Electromigration evaluations at stresses of 1 μA and 400 °C

Today’s more sophisticated, more highly integrated semiconductor devices are the result of ever more advanced microfabrication techniques and the use of new materials. Since these techniques and materials determine device life, high-precision electromigration evaluations under more rigorous accelerated stress test conditions are becoming increasingly important to developers. The Electromigration Evaluation System offers high-precision measurement under temperature (up to 400 °C) and current stresses – the key conditions for accelerated stress testing.
The analysis software provided enables calculations of the parameters needed to determine device life (based on Black’s equation).
Offering better operation, reliability and data analysis, AEM can be used to meet evaluation needs in a wide range of applications, from cutting-edge evaluations to production management.
Performance

- **Test up to 240 channels per cabinet**
  Each oven can support up to 80 DUTs (8 DUT boards per oven x 5 sockets per DUT board x 1 or 2 DUTs per socket). Since test groups can have as few as five DUTs, each oven can have up to 16 sets of test conditions.

- **High-temperature (400 °C max.), high-precision ovens**
  AEM’s ovens can create test temperatures of up to 400 °C with outstanding precision (±2.5 °C distribution at 350 °C setting). Up to three ovens can be mounted in each cabinet, and evaluations can use different temperature conditions in each oven.

- **Low current stress (1 μA min.)**
  To support future Copper interconnect evaluation requirements, AEM can apply stress currents of between 1 μA and 50 mA. Socket can be used for DIP 28-pin 600/300mil type.

- **New high-reliability DUT boards and sockets**
  To ensure that components connect securely, DUT board-to-socket connections have been given a double contact structure (patent pending), and an original ESPEC design has been used for DUT-to-socket connections. These structural improvements dramatically reduce contact failure at high temperatures, enabling low-cost, high-cost-performance DUT boards that can withstand longer tests.

- **Pin assignment scrambling**
  ESPEC DUT boards support pin assignment scrambling, enabling evaluations of DUTs with different pin assignments.
**PC-driven network**
Up to five cabinets can be controlled from a single PC, enabling evaluations of up to 1,200 DUTs (1,200 channels). Evaluations can easily be monitored from a remote office.

**Four types of electromigration evaluation**
AEM is a highly versatile system that supports four types of electromigration evaluation with temperature and current stresses applied: (1) constant-current stress testing (resistance measurement), (2) stress migration testing, (3) TCR (temperature characteristic testing for precise current resistance measurement) testing, and (4) extrusion testing (leak current measurement).

**Space-saving design**
Since the ovens and tester have been combined into a single unit, up to three ovens can be stored in a single cabinet. Up to five cabinets can be controlled from a single PC, greatly reducing the space needed to evaluate large-volume specimens.
Monitor screen

The monitor screen displays all the information needed at a glance, in a single screen in real-time. It contains multiple windows showing items such as the test progress (status) of each DUT, resistance values and rates of change (displayed graphically).

Test condition/ Setup

The ‘Test Condition Set Up’ window lets you enter and check all items in a single screen.
Displays the measured resistance for each DUT in graph form.

Displays the measured resistance for each DUT and temperature in graph form.

Displays the measured resistance for each DUT and time in graph form. Absolute or relative values can be displayed. The wire temperature can be calculated individually from the temperature-characteristic test results.

Displays the temperature-dependence in graph form based on the life (MTTF/median) calculated from the distribution plot. (Arrhenius plot)

Displays the current density dependence in graph form based on the life (MTTF/median) calculated from the distribution plot.

Displays in graph form the dependence on wire length, wire width, thickness and number of contacts.

Distribution Plots (Normal/Log Normal/Weibull)

Temperature

Current density

Other Parameters

Temperature Dependence

Current Density Dependence

Line Width Dependence

Activates energy (Ea)

Current density exponent

Black's model
SPECIFICATIONS

<table>
<thead>
<tr>
<th>Type of evaluation</th>
<th>Output range</th>
<th>+1μA to +50mA DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress-current</td>
<td>Accuracy</td>
<td>1μA to 1mA: ±(0.2% of S.V. ±1μA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.01mA to 50mA: ±(0.2% of S.V. ±25μA)</td>
</tr>
<tr>
<td>Follow voltage</td>
<td>Max.35V</td>
<td></td>
</tr>
<tr>
<td>Extrusion test</td>
<td>Output range</td>
<td>-10V to +20V</td>
</tr>
<tr>
<td>Oven</td>
<td>Accuracy</td>
<td>±(2% of S.V. ±20mV)</td>
</tr>
<tr>
<td></td>
<td>Temperature range</td>
<td>+65°C to +400°C</td>
</tr>
<tr>
<td></td>
<td>Temperature fluctuation</td>
<td>±0.5°C (+65°C to +350°C)</td>
</tr>
<tr>
<td></td>
<td>Temperature uniformity</td>
<td>±2.5°C (+65°C to +350°C)</td>
</tr>
<tr>
<td></td>
<td>Accessories</td>
<td>No gas inlet</td>
</tr>
</tbody>
</table>

SYSTEM VARIATION

<table>
<thead>
<tr>
<th>Model</th>
<th>AEM-240C3 AAA</th>
<th>AEM-160C2 0AA</th>
<th>AEM-080C1 00A</th>
</tr>
</thead>
<tbody>
<tr>
<td>EM module output current</td>
<td>Oven1</td>
<td>Oven2</td>
<td>Oven3</td>
</tr>
<tr>
<td></td>
<td>50mA</td>
<td>50mA</td>
<td>50mA</td>
</tr>
<tr>
<td>Number of test channels</td>
<td>240ch</td>
<td>160ch</td>
<td>80ch</td>
</tr>
<tr>
<td>DUT board</td>
<td>Number of board</td>
<td>24 (8 x 3 Ovens)</td>
<td>16 (8 x 2 Ovens)</td>
</tr>
<tr>
<td>IC sockets</td>
<td>5 sockets/board (both DIP 28-pin 600 mil and DIP 28-pin 300 mil)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power supply</td>
<td>Cabinet</td>
<td>200V AC 3 x 50/60Hz</td>
<td></td>
</tr>
<tr>
<td>Power consumption</td>
<td>Cabinet</td>
<td>Max. 10kW</td>
<td>Max. 4kW</td>
</tr>
<tr>
<td></td>
<td>PC unit</td>
<td>100V AC 1 x 50/60Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PC unit</td>
<td>350W</td>
<td></td>
</tr>
<tr>
<td>Cabinet dimensions (mm)</td>
<td>W580 x D1220 x H1945</td>
<td>W580 x D1220 x H1490</td>
<td>W680 x D640 x H1260</td>
</tr>
<tr>
<td>PC rack dimensions (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oven configuration</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WARNING: Do not use specimens which are explosive or inflammable, or which contain such substances. To do so could be hazardous, as this may lead to fire or explosion.

CAUTION: Vapor from specimens that accumulates in tanks or exhaust ducts may ignite and cause fires, so the equipment must be cleaned periodically. Vapor that seeps into and accumulates in equipment insulating layers may cause more serious fires.
PC rack
- Host PC
  - OS: Windows® XP
  - Test setting, test monitor control and data analysis
- Uninterruptible power source
  - Backup power supply for host PC

Cabinet
- Tester unit
  - One constant-current-source supplies per channel which provided for the unit controlling the DUT power supply and DUT resistance measurement
- Measure PC
  - Collects measured data and controls measurements
- Uninterruptible power source
  - Backup power supply for measure PC
- Oven
  - Temperature control range: +65 to +400 °C

ACCESSORIES
- DUT boards (8 per oven)
- Dummy DUT boards (4 per oven)
- Setup CD
- User’s manual

SAFETY DEVICES
- Leakage breaker
- Upper and lower temperature limit alarms
- Sensor burn-out detection circuit
- Overheat protector (independent type)
- Overheat protector (built inside)
- Emergency stop switch

OPTIONS
- DUT board
  - for +400 °C (DIP28-pin 600/300mil)
  - for +250 °C (DIP28-pin 600mil)
  - for +250 °C (DIP16-pin 300mil)
- Dumper board
- Dummy DUT board
- Resistance check board
- DUT boards safekeeping rack
- Additional statistical processing software licenses
- Spaire parts kit1
- Spaire parts kit2
- Host PC less
- Temperature recorder
- Paperless recorder (outside installation type)