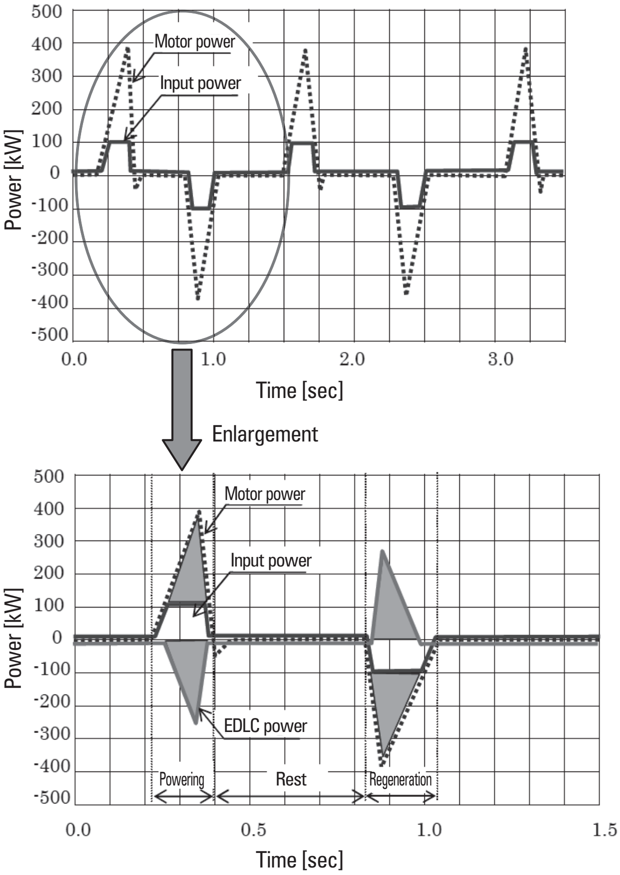


Fig. 2: Operation waveform of “SANUPS K33A”

3. Features and Characteristics

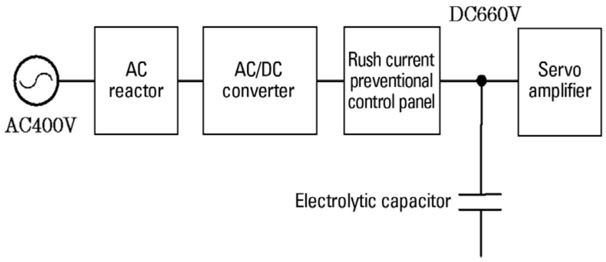
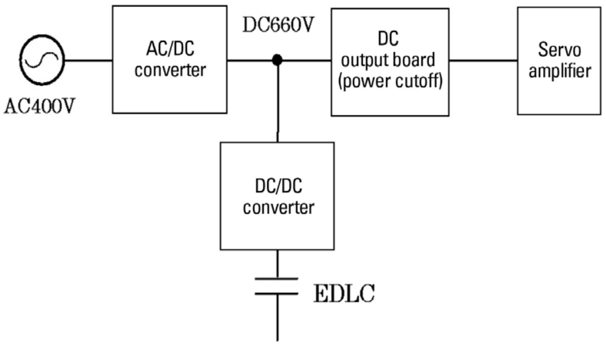
This section describes the features of the “SANUPS K33A”.

Table 1 shows a comparison between the “SANUPS K33A” and the conventional system with the electrolytic capacitor method. In the conventional system, a rush current preventional control panel was required to initially charge the electrolytic capacitor, but the “SANUPS K33A” can provide charge through a DC/DC converter, so an initial charge circuit such as rush current preventional control panel is unnecessary.

Furthermore, in the conventional system, the electrolytic capacitor is directly connected to the DC output, so the power is leveled when powering from the electrolytic capacitor or regenerating power. Therefore, the AC/DC converter in the conventional system converts the leveled power from AC to DC, so as the electrolytic capacitor deteriorates, the received power increases compared to the initial state and the peak-cut performance also deteriorates. On the other hand, even if the EDLC in “SANUPS K33A” deteriorates, the power travels through the DC/DC converter, so EDLC voltage fluctuations during the deteriorated state can be absorbed. As a result, the peak-cut performance is not affected.

For pressing systems, during an emergency stop, the electrical circuit is physically cut in two places for a power cutoff. 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. Compared to this, the “SANUPS K33A” realizes power cutoff by cutting off the large current with an AC/DC converter and DC/DC converter semiconductor switch, followed by a normal magnetic switch.

Table 1: Comparison with the conventional system

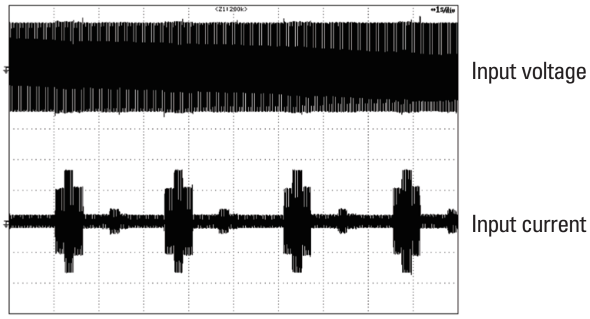
	System configuration	**Input power capacity [kW]**	**Panel dimensions**			**Remarks**
			Width [mm]	**Depth [mm]**	**Height [mm]**	
Conventional system		Initial stage 900 End stage 1200 (Estimated)	7750	1190	2400	· Troubles handling power cutoff · Worsening of input peak-cut characteristics · Larger size
SANUPS K33A		Initial stage 800 End stage 800	5600	1200 Volume = Reduced 27% compared to conventional	2400	· Handles power cutoff · No deterioration of input characteristics · Small size due to use of EDLC · High power factor converter (Power factor 1)

Furthermore, with the AC/DC converter in the conventional system, a large AC reactor board had to be installed externally, but with the “SANUPS K33A” , the input current for the AC/DC converter becomes a sine waveform even when powering or regenerating, as shown in Fig. 3, so a reactor board does not need to be installed externally.

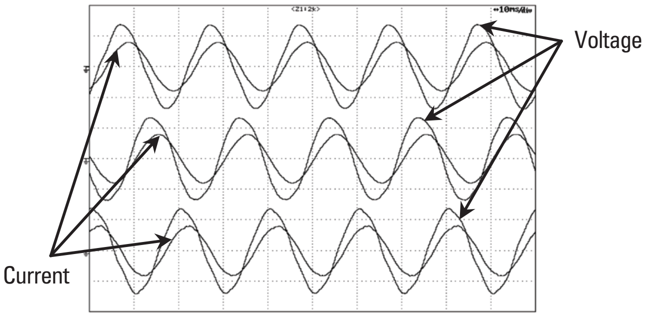
The housing uses an airtight structure to prevent dust in the control areas. For the converter, which generates lots of heat, the housing uses a structure that cools by passing air through a duct that completely separates the converter from the control areas.

The storage device uses an EDLC, which has higher energy density compared to electrolytic capacitors, designed for a smaller size. Through joint reworking of the cooling structure with the manufacturer, we realized a reduction in volume ratio of 67% when comparing the existing EDLC module with the EDLC module shown in Fig. 4.

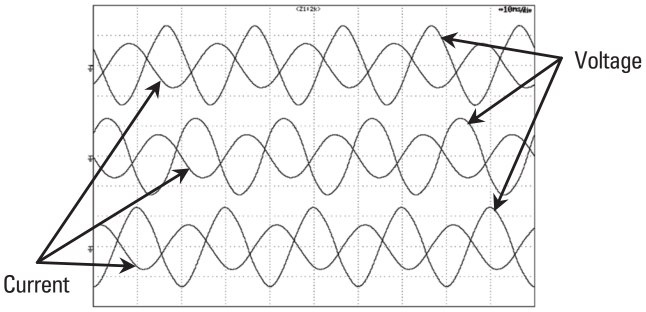
As shown above, the new model has improved characteristics and performance over the conventional system while realizing a volume that is 27% smaller compared to the conventional system.



(a) Overall waveform



(b) Input current waveform during powering



(c) Input current waveform during regeneration

Fig. 3: Input characteristics for peak power cut device

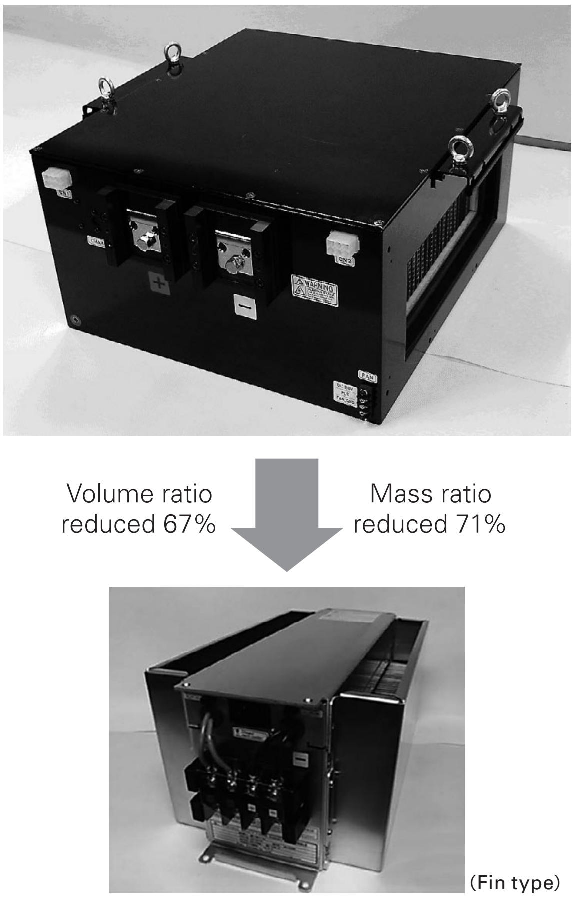


Fig. 4: External appearance of the EDLC

4. Specifications

Table 2 shows an example of the electrical specifications for the “SANUPS K33A” . Fig. 5 shows an example of the appearance.

Fig. 5: Appearance of “SANUPS K33A”

Table 2: Electrical specifications

Item		Units	Standard specifications	Remarks
Device capacity		kW	1800	
Input capacity (max.)		kW	800	AC/DC converter capacity (Note)
Assistance capacity		kW	1000	DC/DC converter capacity (Note)
AC input	**No. of phases/wires**	—	Three phase, three wire	
	Rated voltage	V	380	
	Voltage fluctuation range	V	342 to 418	
	Rated frequency	Hz	50/60	
	Frequency fluctuation range	%	±5	
DC output	**Rated voltage**	V	660	
	Voltage fluctuation range	V	594 to 726	
	Maximum output capacity	kW	1800	
	Maximum output current	A	2727	
Noise		dB	76	
Storage device				
Item		**Units**	**Standard specifications**	**Remarks**
Type		—	Electric double layer capacitor	EDLC
Charge/discharge voltage range		V	376 ～ 540	40°C (ambient temperature)
Rated DC voltage		V	460	
Charge/discharge power		kWs	93.3	
Time until full charge after power on		sec	130	Maximum
Forced discharge time		min	15	Time until 60 V or less (set value)
Life		Years	10	40°C (ambient temperature), running 24 hours a day for 360 days

Note: The input capacity can be freely chosen by the combination of the AC/DC converter unit (200 kW), DC/DC converter unit (200 kW), and EDLC, which enables flexibility to respond to customer demands. Input capacity: Selectable between 200 to 1400 kW.

5. Conclusion

This document introduces the features of the peak power cut device “SANUPS K33A” made for driving large motors in large pressing machines and transport equipment.

In the future, we will advance developments of power converters that can help the customer.

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