



Digitized Automation for a Changing World

Delta Active Power Filter APF2000 Series



PLC1

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 **DELTA**
Smarter. Greener. Together.

Active Power Filter APF2000 Series

Advanced Power Quality Improvement Solution

Delta's 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.





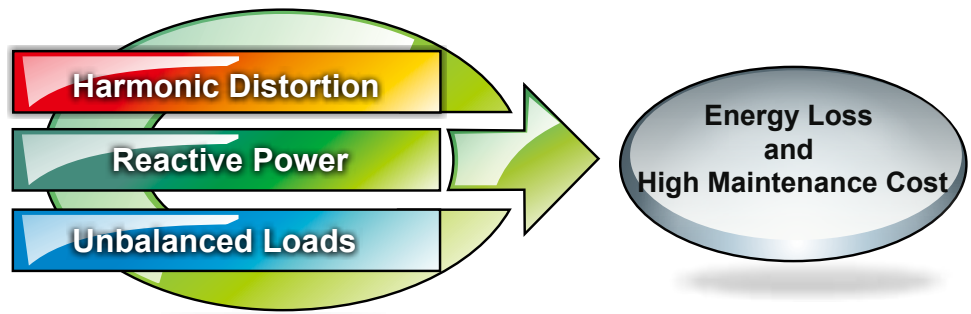


Overview of Power Quality Improvement

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

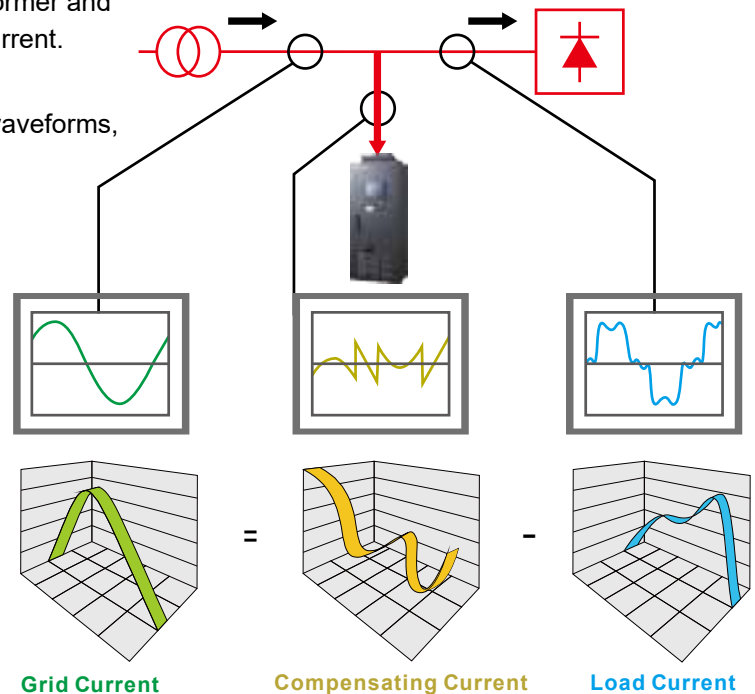
- ▶ Improves reactive power to meet the standard limit and avoid penalties
- ▶ Increases power factor to improve power efficiency
- ▶ 3-phase energy balancing to decrease energy waste
- ▶ Lower apparent current of the system avoids overheating of inverters, copper bars and cables

Active Power Filter Concept

Delta's Active Power Filter APF2000 Series are power filter devices that monitor the load current with a current transformer and filter harmonics in real time to maintain a linear current.

Using the current transformer to detect 3-phase waveforms, the APF2000 Series provides opposing currents to eliminate harmonics after it analyzes the harmonics and reactive power.

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:**
Rail transit such as subway, train, metro / Mass Rapid Transit (MRT), high-speed rail
- **Automobile manufacturing industry:**
Soldering equipment, car painting equipment, battery charger and inverter
- **Telecommunication, medical and construction industries:**
Server station, UPS, 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 logs export & management
- USB host and plug-in USB disk
- Supports SD cards

■ 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



Power Quality Improvement System



■ Quick Start Wizard

Step-by-step easy installation

■ Data Logging

9 sequential history logs exportable to SD cards or USB disk drives as CSV files

■ Waveform Display

Synchronously displays and analyzes up to 12 waveforms & harmonics and real-time monitoring of power quality status

■ System Setting

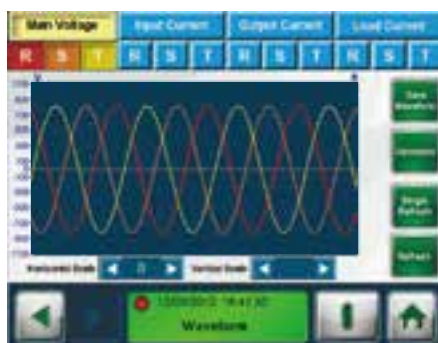
Communication type / Operating mode / Alarm level / Multi-functional output terminal

■ Advanced Functions

Access control for different users and advanced settings for different applications

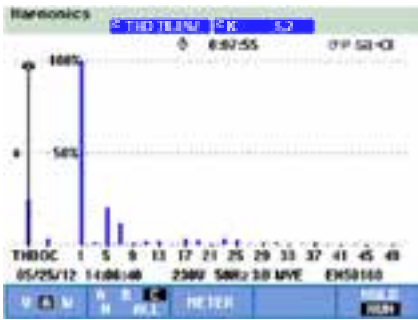
■ System Status

Inquiries of anomalies / maintenance records and system self-diagnosis for general settings and hardware examination

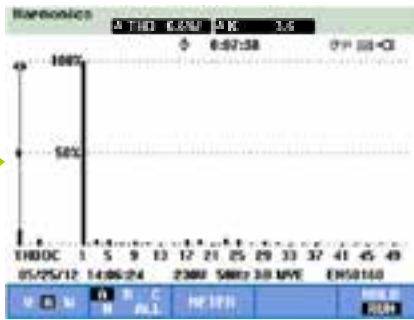


APF2000 Features

Excellent Filtering Results

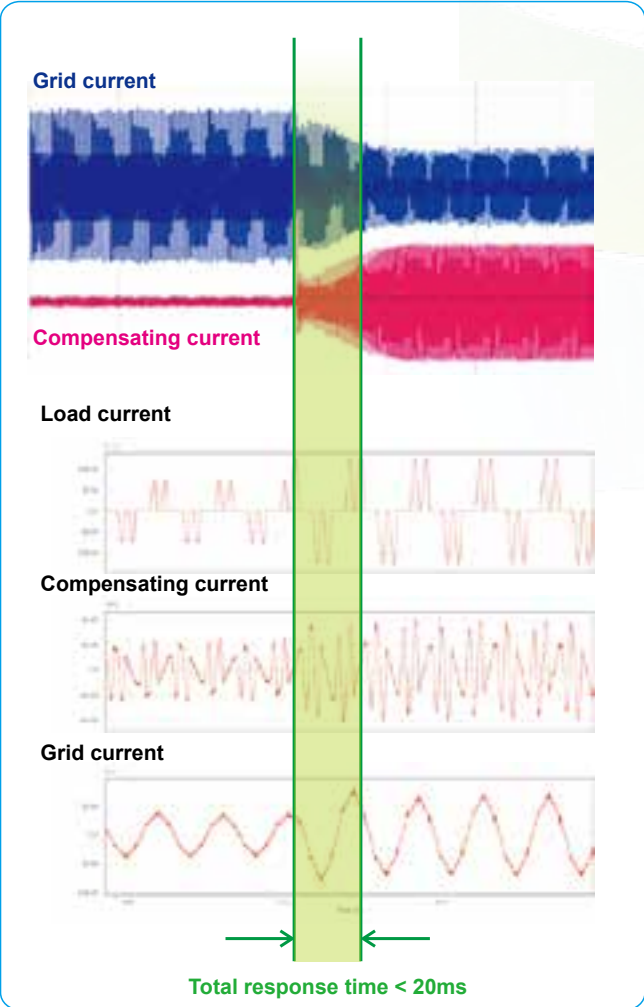


Total current distortion BEFORE compensation



Total current distortion AFTER compensation

Real-time Response and Current Compensation



Compensation to Current, Harmonics and Power Factor

Features	Harmonics Compensation	Reactive Power Compensation	Note
Full Compensation			Enable the compensation function to compensate unbalanced loads under all operation modes. ^{*1}
Harmonics Compensation			
Reactive Power Compensation			

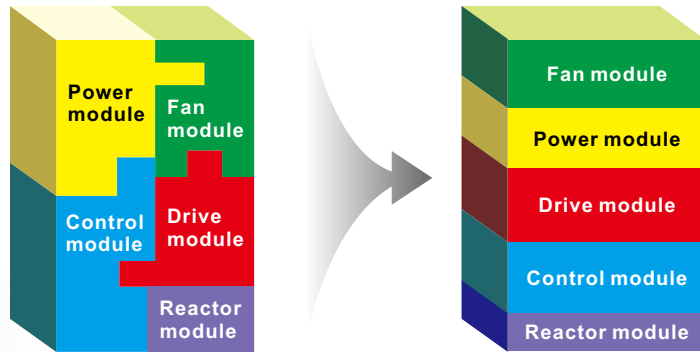
Compensation priority: > ; No Compensation:

^{*1} Verified derating ratio for different unbalanced loads. Please contact Delta technical support or distributors in your region.



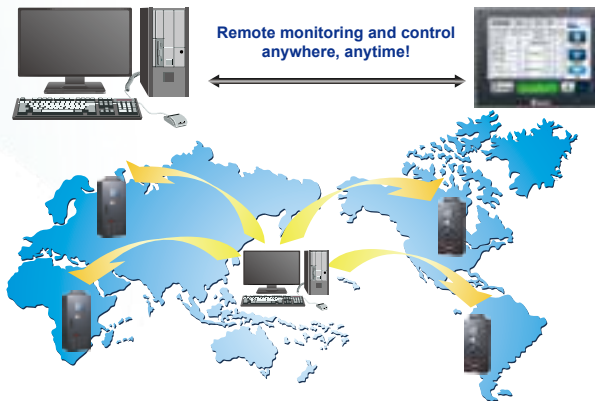
Advanced Modular Design

- Safe, reliable, labor-saving



Communication & Remote Monitoring and Control

- Built-in RS-485 (Modbus) protocol
- Remote monitoring and control



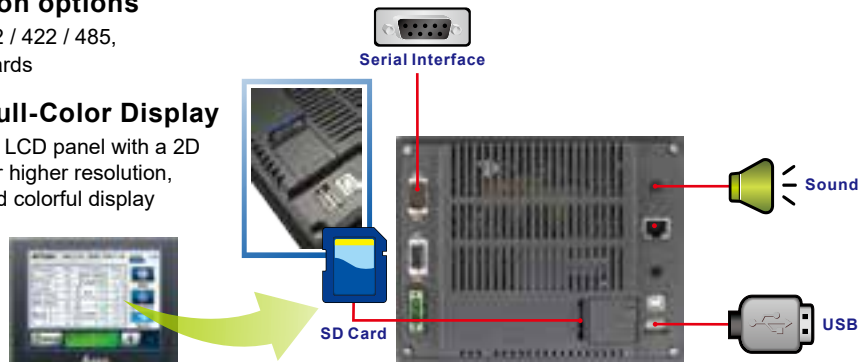
Excellent Operation Interface

- Diversified extension options**

Supports Ethernet, RS-232 / 422 / 485, USB disk drives and SD cards

- High Quality and Full-Color Display**

Adopts a 65,536-color TFT LCD panel with a 2D fast-drawing technology for higher resolution, more images, and vivid and colorful display



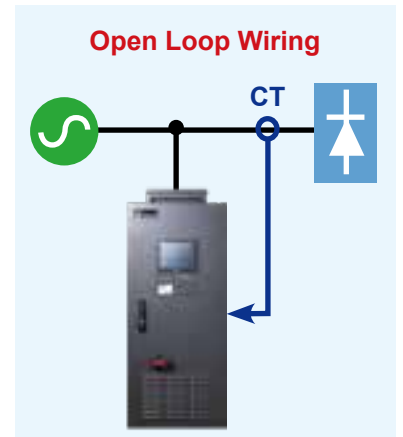
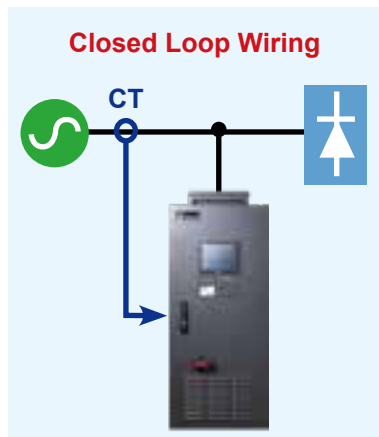
Filter Comparison Chart

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	Grid independence analysis required to prevent harmonics exaggeration	
Filtering Effect Influenced by System Impedance Changes	No	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	Parallel or serial connection may impact filtering effect and reactive power output capacity	

Open / Closed Loop Wiring

- A current transformer (CT) can be installed at both power side or load side to monitor harmonics or reactive power in real time
- For the highest response speed, install a CT at the load side.
For precise harmonics and reactive power compensation, install a CT at the power side.

*Multiple CTs connection in parallel is feasible for open-loop wiring only.



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



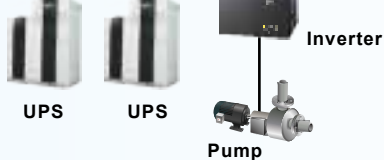
0.4 kV

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



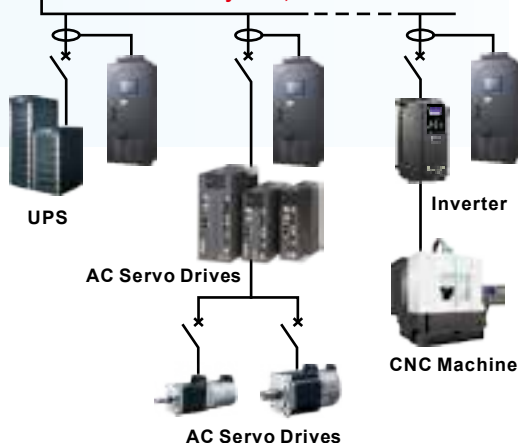
Terminal control

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

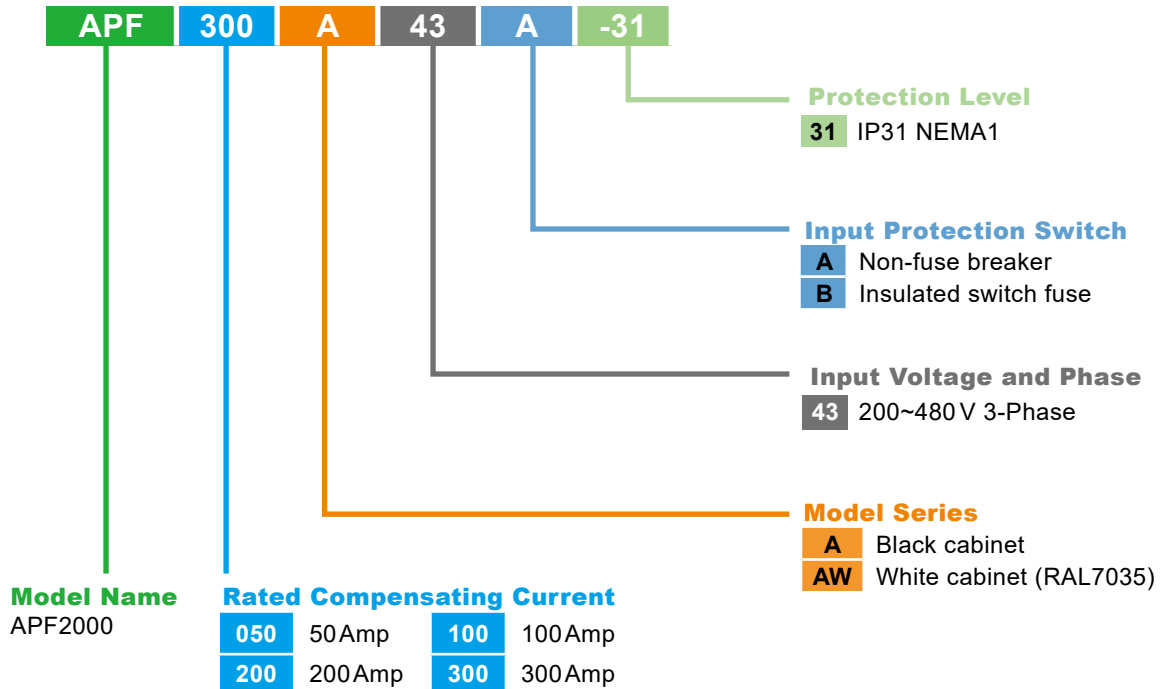
Control room and power distribution system



Low voltage distribution system, level 2



Model Name



Specifications

Model APF__A43X-31	APF050A43X-31	APF100A43X-31	APF200A43X-31	APF300A43X-31
Rated Compensation Current	50A	100A	200A	300A
Rated Voltage	200V ~ 480V			
Voltage Tolerance	-10% ~ +10%			
Wiring	3-phases 3-wire*2			
Grid Frequency	50Hz or 60Hz			
Frequency Tolerance	-5% ~ +5%			
Cooling Method	Force Air Cooling (Fan Cooling)			
Current Transformers Ratio (CT Ratio)	50: 5 to 10, 000: 5			
Power Loss	< 1,600W	< 3,200W	< 6,100W	< 9,100W
Noise Level (ISO 7779)	< 70 dBA	< 70 dBA	< 75 dBA	< 75 dBA
Cable Entry	Bottom	Bottom	Rear / Bottom	
Installation Method	Wall-mounted	Wall-mounted	Cabinet	
Dimensions (W x H x D mm)	A*1	370x590x311	440 x 1,101 x 411	630x2,130x656
	B*1	370x590x345	440 x 1,101 x 445	630x2,130x680
Weight (kg)	50 ± 10%	85 ± 10%	340 ± 10%	375 ± 10%
Enclosure Rating	IP31(NEMA1)			
International Certifications	CE			

*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 μ s
Step Response Time	< 20 ms
Carrier Frequency	15 kHz
Harmonic Compensation	2 nd to 50 th Harmonics (No even harmonics and interharmonics)
Harmonic Compensation Ratio	\geq 95%
Parallel Configuration	2 ~ 6 units
Human Machine Interface	65535 Colors 7" Touchscreen
Data Storage	USB drives and SD cards
Communication Port	D-Sub (RS-232), RJ45 (RS-485)
Communication Protocol	Modbus, Modbus TCP

Operating Environment

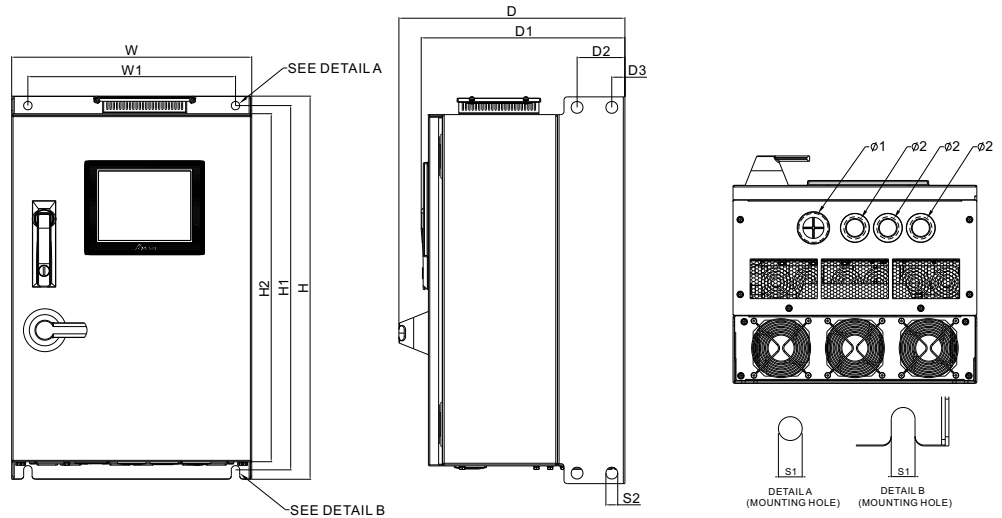
Ambient Temperature	-10°C ~ +45°C	
Installation Location	IEC 60364-1 / IEC 60664-1 Pollution degree 2, indoor use only	
Surrounding Temperature	Storage / Transportation	-25°C ~ +70°C
	Non-condensation, non-frozen	
Rated Humidity	Operation	Max. 90%
	Storage / Transportation	Max. 95%
	Non-condensation, non-frozen	
Atmosphere Pressure	Operation / Storage	86 to 106 kPa
	Transportation	70 to 106 kPa
Pollution Level	IEC 60721-3-3	
	Operation	Class 3C2; Class 3S2
	Storage	Class 2C2; Class 2S2
	Transportation	Class 1C2; Class 1S2
Altitude	Non-condensation, non-frozen	
	Operation	0 - 1,000 m : rated capacity usage 1,000 - 3,000 m: when above 1,000 m, decreases 2% rated current or lowers 0.5°C every 200 m increase in altitude

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



Dimensions

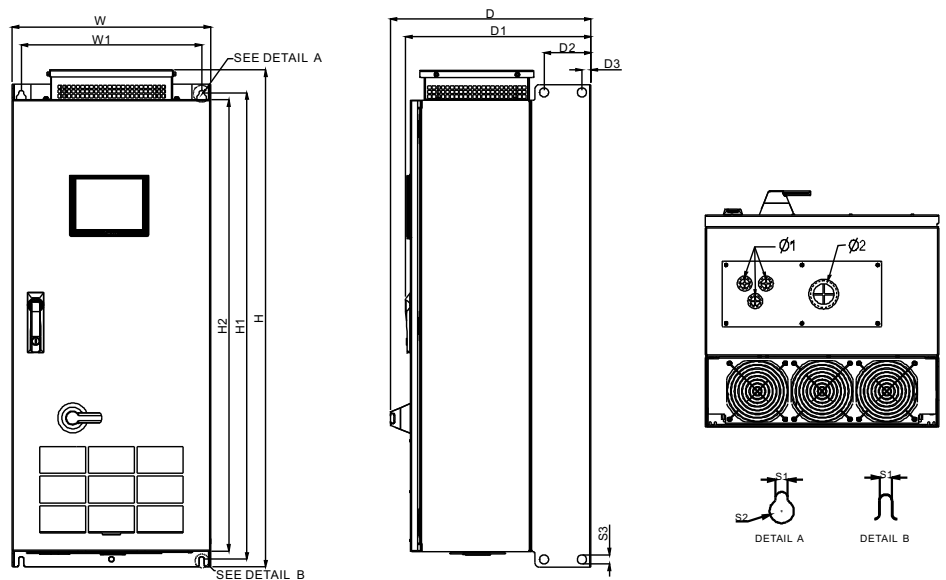
Frame A



MODEL
 APF050A43A-31
 APF050A43B-31

Frame		W	H	D	W1	H1	H2	D1	D2	D3	S1	S2	Ø1	Ø2
APF050A43A-31	mm	370	590	-	320	561	536	311	73	20	13	18	44	33.5
	inch	14.57	23.23	-	12.6	22.09	21.1	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	590	345	320	561	536	311	73	20	13	18	44	33.5
	inch	14.57	23.23	13.58	12.6	22.09	21.1	12.24	2.87	0.79	0.51	0.71	1.73	1.32

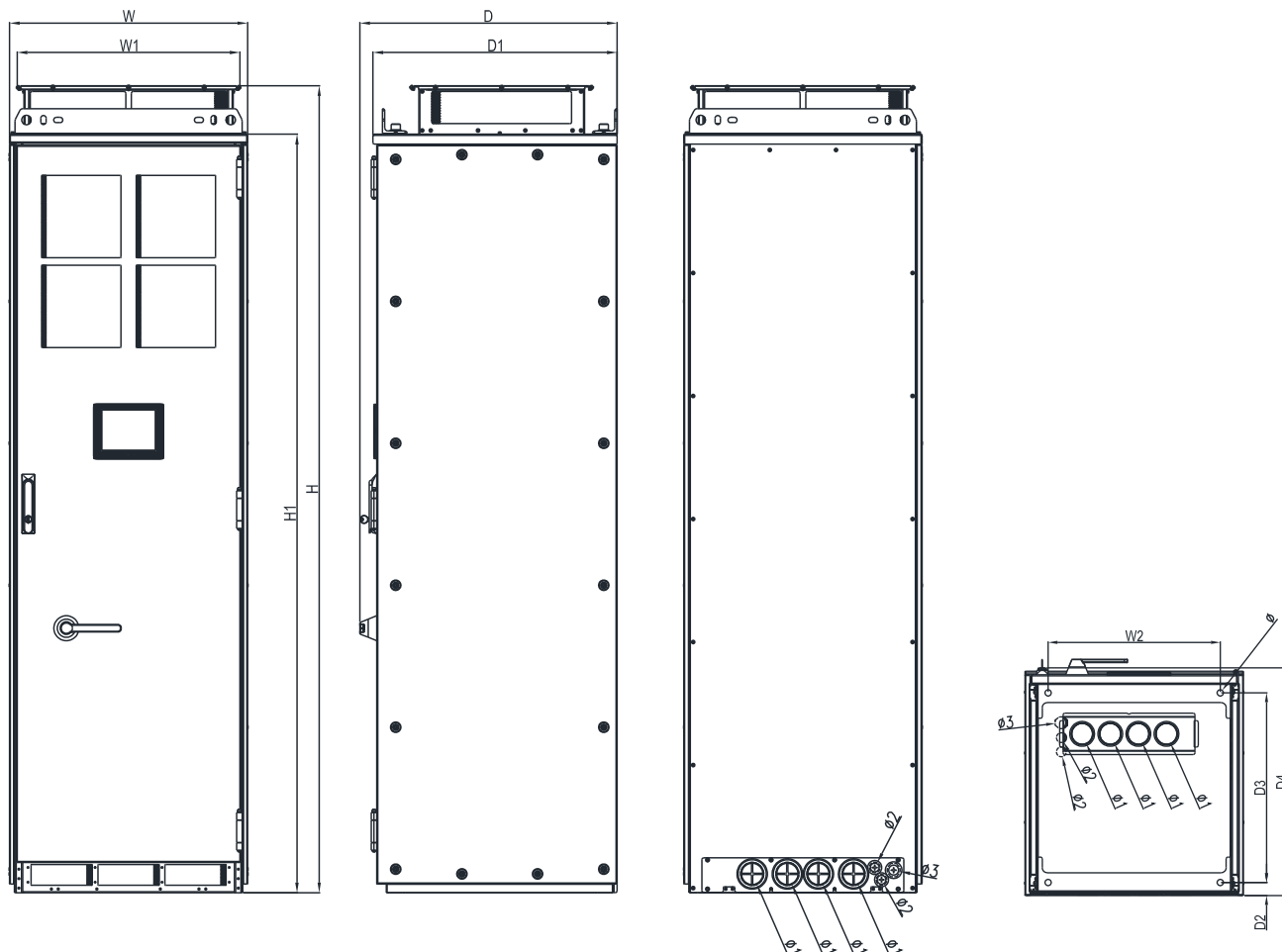
Frame B



MODEL
 APF100A43A-31
 APF100A43B-31

Frame		W	H	D	W1	H1	H2	D1	D2	D3	S1	S2	S3	Ø1	Ø2
APF100A43A-31	mm	440	1,101	-	400	1,033	1,000	411	104	20	11	22	20	22.2	50
	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	mm	440	1,101	445	400	1,033	1,000	411	104	20	11	22	20	22.2	50
	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	2,130	-	588.4	496	2,000	645.6
	inch	24.8	83.86	-	23.16	195.53	78.74	25.42
		D2	D3	D4	Ø	Ø1	Ø2	Ø3
	mm	37.4	546	656	18	61	28	34
	inch	1.47	21.5	25.83	0.71	2.4	1.1	1.34
Frame		W	H	D	W1	W2	H1	D1
APF200A43B-31 APF300A43B-31	mm	630	2,130	680.4	588.4	496	2,000	645.6
	inch	24.8	83.86	26.79	23.16	195.53	78.74	25.42
		D2	D3	D4	Ø	Ø1	Ø2	Ø3
	mm	37.4	546	656	18	61	28	34
	inch	1.47	21.5	25.83	0.71	2.4	1.1	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 400 Hz (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 the CT detection signals (K, L) cannot be swapped, the Active Power Filter must use 3 CTs in three-phase three-wire devices, installed separately in R-phase, S-phase, and T-phase. The arrows point towards load. The 3 CTs must all be in the same direction. If there is anyone of the CTs fixed in a different direction, it will result in errors of current detection.
- (2) The ratio of the 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 0.66 kV. 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	1,000A / 5A	1,000	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	1,000A / 5A	1,000	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C1200	1,200A / 5A	1,200	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C1500	1,500A / 5A	1,500	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C1800	1,800A / 5A	1,800	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-C2500 ²	2,500A / 5A	2,500	5VA	0.50%	C	Outer frame	186x110x46
						Inner frame	121x50x32
CT-D1200	1,200A / 5A	1,200	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32
CT-D1500	1,500A / 5A	1,500	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32
CT-D1800	1,800A / 5A	1,800	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32
CT-D2000	2,000A / 5A	2,000	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32
CT-D3000	3,000A / 5A	3,000	5VA	0.50%	D	Outer frame	226x130x46
						Inner frame	161x70x32

*1. Select a CT model based on the actual primary current (peak RMS current). For example, when the actual current is 280 A, select the model CT-A0300.

*2. All models are UL certified EXCEPT for the 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 wires

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 you install multiple units in parallel, the length of each CT cable must be identical.

▪ CT Cable Selection

Wire Gauge (mm ² /AWG)	Impedance (Ω)	Cable Length (Meter/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 (Meter/Feet)	Minimum Load required by CT (VA)
6/#10	3.4	< 44 / 147	5
6/#10	3.4	< 73 / 243	7.5
6/#10	3.4	< 102 / 340	10
6/#10	3.4	< 161 / 537	15
6/#10	3.4	< 338 / 1,127	30
4/#12	5.1	< 29 / 97	5
4/#12	5.1	< 49 / 163	7.5
4/#12	5.1	< 68 / 227	10
4/#12	5.1	< 107 / 357	15
4/#12	5.1	< 225 / 750	30

Regulation Standards

International Standards		China National Standards
IEEE 519-1992	IEC/EN 61000-2-2	GB/T 14549-93 (Quality of Electric Energy Supply Harmonics in Public Supply Network)
IEC/EN 61000-3-12	IEC/EN 61000-3-3	SD 126-84 Power System Harmonic Management Interim Provisions
IEC/EN 61000-3-4	IEC/EN 61000-2-4	Grid Adjustment Management Regulations
IEC/EN 61000-3-2	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
Frame C 	460V: 200A ~ 300A	APF200A43A-31 APF300A43A-31 APF200A43B-31 APF300A43B-31



Smarter. Greener. Together.

Industrial Automation Headquarters

Taiwan: Delta Electronics, Inc.

Taoyuan Technology Center
No.18, Xinglong Rd., Taoyuan District,
Taoyuan City 33068, Taiwan
TEL: +886-3-362-6301 / FAX: +886-3-371-6301

Asia

China: Delta Electronics (Shanghai) Co., Ltd.

No.182 Minyu Rd., Pudong Shanghai, P.R.C.
Post code : 201209
TEL: +86-21-6872-3988 / FAX: +86-21-6872-3996
Customer Service: 400-820-9595

Japan: Delta Electronics (Japan), Inc.

Industrial Automation Sales Department
2-1-14 Shibadaimon, Minato-ku
Tokyo, Japan 105-0012
TEL: +81-3-5733-1155 / FAX: +81-3-5733-1255

Korea: Delta Electronics (Korea), Inc.

1511, 219, Gasan Digital 1-Ro., Geumcheon-gu,
Seoul, 08501 South Korea
TEL: +82-2-515-5305 / FAX: +82-2-515-5302

Singapore: Delta Energy Systems (Singapore) Pte Ltd.

4 Kaki Bukit Avenue 1, #05-04, Singapore 417939
TEL: +65-6747-5155 / FAX: +65-6744-9228

India: Delta Electronics (India) Pvt. Ltd.

Plot No.43, Sector 35, HSIIDC Gurgaon,
PIN 122001, Haryana, India
TEL: +91-124-4874900 / FAX: +91-124-4874945

Thailand: Delta Electronics (Thailand) PCL.

909 Soi 9, Moo 4, Bangpoo Industrial Estate (E.P.Z),
Pattana 1 Rd., T.Phraksa, A.Muang,
Samutprakarn 10280, Thailand
TEL: +66-2709-2800 / FAX: +66-2709-2827

Australia: Delta Electronics (Australia) Pty Ltd.

Unit 20-21/45 Normanby Rd., Notting Hill Vic 3168, Australia
TEL: +61-3-9543-3720

Americas

USA: Delta Electronics (Americas) Ltd.

5101 Davis Drive, Research Triangle Park, NC 27709, U.S.A.
TEL: +1-919-767-3813 / FAX: +1-919-767-3969

Brazil: Delta Electronics Brazil

Rua Itapeva, 26 - 3º, andar Edifício Itapeva,
One - Bela Vista 01332-000 - São Paulo - SP - Brazil
TEL: +55-12-3932-2300 / FAX: +55-12-3932-237

Mexico: Delta Electronics International Mexico S.A. de C.V.

Gustavo Baz No. 309 Edificio E PB 103
Colonia La Loma, CP 54060
Tlalnepantla, Estado de México
TEL: +52-55-3603-9200

EMEA

EMEA Headquarters: Delta Electronics (Netherlands) B.V.

Sales: Sales.IA.EMEA@deltaww.com
Marketing: Marketing.IA.EMEA@deltaww.com
Technical Support: iatechnicalsupport@deltaww.com
Customer Support: Customer-Support@deltaww.com
Service: Service.IA.emea@deltaww.com
TEL: +31(0)40 800 3900

BENELUX: Delta Electronics (Netherlands) B.V.

De Witbogt 20, 5652 AG Eindhoven, The Netherlands
Mail: Sales.IA.Benelux@deltaww.com
TEL: +31(0)40 800 3900

DACH: Delta Electronics (Netherlands) B.V.

Coesterweg 45, D-59494 Soest, Germany
Mail: Sales.IA.DACH@deltaww.com
TEL: +49(0)2921 987 0

France: Delta Electronics (France) S.A.

ZI du bois Challand 2, 15 rue des Pyrénées,
Lisses, 91090 Evry Cedex, France
Mail: Sales.IA.FR@deltaww.com
TEL: +33(0)1 69 77 82 60

Iberia: Delta Electronics Solutions (Spain) S.L.U

Ctra. De Villaverde a Vallecas, 265 1º Dcha Ed.
Hormigueras – P.I. de Vallecas 28031 Madrid
TEL: +34(0)91 223 74 20

Carrer Llacuna 166, 08018 Barcelona, Spain

Mail: Sales.IA.Iberia@deltaww.com

Italy: Delta Electronics (Italy) S.r.l.

Via Meda 2-22060 Novedrate(CO)
Piazza Grazioli 18 00186 Roma Italy
Mail: Sales.IA.Italy@deltaww.com
TEL: +39 039 8900365

Russia: Delta Energy System LLC

Vereyskaya Plaza II, office 112 Vereyskaya str.
17 121357 Moscow Russia
Mail: Sales.IA.RU@deltaww.com
TEL: +7 495 644 3240

Turkey: Delta Greentech Elektronik San. Ltd. Sti. (Turkey)

Şerifali Mah. Hendem Cad. Kule Sok. No:16-A
34775 Ümraniye – İstanbul
Mail: Sales.IA.Turkey@deltaww.com
TEL: + 90 216 499 9910

MEA: Eltek Dubai (Eltek MEA DMCC)

OFFICE 2504, 25th Floor, Saba Tower 1,
Jumeirah Lakes Towers, Dubai, UAE
Mail: Sales.IA.MEA@deltaww.com
TEL: +971(0)4 2690148