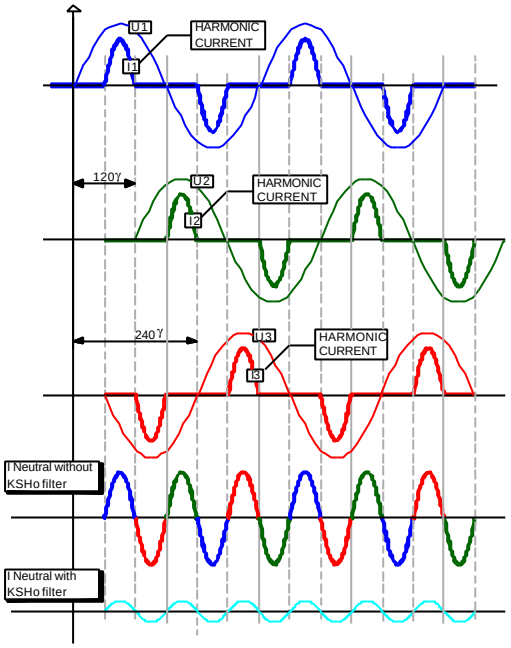
Zero sequenced filters

Cleanwave^{Ò} KSH$_0$

The optimum solution to problems of neutral current

50Hz Version



Neutral current resulting from the addition of phase currents of a non linear load

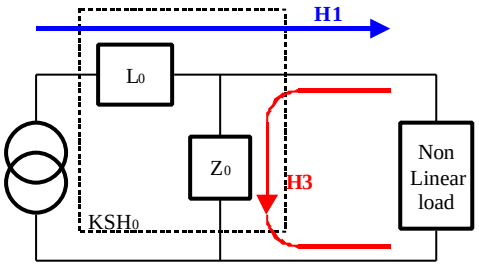
Introduction

Globally we are large users of equipment that inject unwanted and damaging harmonic currents into the upstream mains power supply. Equipment such as switch mode power supplies for computers, fluorescent lighting, electronic speed control of motor drives and induction furnaces etc, all contribute to this phenomena. These non-linear loads generate **harmonic currents** of high intensity : H3 ; H5 ; H7 ; H9 …

Amongst these harmonic currents, the **zero sequenced harmonics** (H3, H6, H9…H3k) are the most critical ones. Indeed, in three phase power supplies with distributed neutrals, the zero sequenced harmonics add up in the **neutral conductor** which is quickly overloaded. It is more and more frequent to find neutral currents more than 50% higher than the phase current.

Effect

- **Overheating** of neutral conductor, transformers… leading to **fire hazard**.
- High increase in **distribution losses**.
- **Power limitation** due to neutral conductor saturation.
- Decrease of **power factor**.
- Unjustified **tripping** of circuit-breakers.
- **Destruction** of electrical devices : UPS, alternators, capacitors (over-current, resonance).
- **Vibration** of magnetic coils.
- Unacceptable injection of harmonic currents to the mains (**EMC regulations**).
- Electromagnetic **disturbances** (electronic instruments, computers…).



Principle diagram

The Cleanwave® KSH_0 filter

The **Cleanwave® KSH$_0$** gives an original, patented, solution to the problems met by users of disturbing loads.

The **KSH$_0$** filter consists of two main elements:

- A **Z$_0$** block shunt connected with the load.
- A **L$_0$** block serial connected with the load.

For direct and reverse currents, the filter has <u>no influence</u> :

- L$_0$ has a nil impedance, contrary to Z$_0$, which conducts no current.

Faced with zero sequenced currents, the situation is the <u>opposite</u> :

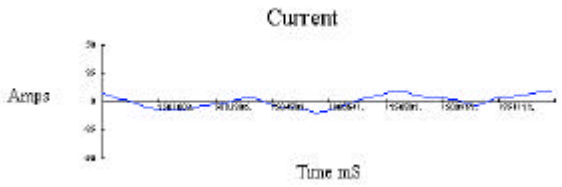
- Z$_0$ is comparable to a short-circuit, while L$_0$ has a high impedance. The zero sequenced currents are short-circuited by Z$_0$ and only a very small part (typically 10%) goes back to the mains.

The whole (L$_0$ + Z$_0$) is available as it is (IP00 version) for integration by the customer or integrated in an electrical enclosure (IP21 version).

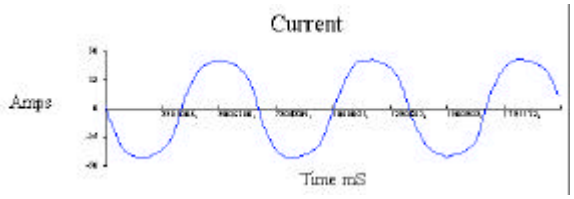
The IP21 version can be equipped with various options :

- Temperature control
- Specific instrumentation
- By-pass (manual or automatic)
- Integrated circuit-breakers
- Etc…

Cleanwave® KSH$_0$-90-B-IP21



Neutral current with KSH$_0$ filter



Neutral current without KSH$_0$ filter

Cleanwave® KSH$_0$-50-A-IP00

Performance

- Impressive reduction of **neutral current** (typically by 10)
- Reduction of the **harmonic currents** injected to the mains.
- Improvement of **voltage wave** shape.
- Partial re-balancing of **unbalanced** loads.
- **Power factor** improvement.
- Reduction of electrical and electromagnetic **disturbances**.
- Reduction of **phase current**.
- **Energy savings** .

Advantages

- Exceptional **reliability** (same as a dry type transformer) :
  - No capacitor.
  - No power electronic devices.
- **Instantaneous** response.
- **Negligible losses** (0.5…1% according to size).
- Extremely **simple study** :
  - No risk of resonance.
  - Independent of short-circuit power.
  - Easy selection.
- Great **flexibility** by easy connection of several filters in **parallel**.
- **Neutral conductor** without impedance.

Method of selection

The selection of a filter is very simple, you just have to :

- Determine the **maximum phase current** $I_{ph\ max}$ and the **maximum neutral current** $I_{N\ max}$.
- Type of filter :
  - If $I_{N\ max} \leq I_{ph\ max}$, choose a **type A** filter.
  - If $I_{N\ max} > I_{ph\ max}$, choose a **type B** filter, for high distorted loads.
- Choose, in the selected range, the filter adapted to $I_{ph\ max}$ and $I_{N\ max}$.
- Choose between the basic IP00 version and the IP21 version.
- Select options if required.

Example :

We wish to place a filter upstream a non linear load protected by a 300A circuit-breaker. Measurement on site shows a neutral current of 450A.

The neutral current is higher than the phase current, so we choose a filter of type B.

We find, in the range, the model **KSH$_0$.B.220** which tolerates a phase current of 321A and a neutral current of 577A.
This filter is the optimum for our application.

Technical specifications

Standards

- General standards : **CEI-289.88**, **CEI-726.82**
- IP rating : **Unprotected : IP00**, **Protected : IP21**

Electrical specifications

- Nominal voltage (phase to phase) : **400V ±10% - 50Hz**(1)
- Reduction ratio $\frac{I_{Neutral.mains}}{I_{Neutral.load}}$: **1:8 to 1:10**
- Ratio : $\frac{I_{Neutral}}{I_{Phase}}$: £ **1.0 (KSH$_0$/A)**

  > **1.0 (KSH$_0$/B)**

- Inrush current : £ **$I_{nominal}$**
- Overload capacity : **10% - 1 hour**, **25% - 10 min**, **50% - 2 min**
- Insulation class : **1.1kV**
- Dielectric strength : **3kV**
- Thermal class of insulation : **H**

Working conditions :(2)

- Max. ambient temperature : **50°C**
- Max. altitude : **1000m**
- Max. relative humidity : **90%**

(1) Available in different voltages and frequencies.
(2) Please, contact us for special environmental conditions

Range

TYPE	Power	I_{phase} Max	$I_{neutral}$ Max	Total losses	Size						Total weight	
					IP00			IP21			IP00	IP21
Type A	[kVA]	[A]	[A]	[W]	W	D	H	W	D	H	[kg]	[kg]
KSH$_0$-A-20KVA	20	29	29	176	360	550	520	510	550	780	100	120
KSH$_0$-A-30KVA	30	43	43	219	360	550	520	510	550	780	110	130
KSH$_0$-A-50KVA	50	72	72	359	360	550	520	510	550	780	120	140
KSH$_0$-A-70KVA	70	101	101	452	420	550	650	510	550	780	130	150
KSH$_0$-A-100KVA	100	144	144	538	700	620	950	830	620	1150	270	300
KSH$_0$-A-160KVA	160	231	231	616	700	620	950	830	620	1150	330	360
KSH$_0$-A-250KVA	250	361	361	972	700	620	950	830	620	1150	390	420
KSH$_0$-A-330KVA	330	476	476	1212	1000	800	1200	1200	800	1400	400	500
KSH$_0$-A-400KVA	400	577	577	1565	1000	800	1200	1200	800	1400	455	630
KSH$_0$-A-500KVA	500	722	722	1568	1000	800	1200	1200	800	1400	520	710
Type B												
KSH$_0$-B-12KVA	12	16	29	176	360	550	490	510	550	780	90	110
KSH$_0$-B-18KVA	18	24	43	219	360	550	490	510	550	780	100	120
KSH$_0$-B-30KVA	30	40	72	359	360	550	490	510	550	780	110	130
KSH$_0$-B-40KVA	40	56	101	452	420	550	600	510	550	780	120	140
KSH$_0$-B-55KVA	55	80	144	538	700	620	900	830	620	1150	250	280
KSH$_0$-B-90KVA	90	128	231	616	700	620	900	830	620	1150	310	340
KSH$_0$-B-140KVA	140	201	361	972	700	620	900	830	620	1150	370	400
KSH$_0$-B-180KVA	180	264	476	1212	1000	800	1200	1200	800	1400	380	480
KSH$_0$-B-220KVA	220	321	577	1565	1000	800	1200	1200	800	1400	435	610
KSH$_0$-B-280KVA	280	401	722	1568	1000	800	1200	1200	800	1400	500	690

Data given for information only and subject to change.