



Introductie BALTO DC high current circuit breaker tester

KMT Werkendam, 5/11/2025

Wim D'Hooghe



Megger : wie zijn wij ?

Megger is an industry leading provider of electrical test, monitoring and data analytics solutions for grid and all electrical power assets.



Megger in spoorwegtoepassingen

RAILWAY OPERATIONS

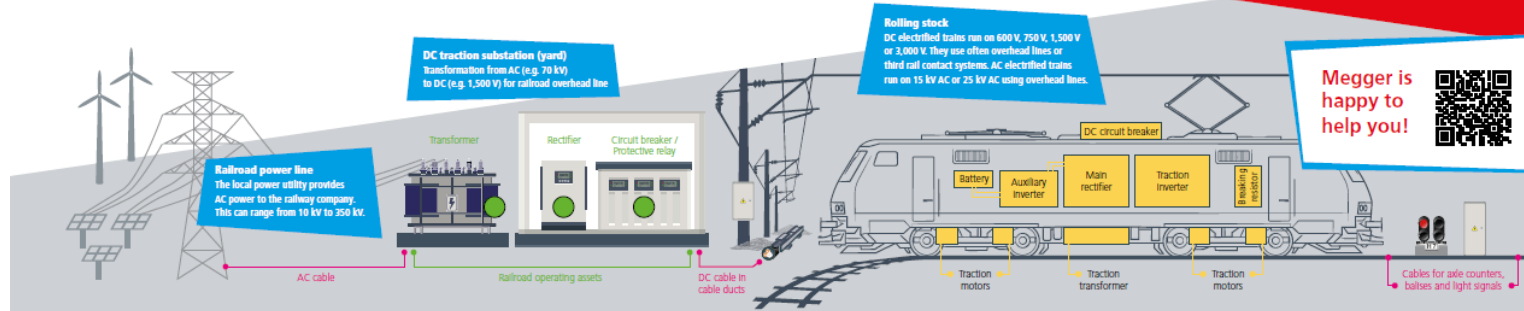
GENERATING AND ENSURING
A FAULTLESS POWER SUPPLY

How is the traction current generated?

Traction current is generated in a variety of ways. The railroads already use as much electricity from renewable sources as possible – in some countries already around 60 percent at present. For example, Bavaria's hydroelectric plants at Donau, Isar and Walchensee lake have been supplying environmentally friendly traction current for almost 100 years. Modern electric vehicles also recycle the electricity released during braking and feed it back into the overhead line.

Megger[®]

V.01



ONE STOP SHOP

MAINTENANCE, TESTING, DIAGNOSTICS, FAULT LOCATION

Rolling stock

Baker ADX
All-in-one automated motor health analyser up to 15 kV for motor winding, coil, assembled motor, traction motor and generator testing



MTR105
Industrial multi-functional motor and generator tester



MIT400/2
1 kV insulation resistance and continuity tester



MIT SERIES
5 - 10 kV insulation resistance tester up to 20 TΩ



DLRO10HDX
10 A digital low resistance ohmmeter



TORKEL900
Battery discharge test system



BALTO COMPACT 4000
DC high current circuit breaker tester up to 4,000 A



Traction substation

EGIL200
Easy-to-use circuit breaker analyser



DLRO100
Digital low resistance ohmmeter



MOM2
Hand-held 200 A micro-ohmmeter



MVCT
Voltage and current transformer analyser



SVERKER 900
3-phase relay and substation test unit



OTS/OTD SERIES
Fully automatic oil testers for accurate dielectric breakdown & tan delta tests on mineral, ester and silicone insulating liquids



TRAX
Multifunctional transformer and substation test system



BALTO MODULAR
DC high current circuit breaker tester up to 40,000 A



Cable infrastructure

GEOLUX GL 660
Earth fault locator for supply systems, isolated control and signalling cable



MFM10 & ESG NT2
DC cable sheath test and sheath fault pinpointing unit



EZ-THUMP SERIES
Ultra-compact (35 kg) battery / AC operated and fully integrated fault locating system, 1.5/3, 4 or 12 kV



STX40
Portable fault location unit with 7 different technologies built-in



digiPHONE-2 NTRX set
Fault pinpointing and line location



VLF Sinus 62-TD
Commissioning testing and condition analysis of medium voltage cables



Centrally controlled test vans for cable infrastructure and transformer / substation



BALTO - geschiedenis

- ❑ STEVO Electric werd opgericht in 1999 en specialiseerde zich in distributie van test & meetapparatuur (o.a. van Megger).
- ❑ **Stefaan Volkaert** (STEVO) is eigenaar
- ❑ Gevestigd in Leopoldsburg (Belgium).
- ❑ Startte eigen productontwikkeling in 2003.
- ❑ BALTO was eerste product op de markt voor het meten van snelschakelaars.
- ❑ BALTO 2e generatie werd gelanceerd in 2011, de BALTO Compact kwam iets later.
- ❑ Tegen 2020 werden een 200-tal BALTO's verkocht wereldwijd.
- ❑ Eind 2020 werd BALTO verkocht aan Megger.

STEVO Electric bvba

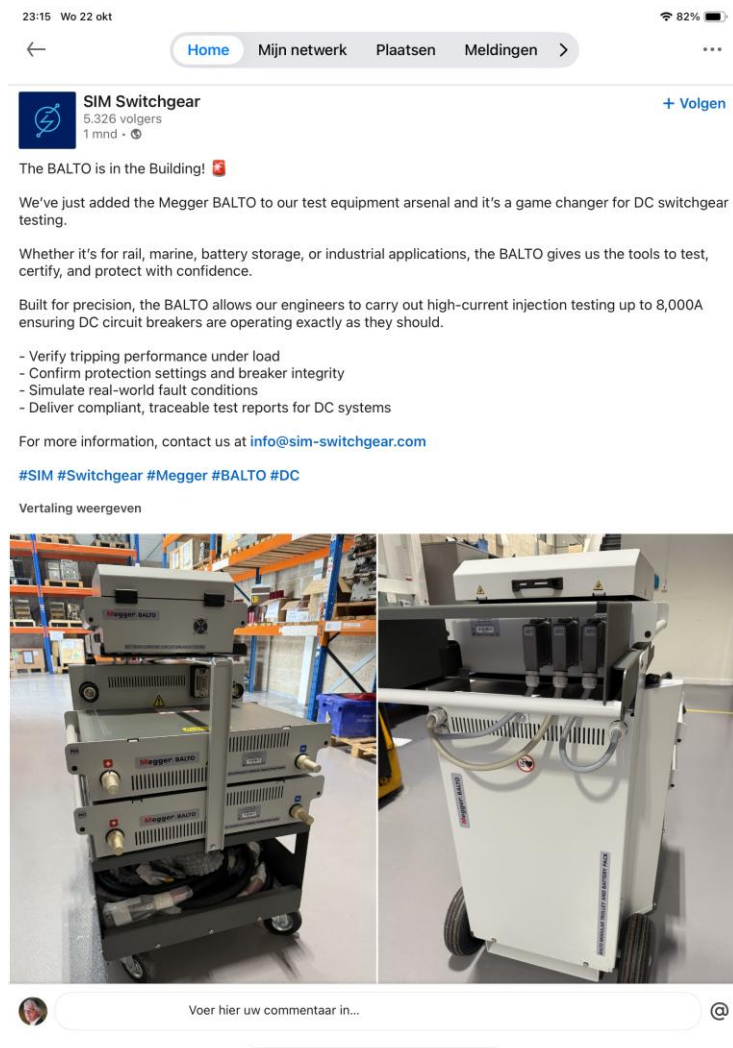
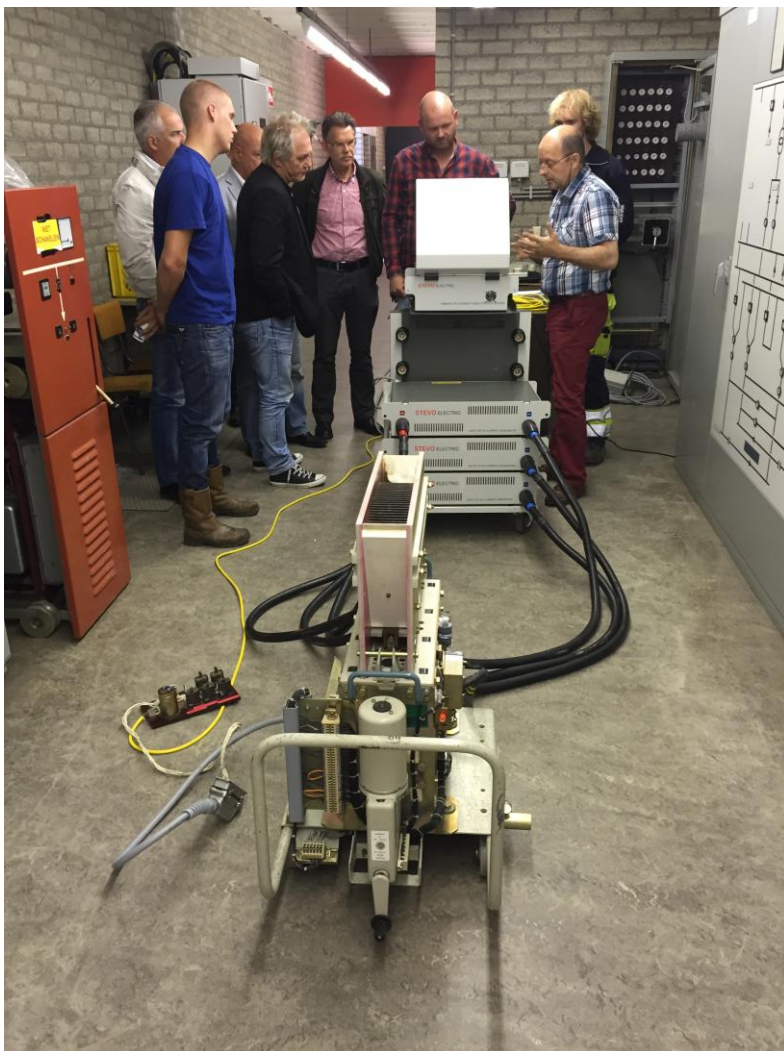


BALTO 1e generatie



BALTO 2e generatie

BALTO gebruikers : spoorwegorganisaties & service companies



Effe iets anders...



Testen van snelschakelaars volgens AI

Many railway organisations operate on DC (Direct Current). In the traction power substations, DC high speed circuit breakers are used. To test these breakers there are basically 2 solutions. One is to perform short circuit testing. The other solution is to use a high current generator and perform primary injection tests. What are the pro's and cons of both solutions?

Testen van snelschakelaars volgens AI

Summary Table

Aspect	Short-Circuit Test	Primary Injection Test
Purpose	Type test / performance validation	Routine / functional check
Test current	Full fault current (tens of kA)	Limited (a few kA max)
Realism	High – reproduces real fault conditions	Low – only checks operation
Safety & cost	Expensive, complex, risky	Safer, cheaper, portable
Breaker stress	High (can be destructive)	Low (non-destructive)
Field suitability	No	Yes
Standard compliance	Required for type approval	Not sufficient for type approval

Conclusion

- **Short-circuit testing** is essential for *type testing* and verifying the breaker's full fault-clearing capability.
- **Primary injection testing** is ideal for *routine maintenance and commissioning*, ensuring operational readiness without exposing the breaker to destructive stress.



Testen van snelschakelaars volgens AI

Aspect	Short-Circuit Test	Primary Injection Test
Doel	Typegoedkeuring / prestatie	Routinecontrole / functionaliteit
Teststroom	Volledige foutstroom (tientallen kA)	Beperkt (enkele kA)
Realisme	Hoog	Laag
Veiligheid & Kosten	Risicovol, duur	Veilig, goedkoop
Stress op schakelaar	Hoog (mogelijk destructief)	Laag (niet-destructief)
Veldtoepassing	Nee	Ja
Normconformiteit	Vereist voor typegoedkeuring	Niet voldoende voor typegoedkeuring

Conclusie

- **Short-circuit testing** is essentieel voor typegoedkeuring en het valideren van het volledige onderbrekingsvermogen.
- **Primary injection testing** is ideaal voor onderhoud en inbedrijfstelling, zonder de schakelaar bloot te stellen aan destructieve stress.

Stuur Copilot een bericht of @ vermeld een tabblad



Snelle reactie ▾



Testen van snelschakelaars volgens AI

In railway traction contexts, field short circuit testing is reserved for rare, high-value validations (e.g., new installations) due to its intensity, while primary injection is preferred for ongoing reliability checks to balance thoroughness with practicality and safety. A hybrid approach—field shorts for certification, injections for maintenance—optimizes lifecycle management. Always consult standards like IEC 60077 for railway-specific protocols.



12:29 Vt 17 okt 50%

Vraag Imagine Begeleiders

Primary Injection Testing Using a High Current Generator

Primary injection testing uses a dedicated high-current generator (e.g., systems like Omicron CPC 100 or dedicated DC units up to 20 kA) to inject controlled currents directly into the breaker's primary circuit on-site, without energizing the full system. This ramps up current to test trip thresholds, timing, and resistance, simulating overloads while measuring via shunts or clamps, aligned with IEC 61992 for railway DC equipment.

Pros:

- **Safer and less invasive:** No actual faults on the live system; uses low-voltage, high-amperage sources isolated from the grid, minimizing risks and allowing tests during limited outages.
- **Cost-effective and flexible:** Portable setups enable routine maintenance (e.g., annual checks) without massive disruptions; quicker setup (minutes to hours) and lower costs (€5,000–20,000 per test) compared to field shorts.
- **Precise control and diagnostics:** Allows adjustable ramp rates, multiple iterations, and data logging for parameters like di/dt (rate of current rise) critical in DC traction; identifies issues like relay miscalibration without damaging the breaker.
- **Minimal system impact:** Can be done phase-by-phase or on de-energized sections, supporting predictive maintenance in operational substations.

Cons:

- **Doesn't replicate full fault dynamics:** Simulates currents but not the exact arc voltages, electromagnetic forces, or system-wide transients of a real catenary short; may miss issues like stray inductance effects.
- **Equipment limitations:** Generators have max output caps (e.g., 10–30 kA vs. 100 kA faults), requiring extrapolation for peak ratings; bulky gear needs transport and skilled operators.
- **Incomplete chain testing:** Bypasses some upstream elements (e.g., rectifier harmonics); results might not catch wiring faults outside the injection loop.
- **Time for setup:** Still requires isolation and calibration, potentially heating contacts if prolonged, though far less than short-circuit risks.

In railway traction contexts, field short circuit testing is reserved for rare, high-value validations (e.g., new installations) due to its intensity, while primary injection is preferred for ongoing reliability checks. Think harder roughness with practicality safety. A hybrid approach—field shorts for certification, injections for maintenance—

Vraag alles

Grok 3

Spreek

12:29 Vt 17 okt 50%

Vraag Imagine Begeleiders

Field Short Circuit Testing for DC High-Speed Circuit Breakers

Field short circuit testing involves intentionally creating a controlled short circuit on the actual traction power system (e.g., via the catenary or overhead lines) to generate real fault currents through the breaker in its operational environment. This is done using specialized mobile short-circuit generators or by coordinating with the power supply to simulate faults at levels up to 50–100 kA, as per railway standards like EN 50163 for DC traction systems. It's typically a commissioning or major overhaul test, ensuring the breaker's performance under site-specific conditions like line inductance and stray capacitance.

Pros:

- **Real-world accuracy:** Tests the breaker in its exact installation, accounting for system-specific factors such as catenary impedance, harmonic distortions, and environmental influences (e.g., temperature, humidity), which lab tests can't replicate.
- **Full-system validation:** Verifies integration with the entire protection chain, including feeders, rectifiers, and neighboring substations; detects issues like improper coordination or voltage drops that might not appear in isolated tests.
- **Regulatory and operational confidence:** Essential for proving compliance in high-stakes railway networks (e.g., per TSI standards in Europe), confirming fault interruption times (<50 ms for DC HS breakers) and energy dissipation under actual fault energies.

Cons:

- **High safety risks:** Involves live high-energy faults on the operational grid, posing dangers to personnel, equipment, and the public; requires extensive safety zones, PPE, and emergency protocols, with potential for arc flashes or explosions.
- **Major operational disruption:** Necessitates full isolation of railway sections (e.g., shutting down lines for hours/days), leading to service cancellations, revenue loss, and logistical challenges in busy networks.
- **Expensive and resource-heavy:** Requires specialized mobile test rigs, coordination with utility operators, and post-test inspections/repairs; costs can exceed €100,000 per session, plus potential damage to the breaker (e.g., contact welding) or system components.
- **Limited repeatability and control:** Fault currents depend on real-time system conditions (e.g., load variations); Think harder consistent; environmental regulations may restrict such tests due to noise, EMI, or ecological impacts.

Vraag alles

Testen van snelschakelaars volgens AI

Feature	Short-Circuit Testing	Primary Injection Testing
Realism	Very High (real network conditions)	Moderate (controlled, lacks network impedance)
Safety	Very Low (high risk of arc flash)	Very High (work on de-energized equipment)
Service Impact High	(requires power shutdown, disrupts service)	Low/None (performed during isolated maintenance)
Test Control	(dependent on network)	High (precise, repeatable current levels)
Equipment Stress	High (stresses entire substation)	Low (stresses only the breaker under test)
Cost	Lower equipment cost, higher operational/downtime cost	High capital cost for test set, lower operational cost
Primary Use Case	System commissioning, validation of protection coordination	Routine maintenance, calibration, troubleshooting



Conclusion and Modern Practice

The trend in the railway industry strongly favors Primary Injection Testing for routine maintenance and commissioning of individual breakers due to its superior safety, control, and lack of service disruption.

Short-Circuit Testing is reserved for specific, high-stakes scenarios:

- Initial commissioning of a new substation or a completely new protection scheme.
- Validating the overall system coordination after major network changes.
- Forensic analysis after a real failure where the performance of the entire system is in question.

En wat zeggen ze in Duitsland ?

VDV-Schrift

520
01/2015

Kurzschluss- und Überlastschutz von
Fahrstromanlagen für Gleichstrom-
Nahverkehrsbahnen



Tobias Schmidt

Traction power supply maintenance technician

It's easy to operate and we have

Instead of performing short-circuit tests test rectifiers can be used in case of renewals, major modifications or regular inspections to set the direct overcurrent releases and to test their tripping. In case of major modifications it also has to be proved that the cut-off condition is still observed by measuring the loop resistance.

Snelschakelaars in Nederland (Nationale spoorwegen) - Infrastructuur

Can you make an estimate of how many DC High Speed Circuit Breakers these 5 railways have in operation today?



2) ProRail (Netherlands, 1.5 kV DC network)

- Best (central) estimate: ~1,500 HSCBs
- Plausible range: ~800 – 2,400 HSCBs

How I arrived at it (summary):

- Dutch main network length $\approx$ 6,800 km track with $\sim$ 75% electrified (1.5 kV DC on many lines). ProRail documents show a dense, largely electrified network. Use shorter substation spacing for 1.5 kV ($\approx$ 8–15 km) and assume each sector/sectioning cabin and substation has multiple breakers (4–10). That yields the range above. (Network / spacing references: ProRail network statements and national rail summaries.) en.wikipedia.org +1

	Estimate	Minimum	Maximum
<i>ProRail</i>	1500	800	2400
<i>Infrabel</i>	2000	1500	2500
<i>Adif</i>	3000	1500	5000
<i>PKP</i>	3000	2000	4500
<i>RFI</i>	4000	2500	6000
Total	13500	8300	20400

I have the same question but now for the largest lightrail organisations in the Netherlands : RET (Rotterdam), GVB (Amsterdam) and HTM (The Hague).



Quick headline estimates

- RET (Rotterdam) — $\approx$ 200–350 DC HSCBs (central $\sim$ 250) . en.wikipedia.org
- GVB (Amsterdam) — $\approx$ 250–450 DC HSCBs (central $\sim$ 300). en.wikipedia.org
- HTM (The Hague) — $\approx$ 150–300 DC HSCBs (central $\sim$ 200). en.wikipedia.org

Combined total (three operators): $\sim$ 600–1,100 HSCBs (best-guess $\sim$ 750).

Snelschakelaars in Nederland (Nationale Spoorwegen) - trein

Totaaloverzicht

- **Sprinters:** ± 337 treinstellen
- **Intercity's:** ± 304 treinstellen
- **Locomotieven:** ± 20
- **Internationale treinen (ICNG België):** ± 20 (in opbouw)



Flirt HRN3	= 33	ICMm2	= 36
Flirt HRN4	= 25	ICMm3	= 17
Flirt TAG	= 6	ICMm4	= 15
SLT 4	= 69	ICNG5	= 30
SLT 6	= 62	ICNG8	= 13
SNG BO3	= 67	ICNG België	= 14
SNG BO4	= 50	VIRM4	= 51
SNG AO3	= 50	Virmm1-4	= 32
SNG AO4	= 38	Virmm1-6	= 47
Totaal Sprinters	= 333	Virmm2/3-4	= 14
		Virmm2/3-6	= 31
		DDZ4	= 28
		DDZ6	= 20
		Totaal Intercity	= 348

1 snelschakelaar/trein = 681 schakelaars

De belangrijkste constructeurs

Constructeur	Product	NS	GVB	Prorail
Secheron	UR...	T		
Hawker-Sidley, Brush, Powell, Whipp & Bourne	NDC...			
Alstom	ARC...			
GE, ABB	Gerapid...			
Microelettrica, EMC, Ansaldo	IR...			

T=Trein

I=Infrastructuur

Vendor	Installed	Share
GE Rapid	20.000	7%
Secheron	157.000	57%
Hawker Siddely	40.000	14%
MicroElletrica	20.000	7%
Other	40.000	14%
Total	277.000	100%

DC HSCB's maintenance : Manufacturer's recommendations

Type of inspection	Intervals of inspection	Work of inspection
General visual and functional check	Recommendation: every 6 months At least once a year	Remove dirt, check drive and trips for correct operations
Checks: • Contacts • Arc probes • Protective walls • Arc chute (LBK)	• After high short circuit openings (>25kA) • at frequent operations with over-load-and/or rated current At least once a year	Check for wear and deposits
Check breaker and tripping mechanism. To be carried out by trained specialist.	After 5.000 mech. operations At least once every 4 years	Check proper operation, setting values and flexible braid
Check arc probes and arc chute screw connections	After each job carried out in the • contacts • probes • arc chute At least once every 6 months	Check for tight fitting

Figure 1

D.2 Periodicity of the inspections



Important!

These frequencies are given for normal (abnormal conditions are listed in § C.2). The user should adapt these frequencies when using this device in other conditions

Operation	Frequency
Basic inspection	At least once a year
Detailed inspection	Whenever one of the following event occurs first: – Every 18-24 months – Or after every 250 overload current interruptions (current value > maximum current release setting I_d). – Or after every 500 manual or remote openings (current value < maximum current release setting I_d).

Figure 2

BALTO : Different Models – Modular & Compact 4000

BALTO MODULAR DC High Current Circuit Breaker Tester

Systems Configuration

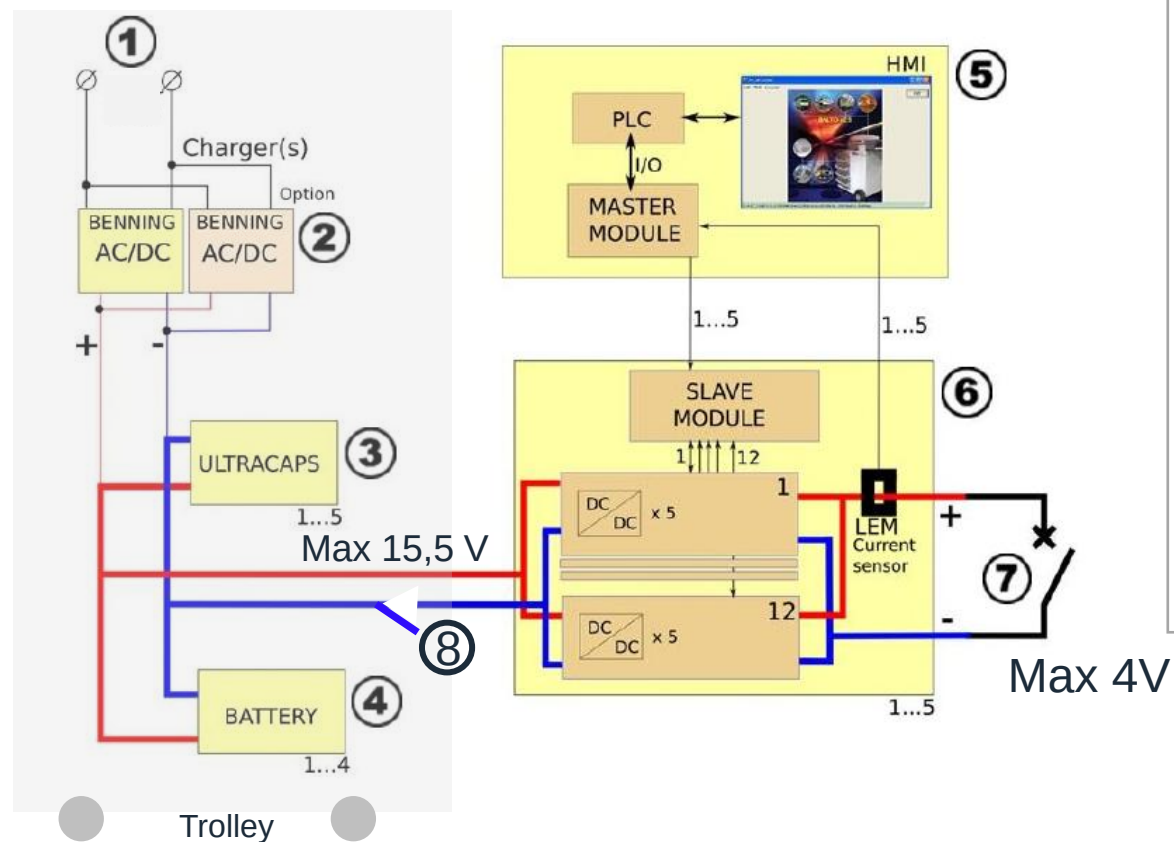
Balto Modular System	Current Output	Trolley Extendable (with additional BALTO Modular Current Generator 4000A)	Protection Relay Test Licence Key	Balto Win Software
BALTO Modular 4000-8	4000 A	8000 A	Optional	Optional
BALTO Modular 4000-12	4000 A	12000 A	Optional	Optional
BALTO Modular 4000-20	4000 A	20000 A	Optional	Optional
BALTO Modular 8000	8000 A	8000 A	Optional	Optional
BALTO Modular 8000-12	8000 A	12000 A	Optional	Optional
BALTO Modular 8000-20	8000 A	20000 A	Optional	Optional
BALTO Modular 12000	12000 A	12000 A	Optional	Optional
BALTO Modular 12000-20	12000 A	20000 A	Optional	Optional
BALTO Modular 16000-20	16000 A	20000 A	Optional	Optional
BALTO Modular 20000	20000 A	20000 A	Optional	Optional
BALTO Modular 24000-40	24000 A	40000 A	Optional	Optional
BALTO Modular 32000-40	32000 A	40000 A	Optional	Optional
BALTO Modular 40000	40000 A	40000 A	Optional	Optional

- The functionality of both models is identical
- Secondary Current Injection
 - Protection Relay Test – Licence Key
- Standard 2m Cable Set

BALTO MODULAR

BALTO COMPACT

BALTO – Algemeen schema



BALTO Modular : Controle paneel



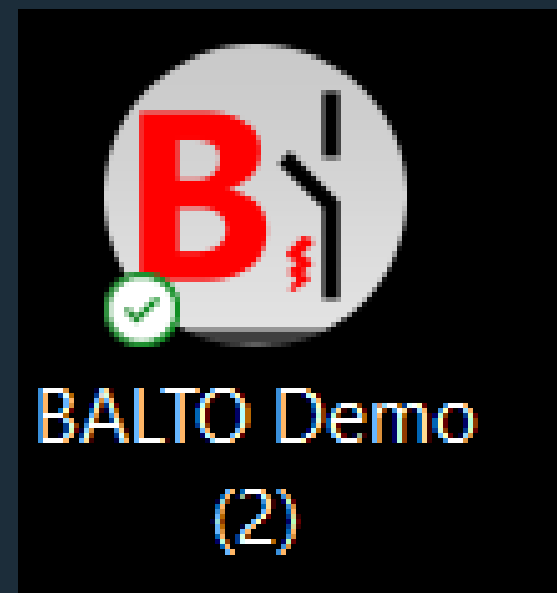
1. Control unit - Display screen (tactile)
2. Push button O/I and signaling PLC
3. Signaling system operational
4. Emergency Stop (soft)
5. External measurement (used for voltage drop and calibration)
6. USB communication
7. Communication RJ45
8. Buzzer



1. Mains
2. System (Charger) on/off
3. Battery charger fuses
4. Charge/Discharge connector
5. Ground Connection



BALTO in operation





Enabling everyone to live
confidently and work safely, with
the energies that power our
world.

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