

Circuit breaker testing equipment



Circuit breaker testing

Why?

- Breakers are main protection of power system on high voltage side.
- They are "extended arm" of relay protection trip contacts
- Assurance that the breaker will operate when needed

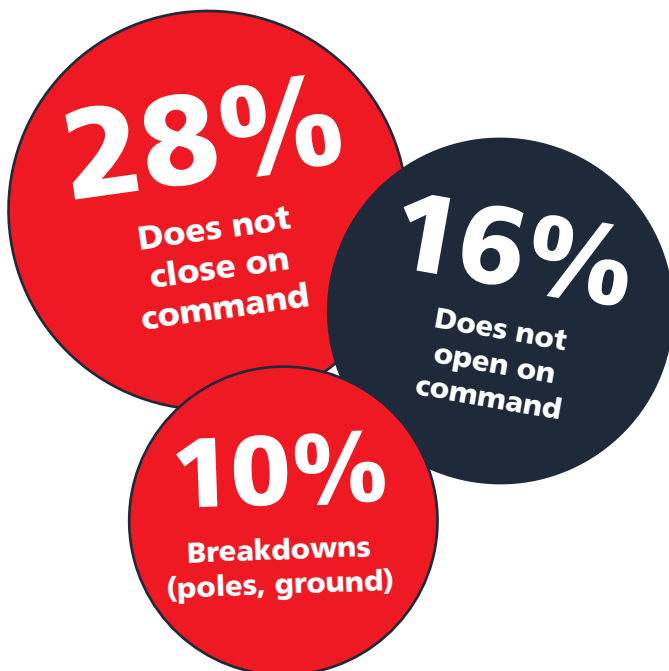
What?

- Insulation resistance test
- Contact resistance (SRM)
- Contact timing
- Travel (stroke, speed, damping, wipe)
- Operating coil current

When?

- Development
- Production
- Commissioning
- Maintenance/fault tracing
- After service (re-commissioning)

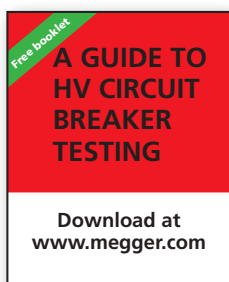
CIRCUIT BREAKER - COMMON FAULTS*



LET US HELP YOU!

Circuit breaker tester selection isn't always straight forward as the tests vary between each type of circuit breaker. Megger is happy to help you select the right product to meet your circuit breaker testing requirements.

**Please contact our
Technical Support Group
which is waiting to assist you.
www.megger.com**



Request a copy of
'A guide to HV Circuit Breaking Testing'

* Cigre 2012

Circuit breaker testing equipment

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The symbol indicates that there is a video in addition to the product information on www.megger.com.

Know-how and tools

High voltage circuit breakers are extremely important for the function of modern electric power supply systems. The breaker is the active link that ultimately has the role of operating the primary circuit when a fault has occurred. The breaker has to perform its duty within a few milliseconds, after months, perhaps years of idly standing by.

Since Reliability Centered Maintenance (RCM) and condition based maintenance have become the established strategies for most owners and operators of electric power supply systems, the need for reliable and accurate field test instruments is obvious.

Ever since the introduction of the first microprocessor based breaker analyser in 1984, many new user requirements have lead Megger to provide test engineers in the field with effective tools for determining the status of circuit breakers.

PRODUCT SELECTION GUIDE

MEASUREMENT ENTITY	CIRCUIT BREAKER CONFIGURATION	EGIL MODEL / CONFIG	EGIL200 MODEL	TM1700 MODEL	TM1800 MODULES / CONFIG
Main and PIR contact timing	1 break / phase	All EGIL	1 break / phase All EGIL200	All TM1700	1 Timing M/R
	2 break / phase	¹⁾	2 breaks / phase EGIL220 and EGIL240	All TM1700	1 Timing M/R
	≥ 3 break / phase	–	4 breaks / phase EGIL240	²⁾	2-7 Timing M/R
DualGround™ Timing		–	with DCM accessories ⁸⁾	with DCM accessories	with DCM accessories
Coil current	1 operating mech.	All EGIL	1 operating mech. All EGIL200	All TM1700	1 Control
	3 operating mech.	–	3 operating mech. All EGIL203 (with additional analog channels)	TM1720/50/60	2 Control or 1 Control + 1 Analog + 3 ext. current clamps
Motion	1 operating mech.	EGIL Motion & EGIL SDRM	1 operating mech. All EGIL200	All TM1700 ³⁾	1 Analog or 1 Digital ⁴⁾
	3 operating mech.		3 operating mech. All EGIL200	All TM1700 ³⁾	1 Analog or 1 Digital ⁴⁾
Auxiliary contact timing	1 operating mech.	All EGIL	1 op mech All EGIL200	All TM1700 ⁵⁾	1 Control ⁵⁾ or 1 Timing AUX
	3 operating mech.	–	3 op mech All EGIL200 ¹⁾	TM1720/50/60	2 Control ⁵⁾ or 1 Control + 1 Timing AUX
	≥ 3 aux / phase	–	>3 aux/ph All EGIL200 ^{1) 7)}	TM1720/50/60	1 Control ⁵⁾ and 1 Timing AUX or 2 Timing AUX
SRM ⁶⁾	Any	EGIL SDRM	All EGIL203 (with additional analog channels) ^{8) 9)}	All TM1700 with Analog channel	1 Timing M/R + 1 Analog
DRM ⁶⁾	Any	EGIL SDRM	All EGIL203 (with additional analog channels) ⁸⁾	All TM1700 with Analog channel	1 Timing M/R + 1 Analog + 1 Digital ²⁾

¹⁾ Phase by Phase

²⁾ Phase by phase and max 6 breaks / phase

³⁾ With 6 digital transducers or option with 3 analog channels

⁴⁾ If digital motion transducer

⁵⁾ TM1710/40 52a/b timing only

⁶⁾ SDRM201/202 accessory required

⁷⁾ Max 3 auxiliary contacts

⁸⁾ Check availability with the local sales representative

⁹⁾ Possible through manual entry

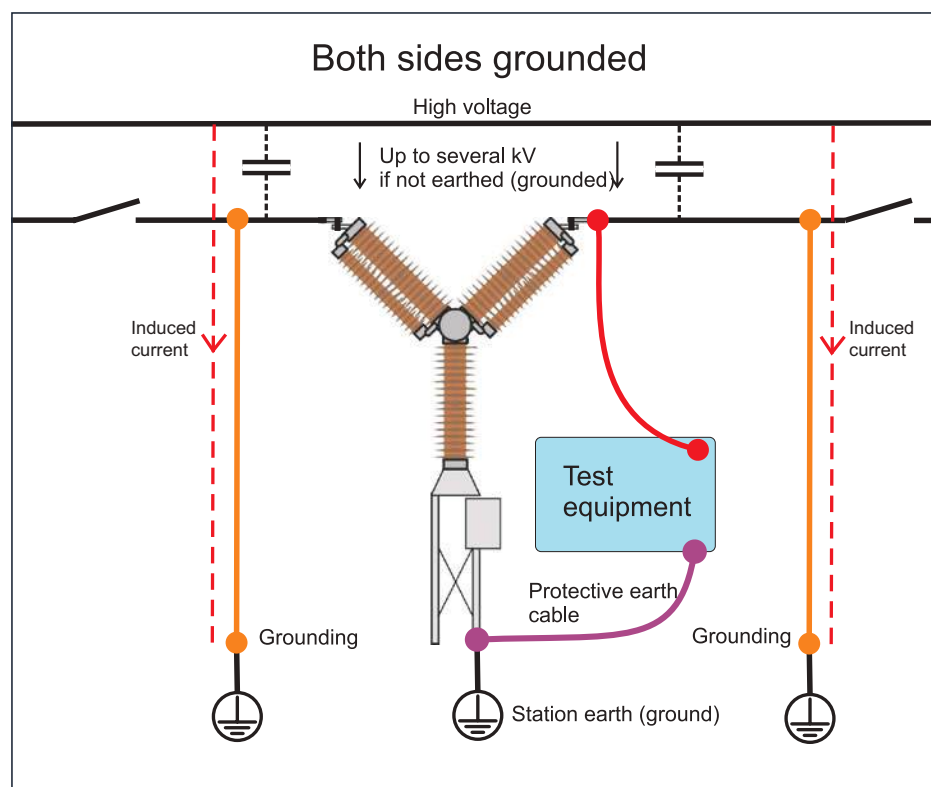
Safety first

DualGround™



The international standard IEC EN 50110-1 states that all parts that are to be worked on shall be earthed and short-circuited. Therefore Megger equipment and methods that support DualGround™ testing are associated with the DualGround symbol. This symbol certifies the use of ground-breaking technology and methods that enable a safe, fast and easy workflow with both sides of the circuit breaker grounded throughout the test.

- Resistance
- Timing
- Motion
- DRM
- Vibration



DualGround™ Timing

DCM Module

DualGround™ timing using the patented DCM module makes the testing safe and time saving by keeping the circuit breaker grounded on both sides throughout the test. The DCM module uses a patented measuring technology called Dynamic Capacitive Measurement, superior to the older DRM method. With DCM it is possible to perform DualGround™ timing on all kind of breakers, including breakers with low resistive ground loop, i.e. GIS or GCBs.



Circuit breaker analyser system



Modular circuit breaker analyser for advanced measurements of any circuit breaker

TM1800

- Modular design to precisely match your needs
- Adapt hardware configuration in the field
- Fast and safe with DualGround™ testing
- First trip and online measurement
- Rugged and reliable for field use
- On-screen assistance

The modular design makes it possible to configure the TM1800 for measurements on all known types of circuit breakers in operation on the world market. The robust design product contains powerful technology that streamlines circuit breaker testing. Sophisticated measurement modules enable great time savings as many parameters can be measured simultaneously, eliminating the need for new setup each time. The circuit breaker can be grounded on both sides throughout all tests including timing due to the patented DCM module. DualGround™ testing makes the testing safe and time saving.



Circuit breaker analyser for advanced measurements of modern HV CBs

TM1700 Series

- Available with full stand-alone functionality or as data acquisition units without user interface
- Fast and safe with DualGround™ testing
- Reliable and accurate test results in noisy high voltage substations
- First trip and online measurement
- On-screen assistance

The little brother in the TM-family have used much of the technology from the top of the line version TM1800 and is limited to timing of 6 main contacts. TM1700 comes in five models starting from PC-remote controlled to fully stand-alone. One important feature is the test wizard that quickly guides the operator through the test setup. All inputs and outputs on the instrument are designed to withstand the challenging environment in high voltage substations and industrial environments.

Accurate PIR measurement

The timing measurement inputs are using a patented Active Interference Suppression algorithm to ensure correct timing and accurate PIR (Pre-Insertion Resistor) values even at high capacitively coupled interference currents.

Circuit breaker analyser system

**MV and HV circuit breaker analyser
for standard measurements**

EGIL200

- Mid-range circuit breaker analyser providing a new level of accuracy to your standard measurements
- Intuitive operation offers final measurement results with a minimum of user interaction
- Measurement performance inherited from market leader Megger TM series circuit breaker analysers
- Instrument and accessories designed for the most demanding field conditions
- Easy-to-use and intuitive interface

EGIL200 is the first incarnation in a new range of circuit breaker analysers from Megger. It has been designed in close cooperation with global industry reference groups drawing experience from the market leading and hugely successful Megger TM series of circuit breaker analysers.

The emphasis in the development of the EGIL200 has been on ease of use, ensuring that the time spent on setting up measurements is kept to a minimum. As such, with the EGIL200, you can get your test results done in no time.

EGIL200 offers all standard measurements from IEEE C37 and IEC 62271 standards and brings high-end features from the TM series into the affordable mid-range segment.



Circuit breaker analyser system

Basic MV circuit breaker analyser

EGIL

- Lightweight <7 kg
- Extremely easy-to-use and reliable
- Two dedicated timing channels for auxiliary contacts
- Multipurpose analog measurement channel
- DRM with the SDRM201 accessory

EGIL is designed for medium voltage breakers having one main contact per phase, to measure three phases simultaneously. Main contacts and parallel contacts having pre-insertion resistors are recorded and displayed simultaneously. Coil currents and two auxiliary contacts are also measured as standard. EGIL can be equipped with an analog channel e.g. for motion measurement and a USB port for communication with the CABA computer program. EGIL with the SDRM option together with the SDRM accessory enables static and dynamic resistance measurements.



Accessories



Static & Dynamic Resistance

SDRM202

- Accurate DRM results through high current supply 2 x 200 A
- Fast charge – minimum waiting intervals
- Low weight, 4.3 kg (weight of the test unit is 1.8 kg and weight of cables 1.3 kg)

DRM was introduced by Megger in the early 90's to assess the condition of the contacts and the arcing contact length in SF₆ Circuit Breakers. The SDRM202 is the 3rd generation and is based on the Megger patented super cap technology which offers high current from an extremely light weight package. The capacitors charge from completely drained to full in about 2 minutes which practically removes waiting time between measurements. The SDRM202 is put close to the interrupters which saves a lot of cable weight.

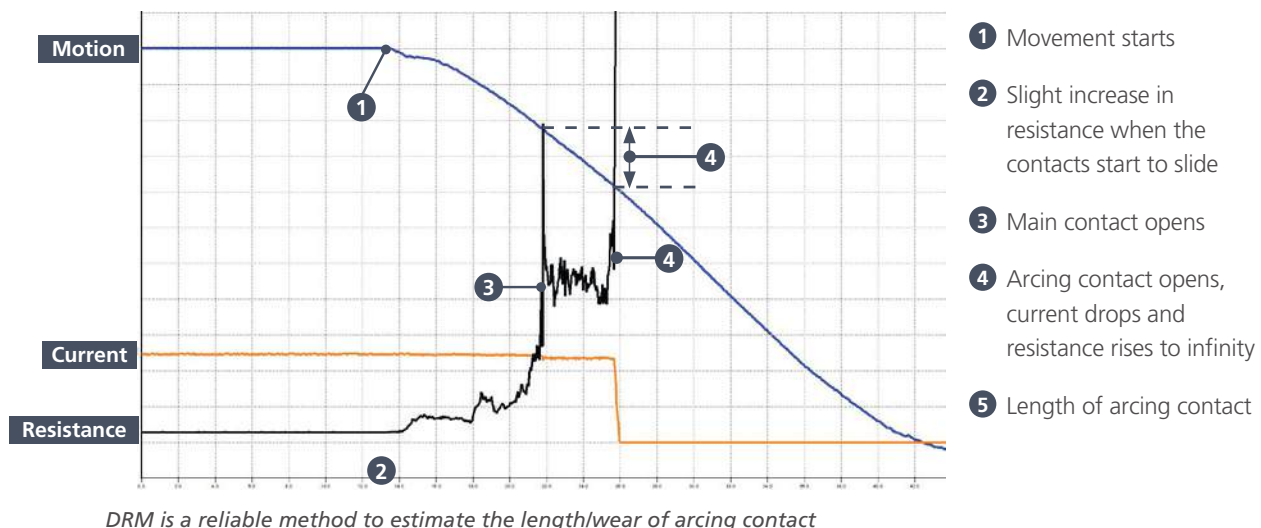
SDRM is compatible with all Megger circuit breaker analysers and measures both the contact resistance during an operation (DRM) as well as the static contact resistance.

Static resistance measurement (SRM)

A static resistance value provides a reference value for all types of electrical contacts and joints. If the contact resistance is too high this will lead to power loss and temperature rise, which often leads to serious trouble. IEC 62271-1 states that this type of resistance is to be measured using a current ranging between 50 A and the breaker's nominal current. IEEE C 37.09 specifies a minimum test current of 100 A.

Other international and national standards set forth similar guidelines in order to eliminate the risk of obtaining erroneously high values if the test current is too low.

Dynamic resistance measurement (DRM)



A circuit breaker will have arcing contact wear by normal operation as well as when breaking short-circuit currents. If the arcing contact is too short or in bad condition, the main contact surfaces can be deteriorated by arcing, resulting in increased resistance, excessive heating and in worst-case explosion.

The main contact resistance is measured dynamically over an open or close operation in DRM. If contact movement is recorded

simultaneously, you can read the resistance at each contact position, which is used to reliably estimate the arcing contact length. The only real alternative in finding the length of the arcing contact is dismantling the circuit breaker.

A reliable DRM interpretation requires high test current and good measurement resolution.

Power supply unit

B10E

- Stable AC and DC power supply for circuit breaker testing
- Continuously variable 24-250 V AC or DC output
- Separate outputs for close coil, trip coil and spring charging motor voltage
- Direct triggering for minimum pick-up test

Supplies power conveniently to breaker coils and springcharging motors. Since this power is unaffected by load and virtually ripple-free, it's ideal for minimum pick-up and under voltage tests that are stated in the international standard IEC 62271-1.



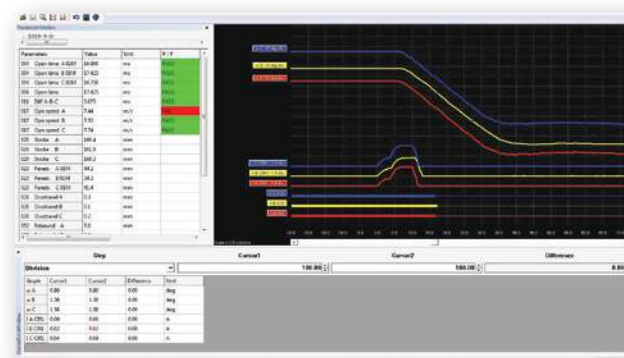
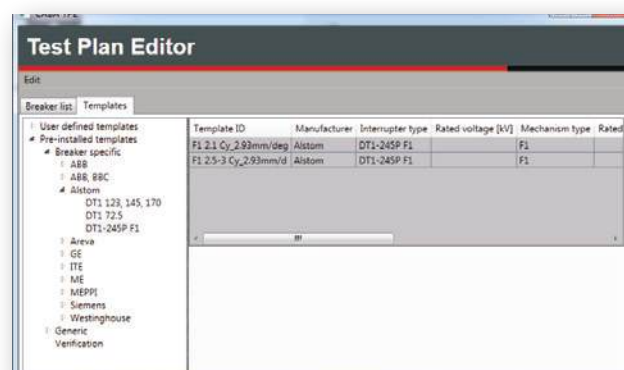
Breaker Analyser software

CABA Win

- Pre-defined standard test plans enables quick and easy testing
- Test Plan Editor to easily create customized test plans
- Accurate comparison with historical test results
- Convenient report generation with Word, Excel or List & Label
- Over 300 predefined calculated parameters

After connecting your breaker analyser to a computer (PC), you can use CABA to speed up testing and improve repeatability. CABA can be used with the TM1800, TM1700 and EGIL. Results are presented on the display both graphically and in table form after each breaker operation so that you can make comparisons with limit values and previous test results.

The Test Plan Editor (TPE) enable you to create individual test plans tailored to individual breakers. Timesaving conversion tables simplify the task of connecting and linking transducers to the breaker. Reports created in your own format can be obtained easily using standard field linking functions.





Vacuum interrupter tester

Vacuum interrupter tester

VIDAR

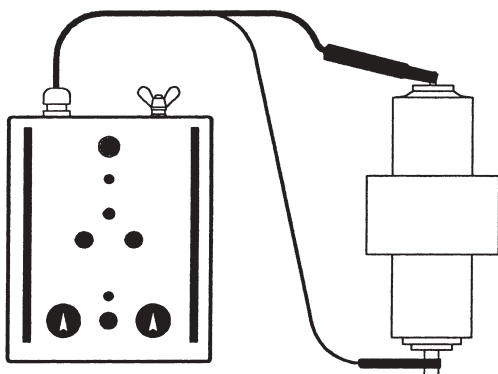
- Low weight and small size
- Fast test and easy to use
- Immediate pass/fail feedback
- 10-60 kV DC test voltage

VIDAR tests vacuum in circuit breaker chambers using DC voltage. When AC is used, the capacitive component of the current flowing through the chamber must be tested. With DC, this is eliminated.

The resistive component of the leakage current is very small compared with the capacitive component, because of the high dielectric strength of the chamber. The DC flashover voltage is equal to the peak AC voltage. Testing can be completed in a few minutes.

The VIDAR vacuum interrupter tester is used to test the ability of the vacuum chamber to inhibit flashovers. The rugged, lightweight, compact and portable VIDAR is ideal for field work and shop floor applications.

The internal pressure of vacuum chambers do not last forever. Leakage starts after years or decades and the interrupters fill with air making the breaker unreliable. In most cases, the leakage process is rapid once it has started. In addition to leakage, dirt on the poles and on the exterior surface of the vacuum chamber can make it unsafe during operation. The mechanics of the breaker can become misaligned so that the distance between the poles no longer is adequate.



Connection diagram for the VIDAR



Contact resistance testing

For testing circuit breaker contact resistance in compliance with IEC62271 and IEEE C37.09 specialized low resistance testers are used with a high output current. For this and other applications that require a higher test current, we offer an extensive range of testers that will fit your testing regime.

A high current output is one of the qualifying characteristics of a true low resistance ohmmeter. Ordinary multimeters do not supply enough current to give a reliable indication of the current-carrying capabilities of joints, welds and bonds under real operating conditions.

Little voltage is required, as measurements are typically being made at the extreme low end of the resistance spectrum.

SELECTION GUIDE MICRO-OHMMETERS



TECHNICAL DATA	MOM2	DLRO 100	DLRO 200	DLRO 600
Test currents	220 A	10 - 110A	10 - 200 A	10 - 600 A
Current steps		1 A	1 A	1 A
Max test time at max current	3 sec - discharging	10 min	> 10 min	> 60 sec
Max continuous current	N/A	100 A (10 min)	200 A (15 min)	200 A (15 min)
Measurement range	0 $\mu\Omega$ - 1000 m Ω	0.1 $\mu\Omega$ - 1.999 Ω	0.1 $\mu\Omega$ - 999.9 m Ω	0.1 $\mu\Omega$ - 999.9 m Ω
Best resolution	1.0 $\mu\Omega$	0.1 $\mu\Omega$	0.1 $\mu\Omega$	0.1 $\mu\Omega$
Inaccuracy	$\pm 1\%$ + 1 $\mu\Omega$	$\pm 0.2\%$ + 2 $\mu\Omega$	$\pm 0.7\%$ + 1 $\mu\Omega$	$\pm 0.6\%$ + 0.3 $\mu\Omega$
Ripple free DC		x		
DualGround		x		
Ramp up/down (Automatic)		x	x	x
AC Demagnetization				
Remote control	x	x		
Built in printer				
Data storage	x	x	x	x
Communication PC	BlueTooth		RS232	RS232
Battery operated	x	x		
CAT rating *		CAT IV 600 V		
IP rating*	IP54	IP65 closed IP54 open	IP53	IP53
Weight excluding leads	1.0 kg (2 lbs)	7.9 kg (18 lbs)	14.5 kg (33 lbs)	14.5 kg (33 lbs)
Dimension	217x92x72 (8.5x3.6x2.8)	400x300x200 (16x12x7.9)	410x250x270 (16x10x11)	410x250x270 (16x10x11)

*For measuring circuits used to measure any other electrical signal (CAT I), the transient stresses must be considered by the user to assure that they do not exceed the capabilities of the measuring equipment. The expected transient level for CAT IV is 6000 V, CAT III 4000 V, CAT II 2500 V and for CAT I 1500 V. For CAT I the transient levels can be specified differently and they are then designed and tested accordingly to assure that they withstand the expected transients.

Contact resistance testing



Request a copy of 'A guide to Low Resistance Testing'



MJÖLNER 200	MJÖLNER 600	MOM 200	MOM 600 A	MOM 690 A
5 - 200 A	5 - 600 A	0 - 200 A	0 - 600 A	0 - 800A
1 A	1 A			
2 min	15 sec	20 sec	15 sec	10 sec
200 A	300 A	100 A (15 min)	100 A	100 A (10 min)
0 $\mu\Omega$ - 999.9 m Ω	0 $\mu\Omega$ - 999.9 m Ω	0 $\mu\Omega$ - 19.99 m Ω	0 $\mu\Omega$ - 1999 m Ω	0 $\mu\Omega$ - 200 m Ω
0.1 $\mu\Omega$	0.1 $\mu\Omega$	1.0 $\mu\Omega$	1.0 $\mu\Omega$	1.0 $\mu\Omega$
$\pm 0.3 \mu\Omega$	$\pm 0.3 \mu\Omega$	$\pm 1\% + 1 \mu\Omega$	$\pm 1\% + 1 \mu\Omega$	$\pm 1\% + 1 \mu\Omega$
x	x			
x	x			
x	x			
				x
x	x			x
x	x			
x	x			
USB	USB			
IP41	IP41	IP20	IP20	IP20
8.8 kg (20 lbs)	13.8 kg (31 lbs)	14.6 kg (32 lbs)	24.7 kg (55 lbs)	23,7 kg (52 lbs)
486x392x192 (19x15x7.6)	486x392x192 (19x15x7.6)	280x178x246 (11x7x9.7)	356x203x241 (14x8x9.5)	350x270x220 (14x11x8.7)

Micro-ohmmeters



Hand-held 220 A Low Resistance

MOM2

- Up to 220 A
- Battery supplied
- Lightweight – 1 kg
- Bluetooth® PC communication
- Complies with IEEE and IEC standards

Battery operated 100 A Low Resistance

DLRO100 series

- CAT IV 600 V AC / 500 V DC for safe operation
- Lightweight 100 A battery powered unit for portability
- High noise immunity for stable readings
- Smooth and ripple free DC Output

200 & 600 A Low Resistance

DLRO200 & DLRO600

- 200 A or 600 A DC output current
- Memory for 300 test results and notes
- RS232 port for download results or printing in real time



Micro-ohmmeters



DualGround Low Resistance

MJÖLNER 200 & MJÖLNER 600

- True DC – ripple free current
- Remote control
- Fully automatic testing
– micro-processor controlled
- Mjölner Win PC Software



750 A Low Resistance

MOM690

- CT's demagnetization through AC output
- Compact and rugged
- Easy-to-use
- MOM Win PC Software

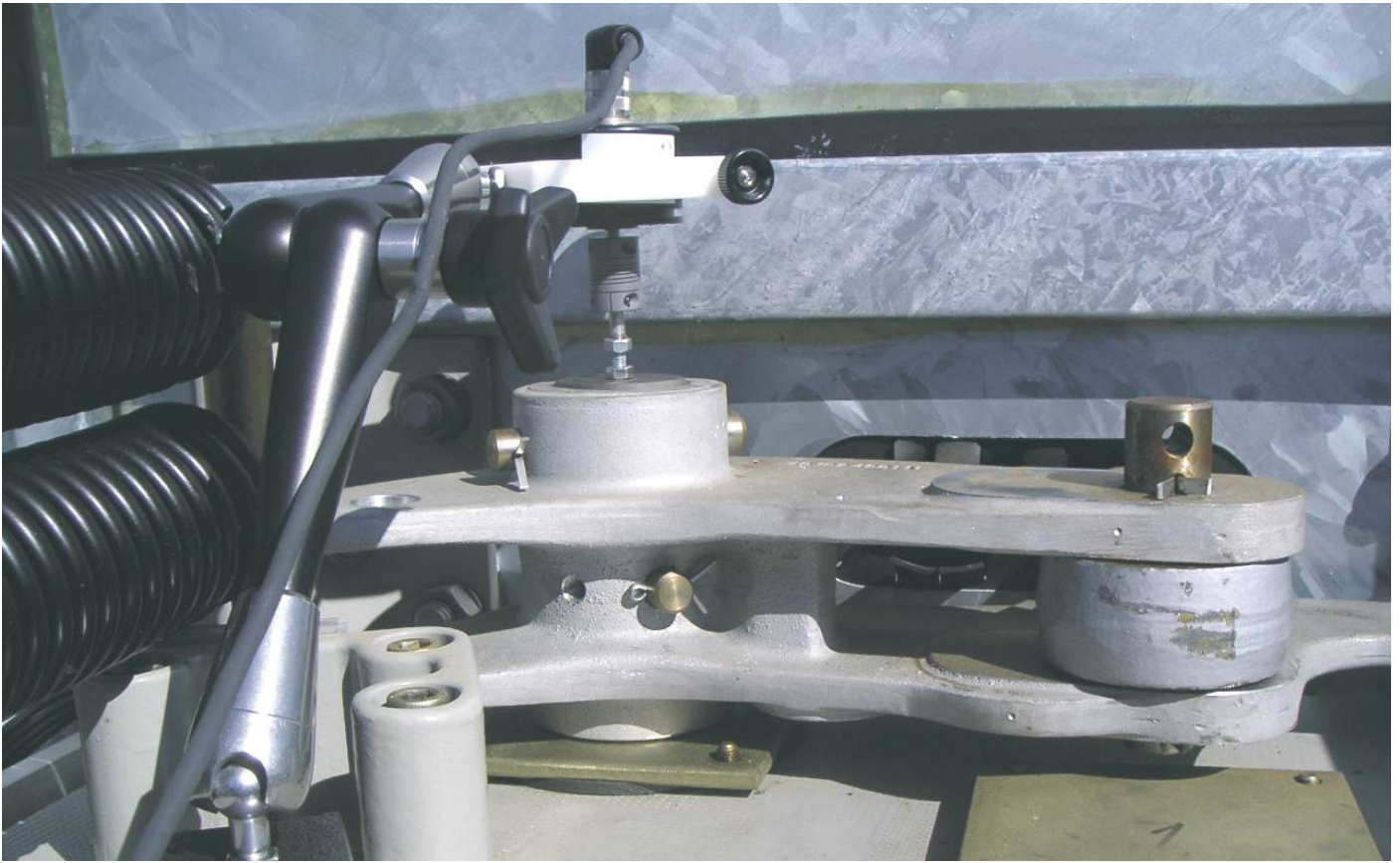
200 & 600 A Low Resistance

MOM200A & MOM600A

- 200 A or 600 A DC output current
- Compact and rugged
- Easy-to-use



Circuit Breaker Application Examples



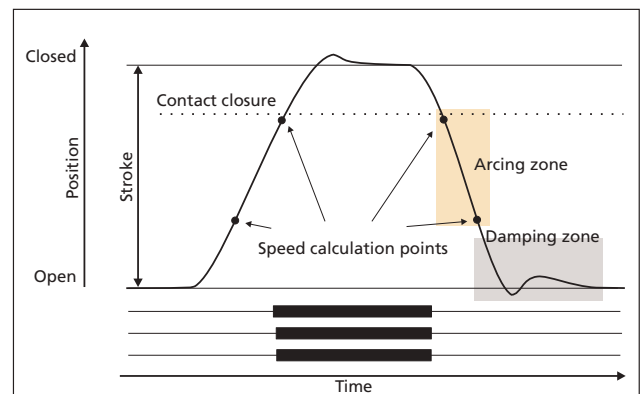
Motion measured in mechanism of the circuit breaker.

Contact motion

A high voltage breaker is designed to interrupt short-circuit current in a controlled manner. This puts great demands on the mechanical performance of all components in the circuit breaker. It is important to interrupt the current to prevent a re-strike. This is accomplished by making sure that the contacts move apart far enough from each other before the moving contact has entered the so-called damping zone.

The travel trace indicates the instantaneous position of the circuit breaker contacts during an operation. This gives important information such as total travel, overtravel, rebound, stroke, penetration of moving contact etc.

For many years, breaker contact motion (travel) has been considered one of the most important parameters for checking a breaker's interrupting capacity.



Motion diagram and timing graphs for close-open operation



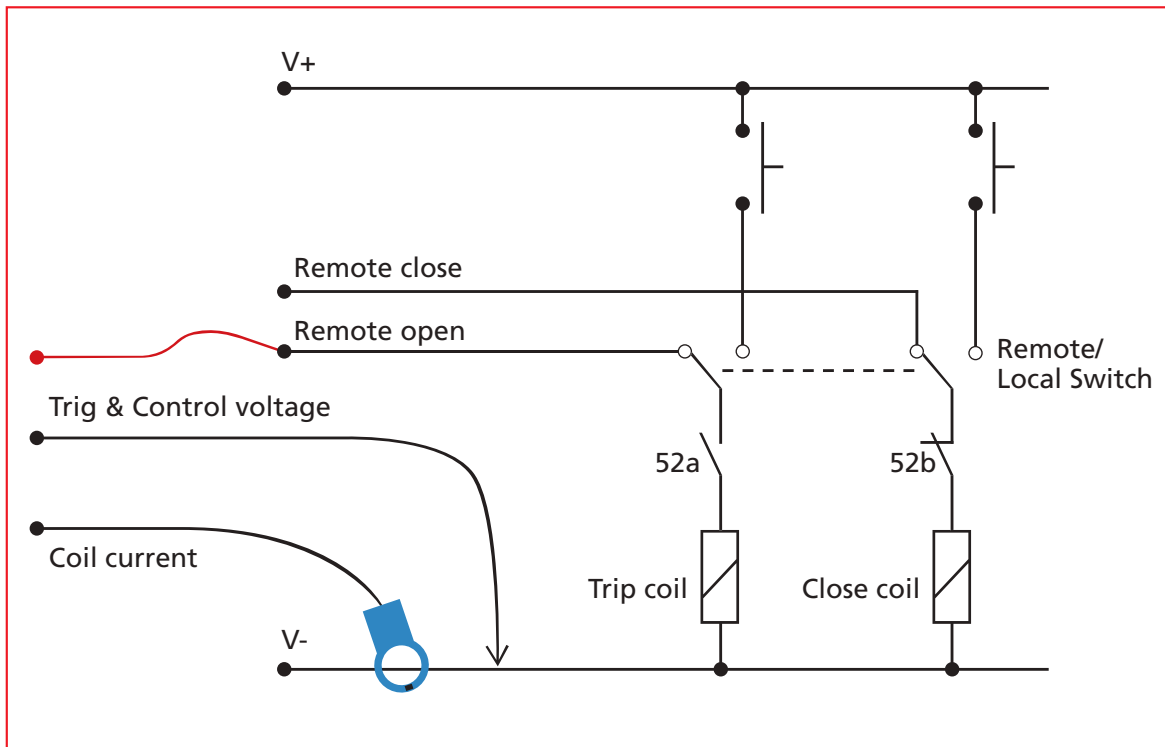
Rotary transducer mounting kit

First trip and online test

First trip and online test

A good and time effective way to check the condition of a circuit breaker is to document its behavior at the first open operation after it has been idle for long time. The measurement and connections to the circuit breaker are carried out while it is still in service. All of the connections are made inside the control cabinet. The biggest benefit of using first trip testing is to test "real world" operating conditions.

Another benefit with this method since the breaker is measured online is that it can be used to quickly screen the breaker population to judge which breakers that needs further investigation, a move to condition based maintenance.



Quick and easy hook up. Current clamps and test clips are used to minimize intrusion in the control circuits.

The most fundamental parameter evaluated at a first trip test is the coil current characteristic. From the coil current shape valuable information about the condition of the CB can be obtained especially when results are compared with either historical ones or with a second measurement performed directly after the first one. Differences in current curve shape discover potential problems with lubrication or corrosion in both coil and link system - important information that normally

would have got lost without performing a first trip recording. As a supplement to coil current the secondary current of the current transformers can be recorded in order to detect the main contacts' make and break times. The coil supply voltage should always be recorded as it constitutes an important reference to all timing related measurements and to first trip measurements in particular. This fact is also supported by the IEC 62271-100 standard.



Test system flexibility is key to cope with the great variety of different situations out there. Many answers to those challenges are in our Circuit Breaker Testing accessory catalogue. Download a copy at www.megger.com



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