M4000

Automated Insulation Analyzer

Measures

- Voltage
- Total Current for Capacitive, Inductive, or Resistive Loads
- Power Loss
- Power Factor/Tan Delta
- Capacitance
- Inductance
- Resistance

Options

- Transformer Leakage Reactance and Loss
- Transformer Turns Ratio
- Doble Test Assistant Software® DTA
  - *Embedded Expert System*
  - *Apparatus Templates*

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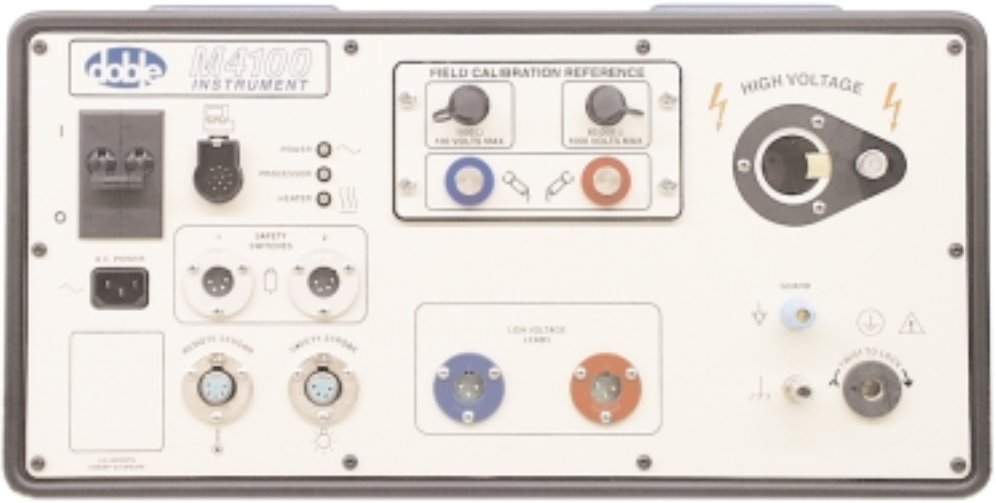


The M4000, together with Doble Test Assistant® (DTA) expert system, was specially developed as a result of feedback from power system executives that their personnel must be empowered to do quality work, though their numbers and experience levels are tending to decrease. Although you may have expert testers now, the situation could be significantly different only a few short years from now.

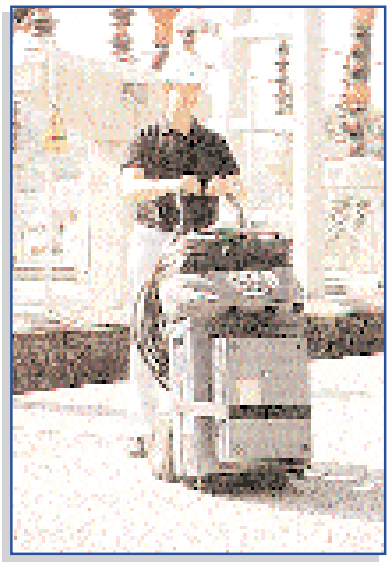
Easy to use "smart" instruments, with expert system software to help interpret the results (in effect, raising a "flag" for all test results outside the norm), will make your test program more efficient, reducing the likelihood that expensive extra outages will be required in the future due to testing mistakes and mis-diagnoses.

Smart technology results in additional benefits, both subtle and profound. For example, with the M4000 design there is less likelihood that excess test voltage will be accidentally applied to specimens. However, to cite an example with more fundamental consequences, in-service failures (which might be the result of calculation errors and mis-diagnoses of test results), also will be less likely to occur when using the "system" approach involving the M4000 in combination with DTA.

Ruggedness, translated into the ability of the instrument to perform consistently despite rough handling and transportation, is another aspect to consider. If the instrument or its associated test leads should fail after the apparatus has been cleared for test, considerable time and effort will have been lost and a second outage may be required. Doble experience in the area of field testing has resulted in the development of rugged and reliable instruments - and test leads!

While in no way intending to minimize the importance of lower voltage apparatus to system reliability, all EHV insulation (at least) should be tested with the Doble M4000. With our new Line Frequency Modulation technique for rejecting interference, many low capacitance EHV specimens (e.g., breaker columns) will be quickly and easily tested without having to disconnect sections of bus and grounding adjacent modules. This alone will save considerable time, effort, and expense, in addition to the fact that the test results will be more accurate and reliable than ever before in locations of unusually severe interference.

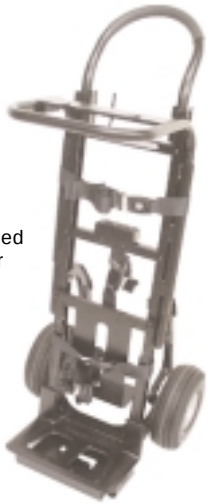
In summary, doing more with less means that field-test engineers must work smarter and more efficiently than before. This requires that they be provided with the optimum tools to do the job.



M4000 test equipment and accessories assembled for field transportation.

M4000 assembled for testing in the field

The M4000 Transport's rugged construction is specifically designed to ensure smooth easy travel over all field conditions.



The safety and protection of the M4000, Transport and Accessories can be ensured through the Doble-designed and NSTA approved Transit Cases. Every component of the Transit Case is specifically designed to individually house and protect each component of the M4000 Insulation Analyzer. The Doble Transit Cases are constructed from the best materials offered for reliability and travel safety.

- *High-densisty plastic molded shell for durability.*
- *Tight seal rubber gaskets to lock out the elements*
- *Custom configured shock absorbing foam rubber lining.*
- *Alloy metal hinges and recessed twist-lock fasteners.*
- *Alloy metal recessed snap-back carry handles.*

For more information regarding Doble products and services please visit our website at: www.doble.com

The M4000 10-kV Portable Automated Insulation Analyzer is the new generation of test equipment for determining the insulation quality of high voltage power apparatus in the field. The new M4000 Insulation Analyzer is now:

- Automated with Windows™ software for easy operation.
- More accurate and sensitive, for testing apparatus under conditions of high electrostatic and electromagnetic interference, due to shielding features and the new Line Frequency Modulation Measuremeant Technique.
- Easier to move and position using the M4300 Transport Option.
- Able to test apparatus over greater range (300 mA maximum current; 12-kV maximum test voltage).
- Simple to operate: select the test mode, select the voltage, press the safety switches, rate the test voltage, observe the display, print the report.

Software Features

Windows™ software
Measures the power factor of all impedances (capacitive, resistive, and inductive).
Measures and records ambient temperature and relative humidity.
Automatic time and date recording.
Measures tan delta or power factor
Software configuration for 50 or 60 Hz.
Measures actual or equivalent 10-kV values.
Digital displays of all parameters.
Real-time analog bar graph display of V, I, and W.
Select series or parallel specimen model.
Doble Test Assistant® (DTA) option, software program with Expert System Analysis (see sample test form, back of brochure).
Software Test Procedures, Apparatus templates, and Help

M4100 Instrument Features

Rugged construction built to travel in back of van or trucks over unpaved road.
Built-in calibration and diagnostics
Turns Ratio can be measured
Short-Circuit Impedence of transformers can be measured (using M4100 Leakage Reactance Interface) Instrument.
Line-Frequency Modulation Measurement Technique maintains high accuracy even under the most severe conditions of electrostatic and electromagnetic interference.
Test frequency is independent of power-line frequency (stable readings with no loss in performance when used with portable generators).
Stable, noise free, test voltage electronically synthesized.
300 mA maximum current at 10-kV; 12-kV maximum test voltage.
Accurate measurements with voltage as low as 25 volts.
Built-in field status diagnostics with suplied software.
Uses internal resistance standard reference; the same Doble 10-kV insulation test instrument standard since the early 1950s.
Resonating Inductor option extends the capacitance range of test specimens to 1μF at 10 kV.

Safety Features

Test instrument and voltage supply are commonly grounded.
Strobe light flashes when voltage is applied.
Audible warning indicator sounds at the start of a test.
Circuitry protects apparatus from damage and personnel from injury.

M4100 Technical Specifications

Power Specifications

Output Voltage

Range: 0 to 12 kV

Distortion: 2% total harmonic distortion for linear loads. Compares with normal building 120 V ac outlets

Output Current 100 mA continuous at 10 kV
300 mA intermitten at 10 kV

Output Power 3 kVA

Input Power 95-132, 190-264 V ac, autoselectable 47 to 63 Hz with no loss in performance when used with portable generators. 20 A max. at 110 V, 10 A max. at 220 V

Measurement Accuracy and Range

Test Frequency

Range: 45 to 70 Hz

Resolution: 0.1 Hz

Accuracy: ±1% of reading

Test Voltage

Range: 25 V to 12 kV

Resolution: 1 V

Accuracy: ±1% of reading, ±1V

Test Current:

Range: 0 to 5.0000 A auto ranging
0 to 50.0 A when corrected or referred to 10 kV

Resolution: 0.0001mA (0.1µA)

Accuracy: ±1% of reading, ±1 µA

Power Factor:

Range: 0 to ±100.00% PF (±0 to 1.0000)

Resolution: 0.01% PF (0.0001)

Accuracy: ±1% of reading
±0.04% PF (0.0004)

Capacitance

Range: 0 to 2.7 µF auto ranging

Resolution: 0.1 pF

Accuracy: ±0.5% of reading, ±1 pF

Inductance

Range: 132 H to 1000 kH at 10 kV

Resolution: 0.001 mH

Accuracy: ±1.5% of reading

Watts

Range: 0 to 2 kW, actual power
0 to 100 kW when corrected or referred to 10 kV

Resolution: 0.5 mW

Accuracy: ±2% of reading at 10 kV
±0.03% of VA, ±0.5 mW

Temperature Measurement

Range: -20°C to+50°C

Accuracy: ±4°C

Maximum Interference Conditions

Electrostatic at Line Frequency 15 mA, rms, maximum current into any lead or cable. Specifications applicable (typically) to maximum ratio of interference current to specimen current of 20:1.

Electromagnetic at Line Frequency 500 µT, at 60 Hz, in any direction

Environmental

Temperature

Operating: -20°C to+50°C

Storage: -40°C to+70°C

Humidity 80% to 90%, non-condensing

Electrostatic Discharge Meets I.E.C. 801-2(1984)

Surge Withstand Capability Meets ANSI/IEEE C37.90.1

Shock and Vibration ASTM D999.75 transport shock test

Dimensions and Weights

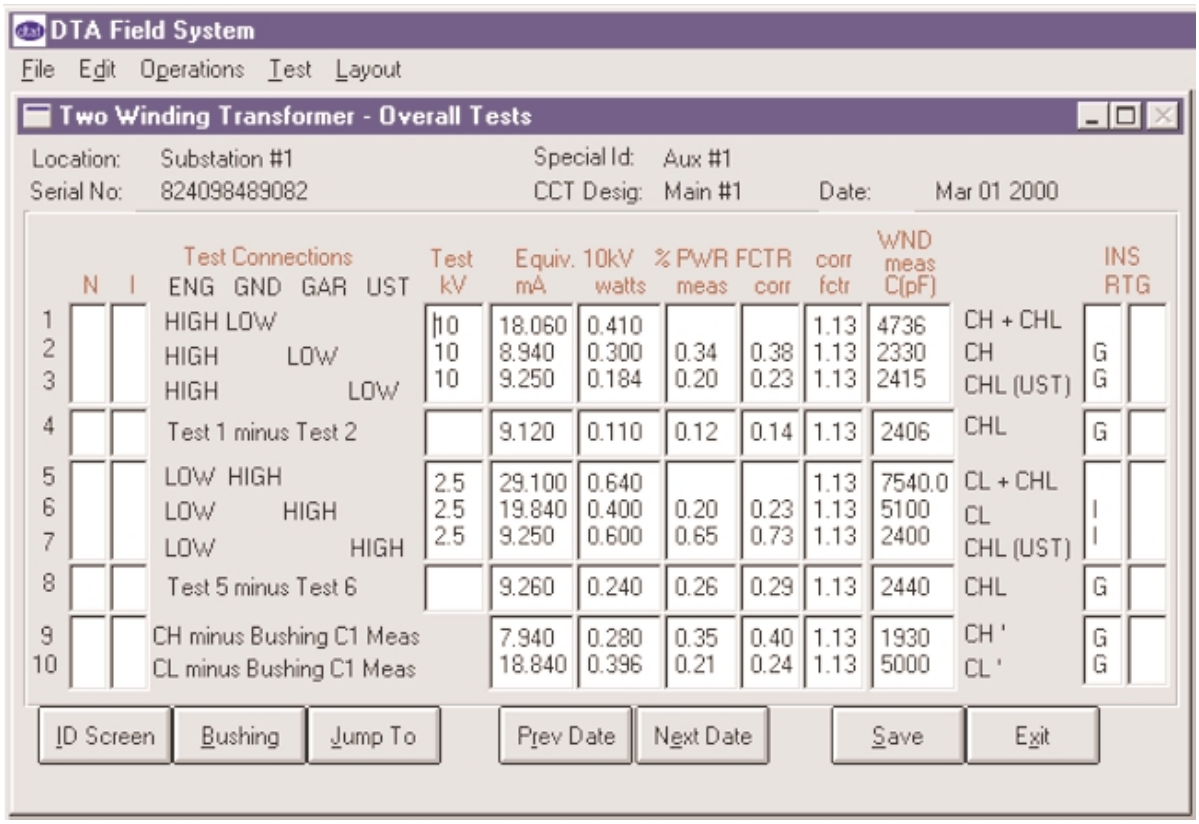
Instrument: 10-1/4"H x 20"W x 25-1/4D" approx 100 lbs.

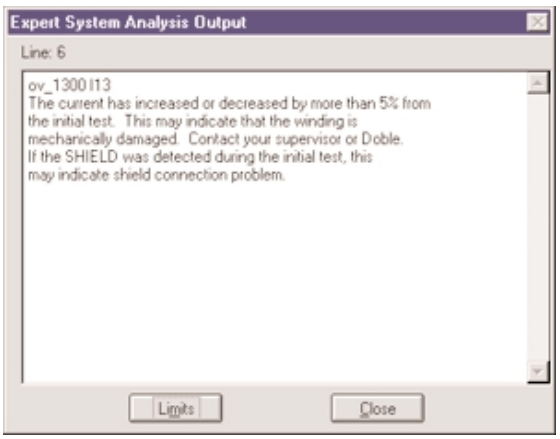
Oil Cell: 9"x 8"x 8" approx. 6 lbs.

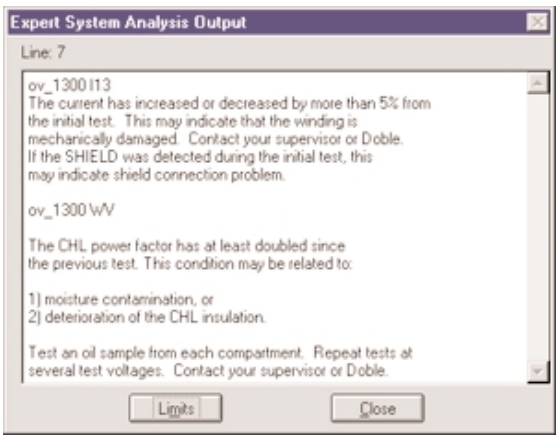
Accessory Case: 20" x 12" x 9" (cable bag 26lbs.; 60' HV cable18 lbs.)

Manual Bag: 18"x12"x3"

Transport: 48-1/2"x20-1/2"wx19-1/2"D 33-1/2 lbs (optional)







Note the Expert System's Investigate "I" rating and explanation screens

Using Doble's DTA Expert System and the M4000 Automated Insulation Analyzer, efficiency and accuracy of apparatus insulation field tests are improved. External interference is eliminated, measurement is automatic, and results are analyzed according to 3700 rules, and then stored in the relational database for scheduling, inventory, and comparative analysis.

Doble Test Assistant® (DTA) is a comprehensive software system designed to enhance test-crew productivity, improve the accuracy of test data used by maintenance engineers for decision making, and provide computerized apparatus nameplate and test data for inventory control, equipment scheduling, and statistical analysis.