Properties of Piezoelectric Ceramics . . . . . .

(Values are averaged and a consistent set)

				Lead Zirconate Titanate							
Material reference Numbers			CPI #	5400	5502	5600	5700	5800	5804	1000	2001
Channel Industries, Inc.			Navy Type	I	II	V	VI	III	III	—	—
			(Universal) PZT	4	5A	5J	5H	8	8	—	—
Coupling Coefficients			k33	.71	.73	.73	.72	.67	.66	.54	.375
			k31	-.36	-.37	-.36	-.37	-.32	-.32	-.255	-.145
			k15	.72	.71	.68	.65	.60	.59	NA	.377
			kp	-.60	-.62	-.62	-.62	-.55	-.54	-.435	-.25
Piezoelectric Constants		10^{-12}m/V	d_{33}	300	400	505	550	245	240	195	71
		"	d_{31}	-135	-185	-225	-250	-107	-105	-78	-27
		"	d_{15}	525	625	670	690	390	382	NA	130
		10^{-3}Vm/N	g_{33}	26.1	25.8	22.0	19.4	25.2	25.8	22	19
		"	g_{31}	-11.7	-11.9	-9.8	-8.8	-11.0	-11.3	-8.8	-6.6
		"	g_{15}	40.5	40.0	31.5	26.4	31.5	32.2	NA	30.8
Free Dielectric Constants			K_3^T	1300	1750	2600	3200	1100	1050	1000	460
			K_1^T	1475	1775	2400	2950	1400	1340	NA	475
Elastic Constants E=short circuit value elastic stiffness D=open circuit value elastic stiffness	$1/s_{11}^E = Y_{11}^E$	10^{10} N/m^2	Y_{11}^E	8.2	6.4	6.2	6.2	8.6	8.6	9.5	11.0
	$1/s_{33}^E = Y_{33}^E$	"	Y_{33}^E	6.5	5.2	5.1	4.8	7.1	7.1	11.8	9.4
Shear Elastic Stiffness	c_{44}^E	"		2.5	2.0	2.2	2.3	2.9	2.9	NA	3.54
Density (min.)		10^3 kg/m^3		7.55	7.6	7.5	7.4	7.55	7.55	7.40	7.4
Mechanical Q				500	75	70	65	1100	1050	650	1400
Curie Point, °C				>300	>350	>240	>190	>300	>300	>350	340
Dielectric Loss Tangent (Max)		@ Low field		.004	.02	.02	.02	.004	.004	.02	.009
		@ 2KV/cm RMS		.02	NA	NA	NA	.007	.005	NA	NA
		@ 4KV/cm RMS		.04	NA	NA	NA	.01	.01	NA	NA
Change in K_3^T (%) (Max)		@ 2KV/cm RMS		5	NA	NA	NA	2.5	2.0	NA	NA
		@ 4KV/cm RMS		18	NA	NA	NA	6.5	4.0	NA	NA
Static Tensile strength psi				11000	11000	11000	12000	12000		10000	11000
Rated Dynamic Tensile strength psi				6000	4000	4000	4000	7000	7000	3500	3500
Change in N1/time Decade %				1.5	0.2	0.25	0.25	1.0	1.0	.04	.06
Change in kp/time Decade %				-2.3	-0.2	-0.35	-0.35	-2.0	-1.8	-0.2	-0.2
Change in K_3^T/time Decade %				-5.5	-1.0	-1.5	-1.5	-5.0	-4.0	-0.6	-0.6
Frequency Constant	N_1	Transverse	Hz m	1650	1470	1450	1450	1680	1700	1780	1900
			kHz in	65	58	57	57	66	67	70	75
	N_t	Thickness	Hz m	2030	1980	1900	1980	2110	2110	2209	2358
			kHz in	80	78	75	78	83	83	87	93
	N_r	Radial	Hz m	2210	1980	1980	1980	2260	2310	939	NA
			kHz in	87	78	78	78	89	91	37	NA
	N_c	Circumferential	Hz m	1040	910	940	910	1070	1070	NA	NA
		(mean dia.)	kHz in	41	36	37	36	42	42	NA	NA
	N_{3C}	Circumferential	Hz m	970	910	910	890	1010	1010	NA	NA
		(mean dia.)	kHz in	38	36	36	35	40	40	NA	NA
	$N_{3\ell}$	Parallel longitudinal	Hz m	1500	1400	1420	1400	1570	1570	NA	NA
			kHz in	59	55	56	55	62	62	NA	NA
	N_S	Thickness shear	Hz m	940	890	890	890	960	960	NA	NA
			kHz in	37	35	35	35	38	38	NA	NA
	N_{SP}	Hollow sphere	Hz m	1730	1550	1520	1520	1800	1830	NA	NA
			kHz in	68	61	60	60	71	72	NA	NA
	N_{3W}	Parallel width	Hz m	1650	1550	1520	1550	1700	1700	NA	NA
			kHz in	65	61	60	61	67	67	NA	NA

NA - not available