Application Note 5SZK 9112-00

Transport of HiPak

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]

Set of classes IE23

Condition	Class
Climatic	2K4[2]
Biological	2B2
Chemically active substances	2C2
Mechanically active substances	2S2
Mechanical	2M2

Climatic conditions[3]

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	95%/+45 °C
Relative humidity, combined with rapid temperature changes:	95%
air/air at high relative humidity	-40 °C/+30 °C
Absolute humidity, combined with rapid temperature changes:	60 g/m^3
air/air at high relative humidity	+70 °C/+15 °C
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/m^2
Heat radiation	600 W/m^2
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.[5]

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/m^3	(0.3 mg/m^3)
	0.37 cm^3/m^3	(0.11 cm^3/m^3)
Hydrogen sulfide	0.5 mg/m^3	(0.1 mg/m^3)
	0.36 cm^3/m^3	(0.071 cm^3/m^3)
Hydrogen chloride	0.5 mg/m^3	(0.1 mg/m^3)
	0.33 cm^3/m^3	(0.066 cm^3/m^3)
Hydrogen fluoride	0.03 mg/m^3	(0.01 mg/m^3)
	0.036 cm^3/m^3	(0.012 cm^3/m^3)
Ammonia	3.0 mg/m^3	(1.0 mg/m^3)
	4.2 cm^3/m^3	(1.4 cm^3/m^3)
Ozone	0.1 mg/m^3	(0.05 mg/m^3)
	0.05 cm^3/m^3	(0.025 cm^3/m^3)
Nitrogen Oxides (expressed in equivalent	1.0 mg/m^3	(0.5 mg/m^3)
values of nitrogen dioxide)	0.52 cm^3/m^3	(0.26 cm^3/m^3)

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 cm^3/m^3 have been calculated from the values given in mg/m^3 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/m^3
Dust (sedimentation)	3 mg/(m^2 h)

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/s^2	15 m/s^2
Frequency range	2-9 Hz	9-200 Hz	200-500 Hz
b) Stationary vibration random			
Acceleration spectral density	1.0 m^2/s^3	0.3 m^2/s^3	
Frequency range	10-200 Hz	200-2000 Hz	
c) Non-stationary vibration including shock			
Shock response spectrum type I	100 m/s^2		
Peak acceleration			
Shock response spectrum type II	300 m/s^2		
Peak acceleration			
d) Free fall			
Mass less than 20 kg	1.2 m		
Mass 20 kg to 100 kg	1.0		
Mass more then 100 k	0.25 m		
e) Toppling			
Mass less than 20kg	Toppling around any of the edges		
Mass 20kg to 100kg	Toppling around any of the edges		
Mass more then 100kg	No		
f) Rolling and pitching			
Angle	±35°		
Period	8s		
g) Acceleration steady state	20 m/s^2		
h) Static load	2 kPa[9]		

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

Tests for class 2K4[10]

Climatic conditions		Recommended IEC 60068-2 - Climatic tests		PTS tests	
Environmental parameter	Class 2K4	Test method	Severity	Test method	Severity
Low air temperature	-40 °C	60068-2-1: Ab	-40 °C, 16 h	60068-2-1: Ab	-40 °C, 16 h
High air temperature: air in unventilated enclosures	+70 °C	60068-2-2: Bb	+70 °C, 16 h	60068-2-2: Bb	+70 °C, 16 h
High temperature: air in ventilated enclosures or outdoor air	+40 °C	60068-2-2: Bb	+40 °C, 16 h	60068-2-2: Bb	+70 °C, 16 h
Change of temperature: air/air	-40 °C/+30 °C	60068-2-14: Na[12]	-40 °C to ambient five cycles t_1 = 3 h, t_2 < 3 min	60068-2-14: Nb[13]	-40 °C to ambient two cycles t_1 = 3 h, t_2 < 5 °C/min
Change of temperature air/water	+40 °C/+5 °C	Test normally not required		No test	
Relative humidity, not combined with rapid temperature changes	95% +45 °C	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% -40 °C/+30 °C	Steady-state humidity test (test Cb) followed immediately by rapid change of temperature test (test Na)		Steady-state humidity test (+40 °C, 93% R.H., 56 d) 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/m^3 +70 °C/+15 °C	60068-2-30: Db Variant 2	+55 °C 90 - 100% R.H.	Forced condensation JEDEC Jesd22-A100 B	Cycles between +30 °C and +65 °C, R.H. between 90 and 98%, 3 cycles a day, 1000 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/m^2 Duration: 5 min minimum	No test [14]	
Solar radiation	1120 W/m^2	Perform the dry-heat test an evluate materials for photochemical reactions		Perform the dry-heat test and evaluate materials for photochemical reactions	
Radiation: heat	600 W/m^2	Test normally not required		No test	
Water from sources other than rain	1 m/s			No test	
Wetness-conditions of wet surfaces		Test normally not required		No test	

Tests for class 2C2

No tests will be done.

Tests for class 2S2

No tests will be done.

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.

Test for class 2M2

IEC 60721-3-2 – Mechanical condition					Recommended test				PTS test	
Environmental parameter	Unit	Class 2M2			Test method	Severity			Test method	Severity
Stationary vibration sinusoidal					60068-2-6 Fc: Vibration				No test	
Displacement	mm	3.5			sinusoidal	3.5				
Acceleration	m/s^2		10	15		10				
Frequency range	Hz	2-9	9-200	200-500		1-500				
Number of axes						3				
Sweep cycles						10				
Stationary vibration random					60068-2-64 Fh: Vibration				60068-2-64 Fh: Vibration	
Acceleration spectral density (ADS)	m^2/s^3	1.0		0.3	broadband random	1.0		0.5	broadband random Cat. 1, Class B	0.65 / 0.015
Slope	dB/ octave						-3			-3
Frequency range	Hz	10-200		200-2000		10-100	100-200	200-2000		5-20 / 20-500
Axes of vibration							3			3 / 3
Duration/axis	min						30			30 / 30
Shock					60068-2-29				60068-2-27	
Shock response spectrum		Type I		Type II	Eb: Bump				Eb: Shock	
Peak acceleration	m/s^2	100		300		100	or	250		100
Duration	ms	11		6		16		6		16
Number of shocks/ bumps										100
Direction of shocks/ bumps										All three directions
Free fall					ISO 4180-2		Two falls in each specified attitude		No test	
Number of falls										
Mass	kg	< 20	> 20	> 100			See below			
Fall height	m	1.2	1.0	0.25						
Transportation by water									No test	
Mass	kg				< 10					
Fall heigth	m				1.0					
Transportation by road, train and air										
Mass	kg				< 10					
Fall heigth	m				0.8					
Drop and topple					60068-2-31 EC: Drop and topple				No test	
1) Dropping on to corner	kg						< 50			
Mass	m	No					0.1 ° or 30 °			
Height							Whatever is less			
							One drop on relevant corner			
2) Topple (or push over)	kg				60068-2-31 Ec: Drop and topple		One topple about each bottom edge		No test	
Mass		< 20	> 20	> 100						
Edges		Any	Any	Any						
Rolling and pitching									No test	
Angle	degree	±35			Test normally not required					
Period	s	8								
Acceleration steady state	m/s^2	20			Test normally not required				No test	
Static load					ISO 12048: Compression and stacking				No test	
Packaged product	kPa	10								

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

Contact us

ABB Switzerland Ltd.
Semiconductors
Fabrikstrasse 3
CH-5600 Lenzburg
Switzerland
Tel: +41 58 586 14 19
Fax: +41 58 586 13 06
E-Mail: abbsem@ch.abb.com
www.abb.com/semiconductors

Application note 5SZK 9112-00 16.09.2013

Power and productivity
for a better world™