

## Fuji Electric Harmonic Mitigation



## ecoWAVE Passive Harmonic Filters Quality and Performance Excellence

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Catalog ecoWAVE Econ-Line IP20 PHF.pdf

### Version history

Revision	Date	Description
EL1M-PHF-CTL/V1.1	Apr 2021	Initial version
EL1M-PHF-CTL/V2	Jan 2023	Version 2

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Other technical documentation of our products is also available in the download area of [www.fujielectric.com](http://www.fujielectric.com)

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

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

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

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

The ecoWAVE Econ-Line passive harmonic filters are used to achieve total harmonic distortion of less than 10% and meeting IEEE-519 standard for AC drive system.

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



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

## Econ-Line Passive Harmonic Filter (EL1M) (THDi 10%)



THDi 10% / IP20 / 50Hz & 60Hz / 4kW to 160kW

- Economy line of passive harmonic filters for THID <10%
- Help to comply with EN 61000-3-12, IEEE-519 and other PQ standards
- Support an efficient utilization of electrical system capacity
- Ideal for motor drives with 6-pulse rectifier front-end
- Suitable for diode and thyristor (SCR) rectifiers applications

Approvals



RoHS



(depending on filter configuration)

### Features and benefits

Fuji Electric ecoWAVE harmonic filters represent an economical solution to the challenge of load-applied harmonics mitigation in three-phase power systems. The Econ-Line models of the ecoWave product family represent the compact "economy line" with a THID performance of ≤10% (with Ldc). Ideal for non-linear three-phase equipment with B6 rectifier front-end that do not require the industry leading <5% THID performance. The performance is still sufficient to comply with EN 61000-3-12 or with IEEE-519 for Isc/IL <50. ecoWAVE filters help to unburden the electrical infrastructure from excess loading and heat caused by current harmonics, and therefore support a better utilization of electric system capacity. Lower harmonics also reduce the risk of system resonances and potential downtime of sensitive electronic equipment.

Technical specifications	50 Hz System	60 Hz System
Nominal operating voltage	3x 380 to 415 VAC ±10%	3 x 380 to 480 VAC ±10%
Operating frequency	50 Hz ± 1Hz	60 Hz ± 1Hz
Nominal motor drive input power rating	3.7 to 160 kW	3.7 to 160 kW / 5 to 250 HP
Total harmonic current distortion THID*	<10% @ rated power (with DC-Link choke) <15% @ rated power (without DC-Link choke) According to IEEE-519	
Total demand distortion TDD	>98% for rated voltage and power	
Efficiency	P -> E 2500 VAC (2 sec)	
High potential test voltage	IP20	
Cooling	Internal fan cooling, unregulated	
Overload capability	1.6x rated current for 1 minute, once per hour	
Ambient temperature range	-25°C to +45°C fully operational -25°C to +70°C transport and storage +45°C to +55°C derated operation**	
Flammability corresponding to	UL 94 V-2 or better	
Design corresponding to	UL 508, EN 61558-2-20, CE (LVD2006/95/EC)	
Earthing System	TN, TT, IT	
MTBF @45°C/415 V (Mil-HB-217F)	200,000 hours	
SCCR****	100 kA	
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	

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

\*\* Iderrated = Inominal \*  $\sqrt{(70^{\circ}\text{C}-T_{\text{amb}})/25^{\circ}\text{C}}$

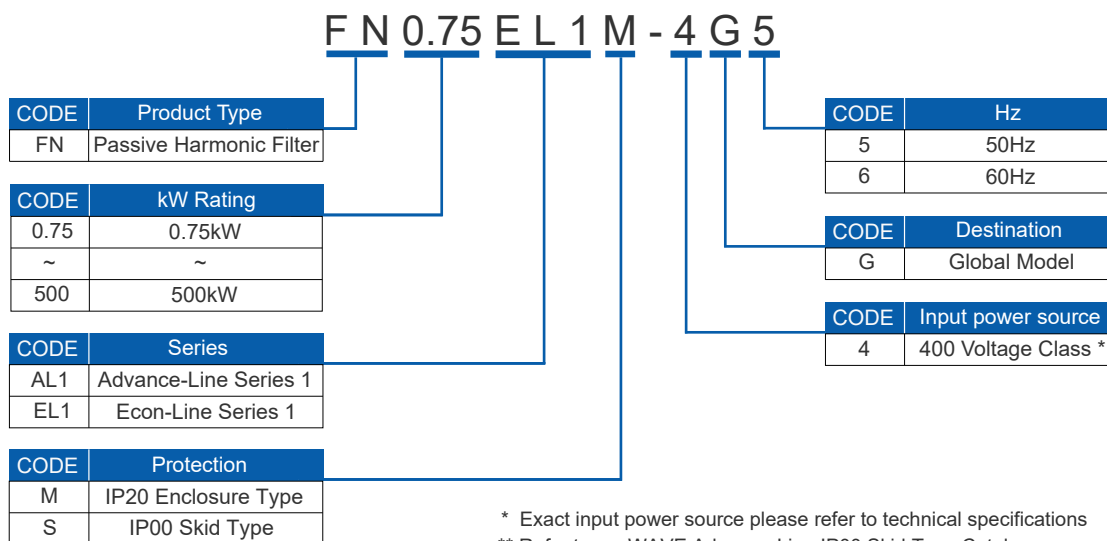
\*\*\* External UL-rated fuses required.

60 Hz System \* System requirements: THVD <2%, line voltage unbalance <1% Note: performance specifications in this brochure refer to six-pulse diode rectifiers. SCR rectifier front-ends will produce different results, dependent upon the firing angle of the thyristors. THID ~5% at rated power for filter <6 HP

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

\*\*\* Iderrated = Inominal \*  $\sqrt{((T_{\text{max}}-T_{\text{amb}})/(T_{\text{max}}-T_{\text{nominal}}))} = \text{Inom} * \sqrt{((70^{\circ}\text{C}-T_{\text{amb}})/25^{\circ}\text{C})}$

## Model code



## Applications

### Typical applications



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

### Harmonic Mitigation for Inverter application

#### Passive Harmonic Filters

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

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



Rated Voltage	Nominal applied motor [kW]	Filter	Motor drive input current [Arms]**	Typical Losses [W]**	Terminal		Frame
							
50Hz 3-Phase 380-415V Class	0.75	-	-	-	-		-
	1.5	-	-	-	-		-
	2.2	-	-	-	-		-
	3.7	FN3.7EL1M-4G5 *	10	135	-44		A
	5.5	FN5.5EL1M-4G5 *	13	183	-44		
	7.5	FN7.5EL1M-4G5 *	16	256	-44		
	11	FN11EL1M-4G5	24	287	-33		B
	15	FN15EL1M-4G5	32	359	-33		
	18.5	FN18.5EL1M-4G5	38	343	-33		
	22	FN22EL1M-4G5	45	460	-33		C
	30	FN30EL1M-4G5	60	570	-34		
	37	FN37EL1M-4G5	75	581	-34		
	45	FN45EL1M-4G5	90	783	-35		D
	55	FN55EL1M-4G5	110	858	-35		
	75	FN75EL1M-4G5	150	1036	-40		
	90	FN90EL1M-4G5	180	1166	-40		E
	110	FN110EL1M-4G5	210	1365	-40		
	132	FN132EL1M-4G5	260	1392		-99	
	160	FN160EL1M-4G5	320	1462		-99	F

\* Filter rating which does not require forced cooling or fan module.

\*\* Filter to be selected by system voltage and load (motor drive) power. Note: the harmonic filter will reduce RMS input current. Therefore, filter selection by current rating, as it is common for EMC/EMI filters, is not recommended.

\*\*\* Calculated power loss at rated load power.

60 Hz Type 3-Phase, 380...480VAC, 60 Hz

Rated Voltage	Nominal applied motor		Filter	Motor drive input current [Arms]**	Typical Losses [W]**	Terminal		Frame
	[kW]	[HP]						
50Hz 3-Phase 380-480V Class	0.75	1	-	-	-	-		-
	1.5	2	-	-	-	-		-
	2.2	3	-	-	-	-		-
	3.7	5	FN3.7EL1M-4G6 *	10	135	-44		A
	5.5	7 1/2	FN5.5EL1M-4G6 *	13	183	-44		
	7.5	10	FN7.5EL1M-4G6 *	16	256	-44		
	11	15	FN11EL1M-4G6	24	287	-33		B
	15	20	FN15EL1M-4G6	32	359	-33		
	18.5	25	FN18.5EL1M-4G6	38	343	-33		
	22	30	FN22EL1M-4G6	45	460	-33		C
	30	40	FN30EL1M-4G6	60	570	-34		
	37	50	FN37EL1M-4G6	75	581	-34		
	45	60	FN45EL1M-4G6	90	783	-35		D
	55	75	FN55EL1M-4G6	110	858	-35		
	75	100	FN75EL1M-4G6	150	1036	-40		
	90	125	FN90EL1M-4G6	180	1166	-40		E
	110	150	FN110EL1M-4G6	210	1365	-40		
	132	200	FN132EL1M-4G6	260	1392		-99	
	160	250	FN160EL1M-4G6	320	1462		-99	F

\* Filter rating which does not require forced cooling or fan module.

\*\* Filter to be selected by system voltage and load (motor drive) power. Note: the harmonic filter will reduce RMS input current. Therefore, filter selection by current rating, as it is common for EMC/EMI filters, is not recommended.

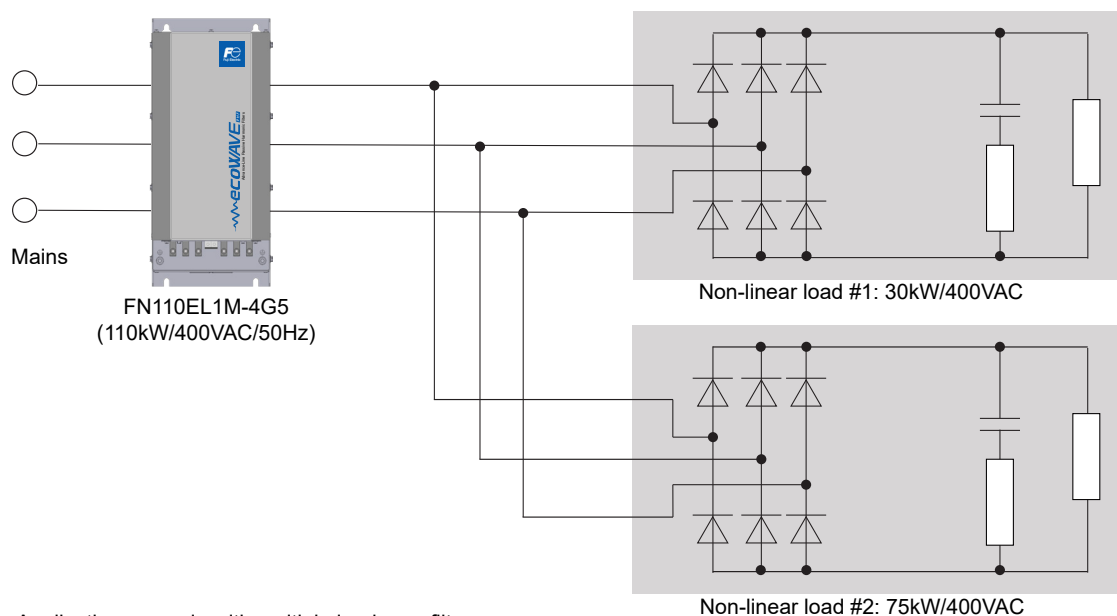
\*\*\* Calculated power loss at rated load power.

\*\*\*\* In case of filter accurate rating, please refer to Horsepower (HP) rating.

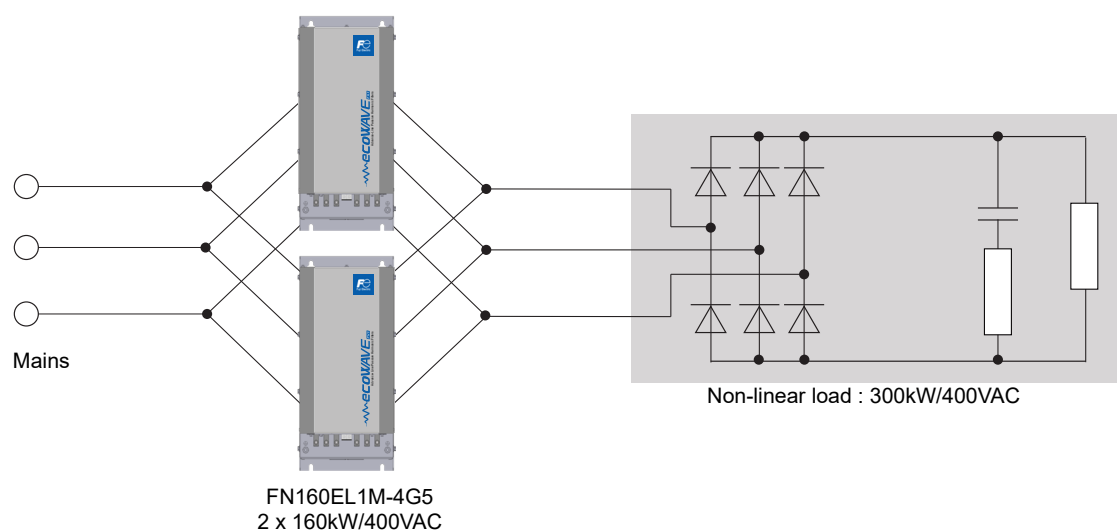
## Harmonic Mitigation

ecoWAVE Econ-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.

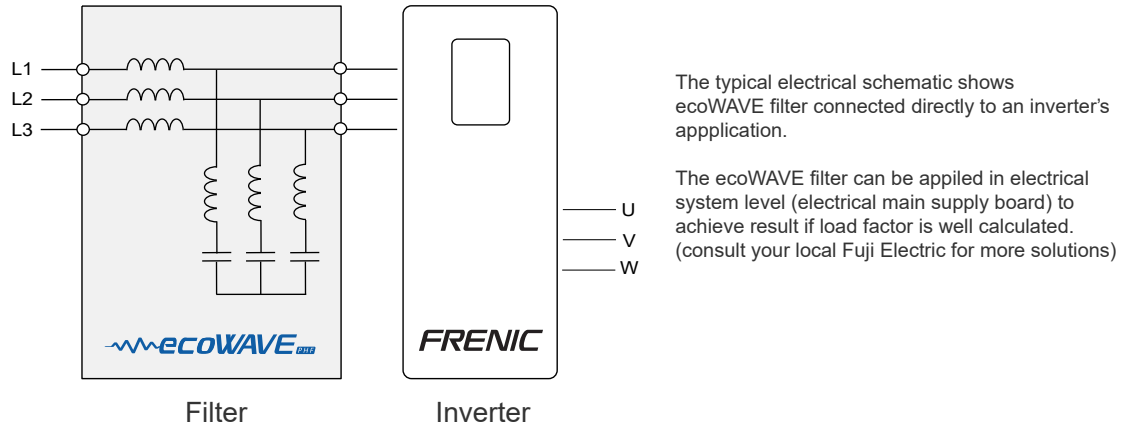
One advantage of load-applied filtering is the fact that the upstream power (relative to the harmonic filter) is clean, i.e. unloaded by the harmonics. This can be of vital importance when the same power bus supplies both motor drives and sensitive loads. ecoWAVE Econ-Line PHF are also suitable for paralleling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



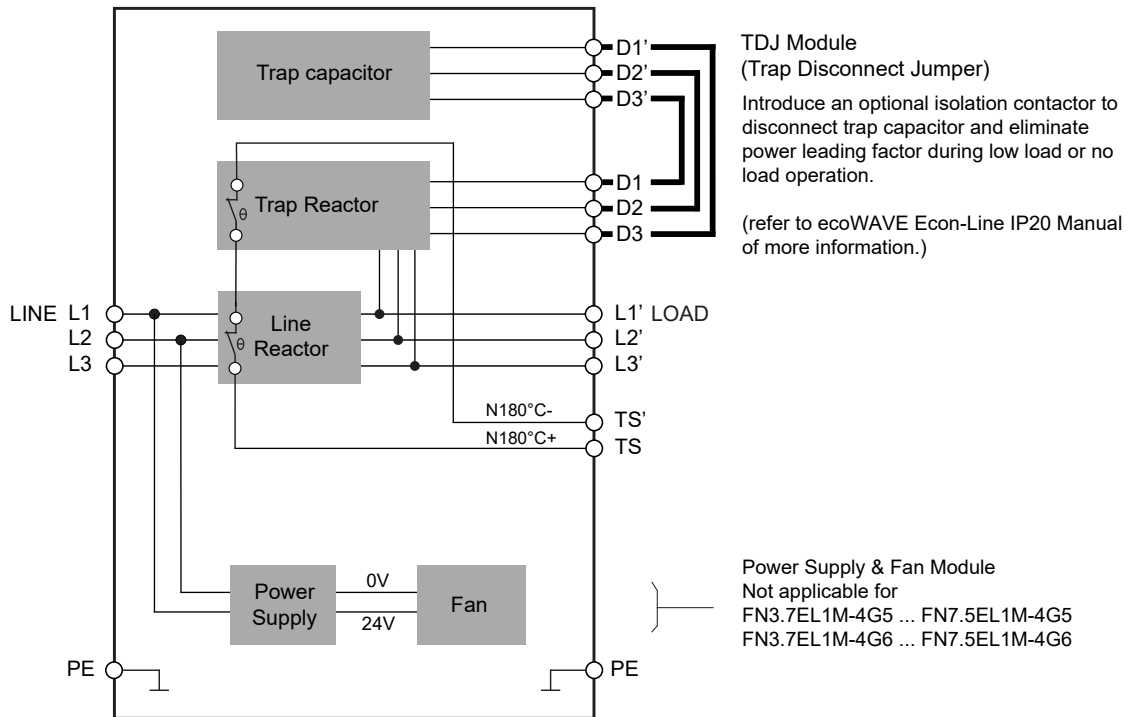
If the expected input power exceeds the rating of the largest available filter, and a custom solution is not desired, then two or more filters can be wired in parallel. In this mode of operation, it is recommended to use filters with equal power ratings to ensure proper current sharing.



### Typical electrical schematic - IP20 Type



### Function diagram - IP20 Type



Parts	Terminal	Functions
LINE Choke (in)	L1 / L2 / L3	Incoming supply terminal
LINE Choke (out)	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
Protective Earth	PE	Protective earth. Threaded stud with washer and nut
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 resistors	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

50 Hz IP20 enclosure

Rated Voltage	Nominal** applied motor [kW]	Filter*	Outside dimensions (mm)			Weight [kg]	Frame
			W	H	D		
50Hz 3-Phase 380-415V Class	0.75	-	-	-	-	-	-
	1.5	-					
	2.2	-					
	3.7	FN3.7EL1M-4G5 *	185	390	190	10	A
	5.5	FN5.5EL1M-4G5 *				10	
	7.5	FN7.5EL1M-4G5 *				15	
	11	FN11EL1M-4G5	250	455	230	20	B
	15	FN15EL1M-4G5				22	
	18.5	FN18.5EL1M-4G5				25	
	22	FN22EL1M-4G5	280	520	248	29	C
	30	FN30EL1M-4G5				37	
	37	FN37EL1M-4G5				43	
	45	FN45EL1M-4G5	450	580	385	47	D
	55	FN55EL1M-4G5				50	
	75	FN75EL1M-4G5				86	E
	90	FN90EL1M-4G5				92	
	110	FN110EL1M-4G5				100	
	132	FN132EL1M-4G5	450	700	385	125	F
	160	FN160EL1M-4G5				135	

\* Filter to be selected by system voltage and load (motor drive) power. Note: the harmonic filter will reduce RMS input current. Therefore, filter selection by current rating, as it is common for EMC/EMI filters, is not recommended.

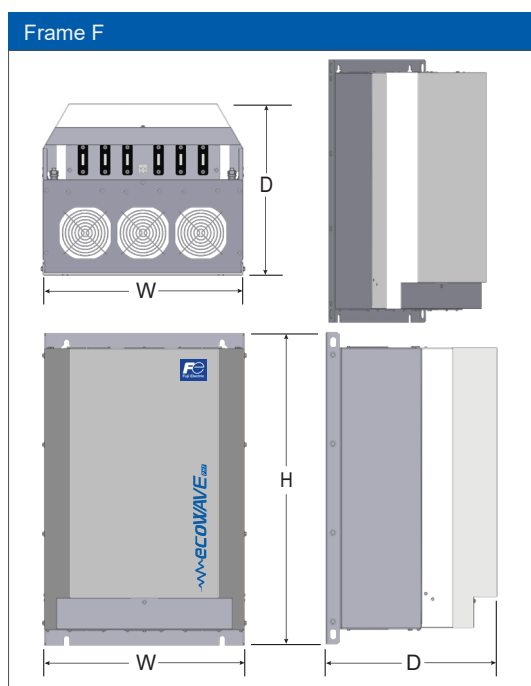
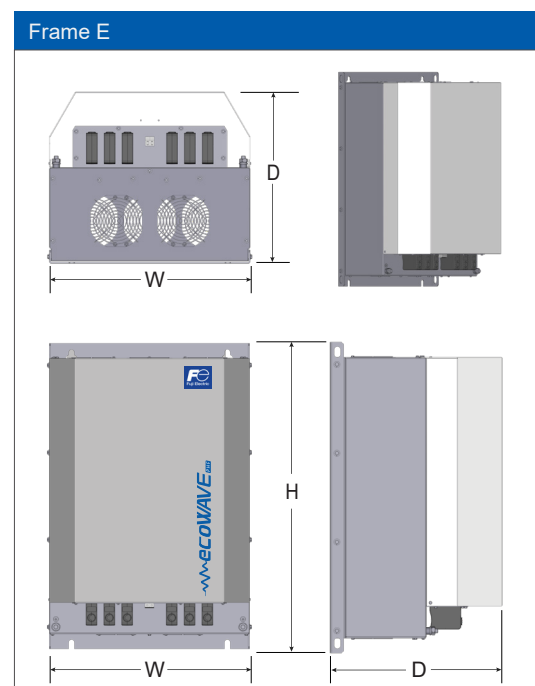
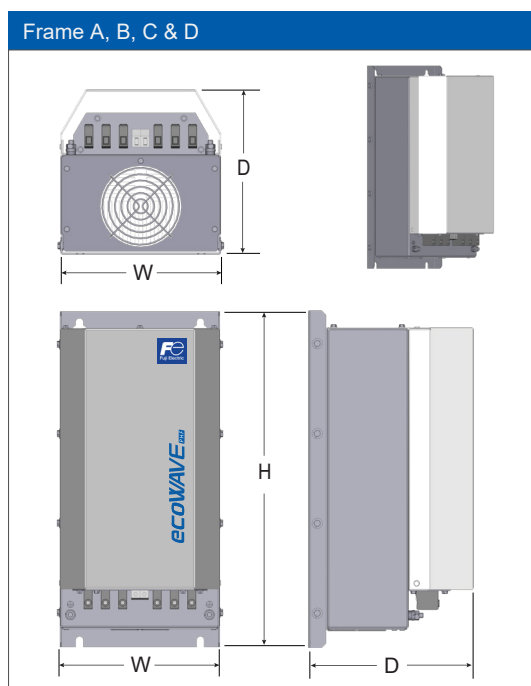
60 Hz IP20 enclosure

Rated Voltage	Nominal** applied motor		Filter*	Outside dimensions (mm)			Weight [kg]	Frame
	[kW]	[HP]		W	H	D		
50Hz 3-Phase 380-480V Class	0.75	1	-	-	-	-	-	-
	1.5	2	-					
	2.2	3	-					
	3.7	5	FN3.7EL1M-4G6 *	185	390	190	10	A
	5.5	7½	FN5.5EL1M-4G6 *				10	
	7.5	10	FN7.5EL1M-4G6 *				15	
	11	15	FN11EL1M-4G6	250	455	230	20	B
	15	20	FN15EL1M-4G6				22	
	18.5	25	FN18.5EL1M-4G6				25	
	22	30	FN22EL1M-4G6	280	520	248	29	C
	30	40	FN30EL1M-4G6				37	
	37	50	FN37EL1M-4G6				43	
	45	60	FN45EL1M-4G6	450	580	385	47	D
	55	75	FN55EL1M-4G6				50	
	75	100	FN75EL1M-4G6				86	E
	90	125	FN90EL1M-4G6				92	
	110	150	FN110EL1M-4G6				100	
	132	200	FN132EL1M-4G6	450	700	385	125	F
	160	250	FN160EL1M-4G6				135	

\* Filter to be selected by system voltage and load (motor drive) power. Note: the harmonic filter will reduce RMS input current. Therefore, filter selection by current rating, as it is common for EMC/EMI filters, is not recommended.

\*\* In case of filter accurate rating, please refer to Horsepower (HP) rating.

50 Hz & 60 Hz Mechanical data of IP 20 enclosure

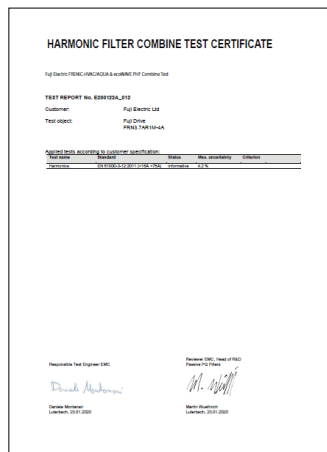


## Overview

Selecting and installing the appropriate ecoWAVE Econ-Line Passive Harmonic Filter in inverter application, AC Drive application within this published technical specifications and achieve guarantee result that current distortion will be less than or equal to 10% THiD at rated power. ecoWAVE filter series can also provide similar performance in other drive applications such as constant torque, DC drives or other phase controlled rectifiers, eg. SCR drives, but actual THiD levels can vary by load and/or speed and/or firing angle of the thyristors and therefore cannot be guaranteed. Consult your local Fuji Electric for assistance when applying ecoWAVE filters on these types of equipment.

## Performance Guarantee

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



Test Certificate

**< 10% THiD**  
Total Harmonic Current Distortion

**ecoWAVE<sub>PHF</sub>**

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

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

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



## **FRENIC** Inverter series

*Technology made possible by Fuji Electric intensive range of inverter*

Fuji Electric delivers high-performance inverters that offer automatically controlled motor operations and operating speeds for a wide variety of drive applications. This precision control allows our drives to operate at an optimal speed throughout your application, reducing overall power and energy consumption to minimize operating costs. Complete your inverter application with ecoWAVE PHF and enhance electrical system power quality.

View complete product line at [www.fujielectric.com](http://www.fujielectric.com)

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