NCE51

Noliac piezoceramic material NCE51 is a standard soft material, particularly suitable for actuators and low power non-resonant applications in which high coupling factor and /or high charge sensitivity are requested.

SPECIFICATIONS

Properties	Symbol & unit	NCE51 NCE51f
DIELECTRIC PROPERTIES (tolerances +/- 10%)		
Relative Dielectric Constant	$\varepsilon^{T}_{33} / \varepsilon_0$	1900
Dielectric Loss Factor	$tg\delta\ [10^{-4}]$	150
Dielectric Loss Factor at 400V/mm	$tg\delta\ [10^{-4}]$	
ELECTROMECHANICAL PROPERTIES (tolerances +/- 5%)		
Electromech. Coupling Factors**	k_p	0.65
	k_{31}	0.38
	k_{33}	0.74
	k_t	0.50
Piezoelectric Charge Constants	$-d_{31}\ [10^{-12}\ C/N]$	208
	$d_{33}\ [10^{-12}\ C/N]$	443
Piezoelectric Voltage Constants	$-g_{31}[10^{-3}\ Vm/N]$	13
	$g_{33}\ [10^{-3}\ Vm/N]$	26
Frequency Constants	N^{E}_{p} [m/s]	1925
	N^{D}_{t} [m/s]	2000
	N^{E}_{1} [m/s]	1370
	N^{D}_{3} [m/s]	1320
PHYSICAL PROPERTIES (tolerances +/- 5%)		
Mechanical Quality Factor	Q_m	80
Density	$\rho\ [10^{3}\ kg/m^{3}]$	7.85
Elastic Compliances	$s^{E}_{11}\ [10^{-12}\ m^{2}/N]$	16
	$s^{E}_{33}\ [10^{-12}\ m^{2}/N]$	19
Curie Temperature	T_c [°C]	360

** Measured in accordance with standard EN 50324

The values listed are for reference purposes only and cannot be applied unconditionally to all shapes and

dimensions. Values vary depending on the actual shape, surface finish, shaping process and post-processing of the product.

EXTENDED SPECIFICATIONS

1. The presented data are determined on standardized specimens in the form of small-signal measurements according to European Standard EN 50324 and IEC Publication 483.
2. The standardized specimens are manufactured using a standard production powder and a standard production technology.
3. The data given represents nominal values which were determined 24 hours after poling process at an ambient temperature 23°C +/- 2°C.
4. Standard Tolerances: Electrical properties ± 10%. Mechanical Properties ± 5%. Piezoelectric properties ± 5%.

Properties	Symbol	Unit	
ELECTRICAL PROPERTIES			
Dielectric dissipation factor	tan δ	[10^{-4}]	150
Relative permittivity	$\varepsilon_{33}^{T}/\varepsilon_0$	[1]	1900
	$\varepsilon_{33}^{S}/\varepsilon_0$	[1]	823
	$\varepsilon_{11}^{T}/\varepsilon_0$	[1]	1940
	$\varepsilon_{11}^{S}/\varepsilon_0$	[1]	906
Curie Temperature	T_c	[°C]	360
Mechanical Properties			
Poisson's ratio	σ^E	[1]	0.32
Density	ρ	[$kg.m^{-3}$]	7850
PIEZOELECTRIC PROPERTIES			
Frequency Constants			
Planar	N_p	[Hz.m]	1925
Thickness shear	N_{15}	[Hz.m]	1180
Transverse	N_{31}	[Hz.m]	1370
Longitudinal	N_{33}	[Hz.m]	1320
Thickness	N_t	[Hz.m]	2000
COUPLING FACTORS			
Planar	k_p	[1]	0.650
Thickness shear	k_{15}	[1]	0.730
Transverse	k_{31}	[1]	0.380
Longitudinal	k_{33}	[1]	0.740
Thickness	k_t	[1]	0.500
Charge Constant	d_{33}	[$10^{-12}C/N$]	443
Voltage Constant	g_{33}	[$10^{-3}V.m/N$]	26.3
Mechanical Quality Factor	Q_m	[1]	80
STABILITY			
Temperature Coefficient			
Range 20 - 80 °C	$\alpha_{permittivity}$	[$10^{-6}K^{-1}$]	4000
	α_{kp}	[K^{-1}]	0
Aging Rates	c_ε	[%] per decade	-1.40
	c_{Np}	[%] per decade	0.25
	c_{kp}	[%] per decade	0.10

COMPLETE COEFFICIENT MATRIX

Elastic Properties

ELASTIC COMPLIANCE MATRIX E					
s^E [$10^{-12}m^2/N$]					
17.0	-5.36	-8.69	0	0	0
-5.36	17.0	-8.69	0	0	0
-8.69	-8.69	21.3	0	0	0
0	0	0	48.9	0	0
0	0	0	0	48.9	0
0	0	0	0	0	44.6

ELASTIC COMPLIANCE MATRIX D					
s^D [$10^{-12}m^2/N$]					
14.5	-7.81	-3.22	0	0	0
-7.81	14.5	-3.22	0	0	0
-3.22	-3.22	9.64	0	0	0
0	0	0	22.9	0	0
0	0	0	0	22.9	0
0	0	0	0	0	44.6

ELASTIC STIFFNESS MATRIX E					
c^E [$10^{10}N/m^2$]					
13.4	8.89	9.09	0	0	0
8.89	13.4	9.09	0	0	0
9.09	9.09	12.1	0	0	0
0	0	0	2.05	0	0
0	0	0	0	2.05	0
0	0	0	0	0	2.24

ELASTIC STIFFNESS MATRIX D					
c^D [$10^{10}N/m^2$]					
13.2	8.76	7.34	0	0	0
8.76	13.2	7.34	0	0	0
7.34	7.34	16.2	0	0	0
0	0	0	4.37	0	0
0	0	0	0	4.37	0
0	0	0	0	0	2.24

Piezoelectric Properties

CHARGE CONSTANT MATRIX					
d [$10^{-12}C/N$]					
0	0	0	0	669	0
0	0	0	669	0	0
-208	-208	443	0	0	0

e [C/m^2]					
0	0	0	0	13.7	0
0	0	0	13.7	0	0
-6.06	-6.06	17.2	0	0	0

VOLTAGE CONSTANT MATRIX					
g [$10^{-3}Vm/N$]					
0	0	0	0	38.9	0
0	0	0	38.9	0	0
-12.4	-12.4	26.3	0	0	0

h [$10^8V/m$]					
0	0	0	0	17.0	0
0	0	0	17.0	0	0
-8.31	-8.31	23.5	0	0	0
0	0	0	38.9	0	0
-12.4	-12.4	26.3	0	0	0

Dielectric properties

PERMITTIVITIES [$10^{-8}F/m$]					
ε_{11}^T	1.72		ε_{11}^S	0.802	
ε_{22}^T	1.72		ε_{22}^S	0.802	
ε_{33}^T	1.68		ε_{33}^S	0.729	

RELATIVE PERMITTIVITIES [1]					
ε_{11r}^T	1940		ε_{11r}^S	906	
ε_{22r}^T	1940		ε_{22r}^S	906	
ε_{33r}^T	1900		ε_{33r}^S	823	

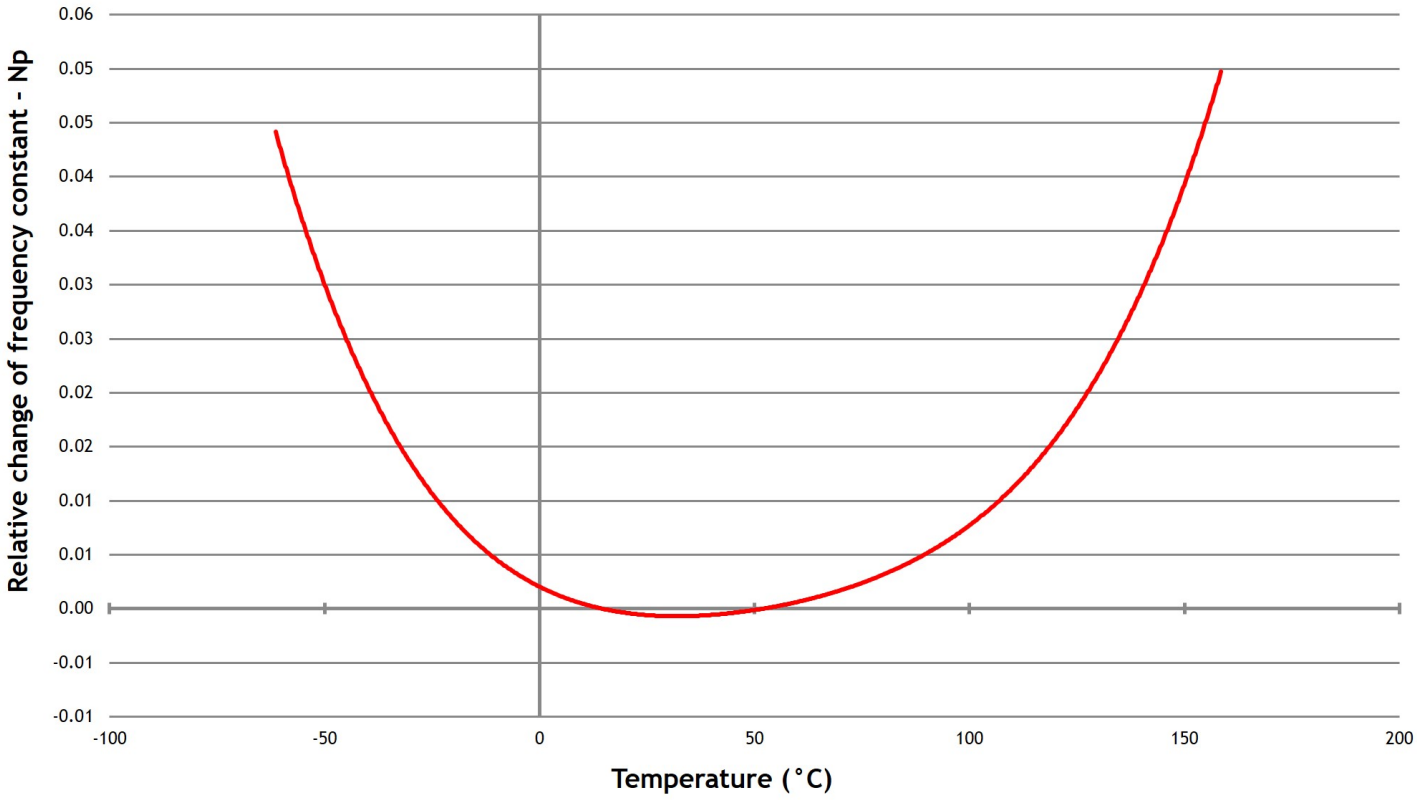
YOUNG MODULUS MATRIX					
Y^E [$10^{10}N/m^2$]					
5.9	-18.6	-11.5	0	0	0
-18.6	5.9	-11.5	0	0	0

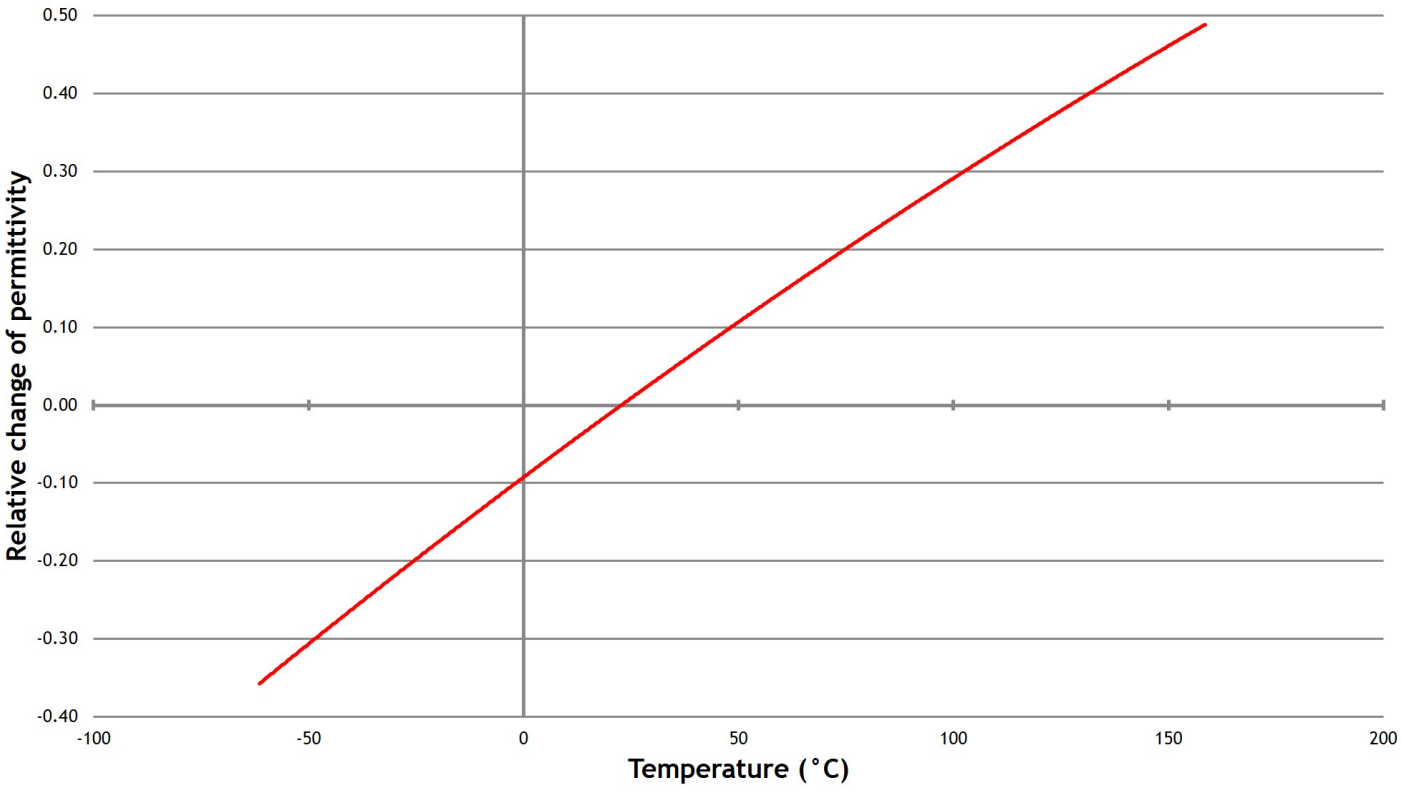
Matrix

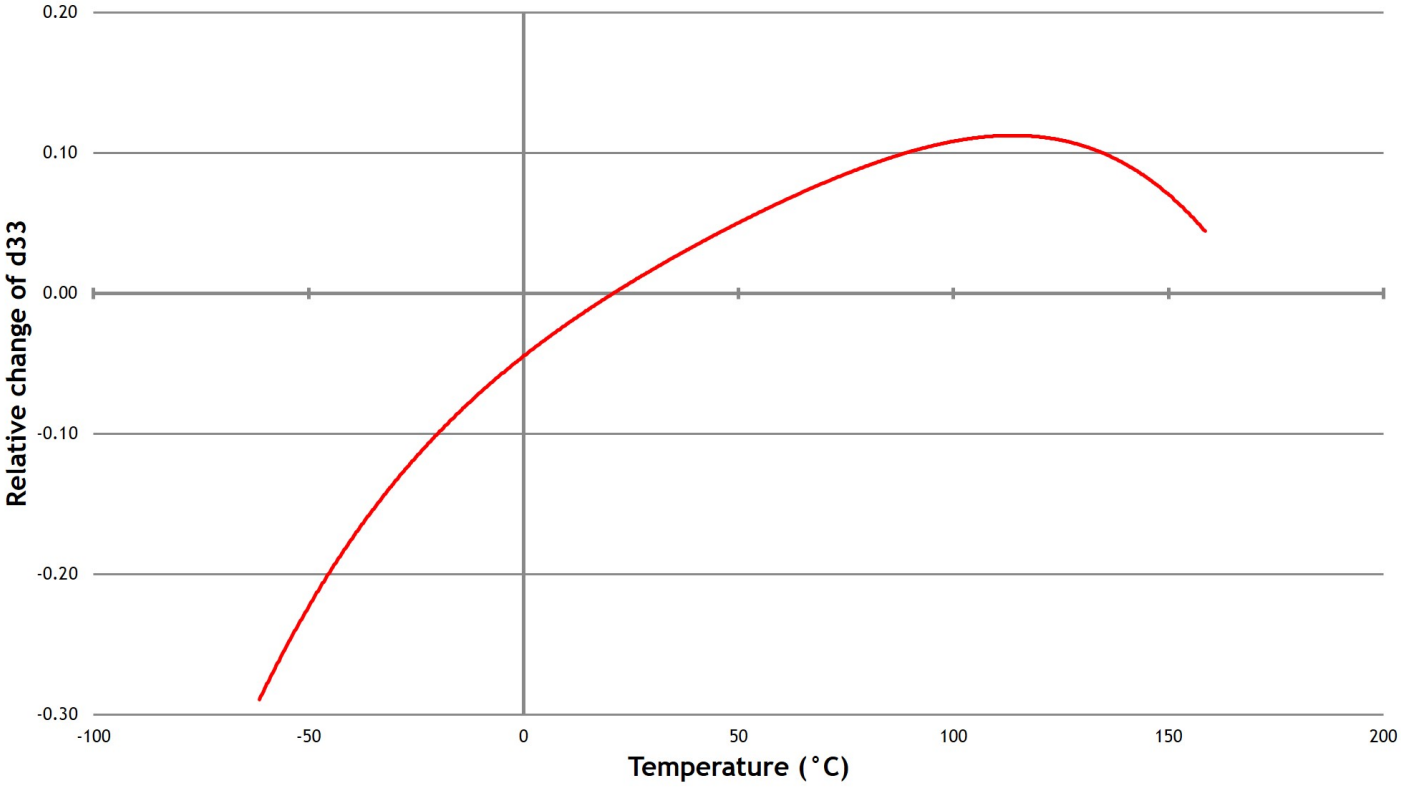
Z_{ab} Z - Property
a - direction
b - direction

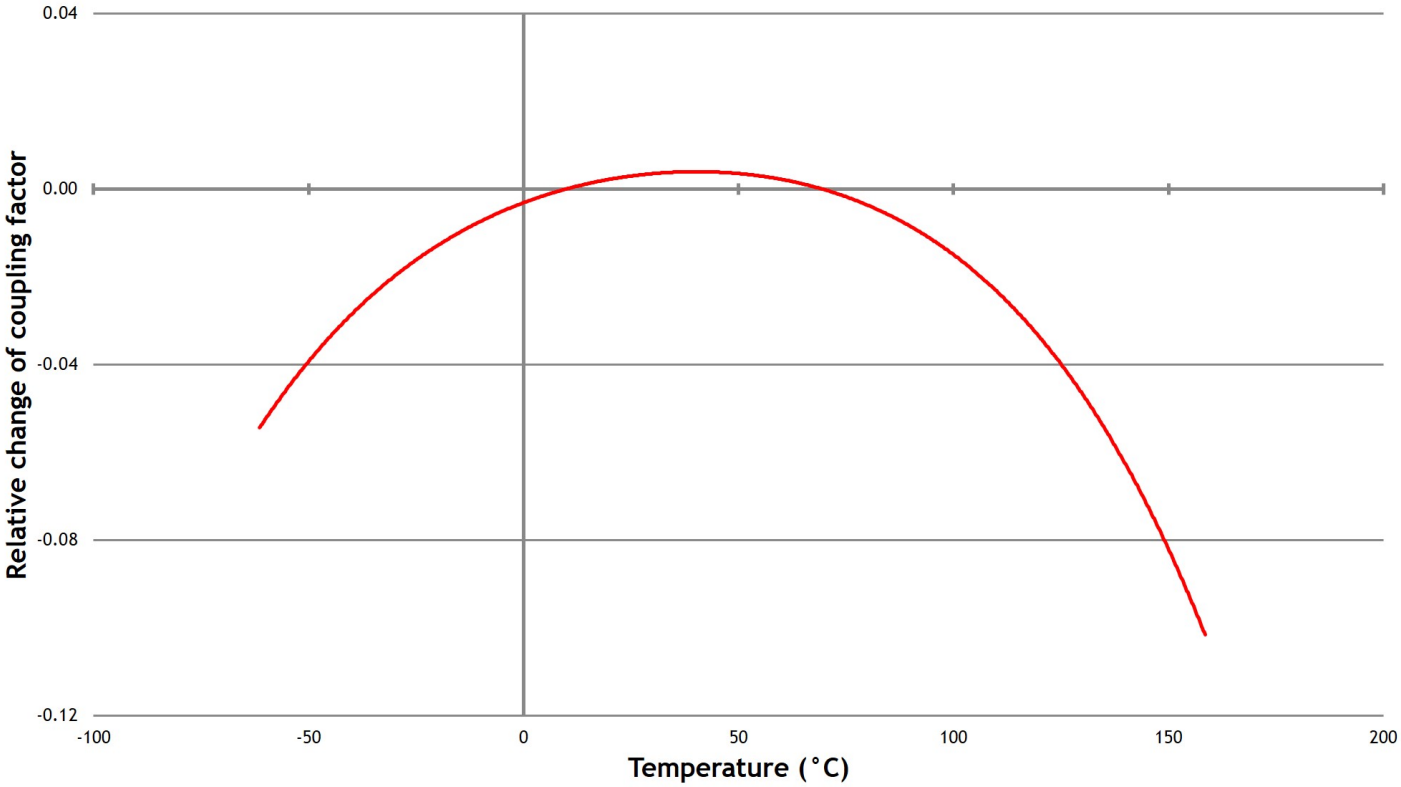
	1	2	3	4
1	Z_{11}	Z_{12}	Z_{13}	→b
2	Z_{21}	Z_{22}	Z_{23}	
3	Z_{31}	Z_{32}	Z_{33}	
4	↓a			

TEMPERATURE DEPENDENCIES






0.20
0.10
0.00
-0.10
-0.20
-0.30
Relative change of d33
-100
-50
0
50
100
150
200
Temperature (°C)


0.04
0.00
-0.04
-0.08
-0.12
Relative change of coupling factor
-100
-50
0
50
100
150
200
Temperature (°C)