

## The Main characteristics of Piezoelectric Ceramic

No.	Parameters	Symbols	Material			
			P -41 (PZT4)	P-51 (PZT5)	P -81 (PZT8)	P -48 (PZT48)
P	Coupling Coefficients	$k_p$	0.56	0.66	0.54	0.59
		$k_{31}$	0.33	0.39	0.31	0.34
		$k_{33}$	0.66	0.74	0.63	0.7
		$k_t$	0.48	0.50	0.47	0.49
2	Dielectric constant(1kHz)	$\epsilon_{r3}^T$	1050	2400	1050	1350
		$\epsilon_{r1}^T$	1450	2700	1400	1600
3	Dielectric Loss Factor	$\text{tg } \delta$	0.004	0.017	0.003	0.004
4	Elastic Constants ( $\times 10^{-12} \text{m}^2/\text{N}$ )	$S_{11}^E$	12.0	15.0	11.0	12.5
		$S_{33}^D$	8.5	9.0	8.5	8.5
5	Piezoelectric Coefficients ( $10^{-12} \text{C}/\text{N}$ )	$d_{31}$	-110	-210	-100	-140
		$d_{33}$	270	550	230	320
6	Mechanical Quality Factor	$Q_M$	600	70	1000	800
7	Frequency Constants ( $\text{Hz} \cdot \text{m}$ )	$N_d$	2250	1980	2300	2230
		$N_1$	1650	1450	1700	1600
		$N_3$	1950	1900	1960	2000
		$N_t$	2270	2250	2280	2300
8	Sound velocity (m/s)	$V_d$	3460	3000	3500	3400
		$V_1$	3300	2900	3400	3200
		$V_3$	3900	3800	3920	4000
		$V_t$	4540	4500	4560	4600
9	Density( $10^3 \text{kg}/\text{m}^3$ )	$\rho$	7.60	7.65	7.65	7.70
10	Curie Point( $^{\circ}\text{C}$ )	$T_c$	310	280	300	300
11	Ten times the rate of time (%)	$A_{nd}$	1.3	0.35	1.3	1.2
		$A_{kp}$	-2.5	-0.40	-2.0	-1.6
		$A_{\epsilon}$	-4.5	-1.5	-4.0	-3.5
12	Temperature changes( $\%$ )- $10^{\circ}\text{C} \sim 50^{\circ}\text{C}$ to $25^{\circ}\text{C}$	$\Delta N_d/N$	1.0	1.5	1.5	1.0
		$\Delta \epsilon / \epsilon$	9.5	20	9.0	9.5
13	Dielectric Properties in High Electric	$\text{tg } \delta$	0.040		0.010	0.025
		$\Delta \epsilon / \epsilon$	0.18		0.06	0.20

**Note: These data are typical values of the main parameters measured at  $25^{\circ}\text{C}$ , 10 days after polarization.**