

Test and Measurement

Power Catalogue

**Transformer testing -
what to buy and how to test**

**Insulation testers -
the complete range from
1 kV to 30 kV**

**Low resistance ohmmeters -
tough new products for real
life use**

**Cable fault location -
the modular approach**



Megger

WWW.MEGGER.COM



Local in more places.

Megger has technical support offices in 14 locations, and distributors in 170 countries. Wherever possible, we create documentation and websites that are centrally supported but locally maintained in your language. 'Local' to us does not just mean geographic proximity; it is about understanding your technical problems, your application issues and the language that you speak.

We are committed to helping customers with their specific test and measurement problems, including advanced diagnostic testing and innovative software.

The company's passion for the business of test and measurement is most clearly shown by a focus on execution – making things happen and learning more. You can see evidence of this from the range of new products made available to you in this catalogue.

We devote enthusiasm to improving the most minor technical details. With a truly massive product range, a programme of innovation and geographic proximity to customers, you win from Megger's innovation strategy. Most companies appreciate the benefits of innovation, but far fewer actually pursue it because of a fear of failure. Megger's culture and financial systems are aligned to ensure a steady flow of innovative products.

You can trust Megger to deliver. Call today with your application problems.

About Megger

A passion for the business of test and measurement

Our passion for business is most clearly shown by a focus on execution - making things happen and learning more. You can see evidence of this in the range of new products made available to you in recent years. Successes include a complete re-engineering of our power factor test sets, the most sophisticated insulation tester range available anywhere and a brand new range of low resistance ohmmeters. We devote enthusiasm to improving even the most minor technical details. With a truly massive range, and a programme of product research and commercial geographic proximity to customers, you gain from Megger's innovation strategy. Most companies appreciate innovation's benefits, but far fewer actively pursue it because of a fear of failure. Megger's culture and financial systems are aligned to ensure a steady flow of innovative

products. Sales, product management and engineering functions follow a New Product Innovation process, which focuses on using a concept called 'voice of the customer'; which provides market led, customer founded innovation to solve your test needs.

Maintaining high growth is driven by investment in technology as well as by sales and marketing strategy. Long term, Megger believes that the best way to secure good quality products and intellectual property is through excellence in engineering and its production facilities. Key processes and expertise are kept in-house. Engineering teams are located on-site at all the company's factories. Advanced manufacturing technology, including automatic wave-solder machinery and robotic surface mount technology helps keep costs down and quality up.



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Technical distribution network

Megger regularly audits the performance of distribution partners to ensure they meet standards for technical proficiency and customer support. You can trust an authorised Megger distributor to help you choose the right test equipment.



Exhibitions

You will find Megger at many major exhibitions where you can talk to Megger experts and see the products before you buy. Check your regional Megger website for an exhibition convenient for you.



Electrical Tester

A newspaper primarily aimed at the Power/Utility industry, Electrical Tester contains informative articles on the latest industry developments and products from Megger. The publication is published in many languages and is available in both print and email formats. To subscribe to Electrical Tester, email ElectricalTester@megger.com with your contact details specifying which version you would like to receive.



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Our technical support team is here to help you with your questions. Trained to provide support for Megger's complete range of products, the technical support group helps with everything from advice on product selection to product usage.



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For more in-depth information on Megger products and application advice visit our website. With improved navigation, it is easier than ever to search for the information you need.



Professional training

You can count on Megger to provide specialised practical, hands-on electrical training presented in our classrooms or on-site at your facility. Through our associated company, AVO Training, we also provide online fundamental training courses, self-study training materials, and training videos. Select from more than 50 different electrical training courses.





Our commitment to quality

All Megger manufacturing facilities are certified to the ISO9001 quality standard. Products conform to the highest standards of accuracy, safety, performance and reliability and meet national and international safety directives. Our commitment to quality is recognised by our customers throughout the world.

You may see these symbols marked on our products:



The Kitemark is one of the UK's most trusted product and service certification marks. Products showing this mark have satisfied the most rigorous of quality processes.



The letters "CE" are an abbreviation of the French phrase "Conformité Européene" which literally means "European Conformity". CE Marking on a product indicates that the product may be legally placed on the market in a European Union country.



The VDE mark indicates conformity with the VDE standards or European or internationally harmonized standards respectively and confirms compliance with protective requirements of the applicable EC Directive(s).



Underwriters Laboratories® is a US based independent product safety certification organization. The UL Mark on a product means that UL has tested and evaluated representative samples of that product and determined that they meet UL requirements.



Based in Canada, CSA International tests products for compliance to national and international standards. A CSA mark on its own, without indicators, means that the product is certified primarily for the Canadian market, to the applicable Canadian standards.



GOST refers to a set of technical standards maintained under the auspices of the Commonwealth of Independent States. Certification is mandatory for a wide range of products. It is based on safety testing (IEC standards with Russian variations), EMC testing, etc.



TÜV is a German organisation that aims to achieve sustained development of safety and quality. The TÜV mark gives evidence that the essential safety requirements of the product have been fulfilled and that production has been inspected by the impartial organisation TÜV Rheinland Product Safety.



Any electrical, mechanical or electro-mechanical product bearing the GS Mark indicates that it was tested and complies with the minimum requirements of the German Equipment and Product Safety Act. The GS Mark, which stands for Geprüfte Sicherheit in German means Safety Tested.



NEW Relay test system (SMRT36)

SMRT36 is a small, rugged, lightweight and powerful 3-phase protective relay test system. With an intuitive manual operation and Smart Touch View interface it will operate with or without a computer. See page 197



NEW Micro-ohmmeter for circuit breaker testing (MOM2)

MOM2 is designed to measure the resistance of circuit breaker contacts, bus-bar joints and other high-current links. This product is designed to be easy to use, versatile and safe, using the DualGround™ method (the test object is grounded on both sides). See page 70



NEW Power factor / dissipation factor test set (DELTA4000)

DELTA4000 is a fully automatic 12 kV insulation power factor / dissipation factor ($\tan\delta$) test set designed for condition assessment of electrical insulation in high voltage apparatus such as transformers, bushings, circuit breakers, cables, lightning arresters and rotating machinery. See page 42



NEW Cable fault locator (PFL22M)

PFL22M1500 is the latest power cable fault locator from Megger and is designed to provide quick, effective, accurate and safe fault location thereby reducing system outages and minutes lost. See page 270



NEW Earth / ground resistance clamp testers (DET14C and DET24C)

DET14C and DET24C represent a new generation of earth / ground testers. They are designed with flat core ends that prevent dirt build up and an elliptical clamp to improve access to earth cables and straps. See page 172



NEW Oil test sets (OTS)

Equally at home in the laboratory, the workshop, in the field, on the bench or on the ground. These new heavy duty OTS oil test sets combine rugged construction with accuracy and ease of use. Includes bright 3 1/2 inch colour display for easy visibility. See page 238



NEW IEC 61850 test system (GOOSER)

GOOSER™ is the world's first general purpose IEC 61850-8-1 GOOSE equipment dedicated to test the GOOSE horizontal communication in substation protection / control applications. See page 207



NEW Micro-ohmmeter for continuity testing (DLRO10HD)

Megger's new heavy duty DLRO10HD low resistance ohmmeter combines rugged construction with accuracy and ease of use. It features an internal rechargeable battery and can also operate from a mains supply, even if the battery is completely flat. See page 59



Circuit breaker testing

VIDAR - Vacuum bottle breakdown tester

TM1800 - Modular timing and motion analyser for multiple break /phase circuit breakers with DualGround™ for operation with both sides of the test piece earthed. 40 kHz sample rate, on-board software, key board, colour display

TM1600 - Modular timing and motion analyser for multiple break / phase circuit breakers

SDRM – Current source for static / dynamic resistance measurement of arcing and main contacts while the circuit breaker operates for use with TM and EGIL products

EGIL - Timing and motion analyser for single break /phase circuit breakers

B10E – Variable d.c. power supply

CABA Win – Circuit breaker analysis software

MJÖLNER – High current testing for circuit breaker contact resistance 200 A and 600 A with DualGround™ for operation with both sides of the test piece earthed

DLRO600 and DLRO200 – High current micro ohmmeters for testing circuit breaker contacts at 600 A and 200 A for compliance with IEC 62271-100

MOM690, MOM600 and MOM200 – High current low resistance ohmmeter for testing circuit breaker contacts at 690 A, 600 A and 200 A for compliance with IEC 62271-100

DLRO10 and DLRO10X – 10 A battery powered low resistance ohmmeter for testing contact resistance and joints

Insulation and continuity test instruments

MIT510/2 – 5 kV go/no go insulation resistance tester

MIT520/2 and MIT1020/2 - 5 kV and 10 kV diagnostic insulation tester offering the range of tests such as PI, SV, DD and DAR

S1-552/2 and S1-1052 - High current diagnostic insulation testers for fast testing of capacitive loads

S1-554/2 and S1-1054/2 - 5 kV and 10 kV diagnostic insulation testers with high noise rejection for environments such as switch yards

DLRO10 and DLRO10X - fully automatic instruments, selecting the most suitable test current up to 10 A d.c.

MIT30 – 30 kV d.c. insulation tester for proof testing

70 to 160 kV d.c dielectric test sets – insulation proof testing

Asset management software

PowerDB – Substation testing, report generation and certification software

Primary testing

ODEN AT – Modular primary current injection test set, for applications >2000 A with CTs, circuit breakers and protection systems

PCITS2000 – Primary current injection test set, for applications up to 2000 A with CTs, and protection systems

CSU600AT – 600 A primary current injection test set with CTs, and protection systems

Current transformer

MAGNUS – Step up transformer for manual ratio and excitation tests (knee-point)

MCT1605 – Fully automated CT tester measuring a number of parameters including knee-point with graphical display and reporting

Relay or secondary testing

SMRT36 – The smallest, lightest, highest output powered, complete three phase relay test system in the world today

MPRT – 4 channel, 3-phase fully automated high power relay test set with advanced manual controller

AVTS – User configurable automatic relay testing software and database for MPRT

FREJA300 – 3-phase fully automatic relay test set, lightweight, simple to use commissioning tool

FREJA306 – As FREJA300 with high current module and 6-phase current and 3-phase voltage

CA30 – High current module for Freja 3 x 35 A

FREJA Win – User friendly relay testing software for Freja

SVERKER650 – Simple single-phase injection test set

SVERKER750 and SVERKER760 – Fully featured single-phase injection test sets, SVERKER 760 offers continuous phase shift function. Can be used with Sverker Win software

TM200 – solid state timer can be used with SVERKER, as additional timer, and CSU A and ODEN A (not required for AT versions)

MGTR – GPS timing reference to synchronise end-to-end testing

PAM360E – Phase angle meter

PMM1 – Power measurement meter

Transformer

FRAX – Sweep frequency response analyser for transformer fingerprinting

DELTA4000 – For tan δ or power factor measurement to test the bushings

TTR25 and TTR100 – Handheld single phase instruments for checking the turns ratio of the windings

TTR300 series – Three-phase instrument for checking the turns ratio of the windings and tap changers, phase deviation and excitation current are also measured

MTO210 – Fully automated transformer ohmmeter for simultaneous measurement of primary and secondary winding resistance

OTS – For assessing the dielectric strength of the transformer oil

IDAX – Frequency domain spectroscopist for looking at transformer insulation and its moisture content particularly in the cellulose based material

KF – For assessing the moisture content of insulating oil

Earth system

DET2/2 – High accuracy 4 terminal substation earth tester

DET4T series – 4 terminal earth resistivity tester with optional clamps for ART and stakeless testing

DET3T series – 3 terminal electrode tester with clamp for ART

DET10C and DET20C – Stakeless earth testing clamps

Battery

TORKEL - Battery load capacity tester max 270 A, 15 kW, 480 V

BITE2P – Battery impedance tester up to 7500 Ah with integral printer

BITE3 – Battery impedance tester up to 2500 Ah with on-board graphical display, memory and database functions

BGFT – Battery ground fault locator

Digital hydrometer – For specific gravity measurement

DCM340 – Clamp-meter for measuring load currents

AVO310 – Multimeter for battery voltage measurement

DLRO10 and DLRO10X – Battery powered low resistance meter for measuring battery straps and connections



AC Insulation Testers

Regular insulation resistance testing is one of the most cost effective methods of identifying ageing in electrical equipment, and with over 60% of equipment failures being ascribed to insulation breakdown, it is a key area to monitor for high levels of customer satisfaction.

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■ feature option
▲ accepts rechargeable cells

See separate catalogue

	MIT200 Series	MIT300 Series	MIT400 Series	MIT510/2	MIT520/2	MIT1020/2	BM12	BMS200 not CE marked	MJ15	BM12	S1-552/2	S1-1052/2	S1-554/2	S1-1054/2	S1-5010	BM15	MJ15	5 kV and 15 kV	5 kV and 10 kV	MIT30 kV
Insulation test voltages																				
10 kV						■						■		■						
5 kV				■	■	■		■	■		■	■	■	■	■	■	■	■	■	■
2.5 kV				■	■	■		■	■		■	■	■	■	■	■	■	■	■	■
1000 V	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
500 V	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
250 V	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	■	■	■	■	■			■	■	■	■	■		■	■	■	■
50 V/100 V			<input type="checkbox"/>		■	■					■	■	■	■	■					
10 V - 100 V			<input type="checkbox"/>		■	■					■	■	■	■						
Insulation test modes																				
Polarization index			<input type="checkbox"/>		■	■		■			■	■	■	■	■					
Dielectric absorption ratio			<input type="checkbox"/>		■	■					■	■	■	■	■					
Step voltage					■	■					■	■	■	■	■					
Dielectric discharge					■	■					■	■	■	■						
Other tests																				
Continuity test	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				■		■											
Frequency measurement			<input type="checkbox"/>					■												
Capacitance measurement			<input type="checkbox"/>	■	■	■					■	■	■	■	■					
Voltage measurement		<input type="checkbox"/>	<input type="checkbox"/>	■	■	■	■	■	■	■		■	■	■	■	■				
Result management																				
Data storage		<input type="checkbox"/>	<input type="checkbox"/>		■	■					■	■	■	■	■					
USB download		<input type="checkbox"/>	<input type="checkbox"/>		■	■					■	■	■	■	RS232					
Bluetooth download																				
Power supply																				
Mains power				■	■	■					■	■	<input type="checkbox"/>	■	■			■	■	■
Rechargeable batteries	▲	▲	▲	■	■	■			<input type="checkbox"/>							<input type="checkbox"/>	<input type="checkbox"/>			
Hand crank									■											
Dry-cell battery	■	■	■				■	■	■								■			
Safety																				
600 V CAT III	<input type="checkbox"/>	<input type="checkbox"/>						■												
300 V CAT IV	<input type="checkbox"/>	<input type="checkbox"/>																		
600 V CAT IV	<input type="checkbox"/>		■	■	■	■					■	■	■	■						
High noise immunity											■	■								
FREE calibration certificate	■	■	■	■	■	■	■	■			■	■	■	■						
Included software																				
Power DB Lite					■	■					■	■	■	■						
PowerDB					<input type="checkbox"/>	<input type="checkbox"/>					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
Download Manager					■	■					■	■	■	■	■					

Insulation Testers

Insulation is important for the safety of all electrical systems, providing a barrier to hazardous live conductors. Insulation can deteriorate due to the effects of moisture, sunlight and heat. A reduction in the value of insulation resistance can lead to a potentially dangerous situation caused by the dangers of electric shock, or arcing causing fire. If insulation resistance is regularly monitored, unusually low values can be investigated before they cause danger or inconvenience and cost due to equipment downtime for repairs.

What they do

Insulation testing can be dangerous. The instrument must be used by suitably trained and competent persons. Insulation testers apply a test voltage for a period of time, across an interposing insulation barrier. The application of this voltage creates electrical stresses on any internal insulation cracks present, in which case the resistance reading could drop. Larger insulation systems will eventually stabilise; smaller systems will stabilise quicker because the capacitive and absorption currents drop to zero faster than on larger systems.



For more than 100 years the Megger name has been synonymous with high quality instruments for the testing and measurement of electrical power applications.

The trademark was first registered in May 1903 and is jealously guarded by the company.

Although best known for insulation testers, Megger products provide testing solutions in some of the most critical maintenance areas including cable fault locating, protection relay testing, and power quality testing, as well as being the supplier of choice for hand-held electrical test and measurement instruments for electrical installation, data and telecom engineers.

Selecting the right tester

Choosing the right insulation tester can appear a bewildering task at first. Actually, all the process requires is a little organisation. Insulation testers perform essentially the same test in fundamentally the same manner. Refinements and added features however, separate one model from another in application and engineer appeal. Make a check list of important or essential features and specifications. This should automatically reduce the choices to a workable number, from which personal preferences can easily determine the final selection.

Test Voltage(s) - An electrician interested only in installation and proof testing may need only a single voltage. A repair or maintenance engineer, however, may want the diagnostic capabilities that derive from comparing tests at different voltages. Base your voltage requirement(s) on the rated voltage of the equipment to be tested, then decide if you want to test at the rated voltage, or perform stress tests at higher voltages.

Step Voltage Tests - Pervasive insulation damage like moisture and oil soaks are revealed at any voltage, while mechanical damage like pinholes may require voltages high enough to arc an air gap in order to be detected. Test instrumentation commonly makes a leap from 1 kV to 5 kV, so this may be your most critical voltage determination and most significant decision in selecting a tester.

Measurement Range - For an electrician or repair engineer interested only in proofing, 100 m Ω readings may be sufficient. For predictive maintenance however, it is critical to be able to see the change in resistance between successive measurements, even though the actual values remain very high. Don't limit your testing capabilities with a short-range model. The newest technologies permit resistance measurements to the tera Ohm (T Ω) range! Try to determine the insulation resistance values of your equipment when new, then select a tester that can actually measure to these values.

Power Source - The test is the same, irrespective of the power source. Not everyone believes you can get 1000 volts out of AA batteries, but you can! Current limitation is the means. Batteries free the operator from the extra work of cranking, while hand-cranks relieve dependence on batteries and the possibility of human error. If you plan to do Polarisation Index (PI) testing, you don't want to crank for 10 minutes!

Rechargeable batteries are the most convenient and environmentally acceptable, but it is useful to have disposables if you have accidentally forgotten to charge your batteries.

Voltage Detection - Most models feature detection of unwanted voltage on the test item. Electricians may want an audible signal for rapid trouble-shooting that is not dependent on visually monitoring the display. Maintenance engineers for large equipment will want to be able to see high-voltage capacitive charges decay at the conclusion of a test.

Display - Digital or analogue is largely a matter of preference, but newer models combine both capabilities in a single, convenient display.

Ω /k Ω Ranges - Generally referred to as "Continuity" and "Resistance" ranges, these are low-voltage, mid- to low-range functions that add greatly to the depth of testing capabilities that your tester offers. They can make the selective difference between several models that are similar in the more apparent functions, and should not be overlooked. Ohm (Ω) ranges can be used to verify integrity of circuits and connections, while kilohm (k Ω) ranges are useful in locating areas of insulation deterioration. The electrician will want an Ω -range, the maintenance engineer will want k Ω , the repair engineer will want both!

Guard terminal

This third terminal shunts surface leakage path of the measurement function. It is useful in eliminating certain components of leakage from the measurement, and provides a valuable extra tool in analytical work. The electrician may not need it, but the maintenance engineer should, and the commissioning engineer will!

Extra features

Insulation testers are not arrayed from 'good' to 'better' tests; they should all perform accurate and reliable measurements. Rather, additional capabilities and greater flexibility are achieved from one model to the next. The newer versions offer such features such as pre-programmed standard tests (Polarisation Index, Step Voltage, Dielectric Discharge), calculation and storage of results, downloading to computer or printer, timed tests, measurement of leakage current and capacitance, and "burn" mode. These may not be necessary, but they certainly are convenient. If it fits your budget, go for it! visit www.megger.com for more information.

CAT IV

Many users of electrical test equipment, including major utilities, require test equipment to be rated for CAT IV applications, as defined in IEC 61010. Such instruments are suitable for use on all parts of low voltage installations, including those parts outside of the building, and at the point where the supply enters the building.

Instrument manufacturers have responded to customer demand for CAT IV instruments by ensuring that their products are designed on the basis of theoretical calculations, to meet the appropriate requirements. This must be followed by electrical testing to prove the design is safe to use when connected to a live circuit and subjected to high voltage transients, to ensure nothing has been overlooked.

This causes a problem for test instrument manufacturers testing an instrument for CATIV 600 V operations since there is a requirement for a high energy 600 V supply and facilities for superimposing transients of up to 8 kV onto that supply. Finding a laboratory that could meet these requirements is difficult as most facilities are limited to a 415 V supply with transients of up to 4 kV.

Megger considered that this situation was not satisfactory. It was thought essential that its products should be properly tested to prove that they not only met, but wherever possible, exceeded the requirements laid down in IEC 61010.

The only way this could realistically be achieved was for the company to make the substantial investment needed to install its own test facility. This facility is capable of testing to the levels prescribed in IEC 61010-1-2001, Table 17, Section 14.9, and is now in full operation at Megger's Dover site.

When a user or specifier chooses an instrument with a high CAT rating, that should be exactly what they get. Now that there's a test facility that can confirm these ratings, it's no longer necessary to rely on calculations.

For more info...

Request a copy of a 'Guide to insulation testing'
call +44 (0)1 304 502100

Safety and convenience of insulation testing

Compact insulation testers are undoubtedly valuable tools for equipment maintenance, but all testers are by no means created equal.

Safety is of course, the first consideration, and the best insulation testers now fully meet the requirements for CATIV 600 V applications defined by IEC 61010. This means that they can be used in all normal electrical service, maintenance and utility applications. Rugged construction is also important, as is a compact design that will allow convenient single-handed operation.

Versatility is another key issue. A choice of test voltages is essential and many users will also need a choice of test methods. For them, the tester should offer PI and DAR testing, as well as straight-forward spot-measurement of insulation.

The MIT400 range provides insulation testing at 250 V, 500 V and 1000 V, together with continuity testing and voltage measurement to CATIV 600 V protection levels. Top of the range is the MIT430, which not only stores test results but also allows them to be transferred to a PC via a Bluetooth™ wireless connection.



Economy insulation tester

The MIT200 series will find applications in electrical contracting, both on domestic and industrial systems, as well as site maintenance and service departments.

The MIT200 series of insulation and continuity testers are ideal for testing transformers, motors, generators, switchgear, panel building, domestic appliances, power tools etc., as well as fixed electrical wiring systems.

Their small size and light weight make them ideal for those engineers that need to carry them for extended periods.

All instruments meet the requirements of most International Standards including VDE 0413 Part 1 and BS 7671 (the 17th Edition of the IEE Wiring Regulations).

Contractors' insulation testers

Developed, after extensive customer research, specifically to meet the needs of today's electrical contractors, the new MIT300 range of insulation and continuity testers from Megger is not only durable and easy to use, but also incorporates a comprehensive set of features designed to ensure operator safety, even under conditions of accidental misuse.

The range includes four models, ensuring an exact match for the needs of every user, all of which offer automatic discharge of the circuit after testing, audible and visual warning if the test probes are applied to a live circuit, and a test inhibit feature which operates automatically under live circuit conditions. The units also conform fully to IEC 61010-1 for use in Category III 600V applications, and provide all of the facilities needed to meet insulation testing requirements relating to the current edition of the IEE Wiring Regulations.

In line with other products in Megger's comprehensive new contractor range, MIT300 insulation testers feature rugged construction, with an impact-resistant rubber-overmoulded case, and innovative circuitry which guarantees high accuracy combined with stability of calibration.



If you need...

More information on any of these products
See our industrial and contracting catalogue

SPECIFICATIONS

Test voltages	250 V, 500 V, 1000 V, 2500 V, 5000 V
Voltage input range	85-265 V rms, 50/60 Hz, 60 VA
Accuracy (23 °C, 5 kV)	±5% up to 1 TΩ ±20% up to 10 TΩ
Default voltmeter range	50 - 600 V a.c. or d.c. Accuracy (23 °C) ±2% or -1 V
Guard	
2% error guarding 500 kΩ leakage with 100 MΩ load	
Display range	
Digital display (3 digits)	10 kΩ to 15 TΩ
Analogue display	100 kΩ to 1 TΩ 50 V
Measurement range	
Capacitance measurement (above 500 V)	10 nF to 50 μF (dependent on test voltage)
Capacitance measurement accuracy (23 °C)	±5% ±5 nF
Voltage output accuracy (0 °C to 30 °C)	+4%, -0% ±10 V of nominal test voltage at 1 GΩ load
Current measurement range	0.01 nA to 5 mA
Current measurement accuracy (23 °C)	±5% ±0.2 nA at all voltages
Environmental	
Ingress protection (lid closed)	IP65
Operating temperature	-20 °C to 50 °C
Storage temperature	-25 °C to 65 °C
Humidity	90% RH non-condensing at 40 °C
Power supply	
Battery life	Typical capacity is 6 hours continuous testing at 5 kV with a 100 MΩ load
Mechanical data	
Dimensions	305 mm x 194 mm x 360 mm
Weight	6.75 kg



MIT510/2

- CAT IV 600 V
- Mains or battery powered
- Digital/analogue backlit display
- Selectable test voltage from 250 V to 5000 V
- Automatic IR test
- Measures to 15 TΩ

Description

MIT510/2 5 kV insulation resistance testers are designed specifically to assist you with the testing and maintenance of high voltage electrical equipment. The case is incredibly rugged and easy to carry, being made of tough polypropylene and achieving an ingress protection rating of IP65. In addition, the model number is marked on both sides of the case for ease of identification in stores or vehicles.

The instrument can test when being powered by the mains or its internal rechargeable battery, a great benefit when site conditions are unknown or long term testing is required.

If you need...

a 5 kV insulation tester with very high noise rejection (for example if you are working in an electrically noisy substation), then S1-554/2 might be what you need

See page 23

ORDERING INFORMATION

Product	Order Code	Product	Order Code
5 kV insulation resistance tester	MIT510/2-EN	3 x 15 m with medium insulated clips	1000-442
Included accessories		3 x 3 m with large insulated clips	6220-811
3 m lead set, medium size insulated clips	6220-820	3 x 10 m with large insulated clips	1000-443
User guide on CD-ROM	2000-213	3 x 15 m with large insulated clips	1000-432
Optional accessories		Control circuit test lead set	
HV test lead sets		2 x 3 m with small insulated clips	6220-822
3 x 3 m with un-insulated small clips	8101-181	Screened HV test leads	
3 x 8 m with un-insulated small clips	8101-182	1 x 3 m, with 5 kV screened un-insulated small clips	6220-835
3 x 15 m with un-insulated small clips	8101-183	1 x 15 m, with 5 kV screened un-insulated small clips	6311-080
3 x 10 m with medium insulated clips	1000-441		

5 kV Diagnostic insulation resistance tester



MIT520/2

- CAT IV 600 V
- Mains or battery powered
- Variable test voltage from 50 V to 5000 V or 10,000 V
- Automatic IR, PI, DAR, SV and DD tests
- Measures to 15 TΩ (5 kV) and 35 TΩ (10 kV)
- RS232 and USB download of results to Megger Download Manager

Description

MIT520/2 is CAT IV safe, and offers the ability to test insulation to 5 kV. It allows automatic IR, PI, DAR, SV and DD tests. Measuring up to 15 TΩ means the MIT520/2 can detect insulation deterioration earlier than other testers. Results storage and download give you full diagnostic information for later analysis. MIT520/2 can be powered using either mains or its on-board rechargeable battery, now with improved battery-life management.

SPECIFICATIONS

Test voltages	50 V to 1 kV in 10 V steps, 1 kV to 5 kV in 25 V steps
Voltage input range	85-265 V rms, 50/60 Hz, 60 VA
Accuracy (23 °C, 5 kV)	±5% to 1 TΩ ±20% to 10 TΩ
Default voltmeter range	50 - 600 V a.c. or d.c. Accuracy (23 °C) ±2% or -1 V
Guard	
2% error guarding 500 kΩ leakage with 100 MΩ load	
Display range	
Digital display (3 digits)	10 kΩ to 15 TΩ
Analogue display	100 kΩ to 1 TΩ
Charge Data	
Short circuit/charge current	3 mA @ 5 kV
Capacitor charge time	<3 seconds per μF at 3 mA to 5 kV
Capacitor discharge time	<120 ms per μF to discharge from 5000 V to 50 V
Measurement range	
Capacitance measurement (above 500 V)	10 nF to 50 μF (dependent on measurement voltage)
Capacitance measurement accuracy (23 °C)	±5% ±5 nF
Voltage output accuracy (0 °C to 30 °C)	+4%, -0%, ±10 V of nominal test voltage at 1 GΩ load
Current measurement range	0.01 nA to 5 mA
Current measurement accuracy (23 °C)	±5% ±0.2 nA at all voltages
Environmental	
Ingress protection (lid closed)	IP65
Power supply	
Battery life	Typical capacity is 6 hours continuous testing at 5 kV with a 100 MΩ load
Mechanical data	
Dimensions (H x W x D)	305 mm x 194 mm x 360 mm
Weight	7.1 kg

If you need...

a 5 kV insulation tester with very high noise rejection (for example if you are working in an electrically noisy substation), then S1-554/2 might be what you need

ORDERING INFORMATION

Product	Order Code	Product	Order Code
5 kV insulation resistance tester	MIT520/2-EN	3 x 15 m medium insulated clips	1000-442
Included accessories			
3 m lead set insulated clips	6220-820	3 x 3 m large insulated clips	6220-811
User guide on CD-ROM	2000-213	3 x 10 m large insulated clips	1000-443
RS232 cable	25955-025	3 x 15 m large insulated clips	1000-432
USB cable	25970-041	Control circuit test lead sets	
Download Manager		2 x 3 m control circuit, small insulated clips	6220-822
PowerDB Lite software		Screened HV test leads	
Optional accessories			
HV test lead sets			
3 x 3 m un-insulated small clips	8101-181	1 x 3 m, 5 kV screened un-insulated small clips	6220-835
3 x 8 m un-insulated small clips	8101-182	1 x 15 m, 5 kV screened un-insulated small clips	6311-080
3 x 15 m un-insulated small clips	8101-183	1 x 3 m, 10 kV screened un-insulated small clips	6220-834
3 x 10 m medium insulated clips	1000-441	1 x 10 m, 10 kV screened un-insulated small clips	6220-861
		1 x 15 m, 10 kV screened un-insulated small clips	6220-833
		PowerDB software (various options)	

SPECIFICATIONS

Test voltages	50 V to 1 kV in 10 V steps, 1 kV to 10 kV in 25 V steps
Voltage input range	85-265 V rms, 50/60 Hz, 60 VA
Accuracy (23 °C, 10 kV)	±5% to 2 TΩ ±20% to 20 TΩ
Default voltmeter range	50 - 600 V a.c. or d.c. Accuracy (23 °C) ±2% or -1 V
Guard	
2% error guarding 500 kΩ leakage with 100 MΩ load	
Charge data	
Short circuit/charge current	3 mA @ 10 kV
Capacitor charge time	<5 seconds per μF at 3 mA to 10 kV
Capacitor discharge time	<250 ms per μF to discharge from 10000 V to 50 V
Measurement range	
Capacitance measurement (above 500 V)	10 nF to 50 μF (dependent on measurement voltage)
Capacitance measurement accuracy (23 °C)	±5% ±5 nF
Voltage output accuracy (0 °C to 30 °C)	+4%, -0%, ±10 V of nominal test voltage at 1 GΩ load
Current measurement range	0.01 nA to 5 mA
Current measurement accuracy (23 °C)	±5% ±0.2 nA at all voltages
Environmental	
Ingress Protection (lid closed)	IP65
Operational temperature	-20 °C to 50 °C
Storage temperature	-25 °C to 65 °C
Humidity	90% RH non-condensing at 40 °C
Mechanical data	
Dimensions (H x W x D)	305 mm x 194 mm x 360 mm
Weight	7.1 kg approx.



MIT1020/2

- CAT IV 600 V
- Mains or battery powered
- Variable test voltage from 50 V to 5000 V or 10,000 V
- Automatic IR, PI, DAR, SV and DD tests
- Measures to 35 TΩ (10 kV)
- RS232 and USB download of results to Megger Download Manager

Description

MIT1020/2 gives you the ability to test insulation to 10 kV, giving great flexibility. It also complies with IEEE43:2000 and has CAT IV safety and measures up to 35 TΩ. It allows automatic IR, PI, DAR, SV and DD tests. Results storage and download give full diagnostic information for later analysis. The instrument is fitted with a guard terminal to enhance accuracy.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
10 kV insulation resistance tester	MIT1020/2-EN	3 x 15 m medium insulated clips	1000-442
Included accessories		3 x 3 m large insulated clips	6220-811
3 m lead set insulated clips	6220-820	3 x 10 m large insulated clips	1000-443
User guide on CD-ROM	2000-213	3 x 15 m large insulated clips	1000-432
RS232 cable	25955-025	Control circuit test lead sets	
USB cable	25970-041	2 x 3 m control circuit, small insulated clips	6220-822
3 x 3 m lead set insulated clips	6220-811	Screened HV test leads	
PowerDB Lite		1 x 3 m, 5 kV screened un-insulated small clips	6220-835
Download Manager		1 x 15 m, 5 kV screened un-insulated small clips	6311-080
Optional accessories		1 x 3 m, 10 kV screened un-insulated small clips	6220-834
HV test lead sets		1 x 10 m, 10 kV screened un-insulated small clips	6220-861
3 x 3 m un-insulated small clips	8101-181	1 x 15 m, 10 kV screened un-insulated small clips	6220-833
3 x 8 m un-insulated small clips	8101-182	PowerDB (various options)	
3 x 15 m un-insulated small clips	8101-183		
3 x 10 m medium insulated clips	1000-441		

BM5200

Insulation resistance tester



BM5200

- 1 T Ω , 1.4 mA, 5 kV digital insulation tester with digital and analogue display
- Five test ranges; 250 V, 500 V, 1000 V, 2500 V and 5000 V
- Insulation (InS), Polarisation index (PI) and variable timed test (t) modes
- Selectable DC or AC (incl. frequency) voltmeter functions
- Guard terminal to shunt surface leakage currents
- CAT III 600 V safety rating

Description

The BM5200 tester is battery powered with a digital and analogue arc display, designed for high voltage insulation resistance testing in the maintenance and servicing of cables, rotating plant machinery, transformers, switchgear and industrial installations.

The guard terminal can be used to minimise the effects of surface leakage and hence erroneous measurements when carrying out insulation resistance tests.

Design safety features include high voltage warning indicator, external voltage display after IR test, automatic discharge of reactive loads and test leads.

SPECIFICATIONS

Ranges

Insulation	100 k Ω to 1 T Ω
------------	--------------------------------

Nominal test voltages

250 V, 500 V, 1000 V, 2500 V and 5000 V

Terminal voltage accuracy

<1000 V 0... +10% of nominal test voltage
≥1000 V 0...+5% of nominal test voltage

Insulation accuracy

Up to 1 G Ω : All ranges $\pm 5\%$ ± 2 digits
5000 V $\pm 5\%$ $\pm 0.04\%$ per G Ω
2500 V $\pm 5\%$ $\pm 0.08\%$ per G Ω
1000 V $\pm 5\%$ $\pm 0.2\%$ per G Ω
500 V $\pm 5\%$ $\pm 0.4\%$ per G Ω
250 V $\pm 5\%$ $\pm 0.8\%$ per G Ω

Short circuit current

1.4 mA ± 0.5 mA

Environment

Operating temperature	-20 °C to +55 °C
Storage temperature	-20 °C to +65 °C
Humidity range	90% RH, 0 °C to 40 °C 70% RH, 40 °C to 55 °C
Ingress protection	IP40

Power supply

8 x LR6/AA batteries

Battery life

5 hours at 5 kV into 100 M Ω with AA Alkaline LR6

Mechanical data

Dimensions (H x W x D)	220 mm x 115 mm x 163 mm
Weight	1.45 kg



ORDERING INFORMATION

Product	Order Code
BM5200 insulation tester	1001-289
Included accessories	
Carry case with lead storage	6420-117
3m leads	6220-820
User guide	2001-444
Quick start guide	2001-445
Test certificate	

This product

is not available for sale in the European Economic Area and North America

SPECIFICATIONS

Test voltages	50 V to 1 kV in 10 V steps 1 kV to 5 kV in 25 V steps
Interference rejection	1 mA per 250 V up to a maximum of 2 mA
Accuracy (23 °C, 5 kV)	±5% to 1 TΩ ±20% to 10 TΩ
Default voltmeter range	50 - 600 V a.c. or d.c. Accuracy (23 °C) ±2% or -1 V
Guard	
2% error guarding 500 kΩ leakage with 100 MΩ load	
Charge data	
Short circuit/charge current	5 mA
Capacitor charge time	<1.5 seconds per F at 5 mA to 5 kV
Capacitor discharge time	<120 ms per F to discharge from 5 kV to 50 V
Measurement range	
Capacitance measurement (above 500 V)	10 nF to 50 F (dependant on measurement voltage)
Capacitance measurement accuracy (23 °C)	±5% ±5 nF
Current measurement accuracy (23 °C)	±5% ±0.2 nA at all voltages
Current measurement range	0.01 nA to 5 mA
Display range	
Digital display (3 digit)	10 kΩ to 15 TΩ
Analogue display	100 kΩ to 1 TΩ
Power supply	
Battery life	Typical capacity is 6 hours continuous testing at 5 kV with a 100 MΩ load
Voltage input range	85-265 V rms 50/60 Hz, 60 VA
Environmental	
Ingress protection (lid closed)	IP65
Operating temperature	-20 °C to 50 °C
Storage temperature	-25 °C to 65 °C
Humidity	90% RH non-condensing at 40 °C
Mechanical data	
Dimensions	305 mm x 194 mm x 360 mm
Weight	7.1 kg



S1-552/2

- 5 mA short circuit current output
- CAT IV 600 V
- Measures to 15 TΩ
- Automatic IR, PI, DAR, SV and DD tests
- On board memory for results storage
- RS232 and USB download of results

Description

S1-552/2 gives a short circuit current of 5 mA essential for the fast charging of high capacitance such as long cables. The 5 mA capability also helps to maintain selected test voltages, for example when testing insulation with high levels of surface leakage guarded. The 2 mA noise rejection makes it ideal for testing in noisy substation environments. It offers CAT IV 600 V safety, making it the choice for external working. Because it measures up to 15 TΩ, insulation deterioration can be monitored from an early stage, assisting maintenance planning. All other features as the MIT520/2.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
5 kV high current insulation resistance tester S1-552/2-EN	1001-289	3 x 10 m medium insulated clips	1000-441
Included accessories		3 x 15 m medium insulated clips	1000-442
3 m lead set, medium size insulated clips	6220-820	3 x 3 m large insulated clips	6220-811
User guide on CD-ROM	2000-213	3 x 10 m large insulated clips	1000-443
Download manager on CD-ROM		3 x 15 m large insulated clips	1000-442
RS232 cable	25955-025	Control circuit test lead sets	
Optional accessories		2 x 3 m small insulated clips	6220-822
HV test lead sets		Screened HV test leads	
3 x 3 m small un-insulated clips	8101-181	1 x 3 m 5 kV small un-insulated clips	6220-835
3 x 8 m small un-insulated clips	8101-182	1 x 15 m 5 kV small un-insulated clips	6311-080
3 x 15 m small un-insulated clips	8101-183	Power DB lite certification software	



S1-1052/2

- High output current 5 mA for fast charging of capacitive loads
- CAT IV 600 V
- Measures to 15 TΩ
- Automatic IR, PI, DAR, SV and DD tests
- On board memory for results storage
- RS232 and USB download of results

Description

S1-1052/2 gives a short circuit current of 5 mA essential for the fast charging of high capacitance such as long cables. The 5 mA capability also helps to maintain selected test voltages, for example when testing insulation with high levels of surface leakage guarded. The 2 mA noise rejection makes it ideal for testing in noisy substation environments. It offers CAT IV 600 V safety, making it the choice for external working. The 10 kV capability means it measures up to 35 TΩ so insulation deterioration can be monitored from a very early stage, assisting maintenance planning. All other features as the MIT1020/2.

SPECIFICATIONS

Test voltages	50 V to 1 kV in 10 V steps 1 kV to 10 kV in 25 V steps
Interference rejection	1 mA per 250 V up to a maximum of 2 mA
Accuracy (23 °C, 10 kV)	±5% to 2 TΩ ±20% to 20 TΩ
Default voltmeter range	50 - 600 V a.c. or d.c. Accuracy (23 °C) ±2% or -1 V
Guard	
2% error guarding 500 kΩ leakage with 100 MΩ load	
Charge data	
Short circuit/charge current	5 mA
Capacitor charge time	<1.5 seconds per F at 5 mA to 10 kV
Capacitor discharge time	<120 ms per F to discharge from 10 kV to 50 V
Measurement range	
Capacitance measurement (above 500 V)	10 nF to 50 F (dependant on measurement voltage)
Capacitance measurement accuracy (23 °C)	±5% ±5 nF
Voltage output accuracy (0 °C to 30 °C)	+4%, -0% ±10 V of nominal test voltage at 1 GΩ load
Current measurement range	0.01 nA to 5 mA
Capacitance measurement accuracy (23 °C)	±5% ±0.2 nA at all voltages
Display range	
Digital display (3 digit)	10 kΩ to 35 TΩ
Analogue display	100 kΩ to 1 TΩ
Power supply	
Battery life	Typical capacity is 4 hours continuous testing at 10 kV with a 100 MΩ load
Voltage input range	85-265 V rms 50/60 Hz, 60 VA
Environmental	
Ingress protection (lid closed)	IP65
Operating temperature	-20 °C to 50 °C
Storage temperature	-25 °C to 65 °C
Humidity	90% RH non-condensing at 40 °C
Mechanical data	
Dimensions	305 mm x 194 mm x 360 mm
Weight	7.1 kg

ORDERING INFORMATION

Product	Order Code	Product	Order Code
10 kV high current insulation resistance tester	S1-1052/2 -EN	3 x 15 m small un-insulated clips	8101-183
Included accessories		3 x 10 m medium insulated clips	1000-441
3 m lead set, medium size insulated clips	6220-820	3 x 15 m medium insulated clips	1000-442
3 m lead set, medium size insulated clips	6220-811	3 x 3 m large insulated clips	6220-811
User guide on CD-ROM	2000-213	3 x 10 m large insulated clips	1000-443
Download manager on CD-ROM		3 x 15 m large insulated clips	1000-442
RS232 cable	25955-025	Control circuit test lead sets	
USB cable	25970-041	2 x 3 m small insulated clips	6220-822
Optional accessories		Screened HV test leads	
HV test lead sets		1 x 3 m 10 kV small un-insulated clips	6220-834
3 x 3 m small un-insulated clips	8101-181	1 x 3 m 10 kV small un-insulated clips	6220-861
3 x 8 m small un-insulated clips	8101-182	1 x 15 m 10 kV small un-insulated clips	6220-833
		Power DB lite certification software	

5 kV Diagnostic insulation resistance tester with high noise rejection

SPECIFICATIONS

Test voltages	50 V to 1 kV in 10 V steps 1 kV to 5 kV in 25 V steps
Interference rejection	1 mA per 250 V up to a maximum of 2 mA
Firmware filter	10, 30 and 100 second time constants (selectable)
Accuracy (23 °C, 5 kV)	±5% to 1 TΩ ±20% to 10 TΩ
Default voltmeter range	50 - 600 V a.c. or d.c. Accuracy (23 °C) ±2% or -1 V
Guard	
2% error guarding 500 kΩ leakage with 100 MΩ load	
Charge data	
Short circuit/charge current	5 mA
Capacitor charge time	<1.5 seconds per F at 5 mA to 5 kV
Capacitor discharge time	<120 ms per F to discharge from 5 kV to 50 V
Measurement range	
Capacitance measurement (above 500 V)	10 nF to 50 F (dependant on measurement voltage)
Capacitance measurement accuracy (23 °C)	±5% ±5 nF
Voltage output accuracy (0 °C to 30 °C)	+4%, -0% ±10 V of nominal test voltage at 1 GΩ load
Current measurement range	0.01 nA to 5 mA
Capacitance measurement accuracy (23 °C)	±5% ±0.2 nA at all voltages
Display range	
Digital display (3 digit)	10 kΩ to 15 TΩ
Analogue display	100 kΩ to 1 TΩ
Power supply	
Battery life	Typical capacity is 6 hours continuous testing at 5 kV with a 100 MΩ load
Voltage input range	85-265 V rms 50/60 Hz, 60 VA
Environmental	
Ingress protection (lid closed)	IP65
Operating temperature	-20 °C to 50 °C
Storage temperature	-25 °C to 65 °C
Humidity	90% RH non-condensing at 40 °C
Mechanical data	
Dimensions	305 mm x 194 mm x 360 mm
Weight	7.1 kg



S1-554/2

- 4 mA noise rejection with firmware filtering
- 5 mA short circuit current output
- CAT IV 600 V
- Measures to 15 TΩ
- Automatic IR, PI, DAR, SV and DD tests
- On board memory for results storage

Description

S1-554/2 gives a short circuit current of 5 mA essential for the fast charging of high capacitance such as long cables. The 5 mA capability also helps to maintain selected test voltages, for example when testing insulation with high levels of surface leakage guarded. The 4 mA noise rejection with firmware time constant filtering makes it the perfect instrument for testing in high-noise environments such as HV switch yards. It offers CAT IV 600 V safety, making it the choice for external working. Because it measures up to 15 TΩ, insulation deterioration can be monitored from an early stage, assisting maintenance planning. All other features as the MIT520/2.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
5 kV insulation resistance tester with high noise rejection	S1-554/2 -EN	3 x 15 m small un-insulated clips	8101-183
Included accessories		3 x 10 m medium insulated clips	1000-441
3 m lead set, medium size insulated clips	6220-820	3 x 15 m medium insulated clips	1000-442
User guide on CD-ROM	2000-213	3 x 3 m large insulated clips	6220-811
Download manager on CD-ROM		3 x 10 m large insulated clips	1000-443
RS232 cable	25955-025	3 x 15 m large insulated clips	1000-442
USB cable	25970-041	Control circuit test lead sets	
Optional accessories		2 x 3 m small insulated clips	6220-822
HV test lead sets		Screened HV test leads	
3 x 3 m small un-insulated clips	8101-181	1 x 3 m 5 kV small un-insulated clips	6220-835
3 x 8 m small un-insulated clips	8101-182	1 x 15 m 5 kV small un-insulated clips	6311-080
		Power DB lite certification software	



S1-1054/2

- 4 mA noise rejection with firmware filtering
- 5 mA short circuit current output
- CAT IV 600 V
- Measures to 35 TΩ
- Automatic IR, PI, DAR, SV and DD tests
- On board memory for results storage

Description

S1-1054/2 gives a short circuit current of 5 mA essential for the fast charging of high capacitance such as long cables. The 5 mA capability also helps to maintain selected test voltages, for example when testing insulation with high levels of surface leakage guarded. The 4 mA noise rejection with firmware time constant filtering makes it the perfect instrument for testing in high-noise environments such as HV switch yards. It offers CAT IV 600 V safety, making it the choice for external working. The 10 kV capability means it measures up to 35 TΩ so insulation deterioration can be monitored from a very early stage, assisting maintenance planning. All other features as the MIT1020/2.

SPECIFICATIONS

Test voltages	50 V to 1 kV in 10 V steps 1 kV to 5 kV in 25 V steps
Interference rejection	1 mA per 250 V up to a maximum of 4 mA
Firmware filter	10, 30 and 100 second time constants (selectable)
Accuracy (23 °C, 5 kV)	±5% to 2 TΩ ±20% to 20 TΩ
Default voltmeter range	50 - 600 V a.c. or d.c. Accuracy (23 °C) ±2% or -1 V
Guard	
2% error guarding 500 kΩ leakage with 100 MΩ load	
Charge data	
Short circuit/charge current	5 mA
Capacitor charge time	<1.5 seconds per F at 5 mA to 10 kV
Capacitor discharge time	<120 ms per F to discharge from 10 kV to 50 V
Measurement range	
Capacitance measurement (above 500 V)	10 nF to 50 F (dependant on measurement voltage)
Capacitance measurement accuracy (23 °C)	±5% ±5 nF
Voltage output accuracy (0 °C to 30 °C)	+4%, -0% ±10 V of nominal test voltage at 1 GΩ load
Current measurement range	0.01 nA to 5 mA
Capacitance measurement accuracy (23 °C)	±5% ±0.2 nA at all voltages
Display range	
Digital display (3 digit)	10 kΩ to 35 TΩ
Analogue display	100 kΩ to 1 TΩ
Power supply	
Battery life	Typical capacity is 4 hours continuous testing at 10 kV with a 100 MΩ load
Voltage input range	85-265 V rms 50/60 Hz, 60 VA
Environmental	
Ingress protection (lid closed)	IP65
Operating temperature	-20 °C to 50 °C
Storage temperature	-25 °C to 65 °C
Humidity	90% RH non-condensing at 40 °C
Mechanical data	
Dimensions	305 mm x 194 mm x 360 mm
Weight	7.1 kg

ORDERING INFORMATION

Product	Order Code	Product	Order Code
10 kV high current insulation resistance tester	S1-1054/2 -EN	3 x 15 m small un-insulated clips	8101-183
Included accessories		3 x 10 m medium insulated clips	1000-441
3 m lead set, medium size insulated clips	6220-820	3 x 15 m medium insulated clips	1000-442
3 m lead set, large size insulated clips	6220-811	3 x 3 m large insulated clips	6220-811
User guide on CD-ROM	2000-213	3 x 10 m large insulated clips	1000-443
Download manager on CD-ROM		3 x 15 m large insulated clips	1000-442
RS232 cable	25955-025	Control circuit test lead sets	
USB cable	25970-041	2 x 3 m small insulated clips	6220-822
Optional accessories		Screened HV test leads	
HV test lead sets		1 x 3 m 10 kV small un-insulated clips	6220-834
3 x 3 m small un-insulated clips	8101-181	1 x 3 m 10 kV small un-insulated clips	6220-861
3 x 8 m small un-insulated clips	8101-182	1 x 15 m 10 kV small un-insulated clips	6220-833
		Power DB lite certification software	

SPECIFICATIONS

Test voltages	500, 1000, 2500, 5000 V 25 to 5000 V in 25 V steps
Test voltage accuracy	±5% on 10 MΩ load and above ±2 V for test voltages <500 V ±12 V for test voltages <125 V
Nominal test current limit	2 mA or 5 mA (selectable)
Charge time	<5 s per μF at 2 mA <2.5 s per μF at 5 mA
Measurement ranges	
Digital resistance	10 kΩ to 500 GΩ @ 500 V 10 kΩ to 1 TΩ @ 1000 V 10 kΩ to 2.5 TΩ @ 2500 V 10 kΩ to 5 TΩ @ 5000 V
Voltage	50 to 1000 V ac/dc (5000 V when testing)
Current	0.01 nA to 999 μA
Capacitor	0.01 μF - 10.0 μF
Analogue	
Resistance	10 kΩ to 1 TΩ
Accuracy (0 to 30 °C) (32 to 86 °F)	
Resistance	±5% of reading (1 MΩ to 1 TΩ @ 5 kV)
DC test voltage	±2% ±1 V
Current	±5% ±0.2 nA
Capacitance	±5% ±0.01 μF
Interference rejection	4 mA at 50/60 Hz for <5% additional error
Maximum capacitance discharge rating	20.0 μF
Guard terminal	
Guards out parallel resistance down to 250 kΩ Maximum additional error 5% @ 100 MΩ	
Operational supply	95 - 280 V ac 12 - 15 V ac or dc
Test time	15 seconds to 90 minutes
Battery	
Internal rechargeable	12 V, 7 Ah lead acid battery
Battery life	At least 8 hours from a fully charged battery
Battery indicator	Bargraph level indicator
Display	
Backlit dot matrix LCD (256 x 128 pixels)	
Safety	
Conforms to IEC 61010-1 voltmeter rated for use on 300 V phase to earth systems, category III	
Environmental	
Ingress protection (with side door closed)	IP654
Operating temperature	-20 °C to 50 °C (-4 to +122 °F)
Storage temperature	-25 °C to 65 °C (-13 to 149 °F)
Humidity	90% RH non-condensing at 40 °C (104 °F)
Mechanical data	
Dimensions	327 x 316 x 196 mm (12.8 x 12.4 x 7.7 in.)
Weight	9 kg (19.8 lbs)



S1-5010

- High specification 5 kV tester
- Automatic test sequences
- PC control and display option
- On-board results storage
- Heavy duty, mains/battery operation
- User defined test procedures with software

Description

The S1-5010 is an advanced insulation tester for measurement of insulation resistance of all types of electrical equipment. The instrument performs automatic tests, enabling consistent operation without operator input. It stores results and can be operated from a PC. Flexible power supply options and robust, portable construction allow the instrument to be used in a wide variety of applications. It is particularly suitable for analysing the insulation of large machines, HV generators and cables.

ORDERING INFORMATION

Product	Order Code
Dignostic insulation tester	S1-5010
Included accessories	
3 x 3 m (10 ft) HV leads	8101-181
RS232 communication lead	25955-025
PC download software	6220-652
Test record cards (5)	6172-112
Accessory pouch	6420-116
User guide	6172-283
Optional accessories	
Fused test lead set	6320-240
3 x 8 m (25 ft) HV leads	8101-182
3 x 15 m (50 ft) HV leads	8101-183
Shielded test lead set 15 m (50 ft)	6311-080
12 V dc automative charging lead	6231-584
S1-S1 PC software for remote operation and data storage	6220-644
CB101, 5 kV calibration box	6311-077

MJ15 and BM15

Analogue 5 kV insulation testers



MJ15 and BM15

- Four test voltages to 5 kV
- Dual power supply option (MJ15) giving the best of both worlds
- Resilient mounted analogue scale for robustness
- Voltage range to 600 V indicates auto discharge
- Pass/fail overlays for rapid testing
- Single scale for insulation values to avoid operator error

Description

BM15 and MJ15 are compact 5 kV insulation testers. They are very simple to use and provide a quick and accurate reading of insulation resistance. The instruments use an analogue display with a maximum reading of 20 GΩ. The BM15 is powered by batteries only. The MJ15 has an additional hand-cranked generator.

The BM15 is powered by 8 x LR6 (AA) alkaline cells. The MJ15 comes with a hand cranked generator plus batteries. If the test button is pressed the MJ15 uses battery power. Otherwise the crank handle is turned to save battery power or for use when the batteries are unavailable.

SPECIFICATIONS

Insulation range

100 kΩ to 20 GΩ (also 0 Ω and ∞)

Test voltages (d.c.)

500 V, 1000 V, 2500 V and 5000 V

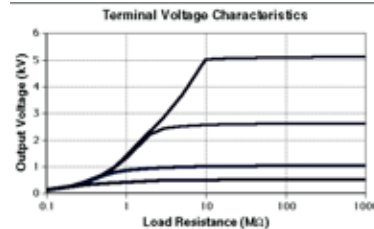
Test voltage accuracy

±5% of nominal test voltages on 20 MΩ load

Accuracy

±2,5% f.s.d. a.c. (with rotary switch in the V position)

Terminal voltage characteristics



Environmental

Operational temperature	0 °C to 30 °C at full specification -20 °C to 50 °C with temperature coefficient ±1%/ °C
Capacitance measurement (above 500 V)	10 nF to 50 μF (dependent on test voltage)
Storage temperature	-25 °C to 65 °C
Humidity range	90% RH at 40 °C

Power supply

Low voltage brushless generator and 8 x AA cells (LR6 or rechargeable)

Mechanical data

Dimensions (H x W x D)	220 mm x 160 mm x 115 mm
Weight BM15	1.2 kg
Weight MJ15	1.6 kg or 1.8 kg with battery holder and cells

If you need...

a 5 kV insulation tester with very high noise rejection (for example if you are working in an electrically noisy substation), then S1-554/2 might be what you need

See page 23

ORDERING INFORMATION

Product	Order Code	Product	Order Code
Hand crank/battery 5 kV insulation tester	MJ15		
Battery powered 5 kV insulation tester	BM15		
Included accessories			
User guide	6172-209		
3 x 3 m HV leads	8101-181		
Carrying case with lead storage	6420-117		
Slide in pass band overlay (5 supplied)	6121-401		
Test record card (pack of 5)	(U.S 210949)		
8 x AA cells (LR6 or rechargeable)			
Optional accessories			
Fused test probes, 1,5 m long (2 used)		6320-240	
Test record card (Pack of 20)		6111-216	
CB101; 5 kV calibration box		6311-077	

SPECIFICATIONS	
Input voltage	120 Vac, 60 Hz
Output current 5 kV Megohmmeter	5 mA continuous
Output current 15 kV Megohmmeter	2 mA continuous (stabiliser out) 50 µA continuous (at 15 kV, stabiliser in)
Short circuit current	12 mA max.
Environmental	
Operating temperature	-17.7 to +50 °C (0 to 122 °F)
Mechanical data	
5 kV Dimensions (H x W x D)	254 x 260 x 355 mm (10 x 10.2 x 14 inches)
15 kV Dimensions (H x W x D)	317 x 292 x 514 mm (12.5 x 11.5 x 20.2 inches)
5 kV Weight	9.3 kg (20.5 lb)
15 kV Weight	15.9 kg (35 lb)



Applications

The units are suitable for dielectric absorption and step voltage testing. Two models are available:

The 5 kV Megohmmeter measures up to 100,000 MΩ; provides output from 250 volts to 5 kV, with direct reading up to 50,000 MΩ at 2.5 kV.

The 15 kV Megohmmeter provides direct reading measurements up to 100,000 MΩ at 5 kV and up to 200,000 MΩ at 10 kV, with a multiplying factor for all other voltages up to 15 kV.

The 15 kV model also features an internal voltage stabiliser that may be activated for improved measurement under extreme field conditions. Separate on/off controls are provided for power and high voltage, and red light indicates when high voltage is on.

Megohmmeter

- Continuously variable test voltage
- Rugged field construction
- Circuit-breaker protection

Description

The 5 and 15 kV Megohmmeters are high-voltage, line-operated instruments. They provide a continuously variable test voltage for highly sensitive insulation resistance measurements of all types of electrical equipment and power cable.

The instruments are designed to withstand harsh field conditions, and feature tough, impact-resistance casing, removable lids and adjustable carrying straps. For complete portability, there is ample room in each case to store cables and the instruction manual.

ORDERING INFORMATION			
Product	Order Code	Product	Order Code
5 kV Megohmmeter	210400		
15 kV Megohmmeter	210415		
Included accessories			
Ground connection cable, 3 m (10 ft)	4702		
Test record card, universal	210954		
Power cord, for CAT No.	17032		
Instruction manual for 5 kV model	AVTM21-40JA		
Instruction manual for 15 kV model	AVTM21-415JA		
Optional accessories			
Test record card, 0 to 1000 GΩ			210959
Test report sheet for rotating equipment			210951-1
Test report sheet for power transformers			210951-2
Test report sheet for power cables			210951-3
Bushing guard spring			217003
"Lowdown on HV DC Testing" manual			AVTM22P-1
"A Stitch in Time" manual			AVTM21-P8B



MIT30

- Continuously variable test voltage, 0 – 30 kV
- Test current 0 - 330 μ A
- Output voltage accuracy, + 1.5% (full scale)
- Built-in adjustable ionization indicator
- Fail-safe grounding and “zero-start” switches

Description

The MIT30 is a portable 30 kV insulation tester that has been developed to satisfy the demand for a variety of high voltage, high accuracy, low current applications. The MIT30 is used to undertake HV insulation tests (proof/ hi-pot test) on insulating material where low levels of leakage current, down to an accuracy of 100 nA, need to be measured.

The MIT30 has a test current of up to 330 μ A, and user selectable trip levels from 0 to 360 μ A, provide protection to the test piece against flashovers (arcing) and further damage in the event of a breakdown. An audible ionization indicator gives an audio indication of any electrical discharges present during the test period.

SPECIFICATIONS

Output	
Output	0 to 30 kV dc (variable negative with respect to earth/ground)
Maximum current	330 μ A
Peak-peak ripple	<0.4%
Line regulation	0.03%
Load regulation	0.001%
Current	
330 μ A continuous	
User selectable trip from 0 to 360 μ A	
Accuracy	
Voltage meter	\pm 1.5% (full scale), 10 V resolution
Current meter	\pm 1.5% (full scale), 100 nA resolution
Input	
Mains ac/dc	ac - 85 - 264 V ac, 47 - 440 Hz dc - 110 - 350 V dc <75 VA
Environmental	
Operating temperature	-10 °C to +55 °C (14 °F to 131 °F)
Storage temperature	-20 °C to +70 °C (-4 °F to +158 °F)
Humidity	0 to 90% RH (non-condensing)
Maximum altitude (full rating)	1600 m (MSL)
Ingress protection	IP67 when closed for transport (Def Stan 81-41/STANAG 4280) IP52 when in use
Mechanical data	
Dimensions (H x W x D)	360 mm x 304 mm x 194 mm (14 in x 12 x 8 in)
Weight	10 kg (22 lb)

ORDERING INFORMATION

Product	Order Code
30 kV high-voltage insulation tester	MIT30
Included accessories	
HV triaxial output cable, 3 m	SKRC080509
Input power cord	17032
Instruction manual	AVTMMIT30
Optional accessories	
High voltage resistance discharge stick	222070-62
“The Lowdown on High-Voltage DC Testing” Guide	AVTM22P-1

SPECIFICATIONS

Input

120 Vac, 50/60 Hz

Output

Cat. No. 220005

Voltage (maximum)	0 to 5 kV dc, negative with respect to ground
Current meter	5 mA continuous

Metering

Kilovoltmeter	102 mm (4 in.) taut band with two ranges, 0 to 2.5 and 0 to 5 kV
Current meter	102 mm (4 in.) taut band with four ranges, 0 to 5/50/500 μ A and 5 mA

Cat. No. 220015

Voltage	0 to 15 kV dc, negative with respect to ground
Current	2 mA continuous
Short Circuit	12 mA max., limited by circuit breaker

Metering

Kilovoltmeter	102 mm (4 in.) taut band with two ranges, 0 to 7.5 and 0 to 15.0 kV
Current meter	102 mm (4 in.) taut band with four ranges, 0 to 5/50/500 μ A and 5 mA

Environmental

Operating temperature	-17.7 to +50 °C (-0 to 122 °F)
Storage temperature	-4 °F to +158 °F (-20 °C to +70 °C)
Humidity	0 to 90% RH (non-condensing)
Maximum altitude (full rating)	1600 m (MSL)
Ingress protection	IP67 when closed for transport (Def Stan 81-41/STANAG 4280) IP52 when in use

Mechanical data

Dimensions (H x W x D)	360 mm x 304 mm x 194 mm (14 in x 12 x 8 in)
Weight	10 kg (22 lb)



5 and 15 kV

- Continuously variable test voltage
- Rugged field construction
- Compact and portable

Description

Dielectric test sets measure leakage current while applying a dc voltage at or above the insulation system's operating level. This measurement aids in determining the insulation system's ability to withstand overvoltages such as lightning strikes and switching surges.

Two models are available; a 5 kV unit for testing equipment rated 2.5 kV and below, and a 15 kV model for use on equipment rated 7.5 kV and below. Both are suitable for testing power cable, switchgear and rotating machinery in accordance with IEEE, ICEA, NEMA and ANSI guidelines.

Because Megger dc dielectric test sets act like full-wave rectified units, they also are suitable for applications involving vacuum bottles.

ORDERING INFORMATION

Product	Order Code
5 kV	220005
15 kV	220015

Included accessories

Ground connection cable, 3 m [10 ft]	4702
kV/M Ω test record graph paper (100 sheet pad)	220000
Power cord, Cat. No. 220015	17032
Instruction manual, Cat. No. 220005	AVTM22-5JB
Instruction manual, Cat. No. 220015	AVTM22-15JA

Optional accessories

Strip chart recorder	220003
High-voltage resistance discharge stick	222070-62
Internal voltage stabilizer, Cat. No. 220015 only	Add -50
Special cable lengths	Add -56
"The Lowdown on High-Voltage DC Testing"	AVTM22P-1



DC Insulation Testers

Accurate and reliable condition assessment of insulations in transformers, bushings, generators and cables is essential to substation maintenance. These diagnostic insulation testing systems maximize the outcome of maintenance activities allowing for load and service life optimization. Using this advanced equipment and plotting the results of your tests as a curve makes it possible to assess the condition of the oil and solid insulation, assess the moisture level in the solid insulation and other potential insulation problems.

2.2

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AC and AC/DC high pot tester	46
70, 120, 160 kV DC high voltage DC dielectric test sets	48
670025 series	50
Optional accessories	52

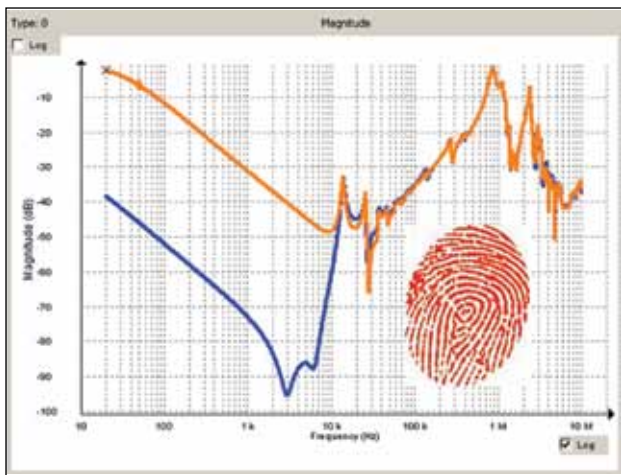
	FRAX 150	FRAX 99/100	IDAX	DELTA 4000	CB100	AC and AC DC high pot	70, 120, 160 kV DC	670025 series
Intelligent temperature correction			■	■	■			
Voltage dependent			■	■	■			
Result management								
Data storage								
USB download								
Mains power	■	■	■	■	■	■	■	■
High noise immunity								
High test current								
Included software								
PowerDB Lite	■	■	■	■	■	■	■	■
PowerDB	□	□	□	□	□	□	□	□
IDAX software			■					
MODS software			■					
Diagnostic capability			■	■	■			

Introduction

Power transformers are some of the most vital components in today's transmission and distribution infrastructure. Transformer failures cost enormous amounts of money in unexpected outages and unscheduled maintenance. It is important to avoid these failures and make testing and diagnostics reliable and efficient.

The FRAX Sweep Frequency Response Analyzer (SFRA) detects potential mechanical and electrical problems that other methods are unable to detect. Major utilities and service companies have used the FRA method for more than a decade. The measurement is easy to perform and will capture a unique "fingerprint" of the transformer. The measurement is compared to a reference "fingerprint" and gives a direct answer if the mechanical parts of the transformer are unchanged or not. Deviations indicate geometrical and/or electrical changes within the transformer.

Power transformers are specified to withstand mechanical forces from both transportation and in-service events, such as faults and lightning. However, mechanical forces may exceed specified limits during severe incidents or when the insulation's mechanical strength has weakened due to aging. A relatively quick test where the fingerprint response is compared to a post event response allows for a reliable decision on whether the transformer safely can be put back into service or if further diagnostics is required.



Collecting fingerprint data using Frequency Response Analysis (FRA) is an easy way to detect electro-mechanical problems in power transformers and an investment that will save time and money.

Considerations When Performing SFRA Measurements

SFRA measurements are compared over time or between different test objects. This accentuates the need to perform the test with the highest repeatability and eliminates the influence from external parameters such as cables, connections and instrument performance. FRAX offers all the necessary tools to ensure that the measured curve represents the internal condition of the transformer.

Good Connections

Bad connections can compromise the test results which is why FRAX offers a rugged test clamp that ensures good connection to the bushings and solid connections to the instrument.

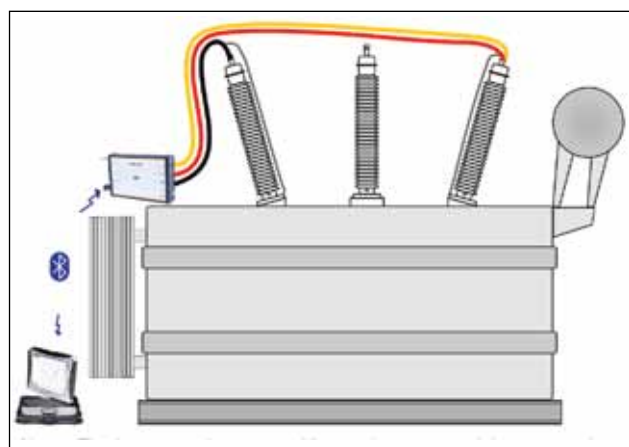


Contacts made with the C-clamp guarantee good connections

Shortest Braid Concept

The connection from the cable shield to ground has to be the same for every measurement on a given transformer. Traditional ground connections techniques have issues when it comes to providing repeatable conditions. This causes unwanted variations in the measured response for the highest frequencies that makes analysis difficult.

The FRAX braid drops down from the connection clamp next to the insulating discs to the ground connection at the base of the bushing. This creates near identical conditions every time you connect to a bushing whether it is tall or short.



The laptop can be operated by touch screen and the communication is wireless via Bluetooth. Measurement ground braids connect close to the connection clamps and run next to the bushing to the flange connection to avoid cable loops that otherwise affect the measurement.

The Power of Wireless

FRAX 101 uses class 1 Bluetooth® wireless communication. Class 1 Bluetooth® has up to 100 m range and is designed for industrial applications. An optional internal battery pack is available for full wireless flexibility. Shorter and more light-weight cables can be used when the user is liberated from cable communication and power supply cables.

A standard USB interface (galvanically isolated) is included for users who prefer a direct connection to their PC.



FTB 101 Field Test Box

Import and export

The FRAX software can import data files from other FRA instruments making it possible to compare data obtained using another FRA unit. FRAX can import and export data according to the international XFRA standard format as well as standard CSV and TXT formats.

Optimized Sweep Setting

The software offers the user an unmatched feature that allows for fast and efficient testing. Traditional SFRA systems use a logarithmic spacing of measurement points. This results in as many test points between 20 Hz and 200 Hz as between 200 KHz and 2 MHz and a relatively long measurement time.

The frequency response from the transformer contains a few resonances in the low frequency range but a lot of resonances at higher frequencies. FRAX allows the user to specify less measurement points at lower frequencies and high measurement point density at higher frequencies. The result is a much faster sweep with greater detail where it is needed.

Variable Voltage

The applied test voltage may affect the response at lower frequencies. Some FRA instruments do not use the 10 V peak-to-peak used by major manufacturers and this may complicate comparisons between tests. FRAX standard voltage is 10 V peak-to-peak but FRAX also allows the user to adjust the applied voltage to match the voltage used in a different test.

FTB 101

Several international FRA guides recommends to verify the integrity of cables and instrument before and after a test using a test circuit with a known FRA response supplied by the equipment manufacturer. FRAX comes with a field test box FTB101 as a standard accessory and allows the user to perform this important validation in the field at any time and secure measurement quality.

FRAX detects problems such as:

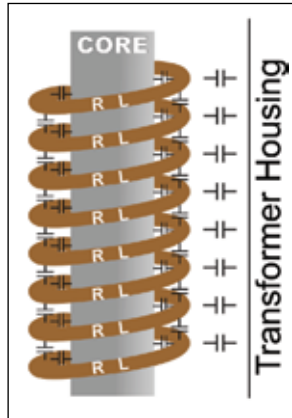
- Winding deformations and displacements
- Shorted turns and open windings
- Loosened clamping structures
- Broken clamping structures
- Core connection problems
- Partial winding collapse
- Faulty core grounds
- Core movements
- Hoop buckling

Method Basics

A transformer consists of multiple capacitances, inductances and resistors, a very complex circuit that generates a unique fingerprint or signature when test signals are injected at discrete frequencies and responses are plotted as a curve.

Capacitance is affected by the distance between conductors. Movements in the winding will consequently affect capacitances and change the shape of the curve.

The SFRA method is based on comparisons between measured curves where variations are detected. One SFRA test consists of multiple sweeps and reveals if the transformer's mechanical or electrical integrity has been jeopardized.



Practical Application

In its standard application, a "finger print" reference curve for each winding is captured when the transformer is new or when it is in a known good condition. These curves can later be used as reference during maintenance tests or when there is reason to suspect a problem.

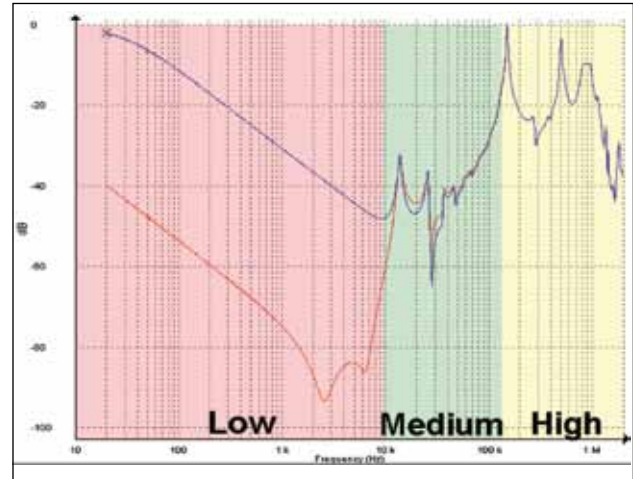
The most reliable method is the time based comparison where curves are compared over time on measurements from the same transformer. Another method utilizes type based comparisons between "sister transformers" with the same design. Lastly, a construction based comparison can, under certain conditions, be used when comparing measurements between windings in the same transformer.

These comparative tests can be performed 1) before and after transportation, 2) after severe through faults 3) before and after overhaul and 4) as diagnostic test if you suspect potential problems. One SFRA test can detect winding problems that requires multiple tests with different kinds of test equipment or problems that cannot be detected with other techniques at all. The SFRA test presents a quick and cost effective way to assess if damages have occurred or if the transformer can safely be energized again. If there is a problem, the test result provides valuable information that can be used as decision support when determining further action.

Having a reference measurement on a mission critical transformer when an incident has occurred is, therefore, a valuable investment as it will allow for an easier and more reliable analysis.

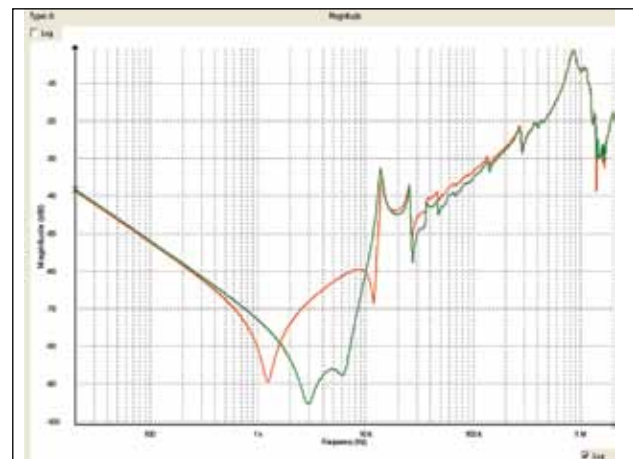
Analysis and Software

As a general guideline, shorted turns, magnetization and other problems related to the core alter the shape of the curve in the lowest frequencies. Medium frequencies represent axial or radial movements in the windings and high frequencies indicate problems involving the cables from the windings, to bushings and tap changers.



An example of low, medium and high frequencies

The FRAX Software provides numerous features to allow for efficient data analysis. Unlimited tests can be open at the same time and the user has full control on which sweeps to compare. The response can be viewed in traditional Magnitude vs. Frequency and/or Phase vs. Frequency view. The user can also choose to present the data in an Impedance or Admittance vs. Frequency view for powerful analysis on certain transformer types.



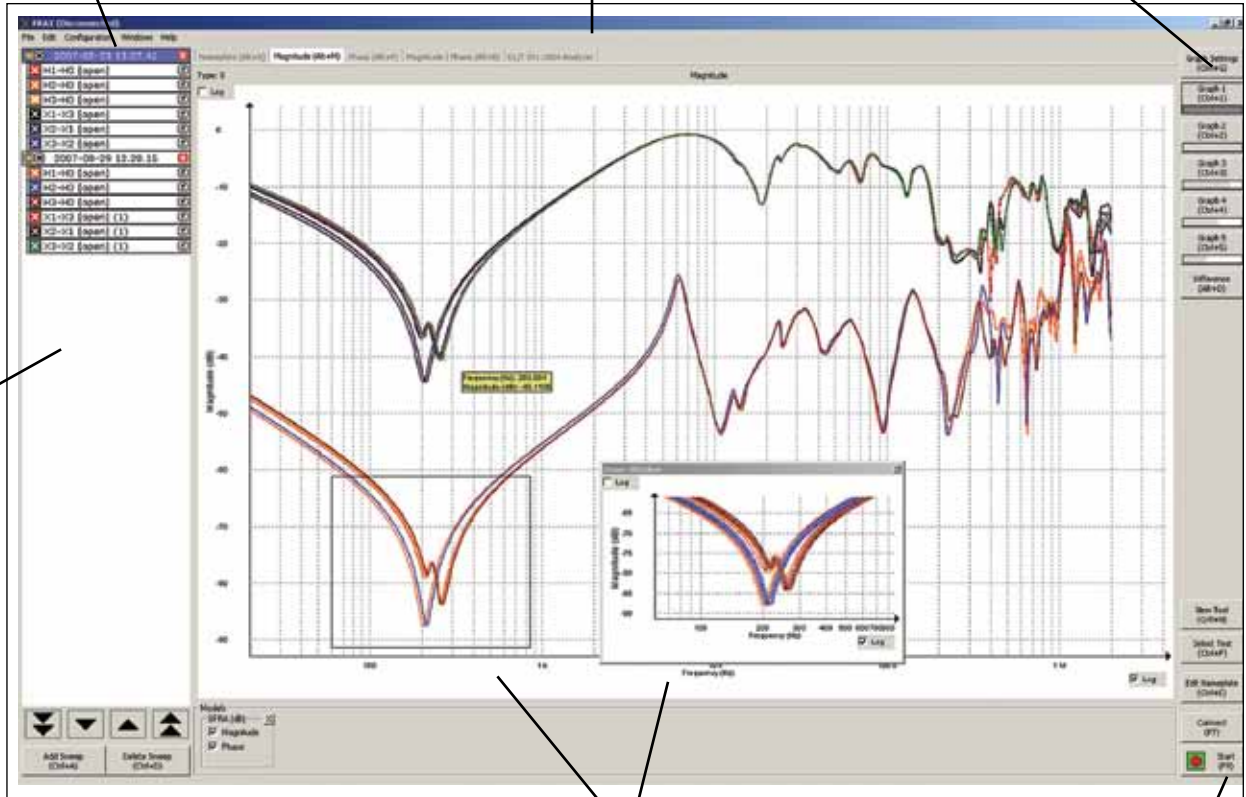
The figure above shows a single phase transformer after a service overhaul where, by mistake, the core ground never got connected (red), and after the core ground was properly connected (green). This potential problem clearly showed up at frequencies between 1 kHz and 10 kHz and a noticeable change is also visible in the 10 kHz - 200 kHz range.

Sweep frequency response analyzer

Test Object Browser — Unlimited number of tests and sweeps. Full user control.

Quick Select Tabs — Quickly change presentation view for different perspectives and analysis tools.

Quick Graph Buttons — Programmable graph setting lets you change views quickly and easily.



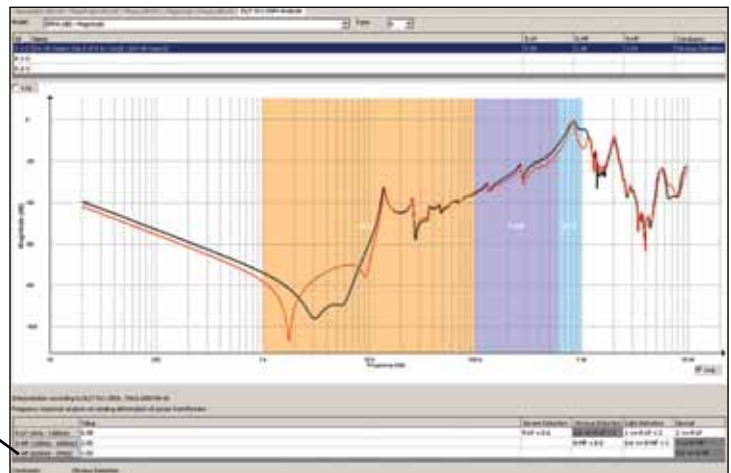
Sweep/Curve Settings — Every sweep can be individually turned on or off, change color, thickness and position.

Dynamic Zoom — Zoom in and move your focus to any part of the curve.

Operation Buttons — All essential functions at your fingertips; select with mouse, function keys or touch screen.

Built-in-decision support is provided by using a built-in analysis tool based on the international standard DL/T 911-2004.

Automated analysis compares two curves using an algorithm that compare amplitude as well as frequency shift and lets you know if the difference is severe, obvious, or light.





FRAX101

- Smallest and most rugged FRA instrument in the industry
- Highest possible repeatability by using reliable cable practice and high-performance instrumentation
- Fulfills all international standards for SFRA measurements
- Highest dynamic range and accuracy in the industry
- Advanced analysis and decision support built into the software
- Imports data from other FRA test sets

FRAX99

As FRAX101 except:

- No internal battery option
- No Bluetooth
- Dynamic range >115 dB
- Fixed output voltage
- Soft transport bag
- Standard cable set
- No active probes

Description

The FRAX Sweep Frequency Response Analyzer (SFRA) detects potential mechanical and electrical problems that other methods are unable to detect. Major utilities and service companies have used the FRA method for more than a decade.

SPECIFICATIONS

General

FRA method	Sweep frequency (SFRA)
Frequency range	0.1 Hz - 25 MHz, user selectable
Number of points	Default 1046, User selectable up to 32,000
Measurement time	Default 64 s, fast setting, 37 s (20 Hz - 2 MHz)
Points spacing	Log., linear or both
FRAX99 Dynamic range/ noise floor	>115 dB
FRAX101 Dynamic range/ noise floor	>130 dB
FRAX99 Accuracy	±0.3 dB down to -105 dB (10 Hz - 10 MHz)
FRAX101 Accuracy	±0.5 dB down to -100 dB (10 Hz - 10 MHz)
IF bandwidth/integration time	User selectable (10% default)
Software	FRAX for Windows 2000/XP/ Vista
FRAX99 PC communication	USB (galvanically isolated)
FRAX100 PC communication	Bluetooth and USB (galvanically isolated)
Calibration interval	Max. 3 years
Standards/guides	Fulfill requirements in Cigré Brochure 342, 2008 Mechanical condition assessment of transformer windings using FRA and Chinese standard DL/T 911-2004, FRA on winding deformation of power transformers, as well as other international standards and recommendations

Analogue output

Channels	1
Compliance voltage	20 V peak to peak
Measurement voltage at 50 Ω	10 V peak to peak
Output impedance	50 Ω
Protection	Short circuit protected

Analogue input

Channels	2
Sampling	Simultaneously
Input impedance	50 Ω
Sampling rate	100 MS/s

Temperature range

Operating temperature	-20 °C to +50 °C (-4 °F to +122 °F)
Operating humidity	<90% non-condensing
Storage temperature	-20 °C to 70 °C (-4 °F to +158 °F)

Safety

IEC61010 (LVD) EN61326 (EMC)

Specifications continued

FRAX99 Mechanical data

Dimensions with case	335 x 310 x 110 mm (13.2 x 12.2 x 4.3 in.)
Soft case dimensions	450 x 300 x 150 mm (17.7 x 11.8 x 5.9 in.)
Instrument weight	1.4 kg (3.1 lbs)
Instrument and case weight	2.5 kg (5.5 lbs)
Soft case with accessories weight	8 kg (17.6 lbs)
Total weight	10.5 kg (23 lbs)

FRAX101 Mechanical data

Dimensions	250 x 169 x 52 mm (9.84 x 6.65 x 2.05 in.)
Dimensions with case	520 x 460 x 220 mm (20.5 x 18.1 x 8.7 in.)
Instrument weight	1.4 kg (3.1 lbs)
Case and accessories weight	15 kg (33 lbs)

PC requirements (PC not included)

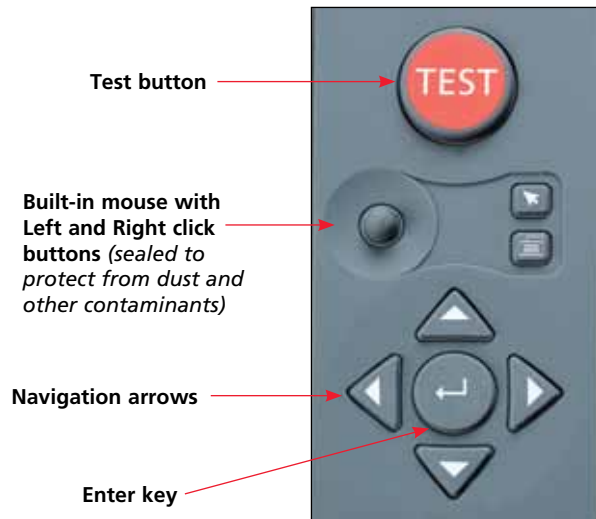
Operating system	Windows 2000/XP/Vista
Processor	Pentium 500 MHz
Memory	256 Mb RAM or more
Hard drive	Minimum 30 Mb free
FRAX 99 Interface	USB
FRAX101 Interface	Wireless or USB (client)

ORDERING INFORMATION

Product	Order Code	Product	Order Code
FRAX 99 complete with: ac/dc adapter, mains cable, ground cable 5 m (16 ft), soft transport case, USB cable, Windows software, 4 x 3 m (10 ft) ground braid set, 2 x C-clamp, field test box FTB 101, generator cable 9 m (30 ft), measure cable 9 m (30 ft), manual	AC-29090	Optional accessories for FRAX99/101	
FRAX 99 complete with: ac/dc adapter, mains cable, ground cable 5 m (16 ft), soft transport case, USB cable, Windows software, 4 x 3 m (10 ft) ground braid set, 2 x C-clamp, field test box FTB 101, generator cable 18 m (60 ft), measure cable 18 m (60 ft), manual	AC-29092	Calibration set	AC-90020
FRAX101 complete with: ac/dc adapter, mains cable, ground cable 5 m (16 ft), transport case, USB cable, Bluetooth adapter, Windows software, 4 x 3 m (10 ft) ground braid set, 2 x C-clamp, field test box, generator cable 18 m (59 ft), measure cable 18 m (59 ft), manual	AC-19090	FRAX demo box FDB 101	AC-90050
FRAX101, including battery, complete with: ac/dc adapter, mains cable, ground cable 5 m (16 ft), transport case, USB cable, Bluetooth adapter, Windows software, 4 x 3 m (10 ft) ground braid set, 2 x C-clamp, field test box, generator cable 18 m (59 ft), measure cable 18 m (59 ft), battery pack, manual	AC-19091	FRAX generator cable, 2 x BNC, 9 m (30 ft)	GC-30040
		FRAX generator cable, 2 x BNC, 18 m (59 ft)	GC-30042
		FRAX measure cable, 1 x BNC, 9 m (30 ft)	GC-30050
		FRAX measure cable, 2 x BNC, 18 m (59 ft)	GC-30052
		FRAX for Windows	SA-AC101
		Optional accessories for FRAX101	
		Battery option, 4.8 Ah	AC-90010
		Calibration set	AC-90020
		Active impedance probe AIP 101	AC-90030
		Active voltage probe AVP 101	AC-90040
		Ground braid set, 4 x 3 m including clamps	GC-30031
		FRAX C-Clamp	GC-80010



CLOSE-UP OF FRAX 150 CONTROL PANEL



FRAX150

- Highest dynamic range and accuracy in the industry
- Built-in PC with powerful backlit screen for use in direct sunlight
- Highest possible repeatability by using reliable cable practice and high-performance instrumentation
- Fulfills all international standards for SFRA measurements
- Advanced analysis and decision support built into the software
- Imports data from other FRA test sets

Description

The FRAX 150 Sweep Frequency Response Analyzer (SFRA) detects potential mechanical and electrical problems that other methods are unable to detect. Major utilities and service companies have used the FRA method for more than a decade. The measurement is easy to perform and will capture a unique "fingerprint" of the transformer. The measurement is compared to a reference "fingerprint" and gives a direct answer if the mechanical parts of the transformer are unchanged or not. Deviations indicate geometrical and/or electrical changes within the transformer.

FRAX 105 detects problems such as:

- Winding deformations and displacements
- Shorted turns and open windings
- Loosened clamping structures
- Broken clamping structures
- Core connection problems
- Partial winding collapse
- Faulty core grounds
- Core movements

INCLUDED ACCESSORIES



Included accessories shown above: Mains cable, ground cable, (2) ground braid sets, (2) earth/ground braid leads (insulated), (2) C-clamps, generator cable, measure cable, field test box, nylon accessory pouch, (2) earth/ground braids with clamp, and canvas carrying bag for test leads

SPECIFICATIONS

General	
FRA method	Sweep frequency (SFRA)
Frequency range	0.1 Hz - 25 MHz, user selectable
Number of points	Default 1046, User selectable up to 32,000
Measurement time	Default 64 s, fast setting, 37 s (20 Hz - 2 MHz)
Points spacing	Log., linear or both
Dynamic range/noise floor	>130 dB
Accuracy	±0.5 dB down to -100 dB (10 Hz - 10 MHz)
IF bandwidth/integration time	User selectable (10% default)
Software	FRAX for Windows
Calibration interval	Max. 3 years
Standards/guides	Fulfill requirements in Cigré Brochure 342, 2008 Mechanical condition assessment of transformer windings using FRA and Chinese standard DL/T 911-2004, FRA on winding deformation of power transformers, as well as other international standards and recommendations
Input power	90 - 264 V ac, 47 - 63 Hz
Analogue output	
Channels	1
Compliance voltage	Output voltage 0.2 - 24 V peak to peak (open circuit)
Measurement voltage at 50 Ω	10 V (adjustable 0.1 - 1.2 V)
Output impedance	50 Ω
Protection	Short circuit protected

Specifications continued

Analogue input	
Channels	2
Sampling	Simultaneously
Input impedance	50 Ω
Sampling rate	100 MS/s
Operating system	
Windows® based	
Memory	
1000 records in internal memory. External storage on USB stick	
Temperature range	
Operating temperature	-0 °C to +50 °C (-32 °F to +122 °F)
Operating humidity	<90% non-condensing
Storage temperature	-20 °C to 70 °C (-4 °F to +158 °F)
Storage humidity	<90% non-condensing
Safety	
IEC61010 (LVD) EN61326 (EMC)	
Mechanical data	
Dimensions	305 x 194 x 360 mm (12 x 7.6 x 14.2 in.)
Instrument weight	6 kg (13 lbs)

ORDERING INFORMATION

Product	Order Code	Product	Order Code
FRAX150 with 18 m (60 ft) leads	AC-39090	2 x C-clamp (ground bushing clamps)	GC-80020
FRAX150 with 9 m (30 ft) leads	AC-39092	FRAX generator cable, 2 x BNC, 9 m (30 ft)	GC-30042
Product		FRAX measure cable, 2 x BNC, 18 m (60 ft)	GC-30052
Included accessories		Field demo box FTB 101	AC-90060
AC power cord (IEC60320-C13 to US standard)	17032	2 x 305 mm (1 ft) earth/ground braid with clamp	GC-90060
AC power cord (IEC60320-13 to Schuko CEE 7/7)	17032-13	Nylon accessory bag	GD-31040
Canvas carrying bag (for leadset)	3015-211	User manual	AVTMFRAX150
Ground cables 5 m (16 ft)	1001-428	Optional accessories	
FRAX software for PC	1001-427	Calibration set	AC-90020
2 x 3 m (9 ft) earth/ground braid lead	GC-30033	FRAX demo box FDB 101	AC-90050
2 x 3 m (9 ft) earth/ground braid lead (insulated)	GC-30036		
2 x C-clamp (bushing clamps)	GC-80010		



IDAX300

- Fast and accurate moisture assessment in power transformers
- Well proven technology; IDA/IDAX units have been in field use for more than 10 years
- Reliable results at any temperature
- Automated analysis of moisture content and oil conductivity — decisions at your finger tip
- True frequency domain measurement for highest noise immunity
- Performs non-intrusive insulation testing of transformers, bushings, cables and generators

Description

IDAX 300 provides an accurate and reliable condition assessment of insulation in transformers, bushings, generators and cables. The IDAX 300 system maximizes the outcome of maintenance activities allowing for load and service life optimization.

IDAX 300 provides reliable data using true DFR (Dielectric Frequency Response), also known as FDS (Frequency Domain Spectroscopy), without compromises. The state-of-the-art software makes testing both easier and faster, allowing transformer moisture assessment in less than 18 minutes.

IDAX 300 measures the capacitance and tan delta/power factor of the insulation between power transformer windings at multiple frequencies. Plotting the results as a curve makes it possible to assess the condition of the oil and solid insulation, assess the moisture level in the solid insulation and other potential insulation problems. The test can be performed at any temperature.

Application

IDAX is a revolutionary insulation diagnostic instrument based on DFR (Dielectric Frequency Response), also known as FDS (Frequency Domain Spectroscopy). This analysis technique has been used in laboratories for decades and IDA/IDAX was the first instrument designed for field use (1997). The IDA/IDAX instrument and measurement principle has been used and verified around the world over the last ten years.

One of the most important applications for IDAX is to determine the moisture content in transformer insulation. Moisture in the insulation significantly accelerates the aging process. Moisture can cause bubbles between windings, resulting in catastrophic failures. IDAX provides reliable moisture assessments in one test. The test can be made at any temperature and takes less than 18 minutes.

Decisions on maintenance and/or replacement should be based on knowing the condition of the insulation and the expected loading of the unit. Adding just a few operational years to the expected end-of-life for a transformer, generator or cable by optimizing the working condition based on reliable diagnostic data means substantial cost savings for the equipment owner.

The FDS technology can also be used to assess the condition and aging of the insulation in bushings, CTs and circuit breakers. Numerous ongoing research projects at institutes and universities around the world is adding experience and value to users of IDAX.

Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 95% RH, non-condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 90 - 265 V AC, 50/60 Hz

Power consumption 250 VA (max)

Dimensions

Instrument 335 x 300 x 99 mm
(17.7" x 6.3" x 16.1")

Transport case 520 x 430 x 220 mm (20.5" x 17" x 8.7")

Weight

Instrument 4.9 kg (11 lbs)

Case & instrument 9.9 kg (22 lbs)

Accessories 8.5 kg (18 lbs) soft bag

Communication ports USB 2.0 and LAN

Measuring section

Inputs Channel 1, channel 2, ground

Capacitance range 10 pF - 100 µF

Accuracy 0.5% +1 pF

Dissipation factor range 0 - 10 (with retained accuracy of capacitance; otherwise higher)

Inaccuracy >1% +0.0003, 1 mHz - 100 Hz,
C > 1 nF
>2% +0.0005, 100 Hz - 1 kHz,
C > 1 nF

Noise Level Max 500 µA at 50 Hz/60 Hz

Test Modes, 2 Channels UST-1, UST-2, UST-1+2, GST, GST-Guard-1, GST-Guard-2, GST-Guard-1+2. With 2-ch measurement option additionally UST-1+UST-2, UST-1+GST-Guard-2, UST-2+GST-Guard-1, UST-1+2+GST
Calibration Calibration set allows field calibration, recommended interval 2 years

Output

Voltage/current ranges, 10 V 0 - 10 V peak 0 - 50 mA peak

Voltage/current ranges, 200 V 0 - 200 V peak 0 - 50 mA peak

Frequency range 0.1 mHz - 10 kHz

PC requirements

Operating system Windows 2000/ XP / Vista / 7

Processor Pentium 500 MHz

Memory 512 Mb RAM or more

Interface USB 2.0

ORDERING INFORMATION

Product	Order Code
IDAX300	AG-19090
IDAX300S	AG-19092
Included accessories	
Mains cable	
Ground cable 5 m (16 ft),	GC-30060
Generator cable 18 m (59 ft),	GC-30312
Measurement cable, red 18 m (59 ft)	GC-30322
Measurement cable, blue 18 m (59 ft)	GC-30332
USB cable	
Windows software	
Transport case	
Soft case for cable	
User manual	
Optional accessories	
Calibration set	AG-90010
Demo box IDB300	AG-90020
2nd channel option (factory upgrade to IDAX300S)	AG-90200
Generator cable, 9 m (30 ft)	GC-30310
Measurement cable, 9 m (30 ft), red	GC-30320
Measurement cable, 9 m (30 ft), blue	GC-30330
IDAX for Windows	SA-AG101



DELTA4000

- Automatic and manual operation for power factor/tan delta measurements
- Accurate and repeatable measurement results with high noise suppression for the most extreme conditions
- Lightweight, rugged two-piece design, with unit weights of 14 kg and 22 kg
- New built-in intelligent temperature correction eliminates the need for temperature correction tables (patent pending)
- New automatic voltage dependence detection (patent pending)

Description

The new DELTA4000 series is a fully automatic 12 kV insulation power factor/dissipation factor ($\tan\delta$) test set designed for condition assessment of electrical insulation in high voltage apparatus such as transformers, bushings, circuit breakers, cables, lightning arresters and rotating machinery. In addition to performing insulation power factor tests, the DELTA4000 series can be used to measure the excitation current of transformer windings as well as to perform automatic tip-up tests and HV turns-ratio testing (an optional TTR capacitor is available).

The test set is designed to provide a comprehensive AC insulation diagnostic test. The high power variable frequency design generates its own test signal independent of line frequency quality and the hardware design uses the latest technology available for digital filtering of the response signal. As a result, the DELTA4000 series produces reliable results and stable readings in the shortest time with the highest accuracy, even in high interference 765kV substations.

The DELTA4000 series operates with PowerDB software for automatic testing and reporting or with Delta Control software for real-time manual testing.

Measurements include voltage, current, power (loss), tan delta, power factor and capacitance. The test results are automatically stored in the computer and can also be downloaded directly to USB storage or a printer.

At present two options are available, the DELTA4310 is a complete stand alone test system with on-board PC control, while the DELTA4110 requires an external computer.



DELTA4110 test set to be used with external computer



DELTA4310 test set with onboard computer

Industry leading performance and accuracy

- **Generates its own test signal** - resulting in accurate and clean measurements even in the most severe conditions and in the event power is required from a portable generator.
- **High noise suppression** and advanced signal acquisition circuitry can handle up to 15 mA interference current or a signal to noise ratio of up to 1:20 resulting in extremely accurate and clean measurements even in the most severe conditions.
- **Industry leading frequency range** (1-500 Hz) reveals details in the insulation characteristics that are not possible to detect with other test sets.
- **Intelligent temperature correction** (patent pending) allows the user to estimate the actual temperature dependence of the test object by measuring tan delta over a frequency range. Mathematically calculating accurate individual temperature correction results in a more accurate measurement of the insulating material's condition.
- **Automatic voltage dependence detection** (patent pending). Various high voltage components may have a voltage dependence where tip-up testing is recommended (i.e. the dissipation factor is pending test voltage). The DELTA4000 series has a patented method for detecting voltage dependence and gives the user an alarm, suggesting additional tests should be performed at different voltage levels.
- **Fast test time** - Dynamic noise suppression minimizes actual test time.

SPECIFICATIONS	
Input power	100-240 V ±10%, 50/60 Hz, 16 A max.
Output voltage	0 to 12 kV, continuously adjustable
Test frequency range	45-70 Hz (12 kV) 15-400 Hz (4 kV) 1-500 Hz (250 V)
Output power	3.6 kVA
Output current	300 mA (4 minutes) 100 mA (continuous) The power supply capacity can be expanded to 4 A at 12 kV using the optional resonating inductor, catalog number 670600
Measuring ranges	
Voltage	25 V to 12 kV, 1 V resolution
Current	0 to 5 amps, 0.1 µA maximum resolution. The measurement can be corrected to either 2.5 kV or 10 kV equivalents.
Capacitance	0 to 100 µF, 0.01 pF maximum resolution
Inductance	6 H to 10 MH, 0.1 mH maximum resolution
Power factor	PF 0-100% (0-1), 0.001% maximum resolution
Dissipation factor	DF 0-100% (0-10.000%), 0.001% maximum resolution
Watt loss	0 to 2 kW, actual power, 0 to 100 kW when corrected to 10 kV equivalent 0.1 mW maximum resolution. The measurement can be corrected to either 2.5 kV or 10 kV equivalents.
Measurement (the following test modes are available)	
UST: Ungrounded Specimen Testing UST-R: UST: Measure Red, Ground Blue UST-B: UST: Measure Blue, Ground Red UST-RB: UST: Measure Red and Blue GST: Grounded Specimen Testing GST-GND: GST: Ground Red and Blue GSTg-R: GST: Guard Red, Ground Blue GSTg-B: GST: Guard Blue, Ground Red GSTg-RB: GST: Guard Red and Blue	
Temperature correction	
Intelligent temperature correction	from 5 °C to 50 °C insulation test temperature to 20 °C reference
Standard tables	as by international standards and manufacturers' data
Environmental	
Operating temperature	-20 °C to +55 °C (-4 °F to +131 °F)
Storage temperature	-50 °C to +70 °C (-58 °F to +158 °F)
Relative humidity	0 to 95% non-condensing
Shock and vibration	ASTM D999.75
Safety	
IEC/ANSI 61010-1	
EMC	EN 61326
Specifications continued	

Mechanical data	
Dimensions (W x H x D)	
DELTA4100 Control unit	14 kg (31 lbs)
DELTA4300 Control unit	15 kg (33 lbs)
DELTA4010 High voltage unit	22 kg (48 lbs)
Cables	15 kg (33 lbs)
Weight all models	30 kg with printer option fitted

ORDERING INFORMATION

Product	Order Code	Product	Order Code
DELTA4110 Insulation diagnostic system (DELTA4100 control unit and DELTA4010 HV unit)	DELTA4110	Optional accessories	670506
DELTA4310 Insulation diagnostic system with onboard computer (DELTA4300 control unit and DELTA4010 HV unit)	DELTA4310	Safety foot switch	1001-852
Included accessories		External strobe	Y37181
High voltage lead: 21 m (70 ft), double shielded	30012-11	External strobe extension cable, 18 m (60 ft)	1001-853
Measurement lead, color-coded Red	25572-1	Transport case, 2-piece design	670501
Measurement lead, color-coded Blue	25572-2	Case for control unit and accessories [1]	2001-746
Ground lead: 9 m (30 ft)	2002-131	Case for HV unit and accessories [1]	2001-746
Mains cable 16 A EU	17032-19	Transport case, 3-piece design	
Mains cable 16 A US	17032-20	Case for control unit [1]	2001-791
Mains cable 16 A UK	17032-21	Case for HV unit [1]	2001-791
Mains cable 16 A no plug	17032-22	Case for accessories [1]	2001-792
Safety hand switch, Interlock #1: 18 m (60 ft)	1001-850	Transport cart / trolley	1001-530
Safety hand switch, Interlock #2: 2.5 m (8 ft)	1001-851	Calibration box set for CAL4000	2002-137
HV unit power cable, 1 m (3 ft)	2002-132	Calibration standard	670500-1
HV unit control cable, 1 m (3 ft)	2002-133	Transit cases for calibration standard	670635
Ground lead cable, 1 m (3 ft)	2002-134	HV TTR capacitor, single phase (10 nF, 10 kV)	36610
USB cable, 3 m (10 ft)	2002-135	HV reference capacitor (100 pF, 10 kV)	36610-1
Ethernet cable, CAT 5, 3 m (10 ft)	2002-136	HV reference capacitor (1000 pF, 10 kV)	36610-2
Soft padded carrying case for control unit [1]	2001-766	Carry case for capacitors	36610-CC
Soft padded carrying case for HV unit [1]	2001-766	Capacitor kit (TTR cap, 2 ref caps, carry case)	36610-KIT2
Soft case for HV cable	2001-507	Resonating inductor	670600-1
Soft case for other cables/accessories	2001-506	Thermal Pentax® printer, 120 V	36493-1
User manual	81331	Thermal Pentax® printer, 240 V	36494-1-KIT
Application guide	81332	Thermal paper (8.5" x 11") for printer	36809-1
Warranty [1 year]		Thermal paper (A4) for printer	36809-2
PowerDB Advanced software with Delta Control		Oil test cell	670511
Optional software		Hot collar belts [3]	670505
PowerDB Pro software, on USB dongle	DB1001S-A	Bushing tap connectors [2]	670506
PowerDB Pro software, via soft key	DB1001-A	External temperature and humidity probes	2002-138
Extended product warranty	36610-1	USB bar code wand and software	36528
1-year extended warranty	Y12-WARRANTY	Accessory kit: hot collar straps [3], external temperature and humidity meters, .75" bushing tap connector [1], 1" bushing tap connector [1], mini bushing tap connectors [2], "J" probe bushing tap connector [1], 1 m (3 ft) non-insulating shorting lead [3], 2 m (6 ft) non-insulating shorting lead [3]	670501
2-year extended warranty	Y24-WARRANTY	Special length cables available upon request	Consult factory
3-year extended warranty	Y36-WARRANTY	Leakage reactance	MLR
PowerDB Advanced support and upgrades	Consult factory	Turns ratio, 3-phase	TTR
PowerDB Pro software support and upgrades	Consult factory	Winding resistance	MTO
Premium support plan [where available] 1-yr, 3-yr, or 5-yr agreement	Consult factory	Sweep Frequency Response Analysis (SFRA)	FRAX
Premium Plus support plan [where available] 1-yr, 3-yr, or 5-yr agreement	Consult factory	Dielectric Frequency Response (DFR) and moisture assessment	IDAX
		DC Insulation	MIT/S1
		Current Transformer Measurements	MCT

SPECIFICATIONS

Bridge circuit	Transformer ratio arm bridge.															
Capacitance	12 multipliers are used to allow measurements from less than 20 pF to 1.2 μF. Accuracy ±0.25% of range ±4 pF.															
Dissipation factor (power factor)	<table border="1"> <thead> <tr> <th>Range</th> <th>Accuracy</th> <th>Resolution</th> </tr> </thead> <tbody> <tr> <td>0.1%</td> <td>±0.03</td> <td>0.001%</td> </tr> <tr> <td>1-10%</td> <td>±0.3</td> <td>0.01%</td> </tr> <tr> <td>10-20%</td> <td>±0.5</td> <td>0.01%</td> </tr> <tr> <td>20-30%</td> <td>±1.0</td> <td>0.01%</td> </tr> </tbody> </table>	Range	Accuracy	Resolution	0.1%	±0.03	0.001%	1-10%	±0.3	0.01%	10-20%	±0.5	0.01%	20-30%	±1.0	0.01%
Range	Accuracy	Resolution														
0.1%	±0.03	0.001%														
1-10%	±0.3	0.01%														
10-20%	±0.5	0.01%														
20-30%	±1.0	0.01%														
Detector	Synchronous, tuned and phase-sensitive null detector.															
Test voltage	28 V, 100 Hz for 60 Hz test set. 28 V, 80 Hz for 50 Hz test set.															
Measurement	The instrument measures the following combinations: UST C_{H-L} (ungrounded specimen test, HI to LO) GST C_{H-G} (grounded specimen test, HI to ground, LO guard) GST C_{L-G} (grounded specimen test, LO to ground, HI guard) GST $C_{H-G} + C_{H-L}$ (grounded specimen test, HI to ground, plus HI to LO) GST $C_{L-G} + C_{L-H}$ (grounded specimen test, LO to ground, plus LO to HI)															
Power (specify one)	120 V, 60 Hz, 5 VA or 240 V, 50 Hz, 5 VA or 220 V, 60 Hz, 5 VA															
CB100-CHEK™	Designed to verify the proper calibration and operation of CB-100. The unit provides a capacitance and dissipation factor constant for each of the five test modes.															
Mechanical data																
Dimensions (W x H x D) instrument	287 x 262 x 216 mm (11.3 x 10.3 x 8.5 in.)															
Case	560 x 330 x 305 mm (22 x 13 x 12 in)															
Leads	One 2 m (6.6 ft) power cord, one 10 m (33 ft) grounded lead, two 10 m (33 ft) coaxial measuring leads.															
Weight all models	30 kg with printer option fitted															



CB100

- Lightweight and portable
- 100 Hertz test frequency
- 28 volt test voltage
- Test mode selector switch
- Direct reading of capacitance and dissipation factor
- Perform tests in UST and GST configuration

Description

The model CB100 low-voltage capacitance and insulation power factor test set is a self-contained instrument for the accurate measurement of electrical insulation characteristics.

Model CB100 is an easily balanced, direct-reading bridge designed for testing in the laboratory, shop or substation. Measurements of capacitance are expressed in μF or pF. The dissipation factor, or "power factor" is indicated directly in percent.

Applications

Model CB100 is used for testing a wide variety of electrical insulation including that found in power transformers, circuit breakers and most other substation apparatus. Using test cells or jigs, it can also test insulating liquids and solids.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
CB100		Transport case	
120 V, 60 Hz	810130	CB100-CHECK calibrator	
240 V, 50 Hz	810130-1	Instruction manual	
220 V, 60 Hz	810130-2	Optional accessories	
CB100 for 120 V, 60 Hz complete with range extension adapter	810130-3	Range extension adapter	
CB100 for 240 V, 50 Hz complete with range extension adapter	810130-4	For 120 V, 60 Hz operation	810132
CB100 for 220 V, 60 Hz complete with range extension adapter	810130-5	For 240 V, 50 Hz operation	810132-1
Included accessories		Leads sets	
Lead set, 10 m (33 ft)		3.3 ft (1 m)	810136-2
		59.4 ft (18 m)	810136-3



AC and AC/DC

- Rapid production line testing to latest UL standards
- Extra safety features
- Rugged design for ease of portability

Description

AC and AC/DC high-pot testers are designed for safety and ease of operation, and readily adapt to development, maintenance or production testing. Three models are available: two ac and one ac/dc. The AC high-pot testers feature a front-panel, NEMA 5-15R three-prong output receptacle. Booted, alligator-clip output and return probes are also supplied with all models.

Applications

These portable instruments are used to test the dielectric strength of electrical insulation and the ground circuit continuity of three-wire appliances and other devices.

Megger high-pot testers comply with most existing UL requirements for dielectric withstand testing, including:

- UL 544 – Electric medical and dental equipment
- UL 982 – Motor-operated household food preparing machines
- UL 1026 – Electric household cooking and serving appliances
- UL 1270 – Radio receivers, audio systems, and accessories

SPECIFICATIONS

SPECIFICATIONS	
Catalogue no.	
230315 AC	
Applied test voltage	0 to 3 kV
Adjustable leakage current trip level	0.3 to 12 mA
Output receptacle	Front panel NEMA5-15R
230415 AC	
Applied test voltage	0 to 4 kV
Adjustable leakage current trip level	0.3 to 12 mA
Output receptacle	Front panel NEMA5-15R
230425 AC/DC	
Applied test voltage	AC: 0.3 to 12 mA DC: 0.43 t 17 mA
Input	
Standard	120 Vac \pm 10%, 1 A, 50/60 Hz
Optional	Nominal 230 Vac, 50/60 Hz line is available on all models at no additional charge. To order, add -47 to Cat. No.
Output	
Maximum output current	12.6 mA
Wave shape	
AC models	Line
AC/DC model	Maximum ripple 0.4% rms per mA at full voltage
Accuracy	
Applied test voltage	\pm 2%
Leakage current	\pm 5%
Mechanical data	
Dimensions (H x W x D)	20.6 x 23 x 21 cm 8 x 9 x 8.4 in.
Weight	
230315 AC 230415 AC	5.6 kg (12.5 lb)
230425	6.1 kg (13.5 lb)

This product

is not available for sale in the European Economic Area

ORDERING INFORMATION			
Product	Order Code	Product	Order Code
AC High-Pot Testers		Optional accessories	
0 to 3 kV	230315	Test probes with retractable tips, 1.2 m [4 ft]	
0 to 4 kV	230415	High-voltage probe for ac models only	230315-2
AC/DC High-Pot Tester, 0 to 4 kV ac/5 kV dc	230425	Return probe for ac models only	230315-3
Standard non-resonant unit with 240 Vac input, 60 Hz operation, analog meters	686100-360W	High-voltage and return probe set for ac/dc model only	230425-2
Included accessories		Adapters, for conversion of output receptacles for use with twist-lock plugs	
Test probes with alligator clips for ac models, includes one Cat. No. 25507 high-voltage probe and one Cat. No. 25136 return probe, 1.2 m [4 ft]; for ac/dc models, includes one Cat. No. 25149 complete assembly, 1.2 m [4 ft]		NEMA L5-15R twist lock	235300-1
Power cord	17032	NEMA L5-20R twist lock	235300-2
Instruction manual for 230315 and 230415	AVTM23-1J	NEMA L5-30R twist lock	235300-4
Instruction manual for 230425	AVTM23-4J		

70, 120, 160 kV

High voltage DC dielectric test sets



70, 120, 160 kV

- Lightest weight available in air-insulated high-voltage model
- Advanced performance with long-term reliability provided by filtered half-wave rectification
- Designed for maximum operator safety

Description

The high voltage DC dielectric test sets (70, 120 and 160 kV) provide the most dependable, portable dc high-voltage sources for checking the quality of electrical power cables, motors, switchgear, insulators, transformers and capacitors.

Applications

The DC dielectric test sets are used to make proof tests and insulation tests on electrical power cables, motors, switchgear, insulators, transformers and capacitors.

Both types of tests are performed by applying controlled high voltages to the unit under test at or above insulation system operating level. Measuring the leakage current helps determine the unit under test's ability to withstand overvoltages such as lightning strikes and switching surges.

The three models described cover a range of output voltages that meet the most commonly specified ratings in 5 kV to 69 kV class cable. All are suitable for testing power cable, switchgear and rotating machinery in accordance with IEEE, IPCEA, NEMA and ANSI guidelines.

SPECIFICATIONS

Input Power

Nominal 120 Vac, 50/60 Hz
For 220/240 Vac, 50/60 Hz operation, add -47 to Cat. No.

	Please note that specifications for the -47 models differ as follows:
Output current	220/240 Vac 120 kV Models: 5 mA for 5 min; 2 mA continuous 160 kV Models: 5 mA for 5 min; 1.5 mA continuous When using external 240/120 volt step-down voltage transformers, the ratings may be used as given for 120 volt input.
Weight	Add approx. 1 kg (2 lb) for -47 control unit

Ammeter

Ranges	0 to 19.9 μ A 0 to 199 μ A 0 to 1.99 mA 0 to 5 mA
Resolution	To 0.1 mA on lowest range
Accuracy	\pm 2% of reading +1 digit

Voltmeter

Resolution	To 100 V over entire range
Accuracy	\pm (2% of reading + 100 V)

Ripple

Less than 2% on capacitive samples at continuous rated output

Environmental

Relative humidity range

Operating	0 to 90% noncondensing
Storage	0 to 95% noncondensing

Mechanical data

Dimensions (H x W x D) Control unit (all models)	510 x 305 x 318 mm. (20 x 12 x 12.5 in)
High voltage unit	70 kV: 510 x 305 x 305 mm (20 x 12 x 12 in.) 120 kV: 740 x 305 x 305 mm (29 x 12 x 12 in.) 160 kV: 1000 x 305 x 305 mm (39 x 12 x 12 in.)
Weight	
Control unit (all models)	10.5 kg (23 lb)
High voltage unit	70 kV: 20 kg (44 lb) 120 kV: 30 kg (65 lb) 160 kV: 33 kg (73 lb)
Cables (including carrying bag)	70 kV: 3 kg (7 lb) 120 and 160 kV: 4 kg (9 lb)

ORDERING INFORMATION			
Product	Order Code	Product	Order Code
Dielectric test sets		Optional accessories	
70 kV dc, digital	220070	Modification of dc test, when ordered, set for operation with an accessory impulse generator	add -61
70 kV dc, analog	220072	External voltage stabilizer	220004
120 kV dc, digital	220123	Return probe for ac models only	230315-3
120 kV dc, analog	220124	High-voltage and return probe set for ac/dc model only	230425-2
160 kV dc, digital	220163	Adapters, for conversion of output receptacles for use with twist-lock plugs	
160 kV dc, analog	220164	NEMA L5-15R twist lock	235300-1
For 220/240 Vac, 50/60 Hz operation, add -47 to Cat. No.		NEMA L5-20R twist lock	235300-2
Included accessories		NEMA L5-30R twist lock	235300-4
Input supply cord, three-wire, 2.4 m (8 ft)	17032		
Ground cables, 4.5 m (15 ft) [2]	4702-5		
Interconnection cable, 4.5 m (15 ft)	18320		
Detachable HV output cable, for 70 kV test sets, 4.5 m (15 ft)	18328		
Detachable HV output cable, for 120 and 160 kV test sets, 4.5 m (15 ft)	25950		
Carrying bag for cables	18313		
Kilovolt/megohm test record graph paper (100 sheet pad)	220000		



670025 series

- Interference suppression circuits for testing in high-voltage switchyards
- Automatic balancing of dissipation factor
- Direct readout of capacitance, dissipation factor and watts dissipated
- Lightweight, compact design

Description

Capacitance and Dissipation Factor (C&DF) Test Sets are used for evaluating the nature and quality of electrical insulation materials and systems.

By measuring dissipation factor losses in electrical insulation, these units can indicate the presence of contaminants, fractures and punctures.

As part of a routine maintenance program, capacitance and dissipation factor testing can aid in predicting potential failure of deteriorating insulation.

The C&DF Test Sets include interference suppression circuits that assure accurate measurements even under severe interference or noise

Applications

The test sets are used for testing high-voltage electrical insulation systems at the power frequency by applying test voltages up to 12 kV.

The purpose of the dissipation factor measurement of high-voltage insulation is to find early signs of weakness in the high-voltage insulation.

SPECIFICATIONS

Instrumentation	Common to all test sets
Voltmeter and Ammeter	Digital readout with LED display
Ammeter	
Accuracy	±(1% of reading +0.1 mA)
Resolution	0.1 mA up to 200 mA; 1 mA above 200 mA Ammeter reads specimen current only.
Voltmeter accuracy	±(1% of reading +1 digit)
Resolution	10 V
Dissipation factor and watts/milliwatts	
0 to 20% DF range	
Operating temperature	-20 °C to +60 °C (-4 °F to +140 °F)
Accuracy	0.01% DF
0 to 200% DF range	
Accuracy	±(2% of reading + 0.05% DF)
Resolution	0.1% DF
Both positive and negative DF values are indicated automatically. Values up to 1200% DF can be measured by indirect methods. LO/HI equivalent milliwatts/watts dissipated in specimen.	
Capacitance	
Range	0 to 220.000 pF in eight ranges; 110/220/1100/2200/11,000/22,000/ 110,000/220,000 pF full scale
Accuracy	±(1% of reading + 2 pF) for ungrounded specimen test ±(1% of reading + 6 pF) for grounded specimen test
Resolution	0.01% of range selected
Mechanical data	
Dimensions (each unit)	310 H X 510 W x 380 D mm (12.5 H x 19.5 W x 15 D in.)
Weight	
2.5 kV unit	23 kg (51 lb)
12 kV measuring unit	22 kg (48 lb)
12 kV HV power unit	29 kg (63 lb)
Cables only	15 kg (34 lb)
2.5 kV test set	
Input (specify one)	120 V, 60 Hz, 3 A continuous 120 V, 50 Hz, 3 A continuous 240 V, 60 Hz, 1.5 A continuous 240 V, 50 Hz, 1.5 A continuous
Output	
Voltage	0 to 2.5 kV ac, digital readout
Current	0 to 100 mA continuous
12 kV test set	
Input (specify one)	120 V, 60 Hz, 10 A continuous 120 V, 50 Hz, 10 A continuous 240 V, 60 Hz, 5 A continuous 240 V, 50 Hz, 5 A continuous
Specification continued	

Instrumentation	Common to all test sets
Voltmeter and Ammeter	Digital readout with LED display
Ammeter	
Accuracy	±(1% of reading + 0.1 mA)
Resolution	0.1 mA up to 200 mA; 1 mA above 200 mA Ammeter reads specimen current only.
Voltmeter accuracy	±(1% of reading + 1 digit)
Resolution	10 V
Dissipation factor and watts/milliwatts	
0 to 20% DF range	
Operating temperature	-4 °F to +140 °F (-20 °C to +60 °C)
Accuracy	0.01% DF
0 to 200% DF range	
Accuracy	±(2% of reading + 0.05% DF)
Resolution	0.1% DF
Both positive and negative DF values are indicated automatically. Values up to 1200% DF can be measured by indirect methods. LO/HI equivalent milliwatts/watts dissipated in specimen.	
Capacitance	
Range	0 to 220,000 pF in eight ranges; 110/220/1100/2200/11,000/22,000/ 110,000/220,000 pF full scale
Accuracy	±(1% of reading +2 pF) for ungrounded specimen test ±(1% of reading +6 pF) for grounded specimen test
Resolution	0.01% of range selected

Mechanical data	
Dimensions (each unit)	310 H X 510 W x 380 D mm (12.5 H x 19.5 W x 15 D in.)
Weight	
2.5 kV unit	23 kg (51 lb)
12 kV measuring unit	22 kg (48 lb)
12 kV HV power unit	29 kg (63 lb)
Cables only	15 kg (34 lb)
Output	
Voltage	0 to 12 kV ac, digital readout
Current	High Range to 5 kV: 0 to 200 mA continuous; 0 to 400 mA for 10 min Low Range to 10 kV: 0 to 100 mA continuous; 0 to 200 mA for 10 min

ORDERING INFORMATION

Product	Order Code	Product	Order Code
2.5 kV capacitance and dissipation factor test set			
120 V ac, 60 Hz	670025	120 Vac, 60 Hz	670070-44
120 V ac, 50 Hz	670025-44	120 Vac, 50 Hz	670070-45
220 V ac, 60 Hz	810130-2	240 Vac, 60 Hz	670070-45
240 V ac, 60 Hz	670025-45	240 Vac, 50 Hz	670070-47
240 V ac, 50 Hz	670025-47	Included accessories	
12 kV capacitance and dissipation factor test set			
120 V ac, 60 Hz	670065	2.5 kV unit	
120 V ac, 50 Hz	670065-44	Line cord, ac	
240 V ac, 60 Hz	670065-45	Transport case	
240 V ac, 50 Hz	670065-47	CB-CHEK calibrator	
12 kV extended range capacitance and dissipation			
Factor test set		Instruction manual	
120 Vac, 60 Hz	670070	Optional accessories	
		Range extension adapter	
		For 120 V, 60 Hz operation	810132
		For 240 V, 50 Hz operation	810132-1
		Lead sets	
		1 m (3.3 ft)	810136-2
		18 m (59.4 ft)	810136-3

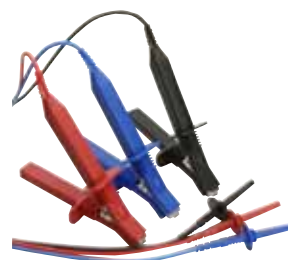


1000-441
HV test lead set, 3 x 10 m medium insulated clips

1000-442
HV test lead set, 3 x 15 m medium insulated clips



6111-216
Test record card (pack of 20)



6220-811
HV test lead set, 3 x 3 m large insulated clips

1000-432
HV test lead set, 3 x 15 m large insulated clips

1000-443
HV test lead set, 3 x 10 m large insulated clips



6311-077
CB101, 5 kV calibration box



6420-088
Companion carrying case with special compartment for test leads (WM6)



8101-181
HV test lead set, 3 x 3 m un-insulated small clips

8101-182
HV test lead set, 3 x 8 m un-insulated small clips

8101-183
HV test lead set, 3 x 15 m un-insulated small clips



FDB101
AC-90050

The FRAX Demo box FDB101 is a transformer kit that can be used for in-house training and demonstrations. The small transformer is a single-phase unit with capability to simulate normal as well as fault conditions. Open as well as shorted measurements can be performed. The unit also contains two test impedances, one of them the same as used in the FDB101 field test box



Low Resistance Ohmmeters

The operation of electrical equipment depends on the controlled flow of current within the design parameters of a given piece of equipment. Measuring low resistance helps identify resistive elements that have increased above acceptable levels.

DLRO10 micro-ohmmeters have been designed primarily for the traction and transportation industry.

MOM and MJÖLNER micro-ohmmeters were designed for switchyards.

In practice, you should check products from both ranges to see which suits your applications.

3

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SELECTION CHART

	DLRO 200	DLRO 600	DLRO 10HD	DLRO10/10X	BT51	24700	MJÖLNER 200	MJÖLNER 600	MOM2	MOM 200	MOM 600	MOM 690
RS232	■	■		■								
Mains power source		■	■									
Rechargeable battery power source	■		■	■	■	■						
Forward and reverse measurement			■	■	■							
Inductive mode			■	■	■							
IP54 ingress protection with case closed			■									
User selectable test limits			■									
Designed for industrial and traction industries	■	■	■	■	■	■						
Designed for switchyards							■	■	■	■	■	■



MOM2 in use

How does a low resistance ohmmeter operate?

A low resistance ohmmeter uses two internal measuring circuits. The supply injects a current into a test sample through two leads, so that the magnitude of the current is measured. The voltage across the item under test is measured and the instrument then performs an internal calculation to determine the resistance of the test sample.

A high current output is one of the qualifying characteristics of a true low resistance ohm-meter. 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.

Choosing a tester

Milli-ohmmeters are less sensitive than micro-ohmmeters, the measurement capability of these testers means they are normally used for general circuit and component verification. These also tend to be less expensive than micro-ohmmeters, making them a good choice if measurement sensitivity and resolution are not critical. The maximum test current is typically less than 2 A and as low as 0.2 A.

The 10 A micro-ohmmeter is the workhorse instrument for most operators and covers the majority of field applications. The 10 A output not only provides a good compromise of signal to noise ratio and low heating effect to make an accurate measurement, but also allows for reduced weight and battery, rather than mains operation. On some instruments, different measurement

modes may be selected which address different types of testing conditions. Measurement modes could include manual, automatic or continuous testing, or a high power test for large windings.

100+ A micro-ohmmeters are field portable micro-ohmmeters that can deliver anywhere from 10 A to 600 A. The best instruments have measurement resolution to 0.1 $\mu\Omega$ and offer variable test current to address a wider range of applications.

By testing at 10 A and then at a higher current, engineers can gain a better understanding of the maintenance requirements of a circuit breaker contact, for example.

The transformer ohmmeter is designed specifically to measure inductive devices such as transformer windings and tap changers. The transformer ohmmeter is a specialist multi-current device, has measurement resolution to 1 micro-ohm and is used both in factory test and for field operating verification. Its use can be the verification of factory test readings, finding defects in transformers and checking tap changers, which are often the most vulnerable part of the system.

Lab micro-ohmmeters are designed for measuring resistance components and use low-pulsed currents to eliminate thermal emf errors, normally with ranges from 199.9 $\mu\Omega$ to 1999 Ω . These types of instrument are not intended for measuring inductive circuits. Due to the low test current the operation in the field is limited as the signal to noise condition will reduce the sensitivity of the measurement.



DLRO10HD in use



Request a copy of 'A guide to low resistance testing'

SPECIFICATIONS

Measurement range	0.1 $\mu\Omega$ to 999.9 m Ω (subject to supply voltage and leads used)
Accuracy: Voltage Current Resistance	$\pm 0.5\% \pm 0.1$ mV $\pm 0.5\% \pm 0.1$ A Better than 1% from 300 $\mu\Omega$ to 100 m Ω Better than $\pm 2\%$ from 100 $\mu\Omega$ to 300 $\mu\Omega$
Maximum continuous test time	More than 60 seconds at 200 A @ 20 °C ambient
Power supply	
Power supply for DLRO200 for full output (unsmoothed d.c.)	100 V to 265 V 50/60 Hz with a load less than 19 m Ω (supply >207 V rms), or 11 m Ω (115 V rms) including current leads
Power supply for DLRO200-115 V for full output (additional smoothing)	100 V to 130 V 50/60 Hz with a load less than 11 m Ω including current leads
Test modes	Manual, Auto, Continuous
Test time	10 seconds NORMAL /AUTO mode Refreshed every 2 seconds in CONTINUOUS mode
Display	Large, high resolution backlit liquid crystal display
Warnings	Current flowing - LED Other warnings are shown on the lcd display
Data transfer	Real time or batch download via RS232 using Download Manager software
Storage capacity	300 result sets and memo, battery backed for 10 years
Memo field	160 characters max
Test current: Range Accuracy	10 A to 200 A d.c. $\pm 2\% \pm 2$ A
Voltmeter input: Impedance Hum rejection	>200 k Ω 5 V rms 50 Hz/60 Hz
Environmental	
Operation temperature	-10 °C to +50 °C
Storage temperature	-25 °C to +65 °C
Calibration	20 °C
Co-efficient	<0.05% per °C
Max. humidity	95% RH non-condensing
Max. altitude	2000 m
Mechanical data	
Dimensions (H x W x D)	410 mm x 250 mm x 270 mm
Weight	14.5 kg (excluding test leads)

ORDERING INFORMATION continued

Product	Order Code
Included accessories for DLRO200-115	
5 m lead set in bag comprising 2 x 25 mm ² current leads with clamps and 2 x potential leads with clips	6220-787
Included accessories for ALL DLRO200 versions	
Download manager	6111-442
User guide on CD-ROM	6172-763
RS232 download cable	25955-025
Quick start guide (English)	6172-782
Quick start guide (French)	6172-783
Warranty card	6170-618



DLRO200

- Test currents from 10 A to 200 A d.c.
- 0.1 $\mu\Omega$ best resolution
- On-board memory for up to 300 test results and notes
- RS232 port to download stored results or for real time output to a printer
- Supplied complete with 5 m test leads and download software
- Smooth, continuous applied current eliminates magnetic transients capable of inductively tripping breaker controls (115 V version)

Description

Megger DLRO200 measures resistances between 0.1 $\mu\Omega$ and 1 Ω , at high currents. This versatile instrument can provide test currents from 10 A up to 200 A subject to the load resistance and supply voltage. A large liquid crystal display provides all the information needed to perform a test; all test parameters and measurement results are displayed.

The unique design allows the weight and size of DLRO200 to be kept to a minimum; the instrument weighs less than 15 kg. This small size makes DLRO200 equally at home in the workshop, on the production floor or in the field. The high current capability and compact design make DLRO200 suitable for testing circuit breaker contacts, switch contacts, busbar joints or other applications where high current is needed.

ORDERING INFORMATION

Product	Order Code
Standard versions with test leads	
DLRO200 high current digital low resistance ohmmeter (QWERTY keyboard)	DLRO200-EN
DLRO200-115 high current digital low resistance ohmmeter 115 V with additional DC output smoothing (QWERTY keyboard)	DLRO200-115
Versions without test leads	
DLRO200 high current digital low resistance ohmmeter (QWERTY keyboard)	DLRO200-EN-NLS
DLRO200-115 high current digital low resistance ohmmeter 115 V with additional output smoothing (QWERTY keyboard)	DLRO200-115-NLS
Included accessories for DLRO200-EN	
5 m lead set set comprising 2 x 50 mm ² current leads with clips and 2 potential leads with clips	6220-755

DLRO600

600 A Low resistance ohmmeter



DLRO600

- Test currents from 10 A to 600 A d.c.
- 0.1 $\mu\Omega$ best resolution
- On board memory for up to 300 test results and notes
- RS232 port to download stored results or for real time output to a printer
- Supplied complete with 5 m test leads and download software

Description

Provides the you with a high resolution, 0.1 $\mu\Omega$, lightweight and portable method of performing on-site low resistance measurements. The unit can be used to test circuit breaker contact resistance, switch contacts, busbars, joints, splices and fuses. The test current is variable from 10 A to 600 A, in 1 A steps, enabling you to perform all the required tests with a single instrument.

The unique design allows the weight and size of DLRO600 to be kept to a minimum; the instrument weighs less than 15 kg. This small size makes it equally at home in the workshop, on the production floor or in the field.

ORDERING INFORMATION

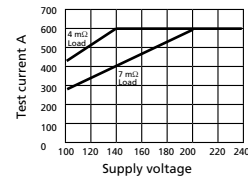
Product	Order Code
Standard versions with test leads	
DLRO600 high current digital low resistance ohmmeter (QWERTY keyboard)	DLRO600-EN
DLRO600 high current digital low resistance ohmmeter (French AZERTY keyboard)	DLR600-FR
Versions without test leads	
DLRO600 high current digital low resistance ohmmeter (QWERTY keyboard)	DLRO600-EN-NLS
DLRO600 high current digital low resistance ohmmeter (French AZERTY keyboard)	DLRO600-FR-NLS
Included accessories	
5 m lead set set comprising, 2 x 50 mm ² current leads with clips and 2 potential leads with clips (ONLY WITH DLRO600-EN)	6220-755
Download manager	6111-442
User guide on CD-ROM	6172-763
RS232 download cable	25955-025
Quick start guide (English)	6172-782
Quick start guide (French)	6172-783
Warranty card	6170-618

SPECIFICATIONS

Measurement range	0.1 $\mu\Omega$ to 999.9 m Ω (Subject to supply voltage and leads used)
Accuracy:	
Voltage	$\pm 0.5\% \pm 0.1$ mV
Current	$\pm 0.5\% \pm 0.1$ A
Resistance	Better than 1% from 100 $\mu\Omega$ to 100 m Ω
Output current	The chart shows the maximum output current available at different supply voltages with a 4 m Ω load (i.e. standard 5 m current leads only) and with a 7 m Ω load
Maximum continuous test time	More than 60 seconds at 600 A @ 20 °C ambient

Power supply

Power supply for	See chart
------------------	-----------



Full output	207 V to 265 V 50/60 Hz with a load less than 7 m Ω including current leads
Reduced output	Down to 100 V 50/60 Hz
Test modes	Manual, Auto, Continuous
Test time	7 seconds NORMAL /AUTO mode Refreshed every 2 seconds in CONTINUOUS mode
Data transfer	Real time or batch download via RS232 using Download Manager software
Storage capacity	300 result sets and memo, battery backed for 10 years
Test current: Range	10 A to 600 A unsmoothed d.c. in 1 A steps
Accuracy	$\pm 2\% \pm 2$ A
Voltmeter input: Impedance	>200 k Ω
Hum rejection	5 V rms 50 Hz/60 Hz

Environmental

Operation temperature	-10 °C to +50 °C
Storage temperature	-25 °C to +65 °C
Calibration	20 °C
Co-efficient	<0.05% per °C
Max. humidity	95% RH non-condensing
Maxi altitude	2000 m

Mechanical data

Dimensions (H x W x D)	410 mm x 250 mm x 270 mm
Weight	14.5 kg (excluding test leads)

If you need...

more detailed information about low resistance ohmmeters, then visit our website at www.megger.com

SPECIFICATIONS

Resistance/current ranges

The green resistance ranges on the keypad indicate low output power (<0.25 W) outputs. Red ranges indicate higher 2.5 W (1 A) and 25 W (10 A) power outputs

Measurement range	0.1 $\mu\Omega$ to 2500.0 Ω manual range selection
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Display and battery

Display size/type	Main 5 digit + 2 x 5 digit secondary displays
Battery type	6 V, 7Ah sealed lead acid
Voltage input range	90 - 264 V, 50-60 Hz
Charge time	8 hours
Backlight	LED backlight
Battery life	1000 Auto (3 sec) tests
Auto power down	300 s
Mode selection	Rotary switch
Range selection	Rotary switch
Reference conditions	20 °C \pm 3 °C

Environmental

Temperature co-efficient	< 0.01% per °C, from 5 °C to 40 °C
Storage temperature and humidity	-25 °C to +60 °C, <90% RH
Operating temperature and humidity	-10 °C to +50 °C <90% RH
Noise rejection	Less than 1% \pm 20 digits additional error with 100 mV peak 50/60 Hz on the potential leads. Warning will show if hum or noise exceeds this level.
Maximum lead resistance	100 m Ω total for 10 A operation irrespective of battery condition
IP rating	IP65 case closed, IP54 battery operation
Maximum altitude	2000 m to full safety specifications



DLRO10HD

- High or low output power selection for condition diagnosis
- Rechargeable battery or line power supply, continuous operation, even with dead battery
- 10 A for 60 seconds, less time waiting to cool, good for charging inductance
- High input protection to 600 V, inadvertent connection to line or UPS voltage will not blow a fuse
- Rotary switch selects one of five test modes, including auto start on connection, giving ease of use
- Backlit display
- Delivered with calibration certificate

Description

Augmenting Megger's DLRO10 and 10X range the DLRO10HD combines ultimate simplicity of operation with a rugged IP65 case designed for stable ground and bench operation.

The DLRO10HD measures low resistance values in applications ranging from railways and aircraft to resistance of components in industry.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
DLRO10HD low resistance ohmmeter	1000-348	DH2 right angle duplex handspikes (1) 6 m	6111-023
Included accessories		DH3 right angle duplex handspikes (1) 9 m	6111-024
DH4 duplex handspike 1.2 m	6111-503	Straight duplex handspikes (2) heavy duty with fixed contacts	
Test lead pouch (lid mounted)	1000-036	2 m	242002-7
DLRO10HD user guide CD	2000-869	5.5 m	242002-18
Warranty book	6170-618	9 m	242002-30
Optional accessories		Duplex heavy duty 5 cm C-Clamps	
Calibration shunt, 10 Ω , current rating 1 mA	249000	(2) 2 m	242004-7
Calibration shunt, 1 Ω , current rating 10 mA	249001	5.5 m	242004-18
Calibration shunt, 100 m Ω current rating 1A	249002	9 m	242004-30
Calibration shunt, 10 m Ω current rating 10 A	249003	Duplex handspikes with replaceable needle points	
Certificate of calibration for shunts, NIST	CERT-NIST	2 m	242003-7
Replacement tips for DH4, DH5 and DH7 handspikes		Duplex 1.27 cm Kelvin clips	
Needle point	25940-012	(2) gold plated 2 m	241005-7
Serrated end	25940-014	silver plated 2 m	242005-7
Optional test leads at extra cost		Duplex 3.8 cm Kelvin clips	
Duplex leads		(2) 2 m	242006-7
DH5 straight duplex handspikes (2)		5.5 m	242006-18
One has indicator lights, 2.5 m	6111-517	9 m	242006-30
DH7 duplex handspikes (2) suitable for working on 600 V systems, 2.5 m	1001-035	Single leads	
Duplex handspikes (2) with spring loaded helical contacts, 2 m	242011-7	Single handspike (1) for potential measurement	
Duplex handspikes (2) 2.5 m	6111-022	2 m	242021-7
		5.5 m	242021-18
		9 m	242021-30
		Current clip (1) for current connections	
		2 m	242041-7
		5.5 m	242041-18
		9 m	242041-30



KC series test leads

- Developed in conjunction with a leading manufacturer of wind turbines
- Allows easy and reliable measurement of lightning protection circuit resistance of wind turbines
- Available in three lengths; 30 m, 50 m and 100 m to suit both manufacturing and maintenance applications
- Long cable fitted on strong metal framed cable reel
- Cable reel fitted with friction brake to avoid tangles when paying out cable

Description

The KC series of test leads provides a complete and convenient solution to the problem of finding reliable test leads that are long enough for testing the continuity of lightning protection conductors in wind turbines.

KC-series wind turbine test leads are available in 100 m, 50 m and 30 m versions that are suitable for use on site or in the manufacturing plant. All lead set versions are 10 A rated.

The lead sets consist of two test leads. The first is a 5 m cable fitted with a duplex handspike for probing the lightning receptors on the tips of the turbine blades. The second cable is either a 30 m, 50 m or 100 m cable, fitted with a large robust Kelvin clip, specially designed to offer ease of use while providing the consistently reliable connections needed to ensure accurate and repeatable test results.

The long cable is wound onto a high quality, robust cable reel fitted with a friction brake to avoid tangles whilst paying out.



If you need...

other test leads for your low resistance ohmmeter see page 81

ORDERING INFORMATION

Product	Order Code
KC100 Kelvin lead kit (1 x 100 m / 1 x 5 m)	1000-809
KC50 Kelvin lead kit (1 x 50 m / 1 x 5 m)	1001-248
KC30 Kelvin lead kit (1 x 30 m / 1 x 5 m)	1001-249

SPECIFICATIONS

Maximum lead resistance	100 mΩ total for 10 A operation irrespective of battery condition
Voltmeter input impedance	> 200 kΩ
Hum rejection	Less than 1% ± 20 digits additional error with 100 mV peak 50/60 Hz on the potential leads Warning will show if hum or noise exceeds this level

Display

DLRO10	Seven segment display
DLRO10X	LCD display

Battery

Capacity	7 Ah NiMH rechargeable
Life	Typically 1000 x 10 A tests before recharge
Recharge	Via external 90 V - 260 V 50/60 Hz charger or from 12 to 15 V d.c. supply
Charging time	2.5 hours to 90% capacity, 4 hours for full charge

Environmental

Temperature	Operation +5 °C to +45 °C at full specification -10 °C to +50 °C at reduced accuracy
Storage	-30 °C to +70 °C
Calibration	20 °C
Co-efficient	<0.01% per °C from 5 °C to 40 °C
Standard charging	0 °C to +45 °C
Fast charging	+10 °C to +45 °C
Humidity	Max 90% RH @ 40 °C non-condensing
Altitude	Max 2000 m to full safety specifications

Mechanical data

Dimensions (H x W x D)	220 mm x 100 mm x 237 mm
Weight	2.6 kg including battery module



DLRO10 and DLRO10X

- Auto current reversal cancels standing emfs
- Protected to 600 V
- Automatically detects continuity in potential and current connections
- Multiple operating modes including fully automatic
- Alpha-numeric keypad for entering test notes (DLRO10X)
- User selectable high and low limits (DLRO10X)
- Printer output and memory (DLRO10X)

Description

DLRO10 and DLRO10X are fully automatic instruments, selecting the most suitable test current up to 10 A d.c. to measure resistance from 0.1 μΩ to 2000 Ω, on one of seven ranges.

For users who want more control over the measurement process, DLRO10X uses a menu system controlled by a two-axis paddle to allow the user to manually select the maximum test current. DLRO10X also adds real time download of results and on board storage for later download to a PC.

Both instruments are built into a strong, lightweight case that is equally at home in the field or in the laboratory. Light enough to be worn around the neck, they are small enough to be taken into areas that were previously too small to access.

ORDERING INFORMATION

Product	Order Code
DLRO10 digital low resistance ohmmeter	6111-428
DLRO10X digital low resistance ohmmeter	6111-429
Included accessories	
7 Ah NiMH battery module	
DH4 duplex handspikes (2), one with indicator lights 1.2 m	6111-503
Battery charger for operation from 115/230 V 50/60 Hz supply	6280-333
Cigar lighter adapter for battery charging	6280-332
User guide	6172-473
Warranty book	6170-618
Optional accessories at extra cost	
Carrying case for DLRO10/10X and all standard accessories	6380-138
Carrying case for optional lead sets	18313
Calibration shunt, 10 Ω, current rating 1 mA	249000
Calibration shunt, 1 Ω, current rating 10 mA	249001
Calibration shunt, 100 mΩ current rating 1 A	249002
Calibration shunt, 10 mΩ current rating 10 A	249003

Product	Order Code
Certificate of calibration for shunts, NIST	CERT-NIST
Replacement tips for DH4, DH5 and DH6 handspikes	
Needle point	25940-012
Serrated end	25940-014
Optional test leads at extra cost	
Duplex leads	
DH5 straight duplex handspikes (2) One has indicator lights, 2.5 m	6111-517
DH6 duplex handspikes (2) suitable for working on 600 V systems, 2.5 m	6111-518
Duplex handspikes (2) with spring loaded helical contacts	
2 m	242011-7
2.5 m	6111-022
5.5 m	242011-18
only 1 lead supplied 6 m	6111-023
9 m	242011-30
Straight duplex handspikes (2) heavy duty with fixed contacts	
2 m	242002-7
5.5 m	242002-18
9 m	242002-30



BT51

- High test current
- Four terminal measurement
- Two measuring ranges (2000 mΩ and 20,000 mΩ) and maximum resolution of 0,01 mΩ
- Protected against inadvertent connection to the mains supply

Description

The BT51 low resistance ohmmeter makes measurements by passing a current through the conductor under test and also monitoring the voltage across it. The test current is limited by a simple current limiting circuit and is measured by monitoring the voltage across a resistor. The test current is maintained at a nominal 2 A, and as the measurement is ratiometric, the reading is unaffected by any current variations.

Instruments that measure low resistance accurately and give the result directly are invaluable in many applications.

The BT51 is a stable, accurate, reliable, low resistance ohmmeter suited to both precision laboratory applications and to applications in the field.

SPECIFICATIONS

Ranges	2000 mΩ, resolution 1 mΩ 20,00 mΩ, resolution 0,01 mΩ
Test current	2 A nominal, with up to 2 Ω across the C terminals
Accuracy	(0 °C to 50 °C) ±1% of reading ±2 digits
Display	3½-digit LED display
Environmental	
Operating temperature	0 °C to 50 °C
Storage	-20 °C to +50 °C
Relay protection for up to 240 V mains supply applied from C1/P1 to C2/P2 100 mA (T) fuse, 20 x 5 mm, ceramic (for charging circuit)	
Power supply	
4 Ah capacity NiCad rechargeable cells with internal charging unit Normal charging time of 10 hours on 240 V, 50 Hz mains supply	
Mechanical data	
Dimensions (H x W x D)	245 mm x 344 mm x 158 mm
Weight	4.5 kg

If you need a...

micro-ohmmeter designed for switchyards, see our MJÖLNER range from page 66

ORDERING INFORMATION

Product	Order Code
Low resistance ohmmeter (240 V operation)	BT51
Low resistance ohmmeter (120 V operation)	BT51/120
Included accessories	
Supply lead for battery charger	25424-860
Duplex handspikes with 2,5 m test leads	6111-022
Operating instruction book	6170-921
Optional accessories	
Test leads with duplex hand spikes 6,0 m	6111-023
Test leads with duplex hand spikes 9,1 m	6111-024
Four terminal lead set with clip connectors	6110-220
Test lead with single hand spikes, 1,8 m	6130-516
Accessory pouch, leather	6430-193

General-purpose low resistance ohmmeters

Two models specially designed for general-purpose testing applications are available.

Each provides up to 10 amperes of test current for measuring resistances to 60 ohms with 1 $\mu\Omega$ resolution and $\pm 0.25\%$ accuracy.

Dual-Pak general purpose model, Cat. No. 247000

This battery-powered unit features separate measuring and charger modules for maximum portability. The charger can be left in the shop, and the measuring module taken to the job site.

It weighs less than 3.6 kg (8 lbs) and provides hours of testing.

Single-Pak general purpose model, Cat. No. 247001

This compact instrument packages measuring circuits, rechargeable batteries and charger in one self-contained unit.

Ruggedly built to handle the most demanding field applications, the Single-Pak is housed in a tough Noryl® case with hinged, removable lid and carrying handle.

It also includes captive wing nuts.

Single-Pak/low range model, Cat. No. 247000

This model provides an extra range, 0 to 599.9 $\mu\Omega$, for applications requiring 0.1 $\mu\Omega$ resolution. It also features a current-reversing switch to average out any voltage offset in the test sample. Captive wing nuts are also standard.

Low range/high current models, Cat. No. 247100 and 247101

These instruments are used when a continuous test current of 100 amperes is required. They include a separate 100 ampere current supply module with a modified standard battery-powered 10 ampere system.

These combinations provide a sixth range, 0 to 599.9 $\mu\Omega$, with the 100 ampere current. For 100 ampere measurements, an interconnecting cable from the 100 ampere current supply module is plugged into a special receptacle on the measuring module.

When the 100 ampere range is not used, a jumper plug is inserted in place of the interconnecting cable.

This feature allows the measuring module to be used as a standard battery-powered, 10 A instrument.

Cat. No. 247100 meets ANSI C37.09, test procedure for AC high voltage circuit breakers.



247000

- Resolution to 0.1 $\mu\Omega$ on 599.9 $\mu\Omega$ range
- Standard accuracy of $\pm 0.25\%$
- Digital readout

Description

Low resistance ohmmeters are a family of highly accurate instruments that provide a simple, practical and reliable means of making low-resistance tests in the field. They also are ideal for production quality control.

They operate on the four-wire measurement principle, thus eliminating lead and contact resistances. With basic accuracies of $\pm 0.25\%$ and resolution down to 0.1 $\mu\Omega$, they are nonetheless designed to be rugged and portable for use at the job site. A variety of optional test leads and calibration resistance standards are offered for use with low resistance ohmmeters.

247000 series

Low resistance ohmmeter

SPECIFICATIONS

Cat. No.	Resistance range	Resolution	Current	Accuracy	Power source	Dimensions (H x W x D)	Weight
24700 - Dual Pak	0-5.999 mΩ 0-59.99 mΩ 0-599.9 mΩ 0-5.999 Ω 0-59.99 Ω	1 μΩ 10 μΩ 0.1 mΩ 1 mΩ 10 mΩ	10 A 1 A 100 mA 10 mA 1 mA	(0.25% reading + 1 lsd)	Rechargeable batteries with separate charger	20 x 23 x 20 cm (8 x 9 x 8 in.)	5.6 kg (12.25 lb)
247001 - Single Pak	0-5999 mΩ 0-59.99 mΩ 0-599.9 mΩ 0-5.999 Ω 0-59.99 Ω	1 μΩ 10 μΩ 0.1 mΩ 1 mΩ 10 mΩ	10 A 1 A 100 mA 10 mA 1 mA	(0.25% reading + 1 lsd)	Rechargeable batteries with internal charger	30 x 16 x 25 cm (12 x 6 x 10 in.)	5.5 kg (12 lb)
247002 - Single Pak, low range	0-599.9 mΩ 0-5.999 mΩ 0-59.99 mΩ 0-5.999 Ω 0-59.99 Ω	0.1 μΩ 1 μΩ 10 μΩ 1 mΩ 10 mΩ	10 A 10 A 1 A 10 mA 1 mA	(0.3% reading + 1 lsd)	Rechargeable batteries with internal charger	30 x 16 x 25 cm (12 x 6 x 10 in.)	5.5 kg (12 lb)
247100 247120 - Power Pak, low range	0.599.9 mΩ	0.1 μΩ	100 A	(0.5% reading + 2 lsd)	Line operated supply	33 x 20 x 25 cm (13 x 8 x 10 in.)	9.3 kg (20 lb)
247101 - Higher ranges Measuring modules 247000-3 or 247001-3	0-5.999 mΩ* 0-59.99 mΩ 0-599.9 mΩ 0-5.999 Ω 0-59.99 Ω or 0.5999 Ω*	1 μΩ 10 μΩ 0.1 mΩ 1 mΩ 10 mΩ	10 A 1 A 100 mA 10 mA 1 mA	(0.25% reading + 1 lsd)	Rechargeable batteries with separate charger or internal charger	Dual-Pak units 20 x 23 x 20 cm (8 x 9 x 8 in.) Single-Pak 30 x 16 x 25 cm (12 x 6 x 10 in.)	5.5 kg (12 lb)

247100 consists of 247000-3 Dual-Pak & 247120 100 ampere Power Supply

247101 consists of 247001-3 Single-Pak & 247120 100 ampere Power Supply

*Alternate range ID for lower range.

Individual test leads				
Type	Termination	Maximum test current	Length	Cat. No.
Potential	Handspikes	N/A	2 m (7 ft)	242021-7
			5.5 m (18 ft)	242021-18
			9 m (30 ft)	242021-30
Current	Terminal clips	10 A	2 m (7 ft)	242041-7
			5.5 m (18 ft)	242041-18
			9 m (30 ft)	242041-30
	Heavy duty clamps	100 A***	5 m (16 ft)	242144-16
			8 m (26 ft)	242144-26

Duplex test leads			
Termination	Maximum test current	Length	Cat. No.
Helical hand Spikes with spring points	10 A	2 m (7 ft)	242011-7
		5.5 m (18 ft)	242011-18
		9 m (30 ft)	242011-30
Helical hand Spikes with spring points and current pushbutton switch	10 A	5.5 m (18 ft)	242009-18
Heavy duty Fixed point Handspikes	10 A	2 m (7 ft)	242002-7
		5.5 m (18 ft)	242002-18
		9 m (30 ft)	242002-30
Replaceable Needle point	10 A	2 m (7 ft)	242003-7
2 in. (5 cm) Heavy duty C Clamps	10 A	2 m (7 ft)	242004-7
		5.5 m (18 ft)	242004-18
		9 m (30 ft)	242004-30
4 in. (10 cm) Heavy duty C Clamps	100 A***	5 m (16 ft)	242104-2-16
		8 m (26 ft)	242104-2-26
0.5 in. (1.3 cm) Kelvin clips	10 A	2m (7 ft)	241005-7* 242005-7**

ORDERING INFORMATION

Product	Order Code	Product	Order Code
DLRO® Digital low resistance ohmmeters Dual Pak, battery-operated (10 A)	247000	Instrument carrying case for Cat. No. 247001, 247002	218748
Single Pak, battery operated (10 A)	247001	Lead carrying case	18313
Single Pak/low range, battery-operated (10 A)	247002	Field test shunt, 10 Ω, current rating 0.001 A	249000*
Low range/high current, line- and battery-operated (100 A)	247100 or 247101	Field test shunt, 1 Ω, current rating 0.01 A	249001*
Included accessories		Field test shunt, 0.1 Ω current rating 1 A	249002*
Line cord, where applicable	17032	Field test shunt, 0.01 Ω current rating 10 A	249003
Instruction manual	AVTM24-1J	Field test shunt, 0.001 Ω current rating 100 A	249004
Optional accessories		Field test, 0.0001 Ω current rating 500 A	249005
Test leads	See chart	Certificate of calibration, NST	CERT-NIST
100 ampere current supply for Cat. No. 247000-3 and 247001-3	247120	*Furnished with protective shield	
100 A adapter plug for Cat. No. 247000 and 247001 only	Add -3		
Input voltage protection for Cat. No. 247000, 247001 and 247002 only	Add -11		
230 V (nominal), 50/60 Hz operation	Add -47		
Instrument carrying case for Cat. No. 247000	218746		



MJÖLNER200

- Fully automatic testing - micro-processor controlled
- Safe test – DualGround™ and Remote control
- True DC – ripple free current
- Lightweight suitcase – withstands the impact of water, dust or sand
- Built in thermal printer
- PC interface connection

Description

The MJÖLNER™200 is designed to measure the resistance of circuit breaker contacts, bus-bar joints, contact elements in bus-bars and other high-current links. This product is designed with safety, ease of use and versatility in mind.

The micro-ohmmeter can be used anywhere to measure a low resistance value with high accuracy. It conducts true DC ripple free current testing of bus bars, circuit breakers, fuses, etc. High current capability, up to 200 A DC – the user avoids problems with incorrect test results due to low test current when testing high current devices such as circuit breakers.

MJÖLNER200 can make measurements using the DualGround™ method. This means that the test object will be grounded on both sides throughout the test giving a safer, faster and easier workflow. The lightweight and rugged suitcase design makes MJÖLNER200 an excellent choice when you need a portable solution in the field. With the case closed, the product can withstand the impact of water, dust or sand – it even floats.

Optional accessories are a remote control and MJÖLNER Win PC software that is compatible with IPS–CEBEX and has export functions for tables to Microsoft® Excel®.

Applications

MJÖLNER 200 test system is designed to serve a number of applications. The most common are contact resistance measurements of low-, medium- and high-voltage breakers and also at bus-bar joints, and other high current links.

The contact resistance measurements concerning breaker testing are particularly called for in the following standards: ANSI C37.09-1979 (5.14), IEC 1208 and IEC 694 (6.4).

If the contact resistance is too high this will lead to power loss and temperature rise, which often leads to serious trouble. To avoid such problems, it is necessary to check the resistance at regular intervals.

The following table demonstrates how important low resistance is at high currents:

Current	Contact resistance	Power loss
10 kA	1 mΩ	100 kW
10 kA	0.1 mΩ	10 kW
1 kA	1 mΩ	1 kW
1 kA	0.1 mΩ	100 W

At 10 kA a contact with the resistance 0.1 mΩ gives a power loss of 10 kW. This power loss in one single point will definitely confer a temperature rise, which may result in overheating and possibly premature failure.

If you need a...

low resistance ohmmeter designed for the transportation industries see our DLRO range from page 57

Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

<i>Application field</i>	For use in high-voltage substations and industrial environments.
<i>Temperature</i>	
<i>Operation</i>	-20 °C to +50 °C (-4 °F to +122 °F)
<i>Storage</i>	-40 °C to +70 °C (-40 °F to +158 °F)
<i>Relative humidity %RH</i>	5%-95%, non condensing

CE-marking

<i>EMC</i>	2004/108/EC
<i>LVD</i>	2006/95/EC

General

<i>Mains voltage</i>	100-120, 200-240 V AC, 50 / 60 Hz
<i>Power consumption</i>	(max) 39 A at 100 V, 18 A at 230 V
<i>Protection</i>	Thermal fuses, Software
<i>Dimensions</i>	486 x 392 x 192 mm (19" x 15.4" x 7.6")
<i>Weight</i>	13.8 kg (30.4 lbs)

Measurement section

<i>Measuring range</i>	0 – 999.9 mΩ
<i>Resolution</i>	0.1 μΩ below 1.0 mΩ 1 μΩ below 10 mΩ 10 μΩ below 100 mΩ 100 μΩ below 1000 mΩ
<i>Inaccuracy, 50 – 600 A, 10 - 40 °C, R < 1 mΩ</i>	Typ ±0.3 μΩ, Max. ±2 μΩ

Outputs

DC+ / COM

<i>Range</i>	5 – 600 A DC (steps of 1 A)
<i>Output voltage (max)</i>	5.25 V DC at 600 A Ripple ptp <2% (0 to +50 °C)

OUTPUT 100 μV/A

<i>Shunt output</i>	From internal shunt 60 mV at 600 A
<i>Inaccuracy</i>	±1%

Inputs

SENSE

Max. 20 V between terminals and to protective earth (ground).

INPUT DC current clamp

Max. 20 V between terminals and to protective earth (ground).

<i>Input sensitivity</i>	Adjustable 0.1 – 20 mV/A
<i>Input impedance</i>	>1 MΩ

ORDERING INFORMATION

Product	Order Code
MJÖLNER200 Incl. Std. cable set 3 m, (current cables 2 x 3 m, 35 mm ² and sensing cables 2 x 3 m), ground cables	BD-19190
Incl. Std. cable set 5 m, (current cables 2 x 5 m, 35 mm ² and sensing cables 2 x 5 m), ground cables	BD-19191
Incl. Std. cable set 3 m, (current cables 2 x 3 m, 35 mm ² and sensing cables 2 x 3 m), ground cable and DC Current clamp (200 A/20 mV)	BD-19192
Optional accessories	
MJÖLNER Win Windows® software	BD-8010X
Remote control	BD-90010
Temperature probe	BD-90012
Thermal paper roll (for printer)	GC-0050
Extension cable set 5 m (current cables 2 x 5 m, 35 mm ² and sensing cables 2 x 8 mm)	GA-03206
Transport case 660 x 240 x 550 mm (26 x 9.4 x 21.6 in.) (L x W x H)	GD-00270



MJÖLNER600

- Fully automatic testing - micro-processor controlled
- Safe test – DualGround™ and remote control
- True DC – ripple free current
- Lightweight suitcase – withstands the impact of water, dust or sand
- Built in thermal printer
- PC interface connection

Description

The MJÖLNER™600 is designed to measure the resistance of circuit breaker contacts, bus-bar joints, contact elements in bus-bars and other high-current links. The product has been designed with safety, ease of use and versatility in mind.

The micro-ohmmeter conducts true DC ripple free current and can be used anywhere to measure a low resistance value with high accuracy. With MJÖLNER600 you can measure using the DualGround™ method. This means that the test object will be grounded on both sides throughout the test giving a safer, faster and easier workflow.

Choose the MJÖLNER600 with sufficient power resources for demanding applications, superior measurement accuracy and when 300 Amp continuous is required.

The lightweight and rugged suitcase design makes MJÖLNER600 an excellent choice when you need a portable solution in the field. When the case is closed, the product can withstand the impact of water, dust or sand – it even floats.

Two optional accessories are; a remote control and the PC software MJÖLNER Win that is compatible with IPS–CBEX and have export functions for tables to Microsoft® Excel®.

Applications

MJÖLNER600 test system is designed to serve a number of applications. The most common are contact resistance measurements of low-, medium- and high-voltage breakers and also at bus-bar joints, and other high current links.

The contact resistance measurements concerning breaker testing are particularly called for in the following standards: ANSI C37.09-1979 (5.14), IEC 1208 and IEC 694 (6.4).

If the contact resistance is too high this will lead to power loss and temperature rise, which often leads to serious trouble. To avoid such problems, it is necessary to check the resistance at regular intervals.

The following table demonstrates how important low resistance is at high currents:

Current	Contact resistance	Power loss
10 kA	1 mΩ	100 kW
10 kA	0.1 mΩ	10 kW
1 kA	1 mΩ	1 kW
1 kA	0.1 mΩ	100 W

At 10 kA a contact with the resistance 0.1 mΩ gives a power loss of 10 kW. This power loss in one single point will definitely confer a temperature rise, which may result in overheating and possibly premature failure.

Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field For use in high-voltage substations and industrial environments.

Temperature

Operation -20 °C to +50 °C (-4 °F to +122 °F)

Storage -40 °C to +70 °C (-40 °F to +158 °F)

Relative humidity %RH 5%-95%, non condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 100-120, 200-240 V AC, 50 / 60 Hz

Power consumption (max) 39 A at 100 V, 18 A at 230 V

Protection Thermal fuses, Software

Dimensions 486 x 392 x 192 mm
(19" x 15.4" x 7.6")

Weight 13.8 kg (30.4 lbs)

Measurement section

Measuring range 0 – 999.9 mΩ

Resolution 0.1 μΩ below 1.0 mΩ
1 μΩ below 10 mΩ
10 μΩ below 100 mΩ
100 μΩ below 1000 mΩ

*Inaccuracy, 50 – 600 A,
10 - 40°C, R < 1 mΩ* Typical ±0.3 μΩ, Max. ±2 μΩ

Outputs

DC+ / COM

Range 5 – 600 A DC (steps of 1 A)

Output voltage (max) 5.25 V DC at 600 A

OUTPUT 100 μV/A

Shunt output From internal shunt 60 mV at 600 A

Inaccuracy ±1%

Inputs

SENSE

Max. 20 V between terminals and to protective earth (ground).

INPUT DC current clamp Max. 20 V between terminals and to protective earth (ground).

Input sensitivity Adjustable 0.1 – 20 mV/A

Input impedance >1 MΩ

ORDERING INFORMATION

Product	Order Code
MJÖLNER600 Incl. Std. cable set 3 m, (current cables 2 x 3 m, 35 mm ² and sensing cables 2 x 3 m), ground cable	BB-59090
Incl. Std. cable set 5 m, (current cables 2 x 5 m, 35 mm ² and sensing cables 2 x 5 m), ground cables	BB-59091
Incl. Std. cable set 3 m, (current cables 2 x 3 m, 35 mm ² and sensing cables 2 x 3 m), ground cable and DC Current clamp (200 A/20 mV)	BB-59092
Optional accessories	
MJÖLNER Win Windows® software	BD-8010X
Remote control	BD-90010
Temperature probe	BD-90012
Thermal paper roll (for printer)	GC-00050
Extension cable set 5 m (current cables 2 x 5 m, 35 mm ² and sensing cables 2 x 8 mm)	GA-03206
Extension cable set 10 m (current cables 2 x 10 m, 35 mm ² and sensing cables 2 x 13 mm)	GA-03208
Calibration kit 200 A/ 20 mV shunt and instruction	BD-90022
DualGround kit DC Current clamp 200 A (incl. cables)	XA-12792



MOM2

- Up to 220 A
- Battery supplied
- Lightweight – 1 kg
- Safe test – DualGround™
- Auto range: 1 $\mu\Omega$ to 1000 m Ω
- Bluetooth® PC communication
- Complies with IEEE and IEC standards

Description

The MOM2 is designed to measure the resistance of circuit breaker contacts, bus-bar joints and other high-current links. This product is designed with safety, ease of use and versatility in mind.

The micro-ohmmeter can be used anywhere to measure a low resistance value with high accuracy.

With MOM2 you can measure using the DualGround™ method. This means that the test object will be grounded on both sides throughout the test giving a safer, faster and easier workflow.

The ruggedness and lightweight makes MOM2 a handheld instrument very suitable for field work, such as in substations. The unit comes with a strong rubber holster accessory which makes it extra durable. MOM2 is dimensioned to make a full day's work of testing without recharge. It can store 190 test values and transfer test data to a PC via Bluetooth.

Applications

MOM2 test system is designed to serve a number of applications.

The most common are contact resistance measurements of low-, medium- and high-voltage breakers and also at bus-bar joints, and other high current links.

If the contact resistance is too high this will lead to power loss and temperature rise, which often leads to serious trouble. To avoid such problems, it is necessary to check the resistance at regular intervals.

The following table demonstrates how important low resistance is at high currents:

Current	Contact resistance	Power loss
10 kA	1 m Ω	100 kW
10 kA	0.1 m Ω	10 kW
1 kA	1 m Ω	1 kW
1 kA	0.1 m Ω	100 W

At 10 kA a contact with the resistance 0.1 m Ω gives a power loss of 10 kW. This power loss in one single point will definitely confer a temperature rise, which may result in overheating and possibly premature failure.

Features and benefits

1. Current output terminal (-).
2. Current output terminal (+).
3. Display.
 - The display offers a combination of analogue arc and a dual digital readout:
 - Analogue arc:
Indicates level of the capacitor charge.
 - Dual digital display:
Large main digital readout for good visibility of all main measurement results.
Second digital display for additional data.
4. Ground (earth) terminal.
5. Keys for navigation and to make settings in the display.
6. TEST-button.
7. "Wake up", Clear log.
8. Function selector.



OFF		
I > I min	0.1 s	Measurement time with minimum current guarantee
	0.6 s	
	3 s	
I = I max	0.1 s	Measurement time with max. charge
	0.6 s	
	3 s	
SET		Bluetooth "pair units"
	CLK	Set Date/Time
	I min	Minimum current guarantee setting
	LOG	Data log settings
	P/F	Pass/Fail settings
PC COM		PC communication (dump data to PC)
USER	1	Stored settings (Set from PC SW)
	2	
	3	

9. Connector for the voltage (-) sense lead.
10. Connector for the voltage sense (+) sense lead.
11. Connector for the battery charger.
12. Battery charger indicator.

Micro-ohmmeter

Specifications MOM2

Specifications are valid at fully charged batteries and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

<i>Application field</i>	For use in high-voltage substations and industrial environments.
<i>Temperature</i>	
<i>Operation</i>	-20 °C to +50 °C (-4 °F to +122 °F) *)
<i>Storage</i>	-40 °C to +70 °C (-40 °F to +158 °F)
<i>Relative humidity %RH</i>	5%-95%, non condensing
<i>Pollution degree</i>	2
<i>Shock</i>	IEC 60068-2-27
<i>Vibration</i>	IEC 60068-2-6
<i>Transport</i>	ISTA 2A
<i>Flammability class</i>	V0

*) Battery operation temperature 0 °C to +50° (32 °F to +122 °F)
 Battery charging temperature +10 °C to +40° (50 °F to +104 °F)

CE-marking

<i>EMC</i>	2004/108/EC
<i>LVD</i>	2006/95/EC

General

<i>Battery power</i>	Five AA (HR6) 2700 mAh NiMH cells
<i>Recharge time</i>	< 12 h
<i>Typical recharge time at 25 °C</i>	3 h
<i>Battery charger</i>	
<i>Mains voltage</i>	100-250 V AC, 50 / 60 Hz
<i>Power consumption</i>	60 W
<i>Protection</i>	Against wrong battery type, low/high temperature.
<i>Real time clock battery life</i>	≥10 years
<i>Audible feedback</i>	Different buzzer sounds
<i>User presets</i>	3
<i>Field calibration</i>	Yes
<i>Encapsulation</i>	IP54
<i>Dimensions (excl. binding posts)</i>	217 H x 92 B x 72 D mm 8.5 H x 3.6 B x 2.8 D in.
<i>Weight</i>	1.0 kg (2.2 lbs) instrument only 5.0 kg (11 lbs) with accessories and carrying case

Measurement section

<i>Minimum current guarantee</i>	Selectable 50 A / 100 A Valid at resistance ≤2 mΩ
<i>Pass / Fail</i>	Settable from 1 μΩ to 1999 mΩ
<i>Number of measurements on fully charged batteries</i>	typ. 2200 at I min = 50 A and 0.1s typ. 800 at I min = 100 A and 0.1s
<i>Interference suppression</i>	Yes
<i>Range</i>	0 - 1000 mΩ
<i>Range selection</i>	Auto
<i>Resolution</i>	
0 – 999 μΩ	1 μΩ
1.0 – 9.99 mΩ	0.01 mΩ
10.0 – 99.9 mΩ	0.1 mΩ
100 – 1000 mΩ	1 mΩ
<i>Inaccuracy</i>	
0 – 1999 μΩ	±1 % of reading ±1 digit
2 – 1000 mΩ	±2 % of reading ±1 digit

Outputs + / -

<i>Range</i>	> 100 A DC (R < 2 mΩ)
<i>Output voltage (max)</i>	2.5 V DC
<i>Generation duration</i>	Selectable: 0.1 s, 0.6 s, 3 s

Recovery time at I min set to 100 A and load 100 μΩ

Generation time	Max	Typ
0.1 s	10 s	8 s
0.6 s	20 s	16 s
3 s	130 s	100 s

Inputs

<i>SENSE + / -</i>	
<i>Connector</i>	4 mm banana jack
<i>Voltage</i>	±3 V DC
<i>Trigger input</i>	Threshold 8 V DC
<i>DC IN</i>	12 – 24 V DC, 2 A max

Logger

<i>Logger, Data</i>	Label. Timestamp, I max, I min, I Limit, Resistance, Meas.time, P/F limit
<i>Labeling schemes</i>	Circuit breaker oriented or diary number
<i>Capacity</i>	190 measurements

Wireless communication

<i>Headset</i>	Bluetooth
<i>PC communication</i>	Bluetooth

ORDERING INFORMATION

Product	Order Code
MOM2 <i>Including:</i> 2 x 1.3 m (4 ft) test cables with Kelvin probes (one with trig button) Transport case, Charger, Rubber holster, Carrying strap, Belt clip, MOM2 Win	BD-59090
MOM2 <i>Including:</i> 1.3 m (4 ft) test cable red with Kelvin clamp 3 m (10 ft) test cable black with Kelvin clamp Transport case, Charger, Rubber holster, Carrying strap, Belt clip, MOM2 Win	BD-59092
Optional accessories	
Test cables with Kelvin probes 2 x 1.3 (4 ft) m (one with trig button)	GA-90000
Test cables with Kelvin clamps 1.3 m (4 ft) red, 3 m (10 ft) black	GA-00386
Cable kit 5 m Current cable 0.5 m (1.6 ft), Connection plate and sense cables 5 m (16 ft), Ground cable	GA-00380
Cable kit 10 m Current cable 0.5 m (1.6 ft), Connection plate and sense cables 10 m (33 ft), Ground cable	GA-00382
Cable kit 15 m Current cable 0.5 m (1.6 ft), Connection plate and sense cables 15 m (49 ft), Ground cable	GA-00384
Bluetooth kit Bluetooth headset and dongle for PC	XC-06000
Calibration kit	BD-90002



MOM200 A

- Compact and rugged
- Easy-to-use
- 200 A output current

Description

The MOM200A™ is designed to check and measure contact resistances in high-voltage circuit breakers, disconnecting switches (isolators) and busbar joints. The instrument is an excellent choice when 200 amperes or less are needed for measurement.

Since the MOM200A weighs only about 14 kg (31 lbs), it's convenient to take along with you.

MOM200A is ideal for finding poor connections since it can put out 100 A for extended periods. Its range extending up to 20 milliohms makes it ideal for measuring many different types of connections.

A complete MOM200A includes a cable set (including separate sensing cables) and a transport case.

Application examples

IMPORTANT!

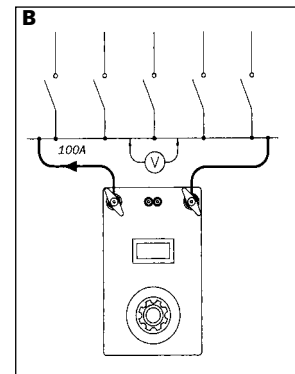
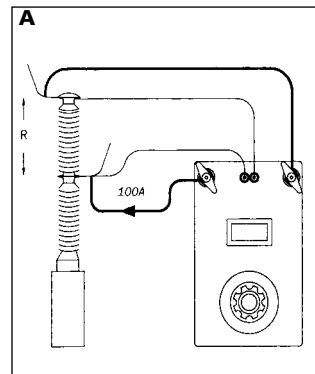
Read the user manual before using the instrument.

A. Measuring the resistance of a circuit breaker element

1. Connect the micro-ohmmeter to the circuit breaker.
2. Set the current (100 A in this example).
3. Press the resistance pushbutton.
4. Read the result.

B. Measuring the resistance of busbar joints

1. Connect the micro-ohmmeter's current cables to the object being tested. Do not connect the sensing cables since measurements will be taken using an external movable voltmeter.
2. Set the current (100 A in this example).
3. Connect an external voltmeter to the bus.
4. Read the voltmeter (0.1 mV = 1 $\mu\Omega$ in this example).
5. Move the voltmeter to the next joint.
6. Repeat step 4.



Specifications MOM200A

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 115/230 V AC, 50/60 Hz

Power consumption 1610 VA (max)

Protection Miniature circuit breakers, thermal cut-outs

Dimensions

Instrument 280 x 178 x 246 mm (11" x 7" x 9.7")

Transport case 560 x 260 x 360 mm
(22" x 10.2" x 14.2")

Weight 14.6 kg (32.2 lbs) 26 kg (54.1 lbs) with accessories and transport case

Current cables 2 x 5 m (16 ft), 25 mm²

Sensing cables 2 x 5 m (16 ft), 2.5 mm²

Measurement section**Resistance**

Range 0 – 1999 μΩ

0 – 19.99 mΩ

Resolution

1 μΩ

10 μΩ

Inaccuracy ±1% of reading + 1 digit

Output

Current 0 – 200 A DC

Open circuit voltage 4.7 V DC

Current shunt output 10 mV/100 A ±0.5%, max 20 mV out,
max 10 V to protective earth (ground)

Max. load capacity

Current adjustment set to 100%

Output current	Min. output voltage	Max. load time	Rest time
100 A DC	3.8 V	5 min.	15 min.
	DC	15 min.	60 min.
200 A DC	3.0 V	20 s	5 min.
	DC		

ORDERING INFORMATION

Product	Order Code
MOM200A Incl. Cable set GA-02053, Ground cable GA-00200, Transport case GD-00010 115 V mains voltage	BD-11190
230 V mains voltage	BD-12290
Optional accessories	
Cable set 10 m 2 x 10 m (33 ft), 35 mm ² (current cables) 2 x 10 m (33 ft), 2.5 mm ² (sensing cables) Weight: 9 kg (19.8 lbs)	GA-03103
Cable set 15 m 2 x 15 m (49 ft), 35 mm ² (current cables) 2 x 15 m (49 ft), 2.5 mm ² (sensing cables) Weight: 18.6 kg (40.9 lbs)	GA-05153
Calibration shunt 200 A/20 mV	BD-90022



MOM600A

- Compact and rugged
- Easy-to-use
- 600 A output current

Description

Switchgear breakdowns are frequently caused by excessively high contact resistance at breakpoints and busbar joints. Moreover, overheating risks are becoming more serious due to the fact that today's distribution networks have to carry heavier loads. Checking contact resistances at regular intervals detects faults before they cause overheating. And here, an ounce of prevention is worth a pound of cure.

Micro-ohmmeters are used to measure contact resistances in high-voltage breakers, disconnecting switches (isolators), knife-contact fuses, bus joints, line joints etc.

The MOM600A™ is in a class apart particularly in environmentally challenging situations. Designed for use from the arctic to the tropics, this rugged, compact micro-ohmmeter is ideal for field work.

A complete set of equipment includes a set of highly flexible cables (including separate measurement cables) and a sturdy transport case.

Application examples

IMPORTANT!

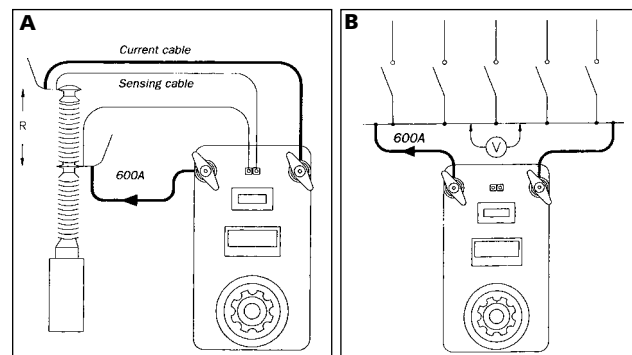
Read the user manual before using the instrument.

A. Measuring the resistance of a circuit breaker element

1. Connect the micro-ohmmeter to the circuit breaker.
2. Set the current (100 A in this example).
3. Press the resistance pushbutton.
4. Read the result.

B. Measuring the resistance of busbar joints

1. Connect the micro-ohmmeter's current cables to the object being tested. Do not connect the sensing cables since measurements will be taken using an external movable voltmeter.
2. Set the current (100 A in this example).
3. Connect an external voltmeter to the bus.
4. Read the voltmeter (0.1 mV = 1 $\mu\Omega$ in this example).
5. Move the voltmeter to the next joint.
6. Repeat step 4.



Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

<i>Application field</i>	The instrument is intended for use in high-voltage substations and industrial environments
<i>Temperature</i>	
<i>Operating</i>	0 °C to +50 °C (32 °F to +122 °F)
<i>Storage & transport</i>	-40 °C to +70 °C (-40 °F to +158 °F)
<i>Humidity</i>	5% – 95% RH, non-condensing

CE-marking

<i>EMC</i>	2004/108/EC
<i>LVD</i>	2006/95/EC

General

<i>Mains voltage</i>	115/230 V AC, 50/60 Hz
<i>Power consumption (max)</i>	115 V, 4370 VA 230 V, 7360 VA
<i>Protection</i>	Miniature circuit breakers, thermal cut-outs
<i>Dimensions</i>	
<i>Instrument</i>	356 x 203 x 241 mm (14" x 8" x 9,5")
<i>Transport case</i>	610 x 290 x 360 mm (24.0" x 11.4" x 14.2")
<i>Weight, 115 V model</i>	25 kg (55.1 lbs) 43.1 kg (95 lbs) with accessories and transport case
<i>Weight, 230 V model</i>	24.7 kg (54.5 lbs), 42.8 kg (94.4 lbs) with accessories and transport case
<i>Current cables</i>	2 x 5 m (16 ft), 50 mm ²
<i>Sensing cables</i>	2 x 5 m (16 ft), 2.5 mm ²

Measurement section

Resistance

<i>Range</i>	0 – 1999 μΩ
<i>Resolution</i>	1 μΩ
<i>Inaccuracy</i>	±1% of reading +1 digit (at 100 – 600 A test current)

Output, 115 V model

<i>Current</i>	0 – 600 A DC
<i>Open circuit voltage</i>	5.2 V DC
<i>Current shunt output</i>	10 mV/100 A ±0.5%, max 60 mV out, max 10 V to protective earth (ground)

Output, 230 V model

<i>Current</i>	0 – 600 A DC
<i>Open circuit voltage</i>	9 V DC
<i>Current shunt output</i>	10 mV/100 A ±0.5%, max 60 mV out, max 10 V to protective earth (ground)

Max. load capacity, 115 V model

Current adjustment set to 100%

Output current	Min. output voltage	Max. load time	Rest time	Input current
100 A DC	4.6 V	-	-	8 A
300 A DC	3.8 V	1.5 min.	15 min.	20 A
600 A DC	2.6 V	10 s	5 min.	38 A

Max. load capacity, 230 V model

Current adjustment set to 100%

Output current	Min. output voltage	Max. load time	Rest time	Input current
100 A DC	8.3 V	-	-	6 A
300 A DC	7.2 V	2.5 min.	15 min.	16 A
600 A DC	5.6 V	15 s	5 min.	32 A

ORDERING INFORMATION

Product	Order Code
MOM600A Complete with: Cable set GA-05053 Ground cable GA-00200 Transport case GD-00010 115 V mains voltage	BB-11190
230 V mains voltage	BB-12290
Optional accessories	
Cable set 10 m 2 x 10 m (33 ft), 35 mm ² (current cables) 2 x 10 m (33 ft), 2.5 mm ² (sensing cables) Weight: 16.8 kg (37 lbs)	GA-07103
Cable set 15 m 2 x 15 m (49 ft), 35 mm ² (current cables) 2 x 15 m (49 ft), 2.5 mm ² (sensing cables) Weight: 29.4 kg (65 lbs)	GA-09153
Calibration shunt 600 A/60 mV	BB-90020



MOM690

- Easy to use
- Automatic range setting
- MOM Win PC-software

Description

Measuring resistance is an important part of maintaining high-voltage breakers and disconnecting switches. Instruments that measure the resistance of high-current contacts and other transmission elements have been included in the Megger line of products for many years.

MOM690™ supplements our family of micro-ohmmeters. In addition to high current capacity, MOM690™ features microprocessor-based measurement, storage and reporting. The built-in software enables you to carry out an individual test or an entire series of tests and store the results.

With the optional MOMWin™ software you can also export the test results to a PC for further analysis and reporting. Ranges are set automatically, resistances are measured continually and test results can be automatically captured at a preset test current. What could be simpler?

After testing a breaker with a CT mounted in its current circuit, e.g. dead tank and GIS breakers, some standards recommended that the CT is demagnetized. This troublesome task can be accomplished quickly and easily thanks to the MOM690's AC output. The AC output can also be used as a general multi-purpose current source in different applications.

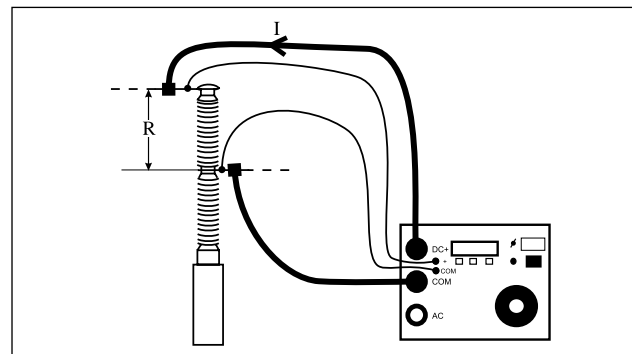
Application example

IMPORTANT!

Read the user manual before using the instrument.

Measuring the resistance of a breaker

1. Make certain the line is de-energized on both sides of the breaker.
2. Ground the breaker on one side and make certain it is closed.
3. Ground the micro-ohmmeter.
4. Make certain the micro-ohmmeter's ON/OFF switch is OFF while making connections.
5. Connect the current cables to the DC+ and COM terminals and the sensing cables to the sensing inputs to both sides of the breaker, making sure that the polarities match properly.
IMPORTANT: The sensing cables must be connected inside the current cables. Otherwise the test data will be incorrect. See Fig.
6. Switch on the MOM690.
7. Select "AUTO" or "MAN" with the <FUNC>-button.
8. Set output current to zero to start the measurement.
9. Increase the current to the desired value (600 A for example).
10. Read the resistance value.



Measuring the resistance of a breaker

Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 115/230 V AC, 50/60 Hz

Power consumption (max) 115 V, 5980 VA (at 600 A output)
230 V, 9660 VA

Protection Miniature circuit breaker, thermal fuse, software

Dimensions

Instrument 350 x 270 x 220 mm
(13.8" x 10.6" x 8.7")

Transport case 610 x 290 x 360 mm
(24.0" x 11.4" x 14.2")

Weight, 115 V model 24 kg (52.9 lbs)
38.9 kg (85.7 lbs) with accessories and transport case

Weight, 230 V model 23.7 kg (52.2 lbs)
38.6 kg (85.1 lbs) with accessories and transport case

Available languages English, French, German, Spanish, Swedish

Current cables 2 x 5 m (16 ft), 50 mm²

Sensing cables 2 x 5 m (16 ft), 2.5 mm²

Optional current cable sets

Ext.1 Extension 2 x 5 m, 50 mm²

Ext.2 Extension 2 x 10 m, 50 mm²

2 x 15 m (49.2 ft) 95 mm²

Measurement section

Ammeter

Range 0 – 800 A

Resolution 1 A

Inaccuracy 100 – 800 A, ±1% of reading +1 digit
50 – 99 A, ±2% of reading +2 digits
0 – 49 A, not specified

Resistance

Range 0 – 200 mΩ, >200 mΩ not specified

Resolution 1 μΩ

Inaccuracy 100 – 800 A, ±1% of reading +1 digit
50 – 99 A, ±2% of reading +2 digits
0 – 49 A, not specified

Max. load resistance / current, 115 V model

Cable set	Standard	Standard + Ext. 1	Standard + Ext. 1	2 x 15 m 95 mm ²
At 300 A	10 mΩ	6 mΩ	3 mΩ	10 mΩ
Max. current	575 A	420 A	360 A	540 A

Max. load resistance / current, 230 V model

Cable set	Standard	Standard + Ext. 1	Standard + Ext. 1	2 x 15 m 95 mm ²
At 300 A	18 mΩ	14 mΩ	11 mΩ	18 mΩ
At 600 A	3.0 mΩ			1.8 mΩ
Max. current	750 A	570 A	480 A	690 A

Output DC (CAT I), 115 V model

Current (A)	Voltage (V)	Max. load time	Input current (A)
0	7.3	–	0.8
50	6.9	30 min.	
100	6.4	10 min.	10
200	5.5	90 s	19
300	4.8	50 s	
400	3.9	30 s	38
500	3.0	15 s	
575 ¹⁾	2.5	10 s	
600	2.2	8 s	52
700	1.5	5 s	
800 ²⁾	0.9	–	

1) Maximum current with standard cables 2 x 5 m 50 mm²

2) At 800 A and above, instant shut off

Note: The above figures shows maximum load time from cold state 25 °C. They are not valid for repeated tests

Output AC (CAT I), 115 V model

Current (A)	Voltage (V)	Max. load time	Rest time
0	8.7	Cont.	–
660	3.5	2 s	4 min.

Note: The DC and AC outputs must not be loaded at the same time.

Output DC (CAT I), 230 V model

Current (A)	Voltage (V)	Max. load time	Input current (A)
0	9.4	–	0.4
50	9.0	30 min.	
100	8.6	10 min.	6
200	8.0	90 s	
300	7.2	50 s	
400	6.4	40 s	
500	5.7	30 s	
600	5.0	15 s	33
700	4.3	8 s	
750 ¹⁾	3.8	5 s	
800 ²⁾	3.6	–	42

1) Maximum current with standard cables 2 x 5 m 50 mm²

2) At 800 A and above, instant shut off

Note: The above figures shows maximum load time from cold state 25 °C. They are not valid for repeated tests

Output AC (CAT I), 230 V model

Current (A)	Voltage (V AC)	Max. load time	Rest time
0	11.2	Cont.	–
660	4.5	2 s	4 min.

Note: The DC and AC outputs must not be loaded at the same time.

Optional accessories

PC Software MOMWin

An optional Windows® program named MOMWin is available for MOM690. It can be used to control measurement, analyse the results and report the results from a PC. It also enables you to retrieve test results stored previously in MOM690.

All readings are saved in ASCII-format and can be easily exported to your favourite spreadsheet program. Results can be presented in table or diagram form in MOMWin.

The program runs in Windows® 95, 98, NT, 2000 or XP. Minimum requirement is a 486 computer with 8 MB of RAM.

Incl. serial cable for RS-232 port.



Cable set and current shunt

ORDERING INFORMATION

Product	Order Code
MOM690 Complete with: Cable set standard GA-05055 Ground cable GA-00200 Transport case GD-00182 115 V mains voltage	BB-41190
230 V mains voltage	BB-42390
Optional	
PC Software MOMWin Incl. serial cable for RS-232 port	BB-8010X
Cable set 15 m (49 ft) 2 x 15 m (49 ft), 95 mm ² (current cables) 2 x 15 m (49 ft), 2.5 mm ² (sensing cables) Weight: 29.4 kg (64.8 lbs)	GA-09155
Cable extension sets Since all current cables have bayonet connectors, standard cables can be easily prolonged with 5- or 10-metre extension sets if so desired. In situations requiring high currents and long cable lengths, heavier cable sets may be necessary however.	
Extension cable set No. 1 2 x 5 m (16 ft), 50 mm ² (current cables). 2 x 10 m (33 ft), 2.5 mm ² (sensing cables). Weight: 7.5 kg (16.5 lbs)	GA-05057
Extension cable set No. 2 2 x 10 m (33 ft), 50 mm ² (current cables). 2 x 15 m (49 ft), 2.5 mm ² (sensing cables). Weight: 15 kg (33 lbs)	GA-05107
Calibration shunt An optional calibration shunt (600 A/60 mV) can be ordered for MOM690, that enables you to make certain that the instrument readings remain correct.	BB-90024
Transport case XL With space for the standard 5 m cable set + extension cable set No. 1 or No. 2.	GD-00042



Large Kelvin clips

- 242006-7
3.8 cm Kelvin clips (2) 2 m
- 242006-18
3.8 cm Kelvin clips (2) 5.5 m
- 242006-30
3.8 cm Kelvin clips (2) 9 m



Duplex handspikes

- 6111-517 DH5
2 off, one with indicator lights, 2.5 m
- 6111-518 DH6
As above, 2.5 m, 600 V rated



Separate current and potential leads

- 242041-7
Current clip leadset 2 m leads
- 242041-18
Current clip leadset 5.5 m leads
- 242041-30
Current clip leadset 9 m leads



Replacement tips for DH4, DH5 and DH7 handspikes

- 25940-012 - needle point
- 25940-014 - serrated end



Kelvin clips

- 241005-7
1.27 cm Kelvin clips (2) gold plated 2 m
- 242005-7
Kelvin Clips 2 m leads - silver plated clips



Single handspikes

- 242021-7
1 for potential measurement 2 m
- 242021-18 - as above 5.5 m
- 242021-30 - as above 9 m



Heavy duty C-clamps

- 242004-7
Heavy duty C-clamps 2 m leads
- 242004-18
Heavy duty C-clamps 5.5 m leads
- 242004-30
Heavy duty C-clamps 9 m leads



Heavy duty fixed point handspikes

- 242002-7 - 2 m leads
- 242002-18 - 5.5 m leads
- 242002-30 - 9 m leads



Duplex probes

- 6111-022
2.5 m Duplex handspikes (2 incl.) with helical sprung contacts.
- 6111-023 DH2
6 m as DH1 but only 1 included
- 6111-024 DH3
9.0m as DH1 but only 1 included



Heavy duty C-clamps

- 6130-516
Test lead with single hand spikes, 1.8 m



Heavy duty fixed point handspikes replaceable tips

- 242003-7 - 2 m leads
- 242002-30 - 9 m leads



Accessory pouch (suitable for BT51 only)

- 6430-193
Accessory pouch, leather



Calibration shunt

- 249000
10 Ω , current rating 1 mA
- 249001
1 Ω , current rating 10 mA
- 249002
100 m Ω , current rating 1 A
- 249003
10 m Ω , current rating 10 A



Shunt calibration certificate

- CERT-NIST
Certificate of calibration for shunts, NIST



GA-90000
Kelvin probes with cables



XC-06000
Bluetooth headset



Bluetooth dongle



Connection plate, used together with cable kits



GA-00386
Kelvin clamps with cables



GA-02053
Cable set

GA-00200
Ground cable

BD-90022
Shunt



Power Quality

Harmonic pollution and voltage transients on supplies are by no means uncommon, and can have expensive consequences. The key to diagnosing and eliminating these ills is effective supply monitoring.

4

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SELECTION GUIDE

■ feature □ option

	PA9 Plus	PA9 Wireless	MDP	MR4	SLM8
Portable power analyzer	■				
Portable quality analyzer		■			
Distribution profilers			■		
Meter adapter recorder				■	
Volt ammeter					■
Onsite analyzer without a computer	■				
Intelligent download	■	■			
Harmonic trending	■	■			
Includes Metrossoft software	■	■	■	■	■
Remote communications	■	■			
Wireless modem		■			
Voltage	■	■		■	■
Current	■	■	■	■	■
Harmonics	■	■	□	■	■
Waveform capture	■	■	□	■	

What is power quality?

For today's electrical engineers, power quality is an important issue. Harmonic pollution and voltage transients on supplies are by no means uncommon, and can have expensive consequences. The key to diagnosing and eliminating these ills is effective supply monitoring.

In our modern world, devices which present a non-linear load to the electrical supply system are everywhere. Almost every computer or television, for example, has a switch-mode power supply, while inverter-based variable speed drives are found in huge numbers in virtually every office building and factory. Even the humble fluorescent light fitting is likely to have an electronic ballast, which is yet another non-linear load.

There's no doubt that these devices perform valuable functions, and that, in many cases, they are very energy efficient, but they do have one significant drawback: by definition, non-linear loads present to the supply system an impedance which varies rapidly with time. Typically, for example, they may draw current only for a small part of each cycle of the supply waveform.

The practical consequence of this behaviour is that non-linear loads give rise to harmonic currents at multiples of the powerline frequency. The presence of these harmonics in the supply can adversely affect the operation of electronic equipment, such as computers and telecommunication installations, but their effect is by no means limited to these relatively sensitive low-power devices. Harmonic currents can cause excessive and even dangerous heating in power distribution transformers and neutral supply conductors, and can also cause nuisance tripping in circuit breakers.

Clearly, for safe and dependable operation of electrical installations, and the equipment connected to them, harmonics must be brought under control. There can, however, be no true control without effective measuring and monitoring, so let's have a look at what's needed to measure and monitor supply harmonics.

First, let's consider the locations where we are likely to be measuring harmonics. Among the most usual places are adjacent to electrical distribution equipment, or near loads which are suspected either of generating harmonics or of being affected by them. In other words, measurements need to be taken in a variety of on-site conditions. This dictates that the instrument should be portable, robust and insensitive to changes in ambient conditions.

Now, let's consider the provision of power for the instrument. Frequently, the only readily available power source is the one which is under investigation. An instrument which requires a clean, regulated supply for correct operation may, therefore, be inconvenient or even impossible to use. A far better option is a portable power quality meter which is self-powered from the supply under test.

The requirements for portability and stability make the use of digital measurement techniques virtually essential. While it would be possible to envisage an analogue instrument based on tuned filters and amplifiers, it would be a brave soul who would guarantee stability and accuracy outside of a laboratory environment!

Power quality monitoring often needs to be continued over a considerable period of time, and if several circuits have to be monitored, it is much easier and more economical to do this with one multi-channel instrument than with several single-channel devices. Further, multi-channel operation means that all records are absolutely synchronised, allowing easy and accurate comparison of the results on different channels.

In many applications, it is also desirable to have facilities for event-triggered recording, where the instrument can be set to record the data associated with a particular power quality phenomenon. This might, for example, be a voltage spike. The best equipped instruments will record events while continuing to store waveform data, and to log trends in voltages, currents and power flows.

A large-capacity memory is needed to store the data collected, together with non-volatile external memory facilities which allow it to be transferred easily to a PC, and software to permit subsequent detailed analysis. It's also worth mentioning that the ability to review and edit the data rapidly prior to transfer is also useful, since it avoids the time wasted in transferring and processing information which is not of interest.

All of the factors we have discussed so far, give a good idea of the capabilities of the ideal modern power quality monitor. In summary, it should be portable, self-powered from an unregulated AC/DC source, measure harmonics up to at least the 60th, offer a real-time graphical display, indicate the direction of harmonic power flow, accommodate multiple channels, and have large data storage facilities.

These are the very factors which were used by Megger engineers as the basis for the design of the PA-9 Plus portable power analyser. Designed specifically for use on site, without a computer, this compact instrument records power quality and power flow, as well as evaluating trends for harmonics, total harmonic distortion (THD), and total demand distortion (TDD).

Power quality matters. Reliable operation of electrical equipment can only be assured if engineers pro-actively manage the quality of the power delivered to their electrical installations, and the only way that they achieve this is by regular and systematic monitoring.

Detailed charts

Megger PA9 plus and PA9 wireless allow you to graph and overlay any or all recorded parameters on a single chart. This feature dramatically reduces the time for problem analysis and identification. An important feature allows you to zoom in/zoom out of particular windows, as well as to copy and paste data directly from the chart to a third-party spreadsheet, database, or analysis program. The scan-line feature provides exacting data and timing information at any particular point in the chart, thus removing all guesswork and approximation in the investigation. In addition, you can graphically view vector information and relationships for any demand interval, as well as modify the look of the chart axis and title information. All charts and graphs may be printed directly to your local or network printer, and copied and pasted to third-party applications.

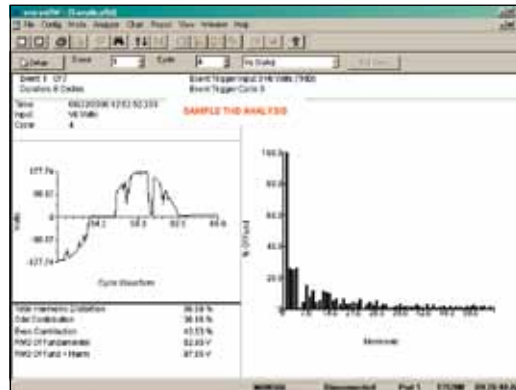
New advanced Metreport utility

MetReport software offers the unprecedented feature of data analysis and custom reporting at your fingertips. The downloaded data files from either PA9Plus or PA9 Wireless can be automatically analyzed against standard specifications such as EN50160, CBEMA, SEMI-F47, SARFI or IEEE519 just to name a few. You can also create your own custom templates to perform data analysis using the Wizard built into the software. Just answers the questions when prompted.

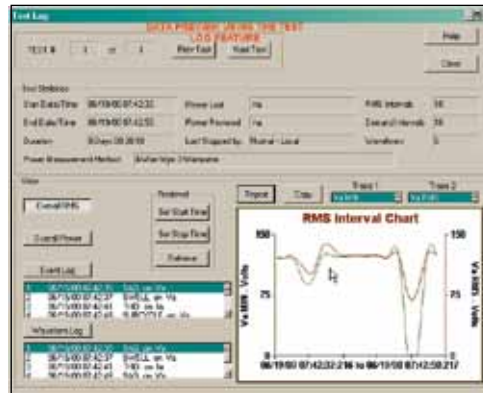
For more sophisticated reporting requirements, our optional METREPORT software creates tailored reports and customized reporting templates. This utility directly reads power quality data files, producing sophisticated reports incorporating company specific logos, in-depth charts, and applicable text into a Microsoft® Word compatible document. New charting capabilities have been added for correlating recorded power quality data to industry manufacturers tolerance curves such as CBEMA, ITIC, and SEMI-F47. These reports are ideal for professional presentation to utility customers, power quality clients, and senior management.



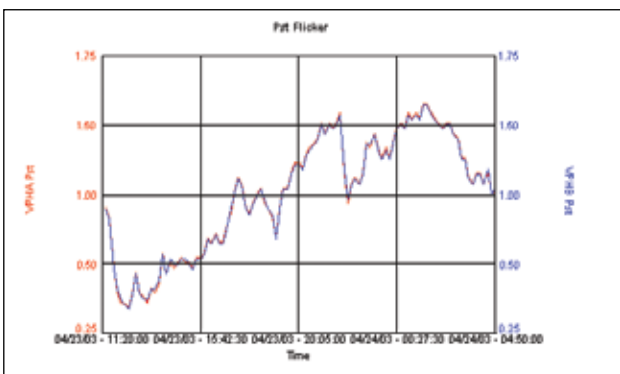
Demand data chart



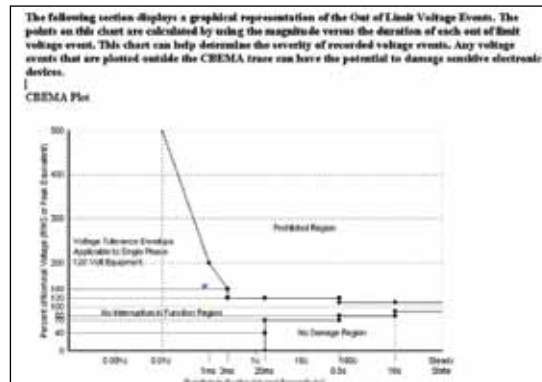
Cycle waveform with bar chart



Selective data download and preview capabilities



Flicker trending per IEC61000-4-15 and EN50160



Comparison to industry tolerance curves using optional METREPORT software



PA9Plus

- Designed to comply with all applicable IEC, IEEE and EN Standards
- On-site analysis and data retrieval without a computer
- Intelligent download - select only the data required
- Trends harmonics, THD & TDD and provides real-time graphical display of individual harmonic power
- Includes Metrosoft® software
- Remote communications and alarm capabilities

Description

The PA9Plus is the latest innovation of the successful PA-9 Power Quality Analyzer platform. It incorporates newly enhanced key features including a faster Digital Signal Processor (DSP) to support continually evolving capabilities, a full 12 MB of nonvolatile internal memory and standard auxiliary power input capabilities.

The PA9Plus is CE marked, supports several international languages, and adheres to applicable European and North American standards (EN50160, IEC61000-4-15, IEEE1159, IEEE519), including automatic phase lock loop synchronization of input frequencies ranging from 20 Hz to 70 Hz, flicker measurements and recording, and out of limits/frequency trending.

The optional removable memory capabilities allows internally recorded data to be copied directly to an external standard compact flash card using the same technology available with most of today's digital cameras. This means that without a computer on site, data can be manually or automatically copied from the instrument to external memory cards, increasing the effective instrument memory storage to the size of the card used. Similarly, new configuration setups may be programmed in the same, simple manner.

SPECIFICATIONS

Specifications are at 25 ° C (77 ° F)

Voltage (4 differential input channels)

Voltage range	Auto ranging between 20-300; 300-600 V ac/V dc scales, true RMS through 63rd harmonic
Voltage accuracy	±0.25% of reading ±0.05% of range through 63rd harmonic

Crest factor

Voltage	3.5 limited to 1500 V peak (does not include impulse)
Current	1.4 of full scale at peak input

Current (5 channels)

Current resolution	0.1% of full scale
Current accuracy	±0.25% of reading ±0.05% of range through 63rd harmonic, plus the current probe accuracy Current channels receive 0 to 1 Volt RMS from probes

Frequency

Fundamental frequency	50 Hz or 60 Hz
Frequency response	dc to the 63rd harmonic with low pass anti-aliasing filter
Frequency resolution	0.01 Hz
Frequency accuracy	0.01 Hz at 60 Hz

Phase angle error

±1° referenced to first voltage channel at 60 Hz

Power supply

Primary input 90-600 V ac, 50/60 Hz, 100-600 V dc. Powered from channel 1 or auxiliary IEC computer-style power input

Battery (12 V backup battery included)

Battery recharge time	16 hours
Run through time	15 minutes, below 90 V ac/110 V dc cutoff. If recording, resume recording on power restoration
Data retention	10 years with nonvolatile, solid-state flash memory

Environmental

Operating temperature	-20 ° to +50 ° C (-4 ° to 122 ° F) ambient temperature
Humidity	Meets NEMA 4X, rain resistant; 90% non-condensing, not watertight
Case	NEMA 4X, (IP54), nonconductive, corrosion resistant, rain resistant, not submersible

Communications

RS232	3 wire up to 115200 baud rate, DB9 standard
Modem (optional)	Internal modem
External RS232 (optional)c	For serial port access to instrument data while front lid remains closed

Mechanical data

Dimensions	Portable - 330 x 254 x 152 mm (13 x 10 x 6 in.)
Weight	5.6 kg (15 lbs)

SPECIFICATIONS

Specifications are at 25 ° C (77 ° F)

Voltage (4 differential input channels)

Voltage range Three high voltage channels	Autoranging between 20 to 600 V ac/dc scales and low voltage channel autoranging between 0.1 to 350 V ac or V dc, true RMS through the 63rd harmonic
Voltage accuracy	±0.25% of reading ±0.05% of range through 63rd harmonic

Crest factor

Voltage	Limited to 1500 V peak (not including impulses) for high voltage channels Limited to 500 V peak for low voltage channel
Current	1.4 of full scale at peak input

Current (5 channels)

Current resolution	0.1% of full scale
Current accuracy	±0.25% of reading ±0.5% of range, plus the current probe accuracy Current channels receive 0 - to 1 V RMS from probes Current channel voltage 0.25% of reading, ±5 mV

Frequency

Fundamental frequency	20 Hz to 70 Hz autoranging via phase lock loop
Frequency response	dc to the 63rd harmonic with low pass anti-aliasing filter
Frequency resolution	0.01 Hz
Frequency accuracy	0.01 Hz at 60 Hz

Phase angle error

±1° referenced to first voltage channel at 60 Hz

Power supply

Primary Input 90-600 V ac, 50/60 Hz, 100-600 V dc. Powered from channel 1 or auxiliary IEC computer-style power input

Battery (12 V backup battery included)

Battery recharge time	16 hours
Run through time	If recording, 15 minutes when instrument power input falls below min. voltage level
Data retention	10 years with nonvolatile, solid-state flash memory

Environmental

Operating temperature	-20 °C to +50 °C (-4 °F to 122 °F) ambient temperature
Humidity	Meets NEMA 4X, rain resistant; 90% non-condensing, not watertight
Case	NEMA 4X, (IP54), nonconductive, corrosion resistant, rain resistant, not submersible

Communications

RS232	3 wire up to 115200 baud rate, DB9 standard
Wireless Raven modem	GPS

Mechanical data

Dimensions	Portable - 330 x 254 x 152 mm (13 x 10 x 6 in.)
Weight	5.6 kg (15 lbs)



PA9 Wireless

- Trends voltage, current, imbalance, power, energy, events, flicker (PST/PLT), THD, TDD, individual harmonics, and frequency
- Real-time, graphical display of harmonic content, power and source direction
- Wireless modem allows for remote analysis of data, remote data retrieval capabilities and remote unit configuration
- Intelligent download—preview and retrieve only the information of interest
- Remote communications and alarming capabilities. Poll the unit automatically or have it email you in case of an event

Description

The PA9 Wireless is the latest innovation of the successful PA9 Power Quality Analyzer platform. It incorporates enhanced key features including a wireless modem for remote communication, a full 12 MB of nonvolatile internal memory and standard auxiliary power input capabilities as well as an optional external flash card for added memory.

The PA9 Wireless is CE marked, supports several international languages, and adheres to applicable European and North American standards (EN50160, IEC61000-4-15, IEEE1159, IEEE519), including automatic phase lock loop synchronization of input frequencies ranging from 20 Hz to 70 Hz, flicker measurements and recording, and out of limits/frequency trending.

The wireless modem allows the user to configure the unit remotely, view real-time data via the remote screen, as well as preview all recorded data without downloading the data. The user can then choose what data they wish to download.

Disclaimer - The PA9 Wireless unit should be used for data analysis ONLY and NOT for real time monitoring and/or control applications.



The PA9Wireless is quick to install and easy to use. Everything needed to remotely monitor power and power quality is included in one package.



The PA9 Wireless incorporates both a Raven Cellular Modem and antenna built into the lid, providing easy, effective remote communications.



The unit on end shows the antenna extension from the lid. Also, when in this upright position, the PA9 Wireless is rain resistant to IP54.



Many additional new starter kit configurations have been created to meet customers evolving power measurement needs

Product

Order Code

Typical starter Kit includes PA9Plus (P9P00021-01000), English display, kit of four (4) fused voltage cables (CA-PA9-22) with crocodile clips and neutral jumpers, US auxiliary input charging cable, external data transfer memory adapter, external compact flash card, three (3) 600/6000CE current clamps, SC-PA9 soft sided carrying case, MEGPA9IEC software, and manual

SK-P9P-US-EN-1

For additional starter kit options (i.e. European versions) including IEC, CTs and voltage probes, contact your sales representative

ORDERING INFORMATION

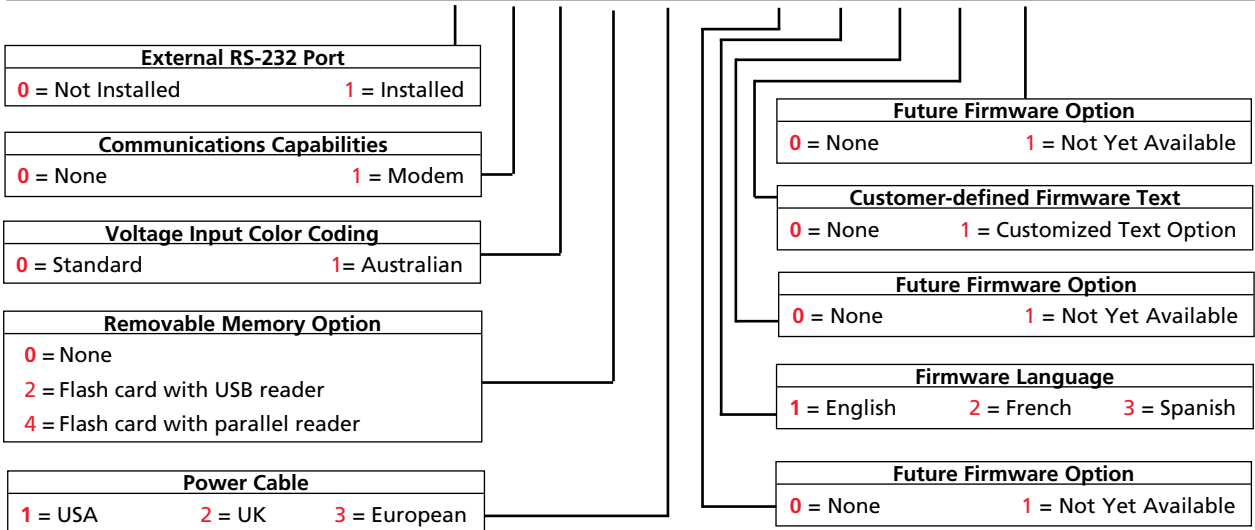
Order a PA9Plus or a PA9 Wireless configured to your specific application. To determine the catalog number, fill in the blanks below with the corresponding number from the detailed information boxes.

Ordering example:

To order a PA9Plus with the removable memory option, flash card with USB reader, English display, and US auxiliary power cord, request catalog number **P9P 0 0 0 2 1 - 0 1 0 0 0**

Fill in these blanks with the corresponding letter or number.

P9P 0 0 0 2 1 - 0 1 0 0 0



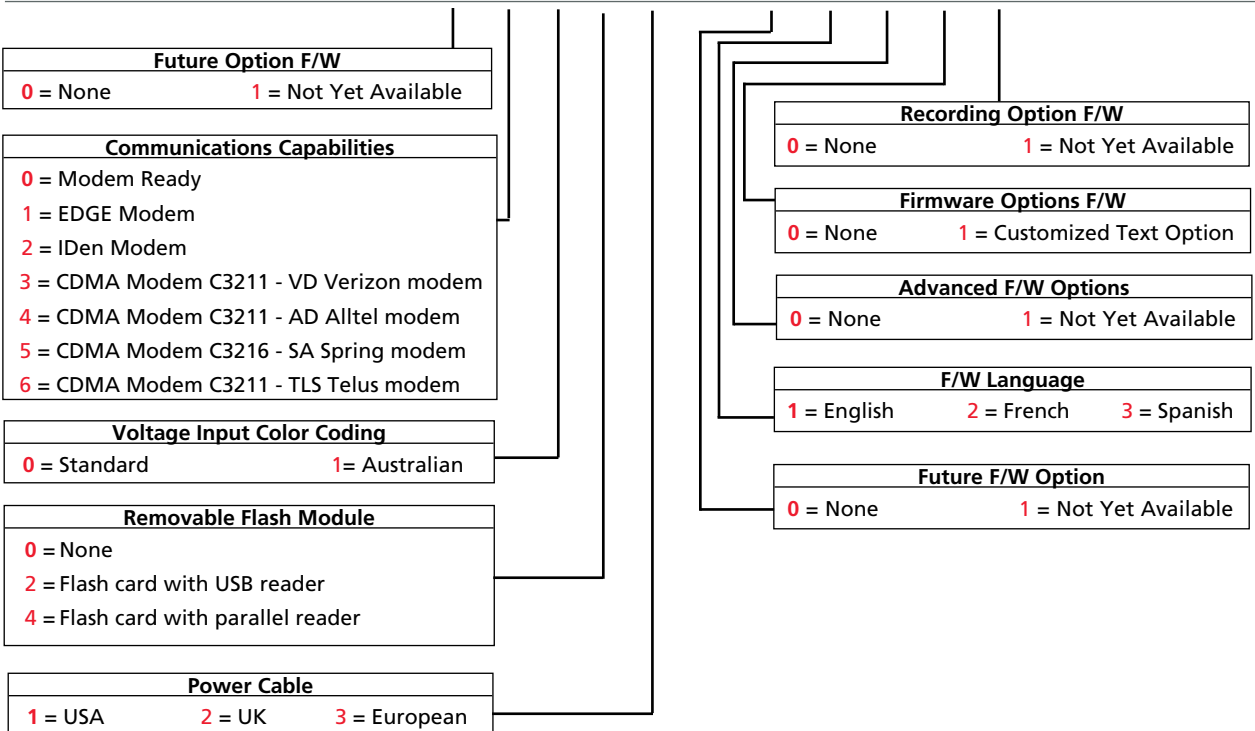
Note: Megger recommends using the Raven Wireless Modem. Megger does not guarantee unit compatibility with other brands.

Ordering example:

To order a PA9 Wireless with the Raven Modem and the removable memory option, flash card with USB reader, English display, and US auxiliary power cord, request catalog number **P9W 0 1 0 2 1 - 0 1 0 0 0**

Fill in these blanks with the corresponding letter or number.

P9W 0 1 0 2 1 - 0 1 0 0 0





MDP series

- Choice of three models that record currents up to 1000 amps, with an additional 200 amp over-range
- Waveform capture and harmonic analysis up to the 32nd order
- Power and power factor
- Accurate data capture via advanced MDP software
- Lightweight, durable unit housed in a weatherable urethane case
- Sturdy battery compartment with easy plug-in access for quick data retrieval

Description

The MDP series of distribution profilers provides power utilities with the most accurate and extensive information ever to precisely evaluate loading on feeders/overhead lines and to identify needed upgrades or replacement. Three different models range from a simple “current-only” version to the most advanced unit that offers a number of user-requested features. Each MDP can be easily upgraded to the next model at any time.

MDP1 (basic)

- Records actual current RMS magnitude up to 1000 amps, with an additional 200 amp over-range

MDP2 (mid range)

Records:

- Actual current RMS magnitude up to 1000 amps, with an additional 200 amp over-range
- Power factor and power

SPECIFICATIONS

All specifications at 25 °C unless otherwise specified

Conductor size	.5 cm to 3.0 cm (0.2 in. to 1.2 in.) cable outside diameter
Current range	10 to 1000 A : 1% ±2 A
Conductor voltage	4 kV to 35 kV
Data retention	10 years with no power
Real time clock accuracy	0.005% over one year

Environmental

Operating temperature	-40 °C to +60 °C (-40 °F to +140 °F)
Storage temperature	-50 °C to +85 °C (-58 °F to 185 °F)
Operating humidity	0 to 90% noncondensing
Storage humidity	0 to 95% noncondensing

Safety

IEC 61010	
EMF	IEC 61326:2002
Storage temperature	-25 °C to 65 °C
Ingress protection	IP54

Power supply

Battery	4 commercial “AA” batteries. For extended temperature applications (below 0° and above +40 °C) Lithium high range “AA” batteries are recommended
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Mechanical data

Dimensions	30 x 13 x 8 cm (12 H x 5 L x 3 W in.)
Weight	2.1 kg (4.6 lbs)

MDP3 (advanced)

Records:

- Actual current RMS magnitude up to 1000 amps, with an additional 200 amp over-range
- Current and relative voltage waveforms
- Power factor and power
- Harmonics
- THD (Total Harmonic Distortion)

System planners, distribution engineers and troubleshooters can easily access, review and record (via a date and time stamp) the following:

- Peak load value/time growth studies
- Phase/load imbalance surveys
- Time/day fluctuation analysis
- Capacitor bank placement analysis



ORDERING INFORMATION

Product	Order Code	Product	Order Code
Single channel 1000 Amp distribution profiler CE approved; isolated, single channel recording profiler for distribution line primary up to 35 kV ac. Hot-stick mountable. Unit records time stamped values of current magnitude with 1 amp resolution for days, weeks or months depending upon data storage interval. True RMS through the 50th harmonic.	MDP1	"AA" battery (4 required)	23415
Single channel 1000 Amp distribution profiler CE marked; in addition to the same features as the MDP1, this unit also records power and power factor	MDP2	Metrosoft software for Windows 32-bit applications software for IBM and compatible computers. Programs unit, provides data retrieval, generates graphs, reports and data files, compatible with Excel software, and saves recorder setup files. Compatible with Windows NT, WIN2000 and XP	36175-1
Single channel 1000 Amp distribution profiler CE marked; in addition to the same features as the MDP2, this unit also records current and relative voltage waveforms, THD data as well as harmonic data through the 32nd harmonic	MDP3	Instruction manual	AVTMMDP
Note: An RS-232 computer interface cable or USB cable and AC adapter are required for individual units.		Starter Kits	
Included accessories		Consists of 3 MDP1 Profilers, (1) AC adapter, (1) nylon carrying case, Phase ID label kit, (1) RS-232/com port cable, (1) USB 2.0 A-B cable, (12) "AA" batteries, Metrosoft software, (1) instruction manual	SK-MDP1
Battery holder	36164	Same as SK-MDP1 except includes 3 MDP2 Profilers instead of MDP1 Profilers	SK-MDP2
RS-232/com port cable	CA-RS232	Same as SK-MDP1 except includes 3 MDP3 Profilers instead of MDP1 Profilers	SK-MDP3
Nylon carrying case for up to three Profilers and accessories	36133		
Phase ID label kit; includes 2 sets of 3 labels, Alpha A, B & C / Numeric 1, 2 & 3	35863		
USB 2.0 A-B cable	CA-USB		



MR-4

- Records voltage and current at the meter
- Ideal for split-phase residential and light commercial investigations
- Detects sags, swells, flicker, loose neutrals and harmonics
- Installs quickly and safely

Description

With more and more equipment and appliances emerging with sensitive electronics, power quality problems have found their way into homes and offices. The MR-4 Meter Adapter Recorders provide a powerful tool to track down these problems. They are ideal for split-phase residential and light commercial power quality monitoring.

The MR-4 simultaneously records the two line currents in addition to the two line voltages, as well as computes the line to line voltage and neutral current. They are digital recorders totally contained in a standard universal ring or ringless type meter adapter.

The MR-4 records voltage and current at the meter. It is installed quickly and safely. There are no external boxes or connections, and no customer panel boxes left open.

SPECIFICATIONS

Input channels

L1-N/L2-N (L1-L2 computed)	2 voltage, 2 current L1 & L2 (neutral current computed)
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Range

Voltage	50-150 V RMS line to neutral; 250 V peak line to neutral
Current	5-200 A RMS/Phase; 350 A
Peak	200 A max. continuous without damage

Sample rate

256 samples/cycle per channel (DSP Based)
 Statistics stored: min/True rms/max for voltage and current per storage interval with cycle resolution, 65 microsec event detection, flicker event detection.

Accuracy and resolution

Voltage accuracy	±0.35% of reading
Voltage resolution	0.1 V AC
Current accuracy (MR-4 only)	0.1 Amp
Real time clock	0.01%

Software

Metrosoft® 32-bit software for Windows

Graphs	Voltage/current with zooming etc.
Reports	Tabular, event (swell, sag, flicker) regulation table and histogram

Power

Battery backup	Sealed lead acid battery
Run-through time	2 minute below 180 V cutoff. Resume recording on power restoration
Data retention	14 days with fully charged battery. Battery charges from L1-L2 voltage
Min. charging voltage	180 V AC

Display

4 digit, 7 segment LED display inside meter adapter. Display continuously scrolls through VL1, VL2, countdown time

Recording

Manual (slide switch inside meter adapter), scheduled run, voltage present, current present, auto-stop, delayed start

Environmental

Operating temperature	-30 °C to +65 °C (-22 °F to +149 °F)
Ingress protection	Weathertight when meter is reinstalled and sealed

ORDERING INFORMATION			
Product	Order Code	Product	Order Code
<p>Four channel recorder (2 voltage/2 current) for split phase service (120/240 V). DSP and flash PROM based. This recorder is totally self-contained within a universal ring/ringless meter adapter for forms 2S, 12S, 25S. Samples at 256 samples/cycle, has integral internal display and external indicating LEDs to indicate recording status, suspected loose neutral, flicker event and surge/sag event. Also, calculates L1-L2 voltage and neutral current. Captures 65 microsecond voltage and current events. Isolated RS-232 port facilitates viewing real time data and retrieving data without removing recorder. Standard 128 KB memory stores 33,000 readings. Includes software for Windows 95/98/NT/2000, neutral blade, neutral clip lead and manual</p> <p>Options and accessories</p> <p>Metrosoft software for Windows 32-bit Windows applications software for IBM and compatible computers. Programs unit, provides data retrieval, generates graphs, reports and data files, compatible with:</p> <p>Lotus 1-2-3 and Excel software, and saves recorder setup files. Compatible with Windows NT and Windows 95, 98, Me, WIN2000</p>	MR-4	Fuse kit	EF-MR
		Neutral blade	NJ-MR
		Neutral clip lead	NL-MR
		Starter kits	
		Includes MR-4 meter adapter recorder, MM-MR-1 memory expansion and CC-MR nylon carrying case	SK-MR-4-01
		Same as SK-MR-4-01 plus DC-MR charger cable for car cigarette lighter and PS-MR external power supply	SK-MR-4-02
		Same as SK-MR-4-02 plus CA-MR optically isolated RS232 cable	SK-MR-4-03
		Same as SK-MR-4-03 plus MM-PQ power quality option and MM-PF power flow option	SK-MR-4-04
		Product kits	
		Includes (6) MR-4 meter adapter recorders, (6) MM-MR-1 memory expansion modules, (6) DC-MR charger cables, (3) PS-MR external power supplies, (1) CA-MR- RS232 computer interface cable and (6) CC-MR nylon carrying case	PK-MR4-6
		Includes (12) MR-4 meter adapter recorders, (12) MM-MR-1 memory expansion modules, (12) DC-MR charger cables, (6) PS-MR external power supplies, (1) CA-MR RS232 computer interface cable and (6) CC-MR nylon carrying case	PK-MR4-12
Memory module - 1 MB memory upgrade	MM-MR-1		
Computer interface cable - RS232 isolated (only 1 per computer required)	CA-MR		
Power quality option - captures waveforms based on time/event trigger. Requires MM-MR-1	MM-PQ		
Power flow option - records Watts, Vars, VA, power factor and other key power parameters. Available for MR-4 only	MM-PF		
External power supply- charges MR-4 from 120 V	PS-MR		
Nylon carrying case, soft-sided	CC-MR		
Charger cable with plug for car cigarette lighter	DC-MR		



SLM-8

- 3-phase voltage, current and flicker recorder
- Records for days, weeks or months
- Removable PCMCIA memory card option
- Creates detailed charts and reports
- Rugged and weatherproof design

Description

The SLM-8 is a low cost, 8-channel paperless recording volt-ammeter used for measuring and recording the true RMS values of up to four voltage channels and four current channels. It is the ideal investigative tool for utility troubleshooters, service investigation groups, meter shop technicians, and facility managers to identify and document the presence of three-phase and single-phase voltage complaints utilizing associated load current information to locate the source of the problem.

True RMS, minimum RMS, maximum RMS, and flicker information may be recorded. High-speed sampling indicates events as fast as one cycle the 4 line x 20 character display is backlit for easy viewing and an LED indicates when the unit is recording. The unit comes complete with a comprehensive graph/reporting package.

The loose neutral indication feature of the SLM-8 is for use on 3-wire split phase systems utilizing V1 and V2 in the calculations for loose neutral diagnosis. If a loose neutral problem is determined, a front-panel LED labeled "Loose Neutral" lights up and remains lit until cleared. Using ms-sl Metrosoft, the loose neutral analysis criteria can be changed as required.

SPECIFICATIONS

Number of channels	4 voltage, 4 current
Frequency	60 Hz
Sample rate (per channel)	1 sample per cycle

Recording response time

Rising inputs: to 86% of final value in one cycle (16.7 msec); to rated accuracy in three cycles (50 msec) max.
 Failing inputs: to 63% of final value in one cycle (16.7 msec); to rated accuracy in six cycles (100 msec) max.

Voltage input ranges	10 to 150 V, 30 to 300 V or 600 V, 720 V max.
Current input ranges	10, 100, 1000, 3000 A clamps, 600 V rated
Resolution	0.1 V on voltage channels; 0.1 A on current channels
Maximum crest factor	3.5 to 1 (limited to 1500 V peak)

Memory

120 KB (60,000 readings); expandable to 1 MB internal memory (512,000 readings) or up to 2 MB (1,000,000 readings) with removable memory card option

Real clock time	0.01% accuracy
Storage interval	Programmable from one cycle to 12 hours

Voltage accuracy

True RMS $\pm 1.0\%$ F.S. through 50th harmonic
 150 V FS unit: $\pm 0.3\%$ of reading ± 0.1 V full scale
 300 V FS unit: $\pm 0.3\%$ of reading ± 0.2 V full scale
 600 V FS unit: $\pm 0.3\%$ of reading ± 0.4 V full scale

Current accuracy	$\pm 0.3\%$ of reading ± 0.2 of full scale
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Display

4 line x 20 character backlit LCD. Three separate LEDs on face panel indicate recording, out-of-limit and loose neutral occurrences

Recording

Manual (slide switch inside meter adapter), Scheduled run, voltage present, current present, auto-stop, delayed start

Battery

Type	Internal lead acid, 6 V, 0.5 Ah, one hour minimum ride-through recording time on backup battery
Data retention	130 days after low battery condition
Charging time	5 hours at 100 V ac input

Minimum voltage for charging and self-powering

90 V ac on channel V1

Environmental

Operating temperature	-30 °C to +65 °C (-22 °F to +149 °F)
Case	NEMA 4X nonconductive corrosion resistant weatherproof case

Mechanical data

Dimensions	29.2 x 31.1 x 13.3 cm (11.5 x 12.3 x 5.3 in.)
Weight	8 kg (17.5 lbs)

ORDERING INFORMATION

Order a SLM-8 configured to your specific application. To determine the catalog number, fill in the blanks below with the corresponding number from the detailed information boxes.

Ordering Example:

To order SLM-8 base unit with cover, 60 Hz frequency, and 1 MB internal memory, request catalog number: SLM-8-0000-002.

Fill in these blanks with the corresponding number or letter.

SLM-8- X X X X - X X X

PCMCIA Card Adapter
0 = None 1 = Yes

Future Option
0 = Not yet available 1 = Not yet available

Future Option
0 = Not yet available 1 = Not yet available

Future Option
0 = Not yet available 1 = Not yet available

Memory
0 = 120 KB memory (60,000 readings)
1 = 500 KB memory (225,000 readings)
2 = 1 MB memory (500,000 readings)

Frequency
0 = 60 Hz only 1 = 50 Hz only

Cover
0 = Standard

Product

Order Code

Options and accessories

Starter Kits

Includes SLM-8, mm-sl-500 KB memory expansion to 500 KBytes, CA-232-01 RS-232 cable, (3) cp-1000WCE current clamps with (3) CA-PA9-7 CT adapter cables and SC-PA9 soft-sided carry case. Includes software for Windows 95/98/NT/2000

SK-SLM-8-01

Includes SLM-8, mm-sl-500 KB memory expansion to 500 KBytes, CA-232-01 RS-232 cable, (3) cp-1000WCE current clamps, (3) cp-20CE current clamps, (6) CA-PA9-7 CT adapter cables and SC-PA9 soft-sided carry case. Includes software for Windows 95/98/NT/2000

SK-SLM-8-02

Integral PCMCIA card adapter for Type 1/SRAM cards.

Maximum internal memory allowed with this option is base 120 KB

MA-SL

Memory options

PCMCIA card; 1 MB (512,000 readings)

MCI-1MB

PCMCIA card; 2 MB (1,000,000 readings)

MCI-2MB

500 KB (225,000 readings)

MM-SL-500KB

1 MB (500,000 readings)

MM-SL-1MB

RS-232 computer interface cable

CA-232-01

Current input extender cable, 15 ft

CA-RA15E

Charging cable

CA-RVA4

Calibration kit

CK-RVA4

Fuse kit

EF-SL

Hardware restart shorting plug

HR-371

Soft-side nylon storage case

SC-PA9

Metrosoft for Windows software: 32-bit application software for IBM and compatible computers.

Programs recorder; provides data retrieval; generates charts, reports and data files; compatible with spreadsheet software; saves recorder setup files.

Compatible with windows 95/98/NTV4.0+/2000/ME. Includes manual.

35173-1



Current transformers

- Used with the PA-9Plus and other data recorders
- Available in a flexible or clamp-on option
- A number of lengths and sizes for all power measurement needs
- Special rain tight CT allows for functionality in outside environments
- Easy to use and install

Description

The SLM-8 is a low cost, 8-channel paperless recording volt-ammeter used for measuring and recording the true RMS values of up to four voltage channels and four current channels. It is the ideal investigative tool for utility troubleshooters, service investigation groups, meter shop technicians, and facility managers to identify and document the presence of three-phase and single-phase voltage complaints utilizing associated load current information to locate the source of the problem.

True RMS, minimum RMS, maximum RMS, and flicker information may be recorded. High-speed sampling indicates events as fast as one cycle. The 4 line x 20 character display is backlit for easy viewing and an LED indicates when the unit is recording. The unit comes complete with a comprehensive graph/reporting package.

The loose neutral indication feature of the SLM-8 is for use on 3-wire split phase systems utilizing V1 and V2 in the calculations for loose neutral diagnosis. If a loose neutral problem is determined, a front-panel LED labeled "Loose Neutral" lights up and remains lit until cleared. Using Metrosoft, the loose neutral analysis criteria can be changed as required.

Cat. No.	Current range	Measurement range	Frequency range	Max. working voltage	Accuracy	Phase shift
CP-600DC	600 A	1 to 400 A ac (600 A peak) 1 to 600 A dc	dc to 10 kHz @ -3 dB	600 V rms	1.5% of rdg ±1 A (1 to 100 A) 2% of rdg (100 to 400 A) 2.5% of rdg (400 to 600 A dc only)	10 to 200 A: ≤2.5° 200 to 400 A: ≤2° 45 to 65 Hz
CP-600/6000CE	600/6000 A, switchable	20 to 6000 A	40 Hz to 20 kHz	600 V rms	1% of rdg ±200 mA	<0.7° @ 50 Hz
CP-600/6000RT	600/6000 A, switchable	20 to 6000 A	40 Hz to 5 kHz	600 V rms	1% of rdg ±200 mA	<0.7° @ 50 Hz
CP-6000B7	600/6000 A, switchable	20 to 6000 A	40 Hz to 5 kHz	1000 V rms	1% of rdg ±200 mA	<1° @ 50 to 60 Hz
CP-100/1000CE	100/1000 A, switchable	10 to 1000 A	40 Hz to 20 kHz	600 V rms	1% of rdg ±200 mA	0.7° @ 50 to 60 Hz
CP-100/1000RT	100/1000 A, switchable	10 to 1000 A	40 Hz to 5 kHz	1000 V rms	1% of rdg ±200 mA	0.7° @ 50 to 60 Hz
CP-1000WCE	1000 A	10 to 1000 A	30 Hz to 5 kHz	600 V rms	Accuracy @ .1 to 10 A ≤ 3% of rdg ±0.1A, Accuracy @ 10 to 100 A ≤0.75% of rdg ±0.25 A Accuracy @ 100 to 1200 A ≤0.5% of rdg ±0.5A	0.01 to 10 A not specified, 10 A ≤3°, 50 A ≤1.5°, 200 A ≤0.75°, 1000 A ≤0.5°
CP-100CE	100 A	1 to 100 A	40 Hz to 10 kHz	600 V rms	Accuracy @ 0.1 to 1 A ≤2% of rdg ±0.2 A, Accuracy @ 10 to 80 A ≤1% of rdg ±0.2A, Accuracy @ 80 to 150 A ≤1.5% of rdg ±0.2 A	0.01 to 1 A not specified, 1 to 20 A ≤3°, 20 to 100 A ≤2°
CP-300/3000CE	300/3000 A, switchable	10 to 3000 A	40 Hz to 20 kHz	1000 V rms	1% of rdg ±200 mA	<0.7° @ 50 to 60 Hz
CP-300/3000RT	300/3000 A, switchable	10 to 3000 A	40 Hz to 5 kHz	1000 V rms	1% of rdg ±200 mA	<0.7° @ 50 to 60 Hz
CP-20CE	20 A	0.1 to 20 A	40 Hz to 10 kHz	600 V rms	Accuracy @ 0.1 to 1 A ≤2.5% of rdg, Accuracy @ 1 to 20 A ≤1% of rdg	0.1 to 1 A ≤5°, 1 to 20 A ≤3°
CP-5CE	5 A	0.1 to 10 A	40 Hz to 3 kHz	600 V rms	1% of rdg ±5 mV	1 to 5 A 1°, 5 to 10 A 1.5°



Current probe
CP-600/6000CE
CP-300/3000CE
CP-100/1000CE



Current clamp
CP1000WCE



Current clamps
CP-5CE
CP-20CE
CP-100CE



Rain tight current probe
CP-600/6000RT
CP-300/3000RT
CP-100/1000RT
CP-6000B7

Specifications and ordering information

Cat. No.	Output signal	Crest factor (Mid-range)	Rain tight	Battery powered	Style	Length	Inside dia, max	Adapter requirements (No adapter needed with PA-9 or PA-9Plus)
CP-600DC	1 mV/A	ac: 3.3 dc: 2.5		9 V alkaline (approx. 80 hrs)	Clamp	9 ft cable	2 in.	CA-PA9-7 to use probes with PA7, SLM-8, RVA4, RA recorders
CP-600/6000CE	1 mV/A, 0.1 mV/A	4.5		N/A	Flexible	36 in. coil	12 in.	CA-PA9FCP-7 to use up to 4 probes with PA7, SLM-8, RVA4, RA recorders
CP-600/6000RT	1 mV/A, 0.1 mV/A	4.5	■	N/A	Flexible	36 in. coil	12 in.	CA-PA9FCP-7 to use up to 4 probes with PA7, SLM-8, RVA4, RA recorders
CP-6000B7	1 mV/A, 0.1 mV/A	10	■	9 V (2000 hrs. min.)	Flexible	36 in. coil	12 in.	CA-PA9-7 to use probes with PA7, SLM-8, RVA4, RA recorders
CP-100/1000CE	10 mV/A, 1 mV/A	9		N/A	Flexible	36 in. coil	12 in.	CA-PA9FCP-7 to use up to 4 probes with PA7, SLM-8, RVA4, RA recorders
CP-100/1000RT	10 mV/A, 1 mV/A	9	■	N/A	Flexible	36 in. coil	12 in.	CA-PA9FCP-7 to use up to 4 probes with PA7, SLM--8, RVA4, RA recorders
CP-1000WCE	1 mV/A	9		N/A	Clamp	9 ft cable	2 in.	CA-PA9-7 to use probes with PA7, SLM-8, RVA4, RA recorders
CP-100CE	10 mV/A	3		N/A	Clamp	9 ft cable	.78 in.	CA-PA9-7 to use probes with SLM-8, RVA4, RA recorders
CP-300/3000CE	10 mV/A, 1 mV/A	3		N/A	Flexible	36 in. coil	12 in.	CA-PA9FCP-7 to use up to 4 probes with PA7, SLM-8, RVA4, RA recorders
CP-300/3000RT	10 mV/A, 1 mV/A	3	■	N/A	Flexible	36 in. coil	12 in.	CA-PA9FCP-7 to use up to 4 probes with PA7, SLM-8, RVA4, RA recorders
CP-20CE	50 mV/A	3		N/A	Clamp	9 ft cable	.78 in.	CA-PA9-7 to use probes with PA7, SLM-8, RVA4, RA recorders
CP-5CE	200 mV/A	3		N/A	Clamp	9 ft cable	12 in.	CA-PA9-7 to use probes with PA7, SLM-8, RVA4, RA recorders



Adapter C/N CA-PA9FCP-7, shown, is used with up to four probes with the PA7, SLM-8, RVA4 and RA recorders. Used with the following CTs:
 CP-600/6000CE
 CP-300/3000CE
 CP-100/1000CE
 CP-600/6000RT
 CP-300/3000RT
 CP-100/1000RT



Adapter C/N CA-PA9-7, shown, is used with a probe with the PA7, SLM-8, RVA4 and RA recorders. Used with the following CTs:

- CP-6000B7
- CP-600DC
- CP-5CE
- CP-20CE
- CP-1000CE
- CP-1000WCE



Current clamp
CP-600DC



Battery Test

Battery testing is crucial to ensure a battery system provides standby and emergency power to operate devices such as lighting, UPS systems, operating controls, switchgear components, protective relays and continuous process systems. Failure of a battery system within environments such as utilities, hospitals and manufacturing plants can result in operational failure of the devices connected to it.

With both capacity and impedance testers available, Megger can provide a battery tester tuned to your specific need.

5

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SELECTION GUIDE

	TOR KEL 820	TOR KEL 840	TOR KEL 860	BGFT	BITE2	BITE2P	BITE3	ProActive	TOR KEL Win	PowerDB
Capacity tester	■	■	■							
Impedance tester					■	■	■			
Software								■	■	■
DC ground fault tracer				■						
Tests most cell types	■	■	■		■	■	■			
Tests cell impedance							■			
Internal ohmic test							■			
Cell voltage test							■			
Float current test							■			
Intercell connection resistance test							■			
Ripple current							■			
Online test	■	■	■		■	■	■			

WHY BATTERIES ARE NEEDED

Batteries are used to ensure that critical electrical equipment is always on. There are so many places that batteries are used it is impossible to list them all. Some of the applications for batteries include:

- Electric generating stations and substations for protection and control of switches and relays
- Telephone systems to support phone service, especially emergency services
- Industrial applications for protection and control
- Back up of computers, especially financial data and information
- “Less critical” business information systems

Without battery back-up hospitals would have to close their doors until power is restored. But even so, there are patients on life support systems that require absolute 100% electric power. For those patients, failure is not an option.

The many blackouts of recent years around the world show how critical electrical systems have become to sustain our basic needs. Batteries are used extensively and without them many of the services that we take for granted would fail and cause innumerable problems.

Why test battery systems

There are three main reasons to test battery systems:

- To insure the supported equipment is adequately backed-up
- To prevent unexpected failures
- To forewarn/predict death

And, there are three basic questions that battery users ask:

- What are the capacity and the condition of the battery now?
- When will it need to be replaced?
- What can be done to improve / not reduce its life?

Batteries are complex chemical mechanisms. They have numerous components from grids, active material, posts, jar and cover, etc. — any one of which can fail. As with all manufacturing processes, no matter how well they are made, there is still some black art to batteries (and all chemical processes).

A battery essentially is two dissimilar metallic materials in an electrolyte. In fact, you can put two coins made from dissimilar metals in a citric fruit such as a lemon and have a battery. Obviously, an industrial battery is more sophisticated than a lemon battery. Nonetheless, a battery, to work the way it is supposed to work must be maintained properly. A good battery maintenance program may prevent, or at least, reduce the costs and damage to critical equipment due to an ac mains outage.

Even though there are many applications for batteries, they are installed for only two reasons:

- To protect and support critical equipment during an ac outage
- To protect revenue streams due to the loss of service

The following discussion about failure modes focuses on the mechanisms and types of failure and why impedance works so well at finding weak cells. Below is a section containing a more detailed discussion about testing methods and their pros and cons.

Why batteries fail

In order for us to understand why batteries fail, a little bit of chemistry is needed. There are two main battery chemistries used today — lead-acid and nickel-cadmium. Other chemistries are coming, like lithium, which is prevalent in portable battery systems, but not stationary systems yet.

Volta invented the primary (non-rechargeable) battery in 1800. Planté invented the lead-acid battery in 1859 and in 1881 Faure first pasted lead-acid plates. With refinements over the decades, it has become a critically important back-up power source. The refinements include improved alloys, grid designs, jar and cover materials and improved jar-to-cover and post seals. Arguably, the most revolutionary development was valve-regulation. Many similar improvements in nickel-cadmium chemistry have been developed over the years.

Assault on batteries

In this electricity-dependent age, batteries are extremely important, not least as a source of power when mains supplies are unavailable. For example, in hospital, who would want to be in the middle of an operation when a power failure occurred and no back-up supply was available? It is no exaggeration to say that it would be hard for us to survive without battery back up.

All batteries use chemical reactions to make electricity, and all comprise two dissimilar metallic materials in a current-carrying medium. In lead-acid batteries, the metallic materials are lead and lead oxide in a sulphuric acid medium. Nickel-cadmium (NiCd) batteries use nickel and cadmium compounds in a potassium hydroxide medium.

Nickel metal hydride (NiMH) batteries use the same nickel compound as NiCd cells, but the cadmium compound is replaced with a metallic hydride and the liquid electrolyte is replaced with a paste. NiMH and NiCd cells are virtually identical in performance; even their voltages are the same. For the purposes of stationary battery testing, however, this article focuses on lead-acid batteries.

How do we know if lead-acid batteries are good or bad? The traditional approach of testing only the voltage and specific gravity doesn't work - never has and never will! The reasons are explained later in this article. Nevertheless, it is still possible to evaluate the performance and condition of a battery by well planned testing.

Battery tests

Some users carry out no battery testing, which is not a good idea assuming the battery support is needed. Others carry out comprehensive, time-consuming and expensive exercises involving virtually every available test. In most cases, this is an equally bad idea.

Routinely available battery tests involve measuring float voltage, specific gravity, float current, ripple current, cell temperature, ambient temperature, discharge current and time, inter-cell connection resistance, capacity and impedance. Let us examine these in more detail.

Float voltage

Measuring float voltage (the voltage at the battery's terminals while it is on charge) can be misleading. Float voltage is undoubtedly important and, if it is abnormal, there is a need for further investigation. If it is normal, however, it indicates nothing at all about the battery's condition, although it does probably confirm that the charger is functioning properly!

Specific gravity

Similar comments apply to measuring the specific gravity of the electrolyte. Sulphate is part of the electrochemical reaction. If the battery is discharged, some of the sulphate migrates to the plates and the electrolyte's specific gravity falls. If the battery is fully charged, all of the sulphate is in the electrolyte and the specific gravity is normal.

There are no studies which indicate any correlation between specific gravity and battery capacity. In fact, the American IEEE 450 standard has de-emphasised specific gravity measurements to the point where it now only requires that 10% of the batteries should have their specific gravity checked each quarter, with the full bank checked annually.

Float current

In order to keep a battery charged, there is a balance between the battery's self-discharge and the action of the charger. The battery is always in a state of self-discharge which means that there is always a difference in EMF between the battery bank and the charger. This difference allows a small current (the float current) to flow to keep the battery fully charged.

The passage of the float current through the battery generates heat. In ordinary flooded lead-acid batteries, this is unlikely to be a problem, as evaporation of the electrolyte keeps the battery cool.

However, many modern batteries are of the valve-regulated lead acid (VRLA) type. These have no surplus electrolyte, nor is their electrolyte in a free liquid form. Therefore, if the float current in a VRLA battery increases because of an impending failure or because of overcharging, the battery temperature increases.

This increase in temperature allows more current to flow, which further increases the temperature of the battery. The result is thermal runaway, which may ultimately result in the battery melting. The interval between the initial increase in float current and the onset of thermal runaway is typically between one and four months. For this reason, regular measurement of float current in VRLA batteries is essential.

Ripple current

Chargers convert AC from the mains supply into the DC needed to charge the battery. This conversion process is not perfect, however, and in all practical charges, residual AC appears at the charger output. This is the ripple current and it can, if necessary, be reduced by the use of filters.

Ripple current generally increases slowly over time as the electronic components in the charger degrade. If, however, a rectifier diode fails in the charger, the ripple current can double instantly. An increase in ripple current above about 5 A RMS for every 100 Ah of battery capacity (5%) leads to increased temperature and shortened battery life. Ripple current is, therefore, another parameter that should be measured regularly.

Temperature

High temperatures do not spell immediate doom for batteries, but they can lead to premature failure. For every increase of 10 °C, battery life is halved. This then means that a 20 year battery maintained at 30 °C instead of the specified 20 °C will only last about ten years. This can be a significant consideration where banks of batteries in, for instance, a large UPS system are concerned.

Discharge current and time

Discharge current and time measurements are being used more frequently in on-line monitors as an aid to determining the amounts of energy removed from and fed into a battery. These measurements, at least in theory, allow the battery capacity to be calculated.

Inter-cell connection resistance

Measurement of inter-cell connection resistance is an essential test, as it has been said that more than 50% of battery bank failures are due to loose inter-cell connectors. Inter-cell connections loosen due to the heating and cooling cycles caused by discharging and recharging. The cell terminal posts expand and contract and, as the

lead from which they are made is very malleable, they cold flow with each cycle.

With the aid of a low-resistance ohmmeter, measuring inter-cell resistance is a straightforward test that can be done either on its own, or in conjunction with other tests.

Capacity

Capacity tests, also known as load tests, have long been seen as a necessary evil. Capacity testing with modern TOR KEL discharge battery testers is much more efficient and effective than they once were, but they are still time-consuming. They may also have limited predictive value, depending upon how frequently they are performed.

Let us consider a battery bank that is designed to provide eight hours of back up time. A proper capacity test requires a second battery to take over the duty of the battery under test if a supply failure occurs while the test is in progress. A resistive load bank is also needed, which is connected to the battery bank under test, along with voltage leads for each battery in the bank. It is quite usual for this preparatory work to take around a day.

On the second day, everything is ready for the eight-hour discharge test. Frequently, however, this is preceded by measurement of the inter-cell connection resistance. There are two schools of thought about this. The first is that the resistances measured will not be true as-found values. The second is that the resistance test is a useful aid to ensuring that no major malfunctions occur which could have been avoided. The arguments are finely balanced, leaving the final decision to individual battery users.

With the battery fully discharged on the second day of testing, the third day is occupied by recharging, and the removal of the test leads. Even with this modestly sized battery, therefore, the test has taken three days, and has involved the use of an expensive loadbank and alternate battery. That having been said, it cannot be denied that a properly conducted capacity test is the only guaranteed way of accurately determining the capacity of a battery bank and some TOR KEL battery testers will allow you to test the batteries while they are still in service.

Impedance

Impedance testing is a measure of the capability of a cell to deliver current. Impedance correlates with capacity and, although this correlation is not 100%, impedance testing is an excellent way of finding weak batteries in a bank.

In impedance testing, an AC voltage is applied to the battery and the resulting current flow is measured. With knowledge of this current and the applied AC voltage, Ohm's law can be used to calculate the battery impedance. Research has shown impedance to be inversely proportional to battery capacity.

This test is fast (typically taking around 30 minutes for a sub-station battery bank) and is non-invasive. It is, therefore, an invaluable alternative to capacity testing, provided that it is clearly understood to be an indirect measurement of capacity which can never offer the same degree of accuracy and certainty as is achieved with a conventional capacity test.

Data Analysis

Whatever testing regime is adopted, the result is sure to be a lot of data which, unless it is properly handled, is likely to lead to analysis paralysis. The recommended approach is to use a database to store

and trend the data, rather than relying on traditional paper forms and laborious manual comparisons.

A specialised database that stores all measured parameters is almost as important as the tests themselves in determining the condition of batteries and banks. For example, limits can be set on measured and calculated parameters. If these limits are chosen to reflect the user's required level of confidence in battery reliability, they can be a significant aid in getting the most from the battery and maximising its service life.

Conclusion

Batteries have many failure modes, but with careful use and regular testing, the probability of in-service failures can be reduced dramatically. Proper testing and data analysis can help determine when a battery should be replaced, as well as reducing the need for unplanned battery replacements, thereby aiding budgetary planning and cutting overall costs.

Finally, a well-implemented battery testing regime is a major step toward achieving the primary goal of every battery installation – that of providing dependable standby power whenever it is needed.

Ask for a copy of our Battery testing guide.



SPECIFICATIONS

Specifications TORKEL820

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +40 °C (32 °F to +104 °F)
Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE-marking

LVD 2006/95/EC
EMC 2004/108/EC

General

Mains voltage 100 – 240 V AC, 50/60 Hz
Power consumption 150 W (max)
Protection Thermal cut-outs, automatic overload protection

Dimensions

Instrument 210 x 353 x 700 mm
 (8.3" x 13.9" x 27.6")

Transport case 265 x 460 x 750 mm
 (10.4" x 18.1" x 29.5")

Weight 22.3 kg (49.2 lbs)
 40.4 kg (89.1 lbs) with accessories and transport case

Display LCD

Available languages English, French, German, Spanish, Swedish

Measurement section

Current measurement

Display range 0.0 – 2999 A
Basic inaccuracy ±(0.5% of reading +0.2 A)
Resolution 0.1 A

Internal current measurement

Range 0 – 270 A

Input for clamp-on ammeter

Range 0 – 1 V
mV/A-ratio Software settable, 0.3 to 19.9 mV/A
Input impedance >1 MΩ

Voltage measurement

Display range 0.0 – 60 V

Basic inaccuracy ±(0.5% of reading +0.1 V)
Resolution 0.1 V

Time measurement

Basic inaccuracy ±0.1% of reading ±1 digit



TORKEL820

- Lightweight
- Expandable system
- Rugged and reliable for field use
- Test without disconnecting the battery from the equipment it serves

Description

During a power outage, crucial telecommunication and radio equipment must be kept operating by batteries. However, the capacity of such batteries can drop significantly for a number of reasons before their calculated life expectancy is reached. Battery capacity should thus be checked to prevent expensive downtime in the event of a power failure.

The most reliable way to determine battery capacity is to conduct a discharge test. The TORKEL820 features a unique design that combines efficiency with portability. Using TORKEL820 you can discharge 24 and 48 V batteries at a current of 270 A, and 12 V batteries at 135 A. Moreover, two or more TORKEL820 units and/or extra load units, TXL, can be linked together if you need higher current. Discharging proceeds at constant current, constant power or constant resistance, or in accordance with a pre-selected load profile.

The TORKEL820 issues a warning and/or shuts down the test automatically when a) the voltage has dropped to a certain level, b) discharging has continued through a certain time interval or c) a certain amount of capacity has been dissipated.

Battery load unit

Load section

Battery voltage	10 – 60 V DC
Max. current	270 A
Max. power	15 kW
Load patterns	Constant current, constant power, constant resistance, current or power profile
Current setting	0-270.0 A (2999.9 A) ¹⁾
Power setting	0-15.00 kW (299.99 kW) ¹⁾
Resistance setting	0.1-2999.8 Ω
Battery voltage range	2 ranges, selected automatically at start of test
Stabilization (For internal current measurement)	±(0.5% of reading + 0.5 A)

	Battery voltage	Highest permissible current	Resistor element (Nominal values)
Range 1	10 – 27.6 V	270 A	0.069 Ω
Range 2	10 – 55.2 V	270 A	0.138 Ω

¹⁾ Maximum value for a system with more than one load unit

Inputs, maximal values

EXTERNAL CURRENT MEASUREMENT	1 V DC, 300 V DC to ground. Current shunt should be connected to the negative side of the battery
EXTERNAL CURRENT	
START/STOP	Closing/opening contact Closing and then opening the contact will start/stop Torkel. It is not possible to keep the contacts in closed position.
Delay until start	200 – 300 ms
Stop delay	100 – 200 ms
Battery	60 V DC, 500 V DC to ground
VOLTAGE SENSE	60 V DC, 500 V DC to ground
SERIAL	15 V
ALARM	250 V DC 0.28 A 28 V DC 8 A 250 V AC 8 A

Outputs, maximal values

START/STOP	5 V, 6 mA
TXL	Relay contact
SERIAL	<15 V
ALARM	Relay contact

Discharging capacity, examples

12 V battery (6 cells) ²⁾

Final voltage	Constant current	Constant power
1.80 V/cell (10.8 V)	0 – 121 A	0 – 1.31 kW
1.75 V/cell (10.5 V)	0 – 117 A	0 – 1.23 kW
1.67 V/cell (10.0 V)	0 – 110 A	0 – 1.10 kW

24 V battery (12 cells) ²⁾

1.80 V/cell (21.6 V)	0 – 270 A	0 – 5.8 kW
1.75 V/cell (21.0 V)	0 – 266 A	0 – 5.59 kW
1.60 V/cell (19.2 V)	0 – 241 A	0 – 4.63 kW

48 V battery (24 cells) ²⁾

1.80 V/cell (43.2 V)	0 – 270 A	0 – 11.6 kW
1.75 V/cell (42.0 V)	0 – 270 A	0 – 11.3 kW
1.60 V/cell (38.4 V)	0 – 259 A	0 – 9.9 kW

²⁾ 2.15 V per cell when test starts

Specifications TXL830/850

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +40 °C (32 °F to +104 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE-marking

LVD 2006/95/EC

EMC 2004/108/EC

General

Mains voltage 100 – 240 V AC, 50/60 Hz

Power consumption 75 W (max)

Protection Thermal cut-outs, automatic overload protection

Dimensions

Instrument 210 x 353 x 600 mm
(8.3" x 13.9" x 23.6")

Transport case 265 x 460 x 750 mm
(10.4" x 18.1" x 29.5")

Weight 13 kg (28.7 lbs)
21.4 kg (47.2 lbs) with transport case

Cable sets for TXL830/850 2 x 3 m (9.8 ft), 70 mm², 270 A, with cable lug. Max. 100 V. 5 kg (11 lbs)

Load section

	TXL830	TXL850
Max. voltage (DC)	28 V	56 V
Max. current	300 A	300 A
Max. power	8.3 kW	16.4 kW

Internal resistance, 3-position selector

Position 1	TXL830	TXL850
<i>Current</i>	0.275 Ω	0.55 Ω
100 A	at 27.6 V (12 x 2.3 V)	at 55.2 V (24 x 2.3 V)
78.5 A	at 21.6 V (12 x 1.8 V)	at 43.2 V (24 x 1.8 V)
50.1 A	–	–
39.2 A	–	–
Position 2	TXL830	TXL850
<i>Current</i>	0.138 Ω	0.275 Ω
200 A	at 27.6 V	at 55.2 V (24 x 2.3 V)
156 A	at 21.6 V	43.2 V (24 x 1.8 V)–
Position 3	TXL830	TXL850
<i>Current</i>	0.092 Ω	0.184 Ω
300 A	at 27.6 V	at 55.2 V (24 x 2.3 V)
235 A	at 21.6 V	43.2 A (24 x 1.8 V)
100 A	–	–
78.4 A	–	–

ORDERING INFORMATION

Product	Order Code
TORKEL820 Complete with: Cable set GA-00554 Transport case GD-00054	BS-49092
Optional accessories	
TORKEL Win PC software	BS-8208X
Extra loads TXL830	BS-59093
TXL850	BS-59095
Cable sets Cable set for TXL830 and TXL850 2 x 3 m, 70 mm ² , with cable lug. Max 100 V 270 A. Weight: 5.0 kg (11 lbs)	GA-00554
Sensing lead set Cable set for measuring voltage at battery terminals. 2 x 5 m (16.4 ft)	GA-00210
Clamp-on ammeters DC clamp-on ammeter, 200 A To measure current in circuit outside TORKEL	XA-12792
DC clamp-on ammeter, 1000 A To measure current in circuit outside TORKEL	XA-12790



Torkel840/860

- Batteries can be tested “in service”
- Unit adjusts to include load currents in the test parameters
- User adjustable alarm and shutdown points to avoid excessive discharge
- Easily expandable for larger battery banks using TXL extra load units
- View test parameters/results “real time” as testing progresses using TORKEl WIN software
- Easily save results to a PC for analysis, report generation and storage

Description

Batteries in power plants and transformer substations must provide the equipment they serve with standby power in the event of a power failure. Unfortunately, however, the capacity of such batteries can drop significantly for a number of reasons before their calculated life expectancy is reached. This is why it is so important to check batteries at regular intervals, and the most reliable way of measuring battery capacity is to conduct a discharge test.

TORKEl840 - UTILITY is used for battery systems ranging from 12 to 250 V – often encountered in switchgear and similar equipment. Discharging can take place at up to 110 A, and if higher current is needed, two or more TORKEl840 units or extra load units, TXL, can be linked together. Tests can be conducted at constant current, constant power, constant resistance or in accordance with a pre-selected load profile.

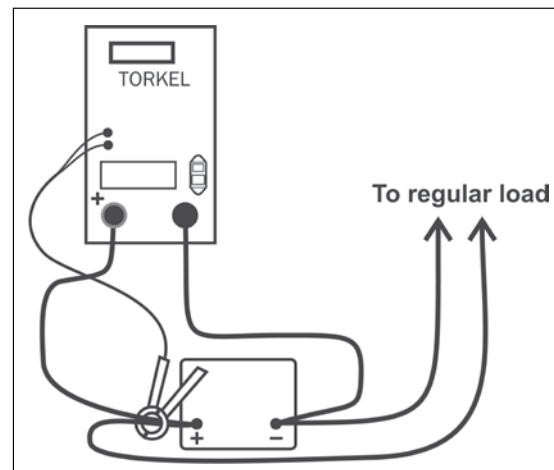
TORKEl860 - MULTI is designed primarily for people who travel from place to place to maintain battery systems having different voltages. It features excellent discharging capacity plus a broad voltage range and outstanding portability – a unique combination.

TORKEl860 is used for systems ranging from 12 to 480 V, and discharging can proceed at up to 110 A. If higher current is desired, two or more TORKEl860 units or extra load units, TXL, can be linked together. Discharging can take place at constant current, constant power, constant resistance or in accordance with a pre-selected load profile.

Application example

Testing can be carried out without disconnecting the battery from the equipment it serves. Via a DC clamp-on ammeter, TORKEl measures total battery current while regulating it at a constant level.

The TORKEl is connected to the battery, the current and the voltage alarm level are set. After starting the discharge TORKEl keeps the current constant at the preset level. When the voltage drops to a level slightly above the final voltage, TORKEl issues an alarm. If the voltage drops so low that there is a risk of deep discharging the battery, TORKEl shuts down the test. The total voltage curve and the readings taken at the end of the test are stored in TORKEl. Later, using the TORKEl Win program, you can transfer these readings to your computer for storage, printout or export. If your PC is connected to TORKEl during the test, TORKEl Win builds up a voltage curve on the screen in real time and displays the current, voltage and capacity readings. You can also control the test using TORKEl Win.



SPECIFICATIONS

Specifications TORKEL840/860

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +40 °C (32 °F to +104 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 100 – 240 V AC, 50/60 Hz

Power consumption (max) 150 W

Protection Thermal cut-outs, automatic overload protection

Dimensions

Instrument 210 x 353 x 700 mm
(8.3" x 13.9" x 27.6")

Transport case 265 x 460 x 750 mm
(10.4" x 18.1" x 29.5")

Weight 21.5 kg (47.4 lbs)
38 kg (83.8 lbs) with accessories and transport case.

Display LCD

Available languages English, French, German, Spanish, Swedish

Measurement section

Current measurement

Display range 0.0 – 2999 A

Basic inaccuracy ±(0.5% of reading +0.2 A)

Resolution 0.1 A

Internal current measurement

Range 0 – 270 A

Input for clamp-on ammeter

Range 0 – 1 V

mV/A-ratio Software settable, 0.3 to 19.9 mV/A

Input impedance >1 MΩ

Voltage measurement

Display range 0.0 – 60 V

Basic inaccuracy ±(0.5% of reading +0.1 V)

Resolution 0.1 V

Display range 0.0 – 500 V

Basic inaccuracy ±(0.5% of reading +1 V)

Resolution 0.1 V

Time measurement

Basic inaccuracy ±0.1% of reading ±1 digit

Load section

Max. battery voltage 288 V DC (TORKEL840)
480 V DC (TORKEL860)

Max. current 110 A

Max. power 15 kW

Load patterns Constant current, constant power, constant resistance, current or power profile

Current setting 0-110.0 A (2999.9 A) 1)

Power setting 0-15.00 kW (299.99 kW) 1)

Resistance setting 0.1-2999.8 Ω

Battery voltage range, TORKEL840 4 ranges, selected automatically at start of test

Battery voltage range, TORKEL860 5 ranges, selected automatically at start of test

Stabilization (For internal current measurement) ±(0.5% of reading +0.5 A)

	Battery voltage	Highest permissible current	Resistor element (Nominal values)
Range 1	10 – 27.6 V	110 A	0.165 Ω
Range 2	10 – 55.2 V	110 A	0.275 Ω
Range 3	10 – 144 V	110 A	0.55 Ω
Range 4	10 – 288 V	55 A	3.3 Ω
Range 5 2)	10 – 480 V	55 A (max power 15 kW)	3.3 Ω

1) Maximum value for a system with more than one load unit

2) TORKEL860

Inputs, maximal values

EXTERNAL CURRENT MEASUREMENT	1 V DC, 300 V DC to ground. Current shunt should be connected to the negative side of the battery
START/STOP	Closing/opening contact Closing and then opening the contact will start/stop Torkel. It is not possible to keep the contacts in closed position.
Delay until start	200 – 300 ms
Stop delay	100 – 200 ms
Battery	480 V DC, 500 V DC to ground
VOLTAGE SENSE	480 V DC, 500 V DC to ground
SERIAL	<15 V
ALARM	250 V DC 0.28 A 28 V DC 8 A 250 V AC 8 A

Outputs, maximal values

START/STOP	5 V, 6 mA
TXL	Relay contact
SERIAL	<15 V
ALARM	Relay contact

Battery load units

Discharging capacity, examples

12 V battery (6 cells)³⁾

Final voltage	Constant current	Constant power
1.80 V/cell (10.8 V)	0 – 50.0 A	0 – 0.54 kW
1.75 V/cell (10.5 V)	0 – 49.0 A	0 – 0.51 kW
1.67 V/cell (10.0 V)	0 – 46.0 A	0 – 0.46 kW

24 V battery (12 cells)³⁾

1.80 V/cell (21.6 V)	0 – 110 A	0 – 2.37 kW
1.75 V/cell (21.0 V)	0 – 110 A	0 – 2.31 kW
1.60 V/cell (19.2 V)	0 – 100 A	0 – 1.92 kW

48 V battery (24 cells)³⁾

1.80 V/cell (43.2 V)	0 – 110 A	0 – 4.75 kW
1.75 V/cell (42.0 V)	0 – 110 A	0 – 4.62 kW
1.60 V/cell (38.4 V)	0 – 110 A	0 – 4.22 kW

110 V battery (54 cells)³⁾

1.80 V/cell (97.2 V)	0 – 110 A	0 – 10.7 kW
1.75 V/cell (94.5 V)	0 – 110 A	0 – 10.4 kW
1.60 V/cell (86.4 V)	0 – 110 A	0 – 9.5 kW

120 V battery (60 cells)³⁾

1.80 V/cell (108 V)	0 – 110 A	0 – 11.9 kW
1.75 V/cell (105 V)	0 – 110 A	0 – 11.5 kW
1.60 V/cell (96 V)	0 – 110 A	0 – 10.5 kW

220 V battery (108 cells)³⁾

1.80 V/cell (194 V)	0 – 55 A	0 – 10.7 kW
1.75 V/cell (189 V)	0 – 55 A	0 – 10.4 kW
1.60 V/cell (173 V)	0 – 51.0 A	0 – 8.82 kW

240 V battery (120 cells)³⁾

1.80 V/cell (216 V)	0 – 55 A	0 – 11.9 kW
1.75 V/cell (210 V)	0 – 55 A	0 – 11.5 kW
1.60 V/cell (192 V)	0 – 55 A	0 – 10.5 kW

UPS battery (180 cells)³⁾ (TORKEL860)

1.70 V/cell (306 V)	0 – 38 A	0 – 15 kW
1.60 V/cell (288 V)	0 – 38 A	0 – 15 kW

UPS battery (204 cells)³⁾ (TORKEL860)

1.80 V/cell (367 V)	0 – 34 A	0 – 15 kW
1.60 V/cell (326 V)	0 – 34 A	0 – 15 kW

3) 2.15 V per cell when test starts

Specifications TXL850/870

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +40 °C (32 °F to +104 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity

5% – 95% RH, non-condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 100 – 240 V AC, 50/60 Hz

Power consumption 75 W (max)

Protection Thermal cut-outs, automatic overload protection

Dimensions

Instrument 210 x 353 x 600 mm (8.3" x 13.9" x 23.6")

Transport case 265 x 460 x 750 mm (10.4" x 18.1" x 29.5")

Weight 13 kg (28.7 lbs)
21.4 kg (47.2 lbs) with transport case

Cable sets

for TXL850 2 x 3 m (9.8 ft), 70 mm², 270 A, with cable lug. Max. 100 V. 5 kg (11 lbs)

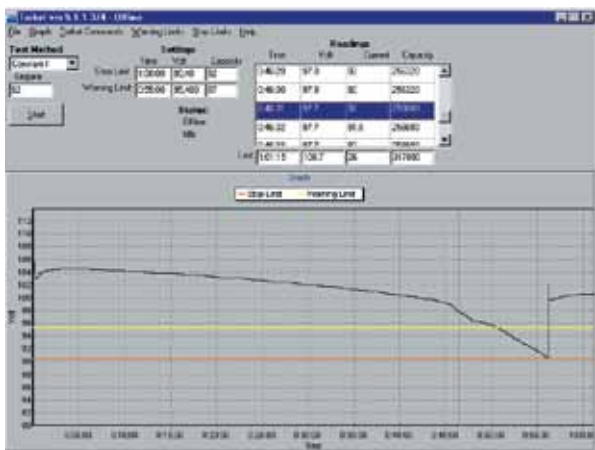
for TXL870 2 x 3 m (9.8 ft), 25 mm², 110 A, with cable clamp/lug. Max. 480 V. 3 kg (6.6 lbs)

Load section

	TXL850	TXL870
Max. voltage (DC)	56 V	140 V/ 280 V
Max. current	300 A	112 A at 140 V 56 A at 280 V
Max. power	16.4 kW	15.8 kW
Internal resistance, 3-position selector		
Position 1	TXL850	TXL870
<i>Current</i>	0.55 Ω	4.95 Ω
<i>100 A</i>	at 55.2 V (24 x 2.3 V)	–
<i>78.5 A</i>	at 43.2 V (24 x 1.8 V)	–
<i>50.1 A</i>	–	at 248.4 V (108 x 2.3 V)
<i>39.2 A</i>	–	at 194.4 V (108 x 1.8 V)
Position 2	TXL850	TXL870
<i>Current</i>	0.275 Ω	2.48 Ω
<i>200 A</i>	at 55.2 V (24 x 2.3 V)	–
<i>156 A</i>	43.2 V (24 x 1.8 V)–	–
Position 3	TXL850	TXL870
<i>Current</i>	0.184 Ω	1.24 Ω
<i>300 A</i>	at 55.2 V (24 x 2.3 V)	–
<i>235 A</i>	43.2 A (24 x 1.8 V)	–
<i>100 A</i>	–	at 124.2 V (54 x 2.3 V)
<i>78.4 A</i>	–	at 97.2 V (54 x 1.8 V)

TORKEl Win

The TORKEl Win program runs on a PC under Windows®, you can transfer readings to your computer for storage, printout or export. If your PC is connected to a TORKEl820 during the test, TORKEl Win builds up a voltage curve on the screen in real time and displays the current, voltage and capacity readings. You can also control the test using TORKEl Win.



ORDERING INFORMATION	
Product	Order Code
TORKEl840 Complete with: Cable set GA-00550 Transport case GD-00054	BS-49094
TORKEl860 Complete with: Cable set GA-00550 Transport case GD-00054	BS-49096
Optional accessories	
TORKEl Win PC software	BS-8208X
Extra loads TXL850	BS-59095
TXL890	BS-59097
Cable sets Cable set for TXL850 2 x 3 m, 70 mm ² , with cable lug. Max 100 V 270 A. Weight: 5.0 kg (11 lbs)	GA-00554
Extension cable set, 110 A 2 x 3 m, 25 mm ² . Max 480 V Weight: 3.0 kg (6.6 lbs)	GA-00552
Sensing lead set Cable set for measuring voltage at battery terminals. 2 x 5 m (16.4 ft)	GA-00210
Clamp-on ammeters DC clamp-on ammeter, 200 A To measure current in circuit outside TORKEl	XA-12992
DC clamp-on ammeter, 1000 A To measure current in circuit outside TORKEl	XA-12990



BGFT

- Easily locates ground faults in ungrounded dc systems
- Operates in high electrical noise environment
- Simplifies fault tracing by identifying fault characteristic (resistive and capacitive) magnitudes

Description

The battery ground fault tracer is an economical, easy-to-use instrument that identifies, traces and locates ground faults in ungrounded dc systems — on-line. It is particularly effective in high electrical noise environments, as the strength of the test signal can be adjusted.

The battery ground fault tracer accelerates fault location by eliminating trial-and-error procedures and because faults can be located without going off-line. It is particularly useful in any industry where supply of power for operating measurement, communication and control equipment is critical.

SPECIFICATIONS

Power source

Transmitter	120/240 V ac, 50/60 Hz, 200 VA max.
Receiver	One 9 V alkaline battery supplies up to 40 hours continuous

Source

Voltage	Variable from 0 to 50 V rms
Current	Load dependent from 0 to 1.7 A rms
Frequency	20 Hz, $\pm 2\%$

Fault resistance

1 k Ω to 399 k Ω at 50 V; bridge accuracy $\pm 10\%$

Line capacitance

0.01 to 11.1 μF ; bridge accuracy $\pm 20\%$

Display

Transmitter	Separate 3 digit LCD meters for volts and current
Accuracy	$\pm 5\%$
Receiver	Digital meter display up to 1.999 (three gain selections)

Mechanical data

Dimensions (Transmitter)	4 H x 9 W x 19 D cm (7.5 H x 18.5 W x 14.5 D in.)
Dimensions (Receiver)	4 H x 9 W x 19 D cm (1.5 H x 3.5 W x 7.5 D in.)
Weight (Transmitter)	15.9 kg (35 lb)
Weight (Receiver)	0.3 kg (0.66 lb)

ORDERING INFORMATION

Product	Order Code	Product	Order Code
Battery ground fault tracer, 120/240 V ac, 50/60 Hz, CE marked	246100B	User manual	AVTM 246100B
Included accessories			
Fused source leads, 6 m (20 ft) (1 pair)	29386-3	Optional accessories	
Current transformer, 5 cm (2 in.) with leads, 1.2 mm (4 ft) (1 pair)	29999-1	Mini-CT, 12 mm (0.5 in.) with 1.3 m (4.25 ft) lead	30595
AC power cord, 1.8 m (6 ft) (1)	17032	Transit case	BG-20001
Feedback cable, 12 m (40 ft) (1)	29998		
Padded accessory bag (1)	29996		
Battery, 9 volt (1)	1482-1		

SPECIFICATIONS

Transmitter

Supply voltage	100 to 130 V, 50/60 Hz, 200 VA max 210 to 250 V, 50/60 Hz, 200 VA max
Source output current	10 A nominal, 50/60 Hz operation

Maximum battery string test voltage

275 V dc at source lead terminals (section the battery if >275 V dc)

Display

Digital LCD meter	0 to 15 A
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Charger

Supply voltage	100 to 130 V, 50/60 Hz, 14 VA 210 to 250 V, 50/60 Hz, 14 VA
Output	6.50 V dc @ 1.10 A dc charging (max) 9.60 V dc open circuit

Receiver

Accuracy	ac impedance 5% +1 LSD dc voltage ±(0.5% of reading +1 LSD)
Precision	Better than 0.5% one sigma

Voltage range and resolution

1 to 2.500 V dc, 1 mV resolution
2.5 to 25.00 V dc, 10 mV resolution

Impedance range and resolution

0 to 1.000 mΩ, 1μΩ resolution
1 to 10.00 mΩ, 10μΩ resolution
10 to 100.0 mΩ, 0.1mΩ resolution

Setting time per reading

3 seconds maximum

Display

LCD, 2 x 16 characters

Supply

4.8 V dc, 800 mAh, quick charge nickel-cadmium battery pack

Battery pack life, full charge	5 hours continuous
Maximum cell/jar test voltage	25 V dc between receiver and potential probe

Safety

Conforms to the EMC Directive 2004/108/EC and the LVD Directive 2006/95/EC

Environmental

Operating temperature	0 °C to 40 °C (32 °F to 105 °F)
Storage temperature	-20 °C to 55 °C (-5 °F to 130 °F)
Humidity	20 to 90% RH, noncondensing

Mechanical data

BITE2 Transmitter	16.5 H x 35.6 W x 27 D cm (6.5 H x 14 W x 10.6 D in.)
BITE2P Transmitter	19 H x 47 W x 37 D cm (7.5 H x 18.5 W x 14.6 D in.)
Receiver (irregular shape)	
BITE2P	18 H x 29 W x 5 D cm (7.25 H x 11.25 W x 2 D in.)
Weight	
BITE2 Transmitter	7.7 kg (17 lb)
BITE2P Transmitter	8.2 kg (18 lb) alone, 14.5 kg (32 lb) packed
Receiver	0.7 kg (1.6 lb)



BITE2 and BITE2P

- Determines condition of lead acid and NiCd cells up to 7000 Ah
- On-board Pass/Warning/Fail indications
- Robust, repeatable instruments
- On-line testing
- Checks charger condition by measuring ac ripple current

Description

The BITE2 and BITE2P battery impedance test equipment determine the condition of lead-acid and nickel-cadmium cells up to 7000 Ah. An advanced feature set has been developed that includes Pass/Warning/Fail calculations based on a user-entered baseline value, advanced printing functions and more. The case of the BITE2P consists of both the transmitter and a carrying case for all of the standard accessories and some of the optional accessories, in an all-in-one unit. The BITE2 and its accessories fit into a sturdy canvas case with a shoulder strap.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
BITE2, 110/230 V ac, 50/60 Hz, CE marked	246002B		
BITE2P, 110/230 V ac, 50/60 Hz, CE marked	24600		
Included accessories			
Transmitter for BITE2	P30044-300		
Transmitter for BITE2P	P30044-100		
Receiver	P30620-3		
Source leads, 6 m (20 ft), fused	29386-2		
Current sensor, 50 mm (2 in.) opening with 1.5 m (5 ft) lead	33863		
CT extension cable, 6 m (20 ft)	33864-1		
Communication cable, 1.8 m (6 ft)	35340		
Charger cable	35341		
Thermal paper	26999		
ProActiv™ battery database management software	BI-9001		
ac line cord, 2.5 m (8 ft)	17032-7		
Canvas carrying case for BITE2	218746		
Manual for BITE2 and BITE2P	246004		
Accessory bag for BITE2	29996		
Optional accessories			
Current sensor 12 mm (0.5 in.) opening with 0.8 m (2.5 ft) lead		246034	
Current sensor, RopeCT™ 60 cm (24 in.) length		246050	
Current sensor, RopeCT™ 90 cm (36 in.) length		246051	
CT extension cable, 6 m (20 ft)		246033	
Current source leads, 3 m (10 ft), fused		246147	
Current source leads, 9.1 m (30 ft), fused		246347	
Current source leads, 12.2 m (40 ft), fused		246447	
Bar code wand with preprinted code sheet		246201	
Transit case for BITE2		35491	

SPECIFICATIONS

BITE 3 instrument

Impedance range and resolution	0.05 to 1.000 m Ω 1 $\mu\Omega$ resolution 1 to 10.00 m Ω 10 $\mu\Omega$ resolution 10 to 100.0 m Ω 0.1 m Ω resolution
Voltage range and resolution	1 to 30 V dc across probes 1 to 8.0 V dc 1 mV resolution 8.0 to 30.00 V dc 10 mV resolution
Current range and resolution	0.5 - 9.99 A ac/dc 0.01 A resolution 10.0 - 99.9 A ac/dc 0.1 A resolution

Accuracy

dc voltage	$\pm(1\% \text{ rdg} + 1 \text{ lsd})$
ac impedance	$\pm(5\% \text{ of rdg} + 1 \text{ lsd})$
ac/dc current	$\pm(5\% \text{ rdg} + 0.5 \text{ A})$

Precision

Better than 0.5% one sigma

Source output current

1/2 A rms

Display

1/4 VGA LCD

Settling time per reading

3 seconds maximum

Battery pack

2 to 4 hours continuous
4.8 V dc, 7000 mAh, quick charge NiMH battery pack

Safety

Designed to meet IEC 61010-1 specifications

Environmental

Operating temperature	0 °C to 40 °C (32 °F to 105 °F)
Storage temperature	-20 °C to 55 °C (-5 °F to 130 °F)
Humidity	20 to 90% RH, noncondensing

Mechanical data

Dimensions	220 x 100 x 237 mm (8.6 x 4 9.5in.)
Weight	2.6 kg (5.7 lbs)

Charger

Supply voltage	90 to 264 Vac, 50/60 Hz 1.6 A max.
Output	12 V dc @ 5 A, 60 W max.

Optional printer

Thermal, with 4 1/4 in. (110 mm) printing width



BITE3

- Determines health of lead-acid cells up to 2000 Ah
- On-line testing with Pass/Warning/Fail calculations
- Measures impedance, interconnection resistance and cell voltage
- Windows CE operating system with 32 MB of memory
- Measures float and ripple currents
- Includes ProActiv™ Database Management Software

Description

The BITE3 battery impedance test equipment determines the health of lead-acid cells up to 2000 Ah by taking measurements of the most important battery parameters. The BITE3 measures cell impedance, an internal ohmic test, cell voltage, intercell connection resistance and ripple current. And, for the first time in a battery instrument, the BITE3 measures float current. There is even a built-in spectrum analyzer to show the harmonic content of the ripple current. It has firmware that can be upgraded through the Internet and supports multiple languages.

It is known that impedance is correlated to battery capacity and there has been a long-standing question as to when a user should replace a cell. BITE3 and ProActiv allow the user to trend data and to enter baseline values for comparison purposes and to make decisions whether onsite or in the office. Both the BITE3's impedance deviation graph and the trend graph in ProActiv clearly show the status of a cell which helps users to decide what action needs to be taken to ensure battery back up reliability based on users' criteria.

Battery impedance test equipment

ProActiv System Requirements

Processor
300 MHz Pentium II or better

Operating System

Windows 98
Windows Me
Windows NT 4.0 (SP6a required)
Windows 2000 (SP2 recommended)
Windows XP
Note: Windows 95 is not supported

Software

Microsoft® Internet Explorer 5 or later
Microsoft .Net Framework will be automatically installed by ProActiv if it is not already installed on your computer. For additional information about Microsoft .Net Framework please visit: www.microsoft.com/net

Hard Drive Space

100 MB
System Memory (RAM)
64 MB (128 MB recommended)

Other Drives

CD-ROM (used only for installation)

Communications Port

COM (used only for importing data from test equipment or to download information to the BITE 3)

Monitor/Display

True color, 800 x 600 resolution

Additional Information

For improved usage, an internet connection will make it easy to get automatic ProActiv software updates. The user should have Microsoft Excel 9.0, or later, to import AVOLink or COMLink files into ProActiv.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
BITE 3, 110/230 V ac, 50/60 Hz, CE marked	BITE3		
Included accessories			
ProActiv™ software	BI-90001	Optional accessories	
Canvas carrying case	35788	Lead set, 1.8 m (6 ft) probe to probe	36616
RS-232 null modem cable	33533-1	Printer, battery operated, 110 V ac	35755-3
Line charger	EV6280-333	Printer, battery operated, 220 V ac	35755-4
Battery	EV6121-492	Printer paper, 1 roll	26999
Dual point lead set	BI-10002	AMP/Burndy lead set	BI-10004
Tip kit	BI-10017	Kelvin clip lead set	BI-10005
Operating manual	AVTMBITE3	Quick disconnect lead set	BI-10006
		Cigarette lighter charger	EV6280-332
		Current transformer kit	35873
		USB-serial adapter	35871
		Probe extensions, lighted	35865
		Hard-sided carrying case	35890
		Standard transit case	35915
		Field test shunt, 0.01 ½, current rating 10 A	249003
		Field test shunt, 0.001 ½, current rating 100 A	249004
		Field test shunt, 0.0001 ½, current rating 500 A	249005

SPECIFICATIONS

System requirements

Processor	300 MHz Pentium II or better
Operating system	Windows 98 Windows Me Windows NT 4.0 (SP6a required) Windows 2000 (SP2 recommended) Windows XP Note:Windows 95 is not supported

Software

Microsoft® Internet Explorer 5 or later
Microsoft .Net Framework
Will be automatically installed by ProActiv if it is not already installed on your computer. For additional information about Microsoft. Net Framework please visit: www.microsoft.com/net

Hard drive space

100 MB

System memory (RAM)

64 MB (128 MB recommended)

Other drives

CD-ROM (used only for installation)

Communication port

COM (used only for importing data from test equipment or to download information to the BITE 3).

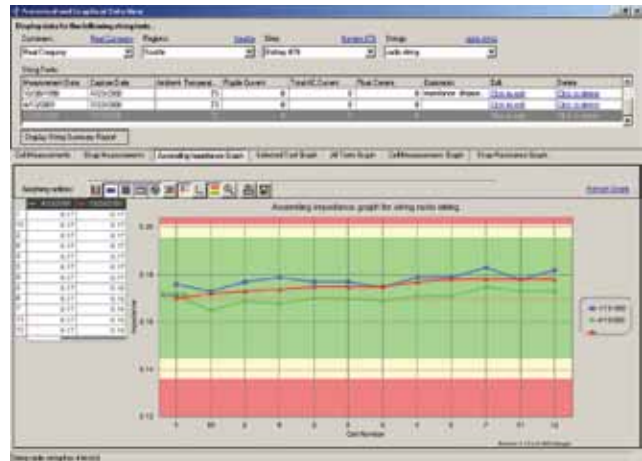
Monitor/display

True color, 800 x 600 resolution

Additional information

For improved usage, an internet connection will make it easy to get automatic ProActiv software updates.

The user should have Microsoft Excel 9.0, or later, to import AVOLink or COMLink files into ProActiv.



ProActiv for use with BITE2/2P and BITE3

- Organizes and manages battery data
- Performs trending analysis
- Utilizes a standard MS Access database format
- Assists the user to manage multiple batteries
- Easy-to-use graphical navigation
- Uses various data import and data entry wizards

Description

The first of its kind, ProActiv is a powerful, easy to use battery database management software designed to analyze each individual battery in a battery system.

Battery testing is crucial to ensure a battery system provides standby and emergency power to operate devices such as emergency lighting, UPSs, operating controls, switchgear components, protective relays and continuous process systems. Failure of a battery system within environments such as utilities, hospitals or manufacturing plants can result in operational failure of the devices connected to it. ProActiv assists the user to avoid battery failures, budget for future battery string and cell replacements, and plan battery changeouts in an orderly manner.

ProActiv utilizes a standard MS Access database format. It allows the user to organize and manage battery data such as voltages, impedance, intercell connection resistance, ripple current, specific gravity, IR thermographs and more.

ProActiv supports the following languages English, French, German, Portuguese, Russian, Spanish and Vietnamese. BITE2 supports all the above languages BITE2/2P supports the above except Russian and Vietnamese.

ORDERING INFORMATION

Product	Order Code
ProActiv battery database management software	BI-90001

BITE accessories

- Enhances the capabilities of the BITE product line
- Designed for unique application situations
- The right tools for battery testing
- Facilitates complete battery testing



Description

Megger offers a complete line of accessories to enhance the capabilities of the BITE product line. Several are listed here, but there are many others including extension cables, calibration shunts, and more, which are not listed. Please contact us for further information. Also, we are continually evaluating additional products as interest arises.



RopeCT™ (Current transformer)

The RopeCT is a flexible, highly accurate current transformer for measuring current flow in larger battery systems with larger buss work. It comes in two lengths, 60 cm (24 in.) and 90 cm (36 in.) for 20 cm (8 in.) and 30 cm (12 in.) diameters, respectively. Since it is flexible, it could form into an oval to easily fit around most any buss work or intercell connection configuration. The RopeCT is designed specifically for use with the BITE2, BITE2P and BITE3. Check the Ordering Information to select the right one.

Miniature 12 mm (1/2 in.) CT (Current transformer)

In some installations, it is difficult to attach the standard 50 mm (2 in.) CT due to the size limitations of the site or size of the cable. To overcome this situation, Megger now offers a 12 mm (1/2 in.) CT for smaller gauge wires and for tight spaces.

Probe extensions

Probe extensions are available for most BITE models. They are mounted on the probes of the BITE3 or on the Receiver and Potential probe of the BITE2 and BITE2P. They are excellent for reaching battery terminals and interconnectors in cabinetized and racked batteries. They are also helpful for reaching batteries on the top rack of a three-tier, two-row rack. One set of probe extension kits consists of two adapters, two 30 cm (12 in.) extensions and six tips. Extensions are threaded for easy assembly. Simply remove the extension and screw the tip into the adapter for normal use. The other tips have a 90°, 135° (45°) and a 180° bend for easy access to most battery configurations. The BITE3 has snap-on adapters and slide-on/off extensions and tips



Digital hydrometer (with memory module)

The digital hydrometer accurately and quickly determines specific gravity of flooded cells. Simply draw the electrolyte into it; the specific gravity and temperature are determined in five seconds. It provides memory for both temperature and specific gravity for eight tests of 256 cells each. The stored data can be easily downloaded into any PC using the included software or into ProActiv, Megger's battery database management software.

Bar code wand

The bar code wand is used to enter header and cell information into the BITE2, and BITE2P. Once the information is entered, it becomes a permanent part of the string's and/or cell's record. It comes with a preprinted and laminated sheet with alphanumeric bar codes and commands (such as "Enter"). Bar code label printing software is available as an option.

COMLink software

COMLink is a tool for downloading data from BITE2, and BITE2P to a PC or laptop. (COMLink files can be imported by ProActiv.) It is shipped FREE with every Megger BITE battery impedance tester.

ProActiv

ProActiv is a battery database management software tool that downloads data and information from the BITE2 and BITE2P, BITE3 and the digital hydrometer (with memory module). ProActiv trends impedance, voltage, specific gravity and temperature data, calculates cells' deviations from the bank average, variation from a baseline and the change in impedance from the previous test. In addition, using its basic reporting structure, budgetary replacements can be planned rather than based on emergency situations. ProActiv is free and is shipped with every BITE.

USB serial adapter

Most laptops do not offer RS232 serial ports. Megger offers an adapter to connect an instrument's RS232 cable to a laptop's USB port.



Calibration shunts

The accuracy of all Megger BITE battery impedance testers can be easily checked in the field using one of Megger's NIST-traceable shunts. Simply check the impedance tester using a shunt in the range of a typical battery impedance value.

Transit cases

The transit cases are extremely durable for the purpose of shipping the appropriate BITE product to many different locations with ease and to prevent shipping damage. They are complete with retractable handles, sturdy foam on the interior walls, and wheels.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
Rope CT, 60 cm (24 in.) for BITE2 and 2P	246050	Optional lead sets for BITE3:	
Rope CT, 90 cm (36 in.) for BITE2 and 2P	246051	AMP/Burndy lead set, 140 cm (56 in.)	BI-10004
Rope CT, 60 cm (24 in.) for BITE3	246053	Kelvin clip lead set, 96 cm (38 in.)	BI-10005
Rope CT, 90 cm (36 in.) for BITE3	246054	Quick disconnect lead set, 115 cm. (45 in)	BI-10006
Miniature 1/2 in. CT for BITE2 and 2P	246034	Lead set, 1.8 m (6 ft) probe to probe	36616
CT extension cable, 6 m (20 ft) for MBITE, BITE2 and 2P	246033	Bar code wand kit (with laminated sheet) for BITE2 and 2P	246036
Standard probe extensions kit, 30 cm (12 in.) for MBITE, BITE2 and 2P	34943-000	Bar code label printing software	246039
Enhanced probe extensions kit, 60 cm (24 in.) for BITE2 and 2P	34943-001	COMLink downloading software (included on ProActiv disc)	35303-2
Extensions, 30 cm (12 in.), pair for BITE2 and 2P	34943-002	ProActiv	BI-90001
Lighted probe extension kit, 30/70 cm (12/27 in.) for BITE3	35865	USB-serial adapter	35871
Digital hydrometer	246052	Calibration shunt, 0.01 Ω, current rating 10 A	249003
		Calibration shunt, 0.001 Ω, current rating 100 A	249004
		Calibration shunt, 0.0001 Ω, current rating 500 A	249005
		Transit case for BITE2P	35491
		Transit case for BITE3	35915



Cable set, GA-00554



Cable set GA-00550



TORTEL Win PC software

- Shows the complete voltage curve
- Last recorded time, voltage, current and discharged capacity
- Scroll window for all recorded values
- Remote control of TORTEL
- Report functions



TXL850



Circuit Breaker Test

Circuit breakers are one of the critical “safety-valves” of electrical systems and basic maintenance procedures are essential to maintain maximum reliability.

Effective circuit breaker maintenance requires well-organized, accurate testing. The ability to accurately compare circuit breaker tests with previous test results is essential. It is, therefore, imperative to conduct tests in exactly the same way and under the same conditions as those conducted earlier.

6

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SELECTION GUIDE

	CabaWin	EGIL	TM1600	TM1800	SDRM202	VIDAR	B10E	MS-2A	OCR-8015/9150
Circuit breaker test software	■								
Circuit breaker test analyser		■	■	■				■	
Static/dynamic resistance measurement					■				
Vacuum interrupter tester						■			
AC/DC voltage power supply							■		
Automatic oil circuit recloser test set									■
Tests overcurrent relays								■	
Predefined test plans	■								
Detailed circuit breaker analysis	■								
Graphic display of measurement and test result	■								
Report generation with MS Word	■								
Compatible with TM1800, TM1600, EGIL	■								
Timing and travel tests	■								
Two separate timing channels		■							
Analogue measurement channels		■							
1 s to 100 s measurement		■							
0.1 ms to 10 ms resolution		■							
3 channels with common grounds		■							
0.05% time based inaccuracy		■							
24 V open circuit voltage		■							
100 mA short circuit current		■							

Circuit breaker test selection is complex.

Over the next 6 pages, we have created a set of detailed selection guides to identify the configuration that is right for you. Please call our Technical Support Group (TSG) if you would like assistance.

TM1800 SELECTION GUIDE

SI	Package	Part no/nos.	Description
1	CG-19290	CG-19290	TM1800 Standard - package incl CABA Win
2	CG-19292	CG-19292	TM1800 Standard with DualGround Timing - package incl CABA Win
3	CG-19293	CG-19293	TM1800 Standard + AUX with DualGround Timing - package incl CABA Win
4	CG-19294	CG-19294	TM1800 Expert - package incl CABA Win
5	CG-19296	CG-19296	TM1800 Expert incl. DualGround Timing - package incl CABA Win
6	CG-19300	CG-19300	TM1800 Standard (Excl Cables, Excl Case, Excl CABA Win)
7	CG-19302	CG-19302	TM1800 Standard w. DualGround Timing (Excl Cables, Excl Case, Excl CABA Win)
8	CG-19303	CG-19303	TM1800 Standard + AUX w. DualGround Timing (Excl Cables, Excl Case, Excl CABA Win)
9	CG-19304	CG-19304	TM1800 Expert (Excl Cables, Excl Case, Excl CABA Win)
10	CG-19306	CG-19306	TM1800 Expert incl. DualGround Timing (Excl Cables, Excl Case, Excl CABA Win)
11	Combo pack 1	CG-19290	TM1800 Standard - package incl. CABA Win
		CG-19030	TM1800 Control Module
		GA-00851	Cable Timing Cable TM1800 Ext R100 - 3 Nos
12	Combo pack 2	CG-19290	TM1800 Standard package incl. CABA Win
		CG-19030	TM1800 Control Module
		GA-00851	Cable Timing Cable TM1800 Ext R100 - 3 Nos
13	Combo pack 3	CG-19050	TM1800 Printer Module
		CG-19292	TM1800 Standard w. DualGround Timing - package incl CABA Win
		CG-19030	TM1800 Control Module
		GA-00851	Cable Timing Cable TM1800 Ext R100 - 3 Nos
14	Combo pack 4	CG-19050	TM1800 Printer Module
		CG-19181	TM1800 DCM 3-ch cable extension 10m - 2 Nos
		CG-19290	TM1800 Standard - package incl CABA Win
		CG-19030	TM1800 Control Module
		GA-00851	Cable Timing Cable TM1800 Ext R100 - 3 Nos
15	Combo pack 5	CG-19050	TM1800 Printer Module
		CG-19000	TM1800 Analog Module
		CG-19292	TM1800 Standard w. DualGround Timing - package incl CABA Win
		CG-19030	TM1800 Control Module
		GA-00851	Cable Timing Cable TM1800 Ext R100 - 3 Nos
16	Combo pack 6	CG-19050	TM1800 Printer Module
		CG-19181	TM1800 DCM 3-ch cable extension 10m - 2 Nos
		CG-19000	TM1800 Analog Module
		CG-19292	TM1800 Standard w. DualGround Timing - package incl CABA Win
		CG-19030	TM1800 Control Module
		GA-00851	Cable Timing Cable TM1800 Ext R100 - 3 Nos
17	Combo pack 7	CG-19050	TM1800 Printer Module
		CG-19060	TM1800 Timing Aux Module
		CG-19294	TM1800 Expert - package incl CABA Win
		GA-00851	Cable Timing Cable TM1800 Ext R100 - 6 Nos
18	Combo pack 8	CG-19000	TM1800 Analog Module
		CG-19294	TM1800 Expert - package incl CABA Win
		GA-00851	Cable Timing Cable TM1800 Ext R100 - 6 Nos
19	Combo pack 9	CG-19050	TM1800 Printer Module
		CG-19040	TM1800 Digital Module
		CG-19294	TM1800 Expert - package incl CABA Win
20	Combo pack 10	GA-00851	Cable Timing Cable TM1800 Ext R100 - 6 Nos
		CG-19030	TM1800 Control Module
		CG-19290	TM1800 Standard - package incl CABA Win
		CG-19080	TM1800 Timing M/R Module
21	Combo pack 11	CG-19080	TM1800 Timing M/R Module
		CG-19290	TM1800 Standard - package incl CABA Win
		GA-00851	Cable Timing Cable TM1800 Ext R100 - 6 Nos

EGIL SELECTION GUIDE

	Part no. Product	BM-19000 EGIL basic without option	BM-19003 EGIL with analogue/PC	BM-19005 EGIL SDRM	BM-19090 EGIL basic without option	BM-19093 EGIL with analogue/PC	BM-19095 EGIL SDRM
1	Control channels	2	2	2	2	2	2
2	Coil current channels (using analogue channels and current clamps for TM1600)	2	2	2	2	2	2
3	Voltage monitoring channels (main timing channels swapped on TM1600)	0	0	0	0	0	0
4	Coil resistance channels	0	0	0	0	0	0
5	Main timing channels	3	3	3	3	3	3
6	Dual ground option for main timing	0	0	0	0	0	0
7	PIR timing channels (main timing channels swapped on TM1600)	3	3	3	3	3	3
8	PIR resistance measurement channels	0	0	0	0	0	0
9	Analogue channels capable of connecting motion, voltage, current and pressure transducers	0	1	1	0	1	1
10	Analogue channels capable of connecting vibration transducers.	0	0	0	0	0	0
11	Digital channels capable of connecting motion transducers	0	0	0	0	0	0
12	Timing auxiliary channels (dry or wet) (main timing channels swapped on TM1600)	2	2	2	2	2	2
13	Free slots for additional modules	0	0	0	0	0	0
14	Includes internal printer	Yes	Yes	Yes	Yes	Yes	Yes
15	Trigger in and out	No	No	No	No	No	No
16	Remote start	No	No	No	No	No	No
17	Ambient temperature measuring channel	No	No	No	No	No	No
18	Printer port	No	No	No	No	No	No
19	SDRM resistance channel	0	0	1	0	0	1
20	Dedicated SDRM trigger out	No	No	Yes	No	No	Yes
21	Internal SDRM current and voltage measurement channel (using analogue channels and SDRM box for TM1600)	0	0	2	0	0	2
22	Ethernet port	No	No	No	No	No	No
23	Serial port	No	No	No	No	No	No
24	USB port	No	Yes	Yes	No	Yes	Yes
25	Optical port	No	No	No	No	No	No
26	Monitor out	No	No	No	No	No	No
27	Includes CABAWIN software	No	No	No	No	Yes	Yes
28	Includes timing test cables	No	No	No	Yes	Yes	Yes
29	Includes hard case	No	No	No	Yes	Yes	Yes

TM1600 SELECTION GUIDE

	Part no. Product	BL-39091 TM1600/4	BL-39092 TM1600/8	BL-39093 TM1600/12	BL-39094 TM1600/16	BL-39095 TM1600/20	BL-39096 TM1600/24
1	Control channels	2	2	2	2	2	2
2	Coil current channels (using analogue channels and current clamps for TM1600)	2	2	2	2	2	2
3	Voltage monitoring channels (Main Timing channels swapped on TM1600)	4	8	12	16	20	24
4	Coil resistance channels	0	0	0	0	0	0
5	Main timing channels	4	8	12	16	20	24
6	Dual ground option for main timing	0	0	0	0	0	0
7	PIR timing channels (main timing channels swapped on TM1600)	4	8	12	16	20	24
8	PIR resistance measurement channels	0	0	0	0	0	0
9	Analogue channels capable of connecting motion, voltage, current and pressure transducers	0	0	0	0	0	0
10	Analogue channels capable of connecting vibration transducers.	0	0	0	0	0	0
11	Digital channels capable of connecting motion transducers	0	0	0	0	0	0
12	Timing auxiliary channels (dry or wet) (main timing channels swapped on TM1600)	4	8	12	16	16	24
13	Free slots for additional modules	5	4	3	2	1	0
14	Includes internal printer	Yes	Yes	Yes	Yes	Yes	Yes
15	Trigger in and out	Yes	Yes	Yes	Yes	Yes	Yes
16	Remote start	Yes	Yes	Yes	Yes	Yes	Yes
17	Ambient temperature measuring channel	No	No	No	No	No	No
18	Printer port	No	No	No	No	No	No
19	SDRM Resistance channel	0	0	0	0	0	1
20	Dedicated SDRM trigger out	No	No	Yes	No	No	No
21	Internal SDRM current and voltage measurement channel (using analogue channels and SDRM box for TM1600)	0	0	0	0	0	0
22	Ethernet port	No	No	No	No	No	No
23	Serial port	No	No	No	No	No	No
24	USB port	No	No	No	No	No	No
25	Optical port	Yes	Yes	Yes	Yes	Yes	Yes
26	Monitor out	No	No	No	No	No	No
27	Includes CABAWIN software	No	No	No	No	No	No
28	Includes timing test cable	No	No	No	No	No	No
29	Includes hard case	Yes	Yes	Yes	Yes	Yes	Yes

BL-39191 TM1600/16 MA61/2	BL-39192 TM1600/16 MA61/2	BL-39193 TM1600/16 MA61/4	BL-39194 TM1600/16 MA61/4	BL-39197 TM1600/16 MA61/6	BL-39098 TM1600/16 MA61/6
2	2	2	2	2	2
2	2	4	4	6	6
16	16	16	16	16	16
0	0	0	0	0	0
16	16	16	16	16	16
0	0	0	0	0	0
16	16	16	16	16	16
0	0	0	0	0	0
2	2	4	4	6	6
0	0	0	0	0	0
0	0	0	0	0	0
16	16	16	16	16	16
2	2	1	1	0	0
Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes
No	No	No	No	No	No
No	No	No	No	No	No
1	1	2	2	3	3
No	No	No	No	No	No
2	2	4	4	6	6
No	No	No	No	No	No
No	No	No	No	No	No
No	No	No	No	No	No
Yes	Yes	Yes	Yes	Yes	Yes
No	No	No	No	No	No
No	Yes	No	Yes	No	Yes
No	No	No	No	No	No
No	Yes	No	Yes	No	Yes

TM1800 SELECTION GUIDE

	Part no. Product	CG19290 TM1800	CG19292 TM1800	CG19293 TM1800	CG19294 TM1800	CG19296 TM1800	CG19300 TM1800	CG19302 TM1800	CG19303 TM1800	CG19304 TM1800	CG19306 TM1800
1	Control channels	3	3	3	6	6	3	3	3	6	6
2	Coil current channels	3	3	3	6	6	3	3	3	6	6
3	Coil voltage channels	3	3	3	6	6	3	3	3	6	6
4	Coil resistance channels	3	3	3	6	6	3	3	3	6	6
5	Main timing channels	6	6	6	12	12	6	6	6	12	12
6	Dual ground option for main timing	0	6	6	0	12	0	6	6	0	12
7	Lead sets for dual ground option	0	6	6	0	12	0	6	6	0	12
8	PIR timing channels	6	6	6	12	12	6	6	6	12	12
9	PIR resistance measurement channels	6	6	6	12	12	6	6	6	12	12
10	Analogue channels capable of connecting motion, voltage, current, pressure, and vibration transducers.	3	3	3	3	3	3	3	3	3	3
11	Digital channels capable of connecting motion transducers	0	0	0	0	0	0	0	0	0	0
12	52a and 52b timing channels	3	3	3	6	6	3	3	6	6	6
13	Timing auxiliary channels (dry or wet)	0	0	6	6	6	0	0	6	6	6
14	Free slots for additional modules	5	4	3	2	1	5	4	3	2	1
15	Includes internal printer	No	No	No	No	No	No	No	No	No	No
16	Trigger in and out	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17	Ambient temperature measuring channel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18	Printer port	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
19	SDRM trigger out	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
20	Ethernet port	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
21	Serial port	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
22	USB ports (2 Nos)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
23	Monitor out	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
24	Includes CABAWIN software / cables / hard case	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No
25	Includes 6 Nos of 10 m extension cables for Dual Ground (DCM) Module (1 Ch/per cable)	No	No	No	No	No	No	No	No	No	No
26	Number of 10 m extension cables for timing M/R module (2 Ch /Per cable)	0	0	0	0	0	0	0	0	0	0

TM1800 SELECTION GUIDE

		Combo pack 1	Combo pack 2	Combo pack 3	Combo pack 4	Combo pack 5	Combo pack 6	Combo pack 7	Combo pack 8	Combo pack 9	Combo pack 10	Combo pack 11
1	Control channels	6	6	6	6	6	6	6				
2	Coil current channels	6	6	6	6	6	6	6	6	6	6	3
3	Coil voltage channels	6	6	6	6	6	6	6	6	6	6	3
4	Coil resistance channels	6	6	6	6	6	6	6	6	6	6	3
5	Main timing channels	6	6	6	6	6	6	12	12	12	12	12
6	Dual ground option for main timing	0	0	6	0	6	6	0	0	0	0	0
7	Lead sets for dual ground option	0	6	6	6	6	6	12	12	0	0	0
8	PIR timing channels	6	6	6	6	6	6	12	12	12	12	12
9	PIR resistance measurement channels	6	6	6	6	6	6	12	12	12	12	12
10	Analogue channels capable of connecting motion, voltage, current, pressure, and vibration transducers.	3	3	3	6	6	6	6	3	3	3	3
11	Digital channels capable of connecting motion transducers	0	0	0	0	0	0	0	0	6	0	0
12	52a and 52b timing channels	6	6	6	6	6	6	6	6	6	3	3
13	Timing auxiliary channels (dry or wet)	0	0	0	0	0	6	6	6	6	0	0
14	Free slots for additional modules	4	3	2	2	1	0	0	1	0	3	4
15	Includes internal printer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
16	Trigger in and out	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17	Ambient temperature measuring channel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18	Printer port	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
19	SDRM trigger out	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
20	Ethernet port	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
21	Serial port	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
22	USB ports (2 Nos)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
23	Monitor out	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
24	Includes CABAWIN software / cables / hard case	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
25	Includes 6 Nos of 10 m extension cables for Dual Ground (DCM) Module (1 Ch/per cable)	No	No	Yes	No	Yes	Yes	No	No	No	No	No
26	Number of 10 m extension cables for timing M/R module (2 Ch /Per cable)	3	3	3	3	3	3	6	6	6	6	6

The objective of all circuit breaker diagnostic testing is to detect defects before they cause damage and system outages. Many test techniques are used to achieve this, but one that receives less attention than it deserves is vibration testing.

A recent CIGRÉ study on circuit breakers in active use revealed that 70% of malfunctions were caused by mechanical rather than electrical faults. What better basis could there be for diagnostic tests, therefore, than looking directly at the mechanical behaviour of the breaker? And this is exactly what vibration testing and more accurately an acoustic signature does.

The test method employed is easy to understand. Accelerometers, which behave in much the same way as microphones, are attached to the circuit breaker under test. As the breaker opens and closes, the vibrations they pick up are recorded in much the same way as an MP3 file might be captured for a voice or music recording. The recordings can subsequently be replayed and analysed at will.

The results are easiest to interpret if a reference recording – often referred to as a reference signature or “footprint” – is available. This is simply a recording made when the breaker was known to be in good condition and operating correctly. The reference signature can be readily compared with subsequent recordings, with any significant changes indicating potential problems.

If no reference signature is available for the specific breaker under test, the comparisons can instead be made with the reference signature of another breaker of the same type. This is however a compromise, not least because it is very different to be certain that the parameters for tests on two individual breakers – such as the exact placement of the accelerometers – are identical.

While it is possible for experienced users of vibration analysis to display the recordings on a computer screen and compare them by eye, dedicated software will always provide more detailed and more reliable results. The analysis looks in particular at two aspects of the comparison, which are usually referred to as time shift and deviation (magnitude).

Particular vibration patterns are associated with specific mechanical events, such as the closing of the breaker's arcing contacts or main contacts. The time shift analysis looks for differences in the timing of these vibration patterns between the reference signature and the test recording. Deviation analysis looks for differences in the amplitude and frequency spectrum of the events.

While experience is undoubtedly the best guide to the interpretation of the results, it is possible to provide some rules of thumb. While these illustrate the usefulness of vibration testing however, it must be understood that they are neither absolute nor universal criteria

and they must not be used without careful consideration of the specific application.

According to these rules of thumb, if the time shift is less than 4 ms, and the deviation curves never diverge by more than 10 dB, it is reasonable to assume that the circuit breaker is in the same mechanical condition as it was when the reference signature was generated. Note that successive tests on the same breaker will typically show differences of between 5 to 7 dB, and this should be regarded as normal.

In cases where the time shift is greater than 4 ms but less than 8 ms, but the deviation curves still never diverge by more than 10 dB, this is likely to mean that the breaker is in the same mechanical condition, but that it is operating more slowly.

This may be due to inadequate lubrication but, if the test is the first operation of the breaker for some considerable time, it is worth repeating it. If the second test gives normal results, it is very probable that the slow operation was caused by poor lubrication and/or corrosion friction. Note that a difference in ambient temperature can also produce a time shift as, in general, the colder the mechanism the slower the operating speed. This is particularly noticeable with hydraulic operating mechanisms.

Finally, in cases where the deviation curves diverge by more than 10 dB or the time shift is greater than 8 ms, this is a strong indication that the breaker is no longer in the same mechanical condition, and that there is a severe risk of it malfunctioning if it is put back into service. At this point, the vibration data can be further analysed to provide a guide to which part of the breaker's mechanical system is behaving differently. This is a good starting point for further diagnostic and remedial work.

This article has concentrated on offering a simple explanation of vibration testing and the type of diagnostic information it can produce. Care must be taken in setting up and carrying out the tests if accurate and dependable results are to be obtained.

In particular, the positioning of the accelerometers that pick up vibrations from the breaker is critical - changes in position of just a centimetre or two can make a big difference to the results. This also means that the positions used for the reference test must be clearly and indelibly marked, so that the accelerometers can be mounted in exactly the same positions for subsequent tests.

Another issue that often needs to be addressed is that of electrical interference such as induction, which is always present in electrical substations. The best instruments, such as the Megger TM1600 and Megger TM1800, are well protected against interference but,

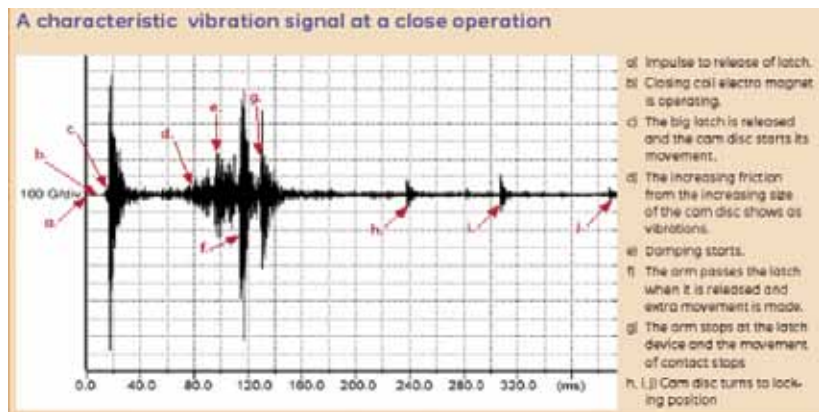
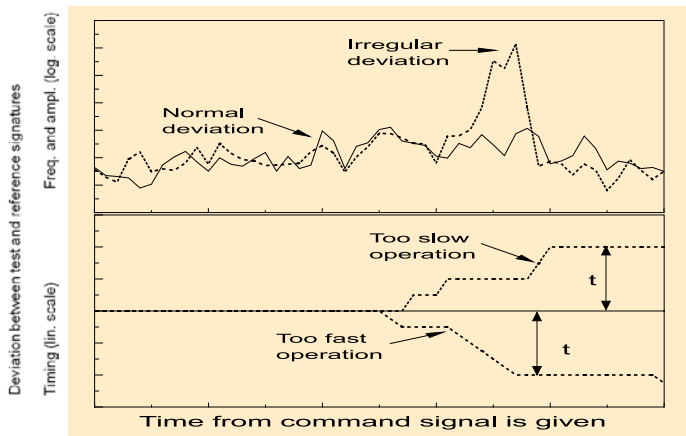
nevertheless, it is still important to inspect the recordings for evidence of its influence. Fortunately, this is in most cases straightforward, as genuine vibration signals are always symmetrical around the zero line, whereas interference signals are not.

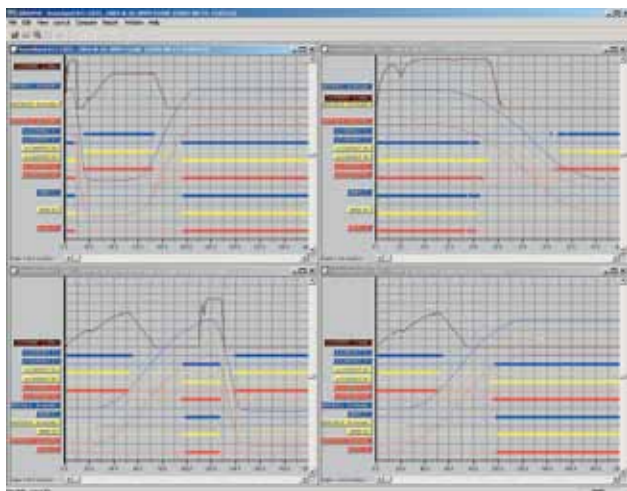
Other factors that affect the quality of the results obtained from vibration testing include the method of attachment of the accelerometers to the circuit breaker, the level of signal pre-amplification used, and the time window used for the result comparisons. Manufacturers of test sets that support vibration analysis can be expected to provide practical and reliable advice in all these areas.

Nothing in this article should be interpreted as meaning that vibration analysis is the only type of testing needed for circuit breakers – it should always be used in conjunction with more conventional motion, timing, DRM (Dynamic Resistance Measurement), and coil current tests to give an overall picture of breaker operation and

condition. Vibration analysis is a very useful weapon in the circuit breaker testing armoury – it is convenient to apply and it can often uncover incipient problems that other test techniques would miss until they had become far more serious.

DTW analysis (Magnitude vs Time and Time vs Time)





CabaWin

- Pre-defined standard test plans for quick and easy testing
- Detailed circuit breaker analysis by accurate comparison with historical test results
- Graphical display of a variety of measurements and timing test results
- Convenient report generation with MS Word or List&Label
- Compatibility with TM1800, TM1600/MA61 and EGIL units

Description

Effective circuit breaker maintenance requires well-organized, accurate testing. The ability to accurately compare circuit breaker tests with previous test results is essential. It is, therefore, imperative to conduct tests in exactly the same way and under the same conditions as those conducted earlier. Comparison can then provide a clear picture of any deviations and changes, thereby indicating whether or not the circuit breaker should be kept in operation or taken out of service for further investigation.

Comprehensive, accurate testing also requires analytical tools and efficient reporting. It must be possible to validate test results in detail and then easily compare them with other test results.

The CABA Win™ (Computer-aided Breaker Analysis) program has earned a benchmark reputation in circuit breaker analysis. Test results from earlier versions of CABA are upwards compatible to CABA Win.

CABA Win can be used with Megger breaker analysers TM1800, TM1600/MA61 and EGIL. CABA Win organizes all the test tasks and ensures that measurements are conducted in the same way for each object being tested. CABA Win saves the results and generates the report. In the analysis section, the user can work with a number of graphic windows,

compare different measurements by overlaying one graph on another in the same display, and use cursors and powerful zoom functions for detailed analysis. CABA Win simplifies testing and ensures the quality of the test procedure.

Application

Test plans

CABA Win can be used for all breaker testing applications, ranging from simple time measurement to dynamic resistance and vibration measurements. A circuit breaker is defined before it is tested the first time. All of the entered data is kept together. This enables CABA Win to guide the user through the test procedure in exactly the same way each time the breaker is tested, regardless of who did the original testing. The result is efficiency gains throughout the test process and more accurate results. Precise comparisons can be confidently made from one test to the next. All of the test and circuit breaker data is saved together with the breaker's unique test plan. It is also possible to enter the results of manually conducted tests, and to enter separate comments for the breaker regarding the test in question. Each breaker is given a unique identity by means of four individually user-defined fields. After being organized on the basis of individual circuit breakers and individual tests, the data can be stored in a database. A breaker specific test plan is automatically created, based on the specified test and breaker data. The test plan controls the individual measurements, the test points that are to be used, the transducers connected to the different measurement channels, and the parameters that are to be calculated. The test plan also specifies the data that is to be presented graphically and how the results are to be reported.

ORDERING INFORMATION

Product	Order code
CABA Win For TM1800 Incl. Ethernet cross-over cable	CG-8000X
CABA Win For TM1600 Incl. fiberoptics and USB interface	BL-8203X
CABA Win For EGIL Incl. USB cable	BL-8204X
CABA Win upgrade Upgrade to latest version	CG-8010X

SPECIFICATIONS

Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in medium-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity

5% – 95% RH, non-condensing

CE marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 115/230 V AC (switchable), 50/60 Hz

Power consumption 100 VA (max)

Dimensions

Instrument 360 x 210 x 190 mm
(14.2" x 8.3" x 7.5")

Transport case 420 x 300 x 230 mm
(16.5" x 11.8" x 9.0")

Weight

6.3 kg (14 lbs), 10 kg (22 lbs) with accessories and transport case

Display

LCD

Available languages

English, German, French, Spanish, Swedish

Measurement section**Time measurement**

Measurement time 1 to 100 s

Resolution 0.1 to 10 ms

Number of channels 3 with common ground

Time base inaccuracy 0.05% of the reading ± resolution

Status thresholds

Closed <10 Ω ±20%

Resistor 10 Ω ±20% to 3 kΩ ±20%

Open > 3 kΩ ±20%

Open circuit voltage 24 V ±20%

Short circuit current 100 mA ±20%

AUX 1&2

Number of channels 2, galvanically isolated

Contact-sensing (Dry)*Status thresholds*

Closed < 600 Ω ±30%

Open > 600 Ω ±30%

Open circuit voltage 20 V ±20% DC

Short circuit current 25 mA ±20%

Voltage sensing (Wet)*Status thresholds*

Open indication <8 V (polarity insensitive)

Close indication >13 V (polarity insensitive)

Working voltage 250 V AC/DC

**Egil**

- Suitable for testing timing and travel on all circuit breakers with single interrupter per phase
- Extremely easy-to-use and reliable
- Two separate timing channels for measurement of auxiliary contacts
- Analog measurement channels for travel transducers or general voltage/current measurements
- Static and dynamic resistance measurements along with the SDRM201 optional accessory

Description

EGIL™, which incorporates benefits gained from experience with our larger instrument, is intended for circuit breakers with one contact per phase. Smaller and simpler, EGIL is equally versatile – and EGIL's price makes it attractive to small power plants. Moreover, it provides an ideal supplementary instrument for maintenance departments at large power companies.

EGIL is designed to test circuit breakers having one main contact per phase. Its three time channels are connected together on one side. Events at parallel contacts equipped with pre-insertion resistors are recorded and displayed simultaneously. There are two separate time channels for measurement of auxiliary contacts. To simplify on-site hookup, EGIL comes with ready-made multi-cable sets for both main and auxiliary contacts.

Coil currents are measured automatically and presented together with other readings immediately after testing on the display window or via the built-in printer. EGIL is easy to use – a built-in sequencer (program unit) sets the instrument automatically for the next sequential breaker operation.

Intended primarily for measuring travel (motion), the optional analog input channel finds many other uses as well. If this channel is not installed, all associated menu commands are hidden.

EGIL with the SDRM option together with the SDRM accessory enables static and dynamic resistance measurements.

EGIL can also be equipped with an optional USB interface for communication with a PC and the CABA Win™ Circuit Breaker Analysis Software.

Circuit breaker analyser

Current measurement

<i>Range</i>	±25 A per channel
<i>Resolution</i>	25 mA
<i>Inaccuracy</i>	1% of the reading ±100 mA
<i>Working voltage</i>	250 V AC/DC

Breaker operation

<i>Sequences</i>	C, O, C-O, O-C, O-C-O
<i>Continuous current</i>	5 A
<i>Max current</i>	25 A during 300 ms, rest time 1 min
<i>Contact function</i>	Two independent control functions
<i>Contact characteristics</i>	Non bouncing, closing time max. 0.1 ms
<i>Make/Break capacity</i>	25 A, 250 V (AC or DC) per contact function
<i>Start breaker operation</i>	By rotary switch
<i>Pulse length</i>	Adjustable in steps of 10 ms
<i>Pulse delay</i>	Adjustable in steps of 10 ms
<i>Working voltage</i>	250 V AC/DC

Motion (optional)

<i>Number of channels</i>	1 independent
<i>Max cable length</i>	10 m (33 ft)

Input

<i>Range</i>	-4 V to +4 V
<i>Resolution</i>	2 mV
<i>Inaccuracy</i>	1% of the measurement range
<i>Transducer resistance</i>	1 kΩ to 5 kΩ
<i>Input impedance</i>	150 kΩ

Output

<i>Open circuit voltage</i>	4,095 V ±4 mV
<i>Short circuit current</i>	115 mA

Printout

<i>Type of printout</i>	Graphic and numeric
<i>Printer</i>	Thermal printer with fixed print head
<i>Graphic resolution</i>	8 dots/mm – 203 dpi
<i>Paper width</i>	114 mm (4.5")

ORDERING INFORMATION

Product	Order code	Product	Order code
EGIL Basic unit	BM-19090	Switch magnetic base	XB-39013
Incl:		Cables	
Time measurement cables	GA-00160, GA-00170	Cable reel	
Cable set for sequencer	GA-00082	20 m (65.5 ft), 4 mm stackable safety plugs	
Transport case	GD-00190	Black	GA-00840
Egil with analog input channel and USB port	BM-19093	Red	GA-00842
Incl:		Yellow	GA-00844
CABA Win	BL-8206X	Green	GA-00845
Time measurement cables	GA-00160, GA-00170	Blue	GA-00846
Cable set for sequencer	GA-00082	Cable sets	
Transducer cable XLR-open	GA-00041	The cable sets consist of 8 cables with clamps and 4 mm stackable safety plugs	
1 m (3.2 ft)		8 x 5 m, (16.4 ft)	GA-00231
Transducer cable XLR-XLR	GA-00042	8 x 10 m, (32.8 ft)	GA-00241
7.5 m (24.6 ft)		8 x 15 m, (49.2 ft)	GA-00251
Transport case	GD-00190	Extension cables, XLR female to male	
Egil with SDRM option and USB port	BM-19095	For analog input, 10 m (32.8 ft)	GA-01005
Incl:		For time measurement of main contacts, 10 m (32.8 ft)	GA-00150
CABA Win	BL-8206X	Open analog cable	
Time measurement cables	GA-00160, GA-00170	For customized analog transducer connection	GA-01000
Cable set for sequencer	GA-00082	XLR to 4 mm safety plugs	
Transducer cable XLR-open	GA-00041	For customized analog transducer connection	GA-00040
1 m (3.2 ft)		Other	
Transducer cable XLR-XLR	GA-00042	VD401	
7.5 m (24.6 ft)		Voltage divider, ratio 400/1	
Transport case	GD-00190	(for TM1600 and EGIL with analog channel)	BL-90070
Upgrade		Thermopaper, 114 mm, 30 m	GC-00030
From BM-19090 to BM-19093	BM-90060	Cable organizer, Hook and loop fastener, 10 pcs	AA-00100
From BM-19093 to BM-19095	BM-90073		
Optional accessories			
CABA Win			
Circuit breaker analysis software			
Incl. USB cable	BL-8206X		
SDRM201	CG-90250		
Extension cables for SDRM201			
10 m (33 ft) extension	GA-12810		
7.5 m (24.6 ft) extension	GA-12815		
Transducers – Linear			
TLH 500	XB-30020		
LWG 225	XB-30117		
TS 150	XB-30030		
TS 25	XB-30033		
Transducers – Rotary			
Novotechnic IP6501	XB-31010		
Flex coupling for IP6501	XB-39030		
Transducer mounting kits			
Universal kits			
Rotary transducer mounting kit			
For transducers XB-31010 and XB-39130	XB-51010		
Universal transducer mounting kit			
for linear and rotary transducers	XB-51020		
Ready-to-use-kits – Rotary			
Incl. transducer XB-31010, mounting kit XB-51010	XB-71010		
Transducer mounting accessories			
Universal support	XB-39029		



TM1600

- Stand-alone functionality – one toolbox for all breaker testing
- Expandable modular concept
- Low-weight
- Rugged and reliable for field use

Description

The TM1600™ circuit breaker analyser measures a circuit breaker's timing cycle. The timing channels record closings and openings of main contacts, resistor contacts and auxiliary contacts.

Since the timing channels are not interconnected, you can take measurements of resistor contacts and series-connected breaker chambers without having to disconnect them.

A built-in program unit permits easy selection of different sequences of breaker control pulses. The delay time between pulses is set on a thumbwheel. The breaker operation unit can be used to control coil currents of up to 25 A. The time values obtained refer to the exact instant at which voltage was applied to the coil, and a built-in printer provides you with a hardcopy printout immediately after measurement.

The TM1600 can be equipped with up to 24 time-measuring channels as required by the user. When more than 24 channels are needed, one or several units can be connected together to get an unlimited number of measurement channels. Modular design also makes it easy to combine the system with the MA61™ Motion Analyser for up to 6 analog channels.

The TM1600 supports communication with the CABA Win™ Breaker Analysis Software. Fully equipped, it weighs only 12 kg (26.5 lbs).

SPECIFICATIONS

Specifications TM1600

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in medium and high-voltage substations and industrial environments.

Operating temperature

TM1600 -20 °C to +50 °C (-4 °F to +122 °F)
MA61 -10 °C to +50 °C (+15 °F to +122 °F)

Storage temperature

TM1600 -30 °C to +70 °C (-22 °F to +158 °F)
MA61 -30 °C to +85 °C (-22 °F to +185 °F)

Humidity

5% – 95% RH, non-condensing

CE marking

EMC 2004/108/EC
LVD 2006/95/EC

General

Mains voltage 85-270 V AC or 100-270 V DC (set automatically), 47-63 Hz
Power consumption 150 W (max)
Battery operation Built-in battery with automatic charger

Dimensions

TM1600 basic unit 400 x 250 x 153 mm
 (15.7" x 9.8" x 6.0")
Transport case 520 x 485 x 210 mm
 (20.5" x 19.1" x 8.3")

Weight

TM1600 basic unit 6.5 kg (14.3 lbs)
Time-measuring module 0.6 kg (1.3 lbs)
MA61 1.1 kg (2.4 lbs)
Transport case 5.1 kg (11.2 lbs)
Complete TM1600/MA61 12 kg (26.5 lbs). 20 kg (44.1 lbs) with accessories and transport case.

Time measurement

Maximum configuration: 24 time-measuring channels (6 time measuring modules) or 16 time-measuring channels and six analog channels (4 time-measuring modules and one MA61).

Range 0 to 6.5 s (up to 1000 s with CABA)
Resolution 0.1 ms
Inaccuracy 0.01% of printed value ±0.1 ms
Start time measurement Automatic a) when breaker is operated from the TM1600, b) when an external event actuates the trigger input or c) optionally when the status of any time-measuring channel is changed.
Trigger input Independent input with its own voltage source. Measurement starts when voltage is detected or when contacts close. Same data as for time-measuring channel when it is in the contact-measuring state or voltage detection state.

Trigger output Closing capacity, up to 1 A

Breaker operation

<i>Contact functions</i>	Two independent contact functions
<i>Contact properties</i>	Bounceless closing. Closing time <0.1 ms
<i>Sequences</i>	C, O, C-O, O-C, O-C-O
<i>Make / break capacity</i>	25 A, 250 V (AC or DC) per contact function
<i>Start breaker operation</i>	Locally via rotary switch or remotely by closing contacts at the opto-isolated start input.
<i>Time difference between control pulse and timer start</i>	<0.1 ms
<i>Pulse delay</i>	Adjustable in steps of 10 ms

Printout

<i>Types of printout</i>	A number of different printout formats are available, both graphic and numeric. Printout can be obtained in English, German, French, Spanish, Italian, Swedish or Finnish.
<i>Printer</i>	Thermal printer with fixed print head
<i>Graphic resolution</i>	8 dots/mm (203 dpi)
<i>Paper width</i>	114 mm (4.5")

Time-measuring module

<i>No. of channels</i>	4
<i>Time-measuring channels</i>	Each channel is independent of the others and has its own limited-current DC voltage source. Each channel can be set to measure main contacts, resistor contacts or to detect voltage. The input circuits are provided with 2.5 kV opto-isolators.
<i>Time-measurement at main contacts</i>	0 to 250 Ω . Test voltage is about 25 V. Measurement current is limited to about 150 mA.
<i>Time-measurement at resistor contacts</i>	250 Ω to 3 k Ω . Test voltage is about 50 V. Measurement current is limited to about 30 mA.
<i>Voltage detection</i>	12 to 250 V. Detection indicates that voltage is present. Independent of polarity. Provides a load of at least 3 W.
<i>Protection of inputs against transients</i>	All inputs have protective diodes. 18 kW, 8/20 μ s between sockets and 4.8 kW, 8/20 μ s between socket and ground.
<i>Induction protection</i>	Capacitive discharge to ground. Max 15 mA per input.

Specifications MA61

<i>No. of channels</i>	2, 4, 6
<i>Measurement ranges</i>	
<i>Transducer resistance</i>	100 Ω to 10 k Ω
<i>Voltage</i>	-4 to +4 V
<i>Measurement resolution</i>	0.03% (0.006% optional)
<i>Basic inaccuracy</i>	0.5%
<i>Dynamic errors</i>	
<i>Motion</i>	1%
<i>Speed</i>	3%
<i>Time-base inaccuracy</i>	0.02%
<i>Measurement interval</i>	50, 100, 200, 400 or 1000 ms, user selectable (up to 200 s with CABA)
<i>Sampling frequency</i>	1-20 kHz (40 kHz optional)
<i>Display</i>	Back-lit LCD, two 16-character lines

ORDERING INFORMATION

Product	Order code	Product	Order code
TM1600		Optional Accessories	
<p>The TM1600/MA61 breaker analyser system can be equipped with time-measuring and analog channels as desired. The TM1600 basic unit includes two rolls of thermal printer paper, 2.5 m (8.2 ft) power cord, transport case and ground cable.</p>		<p>Software and application kits</p>	
TM1600/4		CABA Win – Circuit breaker analysis software	
Basic unit with 4 timing channels	BL-39091	CABA Win	
TM1600/8		incl. fiberoptics and USB interface	
Basic unit with 8 timing channels	BL-39092	BL-8203X	
TM1600/12		CABA Win upgrade	
Basic unit with 12 timing channels	BL-39093	Upgrade to latest version	
TM1600/16		CG-8010X	
Basic unit with 16 timing channels	BL-39094	Vibration analysis	
TM1600/20		Vibration kit	
Basic unit with 20 timing channels	BL-39095	<p>The vibration kit extends TM1600 and CABA Win with the equipment and software required for recording and analysing vibration signals at a circuit breaker. The kit includes the signal conditioning unit SCA606, the software CABA Win vibration and one vibration transducer kit. The vibration solution can be extended up to 6 channels.</p>	
TM1600/24		BL-13090	
Basic unit with 24 timing channels	BL-39096	Vibration transducer kit	
Separate module		<p>Additional vibration transducer kit to be used together with the vibration kit. Each vibration transducer kit includes accele-rometer, accelerometer adapter, cables to SCA606 and cables to TM1600.</p>	
With four time-measuring channels	BL-19010	XB-32010	
MA61		Synchronized Switching Relay test kit	
Each of the MA61/2-6 includes:		SSR kit incl. accessories, soft-ware and cables	
<ul style="list-style-type: none"> ■ One shielded cable/channel, 1 m (3.3 ft) (with female XLR connectors and bare-wire ends) ■ One shielded cable/channel 7.5 m (24.6 ft), (with male and female XLR connectors) ■ One shielded cable, 1 m (3.3 ft) with female XLR connectors and 4 mm safety plugs 		SSR kit for TM1600 (incl. VD401) (delivered in transport case)	
MA61/2		BL-91200	
MA61 basic unit with 2 analog channels	BL-12092	Static and Dynamic Resistance Measurement	
MA61/4		SDRM202	
MA61 basic unit with 4 analog channels	BL-12094	<p>The SDRM202 uses new patent pending technology, with ultra capacitors. The current output is up to 220 A from a box that weighs only 1.8 kg (4 lbs). The weight of the current cables is also low because the SDRM202 is placed very close to the circuit breaker. Timing M/R measurement can be done with the same hook-up</p>	
MA61/6		CG-90200	
MA61 basic unit with 6 analog channels	BL-12096	SDRM202 Pack of 3 units	
Separate module		Pack for CB with 2 Breaks / Phase	
With two analog channels	BL-12010	CG-90230	
MA61S		Extension cable SDRM202	
High speed (40 kHz/14 bit) measurement module for vibration measurements with 2 analogue channels.	BL-12020	7.5 m (24.6 ft)	
TM1600/MA61		10 m (33 ft)	
Basic unit includes two rolls of thermal printer paper, 2.5 m (8.2 ft) power cord, transport case and ground cable.		GA-12815	
Basic unit with 16 time-measuring channels, 2 analogue channels and CABA Win		GA-12810	
Incl. accessories (see MA61)	BL-39192	Transducers – Linear	
Basic unit with 16 time-measuring channels, 4 analog channels and CABA Win		TLH 500	
Incl. accessories (see MA61)	BL-39194	500 mm (20") travel Incl. cable 0.5 m (20")	
Basic unit with 16 time-measuring channels, 6 analog channels and CABA Win		XB-30020	
Incl. accessories (see MA61)	BL-39098	LWG 225	
		225 mm (9") travel Incl. cable 0.5 m (20")	
		XB-30117	
		TS 150	
		150 mm (5.9") travel Incl. cable 1.0 m (39")	
		XB-30030	
		TS 25	
		25 mm (1") travel Incl. cable 1.0 m (39")	
		XB-30033	
		<p>The above transducers are also available in other lengths, please contact Megger for more information.</p>	

ORDERING INFORMATION			
Product		Order code	
Transducers – Rotary			
Novotechnic IP6501	Incl. cable 1 m (39"), 6 mm Flex coupling, Hexagon wrench		XB-31010
Flex coupling for IP6501	For shaft diam. 6 mm		XB-39030
Transducer mounting kits			
Universal kits			
Rotary transducer mounting kit	For transducers XB-31010 and XB-39130		XB-51010
Universal transducer mounting kit	For linear and rotary transducers		XB-51020
Circuit breaker specific kits			
LTB Kit (ABB)	Incl. mounting kit XB-51010, Software conversion table BL-8730X		XB-61010
HPL/BLG Kit (ABB)	Incl. mounting kit XB-51010, Software conversion table BL-8720X		XB-61020
Ready-to-use kits – Rotary			
1-phase kit	Incl. transducer XB-31010, mounting kit XB-51010		XB-71010
3-phase kit	Incl. 3 x 1-phase kits XB-71010		XB-71013
Transducer mounting accessories			
Universal support			XB-39029
Switch magnetic base			XB-39013
Cables			
Cable reel 20 m (65.5 ft), 4 mm stackable safety plugs	Black		GA-00840
	Red		GA-00842
	Yellow		GA-00844
	Green		GA-00845
	Blue		GA-00846
Extension cables, XLR female to male	For analog input, 10 m (32.8 ft)		GA-01005
Open analog cable	For customized analog transducer connection		GA-01000
XLR to 4 mm safety plugs	For customized analog transducer connection		GA-00040
Other			
VD401	Voltage divider, ratio 400/1 (for TM1600 with analog channel)		BL-90070
PIR adapter		Used to test circuit breakers with pre-insertion resistors when resistance is lower than 250 Ω or higher than 3000 Ω. There are two versions:	
	PIR, 15 – 250 Ω		BL-90080
	PIR2, 90 – 4500 Ω		BL-90082
Current sensor		Current sensor kit 1 channel (Fluke 80i-110s incl. cable GA-00140)	
			BL-90600
	Current sensor kit 3 channels (Fluke 80i-110s incl. cables GA-00140)		BL-90610
Thermopaper	114 mm, 30 m		GC-00030
Cable organizer	Velcro straps, 10 pcs.		AA-00100

For more information about optional accessories please contact Megger.

TM1800

Circuit breaker analyser system



TM1800

- Stand-alone functionality – one toolbox for all breaker testing
- Expandable modular concept
- Safer testing – DualGround™, test circuit breakers with both sides grounded
- Designed for off-line and on-line measurement
- Rugged and reliable for field use

Description

The TM1800™ is the instrument platform for circuit breaker maintenance, based on more than 20 years' experience of over 4,000 delivered breaker analysers. The modular construction 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 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 patented DualGround™ testing using the new 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 measuring technology called Dynamic Capacitive Measurement.

Timing M/R uses the patented Active Interference Suppression to obtain correct timing and accurate PIR (Pre-Insertion Resistor) values in high voltage substations.

An adaptive, easy-to-use software suite supports activities from timing, simply turning a knob without the need for presetting, to advanced help functions for hooking up to the

test object. A full keyboard and 8" color screen is the front end of the high-level user interface. The Select-Connect-Inspect workflow guides you to fast results in three steps. Testing is made easier to learn and perform.

The system also offers full connection capability to the local network, printers etc.

Testing with DualGround

Electricity deregulation changes the business environment for utilities, switchgear owners and service companies. Deregulation has been shown to lead directly to increased emphasis on efficiency of operations, maintenance and service levels. Internationalization of business brings new challenges: substantial investments by global corporations will bring with them sharper or new requirements for increased emphasis on health, safety and environmental compliance. Experience has also shown demands for shorter time periods for testing, while the switchgear is less and less available to be taken out of service.

The safety aspect

Network operators and service companies need to maintain and develop their industry safety record. Eminent International bodies including the IEEE® and IEC®, National Safety agencies and Trade Unions increases the demands on safety. During the deregulation applicable safety regulations have been clarified and the application of existing rules has tightened. Keeping a good safety record is becoming a crucial asset in attracting investors and customers.

In all substations capacitive coupling from live high voltage conductors induces harmful/lethal currents in all parallel conductors. Grounding both sides of the test object will lead the induced current to earth and provide a safe area for the test personnel. See figures below on next page.

Both sides grounded

The best way to provide safety in circuit breaker testing is to keep both sides of the circuit breaker grounded throughout the test. This will also make the test faster and easier. Minimum time shall be spent in the substation and focus shall be on the test rather than the equipment.

The DualGround™ testing method is available for all tests on all circuit breakers.

Basic unit

The modularized design makes it very flexible to user needs and enables reconfiguration for new demands and upgrade with new functionality. You can configure TM1800 to a complete test set tailor made for your specific needs. The firmware, CABA Local, guides you to efficient circuit breaker testing. All inputs and outputs on the TM1800 and the

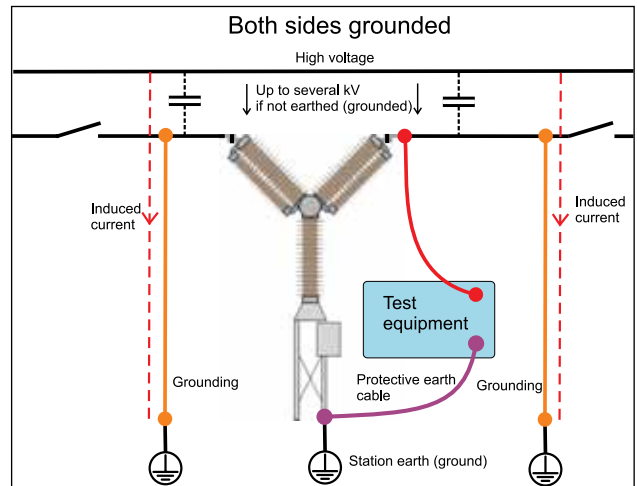
modules are designed to withstand the harsh environment in high-voltage substations and industrial environments.

With built-in protection circuits and software-designed protection the TM1800 has a good guard to influences and even failures caused by over-voltages generated in the environment.

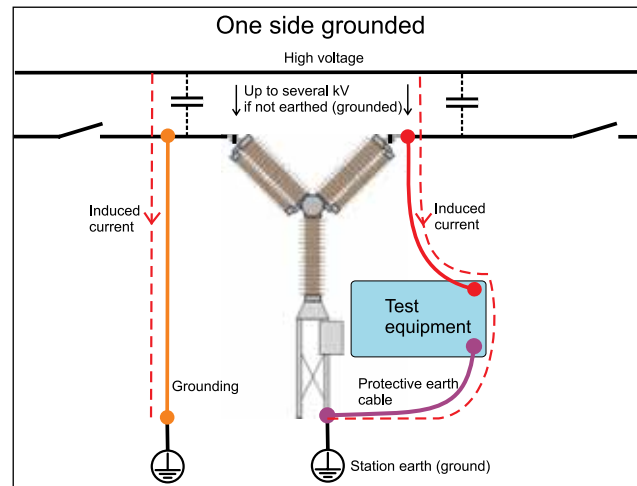
The HDD module is a part of the basic unit and contains the hard drive with all data and software setup. It can easily be removed and changed.

- Eight user configurable slots for modules
- Temperature sensor connection
- Trig inputs and outputs
- Outputs for warning signal and DRM
- Earth (Ground) connection
- Communication interfaces (USB, Ethernet, etc)

Conventional vs. DualGround	
Site preparation (isolate work area, apply safety ground, issue permit to work)	Site preparation (isolate work area, apply safety ground, issue permit to work)
Hook up test equipment. Issue sanction for test	Hook up test equipment. Issue sanction for test
Authorised person removes the ground	Risky step left out
Perform testing	Safe testing with both sides grounded
Authorised person applies ground	Risky step left out
Cancel sanction for test. Disconnect test equipment	Cancel sanction for test. Disconnect test equipment
Site closing (cancel permit to work, disconnect ground)	Site closing (cancel permit to work, disconnect ground)



Testing is much safer using the DCM module and DualGround.



With only one side grounded the induced current can reach values high enough to be harmful or lethal for humans.



- Contact resistance MJÖLNER / SDRM202
- Timing TM1800 with DCM
- Motion TM1800
- SDRM TM1800 with SDRM202
- Vibration CABA Win Vibration / SCA606

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 grounded throughout the test.



The basic unit is only equipped with the HDD module. Add modules to the configuration that supports your needs.

Digital module

With digital transducers motion and other measurements become even more accurate, faster and easier. The digital module enables use of incremental rotary or linear transducers, for measuring e.g. motion, velocity and damping characteristics of circuit breakers.

- Six channels per module
- Incremental transducers with RS422
- Up to ± 32000 pulses resolution
- Up to 20 kHz sampling

Timing Aux module

Expands the TM1800 system with timing inputs for measuring any auxiliary contact on the circuit breaker. It measures timing, polarity insensitive, of both dry and wet contacts for example timing of spring charging motor, anti-pump relay etc.

- Six channels per module
- Polarity insensitive
- Dry and wet auxiliary contacts

Printer module

The Printer module offers a convenient and practical way of making printouts of test results in the field. The printouts contain both numerical and graphical results and printer templates delivered pre-installed in the TM1800 are easy to adapt to suit specific needs for a clear and complete report of all tested parameters.

- Thermal printer sensitive line dot method
- Paper width 114 mm (4")
- Printing speed 50 mm/s (400 dot lines/s)

HDD module

The HDD module is a part of the basic unit. Storage of all set-up, user customization and measurement data is done in the HDD module. The module is easily replaced e.g. when different users are sharing one TM1800 and want individual setups, data and configurations.

- Change set-up, user customization, measurement data by changing HDD module
- Easy to remove during transportation

Optional accessories

Transducers (rotary digital)
See Accessories pages for more details.



Including

3 cable sets, 5 m (16 ft)

Optional accessories

Standard cable sets are used as extension cables: GA-00870



Including

Paper spool (Thermopaper)

Optional accessories

Thermopaper: GC-00040
See Accessories pages for more details.



Optional accessories

Product		Order code
Software and application kits		
CABA Win – Circuit Breaker analysis software		
CABA Win	incl. Ethernet cross-over cable	CG-8000X
CABA Win upgrade	Upgrade to latest version	CG-8010X
Vibration analysis		
Vibration kit	The vibration kit extends TM1800 and CABA Win with the equipment and software required for recording and analyzing vibration signals at a circuit breaker. The kit includes the signal conditioning unit SCA606, the software CABA Win Vibration and one vibration channel. The vibration solution can be extended up to 6 channels.	BL-13090
Vibration channel	Additional vibration channel to be used together with the vibration kit. Each vibration channel includes accelerometer, accelerometer adapter, cables to SCA606 and cables to TM1800.	XB-32010
Synchronized Switching Relay test kit		
SSR kit	Incl. accessories, software and cables (delivered in transport case)	CG-91200
Static and Dynamic Resistance Measurement		
SDRM202	The SDRM202 uses new patent pending technology, with ultra capacitors. The current output is up to 220 A from a box that weighs only 1.8 kg (4 lbs). The weight of the current cables is also low because the SDRM202 is placed very close to the circuit breaker. Timing M/R measurement can be done with the same hook-up	CG-90200
SDRM202 Pack of 3 units	Pack for CB with 2 Breaks / Phase	CG-90230
Extension cable SDRM202	7.5 m (24 ft)	GA-12815
	10 m (33 ft)	GA-12810
Transducers		
Linear		
TLH 500	500 mm (20") travel Incl. cable 0.5 m (20")	XB-30020
LWG 225	225 mm (9") travel Incl. cable 0.5 m (20")	XB-30117
TS 150	150 mm (5.9") travel Incl. cable 1.0 m (39")	XB-30030
TS 25	25 mm (1") travel Incl. cable 1.0 m (39")	XB-30033
The above transducers are also available in other lengths, please contact Megger for information.		
Rotary - Analog		
Novotechnic IP6501	Incl. cable 1 m (39"), 6 mm Flex coupling, Hexagon wrench	XB-31010
Flex coupling	For IP6501, shaft diam. 6 mm	XB-39030

Product		Order code
Rotary - Digital		
Baumer	BDH16.05A3600-LO-B Incl. cable 10 m (33ft), 10/6 mm Flex coupling, Hexagon wrench	XB-39130
Transducer mounting kits		
Universal kits		
Rotary transducer mounting kit	For transducers XB-31010 and XB-39130	XB-51010
Universal transducer mounting kit	For linear and rotary transducers	XB-51020
Circuit breaker specific kits		
LTB Kit (ABB)	Incl. mounting kit XB-51010, Software conversion table BL-8730X	XB-61010
HPL/BLG Kit (ABB)	Incl. mounting kit XB-51010, Software conversion table BL-8720X	XB-61020
Ready-to-use kits – Rotary – Analog		
1-phase kit	Incl. transducer XB-31010, mounting kit XB-51010	XB-71010
3-phase kit	Incl. 3 x 1-pase kits XB-71010	XB-71013
Ready-to-use kits – Rotary – Digital		
1-phase kit	Incl. transducer XB-39130, mounting kit XB-51010	XB-71020
3-phase kit	Incl. 3 x 1-pase kits XB-71020	XB-71023
Transducer mounting accessories		
Universal support		XB-39029
Switch magnetic base		XB-39013
Cables		
TM1800 DCM 3-channel addition	3 DCM cables, 12 m (39 ft, 6 Clamps)	CG-19180
TM1800 DCM 3-channel extension cable	3 DCM extension cables, 10 m (33 ft) GA-00999	CG-19181
Cable reel 20 m (65.5 ft), 4 mm stackable safety plugs	Black	GA-00840
	Red	GA-00842
	Yellow	GA-00844
	Green	GA-00845
	Blue	GA-00846
Extension cables, XLR female to male	For analog input, 10 m (32.8 ft)	GA-01005
	For Timing M/R modules, 10 m (32.8 ft)	GA-00851
Open analog cable	For customized analog transducer connection	GA-01000
XLR to 4 mm safety plugs	For customized analog transducer connection	GA-00040
Digital transducer extension cable	RS422, 10 m (33 ft)	GA-00888
Open digital cable	For customized digital transducer connection	GA-00885
L & L digital cable	For using Leine & Linde 530 digital transducer	GA-00890

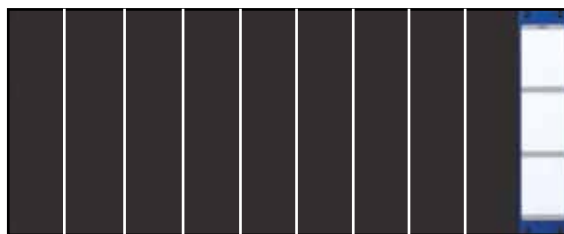
Circuit breaker analyser system

Baumer digital cable	For using Baumer digital transducer	GA-00895
Ethernet cable, network	Cable for connection to network/LAN	GA-00960
Other		
Current sensor	Current sensor kit 1 channel (Fluke 80i-110s incl. cable GA-00140)	BL-90600
	Current sensor kit 3 channels (Fluke 80i-110s incl. cables GA-00140)	BL-90610
Temperature sensor	With the temperature sensor the ambient temperature is automatically recorded with each measurement and stored together with the test result. The temperature becomes a parameter in CABA Win. The temperature sensor should be placed in the shade. Suitable cable is the Analog cable, 10 m GA-01005. Range: -20 °C to +50 °C (-4 °F to +122 °F), Resolution: 0.5 °C (0.9 °F)	CG-90070
Thermopaper	114 mm, Ø 40 mm	GC-00040
Soft case	Made from sturdy nylon fabric	GD-00340
Cable organizer	Velcro straps, 10 pcs.	AA-00100

For more information about optional accessories please contact Megger.

TM1800 – Configurations

Order code

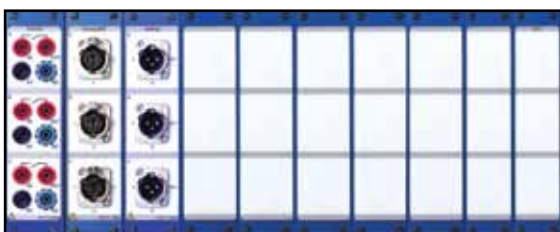


TM1800 Basic Unit

CG-19090

CB testing example

- No testing is possible. Modules have to be ordered separately.



TM1800 Standard

CG-19290

CB testing example

- One common operating mechanism
- Two breaks per phase
- One travel motion



TM1800 Standard – for DualGround

CG-19292

CB testing example

- With both sides grounded
 - ▶ One common operating mechanism
 - ▶ Two breaks per phase
 - ▶ One travel motion



DCM-cables x 6



TM1800 Expert

CG-19294

CB testing example

- Three operating mechanisms
- 6 auxiliary, 6 coil currents, 6 station battery voltages
- Four breaks per phase
- Three travel motions
- 6 independent auxiliary contacts



TM1800 Expert – for DualGround

CG-19296

CB testing example

- With both sides grounded
 - ▶ Three operating mechanisms
 - ▶ 6 auxiliary, 6 coil currents, 6 station battery voltages
 - ▶ Four breaks per phase
 - ▶ Three travel motions
 - ▶ 6 independent auxiliary contacts



DCM-cables x 12

ORDERING INFORMATION

Product	Order code	Product	Order code
TM1800 – Separate items		TM1800 – Configurations	
TM1800 Basic Unit	CG-19090	TM1800 Standard	CG-19290
Complete with: HDD module, CABA Local, Transport case, USB Memory		<i>Including:</i>	
Control Module (3 independent contacts)	CG-19030	CG-19090	TM1800 Basic Unit 1
<i>Including:</i> 3 cable sets, 5 m (16 ft), GA-00877		CG-19030	TM1800 Control Module 1
Timing M/R Module (6 channels + 6 PIR)	CG-19080	CG-19080	TM1800 Timing M/R Module 1
<i>Including:</i> 3 cable sets, 5 m (16 ft) total length, 2 m (6.5 ft) spread, GA-00850		CG-19000	TM1800 Analog Module 1
DCM Module	CG-19190	CG-8000X	CABA Win - TM1800 1
<i>Including:</i> 3 DCM-cables, 12 m (39 ft)		TM1800 Standard – for DualGround testing	
DCM Module	CG-19192	<i>Including:</i>	
<i>Including:</i> 6 DCM-cables, 12 m (39 ft)		CG-19090	TM1800 Basic Unit 1
Analog Module (3 channels)	CG-19000	CG-19030	TM1800 Control Module 1
<i>Including:</i> 3 cable sets, 10 m (33 ft), GA-01005		CG-19080	TM1800 Timing M/R Module 1
Digital Module (6 channels)	CG-19040	CG-19192	TM1800 DCM Module 1
Timing Aux Module (6 channels)	CG-19060	CG-19000	TM1800 Analog Module 1
<i>Including:</i> 3 cable sets, 5 m (16 ft), GA-00870		CG-8000X	CABA Win - TM1800 1
Printer Module	CG-19050	TM1800 Expert	
<i>Including:</i> Paper spool, GC-00040		CG-19294	
Optional accessories		<i>Including:</i>	
See Optional accessories, pages 10- 11		CG-19090	TM1800 Basic Unit 1
CABA Win		CG-19030	TM1800 Control Module 2
See separate datasheet for CABA Win.		CG-19080	TM1800 Timing M/R Module 2
IPS-CBEX		CG-19000	TM1800 Analog Module 1
IPS CBEX is a database for circuit breakers and can be purchased as a stand alone software or as a server version and also as a attractively priced package together with TM1800 Expert.		CG-19060	TM1800 Timing AUX Module 1
For more information please visit our web site or contact customer service.		CG-8000X	CABA Win - TM1800 1
		TM1800 Expert – for DualGround testing	
		CG-19296	
		<i>Including:</i>	
		CG-19090	TM1800 Basic Unit 1
		CG-19030	TM1800 Control Module 2
		CG-19080	TM1800 Timing M/R Module 2
		CG-19192	TM1800 DCM Module 2
		CG-19000	TM1800 Analog Module 1
		CG-19060	TM1800 Timing AUX Module 1
		CG-8000X	CABA Win - TM1800 1

SPECIFICATIONS

Specifications SDRM202

Inaccuracy is specified for 1 year after calibration at 22 °C to 28 °C, relative humidity 90%. Specifications are valid after 30 minutes warm up time. Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Installation category CAT I

Pollution degree 2

Temperature

Operating -20 °C to +50 °C (-4 °F to +122 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Vibration IEC 60068-2-6
2 g for 5-500 Hz

Shock (non-operating) IEC 60068-2-27
30 g, half-sine, 11 ms

Degree of protection

SDRM202 (Box) and SDRM Cable interconnected IP 43

Humidity 5% – 95% RH, non-condensing

CE-marking

LVD 2006/95/EC

EMC 2004/108/EC

General

Dimensions 160 x 240 x 90 mm
(6.3"x 9.4"x 3.5") excl. binding posts

Weight 1.8 kg (4 lbs)
4.3 kg (9.5 lbs) incl. current cables

Total incl. transport case with accessories 11 kg (24 lbs)

SDRM Cable 0.2m (0.7 ft), 0.7 kg (1.5 lbs)

SDRM202 – Terminals**CURRENT OUTPUT terminals 1 and 2**

Open circuit 2.5 V DC (max)

Short circuit current (max)

Instantaneous 500 A DC

After 2 seconds 150 A ±10%

Minimum current with cables

Instantaneous 200 A DC

After 1 second 140 A DC

Overvoltage protection 45 V between terminals and between terminals and ground

Not to be connected to circuits generating peak power pulse above 1500 W (10/1000 μs)

SDRM Cable – Terminals**TM1800/TM1600/EGIL****ANALOG INPUT terminals I₁ and I₂**

Voltage (max) 12 V DC

Voltage 10 V/250 A (TM1800, EGIL)

1 V/250 A (TM1600)

Short circuit current (max) 100 mA

**SDRM202**

- Enables resistance measurement on circuit breakers
- Small and light weight
- A number of operations can be run with short waiting intervals

Description

The SDRM202 is an accessory for TM1800, TM1600 and EGIL. EGIL must be equipped with the SDRM option and CABA Win version R03A or higher is needed.

The SDRM202 is intended to use for both static and dynamic resistance measurements (SRM and DRM) on high voltage circuit breakers or other low resistive devices. Used together with TM1800, TM1600/MA61 or EGIL the current and also the voltage-drop across the circuit breaker contacts are measured. The measuring unit can thus calculate the resistance as a function of time.

A system consists of an SDRM202 unit with current cables and an SDRM Cable which comes in three versions; for TM1800, TM1600 and EGIL respectively. The SDRM Cable is a small box with integrated cables for connection to the SDRM202 and to TM1800, TM1600 or EGIL.

SRM inaccuracy

TM1800/TM1600	1% ±1 μΩ
EGIL	(2% ±2 μΩ)

TM1800/TM1600

DRM OUTPUT terminal / TRIG terminal

Voltage	60 V DC (max)
Trig threshold	9 V (min) 10 V (max)
Trig current at trig threshold	40 mA (max)

Power inlet

24 V / 2.5 A



Voltage	24 V DC (max) 21 V DC (min)
Current	2.5 A (max 50% intermittence)

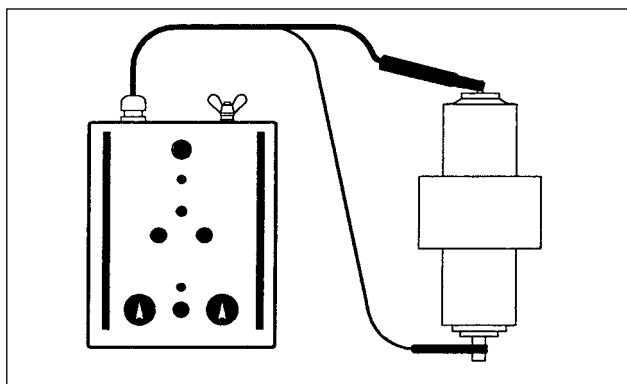
ORDERING INFORMATION

Product	Order code
SDRM202 for TM1800	CG-90200
SDRM202 for TM1800 Pack of 3 units (CG-90200) for circuit breaker with 2 Breaks/Phase	CG-90230
SDRM202 for TM1600	CG-90210
SDRM202 for EGIL	CG-90220
Optional accessories	
Extension cable for CG-90200 and CG-90210 10 m (33 ft) extension	GA-12810
7.5 m (24.6 ft) extension	GA-12811
Separate SDRM Cables	
SDRM Cable for TM1800	CG-90205
SDRM Cable for TM1600	CG-90215
SDRM Cable for EGIL	CG-90225

Applications

The VIDAR vacuum tester is used to test the ability of the VI in a vacuum circuit to inhibit flashover. The rugged, lightweight, compact and portable VIDAR is ideal for field work and shop floor applications.

The VI in vacuum breakers does 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 interrupter can make it unsafe during operation. The mechanics of the breaker can become misaligned so that the distance between the poles is no longer adequate. VIDAR uses high voltage DC to test the integrity of vacuum breakers.



Connection diagram for the VIDAR



VIDAR

- Enables resistance measurement on circuit breakers
- Small and light weight
- A number of operations can be run with short waiting intervals

Description

When a vacuum circuit breaker is commissioned or undergoes routine tests, it is very important to be able to ascertain whether or not the Vacuum Interrupter (VI) is intact before putting it back into operation.

VIDAR enables you to check the integrity of the vacuum interrupter quickly and conveniently by means of the known relationship between the flashover voltage and the vacuum interrupter. A suitable test voltage (DC) is applied to the breaker, and the result is known immediately.

VIDAR permits you to select among test voltages from 10 to 60 kV DC. One of these voltages is customized and specified by the customer when ordering. A green lamp indicates approval of the VI. A red lamp indicates that it is defective. Two-hand control and a high-voltage warning lamps enhances safety.

VIDAR has been developed in close collaboration with leading manufacturers of vacuum circuit breakers. It weighs only about 6 kg (15 lbs), and it is easy to use since interrupters do not have to be dismantled for testing. VIDAR is therefore ideal for use in the field or shop floor applications.

Vacuum interrupter tester

Flashover threshold voltage

The curve shown in Fig. 1 illustrates the relationship between the VI's internal pressure and its ability to inhibit flashover. This relationship permits the vacuum to be checked indirectly by measuring the voltage threshold. One special advantage of this method is that you do not need to disassemble the circuit breaker in order to test it.

The voltage is selected so that test point A is sufficiently far from point B (when the chamber is filled with air). However, the electric stress in the chamber must not be too high. In normal situations, the pressure is less than 10^{-2} mbar.

For guidance on test voltage refer to IEC 694 and ANSI C37-06 standards

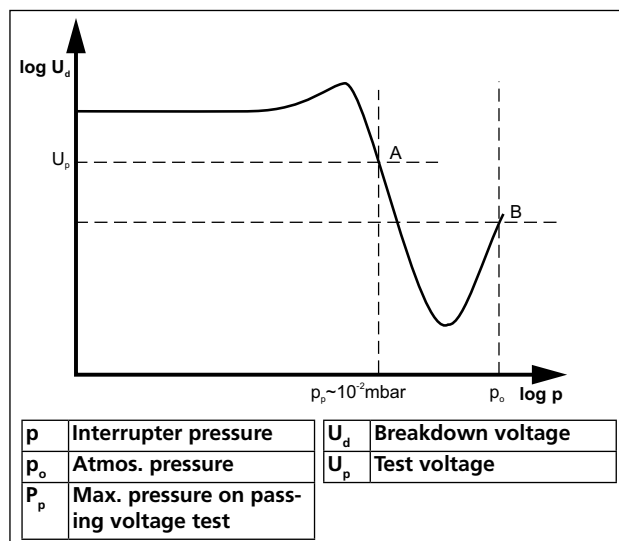
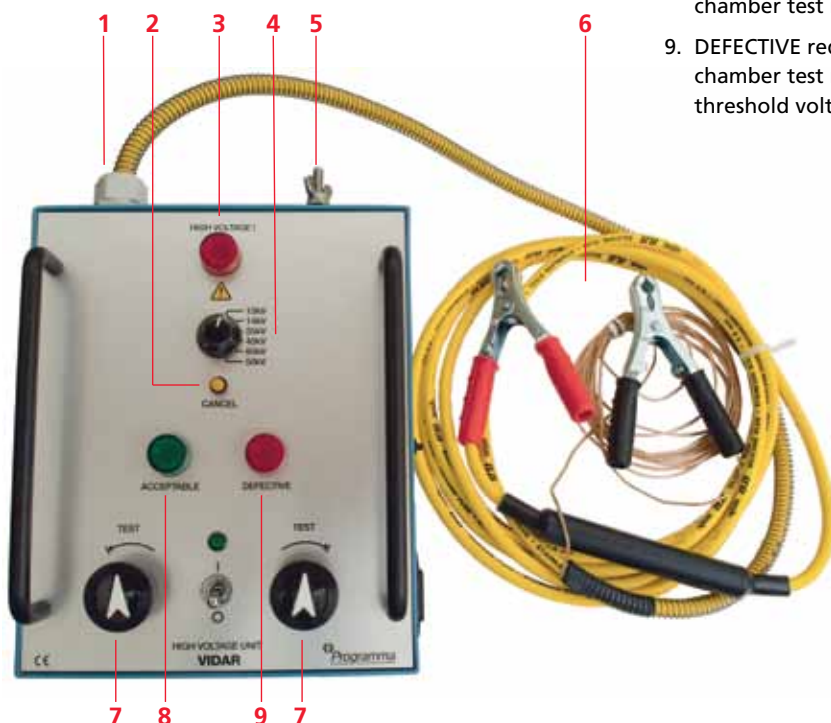


Fig. 1: Flashover threshold voltage plotted against pressure in vacuum interrupter.

Features and Benefits

- High voltage cable. For connection of the test voltage and ground to the vacuum breaking chamber.
- CANCEL lamp. Lights up when:
 - the test interval has exceeded one minute.
 - you try to conduct a one minute test less than two minutes after the latest test.
 - the HIGH-VOLTAGE indicator malfunctions.
- HIGH-VOLTAGE warning lamp. Shows that the high voltage is applied.
- Test voltage selector. 10 to 60 kV DC. One of these voltages is customized and specified by the customer when ordering.
- Protective earth (ground) terminal.
- Large test clip connectors – provides for quicker connection and more efficient testing process
- TEST Safety control knobs. Both knobs must be turned simultaneously to apply high voltage to the test object.
- ACCEPTABLE green lamp. Lights up when the breaking chamber test result is positive.
- DEFECTIVE red lamp. Lights up when the breaking chamber test result is negative, when the flashover threshold voltage is too low.



SPECIFICATIONS

Specifications VIDAR

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in medium and high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE-marking

LVD 2006/95/EC

EMC 2004/108/EC

General

Mains voltage 115/230 V AC (switchable), 50/60 Hz

Power consumption 69 VA (max)

Protection Overload cut-out

Dimensions

Instrument 250 x 210 x 125 mm
(9.8" x 8.3" x 4.9")

Transport case 460 x 430 x 210 mm
(18.0" x 17" x 8.3")

Weight 6.9 kg (15.5 lbs)
10.7 kg (23.6 lbs) with accessories and transport case

Measurement section

Indicators

Green lamp Indicates an approved breaking chamber

Red lamp Indicates a defect breaking chamber, lights up if the current exceeds 0.3 mA

Yellow lamp Indicate that the test was interrupted

Output

Standard voltages, switchable 10, 14, 25, 40 and 60 kV DC

Customized voltage Between 10 and 60 kV DC. Determined at the factory. Default voltage is 50 kV.

Ripple Max 3%

ORDERING INFORMATION

Product	Order code
VIDAR Included accessories: Permanently mounted cable set 5 m (16 ft), ground cable and transport case (GD-00030)	BR-29090



to operate, and the built-in thermal cutout and overload protector make it safe to use. The B10E has been developed in collaboration with breaker manufacturers and testing personnel.

Application

The B10E is a portable self contained test set designed specifically for use in substations and industrial locations. The B10E is intended for testing medium and high-voltage power circuit breakers. Using the latest technology the B10E uses a ripple free variable DC voltage to operate breaker coils, and charging motors to ascertain the condition of these devices with respect to the manufacturer's original specifications.

B10E

- Reliable and stable 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 trip voltage testing
- Operate with a breaker analyzer for efficiency in testing sequence

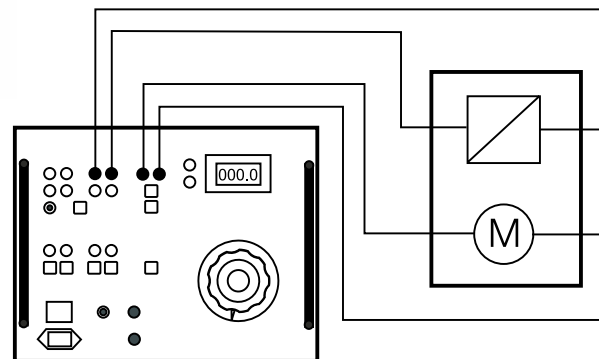
Description

A variable DC voltage is needed to test a circuit breaker. Substation batteries should not be used since this entails considerable risk for testing personnel, testing equipment and also for the equipment being tested. The best way to ascertain whether or not solenoids and protective mechanisms are sluggish or working properly is to perform a test at minimum tripping voltage. The minimum trip voltage test is described in international and national standards such as IEC 62271-100, ANSI C37.09 etc.

B10E can be used to test breaker coils in this manner. It provides a ripple-free variable DC voltage that can easily accommodate a high, variable load.

Since there is a separate output for supplying spring-charging motors, the B10E is ideal for testing circuit breakers where auxiliary voltage is not connected or available.

The compact Power Supply Unit B10E provides reliable assistance to those who do maintenance on high-voltage breakers. The control panel's intuitive layout makes it easy



Testing the minimum trip voltage of a breaker.

SPECIFICATIONS

Specifications B10E

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in medium and high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 115/230 (135/250) V AC, 50/60 Hz

Power consumption (max) 3300 W

Protection Thermal cut-outs, +80 °C (+176 °F)
Short-circuit protectors at DC outputs

Dimensions

Instrument 350 x 270 x 220 mm
(13.8" x 10.6" x 8.7")

Transport case 610 x 290 x 360 mm
(24.0" x 11.4" x 14.2")

Weight 20.8 kg (45.8 lbs)
29.3 kg (64.6 lbs) with accessories and transport case

Test lead set, with 4 mm stackable safety plugs 2 x 0.25 m (0.8 ft), 2.5 mm²
2 x 0.5 m (1.6 ft), 2.5 mm²
8 x 2 m (6.6 ft), 2.5 mm²

Display LCD

Measurement section

Voltmeter – digital

Range 0 – 300 V DC, 0 – 300 V AC

Resolution 1 V

Inaccuracy ±1% of displayed value, DC
±2.5% of displayed value, AC

Current shunt 5 A/50 mV ±0.5% (built-in)

Outputs (DC), CATII

COIL, CLOSING/BREAKING

Output voltage 24-300 V DC
Load interval Max 1 s (at currents over 50 mA)
Ripple 2% peak-to-peak of the preset voltage

No-load voltage (V)	Current (A)	Load dependency
24	10	<6 %
48	10	<3 %
110	7.9	<2 %
250	3	<2 %
300	1.25	<2 %

Outputs (AC), CATII

COIL, CLOSING/BREAKING

Output voltage 24-300 V AC
Load current Max 5 A
Load interval Max 30 min

Output DC, CATII
MOTOR

Output voltage 24-300 V DC (loaded)

Open circuit voltage (V)	Current (A)	Load voltage (V)	Max load interval (s)
44	18	24	20
48	12	40	60
48	18	30	20
120	12	90	60
120	18	70	20
240	6	200	60
240	9	185	20

Max voltage: Terminals to protective earth (ground)

Terminal	Voltage
Coil closing, AC & DC	300 V AC
Coil breaking, AC & DC	300 V AC
Motor	250 V AC
Shunt	250 V AC
Trigger closing	250 V AC
Trigger breaking	250 V AC

ORDERING INFORMATION

Product	Order code
B10E	
Included accessories: Cable set GA-00032 Transport case GD-00182	BG-29092

Circuit breaker and overcurrent relay test set



MS-2A

- Light weight, portable primary injection test instrument
- Overcurrent relay testing
- Ground fault performance testing for NEC 230.95
- Circuit breaker testing

Description

The MS-2A test set is used around the world by several thousand utility companies, industrial plants and electrical service organizations.

The MS-2A is a self-contained test set that incorporates a variable high-current output and appropriate control circuitry and instrumentation for testing thermal, magnetic or solid-state motor overload relays, molded-case circuit breakers, ground-fault trip devices and overcurrent relays.

The MS-2A is capable of testing the time-delay characteristics of overcurrent relays, motor overload relays and molded-case circuit breakers rated up to 125 amperes, when following the recommended test procedure of testing the time delay of these devices at three times their rating.

Higher currents are available for the short durations required to test an instantaneous trip element. For example, the test set will provide a maximum short-duration output of 750 amperes through a typical, 125 ampere, molded-case circuit breaker.

SPECIFICATIONS

SPECIFICATIONS	
Input	
Input Voltage (specify one)	120 V OR 240 V, 50/60 Hz, 1 ϕ
Output	
Output Ranges	The output is continuously adjustable in four ranges to accommodate a variety of test-circuit impedances: 0 to 5 A at 120 V max. 0 to 25 A at 24 V max. 0 to 120 A at 6 V max. 0 to 240 A at 3 V max.
Output Capacity	The output circuit is designed to permit short-duration overloads and the output ranges will provide several times their current rating, provided the output voltage is sufficient to push the desired current through the impedance of the test circuit. The test set is capable of testing the time-delay characteristics of devices rated up to 125 A using a test current of three times their rating (375 A). Additionally, to perform an instantaneous trip test, it will provide 750 A through a typical, 125 A, molded-case circuit breaker connected with the test leads provided with the test set.
Overload Capability	To increase use of the test set, it is designed so that the current ratings may be exceeded for short durations. Because the magnitude of the output current is determined by the impedance of the load circuit, the voltage rating must be sufficient to push the desired current through the device under test and the connecting test leads.

Percent Rated Current	Maximum Time On	Minimum Time Off
100 (1x)	30 min	30 min
200 (2x)	3 min	8 min
300 (3x)	30 s	4 min

Specifications continued	
Output Initiate Circuit	The test set uses a solid-state output initiating circuit. To increase reliability and eliminate contact maintenance, this circuit uses a triac instead of a contactor to initiate the output. The initiating circuit provides momentary and maintained modes to control output duration. The momentary mode is used whenever the output is to be on for a short duration, such as when performing instantaneous trip tests, or to avoid damage or overheating of the device under test while setting the test current. In the maintained mode, the output remains energized until manually turned off or, when performing timing tests, until the device under test operates — which both stops the timer and de-energizes the output.

INSTRUMENTATION

Ammeter

Operating Modes (switch-selected)	Memory Normal
Display	3½ digit, extra-bright LED display with 0.3 in. (7.62mm) numerals
Ranges (switch-selected)	0 to 1.999/19.99/199.9/750 A
Continuous Accuracy (overall ammeter system)	±1% of reading, ±1 digit on three high ranges ±1% of range, ±1 digit on low range
Timer	
Display	5-digit, extra-bright, LED display with 7.62mm (0.3 in.) numerals
Ranges (switch-selected)	0 to 99.999 s 0 to 999.99 s 0 to 99999 cycles
Accuracy	±0.005% of reading, ±1 digit

Timer Control Circuit	This circuit automatically starts the timer when the output is energized and automatically stops the timer and de-energizes the output when the device under test operates. This circuit accommodates the following test conditions by simple switch selection of the appropriate mode:
Current Actuated	Used to test a device that has no auxiliary contacts to monitor, such as a single-pole circuit breaker. The timer stops when the output current is interrupted.
Normally Closed	Used to test a device with normally closed contacts. The timer stops and the output is de-energized when the contacts open.
Normally Open	Used to test a device with normally open contacts. The timer stops and the output is de-energized when the contacts close.
Enclosure	The test set is housed in a high strength, molded, suitcase-type enclosure with carrying handle and removable cover. Storage space is provided for test leads.
Standards	CE marked EN 61326-2-1 EN 61010-1 EN 61010-031
Mechanical data	
Dimensions	25 H x 35 W x 28 D cm (9.9 H x 14 W x 11 D in.)
Weight	15 kg (33 lb)

ORDERING INFORMATION

Product	Order Code
Model MS-2A	
115 volt input	MS-2A-115
230 volt input	MS-2A-230
Included accessories	
Test lead, red, 200 cm [2]	620143
Test lead, black, 200 cm [2]	620144
Alligator clip, red [2]	684006
Alligator clip, black [2]	684007
Test and maintenance record cards	
Green [50]	2239
Buff [50]	2238
No. 2 high-current leads, 0.6 m (2 ft) [2]	620155
Fuses	
0.125 A, 250 V, MDL [5]	981
Instruction manual [1]	750026



OCR-8015 and OCR-9150

- Preprogrammed test sequences for reclosers and sectionalizers
- High-capacity outputs to test virtually all reclosers
- Accurate duplication of high-voltage test results
- Simple operation and precise test results
- Simplified adjustment of test current

Description

The OCR-8015 and OCR-9150 automatic oil circuit recloser test sets are self-contained mobile test sets specifically designed to verify the proper operation of automatic circuit reclosers under simulated overload and fault conditions. This ensures reliable system protection and coordination. Microprocessor-based control and instrumentation systems ensure simple operation with precise test results. OCR-8015 and OCR-9150 provide a variable high-current output with an impedance compensation network to stabilize the output current.

They include appropriate instrumentation and control circuitry to efficiently, accurately and safely test virtually all single-phase and three-phase direct-acting reclosers produced by manufacturers such as Cooper Power Systems, Inc., McGraw-Edison (Kyle, Line Material), Westinghouse, General Electric, Kearney, and Lexington Switch and Controls.

Applications

The automatic oil circuit recloser test sets not only test reclosers incorporating either oil or vacuum interrupters, but also easily test sectionalizers. Additionally, they can perform primary injection (high-current) testing of electronically controlled reclosers.

The following tests are performed on reclosers.

Minimum trip current: This test determines the minimum operating (pickup) point. The minimum pickup test is performed by increasing current flow through the operating coil of the recloser until the recloser begins to operate.

The microprocessor in either unit will detect, measure and display the test current at this point. This is the pickup and is usually two times the current rating of the coil.

Time-current characteristics: This test determines the operating characteristics of the recloser under simulated fault conditions. The time-current characteristics and sequence of events tests are performed by subjecting the recloser to simulated overloads using a recommended test current of four to six times the coil rating.

The current, trip time and reclose time for each operation, as well as the total clearing time, are all automatically measured by the test sets. OCR-9150 has the additional capability to test the time-current characteristics by simulating overloads as high as eight to ten times the continuous current rating.

Sequence of operation: The units verify the number and sequence of operations to lockout.

Operating time: A digital timer measures the elapsed time of each operation.

Reclosing time: A digital timer measures the reclosing interval between each operation.

Total clearing time: A digital timer measures the total elapsed time to lockout.

Similar tests can be performed on electronically controlled reclosers using primary injection testing. Primary injection not only tests the electronic control, but also checks the entire system including the CTs, control cable, auxiliary solenoids or wiring connections.

These test sets can also be used to perform a lockout test on sectionalizers. The lockout test is automatically performed by a special programmed test sequence that automatically applies and removes activating current to the sectionalizer. This simulates the upstream operation of a recloser; therefore, the sectionalizer should go through its normal sequence to lockout. The number of current pulses required to reach lockout is compared to the sectionalizer nameplate data.

OCR-8015 and OCR-9150 can also be used for other high-current applications such as ratioing current transformers, performing heat runs or testing direct-acting circuit breakers.

SPECIFICATIONS

INPUT

Order Code	Input Voltage (Single-Phase)	Input Frequency
OCR-8015-208/60	208 V ±5% at 150 A 230 V ±5% at 150 A 460 V ±5% at 40 A 575 V ±5% at 35 A	60 Hz
OCR-8015-220/50	220 V ±5% at 150 A 224 V ±5% at 150 A 380 V ±5% at 40 A 415 V ±5% at 35 A	50 Hz
OCR-9150	460 V ±5% at 150 A	60 Hz

OUTPUT

Output Rating

Model OCR-8015	15 kVA
Model OCR-9150	50 kVA

Rated Output Ranges
The output is continuously adjustable through the following ranges to meet a wide variety of test circuit impedances:

OCR-8015	OCR-9150
0 to 2000 A at 7.5 V max. 0 to 1500 A at 10 V max. 0 to 1000 A at 15 V max. 0 to 500 A at 30 V max. 0 to 250 A at 60 V max. 0 to 100 A at 150 V max. 0 to 50 A at 300 V max. 0 to 25 A at 600 V max.	0 to 2800 A at 18 V max. 0 to 2000 A at 25 V max. 0 to 1400 A at 36 V max. 0 to 1000 A at 50 V max. 0 to 700 A at 71.5 V max. 0 to 500 A at 100 V max. 0 to 350 A at 143 V max. 0 to 250 A at 200 V max. 0 to 150 A at 334 V max. 0 to 100 A at 500 V max. 0 to 50 A at 1000 V max.

Duty Cycle
The test sets will supply the rated output current indicated above for 30 minutes, followed by 30 minutes off.

Overload Capability
For testing reclosers or for other applications requiring high current for short durations, the test sets will provide output currents significantly above the nominal current ratings given above. Where the output voltage is sufficient to push higher than the rated current through the impedance of the load, the test sets can be overloaded as shown below. The actual output current obtained is determined by the impedance of the load circuit and by the resistance selected in the impedance compensation network.

Percent Rated	Maximum On Time	Minimum Off Time
100%	30 minutes	30 minutes
200%	75 seconds	6 minutes
300%	25 seconds	4 minutes

This product

is not available for sale in the European Economic Area

Specification continued

Impedance Compensation Network

This circuit is used to minimize the change in output current that occurs when the trip rod travels through the series trip coil of the recloser, causing the coil impedance to rise appreciably. A reasonably constant output current is provided by inserting resistance in the primary circuit of the output transformer of the test set. This will minimize the effects of changing impedances within the recloser. The appropriate impedance compensation resistance is selected by a switch mounted on the front panel.

Timer Measurements

An autoranging, solid-state timing system with digital display is incorporated to provide individual indication of the elapsed time of each sequence of the recloser's operation. Operating (trip) times, reclosing intervals and total time to lockout are indicated.

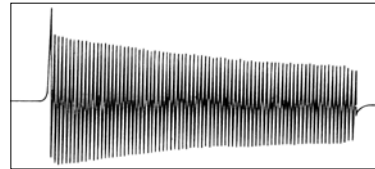


Figure 1: With no impedance compensation a recloser with a 50 ampere coil and an initial test current of 210 amperes operated in 2.641 seconds — three times the manufacturer's specifications.

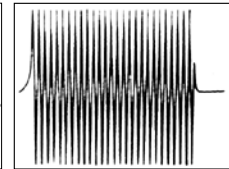


Figure 2: With an impedance compensation network, a recloser with a 50 ampere coil and an initial test current of 210 amperes operated in 0.783 of a second with no significant current decay. The result was well within the manufacturer's specifications.

Timer Ranges (autoranging)	0 to 999.9 s 0 to 9999 cycles
Timer Accuracy	
Seconds Mode	±1 digit or 0.005% of reading, whichever is greater
Cycles Mode	±2 digits or 0.005% of reading, whichever is greater

Current Measurements

A microprocessor-based circuit automatically detects, measures and displays the minimum pickup current. Additionally, a solid-state ammeter with digital display is specifically designed to accurately measure short-duration currents using a read- and-store memory circuit. It also will function as a standard ammeter that continuously measures the output current. Current measurements for each operation of the recloser under test are stored by the microprocessor until displayed or reset.

Ranges (switch-selected)	0 to 19.99 A 0 to 199.9 A 0 to 1.999 kA 0 to 19.99 kA
	Each range has an over-range capability of 10%. In the event a current measurement exceeds the range in use, measurement can be made of currents up to 10% over that range's full-scale rating.

Overall Metering Accuracy

Instrument	±0.5% of reading ±0.1% of full scale ± last digit
Current Transducer	±1% of reading

OCR-8015 and OCR-9150

Automatic oil circuit recloser test sets

Panel indicators

Panel lamps are incorporated for operator safety and convenience. They indicate numerous conditions such as input power on, output energized, excessive shots and excess time.

Accessory outlet

A ground fault protected, 120 volt outlet with a capacity of 1.2 kVA is provided for convenient connection of accessory equipment.

Operator safety interlock system

A safety interlock system, in conjunction with a foot switch, is incorporated to prevent the operator from leaving the control area of the test set. This helps to prevent accidental contact between the operator and the output section.

Output connections

Busbar connections are provided for high-current ranges and insulated terminals are provided for high-voltage ranges.

Protection

Appropriate protective devices are incorporated to protect the test sets from overloads and short circuits.

Enclosure

For safety and mobility, each test set is housed in a single, rugged, sheet-metal enclosure with a low center of gravity, tow ring, lifting eyes and large locking swivel casters with brakes. To increase the maneuverability, all four casters swivel; however, they also can be easily locked into a fixed position when desired. Controls and instrumentation are positioned so the operator can simultaneously observe the recloser under test.

Dimensions

OCR-8015	114 H x 135 W x 66 D cm (45 H x 53 W x 26 D in.)
OCR-9150	114 H x 152 W x 71 D cm (45 H x 60 W x 28 D in.)

Weight

OCR-8015	500 kg (1100 lb)
OCR-9150	729 kg (1620 lb)

ORDERING INFORMATION

Product	Order Code
OCR-8015	
208 volt, 60-Hz input	OCR-8015-208/60
220 volt, 50-Hz input	OCR-8015-220/50
OCR-9150	OCR-9150
OCR-8015 with computer interface option	
208 volt, 60-Hz input	OCR8015-208/60C
220 volt, 50-Hz input	OCR8015-220/50C
OCR-9150 with computer interface option	OCR-9150/C
Included accessories	
Input cables, 4/0, 4.5 m (15 ft) [2]	17163
Output cables	
Single 4/0 [1 pr]	1531
Double 4/0 [1 pr]	1532
Timer leads [1 pr]	2997
Optional accessories	
RS232 and printer port conversion kit	12563
Protective cover, OCR-8015 only [1]	PC-1



Linear transducer, LWG 150



Linear transducer, TLH 225



Linear transducer, TS 25



Switch magnetic base



The SDRM Cable is in three versions; for TM1800, TM1600 and EGL. This picture shows the version for TM1800.



The red current cables are 3.0 m (9.8 ft) and the black ones are 0.5 m (1.6 ft).



Cable set GA-00032



SDRM Cable



Rotary transducer, Novotechnic IP6501 (analog)



Rotary transducer, Baumer BDH (digital)



The SDRM201 is intended to use for both static and dynamic resistance measurements (SRM and DRM) on high voltage circuit breakers or other low resistive devices



Cable reels, 20 m (65.5 ft), 4 mm stack-able safety plugs



Multicable sets GA-00160 and GA-00170 and cable set GA-00082



The SDRM Cable



Transducer cables GA-00041 and GA-00042



Current cables for SDRM201, the red cable is 3.0 m (9.8 ft) and the black one is 0.5 m (1.6 ft)



Extension cable XLR, GA-01005



Extension cable XL, GA-00150



Earth Resistance Testers

Megger has more than 50 years experience of designing and building earth resistance testers. The latest generation is CATIV rated, and they have tough moulded cases.

7

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SELECTION GUIDE



	DET3TD	DET3TC	DET4TD2	DET4TR2	DET4TC2	DET4TCR2	DET14C	DET24C	DET2/2
Stakeless testing							■	■	
Stakeless testing with optional test clamps					■	■			
ART (Attached Rod Technique) with optional clamp		■			■	■			
Selectable test frequency					■	■			■
Earth voltage range 0 to 100 V	■	■	■	■	■	■			
2-wire testing	■	■	■	■	■	■			
3-wire testing	■	■	■	■	■	■			
4-wire testing			■	■	■	■			■
Dry cell batteries	■	■	■		■		■	■	
Recharging socket				■		■			■
Rechargeable batteries				■		■			■
Backlit display					■	■	■	■	■
Digital display	■	■	■	■	■	■	■	■	■
Test result storage							■	■	
Downloadable test results								■	
Earth current range 0.2 mA to 35 A							■	■	
Earth current range 0.5 mA to 19.9 A (with optional measuring clamp)		■			■	■			
Resistance range	0.1 to 2 kΩ	0.1 to 2 kΩ	0.1 to 20 kΩ	0.1 to 20 kΩ	0.1 to 200 kΩ	0.1 to 200 kΩ	0.05 to 1500 kΩ	0.05 to 1500 kΩ	0.010 to 19.99 kΩ
PowerDB Lite included			■	■	■	■		■	



Ask for your copy of 'Getting Down To Earth', an 80 page comprehensive guide to earth resistance testing.

Earth resistance testing is an essential procedure that underpins the safety of electrical installations. Unfortunately it has a reputation for being complicated, inconvenient and difficult to perform, with difficulties in some circumstances of obtaining accurate results.

All of these issues are addressed by the latest range of earth resistance testers from Megger, which has been extended to include a model powered from rechargeable batteries and versions with variable test frequency.

In addition, the maximum resistance that can be measured has been increased ten fold for all models, and you can specify additional options when purchasing test kits.

For demanding applications requiring maximum versatility, Megger offers the DET4TC2 tester, which is powered from standard AA batteries; and the DET4TCR2 tester, which uses rechargeable batteries. The DET4TCR2 has an integral charger, and is supplied complete with a mains adaptor.

These instruments support two-, three- and four-pole testing, as well as Attached Rod Technique (ART), stakeless, leakage current and earth noise voltage measurement. They also let you select the test frequency from one of four options – 94 Hz, 105 Hz, 111 Hz and 128 Hz – making it easy, even in difficult situations, to choose a frequency which minimises the effects of interference.

Also available are the new DET4TD2 and DET4TR2 testers, the former being designed for use with replaceable batteries, the latter with rechargeable cells. Fully supporting the most popular earth resistance test methods – two-, three- and four-pole testing – these very competitively priced instruments are an ideal choice for use where the exceptional versatility of the DET4TC2 models is not needed.

Megger's new earth resistance testers are offered in a wide range of kit options. Basic kits include the instrument, a tough, hard carrying case, a stake and wire kit (15 m, 10 m, 10 m and 3 m lengths) and for rechargeable models, a mains unit. Adaptor kits replace the stake and wire kit with right-angle terminal adaptors to connect bare wires to terminals. Also offered for the DET4TC2 models are kits for ART and stakeless testing.

All accessories are available separately which means that users can if they wish, select the most appropriate combination to suit their own particular needs rather than opting for a pre-configured kit.



2 terminal ground electrode testing

Use where the resistance between a conducting part, such as building steelwork and the ground electrode needs to be measured, or where site conditions means that test stakes are impractical. This test is performed using the same a.c. source as the 3 pole test method and as such may not be suitable for bonding checks as specified by local regulations. All of the new Megger earth testers can perform this test and no external linking on the instrument is required.

Stakeless measurement or clamp ground electrode testing

This technique is suitable for connected ground electrodes and lightning systems as it relies on an existing complete circuit with the soil to take its measurement. No disconnection is required; the DET14C or DET24C is simply placed around the conductor where it generates the signal in the circuit using magnetic induction and then calculates the resistance. They have the added benefit of being able to measure earth current. Care is needed in the application of these instruments to ensure that the circuit under test is valid.

4 terminal testing for soil resistivity testing

Testing soil resistivity is a fundamental part of earth system design, providing the raw data on which the design is based. Factors affecting soil resistivity include soil composition, temperature and moisture content, which can vary with the seasons. Periodic checking of the soil is necessary to ensure that seasonal variations are within the design parameters of the system. The DET4TD2 features 4 pole testing for soil resistivity and includes a kit of four stakes and wires.

3 terminal testing ground electrode testing

The classic methods of testing earth electrode resistance based on fall of potential are used both at installation time and also for periodic checking the condition of the electrodes. Unfortunately soils that have low resistivity are often corrosive to electrodes, making regular checking important. All the new family of Megger earth testers allow you to perform this test and include stake and wire kits as standard.

Attached rod technique (ART)

Testing earth electrodes in existing installations using standard three pole methods normally involves the disconnection of the electrode under test to avoid the influence of parallel paths. These parallel paths are created by the earthing system of the installation or by other ground electrodes forming the ground system. Using the Megger DET3TC ground tester with the ICLAMP allows you to measure the individual earth electrode resistance, using traditional fall of potential methods, but without disconnection of the electrode under test.

High resolution earth testing

A high resolution to 1 mA is required to measure resistivity to adequate depth on many substation and communication sites. Measurement of the low earth values required on many installations, to meet Ground Potential Rise (GPR) requirements need this resolution to ensure valid results. Superior noise filtering greater than 40 V peak to peak retains measurement resolution under real test conditions.



DET3TD

2 and 3 pole earth tester



DET3TD

- 2 and 3 pole testing
- Selectable 25 V or 50 V output
- Complete with lead and stake kit
- Simple one button operation
- Hardwearing carry case
- Delivered with calibration certificate

Description

Electrical contractors choose DET3TD because it is simple to use and robust. Capable of performing 2 and 3 pole measurements, this instrument is ideal for testing both installation and lightning protection ground electrode systems.

The instrument is tough in every way, built to work in the toughest of outside conditions, and built to give you a high level of electrical safety. This is demonstrated by specifications such as IP54 ingress protection, high noise immunity, and CAT IV safety.

ORDERING INFORMATION

Product	Order Code
Digital tester 2 and 3 terminal	DET3TD
Included accessories	
Hard carry case	
Stake and wire kit	
Optional accessories	
Right angled terminal adaptor set	6220-803
2 replacement earth test spikes (200 mm, 80 mm dia.)	6220-804
3 replacement test leads (15 m, 10 m, 3 m)	6220-805
'Getting down to earth' A Megger guide to earth testing	21500-072
Black crocodile clip	6220-850

SPECIFICATIONS

Spike check

C spike check	Automatic
P spike check	Automatic

Noise

Noise check	Automatic
Noise rejection	40 V peak to peak

Wire test

2-wire test	Yes
3-wire test	Yes

Resistance

Resistance accuracy	2% \pm 3 digits
Resistance range	0.01 to 2000 Ω

Maximum probe resistance

Rp limit	100 k Ω (50 V output voltage)
Rc limit	100 k Ω (50 V output voltage)

Limits reduced to 50 k Ω for 25 V output voltage

Limits reduced to 5 k Ω for 0.01 Ω resolution on 18 Ω range

Voltage, frequency and current

Earth voltage accuracy	2% \pm 2 V
Earth voltage range	0 - 100 V a.c.
Test voltage	25 V or 50 V, user selectable (factory setting 50 V)
Test frequency	128 Hz
Test current	450 μ A or 4.5 mA

Display

LCD	
-----	--

Power supply

Battery type	8 off AA cells
Battery life	3 hours or 700 consecutive tests

Temperature range

Operating temperature range	-15 $^{\circ}$ C to +55 $^{\circ}$ C
Storage temperature range	-40 $^{\circ}$ C to +70 $^{\circ}$ C

Environment

Ingress protection	IP54
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Safety

IEC61010-1 CAT IV 100 V	
EN61557-1, EN61557-5	

EMC

IEC61326-1	
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Mechanical data

Dimensions (H x W x D)	203 mm x 148 mm x 78 mm
Weight	1 kg

SPECIFICATIONS

Spike check

C spike check	Automatic
P spike check	Automatic

Noise

Noise check	Automatic
Noise rejection	40 V peak to peak

Wire test

2-wire test	Yes
3-wire test	Yes
No disconnect testing (ART)	Yes, with optional ICLAMP

Earth current

Earth current range with ICLAMP	0.5 mA to 19.9 A
Earth current accuracy	5% ±3 digits

Resistance

Resistance range	0.01 to 2000 Ω
Resistance accuracy	2% ±3 digits

Maximum probe resistance

Rp limit	100 kΩ (50 V output voltage)
Rc limit	100 kΩ (50 V output voltage)

Limits reduced to 50 kΩ for 25 V output voltage

Limits reduced to 5 kΩ for 0.01 Ω resolution on 18 Ω range

Voltage

Earth voltage range	0 - 100 V a.c.
Earth voltage accuracy	2% ±2 V

Display

LCD

Power supply

Battery type	8 x AA cells
--------------	--------------

Temperature range

Operating temperature range	-15 °C to +55 °C
Storage temperature range	-40 °C to +70 °C

Environment

Ingress protection	IP54
--------------------	------

Safety

IEC61010-1 CAT IV 100 V	
EN61557-1, EN61557-5	

EMC

IEC61326-1	
------------	--

Mechanical data

Dimensions (H x W x D)	203 mm x 148 mm x 78 mm
Weight	1 kg



DET3TC

- 2 and 3 pole testing
- Selectable 25 V or 50 V output
- Complete with lead and stake kit
- Simple one button operation
- Hardwearing carry case
- Delivered with calibration certificate

Description

Electrical contractors choose DET3TC because of its simplicity and robustness. Capable of performing 2 and 3 pole measurements, this instrument is ideal for testing both installation and lightning protection ground electrode systems. The DET3TC, with the addition of an ICLAMP adds the capability of performing ART (Attached Rod Technique) measurements, removing the need to disconnect a single electrode from a system to measure it.

ORDERING INFORMATION

Product	Order Code
Digital tester 2 and 3 terminal	DET3TC
Included accessories	
Hard carry case	
Stake and wire kit	
Optional accessories	
Current measuring clamp	ICLAMP
Right angled terminal adaptor set	6220-803
2 replacement earth test spikes (200 mm, 8 mm dia.)	6220-804
3 replacement test leads (15 m, 10 m, 3 m)	6220-805
'Getting down to earth' A Megger guide to earth testing	21500-072
Black crocodile clip (1)	6220-850

DET4TC2 and DET4TCR2

2, 3 and 4 pole earth testers (stakeless)



DET4TC2 and DET4TCR2

- 2, 3 and 4 pole testing
- Stakeless measurements
- User selectable test frequency
- Dry cell or rechargeable battery versions
- User selectable output voltage
- Simple one button operation

Description

The DET4TC2 and its rechargeable counterpart the DET4TCR2 are advanced ground testers offering advanced features to contractors and utilities alike. Capable of performing 2, 3, and 4 pole measurements, these instruments are ideal for testing both ground electrode systems, and soil resistivity.

Offering all the advantages of the DET4TD2 and DET4TR2, benefits are further enhanced with the addition of an ICLAMP and VCLAMP. The ICLAMP will allow the user to perform ART (Attached Rod Technique) measurements, removing the need to disconnect a single electrode from a system to be able to measure it. Using both an ICLAMP and a VCLAMP will add the capability to perform stake-less measurements, just like a clamp-on ground tester, ideal for locations where driving auxiliary stakes is not practical. DET4TC2 also includes variable test frequency allowing you to move away from problem noise frequencies, and it has extended resistance ranges which extends soil resistivity capabilities.

SPECIFICATIONS

Noise

C stake, P stake and Noise check	Automatic
Noise rejection	40 V peak to peak

Testing

2-wire, 3-wire, 4-wire test	Yes, no shorting links required
No disconnect testing (ART)	Yes, with ICLAMP
Stakeless measurement	Yes, with ICLAMP and VCLAMP

Instrument output

Voltage	±25 V or ±50 V at 94 Hz, 105 Hz, 111 Hz and 128 Hz
Current	4.5 mA or 0.45 mA or 0.045 mA
Earth current range with clamp	0.5 mA to 19.9 A
Earth current accuracy	5% ±3 digits
Earth voltage range	0 to 100 V a.c.
Earth voltage accuracy	2% ±2 V

Resistance

Resistance range	0.01 Ω to 200 kΩ
Resistance accuracy	2% ±3 digits
ART measurements	5% ±3 digits
Stakeless measurements	7% ±3 digits

Maximum probe resistance:

Rp limit	200 kΩ (50 V output voltage)
Rc limit	200 kΩ (50 V output voltage)

Limits reduced to 100 kΩ for 25 V output voltage

Limits reduced to 5 kΩ for 0.01 Ω resolution

Power supply

Battery type:	
DET4TC2	8 AA (LR6) cells
DET4TCR2	8 AA (LR6) NiMH rechargeable cells

Temperature range

Storage temperature range	-40 °C to +70 °C
Operating temperature range	-15 °C to +55 °C

Environment

Ingress protection	IP54
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Safety

Complies with the requirements of IEC61010-1 100 V CAT IV between terminal pairs

EMC IEC61326-1

Mechanical data

Dimensions (H x W x D)	203 mm x 148 mm x 78 mm
Weight	1 kg

ORDERING INFORMATION

Product and order code	■ feature □ option	DET4TC2	DET4TCR2	DET4TC2 + CLAMPS	DET4TCR2 + CLAMPS	DET4TC2 + KIT	DET4TCR2 + KIT
		1000-345	1000-346	1000-365	1000-366	1000-404	1000-405
Hard carry case		■	■	■	■	■	■
Stake and wire kit (15 m, 10 m, 10 m, 3 m)		■	■	■	■	■	■
Right angle terminal adaptors (to connect bare wires to terminals)		■	■	■	■	■	■
External AC/DC charger			■		■		■
ICLAMP (for ART testing)		□	□	■	■	■	■
VCLAMP (adds stakeless testing)		□	□	■	■	■	■
Field calibration check for instrument and CLAMPS		□	□	■	■	■	■
Separate professional earth testing kit (2 x 50 m, 2 x 30 m, 4 auger stakes, tape measure, in hard carry case)		□	□	□	□	■	■
PowerDB Lite software		■	■	■	■	■	■

SPECIFICATIONS

Noise

C spike, P stake and Noise check	Automatic
Noise rejection	40 V peak to peak

Wire test

2-wire, 3-wire test, 4-wire test	Yes, no shorting links required
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Instrument output

Voltage	± 25 V or ± 50 V at 128 Hz
Current	4.5 mA or 0.45 mA

Resistance

Resistance range	0.01 Ω to 20 k Ω
Earth voltage range	0 - 100 V
Resistance accuracy	2% \pm 3 digits

Maximum probe resistance:

Rp limit	100 k Ω (50 V output voltage)
Rc limit	100 k Ω (50 V output voltage)

Limits reduced to 50 k Ω for 25 V output voltage

Limits reduced to 5 k Ω for 0.01 Ω resolution

Earth voltage

Earth voltage range	0 to 100 V a.c.
Earth voltage accuracy	2 % \pm 2 V

Display

3½ digit high contrast liquid crystal

Power supply

Battery type:	
DET4TD2	8 AA (LR6) cells
DET4TR2	8 AA (LR6) NiMH rechargeable cells

Temperature range

Operating temperature range	-15 °C to +55 °C
Storage temperature range	-40 °C to +70 °C

Environment

Ingress protection	IP54
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Safety

Complies with the requirements of IEC61010-1 100 V CAT IV between terminal pairs

Mechanical data

Dimensions (H x W x D)	203 mm x 148 mm x 78 mm
Weight	1 kg



DET4TD2 and DET4TR2

- 2, 3 and 4 pole testing
- Selectable 25 V or 50 V output
- Dry cell or rechargeable battery versions
- Simple one button operation
- Robust carry case
- Delivered with calibration certificate

Description

The DET4TD2 and its rechargeable counterpart the DET4TR2 are a popular choice with contractors due to their simplicity and robustness. Capable of performing 2, 3, and 4 pole measurements these instruments are ideal for testing both ground electrode systems, and soil resistivity.

These instruments are built to work in the toughest of outside conditions, and engineered to give the user a high level of electrical safety. This is demonstrated by specifications such as IP54 ingress protection, high noise immunity, and CAT IV safety.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
DET4TD2	1000-347	Replacement earth test leads (x4) for included kit (15 m, 10 m, 10 m, 3 m)	6220-806
DET4TR2 (rechargeable)	1000-324	Replacement external AC/DC charger (DET4TR2 only)	6280-370
Included accessories		Calibration check box (25 Ω)	6220-824
Hard carry case		Right angle terminal adaptor set	6220-803
Stake and wire kit (15 m, 10 m, 3 m)		Black crocodile clip (1)	6220-850
Right angle terminal adaptors (to connect bare wires to terminals)		Professional earth testing kit (2 x 50 m, 2 x 30 m, 4 auger stakes, tape measure, in hard carry case)	6320-245
External AC/DC charger (rechargeable version only)		Vehicle 12 V socket charger (rechargeable versions only)	6280-375
PowerDB Lite software		'Getting down to earth' A Megger guide to earth testing	21500-072
Optional accessories			
Replacement hard carry case	5410-429		
Replacement earth test stakes (x2) (for included kit 200 mm, 8 mm dia.)	6220-804		

DET14C and DET24C

Earth resistance clamp testers



DET14C and DET24C

- Elliptical clamp shape improves access to earth cables and straps up to 50 mm
- Low maintenance flat jaw interface
- Measures ground resistance from 0.05 Ω to 1500 Ω
- Measures true RMS ground leakage current from 0.02 mA rms to 35 A rms
- CAT IV 600 V safety rating
- Backlit LCD display

Description

The DET14C and DET24C represent a new generation of earth/ground clamp-on resistance testers. These instruments induce a test current into earth systems and measure ground resistance in multi ground installations without needing to disconnect the ground. They offer access through elliptical jaw design and short body length to reach into connection wells, with advanced features, simple operation and CAT IV 600 V safety rating.

Designed with flat core ends they prevent dirt build up, ensuring measurement integrity and improved reliability.

ORDERING INFORMATION

Product	Order Code
DET14C Digital earth test clamp-on meter	1000-761
DET24C Digital earth test clamp-on meter	1000-762
Included accessories (DET14C and DET24C)	
Carry case	1001-715
Carrying strap (wrist loop)	1001-716
User guide CD-ROM	1001-198
Calibration check	1001-498
Battery AA (alkaline) (4 required)	25511-841
Included accessories (DET24C)	
USB IrDA dongle	90001-434
PowerDB Lite software	1000-576

SPECIFICATIONS

General

Conductor size	50 mm tapes, 39 mm \varnothing approximately
Battery type	4 x 1.5 V IEC LR6/AA alkaline
Display type	4 digit and 6 digit alpha-numeric with backlight
Range selection	Automatic with each mode
Data logging	DET14C 256 records DET24C 2048 records
Data downloading (DET24C only)	Opto-coupled IrDA-USB interface
Battery life	24 hours (50 Ω lead) continuous testing (whilst measuring resistance)
Sampling time	0.5 seconds typical

Temperature and humidity

Temperature range:

Operating temperature	-20 $^{\circ}$ C to 55 $^{\circ}$ C
Storage temperature	-40 $^{\circ}$ C to 70 $^{\circ}$ C

Humidity:

Operating humidity	Less than 85% RH
Storage humidity	Less than 75% RH

Environment

Ingress protection	IP40 with jaws closed
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Safety

IEC 61010-2-032	
CAT IV 600 V	

EMC

Class B compliant, IEC 61326, BSEN 61326	
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Mechanical data

Dimensions (H x W x D)	235 mm x 85 mm x 65 mm
Weight	960 g approximately

Resistance measurement

Ground resistance range	Resolution	Intrinsic certainty
0.05 - 0.99 Ω	0.01 Ω	$\pm 1.5\%$ 0.05 Ω
1.00 - 9.999 Ω	0.01 Ω	$\pm 1.5\%$ ± 0.1 Ω
10.0 - 99.99 Ω	0.1 Ω	$\pm 2.0\%$ ± 0.5 Ω
100.0 - 199.9 Ω	0.1 Ω	$\pm 3.0\%$ ± 1 Ω
200 - 400 Ω	1 Ω	$\pm 5.0\%$ ± 5 Ω
400 - 600 Ω	1 Ω	$\pm 10\%$ ± 10 Ω
600 - 1200 Ω	10 Ω	$\pm 20\%$
1200 - 1500 Ω	10 Ω	$\pm 35\%$

Current measurement (RMS)

Current range	Resolution	Intrinsic certainty
0.20 - 0.99 mA	0.01 mA	$\pm 2.0\%$ ± 0.05 mA
1.00 - 9.99 mA	0.01 mA	$\pm 2.0\%$ ± 0.05 mA
10.0 - 99.9 mA	0.1 mA	$\pm 2.0\%$ ± 0.1 mA
100 - 999 mA	1 mA	$\pm 2.0\%$ ± 1 mA
1.00 - 99.9 A	0.01 A	$\pm 2.0\%$ ± 0.01 A
10.0 A - 35 A	0.1 A	$\pm 2\%$ ± 0.1 A

SPECIFICATIONS

Resistance

Earth resistance range	0,010 Ω to 19,99 kΩ (auto-ranging), 1 mΩ resolution
Accuracy	(23 °C ±2 °C) ±0,5% of reading ±2 digits
Service error	±5% of reading ±2 digits ±10 mΩ (meets VDE service error over 50 mΩ)

Test

Test frequency	105 to 160 Hz reversing d.c. (50 Hz operation default to 128 Hz, 60 Hz operation default to 150 Hz) Set in steps of 0,5 Hz
Test current	50 mA max (selectable high and low levels)
Maximum output voltage	< 50 V r.m.s.
Maximum Interference	Typically 40 V peak-to-peak (50/60 Hz, sinusoidal nature)

Display

Alphanumeric LCD (130 mm x 35 mm) giving test information and a large (20 mm) 3½-digit reading)

Temperature and humidity

Temperature coefficient	< ±0.1% per °C over the temperature range -10 °C to +40 °C
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Temperature range:

Operating	-10 °C to +40 °C
Storage	-20 °C to +60 °C

Humidity:

Operating	90% RH max. at 40 °C
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Environment

Ingress protection	IP54
Flash test	3 kV a.c.
Voltage withstand	In the event of a system fault, the instrument will withstand 240 V a.c. applied between any two terminals

Power supply

Internal	Rechargeable, sealed lead-acid battery 12 V (nominal), 2,6-Ah capacity Battery voltage over which basic accuracy is maintained is 11,0 to 13,5 V
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Battery life	Approximately 5 hours continuous use
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DET2/2

- High resolution 1 mΩ is ideal for large ground systems
- High accuracy for earth electrode and soil resistivity testing
- Test voltage 50 V max. for safety
- Rechargeable battery power with long battery life and rapid re-charge
- A robust, versatile instrument with IP54 protection
- Filter and high current features to enable valid earth testing in difficult situations

Description

The DET2/2 is the instrument of choice for those performing measurements on larger, more complex grounding systems including communications grounding systems and difficult testing environments. The instrument is suitable for soil resistivity measurements, which are used to establish the optimum ground system location and design.

The instrument provides 1 mΩ resolution down to 10 mΩ, ideal for the largest of ground systems, whilst the adjustable test frequency, test current level and filtering may allow adverse conditions influencing the test to be overcome.

ORDERING INFORMATION

Product	Order Code
Auto earth tester	DET2/2
Included accessories	
Mains supply lead for battery charging	
Operating instruction book	6171-728

Product	Order Code
Optional accessories	
Earth testing kit	6310-755
Comprising carrying case and pouch containing: Four galvanised steel spikes ('L' shape) 10 mm dia. x 350 mm long 30 m of cable on a winder 50 m of cable on a winder Two 3 m leads complete with connectors and clips Hammer	
Reel of cable, 50 m	6121-119

GROUND TESTING METHODS CHART

*Method	Best Applications	Advantages	Limitations
Fall of Potential	Small electrode systems (1 or 2 rods/plates); complex systems if full resistance curve is plotted	Extremely reliable; conforms to IEEE 81; operator has complete control of test set-up	Requires long distances (and long test leads) to the test probes on medium and large systems, time consuming and labour intensive
Simplified Fall of Potential	Small and medium electrode systems	Easier to carry out than full Fall of Potential; much faster	Ineffective if the electrical centre is unknown, less accurate than full Fall of Potential method as fewer measurements are being made
61.8% Rule	Small and medium electrode systems	Simplest to carry out; minimal calculation, fewest number of test probe moves	Assumes perfect conditions; ineffective if electrical centre is unknown; soil must be homogeneous; less accurate
Slope	Large earth ground systems such as substations	Knowledge of electrical centre not necessary; long distances to test probes not necessary	Susceptible to non-homogeneous soil; less accurate, requires maths
Intersecting Curves	Large earth ground systems such as substations	Knowledge of electrical centre not necessary, long distances to test probes not necessary	Numerous calculations and drawing of curves
Dead Earth (Two Point)	Not recommended	Quick and simple to perform	Problems of possible resistance overlap; non-metallic (high resistance) return
Star Delta	Ground systems located in congested urban areas and/or rocky terrain where probe positioning is difficult	Long distances for test probe positioning not necessary	Resistance areas should not overlap a number of calculations required
Four Potential	Medium to large earth ground systems	Knowledge of electrical centre not necessary	Long distances to test probes is still required, a number of calculations required
Clamp-On	Simple earth ground system with existing return path through multiple grounds	Quick, easy; includes bonding and overall connection resistance	Effective only in situations with multiple grounds in parallel; susceptible to noise; no basis in standards; no built-in proof

PowerDB Lite is included with all Megger DET4 range, DET14C and DET24C. PowerDB includes test forms for all of the above methods and performs all the calculations automatically.

*The Attached Rod Technique (ART) is based on Fall of Potential

Do you need...

more information on earth testing? Ask for your copy of 'Getting Down to Earth', Megger's technical guide to ground/earth testing.



6121-119
50 m reel of cable



6220-803
Right angle terminal adaptor set



6220-804
Replacement earth test stakes (x2)
for included kit 200 mm, 8 mm dia



6220-805
3 replacement test leads
(15 m, 10 m, 3 m)



6220-806
Replacement earth test leads (x4) for
included kit (15 m, 10 m, 3 m)



6220-824
Calibration check box (25 Ω)



6220-850
Black crocodile clip



6280-370
Replacement external AC/DC
charger (DET4TR2 only)



6280-375
Vehicle 12 V socket charger
(rechargeable versions only)



5410-429
Replacement hard carrying case



6310-755
Earth testing kit comprising:
Carrying case and pouch
Four galvanised steel spikes ('L'
shape) 10 m dia x 350 mm long
30 m of cable on a winder
50 m of cable on a winder
two 3 m leads complete with
connectors and clips
Hammer



6320-245
Professional earth testing kit (2 x
50 m, 2 x 30 m, 4 auger stakes,
tape measure, hard carry case)



21500-072
Getting Down To Earth
A Megger guide to earth testing



ICLAMP
Current measuring clamp



VCLAMP



Primary Current Injection

Circuit breakers are one of the critical 'safety valves' of electrical systems, and basic maintenance procedures are essential to maintain maximum reliability. Primary current injection test sets are also vital to commissioning high voltage power systems.

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SELECTION GUIDE

	INGVAR	ODEN AT	ODEN A AT	CSU 600-A	PCITS 2002/2
Primary current injection system	■	■	■		
Up to 5,000 A	■				
Up to 21,000 A			■		
Up to 600 A				■	
Up to 2,000 A					■
Up to 8,000 A		■			
Measures inputs	■		■		
Inbuilt timers	■		■	■	■
I / 30 A option	■		■		
Software option			■		

Primary current injection testing is most usually associated with high current and high voltage power distribution systems of the type found in an electricity substation, or in a large industrial installation. While there is some mystique about this form of testing, the principle that underlies it is actually very straightforward: a test current is injected into the primary side of a system – which is often but not always some form of protection scheme – to determine how the system behaves at particular levels of current.

The system under test might, for example, comprise a circuit breaker with an over-current trip relay that operates via a current transformer (CT). By injecting a predetermined current into the circuit breaker, it is possible to determine whether the relay will trip at this current and, if so, how long the current needs to flow before the trip is initiated.

Something similar, of course, could be achieved by injecting a test current directly into the trip relay – that is, on the secondary side of the CT. This is secondary current injection testing and it is widely used, not least because much lower currents are needed than are typically required for primary injection testing.

Secondary injection testing is undoubtedly valuable, but it does not check all of the components in the system. In the scenario discussed, it would not, for example, reveal a defective CT. Neither does it truly mimic in service the operating conditions – the heating effect of the primary current will not be present and, in some types of test, this can significantly affect the results obtained.

For these reasons, there are many situations where primary injection testing is considered useful if not essential. Because it tends to be somewhat disruptive – the plant under test must be taken out of service and de-energised and then arrangements must be made for the high current connections needed for the test – primary injection is most usually performed as part of the commissioning procedure for new plant or after major modifications have been carried out. In some instances, however, it can also be an invaluable aid to faultfinding.

Test sets used for primary injection are invariably built specifically for this purpose. Their primary function is to supply a lot of current – tests typically involve injecting currents from 100 A or so up to 20,000 A. Equipment capable of delivering these sorts of currents is never going to be physically small or lightweight, but remarkable strides have been made over recent years in making primary injection test sets more manageable.

One way this has been achieved is by using modular current sources, so that for lower test currents only one or two sources are needed, but for higher test currents additional current sources can be added. Test sets that adopt this approach are often assembled on wheeled trolleys that can accommodate the control unit plus up to three or four current source modules. This arrangement makes the test sets much easier to handle.

Test equipment manufacturers have also noted that only a few applications of primary injection testing involve the highest currents – many requirements can be satisfied with test sets rated at no more than 5000 A, which paves the way for smaller mid-range units. In addition, the highest currents are usually only required for a comparatively short time, to test, for example an instantaneous overcurrent relay, so the test sets do not need to be continuously rated for their maximum current output. Once again, this allows size and weight to be reduced.

Weight and size are not the only areas where progress has been made. Another useful development is the introduction of test sets where the control unit can be connected to the current generator by a comparatively long control cable. This allows the current generator to be placed very close to the equipment under test, thereby minimising the length of the high current test leads needed, which makes testing easier and more practical.

To ensure versatility, primary injection test sets need to be able to offer options to cope with a wide range of burdens since, if they do not, there is the possibility that they will not be able to deliver the required test current into the impedance presented by the equipment under test plus the test cables. In the best test sets, this issue is addressed by allowing the output voltage of the current generators to be raised at the expense of output current, so that the total power the test set is required to deliver is not increased unduly. This option is particularly valuable when testing CTs, circuit breakers and busbar joints.

Another option of great value is an integral timer that can be set to inject the test current for an accurately controlled time, preset by the user. This makes it easy to perform complete circuit breaker tripping time tests that encompass both the relay and the CTs, by injecting the actual fault currents. Auxiliary voltage and current measuring inputs facilitate the testing of CTs and good test sets can provide a wide range of data, including impedance, resistance, virtual power, active power, reactive power, and power factor, together, of course, with CT ratio and polarity.

A fast acting hold feature for the measuring functions, which is provided in conjunction with a “stop” input further enhances usefulness, as it allows readings to be frozen by applying a signal to the stop input. This makes it possible, for example, to record data relating to the exact moment that a protection relay operates during a test. Some instruments, when used for circuit breaker testing, can even be configured to automatically freeze the measurements at the instant the breaker trips without the need to use the stop input.

A feature that is just starting to become available on the latest primary injection test sets is zero-crossover synchronisation. This ensures that the test current is turned on only at a zero crossing point, which eliminates DC offset effects and also ensures the best possible repeatability for test results.

One issue that has been perennially troublesome in carrying out primary injection tests has been heating of the equipment under test while setting up and adjusting the test current. This effect has even been known to trip a breaker under test during set up before the test proper has commenced. Work-arounds are available – test engineers can perform the set up very quickly to minimise heating, or they can prevent tripping at least by isolating the trip circuits. Neither of these options is particularly convenient, however.

Fortunately, there is a better solution, in that test sets are now available with a so-called I/30 function. This, as its name suggests, reduces the programmed current output of the test set by a factor of 30. Since this means that the heating effect is reduced by a factor of 900, test engineers using this function can take as much care and time as they need in setting up the test with absolutely no risk of significant heating. And, when they are ready to start testing, the output current can be returned to normal at the push of a button.

Some of the principal applications of primary injection testing, including the testing of circuit breakers and CTs, have already been mentioned in this article. Some test sets can, however, also be programmed for more complex functions, such as testing automatic reclosers and sectionalizers.

Finally, it is worth bearing in mind that the high-capacity current source at the heart of every primary injection test set is also useful in its own right as convenient way of providing current to carry out heat runs on busbars and other types of switchgear assembly, and for testing ground grid installations where the test set is used to inject current between a reference ground and the ground to be tested. Measuring the voltage drop and the percentage of current flowing through the ground grid then enables an accurate assessment to be made of the ground grid's performance.

Primary current injection tests are among the most valuable tests that can be carried out on power systems as they take into account the performance of every component and are, therefore, the most reliable way of assessing the performance of the system under real world operating conditions. In the past primary injection testing has been fraught with inconvenience, not least because of the size and weight of the equipment involved, and because of its limited capabilities.

Fortunately, things have changed and, as we have seen, the latest primary injection test equipment is much more user friendly – and far less back breaking! For all those involved in the commissioning and maintenance of power distribution systems this could be a very good time to take a closer look at how primary injection test sets have changed in recent years, and to look again at the benefits that this form of testing undoubtedly offers.



INGVAR

- Most advanced primary current injection test system to simplify all types of switchgear and CT commissioning, ground grid, circuit breaker testing and more
- Two units, each of about 20 kg (44 lbs), simplifies transportation
- Unique I/30 function allows the current to be pre-set using low current to prevent test sample heating, thus eliminating corruption of test result

Description

This powerful test system is designed for primary injection testing of protective relay equipment and circuit breakers. It is also used to test the turns ratio of current transformers and for other applications that require high variable currents.

The system consists of a control unit and a current unit. The two parts are portable, and INGVAR can be quickly assembled and connected.

The control unit has many advanced features – a powerful measurement section for example, that can display turns ratio as well as time, voltage and current. A second measurement channel can be used to test an additional current or voltage. Current transformer turns ratio, impedance, power, power factor ($\cos \phi$) and phase angle are calculated and shown in the display. Current and voltage can be presented as percentages of nominal value. The fast-acting hold function freezes short-duration readings on the digital display when the voltage or contact signal arrives at the stop input, the object under test interrupts the current or injection is stopped.

Application

■ Primary current injection testing and breaker testing

These tests require high currents and the ability to measure very short duration current flow. INGVAR has been designed especially to meet these needs. No extra contacts are needed to measure the operating time of a low-voltage breaker. Testing stops at the instant when the main breaker contacts open to interrupt the current. Output current initiation is synchronized with the currents zero-crossover point to ensure good repeatability and minimized DC offset.

Testing current transformers

For turns ratio testing, the primary current and either the secondary current or the turns ratio are displayed simultaneously. Since the turns ratio is displayed directly as the nominal value (1000/5 for example), no further calculation is needed. Burden of secondary circuits can be measured and presented in VA.

Polarity testing

The currents phase displacement is shown, and the polarities of the outputs are clearly marked.

Heat runs

INGVAR is ideal for performing heat runs. Current can be applied continuously or through programmable intervals. The times can be shown in minutes and hours which facilitates long-term testing capability.

Automatic reclosers and sectionalizers

INGVAR can also be set to test circuit breakers with reclosing relays. Operating limits, partial times, total times and the number of operations before lockout can be measured. User-selectable reclosing sequences can be programmed for testing sectionalizers.

Testing integrity of ground grids and safety-ground devices

One way to test ground grids is by injecting current between a reference ground and the ground to be tested and measuring the voltage drop and the percentage of current flowing through the ground grid.

SPECIFICATIONS

Specifications INGVAR

Specifications are valid for an ambient temperature of +25 °C and nominal input voltage. The specifications are subject to change without notice.

System designation

An INGVAR-system consists of a control unit and one current unit.

Environment

Application field The instrument is intended for use in medium-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (+32 °F to +122 °F)

Storage & transport -25 °C to +55 °C (-13 °F to +127 °F)

Humidity 5% – 95% RH, Non-condensing.

Altitude (operational) <2000 m

Pollution degree 2

CE marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Measurement category CAT I
Rated transient overvoltage: 2200 V

Mains voltage 100 – 240 V AC, 50/60 Hz

Mains inlet IEC 60309-1, -2. 16 A

Input current Output current x open circuit voltage / input voltage

Protection The output transformer has a built-in thermal cut-out, and the primary side is protected by a miniature circuit breaker

Dimensions

Control Unit 546 x 347 x 247 mm
(21.5" x 13.7" x 9.7")

Current Unit 410 x 340 x 205 mm
(16.1" x 13.4" x 8")

Weight

Control Unit 20 kg (44.1 lbs)

Current Unit 18 kg (39.7 lbs)

Data transfer USB Type B female

Display

Type LCD

Available languages English, German, French, Spanish, Swedish.

Outputs

Outputs in parallel, 240 mains voltage

Maximal current	Maximum generation time	Minimum rest time ¹⁾
700 A	continuously	-
1000 A	30 min	5 min
2000 A	3 min	10 min
3000 A	1 min	12 min
5000 A	2 sec	3 min

Outputs in series, 240 mains voltage

350 A	continuously	-
500 A	20 min	15 min
1500 A	2 min	12 min

Measurement section

Ammeters

Measurement method AC, true RMS

Inaccuracy 1% of range ±1 digit

Ammeter 1

Ranges 0 – 2 kA / 1 – 5 kA

Ammeter 2

Ranges 0 – 2 A / 0 – 20 A

Maximum current 20 A (The input is not protected by a fuse)

Voltmeter

Measurement method AC, true RMS

Ranges 0 – 0.2 V, 0 – 2 V, 0 – 20 V,
0 – 200 V, AUTO

Inaccuracy 1% of range ±1 digit

Input resistance (R_{in}) 240 kΩ (range 0 – 200 V)
24 kΩ (other ranges)

Dielectric withstand 2.5 kV

Timer

Presentation In seconds, mains frequency cycles or hours and minutes

Ranges 0.000 – 99999.9 s
0 – 9999 cycles

Inaccuracy ±(1 digit + 0.01% of value)
For the stop condition in INT-mode 1 ms shall be added to the specified measurement error.

Stop input

Max. input voltage 250 V AC / 275 V DC

Phase angle

Range 0 – 359°

Resolution 1°

Inaccuracy ±2° (For voltage and current readings that are higher than 10% of the selected range)

Z, P, R, X, S, Q and power factor (cosφ)

The result is calculated using U, I and φ

I_{max}

Stores highest current value that exists ≥100 ms

INT-level

Threshold indicating that current is interrupted, can be set to 0.7 or 2.1% of range for Ammeter 1

Primary current injection test system

ORDERING INFORMATION

Product	Order code
INGVAR	BH-72490
<i>Including:</i>	
GA-12700 Interconnection cable 3 m (10 ft)	1
GA-12051 Current cable 2 m (6.5 ft) 120 mm ²	2
04-00087 Mains cable 3 m (10 ft)	1
GA-00204 Grounding cable 5 m (16 ft)	1
Optional accessories	
HCP2000, high current probe	AA-90165
Current transformer switchbox	BH-90130
Extension interconnection cable INGVAR, 5 m (16 ft)	GA-12705
Extension interconnection cable INGVAR, 10 m (32 ft)	GA-12710
Multi-cable high current cable sets	
Length	Impedance <i>(Twisted-pair cables)</i>
Cross section area: 240 mm² (2x120)	
2 x 0.5 m (1.6 ft)	0.21 mΩ GA-12205
2 x 1 m (3.3 ft)	0.32 mΩ GA-12210
2 x 1.5 m (4.9 ft)	0.42 mΩ GA-12215
2 x 2 m (6.6 ft)	0.53 mΩ GA-12220
Cross section area: 360 mm² (3x120)	
2 x 0.5 m (1.6 ft)	0.18 mΩ GA-12305
2 x 1 m (3.3 ft)	0.25 mΩ GA-12310
2 x 1.5 m (4.9 ft)	0.32 mΩ GA-12315
2 x 2 m (6.6 ft)	0.39 mΩ GA-12320
Cable set, 2 x 5 m (16 ft)	
Cross section area: 120 mm ²	
Weight: 15.2 kg (33.5 lbs)	
Impedance: 2.2 mΩ	
	GA-12052

Current transformer turns ratio, impedance, resistance, power, power factor ($\cos \phi$) and phase angle are calculated and shown in the display. Current and voltage can be presented as percentages of nominal value. The fast-acting hold function freezes short-duration readings on the digital display when the voltage or contact signal arrives at the stop input, the object under test interrupts the current or injection is stopped.

Application

Primary current injection testing and breaker testing

These tests require high currents and the ability to measure very short duration, current flow. Oden AT has been designed especially to meet these needs. No extra contacts are needed to measure the operating time of a low-voltage breaker. Testing stops at the instant when the main breaker contacts open to interrupt the current. Output current initiation is synchronized with the currents zero-crossover point to ensure good repeatability and minimized DC offset.

Testing current transformers

For turns ratio testing, the primary current and either the secondary current or the turns ratio are displayed simultaneously. Since the turns ratio is displayed directly as the nominal value (1000/5 for example), no further calculation is needed. Burden of secondary circuits can be measured and presented in VA.

Polarity testing

The currents phase displacement is shown, and the polarities of the outputs are clearly marked.

Heat runs

Oden AT is ideal for performing heat runs. Current can be applied continuously or through programmable intervals. The times can be shown in minutes and hours which facilitates long-term testing capability.

Automatic reclosers and sectionalizers

Oden AT can also be set to test circuit breakers with reclosing relays. Operating limits, partial times, total times and the number of operations before lockout can be measured. User-selectable reclosing sequences can be programmed for testing sectionalizers.

Testing integrity of ground grids and safety- devices

One way to test ground grids is by injecting current between a reference ground and the ground to be tested and measuring the voltage drop and the percentage of current flowing through the ground grid. The type X current unit included with Oden AT is designed for this type of application. Personal safety grounds must be tested at rated current, a task for which Oden AT is well suited.



ODEN AT

- Most Advanced Primary Current Injection Test System to simplify all types of switchgear and CT commissioning, ground grid, circuit breaker testing and more
- Modular design to permit optimal user configuration of output current vs. unit size
- Compact transport cart facilitates portability into switchgear rooms with limited space
- Unique I/30 function allows the current to be pre-set using low current to prevent test sample heating, thus eliminating corruption of test result

Description

This powerful test system is designed for primary injection testing of protective relay equipment and circuit breakers. It is also used to test the turns ratio of current transformers and for other applications that require high variable currents.

The system consists of a control unit together with one, two or three current units. There are three versions of the current unit: S, X and H. The S and X current units are identical except that the X unit has an additional 30/60 V output. The H unit is rated for even higher current. This makes it possible to configure an Oden AT system in a suitable way. All parts are portable, and Oden AT can be quickly assembled and connected.

The control unit has many advanced features – a powerful measurement section for example, that can display turns ratio as well as time, voltage and current. A second measurement channel can be used to test an additional current or voltage.

SPECIFICATIONS

Specifications ODEN AT

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

System designation

An ODEN AT-system consists of a control unit and one, two or three current units. There are three different versions of the current units: S-unit (standard), X-unit (extra 30/60 V outlet) and H-unit (high current). The system designation indicates the number and version of current units included.

Example: ODEN AT/2X

2 = Number of current units

X = Version of current unit (S, X or H)

Environment

<i>Application field</i>	The instrument is intended for use in high-voltage substations and industrial environments.
<i>Temperature</i>	
<i>Operating</i>	0 °C to +50 °C (+32 °F to +122 °F)
<i>Storage & transport</i>	-25 °C to +55 °C (-13 °F to +127 °F)
<i>Humidity</i>	5% – 95% RH, non-condensing

CE marking

<i>LVD</i>	2006/95/EC
<i>EMC</i>	2004/108/EC

General

<i>Mains voltage</i>	240/400 V AC, 50/60 Hz 480 V AC / 60 Hz
<i>Mains inlet</i>	IEC 60309-2, 63 A
<i>Input current</i>	Output current x open circuit voltage / input voltage
<i>Protection</i>	The output transformer has a built-in thermal cut-out, and the primary side is protected by a miniature circuit breaker.
<i>Dimensions</i>	
<i>Control unit AT</i>	570 x 310 x 230 mm (22.4" x 12.2" x 9")
<i>Current unit S, X H</i>	570 x 310 x 155 mm (22.4" x 12.2" x 6")
<i>Complete with cart</i>	690 x 350 x 860 mm (27.2" x 13.8" x 33.9")
<i>Weight</i>	
<i>Control unit AT</i>	25 kg (55 lbs)
<i>Current unit S</i>	42 kg (92.6 lbs)
<i>Current unit X</i>	45 kg (99.3 lbs)
<i>Current unit H</i>	49 kg (108 lbs)
<i>Cart</i>	11 kg (24.3 lbs)
<i>Display</i>	LCD
<i>Available languages</i>	English, German, French, Spanish, Swedish.

Measurement section

Ammeters

<i>Measurement method</i>	AC, true RMS
<i>Inaccuracy</i>	1% of range ±1 digit

Ammeter 1

<i>Ranges</i>	0 – 4800 A / 0 – 15 kA 0 – 9600 A / 0 – 30 kA 0 – 960 A / 0 – 3 kA
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Ammeter 2

<i>Ranges</i>	0 – 2.000 A / 0 – 20.00 A
<i>Maximum current</i>	20 A (The input is not protected by a fuse)

Voltmeter

<i>Measurement method</i>	AC, true RMS
<i>Ranges</i>	0 – 0.2 V, 0 – 2 V, 0 – 20 V, 0 – 200 V, AUTO
<i>Inaccuracy</i>	1% of range ±1 digit
<i>Input resistance (Rin)</i>	240 kΩ (range 0 – 200 V) 24 kΩ (other ranges)
<i>Dielectric withstand</i>	2.5 kV

Timer

<i>Presentation</i>	In seconds, mains frequency cycles or hours and minutes
<i>Ranges</i>	0.000 – 999.9 s 0 – 9999 cycles 0.001 s – 99 h 59 min
<i>Inaccuracy</i>	±(1 digit + 0.01% of value) For the stop condition in INT-mode 1 ms shall be added to the specified measurement error.

Stop input

<i>Max. input voltage</i>	250 V AC / 275 V DC
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Phase angle

<i>Range</i>	0 – 359°
<i>Resolution</i>	1°
<i>Inaccuracy</i>	±2° (for voltage and current readings that are higher than 10% of the selected range)

Z, P, R, X, S, Q and power factor (cos φ)

For these measurements the result is calculated using U, I and sometimes φ.

I_{max}

Stores highest current value that exists ≥100 ms

INT-level

Threshold indicating that current is interrupted. Can be set to 0.7% or 2.1% of Ammeter 1 range.

ORDERING INFORMATION

Product	Order code	Product	Order code
<p>A cart (Art.No. 50-00092) is always included with purchase of a complete ODEN system. The cable set(s) for connection to the object under test must however be stated as a separate item in the order. Cable for connecting current units in series is included with purchase of a current unit.</p>			
ODEN AT/1S			
240 V Mains voltage	BH-62411		
400 V Mains voltage	BH-64011		
480 V (60 Hz) Mains voltage	BH-64811		
ODEN AT/2S			
240 V Mains voltage	BH-62412		
400 V Mains voltage	BH-64012		
480 V (60 Hz) Mains voltage	BH-64812		
ODEN AT/3S			
240 V Mains voltage	BH-62413		
400 V Mains voltage	BH-64013		
480 V (60 Hz) Mains voltage	BH-64813		
ODEN AT/1X			
240 V Mains voltage	BH-62421		
400 V Mains voltage	BH-64021		
480 V (60 Hz) Mains voltage	BH-64821		
ODEN AT/2X			
240 V Mains voltage	BH-62422		
400 V Mains voltage	BH-64022		
480 V (60 Hz) Mains voltage	BH-64822		
ODEN AT/3X			
240 V Mains voltage	BH-62423		
400 V Mains voltage	BH-64023		
480 V (60 Hz) Mains voltage	BH-64823		
ODEN AT/1H			
240 V Mains voltage	BH-62431		
400 V Mains voltage	BH-64031		
480 V (60 Hz) Mains voltage	BH-64831		
ODEN AT/2H			
240 V Mains voltage	BH-62432		
400 V Mains voltage	BH-64032		
480 V (60 Hz) Mains voltage	BH-64832		
ODEN AT/3H			
240 V Mains voltage	BH-62433		
400 V Mains voltage	BH-64033		
480 V (60 Hz) Mains voltage	BH-64833		
		Optional accessories	
		HCP2000	AA-90165
		Current Transformer Switchbox	BH-90130
		High Current Serial Bar	BH-90102
		Mains Adapter 240/400V	
		Note: Can only be used together with an ODEN AT prepared for this feature. Contact Megger Sweden.	BH-90120
		ODEN-Select	
		Software tool for finding the best ODEN AT configuration. Free-ware, can be downloaded from the Megger web site.	
		Multi-cable high current cable sets	
	Length	Impedance <i>(Twisted-pair cables)</i>	
Cross section area: 240 mm² (2x120)			
	2 x 0.5 m (1.6 ft)	0.21 mΩ	GA-12205
	2 x 1 m (3.3 ft)	0.32 mΩ	GA-12210
	2 x 1.5 m (4.9 ft)	0.42 mΩ	GA-12215
	2 x 2 m (6.6 ft)	0.53 mΩ	GA-12220
Cross section area: 360 mm² (3x120)			
	2 x 0.5 m (1.6 ft)	0.18 mΩ	GA-12305
	2 x 1 m (3.3 ft)	0.25 mΩ	GA-12310
	2 x 1.5 m (4.9 ft)	0.32 mΩ	GA-12315
	2 x 2 m (6.6 ft)	0.39 mΩ	GA-12320
Cross section area: 480 mm² (4x120)			
	2 x 0.5 m (1.6 ft)	0.16 mΩ	GA-12405
	2 x 1 m (3.3 ft)	0.21 mΩ	GA-12410
	2 x 1.5 m (4.9 ft)	0.27 mΩ	GA-12415
	2 x 2 m (6.6 ft)	0.32 mΩ	GA-12420
Cross section area: 720 mm² (6x120)			
	2 x 0.5 m (1.6 ft)	0.14 mΩ	GA-12605
	2 x 1 m (3.3 ft)	0.18 mΩ	GA-12610
	2 x 1.5 m (4.9 ft)	0.21 mΩ	GA-12615
	2 x 2 m (6.56 ft)	0.25 mΩ	GA-12620
		Cable set, 2 x 5 m (16 ft), 120 mm²	
		Cross section area: 120 mm ²	
		Weight: 15.2 kg (33.5 lbs)	
		Impedance: 2.2 mΩ	GA-12052
		Cable set, 2 x 5 m (16 ft), 25 mm²	
		Cross section area: 25 mm ²	
		For the 30/60 V output of current unit X.	
		Weight: 4 kg (8.8 lbs)	GA-02052



Application

ODEN A can be used in a number of applications where high current is required:

- Primary current injection testing of protective systems
- Circuit breaker testing
- Testing current transformers
- Heat runs
- Example of test objects are joints, circuit breakers and disconnectors
- Testing of safety-ground devices
- Personal safety grounds must be tested at rated current, a task for which ODEN A is well suited
- Testing integrity of ground grids

One way to make this test is by injecting current between a reference ground and the ground to be tested and measuring the voltage drop and the percentage of current flowing through the ground grid. The type X current unit included with ODEN A is designed for this type of application.

ODEN A

- Most advanced primary current injection test system to simplify all types of switchgear and CT commissioning, ground grid, circuit breaker testing and more
- Modular design to permit optimal user configuration of output current vs. unit size
- Compact transport cart facilitates portability into switchgear rooms with limited space
- Unique I/30 function allows the current to be pre-set using low current to prevent test sample heating, thus eliminating corruption of test result

Description

A powerful test system designed for primary injection testing of protective relay equipment and circuit breakers. It is also used to test the transformation ratio of current transformers and for other applications that require high variable currents. Up to 8 kA can be generated.

The ODEN™ A system consists of a control unit together with one or two current units. All parts are portable, and ODEN A can be quickly assembled and connected. There are two versions of the current unit: S and X, S and X are identical except that X has an additional 30/60 V output.

SPECIFICATIONS

Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C (77 °F). Specifications are subject to change without notice.

System designation

An ODEN A-system consists of a control unit and one or two current units. There are two different versions of the current units: S-unit (standard) and X-unit (extra 30/60 V outlet). The system designation indicates the number and version of current units included.

Example: ODEN A/2X

X = Version of current unit (S, or X)

2 = Number of current units

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating -20 °C to +50 °C (-4 °F to +122 °F)

Storage & transport -40 °C to +55 °C (-40 °F to +127 °F)

Humidity

5% – 95% RH, non-condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 240/400 V AC, 50/60 Hz

Mains inlet IEC 60309-2, 63 A

Input current Output current x open circuit voltage / input voltage

Dimensions

Control unit A 570 x 310 x 230 mm (22.4" x 12.2" x 9")

Current unit S, X 570 x 310 x 155 mm (22.4" x 12.2" x 6")

Complete with cart 690 x 350 x 860 mm (27.2" x 13.8" x 33.9")

Weight

Control unit A 20 kg (44.1 lbs)

Current unit S 42 kg (92.6 lbs)

Current unit X 45 kg (99.3 lbs)

Cart 11 kg (24.3 lbs)

Outputs

ODEN A, 240 V mains voltage, 50/60 Hz					
		Open circuit voltage	Max. continuous current ³⁾	Max. current, 3 minutes ³⁾	Max. current, 1 sec ³⁾
ODEN A/1S					
		6 V	1000 A	2000 A	6000 A
ODEN A/2S					
	1)	6 V	1680 A	3600 A	8000 A
	2)	12 V	1000 A	2000 A	4000 A
ODEN A/1X					
High current output		6 V	1000 A	2000 A	6000 A
Output 0 – 30/60 V					
30 V range		30 V	160 A	300 A	600 A
60 V range		60 V	80 A	150 A	300 A
ODEN A/2X					
High current output	1)	6 V	1680 A	3600 A	8000 A
	2)	12 V	840 A	1500 A	4000 A
Output 0 – 30/60 V					
30 V range	1)	30 V	320 A	600 A	1200 A
30 V range	2)	60 V	160 A	300 A	600 A
60 V range	2)	120 V	80 A	150 A	300 A
ODEN A, 400 V mains voltage, 50/60 Hz					
		Open circuit voltage	Max. continuous current ³⁾	Max. current, 3 minutes ³⁾	Max. current, 1 sec ³⁾
ODEN A/1S					
		6 V	1000 A	2000 A	7000 A
ODEN A/2S					
	1)	6 V	1900 A	4000 A	8000 A
	2)	12 V	630 A	1500 A	4000 A
ODEN A/1X					
High current output		6 V	1000 A	2000 A	7000 A
Output 0 – 30/60 V					
30 V range		30 V	160 A	300 A	600 A
60 V range		60 V	80 A	150 A	300 A
ODEN A/2X					
High current output	1)	6 V	1900 A	4000 A	8000 A
	2)	12 V	630 A	1500 A	4000 A
Output 0 – 30/60 V					
30 V range	1)	30 V	250 A	600 A	1200 A
30 V range	2)	60 V	125 A	225 A	600 A
60 V range	2)	120 V	60 A	115 A	300 A

1) Current units connected in parallel
 2) Current units connected in series
 3) Maximum possible current is also limited by the impedance in the test circuit. The current value can not exceed output voltage / impedance value.

Primary current injection test system

ORDERING INFORMATION

Product	Order code	Product	Order code
<p>A cart (Art.No. 50-00092) is always included with purchase of a complete ODEN system. The cable set(s) for connection to the object under test must however be stated as a separate item in the order. Cable for connecting current units in series is included with purchase of a current unit.</p>		<p>Length</p> <p>Impedance (Twisted-pair cables)</p>	
		Cross section area: 240 mm ² (2x120)	
		2 x 0.5 m (1.6 ft)	GA-12205
		2 x 1 m (3.3 ft)	GA-12210
		2 x 1.5 m (4.9 ft)	GA-12215
		2 x 2 m (6.6 ft)	GA-12220
		Cross section area: 360 mm ² (3x120)	
		2 x 0.5 m (1.6 ft)	GA-12305
		2 x 1 m (3.3 ft)	GA-12310
		2 x 1.5 m (4.9 ft)	GA-12315
		2 x 2 m (6.6 ft)	GA-12320
		Cross section area: 480 mm ² (4x120)	
		2 x 0.5 m (1.6 ft)	GA-12405
		2 x 1 m (3.3 ft)	GA-12410
		2 x 1.5 m (4.9 ft)	GA-12415
		2 x 2 m (6.6 ft)	GA-12420
		Cross section area: 720 mm ² (6x120)	
		2 x 0.5 m (1.6 ft)	GA-12605
		2 x 1 m (3.3 ft)	GA-12610
		2 x 1.5 m (4.9 ft)	GA-12615
		2 x 2 m (6.56 ft)	GA-12620
		Cable set, 2 x 5 m (16 ft), 120 mm²	
		Cross section area: 120 mm ²	
		Weight: 15.2 kg (33.5 lbs)	
		Impedance: 2.2 mΩ	GA-12052
		Cable set, 2 x 5 m (16 ft), 25 mm²	
		Cross section area: 25 mm ²	
		For the 30/60 V output of current unit X.	
		Weight: 4 kg (8.8 lbs)	GA-02052
Product	Order code		
240 V Mains voltage	BH-32411		
400 V Mains voltage	BH-34011		
ODEN A/1S			
240 V Mains voltage	BH-32412		
400 V Mains voltage	BH-34012		
ODEN A/1X			
240 V Mains voltage	BH-32421		
400 V Mains voltage	BH-34021		
ODEN A/2X			
240 V Mains voltage	BH-32422		
400 V Mains voltage	BH-34022		
Optional accessories			
HCP2000	AA-90165		
TM200			
External timer			
See the TM200 for more information	BE-29090		
Current Transformer Switchbox	BH-90130		
High Current Serial Bar	BH-90102		
Multi-cable high current cable sets			

CSU600A-AT

- Compact and rugged
- Quick and easy to use
- Broad application range
- Excellent weight/performance ratio

Description

These high-current supply units have two main fields of application. The first is to conduct primary tests on protective relays. A primary test shows whether all parts of the protection system are functioning together properly within the specified time limits under operating conditions.

The second field of application involves conducting current tests on low-voltage circuit breakers and overcurrent devices.

The CSU600A™ is a compact instrument which, together with Timer TM200™ and an external ammeter, meets stringent requirements for accuracy, easy handling and performance. This current supply unit is ideal for a) performance and turn-ratio tests of current transformers, b) primary tests of protective relays, c) current tests on low- and high-voltage circuit breakers and d) commissioning tests that require variable currents.

The CSU600AT™ provides a more comprehensive solution. It has a built-in timer and an analog ammeter that provide rough current settings quickly and easily. As a result, connection time has been reduced to the bare minimum.

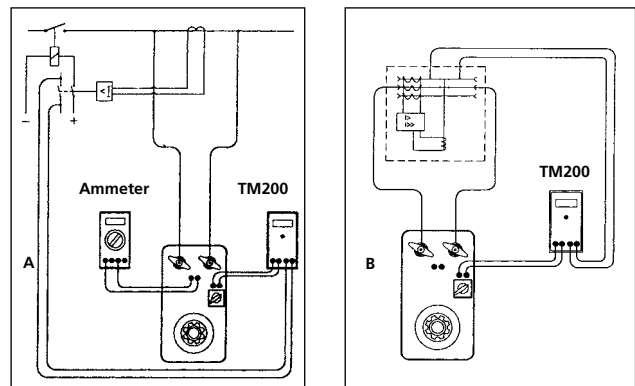
The CSU600A and CSU600AT current supply units have an excellent weight/performance ratio.



Application example

IMPORTANT

Read the user manual before using the instrument.



Primary test of protective relay equipment and low-voltage circuit breaker

Connect the CSU600A's current outputs across the current transformer (diagram A) or to the breaker terminals (diagram B).

- Connect timer TM200's start input to output T and the stop input to the protective relay equipment's auxiliary contact.
- Set the current.
- Execute the test.
- Read the time from TM200.

SPECIFICATIONS

Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

<i>Application field</i>	The instrument is intended for use in high-voltage substations and industrial environments.
<i>Temperature</i>	
<i>Operating</i>	0 °C to +50 °C (32 °F to +122 °F)
<i>Storage & transport</i>	-40 °C to +70 °C (-40 °F to +158 °F)
<i>Humidity</i>	5% – 95% RH, non-condensing

CE-marking

<i>EMC</i>	2004/108/EC
<i>LVD</i>	2006/95/EC

General

<i>Mains voltage</i>	115 or 230 V AC, 50/60 Hz
<i>Power consumption (max)</i>	115 V, 667 VA cont. (interm. 3738 VA) 230 V, 851 VA cont. (interm. 6440 VA)
<i>Protection</i>	Thermal cut-outs and miniature circuit breakers
<i>Dimensions</i>	
<i>Instrument</i>	356 x 203 x 241 mm (14.0" x 8.0" x 9.5")
<i>Transport case</i>	610 x 290 x 360 mm (24.0" x 11.4" x 14.2")
<i>Weight</i>	21.9 kg (48 lbs) 38.3 kg (84.4 lbs) with accessories and carrying case
<i>Current cables</i>	2 x 5 m (16 ft), 50 mm ²

Measurement section

<i>Output for external ammeter</i>	600/6 A
<i>Inaccuracy</i>	±0.5%

Timer (only CSU600AT)

<i>Range</i>	0-999.999 s
<i>Resolution</i>	1 ms
<i>Inaccuracy</i>	±0.02% of shown value + 0 to 2 ms
<i>Other</i>	Output for starting external timer

Outputs, AC, intermittent output ¹⁾ (CAT I)

Current	115 V mains voltage		230 V mains voltage	
	Load time	Minimum output voltage	Load time	Minimum output voltage
0 A	Cont.	6.0 V	Cont.	9.5 V
75 A	–	–	Cont.	9.3 V
100 A	Cont.	5.6 V	1 h	9.0 V
200 A	15 min	5.3 V	5 min	8.5 V
300 A	1.5 min	4.9 V	2 min	8.0 V
400 A	1 min	4.6 V	1 min	7.5 V
500 A	20 s	4.2 V	30 s	7.0 V
600 A	15 s	3.9 V	20 s	6.5 V

1) Maximum load time from cold state 25°C (77°F). Not valid for repeated tests.

Maximum cable lengths at 600 A

<i>115 V mains</i>	2 x 5 m (16 ft), 70 mm ²
<i>230 V mains</i>	2 x 5 m (16 ft), 50 mm ² 2 x 10 m (33 ft), 70 mm ² 2 x 15 m (49 ft), 95 mm ²

ORDERING INFORMATION

Product	Order code
CSU600A Complete with: Cable set GA-05052, Transport case GD-00182	
115 V Mains voltage	BF-11190
230 V Mains voltage	BF-12290
CSU600AT Complete with: Cable set GA-05052, Transport case GD-00182	
115 V Mains voltage	BF-21190
230 V Mains voltage	BF-22290
Optional	
Cable set 5 m (for 115 V) 2 x 5 m (16 ft), 70 mm ² Weight: 8.4 kg (18 lbs)	GA-07052
Cable set 10 m 2 x 10 m (33 ft), 70 mm ² Weight: 16.8 kg (37 lbs)	GA-07102
Cable set 15 m 2 x 15 m (49 ft), 95 mm ² Weight: 29.4 kg (65 lbs)	GA-09152
TM200 External timer See the TM200 for more information	BE-29090

SPECIFICATIONS

Current output ranges (a.c.)

20 A to 2000 A (0 to 3 V) 50 Hz/60 Hz (programmable in 10 A steps)
40 A to 1000 A (0 to 6 V) 50 Hz/60 Hz (programmable in 10 A steps)

Accuracy

Output	±2.5% of programmed value Note: Motor variac driven - subject to mains variation
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Auxiliary voltage output (a.c.)

0 to 250 V, 2 A, 50 Hz/60 Hz
0 to 125 V, 2 A, 50 Hz/60 Hz

Display

Dot matrix LCD

Measurement ranges

Current	0 - 2000 A, resolution 1 A
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Auxiliary voltage/current

0 - 250 V, resolution 1 V
0 - 2 A, resolution 0.01 A

Accuracy	±3% of reading, ±2 digits
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Timer

Range	0 - 600 sec, resolution 0.01 sec
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Accuracy	±0.1%, ±0.05 sec
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Duty cycle

21/2 minutes on circuit and 15 minutes off circuit at full range current and voltage. Duty cycle increases until continuous use is possible at 40% of full range.

Environmental

Operating temperature	0 °C to 40 °C (32 to 104 °F)
Storage temperature	-20 °C to +60 °C (-4 to 140 °F)
Operating humidity	90% RH at 40 °C (104 °F)
Storage humidity	93% RH at 40 °C (104 °F)

Mechanical data

Dimensions	320 mm x 305 mm x 510 mm (12½ in x 12 in x 20 in approx.) excluding handle and wheels.
Controller dimensions	202 mm x 127 mm x 55 mm (8 in x 5 in x 2¼ in approx.)
Weight	61 kg (134 lb approx.)

Safety

The test set will, in general, meet the requirements of the IEC 61010-1 specification.

EMC

IEC 61326-1

Equipment protection

Circuit breakers	30 A rating
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PCITS2002/2

- Test relay protection systems and their current transformers together
- Current level maintained though test circuit resistance may rise due to heating
- Built-in timer to record protection relay operation

Description

This primary current injection test set is rugged, self-contained and designed for operation by one person. The PCITS2000/2 is a two-wheeled unit (with a handle).

The test set has a separate hand-held controller connected by an expandable cable. This allows the operator to work close to a protective relay while controlling a test. The maximum output current is 2000 A a.c. at line frequency. By changing the range switch, half the rated output can be obtained at twice the voltage. Additionally, a separate auxiliary voltage output of 250 V, 2 A a.c. or 125 V, 2 A a.c. is available for testing voltage operated relay coils or checking the magnetisation characteristics of current transformers. All outputs are fully variable and each test set has a nominal duty cycle when delivering full current and voltage. Continuous operation is possible at 40% of maximum current.

ORDERING INFORMATION

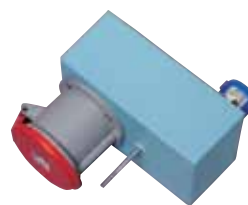
Product	Order Code	Product	Order Code
Primary current injection test sets	PCITS2000/2	Optional accessories	
		2000 A low inductance lead set (3 m long)	6220-462
		Timer/low current leadset	6131-340



AA-90165
HCP2000 High current probe



BH-90130
Current transformer switchbox



BH-90120
Mains adapter 240/400 V



Multi-cable high current cable set
6 x 120 mm²



BH-90102
High Current Serial Bar



BE-29090
TM200 External timer



Protective Relay Testers

The purpose of protective relay equipment is to sense fault states and trip circuit breakers. If a fault is not corrected early, personal injuries and series damage can occur. The equipment must be able to distinguish between permissible heavy load conditions and hazardous operational disturbances.

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SELECTION GUIDE

	SMRT36	MGTR	AVTS4.0	GOOSER	FREJA 306	FREJA 300	CA30	SVERKER 750/780	SVERKER 650	PMM-1	PAM 360E	TM200
3 phase test system	■											
Megger GPS timing reference		■										
Advanced visual test software			■									
IEC 61850 test system				■								
6 phase current and 3 phase voltage test set					■							
3 phase fully automatic test set						■						
Current amplifier high module for FREJA							■					
Relay test set								■	■			
Multifunction measuring instrument										■		
Phase angle meter											■	
Timer												■

More detailed selection guides for relay testers are included on the product pages.

As power grids get bigger and carry more power, the need for quick, reliable disconnection when faults occur becomes more and more urgent. The purpose of protective relay equipment is to sense fault states and trip circuit breakers. If a fault is not corrected early, personal injuries and serious damage can occur.

Disconnection must take place selectively, i.e. it must be limited to the faulty part of the power grid. This is why the protective relay equipment must be able to distinguish between permissible heavy load conditions and hazardous operational disturbances. To avoid unjustifiable interruptions, the protective relay equipment must not react to disturbances beneath a specified level called the pick-up value.

Testing principles

Electric power grid protection systems guard extremely valuable equipment, and protective relay equipment plays a vital role in this protection chain. To ensure consistent reliability, protective relay equipment must be checked by testing at regular intervals.

These tests must make certain that the protective relay equipment is operating according to its preset settings. The test equipment supplies the relay protection equipment with inputs that correspond to different faults and different operating situations. Pick-up values are approached by gradually changing the magnitudes of these inputs. Quick, selective disconnection in the event of a fault also requires correct operating times. These can be measured by supplying the protective relay equipment with inputs that exceed by a wide margin the pick-up value while simultaneously measuring the time that elapses prior to tripping.

There are two main principles for testing protective relay equipment. For primary injection testing, high current is injected on the primary side of the current transformer. The entire chain – current transformer, conductors, connection points, relay protection and sometimes circuit breakers as well – is covered by the test. The system being tested must be taken out of operation during primary injection testing (usually conducted in connection with commissioning and also when secondary circuits are not accessible).

For secondary injection testing, the protective relay equipment is disconnected from the measuring transformers and the circuit breaker. Current and voltage is fed directly to the protective relay equipment, and the system being tested does not have to be taken out of operation.

If a relay's curves/characteristics are to be tested at many points or angles, repeated manual adjustment of the test equipment is time consuming. Test equipment that can conduct a test automatically in accordance with a plan drawn up in advance is much faster and far more convenient. Moreover, the time during which the protective relay equipment is out of operation is minimized and the test can be conducted in exactly the same way every time it is run.

Simulating disturbances

Protective relay equipment must sometimes handle unusual faults that involve distortion, transients and harmonics. These unusual disturbances can be handled by test equipment having a DC-coupled amplifier and a program that generates suitable disturbances or plays back information previously stored on a disturbance recorder. This permits nearly all forms of waveforms and transients to be generated.

Testing current transformers

Current transformers have different cores for protection devices and energy measurement equipment. Measurement cores are highly accurate, but will go into saturation at high fault currents. The protective relay equipment must be connected to the correct core in order to be able to operate properly when a fault is present. This can be checked by plotting an excitation curve. The relay's connection to the current transformer is measured using an AC voltage that is increased until the current transformer becomes saturated. Voltage is then plotted as a function of current, and the knee of the curve indicates saturation. Since the knee is much higher for the relay core than the core used for measuring purposes you can easily see whether or not the relay is connected to the correct core.

Current transformers must also have the correct transformation ratio. This can be tested by injecting high current on the primary side, while simultaneously measuring the current in the secondary winding. Current transformers are tested, for the most part, in connection with commissioning. Since automatic testing proceeds at high speed and can be conducted repeatedly in exactly the same way, the time and effort devoted to preparations made before the first test are well worthwhile.

Applications guide

Protective Relays by IEEE Device #	SMRT 36 Single Channel	SMRT 36 Two Channels	SMRT 36 Three Channels
2 Time Delay	■	■	■
21 Distance Single Phase	■	■	■
21 Distance Three Phase Open Delta		■	■
21 Distance Three Phase Wye			■
24 Volts/Hz	■	■	■
25 Synchronizing		■	■
27/59 Under/Over Voltage	■	■	■
32 Directional Power Single Phase	■	■	■
32 Directional Power Three Phase (Open Delta)		■	■
37/76 DC Under/Over Voltage/Current	■	■	■
40 Loss of Field	■	■	■
46 Phase Balance Current	■	■	■
46N Negative Sequence Overcurrent	■	■	■
47 Phase Sequence Voltage (Open Delta)		■	■
50 Instantaneous Overcurrent	Up to 75 Amps	Up to 150 Amps	Up to 225 Amps
51 Time Delay Overcurrent	Up to 35 Amps	Up to 70 Amps	Up to 105 Amps
55 Power Factor	■	■	■
60 Voltage / Current Balance (Open Delta)	Single Phase	■	■
67 Directional Overcurrent	■	■	■
67N Ground Directional Overcurrent	■	■	■
78 Out of Step	■	■	■
79 Reclosing	■	■	■
81 Frequency	■	■	■
85 Carrier or Pilot Wire	■	■	■
87 Differential	■	■	■
91 Voltage Directional (Open Delta)		■	■
92 Voltage and Power Directional (Open Delta)		■	■
94 Tripping	■	■	■



Model STV1

SMRT36

- Small, rugged, lightweight and powerful
- Operate with or without a computer
- Intuitive manual operation with Smart Touch View Interface
- High current, high power (60 Amps/300 VA rms) per phase
- Network interface provides IEC 61850 test capabilities
- Fully automated testing using AVTS software

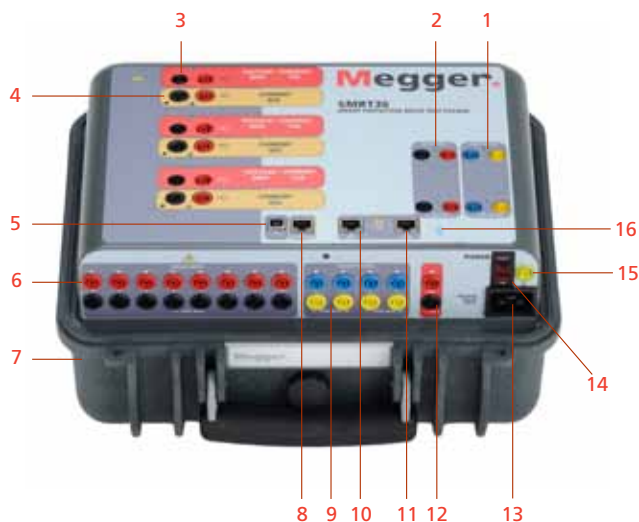
Description

The SMRT is the next generation of Megger programmable secondary relay test systems designed specifically to test microprocessor, solid state, and electromechanical relays. The SMRT36 may be customized by adding the number of Voltage-Current channels, "VIGEN" modules, needed for specific test applications (see Applications Selection).

The SMRT36 test system has the ability to be manually controlled with Megger's new Smart Touch View Interface™ (STVI). The STVI, with its large, full color, high resolution, TFT LCD touch screen allows the user to perform manual, steady-state and dynamic testing quickly and easily using the manual test screen, as well as using built-in preset test routines for most popular relays.

The STVI eliminates the need for a computer when testing virtually all types of relays. Menu screens and touch screen function buttons are provided to quickly and easily select the desired test function. Tests results can be saved to the STVI for download to a memory stick to transfer or print test reports.

For full automatic testing the SMRT36 may be controlled by Megger Advanced Visual Test Software (AVTS). AVTS is a Microsoft® Windows® XP®/Vista™/7 compatible software program designed to manage all aspects of protective relay testing using the new Megger SMRT.



1. Binary outputs 1 and 2: Rated for 300 V at 8 Amps.
2. Binary inputs 1 and 2: Rated 5 to 300 V AC/DC
3. Voltage outputs: Up to 3 channels 300 V at 150 VA, convertible to currents 15 A at 120 VA per phase.
4. Current outputs: Up to 3 channels 60 Amps at 300 VA per phase. Up to 180 Amps at 900 VA single phase.
5. USB 2.0 interface: Communication and control port.
6. Additional binary inputs: Provides 8 additional monitor circuits.
7. Rugged case: Polymeric material.
8. PC/61850 Ethernet port is the primary PC connection port. This port may also be used for connecting to the IEC 61850 substation bus for testing IEC 61850 devices.
9. Additional binary outputs: Adds 4 outputs. Binary outputs 3 and 4 are rated for 300 V AC/DC, 8 amperes. Binary outputs 5 and 6 are high speed and have an AC/DC voltage rating of 400 volts peak, 1 ampere.
10. OUT: Ethernet port used to chain multiple SMRT units together for synchronous multi-unit operation.
11. STVI: Ethernet port is a PoE (Power over Ethernet) port and is used to connect to the STVI for manual control.
12. Battery simulator: Variable 5 to 250 Volts DC output at 100 Watts (4 amperes maximum).
13. Incoming power / Line cord socket: 100 to 240 V, 50/60 Hz.
14. Protective earth ground jack.
15. POWER ON/OFF Switch: Illuminates when power is on.
16. Bluetooth: Bluetooth® provides wireless control.

SPECIFICATIONS

Input power 100 to 240 Volts ($\pm 10\%$) AC, 1 \emptyset , 50/60 Hz, 1800 VA

Outputs

All outputs are independent from sudden changes in mains voltage and frequency, and are regulated so changes in load impedance do not affect the output. Amplifier outputs are available fully isolated or with grounded common returns.

Output current source

The SMRT36 with three VIGEN modules can provide up to six current sources; three high current/high power, and three convertible channels providing lower current/high power. The per channel output current and power ratings are specified in AC rms values and peak power ratings.

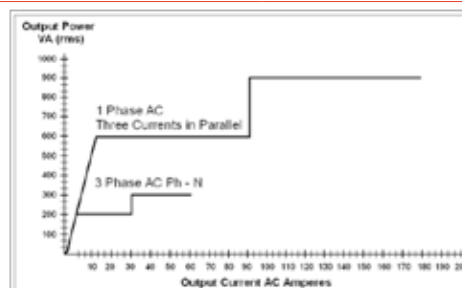
Output current	Power	Max V / Duty cycle
1 Ampere	15 VA	15.0 Vrms Continuous
4 Amperes	200 VA (282 peak)	50.0 Vrms Continuous
15 Amperes	200 VA (282 peak)	13.4 Vrms Continuous
30 Amperes	200 VA (282 peak)	6.67 Vrms Continuous
60 Amperes	300 VA (424 peak)	5.00 Vrms 90 Cycles
DC 200 Watts		

With three currents in parallel:

Output volts	Power	Max I
12 Amperes	600 VA (848 peak)	50.0 Vrms Continuous
45 Amperes	600 VA (848 peak)	13.4 Vrms Continuous
90 Amperes	600 VA (848 peak)	6.67 Vrms Continuous
180 Amperes	900 VA (1272 peak)	5.00 Vrms 90 Cycles

With two currents in series:

The compliance voltage doubles to provide 4.0 Amperes at 100 Volts rms.



Current amplifier - Extended power range

The SMRT current amplifier provides a unique flat power curve from 4 to 30 Amperes per phase to permit testing of electromechanical high impedance relays, and other high burden applications, with an extended operating range up to 60 Amperes at 300 VA rms.

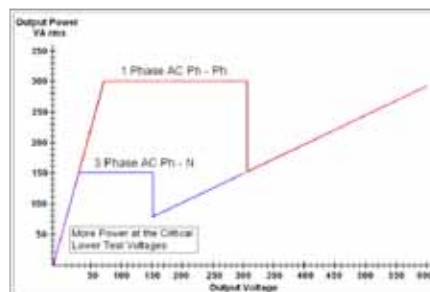
AC voltage output

Outputs are rated with the following ranges:

Output Volts	Power	Max I
30 Volts	150 VA	5 Amps
150 Volts	150 VA	Variable ²
300 Volts	150 VA	0.5 Amps

DC 150 Watts

Duty cycle: Continuous



PowerV™ voltage amplifier - extended power range

The SMRT voltage amplifier provides a flat power curve from 30 to 150 Volts in the 150 V range to permit testing of high current applications such as panel testing.

Voltage amplifier in current mode:

Output current	Power	Max V Duty Cycle
5 Amperes	150 VA (212 peak)	30.0 Vrms Continuous
15 Amperes	120 VA	8.0 Vrms 90 Cycles

Phase angle

Ranges 0.00 to 359.99 degrees, Counter Clock Wise, or Clock Wise rotation, or 0.00 to ± 180.00 degrees

Accuracy: $\pm 0.02^\circ$ typical, $\pm 0.25^\circ$ max at 50/60 Hz

Frequency

The output modules provide a variable frequency output with the following ranges and accuracy.

Ranges

DC

0.001 to 1000.000 Hz

Output amplifiers can provide transient signals with a range of DC to 10 kHz for transient playback using COMTRADE files.

Resolution*: .0001/.001 Hz

Frequency Accuracy:

2.5 ppm typical

25 ppm 0° to 50 °C, at 50/60 Hz Maximum

Total harmonic distortion

Less than 0.1% typical, 2% maximum at 50/60 Hz

² PowerV™ output current varies depending on the voltage setting on the 150 Volt range, see curve.

Timer

The Timer-Monitor Input is designed to monitor and time-tag inputs, like a sequence of events recorder. In addition, the binary input controls enable the user to perform logic AND/OR functions, and conditionally control the binary output relay to simulate circuit breaker, trip, reclose and carrier control operation in real-time. The timer function displays in Seconds or cycles, with the following range and resolution:

Seconds: 0.0001 to 99999.9

(Auto ranging)

Cycles: 0.01 to 99999.9

(Auto ranging)

Accuracy: $\pm 0.001\%$ of reading, typical. ± 2 least significant digit, $\pm 0.005\%$ of reading from 0 to 50° C maximum

Binary Input – Start/Stop/Monitor Gate

To monitor operation of relay contacts or trip SCR, continuity light is provided for the input gate. Upon sensing continuity the lamp will glow. In addition to serving as wet/dry contacts the binary inputs may be programmed to trigger binary output sequence(s).

Input rating: up to 300 V AC/DC

Binary output relays

SMRT36 has independent, galvanically isolated, output relay contacts to accurately simulate relay or power system inputs to completely test relays removed from the power system. The binary output simulates normally open / normally closed contacts for testing breaker failure schemes. The binary output can be configured to change state based on binary input logic.

High Current Output Relays: The first two VIGEN modules have 1 each, and the SMRT36 "P" model adds 2 more.

AC rating: 400 V max., I_{max}: 8 amps, 2000 VA max.

DC rating: 300 V max., I_{max}: 8 amps, 80 W

Response time: <10 ms

High speed output relays: SMRT36 "P" Model adds 2

AC/DC rating: 400 V peak, I_{max}: 1 amp

Response time: <1 ms typical

Waveform generation

Each output channel can generate a variety of output waveforms such as: DC; sine wave; sine wave with percent harmonics at various phase angles; half waves; square waves with variable duty cycles; exponential decays; periodic transient waveforms from digital fault recorders, relays with waveform recording capability or EMT/ATP programs, which conform to the IEEE C37.111 COMTRADE standard format.

Metering

Measured output quantities such as AC Amperes, AC Volts, DC Volts or DC Amperes, and Time may be simultaneously displayed on the large, color TFT LCD touch screen. The AC and DC outputs display the approximate voltage/current output prior to initiation of the outputs.

AC voltage amplitude

Accuracy	$\pm 0.05\%$ reading + 0.02% range typical, $\pm 0.15\%$ reading + 0.05% range maximum
Resolution	.01
Measurement	AC RMS
Ranges	30, 150, 300 V

AC current amplitude

Accuracy	$\pm 0.05\%$ reading + 0.02% range typical, $\pm 0.15\%$ reading + 0.05% range maximum
Resolution	.001/.01
Measurement	AC RMS
Ranges	30, 150, 300 V

DC voltage amplitude

Accuracy	0.1% range typical, 0.25% range maximum
Resolution	0.1
Measurement	RMS
Range	30, 150, 300 V

DC current amplitude

Accuracy	0.1% range typical, 0.25% range maximum
Resolution	0.1
Measurement	RMS
Ranges	30 A

Convertible source in AC current mode

Accuracy	$\pm 0.05\%$ reading + 0.02% range typical, $\pm 0.15\%$ reading + 0.05% range or ± 12.5 mA whichever is greater
Resolution	.001
Measurement	AC RMS
Range	5, 15 A

Environmental

Operating temperature	0 °C to 50 °C (32 °F to 122 °F)
Storage temperature	-25 °C to 70 °C (-13 °F to 158 °F)
Relative humidity	5 - 90% RH, Non-condensing

Specification continued

Dimensions

With the lid on	360 W x 194 H x 305 D mm (14.2 W x 7.6 H x 12.0 D in.)
With the lid off	360 W x 180 H x 305 D mm (14.2 W x 7.2 H x 12.0 D in.)
IEC enclosure rating	IP30
Weight	
With the transit lid on	12.55 kg (27.9 lb.)
With the transit lid off	11.6 kg (28.5 lb.)

Specification continued

Conformance standards

Safety	EN 61010-1, UL 61010-1, CSA-C22.2 #61010-1
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Shock, Vibration and Transit Drop

Shock	MIL-PRF-28800F (30g/11ms half-sine)
Vibration	MIL-RFP-28800F (5-500 Hz, 2.05 g rms)
Steady cold	MIL-STD-810, Method 502.2
Cold storage	MIL-STD-810, Method 502.2
Hot storage	MIL-STD-810, Method 501.2
Steady dry heat	MIL-STD-810, Method 501.2

Electromagnetic Compatibility

Emissions	EN 61326-2-1, EN 61000-3-2/3, FCC Subpart B of Part 15 Class A
Immunity	EN 61000-4-2/3/4/5/6/8/11

Protection

Voltage outputs are protected from short circuits and thermally protected against prolonged overloads. Current outputs are protected against open circuits and thermally protected against prolonged overloads.

Communication interfaces

Ethernet (2), USB 2.0, Bluetooth (optional)

SOFTWARE

AVTS – STVI BASIC

Every unit comes with AVTS Basic software and the PC version of the STVI Basic software packages. AVTS Basic version includes Online Vector control (for single and multi-state timing tests), Online Ramp control (for automatic ramping of voltage, current, phase angles or frequency) and Online Click-On-Fault (for dynamic tests of impedance relays). Test results may be exported directly to Microsoft Word. AVTS software includes a database for saving test results, which can also provide the necessary information needed for system reliability audits.

The PC version of the STVI software includes the ability to bring all STVI test data (from other STVI units) into file folders for retrieval and review whenever needed.

AVTS Advanced

The AVTS Advanced version includes the powerful Test Editor, Dynamic Control (includes dynamic end-to-end testing capability, and waveform recording capability), Modbus communication test capability, ASPEN OneLiner™ or Electrocon CAPE™ SS1 File Converter for dynamic testing, and easy to use programming Tools for creating and editing test modules.

AVTS Professional

The AVTS Professional version includes all of the features of the Basic and Advanced versions plus some other powerful test tools and features. It includes the DFR Waveform Viewer, One-Touch™ Test for fully automatic tests, and Waveform Digitizer to digitize scanned waveforms of electromechanical over current time curves.

IEC 61850 GOOSE

The SMRT with the GOOSE enabled, in conjunction with the Megger GOOSE Configurator (MGC) software, can be used in the testing or commissioning of IEC 61850 compliant devices.

Included accessories

Power Cord - depending on the style number, the unit will come with one of the following,

Line cord, North American 620000

Line cord, with CEE 7/7 Schuko Plug 50425

Line cord, International color coded wire 15065

Ethernet Crossover Cable 620094
Ethernet crossover cable for interconnection to PC, 210 cm (7 ft.) long (Qty. 1 ea)

Instruction manual CD 80989

Deluxe test leads and accessories kit 1001-619

The test leads and test lead accessories are an option. Test leads and accessories can be ordered with the unit, or later as a kit. The deluxe test leads and accessories kit includes sleeved pairs of leads for use with the extra binary inputs/outputs/battery simulator option, as well as the three phase sleeved combination leads for voltage and current channels. The following test leads and test lead accessories are included in the deluxe test leads and accessories kit in quantities shown.

Sleeved combination voltage test leads 2001-395

Keeps the test leads from getting entangled. Sleeved three phase test leads, three red and black, 200 cm (78.7") long, 600 V, 32 Amperes CAT II (Qty. 1 ea)

Sleeved combination current test leads 2001-396

Keeps the test leads from getting entangled. Sleeved three phase test leads, three red and black, 200 cm (78.7") long, 600 V, 32 Amperes CAT II (Qty. 1 ea)

Sleeved pair test leads 2001-394

One red, one black, 200 cm (78.7") long, 600 V, 32 Amperes CAT II, (Qty. 5 pair)

Jumper lead 2001-573

Black, 12.5 cm (5") long, use with voltage/current outputs, 600 V, 32 Amps CAT II (Qty. 4 ea.)

Cable/Spade lug adapter (small) 684004

Small lug fits most new relay small terminal blocks. Lug adapter, red, 4.1 mm, use with test leads up to 1000 V/ 20 Amps CAT II (Qty. 15 ea.)

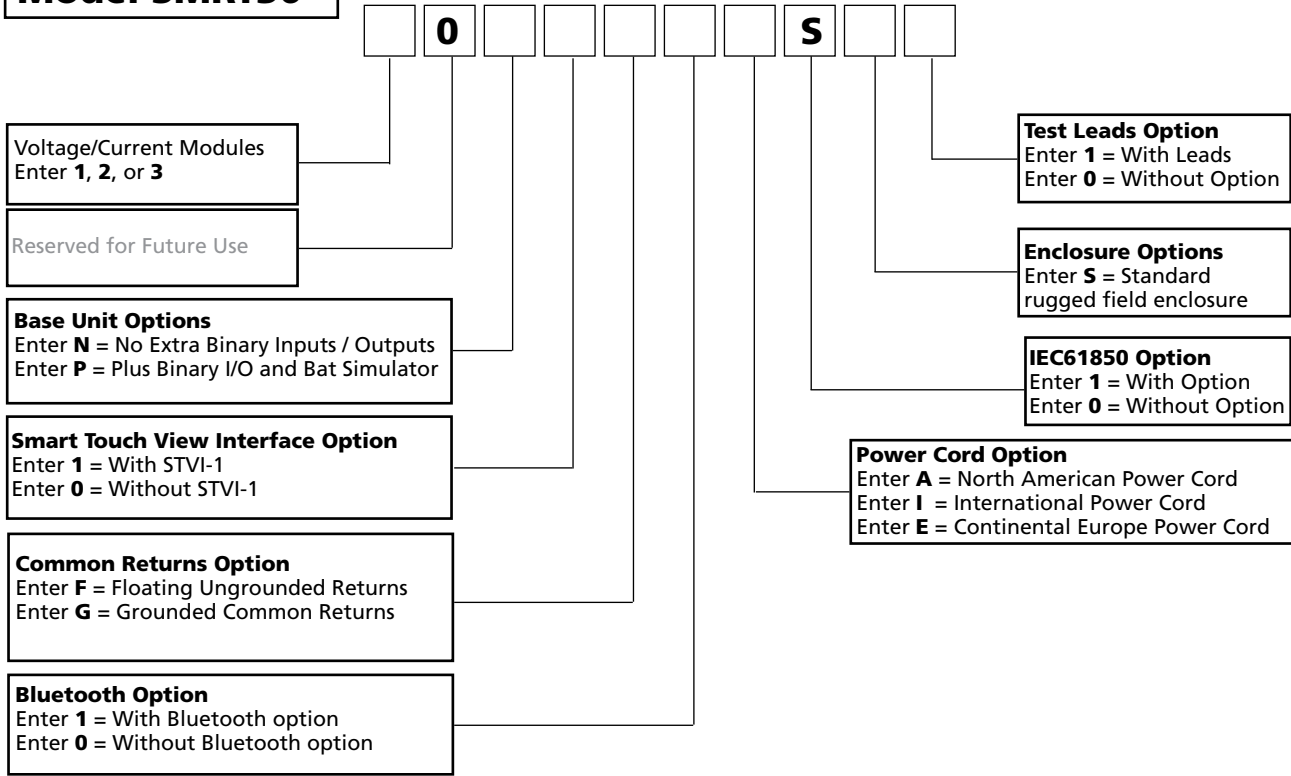
Lug adapter 684005

Black, 4.1 mm, use with test leads up to 1000 V/ 20 amps CAT II (Qty. 15 ea.)

ORDERING INFORMATION

Model SMRT36-

Style Number Identification



Description of Software Options

#	Included Software	Part Number
1	AVTS Basic	544244
2	STVI Application CD	81302
Software Options		
1	AVTS Advanced Test	544245
2	AVTS Advanced Test with IEC 61850 Megger GOOSE Configurator	1001-037
3	AVTS Professional Test	544246
4	AVTS Professional Test with IEC 61850 Megger GOOSE Configurator	1001-038

Descriptions of Hardware Options

Voltage/Current Module: The SMRT 36 unit can have up to a total of 3 voltage/current modules. Enter the number of desired Voltage / Current modules 1, 2 or 3.

Future: 0, Reserved for future use.

Base Unit Options: The first two channels provide 1 binary input and 1 binary output each. Enter N for No extra binary I/O or battery simulator. For the user who requires the extra binary inputs, outputs and/or the battery simulator enter P for Plus option.

Smart Touch View Interface Option: Enter the number 1 for the unit to come with the STVI, or enter the number 0 for without.

Common Returns Option: Enter F for floating returns and G for grounded common returns. The floating returns option provides independent, isolated return terminals for each output channel. The second option is G for grounded common returns, where return terminals are interconnected internally and connected to chassis ground.

Bluetooth Option: For customers, who wish to have a wireless control of the SMRT unit, enter the number 1 for the unit to come with the Bluetooth option, or enter 0 for without.








Power Cord Option: Customers can choose which type of power cord they want the unit to come with.

- Customers in North America, and other countries that use standard NEMA type power outlets, enter A.
- Customers in countries like Australia, India, or the United Kingdom, enter I for the International Cord.
- Customers where the CEE 7 standard connector is used enter E for the Continental Europe Power Cord.

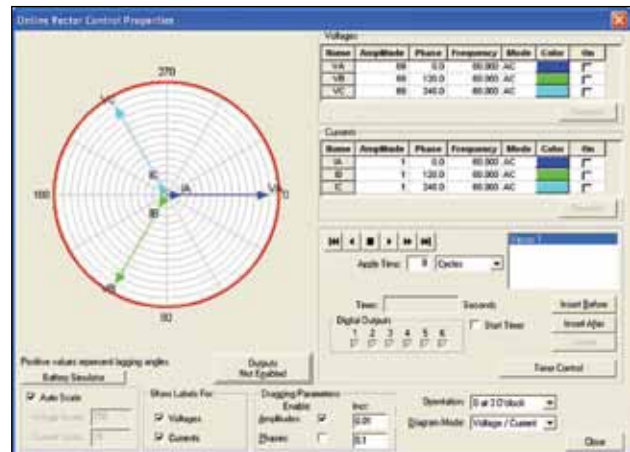
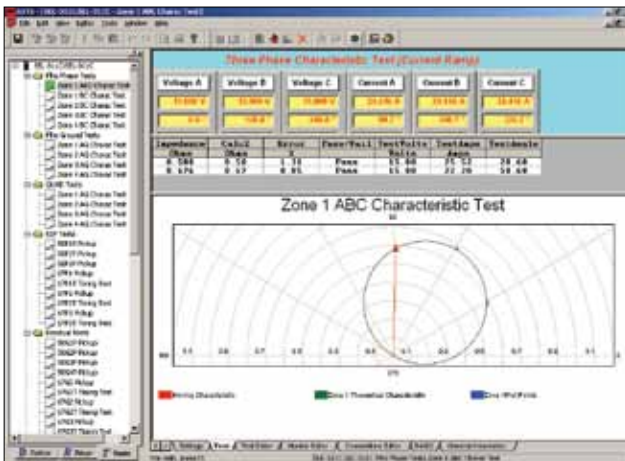
IEC 61850 Option: The SMRT36 in conjunction with the Megger GOOSE Configurator (MGC) software can be used in the testing or commissioning of IEC 61850 compliant devices. In order for the SMRT36 to be able to subscribe as well as publish GOOSE messages, the IEC 61850 feature needs to be enabled. Enter the number 1 for the unit to come with the IEC 61850 option enabled. Enter 0 for the unit without IEC 61850 enabled.

Enclosure Option: S for Standard, rugged, field type enclosure.

Test Leads Option: Enter the number 1 for the unit to come with Test Leads. Enter 0 for the unit without Test Leads.

		STVI, or Binary I/O Bat SIM, or Test Leads Options	One (1) Voltage Current Module	Two (2) Voltage Current Modules	Three (3) Voltage Current Modules	Binary I/O, Battery Simulator Option
	Accessory carry case Use to carry power cord, Ethernet cable, optional STVI and test leads. Carry case may be clipped to the SMRT enclosure, or use carry strap to carry over shoulder.	2001-487 Qty. 1 ea.				
	Sleeved pair of test leads Keeps the test leads in pairs and from getting entangled. Sleeved test leads, one red, one black, 200 cm (78.7") long, 600 V, 32 Amperes CAT II.		2001-394 Qty. 3 pr.	2001-394 Qty. 6 pr.	2001-394 Qty. 2 pr.	2001-394 Qty. 3 pr.
	Cable/Spade lug adapter (small) Small lug fits most new relay small terminal blocks.					
	Lug adapter Red, 4.1 mm, use with test leads up to 1000 V/20 Amps CAT II.		684004 Qty. 3 ea.	684004 Qty. 6 ea.	684004 Qty. 12 ea.	684004 Qty. 3 ea.
	Lug adapter Black, 4.1 mm, use with test leads up to 1000 V/20 Amps CAT II.		684005 Qty. 3 ea.	684005 Qty. 6 ea.	684005 Qty. 12 ea.	684005 Qty. 3 ea.
	Jumper lead Used to common returns together on units with floating ground returns, or parallel of current channels. Jumper lead, black, 12.5 cm (5") long, use with voltage/current outputs, 600 V, 32 Amps CAT II.			2001-573 Qty. 2 ea.	2001-573 Qty. 4 ea.	
	Sleeved combination voltage test leads Keeps the test leads from getting entangled. Three common leads connect to the test set, which are interconnected down to one black common to connect to the relay under test. Sleeved three phase test leads, three red and black, 200 cm (78.7") long, 600 V, 32 Amperes CAT II.				2001-395 Qty. 1 ea.	
	Sleeved combination current test leads Keeps the test leads from getting entangled. Three pairs of leads connect to the test set, with three pairs to connect to the relay under test. Sleeved three phase test leads, three red and black, 200 cm (78.7") long, 600 V, 32 Amperes CAT II.				2001-396 Qty. 1 ea.	

For more info...
 regarding this product, including all the optional accessories
 Visit our website - www.megger.com



Online Vector Control

AVTS 4.0

- Powerful, easy-to-use Microsoft® Windows® 2000/XP®/ Vista™ compatible
- Designed to manage all aspects of protective relay testing using the SMRT or MPRT Relay Test Set
- Now loaded with more features and capabilities:
 - Click-on-fault
 - Dynamic control
 - Binary search
 - Waveform recorder
 - SS1 file reader
 - Modbus communications
- Optional IEC 61850 test capability

Description

AVTS is a Microsoft Windows 2000/XP/Vista software program designed to manage all aspects of protective relay testing using the Megger SMRT, MPRT or older PULSAR relay test sets. More flexibility has been added as well as some new and powerful features.

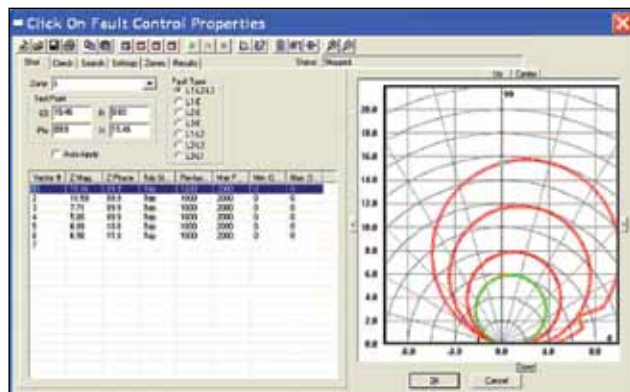
AVTS comes in three different levels:

- Basic
- Advanced
- Professional

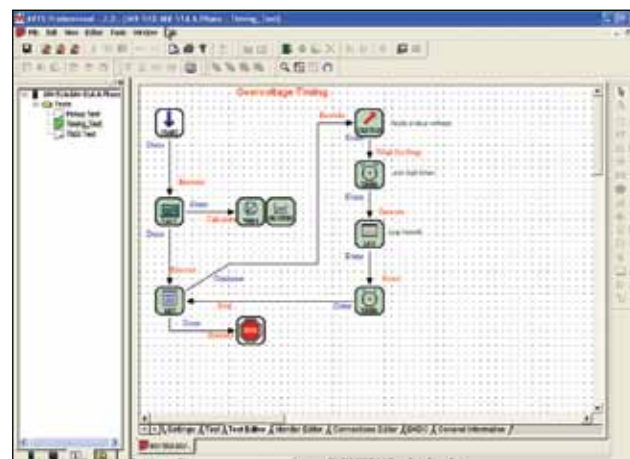
Every MPRT unit comes with AVTS Basic.

The **Basic** version includes Online Vector, Ramp and Click-On-Fault controls with the ability to import, save and execute test modules. In addition, the Basic version includes enhanced Relay Test wizards, including new wizards not previously available.

The **Advanced** version includes the Test Editor, Dynamic Control, Modbus, SS1 Converter, End-to-End test macros and basic programming Tools for creating and editing test modules.



Click-On-Fault RIO Import of SEL 321 characteristic



Test Editor window

The **Professional** version includes all of the features of the Basic and Advanced versions plus some new and powerful features. It includes the DFR Waveform Viewer, One-Touch Test, editor, and Waveform Digitizer.

SPECIFICATIONS

Feature	Description	Basic	Advanced	Professional
Online Vector Control	The Online Vector Control allows the user to have direct control of the Relay Test System. Up to sixteen vector states may be created and sequenced back through the test system. Now includes timer function for timing a given vector state.	■	■	■
Online Ramp Control	Preramp (prefault), Ramp 1 and Ramp 2 are available for use to be played back through the test system. Automatically Ramp or Pulse Ramp outputs. PulseRamp provides the capability to determine reach points on multi-zone distance relays without having to defeat the zone timing elements, and provides pre-fault load conditions for relays that require it. Enable timer control with either ramp. PulseRamp is available down to the basic level.	■	■	■
On-Line Click On Fault	The user can define the type of operating characteristic using the AVTS Theoretical Control or Import files in the RIO file format, then click at a point on the characteristic that they wish to test for, either as a Shot, or using the Search features. If using the Search the test will progress down a line, using click and drag, either as a ramp or a pulse ramp looking for the relay to operate. Test results appear in the RX diagram along with the theoretical operating characteristic of the relay.	■	■	■
RIO File Format	RIO file import allows the user to import an existing RIO file into the click-on-fault R/X diagram ready to proceed with the test.	■	■	■
DFR Playback	Import and execute relay test modules, which contain DFR playback files created using the DFR Waveform Viewer Tool.	■	■	■
Fault Calculator	Calculate fault values for \emptyset - \emptyset , \emptyset -N, and 3 \emptyset faults. Use line voltage, line Z and angle, relay volts and angle, relay amps and Z0/Z1.	■	■	■
Import, Save, and Execute Test Modules	Import relay test files and execute selected tests. Save results to built-in Microsoft Access compatible data base, and print results.	■	■	■
Overcurrent Wizard	Provides automatic testing of overcurrent relays, including pickup, timing characteristic using IEEE/ IEC formulas, Instantaneous, DC target and seal-in tests.	■	■	■
Over/Under Voltage Wizard	Provides automatic testing of over and under voltage relays, including pickup, timing characteristic and DC target and seal-in tests.	■	■	■
Distance Wizard	Provides automatic testing of distance relays. \emptyset - \emptyset , \emptyset -G, and 3 Phase faults are available. Test result graphics are displayed in an R X plane.	■	■	■
Differential Wizard	Provides automatic testing current differential relays, including pickup, slope (includes capability to control up to 8 currents for differential characteristic), and 2nd, 3rd and 5th harmonic restraint tests on transformer differential relays.	■	■	■
Frequency Wizard	Provides automatic testing of under/over frequency relays, including pickup and timing.	■	■	■
Transducer Testing with Touch-View Interface or AVTS software	Use the TVI to do manual testing of all types of transducers. Results maybe saved to the internal memory, downloaded to AVTS and printed later. AVTS users may create a test for any type transducer using the Test Editor Screen and the Analog Input control tool.	ⓘ	■	■
Test Editor	Provides editing tools for modifying tests.		■	■

SPECIFICATIONS

Feature	Description	Basic	Advanced	Professional
Dynamic Control	Accessed through the Test Editor Screen, the Dynamic Control provides dynamic multi-state testing of relays with more flexibility and choices than Vector Control. A "state" can be voltage(s), current(s), phase angle(s), timers, start and stop the analog recorder, set Boolean logic for the binary inputs, set binary output(s), or even use variables to set values. The test transitions from one state to another after a programmed time delay of either milliseconds or cycles, or after a trigger condition. In addition, the Dynamic Control allows the user to easily build harmonic waveforms with frequencies up to 1000 Hz.		■	■
Basic Programming Tool	Provides control tool in the Test Editor. Basic programs can be written using the test system command set for special testing applications.		■	■
Modbus Communications	Used in conjunction with specific Megger Test Modules to automatically download relay settings (into the AVTS setting screen) from microprocessor based relays, which use the Modbus protocol, for full automatic one-touch testing.		■	■
SS1 File Converter	SS1 files are generated using Power System Simulation software programs by Electrocon® CAPE™ or Aspen One-liner®. By modeling the power system and using the SS1 files, the relay can then be tested dynamically using realistic system test scenarios.		■	■
Import Aspen Relay Database®	Capability to import relay settings directly from Aspen Relay Database®.		■	■
End-to-End Test Macro	"End-to-End" testing is used to describe the testing of an entire line protection scheme. This includes all protective relays, interface equipment, and any communication equipment.		■	■
Recorder	In association with the new Dynamic Control is a new Recorder feature, which not only records the action of the binary inputs and outputs, but it also records the actual analogue waveforms of the MPRT voltage and current outputs. Use this new feature to capture and verify analogue output values. Use to monitor Binary Inputs and Outputs to capture and troubleshoot single-pole or three-pole coordination or suspected contact bounce situations. Use to capture multi-state playback to evaluate complex reclosing schemes. It will even record complex waveforms generated by the SMRT/MPRT, which could be used for harmonic evaluations.		■	■
Waveform Digitizer	Provides digitizing tools to create digital time curves for old electromechanical relay time curves (that do not fit any time curve algorithm) up to the most complex relay operating characteristics. Good for digitizing scanned waveforms (like from a light-beam chart recorder).			■
One-Touch	Test Editor control tool, used in conjunction with specific Megger Test Modules, to download relay settings (into the AVTS settings screen) from microprocessor based relays for full automatic one-touch testing. Used with VB script to auto test SEL relays and new MODBUS to auto test GE UR and selected Multilin relays.			■
DFR Waveform Viewer and Playback	Import, view, modify and replay Digital Fault Recordings or EMTP/ATP simulations that are in the COMTRADE file format.			■

ORDERING INFORMATION

Product	Order Code
AVTS Basic Software Included with the purchase of an MPRT Relay Test System	5442444
AVTS Advanced Software	544245
AVTS Professional Software	544246
Extended Software Support Program	10629
1 to 2 users	10098
1 to 5 additional users	10097

MGTR

GPS timing reference



MGTR

- Small and lightweight
- Easy to use programmable output pulse for synchronized end-to-end testing
- 100 ns accuracy within minutes of startup, 12-channel GPS timing receiver
- Near-rubidium stability during temporary GPS signal loss

Description

The MGTR is a small, light-weight, field portable, GPS satellite receiver system specifically designed to perform end-to-end tests of line protection schemes, with Megger SMRT, MPRT and Pulsar relay test systems. The MGTR provides a precise Programmed Output Pulse (POP), with 100 nanoseconds of resolution. This output pulse provides a trigger synchronization of two or more SMRT, MPRT or Pulsar test systems to less than $\pm 1 \mu$ Sec of the Universal Time Coordinated (UTC).

The unit comes with a 50 foot (15.2 m) long cable and all-weather, high-performance, high noise immunity antenna with an integrated low-noise preamplifier. Control of the MGTR is through a standard RS-232 serial connection and an adapter cable with a 9-pin D-sub connect. Software is provided to communicate to, and control, the MGTR unit.

ORDERING INFORMATION

Product	Order Code
Megger GPS timing reference unit	MGTR
MGTR Includes	
Instruction manual (1 ea.)	750018
MGTR receiver unit, with Software CD (1 ea.)	569010
Control cable assy. (1 ea.)	620082
GPS Antenna kit (1 ea.)	801055
Antenna kit contains the following	
GPS Antenna (1 ea.)	650016
15 m 50 ft. cable (1 ea.)	620083
4 inch SS Antenna mount (1 ea.)	650017
AC/DC Power adapter (1 ea.)	561024
Optional accessories	
Soft-sided transit case (1 ea.)	MC6674

SPECIFICATIONS

Input power

AC/DC adapter	90 to 265 VAC, 47-63 Hz to 24 VDC, 400 mA w/4 plug kit
Disciplined oscillator	High performance oversized control (OCXO)
Long-term stability	1×10^{-12} after 24 hours tracking
Short-term stability	1×10^{-11} after 1 second tracking
Accuracy while coasting	1×10^{-10} per day after 3 days of locked operation

Time to first fix (typical)

Hot Start: <30 seconds (with valid almanac, time, date, position and ephemeris)

Warm start: <60 seconds (with valid almanac, time, date and position)

Cold start: <3 minutes typical

Programmable output pulse

Drive	TTL into 50 Ω
Rise/Fall time	10 ns Maximum
Pulse width	Programmable from 1 μ s – 250 ms
Polarity	Selectable, positive/negative
Resolution	100 ns
Accuracy	100 ns RMS

External event input

TTL/CMOS level, edge-triggered, polarity selectable

Resolution	100 ns
Accuracy	100 ns RMS

MUX 1 output

The output is user selectable. Outputs available are: 1, 10, 100 kHz, 1, 5, 10 MHz, 1 PPS

Drive	TTL into 50 Ω
Rise/Fall time	10 ns Maximum

1 PPS output

(Referenced to UTC)	
Drive	TTL into 50 Ω
Rise time	10 ns Maximum
Pulse width	Positive pulse, 1 ms nominal, rising edge on-time.
Accuracy	100 ns RMS

10 MHz output

Standard frequency output 10 MHz. High spectral purity sinewave, +10 dBm into 50 Ω , ± 2 dB

Temperature range (MGTR)

Operating	-20 $^{\circ}$ C to 70 $^{\circ}$ C (14 $^{\circ}$ F to 158 $^{\circ}$ F)
Storage	-40 $^{\circ}$ C to 85 $^{\circ}$ C (-6 $^{\circ}$ F to 185 $^{\circ}$ F)
Relative humidity (MGTR)	95% RH, Non-condensing

Dimensions

MGTR unit enclosure	104.8 W x 38.1 H x 101.6 D mm (4.125 W x 1.5 H x 4.0 D in.)
MGTR unit weight	0.453 kg (1.0 lbs.)

Safety

IEC 61010-1, Amendments 1 and 2

Enclosure

The unit comes mounted in a rugged enclosure for field portability. An optional padded soft-sided carry case is available. The soft-sided carry case protects the unit from light rain and dust. The soft case also has pockets to hold the antenna, cables and AC/DC power supply.

Description

The GOOSER™ is the world's first general purpose IEC 61850-8-1 GOOSE test equipment, dedicated to test the GOOSE horizontal communication in substation protection/control applications.

The GOOSER can convert a GOOSE message received on its rear Ethernet port into binary output and it can convert a binary input into a GOOSE message and publish it at its rear Ethernet port. The conversion time is typically 0.6 ms.

The GOOSER is equipped with 10 binary inputs and 10 binary outputs. Using these it can convert simultaneously up to 20 GOOSE messages.

Binary inputs of the GOOSER can react on DC-voltage presence (voltage sense or "wet" contact mode) or can independently detect an applied closed/open contact (contact sense or "dry" contact mode).

For high speed operation the binary outputs of the GOOSER are solid state, fully protected against incorrect connections and short circuits. These have a strong breaking capacity to drive inductive loads like auxiliary relays.

The GOOSER has two physically isolated Ethernet ports: front and rear. The GOOSE messages are transferred by the firmware from the rear port to the front port, where the messages can be visualized using the provided PC-GOOSER software or with any third party network analyzer.

This functionality allows the GOOSER to act as a secure and safe substation access point.

With the 6.4" color touch screen on the front panel the GOOSER can be used without the need for a PC. The GOOSER configuration files are read from a memory stick inserted in the USB port on the front panel.

The software PC-GOOSER provides mapping of the binary inputs and outputs of the GOOSER to the desired GOOSE messages. The GOOSE messages are read from available SCL (Substation Configuration Language) files or may be automatically detected by scanning the substation network in search of available published GOOSE messages. This process is known as GOOSE "sniffing".

The PC-GOOSER also provides advanced network trouble-shooting tasks such as comparing the GOOSE messages available on the network with the GOOSE messages described on the SCL files with GOOSE Merge functionality; this is also a powerful tool for validating the horizontal communication description (GOOSE) in the supplied SCD file at Factory Acceptance Tests (FAT) in IEC 61850 substations.



GOOSER

- Reliable testing of IEC 61850 relays using any conventional relay test set
- Separate Ethernet ports for the substation LAN and the controlling PC forming a Safe Substation Bus Access Point
- Seamless interaction between SCL GOOSE and GOOSE "sniffing"
- GOOSE merge – SCL GOOSE vs captured GOOSE for network troubleshooting and SCD file validation at FAT
- Stand alone functionality – download a configuration and run
- Patent pending

Specifications GOOSER

The specifications are valid for nominal voltage supply and at an ambient temperature of +25 °C (77 °F). Specifications are subject to change without notice.

Environment

<i>Application field</i>	The instrument is intended for use in high-voltage substations and industrial environments.
<i>Measurement category</i>	CAT I, transient voltage 1500 V
<i>Temperature, operating</i>	0 °C to +50 °C (32 °F to +122 °F)
<i>Temperature storage & transp.</i>	-20 °C to +70 °C (-4 °F to +158 °F)
<i>Vibration</i>	IEC 60068-2-6
<i>Shock (non-operating)</i>	IEC 60068-2-27
<i>Humidity</i>	5% – 95% RH, non-condensing
<i>Altitude (operational)</i>	<3000 m
<i>Pollution degree</i>	2

CE marking

<i>EMC</i>	2004/108/EC
<i>LVD</i>	2006/95/EC

General

<i>Mains voltage</i>	100 – 230 V AC, 50-60 Hz
<i>Current consumption</i>	1 A (max)
<i>Fuses, F1 / F2</i>	F 2A
<i>Dimensions</i>	
<i>Portable version</i>	446 x 290 x 180 mm (17.6" x 11.4" x 7.1")
<i>Rack mounted version</i>	19"
<i>Weight</i>	8.5 kg (18.7 lbs) 18.8 kg (41.4 lbs) with accessories and transport case
<i>User interface</i>	6" LCD touchscreen

BINARY INPUTS

<i>Number</i>	10
<i>Voltage sense</i>	
<i>Max voltage</i>	250 V DC
<i>Transition level</i>	Approx. 15 V DC
<i>Protection</i>	Self-protected against wrong connection
<i>User feedback</i>	Small LED
<i>Galvanic isolation</i>	Groupwise 3+3+2+2
<i>Contact sense</i>	
<i>Output voltage</i>	19 VDC
<i>Short-circuit current</i>	15 mA

BINARY OUTPUTS

<i>Number</i>	10
<i>Protection</i>	Self-protected against wrong connection. Built-in current limiter
<i>Type</i>	Normally open solid state contact
<i>Rated current range</i>	0 – 250 mA DC
<i>Rated voltage range</i>	48 – 220 V DC
<i>Breaking capacity DC at L/R ≤ 40 ms</i>	110 V DC 0.25 A
<i>Galvanic isolation</i>	10 separate outputs
<i>Withstand voltage</i>	250 V DC
<i>User feedback</i>	Small LED

Communication ports

<i>IEC 61850</i>	Ethernet RJ-45 100 Mbps
<i>PC COM</i>	Ethernet RJ-45 100 Mbps
<i>USB MEMORY</i>	USB 2.0 type A

Mappable GOOSE messages to inputs/outputs

<i>Boolean (single point indication)</i>	Explicit and one level structured data set
<i>2-bit string (double point indication)</i>	Explicit and one level structured data set

Conversion time GOOSE – Electric signal

<i>GOOSE → Binary Output</i>	0,6 ms typical
<i>Binary Input → GOOSE</i>	0,5 ms typical

Publishable GOOSE messages

<i>Boolean, 2-bit String,</i>	Explicit and one level structured data set. Value according to mapped Input or default or sniffed data if not mapped.
<i>n-bit String, Integer, Real, Time</i>	Explicit and one level structured data set. Value according to default or sniffed data

SCL file importing

<i>From IEC 61850 Edition 1</i>	cid, scd, icd, xml
<i>From IEC 61850 Edition 2</i>	sed, iid

ORDERING INFORMATION

Product	Order Code
GOOSER Portable version Incl. PC-GOOSER	CL-19000
GOOSER Portable version Incl. PC-GOOSER, Ethernet cable 2 m (GA-00982), Ethernet cable 10 m (GA-00984), USB memory stick, cable kit for GOOSER test cables (GA-00020) and soft case (GD-00215)	CL-19090
GOOSER Portable version Incl. PC-GOOSER, Ethernet cable 2 m (GA-00982), Ethernet cable 10 m (GA-00984), USB memory stick, cable kit for GOOSER test cables (GA-00020) and hard case (GD-00500)	CL-19091
GOOSER 19" rack mounting version Incl. PC-GOOSER	CL-19005
GOOSER 19" rack mounted version Incl. PC-GOOSER, Ethernet cable 2 m (GA-00982), Ethernet cable 10 m (GA-00984), USB memory stick, cable kit for GOOSER test cables (GA-00020) and hard case (GD-00500)	CL-19095
Optional	
PC-GOOSER Windows® software 1 to 4 licenses	CL-8302E
PC-GOOSER Windows® software 5 or more licenses	CL-8402E
Electrical / Fiber Optical Ethernet converter – (RJ45)/(ST) standard multimode	HC-04260
Optical fiber cable, 5 m, ST-ST	GA-00986
Optical fiber cable, 5 m, LC-ST	GA-00987
Cable kit for GOOSER test cables Banana plug, 2p tp black (Jumper) - 3 pcs Test cable red, 0.25 m - 10 pcs Test cable black, 1 m - 5 pcs Test cable red, 1 m - 5 pcs	GA-00020
Ethernet cable, 2 m, non shielded, crossed, red	GA-00982
Ethernet cable, 3 m, shielded, straight, grey	GA-00985
Ethernet cable, 10 m, shielded, straight, grey	GA-00984

Application

FREJA306 is intended primarily for secondary testing of protection relays. Virtually all types of protection relays can be tested.

Examples of what FREJA306 can test	ANSI® No.
Distance protection relay	21
Synchronising or synchronism-check relays	25
Undervoltage relays	27
Directional power relays	32
Undercurrent or underpower relays	37
Negative sequence overcurrent relays	46
Overcurrent-/ ground fault relays	50
Inverse time overcurrent-/ ground fault relays	51
Power factor relays	55
Overvoltage relays	59
Voltage or current balance relays	60
Directional overcurrent relays	67
DC overcurrent relays	76
Phase-angle measuring or out-of-step protection relays	78
Automatic reclosing devices	79
Frequency relays	81
Differential protection relays	87
Directional voltage relays	91
Voltage and power directional relays	92



FREJA306

- Manual and PC remote control
- Easy to use
- Excellent software provides great visuals and simple setup
- High performance amplifiers
- Lightweight and portable
- User can calibrate the unit

Description

FREJA306 is the latest member of the relay testing equipment from Megger, quick and easy to use, like the FREJA300. The rugged hardware design is built for field use over a wide temperature range, with the possibilities of intelligent software to perform rapid testing.

FREJA306 can be operated with or without a PC. After being put into the local mode, FREJA306 can be used stand-alone without a PC. Using the local mode is easy.

FREJA306 is an excellent choice when you want more current outputs, higher amps (3 x 15 A + 3 x 35 A), VA or compliance voltage. Use it to test differential relays with 6 currents, or virtually any single or 3-phase relay.

When testing 1-phase relays, you can make use of either the high current (over 100 A), or the very high compliance voltage. This now makes it possible to test high impedance relays of different kinds, like rotating disc relays, earth protection relays, etc.

FREJA306 can also be used as a disturbance simulator and create and generate simulated disturbances, or import actual recorded disturbances from e.g. EMTP or COMTRADE files.

With the built-in DC source you can directly supply the protection relay.

With use of the GPS receiver accessory, GPS200 – MGTR, several FREJA306 can be synchronized to perform end-to-end testing with the test sets allocated in different substations.

A FREJA300 can be upgraded to a FREJA306.

Local Mode - without PC

Using the dial by turning and clicking it is easy to make the settings. All settings are saved automatically when you exit, but if you prefer you can assign the settings a name and save them separately for convenient access when you conduct your next test. The display can also show the measured value that is being generated. This feature is equivalent to three voltmeters and three ammeters that present RMS values for all generators.

```

2ND 50.00 Hz 63.0 63.0 63.0 63.0 V
* - - VOLT 0.0 0.0 240.0 120.0
o o o -----ms 0.00 0.00 0.00A
2/6 Start SET 0.0 0.0 0.0
    
```

Local Mode General

```

2ND 50.00Hz I: <1.000> U: 45.0V
* - - VOLT R: 45.000 |Z|: 45.000
o o o -----ms X: 0.000 Zφ: 0.0
2/3 Start RST Run: Seq
    
```

Local Mode Rx (I)

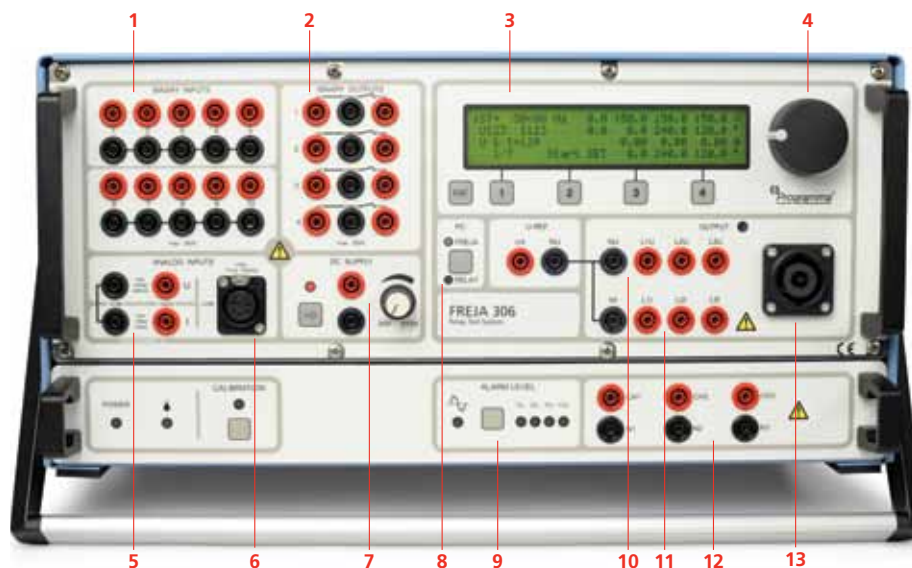
With a PC - FREJA Win

There are a number of instrument programs. You start the different programs at the Control center, where you also save and recall results. Since the test set-ups/results are saved via a regular Microsoft® Explorer display, you can create your own test object structures.

For FREJA Win there is no longer any license file needed and no license keys for the FREJA test sets. Once installed on your PC you can freely control any FREJA test set.

Features and benefits

1. Binary inputs – Response-time compensated
2. Binary outputs – Operating-time compensated
3. Display and buttons used in the Local mode.
4. Dial, press to Enter.
5. Analog inputs, HIGH, for volt- and ammeter
6. Analog inputs, LOW, for measurement transducers
7. DC-supply, connect to (12) to read the values
8. Switch, PC to FREJA300/306 or relay
9. Distortion alarm
10. Voltage outputs – Standard
11. Current outputs – Standard
12. Current outputs – High-end
13. Multiconnector for voltage (L1U, L2U, L3U, NU) and current (L1I, L2I, L3I, NI).



Specifications FREJA306

Specifications are valid for resistive load, nominal voltage supply and ambient temperature $+25\text{ °C} \pm 3\text{ °C}$, ($77\text{ °F} \pm 5.4\text{ °F}$) after 30 minutes warm up time. All hardware data are for full scale values. Specifications are subject to change without notice.

Environment

Application field	For use in high-voltage substations and industrial environments.
Temperature	
Operating	0 °C to +50 °C (32 °F to +122 °F)
Storage & transport	-40 °C to +70 °C (-40 °F to +158 °F)
Humidity	5% – 95% RH, non-condensing
Altitude (operational)	3000 m Full duty cycle up to 2000 m. Duty cycle limitation based on internal over temperature protection for altitudes >2000 m.

CE marking

EMC	2004/108/EC
LVD	2006/95/EC

General

Mains input (nominal)	100 – 240 V AC, 50–60 Hz
Power consumption	1200 VA + 1500 VA (max)
Dimensions	
Instrument	450 x 224 x 410 mm (17.7" x 8.8" x 16.1")
Transport case	610 x 345 x 660 mm (24" x 13.6" x 26")
Weight	
Instrument	23 kg (50.7 lbs)
Transport case	12 kg (26.4 lbs)
Display	LCD
Available languages	English, French, German, Spanish, Swedish

Measurement section

Binary inputs

Number	10 inputs (2 groups of 5 independent)
Type	Dry or wet contacts 275 V DC, 240VAC Response-time compensated
Internal resolution time	50 µs
Galvanic isolation	Galvanically separated from the amplifier section. Two galvanically separated groups: 1 to 5 and 6 to 10
Max measuring time	15264 h (636 days)

Range

0 - 9.9 ms	0.1 ms
10 ms - 60 min	1 ms
1 h - 15264 h	1 s

Resolution

0.1 ms	0.1 ms
1 ms	1 ms
1 s	1 s

DC current measuring input, LOW

Measuring range	$\pm 20\text{ mA}$
Resolution	SW 0.1 µA HW 0.6 µA
Inaccuracy	0.01% typical, 0.03% guaranteed (= 6 µA)

DC voltage measuring input, LOW

Measuring range	$\pm 10\text{ V}$
Resolution	SW 0.1 mV HW 0.3 mV
Inaccuracy	0.01% typical, 0.03% guaranteed (= 3 mV)

AC/DC current measuring input, HIGH ¹⁾

Measuring range	$\pm 14\text{ A DC}$, 10 A AC _{RMS}
Inaccuracy	DC <0.1%, AC <0.3%

AC/DC voltage measuring input, HIGH ¹⁾

Measuring range	$\pm 220\text{ V DC}$, 150 V AC _{RMS}
Inaccuracy	DC <0.05%, AC <0.2%

Measurement, internally generated values

Inaccuracy	
Voltage AC/DC	<1% ± 1 digit
Current AC/DC	<2% ± 2 digit

Binary outputs

Number	2 x 4 (NO & NC)
Type	Zero-potential contacts, controlled via software Response time compensated
Break capacity AC	240 V AC, max 8 A, max load 2000 VA
Break capacity DC	275 V DC, max 8 A, max load 240 W

Low level outputs (Rogowski option)

Setting range	
LLU	3 X 0...2 V _{RMS}
LLI	3 X 0...2 V _{RMS}
Max. output current	5 mA
Inaccuracy	<0.1% typ. (<0.2% guaranteed)
Resolution	250 µV
Distortion (THD+N) ²⁾	<0.05% typ. (<0.1% guaranteed)
Max. generating time	5 minutes

Generator section

Voltage outputs

Range	
4-phase AC	4 x 150 V
1-phase AC (L-L)	2 x 300 V
DC (L-N)	180 V
Power	
3-phase AC	3 x 82 VA at 150 V
1-phase AC (L-L)	1 x 140 VA at 300 V
DC (L-N)	87 W
Resolution	
SW	10 mV
HW	6.5 mV
Inaccuracy ³⁾ (guaranteed)	($\pm 0.01\%$ of range) + ($\pm 0.05\%$ of reading)
Distortion (THD+N) ⁴⁾	0.02% typical (0.04% max)

Current outputs

Standard outputs – L11, L21, L31

Range	
3-phase AC	3 x 15 A
1-phase AC ²⁾	1 x 45 A
DC (L-N)	15 A
3-channel DC	–
Power	
3-phase AC	3 x 87 VA
1-phase AC ²⁾	1 x 250 VA
DC (L-N)	3 x 87 W (max)
Resolution	
SW	1 mA
HW	0.65 mA
Inaccuracy ³⁾ (guaranteed)	(±0.01% of range) + (±0.3% of reading)
Distortion (THD+N) ⁴⁾	0.1% typical (0.2% max)
High-end outputs – Ch1, Ch2, Ch3	
Voltage transients - Immunity	2500 V transient level (to chassis) + working voltage level (255 V)
Working voltage	255 V Not to be used on live circuits
Application	
3-phase AC (per phase)	250 VA, 5 A < I ≤ 25 A 200 VA, 25 A < I ≤ 30 A 150 VA, 30 A < I ≤ 35 A
1-phase AC (3 ch. in parallel)	750 VA, 15 A < I ≤ 75 A 600 VA, 75 A < I ≤ 90 A 450 VA, 90 A < I ≤ 100 A
3-ch. DC	3 x ±20 A
Compliance voltage	≤50 Vrms
Time limits	
Continuous	3 x 20 A, 150 VA (max)
0.5 s on 1 s off repeatedly	3 x 35 A
Resolution	1.6 mA
Inaccuracy ⁵⁾ typical	< 0.3% (of reading), 0.5 A < I ≤ 35 A < 8 mA, 0 A < I ≤ 0.5 A
Phase inaccuracy ⁵⁾	< ±0.2 °
Distortion (THD+N) ⁶⁾	< 0.4% typical

Generators, general

Frequency range	
Continuous signals	DC – 2000 Hz
Transient signals	DC – 3.5 kHz
Frequency resolution	1 mHz
Frequency inaccuracy	0.01%
Phase angle range	0 – 360°
Phase resolution	0.1°
Phase inaccuracy ³⁾	±0.1°
Connection (Amplifier outputs)	4 mm stackable safety plugs or 8-pin amplifier multiconnector

All seven generators are continuously and independently adjustable in amplitude and phase. No switching of range is necessary. All current and voltage outputs are fully overload- and short-circuit-proof and protected against external high voltage transient signals and overtemperature.

Note To allow continuous generation of high DC current (12–15A), a minimum load impedance of 0.2 Ohm is required. For lower load impedances, e.g. short-circuit, the time is limited to 1 minute.

DC auxiliary voltage output

Range	20 – 210 V DC
Output power	75 W at 210 V

Other

On-line measurement of the current and voltage output, presented on the built-in display.

Calibration check when the temperature is changed. Full calibration can be conducted any time using the FREJA calibration box. This means you do not need to send away FREJA for calibration. Only the calibration box needs to be sent for calibration once per year.

Connection to IBM compatible PC (minimum Pentium II 266 MHz, 32 Mb RAM, Win 95/98/2000/XP, NT 4.0) via the serial port.

1) 50 or 60 Hz AC + harmonics only.

2) THD+N: Values at 50/60 Hz, at max amplitude, 50% power and resistive load. Measurement bandwidth 22 Hz – 22 kHz.

3) For sinusoidal signals at 50/60 Hz.

4) Parallel connection.

5) Values at max amplitude, 50% power and resistive load.

6) THD+N: Values at 25 A, 125 VA.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
FREJA306 Complete with: FREJA Win, two test lead sets, hard transport case	CF-29091	Test lead set With touch-proof contacts. 2 x 0.25 m (0.8 ft) / 2.5 mm ² , 2 x 0.5 m (1.6 ft) / 2.5 mm ² , 8 x 2 m (6.5 ft) / 2.5 mm ² . Weight: 0.8 kg (1.8 lbs). Normally you need two sets.	GA-00032
Same as above but with soft transport case	CF-29090	Calibration box	CF-90100
FREJA306 basic unit	CF-29001	GPS200 – MGTR The GPS receiver GPS200 – MGTR makes it possible to synchronize two or more FREJA to conduct end-to-end testing. End-to-end testing provides quick, reliable results showing how two or more protection relay systems interact. The unit comes with a 15 m (50 ft) cable and an allweather antenna. Longer cables can be ordered.	CF-90150
FREJA306, LLA Rogowski option Complete with: FREJA Win, two test lead sets, hard transport case	CF-29095	Cable organizer Velcro straps, 10 pcs.	AA-00100
Same as above but with soft transport case	CF-29094	Floor stand FREJA300/306 For working in standing position with FREJA	GB-00300
FREJA306 basic unit, LLA Rogowski option	CF-29004	IPS REFLEX IPS RELEX is a database for relay protection. For more information please visit our web site or contact customer service relay protection department.	
Optional			
FREJA Win software	CF-90090		
Rebuild FREJA300 to FREJA306	CF-90090		
FREJA Win upgrade	CF-8282X		
Optional accessories			
FREJA Multi-cable Shortens hookup time considerably. Consists of a multi-pole connector that connects to FREJA's three voltage and three current outputs, and a number of banana plugs that connect to the protection relay that is to be tested.	GA-00103		



FREJA300

- Manual and PC remote control
- Easy to use
- Excellent software provides great visuals and simple setup
- Lightweight and portable
- User can calibrate the unit

Description

The FREJA300 relay testing system is a computer-aided relay testing and simulation system. The weight of FREJA300 is only 15 kg. The rugged hardware design is built for field use over a wide temperature range, with the possibilities of intelligent software to perform rapid testing.

FREJA300 can be operated with or without a PC. After being put into the Local mode, FREJA300 can be used stand-alone without a PC. Using the Local mode is easy. The function of each key is described on the display, which also presents the settings and measured values.

The very accurate (typically 0.01%) low level analogue inputs are designed for transducer measurements. The high level inputs can be used as a normal volt- and ammeter. FREJA300 can generate 4x150 V (82 VA) and 3x15 A (87 VA) or 1x45 A (250 VA). Each output can be varied independently. Both static and dynamic testing can be performed, such as prefault and fault generation, simultaneous ramping of several quantities and wave form editing.

FREJA300 can also be used as a disturbance simulator and create and generate simulated disturbances, or import actual recorded disturbances from e.g. EMTP or COMTRADE files.

With use of the GPS receiver accessory, GPS200 – MGTR, several FREJA300 can be synchronized to perform end-to-end testing with the test sets allocated in different substations.

A FREJA300 can be upgraded to a FREJA306.

Application

FREJA300 is intended primarily for secondary testing of protection relays. Virtually all types of protection relays can be tested.

Examples of what FREJA306 can test	ANSI® No.
Distance protection relay	21
Synchronising or synchronism-check relays	25
Undervoltage relays	27
Directional Power relays	32
Undercurrent or underpower relays	37
Negative sequence overcurrent relays	46
Overcurrent-/ ground fault relays	50
Inverse time overcurrent-/ ground fault relays	51
Power factor relays	55
Overvoltage relays	59
Voltage or current balance relays	60
Directional overcurrent relays	67
DC overcurrent relays	76
Phase-angle measuring or out-of-step protection relays	78
Automatic reclosing devices	79
Frequency relays	81
Differential protection relays	87
Directional voltage relays	91
Voltage and power directional relays	92

Local Mode - without PC

Using the dial by turning and clicking it is easy to make the settings. All settings are saved automatically when you exit, but if you prefer you can assign the settings a name and save them separately for convenient access when you conduct your next test. The display can also show the measured value that is being generated. This feature is equivalent to three voltmeters and three ammeters that present RMS values for all generators.

```

2ND 50.00 Hz 63.0 63.0 63.0 63.0 V
* - - VOLT 0.0 0.0 240.0 120.0
o o o -----ms 0.00 0.00 0.00A
2/6 Start SET 0.0 0.0 0.0
    
```

Local Mode General

```

2ND 50.00Hz I: <1.000> U: 45.0V
* - - VOLT R: 45.000 |Z|: 45.000
o o o -----ms X: 0.000 Zφ: 0.0
2/3 Start RST Run: Seq
    
```

Local Mode Rx (I)

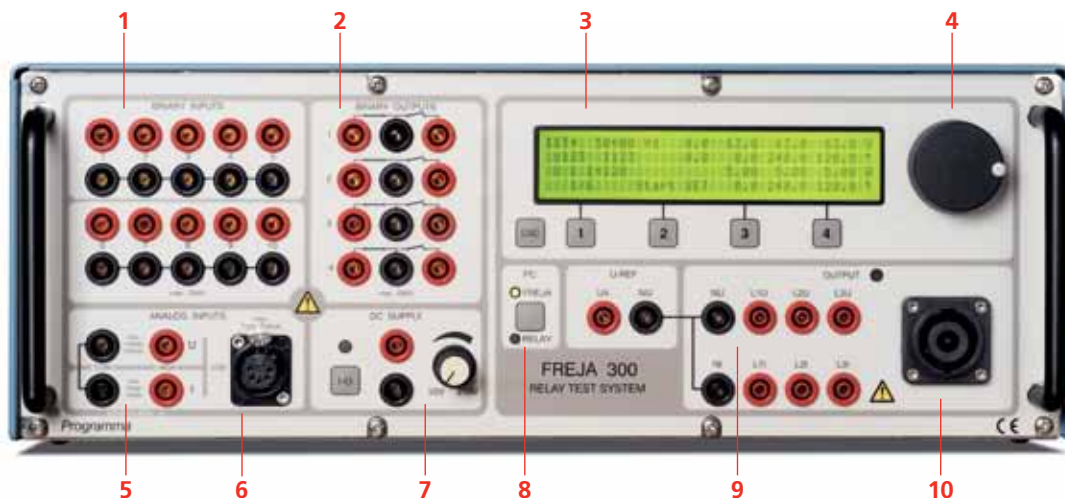
With a PC - FREJA Win

There are a number of instrument programs. You start the different programs at the Control center, where you also save and recall results. Since the test set-ups/results are saved via a regular Microsoft® Explorer display, you can create your own test object structures.

For FREJA Win there is no longer any license file needed and no license keys for the FREJA test sets. Once installed on your PC you can freely control any FREJA test set.

Features and benefits

1. Binary inputs – Response-time compensated
2. Binary outputs – Operating-time compensated
3. Display and buttons used in the Local Mode.
4. Dial, press to Enter.
5. Analog inputs, HIGH, for volt- and ammeter
6. Analog inputs, LOW, for measurement transducers
7. DC-supply, connect to (5) to read the values
8. Switch, PC to FREJA300 or relay
9. Current and voltage outputs.
10. Multiconnector for voltage (L1U, L2U, L3U, NU) and current (L1I, L2I, L3I, NI)..



Specifications FREJA300

Specifications are valid for resistive load, nominal voltage supply and ambient temperature $+25\text{ °C} \pm 3\text{ °C}$, ($77\text{ °F} \pm 5.4\text{ °F}$) after 30 minutes warm up time. All hardware data are for full scale values. Specifications are subject to change without notice.

Environment

<i>Application field</i>	For use in high-voltage substations and industrial environments.
<i>Temperature</i>	
<i>Operating</i>	0 °C to +50 °C (32 °F to +122 °F)
<i>Storage & transport</i>	-40 °C to +70 °C (-40 °F to +158 °F)
<i>Humidity</i>	5% – 95% RH, non-condensing
<i>Altitude (operational)</i>	3000 m Full duty cycle up to 2000 m. Duty cycle limitation based on internal over temperature protection for altitudes >2000 m.

CE marking

<i>EMC</i>	2004/108/EC
<i>LVD</i>	2006/95/EC

General

<i>Mains input (nominal)</i>	100 – 240 V AC, 50–60 Hz
<i>Power consumption</i>	1200 VA (max)
<i>Dimensions</i>	
<i>Instrument</i>	450 x 160 x 410 mm (17.7" x 6.3" x 16.1")
<i>Transport case</i>	560 x 240 x 575 mm (22" x 9.5" x 22.6")
<i>Weight</i>	
<i>Instrument</i>	15 kg (33.1 lbs)
<i>Transport case</i>	7.5 kg (16.5 lbs)
<i>Display</i>	LCD
<i>Available languages</i>	English, French, German, Spanish, Swedish

Measurement section

Binary inputs

<i>Number</i>	10 inputs (2 groups of 5 independent)
<i>Type</i>	Dry or wet contacts 275 V DC, 240 V AC Response-time compensated
<i>Internal resolution time</i>	50 µs
<i>Galvanic isolation</i>	Galvanically separated from the amplifier section. Two galvanically separated groups: 1 to 5 and 6 to 10
<i>Max measuring time</i>	15264 h (636 days)
Range	Resolution
0 - 9.9 ms	0.1 ms
10 ms - 60 min	1 ms
1 h - 15264 h	1 s

DC current measuring input, LOW

<i>Measuring range</i>	$\pm 20\text{ mA}$
<i>Resolution</i>	SW 0.1 µA HW 0.6 µA
<i>Inaccuracy</i>	0.01% typical, 0.03% guaranteed (= 6 µA)

DC voltage measuring input, LOW

<i>Measuring range</i>	$\pm 10\text{ V}$
<i>Resolution</i>	SW 0.1 mV HW 0.3 mV
<i>Inaccuracy</i>	0.01% typical, 0.03% guaranteed (= 3 mV)

AC/DC current measuring input, HIGH ¹⁾

<i>Measuring range</i>	$\pm 14\text{ A DC}$, 10 A AC _{RMS}
<i>Inaccuracy</i>	DC <0.1%, AC <0.3%

AC/DC voltage measuring input, HIGH ¹⁾

<i>Measuring range</i>	$\pm 220\text{ V DC}$, 150 V AC _{RMS}
<i>Inaccuracy</i>	DC <0.05%, AC <0.2%

Measurement, internally generated values

<i>Inaccuracy</i>	
<i>Voltage AC/DC</i>	<1% ± 1 digit
<i>Current AC/DC</i>	<2% ± 2 digit

Binary outputs

<i>Number</i>	2 x 4 (NO & NC)
<i>Type</i>	Zero-potential contacts, controlled via software Response time compensated
<i>Break capacity AC</i>	240 V AC, max 8 A, max load 2000 VA
<i>Break capacity DC</i>	275 V DC, max 8 A, max load 240 W

Low level outputs (Rogowski option)

<i>Setting range</i>	
<i>LLU</i>	3 X 0...2 V _{RMS}
<i>LLI</i>	3 X 0...2 V _{RMS}
<i>Max. output current</i>	5 mA
<i>Inaccuracy</i>	<0.1% typ. (<0.2% guaranteed)
<i>Resolution</i>	250 µV
<i>Distortion (THD+N) ²⁾</i>	<0.05% typ. (<0.1% guaranteed)
<i>Max. generating time</i>	5 minutes

Generator section

Voltage outputs

<i>Range</i>	
<i>4-phase AC</i>	4 x 150 V
<i>1-phase AC (L-L)</i>	2 x 300 V
<i>DC (L-N)</i>	180 V
<i>Power</i>	
<i>3-phase AC</i>	3 x 82 VA at 150 V
<i>1-phase AC (L-L)</i>	1 x 140 VA at 300 V
<i>DC (L-N)</i>	87 W
<i>Resolution</i>	
<i>SW</i>	10 mV
<i>HW</i>	6.5 mV
<i>Inaccuracy ³⁾ (guaranteed)</i>	($\pm 0.01\%$ of range) + ($\pm 0.05\%$ of reading)
<i>Distortion (THD+N) ⁴⁾</i>	0.02% typical (0.04% max)

Current outputs

Standard outputs – L1I, L2I, L3I

Range

3-phase AC	3 x 15 A
1-phase AC ²⁾	1 x 45 A
DC (L-N)	15 A
3-channel DC	–

Power

3-phase AC	3 x 87 VA
1-phase AC ²⁾	1 x 250 VA
DC (L-N)	3 x 87 W (max)

Resolution

SW	1 mA
HW	0.65 mA

Inaccuracy ³⁾ (guaranteed) (±0.01% of range) + (±0.3% of reading)

Distortion (THD+N) ⁴⁾ 0.1% typical (0.2% max)

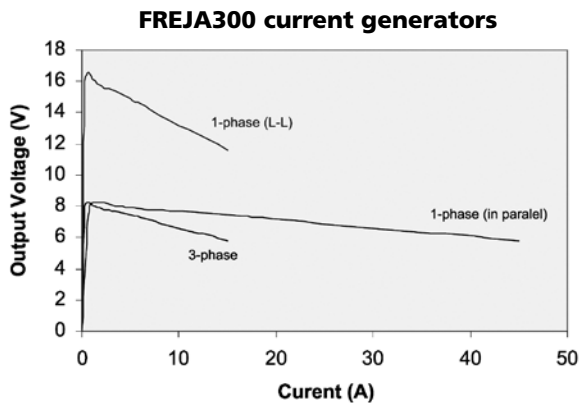
Other

On-line measurement of the current and voltage output, presented on the built-in display.

Calibration check when the temperature is changed. Full calibration can be conducted a any time using the FREJA calibration box. This means you do not need to send away FREJA for calibration. Only the calibration box needs to be sent for calibration once per year.

Connection to IBM compatible PC (minimum Pentium II 266 MHz, 32 Mb RAM, Win 95/98/2000/XP, NT 4.0) via the serial port.

- 1) 50 or 60 Hz AC + harmonics only.
- 2) THD+N: Values at 50/60 Hz, at max amplitude, 50% power and resistive load. Measurement bandwidth 22 Hz – 22 kHz.
- 3) For sinusoidal signals at 50/60 Hz.
- 4) Parallel connection.
- 5) Values at max amplitude, 50% power and resistive load.
- 6) THD+N: Values at 25 A, 125 VA.



Generators, general

Frequency range

Continuous signals	DC – 2000 Hz
Transient signals	DC – 3.5 kHz

Frequency resolution 1 mHz

Frequency inaccuracy 0.01%

Phase angle range 0 – 360°

Phase resolution 0.1°

Phase inaccuracy ³⁾ ±0.1°

Connection (Amplifier outputs) 4 mm stackable safety plugs or 8-pin amplifier multiconnector

All seven generators are continuously and independently adjustable in amplitude and phase. No switching of range is necessary. All current and voltage outputs are fully overload- and short-circuit-proof and protected against external high voltage transient signals and overtemperature.

Note To allow continuous generation of high DC current (12–15 A), a minimum load impedance of 0.2 Ohm is required. For lower load impedances, e.g. short-circuit, the time is limited to 1 minute.

DC auxiliary voltage output

Range	20 – 210 V DC
Output power	75 W at 210 V

ORDERING INFORMATION

Product	Order Code	Product	Order Code
FREJA300 Complete with: FREJA Win, two test lead sets, hard transport case	CF-19091	Calibration box	CF-90100
Same as above but with soft transport case	CF-19090	GPS200 – MGTR The GPS receiver GPS200 – MGTR makes it possible to synchronize two or more FREJA to conduct end-to-end testing. End-to-end testing provides quick, reliable results showing how two or more protection relay systems interact. The unit comes with a 15 m (50 ft) cable and an all weather antenna. Longer cables can be ordered.	CF-90150
FREJA 300 basic unit Incl. FREJA Win	CF-19001	Cable organizer Velcro straps, 10 pcs.	AA-00100
FREJA 300, LLA Rogowski option Complete with: FREJA Win, two test lead sets, hard transport case	CF-19095	AA stand FREJA300/360 For working in standing position with FREJA	GB-00
Same as above but with soft transport case	CF-19094	IPX REFLEX IPS RELEX is a database for relay protection. For more information please visit our web site or contact customer service relay protection department.	
FREJA 300 basic unit, LLA Rogowski option	CF-19004		
Optional			
FREJA Win Software	CF-90090		
Rebuild FREJA300 to FREJA306	CF-90090		
FREJA Win upgrade	CF-8282X		
Optional accessories			
FREJA Multi-cable Shortens hookup time considerably. Consists of a multi-pole connector that connects to FREJA's three voltage and three current outputs, and a number of banana plugs that connect to the protection relay that is to be tested.	GA-00103		
Test lead set With touch-proof contacts. 2x0.25m (0.8ft)/2.5mm ² 2 x 0.5 m (1.6 ft) / 2.5 mm ² 8 x 2 m (6.5 ft) / 2.5 mm ² Weight: 0.8 kg (1.8 lbs). Normally you need two sets.	GA-00032		

Specifications CA30

The specifications are valid at an input voltage of 100 – 240 V and at an ambient temperature of +25 °C (77 °F) and at generated frequency of 50/60 Hz. Specifications are subject to change without notice.

Environment

<i>Application field</i>	The instrument is intended for use in high-voltage substations and industrial environments.
<i>Temperature, operating</i>	0 °C to +50 °C (32 °F to +122 °F)
<i>Temperature storage & transport</i>	-40 °C to +70 °C (-40 °F to +158 °F)
<i>Humidity</i>	5% – 95% RH, non-condensing
<i>Altitude (operational)</i>	3000 m Full duty cycle up to 2000 m. Duty cycle limitation based on internal over temperature protection for altitudes >2000 m.

CE marking

<i>EMC</i>	2004/108/EC
<i>LVD</i>	2006/95/EC

General

<i>Mains voltage</i>	100 – 240 V AC, 50–60 Hz
<i>Power consumption</i>	1500 VA (max)
<i>Dimensions</i>	
<i>Instrument</i>	446 x 55 x 395 mm (17.6" x 2.2" x 15.6")
<i>Transport case</i>	535 x 140 x 520 mm (21" x 5.5" x 20.5")

Weight

<i>Instrument</i>	7,9 kg (17.4 lbs)
<i>Transport case</i>	5,1 kg (11.2 lbs)

Control input

<i>Control voltage</i>	0 – 6 Vrms SELV To be connected to outputs fulfilling IEC/EN 61010-1
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Monitor output

<i>Monitor voltage</i>	0 – 6 Vrms SELV To be connected to inputs fulfilling IEC/EN 61010-1
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CA30

- High output and compliance voltage
- Patent pending technology
- Designed for integration with FREJA300 to boost power and capability

Description

The CA30 is a 3-channel current amplifier with a switched mode power supply capable of delivering up to 3 x 35 A.

The DC-coupled design makes it suitable for acyclic generation.

In use together with FREJA300 the CA30 can increase the current output from FREJA to 3 x 35 A or to 1 x 100 A, but also increase the output voltage at lower current, for example when testing electromechanical relays.

The CA30 is a differential amplifier with floating inputs. The differential amplifier design makes it possible to use CA30 even if there is a small voltage difference in the ground system between input and output.

Maximum output power is 250 VA per channel, and the maximum compliance voltage is 50 VRMS. The amplifier can generate 50 VRMS up to a current generation of 5 A per channel.

CA30, in combination with FREJA, allows the generation of six currents, which is convenient when testing differential relays. See the FREJA306 data sheet for more information.



A FREJA300 can easily be upgraded to a FREJA306 by adding in the CA30.

Current outputs

Voltage transients - Immunity	2500 V transient level (to chassis) + working voltage level (255 V)
Working voltage	255 V
	Not to be used on live circuits

Application

3-phase AC (per phase)	250 VA, 5 A < I ≤ 25 A
	200 VA, 25 A < I ≤ 30 A
	150 VA, 30 A < I ≤ 35 A
1-phase AC (3 ch. in parallel)	750 VA, 15 A < I ≤ 75 A
	600 VA, 75 A < I ≤ 90 A
	450 VA, 90 A < I ≤ 100 A
3-ch. DC	3 x ±20 A

Compliance voltage ≤50 Vrms

Time limits

Continuous	3 x 20 A, 150 VA (max)
0.5 s on 1 s off repeatedly	3 x 35 A

Resolution 1.7 mA

Inaccuracy¹⁾ typical < 0.3% (of reading), 0.5 A < I ≤ 35 A
< 8 mA, 0 A < I ≤ 0.5 A

Phase accuracy error¹⁾ < ±0.2°

Distortion (THD+N)²⁾ < 0.4% typical

1) Values at max amplitude, 50% power and resistive load.

2) THD+N: Values at 25 A, 125 VA.

ORDERING INFORMATION

Product	Order Code
CA30	CA-29000
CA30 Including software FREJA Win and soft transport case	CA-29090
CA30 Including software FREJA Win and hard transport case	CA-29091

Application

Relay Testing

SVERKER750/780 is intended primarily for secondary testing of protective relay equipment. Virtually all types of single-phase protection can be tested. You can also test three-phase protection that can be tested one phase at a time, and also a number of protective relay systems that require phase shifting. Moreover, automatic reclosing devices can be tested.

SVERKER780 can test voltage relays with a frequency range from 15 Hz up to 550 Hz.

Examples of what SVERKER can test

Examples of what SVERKER can test	ANSI® No.
Overcurrent relays	50
Inverse time overcurrent relays	51
Undercurrent relays	37
Ground fault relays	50N, 51N
Directional overcurrent relays	67
Directional ground fault relays	67N
Overvoltage relays	59
Undervoltage relays	27
Directional power relays	32
Power factor relays	55
Differential protection (differential circuits)	87
Distance protection equipment (phase by phase)	21
Negative sequence overcurrent relays	46
Motor overload protection	51/66
Automatic reclosing devices	79
Tripping relays	94
Voltage regulating relays	
Underimpedance relays	21
Thermal relays	49
Time-delay relays	
Frequency relays (SVERKER780)	81



SVERKER750/780

- The engineer's toolbox for all single phase relay testing
- Stand-alone functionality
- Rugged and reliable for field use

Description

The SVERKER750/780 Relay Test Set is the engineer's toolbox. The control panel features a logical layout, still SVERKER650 users will find it comfortably familiar and will be able to start work right away.

The SVERKER750/780 features many functions that make relay testing more efficient. For example, its powerful measurement section can display (in addition to time, voltage and current) Z, R, X, S, P, Q, phase angle and $\cos \phi$. The voltmeter can also be used as a 2nd ammeter (when testing differential relays for example). All values are presented on a single easy-to-read display.

You can also test directional protective equipment efficiently by means of the built-in variable voltage source. In SVERKER780 this has a continuous phase shift function and adjustable frequency as well. Automatic reclosing devices can also be tested – just as easily.

Designed to comply with EU standards and other personal and operational safety standards, SVERKER 750/780 is also equipped with a serial port for communication with personal computers and the PC software SVERKER Win. Since the compact SVERKER weighs only 18 kg (39 lbs), it's easy to move from site to site.

Two or more SVERKER units can also be synchronized, which allows the user to operate a basic 3-phase test set.

Relay test sets

Specifications SVERKER750/780

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)
Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE marking

LVD Low Voltage Directive 2006/95/EC

EMC EMC Directive 2004/108/EC

General

Mains voltage 115/230 V AC, 50/60 Hz

Power consumption (max) 1380 W

Protection Thermal cut-outs, automatic overload protection

Dimensions

Instrument 350 x 270 x 220 mm
(13.8" x 10.6" x 8.7")

Transport case 610 x 350 x 275 mm
(24.0" x 13.8" x 10.8")

Weight

SVERKER750 17.3 kg (38.1 lbs)
26.3 kg (58 lbs) with accessories and transport case

SVERKER780 18.1 kg (39.9 lbs)
27.1 kg (59.7 lbs) with accessories and transport case

Test lead set, with 4 mm stackable safety plugs 2 x 0.25 m (0.8 ft), 2.5 mm²
2 x 0.5 m (1.6 ft), 2.5 mm²
8 x 2.0 m (6.6 ft), 2.5 mm²

Test leads with spade tongue connectors 2 x 3.0 m (9.8 ft), 10 mm²

Display LCD

Available languages Bulgarian, Czech, English, French, German, Russian, Spanish, Swedish, Turkish

Measurement section

Timer

Time can be displayed in seconds or in mains-frequency cycles.

Range	Resolution	Inaccuracy
000-9.999 s	1 ms	±(1 ms + 0.01%)*
10.00-99.99 s	10 ms	±(10 ms + 0.01 %)*
100.0-999.9 s	100 ms	±(100 ms + 0.01 %)*

* For the OFF+TIME start condition in INT mode, 1 ms shall be added to the above measurement error.

Range	Resolution	Inaccuracy
0.0-999.9 cycles	0.1 cycles	±(0.1 cycles + 0.01%)
1000-49999 cycles at 50 Hz	1 cycle	±(1 cycle + 0.01 %)
1000-59999 cycles at 60 Hz		

Ammeter

Measurement method AC, true RMS
DC, mean value

Ranges

Internal 0.00 – 250.0 A
External 0.000 – 6.000 A

Inaccuracy

Internal range ¹⁾
0–10 A AC ±(1% + 20 mA)
0–40 A AC ±(1% + 40 mA)
0–100 A AC ±(1% + 200 mA)

External range ¹⁾
0–0.6 A AC ±(1% + 20 mA)
0–6 A AC ±(1% + 20 mA)
0–0.6 A DC ±(0.5% + 2 mA)
0–6 A DC ±(0.5% + 20 mA)

Resolution

Internal range 10 mA (range <100 A)
100 mA (range >100 A)
External range 1 mA

Voltmeter

Measurement method AC, true RMS
DC, mean value

Range 0.00 – 600.0 V

Inaccuracy ¹⁾ AC, ±(1% + 200 mV) Max. value
DC, ±(0.5% + 200 mV) Max. value
Values are range depending

Extra measurements

Power factor and phase angle measurements

	Range	Resolution	Inaccuracy
Power factor cos φ	-0.99 (cap) to +0.99 (ind)	0.01	±0.04
Phase angle φ (°)	000 – 359°	1°	±2°

Impedance and power measurements

AC Z (Ω and °), Z (Ω), R and X (Ω and Ω), P (W), S (VA), Q (VAR)

DC R (Ω), P (W)

Range Up to 999 kX (X= unit)

Make/Break contact

Max. current 1 A

Max. voltage 250 V AC or 120 V DC

Reclosing test

Items measured Tripping and reclosing times

Display After test is finished a list of all times appears in display

Breaker state feedback The Make/Break contact can be used to feed back the breaker state

Max. number of reclosings 49

Max. testing time 999 s

Sets of resistors and a capacitor

Resistors 0.5 Ω to 2.5 kΩ

Capacitor ²⁾ 10 μF, max voltage 450 V AC

¹⁾ Measurement intervals longer than 100 ms

²⁾ SVERKER750

Outputs**Current outputs – AC**

Range	No-load voltage (min)	Full-load voltage (min)	Full-load current (max)	Load/unload times On (max)/Off (min)
0 – 10 A	90 V	75 V	10 A	2/15 minutes
0 – 40 A	25 V	20 V	40 A	1/15 minutes
0 – 100 A	10 V	8 V	100 A	1/15 minutes
0 – 100 A	10 V	-	250 A* 200 A**	1 sec/5 minutes

* Mains voltage 230 V AC

** Mains voltage 115 V AC

Voltage outputs – AC/DC

Range	No-load voltage (min)	Full-load voltage (min)	Full-load current (max)	Load/unload times On (max)/Off (min)
0 – 250 V AC	290 V AC	250 V AC	3 A	10 min/45 min
0 – 300 V DC	320 V DC	250 V DC	2 A	10 min/45 min

Separate AC voltage source SVERKER750

Range	No-load voltage (min)	Full-load voltage (min)	Full-load current (max)
0 – 60 V AC	70 V	60 V	0.25 A
60 – 120 V AC	130 V	120 V	0.25 A

Both ranges are divided into voltage steps of 10 V that are steplessly variable.

Separate AC voltage source SVERKER780

Range	No-load voltage (min)	Full-load voltage (min)	Full-load power (max)
5 – 220 V AC minimum step 0.1 V	240 V AC	220 V AC at 33 W 200 V AC at 46 W	33 W continuously. 46 W 1 minute

Phase angle Resolution Inaccuracy

0 – 359° 1° ±2°

Frequency Resolution Inaccuracy

15 – 550 Hz 1 mHz ±0.1%

Auxiliary DC output

Range	Voltage	Max. current
20 – 130 V DC	20 V DC	300 mA
	130 V DC	375mA
130 – 220 DC	130 V DC	325 mA
	220 V DC	400 mA

ORDERING INFORMATION

Product	Order Code	Product	Order Code
SVERKER750 Incl. Test lead set GA-00030 and Transport case GD-00182 <i>Language: English, French, German, Spanish, Swedish</i>		SVERKER780 Incl. Test lead set GA-00030 and IP65 HD-case <i>Language: English, French, Spanish</i>	
115 V mains voltage	CD-11190	115 V mains voltage	CD-33190
230 V mains voltage	CD-12390	230 V mains voltage	CD-33390
SVERKER750 Incl. Test lead set GA-00030 and IP65 HD-case <i>Language: English, French, German, Spanish, Swedish</i>		SVERKER780 Incl. Test lead set GA-00030 and Transport case GD-00182 <i>Language: English, German, Swedish</i>	
115 V mains voltage	CD-13190	230 V mains voltage	CD-32392
230 V mains voltage	CD-13390	SVERKER780 Incl. Test lead set GA-00030 and Transport case GD-00182 <i>Language: Bulgarian, English, Turkish</i>	
SVERKER750 Incl. Test lead set GA-00030 and Transport case GD-00182 <i>Language: Czech, English, German, Swedish, Turkish</i>		230 V mains voltage	CD-32394
230 V mains voltage	CD-12392	SVERKER780 Incl. Test lead set GA-00030 and Transport case GD-00182 <i>Language: Czech, English, Russian</i>	
SVERKER750 Incl. Test lead set GA-00030 and Transport case GD-00182 <i>Language: English, French, German, Russian, Swedish</i>		230 V mains voltage	CD-32396
230 V mains voltage	CD-12394		
SVERKER750 Incl. Test lead set GA-00030 and Transport case GD-00182 <i>Language: Bulgarian, English, French, German, Swedish</i>			
230 V mains voltage	CD-12396		
SVERKER780 Incl. Test lead set GA-00030 and Transport case GD-00182 <i>Language: English, French, Spanish</i>			
115 V mains voltage	CD-31190		
230 V mains voltage	CD-32390		
.....			
	Product	Order Code	
	Optional		
	SVERKER Win PC Software Please specify the SVERKER serial number when ordering. SVERKER Win contains software, a copy-protection key and cables (RS232 and USB) for connecting the PC to SVERKER. Note that the software key can be installed on a single SVERKER. The software itself, however, can be installed on an unlimited number of PCs.	CD-8102X	
	SVERKER Win Upgrade	CD-8101X	
	Optional accessories		
	CSU20A Incl. cables and transport case		
	115 V mains voltage	BF-41190	
	230 V mains voltage	BF-42390	
	PSS750	CD-90020	
	Cable organizer Velcro straps, 10 pcs.	AA-00100	

Specifications SVERKER 650

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)

Storage & transport -40 °C to 70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE-marking

LVD 2006/95/EC

EMC 2004/108/EC

General

Mains voltage 115/230 V AC, 50/60 Hz

Power consumption 1100 VA (max)

Protection Thermal cut-outs, miniature circuit breakers

Dimensions

Instrument 280 x 178 x 250 mm (11" x 7" x 9.8")

Transport case 560 x 260 x 360 mm (22" x 10.2" x 14.2")

Weight 16 kg (35.3 lbs)
26 kg (57.3 lbs) with accessories and transport case.

Test lead set, with 2 x 0.25 m (0.8 ft), 2.5 mm²

4 mm stackable 2 x 0.5 m (1.6 ft), 2.5 mm²

safety plugs 8 x 2.0 m (6.6 ft), 2.5 mm²

Test leads with spade-tongue connectors 2 x 3.0 m (9.8 ft), 10 mm²



SVERKER650

- Designed for rugged field use
- 0 to 100 Amp output current
- Suitable for testing many different types of relays such as power, voltage and current
- Easy to operate

Description

The Sverker650 testing unit, whose design incorporates benefits gleaned from many years of experience in field relay testing, enjoys a well-earned reputation for reliability and convenience. Compact and powerful, it provides all of the functions needed for secondary testing of almost all types of single-phase protection now available on the market.

SVERKER650 features logical design and construction, and it is extraordinarily easy to learn and use. Its compact design and light weight makes it extremely portable.

Auxiliary equipment for SVERKER650 includes a test lead set and a rugged transport case. Another useful accessory is the ACA120 voltage source which makes it easier to test directional relays.

Relay test set

Measurement section

Current measurement

Built-in ammeter

Ranges 0 – 10 A / 0 – 100 A

Inaccuracy ±3%

External ammeter

Output for external ammeter Connected to built-in current transformer

Inaccuracy ±0.5%

Timer

Range 0 – 999.999 s

Resolution 1 ms

Inaccuracy ±0.02% of displayed value, +2 ms
Independent of mains frequency

Outputs

Current outputs, AC

Range	No-load voltage (min)	Output voltage (min)	Load / unload times On (max) / Off (min)
0 – 10 A	85 V	75 V (10 A)	2 min / 30 min
0 – 40 A	25 V	19 V (40 A)	20 s / 15 min
0 – 100 A	10 V	7.7 V (100 A)	20 s / 5 min

Voltage outputs, AC/DC

Range	Output voltage (min)
0 – 250 V AC	220 V (2.7 A)
110 V AC (fixed)	110 V (0.3 A)
0 – 350 V DC	280 V (2 A)
20 – 220 V DC (stab.)	200 V (0.25 A)

Other

Built-in capacitor provides phase shift when testing directional protection, and a set of resistors can be used to divide voltages. Output used to start external cycles.

Terminal for external start/stop of built-in timer.

Terminal for connecting serial impedance when testing nonlinear protection.



Test lead set GA-00030

ORDERING INFORMATION

Product	Order Code
SVERKER650	
Incl. Test lead set GA-00030 Transport case GD-00010	
115 V mains voltage	BA-11190
230 V mains voltage	BA-12290
Optional accessories	
ACA120 Variable output , 0-120 V AC	BA-90040

SPECIFICATIONS

Input	
Line	90 - 253 Vac, 50/60 Hz, 30 VA
Battery	
	Rechargeable battery with internal automatic charger. Safety features include internal battery overcharging and charge exhaustion protection.
Operation time	10 hours continuous on full charge
Voltage	
	0 - 650 Volts (AC/DC), 0.01% resolution of range
Accuracy	± 0.05% of reading, 50/60 Hz From 3 - 650 ac Volts (21° - 25 °C). ± 0.1% of reading, from 3 - 650 ac Volts (0° - 50 °C). ± 0.1% of reading ±25 mV, from 3-650 V dc.
Input impedance	1 MΩ
Maximum input	1000 Volts (ac) Between inputs or from inputs to chassis.
Measured	RMS or AVG
Crest factor	3
Current	
Direct input	0 - 100 Amperes (ac), 0.01% resolution of range
Accuracy	±0.05% of reading, 50/60 Hz From 0.10 - 10 A (21° - 25 °C) ±0.1% of reading >10 amperes
Minimum current measurement	2 mA
Burden at 5A	0.1 VA
Crest factor	3
Phase angle	
	0 - 360.00° or ±0 - 180.00°, 0.01° resolution
Accuracy 50/60 Hz	±0.08° input levels above 30 V and 1.0 amp ⁽¹⁾ , ±0.5° input levels above 3 Volts and 0.02 amps, ±2° input levels down to 0.002 amps.
Power	
	±0 - 100 KW, 0.1% resolution.
Accuracy at 50 or 60 Hz	±0.1% of VA.
Reactive power	
	±0 - 100 KVAR, 0.1% resolution.
Accuracy at 50/60 Hz	±0.1% of VA.
Frequency component only of a voltage or current	
	10 - 1000 Hz, 0.01 Hz resolution.
Accuracy	±0.03 Hz.
Harmonics	
	Measures all harmonics content simultaneously of any selected voltage or current, up to the 49th harmonic.
Accuracy	±5% of reading
Time	
	0.000 to 999.999 seconds 0.000 to 9999.9 cycles
Seconds Mode	
	±LSD or ±0.005% of reading, whichever is greater when initiated by a dry contact, a DC potential above 5 volts or an AC potential above 115 VAC*.



PMM-1 V2.12

- Simultaneous measurement and display of all three-phase system parameters
- Accurate phase angle measurement at low current levels
- Versatile, menu-driven instrument with a built-in timer and data-logging
- High-speed measurement mode

Description

The Power MultiMeter (PMM-1) version 2.12 is a multifunction instrument for measuring ac or dc voltage, ac primary and secondary current, power, reactive power, power factor, phase angle and frequency of a single or three-phase electrical system.

In the single-phase mode, the PMM-1 is easily configured to measure the amplitude and phase angle between any two voltages and current inputs. These measured quantities are then displayed in an enlarged font size for easier reading on a graphic display. In three-phase mode, all measured quantities are displayed simultaneously on a large, easy-to-read graphic display.

The firmware in the PMM-1, combined with a built-in, microprocessor-based timer, is specifically designed to ease testing and commissioning of protective relay systems, including induction unit pickup and timing tests. The PMM-1 is a menu-driven instrument equipped with data-retention and data-logging capabilities. It can be used to automatically store measured data at user defined intervals from one minute to 60 minutes.

Power Multimeter PMM-1

Multifunction measuring instrument

Specifications continued	
Cycles Mode	±0.5 cycle when initiated by a dry contact, a DC potential above 5 volts or an AC potential above 115 VAC.* *AC voltage accuracy is worse at lower voltages and is ±8 ms in worst cases (5 V rms applied just following wave-shape peak).
Start/Stop Inputs	5-300 Volts (AC or DC) start or stop inputs. AC or DC applied/ removed, or dry contact closure or opening.
Voltage Applied	Timer starts or stops when an AC or DC potential (5 to 300 V) is applied.
Voltage Removed	Timer starts or stops when an AC or DC potential (5 to 300 V) is removed.
Input Resistance	1000 Ω min.
Response Time	Regular measurement mode 2 readings per second.
High speed measurement mode	20 readings per second for a period of 15, 30 or 60 sec.
Data input/output	
RS232 serial data port	The RS232 port is provided for control of PMM-1 and transferring data from the instrument to a personal computer. PMM-1 software is included.
Printer Port	Parallel printer port is provided to allow the printing of data on an external printer. (Printer is not included with instrument.)
Dimensions	13.5 H x 9 W x 9 D in. (344 W x 242 H 242 D mm)
Weight	13.4lbs (6.0 kg)
Operating Temperature	-15 °C to 55 °C (5 °F to 131°F)
Storage Temperature	-30 °C to 75 °C (-22 °F to 167 °F)

⁽¹⁾ Using current as reference

ORDERING INFORMATION

Product	Order Code
Power MultiMeter	PMM-1
Included accessories	
Accessory pouch	
External mount portable case	17355
Fuses 1.0 A 250 V, 5 x 20 mm [2]	MC7797
Line cord, three wire, 120 V	6828
Instruction manual	17357
Optional accessories	
Standard potential leads [set of 4, 2m]	835312
Fused potential leads [set of 4, 2m]	830213
20-Amp current leads, states plugs [set of 3, 1m]	835313
20-Amp current leads, clips [set of 3, 1m]	835314
100-Amp current leads [set of 3, 1m]	835315
1000:1 clamp-on current transformer	830312
1000:5 clamp-on current transformer	835318
3000:1 clamp-on current transformer	835319
3000:5 clamp-on current transformer	835320
200:1 miniature clamp-on current transformer	50611
Soft carrying case	50775

SPECIFICATIONS

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity 5% – 95% RH, non-condensing

CE marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 115/230 (135/250) V AC, 50/60 Hz

Power consumption (max) 3 W

Protection Thermal cut-outs, +80 °C (+176 °F)
Short-circuit protectors at DC outputs

Dimensions

Instrument 205 x 98 x 225 mm (except handle)
(8.1" x 3.8" x 8.8")

Transport case 320 x 150 x 465 mm
(12.6" x 5.9" x 18.3")

Weight 2.3 kg (5.1 lbs)
4.6 kg (10.1 lbs)
with accessories and transport case

Test lead set, with 4 mm stackable safety plugs 4 x 2 m (6.6 ft), 2.5 mm²

Display LCD

Measurement section

Range 0 – 359.9°

Type of phase angle measurement Current-current, voltage-voltage and current-voltage

Waveform Sinusoidal

Frequency range 15-75 Hz

Resolution 0.1°

Inaccuracy (sinusoidal voltage) ±0.5° (if 20% or more of range is used)
±1° (if less than 20% of range is used)

Current Input Range 0.002 - 10 A. Range can be increased by means of a clamp-on current transformer

Voltage Input Range 0.2 - 500 V



PAM360E

- Designed for power system applications
- Current and voltage inputs
- Compact and lightweight
- Easy to use

Description

The PAM360E Digital Phase Angle Meter is specifically designed for measurements on electrical power systems. It is capable of displaying the phase angle relationship between two power signals, either two currents or two voltages, or any combination. Current signals up to 10 amps and voltage signals up to 500 volts can be applied directly to the instrument. The current input range can be extended with the use of external current transformers.

ORDERING INFORMATION

Product	Order Code
PAM360E Incl. Test lead GA-00082 and transport case 50-00100	BP-29092



TM200

- Rugged and compact
- Precise
- Broad application range
- Contact or voltage trig

Description

A timer is often needed for use with the CSU600A current supply unit or ODEN A primary current injection test system. Testing relays with SVERKER650 also requires an extra timer if more than one timing cycle is to be measured.

Timer TM200 is ideal for these tasks thanks to its precise accuracy, its broad application range and its compact dimensions. Timer TM200 is the obvious choice for maintenance work in substations.

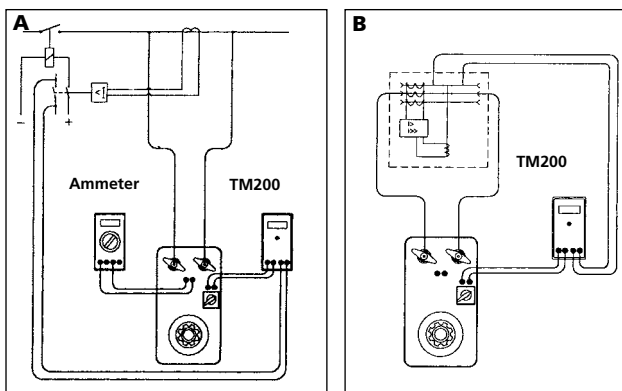
Application example

IMPORTANT!

Read the user manual before using the instrument.

Primary test of protective relay equipment and low-voltage circuit breaker

1. Connect the CSU600A's current outputs across the current transformer (diagram A) or to the breaker terminals (diagram B).
2. Connect TM200's start input to output T and the stop input to the protective relay equipment's auxiliary contact.
3. Set the current.
4. Execute the test.
5. Read the time from TM200.



Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in medium-voltage substations and industrial environments. Altitude <2000 m (6500 ft) above sea level.

Temperature

Operating 0 °C to +50 °C (32 °F to +122 °F)

Storage & transport -20 °C to +70 °C (-4 °F to +158 °F)

Humidity

5% – 95% RH, non-condensing

CE marking

LVD Low Voltage Directive 73/23/ EEC am. by 93/68/EEC

EMC EMC Directive 89/336/EEC am. by 91/263/EEC, 92/31/EEC and 93/68/EEC

General

Mains voltage 115/230 V AC (switchable), 50/60 Hz

Power consumption (max) 20 VA

Dimensions

Instrument, excl. handle 194 x 115 x 49 mm (7.7" x 4.5" x 1.9")

Instrument, incl. handle 252 x 132 x 49 mm (9.9" x 5.2" x 1.9")

Weight 1.0 kg (2.2 lbs)

2.7 kg (6 lbs) with accessories and carrying case

Test lead set, with touch-proof contacts 4 x 2 m (6.6 ft), 2.5 mm²

Measurement section

Range 0-999.999 s

Resolution 1 ms

Inaccuracy ±0.02% + 1 digit of displayed value

Timer inputs

Max input voltage 250 V AC/DC

Voltage mode

Parameter	Min	Max	Unit
Threshold level, Positive at red terminal	8	20	V DC
Threshold level, Negative at red terminal	-20	-8	V DC
Input current at threshold level Positive at red terminal	0.7	2.0	mA DC
Input current at threshold level Positive at black terminal	4	12	mA DC
Threshold level, low to high, 50 Hz	5	15	V AC _{RMS}
Threshold level, high to low, 50 Hz	15	45	V AC _{RMS}

Contact mode

Parameter	Min	Max	Unit
Closed contact detection	0	1	kΩ
Open contact detection	4	-	kΩ
Open circuit voltage	17	20	V DC
Short circuit current	8	13	mA DC

Input current at maximum input voltage, inrush

Parameter	Max	Unit
At 250 V DC, Positive at red terminal	8	mA DC
At 250 V DC, Positive at black terminal	150	mA DC
At 250 V AC	80	mA DC

Input current at maximum input voltage, continuous

Parameter	Max	Unit
At 250 V DC, Positive at red terminal	8	mA DC
At 250 V DC, Positive at black terminal	12	mA DC
At 250 V AC	15	mA DC

ORDERING INFORMATION

Product	Order Code
TM200 Incl. Test lead GA-00082 and Carrying case GD-00230	BP-29090

Optional Accessories



GA-00103 Multi cable



CF-90150 GPS200 – MGTR GPS unit with accessories



GA-00032 Test lead set



CF-90100 Calibration box



Test lead set GA-00030



PSS750



CSU20A



Impact resistant and waterproof (IP65) HD-case with wheels and retractable handle.



Standard Potential Leads
835312
The standard potential leads are for general use when measuring a standard voltage system.
Set of 4 leads,
2 m (6 ft. 6 in.)



20 Amp States Current Plug
835313
The measurement of secondary current from a distribution test switch can be obtained by using the 20 amp states current plug.
Set of 3 states current plugs,
1 m (3 ft. 6 in.)



Fused Potential Leads
830213
The fused potential leads provides the technician protection when measuring a higher system voltage (600 vac/2 amp fuse).
Set of 4 fused leads,
2 m (6 ft. 6 in.)



Miniature Clamp-On CT
50611
The miniature clamp-on CT makes it easy to check current path in a wired distribution panel without worry of interrupting a current circuit in service.
Ratio:
200:1
Accuracy Class:
±1%
Cable Size:
0.59 in. (14.98 mm)
Dimensions:
96.5 H x 43 W x 23 D mm
(3.8 H x 1.69 W x 0.9 D in.)
Weight:
0.11 Kg (0.25 lbs)



Clamp-On CT 1000
830312
835318
Ratio:
1000:1 (Cat. No. 830312)
1000:5 (Cat. No. 835318)
Accuracy Class:
±1%
Cable Opening:
43.18 mm (1.7 in.) (US)
51 mm (2.0 in.) (NS)
Busbar Opening:
43.18 mm x 11.94 mm
(1.7 in. x 0.47 in.) (US)
Dimensions:
203 H x 63.5 W x 40.6 D mm
(8.0 H x 2.5 W x 1.6 D in.)
Weight:
0.55 Kg (1.2 lbs)



Clamp-On CT 3000
835319
835320
Ratio:
3000:1 (Cat. No. 835319)
3000:5 (Cat. No. 835320)
Accuracy Class:
±1%
Cable Opening:
70 mm (2.76 in.)
Busbar Opening:
127 mm x 33 mm or
102 mm x 45.7 mm
(5.0 in. x 1.3 in. or
4.0 in x 1.8 in.)
Dimensions:
144.8 H x 335.3 W x 51 D mm
(5.7 H x 13.2 W x 2.0 D in.)
Weight:
1.7 Kg (3.7 lbs)



Soft Carrying Case
50775
Padded Canvas/polyester case
Dimensions:
281.0 H x 255 W x 255 D mm
(11.0 H x 10.0 W x 10.0 D in.)
Weight:
0.37 Kg (0.8 lb)



Transformer Tests

Transformers maintenance has seen a move toward reliability and condition based maintenance schedules.

To assist and support transformer owners and manufacturers Megger has invested in providing the latest test and diagnostic equipment to ensure your assets' health is kept in check.

10

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SELECTION GUIDE

	OTSPB	OTSAF	VCM 100/80D	KF875/ KF-LAB	MTO210	TTR25	TTR100	TTR300	MCT 1605B	MCT 1605	MAGNUS
Portable oil test set	■										
Laboratory oil test set		■									
Oil test set calibration meter			■								
Karl Fischer test set				■							
Transformer ohmmeter					■						
Transformer turns ratio test set						■	■	■			
Current transformer saturation, ratio and polarity test set									■	■	
Set up transformer											■
Tap changer tester					■						

Do you need...

12 kV insulation diagnostic system or a sweep frequency diagnostic tester?

See the DELTA400 on page 42
FRAX on page 36 and IDAX testers on page 40

Power transformers in industrial premises - are you covered?

It's easy to assume that the substation on your site belongs to the power utility, but are you absolutely sure? If you get it wrong, and you're unlucky enough to suffer a transformer fault, you could find yourself landed with a massive repair bill.

In the substation, the power transformers are probably the most expensive items. And that's not the worst of it. The delivery time for a replacement transformer is typically months, or even years for the largest types. The direct and indirect costs associated with a transformer failure can therefore be enormous.

But there's surely no need for concern. All of the power transformers on your site are the responsibility of your energy supplier, aren't they? It may be a very good idea to check again. In a surprisingly large percentage of installations, the power transformers belong to the owner of the premises, and not to the power utility.

Of course there's still no reason to worry, because transformer failures will certainly be covered by insurance, won't they? The answer is possibly not. Because of the huge costs involved, insurers are understandably cautious about making payouts relating to transformer faults and failures. If there is a claim, they will certainly ask for evidence to show that the transformer has been regularly tested and maintained.

Since many companies are not even aware that they are responsible for the power transformers on their sites, it's not too much of a surprise that there are a lot of transformers that most certainly don't get the regular attention they need.

This is a special concern with the many transformers currently in use that have long exceeded their design lives. Although they may apparently still be working well, it is inevitable that some of the materials used in their construction – in particular the insulating materials – will have started to deteriorate.

If an unmaintained transformer fails, whether it is old or new, it's perfectly possible that the insurers will contest the claim or refuse to pay. Let's take a look at what needs to be done to avoid this potentially devastating situation.

The first and most obvious step is for maintenance departments to check which of the transformers on their site are their responsibility. The next step is to implement a regular testing programme for these transformers.

But what form should the testing take? There are of course many types of conventional tests that can be applied to power transformers to check; for instance, the performance of the tap changers or the windings.

This means that to build up a reasonably complete picture of the transformer's condition, a whole battery of tests is needed, which will take a considerable time to perform. During this time, the transformer will necessarily be out of service, which can be very inconvenient.

There are, however, two tests that between them can provide a wealth of information, not only about the presence of faults but also in many cases their type and location. These tests are sweep frequency response analysis (SFRA) and frequency domain spectroscopy (FDS).

Electrically, a transformer is made up of multiple capacitances, inductances and resistances. It is in effect a very complex circuit that produces a unique "fingerprint" when test signals are injected over a range of frequencies and the results plotted as a curve. In particular the distance between conductors affects the capacitances in the transformer.

Movement of the windings, which can be caused by electrical overloads, mechanical shocks or simply by ageing will therefore alter the capacitances and change the shape of the frequency response curve.

The SFRA test technique for transformers is based on comparisons between measured curves which allow variations to be detected. An SFRA test involves multiple sweeps and reveals whether the mechanical or electrical integrity of the transformer has been compromised.

SFRA tests are used to capture a "fingerprint" reference curve for each winding when the transformer is new or when it is known to be in good condition. These curves are subsequently used as the basis for comparisons during maintenance or when problems are suspected.

The best way to use SFRA testing is to take regular measurements on the same transformer over a period time, and to compare the results. However it is also possible to use type-based comparisons between transformers with the same design. Finally, a construction-based comparison can be used in some circumstances, when comparing measurements between windings in the same transformer.

A single SFRA test can detect winding problems that would otherwise require multiple tests with various kinds of test

equipment, as well as problems that cannot be detected at all by tests of other kinds.

As a general guide, magnetisation and other problems relating to the core alter the shape of the SFRA curve at the lowest frequencies, up to around 10 kHz. Medium frequencies, from 10 kHz to 100 kHz represent axial or radial movements in the windings, and high frequencies above 100 kHz correspond to problems involving the cables from the windings to bushings and tap changers. In modern SFRA test sets, built-in analytical tools simplify comparisons between curves.

While SFRA tests provide a lot of information about the condition of a transformer, they do not give an accurate indication of the presence of contaminants – in particular water – in the transformer insulation. Standard tests, such as the widely used Karl Fischer test are of course available for accurately assessing the moisture content of transformer oil, but this is not the whole story.

In fact, it is usual for a much greater percentage of the moisture in a transformer to be held in solid insulation such as paper than is held in the oil. To further complicate matters, the moisture moves between the solid insulants and the oil in a way that is influenced by many factors including, in particular, temperature.

Measuring the moisture content of the oil may not therefore provide dependable information about the moisture content of the transformer's solid insulation. This is a serious concern, as moisture in the insulation significantly accelerates the ageing process in transformers and it can cause bubbles between windings that lead to sudden catastrophic failures.

To establish the moisture content in the transformer, the second of the tests mentioned earlier – frequency domain spectroscopy (FDS) – could be used. Initially, this may sound a lot like SFRA, as it involves measuring transformer characteristics over a range of frequencies. This time, however, it's the dielectric properties of the insulation (capacitance, loss and power factor) that are measured over a range of frequencies, typically from one millihertz to one kilohertz.

These are, in essence, the same dielectric tests that are often carried out at power frequency, but testing at a single frequency provides far less information than is revealed by FDS testing. Unlike spot-frequency testing, FDS can for example reliably distinguish between a transformer that is dry but has bad oil and one that is wet but has good oil. In the first case, the oil needs refurbishing or replacing; in the second the transformer only needs drying out.

FDS testing also has other benefits – it can be performed at any temperature, and the test can be completed quickly. Software can be used to calculate the water content in percentage terms, and

modern FDS test sets typically provide accurate and detailed results in less than 20 minutes.

Regular testing using the SFRA and FDS test techniques provides a reliable insight into the condition of power transformers, but how can this information best be used by the transformer owner?

A short-circuit fault on the transformer may cause unseen damage inside, and a damaged transformer put back into service could fail catastrophically. An SFRA test can be done before re-energising and compared to a reference trace taken while the transformer was in good working order. If the two traces match, nothing has changed and the transformer can be safely returned to service. Carrying out this test takes less than an hour, reducing outage time and saving money.

Ageing, mechanical damage and moisture content can be seen as a change in the frequency response of the transformer over time and may indicate that remedial action such as drying out the transformer is needed to guard against future failures. In other cases, it may show that the transformer is inevitably coming to the end of its useful life, but even then the information is invaluable.

In this situation, it may be possible to minimise the load on the transformer so that it can continue in service until a replacement is obtained. Even in the worst case, there is at least a warning that failure is imminent, which can allow time for contingency plans to be made and put into place.

There is another very valuable aspect of regular testing, which we touched on earlier. Insurance companies are more likely to honour a claim for failure of a power transformer that's been regularly tested and properly maintained so as to remedy any issues identified by the tests. Such a transformer is, of course, less likely to fail, but if it does there is at least the consolation that the insurers might foot the bill!

Even for those who are aware of their responsibilities in looking after power transformers, regular testing may appear as something of a burden. However, tests with modern instruments can be performed quickly and easily, and they yield dependable informative results. And, if the test regime eliminates just one unforeseen transformer failure that would otherwise have occurred, the effort involved in testing and the cost of the instruments used will have been repaid many times over.



OTS80PB and OTS60PB

- Light-weight, rugged, portable instruments for measuring insulating oil breakdown voltage
- Lock in precision - oil vessel with lockable adjustment
- Bright 3.5 inch colour display visible out-doors
- Suitable for mineral, ester and silicon oils
- Trip detection circuit with direct measurement of voltage and current
- Ultra fast (<10 μs) HV switch off time

Description

Automatic portable oil test sets perform accurate breakdown voltage tests on mineral, ester and silicon insulating liquids. Moulded test vessels give repeatable results in the field and laboratory with lock in precision electrode gap setting adjustment wheels. The transparent, shielded lid is a key feature enabling users to see what is happening within the test chamber.

The portable 60 kV and 80 kV oil test sets are very light ranging from 16 kg to 23.5 kg depending on model and configuration. They come complete with optional carry bag and transport case. The carry bag has pouches for electrode accessory pack, leads, quick user guide, paper roll etc.

Applications

Monitoring and maintenance of oil quality is essential in ensuring the reliable operation of oil filled electrical equipment. Codes of practice have been established in many countries that include several different types of test on insulating oils.

One of the fundamental tests of oil quality is the breakdown voltage test, which is a measure of the oil's ability to withstand electric stress. A low breakdown voltage can indicate the presence of contaminants such as water or conducting particles.

SPECIFICATIONS

Test voltage

OTS60PB	-30 to +30 kVrms
OTS80PB	-40 to +40 kVrms
Voltage resolution	0.1 kV, ±1%, ±2 digits

Programmed test sequences

See page 230

Languages supported

English, French, German, Spanish, Czech, Dutch, Finnish, Italian, Norwegian, Polish, Portuguese, Russian and Swedish.

Vessels 400 ml (standard) 150 ml (option)

Nylon 12 chamber provides precision electrode alignment and adjustment wheels lock electrodes in position, option of 150 ml vessel for low volume oil samples

Temperature sensor resolution	1 °C
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Power supply

Line voltage 85 to 265 VAC
Line frequency 50/60 Hz

Batteries (option)	Lead acid 2 x 12 V 4 Ah, or NiMH 24 V 2 AH
--------------------	--

Interfaces

USB 2.0 compatible
2 x USB type-A (memory stick)
1 x USB type-B (printer or PC)

Printer

Internal printer (option)	Matrix impact printer Paper 57.5 mm wide
External printer	Any printer with USB interface and PCL3 driver

Protection	Safety interlock on cover
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Display	320 x 240 QVGA colour display with backlight
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Environmental

Operating temperature	0 °C to +50 °C
Storage temperature	-30 °C to +65 °C
Humidity	80% RH at 40 °C operation 95% RH at 40 °C storage

Safety

Designed in accordance with IEC 61010

















EMC	Light industrial IEC 61326-1 Class B, CISPR 16-1 and CISPR 16-2
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Mechanical data

Dimensions (W x H x D)	
OTS60PB	520 mm x 340 mm x 250 mm
OTS80PB	520 mm x 380 mm x 250 mm
Weight	
OTS60PB	16 kg (printer, no battery) 16.8 kg (printer, NiMH battery)
OTS80PB	20 kg (printer, no battery) 20.8 kg (printer, NiMH battery) 23.2 kg (printer, lead acid batteries)
Test vessels	1.1 kg (400 ml and 150 ml)

ORDERING CONFIGURATION

Example of an ordering configuration:-OTS80PB-EU2-EP-4C = This order is for an OTS80PB with EU power lead, NiMH battery, IEC electrode set, internal printer, lid stirrer and carry bag.

Model:	OTS	PB-	-	-	-	-	-	-		
Select model	80 kV	80							Weights	
	60 kV	60							19.4 kg	
Select power cord		EU lead	EU							15.3 kg
		UK lead	UK							
		US lead	US							
		Australian lead	AU							
		No Plug lead	BL							
Select battery option		Sealed lead acid	1	OTS80PB ONLY					3.3 kg	
		NiMH	2					0.8 kg		
	NONE	No battery	X					0 kg		
Select electrode set			ASTM set	A						
			IEC set	E						
			Full set	U						
Select printer option			Internal printer	P					0.54 kg	
			No printer	X					0.08 kg	
Select stirrer option			Stirrer lid assembly fitted	4					0.3 kg	
			Stirrer lid assembly not fitted	X						
Select carry case option			Carry case	C					1.3 kg	
			No carry case	X						

OTS80PB and OTS60PB

Portable oil test sets

Programmed test sequences

Country	Standard
US	ASTM D1816-04 ASTM D877A-02 ASTM D877B-02
International	IEC 60156-95
UK	BS-EN-60156-95
Italy	CEI EN-60156-95
Argentina	IRAM 2341
Spain	UNE EN 60156
France	NF EN 60156
South Africa	SABS EN 60156
Germany	VDE 0370 Part 5
Australia	AS 1767.2.1
Japan	JIS C2101-99 (M) JIS CS101-99 (S)
Custom	Configurable by user

ORDERING INFORMATION

Product	Order Code	Product	Order Code
OTS60 PB	Configured*	Optional accessories	
OTS80PB	Configured*	Transport case (with wheels)	1001-476
Included accessories		Vessel 400 ml assembly (no electrodes supplied)	1001-473
Vessel 400 ml assembly		Vessel 150 ml assembly (no electrodes supplied)	1001-474
12 V vehicle charger lead (supplied only on instruments configured with a battery)		VCM100D digital voltage checker	1001-105
Magnetic bead stirrers (2 off)		VCM80D digital voltage checker	1001-801
Magnetic bead retriever		Printer paper, 1 roll (MOV applies) (4 rolls supplied if printer configured)	25995-001
Feeler gauge set 1, 2, 2.5, 2.54 mm		*See ordering configuration on previous page	670506
User manual			
Configured accessories (to order additional or spares)			
IEC60156 electrode set - 12.7 mm spherical (2), 36 mm mushroom (2)	1001-477		
ASTM D877/1816 electrode set - 25.4 mm cylindrical (2 standard, and 2 none standard, 36 mm mushroom (2)	1001-478		
Full electrode set ASTM and IEC electrodes	1001-479		
Vessel lid mounted impeller (ASTM D1816) for use with 400 ml vessel	1001-102		
Carry bag (padded) OTS80PB	1001-476		
Carry bag (padded) OTS60PB	1001-480		

SPECIFICATIONS

Test voltage

OTS60AF	-30 to +30 kVrms
OTS80AF	-40 to +40 kVrms
OTS100AF	-50 to +50 kVrms
Voltage resolution	0.1 kV, $\pm 1\%$, ± 2 digits

Programmed test sequences

See page 233

Languages supported

English, French, German, Spanish, Czech, Dutch, Finnish, Italian, Norwegian, Polish, Portuguese, Russian and Swedish

Vessels 400 ml (standard) 150 ml (option)

Nylon 12 chamber provides precision electrode alignment and adjustment wheels lock electrodes in position, option of 150 ml vessel for low volume oil samples

Temperature sensor resolution	1 °C
-------------------------------	------

Power supply

Line voltage 85 to 265 VAC
Line frequency 50/60 Hz

Batteries (option)	Lead acid 2 x 12 V 4 Ah, or NiMH 24 V 2 AH
--------------------	--

Interfaces	USB 2.0 compatible 2 x USB type-A (memory stick) 1 x USB type-B (printer or PC)
------------	---

Printer

Internal printer (option)	Matrix impact printer Paper 57.5 mm wide
External printer	Any printer with USB interface and PCL3 driver

Protection	Safety interlock on cover
------------	---------------------------

Display	320 x 240 QVGA colour display with backlight
---------	--

Environmental

Operating temperature	0 °C to +50 °C
Storage temperature	-30 °C to +65 °C
Humidity	80% RH at 40 °C operation 95% RH at 40 °C storage

Safety

Designed in accordance with IEC 61010

EMC	Light industrial IEC 61326-1 Class B, CISPR 16-1 and CISPR 16-2
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Mechanical data

Dimensions (W x H x D) all models	580 mm x 420 mm x 290 mm
Weight all models	30 kg with printer option fitted



OTS100AF, OTS80AF, OTS60AF

- Laboratory instruments for measuring insulating oil breakdown voltage
- Lock in precision – oil vessel with lockable adjustment
- Bright 3.5" colour display visible out doors
- Suitable for mineral, ester and silicon oils
- Trip detection circuit with direct measurement of voltage and current
- Ultra fast (< 10 μ s) HV switch off time

Description

These new automatic portable oil test sets perform accurate breakdown voltage tests on mineral, ester and silicon insulating liquids. Moulded test vessels give repeatable results in the field and laboratory with lock in precision electrode gap setting adjustment wheels. The transparent, shielded lid enables users to see what is happening within the test chamber. Megger's portable 60 kV and 80 kV oil test sets are very light ranging from 16 kg to 23.5 kg depending on model and configuration. They come complete with optional carry bag and transport case.

Application

Monitoring and maintenance of oil quality is essential in ensuring the reliable operation of oil filled electrical equipment. Codes of practice have been established in many countries that include several different types of test on insulating oils.

One of the fundamental tests of oil quality is the breakdown voltage test, which is a measure of the oil's ability to withstand electric stress. A low breakdown voltage can indicate the presence of contaminants such as water or conducting particles.












OTS100AF, OTS80AF, OTS60AF

Laboratory oil test sets

ORDERING CONFIGURATION

Example of an ordering configuration:-

OTS100AF-USA-P4 = This order is for an OTS100AF with US power lead, ASTM electrode set, internal printer and lid stirrer.

Model:		OTS		AF-		-				Weights	
Select model	100 kV	100								29.5 kg	
	80 kV	80								29.5 kg	
	60 kV	60								29.5 kg	
Select power cord		EU lead	EU								
		UK lead	UK								
		US lead	US								
		Australian lead	AU								
		No plug lead	BL								
Select electrode set			ASTM set	A							
			IEC set	E							
			Full set	U							
Select printer option			Internal printer	P					0.54 kg		
			No printer	X					0.08 kg		
Select stirrer option			Stirrer lid assembly fitted	4				0.3 kg			
			Stirrer lid assembly not fitted	X							

Programmed test sequences

Country	Standard
US	ASTM D1816-04 ASTM D877A-02 ASTM D877B-02
International	IEC 60156-95
UK	BS-EN-60156-95
Italy	CEI EN-60156-95
Argentina	IRAM 2341
Spain	UNE EN 60156
France	NF EN 60156
South Africa	SABS EN 60156
Germany	VDE 0370 Part 5
Australia	AS 1767.2.1
Japan	JIS C2101-99 (M) JIS CS101-99 (S)
Custom	Configurable by user

ORDERING INFORMATION

Product	Order Code	Product	Order Code
OTS60AF	configured*	Optional accessories	
OTS80AF	configured*	Vessel 400 ml assembly (no electrodes supplied)	1001-473
OTS100AF	configured*	Vessel 150 ml assembly (no electrodes supplied)	1001-474
Included accessories (on all configurations)			
Vessel 400 ml assembly		VCM100D digital voltage checker	1001-105
Magnetic bead stirrers (2 off)		VCM80D digital voltage checker	1001-801
Magnetic bead retriever		Printer paper, 1 roll (MOV applies) (4 rolls supplied if printer configured)	25995-001
Feeler gauge set 1, 2, 2.5, 2.54 mm		Barcode reader, USB	1001-047
User manual CD		* See ordering configuration on previous page	670506
PowerDB Lite software			
Configured accessories (to order additional or spares)			
IEC60156 electrode Set - 12.7 mm spherical (2), 36 mm mushroom (2)	1001-477		
ASTM D877/1816 electrode set - 25.4 mm cylindrical (2 std, and 2 none std), 36 mm mushroom (2)	1001-478		
Full electrode set ASTM and IEC electrodes	1001-479		
Vessel lid mounted impeller (ASTM D1816) for use with 400 ml vessel	1001-102		

VCM100D/VCM80D

Oil test set calibration meter



VCM100D/VCM80D

Description

The VCM100D/VCM80D voltage check meters are used as a high voltage meter for Megger's new Oil Test Set (OTS) family.

This family includes the following models:

- Laboratory units: OTS100AF, OTS80AF and OTS60AF, the OTS100AF requires a VCM100D to check voltages above 80 kV.
- Portable units: OTS80PB, OTS60PB.

The meters enable the high voltage output to be checked.

Operation

New OTS models are programmed with a test sequence suitable for using the VCM100D/VCM80D. This sequence causes the output of the oil test set to ramp up from 0 kV to the maximum voltage value, pausing at each 10 kV point for 10 seconds to allow the voltage output to be checked.

Simply replace the OTS test vessel with the VCM100D/VCM80D, close the lid and navigate to the VCM function on the tools tab. Select using the OK button. After pressing the TEST button, the test will proceed automatically. Read the VCM100D/VCM80D meter when each steady voltage is displayed up to the maximum instrument voltage.

SPECIFICATIONS

Proprietary 100 kV/80 kV Megger OTS voltmeter with 4 digit readout

Accuracy at 23 °C

2.0% +2 digits to 50 kVrms
2.5% +2 digits >50 kVrms to 75 kVrms
3.0% +2 digits >75 kVrms to 100 kVrms

Environmental

Operating temperature	0 °C to 40 °C
Storage temperature	-30 °C to +70 °C
Operational temperature	50% RH at 20 °C
Storage temperature	93% RH at 40 °C

Safety

The meter is only approved for use with Megger oil test sets

Mechanical data

Dimensions (W x H x D)	250 mm x 150 mm x 115 mm
Weight	1.8 kg

ORDERING INFORMATION

Product	Order Code
VCM100	
VCM80D	
Included accessories	
Carrying case	6420-094
Instruction card	6172-044
Certification of calibration	

Reagents

Reagents and other consumable chemicals for coulometric Karl Fischer Titration are available from many different suppliers throughout the world.

Megger recommends the use of:

Part numbers for "Hydranal coulomat" Reagents are:

Part no.	Description
RH-34807	Hydranal coulomat A anode reagent - 500 ml bottle
RH-34840-25	Hydranal coulomat CG cathode reagent - 1 x 25 ml vial
RH-34840-50	Hydranal coulomat CG cathode reagent - 1 x 10 pack of 50 ml ampoules

Part numbers for "Hydranal" water standards are:

Part no.	Description
RH-34828	Hydranal water standard 1.00 - 10 pack of 4 ml ampoules
RH-34847	Hydranal water standard 0.10 - 10 pack of 4 ml ampoules

Details of a local agent where these products can be obtained are available on the Sigma-Aldrich website www.sigmaaldrich.com



KF875 and KF-LAB

- Coulometric Karl Fischer titrimetry
- KF875 optimized for insulating oil with an SG of 0.875, completely portable
- KF-LAB MkII offers greater flexibility, versatility and sample data input than the KF875; also completely portable
- KF-LAB MkII analyzes materials with an SG between 0.6 & 1.4, plus insulating oils with an SG of 0.875

Description

Over 20 years experience has led to the development of the Megger KF875 and KF-LAB MkII Coulometric Karl Fischer Test Sets designed to determine moisture in oil, to provide highly accurate results on-site. The KF875 and KF-LAB MkII are highly portable instruments, complete with integral printer and carrying case, are easy to use and provide highly accurate results.

Application

Optimized for testing insulating oils with a specific gravity of 0.875, the Megger KF875 simply requires the operator to press one button and inject a 1 ml sample into the test cell. The simple 'one touch' operation makes the KF875 so easy to use that it requires no specialist knowledge or training to use it effectively. Results are presented on the instrument display and on the integral printer in both micrograms of water and in milligrams per kilogram (parts per million, ppm).

The KF-LAB MkII allows the titration of samples with a range of specific gravities from 0.60 to 1.40 and also permits the use of different sample sizes. The KF-LAB MkII also has a default setting optimized for analyzing insulating oils with an SG of 0.875. This means it can be used to measure water content in a variety of different materials but is also easy to set up for transformer insulating oils.

KF875 and KF-LAB MkII

Karl Fischer moisture in oil test sets

SPECIFICATIONS

	KF-LAB	KF875
Titration method	Coulometric Karl Fischer Titration	
Electrolysis control	Patented "ACE" control system	
End point detection	AC polarisation	
End point indication	Visual display / print out / acoustic beep	
Measuring range	1 µg - 10 mg water	
Moisture range	1 ppm - 100%	1 ppm - 100 ppm
Max. sensitivity	0.1 µg	
Max. titration speed	2 mg per minute	
Max. current	400 ma	
Drift compensation	Automatically controlled	
Precision	10-100 µg ± 3 µg, 100 µg - 1 mg ± 5 µg, above 1 mg ± 0.5%	
Method storage	10 programmable methods	Preset method
Sample ID number	User programmable	Not available
Display format	µf, mg/kg, ppm, %	mg/kg, ppm
Print format	µg + mg/kg, ppm %	µg + mg/kg, ppm
Calculation modes	Weight/weight Weight/dilution ratio Volume/volume Volume/density User programmable	Volume/density Preset values
Statistics	Up to 99 runs User programmable	Preset up to 99 runs
Start delay time	0-30 mins. selectable	Preset
Min. titration time	0-30 mins. selectable	Not available
Language	English, Français, Español, Portuguese, Deutsch, Magyar	English
Stirrer speed	Microprocessor controlled	
Calendar/clock	Analysis time and date print out	
Keypad/user controls	Non tactile membrane/display prompted menu	
Display	40 character alphanumeric backlit display	
Printer	42 character high speed thermal printer	
Carry case	Standard	
Power supply	90 - 264 V ac, 47 - 63 Hz 12 V dc car adapter/ internal battery	
Battery life	8 hours running time	
Battery low	Display and print out indication	
Environmental		
Operating temperature	0 °C to 45 °C	
Storage temperature	-10 °C to +85 °C	
Humidity	5% to 95%	
Output		
Dimensions (W x H x D)	87 mm x 95 mm x 29 mm	
Weight	0.16 kg	

ORDERING INFORMATION

Product	Order Code	Product	Order Code
KF-LAB Mk II Laboratory coulometric Karl Fischer test set	6111-774	Car adapter	6121-539
KF875 coulometric Karl Fischer test set for insulating oils	6111-636	Injection septa (10)	6121-531
Supplied accessories (also available as spare items)		Glass syringe (1 ml)	6121-532
Titration vessel	6121-527	Luer needle	6121-533
Detector electrode	6121-528	Bottle of molecular sieve	6121-534
Generator electrode	6121-529	Stirrer bar	6121-535
Drying tube	6121-530	Funnel	6121-536
Carrying case	6121-537		
Power pack	6121-538		

Application

The MTO210 transformer ohmmeter is used:

- To verify factory test readings.
- As part of a regular maintenance program.
- To help locate the presence of defects in transformers, such as loose connections.
- To check the “make-before-break” operation of on-load tap-changers.



MTO210

- Direct 2-channel digital reading (1 $\mu\Omega$ to 2000 Ω)
- DC test current up to 10 A maximum
- Patented “Quick Test” measurement technique
- 0.25% measurement accuracy
- Integrated demagnetization feature
- Tests operation of on-load tap-changers
- Very fast auto safety discharge circuit

Description

The MTO210 transformer ohmmeter is a line-operated, field-portable instrument designed specifically to measure the dc resistance of all types of magnetic windings safely and accurately. It can test transformers and rotating machine windings and perform low-current resistance measurements on connections, contacts and control circuits.

The dual set of potential inputs measures the resistance of the primary and secondary windings of a single- or three-phase transformer simultaneously. This dual reading, dual injection characteristic, also help to speed up the measurements when used to test LV windings on large three-phase power transformers.

The transformer ohmmeter is extremely useful when testing the windings and contact resistance of tap-changers with “make-before-break” contacts and voltage regulators. This action will check for pitted or misaligned contacts as the instrument will give an indication if either condition occurs.

Users are also protected by the auto-shutdown safety feature. Any inadvertent disconnection of a test lead or loss of power to the instrument will safely discharge the energy stored in the test sample.

SPECIFICATIONS

Input	120/240 V, 50/60 Hz, 720 VA
Output	
User selectable current range	up to 10 mA up to 100 mA up to 1 A up to 10 A
Open circuit test voltage	up to 50 V dc
Resistance measurement/display	
Resistance	1 $\mu\Omega$ to 2000 Ω
Accuracy:	$\pm 0.25\%$ of reading, $\pm 0.25\%$ full scale (when current has stabilized)
Resolution:	Up to 6 digits
Displays	
Two	1" high, 6 character, 7-segment, LCDs
One	0.71" high, 6 character, 7-segment, LCD
Printer	Via RS232 port
User interface	Black and white alphanumeric displays, keypad
Computer interface (for downloading results)	Via RS232 port
Internal data storage	up to 10,000 data sets
Environmental	
Operating	-10 °C to 50 °C (14 °F to 122 °F)
Storage	-15 °C to 70 °C (5 °F to 158 °F)
Humidity	0-90% non-condensing
Mechanical data	
Dimensions (H x W x D)	216 x 546 x 330 mm (8.5 x 21.5 x 13 in.)
Weight	Net. 13.1 kg (29 lb)

ORDERING INFORMATION

Product	Order Code	Product	Order Code
Transformer Ohmmeter 120/240 volt, 50/60 Hz input	MTO210	Optional accessories	
Included accessories		Cable Assy-V1 Potential Leads, 30 m (100 FT)	2001-403
V1 Potential lead set, 18 m (60 ft)	2000-700	Cable Assy-V2 Potential Leads, 30 m (100 FT)	2001-404
V2 Potential lead set, 18 m (60 ft)	2000-701	Cable Assy-Jumper Leads, 9 m (30 FT)	2001-405
Current lead set, 18 m (60 ft)	2000-702	Cable Assy-Current Leads, 30 m (100 FT)	2001-406
Shorting lead, 4.5 m (15 ft) [1]	2000-703	Cable Assy-Kelvin Leads, 60 FT (18 m)	2001-407
Ground lead, 4.5 m (15 ft) [1]	4702-7	Cable Assy-Kelvin Leads, 30 m (100 FT)	2001-408
RS232 cable for connecting to a PC ad printer	CA-RS232	Test lead set, 30 m (100 FT) including V1, V2, Current and 9 m (30 ft) shorting lead	
Remote trigger switch	30915-220	Kelvin clamps/cables, xx ft (yy m)	
AC power cord (IEC60320-C13 to US standard)	17032	Beacon strobe light	37181
AC power cord (IEC60320-C13 to Schuko CEE 7/7)	17032-13	Printer (includes battery/line powered serial thermal printer	
Interlock connector	37177	120 V, 60 Hz	35755-3
In-lid quick start guide	37178	230 V 50 Hz	35755-4
Canvas carrying bag (for leadset)	30915-211	Foam-lined transit case	37009
Instruction manual	ATVMMTO210	PowerDB (full version) software, 1st machine license, soft key	DB1001
PowerDB LITE software		PowerDB (full version), software, 1st machine license, USB dongle	DB1001S

SPECIFICATIONS

Type of power	Six standard AA (IEC LR-6) alkaline batteries
Battery life	12 hours of field operation
Excitation voltage	
8 V rms for testing distribution or power transformers and PTs; 0.5, 1.5, or 8 V ac rms for testing CTs.	
Test Excitation	55 Hz internally generated providing a universal 50/60 Hz test set
Excitation current range	0 to 100 mA, 4 digit resolution
Transformer polarity	Normal or reversed
Current (rms) accuracy	(2% of reading +1 digit)
Turns ratio	
Range	0 to 100 mA, 4 digit resolution
Accuracy	0.1% (0.8 to 2000)
	0.15% (2001 to 4000)
	0.25% (4001 to 10,000)
	0.5% (10,001 to 20,000)
Display full graphics	LCD module, adjustable back lighting, wide temperature range, 128 x 64 dots (21 characters by 8 lines)
Transformer winding phase relationship	ANSI C57.1270-1978 CE/IEC 76-1:1993 and Publications 616:1978 AS-2374, Part 4-1982 (Australian standard)
Safety Meets the requirements of IEC-1010-1, CE and ASTM D999.75	
Environmental	
Operating	-20 °C to 55 °C (-5 °F to 130 °F)
Storage	-50 °C to 60 °C (-55 °F to 140 °F)
Humidity	Operating: 0 to 90% non-condensing Storage: 0 to 95% non-condensing
Protective devices	
High voltage side shorting relay, transient voltage suppressors and gas surge voltage protectors	
Measuring time	Less than 5 seconds
Measurement method	ANSI/IEEE C57.12.90
Mechanical data	
Dimensions (H x W x D)	240 x 115 x 50 mm (9.5 x 4.5 x 1.9 in.)
Weight	Approximately 1.3 kg (2.8 lb) including leads



TTR25

- Fully automatic; fast; easy-to-use; robust; lightweight
- Battery powered
- Tests turns ratio, excitation current, and polarity
- Simple, one-button operation
- Quick-start guide on front panel
- Operator-selectable languages

Description

The Megger TTR25 is an automatic hand-held battery operated transformer turns ratio test set. It is used to measure the turns ratio, excitation current and polarity of windings in single- and three-phase distribution and power transformers (tested phase by phase), potential & current transformers, and tapped transformers.

The unique design of the TTR25 allows the user to operate the test set while holding it in one hand. It effectively eliminates the user from having to kneel or bend down to operate the instrument and speeds up testing time.

Realizing the extreme environments in which the TTR25 must operate, special attention has been paid to making it extra rugged, with a high impact, shock resistant case, yet incredibly lightweight at a mere 870 g (1.9 lbs).

ORDERING INFORMATION

Product	Order Code	Product	Order Code
Hand-held TTR25	TTR25	Combined test leads, "X/H" winding, 10 m (33 ft)	36042
Included accessories			
Combined test leads, "X/H" winding, 1.8 m (6 ft)	35938	Printer package including battery/line power serial thermal printer with paper, battery pack and charger, printer interface cable, 120 V, 60 Hz	35755-1
Instruction manual	AVTMTTR25	Printer package including battery/line power serial thermal printer with paper, battery pack and charger, printer interface cable, 230 V, 50 Hz	35755-2
Electronic documents	AVTDTTR25	Semi-hard fabric transport case	35788
Optional accessories			
Combined test leads, "X/H" winding, 3.6 m (12 ft)	35942	Quick guide overlay in Spanish, French, German and Portuguese	35945
Combined test leads, "X/H" winding, 6 m (20 ft)	36013		



TTR100

- Single- and three-phase transformer testing
- Fully automatic; fast; easy-to-use; handheld; robust; lightweight
- Battery powered with power-saving and shutdown function
- Tests turns ratio, phase displacement, excitation current, winding resistance and polarity
- RS232 for data transfer and printing
- Stores 200 test results and 100 user-defined transformer test settings

Description

The Megger TTR100 is an automatic handheld, battery operated transformer turns ratio test set used to measure the turns ratio, excitation current, phase displacement, dc resistance and polarity of windings in single- and three-phase distribution transformers (tested phase by phase), potential & current transformers, and tapped transformers. Deviations in the mentioned measurements will quickly indicate problems in transformer windings or in the magnetic core circuits.

The unique design of the TTR100 allows the user to operate the test set while holding it in one hand. No other transformer test set offers this capability. It effectively relieves the user from having to kneel or bend down to operate the instrument and speeds up testing time.

TTR100 often has to operate in extreme environments and special attention has been paid to making it extra rugged, with a high impact, shock resistant case, yet very lightweight at 1.5 kg (3.3 lb.).

SPECIFICATIONS

Type of power	Rechargeable NiMH battery pack, 3.6 V dc, 3800 mAh
Battery life	15 hours of field operation
Optional charger source	
Optional inverter 12 V dc to 115 V ac for powering a charger from vehicle battery (non CE marked)	
Excitation voltage	
8 V rms for testing distribution or power transformers and PTs; 0.5, 1.5, or 8 V ac rms for testing CTs. The excitation voltage is switched automatically if excitation current exceeds a preset value	
Test frequency	55 Hz internally generated providing a universal 50/60 Hz test set
Excitation current range	0 to 100 mA, 4 digit resolution
Phase deviation	
Range	±90°, 1 decimal point for the minutes displayed, 2 decimal points for the degree display, or for the centiradian display
Accuracy	±3 minutes
Winding resistance	
Range	0 to 2000 Ω, 4 digit resolution
Accuracy	±10% (0.8 to 2000) ±0.15% (2001 to 4000) ±0.20% (4001 to 10,000) ±0.25% (10,001 to 20,000)
Turns ratio	
Range	8 V ac: 0.8 to 20,000, 5 digit resolution (for transformers and PT testing) 1.5 V ac: 5.0 to 2200, 5 digit resolution (for CT testing)
Accuracy	0.1% (0.8 to 2000) 0.15% (2001 to 4000) 0.25% (4001 to 10,000) 0.5% (10,001 to 20,000)
Transformer	
Vector group	1PH0 or 1PH6
Polarity	Additive and subtractive
PC/Printer interface	RS232C port, 9 pin, 57.6 Kbaud (19.2 Kbaud for the printer)
Display full graphics	LCD module, wide temperature range, 128 x 64 dots (21 characters by 8 lines)
Test result storage	
Internal, nonvolatile memory for storing up to 200 sets of single-phase measured and calculated ratio, exciting current, phase, ratio error, winding resistance, polarity, vector group, plus header information (company, substation, transformer manufacturer, transformer rating, instrument serial number, temperature, relative humidity and operator name). In addition, up to 100 user-defined transformer settings can be stored.	
Computer software	
Included software for downloading of data to a PC, data storage to database and report printout.	
Safety/EMC/Vibration	
Meets the requirements of IEC-1010-1, CE and ASTM D999.75	
Specifications continued	

Environmental	
Operating	-20 °C to 55 °C (-5 °F to 130 °F)
Storage	-50 °C to 60 °C (-55 °F to 140 °F)
Humidity	Operating: 0 to 90% non-condensing Storage: 0 to 95% non-condensing

Transformer winding phase relationship	
ANSI C57.12.70-1978 CEI/IEC 76-1:1993 and Publication 616:1978 AS-2374, Part 4-1982 (Australian Standard)	
Mechanical data	
Dimensions (H x W x D)	240 x 115 x 48 mm (9.5 x 4.5 x 1.875 in.)
Weight	Approximately 1.5 kg (3.3 lb) including leads

ORDERING INFORMATION

Order a TTR100 configured to your specific application. To determine the catalog number, fill in the blanks below with the corresponding number from the detailed information boxes.

Ordering Example:

To order a TTR100 for North American application, without a deluxe kit, and instruction manual in the English language, request catalog number TTR100-NA0-ENG

TTR100 — N A 0 — E N G

To order a TTR100 for North American application, with a deluxe kit, and instruction manual in the English language, request catalog number TTR100-NA1-ENG

TTR100 — N A 1 — E N G

Fill in these blanks with the corresponding letter or number.

TTR100 — X X X — X X X

Country
NA = North America
UK = United Kingdom
EU = European Union
<i>(Determines power cord requirement)</i>

Instruction Manual
ENG = English
FRN = French
SPN = Spanish

Deluxe Kit Option
0 = No Kit
1 = Deluxe Kit, 120 V, 60 Hz printer package
2 = Deluxe Kit, 230 V, 50 Hz printer package
<i>(Kit consists of TTR100, included accessories as well as all optional accessories, excluding Inverter P/N 35973)</i>

Product	Order code
Included accessories	
Test Leads	
"X" winding, 1.8 m (6 ft)	35502-511
"H" winding, 1.8 m (6 ft)	35502-521
PC interface cable	33147-18
Battery pack	35753
Universal battery charger	35757
Power cable for battery charger	Determined by Country
Protective neoprene carrying case and accessory pouch	55-20008
Software for uploading test results to a PC	35794-2
Quickstart guide	55-20013
Instruction manual	AVTMTR100-XXX (XXX = language code)

Product	Order code
"H" winding, 6 m (20 ft)	35502-519
Semi-hard fabric transport case	35788
Additional battery pack	35753
Inverter cigarette adapter with power cable, 12 V dc to 115 V ac, 60 Hz, non CE marked	35973
Printer package, including battery/line power serial thermal printer with paper, battery pack, battery charger, printer interface cable, 120 V, 60 Hz	35755-1
Printer package, including battery/line power serial thermal printer with paper, battery pack, battery charger, printer interface cable, 230 V, 50 Hz	35755-2
Additional printer paper (1 roll)	27705-1

Optional accessories are ordered separately or with Deluxe Kit

Optional accessories	
Test Leads	
"X" winding, 3.6 m (12 ft)	35502-510
"H" winding, 3.6 m (12 ft)	35502-520
"X" winding, 6 m (20 ft)	35502-512



TTR330 shown

TTR300

- Stand-alone or remote-control operation
- Accurately measures ratio, phase deviation and exciting current
- Field upgradeable without compromise to calibration
- Built-in capability for storing and downloading test results in an XML format, via RS-232, Ethernet or USB ports (depending on model)
- Works in the presence of high interference/high voltage
- Highest ratio measurement (45,000:1); highest accuracy (0.1%)
- Displays % error vs. name plate with pass/fail limits

Description

The TTR300 series of three-phase transformer turns ratio test sets are designed to measure the turns ratio of power, instrument, and distribution transformers in a substation or manufacturing environment. A rugged and robust design makes these instruments well suited for use in a variety of harsh environments. Our leads are specially designed to provide the necessary flexibility needed in cold weather.

The TTR300 series are ideal for use by power transformer manufacturers. Their unique testing procedures and storage capability allows an operator to set up and test difficult three-phase transformers (with multiple tap changers and bushing CTs) in a fraction of the time than it used to take with other TTRs. This test also includes a pass/fail limit of individual ratios.

The TTR300 Series also measure the phase deviation of the transformer primary versus secondary. This quickly indicates problems in the transformer such as partial shorted turns and core faults. This measurement is also useful in verifying phase errors in all types of PTs and CTs.

SPECIFICATIONS

Input power	120/230 V ac $\pm 10\%$, single phase, 50/60 ± 2 Hz 100 VA
Battery operation (optional)	Inverter 12 V dc to 120 V/230 V ac for operation from vehicle battery
Excitation voltage	8, 40 or 80 V rms, automatically or manually selected
Excitation current range and accuracy	0 to 500 mA, 3 digit resolution, $\pm(2\%$ of reading +1 digit)
Phase deviation	
Range	$\pm 90^\circ$, 1 decimal point for the minutes displayed, 2 decimal points for the degree display, or for the centiradian display
Accuracy	± 3 minutes
Turns ratio	
Range	8 V ac: $\pm 0.1\%$ (0.8 to 2000) $\pm 0.25\%$ (2001 to 4000) $\pm 0.35\%$ (4001 to 8000)
	40 V ac: $\pm 0.1\%$ (0.8 to 2000) $\pm 0.15\%$ (2001 to 4000) $\pm 0.3\%$ (4001 to 10,000) $\pm 0.35\%$ (10,001 to 25,000)
	80 V ac: $\pm 0.1\%$ (0.8 to 2000) $\pm 0.15\%$ (2001 to 4000) $\pm 0.25\%$ (4001 to 10,000) $\pm 0.30\%$ (10,001 to 45,000)
Resolution	5 digit for all ratios
PC/Printer interface	
TTR300	Not applicable
TTR310	RS232 port
TTR320	RS232 port
TTR330	USB
interface	
TTR300 and TTR310	RS232 port
TTR320 and TTR330	Ethernet
Safety/EMC/Vibration	
Meets the requirements of IEC1010-1, CE and ASTM D999.75	
Environmental	
Operating temperature	-5 °C to 50 °C (23 °F to 122 °F)
Storage temperature	-50 °C to 60 °C (-58 °F to 140 °F)
Humidity	0 to 90% non-condensing
Measuring time	8 to 20 seconds depending on mode of operation and type of transformer
Measuring method	ANSI/IEEE C57.12.90
Mechanical data	
Dimensions (H x W x D)	216 x 546.1 x 330.2 mm. (8.5 x 21.5 x 13 in)
Weight (instrument only)	TTR300: 9.1 kg (20 lbs) TTR310: 10.4 kg (23 lbs) TTR320: 11.3 kg (25 lbs) TTR330: 11.3 kg (25 lbs)

<p>FEATURES AND BENEFITS GUIDE</p> <p>■ feature □ option</p>	 TTR300	 TTR310	 TTR320	 TTR330
Field upgradeable/interchangeable to any other TTR in the series without compromising calibration (patent pending)	■	■	■	■
Remote controllable	■	■	■	■
Works in the presence of high interference/high voltage	■	■	■	■
Displays % error vs. name plate with pass/fail limits	■	■	■	■
Measures the widest turns ratio range in the industry (45,000:1) and provides the highest accuracy (0.1%)	■	■	■	■
Enables operator to enter the ratio of transformer and all of its taps letting operator know immediately when a tap is outside acceptable limits so problem can be flagged	■	■	■	■
Equipped with "Remote TEST" switch for single person testing, allowing the operator to test transformers with "LTCs" very quickly	■	■	■	■
Measures phase deviation of the transformer primary versus secondary; quickly indicates problems in the transformer such as partial shorted turns and core faults. Useful in verifying phase errors in PTs and CTs	■	■	■	■
Rugged, lightweight design ideal for a harsh field and substation environment	■	■	■	■
User selectable standards: ANSI, IEC, and Australian. Meets IEC 1010 and other standards such as CSA and UL	■	■	■	■
"Quick Test" mode provides a fast determination of turns ratio for single- and three-phase transformers	■	■	■	■
Units can be operated while in transit case	■	■	■	■
Leads can stay connected while in transit case	■	■	■	■
Printing of test results without the use of a computer		4" thermal spool paper	4" thermal spool paper	8.5" x 11" thermal paper
Software				
PowerDB LITE		■	■	■
"PowerDB ONBOARD" allows for operation of the unit through on-screen customizable test forms (patent pending)				■
Full version PowerDB	□	□	□	□
Communications port				
Printer interface		RS-232	RS-232	USB
Internal data storage (data sets)		200	100,000	100,000
External storage device			USB	USB
Computer interface	RS-232	RS-232	Ethernet	Ethernet
User interface				
Display type		5.7" B&W	5.7" color VGA	8.4" color VGA
On-screen view		Text	Graphical icons	Test forms
Keypad		Numeric	QWERTY	QWERTY

Three-Phase transformer turns ratio test sets

ORDERING INFORMATION

Product	Order Code	Product	Order Code
Three-Phase TTR, remote controlled	TTR300	Optional accessories	
Three-Phase TTR, stand alone or remote controlled	TTR310	PowerDB software, 1st machine license, soft key	DB1001
Three-Phase TTR, graphical user interface	TTR320	PowerDB, 1st machine license, USB dongle	DB1001S
Three-Phase TTR with PowerDB ONBOARD	TTR330	TTR check box	550555
<i>Note: 120 V 50/60-Hz operation standard. For 230 V, 50/60-Hz operation Add -47 to Cat. No.</i>		3- ϕ lead set adapter to allow use of Megger TTR C/N 550503 lead set (30915-xxx)	37087
Included accessories		3- ϕ TTR calibration standard	550055
Canvas carrying bag for test leads	30915-211	3- ϕ shielded test lead set, X and H winding, 9.1 m (30 ft)	37093
Power supply cord, 2.5 m (8 ft), 120 V	17032-4	3- ϕ shielded test lead set, X and H winding, 15 m (50 ft)	37094
Power supply cord, 2.5 m (8 ft), 230 V	17032-13	1- ϕ shielded test lead set, X and H winding, 9.1 m (30 ft)	37095
Ground lead, 4.6 m (15 ft)	4702-7	Inverter with 0.91 m (3 ft) cigarette adapter cord	
Hand-held TEST switch assy for remote operation	30915-220	12 V dc to 120 V ac, 60 Hz	35271-1
PowerDB LITE software		12 V dc to 120 V ac, 50 Hz	35271-3
RS232 cable for connecting to a PC for use with TTR300, TTR310 and TTR320	CA-RS232	12 V dc to 230 V ac, 60 Hz	35271-2
Ethernet cable for connecting to a PC for use with TTR320 and TTR330	36798	12 V dc to 230 V ac, 50 Hz	35271-4
Bushing clips (6)	MC7144	TTR printer package for TTR310, TTR320 120 V, 60 Hz	1001-390
Transformer Vector Voltage Diagram Set (for ANSI, IEC, and AS Standards) for TTR310	35314	230 V, 50 Hz	1001-401
Spare fuse kits:		USB portable thermal printer (120 V) for TTR330	36493-1
for TTR300 and TTR310	35026-3	USB portable thermal printer (230 V) for TTR330	36494-1
for TTR300-47 and TTR310-47	35026-4	Thermal paper (8.5" x 11") for printer	36809-1
for TTR320 and TTR330	35026-5	Thermal paper (A4) for printer	36809-2
for TTR320-47 and TTR330-47	35026-2	Replacement/spare battery pack for printer	37077
Instruction manuals:		Transit case (for instrument, leads and accessories)	37009
for TTR300	AVTMTTR300	Field upgrade kits	
for TTR310	AVTMTTR310	TTR330 interface panel	37089-1
for TTR320	AVTMTTR320	TTR320 interface panel	37089-2
for TTR330	AVTMTTR330	TTR310 interface panel	37089-3
		TTR300 interface panel	37089-4

SPECIFICATIONS

Input	100 to 265 V, 1 \emptyset , 50 or 60 Hz, 15 A max.
Output	0 to 40 V at 2.0 A max (5 minute on 15 minute off) 0 to 40 V at 5 A max for burden test 0 to 160 V at 2.0 A max (5 minute on 15 minute off) 0 to 800 V at 1.5 A max (3 min on, 15 min off) 0 to 1600 V at 1.0 A max (3 min on, 15 min off)
Continuously variable in four ranges:	
Instrumentation	
Voltmeters	
Output	4 $\frac{1}{2}$ digit, auto ranging
Resolution:	0.0000 to .9999/19.999/199.99/1999.9
Ranges:	0 to 40/160/800/1600 V
Accuracy:	$\pm 0.5\%$ of reading, and $\pm 5\%$ range typical $\pm 1\%$ of reading and ± 1 V maximum
Input	4 $\frac{1}{2}$ digit, auto-ranging
Ranges:	0 to 2/600
Resolution:	0.0000 to 1.9999/19.999/199.99/600 V
Accuracy	
2 V Range:	$\pm 0.5\%$ of reading and $\pm 0.25\%$ range
600 V Range:	$\pm 0.5\%$ of reading and $\pm 0.5\%$ range
Ammeter	
Range:	0.0000 to 1.0000A/5.000
Accuracy:	$\pm 0.85\%$ of reading and ± 1 LSD
Phase angle	
3 digits	
Range:	0 to 360 degrees
Accuracy:	± 1 degree* (*at nominal voltage)
Ratio	
Range	0.8 to 5000
Accuracy	$\pm 0.4\%$ typical $\pm 0.8\%$ maximum
Ratio test frequency	55 Hz internally generated providing a universal 50/60Hz test set
Winding resistance	
Measuring range	.01 Ω to 99.9 Ω
Accuracy	<9.99 Ω $\pm 3\%$ of reading ± 2 digits <99.9 Ω $\pm 5\%$ of reading ± 2 digits
Insulation test	
Test voltage:	1000 VDC, 500 VDC
Measuring range:	10 k Ω – 999 M Ω
Short circuit current:	1.5 mA nominal
Test current on load:	1 mA at min. pass values of insulation (as specified in BS7671, HD 384 and IEC 364)
Accuracy:	$\pm 3\%$, ± 2 digits up to 10 M Ω $\pm 5\%$, up to 100 M Ω $\pm 30\%$ up to full scale
Communication interfaces	Ethernet/USB
Specifications continued	



MCT1600B

- One button automated test: Demagnetization, on multi-ratio CTs test all Knee Point, Saturation, Polarity, Winding Resistance, Burden, and Insulation Resistance
- Displays multiple instantaneous Saturation Curves with Knee Point
- Integrated 1 kV DC insulation test system
- Color daylight viewable graphical display
- "Save & Print Later" with USB stick
- Fast data entry using full QWERTY keyboard
- 1600 VAC Saturation Test Voltage
- Automatic or manual testing selectable

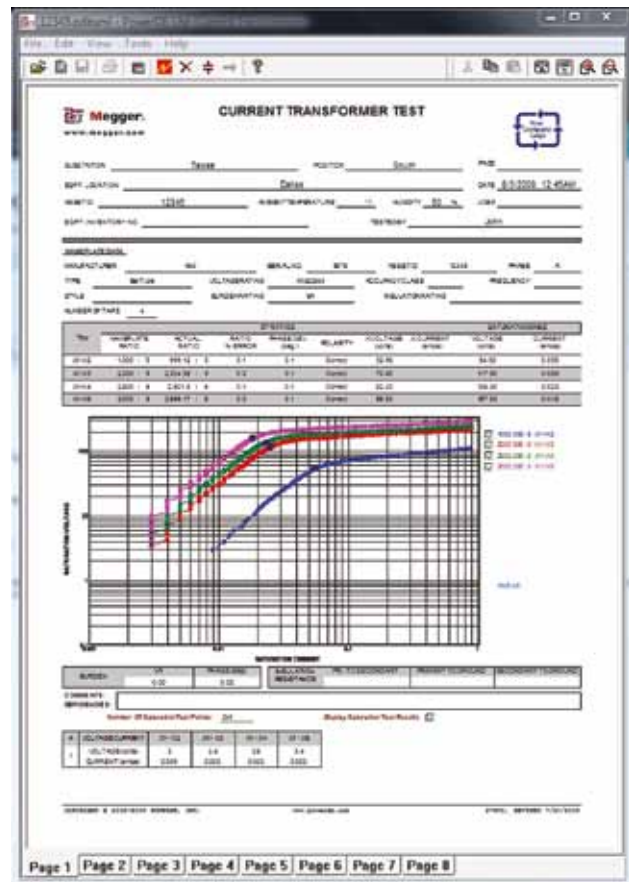
Description

The Megger MCT1600B test set is a lightweight, robust, portable unit used to automatically or manually perform saturation, ratio, polarity, burden tests and insulation tests on current transformers. The MCT provides a microprocessor controlled variable voltage output and precision instrumentation for automatically testing single and multi-ratio CTs. The MCT1600B possesses microprocessor controlled output voltage with precision instrumentation and storage, reducing testing time and increasing productivity. The MCT1600B has a large display, permitting the user to easily read all pertinent data while the test is being performed and providing the ability to view the current transformer's saturation curve.

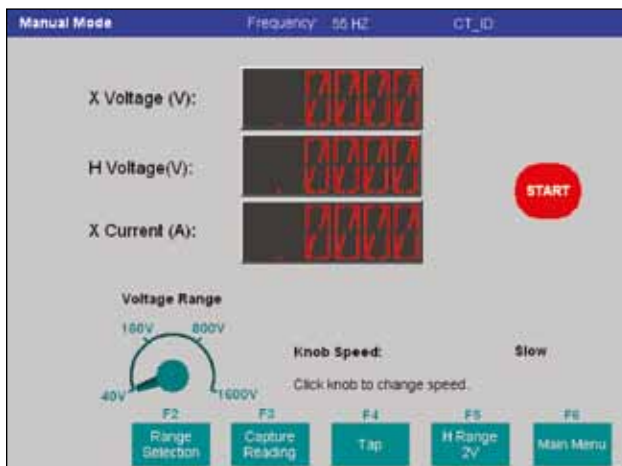
Environment	
Operating:	-10 °C to 40 °C
Storage:	-30 °C to 70 °C
Enclosure	The unit is housed in a rugged enclosure suitable for use in outdoor substations.
Standards	IEC 61010, CSA 22.2, CE
Dimensions	190 H X 489 W X 940 D mm (7.5" H X 19.25" W X 15" D)
Weight	21.6 kg (47.6 lb)



Saturation Curve and all test results displayed at a glance.



Complete report generation with PowerDB Lite



Manual testing screen.

ORDERING INFORMATION

Product	Order Code
MCT1600B Automatic Current Transformer Saturation, Ratio and Polarity Test set	MCT1600B
Included accessories	
Line cord, North American (1 ea)	620000
Line cord, International color coded wire (1 ea)	15065
Test lead, H1 & H2, 40 ft, (1 ea)	620148
Test Lead, X red, 20ft., (1ea.)	620149
Test Lead, X black, 20ft., (1ea)	620150
Gnd lead, green with yellow, with large ground clip, 20ft., (1ea)	620151
Large test clip, red, 40mm opening, (1ea.)	640266
Large test clip, black, 40mm opening, (1ea.)	640267
Alligator clip, red, 4.1 mm, (1ea.)	684006
Alligator clip, black, 4.1 mm, (1ea.)	684007
Soft side lead case	90000-165
USB memory stick	830029
Instruction book	80796
PowerDB Lite	DB0001
Optional accessories	
Transit Case	2001-535

SPECIFICATIONS

INPUT	100 to 265 V, 1ø, 50 or 60 Hz, 15 A max.
OUTPUT	0 to 40 V at 2.0 A max (5 minute on 15 minute off) 0 to 40 V at 5 A max for burden test 0 to 160 V at 2.0 A max (5 minute on 15 minute off) 0 to 800 V at 1.5 A max (3 min on, 15 min off) 0 to 1600 V at 1.0 A max (3 min on, 15 min off)
Continuously variable in four ranges:	

INSTRUMENTATION

Voltmeters

Output	4½ digit, auto ranging
Resolution:	0.0000 to .9999/19.999/199.99/1999.9
Ranges:	0 to 40/160/800/1600 V
Accuracy:	±0.5% of reading, and ±.5% range typical ±1% of reading and ±1 V maximum
Input	4½ digit, auto-ranging
Ranges:	0 to 2/600
Resolution:	0.0000 to 1.9999/19.999/199.99/600 V

Accuracy

2 V Range:	±0.5% of reading and ±0.25% range
600 V Range:	±0.5% of reading and ±0.5% range

Ammeter

Range:	0.0000 to 1.0000 A/5.000
Accuracy:	±0.85% of reading and ±1 LSD

Phase Angle

3 digits

Range:	0 to 360 degrees
Accuracy:	±1 degree* (*at nominal voltage)

Ratio

Range	0.8 to 5000
Accuracy	±0.4% typical ±0.8% maximum

Ratio Test Frequency

55 Hz internally generated providing a universal 50/60Hz test set

Winding Resistance

Measuring Range	.01 Ω to 99.9 Ω
Accuracy	<9.99 Ω ±3% of reading ±2 digits <99.9 Ω ±5% of reading ±2 digits

Insulation Test

Test Voltage:	1000 VDC, 500 VDC
Measuring Range:	10 kΩ – 999 MΩ
Short Circuit Current:	1.5 mA nominal
Test Current on Load:	1 mA at min. pass values of insulation (as specified in BS7671, HD 384 and IEC 364)
Accuracy:	±3%, ±2 digits up to 10 MΩ ±5%, up to 100 MΩ ±30% up to full scale

Communication Interfaces

Ethernet/USB



MCT1605

- One button automated test: Demagnetization, on multi-ratio CTs test all Knee Point, Saturation, Polarity and Deviation, Winding Resistance, Insulation Resistance, and Burden
- Displays multiple instantaneous Saturation Curves with Knee Point
- Integrated 1 kV DC insulation test system
- Color daylight viewable graphical display
- "Save & Print Later" with USB stick
- Fast data entry using full QWERTY keyboard
- 1600 VAC Saturation Test Voltage
- Automatic or manual testing selectable

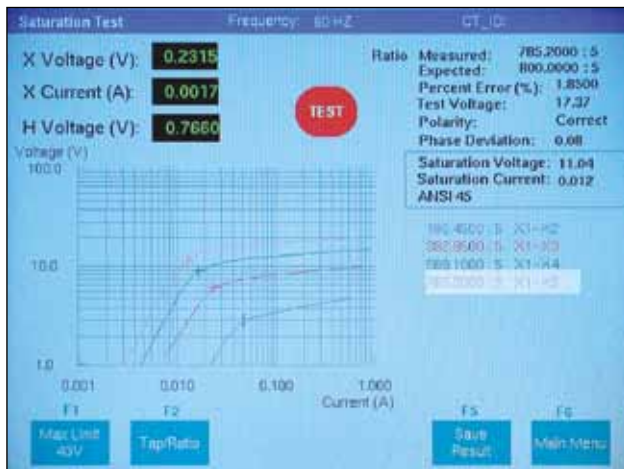
Description

"The MCT1605 test set is a lightweight, robust, portable unit used to automatically or manually perform saturation, ratio, polarity, demagnetizing tests and insulation tests on current transformers. It provides a controlled variable voltage output for automatically testing single and multi-ratio CTs.

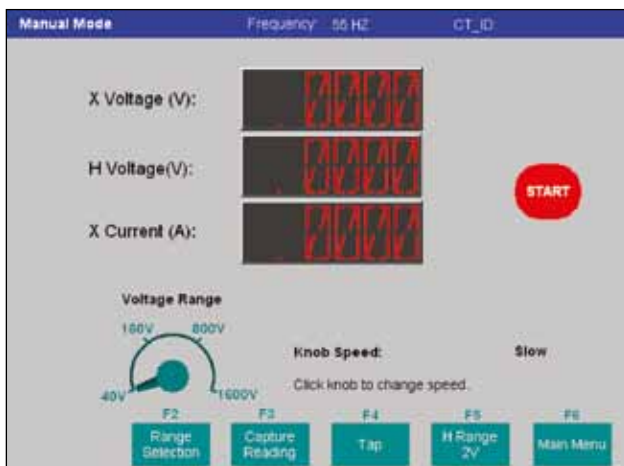
Specifications continued

Environment

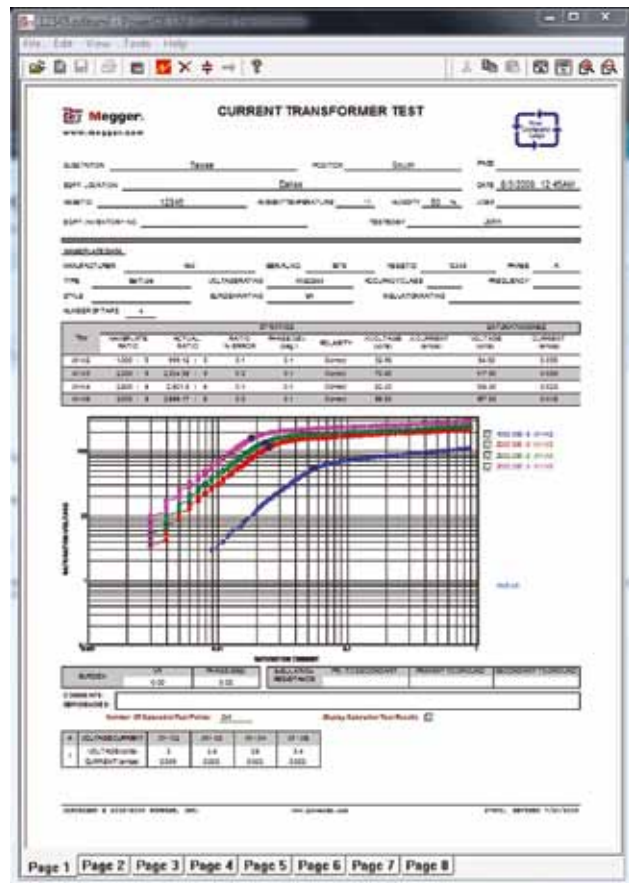
Operating Storage	-10 °C to 40 °C -30 °C to 70 °C
Enclosure	The unit is housed in a rugged enclosure suitable for use in outdoor substations.
Standards	IEC 61010, CSA 22.2, CE
Dimensions	190 H X 489 W X 940 D mm (7.5" H X 19.25" W X 15" D)
Weight	21.6 kg (47.6 lb)



Saturation curve and all test results displayed at a glance.



Manual testing screen.



Complete report generation with PowerDB Lite

ORDERING INFORMATION

Product	Order Code	Product	Order Code
MCT1605 Multi-Tap Automatic Current Transformer Saturation, Ratio and Polarity Test Set	MCT1605	Alligator clip, red, 4.1mm, (1 ea)	684006
Included accessories		Alligator clip, white, 4.1mm, (1 ea)	90000-882
Line cord, North American (1 ea)	620000	Alligator clip, green, 4.1mm, (1 ea)	90000-883
Line cord, International color coded wire (1 ea)	15065	Alligator clip, yellow, 4.1mm, (1 ea)	90000-884
Test lead, H1 & H2, 40 ft, (1 ea)	620148	Alligator clip, blue, 4.1mm, (1 ea)	90000-885
Test lead, X red, 20 ft, (1 ea)	2000-753	Soft side lead case	90001-165
Test lead, X green, 20 ft, (1 ea)	2000-747	USB memory stick	830029
Test lead, X yellow, 20 ft, (1 ea)	2000-748	Ethernet crossover cable (1 ea)	620094
Test lead, X blue, 20 ft, (1 ea)	2000-749	Instruction book	80513
Test lead, X white, 20 ft, (1 ea)	2000-746	PowerDB Lite	DB0001
Ground lead, green with yellow, with large ground clip, 20 ft, (1 ea)	620151	Optional accessories	
Large test clip, red, 40mm opening, (1 ea)	640266	Printer USB, battery operated, (1 ea)	830030
Large test clip, black, 40mm opening, (1 ea)	640267	PowerDB, 1st copy with USB key	DB1001S
		Transit case	2001-535

MAGNUS

- Quick and easy preparation of excitation curves for instrument transformers
- Demagnetize current transformer cores
- Conduct turn-ratio tests on voltage transformers
- Two-hand control enhances personal safety

Description

When power systems are put into operation or when faults occur, it becomes necessary to check the instrument transformers to make sure that they are providing test instruments and protective relay equipment with the correct outputs.

MAGNUS™ permits you to prepare excitation curves for instrument transformers quickly and easily.

MAGNUS is also used to demagnetize current transformer cores and to conduct turn-ratio tests on voltage transformers. Even though it weighs only 16 kg (35 lbs), it provides 1 A at 2.2 kV. Two-hand control enhances personal safety.

As standard, MAGNUS is delivered with a special high-voltage cable and a robust transport case.



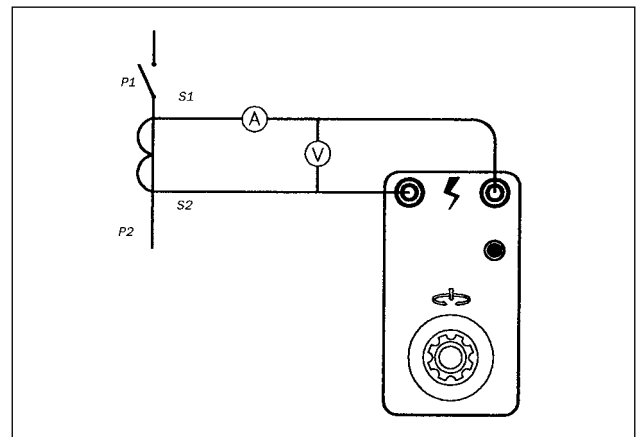
Application example

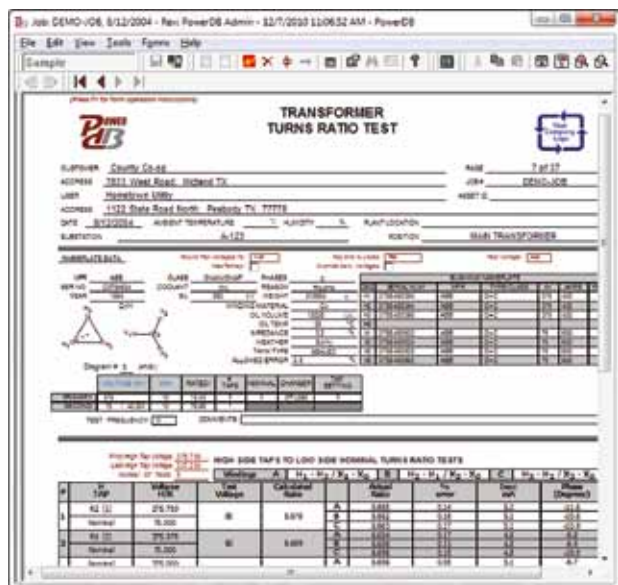
IMPORTANT

Read the user manual before using the instrument.

Prepare an excitation curve

1. Connect MAGNUS to the secondary side of the current transformer being tested and also to an ammeter and voltmeter.
2. Increase the voltage with the dial.
3. Jot down the values of U (voltage) and I (current).
4. Repeat steps 2 and 3 until the current (I) rises sharply without any significant rise in voltage (U).
5. Conclude the test by reducing U (voltage) slowly to zero, thereby providing demagnetization.





MCT1605

- Windows-based PC software available in four versions
- Interfaces to instruments via either Serial RS232, Ethernet, or USB flash drive (depending on instrument)
- Allows user to set up test routines in advance of testing
- Allows analysis, comparison and trending of data
- Merge test results between field and office databases
- Customize reports for professional data presentation

Description

PowerDB is a powerful software package providing data management for each of your acceptance and maintenance testing jobs. Data can be imported from various sources, acquired directly from test instruments, or entered manually. Test results for all electrical apparatus are synchronized to your company's central database. Result and summary reports can be easily generated. PowerDB provides a simple and consistent user interface to many Megger instruments including the DELTA2000, DELTA3000 and DELTA4000 Power Factor Test Sets, 3-Phase TTR, earth testers and 5 and 10 kV insulation testers.

Full database capabilities

- Test results are brought together into a single database file for easy retrieval and review.
- An entire organization's results can be synchronized into a single database, scalable to Microsoft SQL Server.
- One-step report generation maximizes timeliness and facilitates NeRC/FeRC compliance audits.
- Easily trend results over time and compare to all other similar assets.
- Track maintenance intervals and generate work orders for scheduled retests.
- Merge results from multiple test instruments with data imports from other sources to facilitate queries and sorting.
- Maintain calibration data for test instruments.

Optional Add-ons

PowerDB Web Server

Any user can log in by providing a user name and password. They are then able to view each of their jobs, while other jobs are hidden from view. Job equipment information is presented in a tree hierarchy similar to how it is presented in PowerDB. Test reports of recent or historical data for any piece of equipment can be viewed individually. The PowerDB Web Server also allows you to deliver any other electronic documents that you submit for a job, such as a job-documentation package.

Microsoft SQL Server Upgrade

The SQL Server upgrade functions identically to the Access version but supports larger databases and provides a substantial performance increase. PowerDB can seamlessly interact with Access field databases and SQL master databases.

On Site Training

A two day training course can be provided at your facility. Training includes data entry, trending, report generation, data synchronization and forms design.

CMMS Integration

For a flat fee, a PowerDB programmer will aid you in integrating a data exchange service between PowerDB and your CMMS system (or any other system). This service includes up to one week of on-site integration.

COMPARISON GUIDE	PowerDB Version			
	ONBOARD	LITE	ADVANCED	PRO
Runs in a hardened embedded environment	■			
Navigate with arrow and enter keys (no mouse)	■			
Manage data files with internal drive and USB drive	■			
Uses a subset of PowerDB Pro forms applicable to your instrument	■	■		
Files can import into PowerDB Pro	■	■	■	
Relay/Breaker/Recloser curve library	■	■	■	■
Completed forms are saved as files to your computer	■	■	■	■
Associates current test data with historical results	■	■	■	■
Control Megger instruments and download test data		■	■	■
Control non-Megger instruments			■	■
280+ industry standard test forms are provided			■	■
Advanced Relay Form			■	■
Trend historical results for asset for predictive failure analysis			■	■
Trend historical results for asset against other similar assets				■
Database functionality to manage data for all electrical equipment				■
One step report generation				■
Summarize noted comments and/or deficiencies				■
Trigger work order and maintenance schedules				■
Synchronize results from field to master database				■
Synchronize results with other testers				■
Form editor allows test sheets to be created or customized				■
Import data from other software packages				■
Maintain calibration data for test instruments				■

RECOMMENDED PC SYSTEM REQUIREMENTS

Windows® 7/XP/Vista. 2 GHz PC with 2GB RAM

PowerDB is a trademark of PowerDB, Inc., a subsidiary of Megger

ORDERING INFORMATION

Product	Order Code	Product	Order Code
PowerDB Pro Software – 1st copy	DB1001	PowerDB Pro Custom Forms – per page	DB2001
PowerDB Pro Software – 1st copy w/USB	DB1001S	PowerDB Pro CMMS Integration	DB2002
PowerDB Pro Software – 2-5 each copy	DB1002	PowerDB Software Training	DB3000
PowerDB Pro Software – 2-5 each copy w/USB	DB1002S	PowerDB Advanced Software	DB1011
PowerDB Pro Software – 6+ each copy	DB1003		
PowerDB Pro Software – 6+ each copy w/USB	DB1003S		
PowerDB Pro Web Server	DB1004		
PowerDB Pro SQL Server Version	DB1005		

Specifications

Specifications are valid at nominal input voltage and an ambient temperature of +25 °C, (77 °F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating 0 °C to +50°C (32 °F to +122 °F)

Storage & transport -40 °C to +70 °C (-40 °F to +158 °F)

Humidity

5% – 95% RH, non-condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

General

Mains voltage 115/230 V AC, 50/60 Hz

Power consumption 2300 VA (max)

Protection Thermal cut-outs

Dimensions

Instrument 356 x 203 x 241 mm
(14" x 8" x 9.5")

Transport case 610 x 290 x 360 mm
(24" x 11,4" x 14,2")

Weight

16.3 kg (35,9 lbs)
26.7 kg (58.9 lbs) with accessories and transport case

High voltage cables

2 x 5 m (16.4 ft) / 1,5 mm², 15 kV

Measuring outputs

Voltage 100/1, (max load of 1 MΩ)

Inaccuracy ±1,5%

Current 10/1

Inaccuracy ±1,5% at 2 A output current
±3% at 0,5 A output current

Outputs

Voltage outputs, AC

230 V mains voltage

(I) High voltage output ¹⁾ 0 – 2200 V AC

(II) Variable transformer, not isolated from mains ¹⁾ 0 – 250 V AC

Voltage	Current	Max. load time	Rest time
2200 V AC	1 A	30 s ²⁾	10 minutes ²⁾
250 V AC	6 A	Continuous	–

115 V mains voltage

(I) High voltage output ¹⁾ 0 – 2000 V AC

(II) Variable transformer, not isolated from mains ¹⁾ 0 – 110 V AC

Voltage	Current	Max. load time	Rest time
2000 V AC	1 A	30 s ²⁾	10 minutes ²⁾
110 V AC	10 A	Continuous	–

1) The outputs I and II must not be loaded at the same time.

2) The load time and rest time for the high voltage output is calculated at the maximum output voltage and current. During an excitation test the voltage and current is only at their maximum level at the end of the test.



Cable set GA-00090

ORDERING INFORMATION

Product	Order Code
---------	------------

MAGNUS

Complete with:
Cable set GA-00090
Transport case GD-00182

115 V mains voltage	BT-11190
230 V mains voltage	BT-12390



Optional capacitor kit includes carry case, TTR capacitor (left), and 2 reference capacitors (center). Also shown are 2 connectors (right) that will work with the capacitors and are supplied with the DELTA2000 unit.



The optional Oil Test Cell, C/N 670511, is used for testing insulating fluids up to 10 kV.



The optional accessory kit, C/N 670501 includes mini bushing tap connectors, hot collar straps, temperature/humidity meter, .75" bushing tap connector, 1" bushing tap connector, "J" probe bushing tap connector, 3-ft non-insulating shorting leads, 6-ft non-insulating shorting leads.



Optional TTR300D module, for LV three-phase TTR testing, installed inside DELTA HV cabinet. (Lid not shown for clarity.) Via PowerDB software, TTR testing is in accordance with Megger TTR300 product specifications. External laptop is easily placed on top surface of module for added convenience.



Optional bar code wand for recording an alphanumeric test identification.



The optional Calibration Standard traceable to the NIST for quick operating or calibration checks of test set bridges calibrated in watts loss or in dissipation factor.



Power cable test

Power cable fault locating and testing takes on a whole new dimension with the modular cable fault locating concept from Megger. We have geared our development to the industry requirements for a more tempered fault locating method and have developed more sophisticated methods that reduce the stress on insulation systems.

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SELECTION GUIDE

■ feature □ option	PFL40A-1500/200	PFL22M 1500	CFL40A 1500/2000	MTDR	L1050	L1070/1071	MPP1000	SPLIT-BOX PIPE
Mobile cable fault	■	■						
Van mounted cable fault equipment			■					
Engerised and de-engerised cable locator								■
Portable locator					■	■		
Single phase time domain reflectometer				■				
8/16 kV, 1500 joules surge	■	■						
8/16/34 kV, 1500 joules surge	■							
8/16/34 kV, 2000 joules surge		■	■					
4 kV range	□	□	□					
Arc reflection method	■	■	■	■				
Arc reflection plus	■	■	■					
Impulse current	■	■	■	■				
Voltage decay	□	□	□					
Integrated TDR	■	■	■					
Integrated and redesigned TDR	■	■	■					
DC testing up to 40 kV	■	■	■					
Proof/burn up to 34 kV	■	■	■					
Proof/burn up to 20 kV								
IP54 with top cover closed	■	■	■	■				
Fault detection up to 50 m								
Ambient noise reduction headphones							■	
Acoustic signal level indicator							■	
Background interference elimination via selectable acoustic frequency band							■	
Multiple frequencies					■	■		
Transmits AF or RF signals or both simultaneously					■	■		
Peak and null detection					■	■		
Passive 50/60 Hz						■		
Measures current flow in buried conductors						■		
Transmitter variable output power levels						■		
Push-button depth measurements up to 5 m						■		
Conductive or inductive tracing					■			
Two channel receiver				■				

Cable testing on the road

By its very nature, cable fault location often needs to be carried out at remote sites, and even the most modern of cable fault locators could hardly be described as lightweight or easily portable. The solution is to install fault location equipment in a suitably adapted road vehicle, so that it can be driven direct to the site where it's needed, and be ready for immediate use.

To satisfy the need for vehicle-mounted fault location equipment, Megger offers a range of options. Customers can, if they wish, supply their own vehicle and Megger will install equipment to suit individual requirements. Alternatively, Megger can supply equipment for customers to fit themselves. The final option is for Megger to supply a vehicle ready fitted with cable testing equipment.

In every case the cable fault location equipment supplied will be based on products from Megger's PFL20 and PFL40 families. These test sets are designed specifically to aid rapid, accurate location of cable faults in a wide range of power distribution cables, thereby cutting costly downtime.

PFL20 testers offer DC proof testing at up to 20 kV with energies up to 1,500J, while the PFL40 models offer proof testing at up to 40 kV and energies up to 2,000J. To ensure fast and convenient operation, the integral power supply can recharge the testers to full energy and voltage in as little as two seconds.

PFL20 and PFL40 cable fault locators feature a high-voltage DC test set, complemented by a time domain reflectometer (TDR). The DC test set can be used to prove the integrity of cable networks or to confirm faults, and an operator-selectable overcurrent trip is incorporated to protect the system under test in the event of a cable breakdown.

Fault pre-location can be achieved using the TDR in standard pulse echo mode, or by the arc reflection, impulse current or voltage decay methods. To optimize performance in arc reflection mode, the units incorporate inductive filters that enable maximum energy to be delivered to the fault.

The TDR can also be used as a transient analyser. It resolves current transients with the aid of the builtin current coupler, and voltage transients by using the external voltage decay coupler. In addition, the testers support acoustic pinpoint fault location, using their high voltage, high-energy surge generators.

For intermittent or unstable faults, PFL20 and PFL40 testers offer a choice of fault conditioning features. In proof/burn mode, after cable breakdown has occurred, the units apply a high current that stabilizes the fault, making it much easier to locate.

Alternatively, the arc reflection method can be used to establish a temporary bridge to earth, enabling standard pulse echo location techniques to be used.



What do you do with a cable fault that won't "THUMP"?

When you work in the role of technical support you tend to get exposed to some very challenging situations. When an Engineer throws in the towel and picks up his mobile to ask for help you know that he has exhausted all options. After all 'real' men don't stop to ask for directions!

One of the typical challenges that Megger receives from its customers is the elusive cable fault that will not 'thump' to pinpoint the fault. This is often a problem with faults within a splice, blow-outs with either burnt back conductors or neutrals and bolted (solid short) faults.

In all three situations the problem lies within the gap distance between the conductor and neutral.

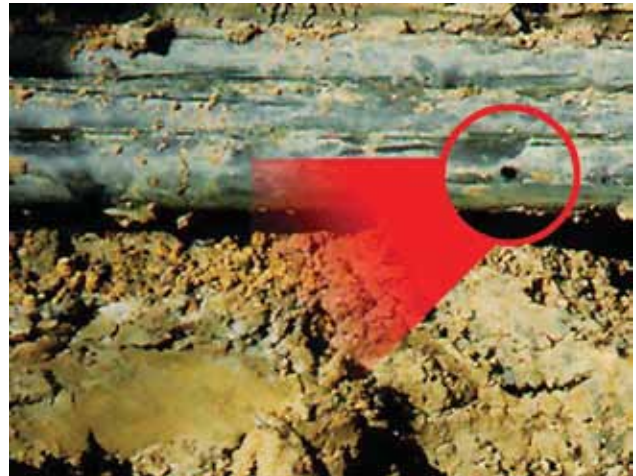
The sole basis of pinpointing and high voltage radar techniques is to create an arc or high voltage breakdown at the point of the fault. The breakdown that is established reduces the impedance of the fault allowing the cable radar to reflect a pulse off the arc that is produced. In the case of splice faults or burnt-back conductors or neutrals, the distance between the conductor and neutral (gap) may be excessive.

When a proof test or high potential test is performed the meters indicate a fault to ground; excessive leakage current and low to no voltage can be sustained. This test confirms that the cable is faulted by the measurement of excessive leakage current, but does not indicate the condition of the gap that the surged voltage must bridge.

When performing an Arc Reflection test a reflection from the fault is never captured because a suitable arc cannot be established across the excessive gap. In the situation of a cable fault that won't "THUMP", a bolted fault or a solid short the problem is that there is NO gap. When this fault is surged we experience a rush of current through the short circuit, but no arc and therefore no 'thump'.

So how are these elusive faults found? The first task is to localise the fault. The Megger MTDR is a very powerful tool with many tricks up its sleeve.

If the problem is a bolted fault (solid short), the MTDR Time Domain Reflectometer will clearly show a negative reflection at the point of the failure. Simply measure the distance to this reflection to obtain an approximate location of the failure. A blow-out (open circuit) will produce a significant positive reflection. Simply measure to this event to localise the fault. The splice is more challenging.



If the Arc Reflection technique does not render results, the MTDR can also perform the Surge Pulse (Impulse Current) fault locating technique. This technique takes full advantage of the thumper discharged energy and will typically produce results even with excessive gaps.

How do you pinpoint a fault that will not thump?

The fault can be pinpointed by using the receiver portion of a cable locator/tracer kit much like the Megger L1070. Apply breakdown surges with a surge generator, like the Megger PFL40. At the point of the fault the peak deflection measured on the tracer's receiver will jump off scale. Now that's a neat trick!

If you need a...

time domain reflectometer (TDR) suitable for testing communication equipment, see our Industrial Test and Contracting Catalogue.

PFL40A 1500/2000

Portable cable fault location

Megger



PFL40A 1500/2000

- Compact, portable fault locating systems
- HV insulation testing to 40 kV
- Proof/burn up to 34 kV
- 8/16/34 kV, 1500 Joules surge output
- Arc Reflection Method
- Integrated large screen colour TDR

Description

The prime objective of any cable fault location system is to provide quick, effective, accurate and safe fault location, thereby reducing system outages and "customer minutes lost."

The complete family of compact Megger cable fault locating systems are designed to meet this criterion. These new systems are seen as a valuable extension to our existing range of CFL instruments and capabilities.

The standard system is a mobile compact system that can be further customised by the customer to meet local requirements. All systems offer the facility to undertake cable testing; cable and fault diagnosis; pre-location of cable faults; fault conditioning; pinpoint location using acoustic methods.

SPECIFICATIONS

Testing

Output	0 - 4 kV (negative wrt earth) 25 mA constant
Resolution	1 mA
Trip	Adjustable current trip
Metering	Analogue and digital metering of current and voltage

Pre-location low voltage

MTDR

Range	60 m - 50 km
Pulse width	40, 80, 160, 320, 640 ns 1, 2, 5, 10 μ s, and auto
Display	8 in., full VGA, colour
Cursors	Dual independant control
Gain	Auto and selectable, x1, 2, 3, 4, 5, 10, 20, 50, 100
Input	Impedance 50 Ω
Inputs	1 pulse echo, 1 current impulse/voltage decay
Ports	1 serial, 2 parallel (printer/USB memory device)

High voltage pre-location

Arc reflection	8/16/34 kV 1500 or 2000 Joule 4 kV at 1500 Joules (optional)
ICE	8/16/34 kV 4 kV at 1500 Joules (optional)
Voltage decay	0 - 40 kV (optional)

Fault conditioning

Arc reflection	8/16/34 kV (optional 4 kV)
Proof/burn	0 - 40 kV 0 - 8 kV, 120 mA 0 - 16 kV, 60 mA 0 - 34 kV, 30 mA 0 - 4 kV, 240 mA (optional)

Pinpoint fault location

Surge	0 - 8/16/34 kV 0 - 4 kV at 1500 Joules (optional) 1500/2000 Joules (dependant on model)
Impulse sequence	Adjustable 2 - 12 seconds single shot

Cables

HV	15 m of 70 kV 1-phase EPR
Input/supply	15 m, 8 mm ²
Earth	15 m, 8 mm ²
Earth monitor	15 m

Specifications continued

Environmental

Operating temperature	-20° to +50 °C (-4 °F to 122 °F)
Storage temperature	-20° to +70 °C (-4 °F to 122 °F)
Elevation	1500 m (5000 ft) Derate voltages at higher altitudes
Humidity	50 to 95% RH non-condensing
Supply	110 to 260 V (50/60 Hz) (Must be defined at time of ordering)
Ingress protection	IP54 (with top/back flaps closed)

Mechanical data

Dimensions (H x W x D)	965 mm x 536 mm x 503 mm
Weight	149 kg

ORDERING INFORMATION

Product	Order Code	Product	Order Code
230 V 40 kV dc, 8/16/34 kV at 1500 J surge	PFL40A1500-22	Optional accessories	
As above including safety earth monitor	PFL40A1500-21	External battery (230 V system)	MPS230
230 V 40 kV dc, 8/16/34 kV at 2000 J surge	PFL40A2000-22	External battery (110 V system)	MPS110
As above including safety earth monitor	PFL40A2000-21	Voltage decay coupler	36569
230 V 40 kV dc, 4/8/16/34 kV at 1500 J surge	PFL40A1500-30	Earthing discharge stick	22070-62
As above including safety earth monitor	PFL40A1500-29	Manual and motorised cable drum assembly	See separate datasheet
230 V 40 kV dc, 4/8/16/34 kV at 2000 J surge	PFL40A2000-30	details available on request	
As above including safety earth monitor	PFL40A2000-29		
Other input voltages and languages available	On Request		
Included accessories			
PFF with integral MTRD1	PFL		
High-voltage shielded output cable, 15 m	36566		
Supply cable, 7.6 m	17032-17		
Flexible earth cable, 15 m	19265-15		
Wheel kit and handle assembly	36306/36409		
Cable bag	18313		
Instruction manual	AVTMPFL40		



PFL22M1500

- Portable, rugged fault locating systems
- HV insulation testing to 20 kV
- Proof/burn up to 20 kV, 115 mA
- 8/16 kV, 1500 Joules surge output
- Arc reflection method
- Arc reflection plus

Description

The PFL22M1500 power cable fault locator is designed to provide quick, effective, accurate and safe fault location, thereby reducing system outages and minutes lost.

The instrument comes in a rugged yet portable enclosure. Its IP64 rating makes it suitable for use in even environmentally hostile conditions.

All systems offer the facility to undertake cable testing: cable and fault diagnosis, pre-location of cable faults, fault conditioning, and pinpoint fault location using acoustic methods.

SPECIFICATIONS

Testing

Output	0 - 20 kV (negative with regard to earth) 0 - 10 kV, 115 mA constant 0 - 20 kV, 58 mA constant
Resolution	1 mA
Trip	Adjustable current trip
Metering	Analogue metering of current and voltage

Pre-location low voltage

MTDR100

Range	50 m - 55 km (164 ft - 180,446 ft)
Pulse width	50, 100, 200, 500 ns, 1, 2.5, 10 μ s, and auto
Pulse amplitude	25 V into 50 Ω
Sampling rate	100 MHz
Timbase accuracy	200 ppm
Resolution ($V_p=55\%$)	0.82 m (2.8 ft)
Display	26.4 mm (10.4 in.), full XGA 1024 x 768 colour display
Cursors	Dual independent control
Gain	60 dB range in 5 dB steps
Input	Impedance 50 Ω
Inputs	1 x TDR/ARC, 1 x current impulse
Ports	1 x printer/USB memory device
Software	CAS1 (cable analysis software)

High voltage pre-location

Arc reflection	0-8 and 0-16 kV, 1500 Joule
Digital Arc reflection	0-8 and 0-16 kV, 1500 Joule
Arc reflection plus	0-8 and 0-16 kV, 1500 Joule 1024-16 traces dependent on range
Differential Arc reflection	0-8 and 0-16 kV, 1500 Joule
Impulse current	0-8 and 0-16 kV, 1500 Joule

Fault conditioning

Proof/burn	0-20 kV 58 mA 0-10 kV 115 mA
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Pinpoint fault location

Surge	0 - 8 and 0-16 kV, @ 1550 Joule
Impulse sequence	Adjustable 5 - 30 seconds Single shot

Cables

HV	Detachable 15 m (25 ft) 1-phase flexible shielded cable with HV croc clips
Input/supply	7.5 m (15 ft) 8 mm ² input cable
Earth	15 m (25 ft) 8 mm ² flexible earth cable with vice grips

Safety

Universal AVSM 2 ranges	108 - 132 V ac and 208 - 265 V ac 47 - 63 Hz
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Specifications continued

Environmental

Operating temperature	-20 °C to +50 °C (-4 °F to 122 °F)
Storage temperature	-20 °C to +55 °C (-4 °F to 131 °F)
Elevation	1600 m (Derate voltages at higher altitudes)
Humidity	5 to 95% RH non-condensing
Supply	108 -135 V and 210 - 265 V ac (50/60 Hz)
Ingress protection	IP64 (with top/back flaps closed)

Mechanical data

Dimensions (H x W x D)	965 mm x 536 mm x 503 mm (3 ft x 1.75 ft x 1.65 ft)
Weight	131 kg (290 lb)

ORDERING INFORMATION

Product	Order Code	Product	Order Code
20 kV dc. 8/16 kV @ 1550 Joule surge	PFL22M1500-EN	Optional accessories	
As above but including 12 V inverter	PFL22M1500-INV-EN	HV vice grips	18944-2
Included accessories		120 V battery trolley	MPS120
High voltage shielded output cable 15 m including MC terminations with HV clamps	1001-123	230 V battery trolley	MPS230
Supply cable, 7.5 m (23 ft)	17032	PFL20M transit case	2001-289
Flexible ground cable, 15 m (50 ft)	19265-15	Stand alone battery supply	100-690
Interlock shorting plug	10226-1	Acoustic/electromagnetic receiver	MPP2000
Cable bag	2001-813	Stand alone cable reel assembly	CBL100HV
Instruction manual	AVTMPFL22	NB. Refer to factory for full list of cable reel assemblies	
Software	CAS-1		



CFL40A2000

- Separate HV and control modules
- HV insulation testing to 40 kV
- 8/16/34 kV, 2000 Joules surge output
- 4 kV /1500 Joules range (optional)
- 34 kV Arc Reflection Method and Arc Reflection plus
- Proof/burn up to 40 KV

Description

The CFL40A vehicle mountable cable fault location system has been developed to provide quick, effective, accurate and safe fault location, reducing system outages and "customer minutes lost."

The CFL40A is a valuable addition to the existing range of highly successful, field proven family of cable fault locating systems, available from Megger.

The system comes as two separate modules, making it suitable for mounting in a vehicle or trailer. The HV module contains all of the high voltage elements. Control of all of the HV elements and CFL methods is by a separate control panel, which also houses the large screen colour TDR.

Systems can be supplied as a kit of parts or alternatively we can provide a completely customised kitted out vehicle to your specification.

SPECIFICATIONS

Testing

Output	0 - 40 kV (negative wrt earth) 25 mA constant
Resolution	1 mA
Trip	Adjustable current trip
Metering	Analogue and digital metering of current and voltage

Pre-location low voltage

MTDR

Range	60 m - 50 km
Pulse width	40, 80, 160, 320, 640 ns 1, 2, 5, 10 μ s, and auto
Display	8 in., full VGA, colour
Cursors	Dual independent control
Gain	Auto and selectable, x1, 2, 3, 4, 5, 10, 20, 50, 100
Input	Impedance 50 Ω
Inputs	1 pulse echo, 1 current impulse/voltage decay
Ports	1 serial, 2 parallel (printer/USB memory device)

High voltage pre-location

Arc reflection	8/16/34 kV at 2000 Joules 4 kV at 1500 Joules (optional)
ICE	8/16/34 kV (optional 4 kV)
Voltage decay	0 - 40 kV (optional)

Fault conditioning

Arc reflection	8/16/34 kV (optional 4 kV)
Proof/burn	0 - 8 kV, 120 mA 0 - 16 kV, 60 mA 0 - 40 kV, 30 mA 0 - 4 kV, 240 mA (optional)

Pinpoint fault location

Surge	0 - 8/16/34 kV at 2000 Joules 0 - 4 kV/100 Joules 2000 Joules (dependent on model)
Impulse sequence	Adjustable 2 - 12 seconds single shot

Cables

CFL40A cable set

Environmental

Operating temperature	-20 °C to +50 °C (-4° to 122 °F)
Storage temperature	-20 °C to +70 °C (-4° to 122 °F)
Elevation	1500 m (5000 ft) Derate voltages at higher altitudes
Humidity	50 to 95% RH non-condensing
Supply	110 -260 V (50/60 Hz) (must be defined at time of ordering)
Ingress protection	IP64 (with top/back flaps closed)

Specifications continued

Mechanical data

Dimensions (H x W x D)

HV module	1000 mm x 536 mm x 501 mm
Control module	480 mm x 490 mm x 180 mm

Weight

HV module	145 kg
Control module	9 kg

ORDERING INFORMATION

Product	Order Code	Product	Order Code
3 range 40 kV dc, 8/16/34 kV, 2000 Joule surge	CFL40A2000-23	Optional accessories	
4 range 40 kV dc, 4/8/16/34 kV, 2000 Joule surge	CFL40A2000-31	External battery (230 V systems)	MPS230
Included accessories		External battery (110 V systems)	MPS110
HV module		Voltage decay coupler	3659
Earth safety monitor/interlock		Earthing/discharge stick	22070-62
Control module and integrated MTDR		3 reel cable tree with 50 m of HV cable, 50 m earth/ground cable with ferrules and 50 m of supply cable with no end termination	CBL167HVP
CFL40A cable kit		3 reel cable tree with 50 m of HV cable, 50 m earth/ground cable with ferrules and 15 m of earth monitor lead	CBL167HVE
Interlock shorting plug		4 reel cable tree with 50 m of HV cable, 50 m earth/ground cable with ferrules, 50 m input power cable with no termination and 15 m of earth monitor lead	CBL167HVPE
Cable bag		Other manual and motorised cable drum assemblies available on request	ask for information
Instruction manual			



MTDR1

- Multiple fault locating methods
- Auto-ranging and auto-fault distance modes
- Single-phase, two-channel transceiver
- Compatible with various other surge generators/filters combo
- User configurable velocity tables and adjustable display cursors

Description

The MTDR1 is used for prelocating cable faults utilizing the following methods: pulse echo, arc reflection, differential arc reflection or transient analysis, both voltage and current. The unit is available as a stand-alone, or can be integrated into the Megger PFL auto series line of products. Using the MTDR for prelocation significantly decreases fault locate times by reducing the number of surges required to prelocate. Consequently this reduces the number of surges required to pinpoint. The major benefit is the reduction of the number of surges required to pinpoint on service aged cables. The MTDR is your prime tool in the battle to quickly find your faults. It eliminates the time consuming and damaging process of repeatedly surging your cable in an effort to find faults.

The MTDR performs the following wave capturing methods:

- TDR (pulse echo)
- Arc reflection
- Burn arc reflection (arc stabilization)
- Surge pulse reflection (impulse current)*
- Voltage decay (voltage transient)*

*When integrated into the PFL40 auto series with the appropriate couplers.

When the arc reflection mode is selected, the MTDR features autoranging and auto fault distance. The MTDR offers features that are unique to the market. The flexible interface allows the operator to access any parameter; the large VGA screen provides easily viewed traces, especially in bright or direct sunlight. The built-in USB port allows for transferring traces between the MTDR and a remote computer. The integrated QWERTY keyboard allows you to input and label trace data for archival purposes.

The MTDR can be used as a stand alone unit or integrated into the PFL Auto Series for a full cable fault finding system. The unit is also fully compatible with nearly any surge generator/ filter combo on the market.

The unit allows the operator to select the best prelocation technique based on the characteristics of the fault. It also allows the user to save and create files, and save cursor offsets. The MTDR also allows recall of previously stored traces and superimposition of a stored trace on an active trace. In this mode, the unit will display as many as three traces simultaneously.

SPECIFICATIONS

Operating modes	Arc reflection, surge, voltage decay, TDR
Ranges	64, 165, 323, 649, 1298, 2682, 5364, 10,668, 21,458 m (210, 540, 1060, 2130, 4260, 8800, 17,600, 35,000, 70,400 ft)
TDR pulse widths	40, 80, 160, 320, 640 ns 1, 2, 5, 10 μ s
Sampling rate	50 megasamples/second
Cursors	Selectable format; meters, feet Dual, independent cursors with both positions displayed Differential cursor position displayed
Resolution	1.50 m (5 ft), depending on range and mode
Horizontal zoom	Selectable via front panel controls
Velocity selectable	30 to 100% 295.1 to 983.5 ft/ μ s 90 to 299.7 m/ μ s 147.6 to 491.7 ft/ μ s (Vp/2)

Inputs

Input 1	channel one acquisition (TDR and ARC)
Input 2	channel two acquisition (SURGE and voltage decay)
TDR Pulse amplitude	10 V nominal, into 50 Ω
Gain	1, 2, 3, 4, 5, 10, 20, 50, 100
Input impedance	50 Ω , all inputs
Max. signal input	250 V peak for transients
Display	Transflective colour LCD
Operating system	Window® XP embedded
External interfaces	USB port, serial port
Printer support (USB printer)	Hewlett Packard or others supporting standard HP-PCL (printer control language)
Memory	Stores up to 200 waveforms internally
Power	100 to 240 V ac 50/60 Hz self configuring for stand-alone unit For integrated unit, power is supplied by PFL series

Environmental

Operating temperature	-20 °C to +50 °C (-4 °F to +122 °F)
Storage temperature	-30 °C to +70 °C (-22 °F to +158 °F)
Humidity	95% RH non-condensing

Mechanical data

Dimensions	305 mm x 194 mm x 360 mm (12 in. x 7.6 in x 14.2 in.)
Weight	6 kg (13 lb)

ORDERING INFORMATION

Product	Order Code
Single phase MTDR	MTDR1
Included accessories	
Power supply cord North American (1 ea) European (1 ea)	
Coaxial cable, 3 m (10 ft) (2 ea)	
ComLink software (1 ea)	
BNC (F) to alligator clip adapter (2 ea)	
Ground cable (1 ea)	
RS232 cable (1 ea)	
User guide (1 ea)	

L1050

Portable locator



Resonating inductor

- Multiple frequencies
- Transmits AF or RF signals
- Portable and lightweight
- Conductive or inductive tracing

Description

The L1050 portable locator rivals any path locator at any price. An innovative concept, the receiver is a one-piece design that is lightweight and highly accurate. The superior filtering of the L1050 receiver picks up the transmitted signal easily at waist height, thus eliminating awkward bending.

Operating the receiver at multiple frequencies optimises performance for the specific needs of the user. Low frequency of 815 Hz provides longer range and reduced errors from adjacent cables, ideal for electric power services. High 82 kHz frequency will path locate past bad telephone bonds, locate underground stubs and permit inductive locating with either the optional flexible coupler or direct soil induction.

Applications

Flexibility remains the key strength of reaching difficult, multi-point, grounded utility locating applications. Combining high power at low frequency virtually eliminates the false coupling into adjacent objects and allows the high transmitter power to burn a signal past several grounds and into multiple distributed grounds.

SPECIFICATIONS

Receiver

Operating frequency	815 Hz or 82.135 kHz
Antenna mode	Null responding vertical coil

Battery

Battery type	8 x AA size alkaline cells
Battery life	120 hours

Environmental

Operating temperature	-20 °C to +55 °C (-4 °F to +133 °F)
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Mechanical data

Dimensions (H x W x L)	7.6 x 7.6 x 33 cm (3 x 3 x 13 in.)
Weight	0.568 kg (1 lbs 4 oz.)

Transmitter

Operating frequency	815 Hz or 82.135 kHz
Output power	815 Hz 100 mW 82.315 Hz 100 mW
	Directly coupled 100 mW Inductively coupled 110 mW

Power

Battery type	8 x D size alkaline cells
Battery life	150 hours

Environmental

Operating temperature	-20 °C to +55 °C (-4 °F to +133 °F)
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Mechanical data

Dimensions (H x W x L)	16 x 19 x 43 cm (6.5 x 7.5 x 17 in.)
Weight	2.8 kg. (6 lb 3 oz)



ORDERING INFORMATION

Product	Order Code
L1050 portable locator	651050
Included accessories	
Peaking receiver, transmitter (2 frequencies), red/black cord, batteries and ground rod	
Instruction manual	
Optional accessories	
Flexible coupler (inductive coupler)	651056

SPECIFICATIONS

Transmitter	
Operating frequency	82 kHz, 8 kHz, 815 Hz, and BOTH (815 Hz/82 kHz) simultaneously
Indicators	AC load resistance measurement, low battery indicator, low battery warning modulated on output signal every 20 seconds
Load matching	Automatic from 5 Ω to 2000 Ω
Output power	
815 Hz and 8 kHz	Normal 0.2 W High 1.0 W
82 kHz	Normal 0.12 W +.06 W High 1.33 W +0.67 W
Battery	
Battery type	Disposable (Used on L1070) 8 x 1.5 V D size alkaline Rechargeable (Used on L1071) 12 V, 7 A hour maintenance free, sealed lead acid.
Battery life Disposable	Continuous: 8 to 15 hours depending on load, frequency and power setting. Intermittent: 40 to 60 hours depending on load, frequency and power setting. 25% duty cycle average.
Battery life Rechargeable	Continuous: 10 to 20 hours depending on load, frequency and power setting Intermittent: 50 to 70 hours depending on load, frequency and power setting. 25% duty cycle average.
Environmental	
Operating temperature	-20 °C to +55 °C (-4 °F to +133 °F)
Mechanical data	
Dimensions (H x W x L)	15.2 x 12.7 x 40.6 cm (6.5 x 6.32 x 16 in.)
Weight	3.5 kg (8 lbs) with alkaline D cells 5.2 kg (11.5 lb) with rechargeable batteries
Receiver	
Operating frequency	815 Hz, 8 kHz, 82 kHz, 50/60~(PASSIVE)
Antenna mode	Null responding vertical coil Peak responding horizontal coil
Audio indication	Variable pitch response on all frequencies
Current measurement	
Display indicated relative current simultaneously between any two selected cables for target cable verification in a multi-conductor environment.	
Battery	
Battery type	6 x 1.5 V C size alkaline
Battery life	Continuous: 40 hours Intermittent: 82 hours Auto power shutoff after 10 minutes of nonuse.
Environmental	
Operating and storage temperature	-20 °C to +55 °C (-4 °F to +133 °F)
Mechanical data	
Dimensions (H x W x L)	23.8 x 9.3 x 76.9 cm (9.4 x 3.75 x 30.3 in.)
Weight	1.36 kg (3 lb)



Resonating inductor

- Multiple frequencies
- Transmit/receive frequency (815 Hz, 8 kHz, 82 kHz)
- SONDE support
- Peak and null detection
- Passive 60 Hz
- Measures current flow in buried conductors

Description

Unparalleled in capability, the L1070 and L1071 portable locators locate buried cable and pipe in various situations. Capable of locating long or short ranges, inductive or conductive, active or passive, the units deliver quick and accurate results with a user-friendly interface.

ORDERING INFORMATION

Product	Order Code
L1070 portable locator	651070
L1071 portable locator	651071
Included accessories	
L1070: Receiver, rechargeable transmitter, red/black cord, batteries, ground rod, instruction manual and soft carrying case	
L1071: Receiver, rechargeable transmitter, red/black cord, batteries, ground rod, AC charger, instruction manual and soft carrying case	
Optional accessories	
Folding ground return probe (grounded fault locator)	651075
Flexible coupler (inductive coupler)	651076
DC charger (automotive) used with 651071	651078



MPP1000

- Universal, upgradeable, flexible pinpoint fault location system
- Electromagnetic, acoustic and time delay fault location methods
- Distance and direction to fault via single or dual detection configuration

Description

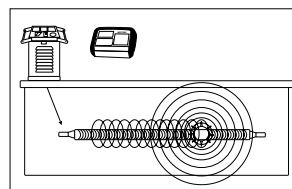
Specifically designed for service, industrial and power utility companies, the MPP1000 pinpoints faults in cable networks using acoustic, electromagnetic and time of flight methods. The MPP1000 comes in three optional configurations: receiver only, single or dual probe/detector. The single probe/detector version is easily upgraded at any time by purchasing a second probe/detector. The MPP1000 stand-alone unit measures electromagnetic surge and supplies the amplitude of that surge which aids in finding the fault.

Overall, the versions can successfully detect both the electromagnetic and acoustic pulses emitted from an arcing fault/flashover, caused by the fault breaking down during an impulse from a surge generator. The MPP1000 can be used with any manufacturer's surge generator.

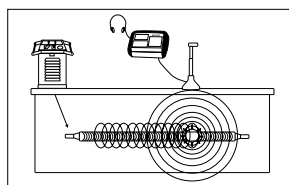
Applications

The MPP1000 pinpoints faults while the cable is being surged by a surge generator, or "thumper." An arc/flashover occurs when the high energy surge delivered from the surge generator breaks the cable fault down and a loud acoustic emission is created. Because acoustic emission from an arcing fault/flashover occurs at a single point along the cable path, information such as distance and direction to the fault becomes critical for efficient pinpointing. Without this information, the acoustic emission can mislead when pinpointing the fault.

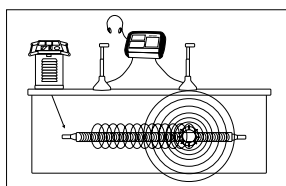
If the cable fault is in a duct or conduit, the loudest acoustic emission will be detected either at the conduit end or the conduit's actual breaking location. When pinpointing over paving, the loudest sound may be at a crack or seam. In these situations, the MPP1000 becomes especially useful.



The MPP1000 stand-alone unit measures electromagnetic surge and supplies the amplitude of that surge which aids in finding the fault.



Single probe/detector measures electromagnetic surge and acoustic emission, providing distance to the fault.



Dual probe/detector measures electromagnetic surge and acoustic emission at each detector, providing distance and direction to the fault.

SPECIFICATIONS

Operating modes	MPP1000 stand alone unit single probe/detector version or dual probe/detector version
Ranges	0 to 99.9 ms
Resolution	0.1 ms
Inputs	2 (left/right) for acoustic pickups
Outputs	1 jack for headphones, 300 Ω per side
Volume	Headphone volume adjustable
Acoustic level	Manual
Electromagnetic gain	Automatic
Acoustic bands	125 to 1000 Hz
Acoustic pickup	1.83 m (6 ft) cord
Display	LCD with switchable backlight
Power	8 standard AA cell batteries Automatic shutdown after 1 hour
Battery life	±65 hours continuous usage, alkaline; ±85 hours continuous usage, lithium (equates to several weeks/months of normal usage)
Environmental	
Operating temperature	-20 °C to +50 °C (-4 °F to +122 °F)
Storage temperature	-40 °C to +70 °C (-40 °F to +158 °F)
Humidity	95% RH non-condensing
Ingress protection	IP54
Mechanical data	
Dimensions	203 mm L x 165 mm W x 83 mm H (8 in. L x 6.5 in. W x 3.25 in. H)
Weight	.98 kg (2.15 lb)

ORDERING INFORMATION

Product	Order Code	Product	Order Code
Pinpointer/Receiver, stand-alone unit	MPP1000	Included accessories	
Pinpointer/Receiver, single probe detector version Includes: (1) MPP1000, (1) carry strap, (1) headphone, (1) geo-phone/ground microphone, (1) carry case, (1) instruction manual, (8) AA batteries	MPP1001	Geo-phone/ground microphone (with cable, rod/ carry handle, knob and spike)	36161
Pinpointer/Receiver, single probe detector version Includes: (1) MPP1000, (1) carry strap, (1) headphone, (2) geo-phone/ground microphone, (1) carry case, (1) instruction manual, (8) AA batteries	MPP100	Headphone	36162
		Carry strap	6220-780
		Carry case	36120
		AA battery (8 required)	23415
		Instruction manual	AVTMMPP
		MPP1000 receiver upgrade to dual/probe/detector	36177-1
		Upgrade from single probe to dual/probe/detector	36161



SPECIFICATIONS

Output frequency	126 kHz
Battery type	4 each 'C' size alkaline for transmitter and receiver
Battery life	50 hours
Audio output	Built-in speaker and headphone jack
Sensitivity	Manual signal adjust
Environmental	
Operating temperature	-20 °C to +70 °C (-5 °F to +158 °F)
Mechanical data	
Dimensions (H x W x L) for Receiver and Transmitter	165 x 60 x 215 mm (6.5 x 2.375 x 8.5 in.)
Weight for Receiver and Transmitter	1.1 kg (2.5 lb)

Split-box pipe and cable locator

- Energised or de-energised lines tracing
- Conductive or inductive coupling
- Peak and null detection capabilities
- Hand-held and lightweight
- Solid construction in a tough, plastic housing

Description

The split-box pipe and cable locator is a hand-held instrument in the classic 'split-box' design, consisting of a transmitter and a receiver. The instrument traces under-ground conductive networks such as water and gas mains, telephone, cable TV and electric power cables. It determines buried lines depth and locates underground metallic masses such as valve caps and manhole covers.

Designed with patented super-inductive technology, the split-box pipe and cable locator is lightweight, portable and easy to use. For easy transport, the instrument and accessories are supplied with a protective tote bag.

Applications

To locate and trace an underground metallic line, the line is energised with a radio frequency signal generated by the transmitter and then detected by the receiver. Inductive or conductive modes of operation are available.

The inductive operational mode does not require direct mechanical line connection.

The conductive mode of operation requires the line to be exposed so that a direct connection can be made.

ORDERING INFORMATION

Product	Order Code
Split-box pipe and cable locator	656902
Included accessories	
Batteries (4 ea.)	
Protective tote bag	
Direct connection cable, 3 ft	
Ground rod	
Instruction manual	
Optional accessories	
Induction lamp	656626
Mini headset	656902-4
Large carrying case (holds induction clamp and large direct connection cable)	656902-5
Direct connection cable, 6 ft	656902-6
Receiver carrying strap	656902-7



Wathour Test

With the testing requirements of today's advanced systems, it is essential to take advantage of the new technological features of the wathour meter test equipment. No matter what size your operation, you will find that Megger provides testing equipment for all of your wathour meter testing needs. Our testing equipment ranges from portable meter testers to advanced test systems incorporating digital signal processing-based technology.

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Phazer™	287

SELECTION GUIDE

	E-Z Test™ 99800	PA2505K	Phazer
Single phase	■		■
Polyphase	■	■	
Three phase			■

The kilowatt-hour meter

An electrical utility has the responsibility to provide electrical service to a defined geographic area. In return, utilities expect to be fairly reimbursed for this service. To do this on an equitable basis, they utilize the electric meter, a device that measures customer usage in kilowatt hours. Therefore, the kilowatt-hour meter is considered to be the “cash register” for the utility. The kilowatt-hour meter must accurately measure voltage, current and power factor continuously over a period of time to arrive at kilowatt-hours.

$\text{Kilowatt-hours} = \text{Watts} \times \text{Hours} / 1000$

The kilowatt-hour meter must register one kilowatt-hour whether the customer uses a 1000-watt electric heater for one hour or uses a 100-watt light bulb for ten hours. We will describe here now the various components of a kilowatt-hour meter and the way they work to measure customer consumption so accurately.

Potential coil

To measure voltage or potential, a coil is used which is made up of many turns of fine wire. This coil is inductive by nature and this, together with its physical placement within the meter, produces a lag or delay of approximately 90° between the potential coil flux and the line voltage and current coil flux.

The potential coil is connected in parallel across the load just as a voltmeter would be to read volts. Instead of utilizing an indicating pointer, however, the potential coil measures voltage by producing a magnetic field proportional to the applied voltage. That is, the higher the voltage, the stronger the field.

This field acts upon the meter disk, which is a closed loop, by inducing an emf (electromotive force) within it, which in turn causes current to flow within the disk. Because these currents flow in a circular path, they are called eddy currents.

While invisible to the eye, eddy currents are evident as a slight vibration of the disk whose effect can be felt by lightly touching the disk while the potential coil is energized and no current is flowing through the meter.

As the sine wave of the voltage in the potential coil rises from zero to plus, back to zero, then to minus, and finally back to zero again, first a north and then a south pole is created by the potential coil flux. These poles are delayed, however, by the 90° lag, or one-quarter of a cycle, inherent in the potential coil. As similar north and south poles are created by the current coil flux, the poles of the two interact either to attract or repel each other so that the meter disk is always driven in a counterclockwise direction.

Without the 90° or quarter-cycle displacement, potential coil and current coil fluxes would arrive at north and south poles simultaneously. Because like poles repel, the disk would first try to go counterclockwise, then clockwise as the current and potential

coil fluxes acted upon each other. The net result would be zero motion.

Current coils

A current coil must produce a flux field whose strength is proportional to amperes drawn by the customer's load. The wire used is large because in self-contained meters, the current coil itself will be carrying all of the customer's loads of up to 200 or even 320 amperes (as in the newest extended-range meters) without overheating. The current coil is in series with the customer load just as an ammeter would be in taking ampere readings.

Because only a few turns of large wire are in a current coil, and very little inductive reactance is present, the current in the coil is in phase with the load current and line voltage. The current coils are wound around, but insulated from, the lower portion of the laminated frame, and its flux field produces eddy currents within the disk. Unlike the potential coil, however, they can neither be seen nor felt.

Retarding magnet

Retarding magnets are permanent magnets arranged one on top and one on the bottom of the air gap so that the disk has to move between them. The flux from the magnets acts upon the moving disk by inducing a voltage within it. Because the disk is a closed loop, eddy currents are created. These currents in turn act against the magnetic flux of the potential and current coils to create a negative torque, or braking action, to movement of the disk.

The faster the disk spins, the more intense the braking action or negative torque tends to be. This phenomenon can be demonstrated by turning the disk in a meter having no potential nor current flowing. Using your finger, turn the disk in a counterclockwise direction very slowly. You will feel very little resistance to your motion. Now try to spin the disk rapidly, and you will feel the increase in resistance.

What happens to the meter in actual operation is that as load increases, the disk speeds up. If no retarding magnet were present, the disk would accelerate to a point restricted only by line voltage frequency and friction.

With the magnet present, the meter does accelerate, but only to a point where its increase in speed is balanced by the additional negative torque created by the retarding magnet. Thus the speed of the disk is at a velocity that represents a measured load, or watt-hours.

E-Z Test™ 99800 Series

- Industry standard
- Unique, simplified connection system
- Tough, glass-impregnated polycarbonate

Description

The 99800 Series E-Z Test™ Meter Test Jacks are designed to increase safety and to simplify testing of socket-type watt-hour meters. They feature dead-front construction and a unique, simplified connection system. Four types are available for field testing of virtually all commonly used socket-type meters.

Molded from a tough, glass-impregnated polycarbonate, E-Z Test Meter Test Jacks will withstand the rigors of daily field use. Time-proven, lever-actuate cams are used to firmly connect the meter blades to the test jack. A husky bypass bus is incorporated to handle customer loads, even at extended range meter installations that use the new 320-ampere, self-contained meters.



SPECIFICATIONS AND ORDERING INFORMATION

Weight: 2.18 kg (4 lb, 13 oz) Dimensions: 206 H x 172 W x 143 D mm (8.125 H x 6.75 W x 5.625 D in.)

FOR TESTING THESE METERS	Form No.	Cat. No.
Single-phase, two-wire self-contained	15	99805A
Single-phase, three-wire self-contained	25	99805A
Transformer-rated, two-wire	35	99805A
Transformer-rated, three-wire	45	99805A
Combination two- and three-wire network	19S, 20S, 21S	99805A
Two-stator, three-wire network	12S, 25S	99805A
Single-stator, three-wire network	23S	99805A
Single-stator network	22S	99805A

Weight: 2.24 kg (4 lb, 15 oz) Dimensions: 206 H x 172 W x 143 D mm (8.125 H x 6.75 W x 5.625 D in.)

FOR TESTING THESE SEVEN-TERMINAL, SELF-CONTAINED METERS	Form No.	600 V Max. Cat. No.
Two-stator, three-phase, four-wire wye	14S	99806A
Two-stator, three-phase, four-wire delta	15S	99806A
Three-stator, three-phase, four-wire wye	16S	99806A
Three-stator, three-phase, four-wire delta	17S	99806A

FOR TESTING THESE 13-TERMINAL, TRANSFORMER-RATED METERS Form No. 600 V Max. Cat. No.

Weight: 2.32 kg (5 lb, 2 oz) Dimensions: 206 H x 172 W x 143 D mm (8.125 H x 6.75 W x 5.625 D in.)

Two-stator, three-phase, four-wire wye	6S	99807A
Two-stator, three-phase, four-wire delta	8S	99807A
Three-stator, three-phase, four-wire wye	9S, 10S	99807A
Three-stator, three-phase, four-wire delta	11S	99807A

FOR TESTING THESE EIGHT-TERMINAL METERS Form No. 600 V Max. Cat. No.

Two-stator, three-phase, three-wire transformer-rated	5S	99808A
Two-stator, three-phase, three-wire self-contained	13S	99808A
Two-stator, two-phase, three- or four-wire transformer-rated	5S	99808A
Two-stator, two-phase, three- or four-wire self-contained	13S	99808A

PA2505K

Phantom load



PA2505K

- Full-scale range simultaneously selected by current-range selector switch
- Eliminate need to change leads
- Selectable 50% or 100% power factor
- Test single or polyphase watt-hour meters
- New compact, heavy-duty metal carrying case

Description

The rugged PA2505K phantom load operates from a single-phase source and is designed for field-testing single-phase and polyphase watt-hour meters at 50 and 100% power factor.

This unit utilizes a heavy-duty selector switch in conjunction with a variable autotransformer to provide continuous adjustment of the load current — a valuable feature that permits close control of the output for different load circuit impedances or in the event of variations in the source voltage.

The unit is rated for continuous duty with forced-air cooling provided by a built-in fan. Primary and secondary test leads are furnished as standard equipment.

PA2505K is provided in a compact, heavy-duty metal, two-compartment carrying case. The case features a soft grip handle and ample space for reference standard and test leads.

SPECIFICATIONS

INPUT	
Primary Voltages (specify one group)	69/120/240/277/480 V, 1 ϕ , 50/60 Hz OR 73/127/220/380/415 V, 1 ϕ , 50/60 Hz fused input circuit
OUTPUT	
Current Ranges (switch-selected)	
Full Load	0 to 2.5/5/15/50 A at 50% OR 100% pf
Light Load	0 to 0.25/0.5/1.5/5 A at 100% pf
Current Control	A variable autotransformer provides continuous control of the output load current from zero to the maximum of each range.
Ammeter Circuit	A 89-mm (3.5-in.) ammeter with knife-edge pointer and $\pm 5\%$ full-scale accuracy indicates output load current.
Output Current Connections	Five output terminals are provided to eliminate the need to change lead connections between the phantom load and the reference watt-hour standard. Four of the output terminals (50, 15, 5 and 1.5 A) are permanently connected to the corresponding input terminals of the reference standard, and the meter under test is then connected in series with the remaining + terminal of the phantom load and the + terminal of the reference standard.
Power Factor	Power factor is maintained above 97% at 100% setting and between 43% and 57% at 50% setting.
Leads	Extra-flexible current and potential test leads and convenient terminals are provided. Leads supplied include those for connecting a reference standard.
Dimensions	519 W x 206 D x 295 H mm (20.4 W x 8.1 D x 11.6 H in.)
Weight	13.3 kg (29.2 lb)

ORDERING INFORMATION

Product	Order Code	Product	Order Code
Phantom Load with carrying case	PA-2505K-69	Fuses	
Phantom Load with carrying case	PA-2505K-73	0.75 A, 600 V, KTK [2]	2837
Included accessories		3 A, 250 V, MDA [5]	951
Accessory leads		Instruction manual [1]	5516
Current, 3 m (10 ft), black [1]	FL508	Optional accessories	
Current, 3 m (10 ft), red [1]	FL509	MA-10-01 etc, reference standards.	
Current, 0.6 m (2 ft) [2]	FL510	See Megger MA-10 datasheet.	
Voltage, 0.6 m (2 ft) [2]	FL511		
Remote reset switch 1.8 m (6 ft) [1]	RM-15		

SPECIFICATIONS

Input	120 V or 240 V ±10%, 50 or 60 Hz, 750 VA
Output	The solid-state voltage and current amplifiers are regulated to their programmed values. The operator will be warned if the amplifier output distorts excessively.
Voltage Amplifier Regulation	±1% @ 10 to 100% of range
Current Amplifier Regulation	±1% or ±5 mA whichever is greater @ 10 to 100% of range
Current and Voltage Distortion	±0.5% THD

Measurement Type	System Accuracy (20-25 °C)
Watt-hour, VA-hour @ 1.0 pf	±0.05% (±0.02% typical)
Watt-hour, VA @ 0.5 pf	±0.10% (±0.03% typical)
Q-hour @ 1.0 pf	±0.10% (±0.03% typical)
Q-hour @ 0.5 pf	±0.05% (±0.02% typical)
VAR @ 0.0 pf	±0.05% (±0.02% typical)
VAR-hour @ 0.866 pf	±0.10% (±0.03% typical)

Programmable Current	Three isolated, independent floating currents, 0 to 120 A or 0 to 20 A, depending on the model selected, each programmable with a resolution of 0.01 A
Programmable Voltage	Three independent, wye-connected potentials, 0 to 600 Vac, each programmable with a resolution of 0.1 V
Programmable Phase	Each of the three current and voltage channels is programmable for 0 to 360°, with a resolution of 0.1°. Phase accuracy at the meter will be within ±1° or ±1.5° at currents below 0.2 A
Optics	Adjustable sensitivity, modulated visible light output, with a 10-segment bar-graph display of reflected intensity. Capable of reflect mode, LCD, LED and infrared detection.
Accuracy	Error increases with temperature 20 ppm/C°
Pulse Inputs	Pulse initiator inputs accommodate meters with up to eight separate KYZ outputs.
Reference Standard	A state-of-the-art, three-phase sampling energy standard that incorporates 16-bit A/D converters to achieve very high accuracy is used. Meets ANSI C 12.1 performance requirements.
Protective Circuits	Each system monitors itself for over-temperature, overcurrent and harmonic distortion. Open current or shorted voltage coils result in amplifier shutdown and warning to the operator.



PHAZER

- Now tests watt-hour meters with installed Turtle® made by Hunt Technologies®. No need to take the Turtle® out of operation
- For testing socket-mounted meters as well as panel-mounted and bottom-connected meters
- True three-phase and single-phase testing capabilities
- Fully automatic operation
- 32-bit operating software - use with Windows® 95, 98, 2000, ME, NT 4.0 and XP
- State-of-the-art optical sensing system

Description

The PHAZER family of watt-hour meter test sets are true three-phase, fully automatic systems capable of testing virtually all types of ANSI socket-mounted and bottom-connected single- and three-phase (three and four wire) electricity meters.

The PHAZER family consists of specific models for testing socket-mounted meters and specific models for testing panel-mounted and bottom-connected meters.

the PHAZER Watt-hour Meter Test Set easily tests any meter with an installed Turtle® made by Hunt Technologies®. Therefore, there is no need to take the Turtle® out of operation.

PHAZER models for testing panel-mounted and bottom-connected meters (T20 & T120), feature current and voltage output binding posts for connections to the panel-mounted meter without disturbing the meter installation.

Watt-hour meter test & calibration system

Specifications continued	
Computer/Controller	<p>The controller may be ordered from Megger with a choice of three different configurations:</p> <ul style="list-style-type: none"> • Standard Controller • Deluxe Controller • Notebook Controller <p>Minimum specification of the supplied computer are: 600 Mhz Pentium, 32 megabytes of RAM, 810-megabyte hard disk, SVGA monitor, 800 to 1600 dpi resolution, and Microsoft Windows® 95, 98, 2000, ME, NT or XP.</p> <p>Note: Controller specifications are based on current available hardware.</p>
External Connections	<p>A 9-pin female serial interface located on the back panel for connection to the computer. A BNC jack on the front panel for pulse input from an external reference standard. This is used during calibration or reference tests.</p> <p>Three banana jack receptacles and a 25-pin connector for use with KYZ pulse initiator signals are included on the front panel.</p> <p>A 9-pin serial interface located on the back panel for connection of a bar code reader.</p>
Environment	
Operating	0 °C to 45 °C (32 °F to 112 °F), 5 °F to 90% non-condensing RH
Storage	-20 °C to +50 °C (-4 °F to +122 °F)
Meter Test Socket	<p>For PHAZER models that test socket-mounted meters, the meter test socket is an electrically operated solenoid with a manual switch control that opens and closes the socket. The socket will remain closed upon power failure. The meter test socket will test the following meter forms:</p> <p>1 through 6 8 through 17 19 through 23 25, 26, 29, 35, 36 and 45</p> <p>The built-in socket accepts all self-contained S-Base meters. Optional adapters are available for A-Base and K-Base style meters.</p>

DIMENSIONS AND WEIGHT	
PHAZER MODELS FOR TESTING SOCKET-MOUNTED METERS:	
PHAZER J120	508 H x 560 W x 445 D mm
Dimensions	(20 H x 22 W x 17.5 D in.)
Weight	61.4 kg (135.2 lbs)
PHAZER MODELS FOR TESTING PANEL-MOUNTED AND BOTTOM-CONNECTED METERS:	
PHAZER T120 and T20	475 H x 540 W x 349 D mm
Dimensions	(18.7 H x 21.3 W x 13.7 D in.)
Weight	51 kg (112.2 lb)
OPTIONAL ADAPTERS	
Universal A-base Adapter	Megger's Universal A-base adapter permits the PHAZER systems constructed with Megger's automated jaw assembly to test virtually all A-base watt-hour meters. This allows the system additional flexibility when there is the need to test both S-base and A-base watt-hour meters.
Regulatory	CE marked. Including but not limited to: IEC 61326-1, EN 50081-1, EN 50082-1.
K-base Adapter	Megger offers two types of K-base adapters, single and three-phase models. The K-base adapter allows PHAZER systems constructed with Megger's automated jaw assembly to test K-base style watt-hour meters. This allows the system additional flexibility when there is the need to test both S-base and K-base watt-hour meters.

ORDERING INFORMATION

Product	Order Code	Product	Order Code
PHAZER models for testing socket-mounted meters		PHAZER models for testing panel-mounted and bottom-connected meters 20 ampere model	
120 V, 60 Hz	PZR-J120-160	115 V, 60 Hz	PZR-T20-160
120 V, 50 Hz	PZR-J120-150	240 V, 50 Hz	PZR-T20-250
240 V, 50 Hz	PZR-J120-250	120 ampere model	
240 V, 60 Hz	PZR-J120-260	115 V, 60 Hz	PZR-T120-160
120 V, 60 Hz (Canada)	PZRC-J120-160	240 V, 50 Hz	PZR-T120-250
Included accessories		Included accessories	
RS-232 serial cable, 9-pin	16350	RS-232 serial cable, 9-pin	16350
Calibration input coaxial cable, 1 m	6593	ROC interconnect cable, 9-pin	15763
Input line cord	6828	Calibration input coaxial cable, 1 m	6593
Instruction manual	750001	Input line cord	6828
Fuse 7A 250 V MDL-7 (2) [115 V systems only]	11848	Instruction manual	750005
Fuse 5A 250 V MDA-5 (2) [230 V systems only]	952	Fuse 7 A 250 V MDL-7 (2) [115 V systems only]	11848
PHAZER software	544049	Fuse 5 A 250 V MDA-5 (2) [230 V systems only]	952
Optional accessories		Optional accessories	
Standard controller	16517-X_	PHAZER software 20 ampere model	544049
Deluxe controller	16517-X_	Voltage leads, 3.6 m (12 ft)	50254
Notebook controller	16517-X_	Current leads, 3.6 m (12 ft) 12 ft Black (3)	50691
Bar code scanner	17293-1	Current leads, 3.6 m (12 ft) Red (3) 120 ampere model	50692
Calibration adapter	50631	Voltage leads, 4/C 1.8 m (6 ft) (1)	50252
A-base adapter, quick connect	50916	Current leads, 0.6 m (2 ft) Black (3)	50256
K-base adapter, single-phase	16412	Current leads, 0.6 m (2 ft) Red (3)	50257
K-base adapter, 3-phase	16411	Optional accessories	
75 adapter	17000	IEC Meter Test Station c/w 30 in. current leads	50362
24S adapter	17001	Transport case for Model J120	51527
		Transport case for Models T120 or T20	50989
		Bar code scanner	17293-1
		Standard controller	16517-X_
		Deluxe controller	16517-X_
		Notebook controller	16517-X_
		Important Notes	
		A computer is NOT INCLUDED when ordering any PHAZER model. The computer must be ordered separately.	
		To print test results Microsoft Access is required.	

that you might find useful

For more information on installation test products, ask for your Industrial test and Contracting Catalogue or go to www.megger.com



MIT400 Industrial insulation tester

MIT400 series testers offer CAT IV 600 V safety in a convenient and easy to hold format. They are true diagnostic instruments measuring insulation resistance up to 200 GΩ. They measure insulation deterioration long before some testers even offer reading.



AVO410 digital multimeter

AVO410 digital multimeter has been designed for the contracting electrician and has the additional features that also make the instrument suitable for wide range of applications and users.

The instrument offers AC and DC voltage and current measurements as well as resistance, frequency and capacitance ranges. True RMS readings on the AC functions are standard on the AVO410 and the instrument features a CATIV 600 V safety rating meaning the instrument is suitable for industrial applications.



Structured cabling tester

Tough and reliable certification. SCT structured cabling certification testers have been designed from the outset to offer long reliable service under the toughest of site conditions.

They combine rugged construction with a novel connector adaptor system that eliminates downtime due to connector damage.



Portable appliance testers

Portable appliance testing has just got easier with the introduction of the new PAT300 and PAT400 series of testers which perform numerous electrical portable appliance and safety tests including; ground/earth continuity, leakage current, circuit test, fuse check, earth bond and insulation.

Why is the CAT rating important?

The CAT (Category) rating of a test instrument defines where in the electrical supply chain the instrument can be safely used. This is usually printed on the instrument across the test connections and appears as CAT II, CAT III or CAT IV. CAT I is generally no longer used, as it has no practical application.

What is a CAT rating?

The CAT rating defines the level of transient (spike or surge) the instrument has been designed to withstand. These transients vary in size and duration depending on the source of the transient. The transient riding on a high-energy supply is more dangerous than a transient on an isolated cable as it can deliver larger currents when a fault occurs (a spike on steroids if you like).

A transient may be several kV in amplitude but its duration is typically very short, maybe only 50 microseconds. On its own the transient will cause little damage. However, when it occurs on top of the normal mains sinusoidal supply voltage it can start an arc (short circuit), which continues until the end of the cycle. In the case of a CAT IV system the available short circuit current can be in excess of 1000 amps.

This generates hundreds of kilowatts of heat in a small space for a few milliseconds, creating a big bang, possibly causing burns, fire or explosion.

Instruments designed with the correct category rating have sufficient clearance between critical parts to prevent an arc from creating the initial breakdown when a transient occurs. IEC 61010 defines the design requirements for instruments that declare a specific category rating and specifies both the electrical and physical requirements.

Recently some companies, especially electrical distribution companies, have stipulated all electrical test instrumentation to be rated CAT IV. This is a result of injuries sustained by engineers using inappropriately rated instruments on the supply.

Where are CAT IV applications found?

The electrical supply can be broken down into categories from CAT I to CAT IV as shown below:

The picture shows the transmission lines (overhead or underground) as Category IV because the energy available from the supply is much higher near to the transformer. Test equipment suitable for use in this environment needs to be rated to CAT IV.

By the time the voltage goes through the fuse panel into the premises, the circuit impedance is higher and transients are damped, reducing the available energy in the transient. The ability of the test instrument to withstand this surge is less stringent, hence a Category III rating.

The further down the supply you progress the lower the protection a test instrument has to provide. At the socket or lighting outlet the circuit is rated CAT II and items such as photocopiers, televisions etc. can be considered as CAT I environments.

Most electricians' testers will be rated to CAT II, and the better ones rated to CAT III. These instruments are not designed to be used on the higher energy CAT IV circuits. However in reality this does occur. Arguably an RCD tester would never need to be CAT IV due to its location in the supply chain.

Why 600 V?

The 600 V working (or steady state) voltage implies the instrument can be connected to a 600 V single phase to earth supply without risk to the instrument or operator.

But isn't an insulation tester for dead system testing?

Absolutely. The MIT400 can also be used for voltage measurement and could be used for verification of supply voltage. In this respect it has multimeter capability as well being a sophisticated insulation tester.

Who will want CAT IV?

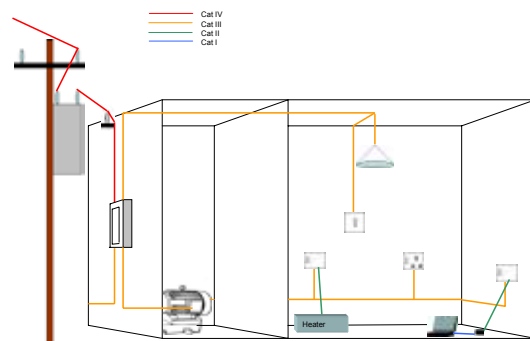
- Electrical Utilities: - As already mentioned, electrical utilities are now specifying CAT IV instruments in an attempt to reduce risk to their operators and consequent liability, where instruments get used both inside and outside the building. This applies to insulation testers as well as live testers, as the capability to measure supply voltage exists on a voltage measurement range, as well as accidental connection to live circuits whilst in other test modes.
- Any engineer: - working outside the premises, either on overhead or underground supplies, will be working in a CAT IV environment, and should be working with suitably rated instruments.

Some basic statistics:

Small transients (a few hundred volts) occur on supply systems most days of the year. Large transients (5 to 10 kV) do not occur very often. However, they are unpredictable, mostly caused by lightning strikes on overhead lines. Using a correctly rated instrument the chances of a dangerous breakdown are approximately one in a million for every hour connected to the supply.

Using one category less increases the chances of an accident by a factor of about 30. This means that if 100 engineers are using instruments with wrong category ratings and they connect to live systems for one hour every day, 200 days a year, a dangerous situation is likely to occur once every 18 months!

If you would like more information on MIT400 1 kV insulation testers, see our Industrial test and Contracting Catalogue.



Megger is all about people...people as customers and suppliers...people as distributors...and people as staff.

Established originally in the late 1800s, the company has been manufacturing test and measurement instruments designed to perform preventative maintenance and troubleshooting for decades. Its products have helped customers all over the world improve their facilities' efficiency, reduce costs, extend the life of apparatus and, through trending and analysis, anticipate equipment performance and future requirements. It now operates locally in many locations with dedicated field sales teams and distributors located all over the world and manufacturing plants in the the UK, Sweden and USA. It is Megger's belief that only by working closely with customers, can it deliver the most appropriate customer solutions and professional after-sales service today, and in the future. Megger is committed to anticipating and identifying client needs by listening to customers and industry specialists, and continually investing in innovative manufacturing techniques, research and development, and design engineering.



Industry leaders in innovation

Megger's commitment to the industry is reflected in its technical leadership and in being the first to design and introduce key products to the marketplace. These include the first portable insulation tester, commercial cable fault locator, DSP based watt-hour meter test system, and software-driven protective relay test system.

Product news and updates

Megger believes in providing you with the very latest industry developments, products and their applications. We deliver this information to you in several ways including -

- our websites at www.megger.com and www.meggernetworks.com
- by personal correspondence and visits
- Regular issues of Electrical Tester our specialist quarterly magazine. If you would like to subscribe to Electrical Tester, please email ElectricalTester@megger.com with your details and whether you would prefer a physical copy or a regular emailed technical update.



How the greatest brands in test and measurement came together

Today, all our products are sold with a single brand name, Megger. The advantages to you are that you know the products and software will work well together and all the products have a distinctive 'look and feel' with their dark and light grey casings. We don't waste colour on trying to make our test instruments pretty - we reserve it for useful functions such as range selectors and displays. Our design engineers come from many different nations, and they regularly exchange ideas and tips with colleagues from other countries. That means you get the latest innovations, and is one of the reasons that Megger products are so advanced.

Whether for technical support or research and development, our systems are geared to keeping things local – localised engineering, localised marketing, localised decision making. Our employees are proud of the companies and brands that go to make our company history and these words are still trademarks or registered trademarks of the company in many countries.

AVO

Named as an acronym for Amps, Volts and Ohms, AVO is best known for its iconic AVOMeter multimeter. AVO merged with Megger in the 1960s when both firms relocated from London to the Dover, England manufacturing site. AVO lives on as our training business, operating from Megger sites around the world.

Biddle

James Biddle was an importer of Megger insulation testers, and later started a high voltage test instrument business. Based in the beautiful National Park of Valley Forge, Pennsylvania, the high voltage tradition continues as Megger's lead site for cable fault location equipment and transformer test equipment.

Megger

Manufacturing insulation testers is where Megger started, and the Megger brand name is so well known today that maintenance professionals often incorrectly use it as a verb when they refer to doing an insulation test. The Dover, England site manufactures hand-held test equipment as well as larger insulation testers, oil test equipment and low resistance ohmmeters.

Multi-Amp

Based in Dallas, Texas, the former Multi-Amp facility concentrates on relay test and circuit breaker test equipment for the world's power industries. Started in the 1960s, Multi-Amp later merged with Biddle and then Megger to form the nucleus of today's company.

Pax

Seeing an opportunity to create a transformer test business based around sweep frequency response analysis, engineers at Programma left to create a new business which they called Pax. Megger saw an opportunity to share the Pax innovations with more customers through Megger's distribution network. Megger acquired the company in 2008 and rebranded its products to Megger. Research and engineering for the product range continues at Täby, Sweden.

PowerDB

There was a gap for a powerful software package to provide data management for acceptance and maintenance testing jobs, which was filled by PowerDB. Located at College Station, Texas – famous for its engineering school – software engineers created a database tool specifically for customers with asset management problems. Since its acquisition by Megger, it operates as a software division while continuing to develop and support PowerDB.

Programma

Proudly Swedish, Programma Electric AB was founded in 1976 and quickly became a world renowned supplier of test equipment and diagnostic methods for protection relays, high voltage circuit breakers, stationary batteries as well as portable high current applications. Headquartered in Täby, Sweden the company was acquired by Megger in 2005. The business has grown in revenues and staff since that time.

STATES

For over 65 years, test technicians and engineers have depended on States terminal blocks and test switches to provide easy access to wiring on panel boards and switchboards, eliminate wiring reconnection errors and save operator time. The States business is co-located at our Dallas site.

Trademarks

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All other trademarks acknowledged. For more information on Megger's trademark policy, please email Legal@Megger.com

Product information

Megger has a policy of continuous product improvement, and you should check with Megger for the latest specification before purchasing.

Calibration and Repair service

Megger operates fully traceable calibration and repair facilities ensuring your instrument continues to provide the high standard of performance and workmanship you expect from Megger. These facilities are complemented by a worldwide network of approved repair and calibration companies, to offer excellent in-service care for your Megger products.

For information on having your instrument calibrated or repaired and to obtain a Returns Authorisation number log in to Megger.com (if you have not registered before, the process is very easy) and navigate to 'Service / support'. Click on the button 'Click Here To Add New RA Request' and add as much detail as you have available. From here, you can request a warranty repair, non-warranty repair or calibration certificate.

The form uses contact information from your original registration to save you the trouble of re-typing. If it is incorrect, you will need to overtype in this form. Please also correct the information in the 'Manage Profile' section, so that we can contact you in the future.

Giving us information on the fault helps our repairs technicians diagnose the problem before it reaches us, which will make it quicker to fix and return to you.

You can track the status of your repair by clicking on the button 'Click Here To View Your RA Status'

If you prefer to contact us by phone, we will be happy to take your call during normal working hours.

Software updates

The latest free upgrades for software and firmware to support Megger instruments can be downloaded by clicking on Software Downloads. You can also check here to see when we last updated the software so that you don't download unnecessarily.

Care for the environment

All of Megger's European manufacturing facilities are certified to ISO14001:2004 which is the requirement for environmental management systems, confirming its relevance for organisations wishing to operate in an environmentally sustainable manner. Megger operates a holistic, strategic approach to its environmental policy.



Teams at the sites regularly review how to reduce waste, limit the amount of landfill requirement, and recycle as much as possible. That is not only good for the environment; in the long term it helps to keep our costs and prices down.



Megger strictly complies with the requirement of European Union Directive 2002/96/EC on waste electrical and electronic equipment, also known as the 'WEEE Directive'. If you use your product within the European Union and you have a Megger product that has reached the end of its life, the scheme we have setup means that its disposal can be handled in an environmentally safe manner using processes that meet the requirements of the WEEE Directive. We ask that you obtain a returns authorization quoting the product reference (refer to your original invoice for details).



Megger has appointed B2B Compliance to handle waste electrical equipment. You can contact them through their website at www.b2bcompliance.org.uk or you can telephone +44 (0) 1691 676 124

What you need to do

1. If the product has memory facilities, remove any data you may need to retain.
2. Safely de-energise your test equipment, remove accessories, batteries, etc. and pack it. If you have your original packing, that is ideal, but any adequate packaging will suffice.
3. Contact Megger or B2B Compliance to arrange for return or pickup.
4. Megger will arrange for its safe and responsible disposal. We will pay for the costs of recycling.

For full terms and conditions, email environmental@megger.com and we will be happy to explain our processes to you.

Training local to you

With 18 sites around the world, you can count on Megger to provide specialized, practical, hands-on electrical training presented in class rooms at dedicated facilities available at most Megger locations, or at your facility. Training can be delivered in English, German, French, Swedish, Spanish or Arabic.

Although Megger's products are designed from the 'outside-in' with ease of use in mind, some technicians may need help either with the product or with more general electrical theory.

AVO Training Institute is a wholly owned Megger subsidiary that is the best choice for electrical maintenance and safety training, electrical engineering studies, and electrical safety solutions. The Division has a diverse range of industry experience encompasses energy, transportation, manufacturing, communications, mining, oil and gas, and government services. No matter how challenging a job or how isolated its location, chances are AVO Training can handle it. That's because AVO Training brings a unique combination of knowledge, skill, experience, and customer commitment to every project.

As one of the oldest electrical training schools AVO Training has been in the forefront of electrical safety for more than 45 years. What began as a support division for parent company Megger in 1963, has grown into a corporation with a strong vision for improving electrical safety and reliability around the world.

The AVO team of instructors, safety inspectors and engineers have over 1,000 combined years of electrical experience in a wide variety of industries and it has been ISO 9001 certified to provide technical training since 1996. As your requirements have changed, we have changed too. Learn more about each of AVO's four unique divisions by going to www.AVOTraining.com



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