Application Note 5SZK 9110-00

Transport of IGCT

The transportation of IGCT is classified according to IEC 60721-3-2 set IE22.

Time limitation for transportation

For the transportation by lorries and trailers within Europe a transportation duration of maximum 10 days shall not be exceeded. For an intercontinental transport including a transport by ship and by airplane a transportation duration of maximum 30 days shall not be exceeded.[1]

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 IE22

This set covers transportation in unventilated enclosures and weather protected[2] conditions, 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; in aircraft lorries and air-cushioned trucks and trailers on parts of the vehicle without high internal damping.[3]

Set of classes IE22

Condition	Class
Climatic	2K2[4]
Biological	2B2
Chemically active substances	2C2
Mechanically active substances	2S2
Mechanical	2M2

Climatic conditions[5]

This class covers transportation in weather protected, ventilated conditions transportation excluding cold temperature climate. 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 is not moved between cold outdoor and warm indoor conditions The product may be exposed to solar
radiation through a window or other opening. It is not placed close to heating elements and not subjected to water from splashing, wet walls, etc. The product may be transported by
air only in heated, pressurized holds.[6]

1 These transportation duration are specific for IGCTs.
2 Since card board boxes with organic glue are used, wetness has to be excluded in deviation to IEC 60721-3-2.
3 see IEC 60721-3-2, Annex B, page 41

Environmental parameter	Class 2K2
Low air temperature	-25 °C
High air temperature, air in unventilated enclosures	+60 °C
High air temperature, air in ventilated enclosures or outdoor	+40 °C
Change of temperature, air/air	-25 °C/+25 °C
Change of temperature air/water	No
Relative humidity, not combined with rapid temperature changes	75 %/+30 °C
Relative humidity, combined with rapid temperature changes: air/air at high relative humidity	No
Absolute humidity, combined with rapid temperature changes: air/air at high relative humidity	No
Low air pressure	70 kPa
Change of air pressure	No
Movement of surrounding medium, air	No
Precipitation, rain	No
Precipitation, solar	700 W/m^2
Heat radiation	No
Water from sources other than rain	No
Wetness	No

Biological conditions

This class includes areas and conditions where mould growth, attacks of animals except termites may occur.[7]

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.[8]

Environmental parameter	Class 2C2	
Sea salts	No conditions of salt mist[9]	
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 values of nitrogen dioxide)	1.0 mg/m^3	(0.5 mg/m^3)
	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.[10]

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.[11]

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 kg	0.25 m		
e) Toppling			
Mass less than 20 kg	Toppling around any of the edges		
Mass 20 kg to 100 kg	Toppling around any of the edges		
Mass more then 100 kg	No		
f) Rolling and pitching			
Angle	±35°		
Period	8s		
g) Acceleration steady state	20 m/s^2		
h) Static load	10 kPa		

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

Tests for Class 2K2[12]

Climatic conditions		Recommended IEC 60068-2 climatic tests		PTS tests	
Environmental parameter [13]	Class 2K2	Test method	Severity	Test method	Severity
Low air temperature	-25 °C	60068-2-1: Ab	-40 °C, 16 h	60068-2-1: Ab	-40 °C, 16 h
High air temperature: air in unventilated enclosures	+60 °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	-25 °C/+25 °C	60068-2-14: Na[14]	-40 °C to ambient five cycles t_1 = 3 h, t_2 < 3 min	60068-2-14: Nb[15]	-40 °C to ambient two cycles t_1 = 3 h, t_2 < 5 °C/min
Change of temperature air/water	No	Test normally not required		No test	
Relative humidity, not combined with rapid temperature changes	75% +30 °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	No	Test normally not required		No test	
Absolute humidity, combined with rapid temperature changes: air/air at high water content	No	Test normally not required		No test	
Low air pressure	70 kPa	Test normally not required		No test	
Change of air pressure	No			No test	
Movement of surrounding air	No	Test normally not required		No test	
Precipitation (rain)	No	Test normally not required		No test [16]	
Solar radiation	700 W/m^2	Perform the dry-heat test an evaluate materials for photochemical reactions		Perform the dry-heat test and evaluate materials for photochemical reactions	
Radiation: heat	No	Test normally not required		No test	
Water from sources other than rain	No			No test	
Wetness-Conditions of wet surfaces	No	Test normally not required		No test	

Tests for Class 2C2

No tests will be done.

Tests for Class 2S2

No tests will be done.

12 see IEC TR 60721-4-1, page 18
13 No climatograms are shown for the transportation classes since they are not included in IEC 60721-3-2
14 For the test variant Na a two chamber system is used.
15 For the test variant Nb a single chamber system is used.
16 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				60068-2-6 Fc: Vibration			
Displacement	mm	3.5			sinusoidal	3.5			sinusoidal	3.5		
Acceleration	m/s^2		10	15		10				10		
Frequency range	Hz	2-9	9-200	200-500		1-500				1-500		
Number of axes						3				3		
Sweep cycles						10				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	1.0	-3	0.5
Slope	dB/ octave						-3			-3		
Frequency range	Hz	10-200		200-2000		10-100	100-200	200-2000		10-100	100-200	200-2000
Axes of vibration							3			3	3	3
Duration/axis	min						30			30	30	30
Shock					60068-2-29				60068-2-29			
Shock response spectrum		Type I		Type II	Eb: Bump				Eb: Bump			
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		ISO 4180-2	Two falls in each		
Number of falls							specifed attitude			specifed attitude		
Mass	kg	< 20	> 20	> 100			See below			See below		
Fall height	m	1.2	1.0	0.25								
Transportation by water												
Mass	kg				< 10							
Fall heigth	m				1.0				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							
1) Dropping on to corner	kg						< 50					
Mass	m	No					0.1 ° or 30 °		30°			
Height							Whatever is less					
							One drop on relevant corner					
					60068-2-31				60068-2-31			
2) Topple (or push over)	kg				Ec: Drop and topple		One topple about each bottom edge		Ec: Drop and topple	One topple about each bottom edge		
Mass		< 20	> 20	> 100								
Edges		Any	Any	Any								
Rolling and pitching												
Angle	degree	±35			Test normally not required				No test			
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										

Revision

Prepared	Checked 1	Checked 2	Approved	Date
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