

TM1800

Circuit Breaker Analyzer System

User's Manual



Megger 

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1 Safety

1.1 General



IMPORTANT

Read and comply with the following instructions.

Always comply with local safety regulations.

Symbols on the instrument



Caution, refer to accompanying documents.



Caution, risk of electric shock.



Protective conductor terminal.



WEEE, Waste Electrical and Electronic Equipment. Please utilize your local WEEE collection facilities in the disposition of this product and otherwise observe all applicable requirements. The unit can also be returned to Megger at any time at no charge for the disposal.

1.2 Safety instructions

- 1] **Read All Instructions.** All safety and operating instructions must be read before using TM1800.
- 2] **Retain All Instructions.** All safety and operating instructions must be retained for future reference.
- 3] **Follow All Instructions.** All operating and usage instructions for the TM1800 must be followed. To avoid damage, do not exceed the maximum specified input limits. **Never** do any work on a circuit breaker unless the control circuits of the circuit breaker are disconnected from the TM1800 control module or remote operation. **Turn off** the power and disconnect all the connected leads and the power plug before dismantling or adding any modules to the TM1800. **Use caution** when working near bare conductors or bus bars. Accidental contact with a conductor may cause electrical shock. At dry locations use caution when working with voltages that exceed 33 V AC and 46 V peak or 70 V DC, such signals pose a shock hazard. At wet locations, use caution when working with voltages that exceed 16 V AC and 22 V peak or 35 V DC. Follow the local safety regulations.
- 4] **Grounding (Earthing).**

Single ground system. This equipment can be used only in electrical systems with single ground. The user must verify before connecting this unit to power, that High Voltage Ground and Low Voltage Protective Ground create a single protective ground with no measurable voltage potential existing between these ground systems. If a voltage potential is found between the ground systems please consult local safety regulations.

Mains cord protective conductor. The TM1800 is equipped with a power cord with integral safety ground pin. Do not defeat the safety ground in any manner. The equipment must be connected to a grounded mains out-

let. Not doing so may result in fire or electric shock.

Separate ground wire. The TM1800 case must also be grounded by the separate protective ground wire with connection to the Protective Conductor Terminal on top of the TM1800. Check the continuity of the protective ground wire before each use. Make sure the connector is fastened properly to the TM1800 Protective Conductor Terminal. Make sure the connection point at the ground system is fastened properly. Route the wire so that it is unlikely to be walked on or that it may loosen accidentally by someone or something moving near it.

Note: The protective ground wire must not be loosened while any input connector is attached to the contacts of a high voltage circuit breaker or another device being subject to inductive or capacitive coupled interference from surrounding high voltage wires.

- 5] Connections and disconnections to the inputs.** All input or output connections and disconnections must be made only while the circuit breaker poles are connected to ground on both sides. Always connect the TM1800 to ground before making any other connections to the TM1800.

The Timing M/R module inputs are designed to handle coupled interference current from surroundings by active interference suppression. The protection, though, is relying on a current path from the connected inputs to ground.

The current passing through the wires may be harmful if there is no current path to ground since, in that case, the high voltage may cause an arc.

Before connecting or disconnecting the TM1800 to a high voltage circuit breaker's contacts, make sure the circuit breaker is closed and connected to ground on both sides.

The rules regarding connection to protective ground given above must be followed closely.

Neglecting these rules may result in fire, electric shock, or other hazards.

The Timing M/R module inputs are designed to CAT I Environment – Secondary (signal level) or battery operated circuits of electronic equipment. Not connected to mains.

DO NOT use the Timing M/R inputs to measure on circuits in measurement category II, III or IV.

- 6] Heat.** The TM1800 must be situated away from any heat sources such as radiators, heat registers, stoves, or other products that produce heat.
- 7] Ventilation.** Slots and openings in the TM1800 are provided for ventilation. They ensure reliable operations of the TM1800, keeping it from overheating. These openings must not be blocked nor covered during operation. Do not install the TM1800 in a closed space, such as a rack or cabinet, unless proper ventilation is provided through following the manufacturer's installation procedure. Blocking the ventilation slots prevents proper airflow and may result in fire, electric shock or equipment damage. Do not run the TM1800 with an empty module slot, insert a Dummy module.
- 8] Water and moisture.** Do not use the TM1800 near water. To prevent fire or shock hazard, do not expose the TM1800 to rain or moisture. Do not touch the plug with wet hands. Doing so may result in electrical shock.
- 9] Accessories.** Do not use any accessories not recommended by the TM1800 manufacturer as they may cause hazards.
- 10] EMC Warning.** The TM1800 generates, uses, and can generate radio frequency energy. If not installed and used in accordance with this manual it may cause interference to radio communications. The TM1800 has been tested and found to comply with the limits for measurement equipment designed to provide reasonable protection against such interference when used in an industrial environment. Operation of the TM1800 in a commercial or residential area is likely to cause interference, at which case, the user,



Figure 1.2-1 Protective conductor terminal

at his own expense, will be required to take whatever measures that may be required to correct the interference.

- 11] Cables.** To conform to the CE requirements for high frequency radiation, shielded cables or cables with added ferrite filters must be used for connection to the inputs/outputs. Do not use auxiliary equipment and/or cables not recommended by the TM1800 manufacturer.
- 12] Cables Protection.** Connecting cables must be routed so that they are not likely to be walked on nor pinched by items placed upon or against them. Do not place them underneath the TM1800 or other heavy objects. Do not pull on or tie them. Pay particular attention to the connectors. To disconnect a cable, unlock the retainer (in case of an XLR connector), grasp the connector firmly and pull. Tugging on the cord may damage and result in fire or electric shock. If an input- or output cable becomes damaged, stop using it. Use of a damaged cable may result in fire or electric shock.
- 13] Power Cord Protection.** Power supply cords must be routed so that they are not likely to be walked on nor pinched by items placed upon or against them. Do not place the cord underneath the TM1800 or other heavy objects. Do not pull on or tie the cord. Pay particular attention to the cords at AC wall plugs and convenience receptacles, and at the point where the cord connects to the TM1800. To disconnect the power cord, grasp the plug firmly and pull. Tugging on the cord may damage and result in fire or electric shock. If the power cord becomes damaged, stop using it. Use of a damaged cord may result in fire or electric shock.
- 14] Power sources.** The TM1800 must be operated from the type of power source indicated on the marking label and in the installation instructions. If you are not sure of the type of power supplied to your facility, consult your local power company. Not doing so may result in fire or electric shock or equipment damage. **Use an easily accessible power outlet.** This will ensure that you can disconnect the power quickly in case of a problem. The TM1800 should be operated only from the type of power source indicated on its nameplate.
- 15] Inputs and outputs.** Do not apply voltage to the outputs. Do not exceed the specified input voltage limit on any of the TM1800 inputs.
- 16] Lightning.** For added protection for the TM1800 during a light storm, or when it is left unattended and unused for long periods of time, unplug it from the AC outlet and from all cables connected to the inputs. This will prevent damage to the TM1800 due to lightning and power supply surges. **Note:** The protective ground wire must not be loosened while any input connector is attached to any source of power, especially the contacts of a high voltage circuit breaker or another device being subject to inductive or capacitive coupled interference from surrounding high voltage wires.
- 17] Overloading.** Do not overload AC wall outlets, extension cords, or integral convenience outlets as this can result in fire or electric shock hazard.
- 18] Object and liquid entry.** Never push objects of any kind into the TM1800 through openings as they may touch dangerous voltage points or short parts that could result in fire or electric shock. Never spill liquid of any kind into the unit.
- 19] Place the TM1800 at a strong and stable place.** Do not place the TM1800 on an unstable cart, stand, tripod, bracket, or table. The unit may fall, causing serious damage to a person, and serious damage to the unit. Do not place the TM1800 in areas with excessive dust, mechanical vibration or shock.
- 20] A TM1800 and Cart Combination** should be moved with care. Quick stops, excessive force, and uneven surfaces may cause the unit and the cart combination to overturn. Disconnect the power cord and cables when moving the unit. Moving the unit with the cord or cables attached is dangerous. It may result in injury.
- 21] Carrying.** Handle with care when carrying the unit. Lifting the unit with your back bended or dropping the unit may result in injury or equipment damage.
- 22] Damaged TM1800.** Do not use the TM1800 if the test leads appear damaged. Do not continue using a damaged TM1800. Using a damaged TM1800 may result in fire or electric shock. **Never touch the plug and power cord if it begins to thunder.** Touching them may result in electric shock.

Do not touch a damaged LCD panel directly with bare hands.

The liquid crystal, which leaks from the panel, is poisonous if it enters the eyes or mouth. If any part of the skin or body comes in direct contact with the panel, please wash thoroughly. If some physical symptoms result, please consult your doctor.

- 23] Servicing.** Do not attempt to service the TM1800 yourself; opening or removing covers can expose you to dangerous voltage and other hazards. Please refer all servicing to qualified service personnel as opening or removing covers may result in fire, electric shock or equipment damage. If, for some reason, you need to return your TM1800, please use either the original transport box or one of equivalent strength.

- 24] Damage requiring service.** Unplug the TM1800 from all connections and refer servicing to qualified service personnel under the following conditions:

- When any connector is damaged, including mains plug.
- If liquid has been spilled or objects have fallen into the TM1800.
- If the TM1800 has been exposed to rain or moisture.
- If the TM1800 does not operate normally (follow operating instructions).
- If the TM1800 has been dropped or damaged in any way.
- When the TM1800 exhibits a distinct change in performance. This indicates a need for service.

If the TM1800 begins to emit smoke, smells like something is burning or makes strange noise, disconnect all power connections immediately and contact your dealer for advice.

- 25] Replacement parts.** When replacement parts are required, be sure the service technician has used replacement parts specified by the manufacturer or that they have the same characteristics as the original parts. Unauthorized substitutions may result in fire, electric shock, or other hazards.

- 26] Safety check.** Upon completion of any repairs to the TM1800, ask the service technician to perform safety checks to determine that the unit is in safe operating condition. Except for visual inspection and function tests, dielectric strength test and Protective Ground (Earth) & Bonding impedance tests are required for safe operation after service. Refer to

manufacturer's production test instructions. Neglecting these measurements after service may result in fire, electric shock, or other hazards.

- 27] Cleaning.** Do not use liquid cleaners or aerosol cleaners. Use only a damp cloth for cleaning. Periodically clean the TM1800 with a soft cloth. Stubborn stains may be removed with a cloth lightly dampened with a mild detergent solution.

Periodically clean the area around the mains plug and at all other connectors.

Dust, water or oil on the connectors may result in fire.


Unplug the TM1800 before cleaning it.

Cleaning the TM1800 while it is plugged into a power outlet or an input or output is being connected to a power source may result in electric shock.

1.3 Protective earthing procedure in HV environments



Protective earth (ground)

Connect the clamp of the yellow/green protective conductor supplied with TM1800 to station earth (ground) and the other end of the conductor to the terminal on TM1800 marked 

This connection must be done before any test cables and the mains supply cable are connected to TM1800 and this connection shall be the last connection removed.

The earthing (grounding) is needed since induced current from the High-Voltage Circuit Breaker can cause hazardous voltages. See Figure 1.3-1.

Preparation of the circuit breaker

Before connecting or disconnecting the TM1800 to a High-Voltage Circuit Breaker, make sure the breaker is closed and earthed (grounded) on both sides according to local safety regulations.

Connection of test cables to the circuit breaker

All connections and disconnections of cables at the Circuit Breaker shall be done while the breaker is closed and grounded on both sides according to local safety regulations.

Mains supply - Voltage

The TM1800 shall only be supplied by power according to the specifications stated at the mains inlet on TM1800.

Always connect the TM1800 to a power outlet with protective ground.

Mains supply - Protective earth (ground)

Dangerous voltage may be present in systems that are earthed separately.

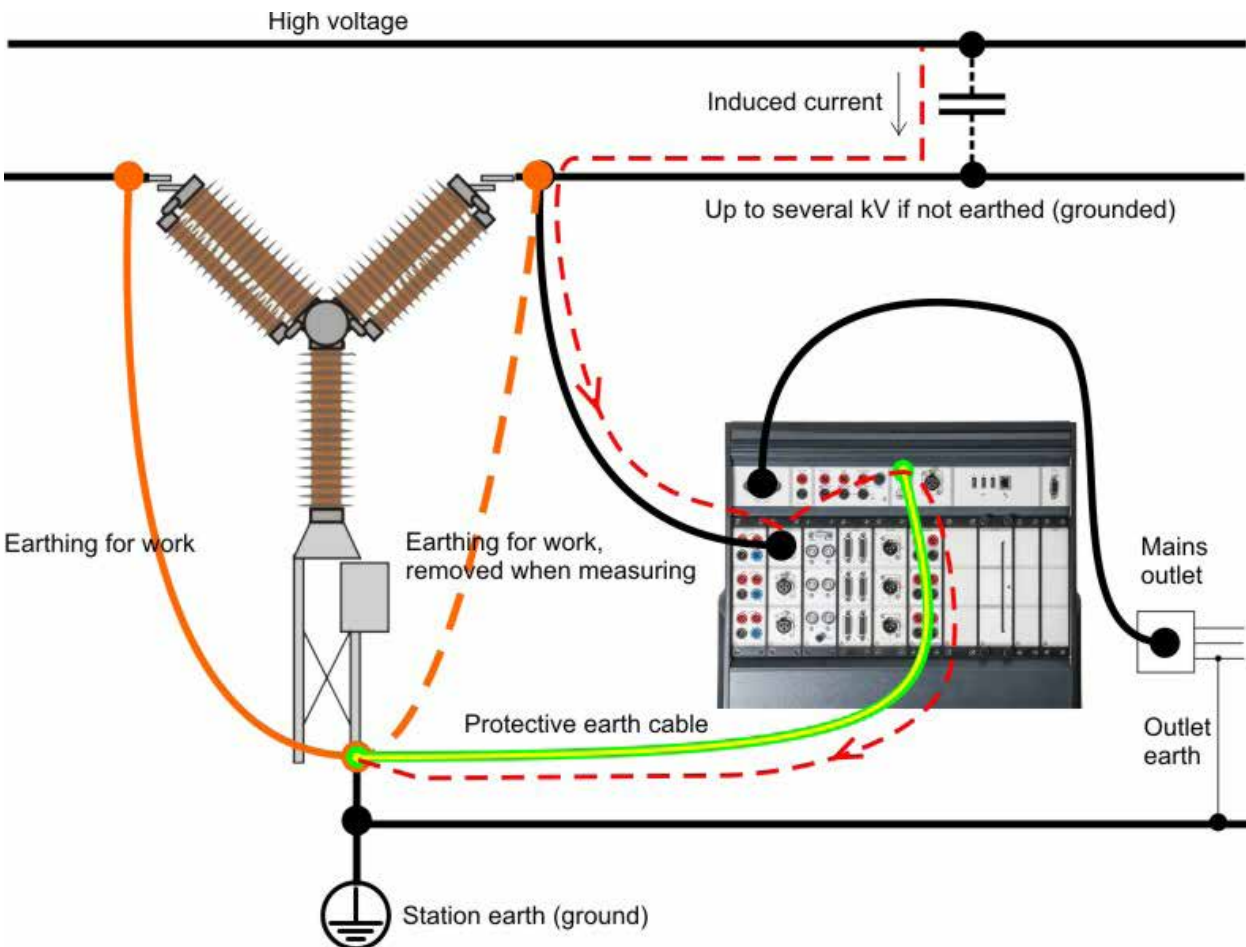


Figure 1.3-1

The mains cable may only be connected to a mains socket with a protective earth that is connected to nearby earth and earthed objects. Check with the nominated person in control of work activity that the systems are connected in accordance with local safety regulations.

If separate earthing cannot be discounted: one of the following methods may be used, on the condition that local safety regulations are observed:

- connect the earth systems temporarily
- use a (portable) electrical power source
- use an isolating transformer; the secondary side's protective earth must not be connected to the primary side's earth

Remove earthing (ground) at one side

Removing of earthing (grounding) at one side must be done in accordance with local safety rules. When only one side of the circuit breaker is connected to earth (ground), two important rules must be followed closely to protect service personnel and measuring equipment from hazardous voltages:

- The TM1800 case must remain earthed (grounded) by the separate protective conductor
- Connections or disconnections of test cables may not be made at the Circuit Breaker

2 Introduction

2.1 Features

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 micro-processor based circuit breaker analyser on the world market, Megger has taken the lead in portable test instruments for high voltage circuit breakers. Over the years, many new user requirements have lead Megger to innovate new solutions to provide test engineers in the field with effective tools for determining the status of circuit breakers.

In line with the Megger product line tradition, the TM1800 Circuit 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 circuit breakers with one contact per phase and one operating mechanism can easily be tested.

Transmission circuit 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.

TM1800 has a straightforward and user-friendly interface, CABA Local. The display is an 8-inch trans-reflective screen that enhances the use in direct sunlight.

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 re-

quired. Furthermore, many functions have been automated to reduce the number of manual exercises and circuit 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.

Benefits

- Integrated software support with predefined breaker templates and application oriented software for testing, assessment and archiving of results. Results in faster and easier breaker testing. Reduced need for operator training, shorter connection and testing time.
- Stand-alone functionality reduces the number of items and boxes the tester needs to bring to the field.
- Communication interface based on 10/100Mbit Ethernet standard makes the communication between TM1800 and PC very fast and reliable.
- Fully modular concept gives user great flexibility. Allows for up to 48 + 48 timing channels.
- USB interfaces enable easy backup and data storage for transport from one system to another by using memory sticks or portable CD/RW etc.
- All parameters measured according to IEC 62271-100, IEC 60694 and IEEE C37.09.

2.2 User's Registration

Please, send in the User's registration form to:

Megger Sweden AB, Box 724

SE-182 17 Danderyd, Sweden

By fax: +46 8 510 195 95

By e-mail: seinfo@megger.com

Note *It is very important that you register as a TM1800 / CABA Local user to get continuous product information and access to various improvements on your actual release.*

2.3 Service and Support

For technical assistance please contact your local Megger representative or direct your request to the office in Sweden.

Contact Information

Internet: www.megger.com

E-Mail: seinfo@megger.com

Tel: +46 8 510 195 00

Fax: +46 8 510 195 95

Checklist before calling/e-mailing for support

- Restart TM1800 with the On/Off button
- Try to repeat the operation if possible
- Try minimize the operation by excluding some measured parameters. Do a timing with no analog measurements.
- Check that no fuse has failed
- Read the manual

2.4 Shipping TM1800

If you are going to send the TM1800 with parcel service use the original transport box or one with equivalent strength. Megger can not take responsibility for transport damages.

Note *Always make a back-up of your valuable data on USB memory before shipping.
If possible it is recommendable to remove the HDD module and transport it as hand luggage.*

3 System overview

3.1 The instrument



- ① Control panel
- ② Display
- ③ Navigation buttons
- ④ Keyboard

3.2 Control panel



From the control panel you operate and monitor the circuit breaker position, you set the operation sequence and run the measurements.

- ① LUMINANCE
Set the brightness of the display
- ② ON/OFF
- ③ POSITION
Indicates the position of the circuit breaker main contacts if the coil circuit is connected to the control module.
"O" indicates Open position
"I" indicates Closed position



- ⑤ Top panel
- ⑥ Module panel

Note *Position indicates per operating mechanism(s). If the Circuit Breaker has common operating mechanism only one LED will indicate the CB position.*

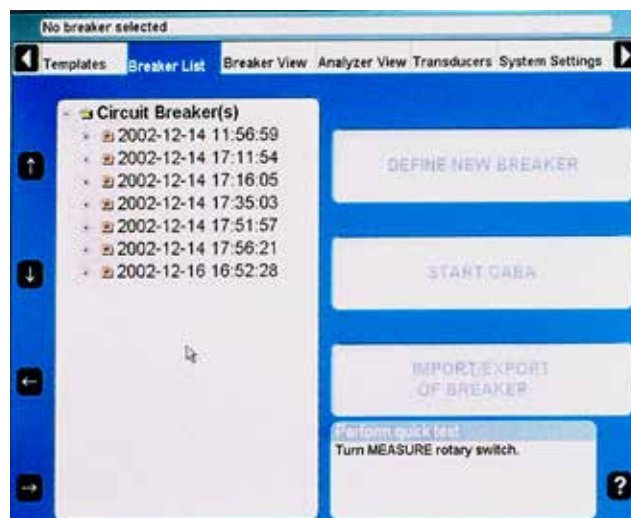
- ④ SEQUENCE
Indicates the next operation of the circuit breaker. If Auto-detect breaker state is enabled in CABA Local or CABA Win, only possible sequences for the circuit breaker are selectable.
- ⑤ Control knob
Green "READY" LED must be lit before turn-

ing the rotary switch.

OPERATE – Initiates the selected operation sequence without measuring. The LED is lit as long as the sequence is performed.

OPERATE/MEASURE – Initiates the selected operation sequence and makes the measurement. The LED is lit as long as the sequence is performed.

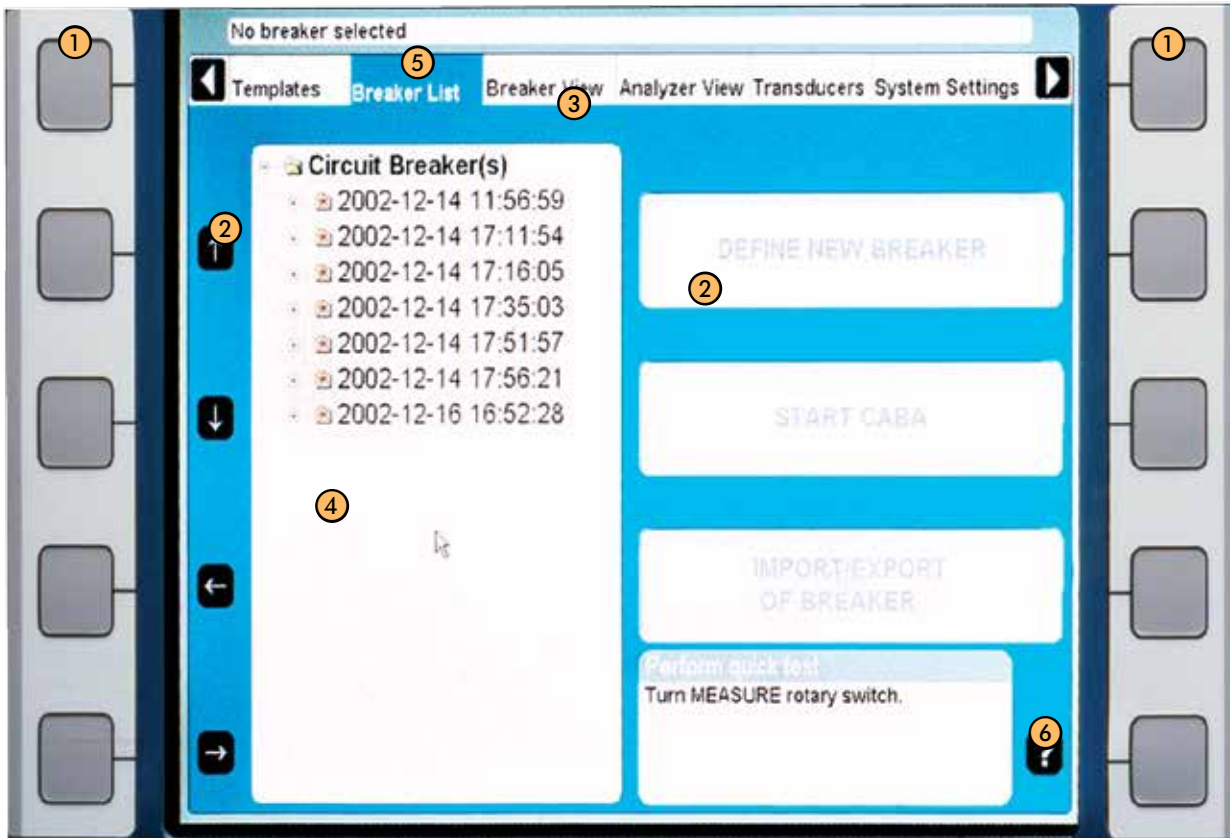
3.3 Display



A high contrast 21cm (8") display with sufficient brightness (350 cd/m²) for viewing in direct sunlight.

Note *The display is not a touch screen. Do not press on the screen since it may cause damage to the equipment.*

3.4 Navigation buttons



① Navigation buttons

Most of the CABA Local functions are controlled by the ten navigation buttons (1). The function of a navigation button is stated on the display button on the screen right next to it.

You can activate the function either by pressing the navigation (1) button or by clicking on the display button (2) using the trackball and "mouse keys" on the keyboard or using an external mouse.

② Display buttons

The arrow buttons are used to move the pointer within the apparent window

③ Main menu

④ Tree structure

⑤ Selected items bar

⑥ Help function

By pressing the "Question mark, "?" button you invoke the help function. Move the pointer to the object in question.

Note *The Navigation buttons are used when buttons are shown on screen. If no buttons are displayed the built in mouse is used to navigate in the menus.*

3.5 Top panel

① Mains input

TM1800 can be supplied with either 100 – 240V AC at 50-60 Hz. The maximum power consumption is 250 VA. Always use the power cord supplied with the unit.

② TRIG IN

Used for external trig of the unit. Starts an initiated measuring sequence from a remote destination by either a contact make or break or voltage signal. Settings are made from CABA Local or CABA Win, if installed.

③ Binary outputs

TRIG OUT

Contact or voltage output to synchronize external equipment with a measuring sequence. Default setting is contact mode. Settings are made from CABA Local or CABA Win if installed. The contact or voltage mode is indicated on the output terminals.

DRM

Contact or voltage output to DRM injection control unit. Settings are made from CABA Local or CABA Win if installed. The contact or voltage mode is indicated on the output terminals.

Warning

Output for external device used to give audio and/or visual signal before and during measuring sequence. Default setting is voltage mode. Settings are made from CABA Local or CABA Win if it is installed. The contact or voltage mode is indicated at the output terminals.

TM1800 does not have an internal warning signal.

Fuse

For specification see chapter 9, External outputs.

④ Protective conductor terminal

Connection to earth (ground), see chapter 1 Safety

⑤ TEMP

Input for digital temperature sensor. Type High Precision 1-wire® Digital Thermometer Dallas DS18S20.

⑥ USB (1 2 3)

Ports for connection of accessories like CD-ROMs, printers, memory sticks, keyboard, mouse etc.

Ethernet

Port for connection to network or external computer

⑦ SVGA

Output for external screen

Disabled in BIOS at delivery.

To enable see section “3.8 External equipment” on page 23.



3.6 Module panel

The module panel has 10 slots. In slot 1-8 you can place any of the standard modules.

Slot 9 is reserved for future extension.

Slot 10 is dedicated for the HDD module.

The standard modules are:

- ① **Control**
- ② **Timing M/R**
- ③ **DCM**
- ④ **Digital**
- ⑤ **Analog**
- ⑥ **Timing Aux.**
- ⑦ **Dummy**
- ⑧ **Printer**
- ⑨ Reserved for future extension
- ⑩ **HDD (Hard Disk Drive)**

The modules are described in chapter "4 Modules".

3.7 Keyboard



The keyboard is for communication with CABA Local and TM1800 operating system.

The aluminum keyboard is designed for heavy duty use. It has 66 keys, all the standard characters are available plus additional measuring specific characters such as μ , $^\circ$, \pm and Ω . Built-in trackball with left and right mouse buttons.

If you want to use a standard PC mouse to control TM1800, connect a PC mouse to the USB or COM port on the top panel. Any configurations needed, follow instructions for the PC mouse.



IMPORTANT

The module slots 1 to 8 must have a module/Dummy module mounted to achieve a correct cooling of the TM1800.



3.8 External equipment

Network/External computer

The TM1800 can be connected to a network or direct to an external computer.

For connection to a network an Ethernet cable can be used and for connection to an external computer a twisted Ethernet cable.

The TM1800 can be connected to Microsoft network and Novell network.

Network settings

Services

- Client for Microsoft Networks
- File and Print Sharing for Microsoft Networks

Protocols

- TCP/IP Protocol

Settings for TCP/IP

- Dynamic IP Address
- Dynamic DNS Server Address
- NetBIOS Enabled over TCP/IP

Printer

Software for printers and back-up media can be installed without acceptance from Megger. Please see the Microsoft Windows XP HCL (Hardware Compatible List) for printers and back-up media that are hardware compatible. (<http://www.microsoft.com/windows2000/server/howtobuy/upgrading/compat/search/devices.asp>)

See also section "Printer" in 6.14 System settings menu".

Backup media

As backup media you can use USB memory stick, PC flash card, CD recorder or similar. USB memory stick are used for software updates

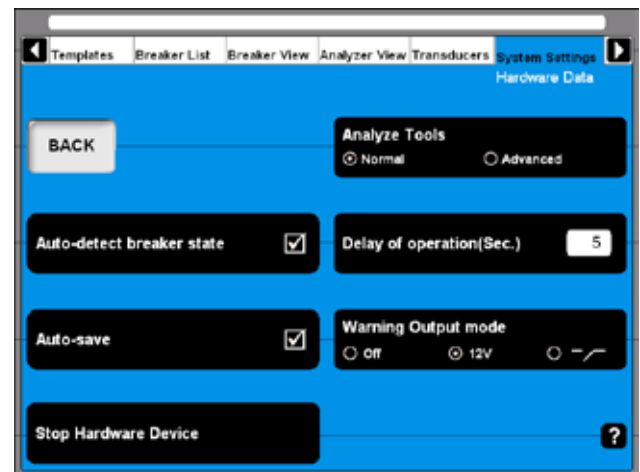
Connecting/removing USB memory

Connecting

- 1] Insert the USB memory.

Removing

- 1] Navigate to "System Settings", "Hardware Data".
- 2] Press the "Stop Hardware Device" button.



- 3] Remove the USB memory stick.

External screen

You can connect an external monitor to the TM1800. Use the connector on the top panel for SVGA monitor. Both the internal monitor and the external monitor will show the same display.

Note From serial number 1500985 the SVGA output is disabled in BIOS by default. To activate the SVGA output proceed as follows.

How to activate the SVGA output

- 1] Connect an external USB keyboard to the TM1800.
- 2] Power on the TM1800.
- 3] As soon as the first text appears on screen, press the DEL button repeatedly to initiate the BIOS setup.
- 4] When the screen prompts "Enter CURRENT Password:" type "energy" and press "Enter".
- 5] While in the BIOS setup, navigate to the "Advanced" tab.
- 6] Change the "Megger Display mode" parameter to "Disabled".
- 7] Chose "Save and Exit" and confirm with "OK".

Note When Megger Display mode is Disabled the internal screen will flicker during start up. This is a normal behaviour in this mode.

Megger Display mode = Enabled

This is the preferred mode for all TM1800 units. It has the following properties:

- The screen flickering during boot is minimized.
- The external display is disabled (output).
- It is not possible to enter Windows Safe Mode.

Megger Display mode = Disabled

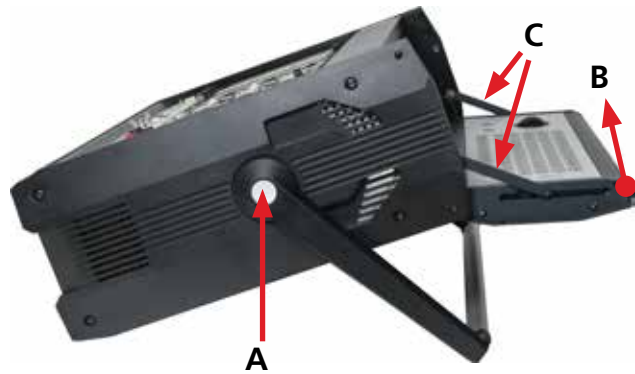
This mode is used when the external display (SVGA output) needs to be enabled. It has the following properties:

- The external display is enabled.
- If used with the built-in display, the screen flickers during boot up.
- After the BIOS boot screen is shown, no further information is shown on the built-in display until Windows starts. Even if the boot process stops, for example to "Repair Disc", this is not shown on the internal display. It is however shown on the external display.
- It is possible to enter Windows Safe Mode by pressing F8 during boot, but this menu is only shown on the external display.

3.9 Operating positions

The TM1800 can be operated in different positions, either on a table or on the ground. The handle and the keyboard are then set into the suitable position. Here we will show three combinations.

- 1] Use both hands and simultaneously push the buttons "A" on each side of the handle to release it and then turn the handle to desired position.
- 2] Still using both hands, raise the keyboard slightly "B" and with your thumbs press the keyboard bar "C" down and move the keyboard into desired position.



The keyboard has three fixed positions except the closed position. This image shows the keyboard with the keyboard bar in position "1", which is the first position after opening.





Keyboard in position "3".

4 Modules

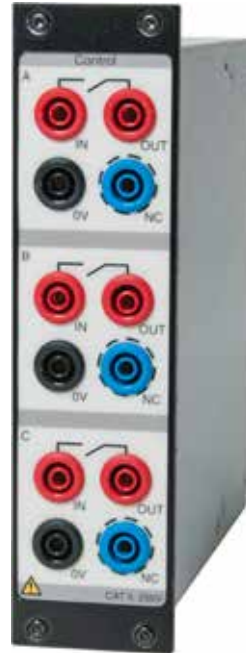
There are seven types of standard modules, one special module and the Dummy module

The standard modules are: Control, DCM, Timing M/R, Analog, Digital, Timing Aux. and Printer module.

The special module is the HDD module. The HDD module is part of the Basic Unit and always placed in slot 10.

The Dummy module is mounted where there is no standard module mounted. This is important for the cooling of the TM1800.

4.1 Control module



The module 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 phase A for close and phase B for open. If two modules are used you can have 3-phase operation with separate voltage for all phases and close and open operation. You can use the same voltage for all operations, just connect inputs in parallel.

The start and stop of the pulse is set in CABA Local or in CABA win.

During use control module measures coil current and battery voltage (supply voltage to coils) and timing of auxiliary contacts in control circuit of circuit breaker. The unit also measures the coil resistance. This features are possible to set in CABA Local and CABA Win.

- 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 or CABA Win.
- Station auxiliary voltage measurement (when station battery voltage is used for operation)

Note Auxiliary contact timing is measured for single operation. Depending on time lapse between O and C pulse timing may work for combined operations. When there are auxiliary contacts in series the result is dependent on both contacts and it is not possible to distinguish each contact separately.

For specifications, see "Control module" in chapter 9 Specifications.

Terminal configuration

The module has safety connectors. Use cables with touch-proof plug contacts. The terminals are grouped in three similar sections A, B and C suited for 3-phase operation or for close, open and motor operations in 1-phase system.

IN	connect the supply (+)
OUT	connect to close/open circuit of the circuit breaker
0V	connect zero (-) if needed
NC	(No Connection) This is a blind terminal that can be used for temporary placement, for safety, of cable plugs when you want to disconnect coil circuits.

Number of modules needed

Normally you need one or two modules.

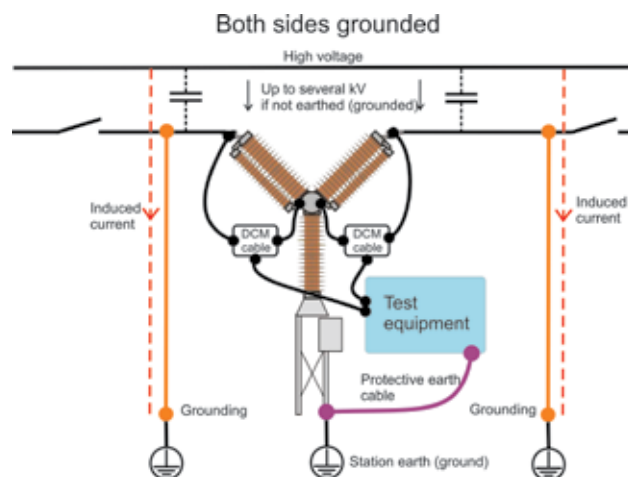
- 1 module to operate circuit breakers with 3-phase operation mechanism.
- 1 module more to operate circuit breakers with 1-phase operating mechanism.

4.2 DCM module



The DCM module uses a measuring technology called Dynamic Capacitive Measurement. One pair of DCM and Timing M/R modules measures timing on up to six breaks (e.g. three phase circuit breakers with two breaks per phase) with both sides grounded, Dual-Ground™ technology. The TM1800 system can be equipped with multiple DCM and Timing M/R module pairs that enable timing measurement on up to 18 breaks.

For specifications, see "DCM Module" in chapter 9 Specifications.



Using the DCM module and the DualGround technology makes testing a lot safer.

DCM capability

Limitations

The technology utilised in DCM is applicable on all circuit breaker technologies. Still some limitations are present for certain circuit breaker configurations.

GIS circuit breakers

When timing GIS circuit breakers, attach ferrite clamps with permeability greater than 1500 on the connections between ground switch and grounded enclosure according to figure 4.2-1.

Note A Ferrite kit is available as an optional accessory. Art.no. XB-40090

If it is not possible to mount ferrites on the grounding links/shunts of the insulated ground switch, connect an additional 20-meter ground cable between ground switch and stationary ground. Then remove the links/shunts between ground switch and enclosure according to 4.2-1 and 4.2-3. If it is not possible to increase the impedance of the grounds the DCM technology will fail.



Fig. 4.2-1

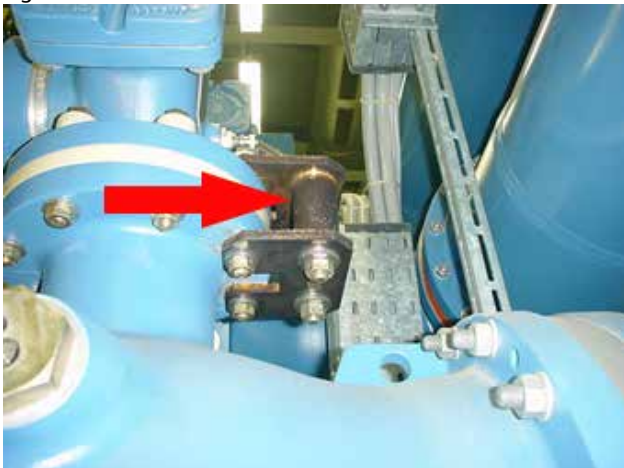


Fig. 4.2-2

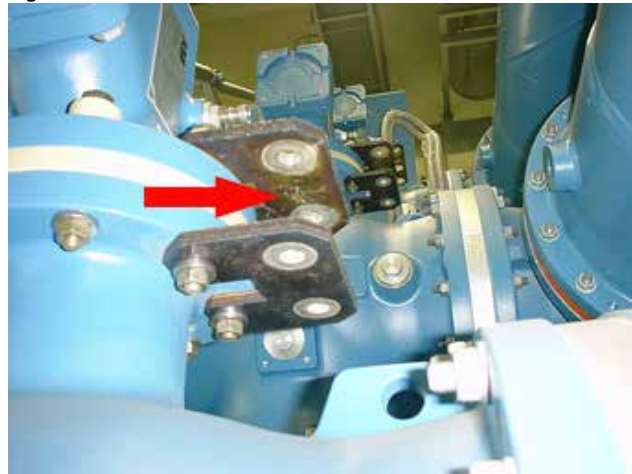


Fig. 4.2-3

Circuit breakers with parallel resistor contacts

The parallel resistor contact itself is not detected by DCM timing. Only the main contact is detected. Parallel contacts with resistors from 10 Ohm and above is not interfering with the main contact DCM timing.

Graphite nozzle breakers

DCM timing is carried out the same way as conventional timing, i.e. closing time can be either graphite-graphite or graphite-silver transition, depending on the moving contact alignment. Due to this DCM, and all other timing, is not suitable for timing graphite nozzle breakers. Instead you shall use DRM together with CABA Local SW (version R04A and later) for a specific evaluation.

Long distance between accessible DCM cable connection points

Some circuit breakers, e.g. certain models of dead tank breakers, may have longer distance between the accessible connection points than the maximum spread of the DCM cable (4 meters). Thus, you need to extend the DCM cable in such case. However, if you extend the DCM cable it is not guaranteed that the DCM works properly

Terminal configuration

The module is equipped with six female DIN connectors on the front grouped pairwise in phase sections named A, B and C. Each phase section has two connectors for connection to two breaks.

The module is also equipped with one female D-SUB connector for connection to its peer Timing M/R module using an interconnection cable (included with DCM module).

Number of modules needed

- 1 module to measure circuit breakers with up to 2 breaks per phase
- 2 module support circuit breakers with up to 4 breaks per phase
- 3 module support circuit breakers with up to 6 breaks per phase

4.3 Timing M/R module



The Timing M/R module measures timing on Main and Resistive (parallel) contacts. The module measures up to six breaks with both main and resistive contact, giving in total 12 measuring channels. The TM1800 system can be equipped with multiple Timing M/R modules that enable any type of test setup to be performed. All three connectors (phases) are galvanically isolated and have built-in voltage source.

For specifications, see “Timing M/R Module” in chapter 9 Specifications.

Terminal configuration

The module is equipped with three XLR female connectors on the front grouped in phase sections named A, B and C. Each connector has three pins for connection to two breaks.

- | | |
|---|------------------------------|
| 1 | First break point |
| 2 | Second break point |
| 0 | Common point for both breaks |

Number of modules needed

- 1 module to measure circuit breakers with up to 2 breaks per phase
- 2 modules supports circuit breakers with up to 4 breaks per phase
- Up to 8 modules can be mounted in the TM1800

4.4 Analog module



Analog channel is for measurement of motion, voltage, current, vibration, density, pressure etc.

The module is for motion measurements with standard linear or rotary transducers (resistive analog type), shunts and 4-20 mA transducers.

Standard XLR male contact connection in module. Transducer cable with female XLR contact.

- Three channels per module

Terminal Configuration

The terminals are grouped in three similar sections A,B and C suited for 3-phase operation (L1 L2 L3, RST).

Standard XLR male connection in module. Cable with female XLR contact needed, included in the delivery of TM1800.

- 0 earth
- IN input value from transducer
- OUT output from unit to transducer

Note *These channels should be turned off in CABA Local or CABA Win when not in use, to avoid error messages.*

Number of modules needed

1 module for three analog measurements simultaneously.

Example: For 3 motion measurements, 1 voltage and 1 current measurement you need 2 modules.

For technical specification see "Analog Module" in chapter 9 Specifications.

4.5 Digital module



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

- Number of channels 6x per module
- Measurement ranges transducer resolution up to +/- 32000 pulses.
- Power supply: 5 V +/-5% and 12 V DC +/-5% at 200 mA.

For specifications, see "Digital Module" in chapter 9 Specifications.

Terminal configuration

The terminals are grouped in three similar sections A,B and C suited for 3-phase operation (L1 L2 L3, RST).

Interface type: RS422 female connection on module, cable with male RS422 needed, included in the delivery of the Digital module.



IMPORTANT

Make sure that the transducer you connect has the correct pin configuration. Wrong configuration can damage the TM1800.

Number of modules needed

1 module for each six digital motion measurements.

4.6 Timing Aux module



Measures timing of up to six (6) auxiliary contacts in voltage or contact mode. For example:

- a and b contacts timing
- Spring charging motor timing
- Anti-pump contact timing

Note *When at least one a and one b contact is selected in Breaker View the a and b contacts in the coil circuit are measured automatically by the Control module.*

When more than one a or b contact is selected the Timing Aux module will be used to measure the remaining contacts.

For specifications, see "Timing Aux Module" in chapter 9 Specifications.

Terminal configuration

The terminals are grouped in three similar sections A,B and C suited for 3-phase operation (L1 L2 L3, RST).

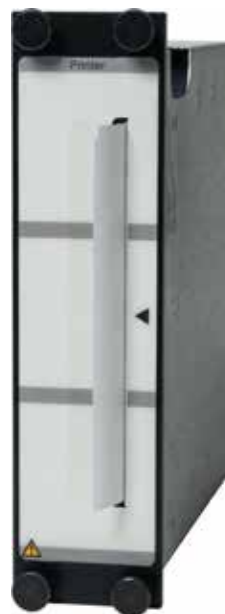
Red recommended for plus voltage

Black recommended for minus voltage

Number of modules needed

1 module for six auxiliary contacts on the circuit breaker.

4.7 Printer module



Module for making printouts. Printouts can also be made via parallel (LPT) 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 and CABA Win.

- Thermal printer sensitive line dot method
- Paper width 114 mm (4")
- Paper thickness 60 to 100 micrometer
- Printing speed 50 mm/s

For specifications, see "Printer Module" in chapter 9 Specifications.

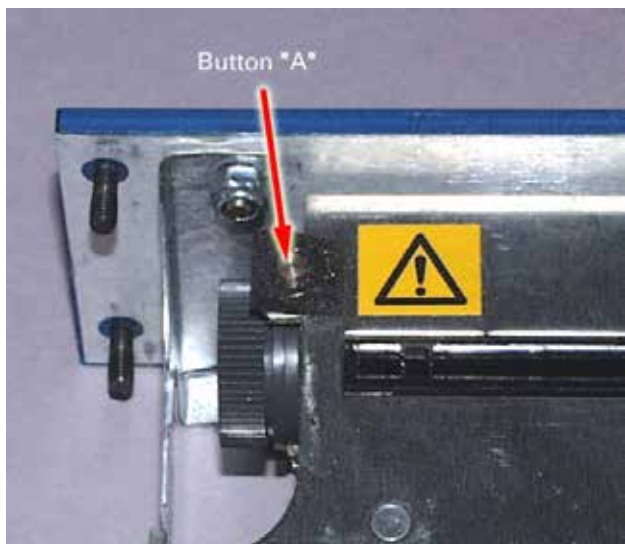
Terminal configuration

No connections needed.

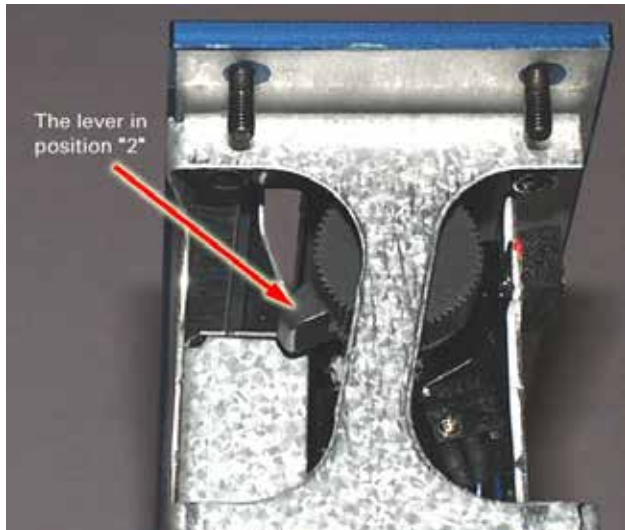
For connection of external printer see "Printer" in 3.8 External equipment and in 6.14 System settings menu.

How to change paper

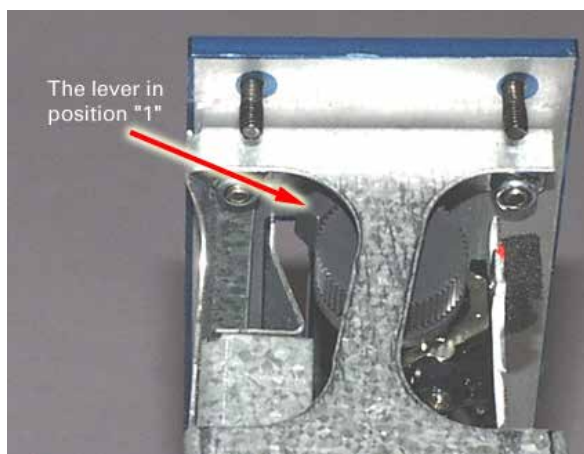
- 1] Turn off the TM1800.
- 2] Remove the four screws on the printer module.
- 3] Remove the old paper holder.
- 4] Push the button "A", the lever below will snap to position "2".



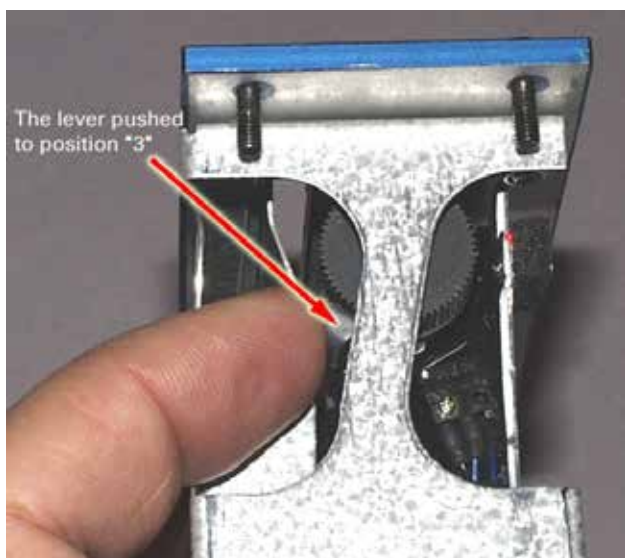
8] Pull the paper out about 20 cm (8 inches) and tear of excess.



9] Push back the lever to position "1".



5] Push the lever from "2" to position "3".



10] Insert the module gently into the slot number 8. Check that the module PCB-connector fits into the connector at the bottom.

11] Fasten the module using the four screws and washers.

6] Mount the new paper roll.

7] Feed the paper until it comes out from the slot, see picture below.

4.8 HDD module



HDD module is a special module which is a part of the basic unit. The purpose with the module is data storage.

This module is intended to be in slot 10 in the module panel.

Note *TM1800 can not work without this module.*

It is advised to remove this module when TM1800 is stored and during rough /long transports, to be carried as hand luggage

See chapter 5 Installing/removing modules.



IMPORTANT

After transport or storage, earth (ground) TM1800 and plug in the HDD module in TM1800 before you connect the TM1800 to supply voltage.

See chapter 5 Installing/removing modules.

For specifications, see “HDD module” in chapter 9 Specifications.

4.9 Dummy module




A Dummy module is always mounted in a slot where there is no other module mounted. This is important for the cooling of the TM1800.

5 Installing/removing modules


5.1 Installing a module

Choose a slot (1-8) for the new module. Slot number 10 is dedicated for the HDD module.


 **IMPORTANT**
Use ESD bracelet when removing module covers or modules.

Do not remove any other covers, but the covers for the modules.

- 1] Turn off TM1800.
- 2] Disconnect all cables including voltage supply to TM1800.
- 3] Remove the dummy module (use a Torx T10 screwdriver, included in the delivery of TM1800).
- 4] Push the module gently, straight into the slot. Make sure the contact terminal fits correct into the socket-contact in the bottom of the slot.
- 5] Fasten the module using all the four screws and washers.
- 6] Save the dummy module. It has to be installed again if you remove a module.

 **Tip**
You do not need to loosen the screws entirely, see picture below. The screw holes in the module covers are treaded and the screws has a waist to prevent losing the screws.



 **IMPORTANT**
Replace worn or damaged screws and washers.

This is important to ensure a good protective earth (ground) connection.

Slots number 1 to 8 must have a module/ Dummy module mounted to achieve a correct cooling of the TM1800.

5.2 Removing a module



IMPORTANT

Use ESD bracelet when removing module covers or modules.

Do not remove any other covers, but the covers for the modules.

- 1] Turn off TM1800.
- 2] Disconnect all cables including voltage supply to TM1800.
- 3] Remove the four screws holding the module.
- 4] Pull the module straight up.
- 5] Insert and fasten a Dummy module by means of the four screws with lock washers.
- 6] Fasten the module cover using the four screws and washers.

6 CABA Local

CABA Local is the standard software program to operate the TM1800 circuit breaker analyzer. In CABA Local you run the tests, view the measurements, do set-ups etc.

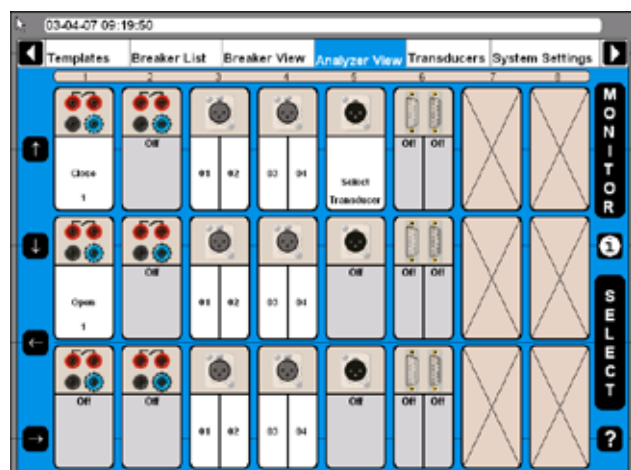
6.1 Start/Shut down CABA Local

Start

- 1] Connect the TM1800 to the mains, 100-240 V AC at 50/60 Hz. The maximum power consumption is 250 VA. Always use the power cord supplied with the unit.
- 2] Switch on the TM1800 by pressing the ON/OFF button on the control panel.
- 3] During the start-up procedure the ON/OFF indication lamp will blink until Windows® XP starts. Then all indication lamps on the control panel will lighten up, the OPERATE and OPERATE/MEASURE lamps blinking.

Note *During the start-up procedure do not try to operate TM1800. If you try to do a measurement during the start-up you will risk losing the recorded data.*

- 4] When the screen below is shown the TM1800 is ready to run. The Analyzer View is the start screen that visualizes the link between TM1800 and the test object.



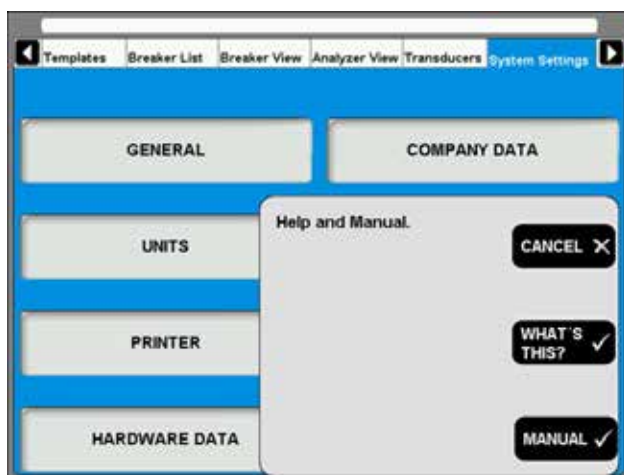
Shut down

- 1] Press the ON/OFF button.

6.2 OnLine Help

By pressing the "Question mark, "?" button you invoke the OnLine Help function. You can get direct information on current topic or go to the complete manual and search for information.

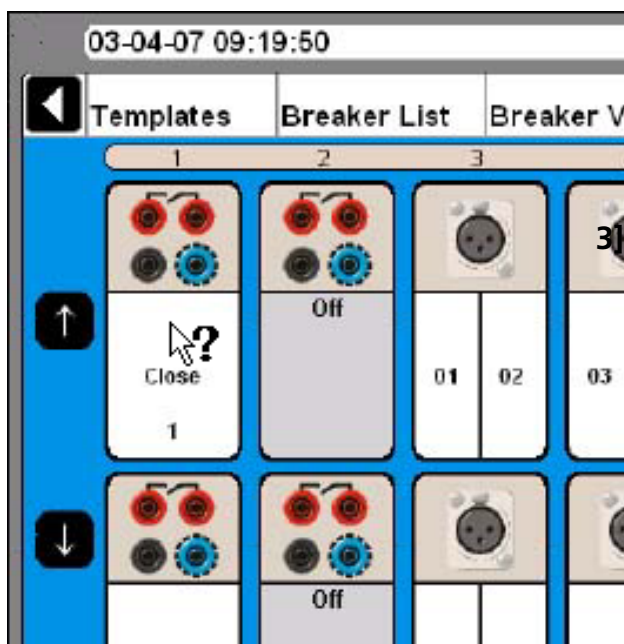
Note *The OnLine Help is not available in the "Analyzer Window".
The keyboard button F1 does not invoke the OnLine Help function.*



WHAT'S THIS?

Using this option will automatically direct you to the current topic in the OnLine Help.

- 1] Press the button "WHAT'S THIS?".
- 2] Move the pointer to desired object and click left mouse button.
The user manual will be opened.



MANUAL

- 1] Press the "MANUAL" button to get access to the OnLine Manual.
- 2] Click the "Bookmarks" tab to view the content.
- 3] Click on desired topic.

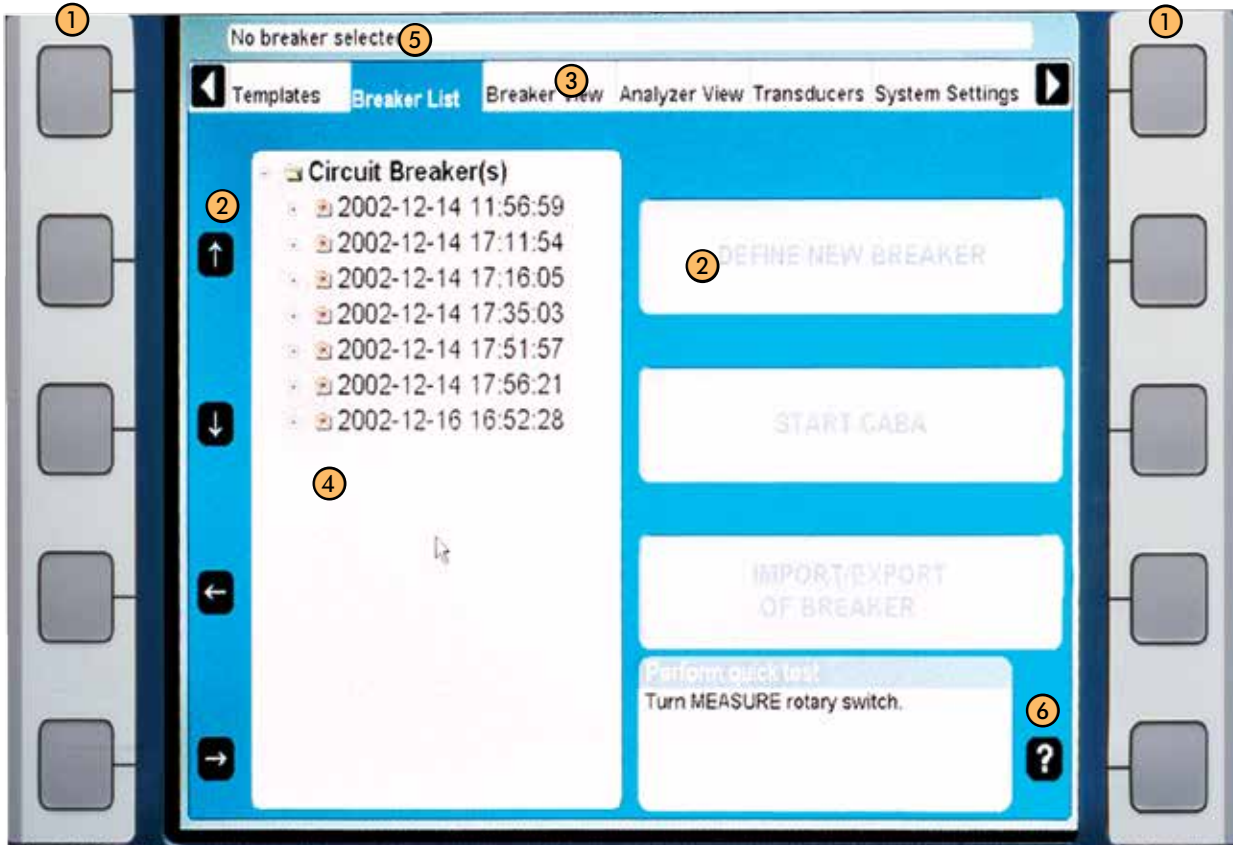


Tip

You can also go to the manual index and look for the desired topic.

6.3 Navigation & display buttons

Most of the CABA Local functions are controlled by the ten navigation buttons (1). The function of a navigation button is stated on the display button (2) on the screen right next to it.



①	Navigation buttons
②	Display buttons
③	Main menu
④	Tree structure
⑤	Selected items bar
⑥	By pressing the "Question mark, "?", button you invoke the OnLine help function. See section 6.2 OnLine Help.

You can activate the function either by pressing the navigation (1) button or by clicking on the display button (2) using the trackball and "mouse keys" on the keyboard or using an external mouse. We will use the term "Press the xxx button" in the following instructions.

The arrow buttons to the left are used to move the pointer within the apparent window.

6.4 Main and submenus

There are six main menus (3), each having several sub menus in a tree structure. The top left and right navigation buttons are dedicated to move between the main menus.

Moving between the main menus does not affect the state of how it is displayed. The chosen sub menu will always remain despite moving to other main menus. Example: If you go from one main menu, also showing submenu, to another main menu and back again, the first main menu will look the same as it was before you left it, with the submenu.

Selected items bar

The selected items bar (5) shows the selected template or breaker and is useful when moving between the sections. If no item is selected the bar displays: No Breaker or Template Selected.

6.5 Repair CABA Local

If you are experiencing problems with your TM1800 that could be software related there is an option to repair the system. The repair reinstalls the original TM1800 system files without removing any existing measurements (breakers in breaker list). You can initiate a repair with the following procedure:

- 1]** Turn off the TM1800.
- 2]** Turn on the TM1800 and then directly press and hold the "Ctrl" key on the keyboard until message "Repair started, please wait while restoring TM1800 system" is shown in a command window named "TM1800 Startup Manager". (This will take a few minutes).
- 3]** Wait while your TM1800 software files are updated.
- 4]** When asked to "Close the following applications before continuing the install" choose "Ignore".
- 5]** Click "OK" when informed "TM1800 Setup completed successfully".
- 6]** Click "Yes" when prompted to restart.

Done! You have now repaired your software.

If the problems still remain – contact the Megger support team.

6.6 Updating CABA Local

For updates of CABA Local use the USB memory .

Note *Do not connect the TM1800 to the Internet.*

To update the software in your TM1800 contact the Megger support team.

6.7 Optional software



IMPORTANT

Do not install other software in TM1800, except printer drivers, software for back-up media and virus protection. Installing other software could cause the TM1800 to fail or damage.

If virus protection is installed in TM1800 it is on the user's responsibility.

Megger Sweden AB will not take any responsibility for optional soft-wares that are installed.

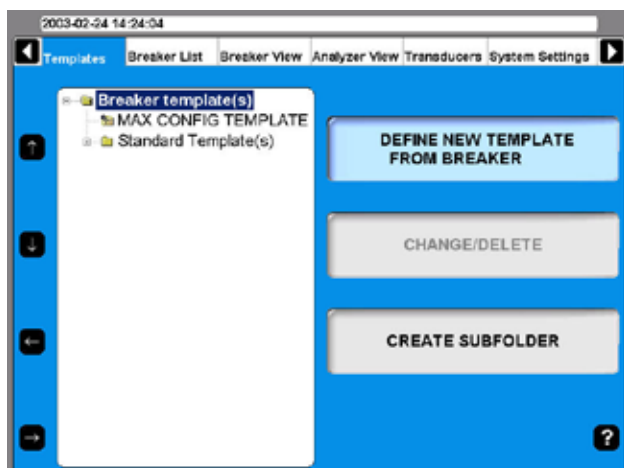
Printer and Back-up media

Please see the Microsoft Windows XP HCL (Hardware Compatible List) for printers and back-up media that are hardware compatible.

Antivirus

We recommend you to use Norton Antivirus software for the TM1800. This software is tested by Megger Sweden AB. It is the user's responsibility to keep the antivirus software updated.

6.8 The main menu



Templates

Create your list of templates and use as base when you create a new circuit breaker

Breaker List

Here you do measurements on your current circuit breakers and tests. You can also create circuit breaker setups.

Breaker View

Here you do settings for your circuit breaker.

Analyser View

Here you see the view of how your modules are used in current test. You can also continuously view the state of each channel, MONITOR mode.

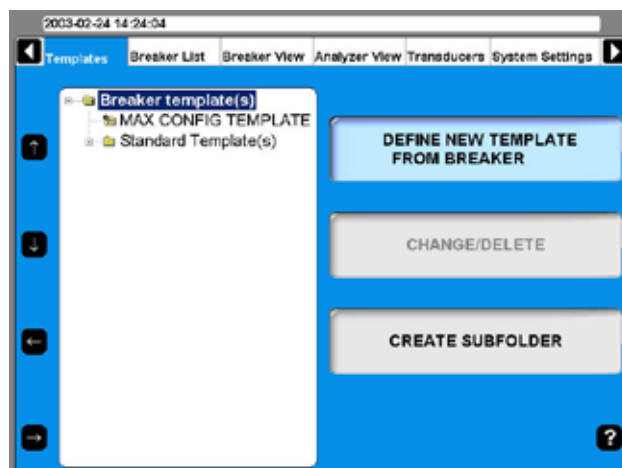
Transducers

Here you define and calibrate your transducers.

System Settings

Here you do the system settings for TM1800 and CABA Local

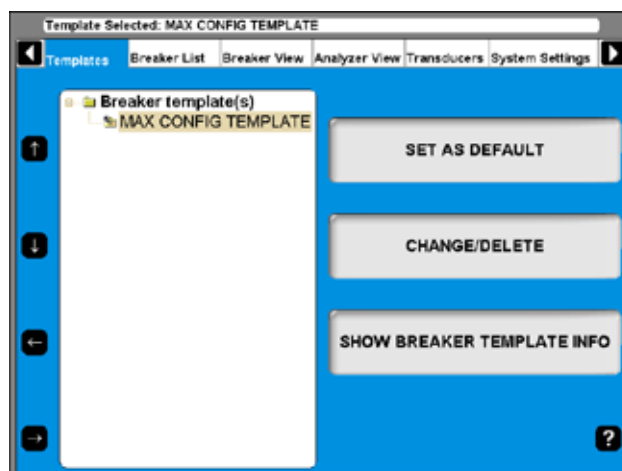
6.9 Templates menu



The Templates main menu is the starting-point when you edit your list of circuit breaker testing templates. These templates are used to create set-ups for new circuit breakers. The templates are displayed in alphabetical order in a tree structure.

When the top level "Breaker template(s)" is highlighted you can define new breaker template from breaker or create a sub folder.

If you go down in the tree structure to "MAX CONFIG TEMPLATE" the display buttons to right will change, see image below.



The "MAX CONFIG TEMPLATE" is set automatically to maximum measuring possibilities of your TM1800 depending on the hardware configuration, number and types of modules, without motion measurements.

What is a template

The template contains all test plan information and settings. This helps you to test the breaker in exactly the same way each time, which ensures accurate comparisons under same test conditions and settings.

The template contains settings for the TM1800; channels in use and configuration, connecting, timing

pulse and graphs settings. Every setting that is needed for the test but the selection of transducers. However, if a conversion table for the transducer is used this is stored in the template. During a test it adapts the TM1800 for your needs.

There are three kinds of templates, the Max Config template, Standard templates (delivered with the TM1800) and custom made templates. The Max Config template and Standard templates are non-editable.

Note *Breakers associated to a Standard template cannot be edited.*

How to create a template

- 1] To create a template for a breaker you must have created the breaker in the "Breaker List", see section 6.10.
- 2] Create a breaker by choosing "MAX Config Template" or one of the standard templates. Do all needed settings under "Breaker View".
- 3] Go to "Templates".
- 4] Choose the "Define New Template" and choose your breaker from "Breaker List". Give the template a suitable name e.g. for which type of circuit breaker is it meant to be used. All settings done for the breaker are now also set in the new template. When you in the future will test a new breaker of the same type you choose this template and then run the test.

Max Config Template

As factory setting the "MAX CONFIG TEMPLATE" is set as default. This is to make sure that you can run a test the first time without any settings. If you get into problem doing measurements due to settings, it is a good basic template to use to see that the TM1800 and the breaker works correct together. When you make breaker setup it is also good to use the "MAX CONFIG TEMPLATE" as a base.

The "MAX CONFIG TEMPLATE" is automatically updated every time you start the analyzer. This procedure is done to make sure that the "MAX CONFIG TEMPLATE" always comply with the TM1800 configuration.

Note *If you work with a certain type of breaker during a period in time you can set its template as default. By this you do not have to choose template. As soon as you turn the operation knob the TM1800 use your template.*

If you do not select any breaker before you run a measurement (i.e. turn the operation directly after starting the analyzer) the TM1800 use the template that is set as default ("MAX CONFIG TEMPLATE").

Note *If you set another template as default, that template can not be adapted to the current configuration of the TM1800.*

Comparison to test plans in CABA Win

The template in CABA Local is a test plan with additional settings. All possible settings are made, only transducer needs to be selected before the test is performed.

Create a subfolder

The TM1800 is delivered with a set of standard breaker templates located in the Standard Template(s) folder. You may however want to create your own sets of templates. Start off by creating a subfolder:

- 1] Navigate to the folder in which you want to create a subfolder.
- 2] Press the "CREATE SUBFOLDER" button.
- 3] Write the name (ABB in this example) of the folder in the Folder ID text field.
- 4] Press the "OK" button.

Delete a subfolder

This is how you delete a subfolder and all its content:

- 1] Navigate to the folder that you want to delete.
- 2] Press the "CHANGE/DELETE" button.
- 3] Press the "DELETE" button.
- 4] Confirm deletion by pressing the "YES" button.

Rename a subfolder

- 1] Navigate to the folder you want to rename.
- 2] Press the "CHANGE/DELETE" button.
- 3] Enter the new name of the folder in the Folder ID text field.
- 4] Press the "OK" button.

Create a template from a breaker

Templates can be created by copying the breaker setup from any breaker in the breaker list. You can create a template from any breaker in the “Breaker List”, see section 610 “Create a breaker”.

- 1] Choose the “Define New Template”.
- 2] Choose the breaker from “Breaker List” that you want to create a template of.
- 3] Give the template a suitable name e.g. for which type of circuit breaker is it meant to be used.

All settings done for the breaker are now also set in the new template. When you in the future will test a new breaker of the same type you choose this template and then run the test.

Rename a template

- 1] Navigate to the template you want to re-name.
- 2] Press the “CHANGE/DELETE” button.
- 3] Enter the new name of the template in the Folder ID text field.
- 4] Press the “OK” button.

Set a template as default

The default template is used when you want to run a quick test (see chapter 7 Perform testing, section 7.4 Quick test).









- 1] Navigate to the template you want to set as default.
- 2] Press the “SET AS DEFAULT” button.

Delete a template

- 1] Navigate to the template that you want to delete.
- 2] Press the “CHANGE/DELETE” button.
- 3] Press the “DELETE” button.
- 4] Confirm deletion by pressing the “YES” button.

6.10 Breaker List menu

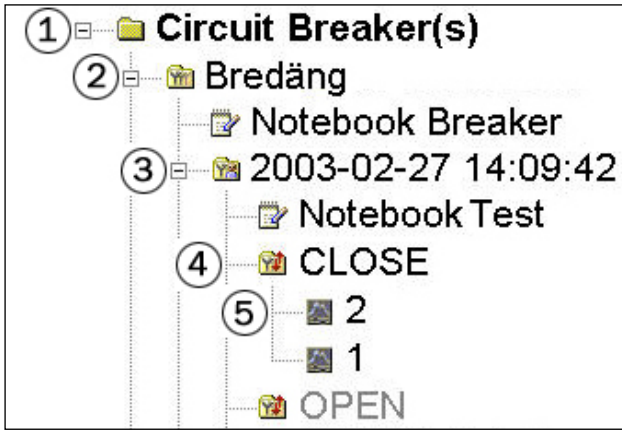
The Breaker List main menu is the starting-point when creating, editing, importing, exporting and initiating a breaker test. Access to the test recordings are also obtained via this list.

	The CABA Win icon. The breaker has been created in CABA. Few new settings can be changed in CABA Local e.g. pulse. Non changeable data is grey out in “Breaker view”.
	CABA Win icon is grey, means that the breaker is created in CABA Win and not converted to CABA Local format. Once the breaker is marked it will be converted.
	The CABA Local icon. The breaker has been created in TM1800.
	CABA Local icon is grey. The breakers are non editable in CABA Local. This can be a breaker created by a non standard test plan in CABA Win. Breaker view is not accessible.
	The test icon shows the test level of your breaker.
	The operation icon shows the operation level of your breaker.
	The recording icon shows the record level of your breaker.
	The Notebook icon shows the notebook in your breaker or test.



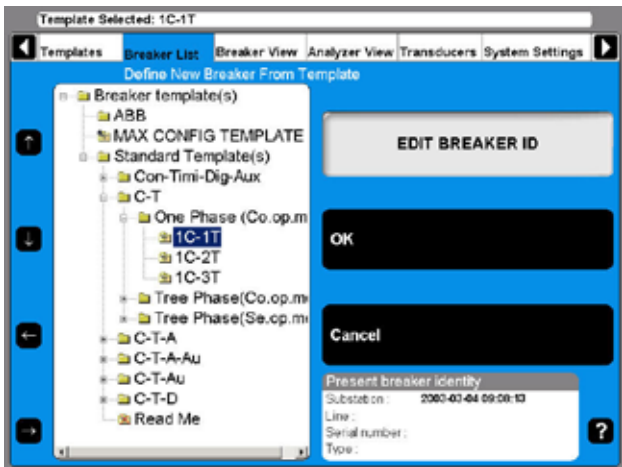
When the symbols are red crossed, means the breaker test (or tests) cannot be performed by this TM1800 (lack of channels or breaker with special CABA Win test plan).

All individual breakers are organized in alphabetical order at a breaker level (2) that is situated below the root level (1). Underneath each breaker there is a test level (3) where the test occasions are sorted in descending order (the latest on top). A test contains a set of operations on the operation level (4). Finally, the recordings of an operation are sorted in descending order at the recording level (5).

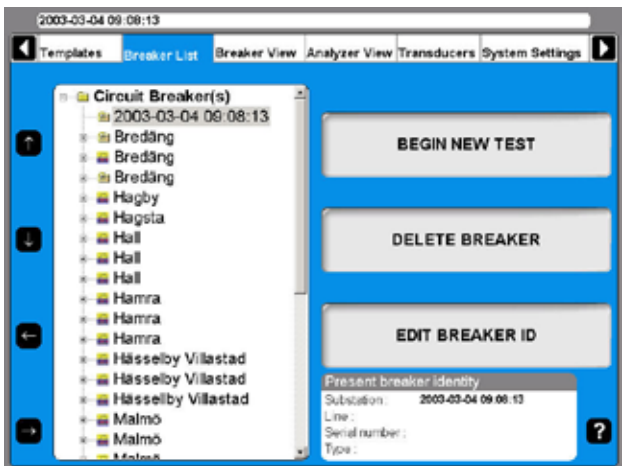


Create a breaker

- 1] Navigate to the root level folder labeled Circuit Breaker(s).
- 2] Press the "DEFINE NEW BREAKER FROM TEMPLATE" button. The list of templates appears in the tree menu.



- 3] Navigate to the desired template.
- 4] Press the "OK" button.

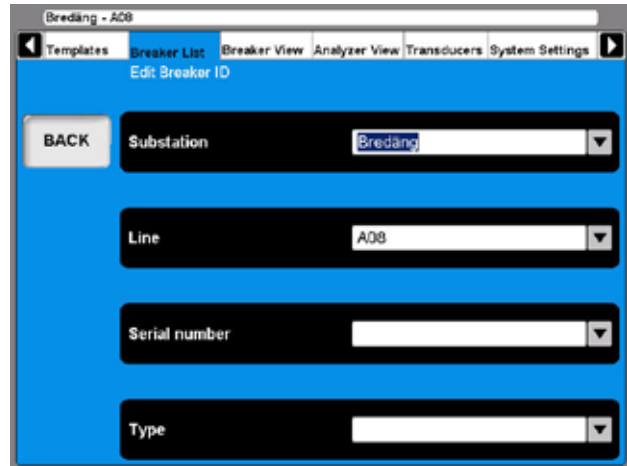


A breaker is added to the list. By default the name is equal to the date and time when it was created.

If you want to rename it see the next section, "Edit breaker ID".

Edit Breaker ID

- 1] Navigate to the breaker that you wish to edit.
- 2] Press the "EDIT BREAKER ID" button.



The default label for ID1 is Breaker ID1. In this example it has been set to Substation. The four labels for the ID:s can be user defined, see section "6.14 System Settings Menu".

- 3] Press the "Substation" (Breaker ID1) button.

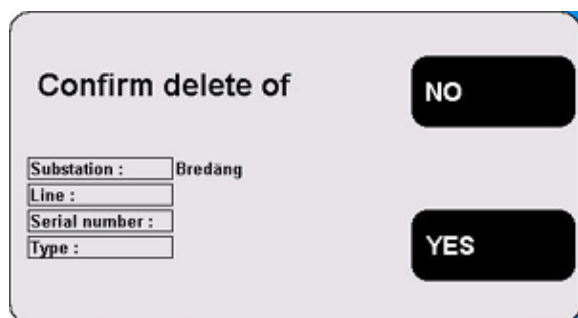


- 4] Use the "Scroll up" / "Scroll down" navigation buttons to choose from the user defined drop down menu. Go to the next step if you wish to add a breaker ID to the drop down menu.
- 5] Fill in the text field with a new substation name.
- 6] Press the "Add to List" button. (Use the Delete button to remove items from the list.)
- 7] Press the "BACK" button.
- 8] Repeat from step 3 to define the 3 additional ID:s.

Note To change set-up of a breaker please refer to chapter "6.5 Breaker view menu".

Delete a breaker

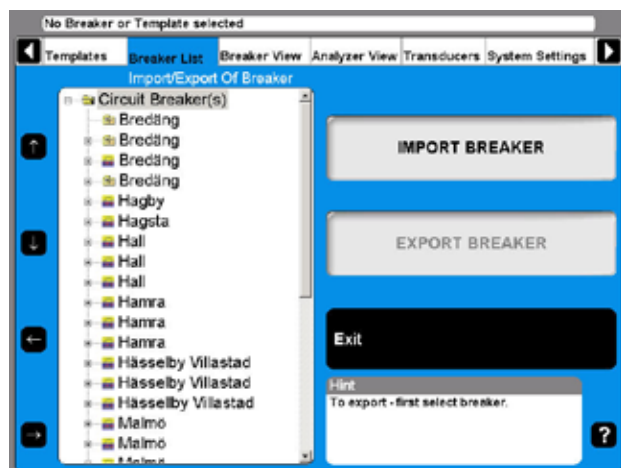
- 1] Navigate to the Breaker that you wish to delete.
- 2] Press the "DELETE BREAKER" button.



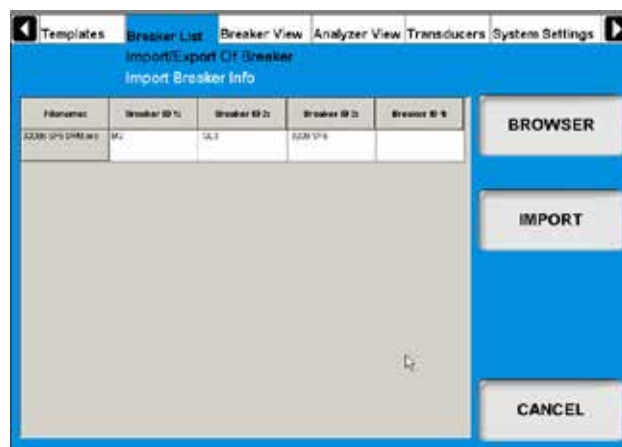
- 3] Confirm the deletion by pressing the "YES" button.

Import a breaker

- 1] Navigate to the root level folder labeled Circuit Breaker(s).
- 2] Press the "IMPORT/EXPORT OF BREAKER" button.



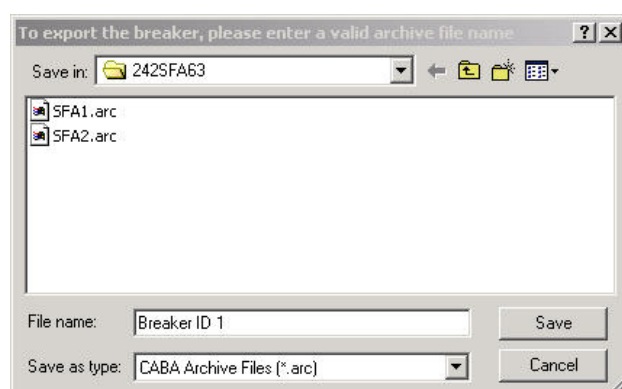
- 3] Press the "IMPORT BREAKER" button.



- 4] Navigate to the volume and folder where the breaker files (*.arc) that you wish to import are located, by using the Browse button.
- 5] Click the "Open" button in the Browse window.
- 6] In the list, select the breakers you want to import and click "IMPORT".
The selected breakers are now added to the breaker list.
- 7] Repeat from step 4 if you want to import breakers from other locations.
- 8] When you are done, press the "EXIT" button.

Export a breaker

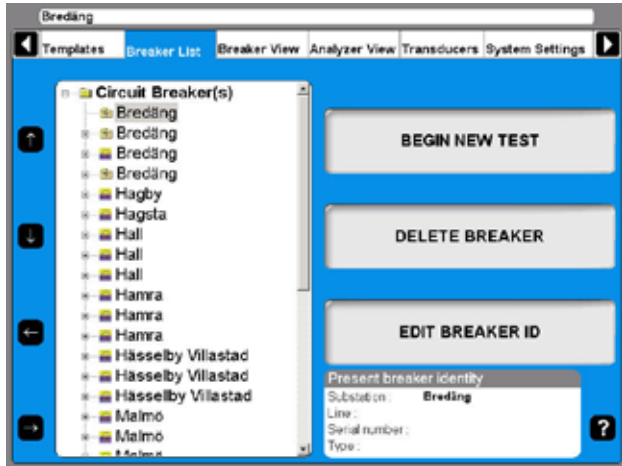
- 1] Navigate to the root level folder labeled Circuit Breaker(s).
- 2] Press the "IMPORT/EXPORT OF BREAKER" button.
- 3] Navigate to the breaker you want to export.
- 4] Press the "EXPORT BREAKER" button.



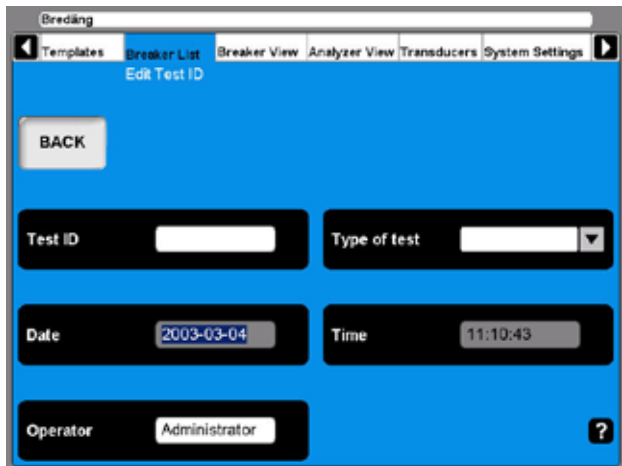
- 5] Navigate to the volume and folder where you want the breaker file to be saved.
- 6] Enter a valid archive file name.
- 7] Click the "Save" button.

Begin a new test

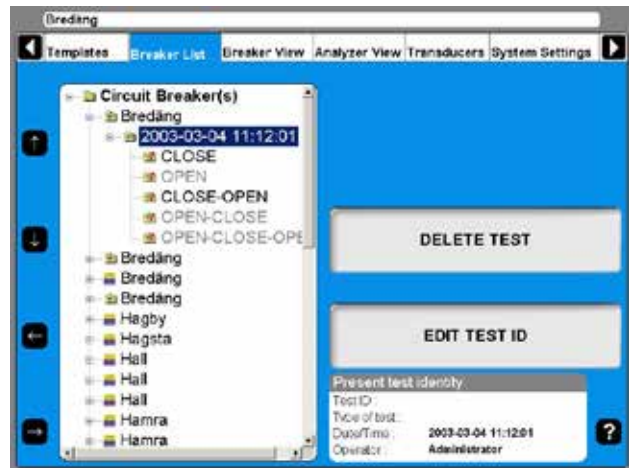
- 1] Navigate to the breaker that is going to be tested.
- 2] Press the "BEGIN NEW TEST" button.



- 3] Fill in the "Test ID" and "Type of Test" text fields. This is optional, also see the next section "Edit a Test".

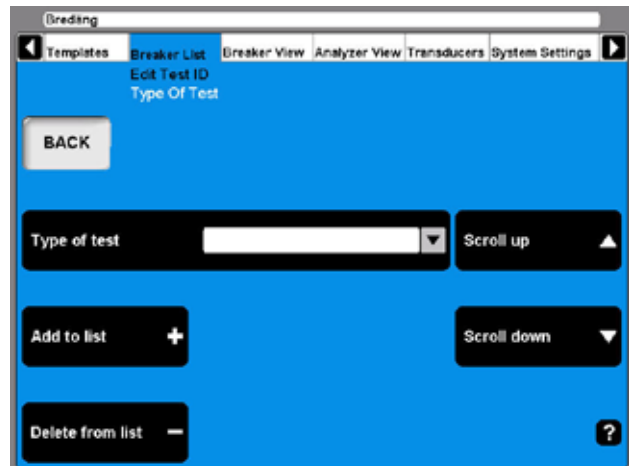


- 4] Press the "BACK" button in order to view the test.

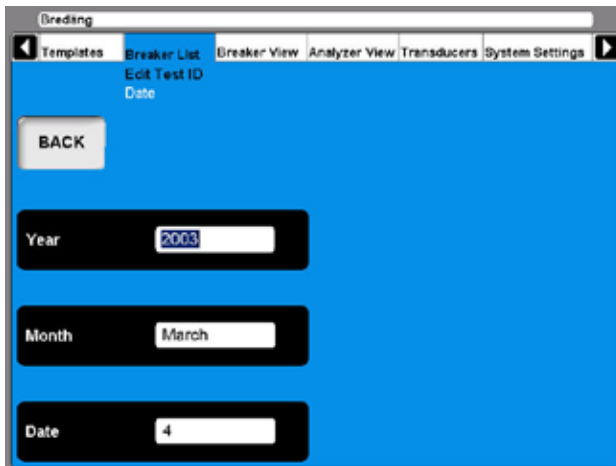


Edit Test ID

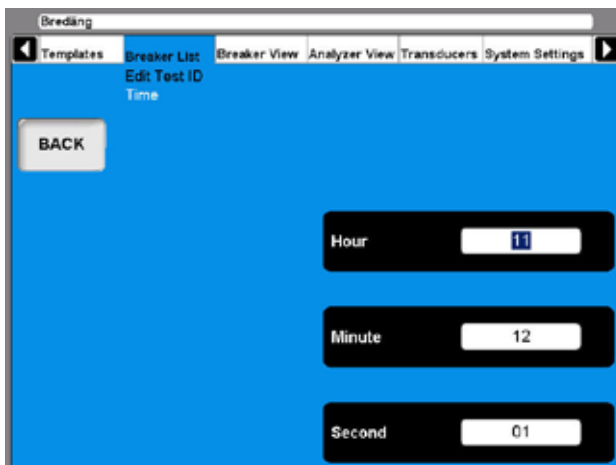
- 1] Navigate to the test designation that you want to edit.
- 2] Press the "EDIT TEST ID" button.
- 3] Fill in the "Test ID" text field with the new designation. If this field is left empty the date and time designation will be shown in the breaker list.
- 4] Press the "Type of test" button.



- 5] Use either of the "Scroll up/Scroll down" navigation buttons to choose from the user defined drop down menu. Go to the next step if you wish to add a new type.
- 6] Fill in the "Type of Test" text field.
- 7] Press the "Add to list" button. (Use the "Delete from list" button to remove items from the list.)
- 8] Press the "BACK" button.



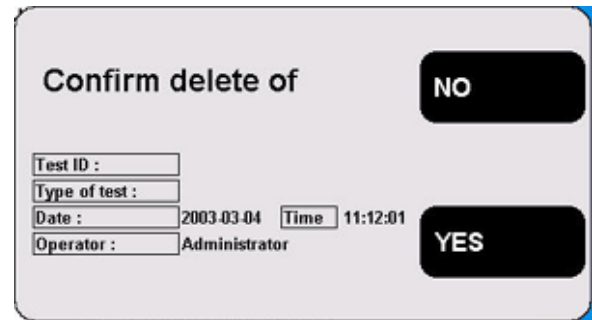
- 9] Press the "Date" button if you for some reason want to alter the date of the test occasion.
- 10] 10.Fill in the "Year" text field. Press the "Month" and "Date" buttons repeatedly until the desired month and day appear in the respective text fields.
- 11] Press the "BACK" button.
- 12] Press the "Time" button.



- 13] Press the "Hour", "Minute" and "Second" buttons repeatedly to alter the time.
- 14] Press the "BACK" button twice to return to the Breaker List main menu.

Delete a test

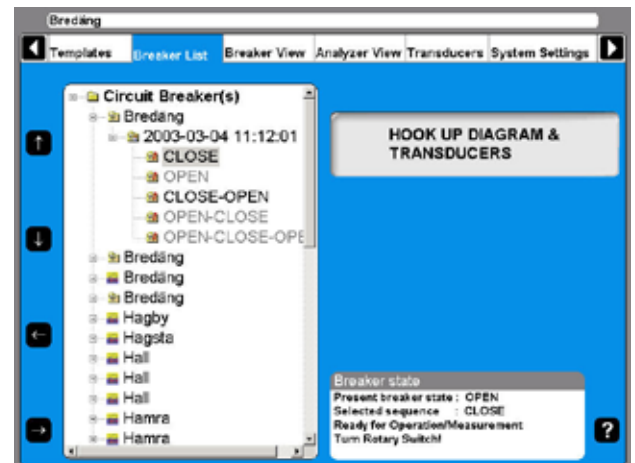
- 1] Navigate to the test that you wish to delete.
- 2] Press the "DELETE TEST" button.



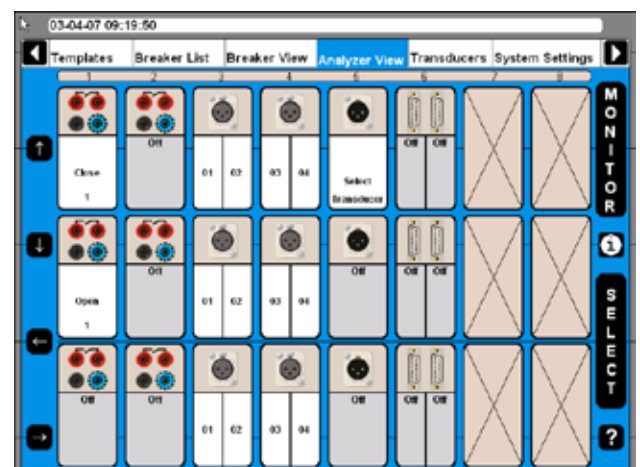
- 3] Confirm deletion by pressing the "YES" button.

Hook up diagrams & transducers

- 1] Navigate to the breaker operation designation that you want to perform.
- 2] Press the "HOOK UP DIAGRAM & TRANSDUCERS" button.



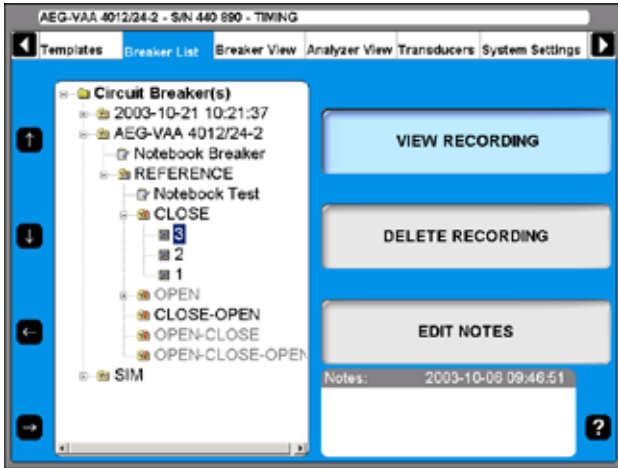
- 3] The Analyzer View will be shown. Refer to the section "6.6 Analyzer view menu" for details.



View a recording

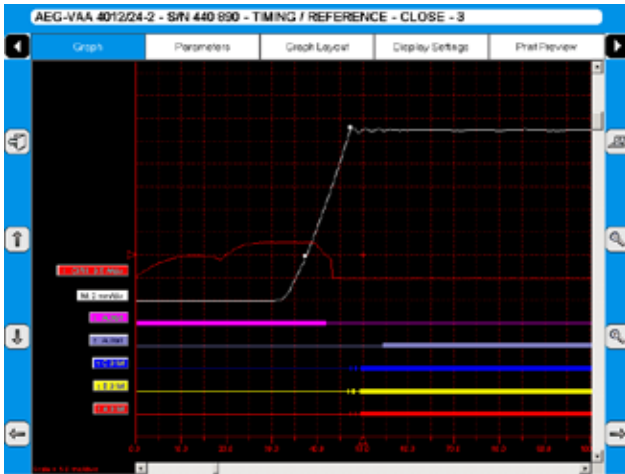
- 1] Navigate to the measurement recording designation that you want to view.

2] Press the "VIEW RECORDING" button.



Graph

When viewing the recording you can choose to view the graph.



	Navigate in Analyse Menu
	Exit Analyse Window
	Scroll up
	Scroll down
	Scroll left
	Scroll right
	Zoom in
	Zoom out
	Print Protocol

Label names

In the graph window the recordings have a label for identification.

The label names in the graph view and parameter view are abbreviated. The first character shows the measured quantity, the rest of the label name is the object ID.

General text object ID

CIR	Operation coil circuit
CMD	Command, control pulse
T	Trip
C	Close (note C is also used for phase C)
M	Main contact timing
R	Resistor contact timing (not R is also used for right part of Head)
R	Right part of head
L	Left part of head

Head naming is a way of naming the breaking chambers on a general stand/structure.

A	Phase A
B	Phase B
C	Phase C

The first character in the label name

DCM Impedance	Z
Current	I
Voltage	V
Angle	w
Motion	M
Resistance	R
Time	t
Velocity	v
Acceleration	a

Object ID list

[n] - the letter n stand for a digit, 0 - 9

Object ID	Explanation
CIR[n]	Common phase, close&trip coil current circuit [n]
A CIR[n]	Phase A, close&trip coil current circuit [n]
B CIR[n]	Phase B, close&trip coil current circuit [n]
C CIR[n]	Phase C, close&trip coil current circuit [n]
CCIR[n]	Common phase, close coil current circuit [n]
ACCIR[n]	Phase A, close coil current circuit [n]
BCCIR[n]	Phase B, close coil current circuit [n]

CCCIR[n]	Phase C, close coil current circuit [n]
TCIR[n]	Common phase, trip coil current circuit [n]
ATCIR[n]	Phase A, trip coil current circuit [n]
BTCIR[n]	Phase B, trip coil current circuit [n]
CTCIR[n]	Phase C, trip coil current circuit [n]
CMD[n]	Common phase, close&trip command [n]
A CMD[n]	Phase A, close&trip command [n]
B CMD[n]	Phase B, close&trip command [n]
C CMD[n]	Phase C, close&trip command [n]
CCMD[n]	Common phase, close command [n]
ACCMD[n]	Phase A, close command [n]
BCCMD[n]	Phase B, close command [n]
CCCMD[n]	Phase C, close command [n]
TCMD[n]	Common phase, trip command [n]
ATCMD[n]	Phase A, trip command [n]
BTCMD[n]	Phase B, trip command [n]
CTCMD[n]	Phase C, trip command [n]
AUXa[n]	Common phase, a-contact [n]
AAUXa[n]	Phase A, a-contact [n]
BAUXa[n]	Phase B, a-contact [n]
CAUXa[n]	Phase C, a-contact [n]
AUXb[n]	Common phase, b-contact [n]
AAUXb[n]	Phase A, b-contact [n]
BAUXb[n]	Phase B, b-contact [n]
CAUXb[n]	Phase C, b-contact [n]
-	Common phase
A	Phase A
B	Phase B
C	Phase C
A [nn]	Phase A, break No. [nn]
B [nn]	Phase B, break No. [nn]
C [nn]	Phase C, break No. [nn]
A [nn]M	Phase A, break No. [nn], main contact
A [nn]R	Phase A, break No. [nn], resistor contact
B [nn]M	Phase B, break No. [nn], main contact
B [nn]R	Phase B, break No. [nn], resistor contact
C [nn]M	Phase C, break No. [nn], main contact
C [nn]R	Phase C, break No. [nn], resistor contact
A[n]	Phase A, head [n]
B[n]	Phase B, head [n]
C[n]	Phase C, head [n]

A[n] L	Phase A, head [n], left break
A[n] R	Phase A, head [n], right break
B[n] L	Phase B, head [n], left break
B[n] R	Phase B, head [n], right break
C[n] L	Phase C, head [n], left break
C[n] R	Phase C, head [n], right break
A[n] LM	Phase A, head [n], left break, main contact
A[n] LR	Phase A, head [n], left break, resistor contact
A[n] RM	Phase A, head [n], right break, main contact
A[n] RR	Phase A, head [n], right break, resistor contact
B[n] LM	Phase B, head [n], left break, main contact
B[n] LR	Phase B, head [n], left break, resistor contact
B[n] RM	Phase B, head [n], right break, main contact
B[n] RR	Phase B, head [n], right break, resistor contact
C[n] LM	Phase C, head [n], left break, main contact
C[n] LR	Phase C, head [n], left break, resistor contact
C[n] RM	Phase C, head [n], right break, main contact
C[n] RR	Phase C, head [n], right break, resistor contact

Parameters

The Parameters view shows a list of the recorded parameters.

Parameter	Value	Unit
Phase A	47.2	ms
Phase B	2.5	ms
Phase C	6.2	ms
Phase A [nn]	46.0	ms
Phase B [nn]	2.6	ms
Phase C [nn]	6.5	ms
Phase A [nn]M	47.4	ms
Phase A [nn]R	2.4	ms
Phase B [nn]M	6.1	ms
Phase B [nn]R	2.4	ms
Phase C [nn]M	6.5	ms
Phase C [nn]R	6.2	ms
Phase A [nn]M	47.2	ms
Phase A [nn]R	2.5	ms
Phase B [nn]M	6.2	ms
Phase B [nn]R	6.1	ms
Phase C [nn]M	6.2	ms
Phase C [nn]R	6.1	ms
Phase A [nn]M	47.2	ms
Phase A [nn]R	2.5	ms
Phase B [nn]M	6.2	ms
Phase B [nn]R	6.1	ms
Phase C [nn]M	6.2	ms
Phase C [nn]R	6.1	ms
Phase A [nn]M	47.2	ms
Phase A [nn]R	2.5	ms
Phase B [nn]M	6.2	ms
Phase B [nn]R	6.1	ms
Phase C [nn]M	6.2	ms
Phase C [nn]R	6.1	ms

List of measurement results is shown in table format.

Note Pass/Fail limits can be also displayed here but only if this functionality was setup and activated in CABAWin. It is not possible to do this in CABA Local.

Graph layout

Navigation and operation of this screen can be done using the trackball and mouse buttons. Alternatively the arrow keys can be used.



Use the buttons to select column



When the cursor is in the On/Off column use the buttons to change the setting.



Entries in the Position, Color and Y-scale columns can be changed using the buttons.



Per recorded trace you can set graphical presentation options such as On/Off (visible/not visible), Position of the trace, trace color and scale of trace.

Display settings

Navigation and operation of this screen can be done using the trackball and mouse buttons. Alternatively the arrow keys can be used.



Use the buttons to select column.

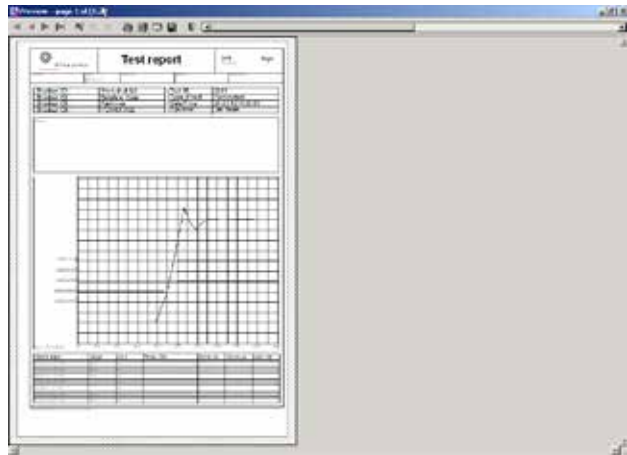


Entries are changed using the buttons.



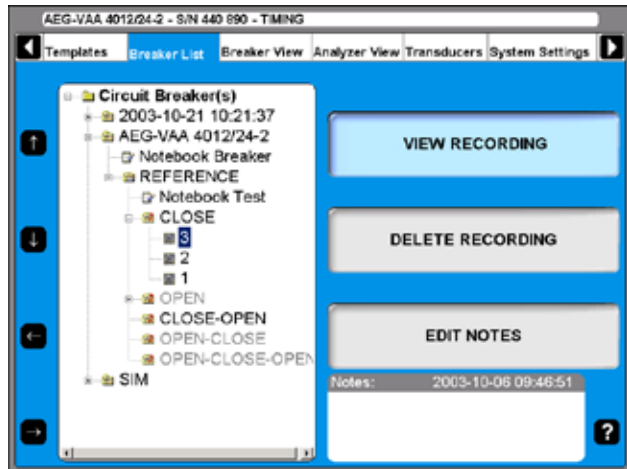
Print preview

This image shows an example of a test report, see section 7.7 Reporting for more information.



Delete recording

1] Press "DELETE RECORDING"



2] Confirm delete of single recording by pressing "YES"

Edit notes

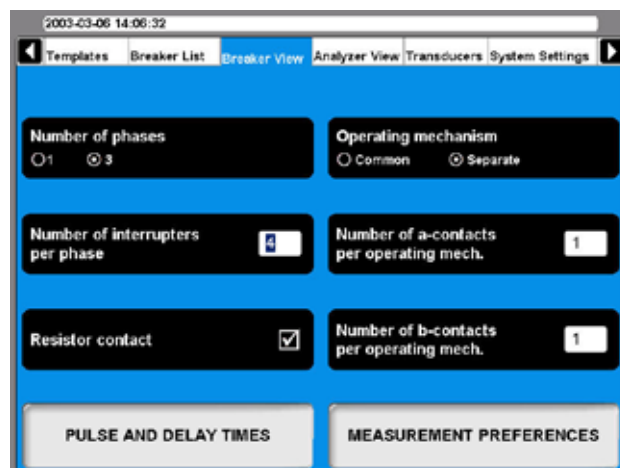
- 1] Press "EDIT NOTES".
- 2] Make your notes, and press "BACK".

6.11 Breaker View menu

The Breaker View main menu is the starting point for setting up the technical breaker and measurement details. All settings done here will affect the breaker individual that is marked in the breaker list.

The values can be set by using the numeric keys or by using the display buttons. Some limitations are set by the system according to how the TM1800 is equipped, e.g. you cannot select more than two breaks per phase if the TM1800 only has one Timing M/R module.

Make settings for a breaker



Number of Phases

Here you enter whether the test object is a single or a three-phase breaker.

Number of interrupters per phase

By repeatedly pressing the button you alter the value to what is necessary for your test. The highest possible value is depending on the number of Timing M/R Modules installed in TM1800.

Resistor contact

Here you select whether the test object is equipped with resistor contacts (PIR, Pre-insertion resistor contact) or not.

Operating mechanism

This button is used to select whether the test object has a common or one separate operating mechanism per phase.

Number of a-contacts per operating mech.

By repeatedly pressing the button you alter the number of a-contacts per operating mech.

Number of b-contacts per operating mech.

By repeatedly pressing the button you alter the number of b-contacts per operating mech.

Breaker set up example

The setting shown above is done for a circuit breaker with three phases and a separate operating mechanism for each phase. Then it is recommended that the TM1800 have two Control modules.

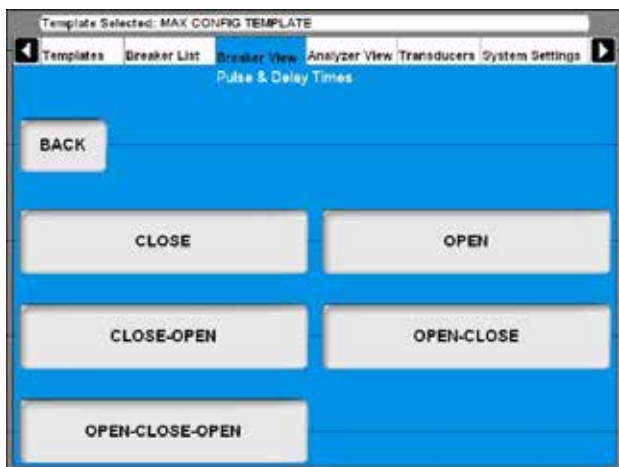
The circuit breaker has four breaks per phase. It is probably a high voltage circuit breaker for 400 kV (medium voltage circuit breakers have one break per phase). For this the TM1800 needs to have two Timing M/R modules.

The Circuit breaker has one a- and one b-contact per operating mechanism. By setting the TM1800 like shown here it will automatically measure the contacts in series with the operating coil. Totally six auxiliary contacts will be measured when you have selected separate and one a-contact and one b-contact. The Control module will measure this and no extra cabling is needed. If you have auxiliary contacts that are not in the coil circuit you have to select more auxiliary contacts i.e. if you want to measure one a-contact that is not in series you have to select two a-contacts in the TM1800. For other auxiliary contacts you have to connect them to an Auxiliary module.

Resistor contacts are also chosen. By this the resistor contact timing and the resistor value (PIR contacts) will be measured automatically by the same channel that measures the main contact.

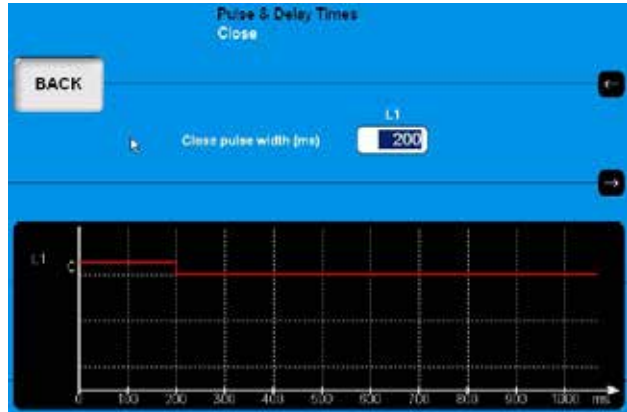
Setting the pulse and delay times

- 1] In Breaker View press the "PULSE AND DELAY TIMES" button to make the settings. The following submenu appears.



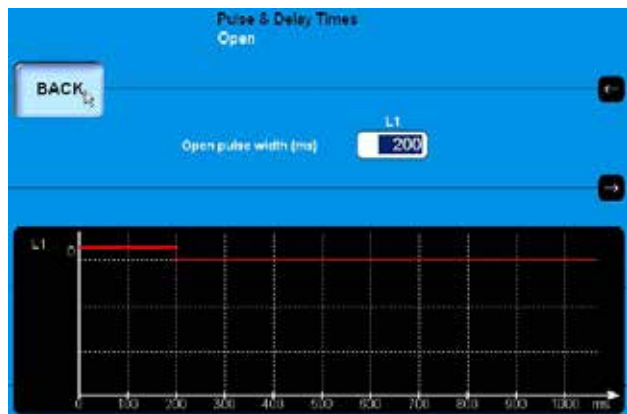
- 2] For each operation sequence the settings are to be done separately. Press the desired sequence button. For each sequence the settings are done as follows.

Close



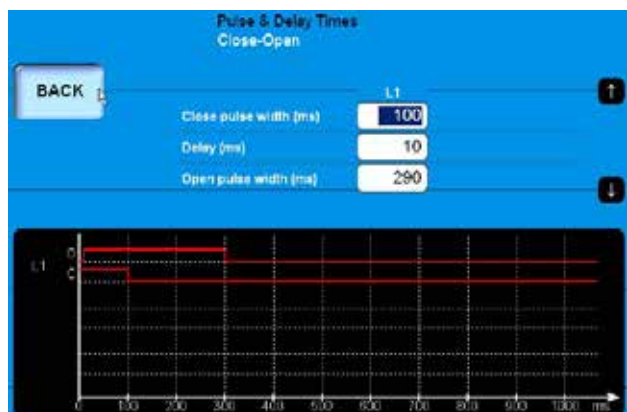
- 1] Use the keyboard to enter the desired value.
- 2] Press the "BACK" button to leave this screen.

Open



- 1] Use the keyboard to enter the desired value.
- 2] Press the "BACK" button to leave this screen.

Close - Open



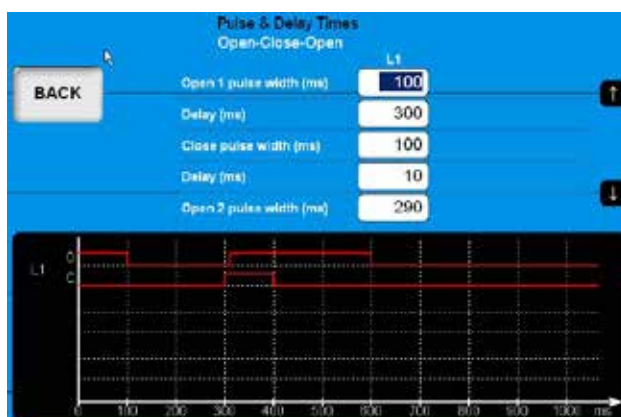
- 1] Use the keyboard to enter the desired value. The arrow-up and arrow-down buttons can be used for quick navigation between the input fields.
- 2] Press the "BACK" button to leave this screen.

Open - Close



- 1] Use the keyboard to enter the desired value. The arrow-up and arrow-down button can be used for quick navigation between the input fields.
- 2] Press the "BACK" button to leave this screen.

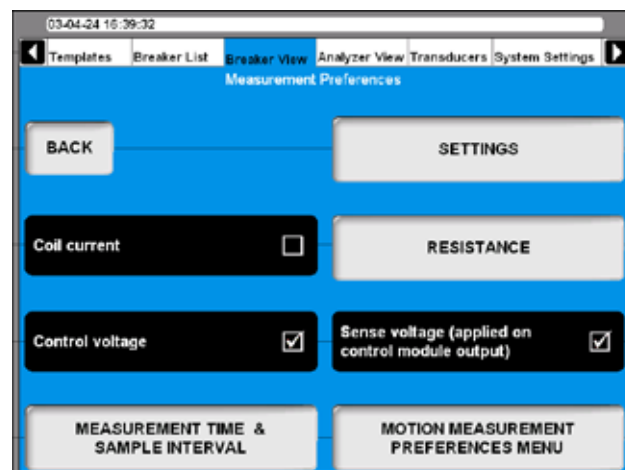
Open - Close - Open



- 1] Use the keyboard to enter the desired value. The arrow-up and arrow-down buttons can be used for quick navigation between the input fields.
- 2] Press the "BACK" button to leave this screen.

Setting the measurement preferences

- 1] In "Breaker View" menu press the "MEASUREMENT PREFERENCES" button to make trigger settings. The following screen appears:



Coil current

Pressing the button enables/disables coil current recording.

Control voltage

Pressing the button enables/disables control voltage recording.

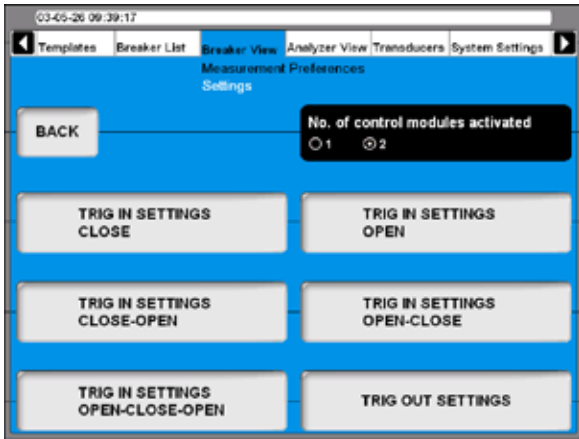
Sense voltage

Pressing the button enables/disables the sensing voltage source in the control modules. If checkbox is marked, the TM1800 will generate a sensing voltage on the output of the control module. The sense voltage is for calculation of coil resistance and auxiliary contacts in the control circuit. The output power is very low, no load voltage is about 30 V DC and short circuit current less than 30 mA, so it can under normal circumstances not operate a circuit breaker. For sensitive circuits this voltage can be turned off, by unmarking this box.

Note *With "Sense voltage" turned off the resistance of coil and auxiliary contacts can't be measured and calculated automatically by the control module.*

Settings

- 1] In Breaker View/Measurement Preferences press the "SETTINGS" button to make the settings. The following screen appears.



No. of control modules activated

By pressing the button you select if 1 or 2 control modules shall be used to control the circuit breaker during the test.

Note *This function does only have an effect when 2 control modules are installed and the option separate operating mechanism is selected.*

If you have two control modules but activate one you can measure three times motion but with common breaker control.

DCM

1] By pressing the button you select if DCM shall be used for timing measurement.

Setting the trig in settings

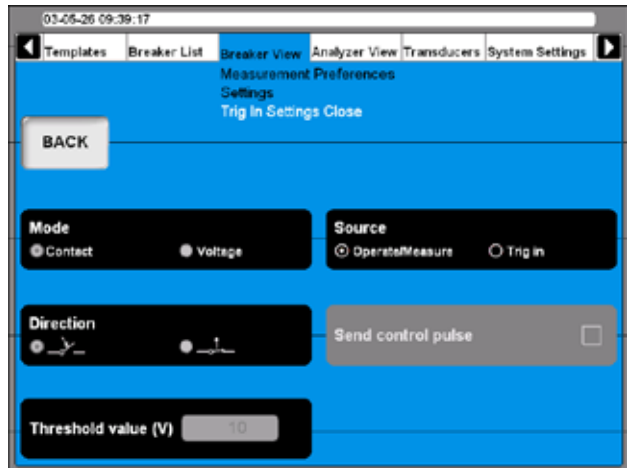
1] In "Settings" menu press the "TRIG IN SETTINGS" button to make trigger settings. The following screen appears:



The trigger settings can be individually adjusted for each breaker sequence.

2] Press the "TRIG IN SETTINGS" button for the desired sequence to make the settings. The following picture shows the settings for

"CLOSE". The settings for the other sequences are the very same.



Source

Use the button to select if the measurement shall start upon turning the Operate/Measure knob on the panel or upon fulfillment of trigger condition on the Trig in terminal. To be able to do settings here Trig in must be selected of course.

Mode

With the button you toggle between "Contact" (dry) or "Voltage" (wet) sense on the trig in terminal.

Direction

With the button you select if the trigger signal shall be a closing or opening contact in contact mode or a positive or negative flank in voltage mode.

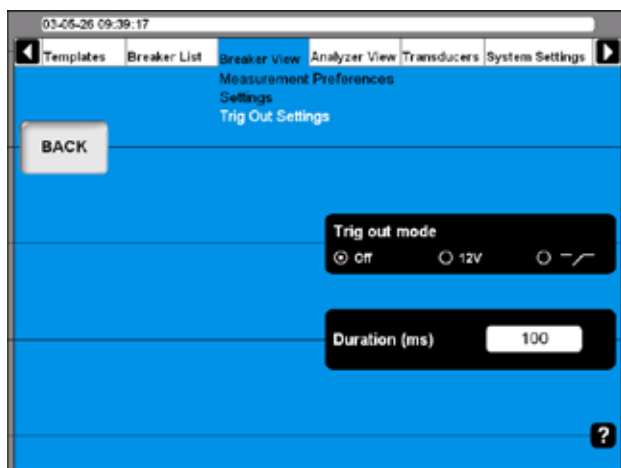
Send control pulse

If the button is marked the TM1800 will generate breaker control commands on the control modules. If not only the measurement will take place.

Threshold value (V)

Enter the appropriate value in the field if voltage mode is selected.

Synchronous to the measurement start, TM1800 can generate an output signal. In the "Settings" menu press the "TRIG OUT SETTINGS" to do the settings.



Trig out mode

By pressing the button repeatedly you toggle between:

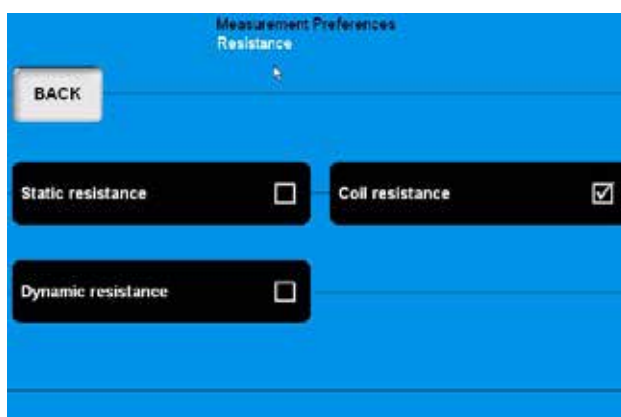
- Trig out = Off
- Trig out = a 12V signal
- Trig out = closing contact

Duration (ms)

In the field you enter the desired duration of the trig out signal.

Setting the resistance measurement preferences

- 1] In Breaker View/Measurement Preferences press the "RESISTANCE" button to make the settings. The following screen appears.



Static resistance

Pressing the button enables/disables static resistance measurements.

Coil resistance

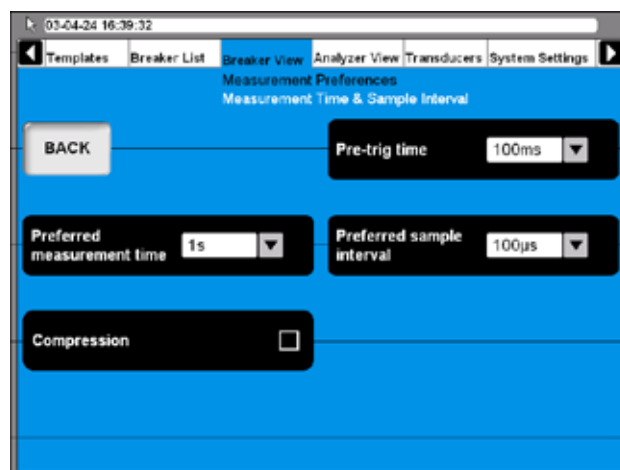
Pressing the button enables/disables coil resistance measurements.

Dynamic resistance

Pressing the button enables/disables dynamic resistance measurements.

Setting the measurement time & sample interval

- 1] In Breaker View, Measurement Preferences press the "MEASUREMENT TIME & SAMPLE INTERVAL" button to make the settings. The following screen appears.



- 2] Settings can either be done by pressing the respective buttons repeatedly or by selecting the desired value from the drop down lists using the mouse/trackball

Pre-trig time

This is the time duration the recording starts before the sequence is initialized.

Preferred measurement time

This is the total recording time including pre-trig time.

Preferred sample interval

Depending on the measuring method the value might be automatically set (e.g. DRM).

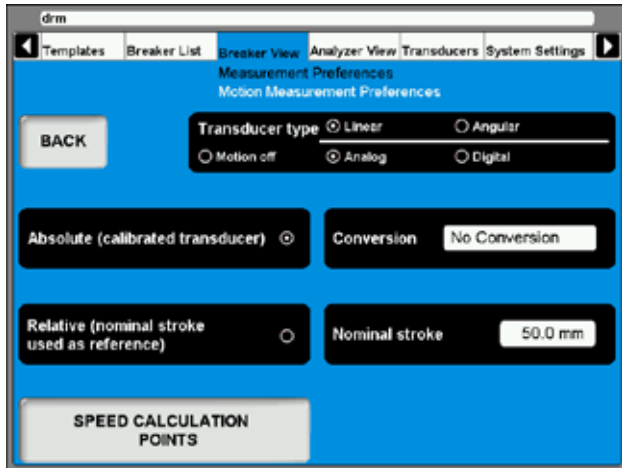
Compression

When you check this box the TM1800 will use data compression. This will affect the measuring time and resolution.

When you set the "Preferred measurement time" and "Preferred sample interval" the TM1800 calculates if compression is necessary. If it is necessary you will get a message where you are asked if you want to use compression. If you answers "NO" the test will run although and data will be recorded until the recording memory is full.

Motion measurement preferences menu

1] In Breaker View/Motion Measurement Preferences press the “MOTION MEASUREMENT PREFERENCES MENU” button to make the settings. The following menu appears.



Transducer type

By Pressing the button you select the transducer type to be used for testing this breaker.

“Absolute” and “Relative”

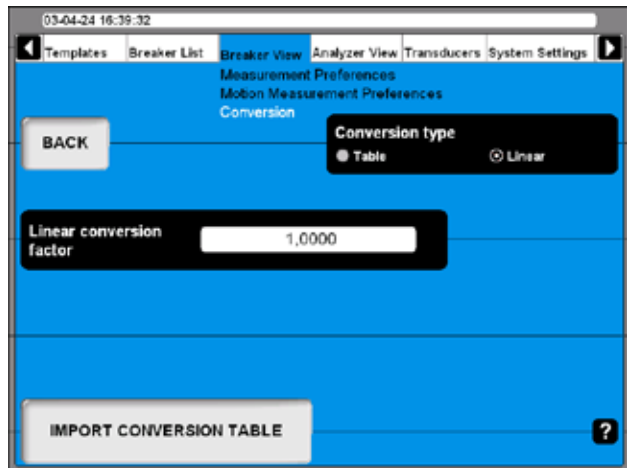
The buttons are used to toggle between the transducer modes.

- If Relative is selected you must enter a value for the "Nominal stroke".
- If "Absolute" is selected you can optionally specify a "Conversion" of transducer values into main contact values.

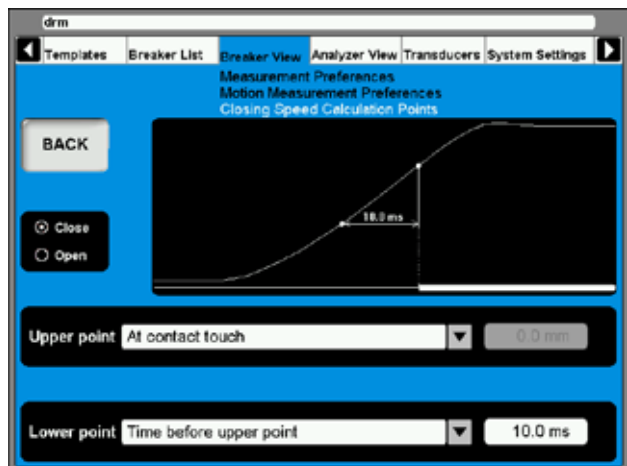
Note *If you use an angular transducer and want to use “Relative (nominal stroke used as reference)” select “Linear” as “Transducer type”.*

Conversion

1] Press the button whereupon the following screen appears.



- 2] Press button to select Conversion type, “Table” or “Linear”.
 - If the option "Table" is selected a conversion table file must be loaded by pressing the "IMPORT CONVERSION TABLE" button
 - If "Linear" is selected enter the "Linear conversion factor".
- 3] Press “BACK” to leave the Conversion screen.
- 4] Press the button “SPEED CALCULATION POINTS” whereupon the following screen appears.

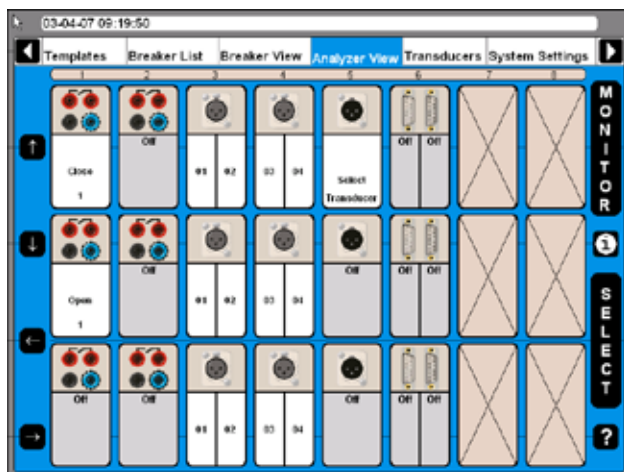


- 5] Do the appropriate settings for “Close” and/or “Open”. Whenever possible refer to the breaker manufacturers definition.
- 6] Press “BACK” to leave this screen.

6.12 Analyzer view menu

The Analyzer View visualizes the link between TM1800 and the test object. In Analyzer View you obtain information about your system configuration, channel occupancy, hook-up instructions and so on.

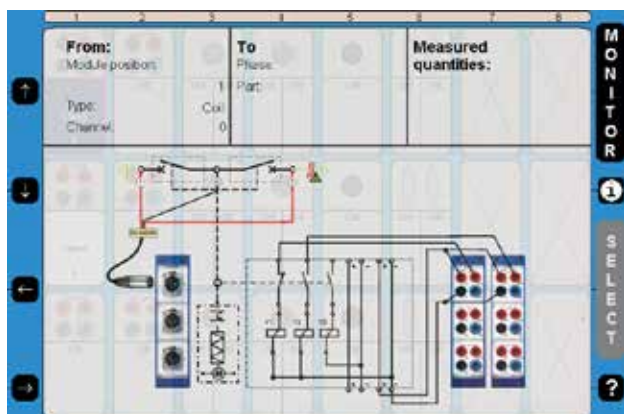
When entering the Analyzer View the hook-up screen is shown.



- The screen shows all modules that are installed and where they are located in the system
- Channels that are, due to the definitions made in breaker view, not used are marked Off.
- The usage for all active channels are stated e.g. Close for the upper channel of the first Control Module.
- Each active channel can be marked with the cursor with the help of the arrow buttons on the left hand side of the screen or by using the mouse/trackball.

Hook-up instructions

- 1] Mark any channel and press the "i" button in the middle of the right hand side of the screen upon which the system provides you with the information on how to connect. Below is an example.

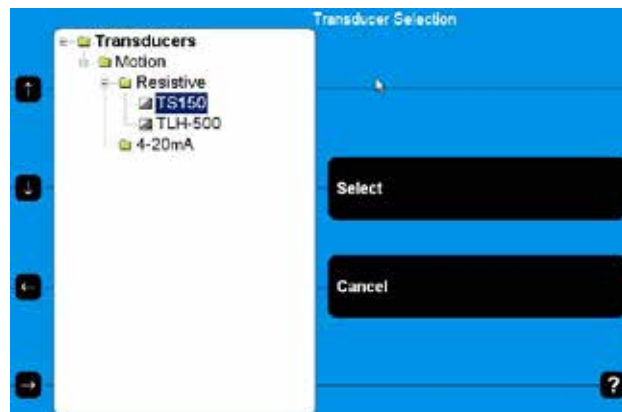


- 2] Press the "i" button a second time to go back to monitor view.

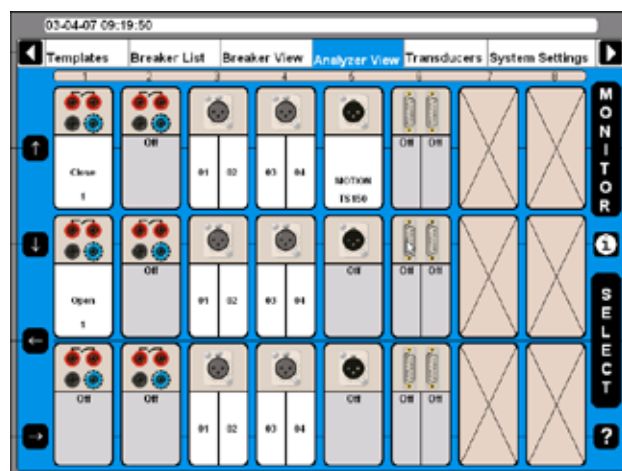
Select transducer

If you in Breaker View, Motion measurement preferences have selected Absolute (see section 6.12) "Select Transducer" is blinking on the active channel.

- 1] For selecting a transducer press the "SELECT" button whereupon the transducer list appears.



- 2] Select the appropriate transducer and press the "Select" button.



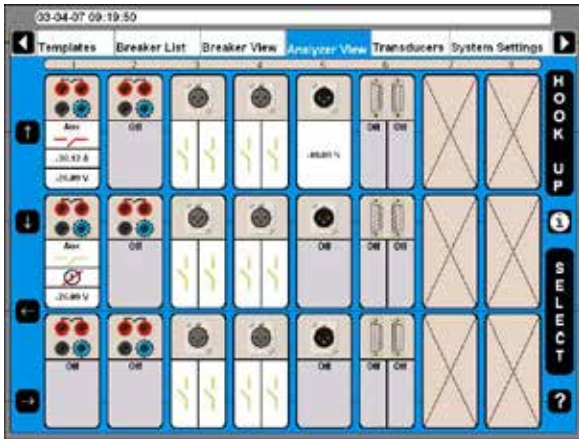
Now the transducer is selected which then is indicated by displaying the transducer name at that specific channel.

Monitor

- 1] By pressing the "MONITOR" button you will see information about the actual breaker measurement and status.

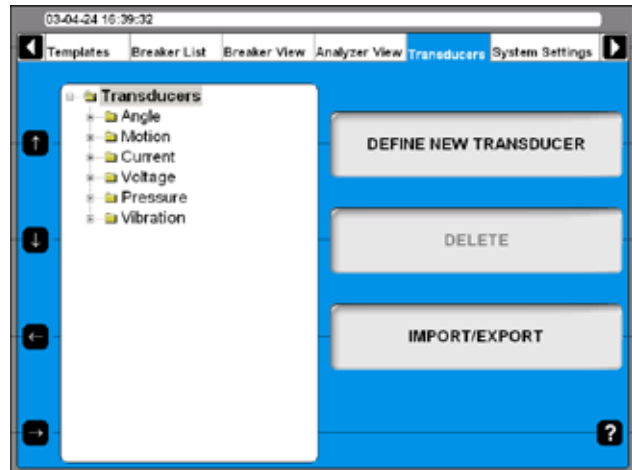
Note To get information from control modules connect blue cable to NC and red cable to OUT.

6.13 Transducers menu



The actual situation is displayed for each channel which is either a measurement value or a graphical contact open/close information.

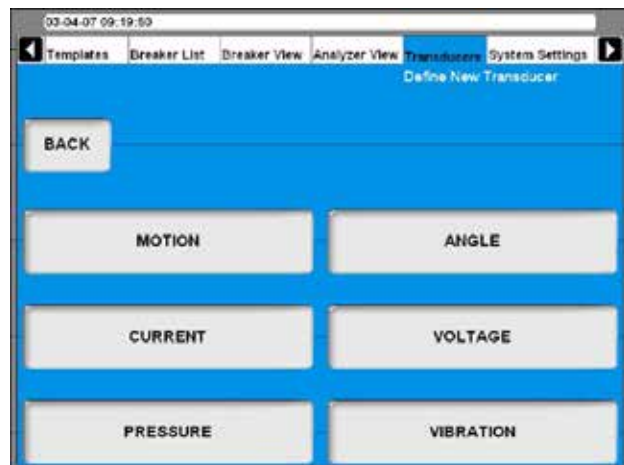
- 2] Press the "HOOK UP" button to go back to the hook-up presentation.



All transducers that you use for circuit breaker testing are administrated and calibrated via this menu. Once the transducers are defined it is just to pick them from the list when testing.

Define new transducer

- 1] Press the "DEFINE NEW TRANSDUCER" button and the following screen appears.

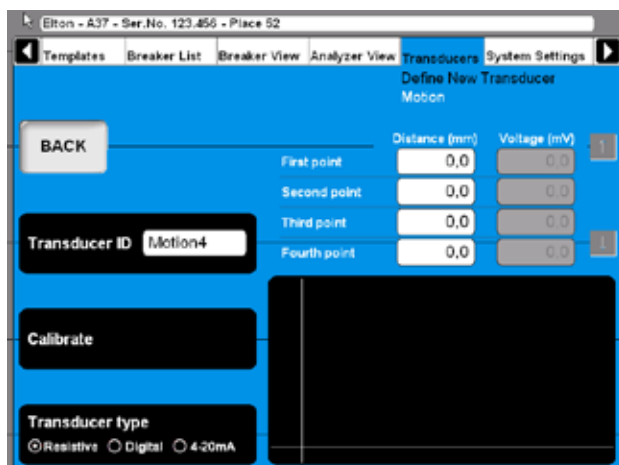


In CABA Local transducers are sorted in groups depending on the transducer input type.

- 2] Select the desired transducer type.

Defining motion transducer

- 1] Press the "MOTION" button.



- 2] Select the appropriate transducer output type by pressing the "Transducer type" button repeatedly. There are three different transducer output types available:

- "Resistive" transducer output is a voltage that is depending on the position of the transducer.
- "Digital" transducer outputs are pulses depending on the position of the transducer.
- "4 – 20 mA" transducer output is a current depending on the position of the transducer.

Calibrating resistive transducers

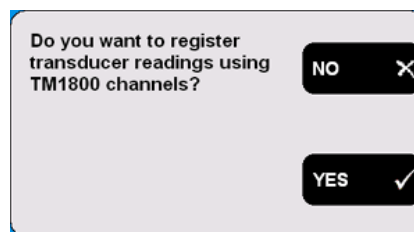
The calibration can be done in three different ways:

- A]** Manual. Enter all values (pairs of position & voltage reading) manually.
- B]** Using TM1800 readings as reference. Enter position value manually while using automatic TM1800 voltage reading.
- C]** Using digital transducer as reference. Using automatic position reading from a digital transducer and automatic voltage reading from TM1800.

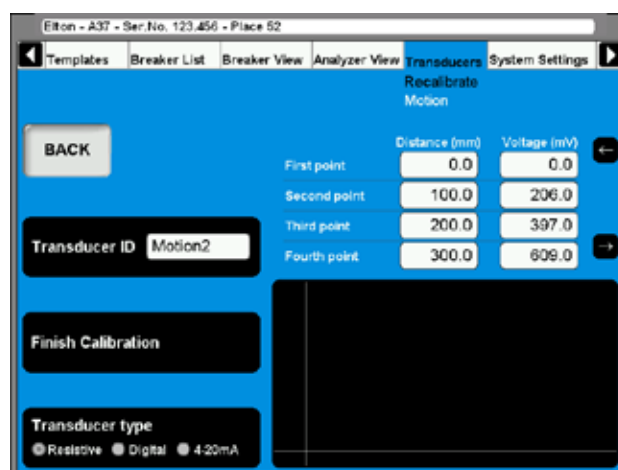
Note *The system assumes that you use a voltage reference of 4095 mV applied across the transducer to be calibrated. If you connect any other reference you have to multiply each voltage reading with 4095 / (applied ref. volt (mV)).*

A. Manually calibrating a resistive transducer

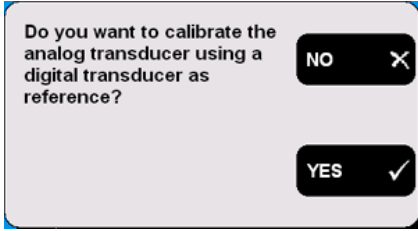
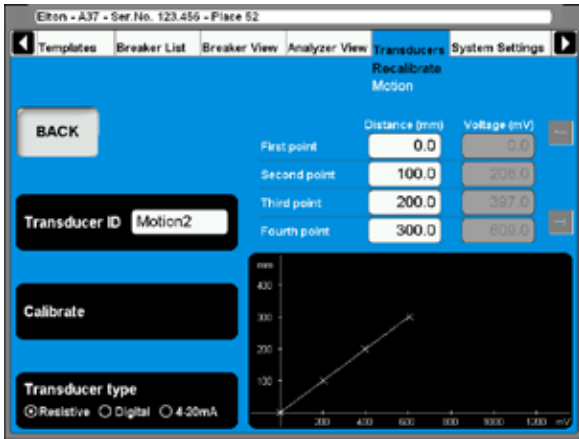
- 1] Press the "Calibrate" button. The following question appears.



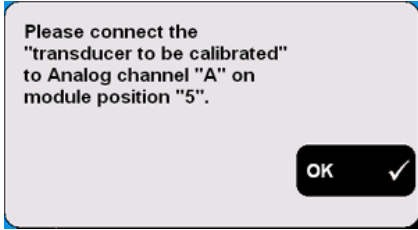
- 2] Press the "NO" button. The following screen appears.



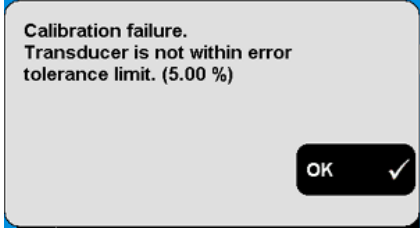
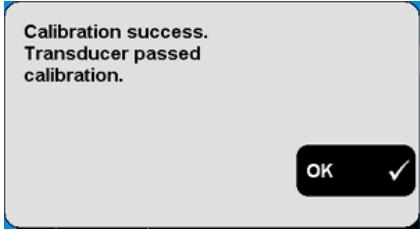
- 3] Enter the calibration values in the fields shown above the graphic. For quick navigation between the fields use the arrow buttons next to it.
- 4] Type in a significant name for the transducer into the "Transducer ID" field.
- 5] Press the "Finish Calibration" button. The evaluation starts and you will see the result. If you get the "Calibration failure" message you must recalibrate.



3] Press the "NO" button. The following message appears.



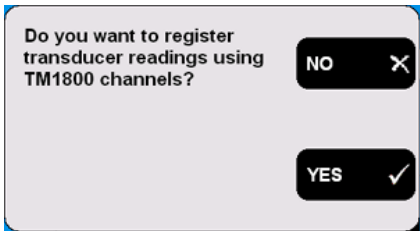
4] Connect the transducer to the specified channel. Confirm by pressing "OK". The following screen appears.



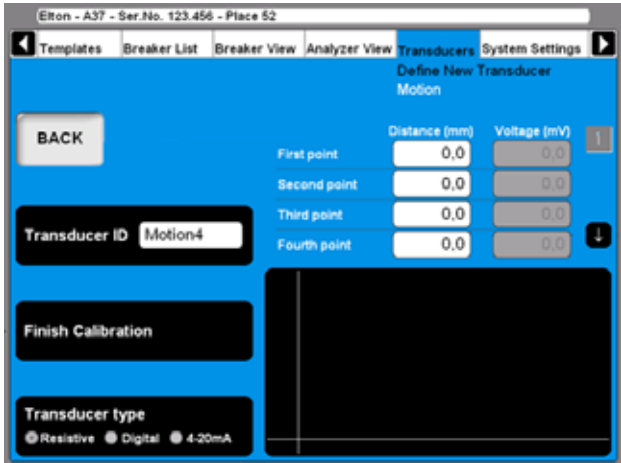
6] Press the "BACK" button to leave the screen.

B. TM1800 as reference for calibrating a resistive transducer

1] Press the "Calibrate" button. The following question appears.



2] Press the "YES" button. The following question appears.



5] Move the transducer sliding contact to the desired position and keep it there. Enter the "Distance (mm)" value in the field "First point", see screen above. The value in the corresponding "Voltage (mV)" field will follow automatically.

6] Move the cursor to the entry field for the second point. For quick navigation between the fields use the arrow buttons next to it. Proceed in the same way to calibrate the remaining positions. The calibration data of each position is stored automatically when moving the cursor to the next field.

7] Type in a significant name for the transducer into the "Transducer ID" field.

8] Press the "Finish Calibration" button.

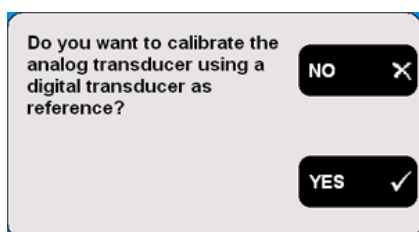
9] Press the "BACK" button to leave this screen.

C. Digital transducer as reference for calibrating a resistive transducer

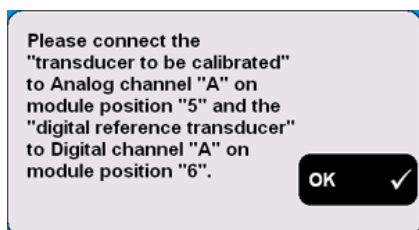
- 1] Press the "Calibrate" button. The following question appears.



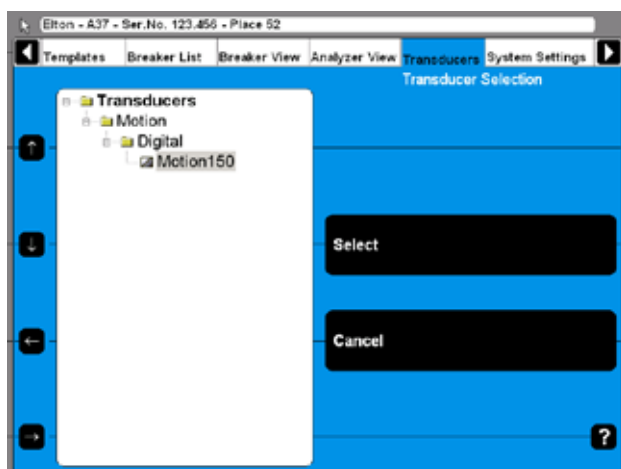
- 2] Press the "YES" button. The following question appears.



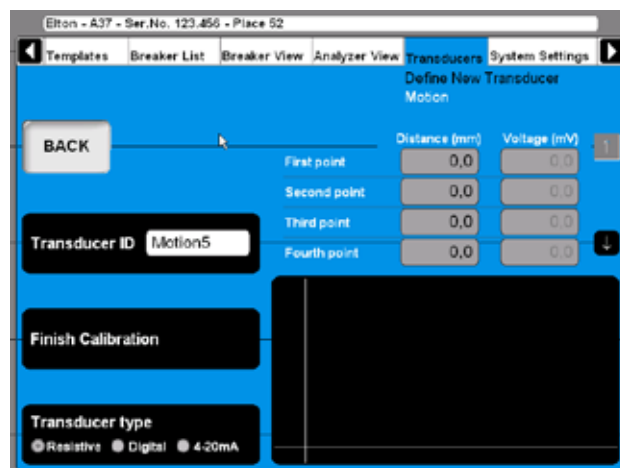
- 3] Press the "YES" button. The following message appears.



- 4] Connect the transducers to the specified channels. Confirm by pressing "OK". The following screen appears.



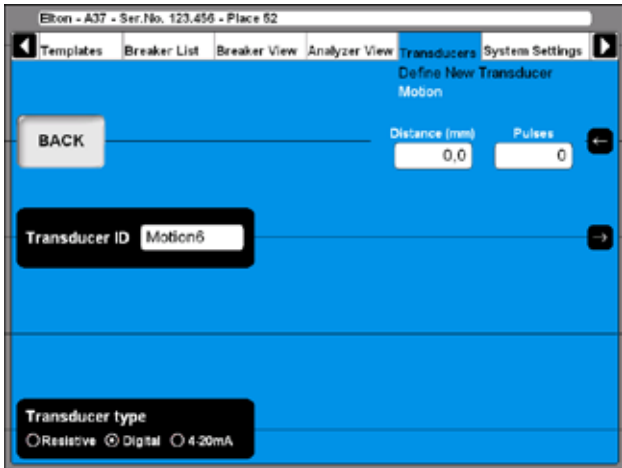
- 5] Select the digital reference transducer from the list. Press the "Select" button to continue. The following screen appears.



- 6] Now the transducers (digital reference & resistive) should be mechanically connected in a way that the slider of the resistive one is following exactly the reference. Move the transducer sliding contact to the desired position and keep it there. The distance/position value in the fields shown above the graphic is displayed automatically using the data from the digital transducer. The value in the corresponding voltage field will follow automatically.
- 7] Move the cursor to the entry field for the next position. For quick navigation between the fields use the arrow buttons next to it. The calibration data of each position is stored automatically when moving the cursor to the next field.
- 8] Proceed in the same way to calibrate the remaining positions.
- 9] Type in a significant name for the transducer into the "Transducer ID" field.
- 10] Press the "Finish Calibration" button.
- 11] Press the "BACK" button to leave this screen.

Calibrating digital motion transducers

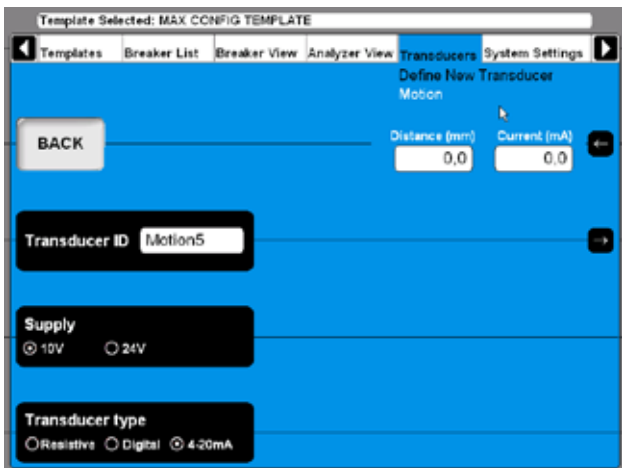
- 1] Press the "Transducer type" button repeatedly to select the option "Digital". The following screen appears.



- 2] Enter the calibration values in the fields shown in the upper right corner. For quick navigation between the fields use the arrow buttons next to it.
- 3] Type in a significant name for the transducer into the "Transducer ID" field.
- 4] Press the "BACK" button to leave this screen.

Calibrating 4 - 20 mA motion transducers

- 1] Press the "Transducer type" button repeatedly to select the option "4 - 20mA". The following screen appears.



- 2] Enter the calibration values in the fields shown in the upper right corner. For quick navigation between the fields use the arrow buttons next to it.
- 3] Press the "Supply" button to select the power supply for the transducer, "10V" or "24V".
- 4] Type in a significant name for the transducer into the "Transducer ID" field.
- 5] Press the "BACK" button to leave this screen.

Defining pressure transducers

- 1] Press the "Pressure" button on the "DEFINE NEW TRANSDUCER" screen.

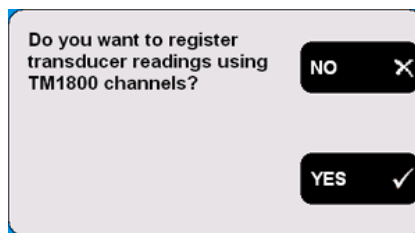


Calibrating pressure transducers can be done in two different ways:

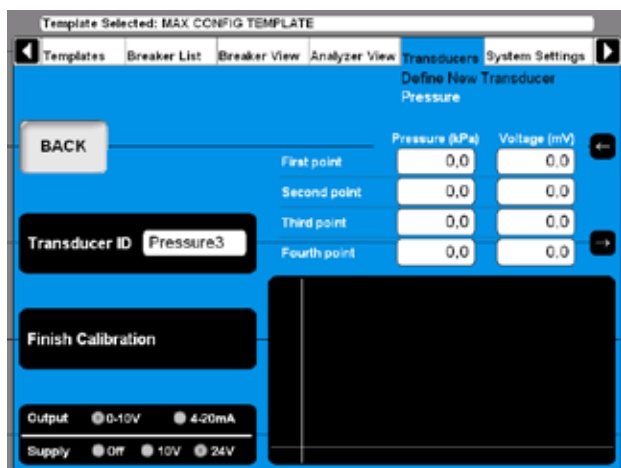
- A] Manual. Enter all values (pairs of pressure & voltage or current value) manually.
- B] Using TM1800 readings as reference. Enter pressure value manually while using automatic TM 1800 voltage or current reading

A. Manually calibrating a pressure transducer

- 1] Select the appropriate transducer output type and if needed the power supply by pressing the "Output/Supply" button repeatedly.
- 2] Press the "Calibrate" button. The following question appears.



- 3] Press the "NO" button. The following screen appears.



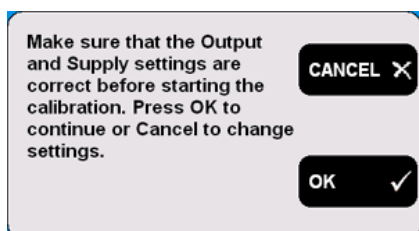
- 4] Enter the calibration values in the fields above the graphic. For quick navigation between the fields use the arrow buttons next to it.
- 5] Type in a significant name for the transducer into the "Transducer ID" field.
- 6] Press the "Finish Calibration" button.
- 7] Press the "BACK" button to leave this screen.

B. TM1800 as reference for calibrating a pressure transducer

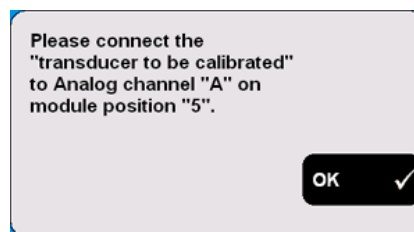
- 1] Press the "Calibrate" button. The following question appears.



- 2] Press the "YES" button. The following screen appears.



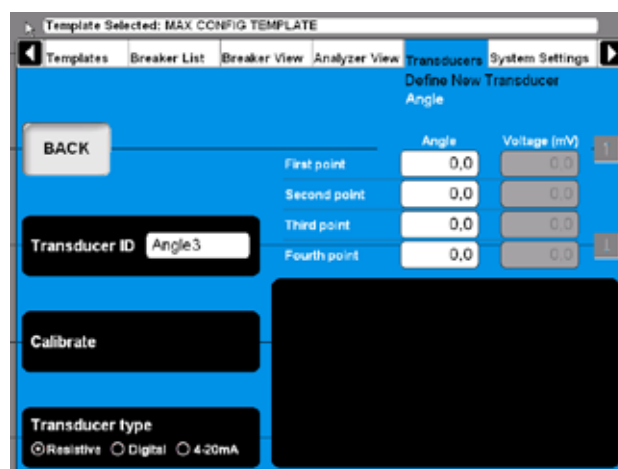
- 3] Press the "CANCEL" button if those settings need to be corrected and start at point 1 again. Press the "OK" button if the settings are correct. The following message appears.



- 4] Connect the transducer to the specified channel. Confirm by pressing "OK".
- 5] Change the pressure to the transducer to the desired pressure value and keep it constant.
- 6] Enter the pressure values in the fields shown above the graphic. The value in the corresponding voltage or current field will follow automatically.
- 7] Move the cursor to the entry field for the next pressure value. For quick navigation between the fields use the arrow buttons next to it. The calibration data of each position is stored automatically when moving the cursor to the next field.
- 8] Proceed in the same way to calibrate the remaining positions.
- 9] Type in a significant name for the transducer into the "Transducer ID" field.
- 10] Press the "Finish Calibration" button.
- 11] Press the "BACK" button to leave this screen.

Defining angle transducers

- 1] Press the "Angle" button on the "DEFINE NEW TRANSDUCER" screen.



- 2] Defining angle transducers is following the very same procedure as defining motion transducers, see section "Defining motion transducer" above. The only difference is

that the quantity motion changes to angle.

Defining current transducers

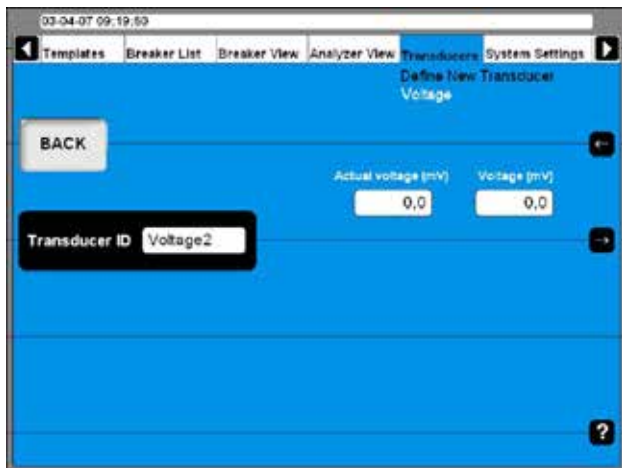
- 1] Press the "Current" button on the "DEFINE NEW TRANSDUCER" screen.



- 2] Press the "Supply" button repeatedly to select the correct power supply for the transducer.
- 3] Enter the transducers ratio (current and voltage) and offset values.
- 4] Type in a significant name for the transducer into the "Transducer ID" field.
- 5] Press the "BACK" button to leave this screen.

Defining voltage transducers

- 1] Press the "Voltage" button on the "DEFINE NEW TRANSDUCER" screen.



- 2] Enter the transducers ratio values (Actual voltage and Voltage).
- 3] Type in a significant name for the transducer into the "Transducer ID" field.
- 4] Press the "BACK" button to leave this screen.

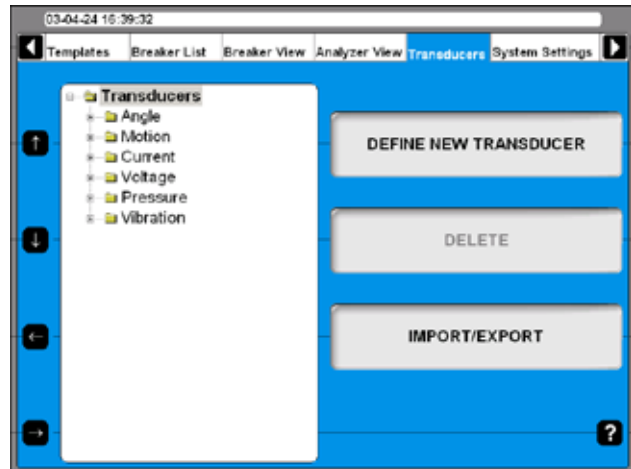
Defining vibration transducers

- 1] Press the "Vibration" button on the "DEFINE NEW TRANSDUCER" screen.

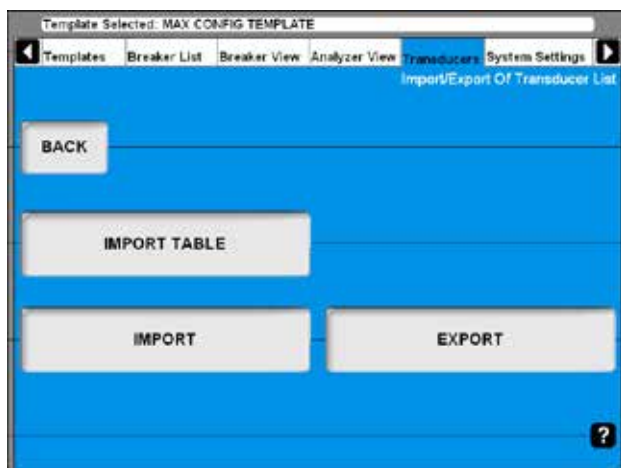


- 2] Enter the transducers ratio values.
- 3] Type in a significant name for the transducer into the "Transducer ID" field.
- 4] Press the "BACK" button to leave this screen.

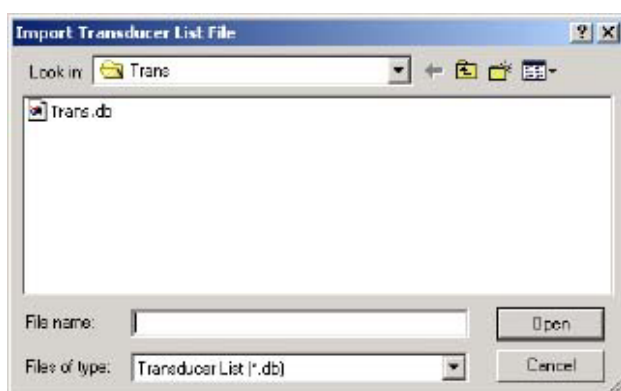
Import/export of transducer list



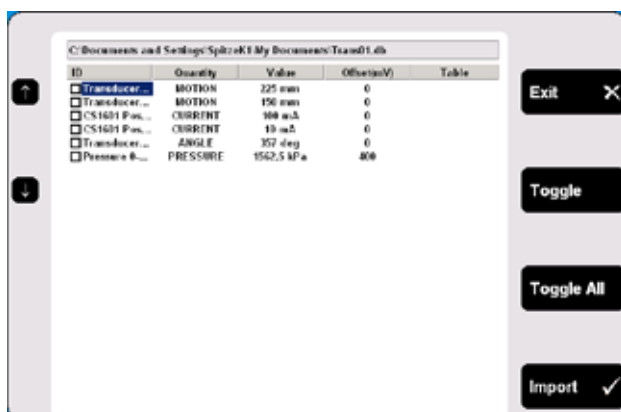
- 1] Press the "IMPORT/EXPORT" button, the following screen appears.



- 2] Upon pressing one of the buttons a Windows® file selection box will appear.



- 3] Select the appropriate file and click on "Open".
Transducers are imported from or exported to a transducer list file that can contain a number of different transducers. To be able to import and export selected transducers from into that list the following screen appears.



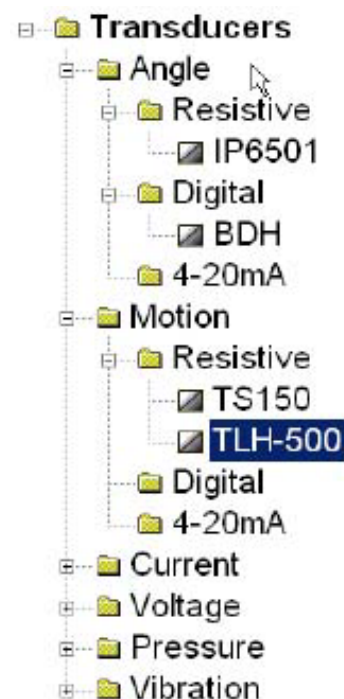
- 4] Navigate to any transducer by using the arrow up/down buttons on the left hand side.
- 5] Select marked transducer for import by pressing the "Toggle" button.
- 6] Select all desired transducers or press the "Toggle All" button to select all transducers

from the list.

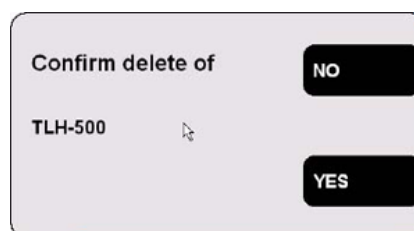
- 7] Press the "Import" button to import selected transducers. To abort, press the "Exit" button.

Delete transducer

- 1] Navigate to the transducer you want to delete.



- 2] Press the "Delete" button.
- 3] Confirm deletion by pressing the "Yes" button.



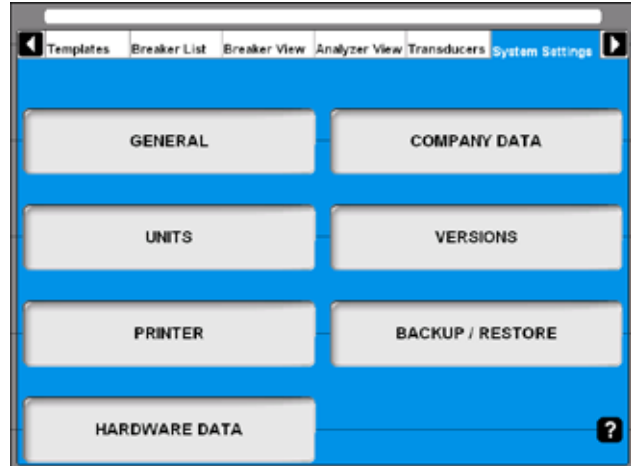
Recalibrate transducer

- 1] Navigate to the transducer you want to recalibrate.
- 2] Press the "RECALIBRATE" button.
- 3] Enter new calibration values (screens are the same as when defining new transducer).
- 4] Press the "Calibrate" button.
- 5] Press the "BACK" button to finish.

- 6] Confirm the “Do you want to save changes?” message by pressing the “Yes” button.

6.14 System Settings menu

In the System Settings you define basic settings that influence test procedures and measurements. Furthermore backup tools and hardware information can be obtained. Each button you press leads to a certain group of settings that are described following.



General



Language

- 1] By pressing the button repeatedly you alter the CABA Local language.

Phase labels

- 1] By pressing the button repeatedly you alter the Phase labels.

Date format

- 1] Press the button repeatedly to alter the Date format.

Time format

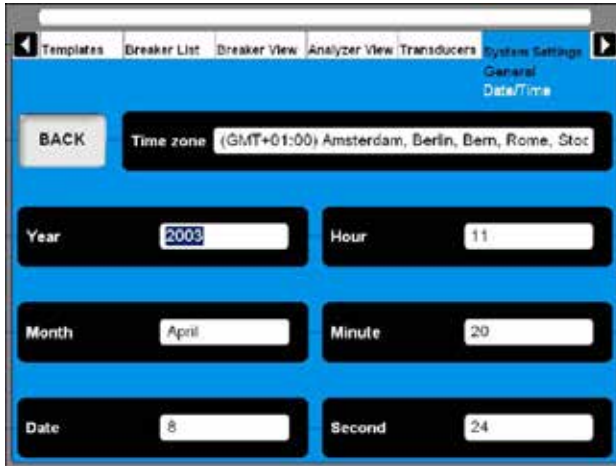
- 1] Press the button repeatedly to alter the Time format.

DATE & TIME

- 1] Press the button to set date and time as described below.

Date & time

- 1] Select "Systems Settings", "GENERAL" and "DATE & TIME".

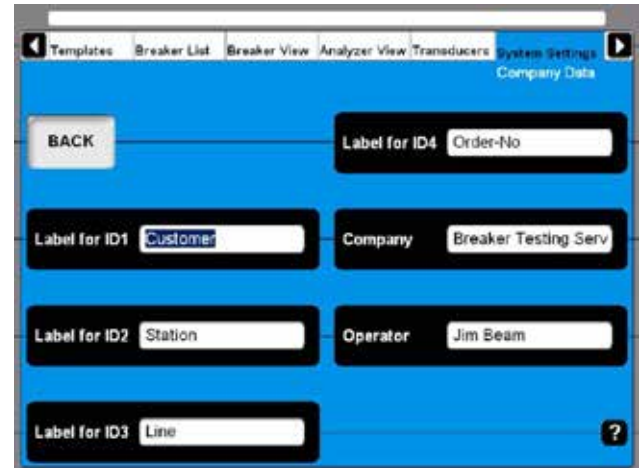


- 2] To set "Time zone", "Month" and "Date": Press the respective button repeatedly to alter the settings or use the keyboard (arrow keys, up and down).
- 3] To set Year, Hour, Minute and Second: Enter the desired value via the keyboard to change the settings.

Note If you are running MS Windows 2000 you must be logged in as administrator to set date and time.

- 1] Press and hold down the "CTRL", "ALT" and "DELETE" keys simultaneously.
- 2] Select "Log Off" and click "Yes".
- 3] Click "OK" to log in again, using ID as "administrator" and use password "energy".

Company data



Label for ID1 – ID4

CABA Local uses 4 different labels to unify a test object (CB). The naming of the labels can be defined here by typing in your own significant terms.

Company

This field can be used to enter your company name.

Operator

This field can be used to enter the examiners name.

Units



Time

This button alters the time unit.

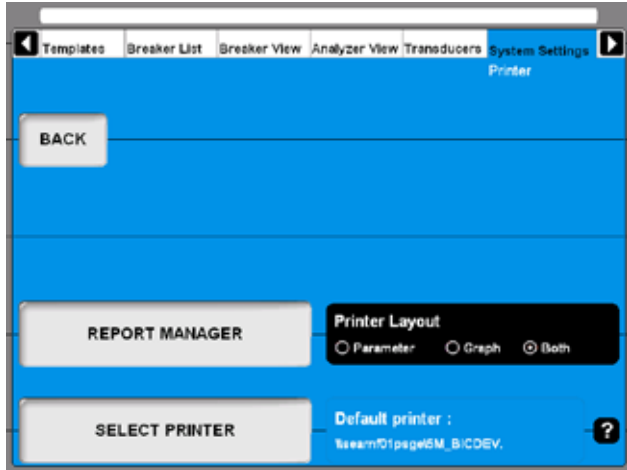
Distance

This button to alters the distance unit.

Pressure

This button to alters the pressure unit.

Printer



REPORT MANAGER

Press this button for going to the Report Manager screen

SELECT PRINTER

Press this button for going to the Select Printer screen

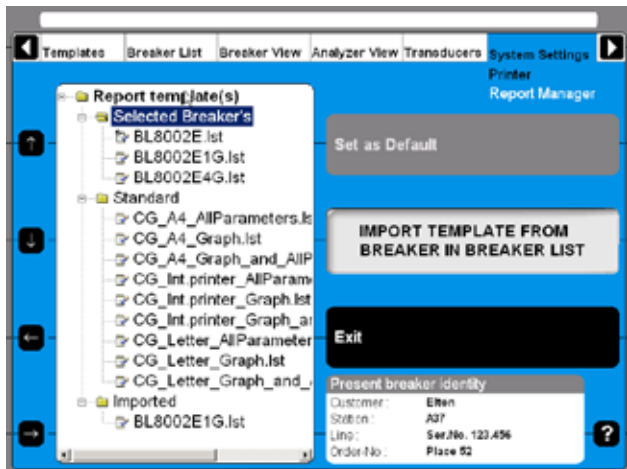
Printer Layout

This button enables to alter the printout style if no report template was dedicated to the breaker in the report manager.

Note To select another printer, see section 7.7 Print preview.

Report manager

Here you can assign a report template to a specific breaker. When it is done the report template will always be used with that breaker.



Report templates are grouped in three subfolders.

Selected Breaker's

Contains all templates that come originally with the breaker e.g. from an imported CABA Win breaker. Templates from this folder are available for the in Breaker List selected breaker only.

Standard

Contains all templates that come with the standard delivery of TM1800 or CABA Local respectively. Templates from this folder are available for all breakers in CABA Local.

Imported

Contains all imported templates e.g. from breakers created in CABA Win. Templates from this folder are available for all breakers in CABA Local. This folder is empty at delivery.

Assign a report template to the selected circuit breaker

Information about the breaker presently selected is shown in the "Present breaker identity" field at bottom right of picture above. Selecting breakers takes place in the Breaker List.

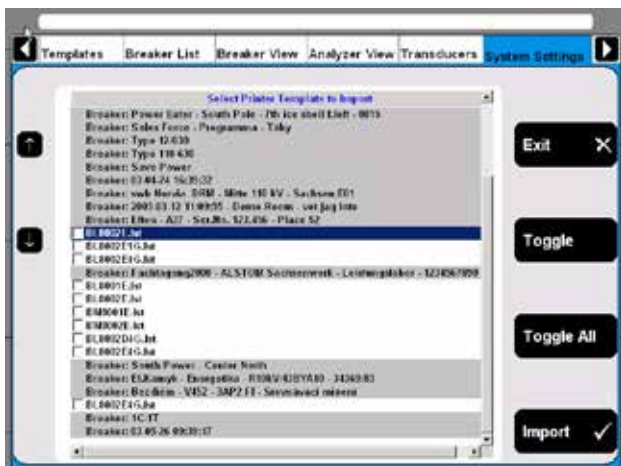
- 1] Navigate to the dedicated template using the arrow keys on the left hand side of this screen or use the mouse/trackball.
- 2] Press the "Set as Default" button to assign the highlighted template to the selected breaker.

Note If done so this template will be used anytime for printouts and print previews. Observe that the Printer Layout setting on the previous screen will not have effect anymore if a template is assigned to the breaker.

- 3] Press the "Exit" button to leave this screen.

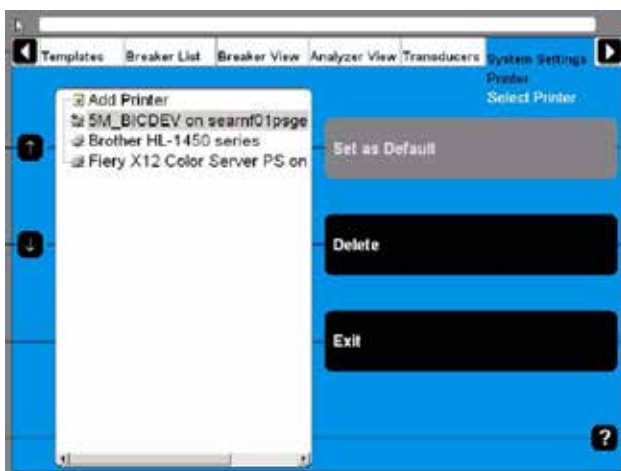
Import a report template

- 1] Press the "IMPORT TEMPLATE FROM BREAKER IN BREAKER LIST" button. The following screen appears showing a list of all available templates.



- 2] Navigate to any template by using the arrow up/down buttons on the left hand side.
- 3] Select the marked template for import by pressing the "Toggle" button.
- 4] Select all desired templates or press the "Toggle All" button to select all templates from the list.
- 5] Press the "Import" button to import selected templates. Press "Exit" button to abort.

Select printer



- Upon navigating to the desired printer it can be either set to be the default printer or it can be deleted by pressing the respective buttons.
- When the Internal Printer is set as default printer the print out will automatically be suited for the paper in the internal printer. If another printer is selected as default printer the layout will be for A4 or Letter format, depending on the printer settings.
- Upon navigating to Add printer an "Add Printer" button will be enabled. Pressing this button starts the Windows® Add Printer Wizard that allows you to install an external printer of your choice.

System Versions

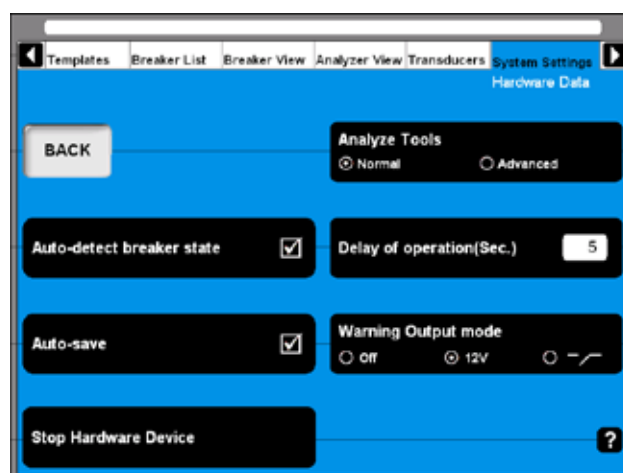


All information about the TM1800 system is stored here, e.g. calibration data and serial number.

- Press the arrow buttons to scroll through the information on screen.
- Press the "PRINT" button to print out the information.
- Press the "SAVE" button to save the information in a text file
- Press "BACK" to leave this screen.

Note *In case of service and support question you might be asked for the above-mentioned information. In that case you can provide this via Fax (printout) or via Email (text file) at your choice.*

Hardware Data



Analyze Tools

- 1] Press this button to toggle between Normal and Advanced mode

Note *In Advanced mode the very same analyze tool as in the optional CABA Win software is used when clicking on View a recording in the breaker list. Please refer to the appendix for detailed information.*

Auto-detect breaker state

- 1] Press the button to enable/disable automatic breaker state detection. Default setting is enable.

Auto-save

- 1] Press this button to enable/disable automatic saving. Default setting is enable.

Delay of operation(Sec.)

- 1] Enter the time duration from turning the Measure/Operate knob on the TM1800 breaker control panel until the breaker operation takes place.

Warning Output mode

- 1] Press the button repeatedly to alter the mode.

Note *The warning output is active from turning the Measure/Operate knob until the operation is executed. In other words, the duration of the warning signal depends on the value set in the Delay of operation (Sec.) field.*

Stop Hardware Device

- 1] Press the button prior removing plug & play devices such as USB memory stick.

Backup/Restore

Backup

You should choose an external storage for your backup. We advise you to use the USB memory stick to transport the backup of data from the TM1800 to an external computer.

It is also possible to connect an external computer directly to the TM1800 but we only recommend it if you are familiar with how do it.

Note *Do not place your backup in the TM1800 to avoid loss of data if the TM1800 fails.*



IMPORTANT

Do not remove the USB stick until you have "stopped hardware device", see below

- 1] Insert the USB memory stick into the USB port on the top panel.
- 2] Select System Settings and press "Backup/Restore".
- 3] Press the "BACKUP" button.



- 4] Select the target destination.
- 5] Click on "OK" to confirm.
- 6] Press the button "HARDWARE DATA".
- 7] Press "Stop Hardware Device".
- 8] Follow the instructions on the screen.
- 9] When the USB stick is removed you can insert it to an external computer and store the backup data on a network or other safe media.

Restore

- 1] Press the button "RESTORE".
- 2] Follow the instructions on the screen.

7 Perform testing

7.1 TM1800 Start-up

See section 6.1 Start/Shut down CABA Local for how to start TM1800.

7.2 Check list - before testing



IMPORTANT

Always follow the safety regulations in chapter 1 of this manual.
Always comply with local safety regulations.

Prior testing a breaker check what of the following is needed and available:

- TM1800 circuit breaker analyzer with a sufficient number of measurement channels
- Transducers — if e.g. contact travel shall be measured
- Timing and transducer cables
- Mounting accessories for transducers
- Accessories for advanced testing applications such as DRM or vibration
- Cables for breaker control and information about how to connect them to the operating mechanism

The breaker definition must be available in the breaker list in CABA Local before testing starts or you run a quick test with definitions from the selected template.

You must either:

- A]** select a breaker in the list
- B]** define a new breaker
- C]** import an existing circuit breaker from CABA Win.
- D]** run a quick test

Also make sure that all necessary transducers are predefined and by that available in the transducer list of CABA Local.

7.3 Basic test



IMPORTANT

Follow the Safety regulations in chapter 1.

Make use of the blind terminals (blue color, marked NC) to avoid unintended breaker operation while still doing connections to the breaker.

- 1] Make the correct protective earthing of the test object and TM1800, see section 1.3
- 2] Power-up TM1800.
- 3] Select the breaker in the "Breaker List" or define a new breaker.
- 4] Select an existing test or create a new test.
- 5] Go to Analyzer View / Hook-Up screen.
- 6] Follow connection instructions.
- 7] Connect the main contact cable set.
- 8] Connect the close and trip coils.
- 9] Connect any transducers.
- 10] Remove the ground connection on one side of the circuit breaker.

Note *Keep both sides grounded if you use the DCM module with DualGround technology.*

- 11] Select operation on the control panel.

Note *First operation must be a single close or open operation!*

- 12] Turn the operating/measure knob on the control panel.
- 13] Wait while TM1800 execute the operation and measurements.
- 14] When it is ready you will see the graph presentation on the screen. See section 6.10 View a recording.

7.4 Quick test

TM1800 can make a test without a circuit breaker definition selected or created. TM1800 will choose open or close operation depending on the status of the circuit breaker. The measurement will be performed according to system settings and maximum possibilities of timing according to the modules of TM1800 (MAX CONFIG TEMPLATE). No motion will be recorded.



IMPORTANT

Follow the Safety regulations in chapter 1.

Make use of the blind terminals (blue color, marked NC) to avoid unintended breaker operation while still doing connections to the breaker.

- 1] Make the correct protective earthing of the test object and TM1800, see section 1.3.
- 2] Power-up TM1800.
- 3] Connect your timing and control cables according to the Hook-up screen in the Analyzer View of TM1800 CABA Local.
- 4] Remove the ground connection on one side of the circuit breaker.

Note *Keep both sides grounded if you use the DCM module with DualGround technology.*

- 5] Turn the OPERATE / MEASURE knob on the control panel.
If you are in the "Analyzer view" a measurement will be initiated if not you will be directed automatically to "Analyzer View" and from there turn the OPERATE / MEASURE knob ones more to confirm the measurement start.
- 6] Wait while TM1800 execute the operation and measurements.
- 7] When it is ready you will see the graph presentation on the screen. See section 6.10 View a recording.

Note *If you have a template highlighted and do a quick test you will get the setting of this template.*

7.5 Define a new circuit breaker

- 1] In Breaker list press the button "DEFINE NEW BREAKER FROM TEMPLATE". You have to be at the top position, Circuit Breaker(s), on the breaker list to see the button for defining a new breaker.
- 2] Select the MAX CONFIG TEMPLATE.
- 3] Press the "EDIT BREAKER ID" button and name the breaker.
- 4] Press "BACK"
- 5] Press "OK"
- 6] Go to Breaker View.
- 7] Set up your breaker settings. Refer to chapter 6.5 for details.

Note *When you change settings in Breaker View the breaker you have marked in Breaker List will be changed.*

- 8] Go back to Breaker List.
- 9] Press "Begin New Test" button.
- 10] Give the test a identification (Test ID). Choose type of test.
- 11] Choose the operation sequence on the control panel.
- 12] Turn Operating/Measure knob on the control panel.
- 13] Now the system asks you to check the connections and will automatically change to Analyzer View.
- 14] Follow the connection instructions.
- 15] When done, turn the Operating/Measure knob once again and the sequence will be performed.
- 16] Results can be checked on screen. Continue with the remaining sequences.

7.6 Using circuit breaker created in CABA Win

Breakers created in CABA contain less information than breakers created in TM1800. Therefore, the missing information has to be added when importing a CABA breaker to the TM1800 unit. This addition of information is done only when it is required, i.e. the first time a breaker is imported to TM1800.

The added parameters will initially get default values according to below. After completed import the user has to go through the values under the Breaker View tab. The user can change some of the values, see table next page.

Note *If a breaker that has been located in TM1800 is exported to an old version of CABA there is a risk that some information get lost. In this case the user will be notified that default values are added and that he has to check all the settings again*

When a CABA breaker is imported to TM1800 the attached test plan is changed to a non-edible type, which means that it can neither be altered in CABA nor in TM1800 regarding number of contacts etc. The reason behind this is that changes might destroy the possibility to compare old test results with new. However, still speed calculation points can be edited in CABA.

Parameter	Default value	Editable in TM1800
Number of phases	Same as original breaker	No
Number of interrupters per phase	Same as original breaker	No
Resistor contact	Same as original breaker	No
Operating mechanism	Same as original breaker	No
Number of a-contacts per operating mech.	Same as original breaker	No
Number of b-contacts per operating mech.	Same as original breaker	No
Pulse and delay times: C, O, CO, OC & OCO	User defined in System settings	Yes
Coil current	Same as original breaker	Yes
Control voltage	Off	Yes
Sense voltage	On	Yes
Measurement time	Same as original breaker	Yes
Pre-trig time	0	Yes
Preferred sample interval	100µs	Yes
Compression	Off	Yes
No. of Control modules activated	1	Yes (If applicable)
Trig out mode	Off	Yes
Duration	100ms	Yes
Trig in Source C, O, CO, OC, OCO	Operate / Measure	Yes
Static resistance	Off	Yes
Dynamic resistance	Off	Yes
Coil resistance	Off	Yes
Transducer type Analog/Digital	Analog	Yes
Transducer type Linear/Angular	Same as original breaker	No
Absolute / Relative	Absolute	Yes
Nominal stroke	Same as original breaker	Yes (Per Motion channel. Before only one entry per breaker)
Conversion - Conversion table	No conversion	Yes (If applicable, i.e. if there is a calculated MOTION graph defined in the test plan for the corresponding Objectid)
Conversion Linear - Conversion factor	1	Yes (If applicable, i.e. if there is no calculated MOTION graph defined in the test plan for the corresponding Objectid)
Speed calculation points	Same as original breaker	Yes

Import circuit breaker set-ups from CABA Win

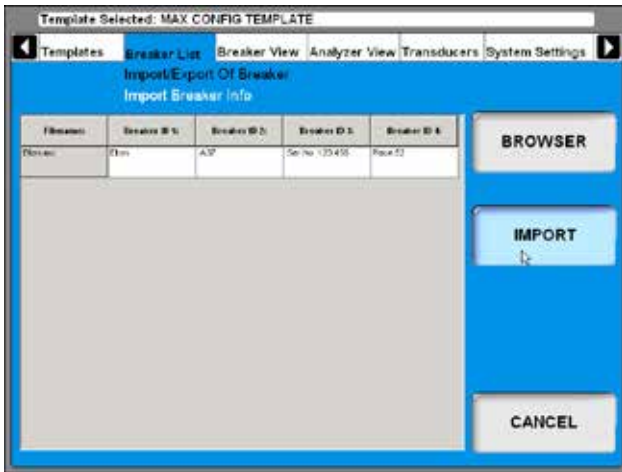
You can import pre-defined breakers from CABA Win into CABA Local in the TM1800.



IMPORTANT

The import function only supports circuit breaker set-up/test plans created or approved by Megger Sweden AB. Megger Sweden AB takes no responsibility for circuit breaker set-up/test plans manually edited or created by users.

- 1] Select "Import Breaker" from the Breaker List.



- 2] Browse for the breaker you wish to import and click the "IMPORT" button.

7.7 Reporting

The TM1800 has an integrated Report Manager that can view and print user defined or default reports. See section "6.14 System Settings menu", "Printer", "Report Manager".

Print preview

Here is an example of a print out, this is the parameter list. If you also want to have the graph printed or select printer see Section "6.14 System Settings menu", "Printer".

Preview - page 1 of [1..1]

Date 19/09/2003		
Location	Tested by	
Signature	Approved by	
Breaker ID1:	17/09/2003 10:08:41	
Breaker ID2:		
Breaker ID3:		
Breaker ID4:		
Test ID :		
Type of test:		
Date/Time :	17/09/2003 10:08:41	
Operator :	TM1800	
Parameters	Value	Unit
Close time A01M	...	ms
Bounce t A01M	...	ms
Close time A01R	...	ms
DiffM-R A01R	...	ms
PIR Res. A01R	...	ohm
Close time A02M	...	ms
Bounce t A02M	...	ms
Close time A02R	...	ms
DiffM-R A02R	...	ms
PIR Res. A02R	...	ohm
Close time B01M	...	ms
Bounce t B01M	...	ms
Close time B01R	...	ms
DiffM-R B01R	...	ms
PIR Res. B01R	...	ohm
Close time B02M	...	ms
Bounce t B02M	...	ms
Close time B02R	...	ms

Header logotype

You can change the logotype in the report header to another one or simply remove it.

How to change logo in all report templates

In all delivered report templates there is a logo in the header. If you want to use your own logo it must be a bitmap image, preferably in black if you use the TM1800 internal printer. The size should be 736*292 pixels.

To change or remove the logo, do as follows.

- 1] Start CABA Local (see section 6.1, "Start")
- 2] When the screen "Analyzer View" is shown, press the CTRL + ALT + DEL keys simultaneously.
- 3] Select "Task Manager".
- 4] Move the pointer to the bottom of the screen and click with the right mouse button on "Start" in the left corner.
- 5] Click on "Explore".
- 6] In the "Address" field at top enter the following: "D: \HMI\Report Templates\English"

Note *If you have selected another language for CABA Local you shall enter the current language, e.g. if it is German you enter "D: \HMI\Report Templates\German".*

- 7] a) If you want to remove the logo, delete the file "logo.bmp".
b) If you want another logo, exchange the file with the one you want. Copy the new logo file from a memory stick.

Note *The name of the new file must be "logo.bmp" and the size 736*292 pixels.*

- 8] Close "Explore" and "Task Manager".

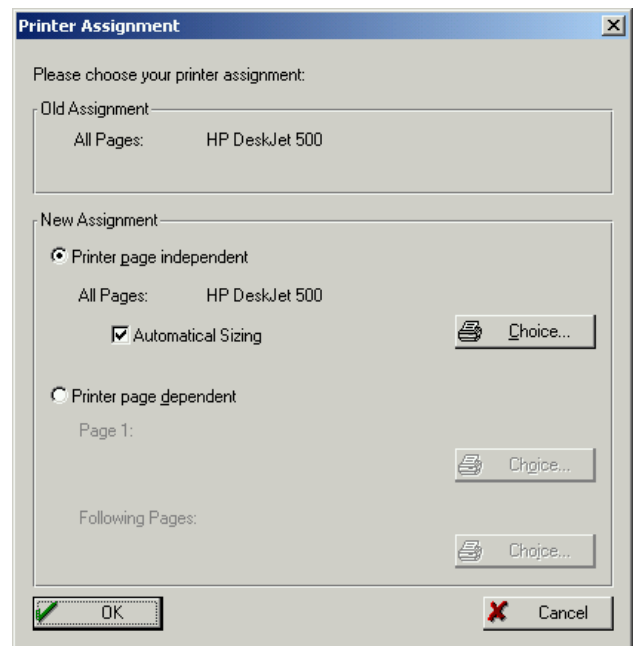
Print report

In System Settings, Printer you can select printer, default printer is the internal printer if it is installed. You can also select if you want to print a graph, parameters or both from your measurements.

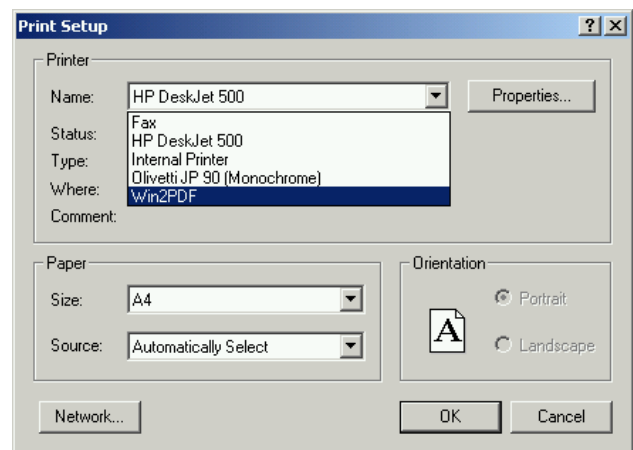
When viewing a recording you can choose to print a report by clicking the button



- 1] You can select another printer by clicking with the right mouse button on one of the printer icons in the Preview page, see above. The left printer icon prints the first page only, the right printer icon prints all pages.
- 2] Click the "Choice" button.



- 3] Select printer and click "OK" in the open windows.



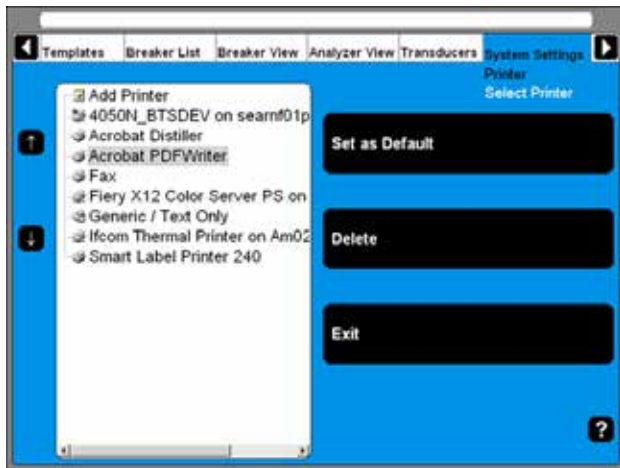
Note *This selection of printer is only valid for the current printout. To make a permanent choice of printer see section 6.14 System settings menu/Printer/Select printer.*

Send recordings to other report formats

Note *You need Acrobat writer or similar programs to do this. See section 6.7 Optional software.*

If you have Acrobat Writer installed you can choose to print a recording to a PDF file.

- 1] Go to System Settings, Printer, Select Printer and mark the Acrobat PDF Writer.
- 2] Press the button "Set as Default".
- 3] Then from View Recording you can print the report containing the recording.



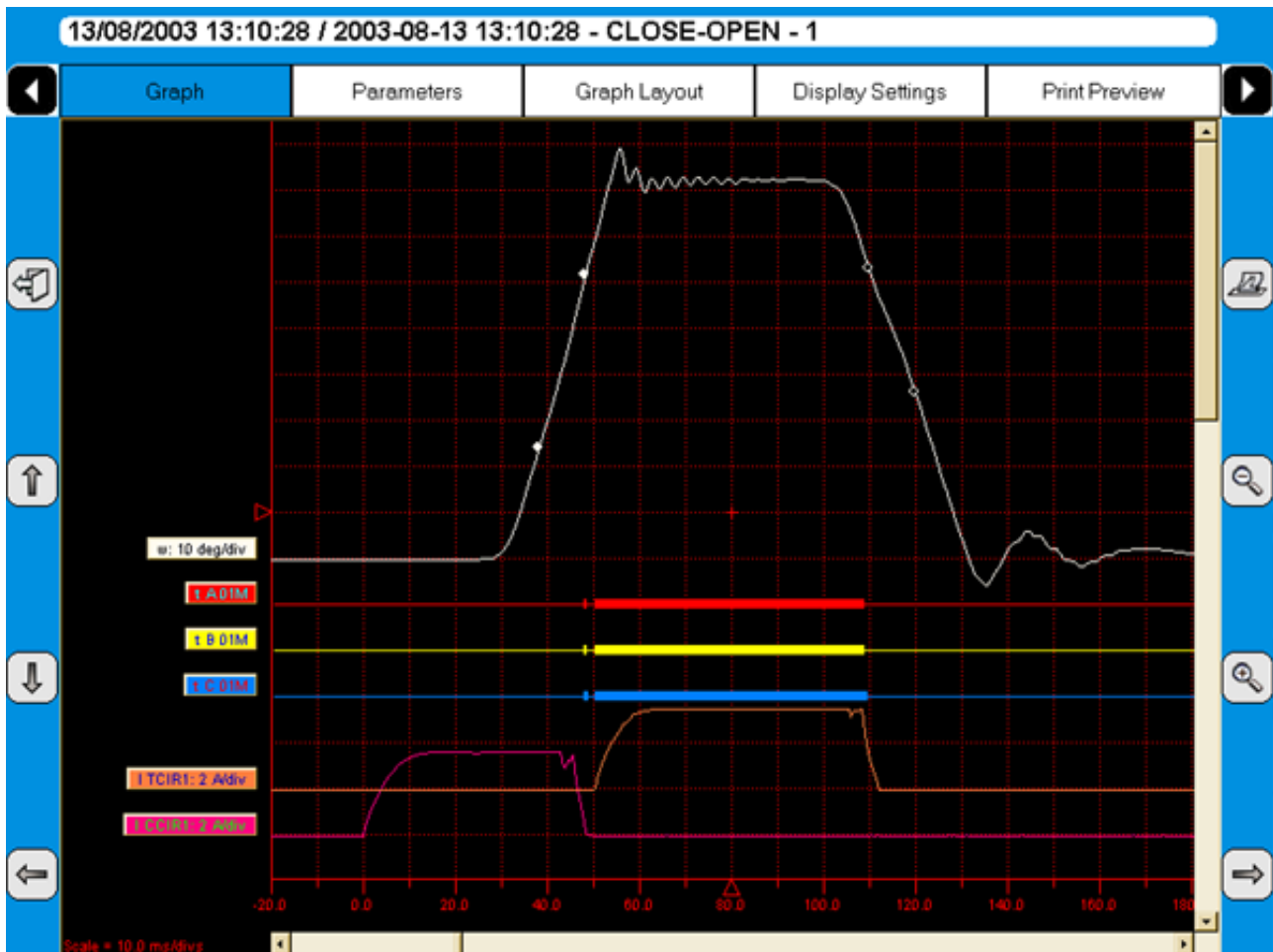
7.8 Evaluate the results

You can evaluate the results by viewing the recordings. In the following are some guidelines for how to interpret the graphs. However these interpretations are not valid for all circuit breakers. Contact the circuit breaker manufacturer for specific information.

Timing measurement

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 10 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.



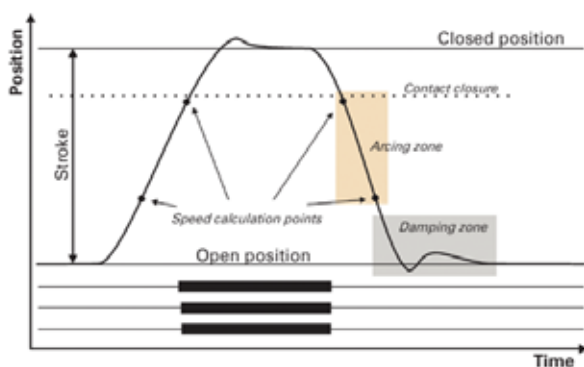
There are no generalized time limits for the time relationships between main and auxiliary contacts, but it is still important to understand and check their operation. The purpose of an auxiliary contact is to close and open a circuit. Such a circuit might enable a closing coil when a breaker is about 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 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-cross-over. 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.

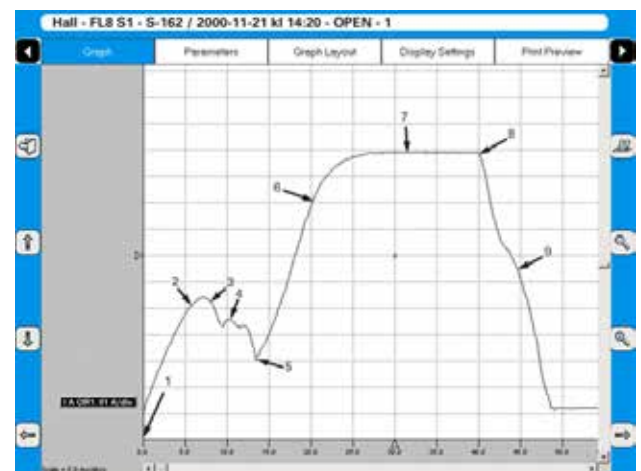
Damping is an important parameter for the high-energy operating mechanisms used to open and close a circuit breaker. If the damping device does not func-

tion 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.

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)

The DRM test method is very suitable for diagnostic testing. Tests are conducted by injecting high DC current, approximately 250 A or higher, through the breaker and measuring the voltage drop and current while the breaker is operated, not to be confused with static resistance measurement (microohm measurement), which measures contact resistance when a breaker is closed.

The breaker analyzer then calculates and plots resistance as a function of time.

DRM has a number of applications. On circuit breakers with an arcing contact design (mainly SF6 types) DRM can be used to measure the arcing contact wear. When contact movement is recorded simultaneously, you can read the resistance at each point of contact. Since there is a significant difference in resistance between the main- and arcing contacts the resistance graph and the motion graph will indicate the length of the arcing contact. In some cases, circuit breaker manufacturers can supply reference curves for the type of contact in question.

Other applications e.g. timing measurements can with DRM be performed on circuit breakers grounded on

both sides. Either the circuit breaker has to be grounded during test due to safety regulations or the circuit breaker design does not allow removing one 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.



DRM example

7.9 Store measurements

Measurements are automatically stored in the TM1800.

To do backup

Be sure you make regular backups of your recordings. See section 6.14, Backup/Restore.

8 Application examples

8.1 Example 1

3-phase circuit breaker with two interrupters per phase and separate operating mechanism with DualGround

Test quantities

- Main contact timing measured by the DCM and Timing M/R modules
- Auxiliary contact timing (one a & one b contact) measured by the Control module
- Coil current & voltage measured by the Control module

Transducer in use

- N/A

Others

- No resistor contacts

Necessary settings in Breaker View

Breaker View

Number of phases	3
Operating mechanism	Separate
Number of interrupters per phase	2
Resistor contacts	None
Number of a-contacts per phase	1
Number of b-contacts per phase	1

Breaker View \ Pulse & Delay Times

These settings are depending on the circuit breaker type. Please refer to the breaker manufacturers data.

Breaker View \ Measurement Preferences

Coil current	On
Control voltage	On
Sense voltage	On

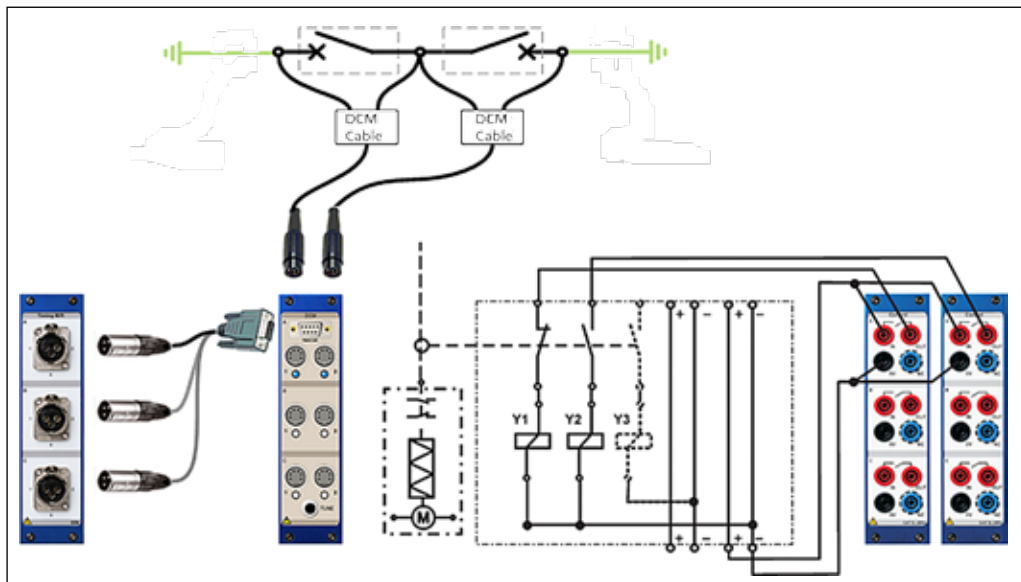
Breaker View \ Measurement Preferences \ Settings

DCM	On
-----	----

Breaker View \ Measurement Preferences \ Measurement Time & Sample Interval

The default settings should be sufficient in most of the cases.

Fig. 8.1 Uppkoppling (per fas).



Breaker View \ Measurement Preferences \ Motion Measurement Preferences

Transducer type | Off

Tuning

- 1] Ensure that breaker is closed and press "TUNE" button on DCM module.

Measure

- 1] Turn the OPERATE/MEASURE button.

GIS circuit breaker - DCM in GIS mode

The TM1800 DCM module has two modes – **Normal mode** and **GIS mode**. The difference between the two modes is that the GIS mode is more sensitive. After starting TM1800 the DCM mode is always reset to normal mode.

- The normal mode shall be used on open air circuit breakers.
- The GIS mode shall be used for GIS circuit breakers but it can also be used for open air circuit breakers having one interrupter per phase.

How to enter the GIS mode

- 1] Keep the TUNE button pressed down for more than five seconds.
The DCM module will confirm the mode change by flashing all LEDs simultaneously.

Once the TUNE button is released the tuning will start in opposite channel order, i.e. beginning with channel C2 and ending with channel A1.

The reversed tuning order is an indication of that the DCM module is in GIS mode.

To switch back to normal mode

- 1] Keep the TUNE button pressed down for more than five seconds.
The DCM will confirm the mode change by flashing all LEDs simultaneously.

Once the TUNE button is released the tuning will start beginning with channel A1 and ending with channel C2.

Note *If tuning is not successful (LEDs off after completed tuning) it could hint that the impedance of the circuit is too low. To fix this problem the DCM cables between the small box and the clamps can be spread from each other.*

If you move the position of a DCM cable's high frequency part (between small box and circuit breaker) you need to re-tune the system. The same applies if ferrites are moved/ added/removed.

How to connect the DCM-cables

The access point for one of the test lead clamps is on the isolated part of the ground switch. However, choosing the second access point might not be equally obvious.

The principles for selecting measurement lead access points are:

- The longer ground loop the better
- The shorter loop through the circuit breaker the better

So, if there is a choice of access points the most suitable ones according to the above rules should be selected.

See also section "4.2 DCM module" on page 27.



In most cases though it is sufficient to connect the test clamps on each side of the ferrite.

Tuning

Once all ferrites are attached the system need to be tuned. This must be done when the circuit breaker is in closed position.

- 1] Check that the circuit breaker is in closed position.
- 2] Press the TUNE button shortly.
The tuning is performed automatically channel by channel and its corresponding LED flashes. Tuning will take about half a minute and when finished all channel LEDs, with cables connected, will be lit.
- 3] Proceed as a normal time measurement.

8.2 Example 2

3-phase circuit breaker with single interrupter per phase and common operating mechanism

Test quantities

- Main contact timing measured by the Timing M/R module
- Auxiliary contact timing (one a & one b contact) measured by the Control module
- Coil current & voltage measured by the Control module
- Main contact motion & velocity

Transducer in use

- Linear, resistive, 150 mm

Others

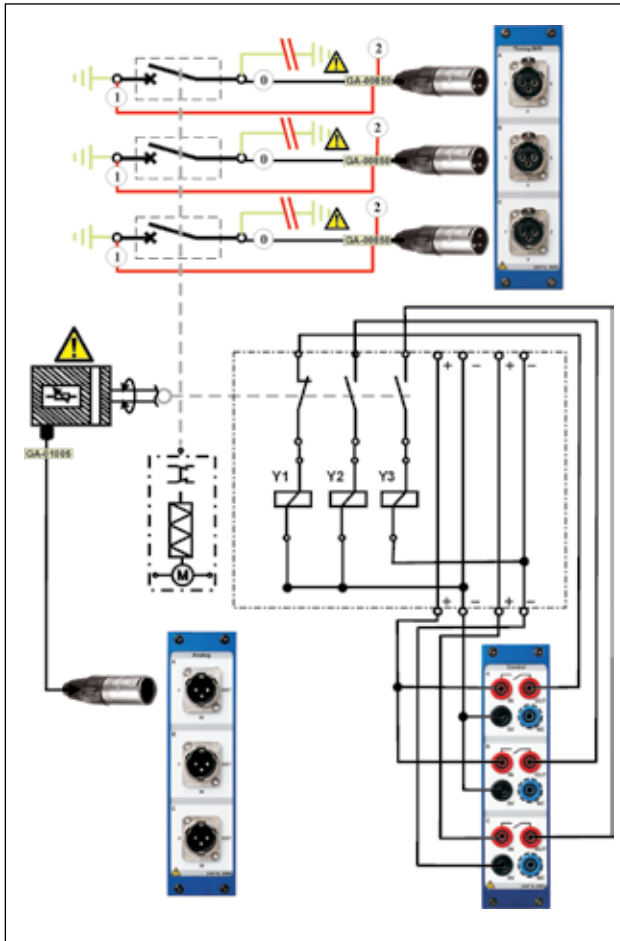
- No resistor contacts, no grading capacitors

Necessary settings in Breaker View

Breaker View

Number of phases	3
Operating mechanism	Common

How to connect



Number of interrupters per phase	1
Resistor contacts	None
Number of a-contacts	1
Number of b-contacts	1

Breaker View \ Pulse & Delay Times

These settings are depending on the circuit breaker type. If you are uncertain please refer to the breaker manufacturers data.

Breaker View \ Measurement Preferences

Coil current	On
Control voltage	On
Static voltage	On

Breaker View \ Measurement Preferences \ Measurement Time & Sample Interval

The default settings should be sufficient in most of the cases.

Breaker View \ Measurement Preferences \ Motion Measurement Preferences

Transducer type	Linear, Resistive
Absolute (calibrated transducer)	On

Breaker View \ Measurement Preferences \ Motion Measurement Preferences \ Speed Calculation points

Whenever possible do settings according to manufacturers definition. However if that is not available you can make your own choice and use it as your own reference.

8.3 Example 3

3-phase circuit breaker with two interrupters per phase and separate operating mechanism

Test quantities

- Main contact timing measured by the Timing M/R module
- Auxiliary contact timing (one a & one b contact) measured by the Control module
- Coil current & voltage measured by the Control module

Transducer in use

- n/a

Others

- No resistor contacts, no grading capacitors

Necessary settings in Breaker View

Breaker View

Number of phases	3
Operating mechanism	Separate
Number of interrupters per phase	2
Resistor contacts	None
Number of a-contacts per phase	1
Number of b-contacts per phase	1

Breaker View \ Pulse & Delay Times

These settings are depending on the circuit breaker type. If you are uncertain please refer to the breaker manufacturers data.

Breaker View \ Measurement Preferences

Coil current	On
Control voltage	On
Static voltage	On

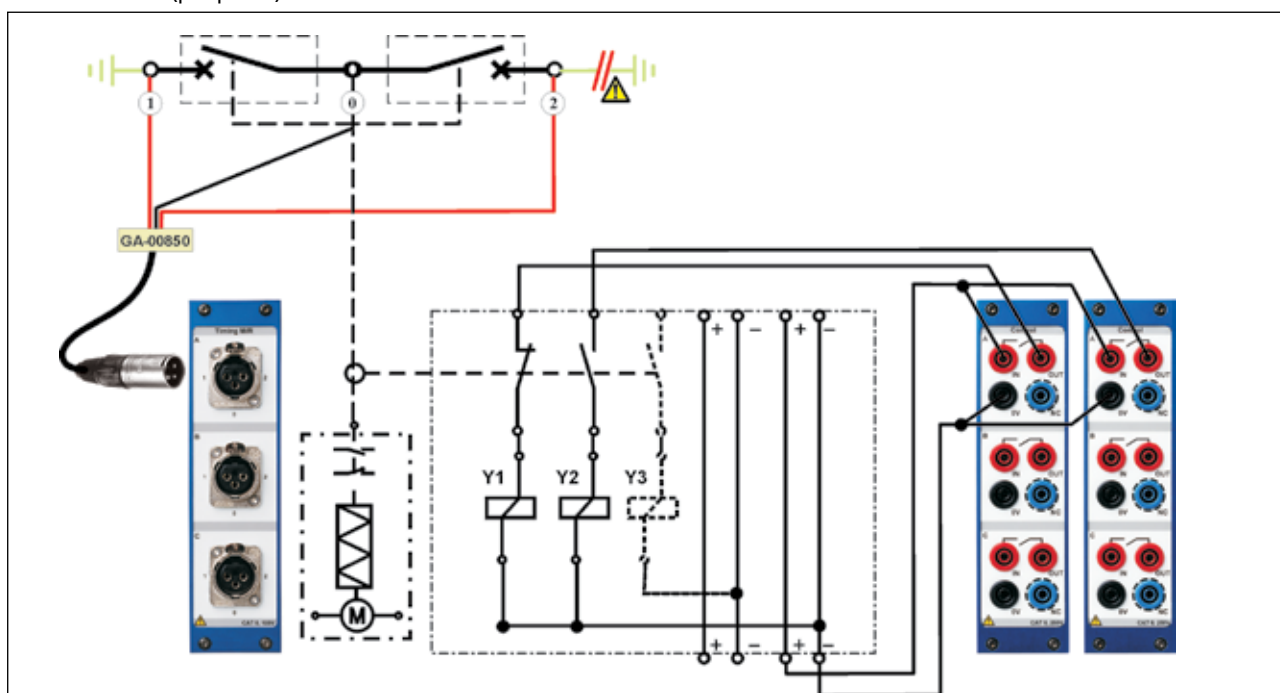
Breaker View \ Measurement Preferences \ Measurement Time & Sample Interval

The default settings should be sufficient in most of the cases.

Breaker View \ Measurement Preferences \ Motion Measurement Preferences

Transducer type	Off
-----------------	-----

How to connect (per phase)



9 Specifications

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 -20°C to +50°C (-4°F to +122°F)

Storage & transport -55°C to +70°C (-67°F to +158°F)

Humidity 5% – 95% RH, non-condensing

CE-marking

EMC 2004/108/EC

LVD 2006/95/EC

Basic unit

General

Mains input (nominal) 100 – 240 V AC, 50/60 Hz

Power consumption 250 VA (max)

Dimensions 515x173x452 mm (20.3" x6.8" x17.8")

Weight 11.5 kg (25.4 lbs)

HDD module

Weight 0.6 kg (1.3 lbs)

Temperature, storage -55°C to +70°C (-67°F to +158°F)

External input

TRIG IN

Voltage mode

Input range 0 – 250 V AC / 0 – 350 V DC

Threshold level User configurable in software in steps of 1 V

Contact mode

Open circuit voltage 35 V DC $\pm 20\%$

Short circuit current 10 – 40 mA

Threshold level 1 – 2 k Ω

External outputs

TRIG OUT

Pulse duration 1 – 999 ms, user configurable in steps of 1 ms

Voltage mode

Open circuit voltage 12 V DC $\pm 5\%$

Voltage at 0.5 A 9 V DC $\pm 10\%$

Max. short circuit current 1.5 A

Contact mode

Max. switching current 0.5 A at 12 V and resistive load

Voltage drop at 0.5 A 4.5 V DC $\pm 10\%$

Max. short circuit current 1.5 A

DRM (only for SDRM202 and DRM1800)

WARNING

Relay For lamp or horn

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

Voltage mode

Output Voltage 12 V DC $\pm 10\%$

Short circuit protection Fuse 1 A DC fast acting type (F1H250V)

Contact mode

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

Communication interfaces

USB Universal Serial Bus ver. 2.0

Ethernet 100 base-Tx Fast Ethernet

External screen SVGA, up to 800 x 600 at 24 bit color, 32 MB SDRAM

HMI, Human-Machine interface

CABA Local Circuit breaker analyzing software

Available languages English, French, German, Spanish, Swedish. Translation kit available

Display Super-Bright for good visibility in direct sunlight

Diagonal size 21 cm (8")

Keyboard Built-in

Modules

Control module

General

No. of channels 3

Time base inaccuracy $\pm 0.01\%$ of reading ± 1 sample interval

Max. sample rate 10 kHz

Measurement time 45 s at 10 kHz sample rate,
90 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 current 60 A AC/DC, pulse ≤ 100 ms

Fuse 15 A DC

Duration User configurable in steps of 1 ms

Delay User configurable in steps of 1 ms

Current measurement

Measurement range 0 – 60 A AC/DC

Resolution 16 bits (15 bits at data compression)

Inaccuracy $\pm 2\%$ of reading $\pm 0.1\%$ of range

Voltage measurement

Measurement range 0 – 250 V AC, 0 – 350 V DC

Resolution 20 mV (40 mV at data compression)

Inaccuracy $\pm 1\%$ of reading $\pm 0.1\%$ of range

Timing M/R module

General

No. of channels 6

Time base inaccuracy $\pm 0.01\%$ of reading ± 1 sample interval
0.05 ms

Min. resolution 0.05 ms

Max. sample rate 40 kHz

Measurement time 8 s at 40 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 $\pm 10\%$ (Toggling at every second sample at sample rates from 10 kHz and upwards.)

Short circuit current 9.7 mA or 42 mA $\pm 10\%$

Status threshold

Main Closed $< 10 \Omega < \text{Open}$

Main and Resistor Main $< 10 \Omega < \text{PIR} < 10 \text{ k}\Omega < \text{Open}$

PIR resistance measurement

Supported PIR types Linear PIR

Measurement range 10 Ω – 10 k Ω

Inaccuracy $\pm 10\%$ of reading $\pm 0.1\%$ of range

Voltage measurement

Measurement ranges $\pm 50 V_{\text{peak}}$, $\pm 15 V_{\text{peak}}$, $\pm 0.5 V_{\text{peak}}$

Resolution 16 bits

Inaccuracy $\pm 1\%$ of reading $\pm 0.1\%$ of range

DCM module**General**

No. of channels 6

Weight 0.6 kg (1.3 lbs)

Output

Voltage 0 - 5 V rms AC

Current 0 - 70 mA rms AC

Analog module**General**

No. of channels 3

Time base inaccuracy $\pm 0.01\%$ of reading ± 1 sample interval

Max. sample rate 40 kHz

Measurement time 35 s at 40 kHz sample rate,
70 s at 20 kHz sample rate,
200 s at 10 kHz sample rate using data compression

Transducer resistance 500 Ω – 10 k Ω at 10 V output

Weight 0.8 kg (1.8 lbs)

Output

Voltage output 10 V DC $\pm 5\%$, 24 V DC $\pm 5\%$

Max. output current 30 mA

Current measurement

Measurement range 0 – 20 mA DC

Resolution 16 bits (15 bits at data compression)

Inaccuracy $\pm 1\%$ of reading $\pm 0.1\%$ of range

Voltage measurement

Input voltage range 0 – 250 V AC, 0 – 350 V DC

Measurement ranges ± 10 V DC, 0 – 250 V AC/DC

Resolution 16 bits (15 bits at data compression)

Inaccuracy

250 V range $\pm 1\%$ of reading $\pm 0.1\%$ of range

10 V range $\pm 0.1\%$ of reading $\pm 0.01\%$ of range

Digital module**General**

No. of channels 6

Supported types Incremental transducers, RS422

Time base inaccuracy $\pm 0.01\%$ of reading ± 1 sample interval

Max. sample rate 20 kHz

Measurement time 35 s at 20 kHz sample rate,
70 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 $\pm 5\%$ or 12 V DC $\pm 5\%$

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 $\pm 0.01\%$ of reading ± 1 sample interval

Max. sample rate 20 kHz

Measurement time 35 s at 20 kHz sample rate,
70 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, 0 – 350 V 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 $< 100 \Omega$, Open $> 2 \text{ k}\Omega$

Printer module**General**

Printer type Thermal printer

Paper type Thermal 114 mm

Storage and transport temperature -20°C to $+60^\circ\text{C}$ (-4°F to $+140^\circ\text{F}$)

Weight 0.8 kg (1.8 lbs)

10 Troubleshooting & FAQ

10.1 Troubleshooting

Problem	Possible cause	Solution
When TM1800 starts in safe mode the date and time are not correct	<i>The internal battery is faulty</i>	Send TM1800 to a service center
I'm not able to delete a template	<i>The template is defined as default</i>	Change the default setting
I get no voltage from the output	<i>The fuse is damaged</i>	Replace the damaged fuse with a F1H250V. A high breaking capacity type must be used
The TM1800 does not start up properly	<i>A faulty module</i>	Remove the modules and insert one by one
My auxiliary contacts do not get detected automatically	<i>If the circuit breaker has AC coils the control module can't detect the auxiliary contacts</i>	If you have a Timing Aux module installed, set up your breaker in "Breaker view" to measure more than 1 auxiliary contacts per mechanism. This means that the Timing Aux Module will measure the auxiliary contact when you connect it to the a and b contacts
The position indicators on the Control Panel only show one phase		The TM1800 sense the position of the circuit breaker via the control module i.e. the operating mechanism position, therefore if common operating mechanism is selected only one LED indicates the position for the whole breaker.
It is not possible to turn off the unit and/or the On/Off LED is blinking		First press ctrl+alt+del and select "Task Manager", then under the "Processes" tab in the list locate and highlight "HMI.exe". Click the button "End Process" in the lower right corner. The desktop will then be displayed and you click "Start" and "Shut Down".
I have problems with import and using of TM1600 and/or Egil measurements		If the imported measurements are based on a special (custom made) testplans for TM1600 and/or Egil you need to consult with us before continuing. Please contact support for technical assistance.

10.2 FAQ - Frequently Asked Questions

Can I use DC supply to TM1800?

TM1800 is not rated for DC inlet supply but there are several types of DC to AC converters available on the market. Please contact us for more information.

Can TM1800 run on the internal battery without power supply?

The internal battery of the TM1800 is a low power battery for keeping date and time in the TM1800.

Can I use my old printer for TM1800?

Yes if your printer is supported by Windows XP operating system.

Many manufacturers offer drivers for Windows XP for free on their web site. Please consult the manufacturer of the printer before attempting to install the printer.

Do I need external power unit for operating the circuit breaker?

Yes, for operating coils or charging spring motors of the circuit breaker an external power source is needed. Please contact your local sales representative.

Can I measure the resistance of the PIR resistors?

Yes the PIR resistance will be measured automatically by Timing M/R module if the PIR type in the circuit breaker has linear characteristics. Please refer to the specifications for the Timing M/R module.

I have incremental (digital) transducers can I use them with TM1800?

Yes you can use any type of incremental transducers with the TM1800 Digital module. Check Appendix A for Pin configuration and type of connector you need.

I used to work with CABA Win. Can I use the set-up and test plan from CABA Win in TM1800?

Yes CABA Local can use the set-up with test plan from CABA Win. Please refer to "import a breaker" section in TM1800 users manual.

I need more Analog modules; can I buy the modules and add them to my TM1800?

Yes follow instruction in the manual how to install modules. No set-up or changes in the Basic Unit is needed.

My printer (or other HW devices) does not work?

Please make sure the proper drivers are installed in the TM1800 and they are created for use with Windows XP. Please refer to "Optional software" in the TM1800 users manual.

The Breaker or Printer template I need does not exist?

Please refer to "create a new template" in the users manual or contact support for technical assistance.

11 Data analysis

11.1 Analysis window (CABAana)

The test results are presented graphically and as parameter values here. The results can be analyzed in detail, and a report can be generated. In addition to the functions presented below, a number of Windows® functions are available (moving and editing windows and columns and using scroll bars for example).

The following functions are available in the instrument/analysis program:

File menu

Open



Opens a new recording (set of readings). Double-click to select; breakers, tests and recordings.

Close

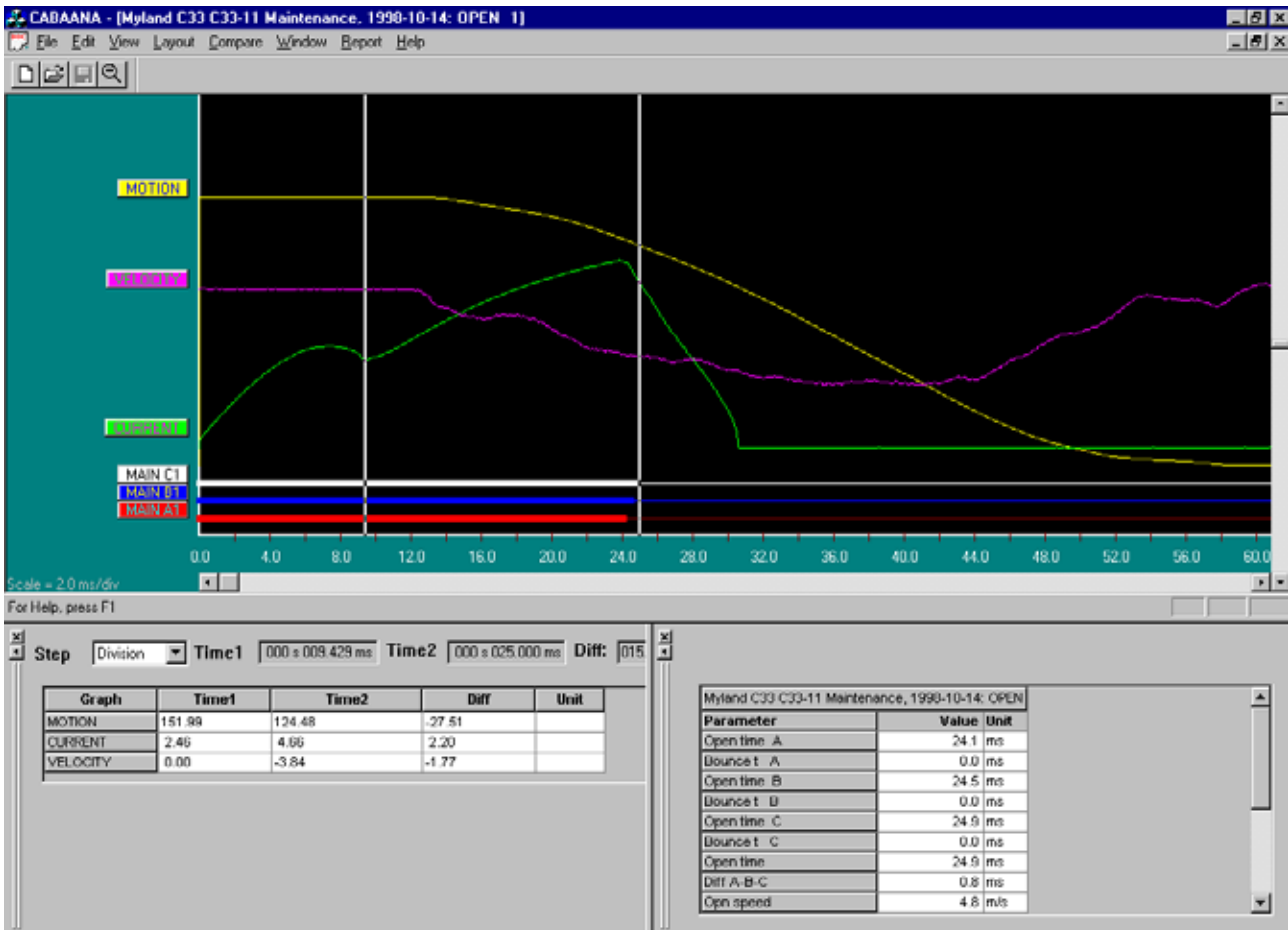
Close the recording (set of readings) in the active window.

Print

Open the printer dialogue box for printing the computer screen.

Exit

Exits



Edit menu

Notes

Used to edit notes for the selected operation.

Copy Graph/Parameters to Clipboard

Copies the active/selected graph or parameter table to the clipboard for use in other programs.

Copy Graph to File

Copies the selected graph as a bitmap file to the selected directory.

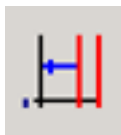
View menu

Cursor Data

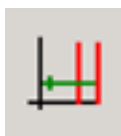
Opens an on-chart-marking window to facilitate detailed analysis.

The two cursors can be moved using the mouse.

- 1] Hold down left button, pick up at left edge of window or with left/right arrow keys.
- 2] Select cursor by clicking on "Time 1" or "Time 2". Movement steps are user-selectable.
- 3] To reset the cursors to time zero, use the icon buttons on the toolbar.



Time 1 reset.



Time 2 reset.

The table displays measurement values at time 1 and 2 and also the difference. Please note that for the velocity graph the "difference" is instead the average velocity between the two cursor positions.

Speed calculation points

Select if the speed calculation points should be displayed.

Zoom In



Zooms the x-axis (time). Select zoom in, position the mouse at the left of zooming area, move the mouse to right of zooming area while holding down left button. Release left button. This function is also available on the toolbar.

Zoom Out

Restores the display to the original setting.

Toolbar

Show/hide toolbar.

Status Bar

Show/hide status bar.

Parameter Window

Opens a parameter window used for measured/calculated parameters. To view all parameters use the scroll bar in the parameter window

Graph Window

Labels

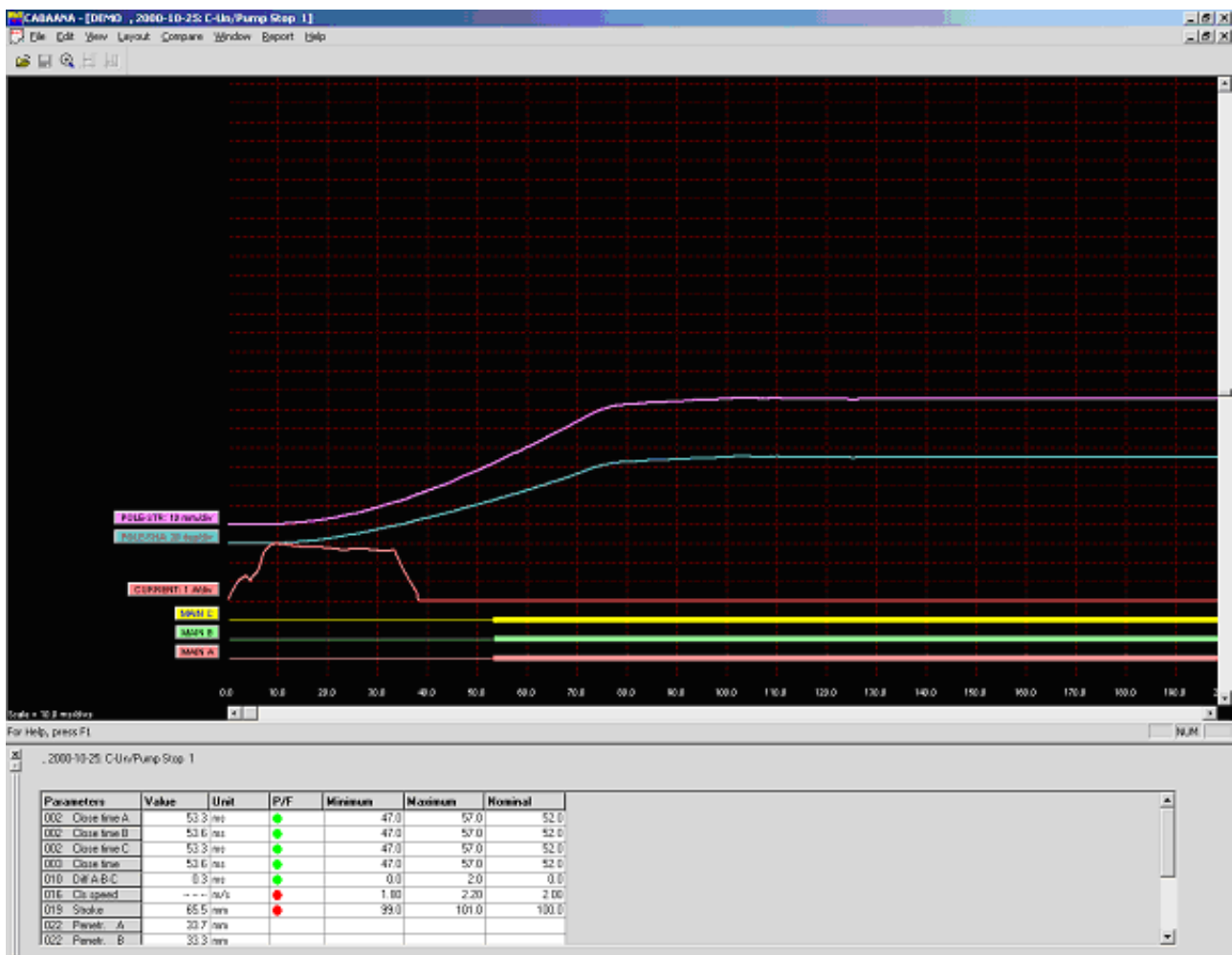
Double-clicking on any of the graph labels will open a dialogue box used for making display settings.

Lower Scroll bar

Changes x-axis offset.

Right Scroll bar

Changes y-axis offset.



Layout menu

Graph

Opens dialogue box used for graph settings. On/off, colours, position, scaling etc. Selecting "store as current" or "store as original layout" will save the settings while you work with the actual test or save the settings as original settings for the test.

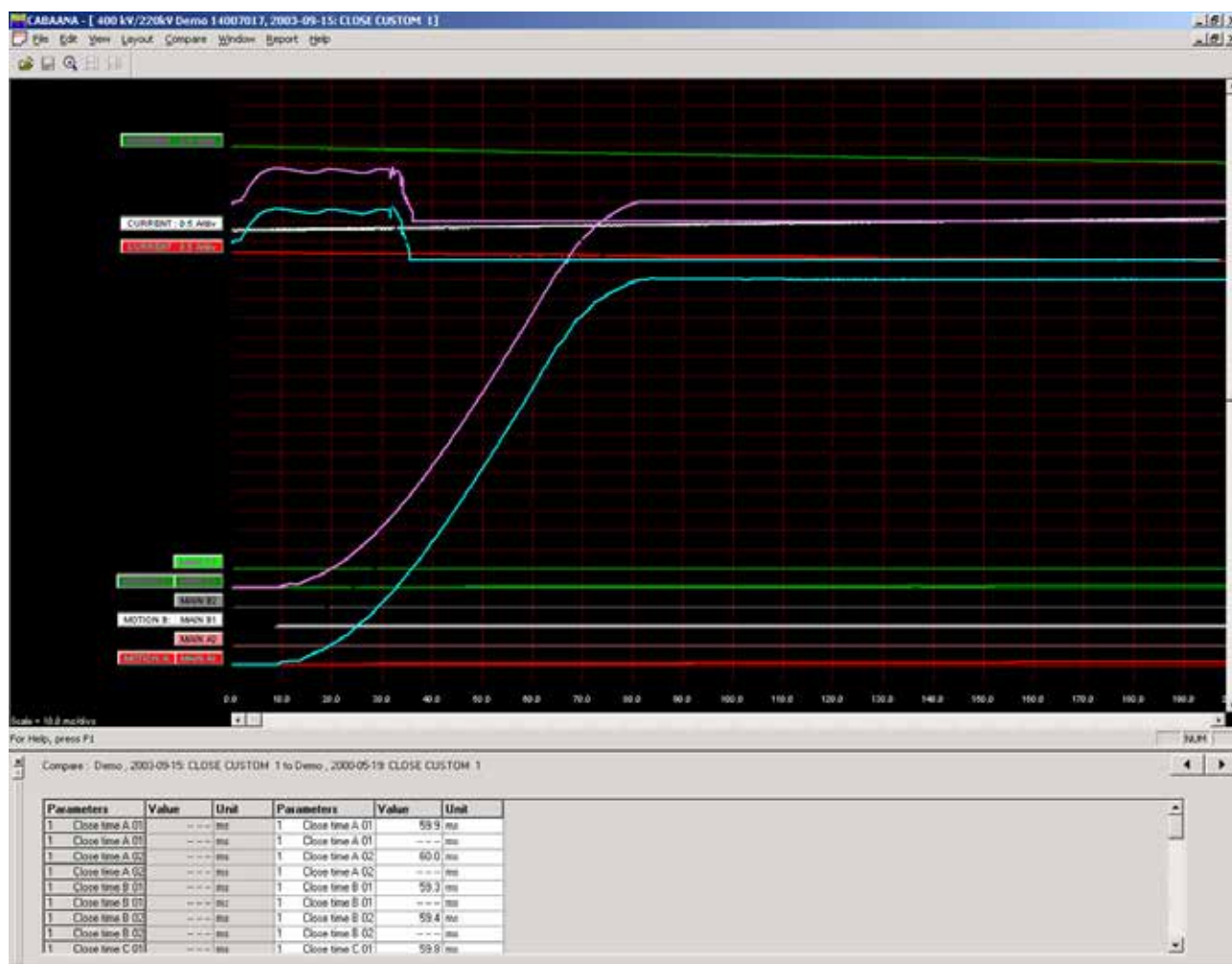
Display

Opens dialogue box used for display settings. Grid on/off, x/y-scales and offsets, colour/monochrome etc.

It is also possible to change the graph and display directly on the screen by double-click on a label (graph settings) or right-click anywhere inside the display (display settings). These changes are temporary and will not be stored when you close the window.

Pass/Fail

Opens dialogue box used for pass/fail presentation (if enabled for the actual test), see below.



Compare - menu

The compare function displays two recordings in the same graph. The arrow indicators in the lower right corner of the screen are used to scroll between possible comparisons (if any).

None

No comparison is made

Within Test

Automatic selection of comparable operations within the same test

Between Tests

Automatic selection of similar operations for different tests of the same circuit breaker

Free Selection

Free selection of comparisons. CABA Win will give a warning when operations/parameters do not match.

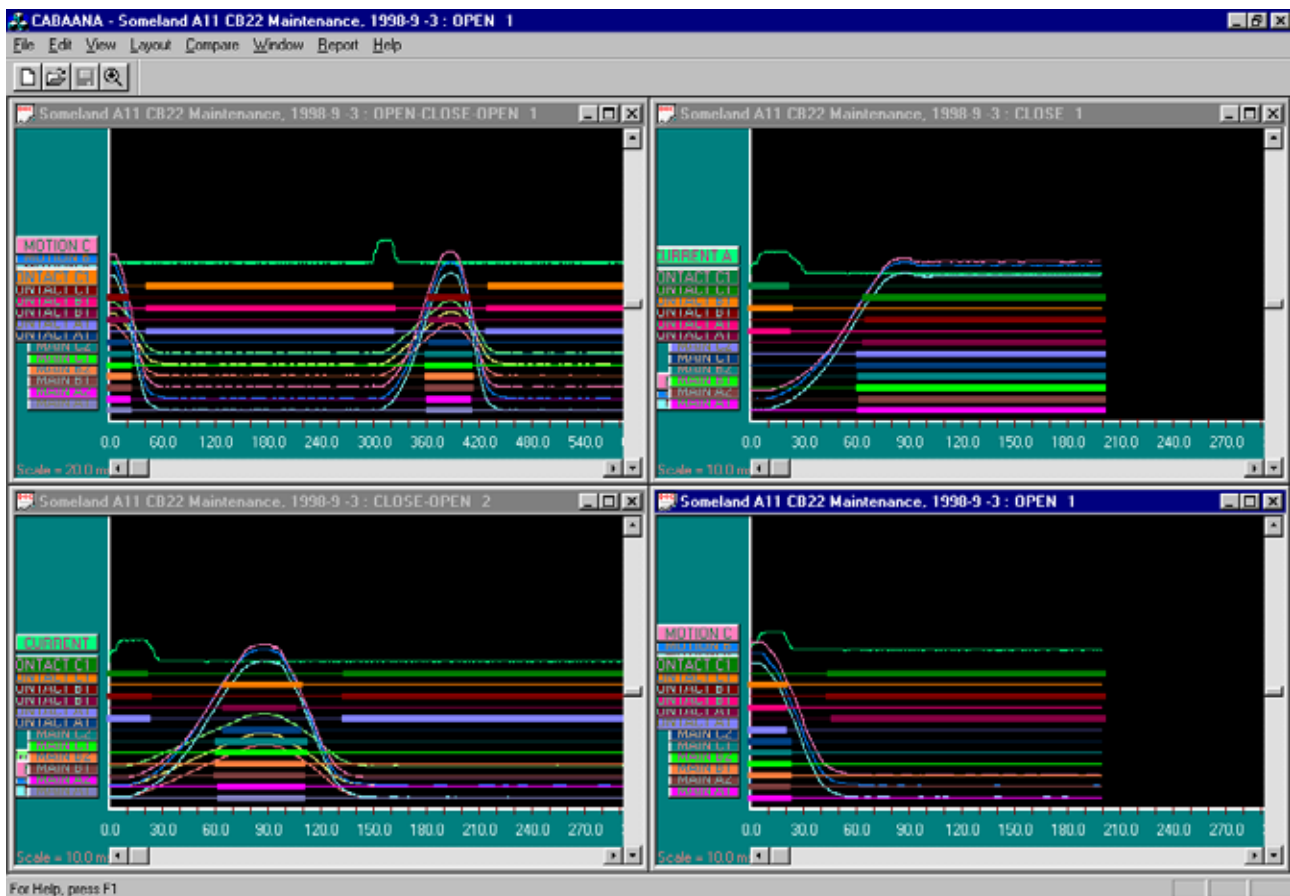
Window menu

Cascade

Cascade all open windows

Tile

Tiles all open windows on full screen



Report

Report a Recording

This format is used for reporting a single recording with its parameters in a table format. Report templates that fits all circuit breakers and test plans are available.

You can make a report using List&Label or using Microsoft® Word. For Word you need CABA Win version R02A or higher.

Report a Test

This format is used for reporting a test with several operations/recordings. Standard templates for different test plans are available but individual breakers might need editing of variable names before they can be reported with a default template. All recordings that are to be reported in the template has to be opened in CABAana, i.e. open, close, open- close and close-open operations for a template where the different operating times should be printed.

You can make a report using List&Label or using Microsoft® Word. For Word you need CABA Win version R02A or higher.

The dialog boxes contains the following functions:

Browse

Browse to a template directory.

Set as default

The selected template will be set as default for the selected circuit breaker.

New

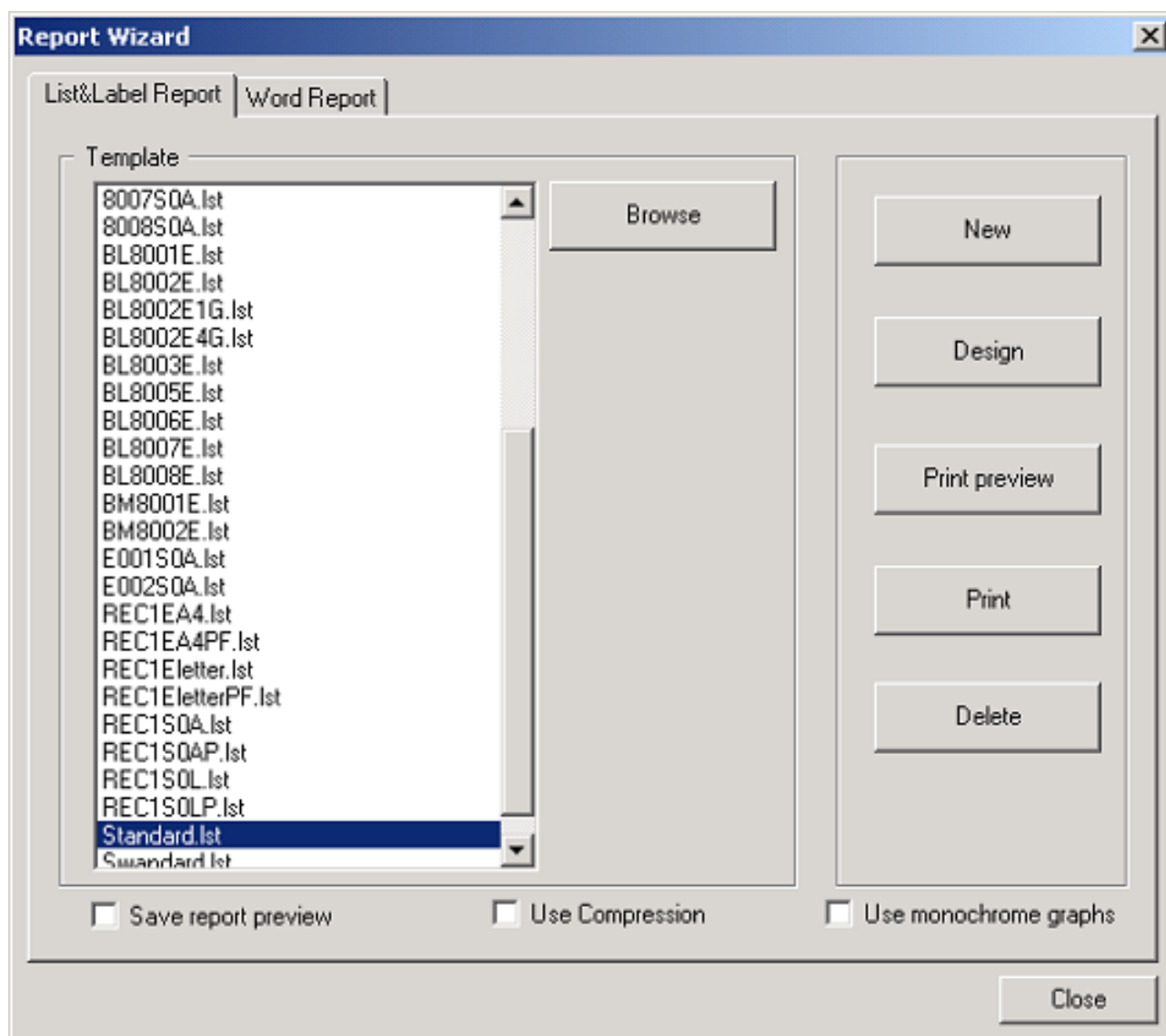
Open a new blank template

Design

Open the selected test and template for editing

Print preview

Print preview of the selected test on the selected template.



Generate

Create a Word document.

Print

Print the selected test on the selected template.

Delete

Delete the selected template.

Close

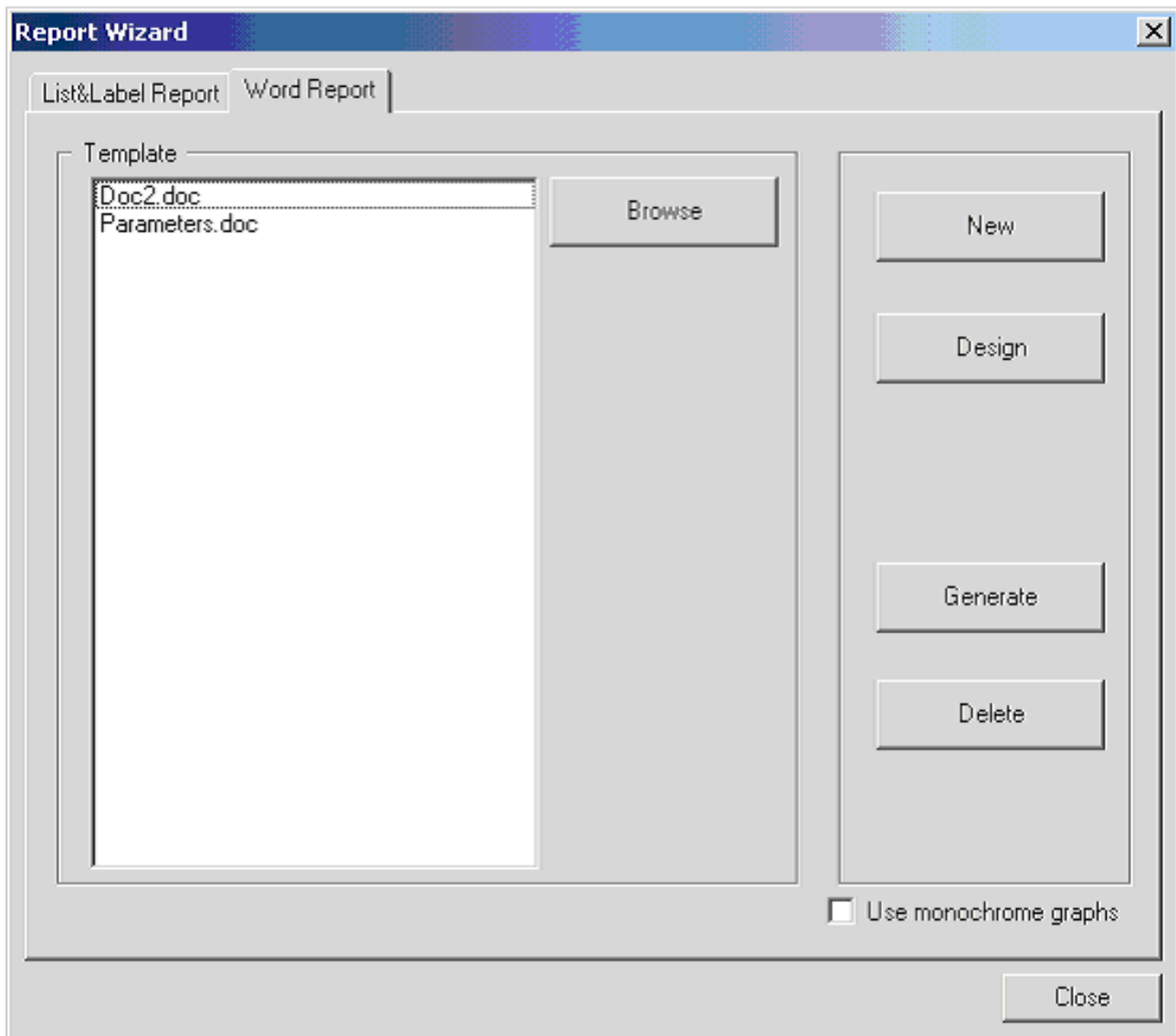
Close the dialog box.

Generic graphs

Automatic graph reporting following the numbering in the window menu in the analysis program.

Save report preview

The preview file (*.ll format) will be stored together with the breaker and can be viewed in the database. Please note that the preview file(-s) may take considerably disk space and default setting for this feature is "off" to avoid unnecessary use.



12 Quick Guide

Select – Connect – Inspect

Working with TM1800 means fast and easy testing. Testing is done with a three-step process.

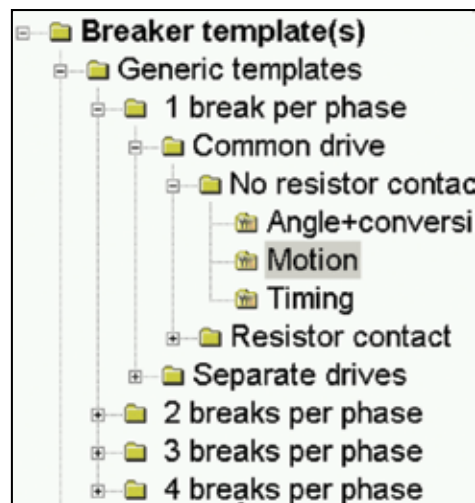
IMPORTANT
 Always follow the safety regulations in chapter 1 of the TM1800 User’s manual.

Always comply with local safety regulations.

Note *This Quick Guide instruction assumes that factory settings are used.*

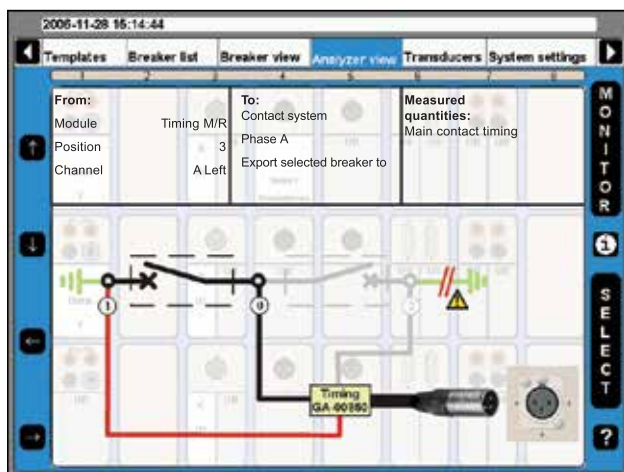
STEP 1: Select

First step is to select a suitable template from the template library (Templates) depending on number of contacts per phase, motion or not, resistor contacts and more



STEP 2: Connect

Second step is to connect the test leads according to the graphical help screen (Analyzer view).



- 1] Turn the OPERATE/MEASURE button. TM1800 automatically selects and performs close or open operation depending on the actual circuit breaker state (Auto-detect breaker state).

Note *Auto-detect breaker state* is the default setting in "System Settings".

STEP 3: Inspect

The measurement is performed, analysed and the results will be displayed on the screen. Magnification and compare functions are available.



Note *For more advanced setup there is still the opportunity to control all the details in the measurement.*

After the test it is possible to print a test report, either from the TM1800 printer module or using CABA Win on a PC. With CABA Win you can make a more advanced analysis of the data. CABA Win is also the archive for common test data and interface to CEBEX. With CEBEX the test is stored in a database.

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Your "One Stop" Source for all your electrical test equipment needs

- Battery Test Equipment
- Cable Fault Locating Equipment
- Circuit Breaker Test Equipment
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- Insulation Resistance Test Equipment
- Line Testing Equipment
- Low Resistance Ohmmeters
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- Portable Appliance & Tool Testers
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- STATES® Terminal Blocks & Test Switches
- Professional Hands-On Technical and
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Megger is a world leading manufacturer and supplier of test and measurement instruments used within the electric power, building wiring and telecommunication industries.

With research, engineering and manufacturing facilities in the USA, UK, Germany and Sweden, combined with sales and technical support in most countries, Megger is uniquely placed to meet the needs of its customers worldwide.

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