The transportation of HiPak is classified according to IEC 60721-3-2 set IE23.

**Time limitation for transportation**
For the transportation by lorries, trailers, trains, ships and airplanes a transportation duration of maximum 30 days shall not be exceeded.

The specification as described in this document is only valid for modules as produced and packed by ABB Switzerland Ltd, Semiconductors. The situation has to be considered separately for units on a higher assembly integration level (e.g. modules connected with gate units, coolers etc.).

**Description of class IE23**
This set includes transportation in all kind of lorries and trailers; in areas with well developed road systems, by train with specially designed shock-reduced buffers and by ships, if by air only in heated, pressurized holds; with risk of mould growth and attacks by animals except termites; in areas with normal industrial activities excluding those with large quantities of chemical pollutants; excluding sand desert areas.¹

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**Set of classes IE23**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climatic</td>
<td>2K4²</td>
</tr>
<tr>
<td>Biological</td>
<td>2B2</td>
</tr>
<tr>
<td>Chemically active substances</td>
<td>2C2</td>
</tr>
<tr>
<td>Mechanically active substances</td>
<td>2S2</td>
</tr>
<tr>
<td>Mechanical</td>
<td>2M2</td>
</tr>
</tbody>
</table>

**Climatic conditions³**
This class covers transportation in unventilated enclosures including weather protected transportation in cold temperature climate. Transportation by air only in heated, pressurized holds is included. The high air temperatures are limited to those within the general open-air climates. The conditions of humidity of the worldwide open-air climates are not more severe than in the general open-air climates and therefore, such a limitation is not made for the humidity conditions. The product may be moved between cold outdoor and warm indoor conditions. It may be exposed to direct solar radiation. Outdoor exposure does not include subjection to sea waves.⁴
Environmental parameter | Class 2K4
--- | ---
Low air temperature | -40 °C
High air temperature, air in unventilated enclosures | +70 °C
High air temperature, air in ventilated enclosures or outdoor | +40 °C
Change of temperature, air/air | -40 °C/+30 °C
Change of temperature air/water | +40 °C/+5 °C
Relative humidity, not combined with rapid temperature changes: air/air at high relative humidity | 95%/+45 °C
Absolute humidity, combined with rapid temperature changes: air/air at high relative humidity | 60 g/m³
Low air pressure | 70 kPa
Change of air pressure | No
Movement of surrounding medium, air | 20 m/s
Precipitation, rain | No
Precipitation, solar | 1120 W/m²
Heat radiation | 600 W/m²
Water from sources other than rain | 1 m/s
Wetness | No

**Biological conditions**

This class includes areas and conditions where mould growth, attacks of animals except termites may occur.³

Environmental parameter | Class 2B2
--- | ---
Flora | Presence of mould, fungus, etc
Fauna | Presence of rodents or other animals harmful to products, excluding termites.

**Chemical conditions**

This class covers transportation, where the product is placed indoors in such a way that it is protected from salt mist. This class also includes outdoor transportation except sea transport on open decks of ships. Transportation also takes place in areas with normal industrial activities, excluding those where large quantities of chemical pollutants are emitted.⁶

Environmental parameter | Class 2C2
--- | ---
Sea salts | No conditions of salt mist
Sulfur dioxide | 1.0 mg/m³ (0.3 mg/m³)
Hydrogen sulfide | 0.5 mg/m³ (0.1 mg/m³)
Hydrogen chloride | 0.5 mg/m³ (0.1 mg/m³)
Hydrogen fluoride | 0.03 mg/m³ (0.01 mg/m³)
Ammonia | 3.0 mg/m³ (1.0 mg/m³)
Ozone | 0.1 mg/m³ (0.05 mg/m³)
Nitrogen Oxides (expressed in equivalent values of nitrogen dioxide) | 1.0 mg/m³ (0.5 mg/m³)

The figures given are maximum values, occurring over a 30 min period per day. The figures within brackets are the expected long-term mean values. The values given in cm³/m³ have been calculated from the values given in mg/m³ and refer to 20 °C and 101.3 kPa. The table uses rounded values.

**Mechanically active substances**

This class covers outdoor transportation, as well as indoor, where sweeping of dusty floors is taken into account. Transportation in sand desert areas is not included.⁷

Environmental parameter | Class 2S2
--- | ---
Sand in air | 0.1 g/m³
Dust (sedimentation) | 3 mg/(m²h)

**Mechanical conditions**

This class covers mechanical loading as well as transportation in aircraft, in all kinds of lorries and trailers in areas with well-developed road systems. It also includes transportation by trains with specially designed shock reducing buffers and by ships.⁸

Environmental parameter | Class 2M2
--- | ---
a) Stationary vibration sinusoidal | Displacement 3.5 mm
| Acceleration 10 m/s² 15 m/s²
| Frequency range 2–9 Hz 9–200–500 Hz
b) Stationary vibration random | Acceleration spectral density 1.0 m²/s³ 0.3 m²/s³
| Frequency range 10–200 Hz 200–2000 Hz
c) Non-stationary vibration including shock | Peak acceleration 100 m/s²
| Shock response spectrum type I
| Shock response spectrum type II
| Peak acceleration 300 m/s²
d) Free fall | Mass less than 20 kg 1.2 m
| Mass 20 kg to 100 kg 1.0
| Mass more than 100 kg 0.25 m
e) Toppling | Mass less than 20 kg Topping around any of the edges
| Mass 20 kg to 100 kg Topping around any of the edges
| Mass more than 100 kg No
f) Rolling and pitching | Angle ±35°
| Period 8 s
| Acceleration steady state 20 m/s²
| Static load 2 kPa²

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1 see IEC 60721-3-2, Annex B, page 41
2 This class is only valid with restrictions described in the paragraph for Climatic conditions
3 The description of the climatic conditions deviates from the original description of the standard.
4 see IEC 60721-3-2, Annex A, page 35, 36
5 see IEC 60721-3-2, Annex A, page 37
6 see IEC 60721-3-2, Annex A, page 38, 39
7 see IEC 60721-3-2, Annex A, page 35
8 see IEC 60721-3-2, Annex A, page 39
9 In deviation with IEC 60721-3-2

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2 Transport of HiPak I Application Note 5SZK 9112-00
## Tests for class 2K4

<table>
<thead>
<tr>
<th>Environmental parameter</th>
<th>Class 2K4</th>
<th>Test method</th>
<th>Severity</th>
<th>Test method</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low air temperature</td>
<td>-40 °C</td>
<td>60068-2-1: Ab</td>
<td>-40 °C, 16 h</td>
<td>60068-2-1: Ab</td>
<td>-40 °C, 16 h</td>
</tr>
<tr>
<td>High air temperature: air in unventilated enclosures</td>
<td>+70 °C</td>
<td>60068-2-2: Bb</td>
<td>+70 °C, 16 h</td>
<td>60068-2-2: Bb</td>
<td>+70 °C, 16 h</td>
</tr>
<tr>
<td>High temperature: air in ventilated enclosures or outdoor air</td>
<td>+40 °C</td>
<td>60068-2-2: Bb</td>
<td>+40 °C, 16 h</td>
<td>60068-2-2: Bb</td>
<td>+70 °C, 16 h</td>
</tr>
<tr>
<td>Change of temperature: air/air</td>
<td>-40 °C/+30 °C</td>
<td>60068-2-14: Na</td>
<td>-40 °C to ambient five cycles ( t_1 = 3 , \text{h}, t_2 &lt; 3 , \text{min} )</td>
<td>60068-2-14: Nb</td>
<td>-40 °C to ambient two cycles ( t_1 = 3 , \text{h}, t_2 &lt; 5 , ^\circ \text{C/min} )</td>
</tr>
</tbody>
</table>

### Change of temperature air/water

- +40 °C/+5 °C: Test normally not required
- No test

### Relative humidity, not combined with rapid temperature changes

- 95% | 60068-2-56: Cb | +40 °C, 93% R.H., 96 h minimum | 60068-2-78 | +40 °C, 93% R.H., 56 d |

### Relative humidity, combined with rapid temperature changes: air/air at high relative humidity

- 95% | Steady-state humidity test (test Cb) followed immediately by rapid change of temperature test (test Na) |

### Absolute humidity, combined with rapid temperature changes: air/air at high water content

- 60 g/m³ | 60068-2-30: Db | +55 °C, 90 - 100% R.H. |

### Low air pressure

- 70 kPa: Test normally not required
- No test

### Change of air pressure

- No: No test

### Movement of surrounding air

- 20 m/s: Test normally not required
- No test

### Precipitation (rain)

- 6 mm/min | 60068-2-18: Rb | Method 2.2 | Exposure: 1 min/m² | Duration: 5 min minimum | No test |

### Solar radiation

- 1120 W/m² | Perform the dry-heat test and evaluate materials for photochemical reactions |

### Radiation: heat

- 600 W/m² | Test normally not required |

### Water from sources other than rain

- 1 m/s | Test normally not required |

### Wetness-conditions of wet surfaces

- Test normally not required | No test |

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10 see IEC TR 60721-4-1, page 18
11 No climatograms are shown for the transportation classes since they are not included in IEC 60721-3-2
12 For the test variant Na a two chamber system is used.
13 For the test variant Nb a single chamber system is used.
14 Since no precipitation is allowed.

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**Tests for class 2C2**

No tests will be done.

**Tests for class 2S2**

No tests will be done.
### Test for class 2M2

<table>
<thead>
<tr>
<th>Environmental parameter</th>
<th>Unit</th>
<th>Class 2M2</th>
<th>Test method</th>
<th>Severity</th>
<th>Test method</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stationary vibration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displacement</td>
<td>mm</td>
<td>3.5</td>
<td>10</td>
<td>15</td>
<td>60068-2-6</td>
<td>3.5</td>
</tr>
<tr>
<td>Acceleration</td>
<td>m/s²</td>
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<td></td>
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</tr>
<tr>
<td>Frequency range</td>
<td>Hz</td>
<td>2-9</td>
<td>9-200</td>
<td>200-500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of axes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweep cycles</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stationary vibration</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displacement</td>
<td>mm²/³</td>
<td>1.0</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceleration spectral density (ADS)</td>
<td>dB/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency range</td>
<td>Hz</td>
<td>10-200</td>
<td>200-2000</td>
<td>200-2000</td>
<td>300</td>
<td>6</td>
</tr>
<tr>
<td>Axes of vibration</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration/axis</td>
<td>min</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td><strong>Shock</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Peak acceleration</td>
<td>m/s²</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>ms</td>
<td>11</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of shocks/bumps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction of shocks/bumps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Free fall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of falls</td>
<td>kg</td>
<td>&lt; 20</td>
<td>&gt; 20</td>
<td>&gt; 100</td>
<td>ISO 4180-2</td>
<td>Two falls in each specified attitude</td>
</tr>
<tr>
<td>Fall height</td>
<td>m</td>
<td>1.2</td>
<td>1.0</td>
<td>0.25</td>
<td></td>
<td>See below</td>
</tr>
<tr>
<td><strong>Transportation by water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>kg</td>
<td>&lt; 10</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transportation by road, train and air</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>kg</td>
<td>&lt; 10</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall height</td>
<td>m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drop and topple</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>kg</td>
<td>&lt; 20</td>
<td>&gt; 20</td>
<td>&gt; 100</td>
<td>60068-2-31</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>Height</td>
<td>m</td>
<td>No</td>
<td></td>
<td></td>
<td>EC: Drop and topple</td>
<td>0.1 ° or 30 ° Whatever is less One drop on relevant corner</td>
</tr>
<tr>
<td><strong>Rolling and pitching</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle</td>
<td>degree</td>
<td>±35</td>
<td>Test normally not required</td>
<td>No test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period</td>
<td>s</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Static load</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaged product</td>
<td>kPa</td>
<td>10</td>
<td></td>
<td></td>
<td>ISO 12048: Compression and stacking</td>
<td>No test</td>
</tr>
</tbody>
</table>

**Prepared:** Backlund  **Checked 1:** Schnell  **Checked 2:** Duran  **Approved:** Schlegel  **Date:** 22.03.11
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