4

Wafer Geometry System
Resistivity System
Calibration

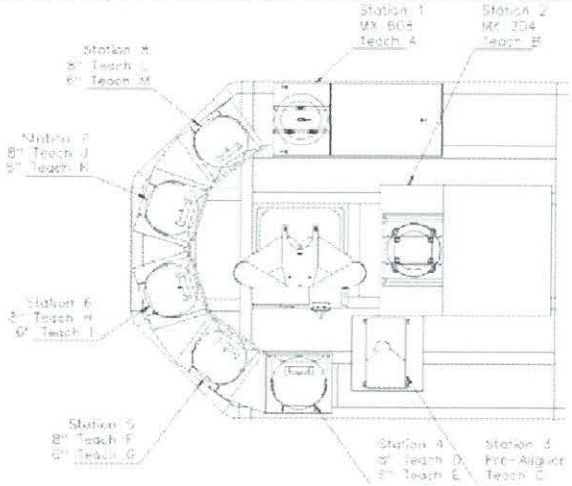
MESSGERÄTEBAU

MX204-608-DRA-5C
Calibration Instruction

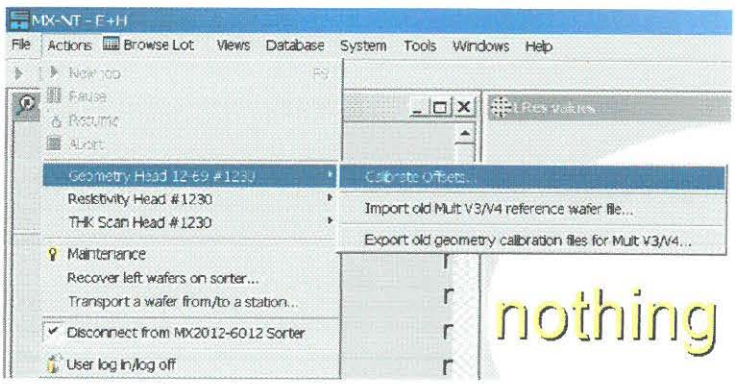
This recalibration may and shall be performed by the user, whenever the "Daily Check" indicates that the measured values are out of their limits. This may be due to a lasting change in ambience temperature, or to shock when either the upper probe head or the whole gauge was put back to its place to hard. Before beginning to recalibrate, make sure the **MX204-608-DRA-5C** has its operating temperature (i.e. it has been powered on for at least one hour), also that temperature change due to air current are avoided (close doors and windows), and shocks and vibrations are avoided (stop machines in the vicinity).

1 Geometry Head Calibration

Start MXNT in the normal Modus with the main Desktop link. Place the cassette with the calibration wafer #00414 inside on station number four.

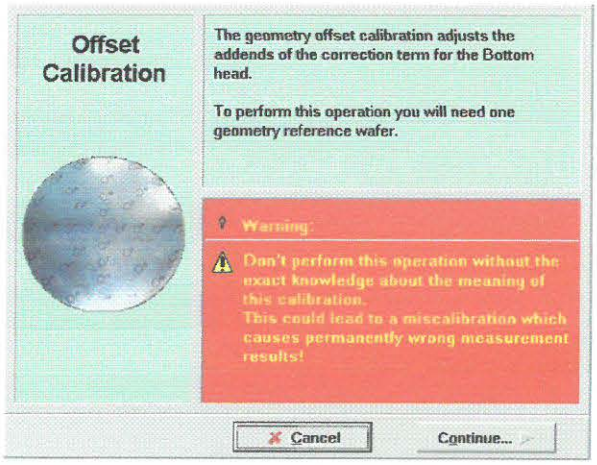


Open the menu item Action > Geometry Head 12-69 #1234 > Calibrate Offsets…

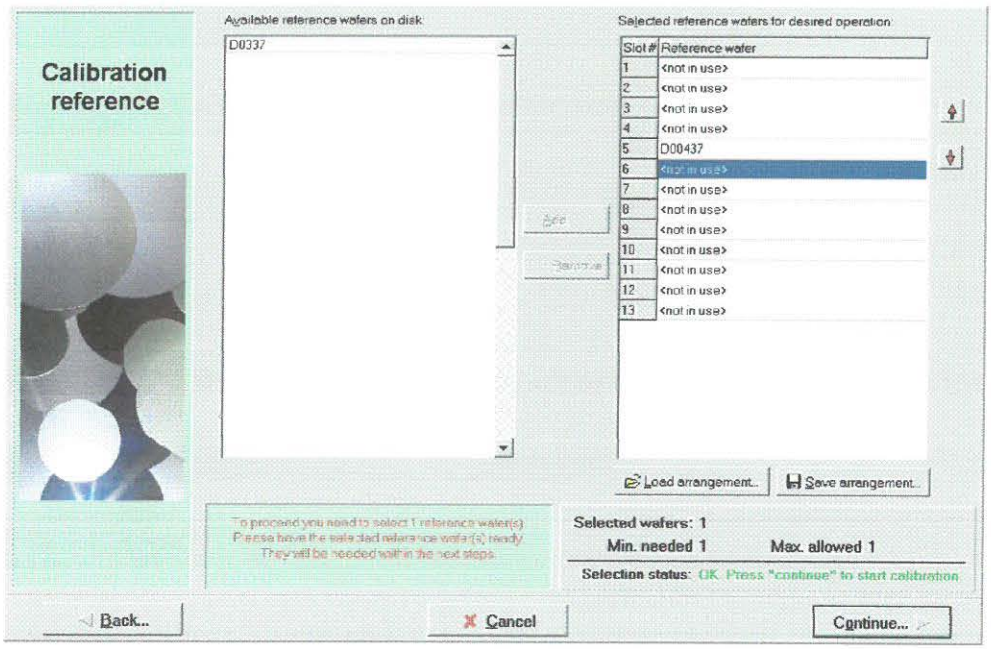


Normally this menu item is password protected. Enter your user name and the right password to get access.

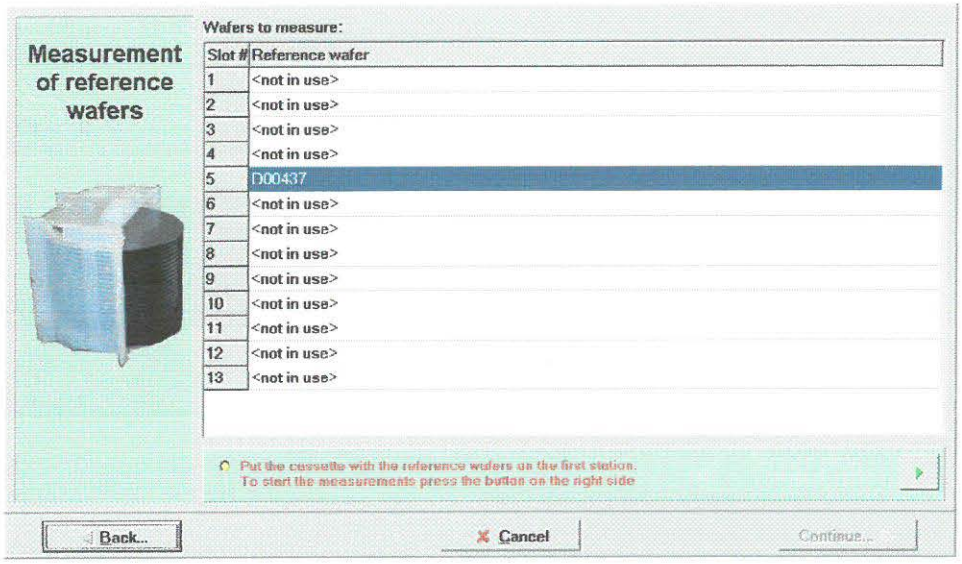
After this a window appears with some information and warnings.



In the next window you can choose the calibration wafer you want (in some cases a costumer has more then one). Put the wafer in the right slot.



Press "Continue…"

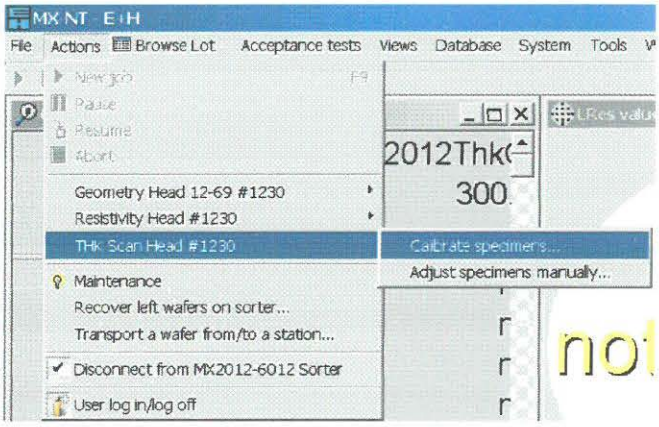


If everything is ok you can press the "Play" button to start the calibration measurement. If the mesurement is valid the yellow light turns to green and the "Continue…" button is highlighted. Follow the instruction and store the new calibration file.

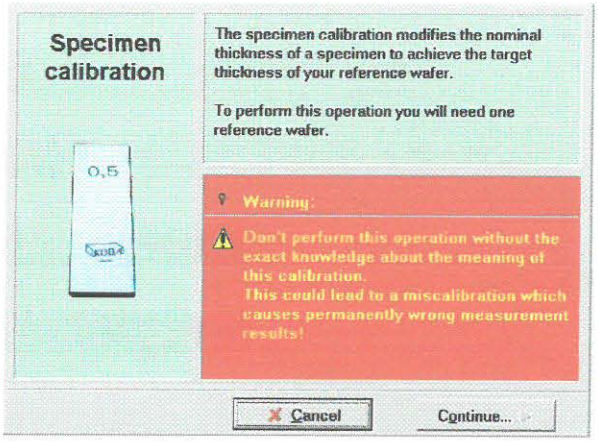
2 Thickness Scan Head Calibration

Start MXNT in the normal Modus with the main Desktop link. Place the cassette with the calibration wafer #00414 inside on station number four.

Open the menu item Action > THK Scan Head #1234 > Calibrate Specimen…



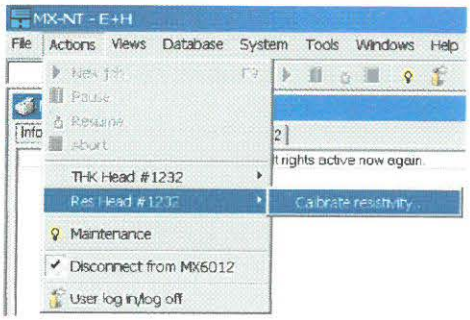
Enter user name and password to get access. The following window give you some information and warnings:



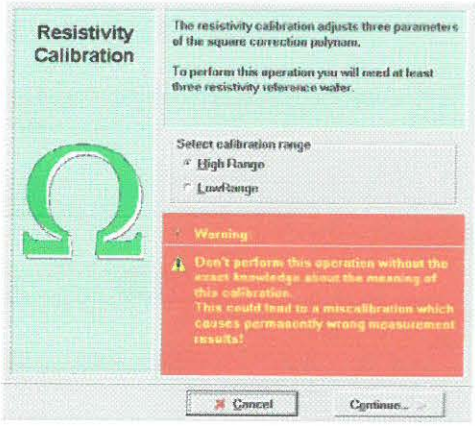
Press "Continue…" and choose in the next window the calibration wafer you want to use. Follow the instruction and store the new calibration file.

3 Resistivity Head Calibration

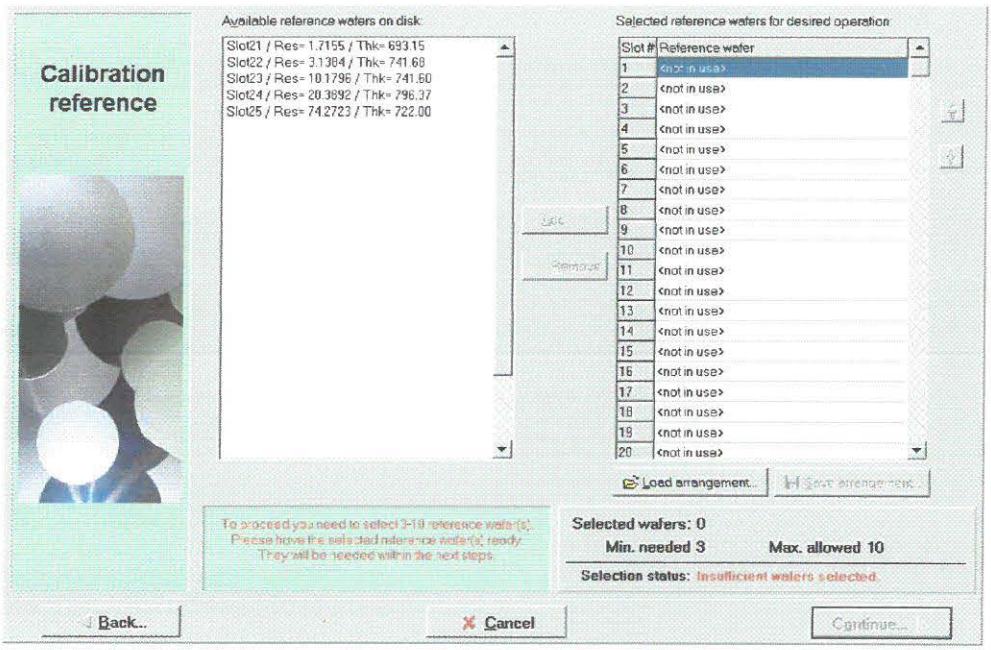
Open the menu item Actions > Res Head #1234 > Calibrate resistivity…



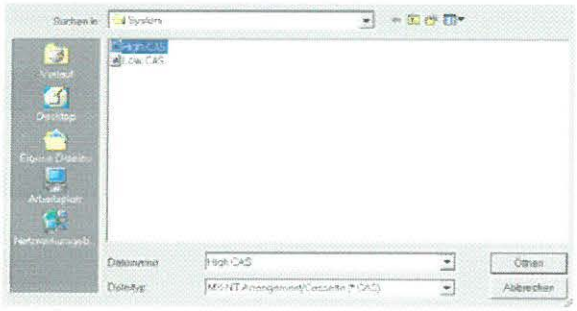
A window appears with some information and warnings. In this window you must also select the resistivity range you want to calibrate:



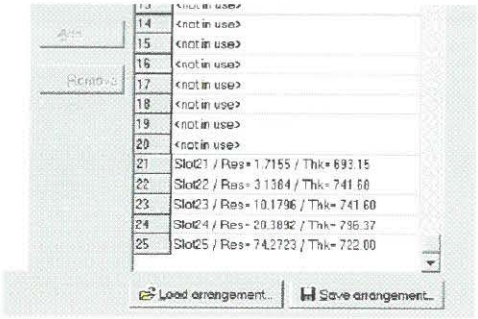
A resistivity calibration needs minimum three wafer. Choose the wafer you want. To make this step easier you can store or load a arrangement.



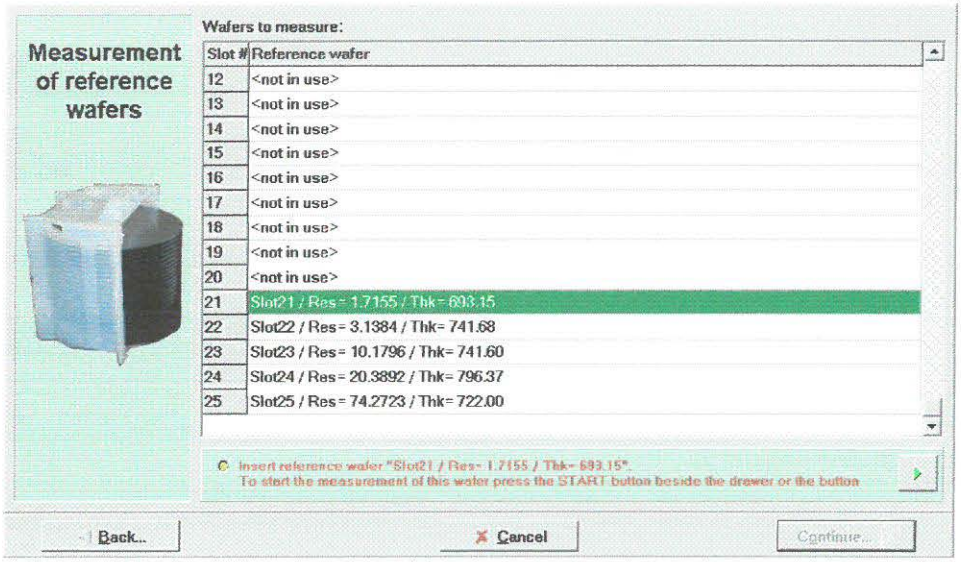
The original delivered arrangements are stored inside the \system subdirectory.



Choose the **high.cas** or **low.cas** resistivity arrangement. Some times you must scroll to see the wafer.

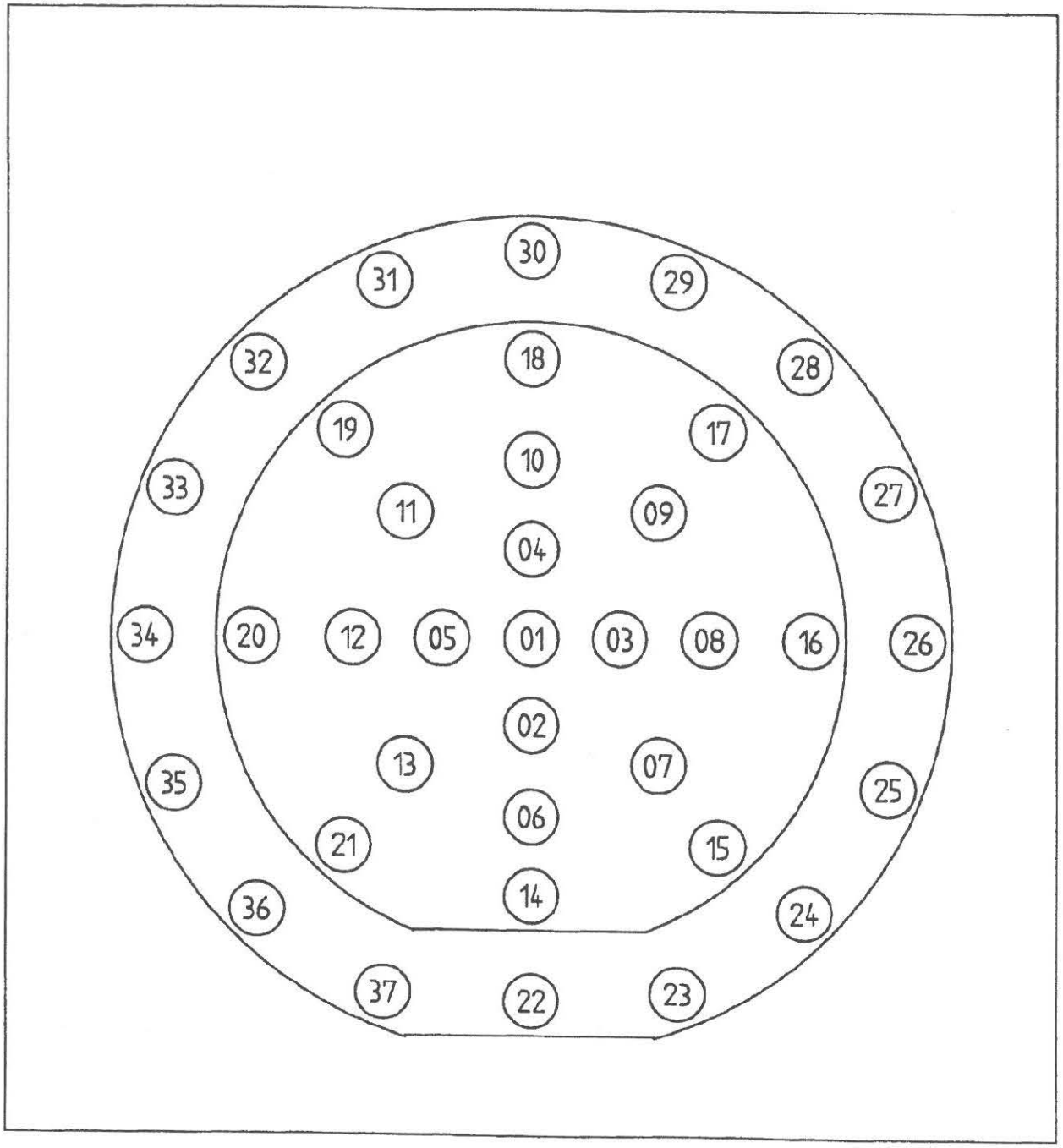


Press “Continue…”.



Press the green “Play” button to start the measurement. Measure in this way all wafers one after the other.

I all measurements are done the “Continue…” button is high lighted. Follow the instructions and store the new calibration file.



Sensor Numbers

i	X(i)	Y(i)
1	0.0	0.0
2	0.0	21.3
3	21.3	0.0
4	0.0	21.3
5	-21.3	0.0
6	0.0	-42.5
7	30.1	-30.1
8	42.5	0.0
9	30.1	30.1
10	0.0	42.5
11	-30.1	30.1
12	-42.5	0.0
13	-30.1	-30.1
14	0.0	-61.5
15	44.5	-49.4
16	66.5	0.0
17	44.5	49.4
18	0.0	66.5
19	-44.5	49.4
20	-66.5	0.0
21	-44.5	-49.4
22	0.0	-87.0
23	35.2	-85.0
24	65.1	-65.1
25	85.0	-35.2
26	92.0	0.0
27	85.0	35.2
28	65.1	65.1
29	35.2	85.0
30	0.0	92.0
31	-35.2	85.0
32	-65.1	65.1
33	-85.0	35.2
34	-92.0	0.0
35	-85.0	-35.2
36	-65.1	-65.1
37	-35.2	-85.0

Sensor Locations

```
Datei: GEO1211.DAT
          Total_Distance= 2525.2868282448704000

   Reference_Specimen_Thk= 0.0000000000000000

             Warp_Offset= 0.0000000000000000

; Top sensors corection terms (factor, offset)
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; Bottom sensors corection terms (factor, offset)
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Datei: GEO1211.DAT

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(9.971509971509970E-1, 1.384057142857130E1),
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(9.938946471673999E-1, -3.264721428571460E0))
```

Wafer Geometry Characteristics

Contents

1.1 Total Distance (TotDist)

In our MX 203 Series Contactless Wafer Geometry Gauges, the evaluation of all wafer geometry characteristics is based upon distance measurements performed by multiple capacitive sensors embedded in two probe plates facing each other, and the surface of the test piece positioned in the air gap between the two plates. Thanks to correction data yielded by the calibration procedure, the two probe plates can be assumed to be perfectly flat, and to be mounted in a constant total distance between each other.

1.2 Thickness (LThk, CntThk)

The Thickness of the wafer at a given sensor pair results from the difference of Total Distance minus distance at bottom sensor minus distance at top sensor.

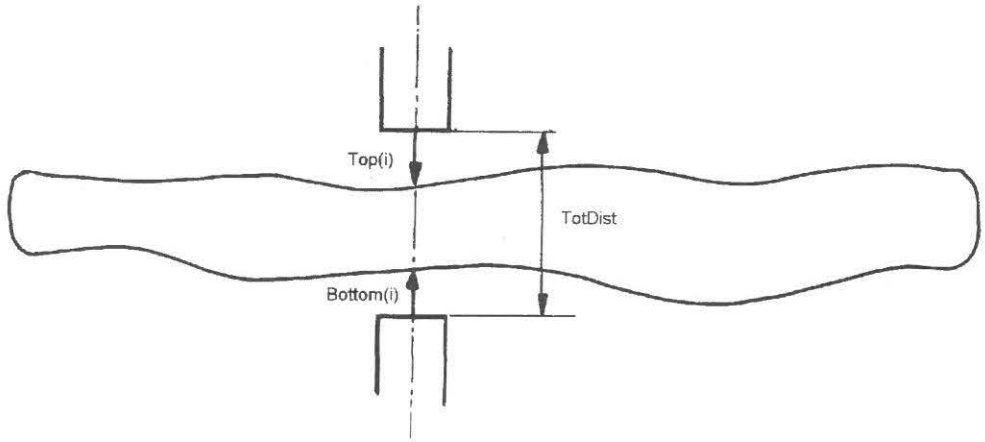


Figure 1

$$Thk(i) = TotDist - Bottom(i) - Top(i)$$

LThk = Local thickness values on every sensor pair
CntThk = Thickness value in the middle

1.3 Average Thickness (AvgThk)

The average of all thickness values.

$$AvgThk = \frac{\sum Thk(i)}{n}$$

AvgThk = Average thickness

1.4 Minimum-, Maximum Thickness (MinThk, MaxThk) and Total thickness variation (TTV)

In an MX 203-8-37, e.g., a six inch wafer is measured at 21, a eight inch wafer at 37 sensor positions. The software computes the two thickness extrema, TTV (Total Thickness Variation) is the difference between them.

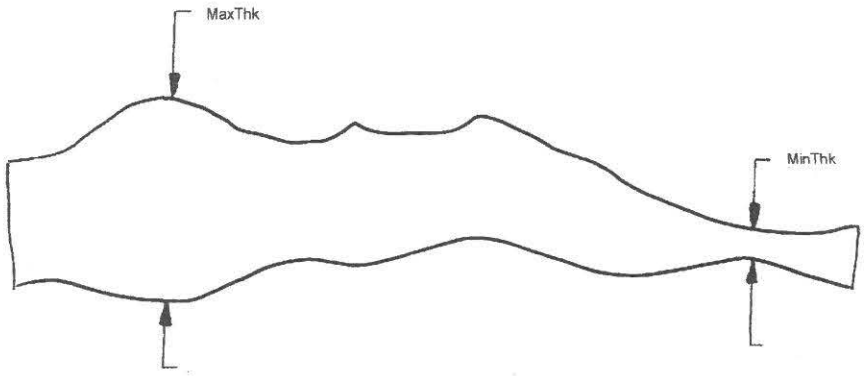


Figure 2

$$TTV = MaxThk - MinThk$$

MinThk	=	Minimum local thickness value
MaxThk	=	Maximum local thickness value
TTV	=	Total thickness variation

1.5 Standard Thickness (StdThk)

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i \Rightarrow FS_{\min} = \sum_{i=1}^{N}(x_i - \bar{x})^2 \Rightarrow s = \sqrt{\frac{FS_{\min}}{N-1}} \Rightarrow \qquad StdThk = \frac{s}{\sqrt{N}}$$

N	=	number of local thickness values
$\bar{x}$	=	arithmetic mean value
FS_{min}	=	minimum mistake sum
s	=	standard deviation
StdThk	=	standard deviation of arithmetic mean value

1.6 Shape

The mean value computed from the thickness values at the edge of wafer is subtracted from the center thickness value.

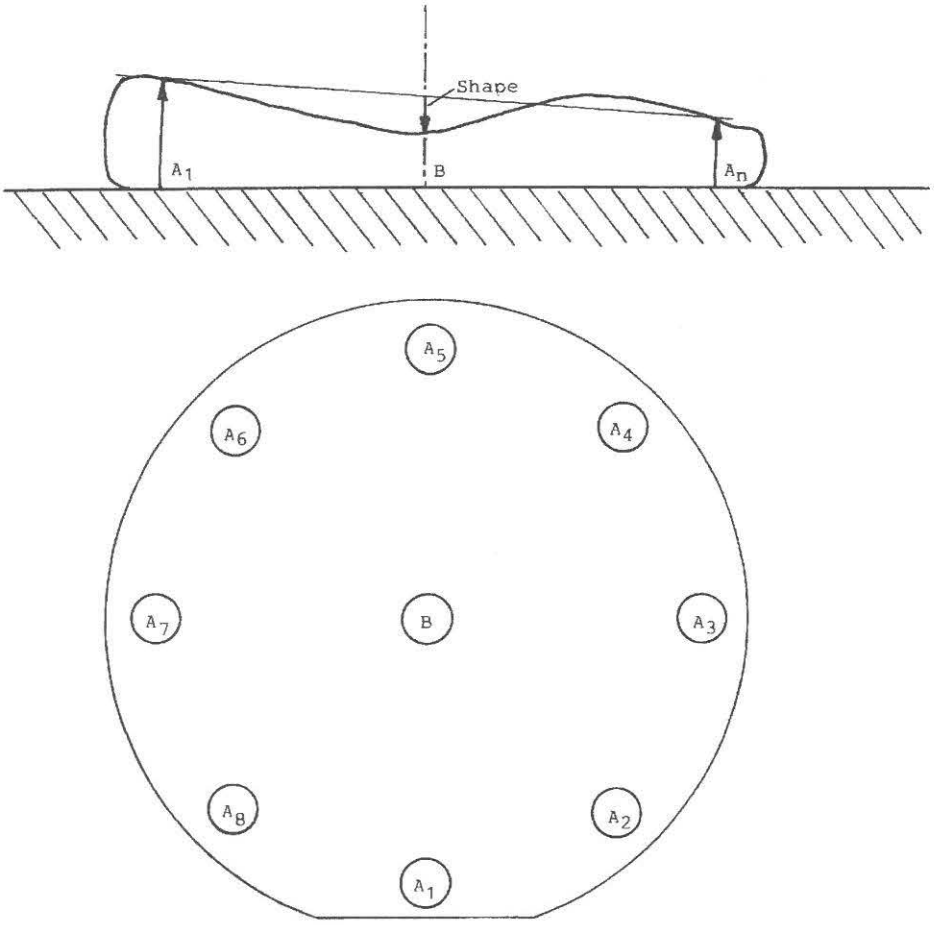


Figure 3

$$Shape = CntThk - \frac{\sum_{i=1}^{n(Shape)} Thk(Shape(i))}{n(Shape)}$$

1.7 Max.Neg., Max. Pos. FPD, TIR

FPD = Focal plane deviation
TIR = total indicator reading

By representing all thickness values overhead a common plane, a vacuum chuck is simulated mathematically. By application of the „last squares fit" algorithm to the given thickness values, a theoretical plane is computed, which is the best approximation to these values. It is called Focal Plane, at every sensor position, there is a local deviation between the plane and the local wafer thickness.

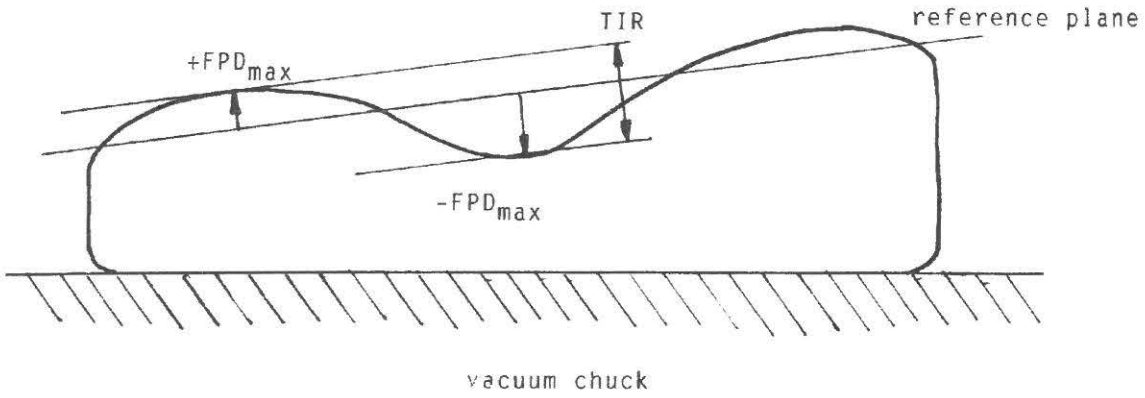


Figure 4

The extrema found in the given set of Focal Plane Deviation values are called Maxima Negative and Maximum Positive Focal Plane Deviation. TIR (Total Indicator Rating) is the sum of the absolute values of those two extrema.

1.8 Local Warp, Max. Neg. Warp, Max. Pos. Warp, Total Warp

Applying the least squares fit algorithm to center line values yields local deviations with respect to the approximated plane computed here. These are called Local Warp Values, their extrema are called Maximum Negative and Maximum Positive Warp, Total Warp is the sum of the absolute values of those two extrema.

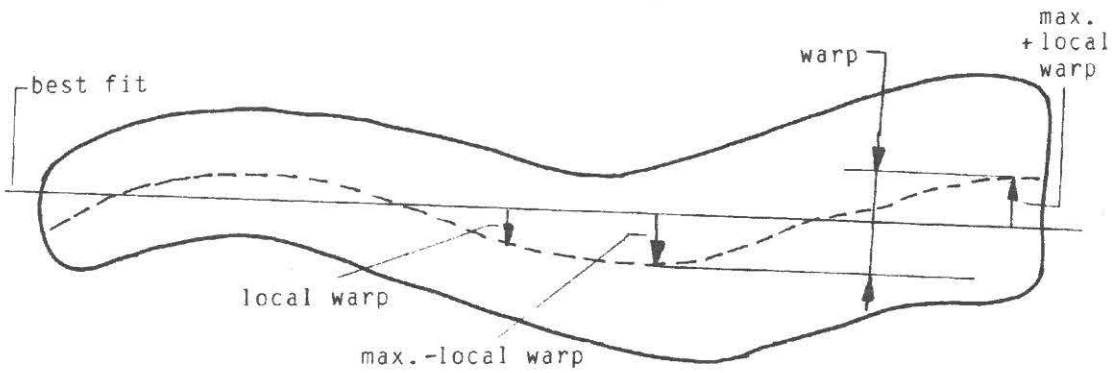


Figure 5

1.9 Bow-BF

The Local Warp value in the center of the wafer is called Bow-BF

1.10 Bow-X, Bow-Y, Max-Bow-XY

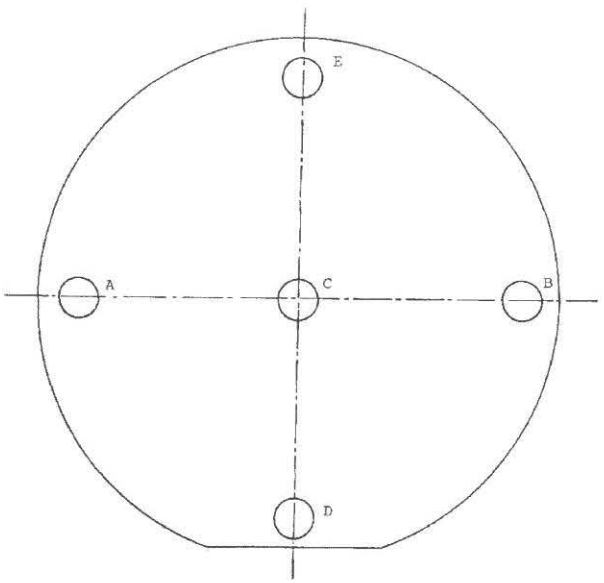


Figure 6

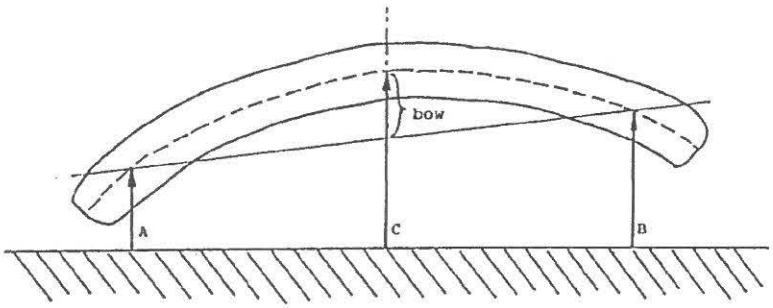


Figure 7

$$Bow - X = C - \frac{A+B}{2} \qquad Bow - Y = C - \frac{D+E}{2}$$

The biggest value is MaxBow-XY.

1.11 CntBow, Delta CntBow

Center Bow is a specific Bow who employs all edge warp values for calculation.

$$b_c = \frac{\sum \text{warp values at the border}}{\text{number}} - \text{warp value in the center}$$

Delta Center Bow is only available if you use the „Stress Modul". It is the difference between a pre- and a post measurement.

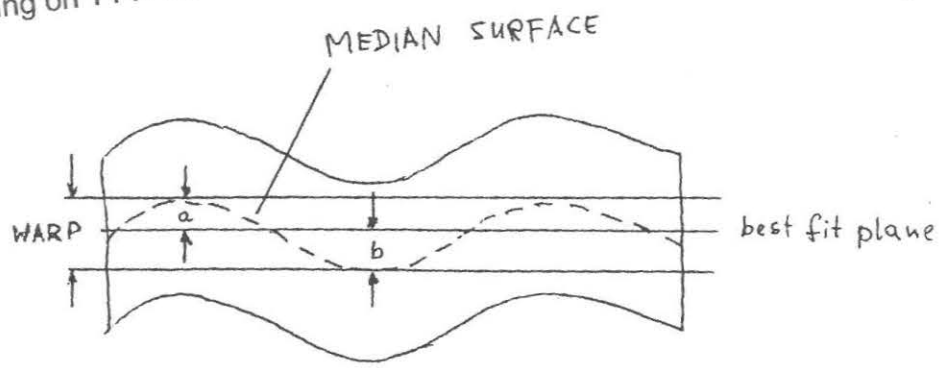
$$\Delta b_c = b_c(\text{post}) - b_c(\text{pre})$$

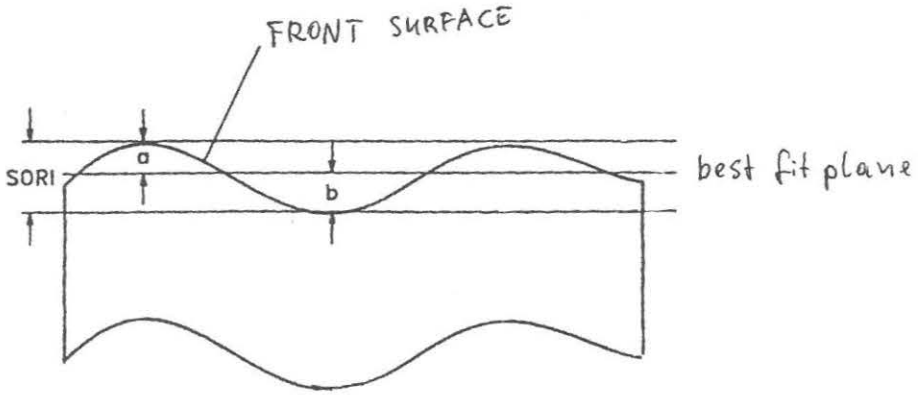
1.12 Sori

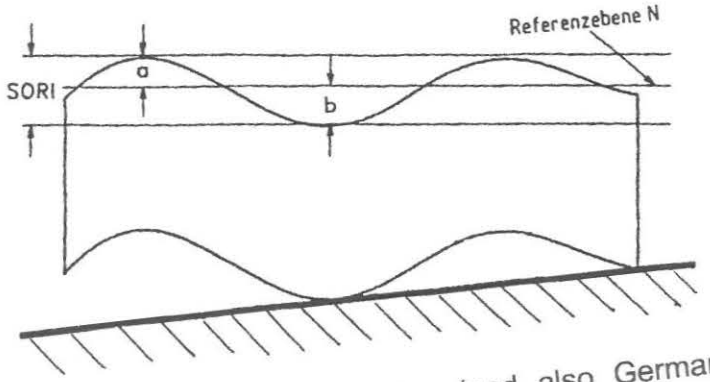
is the Japanese word for Warp. According to the JEIDA standard, it represents the maximum variations between individual points on the upper side of the wafer with respect to a least squares fit plane based on these points. E+H supplies special probe heads with multiple resting points for the wafer to approximate the required plane.

1.13 Warp vs. Sori

According SEMI's Shape Decision Tree there is a very small difference only, depending on TTV. With low TTV values the difference is really negligible:



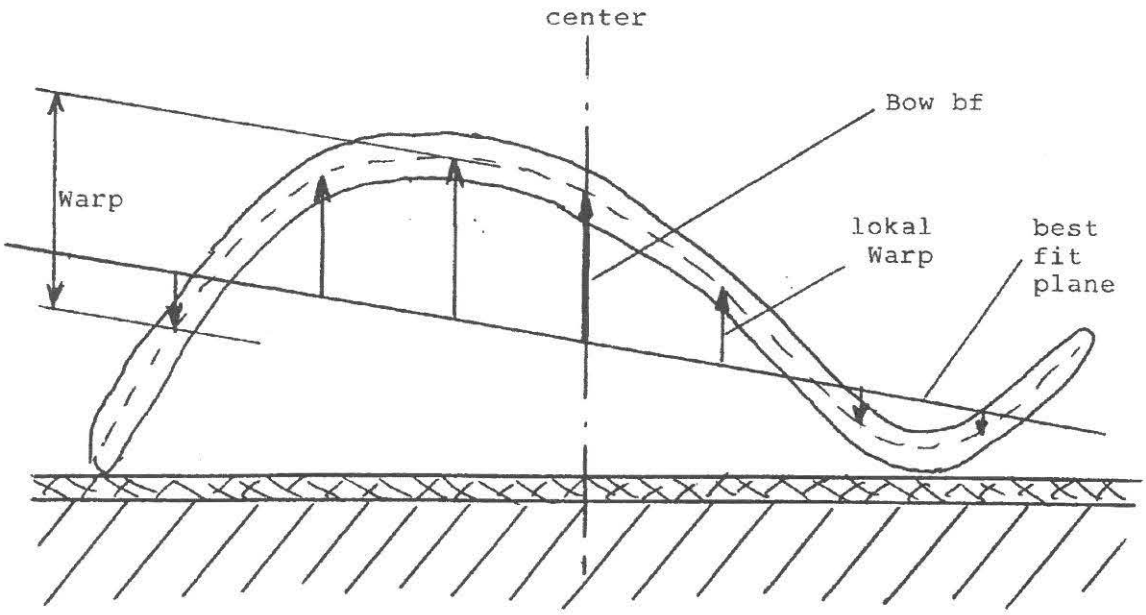




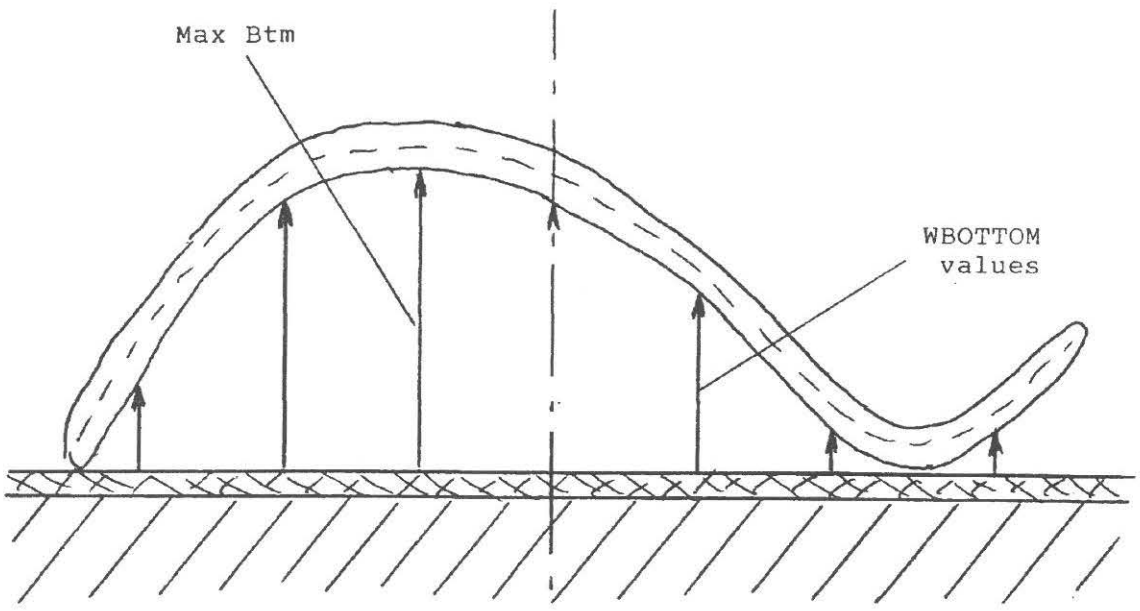
The original Japanese SORI definition (and also German DIN) has a serious difference:

The wafer is resting on a flat plane, not gravity corrected!

1.14 WBottom



In this case the warp is **MUCH** greater than the thickness and TTV. That is why it does not matter at all whether we use the lower surface of the wafer, or ist upper surface (sori) or the median (warp) to compute the wafer property "warp".



WBOTTOM = local distance between sensor in the lower probe head and the bottom surface of the wafer.
MaxBtm = the maximum among the WBOTTOM values