

# **NEUTRAL GROUNDING RESISTORS**



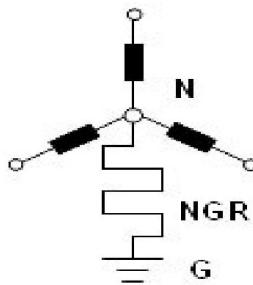
**TECHNICAL INFORMATION**

# *Contents*

<b>1- GENERAL DESCRIPTION .....</b>	<b>3</b>
<b>2- SPECIFICATION .....</b>	<b>3</b>
<b>2-1- System Voltage .....</b>	<b>3</b>
<b>2-2- Rated Voltage .....</b>	<b>3</b>
<b>2-3- Rated Current .....</b>	<b>3</b>
<b>2-4- Resistance value .....</b>	<b>4</b>
<b>2-5- Time .....</b>	<b>4</b>
<b>2-6- Continuous current .....</b>	<b>4</b>
<b>2-7- Temperature Coefficient of Resistance (<math>\alpha</math>) .....</b>	<b>4</b>
<b>2-8- Max. Temperature rise .....</b>	<b>4</b>
<b>3- TYPES OF RESISTOR ELEMENTS .....</b>	<b>4</b>
<b>4- ENCLOSURE .....</b>	<b>5</b>
<b>5- SOME ADVANTAGES OF PAARSUN RESISTORS .....</b>	<b>5</b>
<b>5-1- Choice .....</b>	<b>5</b>
<b>5-2- Stability .....</b>	<b>5</b>
<b>5-3- Predictability .....</b>	<b>5</b>
<b>5-4- Rapid cooling and short time ratings .....</b>	<b>6</b>
<b>5-5- Ease of installation .....</b>	<b>6</b>
<b>5-6- Low operating costs .....</b>	<b>6</b>
<b>5-7- Reliability .....</b>	<b>6</b>

# 1- GENERAL DESCRIPTION

Neutral Grounding Resistors (NGRs) are used for resistance grounding of industrial power system .They are usually connected between earth ground and the neutral of power transformers and power generators. Their main purpose is to limit the maximum fault current to a value which will not damage generating, distribution or equipments in the power system, yet allow sufficient flow of fault current to operate protective relay to clear the fault.



The rating of the NGR is chosen to meet the requirements of the system protection; this will include consideration of maximum acceptable fault current, earth potential levels, and minimizing damage caused by the fault. Based on the information provided in your order the resistor has been designed to meet the requirements of IEEE-32 when operated at the rating specified in your order.

The resistor bank is built up from a number of individual, replaceable parts arranged in banks to meet your specified details. These parts and bank design distribute specified working voltage across the various level of insulation and is fully tested in accordance with the routine test requirements of standard before dispatch.

The enclosure has sufficient creepage and clearances for the voltage specified by yourselves in your order. The construction allows for the resistor reaching a temperature of 760°C during a full earth fault.

## 2- SPECIFICATION

### 2-1- System Voltage:

NGRs never experience voltage in excess of line voltage. Insulation level is specified based on line voltage.

### 2-2- Rated Voltage ( $U_n$ ):

The rated voltage of the NGR shall be equal or higher than Line –to– Neutral nominal voltage of the power system (system voltage  $\sqrt{3}$ ).

### 2-3- Rated Current ( $I_n$ ):

Resistors are rated by current at line voltage. Choice of current rating depends on the characteristics of the system and equipment, also the type of employed relay protection system. Current values are usually 10, 12.5, 16, 20, 25, 32, 40, 50, 63 and multiples therefore.

## **2-4- Resistance value:**

The resistance value is calculated with the formula  $U_n/I_n$  and shall refer to  $20^\circ\text{C}$ . The allowed tolerance on measurement under D.C. current is  $\pm 10\%$ .

## **2-5- Time:**

Resistors are generally rated to carry their current for a time. The current will actually flow for a **much shorter time** than this. This time is chosen to allow for the occurrence of multiple events. One NGR is often used to limit grounding current on several outgoing feeders. This reduces equipment damage, limit voltage rise and improve voltage regulation.

Since earth faults could occur in rapid succession on different feeders, 10 second rating is not satisfactory and one minute rating is applied.

Some engineers specify 10 minutes rating to prove an added margin of safety. There is however, a corresponding increase in cost.

## **2-6- Continuous current:**

NGRs are generally rated for occasional use and only have a limited capacity to handle continues current. Where necessary, NGRs can be specified to handle significant continues current. This requirement significantly increases size weight and cost.

## **2-7- Temperature Coefficient of Resistance ( $\alpha$ ):**

This factor is change in resistance per degree, at initial temperature.  $R = R_0(1 + \alpha\theta)$

## **2-8- Max. Temperature rise:**

Neutral Grounding Resistors must be capable of carrying rated current for the allowable on time without exceeding the allowable temperature rise established by IEEE standard 32-1972.

All PAARSUN Neutral Grounding Resistors are designed, manufactured and tested in strict compliance with IEEE-32 rating and permissible temperature rise above  $30^\circ\text{C}$  ambient is shown in Table 1.

**Table 1**

<b>Time Rating ( on time )</b>	<b>Permissible Temp. Rise ( above <math>30^\circ\text{C}</math> )</b>
Ten Seconds ( Short time )	$760^\circ\text{C}$
One Minute ( Short Time )	$760^\circ\text{C}$
Ten Minutes ( Short Time )	$610^\circ\text{C}$
Extended time	$610^\circ\text{C}$
Steady state ( Continues )	$385^\circ\text{C} *$

\*permissible rise is  $375^\circ\text{C}$  over  $40^\circ\text{C}$  ambient on a continues duty

## **3- TYPES OF RESISTOR ELEMENTS**

- Wire wound resistors
- Edge wound resistors
- Stamped grid resistors

- Ribbon resistors
- Spiral wound resistors
- Cast alloy resistors

The kind of element for an NGR is depending on the level of fault current. **PAARSUN** has an extensive range of element using wire wound; plate grids of 0.5 mm, 1mm, 2mm and 4mm. The most important parameter to consider from IEEE-32 is the allowable temperature rise of the element for different “on” times.

For the majority of ratings the suitable elements are Wire wound and Edge wound types. These resistors are manufactured from continuous stainless steel alloy strip or wire in to coils. Each coil is supported by ceramic insulators mounted on a stainless steel center support with stainless steel terminals welded to each end.

The arrangement freely allows expansion and contraction of the resistor elements without imposing strain on the coils or terminals.

The coils are assembled in bank formation for duty at high working temperature. Some resistance alloys that we use are high temperature stainless steels, capable of withstanding temperature up to 1100°C. NGR's designed for operation to higher temperatures require less active mass, resulting more compact and economical designs.

## **4- ENCLOSURE**

**PAARSUN** can produce NGRs in an enclosure with protection degree from IP00 for indoor application to IP55 for outdoor application.

It should be noted that IP rating is only avoid to ingress of water and dust in the context of NGRs that may have exposed live parts such as bushing.

The standard enclosure is designed to IP23 that is suitable for indoor and outdoor use. This allows sufficient cooling and provides adequate protection unless environmental conditions are exceptional. In these cases higher degrees of protection up to IP55 can be provided.

It should be realized that if poorly ventilated enclosures are used, external surfaces can become very hot, particularly if continues rating are specified.

The enclosures is made of stainless steel (2mm thickness) mill galvanized, hot dip galvanized or painted steel (100 micron).

## **5- SOME ADVANTAGES OF PAARSUN RESISTORS**

### **5-1- Choice**

An extensive range of resistor elements allows selection of the most efficient and cost effective solution for any required duty. **PAARSUN** can manufacture NGR's for any system voltage or initial current and with rated times from a few seconds to continuous.

### **5-2- Stability**

The resistance value is set at the manufacturing stage and remains constant throughout the life of the NGR.

### **5-3- Predictability**

The change in resistance with increasing or decreasing of temperature during operation is predictable. This means that protection levels can be accurately pre-determined.

#### **5-4- Rapid cooling and short time ratings**

Modern protection systems typically clear faults in less than a second. However, the time rating of an NGR usually needs to cater for the possibility of several successive faults. PAARSUN metallic resistors cool down very much faster than liquid type after operation.

#### **5-5- Ease of installation**

PAARSUN NGR's are compact and do not require site calibration or auxiliary power supplies.

#### **5-6- Low operating costs**

Fixed resistance values mean that maintenance is limited to periodic inspection and cleaning only.

#### **5-7- Reliability**

NGR's may only be called upon to operate a few times in their service life, which may be 25 years or more. Reliability is imperative, and has been proved over many years in electric traction rolling stock and under conditions of severe vibration and extreme climate world-wide.