



# Piezoceramic Soft Materials

**CeramTec**  
THE CERAMIC EXPERTS

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CA220109/EN/2205/IM

# Material characteristics

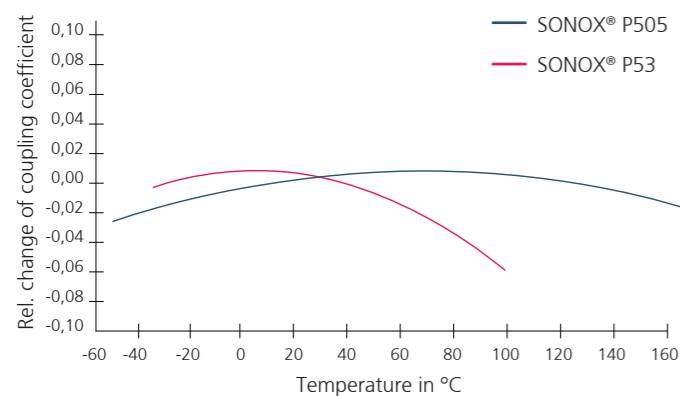
Material		Sonox® P5	Sonox® P502	Sonox® P504	Sonox® P508	Sonox® P505	PZT5A1	
Navy Type		II	II	II	II	II	II	
<b>Dielectric properties</b>								
Relative permittivity $\epsilon_r$	$\epsilon_{33}^T/\epsilon_0$	1850	1850	1730	1500	1880	1800	
	$\epsilon_{33}^S/\epsilon_0$	865	876	835	625	780	960	
	$\epsilon_{11}^T/\epsilon_0$	1850	1950	1920	1700	1850	1440	
	$\epsilon_{11}^S/\epsilon_0$	1220	1260	1085	900	900	920	
Dielectric dissip. factor $\tan \delta$	$10^{-3}$	20,0	12,5	12,0	18,0	15,0	20,0	
Curie temperature $T_c$	C°	340	335	350	340	335	370	
<b>Electromechanical properties</b>								
Frequency constant	$N_p$	2030	2020	2020	2050	2010	2000	
	$N_t$	1900	2030	2035	2090	1880	1940	
	$N_1$	1380	1325	1320	1340	1360	1370	
	$N_3$	1310	1260	1250	1300	1300	1415	
Coupling coefficient	$k_p$	0,62	0,62	0,59	0,61	0,65	0,62	
	$k_{31}$	0,34	0,33	0,32	0,35	0,33	0,34	
	$k_{33}$	0,73	0,72	0,71	0,72	0,73	0,67	
	$k_t$	0,49	0,48	0,51	0,58	0,53	0,45	
	$k_{15}$	0,72	0,74	0,66	0,71	0,71	0,69	
Charge constant	$d_{33}$	450	440	390	440	475	410	
	$d_{31}$	$10^{-12}$ C/N	-180	-185	-157	-165	-180	-175
	$d_{15}$		550	560	530	550	670	490
Voltage constant $g_{33}$	$10^{-3}$ Vm/N	27,5	26,9	25,5	33,1	28,5	25,7	
<b>Mechanical properties</b>								
Elastic compliance	$S_{11}^E$	$10^{-12}$ m <sup>2</sup> /N	17,1	18,5	16,3	17,0	17,9	16,7
	$S_{33}^E$		19,0	20,7	17,5	19,0	24,0	17,2
Elastic stiffness	$C_{33}^D$	$10^{10}$ m <sup>2</sup> /N	14,5	15,7	14,9	15,8	14,7	15,8
	$C_{55}^D$		5,8	6,5	4,4	6,0	4,0	4,0
Density $\rho$	$10^3$ kg/m <sup>3</sup>	7,65	7,74	7,65	7,80	7,70	7,75	
Mechan. quality factor $Q_m$		90	80	90	60	80	60	
<b>Stability</b>								
Aging rate	Capacitance	%/Decade	-2,3	-0,3	-0,4	-0,3	-1,6	-1,6
	Frequency		0,3	0,15	0,4	0,2	0,5	0,2
	Coupling coefficient		0,1	0,2	0,1	-0,1	0,6	-0,4

Material		PZT5A4	PZT5H1	Sonox® P53	PZT503	PZT507	
Navy Type		II	VI	VI	-	-	
<b>Dielectric properties</b>							
Relative permittivity $\epsilon_r$	$\epsilon_{33}^T/\epsilon_0$	1850	3400	3800	2100	4400	
	$\epsilon_{33}^S/\epsilon_0$	960	1575	1625	735	1875	
	$\epsilon_{11}^T/\epsilon_0$	1650	2295	3580	1800	3300	
	$\epsilon_{11}^S/\epsilon_0$	920	1295	1670	970	590	
Dielectric dissip. factor $\tan \delta$	$10^{-3}$	17,0	25,0	16,0	20,0	16,0	
Curie temperature $T_c$	C°	360	195	215	285	165	
<b>Electromechanical properties</b>							
Frequency constant	$N_p$	1970	1975	1960	1975	1925	
	$N_t$	2060	1895	1890	1850	1800	
	$N_1$	1400	1375	1420	1450	1400	
	$N_3$	1420	1410	1190	1450	1370	
Coupling coefficient	$k_p$	0,66	0,60	0,65	0,68	0,75	
	$k_{31}$	0,37	0,35	0,38	0,38	0,39	
	$k_{33}$	0,72	0,72	0,74	0,75	0,80	
	$k_t$	0,49	0,50	0,51	0,55	0,55	
	$k_{15}$	0,68	0,66	0,73	0,66	0,66	
Charge constant	$d_{33}$	460	620	680	500	820	
	$d_{31}$	$10^{-12}$ C/N	-195	-250	-275	-215	-360
	$d_{15}$		550	740	770	515	740
Voltage constant $g_{33}$	$10^{-3}$ Vm/N	28,1	20,6	20,2	26,9	21,0	
<b>Mechanical properties</b>							
Elastic compliance	$S_{11}^E$	$10^{-12}$ m <sup>2</sup> /N	16,0	16,4	15,8	15,0	16,0
	$S_{33}^E$		18,0	20,8	22,9	18,0	20,0
Elastic stiffness	$C_{33}^D$	$10^{10}$ m <sup>2</sup> /N	16,8	14,3	15,2	16,8	14,5
	$C_{55}^D$		4,5	3,7	6,1	4,6	3,8
Density $\rho$	$10^3$ kg/m <sup>3</sup>	7,90	7,40	7,83	7,80	7,80	
Mechan. quality factor $Q_m$		80	65	75	75	80	
<b>Stability</b>							
Aging rate	Capacitance	%/Decade	-2,0	-1,5	-0,8	-1,0	-1,0
	Frequency		0,1	0,3	0,1	0,5	0,3
	Coupling coefficient		-0,1	-0,2	-0,1	-0,5	-0,6

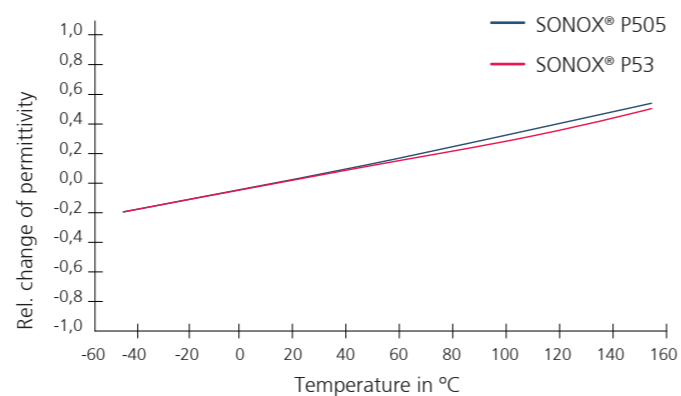
The materials data shown were evaluated on specific sample components and shall only be used to give an indication for design purposes. These values were determined based on national and international standards, if those standards were not available, then the values were determined on the basis of CeramTec internal standards. The displayed values are material properties and do not guarantee any properties of piezoceramic parts / products. CeramTec and its affiliates do not assume any responsibility for the correctness of such information nor for any damages subject to its use. Please note that material specifications and information detailed in this media are subject to changes.

# Thermal dependency of piezo electric characteristics

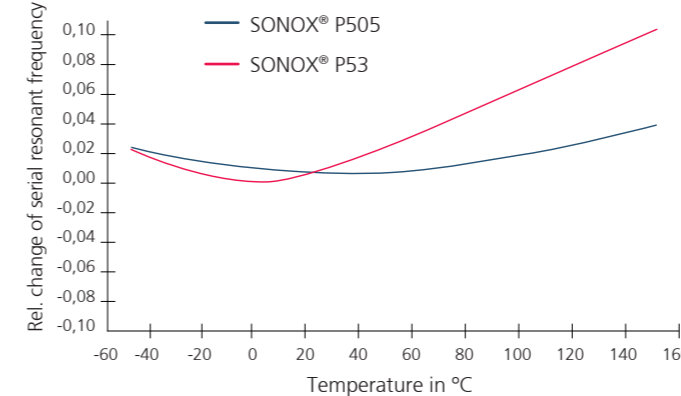
Relative temperature dependence of coupling coefficient



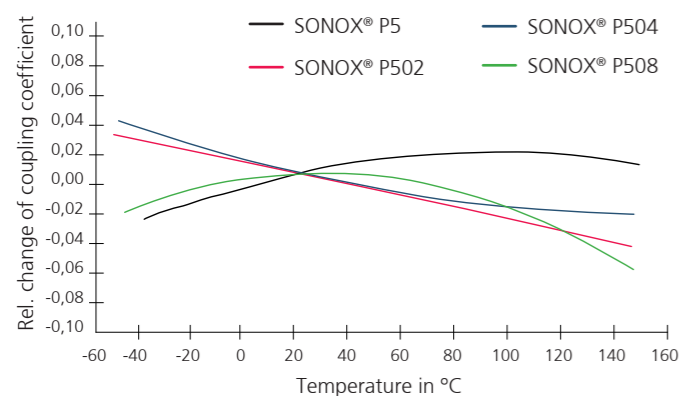
Relative temperature dependence of permittivity



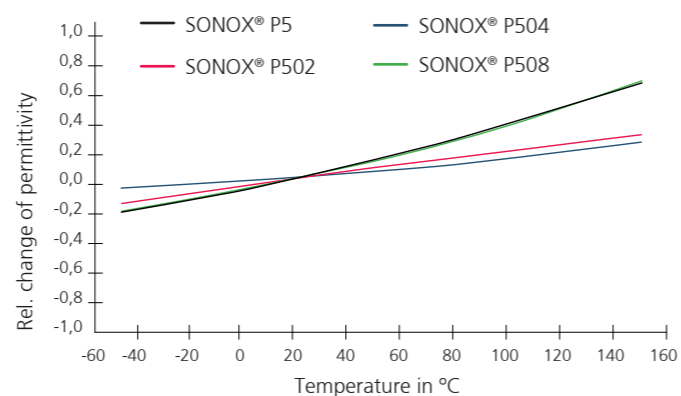
Relative temperature dependence of serial resonant frequency



Relative temperature dependence of coupling coefficient



Relative temperature dependence of permittivity



Relative temperature dependence of serial resonant frequency

