# Type IHF

# Input Harmonic Filters

## for use with adjustable speed drives

## and other 6-pulse rectifiers

## 480 Volt Kits

## Flexible Filtering Options for Adjustable Speed Drive Systems

c UL us

Up to 690 Vac

German Engineering & Quality

Stocked in USA and Canada

Factory support located in Wisconsin

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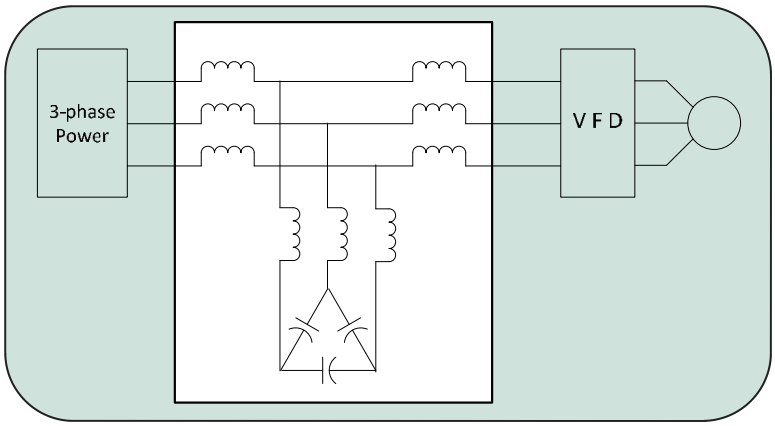
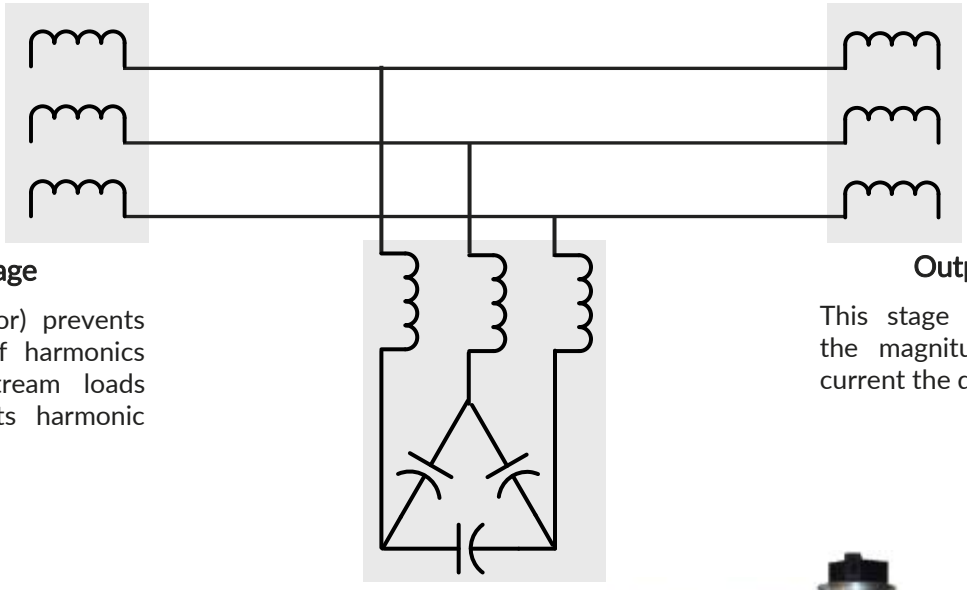
# A Wide Band Harmonic Filter




## Three Stages of Filtering

Mangoldt's standard Type IHF Input Harmonic Filters provide three stages of filtering to achieve low residual harmonic distortion levels, enabling electrical power systems to comply with the limits of IEEE-519 and other international power quality standards. They are wide band harmonic filters, where low frequency current, such as 60Hz or 50hz, passes easily through the filter, but the harmonic currents are attenuated (filtered). All harmonic currents, that are characteristic of a 3-phase, 6-pulse rectifier, will be significantly reduced.

Mangoldt gives you the choice of 5% THD-i, 8% THD-i or 12% THD-i and also considers any internal reactor in the drive so you get the performance you need at the lowest price. The Input Stage and Shunt Stage are the same whether a filter is to achieve 5%, 8% or 12% THDi. Only the Output Stage reactor changes to achieve the various THD-i performance levels.



### Input Stage

This stage (reactor) prevents the absorption of harmonics from other upstream loads and also prevents harmonic resonance.

### Output Stage

This stage (reactor) reduces the magnitude of harmonic current the drive produces.

### Shunt Stage

This stage (reactor & capacitor) removes nearly all of the 5th harmonic and reduces higher order harmonics.

**Performance Guarantee**

VFDs using properly selected Mangoldt Input Harmonic Filters will contribute less than or equal to 5%THDi, 8%THDi or 12%THDi harmonic distortion, based on the unit selected, at their rated current. Pre-existing voltage distortion may add to this level.

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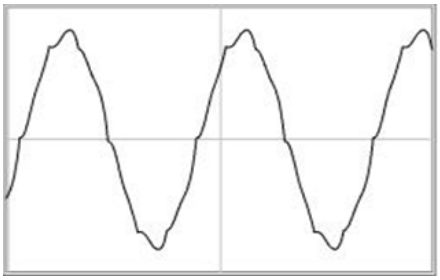
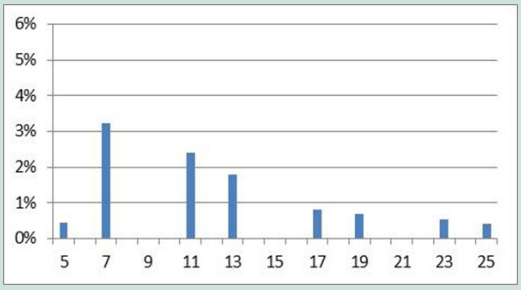
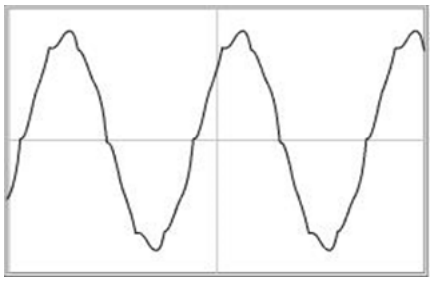
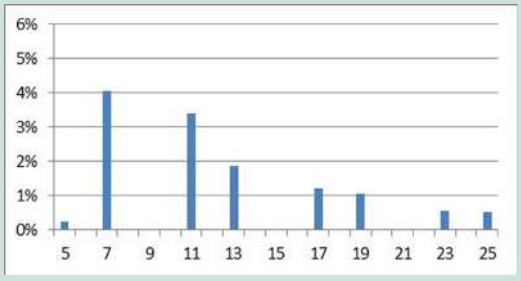
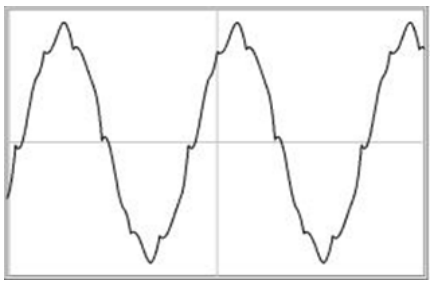
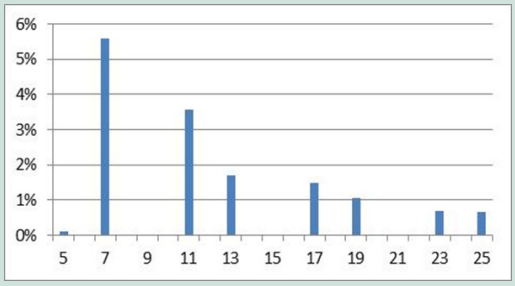
# Wide Band Filter Performance

Mangoldt (Type IHF) Input Harmonic Filters offer reliable performance for 6-pulse variable frequency drive systems. They attenuate the harmonics associated with 6-pulse VFDs and may also be used for DC drives and other AC to DC converters. For more information about SCR/Thyristor and other types of converters, refer to Page 15 or contact our Stocking Partner or Technical Support Office.

| Filter Performance | Typical Input Current Waveform at 100% Load | Typical Input Harmonic Current Spectrum at 100% Load |
|---|---|---|
| 5% THDi |  |  |
| 8% THDi |  |  |
| 12% THDi |  |  |



**Harmonic Current:**

Mangoldt Input Harmonic Filters reduce the harmonic currents generated by variable frequency and DC drives. The table below indicates the typical input harmonic current spectrum for VFDs using our optional standard filters.

| Typical Harmonic Current Spectrum at Filter Input Terminals (at rated load) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Filter | $I_1$ | $I_5$ | $I_7$ | $I_{11}$ | $I_{13}$ | $I_{17}$ | $I_{19}$ | $I_{23}$ | $I_{25}$ | %THDi |
| 5% THDi | 100% | <1% | 3.5% | 2.4% | 1.8% | 1% | 0.75% | 0.6% | 0.5% | ≤5% THDi |
| 8% THDi | 100% | <1% | 5% | 4% | 3% | 2% | 1.25% | 1% | 1% | ≤8% THDi |
| 12% THDi | 100% | <1% | 8% | 6% | 4% | 2.5% | 1.5% | 1% | 1% | ≤12% THDi |

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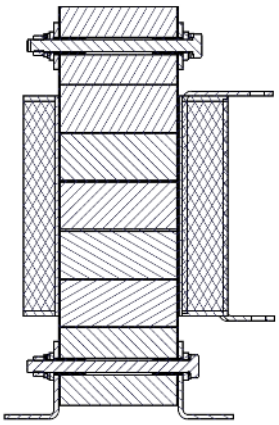
# Mangoldt's Unique PolyGap® Cores

## PolyGap® Reduces Power Losses

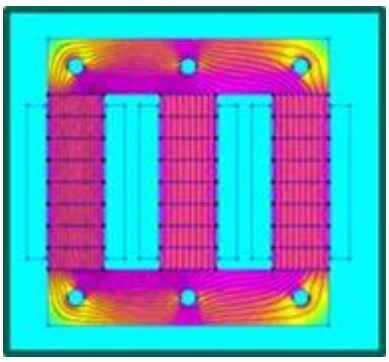
Mangoldt PolyGap® cores are constructed using many tiny air gaps instead of the typical single large air gap. The length of each individual air gap is optimized throughout the core in order to realize the lowest reactor and filter power losses.

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 frequencies.

## Mangoldt PolyGap® Reactors



Cross section view



Finite Element Analysis (FEA) view

Note: There is no magnetic field (yellow) near air gaps or coils.

PolyGap® reactors eliminate 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

### Mangoldt vs. Traditional Reactors

Mangoldt PolyGap® reactors are different than traditional reactors which typically have the 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 fields cause extra heating due to harmonics and can also interfere with sensitive electronic equipment when the magnetic fields extend outside of the reactor. Mangoldt reactors with PolyGap® cores prevent stray magnetic fields, resulting in lower heat and power losses.

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# Benefits that set Mangoldt above the rest!

Up to 690 Vac

## UL Tested with Real World Harmonic Currents

Traditional UL testing of reactors and filters has typically been performed at 60Hz only. However, Mangoldt filter reactors were tested by UL with full (real world) harmonic currents. Temperature rise, heat and power losses were confirmed with actual harmonic currents.

## Optimum Filtering Due to Precise Components

Optimum filtering requires that inductance and capacitance be precise and balanced in all three phases. Reactors with PolyGap® construction offer inductance that is balanced in all three phases and each phase is within -/+ 3% of the nominal inductance rating. Capacitors used in our filters have a tolerance band of –0%, +5%. The precise tuning of our filter, in all three phases, helps to assure filter performance and reliability.

## Vacuum and Over-Pressure Impregnation

Long life and quiet operation are the key benefits of Mangoldt's varnish impregnation process. Mangoldt reactors are impregnated with UL Class H varnish in a process involving vacuum, varnish, apply over-pressure and then baking. The result is a long life and a quiet operating reactor.

## High Efficiency

Reactors are the major source of heat loss in harmonic filters, but Mangoldt maximizes efficiency by using PolyGap® cores. Mangoldt filter reactors include three key design elements to reduce power losses. These features include PolyGap® cores, unique coil design, plus flux density control. This unique combination minimizes the power losses, especially those due to harmonic frequencies. Mangoldt Input Harmonic Filter efficiency is typically 99% or higher.

## Reactor Over-Temperature Sensing

The shunt circuit reactors (ACS43-xxxx) are equipped with a N.C. over-temperature sensor in the center coil. This temperature switch may be used to activate an alarm or de-energize a circuit in the event of an over-temperature condition. Refer to Page 12 for electrical and thermal specifications.

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# Selecting the Right Filter - 480V, 60Hz

Mangoldt standard Input Harmonic Filters provide 3 stages of filtering to minimize harmonic distortion for adjustable speed drive systems. 2-stage versions are available for use with VFDs having an internal reactor. The filter Catalog Number consists of a basic catalog number (ie: IHF56-0185) indicating maximum rated current plus an optional letter suffix indicating the output stage reactor used for the desired %THD-i level.

The selection table on Page 7 may be used in all cases, however, if your VFD has an internal reactor, then a lower price filter can be selected on either Page 8 (when VFD has ≥3% impedance reactor) or Page 9 (when VFD has ≥5% impedance reactor).

Step 1: Which selection table to use

| VFD Internal Reactor | Selection Table |
|---|---|
| Not sure | Page 7 |
| No | Page 7 |
| ≥3% impedance | Page 8 |
| ≥5% impedance | Page 9 |

Step 2: Which suffix to use

| VFD internal reactor | Desired %THD-i Performance | | |
|---|---|---|---|
| | 5% THDi | 8% THDi | 12% THDi |
| NONE | IHF56-xxxx-A | IHF56-xxxx-B | IHF56-xxxx-C |
| 3% Z | IHF56-xxxx-B | IHF56-xxxx-C | IHF56-xxxx |
| 5% Z | IHF56-xxxx-C | IHF56-xxxx | IHF56-xxxx |

Note: Suffix indicates which optional reactor is used near the VFD

Note: Suffixes "-A", "-B" and "–C" are 3-stage filters

Note: No suffix indicates a 2-stage filter

## Compliance with IEEE-519

The IEEE-519 limit for Total Demand Distortion (%TDD) can be 5%, 8%, 12%, 15% or 20% TDD. That is why Mangoldt gives you a choice of filters to achieve Total Harmonic Current Distortion of 5%, 8% or 12% THDi. Mangoldt filters meet these levels of %THDi at the input to the filter. In most cases, due to the presence of non-harmonic producing loads in a facility, the total demand distortion at the Point of Common Coupling (PCC) will be lower than this value.

| IEEE-519-2014 Limits | |
|---|---|
| $I_{SC}$ / $I_L$ | TDD |
| <20 | 5% |
| 20 < 50 | 8% |
| 50 < 100 | 12% |
| 100 < 1000 | 15% |
| 1000 + | 20% |

| Filter %THDi | %THDi at Filter Input | % TDD at PCC | | | |
|---|---|---|---|---|---|
| | | VFDs are 25% of demand | VFDs are 50% of demand | VFDs are 75% of demand | VFDs are 100% of demand |
| **5%** | 5% | 1.25% | 2.5% | 3.75% | 5% |
| **8%** | 8% | 2% | 4% | 6% | 8% |
| **12%** | 12% | 3% | 6% | 9% | 12% |

Note: chart assumes all VFDs include the same type (THDi) of filter.

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# Selection Tables — 480V, 60Hz

## For VFDs without Internal Reactor and for DC Drives

1) Find the column heading for your desired THDi performance level (5%, 8% or 12% THDi).
2) Select catalog number based upon motor full load amperes (FLA) or horsepower (HP) rating.
3) Make sure filter rated current (FLA) is adequate (if not, select an appropriate higher rating).
4) Contact our Technical Support Office for other voltages or frequencies.

**For Enclosed Filters:**
Refer to Stocking Partner for Type 1 (–N1) or Type 3R (–N3R) enclosed versions.

**For DC Drives**
Filter selection should be based on DC Drive HP x 1.33 and always requires "–A" suffix.
See Page 15 for further explanation.

| HP | FLA | 5% THDi (3-stage) | 8% THDi (3-stage) | 12% THDi (3-stage) |
|---|---|---|---|---|
| 5 | 8 | IHF56-0008-A | IHF56-0008-B | IHF56-0008-C |
| 7.5 | 11 | IHF56-0011-A | IHF56-0011-B | IHF56-0011-C |
| 10 | 14 | IHF56-0014-A | IHF56-0014-B | IHF56-0014-C |
| 15 | 21 | IHF56-0021-A | IHF56-0021-B | IHF56-0021-C |
| 20 | 27 | IHF56-0027-A | IHF56-0027-B | IHF56-0027-C |
| 25 | 34 | IHF56-0034-A | IHF56-0034-B | IHF56-0034-C |
| 30 | 40 | IHF56-0040-A | IHF56-0040-B | IHF56-0040-C |
| 40 | 52 | IHF56-0052-A | IHF56-0052-B | IHF56-0052-C |
| 50 | 65 | IHF56-0065-A | IHF56-0065-B | IHF56-0065-C |
| 60 | 77 | IHF56-0077-A | IHF56-0077-B | IHF56-0077-C |
| 75 | 100 | IHF56-0100-A | IHF56-0100-B | IHF56-0100-C |
| 100 | 125 | IHF56-0125-A | IHF56-0125-B | IHF56-0125-C |
| 125 | 156 | IHF56-0156-A | IHF56-0156-B | IHF56-0156-C |

| HP | FLA | 5% THDi (3-stage) | 8% THDi (3-stage) | 12% THDi (3-stage) |
|---|---|---|---|---|
| 150 | 185 | IHF56-0185-A | IHF56-0185-B | IHF56-0185-C |
| 200 | 240 | IHF56-0240-A | IHF56-0240-B | IHF56-0240-C |
| 250 | 302 | IHF56-0302-A | IHF56-0302-B | IHF56-0302-C |
| 300 | 361 | IHF56-0361A | IHF56-0361B | IHF56-0361C |
| 350 | 415 | IHF56-0415-A | IHF56-0415-B | IHF56-0415-C |
| 400 | 480 | IHF56-0480-A | IHF56-0480-B | IHF56-0480-C |
| 450 | 515 | IHF56-0515-A | IHF56-0515-B | IHF56-0515-C |
| 500 | 590 | IHF56-0590-A | IHF56-0590-B | IHF56-0590-C |
| 600 | 720 | IHF56-0720-A | IHF56-0720-B | IHF56-0720-C |
| 700 | 840 | IHF56-0840-A | IHF56-0840-B | IHF56-0840-C |
| 800 | 960 | IHF56-0960-A | IHF56-0960-B | IHF56-0960-C |
| 900 | 1080 | IHF56-1080-A | IHF56-1080-B | IHF56-1080-C |
| 1200 | 1440 | IHF56-1440-A | IHF56-1440-B | IHF56-1440-C |

### VFDs with internal inductance:

For VFDs with 3% impedance internal inductance (AC or DC), use the selection tables on Page 8.

For VFDs with 5% impedance internal inductance (AC or DC), use the selection tables on Page 9.

# Selection Tables — 480V, 60Hz

## Filters for VFDs with ≥3% internal inductance

1) Find the column heading for your desired THDi performance level (5%, 8% or 12% THDi).
2) Select catalog number based upon the motor full load amperes (FLA) or horsepower (HP) rating.
3) Make sure filter rated current (FLA) is adequate (if not, select an appropriate higher rating).
4) Contact our Technical Support Office for other voltages or frequencies.

**For Enclosed Filters:**
Refer to Stocking Partner for Type 1 (–N1) or Type 3R (–N3R) enclosed versions.

**For DC Drives**
For DC Drives, use the selection tables on Page 7 and also refer to Page 15.

| HP | FLA | 5% THDi (3-stage) | 8% THDi (3-stage) | 12% THDi (2-stage) |
|---|---|---|---|---|
| 5 | 8 | IHF56-0008-B | IHF56-0008-C | IHF56-0008 |
| 7.5 | 11 | IHF56-0011-B | IHF56-0011-C | IHF56-0011 |
| 10 | 14 | IHF56-0014-B | IHF56-0014-C | IHF56-0014 |
| 15 | 21 | IHF56-0021-B | IHF56-0021-C | IHF56-0021 |
| 20 | 27 | IHF56-0027-B | IHF56-0027-C | IHF56-0027 |
| 25 | 34 | IHF56-0034-B | IHF56-0034-C | IHF56-0034 |
| 30 | 40 | IHF56-0040-B | IHF56-0040-C | IHF56-0040 |
| 40 | 52 | IHF56-0052-B | IHF56-0052-C | IHF56-0052 |
| 50 | 65 | IHF56-0065-B | IHF56-0065-C | IHF56-0065 |
| 60 | 77 | IHF56-0077-B | IHF56-0077-C | IHF56-0077 |
| 75 | 100 | IHF56-0100-B | IHF56-0100-C | IHF56-0100 |
| 100 | 125 | IHF56-0125-B | IHF56-0125-C | IHF56-0125 |
| 125 | 156 | IHF56-0156-B | IHF56-0156-C | IHF56-0156 |

| HP | FLA | 5% THDi (3-stage) | 8% THDi (3-stage) | 12% THDi (2-stage) |
|---|---|---|---|---|
| 150 | 185 | IHF56-0185-B | IHF56-0185-C | IHF56-0185 |
| 200 | 240 | IHF56-0240-B | IHF56-0240-C | IHF56-0240 |
| 250 | 302 | IHF56-0302-B | IHF56-0302-C | IHF56-0302 |
| 300 | 361 | IHF56-0361-B | IHF56-0361-C | IHF56-0361 |
| 350 | 415 | IHF56-0415-B | IHF56-0415-C | IHF56-0415 |
| 400 | 480 | IHF56-0480-B | IHF56-0480-C | IHF56-0480 |
| 450 | 515 | IHF56-0515-B | IHF56-0515-C | IHF56-0515 |
| 500 | 590 | IHF56-0590-B | IHF56-0590-C | IHF56-0590 |
| 600 | 720 | IHF56-0720-B | IHF56-0720-C | IHF56-0720 |
| 700 | 840 | IHF56-0840-B | IHF56-0840-C | IHF56-0840 |
| 800 | 960 | IHF56-0960-B | IHF56-0960-C | IHF56-0960 |
| 900 | 1080 | IHF56-1080-B | IHF56-1080-C | IHF56-1080 |
| 1200 | 1440 | IHF56-1440-B | IHF56-1440-C | IHF56-1440 |

### VFDs without internal inductance:

For VFDs without internal inductance (reactor), use the selection tables on Page 7.

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# Selection Tables — 480V, 60Hz

## Filters for VFDs with ≥5% internal inductance

1) Find the column heading for your desired THDi performance level (5%, 8% or 12% THDi).
2) Select catalog number based upon the motor full load amperes (FLA) or horsepower (HP) rating.
3) Make sure filter rated current (FLA) is adequate (if not, select an appropriate higher rating).
4) Contact our Technical Support Office for other voltages or frequencies.

**For Enclosed Filters:**
Refer to Stocking Partner for Type 1 (–N1) or Type 3R (–N3R) enclosed versions.

**For DC Drives**
For DC Drives, use the selection tables on Page 7 and also refer to Page 15.

| HP | FLA | 5% THDi (3-stage) | 8% THDi (2-stage) | 12% THDi (2-stage) |
|---|---|---|---|---|
| 5 | 8 | IHF56-0008-C | IHF56-0008 | IHF56-0008 |
| 7.5 | 11 | IHF56-0011-C | IHF56-0011 | IHF56-0011 |
| 10 | 14 | IHF56-0014-C | IHF56-0014 | IHF56-0014 |
| 15 | 21 | IHF56-0021-C | IHF56-0021 | IHF56-0021 |
| 20 | 27 | IHF56-0027-C | IHF56-0027 | IHF56-0027 |
| 25 | 34 | IHF56-0034-C | IHF56-0034 | IHF56-0034 |
| 30 | 40 | IHF56-0040-C | IHF56-0040 | IHF56-0040 |
| 40 | 52 | IHF56-0052-C | IHF56-0052 | IHF56-0052 |
| 50 | 65 | IHF56-0065-C | IHF56-0065 | IHF56-0065 |
| 60 | 77 | IHF56-0077-C | IHF56-0077 | IHF56-0077 |
| 75 | 100 | IHF56-0100-C | IHF56-0100 | IHF56-0100 |
| 100 | 125 | IHF56-0125-C | IHF56-0125 | IHF56-0125 |
| 125 | 156 | IHF56-0156-C | IHF56-0156 | IHF56-0156 |

| HP | FLA | 5% THDi (3-stage) | 8% THDi (2-stage) | 12% THDi (2-stage) |
|---|---|---|---|---|
| 150 | 185 | IHF56-0185-C | IHF56-0185 | IHF56-0185 |
| 200 | 240 | IHF56-0240-C | IHF56-0240 | IHF56-0240 |
| 250 | 302 | IHF56-0302-C | IHF56-0302 | IHF56-0302 |
| 300 | 361 | IHF56-0361-C | IHF56-0361 | IHF56-0361 |
| 350 | 415 | IHF56-0415-C | IHF56-0415 | IHF56-0415 |
| 400 | 480 | IHF56-0480-C | IHF56-0480 | IHF56-0480 |
| 450 | 515 | IHF56-0515-C | IHF56-0515 | IHF56-0515 |
| 500 | 590 | IHF56-0590-C | IHF56-0590 | IHF56-0590 |
| 600 | 720 | IHF56-0720-C | IHF56-0720 | IHF56-0720 |
| 700 | 840 | IHF56-0840-C | IHF56-0840 | IHF56-0840 |
| 800 | 960 | IHF56-0960-C | IHF56-0960 | IHF56-0960 |
| 900 | 1080 | IHF56-1080-C | IHF56-1080 | IHF56-1080 |
| 1200 | 1440 | IHF56-1440-C | IHF56-1440 | IHF56-1440 |

### VFDs without internal inductance:

For VFDs without internal inductance (reactor), use the selection tables on Page 7.

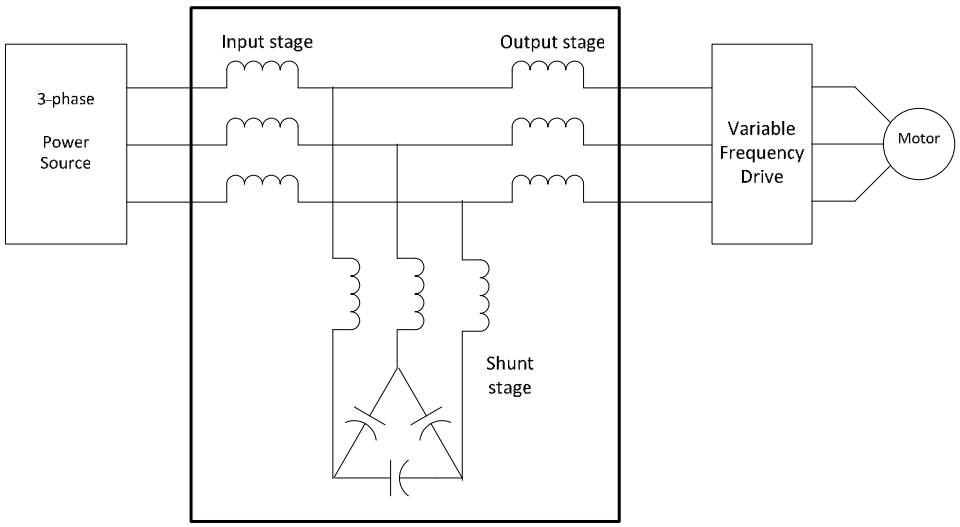
# Standard Filter Configurations

## Flexibility by Design

Mangoldt's Input Harmonic Filters offer a choice of the %THDi performance level (5%, 8% or 12% THDi) and you can also take advantage of VFD internal inductance to minimize your filter cost. It is also convenient to construct filters with adjustability of the shunt circuit capacity when multiple drives will be served from a single filter or to remove capacitance at light load conditions. Mangoldt filters are flexible by design.

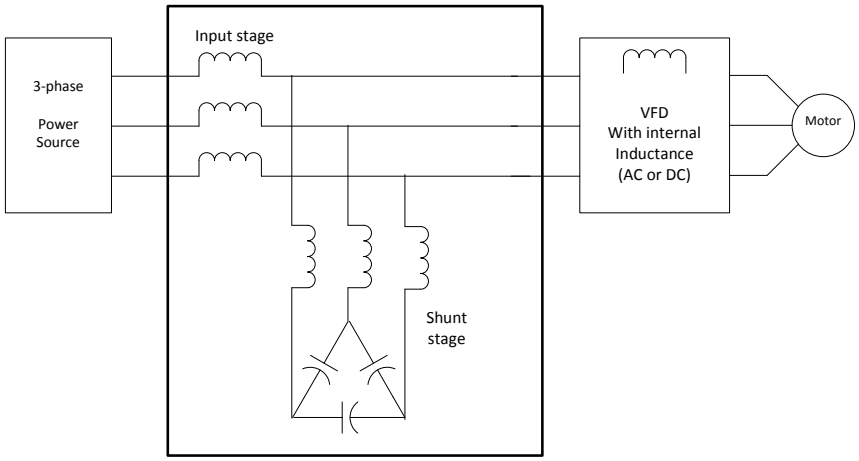
## Standard 3-stage Filter Configuration

This is the standard filter configuration for use with any VFD whether or not it includes an internal reactor (AC or DC) and it is also for use with DC Drives.




## Standard 2-stage Filter Configuration—for VFDs with Internal Inductance (AC or DC)

This configuration is popular for use with VFDs that include an internal reactor (AC or DC). When the VFD's internal reactor is of sufficient value (3% or 5% impedance) and depending on the desired %THDi performance level, the VFD reactor can take the place of our normal output stage reactor and reduce your filter cost. This is now referred to as a 2-stage filter. Refer to product selection tables on Pages 8-9 for VFDs having an internal reactor.

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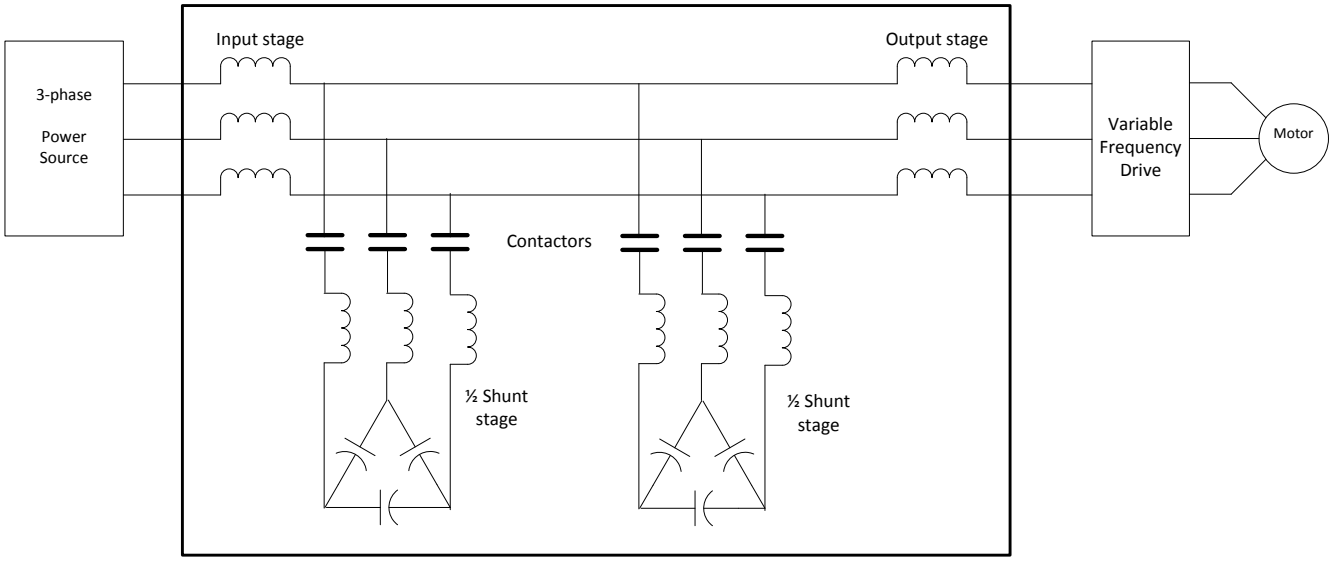
# Optional Filter Configurations

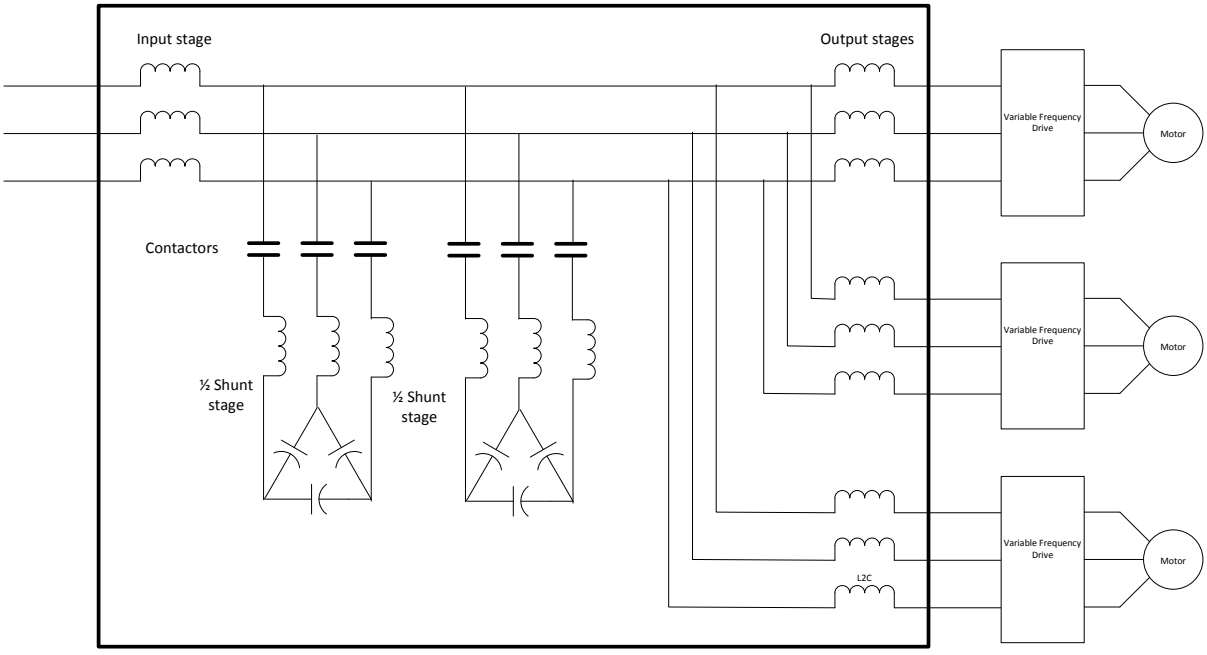
## Multiple Shunt Circuits

In some cases, it may be desirable to reduce the reactive power and capacitor current of the shunt circuit when the VFD operates at reduced load. This can be accomplished by using multiple shunt circuits and using contactors to switch them on/off individually as needed. Please contact the Stocking Partner or Technical Support office for assistance.




## Multiple Drives served from a Single Filter

Mangoldt's standard filters may be configured to serve multiple drives with a single filter. In this case, individual output stage reactors should be selected based on the ratings of the individual drives they serve. Performance may vary based on the specific operating conditions. Please contact the Stocking Partner or Technical Support office for assistance.

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# Input Harmonic Filter General Specifications

| | | |
|---|---|---|
| Voltage Rating | | 480V, 3-phase (Please contact us for other voltage ratings up to 690V) |
| Frequency | | 60Hz (Please contact us for 50Hz filters) |
| Current Ratings | | 3 to 1440 Amps (rms) |
| Current Overload | | 150% current (up to 1 minute, 3x per hour) |
| Harmonic Current Distortion | 5% THDi | ≤5% THDi at 100% load; ≤10% THDi at 20% load |
| | 8% THDi | ≤8% THDi at 100% load; ≤12% THDi at 20% load |
| | 12% THDi | ≤12% THDi at 100% load; ≤15% THDi at 20% load |
| Input Power Factor | 5% THDi | ≥0.99/100% load; ≥0.99/80% load; ≥0.96/60% load |
| | 8% THDi | ≥0.99/100% load; ≥0.98/80% load; ≥0.95/60% load |
| | 12% THDi | ≥0.99/100% load; ≥0.98/80% load; ≥0.94/60% load |
| Efficiency | | Typically >99% |
| Voltage Regulation | | Typically -/+ 2.5% |
| Dielectric Strength | | 3kV (1 minute) coil-coil, coil–core |
| Surrounding Air Temperature | | 50°C maximum |
| Over-Temperature Sensor<br>T10/180 NC (H) | 2.5A (1.0PF)<br>1.6A (0.60PF) | Temperature sensor in middle coil of shunt reactor (ACS43-xxxx). The switch opens at 180°C (-/+ 6C). |
| Terminations | | Solid copper bars or tin-plated copper pressure plate terminals |
| Relative Humidity | | Maximum 95% without condensation |
| Agency Approvals | | CUL Listed (E173113), IEC/EN60076-3, VDE0532-76-6, CE marked |
| Other | | Suitable for generator applications (Refer to Page 15) |

**Performance Guarantee**

VFDs using properly selected Mangoldt Input Harmonic Filters will contribute less than or equal to 5%THDi, 8%THDi or 12%THDi harmonic distortion, based on the unit selected, at their rated current. Pre-existing voltage distortion may add to this level.

## Harmonic Current Distortion (%THD-i) at Filter Input Terminals

The percent harmonic current distortion at the filter input terminals will be the lowest when the drive input current is equal to the filter rated current. The measured %THD-i will increase slightly as filter load current is reduced, however the amperes of harmonic current typically decrease as load current is reduced. This means that harmonic voltage distortion and %TDD will typically reduce as the load current is reduced.

| Filter Type %THDi | %THD-i vs. Rated Load | | | |
|---|---|---|---|---|
| | 40% Load | 60% Load | 80% Load | 100% Load |
| 5% | 8% | 6% | 5.5% | ≤ 5% |
| 8% | 10% | 8% | 7% | ≤ 8% |
| 12% | 13% | 11% | 9% | ≤ 12% |

## Harmonic Current Distortion (%TDD) at Point of Common Coupling (PCC)

The %TDD at the Point of Common Coupling depends upon the total of linear and non-linear loads that are operating on the power system. The chart below shows the expected %TDD at the PCC for filtered VFDs as a percentage of the total load. This chart assumes that all of the VFDs are using the same type of filter and the balance of the loads are linear loads (non-harmonic producing).

| Filter Type (%THDi) | %TDD at PCC - for VFD Load as a % of Total Load | | | | |
|---|---|---|---|---|---|
| | 20% VFDs | 40% VFDs | 60% VFDs | 80% VFDs | 100% VFDs |
| 5 % | 1.0% | 2.0% | 3.6% | 4% | 5% |
| 8 % | 1.6% | 3.2% | 4.8% | 6.4% | 8% |
| 12 % | 2.4% | 4.8% | 7.2% | 9.6% | 12% |

For application engineering: Contact the Technical Support Office—see back cover.

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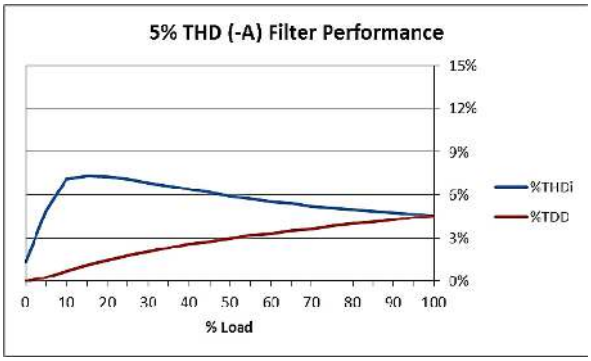
# Application Data

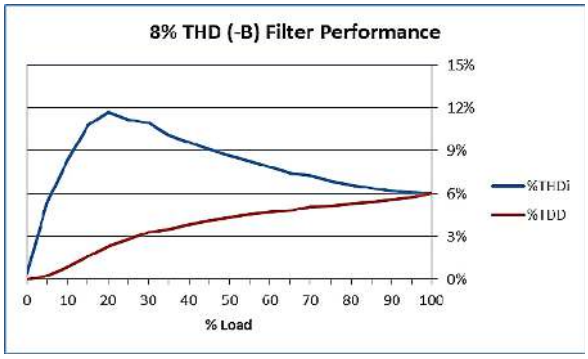
## Typical Filter Performance

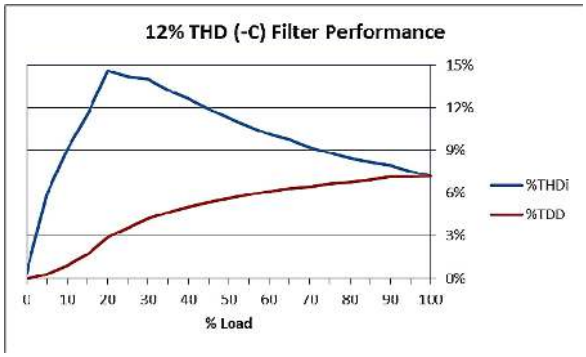
The best harmonic filter performance is achieved when operating near the filter rated current. While operating at lower current, the amperes of harmonic current and the harmonic voltage distortion will typically both reduce, however, the %THDi will increase slightly. Mangoldt Input Harmonic Filters have near unity power factor at rated current and maintain high power factor at reduced load. As an option, the shunt circuit may be opened through the use of optional contactors to eliminate capacitive current at light load or no load operating conditions. Please contact the Stocking Partner or Technical Support Office for assistance.

### Current Distortion vs Rated Load

Pre-existing harmonic voltage distortion will add to these values.

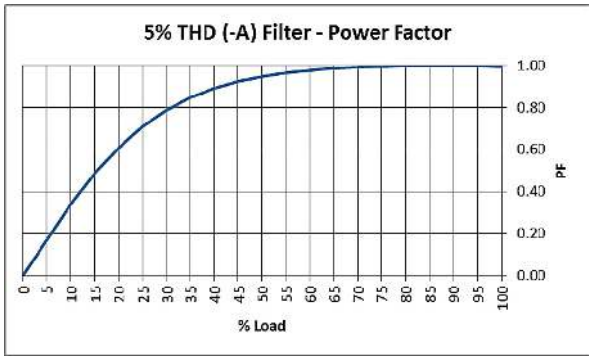


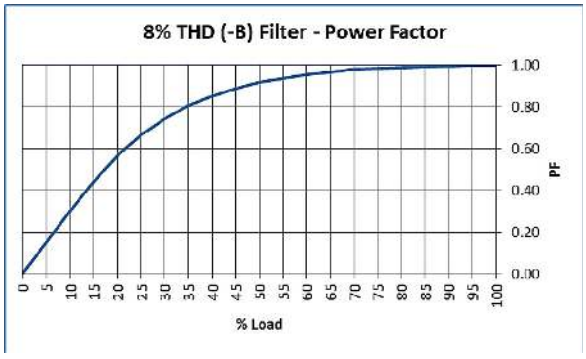



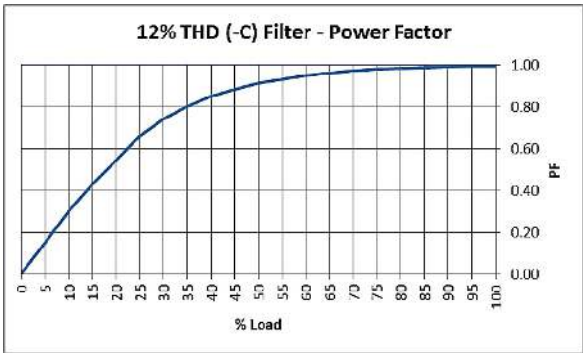




### Input Power Factor vs Rated Load

PF can be further improved when using optional contactors to remove capacitors at light load.




For application engineering: Contact the Technical Support Office

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## DC Drive and SCR Rectifier Applications

The use of harmonic filters for SCR applications is different than for VFD applications. Silicon Controlled Rectifiers (SCR), such as those used in DC drives, cause significant voltage distortion due to notching, high input harmonic current distortion and lower power factor than for VFD applications. Therefore, a higher capacity filter is required in order to achieve satisfactory results. Filters used for DC Drives and other SCR rectifiers should always use the suffix "-A" filters. Refer to the selection table on Page 7.

**Selecting Input Harmonic Filters for DC Drives:**

1) Multiply DC Drive HP rating x 1.33

2) Select IHF56 filter based on this new HP rating.

DC Drive: ____HP x 1.33 = ____HP (IHF filter rating)

For DC Drive and other SCR rectifier applications, it Is generally not possible to guarantee the performance results. %THD-i will vary depending on the rectifier output voltage and SCR conduction angle. Although Mangoldt's IHF Input Harmonic Filters are effective for reducing harmonic distortion for DC Drives and other SCR rectifiers, %THD-i is not guaranteed for DC Drive or SCR applications.

## Enclosed Filters

Refer to the Stocking Partner for enclosed versions of these filters. When ordering, add suffix "-N1" for Type 1 (indoor) and "-N3R" for Type 3R (outdoor) versions.

## VFD Nuisance (O.V.) Tripping Prevented

VFDs using Mangoldt Input Harmonic Filters are also protected from the effects of typical utility capacitor switching transients that cause over-voltage tripping of VFDs. This added protection is accomplished by the use of reactors with very high inductance linearity resulting in nearly 100% of rated inductance during a 200% voltage spike and corresponding 200% current surge.

## Generator Applications

Mangoldt Input Harmonic Filters may be used with VFDs that will be served from a generator. However, a generator power source is not the same as a utility transformer power source. Generators have much larger impedance than transformers and typically will accept only a limited amount of capacitive kVARs. Generator stability may also be adversely affected by harmonic voltage distortion.

1) To prevent generator interference while operating filtered VFDs at light load, a contactor may be used to open the shunt circuit. It is also possible to construct the filter with multiple shunt circuits enabling portions of the shunt circuit to be removed in stages.

2) A VFD with Mangoldt Input Harmonic Filter may be used on a generator, without a shunt circuit removal contactor, if the generator capacity in kVA is at least 2.5 times the filter rated HP.

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