



Automation for a Changing World

Delta Active Power Filter APF2000 Series



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 **DELTA**
Smarter. Greener. Together.

Active Power Filter APF2000 Series

Advanced Power Quality Improvement Solution

Delta Active Power Filter APF2000 Series is your key to a clean grid for more efficient production. It adopts the industry's highest standard 32-bit digital microprocessor to instantly compensate for all types of harmonics for ultimate power quality improvement.

The APF2000 is compact in design and provides flexible installation methods for users to efficiently manage their space. It is also mounted with Delta's 65,536-color TFT HMI for more realistic images and a vivid display. Delta's APF2000 is the best solution for harmonic distortion, voltage and current distortion, reactive power loss and load imbalances. Improve your power quality and lower your energy loss and maintenance costs with the Delta Active Power Filter APF2000 Series.





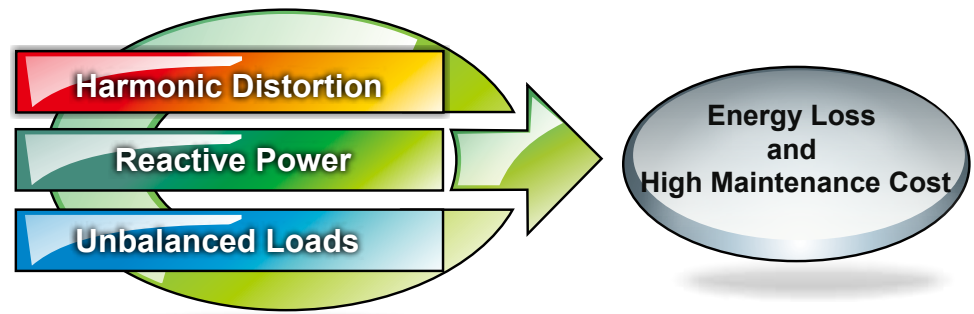


Overview of Power Quality Improvement

Power Quality - the Major Influence on Power Efficiency

Modern automation equipment benefits us with greater convenience as well as cost savings from higher production efficiency. However, it can also bring significant wave distortion problems to the power grid that can lead to energy loss, increasing costs and many other power quality issues.

A clean and efficient power system normally generates a sinusoidal current waveform, but the electric equipment used in today's industrial automation industry generates non-sinusoidal currents that tend to cause many power quality problems. Voltage or current distortion, reactive power impact, and unbalanced loads, are common problems that lower power reliability and power efficiency and also increase operation costs. Major concerns in the industrial automation industry are how to improve power quality and how to manage power grids.



Harmonic Interference Increases Operation Cost

- ▶ Traditional reactive power compensation capacitance devices have a high chance of overloading that may burn out chips or create a fire hazard.
- ▶ High order harmonic distortion may cause the overheating of electric cables and copper bars, and eventually wear off the insulation and shorten equipment lifespan.
- ▶ Excess harmonic peak voltage may break through the equipment's input module and decrease operation reliability.
- ▶ Excess harmonics may cause the malfunction of low and mid power systems and also interfere with communication systems.
- ▶ Harmonic interference can cause load imbalances which would lead to operation safety problems.
- ▶ A large amount of zero sequence current in the system causes neutral current to over-peak. In certain single phase load applications, neutral current might exceed phase line current and cause serious overload failure.



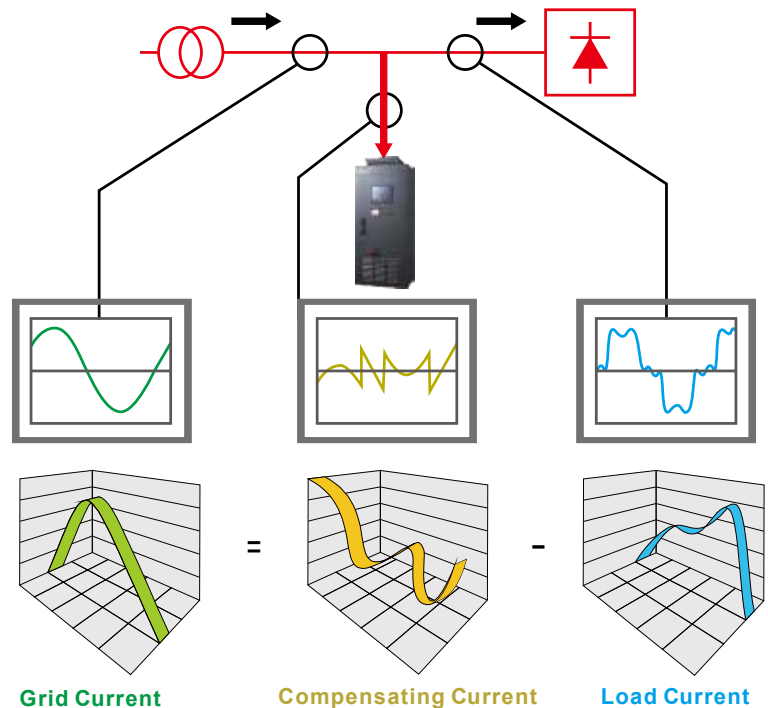
Reactive Power Compensation and Load Balance Increases Power Efficiency

- ▶ Improves reactive power to meet the standard limit and avoid penalties
- ▶ Increases power factor to improve power efficiency
- ▶ 3-phase energy balancing to decrease energy waste
- ▶ Lower system current avoids overheating of inverters, copper bars and cables

Active Power Filter Concept

The Delta Active Power Filter APF2000 Series is a power filter device that can monitor load current and filter harmonics in real-time to maintain a linear current. Using a current transformer to monitor the real-time load current, the APF2000 injects the exact opposite phase to the network of components that are to be filtered.

It can also provide leading and lagging reactive current in real-time to improve the power factor and compensate reactive power.



Applications

- **Metallurgy and petrochemicals industries:**
Rectifier, converter, rolling mill, electric arc furnace, medium frequency furnace, inverter
- **Chemical and electrolysis industries:**
Rectifier, calcium carbide furnace, electric soldering, inverter
- **Mechanical industries:**
Rectifier, rolling mill, inverter, electric arc equipment
- **Metal, paper, plastic processing and textile industries:**
Rectifier, rolling mill, inverter, electric arc furnace, electric furnace
- **Transportation industries:**
Rectifier and inverter of electric vehicles, electric motorcycles and metro systems
- **Automobile manufacturing industry:**
Soldering equipment, car painting equipment, battery charger and inverter
- **Telecommunication, medical and construction industries:**
Server station, EPS, UPE, converter, charger, inverter



APF2000 System Structure



■ APF2000 Flexible Control Panel

- 7" HMI TFT LCD 65536 Color (800 x 600)
- Real-time and continuous monitoring of grid data and 3-phase wave form
- 100 sets of error records
- Data logging and export
- USB Host and plug-in USB disk
- Supports SD card
- Monitoring, control, and management via Ethernet

■ Optimized Ventilation Design

- Modular fan design
- Continuous variable transmission (CVT) fan
- Highly efficient heat pipe ventilation system

■ Modularized Hardware Design

- Easy-to-assemble power factor module
- Digital signal integrated circuit board
- Plug-in capacitance module

■ Digital Signal Processing (DSP) Control

- Filter self diagnosis
- Intensified overloading protection
- Innovative PWM variation technology
- Multi-functional programmable digital input / output terminals

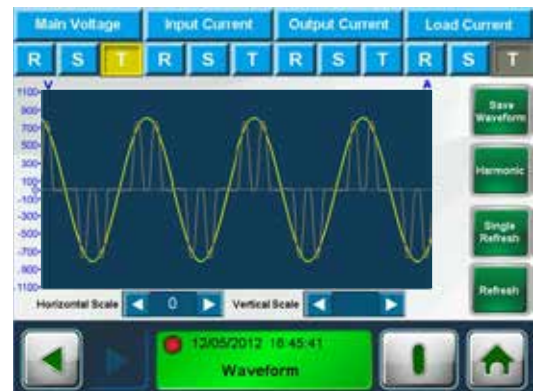
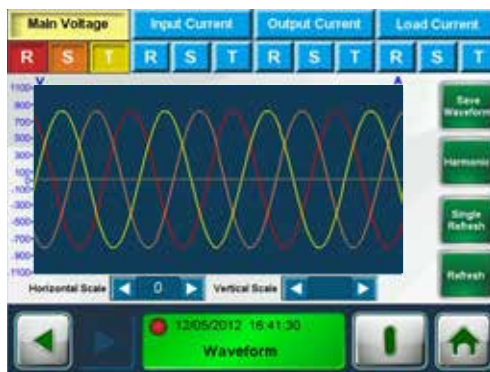
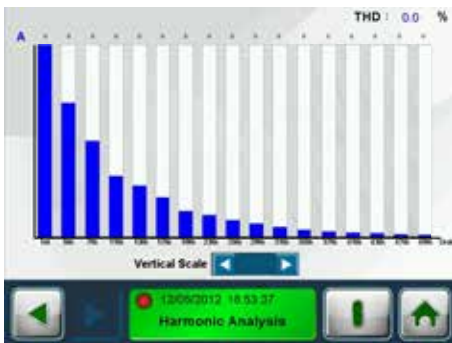
■ Standard Power Input with Hardware Protection *

*Optional insulation fuse switch or non-fuse breaker

■ Built-in High Voltage Lightning Protection Module



APF2000 Power Quality Improvement System



Quick Start Wizard

Quick and simple set up with one-press, easy installation step-by-step



Data Logging

Records 9 sequential history data, easy to export to SD card or USB disk



Waveform Display

Displays and analyzes up to 12 wave and harmonic forms synchronously and real-time monitoring of the power quality status



System Setting

Communication type / Operating mode / Alarm level / Multi-functional output terminal



Advanced Functions

Access control for different users and advanced settings for different applications

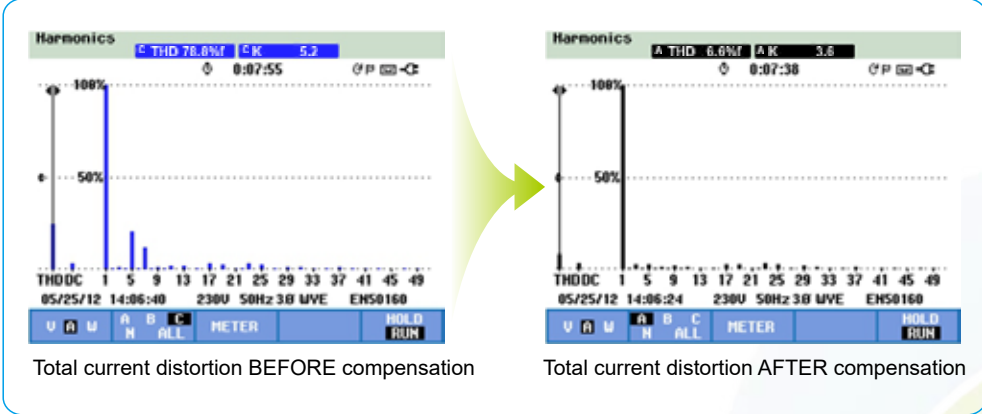


System Status

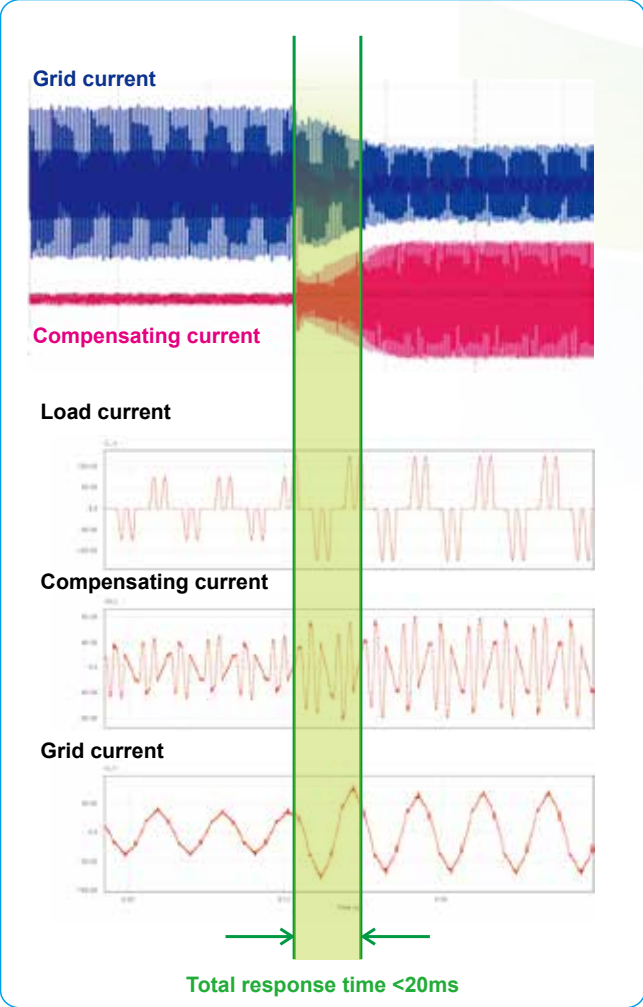
Review error / maintenance records and self-diagnosis function to check basic settings and hardware

APF2000 Features

Excellent Filtering Results



Real-time Response and Current Compensation



Compensation to Current, Harmonics and Power Factor

Features	Harmonics Compensation	Reactive Power Compensation	Note
Full Compensation	█	█	Under all operation modes, the "Unbalanced Compensation" functions compensate unbalanced loads ^{*1}
Harmonic Compensation	█	█	
Reactive Power Compensation	█	█	

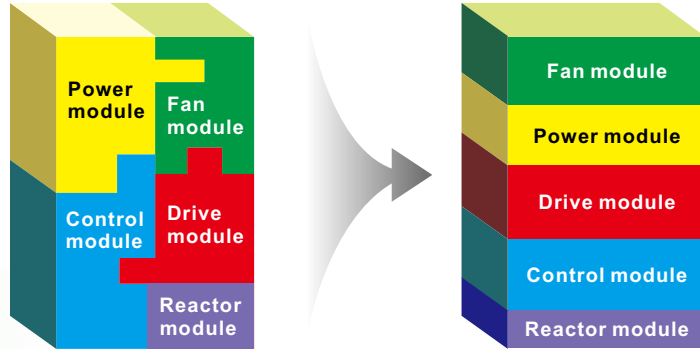
Compensation priority: █ > █ ; No Compensation: █

*1 Verified derating ratio for different unbalanced loads. Please contact technical engineers of Delta or distributors in your region.



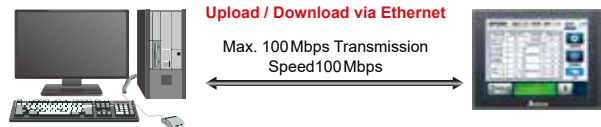
Advanced Modular Design

- Safe, reliable, labor-saving



High-speed Network, Remote Monitoring and Control

- Built-in RS-485 protocol
- Provides diversified communication network and optional fieldbus card



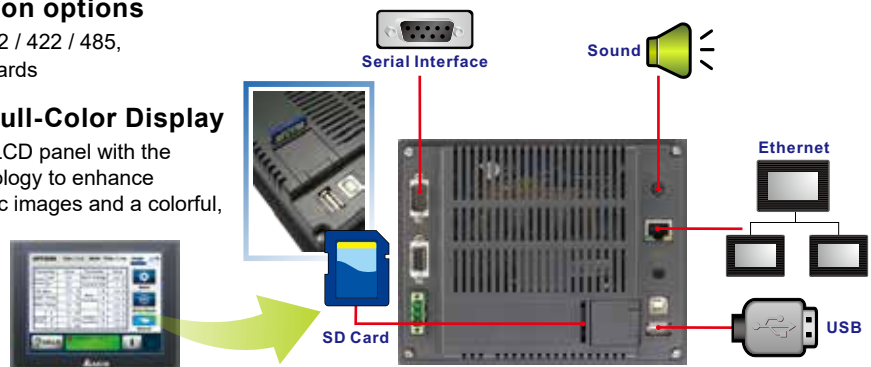
-
- CANopen (DS301)
- DeviceNet
- MODBUS TCP



Remote monitoring and control anywhere, anytime!

Excellent Operation Interface

- Diversified extension options
Supports Ethernet, RS-232 / 422 / 485, USB disk drives and SD cards
- High Quality and Full-Color Display
Adopts 65,536 color TFT LCD panel with the newest 2D drawing technology to enhance resolution for more realistic images and a colorful, vivid display

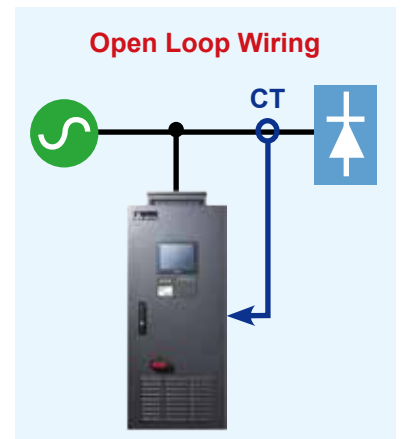
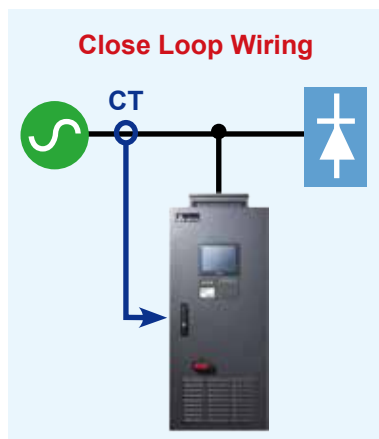


Filter Comparison Chart

Features	Active Power Filter	LC Passive Filter	TSF Switching Passive Filter
Operation and Maintenance	Easy-to-use touch panel	Simple and convenient	Complex
Harmonic Compensation	Up to 50 th order harmonics	Only for certain order of harmonics	
Harmonic Filtering Effect	95% and above	Up to 50~80%, corresponding to system impedance	
Dynamic Harmonics Compensation	Strong compensation ability	No compensation	Only to certain order of harmonics
Harmonics Filtering with Reactive Power Compensation	Simultaneously smooth and adjustable reactive power output	Fixed reactive power output	Reactive power compensation for different order of harmonics
		Reactive power compensation doesn't match filtering requirement	
Characteristic of Reactive Power Compensation	Lagging or leading reactive power	Usually leading reactive power only	
Unbalanced Load Compensation	Yes	N/A	Yes
Dynamic Filtering Responding Speed	Fast (300 μ s~1 ms)	N/A	Slow: ~100 ms
Overload	Auto current limit protection to prevent equipment from overload	No protection. Possible damage may occur when the amount of harmonic current exceeds the system rated capacity	
Grid Impedance Analysis before Model Selection	No need	Yes. Grid independence analysis required to prevent harmonics exaggeration	
Filtering Effect Influenced by System Impedance Changes	No	Yes. System overvoltage or overcurrent may occur due to harmonic current resonance at certain frequencies	
System Resonance Suppression Ability	Yes	No	
Capacity Expansion	Yes, via parallel connection	Difficult, parallel or serial connection may impact filtering effect and reactive power output capacity	

Open / Close Loop Wiring

- Current transformer (CT) can be installed at both power side or load side to monitor real-time harmonics or reactive power
- CT installed at the load side for highest response speed; CT installed at the power side for precise harmonic and reactive power compensation



APF2000 Series Applications

Concentrated control

- **APF input terminal:** 10 KV at transformer input side
- **Product:** APF2000 Series
- **Harmonic current improvement:** THDI<5% : THDU<3%
- **Power factor:** >0.96

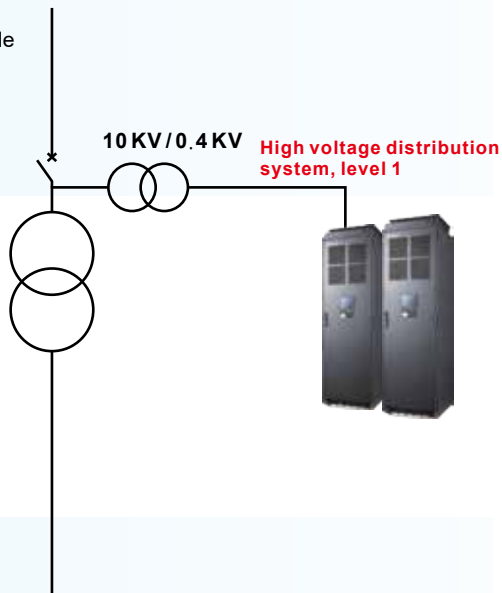
Main electricity distribution system

Transformer



10 KV / 0.4 KV

High voltage distribution system, level 1



Low pressure concentrated control

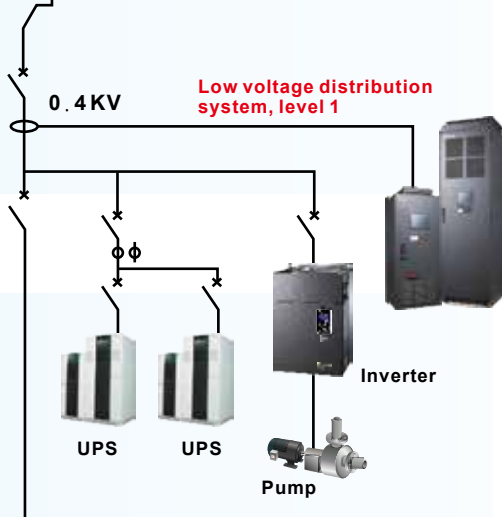
- **APF input terminal:** at transformer input side
- **Product:** APF2000 Series
- **Harmonic current improvement:** THDI<5% : THDU<3%
- **Power factor:** >0.96

Low voltage distribution system



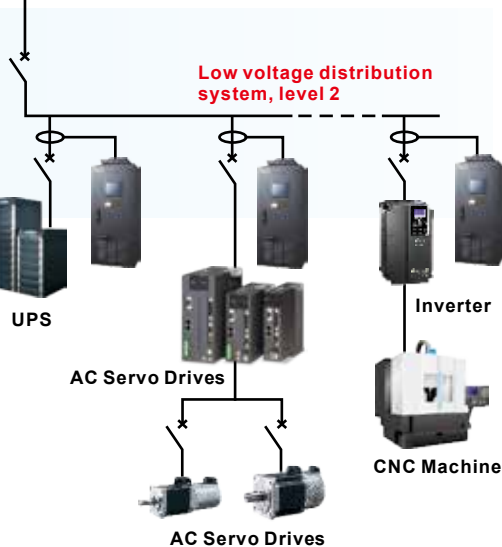
0.4 KV

Low voltage distribution system, level 1



Area control

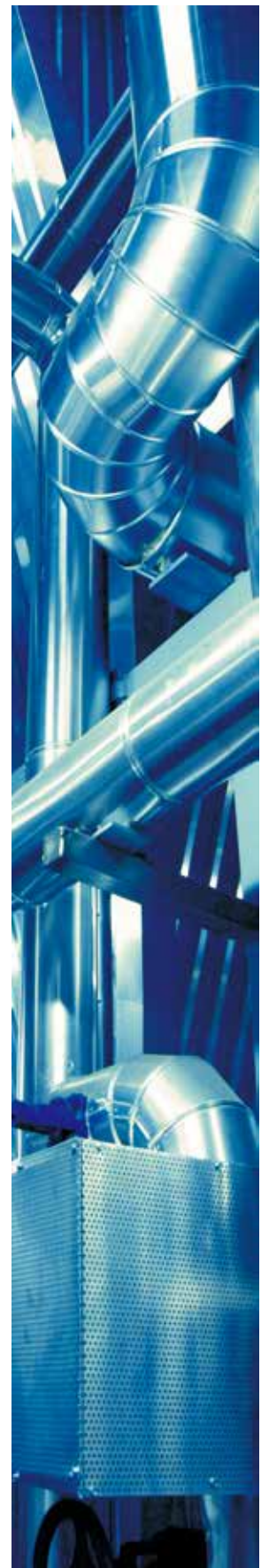
- **APF input terminal:** at a different area or floor, near AC main power switch
- **Product:** APF2000 Series
- **Harmonic current improvement:** THDI<5% : THDU<3%
- **Power factor:** >0.96



Terminal control

- **APF input terminal:** install between the equipment and power supply
- **Product:** APF2000 Series
- **Harmonic current improvement:** THDI<5% : THDU<3%
- **Power factor:** >0.96

Control room and power distribution system



Specifications

Model APF__A43X-31	APF050A43X-31	APF100A43X-31	APF200A43X-31	APF300A43X-31
Rated Compensation Current	50A	100A	200A	300A
Rated Voltage	200 V ~ 480 V			
Voltage Tolerance	-10% ~ +10%			
Wiring	3-phases 3-wire*2			
Grid Frequency	50 Hz or 60 Hz			
Frequency Tolerance	-5% ~ +5%			
Cooling Method	Force Air Cooling (Fan Cooling)			
Current Transformers Ratio (CT Ratio)	50: 5 to 10, 000: 5			
Power Loss	<1500 W	<2800 W	<6000 W	<9000 W
Noise Level (ISO 7779)	63 dBA	68 dBA	70 dBA	70 dBA
Cable Entry	Bottom	Bottom	Bottom/Top	
Installation Method	Wall-mounted	Wall-mounted	Cabinet	
Dimensions (W x H x D mm)	A*1	370x590x311	423x1101x440	630x2130x656
	B*1	370x590x345	445x1101x440	630x2130x680
Weight (kg)	50 kg	90 kg	350 kg	370 kg
Enclosure Rating	IP31 (NEMA1)	IP31(NEMA1)		
International Certifications	CE, UL, cUL, C-Tick			

*1 A=APFXXXA43A, B=APFXXXA43B

*2 Supports 3-phases 4-wire system, but no compensation to neutral point (N)

Technical Specifications

Step Response Time	<300 μs
Step Response Time	<20 ms
Carrier Frequency	15 kHz
Harmonic Compensation	2 nd to 50 th Harmonic
Harmonic Compensation Ratio	≥95%
Parallel Configuration	2 ~ 6 units
Human Machine Interface	65535 Colors 7" Touchscreen
Data Storage	USB Drive, SD Card
Communication Port	RJ45 (Ethernet), D-Sub (RS-232), RJ45 (RS-485)
Communication Protocol	MODBUS, MODBUS TCP *Optional: DeviceNet, PROFIBUS, CANopen

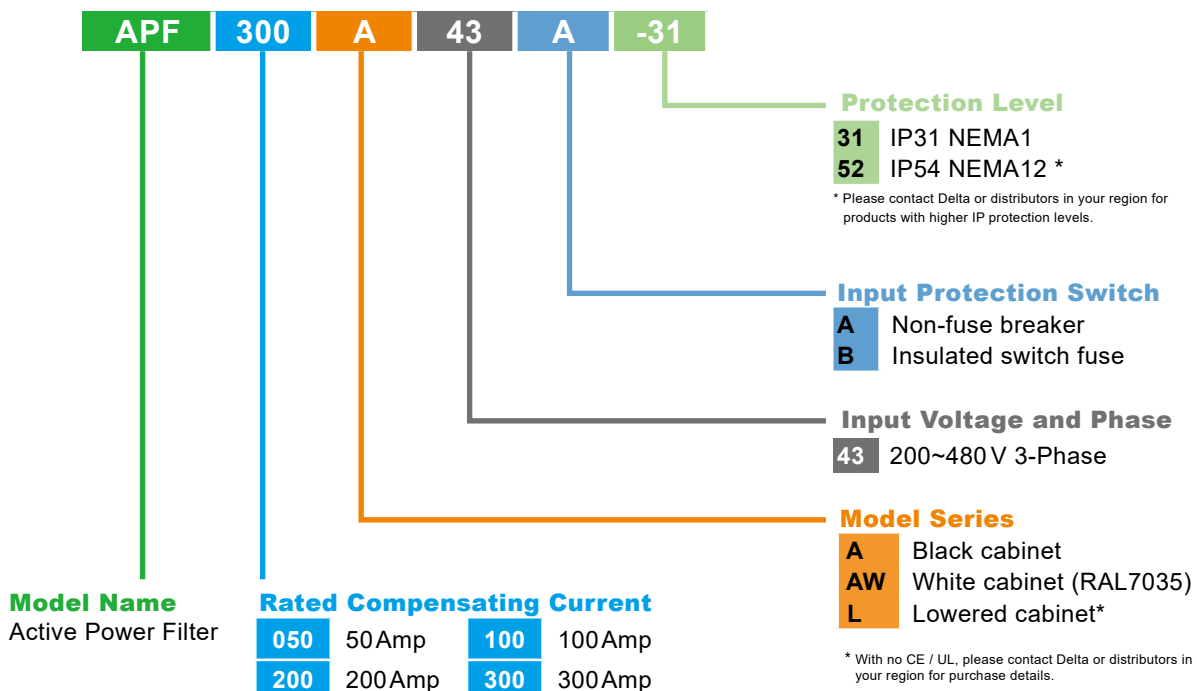


Environment for Operation, Storage and Transportation

Ambient Temperature	-10°C ~ +45°C	
Installation Location	IEC60364-1/IEC60664-1 Pollution degree 2, indoor use only	
Surrounding Temperature	Storage / Transportation	-25° C ~ +70° C
	Non-condensation, non-frozen	
Rated Humidity	Operation	Max. 90%
	Storage / Transportation	Max. 95%
	Non-condensation, non-frozen	
Atmosphere pressure	Operation / Storage	86 to 106 kPa
	Transportation	70 to 106 kPa
Pollution Level	IEC60721-3-3	
	Operation	Class 3C2; Class 3S2
	Storage	Class 2C2; Class 2S2
	Transportation	Class 1C2; Class 1S2
	Non-condensation, non-frozen	
Altitude	0 - 1000 m : rated capacity usage	
	1000 - 3000m: when above 1000 m, decreases 2% rated current or lowers 0.5°C every 200m increase in altitude	

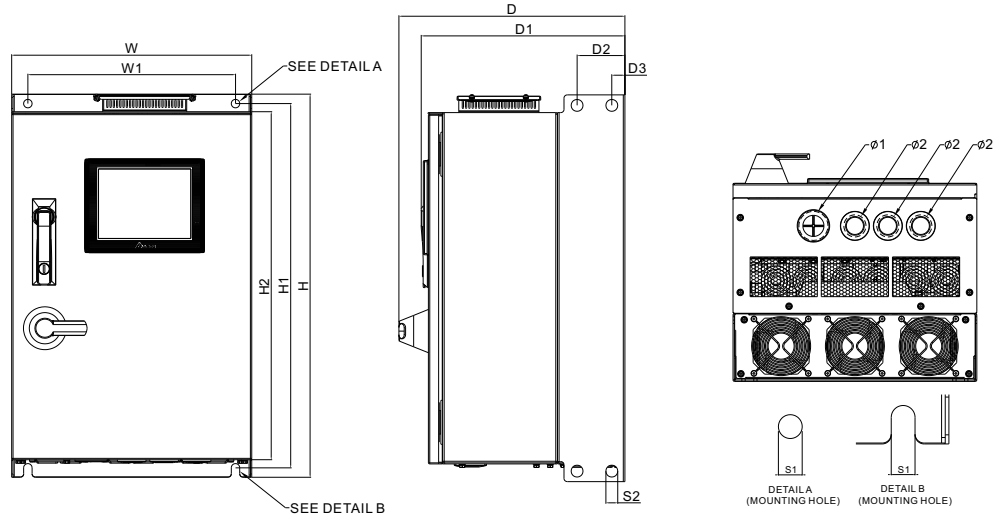
DO NOT expose the Active Power Filter to harsh environments with pollution-carrying materials such as dust, direct sunlight, corrosive / inflammable gasses, humidity, liquid or vibration. The salt in the air must be less than 0.01mg/cm² per year, or users require cabinets with higher IP protection level for the APF.

Model Name



Dimensions

Frame A

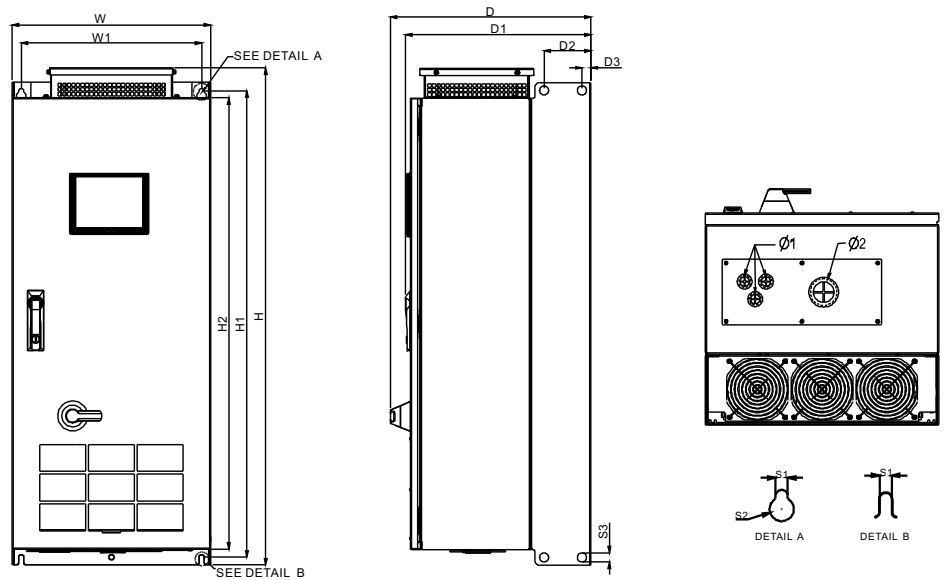


MODEL

APF050A43A-31
APF050A43B-31

Frame		W	H	D	W1	H1	H2	D1	D2	D3	S1	S2	Ø1	Ø2
APF050A43A-31	mm	370.0	590.0	-	320.0	561.0	536.0	311.0	73.0	20.0	13.0	18.0	44.0	33.5
	inch	14.57	23.23	-	12.60	22.09	21.10	12.24	2.87	0.79	0.51	0.71	1.73	1.32
Frame		W	H	D	W1	H1	H2	D1	D2	D3	S1	S2	Ø1	Ø2
APF050A43B-31	mm	370.0	590.0	345.0	320.0	561.0	536.0	311.0	73.0	20.0	13.0	18.0	44.0	33.5
	inch	14.57	23.23	13.58	12.60	22.09	21.10	12.24	2.87	0.79	0.51	0.71	1.73	1.32

Frame B

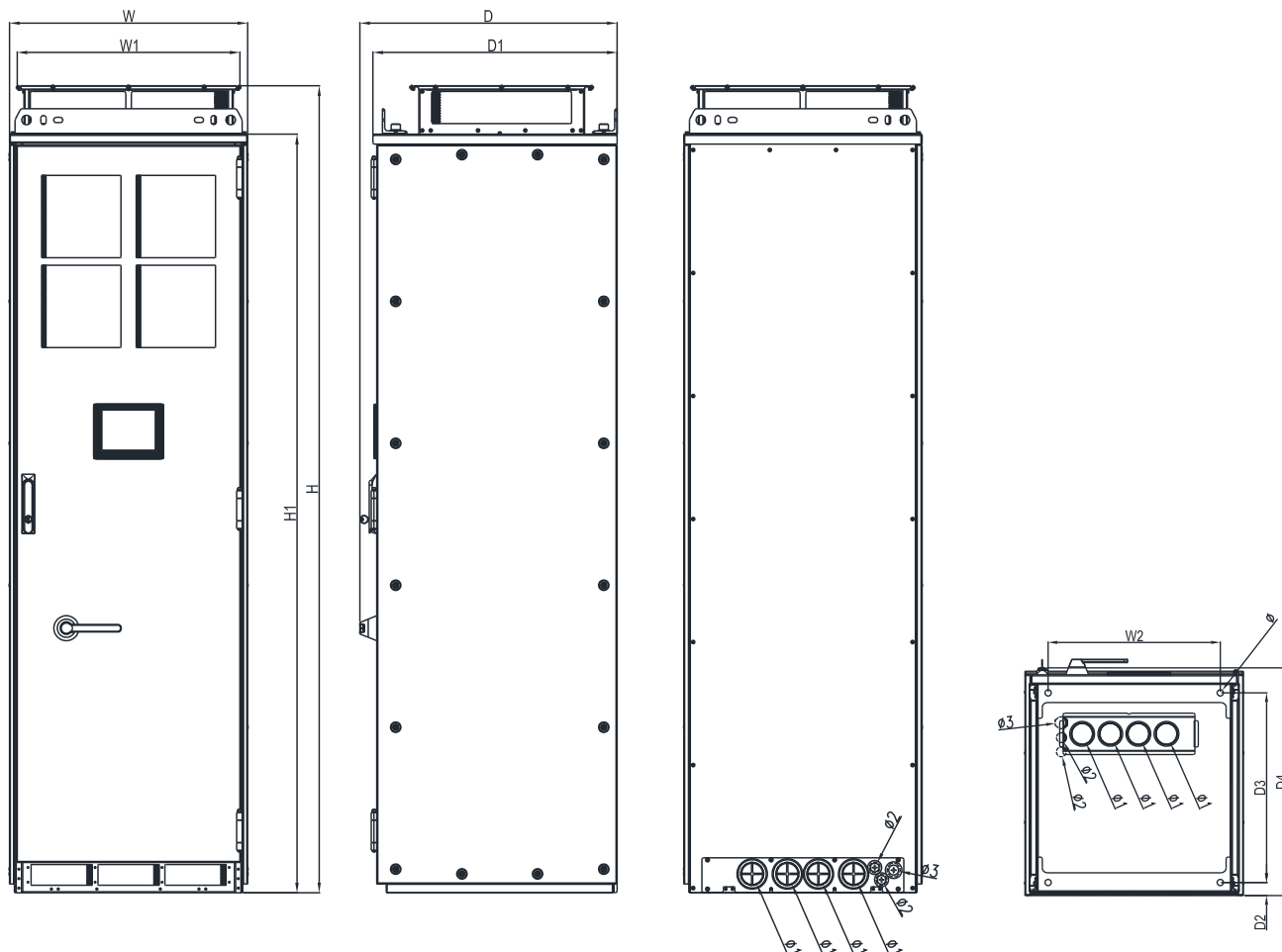


MODEL

APF100A43A-31
APF100A43B-31
APF100A43A-52
APF100A43B-52

Frame		W	H	D	W1	H1	H2	D1	D2	D3	S1	S2	S3	Ø1	Ø2
APF100A43A-31 APF100A43A-52	mm	440.0	1101.0	-	400.0	1033.0	1000.0	411.0	104.0	20.0	11.0	22.0	20.0	22.2	50.0
	inch	17.32	43.35	-	15.75	40.67	39.37	16.18	4.09	0.79	0.43	0.87	0.79	0.87	1.97
Frame		W	H	D	W1	H1	H2	D1	D2	D3	S1	S2	S3	Ø1	Ø2
APF100A43B-31 APF100A43B-52	mm	440.0	1101.0	445.0	400.0	1033.0	1000.0	411.0	104.0	20.0	11.0	22.0	20.0	22.2	50.0
	inch	17.32	43.35	17.52	15.75	40.67	39.37	16.18	4.09	0.79	0.43	0.87	0.79	0.87	1.97

Frame C



MODEL

APF200A43A-31	APF200AW43A-31
APF300A43A-31	APF300AW43A-31
APF200A43B-31	APF200AW43B-31
APF300A43B-31	APF300AW43B-31

Frame		W	H	D	W1	W2	H1	D1
APF200A43A-31 APF300A43A-31	mm	630.0	2130.0	-	588.4	496.0	2000.0	645.6
	inch	24.80	83.86	-	23.16	195.53	78.74	25.42
		D2	D3	D4	Ø	Ø1	Ø2	Ø3
	mm	37.4	546.0	656.0	18.0	61.0	28.0	34.0
	inch	1.47	21.5	25.83	0.71	2.40	1.10	1.34
Frame		W	H	D	W1	W2	H1	D1
APF200A43B-31 APF300A43B-31	mm	630.0	2130.0	680.4	588.4	496.0	2000.0	645.6
	inch	24.80	83.86	26.79	23.16	195.53	78.74	25.42
		D2	D3	D4	Ø	Ø1	Ø2	Ø3
	mm	37.4	546.0	656.0	18.0	61.0	28.0	34.0
	inch	1.47	21.5	25.83	0.71	2.40	1.10	1.34

Accessories

▪ Current transformer

Delta's Active Power Filter requires 3 current transformers (or CT), which use the rated frequency for standard transformers of 400Hz (precision better than 1%); CT's rated output value must be 5A. Users can select a suitable CT from table 3-1 CT model selection to install.

▪ Notes on CT model selection:

- (1) Be aware of the installation direction of CTs. The phase sequence of CT detection signals (K, L) cannot be swapped, the Active Power Filter must use 3 CT's in three-phase three-wire devices, installed separately in R-phase, S-phase, and T-phase. The arrows point towards load. The 3 CT's must all be in the same direction, any fixed in the wrong direction will lead to errors in the detection of current values.
- (2) The ratio of rated primary/secondary current must be selected reasonably, the recommended primary current is 1.2-times (actual rated current).
- (3) The primary/secondary isolation voltage is 0.66V; select 5A as the secondary current.

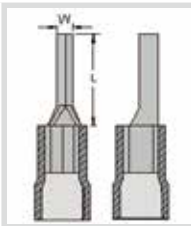
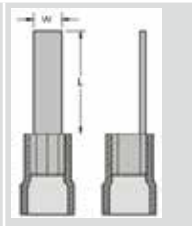
Mode	Current Ratio (A)* 1	Primary Current (A)	Secondary Output Power (VA)	Accuracy	Dimension Code	Dimensions (L x W x D mm)	
CT-A0300	300A / 5A	300	2.5VA	1%	A	Outer frame	115x110x46
						Inner frame	51x50x32
CT-A0600	600A / 5A	600	5VA	1%	A	Outer frame	115x110x46
						Inner frame	51x50x32
CT-B0300	300A / 5A	300	5VA	0.50%	A	Outer frame	155x110x46
						Inner frame	51x50x32
CT-B0600	600A / 5A	600	5VA	0.50%	B	Outer frame	155x110x46
						Inner frame	90x50x32
CT-B0800	800A / 5A	800	5VA	0.50%	B	Outer frame	155x110x46
						Inner frame	90x50x32
CT-B1000	1000A / 5A	1000	5VA	0.50%	B	Outer frame	155x110x46
						Inner frame	90x50x32
CT-C0300	300A / 5A	300	5VA	1%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C0500	500A / 5A	500	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C0800	800A / 5A	800	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C1000	1000A / 5A	1000	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C1200	1200A / 5A	1200	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C1500	1500A / 5A	1500	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C1800	1800A / 5A	1800	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C2500*2	2500A / 5A	2500	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-D1200	1200A / 5A	1200	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32
CT-D1500	1500A / 5A	1500	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32
CT-D1800	1800A / 5A	1800	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32
CT-D2000	2000A / 5A	2000	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32
CT-D3000	3000A / 5A	3000	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32

*1. When selecting CT's, pick the model with current closest to the actual primary current value (peak rms current). For example: select model CT-A0300 if the actual current is 280A. The same logic applies to the rest.

*2. All models are UL certified EXCEPT for model CT-C2500.

▪ Current Transformer

(4) Crimp terminal connectors must be used for CT's terminal lines, and securely tightened K(S1), L(S2) terminal wirings

Terminal:	K1,L1, K2,L2, K3,L3,	
Wire diameter	24 ~ 10 AWG	
Applicable terminal block (used with figure 3-1 position A)	Pin Insulated terminal	Blade Insulated terminal
	 W: 2.7 mm L: 14 mm	 W: 2.8 mm L: 10 mm

(5) The CT cable length is limited; cables that are too long will cause the CT to decrease in accuracy.

(6) When installing multiple parallel units, the length of each CT cable must be identical.

▪ CT Cable Selection

Wire Gauge (mm ² /AWG)	Impedance (Ω)	Cable Length (Meters/Feet)	Minimum Load required by CT (VA)	Recommendation
4/#12	2.1	50/164	> 6.3	10VA
6/#10	3.4	50/164	> 4.2	7.5VA

▪ Range of Cable Length

The formula for the CT's fixed maximum load is: cable length (M) = [(VA)-1.25] / [25*(ohm/M)] (VA): 25*(ohm/M)* M+1.25; (ohm/M): impedance

Wire Gauge (mm ² /AWG)	Impedance (Ω)	Cable Length (Meters/Feet)	Minimum Load required by CT (VA)
6/#10	3.4	< 44 m/147	5
6/#10	3.4	< 73 m/243	7.5
6/#10	3.4	< 102 m/340	10
6/#10	3.4	< 161 m/537	15
6/#10	3.4	< 338 m/1127	30
4/#12	5.1	< 29 m/97	5
4/#12	5.1	< 49 m/163	7.5
4/#12	5.1	< 68 m/227	10
4/#12	5.1	< 107 m/357	15
4/#12	5.1	< 225 m/750	30

Regulation Standards

International Standards		China National Standards
IEEE519-1992	IEC/EN61000-2-2	GB/T14549-93 (Quality of Electric Energy Supply Harmonics in Public Supply Network)
IEC/EN61000-3-12	IEC/EN61000-3-3	SD 126-84 Power System Harmonic Management Interim Provisions
IEC/EN61000-3-4	IEC/EN61000-2-4	Grid Adjustment Management Regulations
IEC/EN61000-3-2	TOR D2	
G5/4	D-A-CH-CZ	

Ordering Information

Frame Size	Power Range	Models
Frame A 	460V: 50A	APF050A43A-31 APF050A43B-31
Frame B 	460V: 100A	APF100A43A-31 APF100A43B-31 APF100A43A-52 APF100A43B-52
Frame C 	460V: 200A ~ 300A	APF200A43A-31 APF300A43A-31 APF200A43B-31 APF300A43B-31



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