TM1600
Circuit Breaker Analyzer

- **Stand-alone functionality – one toolbox for all breaker testing**
- **Expandable modular concept**
- **Low-weight**
- **Rugged and reliable for field use**

Description

The TM1600™ circuit breaker analyzer measures a circuit breaker's timing cycle. The timing channels record closings and openings of main contacts, resistor contacts and auxiliary contacts.

Since the timing channels are not interconnected, you can take measurements of resistor contacts and series-connected breaker chambers without having to disconnect them.

A built-in program unit permits easy selection of different sequences of breaker control pulses. The delay time between pulses is set on a thumbwheel. The breaker operation unit can be used to control coil currents of up to 25 A. The time values obtained refer to the exact instant at which voltage was applied to the coil, and a built-in printer provides you with a hardcopy printout immediately after measurement.

The TM1600 can be equipped with up to 24 time-measuring channels as required by the user. When more than 24 channels are needed, one or several units can be connected together to get an unlimited number of measurement channels. Modular design also makes it easy to combine the system with the MA61™ Motion Analyzer for up to 6 analog channels.

The TM1600 supports communication with the CABA Win™ Breaker Analysis Software. Fully equipped, it weighs only 12 kg (26.5 lbs).

Application example

1. Setup

- A typical breaker test hookup is shown in the figure below.

2. Preparation

- Set the desired breaker operating sequence on the TM1600. In this case, CLOSE-OPEN (C-O).

3. Recording

- Enable recording with the READY button. Start the breaker sequence and measurement simultaneously by turning the START switch.

4. Test report

- The result is printed automatically. This example shows a CLOSEOPEN (C-O) sequence presented in the report 1 format (85 % of actual size). Only the initial contact closing time (for CLOSE) and final contact separation time (for OPEN) are presented in the report 1 format. Short bounces are not shown.

Timing with motion recording

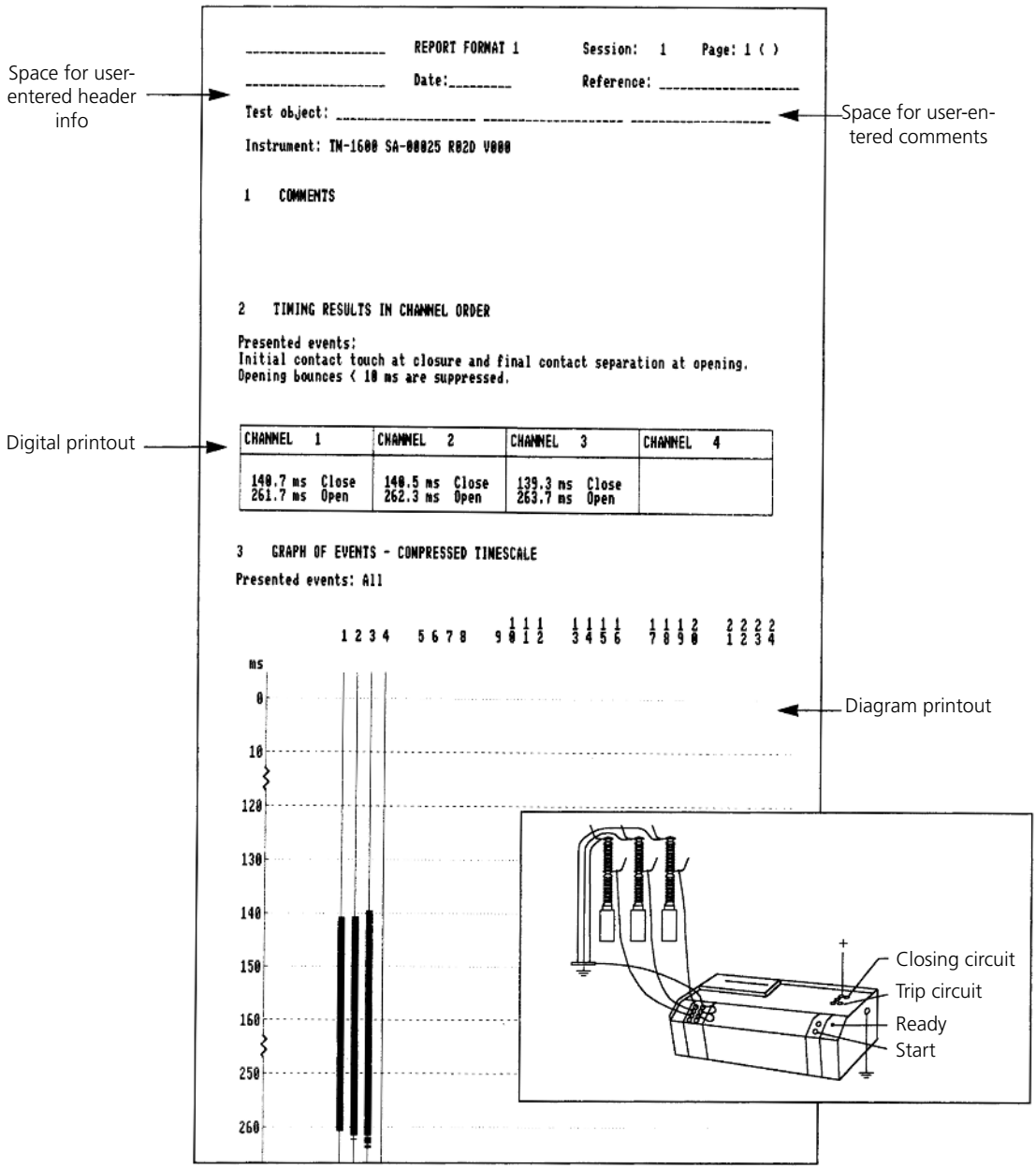
1. Setup

- Connect the transducers to the circuit breaker.

2. Preparation of the MA61

The following additional settings are needed when you include motion recording in circuit breaker analysis. These settings are menudriven via the built-in display on the MA61.

- Select test interval (50 ms to 1 s).
- Calibrate the input(s) connected to the position transducer(s) as follows:
  a) Close the circuit breaker.
  b) Record the closed position via a menu option.
  c) Open the circuit breaker.
  d) Record the open position.
  e) Estimate or measure breaker stroke. Enter the value via the menu.
  f) Enter speed calculation parameters.
- Enter the current range and the scale factor for the current shunt if current is to be measured.



REPORT FORMAT 1 Session: 1 Page: 1 ( )
Date:_____ Reference: _____
Test object: _____ _____ _____
Instrument: TM-1600 SA-00025 R02D V000

1 COMMENTS

2 TIMING RESULTS IN CHANNEL ORDER

Presented events:
Initial contact touch at closure and final contact separation at opening.
Opening bounces < 10 ms are suppressed.

CHANNEL 1	CHANNEL 2	CHANNEL 3	CHANNEL 4
140.7 ms Close 261.7 ms Open	140.5 ms Close 262.3 ms Open	139.3 ms Close 263.7 ms Open	

3 GRAPH OF EVENTS - COMPRESSED TIMESCALE

Presented events: All

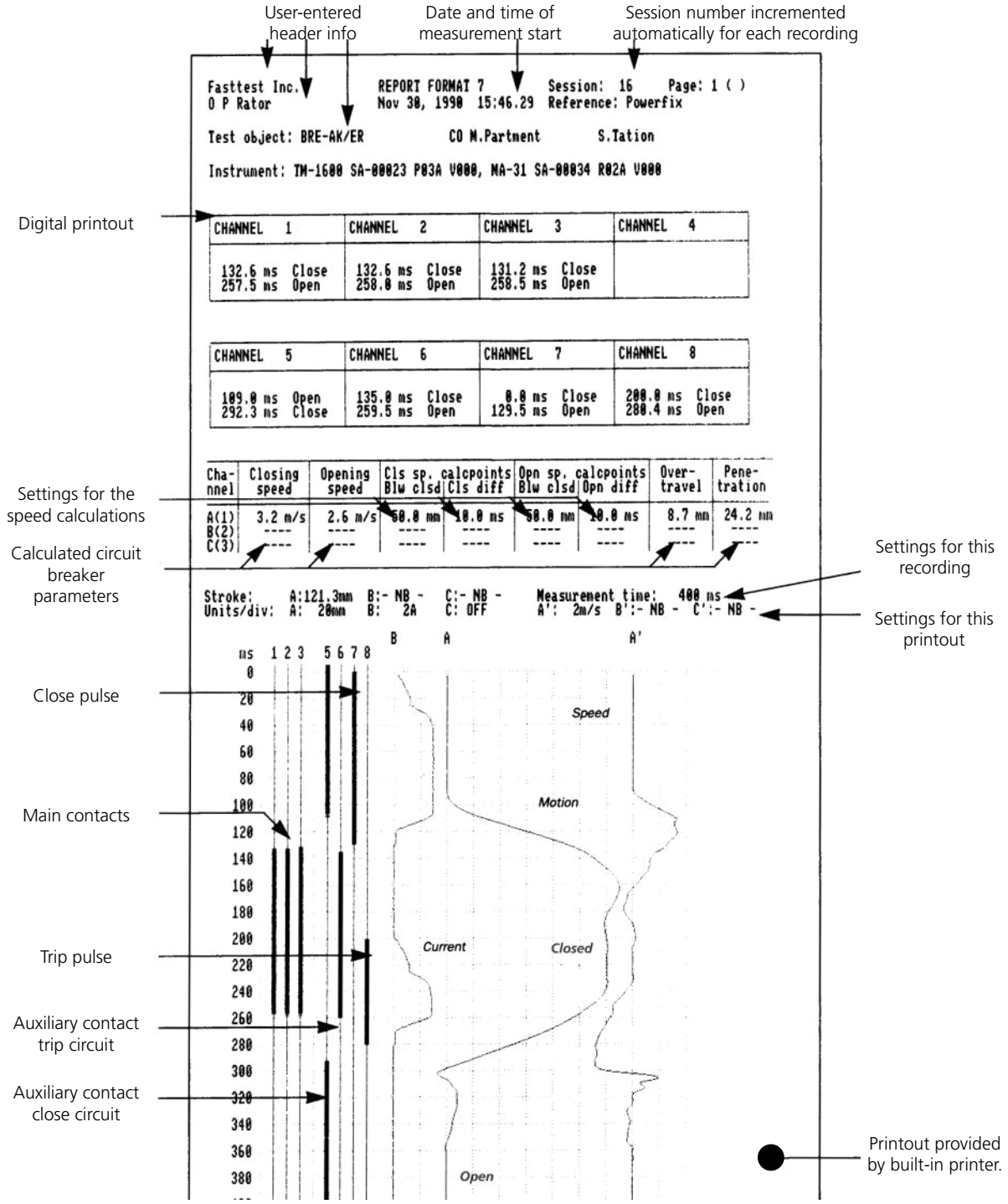
- Enter range and scale factor for other transducers (if used).

3. Recording

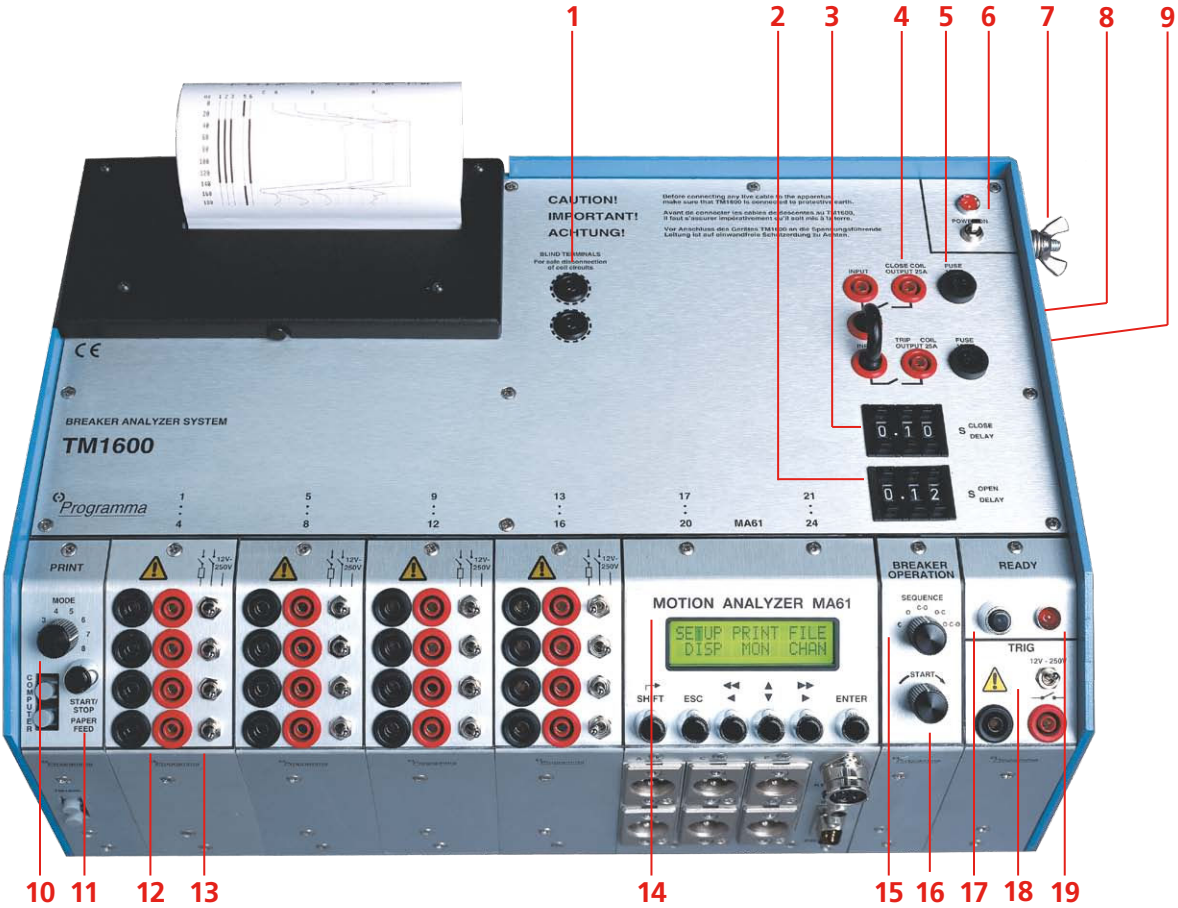
- Press the READY button to prepare the TM1600 for measurement.
- Turn the START knob. Travel measurement, time measurement and the breaker sequence all start simultaneously. The inputs now record the input voltages obtained from the connected transducers.

4. Test report

- The motion recording report includes both curves and a table. The table presents calculated breaker parameters such as closing speed, opening speed, overtravel and penetration.
- The diagram shows one or more time/amplitude curves and the calculated breaker parameters. The time axis scale factor can be changed to provide you with a quick overview or an enlarged view of part of the diagram.
- The position of the curve in the diagram and the amplitude scale factor can also be changed to make best use of the available space.
- The damping and speed variations at closing and opening times can be studied on the speed curve obtained from each of the motion-monitoring channels.



1. **"PARKING" TERMINALS.** Safety terminals for breaker control wires. Not connected to internal circuits.
2. **OPEN DELAY.** Trip pulse delay setting. Pulse delay is measured from the start of the previous pulse. 10 ms resolution.
3. **CLOSE DELAY.** Closing pulse delay setting. Pulse delay is measured from the start of the previous pulse. 10 ms resolution.
4. **Breaker control outputs.** Two separate contact functions.
5. **Fuses** for breaker control outputs.
6. **Power ON/OFF** Power-ON lamp. Flashing = Low battery
7. **Earth** (ground) connection
8. **TRIG OUT**. Output for synchronous start of other equipment. Short-circuits the terminals at instant of triggering. Used when several TM1600s are used together.
9. **REMOTE START** input. External short-circuit provides same result as turning the start switch (item 16).
10. **PRINT MODE**. Report format selector switch.
11. **Printer START/STOP** and PAPER FEED button. Paper feed if pressed longer than 1 s.
12. **Timing channel** input terminals.
13. **Timing channel mode switch**.
    Contact mode: 0-250 Ω
    Resistor contact mode: 0-3 kΩ
    Voltage mode: 12-250 V unpolarized
14. **Motion Analyzer** MA61.
15. **Breaker operation SEQUENCE** selector switch.
    C = Close, O = Open
16. **START** of breaker operation and recording switch. Recording starts only if the Ready lamp is on.
17. **READY** for measuring button. Enables the timing channels.
    1st touch: Prepares for normal recording. Enables the timing channels throughout 90 s.
    2nd touch: Provides long-term monitoring (optional).
18. **TRIG**. Input for external start of recording. Recording starts if the READY lamp is on.
    Contact mode: 0-250 Ω
    Voltage mode: 12-250 V unpolarized
19. **READY** lamp.
    Steady light: Ready for normal recording.
    Slow flash: Ready for long term monitoring (optional).
    Fast flash: Measurement in progress.



MA61 Motion Analyzer

The MA61 Motion Analyzer is an excellent supplement to the TM1600. It combines the easy readability of an oscillograph with the extra accuracy ensured by computerized measurement and computer-processed readings. Menu-driven button selection via the built-in display makes operation simple and easy.

The MA61 can be equipped with up to 6 analog channels, and it can be easily adapted to the different measurement requirements for high-voltage circuit breaker testing. It can measure and calculate contact paths and the speeds at which breaker contacts operate as well as the current in operating coils. It can also measure dynamic resistance (DRM), voltage, pressure, vibration signals and other analog entities.

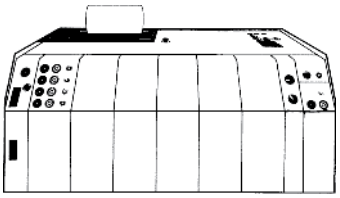
After measurement, the MA61 performs the necessary calculations and prints results in both diagram and table form via the TM1600's built-in printer. Moreover, parts of curves can be easily enlarged for closer study.

The MA61 incorporates a battery-backed memory that can store up to ten measurements for subsequent processing.

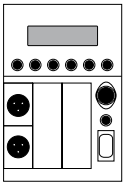
CABA Win

CABA Win is a circuit breaker analysis software designed to be used with the TM1600/MA61. CABA Win organizes all the test tasks and ensures that measurements are conducted in the same way for each object being tested.

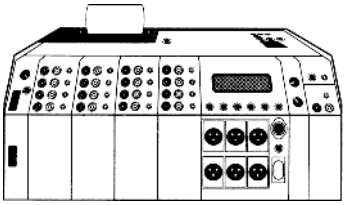
CABA Win saves the results and generates the report. In the analysis section, you can work with a number of graphic windows, compare different measurements by overlaying one graph on another in the same display, and use cursors and powerful zoom functions for detailed analysis. CABA Win simplifies testing and ensures the quality of the test procedure.



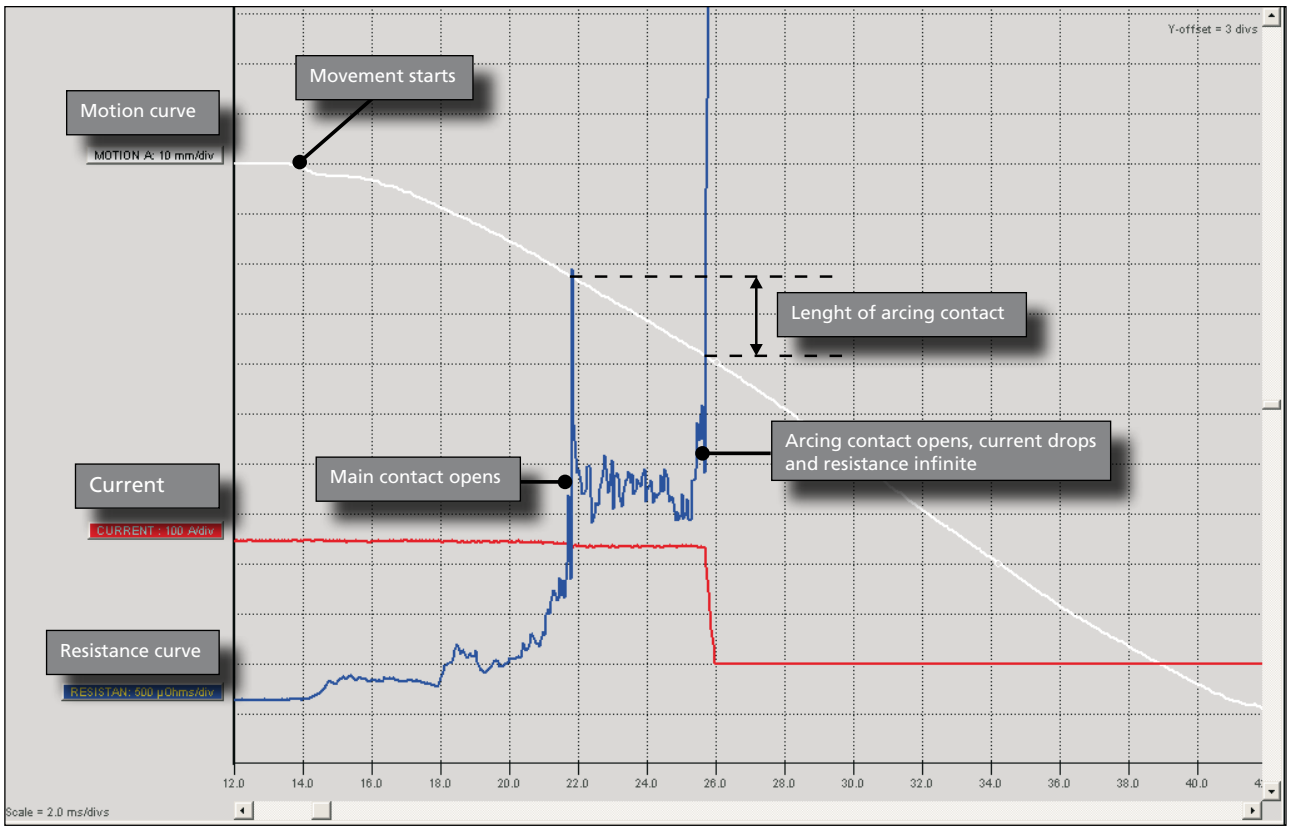
TM1600 Basic Unit with four time-measuring channels, BL-39091



MA61 Basic Unit with two analog channels, BL-12092



Fully equipped TM1600 with 16 time-measuring channels and MA61 with six analog channels, BL-39098



DRM is a reliable method to estimate the length/wear of the arcing contact. The SDRM202 provides high current and the TM1600 gives an accurate measurement with very good resolution.

Specifications TM1600

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

Environment

Application field	The instrument is intended for use in medium and high-voltage substations and industrial environments.
Operating temperature	
TM1600	-20 to +50°C (-4 to +122°F)
MA61	-10 to +50°C (+15 to +122°F)
Storage temperature	
TM1600	-30 to +70°C (-22 to +158°F)
MA61	-30 to +85°C (-22 to +185°F)
Humidity	5% – 95% RH, non-condensing

CE-marking

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

General

Mains voltage	85-270 V AC or 100-270 V DC (set automatically), 47-63 Hz
Power consumption	150 W (max)
Battery operation	Built-in battery with automatic charger
Dimensions	
TM1600 Basic Unit	400 x 250 x 153 mm (15.7" x 9.8" x 6.0")
Transport case	520 x 485 x 210 mm (20.5" x 19.1" x 8.3")
Weight	
TM1600 Basic Unit	6.5 kg (14.3 lbs)
Time-measuring module	0.6 kg (1.3 lbs)
MA61	1.1 kg (2.4 lbs)
Transport case	5.1 kg (11.2 lbs)
Complete TM1600/ MA61	12 kg (26.5 lbs). 20 kg (44.1 lbs) with accessories and transport case.

Time measurement

Maximum configuration: 24 time-measuring channels (6 time measuring modules) or 16 time-measuring channels and six analog channels (4 time-measuring modules and one MA61).

Range	0 to 6.5 s (up to 1000 s with CABA)
Resolution	0.1 ms
Inaccuracy	0.01% of printed value ± 0.1 ms
Start time measurement	Automatic a) when breaker is operated from the TM1600, b) when an external event actuates the trigger input or c) optionally when the status of any time-measuring channel is changed.
Trigger input	Independent input with its own voltage source. Measurement starts when voltage is detected or when contacts close. Same data as for time-measuring channel when it is in the contact-measuring state or voltage detection state.
Trigger output	Closing capacity, up to 1 A

Breaker operation

Contact functions	Two independent contact functions
Contact properties	Bounceless closing. Closing time < 0.1 ms
Sequences	C, O, C-O, O-C, O-C-O
Make / break capacity	25 A, 250 V (AC or DC) per contact function
Start breaker operation	Locally via rotary switch or remotely by closing contacts at the opto-isolated start input.
Time difference between control pulse and timer start	< 0.1 ms
Pulse delay	Adjustable in steps of 10 ms

Printout

Types of printout	A number of different printout formats are available, both graphic and numeric. Printout can be obtained in English, German, French, Spanish, Italian, Swedish or Finnish.
Printer	Thermal printer with fixed print head
Graphic resolution	8 dots/mm (203 dpi)
Paper width	114 mm (4.5")

Time-measuring module

No. of channels	4
Time-measuring channels	Each channel is independent of the others and has its own limited-current DC voltage source. Each channel can be set to measure main contacts, resistor contacts or to detect voltage. The input circuits are provided with 2.5 kV opto-isolators.
Time-measurement at main contacts	0 to 250 Ω. Test voltage is about 25 V. Measurement current is limited to about 150 mA.
Time-measurement at resistor contacts	250 Ω to 3 kΩ. Test voltage is about 50 V. Measurement current is limited to about 30 mA.
Voltage detection	12 to 250 V. Detection indicates that voltage is present. Independent of polarity. Provides a load of at least 3 W.
Protection of inputs against transients	All inputs have protective diodes. 18 kW, 8/20 µs between sockets and 4.8 kW, 8/20 µs between socket and ground.
Induction protection	Capacitive discharge to ground. Max 15 mA per input.

Specifications MA61

No. of channels	2, 4, 6
Measurement ranges	
Transducer resistance	100 Ω to 10 kΩ
Voltage	-4 to +4 V
Measurement resolution	0.03% (0.006% optional)
Basic inaccuracy	0.5%
Dynamic errors	
Motion	1%
Speed	3%
Time-base inaccuracy	0.02%
Measurement interval	50, 100, 200, 400 or 1000 ms, user selectable (up to 200 s with CABA)
Sampling frequency	1-20 kHz (40 kHz optional)
Display	Back-lit LCD, two 16-character lines

Accessories

Vibration kit, BL-13090
Includes: SCA606, CABA Win Vibration software and one Vibration transducer kit

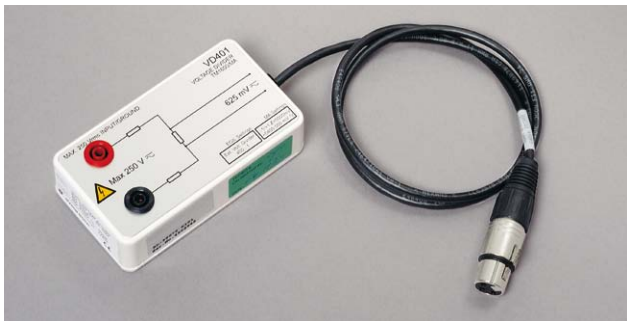
Vibration transducer kit, XB-32010
Includes: Cable SCA606/COAX, Transducer DYTRAN 3200B5, Cable DYTRAN, Cable XLRF/XLRM 1m and Transducer kit VIB.

SDRM202

SDRM Cable

Rotary transducer mounting kit, XB-51010

Rotary transducer, Novotechnic IP6501 (analog)



Voltage divider, VD401

Linear transducer, LWG 150

Switch magnetic base

Universal support

Cable XLR, GA-00760

Extension cable XLR, GA-01005

Linear transducer, TLH 225

Linear transducer, TS 25

Cable reels, 20 m (65.5 ft), 4 mm stackable safety plugs

Ordering information

Item	Art.No.
TM1600	
The TM1600/MA61 Breaker Analyzer System can be equipped with time-measuring and analog channels as desired. The TM1600 Basic Unit includes two rolls of thermal printer paper, 2.5 m (8.2 ft) power cord, transport case and ground cable.	
TM1600/4 Basic Unit with 4 timing channels	BL-39091
TM1600/8 Basic Unit with 8 timing channels	BL-39092
TM1600/12 Basic Unit with 12 timing channels	BL-39093
TM1600/16 Basic Unit with 16 timing channels	BL-39094
TM1600/20 Basic Unit with 20 timing channels	BL-39095
TM1600/24 Basic Unit with 24 timing channels	BL-39096
Separate module With four time-measuring channels	BL-19010
MA61	
Each of the MA61/2-6 includes: ■ One shielded cable/channel, 1 m (3.3 ft) (with female XLR connectors and bare-wire ends) ■ One shielded cable/channel 7.5 m (24.6 ft), (with male and female XLR connectors) ■ One shielded cable, 1 m (3.3 ft) with female XLR connectors an 4 mm safety plugs	
MA61/2 MA61 Basic Unit with 2 analog channels	BL-12092
MA61/4 MA61 Basic Unit with 4 analog channels	BL-12094
MA61/6 MA61 Basic Unit with 6 analog channels	BL-12096
Separate module With two analog channels	BL-12010
MA61S High speed (40 kHz/14 bit) measurement module for vibration measurements with 2 analog channels.	BL-12020
TM1600/MA61	
Basic unit includes two rolls of thermal printer paper, 2.5 m (8.2 ft) power cord, transport case and ground cable.	
Basic unit with 16 time-measuring channels, 2 analog channels and CABA Win Incl. accessories (see MA61)	BL-39192
Basic unit with 16 time-measuring channels, 4 analog channels and CABA Win Incl. accessories (see MA61)	BL-39194
Basic unit with 16 time-measuring channels, 6 analog channels and CABA Win Incl. accessories (see MA61)	BL-39098

Item	Description	Art. No.
Optional Accessories		
Software and application kits		
CABA Win – Circuit Breaker analysis software		
CABA Win	incl. fiberoptics and USB interface	BL-8203X
CABA Win upgrade	Upgrade to latest version	CG-8010X
Vibration analysis		
Vibration kit	The Vibration kit extends TM1600 and CABA Win with the equipment and software required for recording and analyzing vibration signals at a circuit breaker. The kit includes the signal conditioning unit SCA606, the software CABA Win Vibration and one Vibration transducer kit. The vibration solution can be extended up to 6 channels.	BL-13090
Vibration transducer kit	Additional Vibration transducer kit to be used together with the Vibration kit. Each Vibration transducer kit includes accelerometer, accelerometer adapter, cables to SCA606 and cables to TM1600.	XB-32010
Synchronized Switching Relay test kit		
SSR kit incl. accessories, software and cables	SSR kit for TM1600 (incl. VD401) *(delivered in transport case)*	BL-91200
Static and Dynamic Resistance Measurement		
SDRM202	The SDRM202 uses new technology, patent pending, with ultra capacitors. The current output is up to 220 A from a box that weighs only 1.8 kg (4 lbs). The weight of the current cables is also low because the SDRM202 is placed very close to the circuit breaker. Timing M/R measurement can be done with the same hook-up	CG-90200
SDRM202 Pack of 3 units	Pack for CB with 2 Breaks / Phase	CG-90230
Extension cable SDRM202	7.5 m (24.6 ft)	GA-12815
	10 m (33 ft)	GA-12810
Transducers – Linear		
TLH 500	500 mm (20”) travel Incl. cable 0.5 m (20”)	XB-30020
LWG 225	225 mm (9”) travel Incl. cable 0.5 m (20”)	XB-30117
TS 150	150 mm (5.9”) travel Incl. cable 1.0 m (39”)	XB-30030
TS 25	25 mm (1”) travel Incl. cable 1.0 m (39”)	XB-30033

Ordering information

Item	Description	Art. No.
The above transducers are also available in other lengths, please contact Megger for more information.		
Transducers – Rotary		
Novotechnic IP6501	Incl. cable 1 m (39”), 6 mm Flex coupling, Hexagon wrench	XB-31010
Flex coupling for IP6501	For shaft diam. 6 mm	XB-39030
Transducer mounting kits		
Universal kits		
Rotary transducer mounting kit	For transducers XB-31010 and XB-39130	XB-51010
Universal transducer mounting kit	For linear and rotary transducers	XB-51020
Circuit breaker specific kits		
LTB Kit (ABB)	Incl. mounting kit XB-51010, Software conversion table BL-8730X	XB-61010
HPL/BLG Kit (ABB)	Incl. mounting kit XB-51010, Software conversion table BL-8720X	XB-61020
Ready-to-use kits – Rotary		
1-phase kit	Incl. transducer XB-31010, mounting kit XB-51010	XB-71010
3-phase kit	Incl. 3 x 1-pase kits XB-71010	XB-71013
Transducer mounting accessories		
Universal support		XB-39029
Switch magnetic base		XB-39013
Cables		
Cable reel 20 m (65.5 ft), 4 mm stackable safety plugs	Black	GA-00840
	Red	GA-00842
	Yellow	GA-00844
	Green	GA-00845
	Blue	GA-00846
Extension cables, XLR female to male	For analog input, 10 m (32.8 ft)	GA-01005
Open analog cable	For customized analog transducer connection	GA-01000

Item	Description	Art. No.
XLR to 4 mm safety plugs	For customized analog transducer connection	GA-00040
Other		
VD401	Voltage divider, ratio 400/1 (for TM1600 with analog channel)	BL-90070
PIR adapter	Used to test circuit breakers with pre-insertion resistors when resistance is lower than 250 Ω or higher than 3000 Ω. There are two versions: PIR, 15 – 250 Ω	BL-90080
	PIR2, 90 – 4500 Ω	BL-90082
Current sensor	Current sensor kit 1 channel (Fluke 80i-110s incl. cable GA-00140)	BL-90600
	Current sensor kit 3 channels (Fluke 80i-110s incl. cables GA-00140)	BL-90610
Thermopaper	114 mm, 30 m	GC-00030
Cable organizer	Velcro straps, 10 pcs.	AA-00100

For more information about optional accessories please contact Megger Sweden AB.

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