Application note 5SZK 9120-03

Operation of HiPak (traction)

The operation of the HiPak is classified according to IEC 60077 7.1 - 7.9 (incl.) (1999), IEC 60721-3-5 (1997) and IEC 61373 (1999).

Validity

This specification is effective from delivery date 2005-01-02.

Time limitation for operation

Within the context of this specification a useful life of 30 years is assumed. The time limitation of operational life however may be dominated by the applied functional load, which is not a topic of this generic specification.

Altitude

The altitude at which the equipment is normally to function does not exceed 2'000 m above sea level.

Note – For installation at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and of the cooling effect of the air. Equipment so used should be used according to an agreement between the manufacturer and the user.

Set of classes

Condition	Class
Climatic	5K2
Biological	5B1[1]
Chemically active substances	5C2
Mechanically active substances	5S1[2]
Pollution degree	PD2, PD3[3]
Contaminating fluid	5F1
Mechanical	IEC 61373 Class B

Climatic conditions

This class covers products installed in enclosed or partly open, heated or unheated, unventilated compartments.
The products may be subjected to heat from heating elements and solar radiation through windows or other openings. Includes vehicles used outdoors.
The outdoor use of vehicles is limited to climatic areas with normal rain intensities, excluding extremely cold, cold, cold temperate and extremely warm dry climates. The product may be

directly subjected to outdoor cold air entering the compartments when the vehicle is moving. The vehicle may be moved between cold outdoor and warm indoor conditions.
The class also covers products installed in engine compartments of vehicles powered by electrical engines, used outdoors. They may not be subjected to ingress of water and snow.[4]

Class 5K2	
Low air temperature	-25 °C
High air temperature in ventilated compartments (except engine compartments) or outdoor air[5]	+40 °C
High air temperature in unventilated compartments (except engine compartments)[6]	+70 °C
High air temperature, air in engine compartments	+70 °C
Change of temperature air/air[7]	-25 °C/+30 °C
Gradual change of temperature air/air, except in engine compartments	-25 °C/+30 °C 5 °C/min
Gradual change of temperature air/air, in engine compartments	-25 °C/+60 °C 10 °C/min
Change of temperature air/water, except in engine compartments[6, 8]	No
Change of temperature air/water, in engine compartments[6, 7]	+60 °C/+5 °C
Change of temperature air/snow, in engine compartments only	+60 °C/-5 °C
Low relative humidity, not combined with rapid temperature changes, except in engine compartments of vehicles powered by internal combustion engines	95 % +40 °C
Low relative humidity, not combined with rapid temperature changes, in engine compartments of vehicles powered by internal combustion engines	No
Low relative humidity, combined with rapid temperature changes, air/air, at high relative humidities. Not in close proximity of refrigerator air conditioning systems	95 % -25 °C / +30 °C
Low relative humidity, combined with rapid temperature changes, air/air, at high relative humidities. In close proximity of refrigerator air conditioning systems	95 % +10 °C / +70 °C
Absolute humidity combined with rapid temperature changes, air/air at high water content[9]	60 g/m^3 of air +70 °C / +15 °C
Low relative humidity	10 % +30 °C
Low air pressure	70 kPa[10, 11]
Movement of surrounding medium, air	20 m/s
Precipitation, rain	No
Solar radiation	700 W/m^2
Radiation, heat, not in engine compartments	600 W/m^2
Radiation, heat, in engine compartments	600 W/m^2
Water from sources other than rain	No[12]
Wetness	No[13]

Biological conditions

Class covers installations in areas without particular risks of biological attacks, from flora or fauna. It includes installations in compartments of such construction that mould growth, attacks by animals, etc. are not probable.

Environmental parameter	Class 5B1
Flora	No
Fauna	No

Chemical conditions

Covers installations in vehicles used indoors, externally mounted products and products internally mounted in partly open compartments. In deviation to the standard salt mist, road salt and splashing water are not allowed.[14]

Environmental parameter	Class 5C2[15]
Sea and road salts	No[16]
Sulfur dioxide	1.0 (0.3) mg/m^3
Hydrogen sulfide	0.5 (0.1) mg/m^3
Hydrogen chloride	0.5 (0.1) mg/m^3
Hydrogen fluoride	0.03 (0.01) mg/m^3
Ammonia	3 (1.0) mg/m^3
Ozone	0.1 (0.05) mg/m^3
Nitrogen Oxides (expressed in equivalent values of nitrogen dioxide)	1 (0.5) mg/m^3

Notes

The figures given are maximum values, occurring over a 30 min period per day. The figures in brackets are mean values.

Mechanically active substances

This class covers installations of internally mounted products not protected from dust but mainly protected from sand.

Environmental parameter	Class 5S1
Sand	No
Dust (sedimentation)	1.0 mg / m^{2}h

Contaminating Fluids

Covers installations outside engine compartments.

Environmental parameter	Class 5F1
Motor oil	No
Gearbox oil	No
Hydraulic oil	No
Transformer oil	No
Brake fluid	No
Cooling fluid	No
Grease	No
Fuel	No
Battery electrolyte	No

Pollution degree

For the class PD3 conductive pollution or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected for the different housing types.[17]

Housing Type	Creepage Distance	Clearance Distance	CTI of housing	Max. rated insulation voltage for PD 3
- 1.7 kV	15 mm	10 mm	600	1.2 kV
- 3.3 kV	28 mm	19 mm	600	2.3 kV
- 6.5 kV	56 mm	26 mm	600	4.5 kV

1 n deviation with class 5B2, see IEC 60077-1, page 31
2 In deviation with class 5S2, see IEC 60077-1, page 31
3 In dependence of the voltage class and the housing type of the module.
4 In deviation with class 5K2, see IEC 60721-3-5, page 47
5 The high temperature of the surface of the module may be influenced by the surrounding air temperature given here and the solar radiation defined below, see IEC 60721-3-5, page 15.
6 The high temperature of the surface of a module may be influenced by the surrounding air temperature given here and the solar radiation through a window or other opening, see IEC 60721-3-5, page 15.
7 A direct transfer of the module between the to temperatures given is presumed, see IEC 60721-3-5, page 15.
8 The lower temperature is equivalent to the temperature of tap water, see IEC 60721-3-5, page 15.

Mechanical Conditions

Equipment is submitted to vibration and shock throughout the range of frequencies and acceleration levels experienced in service as required in IEC 61373, category 1, Class B.[17]

Tests for Class 5K2[18]

Climatic conditions[a]		Recommended IEC 60068-2 Climatic tests		PTS tests	
Environmental parameter		Test method	Severity	Test method	Severity
Low air temperature	-25 °C	60068-2-1: Ab	-25 °C, 16 h		
High air temperature in ventilated compartments (except engine compartments) or outdoor air	+40 °C	60068-2-2: Bb	+40 °C, 16 h		
High air temperature in unventilated compartments (except engine compartments)	+70 °C	60068-2-2: Bb	+70 °C, 16 h	60747-9	See Appendix 1
High air temperature, air in engine compartments	+70 °C	60068-2-2: Bb	+70 °C, 16 h	60747-9	See Appendix 1
Change of temperature air/air	-25 °C / +30 °C	60068-2-14: Na	-25 °C to ambient five cycles t_1 = 3 h, t_2 < 3 min		
Gradual change of temperature air/air, except in engine compartments	-25 °C / +30 °C 5 °C/min	Test normally not required			
Gradual change of temperature air/air, in engine compartments	-25 °C / +60 °C 10 °C/min	60068-2-14: Na	-25 °C to +60 °C two cycles 10 °C/min t_1 = 3 h	60068-2-14	Tmin = -40 °C, Tmax = 125 °C 500 cycles, tc = 3.5 h 500 cycles, tc = 4 h
Change of temperature air/water, except in engine compartments	No				
Change of temperature air/water, in engine compartments	+60° C / +5 °C	No IEC 60068-2 test			
Change of temperature air/snow, in engine compartments only	+60 °C / -5 °C	No IEC 60068-2 test			
Low relative humidity, not combined with rapid temperature changes, except in engine compartments of vehicles powered by internal combustion engines	95 % +40 °C	60068-2-56: Cb	40 °C, 93 % RH, 95 h	60749	See Appendix 2
Low relative humidity, not combined with rapid temperature changes, in engine compartments of vehicles powered by internal combustion engines	No				
Low relative humidity, combined with rapid temperature changes, air/air, at high relative humidities. Not in close proximity of refrigerator air conditioning systems	95 % -25 °C / +30 °C	Damp heat, steady state test (test Cb in this table) followed immediately by the rapid-change-of-temperature test (test Na)			
Low relative humidity, combined with rapid temperature changes, air/air, at high relative humidities. In close proximity of refrigerator air conditioning systems	95 % +10 °C/+70 °C	Damp heat, steady state test (test Cb in this table) followed immediately by the 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 % to 100 % RH Two cycles		
Low relative humidity	10 % +30 °C	No IEC 60068-2 test			
Low air pressure	70 kPa	Test normally not required			
Movement of surrounding medium, air	20 m/s	Test normally not required			
Precipitation, rain	No				
Solar radiation	700 W/m^2	Add 10 °C to the dry heat test and evaluate materials for photochemical reactions.			
Radiation, heat, not in engine compartments	600 W/m^2	Test normally not required			
Radiation, heat, in engine compartments	600 W/m^2	Test normally not required			
Water from sources other than rain	No				
Wetness	No				

Note: «No» in the class column means that no IEC 60721-3-5 condition is specified or that in deviation with IEC 600721-3-5 the condition is not applicable.

[a] No climatogram is shown for the climatic class since it is not included in IEC 60721-3-5

Tests for Class 5C2

Tests were done according DIN 60068-2-11 (salt mist) and DIN EN 60068-2-60 (method 1) with 6.5kV HiPak2 and 3.3kV HiPak2.

Tests for Class 5S1

No tests will be done.

Tests for mechanical conditions

IEC 61373, category 1, Class B.

Appendix 1

PTS Test method	Severity
HTRB: High Temperature Reverse Bias	Tj = 125 °C, 1000 h
5SNA 1200E330100	Vce = 2880 V
5SNA 1200E250100	Vce = 2080 V
5SNA 0600G650100	Vce = 5200 V
HTGB: High Temperature Gate Bias	Tj = 125 °C
5SNA 1200E250100	Vce = 0V, 2 x 500 h
	Vge = +/- 20 V

Appendix 2

PTS Test method	Severity
THB: High Temperature Humidity Bias	Tj = 85 °C, R.H. = 85%, 1000 h
5SNA 1200E250100	Vce = 80 V, Vge = -20 V
5SNA 0600G650100	Vce = 80 V, Vge = -20 V

Revision history

Prepared	Checked	Approved	Date
			2005-07-20
			2006-05-05
			2007-01-16
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9 The module is assumed to be subjected to a rapid decrease of temperature only (no rapid increase). The figures of water content apply to temperatures down to the dew point. At lower temperatures the relative humidity is assumed to be approximately 100%.
10 The operation at low air pressure due to high altitude is limited by the influence of cosmic ray.
11 During operation at low air pressure a sufficient air-cooling must be guaranteed.
12 In deviation with class 5K2, see IEC 60721-3-5, page 15
13 In deviation with class 5K2, see IEC 60721-3-5, page 15
14 In deviation with class 5C2, see IEC 60721-3-5, page 17
15 See IEC 60721-3-5 Table 3, page 17
16 See IEC 60721-3-3, page 27: Salt mist may be present in sheltered locations of coastal areas and in offshore sites.
17 See IEC 60077-1, page 31
18 See IEC TR 60721-4-5, page 20. 21, 22

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