Experience

Innovation

Technology

TM1800™

Circuit Breaker Analyzer System

PROGRAMMA PRODUCTS

GE Power Systems

TM1800™ CIRCUIT BREAKER

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 condition based maintenance has become the established strategy for most owners and operators of electric power supply systems, the need for reliable and accurate field test instruments is obvious.

TM1800™ Circuit Breaker Analyzer Capabilities

- System platform for testing high voltage circuit breakers
- Expandable modular concept – high flexibility (up to 48 + 48 timing channels)
- Stand-alone functionality – one toolbox for all breaker testing
- Designed for Off-line and On-line measurements
- Analog or digital transducers for contact travel measurements
- Calibration module for stable accuracy
- Predefined circuit breaker templates –Automatic testing
- Enhanced contact timing
- Active interference suppression - patent pending
- Integrated static contact resistance measurement
- Automatic measurement of coil voltage and current
- Automatic measurement of a and b auxiliary contacts
- Quick test functions
- Vibration measurement
- Temperature measurement
- CABA backwards compatibility
- Rugged and reliable for field use
- Multilingual Human-Machine Interface
- Enhanced reporting, assessments and archiving of test results

ANALYZER SYSTEM

Market Trends

Many new breaker technologies and designs have been introduced over the past decades. At the same time, the lifetime of an installed circuit breaker is often longer than 40 years. This means that at most sites, the vast range of existing circuit breakers with different configurations present an enormous challenge to the test engineers.

Another factor has been market driven reorganizations of electric power utilities. Frequently, the established service organizations within utilities have given way to slimmed operations with outsourced maintenance and service. Again, this has meant that a lot of practical know how and background history about specific breakers has been lost along the way.

The financial requirements on utilities have tightened as well. Asset optimization has become a priority. The possibility to continue using a costly circuit breaker rather than unnecessarily replacing it with a new is very interesting from this perspective – as long as it does not put the safety and reliability of the electric power supply at risk. This again puts the possibility to quickly and reliably diagnose the breaker's condition into focus.

The reorganizations within the industry mentioned above, (leading to outsourcing of service and maintenance), means that reporting, archiving and evaluation of test results become more critical. Modern service organizations need tools and facilities to provide the breaker owner/operator with reports and recommendations in formats that are suitable.

The Response

In response to all these challenges, GE Power Systems has designed the TM1800 breaker analyzer system. The objective was to incorporate all relevant test functions in one compact unit that should be flexible enough to test any circuit breaker that exists on the market.

In line with the Programma product line tradition, the new TM1800 Breaker Analyzer System is portable and rugged, making it suitable for use in any type of environment. The concept is a flexible, modular system that can be easily configured for any type of circuit breaker. Distribution breakers with one contact per phase and one operating mechanism can easily be tested. Transmission breakers often have a more complex design with several contacts per phase and separate operating mechanisms. Even here, TM1800 is fully capable of capturing any parameter. For example, when testing circuit breakers with pre-insertion resistor (PIR) contacts, the TM1800 automatically measures timing of the main and PIR contacts, as well as the resistance value of the pre insertion resistor. Furthermore, with the TM1800 system, test methods such as static resistance measurement (SRM), dynamic resistance measurement (DRM) and vibration testing are easily integrated in the circuit breaker testing.

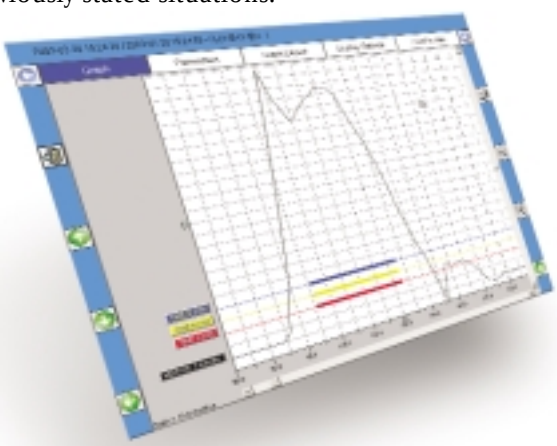
TM1800 has a straightforward and user-friendly interface, CABA Local. The display is an 8-inch trans-reflecive screen that enhances the use in direct sunlight. You can also use a separate PC with the optional CABA Win software to prepare and evaluate the tests.

The user interface, CABA Local, has been designed to facilitate setup and analysis. There are, for example, integrated help functions that guides the user throughout the testing. Special efforts have also been made to reduce the number of connecting leads required. Furthermore, many functions have been automated to reduce the number of manual exercises and breaker operations required to perform a test. As a result, the training needed to use the TM1800 to its full extent is minimized and the time to carry out actual tests is minimal.

Timing Measurements

Simultaneous measurements within a single phase is 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.

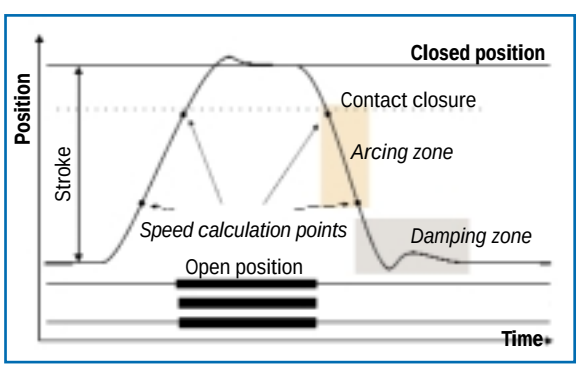
Motion Measurement

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 adquate 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.

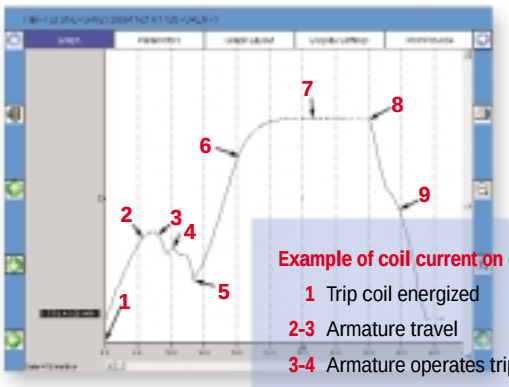
Speed is calculated between two points on the motion curve. The upper point is defined as a distance in length, degrees or percentage of movement from a) the breaker's closed-position or b) the contact-closure or contact-separation point. The time that elapses between these two points ranges from 10 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



Example of coil current on circuit breaker:

- **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

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 Measurements (DRM)

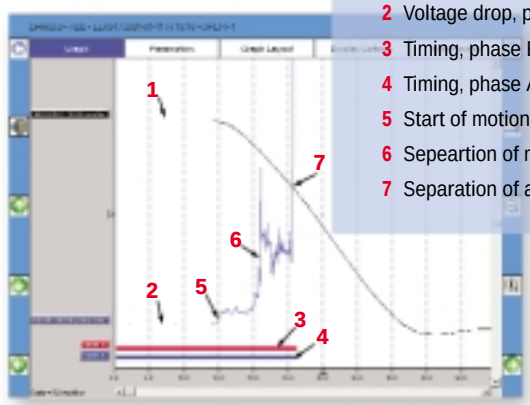
DRM procedures measure variations in contact resistance during breaker operation – not to be confused with static resistance measurement, which measures contact resistance when a breaker is closed.

DRM has a number of applications. On certain types of breakers DRM can be used to measure the shortening of arcing contacts. When breaker contact motion is measured simultaneously with resistance, the results can be used to determine the length of the arcing contact. In some cases, breaker manufacturers can supply reference curves for the type of contact in question.

In another application, timing measurements can be performed on a breaker with both sides grounded, and it is difficult (because of practical considerations) to disconnect one side from ground. If a sufficiently high current is used (about 250 A or higher), there will be a noticeable step in the voltage change when the breaker contact closes or opens in spite of the parallel ground connections. Similarly, DRM can be used when a breaker has parallel main contacts.

Example of DRM measurement:

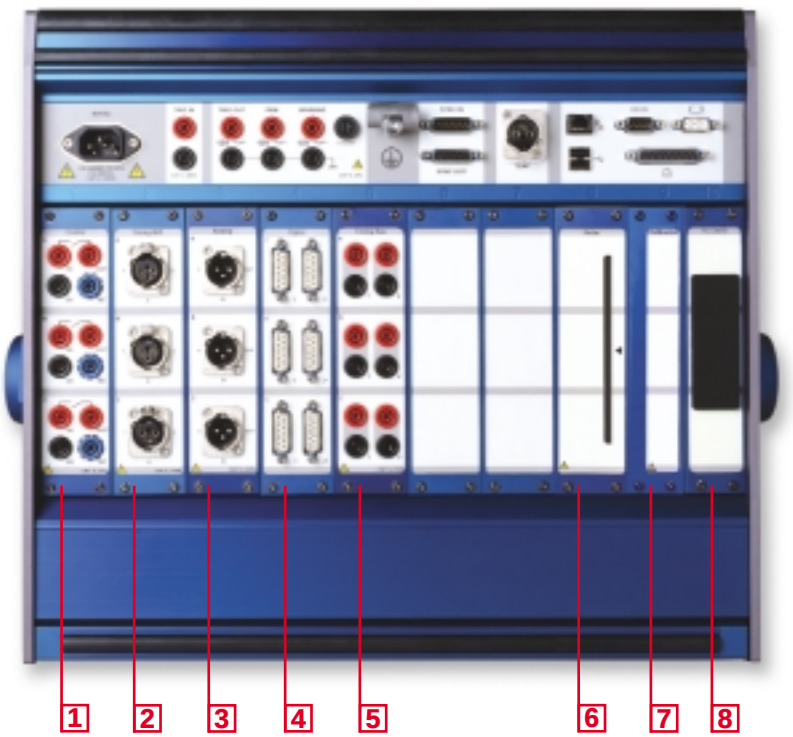
- **1** Motion measurement, phase C
- **2** Voltage drop, phase C
- **3** Timing, phase B
- **4** Timing, phase A
- **5** Start of motion
- **6** Sepeartion of main contact
- **7** Separation of arcing contact



FLEXIBILITY WITH MODULAR

The TM1800 Breaker Analyzer System can determine the condition of any circuit breaker type and model from any manufacturer. Thanks to its modular design it permits user configuration for any application. It also enables upgrading for future circuit breaker applications and designs.

The main part of the top panel is designed for the modules. You can configure your TM1800 with the type of module that suit your needs and of course add / replace modules whenever you like. In an“empty” slot there should always be a dummy module.



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

- Power supply
- Trig inputs and trig outputs
- External outputs for DRM trig and warning signal (alerting nearby personnel that breaker operation is about to take place).
- Earth (Ground) Connection
- Sync input and sync output
- Temperature transducer input
- Communication interfaces (USB, Ethernet etc.)

CONFIGURATION

1 CONTROL

Controls the operation of the circuit breaker. It gives a pulse to the coil for close, open and for the motor operation. The module has three contact closures, one for each phase. For 1-phase operation use A for close and B for open, C can be used for motor operation or second trip coil. If two modules are used you can have 3-phase operation with separate voltage for all phases and close and open operation.

The control module measures coil current and voltage and timing of auxiliary a and b contacts.

- Three independent contact functions per module.
- Sequences C, O, C-O, O-C, O-C-O
- The function of the sequence is set in CABA Local

2 TIMING M/R

Measures the timing of the main and parallel resistor contacts. Each pair of channels is independent of the others and has its own current limited DC voltage source. Measurement current is limited to 27 mA.

One channel can measure both the main and the resistor contact and resistance of linear PIR.

For DRM measurements you need two channels per break.

- Six channels per module (grouped 3x2 in pairs with common return)
- Main contact timing
- Parallel contact timing
- Ohmic value of parallel resistors

ANALOG 3

The analog module is for measurement of any analog signal measured with an industrial standard transducer with voltage (10V) or current (4-20mA) output. Typical quantities that are measured are for example motion, voltage, current, vibration (acoustic), pressure etc.

- Three channels per module
- 10 V and 24 V output
- Measure with any industrial standard analog transducer

DIGITAL 4

Digital channels for measurement of motion, both linear and rotary with incremental transducer.

- Six channels per module
- Measurement ranges transducer resolution up to ±32000 pulses.
- Power supply: 5 V and 12 V DC

5 TIMING AUX

Measures timing of any auxiliary contact, for example spring motor auxiliary contacts.

- Timing of contact or voltage. Polarity insensitive.
- Six channels per module (each one separately) grouping marked with background colour
- Safety plug type of connections

6 PRINTER

For making printouts. Printouts can also be made via parallel (LPT) or USB output in top module or from PC with CABA Win.

A number of different printout formats are available as well as user adapted, both graphic and numeric. You can have printouts in English, German, French, Spanish, Swedish. The printing can be set to automatic printout in CABA Local.

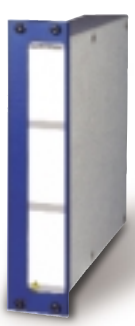
- Thermal printer sensitive line dot method
- Paper width 114mm (4")
- Printing speed 50mm/s (400 dot lines/s)

CALIBRATION 7

For on-site calibration of measuring inputs. The calibration module is slightly smaller than the other modules and has a designated module place.

Like any other measuring instrument TM1800 has to be calibrated to traceable standards on a regular basis. With the calibration module the unit can be calibrated in field.

- The calibration module is intended to be in slot 9 in the module panel.
- You only need to send this module for calibration and you can use TM1800 without it.



PC-CARD 8

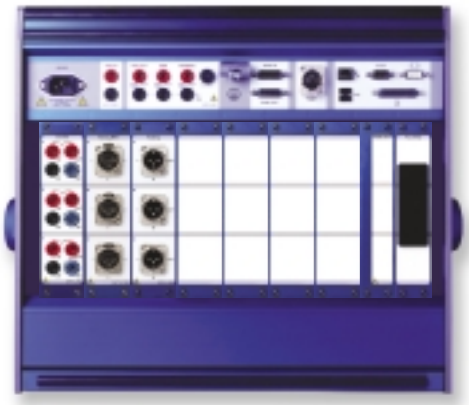
PC-card module is a non-optional module, which is part of the basic unit. The two PC-card slots are for any type of PCMCIA card i.e. storage, modem, network, wireless communication etc. The module also contains the hard disk for the system for easy extraction and secures storage of recorded data during transport.

This module is always in slot 10 in the module panel.

- Two PC-card slots
- Type I/II/III PCMCIA cards
- 20 GB storage capacity on built-in hard drive
- Optional: Flash disk

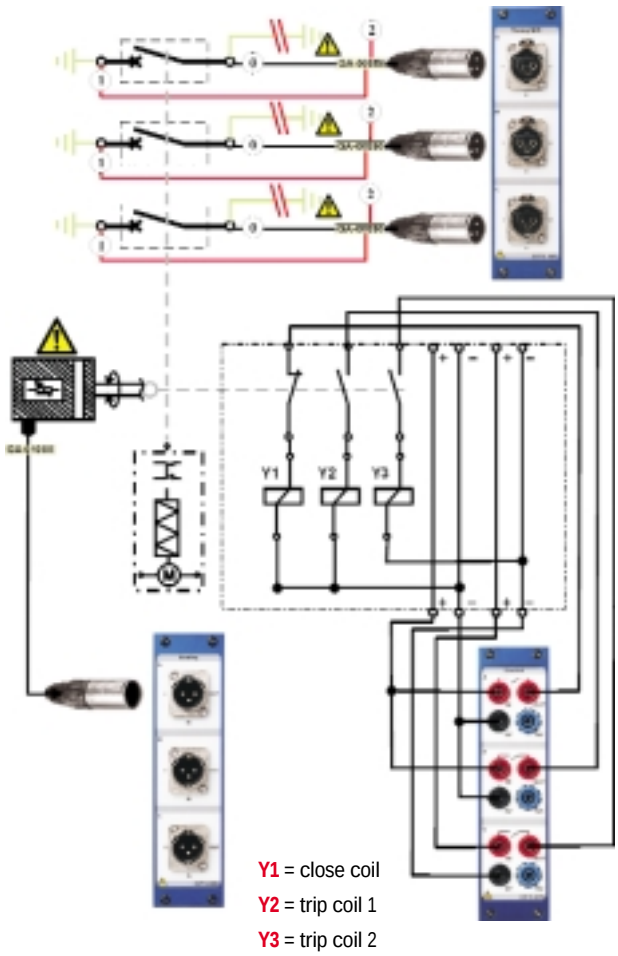
APPLICATION EXAMPLES

Circuit Breaker System with Common Operating Mechanism



Minimum configuration of modules for this application is:

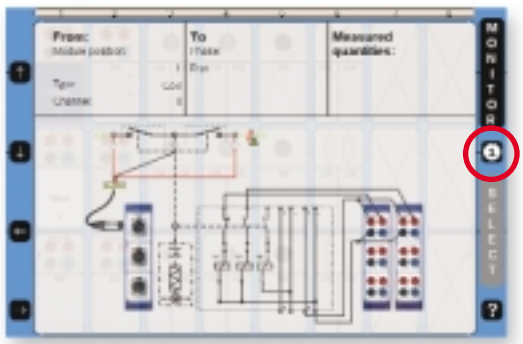
- 1 Control module
- 1 Timing M/R module
- 1 Analog module



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 are easy to manage using the internal software, CABA Local. It offers easy access via function keys and the built-in key-board. It comes with a track ball and large, bright screen which works as well in direct sunlight.



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.

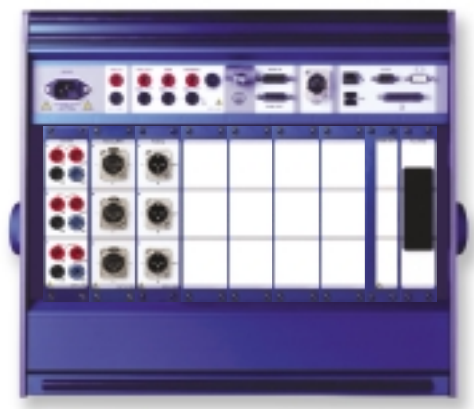
Two control modules (six outputs) are needed to control each coil (Y1/Y2) for every pole. The below set-up shows the wiring of pole A. This also automatically tests timing on the auxiliary contacts that are connected in series to the coils.

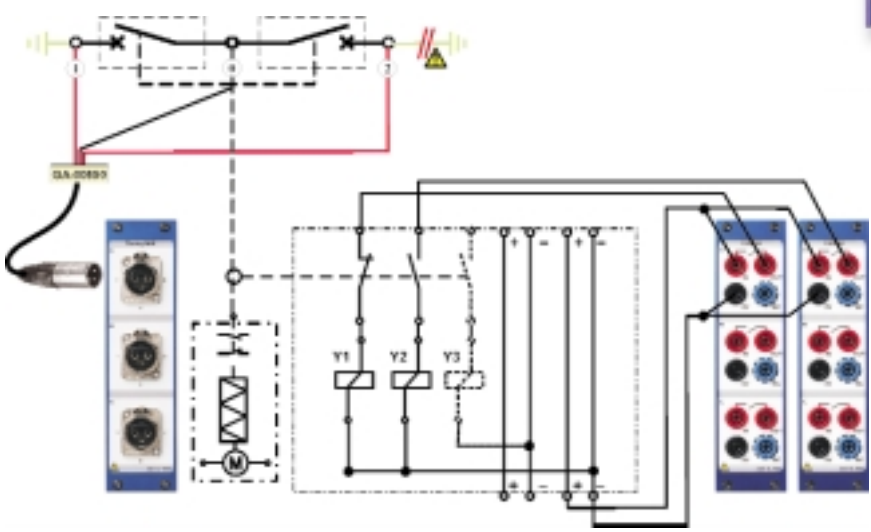
When on site doing the hook-up, you can get help on how to connect by pressing the i-button (see example on the left).

Circuit Breaker System with Separate Operating Mechanism Per Pole

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

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

SPECIFICATIONS

General

Specifications are valid after 30 minutes warm up time.
Specifications are subject to change without notice.

Environment	
Application Field	For the 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 t +85°C (-67°F to +185°F)
Enclosure Class	IP41
Humidity	5% - 95% RH, non-condensing. Operating and non-operating
Transport	ISTA 2A (unit in transport case)
Compliance	
EMC	EN 61326:1997+ A1:1998 + A2:2001
Safety	EN 61010-1:2001
Certifications	
CB-Certificate	IEC 61010-1:2001 (incl. all national deviations) CE marking

Basic unit

General	
Mains input	100 – 240 V ±10% AC, 50 – 60 Hz
Max power consumption	200 VA
Dimensions	513x175x438 mm (20.2"x17.2"x6.9")
Weight	15.5 kg (34.2 lbs)
Display	
Type	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/m2
Keyboard	
Available languages	English, Swedish, Spanish, French, German
Pointing device	Built-in trackball and mouse buttons
External input	
Trig in	
Voltage mode	
Input range	0 – 250 V AC/DC
Threshold level	User configurable in software in steps of 1 V
Time inaccuracy	±0.01% of reading ±0.1 ms
Contact mode	
Output voltage	25 – 30 V DC
Output current	20 mA ±5 mA
Threshold level	1.5 kΩ ±0.5 kΩ
External outputs	
General	
No. of channels	3, (TRIG OUT, DRM, WARNING)
TRIG OUT	
Switch	Electronic
Resolution	1 ms
Duration	User configurable in software
Inaccuracy	±0.01% of reading ±0.1ms
Delay from Trig in	minimum 5ms
Voltage mode	
Output Voltage	12 V DC ±5%
Output Resistance	25Ω ± 5Ω
Contact mode	
Making/Breaking range	max. 0.5 A
Resistive load	at 12 V
DRM	
Switch	Relay
Resolution	10 ms
Inaccuracy	±0.01% of reading ±10ms
Voltage mode	
Output voltage	12 V DC ±5%
Output current	max 0.5 A
Contact mode	
Making/Breaking range	max. 0.5 A
Resistive load	at 12 V
WARNING	
Switch	Relay
Resolution	10 ms
Duration	User configurable in software
Inaccuracy	±0.01% of reading ±10ms
Voltage mode	
Output Voltage	12 V DC ±5%
Output Current	max 1 A
Contact mode	
Making/Breaking range	max. 1 A
Resistive load	at 12 V
Temperature	
Interface	for HighPrecision 1-wire® Digital Thermometer
Communication interfaces	
PC-card	Type I/II/III PCMCIA cards
USB	Universal Serial Bus ver. 1.1
Ethernet	100 base-Tx Fast Ethernet
Printer port	LTP, Multi-mode parallel (ECP/EPP/SPP)
Serial port	RS232, 9-pin D-Sub female
External screen	SVGA, up to 800 x 600 at 64k color, 2 MB SDRAM

Modules

Control Module

General	
No. of channels	3
Time base inaccuracy	±0.01% of reading ±0.1 ms
Resolution	0.1 ms
Bandwidth	5 kHz
Measuring time	19 sec at 10 kS/s, 39 sec at 5 kS/s, 200 sec at 10 kS/s (Data compression)
Input voltage range	0 – 250 V AC/DC
Weight	1.0 kg (2.2 lbs)
Non-bouncing switch	
Function	Normally Open/Normally closed, dual direction
Continuous current	16 A
Max current	60 A during 100 ms with intermittence of 5%
Delay from trig in (if applicable)	<2.5 ms
Current measuring	
Measuring range	±60 A
Resolution	3 mA (At data compression x 2)
Inaccuracy	±1% of reading ±0.1% of range
Voltage measuring	
Measuring range	±250 V
Resolution	20 mV
Inaccuracy	±1% of reading + 0.1% of range
Auxiliary contact status/resistance	
Open circuit voltage	30 V ±10%
Short circuit current	< 25 mA
Status threshold	Open > 10 kΩ > close
Resistance range	0 – 10 kΩ
Resolution	100Ω; 50mΩ 10 kΩ; 5Ω
Inaccuracy	±2% of reading ±0.2% of range

Timing M/R Module

General	
No. of channels	6, in pairs of 2
Time base inaccuracy	±0.01% of reading ±0.05 ms
Resolution	0.05 ms
Bandwidth	5 kHz at ≤10 kS/s, 10 kHz at 20 kS/s
Measuring time	8 sec at 20 kS/s, 16 sec at 10 kS/s, 1000 sec at 20 kS/s (Data compression)
Induction protection	Capacitively coupled interference current from surroundings max 20 mA per channel. Active interference suppression – patent pending.
Weight	0.8 kg (1.8 lbs)
Timing of main and resistive contacts	
Measuring voltage	55 V ±10%
Measuring current	≤27 mA ±10%
Status threshold	Main < 10Ω <PIR < 10 kΩ < Open
PIR resistance measurement	
Supported PIR types	Linear PIR
Measuring range	0 Ω – 10 kΩ
Inaccuracy	±10% of reading ±0.1% of range
Voltage measurement	
Measuring range	±100 V, ±10 V, ±0.5 V,
Resolution	20 mV*, 0.4 mV*, 20μ V*
Inaccuracy	±1% of reading ±0.1% of range

* At data compression x 2

Analog Module

General	
No. of channels	3
Time base inaccuracy	±0.01% of reading ±0.025 ms
Sampling rate	1 – 40 kS/s
Bandwidth	15 kHz
Measuring time	10 sec at 40 kS/s, 20 sec at 20 kS/s
Transducer Resistance	500Ω - 10kΩ at 10 V output
Weight	0.8 kg (1.8 lbs)
Output	
Voltage output	10 V ±5%, 24 V ±5%
Current output	0 – 22 mA
Current measuring	
Current meas. range	0 – 22 mA
Resolution	0.35 μ A (At data compression x 2)
Inaccuracy	±1% of reading ±0.1% of range
Voltage measuring	
Input voltage range	0 – 250 V AC/DC
Measuring range	±10 V, ±250 V
Resolution	0.3 mV, 20mV
Inaccuracy	±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 ±0.05 ms
Measuring time	16 sec at 20 kS/s
Weight	0.7 kg (1.5 lbs)
Output	
Voltage	5 V DC ±5% or 12 V DC ±5%
Current output	< 200 mA
Digital input	
Sampling rate	1 – 20 kS/s
Range	±32000 pulses
Resolution	1 pulse
Inaccuracy	±1 pulse

Timing Aux Module

General	
No. of channels	6
Time base inaccuracy	±0.01% of reading ±0.05 ms
Resolution	0.05 ms
Measuring current	< 25 mA
Measuring time	16 sec at 20 kS/s, 32 sec at 10 kS/s
Weight	0.8 kg (1.8 lbs)
Contact Mode	
Measuring voltage	27 V ±10%
Status threshold	Closed < 100Ω, Open > 1 kΩ
Inaccuracy	±5% of threshold
Voltage Mode	
Input voltage range	0 – 250 V AC/DC
Status threshold	10 V
Inaccuracy	±0.5 V

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
Enclosure class	IP21
Weight	0.8 kg (1.8 lbs)

Calibration module

General	
Reference Stability	±250 ppm per year
Weight	0.6 kg (1.3 lbs)

1. Dolphin Clips
2. Ground Cable
3. USB Memory 256 mb
4. Timing M/R Cable
5. Analog Module Cable
6. Timing AUX Cable
7. Transducers and Mounting Kit
8. Digital Transducer Cable
9. Cable Reels

Ordering Information		Art. No:
TM1800 Basic Unit		**CG-19090**
Complete with: Transport case, User's manual, Mains and Ground cable, USB memory pen		
Control module		**CG-19030**
Complete with: 3 cable sets, 5 m		**GA-00870**
Timing M/R module		**CG-19080**
Complete with: 3 cable sets, 5 m	**GA-00850**	
3 dolphin clips, black	**40-08320**	
6 dolphin clips, red	**40-08322**	
Analog module		**CG-19000**
Complete with: 3 cable sets, 10 m		**GA-01005**
Digital module		**CG-19040**
Cables delivered with transducers		
Timing Aux module		**CG-19060**
Complete with: 3 cable sets, 5 m		**GA-00870**
Calibration module		**CG-19020**
Complete with: Calibration cable		**GA-001006**
Printer module		**CG-19050**
Complete with: Paper role		
Dummy module		**CG-19010**
Optional Accessories		
CABA Win R02A		**CG-8000X**
Temperature Sensor with sensor cable, 5 m		**XB-31010**
Motion Transducers – Rotary – Digital		
1-phase Ready-to-Use Digital Rotary Transducer		**XB-39110**
3-phase Ready-to-Use Digital Rotary Transducer		**XB-39120**
Complete with: Mounting and calibration kit		
Baumer BDH Digital transducer		**XB-39130**
Complete with: Transd.cable & Flex coupling		
Motion Transducers – Rotary – Analog		
1-phase Ready-to-Use Analog Rotary Transducer		**XB-31091**
3-phase Ready-to-Use Analog Rotary Transducer		**XB-31093**
Complete with: Mounting and calibration kit		
IP 6501 rotary transducer 357°		**XB-31010**
Complete with: Transducer cable		
Motion Transducers – Linear – Analog		
TLH 500 linear transducer, 500 mm (20") travel.		**XB-30020**
LWG 225 linear transducer, 225 mm (9") travel.		**XB-30117**
TS 150 linear transducer, 150 mm (6") travel.		**XB-30030**
Mounting kits		
Kit for TLH, LWG, TS and IP transducers.		**XB-39010**
Kit for linear transducers, TLH/LWH		**XB-39065**
Kit for vibration transducers		**XB-39070**
Kit for calibration of rotary transducer, IP6501		**XB-39095**
Breaker-Specific Transducer Mounting Kits		
For HPL circuit breaker (ABB)		**XB-39080**
For LTB circuit breaker (ABB)		**XB-39090**
For BLG operating mechanism (ABB)		**XB-39085**
Extension cables		
Analog cable TM1800, XLR female to male, 10 m		**GA-01005**
For Analog and Timing M/R cables and temperature sensor		
Cable reel, 20 m (65.5 ft) *black*		**GA-00840**
red		**GA-00842**
blue		**GA-00846**
green		**GA-00845**
yellow		**GA-00844**
Dynamic resistance measurement		
DRM1000 Injection Control		**BL-90041**
Complete with: Connection box, Cables (red and blue for vehicle battery) and Sensing cables		
Vibration testing		
Signal Conditioning Amplifier SCA606		**BL-13096**
Accelerometer DYTRAN 3200B5		**XB-32010**
Vibration Analysis Software		
Separate CABA option for DTW-analysis.		**BL-8270X**

TM1800™

Circuit Breaker Analyzer System

PROGRAMMA PRODUCTS

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