Low Voltage Products

Enclosed Third Harmonic Filter THF and THF* star
Enclosed units
The Third Harmonic - a Growing Problem

Today’s electrical networks and plants are under much more stress than a decade ago. One reason for this is the increasing use of electric equipment that generate harmonics: in particular the third harmonic. This harmonic can generate exceptionally high neutral currents which can often exceed even the phase current.

Equipment that generate harmonics:

- Fluorescent lighting systems
- Computers
- Welding equipment
- UPS
- Rectifiers
- TV monitors
- Microwave ovens

The Third Harmonic Causes Many Problems

In network:

- Overheating
- Increased power losses
- Poor quality of electricity
- Electromagnetic fields
- Malfunctions in earth fault control
- Failure in remote control systems

In plants:

- Malfunction in electronics
- Damage to capacitors
- Power losses
- Increased magnetic fields
- Overload in neutral conductor
- Cable fires
- Abnormal temperature changes and noise in transformers
- Nuisance tripping in circuit-breakers
- Shorter life time

The third harmonics are accumulated in the neutral conductor.
The Solution - The Third Harmonic Filter THFstar

The third harmonic filter THFstar removes the third harmonic current from the network. The third harmonic currents generated by the single phase loads flowing in the phase conductors sum up in the neutral conductor. The neutral current may be higher than the phase current. The THF filter mitigates the third harmonic current from the whole network from the luminances to the distribution panel, main switchboard up to the supply transformers medium voltage winding. The mitigation effect is the same both at the line and load side. The filtering application is patented.

Benefits of THF for lighting and mixed load

Increased efficiency in low voltage network
- Reduction in transmission losses
- Increased loadability of the existing network and switchboards
- Lower temperature of cables, switchboards and transformers
- Elimination of third harmonic current in neutral and phase conductor

Increased efficiency in lighting appliance and pc-load
- Less power or more lighting
- Less maintenance
- Longer lifetime of the lamps and capacitors

Reduced Magnetic fields
- The reduction of third harmonic component of the current reduces the total magnetic field
- Diagram indicating an example of the total magnetic field spectrum typically in various locations

Diagram indicating the level of magnetic field with and without Third Harmonic Filter, Hospital building.
Selection and dimensioning of the THF product range

**Third harmonic filters THF\_star and THF**

The size of the THF-filters is selected according to the supply transformer or back up fuses. The protection unit needs to be used, in case the dimensioning exceeds the thermal rating of the filter.

The basis of dimensioning is that the filter withstands the 150Hz voltage and the fundamental neutral current generated by the phase unbalance.

The THF\_star filters are tested according to the highest possible short circuit current or back up fuse. The filter is not suitable for applications including largely dimmer loads. Please consult with us.

**Installation to the transformer star point, enclosed filters and system components, THF\_star**

The new generation third harmonic filter THF\_star is designed for small size and economical solutions to places, which are especially exposed by third harmonic currents. The filter can be installed outdoor in vicinity of transformer stations, as retrofitting to existing transformer station or as additional field of main switchboard. It is recommended to install the filter THF\_star in PEN-conductor, whenever possible, equipped with appropriate protection unit THF1S\_.

**DIMENSIONING:** According to the supply transformer

**PROTECTION:** Protection unit THFS1\_S, 50Hz and 150 Hz measurement according to the mounting instruction

<table>
<thead>
<tr>
<th>Network TN-C, TN-S</th>
<th>Rated current of the group fuse A</th>
<th>Transformer size kVA</th>
<th>Enclosed Units Indoor IP30</th>
<th>System components System components IP 00</th>
<th>Input-Output cable/ busbar</th>
<th>Internal connection to the filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>800(^{1})</td>
<td>630</td>
<td>THFS500US1</td>
<td>THFS400A1 + THF 1_S</td>
<td>Acc. to phase conductors 33% of phase conductor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>630</td>
<td>THFS630S1</td>
<td>THFS630U1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1250</td>
<td>1000</td>
<td>THFS1600S1</td>
<td>THFS1000U1</td>
<td>Acc. to phase conductors 33% of phase conductor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2500</td>
<td>1600</td>
<td>THFS1600U1x2</td>
<td>THFS1600U1x2</td>
<td>Acc. to phase conductors 33% of phase conductor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3200</td>
<td>2000</td>
<td>THFS1600U1x2</td>
<td>THFS630A1x2</td>
<td>Acc. to phase conductors 33% of phase conductor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: System components in brochure THFS 2 GB

**Installation for distribution boards in TN-S-system, enclosed filter and system components, THF**

THF filters are designed in TN-S-systems to provide selective mitigation of isolated groups with local or central compensation. The THF is normally installed in the load side neutral output of UPS-devise. THF is dimensioned according to the group fuses. In case the dimensioning is below 100% it is recommended to use additional protection unit. The filter types THF 25...160NV include guard units to keep track of the PE-current in the area of 4...10 A.

**DIMENSIONING:** According to the group fuse- rated current = rated current of the fuse link

**PROTECTION:** Guard unit (\_V), 150Hz measurement from PE-conductor of the group

<table>
<thead>
<tr>
<th>Network TN-S</th>
<th>Rated current of the group fuse A</th>
<th>Enclosed Units Indoor IP30</th>
<th>System components System components IP 00</th>
<th>Cross-section Input-Output cable mm(^\circ)</th>
<th>Internal connection to the filter mm(^\circ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25</td>
<td>THF25NV</td>
<td>THF63NB</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>63</td>
<td>THF63NV</td>
<td>THF63NB</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>125</td>
<td>THF125NV</td>
<td>THF63NB x 2</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>THF160NV</td>
<td>THF63NB x 3</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>THF125NLV + THF125N</td>
<td>THF63NB x 4</td>
<td>95</td>
<td>35</td>
</tr>
</tbody>
</table>

Note: System components in brochure THFS 2 GB
Enclosed third harmonic filters \( \text{THF}_{\text{star}} \), THF

Ordering information

Technical information

**Enclosed third harmonic filters \( \text{THF}_{\text{star}} \)**

**Installation to transformer star point.** The delivery includes protection unit, by-pass contactor and switch as well as the overload proof current transformer.

**Indoor use IP 30. Cabling from bottom or top**

<table>
<thead>
<tr>
<th>Transformer size ([\text{kVA}])</th>
<th>Dimensions (L \times S \times K) ([\text{mm}])</th>
<th>Input-Output Cabling / Busbar</th>
<th>Type</th>
<th>Order Code</th>
<th>Weight ([\text{kg}])</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>800</td>
<td>1050 x 360 x 1200</td>
<td>2 x 150 mm(^2) Cu (max 4 cables)</td>
<td>THFS 500US1(^1)</td>
<td>300</td>
</tr>
<tr>
<td>630</td>
<td>900</td>
<td>654 x 654 x 2260</td>
<td>4 x 150 mm(^2) Cu (max 6 cables)</td>
<td>THFS 630S1</td>
<td>400</td>
</tr>
<tr>
<td>1000</td>
<td>1450</td>
<td>654 x 654 x 2260</td>
<td>Busbar 2x10x120 6 x 150 mm(^2) Cu</td>
<td>THFS 1000S1</td>
<td>520</td>
</tr>
<tr>
<td>1600</td>
<td>2300</td>
<td>840 x 654 x 2260</td>
<td></td>
<td>THFS 1600S1</td>
<td>650</td>
</tr>
</tbody>
</table>

\(^1\) Cabling from bottom

**Outdoor use IP 34. Includes base element, cabling from bottom**

<table>
<thead>
<tr>
<th>Transformer size ([\text{kVA}])</th>
<th>Dimensions (L \times S \times K) ([\text{mm}])</th>
<th>Input-Output Cabling / Busbar</th>
<th>Type</th>
<th>Order Code</th>
<th>Weight ([\text{kg}])</th>
</tr>
</thead>
<tbody>
<tr>
<td>630</td>
<td>900</td>
<td>1050 x 360 x 1200</td>
<td>2 x 150 mm(^2) Cu</td>
<td>THFS 630U1 ((\text{max } 4 \text{ cables}))</td>
<td>310</td>
</tr>
<tr>
<td>1000</td>
<td>1450</td>
<td>1050 x 720 x 1200</td>
<td>4 x 150 mm(^2) Cu</td>
<td>THFS 1000U1 ((\text{max } 6 \text{ cables}))</td>
<td>450</td>
</tr>
<tr>
<td>1600</td>
<td>2300</td>
<td>1050 x 720 x 1200</td>
<td>Busbar 2x10x120</td>
<td>THFS 1600U1</td>
<td>550</td>
</tr>
</tbody>
</table>

THFS U1

**Group Connection**

<table>
<thead>
<tr>
<th>Dimensions (L \times S \times K) ([\text{mm}])</th>
<th>Protection Type</th>
<th>Order Code</th>
<th>Weight ([\text{kg}])</th>
</tr>
</thead>
<tbody>
<tr>
<td>250x180x400</td>
<td>IP 30</td>
<td>THF 25NV</td>
<td>19</td>
</tr>
<tr>
<td>400x230x1400</td>
<td>IP 30</td>
<td>THF 125NV</td>
<td>83</td>
</tr>
<tr>
<td>800x230x1000</td>
<td>IP 30</td>
<td>THF 160NV</td>
<td>110</td>
</tr>
</tbody>
</table>

**Current transformers**

<table>
<thead>
<tr>
<th>Current ratio</th>
<th>Overload value</th>
<th>Type</th>
<th>Order Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>250/1</td>
<td>800A</td>
<td>KORE 06F1-250/1THF</td>
<td>1SCA022458R4260</td>
</tr>
</tbody>
</table>
Enclosed third harmonic filters $\text{THF}_{\text{star}}$

**Installation to the transformer star point**

The third harmonic filters $\text{THF}_{\text{star}}$ are installed in the neutral- or PEN-conductor between the un earthed transformer star point and the neutral bus bar of the distribution board.

All neutral and earth currents need to be conducted through the current transformer of the protection unit. The protection unit is connected to reliable auxiliary voltage source.

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**Installation of $\text{THF}_{\text{star}}$ filters in transformer circuits in TN-C system**

In TN-C system the $\text{THF}_{\text{star}}$ filter is installed in the transformer star point. There must be no earthing between the starpoint of the transformer and the incoming terminal of $\text{THF}_{\text{star}}$ filter.

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**Approvals**

SGS-FIMKO Oy’s certification on use in neutral conductor.

No standards available so far.

Approval in EU area acc. to CENELEC Memorandum 7.

CE certificate

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**Standards**

IEC 439-1

+ IEC 76-1

IEC 289

IEC 831-1/2
Protection unit

The purpose of the protection unit is to limit the fundamental unbalance current, protect THF_{star} for overloading and to detect the increased third harmonic current due to network failure or failure of THF_{star}.

The protection unit THF1_S and current transformer are included in the delivery. The protection unit include 50Hz and 150Hz measurement circuits. The current transformer need to be installed so that all neutral and vagabonding currents pass through it to the star point of the transformer. In case of failure the protection unit is closing the by-pass contactor of the filter.

![Diagram of protection unit](image)

Installation of THF_{star} in the star points of parallel transformers or generators

THF_{star} is installed between points A and B. The isolation resistance after the point B needs to be measured over R_s > 50 \, k\Omega. The filters in both star points, N-conductors- need to be controlled simultaneously.

Alternative ways of installation:

![Alternative ways of installation diagrams](image)
Installation of THF filter for distribution boards TN-S -system

**TN-S -system**

In TN-S system the THF filter can be installed in the neutral conductor. The network must be a pure TN-S system. Fault current monitoring is recommended. Before the installation the state of TN-S-system shall be verified by measuring the isolation resistance in the poles where THF is to be installed.

It is advisable to install the filter in the transformer star point even in TN-S-system. In that case there is no 150 Hz voltage between N and PE. See installation of THF _sta_ , filter for transformer circuits on page 6.

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**Selection of filter for distribution boards in the TN-S-system**

The THF filter is installed in the neutral conductor. A filter is sized according to the distribution board or the fuse, which is supplying the group. The basis of the factory dimensioning of the filter is the fact that a filter installed in the neutral conductor bears, in addition to the 150 Hz current, a 50 Hz component which may reach 100 % of the phase current (fully asymmetrical load).

<table>
<thead>
<tr>
<th>Size of feeding fuse [A]</th>
<th>THF Quantity &amp; Type</th>
<th>Recommended cable size of neutral conductors in-out Cross section</th>
<th>Cables between filters Cross section</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 1 x THF 25NV</td>
<td>6 mm²</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>63 1 x THF 63NV</td>
<td>16 mm²</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>125 1 x THF 125NV</td>
<td>35 mm²</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>160 1 x THF 160NV</td>
<td>50 mm²</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>200 1 x THF 160NV + 1 x THF 63N</td>
<td>70 mm²</td>
<td>16 mm²</td>
<td>-</td>
</tr>
</tbody>
</table>

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Guard unit

The THF-units for TN-S-system include guard unit (\_V). The purpose of guard unit is to supervise the network condition by measuring the level of the current of the PE-conductor of the group. In case the PE-current exceeding the set level in the area of 4A...10A, the guard unit closes the by-pass contactor of THF and can give an alarm.

If increased protection is needed, the group fuse is bigger than the rated current of the filter, or in case of large cable diameters, the THF-filters can be provided with an extra protection unit and current transformer. In those cases the THF\_star is recommended. The protection unit is controlling the by-pass contactor of the THF in case of large 50 Hz current or when the 150Hz current exceeds the set limit. The current transformer is installed in the PE-conductor alt. the PEN-conductor depending on the installation.

Connection example: THF filter with guard unit

THF25NV
THF63NV
THF125NV
THF160NV

THF equipped with guard unit.
THF equipped with optional protection unit.

THF\_star filter installed in neutral conductor of TN-S system equipped with optional protection unit. Measurement from N and PE conductors.
Specification of harmonic filter
Example THF star

**Type:** THFS 1600 S1

**Rated voltage:** 400V

Dimensioning according to the transformer size: 1600 kVA

Removes the third harmonic current from the phase and neutral conductor

Dimensioning current/ Max continuous current: 2250A/ 800A

Dimensioning voltage: 40V 150Hz

The filter allows subsequent increasing of the harmonic load without retrofitting

Short circuit dimensioning according to max. available short circuit

The filter is stand alone type and not influencing on the power factor compensation

The filter is not influencing on carrier- wave-line.

Main incoming breaker: Max. time delay: 0,2 s

Terminations: Max six cables of 300mm²

The filter is equipped with by-pass switch for commissioning

**Stand along enclosure:**
- indoor use IP30
- outdoor use IP34

**Accommodation:**
- In the vicinity of transformer station
- Retrofitting to the transformer station
- In the main switchboard

The THF star removes typically 95% of the third harmonic current from the whole network from line and load side independent of the magnitude of the third harmonic current. For example the neutral current reduces from 450A down to 25A and in the phase conductors from 150A to 10A. The same mitigation prevails in the whole network from the transformer windings to the lamps and computers.

The magnetic field from the construction and earthing wiring reduces typically by 50% due to mitigation of the vagabonding currents (50% of magnetic field usually of 150 Hz origin).

The iron, copper and resistance losses reduce the temperature and noise level of the supply transformer doubling the lifetime of the transformer by every 8 degrees C.

The filter reduces the resistance losses (I²R) For example:

Before: (450A)² x 0,1 Ω = 2025 W

Filter installed: (25A)² x 0,1 Ω = 62,5 W

The filter include protection unit, which limit the 50Hz unbalance current and 150Hz fault current

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**Check THF star filters**

**Installation and commissioning:**

The installation of THF star is in theory easy but in practice certain points have to be checked:

✓ Ensure by measurement that there is no parallel current path to the filter
✓ Check up also the possible influence of parallel transformers or generators
✓ Ensure that the filter is installed in the right location. The neutral conductor from the star point of the transformer is the recommended place.
✓ Check up that the current measurement is right. The CT shall always measure the sum of all neutral and earth currents of the network.
✓ Check up the relay setting of the protection unit.
✓ Check up that there is no largely dimmer loads.
✓ Read mounting instruction 34THF1S
Installation examples

TN-S system, where the original cabling to the transformer star point need to be displaced to fundamentally same position in the N-conductor of the main switchboard.

THF installation.

1) In this installation model, the current transformer need to measure both N- and PE-current, unless additional guard unit is used.

TN-C-S system
Alternative installation examples when using THF with protection unit(_S) or THF with guard unit(_V).

TN-S system
Alternative installation example when using THF with protection unit(_S) or THF with guard unit(_V).
The technical data and dimensions are valid at the time of printing. We reserve the right to subsequent alterations.