Fuji Electric

Innovating Energy Technology

Fuji Electric Harmonic Mitigation

ecoWAVE PHF

Advance-line Passive Harmonic Filters

Installation & User Manual

Fuji Electric Asia Pacific Pte. Ltd.

AL1M-PHF-MNL/V2

Fuji Electric

ecoWAVE PHF
Passive Harmonic Filters

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Version history

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

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 www.fujielectric.com

Table of Contents

ecoWAVE Advance-Line Passive Harmonic Filter

Safety Information

Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

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.

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!

DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

WARNING indicates a hazardous situation which, if not avoided, will result in death or serious injury.

CAUTION

CAUTION indicates a hazardous situation which, if not avoided, will result in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical imjury

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Fuji Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

Qualification Of Personnel

Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation are authorized to work on and with this product. In addition, these persons must have received safety training to recognize and avoid hazards involved. These persons must have sufficient technical training, knowledge and experience and be able to foresee and detect potential hazards that may be caused by using the product, by changing the settings and by the mechanical, electrical and electronic equipment of the entire system in which the product is used. All persons working on and with the product must be fully familiar with all applicable standards, directives, and accident prevention regulations when performing such work.

Product Application type

This product is a Passive Harmonic Filter for 3-phase 400V class inverter, UPS, DC fast chargers ect. Or any 3-phase power conversion equipment with front-end six-pulse rectifier AC and DC motor drives in low dynamic applications intended for industrial use according to this manual. The product may only be used in compliance with all applicable safety regulations and directives, the specified requirements and the technical data. Prior to using the product, you must perform a risk assessment in view of the planned application. Based on the results, the appropriate safety measures must be implemented. Since the product is used as a component in an entire system, you must ensure the safety of persons by means of the design of this entire system (for example, machine design). Any use other than the use explicitly permitted is prohibited and can result in hazards. Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel.

Product Related Information

Read and understand these instructions before performing any procedure with this product.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation and who have received safety training to recognize and avoid hazards involved are authorized to work on and with this filter system. Installation, adjustment, repair and maintenance must be performed by qualified personnel.
- The system integrator is responsible for compliance with all local and national electrical code requirements as well as all other applicable regulations with respect to grounding of all equipment.
- Many components of the product, including the printed circuit boards, operate with mains voltage. Do not touch. Use only electrically insulated tools.
- Do not touch unshielded components or terminals with voltage present.
- Prior to performing any type of work on the filter system, isolate power supply to prevent electric shock circuit.
- AC voltage can couple voltage to unused conductors in the power cable. Insulate both ends of unused conductors of the motor cable.
- Do not short across the filter's bus terminals or control bus terminals.
- Before performing work on the passive harmonic filter system:
  - Disconnect all power, including external control power that may be present.
  - Place a Do Not Turn On label on all power switches.
  - Lock all power switches in the open position.
  - Wait 15 minutes to allow the DC bus capacitors to discharge.
  - If the AC bus capacitors do not discharge properly, contact your local Fuji Electric representative. Do not repair or operate the product.
- Install and close all covers before applying voltage.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNEXPECTED SHOCK CIRCUIT

Harmonic Filter systems may result unexpected shock circuit because of incorrect power wiring, incorrect control wiring or other errors.

- Carefully install the wiring in accordance with this manual's informatiuon.
- Do not operate the product with unknown or unsuitable applications or connection.
- Perform a comprehensive commissioning test.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Damaged products or accessories may cause electric shock or unanticipated equipment operation.

⚠ ⚠ DANGER

ELECTRIC SHOCK OR UNANTICIPATED EQUIPMENT OPERATION

Do not use damaged products or accessories.

Failure to follow these instructions will result in death or serious injury.

Contact your local Fuji Electric sales office if you detect any damage whatsoever.

NOTICE

DESTRUCTION DUE TO INCORRECT MAINS VOLTAGE

Before switching on and configuring the product, verify that it is approved for the mains voltage

Failure to follow these instructions can result in equipment damage.

The metal surfaces of the product may exceed 100 °C (212 °F) during operation.

⚠ WARNING

HOT SURFACES

- Ensure that any contact with hot surfaces is avoided.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity of hot surfaces.
- Verify that the heat dissipation is sufficient by performing a test run under maximum load conditions.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

About this manual

At a Glance

Document Scope

The purpose of this document is:

- to give you mechanical and electrical information related to the ecoWAVE Passive Harmoinc Filter,
- to show you how to install and wire this filter.

Validity Note

NOTE:
The products listed in the document are not all available at the time of publication of this document online. The data, illustrations and product specifications listed in the guide will be completed and updated as the product availabilities evolve. Updates to the guide will be available for download once products are released on the market.

This documentation is valid for the ecoWAVE Advance-Line IP20 Passive Harmonic Filter series.

The technical characteristics of the devices described in this document also appear online. To access this information online:

Step	Action
1	Go to the Fuji Electric home page www.fujielectric.com .
2	In the Search box type the reference of a product or the name of a product range or look under Inverter product category for ecoWAVE Passive Harmonic Filter series.

The characteristics that are presented in this manual should be the same as those characteristics that appear online.
In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy.
If you see a difference between the manual and online information, use the online information as your reference.

How to read the 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

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 series.

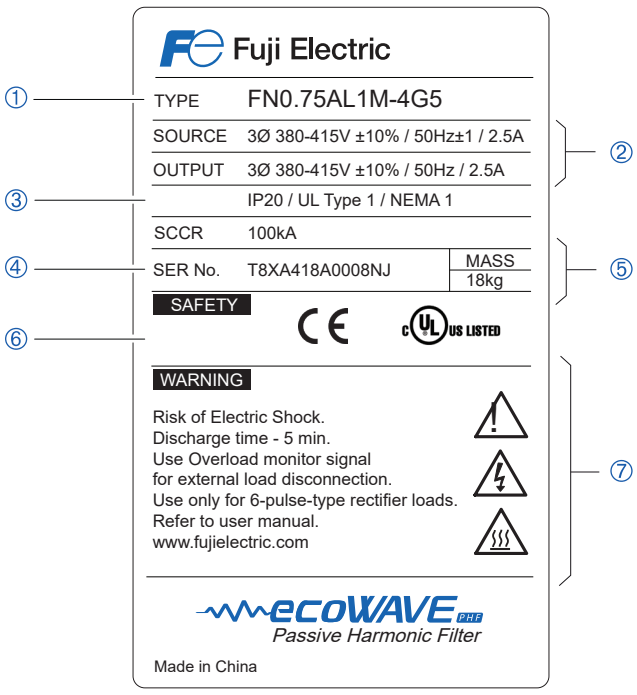
Examples of 22kW 50Hz filter select to meet 5% THDi;
ecoWAVE Advance-Line PHF
FN22AL1M-4G5 : Filter for 50 Hz, 380–415 V AC grid, motor inverter power rating 22kW, IP20

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

Nameplate example

The product nameplate contains the following data:



① Model Code
② Power part supply
③ Degree of protection
④ Serial Number
⑤ Product weight
⑥ Certifications
⑦ Safety Warning

Additional Electrical Specifications

Altitude correction

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:

Table 1 - Altitude correction factors

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

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

Cooling requirement

Table 2 - Inlet air flow required for cooling

Frame Size	Minimum Air Volume* [m^3 / h]
A, B, C	0
D	128
E	204
G	408
H	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 Type

Item	50 Hz System
Nominal operating voltage	3 x 380 VAC to 415 VAC ± 10%
Operating frequency	50 Hz ± 1 Hz
Nominal motor drive input power rating	50 Hz, 0.75 to 250kW
Total harmonic current distortion THDi ②	≤5% at rated power ①
Total demand distortion TDD ②	According to IEEE 519
Drive dc-link voltage ③	-5% ~ +10% nominal VDC
Efficiency	>98% for rated voltage and power
High potential test voltage ④	P --> E 2160 VAC (1s)
Protection category	IP20
Overvoltage category	OV III (IEC 60664 / UL 61800-5-1)
Overload capability	1.6x rated current for 1 mintute, once per hour
Cooling	Internal fan cooling or external cooling ⑥
Ambient temperature rage	- 25°C to +45°C fully operational +45°C to +70°C derated operation ⑦ - 25°C to +85°C transport and storage
Flammability corresponding to	UL 94 V-2
Insulation class of magnetic components	N (200°C), H (180°C)
Design corresponding to	Filter: UL 61800-5-1, EN 61800-5-1 Chokes: EN 61558-2-20 or EN 60076-6
Earth system	TN, TT, IT
SCCR ⑤	100 kA
MTBF @ 45°C) / 415V (Mil-HB-217F)	>200,000 hours
MTTR	<15 minutes (capacitor modules and fan modules)
Safety monitor output signal	Thermal switch NC 180°C (UL-approved) to detect overload of chokes)
Pollution degree	PD3 (according to standard IEC 60664-1)
Lifetime (calculated)	≥10 years
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

① THDi ~5% at rated power for filter <4kW.
② System requirements: THDv <2%, line voltage unbalance <1% Performance specification for six-pulse diode ectifiers. SCR rectifier front-ends produce different results, depending upon the firing angle of the thyristors.
③ Conditions: line impedance <3%
④ Repetitive tests to be performed at max. 80% of above levels, for 2 seconds.
⑤ External UL-rated fuses required.
⑥ Please check the inlet air flow required for cooling at page 9 Table 2 (Cooling requirement)
⑦ Iderated = Inominal×√ ((70°C-Tamb)/25°C)

Specifications 50 Hz Type

Technical data

3-Phase, 380...415VAC, 50 Hz

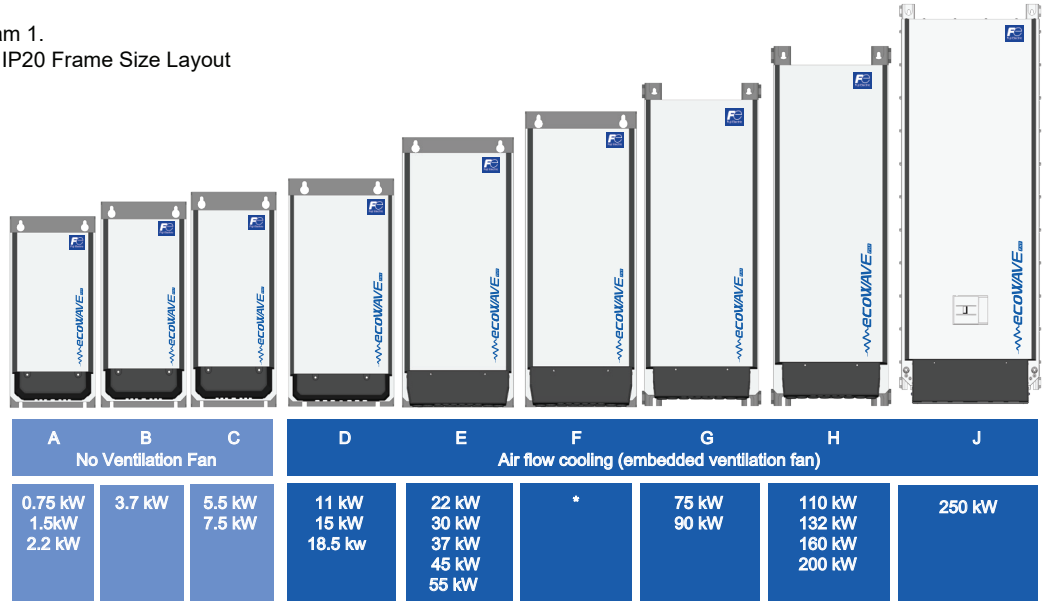
Rated Voltage	Nominal applied motor [kW]	Filter	Motor drive input current [Arms]***	Rated filter input current [Arms]	Typical Losses [W]****	Terminal	Frame
50Hz 3-Phase 380-415V Class	0.75	FN0.75AL1M-4G5 *	3	1.63	61	110	A
	1.5	FN1.5AL1M-4G5 *	5.5	3.26	87	110	
	2.2	FN2.2AL1M-4G5 *	5.5	3.26	87	110	
	3.7	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

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.

Diagram 1.
50 Hz IP20 Frame Size Layout



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

Specifications

60Hz Type

Item	60 Hz System
Nominal operating voltage	3 x 440 VAC to 480 VAC ± 10%
Operating frequency	60 Hz ± 1 Hz
Nominal motor drive input power rating	60 Hz, 0.75 to 220kW
Total harmonic current distortion THDi ②	≤5% at rated power ①
Total demand distortion TDD ②	According to IEEE 519
Drive dc-link voltage ③	-5% ~ +10% nominal VDC
Efficiency	>98% for rated voltage and power
High potential test voltage ④	P --> E 2160 VAC (1s)
Protection category	IP20
Overvoltage category	OV III (IEC 60664 / UL 61800-5-1)
Overload capability	1.6x rated current for 1 mintute, once per hour
Cooling	Internal fan cooling or external cooling ⑥
Ambient temperature rage	- 25°C to +45°C fully operational +45°C to +70°C derated operation ⑦ - 25°C to +85°C transport and storage
Flammability corresponding to	UL 94 V-2
Insulation class of magnetic components	N (200°C), H (180°C)
Design corresponding to	Filter: UL 61800-5-1, EN 61800-5-1 Chokes: EN 61558-2-20 or EN 60076-6
Earth system	TN, TT, IT
SCCR ⑤	100 kA
MTBF @ 45°C) / 415V (Mil-HB-217F)	>200,000 hours
MTTR	<15 minutes (capacitor modules and fan modules)
Safety monitor output signal	Thermal switch NC 180°C (UL-approved) to detect overload of chokes
Pollution degree	PD3 (according to standard IEC 60664-1)
Lifetime (calculated)	≥10 years
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

① THDi ~5% at rated power for filter <4kW.
② System requirements: THDv <2%, line voltage unbalance <1% Performance specification for six-pulse diode ectifiers. SCR rectifier front-ends produce different results, depending upon the firing angle of the thyristors.
③ Conditions: line impedance <3%
④ Repetitive tests to be performed at max. 80% of above levels, for 2 seconds.
⑤ External UL-rated fuses required.
⑥ Please check the inlet air flow required for cooling at page 9 Table 2 (Cooling requirement)
⑦ Iderated = Inominal×√ ((70°C-Tamb)/25°C)

Specifications 60 Hz Type

Technical data

3-Phase, 440...480VAC, 60 Hz

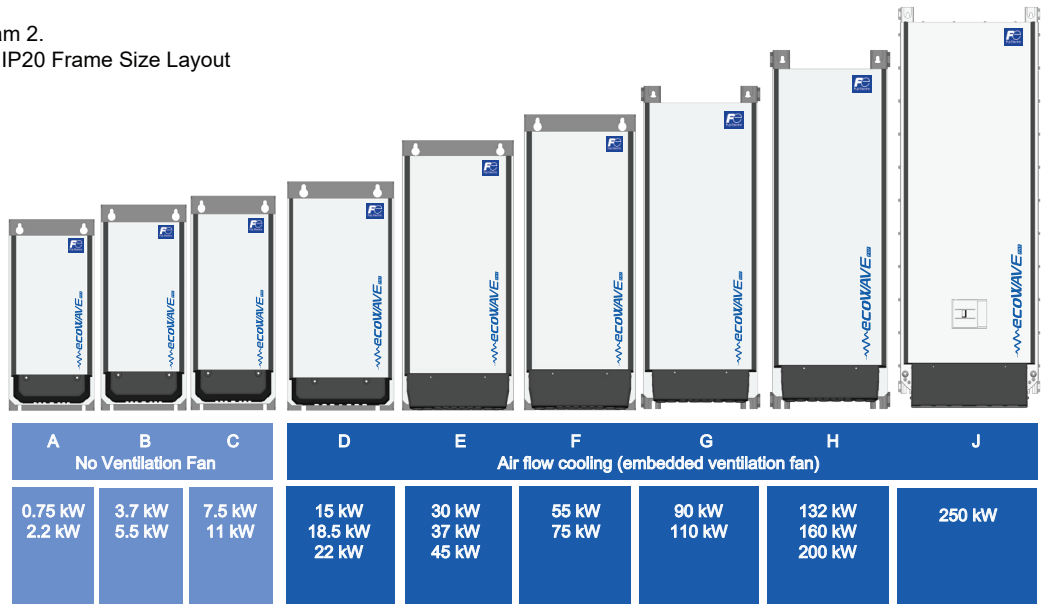
Rated Voltage	Nominal applied motor		Filter	Motor drive input current [Arms]***	Rated filter input current [Arms]	Typical Losses [W]****	Terminal	Frame
	[kW]	[HP]						
60Hz 3-Phase 440-480V Class	0.75	1	FN0.75AL1M-4G6 *	2	1.37	50	110	A
	1.5	2	FN1.5AL1M-4G6 *	4	2.76	67	110	
	2.2	3	FN2.2AL1M-4G6 *	4	2.76	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

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 2. 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 2.
60 Hz IP20 Frame Size Layout

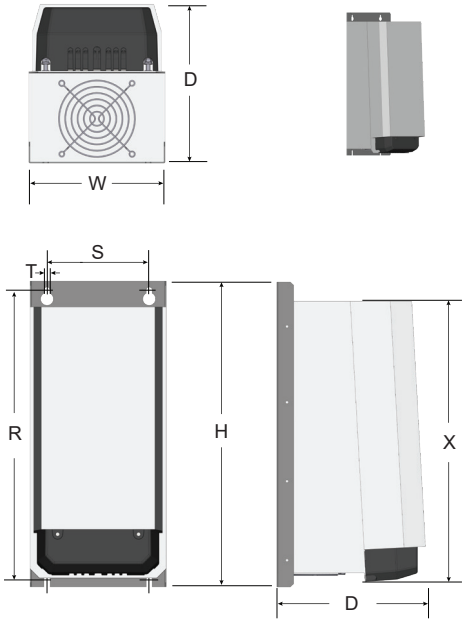
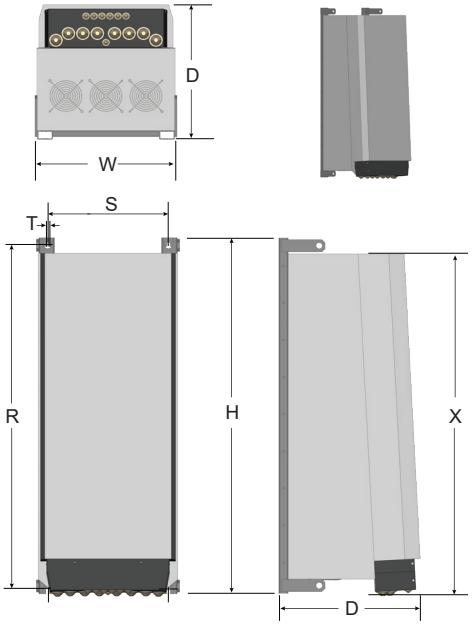


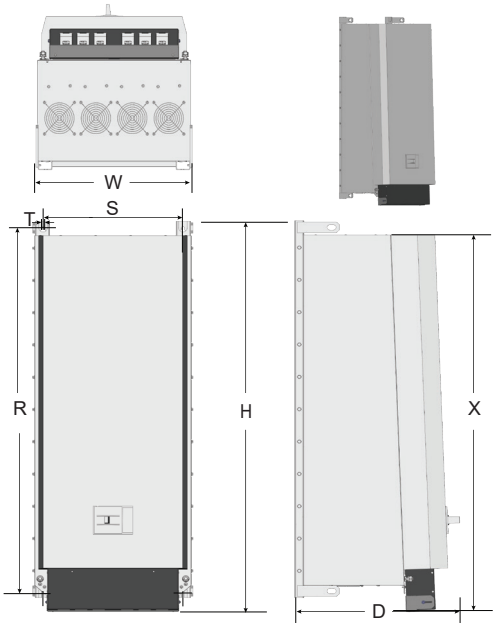
For higher kW rating rating filter; The ecoWAVE Advance-Line IP00 Skid Type (enginnering filters) Please refer to ecoWAVE Advance-Line IP00 Skid Type catalog.

Filter Overview

Frame Sizes for IP20

The ecoWAVE Advance-Line PHF includes 8 frame sizes for IP20 products.

Frame design for A, B, C & D	Frame design for E, F, G & H
	
• FN0.75AL1M-4G5 ... FN18.5AL1M-4G5 • FN0.75AL1M-4G6 ... FN22AL1M-4G6	• FN22AL1M-4G5 ... FN200AL1M-4G5 • FN30AL1M-4G6 ... FN220AL1M-4G6

Frame design for J

• FN250AL1M-4G5

NOTE: Frame J integrated with MCCB.

Specifications 50 Hz Type

Dimensions

50 Hz, 3-phase, 380-415V

Model Number	Nominal Power	Outside dimensions (mm)			Mounting Drill (mm)			Front Cover	Frame
	kW	W	H	D	R	S	T	X	
FN0.75AL1M-4G5*	0.75	160	360	185	340	120	7	302	A
FN1.5AL1M-4G5*	1.5								
FN2.2AL1M-4G5*	2.2								
FN3.7AL1M-4G5	3.7	180	425	206	405	120	7	370	B
FN5.5AL1M-4G5	5.5	210	483	221	460	150	7	430	C
FN7.5AL1M-4G5	7.5								
FN11AL1M-4G5	11	260	560	252	540	180	11	491	D
FN15AL1M-4G5	15								
FN18.5AL1M-4G5	18.5								
FN22AL1M-4G5	22	290	750	319	680	220	11	635	E
FN30AL1M-4G5	30								
FN37AL1M-4G5	37								
FN45AL1M-4G5	45								
FN55AL1M-4G5	55								
FN75AL1M-4G5	75	353	960	386	920	280	11	683	G
FN90AL1M-4G5	90								
FN110AL1M-4G5	110	462	1150	456	1115	390	11	1053	H
FN132AL1M-4G5**	132								
FN160AL1M-4G5**	160								
FN200AL1M-4G5**	200								
FN250AL1M-4G5**	250	550	1400	555	1348	480	11	1300	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

Dimensions

60 Hz, 3-phase, 440-480V

Model Number	Nominal *** Power		Outside dimensions (mm)			Mounting Drill (mm)			Front Cover	Frame
	kW	HP	W	H	D	R	S	T	X	
FN0.75AL1M-4G6*	0.75	1	160	360	185	340	120	7	302	A
FN1.5AL1M-4G6*	1.5	2								
FN2.2AL1M-4G6*	2.2	3								
FN3.7AL1M-4G6	3.7	5	180	425	206	405	120	7	370	B
FN5.5AL1M-4G6	5.5	7 1/2								
FN7.5AL1M-4G6	7.5	10	210	483	221	460	150	7	430	C
FN11AL1M-4G6	11	15								
FN15AL1M-4G6	15	20	260	560	252	540	180	11	491	D
FN18.5AL1M-4G6	18.5	25								
FN22AL1M-4G6	22	30								
FN30AL1M-4G6	30	40	290	750	319	680	220	11	635	E
FN37AL1M-4G6	37	50								
FN45AL1M-4G6	45	60								
FN55AL1M-4G6	55	75	340	752	343	730	250	11	684	F
FN75AL1M-4G6	75	100								
FN90AL1M-4G6	90	125	353	960	386	920	280	11	683	G
FN110AL1M-4G6	110	150								
FN132AL1M-4G6**	132	200	462	1150	456	1115	390	11	1053	H
FN160AL1M-4G6**	160	250								
FN220AL1M-4G6**	220	268								

* 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

Terminals

Terminal Data

50Hz/60Hz IP20 Power Terminals

Power Terminal					Earth Terminal (PE)		Signal Terminal	
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]
A	M3	14 - 22	0.4 - 2.5	7	M5	2.2	M3***	0.5
B	M4	10 - 22	0.4 - 4.6	10	M6	4		
C								
D	M6	6 - 18	0.75 - 16	15	M8	9		
E	M8	1/0 - 8	10 - 50					
F					M10	17		
G		3/0 - 8	10 - 95	17				
H	M10	3/0 - 500 kcmil	95 - 240	35				
J	M16	350 - 750 kcmil	185 - 400	48	M12	25		

* 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 ecosine 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)

NOTICE

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.

NOTICE

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

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

Filter is applied to rated voltage and power THDv <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

NOTICE

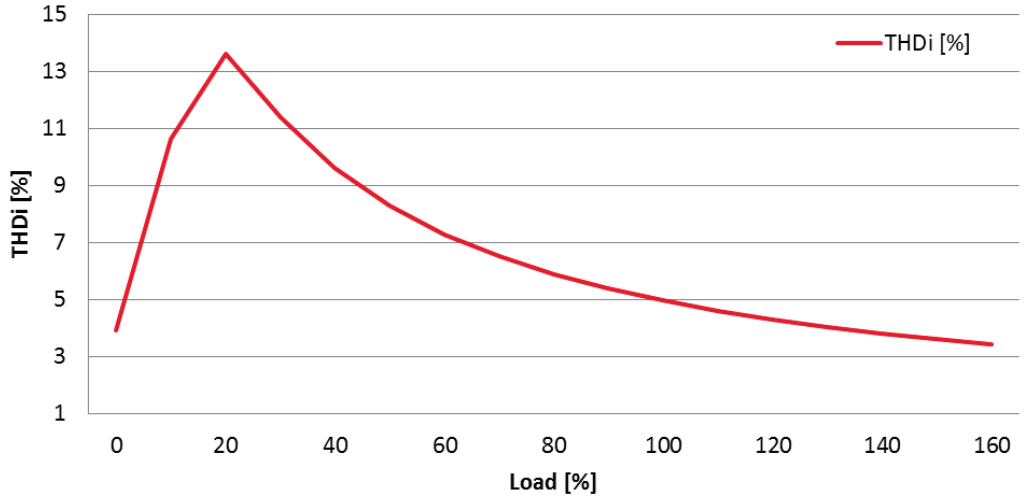
132…200 kW of 50Hz ecoWAVE Advance-Line PHF , and 160…220kW of 60Hz ecoWAVE Advance-Line PHF series do not need RC damper module when the equivalent phase to star point capacitance of the EMI filter is not bigger than 10 µF.

NOTICE

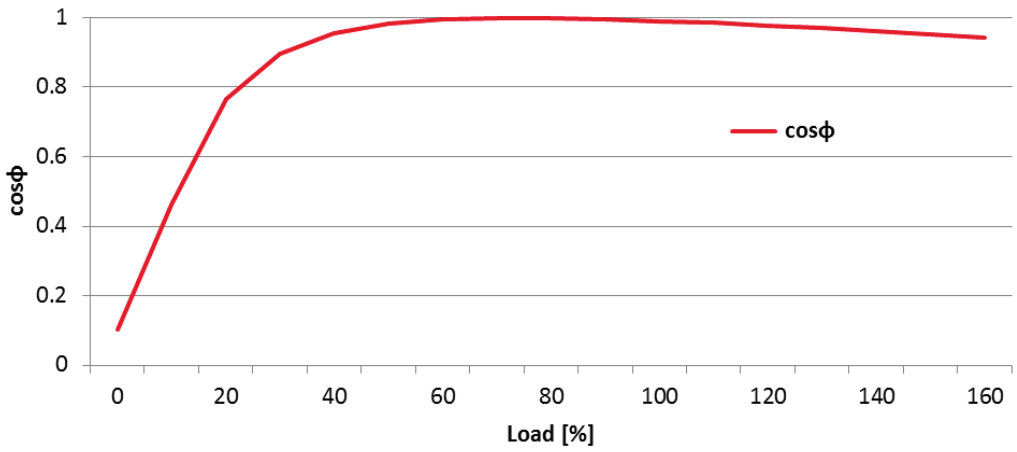
5% THDi is not guaranteed for thyristor rectifier application. The performance of the filter is dependent on the firing angle of the thyristors.

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

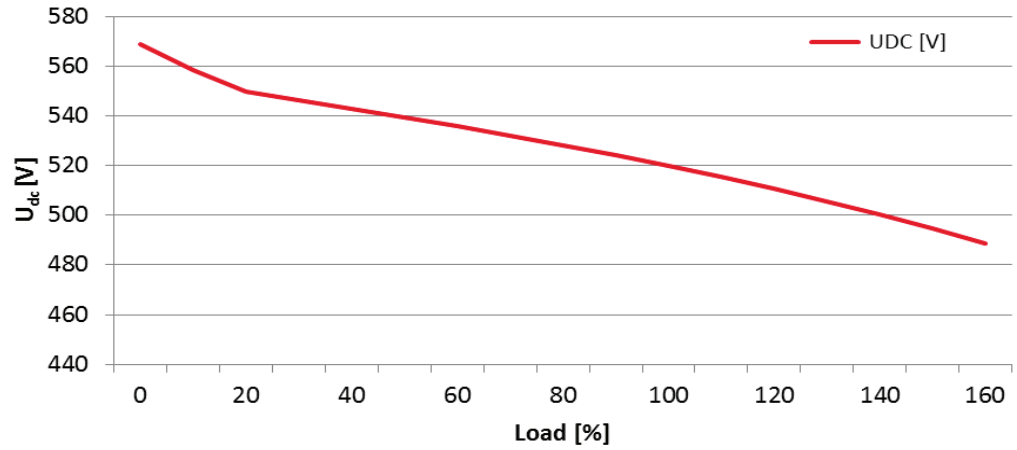
Above charts show ecoWAVE Advance-Line PHF performance (THID, power factor and Udc) under different load conditions.



THID vs. load (diode rectifier front-ends)

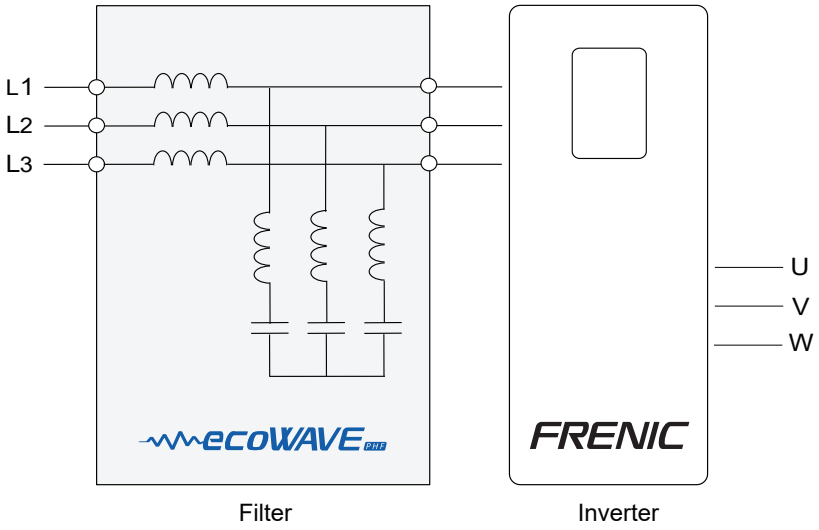


Power factor vs. load (diode rectifier front-ends)



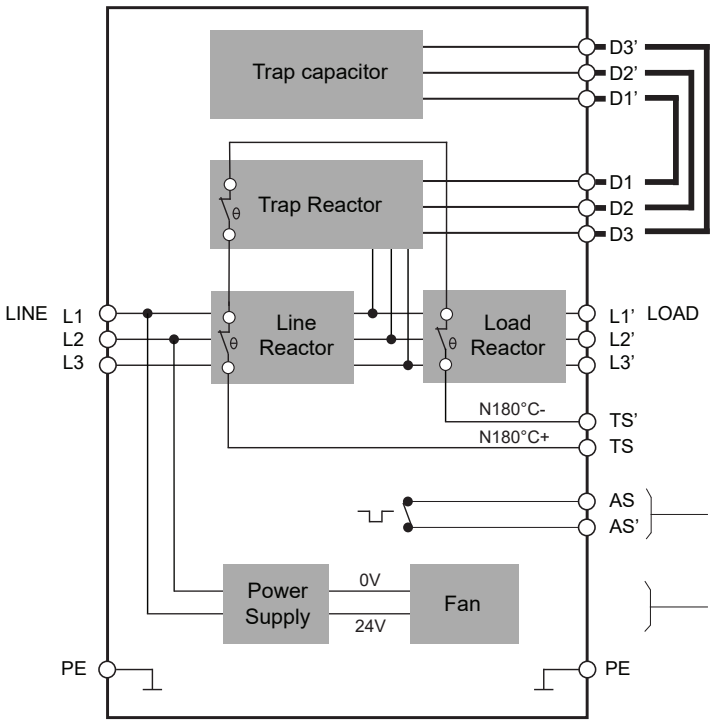
Drive dc-link voltage vs. load (diode rectifier front-ends, with 50Hz series)

Typical electrical schematic - IP20 Enclosure Type



The typical electrical schematic shows ecoWAVE filter connected directly to an inverters 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)

Wiring Diagram - IP20 Enclosure Type



TDJ Module
(Trap Disconnect Jumper)

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

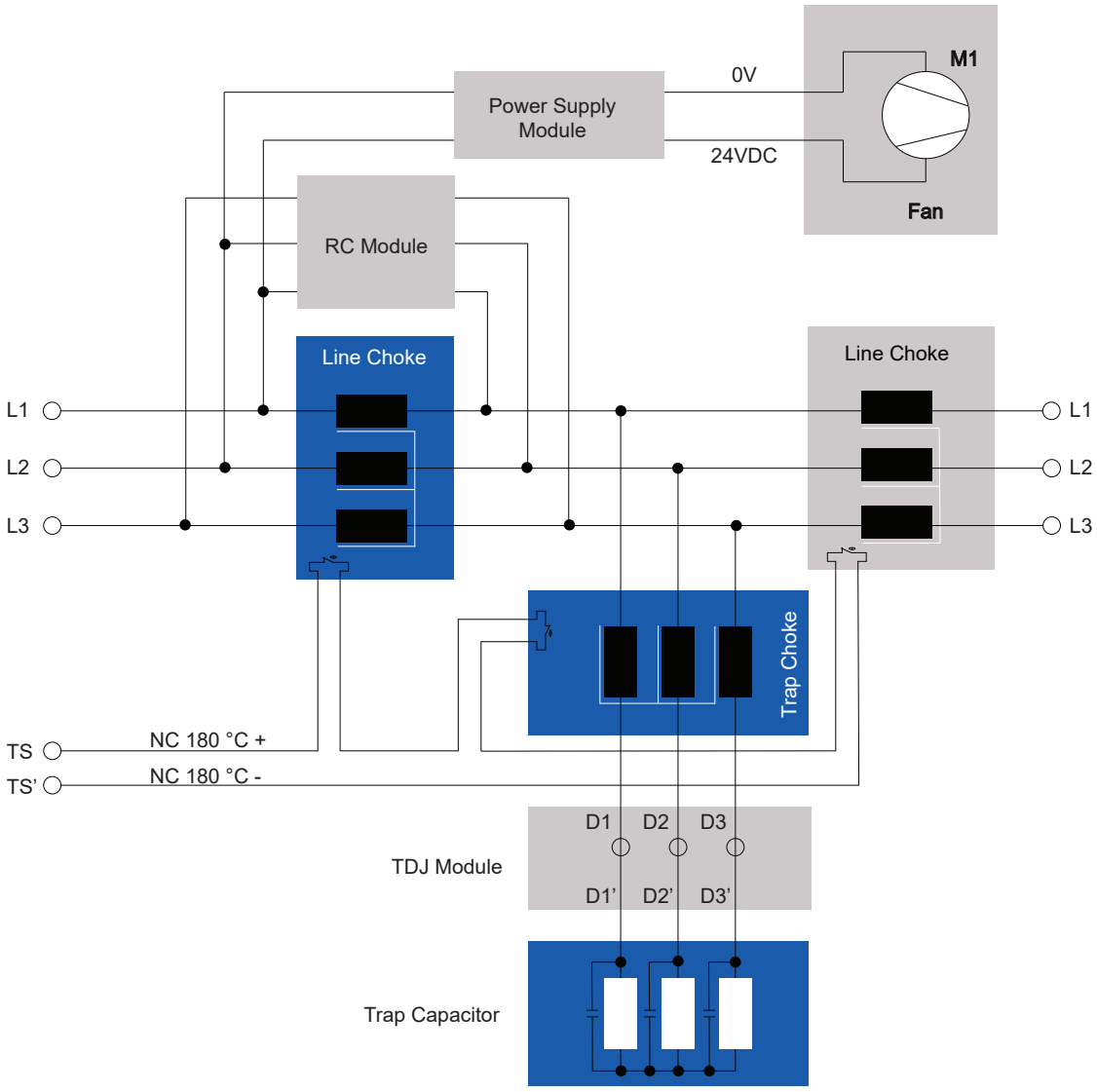
(refer to page 35 & 36 for sizing of the contactor for diffrent rating.)

Only applicable for
FN250AL1M-4G5

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

Wiring

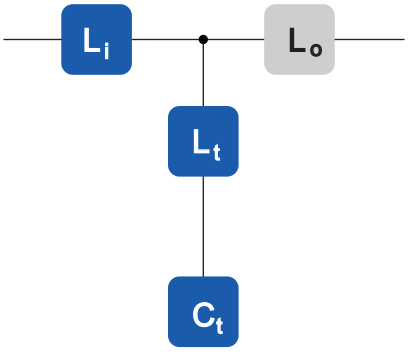
Wiring Diagram



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
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

Module

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 ilter for frame sizes G – H, which are explained in detail in the following sections.

IP 20 Enclosure
ecoWAVE Advance-Line passvie harmonic filters with IP 20 protection shown in Figure 1, 2 & 3.
The filters are equipped with cover and finger guard.

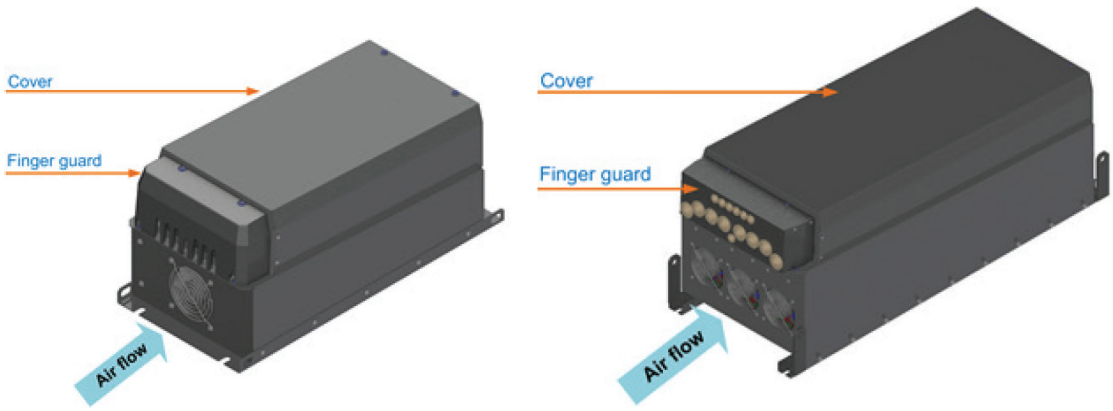


Figure 1 & 2.
Design of IP 20 version ecoWAVE Advance-Line PHF with frame size D (left) and frame size H (right)

(continued)

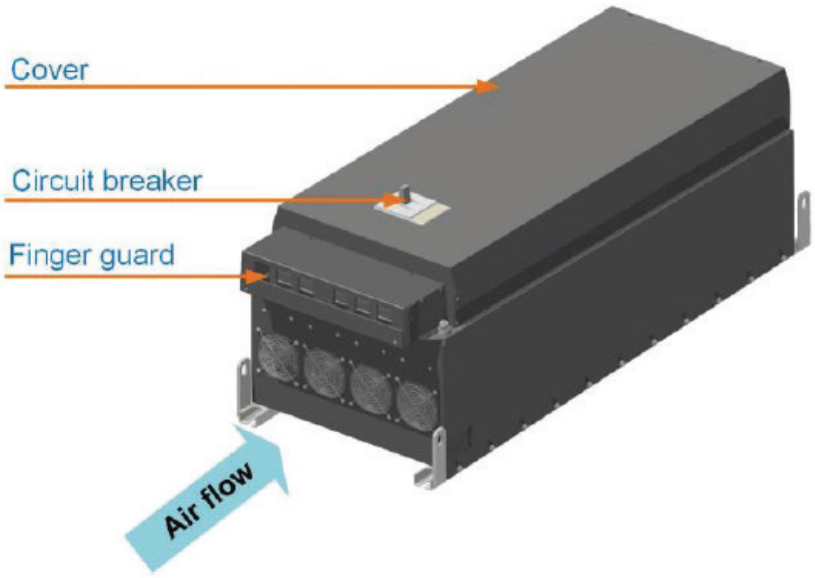


Figure 3 Design of IP 20 version ecosine evo filter with frame size J

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

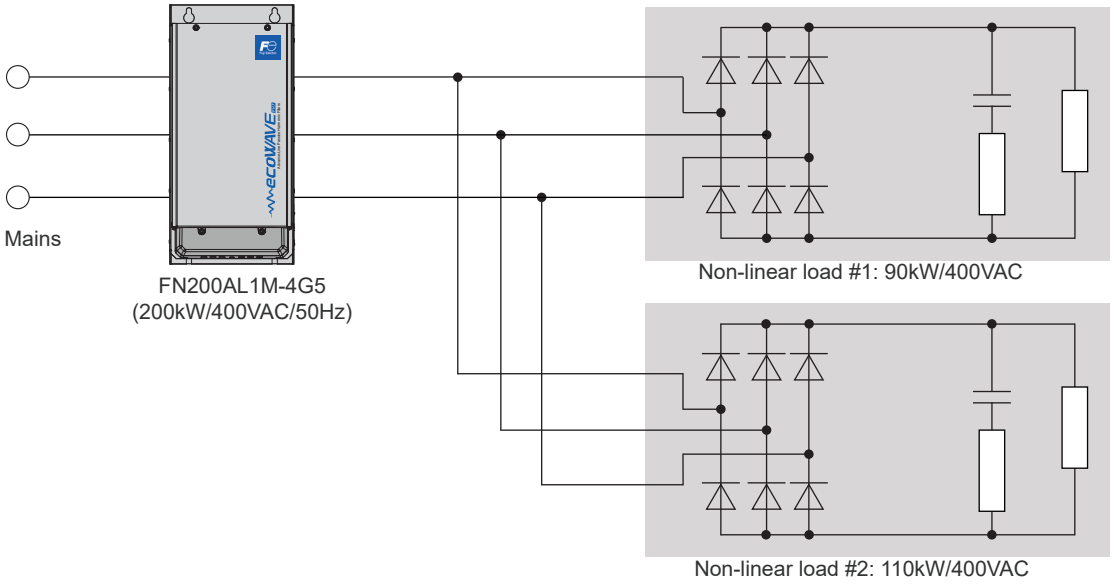
Table 5 Parameters of finger guard of IP 20 enclosure

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

Example

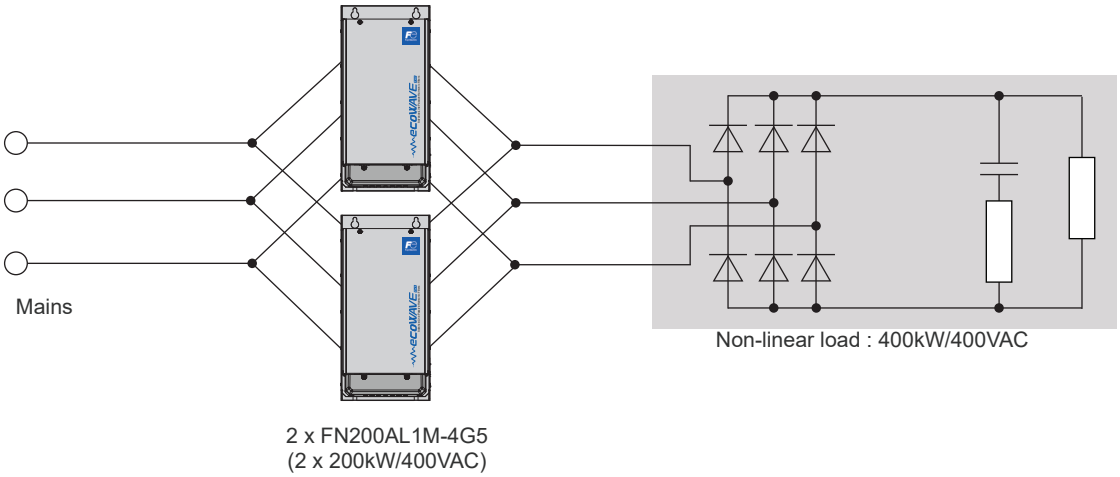
ecoWAVE Advance-Line PHF are designed to mitigate harmonic current of non-linear loads, in particular of three-phase diode-type rectifiers. Contrary to “bus-applied or PCC” filters, which are being installed e.g. at the main feeder, they are specifically designed to be used with either an individual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

Example

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 10 (50 Hz type) or page 12 (60 Hz type) on specification's Ambient temperature range.

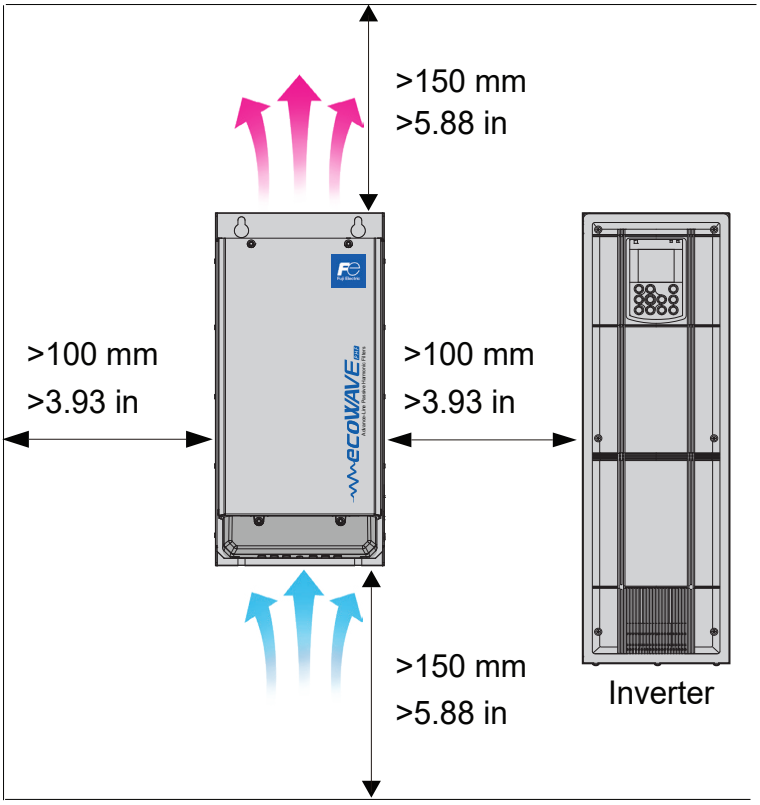
Step 2: Mounting

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.



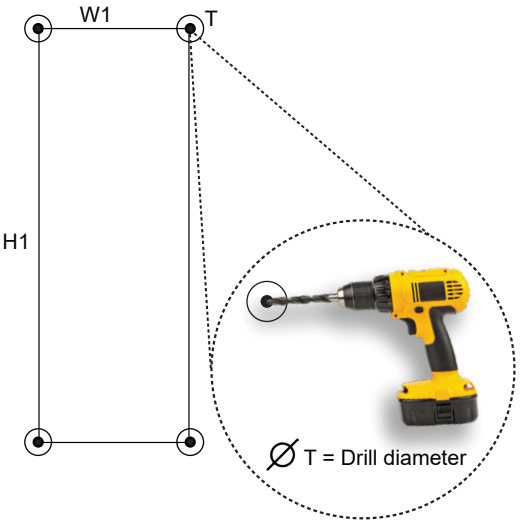
(continued)

1) Screw hole positions for wall mounted filters
(as indicated in Table 6):

Table 6. Mounting screw hole positions.

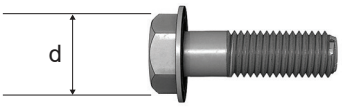
Frame	Drill pattern [mm]		
	W1	H1	T⌀
A	120	340	7
B	120	405	7
C	150	460	7
D	180	540	11
E	220	680	11
F	250	730	11
G	280	920	11
H	390	1115	11
J	480	1348	11

All dimensions in mm; 1 inch = 25.4mm



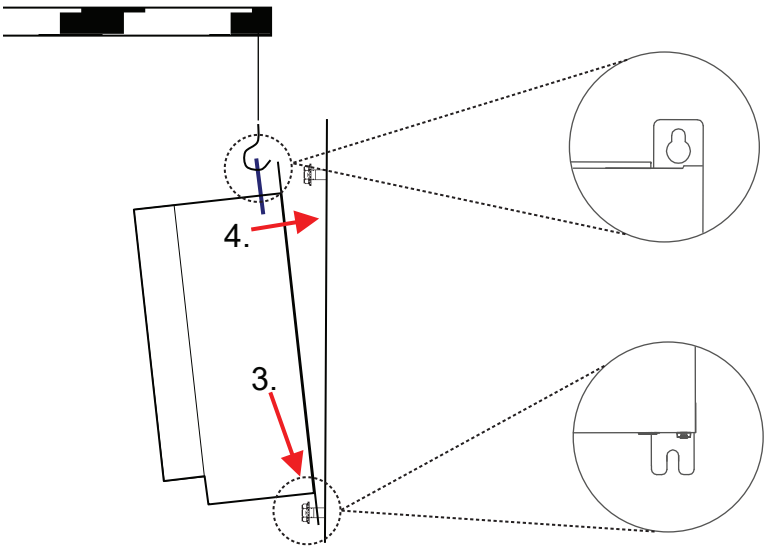
2) Screw selection:
Fuji Electric recommends zinc coated hex ribbed flange steel bolts. Respect filters weight for appropriate choice of screws! Head diameters must not exceed these dimensions:

M6: d ≤14.2mm, M10: d ≤21.2mm



3) Filter placement:

1. 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.
3. Place filter first onto lower screws…
4. ...then position it through backplane head openings on upper screws.
5. Fix screws with appropriate torque (depending upon the material of the back plane and local standards).



Step 3: Wiring

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

⚠ ⚠ DANGER

ELECTRIC SHOCK OR UNANTICIPATED EQUIPMENT OPERATION

Verify safe disconnection of all line side power.

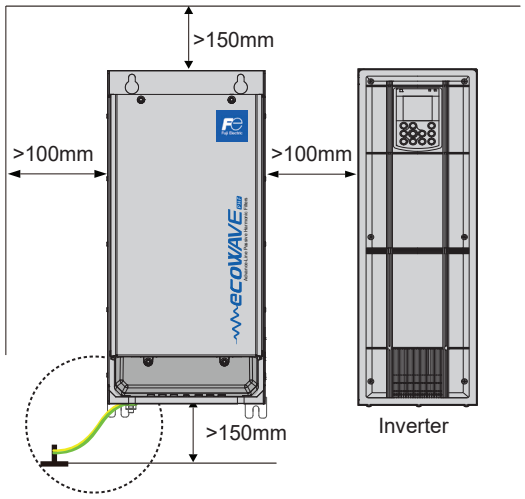
Failure to follow these instructions will result in death or serious injury.

2. 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 codes and safety instructions.

3. Connect PE wire of ecosine filter with appropriate cable lug to threaded stud.

   - torque M5: 2.2 Nm
   - torque M6: 4 Nm
   - torque M8: 9 Nm
   - torque M10: 19 Nm
   - torque M12: 25 Nm



4. Connect ecosine 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 ecosine evo 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.

(continued)

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.

Diagram 5. Cable gromment

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.

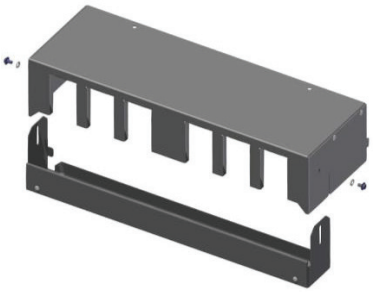


Diagram 6. Finger guard

NOTICE

DESTRUCTION DUE TO INCORRECT MAINS VOLTAGE

In case the cables on the power terminals are installed without cable lug, it is recommended to follow the maintenance manual closely. For maintenance information, consult our local Fuji Electric.

Failure to follow these instructions can result in equipment damage.

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.

   THE USE OF CAPACITIVE SWITCHES/CONTACTORs IS REQUIRED. OTHERWISE CAPACITOR LIFETIME MAY BE REDUCED.

Contactor performance estimate:

Example: FN55AL1M-4G5

The nominal power rating in kW multplies 20% and the grid voltage, then divided by the nominal voltage.

Is the approximate reactive power
Contactor rating =

$$55KW * 20\% * \frac{V_{grid}}{V_{nom}} = 55KW * 20\% * \frac{400V}{400V} = 11KVAR$$

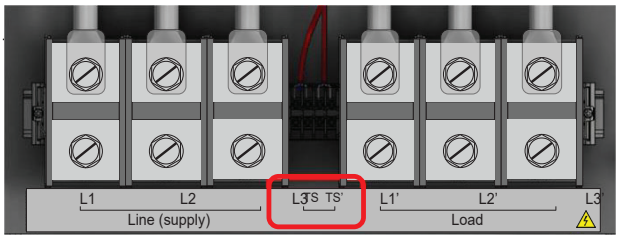
6. Connect monitor switch TS- TS'
   The monitor switch is a relay contact, which is open in ALARM state. It is constituted by a thermal switch NC 180°C (UL-approved) to detect overload of chokes. It may either be used to remotely disconnect the drive's load via respective input of drive control (check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

(continued)

The “TS & TS’ ” signal command connecting terminals to thermal switch NC 180°C (ULapproved) overload in reactor. It is open in abnormal condition. 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.



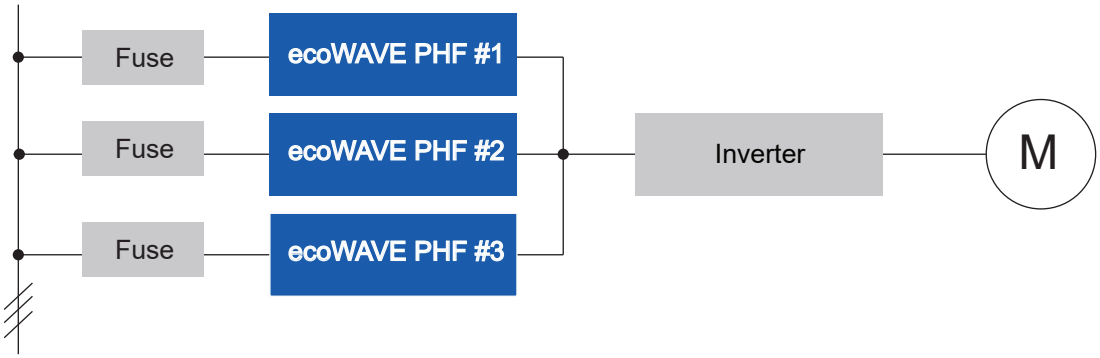
8. Connect ecosine line side terminals L1, L2, L3 to power input protection (current limiting fuses – see below). IP 20 enclosure cable wiring please refer to the remarks for the load side cable wiring.

   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.

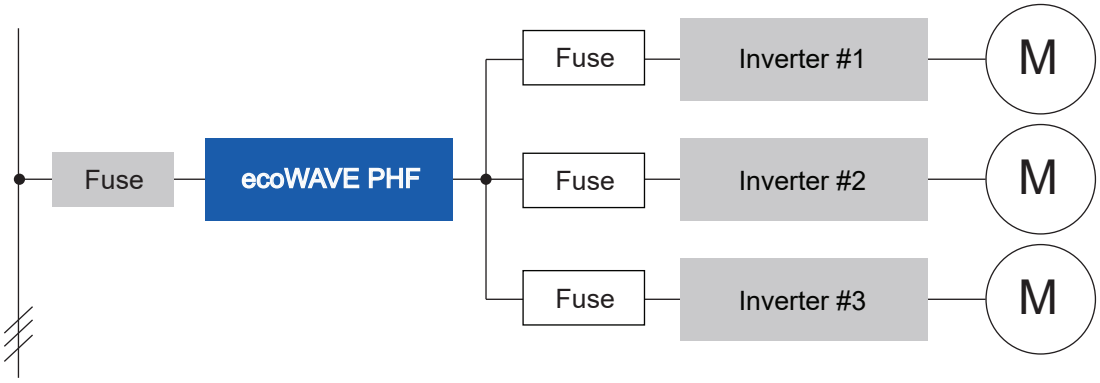
9. Fuses
   ecoWAVE PHF need external over-current protection for compliance with UL/cUL standard. Fuses and associated fuse holders must be UL listed and rated for 100kA SCCR supplies. Table 7 on page 27 show requested fuse current ratings for UL class J and, where UL compliance is not mandatory, for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



Fuse

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

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

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
200	FN200AL1M-4G6 **	300
220	FN220AL1M-4G6 **	400

Detail

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.

Safety

⚠ ⚠ WARNING

UNEXPECTED SHOCK CIRCUIT

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.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

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	X	X	X	X	X	X	X	X	X	X
Replace fan(s)					X					X		
Check & tighten el. Connections *	X	X	X	X	X	X	X	X	X	X	X	X
Check el. values of capacitors		X		X		X		X		X		X
Replace power capacitors										X		

* 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 Schaffner ecosine evo 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.

(continued)

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.

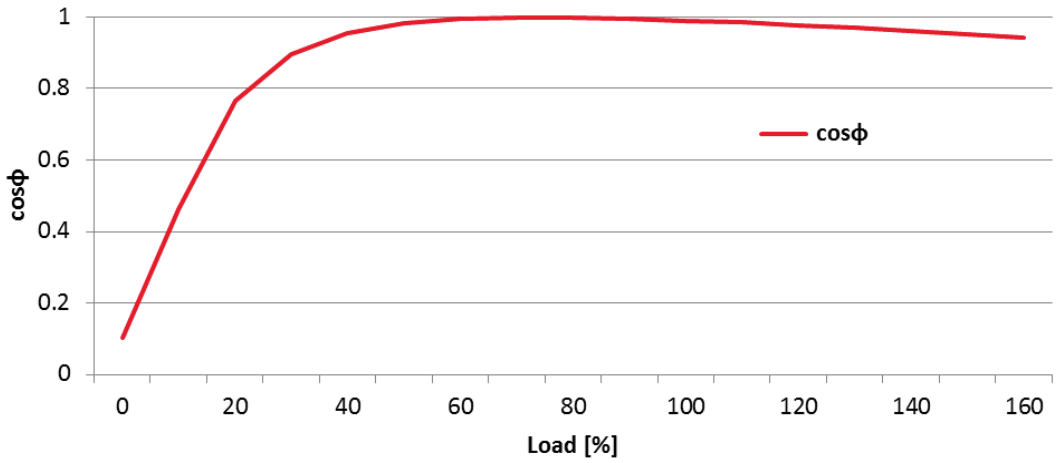
Therefore, Fuji Electric recommends to check and tighten all electrical connections on the occasion of a regular scheduled maintenance of the entire device that incorporates the filter.

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

Trap Circuit Disconnect

Detail

When applying ecoWAVE Advance-Line PHF on inverter application the capacitive current during low load or no load operation may present which will create a power leading factor on the electrical system. The trap circuit disconnect feature is a modular option for the purpose of reducing the capacitive current during low load or no load operation, if needed. With permanently connected trap circuit, cosφ 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.

For Inverter Application
Introduce an optional isolation contactor to disconnect trap capacitor and eliminate power leading factor when inverter is not operating (stand-by mode).
(refer to page 25 for sizing of the contactor for diffrent rating.)

(continued)

Fuji Electric recommends to engage and disengage the trap circuit disconnect using mangetic contactor. The contactor will disconnect the filter's capacitor when the application's equipment is on low load or no load operation mode to prevent the leading power factor occurred and achieve a better system power quality. The recommended Fuji Electric contactor selection shown in the table below.

3-phase, 380...415Vac 50 Hz

Model Number	Nominal Power	Fuji Electric SC series contactor	
	kW	Type*	[A]
FN0.75AL1M-4G5	0.75	SC-03 AC220V 1A	2.4 ~ 8.7
FN1.5AL1M-4G5	1.5		
FN2.2AL1M-4G5	2.2		
FN3.7AL1M-4G5	3.7		
FN5.5AL1M-4G5	5.5		
FN7.5AL1M-4G5	7.5		
FN11AL1M-4G5	11		
FN15AL1M-4G5	15		
FN18.5AL1M-4G5	18.5		
FN22AL1M-4G5	22	SC-4-0 AC220V 1A	13
FN30AL1M-4G5	30		
FN37AL1M-4G5	37	SC-4-1 AC220V 1A	17
FN45AL1M-4G5	45	SC-N1 AC220V 2A2B	24
FN55AL1M-4G5	55		
FN75AL1M-4G5	75	SC-N2 AC220V 2A2B	32.5
FN90AL1M-4G5	90	SC-N2S AC220V 2A2B	39.5
FN110AL1M-4G5	110	SC-N3 AC220V 2A2B	46.5
FN132AL1M-4G5	132	SC-N4 AC220V 2A2B	62
FN160AL1M-4G5	160	SC-N5A AC220V 2A2B	76
FN200AL1M-4G5	200	SC-N6 AC220V 2A2B	90
FN250AL1M-4G5	250	SC-N8 AC220V 2A2B	110

* All contractor come with 1 "NO" aux contract.

Sizing of contactor

Step 1

Example: FN55AL1M-4G5

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

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 :

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

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 :

$$Ie\ (\text{Contactor}) = I1 \times 1.43 = 15.87 \times 1.43 = 22.7\text{A}$$

The selected contactor should not be smaller then 22.7A

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

Disclaimer

(continued)

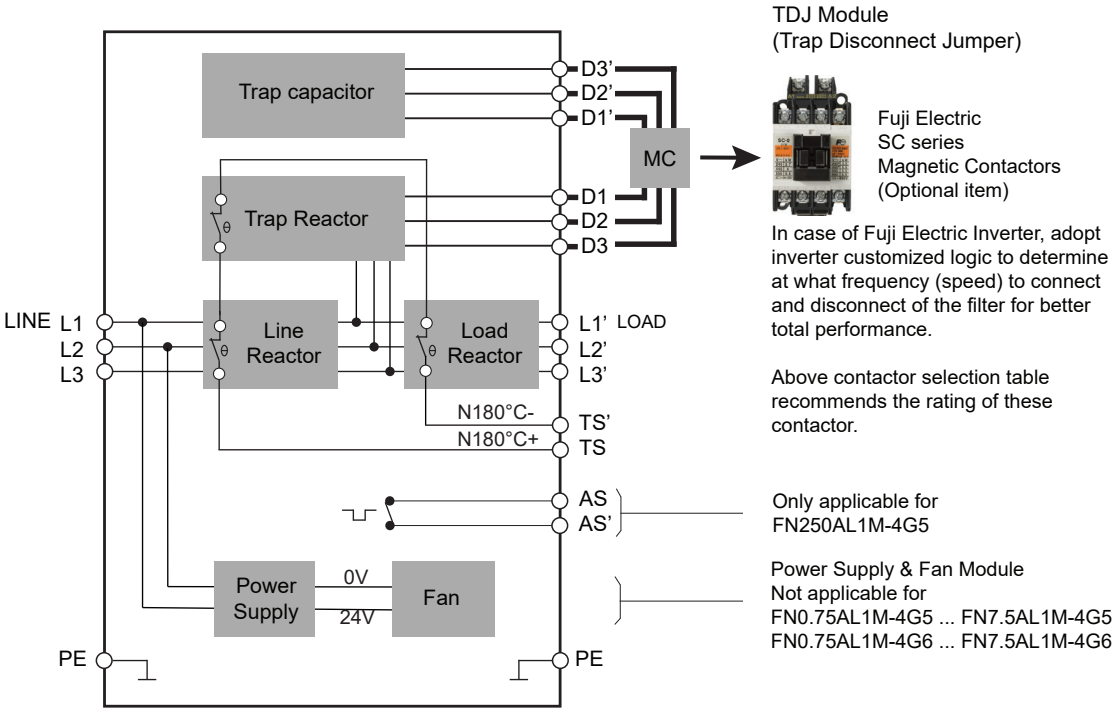
Fuji Electric recommends to engage and disengage the trap circuit disconnect using mangetic contactor. The contactor will disconnect the filter's capacitor when the application's equipment is on low load or no load operation mode to prevent the leading power factor occurred and achieve a better system power quality. The recommended Fuji Electric contactor selection shown in the table below.

3-phase, 440...480Vac 60 Hz

Model Number	Nominal Power		Fuji Electric SC series contactor	
	kW	HP	Type*	[A]
FN0.75AL1M-4G6	0.75	1	SC-03 AC240V 1A	2.4 ~ 8.7
FN1.5AL1M-4G6	1.5	2		
FN2.2AL1M-4G6	2.2	3		
FN3.7AL1M-4G6	3.7	5		
FN5.5AL1M-4G6	5.5	7 1/2		
FN7.5AL1M-4G6	7.5	10		
FN11AL1M-4G6	11	15		
FN15AL1M-4G6	15	20		
FN18.5AL1M-4G6	18.5	25		
FN22AL1M-4G6	22	30		
FN30AL1M-4G6	30	40	SC-4-0 AC240V 1A	13
FN37AL1M-4G6	37	50	SC-4-1 AC240V 1A	17
FN45AL1M-4G6	45	60		
FN55AL1M-4G6	55	75	SC-N1 AC240V 1A	24
FN75AL1M-4G6	75	100	SC-N2 AC240V 1A	32.5
FN90AL1M-4G6	90	125	SC-N2S AC240V 1A	39.5
FN110AL1M-4G6	110	150		
FN132AL1M-4G6	132	200	SC-N4 AC240V 1A	62
FN160AL1M-4G6	160	250		
FN220AL1M-4G6	220	295	SC-N6 AC240V 1A	90

* All contractor come with 1 "NO" aux contract.

Wiring Diagram



TDJ Module
(Trap Disconnect Jumper)

Fuji Electric
SC series
Magnetic Contactors
(Optional item)

In case of Fuji Electric Inverter, adopt inverter customized logic to determine at what frequency (speed) to connect and disconnect of the filter for better total performance.

Above contactor selection table recommends the rating of these contactor.

Only applicable for FN250AL1M-4G5

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

(continued)

Fuji Electric ecoWAVE passive 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

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The purpose of this manual is to provide accurate information in the handling, setting up and operating of the ecoWAVE Passive Harmonic Filter 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.

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