Harmonic Filtering
Compact, fast response harmonic mitigation solution.
NHP Electrical Engineering Products

An Australian owned company, NHP is committed to serving the Australasian industry with quality products and customer support. This is achieved through an 900+ strong team which is distributed across 25 branches and 24 regional locations throughout Australia and New Zealand.

While NHP stock an impressive 70,000+ line items, we are much more than a component supplier. NHP source the highest quality products from leading global suppliers, and customise these into solutions for the local Australian and New Zealand markets, providing a complete fit to purpose systems and solutions service.

At NHP we have a strong customer focus and we look to provide the right product and product solutions for our customers’ requirements and applications, all at a competitive price. We value and care for our customers and support them by offering personalised service and assistance to meet their every need and demand. Our customers can have 100% confidence in our ability to support them when, where and how it is needed.

Put simply, NHP is ‘easy to do business with’.
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What are harmonics?

The term “harmonics” refers to the voltage and current harmonic distortion within an AC circuit. Any waveform which is not sinusoidal (complex) can be shown to contain sinusoidal waveforms of integer multiples of the fundamental. In a 50 Hz electrical system, 250 Hz is the 5th harmonic, 350 Hz is the 7th harmonic etc.

An electrical system supplies power to loads by delivering current at the fundamental frequency. Only fundamental frequency current can provide real power. Current delivered at harmonic frequencies do not deliver any real power to the load.

The percentage of harmonics in a waveform is called THD (total harmonic distortion) and can be further broken up into THVD (total harmonic voltage distortion) and THID (total harmonic current distortion). As the THVD and THID increases, the efficiency of the system is greatly reduced.

Harmonic currents create harmonic voltages and it is the harmonic voltages that cause the problems with other equipment that are connected to the same secondary of the transformer where the harmonic originated.

Harmonics are created by the increased use of non-linear devices such as UPS systems, solid state variable speed motor drives, rectifiers, welders, arc furnaces, fluorescent ballasts, and personal computers. The current drawn by these devices is not proportional to the supplied voltage, and so, such loads are referred to as non-linear loads.
Problems Caused by Harmonics

High voltage distortion, current distortion and high neutral-to-ground voltage caused by harmonics can result in equipment failure, production down time and costly repairs to the electrical distribution network.

It is critical that the consumer is aware of the costly problems and hazards associated with high levels of harmonics especially given the dramatic increase in use of non linear devices. These harmonics can greatly impact the electrical distribution network along with all facilities and equipment that are connected.

Main problems associated with harmonics include:

- Large load currents in the neutral wires of a 3 phase system. This can cause overheating of the neutral wires, which can result in a potential fire hazard.
- Interference in telecommunications systems and equipment
- Erratic operation of control and protection relays
- Tripping of circuit breakers and other protective devices
- Failure or malfunction of computers, motor drives, lighting circuits and other sensitive loads
- Overheating of standard electrical supply transformers resulting in costly down time and repairs or replacement of transformer.
- Poor power factor.
- Resonance which produces over-current surges.

Harmonic Resonance

Resonance occurs when the system reactances (i.e. capacitive and inductive reactance) are equal. Excessive currents will result if the resulting resonant frequency corresponds to the frequency on which electrical energy is present and this will cause serious problems as mentioned above.

Some indicators of resonance include overheating, frequent circuit breaker tripping, irregular fuse operation, capacitor failure, electronic equipment malfunction, flicking lights and telephone interference.
Harmonic Standard Compliance

Power utility companies and Australian Standards stipulate maximum harmonic levels which apply at a customer’s PCC (point of common coupling). Generally, the maximum permissible harmonic levels are given in terms of % THVD however to achieve a reduction in THVD, the customer is required to reduce their THID through the use of harmonic mitigation equipment. Commonly, THVD levels are required to be between 5-8%, however this will vary from state to state. IEEE STD 519 (1992) and AS/NZS 61000.3.6 (2001) are two widely used harmonic limit standards, however other standards may also be relevant including AS/NZS 61000.3.2 2007. Please confirm harmonic requirements with your utility provider. For more information on the following tables please refer to the relevant standard.

IEEE STD 519-1992

Table 10.3 – Current Distortion Limits for General Distribution Systems (120 V Through 69 000 V)

<table>
<thead>
<tr>
<th>Individual Harmonic Order (Odd Harmonics)</th>
<th>ISC / IL</th>
<th>&lt;20</th>
<th>20&lt;50</th>
<th>50&lt;100</th>
<th>100&lt;1000</th>
<th>&gt;1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>l&lt;sub&gt;c&lt;/sub&gt; / l&lt;sub&gt;i&lt;/sub&gt;</td>
<td>l&lt;sub&gt;c&lt;/sub&gt; / l&lt;sub&gt;i&lt;/sub&gt;</td>
<td>l&lt;sub&gt;c&lt;/sub&gt; / l&lt;sub&gt;i&lt;/sub&gt;</td>
<td>l&lt;sub&gt;c&lt;/sub&gt; / l&lt;sub&gt;i&lt;/sub&gt;</td>
<td>l&lt;sub&gt;c&lt;/sub&gt; / l&lt;sub&gt;i&lt;/sub&gt;</td>
<td>l&lt;sub&gt;c&lt;/sub&gt; / l&lt;sub&gt;i&lt;/sub&gt;</td>
<td>l&lt;sub&gt;c&lt;/sub&gt; / l&lt;sub&gt;i&lt;/sub&gt;</td>
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<tr>
<td>15.0</td>
<td>2.0</td>
<td>3.5</td>
<td>4.5</td>
<td>5.5</td>
<td>7.0</td>
<td>15.0</td>
</tr>
<tr>
<td>10.0</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
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<td>3.5</td>
<td>4.5</td>
<td>5.0</td>
<td>6.0</td>
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<td>2.0</td>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
<td>3.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Even harmonics are limited to 25% of the odd harmonic limits above

Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed

*All power generation equipment is limited to these values of current distortion, regardless of actual ISC / IL

where

ISC = maximum short-circuit current at PCC

IL = maximum demand load current (fundamental frequency component) at PCC.

AS/NZS 61000.3.6:2001 Standard

Table 1 – Compatibility levels for harmonic voltages (in percent of the nominal voltage) in LV and MV power systems.

<table>
<thead>
<tr>
<th>Odd Harmonics non multiple of 3</th>
<th>Odd Harmonics non multiple of 3</th>
<th>Even Harmonics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order h</td>
<td>Harmonic voltage %</td>
<td>Order h</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>3.5</td>
<td>15</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>&gt;21</td>
</tr>
<tr>
<td>19</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>&gt;25</td>
<td>0.2 + 1.3 (25/h)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Total harmonic distortion (THD) 8%
The Green Star Advantage

Did you know you can now take full advantage of the Green Star Initiative when applying harmonic mitigation? The Green Star initiative rewards businesses for improved power and energy use and through harmonic mitigation businesses will actively reduce peak energy demand. This benefit complies to the Green Star – Ene-5 Peak Energy Demand Reduction opportunity and since harmonics inherently draw unwanted currents, harmonic mitigation means peak energy demand reduction can be achieved. Also relevant is the fact that harmonic mitigation will improve your total power factor (as detailed further below), which results in reducing “wasted work”. For more information on NHP’s Green Star Solution please contact your local NHP branch.

Displacement & Total Power Factor

The benefits of harmonic filtering are not limited to preventing equipment failure and conforming to required industry standards, but it can also improves your total power factor.

Total (or true) power factor includes both displacement power factor and distortion power factor and can be defined as:

\[
PF = \frac{1}{\sqrt{1 + THDI^2}} \cdot \cos \varphi
\]

where:

- \(PF\) = power factor
- \(THDI\) = total harmonic distortion current
- \(\cos \varphi\) = \(\frac{\text{Real Power}}{\text{Apparent Power}}\)

Referring to the relationship above, by mitigating harmonics, THDI decreases and hence total PF improves. With improved power factor, inductive reactive power, (and by result current draw), from the supply decreases and additional savings in the form of reduced tariffs may be achieved.

Another important consideration is the harmful effects harmonics can have on capacitors, which may be present in the load or where power factor correction (PFC) systems are utilized. Harmonics on the supply cause a higher current to flow in the capacitors. This is a result of the capacitors having lower impedance as the frequency increases. This increase in current flow through to the capacitor will result in additional heating of the capacitor and will reduce its life.

The use of “blocking” reactors are utilised in NHP PFC systems to protect the capacitors from harmonics as long as THVD is less than 7%. If harmonics levels in the system are greater than this, harmonic filters are a must for the safe and reliable operation of any load containing capacitors.
Harmonic Mitigation Solutions

Traditional solutions to minimize harmonic distortion often involved one of the following methods:

- Over-sizing or de-rating of the installation
- Specially connected transformers
- Series Reactors
- Tuned passive filter

However, the above solutions all presented disadvantages related to exhibiting higher utility costs because of continued poor power factor. Today, the most common forms of harmonic mitigation involve either:

- Passive Harmonic Filtering
- Active Harmonic Filtering
- Hybrid Harmonic Filtering

Passive Harmonic Filtering

Passive filters are series capacitor and reactor resonant circuits ‘tuned’ to present a high impedance path to the fundamental frequency and low impedance path to higher specific frequencies (i.e. 5th - 250Hz, 7th - 350Hz). They are more commonly connected to individual loads in the plant rather than at the point of common coupling (PCC) since their application requires consistent loading for effective harmonic mitigation.

Active Harmonic Filtering

Active harmonic filtering (AHF) is the process by which harmonic current produced by the load is continuously monitored and an adaptive waveform is then generated which corresponds to the exact shape of the non linear portion of the load current. The AHF introduces this adaptive current into the load at the point of connection and the response time of a Schaffner AHF is 300 μs. Unlike passive harmonic filters, these filters can provide harmonic mitigation under any load conditions up to their rated capacity.

Hybrid Harmonic Filtering

Hybrid harmonic filtering is the combination of passive and active harmonic filtering. Hybrid harmonic filtering combines the two solutions in situations where the use of passive harmonic filters can be used reliably for static loads of an electrical installation and a smaller active filter can be used to mitigate harmonics generated by the other variable loads. This solution can be both cost and application effective.
Harmonics Filtering Application Example - VSDs

Most variable speed drives (VSD’s) operate by using a bridge rectifier to convert the incoming AC voltage into a DC voltage. A capacitor bank is then used to filter out the AC ripple. Insulated Gate Bipolar Transistors (IGBT’s) are used to convert the DC voltage into a controlled voltage and frequency for speed control of the motor.

Although the drive may be of an efficient design for motor control, problems with the AC power line can result due to the way the drive draws the AC current. One problem is due to the fact current cannot flow from the rectifier into the DC bus before the input voltage is greater than the DC bus voltage. As highlighted in figure 4, this only occurs for a very short period of time for each phase. Hence, to transfer the energy required by the motor in such a short period of time, the peak current must be high.

The input current, shown in figure 4, is non-sinusoidal and consists of two discrete pulses per half period. This is an example of a current waveform with a high level of harmonic distortion. Most modern electronic equipment use a bridge rectifier power supply similar to that which has been described. These equipment include computers, electronic ballasts VSDs and many more.

Individual harmonic frequencies will vary in amplitude and phase angle, depending on the harmonic source, which may be internal or external to the electrical installation.

Figure 4. 6-pulse rectifiers inherently draw current in a non-sinusoidal fashion from the grid, creating a current wave rich in harmonics. Harmonic currents flow through system impedance and create harmonic voltages.
ECOsine™ – Passive Harmonic Filters

Schaffner ECOsine™ passive harmonic filters represent an economical solution to the challenge of load-applied harmonic mitigation in three-phase power systems. With features including more compact dimensions to comparable products, quick installation and easily commissioned, the ECOsine™ range of passive harmonic filtering offer customers the ideal passive harmonic mitigation solution.

The filters efficiently reduce the harmonic currents to negligible levels and ensure, that a sine-wave current is drawn from the grid. In the process, they also reduce peak currents and RMS input current, allowing for lower wire cross sections in conductors, smaller fuses, breakers, and transformers. In existing installations, more drives can be used on the same distribution transformer.

Schaffner ECOsine™ harmonic filters are designed for the operation on the line side of power electronic equipment with 6-pulse rectifier front ends in balanced three-phase power systems.

**Installation:** All filters from FN3410-10-44 to FN3410-110-35 are wall mountable and must be operated vertically. The filters FN3410-150-40 and higher are designed for floor mounting. In order to allow for sufficient air flow all filters must be clear on top and bottom a minimum of 150 mm.

**Note:** ECOsine™ filters are not designed for single-phase or split-phase applications.
Passive Harmonic Filter Application

ECOsine™ filters are 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, then two filters can be wired in parallel. In this mode of operation, it is recommended to use filters with equal power ratings to ensure correct current sharing.

AC line reactors and/or DC-link chokes are not required when ECOsine™ passive filters are installed. For a new system, this helps to offset a good portion of the harmonic filter cost. If a harmonic filter is added to a drive with an existing AC line reactor, it is recommended to remove the reactor if possible.
# ECOsine™ Passive Harmonic Filter

## Selection Table

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Rated Load Power (kW) @ 400 V AC/50 Hz</th>
<th>Rated Load Current (A) @ 400 V AC/50 Hz</th>
<th>Standby Losses (W)</th>
<th>Loaded Losses (W)</th>
<th>Dimensions H x W x D (mm)</th>
<th>Weight (kG)</th>
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<tbody>
<tr>
<td>FN 3410-10-44</td>
<td>4</td>
<td>10</td>
<td>0.8</td>
<td>60</td>
<td>400 x 170 x 190</td>
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<td>FN 3410-13-44</td>
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<td>0.8</td>
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<td>FN 3410-16-44</td>
<td>7.5</td>
<td>16</td>
<td>0.9</td>
<td>113</td>
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<td>FN 3410-24-33</td>
<td>11</td>
<td>24</td>
<td>0.9</td>
<td>165</td>
<td>520 x 250 x 280</td>
<td>27</td>
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<td>FN 3410-32-33</td>
<td>15</td>
<td>32</td>
<td>1.8</td>
<td>225</td>
<td>520 x 250 x 280</td>
<td>31</td>
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<td>FN 3410-38-33</td>
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<td>38</td>
<td>1.8</td>
<td>259</td>
<td>520 x 250 x 280</td>
<td>35</td>
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<td>FN 3410-45-34</td>
<td>22</td>
<td>45</td>
<td>1.8</td>
<td>286</td>
<td>590 x 300 x 300</td>
<td>45</td>
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<td>FN 3410-60-34</td>
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<td>75</td>
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<td>407</td>
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<td>FN 3410-90-35</td>
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<td>FN 3410-150-40</td>
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<td>FN 3410-180-40</td>
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<td>180</td>
<td>6.6</td>
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<td>136</td>
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<td>FN 3410-210-40</td>
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<td>7.8</td>
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<td>260</td>
<td>8.2</td>
<td>792</td>
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<td>FN 3410-320-99</td>
<td>160</td>
<td>320</td>
<td>8.6</td>
<td>960</td>
<td>1000 x 500 x 450</td>
<td>201</td>
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</tbody>
</table>

### Part number coding

- **Schaffner standard filter range**
  - **FN 34xx**
  - **-xxx**
  - **-xx**
  - **Connection Style**
    - 33 = safety terminal block 16 mm² max
    - 34 = safety terminal block 35 mm² max
    - 35 = safety terminal block 50 mm² max
    - 40 = safety terminal block 95 mm² max
    - 44 = safety terminal block 10 mm2 max
    - 99 = copper bus bars

- **Filter family**
  - 3410 = filter for 50 Hz, 380-500V

- **Rated, unfiltered load (drive input) current (A)**
External filter elements

Monitoring Status

<table>
<thead>
<tr>
<th>LEDs</th>
<th>Monitor switch</th>
<th>Filter state</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Power off</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power on, internal temperature does not require fan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power on, active fan cooling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power on, over-temperature or fan error *</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power on, sensor short or monitor error</td>
</tr>
</tbody>
</table>

* Fan or sensor disconnection is recognised
ECOsine™ – Active Harmonic Filters

The latest in active harmonic filter technology, the ECOsine™ Active offers superior performance with numerous advantages over traditional technology. The filters eliminate harmonic currents up to the 50th harmonic, improving power quality and reducing reactive power usage costs.

Some of the key features and benefits of the ECOsine™ Active include:

- **Ultra-fast**: Responds to disturbances in less than 300μs and eliminates them before they can cause damage
- **Super-compact**: Each unit provides the highest performance in the most compact package
- **Optimised for maintenance**: The central modules in the 200 to 300 A industrial models can be removed in less than 15 minutes.
- **Suitable for industrial use**: With the IP54 protection class the ECOsine™ Active is resistant to dust and other environmental influences
- **Numerous Options**: The ECOsine™ Active range covers specifications from 30 to 300 A and 400 to 480 V in either 3 or 4-wire technology.
- **Adaptive**: ECOsine™ Active compensates for individual disturbance patterns in a targeted manner and automatically adapts to changing network topologies.

The ECOsine™ Active’s flexible design allows different size systems to connect in parallel achieving greater compensation current. This is particularly useful when considering future expansion or changes to the electrical networks which increases harmonic levels and requiring greater harmonic mitigation current. These filters can be connected either load or line side, however to combine units in parallel the units must be connected load side.

Once configured with just a few clicks, the preset line current will be permanently measured and all harmonics and phase displacements actively compensated. To achieve this, the ECOsine™ Active calculates the appropriate compensation currents within microseconds, which are then generated and fed into the network. Remote monitoring via PLC or BMS is possible via Modbus over RS485 interface.

Three simple steps to improve power quality

[Images of graphs and device illustrations]
ECOsine™ AHF Parallel Operation

The available compensation current can be increased through parallel operation of several ECOsine™ Active units. In doing so, the current signal from the external current transformers is looped through all the ECOsine™ Active units in accordance with the following schematic. The current transformers must be installed on load side (between the mains connection of the filter and the mains connection of the load to be compensated).

NOTE: A maximum of five ECOsine™ Active may be operated on one current transformer set due to the maximum power output of the external current transformers. Additional current transformers must be installed if more than five devices are to be operated in parallel. For parallel operation of more than one ECOsine™ Active the current transformers must be installed on load side of the filter.

Figure 7. Current transformer wiring for parallel operation of up to five ECOsine™ Active
ECO\textsuperscript{TM} Active 30/50A (3 wire)
– The compact and easy-to-install filter
The smallest ECO\textsuperscript{TM} Active version is ideal for the reliable compensation up to the 50th harmonic, as well as reactive power, in a targeted manner. Due to its compact dimensions and low weight, this filter can be easily installed in any environment. Both wall and cabinet installations are possible offering IP 20 protection as standard with IP 54 optional. Not only space-saving, it is also economical in terms of power loss with only 1300 W. With a response time of under 300 μs in ultra-fast mode, it is also possible to optimally compensate dynamic loads. A higher power level can be easily attained by paralleling up to 5 units.

ECO\textsuperscript{TM} Active 30/60A (4 wire)
– The solution for building technology
This ECO\textsuperscript{TM} Active version mitigates harmonics on all three phases as well as the neutral wire and is particularly useful for the reliable compensation of the triple harmonics up to the 50th order. This compact package is the ideal system for commercial type installations where switch-mode power supplies and information technology equipment are common sources of harmonic generation.

ECO\textsuperscript{TM} Active 100/120 A
– The standard for 3 and 4 wire technology is always the perfect fit
Only marginally larger and heavier than the 30/50 A system, the 100 A unit can deal with twice the current. It is the perfect solution for those who need greater performance. The 4 wire unit also allows for compensation on the neutral conductor.

ECO\textsuperscript{TM} Active 200/250/300A
– The industrial model is a real power pack
With up to 300 A of compensating current, this filter remains fully capable for the highest requirements such as large production facilities, like those found in the automotive industry. The cabinet version comes with forced air cooling, as well as internal liquid cooling for the power electronics including an integrated water/air heat exchanger. These powerful units are available in either 3-wire or 4-wire units and come with a protection class of IP 54.
Minimal time-to-repair thanks to a modular design (MTTR <15 minutes).

The ready-for connection industrial cabinet unit is modular in design with each individual module easily accessible and removable from the front of the cabinet. An MTTR value of <15 minutes with an MTBF value of up to 100,000 hours provides for the fastest service times and long maintenance intervals.

ECOsine™ Active provides:

- **Reliability:** Eliminates all relevant disturbance patterns in the power lines
- **Cost-savings:** Avoids/reduces wear on electrical loads and over-heating of cables and transformers
- **Efficiency:** Prevents losses due to production downtimes
- **Flexibility:** Constantly adapts to the network topology
- **Fast response time:** Compensates disturbances before they can cause damage
- **Economy:** Lowers energy cost through reduced reactive power demand
- **Compact dimensions:** Requires very little space compared to traditional solutions
- **Ruggedness:** Provides protection according to IP 54
- **Effortless:** Simple installation and intuitive operation.
Recommended External AC mains protection

Part number coding

Schaffner standard filter range

- **Filter family**
  - **3420** = 3 wire active filter for 50 Hz
  - **3430** = 4 wire active filter for 50 Hz

- **System Voltage**
  - 3 – 3 wire systems
  - 4 – 4 wire systems

- **Rated compensation current [A]**

Examples

- **FN 3420 – 50 – 480 – 3**: Filter for 50 Hz, 480V, 50 A input current for 3 wire systems
- **FN 3420 – 250 – 400 – 4**: Filter for 50 Hz, 400V, 250 A input current for 4 wire systems

<table>
<thead>
<tr>
<th>Device</th>
<th>External fuse (cable protection fuses, e.g. type gL/gG)</th>
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</thead>
<tbody>
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<td>ECOSine™ Active -30-xxx-x</td>
<td>50 A</td>
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<td>ECOSine™ Active -50-480-3</td>
<td>80 A</td>
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<td>ECOSine™ Active -60-400-4</td>
<td>100 A</td>
</tr>
<tr>
<td>ECOSine™ Active -100-xxx-x</td>
<td>160 A</td>
</tr>
<tr>
<td>ECOSine™ Active -120-xxx-x</td>
<td>200 A</td>
</tr>
</tbody>
</table>

**Note:** Internal 400 A fuse block supplied with ECOSine™ Active – 200/250/300-xxx-x
ECOsine™ – Active Harmonic Filters

<table>
<thead>
<tr>
<th>FN 3420-..</th>
<th>3-wire</th>
<th>30 A</th>
<th>30 A</th>
<th>-</th>
<th>100 A</th>
<th>120 A</th>
<th>200 A</th>
<th>250 A</th>
<th>300 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>FN 3430-..</td>
<td>4-wire</td>
<td>30/90 A</td>
<td>-</td>
<td>60/180 A</td>
<td>100/300 A</td>
<td>120/360 A</td>
<td>200/600 A</td>
<td>250/750 A</td>
<td>300/750 A</td>
</tr>
</tbody>
</table>

- **Rated comp. current**
- **Switching frequency** 16 kHz
- **Overload capability** 3)
- **Cooling type** Forced air cooling
- **Ambient temperature** 40 °C 3) 30 °C 3) 40 °C 30 °C 3)
- **Parallel operation** Up to 5 units
- **Interfaces** Modbus RTU (RS485), Modbus TCP/IP (Ethernet)
- **Power loss**
- **Noise level** (1m)
- **Filter performance** Up to the 50th order
- **Altitude** 1,000 m / derating up to 4,000 m, 1% / 100 m
- **Mains Voltage**
- **Mains frequency** 47 to 63 Hz 50 Hz ± 5%
- **Response time** 300 µs
- **Controller topology** Digital with FFT analysis
- **Current limitation** Normal Current
- **Current transformer** 100 : 5 to 5000 : 5
- **Dimensions (w x h x d) (mm)**
- **Weight**
- **Protection class** Standard IP20, optional IP 54
- **Approval** C - tick

1) Peak Value
2) Derating up to 40°C, 1.2%/K
3) Derating up to 50°C, 2%/K
4) Derating up to 40°C, 1.7%/K

For more information on Harmonic Filters please contact your local NHP branch.