

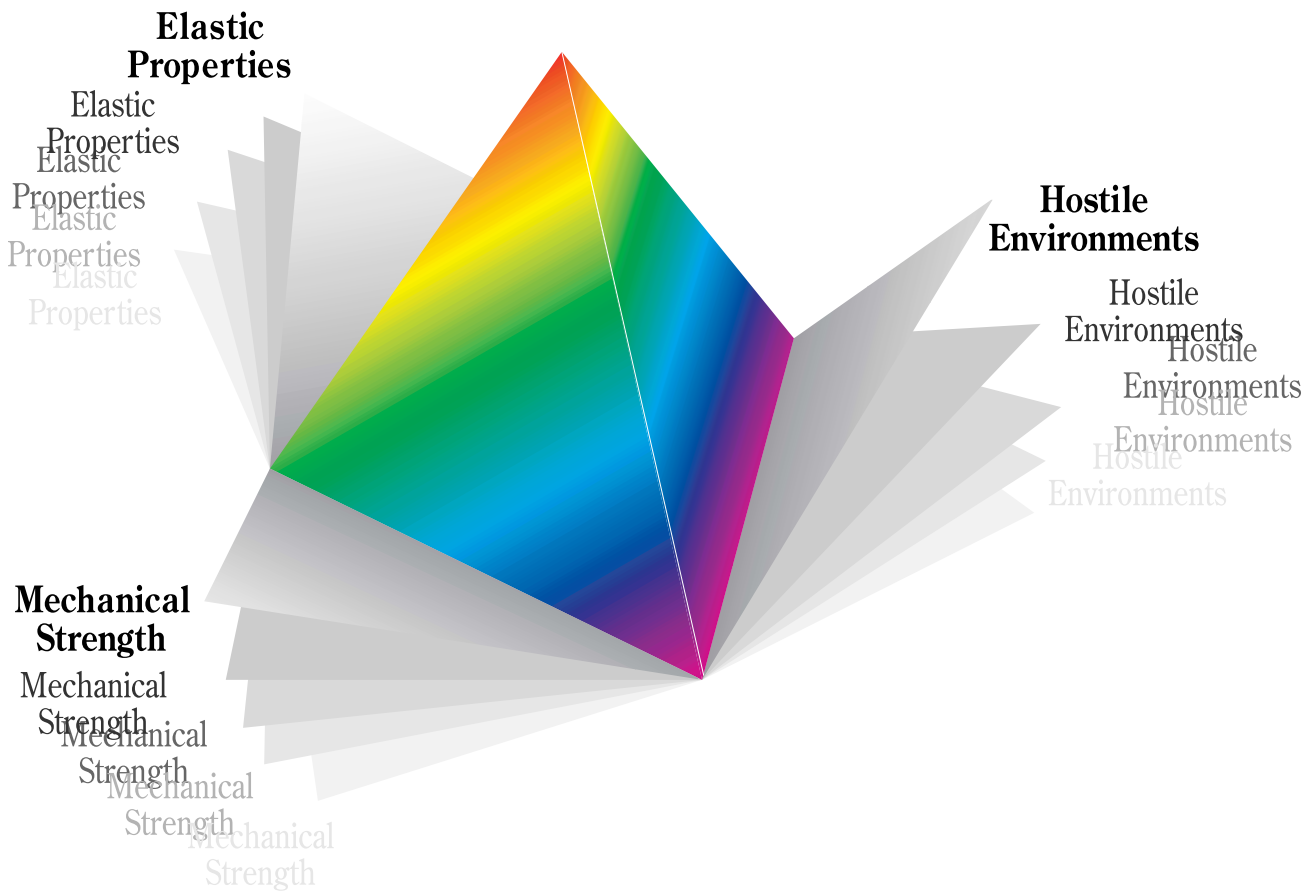
DuPont™ Hytrel®

thermoplastic polyester elastomer

Product guide and properties



Design Flexibility



Illustrations of the cover page

- 1 – Gears
- 2 – SCOTT Sun glasses: bridge for lens, rear frame and arms HYTREL®, frame of lens DELRIN®
- 3 – Lens support for SONY CD-player
- 4 – “Energizer” spring for in-line skate
- 5 – Air duct

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HYTREL® thermoplastic polyester elastomer

HYTREL® is DuPont's registered trademark for its family of thermoplastic polyester elastomers. HYTREL® thermoplastic polyester elastomers are block copolymers, consisting of a hard (crystalline) segment of polybutylene terephthalate and a soft (amorphous) segment based on long-chain polyether glycols. Properties are determined by the ratio of hard to soft segments and by the make-up of the segments.

Properties and Characteristics

HYTREL® is a thermoplastic polyester elastomer which combines many of the most desirable characteristics of high-performance elastomers and flexible plastics. It features: exceptional toughness and resilience; high resistance to creep, impact and flex fatigue; flexibility at low temperatures; and good retention of properties at elevated temperatures. In addition, it resists many industrial chemicals, oils and solvents.

Processing

HYTREL® can be readily formed into high-performance parts by a variety of thermoplastic processing techniques, including injection moulding, extrusion, blow moulding, rotational moulding and melt casting. For injection-moulding HYTREL® processes at temperatures between 175°C and 260°C depending on the polymer type. All grades have a sharp melting point and very good melt stability.

For additional information relating to processing of HYTREL®, see:

- Injection moulding guide.
- Extrusion of HYTREL®.

Recycling

For recycling purposes, the international acronym for DuPont's thermoplastic polyester elastomer HYTREL® is TEEE (thermoplastic elastomer ether ester).

Hardness of HYTREL®

Many HYTREL® grades are conveniently classified and named according to their nominal values of hardness on the Shore D scale.

However, Shore D Hardness is an imprecise parameter that may vary substantially according to the nature of the specimen measured. Therefore, only typical values are given in this brochure.

In general, Shore D Hardness relates to more precisely measurable and more directly useful parameters like flexural modulus, low and high temperature stress-strain and impact behaviour and solvents resistance.

CVJ boot

Blow moulded boots are very cost effective compared to their rubber counterparts, and offer superior toughness and resistance to greases, particularly at low temperatures.

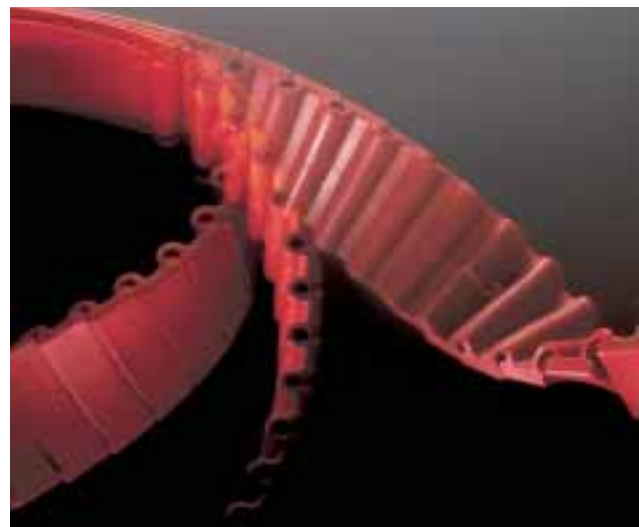


Key pad

The change to HYTREL® from the traditional silicone rubber for keypads of remote control resulted in shorter production cycles, increased design flexibility and an agreeable 'touch'.

Head phone

Innovative design features the combination of high flexibility and mechanical strength.



Seal for perfume bottle

HYTREL® has good chemical and abrasion resistance; more important it is resistant to all chemicals and the odours from the content of the bottle.

Product line description

There are two main groups of products depending on the type of soft segment used.

These are:

1. Standard grades: The most economical grades offer the best balance of cost and performance. These grades range in Shore D hardness from 35 to 82.
2. High Performance grades: These grades provide an extra measure of performance and service life

in applications where properties such as abrasion resistance and tear strength are critical. They range in Shore D hardness from 30 to 72.

Within each of these groups a range of hardnesses or flexural modulus is obtained by varying the ratio of hard and soft segments.

Available grades in each group are:

Hardness	Flexural modulus, MPa	Multipurpose	High performance
35D	35	G3548L	
40D	55-67	G4074/G4078W	4056/4068
45D	94		4556
47D	117	G4774	
55D	193-207	G5544	5526/5556/5586
63D	300	6358	6356
72D	570	7248	7246
104R*	1207	8238	

* Rockwell R

Specific properties of all these grades can be enhanced through the addition of any of the following concentrates:

Concentrate	Typical letdown ratio	Description
Carbon black 40CB and 41CB	2,5 to 6%	Provides protection against W light exposure.
UV light stabilizer 20UV	2,5 to 4%	Provides protection against UV light exposure or light-coloured parts.
Heat stabilizer 30HS	5%	Retards thermal oxidative degradation and extends useful life at elevated temperatures. Some discoloration, which has no effect on properties, will occur.
Flame retardants 51FR and 52FR	10–13%	Improves flame retardancy to attain UL94 V2 rating.

For more detailed information on the effects of these concentrates, refer to their individual data sheets.

In addition, the following special grades are available:

Specialities			
Description	Grades	Hardness (Shore D)	Flexural modulus (MPa)
Flame retardant UL94 V0 at 1,57 mm thickness	HTR8068	46	131
Blow moulding	HTR5612 BK	50	124
Blow moulding	HTR4275 BK316	55	160
Improved heat ageing performance	5555HS	55	207

Product form and packaging

HYTREL® thermoplastic polyester elastomers are supplied as cylindrical pellets (approximately 3 mm in diameter by 3 mm long), having a bulk density of about 700 kg/m³. They are packaged in 25 kg multiwall paper bags with a moisture barrier inner wall. Palletized units contain 40 bags, or 1000 kg net weight, wrapped in polyolefin film on disposable wooden pallets.

Most HYTREL® grades are also available in 1000 kg bulk boxes with a moisture resistant liner. Check with your local DuPont representative for details regarding which packages are available for the specific grade you need.

Product literature

This “General guide to products and properties” contains information on the complete line of HYTREL® products. Additional handling, processing and product information is available in a variety of other technical literature. Also, tips on designing parts with HYTREL® are available in the “HYTREL® Design Handbook” (H-38344). Further information and copies of the above mentioned literature can be obtained from your local DuPont representative.

Applications




The excellent properties of HYTREL® thermoplastic polyester elastomer qualify it for a number of demanding applications where mechanical strength and durability are required in a flexible component.

Examples include seals, belts, bushings, pump diaphragms, gears, protective boots, hose and tubing, springs and couplings, hinges, impact and sound absorbing devices. In many of these applications, HYTREL® allows a multipiece rubber, or even metal composite assembly to be replaced with a single part. Some of the industries where HYTREL® is used include: automotive, fluid power, electrical/electronic, appliance and power tool, sporting goods, furniture and off-road transportation/equipment. The potential for using HYTREL® in other industries is limited only by your imagination.

Product selection

The following tables offer some general guidelines to assist you in selecting the most suitable grade of HYTREL® for your specific application. More detailed product data is available and should be consulted prior to making your final material selection.

For simplicity, the HYTREL® products have been grouped into three hardness ranges. Their ability to meet end-use requirements is indicated by the following codes:

	very suitable
	generally suitable
	not suitable

Often, the starting point in selecting the right material is to consider the end-use environment, to what the application will be exposed to (i.e. – temperature, chemicals, etc.).

The best heat and chemical resistance is typically provided by the hardest, stiffest HYTREL® grades; whereas the softer, more flexible HYTREL® grades, usually provide better performance in low temperature environments.






















It is important to keep in mind that the part design must accommodate the mechanical behaviour of the material selected based on the environmental conditions. In addition physical properties, methods of assembly and other criteria all play a part in making the best material selection for your application.

1. End-use environment:





















	Hardness		
	30D to 40D	45D to 55D	63D to 82D/104R
Temperature:			
• High temperature mechanical properties			
• Standard grades			
• High performance grades			
• Low temperature flexibility			63D  82D/104R 
• Heat ageing (with 30 HS concentrate)			
Chemicals: See footnote below			
Weathering:			
• With 20 UV and/or 40CB/41CB			

Note: For more detailed information see page 9 of this brochure or the individual data sheets for the relevant concentrates.










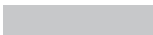
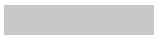
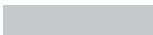









2. Assembly

	Hardness		
	30D to 40D	45D to 55D	63D to 82D/104R
Heat welding			
High frequency welding			
Ultrasonic welding			
Solvent welding			
Bonding with adhesives			
Spin welding			
Snap fit			
Overmoulding (specific grades + process recommendations)	Contact DuPont representative for grades and process recommendations		

3. Physical properties

	Hardness		
	30D to 40D	45D to 55D	63D to 82D/104R
Impact strength (from -20 to +60°C)			 
Abrasion resistance			
• Standard grades			
• High performance grades			
Tear strength			
• Standard grades			
• High performance grades			
Flexural fatigue			
Creep			

4. Fluid resistance

	Hardness		
	30D to 40D	45D to 55D	63D to 82D/104R
Mineral oils and greases, other non-aromatic hydrocarbons			
Benzene, toluene, other aromatic hydrocarbons, chemicals and solvents			
Water, alcohols, glycols			
• at ambient temperature			
• >50°C with 10MS			
without 10MS			
Acids and bases			
• diluted			
• concentrated			

Grade of HYTREL®

STANDARD GRADES

These grades offer the best balance of properties and cost.

	Description	Characteristics ¹⁾	Typical uses
HYTREL® G3548L	Low modulus moulding and extrusion grade. Contains improved colour-stable antioxidants and some UV stabilizer.	Very flexible grade of HYTREL®. Excellent flex-resistance, especially at low temperatures. Mouldable even in thin sections. Can be used in light-coloured products.	Applications requiring flex life coupled with good flexibility at low temperatures. Thin, flexible membranes. Good for high original colour retention.
HYTREL® G4074	Low modulus moulding and extrusion grade. Contains a discolouring antioxidant.	Excellent heat-ageing resistance and resistance to oils at high temperatures. Best low modulus moulding and extrusion grade.	Tubing. Hose Jackets. Wire and cable jackets. Film sheeting. Moulded products.
HYTREL® G4078W	Low modulus moulding and extrusion grade. Contains improved colour-stable antioxidants and some UV stabilizer.	Like HYTREL® G4074, except that heat-ageing resistance is reduced. Can be used in light-coloured products.	Applications requiring high original colour retention. Moulded and extruded products for consumer use.
HYTREL® G4774	Medium-low modulus moulding and extrusion grade. Contains a discolouring antioxidant.	Excellent heat-ageing resistance and resistance to oils at high temperatures. Good resistance to oils, fuels and solvents.	Tubing. Hose jackets. Wire and cable jackets. Profiles. Moulded products.
HYTREL® G5544	Medium modulus moulding and extrusion grade. Contains a discolouring antioxidant.	Excellent heat-ageing resistance and resistance to oils at high temperatures.	Same as HYTREL® G4774.
HYTREL® 6358	Medium modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Excellent heat-ageing resistance and resistance to oils at high temperatures.	Applications requiring high original colour retention. Moulded and extruded products for consumer use.
HYTREL® 7248	Medium modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Excellent heat-ageing resistance and resistance to oils at high temperatures.	Applications requiring high original colour retention. Moulded and extruded products for consumer use.
HYTREL® 8238	Highest modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Highest service temperature. Best resistance to oils, fuels, and solvents. Lowest fuels permeability.	Tubing. Wire and cable jackets. Gears and sprockets. Oil field parts. Electrical connectors.

HIGH-PERFORMANCE GRADES

These grades provide an extra measure of strength or performance in the most demanding applications, can be used in light-coloured products (except HYTREL® 5555HS).

	Description	Characteristics ¹⁾	Typical uses
HYTREL® 4056	Low modulus extrusion grade. Contains colour-stable anti-oxidants.	Excellent low-temperature properties. Excellent flex-fatigue resistance. Excellent creep resistance.	Hose jackets. Wire and cable jackets. Film and sheeting. Belting. Seals.
HYTREL® 4068	Low modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Low modulus grade similar to HYTREL® 4056, with a higher melting point.	Same as HYTREL® 4056 + Moulded products.
HYTREL® 4556	Medium-low modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Same as HYTREL® 4068.	Same as HYTREL® 4056 + Moulded products.
HYTREL® 5526	Medium modulus moulding grade. Contains colour-stable antioxidants.	Combines the best balance of properties of the product line.	Seals, packing and gaskets. Gears and bearings.
HYTREL® 5556	Medium modulus extrusion grade. Contains colour-stable antioxidants.	Combines the best balance of properties of the product line.	Tubing and hose. Wire and cable jackets. Film and sheeting. Belting.
HYTREL® 6356	Medium-high modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Very good resistance to oils, hydraulic fluids and fuels. Very good resistance to permeation by gases and liquids.	Tubing and hose. Film. Profiles. Seals. Gears and sprockets. Fuel tanks.
HYTREL® 7246	High modulus moulding an extrusion grade. Contains colour-stable antioxidants.	High service temperature. Retains good low-temperature flexibility. Excellent resistance to oils, fuels and solvents. Low fuel permeability.	Tubing. Wire and cable jackets. Gears and sprockets. Oil field parts.

SPECIALITY GRADES

	Description	Characteristics*	Typical uses
HYTREL® 5555HS	Heat-stabilized grade of HYTREL® 5556. Contains a discolouring antioxidant.	Combine the best balance of properties of the product line.	Used where increased heat-ageing stability is required.
HTR4275 BK316	Medium modulus, high viscosity grades. Contains a discolouring antioxidant. HTR4275 BK is pigmented black. Particularly suitable for extrusion blow moulding and extrusion.	Good balance of properties combined with high viscosity for extrusion and blow moulding applications.	Hollow thin-walled parts. Blown film and sheeting. Large diameter tubing. Profiles. Automotive boots, air ducts and covers.
HTR5612 BK	Medium modulus, high-viscosity grades. Particularly suitable for blow moulding and extrusion.	Good balance of properties combined with high viscosity for extrusion and blow moulding applications.	Blown thin-walled parts. Blown film and sheeting. Large diameter tubing. Profiles. Automotive boots and covers.
HTR8068	Medium-low modulus moulding and extrusion grade, flame retarded antidrip compound.	Meets requirements of UL94 class V0 at 1,6 mm thickness.	Tubing and hose. Wire and cable jackets. Film and sheeting.

* The characteristics shown are those of the unmodified standard composition. Special stabilizers and additives can be mixed into HYTREL® to improve its resistance to ultraviolet light, heat-ageing and moisture.

CONCENTRATES*

These concentrates are in a base of HYTREL® 4056.

	Description	Characteristics ¹⁾ and typical uses
HYTREL® 20UV	Ultraviolet (UV) light stabilizer concentrate.	HYTREL® 20UV is used for protection of lightcoloured parts against UV degradation. Recommended letdown ratio is 25:1 or less.
HYTREL® 30HS	Heat stabilizer concentrate.	For blending with other grades of HYTREL® to retard thermal oxidative degradation and extend useful life at elevated temperatures. Recommended letdown ratio is between 16:1 and 40:1, usually about 20:1.
HYTREL® 40CB HYTREL® 41CB	Concentrates of a fine particle size carbon black.	HYTREL® must be protected against degradation from exposure to UV light when used outdoors or when exposed to sunlight. HYTREL® 41CB provides the most effective protection. Recommended letdown ratio for direct outdoor exposure is from 20:1 to 9:1.
HYTREL® 51FR HYTREL® 52FR	Flame retardant concentrate.	For blending with soft (up to 47D: HYTREL® 51FR) and hard (from 55D: HYTREL® 52FR) grades of HYTREL® to improve the flame retardancy as measured by the time to flame extinction of the burn rate. Recommended letdown ratio is 10:1.).

* All concentrates are supplied in pellet form. They can be dry-blended with pellets of unmodified grades, then melt-mixed in the screw of an extruder or injection moulding machine.

Fluid resistance

HYTREL® has excellent resistance to non-polar materials, even at elevated temperatures. Polar materials at elevated temperatures may have severe effects on HYTREL®. In general, fluid resistance of HYTREL® improves as the stiffness of the grade increases.

Properties of HYTREL® thermoplastic polyester elastomer resins

					Standard grades					
Property ¹⁾	Test conditions	ISO test method	Units							
				G3548L	G4074	G4078W	G4774	G5544		
MECHANICAL	Stress at break (tensile)	50 mm/min	527-1/-2	MPa	10	16	17	20	35	
	Strain at break (tensile)	50 mm/min	527-1/-2	%	200	340	310	275	480	
	Stress at 5% strain	50 mm/min	527-1/-2	MPa	1,7	2,4	3,0	3,8	6,0	
	Stress at 10% strain	50 mm/min	527-1/-2	MPa	2,6	3,8	4,5	6,0	10,5	
	Tensile modulus	1 mm/min	527-1/-2	MPa	28	55	51	108	185	
	Flexural modulus			178	MPa					
			-40°C			62	207	166	320	850
			23°C			32	60	66	117	183
			100°C			7	33	16	69	125
	Izod impact strength (notched) ²⁾			ASTM						
		-40°C	D256	J/m	No Break	27	27	144	133	
		23°C	Method A		No Break	No Break	No Break	No Break	No Break	
THERMAL	Melting temperature, by DSC	10°K/min	3146 C	°C	156	170	170	208	215	
	Temperature of deflection under load			75-1/2						
			0,45 MPa		°C		50	50	65	100
			1,8 MPa		°C			45	45	
Vicat softening temperature	10 N	306		°C	75	110	120	175	190	
RHEOL.	Melt mass-flow rate		1133	g/10 min	10	5,2	5,3	11	10	
		Temperature/Load		°C/kg	190/2,16	190/2,16	190/2,16	230/2,16	230/2,16	
	Density		1183	kg/m ³	1150	1180	1180	1200	1220	
	Water absorption	Saturation, immersed	Similar to ISO 62	%	5,0	3,7	5,4	4,1	2,2	
OTHERS	Shore hardness D	(max. reading)	ASTM D2240	points	35	40	40	47	55	
		15 s	868		26	34	34	43	50	
	Resistance to flex cut growth, Ross (pierced)		ASTM D1052	Cycles to 5 × cut	>10 ⁶	>10 ⁶	>10 ⁶	>10 ⁶	0,8 × 10 ⁶	
	Abrasion resistance		ASTM D1044	mg/1000 rev.						
			Taber, CS-17 wheel		30	9	20	13	9	
		Taber, H-18 wheel		310	193	260	168	116		
Initial tear resistance	2 mm, die C	34		kN/m	51	81	88	94	123	

1) All properties were measured on injection-moulded specimens at 23°C, unless specified otherwise.

2) Specimens 6,35 mm thick.

The values shown are for unmodified grades. Colourants or additives of any kind may alter some or all of these properties. The data listed here fall within the normal range of product properties, but they should not be used to establish specification limits or used alone as the basis of design.

All the above information is subject to the disclaimer printed on the back page of this document.

Standard grades			High-performance grades							Specialty grades			
6358	7248	8238	4056	4068	4556	5526	5556	6356	7246	5555HS	HTR 4275 BK	HTR 5612	HTR 8068
41	46	49	30	28	31	40	42	46	53	40	40	36	13
420	350	400	420	600	550	500	500	490	450	500	450	450	240
9,0	14,0	27,6	2,4	2,4	4,1	6,9	6,9	12,0	14,0	6,9	7,6	5,5	3,9
13,1	20,0	30,3	3,6	3,5	5,7	10,3	10,3	16,0	20,0	10,3	10,3	8,3	5,2
280	525	1150	53			188	180	280	525		150	115	140
1850	2390	3030	155	172	230	760	760	1800	2410	760	910	510	650
290	544	1210	62	55	80	200	180	296	527	207	160	134	174
		255	27	28	44	110	110	150	207	110	59	46	50
30	40	30	No Break	No Break	No Break	128	170	48	40	43	70	110	90
No Break	210	40	No Break	No Break	No Break	No Break	No Break	No Break	210	No Break	No Break	No Break	No Break
213	218	223	150	193	193	203	203	211	218	203	196	201	169
115	95	105	50	55	50	65	70	85	95	60	68	62	
51	45	45			35	45	45	45	45	40	45	44	
195	205	210	110	135	160	180	180	195	205	180	174	155	110
9	13	12,5	5,3	8,5	8,5	18	7,5	8,5	12,5	8,5	2,0	3,0	4,6
230/2,16	240/2,16	240/2,16	190/2,16	220/2,16	220/2,16	220/2,16	220/2,16	230/2,16	240/2,16	220/2,16	230/5,0	230/2,16	230/2,16
1220	1250	1280	1150	1100	1140	1190	1200	1220	1260	1220	1160	1160	1430
0,6	0,6	0,6	0,7	0,7	0,6	0,6	0,6	0,6	0,6	0,7	0,6	0,6	*
63	72	82	40	40	45	55	55	63	72	55	55	50	46
58	68	74	39	33	40	51	52	58	68	50	52		
		N/A	>10 ⁶	>10 ⁶		5 × 10 ⁵	5 × 10 ⁵	5 × 10 ⁵	3 × 10 ⁴	10 ⁵	5 × 10 ⁴		
			>10 ⁶	>10 ⁶	>10 ⁶	>5 × 10 ⁵	>5 × 10 ⁵	>5 × 10 ⁵	>3 × 10 ⁴	>10 ⁵	>5 × 10 ⁴	>6 × 10 ⁵	
		9	3	15	3	7	6	7	13		20	38	25
		20	100	80	72	70	64	77	47	112	227	186	
		253	101	95	116	158	158	175	200	158	163	145	75

N/A = not applicable

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