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AUTOSTEP200
ADVANCED LITHOGRAPHY SYSTEM

A Guide to Reticle Design on the Autostep 200
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Table of Contents

Introduction:
This guide will introduce reticle design concepts for use on the AS200 stepper, and will explain the basic concepts of reticle management and global alignment. The information required for CAD layout will be discussed and provided later.

Section 1 – Reticle Management System (RMS):
<u>Introduction</u>
The AS200 uses RMS alignment windows to align the reticle to the platen chuck and to the X and Y-axis stages of the wafer stepper system. The alignment windows are typically located in the center of the reticle, or offset 11mm from the center position to eliminate possible pattern generation interference, as shown below.
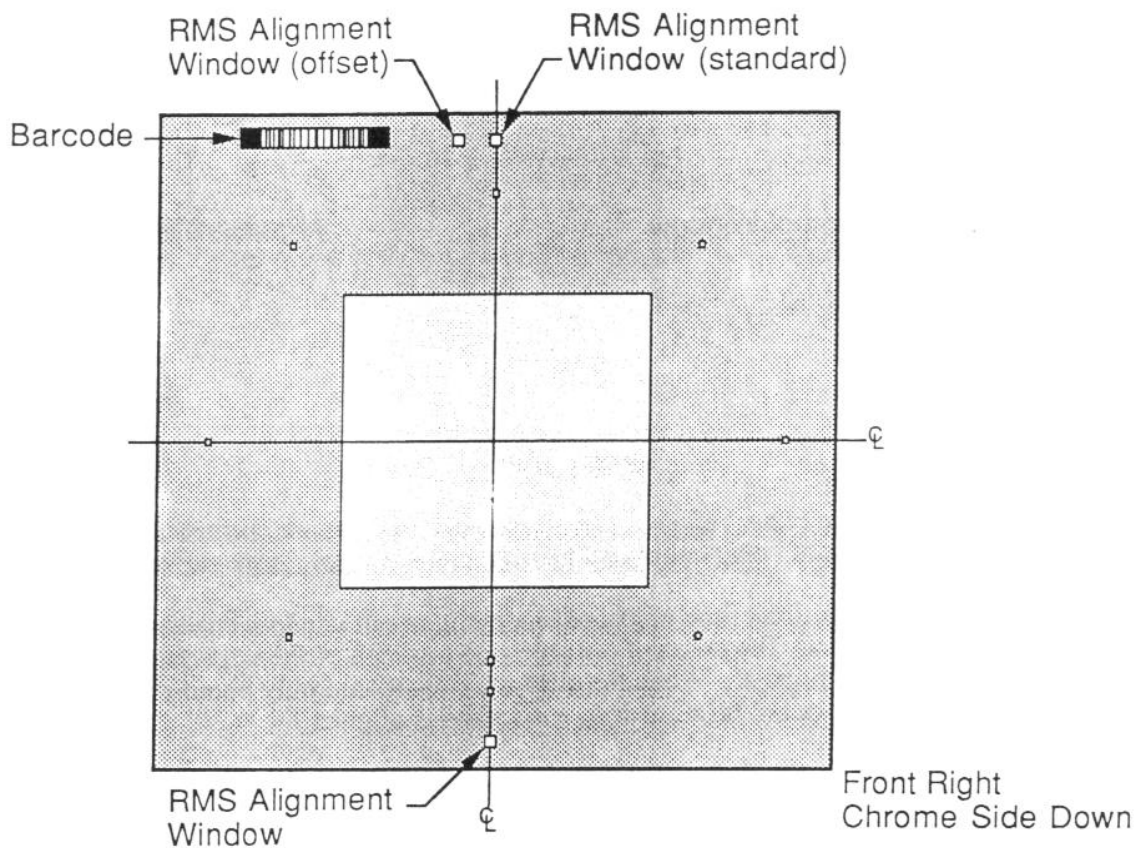

Figure 2.1 - Typical Alignment Window Locations

The standard reticle phase and alignment window is negative. A negative phase indicates that the alignment window is a clear opening in the chrome background of the reticle as shown below. Positive phase reticles exist, but are not commonly used. The RMS is capable of using either positive or negative phase reticles.
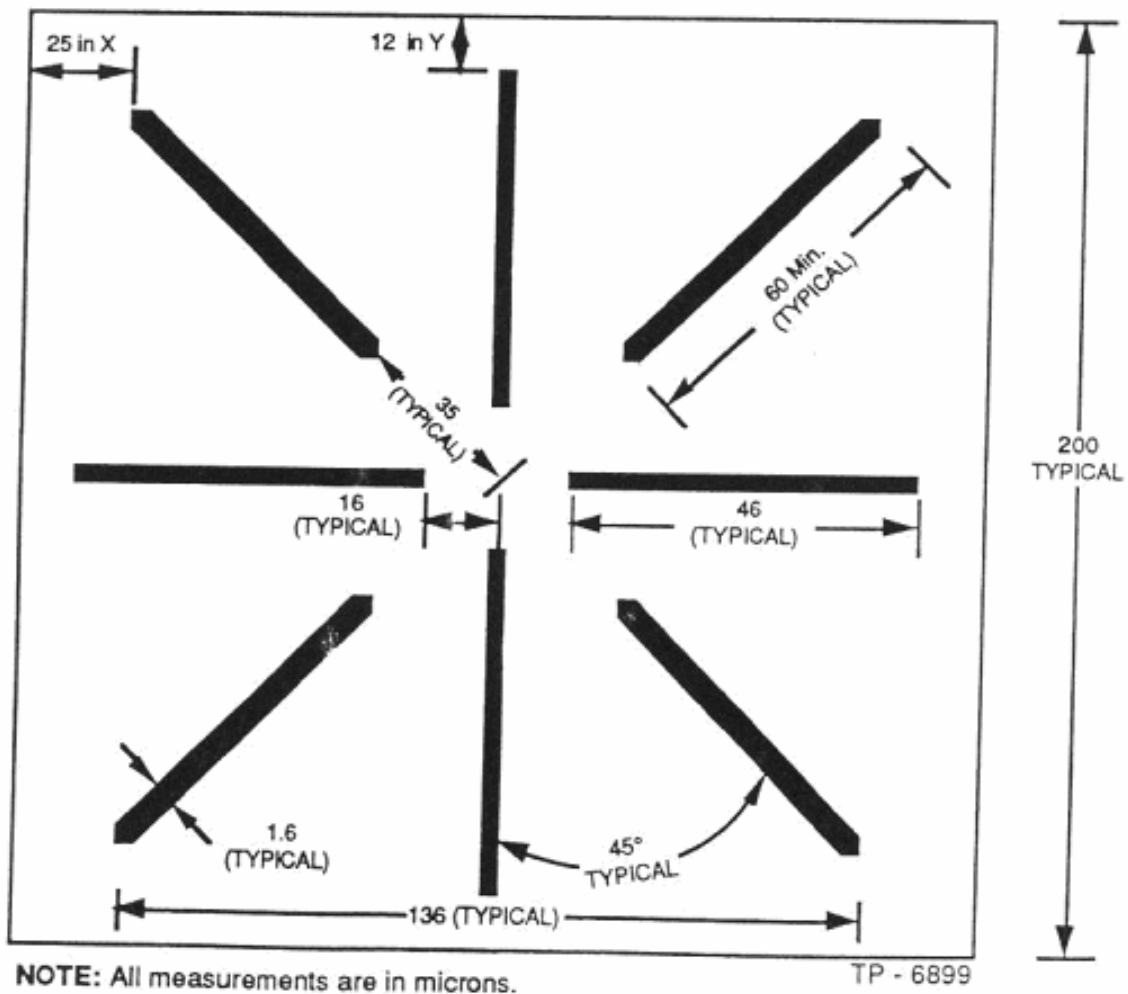
The position of the alignment window corresponds to RMS aligner detectors. The detector observes the position of the window with respect to the aligner fiducial.

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Section 2 – Global Alignment System

Global alignment is an important first step in aligning the entire wafer to the wafer stepper system. This alignment can be performed by 1 of 2 methods, by the operator manually or automatically by the Automatic Wafer Aligner/Digital (AWA/D). The AWA/D performs automatic global alignment in a more consistent, fast, and reliable method than the typical operator.

Global Scan

A global scan of the AWA/D is used to determine the general location of the wafer alignment mark by scanning the whole digitized video image. The wafer mark is shown below.

NOTE: All measurements are in microns.

NOTE: Minimum separation distances of 25 microns in the X-axis, and 12 microns in the Y-axis between the ends of the target lines and any other geometries.

Figure 3.2 – Typical Wafer Alignment Mark

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Reference Scan

A reference scan of the AWA/D is used to determine the precise location of the center of the wafer alignment microscope reference mark within the digitized video image. The wafer alignment microscope reference marks are located on a reticle within the wafer alignment microscope as shown below.
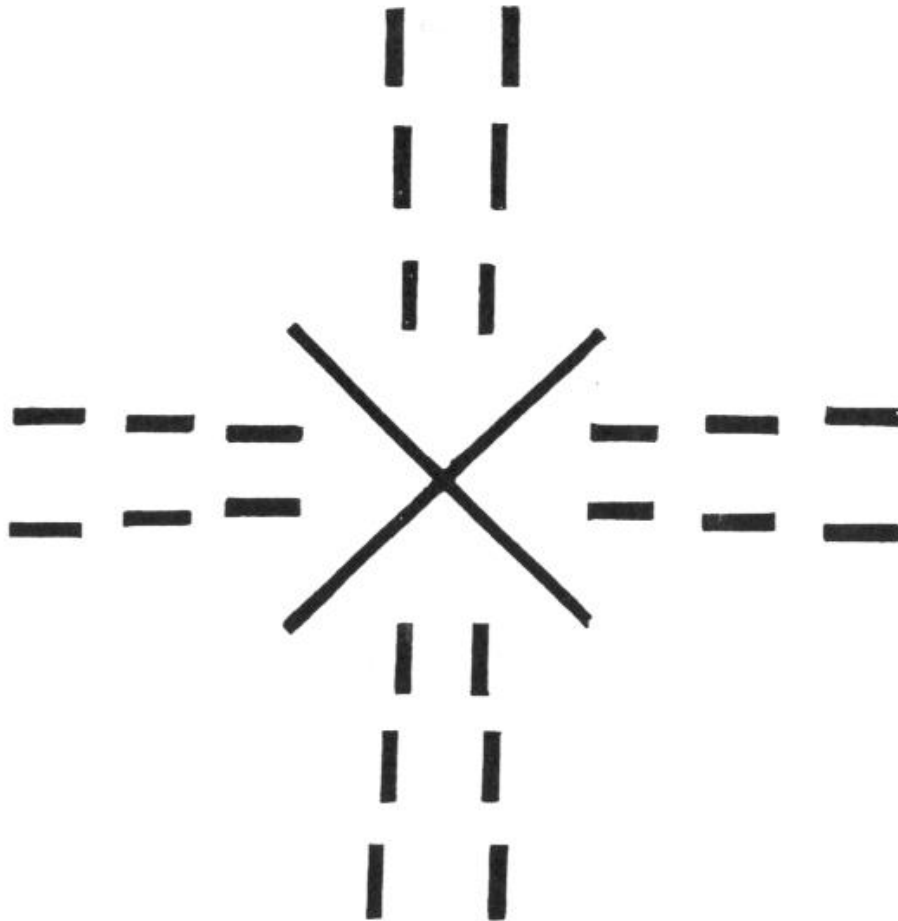

Figure 3.3 – Wafer Alignment Microscope Reference Mark

Fine Scan

A fine scan of the AWA/D is used to determine the precise location of the wafer alignment mark and the wafer alignment microscope reference mark by scanning the video image within two regions about the center of the alignment area. The wafer alignment microscope reference mark and the wafer alignment mark should be aligned well to each other after a successful fine scan as shown below.
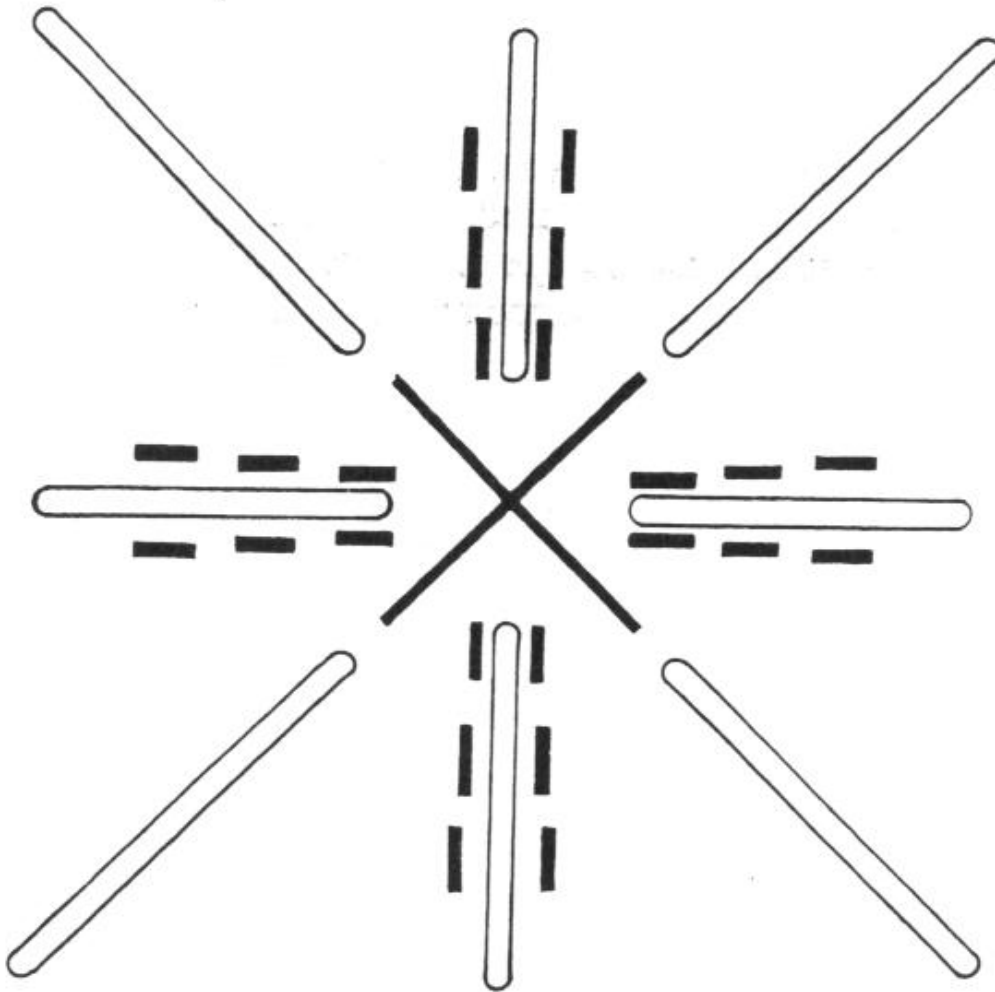
Figure 3.4 – Wafer Alignment Mark and Wafer Alignment Microscope Reference Mark Aligned after Fine Scan.

Section 3 – Local Alignment Systems
This section will be available in the future.

Section 4 – Alignment Target CAD Layout

Introduction

This section will provide the necessary information needed to create a reticle set. It will include specification and placement requirements for RMS alignment windows, global alignment targets, local alignment targets (future), and INSITU alignment targets.

Constant Reticle Perimeter Data

The constant reticle perimeter data will be consistent for all reticle sets generated for a specific configuration. The periphery data includes: RMS alignment windows, DFAS reticle windows, and INSITU alignment targets as shown below.
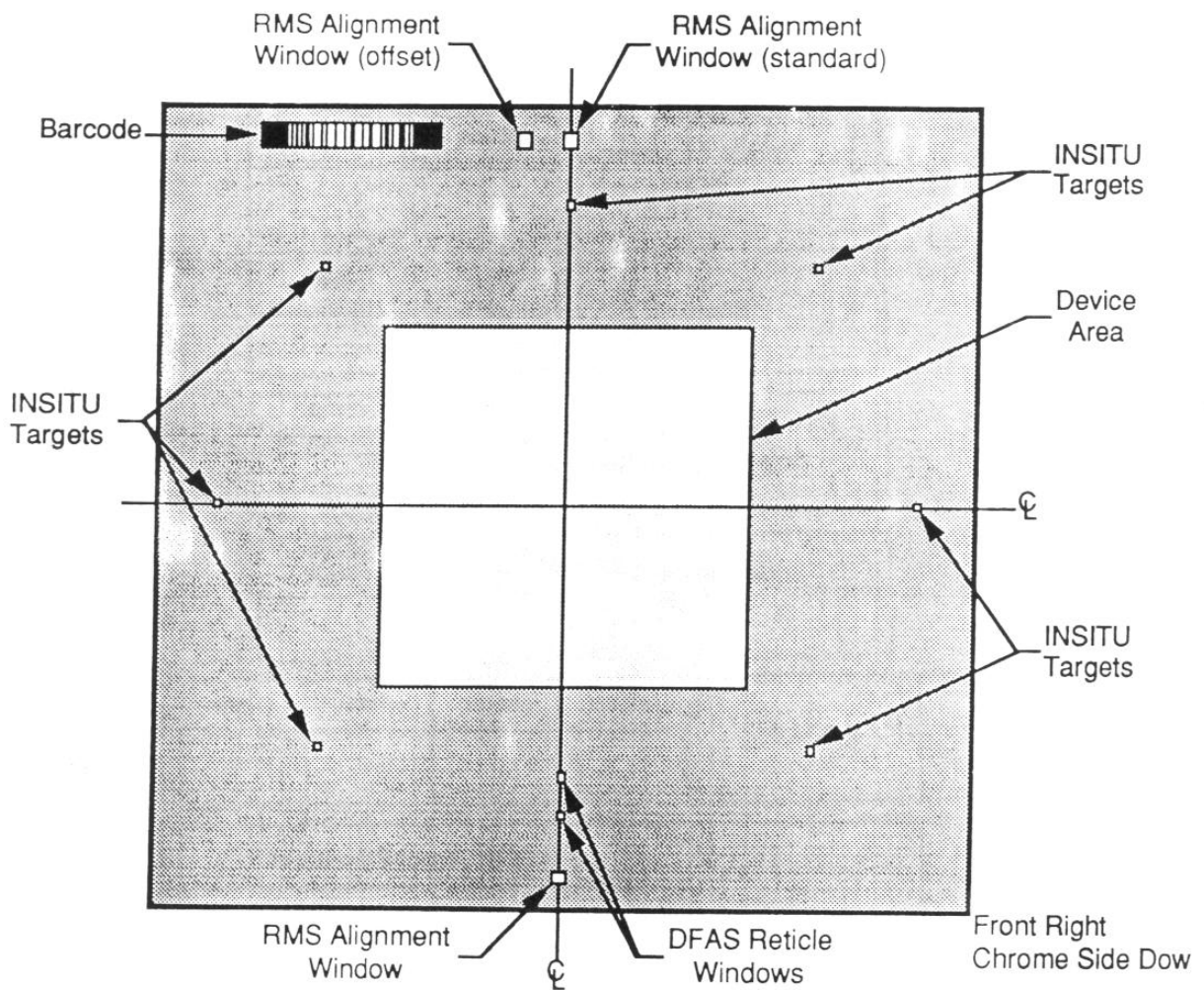

Figure 5.2 - Constant Reticle Perimeter Data

RMS Reticle Alignment Windows

The reticle alignment windows are used to align the reticle to the platen chuck of the wafer stepper system. The window phase is typically negative, which consists of a square hole in the chrome.

The reticle aligner assemblies in the platen casting observe the edge of the reticle alignment window in the chrome. When there is a balance of illumination in the fiducial between window and chrome at the top and bottom of the reticle, the reticle is considered to be aligned as shown below.
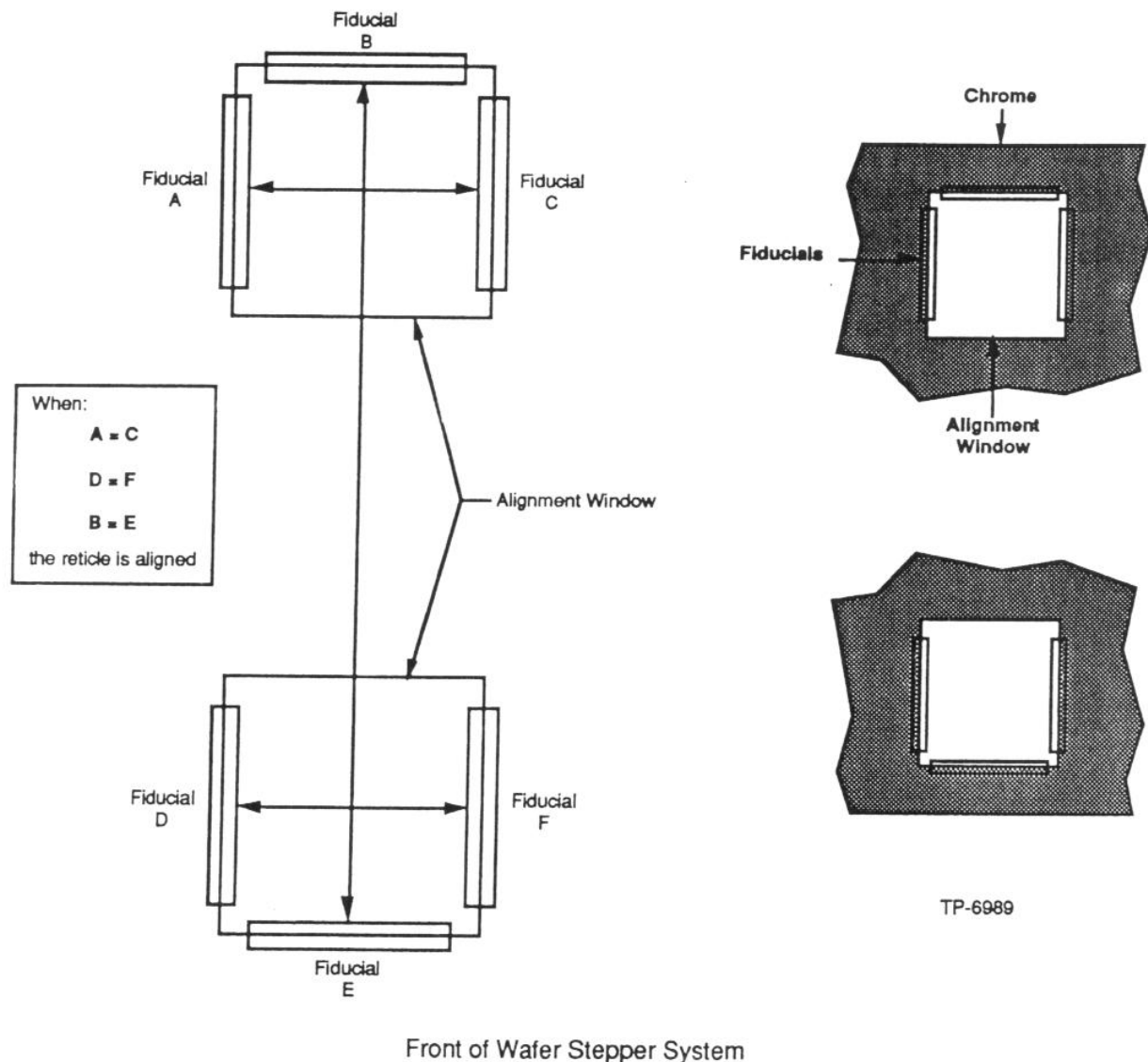

Figure 5.3 – Alignment of a Negative Phase Reticle

The offset alignment window option is offered to eliminate interference problems in the manufacture of reticles. One of the fiducials is offset from center by 11mm, removing possible pattern generation interferences.

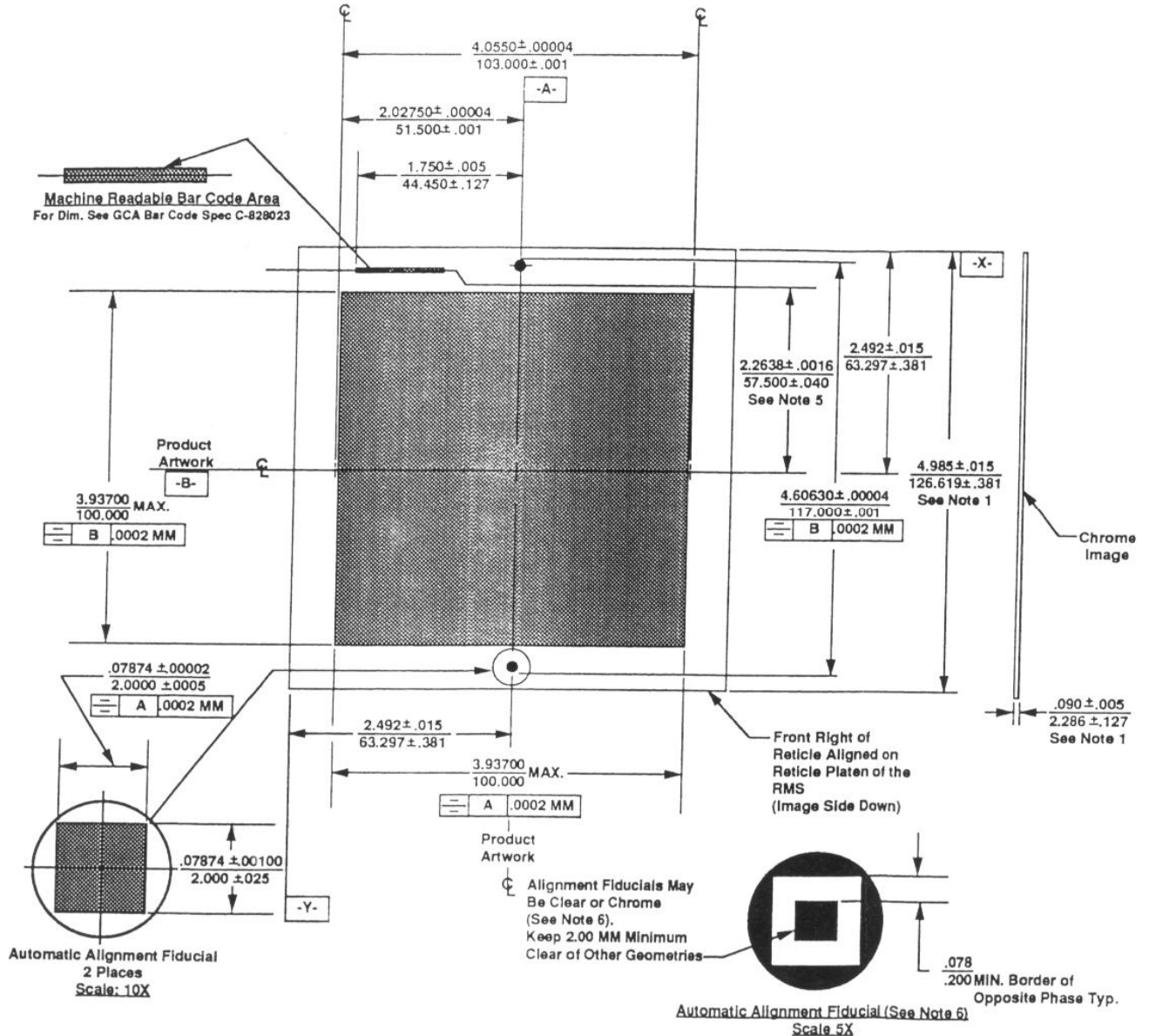The location and dimensions for RMS alignment marks should comply with the figure below.

Figure 5.4 – Standard Reticle Artwork Location and Dimensions.

INSITU Reticle Alignment Target Placement Specification

To ensure optimum overlay, it is important that the alignment of the product reticle in relation to the previous alignment of the calibration reticle be determined accurately. In order to achieve this, upon completion of the reticle loading and the alignment by the RMS, the alignment strategy uses INSITU to accurately determine the product reticle position by aligning to the INSITU reticle windows located at fixed positions on the product reticle.

The location and dimensions of the INSITU reticle windows should comply with the figures below.
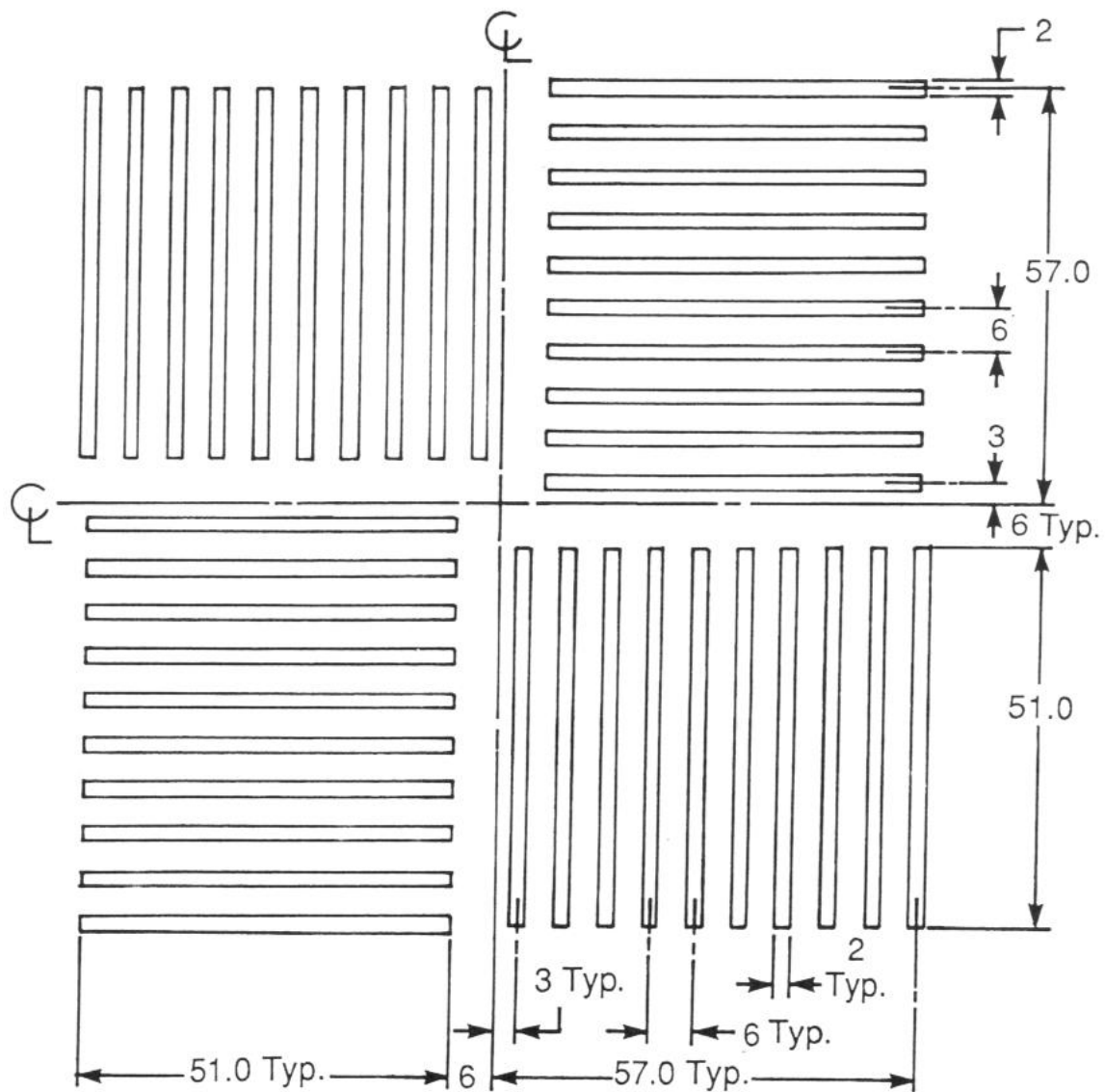

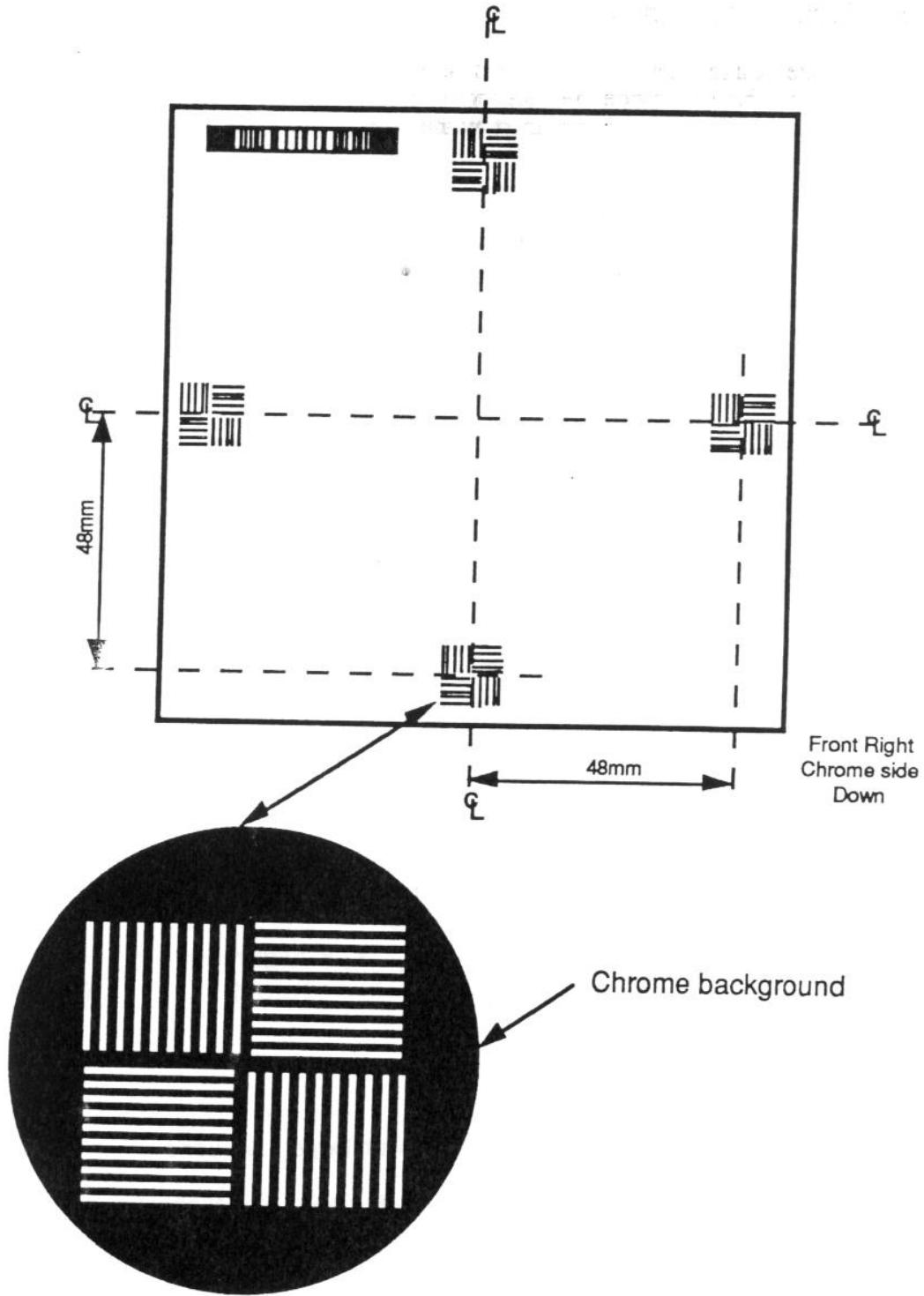Figure 5.11 – DFAS Reticle Alignment Window

Figure 5.12 – INSITU Reticle Window Locations

Alignment Target Placement Strategy

There are two alignment techniques which are available on the wafer stepper system, they are: Global, which is performed manually or automatically by the AWA/D, and local (will be discussed in the future) which is performed by the Micro DFAS.

The alignment marks are to be placed above your device area in a 200 micron scribe street. The 1st mark will be placed at the upper right, and the 2nd mark will be placed at a determined offset left of the 1st mark.

Global Alignment

By aligning 2 global alignment marks on either side of the wafer for X, Y and theta, total overlay may be achieved for less critical alignments as shown in the figure below:
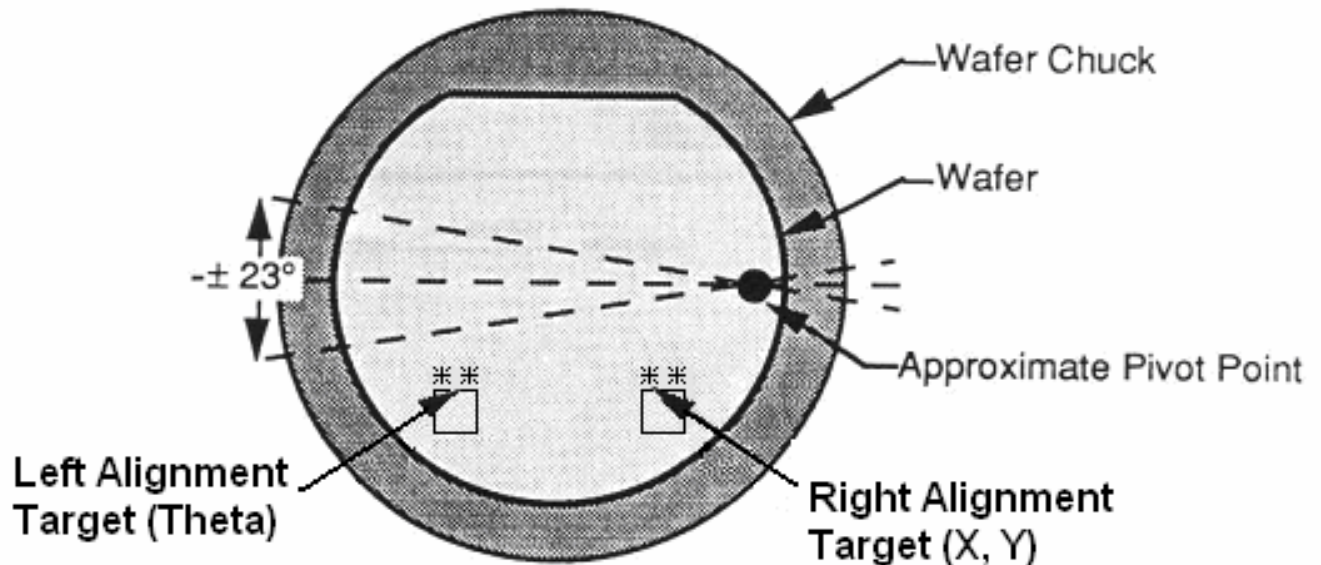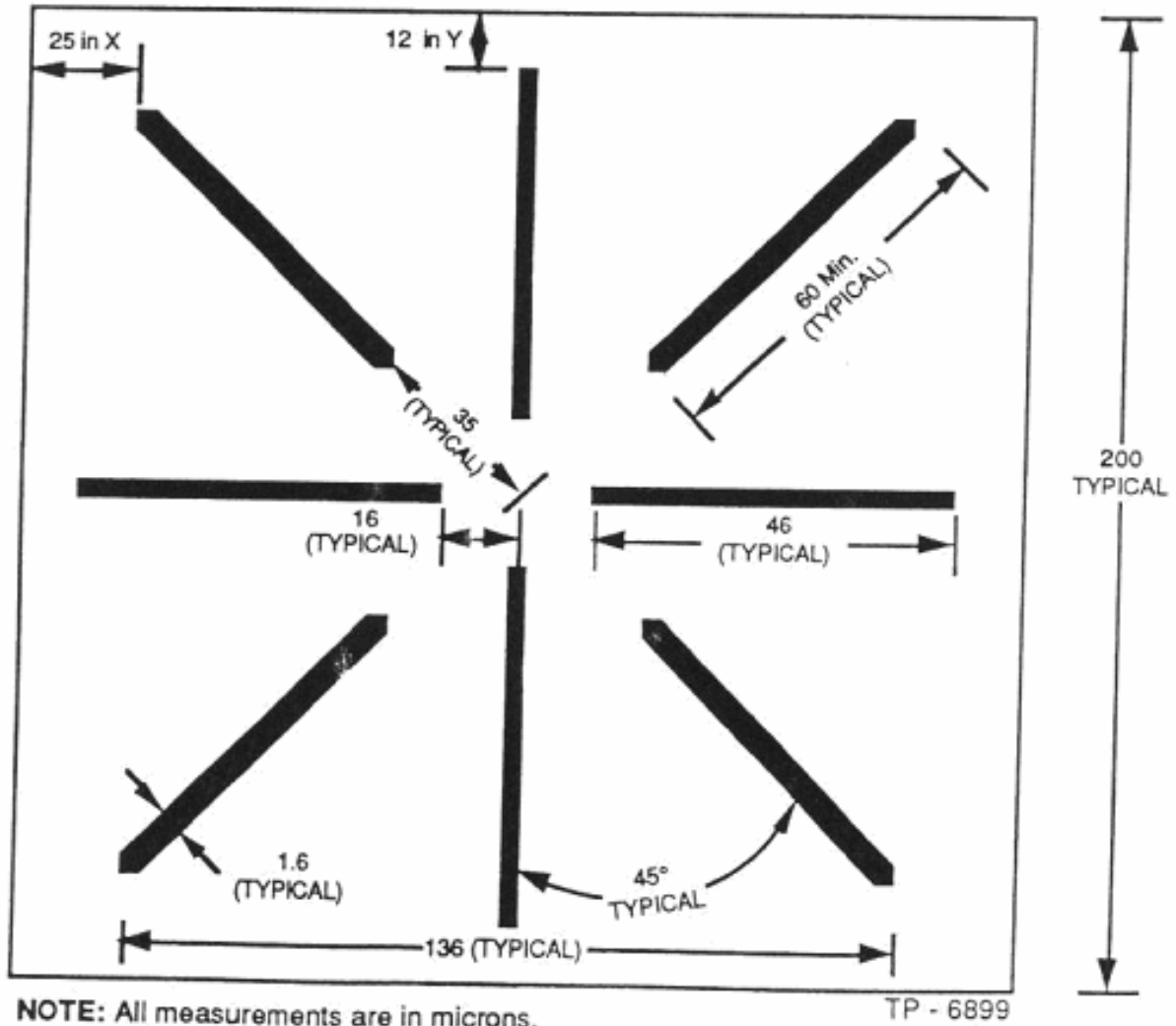

Figure 5.13 – X, Y-axis and Theta Wafer Alignment Target Locations

The global alignment target is used to align the entire wafer during the global alignment process. The marks located at 45 and 135 degree are used for the automatic global alignment performed by the AWA/D while the 90 and 180 degree marks are typically used during manual operator alignment. The global alignment target shown below is a typical target used for either manual or automatic wafer global alignment.

NOTE: All measurements are in microns.

NOTE: Minimum separation distances of 25 microns in the X-axis, and 12 microns in the Y-axis between the ends of the target lines and any other geometries.

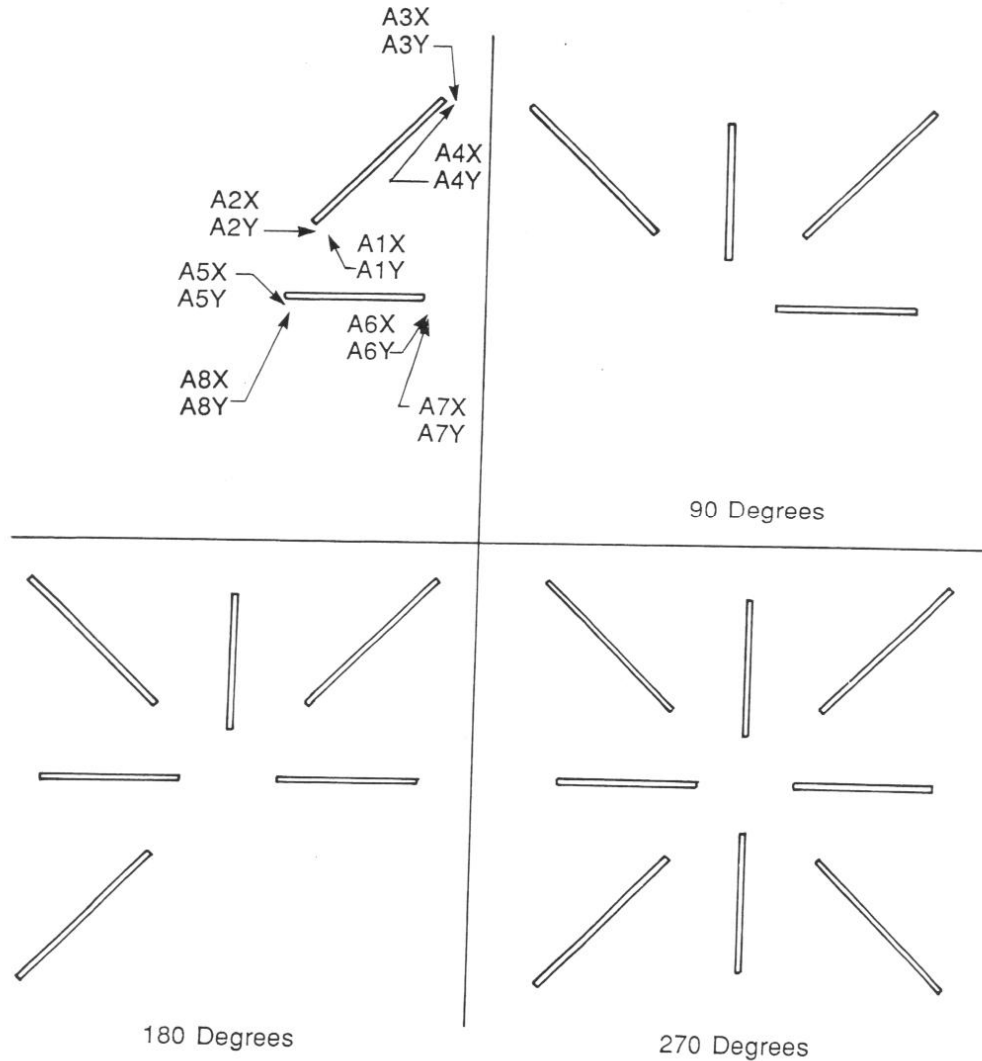Figure 5.20 – Typical Wafer Alignment Target for Operator or AWA/D

Figure 5.29 – Global Alignment Target

The design of the wafer alignment target is critical to optimize the use of the target as shown in the figure above. The following includes guidelines that should be followed when designing wafer alignment marks:

- Line width of target should be 1.0 to 2.4 microns (1.6 is standard)
- Maintain a minimum separation of 25 microns in the X-axis and 12 microns in the Y-axis between the ends of the target lines and any other geometry.
- The AWA/D aligns better to solid targets rather than hollow targets.
- Positive and negative phase targets may be used however, depending on the process level, the target that provides the best optical contrast is preferred.

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The spacing of the alignment target in the wafer alignment microscope is fixed at 76.2mm.

If you only use one alignment target on your level for stepping, it would not generate the necessary 2 alignment keys at 76.2mm apart. For example, if your step size was 11mm, as shown below, the alignment targets would fall at 0, 11, 22, … , 66, 77mm, none of them would fall at 76.2mm.
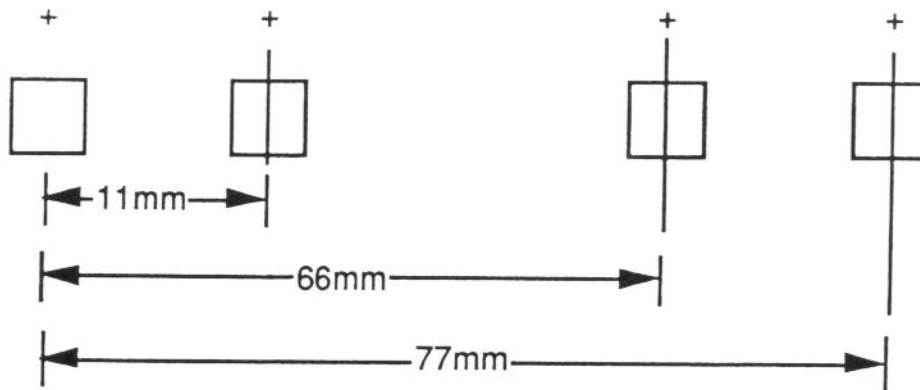

Figure 5.21 – Alignment Target Spacing Example

At first it would appear that the only way to get your alignment target to fall at 76.2mm is to step only in stepping distances that can evenly be divided into 76.2mm, which is unacceptable. The solution is to add a 2nd alignment target in your design slightly offset from the 1st alignment so that the 2nd target will fall 76.2mm from your first target. For example, if in the case above we add a 2nd alignment target at 0.8mm left of the first, there is an alignment target located exactly 76.2mm apart.
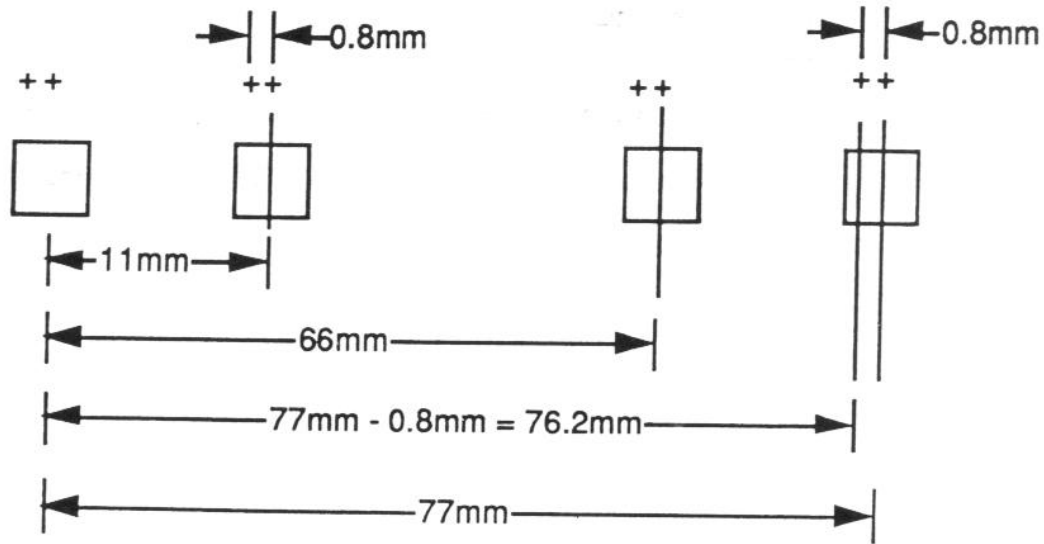
Figure 5.22 – 2nd Alignment Target Example

The procedure can be generalized in a few simple equations. To determine the correct offset for the 2nd alignment target from the 1st target, use these equations:

Formula 1:
[76.2mm / Step Distance (mm)] = X

X has a whole integer, and a decimal remainder.

Formula 2:
Step distance – (Remainder x Step Distance) = the 2nd alignment target offset to the left of the 1st alignment target

The following is an example of a Global Alignment Target Cell with all levels, and a break down of each level.

Please note: If your step size divides almost evenly into 76.2mm, you will have limited space to place alignment targets. If this is the case, you may choose to adjust your step size so that it does divide exactly into 76.2mm evenly.
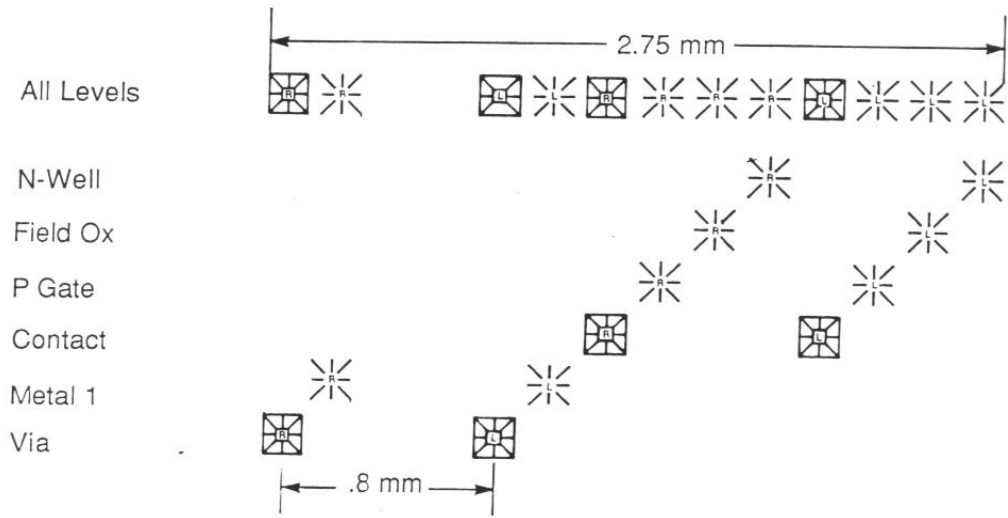
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Figure 5.32 – Global Alignment Target Cell Example with Breakdown Descriptions