Fuji Electric

Innovating Energy Technology

Fuji Electric Harmonic Mitigation

ecoWAVE PHF

Advance-Line Passive Harmonic Filters (IP00 Skid Type)



Fuji Electric Asia Pacific Pte. Ltd.

FN-AL1S-PHF-2020/0001

Fuji Electric

ecoWAVE Passive Harmonic Filters
Quality and Performance Excellence

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Document name:
Catalog ecoWAVE Advance-Line PHF.pdf

Version history

Revision	Date	Description
01	Jun 2020	Initial version
02	Jun 2023	Version 2

ecoWAVE (AL1S)

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These instructions (PDF format) can be obtained from www.fujielectric.com or from your local Fuji Electric sales representative. Other technical documentation of our products is also available in the download area of
https://www.sg.fujielectric.com/products/harmonic-mitigation/ecowave-al1s/

Electricity supply represents one of the most essential basic services for the support of an industrial society. Power generation, transmission, distribution and usage are undergoing significant changes due to heavy demand on energy. That will affect the electrical quality and performance needs of all connected energy users.

One major aspect of electrical power is its quality and stability – or so called power quality. A high level of power quality is needed to enable the reliable function of equipment and systems and can only be guaranteed with reliable partners such as the Fuji Electric. This is in particular true for harmonic distortions which are created by non-linear loads which account for the biggest group of loads in our today's modern society.

Fuji Electric offers a unique mixture of knowledge and solutions to help rebuilding and maintaining a quality of the power that is appropriate in terms of local or international standards as well as customer requirements.

Fuji Electric ecoWAVE harmonic filters represent an economical solution to the challenge of load-applied harmonics mitigation in three-phase power systems. With a plug-and-play approach and more compact dimensions than comparable products, they can be quickly installed and easily commissioned. They increase the reliability and service life of electric installations,…

The ecoWAVE Advance-Line passive harmonic filters are used to achieve total harmonic distortion of less than 5% and meeting IEEE-519 standard for AC drive system.

Reactive power increases at no load or low load. To help reduce this reactive power, the filter capacitors can be disconnected. (refer to your local Fuji Electric)



Follow the above selection guideline carefully and enjoy maximum benefits of these filter.

ecoWAVE PHF

Advance-Line Passive Harmonic Filter (AL1S) (THDi 5%)



THDi 5% / IP00 Skid Type / 50Hz & 60Hz / 250kW to 500kW

- Demonstrate best cost-performance ratio
- Achieve 5% THDi for diode rectifier without DC-link choke and thyristor rectifier
- Best-in-class partial load performance
- Most compact open panel design for cabinet integration
- Reliable and robust

Approvals (UL Pending) CE RoHS cULus (depending on filter configuration)

Features and benefits

Fuji Electric ecoWAVE Advance-Line harmonic filters represent a solution to the challenge of load-applied harmonics mitigation in three-phase power systems. With a plug-and-play approach and more compact dimensions than comparable products, they can be quickly installed into electrical cabinet and easily commissioned. They increase the reliability and service life of electric installations, help utilize electric system the key to meet Power Quality standards such as IEEE 519. ecoWAVE filters reshape your distorted current back to the desired sinusoidal wave-form and work perfectly with Fuji Electric FRENIC inverter series. Fuji Electric ecoWAVE filters can be applied to virtually any kind of power electronics with front-end six-pulse rectifiers, 3-phase diode or thyristor bridges, where harmonic current distortion needs to be reduced to defined limits.

Technical specifications	50Hz System	60Hz System
Nominal operating voltage	3 x 380 VAC to 415 VAC ± 10%	3 x 440 VAC to 480 VAC ± 10%
Operating frequency	50 Hz ± 1Hz	60 Hz ± 1Hz
Nominal motor drive input power rating	250 to 500kW	260 to 450kW / 350 to 600HP
Total harmonic current distortion THID*	<5% @ rated power for drives without Ldc ~3.5% @ rated power for drives equipped with 4% Ldc	
Efficiency	>99% for rated voltage and power	
High potential test voltage	P -> E 2520 VAC (1s)	
Protection category	IP00 Skid	
Cooling	External cooling**	
Overload capability	1.6x rated current for 1minute, once per hour	
Ambient temperature range	– 25℃ to +45℃ fully operational +45℃ to +70℃ derated operation*** – 25℃ to +85℃ transport and storage	
Flammability corresponding to	UL 94 V-2	
Design corresponding to	Filter: UL 61800-5-1, EN 61800-5-1 Chokes: EN 60076-6	
Earthing System	TN, TT, IT	
MTBF @ 45℃/415 V (Mil-HB-217F)	>200,000 hours	
Overvoltage category	OV III (IEC 60664-1)	
Typical applications	Equipment with front-end six-pulse rectifier / Motor drives / Factory automation equipment Water/wastewater treatment facilities / Fan and pump applications / HVAC applications Mission-critical processes / DC fast chargers	

* System requirements: THVD <2%, line voltage unbalance <1%
Note: performance specifications in this brochure refer to six-pulse diode rectifiers.
SCR rectifier front-ends will produce different results, dependent upon the firing angle of the thyristors.

** Please check the inlet air flow required for cooling table on page 6 of this document.

*** Iderated = Inominal*√((Tmax-Tamb)/(Tmax-Tnominal)) = Inom*√((70°C-Tamb)/25°C)

PASSIVE HARMONIC FILTERS
ecoWAVE Advance-Line PHF IP00 Skid Type
How to read the model code

F N 250 A L 1 S - 4 G 5

CODE	Product Type
FN	Passive Harmonic Filter

CODE	kW Rating
250	250kW
~	~
500	500kW

CODE	Series
AL1	Advance-Line Series 1

CODE	Protection
M	IP20 **
S	IP00

CODE	Hz
5	50Hz
6	60Hz

CODE	Destination
G	Global Model

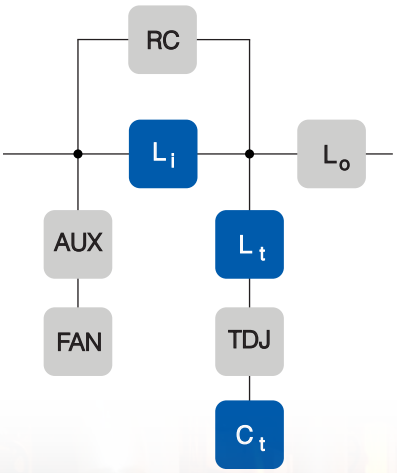
CODE	Input power source
4	400 Voltage Class *

* Exact input power source please refer to technical specifications
** Refer to ecoWAVE Advance-Line Catalog.

Typical applications

- Equipment with front-end six-pulse rectifier
- Motor drives
- Factory automation equipment
- Water/wastewater treatment facilities
- Fan and pump applications
- HVAC installations
- Mission-critical processes
- DC fast chargers

Typical electrical schematic



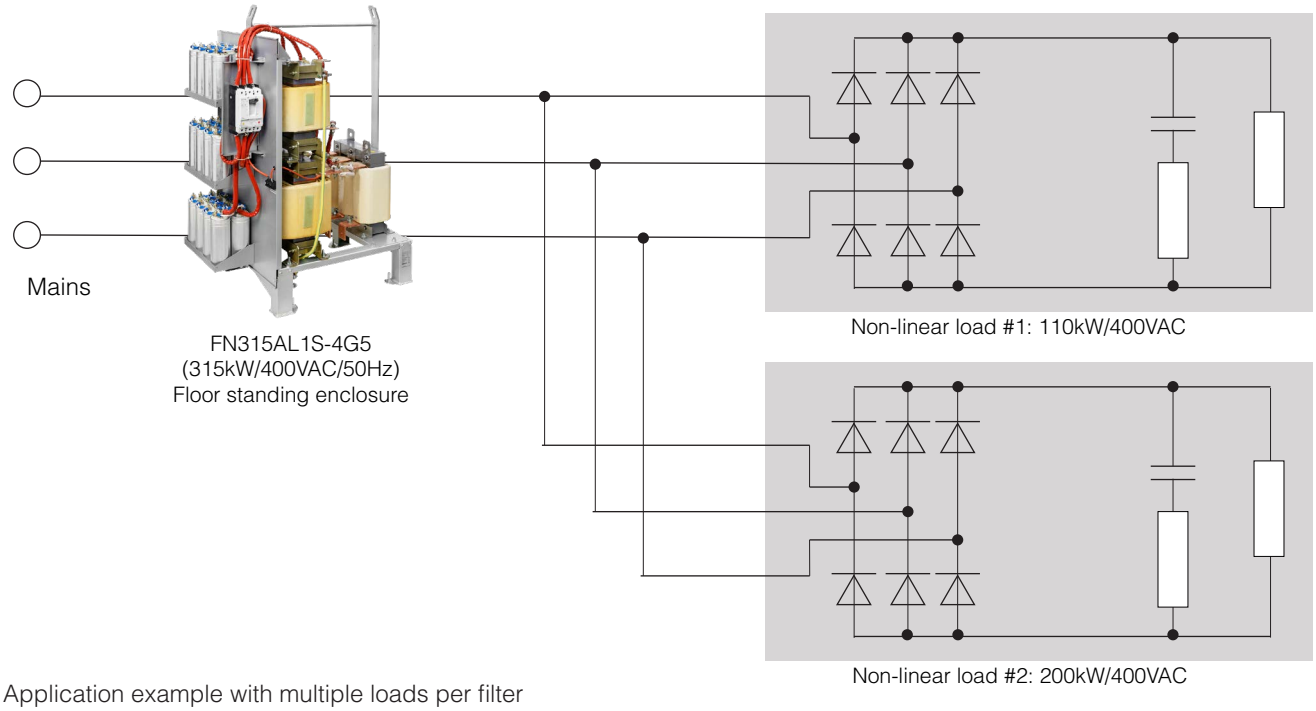


Harmonic Mitigation for Inverter application

Passive Harmonic Filters
- Also known as 'Low Pass Filters'.
- For reducing harmonics at the VSD / Inverter or other non-linear devices.
- Reduction of harmonics to 5-10%
- Reduce cable heating and line losses.
- Improve power factor and reduce system loss.
- Minimise interference with other equipment.
- Improved system voltage/current waveform.
- Prevent nuisance tripping of fuse and circuit breakers.
- Meets the IEEE519 Standard

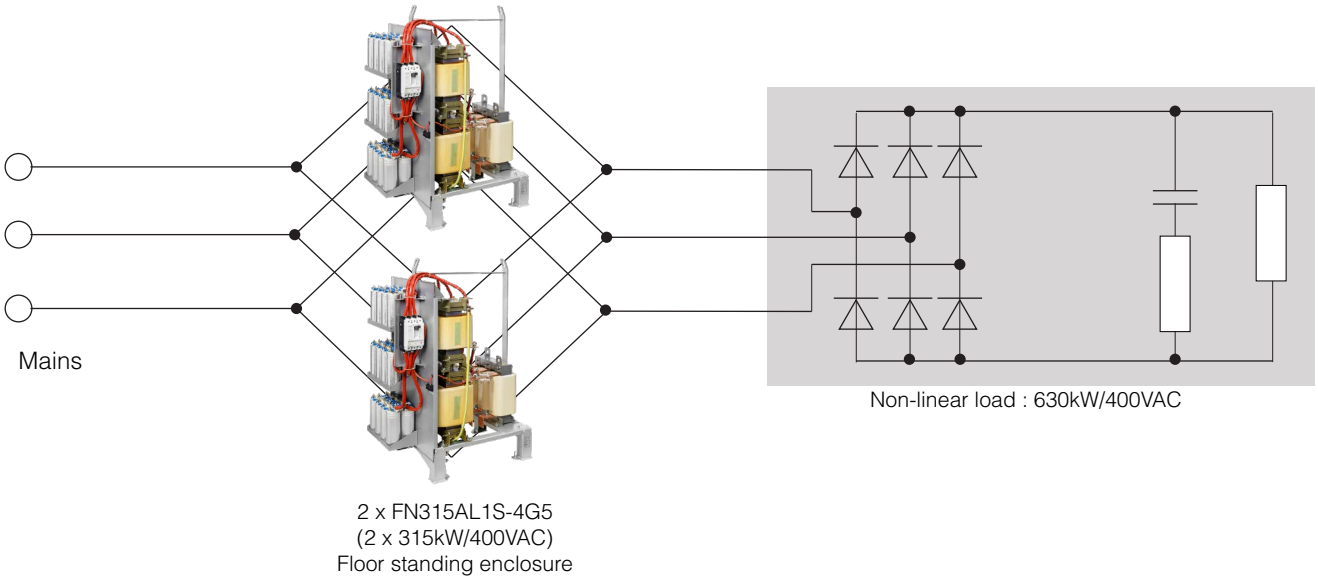
ecoWAVE Advance-Line PHF are designed to mitigate harmonic current of non-linear loads, in particular of three-phase diode-type rectifiers. Contrary to “bus-applied or PCC” filters, which are being installed e.g. at the main feeder, they are specifically designed to be used with either an individual non-linear load, or with a group of non-linear loads.

One advantage of load-applied filtering is the fact that the upstream power (relative to the harmonic filter) is clean, i.e. unloaded by the harmonics. This can be of vital importance when the same power bus supplies both motor drives and sensitive loads. ecoWAVE Advance-Line PHF are also suitable for paralleling lower power non-linear loads on a higher power harmonic filter to improve overall system economy. In this case the total expected load power of all connected drives must match the filter.



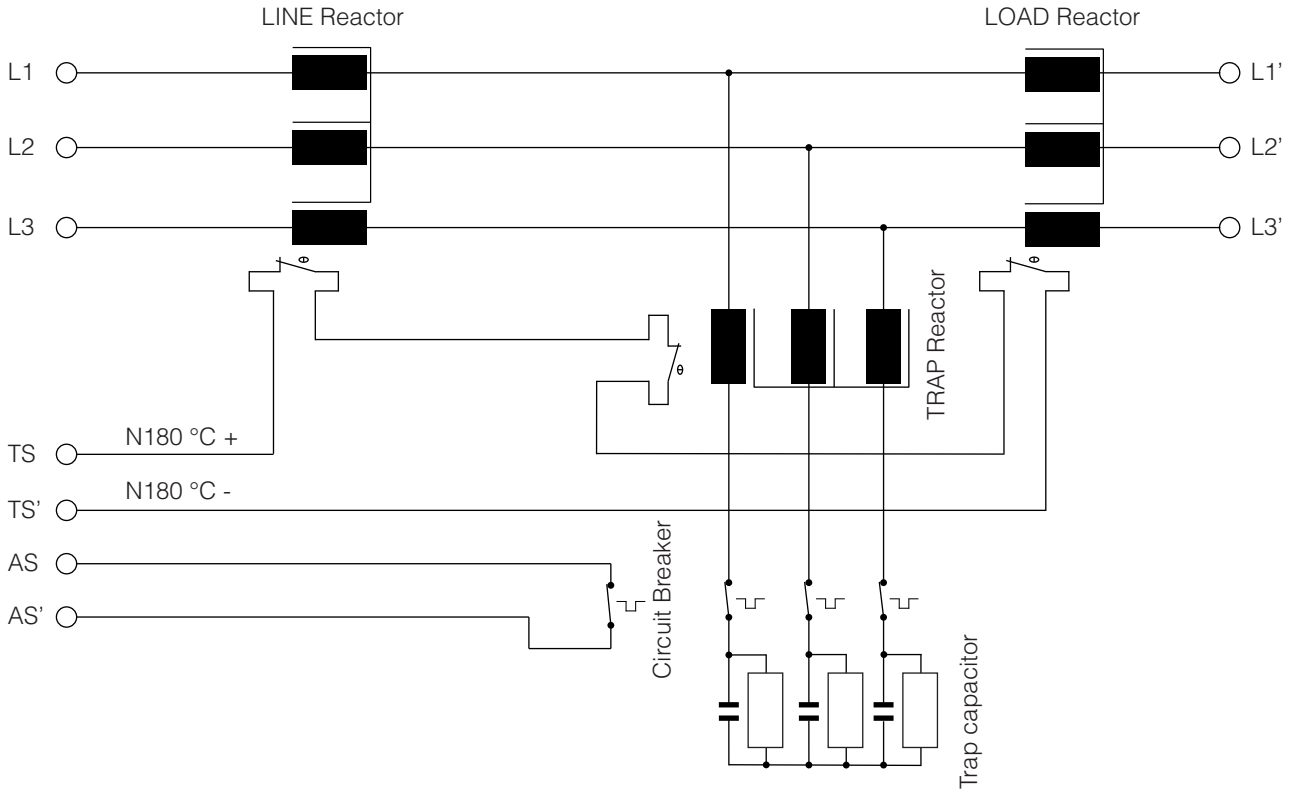
Application example with multiple loads per filter

If the expected input power exceeds the rating of the largest available filter, and a custom solution is not desired, then two or more filters can be wired in parallel. In this mode of operation, it is recommended to use filters with equal power ratings to ensure proper current sharing.



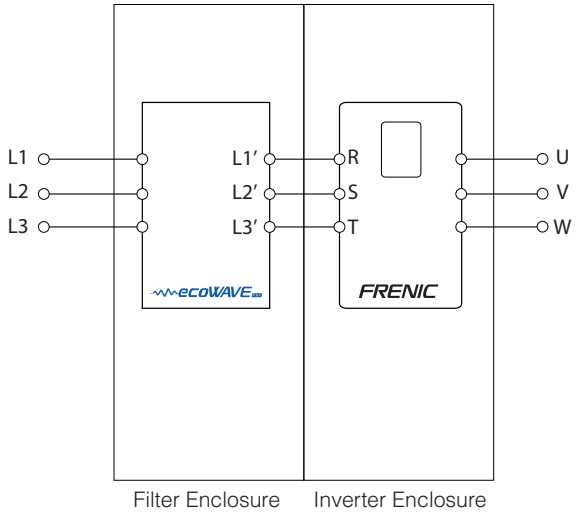
Application example with 2 filters in parallel for larger load

Function diagram - IP00 Skid Type



Filter terminals	Line L1/L2/L3	3 busbar terminals at line side
	Load L1'/L2'/L3'	3 busbar terminals at load side
	TS, TS'	Connecting terminals to thermal switch NC 180°C (UL-approved) to detect overload in chokes
	AS, AS'	Terminal for auxiliary connection, details refer to "ecoWAVE Advance-Line PHF Installation & User Manual"
	PE	Protective earth. Threaded stud with washer and nut
Function blocks	Chokes	Power magnetic components incl. temperature sensors
	Capacitors	Power capacitors incl. discharge resistors
	Circuit breaker	Make sure the status is "On" when install the filter Status "On" during normal operation Investigation of the system is required when the status of the switch changed to "Off"

Typical Electrical Schematic



The typical electrical schematic shows ecoWAVE IP00 Skid type (engineering filter) integrated directly to inverterm appplication within the enclosure system.

The ecoWAVE filter can be appiled in electrical system level (electrical main supply board) to achieve result if load factor is well calculated.

(consult your local Fuji Electric for more informations)

50Hz IP00 Skid Type

Rated Voltage	Nominal applied motor [kW] ***	Filter	Motor drive input current [Arms]*	Rated filter input current [Arms]	Typical Losses @ 45°C [W]	Circuit breaker rated current [A]	Skid
50Hz 3-Phase 380-415V Class	250	FN250AL1S-4G5	435	376	3029	250	S10
	315	FN315AL1S-4G5	655	475	3295	250	S10
	355	FN355AL1S-4G5	727	538	3527	300	S12
	400	FN400AL1S-4G5	808	608	4617	400	L10
	500	FN500AL1S-4G5	985	766	4475	400	L12

*** Motor drive input current without harmonic filter.

60Hz IP00 Skid Type

Rated Voltage	Nominal applied motor [kW] / [HP]***	Filter	Motor drive input current [Arms]*	Rated filter input current [Arms]	Typical Losses @ 45°C [W]	Circuit breaker rated current [A]	Skid
60Hz 3-Phase 440-480V Class	260 / 350	FN260AL1S-4G6	472	327	2832	200	S10
	300 / 400	FN300AL1S-4G6	537	375	3200	200	S10
	335 / 450	FN335AL1S-4G6	595	420	3451	250	S10
	370 / 500	FN370AL1S-4G6	656	469	3404	250	S12
	450 / 600	FN450AL1S-4G6	773	563	4173	300	L10

*** Motor drive input current without harmonic filter.

Dimensions

50Hz IP00 Skid Type

Rated Voltage	Nominal applied motor [kW] ***	Filter	Outside dimensions (mm)			Weight [kg]	Frame Size	Inlet air flow required for cooling Min air volume* [m3/h]
			W	H	D			
50Hz 3-Phase 380-415V Class	250	FN250AL1S-4G5	890	1120	505	270	S10	1050
	315	FN315AL1S-4G5				295		
	355	FN355AL1S-4G5	1060			320	S12	
	400	FN400AL1S-4G5	890		557	426	L10	
	500	FN500AL1S-4G5	1060			510	L12	

*** Motor drive input current without harmonic filter

NOTE: Enclosure ventilation fan is required for these engineering filter. Recommended installation on top of cabinet.

60Hz IP00 Skid Type

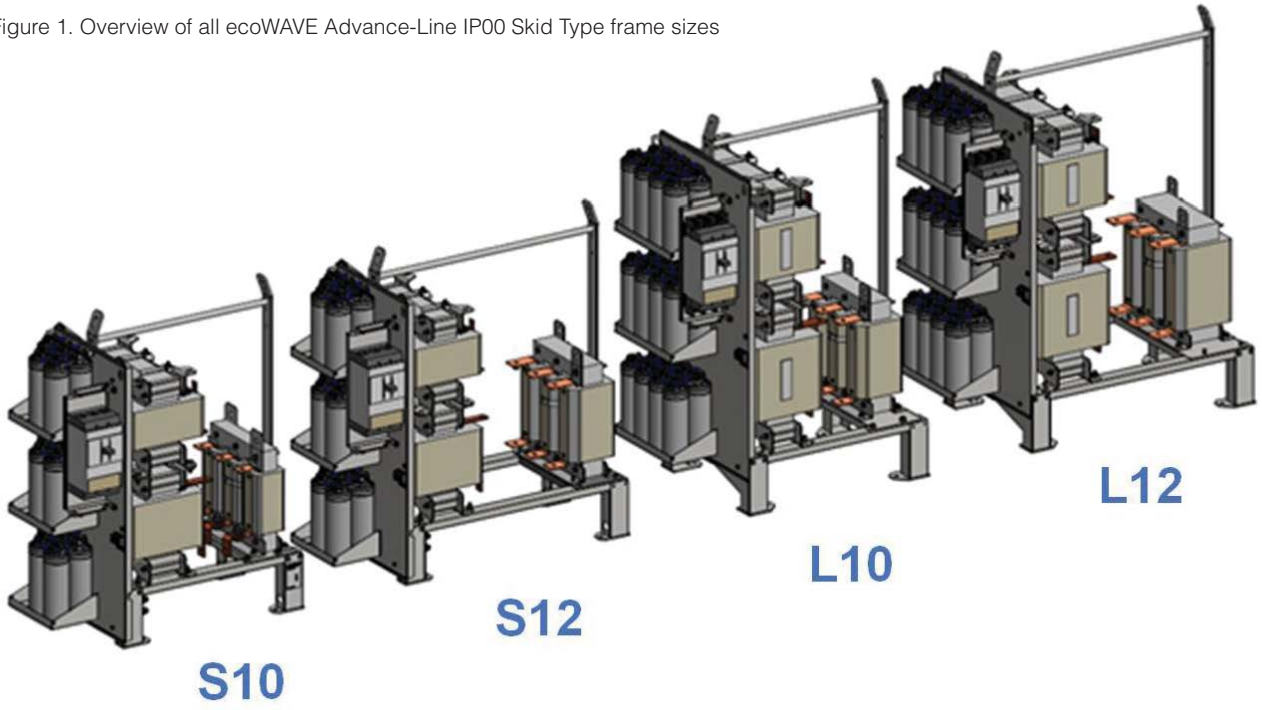
Rated Voltage	Nominal applied motor [kW] / [HP]***	Filter	Outside dimensions (mm)			Weight [kg]	Frame Size	Inlet air flow required for cooling Min air volume* [m3/h]
			W	H	D			
50Hz 3-Phase 440-480V Class	260 / 350	FN260AL1S-4G6	890	1120	505	245	S10	1050
	300 / 400	FN300AL1S-4G6				270		
	335 / 450	FN335AL1S-4G6	1060			295	S12	
	370 / 500	FN370AL1S-4G6	890	1320	557	320	L10	
	450 / 600	FN450AL1S-4G6	1060			385	L12	

*** Motor drive input current without harmonic filter

NOTE: Enclosure ventilation fan is required for these engineering filter. Recommended installation on top of cabinet.

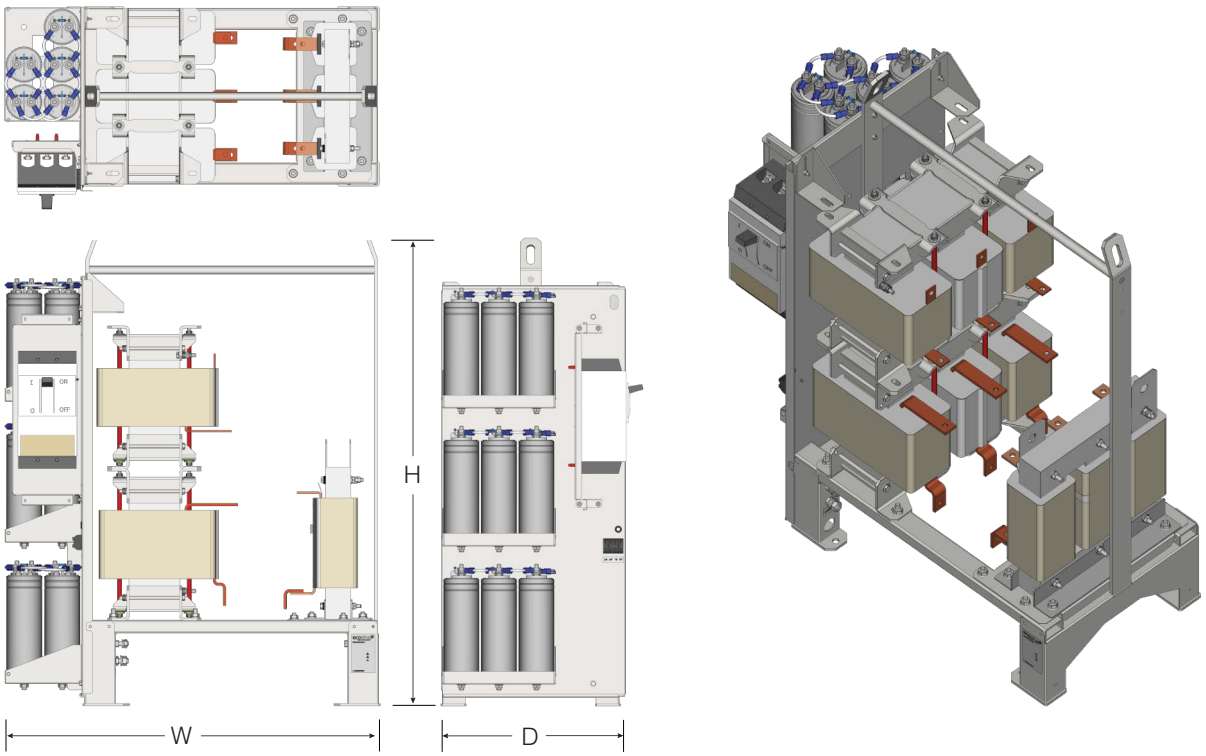
All ecoWAVE Advance-Line IP00 Skid Type passive harmonic filters are realized with 4 frame sizes, S10/S12 and L10/L12. Dimensions and footprint are provided in page 4. ecoWAVE Advance-Line IP00 Skid Type passive harmonic filters are IP00 and external air cooling is needed, details are provided in page 4. The overview of all frame sizes is shown in Figure 1.

Figure 1. Overview of all ecoWAVE Advance-Line IP00 Skid Type frame sizes



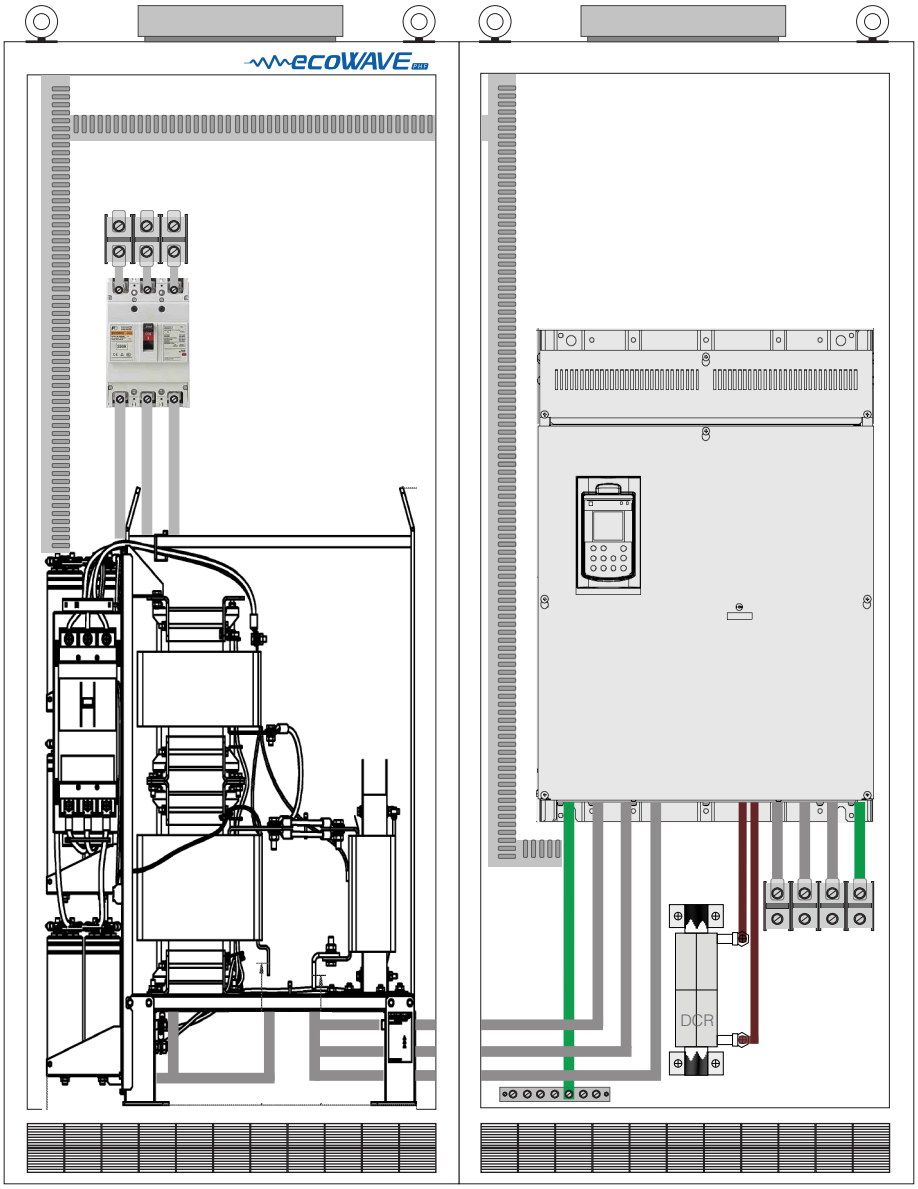
50Hz & 60Hz Mechanical data of IP00 Skid Type footprint

IP00 Skid (S10, S12, L10 & L12)



* External air flow required for filter configurations without embedded ventilation. Recommended installation on top of cabinet.

IP00 Skid Type (Engineering Filter)





Inverter panel with ecoWAVE PHF Skid module

Features and benefits

Fuji Electric ecoWAVE Advance-Line PHF represent an economical solution to the challenge of load-applied harmonics mitigation for higher capacity load application in three-phase power systems.

With a IP00 skid module plug-and-play approach and more compact dimensions than comparable products, they can be quickly installed into your prefer ingress protection enclosure and easily commissioned. They increase the reliability and service life of electric installations, help utilize electric sytem capacity better, and are the key to meet Power Quality standards such as IEEE 519. ecoWAVE PHF reshape your distorted current back to the desired sinusoidal waveform.

Fuji Electric ecoWAVE Advance-Line PHF can be applied to virtually any kind of power electronics with front-end six-pulse rectifiers, 3-phase diode or thyristor bridges, where harmonic current distortion needs to be reduced to defined limits.

These engineering filter come in rating of;

250 kW - 50 Hz	260 kW/350 HP - 60 Hz
315 kW - 50 Hz	300 kW/400 HP - 60 Hz
355 kW - 50 Hz	335 kW/450 HP - 60 Hz
400 kW - 50 Hz	370 kW/500 HP - 60 Hz
500 kW - 50 Hz	450 kW/600 HP - 60 Hz

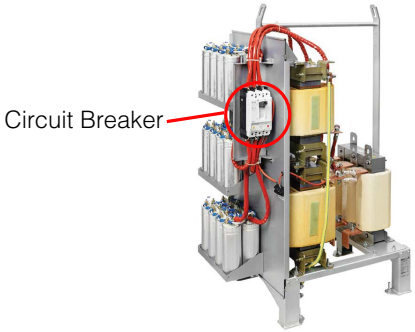
Consultant your local Fuji Electric for more information.

Load choke and circuit breaker

The general design of ecoWAVE Advance-Line IP00 Skid Type filters with load choke and circuit breaker module is shown in Figure 2.

On the right side of the frame, there is trap choke Lt sitting on top of the line choke Li, and the load choke Lo is next to them. The trap capacitor Ct, and circuit breaker or trap disconnect jumper is mounted on the left side of the frame. Switch module, namely a circuit breaker, is required in high power passive harmonic filters for safety reasons.

The short circuit current of high power passive harmonic filters can go beyond 10'000A, however the capacitors are only protected with failure current of max. 10'000A. Therefore, an external switch able to disconnect the capacitors automatically under overloading and short circuit conditions is mandatory to ensure the installation safety at all operation situations. When the filter is overloaded, depending on the overcurrent value, circuit breaker will release after a certain time. The higher the current, the faster will the circuit breaker release. The characteristics curve of current and tripping time and more information can be found in the circuit breaker datasheeti. In case the circuit breaker is released, the connected load must be shut down immediately and remains off until the failure is investigated, and problem is solved. Once everything solved and source of issue removed, the circuit breaker can be switched on again to re-start the system.



The filter come with standard Trap Disconnect Jumper (TDJ) and can operate at such or introduce a circuit breaker (optional). These circuit breaker is an optional item and can be incorporated during engineering of the filter. Depend on the filter rating, the circuit breaker come in 250A, 300A, 400, & 500A.

Recomended the use of Fuji Electric Molded Case Circuit Breakers (MCCB) G-Twin Series for these option.

Figure 2. Indicate the circuit breaker incorporated



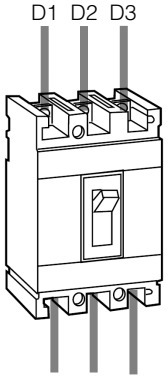
50Hz IP00 Skid Type

Rated Voltage	Nominal applied motor [kW]	Filter	Circuit breaker rated current [A]	Fuji Electric MCCB Model	Breaking capacity (Icu/Isc)*
50Hz 3-Phase 380-415V Class	250	FN250AL1S-4G5	250	BW250RAGU-3P250	50/25kA
	315	FN315AL1S-4G5	250	BW250RAGU-3P250	50/25kA
	355	FN355AL1S-4G5	300	BW400RAGU-3P300	50/25kA
	400	FN400AL1S-4G5	400	BW400RAGU-3P400	50/25kA
	500	FN500AL1S-4G5	400	BW400RAGU-3P400	50/25kA

60Hz IP00 Skid Type

Rated Voltage	Nominal applied motor [kW] / [HP]	Filter	Circuit breaker rated current [A]	Fuji Electric MCCB Model	Breaking capacity (Icu/Ics)*
50Hz 3-Phase 440-480V Class	260 / 350	FN260AL1S-4G6	250	BW250RAGU-3P250	50/25kA
	300 / 400	FN300AL1S-4G6	250	BW250RAGU-3P250	50/25kA
	335 / 450	FN335AL1S-4G6	300	BW400RAGU-3P300	50/25kA
	370 / 500	FN370AL1S-4G6	400	BW400RAGU-3P400	50/25kA
	450 / 600	FN450AL1S-4G6	400	BW400RAGU-3P400	50/25kA

(from Trap Reactor)
D1 D2 D3



D1' D2' D3'
(to Trap Capacitor)

* NOTE

In order for the filter to comply to UL standard, an UL certified (Icu/Ics) MCCB should be use.	
Recommended MCCB complied to;	IEC 60947-2, EN 60947-2, JIS C 8201-2-1 Icu/Ics (kA) GB 14048.2 Icu/Ics (kA) UL 489, CAN/CSA C 22-2 No.5 (kA)
Comforming standards;	CE Marking (TÜV), CCC certificate, UL Listed (NEMA AB1)

(see detail connection in ecoWAVE Advance-Line IP00 Skid Type Installation Maunal)
(consult your local Fuji Electric for more informations)

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FRENIC Inverter series

Technology made possible by Fuji Electric intensive range of inverter

Fuji Electric delivers high-performance inverters that offer automatically controlled motor operations and operating speeds for a wide variety of drive applications. This precision control allows our drives to operate at an optimal speed throughout your application, reducing overall power and energy consumption to minimize operating costs. View our complete line at www.fujielectric.com

Complete your inverter application with ecoWAVE PHF and imporve power quality.

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Inverter
Low Voltage AC Drives

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