ZENSOL AUTOMATION INC.

COMPUTERIZED TEST EQUIPMENT

ZENSOL

CIRCUIT BREAKER PERFORMANCE ANALYZER

CBA-32P

MANUAL 9W E
Kit-ZLR & KIT-ZMS User's Guide

Version 2 **February 8, 2011**

Man9wf.doc Rév1

1 General overview

1.1 KIT-ZLR

You will find in this kit all the essential accessories required to perform your displacement measurements.

Its base adapts to any type of circuit breaker with linear movement where space and access are limited and the clamps will allow you to precisely install your measurement apparatus.

To help you with installation, schematics are provided with the kit.

The kit is supplied with a hard carrying case ensuring maximum protection for the equipment.

The KIT-ZLR consists of:

- A mechanical base.
- A rod-to-transducer coupling.
- A cable for connecting to the CBA-32P.
- Two clamps.
- A hard carrying case for the entire kit.
- A user's guide.

Note : The KIT-ZLR in the above picture is shown with a transducer. Transducers are sold separately as there are many choices of transducers available.

The Kit-ZLR has the advantage of being adaptable to any type of circuit breaker with a linear movement and where a linear transducer kit (KIT-ZLB) can not be used.

This kit also allows a very good precision in measurements, and is very reliable and sturdy. Moreover, its small size makes it possible to use it in situations where the breaker is very difficult to access

It can be used with rotary transducers and optical encoders supplied by Zensol: ZRT-01, ZRT-03, ZRT-05, or ZRT-10 and ZOT-2000..

1.2 KIT-ZMS

The KIT-ZMS is a good alternative where space and access to the breaker mechanism are limited. It is only used on breakers with rotary movements such as HPL from ABB, HGF and GL from Areva, etc. It can not be used on breakers with linear movements.

Thanks to its magnetic base and articulated arms it can be positioned in almost any directions to better fit your breaker mechanism.

It can be used with rotary transducers and optical encoders supplied by Zensol: ZRT-01, ZRT-03, ZRT-05, or ZRT-10 and ZOT-2000.

The KIT-ZMS consists of :

- clamps 2’’
- L shape support for the transducer
- screw 6-32 * ½ pan Phillip head stainless steel
- screw M4*12 pan Phillips head m/s stainless steel
- magnetic base
- 2 articulated arms
- cable clamps 1/4"
- round rod 3/8 *10 inch
- Coupling piece for transducers (stainless steel)
- screw drive Ball Allen 2MM
- 2 Clamps specifically designed for attaching the magnetic base and articulated arms
- cable 6“
- user’s guide

1.3 Rotary tranduscer and Optical encoders

The ZRT (optional)

The ZRT is an "industrial grade" potentiometer specially designed to work in severe conditions, as it is often the case in the industry.
It is contained within a rugged and waterproof casing. Thanks to its reliability, good linearity, high resolution, high operating speed and its corrosion resistance, these components allow applications that up to now were impossible with conventional potentiometers.

The ZOT-2000 (optional)

This incremental transducer has been specially designed to fulfill the strict requirements of the electrical industry.

Of sturdy construction, the ZOT-2000 has such a degree of protection (IEC60529 IP64) that it can operate efficiently in many kinds of noisy, humid or greasy environments.

Optical encoders can only be used when digital inputs for optical encoders (DIG-INP optional) are already installed on your instrument. If not already installed on your instrument, the DIG-INP module can be easily added for a minimal cost. Price available on request.

2 How to use the kit

2.1 How do I connect the ZRT to the CBA?

Connect the displacement transducer's cable to one of the 0-10 volt analog inputs on the CBA-32P (it is possible to use extension cables).

2.2 How do I connect the ZOT to the CBA

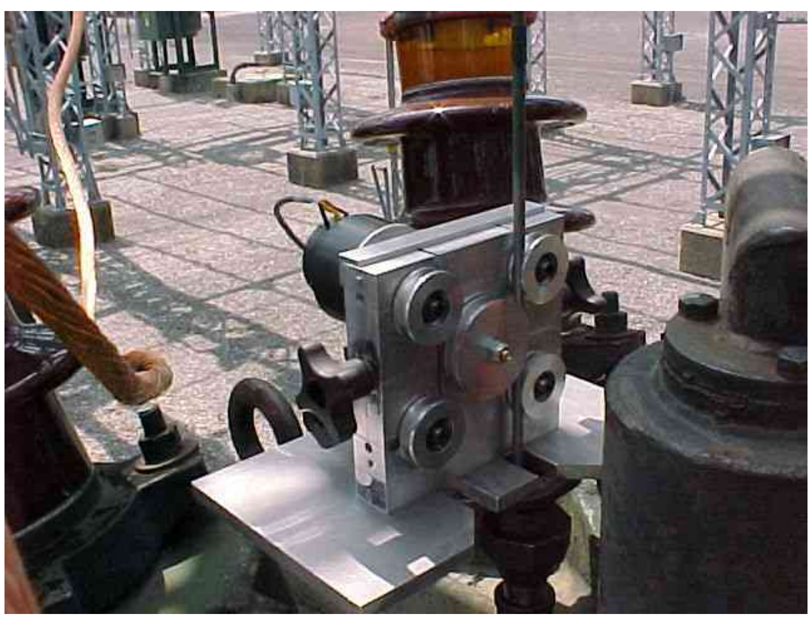
Connect the optical encoder cable (blue cable) to one of the digital inputs for optical encoders (DIG-INP optional) available on your CBA-32P.

2.3 How do I mount the KIT-ZLR & the KIT-ZMS to the breaker?

Here are a few photos that show various methods to mount your rotary transducer and kits to a circuit breaker. Some of these setups have not been made with the latest version of the Kits but with a very similar model, so they can inspire you to mount your rotary mechanical base on the breaker.

Further examples at the end of the manual.

Example 1



Example 2

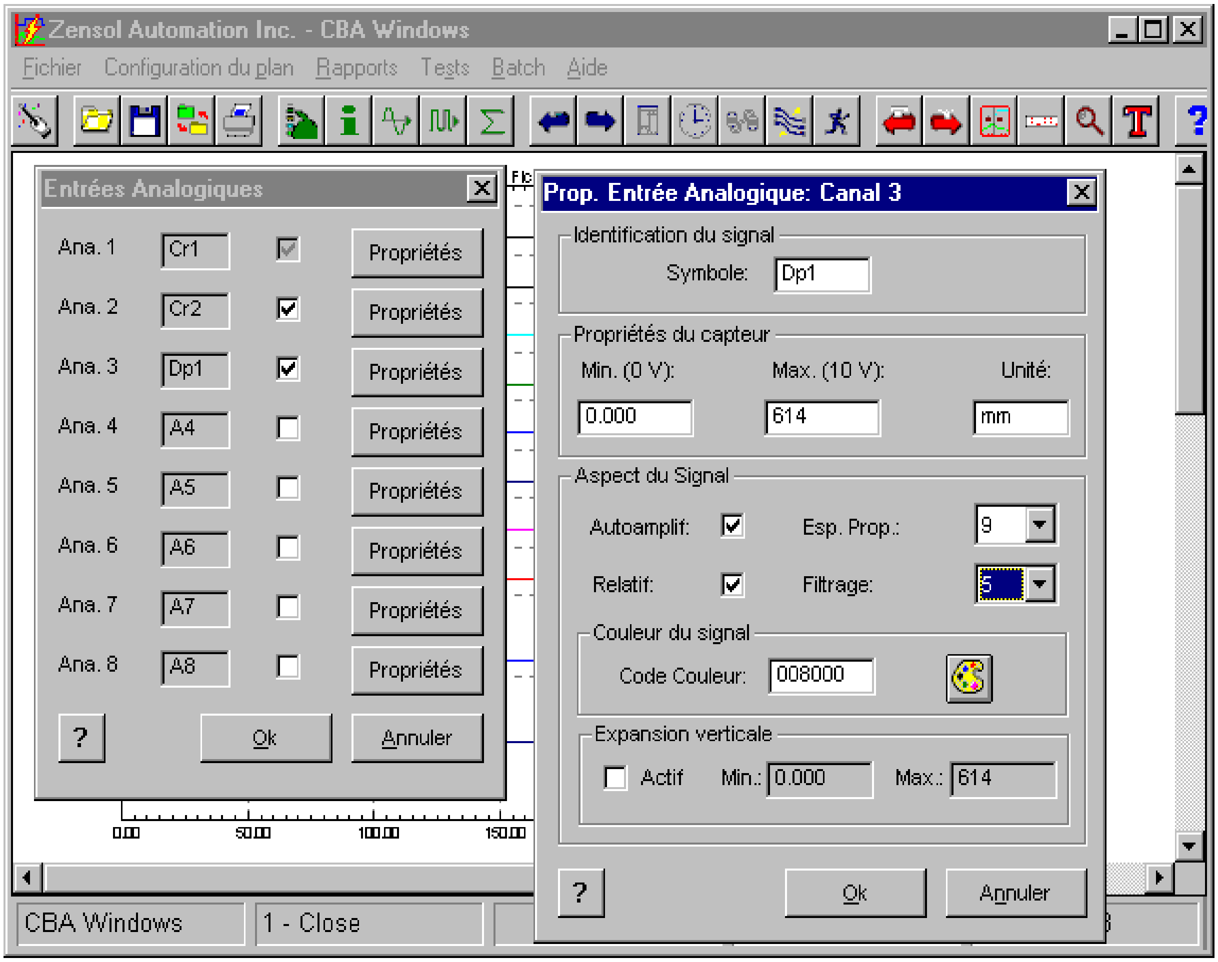
Example 3

3 Analyzing and using the results

3.1 Configuring CBA Win software for a rotary transducer

Analog input configuration:

These screens allow the enabling or disabling of the analog inputs, as well as setting the specifications of each analog input.



To activate an analog input, click the corresponding checkbox. To change the properties of a channel, click on the associated Properties button.

The function of each analog input is as follows:

- Channel 1: Current sensor (close).
- Channel 2: Current sensor (open).
- Channels 3-8: General 0-10 VDC analog inputs, or displacement transducers

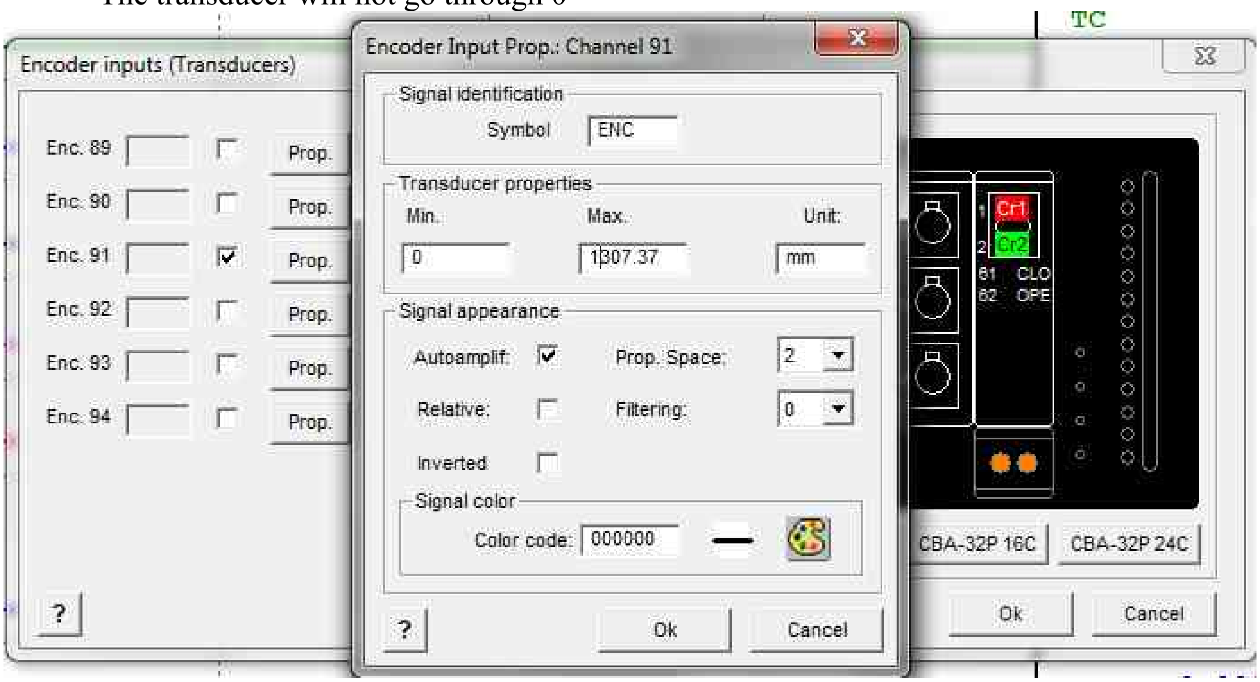
Note 1: To see the analog channels on a graphic page, add their channel numbers to that page in the Graphics Report Designer.

Note 2: The checkbox for analog input #1 is gray and not accessible. This channel must absolutely be active for all tests.

3.2 Configuring CBA Win software for a optical encoder

Optical encoders are considered easier to use for the following reasons:

- The calibration value is always the same (min. 0 mm and max. 1307.37 mm)
- The transducer will not go through 0



3.3 Acquisition and display of results.

The acquisition and display of results is effected by the ZENSOL CBA-32P and its analog channels. (see Fig. 2.4a)
Each analog channel has three wires numbered (1), (2), and (3) on its connector.
Between (1) and (3) is a 10 volt signal generated during the test. The signal returned from the displacement transducer is collected between wires (2) and (3) and transmitted to the CBA Win

analysis software, which traces the displacement curve over time on the computer screen. In (Fig. 2.4b) is an example of a graphic page displayed by CBA Win as seen on a computer screen.

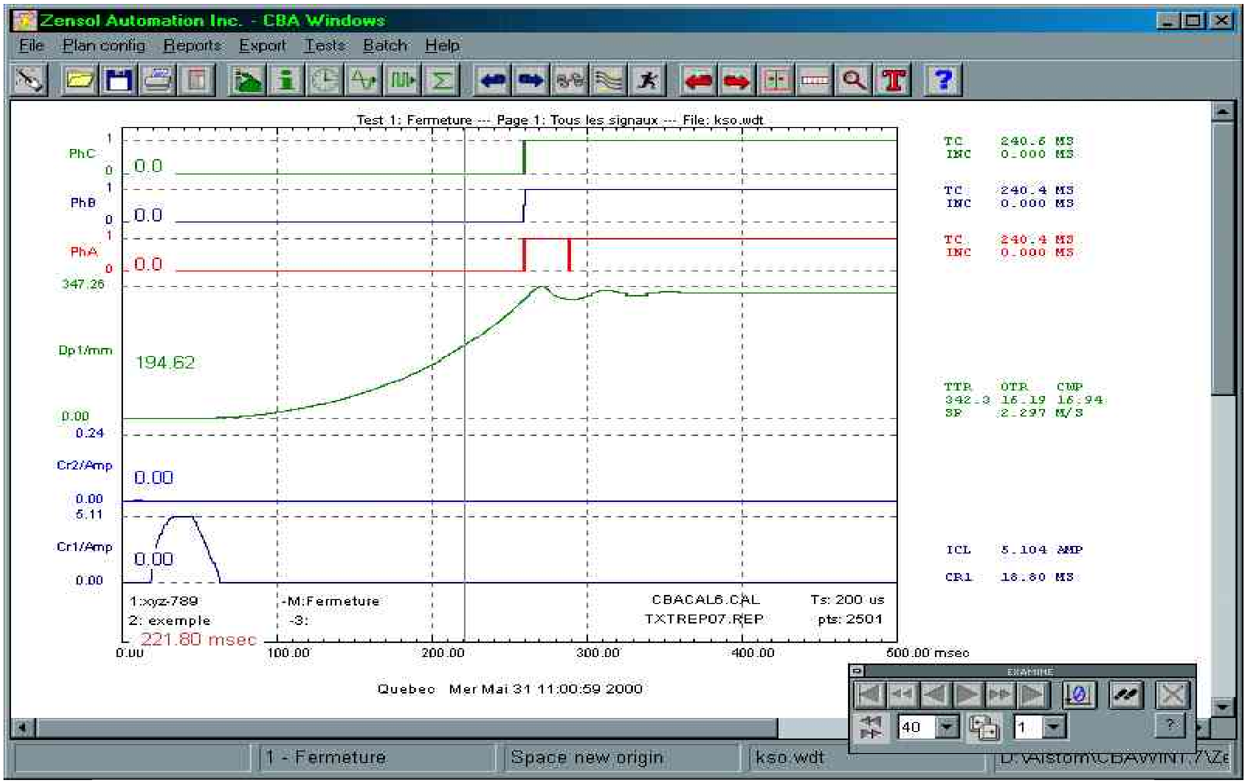


Fig 2.4b CBA Win graphic page as seen on a computer screen

3.3.1 General rules

When installing a transducer and its mechanical base, there are a few general rules to respect :

3.3.1.1 *Inverted curves*

In general, displacement curves are shown with the "CLOSED" position higher than the "OPEN" position. To maintain this rule, wires 2 and 3 must not be reversed on the transducer, otherwise the curve will be displayed upside-down (see figs. 2.5.6a and b)

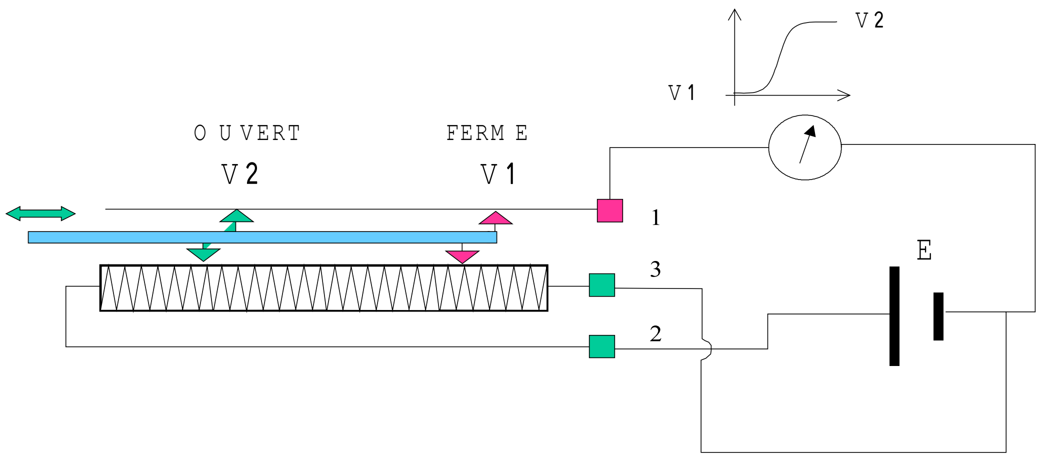


Fig 2.5.6a Connection causing inverted curves to be displayed

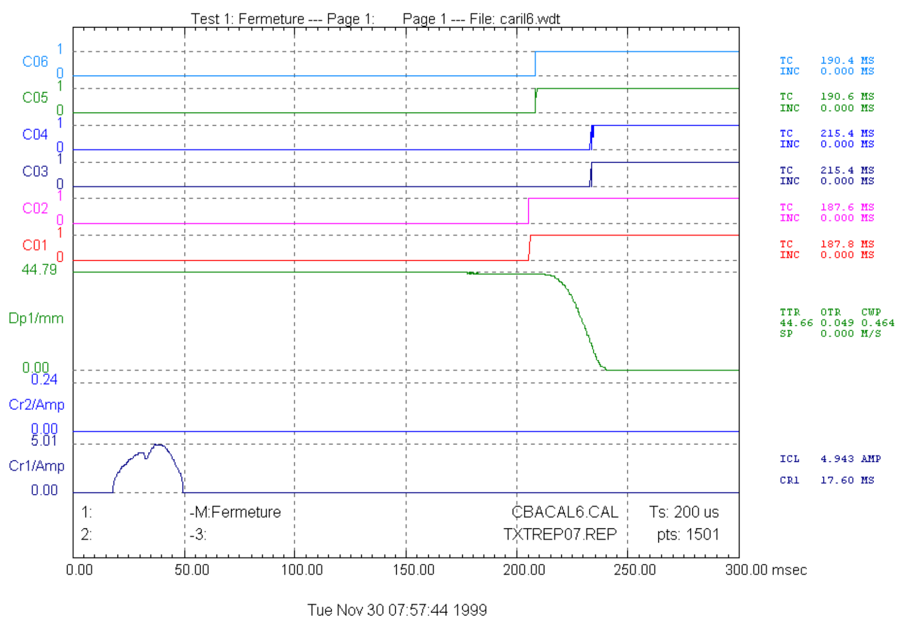


Fig 2.5.6b Example of inverted displacement curve (close)

3.3.1.2 <u>Transducer capacity</u>

When installing the transducer, one must ensure that the measured motion does not exceed the capacity of the transducer or it will be damaged, and the displayed curve will not show the true motion of the breaker. Figure 2.5.6.2 illustrates a case where the transducer has reached the end of its travel range, or "bottoms out" before the breaker has finished its motion in an open operation. The abrupt angle at the bottom of the curve is evidence for this condition.

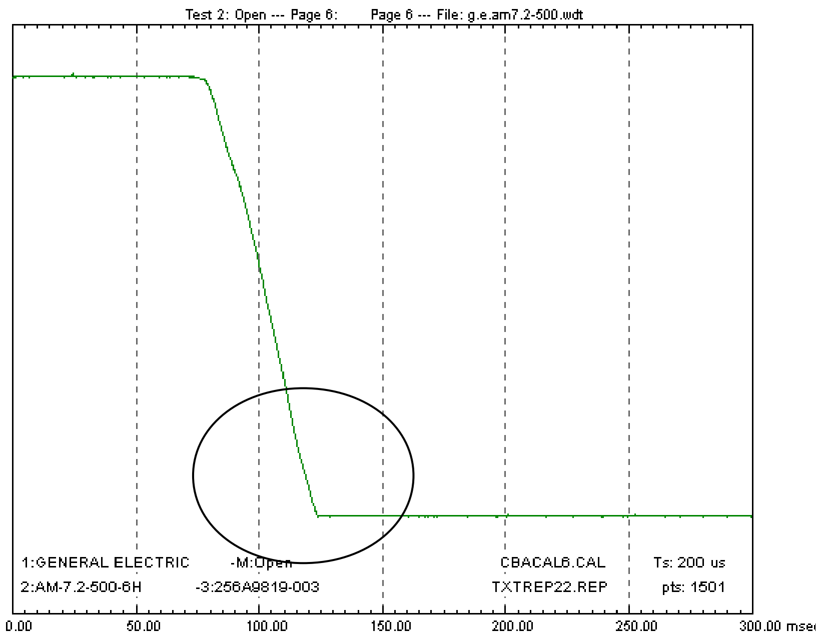
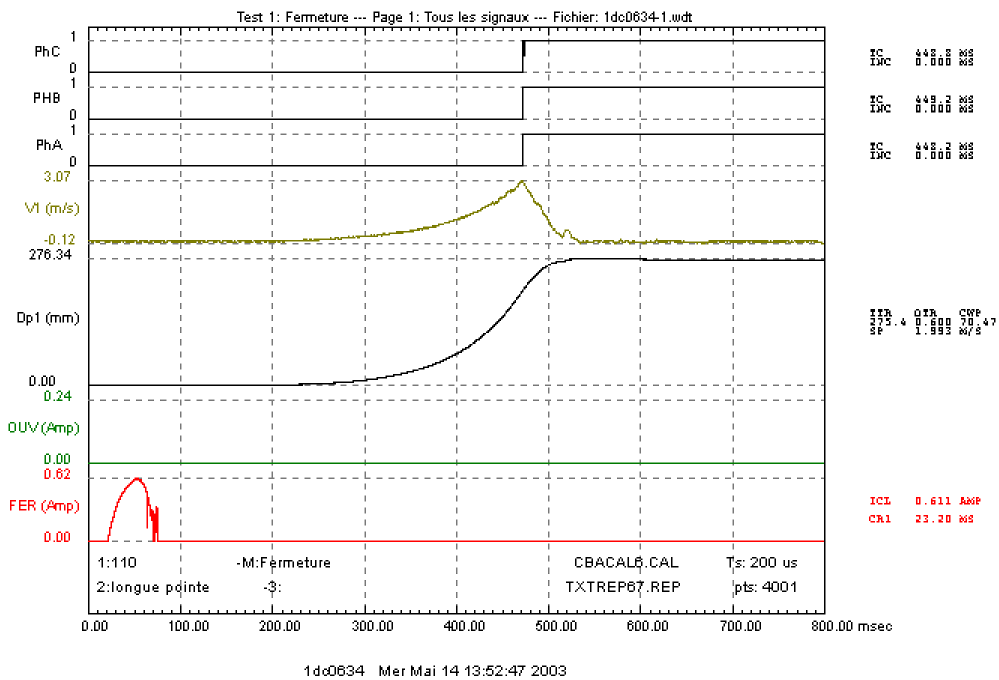


Fig. 2.5.6.2 Example of displacement curve beyond the transducer's capacity

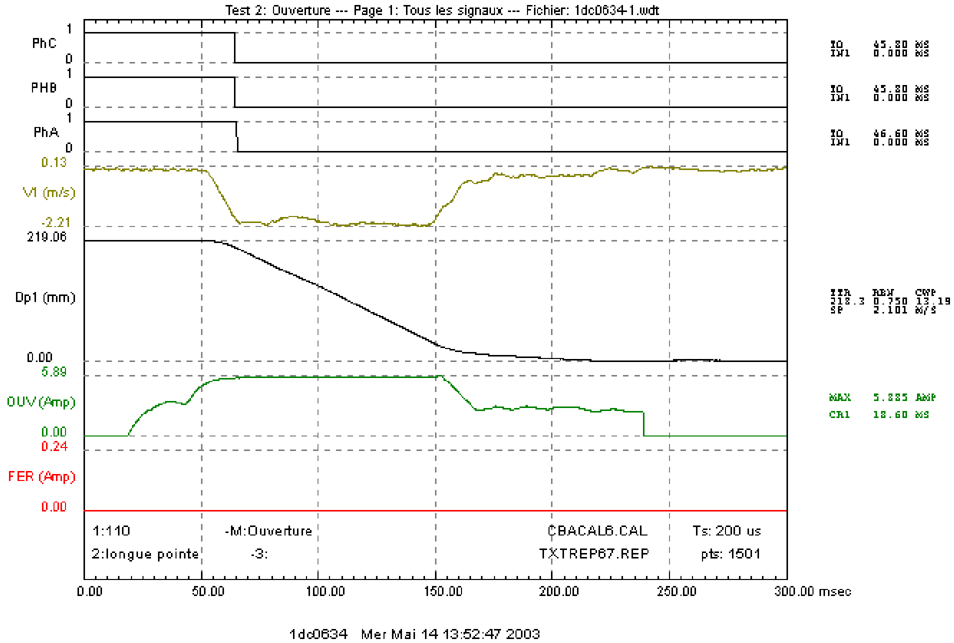
3.3.2 Example curves

In order to help you validate your tests, here are a series of typical curves. Recorded curves resembling the examples indicate a successful installation.

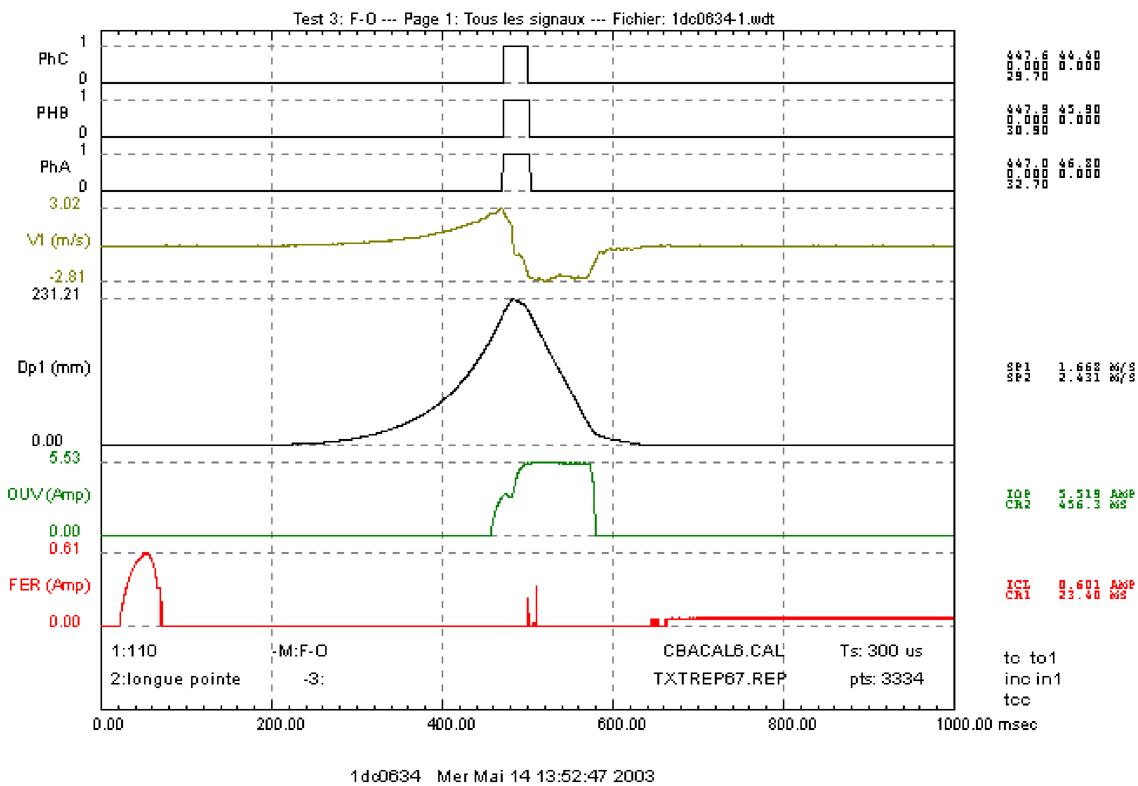
Close test:



Open test:


Test 2: Ouverture --- Page 1: Tous les signaux --- Fichier: 1dc0634-1.wdt
PhC
PHB
PhA
Vl (m/s)
0.13
-2.21
219.06
Dp1 (mm)
0.00
5.89
OUV (Amp)
0.00
0.24
FER (Amp)
0.00
1:110
2:longue pointe
-M:Ouverture
-3:
CBACAL6.CAL
TXTREP67.REP
Ts: 200 us
pts: 1501
0.00
50.00
100.00
150.00
200.00
250.00
300.00 msec
45.80 MS
0.000 MS
45.80 MS
0.000 MS
46.60 MS
0.000 MS
218.3 0.750 13.19
2.101 M/S
MAX 5.885 AMP
CR1 18.60 MS
1dc0634 Mer Mai 14 13:52:47 2003

Close-Open test:



It is normal that the curves are the same as for linear transducers because the displacements are virtually identical.

4 Rotary displacement transducer theory

The displacement transducer, in its simplest form, consists of a fixed component and a mobile one. The moving part is attached to the moving contact of the breaker under test and moves with it, while the fixed or stationary component becomes the reference point.

Many types of transducers are available on the market. They differ by the method used to identify the relative value versus the reference value. For example:

- Magnetic transducers
- Optical transducers
- Resistive transducers
- Etc.

The resistive transducer is the most widely used. This type of transducer consists of a resistor and mobile cursor moving along the resistor.
One type of resistive transducer is the rotary displacement transducer, schematically represented here:

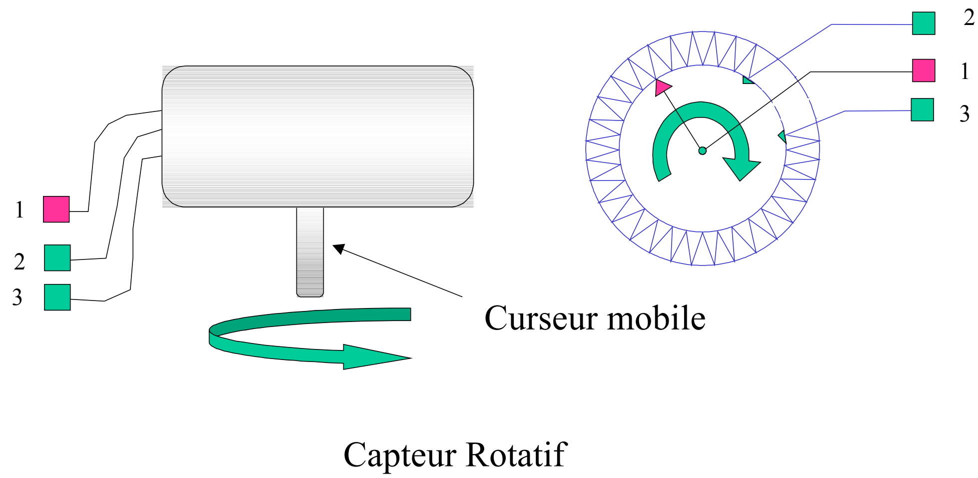


Fig 2.11b Rotary transducer

5 General circuit breaker theory

5.1 Description

A high-voltage circuit breaker consists of two main parts:

1. Electric power section (active part)
2. Control section

The first has the task of making or breaking the current in the high-voltage circuit where the breaker is installed. The second has the task of generating the required energy to effect these operations.

The connection between the control and active sections is usually made by means of an insulated rod, shown in red in Fig. 2.21.

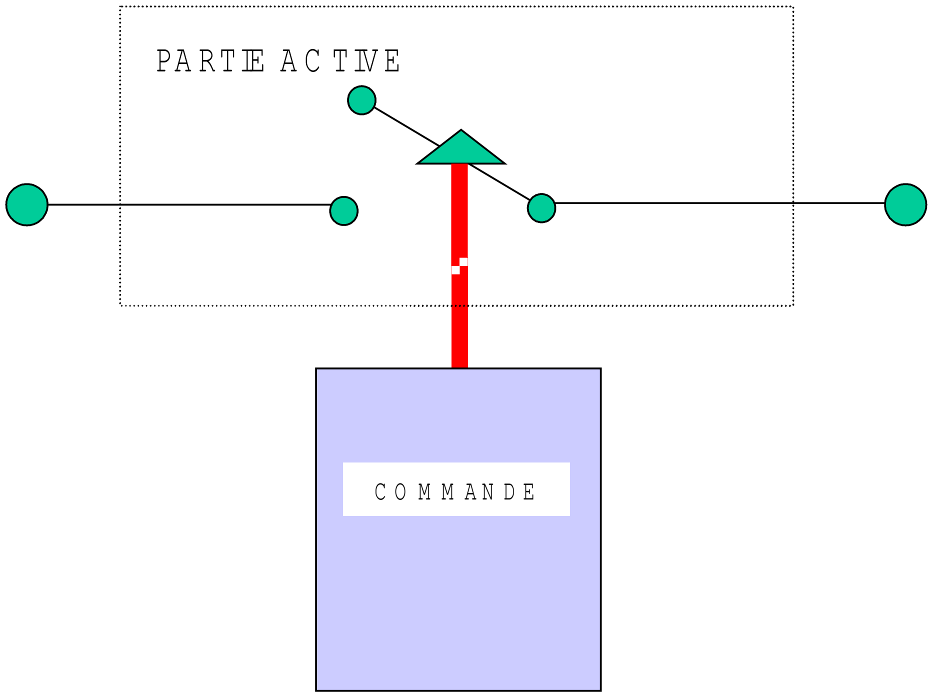


Fig 2.21 Circuit breaker principle

5.1.1 Power section

This part is usually composed of three equal phases. Each phase has a fixed contact assembly and a moving contact assembly. When the two contact assemblies touch, it is said that the breaker is "CLOSED" and current passes through the power section.
To interrupt the current flowing through the power circuit, the moving contact assembly is physically moved away from the fixed contact assembly and stopped at a sufficient distance to ensure electrical isolation.
.

5.1.2 Control section

This section creates the necessary energy to perform the mechanical work required by both open and close operations.

Three types of controls are widely used in high-voltage circuit breakers:

- Pneumatic control
- Hydraulic control
- Mechanical spring control

5.1.2.1 Pneumatic Control

This is usually found in compressed air breakers. This type of circuit breaker uses compressed air as a dielectric medium and has piston-type moving contacts.

A series of valves, activated at precise moments, injects compressed air on one side of the piston, which displaces it through the action of the pressure difference between opposite sides of the piston. The motion of the moving contact is not usually accessible in this type of circuit breaker, which makes it nearly impossible to use conventional transducers.

5.1.2.2 Hydraulic Control

This type of control has an energy storage device, or accumulator, as nitrogen under pressure or as springs compressed by hydraulic oil and a pump. The breaker's moving contact is connected to the piston of a powerful hydraulic ram though an insulating connecting rod.

A set of hydraulic valves allows the pressure previously accumulated to be placed on one side or the other of the ram's piston, which moves the moving contact in the desired direction.

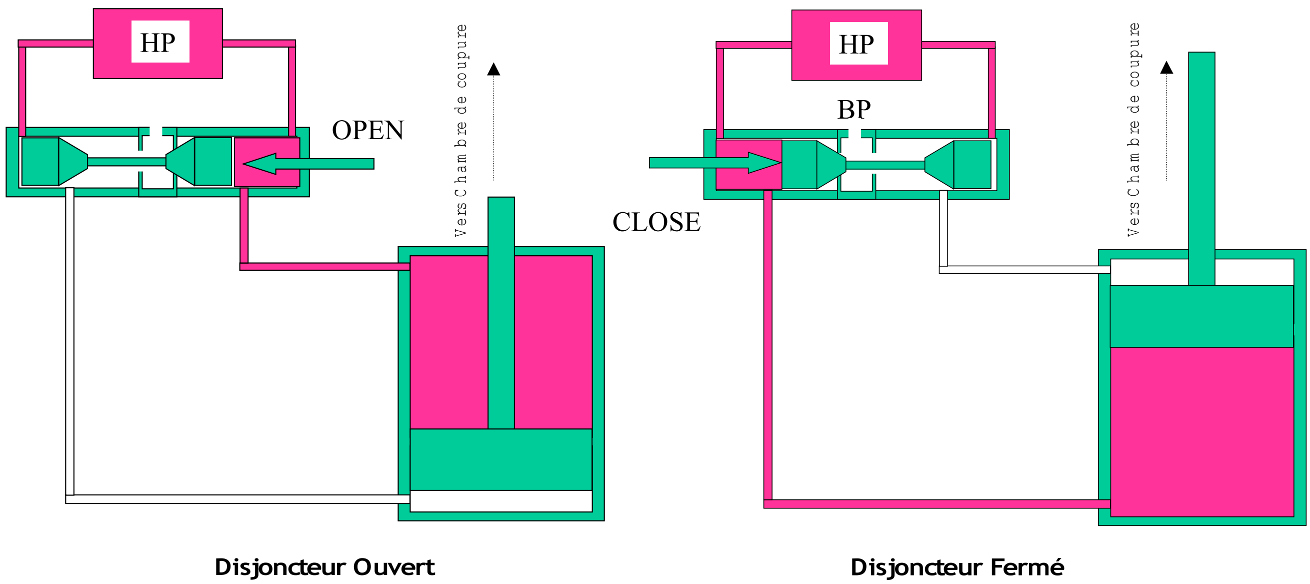


Fig 2.2.32 Hydraulic control in open (left) and closed (right) positions

5.1.2.3 Mechanical spring control

This type of control is much sought after because of its proven reliability and low periodic maintenance frequency.

It usually consists of a compressed spring that accumulates energy required for the close operation, and another spring containing energy for the open operation.
The Close spring (E) is manually compressed with a lever, or electrically with a motor. A set of locking levers holds the energy accumulated in the Close spring.

This energy is released by the release of the Close spring, and provokes the displacement of the mobile contact toward the fixed contact, through the connecting rods, while loading the Open spring, which is held by its own locking levers to store energy for the next Open operation.

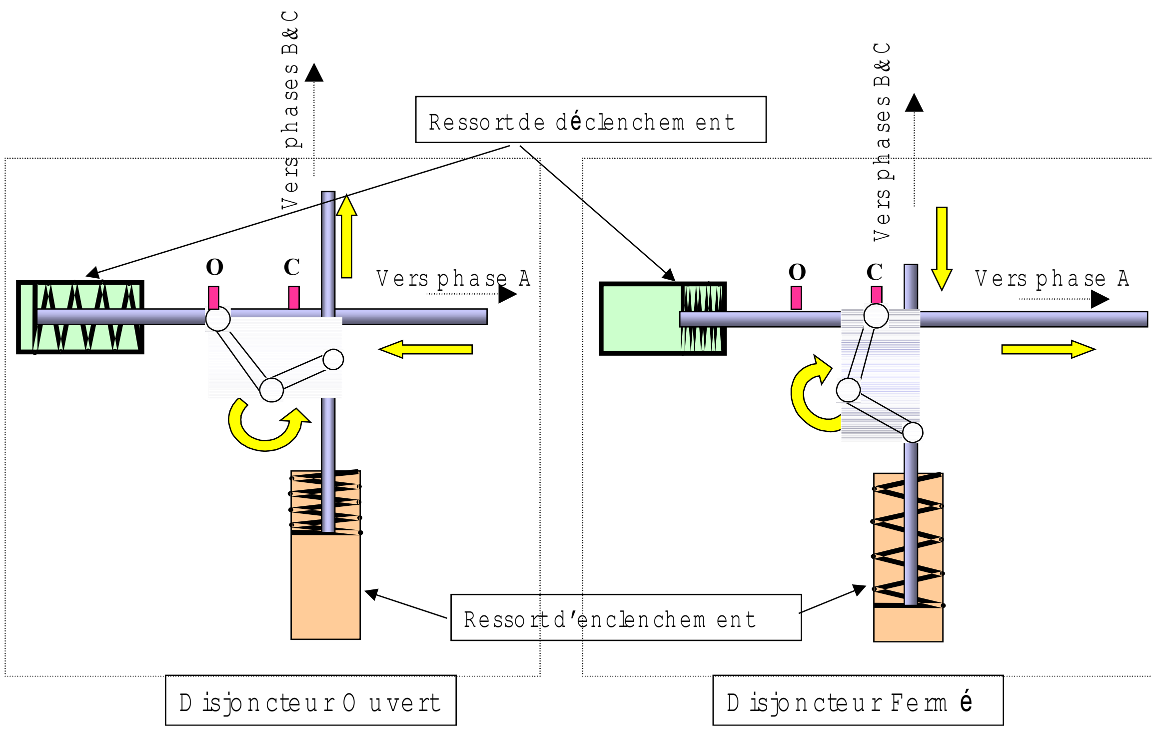


Fig. 2.2.33 Mechanical spring control in open (left) and closed (right) positions

5.2 Transducer operating principle

The transducer is solidly attached to the breaker support, and the moving cursor is solidly attached to the moving contact's control rod.
A fixed voltage source (E) is connected to points (1) and (3). When the breaker is in the CLOSED position, the voltage measured at points (2) and (3) of the transducer is (V1); as the moving contact moves toward the OPEN position, the measured voltage (Vt) between (2) and (3) decreases with time down to (V2), which is less than (V1), at the end of the contact's travel.

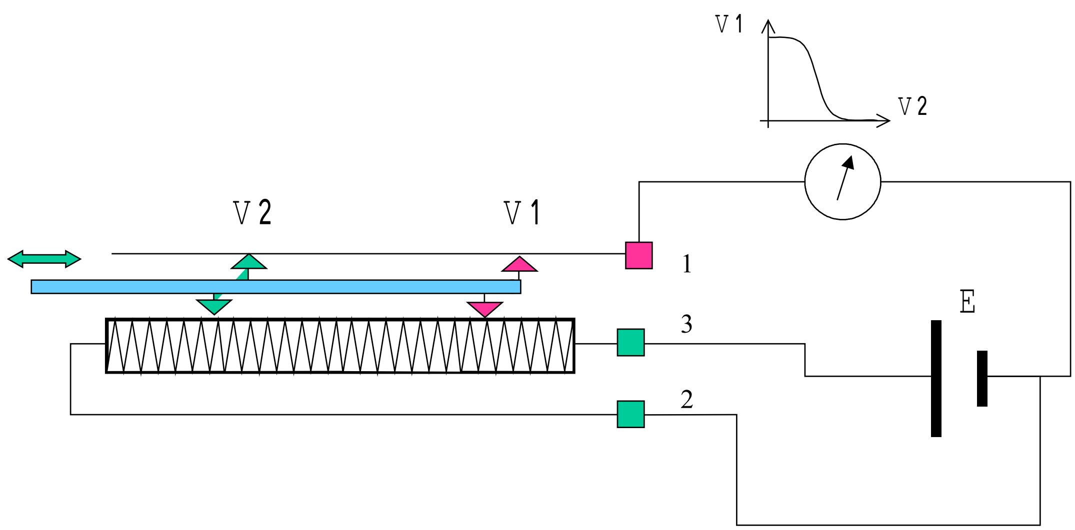


Fig. 2.12 How a displacement transducer works

5.3 The displacement curve

5.3.1 Description

During a circuit breaker timing test, the operating time from the start of the command in the command coil, up to the change of the state of the main contact, is recorded by the timing instrument, for example the ZENSOL CBA-32P.
These readings give valuable information on the state of the breaker and more often than not precisely shows the presence or absence of anomalies and malfunctions. But even this valuable information doesn't reveal all the breaker's secrets. Important information still remains hidden from view.
Where possible, a point-by-point recording of the movement of the internal parts of the breaker, over the entire travel range, allows tracing what is called a DISPLACEMENT CURVE.
While the timing curve of the main contact only shows when movement begins and when the contact changes state, the information revealed by the displacement curve is interesting because it shows is the entire motion from beginning to end.

5.3.2 Operation on open

An example of a displacement curve for an Open operation is shown in **Fig. 1.2** superimposed on a main contact timing curve (in red).

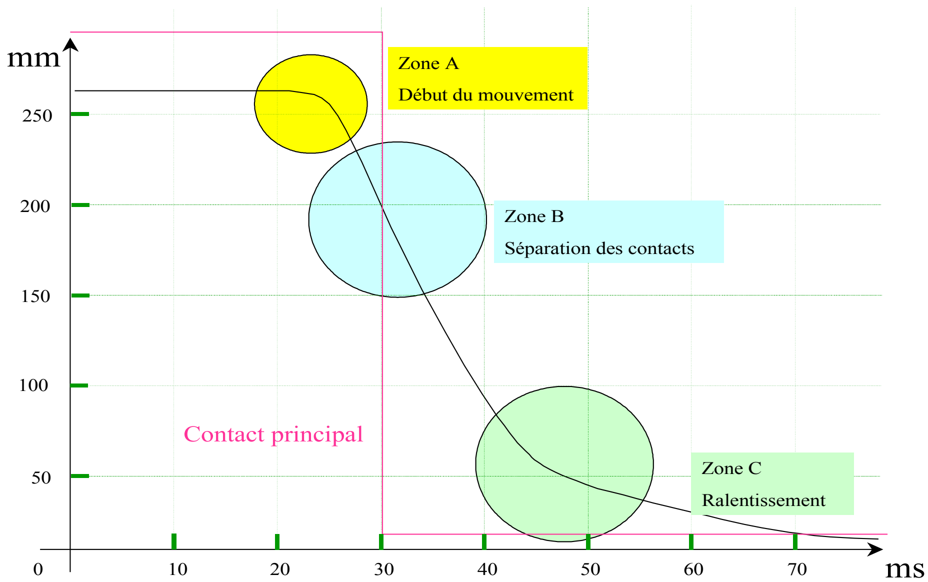


Fig 1.2 Displacement curve for Open operation

Even if the general appearance of the curve is to be checked first, three zones (circled in Fig.1.2) merit particular attention:

1. Zone A: start of motion
2. Zone B: time of contact separation.
3. Zone C: from the start of deceleration until the final rest point.

5.3.2.1 Zone A : Start of motion

This is where the motion begins. It is extremely important to know if the motion has started at the correct point. For example, a delay relative to the reference specification means there is an electrical problem, if the coil is not energized in time, or a mechanical one somewhere between the control mechanism where the motion is initiated and the moving contact of the breaker.

5.3.2.2 Zone B: Contact separation

This is where the main contacts separate. At this moment the arc is formed and the breaker begins the arc extinguishing process. Separation speed is an important factor and of prime importance to succeed in breaking the circuit.
The calculation method for the average speed in this zone is determined by the designer of the breaker. Only the designer can determine the calculation method and the reference value.

5.3.2.3 Zone C: Deceleration

This is where the motion slows down until the moving contacts have completely stopped.
The energy released in the interruption process is as great or greater than the current being interrupted. Once the current has been interrupted and the arc is extinguished, this energy is quite large.
Effective means of damping are implemented to absorb this excess energy, thus reducing the risk of damage to the breaker's internal components. Examination of this zone shows if the damping or absorption is optimal, meaning that the motion is stopped gently.
Insufficient damping, or underdamping, allows the moving parts to undergo shocks at the end of the travel, which causes severe damage.
A sudden damping, where the kinetic energy developed by the moving parts is absorbed over a very short time, causes damage similar to underdamping, This phenomenon is called overdamping.

5.3.3 Operation on closing

An example of a displacement curve for a Close operation is shown in Fig.1.3, superimposed on a timing curve for the main contact (in red).
Even if the general appearance of the curve is to be checked first, three zones (circled in Fig.1.2) merit particular attention:

1. Zone A: start of motion
2. Zone B: time of contact separation.
3. Zone C: from the start of deceleration until the final rest point.

5.3.3.1 Zone A: Start of motion

As in the case of the opening displacement curve, this is where motion starts, and it is extremely important to know if the motion started at the correct point.

5.3.3.2 Zone B: Contact closing

This is where the main contacts come into contact. In this zone, also called the pre-arc zone, as the contacts come closer to each other, the dielectric, as a function of the separation distance, becomes insufficient and a pre-arc current forms within an arc, the duration of which is a function of the speed of the contacts.
Thus, contact velocity is an important factor in limiting premature wear of the contacts.
As in the case of the open operation, the method for calculating the average speed in this zone is also determined by the designer of the apparatus. Only the designer may determine this calculation and establish the reference specification.

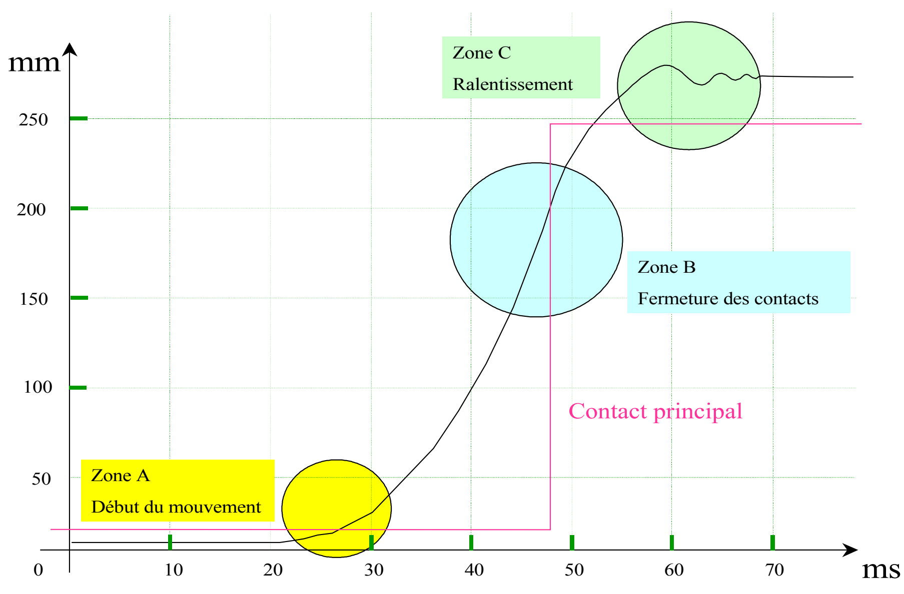


Fig 1.3 Displacement curve for Close operation

5.3.3.3 Zone C: Deceleration

This is where the motion slows down to a complete stop of the breaker's moving contacts.
The energy involved in the closing process is less than that developed in the breaking process, but it is nonetheless quite considerable.
Excess energy is translated into overtravel which, if it exceeds tolerances, may cause severe damage to the device.

5.3.4 Velocity curve

A velocity curve is calculated by the derivative of the displacement curve, using the CBA Win analysis software, for example. The velocity curve gives the speed as a function of time, which gains new information on the dynamic behavior of the circuit breaker.

5.3.5 Acceleration curve

In the same manner, an acceleration curve can be traced, as the derivative of the velocity curve, again using the CBA Win analysis software, which gives us even more useful data.

6 Calibration procedure for a ZRT transducer

Goal:
Calibrating a ZRT transducer, before first use or for maintenance purposes.

Required materials:
The TLH to calibrate, 1 CBA-32P connected to a computer, an appropriate standard rod et 1 C-Clamp.

Preparation phase:

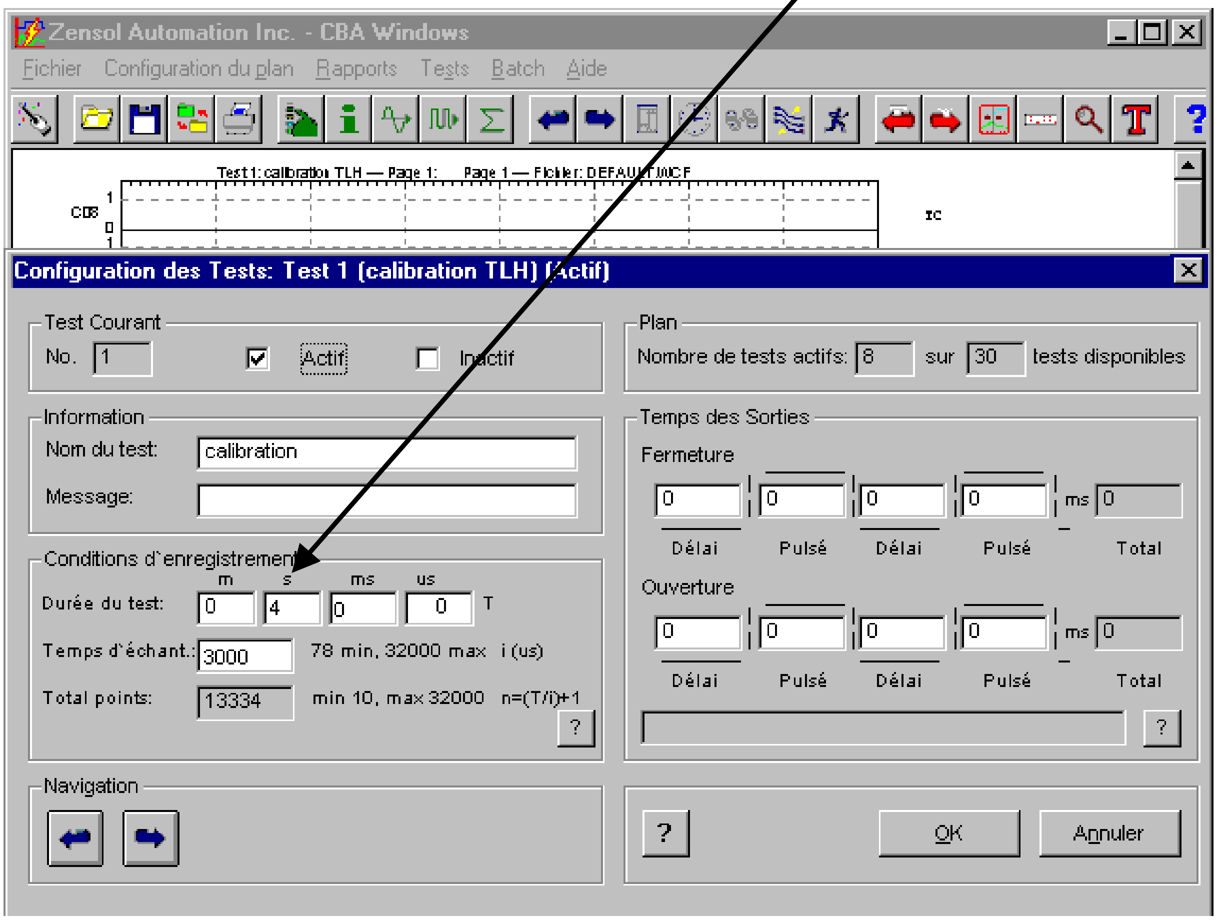
- Connect the ZRT on one of the analog inputs (except 1 and 2) of the CBA-32P.
- Turn on the CBA-32P.
- Attach the Kit-ZRT on a table using one of the C-Clamps.
- Check that the ZRT transducer is not at the end of its travel. There is a method to determine this.

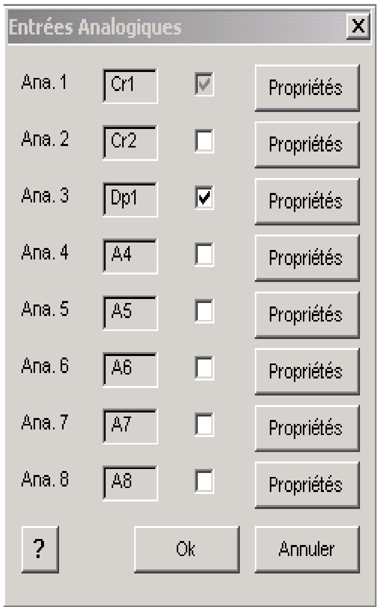
Method:

With an ohmmeter connected as shown below, check that the resistive transducer is not at the end of its travel (for a ZRT transducer, the maximum value at the end of travel is about 5 K-ohms)

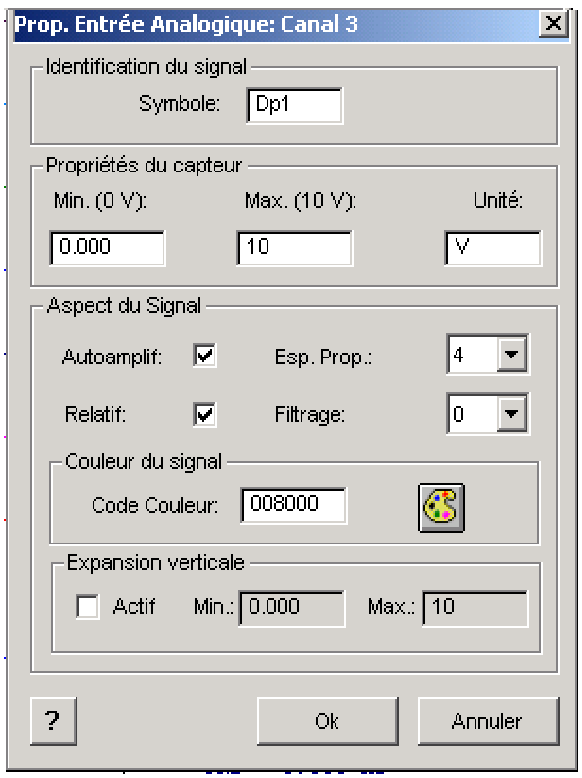
- Insert the standard rod in the linear-to-rotary motion as shown below. This rod will limit the movement of the cursor to a well-defined length.

- In CBA Win, set the duration of the test in the **Test Configuration** screen, as shown below. We will use a test duration of **4 seconds**.





One must now set the parameters for the analog input on which the TLH is connected. Locate the analog channel number on the CBA-32P where the TLH transducer is connected.
In CBA Win, click on **Analog Inputs**, then on the **Properties** button associated with the appropriate analog channel, as shown below.



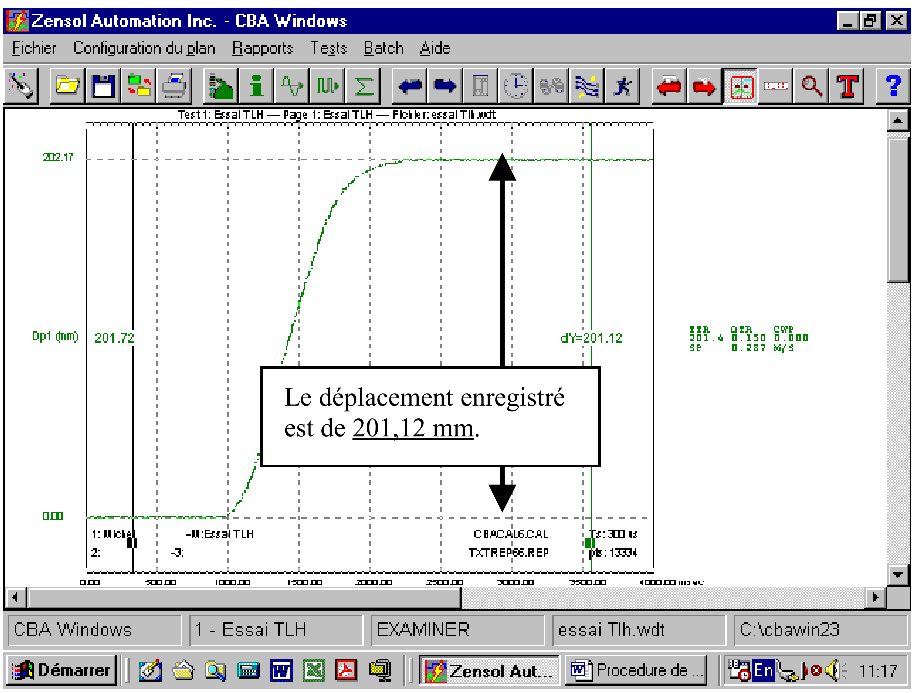
In the **Transducer properties**, put 0 (zero) in the Min. (0V) box and in 10 the Max. (10 V) box, and V in the units box.

Testing phase:

- The testing phase is organized as follows:
  - Trigger the test.
  - Wait about one second.
  - Move the rod downward to the other end quickly enough so that about one second remains until the end of the test.
  - Wait for the results to display.
  - End of test.

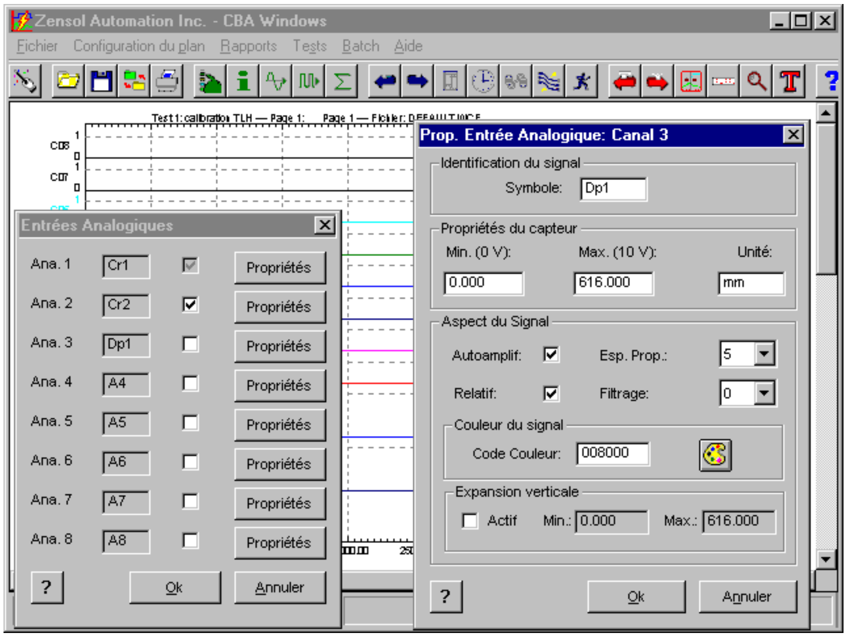
Click on the **Examine** button in the button bar. A vertical bar will appear.

- Using the mouse, move the bar to the left-hand level section. Press the Space Bar and move the second bar to the right-hand level section. The screen should appear approximately as shown below. The dY measurement, on the right, indicates the difference in voltage registered.



We know the voltage difference for a displacement of 233.56 mm (the rod's motion) so by a simple calculation we can deduce the displacement for a difference of 10 volts.

One must now redefine the parameters for the analog input where the ZRT is connected. In CBA Win, click on **Analog Inputs**, then on the **Properties** button associated with your analog input, as shown below.



In the **Transducer properties**, in Max. (10 V), enter the displacement that you have just calculated for a 10-volt difference; enter mm in the units box. Click OK.

- Trigger the test.
- Wait about one second.
- Move the rod downward to the other end quickly enough so that about one second remains until the end of the test.
- Wait for the results to display.
- End of test.

- Click on the **Examine** button in the button bar. A vertical bar will appear
- Using the mouse, move the bar to the left-hand level section. Press the Space Bar and move the second bar to the right-hand level section. The screen should appear approximately as shown below. The dY measurement, on the right, indicates the difference in displacement registered.

Two cases are possible:

- It is a maintenance procedure:
  - If the recorded displacement is equal to that indicated on the rod, your ZRT is well calibrated.
  - Otherwise, proceed to the calculation step below.
- This is the first time the TLH is calibrated. The procedure is as follows:
  - If the recorded displacement is equal to the length of the rod, your ZRT is well calibrated and the value entered for Max. (10V) will be the value to be shown on your ZRT..
  - Otherwise, you must apply the following calculation rule:

Calculation phase:

Note: to illustrate the calculation rule, we will use our example of: Max (10 V) = 810,97 mm and dY=233,88

So : error = 233,56 – *233,88*

Measured length in CBA Win.

Displacement length on the standard rod

⇔ So error = -0,32

Error for:	**233,56 mm**	is:	**-0,32mm**
And so for:	**810,97 mm**	it is:	**z**

We obtain: $z = \frac{810,97 * (-0,32)}{233,56}$ = **-1,11 mm**

You must now enter, for Max.(10 V): 810,97 **- 1,11** = 809,86 mm.

- Redo the test using the new Max. (10 V) setting, and if the measured value differs from the length of the standard rod, you must repeat the preceding steps until the values are equal.

7. TRANSDUCERS' SET-UPS EXAMPLES

We have gathered 18 mounting examples in the following pages, taken from our own testing experiences and gathered over the years in many locations around the world. These tests were all performed using the CBA-32P circuit breaker analyzer and the CBA Win software.

We hope that you will find these photos useful and that they will inspire you when you will make your tests.

We take this opportunity to thank our customers, who gave us permission to take these photos and to show them to you, so that everyone can benefit from their experience.

The examples shown below do not represent all possible cases. The displacement kits may be used for other types of breakers with either minimal adaptation or none at all.

We wish to emphasize that all the rods used to connect the transducer to the mechanisms of the breakers shown in these examples were supplied by the customer.

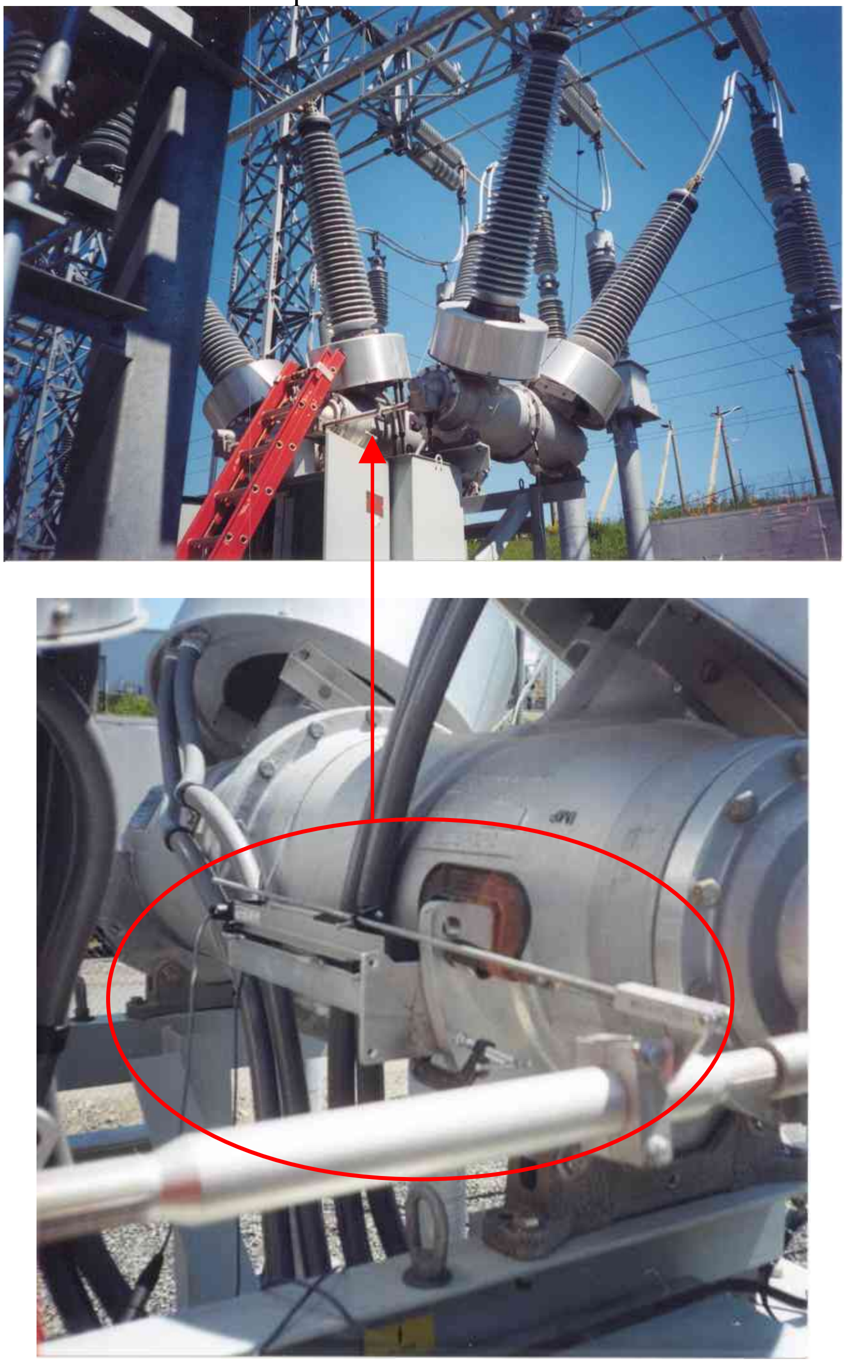
We keep on adding examples in our website. Please visit the following section for up-dates:

http://www.zensol.com/en/transducers-installation-examples

Note: You will find below a few examples with the KIT-ZLB (linear transducer kit). In all examples where a KIT-ZLB is used, a KIT-ZLR can be used in its place in almost all cases.

EXAMPLE 1 : ABB breaker (tests performed in British Columbia, Canada)

The ABB breaker shown here is a compressed air breaker.



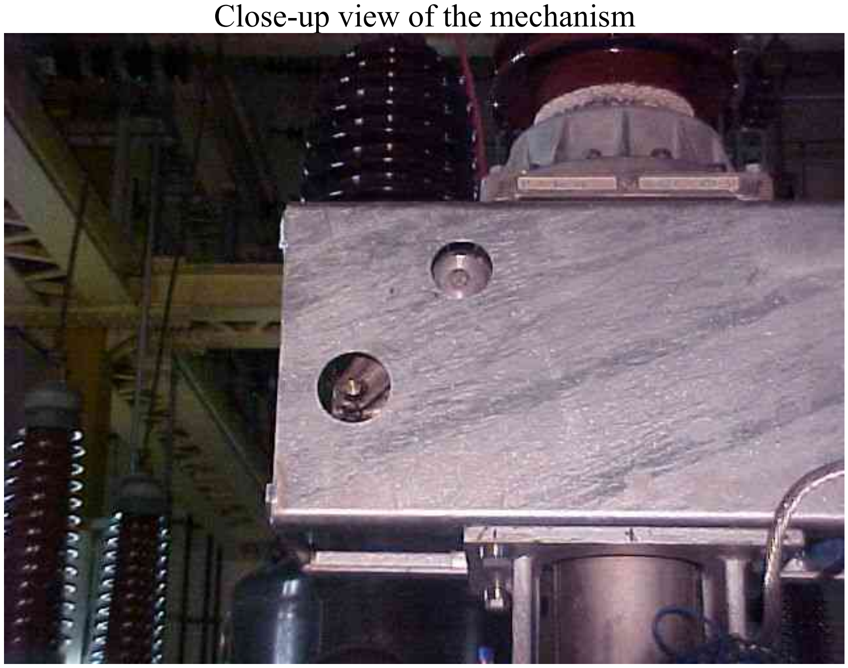
The kit used is a KIT-ZLB linear kit with a ZLT-300 linear transducer. This breaker's mechanism makes only a small rotation of less than one-quarter turn. In order to use the linear transducer, the customer supplied the linkage assembly shown here, along with the base kit supplied by Zensol.

Linkage assembly used with the kit.

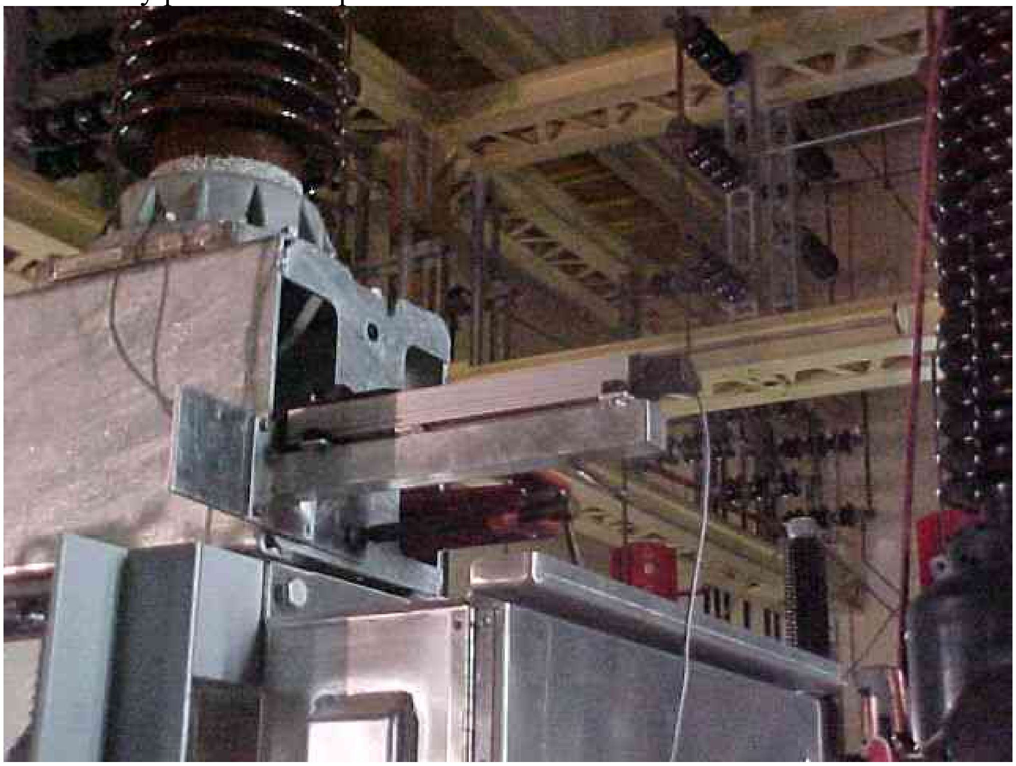
EXAMPLE 2 : AREVA GL Breaker (tests performed in Québec, Canada)

The GL212 breaker is manufactured by AREVA (formerly Alstom). The motion of this breaker can be checked at both ends of the breaker with different displacement kits.

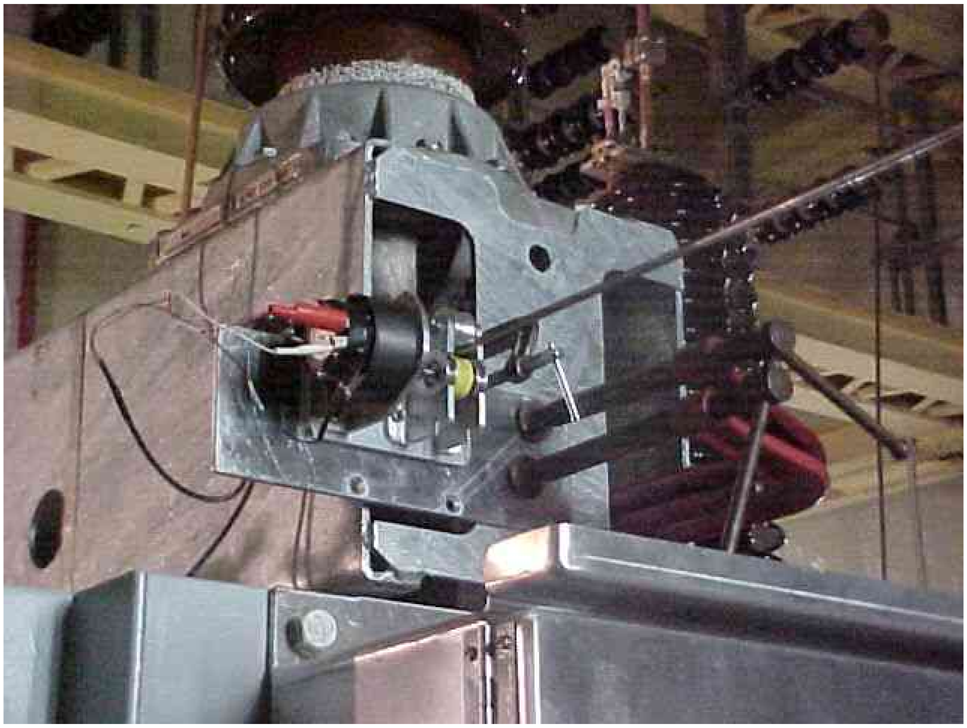
Close-up view of the mechanism



As shown below, the KIT-ZLB linear kit was directly installed with a ZLT-225 linear transducer without any particular adapation.

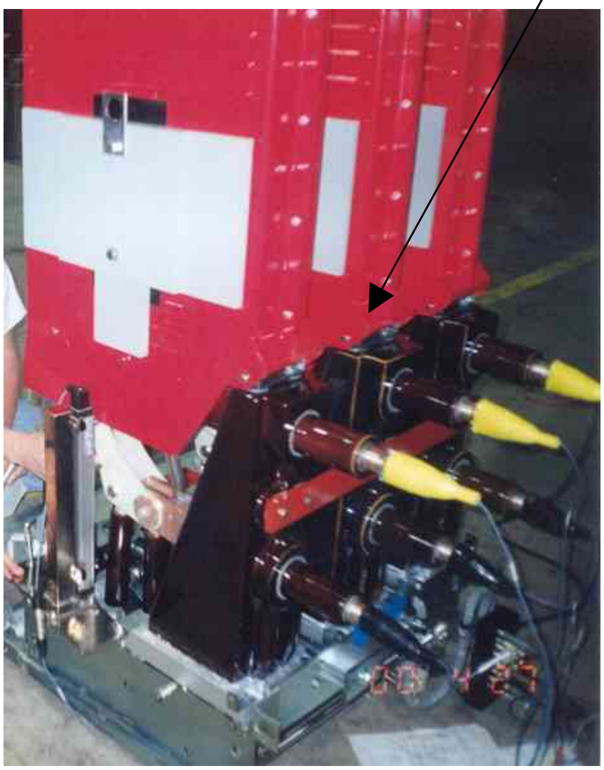


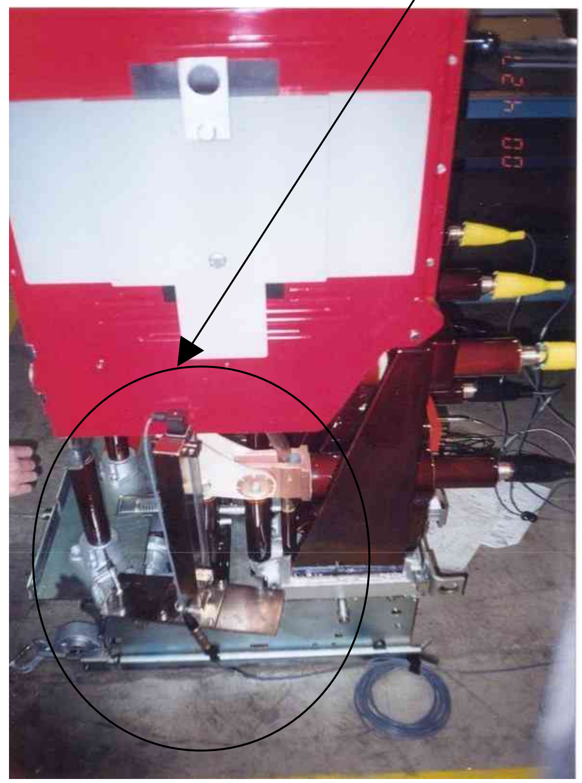
Here is the same breaker with a KIT-ZLR linear-to-rotary converter (Hydro-Québec licence) in place, along with a ZRT-10 ten-turn rotary transducer (note: ZRT-3 three-turn transducer could also have been used here or an optical encoder ZOT-2000). The mechanical base used here was an older model. To see the new model, please see our accessories section.



EXAMPLE 3 : SPRING-TYPE BREAKER (tests performed in Texas, USA)

The breaker shown here is one widely used by industrial customers, such as aluminum factories, mines, pulp and paper mills, etc. The three phases are visible here. The KIT-ZLB linear displacement kit and its transducer have been mounted on the side of the breaker without any special adaptation.





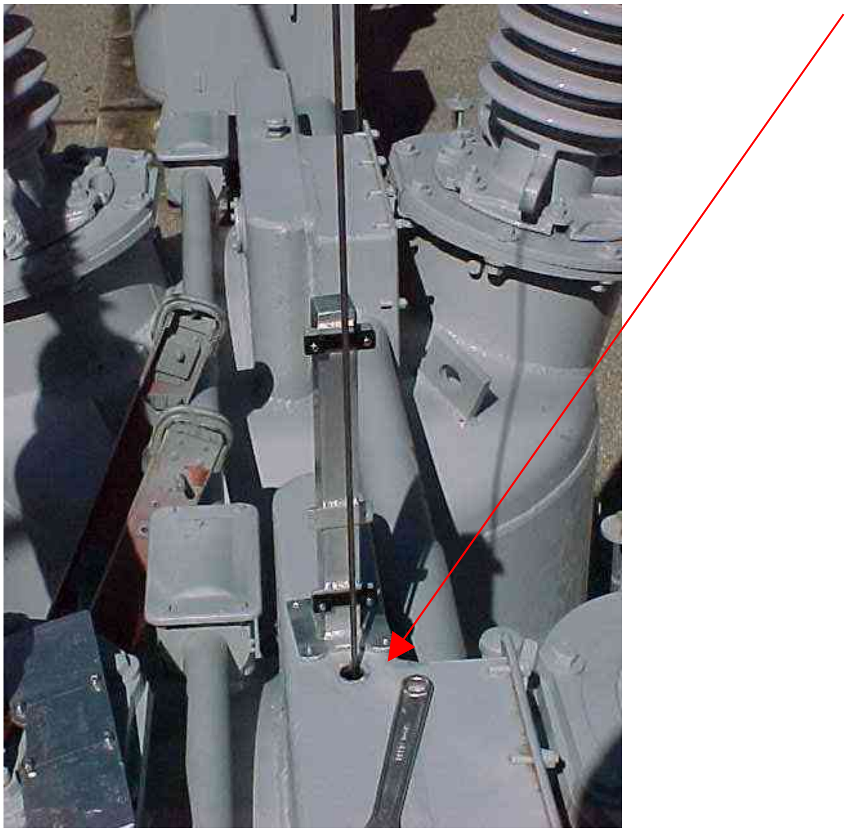
EXAMPLE 4 : T-TYPE BREAKER (tests performed in Mexico City, Mexico and Guatemala City, Guatemala)

The circuit breakers shown here are 6-contact units (2 contacts per phase), commonly called T-type breakers.
The transducer used is a KIT-ZLB linear kit with a ZLT-225 transducer. The transducer is mounted at the bottom of the breaker, as shown in the photos below.

EXAMPLE 5 : GE BREAKER (tests performed in Alabama, USA)

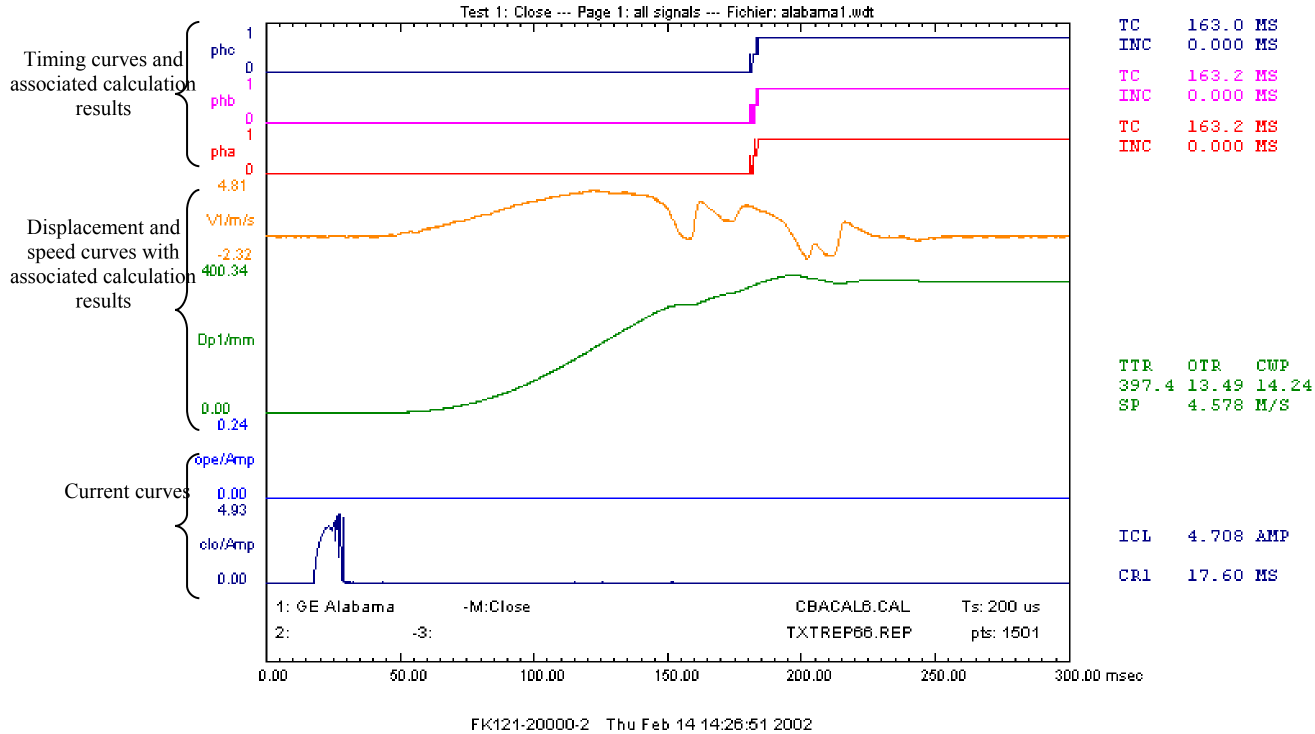
The breaker shown here is a 3-contact unit, one contact per phase.

For the displacement measurement, this breaker has a place for this purpose, where a rod can be inserted and screwed to the mobile part of the contact, as shown in the photo below:



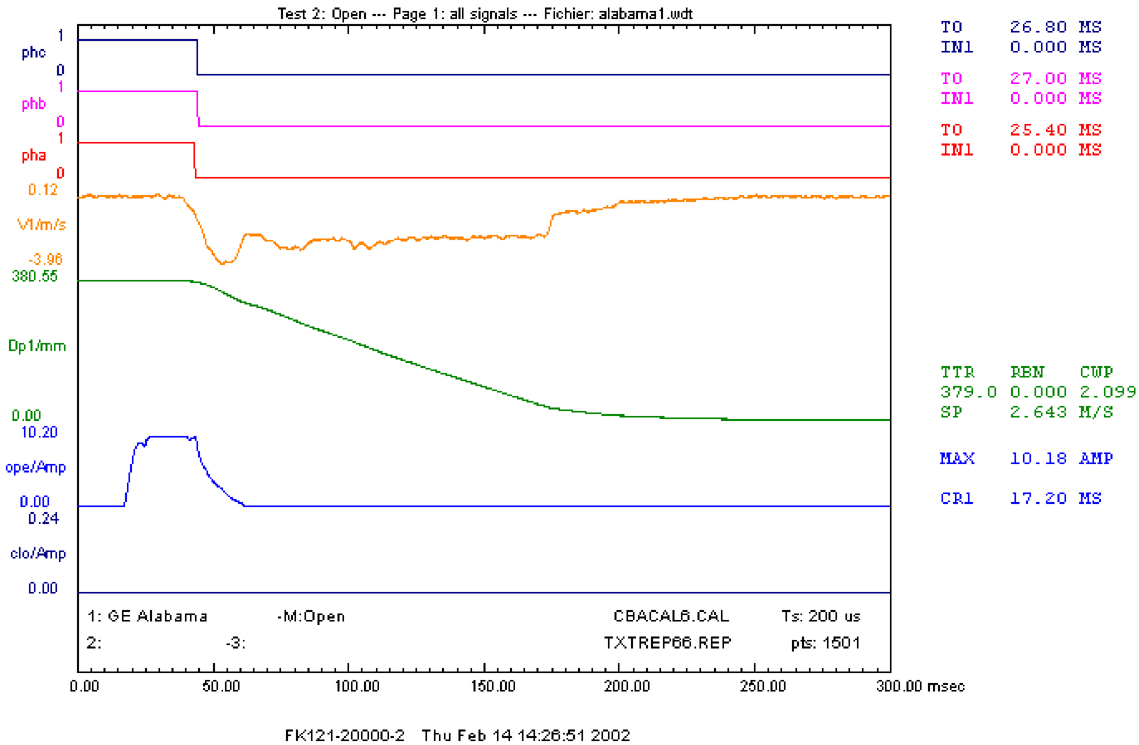
The KIT-ZLB linear kit used with a ZLT-600 transducer.

Test results on Close operation using CBA WIN software

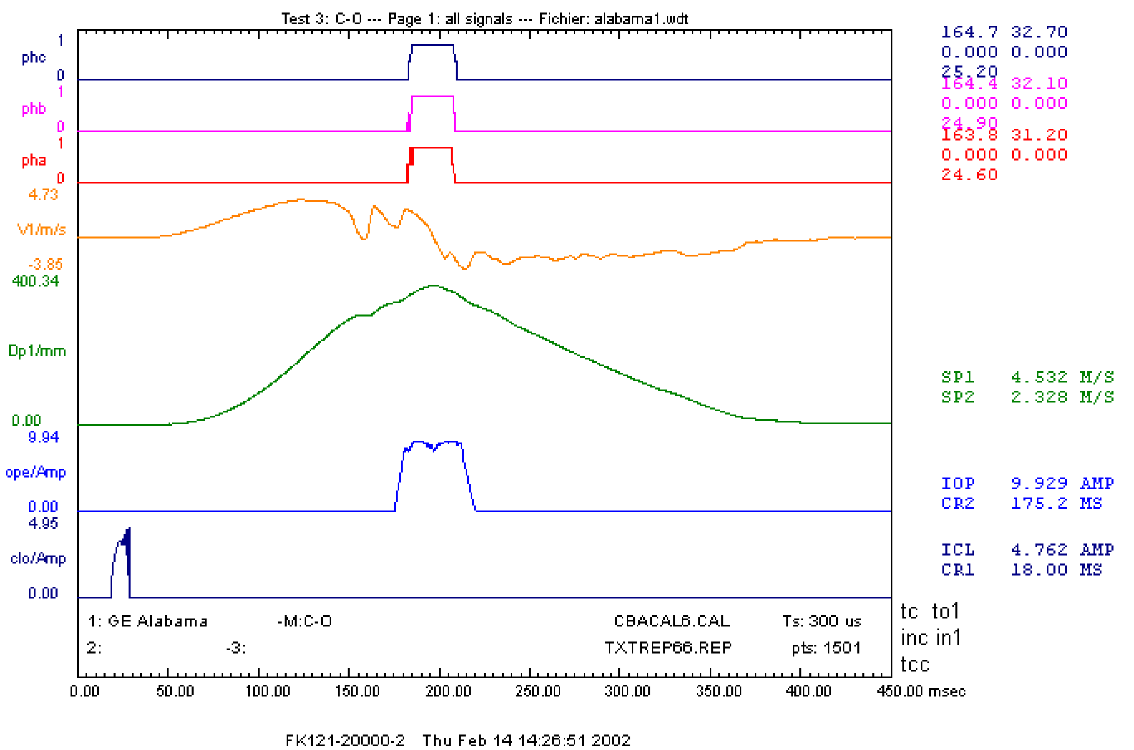


In these test results, in addition to the usual curves we can see the instantaneous velocity curve, drawn in orange on the graph.

Test results on Open operation using CBA WIN software



Test results on Close-Open operation using CBA WIN software

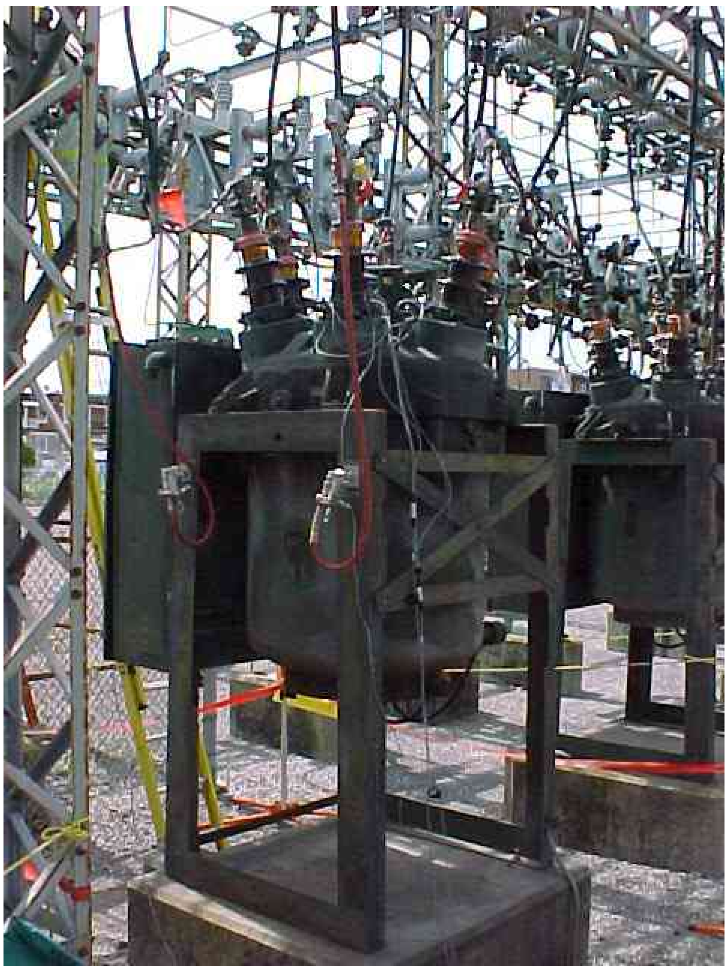


EXAMPLE 6 : BULK OIL BREAKER (tests performed in Québec, Canada)

Oil breakers are among the oldest types of circuit breakers on the market. Many are in service for over 50 years. Their reliability and simple operation account for their endurance. They are available in various sizes and voltage ratings.

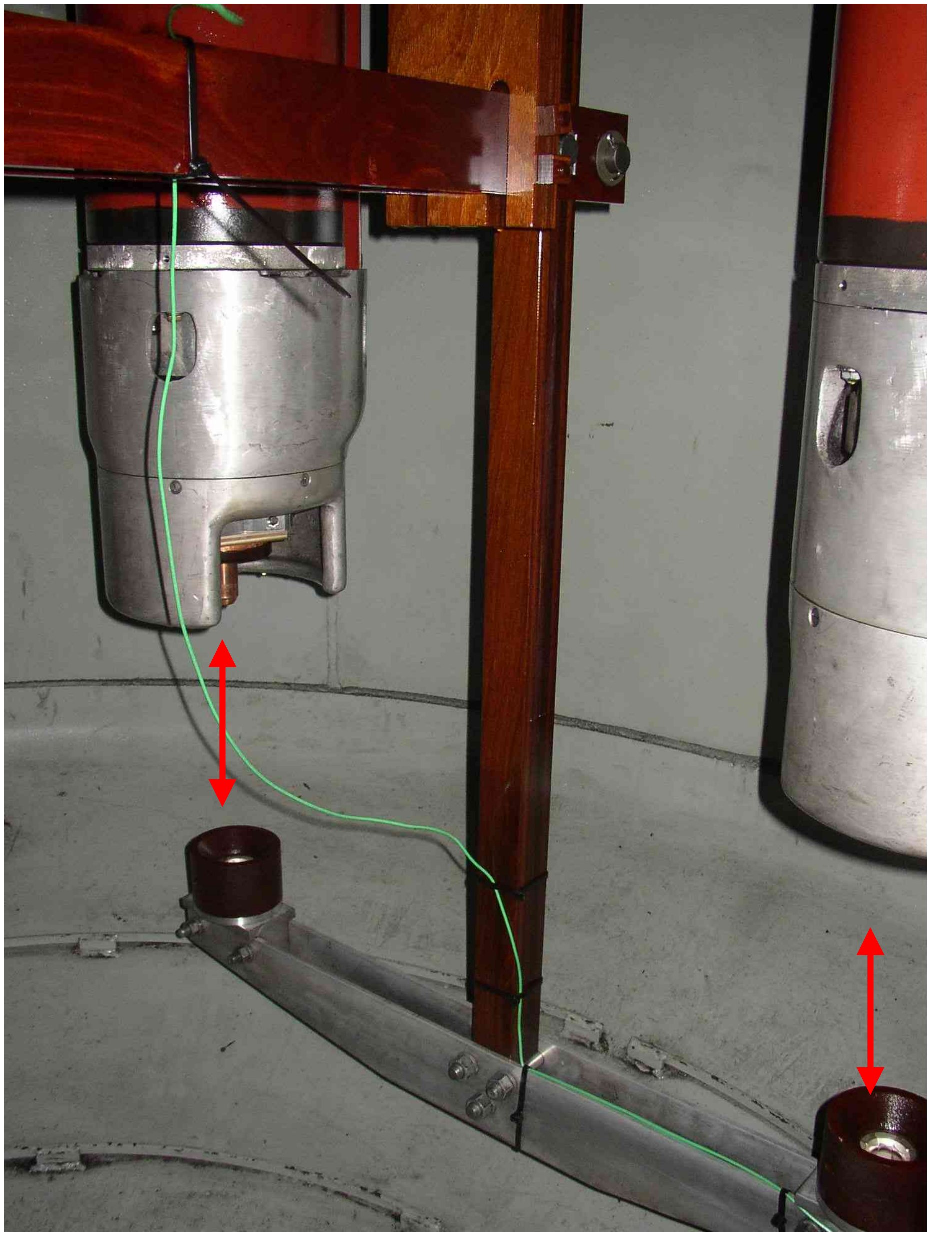
The KIT-ZLB linear kit is usually used for this type of circuit breaker, along with a ZLT-600 linear transducer, since the total travel of this type of breaker is among the longest of all.

However, ZRT rotary transducers may also be used in combination with our KIT-ZLR linear-to-rotary motion converter. In the case of the rotary transducer, either the ZRT-03 or ZRT-05 or ZOT-2000 transducers should be adequate for this purpose.



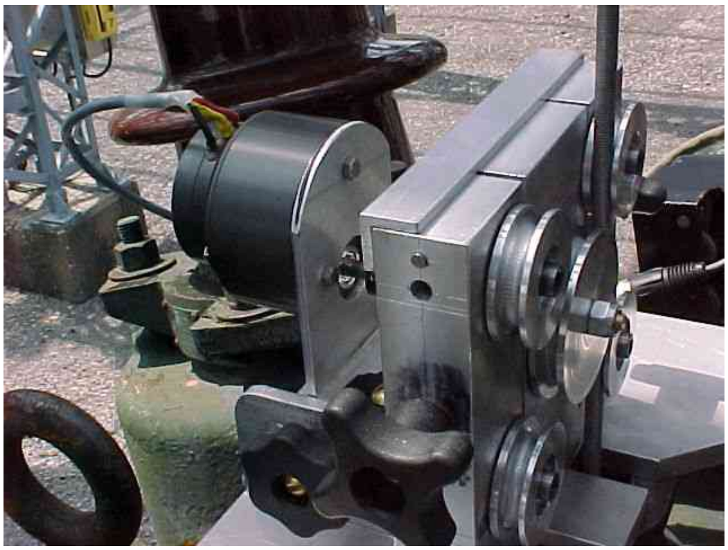
Minimum oil circuit breaker

Here, you will also find photographs of the inside of these breakers and their mechanisms.



Bulk oil breaker

With a KIT-ZLB linear kit and a ZLT-600 linear transducer.

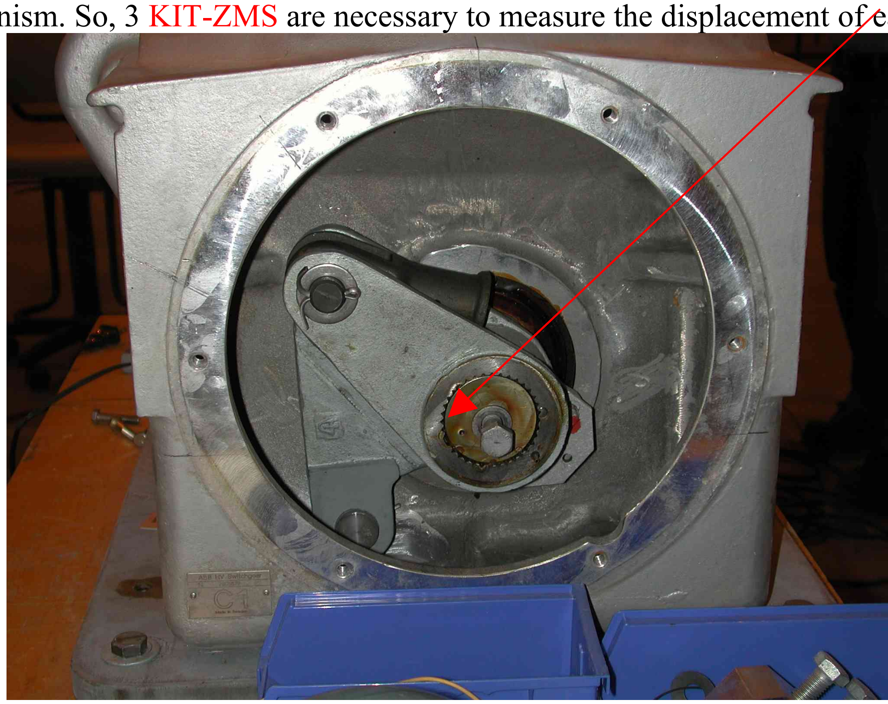


With a our KIT-ZLR linear-to-rotary motion converter and a ZRT-05 rotary transducer.

EXAMPLE 7 : HPL BREAKER (tests performed in Québec, Canada)

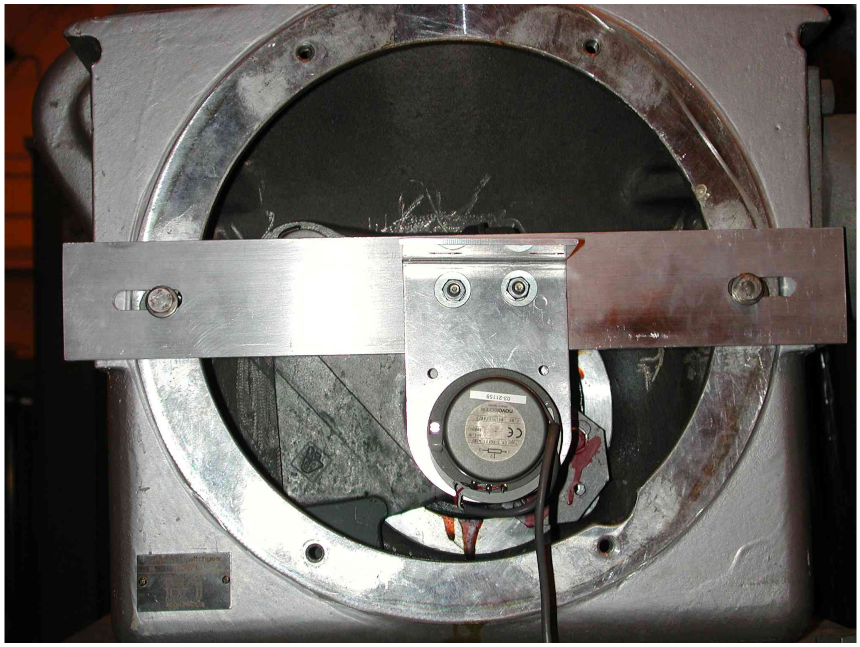
The HPL breaker is manufactured by ABB, and exist in several models with different mechanisms.

In the mechanism shown below, it is obvious that a rotary-type transducer is required. The transducer must be attached to the rotating part of the mechanism. Each phase of the breaker has such a mechanism. So, 3 KIT-ZMS are necessary to measure the displacement of each phase.

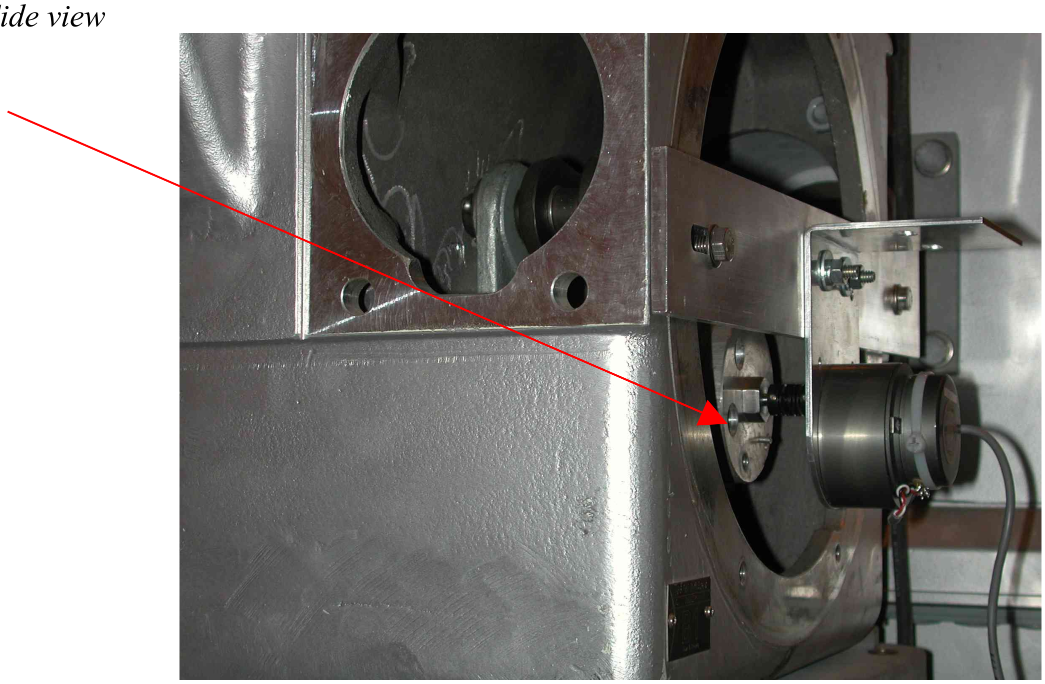


Here is an example of a mechanical base for a rotary transducer. As seen in the following photos, this base has unused holes and angles that can be used in other types of breakers.

Face-on view



Side view



The bolt, as well as the coupler that connects the transducer to the breaker's mechanism, are supplied with the KIT-ZMS.

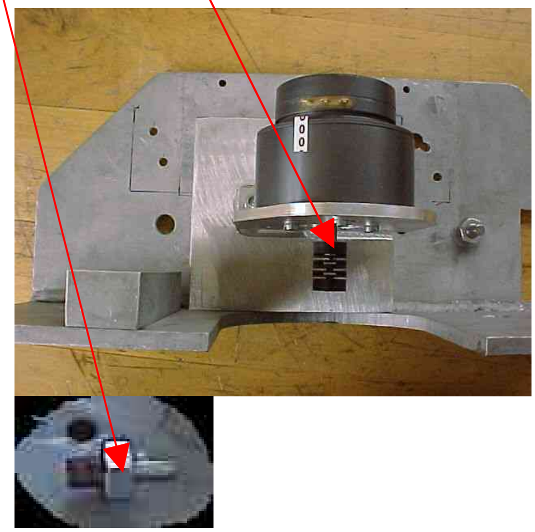
EXAMPLE 8 : T-TYPE HPL BREAKER (BLG MECHANISM) (tests performed in Québec, Canada)

The HPL breaker shown here is completely different from the one in the previous example.

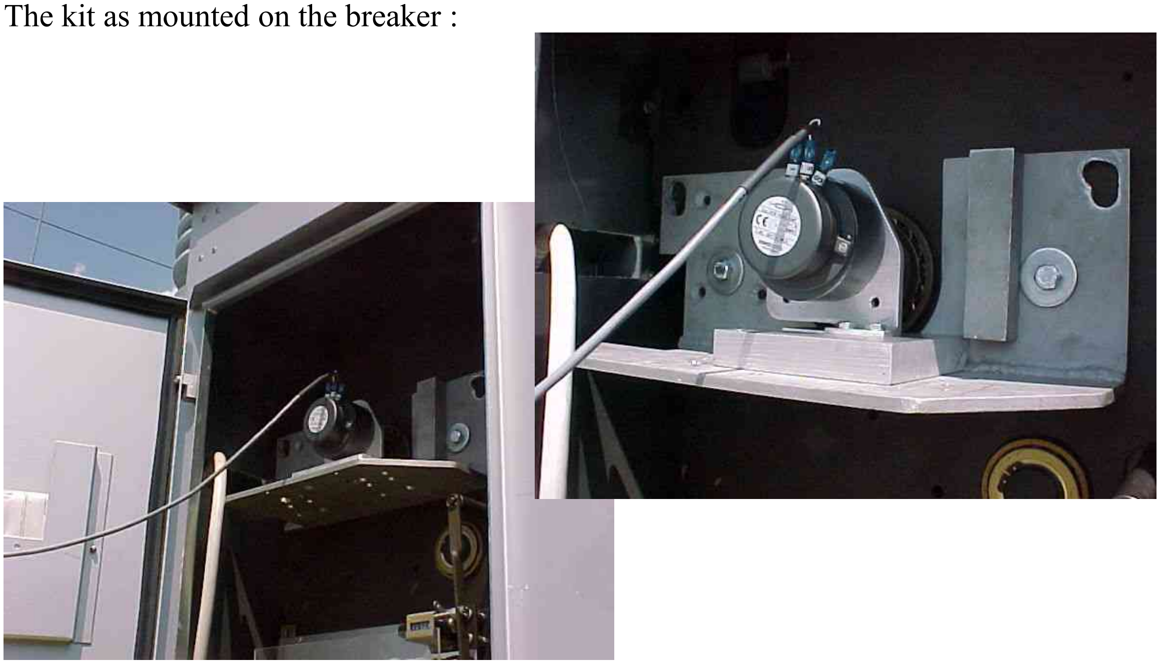
The photo below shows the mechanism in the lower part of the HPL breaker. Three kits are required to measure all three phases of the breaker.

Below is the mechanical base used. (note : since then, the mechanical base has been replaced by the one shown in example 7)

In these photos, we can more clearly see the bolt and the coupler mentioned in example 7.



The kit as mounted on the breaker :



EXAMPLE 9 : GFX BREAKER (tests performed in Québec, Canada)

The GFX breaker is manufactured by AREVA. It is a cold-weather version of the FX-type breaker. Hydro-Québec has developed its own mechanical base for this breaker.

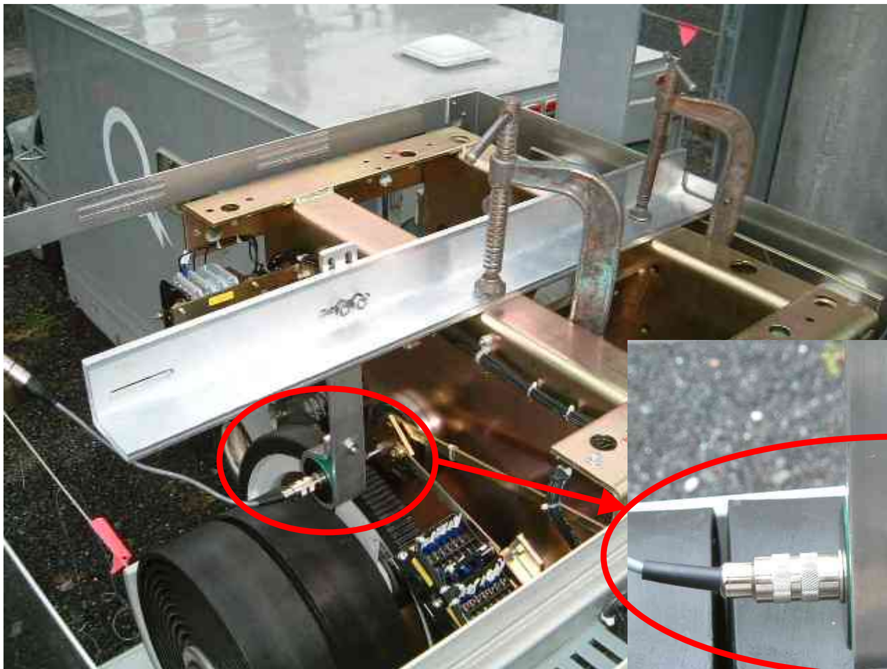
The measurement displacement done here is part of dynamic contact resistance measurements of the breaker's main contacts, using the KIT Z-DRM-2 along with the CBA-32P circuit breaker analyzer, in order to detect defects in the breaker's contacts without having to open each one of them.

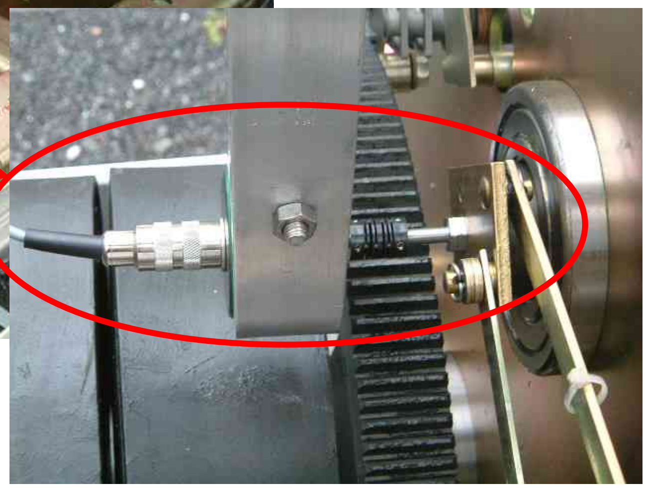
Once again, the ZLT linear transducer is used with a mechanical base and a coupler specially made for this breaker by Hydro-Québec.

Since each phase has its own mechanism, each requiring its own kit, three kits are required in total.

EXEMPLE 10 : TYPE-T GL BREAKER (tests performed in Québec, Canada)

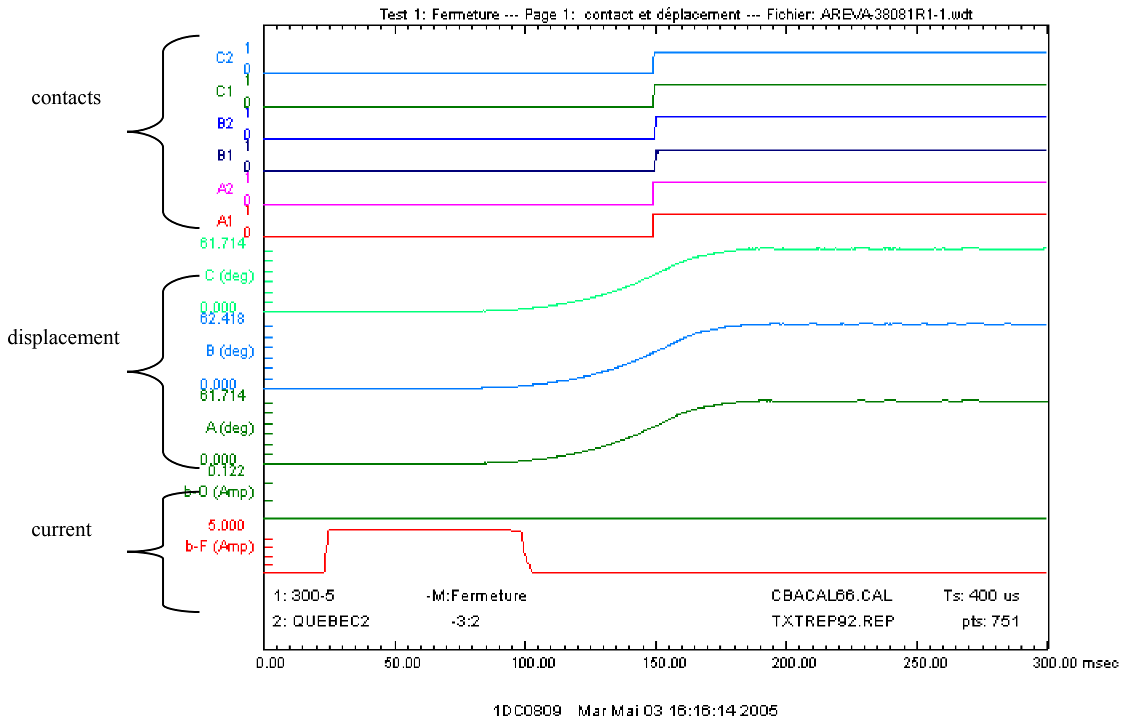
Here is another type of GL breaker: it will only work with a KIT-ZMS. The mechanical base (one per phase) shown below was specifically developed by Hydro-Québec for this type of circuit breaker. The bolt and the coupler required to link the transducer to the breaker can be seen here. Three kits are required, one for each phase.





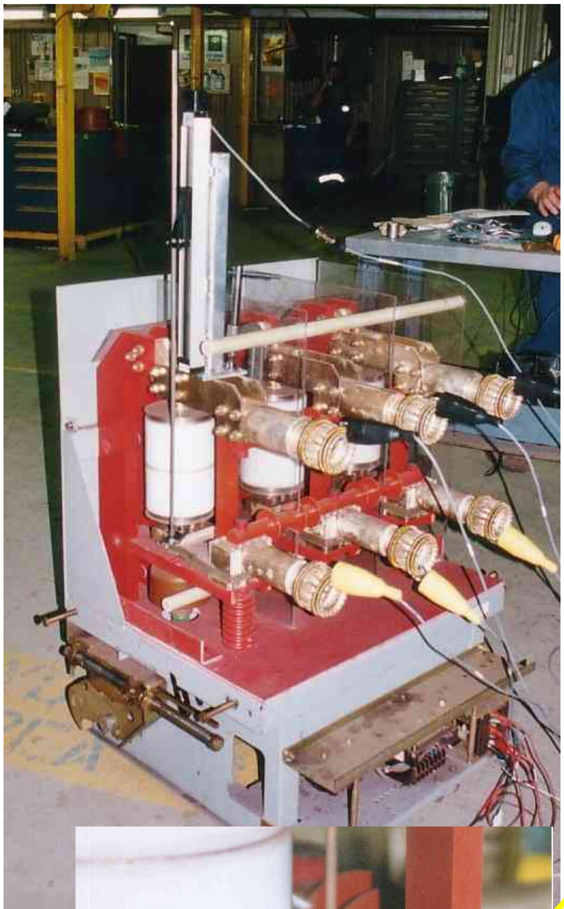
Typical test results from a Close operation on a GL breaker as shown above:

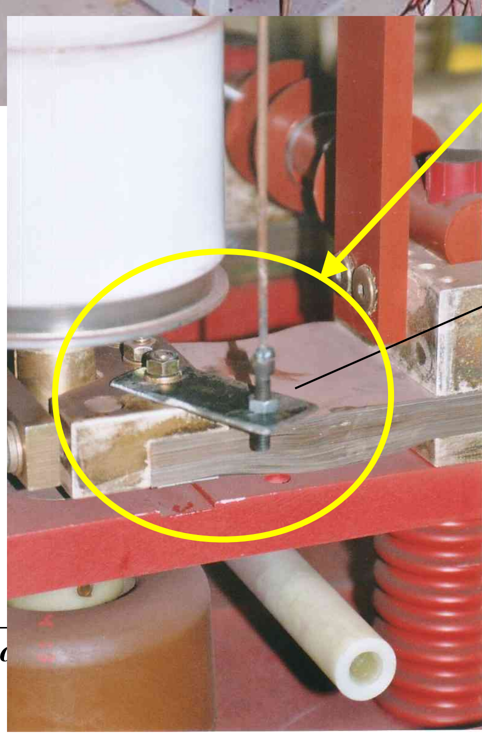
This GL215 has two contacts per phase, for a total of six contacts, and one mechanism per phase, giving three displacement curves. Everything is clearly shown on the graph below:


Test 1: Fermeture --- Page 1: contact et déplacement --- Fichier: AREVA-38081R1-1.wdt
contacts
C2
C1
B2
B1
A2
A1
displacement
61.714
C (deg)
0.000
62.418
B (deg)
0.000
61.714
A (deg)
0.000
current
0.122
b-O (Amp)
5.000
b-F (Amp)
1: 300-5
-M:Fermeture
CBACAL66.CAL
Ts: 400 us
2: QUEBEC2
-3:2
TXTREP92.REP
pts: 751
0.00
50.00
100.00
150.00
200.00
250.00
300.00 msec
1DC0809 Mar Mai 03 16:16:14 2005

EXAMPLE 11 : MAGNA BLAST BREAKERS (tests performed in Labrador, Canada)

The breakers shown here are widely used by industrial customers such as aluminum factories, mines, paper mills, etc. The three phases are visible. The transducer was installed on top of the breaker with a minor adaptation, as shown in the following photos.

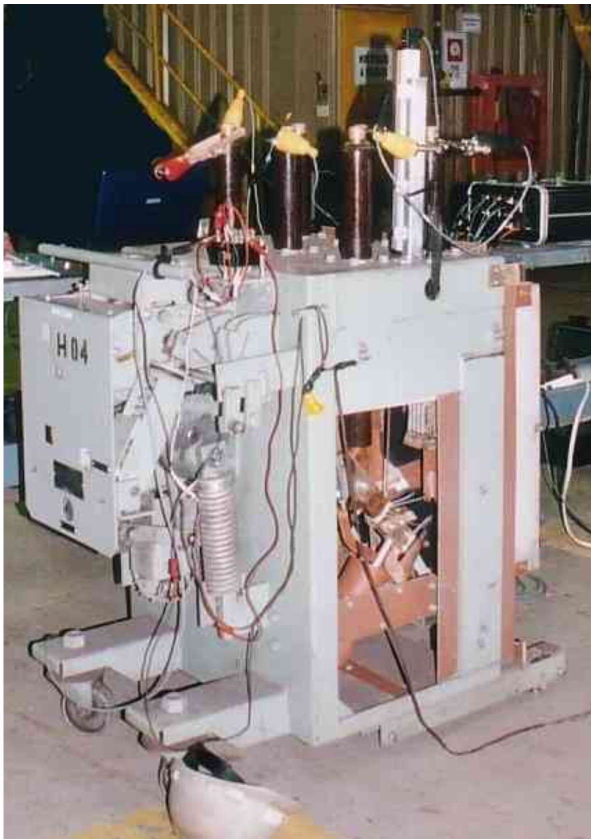




The displacement of this breaker is very small (less than ½ inch).
The rod was attached to the breaker with a simple steel plate.

EXAMPLE 12 : ABB BREAKER (tests performed in Labrador, Canada)

The mechanism of this breaker has an up-down swinging motion. Even if the motion is slightly inclined, it is still possible to use the KIT-ZLB (with ZLT linear transducer). It was connected to the mechanism with a simple cable tie (tie-wrap).


H04

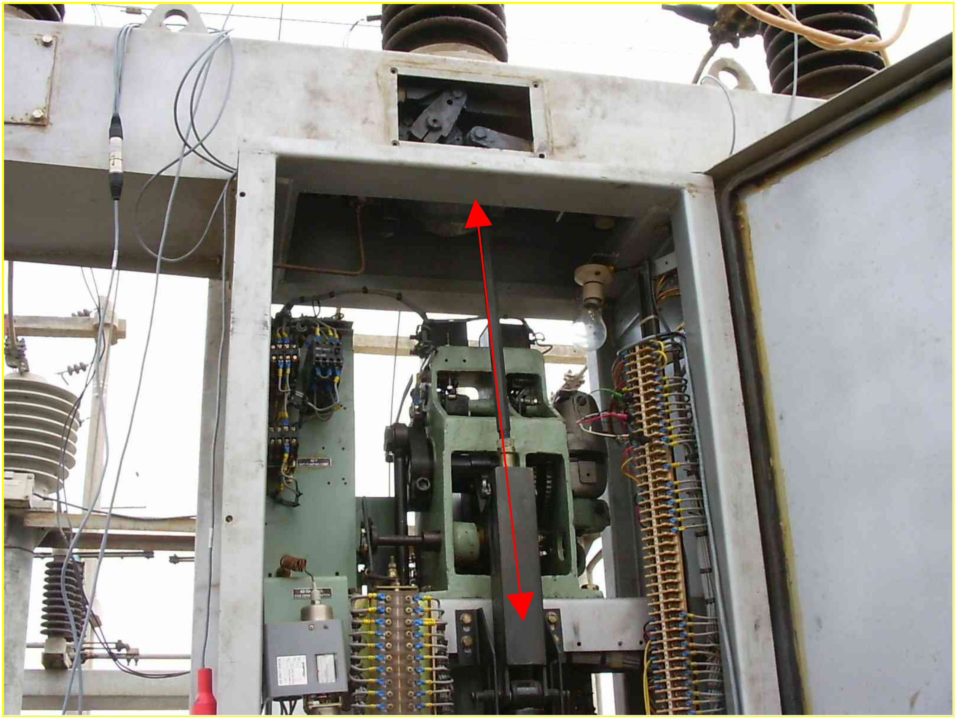
EXAMPLE 13 : MOUNTING EXAMPLE WITH A MAGNETIC BASE (tests performed in Québec, Canada)

This base is ideal for small distribution-type or low-voltage breakers. A KIT-ZMS was used.

EXAMPLE 14 : CROMPTON GREAVES BREAKER (tests performed in Hidrandina, Peru)

This apparently simple circuit breaker is somewhat challenging when it comes to placing the displacement transducer.

The motion of this mechanism is vertical. The difficult task is to secure the KIT-ZLB linear kit to the moving part of the breaker (shown in red in the photo below), though space seems to be very limited.

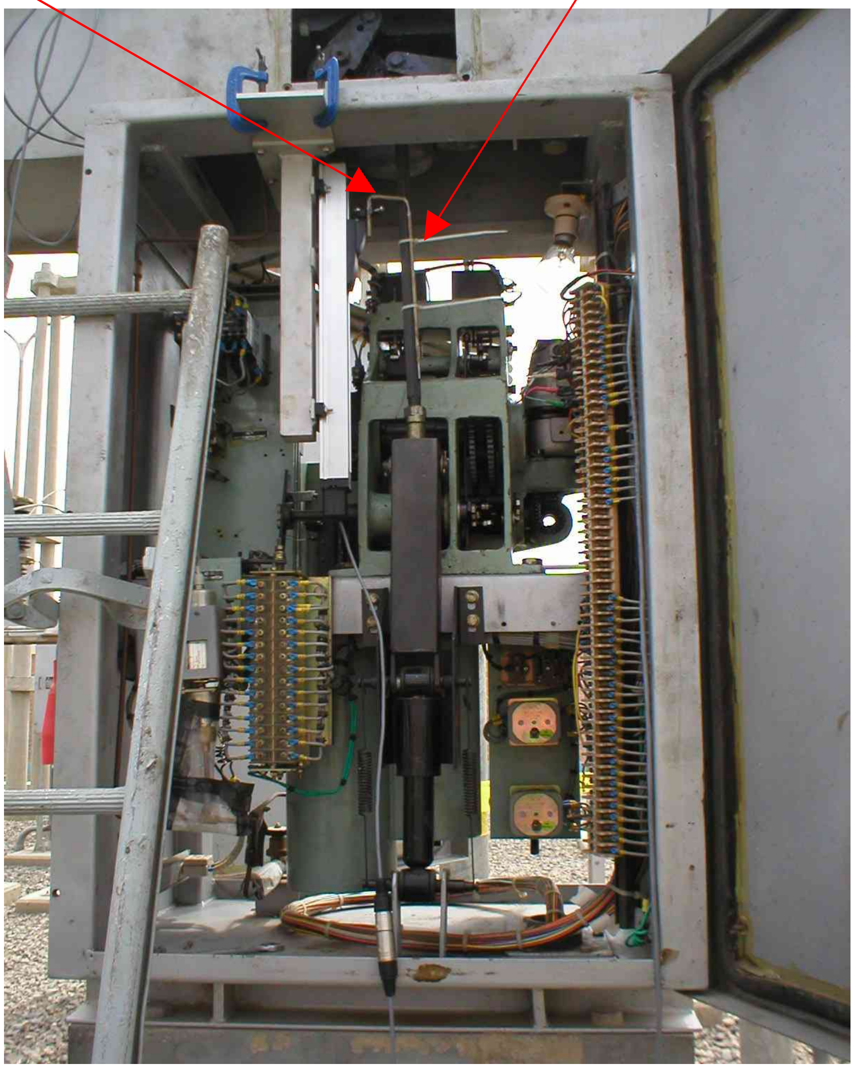


The other challenge is that one is located in the middle of the Peruvian desert without a machine shop in the area that can fabricate a specific part.

In these peculiar conditions, one of the technicians present thought of a temporary solution, as shown below.

Even if this setup seems rudimentary, it has proven quite effective, as shown in the results presented on the next page.

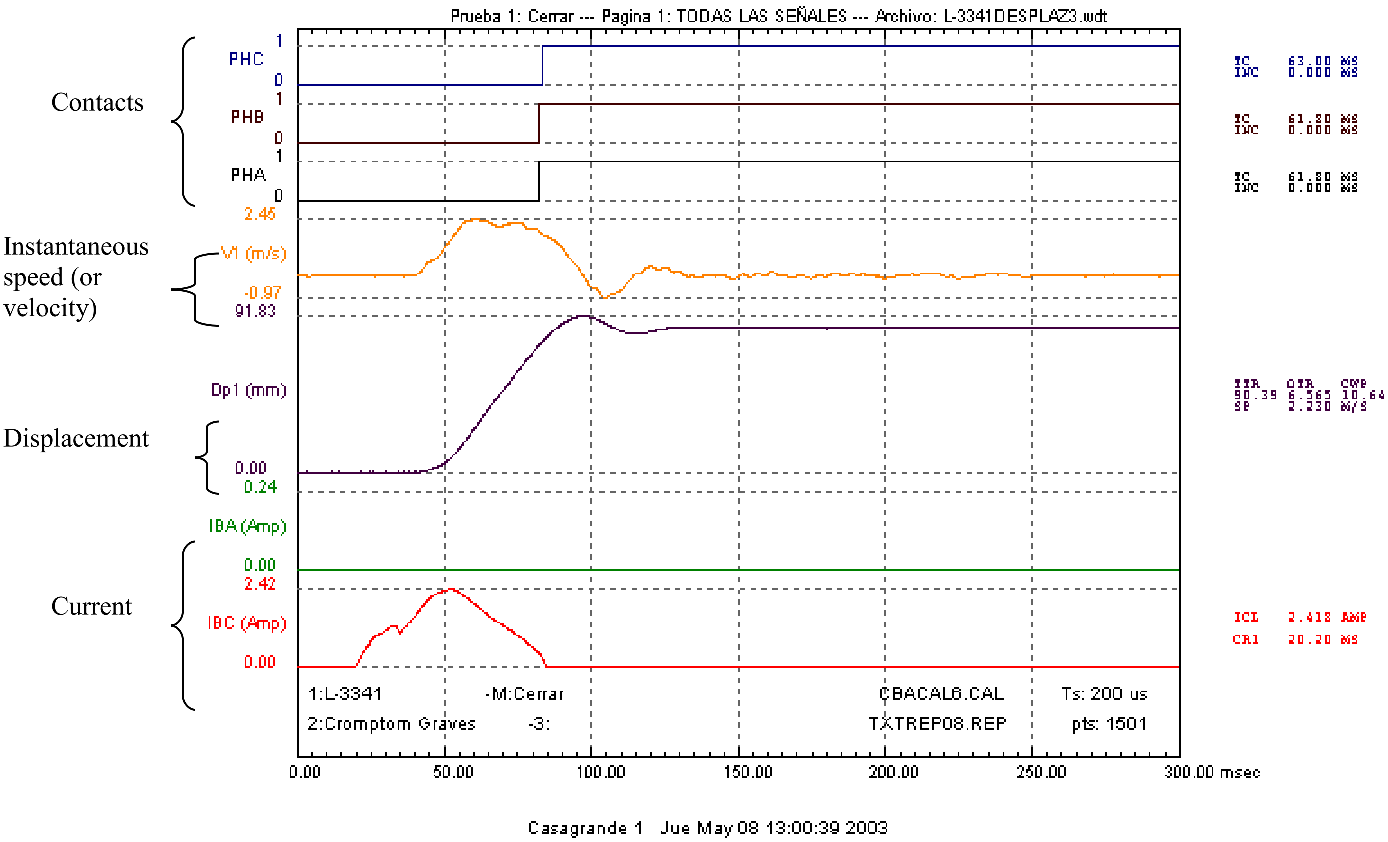
The solution consists of mounting the kit upside-down and to link the transducer to the breaker with a curved rod, attached to the breaker with cable ties (tie-wraps).



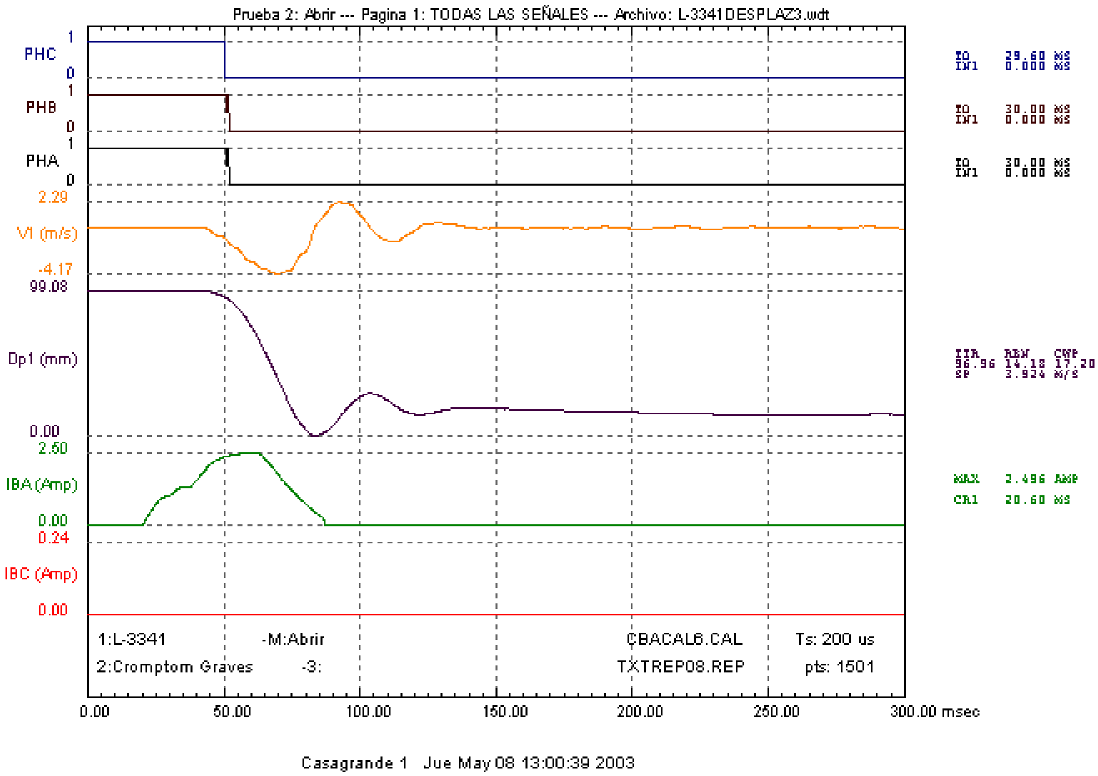
Based on this setup, a special part can be fabricated later if the customer wishes, when they have returned to their offices.

Also, to remember this setup, the customer has placed this photo directly in this breaker's test plan in the CBA Win software.

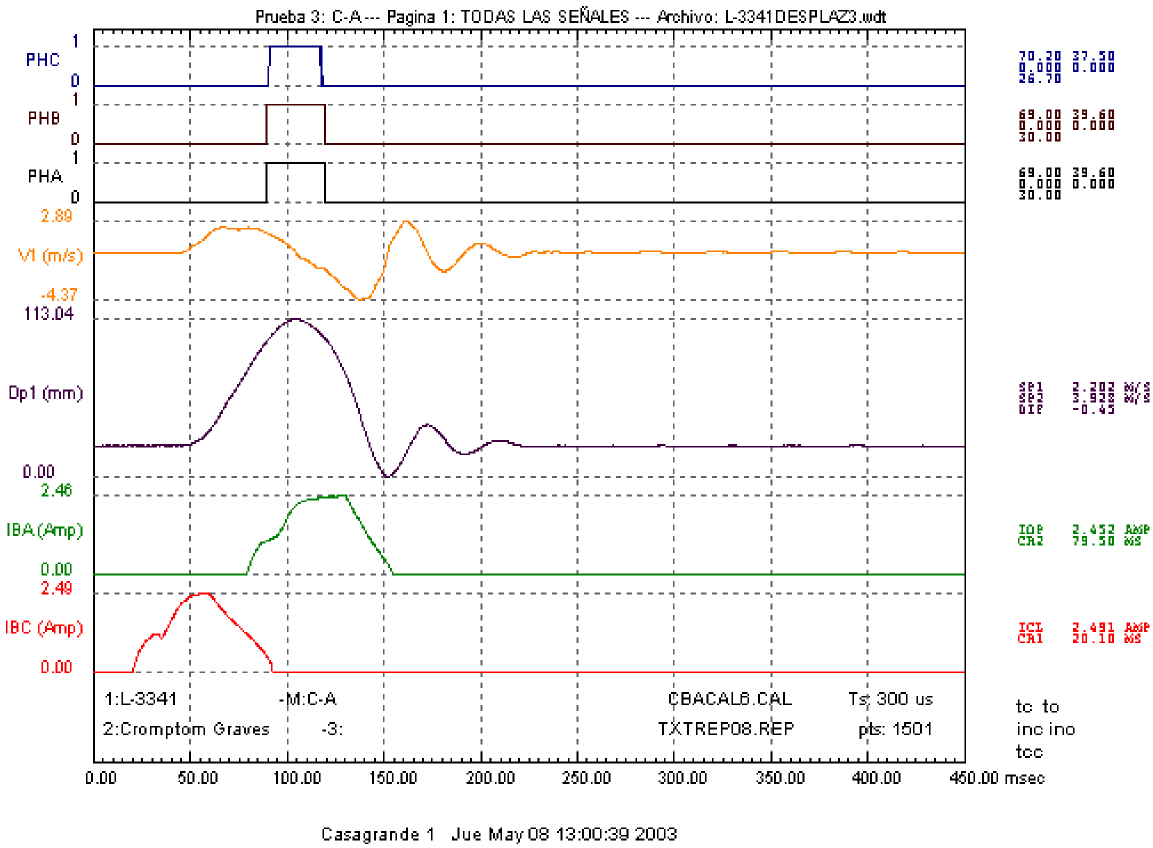
Results obtained on Close operation with the CBA WIN software.



Results obtained on Open operation with the CBA WIN software.

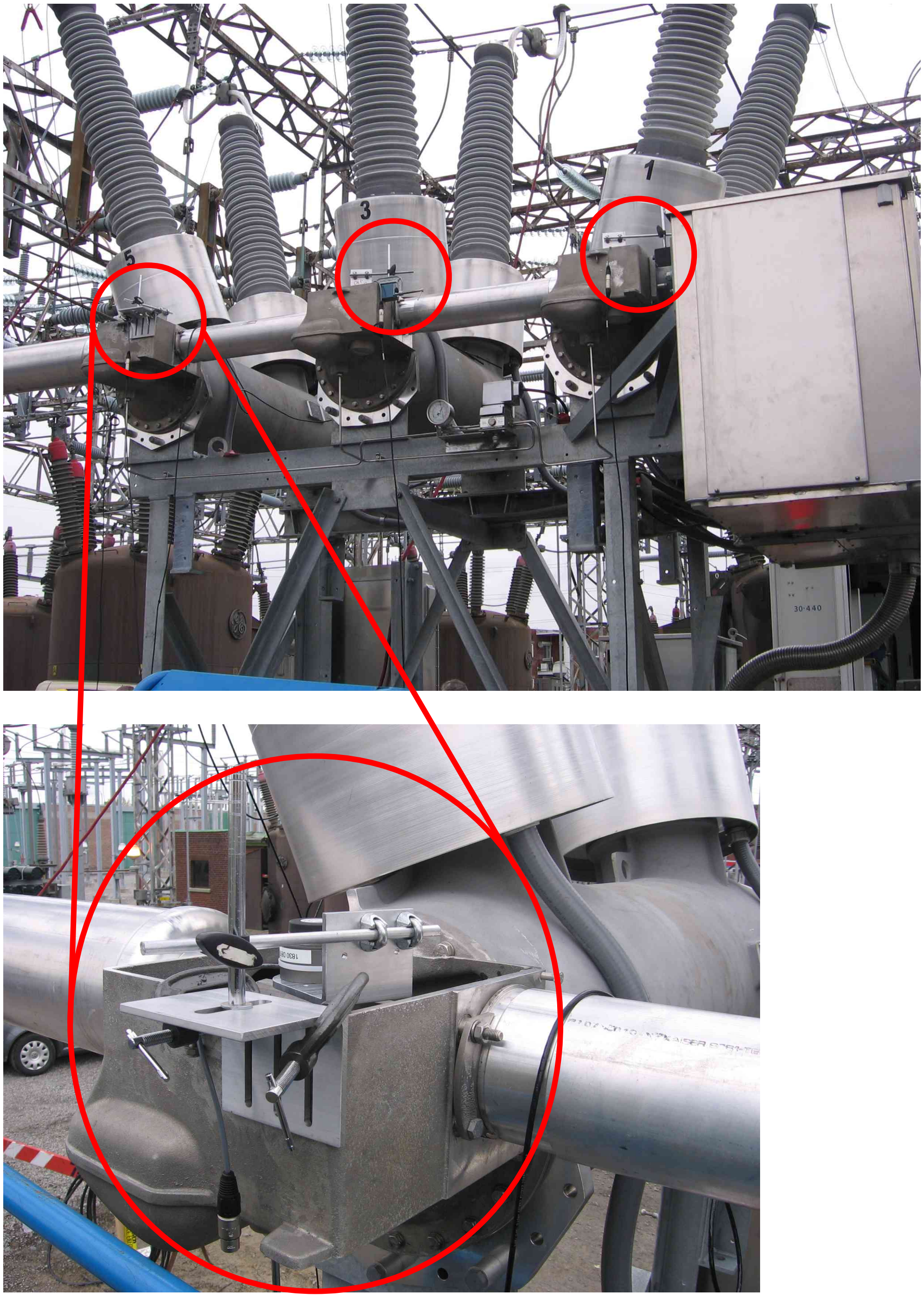


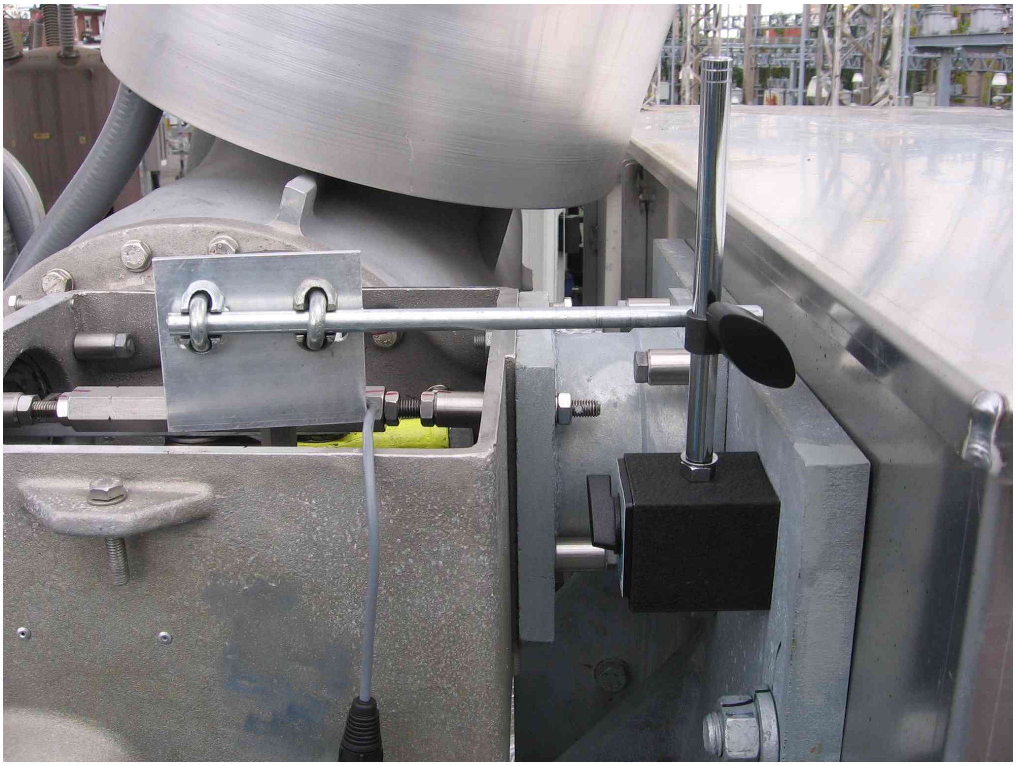
Results obtained on Close-Open operation with the CBA WIN software.

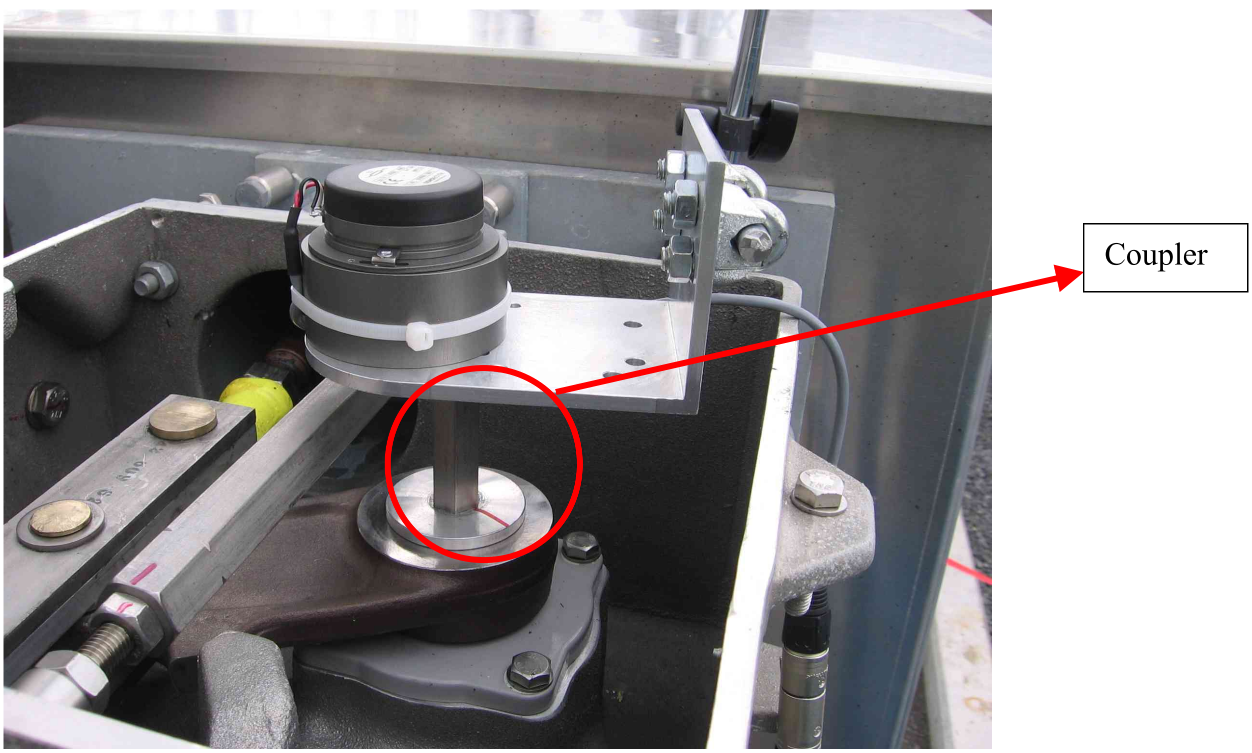


EXAMPLE 15 : HGF DEAD TANK BREAKER BY AREVA (QUÉBEC, CANADA)

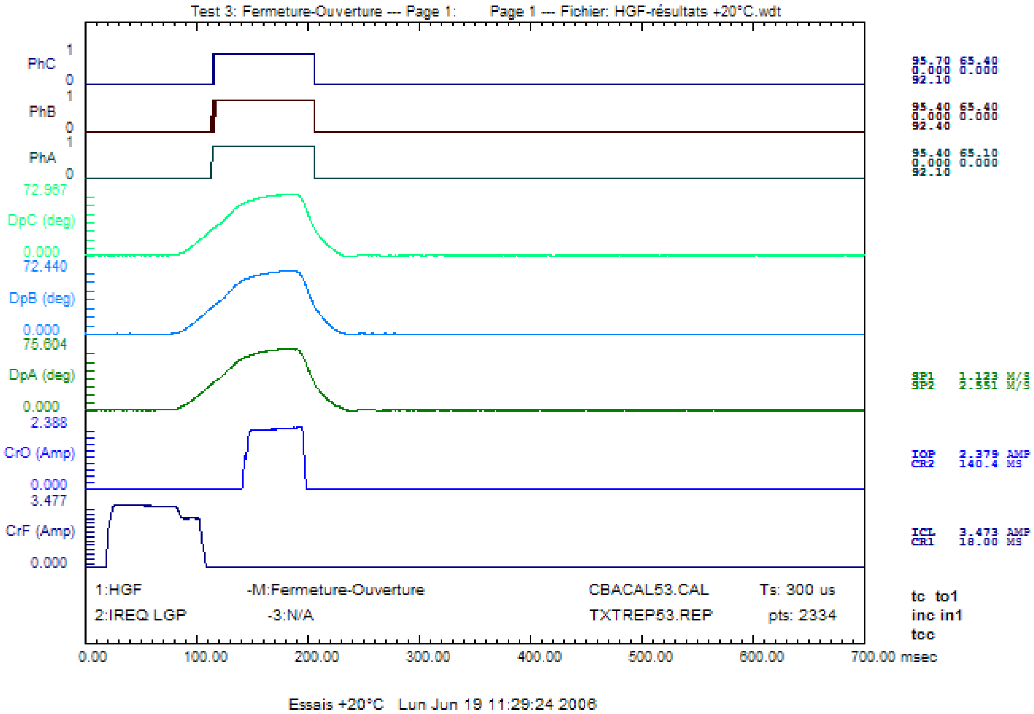
This breaker is a new type by AREVA. It required the use of three ZRT rotary transducers. The mechanical base (one per phase) shown below is our KIT-ZMS. Also, Hydro-Québec has fabricated a special coupling for this breaker, which will be left in place on the breaker for future tests. Three kits are required, one for each phase.27



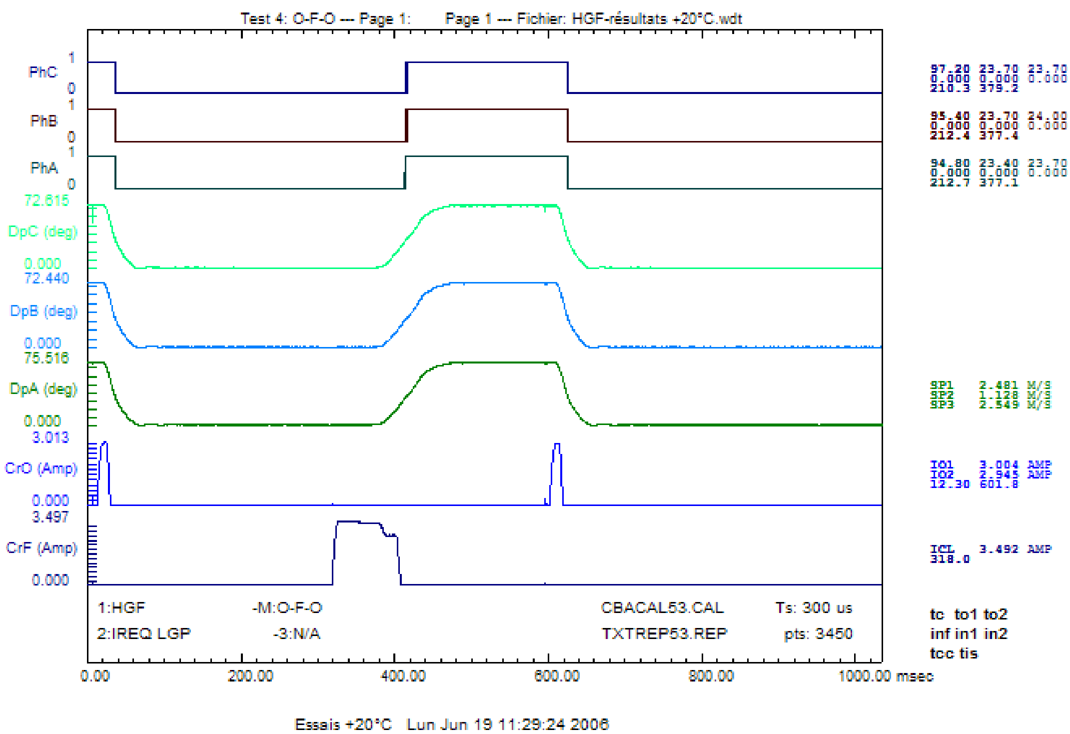



Coupler

Results obtained on Close-Open operation with the CBA WIN software.



Results obtained on Open-Close-Open operation with the CBA WIN software.

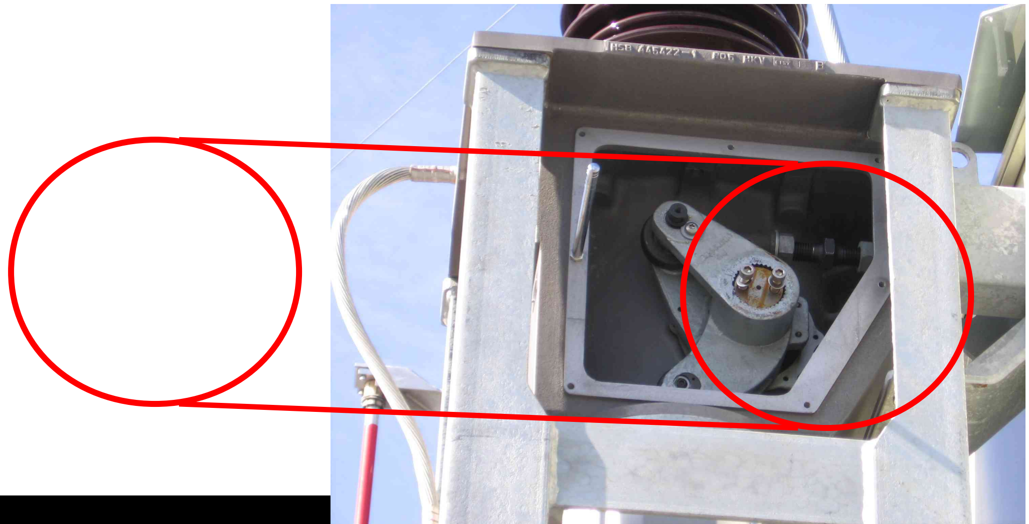


EXAMPLE 16 : HPL 245 FROM ABB (QUÉBEC, CANADA)

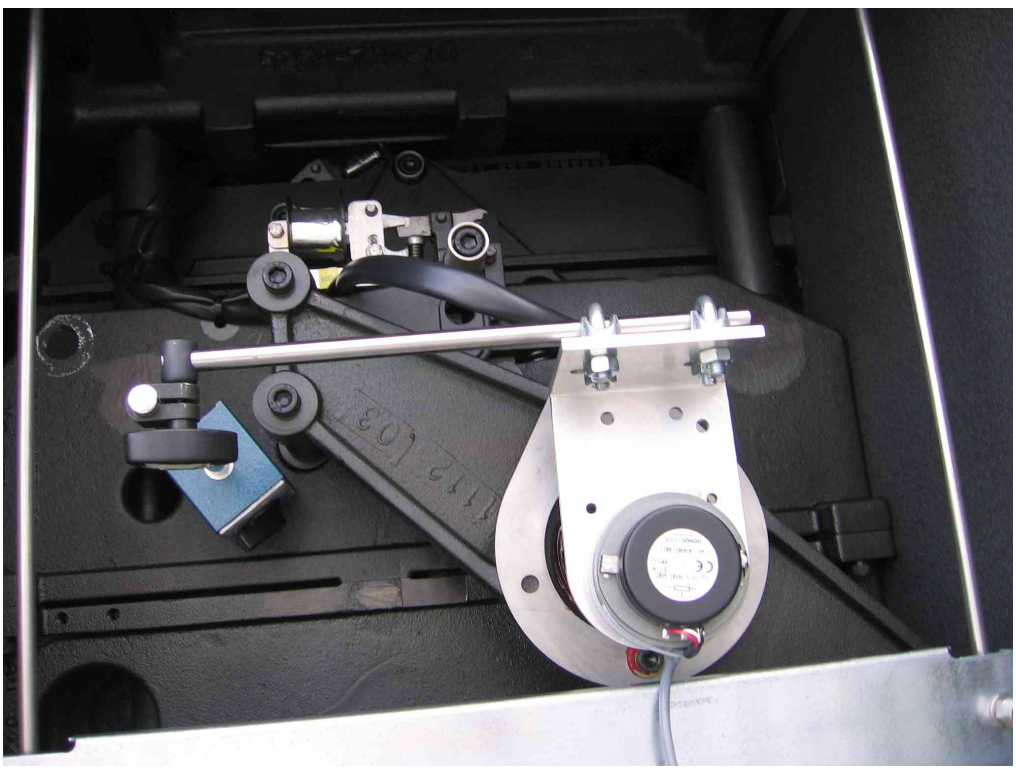
On this SF6 breaker from ABB, during the displacement measures, two parameters are
To be checked : the contact's displacement and the damper's closing displacement. Two rotary transducers per phase are then needed : 1 for the contact and 1 for the damper. For both we will need a KIT- ZMS. Two bases implies the use of a bolt specifically created for this breaker and a coupling piece.
General view of the breaker Moving parts

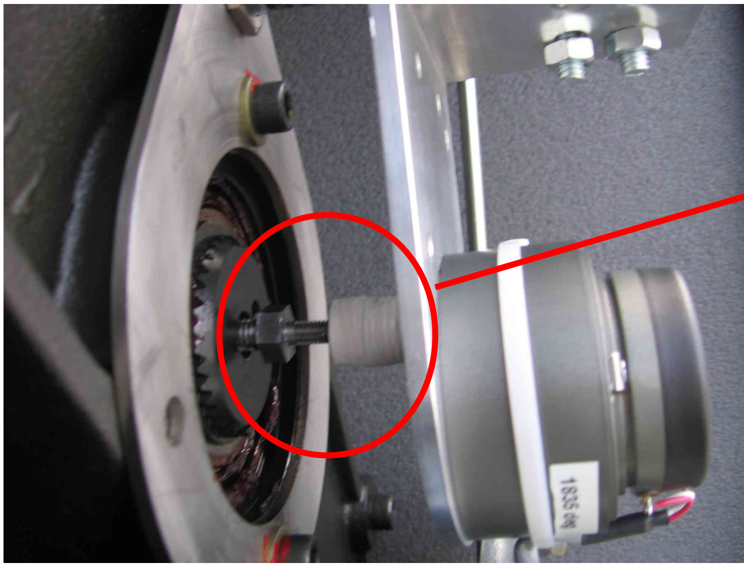
General view of the breaker

Displacement part of the breaker



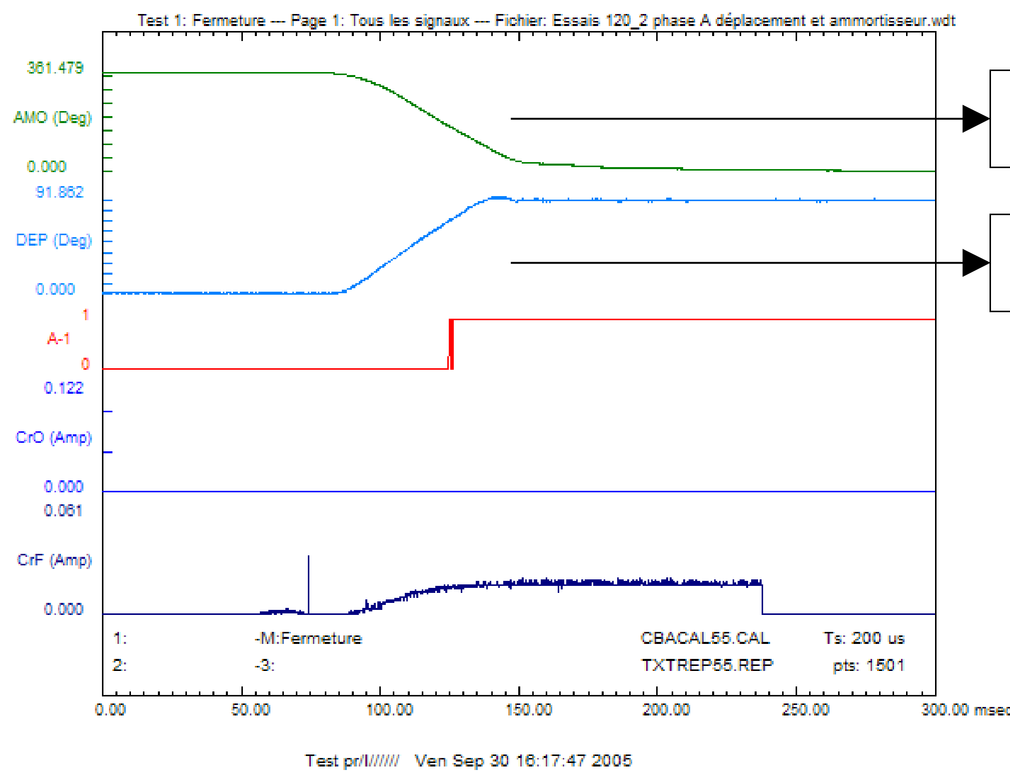
Damper part of the breaker (can not be seen on the picture on the left)





Piece d'accouplement et boulon spécial

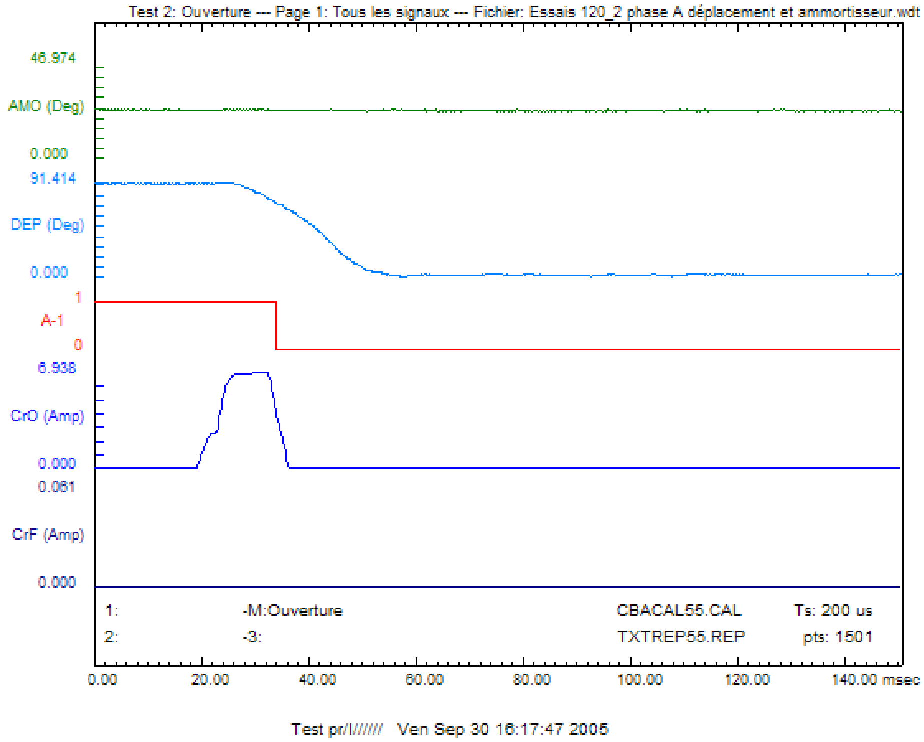
Résultats obtenus à la fermeture avec le logiciel CBA WIN



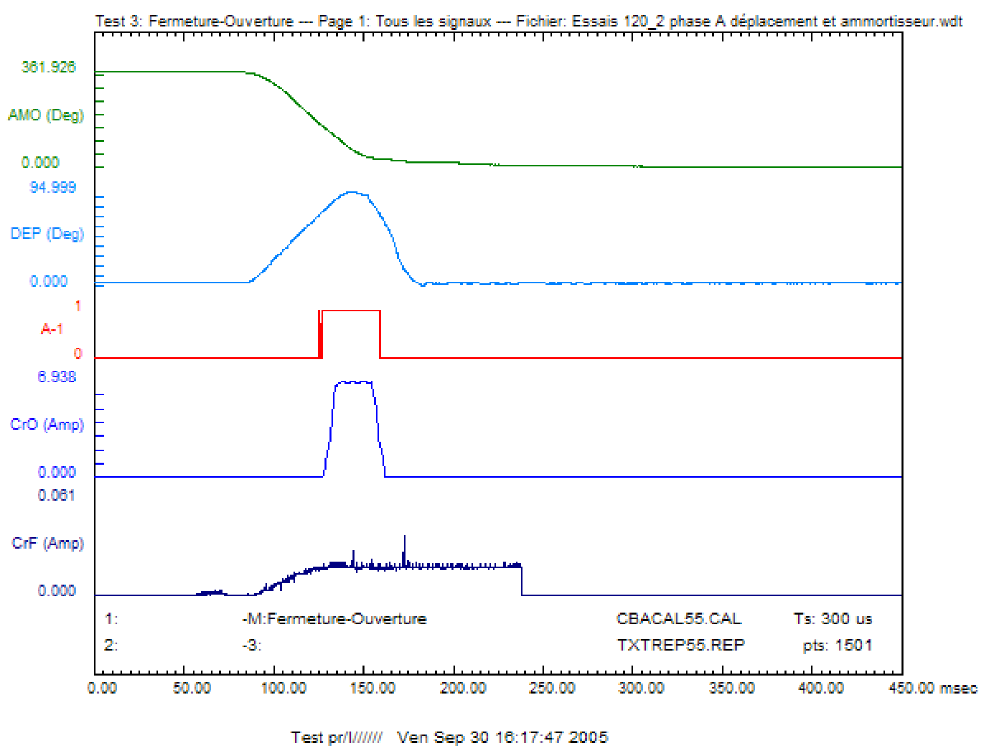
Courbe d'amortissement

Courbe de déplacement

Résultats obtenus à l'ouverture avec le logiciel CBA WIN



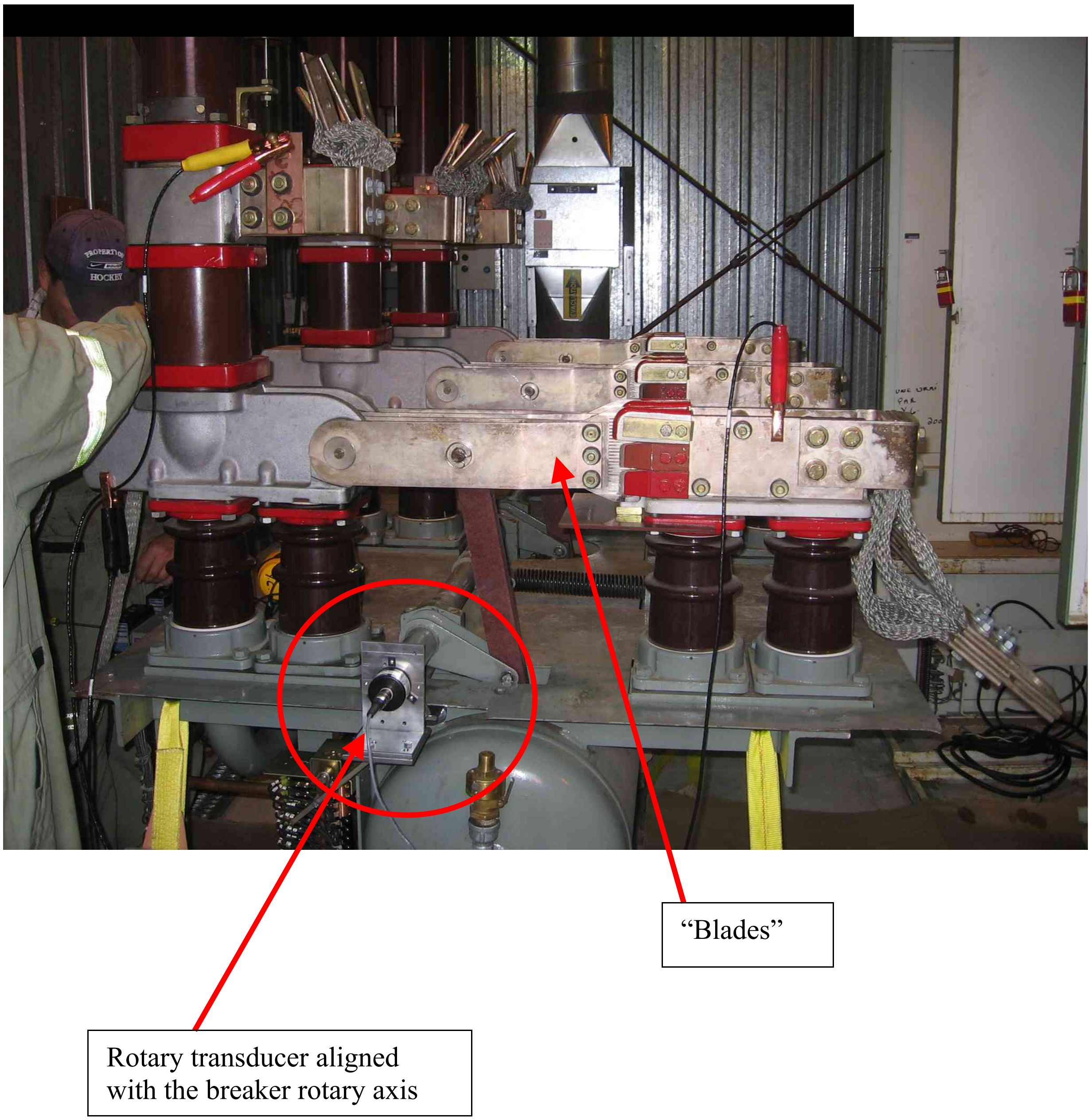
Résultats obtenus à la Fermeture-Ouverture avec le logiciel CBA WIN



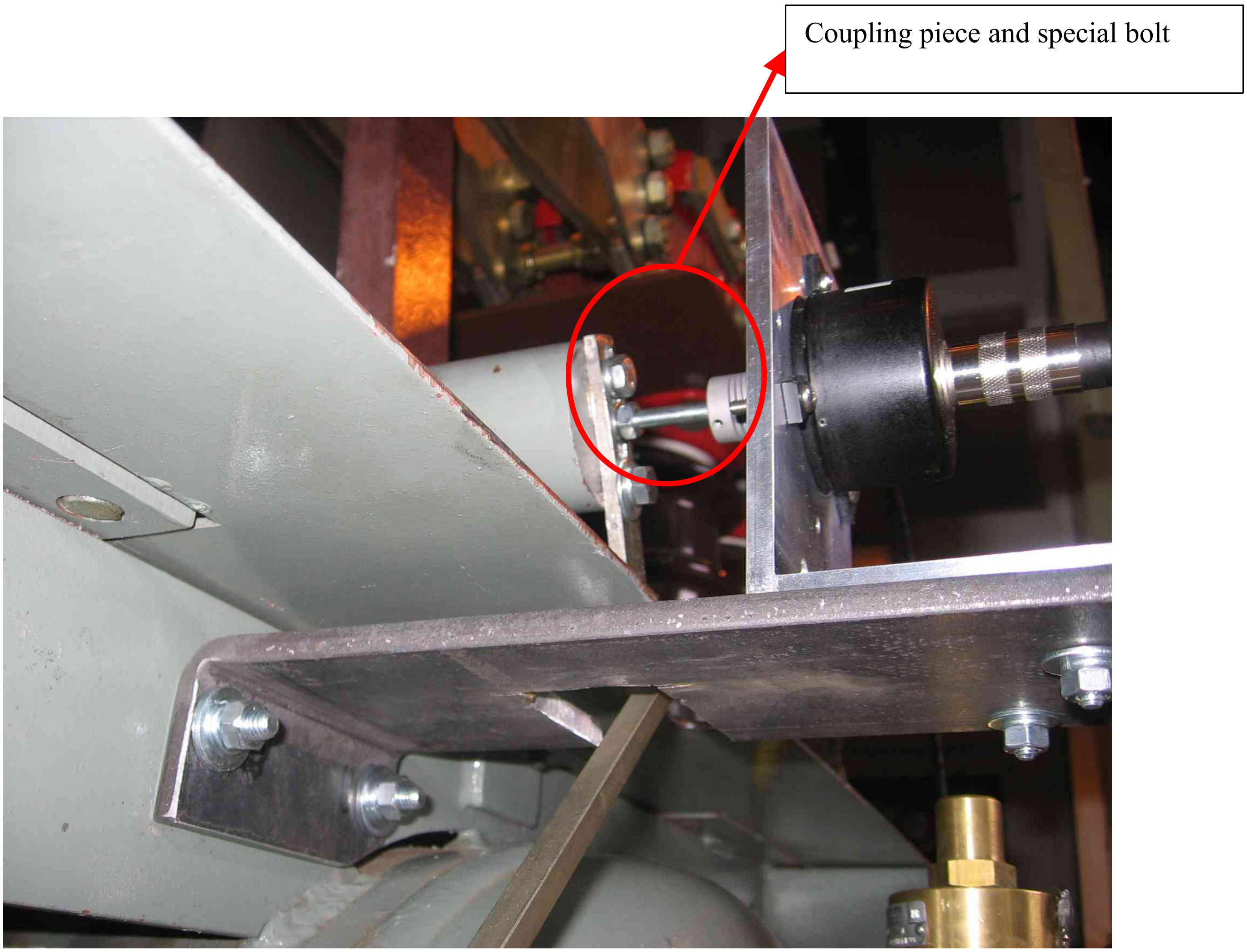
EXAMPLE 17 : DB BREAKER FROM WESTINGHOUSE (QUEBEC, CANADA)

Measuring the travel of the blade can be critical on DB breakers. If the blades are not well aligned or move too fast, it can result in breaker damages which can be costly to repair.

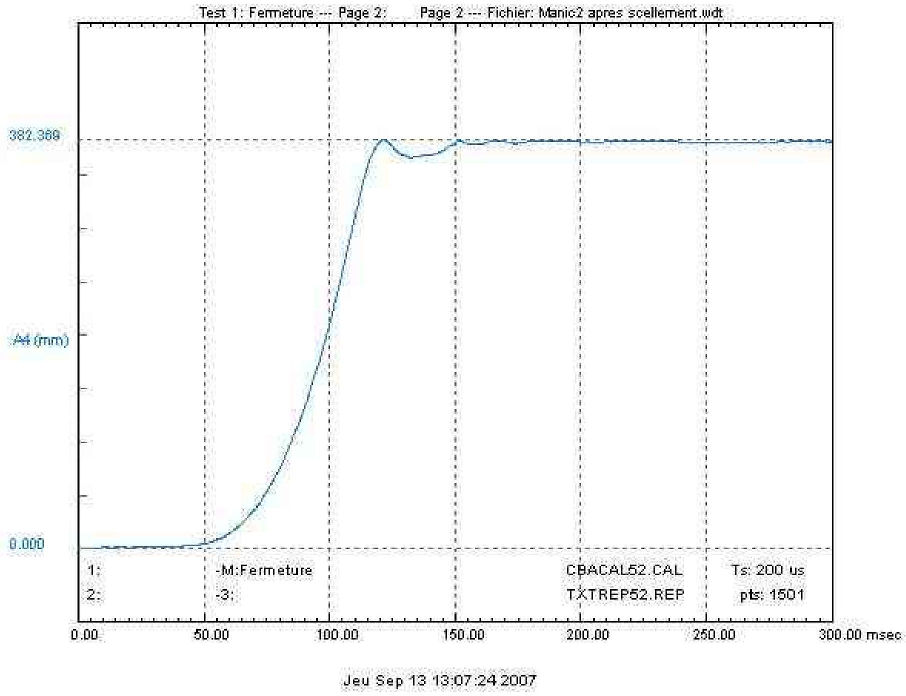
On this air blast breaker, the travel measured is represented by the movement of the blades. Our rotary transducer ZRT must be positioned directly aligned with the breaker rotary axis as shown below. In this case we will use part of the KIT-ZMS



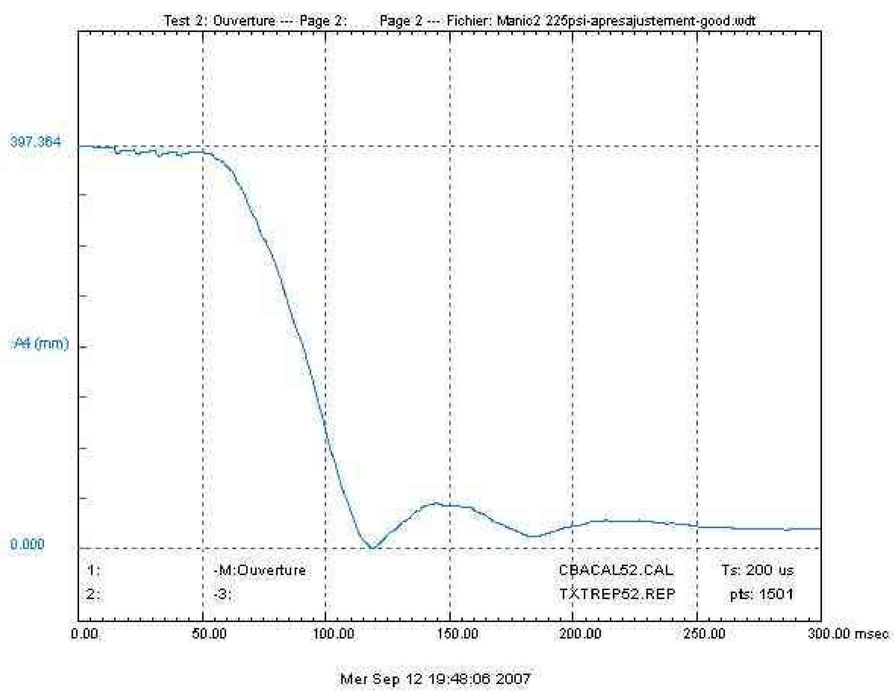
The mechanical support of the KIT-ZMS allows to afix solidly the transducer to the breaker moving part. A special bolt must be inserted onto the breaker rotary axis. In this case the breaker technicians had to thread the axis hole to be able to insert the bolt.



Here is the measured travel curve at the close operation.



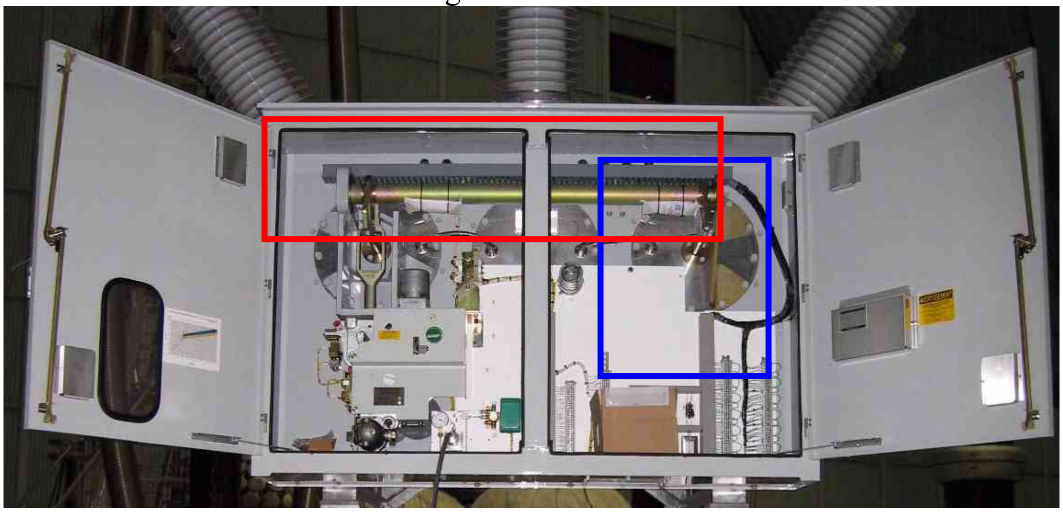
Here is the measured travel curve at the open operation.



EXAMPLE 18: SFMT DEAD TANK BREAKER BY MITSUBISHI (TEST PERFORMED IN QUÉBEC, CANADA)

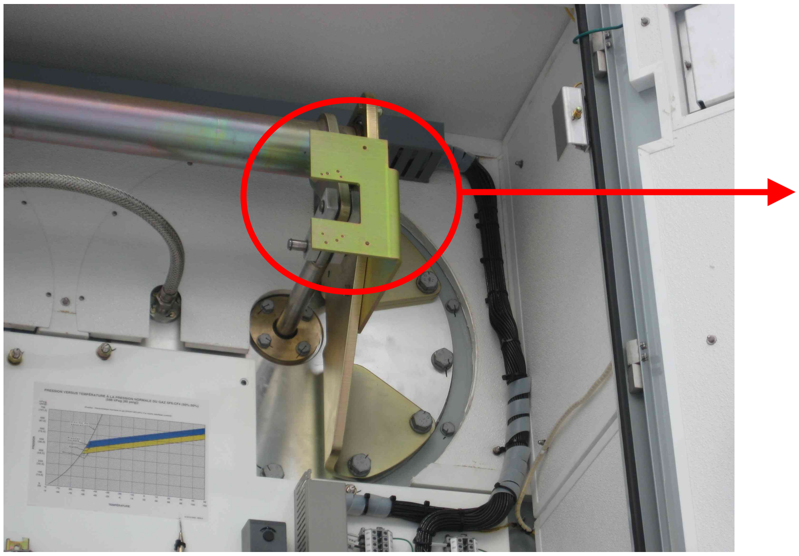
(**Fig 1**) Circuit breaker

This 3 contact dead tank breaker manufactured by Mitsubishi has one contact per phase.
The travel mechanism of this breaker is common to all three phases (see red rectangle in fig.2). Only one single transducer is required to measure the breaker travel. This transducer will be connected in the area outlined in blue in fig. 2.



(**Fig 2**) Mechanism

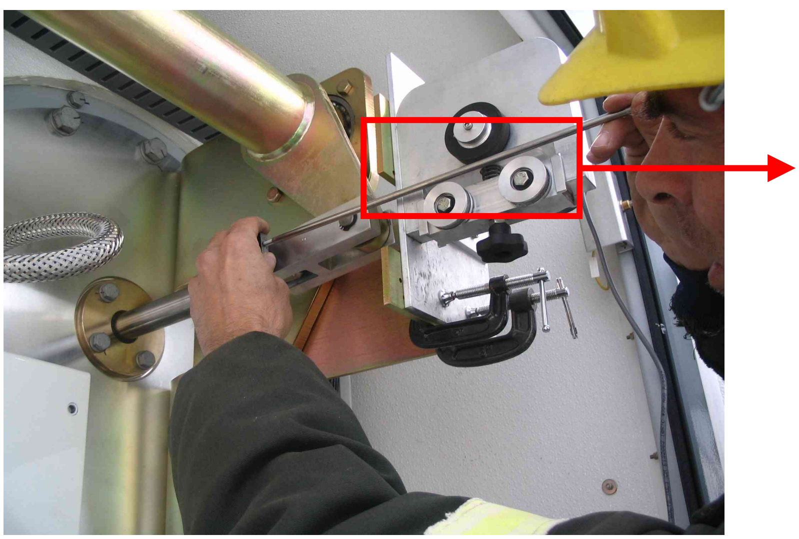
Measurement of the travel and velocity is part of the regular maintenance required by the manufacturer on this breaker.
The contacts move in a linear motion. For this, we can use either a **rotary transducer** or an **optical encoder** connected to our linear to rotary converter **KIT-ZLR** used in conjunction with the **bracket** supplied by the manufacturer (shown in fig. 3).



Bracket

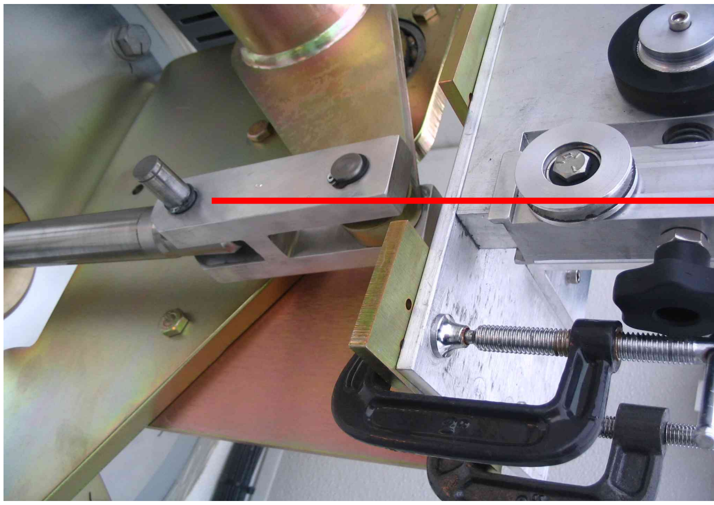
(**Fig 3**) Bracket

To this **bracket** we connect our KIT-ZLR. A rod directly attached to the breaker mechanism will be connected to the three wheels of our KIT-ZLR.



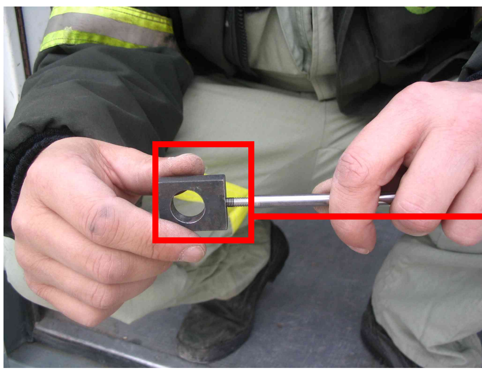
Rod

(**Fig 4**) Rod



Attachment for the Coupling piece

(**Fig 5**) Coupling piece



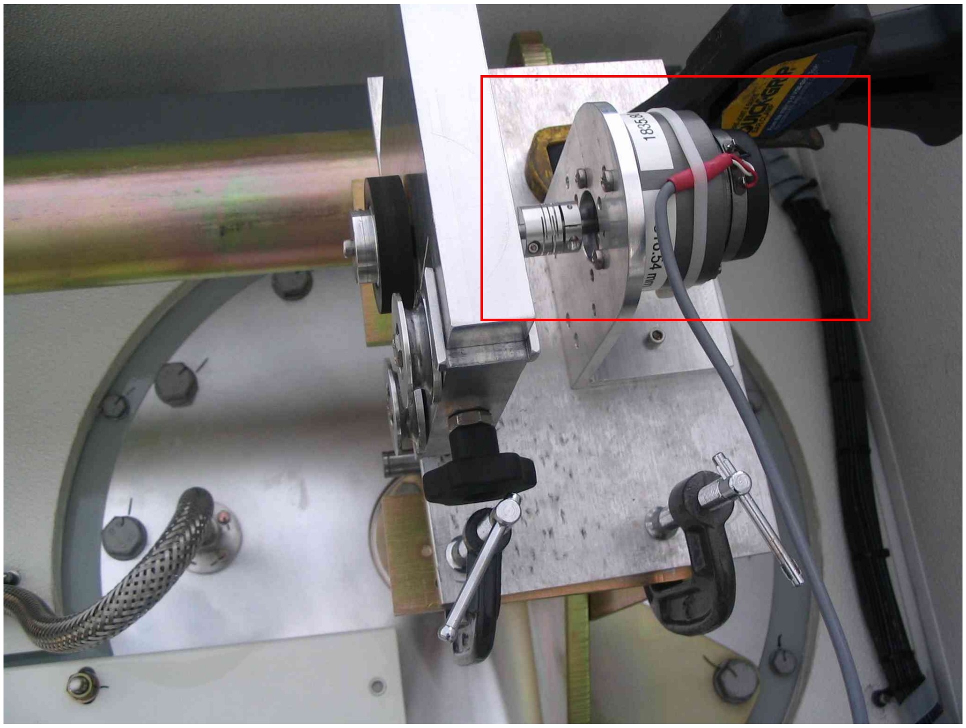
Coupling piece

(**Fig 5 Bis**) Coupling piece

As for all breakers with linear movement, we are going to connect a **rod** to the breaker mechanism fig 4 thanks to the **coupling piece** shown in fig 5bis

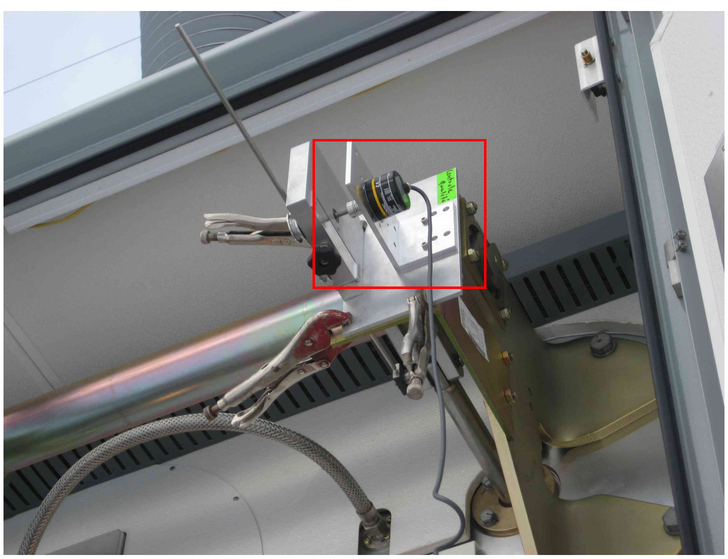
Final mounting

with **rotary transducer**….



(fig 6)

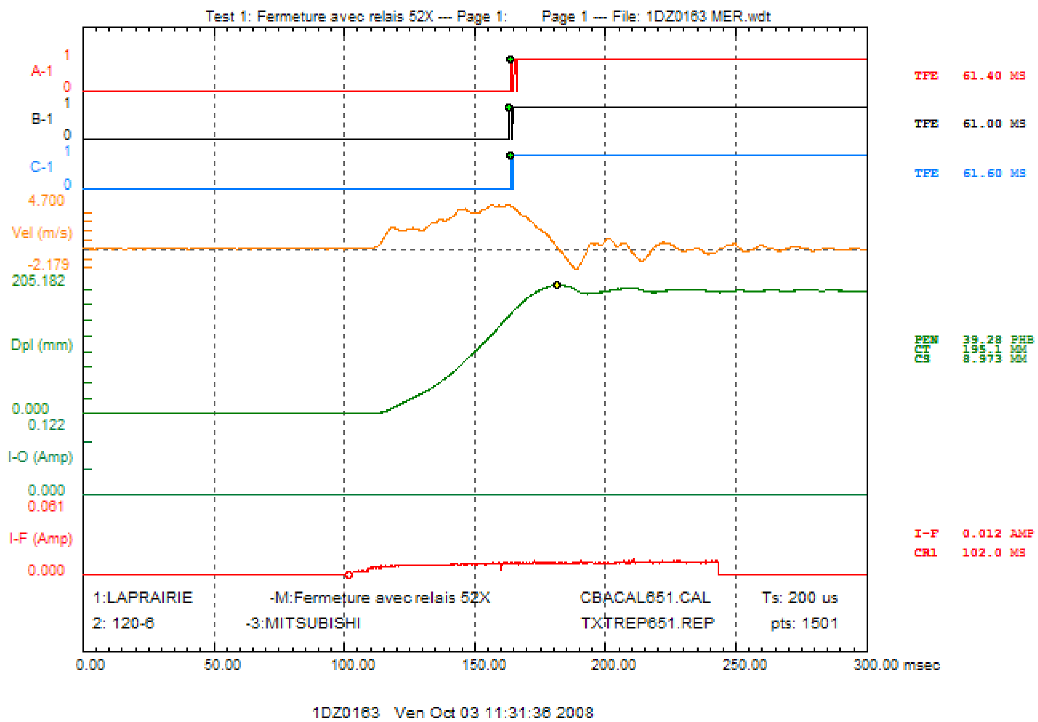
…with **Optical Encoder**



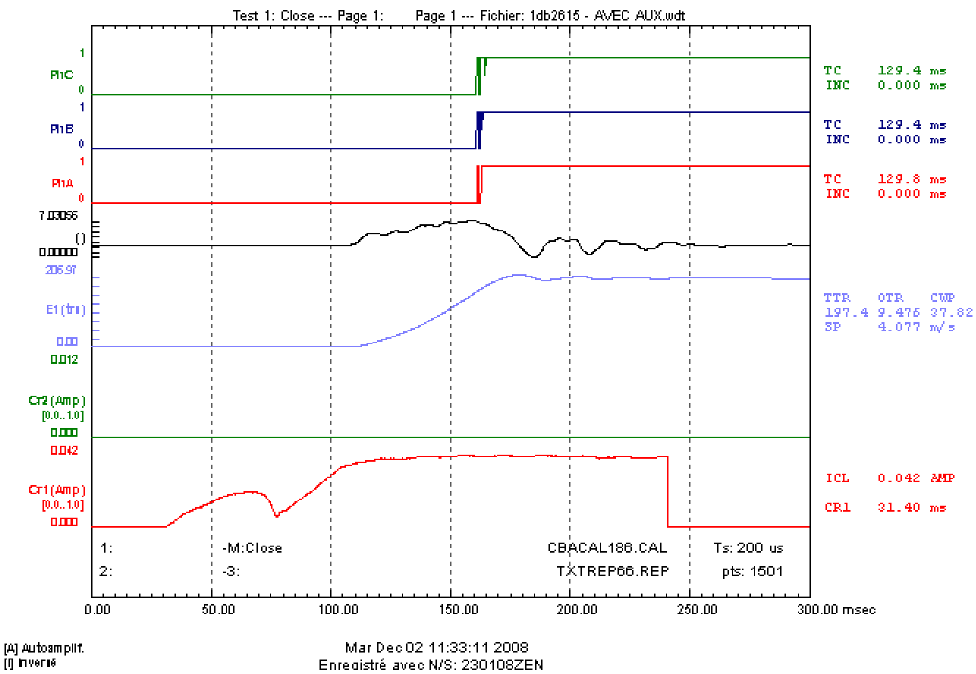
(**Fig 6 bis**)

<u>Results obtained on Close operation with the CBA WIN software.</u>
Below you will see two examples of the Close test done with the two types of transducers. As you can see, the travel curves are almost identical.

<u>With Rotary transducer</u>

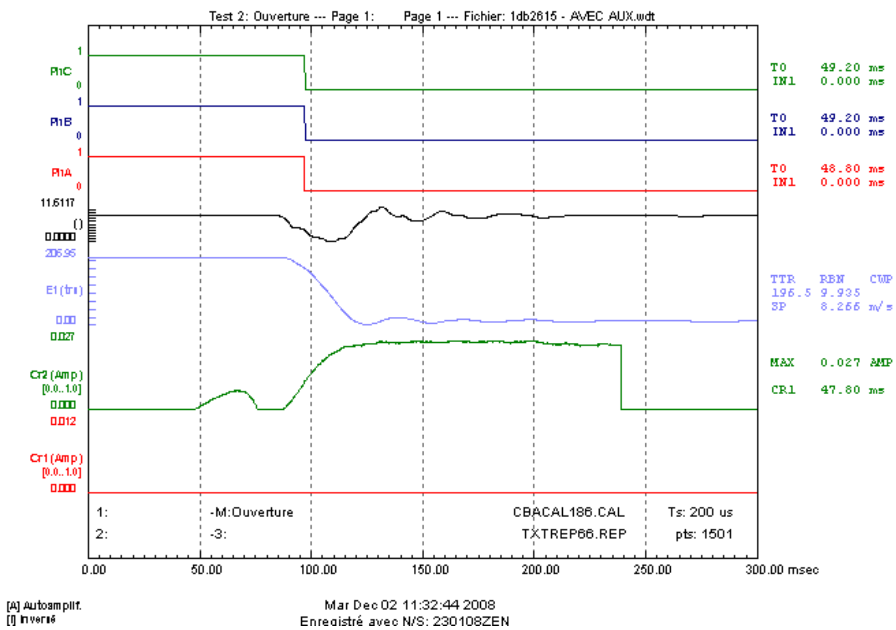


With Optical encoder



Results obtained on Open operation with the CBA WIN software.

With optical encoder



Results obtained on Close-Open operation with the CBA WIN software.

With optical encoder