

# PiezoPower™

## PZT5A & 5H Materials Technical Data (Typical Values)

Property	Symbol	Units	Material Type				
			3195STD	3195HD	3221HD	3203STD	3203HD
Dielectric Constant (1KHz)	$K^T_{33}$		1800	1900	3450	3250	3800
Dielectric Loss Factor (1KHz)	$\tan\delta_e$	%	1.8	1.8		2.0	2.0
Density	$\rho$	g/cm <sup>3</sup>	7.7	7.8	7.87	7.7	7.87
Curie Point	$T_c$	°C	350	350	242	235	225
Mechanical Quality Factor	$Q_m$		80	80		30	30
Coercive Field (Measured < 1 Hz)	$E_c$	kV/cm	14.9	12.0	8.8	10.6	8.0
Remanent Polarization	$P_r$	μCoul/cm <sup>2</sup>	39.2	39.0		37.2	39.0
Coupling Coefficients	$k_p$		0.63	0.65		0.69	0.75
	$k_{33}$		0.70	0.72	0.78	0.73	0.75
	$k_{31}$		0.35	0.36	0.44	0.41	0.43
	$k_t$		0.49	0.48	0.55	0.53	0.55
	$k_{15}$			0.59	0.78		0.78
Piezoelectric Charge (Displacement Coefficient)	$d_{31}$	Coul/N x 10 <sup>-12</sup>	-175	-190	-300	-275	-320
	$d_{33}$	(or) m/V x 10 <sup>-12</sup>	350	390	595	550	650
Piezoelectric Voltage Coefficient (Voltage Coefficient)	$g_{33}$	V•m/N x 10 <sup>-3</sup>	24.2	24.0	19.9	19.0	19.0
	$g_{31}$		-11.0	-11.3	-10.2	-9.6	-9.5
Elastic Modulus	$Y^E_{11}$	N/m <sup>2</sup> x 10 <sup>10</sup>	6.9	6.7	6.2	6.3	6.2
	$Y^E_{33}$		5.5	5.3	5.1	5.0	4.9
Frequency Constants Radial	$N_r$	KHz•cm	202			192	
Resonant Thickness	$N_{tr}$	KHz•cm	204	211	202	191	202
Anti-Resonant Thickness	$N_{ta}$	KHz•cm	229	236	235	222	236
Thermal Expansion (Perpendicular to poling)	$\alpha$	ppm/°C		3.0			3.5
Specific Heat	$C_p$	J/kg•°C		440			420
		J/mol•°C		145			138
Thermal Conductivity with Au Electrodes	$K_d$	W/cm•°C		1.9-2.3			1.9-2.3
		W/m•°K		1.2			1.2
		W/m•°K		1.45			1.45
Poisson's Ratio	$\nu$			0.31			0.31
Elastic Constants Short Circuit	$S^E_{11}$	x 10 <sup>-12</sup> m <sup>2</sup> /N		16.2	16.0		16.6
	$S^E_{33}$			18.6	19.8		21.0
Elastic Constants Open Circuit	$S^D_{11}$	x 10 <sup>-12</sup> m <sup>2</sup> /N		14.6	13.0		13.9
	$S^D_{33}$			9.6	7.7		8.8
Elastic Constants Short Circuit	$Y^E_{11}$	x 10 <sup>10</sup> N/m <sup>2</sup>		6.7	6.2		6.2
	$Y^E_{33}$			5.3	5.1		4.9
Elastic Constants Open Circuit	$Y^D_{11}$	x 10 <sup>10</sup> N/m <sup>2</sup>		6.8	7.8		7.0
	$Y^D_{33}$			10.6	13.0		11.0

Formulas	
Disc Capacitance	$(d^2 \cdot K^T_{33}) / (5.67 \cdot t)$
Plate Capacitance	$(l \cdot w \cdot K^T_{33}) / (4.45 \cdot t)$
Disc $K^T_{33}$	$(5.662 \cdot \text{Cap} \cdot t) / d^2$
Plate $K^T_{33}$	$(4.447 \cdot \text{Cap} \cdot t) / (l \cdot w)$
$f_r$ (radial)	$N_r / (2.54 \cdot d)$
$f_r$ (length)	$N_{31r} / (2.54 \cdot l)$
$f_r$ (width)	$N_{31r} / (2.54 \cdot w)$
$f_t$ (thickness)	$N_t / (2.54 \cdot t)$

Formula length, width, and diameter are for electroded area only.

Definitions			
$\tan\delta_e$	Dielectric Loss Factor	<b>C</b>	Capacitance (nF)
$\rho$	Mass Density of Ceramic	<b>l</b>	Length (in.)
$T_c$	Curie Point	<b>w</b>	Width (in.)
$d_{33}$	Direct Charge Coefficient	<b>d</b>	Diameter (in.)
$d_{31}$	Transverse Charge Coefficient	<b>t</b>	Thickness (10 <sup>-3</sup> in.)
$E_c$	Coercive Field	$k_{33}$	Direct Electromechanical Coupling Coefficient
$g_{33}$	Direct Voltage Coefficient	$k_{31}$	Transverse Electromechanical Coupling Coefficient
$g_{31}$	Transverse Voltage Coefficient	$K^T_{33}$	Free Dielectric Constant Measured Along Poling Axis
$k_p$	Planar Electromechanical Coupling Coefficient		
		$N_r$	Radial Frequency Constant
		$N_t$	Thickness Mode Frequency Constant
		$P_r$	Remanent Polarization
		$Q_m$	Mechanical Q (Quality Factor)
		$Y^E_{33}$	Direct Young's Modulus
		$Y^E_{11}$	Elastic Modulus
		$f_r$	Resonant Frequency
		$f_a$	Anti-Resonant Frequency

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