Circuit Breaker Testing Guide

For NETA Technicians and Maintenance Engineers

A field-ready reference for circuit breaker timing, travel, dynamic resistance, and contact resistance testing — aligned with ANSI/NETA MTS standards.

Test Equipment + Field Services + Technical Advisory
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Why Circuit Breaker Testing Matters

A circuit breaker is the last line of defense between a fault and a catastrophic failure. It must interrupt current quickly and reliably under the worst conditions: high fault current, high voltage, extreme temperatures. When it fails to operate correctly, the consequences range from extended outages to equipment destruction and personnel safety events.

Testing circuit breakers is not just about confirming they work today. It is about detecting early-stage degradation before it becomes a failure in service. A breaker that trips in 87 milliseconds when it should trip in 45 milliseconds is a problem. So is a breaker with a contact resistance reading 50% higher than its last test. These are measurable signs that something is changing, and trending that data over time is how you catch problems before the next fault.

NETA Requirement

ANSI/NETA MTS (Maintenance Testing Specifications) requires circuit breaker testing as part of acceptance and periodic maintenance programs. Most utility and industrial breakers fall in the 1-3 year interval category per NETA Table 100.1.

Circuit Breaker Types and What Differs

Technology	Interrupting Medium	Key Test Concerns
SF6	Sulfur hexafluoride gas	Gas pressure/purity, arcing contact wear (DRM), timing consistency
Vacuum	Vacuum (interrupter bottle)	Contact gap integrity (hi-pot), contact erosion (travel/timing)
Air Blast	Compressed air	Air supply pressure, valve operation, timing
Oil	Mineral oil	Oil condition, contact erosion, timing, arcing contact DRM
Air Magnetic (LV)	Air	Contact resistance, timing, mechanical condition

The Four Core Tests

1. Timing Test

Timing measures how long it takes from the trip or close command signal to the actual separation or engagement of the main contacts. Consistently slow timing is a sign of mechanical degradation: worn mechanisms, lube breakdown, or control system issues.

What you measure:

- Open time: Time from trip coil energization to contact separation
- Close time: Time from close coil energization to contact engagement
- Contact spread time (3-phase): Time difference between first and last pole to open or close
- Reclose time (where applicable): For breakers with automatic reclosing function

Voltage Class	Typical Open Time (ms)	Max Acceptable Spread (ms)
15 kV Class	33 to 50 ms	< 2 ms between poles
38 kV Class	33 to 50 ms	< 2 ms between poles
115-230 kV Class	16 to 50 ms (2-3 cycle)	< 1 ms between poles
345-500 kV Class	16 to 33 ms (1-2 cycle)	< 1 ms between poles

Note on Acceptance vs. Maintenance Values
Always compare against the manufacturer's specification first. A breaker consistently within 5% of its factory baseline is more important than hitting a generic target. Trend the data.

2. Contact Travel Test

A travel transducer attached to the breaker mechanism records the contact position throughout the open or close stroke. The travel curve reveals:

- Total travel (stroke): How far the contact moves from fully open to fully closed
- Overtravel: How far the contact moves past the closed position
- Contact velocity at moment of separation or engagement: Critical for interrupting performance
- Contact bounce: Repeated engagement/disengagement visible as oscillations on the closing curve
- Mechanism anomalies: Any hesitation or irregular acceleration indicates wear, lube breakdown, or binding

What to Watch For
A travel curve that looks different from the last test is the red flag, even if the numbers still pass. Subtle changes in curve shape often precede timing failures by one or two maintenance cycles.

3. Dynamic Resistance Measurement (DRM)

DRM is the most powerful diagnostic test available for circuit breakers. While timing and travel tests assess mechanical performance, DRM assesses the condition of the arcing contacts.

How it works: A DC test current (typically 100A or 200A) is applied to the breaker while the contacts open or close. The resistance is measured continuously throughout the travel. As the arcing contacts separate, the resistance curve shows a characteristic signature.

What DRM reveals:

- Arcing contact condition: Worn arcing contacts produce a different resistance signature than healthy ones. Estimate remaining service life without disassembly.
- Contact wipe on closing: Indicates springiness and alignment of the contacts.
- Internal fault signatures: A breaker that has interrupted a large fault often shows arcing contact erosion detectable only by DRM.

DRM is particularly valuable for SF6 breakers, where the arcing contacts are sealed inside a pressurized chamber. DRM gives you diagnostic information without opening the equipment.

4. Contact Resistance Test (Micro-ohmmetry)

A static contact resistance test measures the DC resistance of the closed main contact path. High contact resistance generates heat, which wastes energy and damages the contact assembly over time.

How it works: A high-current DC source (typically 100A to 200A) is injected through the closed breaker. A four-wire (Kelvin) measurement eliminates lead resistance. The result is contact resistance in microohms.

Voltage Class / Type	Typical New Contact Resistance	Action Level
15 kV SF6/Vacuum	50 to 200 microohms	> 300% of baseline OR > manufacturer max
38 kV SF6	30 to 150 microohms	> 300% of baseline OR > manufacturer max
115-500 kV SF6	15 to 80 microohms	> 300% of baseline OR > manufacturer max
Low-Voltage Power	100 to 500 microohms	> 300% of baseline OR > manufacturer max

Common Mistake

Applying too low a test current gives a meaningless reading. The test current must be at least 100A DC. Readings taken with a handheld meter are not reliable for circuit breaker contact resistance.

Test Sequence and Preparation

Before You Test

- Confirm isolation: Verify the breaker is racked out, grounded per your switching procedure, and tagged out.
- Review previous test records: Know the baseline values for this specific breaker.
- Check control power: Verify the control supply (usually 125V DC or 48V DC) is available or have a portable supply ready.
- Inspect visually first: Look for mechanical damage, oil or gas leaks, corroded terminals, or burned contacts before connecting instrumentation.
- Record ambient temperature: Contact resistance varies with temperature. Document it for trending purposes.

Recommended Test Order

1. **Contact resistance (static, as-found):** Perform first, in current condition. Most important single data point for trending.
2. **Timing and travel (open stroke):** Command a trip with all instrumentation connected. Record timing for each pole and the complete travel curve.
3. **DRM (open stroke):** Combine with the timing/travel test on the open stroke. Applies DC test current during opening to capture arcing contact separation.
4. **Timing and travel (close stroke):** Command a close. Record timing and closing curve, including contact bounce and overtravel.

5. **Minimum pickup voltage test:** Apply reduced voltage to trip and close coils. Most specifications require reliable operation at 70% of rated coil voltage.

Interpreting and Documenting Results

The Trending Rule

A single test result tells you where you are. A series of results over time tells you where you are headed. When reviewing results, ask:

- Is the result within the manufacturer's specification? If not, this is an immediate action item.
- How does it compare to the last test? A 20% change in contact resistance or a 10ms timing change is worth flagging even if it still passes.
- Is one pole behaving differently from the other two? Single-phase anomalies are often the first sign of a developing problem.

Documentation Requirements

- Equipment: Substation/location, breaker designation, manufacturer, model, serial number, rated kV, rated interrupting current
- Test date, technician name, test equipment model and serial number
- Ambient temperature at time of test
- All measured values for each pole: open time, close time, pole spread, contact resistance, travel (stroke, overtravel, velocity)
- DRM curve files stored with the test record
- Pass/fail determination and reference standard used

Best Practice

Store test records with the asset. DV Power test systems export results in PDF and Excel formats. Keep the raw data files and the exported report. When there is a question six years from now, you want the original curve, not just a summary table.

Test Equipment Overview

Test Function	What You Need	DV Power Model
Timing + Travel + DRM	Integrated breaker analyzer with transducer input and DRM current source	CBT series
Contact Resistance (micro-ohmmeter)	High-current DC source (100-200A) with Kelvin measurement	RMO series (200A, 600A options)
Combined timing + contact resistance + DRM	Full-capability breaker diagnostic system	DV Power CBT + RMO combined
Winding resistance	Precision winding resistance meter	DV Power RMO-W series

DV Power test systems are manufactured in Sweden and backed by a 3-year warranty. All units supplied by ProgUSA are supported by U.S.-based calibration and repair from our Florida service center. No shipping to Europe.

Questions About Your Circuit Breaker Program?

ProgUSA supplies DV Power circuit breaker and transformer diagnostic test systems to utilities, NETA firms, and industrial operators across the United States.

We help you select the right configuration for your breaker population, support commissioning, and provide U.S.-based calibration, repair, and technical backup.

Application Support	Demo and Training	U.S.-Based Calibration
Not sure which DV Power configuration fits your breaker types? We'll help you sort it out. No obligation.	On-site demos and training for DV Power systems. See the equipment in action on your own breakers before you buy.	All DV Power instruments calibrated and repaired at our Florida service center. 3-year warranty on all new units.

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