

MEGGITT

Enabling the Extraordinary  
To Fly To Power To Live

MEGGITT A/S

FERROPERM™ PIEZOCERAMICS

# Material data for Ferroperm™ Piezoceramics (based on typical values)

MEGGITT

Navy Type / Industry "equivalent"	Symbol	Unit	Traditional Soft PZT				Traditional Hard PZT				
			Pz23	Pz27	P188**	Pz29	Pz24	Pz26	Pz28	P762**	P189**
			N/A	Navy 2 "PZT5A"	Navy 2 "PZT5A"	Navy 6 "PZT5H"	"PZT7A"	Navy 1 "PZT4D"	Navy 3 "PZT8"	Navy 1 "PZT4D"	Navy 3 "PZT8"
<b>Electrical Properties</b>											
Relative Free Dielectric Constant (1 kHz)	$K_{33}^{-1}$		1500	1800	1850	2900	400	1300	1030	1300	1150
Dielectric dissipation factor (1 kHz)	$\tan \delta (\text{s}^{-1})$	$10^{-3}$	15	17	20	19	3	3	4	5	3
Curie Temperature	$T_c >$	°C	350	350	340	235	330	330	330	300	320
Recommended maximum working range	$T <$	°C	250	250	240	150	230	230	250	200	220
<b>Electromechanical Properties</b>											
Coupling factors	$k_p$		0,52	0,59	0,65	0,64	0,50	0,56	0,58	0,58	0,51
	$k_t$		0,45	0,47	0,49	0,52	0,52	0,47	0,47	0,47	0,46
	$k_{31}$		-0,29	-0,33	-0,37	-0,37	-0,29	-0,33	-0,34	-0,35	-0,32
	$k_{33}$		0,65	0,70	0,74	0,75	0,57	0,68	0,69	0,68	0,65
Piezoelectric charge coefficients	$-d_{31}$	$10^{-12}$ C/N	130	170	185	240	55	130	120	130	108
	$d_{33}$	$10^{-12}$ C/N	330	425	425	575	90	300	275	300	240
	$d_{15}$	$10^{-12}$ C/N	420	500	400	700	150	330	400		280
Piezoelectric voltage coefficients	$g_{31}$	$-10^{-3}$ V m/N	10	11	11	10	16	11	13	-11	-11
	$g_{33}$	$10^{-3}$ V m/N	25	27	26	23	54	28	31	26	23
Frequency constants	$N_p$	m/s	2160	2010	1970	1970	2400	2230	2180	2250	2350
	$N_t$	m/s	2030	1950	2020	1960	2100	2040	2010	2050	2150
	$N_{31}$	m/s	1480	1400	1450	1410	1670	1500	1600	1650	1750
	$N_{33}$	m/s	1600	1500	1890	1500	1600	1800	1500	1920	2060
<b>Mechanical Properties</b>											
Density	$\rho$	kg/m <sup>3</sup>	7700	7700	7700	7460	7700	7700	7700	7600	7650
Mechanical quality factor	$Q_{m1}^E$		100	80	80	90	>1000	>1000	>1000	>600	>1000

**Notes**

\* All Pz31, Pz36, Pz37, Pz39 are a new family of materials containing a porous structure. Tolerances might therefore vary more than standard, and be more dependent on size and geometry.

\*\*P188,P189, P762 and P194 are a part of a full technology transfer of the Quartz & Selice programme from Saint-Gobain Quatz to Meggitt A/S in 2010.

Please be aware that extreme dimensions and geometries can lead to exaggeration in tolerances in all materials.

# Material data for Ferroperm™ Piezoceramics (based on typical values) cont'd

MEGGITT

Navy Type / Industry "equivalent"	Symbol	Unit	Low-Acoustic Impedance Family				HIFU Family			Very Soft Relaxor-Based Comp			High Temp
			Pz31*	Pz36*	Pz37*	Pz39*	Pz34	Pz52	Pz54	Pz21	P194**	Pz59	Pz46
			"K81"	N/A	N/A	N/A	"PZT2"	N/A	N/A	"3203HD"	"3203HD"	N/A	"K15"
<b>Electrical Properties</b>													
Relative Free Dielectric Constant (1 kHz)	$K_{33}^T$		295	610	1150	1750	210	1900	2700	3800	4300	5100	120
Dielectric dissipation factor (1 kHz)	$\tan \delta (\text{s}^\circ)$	$10^{-3}$	4	3	17	19	14	3	3	18	25	18	4
Curie Temperature	$T_C >$	°C	330	330	350	220	400	235	220	220	185	150	650
Recommended maximum working range	$T <$	°C	230	230	250	130	150	150	130	130	85	80	550
<b>Electromechanical Properties</b>													
Coupling factors	$k_p$		0,30	0,26	0,35	0,18	0,07	0,60	0,57	0,59	0,61	0,55	0,03
	$k_t$		0,52	0,52	0,52	0,53	0,40	0,53	0,48	0,47	0,50	0,46	0,20
	$k_{31}$				-0,15		-0,05	-0,35	-0,35	-0,34	-0,38		-0,02
	$k_{33}$				0,60		0,40	0,70	0,70	0,70	0,70		0,09
Piezoelectric charge coefficients	$-d_{31}$	$10^{-12}$ C/N					5	170	200	250	305		2
	$d_{33}$	$10^{-12}$ C/N	160	230	350	480	50	440	440	600	640	645	18
	$d_{15}$	$10^{-12}$ C/N					40			620			16
Piezoelectric voltage coefficients	$g_{31}$	$-10^{-3}$ V m/N					3			7	-7		2
	$g_{33}$	$10^{-3}$ V m/N	54	40	40	28	25	25	20	18	15		17
Frequency constants	$N_p$	m/s			1550		2770	2090	2100	2030	1930	1955	2470
	$N_t$	m/s	1520	1270	1400	1190	2200	1960	2000	1970	2000	2050	2000
	$N_{31}$	m/s					2050			1375	1380		1900
	$N_{33}$	m/s								1325	1830		
<b>Mechanical Properties</b>													
Density	$\rho$	kg/m <sup>3</sup>	6200	5600	6000	5800	7550	7350	7800	7780	7900	7900	6550
Mechanical quality factor	$Q_{m1}^E$		900	500	50	70	>1000	550	>1000	65	60	40	>600

**Notes**

\*Pz31, Pz36, Pz37, Pz39 are a new family of materials containing a porous structure. Tolerances might therefore vary more than standard, and be more dependent on size and geometry.

\*\*P188, P189, P762 and P194 are a part of a full technology transfer of the Quartz & Selice programme from Saint-Gobain Quartz to Meggitt A/S in 2010

All Please be aware that extreme dimensions and geometries can lead to exaggeration in tolerances in all materials.