Electrical Properties of SCHOTT Thin Glasses

SCHOTT offers a wide range of glass types produced in various hot forming technologies. These glasses have applications throughout the electronic industry. Glasses have a high breakdown strength[1] as well as good dielectric properties and are used in mm-wave packages where antenna compounds and different semiconductor components are integrated into a single package. Excellent thermal properties make high power packages possible. Smooth glass surfaces and industrial established metallization technologies enable excellent and accurate high-frequency designs. Some of the main areas where glasses can be applied are as interposer in the semiconductor industry, mm-wave packages, including antennas for 5G applications, gesture recognition, and automotive radar operating in the range above 30 GHz as well as high power packages in 5G transmission applications.

SCHOTT D 263® T eco

Frequency in GHz[3][4]	**1**	**2**	**5**	**24**	**77**
Dielectric constant (permittivity) ε_r[2]	6.4	6.4	6.3	6.3	6.1
Loss tangent *tan(δ)* in 10^{-4}	74	81	101	210	240

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	$1.6 \cdot 10^{8}$
	ρ_D at ϑ = 350 °C in Ω·cm	$3.5 \cdot 10^{6}$

SCHOTT AF 32® eco

Frequency in GHz[3][4]	**1**	**2**	**5**	**24**[7]	**77**[7]
Dielectric constant (permittivity) ε_r[2]	5.1	5.1	5.1	5.1	5.0
Loss tangent *tan(δ)* in 10^{-4}	35	39	49	90	110

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	$7.9 \cdot 10^{11}$
	ρ_D at ϑ = 350 °C in Ω·cm	$1.1 \cdot 10^{10}$

SCHOTT AS87® eco

Frequency in GHz[3][4]	**1**	**2**	**5**	**24**	**77**
Dielectric constant (permittivity) ε_r[2]	7.3	7.3	7.2	7.2	7.1
Loss tangent *tan(δ)* in 10^{-4}	133	148	172	330	380

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	–
	ρ_D at ϑ = 350 °C in Ω·cm	–

SCHOTT MEMpax®

Frequency in GHz[3][4]	**1**	**2**	**5**	**24**[7]	**77**[7]
Dielectric constant (permittivity) ε_r[2]	4.4	4.5	4.4	4.4	4.5
Loss tangent *tan(δ)* in 10^{-4}	58	62	73	130	140

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	$1.18 \cdot 10^{8}$
	ρ_D at ϑ = 350 °C in Ω·cm	$4.24 \cdot 10^{6}$

SCHOTT BOROFLOAT® 33

Frequency in GHz[3][4]	**1**[7]	**2**[7]	**5**[7]	**24**[7]	**77**[7]
Dielectric constant (permittivity) ε_r[2]	4.5	4.5	4.5	4.5	4.4
Loss tangent *tan(δ)* in 10^{-4}	51	57	73	120	130

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	$1.0 \cdot 10^{8}$
	ρ_D at ϑ = 350 °C in Ω·cm	$3.2 \cdot 10^{6}$

SCHOTT B 270® D

Frequency in GHz[3][4]	**1**	**2**	**5**	**24**	**77**
Dielectric constant (permittivity) ε_r[2]	6.8	6.8	6.7	6.8	6.5
Loss tangent *tan(δ)* in 10^{-4}	52	58	75	200	230

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	$2.4 \cdot 10^{8}$
	ρ_D at ϑ = 350 °C in Ω·cm	$5.8 \cdot 10^{6}$

SCHOTT B 270® i

Frequency in GHz[3][4]	**1**	**2**	**5**	**24**	**77**
Dielectric constant (permittivity) ε_r[2]	6.7	6.8	6.7	6.6	–
Loss tangent *tan(δ)* in 10^{-4}	59	66	84	150	–

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	$6.1 \cdot 10^{7}$
	ρ_D at ϑ = 350 °C in Ω·cm	$1.6 \cdot 10^{6}$

SCHOTT FOTURAN® II (glass)

Frequency in GHz[3][4]	**1**	**2**	**5**	**24**	**77**
Dielectric constant (permittivity) ε_r[2]	6.4	6.4	6.3	–	–
Loss tangent *tan(δ)* in 10^{-4}	84	90	109	–	–

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	$2.0 \cdot 10^{6}$
	ρ_D at ϑ = 350 °C in Ω·cm	$1.0 \cdot 10^{5}$

SCHOTT FOTURAN® II (ceramized 560 °C)[5]

Frequency in GHz[3][4]	**1**	**2**	**5**	**24**	**77**
Dielectric constant (permittivity) ε_r[2]	5.8	5.9	5.8	5.9	5.6
Loss tangent *tan(δ)* in 10^{-4}	58	65	79	146	185

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	$2.0 \cdot 10^{8}$
	ρ_D at ϑ = 350 °C in Ω·cm	$4.0 \cdot 10^{6}$

SCHOTT FOTURAN® II (ceramized 810 °C)[6]

Frequency in GHz[3][4]	**1**	**2**	**5**	**24**	**77**
Dielectric constant (permittivity) ε_r[2]	5.4	5.5	5.4	5.4	5.3
Loss tangent *tan(δ)* in 10^{-4}	39	44	55	105	135

Specific electrical volume resistivity ρ_D at 50 Hz	ρ_D at ϑ = 250 °C in Ω·cm	$6.3 \cdot 10^{8}$
	ρ_D at ϑ = 350 °C in Ω·cm	$1.6 \cdot 10^{7}$

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[1] The dielectric strength of glasses depends on many factors like frequency, rate of increase in voltage, temperature, glass composition and external test conditions. Furthermore, the breakdown field strength increases substantially with decreasing glass thickness. For ultra-thin glasses, the dielectric breakdown strength can show extremely large values. For example a breakdown strength of 1200 kV/mm was measured on 12 µm thick alkaline free glass specimen.

[2] The data of the dielectric constant ε_r at 1 GHz, 2 GHz, 5 GHz, 24 GHz and 77 GHz have an accuracy of ±0.1.

[3] The data at 1 GHz, 2 GHz and 5 GHz are measured using a split-post-dielectric resonator and have an accuracy for the loss tangent of approx. 10^{-5}.

[4] The data at 24 GHz and 77 GHz are obtained with an open resonator technique which has an accuracy for the loss tangent of approx. 10^{-3}.

[5] Ceramization parameter: +5 K/min – 400 °C; +1 K/min – 500 °C; 1 h – 500 °C; +1 K/min – 560 °C; 1 h – 560 °C; –0,5 K/min – 420 °C; ambient air cooling inside furnace to room temperature

[6] Ceramization parameter: +10 K/min – 400 °C; +1 K/min – 810 °C; 1 h – 810 °C; –1 K/min – 400 °C; ambient air cooling inside furnace to room temperature

[7] Preliminary Data. All data subject to chance.

SCHOTT
glass made of ideas

Main Glass Properties of SCHOTT Thin Glasses

For many of the challenges of innovations and new products, glass offers the right path to the solution. The properties of each glass are unique and can be customized individually if necessary. In more than 130 years of development SCHOTT AG has created a wide range of different specialty glasses and glass-ceramics for many different applications. A selection of the fundamental physical and chemical properties of our most commonly used thin glass types are mentioned below. Further information about a specific type can be received at www.schott.com.

SCHOTT D 263® T eco

Glass type	Borosilicate
CTE α (20 °C; 300 °C) in 10^{-6} K^{-1}	7.2
Transformation temperature T_g in °C	557
Density p in g/cm³	2.51
Young's modulus E in GPa	72.9
Refractive index (as drawn) n_D	1.5230

	λ in nm	τ in %	τ_i in %
UV transmission at a thickness of 1 mm8)	308	0.2	0.2
	355	87.4	96.1

SCHOTT AF 32® eco

Glass type	Aluminoborosilicate
CTE α (20 °C; 300 °C) in 10^{-6} K^{-1}	3.2
Transformation temperature T_g in °C	717
Density p in g/cm³	2.43
Young's modulus E in GPa	74.8
Refractive index (as drawn) n_D	1.5099

	λ in nm	τ in %	τ_i in %
UV transmission at a thickness of 1 mm8)	308	64.2	70.4
	355	88.3	96.6

SCHOTT AS87® eco

Glass type	Aluminosilicate
CTE α (20 °C; 300 °C) in 10^{-6} K^{-1}	8.7
Transformation temperature T_g in °C	621
Density p in g/cm³	2.46
Young's modulus E in GPa	73.3
Refractive index (as drawn) n_D	1.5040

	λ in nm	τ in %	τ_i in %
UV transmission at a thickness of 1 mm8)	308	30.9	34.2
	355	79.2	87.2

SCHOTT MEMpax®

Glass type	Borosilicate
CTE α (20 °C; 300 °C) in 10^{-6} K^{-1}	3.26
Transformation temperature T_g in °C	532
Density p in g/cm³	2.22
Young's modulus E in GPa	62.7
Refractive index (as drawn) n_D	1.4714

	λ in nm	τ in %	τ_i in %
UV transmission at a thickness of 1 mm8)	308	74.1	80.3
	355	91.8	99.4

SCHOTT B 270® D

Glass type	Soda-lime
CTE α (20 °C; 300 °C) in 10^{-6} K^{-1}	9.4
Transformation temperature T_g in °C	536
Density p in g/cm³	2.56
Young's modulus E in GPa	69.8
Refractive index (as drawn) n_D	1.5229

	λ in nm	τ in %	τ_i in %
UV transmission at a thickness of 1 mm8)	308	58.9	64.8
	355	90.2	99.1

SCHOTT B 270® i

Glass type	Soda-lime
CTE α (20 °C; 300 °C) in 10^{-6} K^{-1}	9.4
Transformation temperature T_g in °C	542
Density p in g/cm³	2.56
Young's modulus E in GPa	71.1
Refractive index (as drawn) n_D	1.5229

	λ in nm	τ in %	τ_i in %
UV transmission at a thickness of 1 mm8)	308	–	–
	355	–	–

SCHOTT FOTURAN® II (glass)

Glass type	Photo-sensitive glass
CTE α (20 °C; 300 °C) in 10^{-6} K^{-1}	8.49
Transformation temperature T_g in °C	455
Density p in g/cm³	2.37
Young's modulus E in GPa	76.6
Refractive index (as drawn) n_D	1.515

	λ in nm	τ in %	τ_i in %
UV transmission at a thickness of 1 mm8)	308	–	–
	355	–	–

SCHOTT BOROFLOAT® 33

Glass type	Borosilicate
CTE α (20 °C; 300 °C) in 10^{-6} K^{-1}	3.25
Transformation temperature T_g in °C	525
Density p in g/cm³	2.23
Young's modulus E in GPa	64
Refractive index (as drawn) n_D	1.4714

	λ in nm	τ in %	τ_i in %
UV transmission at a thickness of 1 mm8)	308	88.2	–
	355	92.4	–

The **thermal conductivity** λ at ϑ = 90 °C is approx. 1 W/(m·K) for all glass types.

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8) Numbers for 1 mm thick glass are based on transmission measurements and calculations

SCHOTT AG
Hattenbergstrasse 10
55122 Mainz
Germany
Phone +49 (0)6131/66-3572
info.special-glass-wafer@schott.com

www.schott.com/special-glass-wafer

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Version September 2018 | SCHOTT reserves the right to make specification changes in this product flyer without notice.