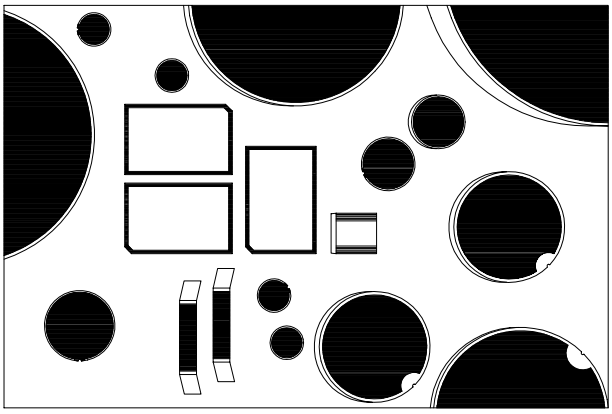

Piezoceramic materials are used to convert mechanical energy into electrical energy and vice versa.

The materials, based on lead-zirconate-titanate, are optimized for various specifications, thus making them suitable for many different applications in the sensor and actuator technologies.

Our manufacturing technology makes it possible to produce piezoceramics in varied and complex geometries to better serve your applications.

A large proportion of our piezoceramic products is used in our own components, actuator and sensor systems. We also supply half-finished products and components customized to our customers' needs. Our designers are at your service with their expertise in the field of production and application of piezoceramic materials, components and systems.

FPM 110

FPM 110 is a hard piezo electric material with small hysteresis and a very high mechanical quality factor. As a hard material, it is characterized by a very high load constant. It is especially suited for high performance ultrasonics. It can also be used for sensors in multilayer technology. Its deformation is particularly high for a hard material ($S_3 = 0.06\%$ at 2 kV/mm).

FPM 231

FPM 231 is a soft material with a high deformation ($S_3 = 0.188\%$ bei 2 kV/mm) and thus an excellent material for actuators such as marco's Torque-Blocks®, bending elements and multilayer stacks. It is a soft piezoelectric material with a low mechanical quality factor and relatively high dielectric constant. FPM 231 is characterized by a very high piezoelectric load constant. The material can be manufactured in film technology.

FPM 220

FPM 220 is also a soft piezoceramic material which is mainly used for high-voltage actuators. FPM 220 is a standard material with a high piezo electric load constant and a medium mechanical quality factor. The deformation of this material is slightly lower than that of FPM 231 with $S_3 = 0.17\%$ at 2 kV/mm.

FPM 202

This soft material features high electromechanical coupling factors, a low relative dielectric constant, and high piezoelectric load and pressure constants. It can be used for air ultrasonic sensors, modular transducers, accelerometers, and similar devices. Its high Curie temperature makes it suitable for use in extended temperature ranges.

FPM 203

FPM 203 is specially designed for high-voltage actuators used in an extended temperature range. Its high Curie temperature is, however, coupled with greater temperature coefficients of the dielectric constant. Its low dielectric constant and high deformation (approx. 1.8 ‰) present great advantages for the multilayer actuator technology. FPM 203 can also be used for ultrasonic applications. Its frequency constants are very similar to those of FPM202.

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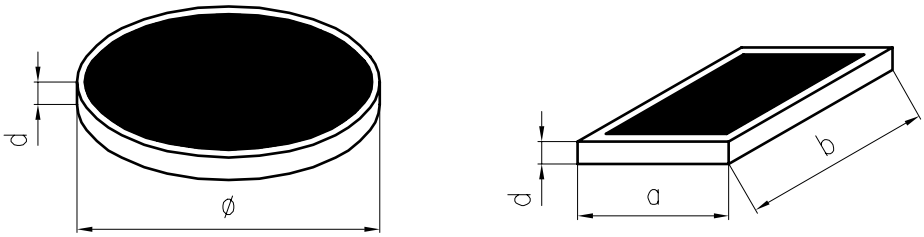
FPM 240

FPM 240 is specially designed for bender actuators.

Standard Shapes



Plates	Side Dimensions a x b [mm]: min 2x2 to max 50x50; 70x20 Thickness d [mm]: 0.2; 0.5; 1; 1.5 - 5 (depending on side dimensions) e.g.: pb/202/v/p2/27x5
Discs/Cylinders	Diameter ∅ [mm]: 5; 10; 15; 16; 20; 25; 30 Thickness d [mm]: 0.2; 0.5; 1; 1.5 - 15 (depending on diameter) e.g.: pb/110/v/d0,5/10

Non Standard Shapes
Other dimensions than those presented above are available upon request.

Metallization

- adhesive multi-layer metallization with a Cu-Ni coating as the standard metallization, easily soldered
- Cu coatings are available for special applications

Electrodes

Standard Electrode: *One Electrode* with insulated edges ≤0.5 mm

One Electrode with side contact and *indent*
One Electrode with *contact to other side*
Special electrodes

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Piezo Electric Ceramic Specifications, Low-Level Signal Values

Electromechanical Parameter	Symbol	Unit	Material					
			FPM 202	FPM 203	FPM 231	FPM 220	FPM 240	FPM 110
Density	ρ	kg/dm^3	7,71	7,64	7,7	7,8	7,82	7,68
Relative	$\varepsilon_{33}^T/\varepsilon_0$		1560	800	2990	2650	3680	1075
Dielectric Constant	$\varepsilon_{11}^T/\varepsilon_0$		1600	1160	2930	2085	3650	1480
	$\varepsilon_{11}^S/\varepsilon_0$		950	700	2180	1385	2090	910
	$\varepsilon_{33}^S/\varepsilon_0$		780	370	1410	1260	1470	648
Dielectric	$\tan\delta$		18	21	22	20	19	6
Loss Factor	$\cdot 10^{-3}$							
Curie Temperature	θ_C	°C	365	360	192	220	202	272
Electromechanical	k_p		62	62	61	63	69	51
Coupling Factor	k_{31}		35	32	39	32	43	32
	k_{33}	%	65	64	63	66	72	64
	k_t		44	51	50	46	50	43
	k_{15}		64	63	50	58	65	62
Piezoelectric	d_{33}	C/N (m/V)	330	220	500	430	630	270
Load Constant	d_{31}		-165	-104	-260	-200	-300	110
	d_{15}		510	425	525	506	807	440
	$\cdot 10^{-12}$	C/N (m/V)						
Mechanical	Q_m		86	88	77	82	75	1400
Quality Factor								
Temperature Coefficient*								
by $\varepsilon_{33}^T/\varepsilon_0$	$TK_{\varepsilon_{33}}$		3,6	10,4	8,4	5	7,4	6,4
by k_p	TK_{k_p}		-0,2	0,9	-3	-0,5	-2,1	-0,2
by k_{31}	$TK_{k_{31}}$		-0,9	0,6	-3	-0,4	-2,5	-0,8
by d_{31}	$TK_{d_{31}}$		1,8	5	-0,4	1	2,3	1,3
by g_{31}	$TK_{g_{31}}$		-2,8	-1,6	-5	-2	-5	-2,9
	$\cdot 10^{-3}$	K^{-1}						
Elastic	s_{11}^E		16	15	16	16	15	13
Compliance	s_{33}^D		10	10	10	10	9	8
	s_{55}^D		27	27	31	27	27	23
	s_{11}^D		14	13	14	15	12	11
	s_{55}^E		46	44	42	41	47	38
	s_{33}^E		18	17	17	17	20	15
	s_{12}^E		5	7	2	8	3	3
	s_{13}^E		10	9	9	10	10	7
	$\cdot 10^{-12}$	m^2/N						

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Electromechanical Parameter	Symbol	Unit	Material					
			FPM 202	FPM 203	FPM 231	FPM 220	FPM 240	FPM 110
Elastic	c_{33}^{D}		14,6	15,3	14,8	15,6	15,8	15,1
Stiffness	c_{33}^{E}		11,8	11,2	11,1	12,2	12	12,3
	c_{55}^{D}		3,7	3,7	3,2	3,6	3,7	4,3
	c_{55}^{E}		2,2	2,3	2,4	2,4	2,1	2,6
	c_{11}^{E}		9,6	10,7	8,9	10,2	10,6	11
	c_{12}^{E}		0,1	-1,7	1,5	-1,6	2,1	1
	c_{13}^{E}		-5,5	-4,9	-5,3	-5,2	-6,6	-5,7
	$\cdot 10^{10}$	N/m^2						
planar Poisson's number	σ^{E}		0,296	0,296	0,295	0,297	0,300	0,287
Frequency Constant	N_p		1985	2035	1970	1985	1910	2255
	N_1		1420	1490	1420	1390	1450	1610
	N_3	Hzm	1405	1440	1415	1420	1335	1548
	N_t		1996	1969	1940	2022	2000	2034
	N_5		874	893	902	910	858	957
Piezoelectric	g_{33}		23	32	14	18	16	23
Voltage Constant	g_{31}		-11	-15	-10	-8	-9	-12
	g_{15}		36	41	20	27	25	34
	$\cdot 10^{-3}$	Vm/N						
Specific Resistance	ρ_e	Ωm	10^{10}	$2 \cdot 10^{10}$	$0{,}5 \cdot 10^{10}$	$0{,}5 \cdot 10^{10}$	10^{10}	10^{10}

*) Teperature range: 25 ... 85 °C

Measurements were in progress on DIN EN 50324-2 VDE 0336-2 "Piezoelektrische Eigenschaften von keramischen Werkstoffen und Komponenten" Teil 2: Messverfahren - Kleinsignal (Dezember 2002).

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