

PolyGap[®] Sine Wave Filters

and L-C-L Filters

for Active Front End
(AFE) Converters

480 Volts



Dependable Protection & Power Quality for:

- Motors Controlled by Variable Frequency Drives
- Renewable Energy Inverters
- Drives and Converters with Active Front Ends

Mangoldt...The Engineer's Choice

Power Protection for Adjustable Speed Drive Systems



German Engineering & Quality
Stocked in Wisconsin
Factory support located in Wisconsin

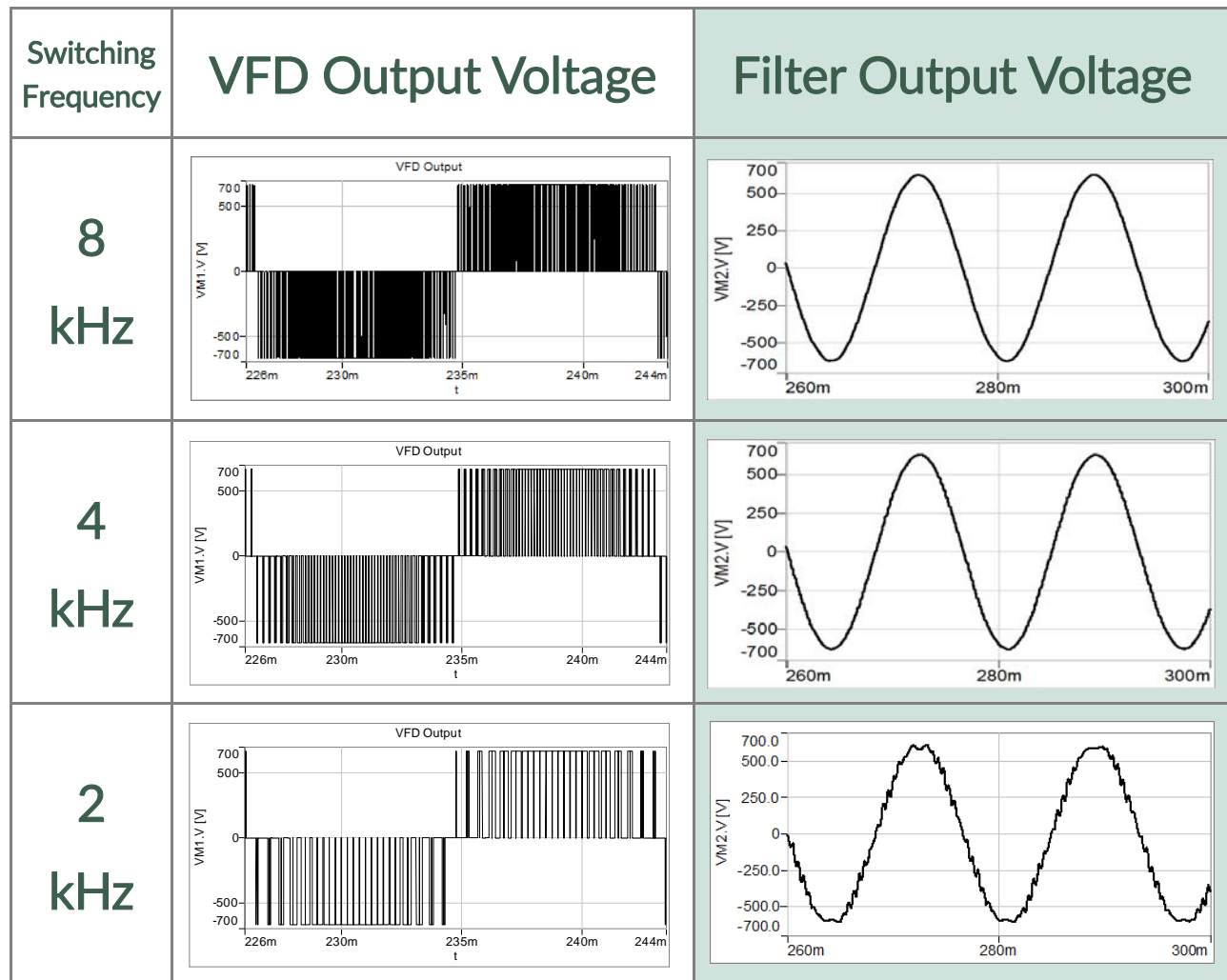


PolyGap[®] Sinewave Filter Performance

Mangoldt PolyGap[®] Sinewave Filters convert variable frequency drive output voltage from PWM to a sinewave. This extends motor life by eliminating high peak voltage associated with reflected voltage pulses in applications having long motor cables.

Sinewave filters can eliminate motor cable length restrictions. Mangoldt sinewave filters may be used for switching frequencies of 2kHz and higher. Higher switching frequency settings will achieve voltage waveforms of the highest purity.

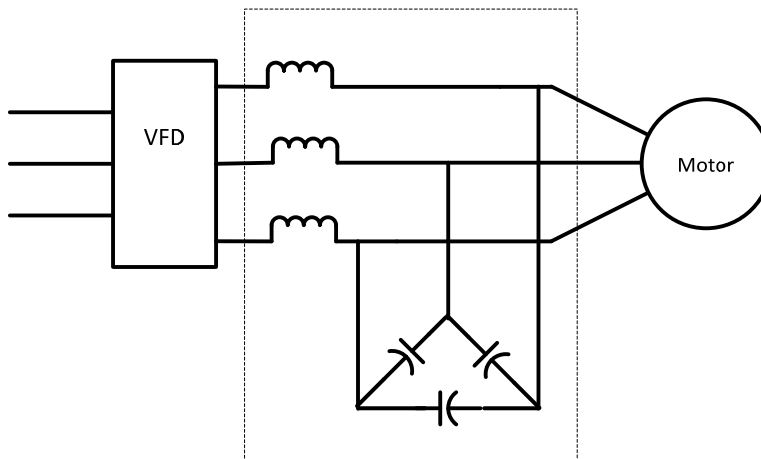
- Convert PWM to near sine wave voltage
- Extend usable motor cable length
- Eliminate harmful reflected voltage pulses
- Reduce motor voltage waveform dv/dt



Note: Use filter with switching frequency of 2kHz or higher. Higher switching frequency will result in lower distortion as shown above.

PolyGap[®] Sine Wave Filter Specifications

For use at switching frequency of 2kHz or higher



Voltage Distortion	Typically <5% THD-v at rated output frequency for $f_{sw} < 4\text{kHz}$ Typically <3% THD-v at rated output frequency for $f_{sw} \geq 4\text{kHz}$
Voltage Rating/Frequency	500V class: 380V–480V/ 80Hz maximum 690V class: 600V/80Hz maximum; 690V/70Hz maximum
PWM Pulse Frequency	$\leq 600\text{V}$: 2kHz and higher 690V: 1.5kHz and higher
Current Ratings (I_N)	5 to 1460 Amps (rms); Higher ratings available upon request
Voltage Drop	480V: $\leq 10\%$ at rated current 600V: $\leq 12.5\%$ at rated current 690V: $\leq 11.5\%$ at rated current
Dielectric Strength	3kV (1 minute) coil-coil, coil-core
Impulse Voltage Test	4200 Peak Volts
Overload	150% x I_N for 60sec / every 10 minutes ($T_{amb} \leq 45^\circ\text{C}$)
Surrounding Air Temperature	Maximum 45°C (Capacitors) and 50°C (Reactors)
Reactor Temperature Rise	115°C, in 50°C surrounding air temperature
Reactor Insulation System	Class H, 180°C
Terminations	Solid copper bar or tin-plated copper pressure plate terminal
Reactor Impregnation	Vacuum Overpressure (VPI)
Relative Humidity	Maximum 95% non-condensing
Maximum Altitude	1000 meters (de-rate above this)
Agency Approvals	CUL Listed (E173113), IEC/EN60076-3, VDE0532-76-6

Note: Filters for higher fundamental frequencies are available upon request

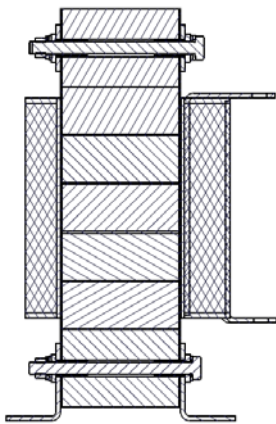
Unique features from Mangoldt

PolyGap® Reduces Power Losses

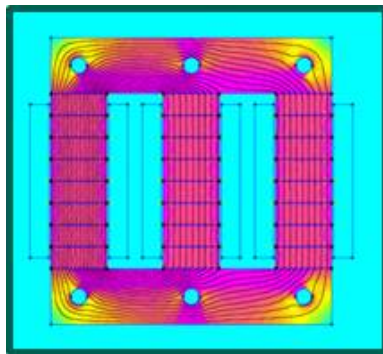
Mangoldt PolyGap® cores are constructed using many tiny air gaps instead of the typical single large air gap. The length of each individual air gap is optimized throughout the core in order to realize the lowest power losses.

PolyGap® achieves balanced inductance in each phase, high inductance linearity over a wide range of current and frequencies, and virtually eliminates stray magnetic fields associated with harmonic and PWM switching frequencies.

Mangoldt PolyGap® Reactors



Cross section view



Finite Element Analysis (FEA) view

PolyGap® Sinewave Filters eliminate the heat producing circulating currents in reactor coil windings, which are caused by stray magnetic fields emitted by large air gaps.

The direct benefits of PolyGap® include:

- Low power losses (lower watts, less heat)
- No interference with neighboring equipment
- Multiple filters may be connected in parallel



Traditional Reactors

Traditional reactors used in industry typically have the total air gap concentrated into one or two large air gaps. This concentrated air gap can cause large stray magnetic fields around the air gaps, in the coil windings and surrounding the reactor. The large magnetic field causes extra heating due to harmonics and switching frequency and can also interfere with sensitive electronic equipment when the magnetic field extends outside of the reactor.

Benefits that set Mangoldt above the rest!

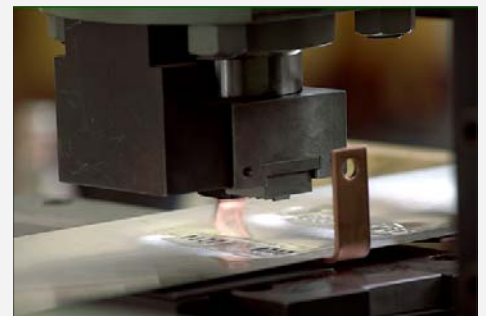


High Performance & Quality, yet Economical

At Mangoldt, processes such as core manufacturing, coil winding plus routine testing are highly automated, which enables us to produce reactors of the highest performance and quality at competitive prices. Additionally, all Mangoldt reactors are 100% tested and serialized. The test report for any serial number is available upon request.

Reliable, Low Loss Terminations

Solid copper terminals are bonded to coil winding conductors without heat using a cold pressure welding process. Terminals are permanently attached by bonding atoms of both materials together without thermal stress to either material. This achieves a secure bond with minimal contact resistance for a lifetime of trouble free and low power loss connections.



Quiet, Long Life Reactors

Mangoldt reactors are thoroughly impregnated with UL Class H varnish in a multi-step process including vacuum, varnish, over-pressure and then baking. The result is a long lifetime for the reactor and quiet operation.

Low Power Losses = High Efficiency

Mangoldt's combination of many tiny air gaps (PolyGap®), plus unique coil design and flux density control minimizes the overall reactor power losses, especially those losses due to harmonics or PWM frequencies. Higher efficiency means low operating costs over the lifetime of the reactor.

Improved Filtering, Flexibility

Mangoldt reactors with PolyGap® cores have balanced inductance (-/+3%), in all three phases, to achieve consistent filtering and voltage drops in all phases along with balanced voltage and the best overall motor performance. PolyGap® cores enable parallel connections of multiple filters for higher current requirements.



480V Motor Filters

Convert PWM to Sinewave



Mangoldt PolyGap® Sinewave Filters are selected based upon motor voltage and full load amperes (FLA) when known, otherwise use either VFD or motor HP (or kW) rating. Please check with our Stocking Partner or Technical Support Office for other voltages or frequencies and for custom filters.

For added convenience, capacitor modules may be mounted separately. Please contact the Stocking Partner or Technical Support Office for more information.

Cat. No.	Arms	HP	kW	mH	uF	Terminal	Watts Loss	Weight kg/lbs
PSF53-0005	5	3	2.2	14.5	1.5	term blk	45	6.4 / 14
PSF53-0008	8	5	3.7	9	2.2	term blk	70	7.6 / 17
PSF53-0011	11	7.5	5.6	6.5	3	term blk	90	10.8 / 24
PSF53-0015	15	10	7.5	4.8	4.7	term blk	110	12.7 / 28
PSF53-0021	21	15	11	3.4	6.8	term blk	140	15.8 / 35
PSF53-0027	27	20	15	2.7	6.8	Cu bar	170	23.8 / 52
PSF53-0035	35	25	19	2	10	Cu bar	180	24.4 / 54
PSF53-0040	40	30	22	1.8	10	Cu bar	220	28.9 / 64
PSF53-0052	52	40	30	1.38	15	Cu bar	260	30.9 / 68
PSF53-0065	65	50	37.3	1.1	20	Cu bar	310	41.5 / 91
PSF53-0077	77	60	45	0.93	20	Cu bar	350	40.4 / 89
PSF53-0100	100	75	56	0.72	33	Cu bar	410	58.7 / 129
PSF53-0125	125	100	75	0.57	33	Cu bar	450	68.9 / 152
PSF53-0156	156	125	93	0.46	47	Cu bar	550	78.4 / 172
PSF53-0187	187	150	112	0.39	47	Cu bar	620	91.9 / 202
PSF53-0240	240	200	149	0.3	66	Cu bar	850	121 / 266
PSF53-0302	302	250	187	0.24	94	Cu bar	935	158 / 348
PSF53-0361	361	300	224	0.2	94	Cu bar	1050	175 / 385
PSF53-0420	420	350	261	0.17	94	Cu bar	1200	195 / 429
PSF53-0480	480	400	298	0.15	141	Cu bar	1350	216 / 475
PSF53-0520	520	450	336	0.138	141	Cu bar	1400	244 / 537
PSF53-0590	590	500	373	0.12	141	Cu bar	1500	259 / 570
PSF53-0720	720	600	448	0.1	188	Cu bar	1750	302 / 664
PSF53-0840	840	700	522	0.085	188	Cu bar	1850	338 / 744
PSF53-1000	1000	850	634	0.07	282	Cu bar	2650	415 / 913
PSF53-1220	1081	900	671	0.06	282	Cu bar	2750	469 / 1032
PSF53-1220	1220	1000	746	0.06	282	Cu bar	3100	469 / 1032
PSF53-1460	1460	1200	895	0.05	376	Cu bar	3500	565 / 1243

Note: Refer to drawings and datasheets for complete current information.

Note: Mangoldt Sinewave Filters are also available as Kits.

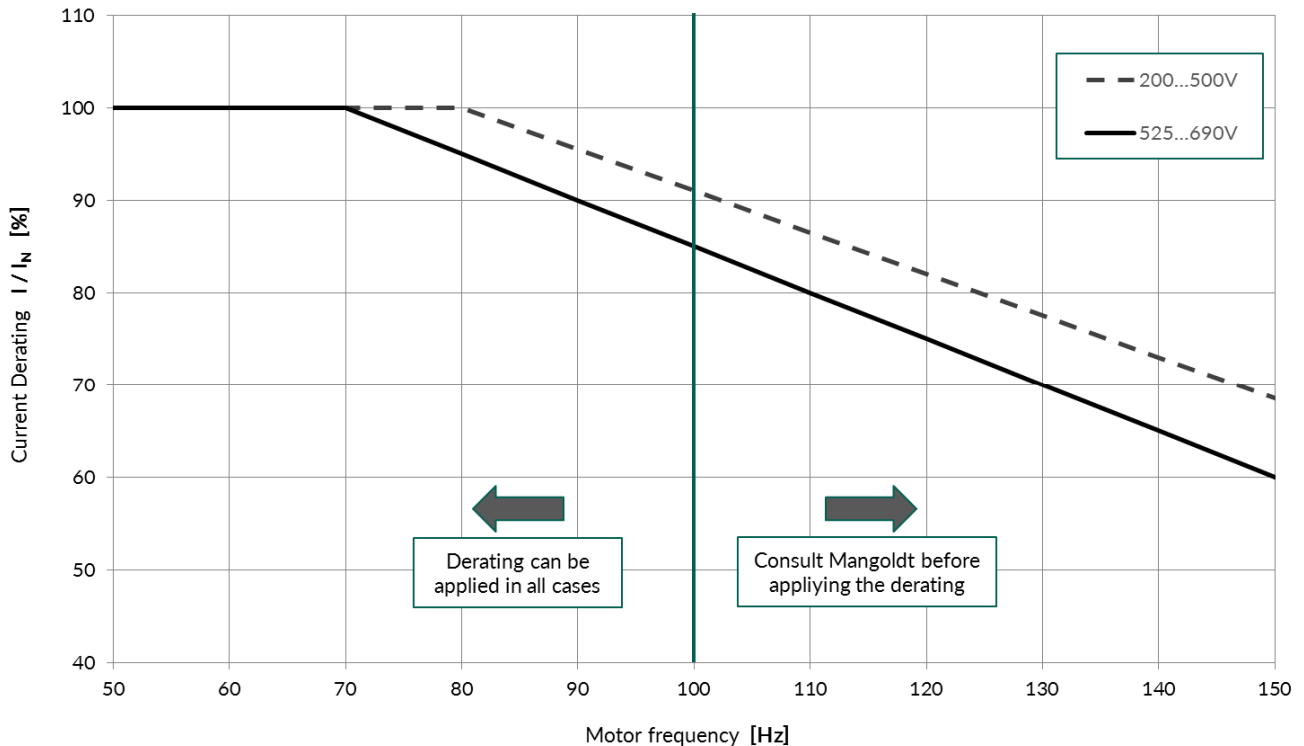


Application Engineering Support

Mangoldt has several decades of experience in the design and application of filters and filter reactors. We offer Application Notes for a wide variety of topics. If you have questions regarding an application, please feel free to contact our Stocking Partner or Technical Support Office.

Mangoldt Sinewave Filters for use at up to 150Hz VFD output frequency

For VFD applications where the motor fundamental frequency will exceed 60Hz but will not exceed 150Hz, apply the filter at reduced current per the chart below.



Mangoldt Sinewave Filters for use above 150Hz VFD output frequency

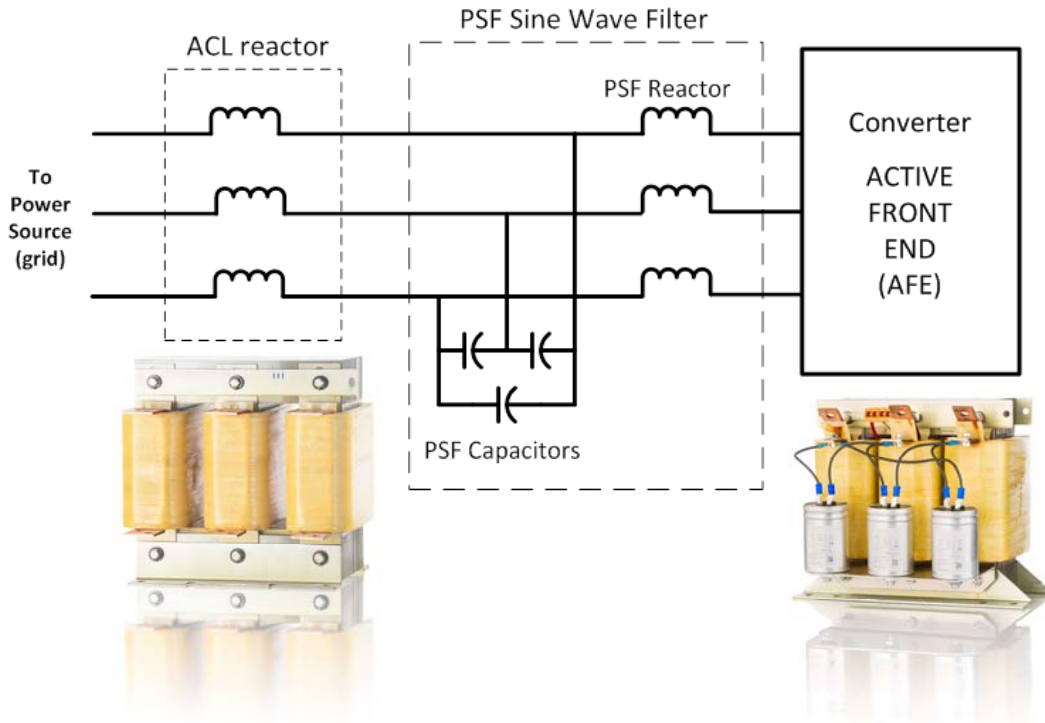
For high speed motor applications where the fundamental frequency will exceed 150Hz, please contact the Technical Support Office or Stocking Partner. Mangoldt offers “medium frequency” sinewave filters as custom products.



480V L-C-L Filters

For Active Front End Converters

L-C-L Filters are intended for applications of renewable energy (grid tied) inverters and motor drives with active (IGBT) front ends. The L-C-L filter is comprised of a standard PSF Sinewave Filter plus a standard ACL “5-in-1” Line/Load Reactor (5% impedance). The following pages include data and selection tables for L-C-L filters. Select both the PSF number and ACL number for one complete L-C-L Filter.



Phases	3-phase
Voltage Rating	400V/50Hz; 480V/60Hz; 600V/60Hz; 690V/50Hz
Frequency (system)	50 to 60 Hz
PWM Pulse Frequency	3kHz to 10kHz
Current Ratings (I_N)	5 to 1460 Amps (rms)
Dielectric Strength	3kV (1 minute) coil-coil, coil-core
Impulse Voltage Test	4200 Peak Volts
Overload	150% x I_N for 60sec / every 10 minutes ($T_{amb} \leq 45C$)
Surrounding Air Temperature	45°C maximum (capacitors) and 50°C (reactors)
Temperature Rise	115°C, in 45C surrounding air temperature
Insulation System	Class H, 180°C
Terminations	Solid copper bar or tin-plated copper pressure plate terminal
Reactor Impregnation	Vacuum & Overpressure (VPI)
Relative Humidity	Maximum 95% non-condensing
Maximum Altitude	1000 meters (de-rate above this)
Agency Approvals	CUL Listed (E173113), IEC/EN60076-3, VDE0532-76-6

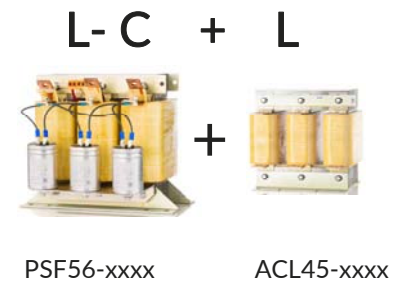


480V L-C-L Filter Selection For Active Front End Converters



PolyGap® Sinewave Filters are designed for two purposes. In addition to being used in VFD motor drive applications to improve motor voltage waveforms, they can also be used as part of an L-C-L Filter for active front end converters. The purpose of these L-C-L filters is to remove harmonic current and voltage associated with the PWM switching frequency of the IGBTs. For a complete L-C-L Filter, both a PSF Sinewave Filter plus an ACL line reactor is required.

480V	For LCL FILTER (Use 1 of each)		Rated Current	Total Losses	Total Weight
HP	PSF (L-C)	+ ACL (L)	A rms	(watts)	(kg / lbs)
3	PSF53-0005	+ ACL45-0005	5	80	9.5 / 21
5	PSF53-0008	+ ACL45-0008	8	110	13.2 / 29
7.5	PSF53-0011	+ ACL45-0011	11	135	16.4 / 36
10	PSF53-0015	+ ACL45-0014	14	160	19.5 / 43
15	PSF53-0021	+ ACL45-0021	21	210	25 / 55
20	PSF53-0027	+ ACL45-0027	27	250	35 / 77
25	PSF53-0035	+ ACL45-0034	34	290	36 / 79
30	PSF53-0040	+ ACL45-0040	40	340	42 / 91
40	PSF53-0052	+ ACL45-0052	52	390	49 / 108
50	PSF53-0065	+ ACL45-0065	65	450	61 / 133
60	PSF53-0077	+ ACL45-0080	77	530	61 / 133
75	PSF53-0100	+ ACL45-0106	100	620	82 / 180
100	PSF53-0125	+ ACL45-0129	125	685	100 / 219
125	PSF53-0156	+ ACL45-0159	156	810	113 / 249
150	PSF53-0187	+ ACL45-0185	185	915	133 / 292
200	PSF53-0240	+ ACL45-0243	240	1240	165 / 363
250	PSF53-0302	+ ACL45-0302	302	1375	209 / 460
300	PSF53-0361	+ ACL45-0366	361	1560	233 / 513
350	PSF53-0420	+ ACL45-0429	420	1770	253 / 557
400	PSF53-0480	+ ACL45-0488	480	2010	290 / 638
450	PSF53-0520	+ ACL45-0530	520	2150	341 / 750
500	PSF53-0590	+ ACL45-0615	590	2300	363 / 797
600	PSF53-0720	+ ACL45-0731	720	2620	425 / 935
700	PSF53-0840	+ ACL45-0848	840	2840	463 / 1019
800	PSF53-1000	+ ACL45-0975	975	3700	567 / 1247
900	PSF53-1220	+ ACL45-1081	1081	4050	623 / 1371
1000	PSF53-1220	+ ACL45-1224	1220	4400	649 / 1428
1200	PSF53-1460	+ ACL45-1500	1460	5200	888 / 1954



Two items are required.

L-C-L Filters are constructed using two standard Mangoldt products:

L-C: PSF Sinewave Filter (PSF56-xxxx)

L: ACL “5-in-1” Line/Load Reactor (5% impedance) (ACL45-xxxx)

For a complete L-C-L Filter, please order both items.

Note: Mangoldt L-C-L Filters are also available as Kits. Consult Stocking Partner or Technical Support Office for assistance.

Consult Technical Support Office or Stocking Partner for any other ratings.



Sine Wave Filter Dimensions & Weight

480 Volts

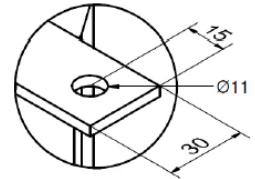
Note: Data subject to change without notice.

Refer to drawings and datasheets for complete current information.

Cat. No.	Arms	HP	kW	mH	uF	Terminal	Watts Loss	Weight kg/lbs
PSF53-0005	5	3	2.2	14.5	1.5	term blk	45	6.4 / 14
PSF53-0008	8	5	3.7	9	2.2	term blk	70	7.6 / 17
PSF53-0011	11	7.5	5.6	6.5	3	term blk	90	11 / 24
PSF53-0015	15	10	7.5	4.8	4.7	term blk	110	13 / 29
PSF53-0021	21	15	11	3.4	6.8	term blk	140	16 / 35
PSF53-0027	27	20	15	2.7	6.8	Cu bar	170	24 / 53
PSF53-0035	35	25	19	2	10	Cu bar	180	24 / 53
PSF53-0040	40	30	22	1.8	10	Cu bar	220	29 / 64
PSF53-0052	52	40	30	1.38	15	Cu bar	260	31 / 68
PSF53-0065	65	50	37.3	1.1	20	Cu bar	310	42 / 92
PSF53-0077	77	60	45	0.93	20	Cu bar	350	40 / 88
PSF53-0100	100	75	56	0.72	33	Cu bar	410	59 / 130
PSF53-0125	125	100	75	0.57	33	Cu bar	450	69 / 152
PSF53-0156	156	125	93	0.46	47	Cu bar	550	76 / 167
PSF53-0187	187	150	112	0.39	47	Cu bar	620	92 / 202
PSF53-0240	240	200	149	0.3	66	Cu bar	850	121 / 266
PSF53-0302	302	250	187	0.24	94	Cu bar	935	143 / 315
PSF53-0361	361	300	224	0.2	94	Cu bar	1050	175 / 385
PSF53-0420	420	350	261	0.17	94	Cu bar	1200	195 / 429
PSF53-0480	480	400	298	0.15	141	Cu bar	1350	216 / 475
PSF53-0520	520	450	336	0.138	141	Cu bar	1400	244 / 537
PSF53-0590	590	500	373	0.12	141	Cu bar	1500	259 / 570
PSF53-0720	720	600	448	0.1	188	Cu bar	1750	302 / 664
PSF53-0840	840	700	522	0.085	188	Cu bar	1850	338 / 744
PSF53-1000	1000	850	634	0.07	282	Cu bar	2650	415 / 913
PSF53-1220	1081	900	671	0.06	282	Cu bar	2750	468/1030
PSF53-1220	1220	1000	746	0.06	282	Cu bar	3100	468 / 1030
PSF53-1460	1460	1200	895	0.05	376	Cu bar	3500	564 / 1241

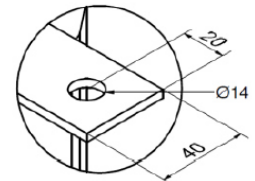
Bus Bar 30 mm

Fig. 1



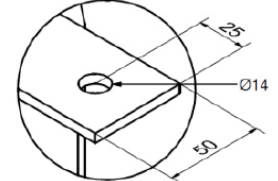
Bus Bar 40 mm

Fig. 2



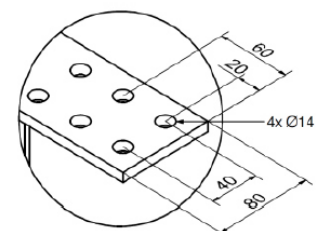
Bus Bar 50 mm

Fig. 3

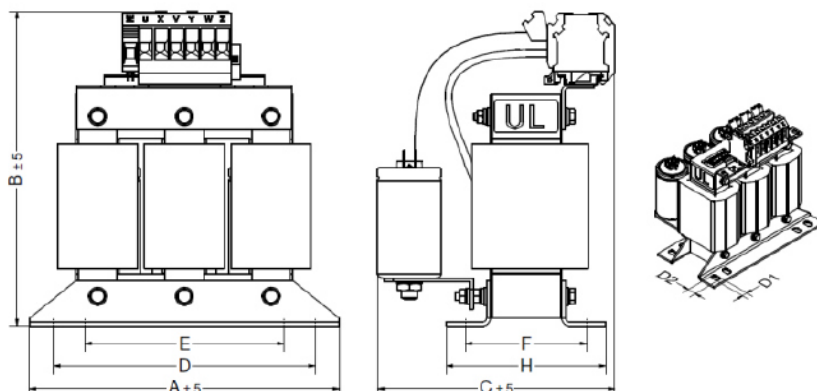


Bus Bar 80 mm

Fig. 4



5...21 A Types (Terminal Block)

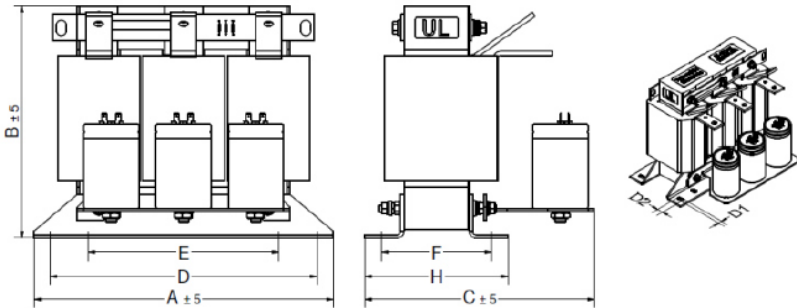


Sine Wave Filter Terminations

480 Volts

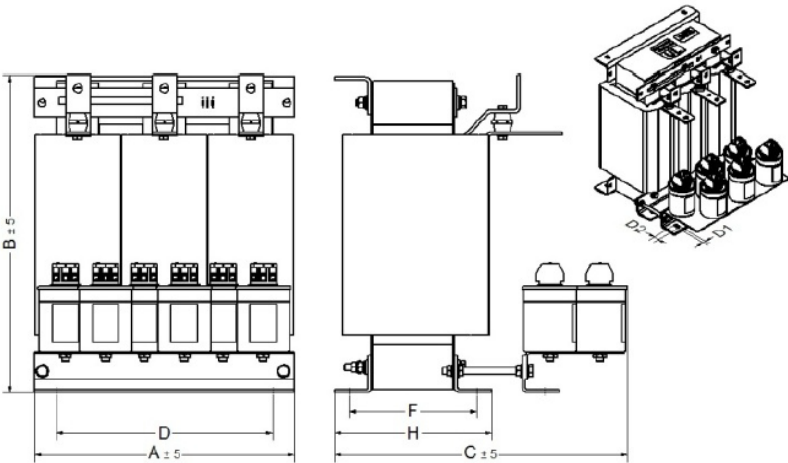
Note: Refer to drawings and datasheets for complete current information.

35...187 A Types (Copper Bus Bars)



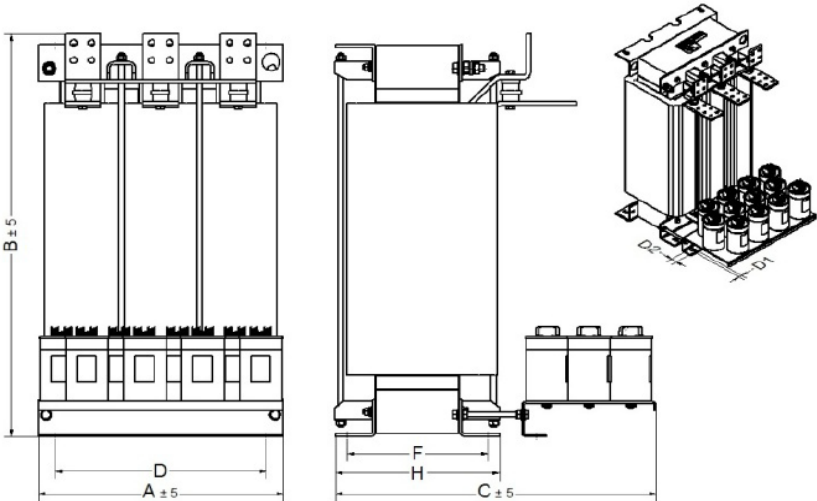
2D & 3D drawings:
Please contact the Technical Support Office or the Stocking Partner Sales Office for PDF, DWG or STP files.

240...360 A Types (Copper Bus Bars)



Datasheets :
Please contact the Technical Support Office or the Stocking Partner Sales Office for filter datasheets.

480...1460 A Types (Copper Bus Bars)



Reactor Technology at its Best

Since 1941

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- Sinewave Filters
- VFD Input Harmonic Filters
- 5%, 8%, 12% THDi Filters
- Standards & Customs



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Air Core & Iron Core Reactors

Filter Reactors

Common Mode Chokes

Line/Load/dv/dt/PWM/Notch Reactors

Audio Frequency Blocking Filters

Tuning Inductors

VFD Input Harmonic

Current Limiting Reactors

PWM Sinusoidal Filter Reactors

Liquid-Cooled Reactors

Smoothing Reactors

Active Filter Reactors

PWM Reactors

dv/dt Limiting Inductors

Sales & Technical Support Locations

Stocking Partner Sales Office

Power **Quality** Components

W136N5239 Campbell Court
Menomonee Falls, WI 53051

P: 1-262-777-2360

F: 1-262-783-5974

www.pqcomponents.com

info@pqcomponents.com



Technical Support Office

Power Quality Specialists

Allied Industrial Marketing, Inc.
W67 N222 Evergreen Blvd. Suite 209
Cedarburg, WI 53012

P: 1-262-618-2403

F: 1-262-618-2303

www.alliedindustrialmarketing.com

World Headquarters

Hans von Mangoldt GmbH

Hergelsbendenstr. 18

D- 52080 Aachen

www.mangoldt.com

