Fuji Electric

Innovating Energy Technology

Fuji Electric Harmonic Mitigation

ecoWAVE PHF

Advance-Line Passive Harmonic Filters

Fuji Electric Asia Pacific Pte. Ltd.

AL1M-PHF-CTL/V2

Fuji Electric

ecoWAVE Passive Harmonic Filters
Quality and Performance Excellence

Document name:
Catalog ecoWAVE Advance-Line IP20 PHF.pdf

Version history

Revision	Date	Description
AL1M-PHF-CTL/V1.1	Aug 2022	Version 1.1
AL1M-PHF-CTL/V2	Jan 2023	Version 2

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Other technical documentation of our products is also available in the download area of www.fujielectric.com

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.

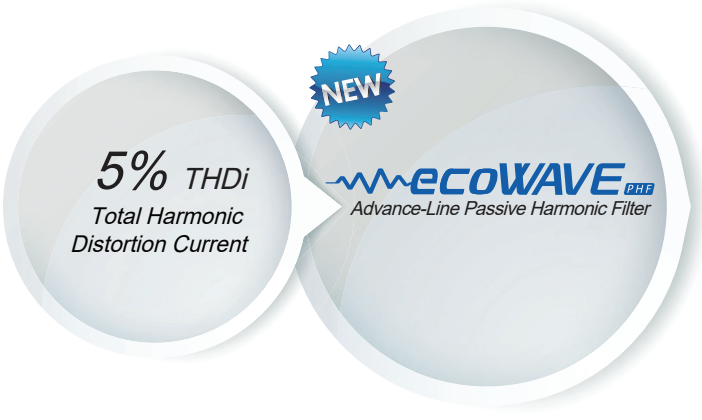
One major aspect of electrical power is its quality and stability – or so called power quality. A high level of power quality is needed to enable the reliable function of equipment and systems and can only be guaranteed with reliable partners such as the Fuji Electric. This is in particular true for 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% THDi and meeting IEEE-519 standard for inverter (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 filters.

ecoWAVE PHF

Advance-Line Passive Harmonic Filter (AL1M) (THDi 5%)

THDi 5% / IP20 / 50Hz & 60Hz / 0.75kW to 250kW

- The industry standard for 6-pulse rectifier and motor drives
- Filters for diode rectifier without DC-link choke and thyristor rectifier
- Best-in-class partial load performance
- Most compact design
- Plug and play, ready to use

Approvals

(depending on filter configuration)

Features and benefits

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, 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	50 Hz, 0.75 to 250kW	60 Hz, 0.75 to 200kW
Total harmonic current distortion THDi*	≤5% at rated power	
Efficiency	>98% for rated voltage and power	
High potential test voltage	P –> E 2160 VAC (1s)	
Protection category	IP20	
Cooling	Internal fan cooling or external cooling**	
Overload capability	1.6x rated current for 1minute, once per hour	
Ambient temperature range	–25°C to +45°C fully operational +45°C to +70°C derated operation*** –25°C to +85°C transport and storage	
Flammability corresponding to	UL 94 V-2	
Design corresponding to	Filter: UL 61800-5-1, EN 61800-5-1 Chokes: EN 61558-2-20 or EN 60076-6	
Earthing System	TN, TT, IT	
MTBF @45°C/415 V (Mil-HB-217F)	>200,000 hours	
SCCR****	100 kA	
Overvoltage category	OV III (IEC 60664-1 / UL 61800-5-1)	
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: THDv <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. THDi ~5% at rated power for filter <6 kW

** 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)

**** External UL-rated fuses required. Please consult the user manual.

Model code

F N 0.75 A L 1 M - 4 G 5

CODE	Product Type
FN	Passive Harmonic Filter

CODE	kW Rating
0.75	0.75kW
~	~
500	500kW

CODE	Series
AL1	Advance-Line Series 1
EL1	Econ-Line Series 1

CODE	Protection
M	IP20 Enclosure Type
S	IP00 Skid Type

CODE	Hz
5	50Hz
6	60Hz

CODE	Destination
G	Global Model

CODE	Input power source
4	400 Voltage Class *

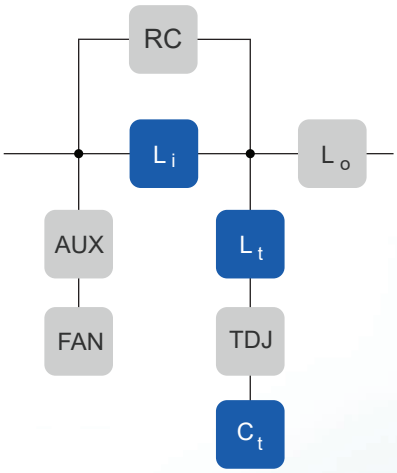
* Exact input power source please refer to technical specifications
** Refer to ecoWAVE Advance-Line IP00 Skid Type Catalog.

Applications

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% THDi
- 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

50 Hz IP20 enclosure

Rated Voltage	Nominal applied motor [kW]	Filter	Motor drive input current [Arms]***	Rated filter input current [Arms]	Typical Losses [W]****	Terminal	Frame
50Hz 3-Phase 380-415V Class	0.75	FN0.75AL1M-4G5 *	3	1.63	61	110	A
	1.5	FN1.5AL1M-4G5 *	5.5	3.26	87	110	
	2.2	FN2.2AL1M-4G5 *	5.5	3.26	87	110	
	3.7	FN3.7AL1M-4G5 *	10	5.93	135	112	B
	5.5	FN5.5AL1M-4G5 *	13	8.17	183	112	C
	7.5	FN7.5AL1M-4G5 *	16	11.1	256	112	
	11	FN11AL1M-4G5	24	16.3	287	113	D
	15	FN15AL1M-4G5	32	22.2	359	113	
	18.5	FN18.5AL1M-4G5	38	28.2	343	113	
	22	FN22AL1M-4G5	45	32.5	460	115	E
	30	FN30AL1M-4G5	60	44.4	570	115	
	37	FN37AL1M-4G5	75	54.8	581	115	
	45	FN45AL1M-4G5	90	66.7	783	115	
	55	FN55AL1M-4G5	110	81.6	858	115	
	75	FN75AL1M-4G5	150	111	1036	116	G
	90	FN90AL1M-4G5	180	134	1166	116	
	110	FN110AL1M-4G5	210	164	1365	118	H
	132	FN132AL1M-4G5 **	260	197	1392	118	H
	160	FN160AL1M-4G5 **	320	240	1462	118	
	200	FN200AL1M-4G5 **	400	300	1644	118	
	250	FN250AL1M-4G5 **	530	376	1746	119	J

* Filter rating which does not require forced cooling or fan module.
** Filter rating which does not require RC damping module for rectifiers with EMI filter.
*** Motor drive input current without harmonic filter
**** Typical losses @ 45°C, 400 V, 50 Hz and rated load power

60 Hz IP20 enclosure

Rated Voltage	Nominal applied motor		Filter	Motor drive input current [Arms]***	Rated filter input current [Arms]	Typical Losses [W]****	Terminal	Frame
	[kW]	[HP]						
60Hz 3-Phase 440-480V Class	0.75	1	FN0.75AL1M-4G6 *	2	1.37	50	110	A
	1.5	2	FN1.5AL1M-4G6 *	4	2.76	67	110	
	2.2	3	FN2.2AL1M-4G6 *	4	2.76	67	110	
	3.7	5	FN3.7AL1M-4G6 *	7	4.57	116	112	B
	5.5	7 1/2	FN5.5AL1M-4G6 *	11	6.91	132	112	
	7.5	10	FN7.5AL1M-4G6 *	14	9.29	160	112	C
	11	15	FN11AL1M-4G6	21	13.8	237	113	
	15	20	FN15AL1M-4G6	27	18.5	294	113	D
	18.5	25	FN18.5AL1M-4G6	34	23.1	351	113	
	22	30	FN22AL1M-4G6	44	27.8	354	113	
	30	40	FN30AL1M-4G6	52	37.2	459	115	E
	37	50	FN37AL1M-4G6	66	46.2	571	115	
	45	60	FN45AL1M-4G6	83	55.6	589	115	
	55	75	FN55AL1M-4G6	103	69.3	821	115	F
	75	100	FN75AL1M-4G6	128	92.5	1028	115	
	90	125	FN90AL1M-4G6	165	115	1067	116	G
	110	150	FN110AL1M-4G6	208	139	1143	116	
	132	200	FN132AL1M-4G6 **	240	184	1538	118	H
	160	250	FN160AL1M-4G6 **	320	231	1411	118	
	220	300	FN220AL1M-4G6 **	403	279	1775	118	

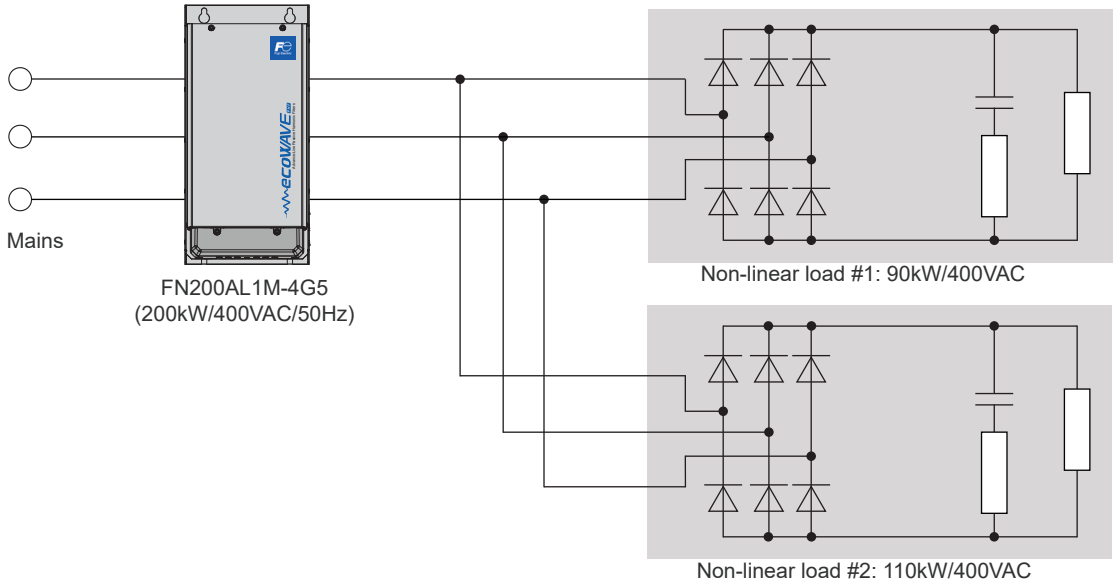
* Filter rating which does not require forced cooling or fan module.
** Filter rating which does not require RC damping module for rectifiers with EMI filter.
*** Motor drive input current without harmonic filter
**** Typical losses @ 45°C, 400 V, 50 Hz and rated load power

Harmonic Mitigation

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.

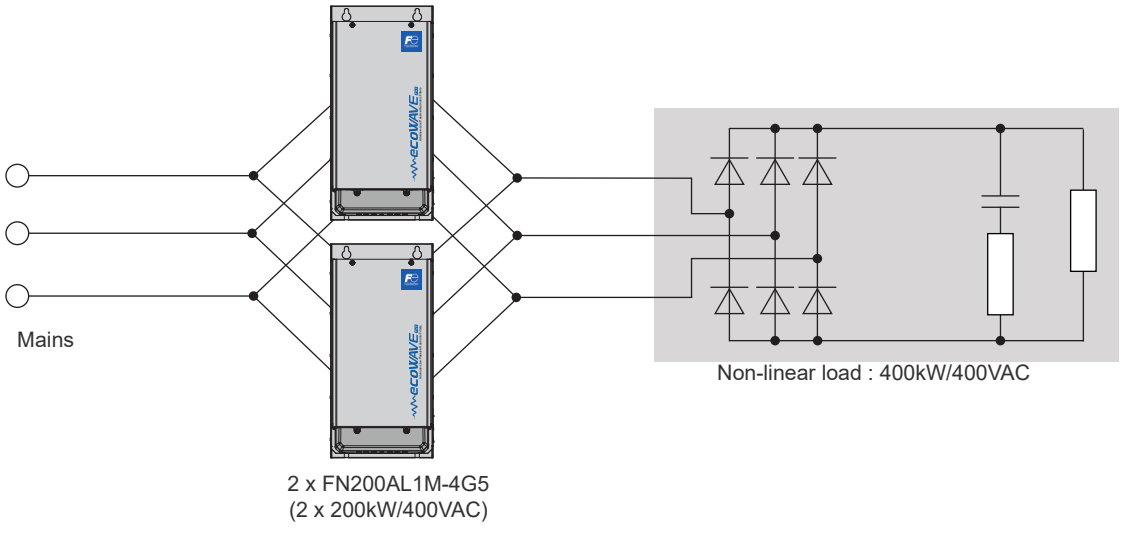
One advantage of load-applied filtering is the fact that the upstream power (relative to the harmonic filter) is clean, i.e. unloaded by the harmonics. This can be of vital importance when the same power bus supplies both motor drives and sensitive loads. ecoWAVE Advance-Line PHF are also suitable for 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

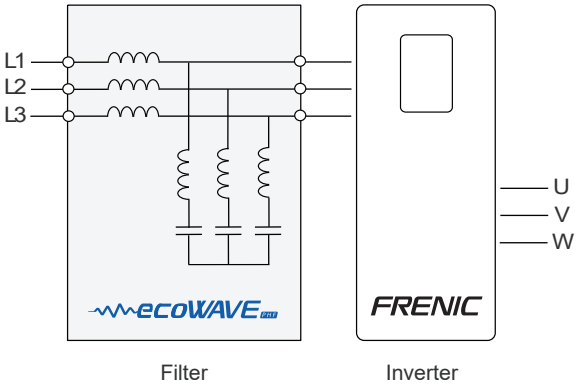


Application example with 2 filters in parallel for larger load

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.

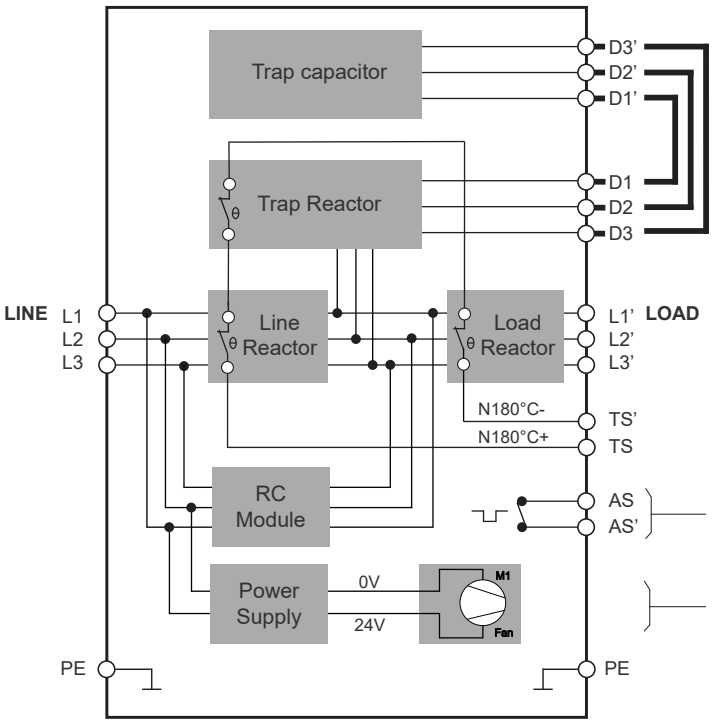


Typical electrical schematic - IP20 Type



The typical electrical schematic shows ecoWAVE filter connected directly to an inverter application. The ecoWAVE filter can be applied in electrical system level (electrical main supply board) to achieve result if load factor is well calculated.
(consult your local Fuji Electric for more solutions)

Function diagram - IP20 Type



TDJ Module
(Disconnect jumper)

Introduce an optional isolation contactor to disconnect trap capacitor and eliminate power leading factor when low load or no load.

(refer to ecoWAVE Advance-Line IP20 Manual for more information.)

Only applicable for FN250AL1M-4G5

Power Supply & Fan Module
Not applicable for
FN0.75AL1M-4G5 ... FN7.5AL1M-4G5
FN0.75AL1M-4G6 ... FN7.5AL1M-4G6

Parts	Terminal	Functions
LINE Choke	L1 / L2 / L3	Incoming supply terminal
LOAD Choke	L1' / L2' / L3'	Outgoing load terminal
Thermal Switch	TS / TS'	Connecting terminals to thermal switch NC 180°C (UL approved) to detect overload in chokes
Auxiliary Supply	AS / AS'	Terminal for auxiliary connection - Only application for FN250AL1M-4G5
Protective Earth	PE	Protective earth. Threaded stud with washer and nut
TDJ Module (Trap disconnect)	D1 / D2 / D3 D1'/ D2'/ D3'	3 couples of terminals. For optional configurations with TDJ*, wire bridges are installed for immediate operation of the filter. They allow for the connection of an external contactor for load dependent disconnection of the trap circuit, if needed.
Chokes	Temperature sensors	Power magnetic components incl. temperature sensors
Capacitors	Discharge resisitors	Power capacitors incl. discharge resistors
Fan	24V ventilation fan	Field replaceable fan for choke air cooling
Power Supply	24V power supply	Internally generate 24 V DC source for fan supply
RC Module	Controller	Temperature monitoring, monitor switch triggering

50 Hz Mechanical frame sizes

ecoWAVE Advance-Line PHF are implemented on a base plate (IP20 enclosure) featuring 8 different base plate frame sizes, Frame A to J from the lowest to the highest rating. Frame size footprint are provided in diagram 1.

In particular, the IP20 enclosure frame sizes A to C do not require air flow, while the IP20 frame sizes D to J need embedded fan or external ventilation. In additional, ventilation fan is require when mounting these IP20 enclosure type filters in an electrical panel.

Diagram 1.
IP20 Frame Size Footprint

A	B	C	D	E	F	G	H	J
No Ventilation Fan			Air flow cooling (embedded ventilation fan)					
0.75 kW 1.5 kW 2.2 kW	3.7 kW	5.5 kW 7.5 kW	11 kW 15 kW 18.5 kw	22 kW 30 kW 37 kW 45 kW 55 kW	*	75 kW 90 kW	110 kW 132 kW 160 kW 200 kW	250 kW

* Do not utilize frame F for 50 Hz system.

50 Hz Engineering Filters

In case of larger capacity rating filter; The ecoWAVE Advance-Line IP00 Skid Type (engineering filters) Please refer to ecoWAVE Advance-Line IP00 Skid Type catalog.

50 Hz IP00 Skid Type (engineering filters)	
250 kW	Skid S10 Frame
315 kW	Skid S10 Frame
355 kW	Skid S12 Frame
400 kW	Skid L10 Frame
500 kW	Skid L12 Frame

NOTE: Consult your local Fuji Electric for these engineering filters or refer to this installation and user manual.

50Hz IP20 enclosure

Rated Voltage	Nominal applied motor [kW] ***	Filter	Outside dimensions (mm)			Weight	Frame Size
			W	H	D	[kg]	
50Hz 3-Phase 380-415V Class	0.75	FN0.75AL1M-4G5 *	160	360	185	8	A
	1.5	FN1.5AL1M-4G5 *				11	
	2.2	FN2.2AL1M-4G5 *				11	
	3.7	FN3.7AL1M-4G5 *	180	425	206	15	B
	5.5	FN5.5AL1M-4G5 *	210	483	221	19	C
	7.5	FN7.5AL1M-4G5 *				23	
	11	FN11AL1M-4G5	260	560	252	32	D
	15	FN15AL1M-4G5				36	
	18.5	FN18.5AL1M-4G5				37	
	22	FN22AL1M-4G5	290	750	319	53	E
	30	FN30AL1M-4G5				55	
	37	FN37AL1M-4G5				66	
	45	FN45AL1M-4G5				73	
	55	FN55AL1M-4G5				75	
	75	FN75AL1M-4G5	353	960	386	126	G
	90	FN90AL1M-4G5				147	
	110	FN110AL1M-4G5	462	1150	456	175	H
	132	FN132AL1M-4G5 **				194	
	160	FN160AL1M-4G5 **				219	
	200	FN200AL1M-4G5 **				267	
	250	FN250AL1M-4G5 **	550	1400	555	350	J

* Filter rating which does not require forced cooling or fan module
** Filter rating which does not require RC damping module for rectifiers with EMI filter
*** Motor drive input current without harmonic filter

Sample view of the filter

60 Hz Mechanical frame sizes

ecoWAVE Econ-Line PHF are implemented on a base plate (IP20 enclosure) featuring 8 different base plate frame sizes, Frame A to J and 2 different base frame sizes,

In particular, the IP20 enclosure frame sizes A to C do not require air flow, while the IP20 frame sizes D to H need embedded fan or external ventilation. In additional, ventilation fan is require when mounting these IP20 enclosure type filters in an electrical panel.

Diagram 2.
IP20 Frame Size Footprint

A	B	C	D	E	F	G	H
No Ventilation needed			Air flow cooling (embedded ventilation fan)				
0.75 kW 1.5 kW 2.2 kW	3.7 kW 5.5 kW	7.5 kW 11 kW	15 kW 18.5 kW 22 kW	30 kW 37 kW 45 kW	55 kW 75 kW	90 kW 110 kW	132 kW 160 kW 220 kW

60 Hz Engineering Filters

In case of larger capacity rating filter; The ecoWAVE Advance-Line IP00 Skid Type (engineering filters) Please refer to ecoWAVE Advance-Line IP00 Skid Type catalog.

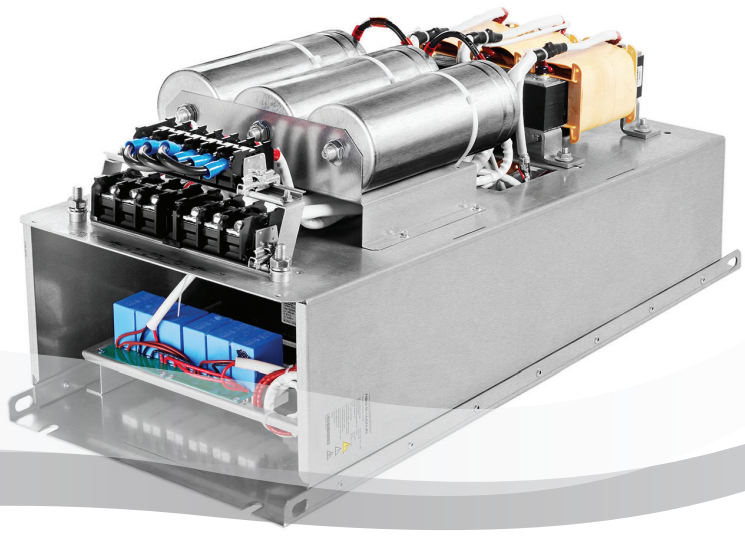
60 Hz IP00 Skid Type (engineering filters)	
260 kW	Skid S10 Frame
300 kW	Skid S10 Frame
335 kW	Skid S12 Frame
370 kW	Skid L10 Frame
450 kW	Skid L12 Frame

NOTE: Consult your local Fuji Electric for these engineering filters.

60Hz IP20 enclosure

Rated Voltage	Nominal*** applied motor		Filter	Outside dimensions (mm)			Weight	Frame Size
	[kW]	[HP]		W	H	D	[kg]	
60Hz 3-Phase 440-480V Class	0.75	1	FN0.75AL1M-4G6 *	160	360	185	7	A
	1.5	2	FN1.5AL1M-4G6 *				9	
	2.2	3	FN2.2AL1M-4G6 *				9	
	3.7	5	FN3.7AL1M-4G6 *	180	425	206	11	B
	5.5	7 1/2	FN5.5AL1M-4G6 *				14	
	7.5	10	FN7.5AL1M-4G6 *	210	483	221	17.4	C
	11	15	FN11AL1M-4G6				20	
	15	20	FN15AL1M-4G6	260	560	252	31	D
	18.5	25	FN18.5AL1M-4G6				35	
	22	30	FN22AL1M-4G6				40	
	30	40	FN30AL1M-4G6	290	750	319	52	E
	37	50	FN37AL1M-4G6				57	
	45	60	FN45AL1M-4G6				65	
	55	75	FN55AL1M-4G6	340	752	434	67	F
	75	100	FN75AL1M-4G6				90	
	90	125	FN90AL1M-4G6	353	960	386	125	G
	110	150	FN110AL1M-4G6				146	
	132	200	FN132AL1M-4G6 **	462	1150	456	187	H
	160	250	FN160AL1M-4G6 **				204	
	220	300	FN220AL1M-4G6 **				269	

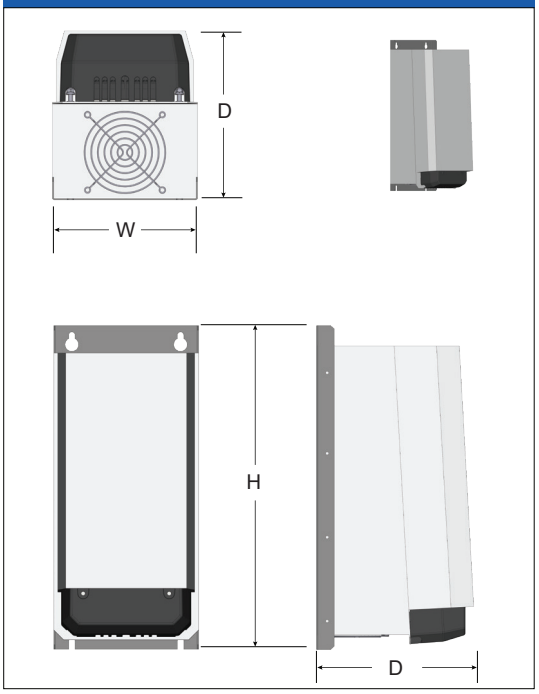
* Filter rating which does not require forced cooling or fan module
** Filter rating which does not require RC damping module for rectifiers with EMI filter
*** Motor drive input current without harmonic filter



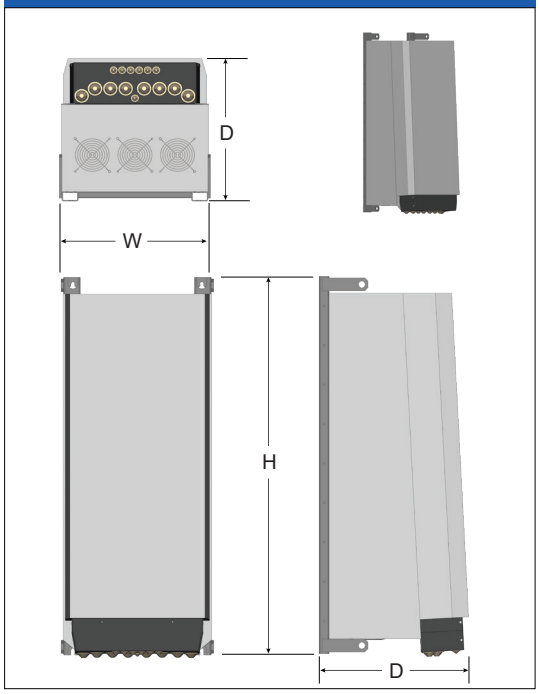
Sample view of the filter without front cover

50 Hz / 60 Hz IP20 enclosure outline

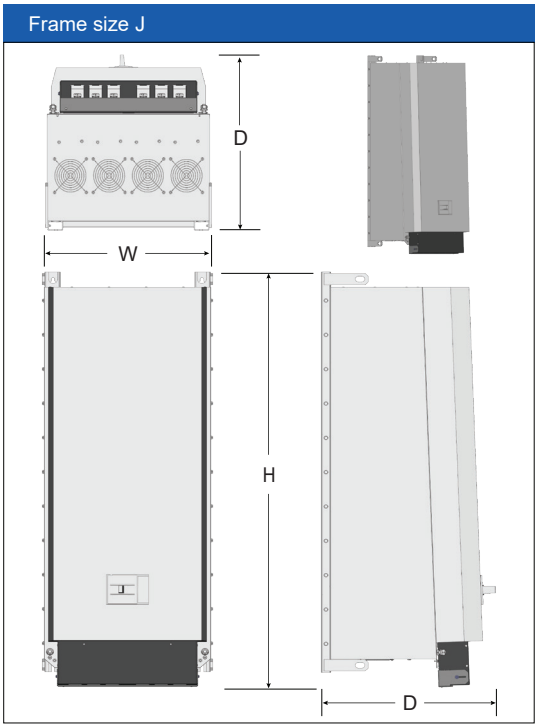
Frame sizes A, B, C & D



Frame sizes E, F, G & H



Frame size J



NOTE: Frame J integrated with MCCB.

The IP20 enclosure protective structure included safety finger guard.
Refer to ecoWAVE Advance-Line IP20 installation & user manual for more information.

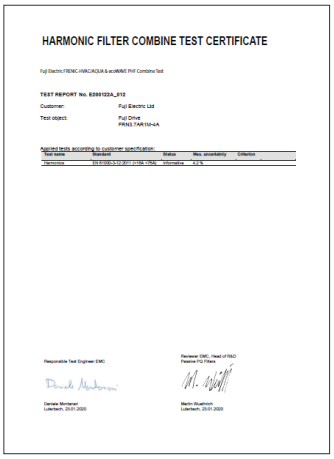
Overview

Selecting and installing the appropriate ecoWAVE Advance-Line Passive Harmonic Filter in inverter application within this published technical specifications and achieve guarantee result that current distortion will be less than or equal to 5% THDi at rated power. ecoWAVE filter series can also provide similar performance in other inverter applications such as constant torque, DC drives or other phase controlled rectifiers, eg. SCR drives, but actual THDi levels can vary by load and/or speed and/or firing angle of the thyristors and therefore cannot be guaranteed.

Consult your local Fuji Electric for assistance when applying ecoWAVE filters on these types of equipment.

Performance Guarantee

ecoWAVE Advance-Line filter series are combine tested with Fuji Electric FRENIC inverter series for guarantee performance. These tests was done in international standard laboratory with analysis of harmonic disturbances meeting the most stringent compliance in the industries conforming IEEE 519-2014 standard. This catalog offers the essential knowledge on the selection of the filters. Follow the above guideline carefully and enjoy maximum benefits of these filters.



HARMONIC FILTER COMBINE TEST CERTIFICATE

Fuji Electric FRENIC-HVAC/AQUA & ecoWAVE PHF Combine Test

TEST REPORT No. 82001234_012

Customer: Fuji Electric Ltd

Test object: Fuji Drive
FRN3.7AR1M-4A

Applied tests according to customer specification:

Test name	Standard	Status	Max. uncertainty	Criterion
Harmonics	EN 61000-3-12:2011 (=IEC 61000-3-12:2011)	informative	4.0 %	

Responsible Test Engineer EMC

Daniele Monterosi
Lüneburch, 23.01.2020

Reviewer EMC, Head of R&D
Passive PQ Filters

Martin Wuethrich
Lüneburch, 23.01.2020

Test Certificate

< 5% THDi

Total Harmonic Distortion Current

ecoWAVE PHF

Fuji Electric offers an extensive range of support services to help ensure the reliability of your installation in the long term, control your maintenance costs, and keep your process running at peak performance for maximum efficiency. ecoWAVE PHF series has been tested in harmony with range of FRENIC inverter and services offered by Fuji Electric.

Our field service engineers follow a proven Inverter & filters certification program designed to support you with maximum expertise and efficiency using range of professional tools and software to provide fast, in-depth diagnostics and repairs.

Consult your local Fuji Electric for these maintenance and support program.

Fuji Electric

Innovating Energy Technology

FRENIC *Inverter series*

Technology made possible by Fuji Electric intensive range of inverter

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