

# Development of the *SANUPS C23A* Voltage Dip Compensator with Compliance with European Standards

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## 1. Introduction

In recent years, an increasing number of industrial equipment manufacturers in Japan have introduced semiconductor manufacturing facilities in China and other Asian countries. Taking unstable local power environments, these facilities often need to be combined with a voltage dip compensator and harmonic solution equipment.

Our existing product, the *SANUPS C23A* voltage dip compensator, can be used for such needs to reduce the initial cost and installation man-hours because, with its active filter, it can solve the voltage dip problem and harmonics problem in one unit. <sup>(1)</sup>

Furthermore, the equipment installed in the factories in China and other Asian countries has been increasingly required to have CE markings to comply with European safety standards.

To meet this need, we newly developed CE-compliant models of the *SANUPS C23A* voltage dip compensator and added them to the lineup. This article introduces the features of this new model.

## 2. Product Overview

The new models of the *SANUPS C23A* have capacities of 50, 100, and 200 kVA.

Figure 1 shows the appearance of the 200 kVA model, and Figure 2 shows the basic circuit block diagram of the *SANUPS C23A*.

The *SANUPS C23A* features a parallel processing topology and uses an electric double-layer capacitor (EDLC) as an energy storage device. The parallel processing topology supplies power to loads mainly via an AC switch. When it does this, the bi-directional inverter configures redundancy in parallel with the grid power and charges the EDLC while the active filter suppresses harmonic currents and corrects the input power factor. In other words, the grid power supplies power to the load, while

the bi-directional inverter supplies only the necessary power for the harmonic current suppression and input power factor correction. This significantly reduces power loss and makes a high-efficiency and high-quality power supply possible.

If the grid power fails, the *C23A* immediately isolates the grid power and continues supplying power from the bi-directional inverter without interruption. <sup>(1)</sup>



Fig. 1 *SANUPS C23A* (200 kVA model)

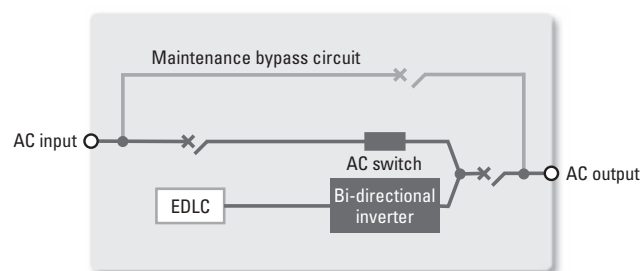


Fig. 2 Basic circuit configuration

## 3. Features

### 3.1 Compliance with international safety standards

The new models of the *SANUPS C23A* are compliant with European safety standards of the Low Voltage Directive

(2014/35/EU), EMC Directive (2014/30/EU), and RoHS Directive (2011/65/EU, (EU) 2015/863), with most of the features of the current models maintained. Therefore, they can be used in countries and companies that require CE marking.

In particular, the customers who have used the existing *SANUPS C23A* as a power supply for semiconductor manufacturing equipment in Japan can now use the same system overseas without the need to design or purchase a new power supply system.

### 3.2 Extended expected life

The expected life of the current models of the *SANUPS C23A* is 10 years. However, the new models have a longer expected life of 15 years with a new electrolytic capacitor and other components used. Components that last less than 15 years, such as the EDLC, fans, fuses, and electromagnetic contactors, are classified as periodic replacement parts, specifying the maintenance cost for customers who intend to use the product for 15 years.

### 3.3 Improved maintainability

The new models have an expected life of 15 years. However, as described in Section 3.2, this requires that some components be replaced periodically. For easy replacement work, we have revised the layout of components and the mounting structure. In addition, we also revised the electrolytic capacitor in the bi-directional inverter unit so that it would last for 15 years and require no replacement. This helped reducing the replacement time and costs.

EDLCs have a service life of about 10 years, so they would be subject to replacement. However, similar to lead-acid batteries, an EDLC remains charged with a certain voltage stored even after the power is disconnected. Replacing the EDLC in this state could cause an electric shock or short circuit. To prevent this and ensure safe EDLC replacement, we added the new models with a new function for discharging the EDLC. The EDLC discharge proceeds in two steps. The first step is shown in Figure 3 (1). This requires consuming the charge that remains in the EDLC so that it falls below a dangerous level (60 VDC). This is done by using the bi-directional inverter's no-load loss that results from switching the bi-directional inverter. The second step is shown in Figure 3 (2). This requires connecting a resistor to the EDLC discharge circuit breaker after stopping the unit, and then turning on the circuit breaker to discharge the EDLC to almost no voltage. After these steps, technicians can safely and quickly replace EDLCs and perform necessary maintenance work.

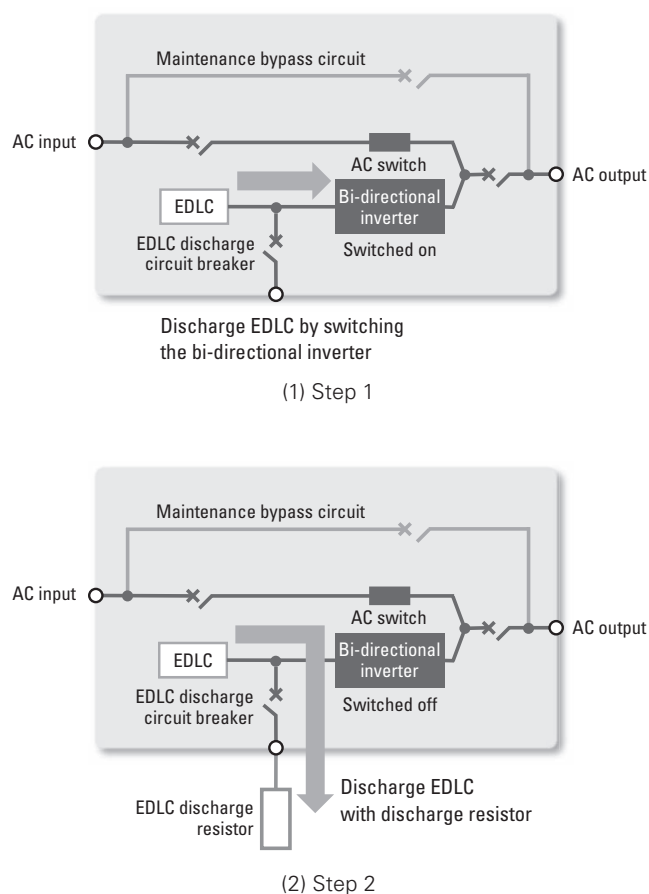


Fig. 3 Self-discharge of EDLC

### 3.4 Dimensions

Table 1 compares the dimensions of the new *SANUPS C23A* models with current models. For the new models, we added a circuit to conform to the EMC Directive and secured insulation by providing more clearance between components to conform to the Low Voltage Directive. Although the new 200 kVA model has a 100 mm longer width than that of the current 200 kVA model, we managed to maintain the dimensions of our current models for 50 and 100 kVA capacities by revising the component layout and other efforts. This means that the current models can easily be replaced with the new models.

Table 1 Dimensions

Output capacity	Model no.	Size (width × depth × height) Unit: mm
50 kVA	C23A503C (New model)	750 × 700 × 1775
	C23A503 (Current model)	750 × 700 × 1775
100 kVA	C23A104C (New model)	1050 × 800 × 1950
	C23A104 (Current model)	1050 × 800 × 1950
200 kVA	C23A204C (New model)	1650 × 800 × 2075
	C23A204 (Current model)	1550 × 800 × 2075

## 4. Specifications

Table 2 shows the electrical specifications of the new product.

Table 2 Electrical specifications

Items		Model no.	C23A503C	C23A104C	C23A204C	Remarks	
Rated output capacity	Apparent power		50 kVA	100 kVA	200 kVA		
	Active power		40 kW	80 kW	160 kW		
Enclosure type		Steel-sheet free-standing enclosure (Ingress protection rating: IP2X)					
Topology		Parallel processing					
Cooling system		Forced air cooling					
Energy storage device		Electric double-layer capacitor (EDLC)					
AC input	No. of phases/wires		3-phase 3-wire				
	Rated voltage		200/210/220 V				
	Rated frequency		50/60 Hz				
	Current harmonic distortion compensation	Compensation capacity		Within rated capacity			
		Harmonic current		85% or higher compensation			At 100% rectifier load
		Compensation order		2nd to 20th harmonics			
Input power factor		0.98 or greater			At rated output		
AC output	No. of phases/wires		3-phase 3-wire				
	Rated voltage		200/210/220 V				
	Voltage regulation	In grid operation		Within -8 to +10% of rated voltage		User-selectable	
		In capacitor operation		Within $\pm 2\%$ of rated voltage		(1)	
	Rated frequency		50/60 Hz				
	Frequency regulation	In grid operation		Within $\pm 4\%$ of rated frequency			
		In capacitor operation		Within $\pm 0.1$ Hz of rated frequency		(1)	
	Load power factor	Rated		0.8 (lagging)			
		Fluctuation range		0.7 to 1.0 (lagging)		(2)	
	Voltage harmonic distortion (In capacitor operation)	At linear load		2% or less			
		At rectifier load		5% or less			
	Voltage unbalance (In capacitor operation)		2% or less			With a load of 1/3 the total capacity on one line	
	Transient voltage fluctuation (In capacitor operation)	Fluctuation		Within $\pm 5\%$			
		Settling time		50 ms or less			
	Overload capability (Bypass circuit)		200% (for 30 s), 800% (for 0.5 s)				
Overcurrent protection		The inverter shuts down at 110% of the rated output, then the grid power will be supplied by bypass. When the current falls equal to or below the rated current, the inverter will automatically start up for normal operation.					
Transfer time to capacitor operation		0 s (No interruption)					
Dip compensation time		1 s or more (At rated load)			(3)		
Initial charging time		Within 60 s			Capacitor voltage from 0 to 100%		
Recharging time		Within 10 s			After compensating for a 1-second voltage dip		
Acoustic noise		65 dB or less			A-weighting, at 1 m from front of unit		
Heat dissipation		2.6 kW	5.1 kW	10.2 kW	At rated output, after battery charging completed <sup>(4)</sup>		
Operating environment		Ambient temperature: 0 to 40°C Relative humidity: 30 to 90% (non-condensing)					
Standards		CE (Low Voltage Directive, EMC Directive): EN 62040-1, -2, RoHS Directive					

(1) When switched to the capacitor operation with the rated input voltage and rated frequency; indicates the performance of the inverter.

(2) In continuous operation

(3) At the rated load level, a load power factor of 0.8 lagging and 25°C ambient temperature.

(4) Calculated with a load power factor of 0.8.

## 5. Conclusion

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This article introduced the features of our new CE-marking compliant models of the *SANUPS C23A* voltage dip compensator.

Compared to the current models, the new models have the following added advantages:

- (1) Compliance with the following European safety standards: the Low Voltage Directive, EMC Directive, and RoHS Directive
- (2) Extended service life and improved maintainability

With these advantages, the new models can meet the needs of customers who require CE marking compliance for use in Asia and Europe. In addition, they can reduce the initial investment and maintenance costs for these customers.

Moving forward, we will continue to keep up with the needs of customers to swiftly develop products that can satisfy them.

### References

- (1) Shoichi Ota and 7 others: Development of the High Performance Voltage Dip Compensator *SANUPS C23A*  
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