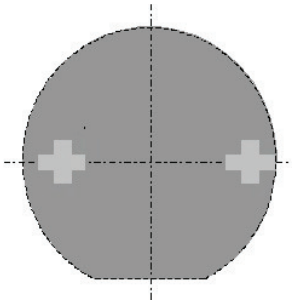
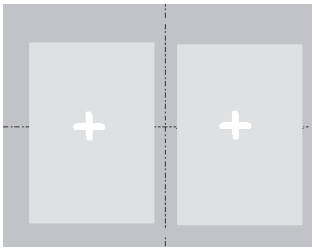
3.4. Target Design for Advanced Alignment on an MA/BA6 Gen3

The use of Assisted and AutoAL alignment methods requires certain conditions to be met to ensure that alignment of the targets will perform correctly on the aligner. Some basic essentials for successful alignments are presented next:

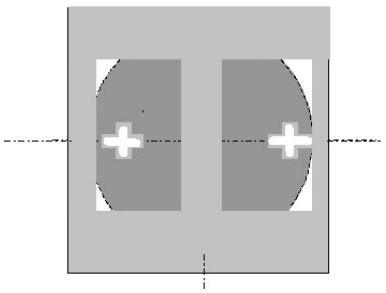
3.4.1. The Clear Field (TSA Auto and Assisted Alignment)



Wafer with alignment targets



Mask with clear field and alignment targets



Mask aligned to wafer in clear field area

In order to see the wafer under the mask, a clear area must be provided near each alignment target. This allows an unobstructed view of the wafer under the mask.

The clear field size must be large enough to allow an unobstructed view of the wafer targets. Typically this will be about two or three times the size of the wafer target size. (See Field of View table below for recommended clear field size based upon microscope objective magnification).

The Field of View (FOV)

Objective	Olympus 5X	Olympus 10X	Olympus 20X
FOV	1300 x 900	650 x 460	250 x 190
Magnification	210	420	1050
Recommended Clear Area	1400 x 1000	750 x 560	350 x 290

All values in microns (µm)

The size of a clear area depends on two more variables:

- The **field of view,** which depends on the **objective magnification** (see size information shown in the table left) and
- The **wafer misplacement errors** of the operator, if the clear field is smaller than the field of view.

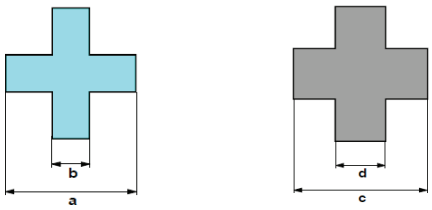
3.4.2. Alignment Targets for Assisted and Automatic Alignment

The key for a successful assisted and automatic alignment is the design of a **unique** target within the field of view. As a rule of thumb you can say that mask and the wafer targets should have less than 25% of the same edges.

If the targets are not unique then the system may locate an image that is not correct and misalignments may occur.

- **Target 1 in FOV ≠ Target 2 in FOV**

Target Size Ratio



Mask (left) & wafer (right) target

Mask target aligned to wafer target

The targets at the left are the most commonly used alignment marks.

In manual mask aligners it is essential that the mask target does not cover the wafer target completely! In most cases this delta should be greater than five microns edge to edge.

The final alignment accuracy depends greatly on the quality of mask and wafer alignment targets due to process related parameters (contrast, topography, form fidelity, etc.).

- **c ≥ a + 10µm (2 x 5µm)**
- **d ≥ b + 10µm (2x 5µm)**

Comparison Target Size to Field of View

Mask:

Objective	a [µm]	b [µm]
20X TSA Only	70	20
10X TSA &BSA	124	35
5xTSA &BSA	250	70

Dimensions of mask alignment targets

Wafer:

Objective	c [µm]	d [µm]
20X TSA Only	80	30
10X TSA & BSA	132	43
5X TSA & BSA	265	85

Dimensions of wafer alignment targets

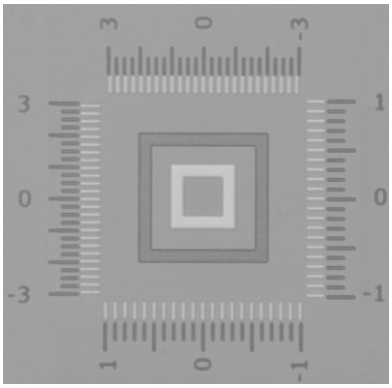
The tables on the left show typical dimensions for mask / wafer targets based upon the objective that is used.

3.4.3. Working with Auto Origin

Auto Origin = Automatic setting of the target center, which is done by the MA/BA6 Gen3 automatically after the target has been defined.
When the target has been found the image is switched around by 180° and the center is calculated. This is usually more precise than a manual setting of the target center.

Note!
For the Auto Origin function the targets need to be symmetrically.

3.4.4. Working with Manual Origin

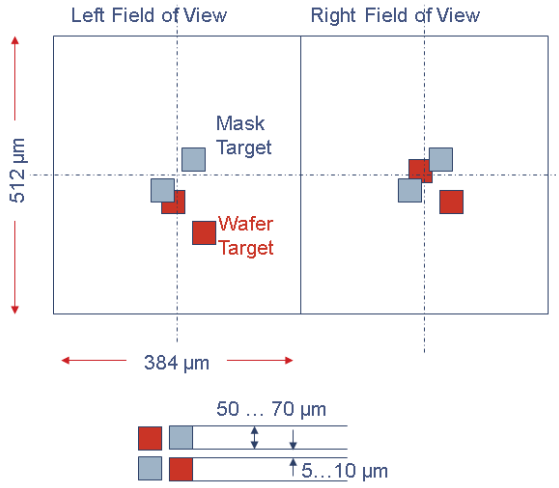


If the targets are **not symmetrically**, it is possible to set the origin **manually**.

For the **visual alignmen**t check there are two options:

- If there is enough space **verniers** (see image on left side) can get created on the mask and wafer, which can be read on the screen before exposure. This is the most precise version.
- It is also possible to design the wafer and mask targets as described in 3.4.2. A skilled operator will be able to work with it.

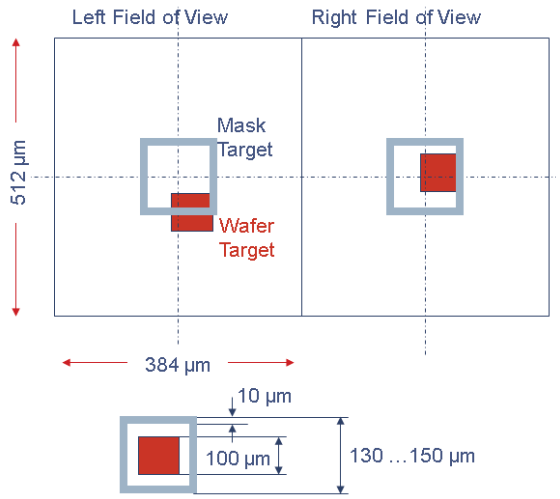
3.4.5. Proposed Target Design for Assisted and Automatic Alignment (MA/BA6 Gen3)



Proposal 1

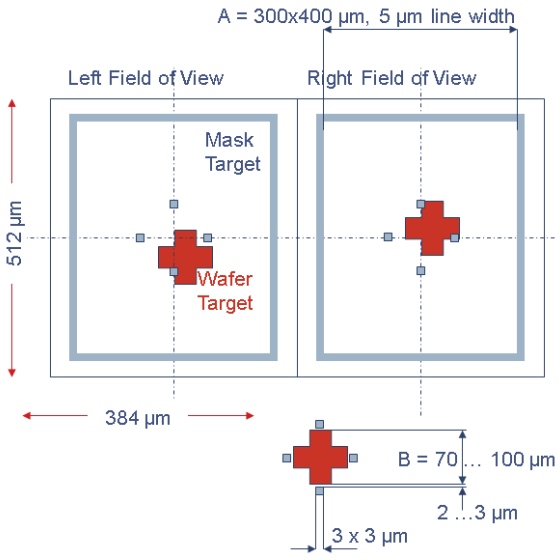
- **Independent mask / wafer targets**
- **Partial occlusion possible**

In the design example shown left the wafer and mask targets can be seen independently. It may occur that the wafer target is partially covered by the mask target. In this case an automatic or manual movement of the mask target may be required.



Proposal 2

- **Same capabilities as Proposal 1**
- **Application of synthetic targets possible**
- **Partial occlusion may occur**



Proposal 3

- **Proposal 3 target solution**

In this target combination no occlusion will occur. The large rectangle is used for alignment. The small squares on the mask do not cover the wafer targets (cross shaped). They have been designed for visual control.

Based on Proposal 3 the following equation describes the ideal MA/BA6 Gen3 target:

Condition to be fulfilled in X and Y:

$$0.5*(A-B) > \mathrm{sqr}\,[(3*\sigma_{PAL})^2 + (3*\sigma_{1st\ Exposure})^2 + (3*\sigma_{Chuck\ Position})^2]$$