Active Filter installation guidelines

APPLICATION NOTE

(M217E0202-03-19A)

SAFETY PRECAUTIONS

Follow the warnings described in this manual with the symbols shown below.

	**DANGER** Warns of a risk, which could result in personal injury or material damage.

	**ATTENTION** Indicates that special attention should be paid to a specific point.

If you must handle the unit for its installation, start-up or maintenance, the following should be taken into consideration:

	Incorrect handling or installation of the unit may result in injury to personnel as well as damage to the unit. In particular, handling with voltages applied may result in electric shock, which may cause death or serious injury to personnel. Defective installation or maintenance may also lead to the risk of fire. Read the manual carefully prior to connecting the unit. Follow all installation and maintenance instructions throughout the unit's working life. Pay special attention to the installation standards of the National Electrical Code.

	**Refer to the instruction manual before using the unit** In this manual, if the instructions marked with this symbol are not respected or carried out correctly, it can result in injury or damage to the unit and /or installations.

LIFASA, reserves the right to modify features or the product manual without prior notification.

DISCLAIMER

LIFASA, reserves the right to make modifications to the device or the unit specifications set out in this instruction manual without prior notice.

LIFASA, on its web site, supplies its customers with the latest versions of the device specifications and the most updated manuals.

www.lifasa.es

	**LIFASA,** recommends using the original cables and accessories that are supplied with the device.

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REVISION LOG

Table 1: Revision log.

Date	Revision	Description
10/20	M217E0202-03-19A	Initial Version

Note: *The images of the devices are for illustrative purposes only and may differ from the original device.*

1.- DIMENSIONING CONSIDERATIONS

1.1.- Correctly dimension the device:
Note: *If you need advice contact* **LIFASA**.

✓ If it is required power factor correction or phase balancing as one of the main functions, it must be oversized for such functions.

✓For the sizing of an active filter, it will always be necessary to know the following data from the installation:

A.- Single-line diagram (SLD) of the installation with:
- •Indicator in the SLD where it is planned to install the active filter.
- •Identify the points where the harmonic measurements will be made. Minimum points:
  - → In mains of the installation (points ① and ② in **Figure 1**)
  - → Lines with distorting loads (points ④ and ⑤)

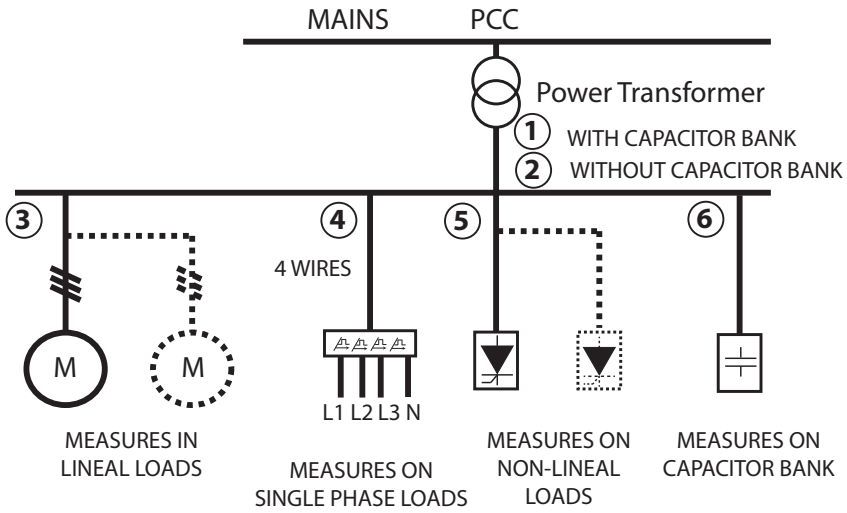

Figure 1: Single-line diagram (SLD) of the installation.

B.- Data of the Power Transformer:
- Power: S_n (kVA)
- Voltage in the Secondary of the Transformer: U_2 (V)
- Short-circuit voltage: U_{cc} (%)

C.- Measurement of harmonics and electrical parameters in the different points identified:
- Total harmonic distortion (THD) (total and individual): Voltage THD (V) and Current THD (I).
- Current In at 50 Hz and harmonic currents.

D.- If there is a capacitor bank:
- Capacitor bank power, Q (kvar), with or without detuned reactors.
- Active power of the installation, P (kW).
- The measurement in mains (points ① and ②), with capacitor bank connected (working) and with capacitor bank disconnected.

✓ In the case of a new project based on blueprints information, a single-line diagram with exhaustive load descriptions and simultaneity factors data is required.

✓ Be aware of the safety factor to be applied in relation to the installation's voltage THD, due to the increase in distortion caused by some loads when their power supply voltage is improved, as explained below:

The purchased active filter must be sized for the harmonic currents that has to eliminate. The rated current of the **SINAF** must be at least 20% higher than the maximum level of harmonics to be filtered. This factor may be higher depending on the installation features.

The active filters can suffer from overloading when trying to cancel the harmonic currents in high-impedance, short-circuit mains. A clear example of a symptom for detecting such cases is that they originally start from a **THD(V)** higher than a 3%. It has been detected that the higher the initial **THD(V)**, the greater the chance of filter overload.
The reason for this behaviour is that the load does not behave as a current source, but rather the more harmonic current eliminated by the filter the more harmonics are produced by the load, which can produce up to more than double what was initially measured.
To avoid this phenomenon, it is best to oversize the active filter by multiplying the initial current of harmonics measured in the load by a **safety factor** (FS_h). In other words:

$$I_{FILTER}(SINAF) = [FS_h * I_{LOAD} * THD(I)]$$

Where:

I_{FILTER} **(SINAF)**: rated current of the active filter.

FS_h: safety factor > 1.2.

I_{LOAD}: maximum current of the load.

THD(I): harmonic distortion of the load current.

Equation 1:Rated current of the SINAF.

To calculate this **safety factor** you must first know the parameter called **short-circuit ratio** R_{SC}, at the connection point of the non-linear loads (not on the installation input). The short-circuit ratio is defined as the ratio between the short-circuit current of a main (I_{SC}) and the rated current of the set of non-linear loads (I_{CNL}) producing the harmonics to be filtered.
(**Equation 2**)

$$R_{SC} = \frac{I_{SC}}{I_{CNL}}$$

Equation 2:Calculating the short-circuit ratio R_{SC}.

In a real installation, the short-circuit current (I_{SC}) in the point of connection mentioned can be calculated by having the voltage at the said point for two different load currents.
For example, full load, I_A and 10% load, I_B. If V_{OC} is the rated voltage at no-load, the I_{SC}, can be calculated using the formula shown in **Figure 1**:

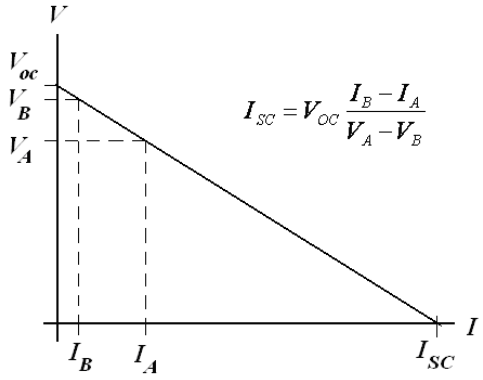

Figure 2:Graph for calculating I_{sc}.

The safety factor (**FS_h**) can be obtained from the graph in **Figure 2**:

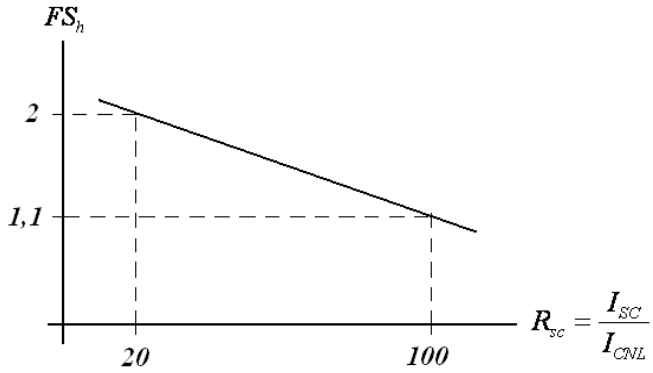

Figure 3:Approximate graph for calculating the FS_h.

1.2.- If Current Transformers (CT) are to be used in an installation with load variability where the lowest current is less than 10% of the maximum, please notify us. Contact **LIFASA'S** technical department to select the transformer type.

✓ Transformers suitable for load variability are **LIFASA'S** proprietary 0.2 S class models from the TC or TCH ranges.

1.3.- If harmonic currents need to be eliminated from the neutral cables, an **SINAF3440** or **SINAFM440** three-phase active filter with neutral is required. This model must not be used in three-phase networks without neutral.

1.4.- Minimum size for current protection devices, **Table 2**:

Table 2:Minimum size for current protection devices.

Active Filters	Current protection device
SINAF 3.0 30A	40 A, C curve
SINAF 3.0 100A	125 A, C curve
SINAF 3.0 200A	250 A, C curve

Select devices with a breaking capacity according to the connection point and the country's installation standards.
Check that the neutral current is less (<) than the phase current.

1.5.- Where necessary, use residual current protection devices (RCD); with **SINAF 3.0** and **SINAFM**, only type B RCD devices may be installed.

1.6.- Contact **LIFASA** if any of the following situations arise in your installation:

- ✓ Installation with a backup generator.
- ✓ Parallel transformers with interconnecting switch between both installations.

2.- INSTALLATION CONSIDERATIONS

2.1.- Filter location in the installation:

✓ Do not install filters in series. (A filter downstream of another filter).

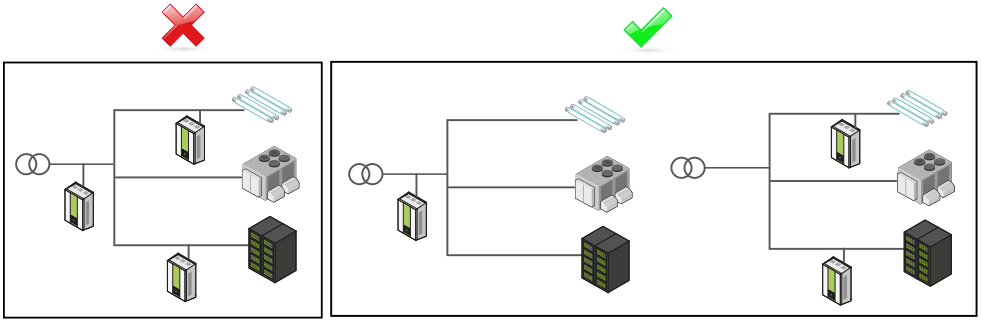

Figure 4: Correct vs. incorrect installation.

✓ Do not install active filters in a UPS output, except for power factor correction and/or phase balancing.

✓ Do not install active filters in an installation with capacitor banks without detuned reactors. In case of having reactors, the best connection place to avoid possible resonances is shown in **Figure 4**.

If the capacitor bank has detuned reactors protected from the 5th harmonic or higher, **DO NOT** select filtering the 3rd harmonic when the commissioning is being done.

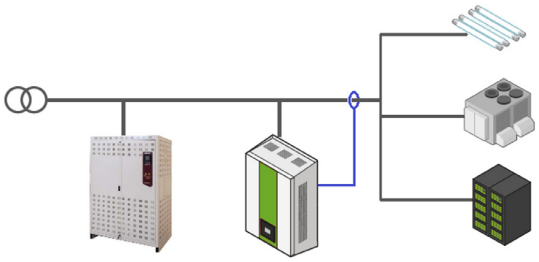

Figure 5: Active filters with capacitor bank.

Note: *If the measurement is taken upstream of the capacitor bank, it can work perfectly but possible resonances will be more likely.*

2.2.- SINAF 3.0 100A (SINAF3xxx100), 200A (SINAF3xxx200), SINAFM 100A (SINAF-Mxxx100C), 200A (SINAFMxxx200C), 300A (SINAFMxxx300C) and 400A (SINAFMxxx400C) models:

✓Turn the device's top over, **placing the face without holes at the front**.

Note: *The device's top is upside down to facilitate the transportation.*

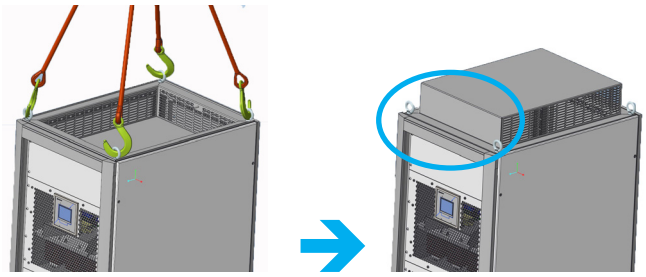

Figure 6: Turn the device's top over.

✓Make all power and measurement connections to the connection module included in the cabinet.

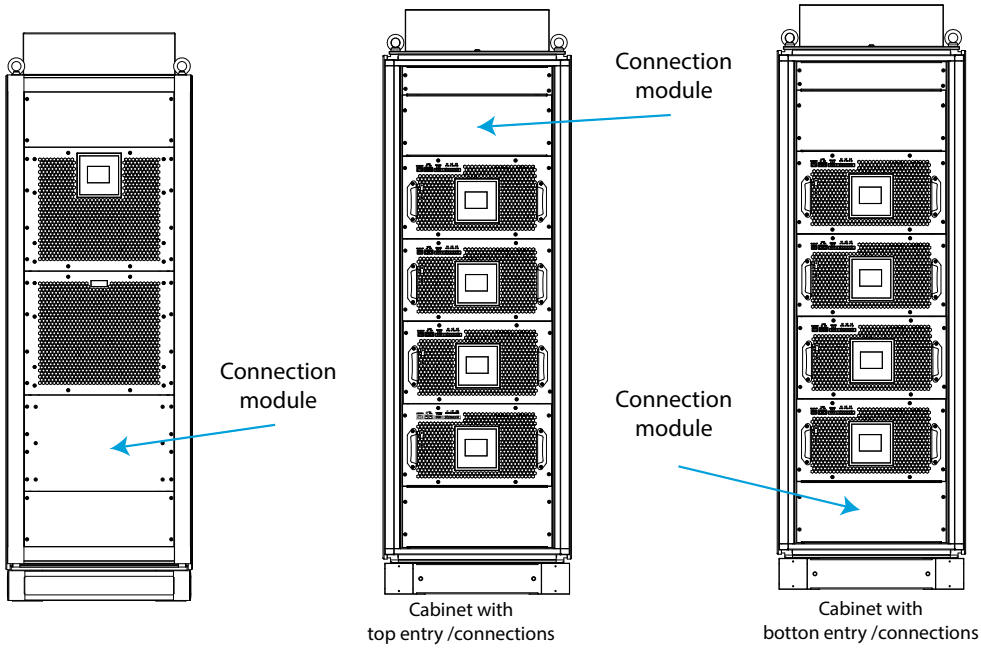

Figure 7: Models.

3.- CONNECTION CONSIDERATIONS FOR THE DEVICE

3.1.- Check 4 wire devices (**4W**) have the neutral connection, otherwise the device will not work.

3.2.- The CT terminal blocks has housed jumpers to short circuit the CT conductors when they must be disconnected from the device.

3.3.- Make sure that the CT installed in L1 is connected to the device's L1 terminal. And likewise, for L2 and L3 respectively. Otherwise the device will not work correctly. Also check that each Main line is correctly connected.

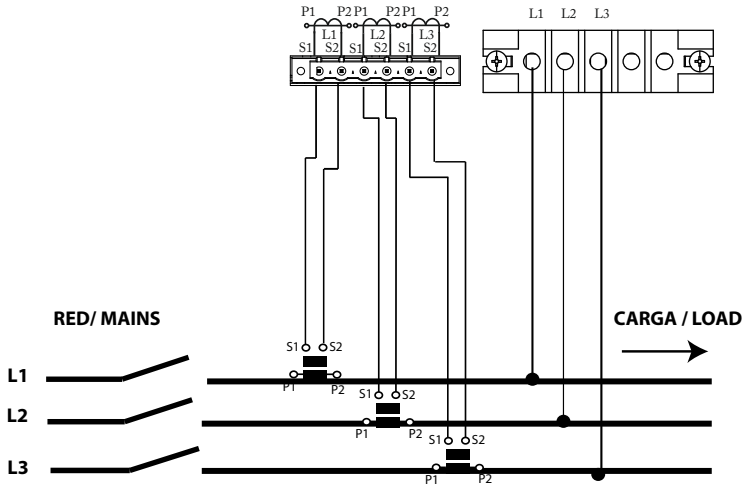

Figure 8: CT connection.

4.- CONFIGURATION AND COMMISSIONING CONSIDERATIONS

4.1.- Select only those harmonics of great magnitude that are required to be filtered.
Note : *Selecting all harmonics may cause resonances due to mains impedances.*

4.2.- When a single active filter/module has to be commissioned in an installation, the device should be selected as **"Single"**, not as "**Master**". The **"Master"** option must only be selected when multiple filters/modules are installed.

4.3.-Considerations for **SINAF** commissioning:

1.- Use the document: ***"Commissioning of active filters"*** (**M217E0102-03-xxx**), provided by **LIFASA** to follow all the steps of the commissioning.

2.- Check the conductors cross section are adequate.

3.- Check that the torque setting is correct in all terminals.

4- By Visual Inspection, check the **CT's** are correctly placed on the main or load sides whenever possible**.**

5.- Once the **SINAF** is powered, check that the booting process is carried out without any alarms, the **DC** bus load is completed, and the **SINAF** changes to **STOP** mode.

6.- With the filter in **Stop** mode, check for the expected Voltage, Current, Cos φ and Power values.

7.- Check that the device is correctly connected by means of the Cos φ value (between 0.7 inductive and - 0.95 capacitive) or by means of the phasor diagram.

8.- Check there is enough current for CT measurement within the required class/precision (>10% full scale).

9.- Check which frequency orders should be filtered (as a rule: those frequencies that have a THD current higher than 12%). Where the **SINAF** filter is needed for power factor correction or phase balancing, calculate if the **SINAF** power is enough.

10.- If several filters are connected in parallel, use the **Master** device to check that all **Slave** device ID numbers have been identified.

11.- Parametrize the **SINAF** filter according to the values set in points **4**, **8** and **9**.

12.- With the filter **ON,** use the different display screens to check if the filtering, power factor correction or phase balance values decrease accordingly in the MAINS side.

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