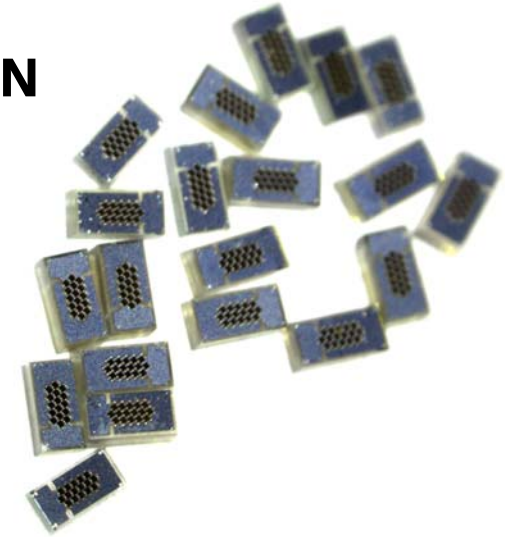
Capacitive Pressure Sensor E1.3N



Features

- Surface micromachined capacitive absolute pressure sensor fabricated on non-conducting fused silica
- Very small die size (0.6x1.2 mm², height 0.48 mm)
- 0.5 to 1.3 measuring range
- Very high input resistance >300 MΩ
- Overpressure >>9 bar causes no damage
- Floating capacitance
- Large bond pads for conductive adhesive mount
- Membrane counter electrode with dielectric insulation

General Description

The ultra small surface micromachined capacitive sensor element aims at all applications where size and low power-dissipation matters that are medical and wireless systems as well as industrial transducers. The special choice of fused silica as a non-conducting substrate material results in the elimination of all parasitic capacitances to the substrate. This implies strong advantages for sensor design, fabrication and application. The remaining parasitic capacitance can be controlled via mask design, changes in wiring layout do not impact sensor performance, hence offset capacitance and contact geometry can be designed according to customer specifications. Large bond pads allow a chip mount by means of conductive adhesive which does not cause parasitic capacitances. Furthermore the sensor is a floating capacitance and no substrate contact is necessary. The transparent substrate allows optical monitoring of the packaging process. Design options include wider non-metallic conductor tracks for high temperature applications.

Sensor Functionality

The sensor is designed as a surface micromachined plate capacitor array with deformable pressure sensitive membranes on top of insulated counter electrodes. This dielectric insulation allows the sensor to be operational in normal- and touch-mode. During normal operation the membrane deflects freely and does not touch the rigid counter electrode. If pressure is increased the membranes sink down, touch the counter electrodes and roll out as pressure further increases. In touch-mode membrane stress does not increase significantly and as consequence the sensor can withstand very high overpressures with no damage. E1.3N operates in normal-mode and is the best choice if the need for high accuracy and a very small hysteresis outranks larger thermal coefficients and more demanding packaging. An operation in touch-down should be considered if the target application requires a sensor device that is less sensitive to packaging stress for larger temperature and pressure ranges at a reduced accuracy (please contact microFAB for possible sensor options).

Measurements are taken at P_{ref}, T_{ref}, 0 V_{DC}, 1 V_{AC} and sensor contact C(+) (see fig. 6) connected to positive potential if not otherwise specified.

Physical Data		Value	Unit	Notes
Zero-scale pressure	P_{ZS}	0.5	bar	
Full-scale pressure	P_{FS}	1.3	bar	
Reference pressure	P_{ref}	1.0	bar	
Width	W	0.6	mm	see fig. 5
Length	L	1.2	mm	see fig. 5
Height	H	0.48	mm	Thin elements with H>0.2 mm possible (see fig. 5).
Exposed Materials				Polycrystalline silicon, silicon nitride, silicon oxide, aluminum (optional: polycrystalline silicon conductors or nickel/gold metallization)

Maximum Ratings		Value	Unit	Notes
Proof pressure	P_P	>9	bar	Test equipment limited to 9 bar.
Cont. operation temperature	T_{OMax}	TBD*	°C	
Storage temperature	T_{SMax}	TBD*	°C	
Momentary temperature	T_{MMax}	400	°C	Limitation due to Al metallization (optional: polycrystalline silicon conductors)
DC Voltage	V_{DCMax}	TBD*	V	

* to be determined

Electrical Model		Value	Unit	Notes
Offset capacitance	C_0	5.734	pF	See fig. 1, fig. 2
Sensor capacitance	C_{Sens}	0.293	pF	@ P_{ref}, see fig. 1, fig. 2
Parallel resistance	R_P	>300	MΩ	@ P_{ref}, see fig. 1, fig. 2
Series resistance	R_S	<50	Ω	See fig. 1, fig. 2
Input resistance	R_I	>300	MΩ	See fig. 1, fig. 2
Minimum AC frequency	f_{Min}	<100	Hz	See fig. 1, fig. 2
Maximum AC frequency	f_{Max}	>10	MHz	See fig. 1, fig. 2

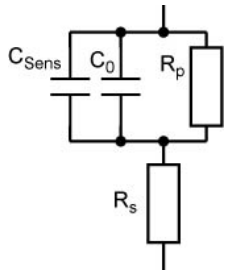


Fig. 1: Electric sensor model.

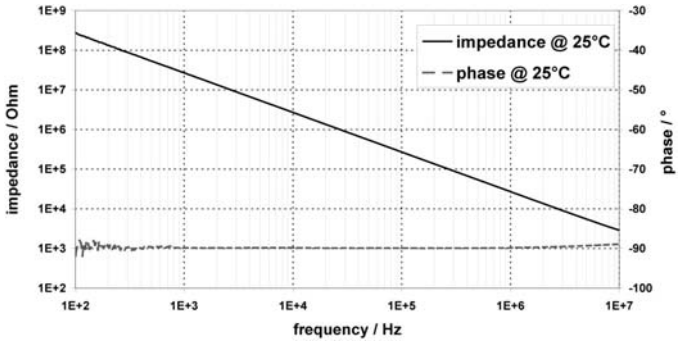


Fig. 2: Bode-plot @ P_{ref}.

Physical Model		Value	Unit	Notes
Capacitance @ P_{ZS}	C_{ZS}	5.838	pF	@ 0 V_{DC}, T_{ref}
Capacitance @ P_{ref}	C_{ref}	6.026	pF	Sensor characteristics are 100%-tested on wafer-level. The number of data points can be chosen according to the appication's requirements.
Capacitance @ P_{FS}	C_{FS}	6.206	pF	
Full-scale sensitivity	S_{FS}	7.6	%	$(C_{FS}-C_{ZS})/C_{ref}$ x 100, @ T_{ref}
Average sensitivity	S	0.451	pF/bar	(S_{ref}=0.519 pf/bar @ Pref)
Capacitance @ P_{ZS}	C_{ZS}	5.822	pF	@ 50°C
Capacitance @ P_{ref}	C_{ref}	6.005	pF	@ 50°C
Capacitance @ P_{FS}	C_{FS}	6.183	pF	@ 50°C
Reference Temperature	T_{ref}	25	°C	
Hysteresis	ΔC_H	$<2x10^{-2}$	%	Max. $(C_{Down}-C_{Up})/C_{FS}$ x 100

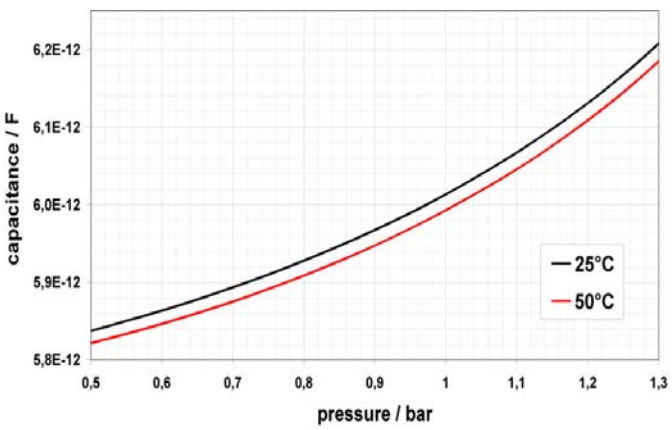


Fig. 3: Capacitance vs pressure plots.

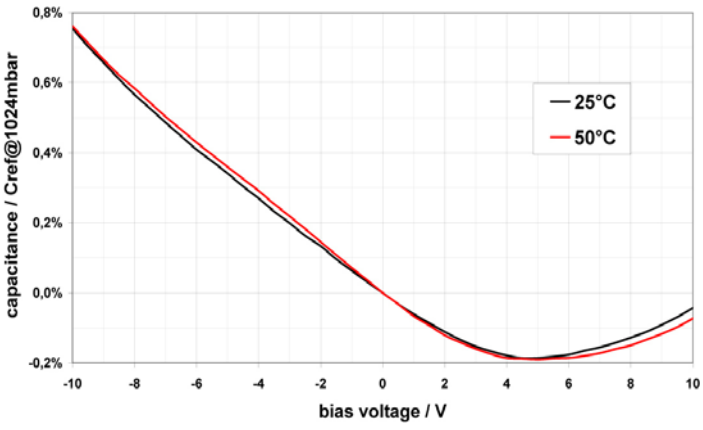


Fig. 4: Capacitance vs DC voltage plot @ P_{ref}

Packaging Information		Value	Unit	Notes
Bond pad length	L_{BP}	210	µm	see fig. 6
Bond pad width	W_{BP}	534	µm	see fig. 6
Bond pad pitch	D_{BP}	957	µm	see fig. 6
Topography on die	H_{BP}	<5 µm	µm	Highest structures above substrate surface (see fig. 6).
Sensitive area length	L_S	694	µm	Area must keep clear of adhesives (see fig. 6).
Sensitive area width	W_S	374	µm	Area must keep clear of adhesives (see fig. 6).
Bond pad material				Aluminium (optional: polycrystalline silicon conductors or nickel/gold metallization)

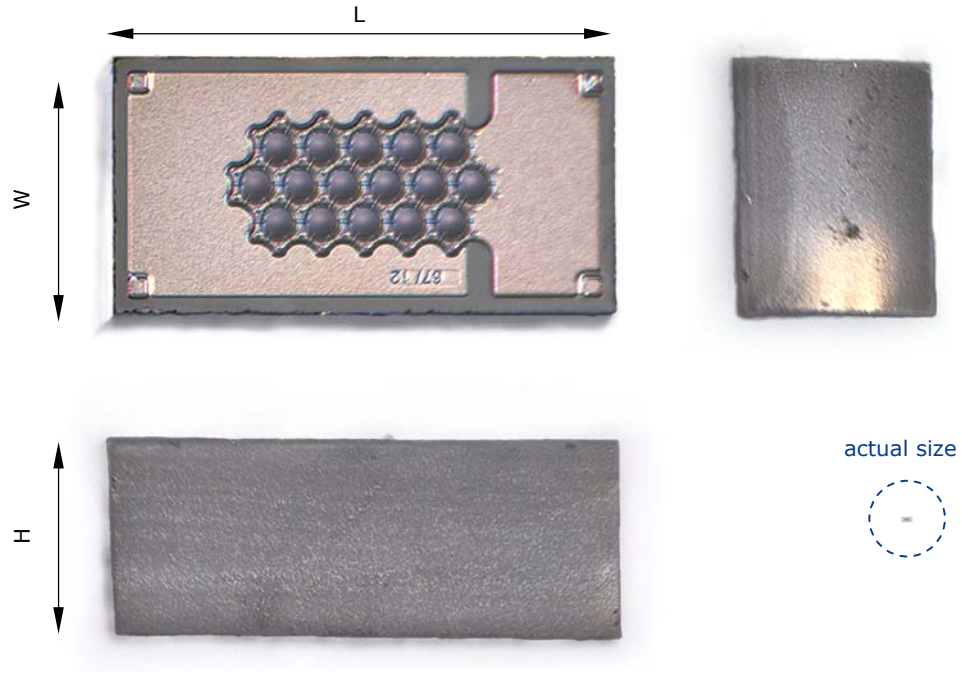


Fig. 5: Sensor die dimensions.

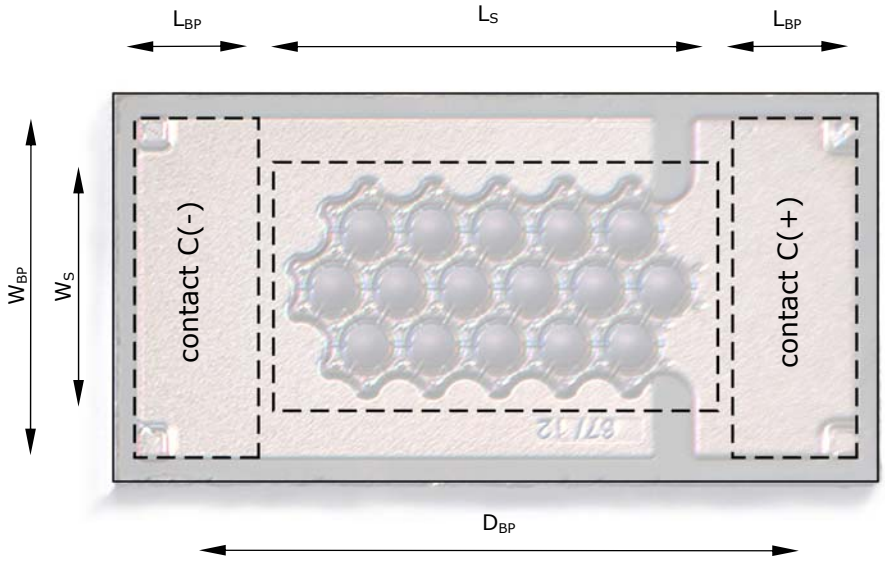
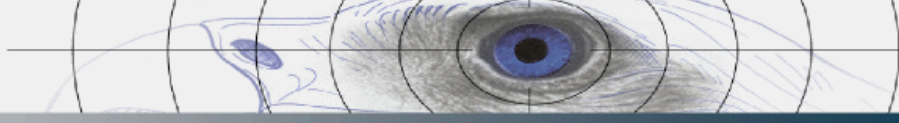


Fig. 6: Packaging dimensions.



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