GE Energy

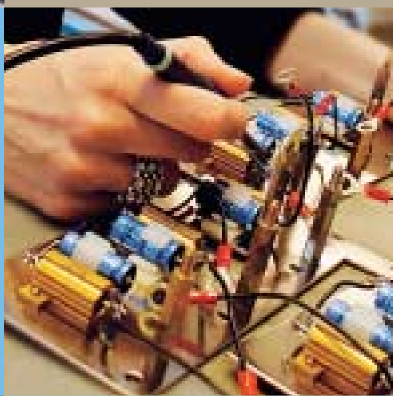
2005

Electrical Test Equipment

Programma® Products

Portable test instruments for maintenance of electric power protection equipment





All over the world competent power professionals and large investments in power plants, transmission lines, substations and cables ensure that electricity is delivered without interruptions to homes, offices and industries. Today's high-tech, high-voltage systems require effective means to minimize the risk of damages resulting from power failures. Without such means, vital aspects of our daily life are in danger.

Programma Electric was founded in 1976 to provide rugged, portable test equipment to satisfied customers throughout the world.
In March 2001 GE Energy acquired Programma Electric.

Our mission is to create efficient test systems for the main parts of power-system substations such as switchgear, transformers, protective relays and battery systems. Today, the Programma® range of products incorporate both hardware and software. But our commitment does not stop here. Continuous support, service and courses in power testing/ maintenance are examples of the "extras" that are built into our total solutions to customers' testing and maintenance problems.

Our rugged and portable instruments are known to be both reliable and user-friendly. We are in the business of reliability, and one important step is to comply fully with the ISO 9001 Quality Standards as well as with other applicable IEC and ANSI standards, and we strive to continuously improve our products and services.

Contents

Testing protective relays

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.

SVERKER 750™/760™

Relay Test Unit

The Sverker 750/760™ Relay Test Unit is the engineer's toolbox. The control panel features a logical layout, still SVERKER 650™ users will find it comfortably familiar and will be able to start work right away.

The SVERKER 750/760™ 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 φ. 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 efficiantly by means of the built-in variable voltage source. In SVERKER 760™ this has a continuous phase shift function 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 750/760™ 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 for example allows the user to connect three SVERKER™ into a basic 3-phase test set.

Application

Relay Testing

SVERKER 750/760 is intended primarily for secondary testing of protective relay equipment. Virtually all types of single-phase protection can be tested.

SVERKER 750/760 is able to 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.

Examples of what SVERKER 750/760 can test:	IEEE® No.
Overcurrent relays	50/76
Inverse time overcurrent relays	51
Undercurrent relays	37
Ground fault relays	50
Directional overcurrent relays	67
Directional ground fault relays	67N
Overvoltage relays	59
Undervoltage relays	27
Directional voltage relays	91
Directional power relays	32
Power factor relays	55
Differential protection (differential circuits)	87
Distance protection equipment (phase by phase)	21
Negative sequence overcurrent relays	46N
Motor overload protection	51/86
Automatic reclosing devices	79
Tripping relays	94
Voltage regulating relays	
Overimpedance relays, Z>	
Underimpedance relays, Z	
Thermal relays	
Time-delay relays	

Other fields of application

- Plotting excitation curves
- Current and voltage transformer ratio tests
- Burden measurement for protective relay test equipment
- Impedance measurement
- Efficiency tests
- Polarity (direction) tests
- Injection
  - Maintained
    - Injection continues without any time limitation.
  - Momentary
    - Injection continues only as long as the button is kept depressed.
  - Max. time
    - Injection stops automatically when the preset maximum time is reached.
- Filtering

  When filtering is selected, five successive readings are averaged. The following can be filtered: Current, Voltage and Extra items that are measured.
- Off delay

  The turning off of generation can be delayed after tripping throughout a specified time interval that is expressed in mains-frequency cycles.

Application example

IMPORTANT!

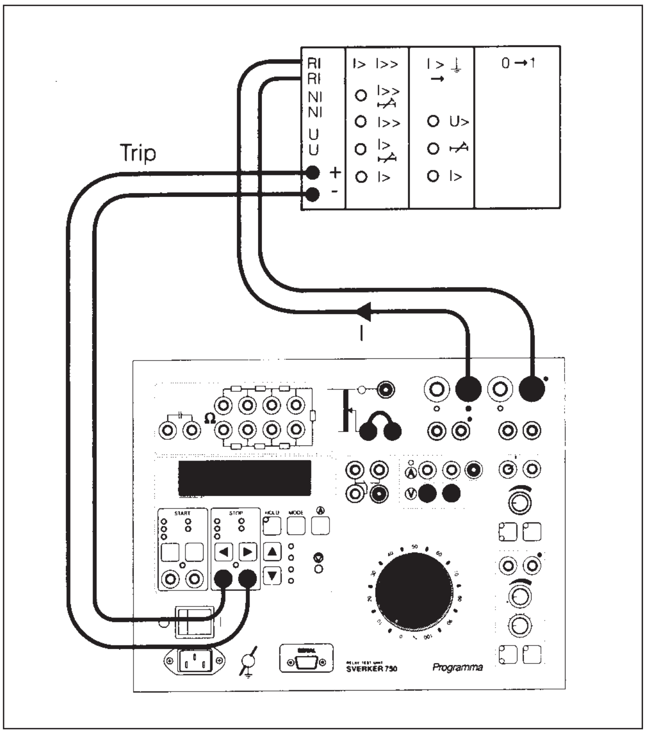
Read the User's manual before using the instrument.

Testing the pick-up and drop-out (SVERKER 760)

1. Connect as shown in the diagram.
2. Select stop conditions, dry or wet contact.
3. Select **HOLD** to freeze the current reading.
4. Press button **SEL/Ⓐ** until you get a red light at the built-in ammeter. **Note!** Maximum allowed current through the separate ammeter used in this connection example is 6 A. The other measurement points do not have this limitation.
5. Press the **MODE** button.
6. Use the key ▼ to select Ω, φ, **W, VA...**
7. Press **CHG** (Change)
8. Select φ (**°**, **Iref**) or (**°**, **Uref**) by using the key ▼.
9. Press **SEL** (Select)
10. Press **ESC**
11. Set the voltage amplitude with the upper small knob.
12. Make sure the main knob is set to **0**.
13. Turn on the SVERKER output by activating **ON** using the start switch ▼.
14. Set the phase-angle. Use the lower knob for fine adjustment, and the middle knob for step of 90°. **Note!** A small current flowing in the circuit is required to measure the phase angle.

Testing the operation time

15. Increase the current to 1.5 times the pick-up value.
16. Invoke the ON+TIME state by means of the start switch. The outputs will now remain turned on until the protective relay equipment operates.
17. Read the time from the display. Check also the high current setting using the same procedure.



1 Set of resistors
Fine regulation of current and voltage are easy thanks to the built-in set of resistors.

2 Display
Presents time, current, voltage and other entities. Also used to make many setting, after you enter the setting mode by pressing button marked MODE.

3 Freeze function (HOLD)
This makes it possible to measure voltages and current as short as a quarter of a mains-voltage period by immobilizing the reading on the display. Voltage and current readings are frozen when the timer stops. If the timer does not stop, the reading present when the current was interrupted is frozen on the display.

4 Start and stop conditions
The timer's start and stop inputs respond to changes, voltage or contact closing/ openings. The timer's start input is also used when testing auto-reclosing relays, to synchronize two or more SVERKER units and to start generation with an external signal.

5 Status indicator
The timer's start and stop inputs are each equipped with indicator lamps which, when lighted, indicate a closed circuit (useful for detecting contact closings/ openings) or the presence of voltage. These indicator lamps make it possible (for example) to check circuits before starting a measurement cycle.

6 Timer inputs
The timer has separate start and stop inputs, and it can be used to measure both external cycles and sequences initiated by SVERKER. The measured time appears on the display. Each input can be set to respond to the presence or absence of voltage (AC or DC) at a contact.

7 Start switch
Controls the turning on and off of the current source and timer. Can be set to one of four states. ON+TIME. Starts generation and timing simultaneously. Used to test over... relays (...means current, voltage or some other entity). Generation continues a) until the protective relay equipment operates and stops the timer or b) until the maximum time expires or the start switch is released if time-limited generation has been selected. OFF. Turns off the current source, whereupon generation is interrupted. ON. Turns on the current source in the generating state. OFF+TIME. Interrupts generation and starts the timer simultaneously. Used when testing under ...relays (...means current, voltage or some other entity). The timer is stopped when the protective relay equipment operates. When automatic reclosing is to be tested, SVERKER an be set so that new generation will start when the timer's start input is activated by the closing command.

8 Computer communication interface
SVERKER is equipped with a serial port for communication with personal computers and the PC software Sverker Win.

9 Make/break contact
Changes state automatically when a test is started. Can be used (for example) to synchronize two or more SVERKER units, other eternal equipment or to switch the voltage applied to the protective relay equipment back and forth between non-faulty and faulty.

10 Current source
Provides 0-250 A AC, 0-250 V AC or 0-300 V DC, depending on the output that is being used. Settings are made using the main knob. The readings of current, voltage and other entities appear on the display. The start switch is used to turn the current source on and off. When time is being measured, this is done in synchronization with the timer.

11 Ammeter and voltmeter
Current and voltage are measured by the built-in ammeter and voltmeter. Resistance, impedance, phase angle, power and power factor can also be measured. Readings appear on the display. These instruments can also be used to take measurements in external circuits. The voltmeter can also be used as a 2nd ammeter (when testing differential relays for example). Current and voltage can be displayed either as amperes and volts or as percentages of a given current or voltage (the present settings of the protective relay equipment for example).

12 Auxiliary voltage source
Provides 20-220 V DC in two ranges. Equipped with overload protection and separated from the other outputs. Used frequently to supply the object being tested.

13 AC voltage source
Intended primarily for use with voltage inputs to the protective relay equipment. Can provide 0-140 V AC and 0-359° phase shift (SVERKER 760). Since the AC voltage source is separated from the other outputs, it can be set independently of the current source.

14 Tripping indicator
Lights when a stop condition is fulfilled to indicate operation of the protective relay equipment. If the test being conducted incorporates timing, this indicator starts to blink when relay operation occurs.

15 Main knob
Used to set current output from the current source.

Optional accessories

CSU20A

Current and Voltage Source

CSU20A is a small light-weight current and voltage source primarily intended to work together with the SVERKER 750/760 Relay Testing Unit when testing differential relays. Using the CSU20A together with SVERKER 750/760 gives the user two independent current sources, and the timer/measurement section in SVERKER 750/760 is used both for measuring the two outputs as well as measuring the trip time of the relay.

Besides testing differential relays the unit can be used as a multi-purpose AC/DC source. The CSU20A features one AC current/voltage output, one fully rectified DC output and one half-wave rectified DC output for harmonic restraint testing.

Other features are a current measurement shunt, selectable current/voltage ranges and an AC mains input/output. Connecting the SVERKER 750/760 mains to the mains output of the CSU20A gives an in-phase synchronization of the two units.

PSS750

Phase Selector Switch

The PSS750 is specifically designed to work with SVERKER 750/760 when testing three-phase relays. It is connected between SVERKER 750/760 and the relay inputs and allows the user to easily select which phase to test.

The PSS750 handles both the current and voltage sources and single-phase or phase-phase testing can be selected. Together with the output-input switching the unit also contains a variable resistor that can be used together with the built-in capacitor in SVERKER 750/760. This feature gives the user the possibility to create a variable phase shift at a decreased amplitude of the test voltage.

The design is passive which makes it very general. You may for example use any of the inputs for current or voltage as long as you do not exceed the specification. It is also possible to connect the measuring inputs of the SVERKER 750/760 to the PSS750 and use the switch for selecting measurement signals.

The PSS750 simplifies phase switching, selecting type of fault, phase reversing and gives a possibility to create a variable phase shift.

Specifications CSU20A

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

Operating temperature	-20°C to +50°C (-4°F to +122°F)
Mains voltage	115 / 230 V AC, 50 / 60 Hz
Thermal protection	Built-in
Dimensions	280 x 178 x 246 mm (11" x 7" x 9.7")
Weight	5.9 kg (13 lbs) excl. transport case
Current measurements	Current shunt 0.1 A / 1 V, ± 2%

Output, AC

20 A setting	*Output voltage (min)*	*Load time*
Idle/non-load	26 V	Continuous
5 A	25 V	Continuous
10 A	22 V	Continuous
20 A	18 V	2 min
10 A setting	***Output voltage (min)***	***Load time***
Idle/non-load	52 V	Continuous
3 A	50 V	Continuous
5 A	47 V	Continuous
10 A	41 V	10 min

Output, DC

DC current	As above, less the voltage drop over the rectifying diodes

Specifications PSS750

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

Max input voltage	250 V AC / 3 A
Max input current	6 A / 250 V AC
Max resistor loading	200 V AC / 200 mA (0.5 A during 5 seconds)
Dimensions	200 x 120 x 85 mm (7.9" x 4.7" x 3.3")
Weight	1.3 kg (2.9 lbs)

CSU20A

PSS750

Application example

IMPORTANT!
Read the User's manual before using the instrument

1. Connect the current and voltage outputs of SVERKER 750/760 to the PSS750 inputs.
2. Connect the current and voltage inputs of the relay to the PSS750 outputs.
3. Select which phase to test and type of test (phase-to-ground or phase-phase) with the selector switch.
4. Proceed with the test for each phase and fault type.
5. To create a phase shift, connect the 10 µF capacitor in SVERKER 750/760 in series between the voltage output and the PSS750 input, and connect the variable resistor in parallel with the PSS750 input.
6. Set the SVERKER 750/760 for phase (and impedance) measurement. Connect the voltage measurement input to the PSS750 input.
7. Start the test with the resistor in maximum position. Gradually decreasing the resistor gives increasing phase shift in the voltage signal. The test voltage/impedance will decrease at the same time so an adjustment of the test current might be necessary to get the correct impedance. Please observe that the phase shift depends on the input resistance and may vary between different relays. Some relays may also have a low voltage limit where the relay will not operate. For additional 180 degrees phase shift use the phase reversal switch.

SVERKER Win

PC software for SVERKER 750/760

The SVERKER Win software makes fieldwork easier while providing neater reports. The SVERKER Win software enables you to control the SVERKER from a PC. The SVERKER is connected to the PC's serial port. Test results can be reported either directly with table and graph, or from an external program, e.g. Microsoft® EXCEL.

SVERKER Win enables customised reports in an easy way. Very useful are the reference graphs, together with the current/voltage graph presentation for each test point during the test. The graph can of course be printed out on the test report if you like.

A new feature is the ready-made current curves available for many relay types.

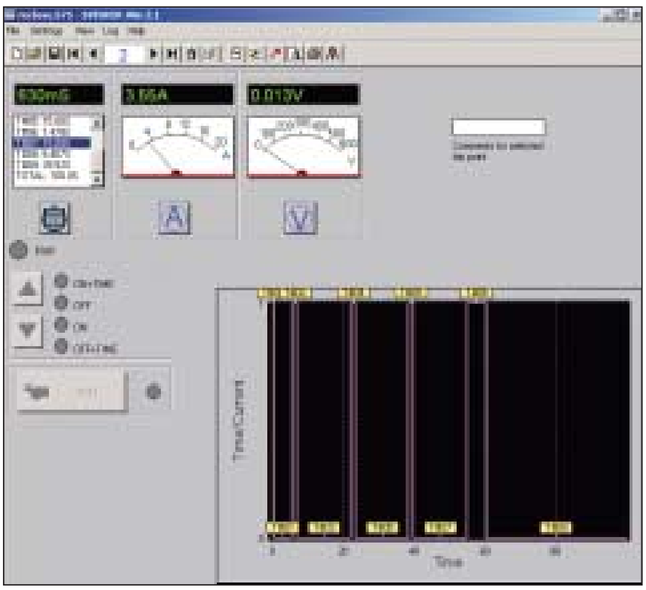
During relay testing, each measured value is stored in a log list. In this list you can add comments to each test point. When the entire test is finished, you can save everything as a data file. Later, you can print out the test results. You save time by not having to write your report in the field. All report writing can be done conveniently back at the office.

The SVERKER Win software provides easy access to connection instructions, test instructions and the like, which you prepare in advance. These instructions, which can contain both text and graphics, can be prepared using standard word processing packages.

The settings you make on SVERKER are also saved in a file, so that the next time you want to test the same or similar protective relay equipment, all you have to do in order to set-up the SVERKER, is to open the file.

Specifications SVERKER Win

The SVERKER Win software comprises a 32-bit program written to run under Windows® 95/98/2000/NT/XP. We recommend a Pentium® computer with at least 16 MB of RAM. The amount of space needed to save reports and settings will depend on how many protective systems that are to be tested. Roughly estimated, you will thus need a total of about 20-100 MB of free space on the hard disk. Languages in SVERKER Win are: Czech, English, French, German, Spanish and Swedish.



SVERKER Win

Specifications SVERKER 750 / 760

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 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, 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	
SVERKER 750	17.3 kg (38.1 lbs) 26.3 kg (58 lbs) with accessories and transport case
SVERKER 760	17.9 kg (39.5 lbs) 26.9 kg (59.3 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 mm^2 2 x 0.5 m (1.6 ft), 2.5 mm^2 8 x 2.0 m (6.6 ft), 2.5 mm^2
Test leads with spade-tonge connectors	2 x 3.0 m (9.8 ft), 10 mm^2
Display	LCD
Available languages	English, French, German, Spanish and Swedish

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 1000-59999 cycles at 60 Hz	1 cycle	±(1 cycle + 0.01 %)

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 [1]	10 µF, max voltage 450 V AC

1) Measurement intervals longer than 100 ms. 2) SVERKER 750

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	1 sec / 5 minutes

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

SVERKER 750

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.

SVERKER 760

Range	*No-load voltage (min)*	*Full-load voltage (min)*	*Full-load current (max)*
0 – 130 V AC	140 V	130 V	0.25 A cont. 0.35 A, 1 minute

Phase angle	*Resolution*	*Inaccuracy*
0 – 359°	1°	±2°

Auxiliary DC output

Range	*Voltage*	*Max. current*
20 – 130 V DC	20 V DC 130 V DC	300 mA 400 mA
130 – 220 DC	130 V DC 220 V DC	235 mA 400 mA

Ordering information

SVERKER 750	Art.No.
Complete with: Test lead set GA-00030 Transport case GD-00182	
115 V Mains voltage	**CD-11190**
230 V Mains voltage	**CD-12390**
SVERKER 760	
Complete with: Test lead set GA-00030 Transport case GD-00182	
115 V Mains voltage	**CD-21190**
230 V Mains voltage	**CD-22390**
Optional accessories	
SVERKER Win PC Software Please specify the SVERKER serial number when ordering. SVERKER Win contains software, a copy-protection key and a cable used to connect 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**
PROM* update, done by GE Energy	**CD-89010**
PROM* update, done by customer	**CD-89011**
* SVERKER Win requires PROM-version R04A or higher	
CSU20A Complete with cables and transport case 115 V Mains voltage	**BF-41190**
CSU20A Complete with cables and transport case 230 V Mains voltage	**BF-42390**
PSS750	**CD-90020**


Test lead set

SVERKER 650™

Relay Testing Unit

The Sverker 650™ 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.

SVERKER 650™ features logical design and construction, and it is extraordinarily easy to learn and use. Its compact design and light weight makes it extremely portable.

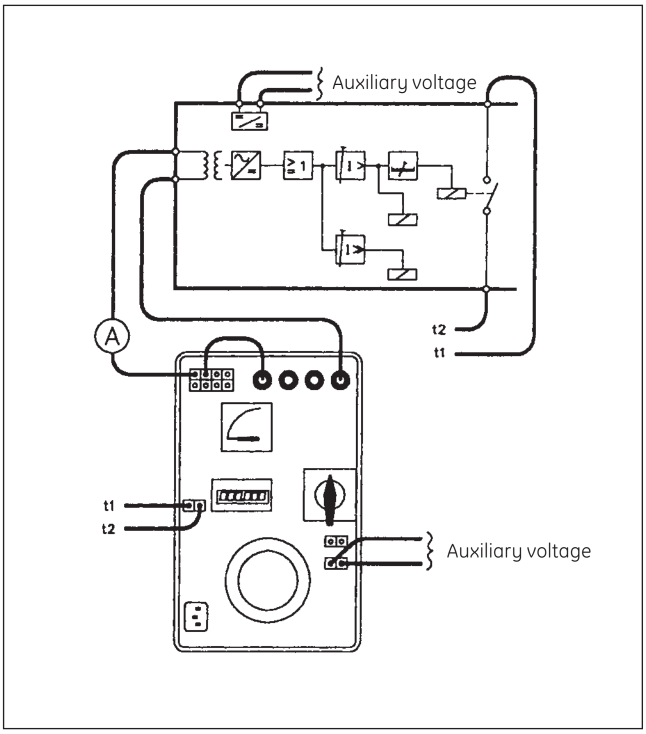
Auxiliary equipment for SVERKER 650™ includes a test lead set and a rugged transport case. Another useful accessory is the ACA120™ voltage source which makes it easier to test directional relays.

Application example

IMPORTANT!

Read the User's manual before using the instrument.

1. Set the desired auxiliary voltage using SVERKER 650.
2. Connect the current and time measurement circuits.
3. Increase the current until tripping occurs.
4. Decrease the current until reset occurs (for the I> function).
5. Increase the current to 1.2-1.5 times the I> function value (1.1-1.2 times the I> function value).
6. Zero-set the timer and power down SVERKER 650.
7. Power up SVERKER 650 (in the timing mode) and make a note of the function times.
8. Repeat steps 3 and 5-7 above but for the I>> function.



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	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, 50 / 60 Hz
Power consumption (max)	1100 VA
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 4 mm stackable safety plugs	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 2.0 m (6.6 ft), 2.5 mm^2
Test leads with spade-tonge connectors	2 x 3.0 m (9.8 ft), 10 mm^2

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.

Optional accessories

ACA120 - Variable voltage source

The ACA120 voltage source provides a variable output voltage of 0 to 120 V AC. This makes it easier to test directional protection using SVERKER 650. Power is supplied from the relay testing unit's 110 V AC output. Housed in a small plastic case. Maximum output current is 90 mA.
Dimensions: 80 x 150 x 65 mm (3.1" x 5.9" x 2.6")
Weight: 0.6 kg (1.3 lbs)

Ordering information

SVERKER 650	Art.No.
Complete with: Test lead set GA-00030 Transport case GD-00010	
115 V Mains voltage	**BA-11190**
230 V Mains voltage	**BA-12290**

Optional accessories

ACA120	**BA-90040**

Test lead set

ACA120

FREJA 300™

Relay Testing System

The Freja 300™ relay testing system is a computer-aided relay testing and simulation system. The weight of FREJA 300™ 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.

FREJA 300™ can be operated with or without a PC. After being put into the Local mode, FREJA 300™ 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. FREJA 300™ can generate 4x150 V (82 VA) and 3x15 A (87 VA) or 1x45 A (250 VA), or with the optional external amplifier CA3, six currents. 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.

FREJA 300™ 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 (and edit the wave forms), by using the FREJA SIM™ Disturbance Simulator Software. With the built-in DC source you can supply the relay protection.

Application

Relay Testing

FREJA 300 is intended primarily for secondary testing of protective relay equipment. Virtually all types of protection relays can be tested.

Examples of what FREJA 300 can test	IEEE® No.
Distance protection equipment	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 protective relays	78
Automatic reclosing devices	79
Frequency relays	81
Differential protective relays	87
Directional voltage relays	91
Voltage and power directional relays	92

Operation

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.

With a PC - FREJA WIn

FREJA Win Control center

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.

General

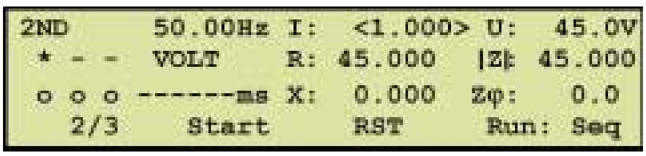
The all-round General instrument program serves as a convenient, easy to understand, user-friendly toolbox. On the Connect page, you can enter information about how to connect the relay, including pictures if so desired.

On the Sequence page, you can vary all generator parameters independently. You can have up to 25 different states (prefault, fault1, fault2, fault3 etc.). This is useful when testing autoreclose relays or motor protection.

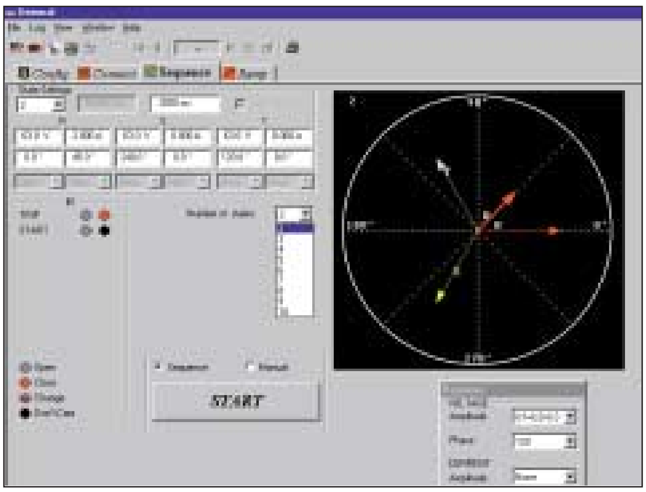
On the Ramp page, you can ramp all generator parameters independently. Amplitudes and angles are shown on a vector diagram, and values can be set with a dial, keyboard or mouse. It's also possible to generate up to the 25th harmonic.

Control center

Local Mode General



Local Mode Rx (I)



General Instrument

Distance

The Distance instrument program is designed to test distance relays. On the Configuration page, you enter the number of zones that are to be tested and also the time and impedance tolerances, thereby creating an automatic test. No programming is needed. Later, when you recall this object via the Control center, all settings are re-established so that you can start testing immediately.

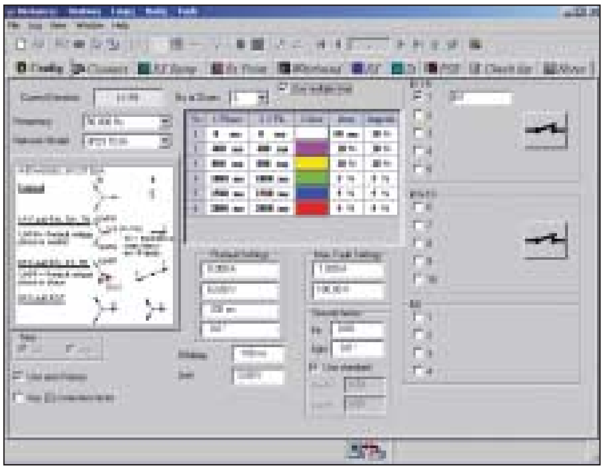
On the Connect page you enter information about how to make connections to the relay, including pictures if so desired. Since this information is saved together with the object in the Control center, it can be displayed again the next time you want to test this relay.

The Zt page is designed for time testing of a distance relay. Normally, you test one type of fault at a time when testing relays. With FREJA Win, however, you can test all seven fault types automatically if so desired. All you have to do is press the <Start> button. FREJA will test all seven fault types automatically and then compare the readings with the theoretical values that you entered on the Configuration page. If the readings are OK, a green lamp lights. If not, a red lamp lights. If you want to check the reverse direction, the test can start below zero ohms in the 3rd quadrant.

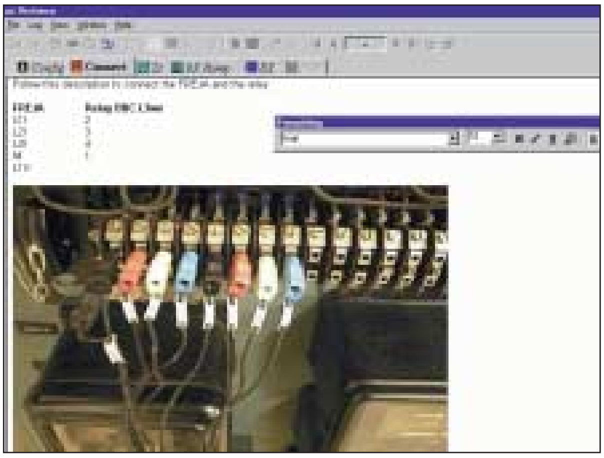
The RX-ramp page, which is part of the Distance instrument program, is designed to test the reach of a distance relay. First, you define the start and stop angles and the delta phi between the ramps. Then press the <Start> button and relax. FREJA will automatically test all seven types of faults using the timesaving "search-half" method. You can also define your own ramps, using the mouse to specify starting and ending points wherever desired. If you have defined a theoretical reference graph, the program will compare the actual test result with your graph and check for any deviations from the tolerances entered on the Configuration page. If the results are OK, a green lamp lights. If not, a red lamp lights.

The RX page enables you to define test points manually. You can define different points on the oscilloscope using the mouse or keyboard. Select the automatic mode and press the <Start> button. FREJA will test all points for the selected fault types. The points will be assigned different colors, depending on the trip time. If you select the manual mode, you can use the dial to search for a boundary.

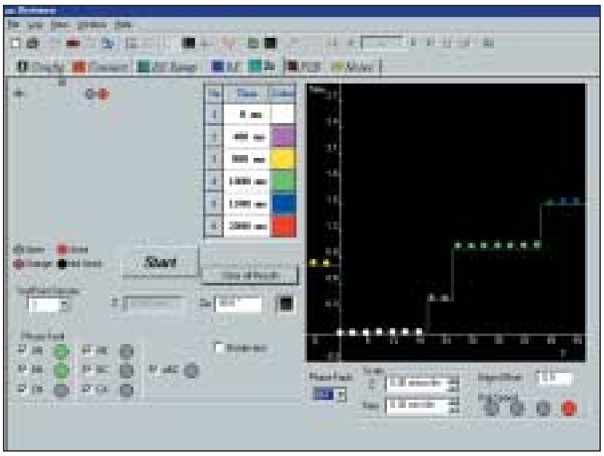
The RX point page, a new feature in FREJA Win 5.2, speeds up the reach tests.



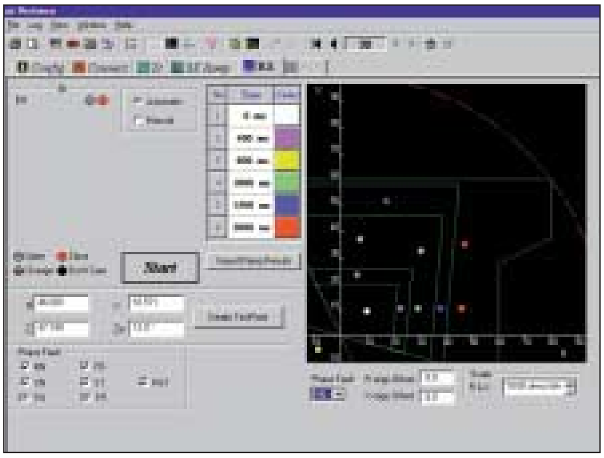
Distance, Config



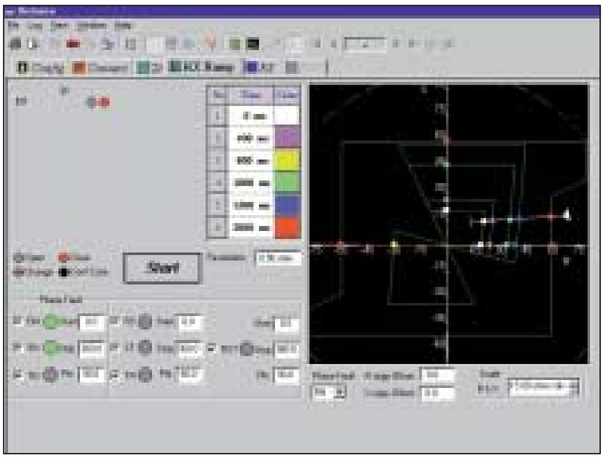
Distance, Connect



Distance, Zt



Distance, RX



Distance, RX ramp

Reference graphs

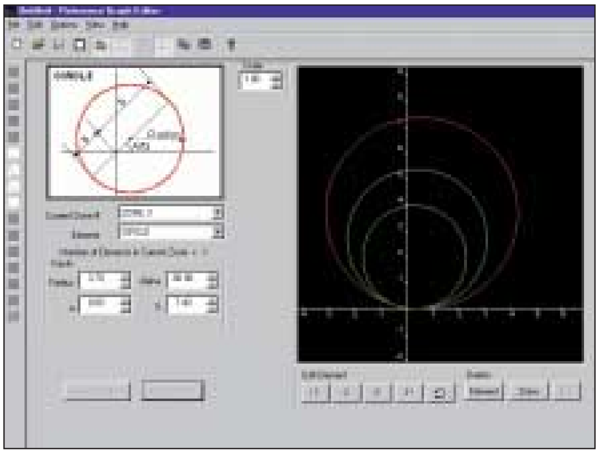
Efficient testing and performance analysis require well-defined reference values. FREJA can automatically create the IEC and IEEE® standard curves for overcurrent relays. It is also possible to create reference graphs in the impedance plane using the included library of distance relays made by major manufacturers and/or create other characteristics using the standard circular lens and linear elements (including mho, quadrilateral and ice-cream cone shapes).

The cut and paste buttons make it easy to take copies of the first zone and then edit these copies by inserting zone 2 and zone 3 values.

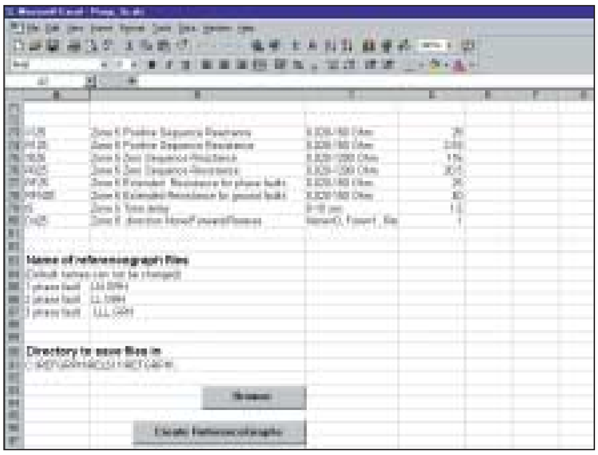
State-of-the-art distance relays having sophisticated impedance characteristics and several setting groups require many parameter settings. The optional ProGraph feature enables you to import the parameter settings from a master selectivity plan prepared in Microsoft® Excel. This eliminates manual transfer errors, and the FREJA software creates the reference graph automatically.

Some relay manufacturers can create a RIO-file with the settings of the relay. Using the FREJA RIO-converter you can create reference graphs based on these settings.

A new feature is the ready-made current curves available for many relay types.



Edit a reference graph



Prograph

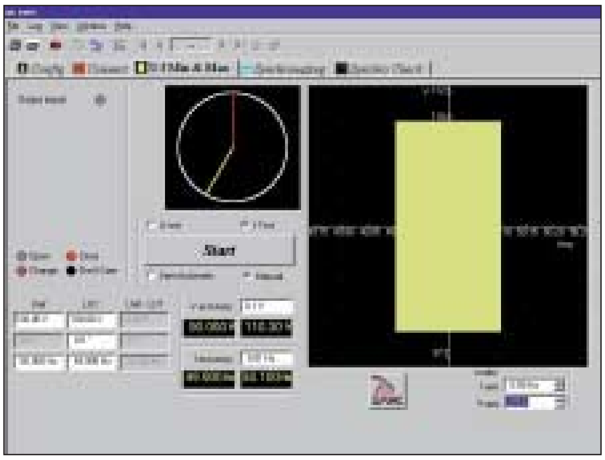
Sync

The U-f Min & Max part of the Sync instrument program is designed especially to test voltage and frequency boundaries for a synchronizing relay. This test is carried out automatically. Simply press the <Start> button, whereupon the program itself searches for the boundaries.

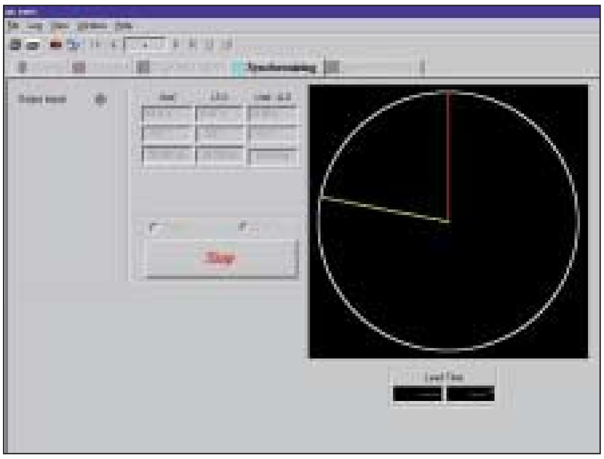
The Synchronizing page is designed to measure lead-time. It also enables you to measure the pulses sent out from the synchronizing relay.

The Synchro Check page is designed to test synchrocheck relays.

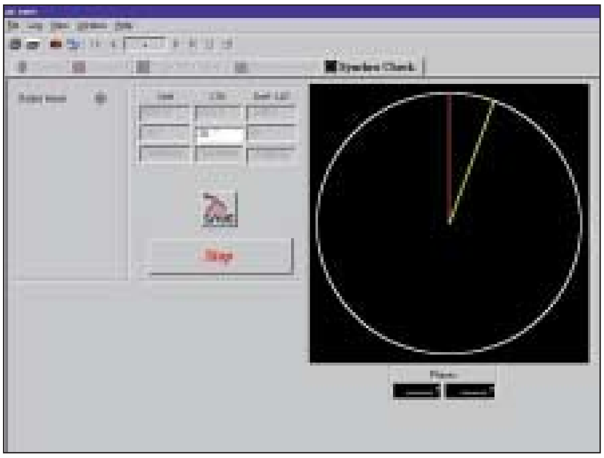
First set the phase angle to +20° (or some other starting point). Then change the phase angle until you reach the boundary. You press the <Save> button to store the result. Now test on the other side, starting at -20°, change the phase angle until you reach the other boundary.



Sync, U-f Min & Max



Sync, Synchronizing



Sync, Synchro Check

❶ Binary inputs.

❷ Binary outputs (normally-closed and normally-open).

❸ Display and buttons used in the Local Mode.

❹ Dial, press to Enter.

❺ Multiconnector for voltage (L1U, L2U, L3U, NU) and current (L1I, L2I, L3I, NI).

❻ Current and voltage outputs.

❼ Switch, PC to Freja 300 or relay.

❽ DC-supply, connect to (11) to read the values (in General mode page 5/6 on the display).

❾ Analog inputs, LOW, for measurement transducers.

❿ Fuse (50 mA) at the bottom, for Analog inputs LOW (9).

⓫ Analog inputs, HIGH, for volt- and ammeter.

Remote control

Test lead set

Optional accessories

Remote control
Remote control with cable, 3 m (10 ft), for the dial.

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.
Normally two sets of this type is needed.
Weight: 0.8 kg (1.8 lbs)

FREJA 300 Multi-cable
Shortens hookup time considerably. Consists of a multi-pole connector that connects to FREJA 300's three voltage and three current outputs, and a number of banana plugs that connect to the protective relay equipment that is to be tested.

Current amplifier CA3
Three-phase current amplifier. For higher output power and current. See section "CA3/CA1" for more information.

Current amplifier CA1
Single-phase current amplifier. For higher output power and current. See section "CA3/CA1" for more information.

GPS100
The GPS100 makes it possible to synchronize two or more FREJA 300s to conduct end-to-end testing. End-to-end testing provides quick, reliable results showing how two or more protective relay systems interact. The GPS100 includes a power pack, an antenna with 20-metre cable and a carrying case.

Transient instrument (SW)
The Transient instrument is used to generate transient waveforms from a disturbance recorder.

Transducer instrument (SW)
Transducers are used to measure e.g. current, voltage, power, phase angle or frequency. The output from the transducer is then either a DC voltage or a DC current. Standard ranges are 0-10 V or 4-20 mA, and in some cases also 0-1 mA.

The transducers input signals are connected to FREJA's voltage and/or current generators. The transducer's output signal is connected to the Low Analog input. The accuracy of the measurement is very high.

You can test all different types of transducers in a fully automatic way. Just press START, and the program will test the transducer and present the full scale, absolute, and relative error. In the report you get both graphs, and a table of the result.

Auto 21 instrument (SW)
The AUTO21 converts FREJA RTS 11, 21, 21D and FREJA 300 DOS testplans to FREJA 300 Windows®. This will make it possible to run and printout in a Windows® environment.

FREJA Win ProGraph
Automatic reference graph program.
Contact GE Energy for more information.

Soft transport case for FREJA 300/CA3
Dimensions: 470 x 440 x 190 mm (18.5" x 17.3" x 7.5")
Weight: 1.8 kg (4 lbs)

Multi cable

GPS100

Specifications FREJA 300

Specifications are valid for resistive load, nominal voltage supply and ambient temperature +25°C ±3°C, (77°F ±5.4°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 a +50°C (32°F a +122°F)
Storage & transport	-40°C a +70°C (-40°F a +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 input (nominal)	90 – 264 V AC, 47 – 63 Hz
Power consumption	600 VA typical (1200 VA max.)
Dimensions	
Instrument	450 x 160 x 410 mm (17.7" x 6.3" x 16.1")
Transport case	560 x 240 x 575 mm (22" x 9.5" x 22.6")
Weight	
Instrument	15 kg (33.1 lbs)
Transport case	7.5 kg (16.5 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, 240 V AC
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	***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

Measuring range	±20 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	±10 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	±14 A DC, 10 A ACRMS
Inaccuracy	DC <0.1%, AC <0.3%

AC / DC voltage measuring input, HIGH [1)]

Measuring range	±220 V DC, 150 V ACRMS
Inaccuracy	DC <0.05%, AC <0.2%

Measurement, internally generated values

Inaccuracy	
Voltage AC / DC	<1% ±1digit
Current AC / DC	<2% ±2digit

Binary outputs

Number	2 x 4 (NO & NC)
Type	Zero-potential contacts, controlled via software
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 (ROGOW)

Setting range	
LLU	3 X 0...2 VRMS
LLI	3 X 0...2 VRMS
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

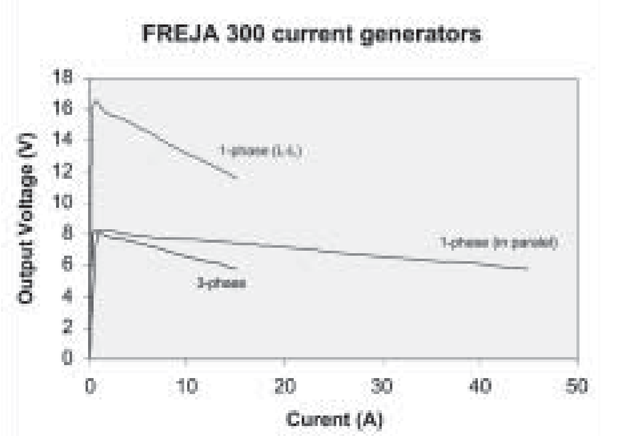
Generator section

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)*	(±0.01% of range) + (±0.05% of reading)
Distortion (THD+N) [2)]	0.02% typical (0.04% max)

Current outputs [4)]

Range	
3-phase AC	3 x 15 A
1-phase AC [5)]	1 x 45 A
DC (L-N)	15 A
Power	
3-phase AC	3 x 87 VA
1-phase AC [5)]	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) [2)]	0.1% typical (0.2% max)



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

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, NT 4.0) via the serial port. The FREJA has a built-in switch that enables you to switch communication back and forth between the PC and your relay.

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) For higher current or output power you can use amplifier CA3.
5) Parallel connection.

Ordering information

FREJA 300	Art.No.
Complete with: FREJA Win Standard Freja 300 PC software key Two test lead sets Calibration box Hard transport case	CF-19091
Same as above but with soft transport case	CF-19090
FREJA 300 Basic Unit	
Incl. calibration box	CF-19000
FREJA 300, LLA (Rogowski option)	
Complete with: FREJA Win Standard Freja 300 PC software key Two test lead sets Calibration box Hard transport case	CF-19095
Same as above but with soft transport case	CF-19094
FREJA 300 Basic Unit, LLA	
Incl. calibration box	CF-19004
Optional accessories	
FREJA Win Standard, with software key	CF-8203X
Upgrade FREJA Win Standard	CF-8282X
Transient instrument (SW)	CF-8214X
Transducer instrument (SW)	CF-8215X
Auto 21 instrument (SW)	CF-8221X
FREJA Win ProGraph Automatic reference graph program. Contact GE Energy for more information.	
Current amplifier CA3	CA-19090
Current amplifier CA1	CB-19090
GPS100	CF-90050
Remote control	CF-90010
FREJA 300 Multi-cable	GA-00103
Test lead set	GA-00032
Soft transport case for FREJA 300/CA3	GD-00215


Calibration box

CA3™/CA1™

Current Amplifiers

Higher voltages are often needed to provide test currents for older electro-mechanical relays. The three-phase switched current amplifier designated CA3™ solves this problem. It can provide 3 x 30 A or 1 x 60 A connected in parallel. Maximum output power is 600 VA (3 x 25 A at 8 V). If higher voltage is needed, you can make the connection between two phases (L-L).

If a higher voltage is needed than the CA3™ can provide, or if you want to use a single-phase current amplifier, you should choose the CA1™. If you need even higher current, two or more current amplifiers can be connected in parallel, thus bringing the output current up to 180 A.

The current amplifiers can also be used in situations where more current generators are needed than the three built into FREJA™. Since the amplifiers can be controlled by both current and voltage, they can be connected to FREJA's voltage generators. The number of current generators can thus be increased to six, which is convenient when testing differential relays.

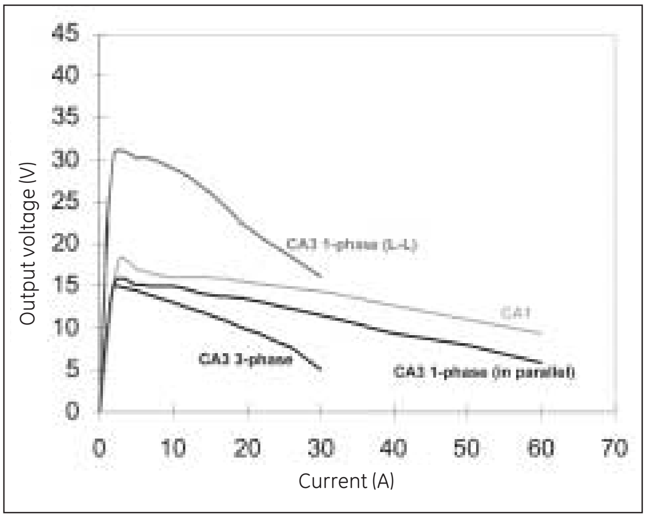
Specifications CA3/CA1

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	
CA3	0°C to +50°C (32°F to +122°F)
CA1	0°C to +45°C (32°F to +113°F)
Temperature storage & transport	-40°C to +70°C (-40°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	
CA3	105 – 264 V AC, 47 – 63 Hz
CA1	115 / 230 V AC (switchable), 50 / 60 Hz
Power consumption (max)	
CA3	1200 VA
CA1	1800 VA
Dimensions Instrument	
CA3	450 x 132 x 410 mm (17.7" x 5.2" x 16.1")
CA1	500 x 300 x 245 mm (19.6" x 11.8" x 9.6")
Dimensions Transport case	
CA3	570 x 240 x 560 mm (22.4" x 9.4" x 22.0")
CA1	710 x 410 x 300 mm (28.0" x 16.1" x 11.8")
Weight	
CA3	11 kg (24 lbs)
CA1	20 kg (44 lbs)

Current outputs

	CA3	CA1
Setting range		
3-phase AC	3 x 0 – 30 A (symmetrical phases)	–
1-phase AC	1 x 0 – 60 A (generators in parallel)	1 x 0 – 60 A
3-channel DC	3 x ±20 A	–
1-channel DC	–	1 x ±60 A
Power		
3-phase AC	600 VA, 3 x 200 VA (8 V at 25 A)	–
1-phase AC (L-L)	1 x 480 VA at 30 A (16 V)	–
1-phase AC	1 x 400 VA at 50 A (8 V) (generators in parallel)	560 VA, 9.3 V at 60 A
Time limits		
Continuous	0 - 7 A	0 - 20 A
10 s	> 7 A	20 - 60 A
Phase inaccuracy	0.4° ±0.2° at 50 Hz 0.5° ±0.2° at 60 Hz	± 0.3°
Distortion	1% max, 0.1% typical	2% max, 0.5% typical
Inaccuracy	± (0.4% of actual value + 0.1% of range)	± (1% of actual value + 0.2% of range)



Ordering information

CA3	Art.No.
CA3 including hard transport case GD-00210	**CA-19090**
CA1	
CA1 including hard transport case GD-00170	**CB-19090**
Optional accessories	
Soft transport case for CA3	**GD-00215**

PAM360™

Phase Angle Meter

The PAM 360™ phase angle meter is designed to test for example directional protection relays and to conduct directional tests on instrument transformers.

Since precise accuracy and versatility were given top priority by designers of the compact and handy PAM360™, its capabilities are equal to those of its heavier and more expensive competitors.

Thanks to fine resolution and high accuracy, the PAM360™ is also ideal for testing sensitive distance protection. It has a broad range and can sense either current or voltage. Moreover, the PAM360's inputs are galvanically separated from each other and from the mains.

Its many outstanding features make the PAM360™ a highly versatile instrument, and it is priced competitively.

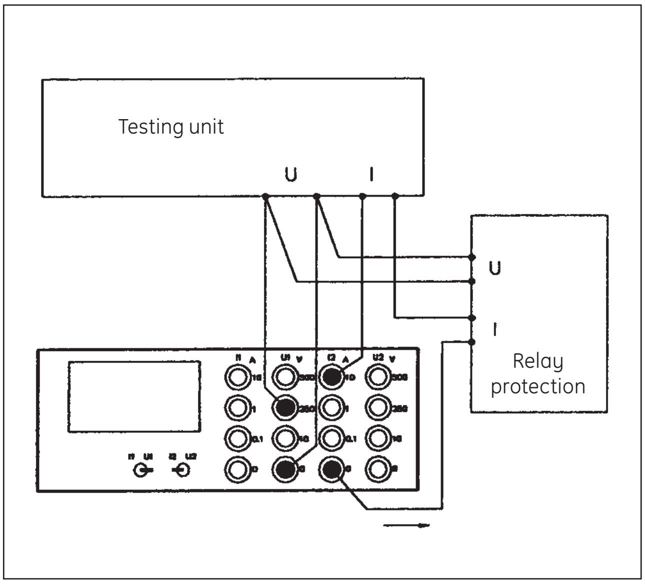
The PAM360™ is delivered complete with test lead set in a handy transport case.

Application example

IMPORTANT!
Read the User's manual before using the instrument.

Directional test of relay protection

1. Connect PAM360 inputs U1 and I2 to the testing unit (SVERKER for example) and the relay protection.
2. Select U1 and I2 on the toggle switches.
3. Use the testing unit to trip the protective relay equipment.
4. Check that the relay trips within the specified angle range by reading the angle shown on the PAM360's display.



Specifications PAM360

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 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, 50 / 60 Hz
Power consumption (max)	3 W
Dimensions	
Instrument	180 x 180 x 70 mm (7.1" x 7.1" x 2.8")
Transport case	350 x 280 x 90 mm (13.7" x 11" x 3.5")
Weight	2.1 kg (4.6 lbs) 3.1 kg (6.8 lbs) with accessories and transport case.
Test lead set, with 4 mm stackable safety plugs	4 x 2 m (6.6 ft), 2.5 mm^2
Display	LCD, 4 digits, 12.7 mm (0.5") high
Measurement section	
Range	0 – 359.9°
Type of phase angle measurement	Current-current, voltage-voltage and current-voltage
Wave form	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)
Inputs	
Current inputs	
Range	0.002 – 10 A. Range can be increased by means of a clamp-on current transformer.
Voltage inputs	
Range	0.2 – 500 V

Ordering information

PAM360	Art.No.
Complete with: Test lead set GA-00082 Transport case 50-00100	**BP-19090**

MAGNUS™

Step-Up Transformer

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.

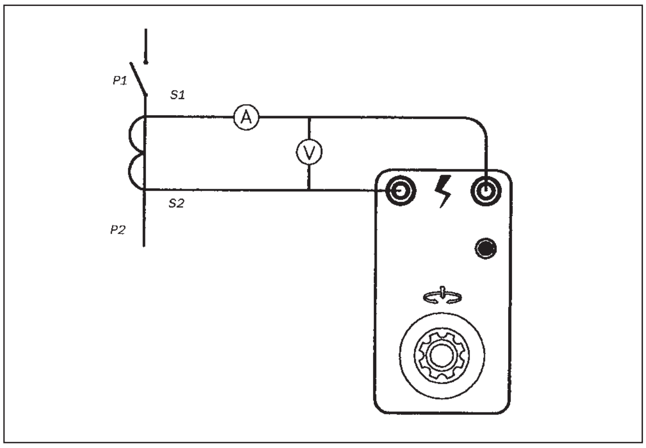
As standard, MAGNUS™ is delivered with a special high-voltage cable and a robust transport case.

Application example

IMPORTANT!
Read the User's 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.



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 (CAT I)

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.

Specifications MAGNUS

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 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, 50 / 60 Hz
Power consumption (max)	2300 VA
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

Ordering information

Magnus	Art.No.
Complete with: Cable set GA-00090 Transport case GD-00182	
115 V Mains voltage	**BT-11190**
230 V Mains voltage	**BT-12390**

Cable set GA-00090

Testing circuit breakers

High voltage circuit breakers are extremely important for the function of modern electric power supply systems. The breaker is the active link that ultimately has the role of quickly opening the primary circuit when a fault has occurred. Many times, the breaker has to perform its duty within a few milliseconds, after months, perhaps years of idly standing by. Since RCM and condition based maintenance have become the established strategies for most owners and operators of electric power supply systems, the need for reliable and accurate field test instruments is obvious.

Ever since its introduction in 1984 of the first microprocessor based breaker analyzer on the world market, GE Energy has taken the lead in portable test instruments for high voltage circuit breakers. Over the years, many new user requirements have lead GE Energy to innovate new solutions to provide test engineers in the field with effective tools for determining the status of circuit breakers.

Different maintenance strategies

If a maintenance strategy that is strictly corrective is adopted, no attempts are made to deal with a developing circuit breaker fault before it becomes fatal. This does not, however, ensure the reliable supply of electric power that consumers are entitled to expect. Short-term savings in maintenance costs will soon be eaten up by the cost of the damage and the cost of correcting a fault.

Preventive maintenance - which includes inspection, testing, overhauls and modifications - is a strategy that is encountered more frequently.

In time interval-based maintenance, a number of specific measures are taken at predetermined times, regardless of the conditions under which a circuit breaker operates. If this method is applied too strictly, however, it may lead to needless intervention. Disassembling a circuit breaker that has no faults entails needless expense, and it does not improve reliability.

Condition-based maintenance is being used more and more. Here, you ascertain the condition of a circuit breaker through testing and inspection. The results, supplemented with statistical data and cumulative experience, are then used to plan maintenance for the circuit breaker in question. The breaker's need for maintenance is based less on time than on the conditions to which it is exposed, how frequently it operates and its environment. Condition-based maintenance provides excellent opportunities to improve reliability and cut costs, but it requires effective diagnostic methods. Many circuit breakers provide longer service lives than expected. If you can ascertain that a breaker is in good condition, you can continue to use it rather than replace it. Here too, however, effective diagnostic methods are of prime importance.

Circuit Breaker Testing

Before a new circuit breaker is delivered, it is tested at the factory. After it has been installed, it is submitted to a commissioning test before being taken into service. Thereafter, it is inspected and tested on different occasions. Usually, a circuit breaker has to be taken out of service in order to test it.

The following parameters are often tested on a circuit breaker: closing time, opening time, resistance of the main contacts and synchronization of contact operation. Contact travel and speed are also tested (as recommended in the IEC 62271-100 and IEEE® C37.09 standard and other literature). Some other methods for circuit breaker diagnostics are dynamic resistance and vibration testing. Moreover, checks are made to see that the solenoids and latches operate properly. This is done by measuring the lowest breaker operating voltage and checking the shape of the coil current curve.

Measured values are compared with limit values specified by the manufacturer or values that have been arrived at by the maintenance organization through experience. In many cases, a "fingerprint" consisting of different measurements taken when a breaker is new is compiled. This fingerprint can then be used as a reference for subsequent measurements. Any change that is found clearly indicates a change in the breaker's condition.

TM1800™

Circuit Breaker Analyzer System

The TM1800™ is a recently developed instrument platform for circuit breaker maintenance, based on 20 years' experience of over 4,000 delivered breaker analyzers. The modular construction makes it possible to configure the TM1800™ for measurements on all known types of breaker in operation on the world market.

The robust design contains powerful new 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.

A new type of timing channel with high analog resolution can not only measure contact timing, but also provide resistance values for series resistance and main contacts. A highly capable, easy-to-use piece of software supports everything from timing using a simple knob without the need for presettings, to advanced help functions for hooking up to the test object.

The system also offers full connection capability to the local network, printers etc

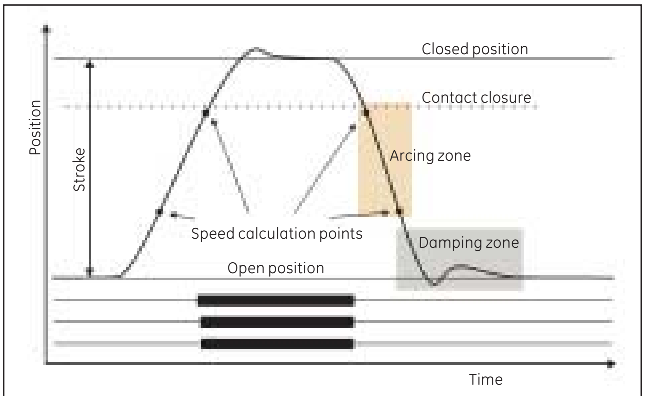
Application

Timing Measurements

Simultaneous measurements within a single phase are important in situations where a number of contacts are connected in series. Here, the breaker becomes a voltage divider when it opens a circuit. If the time differences are too great, the voltage becomes too high across one contact, and the tolerance for most types of breakers is less than 2 ms. The time tolerance for simultaneous measurements between phases is greater for a 3-phase power transmission system running at 50 Hz since there is always 6.67 ms between zero-crossovers. Still, the time tolerance is usually specified as less than 2 ms, even for such systems. It should also be noted that breakers that perform synchronized breaking must meet more stringent requirements in both of the previously stated situations. There are no generalized time limits for the time relationships between main and auxiliary contacts, but it is still important to understand and check their operation. The purpose of an auxiliary contact is to close and open a circuit. Such a circuit might enable a closing coil when a breaker is about to perform a closing operation and then open the circuit immediately after the operation starts, thereby preventing coil burnout. The a contact must close well in advance of the closing of the main contact. The b contact must open when the operating mechanism has released its stored energy in order to close the breaker. The breaker manufacturer will be able to provide detailed information about this cycle.

Motion Measurements

A high-voltage breaker is designed to interrupt a specific short-circuit current, and this requires operation at a given speed in order to build up an adequate cooling stream of air, oil or gas (depending on the type of breaker). This stream cools the electric arc sufficiently to interrupt the current at the next zero-crossover. It is important to interrupt the current in such a way that the arc will not re-strike before the breaker contact has entered the so-called damping zone. Speed is calculated between two points on the motion curve. The upper point is defined as a distance in length, degrees or percentage of movement from a) the breaker's closed position, or b) the contact-closure or contact-separation point. The time that elapses between these two points ranges from 10 to 20 ms, which corresponds to 1-2 zero-crossovers. The distance throughout which the breaker's electric arc must be extinguished is usually called the arcing zone. From the motion curve, a velocity or acceleration curve can be calculated in order to reveal even marginal changes that may have taken place in the breaker mechanics. Damping is an important parameter for the high energy operating mechanisms used to open and close a circuit breaker. If the damping device does not function satisfactorily, the powerful mechanical strains that develop can shorten breaker service life and/or cause serious damage. The damping of opening operations is usually measured as a second speed, but it can also be based on the time that elapses between two points just above the breaker's open position.



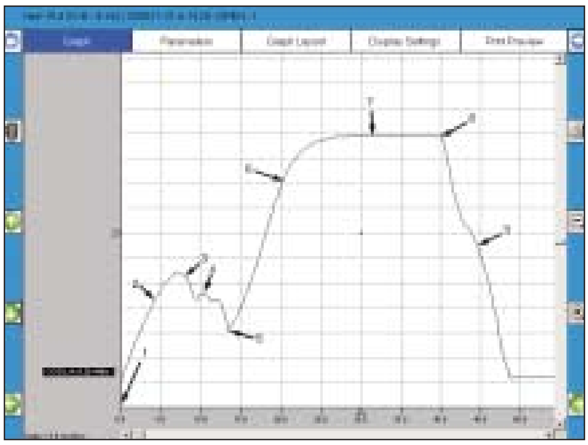
Motion Curve

Coil Currents

These can be measured on a routine basis to detect potential mechanical and/or electrical problems in actuating coils well in advance of their emergence as actual faults. The coil's maximum current (if current is permitted to reach its highest value) is a direct function of the coil's resistance and actuating voltage. This test indicates whether or not a winding has been short-circuited. When you apply a voltage across a coil, the current curve first shows a straight transition whose rate of rise depends on the coil's electrical characteristic and the supply voltage (points 1-2). When the coil armature (which actuates the latch on the operating mechanism's energy package) starts to move, the electrical relationship changes and the coil current drops (points 3-5). When the armature hits its mechanical end position, the coil current rises to the current proportional to the coil voltage (points 5-8). The auxiliary contact then opens the circuit and the coil current drops to zero with a current decay caused by the inductance in the circuit (points 8-9). The peak value of the first, lower current peak is related to the fully saturated coil current (max current), and this relationship gives an indication of the spread to the lowest tripping voltage. If the coil was to reach its maximum current before the armature and latch start to move, the breaker would not be tripped. It is important to note, however, that the relationship between the two current peaks varies, particularly with temperature. This also applies to the lowest tripping voltage.

Dynamic Resistance Measurement (DRM)

The main contact resistance during operation is obtained by DRM. DRM is mainly used for determination of arcing contacts shortening.



1 Trip coil energized
2-3 Armature travel
3-4 Armature operates trip latch
4-5 Armature completes its travel
5 Armature hits stop
6 Change in coil inductance
7 Proportional to DC coil resistance
8 Auxiliary contact opens
9 Current decay

Example of coil current on circuit breaker

Modular design

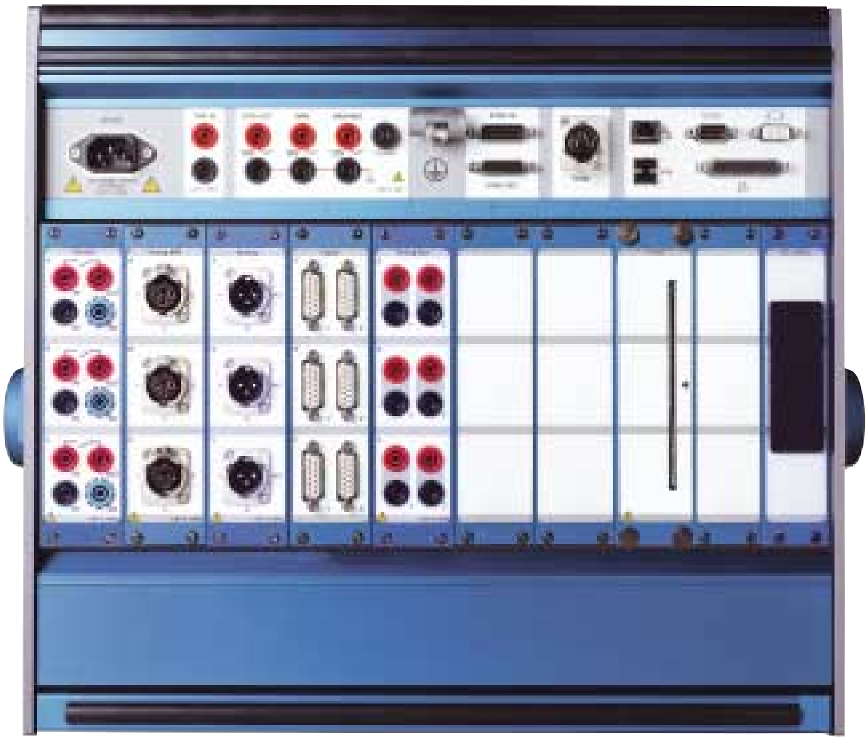
Basic Unit

TM1800™ has a modular design that makes it very flexible to user needs. You can configure the Basic Unit to a complete test set with the types of modules you need, for a specific test as-well as for general needs. The modularised design enables any user to upgrade or reconfigure the hardware for improved/new functionality.

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.

On the top panel of the basic unit are the following inputs and outputs:

- 8 user configurable slots for modules
- Mains input
- Trig inputs and outputs
- Outputs for warning signal
- Earth (Ground) Connection
- Communication interfaces (USB, Ethernet, RS232, LTP and VGA)



Control Module

Generates the selected circuit breaker sequences accurate and bounce-less when the TM1800 is operated. The Control Module can be configured to operate any close and trip coil to perform the programmed sequence and measure important parameters during the sequence like current, voltage, resistance and auxiliary contact timing. Two control modules can be used to control the breaker and measure coil current, control voltage, coil resistance and auxiliary contact timing for each phase on one phase operated circuit breakers.

- Three independent contact functions per module
- Pre-programmed sequences C, O, C-O, O-C, O-C-O
- All sequence settings are user configurable in CABA Local (internal software)
- Timing of a and b auxiliary contacts

Timing M/R Module

Introduces the new generation of timing measurements with an analog design that enables a more accurate and faster testing of circuit breaker parameters. The Timing M/R module uses one hook-up for testing all the important timing parameters of an interrupter without the need of reconnections or special set-ups. One Timing M/R module will measure up to six interrupters including linear PIR contacts timing and present the result individually for each contact.

The Timing M/R also measures the voltage drop when DRM is performed without need of time consuming and hazardous reconnections since the same test leads are used for both timing and voltage measurement.

- Six channels per module
- Main contact timing
- Parallel resistor contact timing
- Resistance value of parallel resistors

Analog Module

The Analog module measures any analog entity from a transducer mounted on a circuit breaker. It enables measurements of motion, speed, current, voltage, pressure, vibration etc. With the flexible and easy to use interface it makes motion measurement of a circuit breaker like a walk in the park.

- Three channels per module
- 10 V and 24 V output
- Input range 4-20mA
- Supports industrial analog transducers

Printer Module

The Printer module offers a convenient and practical way of making printouts of test results directly from the TM1800. 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. Printouts can also be made on any external printer via the parallel (LPT) or the USB of TM1800.

- Thermal printer sensitive line dot method
- Paper width 114 mm (4")
- Printing speed 50 mm/s (400 dot lines/s)

Digital Module

With the Digital module motion measurement with the TM1800 system becomes even more accurate and the set-up even easier. It enables the use of incremental rotary or linear transducers, for measuring motion, velocity of circuit breakers and the damping characteristics on drive mechanisms

- Six channels per module
- Incremental transducers with resolution up to ±32000 pulses
- Built in power supply with 5 V or 12 V DC

PC-card Module

Storage of recorded data is done in the PC-card module that is delivered with every TM1800 system. This module is easily removed during transport or storage of the TM1800 to minimize the risk of data getting lost. The PC-card module comes with two standard PCMCIA slots that can be used for memory cards, w-lan etc. As an option the standard mechanical hard disk can be replaced with a flash disk that withstand higher environmental requirements when used in rougher environments or often transported. This module is always fitted into slot 10.

- Two type I/II/III PCMCIA slots
- 20 GB storage capacity on built-in hard drive
- Optional: Flash disk (ordered separately)

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 timing inputs
- Polarity insensitive
- Dry and wet auxiliary contacts

Application examples

IMPORTANT!

Read the User's manual before using the instrument.

Circuit Breaker System with Common Operating Mechanism

TM1800™ Set-up for one main contact and common operating mechanism

The drawing shows an analog measurement but it can also be done with a digital module and incremental transducers. The settings in the TM1800™ system are easy to manage using the internal software (CABA Local). It offers easy access via function keys and the built-in keyboard. It comes with a track ball and large, bright screen that works as well in direct sunlight.

Minimum configuration of modules for this application is:

1 Control module
1 Timing M/R module
1 Analog module

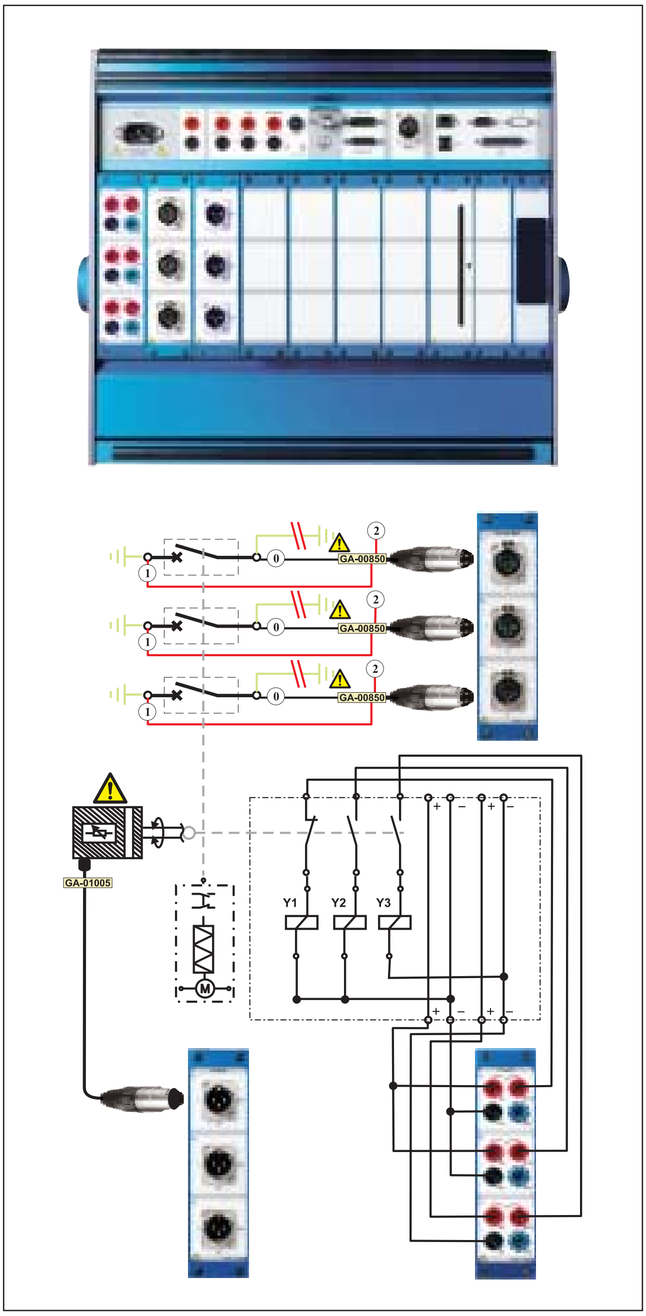
Circuit Breaker System with Separate Operating Mechanism

TM1800™ Set-up for two main contacts and one operating mechanism per pole.

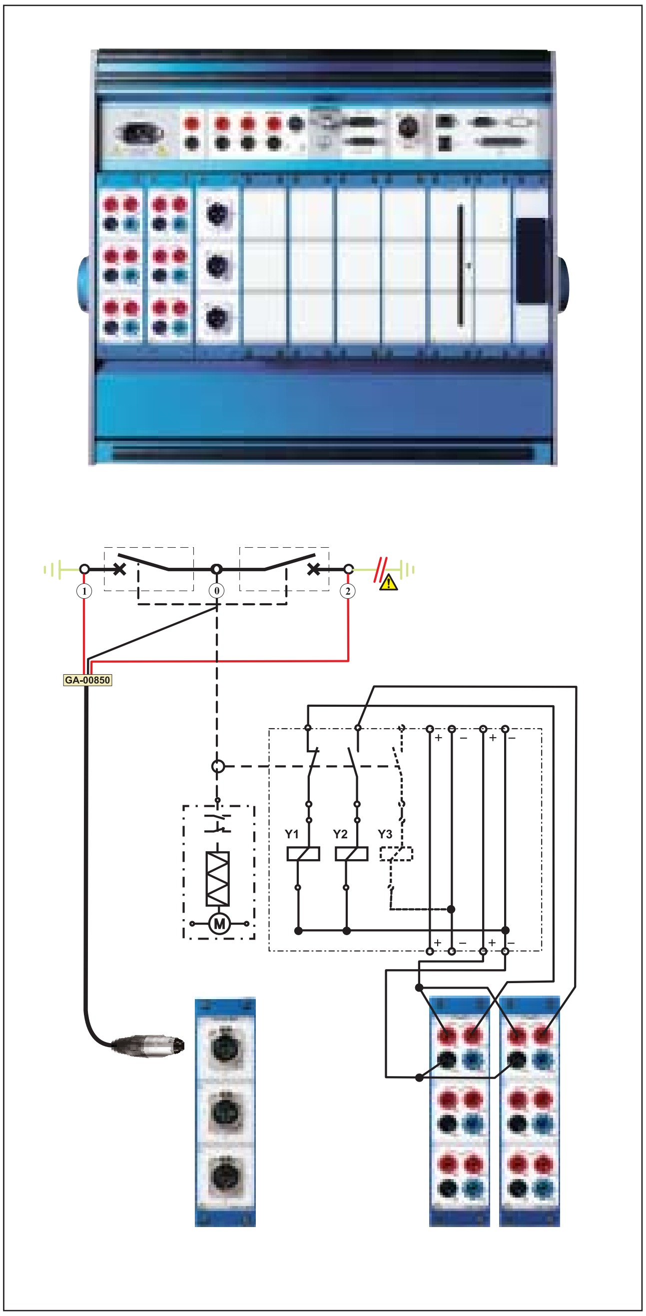
Below set-up shows complete wiring for pole A. The timing hook-up for remaining pole B and C is done accordingly to pole A. Two control modules (six outputs) are needed to control each coil (Y1/Y2) for every pole. The set-up below shows the wiring of pole A. This also automatically tests timing on the auxiliary contacts that are connected in series to the coils.
Motion measurement can be added with an analog or digital module.

Minimum configuration of modules for this application is:

2 Control modules
1 Timing M/R module



Y1 = close coil, Y2 = trip coil 1, Y3 = trip coil 2



Y1 = close coil, Y2 = trip coil 1, Y3 = trip coil 2

Specifications TM1800

General

Specifications are valid after 30 minutes warm up time.
System time base drift 0.001% per year.
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) -20°C to +50°C (-4°F to +122°F), with flash disk
Storage & transport	-55°C to +70°C (-67°F to +158°F)
Humidity	5% – 95% RH, non-condensing

CE-marking

EMC	EMC Directive 89/336/EEC am. by 91/263/EEC, 92/31/EEC and 93/68/EEC
LVD	Low Voltage Directive 73/23/ EEC am. by 93/68/EEC

Basic unit

General

Mains input (nominal)	100 – 240 V AC, 50 / 60 Hz
Power consumption (max)	250 VA
Dimensions	515 x 173 x 452 mm (20.3” x 6.8” x 17.8”)
Weight	15.5 kg (34.2 lbs)

External input

Trig in

Time inaccuracy	±0.1 ms

Voltage mode

Input range	0 – 250 V AC / DC
Threshold level	User configurable in software in steps of 1 V

Contact mode

Open circuit voltage	35 V DC ±20%
Short circuit current	10 – 40 mA
Threshold level	1 – 2 kΩ

External outputs

General

No. of channels	3, (TRIG OUT, DRM, WARNING)

TRIG OUT

Switch	Electronic
Pulse duration	1 – 999 ms, user configurable in steps of 1 ms
Inaccuracy	±0.1 ms

Voltage mode

Open circuit voltage	12 V DC ±5%
Voltage at 0.5 A	9 V DC ±10%
Max. short circuit current	1.5 A

Contact mode

Max. switching currrent	0.5 A at 12 V and resistive load
Voltage drop at 0.5 A	4.5 V DC ±10%
Max. short circuit current	1.5 A

DRM

Switch	Relay

Voltage mode

Open circuit voltage	12 V DC ±5%
Voltage at 0.5 A	11 V DC ±10%
Max short circuit current	1.5 A

WARNING

Switch	Relay
Pre-operation warning	0 – 999 s, user configurable in steps of 1 s

Voltage mode

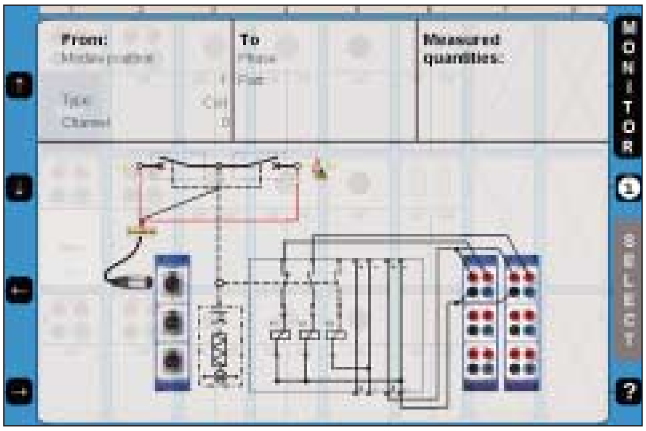
Output Voltage	12 V DC ±10%
Short circuit protection	Fuse 1 A DC fast acting type (F1H250V)

Contact mode

Max. switching currrent	1 A at 12 V and resistive load

External temperature sensor (optional accessory)

Range	-20°C to +50°C (-4°F to +122°F)
Resolution	0.5°C (0.9°F)



When on site doing the hook-up, you can get help on how to connect by pressing the i-button.

Communication interfaces

PC-card	Type I/II/III PCMCIA cards, 5 V supply
USB	Universal Serial Bus ver. 1.1
Ethernet	100 base-Tx Fast Ethernet
Printer port	LTP, Multi-mode parallel (ECP/EPP/SPP) 25-pin D-sub female
Serial port	RS232, 9-pin D-Sub male
External screen	SVGA, up to 800 x 600 at 24 bit color, 32 MB SDRAM

HMI, Human-Machine interface

Operating system	Windows XP Embedded
CABA Local	Circuit breaker analyzing software
Available languages	English, German
Display	Transreflecting to increase visibility in direct sunlight
Diagonal size	21 cm (8")
No. of pixels	800 x 600 (W x H)
Display mode	256k colour
Luminance	350 cd/m^2
Keyboard	Built-in trackball and mouse buttons

Modules

Control module

General

No. of channels	3
Time base inaccuracy	±0.01% of reading ±1 sample interval
Min. resolution	0.1 ms
Max. sample rate	10 kHz
Measurement time	19 s at 10 kHz sample rate, 39 s at 5 kHz sample rate, 200 s at 10 kHz sample rate using data compression
Weight	1.0 kg (2.2 lbs)

Non-bouncing switch

Max. continuous current	15 A AC / DC
Max current	60 A AC / DC during 100 ms with intermittence of 5%
Short circuit protection	15 A DC
Duration	1 ms – 1000 s, user configurable in steps of 1 s
Delay	0 – 999 s, user configurable in steps of 1 s

Current measurement

Measurement range	0 – 60 A AC / DC
Resolution	3 mA (6 mA at data compression)
Inaccuracy	±2% of reading ±0.1% of range

Voltage measurement

Measurement range	0 – 250 V AC / DC
Resolution	20 mV (40 mV at data compression)
Inaccuracy	±1% of reading ±0.1% of range

Auxiliary contact status/resistance

Open circuit voltage	25 – 35 V DC
Short circuit current	10 – 40 mA
Status threshold	Open > 10 kΩ > closed
Resistance range	0 – 10 kΩ
Resolution	100 mΩ at 100 Ω, 5 Ω at 10 kΩ
Inaccuracy	±2% of reading ±0.2% of range

Timing M/R module

General

No. of channels	6, (2 voltage ranges per channel when used in voltage mode)
Time base inaccuracy	±0.01% of reading ±1 sample interval
Min. resolution	0.05 ms
Max. sample rate	40 kHz
Measurement time	16 s at 20 kHz sample rate, 32 s at 10 kHz sample rate, 200 s at 10 kHz sample rate using data compression Data compression is available at sample rates up to 20 kHz
Weight	0.8 kg (1.8 lbs)

Timing of main and resistive contacts

Open circuit voltage	6 V or 26 V ±10% (Toggling at every second sample at sample rates from 10 kHz and upwards.)
Short cicuit current	9.7 mA or 42 mA ±10%
Status threshold	
Main	Closed < 10 Ω < Open
Main and Resistor	Main < 10 Ω <PIR < 10 kΩ < Open

PIR resistance measurement

Supported PIR types	Linear PIR
Measurement range	10 Ω – 10 kΩ
Inaccuracy	±10% of reading ±0.1% of range

Voltage measurement

Measurement ranges	±50 V_{peak}, ±15 V_{peak}, ±0.5 V_{peak}
Resolution	2 mV, 0.5 mV, 20 µV (4 mV, 1 mV, 40 µV at data compression)
Inaccuracy	±1% of reading ±0.1% of range

Analog module

General

No. of channels	3
Time base inaccuracy	±0.01% of reading ±1 sample interval
Min. resolution	0.025 ms
Max. sample rate	40 kHz
Measurement time	10 s at 40 kHz sample rate, 20 s at 20 kHz sample rate, 200 s at 10 kHz sample rate using data compression
Transducer resistance	500 Ω – 10 kΩ at 10 V output
Weight	0.8 kg (1.8 lbs)

Output

Voltage output	10 V DC ±5%, 24 V DC ±5%
Max. output current	20 – 30 mA

Current measurement

Measurement range	0 – 20 mA DC
Resolution	0.35 µA (0.7 µA at data compression)
Inaccuracy	±1% of reading ±0.1% of range

Voltage measurement

Input voltage range	0 – 250 V AC / DC
Measurement ranges	±10 V DC, 0 – 250 V AC / DC
Resolution	0.3 mV, 13 mV (0.6 mV, 26 mV at data compression)
Inaccuracy	
250 V range	±1% of reading ±0.1% of range
10 V range	±0.1% of reading ±0.01% of range

Digital module

General	
No. of channels	6
Supported types	Incremental transducers, RS422
Time base inaccuracy	±0.01% of reading ±1 sample interval
Min. resolution	0.05 ms
Max. sample rate	20 kHz
Measurement time	16 s at 20 kHz sample rate, 32 s at 10 kHz sample rate, 200 s at 10 kHz sample rate using data compression
Weight	0.7 kg (1.5 lbs)
Output	
Voltage	5 V DC ±5% or 12 V DC ±5%
Max. output current	200 mA
Digital input	
Range	±32000 pulses
Resolution	1 pulse
Inaccuracy	±1 pulse

Timing Aux module

General	
No. of channels	6
Time base inaccuracy	±0.01% of reading ±1 sample interval
Min. resolution	0.05 ms
Max. sample rate	20 kHz
Measurement time	15 s at 20 kHz sample rate, 30 s at 10 kHz sample rate, 200 s at 10 kHz sample rate using data compression
Weight	0.8 kg (1.8 lbs)
Voltage Mode	
Input voltage range	0 – 250 V AC / DC
Status threshold	±10 V
Inaccuracy	±0.5 V
Contact mode	
Open circuit voltage	25 – 35 V
Short circuit current	10 – 30 mA
Status threshold	Closed < 100 Ω, Open > 2 kΩ

Printer module

General	
Printer type	Thermal printer
Paper type	Thermal 114 mm
Printing speed	50 mm/s (400 dotlines/s)
Horizontal resolution	8 dots/mm
Vertical resolution	8 dots/mm
Storage and transport temperature	-20°C to +60°C (-4°F to +140°F)
Weight	0.8 kg (1.8 lbs)

Ordering information

TM1800	**Art. No.**
Complete with: CABA Local Transport case USB Memory	
TM1800, Basic Unit	**CG-19090**
TM1800, Basic Unit, with Flashdisk	**CG-19091**

Modules

Control Module Including 3 cable sets, 5 m (16 ft), GA-00877	**CG-19030**
Timing M/R Module Including 3 cable sets, 5 m (16 ft) total length, 1.5 m (4.9 ft) spread, GA-00850	**CG-19080**
Analog Module Including 3 cable sets, 10 m (33 ft), GA-01005	**CG-19000**
Digital Module	**CG-19040**
Timing Aux Module Including 3 cable sets, 5 m (16 ft), GA-00870	**CG-19060**
Printer Module Including paper spool, GC-00040	**CG-19050**

Optional accessories

See section “Circuit breaker testing accessories”

EGIL™

Circuit Breaker Analyzer

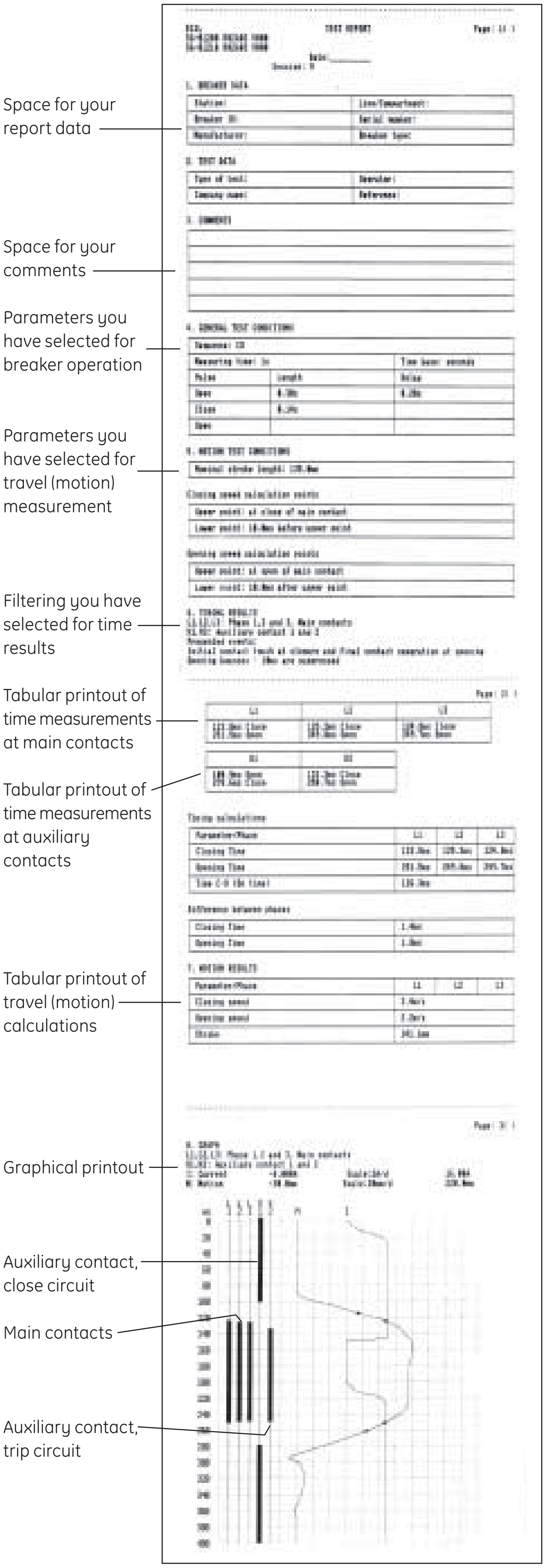
EGIL™, which incorporates benefits gained from experience with our larger TM1600™/MA61™ instrument, is intended primarily for testing distribution and smaller transmission breakers. Smaller and simpler, EGIL™ is equally versatile – and EGIL's price makes it attractive to small power plants. Moreover, it provides an ideal supplementary instrument for maintenance departments at large power companies.

EGIL™ is designed to test circuit breakers having only 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™ can also be equipped with an optional serial interface (RS-232C) for communication with a personal computer (PC) and the CABA Win™ Circuit Breaker Analysis Software.



Example of report printed out on the built-in printer. Close-Open operation. Time, coil currents and travel (motion) were measured. (Travel measurement is optional.) The above example is 55% of actual size.

Application

EGIL is intended primarily for testing high-voltage circuit breakers at medium-level voltages. There must not, however, be more than one breakpoint per phase since the time channels are not galvanically isolated. Contact times are recorded for main contacts, pre-insertion resistor contacts and auxiliary contacts. Coil currents are also recorded.

Besides the actual measurement values several parameters according to IEC standards are calculated and shown in the report, e.g. closing and opening time, difference between phases, over-travel, CO and OC time (and others).

Application example

IMPORTANT!
Read the User's manual before using the instrument.

1. Ground EGIL using the included ground cable. Make certain that the circuit breaker is closed and grounded on both sides.
2. Connect the main contact cable set to EGIL and the breaker.
3. Connect the auxiliary contact cable set to the a- and b-contacts on the operating mechanism.
4. Connect the EGIL sequencer to the close- and trip-coils and to the auxiliary voltage.
5. Remove the breaker's ground connection on one side.
6. You are now ready to proceed with the test. Simply turn the MEASURE rotary switch and read the results.

Specifications EGIL

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 up to 130 kV.
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 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)	100 VA
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, polarity insensitive	< 8 V
Close indication, polarity insensitive	> 13 V
Working voltage	250 V AC / DC

Current measurement

Range	±25 A per channel, sum of currents is measured
Resolution	25 mA
Inaccuracy	1% of the reading ±100 mA
Working voltage	250 V AC / DC

Breaker operation

Sequences	C, O, C-O, O-C, O-C-O
Continuous current	5 A
Max current	25 A during 300 ms, rest time 1 min
Contact function	Two independent control functions
Contact characteristics	Non bouncing, Closing time maximum 0.1 ms
Make/Break capacity	25 A, 250 V (AC or DC) per contact function
Start breaker operation	By rotary switch
Pulse length	Adjustable in steps of 10 ms
Pulse delay	Adjustable in steps of 10 ms
Working voltage	250 V AC / DC

Motion (optional)

Number of channels	1 independent
Max cable length	10 m (33 ft)

Input

Range	-4 V to +4 V
Resolution	2 mV
Inaccuracy	1% of the measurement range
Transducer resistance	1 kΩ to 5 kΩ
Input impedance	150 kΩ

Output

Open circuit voltage	4,092 V ±4 mV
Short circuit current	115 mA

Serial interface for PC (optional)

Type	V24, RS232C
Format	8 bits, 1 stop bit, no parity
Speed	1200 - 19200 baud
Flow control	Xon/Xoff

Printout

Type of printout	Graphic and numeric
Printer	Thermal printer with fixed print head
Graphic resolution	8 dots/mm – 203 dpi
Paper width	114 mm (4.5”)

Multicable sets GA-00160 and GA-00170 and cable set GA-00082.

❶ Built-in coil current measurement. Readings are presented on autoscaled graphs.

❷ Sequencer for coil signals permits delays to be introduced for coil impulses that differ relative to each other.

❸ Mains voltage changeover switch, 115/230 V AC.

❹ Built-in printer features autoscaling, 114 mm (4,5") wide paper can be changed quickly and easily.

❺ Galvanically isolated sockets ensure safe, reliable disconnection of operating coil cables before working in or on the breaker.

❻ Three timing channels. Both main contacts and pre-insertion resistor contacts can be timed on the same channel. Results are presented both graphically and numerically.

❼ Two galvanically isolated timing channels. Can be used for timing of dry or wet auxiliary contacts.

❽ Optional analog input channel is intended for measuring travel (motion) or any other analog voltage.

❾ Optional serial (RS-232C) interface for a computer (PC). Supports communication with the CABA breaker analysis software.

❿ Menu-driven procedures automatically invoke default settings to eliminate time-consuming presetting. All menu lines associated with uninstalled optional equipment are hidden to enhance simplicity. For the basic egil unit you simply connect the multicable sets and turn the MEASURE knob.

⓫ AUX 1 & 2 buttons used for time channels that measure timing of auxiliary contacts. Contactsensing or voltage-sensing can be selected.

⓬ Switch used to start a preset sequence of breaker operations for which measurements are conducted simultaneously.

⓭ Designed and tested to meet the CE emission, immunity and electrical safety standards.

⓮ Breakerstate indicator. Egil measures the state (open or closed) of the breaker, whereupon the sequencer sets the instrument automatically for the next sequential operation.

⓯ Switch used to set the breaker to the desired state without activating the measurement channels.

⓰ Fast-select buttons for frequently used functions such as selecting a sequence of operations (C, O, C-O, O-C or O-C-O) and printing results.

Transducer cables GA-00041 and GA-00042.

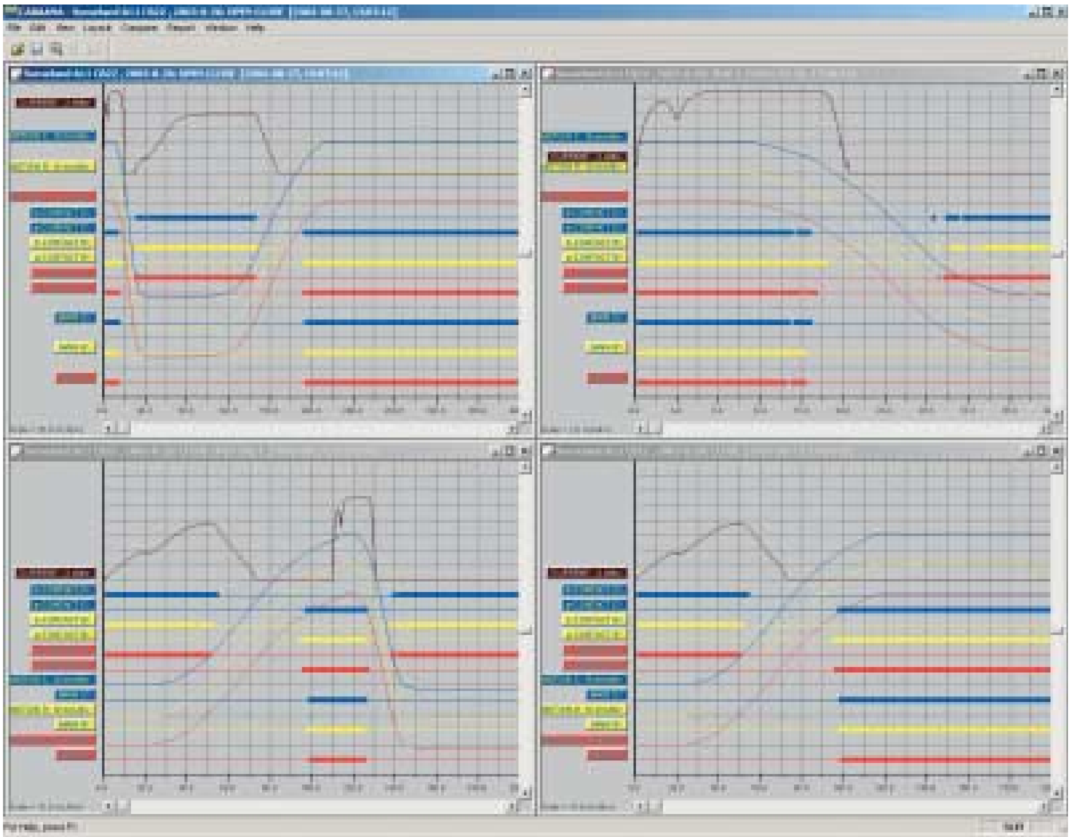
Ordering information

EGIL	Art.No.
Basic unit Complete with: Time measurement cables GA-00160, GA-00170 Cable set for sequencer GA-00082 Transport case GD-00190	**BM-19090**
Egil with analog input channel and serial PC interface Complete with: Time measurement cables GA-00160, GA-00170 Cable set for sequencer GA-00082 Transducer cable XLR-open, 1 m (3.2 ft) GA-00041 Transducer cable XLR-XLR, 7.5 m (24.6 ft) GA-00042 Serial cable RS-232C Transport case GD-00190	**BM-19093**

Optional accessories

See section "Circuit breaker testing accessories"

CABA Win™



Circuit Breaker Analysis Software

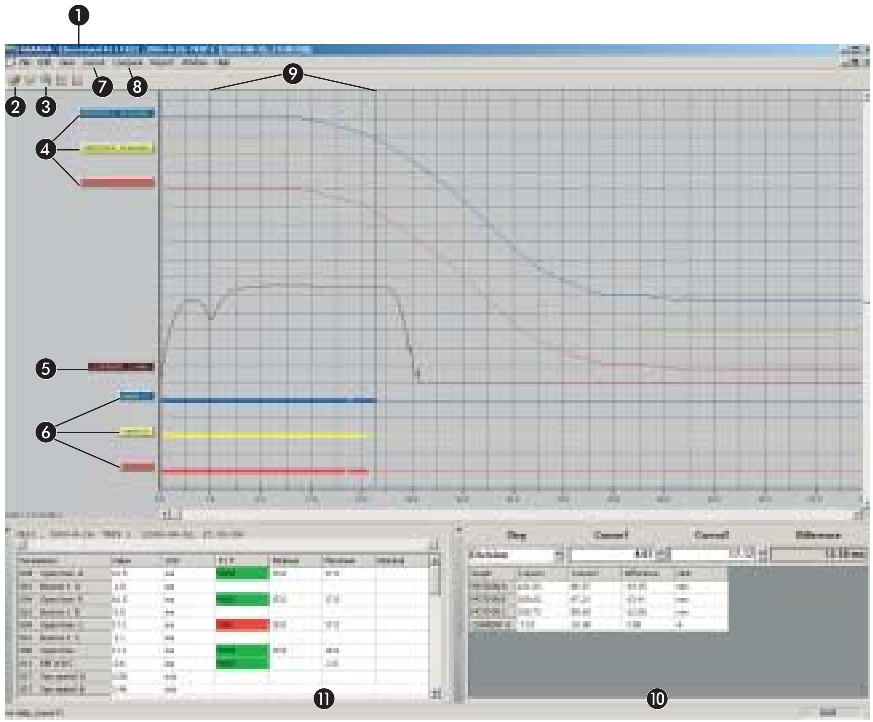
Effective circuit breaker maintenance requires comprehensive, accurate testing. The ability to accurately compare circuit breaker tests with previous test results is essential. It must thus be possible to conduct tests in exactly the same way and under the same conditions as those conducted earlier. 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.

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 Programma Computer-aided Breaker Analysis (CABA Win™) program has earned an enviable reputation in this field. Test results from earlier versions of CABA™ are upwards compatible to CABA Win™.

CABA Win™ can be used with Programma breaker analyzers 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.

1. Test ID with information about the actual circuit breaker and measurement
2. Display additional tests
3. Zoom
4. Motion trace
5. Coil current trace
6. Time measurements
7. Design/change analysis window, test curves, colors, scales and positioning
8. Compare with other tests
9. Cursors for detailed analysis
10. Cursor values
11. Calculated parameters for the actual operation



Operation

Test plans

CABA 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 step the user through the test procedure in exactly the same way each time the breaker is tested. This results in efficiency gains throughout the test process, since the tests are conducted in exactly the same way regardless of who did the original testing. Accurate 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. After being organized on the basis of individual circuit breakers and individual tests, the data can be stored in a data-base. Each breaker is given a unique identity by means of four individually user-defined fields. 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.

Test data and breaker data

The test data and all the items of information about the circuit breaker are stored individually. The data can be copied and/or exported to other data media and formats. Test data, test plans and conversion tables from older versions of CABA can be easily transferred into CABA Win.

Transducers and conversion tables

Linear and angular travel, voltage, current, pressure and vibration transducers can be defined and calibrated with CABA Win. The calibration accuracy for a transducer is determined by the user. The calibration program automatically indicates whether or not the desired accuracy has been achieved, along with the actual calibration data. A conversion table needed to recalculate data from angular movement to linear movement can be linked to a given transducer. This makes it possible to measure contact travel of a circuit breaker in situations where a transducer cannot be connected directly to the moving contact.

Analyzing the test data

The test data is presented graphically and in table form. Multiple graphs and testresults can be displayed simultaneously. Zoom functions and cursors make it easy to conduct detailed analysis of test data. Comparisons between different tests can be viewed conveniently by overlaying them in a single window. Colors, grids, scales and the positioning of the test data are all controlled by the user.

Calculation parameters

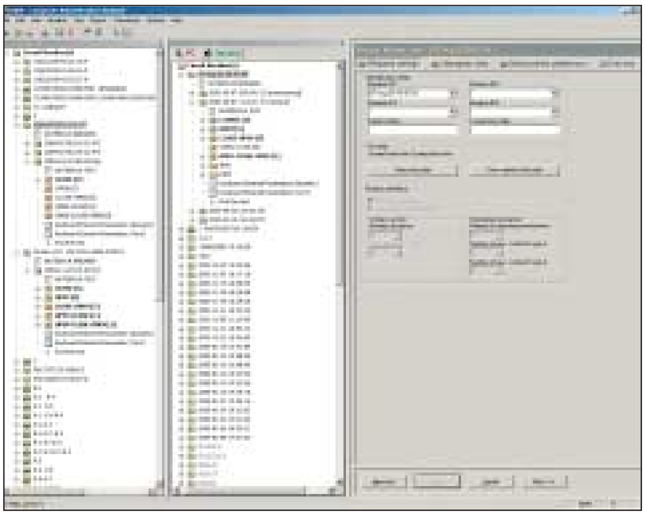
Readings and calculated values are presented in table form.
The test plan determines which parameters are to be calculated and presented. The user can delete and/or add calculable parameters, depending on the circuit breaker design, the way it is hooked up and the operations being performed. More than 200 different calculation parameters are defined in CABA Win.

Limits
For each parameter and operation, the user can define pass and fail limits for each circuit breaker. If the user activates the function, CABA Win automatically compares each measured value to the actual limits and flags the values which are outside the limits.

Database
A database for storing measurements. For easy administration and backup of measurements.

Reporting
CABA Win contains a complete report generator which enables the user to design unique report forms as desired. A number of pre-defined standard reports can be used as supplied, or they can be edited. The report form is saved together with the breaker data, and can be used in future tests.
Graphs and screen displays can be copied to the clipboard and to a folder for additional processing in other Windows®applications software.

Data communication
TM1800 Ethernet
TM1600/MA61 RS232/fibre-optic modem
EGIL Standard RS232
CABA Win runs under Windows® 98/Me/2000/NT/XP. A 400 MHz Pentium® processor and 96 MB of RAM are recommended.



Test and circuit breaker data and are stored individually

Optional accessories

Vibration analysis software

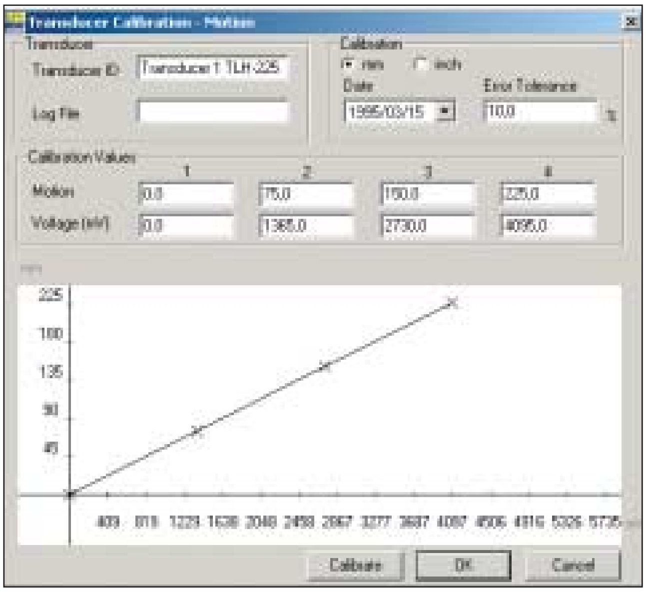
Vibration analysis is a non-invasive method using an acceleration sensor without moving parts. The breaker can stay in service during the test. A single Open-Close operation is all that is required for the measurement. The first operation is different compared to the second and third because of corrosion and other metal to metal contact issues. Vibration is an excellent method to capture the first operation after long time in the same position.

The analysis compares the vibration time series with earlier taken reference. In addition to the clear indication on breaker functionality more detailed information can be obtained within the analysis software. The indication is based on a DTW (Dynamic Time Warping) analysis of difference to reference data. The vibration method detects faults that can hardly be indicated with conventional methods. But if conventional data such as contact time, travel curve, coil current and voltage are available in addition to the vibration data even more precise condition assessment is possible. The vibration data is stored together with available conventional data.

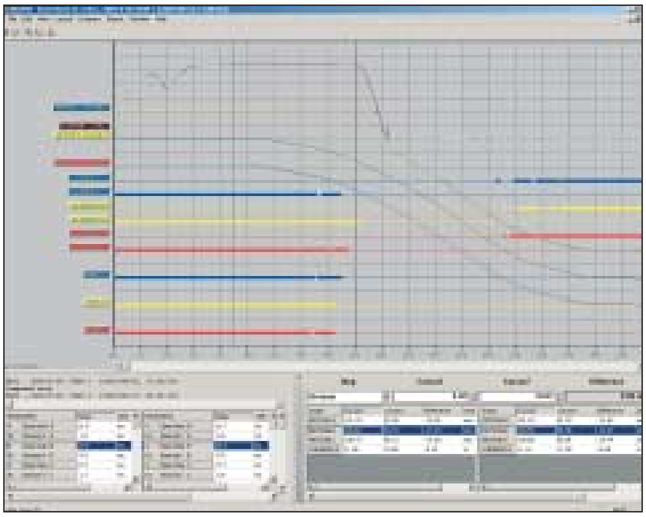
The Vibration method is published in CIGRÉ and IEEE® papers. Since about 10 years is it utilized in the industry for testing all kind of breakers from 400 kV distribution to industrial sites. The method was first established on the Scandinavian market. Vibration can be performed under very safe manners for the test technician as both sides can be grounded throughout the test. Also less climbing is required since no access to the breaker contact system is needed, the acceleration sensor is easily mounted on the breaker.

Test plans

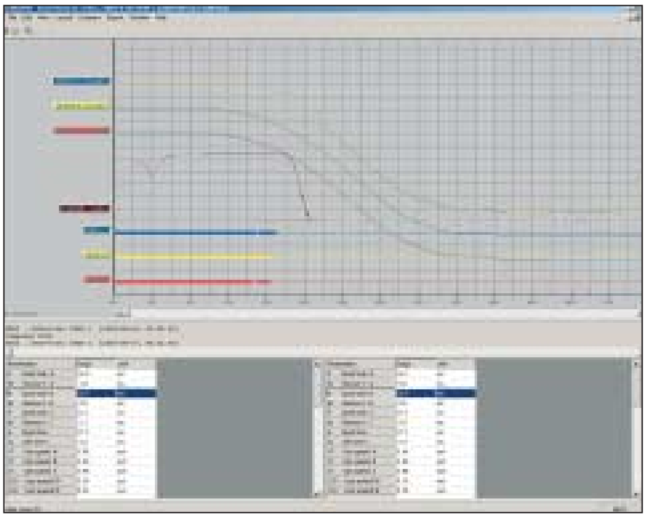
A number of standard test plans are delivered with CABA Win. Contact your GE Energy supplier for customer-specific test plans and conversion tables.



Linear and angular travel, voltage, current, pressure and vibration transducers can be defined and calibrated with CABA Win.



Multiple graphs and test results can be displayed simultaneously.



The user can define pass and fail limits for each circuit breaker operation.

Ordering information

See section "Circuit Breaker Testing Accessories"

MOM690™

Microhmmeter

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 Programma line of products for many years.

MOM690™ supplements our family of microhmmeters. 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's 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. Ground the breaker on one side and make certain it is closed.
2. Ground the microhmmeter.
3. Make certain the microhmmeter's ON/OFF switch is OFF while making connections.
4. 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.
5. Switch on the MOM690.
6. Select "AUTO" or "MAN" with the <FUNC>-button.
7. Set output current to zero to start the measurement.
8. Increase the current to the desired value (600 A for example).
9. Read the resistance value.

Measuring resistance at busbar joints

1. Make certain the line is de-energized and the test object is grounded.
2. Ground the microhmmeter.
3. Make certain the microhmmeter's ON/OFF switch is OFF while making connections.
4. Connect the microhmmeter's current cables to the test object. Do not connect the sensing cables. Measurement will be done manually using an external portable voltmeter.
5. Switch on the MOM690.
6. Select "MAN" with the <FUNC>-button.
7. Set output current to zero to start the measurement.
8. Increase the current to the desired value (100 A for example).
9. Using an external voltmeter, measure the voltage drop across each contact element within every section of the busbar being tested. The voltmeter must be set to DC.
10. Calculate the actual resistance. **Example:** If the voltage drop is 0.0067 V at a current of 100 A, the resistance will be 0.0067/100 Ω, i.e. 67 μΩ.

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 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)

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)

Extension cable set No. 2

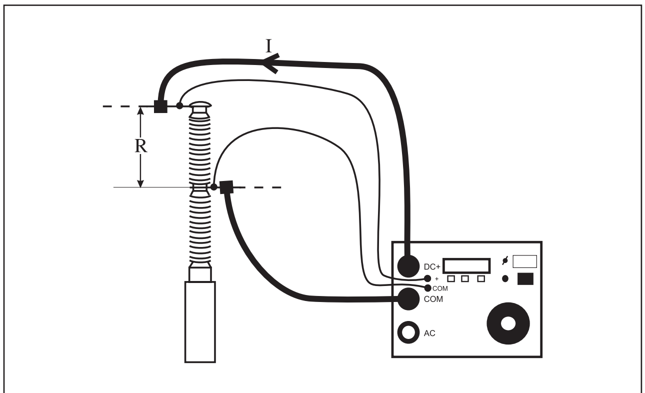
2 x 10 m (33 ft), 50 mm^2 (current cables).
2 x 15 m (49 ft), 2.5 mm^2 (sensing cables).
Weight: 15 kg (33 lbs)

Calibration shunt

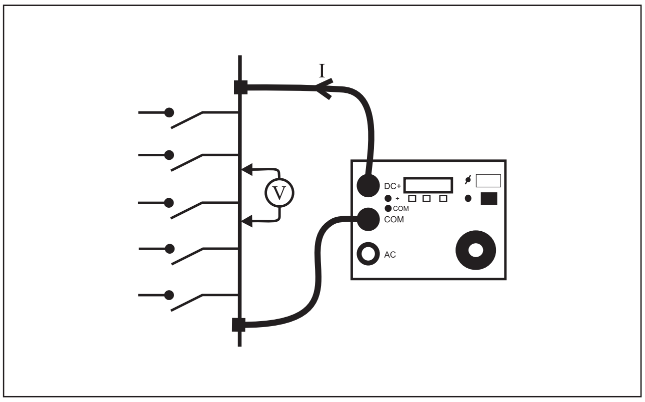
An optional calibration shunt (600 A/60 mV) can be ordered for MOM690, that enables you to make certain that the instrument readings remain correct.

Transport case XL

With space for the standard 5 m cable set + extension cable set No. 1 or No. 2.



Measuring the resistance of a breaker



Measuring resistance at busbar joints

Specifications MOM690

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 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, 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
Display	LCD
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 mm²*
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*	*Stadard + Ext. 1*	*Stadard + Ext. 1*	*2 x 15 m 95 mm²*
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.

1. Grounding terminal
2. Connection for mains voltage
3. Miniature circuit breaker for mains
4. Switch for mains voltage
5. Variable transformer
6. AC current output
7. Common output terminal
8. DC current output
9. Voltage measurement input
10. Display
11. Setting selector
12. Function selector
13. Interrupts current and toggles the display between resistance and voltage
14. RS 232 Serial interface

Information about current generation or memory location.

Value of the generated current.

Indicates whether the current is above (<) or below (>) a preselected value.

Selected test current for "Auto"/"DC Off". Scroll using the <▲>- button.

Selected function. Scroll using the <FUNC>-button.

Shows the measured resistance or voltage value. Toggle by pressing the <Ω>-button.

Ordering information

MOM690	Art.No.
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 accessories

PC Software MOMWin Incl. serial cable for RS-232 port	BB-8010X
Cable set 15 m (49 ft)	GA-09155
Extension cable set No. 1	GA-05057
Extension cable set No. 2	GA-05107
Calibration shunt	BB-90024
Transport case XL	GD-00042

Cable set and current shunt

MOM600A™

Microhmmeter

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.

Microhmmeters 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 on world markets. Designed for use from the arctic to the tropics, this rugged, compact microhmmeter is ideal for field work.

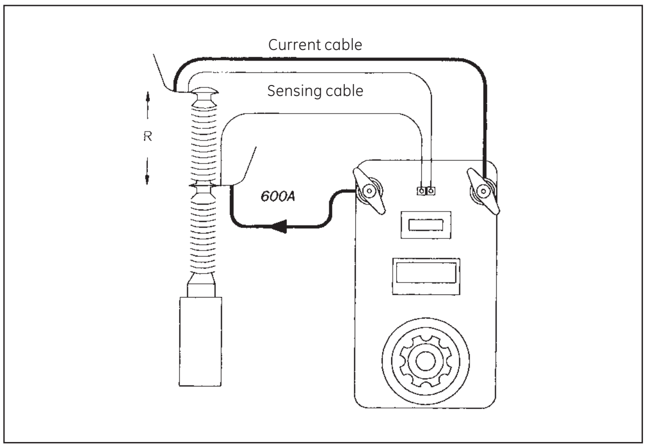
A complete set of equipment includes a set of highly flexible cables (including separate measurement cables) and a sturdy transport case.

Application example

IMPORTANT!
Read the User’s manual before using the instrument.

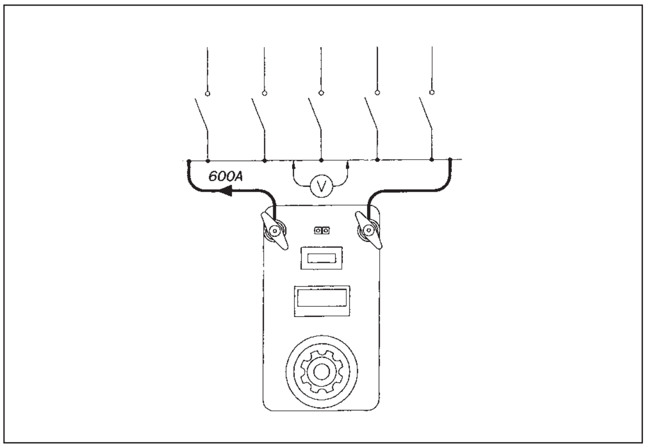
Measuring the resistance of a breaker element

1. Connect the microhmmeter to the circuit breaker.
2. Set the current (600 A in this example).
3. Press the resistance pushbutton.
4. Read the result.



Measuring the resistance of busbar joints

1. Connect the microhmmeter'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 μΩ in this example).
5. Move the voltmeter to the next joint.
6. Repeat step 4.



Optional accessories

Cable set 10 m (33 ft)

2 x 10 m (33 ft), 70 mm² (current cables)
2 x 10 m (33 ft), 2.5 mm² (sensing cables)
Weight: 16.8 kg (37 lbs)

Cable set 15 m (49 ft)

2 x 15 m (49 ft), 95 mm² (current cables)
2 x 15 m (49 ft), 2.5 mm² (sensing cables)
Weight: 29.4 kg (65 lbs)

Calibration shunt

600 A/60 mV

Specifications MOM600A

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 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, 50 / 60 Hz
Power consumption (max)	115 V, 4370 VA 230 V, 7360 VA
Protection	Miniature circuit breakers, 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 (24.0" x 11.4" x 14.2")
Weight, 115 V model	25 kg (55.1 lbs) 43.1 kg (95 lbs) with accessories and transport case
Weight, 230 V model	24.7 kg (54.5 lbs), 42.8 kg (94.4 lbs) with accessories and transport case
Current cables	2 x 5 m (16 ft), 50 mm²
Sensing cables	2 x 5 m (16 ft), 2.5 mm²
Optional 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
Display	LCD
Measurement section	
Resistance	
Range	0 – 1999 μΩ
Resolution	1 μΩ
Inaccuracy	±1% of reading + 1 digit (at 100 – 600 A test current)

Output, 115 V model	
Current	0 – 600 A DC
Open circuit voltage	5.2 V DC
Current shunt output	10 mV / 100 A ±0.5%, max 60 mV out, max 10 V to protective earth (ground)
Output, 230 V model	
Current	0 – 600 A DC
Open circuit voltage	9 V DC
Current shunt output	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

Cable set GA-05053, GA-00200 and shunt BB-90020.

Ordering information

MOM600A

	Art.No.
Complete with: Cable set GA-05053 Ground cable GA-00200	
115 V Mains voltage	**BB-11190**
230 V Mains voltage	**BB-12290**

Optional accessories

Cable set 10 m	**GA-07103**
Cable set 15 m	**GA-09153**
Calibration shunt, 600 A/60 mV	**BB-90020**

MOM200A™

Microhmmeter

Like the MOM690™ and MOM600A™, this model is designed to check and measure contact resistances in highvoltage circuit breakers, disconnecting switches (isolators) and busbar joints. The MOM200A™ 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.

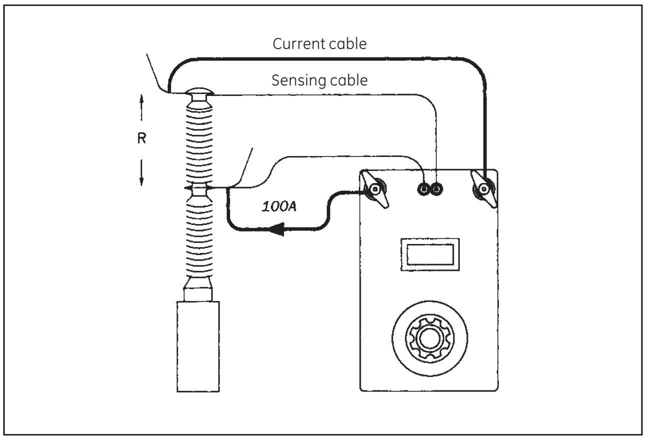
A complete MOM200A™ includes a cable set (including separate sensing cables) and a transport case.

Application example

IMPORTANT!
Read the User's manual before using the instrument.

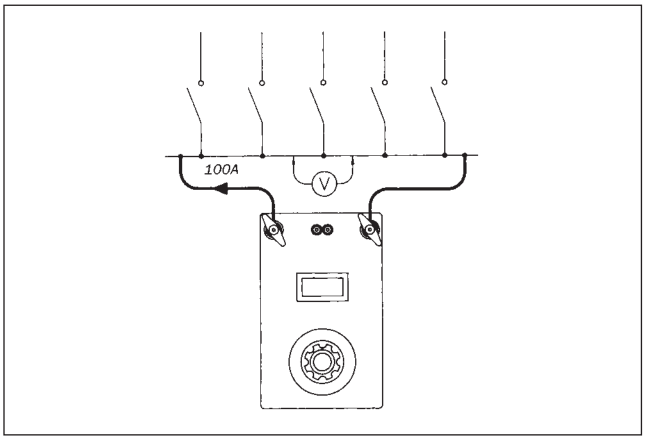
Measuring the resistance of a breaker element

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



Measuring the resistance of busbar joints

1. Connect the microhmmeter'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 μΩ in this example).
5. Move the voltmeter to the next joint.
6. Repeat step 4.



Optional accessories

Cable set 10 m (33 ft)

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)

Cable set 15 m (49 ft)

2 x 15 m (49 ft), 50 mm^2 (current cables).
2 x 15 m (49 ft), 2.5 mm^2 (sensing cables)
Weight: 18.6 kg (40.9 lbs)

Calibration shunt

200 A/20 mV

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

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, 50 / 60 Hz
Power consumption (max)	1610 VA
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
Display	LCD

Measurement section

Resistance

Range	0 – 1999 mΩ 0 – 0-19.99 mΩ
Resolution	1 mΩ 10 mΩ
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***	***Input current at 115/230 V AC***
100 A DC	3.8 V DC	5 min. 15 min.	15 min. 60 min.	–
200 A DC	3.0 V DC	20 s	5 min.	14 A / 7 A


Cable set GA-02053, GA-00200 and shunt BD-90022.

Ordering information

MOM200A

	Art.No.
Complete with: Cable set GA-02053 Ground cable GA-00200 Transport case GD-00010	
115 V Mains voltage	**BD-11190**
230 V Mains voltage	**BD-11190**

Optional accessories

Cable set 10 m	**GA-03103**
Cable set 15 m	**GA-05153**
Calibration shunt, 200 A/20 mV	**BD-90022**

B10E™

Power Supply Unit

A variable DC voltage is usually 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 set improperly is to perform a test at minimum tripping voltage. The minimum trip voltage test is described in a number of 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 accomodate 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 (industrial-truck circuit breakers for example).

The Programma 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 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 example

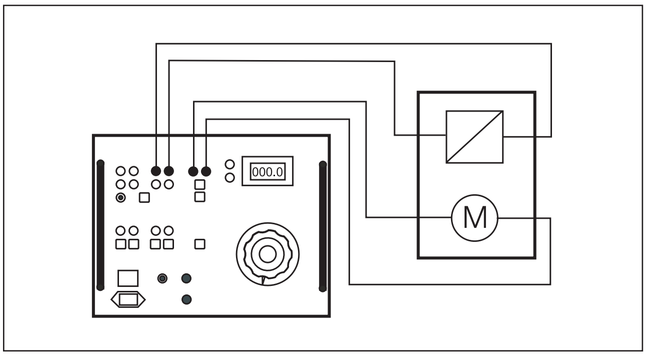
IMPORTANT!
Read the User's manual before using the instrument.

Testing the minimum trip voltage of a breaker

1. Connect Power Supply Unit B10E to the breaker's opening circuit and to the spring-charging motor.
2. Set the desired test voltage using the variac.
3. Activate the trip pulse switch.
4. Repeat steps 2-3 at a higher voltage if the circuit breaker does not trip.

When using the B10E, we recommend that the incoming power be protected by a 16 A wall-socket fuse. The incoming current surge occurring at certain combinations can blow the fuse if a slow-blow 10 A fuse or a quick-action 16 A fuse is used.

To minimize blowing of the wall-socket fuse, the B10E Softstart is equipped with a device that reduces the peak current surges that can blow this fuse. The B10E Softstart will substantially reduce – but will not fully eliminate – the blowing of 10 A fuses.



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 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 89/336/EEC	EMC Directive 89/336/EEC am. by 91/263/EEC, 92/31/EEC and 93/68/EEC
LVD	Low Voltage Directive 73/23/ EEC am. by 93/68/EEC
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	0.1 V
Inaccuracy	±1% of displayed value, DC ±2.5% of displayed value, AC
Current shunt	5 A / 50 mV ±0.5% (built-in)

Outputs for trip coils, DC outputs

Output voltage	24-250 V DC
Load interval	Max 1 s
Ripple	2% peak-to-peak of the preset voltage

No-load voltage (V)	*Current (A)*	*Load dependency*
24	10	< 6 %
48	10	< 3 %
110	6.5	< 2 %
250	3	< 2 %

Outputs for trip coils, AC outputs

Output voltage	24-250 V AC
Load current	Max 5 A
Load interval	Max 30 min

Outputs for spring-charging motor, DC outputs

Open circuit voltage (V)	*Current (A)*	*Load voltage (V)*	*Max load interval (s)*
48	12	40	60
48	18	30	20
120	12	90	60
120	18	70	20
240	6	200	60
240	9	185	20

Ordering information

B10E	Art.No.
Complete with: Cable set GA-00032 Transport case GD-00182	**BG-29092**

Test lead set GA-00032.

VIDAR™

Vacuum Tester

When a vacuum circuit breaker is commissioned or undergoes routine tests, it's very important to be able to ascertain whether or not the vacuum bottle is intact before putting it back into operation.

VIDAR™ enables you to check the integrity of the vacuum bottle quickly and conveniently by means of the known relationship between the flashover voltage and the underpressure in the breaking chamber. A suitable test voltage is applied to the breaker, and the result is displayed immediately.

VIDAR™ permits you to select among six 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 breaking chamber. A red lamp indicates that it is defective. A two-hand control and a high-voltage warning lamp enhances safety.

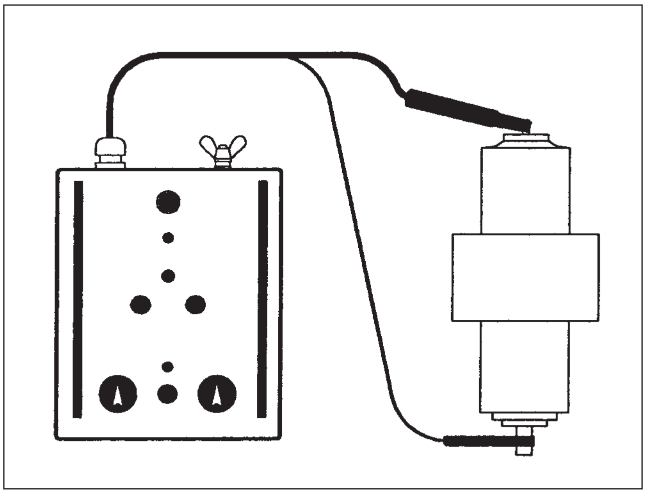
VIDAR™ has been developed in close collaboration with leading manufacturers of vacuum circuit breakers. It weighs only about 6 kg (15 lbs), and it's easy to use since breaking chambers do not have to be dismounted for testing. VIDAR™ is therefore ideal for use in the field.

Application example

IMPORTANT!
Read the User's manual before using the instrument.

Testing a vacuum breaker's dielectric strength

1. Connect the two VIDAR alligator clamps to the two connectors on the breaking chamber.
2. Select a test voltage, depending on the type of breaking chamber being tested.
3. Power up VIDAR.
4. Turn the two rotary switches simultaneously.
5. If the green lamp lights up, the breaking chamber is approved.



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 high-voltage substations and industrial environments.
Personal safety	Maximum permissible transient current through the external load is 12 mA. Maximum discharge time for internal high-voltage circuit is 0.3 s.
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 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)	69 VA
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

VIDAR	Art.No.
Complete with: Permanently mounted cable set 5 m (16 ft), ground cable and transport case	BR-29090

Permanently mounted cable set and ground cable.

Circuit Breaker Testing Accessories

Item	Description	TM1800	TM1600	EGIL	Art. No.
CABA – Software					
CABA Win	Breaker analysis software, incl. Ethernet cross-over cable	X			**CG-8000X**
	Breaker analysis software, incl. fiberoptics and USB interface		X		**BL-8203X**
	Breaker analysis software, incl. RS232 cable			X	**BL-8204X**
CABA Win upgrade	Upgrade	X	X	X	**CG-8010X**
Transducers – Linear					
TLH 500	500 mm (20") travel Incl. cable 0.5 m (20")	X	X	X	**XB-30020**
LWG 225	225 mm (9") travel Incl. cable 0.5 m (20")	X	X	X	**XB-30117**
TS 150	150 mm (5.9") travel Incl. cable 1.0 m (39")	X	X	X	**XB-30030**
TS 25	25 mm (1") travel Incl. cable 1.0 m (39")	X	X	X	**XB-30033**
The above transducers are also available in many other lengths, please contact GE Energy for more information.					
Transducers – Rotary					
Analog					
Novotechnic IP6501	Incl. cable 1 m (39"), 6 mm Flex coupling, Hexagon wrench	X	X	X	**XB-31010**
Digital					
Baumer BDH16.05A3600-LO-B	Incl. cable 10 m (33ft), 10/6 mm Flex coupling, Hexagon wrench	X			**XB-39130**
Transducer mounting kits – Universal					
Rotary transducer mounting kit	For transducers XB-31010 and XB-39130	X	X	X	**XB-51010**
Universal transducer mounting kit	For linear and rotary transducers	X	X	X	**XB-51020**
Transducer mounting kits – Circuit breaker specific					
LTB Kit (ABB)	Incl. mounting kit XB-51010, Software conversion table BL-8730X	X	X		**XB-61010**
HPL/BLG Kit (ABB)	Incl. mounting kit XB-51010, Software conversion table BL-8720X	X	X		**XB-61020**
Ready-to-use kits – Rotary					
Analog					
1-phase kit	Incl. transducer XB-31010, mounting kit XB-51010	X	X	X	**XB-71010**
3-phase kit	Incl. 3 x 1-pase kits XB-71010	X	X		**XB-71013**
Digital					
1-phase kit	Incl. transducer XB-39130, mounting kit XB-51010	X			**XB-71020**
3-phase kit	Incl. 3 x 1-pase kits XB-71020	X			**XB-71023**
Accessories for transducer mounting					
Universal support		X	X	X	**XB-39029**
Switch magnetic base		X	X	X	**XB-39013**
Cables					
Cable reel 20 m (65.5 ft), 4 mm stackable safety plugs	Black	X	X	X	**GA-00840**
	Red	X	X	X	**GA-00842**
	Yellow	X	X	X	**GA-00844**
	Green	X	X	X	**GA-00845**
	Blue	X	X	X	**GA-00846**
Timing cable sets	The cable sets consist of 8 cables with clamps and 4 mm stackable safety plugs				
	8 x 5 m, (16.4 ft)		X		**GA-00231**
	8 x 10 m, (32.8 ft)		X		**GA-00241**
	8 x 15 m, (49.2 ft)		X		**GA-00251**
Cable reel	Cable reel and multi-connector for 4 timing channels Note: without cable		X		**BL-90060**
Extension cable	Cable for cable reel BL-90060. Specify length when ordering		X		**03-10070**
Extension cable XL	10 m (32.8 ft), for time measurement of main contacts			X	**GA-00150**
Open analog cable	For customized analog transducer connection	X	X	X	**GA-01000**
XLR to 4 mm safety plugs	For customized analog transducer connection	X	X	X	**GA-00040**
Digital transducer extension cable	10 m (33 ft)	X			**GA-00888**
Open digital cable	For customized digital transducer connection	X			**GA-00885**


Linear transducer, TLH 225


Linear transducer, TS 25


Rotary transducer, Novotechnic IP6501 (analog)


Rotary transducer, Baumer BDH (digital)


Rotary transducer mounting kit


Switch magnetic base


Cable reels, 20 m (65.5 ft), 4 mm stack-able safety plugs


Universal support

Item	Description	TM1800	TM1600	EGIL	Art. No.
L & L digital cable	For using Leine & Linde 530 digital transducer	X			**GA-00890**
Ethernet cable, network	For connection to network	X			**GA-00960**
Vibration testing					
SCA606	Signal Conditioning Amplifier. Power supply, amplifier and signal conditioning filter for vibration testing using accelerometers with built-in charge amplifiers. (Note: DTW-analysis software needed)		X		**BL-13096**
Vibration analysis software	CABA option for DTW-analysis		X		**BL-8270X**
Accelerometer	DYTRAN 3200B5		X		**XB-32010**
Synchronized Switching Relay test kit					
SSR kit incl. accessories, software and cables (delivered in transport case)	SSR kit for TM1800	X			**CG-91200**
	SSR for TM1600 (incl. VD401)		X		**BL-91200**
Dynamic resistance measurement					
DRM1000	Dynamic resistance measurement of breaker contacts. Controls injection current up to 1000 A. External supply 12 V DC. Delivered complete, including the following:		X		**BL-90041**
	• Control unit DRM1000 incl. cable KG-00702 (red) and cable KG-00706 (blue) with snap-on connectors for a sealed 12 V battery.		X		BL-90040
	• Connection box		X		BL-90035
	• Sensing cables, 2 x 2 m, (6.5 ft) with clamps for connecting the circuit breaker to the connection box		X		GA-00430
	• Transport case		X		**50-00110**
DRM for TM1800	(To be released)	X			
Current cables	100 A		X		**GA-00424**
	250 A		X		**GA-00422**
	1000 A		X		**GA-00420**
Other					
VD401	Voltage divider, ratio 400/1 (for TM1600 and EGIL with analog channel)		X	X	**BL-90070**
PIR adapter	The adapter is used to test circuit breakers with pre-insertion resistors, when the resistance is lower than 250 Ω or higher than 3000 Ω. There are two versions:				
	PIR, 15 – 250 Ω		X		**BL-90080**
	PIR2, 90 – 4500 Ω		X		**BL-90082**
Current	AC/DC clamp/clip-on/current probe, Fluke 80i-110s				
	Current sensor kit 1 channel (Fluke 80i-110s incl. cable GA-00140)	X	X		**BL-90600**
	Current sensor kit 3 channels (Fluke 80i-110s incl. cables GA-00140)	X	X		**BL-90610**
Temperature sensor	For ambient temperature measurement (To be released)	X			
Long term monotoring	EPROM to be mounted in the TM1600				
LTM1	Starts measurement when there is a change at any of the time-measuring inputs		X		**BL-80010**
LTM2	Functions in the same way as a standard TM1600, but returns automatically to the READY state after measurement		X		**BL-80011**
Thermopaper	114 mm, 30 m		X	X	**GC-00030**
Thermopaper	114 mm, Ø 40 mm	X			**GC-00040**
Soft case		X			**GD-00340**

For more information about optional accessories please contact GE Energy.

Signal conditioning amplifier, SCA606

Cable reel, BL-90060

Extension cable XL, GA-00150

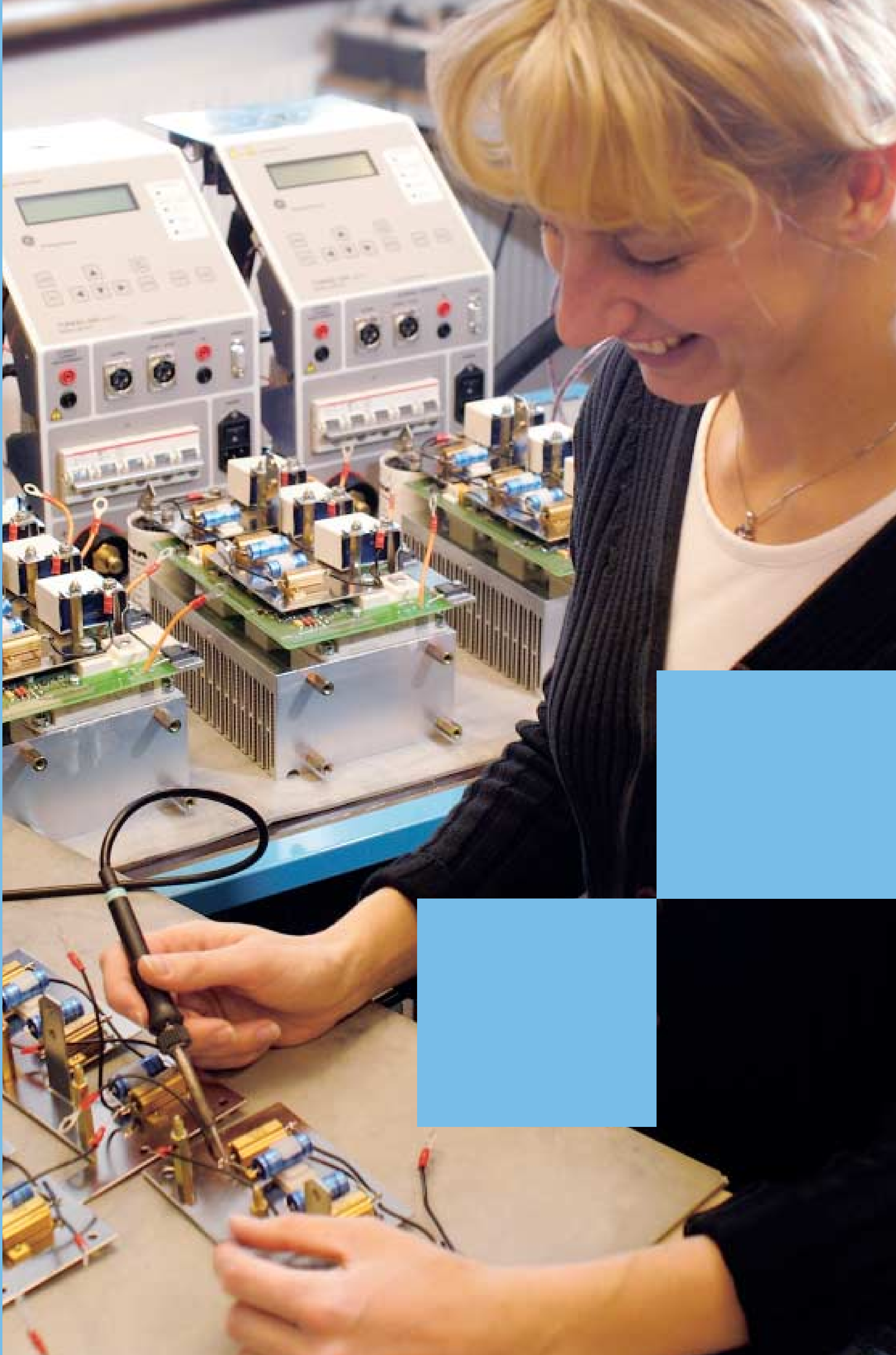
Accelerometer, Dytran 3200B5 and cable

DRM1000

Voltage divider, VD401

PIR adapter

Soft case



Testing battery systems

In the event of a power failure, battery systems are often used to provide standby power for important items of equipment such as protective relay systems, circuit breakers and monitoring devices – all of which require standby power during power outages.

Electric power plants are equipped with many different types of battery systems. Here, the pumps that lubricate generator bearings are examples of equipment for which standby power is crucial.

Telephone exchanges must also be kept operating on standby power.

Computer systems depend heavily on standby power. Even a brief power outage can cause critical data to be lost. Recovering from such damage is often very expensive.

Maintaining batteries

A battery system must be inspected and tested at regular intervals. Faults can occur long before the system's life expectancy is reached. Experience shows that these statements hold true for all types of battery systems.

A number of standards (IEEE® 450 and IEEE® 1188 for example) cover the maintenance of battery systems.

There are many reasons to thoroughly inspect a battery system (see IEEE® 450).

- Battery charger settings need attention.
- Faulty charging shortens a battery's service life.
- Voltages can vary so much from cell to cell that an equalizing charge is needed.
- There may be corrosion on the terminal posts, at internal connections etc.
- Leakage.
- Improper ambient temperature and/or ventilation.

Normally a general inspection is conducted at regular intervals (ranging from monthly to yearly). The battery should be connected as usual during inspection, i.e. the charger should be carrying the load and float-charging the battery.

A number of parameters should be measured in connection with a general inspection: a) ambient temperature, b) total terminal voltage, c) charger output current and output voltage, d) cell voltages, e) acid density, f) electrolyte temperature and level, g) water consumption and h) resistances of connections.

Battery capacity

A battery system must be able to provide power throughout a given interval without having its terminal voltage drop below a specified minimum value. Current multiplied by time expressed in hours (Ah) is called capacity. The manufacturer specifies a battery's capacity rating. New batteries must be in operation for a while before they are able to reach maximum capacity.

As a battery ages its capacity drops, and it cannot provide the specified current for as long as previously. Under favorable circumstances, a battery's life expectancy can range up to 20 years, but many have shorter service lives.

By measuring actual capacity it is possible to determine whether or not it is time to replace a battery system. You can save a great deal of money by ascertaining the best time to replace a battery. Since batteries age much faster as they get older, measuring capacity at regular intervals is of prime importance.

Capacity test

The most reliable and most widely accepted method of determining battery system capacity is to conduct a discharge test.

Prior to testing, the battery system must be well charged. The test is conducted by discharging the battery at a constant current specified by the battery manufacturer. This continues until battery voltage has dropped to a level which corresponds to that of a discharged battery.

The hours needed to reach this minimum level are then multiplied by the current to obtain the actual capacity (Ah). Cell voltages are also measured at regular intervals, and this becomes increasingly important toward the end of the test when it reveals the presence of weak cells.

TORKEL 820™ – Telecom

Battery Load Unit

During a power outage, crucial telecommunication and radio equipment must be kept operating by batteries. Unfortunately, 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 TORKEL 820™ Battery Load Unit features a unique design that combines efficiency with portability. Using TORKEL 820™ 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 TORKEL 820™ 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.

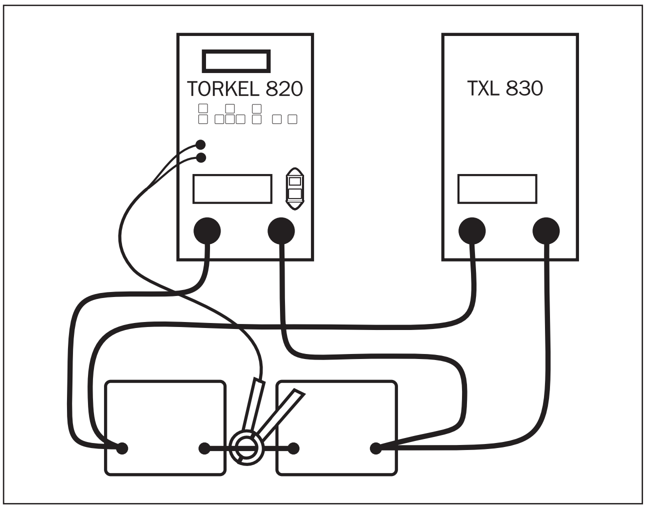
TORKEL 820™ issues a warning and/or shuts down the test automatically when a) the voltage has dropped to a certain level, b) discharging has continued through a certain time interval or c) a certain amount of capacity has been dissipated.

Application example

IMPORTANT!
Read the User's manual before using the instrument.

Testing can be carried out without disconnecting the battery from the equipment it serves. Via a DC clamp-on ammeter, TORKEL 820 measures total battery current while regulating it at a constant level.

1. Connect TORKEL 820 to battery.
2. Set the current and start discharging. TORKEL 820 keeps the current constant at the preset level.
3. When the voltage drops to a level slightly above the final voltage, TORKEL 820 issues an alarm.
4. If the voltage drops low enough so that there is risk of deepdischarging the battery, TORKEL 820 shuts down the test. The total voltage curve and the readings taken at the end of the test are stored in TORKEL 820. Later, using the TORKEL Win program which runs on a PC under Windows®, you can transfer these readings to your computer for storage, printout or export. If your PC is connected to TORKEL 820 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.



TORKEL 820 and the extra load TXL 830

Specifications TORKEL 820

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	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

Standards

Safety standards	IEC 61010-1:2001 Incl. national dev. for US and CA EN 61010-1:2001
EMC standards	EN 61326: 1997+A1:1998+A2:2001

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	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

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

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
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

Cable set, GA-00554

Ordering information

TORKEL 820	Art.No.
Complete with: Cable set GA-00554 Transport case GD-00054	**BS-49092**

Optional accessories

See section "Battery Testing Accessories"

TORKEL 840™/860™

Battery Load Units

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 the check batteries at regular intervals, and the only reliable way of measuring battery capacity is to conduct a discharge test.

TORKEL 840-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 TORKEL 840™ 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.

TORKEL 860-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.

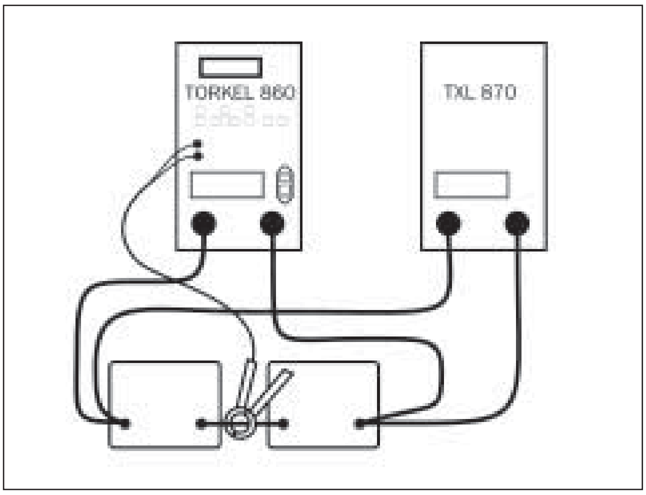
TORKEL 860™ is used for systems ranging from 12 to 480 V, and discharging can proceed at up to 110 A. If higher current is desired, two or more TORKEL 860™ units or extra load units, TXL, can be linked together. Discharging can take place at constant current, constant output, constant resistance or in accordance with a pre-selected load profile.

Application example

IMPORTANT!
Read the User's manual before using the instrument.

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.

1. Connect TORKEL to battery.
2. Set the current and start discharging. TORKEL keeps the current constant at the preset level.
3. When the voltage drops to a level slightly above the final voltage, TORKEL issues an alarm.
4. If the voltage drops low enough so that there is risk of deepdischarging 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 which runs on a PC under Windows®, 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.



TORKEL 860 and the extra loads TXL 870

Specifications TORKEL 840/860

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

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	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 (TORKEL 840) 480 V DC (TORKEL 860)
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, TORKEL 840	4 ranges, selected automatically at start of test
Battery voltage range, TORKEL 860	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) TORKEL 860

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

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) (TORKEL 860)		
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) (TORKEL 860)		
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

Cable set GA-00550

Ordering information

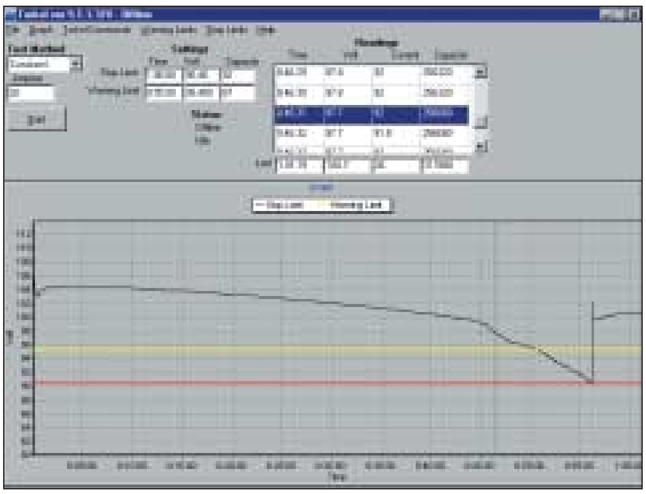
TORKEL 840	**Art.No.**
Complete with: Cable set GA-00550 Transport case GD-00054	**BS-49094**
TORKEL 860	
Complete with: Cable set GA-00550 Transport case GD-00054	**BS-49096**

Optional accessories

See section "Battery Testing Accessories"

Battery testing accessories

Item	Description	TORKEL 820	TORKEL 840/860	Art. No.
TORKEL 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 TORKEL • Report functions			
TORKEL Win		X	X	**BS-8208X**
TXL units	Extra loads These resistive extra loads do not perform any regulating functions. They are designed for use together with TORKEL Battery Load Units. Their purpose is to provide higher load currents for use in constant current or constant power tests. Together, TORKEL and the TXL Extra Loads form a system that can discharge batteries with currents of up to several kA. TXL Extra Loads are connected directly to the battery, and TORKEL measures the total current using a clamp-on ammeter. TXL Extra Loads are shut down automatically when TORKEL is stopped.			
TXL830	TXL830 is intended for 24 V systems. Complete with cable set GA-00554 and transport case GD-00054. A DC clamp-on ammeter must be used to enable TORKEL 820 to measure the total current.	X		**BS-59093**
TXL850	TXL850 is intended for 48 V systems. Complete with cable set GA-00554 and transport case GD-00054. A DC clamp-on ammeter must be used to enable TORKEL 850 to measure the total current.	X	X	**BS-59095**
TXL870	TXL870 is intended primarily for 125 and 240 V battery systems. Complete with cable set GA-00550 and transport case GD-00054. A DC clamp-on ammeter must be used to enable TORKEL 870 to measure the total current.		X	**BS-59097**
Cable sets				
Cable set for TXL830 and TXL850	2 x 3 m, 70 mm², with cable lug. Max 100 V 270 A. Weight: 5.0 kg (11 lbs)	X	X	**GA-00554**
Extension cable set, 110 A	2 x 3 m, 25 mm². Max 480 V. Weight: 3.0 kg (6.6 lbs)		X	**GA-00552**
Sensing lead set	Cable set for measuring voltage at battery terminals. 2 x 5 m (16.4 ft)	X	X	**GA-00210**
Clamp-on ammeter				
DC clamp-on ammeter, 200 A	To measure current in circuit outside TORKEL	X	X	**XA-12792**
DC clamp-on ammeter, 1000 A	To measure current in circuit outside TORKEL	X	X	**XA-12790**



TORKEL Win showing total voltage curve

TXL870

Specifications TXL 830/850/870

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

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	100 – 240 V AC, 50 / 60 Hz
Power consumption (max)	75 W
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)
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

	TXL830	*TXL850*	*TXL870*
Max. voltage (DC)	28 V	56 V	140 V/ 280 V
Max. current	300 A	300 A	112 A at 140 V 56 A at 280 V
Max. power	8.3 kW	16.4 kW	15.8 kW

Internal resistance, 3-position selector

Position 1	*TXL830*	*TXL850*	*TXL870*
Current	0.275 Ω	0.55 Ω	4.95 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	–	–	at 248.4 V (108 x 2.3 V)
39.2 A	–	–	at 194.4 V (108 x 1.8 V)

Position 2	*TXL830*	*TXL850*	*TXL870*
Current	0.138 Ω	0.275 Ω	2.48 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*	*TXL870*
Current	0.092 Ω	0.184 Ω	1.24 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	–	–	at 124.2 V (54 x 2.3 V)
78.4 A	–	–	at 97.2 V (54 x 1.8 V)

TORKEL / TXL systems – examples

Max. constant current (A)	***Number of TORKEL-units***	***Number of TXL-units***
TORKEL 820 + TXL830, 12 V battery (6 cells)[1)]		
234	1	1
571	1	4
918	2	6
TORKEL 820 + TXL830, 24 V battery (12 cells)[1)]		
495	1	1
1170	1	4
1890	2	6
TORKEL 820 + TXL850, 48 V battery (24 cells)[1)]		
499	1	1
1189	1	4
1918	2	6
TORKEL 840/860 + TXL830, 24 V battery (12 cells)[1)]		
263	1	1
670	2	2
1005	3	3
TORKEL 840/860 + TXL850, 48 V battery (24 cells)[1)]		
264	1	1
909	2	3
TORKEL 840/860 + TXL870, 110 V battery (54 cells)[1)]		
188	1	1
532	2	4
845	2	8
TORKEL 840/860 + TXL870, 120 V battery (60 cells)[2)]		
194	1	1
557	2	4
895	2	8
TORKEL 840/860 + TXL870, 220 V battery (108 cells)[1)]		
94	1	1
266	2	4
423	2	8

1) Discharge from 2.15 V to 1.8 V per cell
2) Discharge from 2.15 to 1.75 V per cell

Primary injection testing

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 service during primary injection testing, usually conducted in connection with commissioning.

Low voltage circuit breakers are used in distribution networks, in industry, ships, trains etc. Reliable operation of LV-breakers is in many cases very important, for example in nuclear power plants, subways and oil platforms. The only way to verify that a direct-acting low voltage circuit breaker operates properly is to inject a high current.

ODEN AT™

Primary Current Injection Test System

This powerful test system is 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.

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 transformation 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, resistance, power, power factor (cos φ) 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 current and time cycles. 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.

Automatic reclosers and sectionalizers

Oden AT can also be set to test direct-acting automatic reclosers and sectionalizers. 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. 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.

Cable application

❶ **Miniature circuit breaker used for current output**
Interrupts output current. Can also be actuated manually for safe disconnection of load.

❷ **Display**
The display presents time, output current, voltage, current shown on ammeter 2 and phase angle. You can scroll through entities Z, P, Q, R, X, S, power factor (cos φ) and I max.

❸ **Hold function**
This function freezes readings on the display.

❹ **Setting buttons**
Personnel unfamiliar with Oden AT can use the pre-defined settings very effectively, while experienced users can make their own basic settings.
AMMETER. Used to set the main current-output ammeter. You can select the desired range or select autoranging.
V/A METER. Toggles between the voltmeter and ammeter 2. Also used to select the desired range or select autoranging.
SYSTEM. Used for general settings.
MEMORY. Used to save or recall settings to or from the ten Oden AT memories. One of these memories contains the default (pre-defined) settings that are invoked when Oden AT is powered up.
APPLICATION. Used to invoke the desired measurement mode:
a) automatic recloser, b) sectionalizer or c) microhmmeter. Oden AT can also be set to generate pulse trains with user-selectable pulse and pause times.

❺ **Selection/setting (CHANGE) knob**
Selects the desired menu option (shown in the display window). Also used to change numerical values.

❻ **Knob for fine adjustment of current and +/- buttons for coarse adjustment.**

❼ **Current reduction button**
Used during setting to reduce the output current to 1/30. Useful in order to avoid for example unintentional tripping and overheating.

❽ **Injection**
Starts current injection and timing.

❾ **Momentary Injection**
When this button is used, injection continues only as long as it is pressed. Useful in order to avoid for example overheating.

❿ **RS232 for computer**
Oden AT is equipped with a serial port for communication with personal computers (for transfer of test data for example).

⓫ **Manual shutoff**
Injection and timing are stopped when this button is pressed.

⓬ **Automatic injection stop**
Generation stops after a user-specified interval or when condition at the input is met. The diodes show the selected OFF condition.

⓭ **Input for voltmeter**
Used to measure voltage and also for microhmmeter measurement.

⓮ **Indicator lamps**
Indicate whether ammeter 2 or the voltmeter is enabled.

⓯ **Input for ammeter 2**
Used to measure current in an external circuit (in a current transformer´s secondary winding for example).

⓰ **Stop-condition indicator**
Indicates that a contact connected to the input is closed or if voltage is present.

⓱ **Status indicator**
Indicates if a contact connected to the input is closed or if voltage is present.

⓲ **Stop input**
Used to freeze a reading or stop injection. Activated when current is interrupted by the object being tested, when an external contact is actuated or when a voltage is applied or removed.

To combine outstanding versatility with user-friendliness, ODEN AT's designers gave the front panel and user interface top priority. The clearly marked control panel is divided into sections. There are a number of pre-defined settings for frequently encountered applications. You can repeat any test by pressing a single button.

Optional accessories

HCP2000
The High Current Probe, HCP2000, is a tool that makes it possible to test automatic circuit breakers, also known as Moulded Case Circuit Breakers (MCCB), without removing/uninstalling the circuit breaker. These circuit breakers can for example be found in power plants and industry. The circuit breakers operates from 16 A up to 1500 A trip current.

ODEN DC Box
Designed for use together with ODEN primary current injection systems.
For test of DC circuit breakers.
Forced air-cooling.
Max output: 5000 A DC
Dimensions: 750 x 655 x 335 mm
Weight: 42 kg

Current Transformer Switchbox
The Current Transformer (CT) Switchbox to ODEN AT is a tool that is used to facilitate CT testing with ODEN AT. The secondary windings on the CT are connected to the CT Switchbox inputs and the CT Switchbox output is connected to ODEN AT Ammeter 2. The switch on the CT Switchbox is used to select which secondary winding on the CT that should be measured. The windings that aren't measured are short-circuited. The CT Switchbox can handle up to 5 secondary windings.

High Current Serial Bar
For serial connecting of ODEN current units.

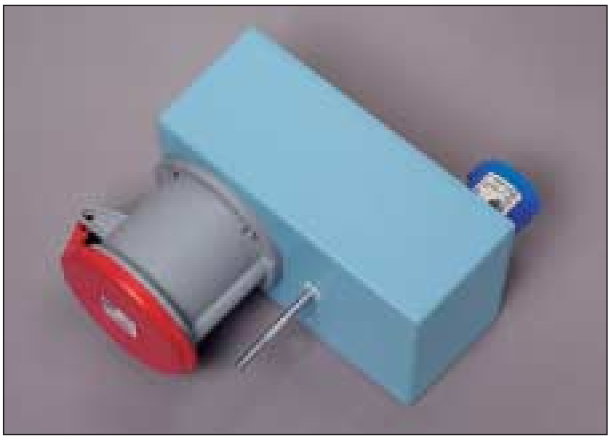
Mains Adapter 240/400V
Used to run a 400 V ODEN AT at 240 V. Can only be used together with an ODEN AT prepared for this feature.

Multi-cable high current cable sets
Low-impedance multi-cable sets for higher output current. Available with 2, 3, 4 or 6 parallel cables, and in lengths of 0.5, 1.0, 1.5 or 2 meters. See Ordering information.

Cable Sets
See Ordering information.


Current Transformer Switchbox


High Current Serial Bar


Mains adapter 240 V to 400 V


HCP2000 - High Current Probe


Multi-cable high current cable set 6 x 120 mm^2

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 an 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

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

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	240 / 400 V AC, 50 / 60 Hz 480 V AC / 60 Hz
Mains inlet	IEC 60309-2, 63 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 AT	570 x 310 x 230 mm (22.4" x 12.2" x 9")
Current unit S, X H	570 x 310 x 155 mm (22.4" x 12.2" x 6")
Weight	
Control unit AT	25 kg (55 lbs)
Current unit S	42 kg (92.6 lbs)
Current unit X	45 kg (99.3 lbs)
Current unit H	49 kg (108 lbs)
Display	LCD
Available languages	English, German, French, Spanish, Swedish.

Measurement section

Ammeters

Measurement method	AC, true RMS
Inaccuracy	1% of range ±1 digit

Ammeter 1

Ranges	0 – 4800 A / 0 –15 kA 0 – 9600 A / 0 – 30 kA 0 – 960 A / 0 – 3 kA

Ammeter 2

Ranges	0 – 2.000 A / 0 – 20.00 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 (Rin)	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 0.001 s – 99 h 59 min
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 (cos φ)

For these measurements the result is calculated using two or three items. The accuracy depends on the errors for the items included (U, I and sometimes φ).

Imax

Stores highest current value that exists ≥100 ms

INT-level

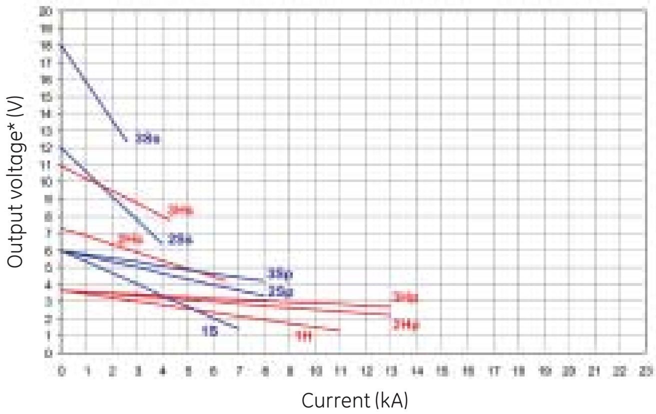
Threshold indicating that current is interrupted. Can be set to 0.7% or 2.1% of Ammeter 1 range.

Outputs

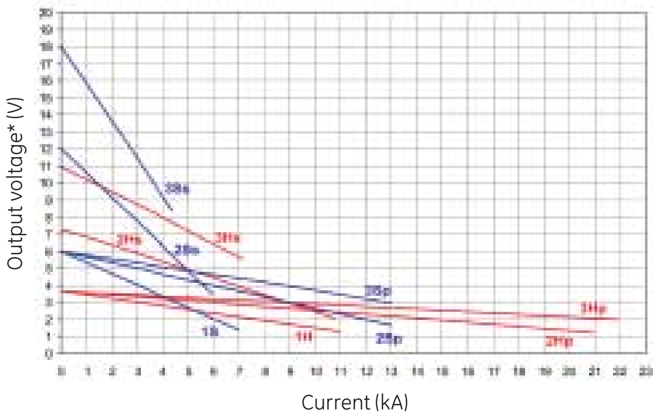
ODEN AT, 240 V mains voltage, 50 / 60 Hz

		Open circuit voltage	*Max. continuous current* [3]	*Max. current, 3 minutes* [3]	*Max. current, 1 sec* [3]
ODEN AT/1S					
		6 V	1000 A	2000 A	7000 A
ODEN AT/2S					
	1)	6 V	1680 A	3600 A	8000 A
	2)	12 V	1000 A	2000 A	4000 A
ODEN AT/3S					
	1)	6 V	2500 A	5200 A	8000 A
	2)	18 V	840 A	1700 A	2600 A
ODEN AT/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	1200 A
60 V range		60 V	80 A	150 A	600 A
ODEN AT/2X					
High current output	1)	6 V	1680 A	3600 A	8000 A
	2)	12 V	1000 A	2000 A	4000 A
Output 0 – 30/60 V					
30 V range	1)	30 V	320 A	600 A	1600 A
30 V range	2)	60 V	160 A	300 A	800 A
60 V range	2)	120 V	80 A	150 A	400 A
ODEN AT/3X					
High current output	1)	6 V	2500 A	5200 A	8000 A
	2)	18 V	840 A	1700 A	2600 A
Output 0 – 30/60 V					
30 V range	1)	30 V	480 A	900 A	1600 A
30 V range	2)	90 V	160 A	300 A	520 A
60 V range	2)	180 V	80 A	150 A	260 A
ODEN AT/1H					
		3.6 V	1250 A	2600 A	11 kA
ODEN AT/2H					
	1)	3.6 V	2500 A	5500 A	13 kA
	2)	7.2 V	1250 A	2800 A	6500 A
ODEN AT/3H					
	1)	3.6 V	3800 A	8000 A	13 kA
	2)	10.7 V	1250 A	2800 A	4300 A

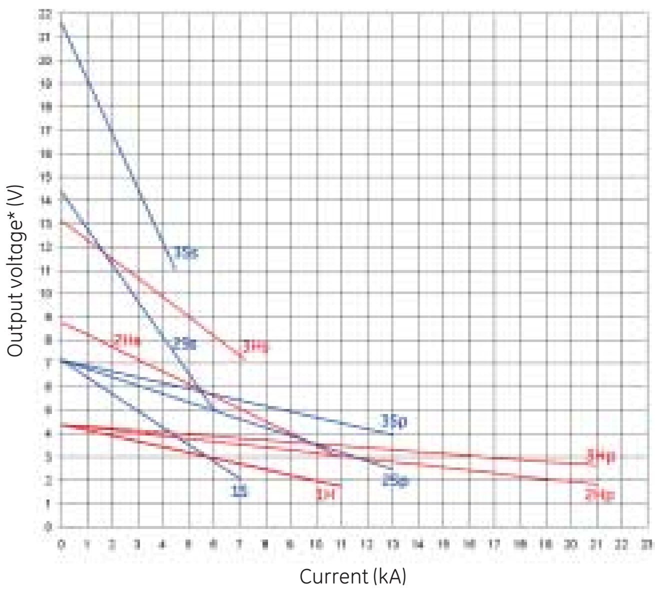
High current output - ODEN AT systems for 240 V, 50 Hz



High current output - ODEN AT systems for 400 V, 50 Hz



High current output - ODEN AT systems for 480 V, 60 Hz



S or X units
H units
p = units in parallel, s = units in series
*) Voltage between output terminals

ODEN AT, 400 V mains voltage, 50 / 60 Hz

		Open circuit voltage	Max. continuous current3)	Max. current, 3 minutes3)	Max. current, 1 sec3)
ODEN AT/1S					
		6 V	1000 A	2000 A	7000 A
ODEN AT/2S					
	1)	6 V	1900 A	4000 A	13 kA
	2)	12 V	900 A	2000 A	6000 A
ODEN AT/3S					
	1)	6 V	1900 A	4000 A	13 kA
	2)	18 V	600 A	1400 A	4400 A
ODEN AT/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	1200 A
60 V range		60 V	80 A	150 A	600 A
ODEN AT/2X					
High current output	1)	6 V	1900 A	4000 A	13 kA
	2)	12 V	900 A	2000 A	6000 A
Output 0 – 30/60 V					
30 V range	1)	30 V	320 A	600 A	2500 A
30 V range	2)	60 V	160 A	300 A	1200 A
60 V range	2)	120 V	80 A	150 A	600 A
ODEN AT/3X					
High current output	1)	6 V	1900 A	4000 A	13 kA
	2)	18 V	600 A	1400 A	4400 A
Output 0 – 30/60 V					
30 V range	1)	30 V	380 A	850 A	2600 A
30 V range	2)	90 V	120 A	290 A	880 A
60 V range	2)	180 V	60 A	145 A	440 A
ODEN AT/1H					
		3.6 V	1250 A	2600 A	11 kA
ODEN AT/2H					
	1)	3.6 V	2500 A	5300 A	21 kA
	2)	7.2 V	1250 A	2500 A	10.9 kA
ODEN AT/3H					
	1)	3.6 V	3800 A	7700 A	21.9 kA
	2)	10.7 V	1250 A	2600 A	7200 A

ODEN AT, 480 V mains voltage, 60 Hz

		Open circuit voltage	Max. continuous current 3)	Max. current, 3 minutes 3)	Max. current, 1 sec 3)
ODEN AT/1S					
		7.2 V	1000 A	2000 A	7000 A
ODEN AT/2S					
	1)	7.2 V	1900 A	4000 A	13 kA
	2)	14.4 V	900 A	2000 A	6000 A
ODEN AT/3S					
	1)	7.2 V	1900 A	4000 A	13 kA
	2)	21.6 V	600 A	1400 A	4400 A
ODEN AT/1X					
High current output		7.2 V	1000 A	2000 A	7000 A
Output 0 – 30/60 V					
30 V range		36 V	160 A	300 A	1200 A
60 V range		72 V	80 A	150 A	600 A
ODEN AT/2X					
High current output	1)	7.2 V	1900 A	4000 A	13 kA
	2)	14.4 V	900 A	2000 A	6000 A
Output 0 – 30/60 V					
30 V range	1)	36 V	320 A	600 A	2500 A
60 V range	1)	272 V	160 A	300 A	1200 A
60 V range	2)	144 V	80 A	150 A	600 A
ODEN AT/3X					
High current output	1)	7.2 V	1900 A	4000 A	13 kA
	2)	21.6 V	600 A	1400 A	4400 A
Output 0 – 30/60 V					
30 V range	1)	36 V	380 A	850 A	2600 A
30 V range	2)	108 V	120 A	290 A	880 A
60 V range	2)	216 V	60 A	145 A	440 A
ODEN AT/1H					
		4.3 V	1250 A	2600 A	11 kA
ODEN AT/2H					
	1)	4.3 V	2500 A	5300 A	21 kA
	2)	8.7 V	1250 A	2500 A	10.9 kA
ODEN AT/3H					
	1)	4.3 V	3800 A	7700 A	21.9 kA
	2)	13.0 V	1250 A	2600 A	7200 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.

Ordering information

A carriage (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 control unit.

ODEN AT/1S	Art.No
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-90160
ODEN DC Box	BH-90140
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 GE Energy.	BH-90120

Multi-cable high current cable sets

Length	*Impedance (Twisted-pair cables)*	
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 mm² 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 mm² For the 30/60 V output of current unit X. Weight: 4 kg (8.8 lbs)	GA-02052

ODEN A™

Primary Current Injection Test System

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 versons of the current unit: S and X, S and X are identical except that X has an additional 30/60 V output.

Application

Oden A can be used in a number of applications where high current is required:

Primary current injection testing of protective systems

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.

Optional accessories

See also Optional accessories for ODEN AT

TM200

External timer
See the TM200 product pages for more information.

Timer TM200

Cable application

Multi-cable high current cable set 6 x 120 mm²

Specifications ODEN A

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 an 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 medium-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

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	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")
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)

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.

Ordering information

A carriage (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 control unit.

ODEN A/1S	Art.No.
240 V Mains voltage	BH-32411
400 V Mains voltage	BH-34011
ODEN A/2S	
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-90160
TM200	BE-29090
ODEN DC Box	BH-90140
Current Transformer Switchbox	BH-90130
High Current Serial Bar	BH-90102

Multi-cable high current cable sets

Length	*Impedance (Twisted-pair cables)*	
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 mm²
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 mm²
For the 30/60 V output of current unit X.
Weight: 4 kg (8.8 lbs) — GA-02052

CSU600A™/600AT™

Current Supply Units

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 more sophisticated 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.

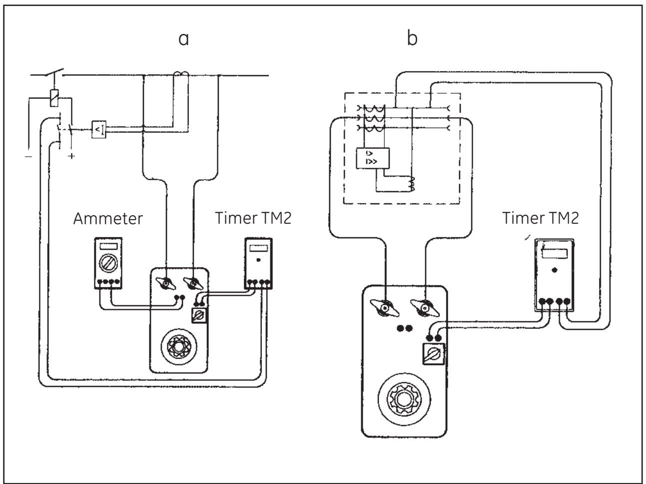
The CSU600A™ and CSU600AT™ current supply units have an excellent weight/performance ratio.

Application example

IMPORTANT!
Read the User's 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 Timer 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 Timer TM200.



Optional accessories

Cable set (for 115 V), 2 x 5 m (16 ft), 70 mm²

Weight: 8.4 kg (18 lbs)

Cable set, 2 x 10 m (33 ft), 70 mm²

Weight: 16.8 kg (37 lbs)

Cable set, 2 x 15 m (49 ft), 95 mm²

Weight: 29.4 kg (65 lbs)

TM200

External timer
See the TM200 product pages for more information

Specifications CSU600A/AT

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 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 or 230 V AC, 50 / 60 Hz
Power consumption (max)	115 V, 667 VA cont. (interm. 3738 VA) 230 V, 851 VA cont. (interm. 6440 VA)
Protection	Thermal cut-outs and miniature circuit breakers
Dimensions	
Instrument	356 x 203 x 241 mm (14.0" x 8.0" x 9.5")
Transport case	610 x 290 x 360 mm (24.0" x 11.4" x 14.2")
Weight	21.9 kg (48 lbs) 38.3 kg (84.4 lbs) with accessories and carrying case
Current cables	2 x 5 m (16 ft), 50 mm²

Measurement section	
Ammeter	Built-in, 0 – 600 A (only on CSU600AT) Output for external ammeter
Current transformer	500/5 A, class 0.5
Timer (only CSU600AT)	
Range	0-999.999 s
Resolution	1 ms
Inaccuracy	±0.02% of shown value + 0 to 2 ms
Other	Output for starting external timer

Outputs, AC, intermittent output [1] (CAT I)

	115 V mains voltage		***230 V mains voltage***	
Current	***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	
115 V mains	2 x 5 m (16 ft), 70 mm²
230 V mains	2 x 5 m (16 ft), 50 mm² 2 x 10 m (33 ft), 70 mm² 2 x 15 m (49 ft), 95 mm²

Ordering information

CSU600A

	Art.No.
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 accessories

Cable set 5 m (for 115 V)	**GA-07052**
Cable set 10 m	**GA-07102**
Cable set 15 m	**GA-09152**
TM200	**BE-29090**

Cable set GA-05052

TM200™

Timer

A timer is often needed for use with the CSU600A™ current supply unit or ODEN A™ primary current injection test system. Testing relays with SVERKER 650™ also requires an extra timer if more than one timing cycle is to be measured.

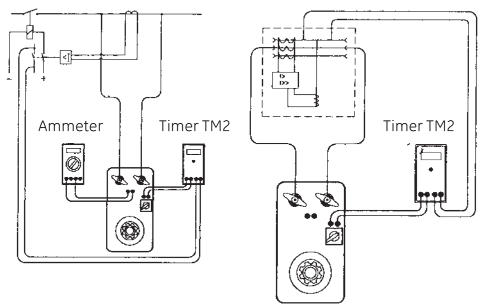
Timer TM200™ is ideal for these tasks thanks to its precise accuracy, its broad application range and its compact dimensions. Timer TM200™ is the obvious choice for maintenance work in substations.

Application example

IMPORTANT!
Read the User's 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 Timer 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 Timer TM200.



Specifications TM200

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 +55°C (-4°F to +131°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	195 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*	*Typ*	*Max*	*Unit*
Threshold level, DC	10	12.5	15	V DC
Input current at threshold level DC Positive at red terminal	0.7	1.1	1.5	mA DC
Input current at threshold level DC Positive at black terminal	4	6	8	mA DC
Threshold level, Applying voltage at 50 Hz	5	10	15	V ACRMS
Threshold level, Removing voltage at 50 Hz	60	90	140	V ACRMS

Contact mode

Parameter	*Min*	*Typ*	*Max*	*Unit*
Threshold level	1	2	4	kΩ
Open circuit voltage	17	18.5	20	V DC
Short circuit current	8	10	13	mA DC

Input current at maximum input voltage, inrush

Parameter	*Min*	*Max*	*Unit*
At 250 V DC, Positive at red terminal	4.5	5	mA DC
At 250 V DC, Positive at black terminal	130	150	mA DC
At 250 V AC	55	80	mA DC

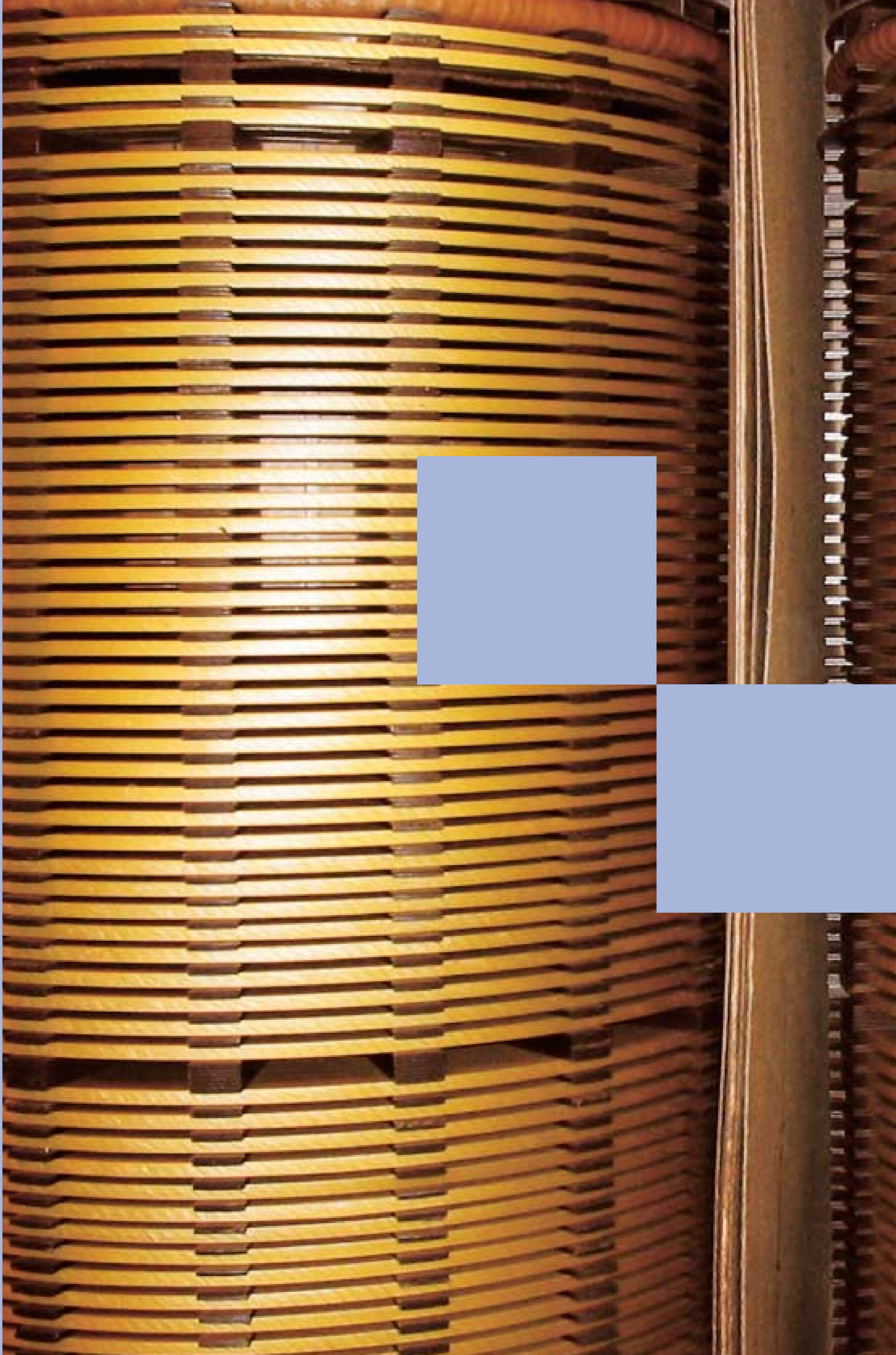
Input current at maximum input voltage, continuous

Parameter	*Min*	*Typ*	*Max*	*Unit*
At 250 V DC, Positive at red terminal	4	4.5	5	mA DC
At 250 V DC, Positive at black terminal	7	8	9	mA DC
At 250 V AC	2.5	3.3	4	mA DC

Ordering information

TM200	Art.No.
Complete with: Test lead set GA-00082 Carrying case GD-00230	**BE-29090**

DIAGNOSTIC TESTING OF INSULATION



Diagnostic Testing of Insulation

Electric utilities the world over are facing an increasingly difficult challenge – to secure steady electrical supply to demanding customers, while at the same time having to cut costs in operations and maintenance to remain commercially competitive. The single largest cause of costly downtime at high voltage installations is aging and damage to insulation materials. One can take the power transformer as an example, the most expensive component at a substation, with a relatively long expected life span. By being able to ensure that the transformer's insulation material is in good condition, its life span can be safely increased, which provides a profit for the transformer owner. Detection can also be made of when aging of the insulation has gone too far and maintenance can be schedule to avoid changing the transformer prematurely, also providing economic benefits.

There has been a problem with the lack of suitable measurement instruments for diagnosis of insulation material in a reliable manner that does not damage equipment and material. The diagnostic methods that have been available have most often been limited to use in laboratory environments, and have therefore been difficult to apply in the field. Another problem is that they have not provided sufficient information to form a basis for further action. Other available methods have entailed excessive electrical stress on the object under evaluation, which introduces risks for object failure during testing. Often, a combination of the mentioned obstacles has resulted in a situation where no or few measurements are performed on installed units.

Because premature repairs and replacements are much more expensive than scheduled maintenance, we are convinced that there is an unfulfilled demand for a lightweight, portable and user-friendly system for insulation diagnostics that is suitable for use in the field. At the same time, all measurement results must be accurate and sufficiently detailed to form a basis for decisions on maintenance and replacement of expensive components in substations.

In the past, using traditional measurement methods (often variations of the classic Schering bridge), high voltages have been required of up to several thousand volts to attain accurate results. One of the reasons for this has been the corruption of measurements caused by mains frequency interference from adjacent high voltage lines in substations. To bring down the resulting errors, a relatively high voltage has been required to perform measurements.

With the IDA 200™ – Insulation Diagnostics System 200™ – GE Energy has chosen a different path. With the focus on aging of insulation materials, we use a lower voltage in that this often offers advantages in comparison to using high measuring voltages. The IDA 200™ measures the capacitance and dielectric losses at discrete frequencies, both above and below the mains frequency (output signals with frequencies from 0.1 mHz to 1 kHz are available). By avoiding the mains frequency and its harmonics, the influence of disturbances can be effectively filtered. By measuring the capacitance and the dielectric losses over a frequency spectrum (rather than at a fixed frequency alone), much information can be obtained on the condition of insulation materials. For example, it is possible to differentiate between different materials, and also to identify aging processes in the insulation material.

IDA 200™

Insulation Diagnostics System

The measurement and analysis methods employed in the IDA 200™ are based on research conducted at the Royal Institute of Technology in Stockholm, with resources and input from leading users and manufacturers of high voltage equipment. These methods, along with design and selection of components, have resulted in a unique diagnostics system. In regards to size and weight, as well as to accuracy and depth of analysis, the IDA 200™ is definitely in a class of its own. With the IDA 200™, it is possible to diagnose insulation material in most objects in a substation (e.g., power transformers, measuring transformers, bushings, paper-insulated cables, etc.). The diagnostic measurements are made by applying a relatively low voltage – up to 140 V. The IDA 200™ measures the capacitance and dielectric losses (tan δ, PF) at discrete frequencies, both above and below mains frequency. By avoiding the mains frequency and its harmonics, the influence of disturbances can be effectively filtered. By measuring at several frequencies, and obtaining a curve instead of a point, precise compensation can be made for the temperature differences that can occur at several different measurement occasions. This means that temperature independence is achieved with this method.

Application

IDA 200 is designed for diagnostic measurements of electrical insulation. Examples of application areas: Power and instrument transformers, bushings and paper insulated cables.

Electrical insulation come in all three states of matter: solid (such as cellulosic paper and porcelain), liquid (such as mineral oil), and gas. Insulation systems that include solid and/or liquid insulation are candidates for diagnostic measurements. IDA 200 is not suited for pure gas insulated systems.

Electrical insulation systems as found in the objects listed above usually consist of a combination of different materials. In the following, we will illustrate how IDA 200 can be used to determine the condition in some of the most commonly used insulation systems.

Application examples

Dielectric properties of mineral oils

Transformer oil is a non-polar liquid with a capacitance that changes very little with frequency. But oil also has a DC conductivity that varies with the oil's quality and temperature. The measured dissipation factor for the oil is inversely proportional to the frequency, which results in a very simple curve form.

Dielectric properties of cellulosic paper

Oil-impregnated cellulose, e.g., transformer pressboard and the Kraft paper used in paper-insulated cables, has a more complex structure and is characterized by frequency dependence in both capacitance and losses. Since aging produces moisture, the moisture content of cellulose is used as an indicator of age.

Diagnosis of insulation in power transformers

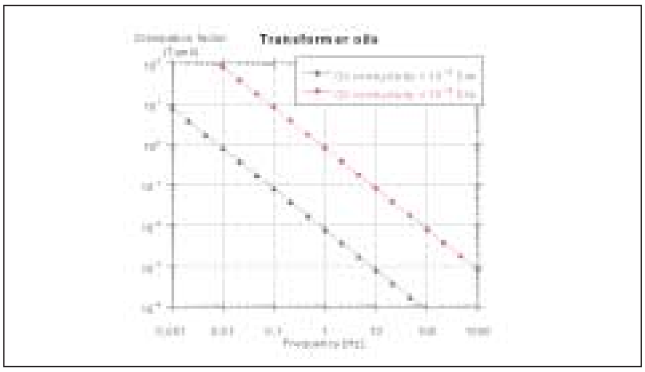
The insulation system of most power transformers consists of oil and cellulose (paper). The dielectric properties of both of these materials changes over the transformer's life span. When measured at mains frequency alone, the property changes in the different materials cannot be differentiated. An analysis of the measured dissipation factor's frequency properties provides a more complete diagnosis of the examined insulation. The graph below shows the results of measurements made with the IDA 200™ on the insulation between primary and secondary to tertiary windings on an auto power transformer. At higher frequencies, the transformer's pressboard and oil volume determine the dielectric loss; at medium frequencies, the oil conductivity is the dominant factor; and in the lower frequency range, is dominated by the transformer pressboard's dielectric loss. Based on analysis of the measurement results with the IDA 200 MODS software, a moisture content of 1–1.5% was deduced. Normally, moisture content above 3.5–4% entails transformer replacement to avoid insulation breakdown. Operating a transformer close to or higher than its rated output can be necessary under certain circumstances. This entails risks, but when the moisture content of the paper is known to be low, temporary overloads can be handled without the risk of insulation breakdown.

MODS – A tool for analysing measurement results

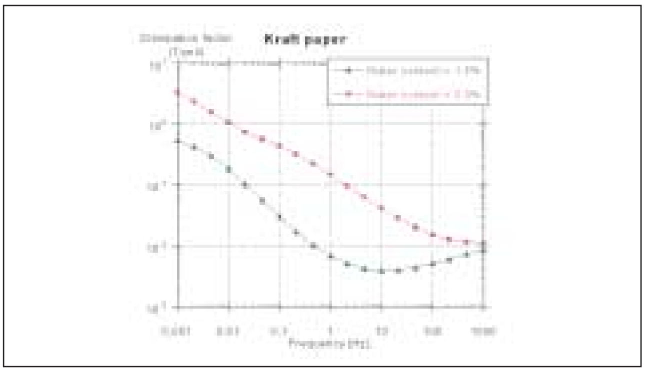
Included in the IDA 200™ system is an analysis program, MODS, for determining the moisture content in transformer pressboard. Using the measurement results from the IDA 200™ and the temperature of the insulation during measurement, the responses from the oil and pressboard can be differentiated, and a good estimation of the pressboard's condition obtained.

Diagnosis of cellulose-insulated power cables

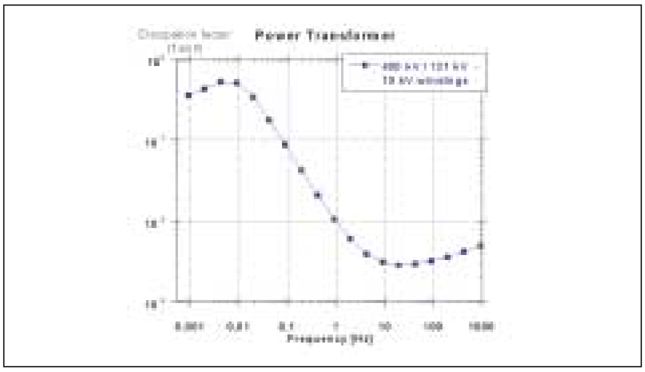
Since moisture produces a characteristic change to the cellulose's response, the IDA 200™ is very suitable for accessing the average moisture content in paper-insulated power cables (PILC cables).



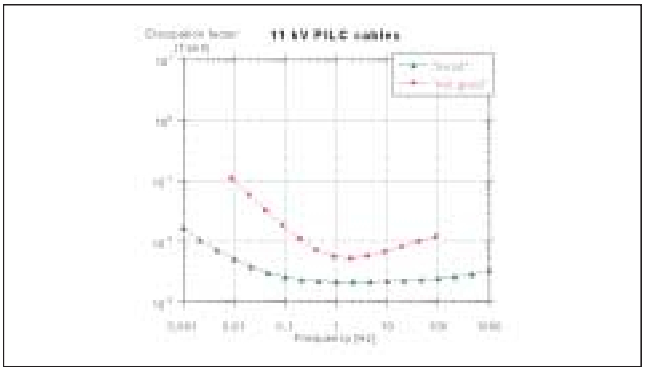
The figure shows a typical response of oil with low conductivity (good oil) and another oil with higher conductivity (bad oil), both at same temperature.



Here is an example of how moisture affects the dissipation factor of Kraft paper at 20° C.

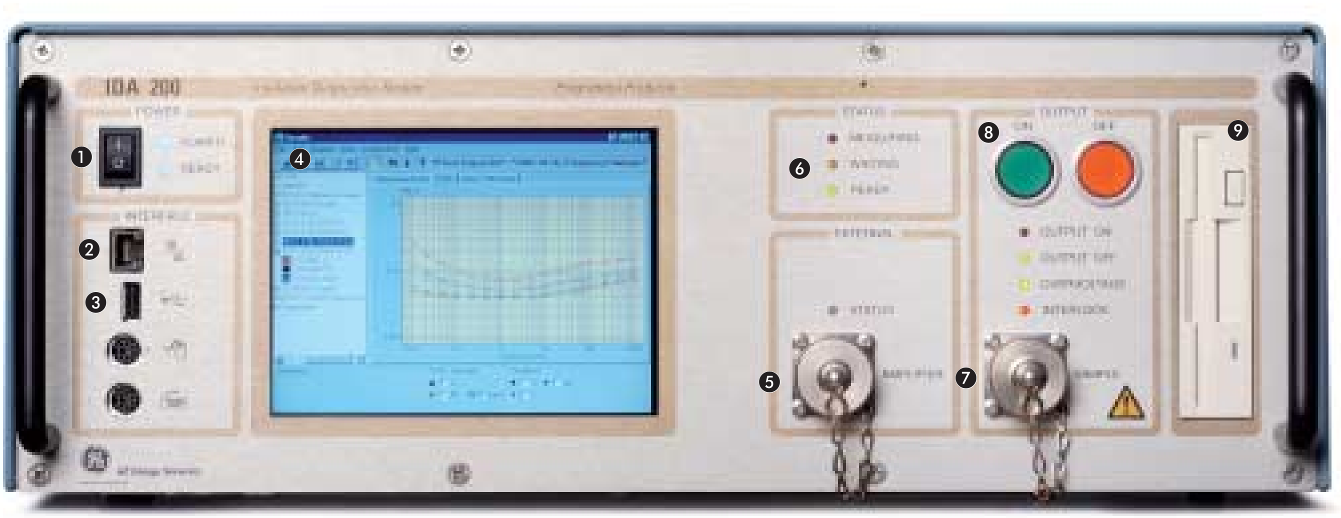


Measurement results of the insulation between primary and secondary to tertiary windings on a power transformer.



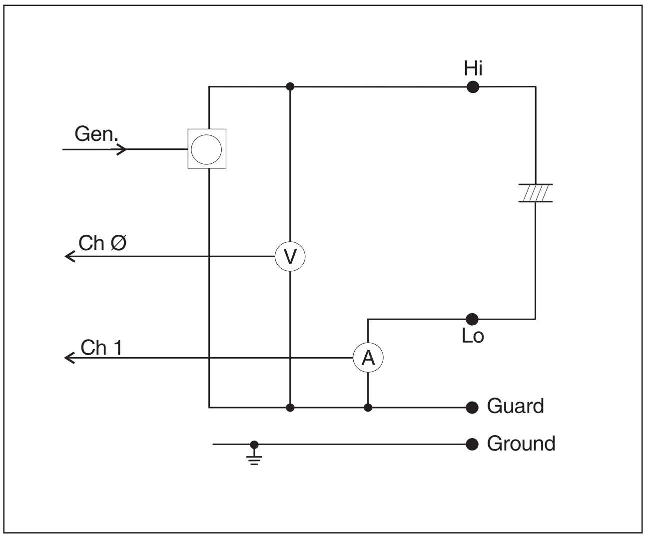
The graph shows the results from measurements of a new cable and a service aged cable.

1. Mains switch/indicator
2. Ethernet Interface
3. USB-port
4. Computer screen for integrated PC
5. Terminal for connecting optional external voltage amplifier
6. Measuring status indicator
7. Terminal for connecting sample to be diagnosed (Voltage output/measuring input)
8. Output On/Off buttons
9. Floppy Disk Drive (1.44 MB).



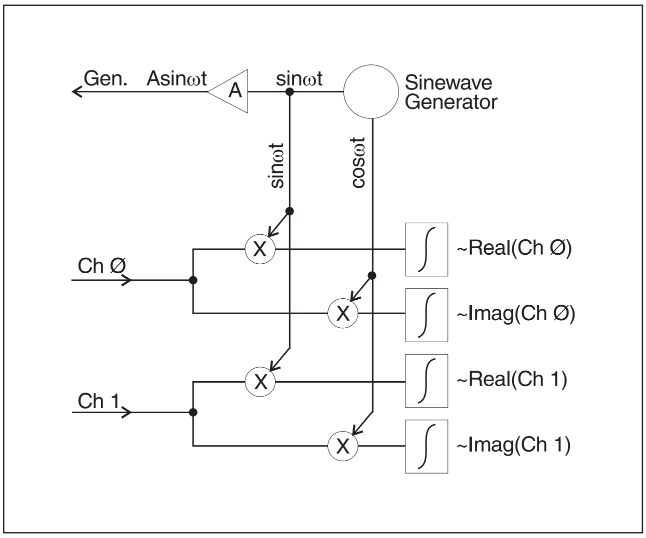
Technical description

The system measures the impedance of a specimen at a variable voltage and frequency. A Digital Signal Processing (DSP) unit generates a test signal with the desired frequency. This signal is amplified with an internal amplifier and then applied to the specimen. The voltage over and the current through the specimen are measured with high accuracy using a voltage divider and an electrometer (Ampere meter).



Schematic block diagram of the IDA 200-system.

For the measuring input, IDA 200 uses the DSP unit that multiplies the input (measurement) signals with reference sine voltages, and then integrates the results over a number of cycles. With this method, noise and interference is almost completely rejected - allowing IDA 200 to work with low voltage levels and still achieve high accuracy.



Principle of the sine correlation technique

Optional accessories

IDA 200 HVU

The High Voltage Unit (HVU) is used with the IDA 200 system to increase the output voltage up to 30 kV (21 kVRMS). The main application for this combination is for diagnosis of water tree deteriorated XLPE-cables. The system works equally well when other types of non linear materials are to be characterized.

Termination box IDA 200 (special)

Alike the standard Termination box but with BNT connectors instead of cables.

IDA 200 HVU

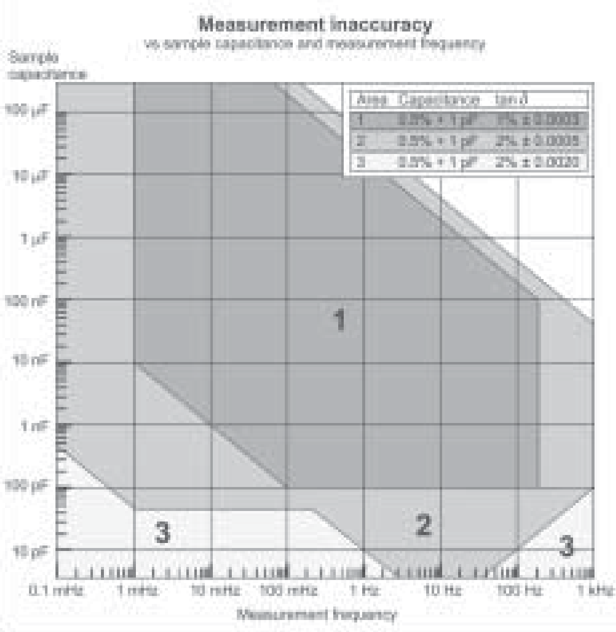
Termination box, special

Specifications IDA 200

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	
Operating	0°C to +55°C (-4°F to +131°F)
Storage & transport	-40°C to +70°C (-40°F to +158°F)
Humidity	<95% RH (non-condensing), 30 days/year, 85% RH remaining time
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
Standards	
Safety standards	IEC 61010-1:90 + A1:92 + A2:95 UL 3101-1, 3111-1 (1994) CAN-CSA 22.2 No. 1010.010 – 30
EMC standards	EN 61 326-1 1997 + A1 1998
General	
Mains input (nominal)	115 / 230 V AC, 50 / 60 Hz
Power consumption (max)	250 VA
Dimensions	
Instrument	450 x 160 x 410 mm (17.7" x 6.3" x 16.1")
Transport case	560 x 230 x 565 mm (22.1" x 9.1" x 22.2")
Weight	15 kg (33.1 lbs) 30 kg (66 lbs) with accessories and transport case
Display	TFT Colour Monitor, 16 cm (6.4")
Available languages	English, French, German, Spanish, Swedish
Measurement section	
Capacitance	
Range	10 pF – 100 µF
Dissipation factor	
Range	0 – 10 (with retained accuracy of capacitance – otherwise higher)

Measurement inaccuracy



The inaccuracies specified above are valid for a measurement voltage of 200 Vpeak, provided that the optimum capacitive feedback ratio in the electrometer *CFBR* is used and that the hum current, I_H, satisfies:

$$I_H < \frac{I_{SAMPLE} \times CFBR \times f_H}{f_{SAMPLE}}$$

where, I_{SAMPLE} is the sample current, f_{SAMPLE} is the measurement frequency and f_H is the hum frequency.

Outputs	
Voltage / current ranges	
10 V	0 – 10 Vpeak / 0 – 50 mA
200 V	0 – 200 Vpeak / 0 – 50 mA
Frequency	
Range	0.0001 Hz - 1 kHz [1]

1) Due to current limitation the upper frequency limit can be lower.

Ordering information

IDA 200	Art.No.
Complete with: IDA 200 instrument software IDA 200 MODS software Transport case, GD-00270 Keyboard with integrated mouse Calibration box, CK-90010 Termination box IDA 200 (standard), CK-90030 Multi-cable (blue) 1 x 15 m (49 ft), GA-00615 Test capacitor box, CK-90050 Ground cable 1 x 10 m (32.8 ft) GA-00208	**CK-19090**

Optional accessories

IDA 200 HVU	**CK-29090**
Termination box IDA 200 (special)	**CK-90040**
Multi-cable (blue), 1 x 1 m (3.3 ft)	**GA-00611**
Multi-cable (blue), 1 x 3 m (9.8 ft)	**GA-00613**
Multi-cable (blue), 1 x 35 m (114.8 ft)	**GA-00635**


Test capacitor box and ground cable


IDA 200 can be operated while it is in the transport case.


Termination box, standard


Calibration box


Multi-cable

Training courses

Reliable, efficient electricity supply depends on well-planned maintenance strategies. The necessary tests within this framework have in recent years become more complex and demanding.

In order to meet increasingly stringent requirements, not only good test equipment but also testing skills are important components in a successful maintenance strategy.

For those who share the opinion that even the best handbooks only can offer theory, GE Energy offers Training Courses with a practical, "hands-on" approach. In doing this we have taken special care to ensure that the exercises are performed using relevant testing devices for the various test objects. In order that participants can work effectively, the number of participants is limited.

If you are interested in knowing more about GE Energy training courses, please visit our Website www.gepower.com or contact us.

Index – Article number

Programma Electric AB
Eldarvägen 4
SE-187 75 TÄBY
Sweden

Tel +46 8 510 195 00
Fax +46 8 510 195 95
E-mail programma@ge.com
Internet www.gepower.com

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