



**ISOLATION TRANSFORMER  
FOR 3<sup>rd</sup> HARMONIC FILTERING**

**TSA**

**INSTRUCTIONS MANUAL**

**M-981231-01A**

## 1 INTRODUCTION

There is a lot of electrical supply installations where most of the loads are single phase, supplying a rectifier plus a filter . This case is very common in office buildings, big stores, TV studios, where there is a lot of computers and electronic devices using DC supply.

In such installations there is a particular type of problem with harmonics of 3<sup>rd</sup> order and their multiples (called some times “the triplens”). The current of the triplens add on the neutral in phase, instead of adding like vectors at 120°. Because of that , the current at the neutral may be higher than the current at the phase cables, even in case that the three phases are perfectly balanced. This causes unexpected tripping of thermal protections and overheating of the neutral cables.

The **TSA** filters are the optimal solution to solve such problems , since the filtering of third harmonic by other types of passive filters may cause the saturation of transformers and may spoil the situation instead of improving. The basis of the **TSA** is a three phase D-Y isolating transformer, which eliminates the third harmonic upstream. At the output there is also a wide band passive filter to damp down the 5<sup>th</sup> and 7<sup>th</sup> harmonics.

## 2 LOCATION AND SIZE OF THE TSA FILTERS.

### 2.1 Where to locate the TSA?

It is important to locate the TSA as close as possible to the disturbing loads. Because of that we don't recommend the solution of big centralized TSA filters to compensate the whole power distribution. It's better to split up the filter in several smaller filters, placed as close as possible of the single phase lines causing the disturbances. In that way the currents upstream the TSA will be practically exempt of 3<sup>rd</sup> harmonic.

### 2.2 How to size the TSA?

The TSA filters are selected by its total power in kVA , but to calculate the current that they can deliver , a power factor correction must be applied. Such power factor depends on the distortion of the current that the TSA must supply downstream to the loads. To calculate the kVA of the TSA , the fundamental and the most significant harmonics to be supplied to the load side must be known and then the rated power may be calculated according to the following formula.

$$S(VA) = 1,732 * U_c * I_1 * \sqrt{\sum_1^n (n * \frac{\% I_n}{100})^2}$$

Where :  $U_c$  is the phase to phase voltage at the secondary side (usually 220V or 230V)

$I_1$  is the fundamental current at the load side.

$n$  is the harmonic order

$\%I_n$  is the % of harmonic  $n$  (Including the 3<sup>rd</sup> harmonic to be filtered)

The coefficient  $FS = \sqrt{\sum_1^n (n * \frac{\% I_n}{100})^2}$  is named the “overload factor”

**REMARK:** The current written in the characteristics plate is the rated current given by the

weighted addition of fundamental and all the harmonics as follows:  $I_1 * \sqrt{\sum_1^n (n * \frac{\% I_n}{100})^2}$

### 3 TSA FILTER DESCRIPTION. (See schematics).

The TSA filter is formed by the following parts :

**ISOLATION TRANSFORMER:** With the following characteristics.

**Primary side:** Delta connection. **Input terminals:** U1, V1, W1, N , PE (see wire diagram)

**Secondary side:** Star connection, usually with 230 V phase to phase. The neutral conductor is not used in the load. The star point is connected to the protection earth cable (PE). **Output terminals:** U2, V2, W2., PE (see wire diagram)

**LC FILTER:** 5<sup>th</sup> harmonic filter

**THREE PHASE POWER CIRCUIT BREAKER:** The size depends on the rated power of the TSA. The circuit breaker is placed at the primary side. The breaker trips in case that an earth leakage is detected at the secondary side circuit.

**SINGLE PHASE AUXILIARY SUPPLY CIRCUIT BREAKER:** This breaker protects the earth leakage relay and other auxiliary protection circuits.

**EARTH LEAKAGE RELAY:** This relay provides a protection in case of earth leakage at the load side. The standard protection relay is adjustable from 30mA to 300mA and has an adjustable delay.

### 4 TECHNICAL CHARACTERISTICS

TSA filters are often designed under particular specifications, but all of them have a set of common characteristics which are listed below.

#### Transformer

Standard primary voltage .....	400 V phase to phase
Standard secondary voltage.....	230 V phase to phase
Short circuit voltage ratio ucc% .....	6%
Power kVA .....	Depending on type
Constructive standards .....	EN 60 742

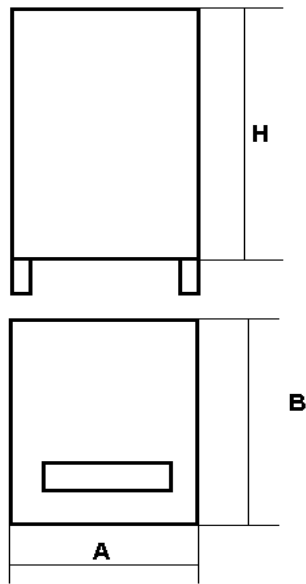
#### LC Filter

Resonance frequency .....	225 Hz
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#### 4.1 Types and components (see wire diagram)

TYPE	TR (kVA)	L1 Three phase	C1	RD	IA1 (A)	IA2 (A)
TSA-10	10	R-15-400	CV-40-10	WRTR-35/03	1	20
TSA-20	20	R-15-400	CV-40-10	WRTR-35/03	1	40
TSA-30	30	R-15-400	CV-40-10	WRTR-35/03	1	63
TSA-40	40	RB-30-400	CV-40-20	WRTR-35/03	1	80
TSA-50	50	RB-30-400	CV-40-20	WRTR-35/03	1	100
TSA-80	80	RB-30-400	CV-40-20	WRTR-35/03	1	160
TSA-100	100	RB-30-400	CV-40-20	WRTR-35/03	1	250

## 4.2 Dimensions:



TYPE	A	B	H
TSA-10	505	580	780
TSA-15	505	580	780
TSA-20	505	580	780
TSA-30	740	880	1050
TSA-40	740	880	1050
TSA-50	740	880	1050
TSA-80	740	880	1050
TSA-100	740	880	1050

## 5 INSTALLATION AND SET-UP.

### 5.1 Important remarks!

- Loads at the secondary side must be connected at the SALIDA / OUTPUT side phase to phase. (U2-V2 , V2-W2 , W2-U2 , see wire diagram)
- To get the maximum effectiveness of the TSA filter the loads must be as balanced as possible between the three possible pairs of phases (U2-V2 , V2-W2 , W2-U2 , see wire diagram)
- Never connect a load between a phase and the PE (protection earth) cable.
- Loads which do not produce 3<sup>rd</sup> harmonic, as incandescent lighting, heating, etc., do not need to be connected to the TSA output. They can be connected at the primary side between phase and neutral
- The TSA must be connected to mains by the side named ENTRADA/INPUT. The three phases shall be connected to U1, V1, W1 and the neutral to N. **The neutral is used only as auxiliary supply for the protection elements. Do not connect it to the load side.** (see fig.1)
- Connect the PE terminal of the TSA to the protection earth cable in the existing installation.
- Loads to be filtered must be connected to the side named SALIDA/OUTPUT. Terminals U2, V2, W2 without the neutral (see wire diagram)
- **The 230 V output is phase to phase.** All the single phase loads must be connected phase to phase. If the TSA is mounted in an existing installation where loads were supplied between phase and neutral , a new distribution has to be made, trying to keep the maximum balance between the pairs of phases (U2-V2, V2-W2, W2-U2) , see wire diagram.
- The earth cable to be distributed to the load is the already existing earth , connected to PE
- Adjust the sensitivity and the desired delay for the earth leakage relay according to the load needs and the desired selectivity. For TSA units with rated power below 50 kVA , adjust in the

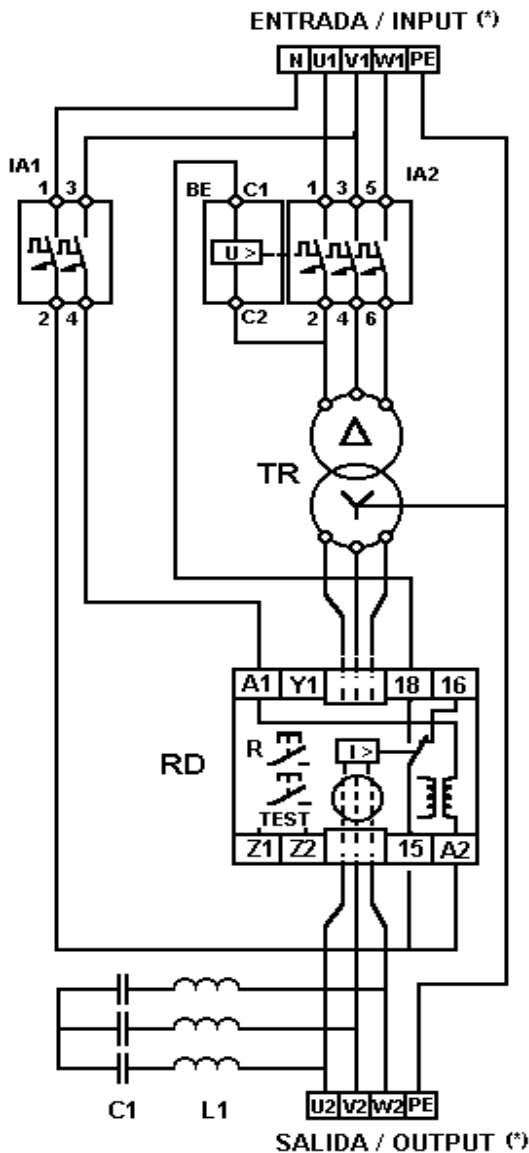
low range (30 to 100mA) For higher powers the threshold can be increased up to 300mA. In case that the relay trips, check the leakage current.

**REMARK! :** In case that the loads are mainly single phase supplying computers, printers, speed controllers , etc. , the trip threshold of leakage relay must be increased due to the EMI filters leakage.

## 6 TROUBLE SHOOTING AND MAINTENENCE.

- Check periodically that the earth leakage relay operates properly. Use the test push button of the relay.
- Check periodically that the rated power of the TSA is not surpassed because of the addition of new loads. (Take into account the overload factor due to harmonics)
- If new loads have to be added, take care of the load balance. Split the loads up in the three line pairs (U2-V2, V2-W2, W2-U2) , see wire diagram.

## 7 SCHEMATICS



Tipo Type	Sr(kVA)	V1 Fase-Fase Ph to Ph	V2 Fase-Fase Ph to Ph	Frec Freq
TSA-10	10	400 V	230 V	50 Hz
TSA-15	15	400 V	230 V	50 Hz
TSA-20	20	400 V	230 V	50 Hz
TSA-30	30	400 V	230 V	50 Hz
TSA-40	40	400 V	230 V	50 Hz
TSA-50	50	400 V	230 V	50 Hz
TSA-80	80	400 V	230 V	50 Hz
TSA-100	100	400 V	230 V	50 Hz
TSAE-10	10	<b>Especial:</b> Según especificaciones  <b>Special:</b> According to specifications		
TSAE-15	15			
TSAE-20	20			
TSAE-30	30			
TSAE-40	40			
TSAE-50	50			
TSAE-80	80			
TSAE-100	100			

**RD:** Relé diferencial 30mA a 300mA  
*Earth leakage relay , 30mA to 300mA*

**IA1:** Interruptor magnetotérmico , 6A  
*Circuit breaker, 6A*

**IA2:** Interruptor automático. Calibre según la potencia nominal  
**RC:** *Circuit breaker. Size according to rated power*

**L1:** Filtro 5<sup>o</sup> armónico  
**C1** *5th harmonic filter*