

# 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**

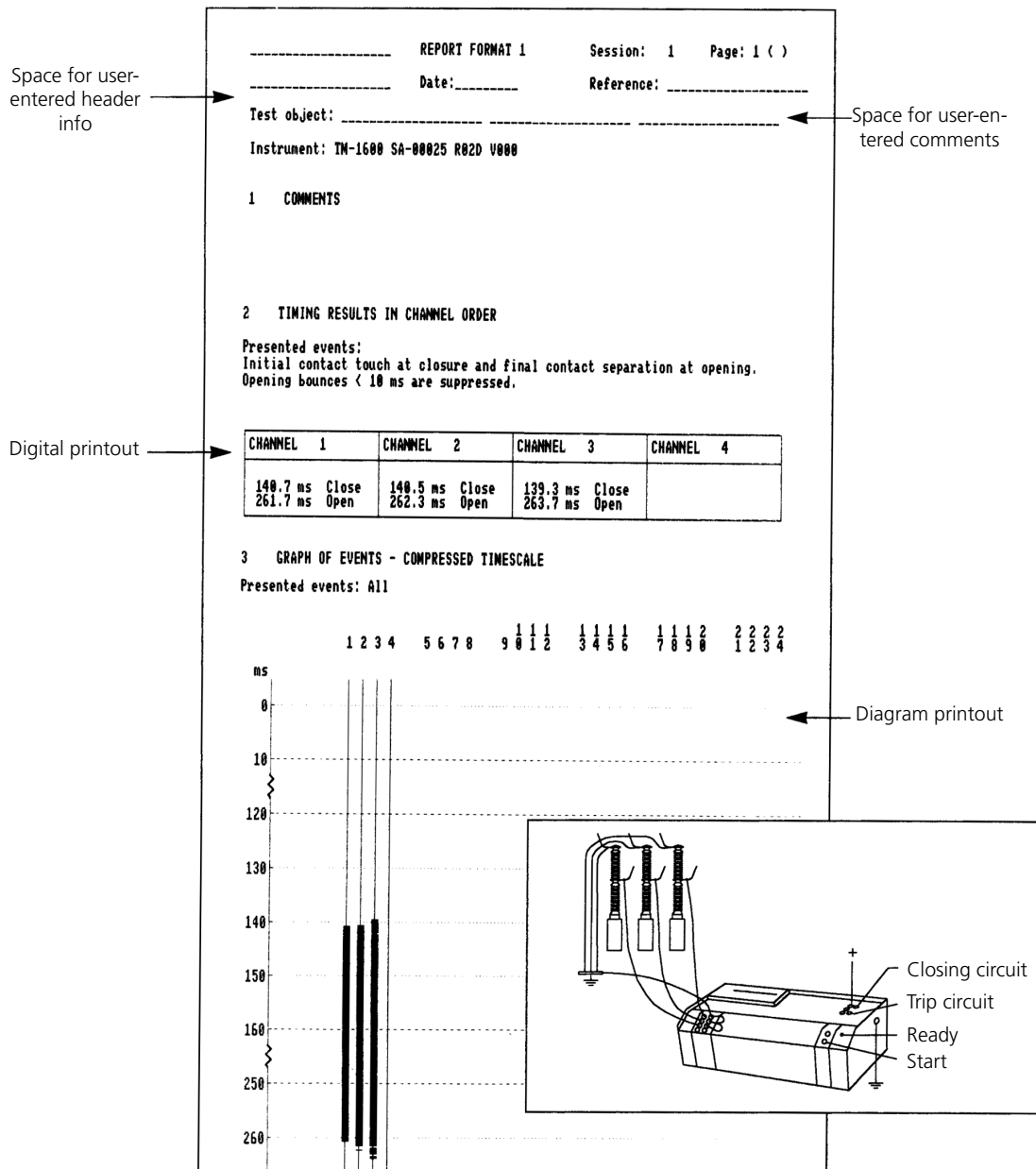
1. Setup
  - A typical breaker test hookup is shown in the figure below.
2. Preparation
  - Set the desired breaker operating sequence on the TM1600. In this case, CLOSE-OPEN (C-O).
3. Recording
  - Enable recording with the READY button. Start the breaker sequence and measurement simultaneously by turning 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
 

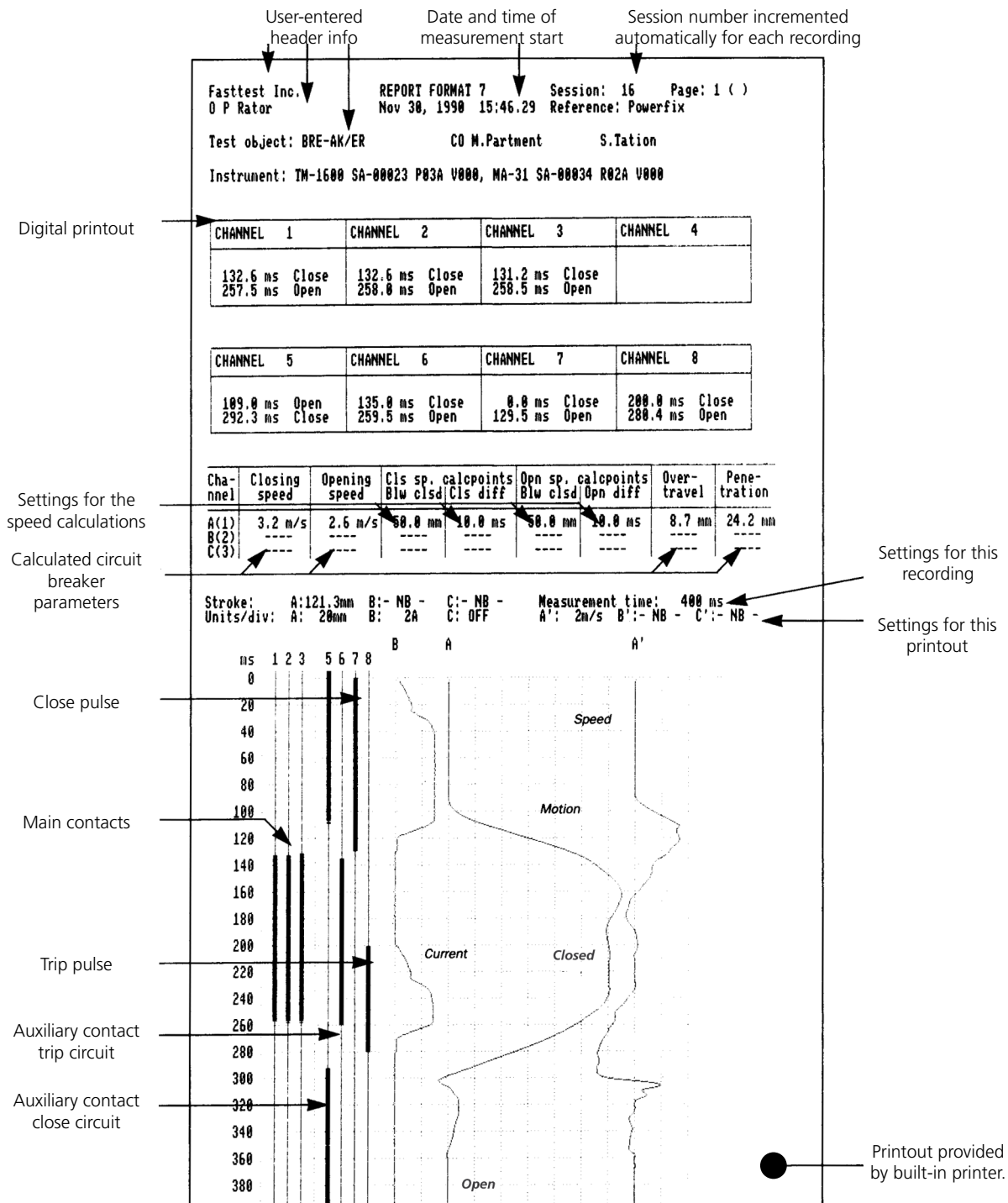
The following additional settings are needed when you include motion recording in circuit breaker analysis. These settings are menu-driven via the built-in display on the MA61.

  - 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.

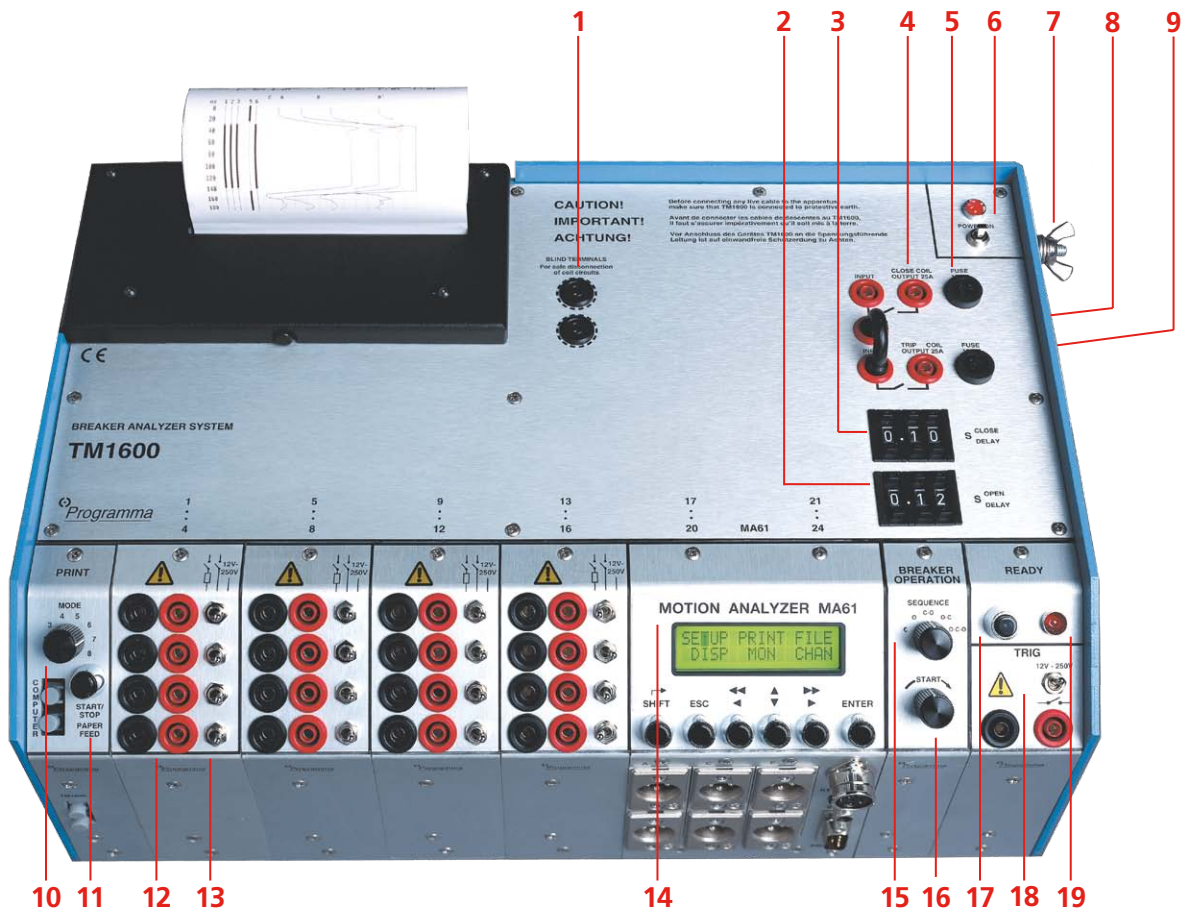


- Enter range and scale factor for other transducers (if used).
3. Recording
- Press the READY button to prepare the TM1600 for measurement.
  - Turn the START knob. Travel measurement, time measurement and the breaker sequence all start simultaneously. The inputs now record the input voltages obtained 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.

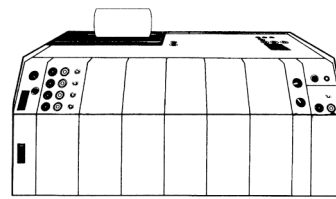
After measurement, the MA61 performs the necessary calculations and prints results in both diagram and table form via the TM1600's built-in printer. Moreover, parts of curves can be easily enlarged for closer study.

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

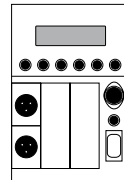
**CABA Win**

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.

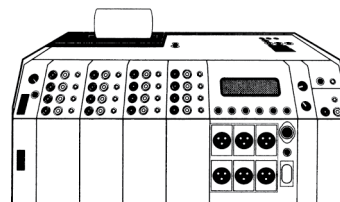
CABA Win saves the results and generates the report. In the analysis section, you can work with a number of graphic windows, compare different measurements by overlaying one graph on another in the same display, and use cursors and powerful zoom functions for detailed analysis. CABA Win simplifies testing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



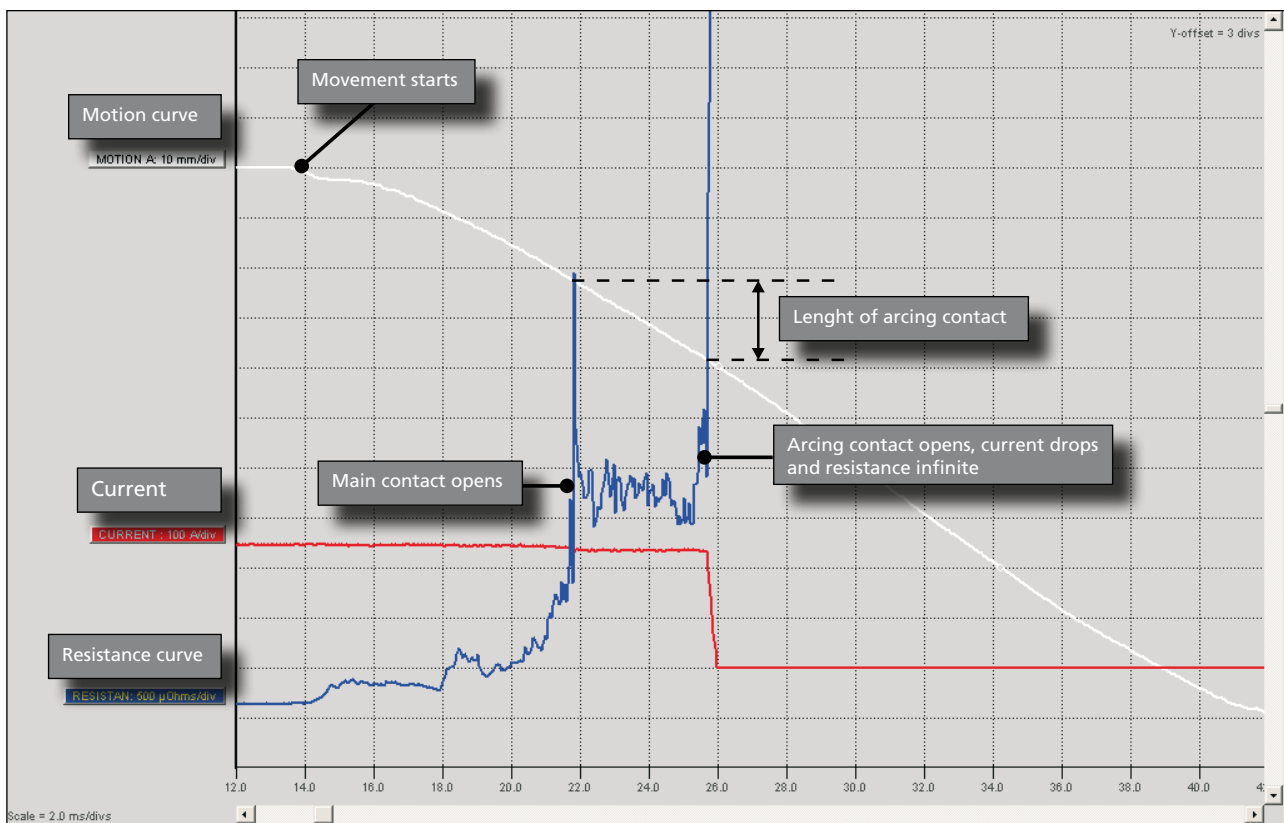
**TM1600 Basic Unit with four time-measuring channels, BL-39091**



**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**

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

**CE-marking**

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

**General**

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

<i>Range</i>	0 to 6.5 s (up to 1000 s with CABA)
<i>Resolution</i>	0.1 ms
<i>Inaccuracy</i>	0.01% of printed value ± 0.1 ms
<i>Start time measurement</i>	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.
<i>Trigger input</i>	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.
<i>Trigger output</i>	Closing capacity, up to 1 A

**Breaker operation**

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

**Printout**

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

**Time-measuring module**

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

**Specifications MA61**

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

**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



Linear transducer, TLH 225



Cable XLR, GA-00760



Extension cable XLR, GA-01005



Linear transducer, TS 25



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



Ordering information

Item	Art.No.	Item	Description	Art. No.
<b>TM1600</b>		<b>Optional Accessories</b>		
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.		<b>Software and application kits</b>		
<b>TM1600/4</b> Basic Unit with 4 timing channels		<b>CABA Win – Circuit Breaker analysis software</b>		
<b>TM1600/8</b> Basic Unit with 8 timing channels		<i>CABA Win</i>	incl. fiberoptics and USB interface	BL-8203X
<b>TM1600/12</b> Basic Unit with 12 timing channels		<i>CABA Win up-grade</i>	Upgrade to latest version	CG-8010X
<b>TM1600/16</b> Basic Unit with 16 timing channels		<b>Vibration analysis</b>		
<b>TM1600/20</b> Basic Unit with 20 timing channels		<i>Vibration kit</i>	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
<b>TM1600/24</b> Basic Unit with 24 timing channels		<i>Vibration transducer kit</i>	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
<b>Separate module</b> With four time-measuring channels		<b>Synchronized Switching Relay test kit</b>		
BL-19010		<i>SSR kit incl. accessories, software and cables</i>	SSR kit for TM1600 (incl. VD401) (delivered in transport case)	BL-91200
<b>MA61</b>		<b>Static and Dynamic Resistance Measurement</b>		
Each of the MA61/2-6 includes:		<i>SDRM202</i>	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
<ul style="list-style-type: none"> <li>■ One shielded cable/channel, 1 m (3.3 ft) (with female XLR connectors and bare-wire ends)</li> <li>■ One shielded cable/channel 7.5 m (24.6 ft), (with male and female XLR connectors)</li> <li>■ One shielded cable, 1 m (3.3 ft) with female XLR connectors an 4 mm safety plugs</li> </ul>		<i>SDRM202 Pack of 3 units</i>	Pack for CB with 2 Breaks / Phase	CG-90230
<b>MA61/2</b> MA61 Basic Unit with 2 analog channels		<i>Extension cable SDRM202</i>	7.5 m (24.6 ft) 10 m (33 ft)	GA-12815 GA-12810
<b>MA61/4</b> MA61 Basic Unit with 4 analog channels		<b>Transducers – Linear</b>		
<b>MA61/6</b> MA61 Basic Unit with 6 analog channels		<i>TLH 500</i>	500 mm (20") travel Incl. cable 0.5 m (20")	XB-30020
<b>Separate module</b> With two analog channels		<i>LWG 225</i>	225 mm (9") travel Incl. cable 0.5 m (20")	XB-30117
BL-12010		<i>TS 150</i>	150 mm (5.9") travel Incl. cable 1.0 m (39")	XB-30030
<b>MA61S</b> High speed (40 kHz/14 bit) measurement module for vibration measurements with 2 analog channels.		<i>TS 25</i>	25 mm (1") travel Incl. cable 1.0 m (39")	XB-30033
BL-12020				
<b>TM1600/MA61</b>				
Basic unit includes two rolls of thermal printer paper, 2.5 m (8.2 ft) power cord, transport case and ground cable.				
<b>Basic unit with 16 time-measuring channels, 2 analog channels and CABA Win</b> Incl. accessories (see MA61)				
BL-39192				
<b>Basic unit with 16 time-measuring channels, 4 analog channels and CABA Win</b> Incl. accessories (see MA61)				
BL-39194				
<b>Basic unit with 16 time-measuring channels, 6 analog channels and CABA Win</b> Incl. accessories (see MA61)				
BL-39098				

**Ordering information**

Item	Description	Art. No.	Item	Description	Art. No.
The above transducers are also available in other lengths, please contact Megger for more information.			<i>XLR to 4 mm safety plugs</i> For customized analog transducer connection GA-00040		
<i>Transducers – Rotary</i>			<i>Other</i>		
<i>Novotechnic IP6501</i>	Incl. cable 1 m (39”), 6 mm Flex coupling, Hexagon wrench	XB-31010	<i>VD401</i>	Voltage divider, ratio 400/1 (for TM1600 with analog channel)	BL-90070
<i>Flex coupling for IP6501</i>	For shaft diam. 6 mm	XB-39030	<i>PIR adapter</i>	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:	
<i>Transducer mounting kits</i>				<i>PIR, 15 – 250 Ω</i>	BL-90080
<i>Universal kits</i>				<i>PIR2, 90 – 4500 Ω</i>	BL-90082
<i>Rotary transducer mounting kit</i>	For transducers XB-31010 and XB-39130	XB-51010	<i>Current sensor</i>	Current sensor kit 1 channel (Fluke 80i-110s incl. cable GA-00140)	BL-90600
<i>Universal transducer mounting kit</i>	For linear and rotary transducers	XB-51020		Current sensor kit 3 channels (Fluke 80i-110s incl. cables GA-00140)	BL-90610
<i>Circuit breaker specific kits</i>			<i>Thermopaper</i>	114 mm, 30 m	GC-00030
<i>LTB Kit (ABB)</i>	Incl. mounting kit XB-51010, Software conversion table BL-8730X	XB-61010	<i>Cable organizer</i>	Velcro straps, 10 pcs.	AA-00100
<i>HPL/BLG Kit (ABB)</i>	Incl. mounting kit XB-51010, Software conversion table BL-8720X	XB-61020	For more information about optional accessories please contact Megger Sweden AB.		
<i>Ready-to-use kits – Rotary</i>					
<i>1-phase kit</i>	Incl. transducer XB-31010, mounting kit XB-51010	XB-71010			
<i>3-phase kit</i>	Incl. 3 x 1-pase kits XB-71010	XB-71013			
<i>Transducer mounting accessories</i>					
	<i>Universal support</i>	XB-39029			
	<i>Switch magnetic base</i>	XB-39013			
<i>Cables</i>					
<i>Cable reel</i>	Black	GA-00840			
<i>20 m (65.5 ft), 4 mm stackable safety plugs</i>	Red	GA-00842			
	Yellow	GA-00844			
	Green	GA-00845			
	Blue	GA-00846			
<i>Extension cables, XLR female to male</i>	For analog input, 10 m (32.8 ft)	GA-01005			
<i>Open analog cable</i>	For customized analog transducer connection	GA-01000			