TM1600

Circuit Breaker Analyzer System

Programma®

TM1600

Circuit breaker analyzer

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

Since the timing channels are not interconnected, you can take measurements of resistor contacts and seriesconnected 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).

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-voltage substations and industrial environments up to 130 kV.
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	
LVD	Low Voltage Directive 73/23/ EEC am. by 93/68/EEC
EMC	EMC Directive 89/336/EEC am. by 91/263/ EEC, 92/31/EEC and 93/68/EEC
General	
Mains voltage	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 timemeasuring 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 200 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 timemeasuring 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	6 dots/mm (150 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

Application example

Setup
A typical breaker test hookup is shown here.

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

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

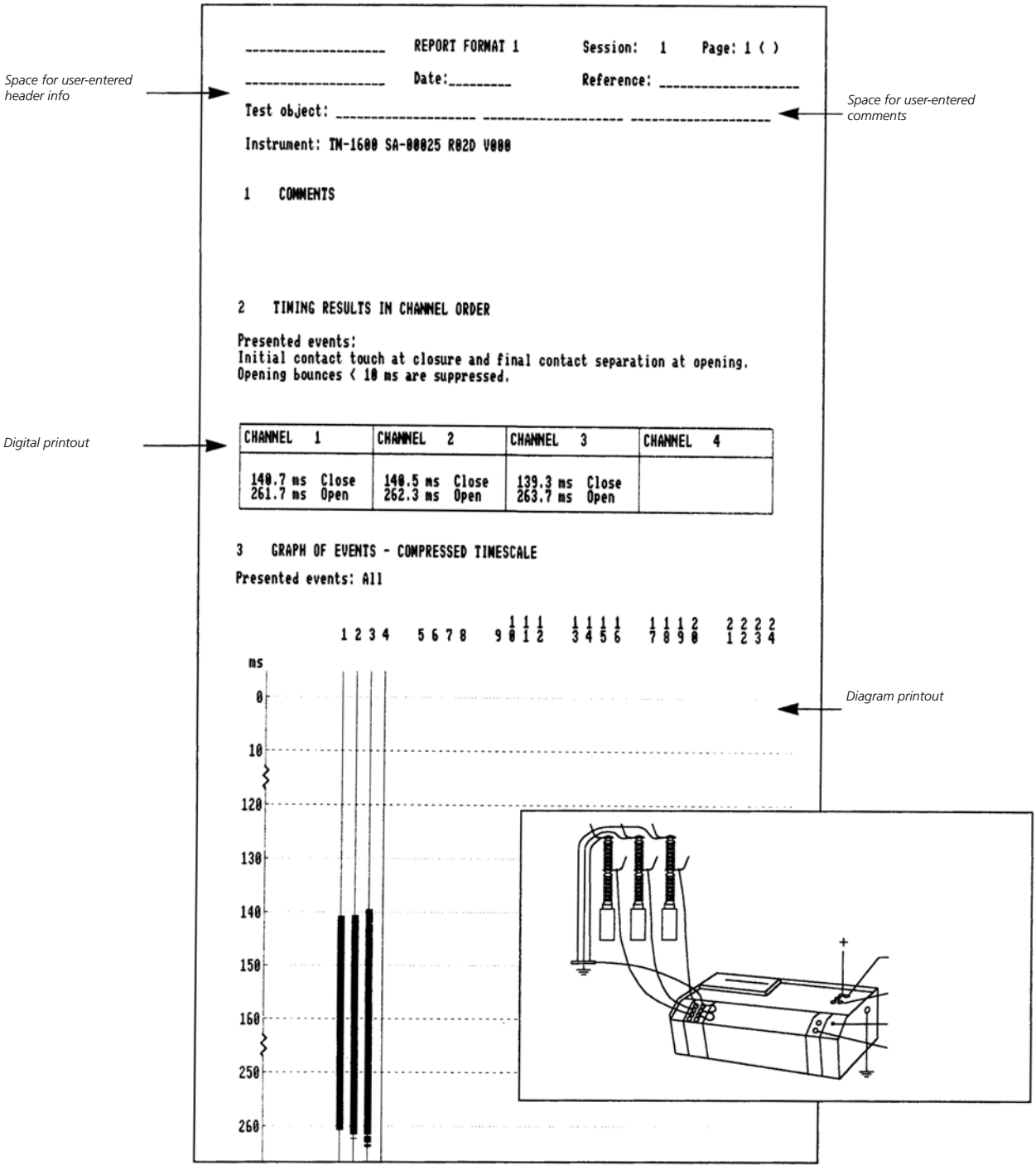
Test report
The result is printed automatically. This example shows a CLOSEOPEN (C-O) sequence presented in the report 1 format (85 % of actual size). Only the initial contact closing time (for CLOSE) and final contact separation time (for OPEN) are presented in the report 1 format. Short bounces are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

Timing with motion recording

Setup
Connect the transducers to the circuit breaker.

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.

1. Select test interval (50 ms to 1 s).
2. 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.



3. Enter the current range and the scale factor for the current shunt if current is to be measured.
4. Enter range and scale factor for other transducers (if used).

Recording

Press the READY button to prepare the TM1600 for measurement.

Travel measurement, time measurement and the breaker sequence all start simultaneously when you turn the START knob.

The inputs now record the input voltages obtained from the connected transducers.

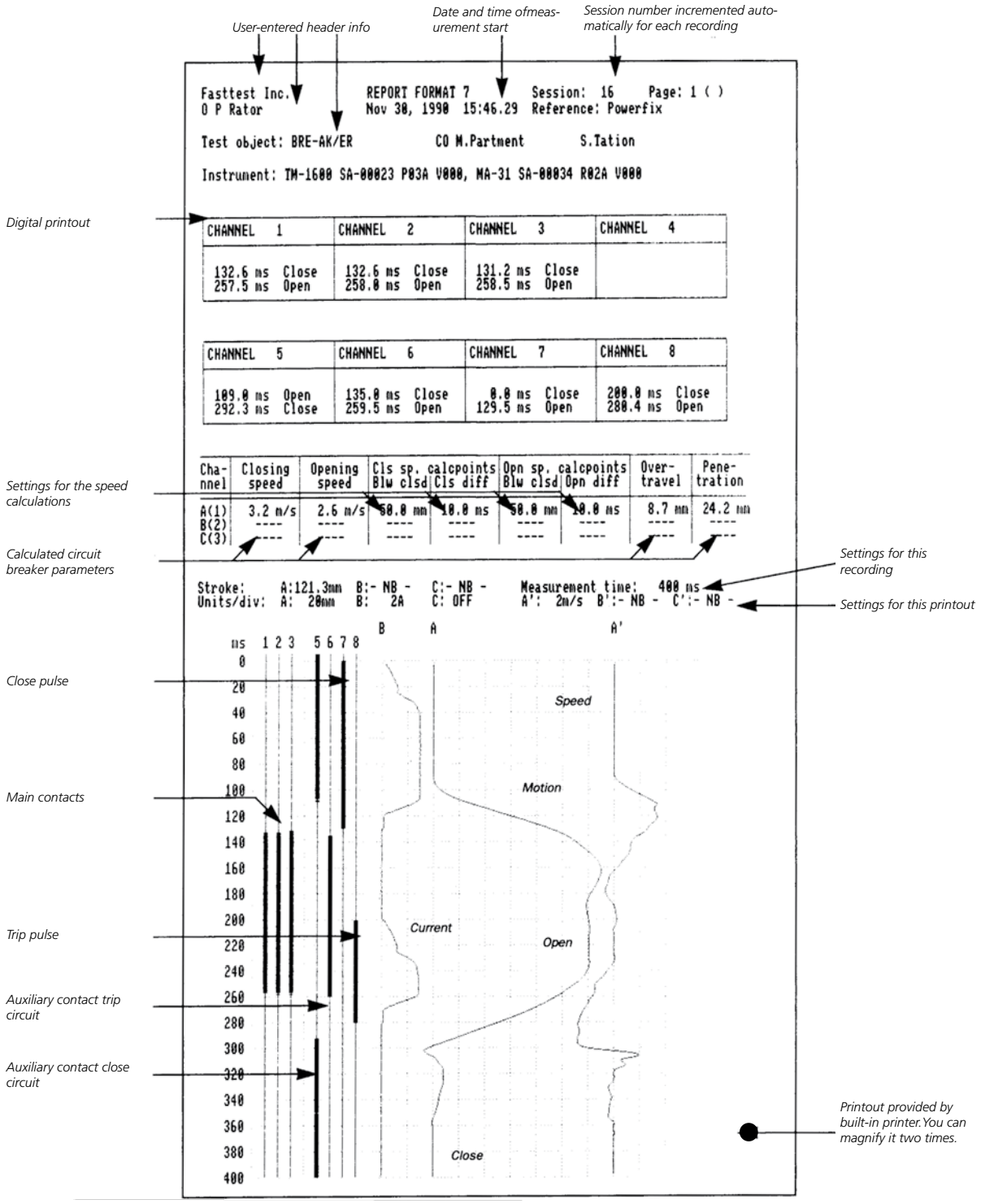
Test report

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.



❶ Earth (ground) connection

❷ "PARKING" TERMINALS. Safety terminals for breaker control wires. Not connected to internal circuits.

❸ Power ON/OFF

❹ POWER-ON lamp. Flashing = Low battery

❺ Breaker control outputs. Two separate contact functions.

❻ Breaker operation SEQUENCE selector switch.
C = Close, O = Open

❼ START of breaker operation and recording switch.
Recording starts only if the Ready lamp is on.

❽ CLOSE DELAY. Closing pulse delay setting.
Pulse delay is measured from the start of the previous pulse.
10 ms resolution.

❾ OPEN DELAY. Trip pulse delay setting. Pulse delay is measured from the start of the previous pulse. 10 ms resolution.

❿ Timing channel input terminals.

⓫ Timing channel mode switch.
Contact mode: 0-250 Ω
Resistor contact mode: 0-3 kΩ
Voltage mode: 12-250 V unpolarized

⓬ 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).

⓭ READY lamp.
Steady light: Ready for normal recording.
Slow flash: Ready for long term monitoring (optional).
Fast flash: Measurement in progress.

⓮ PRINT MODE. Report format selector switch.

⓯ Printer START/STOP and PAPER FEED button. Paper feed if pressed longer than 1 s.

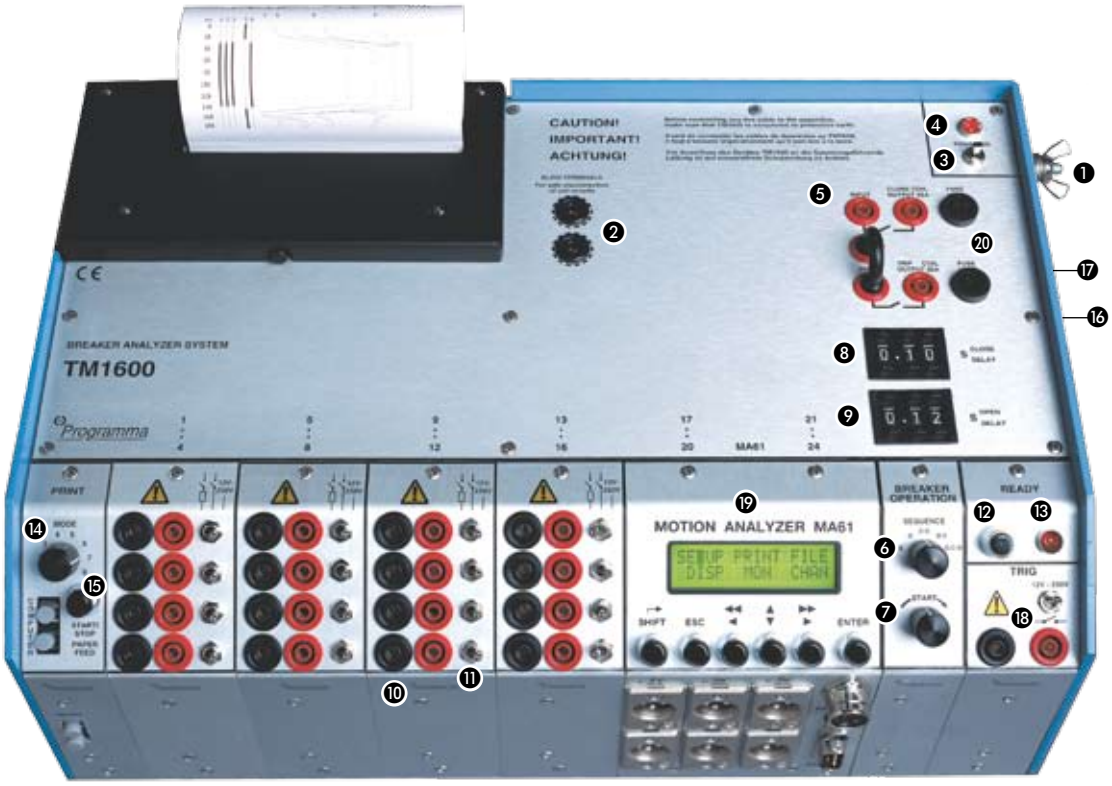
⓰ REMOTE START input. External short-circuit provides same result as turning the start switch (item 7).

⓱ TRIG OUT. Output for synchronous start of other equipment. Short-circuits the terminals at instant of triggering. Used when several TM1600s are used together.

⓲ 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

⓳ Motion Analyzer MA61.

⓴ Fuses for breaker control outputs.



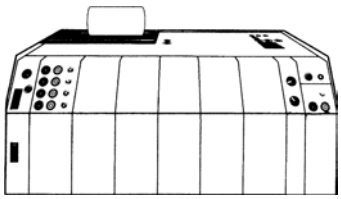
MA61 Motion Analyzer

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.

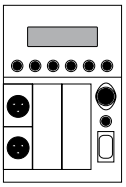
The MA61 can be equipped with up to 6 analog channels, and it can be easily adapted to the different measurement requirements for high-voltage circuit breaker testing. It can measure and calculate contact paths and the speeds at which breaker contacts operate as well as the current in operating coils. 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 on a connected printer (letter-size A4 paper) or via the TM1600's built-in printer. Moreover, parts of curves can be easily enlarged for closer study.

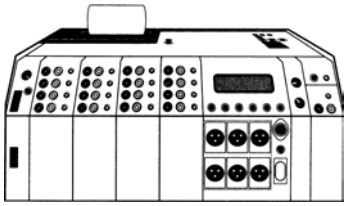
The MA61 incorporates a battery-backed memory that can store up to ten measurements for subsequent processing.



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

Ordering information

	Art.No.
The TM1600/MA61 Breaker Analyzer System can be equipped with time-measuring and analog channels as desired.	

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 1.0 m (3.3 ft) shielded cable/channel (with female XLR connectors and bare-wire ends), and one 7.5 m (24.6 ft) shielded cable/channel (with male and female XLR connectors)

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 and 2 analog channels	
Incl. accessories (see MA61)	**BL-39192**
Basic unit with 16 time-measuring channels and 4 analog channels	
Incl. accessories (see MA61)	**BL-39194**
Basic unit with 16 time-measuring channels and 6 analog channels	
Incl. accessories (see MA61)	**BL-39098**

Optional accessories

See section "Circuit breaker testing accessories"

Programma Electric AB
Eldarvägen 4
Box 2970
SE-187 29 TÄBY
Sweden

T +46 8 510 195 00
F +46 8 510 195 95
info@programma.se
www.programma.se

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