

H.V. CIRCUIT BREAKERS: RESISTANCE AS SEEN FROM THE TERMINALS. WHY THIS EASY and IMPORTANT INFORMATION IS RARELY INCLUDED IN THE MANUFACTURERS CATALOGUES

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Resistance between these 2 points as seen from the external bars

Link for the article is above

COGNITOR INPUT DATA screen

Geometry of the TYPE OF EQUIPMENT
LVSW 1.42 = Low Voltage switchgear, MVSW1 = Medium Voltage Switchgear-DUCT, 1 in bus way, etc.

Click INPUT DATA to change data or click RESULTS to do the calculations and to see the test results

PARAMETERS IMPACTING TEMPERATURE RISE

- Main contact resistances (should not be only the total resistance per phase)
- Type and area of ventilation openings
- Forced ventilation
- Cross-section- Lateral area & geometric position of the bars (vertical, horizontal)
- Materials of the bus bars and their coating
- Color of paint Painted or having a plastic cover

But both have the same total resistance per phase and different resistances as seen from terminals. So, test is not reproducible

Why Temperature Rise Limits shall not be exceeded ?

- Materials age very quickly beyond limits.
- Risk of burns on contact with casing

Part	Contact material and medium where it is used	Temperature rise (K)	Temperature rise (°C)	Comments
SPRING CONTACT	Copper and copper alloys	150	150	
	Silver or silver alloys	100	100	
	Silver or nickel plated	100	100	
	For contactors in air	100	100	
BOLTED CONTACT	Copper, aluminium and alloys	150	150	Oil deterioration
	Silver or nickel plated or of SPS	100	100	
	Silver or nickel plated in oil	100	100	Oil deterioration
	For contactors in air	100	100	
METALLIC PARTS	In contact with insulation class V / A / G	100 / 100 / 100	100 / 100 / 100	Oil deterioration
	In contact with insulation class H	100 / 100	100 / 100	Oil deterioration
SURFACES	In hot air	100 / 100	100 / 100	Paintwork deterioration
	Can be touched (not hot and accessible but not too hot)	100 / 100	100 / 100	Do not require permits

1. WHY I NEED THE VALUES

In the last 20 years I have been doing testing simulations to demonstrate to manufacturers and certifiers what is the performance expected during the real test. I use this to – sometimes – suggest modifications in the design to assure with more than 95% of probability if the equipment will be approved in the real expensive test in the lab. Before this I worked 25 years as a researcher, test engineer and manager of the main testing labs of South America.

Usually, the mentioned testing simulations are done for internal arc tests, short time current tests (short circuit forces) and, our focus in this article, temperature rise tests.

A strange thing, which happens almost every time, like now, when I am doing a study for a manufacturer, is that the resistance values of MV/HV breakers are necessary, but very difficult to find in the manufacturers catalogues. When you call the manufacturer, the salespeople have to consult the “engineering” because they, too, have no idea of the importance of this data or where to find it. This has happened to me dozens of times.

It's kind of disappointing to see how manufacturers have difficulty in informing and the IEC technical standards themselves don't seem to understand their importance.

First of all, this information is important because, after receiving the supplied the circuit breaker, the resistance will be the main reference to follow up on predictive maintenance. I got experience with this because the testing staff of the high-power labs I worked and managed were responsible for the maintenance of the testing equipment. In a high-power testing lab, the maintenance is a key factor because the equipment operates with very high frequency at extreme conditions.

I also learned about the importance of the values of the resistance for predictive maintenance when I represented an important company expert on these matters.

I need to find these values because they are the more impacting factor in a temperature rise test of switchgear / controlgear of IEC 62271-200. I learned this when I became an expert in testing simulations but never perceived when I was a testing engineer.

COGNITOR INPUT DATA screen Temperature Rise

Click INPUT DATA to change data or click RESULTS to do the calculations and to see the test results

Geometry of the TYPE OF EQUIPMENT
LVSW 1 & 2 = Low Voltage switchgear, MVSW1 – Medium Voltage Switchgear DUCT_1 = bus way , etc

Click the button NEW to create a new project equal to the one which is selected (only the name is different) and then change the data and geometry

Why Temperature Rise Limits shall not be exceeded ?

- Materials age very quickly beyond limits.
- Risk of burns on contact with casing

Gradual loss of life Accelerated ageing

Part	Contact material and medium where it is used	Temperature Rise max. (K) @ 20°C	Temperature max. (°C) ambient 40°C	Comments
SPRING CONTACT	Copper and copper alloys uncoated	35		
	- in air	50		
	- in SF6	40		
	- in oil	50		
	Tinned - in air, SF6 or in oil	50		
	Silver or nickel plated - in air	65		
	- in oil	50		
	For contactors in oil		105	Oil deterioration
BOLTED CONTACT	Copper, aluminum and alloys uncoated in air	50		
	uncoated in SF6	65		
	Tinned in air or SF6		105	Tin "creep point"
	Silver or nickel plated air or SF6	75		
	Silver or nickel plated in oil		100	Oil deterioration
	For contactors in oil		105	Oil deterioration
METALIC PARTS	In contact with insulation class Y / A / E		90 / 105 / 120	Isolation ageing
	B / F / H		30 / 155 / 150	
	Acting as spring		case a case	Permanent deformation /Break
	In soldering position		100	
SURFACES	Can be touched (met / non met.)		70 / 80	Do not injure persons
	Accessible but not touched		80 / 90	

2. THE IMPACT OF THE CIRCUIT BREAKER RESISTANCE IN THE RESULTS OF TEMPERATURE RISE TEST

If you wish to understand the impacting factors start reading IEC 62271-307 (I am coauthor). It is very well explained there. In general, the higher the resistance, closer to the temperature rise limits of the IEC62271-100 (circuit-breaker) you will be. When installing the circuit breaker inside a switchgear / controlgear (IEC 62271-200) the hottest point is usually in the connections from the circuit breaker to the busbar.

If you use a breaker with a "tighter" setting in the temperature rise tests you will have a lower temperature rise in the test because the resistance is lower than in the normal use. Do the right thing and don't do it

The reason is because, this will not correspond to the regulation recommended by the manufacturer to be used in everyday life. If, on a daily basis, you use a tighter adjustment than recommended by the manufacturer, you will quickly have to redo the adjustments. I learned this by doing maintenance on many circuit breakers in the laboratories where I worked.

For this reason, it should be mandatory in the IEC 62271-1 temperature rise test to measure both the total resistance of the circuit and that of the circuit breaker alone.

For the same total resistance value, you can pass or fail the test, depending on the setting. In other words, the temperature-rise test of IEC 62271-1 is not reproducible without the two measurements.

That's why I need the values to use in simulations of temperature rise tests on products of IEC 62271-200. I need to complete this table with many values of many manufacturers and types , for my own use.

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APPROVED

NOT APPROVED

But both have the same total resistance per phase and different resistances as seen from terminals. So, test is not reproducible

Total resistance per phase (circuit breaker + busbar + connections) = 72 μΩ
Circuit breaker resistance per phase = 18 μΩ

Today is not a "reproducible" test

Circuit breaker resistance per phase = 30 μΩ

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3. CAN ANYONE HELP ME TO FIND THE DATA ? THE TABLE I NEED TO COMPLETE

Since yesterday when I posted in LinkedIn a request for values of the resistance, 800+ people clicked the post. Many of them are the main worldwide manufacturers of circuit breakers (ABB, Schneider, Eaton, Siemens, GE Hitachi, Tavrada, Alstom and others). Many clicks but I did not receive any data.

So, could any of you spend some minutes of your time, helping me to get the values ?

Test reports of the temperature rise test of the circuit breaker are also welcome but not essential . If you send me the report it will not be disclosed in any way.

NON CONFIRMED VALUES INCLUDED ONLY TO EXEMPLIFY, AS ORDERS OF MAGNITUDE

Manufacturer of circuit breaker / Rated voltage / Rated current	Resistance as seen from the terminals of the circuit breaker (as seen from external bars) μΩ	
	Installation Fixed	Extractable (Plug In)
Schneider Evolis 17,5 KV * 185/145 mm	35 μΩ	68 μΩ
Schneider Evolis 17,5 KV * 240 mm	18 μΩ	30 μΩ
AREVA VAA (vacuum) 36 kV	42 μΩ	90 μΩ
AREVA HVX (vacuum) 17-30-20E	19 μΩ	25 μΩ
TAVRIDA 17,5 kV	18 μΩ	
ABB VD4 40kA and 50 kA	??? 70 μΩ ?????	??? 70 μΩ ?????
EATON		
SIEMENS		
Etc		

I thank you all in advance.

To send data please use preferably my e-mail instead of LinkedIn

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//////////////////////////////////// End of the article. //////////////////////////////////////

The author of this article is Eng. Sergio Feitoza Costa. Sergio is an electrical engineer, M.Sc. in power systems and director of COGNITOR. It has 40+ years of experience in the design, operation and management of high power, high voltage, and other testing laboratories. After leaving CEPEL's testing labs, Sergio gained considerable experience using test simulations to support manufacturers and certification companies in substation equipment projects. He is co-author of several IEC and ABNT standards. Sergio is the author of SwitchgearDesign simulation software and DECIDIX.

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