

Appendix:
Protection/combustion classes
Materials and properties





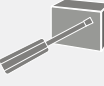














Protection classes EN 60529

An important element for housings is protection of integrated elements against drilling, foreign particles and water. The various protection properties are divided into IP classes (IP = international protection). The framework conditions that a protection class must guarantee are laid out in DIN 40050 and IEC-EN 60529.

IP protection classes are indicated through a two digit code (IPXX). The first digit indicates protection against contact and foreign particles, the second the water protection factor. Accordingly the class IP65 is completely protected against contacts, dustproof (1st digit = 6) and is protected against jets of water from a nozzle in all directions (2nd digit = 5).

First index no.	Contact protection	Foreign particle protection	Second index no.	Brief description	Water protection
0	No protection		0	No protection	
1	Protected against solid foreign objects of 1.97 inches and larger	The object probe, a sphere of 1.97 inches in diameter, must not fully penetrate. 	1	Protected against vertical falling drops of water	Drops which fall vertically must not have any harmful effect. 
2	Protected against solid foreign substances of 0.49 inches dia. and above	The object probe, a sphere of 0.49 inches in diameter, must not fully penetrate. 	2	Protected against diagonally falling (up to 15°) drops of water	Drops which fall vertically must not have any harmful effects if the housing is tilted on both sides at an angle of 15° from the perpendicular. 
3	Protected against solid foreign substances of 0.10 inches dia. and above	The object probe of 0.10 inches, shall in no way penetrate. 	3	Protected against diagonally falling spray (up to 60°)	Water which is sprayed on both sides at up to 60° from the perpendicular must not have any harmful effects. 
4	Protected against solid foreign substances of 0.04 inches dia. and above	The object probe of 0.04 inches, shall in no way penetrate. 	4	Protected against spray from all directions	Water which is sprayed against the housing from one direction must not have any harmful effects. 
5	Dustproofed	The ingress of dust is not fully prevented; however, it must not penetrate to such an extent that satisfactory operation or safety are impaired. 	5	Protected against jets of water (nozzle)	Water which is sprayed in a jet against the housing from any direction must not have any harmful effects. 
6	Impervious to dust	No ingress of dust. 	6	Protected against strong water jets (flooding)	Water which is sprayed as a strong jet against the housing from any direction must not have any harmful effects. 
			7	Protected against the effect of temporary immersion in water	Water must not penetrate to an extent that will cause harmful effects if the housing is temporarily submerged in water under pressure and under time conditions. 
			8	Protected against the effect of temporary submersion in water	Water must not penetrate to such an extent that it will cause harmful effects if the housing is permanently submerged in water. 
			9k	Protection against highly pressurized water/steam jet cleaning	IP x9K according to DIN 40050 Water jet at 0°, 30°, 60° and 90° Cycle: 30 seconds each Distance: 10 - 15 cm Water volume: 14 - 16 liters per minute Water temperature: 176 °F +/- 5 °F Water pressure: 80-100 bar 

Description of fire classification pursuant to UL 94



Fire classification HB

The material burns slowly in the horizontal combustion test. The rate of combustion must not exceed 3 inch/min. for wall thicknesses of up to 0.12 inches, and 1.5 inches/min. for wall thicknesses over 0.12 inches. Any materials exceeding these combustion rate limits are not registered by UL.



Fire classification V2

In the vertical combustion test, self-extinguishing must occur after an average of 25 seconds (individual values not to exceed 30 seconds). Any dripping material may ignite cotton wool located underneath. However, any afterglow must not exceed 60 seconds.



Fire classification V1

In the vertical combustion test, self-extinguishing must also occur after an average of 25 seconds (individual values not to exceed 30 seconds). However, any material dropping off must not ignite cotton wool placed underneath. Any afterglow must not exceed 30 seconds.



Fire classification V0

In the vertical combustion test, self-extinguishing must occur after an average of less than 5 seconds (individual values not to exceed 10 seconds). Any material dropping off must not ignite cotton wool placed underneath and any afterglow must not exceed 30 seconds.

Description of fire classification pursuant to DIN 5510 (German Standard)



Combustion class S4

Test procedure: acc. to DIN 54837

Requirements:

- Length of the destroyed area: ≤ 7.87 inch
- No afterburning

Products may also be assigned to combustion class S4 if afterburning occurs within the burned testing area and the average duration of afterburning does not exceed 10 seconds. If afterburning

occurs in the undamaged area of the test piece, the product must not be assigned to combustion class S4.

If the afterburning of a test object lasts longer 120 seconds, such products must not be assigned to combustion class S4.



Burning behavior

The flame-retardant properties of Murrplastik drag chains meet various classifications:

Test procedures acc. to VDE 0304 Parts 3/5.70

Classification: IIc

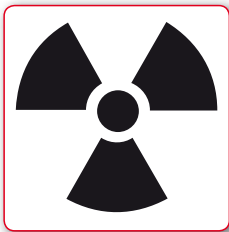
Testing based on "UL 94 – Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances"

Classification: 94 HB with a 0.13 and 0.06 inches body thickness

Tested acc. to DIN 4102 "Fire behavior of building materials and elements"

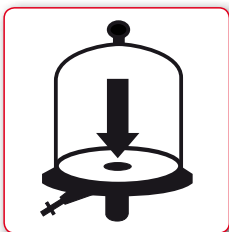
Classification: Materials class B2

In case of more stringent applications please contact us.



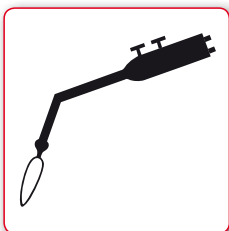
Radiation resistance

Murrplastik drag chains are very resistant to radiation. In the range of 8×10^6 Gy gamma radiation, the mechanical properties change very little.



Vacuum

Murrplastik plastic cable drag chains may be safely used in a vacuum. Gas will only be given off in very low amounts.



Welding flashes and hot sparks

For cables on robotic welding machines, Murrplastik cable drag chains offer the best line protection possible. This has been demonstrated both in laboratory testing and numerous references. The material may appear optically impaired but in no way will its function be reduced. Murrplastik cable drag chains have successfully passed tests involving medium-sized hot metal swarf at 932 °F.



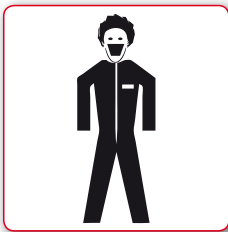
Use in EX explosion proof areas

The Murrplastik cable drag chain may be used in explosion proof areas if manufactured to specification with a special material and if the standard regulations are observed. All Murrplastik cable drag chains are certified based on ATEX-Europa guideline 94/9 EG and can be deployed safely in the corresponding areas.



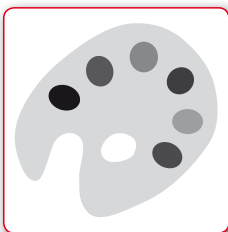
Weatherproof

Murrplastik cable drag chains are suitable for outdoor applications. Experience has shown that the mechanical properties are not impaired.



Use in clean rooms

Murrplastik uses a special material. This reduces even further the very low wear of a normal chain. In many applications in which difficult special conditions apply, the cable drag chain can still be used. An intensive test program can be set up to verify its suitability in self-supporting and gliding applications.



Special colors

Cable drag chains can be supplied in colors other than black on request. Several colors can also be combined where color-psychological effects are desired. Minimum order quantities and special prices apply.



Use in cold storage

Chain made of a special material can be supplied for use in cold storage.

Parts made of plastic / standard material



Murrplastik drag chains have been developed for use in extreme conditions. The standard material is glass-fiber reinforced plastic in standard black.

Properties

The PA (polyamide) we have developed meets stringent requirements for high mechanical capability regarding strain, pressure, torsion and free running. For specific, problematic scenarios (e.g. clean-room applications, specific climatic requirements, deployment in hygienically demanding environments), we draw on our long-standing experience to offer modified materials and can hence offer a solution to match almost any scenario.

The drag chain plastic is free of halogens, silicones and hard metals such as lead and cadmium. No formaldehydes are used in manufacturing.

Mechanical properties		Test	Test value	Unit
Tensile strength (DIN 53 455)		dry	190	N/mm ²
		humidity	120	N/mm ²
Crack resistance (DIN 53 455)		dry	4	%
		humidity	6	%
Elasticity module	Tensile test	dry	7000	N/mm ²
		humidity	10000	N/mm ²
Impact resistance (DIN 53 455)	73 °F	dry	60	kJ/m ²
	73 °F	humidity	75	kJ/m ²
	-40 °F	dry	50	kJ/m ²
Creep module E	73 ... 122 °F	humidity	5400	N/mm ²
	248 °F	dry	2100	N/mm ²
Heat conductivity			0.3	W/k x m
Static electricity value (DIN 53 455)		dry	3.8	MHz
		humidity	6.8	MHz
Special volume resistance		dry	10 ¹⁵	Ω x cm
		humidity	10 ¹²	Ω x cm
Impact resistance	Thickness 0.6 ... 0.8 mm		80	kV/mm
Surface resistance ROA		dry	10 ¹²	Ω
		humidity	10 ¹⁰	Ω
Moisture absorption	73 ... 77 °F		1.8±0.2	%
Temperature limits				
	permissible temperature		-22 ... 212 °F	
	5000 hours		up to 275 °F	
	several hours		up to 338 °F	
Other properties				
Density		dry	1.4 g/cm ³	
Coefficient of sliding friction		unlubricated	0.3–0.45	
Fire behavior		DIN VDE 0304 Part 3		
Fire classification acc. to UL		HB		

Parts made of metal / standard material

The advantage of using light metal for certain parts lies in the combination of its mechanical strength, resistance to chemical attack and its physical properties.



Murrplastik use a special aluminum alloy with the following properties. It stands out due to the following characteristics:

- Light, stable, hard and smooth
- Visually appealing
- Very low friction and wear profile for this light metal against cabling materials
- No tendency to become brittle at low temperatures
- Brine-resistant

Aluminum is used by Murrplastik for the following products: Cross member profiles and profiles for variable guide channel system VAW.

Directives: What's meant by these abbreviations?

The use of specific materials in vehicles, as in electric and electronic devices, is restricted and/or forbidden by a set of European directives. Various associations and fabricators have furthermore published their own lists of materials considered undesirable.

RoHS Directive 2002/95/EC (RoHS = Restriction of the use of certain Hazardous Substances in electrical and electronic equipment)

The guidelines limiting specific hazardous materials in electric and electronic devices categorized the following materials and their compounds as dangerous: lead, mercury, cadmium, chrome 6, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE).

VDA Lists (VDA = Verband der Automobilindustrie in Deutschland, German Automotive Industry Association)

Alongside the legal stipulations, there are also a variety of material and declaration lists prescribed by various associations and fabricators. They contain materials and material groups that are undesirable or forbidden from the corresponding processing branch for a variety of reasons. Several of the

most well-known lists are shown in the following, their content drawn from other sources and in some cases expanded: VDA list 232-101 for notifiable materials; Bosch Standard N 2580. The VDA list is part of the ILRS list ("List for materials in automobile manufacture requiring declaration--substances in components and raw materials") that is used in the IMDS (International Material Data System).

ELV Directive 2000/53/EC

(ELV = End-of-Life Vehicles)

The heavy metals listed in the ordinance (ELV) are a portion of those named in the RoHS guidelines, including lead, mercury, cadmium, chrome 6.

WEEE Directive 2002/96/EC (WEEE = Waste from Electric and Electronic Equipment)

Goal of the guidelines is the avoidance of waste from electric and electronic devices, as well as their recovery and recycling. They require selective handling of used devices with specific critical materials, as named in the guideline appendices.



Chemical resistance of plastics



Reagent	Concentration %	At + °F	Polyethylene PE	Polyamide PA6	Polyamide PA 12	Polypropylene PP	Polyurethane PU
Acetaldehyde	100	68	+	40% o	+		+
Acetic acid	10	68	+o	o	+	o	
Acetone	100	68	++	+	+	-	
Allyl alcohol	96	68		30% o	o	+	-
Alum, aqueous	diluted	104			+	+	
Aluminium chloride, aqueous	diluted	104	+		+	+	+
Aluminium sulphate, aqueous	diluted	104	+			+	+
Ammonia, aqueous	any	68	+	20% +		+	o
Ammonium chloride, aqueous	any	149	+		o	+	+
Ammonium nitrate, aqueous	diluted	104	+			+	+
Ammonium sulphate, aqueous	diluted	104	+			+	+
Aniline chlorohydrate, aqueous	saturated	68					
Aniline, pure	100	68	+	o	o	+	-
Benzaldehyde, aqueous	0,3	68	-	pure o	o	+	
Benzene	100	68	-	+	+	o	+
Benzoic acid	any	104	+		o	+	+
Benzol	100	68	--	+	o	-	
Bleaching lye	12.5 Cl	68		-	o	o	
Boracic acid, aqueous	diluted	104	+	o	+	+	-
Borax, aqueous	diluted	104		o	+	+	
Boron	50	104		o			
Bromine, liquid	100	68	-	-	o	-	-
Butane diol	10	68		pure +		+	o
Butanol	100	68				+	+
Butyl acetate	100	68				o	-
Butyl alcohol	100	68	-			+	o
Calcium chloride, aqueous	any	104	+	+	o	+	+
Calcium nitrate, aqueous	50	104	+			+	+
Caustic potash solution	50	68		50% +		+	o
Chlorine	any	68	-	-	-	-	-
Chromic alum, aqueous	diluted	104				+	
Crystallisable acetic acid	100	68			o	+	
Cyclohexanol	100	68		+		+	-
Ethyl acrylate/acrylic resin lacquer	100	68	-	30% -	-		
Ethyl alcohol, aqueous	10	68		o		+	+
Ethyl ether	100	68		30% +		o	-
Ethylene chloride	100	68				o	-
Ethylene oxide, liquid	100	68					
Exhaust gases containing carbon dioxide	any	149				+	+
Exhaust gases containing carbon oxide	any	149				+	+
Fluorine	50	104		-			
Formaldehyde, aqueous	diluted	104	+	pure +	o	+	o
Formic acid, aqueous	100	68		10% o	-	+	-
Glucose, aqueous	any	68	+			+	+
Hydrobromic acid, aqueous	10	104	+	-		+	-
Hydroxylamine sulphate, aqueous	12	95					+
Iron chloride, aqueous	10	104	+	o	+	+	+
Methyl chloride	100	68					
Potassium bromide, aqueous	any	149	+	10% +		+	o
Potassium ferrocyanide, aqueous	any	149	o			+	
Urea, aqueous	10	104		20% +		+	+

The information provided above enables an initial choice to be made. However, it is not intended as a guarantee of particular properties of the products or their suitability for a particular application. It does not release the buyer from the duty of carrying out suitability checks.

+ means: resistant
o means: limited resistance
- means: not resistant



Reagent	Concentration %	At + °F	Polyethylene PE	Polyamide PA6	Polyamide PA 12	Polypropylene PP	Polyurethane PU
Carbon bisulphide	100	68	-	o	+	+	+
Carbon dioxide	100	149	+			+	+
Carbon oxide	100	149	+			+	+
Carbon tetrachloride	100	68		+	o	o	+
Citric acid	10	104	+			+	o
Copper chloride, aqueous	saturated	68	+			+	+
Copper sulphate, aqueous	any	104	+			+	+
Cresol, aqueous	90	68	-	pure -	-	+	-
Hydrochloric acid	10	86-104					
Hydrochloric acid, aqueous	10	68	+	20% -	o	+	-
Hydrogen	100	149		+			+
Hydrosilicofluoric acid	30	68	-				
Lactic acid, aqueous	50	68	o	pure +	o	+	o
Magnesium carbonate	any	68					+
Magnesium chloride, aqueous	any	68	+	10% o		+	+
Mercury		149	+	+	+	+	+
Methyl alcohol	100	68	+			+	o
Methylene chloride	100	68		o	o	-	-
Nickel chloride, aqueous	any	68		10% o		+	+
Nickel sulphate, aqueous	any	68	+	10% o		+	+
Nitric acid, aqueous	6	68	+	50% -	-	+	-
Nitroglycerine	diluted	68					
Oils and greases		68	o	+	+	+	+
Oleic acid	100	68		+		+	o
Oxalic acid	saturated	68	+	10% o		+	o
Ozone	100	68	o	o	+	o	o
Petroleum							+
Phosgene, liquid	100	68					-
Phosphoric acid, aqueous	diluted	68	+	10% -	o	+	o
Phosphorus pentoxide	100	68				+	
Photographic developer		104				+	
Potash, aqueous	saturated	104			+		+
Potassium chloride, aqueous	any	68	+	10% +		+	+
Potassium dichromate, aqueous	40	68				+	+
Potassium nitrate	any	68	+	10% +	+	+	+
Potassium permanganate, aqueous	6	68	+		o	+	-
Potassium persulphate, aqueous	diluted	104	-		+	+	+
Salt solution	any	104			+	+	+
Seawater		104	+	+	o	+	+
Soap solution, aqueous	concentrated	68		o		+	+
Soda lye, aqueous	10	68	+	+	+	+	o
Sodium chlorate, aqueous	any	68	+	10% o		+	
Sodium sulphide, aqueous	diluted	104				+	
Sulphuric acid	10	68	+	40-80% -	o	+	+
Tin chloride, aqueous	diluted	104			+	+	+
Toluene	100	68	-	+	+	o	+
Trichloroethylene	100	68	-	o		o	-
Vinyl acetate	100	68					-
Xylene	100	68		+	+	o	+
Zinc chloride, aqueous	diluted	149	+	10% o	o	+	+
Zinc sulphate, aqueous	diluted	149	+			+	+



Appendix

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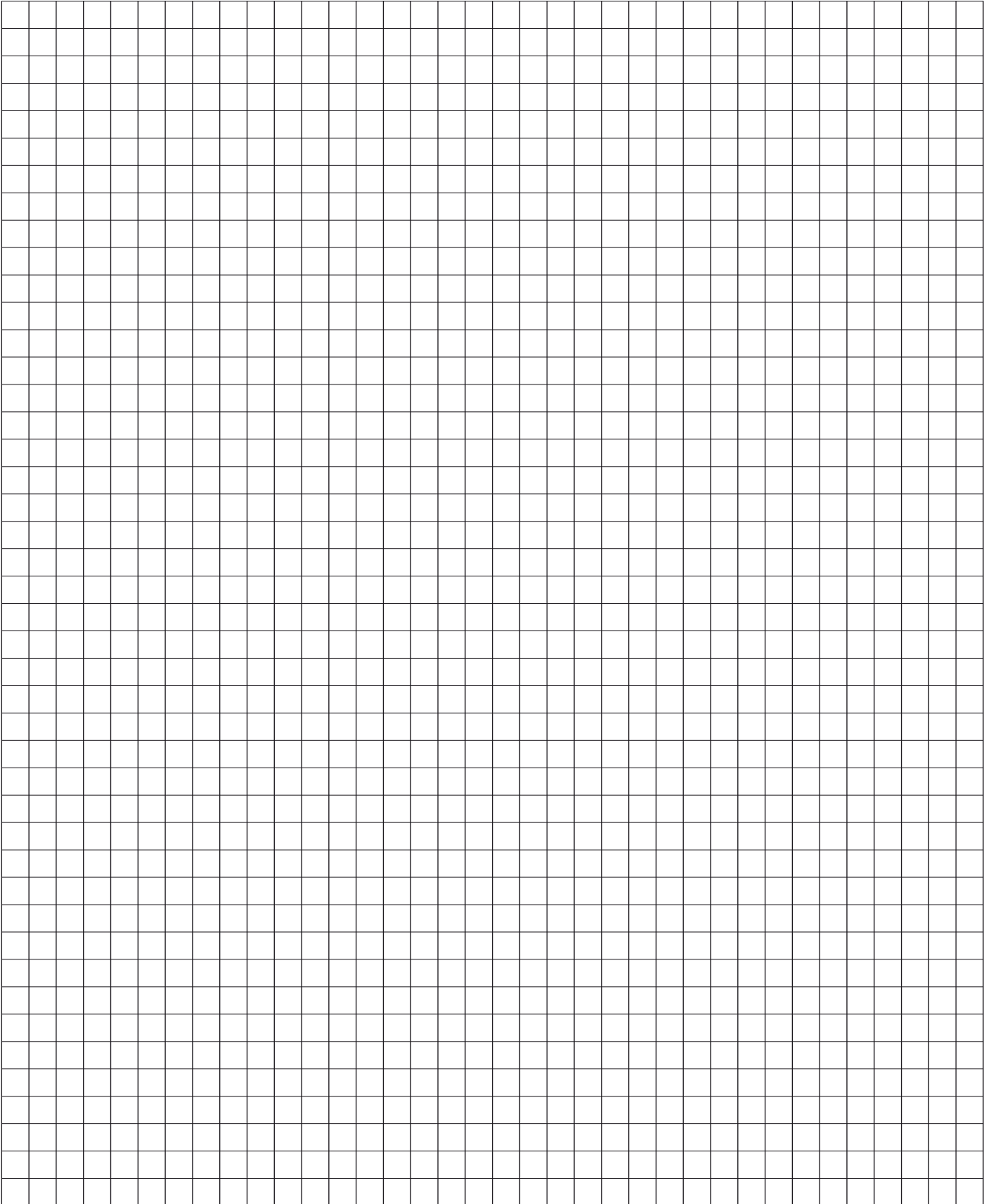
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Notes



All details given in our sales material prospectuses and catalogs as well as the information available online are based on our current knowledge of the products described.

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Our General Terms and Conditions apply.

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