Application Note

Contact Resistance measurement with up to 600 A

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CIBANO 500

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Circuit Breaker

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Abstract

Measuring (or testing) the contact resistance is one of the most common measurements on all types of circuit breakers. With our CIBANO 500 main device it is possible to measure with up to 150 [A], while with the CB MC2 it is possible to measure even up to 200 [A]. Some customers require the Contact Resistance test to be done with even higher currents. This application note will describe the possibility of using three (3) CB MC2s in parallel to inject up to 600 [A][1] during Contact Resistance measurement.

[1] NOTE: Even more than three (3) CB MC2s could be used in parallel to inject even higher currents.

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1 Safety instructions

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Instructions are always characterized by a ▶ symbol, even if they are included in a safety instruction.

NOTICE

Equipment damage or loss of data possible

- Carefully read and understand the content of this Application Note as well as the manuals of the systems involved before taking them into operation.
- Please contact OMICRON support if you have any questions or doubts regarding the safety or operating instructions.
- Follow each instruction listed in the manuals, especially the safety instructions, since this is the only way to avoid the danger that can occur when working on high voltage or high current systems.
- Only use the equipment involved according to its intended purpose to guarantee safe operation.
- Existing national safety standards for accident prevention and environmental protection may supplement the equipment's manual.
- Before starting a test always check that the test signals are suitable for your system under test.

Only experienced and competent professionals that are trained for working in high voltage or high current environments may implement this Application Note. Additionally, the following qualifications are required:

- Authorized to work in environments of energy generation, transmission or distribution, and familiar with the approved operating practices in such environments.
- Familiar with the five safety rules.
- Good knowledge/proficient in working with the CIBANO 500.

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2 Contact Resistance measurement on circuit breakers

2.1 Introduction

Measuring (or testing) the contact resistance is one of the most common measurements on all types of circuit breakers. This measurement is performed to check the status of the main contact but can also be used to check the status of other connections in a substation e.g. bus bar junctions or disconnector contacts.

The measurement is done while the breaker is offline and in closed position. Typical resistance values for a main contact are between 10 [µΩ] and 100 [µΩ]. Due to the low resistance value it is important that the measurement is done with the so-called four-point resistance measurement method.

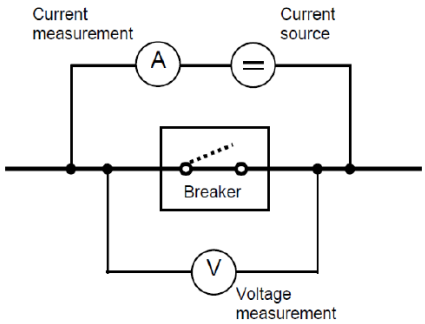

Figure 3-8: Four point resistance measurement [CIGRE_167_2000]

This is done to exclude the contact resistance of the leads and in this way get a more accurate resistance value.

Recommended measurement currents i.e. injected currents according to the standards are, at least:

- 50 [A] (IEC 60694)
- 100 [A] (ANSI)

With CIBANO 500 main device it is possible to measure with up to 150 [A], while with the CB MC2 it is possible to measure even up to 200 [A]. But there are some customers that require that the Contact Resistance test is done with even higher currents.

This application note will describe the possibility to use three (3) CB MC2s in parallel to inject up to 600 [A][2] during a Contact Resistance measurement.

[2] NOTE: Even more than three (3) CB MC2s could be used in parallel to inject even higher currents.

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2.2 How to inject higher current

Normally, the contact resistance measurement with CB MC2 is done by connecting one CB MC2 to each pole. If the pole has one interrupter it is possible to connect the output channels in parallel to inject 200[A] per phase.

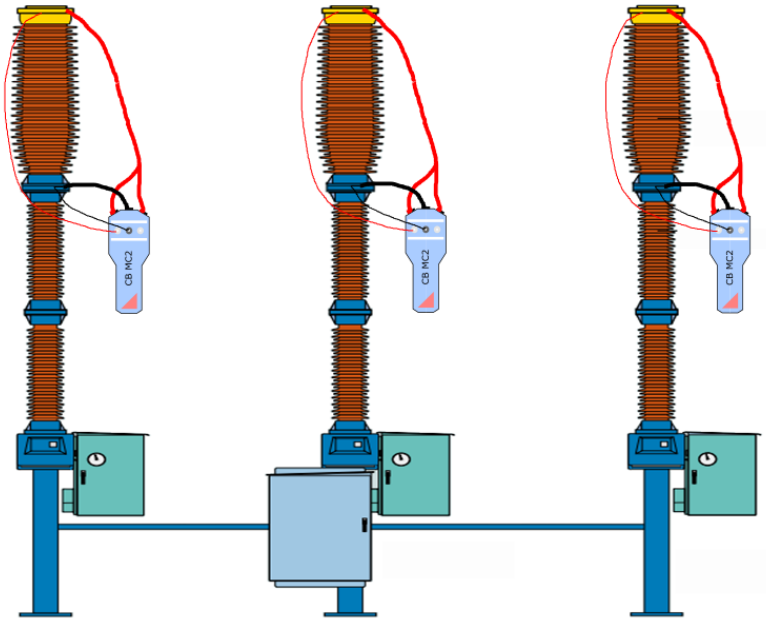

Figure 1 - Setup for Contact Resistance measurement with 200[A]

Here the normal Contact Resistance test would give the following test results (as example):

Channel	Phase	I DC	V DC	R meas	Assessment
L1 1	A	199,85 A	44,409 mV	222,22 µΩ	Not rated
L2 1	B	199,07 A	12,506 mV	62,82 µΩ	Not rated
L3 1	C	200,78 A	7,584 mV	37,77 µΩ	Not rated

Figure 2 - Contact Resistance results from ABB HPA at OMICRON in Klaus

As each CB MC2 is synchronized with CIBANO 500 they will also start to inject the current at the same time. Therefore, it would be possible to connect more CB MC2s to one phase. E.g. take the CB MC2s from the other phases and connect them to phase A.

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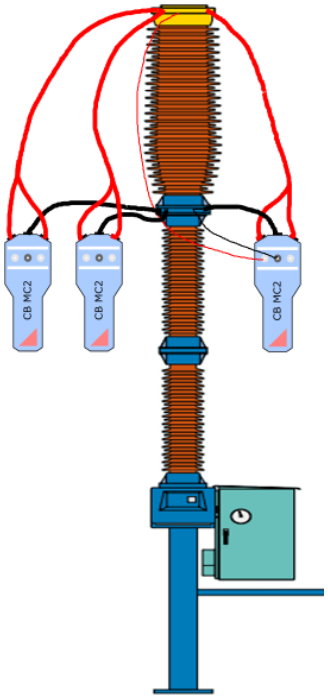

Figure 3 - Three CB MC2s connected parallel

The measurement would in this case be made phase by phase (if nine (9) CB MC2s are not available). Note also that the voltage drop is only measured with one CB MC2. The results would be as follows.

Channel	Phase	I DC	V DC	R meas	Assessment
L1 1	A	199,88 A	139,909 mV	699,96 µΩ	Not rated
L2 1	B	199,06 A	-0,001 mV	0,01 µΩ	Not rated
L3 1	C	200,78 A	0,004 mV	0,02 µΩ	Not rated

Figure 4 - Contact Resistance results from phase A on ABB HPA at OMICRON in Klaus

Channel	Phase	I DC	V DC	R meas	Assessment
L1 1	A	199,81 A	-0,001 mV	0,00 µΩ	Not rated
L2 1	B	199,05 A	37,801 mV	189,90 µΩ	Not rated
L3 1	C	200,78 A	0,004 mV	0,02 µΩ	Not rated

Figure 5 - Contact Resistance results from phase B on ABB HPA at OMICRON in Klaus

Channel	Phase	I DC	V DC	R meas	Assessment
L1 1	A	199,82 A	-0,004 mV	0,02 µΩ	Not rated
L2 1	B	199,05 A	-0,005 mV	0,02 µΩ	Not rated
L3 1	C	200,77 A	22,555 mV	112,34 µΩ	Not rated

Figure 6 - Contact Resistance results from phase C on ABB HPA at OMICRON in Klaus

As it can be observed, the Contact Resistance results differ from the ones measured with 200[A]. The reason for this is that now we are injecting ~600[A] per measurement but PTM is using only the measured

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current from the corresponding CB MC2, i.e. ~200[A]. This means that the Contact Resistance value is three (3) times higher.

2.3 How to calculate the correct contact resistance value

There are at least two ways to re-calculate the Contact Resistance value.

The first one is to create an Excel table and take the measured values from Figure 4, Figure 5 & Figure 6 and recalculate the resistance value accordingly:

For phase A: $R\ meas_{NewA} = V\ DC_A / (I\ DC_A + I\ DC_B + I\ DC_C)$

For phase B: $R\ meas_{NewB} = V\ DC_B / (I\ DC_A + I\ DC_B + I\ DC_C)$

For phase C: $R\ meas_{NewC} = V\ DC_C / (I\ DC_A + I\ DC_B + I\ DC_C)$

	$I\ DC_A$	$I\ DC_B$	$I\ DC_C$	$I\ DC_{sum}$	V DC	$R\ meas_{New}$
Phase A	199,88 [A]	199,06 [A]	200,78 [A]	**599,72 [A]**	**139,91 [mV]**	**233,29 [µΩ]**
Phase B	199,81 [A]	199,05 [A]	200,78 [A]	**599,64 [A]**	**37,80 [mV]**	**63,04 [µΩ]**
Phase C	199,82 [A]	199,05 [A]	200,77 [A]	**599,64 [A]**	**22,56 [mV]**	**37,61 [µΩ]**

Figure 7 - Contact Resistance re-calculated with Excel

The second way is to use the PTM Report designer to create a custom report. I.e. create a Custom Report template that is using the formulas above to re-calculate the Contact Resistance value.

Contact resistance with 600[A]

	I DC	V DC	R meas
Phase A	599,72 A	139,91 mV	233,29 µΩ
Phase B	599,64 A	37,80 mV	63,04 µΩ
Phase C	599,64 A	22,55 mV	37,61 µΩ

Figure 8 - Custom Report template used to re-calculate the Contact Resistance values

Note: The PTM Report Designer is a licensed Primary Test Manager (PTM) feature.
Order Number: P0000054.

2.4 Summary

To measure the Contact Resistance with currents above 200[A], it is possible to use more than one CB MC2 in parallel to increase the injected current.

Note, however, that the PTM software is not prepared for this and therefore does not calculate the correct contact resistance value. To calculate the correct contact resistance value, either use an Excel sheet or the PTM Report Designer.

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