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High and medium voltage circuit breaker testing

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Circuit breaker testing

Why?

- Breakers are the most important compontents of the protection system on the the hight voltage side
- They are "extended arm" of relay protection trip contacts
- Assurance that the breaker will operate when needed

What?

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

When?

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

CIRCUIT BREAKER - Of those that fail*:

LET US HELP YOU!

Selecting the right circuit breaker tester isn't always straight forward because 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

* Cigre 2012

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VIDEO

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 modern electric power supply systems to function properly. The breaker is the active link that operates 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 analyzer 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	TM1700 MODEL	TM1800 MODULES / CONFIGURATION
Main contact timing	1 break / phase	All EGIL	All TM1700	1 Timing M/R
	2 break / phase	[1]	All TM1700	1 Timing M/R
	≥ 3 break / phase	–	[2]	2-7 Timing M/R
DualGround™		–	with DCM accessories	with DCM accessories
Main and PIR contact timing	1 break / phase	All EGIL	All TM1700	1 Timing M/R
	2 break / phase	[1]	All TM1700	1 Timing M/R
	≥ 3 break / phase	–	[2]	2-7 Timing M/R
Coil current	1 operating mech.	All EGIL	All TM1700	1 Control
	3 operating mech.	–	TM1720/50/60	2 Control or 1 Control + 1 Analog + 3 ext. current clamps
Motion	1 operating mech.	EGIL Motion & EGIL SDRM	All TM1700 [3]	1 Analog or 1 Digital [4]
	3 operating mech.		All TM1700 [3]	1 Analog or 1 Digital [4]
Auxiliary contact timing	1 operating mech.	All EGIL	All TM1700 [5]	1 Control [5] or 1 Timing AUX
	3 operating mech.	–	TM1720/50/60	2 Control [5] or 1 Control + 1 Timing AUX
	≥ 3 aux / phase	–	TM1720/50/60	1 Control [5] and 1 Timing AUX or 2 Timing AUX
SRM [6]	Any	EGIL SDRM	All TM1700 with Analog channel	1 Timing M/R + 1 Analog
DRM [6]	Any	EGIL SDRM	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

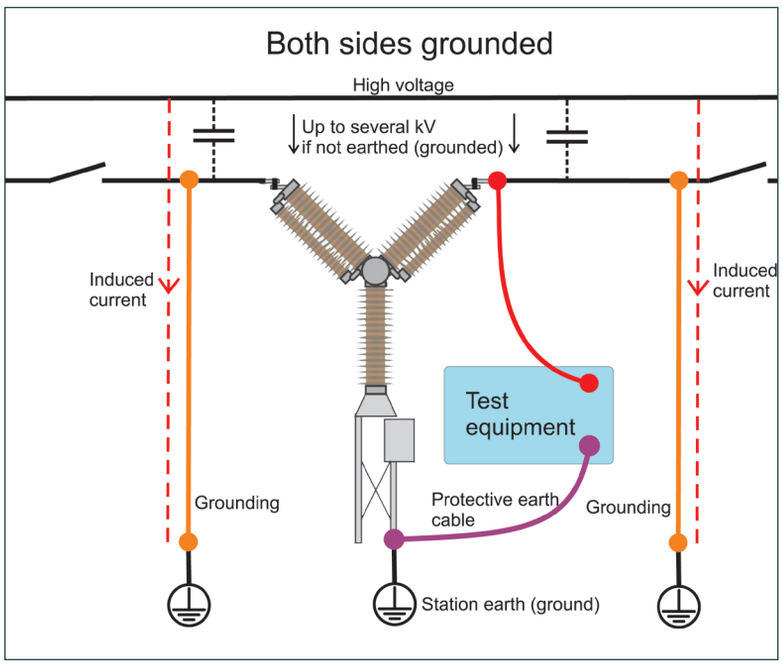
[6] SDRM201/202 accessoriy required

Safety first

DualGround™

The international standard IEC EN 50110-1 states that all parts to be worked on must 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 provide a safe, fast and easy test process with both sides of the circuit breaker grounded throughout.

- **Resistance**
- **Timing**
- **Motion**
- **DRM**
- **Vibration**



DualGround™ Timing

DCM Module

DualGround™ Timing in the patented DCM module makes each test safe and efficient 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.

Multiple-breaks-per-phase circuit breaker tester

TM1800

- **Modular design to precisely match your needs**
- **Can test breakers with common and individual operating mechanisms**
- **Adapt hardware configuration in the field**
- **Fast and safe with DualGround™ testing**
- **First trip and online measurement**
- **Rugged and reliable for field use**

The modular design makes it possible to configure the TM1800 for measurements on all known types of circuit breakers in operation in the global market. The robustly designed product contains powerful technology that streamlines circuit breaker testing. Sophisticated measurement modules save test time 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 efficient.

Two-breaks-per-phase circuit breaker tester

TM1700-series

- **Available with full stand-alone functionality or as data acquisition units without user interface**
- **Can test breakers with common and individual operating mechanisms**
- **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 uses much of the technology from the top-of-the-line TM1800 and is limited to time six main contacts. The TM1700 comes in five models ranging from remote controlled via a PC to fully standalone. 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 environments of high voltage substations and industry.

Accurate PIR measurement

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

Free booklet

A GUIDE TO HV CIRCUIT BREAKER TESTING

Download at www.megger.com

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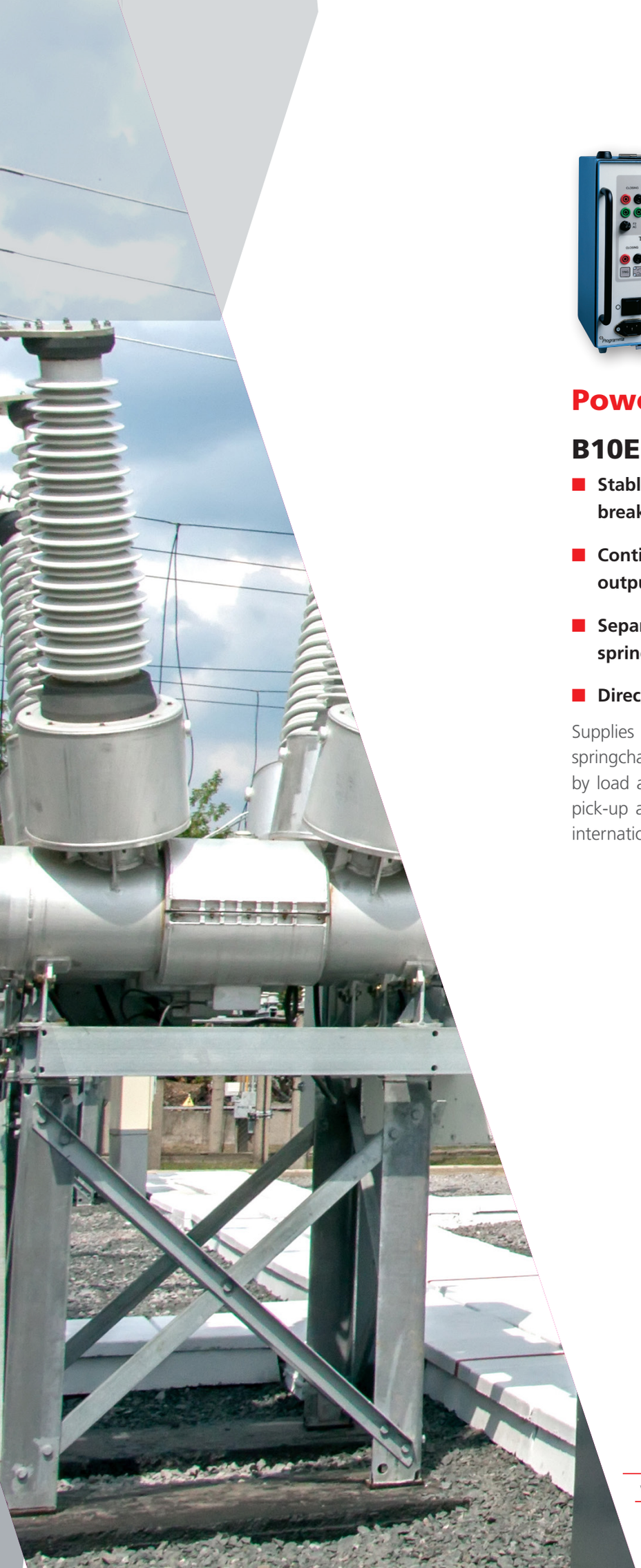
For further information on HV and MV circuit breakers and circuit breaker testing be sure to download our application guide ‘A guide to HV CB testing’.

One-break-per-phase circuit breaker tester

EGIL

- **Lightweight <7 kg**
- **Can test breakers with common operating mechanisms**
- **Extremely easy to use and reliable**
- **Two dedicated timing channels for auxiliary contacts**
- **Multipurpose analog measurement channel**
- **DRM with the SDRM201 accessory**

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

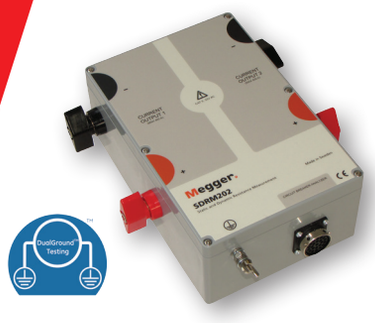


Power supply unit

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.



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 incl. cables**

DRM was introduced by Megger in the early '90s to assess the condition of contacts and arcing contact lengths in SF_6 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 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 analyzers 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)

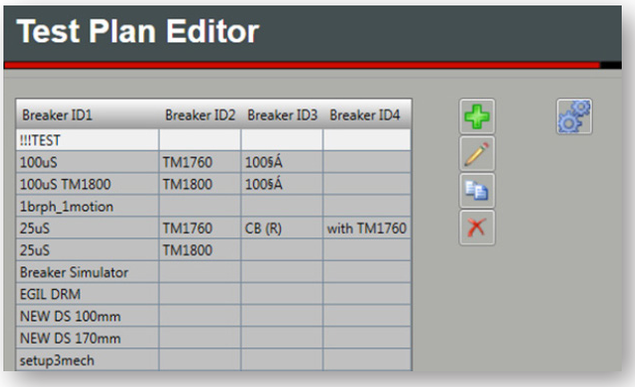
1. Movement starts
2. Slight increase in resistance when the contacts start to slide
3. Main contact opens
4. Arcing contact opens, current drops and resistance rises to infinity
5. Lenght of arcing contact

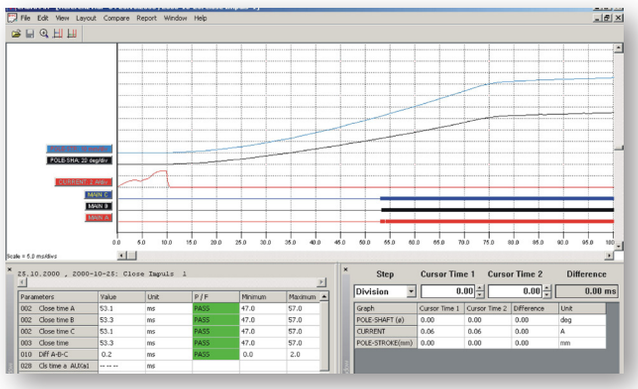
DRM is a reliable method to estimate the length/wear of arcing contact

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 arching, resulting in increased resistance, excessive heating and, in the worst case, explosion.

In a Dynamic Resistance Measurement the main contact resistance is measured during an open or close operation. 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.





Breaker Analyzer software

CABA Win

- **Pre-defined standard test plans enable 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**

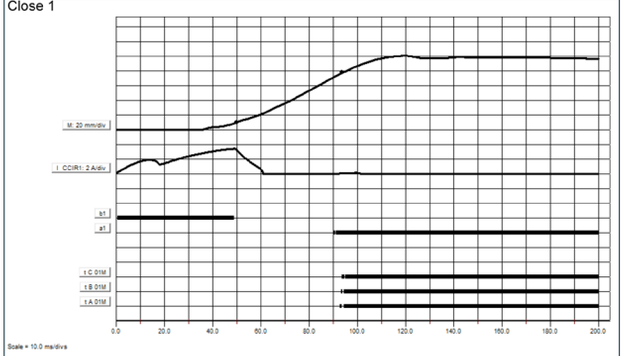
After connecting your breaker analyzer to a computer, you can use the CABA Win software to speed up testing and improve repetability. CABA can be used with the TM1800, TM1700 and EGIL. Results are presented on the display both graphically and in table form after each breaker operation so that you can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

The Test Plan Editor (TPE) lets you 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.

Megger. Report Recording — Date 1 September 2016

Station	**Rocky Island**	Inv. No.	**62E31-H535**
Line	**2B-SW**	Location	**Reserve**
Serial no.	**941229293**	Reference	**Job 16-87**
Manufacturer	**HV Breaker Inc.**	Breaker type	**CHF**
Rated Voltage [kV]	**121**	Rated Frequency [Hz]	**60.0**
Rated Current [A]	**1 200**	Rated Breaking Current	**31.5**
Rated Supply Voltage	**125V DC**	Rated Motor Voltage [V]	**240 VAC**
Interrupting medium	**SF6-Single**	Nominal stroke	**100.0**
Commision date	**1995**		
Recording notes			

Close 1



Parameters	Value	Unit	Minimum	Maximum	Nominal	Pass / Fail
Close time A 01M	93.050	ms	90.0	95.0	-	Pass
Close time B 01M	93.125	ms	90.0	95.0	-	Pass
Close time C 01M	93.825	ms	90.0	95.0	-	Pass
Diff A-B-C	0.775	ms	-	3.3	-	Pass
Cls speed	1.54	m/s	1.50	2.00	-	Pass
Stroke	96.700	mm	95.0	100.0	-	Pass
Penetr. A 01M	20.500	mm	20.0	25.0	-	Pass
Penetr. B 01M	20.400	mm	20.0	25.0	-	Pass
Penetr. C 01M	19.300	mm	20.0	25.0	-	Fail
Overtravel	3.900	mm	3.0	5.0	-	Pass
Rebound	96.700	mm	-	3.0	-	Fail

VIDEO

Vacuum interrupter tester

VIDAR

- **Small and light**
- **Efficient and easy to use**
- **Immediate pass/fail feedback**
- **10-60 kV DC test voltage**

VIDAR tests the 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.


Megger

Contact resistance testing

For testing circuit breaker contact resistance in compliance with IEC62271 and IEEE C37.09, specialized low recistance 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 on the low resistance ohmmeters' current outputs, 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 µΩ - 1000 mΩ	0.1 µΩ - 1.999 Ω	0.1 µΩ - 999.9 mΩ	0.1 µΩ - 999.9 mΩ
Best resolution	1.0 µΩ	0.1 µΩ	0.1 µΩ	0.1 µΩ
Inaccuracy	±1 % +1 µΩ	± 0.2% + 2 µΩ	± 0.7% + 1 µΩ	± 0.6% + 0.3 µΩ
Ripple free DC		x		
DualGround		x		
Ramp up/down (Automatic)		x	x	x
AC Demagnitization				
Remote control	x	x		
Built in printer				
Data storage	x	x	x	x
Communication PC	BlueTooth		RS232	RS232
Battery operated	x	x		
CAT rating *		CATIV 600v		
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)

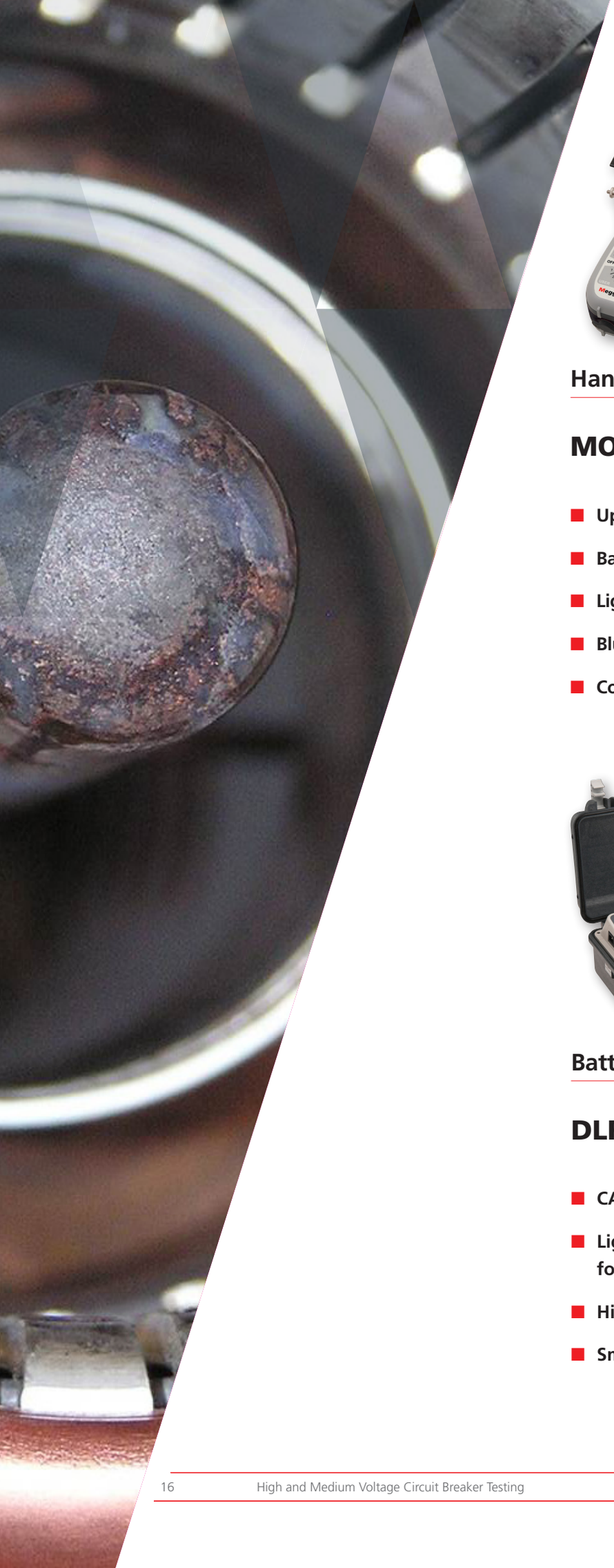
*For measuring circuits used to measure any other electrical signal (CAT I), the transient stresses must be considered by the user to assure that they do not exceed the capabilities of the measuring equipment. The expected transient level for CAT IV is 6000V, CAT III 4000V, CAT II 2500V and for CAT I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

Request a copy of 'A guide to Low Rresistance 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 µΩ - 999.9 mΩ	0 µΩ - 999.9 mΩ	0 µΩ - 19.99 mΩ	0 µΩ - 1999 mΩ	0 µΩ - 200 mΩ
0.1 µΩ	0.1 µΩ	1.0 µΩ	1.0 µΩ	1.0 µΩ
± 0.3 µΩ	± 0.3 µΩ	± 1% + 1 µΩ	± 1% + 1 µΩ	± 1% + 1 µΩ
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)



VIDEO

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 VAC / 500 VDC 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

750 A Low Resistance

MOM690

- CT's demagnitization through AC output
- Resistance measurement at any current value between 50-800A
- Easy to use
- MOM Win PC Software

DualGround Low Resistance

MJÖLNER 200 & MJÖLNER 600

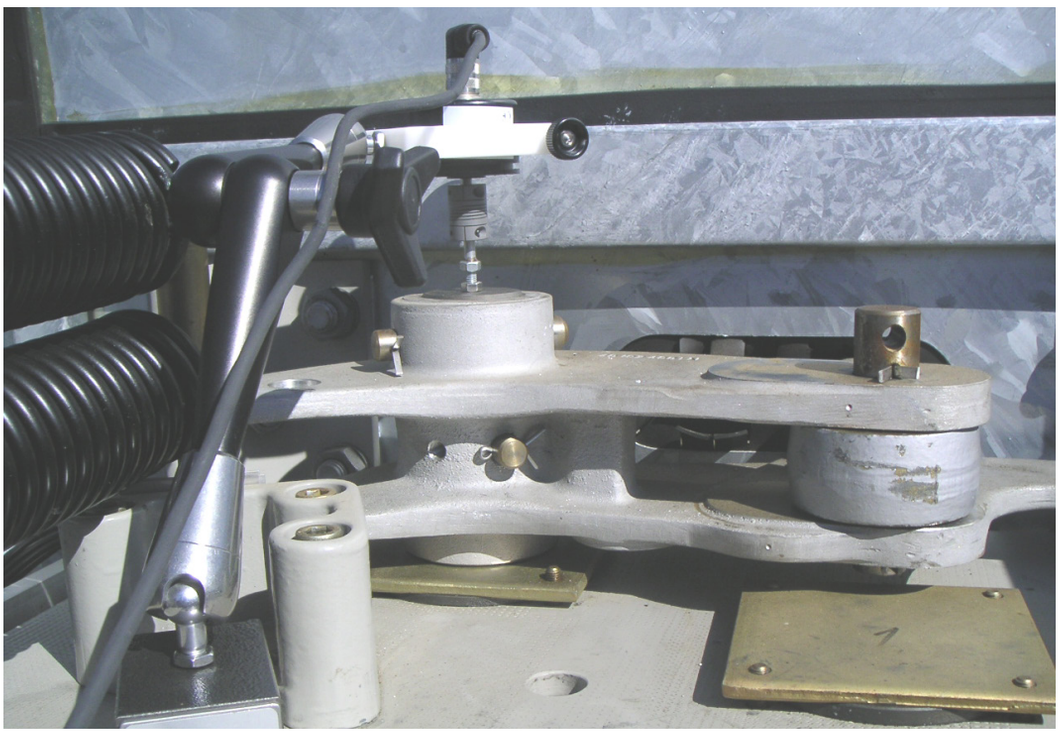
- True DC – ripple free current
- Remote control
- Fully automatic testing
  - micro-processor controlled
- Mjölner Win PC Software

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



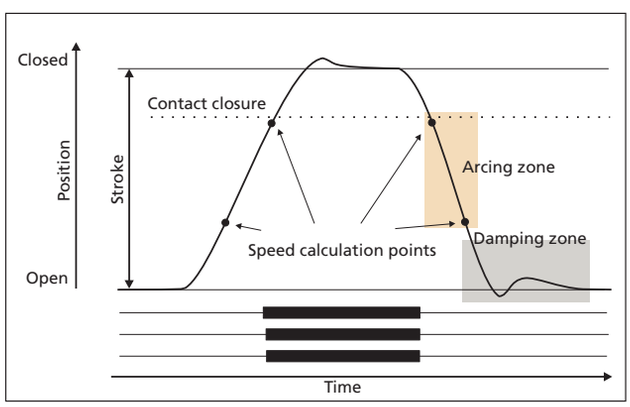
Motion measured in mechanism of the circuit breaker.

Contact motion

A high voltage breaker is designed to interrupt short-circuit currents 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 and penetration of moving contacts etc.

For many years, breaker contact motion (travel) has been considered one of the most important parameters for checking a breaker's interrupting capacity. Megger provides several universal and breaker specific transducer kits that cover the vast majority of travel measurement needs. For more information download the Megger Circuit Breaker Testing accessory catalogue.



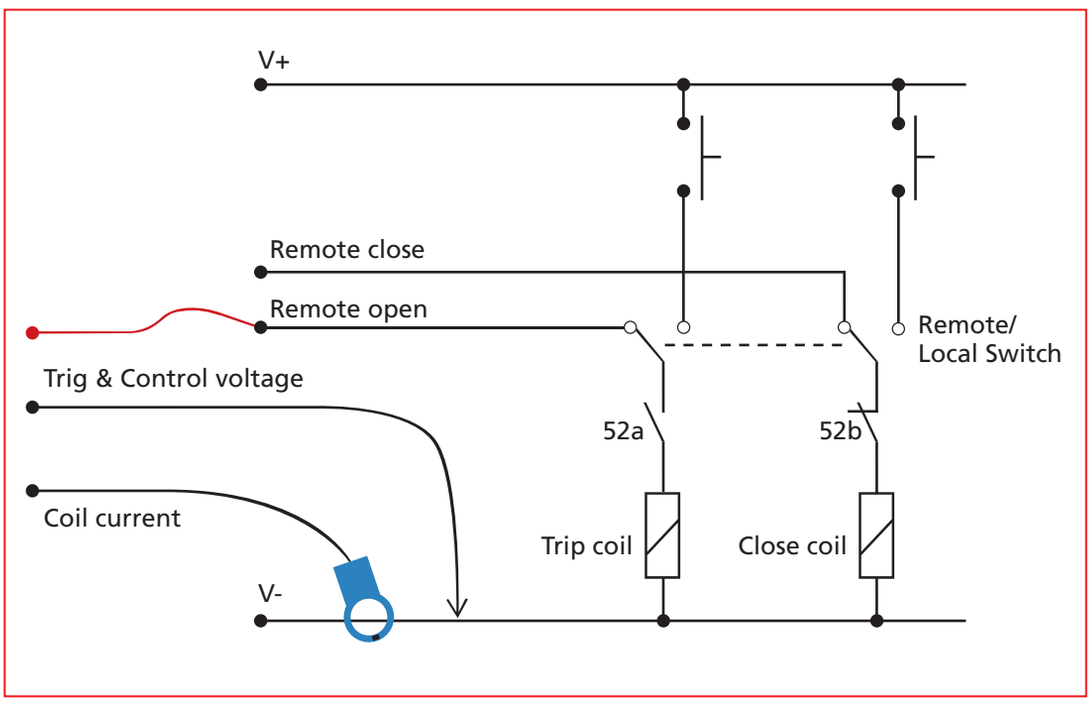
Motion diagram and timing graphs for close-open operation

Rotary transducer mounting kit

First trip and online test

A good and time efficient way to check the condition of a circuit breaker is to document its behavior upon its 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 is that it can be used to quickly screen the breaker population to judge which breakers need further investigation - a move towards 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 highlight potential problems with lubrication or corrosion in both coil and link systems. This important information is often lost if a first-trip test is not performed. Supplementing the coil current, the secondary current of 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