

Innovating Energy Technology

Fuji Electric Harmonic Mitigation



# Installation & User Manual



Fuji Electric Asia Pacific Pte. Ltd.





#### © All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means without the prior written permission of Fuji Electric Co., Ltd. The information in this manual is subject to change without notice. Every precaution has been taken in the preparation of this manual.

Fuji Electric assumes no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained in this publication.

#### Document name:

ecoWAVE Advance-Line PHF Installation and User Manual .pdf

Version history Revision	Date	Description
01	Jun 2020	Initial version
02	Jun 2023	Version 2.0

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-al1m/

NOTE: This manual consist of 2 different model PHF;

- 50Hz ecoWAVE Advance-Line PHF / IP20 Enclosure type - 60Hz ecoWAVE Advance-Line PHF / IP20 Enclosure type

# > Product Highlights

Fuji Electric ecoWAVE Advance-Line passive harmonic filters (PHF) are configurable products which provide a tailored solution to each specific problem of current harmonics mitigation of 3-phase non-linear loads.

The product type Advance-Line 50Hz (FNXXXAL1M-4G5) & Advance-Line 60Hz (FNXXXAL1M-4G6) are applicable for low voltage 50 Hz and 60 Hz systems and they are particularly suitable for AC and DC motor drives, battery chargers and other power electronics applications with 6-pulse front-end rectifiers.

ecoWAVE Advance-Line passive harmonic filter technology represents an evolution following aspects of novelty:

- ecoWAVE Advance-Line PHF is designed for the most demanding harmonic mitigation tasks. The filter are designed for three-phase diode and thyristor rectifier, to achieve THDi ≤5% even without DC-link choke included in the drive. The new generation filters guarantee compliance with the toughest requirement of IEEE-519 and other stringent international power quality standards.
- ecoWAVE Advance-Line PHF demonstrates superior partial load performance. The excellent performance of ecoWAVE filters not only reflects on mitigating harmonic current and bringing the THDi down to 5% (diode rectifiers @ rated power), but also introducing minimum reactive power, even at partial or no load condition. The displacement power factor remains at cosφ >0.98 @ 50% load.
- The modular concept of the filters offers optimal tailored solution. ecoWAVE Advance-Line PHF are configurable filters, optional modules includes fan with aux. power supply, fan without aux. power supply, trap disconnect jumper and RC damper modules. Optimal solutions can be achieved by merely plugging a new module according to different installation conditions and drive setups.
- Most compact design, robust, reliable and ready to use.

This user manual is intended to support designers, installers, and application engineers with filter selection, installation, application and maintenance. It provides helpful solutions to overcome harmonics mitigation challenges and answers frequently asked questions.

If you require additional support, please feel free to contact your local Fuji Electric representative.

# > Performance Guarantee

Selecting and installing the appropriate ecoWAVE Advance-Line PHF in a inverter application, Fuji Electric FRENIC inverter series or inverter application within our published technical specifications we guarantee that the input current distortion will be less than or equal to 5% THDi\* for standard ecoWAVE Advance-Line series filters at rated power.

ecoWAVE Advance-Line filters can also provide similar performance in other inverter (AC drive) applications such as constant torque, DC drives or other phase controlled rectifiers, e.g. SCR drives, but actual THDi levels can vary by load and/or speed and/or firing angle of thyristors and therefore cannot be guaranteed. Consult your local Fuji Electric representative for assistance when applying ecoWAVE Advance-Line PHF on these types of equipment.

#### **Minimum system requirements**

- The guaranteed performance levels of this filter will be achieved when the following system conditions are met:
- Type of load: Any 3-phase equipment with front-end six-pulse diode rectifier without DC-link choke (FNXXXAL1M-4G5 or FNXXXAL1M-4G6)\*\*
- Type of source: 3-phase power line without neutral
- Line impedance: <3% (calculated for the rated filter power)
- Line frequency: 50 Hz ±1 Hz (FNXXXAL1M-4G5)\*\*, 60 Hz ±1 Hz (FNXXXAL1M-4G6)\*\*
- Line voltage: Nominal line voltage ±10%
- Line voltage unbalance: <1%
- Line voltage distortion: THDv <2%

If a properly sized and installed filter fails to meet the 5% THDi level, Fuji Electric will provide the necessary application engineering support or filter replacement at no charge.

# Important user notice

Fuji Electric ecoWAVE Advance-Line PHF are designed for the operation on the input (grid) side of power electronic equipment with six-pulse rectifier front-ends in balanced three-phase power systems, like typically used in AC or DC motor drives and high power DC supplies. Filter suitability for a given application must be determined by the user on a case by case basis. Fuji Electric will not assume liability for any consequential downtimes or damages resulting from use or application of ecoWAVE filters outside of their specifications. ecoWAVE filters are not designed for single-phase or split-phase applications.

\* THDi: Total Harmonic Distortion Current

\*\* Refer to page 1 for understanding of product code.



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



# > General Safety Notes and Installation Guidelines

# For Fuji Electric

# FUJI ELECTRIC CO., LTD.

Gate City Ohsaki, East Tower, 11-2, Osaki 1-chome, Shinagawa-ku, Tokyo 141-0032, Japan www.fujielectric.com

Fuji Electric Power Quality Filters

#### 1. Important Information

These general safety notes refer to the group of power quality filters including Advance-Line passive harmonic filter (PHF). Do not attempt to install, operate, maintain or inspect power quality filters until you have read through the safety notes and installation guidelines as well as installation manual and product specification. Do not use any Fuji Electric product until you have a full knowledge of the equipment, safety notes and installation guidelines. The same applies to all warnings placed on the filters. Please ensure that those are not removed and their legibility is not influenced by external factors.

The following symbols, terms and designation are used in these general safety notes and installation guidelines:

Label	Description
	Follow these instructions to avoid hazardous conditions which could case minor or moderate injury or may cause damages to the unit.
	Follow these instructions to aviod hazardous conditions which could result in death or serious injury.
NOTICE	Indicates content to be noted by the reader.

# 2. General Installation Notes

Please read and follow the safety and application notes below.

Carefully inspect the shipping container and the product prior to the installation. In case of visual damage, don't install the filter and file a claim with freight carrier involved.

Filters may be heavy. Follow the instruction for lifting heavy equipment defined by your company.

Use an appropriately sized threaded bolt for every mounting hole/slot provided by the filter flange. The strength class of the bolt must be determined by the installer, depending upon filter weight and material of the mounting surface.

Connect the filter to the protective each (PE) terminal(s).

Remove all line side power, then connect the phase terminal(s) and neutral terminal (if any) of the filter. The filter label may also indicate LINE (grid side terminal) and LOAD (power electronics terminals).

For the electrical connection of the filter terminals, apply the torques recommended on the filter label and/or in the publish filter datasheets.

Cable or busbar cross section have to be chosen in accordance with national and international electric codes and applicable product standards governing the equipment that will incorporate the power quality filters and the equipment in use.

Some filters provide additional terminals, e.g. for over-temperature monitoring. These features have to be properly used before energizing the filter. if uncertain, please consult your local Fuji Electric representative.

In order to get maximum benefit out of your power quality filter, please also consult additional user manuals, installation manuals, whitepaper and other material, published in the download section of www.fujielectric.com These additional guidelines provide helpful hints for equipment related topics as well as technical knowledge.



# > Safety Notes and Regulations

<ol> <li>Label on equipment</li> <li>Safety note category</li> </ol>	Safety note regulations
	Equipment installation, start-up. operation and maintenance (if any) have to be carried out by a trained and certified electrician or technician, who is familiar with safety procedures in electrical system. Non-qualified person are not allowed to use, install, operate or maintain the PQ filters!
	High voltage potentials are involved in the operation of power quality equioment. Always remove power before handling energized parts of the filter, and let ample time elaspse for the capacitors to dischange to safe levels (<42V). Residual voltage are to be measured both line to line and line to earth.
	Correct protective earthing of the equipment must be established and the user must be protected against supply voltage in accordance with applicable national and local regulations. Always practice the safety procedures defined by your company and by applicable national electric codes when handling, installing, operating or maintaining electrical equipment.
	Some product may include EMC filters which may cause leakage currents to ground. Always connect the filter to protective earth (PE) first, then continue with the wiring of phase/neutral terminals. When decommissioning the filter, remove the PE connection at the end.
	Follow the general installation and environmental condition notes closely. Ensure that cooling slots (if any) are free from obstructions that could inhibit efficient air circulation. Operate the filter within its electrical, mechanical, thermal and ambient specifications at all times.
	Follow the general installation and environmental condition notes closely. Ensure that cooling slots (if any) are free from obstructions that could inhibit efficient air circulation. Operate the filter within its electrical, mechanical, thermal and ambient specifications at all times.
NOTICE	At altitudes above 2000m, please contact Fuji Electric prior to Installation.
NOTICE	Filter suitability for a given application must ultimately be determined by the user (the party that is putting the filter into operation) on a case by basis. Fuji Electric will not assume liability for any consequential downtimes or damages resulting from use of the filters outside their specifications.
	In case of uncertainty and question please contact your local Fuji Electric or its partner for assistance (details per region available at www.fujielectric.com).



# ecoWAVE Advance-Line

Passive Harmonic Filter

# > Content

Product Versions	page A
Introduction	
- Product highlights	page B
- Performance Guarantee	page C
- General Safety Notes and Installation Guidelines	page D
- Safety Notes and Regulations	page E
Madel Colortion	
Model Selection	page 1
	page 1
Specifications	
- Additional electrical specifications	page 2
Specifications (50 hz Type)	
- General electrical specifications (50 Hz filters)	page 3
- 50 Hz Technical data	page 4
- 50 Hz Frame size	page 5
- 50 Hz Outline drawing	page 6
- 50 Hz Dimensions data	page 7
Specifications (60 hz Tune)	
- General electrical specifications (60 Hz filters)	page 8
- 60 Hz Technical data	page 9
- 60 Hz Frame size	page 10
- 60 Hz Outline drawing	page 11
- 60 Hz Dimensions data	page 12
- Terminals	page 13 - 14
- Filter performance	page 15 - 16
- Wiring Diagram	page 17 - 18
- Structure Design	page 19-20
- Application	page 21
Installation	
- Step 1: Visual inspection	page 22
- Step 2: Mounting	page 23
- Step 3: Wiring	page 24 - 26
- Fuse	page 27
Maintenance	
- Maintenance schedule	page 28
- Ventilation Fan	page 28
- Power capacitors	page 29
- Electrical connections	page 29
Additional Information	
- Trap circuit disconnect (TDJ module)	page 30
- Troubleshooting	page 31
- Publications disclaimer	page 32

# Explanation of product code



# Model selection

Select the most suitable filter rating for your application, even if there is no DC-link choke present in the inverter, ecoWAVE Advance-Line PHF series help to reduce THDi to 5% @ rated power. In other words, there are three chokes (line choke, trap choke and load choke) included in this filter series.

For ecoWAVE Advance-Line (AL) series.

Examples of 22kW 50Hz filter select to meet 5% THDi; ecoWAVE Advance-Line PHF FN22AL1M-4G5 : Filter for 50 Hz, 380–415 V AC grid, motor inverter power rating 22kW, IP20

Examples of 22kW 60Hz filter select to meet 5% THDi; ecoWAVE Advance-Line PHF **FN22AL1M-4G6** : Filter for 60 Hz, 440–480 V AC grid, motor inverter power rating 22kW, IP20

In case of ecoWAVE Econ-Line (EL) series.

Examples of 18.5kW 50Hz filter select to meet 10% THDi; ecoWAVE Econ-Line PHF FN18.5EL1M-4G5 : Filter for 50 Hz, 380–415 V AC grid, motor inverter power rating 18.5kW, IP20 Examples of 18.5kW 60Hz filter select to meet 10% THDi; ecoWAVE Econ-Line PHF FN18.5EL1M-4G6 : Filter for 60 Hz, 440–480 V AC grid, motor inverter power rating 18.5kW, IP20

(Refer to ecoWAVE Econ-Line series User and Installation Manual.)

In case you have difficulties to decide for the right filter, please contact your local Fuji Electric or representative for support.

# Altitude correction factors

ecoWAVE Advance-Line PHF general electrical specifications refer to operating altitudes up to 2000m a.s.l. (6600ft). Operation between 2000m and 4000m (6600ft and 13123ft) requires a derating for current and clearance according to IEC 60664-1, hereafter enclosed:

Altitude m	Normal Barometric Pressure kPa	Multiplication factor for Clearance
2,000	80.0	1.00
3,000	70.0	1.14
4,000	62.0	1.29
5,000	54.0	1.48
6,000	47.0	1.70
7,000	41.0	1.95
8,000	35.5	2.25
9,000	30.5	2.62
10,000	26.5	3.02
15,000	12.0	6.67
20,000	5.5	14.5

Table 1 - Altitude correction factors

Remark: Do not use ecoWAVE PHF in altitudes above 4000m without consulting Fuji Electric first.

# **Cooling requirement**

Inlet air flow requirements for each frame size are listed in Table 2. Please notice that the filters with frame size A, B and C do not require air cooling. For frame sizes D to J, the required inlet air flow should be fulfilled, either by including the optional Fan module or by providing sufficient external air flow.

Table 2 - Inlet air flow required for cooling

Frame Size	Minimum Air Volume* [ m³ / h ]
A, B, C	0
D	128
E	204
G	408
Н	612
J	816

\* External air flow required filter configurations without embedded ventilation

Remark: External air flow is required for the cooling at filter's inlet as defined in the table only for filters without embedded ventilation.



50 Hz System





Mounting type		Wall mounting			
Degree of protect	ion	IP 20			
Power range for	Nominal operating voltage	Three-phase: 380415 V			
50 Hz line	Voltage tolerance range	Three-phase: 342457 V			
supply	Operating frequency	50 Hz ±1 Hz			
	Nominal motor drive input power rating	0.75250kW			
Network	According IEC 60364-3	TN earthing			
		TT earthing			
		IT earthing			
Performance	Total harmonic distortion current (THDi)@	<5% @ rated power 0			
	Total demand distortion (TDD) 🧕	According to IEEE 519			
	Efficiency	>98% @ nominal line voltage and power			
	Drive dc-link voltage 🔞	-5% ~ +10% nominal VDC			
Safety	High potential test voltage <b>(</b>	P> E 2160 VAC (1s)			
	SCCR 0	100kA, fuses according UL class J			
(	Overload capability	1.6x rated current for 1 minute, once per hour			
	Capacitive current @ no load	<20% of rated input current, at 480 V AC			
	Flammability class	UL 94V-2			
	Insulation class of magnetic components	1N (200°C), H (180°C)			
	Safety monitor output signal	Thermal switch NC 180° C (UL-approved) to detect overload of chokes			
Ambient	Fully operational	-25°C to +45°C			
range	Derated operation	+45°C to +70°C 0			
-	Transportation and storage	-25°C to +85°C			
	Cooling	Internal fan cooling or external cooling 3			
Maintenance	Lifetime (calculated)	≥10 years			
	MTBF @ 45°C/415 V (Mil-HB-217F)	>200,000 hours			
	MTTR	<15 minutes (capacitor modules and fan modules)			
Standard	Complete	UL 61800-5-1, EN 61800-5-1			
	Chokes	EN 61558-2-20 or EN 60076-6			
	Pollution degree	PD3 (according to standard IEC 60664-1)			
References					

THDi ~5% at rated power for filter <4kW.

System requirements: THDv <2%, line voltage unbalance <1% Performance specification for six-pulse diode rectifiers.</li>
 SCR rectifier front-ends produce different results, depending upon the firing angle of the thyristors.

Conditions: line impedance <3%

@ Repetitive tests to be performed at max. 80% of above levels, for 2 seconds.

External UL-rated fuses required.

- Please check the inlet air flow required for cooling in Table 17
- Iderated = Inominal × $\sqrt{((70^{\circ}C-Tamb)/25^{\circ}C)}$

# > Filter Selection - 50 Hz Type Technical Data

# 50Hz IP20 enclosure

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

For 250kW to 500kW rating filter, please refer to ecoWAVE Advance-Line IP00 Skid Type (Engineering filters).

# 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. Dimensions and 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.



Example of the higher kW rating filter; The ecoWAVE Advance-Line IP00 Skid Type (enginnering filters) Please refer to ecoWAVE Advance-Line IP00 Skid Type catalog.



50 Hz IP00 Skid	I 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.

# > Dimensions Outline Drawing

50 Hz & 60 Hz IP20 Enclosure Outline Drawing







# > 50 Hz Dimensions Data

# 50Hz IP20 enclosure

Rated	Nominal applied motor	Filter	Frame	Outside dimensions (mm)			Mounting Drill (mm)			Front
Voltage	[kW]	[kW]	1 faile	W	н	D	W1	H1	тø	X
	0.75	FN0.75AL1M-4G5 *							7	
	1.5	FN1.5AL1M-4G5 *	A	160	160 360	185	120	340		302
	2.2	FN2.2AL1M-4G5 *								
	3.7	FN3.7AL1M-4G5 *	В	180	425	206	120	405	7	370
	5.5	FN5.5AL1M-4G5 *	0	210	193	221	150	460	7	430
	7.5	FN7.5AL1M-4G5 *	C	210	405	221	150	400		
	11	FN11AL1M-4G5	D	260	560	252	180	540	11	491
	15	FN15AL1M-4G5								
	18.5	FN18.5AL1M-4G5								
50Hz	22	FN22AL1M-4G5	E	290	750	319	220	680	11	635
3-Phase 380-415V	30	FN30AL1M-4G5								
Class	37	FN37AL1M-4G5								
	45	FN45AL1M-4G5								
	55	FN55AL1M-4G5								
	75	FN75AL1M-4G5	G	353	960	386	280	920	11	683
	90	FN90AL1M-4G5	9	353						
	110	FN110AL1M-4G5					390	1115		4050
	132	FN132AL1M-4G5 **	u	460	1150	456				
	160	FN160AL1M-4G5 **	п	402	1150					1000
	200	FN200AL1M-4G5 **								
	250	FN250AL1M-4G5 **	J	550	1400	555	480	1348	11	1300

\* 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

For higher kW rating filter; The ecoWAVE Advance-Line IP00 Skid Type (enginnering filters) Please refer to **ecoWAVE Advance-Line IP00 Skid Type** catalog.



60 Hz System





Mounting type		Wall mounting
Degree of protect	lion	IP 20
Power range for	Nominal operating voltage	Three-phase: 440480 V
60 Hz line	Voltage tolerance range	Three-phase: 396528 V
suppiy	Operating frequency	60 Hz ±1 Hz
	Nominal motor drive input power rating	0.75220kW / 1.5300 HP
Network	According IEC 60364-3	TN earthing
		TT earthing
		IT earthing
Performance	Total harmonic distortion current (THDi)	<5% @ rated power 0
	Total demand distortion (TDD) 🥹	According to IEEE 519
	Efficiency	>98% @ nominal line voltage and power
	Drive dc-link voltage 😧	-5% ~ +10% nominal VDC
Safety	High potential test voltage 4	P> E 2160 VAC (1s)
	SCCR 🗿	100kA, fuses according UL class J
	Overload capability	1.6x rated current for 1 minute, once per hour
	Capacitive current @ no load	<20% of rated input current, at 480 V AC
	Flammability class	UL 94V-2
	Insulation class of magnetic components	1N (200°C), H (180°C)
	Safety monitor output signal	Thermal switch NC 180° C (UL-approved) to detect overload of chokes
Ambient	Fully operational	-25°C to +45°C
range	Derated operation	+45°C to +70°C 0
	Transportation and storage	-25°C to +85°C
	Cooling	Internal fan cooling or external cooling O
Maintenance	Lifetime (calculated)	≥10 years
	MTBF @ 45°C/415 V (Mil-HB-217F)	>200,000 hours
	MTTR	<15 minutes (capacitor modules and fan modules)
Standard	Complete	UL 61800-5-1, EN 61800-5-1
	Chokes	EN 61558-2-20 or EN 60076-6
	Pollution degree	PD3 (according to standard IEC 60664-1)
References		FN□□AL1M-4G6

• THDi ~5% at rated power for filter <4kW.

Ø System requirements: THDv <2%, line voltage unbalance <1% Performance specification for six-pulse diode rectifiers.</p>

SCR rectifier front-ends produce different results, depending upon the firing angle of the thyristors.

- Conditions: line impedance <3%
- Repetitive tests to be performed at max. 80% of above levels, for 2 seconds.
- External UL-rated fuses required.
- Please check the inlet air flow required for cooling in Table 17
- Iderated = Inominal× $\sqrt{(70^{\circ}\text{C-Tamb})/25^{\circ}\text{C}}$

# > Filter Selection - 60Hz Technical Data

# 60Hz IP20 enclosure

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

\* 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

For 250kW to 450kW rating filter, please refer to ecoWAVE Advance-Line IP00 Skid Type (Engineering filters).

# 60 Hz Mechanical frame sizes

ecoWAVE Econ-Line PHF are implemented on a base plate (IP20 enclosure) or base frame (IP00 Skid type) featuring 9 different base plate frame sizes, Frame S10 & S12 from the lowest to the highest rating. Dimensions and footprint are provided in diagram 2 and diagram 3.

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. The IP00 Skid type filter require air flow according to the "Inlet air flow required for cooling" shows in the dimensions data pages and should adopt additional electrical panel ventilation fan.



Example of the higher kW rating filter; The ecoWAVE Advance-Line IP00 Skid Type (enginnering filters) Please refer to **ecoWAVE Advance-Line IP00 Skid Type** catalog.



250 kW Skid S10 Frame 315 kW Skid S10 Frame 355 kW Skid S12 Frame
400 kW Skid L10 Frame 450 kW Skid L12 Frame

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

# > Outline Drawing

50 Hz & 60 Hz IP20 Enclosure Outline Drawing







# > 60 Hz Dimensions

# 60Hz IP20 enclosure

Rated Voltage     a       60Hz     a       3-Phase     a       440-480V     a       Class     a	Nominal	Filter	Frame	Outsid	e dimension	is (mm)	Mou	Front		
	[kW]	W] Size W	Н	D	W1	H1	тø	X		
	0.75	FN0.75AL1M-4G6 *						ĺ		
60Hz 3-Phase 440-480V Class	1.5	FN1.5AL1M-4G6 *	A	160	360	185	120	340	7	302
	2.2	FN2.2AL1M-4G6 *								
	3.7	FN3.7AL1M-4G6 *	B	190	425	206	120	405	7	370
	5.5	FN5.5AL1M-4G6*	В	100	420	200	120	405	1	570
	7.5	FN7.5AL1M-4G6 *	C	210	483	221	150	460	7	430
	11	FN11AL1M-4G6								430
60Hz	15	FN15AL1M-4G6		260	560	252	180	540		
	18.5	FN18.5AL1M-4G6	D						11	491
	22	FN22AL1M-4G6								
3-Phase 440-480V	30	FN30AL1M-4G6		290	750	319	220	680		
440-480V Class	37	FN37AL1M-4G6	Е						11	635
	45	FN45AL1M-4G6								
	55	FN55AL1M-4G6	_	0.40	750	242	050	700		004
	75	FN75AL1M-4G6	F	340	752	343	250	730	11	684
	90	FN90AL1M-4G6	G	353	960	386	280	920	11	693
	110	FN110AL1M-4G6	0	555	900	500	200			000
	132	FN132AL1M-4G6 **								
	160	FN160AL1M-4G6 **	н	462	1150	456	390	1115	11	1053
	200	FN200AL1M-4G6 **								
	220	FN220AL1M-4G6 **	J	550	1400	555	480	1348	11	1300

\* 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

For higher kW rating filter; The ecoWAVE Advance-Line IP00 Skid Type (enginnering filters) Please refer to **ecoWAVE Advance-Line IP00 Skid Type** catalog.

# > Terminal Data

	Power Terminal					minal (PE)	Signal <sup>-</sup>	Ferminal
Frame Size*	Screw Thread	Flex Wire AWG	Screw Torque Value [Nm]	Max Width** Cable lug [mm]	Screw Thread	Screw Torque Value [Nm]	Screw Thread	Screw Torque Value [Nm]
Α	M3	14 - 22	0.4 - 2.5	7	M5	2.2		
В	M4	10 - 22	04 46	10	M6	4		
С		10-22	0.4 - 4.0	10	WIO			
D	M6	6 - 18	0.75 - 16		M8	0	M0***	0.5
E		1/0 - 8	10 - 50	15	IVIO	9	IVIS	0.5
F	M8	170 - 0	10 - 50					
G		3/0 - 8	10 - 95	17	M10	17		
Н	M10	3/0 - 500 kcmil	95 - 240	35				
J	M16	350 - 750 kcmil	185 - 400	48	M12	25		

# 50Hz/60Hz IP20 Power Terminals

\*\*\* Recommended connector type: wire or cable lug for frame A to frame D, only cable lug for frame E to frame H.

\*\*\* To fufill creepage/clearance acc. UL61800-5-1 without additional protection (insulation). Creepage/clearance can vary depending on applicable

standard and must be reviewed by customer. Creepage/clearance may be reduced when additional protection (insulation) is provided.

\*\*\* Max width cable lug = 7 mm

ecoWAVE Advance-Line PHF need to be carefully selected and configured in order to enjoy maximum benefits.

#### Step 1: Grid frequency

Determine, whether the system in consideration will be operated in a 50 Hz or 60 Hz electricity grid, and select the corresponding filter series according to the following table:

- 50 Hz grid Europe, Middle East, parts of Asia, parts of South America (FSXXXAL1X-4G5)
- 60 Hz grid North and Central America, parts of Asia, parts of South America (FSXXXAL1X-4G6)

Note: a 50 Hz filter will not provide satisfying harmonics mitigation in a 60 Hz grid, and vice versa.

#### Step 2: Grid voltage

Verify that the grid configuration is suitable for standard ecoWAVE Advance-Line PHF according to the following table:

•	50 Hz grid Nominal voltage 380–415 V AC	 TN, TT, IT configuration
	60 Hz grid Nominal voltage 440–480 V AC	 TN, TT, IT configuration

Step 3: Rectifier type, presence of DC-link choke in drive

ecoWAVE filter only for use in 6-pulse diode rectifier with or without DC-link choke

#### Step 4: Rectifier/Drive input power

 The individual filter must be selected with respect to the rectifier/motor drive input power in kW respectively. It is important to match rated filter power as close as possible with the effective input power of the rectifier/ drive.

Note that if the rectifier/drive is being operated very close to its rated power, then the filter can be selected by the motor drive's nominal power rating. However, if the drive will be operated e.g. at only 66% of its rated power, then a smaller filter should be selected in order to get maximum harmonics mitigation performance and the optimum in terms of cost, size, and weight. In that case the customer is responsible to ensure that ecoWAVE passive harmonic filter will be operated within specification. This is particular important in terms of overload.

Please refer to the following examples:

Example 1: Power line rating: 400 V, 50 Hz (FN15AL1M-4G5) Drive rating: 380–500 V, 50–60 Hz, 15 kW, 22.5 A, B6-diode rectifier without DC-link choke Planned rectifier/drive input real power: 15 kW (100% of drive rating)

Example 2: Power line rating: 480 V, 60 Hz (FN15AL1M-4G6) Drive rating: 380–500 V, 50–60 Hz, 15 kW, 22.5 A, diode rectifier Planned rectifier/drive input real power: 15 kW (100% of drive rating)

Oversizing of passive harmonic filters is not recommended because of the inherent lower harmonic mitigation performance at partial load as well as higher cost, size, and weight.

ecoWAVE Advance-Line Filter with embedded ventilation. The filters 0.75kW - 250kW IP20 tenclosure ype contain embedded ventilation, which means the filters contain fan and aux. power supply.

# > Techincal Data - Filter performance

ecoWAVE Advane-Line PHF achieve 5% THID with 6-pulse diode rectifiers under the following condition.

Filter is applied to rated voltage and power THVD <2%, line voltage unbalance <1%

RC damper module is required to be included in the filter if there is EMI filter present in the drive. Typical expected EMI filter capacitance (phase to star point) are shown in Table 3 & Table 4.

#### Table 3

Typical expected EMI filter capacitance (phase to star point) for series 50Hz ecoWAVE Advance-Line PHF

kW Rating	Microfarads
1.1kW	1.5 µF
2.2kW	2.2 µF
3.7kW - 11kW	3.3 µF
15kW - 45kW	4.7 µF
55kW - 250kW	10 µF

# Table 4

Typical expected EMI filter capacitance (phase to star point) for series 60Hz ecoWAVE Advance-Line PHF

kW Rating	Microfarads
1.1kW	1.5 µF
2.2kW	2.2 µF
3.7kW - 15kW	3.3 µF
18.5kW - 45kW	4.7 μF
55kW - 220kW	10 µF

Note:

132...200 kW of 50Hz ecoWAVE Advance-Line PHF , and 160...220kW of 60Hz ecoWAVE Advance-Line PHF series do not need RC damper module when the equivalent phase to star point capacitance of the EMI filter is not bigger than 10 µF.

5% THID is not guaranteed for thyristor rectifier application. The performance of the filter is dependent on the firing angle of the thyristors.

ecoWAVE Advance-Line PHF performance (THID, power factor and Udc) under different load conditions with are shown in the following charts.



THID vs. load (diode rectifier front-ends)





Drive dc-link voltage vs. load (diode rectifier front-ends, with 50Hz series)



# > Techincal Data

• Wiring Diagram - IP20 Enclosure Type



# • Typical electrical schematic - IP20 Enclosure Type



The typical electrical schematic shows ecoWAVE filter connected directly to an AC drive's appplication. 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 solutions)

# > Techincal Data

• Wiring Diagram - IP00 Skid Type



Filter	Line (supply)	L1/L2/L3					
terminals	Load (output)	L1' / L2' / L3'					
	Signal	Connecting terminals to thermal switch NC 180°C (ULapproved) to detect overload in chokes					
	PE	Protective earth. Threaded stud with washer and nut					
	Trap disconnect	3 couples of terminals. For optional configurations with TDJ, wire					
	D1/D2/D3 & D1'/D2'/D3'	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.					
Function	Chokes	Power magnetic components incl. temperature sensors					
blocks	Capacitors	Power capacitors incl. discharge resistors					
	Fan	Field replaceable fan for choke air cooling					
	Power supply	Internally generate 24 V DC source for fan supply					
	RC damper	RC damper module, as option configurable in case of rectifier equipped with EMI filter					

# > Techincal Data - Structure Design

The base module of 50Hz / 60Hz filter series contains line choke, load choke, trap choke and trap capacitor, which helps reduce THID to 5% for motor drives without DC-link choke present.



There are five modules within the filter;

Fan and aux. power supply module
Fan only module
Trap disconnect jumper module
Switch module (only for frame J)
RC damper module

# Filter appearance and elements

The very compact and neat design of ecoWAVE passive harmonic filters is realized by a two-stage construction. The filter construction of all frame size are identical, except the position of the load choke. The load choke is build on the upper-stage of the filter for frame size A- F, and on the lower-stage of the filter for frame sizes G - H, which are explained in detail in the following sections.

IP 20 Enclosure

ecoWAVE passvie harmonic filters IP 20 versions are shown in Figure 16 and Figure 17. The filters are equipped with cover and finger guard.



Figure 1 & 2 Design of IP 20 version ecoWAVE Advance-Line PHF with frame size D (left) and frame size H (right)



Figure 3 Design of IP 20 version ecoWAVE filter with frame size J

Parameters of IP 20 enclosure finger guard are shown in Table 5.

Frame size	Finger guard cross-section width /diameter [mm]	Material
A	5.5	Plastic
В	8.0	Plastic
С	8.0	Plastic
D	11	Plastic
E	14	Metal
F	14	Metal
G	18.5	Metal
н	30	Metal
J	42	Metal

Table 5 Parameters of finger guard of IP 20 enclosure

# **Application example**

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. n this case the total expected load power of all connected drives must match the filter.



Application example with multiple loads per filter

Non-linear load #2: 75kW/400VAC

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

# Installation Details

Please follow the simple steps below to ensure a safe and reliable filter function for many years. Please do also always follow the general safety and installation guidelines provided within this document as well as relevant local, national or international standards that are applicable. Please note that the following installation steps are applicable for the IP 20 enclosure.

#### Step 1: Visual inspection

All ecoWAVE Advance-Line PHF have undergone rigorous testing before they left the ISO 9001:2008 certified factories. They are packaged with great care in a sturdy container for international shipment.

However, carefully inspect the shipping container for damage that may have occurred in transit. Then unpack the filter and carefully inspect for any signs of damage. Keep the shipping container for future transportation of the filter.

In the case of damage, please file a claim with the freight forwarder involved immediately and contact your local Fuji Electric partner for support. Under no circumstances install and energize a filter with visible transportation damage.

If the filter is not going to be put in service upon receipt, store within the original container in a clean, dry location, free of dust and chemicals and with respect to named temperature limits, refer to page 3 on **General electrical specification's** ambient temperature range.

#### Step 2: Mounting

ecoWAVE Advance-Line PHF are best installed as close as possible to the non-linear load. Ideally they are mounted next to the rectifier or motor drive inside the electrical cabinet or control room.

The ecoWAVE Advance-Line PHF are designed for wall-mounting installation.

#### Important:

In order to ensure sufficient air flow, keep a clearance of min. 150mm above and below the filter to walls or other components. Additional work to access the device, caused by not respected clearance distances, will be accounted separately.

It must be ensured that the environmental temperature is kept below 45°C with appropriate thermal management (e.g. cabinet cooling). Filter operation in environments with higher temperatures require a temperature derating.



For more information. Refer to "Getting Started with ecoWAVE Advance-Line PHF" instruction manual. Document #AL1M-PHF-INM/V1.1 1) Screw hole positions for wall mounted filters (as indicated in Table 6):

Table 6. Mounting screw hole positions.									
Frame	Drill pattern [mm]								
Tame	W1	H1	ТØ						
А	120	340	7						
В	120	405	7						
С	150	460	7						
D	180	540	11						
E	220	680	11						
F	250	730	11						
G	280	920	11						
Н	390	1115	11						
J	480	1348	11						

All dimensions in mm; 1 inch = 25.4mm

 Screw selection: Fuji Electric recommends zinc coated hex ribbed flange steel bolts. Respect filters weight for appropriate choice of screws! Head diameters must not exceed these dimensions:





M6: d ≤14.2mm, M10: d ≤21.2mm

3) Filter placement:

- Set screws loose into wall, leave 5mm distance from head to wall.
- 2 Lift filter with appropriate crane, smallest types (up to 25kg) may be lifted manually by two persons.
- Place filter first onto lower screws...
- ...then position it through backplane head openings on upper screws.
- Fix screws with appropriate torque (depending upon the material of the back plane and local standards).



For more information. Refer to "Getting Started with ecoWAVE Advance-Line PHF" instruction manual.

Document #AL1M-PHF-INM/V1.1

# Installation

#### Step 3: Wiring

1. Verify safe disconnection of all line side power. Consult your local safety instructions.



- Carefully connect protective earth (PE) wire to adequate earth potential close to ecoWAVE filter. Use a wire diameter of equal or bigger size as foreseen for line/load side power cables – according to your local codesand safety instructions.
- 3. Connect PE wire of ecoWAVE filter with appropriate cable lug to threaded stud.



Ensure proper grounding from load to supply.

Refer to user manual, ensure the ground cable are the recommended size according to application rating.

4. Connect ecoWAVE load side terminals L1', L2', L3' to respective motor drive or rectifier inputs.

See Table 1 for the recommended wire size and torque. Use stranded copper wire with a temperature rating of 75°C or higher.

An optional workflow to connect power terminals without having the TDJ module in way is applied. You might consider following these steps:

Connecting power terminals of passive harmonic filters ordered with TDJ module can be facilitated by removing the trap disconnect wires while connecting the cables to the main terminals. Afterwards the trap disconnect jumper cables need to be applied to the original position again. Please follow these steps: Open terminals D1- D1', D2- D2'and D3- D3', remove the wires, add main terminals and then fix wires on terminals D1- D1', D2- D2'and D3- D3' again. The recommended torques given on the terminal label must be applied.

#### Remarks regarding IP 20 enclosure

1. To connect ecoWAVE line and load side terminals, the fingure guard has to be removed as a first step, and be installed again when the line and load side terminals are connected. The screw thread and torque value for all the frame sizes are:

| Screw thread: M5 | Screw torque value: 4Nm

2. The metal finger guard for frame sizes E, F and G are equipped with grommets, whilst figner guard H is equipped with stepped collars. Modify the stepped collars according to the cable isolated diameter, 5-10mm margin is recommended to feed the cable easier.

# Installation

- 3. Note that if the cable lug is wider than the cross-section width/diameter of the finger guard (see page 20, Table 5), do not add cable lugs before feeding all cables though the cable grommet (finger guard). Crimp cable lug when the cables are fed through the cable grommet.
- 4. Install shrinking tube for the uninsulated cable lug to fulfill the clearance and creepage requirement.
- 5. To install finger guard for frame size J, firstly connect the load and line side terminals, then install the upper part of the finger guard by placing the cables through the slots and tighening the screw on the top, thirdly close the other part of the finger guard. The bottom part of the finger guard shall be pushed as close as possible to the cable, and tighten the other two screws on the sides.

#### Note:

In case the cables on the power terminals are installed without cable lug, it is recommended to follow the maintenance manual closely. Maintenance manual is available on your request per Fuji Electric contact.

5. Use wired trap circuit or install external capacitive current control. When interconnected via an external capacitor contactor (not supplied by Fuji Electric) they allow for load dependent disconnection of the trap circuit, if needed. Thus capacitive current can be minimized for low load operation. Estimation of required contactor size: see box to the right.

Recommended contactor:

- Fuji Electric SC series contactor
   Fuji Electric SK series contactor

# Sizing of contactor

#### Step 1

Example: FN55AL1M-4G5

55kW x 20% x 
$$\frac{Vgrid}{Vnom}$$
 / 55kW x 20% x  $\frac{400V}{400V}$  = 11kVAR

Contactor performance estimate: The nominal power rating in kW multplies 20% and the grid voltage, then divided by the nominal voltage. The approximate reactive power Contactor rating for FN55AL1M-4G5 = 11kVAR

# Step 2

Calculate the line current i1 :

$$i1 = \frac{Q}{U\sqrt{3}} = \frac{11000}{400 \times 1.732} = 15.87A$$

In case of 60 Hz calculation, use 460V instead of 400V.

#### Step 3

Use a safety factor (standard) to take harmonics into account, this gives :

```
Ie (Contactor) = I1x1.43 = 15.87 x1.43 = 22.7A
```

The selected contactor should not be smaller then 22 7A

The selected contactor SC series : SC-N1 AC220V 2A2B (24A)

In case of inverter application, its recommended the use of "delay run" of at least 3 second on the inverter to enable the harmonic filter's capacitor to charge up when contactor closed. This will prolong the lifetime of these capacitor.

6. Connect monitor switch TS-TS'

The monitor switch is a relay contact, which is open in ALARM state. It is constituted by a thermal switch NC 180°C (UL-approved) to detect overload of chokes. It may either be used to remotely disconnect the drive's load via respective input of drive control (check drive manual) or as alarm sensor for system control unit.

AN ENGAGED MONITOR SWITCH MUST LEAD TO IMMEDIATE LOAD SHUTDOWN AND INVESTIGATION OF THE PROBLEM.

7. Connect auxiliary switch AS- AS' (only relevant for frame J filter 50Hz types) The auxiliary switch is a contact, which indicates state. AN ENGAGED AUXILIARY SWITCH MUST LEAD TO IMMEDIATE LOAD SHUTDOWN AND INVESTIGATION OF THE PROBLEM.





D2

D3



Diagram 5.



# Installation

The auxiliary switch is a contact, which indicates state of circuit breaker. It is closed under normal operation (CB on) and is open in abnormal condition (CB off). Abnormal condition can be a short circuit in the trap capacitors, overcurrent in the trap circuit, too hot ambient temperature or switch-off status in low load condition (use of motor mechanism together with the circuit breaker – check relevant section in user manual).



- Connect ecoWAVE line side terminals L1, L2, L3 to power input protection (current limiting fuses see below). IP 20 enclosure cable wiring please refer to the remarks for the load side cable wiring.
  - Note: For IP 20 filter versions the IP 20 finger guard must be installed in order to achieve IP 20 protection. When the finger guard is not installed, Fuji Electric do not guarantee IP 20 protection.

#### 9. Fuses

ecoWAVE PHF need external over-current protection for compliance with UL/cUL standard. Fuses and associated fuse holders must be UL listed and rated for 100kA SCCR supplies. Table 7 on page 27 show requested fuse current ratings for UL class J and, where UL compliance is not mandatory, for IEC class gG. The fuse rating is independent of the supply voltage.

A system with multiple ecoWAVE PHF paralleled for a high power load need each a separate 3-phase line side fuse block, corresponding to the respective filter and according to above table.

The drive's application manual may prescribe line-side fuse protection as well, which in this case either corresponds to the sum of the filter fuse ratings or, if lower, would request separate drive fuses at its input.



An application, having one ecoWAVE filtering harmonics of several drives, requires in any case line side fuse protection of the drives as well as the correct filter protection according to Table 7 on page 27.



Nominal applied motor [kW]	50Hz Filter	Fuse class J [A]	Fuse class gG [A]
0.75	FN0.75AL1M-4G5 *	2.5	2
1.5	FN1.5AL1M-4G5 *	8	8
2.2	FN2.2AL1M-4G5 *	8	8
3.7	FN3.7AL1M-4G5 *	10	10
5.5	FN5.5AL1M-4G5 *	15	10
7.5	FN7.5AL1M-4G5 *	20	16
11	FN11AL1M-4G5	25	20
15	FN15AL1M-4G5	35	35
18.5	FN18.5AL1M-4G5	40	35
22	FN22AL1M-4G5	50	50
30	FN30AL1M-4G5	75	63
37	FN37AL1M-4G5	80	80
45	FN45AL1M-4G5	100	100
55	FN55AL1M-4G5	150	125
75	FN75AL1M-4G5	175	160
90	FN90AL1M-4G5	200	200
110	FN110AL1M-4G5	250	224
132	FN132AL1M-4G5 **	300	250
160	FN160AL1M-4G5 **	350	300
200	FN200AL1M-4G5 **	400	400
250	FN250AL1M-4G5 **	600	600

Table 7 Requested fuse current rating for UL class J and for IEC class gG

Nominal applied motor [kW]	60Hz Filter	Fuse class J [A]
0.75	FN0.75AL1M-4G6 *	2
1.5	FN1.5AL1M-4G6 *	4
2.2	FN2.2AL1M-4G6 *	4
3.7	FN3.7AL1M-4G6 *	7
5.5	FN5.5AL1M-4G6*	10
7.5	FN7.5AL1M-4G6 *	15
11	FN11AL1M-4G6	20
15	FN15AL1M-4G6	30
18.5	FN18.5AL1M-4G6	35
22	FN22AL1M-4G6	40
30	FN30AL1M-4G6	50
37	FN37AL1M-4G6	60
45	FN45AL1M-4G6	80
55	FN55AL1M-4G6	90
75	FN75AL1M-4G6	125
90	FN90AL1M-4G6	150
110	FN110AL1M-4G6	175
132	FN132AL1M-4G6 **	250
160	FN160AL1M-4G6 **	250
185	FN185AL1M-4G6 **	300
220	FN220AL1M-4G6 **	400

# > Maintenance Details

ecoWAVE PHF described in this manual are equipped with long life components that ensure a satisfactory function for many years under normal operating conditions. Any operation under extreme conditions such as over-temperatures, overvoltage situations, polluted environments etc. reduces the life expectancy. Following maintenance recommendation will help maximizing filter lifetime.

# Warnings:



High voltage potentials are involved in the operation of this product. Always remove line side power before attempting to perform maintenance, and let ample time elapse for the capacitors to discharge to safe levels (<42 V). Residual voltages are to be measured both line to line and line to earth.



Line side power must be disconnected prior to replacement of any part.

# 1. Maintenance schedule

Table 8. Maintenance schedule

Year	1	2	3	4	5	6	7	8	9	10	11	12
Check and clean fan(s)	X	X	Х	Х	Х	Х	X	Х	Х	Х	X	Х
Replace fan(s)					Х					Х		
Check & tighten el. Connections *	X	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Check el. values of capacitors		Х		Х		Х		Х		Х		Х
Replace power capacitors										Х		

\* Only external connections need to be checked.

#### 2. Fan

ecoWAVE PHF are reliable low maintenance products. Many products like power supplies, inverters or motor drives utilize fans for forced cooling to minimize size and weight. ecoWAVE PHF are designed with a similar temperature management concept and therefore, fans may have to be maintained and replaced in certain intervals to sustain the function and value of the product. Fans are 100% field replaceable without the need to uninstall and disconnect the filter.

Forced cooling devices are needed for the operation of ecoWAVE passive harmonic filters up to their nominal rating. Such cooling devices must be checked and cleaned regularly (if installed) to ensure sufficient air flow at all times.

Note: increased audible noise is a typical indicator of a fan that needs maintenance or replacement also outside of a maintenance schedule.

Before cleaning or replacing the cooling devices, make sure to consult the recommended maintenance procedures and schedules of the supplier of the cooling device in use.

#### 3. Power capacitors

The power capacitors supplied with the filter modules are high quality components with an expected life time of up to 100'000 hours (11 years). Nevertheless, their useful service life can be shortened by electrical or thermal stress beyond their specification.

Power capacitor damage may also be caused by severe abnormal supply voltage peaks (i.e. lightning – depending upon system protection), but may only be recognizable through the measurement of line side harmonics distortion. This may be checked with a modern energy meter or by regular checkup with a power quality analyzer. According to the above considerations, a 2 year inspection interval is advisable.

Note: an inspection should as well be performed after extreme overvoltage situations in the system.

# Note: Storage of capacitors

Up to 3 years-long storage, electrolitic capacitors can be operated without any restriction and the nominal voltage can be applied without any preliminary preparation. System reliability and life-time expectancy are not affected.

On the other side, a longer ( >3 yrs) storage of electrolitic capacitors without applying any voltage can weaken the dielectric properties because of disslution processes. The electrolitic solution is aggressive and it can affect and weaken the dielectric in the timeframe between production and product commissioning. The weak points are responsible for the higher leakage current shortly after the device turn-on on site.

The residual current of electrolitic capacitors depends upon time, voltage and temperature. The residual current increases after long storage without applying voltage.

The amplitude of resulting residual current during unit commissioning can be up to 10 times larger on short term. The capacitor's residual current assumes the typical expected value at steady state for nominal voltage.

During comissioning after long storage, it is recommended to restore the dielectric characteristics by applying voltage progressively and with respect to the time frame the filters have been stored.

#### 4. Electrical connections

Depending upon the environment and application, electrical connections, in particular threaded bolts and nuts, can degrade over time by means of losing their initial tightening torque. This holds true not only for the filter, but for any such joint within an electrical installation.

Therefore, Fuji Electric recommends to check and tighten all electrical connections on the occasion of a regular scheduled maintenance of the entire device that incorporates the filter.

Check of internal connections within the filters is not needed or should be conducted by a Fuji Electric service representative.

#### Trap circuit disconnect

The trap circuit disconnect feature is a modular option for the purpose of reducing the capacitive current during low load operation, if needed. With permanently connected trap circuit, cos vs. load shows following characteristics:



When the trap circuit is disconnected, cos(phi) returns to ~0.98. At the same time, the THID will increase. This may be negligible, since absolute values are low due to reduced load power. Needed external components (not part of ecoWAVE filter) or system functions for fully automated capacitive current control:

| Motor load (power factor) monitoring device

#### | Capacitor contactor

A reduced load system status may be available as system controller output signal. In this case, only adequate driving of capacitor contactor has to be assured.

Note: It is necessary to take into account overall concept of power factor correction. A system PFC correction unit with large capacitor banks may become obsolete or massively reduced, when harmonic filters are installed. In such cases it may not be necessary to install trap circuit disconnect functions.

#### Recommended settings:

Fuji Electric recommends to engage and disengage the trap circuit disconnect at following load levels:

Trap circuit status	Proposed load level
Disconnect	When load level drops under 10–15%
Connect	When load level rises above 20–25%

#### Troubleshooting

ecoWAVE PHF are high quality products and have undergone rigorous testing and qualification procedures. Every unit runs through suitable tests in our ISO 9001:2000 factories. Due to this reason no major issues need to be expected if the filter is installed, operated, and maintained as described in this document.

In the unlikely event of a problem, please contact your local Fuji Electric or partner for assistance.

# 11. Troubleshooting

Fuji Electric ecoWAVE harmonic filters are high quality products and have undergone rigorous testing and qualification procedures. Every unit runs through suitable tests in our ISO 9001:2000 factories. Due to this reason no major issues need to be expected if the filter is installed, operated, and maintained as described in this document.

In the unlikely event of a problem, please contact your local Fuji Electric or partner for assistance.

# Disclaimer

This document has been carefully checked. However, Fuji Electric does not assume any liability for errors or inaccuracies. Published specifications are subject to change without notice. Product suitability for an area of application must ultimately be determined by the customer. In all cases, products must never be operated outside their published specifications.

The purpose of this manual is to provide accurate information in the handling, setting up and operating of the ecoWAVE PHF series. Please feel free to send your comments regarding any errors or omissions you may have found, or any\ suggestions you may have for generally improving the manual.

In no event will Fuji Electric be liable for any direct or indirect damages resulting from the application of the information in this manual.

Fuji Electric does not guarantee the availability of all published products.

Latest publications and a complete disclaimer can be downloaded from the Fuji Electric website. All trademarks recognized.

Copyright © 2020 Fuji Electric Asia Pacific Pte Ltd. All rights reserved.





F Fuji Electric Asia Pacific Pte. Ltd.

151 Lorong Chuan #03-01/01A, New Tech Park Lobby A, Singapore 556741

Tel: +65 6533-0014

Fax: +65 6533-0021

Website: www.sg.fujielectric.com

Email x-fap-sales@fujielectric.com

© 2020 Fuji Electric Asia Pacific Pte Ltd. All Rights Reserved. Information in this catalog are subject to changes without prior notice. Fuji Electric can accept no responsibility for possible errors in catalog, brochures and other printed material. Fuji Electric is a trademark and property of Fuji Electric Co., Ltd. its subsidiaries and affiliated companies.