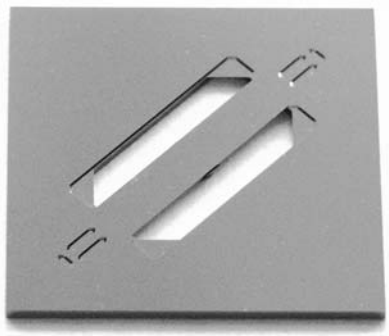
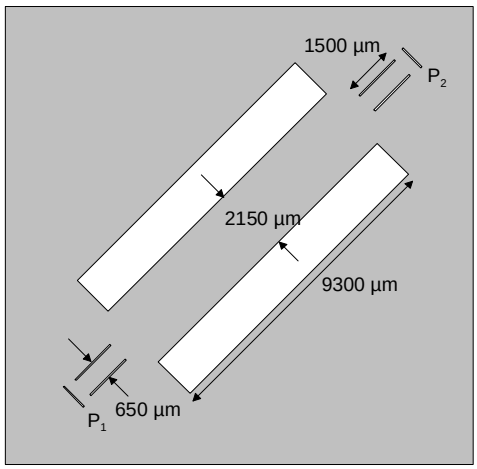


Force Standard
Type FS-B

1. Structure



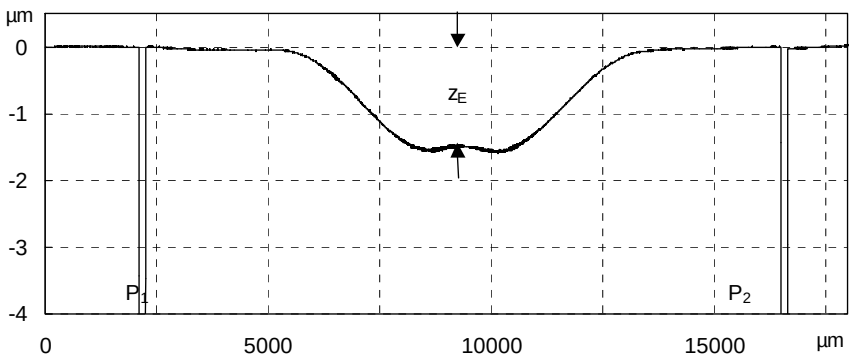
Force standards of type FS-B are bending beams ("**b**ridge") with rectangular cross section fastened at two sides inside a frame of a {100}-silicon chip.
The direction of the beam is parallel to the <100>-direction of the silicon. The bridge is anisotropically wet etched from a mono-crystalline silicon wafer with a thickness of 525 µm. In the middle of the beam a boss is situated so that the bridge is protected when the loading is performed. The centre of the boss marks the place of the loading point for which the standard is calibrated.

The chip size of the standard is 15 mm x 15 mm.
The bridge is mounted onto a chip frame or a support with a deepening so that the beam can be freely moved in vertical direction. The marks P_1 and P_2 and the guiding marks are grooves lying at the end of the bridge. They support the measurement at the profilometers.
The weight of the bridge and internal stresses cause a deflection z_0 of the bridge ("zero load bending") relative to the chip frame. This deflection must be measured by an optical method.
The stiffness k_E (spring constant) by loading in the middle of the boss and the **zero load** bending z_o at this point are stable characteristics of the force standards which can be certified.

2. Process of Calibration

The measurement of the probing force is based on a scan along the bridge of the force standard analogous to the common use of tactile instruments.
Because of the measuring force of the stylus tip the bridge is deflected when profiling with the stylus. The stiffness of the boss is reflected in the lower plateau in the middle of the scan. A symmetrical deflection profile results.
The probing force F can be calculated from the measured profile by multiplication of the difference between the level z_P of the plateau at the marks P_1 and P_2 and the deflection $\boldsymbol{z_E}$ at the boss with the here effective stiffness k_E: $F = k_E * (z_P - z_E)$
For the determination of the level z_P and the deflection z_E the profile must be rotated creating a horizontal region between the marks P_1 and P_2.
In the common case of the existence of a zero load bending z_o because of internal stress and the weight of the bridge the measured profile depth must be corrected by z_o (zero load bending upward: $z_o < 0$): $F = k_E * ((z_P - z_E) - z_o)$.

The standard is available either with a PTB calibration certificate (PTB: Physikalisch-Technische Bundesanstalt, the national metrology institute of Germany) or a calibration certificate (traceable to the PTB) by SiMETRICS. It contains the stiffness together with the zero load bending (and dimensions of the beam).



3. Packaging, Handling and Cleaning

For a better handling the silicon standards are mounted on borosilicate glass with a size of 5 cm x 5 cm as substrate. Further sizes and different support materials are possible on request. The chips are mounted by an epoxy resin adhesive.
The standards are stored in a membrane box. The beam does not come into contact with the membrane.
In all cases the suitability of clean room use is guaranteed.
Do not touch the silicon chip especially the regions destinated for measuring and calibration. Use suitable (plastic) tweezers for handling.
For cleaning the force standards the following procedures are recommended:
• Removing of particles of dust: blowing off by softly flowing pure nitrogen or air
• Removing of tightly sticking particles: rinsing with deionised water, blowing dryly by softly flowing nitrogen or air
• Removing of organic deposits: rinsing with ethanol (analytic-grade) rinsing with deionised water, blowing dryly by softly flowing pure nitrogen or air.
If none of these methods is successful please contact SiMETRICS for a cleaning process.

4. Assortment and Specification

Type	Nominal stiffness (mN/µm)	Nominal thickness of spring (µm)	Maximum bending (µm)	Maximum force (mN)
FS-B 300	0.3	30	3	10
FS-B 750	0.75	45	4.5	15
FS-B 3000	3.0	70	7	20