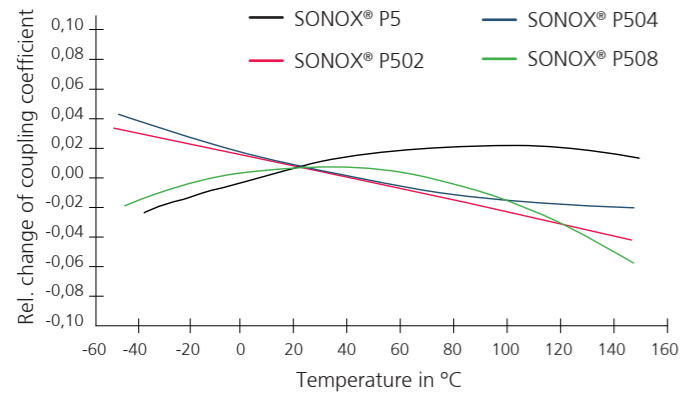
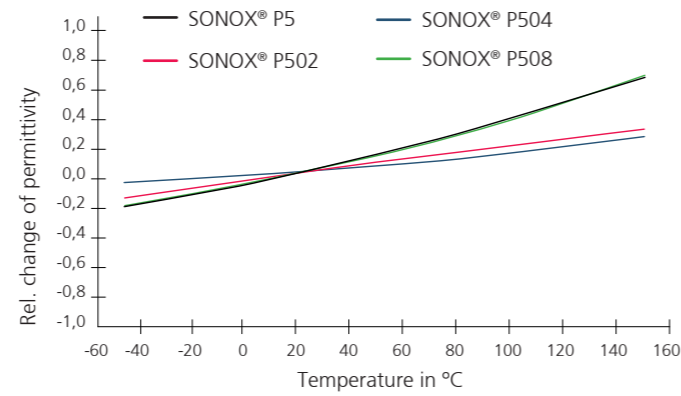


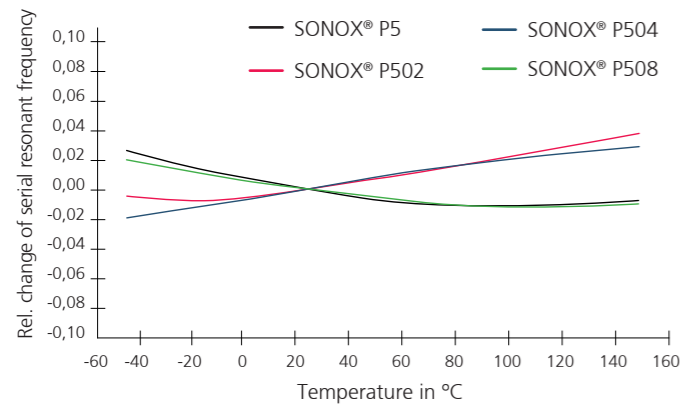
Relative temperature dependence of coupling coefficient



Relative temperature dependence of permittivity



Relative temperature dependence of serial resonant frequency



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MATERIAL DATA

CERAMTEC

**Piezoceramic
Soft Materials**

Thermal dependency of piezo electric characteristics

Material		Sonox® P5	Sonox® P502	Sonox® P504	Sonox® P508	Sonox® P505	PZT5A1	PZT5A2	PZT5H1	Sonox® P53	PZT503	PZT507	
Navy Type		II	II	II	II	II	II	II	VI	VI	-	-	
Dielectric properties													
Relative permittivity ϵ_r	$\epsilon_{33}^T/\epsilon_0$	1850	1850	1730	1500	1880	1800	1800	3400	3800	2100	4400	
	$\epsilon_{33}^S/\epsilon_0$	865	876	835	625	780	960	870	1575	1625	735	1875	
	$\epsilon_{11}^T/\epsilon_0$	1850	1950	1920	1700	1850	1440	1730	2295	3580	1800	3300	
	$\epsilon_{11}^S/\epsilon_0$	1220	1260	1085	900	900	920	840	1295	1670	970	590	
Dielectric dissip. factor $\tan \delta$	10^{-3}	20,0	12,5	12,0	18,0	15,0	20,0	20,0	25,0	16,0	20,0	16,0	
Curie temperature T_c	$^{\circ}\text{C}$	340	335	350	340	335	370	375	195	215	285	165	
Electromechanical properties													
Frequency constant	N_p	2030	2020	2020	2050	2010	2000	1960	1975	1960	1975	1925	
	N_t	1900	2030	2035	2090	1880	1940	1880	1895	1890	1850	1800	
	N_1	1380	1325	1320	1340	1360	1370	1400	1375	1420	1450	1400	
	N_3	1310	1260	1250	1300	1300	1415	1415	1410	1190	1450	1370	
Coupling coefficient	k_p	0,62	0,62	0,59	0,61	0,65	0,62	0,60	0,60	0,65	0,68	0,75	
	k_{31}	0,34	0,33	0,32	0,35	0,33	0,34	0,34	0,35	0,38	0,38	0,39	
	k_{33}	0,73	0,72	0,71	0,72	0,73	0,67	0,71	0,72	0,74	0,75	0,80	
	k_t	0,49	0,48	0,51	0,58	0,53	0,45	0,44	0,50	0,51	0,55	0,55	
	k_{15}	0,72	0,74	0,66	0,71	0,71	0,69	0,69	0,66	0,73	0,66	0,66	
Charge constant	d_{33}	450	440	390	440	475	410	375	620	680	500	820	
	d_{31}	10^{-12} C/N	-180	-185	-157	-165	-180	-175	-170	-250	-275	-215	-360
	d_{15}	550	560	530	550	670	490	585	740	770	515	740	
Voltage constant g_{33}	10^{-3} Vm/N	27,5	26,9	25,5	33,1	28,5	25,7	23,5	20,6	20,2	26,9	21,0	
Mechanical properties													
Elastic compliance	S_{11}^E	10^{-12} m ² /N	17,1	18,5	16,3	17,0	17,9	16,7	16,4	15,8	15,0	16,0	
	S_{33}^E	19,0	20,7	17,5	19,0	24,0	17,2	18,8	20,8	22,9	18,0	20,0	
Elastic stiffness	C_{33}^D	10^{10} m ² /N	14,5	15,7	14,9	15,8	14,7	15,8	14,3	15,2	16,8	14,5	
	C_{55}^D	5,8	6,5	4,4	6,0	4,0	4,0	4,0	3,7	6,1	4,6	3,8	
Density ρ	10^3 kg/m ³	7,65	7,74	7,65	7,80	7,70	7,75	7,5	7,40	7,83	7,80	7,80	
Mechan. quality factor Q_m		90	80	90	60	80	60	75	65	75	75	80	
Stability													
Aging rate	Capacitance	%/Decade	-2,3	-0,3	-0,4	-0,3	-1,6	-1,6	-0,9	-1,5	-0,8	-1,0	
	Frequency	0,3	0,15	0,4	0,2	0,5	0,2	0,1	0,3	0,1	0,5	0,3	
	Coupling coefficient	0,1	0,2	0,1	-0,1	0,6	0,4	-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.

