

Innovating Energy Technology

Fuji Electric Harmonic Mitigation





Fuji Electric Asia Pacific Pte. Ltd.

F Fuji Electric

ecoWAVE Passive Harmonic Filters Quality and Performance Excellence

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Revision	Date	Description
01	Jun 2020	Initial version
02	Jun 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



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

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

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

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

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

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



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



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



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

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

Approvals



(depending on filter configuration)

Features and benefits

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

Technical spec	cifications	50 Hz System	60 Hz System			
Mounting type		Wall mounting				
Degree of protect	tion	IP 20				
Power range for	Nominal operating voltage	Three-phase: 380415 V	Three-phase: 440480 V			
5060 Hz line	Voltage tolerance range	Three-phase: 342457 V	Three-phase: 396528 V			
Supply	Operating frequency	50 Hz ±1 Hz	60 Hz ±1 Hz			
	Nominal motor drive input power rating	0.75250kW	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 1				
	Total demand distortion (TDD) 2	According to IEEE 519				
	Efficiency	>98% @ nominal line voltage and power				
	Drive dc-link voltage 3	-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 d	etect overload of chokes			
Ambient	Fully operational	-25°C to +45°C				
range	Derated operation	+45°C to +70°C 🖸				
-	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		FN 🗆 🗆 AL1M - 4G5	FN 🗆 🗆 AL1M - 4G6			

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

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

3 Conditions: line impedance <3%

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

6 External UL-rated fuses required.

Please check the inlet air flow required for cooling in Table 17

1 Iderated = Inominal× $\sqrt{(70^{\circ}\text{C-Tamb})/25^{\circ}\text{C}}$



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

Typical electrical schematic



Harmonic Mitigation for Inverter application

Passive Harmonic Filters

- Also known as 'Low Pass Filters'.
- For reducing harmonics at the VSD / Inverter or other non-linear devices.
- Reduction of harmonics to 5%
- 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

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	
	1.5	FN1.5AL1M-4G5 *	5.5	3.26	87	110	А
	2.2	FN2.2AL1M-4G5 *	5.5	3.26	87	110	
	3.7	FN3.7AL1M-4G5 *	10	5.93	135	112	В
	5.5	FN5.5AL1M-4G5 *	13	8.17	183	112	C
	7.5	FN7.5AL1M-4G5 *	16	11.1	256	112	C
	11	FN11AL1M-4G5	24	16.3	287	113	
	15	FN15AL1M-4G5	32	22.2	359	113	D
	18.5	FN18.5AL1M-4G5	38	28.2	343	113	
50Hz	22	FN22AL1M-4G5	45	32.5	460	115	
3-Phase 380-415V	30	FN30AL1M-4G5	60	44.4	570	115	E
Class	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	0
	90	FN90AL1M-4G5	180	134	1166	116	9
	110	FN110AL1M-4G5	210	164	1365	118	Н
	132	FN132AL1M-4G5 **	260	197	1392	118	
	160	FN160AL1M-4G5 **	320	240	1462	118	Н
	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

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-4G6 *	2	1.37	50	110	
	1.5	FN1.5AL1M-4G6 *	4	2.76	67	110	А
	2.2	FN2.2AL1M-4G6 *	4	2.76	67	110	
	3.7	FN3.7AL1M-4G6 *	7	4.57	116	112	в
	5.5	FN5.5AL1M-4G6 *	11	6.91	132	112	ם
	7.5	FN7.5AL1M-4G6 *	14	9.29	160	112	C
	11	FN11AL1M-4G6	21	13.8	237	113	C
	15	FN15AL1M-4G6	27	18.5	294	113	
60Hz	18.5	FN18.5AL1M-4G6	34	23.1	351	113	D
3-Phase	22	FN22AL1M-4G6	44	27.8	354	113	
Class	30	FN30AL1M-4G6	52	37.2	459	115	
	37	FN37AL1M-4G6	66	46.2	571	115	Е
	45	FN45AL1M-4G6	83	55.6	589	115	
	55	FN55AL1M-4G6	103	69.3	821	115	Е
	75	FN75AL1M-4G6	128	92.5	1028	115	Г
	90	FN90AL1M-4G6	165	115	1067	116	C
	110	FN110AL1M-4G6	208	139	1143	116	0
	132	FN132AL1M-4G6 **	240	184	1538	118	
	160	FN160AL1M-4G6 **	320	231	1411	118	Н
	220	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

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Harmonic Mitigation

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

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



Application example with multiple loads per filter

Application example with 2 filters in parallel for larger load

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





Typical electrical schematic - IP20 Type

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



Function diagram - IP20 Type



Filter	Line (supply)	L1/L2/L3			
terminais	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			



50 Hz Mechanical frame sizes

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

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



* Do not utilize frame F for 50 Hz system.

50 Hz Engineering Filters

In case of higher capacity 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	Type (engineering filters)
250 kW 315 kW 355 kW 400 kW 500 kW	Skid S10 Frame Skid S10 Frame Skid S12 Frame Skid L10 Frame Skid L12 Frame

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



Rated	Nominal	Filter	Outside dimensions (mm)			Weight	Frame
Voltage	[kW] ***		W	н	D	[kg]	Size
	0.75	FN0.75AL1M-4G5 *		360		8	A
	1.5	FN1.5AL1M-4G5 *	160		185	11	
	2.2	FN2.2AL1M-4G5 *				11	
	3.7	FN3.7AL1M-4G5 *	180	425	206	15	В
	5.5	FN5.5AL1M-4G5 *	010	102	221	19	C
	7.5	FN7.5AL1M-4G5 *	210	403	221	23	C
	11	FN11AL1M-4G5				32	E
	15	FN15AL1M-4G5	260	560	252	36	
	18.5	FN18.5AL1M-4G5				37	
50Hz	22	FN22AL1M-4G5	290	750	319	53	
3-Phase 380-415V	30	FN30AL1M-4G5				55	
Class	37	FN37AL1M-4G5				66	
	45	FN45AL1M-4G5				73	
	55	FN55AL1M-4G5				75	
	75	FN75AL1M-4G5	252		386	126	0
	90	FN90AL1M-4G5	353	960		147	G
	110	FN110AL1M-4G5				175	Н
	132	FN132AL1M-4G5 **	400	4450	456	194	
	160	FN160AL1M-4G5 **	402	1150		219	
	200	FN200AL1M-4G5 **				267	
	250	FN250AL1M-4G5 **	550	1400	555	350	J

* Filter rating which does not require forced cooling or fan module
** Filter rating which does not require RC damping module for rectifiers with EMI filter

*** Motor drive input current without harmonic filter



Sample view of the filter



60 Hz Mechanical frame sizes

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

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





60 Hz Engineering Filters

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



60 Hz IP00 Skie	d Type (engineering filters)
250 kW 315 kW 355 kW 400 kW 450 kW	Skid S10 Frame Skid S10 Frame Skid S12 Frame Skid L10 Frame Skid L12 Frame

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



Rated	Nominal	Filter	Outside dimensions (mm)			Weight	Frame
Voltage	[kW] ***		W	Н	D	[kg]	Size
	0.75	FN0.75AL1M-4G6 *		360		7	A
	1.5	FN1.5AL1M-4G6 *	160		185	9	
	2.2	FN2.2AL1M-4G6 *				9	
	3.7	FN3.7AL1M-4G6 *	100	405	206	11	D
	5.5	FN5.5AL1M-4G6 *	100	420	206	14	В
	7.5	FN7.5AL1M-4G6 *	010	400	221	17.4	0
	11	FN11AL1M-4G6	210 483		221	20	C
	15	FN15AL1M-4G6		560	252	31	D
60H-7	18.5	FN18.5AL1M-4G6	260			35	
3-Phase	22	FN22AL1M-4G6				40	
440-480V	30	FN30AL1M-4G6		750	319	52	E
Class	37	FN37AL1M-4G6	290			57	
	45	FN45AL1M-4G6				65	
	55	FN55AL1M-4G6	240	750	434	67	F
	75	FN75AL1M-4G6	340	752		90	
	90	FN90AL1M-4G6	252	000	296	125	G
	110	FN110AL1M-4G6	303	900	300	146	
	132	FN132AL1M-4G6 **				187	Н
	160	FN160AL1M-4G6 **	462	1150	456	204	
	220	FN220AL1M-4G6 **				269	

* Filter rating which does not require forced cooling or fan module
** Filter rating which does not require RC damping module for rectifiers with EMI filter

*** Motor drive input current without harmonic filter



Sample view of the filter without front cover





50 Hz & 60 Hz Mechanical data of IP20 enclosure









Innovating Energy Technology



Fuji Electric Harmonic Mitigation Passive Harmonic Filter.





Innovating Energy Technology



FRENIC INVERTER Technology made possible by Fuji Electric intensive range of inverter

The FRENIC inverter series is equipped with functions and performance to meet all types of requirements, providing easy maintenance, energy and cost saving and environmental friendliness. The 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





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