

IT'S ALL A MATTER OF TIMING: CIRCUIT BREAKER MOTION TESTS - PART II

By Fouad Brikci, Ph.D., Zensol Automation Inc.; Emile Nasrallah, P.Eng., Circuit Breaker Specialist

Editor's Note: This is the second part of this article from the previous issue:

2.5 Displacement curve

The displacement curve is generally drawn with the unit of measurement (millimeters – mm) on the vertical axis and the time in milliseconds on the horizontal axis.

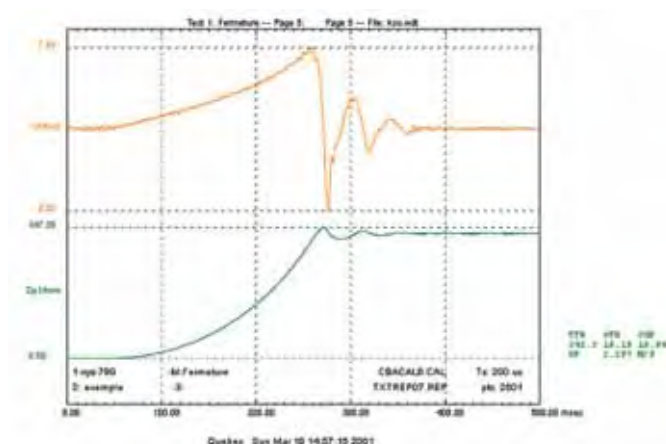
2.5.1 Velocity

The speed of the contacts on opening, as on closing, is an important parameter in the operation of high-voltage circuit breakers. The displacement curve also serves to calculate the speed of the contacts at a specific moment, or instantaneous velocity, or it may serve to calculate the average speed for a predetermined time interval, or average velocity.

2.5.2 Instantaneous velocity curves

The CBA Win software draws a curve of the instantaneous velocities, calculated by deriving the data in the displacement

curve. Below is an example of the derivation of a displacement signal (in green) that produced a curve showing the evolution of the displacement velocity (in orange).



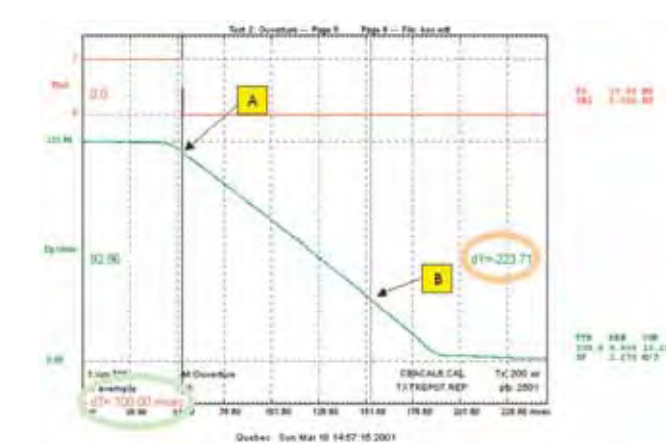
2.5.3 Average velocity

The velocity usually sought is at the moment the breaker contacts make (on Close) or break (on Open). However, since it is difficult to obtain a consistent speed for each operation, it is better to calculate an average speed over a time interval extending before and after this point.

The exact calculation method must be obtained from the circuit breaker's manufacturer so the measured values may be compared to the reference specification of the manufacturer.

2.5.4 Average velocity calculation example for OPEN operation

To calculate the average speed on Opening, point A on the displacement curve, which is the exact moment the main contacts separate, must be determined. Point B is determined by adding dT milliseconds (ms) to the time of Point A.



Megger Quality Affordably Priced



CSA APPROVED - Insulation Tester

- Tough
(Rubber Armored and Drop Tested to 3ft.)
- Safe
(Live Voltage Warning/Lockout)
- Hands Free Operation
(Remote Probe)

\$550-\$850 CND

Megger[®]

www.megger.com

Available at Torbram Electric Supply.

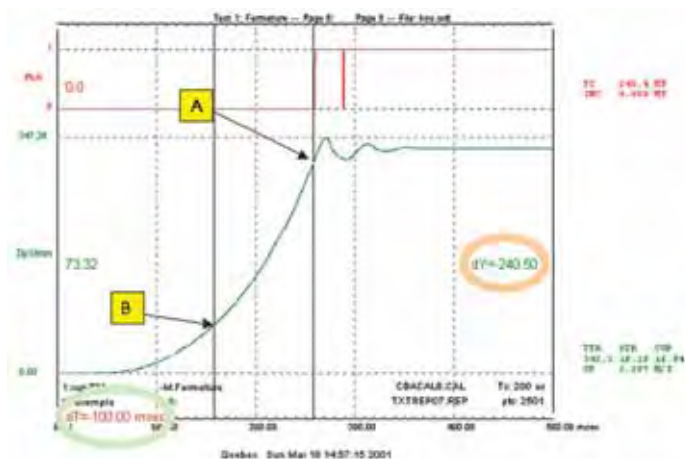
1-800-297-9688

Displacement axis value of point A = YA mm
 Time axis value of point A = XA ms
 Displacement axis value of point B = YB mm

The average velocity on Opening, in meters per second (m/s), is calculated using the following formula:

$V_o(m/s) = (YA - YB) (mm) / (XB - XA)(ms)$
 In this case $XB - XA = dT = 100$ ms
 $YA - YB = dY = 223.71$ mm, so:
 $V_o = 223.71 / 100 = 2.24$ m/s

2.5.5 Average velocity calculation example for CLOSE operation



To calculate the average velocity for a Close operation, point A on the displacement curve, which is the exact moment the main contacts make contact, must be determined. Point B is found by subtracting dT milliseconds (ms) from the time of point A.

Displacement axis value of Point A = YA mm
 Time axis value of Point A = XA ms
 Displacement axis value of Point B = YB mm
 Time axis value of Point B = XB ms

The average velocity on Closing, in meters per second (m/s), is calculated using the following formula:

$V_o(m/s) = (YA - YB) (mm) / (XA - XB)(ms)$
 In this case $XA - XB = dT = 100$ ms
 $YA - YB = dY = 240.5$ mm, so :
 $V_o = 240.5 / 10 = 2.4$ m/s

2.5.6 GENERAL PRECAUTIONS

Certain precautions are to be observed when the transducer is installed and the cables are connected:

2.5.6.1 Inverted curves

In general, displacement curves show the CLOSED position higher than the OPEN position. To observe this rule, the wires must not be interchanged between terminals 2 and 3 of

the transducer. Otherwise, the curve will be drawn upside down (see figures 2.5.6a and b)

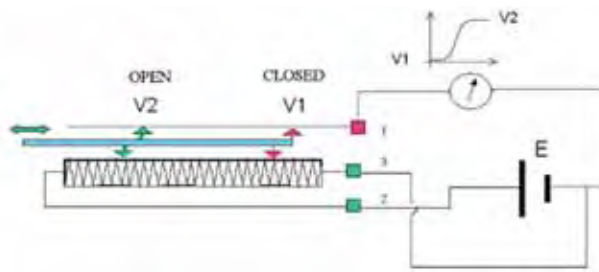


Fig 2.5.6a Connections causing an inverted displacement curve

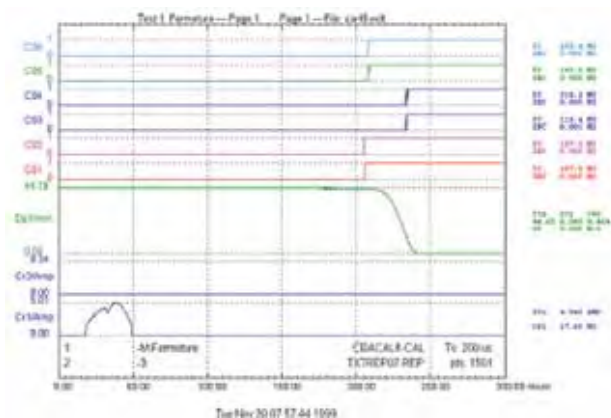


Fig 2.5.6b Inverted displacement curve example (Close)

2.5.6.2 Transducer capacity

When the transducer is installed, it must be ensured that the motion measured does not exceed the capacity of the transducer or it will be damaged and the curve shown will not represent the true motion of the circuit breaker. The following graphic shows an example of what happens when the transducer « bottoms out » before the breaker attains the end of its movement, as seen by the sharp angle at the bottom of the graphic.

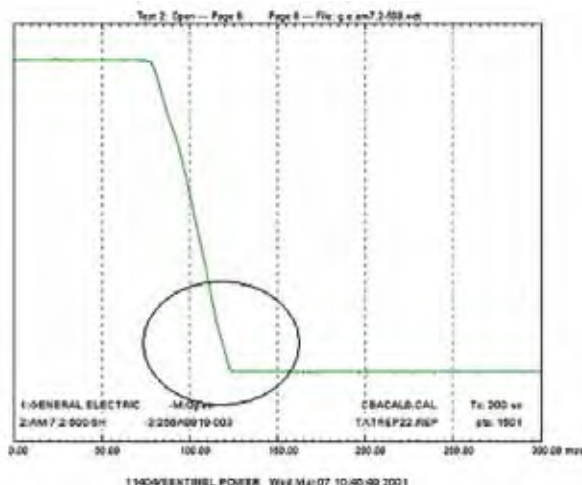


Fig. 2.5.6.2 Example of a displacement curve exceeding a transducer's range