advanced customized characterization technologies

TF 2000 E

TF Analyzer 2000 E Measurement System

The TF Analyzer 2000 E is the most sophisticated analyzer of electroceramic materials and devices. The test equipment is based on a modular idea, where four different probe heads can be connected to one and the same basic unit. Each of the four probe heads offers different characterization methods.

- Ferroelectric standard testing → **FE module**
- Magnetoresistive & ferroic material testing → **MR module**
- Relaxation current measurement → **RX module**
- Self discharge testing → **DR module**

By simply changing the module (probe head) you switch to a different test method.
The system can control and operate with additional external hardware equipment, such as temperature units, probing stations, high voltage amplifiers, laser interferometers etc. Communication via serial interface, IEEE interface, or Ethernet is supported. Several other aixACCT measurement (e.g. aixDBLI, aixPES or aixCMA) systems are based on the TF Analyzer 2000 E as a core component.

Features

→ **FE module**
The FE module is available in different performance levels.
The *standard* configuration offers a frequency range from 1 mHz to 5 kHz.
A special *high speed* hardware configuration of Basic Unit and FE-Module offers a frequency range up to 1 MHz for high speed applications.

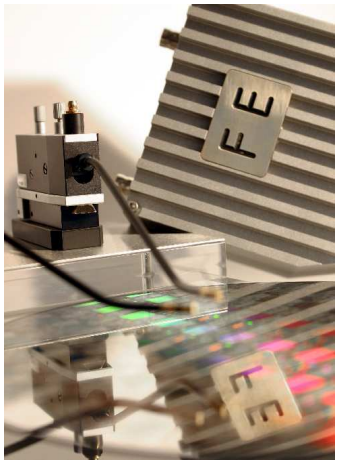
The ferroelectric test module TF Analyzer 2000 FE is designed to make various measurements on ferroelectric materials to determine its main electronic characteristics.

Standard features of the FE-Module are:

- Hysteresis measurement
- PUND measurement
- Fatigue measurement
- Retention measurement
- Static hysteresis measurement
- Imprint measurement
- Leakage current measurement

and optional

- C(V) measurement



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- Piezo measurement
- Pyroelectric measurement
- Impedance measurement (only with the *enhanced* system configuration)

As further options, which are essentially for testing ultra thin films and for ultra small capacitors, aixACCT offers as unique features of the TF Analyzer 2000 series:

- **In-situ Compensation**, and
- **Dynamic Leakage Current Compensation** (see below)

→ **MR module**
This module allows the investigation of magnetoresistive and ferroic materials. Additional hardware components are required like they are described in the aixMR system documentation. The module supplies a constant current excitation and measures the voltage drop across the sample with a high accuracy four point measurement.

→ **RX module**
The relaxation module TF Analyzer 2000 RX is designed to investigate polarization and depolarization currents of dielectric and ferroelectric materials. This module uses the voltage step method with a six decade current amplifier, which allows measurements without changing the amplification range. It is especially designed to investigate the relaxation behavior and the leakage current of integrated capacitors.

→ **DR module**
Investigation of the self discharge behavior of dielectric materials: voltage pulse method with an electrometer amplifier offering 30 fF input capacitance.

The DRAM module TF Analyzer 2000 DR is designed to measure the self-discharge behaviour of charged integrated capacitors to test the suitability of the material for DRAM applications and to check the minimum pulse width of a write operation.

→ **In-situ compensation**
With small pad sizes, below approximately 10 µm squared capacitors the influence of the parasitic capacitance becomes increasingly important. For sub micrometer dimensions the compensation is essential in order to derive correct and precise results. The only way to measure these data correctly is with the aixACCT patented method of a compensation of the influence during the measurement. Using a numerical calculation to compensate this influence does not work, because the recording amplifier is already saturated by the contribution of the parasitic capacitor to the current response.

→ **Dynamic Leakage Current Compensation**
With ultra thin films the influence of leakage current becomes significant on the results of the hysteresis curve of the ferroelectric material. A compensation based on static leakage current measurements is not very accurate and is very time consuming. Therefore a method has been developed by aixACCT to eliminate the influence of the leakage current on the results of the hysteresis curve. Using hysteresis measurements, the influence of the leakage current can be eliminated and the remaining material property is received.

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Specifications

1. Computer hard- and software:

- Celeron M processor ≥ 1.6 GHz
- VGA graphical interface
- USB port
- CD / DVD writer
- 80 GB hard disk or larger
- 512 MB RAM
- Operating system Windows XP
- 16-bit resolution further increased by lock-in technology
- 4 input channels
- aixACCT's sophisticated and highly flexible ferroelectric test software
- Remote and script control (optional)

2. Measurement Modules

FE module

Driving unit:

- Voltage range ±25 V
  (optional external amplifier up to 10.000 V)
- Output impedance 10 Ω
- Maximum hysteresis excitation frequency (load dependent) < 5 kHz (250 kHz / 1 MHz with advanced high speed system and probe head adapted to the sample)
- Min. pulse width 2 µs (50 ns high speed)
- Min. rise time 1 µs (10 ns high speed)
- Maximum capacitive load (freq. dependent) 1 µF
- Maximum output current ±1 A

Current amplifier:

- Voltage virtual ground input
- Current range 1 pA - 1 A
- High-voltage protection (optional)

Fatigue parameter:

- Maximum frequency 300 kHz

  Test conditions: amplitude: 10 V peak to peak
  capacitive load: 1 nF

MR module

The electrometer amplifier offers ultra high impedance for voltage measurement

1. voltage range 10 V, 500 mV, 5 mV at 16 bit resolution
   accuracy better 1%
2. Current range: +/- 30 mA or 500 µA, resolution ca. 15 nA
3. Maximum resistance of device under test 1 MΩ
4. Minimum resistance of device under test 10 mΩ

I/V measurement

- current sine wave, measurement time: 10 ms to 5 s
- Voltage compliance range +/- 10 V
- Current read back amplifier for true current measurement

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RX module	DR module
Voltage-step generator: • Max. amplitude ±10 V • Output resistance < 5Ω *Current amplifier:* • Range 100 mA - 10 pA • Bandwidth (I > 50 µA) 300 kHz, (I > 1 mA) 500 kHz	*Voltage-pulse generator:* • Maximum amplitude ±10 V • Minimum pulse length 50 ns • Maximum pulse length 640 µs *Switching properties:* • Turn-on delay time < 2 ns • R_{on} < 50 Ω • R_{off} > 10^{13} Ω *High impedance electrometer:* • Input resistance 10^{13} Ω • Input capacitance 30 fF

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