Product Documentation

CONFIGURATION

SYS	:	PAS5500 series, TWINSCAN series
HW	:	6 Inch reticles for 4x and 5x demagnification
SW	:	n.a.

Order Code
50163

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Final

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Reticle Design Manual

6 Inch reticles

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- The issue date
- The ordering code number
- The page number, chapter or part number
- Your comment
- A description of any errors
- A proposal of any improvements.

Thank you for your support.

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PREFACE

Note

Please note that with the introduction of this manual the reticle design specifications of previous releases of the Reticle Design Manual are not valid anymore.

This manual gives a description of the layout requirements for reticles used in the 6-inch reticle versions of:

- The PAS 5500 wafer steppers
- The PAS 5500 Step & Scan models
- The TWINSCAN models.

Also described in this manual are:

- The areas which can be used for identification of the reticle.
- The pellicle specifications for the various reticles.
- The defect specifications for the various reticle patterns.
- The release pin areas.

Note

Any deviation from the positions or dimensions described may cause damage to, or malfunctioning of the system.

A Calma GDS2 description, in STREAM format, of all the reticle layers of different systems, the TIS mark set and typical alignment marks is available on ASML CustomerNet.

For additional help with reticle patterns, please contact your local ASML sales office.

IMPROVEMENTS

With reference to the previously released Reticle Design Manual (50163 issue 2.0) this manual contains the following improvements and changes:

- The section that describes the Bar Code (see “Bar code” on page 39) is improved.
  - An error in the example of Figure 3.12. was corrected. (please note that the actual bar codes did not change, only the example “A”)
  - The text in the Bar Code section and Figure 3.14 did not match. Therefore it was not clear how to position the bar code on the reticle. The text is now in line with Figure 3.14 and Figure 3.13 is added for additional clarification.

With reference to the previously released Reticle Design Manual (50163 issue 1.1) this manual contains the following improvements and changes:

- Section on vertical TIS_RSC mark use is updated.
- The 2D Barcode option is incorporated into the manual.
- The manual is updated for the support of XT:1700i and XT:1900i.
- A specification for image rotation on 5x reticles is added.
- Some drawings/illustrations are added/improved for more clarity.
- Some parts of the text are improved for more clarity.
- In chapter 8 some tables were misplaced. This is corrected.

I

RETICLES FOR 4X REDUCTION

A DESCRIPTION OF THE LAYOUT OF 6 INCH RETICLES USED IN:

- THE PAS 5500/3X0 WAFER STEPPER
- THE PAS 5500 STEP & SCAN MODELS
- THE TWINSCAN MODELS.

1

DEFINITIONS OF TERMS AND CONCEPTS

To avoid confusion, some terms and concepts are defined in this chapter. These definitions only apply to this manual.

INTRODUCTION

In addition to the product image, the reticle must always have a number of additional patterns to ensure the correct operation of the ASML system. There are patterns to support the:

- Alignment of the reticle to the reticle table
- Alignment of the reticle to the wafer
- Handling of the reticle.

In this part of the manual the locations and dimensions of these patterns are described for 6 inch reticles that support systems with 4x reduction. These systems are:

- The PAS 5500/3x0 wafer steppers.
- The PAS 5500 Step & Scan models.
- The TWINSCAN AT/XT and PAS 5500 Step & Scan models equipped with a Reticle Blue Alignment system.

Also described in this part of the manual are:

- The areas which can be used for further identification of the reticle.
- The pellicle specifications and the default specifications for the various reticle patterns.
- The release-pin areas.

CAUTION

Any deviation from the locations or dimensions described may cause damage to, or malfunctioning of, the system.

A Calma GDS2 description, in STREAM format, of all the reticle layers of different systems, the TIS mark set and typical alignment marks is available on ASML's CustomerNet.

For more help with reticle patterns, please contact your local ASML sales office.

Note

All figures showing reticle layout and pattern details are viewed through the glass, chromium side down. All dimensions in the figures are in micrometers (μm), unless stated otherwise.

THE DEFINITION OF A LOCATION ON A RETICLE

Sometimes terms as top/bottom, left/right, horizontal/vertical, upper/lower are used to describe the location of features on a reticle. In Figure 1.1 these sides are indicated.

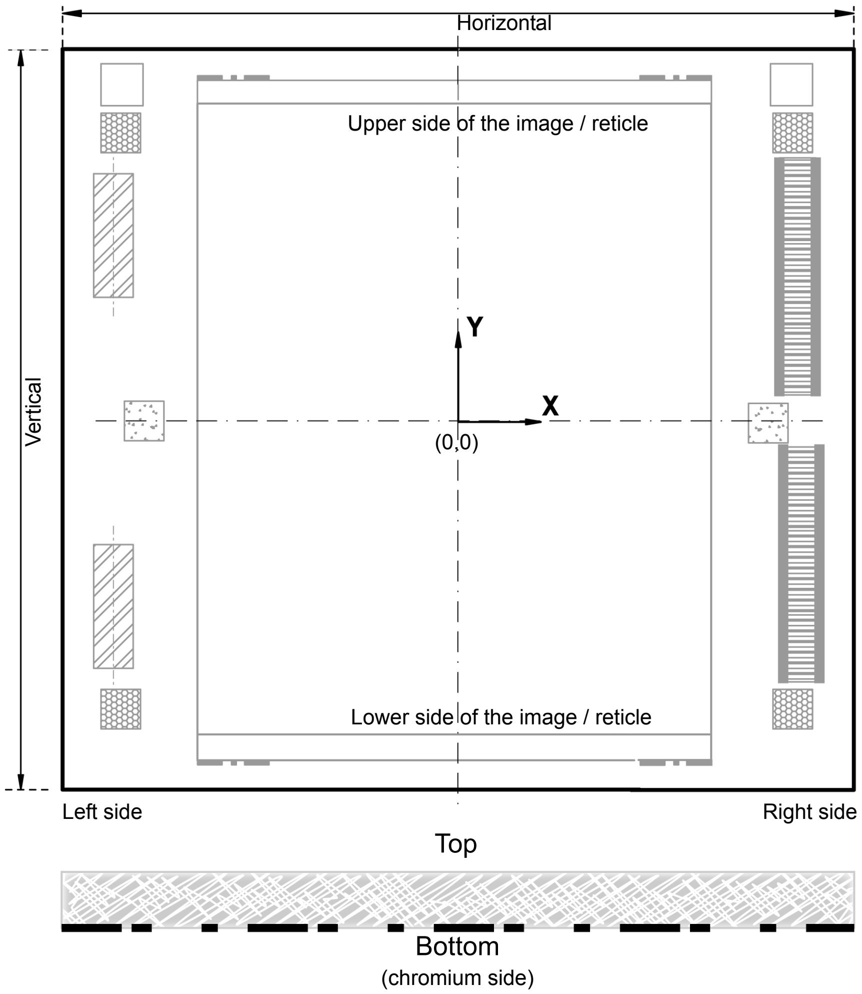


Figure 1.1 Definition of locations on a reticle

RETICLE LAYOUT AND ORIENTATION

Figure 1.3 shows the schematic layout of a 6- reticle. This figure gives an overview of all possible reticle patterns. The machine type (or types) on which the reticle is to be used, determines which patterns must be included on the reticle. The location of each possible reticle pattern is shown.

The point S is the center of the substrate. This is defined as 76 mm ± 0.5 mm from the left and bottom edge of the substrate.

The point R is the center of the reticle layout, and must be positioned within a window of 1.0 mm^2 around the substrate center (S). The rotation of the reticle layout around the reticle layout center R, with reference to the lower side of the substrate, must be less than 3.3 mrad. The point R is the zero (X and Y) reference for the location of each pattern on the reticle.

The location of each reticle pattern is defined by the location of the center of the pattern with reference to the reticle layout center (R).

Figure 1.2 shows the relationship between the reticle and wafer coordinate system. There is a four times reduction from the reticle to the wafer, and the image is inverted over the X and Y axes.

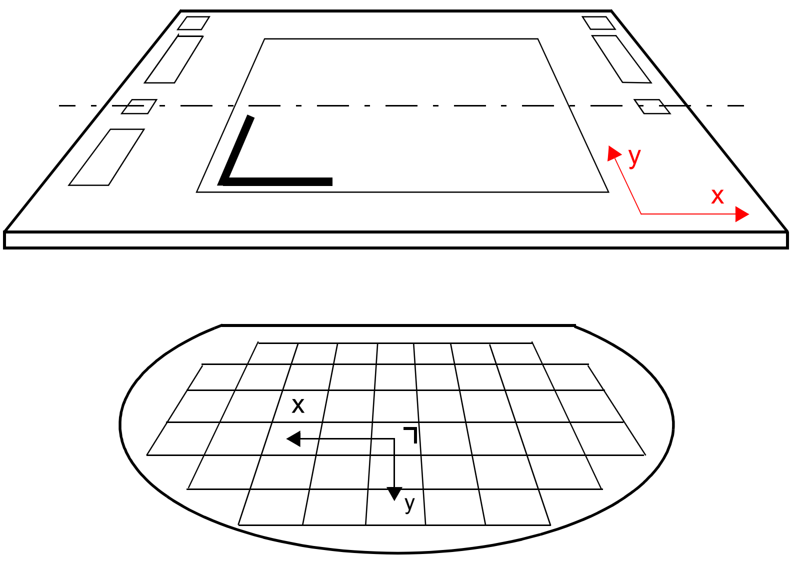
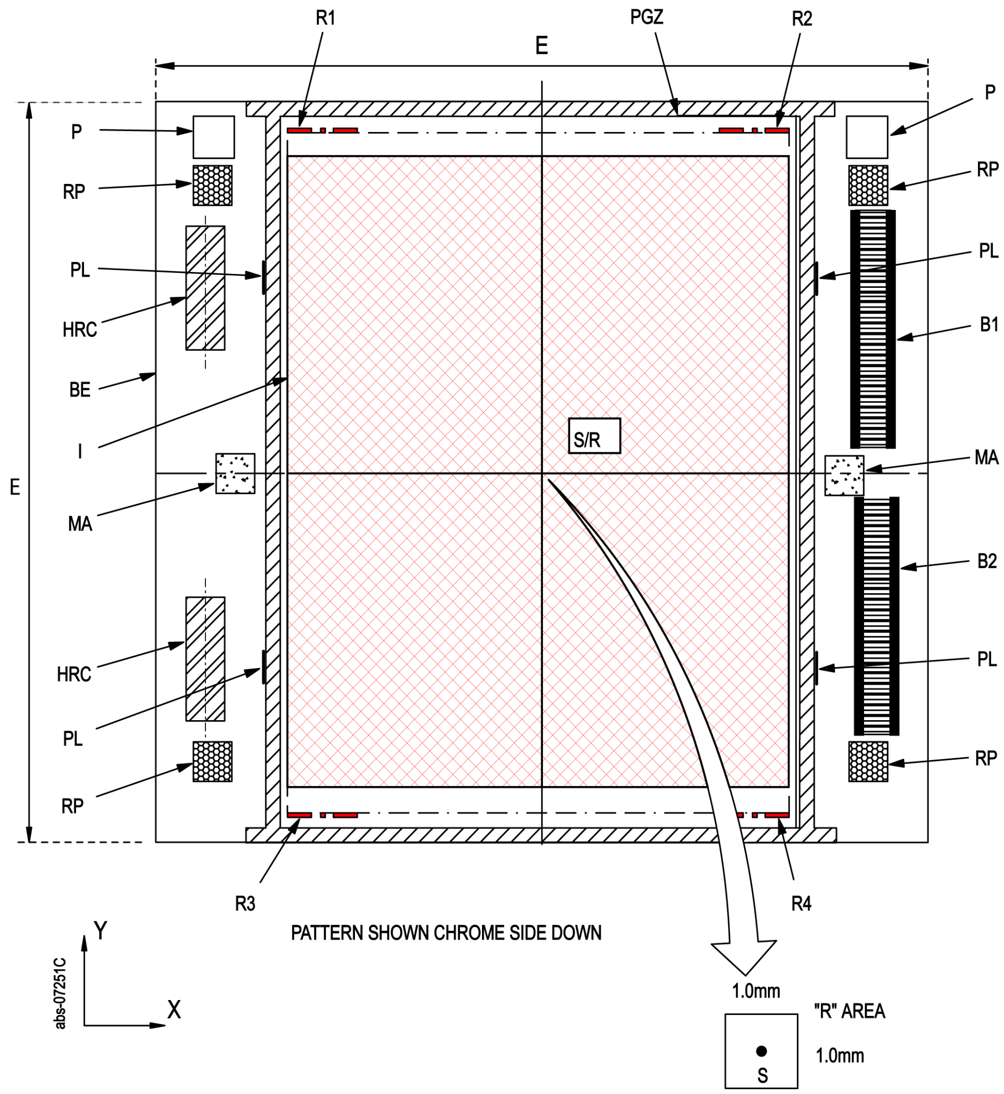


Figure 1.2 Relationship between reticle and wafer coordinate system



B1	Bar code area	**BE**	Bevelled Edge
B2	Additional barcode area for 24 character barcode (optional)	**PL**	Pellicle position line
E	Edge length of the reticle (6” = 152.4 mm)	**R**	Center of reticle layout
HRC	Human Readable Code	**RP**	Release Pin area
I	Image field	**S**	Center of substrate
MA	Reticle alignment mark (PAS 5500 only)	**PGZ**	Pellicle Glue Zone
P	Reticle prealignment mark	**R1-R4**	TIS mark

Figure 1.3 Schematic layout of a 4X reduction reticle for Step & Scan systems

THE DEFINITION OF CHROMIUM BORDER

All patterns need to be surrounded by a chromium area to avoid interference from other patterns. So different reticle patterns cannot be placed contiguous on the reticle. There always needs to be a certain space between the patterns. This space is called the chromium border. So each pattern on the reticle has, by definition, a chromium border.

However to save reticle space, two different patterns can be placed on the reticle in such a way that their individual chromium borders overlap.

There is one reticle pattern, the TIS mark, that has an additional specification for part of its chromium border. We can distinguish two distinctive areas in the chromium border of a TIS mark. These areas are:

1. The **compulsory** chromium border. This area only applies to the individual TIS-mark components (see also Figure 1.4). This compulsory chromium border is the area round the individual gratings of a TIS mark in which no other features are allowed.
2. The **required** chromium area (border) around the TIS mark.
   The complete TIS mark again must be surrounded by a chromium area. (See Figure 1.4). Note that this specification is especially important for phase-shift reticles.

   For all types of reticles applies that in this required chromium area some features can be allowed, but only if the total transmission in that area does not exceed 15%.

   For more details see See “TIS marks for Reticle Blue Alignment” on page 25.

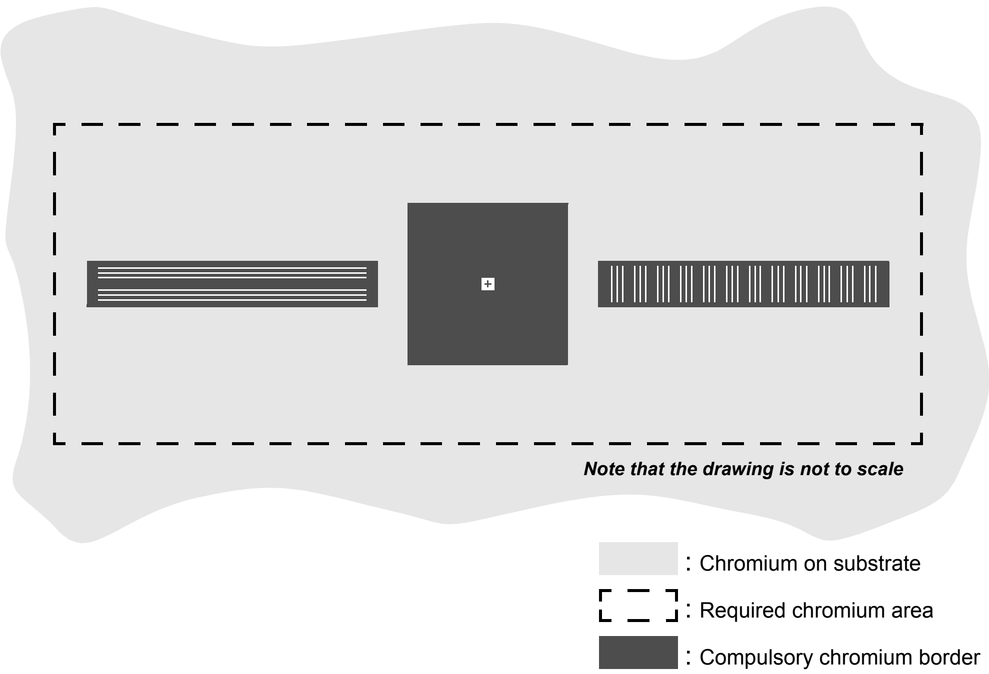


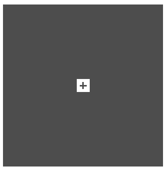
Figure 1.4 ***Chromium borders for TIS marks***

The size of the required chromium area is specified in Chapter 3.

NAME CONVENTIONS FOR TIS MARKS

The different parts of a TIS_RBA mark are referred to as:

- Tr mark or Ratio mark

  The center of the Tr mark is the center of the TIS mark, and indicates the position of the mark on the reticle.
- Tyh and Txh mark

  – The T indicates that the mark is a TIS mark
  – The x or y indicates the scan direction of the TIS sensor
  – The h indicates the orientation of the TIS mark on the reticle

2

GENERIC INFORMATION ON RETICLE DESIGN

RETICLE SUBSTRATE SPECIFICATIONS

The specifications for the reticle substrate must meet SEMI standard P1-1101 for Hard Surface Photomask Substrates. The tolerances on reticle dimensions are according to SEMI standard P1-1101.

The generic specifications for reticles are:

Nominal edge length The nominal edge length is 6-inch (152.40 mm). The nominal edge length is defined as the edge length you want to design to.

> **Note**
>
> The nominal length of 152.40 mm is also the maximum edge length.

Recommended thickness The recommended thickness for reticles is 0.250 inch (6.35 mm).

> **Note**
>
> The recommended thickness is mandatory for reticles that are to be used on TWINSCAN systems.

Optional thickness For reticles that are only to be used in PAS 5500 systems additional reticle thickness values are optional. These values are: 0.150 inch (3.81 mm), or 0.120 inch (3.05 mm)

Substrate type Ultra low thermal-expansion quartz.

Recommended reticle flatness Stepper: 1 μm (1T); total indicated range over square quality flatness area.

Step & Scan: 0.5 μm (0.5T); total indicated range over square quality flatness area.

Chromium layer density Optical density OD3 is recommended.

The birefringence of the substrate

To enable the use of polarized light for imaging, the optical properties of the reticle substrate must be in line with the requirements of the imaging application.

ASML advises to use substrate material that has a birefringence of less than 5 nm/cm.

> **Note**
>
> If you are not completely clear on the complex topic of birefringence please contact ASML's Application Support before a reticle design is transferred to a mask shop.

Phase Shift Mask (PSM) reticles

Reticle patterns outside the image field must be located in a chromium area. This applies to PAS 5500 models and TWINSCAN models.

These reticle patterns are:

- The bar code(s)
- The reticle prealignment marks
- The reticle alignment marks.

RETICLE COMPATIBILITY

This section describes the compatibility of reticles between different machine types. In principle, each machine type has a corresponding reticle that contains the minimum set of reticle patterns, and has specific characteristics for the correct operation of that particular machine type. By combining different reticle patterns, reticles can be made compatible for different machine types. This compatibility is shown in Table 2.1. The primary machine type for the reticle is shown horizontally. The corresponding machine types for which the reticle can be made compatible are shown vertically. The cells contain the required modifications to the specification of the basic reticle of the primary machine type.

Table 2.1 Reticle compatibility matrix

Matched tool \ Primary tool	PAS 5500/3x0	PAS 5500 Step & Scan equipped with TTL alignment	TWINSCAN and PAS 5500 equipped with Reticle Blue Alignment (TIS marks mandatory)
PAS 5500/3x0	PAS 5500/3x0 reticle	PAS 5500/3x0 reticle layout – R-pin areas – Enlarged image border (pellicle frame dimensions PAS 5500 /3x0) – Pellicle film compatibility (DUV - i-line)	Not supported
PAS 5500 Step & Scan equipped with TTL alignment	PAS 5500 Step & Scan reticle layout – pellicle frame dimensions/3x0 – pellicle film compatibility (DUV - i-line)	PAS 5500 Step & Scan reticle	TWINSCAN layout – MA marks – R-pin areas
TWINSCAN and PAS 5500 equipped with Reticle Blue Alignment (TIS marks mandatory)	Not supported	PAS 5500 Step & Scan reticle layout – TIS marks – Pellicle frame dimensions of TWINSCAN models	TWINSCAN reticle layout

Notes

– Always check for compatibility of the field sizes.
– DUV-193nm pellicle films are **not** compatible with i-line and DUV-248nm exposure wavelengths.

For the exact location of the reticle patterns, see Chapter 4 on page 51.

CONTAMINATION AND DEFECTS

The reticle patterns used for alignment and identification are normally not inspected for contamination or defects. However, too many defects can affect the accuracy of the alignment system and cause bar code reader errors. It is therefore important that these reticle areas are also inspected.

The alignment system and bar code reader are affected by the total defect area. The number of defects is based on what can generally be expected from the maximum number of defects/area in these regions, together with the stepper specifications.

Bar code

The bar code consists of alternating bright and dark lines 5000 μm long. The width of the lines is either 200 or 450 μm. The only error which can occur due to defects is that the bar code reader does not correctly interprets the actual width. This can cause a wrong or even failed reticle identification.

No defects larger than 30 μm are allowed in the bar code area. This is including the quiet zones at the start and end of the bar code.

Reticle prealignment mark

The registration of this mark is based on the intensity variation between the four quadrants of a quad cell. The mark has a four-fold symmetry. A defect in one of the quadrants can result in an intensity difference. When this happens it can cause an erroneous shift in the measured location.

No defects larger than 10 μm are allowed in the prealignment mark. This is including the chromium border of the mark.

Reticle alignment mark

The principle of this alignment is scanning the images of two gratings (reticle and wafer) over each other. The sine wave intensity is measured, and is related to a stage location. The reticle grating has a 32 μm period and the lines are 640 μm long for each direction. The scan uses 20 periods in the reticle grating. Defects may cause a shift in the apparent line location and, therefore, a shift in the center of gravity of the grating. This results in a shift in the alignment location.

No defects larger than 3 μm are allowed in the 32 μm period areas including the chromium border.

RETICLE DATA FILES

The possible reticle patterns and layouts for each system with 4x reduction are described in so called GDS files. These files can be downloaded from Customer Net.

The 4X data is stored in GDS files in STREAM format, with these filenames:

- 5500-300.gds
- 5500_scanner.gds
- AT.gds

Each GDS file contains five layers:

Layer 0: Prealignment marks (mark design and location)
Layer 1: Reticle alignment marks, MA and/or TIS (mark design and location)
Layer 2: Pellicle location lines (standard design, location and orientation)
Layer 3: Borders of all reticle patterns
Layer 4: Wafer mark layouts (4X) (see Table 2.2 on page 16).

The combination of layers 0, 1 and 2 give the standard layout. Layer 3 can be used to verify whether, for example, titles and bar codes are within the specified areas.

Table 2.2 location of wafer marks (4X) in GDS layout

Name in GDS file	ASML name	X location	Y location	Rotation	Mag.
Y_450_2355_2	XPA-XS	-11680	23360	0	0.8
Y_450_2353_2	XPA-YS	11680	23360	0	0.8
Y_450_2404_1	SPM-XS	-11680	11680	0	0.8
Y_454_2017_1	XPA-S	0	11680	0	0.8
Y_450_2403_1	SPM-YS	11680	11680	0	0.8
Y_450_2401_1	SPM-Y	11680	-11680	0	0.8
Y_454_2016_2	XPA	0	-11680	0	0.8
Y_435_7693_1	PM	0	0	0	0.8
Y_450_2402_1	SPM-X	-11680	-11680	0	0.8
Y_450_2354_2	XPA-X	-11680	-23360	0	0.8
Y_450_2352_2	XPA-Y	11680	-23360	0	0.8
Y_455_5937_1	TIS set TIS patterns are paired R1 + R2 R3 + R4	0	Variable (see Figure 4.5 and Figure 4.10)	0	1.0

Additionally there is a file that contains the data for the TIS markers.

This file is called tis-set.gds.

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Reticle Database Format information

The Reticle Database Format can be used to:

1. Store general information about reticles.
   Storing the general information on General Performance has the advantage that it can be made visible in the ASML software when defining jobs or when service actions are required.
2. Store measured performance characteristics for reticles.
   Stored measured performance characteristics may be used automatically during batch processing.

Alignment marks:

- Measured xy-deviations from the nominal values may be corrected for automatically during alignment

Image:

- Measured deviations from nominal on translation.
- Rotation, Magnification, Asymmetrical Rotation and Asymmetrical Magnification may be corrected for automatically during exposure.
- Measured Transmission factor (open/close ratio) maybe used automatically for lens heating correction.
- Measured CD-imperfections maybe corrected automatically by specifying an energy offset

The extension of a file according to the Reticle Database Format must be .ret

Files according to the Reticle Database Format must be stored in:

PAS 5500: user_data/reticle_database/ret

TWINSCAN: To be defined

Typical usage

```
/* This file Contains the typical content of a Reticle Datafile     */
/* that will be used for production-reticles                        */
/* It shall be readable without errors                              */
/*                                                                  */
/* On input:                                                        */
/*   text between slashes & stars is ignored                        */
/*   spaces, tabs, linefeeds and carriage_returns are used          */
/*   as fieldseperator                                              */
/*   multiple spaces, tabs, linefeeds & carriage_returns are ignored*/
/*   string input shall be between double quotes: "string input"    */
/*   Keywords and enumeration-type words are CAPITAL              */
/* On output:                                                       */
/*   Ordering is as below                                           */
/*   Sections headers are as below                                  */
/* Supported Masks: "BIM"        Binary Mask                       */
/*                  "ALT_PSM_CR"  Alternating Phaseshift With Chrome*/
/*                  "ATT_PSM"     Attenuated Phaseshift             */
/*------------------------------------------------------------------*/
/*------------------------------------------------------------------*/
/* Reticle Data                                                     */
/*------------------------------------------------------------------*/
START_SECTION RETICLE
  USER_INFO                   "Comment line  1 MAX 44"
                              "Comment line  2 MAX 44"
                              "Comment line  3 MAX 44"
                              "Comment line  4 MAX 44"
                              "Comment line  5 MAX 44"
                              "Comment line  6 MAX 44"
                              "Comment line  7 MAX 44"
                              "Comment line  8 MAX 44"
                              "Comment line  9 MAX 44"
```

```
                                  "Comment line 10 MAX 44"
  TOOL_OF_MEASUREMENT             "LMS"
  TIME_OF_MEASUREMENT             "25:09:00 09:12:03"
  TIME_OF_FILING                  "30:09:00 10:11:59"
  RETICLE_ID                      "123456789AB"
  CLASS                           "PRODUCTION"
  TYPE                            "BIM"
  SIZE                          0.15200
  THICKNESS                     0.01000
  MAGNIFICATION                 4.00
  TRANSMISSION_FACTOR          49.05
  ENERGY_OFFSET              -166.00

  /*------------------------------------------------------------------*/
  /* Default Image section                                            */
  /*------------------------------------------------------------------*/
  START_SECTION DEFAULT_IMAGE
    ALIGNMENT_TYPE                  "RED"
    TRANSLATION_X                 0.0520
    TRANSLATION_Y                -0.0430
    ROTATION                      4.00
    MAGNIFICATION                 5.00
    ASYMMETRIC_MAGNIFICATION      6.00
    ASYMMETRIC_ROTATION           7.00
  END_SECTION

  START_SECTION DEFAULT_IMAGE
    ALIGNMENT_TYPE                  "BLUE"
    TRANSLATION_X                 0.0520
    TRANSLATION_Y                -0.0130
    ROTATION                      4.00
    MAGNIFICATION                 5.00
    ASYMMETRIC_MAGNIFICATION      6.00
    ASYMMETRIC_ROTATION           7.00
  END_SECTION
  /*------------------------------------------------------------------*/
  /* Alignment target section                                         */
  /*------------------------------------------------------------------*/
  START_SECTION MARK TYPE "MA"     NOM_POS -65.5000000   0.0000000
ACT_POS -65.5000000   0.0000000  END_SECTION
  START_SECTION MARK TYPE "MA"     NOM_POS  65.5000000   0.0000000
ACT_POS  65.5000000   0.0000000  END_SECTION
  START_SECTION MARK TYPE "MA"     NOM_POS -63.0000000   0.0000000
ACT_POS -63.0000000   0.0000000  END_SECTION
  START_SECTION MARK TYPE "MA"     NOM_POS  63.0000000   0.0000000
ACT_POS  63.0000000   0.0000000  END_SECTION
  START_SECTION MARK TYPE "TIS_TR" NOM_POS -43.6000000  68.5880000
ACT_POS -43.6000000  68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_XH" NOM_POS -35.6000000  68.5880000
ACT_POS -35.6000000  68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_YH" NOM_POS -51.6000000  68.5880000
ACT_POS -51.6000000  68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_TR" NOM_POS  43.6000000  68.5880000
ACT_POS  43.6000000  68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_XH" NOM_POS  51.6000000  68.5880000
ACT_POS  51.6000000  68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_YH" NOM_POS  35.6000000  68.5880000
ACT_POS  35.6000000  68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_TR" NOM_POS -43.6000000 -68.5880000
ACT_POS -43.6000000 -68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_XH" NOM_POS -35.6000000 -68.5880000
ACT_POS -35.6000000 -68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_YH" NOM_POS -51.6000000 -68.5880000
ACT_POS -51.6000000 -68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_TR" NOM_POS  43.6000000 -68.5880000
ACT_POS  43.6000000 -68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_XH" NOM_POS  51.6000000 -68.5880000
ACT_POS  51.6000000 -68.5880000  END_SECTION
  START_SECTION MARK TYPE "TIS_YH" NOM_POS  35.6000000 -68.5880000
ACT_POS  35.6000000 -68.5880000  END_SECTION

END_SECTION
Minimal usage
This sample illustrates the MINIMAL amount of data that needs to be included in order to be able to read
the system. The use of a file like this is limited since only some general identification data is made
available.
-------------------------------------------

/*------------------------------------------------------------------*/
/* Sample File info: Product Reticle Minimal content                */
/*                                                                  */
/* This file contains the minimum readable version for              */
/* production reticles.                                             */
/* (usage of this file is low, no information at all is included)   */
/* It shall be readable without errors                              */
```

```
/*                                                              */
/* On input:                                                    */
/*   text between slashes & stars is ignored                    */
/*   spaces, tabs, linefeeds and carriage_returns are used      */
/*   as fieldseperator                                          */
/*   multiple spaces, tabs, linefeeds & carriage_returns are ignored*/
/*   string input shall be between double quotes: "string input"   */
/*   Keywords and enumeration-type words are CAPITAL          */
/* On output:                                                   */
/*   Ordering is as below                                       */
/*--------------------------------------------------------------*/

/*--------------------------------------------------------------*/
/* Reticle Data                                                 */
/*--------------------------------------------------------------*/
START_SECTION RETICLE

  /*------------------------------------------------------------*/
  /* General information section                                */
  /*------------------------------------------------------------*/
  TIME_OF_FILING                   "30:09:00 10:11:59"

  /*------------------------------------------------------------*/
  /* General reticle properties section                         */
  /*------------------------------------------------------------*/
  RETICLE_ID                       "123456789AB"
  CLASS                            "PRODUCTION"

END_SECTION
```

DATA FILES ON WAFER ALIGNMENT MARKS

All wafer alignment mark-designs are also available in GDS format. The wafer alignment marks are described in the Wafer Mark Manual which is available on CustomerNet.

Marks dimensions given in the ASML GDS file are leading.
All available GDS mark/clearout files are available on ASML CustomerNet.

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Note

For additional information on alignment mark designs and how to

prevent grid-snapping problems please refer to the Application Note on the topic. This Application Note can be found on Customer Net

3

RETICLES PATTERNS (4X REDUCTION)

SUMMARY

For correct operation a number of reticle patterns with special characteristics is necessary on each reticle.

These reticle patterns are:

- Patterns to support the alignment of the reticle in the system:
  - Reticle prealignment mark
  - Reticle alignment mark (PAS 5500)
  - TIS marks for Reticle Blue Align (RBA)
  - TIS marks for Reticle Shape Correction (RSC). Note that this is a TWINSCAN option.
- Patterns for handling the reticle
  - Bar code(s) for the system to identify the reticle
  - Pellicle location lines to correctly place the pellicle on the reticle
  - Human Readable code to identify the reticle when it is not in the system
  - Release pin (R-pin) area. Special chromium-free areas to handle the reticle in the system. These areas must be chromium free to minimize the possibility of chromium contamination after repeated handling.

Note that from each pattern there can be more than one necessary on a single reticle. For detailed information see the following sections.

Additional to the reticle patterns mentioned above, there is the image field. Like all other patterns on the reticle, also the image field requires a chromium border.

Because the chromium border for the image field has a great influence on the reticle design it is also discussed in detail in this manual.

Note that the required chromium border for the image field depends strongly on the system configuration. (see section: Image Border (page 35)).

RETICLE PREALIGNMENT MARK

The reticle prealignment mark (P) is a star-shaped pattern (see Figure 3.1) that is found twice on the reticle.

These marks are used by the Reticle Handling subsystem to prealign the reticle on the reticle table. The marks should be clear on a dark (chromium) background.

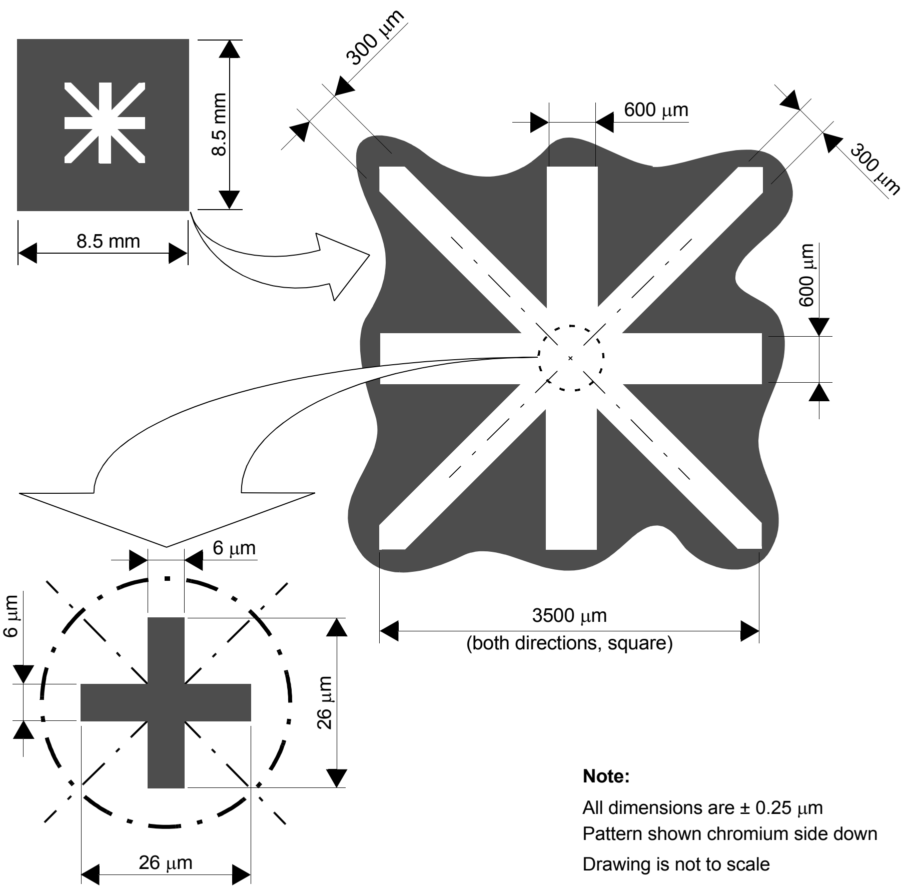

Figure 3.1 The reticle prealignment mark

The chromium border for the prealignment mark must be an area of at least 8.5 mm x 8.5 mm centered around each prealignment mark. The chromium cross in the center of the prealignment mark can be used for inspection with an optical metrology tool.

For the locations of the mark on the reticle, see section: Reticle Layout (4x reduction) (page 51).

RETICLE ALIGNMENT MARK FOR PAS 5500

The reticle alignment mark (MA) for PAS 5500 is a square pattern, subdivided into four quadrants (see Figure 3.2). There are two vertical and two horizontal gratings, with one grating in each quadrant. In two of the gratings (one horizontal and one vertical) the grating period is 32 μm and in the other two the period is 35.2 μm. The duty cycle of the gratings must be 50% (± 25%).

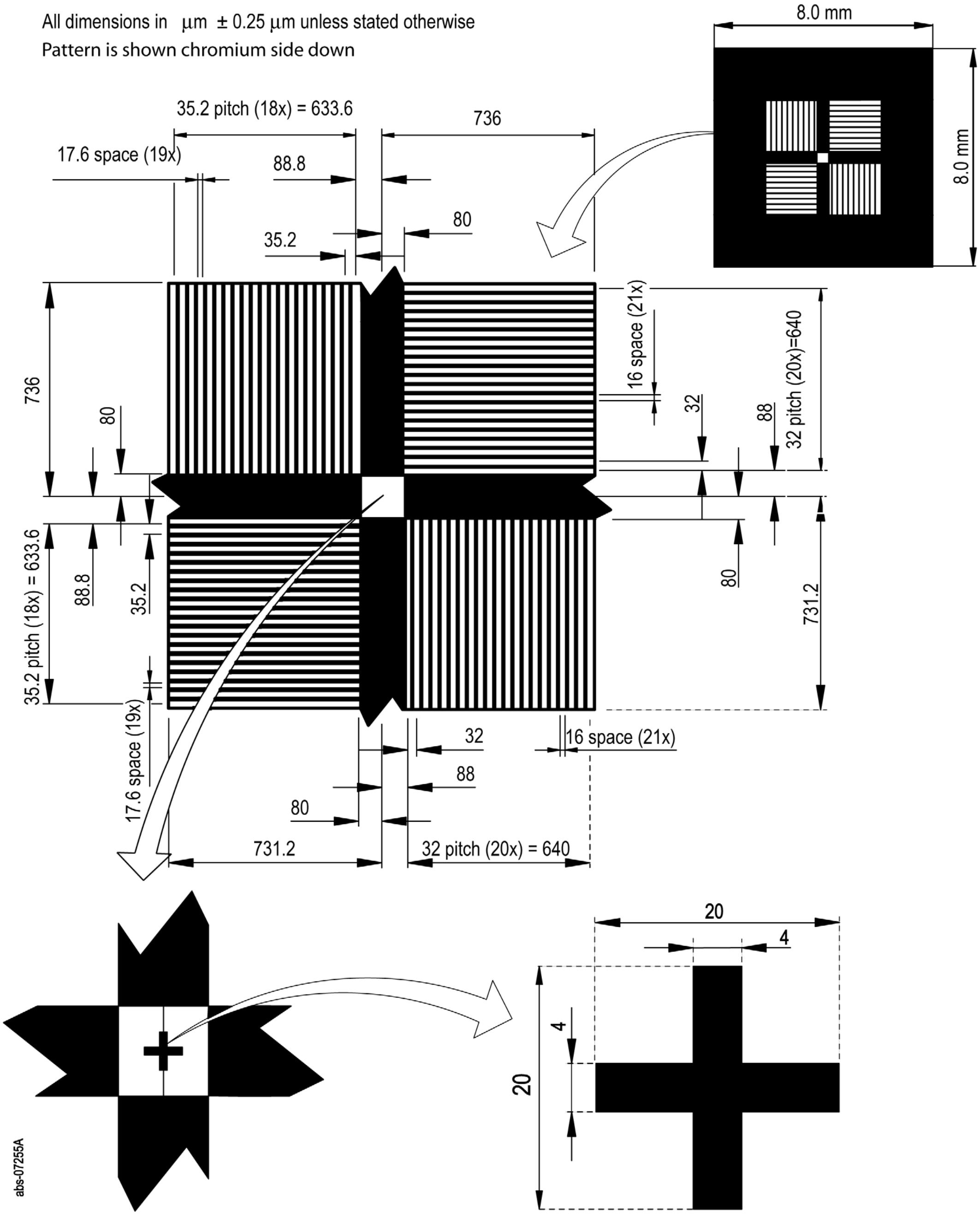

Figure 3.2 The reticle alignment mark

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The chromium cross in the center of the mark can be used for inspection with an optical metrology tool.

On PAS 5500 step and repeat and Step & Scan models, two reticle alignment marks (MA) are used for Through The Lens (TTL) alignment of the reticle to the wafer in global and/or field by field alignment mode. The nominal distance between the marks is 131 mm.

The mark must have a dark (chromium) background with an area of at least 8.0 mm x 8.0 mm centered around each alignment mark. In Figure 3.2 all dimensions are in μm ± 0.25 μm unless stated otherwise. The pattern is shown with chromium side down. For the location of the marks on the reticle, See “Reticle Layout (4x reduction)” on page 51.

TIS MARKS FOR RETICLE BLUE ALIGNMENT

All TWINSCAN systems, and PAS 5500 systems equipped with Reticle Blue Alignment, use an alignment methodology that is different from all previous PAS 5500 step and repeat, and Step & Scan models. This alignment method is called Reticle Blue Alignment (RBA) and is based on the use of a Transmission Image Sensor (TIS). The RBA uses TIS marks for reticle alignment. This means that TIS marks must be placed on all reticles used with TWINSCAN and PAS 5500 systems equipped with RBA.

The TIS marks R1 + R2 and R3 + R4 are used in pairs (see Figure 1.3 for the location of the TIS marks on the reticle). These marks must be placed on all reticles to ensure compatibility.

Also refer to Figure 4.5 and Figure 4.6 for the recommended TIS mark locations for RBA.

> **Note**
>
> All TWINSCAN and PAS 5500 systems equipped with Reticle Blue Alignment must have the TIS marks R1, R2, R3 and R4 on the reticle. (see Figure 1.3). The TIS mark designs are available in GDS format. The TIS mark designs in GDS are leading for design usage.
>
> The most current GDS files for reticle mark design can be found on ASML's CustomerNet.

A single TIS mark for RBA is made up of three parts:

1. A square ratio mark for coarse capturing.

   Note that the center of the ratio marks contains a small cross which can be used as a reference for optical quality inspection with a metrology tool.
2. A TIS X-mark containing vertical gratings.
3. A TIS Y-mark containing horizontal gratings.

> **Note**
>
> After production of the reticle, the location of the ratio (Tr) mark can be used to verify the location of the complete TIS mark. In the lithography process however the location of the TIS-mark gratings is used to define the properties of the image field.
>
> Therefore it is better to measure the location of the image field of a product reticle with reference to the location of the gratings (Txh and Tyh) rather than to reference the image location to the center of the TIS (Tr) mark.

The chromium borders for TIS_RBA marks

We can distinguish two distinctive areas in the chromium around a TIS mark that are of importance for the design of that TIS mark on the reticle. These two areas are:

1. The **compulsory** chromium border. This area only applies to the individual TIS-mark components (see also Figure 3.3). This compulsory chromium border is the area round the individual gratings of a TIS mark in which no other features are allowed.
2. The **required** chromium border (area) around the TIS mark. The complete TIS mark itself must also be surrounded by a chromium area. (See Figure 3.3).

   For all types of reticles applies that in this chromium area some features can be allowed, but only if the total transmission in that area does not exceed 15%, (see section : ‘TIS marks for Reticle Blue Alignment’).

Note

The specified area for the required chromium-border around the TIS mark is especially important for phase-shift reticles. For binary reticles the TIS mark is already in a large chromium area.

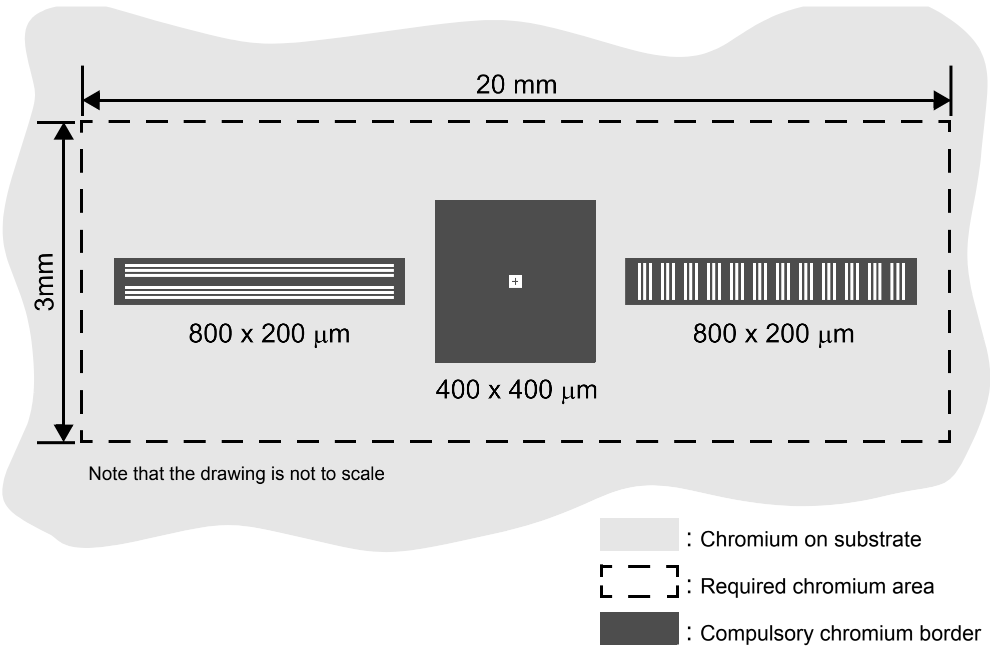


Figure 3.3 Chromium borders around TIS marks

TIS_RBA-mark dimensions

Notes on Figure 3.4

1. All dimensions are in micrometers (µm) unless stated otherwise.
2. The TIS pattern as shown on the reticle is chromium side down and seen through the glass.
3. On the reticle the actual image of the TIS mark is transparent on a chromium background.
4. All dimensions have a tolerance of ± 0.15 µm unless stated otherwise.

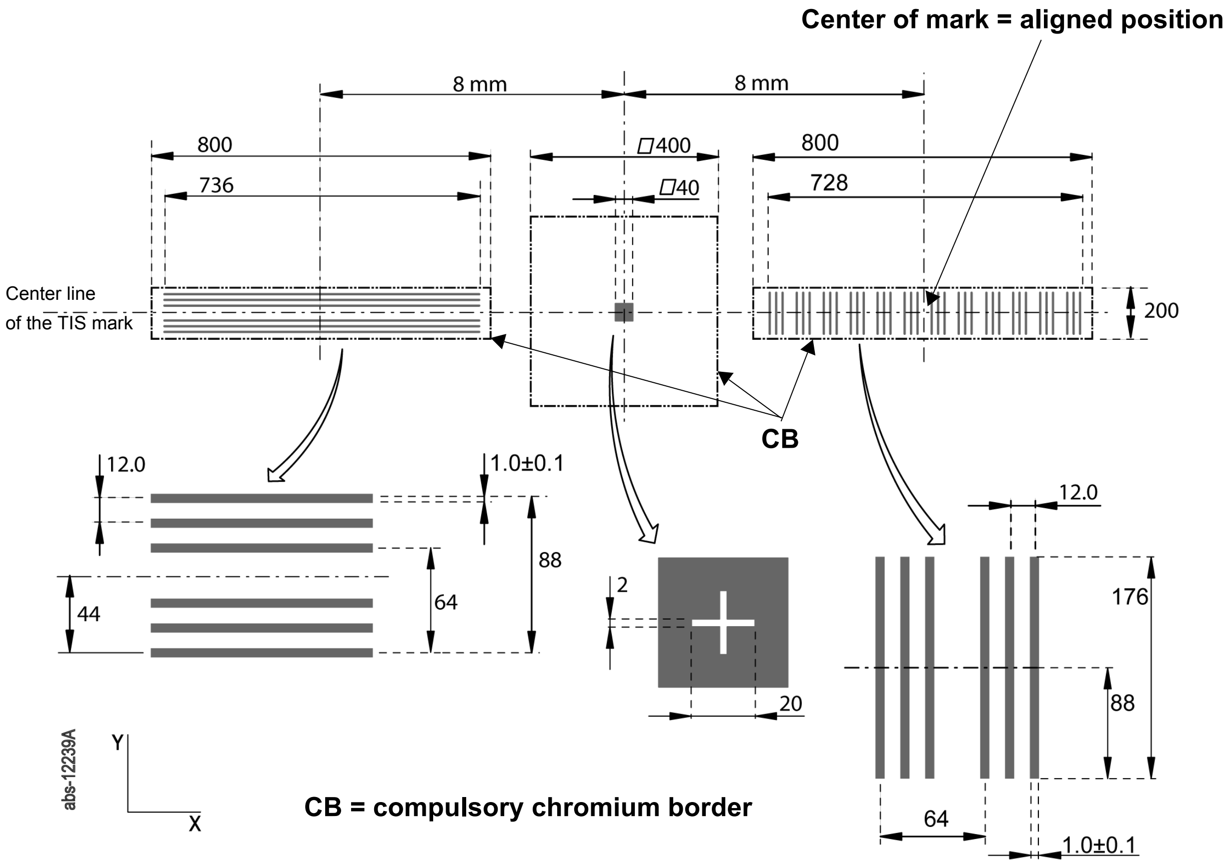


Figure 3.4 Dimensions of the standard TIS_RBA-mark

Required chromium border around the TIS mark

Around a TIS mark there must be a chromium area of at least 3 mm x 20 mm. This area must be centered around the center of the Tr mark.

Required chromium border between image field and TIS mark

The REMA system also requires the design of a chromium border around the image field. As the TIS marks are located outside the image field, this chromium border will prevent the exposure of the TIS marks on the wafer during the exposure of the image.

For chromium-border dimensions in the Y-direction, between the exposed image and the TIS marks, see section “Image Border” on page 35.

TIS marks placement on production reticles

On standard production reticles the TIS marks must be placed as follows:

Fixed X-location of the TIS marks

– The TIS marks must be positioned at fixed X-locations (– 43.60 mm for R1 and R3, and at +43.60 mm for R2 and R4) so that the marks can be found during the alignment scan.
– The mark location is defined by the center of the Tr mark.

Variable Y-location of the TIS marks

– The TIS marks can be positioned at any Y-location in the available field - 68.588 mm < Y < + 68.588 mm at the reticle level.
(See also the example in Figure 4.6)
– The R1 and R2 marks are paired and must have identical Y-locations. The R3 and R4 marks are also paired and must have identical Y-locations.

TWINSCAN supports a maximum field of 137.176 mm at reticle level. (Note that this 137.176 mm is measured from the center of R1 to the center of R3).

Note

On CustomerNet there are Application Notes available that give background information on the use of alignment marks.

TIS MARKS FOR RETICLE SHAPE CORRECTION

To be able to use the Reticle Shape Correction option on a TWINSCAN system a reticle must have the additional Reticle Shape Correction (RSC) marks. The RSC marks are also measured with the TIS sensor. Therefore these marks are also called TIS_RSC marks. Refer to Figure 4.9 for the recommended reticle layout when the TIS_RSC marks have to be included.

For additional information on the use of Reticle Shape Correction please refer to the Applications Note on Reticle Shape Correction.

Note

PAS 5500 systems do not have the Reticle Shape Correction option.

The layout of TIS_RSC marks

A complete set of TIS_RSC marks consists of two different sets of mark types:

1. The first mark type is found in X-direction (‘horizontal’) on both the upper and the lower side of the image field. The layout and specifications for this mark are identical to the layout and specification of the standard TIS_RBA mark.
2. The second mark type is found in Y-direction (‘vertical’) on the left and the right side of the image field. The layout of this mark (see Figure 3.5) is a part of the standard TIS_RBA mark. The RSC mark consists of two parts of the TIS_RBA mark:
   a. Tr mark.
   This is the square ratio-mark which is needed for coarse capturing.
   b. Tyv-mark.
   This part of the TIS mark contains the horizontal gratings.

Note

Because the illumination slit-size does not allow exposure of full vertical TIS marks, only the Tyv part of the TIS mark is used for RSC in Y-direction.

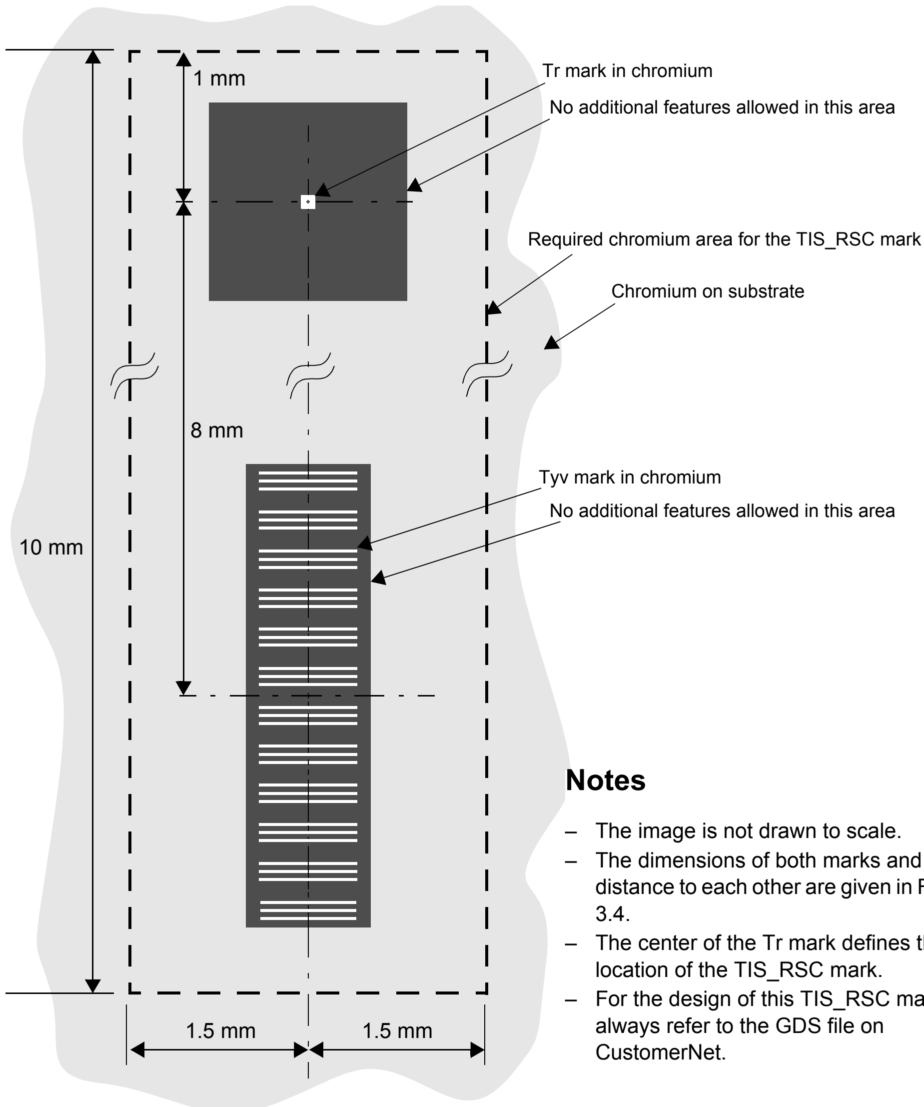
Chromium borders for vertical TIS_RSC marks

The vertical TIS_RSC marks require to be in a chromium area (see Figure 3.5) of 10 mm x 3 mm. Some third-party features are allowed overlap with this chromium area. Note that this overlap has to be within specific conditions as explained in Chapter 3 on page 33. The two parts of TIS_RSC marks are also binary features with a required chromium background of the following size:

Table 3.1

TIS part	Chromium border
Ratio mark	400 x 400 μm
Tyv-mark	200 x 800 μm

Note that the design of the Ratio mark and the Y-mark are according to Figure 3.4. For the actual design on the reticle the GDS file is leading.



Notes

- The image is not drawn to scale.
- The dimensions of both marks and their distance to each other are given in Figure 3.4.
- The center of the Tr mark defines the location of the TIS_RSC mark.
- For the design of this TIS_RSC mark always refer to the GDS file on CustomerNet.

Figure 3.5 The vertical TIS_RSC mark

Note that the chromium border of the image field, as shown in Figure 3.6, can overlap the compulsory chromium border of the Tyv mark.

Note (Only for XT:1700i and XT:1900i systems)

If the reticle is **only** used in **XT:1700i** and/or **XT:1900i** systems, the Tr mark (see Figure 3.5) itself does not need to be printed on the reticle. This results in less straylight from the reticle.

Be aware that all the design rules for the vertical TIS_RSC mark still apply. This means that the location of the Tr mark (although it is not printed) will still be the reference for the location of the mark. Also note that still no other structures are allowed in the compulsory chromium border of the Tr mark.

Chromium border between image field and vertical TIS_RSC marks

The REMA system requires a chromium border, for dimensions See “Image Border” on page 35., in the X-direction between the exposed image and the vertical TIS_RSC markers. Positioning the TIS marks outside the chromium border of the product field avoids exposing those vertical TIS_RSC marks on the wafer during the exposure of the image.

Vertical TIS_RSC marks placement on production reticles

Variable X-location of vertical TIS_RSC marks:

- The vertical TIS_RSC marks can be placed at any X-location in the specified field. (– 54.088 mm < X < +54.088 mm at reticle level; see also Table 3.2)

Variable Y-location of vertical TIS_RSC marks:

- The vertical TIS_RSC marks can be placed at any Y-location in the specified field. (– 68.000 mm < Y < +68.000 mm at reticle level; see also Table 3.2).

Note

The vertical RSC marks on left and right side are paired and must have the same Y-locations.

The horizontal RSC marks on top and bottom side are also paired and must have the same X-locations.

Table 3.2 Requirements and guidelines for the placement of TIS_RSC marks

Horizontal marks, number	Minimum 5, maximum 5* per row. Two rows must be used. All horizontal marks at the top side of the image field have to be at identical Y locations. All horizontal marks at the bottom side of the image field have to be at identical Y locations.
Horizontal marks, Y location	Minimum – 68.588 mm, maximum +68.588 mm
Horizontal marks, X location	Fixed, no shifts possible*
Horizontal marks, chromium border	Embed in a 20 mm x 3 mm area that has a transmission ≤ 15%**
Vertical marks, number	Minimum 5, maximum 9 per column. Two identical columns must be used. All vertical marks at the left side of the image field have to be at identical X locations. All vertical marks at the right side of the image field have to be at identical X locations.
Vertical marks, Y location	Center mark, centre of triplet: – 8.0 mm < Y < 8.0 mm
Vertical marks, X location	Columns may be moved with image field while observing chromium border towards image field: 2.0 mm.
	Minimum – 54.088 mm, maximum +54.088 mm
Top mark	Center of triplet, distance to top of image field $\delta Y \leq 8.0$mm Top mark (ratio hole) maximum location: Y ≤ 68.588 mm
Bottom mark	Center of triplet, distance to bottom of image field $\delta Y \leq 8.0$mm Bottom mark (ratio hole) ≥ – 60.588 mm
	The maximum Y-location minus the minimum Y-location ≥ 80.0 mm
	Distance between Y locations of vertical marks ≥ 12.0 mm
Vertical marks, chromium border	Embed in a 3 mm x 10 mm area that has a transmission ≤ 15%**

**) The X locations of the horizontal marks are such that the 5 marker layout is identical to the layout of the TIS marks on the TIS fiducial.*

***) If patterns, that are not part of the TIS_RSC mark, have to be inside the chromium border of a TIS_RSC mark (3 mm x 10 mm), these patterns should be such that the overall transmission of this area will stay below 15% in order to avoid straylight problems in the TIS sensor.*

Design guideline: Try to keep spacing of vertical TIS_RSC marks as equidistant as possible. (See also the Application Note on Reticle Shape Correction).

HOW TO DEAL WITH THIRD-PARTY RETICLE PATTERNS

The boundaries and guidelines described in Table 3.2 have to be observed in order to make ASML's requirements compatible with additional third-party reticle patterns that claim the same locations as the RBA and RSC mark-layout. Only in this way it is possible to ensure the performance of the RBA and RSC-TIS function.

This is essential because the measurement of reticle x-curvature on these horizontal marks is a relative measurement with respect to the lot-correction measurements on the TIS fiducial.

In Figure 3.6 an example of all chromium border requirements is shown. In this figure there is also an example of third-party reticle features that may be found inside the TIS chromium-border area.

Please note that these third-party features should not overlap with:

- The 3 parts of TIS_RBA marks and the additional horizontal TIS_RSC marks
- The image chromium border around the field image (to avoid ghost images on product).

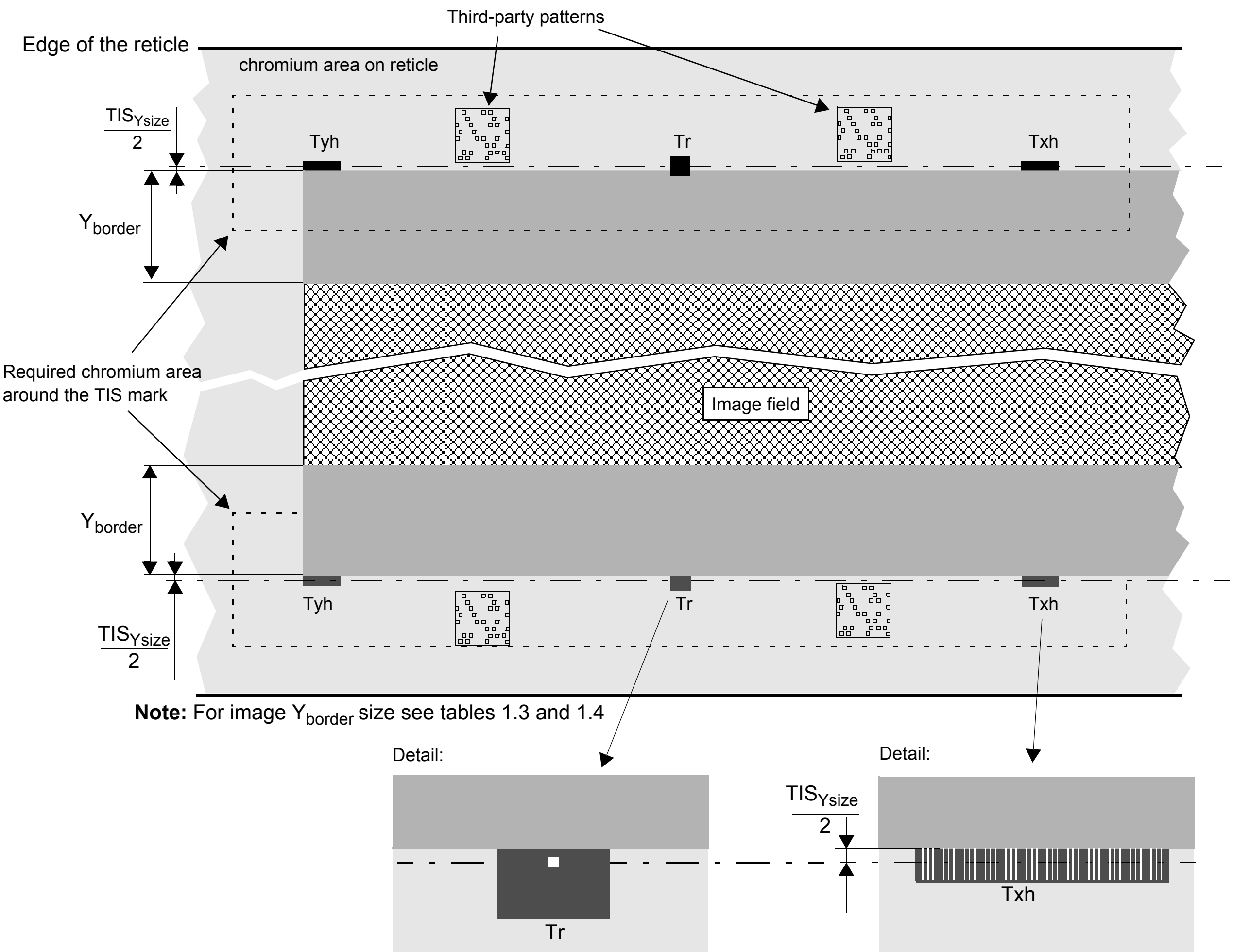


Figure 3.6 Example of the use of various chromium borders (Y direction)

Note

Patterns that are not part of the TIS mark are allowed inside the required chromium border area (20.0 x 3 mm) of the TIS_RBA and TIS_RSC marks, but only when these patterns have less than 15% transmission in this area.

These patterns, that are not part of the TIS mark, may **not** coincide with the compulsory chromium border areas of the TIS mark, and may not coincide with the image chromium border.

In Figure 3.7 the chromium border requirements are given when the vertical TIS_RSC-marks need to be interleaved with patterns that are not part of the TIS mark.

These patterns, which are often third party features, should not overlap with the 2 parts of vertical TIS_RSC marks and the image chromium border around the field image.

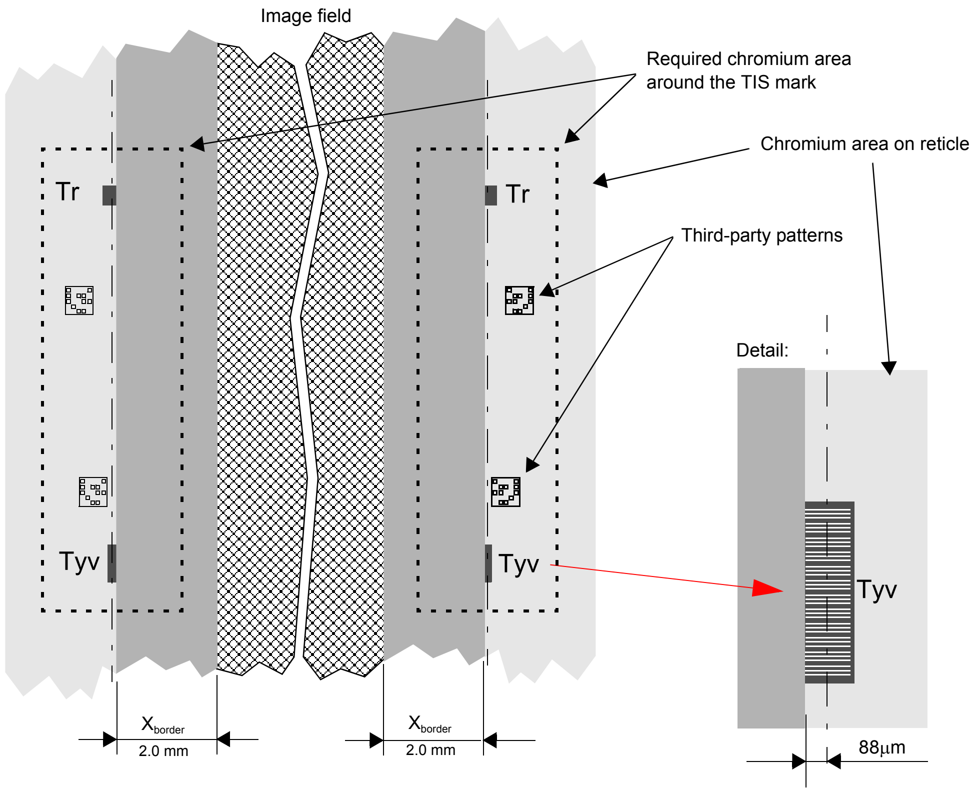


Figure 3.7 Example of various chromium borders (X direction) with TIS_RSC-marks on the left and right side of the image field

IMAGE BORDER

To print only a part of the image field, the REMA blades of the system can put a window over the reticle. Because of the accuracy of the REMA blades and the half-shadow effect, each image in the image field must be surrounded by a chromium border.

For PAS 5500/3x0 wafer stepper systems, the required width for the image border is 3 mm, see section: Reticle Layout (4x reduction) (page 51). This is shown as W in Figure 3.8.

The required widths for the PAS 5500 Step & Scan systems, and TWINSCAN systems, see section: Reticle Layout (4x reduction) (page 51) are dependent on system configuration. The possible widths are shown as:

- W1 and W2 in Figure 3.9, where W1 (the width in the non-scan direction) is 3 mm, and W2 (the width in the scan direction) is 4.5 mm.
- W in Figure 3.8, where W = 2.5 mm in both directions

The inner edge of the border defines the area which is printed. This inner edge may be located just on the edge of the image field with the rest of the border outside this field. In this case the width specified in section Reticle Layout (4x reduction) (page 51) is still required.

Table 3.3 Required image border-size for PAS 5500/3x0

PAS 5500	**Chromium border size, (Reticle dimensions)**
/3x0	3.0 x 3.0 **[mm]**

Table 3.4 Overview of supported field size and corresponding chromium border size for PAS 5500

PAS 5500	**TTL Field size [mm]**	**Chromium border size, (Reticle dimensions) [mm]**	**IOSC-2 option Field size [mm]**	**Chromium border size, (Reticle dimensions) [mm]**
/400 series	26 x 33	3.0 x 4.5	26 x 32	3.0 x 4.5
/5x0 series	26 x 33	3.0 x 4.5	26 x 32	3.0 x 4.5
/7x0 series	26 x 33	3.0 x 4.5	26 x 32	3.0 x 4.5
/750G	26 x 33	3.0 x 4.5	**26 x 33** (std.)	2.5 x 2.5
/800	not appl.		26 x 32	3.0 x 4.5
/850B	not appl.		26 x 32	3.0 x 4.5
/850C	not appl.		26 x 33	2.5 x 2.5
/850D	not appl.		26 x 33	2.5 x 2.5
/9x0 series	26 x 33	3.0 x 4.5	not appl.	3.0 x 4.5
/1100 series	not appl.		26 x 32	3.0 x 4.5
/1150C	not appl.		26 x 33	2.5 x 2.5

Table 3.5 ***Overview of supported field size and corresponding chromium border size for TWINSCAN***

TWINSCAN	Field size	Chromium border size	RSC option Field size	Chromium border size
AT:400B	26 x 32	3.0 x 4.5	-	-
AT:400C	26 x 33	2.5 x 2.5	-	-
AT:400D	26 x 33	2.5 x 2.5	-	-
AT:750	26 x 32	3.0 x 4.5	See Note [(a)]	See Note[(a)]
AT:750B	26 x 33	2.5 x 2.5	26 x 33	2.0 x 2.5
AT:760X	26 x 33	2.5 x 2.5	26 x 33	2.0 x 2.5
AT:850B	26 x 33	2.5 x 2.5	26 x 33	2.0 x 2.5
AT:850C	26 x 33	2.5 x 2.5	26 x 33	2.0 x 2.5
AT:850D	26 x 33	2.5 x 2.5	26 x 33	2.0 x 2.5
AT:1100B	26 x 33	2.5 x 2.5	26 x 33	2.0 x 2.5
AT:1100C	26 x 33	2.5 x 2.5	26 x 33	2.0 x 2.5
AT:1150C	26 x 33	2.5 x 2.5	26 x 33	2.0 x 2.5
AT:1200B	26 x 33	2.5 x 2.5	26 x 33	2.0 x 2.5
AT:1250	RSC standard specifications		26 x 33	2.0 x 2.5
XT:1250			26 x 33	2.0 x 2.5
XT:1400			26 x 33	2.0 x 2.5
XT1700i			26 x 33	1.5 x 1.5
XT1900i			26 x 33	1.5 x 1.5

(a): The values for Field size and Chromium border size depend on the actual configuration of your AT:750. Please contact your local account team if RSC needs to be implemented on your AT:750.

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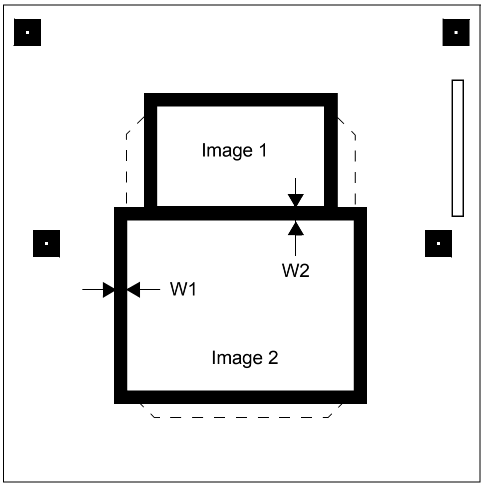
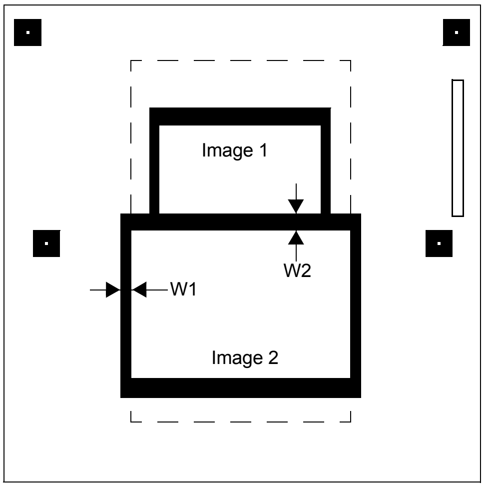
> **Note**
>
> Future PAS and TWINSCAN models will support 26 x 33 field size.

When two images are located inside the image field, each image should be surrounded by an image border. So the images have to be separated by only one border stripe (See Figure 3.8 and Figure 3.9).



PAS 5500/3x0:	W1 = W2 = 3 mm
PAS 5500 Step & Scan with field size 26 x 33 and IOSC-2 option:	W1 = W2 = 2.5 mm
TWINSCAN with field size 26 x 33:	W1 = W2 = 2.5 mm

Figure 3.8 Systems with image borders where W1=W2



PAS 5500 Step& Scan with TTL and field size 26 x 33:	W1 = 3 mm; W2 = 4.5 mm
PAS 5500 Step& Scan with IOSC-2 and field size 26 x 32:	W1 = 3 mm; W2 = 4.5 mm
TWINSCAN with field size 26 x 32:	W1 = 3 mm; W2 = 4.5 mm

Figure 3.9 Systems with image borders where W1 $\neq$ W2

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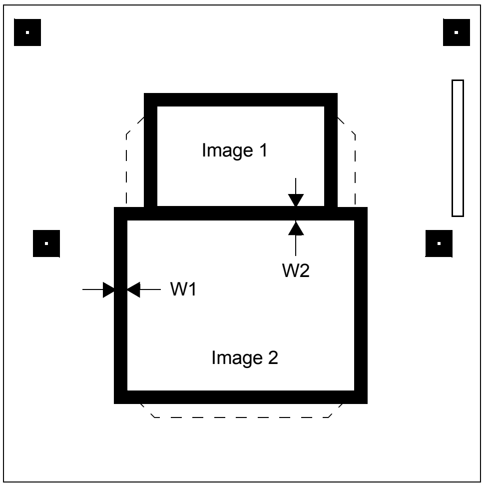

TWINSCAN AT:1250; XT:1250; XT:1400: W1 = 2.0 mm; W2 = 2.5 mm
TWINSCAN XT:1700i; XT:1900i: W1 = W2 = 1.5 mm

Figure 3.10 Systems on which RSC is standard

Minimum window size (PAS 5500 and TWINSCAN)

The minimum REMA-window size for all applicable configurations is given in Figure 3.11. When smaller images must be printed, the chromium border around these images must be made wider. The width of the chromium border must then extend over the minimum window size. An example of this extended image border is shown in Figure 3.11, where (A) is an example of a normal image border for a scanner and (B) is an example of an extended image border.

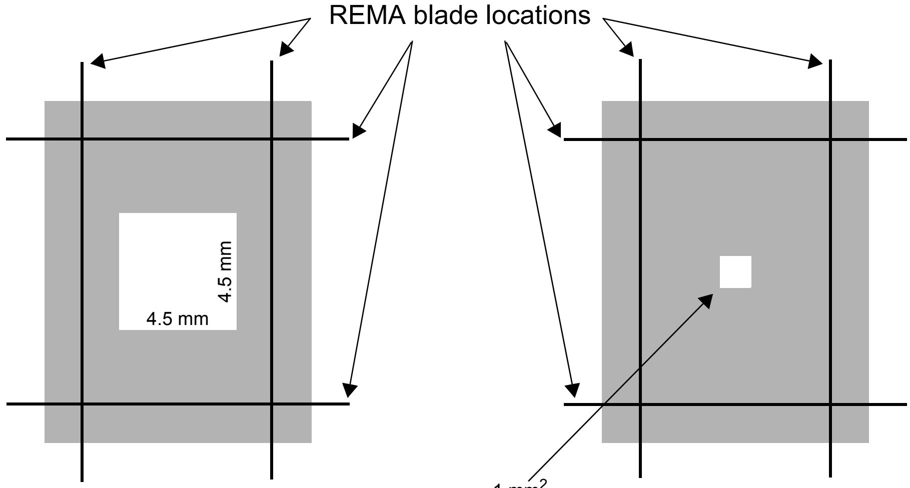

Figure 3.11 Example of a normal and extended image border (scanner situation)

BAR CODE

The bar code is used for automatic identification of the reticle. The system uses the Alpha-39 industrial standard bar code which has an alphanumeric character set consisting of the integers 0-9, upper case letters A-Z, and five special characters: %, +, $, –, and “space” (see Figure 3.12).

The code format (see Figure 3.12) consists of:

- A quiet zone
- A start character
- The actual code
- A stop character
- Another quiet zone.

The actual user defined code may consist of up to 12 characters. The beginning and ending characters are identical START/STOP characters

Each character of the bar code, including START/STOP, consists of nine elements. These elements are five clear rectangles separated by opaque chromium spaces which are all 0.2 or 0.45 mm wide. Every character structure begins and ends with a clear rectangle.

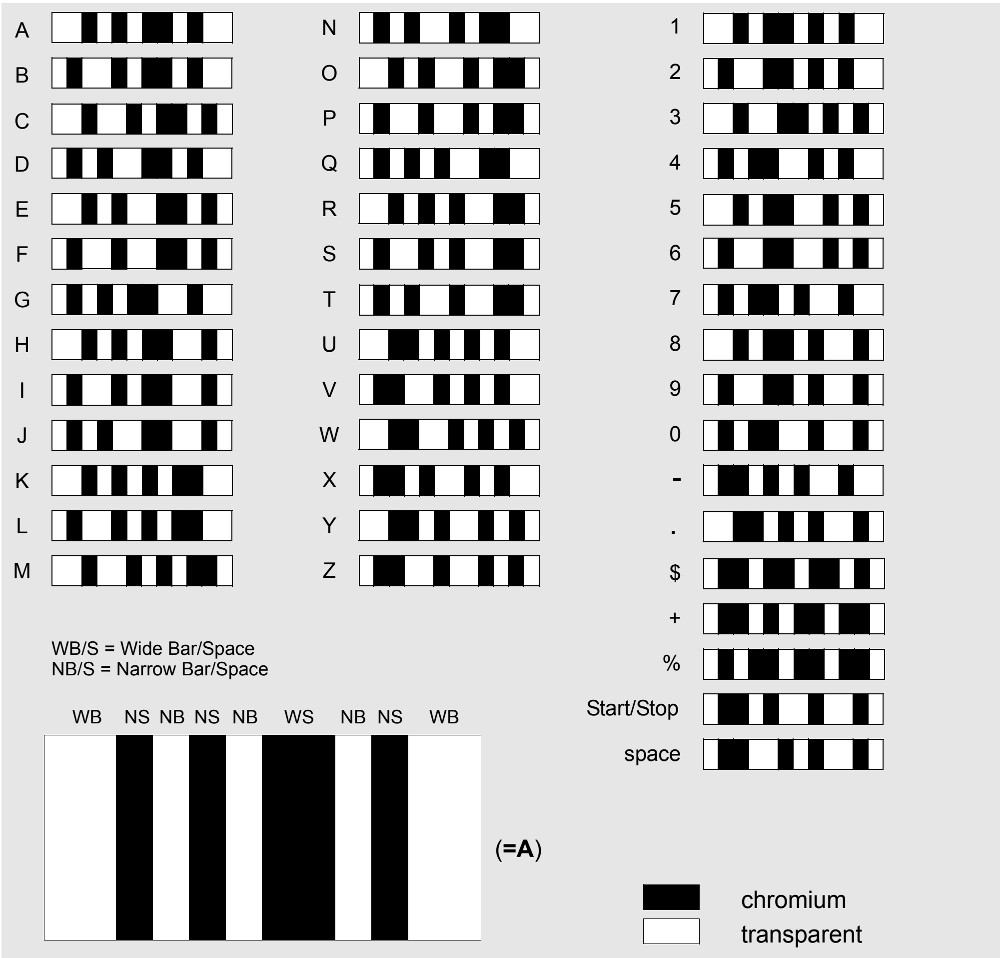

Figure 3.12 The bar code characters

Bar Code orientation

The quiet zone 2 at the beginning consists of an 8 mm x 5 mm chromium area and the quiet zone 1 at the end is a 2 mm x 5 mm chromium area. (Quiet zone 2 must be located closest to the P mark. See also Figure 3.13.) .

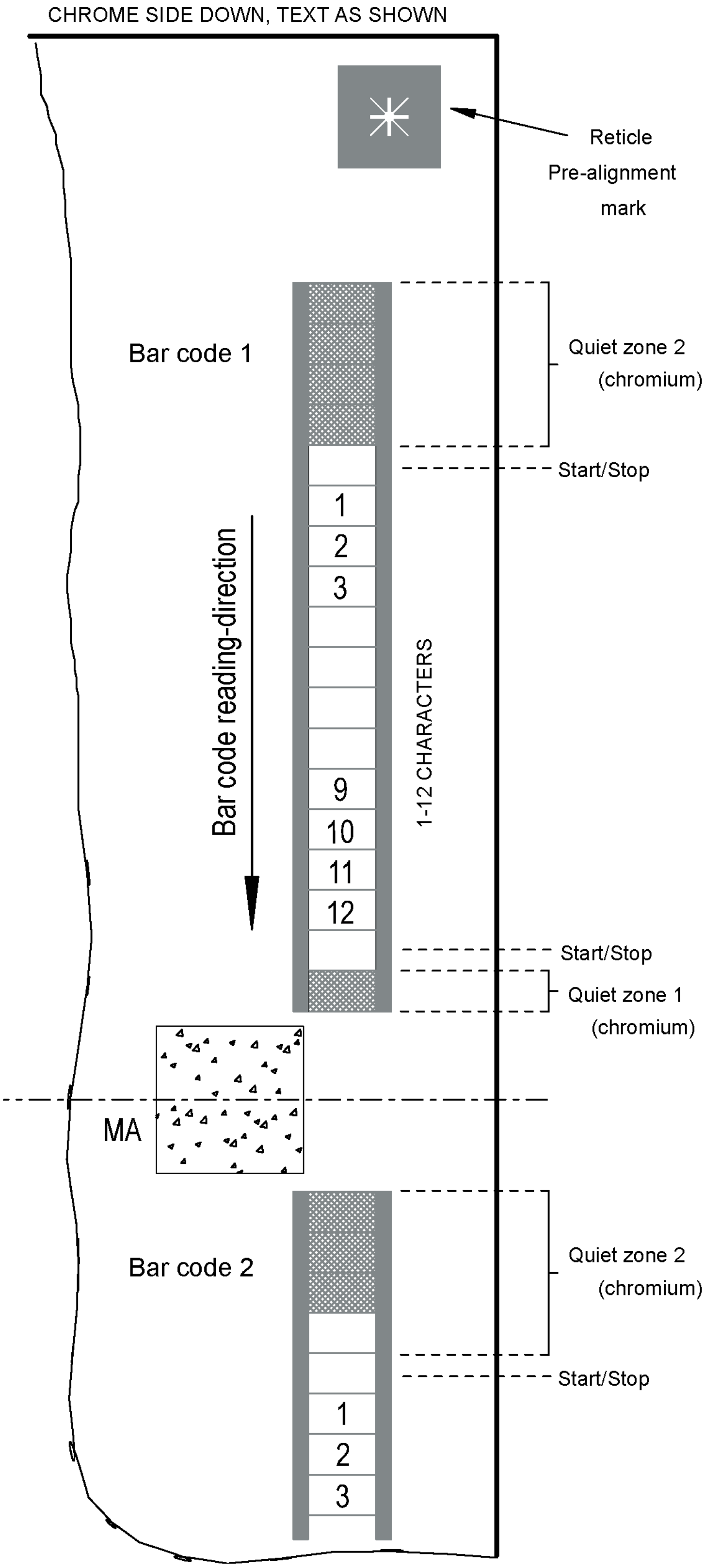

Figure 3.13 The orientation of the Bar Code on the reticle

Bar Code dimensions

The characters must be 2.55 mm wide, and therefore consist of three wide (0.45 mm) and six narrow (0.2 mm) elements. The height of each element is 5 mm. Between the characters, there is a spacing of 0.2 mm. Depending on the number of characters in the user defined code, the length of the bar code varies between 15.3 (two code characters) and 48.3 mm (12 code characters), including the quiet zones.

A chromium line, at least 2 mm wide, must be along each side of the bar code. It is not required before or after the quiet zones.

An area on the reticle is reserved for the location of the bar code. The bar code should be positioned somewhere inside this area. For the location of this area, see section: Reticle Layout (4x reduction) (page 51) on different reticles.

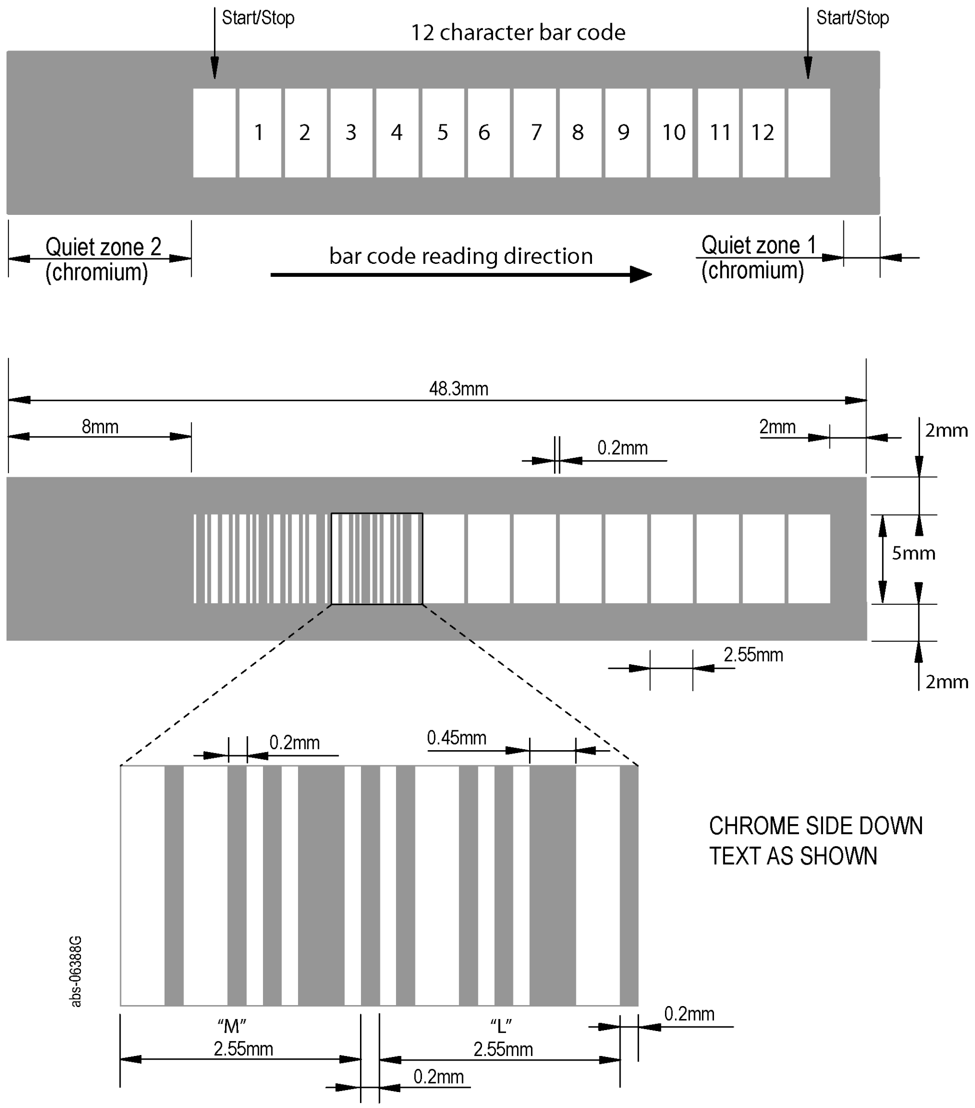

Figure 3.14 The bar code structure and dimensions

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The 24-character bar code option

The 24-character bar code option is designed to enable larger logical codes for distinguishing reticles. It allows customers to double the length of the identification bar codes from the standard 12 characters to 24 characters, and allows those who use a large number of reticles to easily distinguish them by reading the bar code.

This option is available on PAS 5500 Stepper and Step & Scan systems with ARMS installed, and with software release 8.5 and higher. For TWINSCAN this option is available in software release 3.2 and up.

The 24-character bar code option can still be used with old jobs made with the 12 character reticle bar code system and older software releases. New jobs that use the 24-character bar code option can also be read on older software releases, but in this case the reticle bar code will be truncated to the original 12 character bar code. Because of the unique nature of the 24-character bar code option, it will not be possible to downgrade to previous software releases. It is therefore advisable to use 24-character bar codes across the whole fabrication facility.

The 2D-Barcode option

The 2D-Barcode function is an option. This option enables the design and use of reticles with 2D bar codes.

Apart from the change in reticle design, the 2D-Barcode support involves hardware and software changes to the TWINSCAN.

Note

To be able to use the 2D Barcode option, the presence of the IRL (Integrated Reticle Library) and software release AT4.0.0c or higher is required.

TWINSCAN systems that have the 2D-Barcode option installed support 2D bar codes that are formatted in QR code, see standard ISO/IEC 18004 for details, and adhere to the following specifications:

- Model: 2
- Version: 4
- Error correction level: H

For quick reference we have listed the most important properties of the QR standard in Table 3.6 and in Figure 3.15 the basic layout of the 2D-Barcode field is shown.

Table 3.6 The QR code

Requirement	QR code
Cell spacing (center to center)	100 µm
Cell / dot / module size (edge length)	100 ± 5 µm
Number of cells in a row	33
Number of cells in column	33
Minimum quiet zone around the bar code	4 cells (400 µm)
Dimensions of the code area (including quiet zone)	4.1 X 4.1 mm

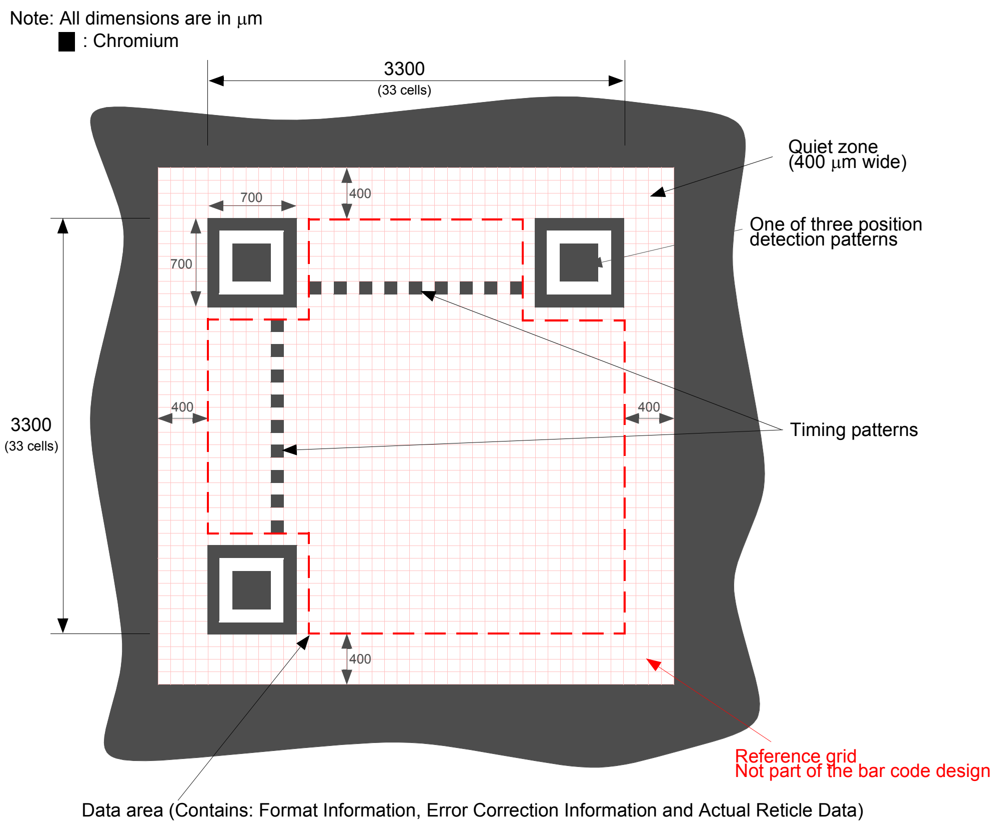
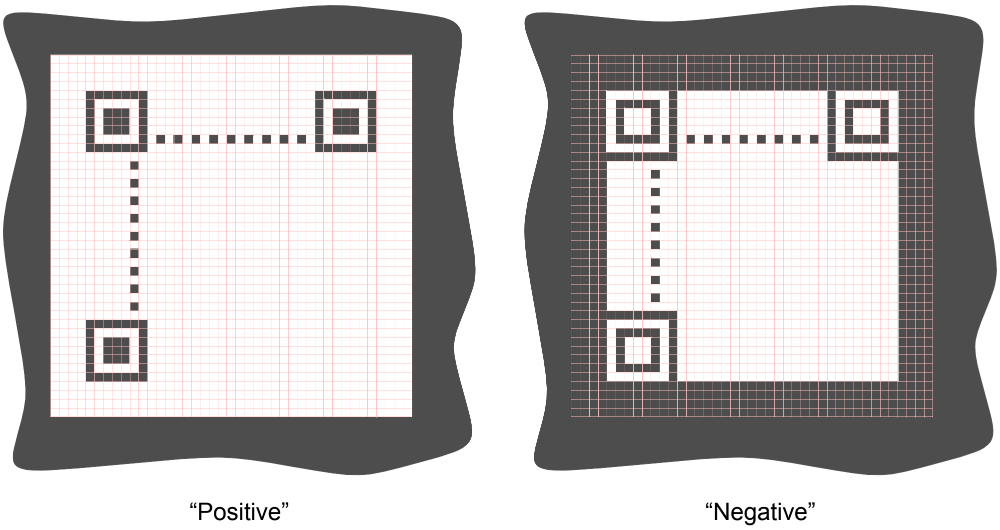


Figure 3.15 The basic 2D Barcode field (without data)

The 2D-Barcode option supports both positive (blank-glass pattern in chromium) and negative (chromium pattern on blank glass) bar code designs. See Figure 3.16 for an example of both patterns (These patterns are without any data information).



Note: The (red) grid is for reference only. It is not part of the bar code design

Figure 3.16 Supported formatting of the 2D bar code fields (without data)

The 2D-Barcode option currently only supports 24 characters or less per bar code. This number includes leading and trailing spaces. ASML supports the following characters:

- integers 0–9
- upper case letters A–Z
- seven special characters: % + / $. - and <space>

Always make sure that there is sufficient contrast in the pattern to get a reliable read-out.

Note

It is possible to combine the traditional (“1D”) bar code and a 2D bar code—in position A in Figure 3.17—on a single reticle. In that case the TWINSCAN uses the 1D barcode to identify the reticle.

The Location of the 2D Barcode

ASML supports two locations for the 2D barcode on the reticle:

- Location A (left)
  Center of the barcode in relation to the center of the reticle ± 0.5 mm:
  X = –65.2 mm; Y = +35.0 mm.
- Location B (right)
  Left bottom corner of the barcode in relation to the left bottom corner of the reticle:
  X = 139.6 ± 0.5 mm; Y = 110.4 ± 0.5 mm.

Note

A TWINSCAN can only be configured for **one** location on the reticle for a 2D bar code. The TWINSCAN will not attempt to read a 2D bar code on the location that the TWINSCAN is not configured for.

Figure 3.17, Figure 3.18, and Figure 3.19 show these locations.

Figure 3.17 shows the locations for the 2D barcode on the reticle.

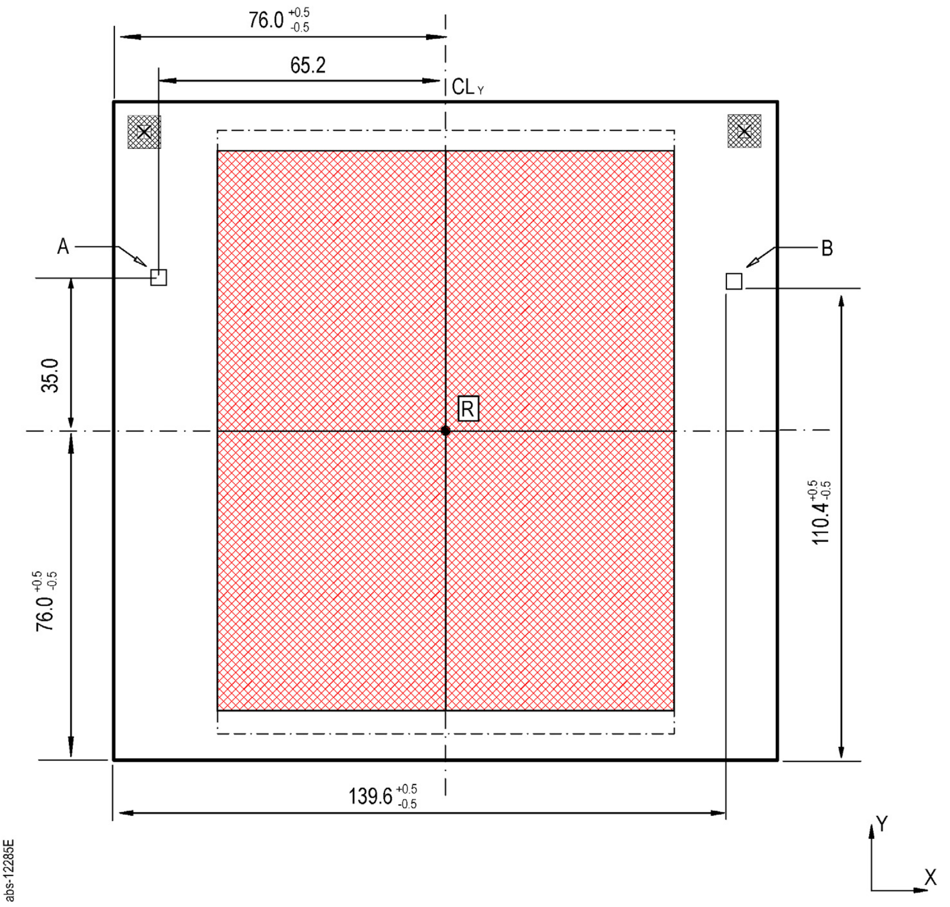


Figure 3.17 The two supported locations for a 2D bar code

In Figure 3.17 ‘R’ is the center of the reticle, ‘A’ and ‘B’ are the locations for the 2D bar code.

Figure 3.18 and Figure 3.19 give additional details on locations ‘A’ and ‘B’.

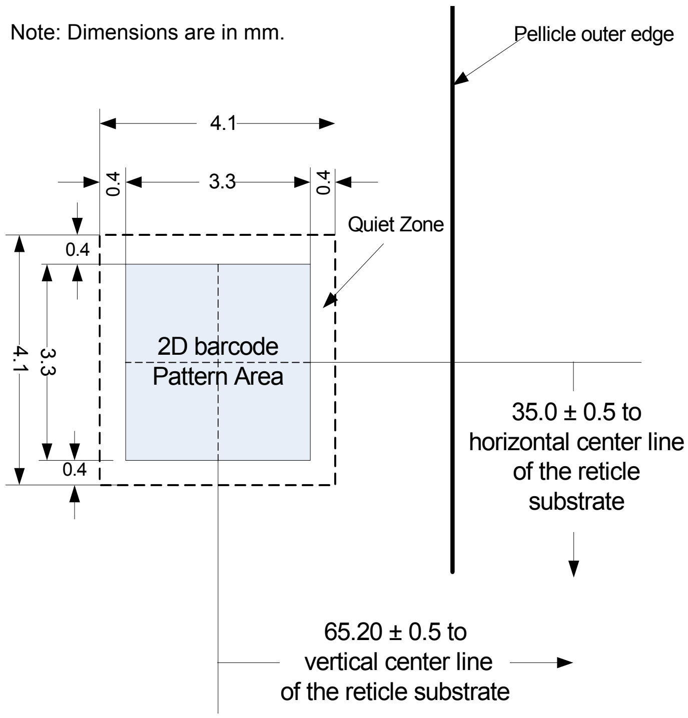


Figure 3.18 Details of location 'A' (left)

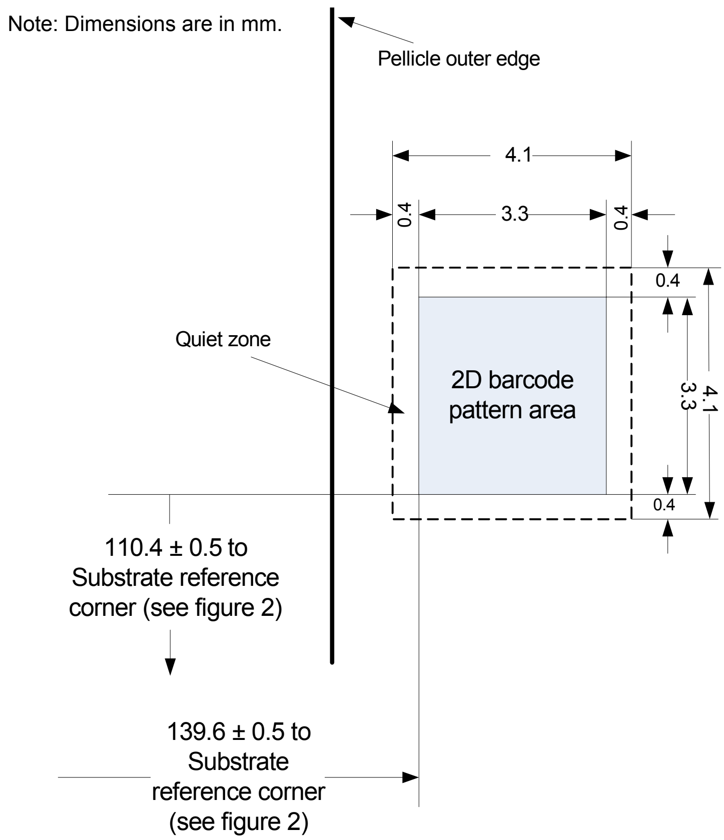


Figure 3.19 Details of location 'B' (right)

HUMAN READABLE CODE

On the reticle there are two areas reserved for user defined, human-readable codes. The size of each area is (25 x 8) mm.

For the location of these areas, see section: Reticle Layout (4x reduction) (page 51).

RELEASE PIN (R-PIN) AREA

On the PAS 5500 Step & Scan systems, the reticle has to be released from the reticle table before it can be picked up by the gripper. The reticle is pushed upwards by four pins. To reduce contamination from the pins on the reticle, the areas on the reticle where the pins make contact, should be free of chromium (see Figure 3.20).

Note

When reticles are used only on PAS 5500 stepper, or only on TWINSCAN systems, the R pin areas do not have to be defined.

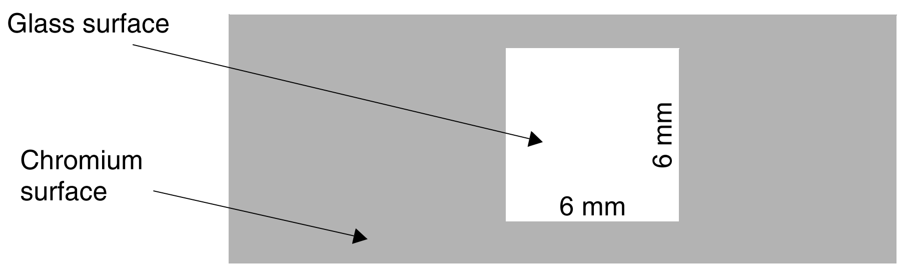


Figure 3.20 Release pin area

PELLICLE DESIGN

The PAS 5500 stepper systems can use reticles which have pellicles on both sides. The PAS 5500 Step & Scan and TWINSCAN systems can only use reticles with a pellicle on the chromium side. Glass side pellicles cannot be used with PAS 5500 Step & Scan or TWINSCAN systems.

Note (for XT:1900i only)

The pellicle introduces an apodization effect that can influence the OPE behavior. Therefore if the reticles used for production will have a pellicle, then the reticles that are used to determine OPE (Optical Proximity Effects) must also have a pellicle.

General requirements for pellicles

The total frame standoff height, including possible film curvature, adhesive and film thickness, depends on the substrate thickness and must not be more than the values shown in Figure 3.21.

Also note that:

- A minimum height of 2.5 mm is required for pellicle detection.
- Only one pellicle frame per surface is to be used.
- The pellicle frame must be positioned symmetrically with reference to the center of the reticle layout (center of image field).

The pellicle film type should be optimized for the exposure wavelength. For ASML systems, the exposure wavelengths are:

- UV (i-line ultraviolet) - 365 nm
- DUV (deep ultraviolet) - 248 nm
- 193 nm tools - 193 nm

Reflection of the pellicle film illuminated at a wavelength of 800 nm to 600 nm, at an angle between 20 to 40 degrees, must be more than 5% to be able to scan the pellicle surface with the IRIS option installed.

CAUTION

To prevent pellicle or reticle damage, the pellicle film must not extend more than 100 μm above the frame.

CAUTION

If the pellicle is placed outside the inner edge of the pellicle location lines, a reticle handling error can occur. This may cause damage to the reticle, the reticle management system and the pellicle.

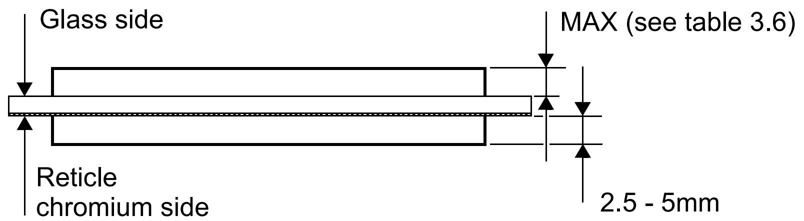


Figure 3.21 ***Pellicle frame standoff height (including possible film bow, adhesive and film thickness)***

Table 3.7 ***Pellicle frame standoff height (including possible film curvature, adhesive and film thickness)***

Reticle thickness [inch]	PAS 5500 only; Pellicle thickness (glass side) [mm]	Pellicle thickness (chromium side) [mm]
0.120	2.5 - 3	2.5 - 5
0.150	2.5	2.5 - 5
0.250	0	2.5 - 5

Pellicle location lines

The pellicle location lines can be used to position the pellicle correctly on the reticle. The outer edge of the pellicle must be within the boundaries indicated by these lines. The outer front and rear edges (in the Y direction) of the pellicle must not extend outside the edge of the substrate. For the PAS 5500/3x0, at least three pellicle location marks must be visible on the corner surfaces.

A pellicle location line is a rectangle of 5.0 x 0.3 mm (see Figure 3.22). There are eight pellicle location lines on PAS 5500/3x0 reticles and four pellicle location lines on PAS 5500 Step & Scan reticles and TWINSCAN reticles. The edge of the PAS 5500 Step & Scan reticles and the TWINSCAN reticles must be used as the reference location in the Y-direction.

The size of the pellicle location lines may vary from that shown in Figure 3.22 but the location of the inner edge (closest to the image field) must remain the same.

The pellicle location lines can be used to correctly place the pellicle on the reticle. The outer edge of the pellicle must be within the boundaries indicated by these eight lines for the PAS 5500 /3x0, or four lines for the PAS 5500 Step & Scan systems and TWINSCAN systems. The outer edges of the pellicle in the Y-direction must not extend outside the edge of the substrate.

For more information on using a pellicle, see section: General requirements for pellicles (page 48). For the location of the pellicle location lines and the dimensions for the two models, see section: Reticle Layout (4x reduction) (page 51).

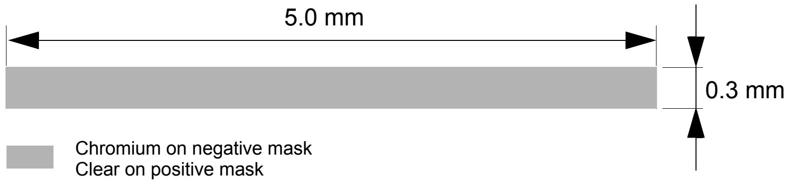


Figure 3.22 The pellicle location line

4

Reticle Layout (4x reduction)

Summary

In this section the reticle layout requirements for different systems are shown. The systems for which the reticle layout is described are:

- PAS 5500/3x0
- PAS 5500 Step & Scan family
- TWINSCAN
- TWINSCAN with the RSC option installed

Additionally there is a chapter on the reticle compatibility between various systems.

PAS 5500/3X0

The PAS 5500/3x0 is a step and repeat (Stepper) system which uses DUV as the exposure wavelength (248 nm).

The maximum field size is:

	Wafer level	Reticle level
Diameter:	31.1 mm	124.4 mm
Maximum Y:	27.4 mm	109.6 mm
Maximum X:	22.0 mm	88.0 mm

The distance between the two reticle alignment marks (MA) is 131 mm.

Note

If the reticle is also to be used in PAS 5500 Step & Scan systems, the horizontal chromium borders must have a width of 4.5 mm, and the R-pin areas must be added.

Figure 4.1 shows a detailed layout of a PAS 5500/3x0 reticle, including dimensional tolerances. The dimensions in Figure 4.1 use the left reticle alignment mark (MA) as a reference point, and the midpoint between the left and right alignment marks as the center of the image field. The left reticle alignment mark must be positioned within ± 0.5 mm accuracy relative to the left and bottom edge of the substrate.

The recommended image-border width is 3.0 mm (see also section Image Border (page 35)).

For the recommended pellicle frame see Figure 4.2. Ventilation holes with a diameter of 0.2 mm are recommended, to prevent the pellicle height from increasing. The holes must be located on the side (long edge) of the frame.

PAS 5500/3x0 reticle pattern location

The coordinates in Table 4.1 on page 52 are referenced to the center of the reticle layout (center of image field). The location of this center is 76 ± 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the location shown in the previous columns. A positive orientation is a counterclockwise rotation, a negative orientation is clockwise.

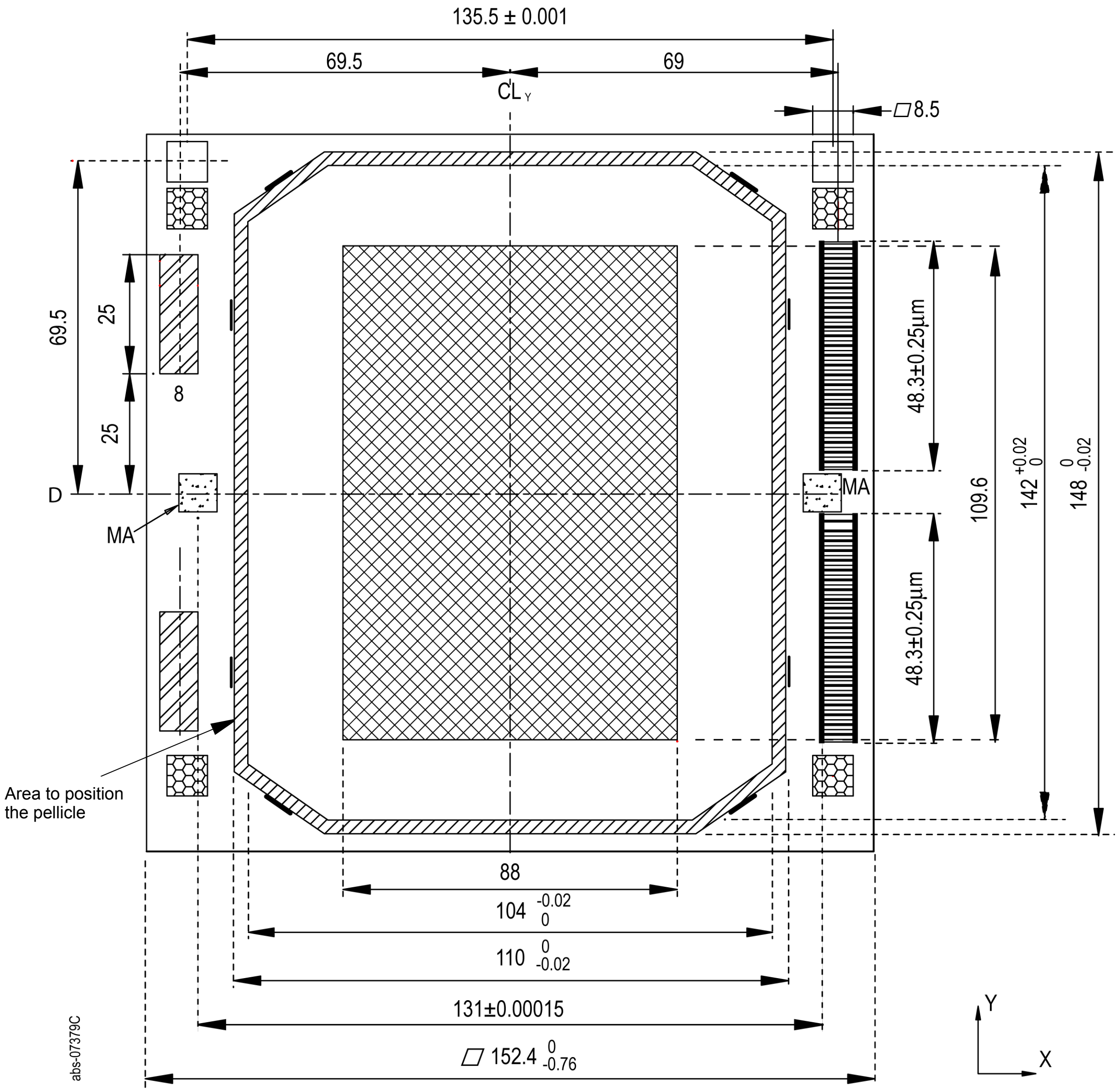
Table 4.1 PAS 5500/3x0 reticle pattern location

Pattern	X size (mm)	Y size (mm)	X pos. (mm)	Y pos. (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
MA	1.467	1.467	-65.50	0	0	

Table 4.1 PAS 5500/3x0 reticle pattern location (Continued)

Pattern	X size (mm)	Y size (mm)	X pos. (mm)	Y pos. (mm)	Orientation (Degrees)	Remarks
			65.50	0	0	
	8.00	8.00				With chromium border
PL	0.30	5.00	55.15	-37.50	90	
			55.15	37.50	90	
			48.66	69.49	-35	
			-48.66	69.49	35	
			-55.15	37.50	90	
			-55.15	-37.50	90	
			-48.66	-69.49	-35	
			48.66	-69.49	35	
B_1	5.00	48.30	69.00	29.15	90	Including quiet zones
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	Including quiet zones
	5.00	48.30				With chromium border
HRC	8.00	25.00	-69.50	37.50	90	
			-69.50	-37.50	90	
For PAS 5500/500 compatibility						
R-pin	6.00	6.00	-71.60	58.00	0	
			-71.60	-58.00	0	
			71.60	58.00	0	
			71.60	-58.00	0	

Reticle and pellicle dimensions for PAS 5500/3x0



Notes:

- CLy is the center line and perpendicular to line D.
  This line divides the distance between the two MA marks into two equal parts.
- The recommended flatness for the reticle is better than 1 micrometer.
- The pattern shown is with chromium side down.
- All dimensions are in mm unless indicated differently.
- All borders are in chromium.

Figure 4.1 PAS 5500/3x0 reticle layout

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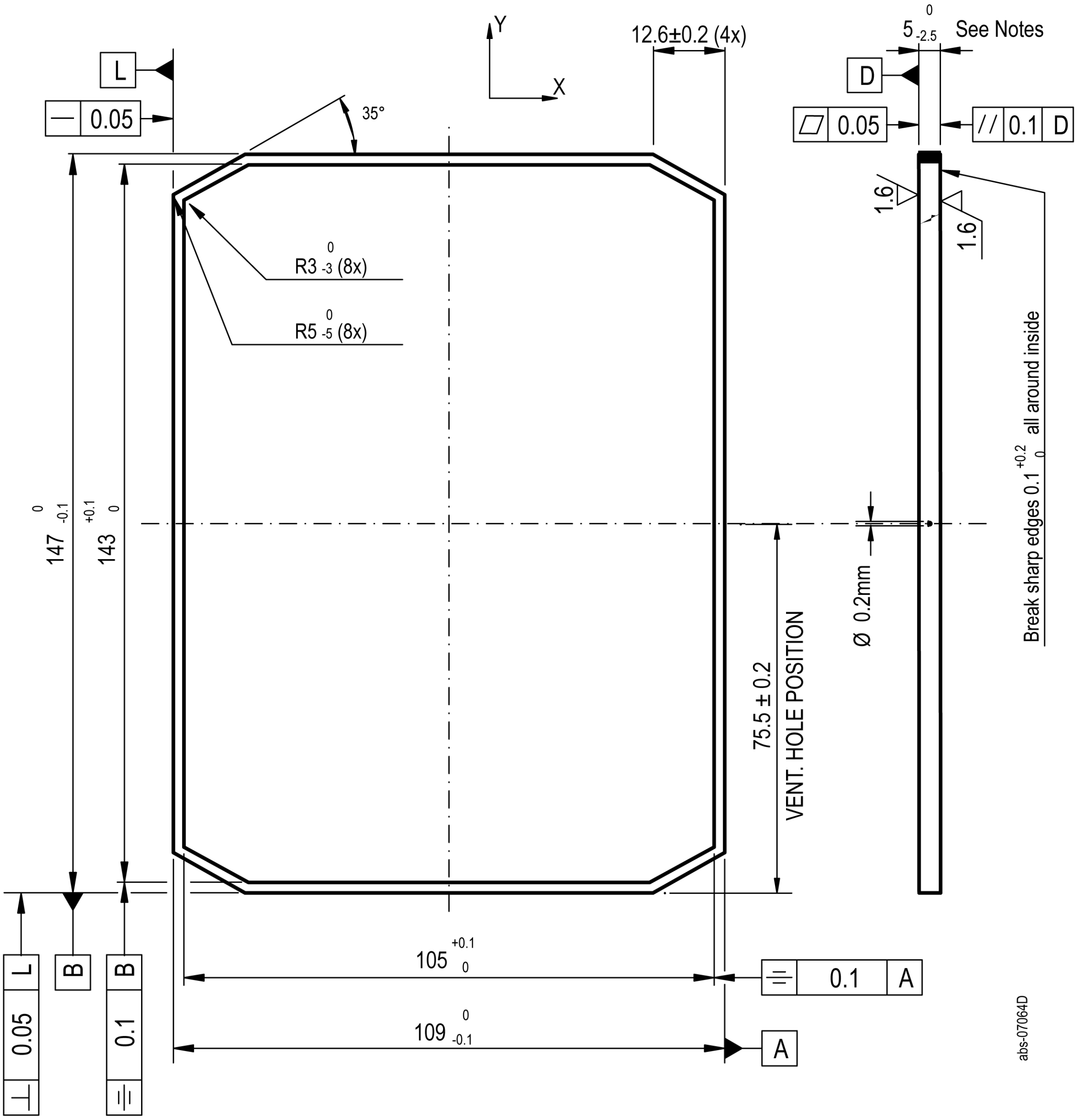


Notes:
- The pellicle height includes pellicle film and pellicle attachment-tape thickness.
- The pellicle attachment- tape is not to protrude beyond the inner and outer edges of the pellicle frame.
- Inserts for pellicle handling may be considered.
- All dimensions are in mm.
- Ventilation holes are recommended.

Figure 4.2 The recommended pellicle frame for PAS 5500/3x0 systems

PAS 5500 STEP & SCAN FAMILY

In the PAS 5500 Step & Scan family we can distinguish three types based on the illumination subsystem:

1. The i-line Step & Scan systems that use an exposure wavelength of 365 nm.
2. The DUV Step & Scan systems that use an exposure wavelength of 248 nm.
3. The 193 nm Step & Scan systems that use an exposure wavelength of 193 nm.

For PAS 5500 systems the maximum image-field size is dependent on the configuration. For an overview of field sizes and the recommended image border see section Image Border (page 35).

PAS 5500 systems equipped with RBA (Reticle Blue Alignment) require the four TIS_RBA marks on the reticle.

Figure 4.3 shows a detailed layout of a PAS 5500 Step & Scan reticle, including dimensional tolerances. The dimensions in Figure 4.3 use the left reticle alignment mark (MA) as a reference point, and the midpoint between the left and right alignment marks as the center of the image field. The left reticle alignment mark should be positioned with ± 0.5 mm accuracy relative to the left and bottom edge of the substrate.

For the recommended pellicle frame, see Figure 4.4.
Ventilation holes with a diameter of 0.2 mm are recommended, to prevent the pellicle height increasing. The holes must be located on the side (long edge) of the frame.

Note

If the reticle is to be used on an i-line and a DUV system, the pellicle film must be compatible with both i-line and DUV.

Note

ASML advises that the compatible Step & Scan reticle design (see “RBA and TTL Compatible reticle for Step & Scan systems” on page 68) is used for platform compatibility.

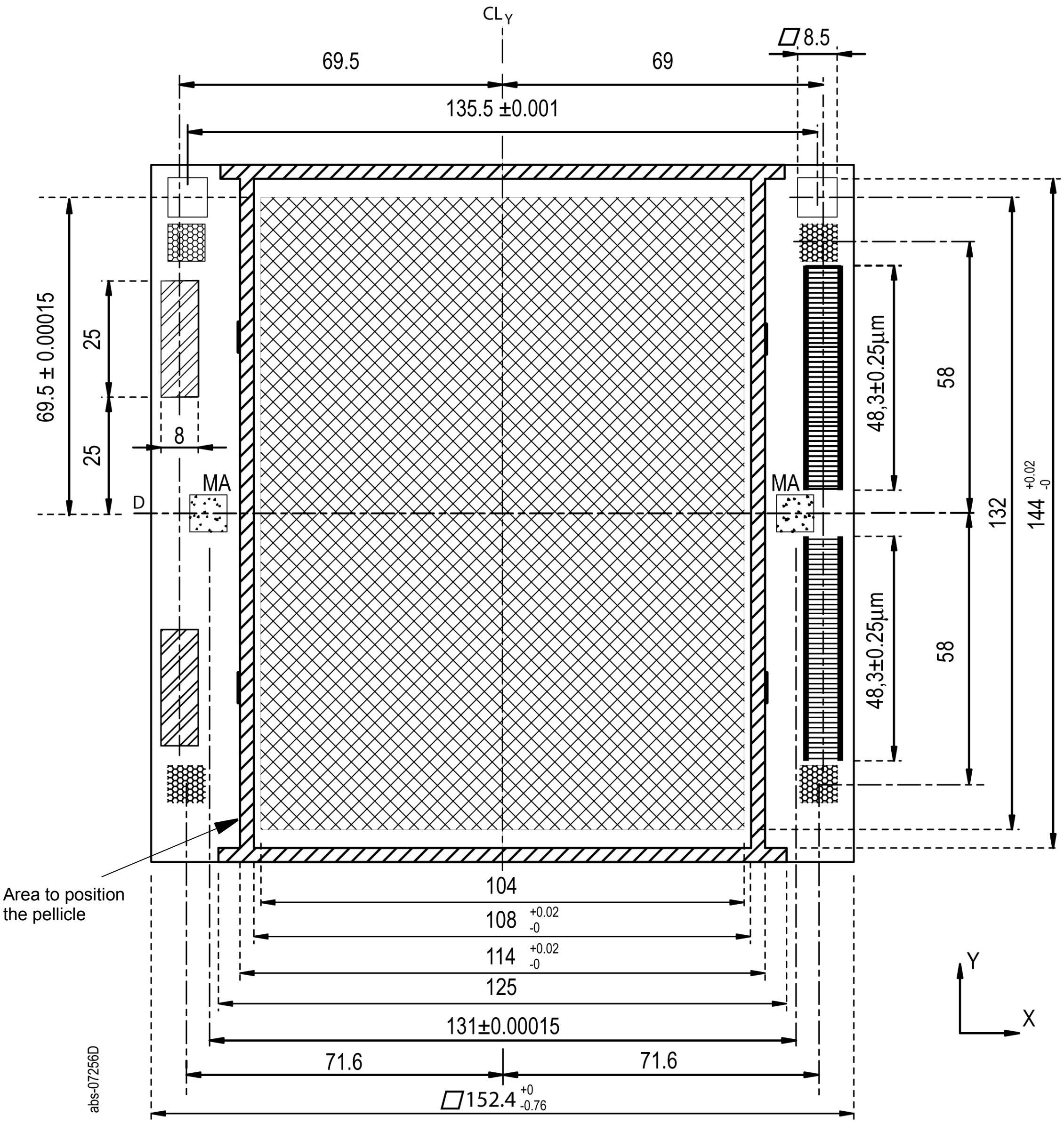
PAS 5500 reticle pattern location

The coordinates in Table 4.2 are referenced to the center of the reticle layout (center of image field). The location of this center is 76 ± 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the location shown in the previous columns. A positive orientation is a counterclockwise rotation, a negative orientation is clockwise.

Table 4.2 PAS 5500 Step & Scan reticle pattern location

Pattern	X size (mm)	Y size (mm)	X pos. (mm)	Y pos. (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
MA	1.467	1.467	-65.50	0.00	0	
			65.50	0.00	0	
	8.00	8.00				With chromium border
PL	0.30	5.00	57.15	-37.50	90	
			57.15	37.50	90	
			-57.15	37.50	90	
			-57.15	-37.50	90	
B_1	5.00	48.30	69.00	29.15	90	Including quiet zones
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	Including quiet zones
	5.00	48.30				With chromium border
HRC	8.00	25.00	-69.50	37.50	90	
			-69.50	-37.50	90	
R-pin	6.00	6.00	-71.60	58.00	0	
			-71.60	-58.00	0	
			71.60	58.00	0	
			71.60	-58.00	0	
TIS R1	note	note	-43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4.
TIS R2	note	note	+43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4. The Y-location of R2 must be the same as the Y-location of R1.
TIS R3	note	note	-43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4.
TIS R4	note	note	+43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4. The Y-location of R4 must be the same as the Y-location of R3.

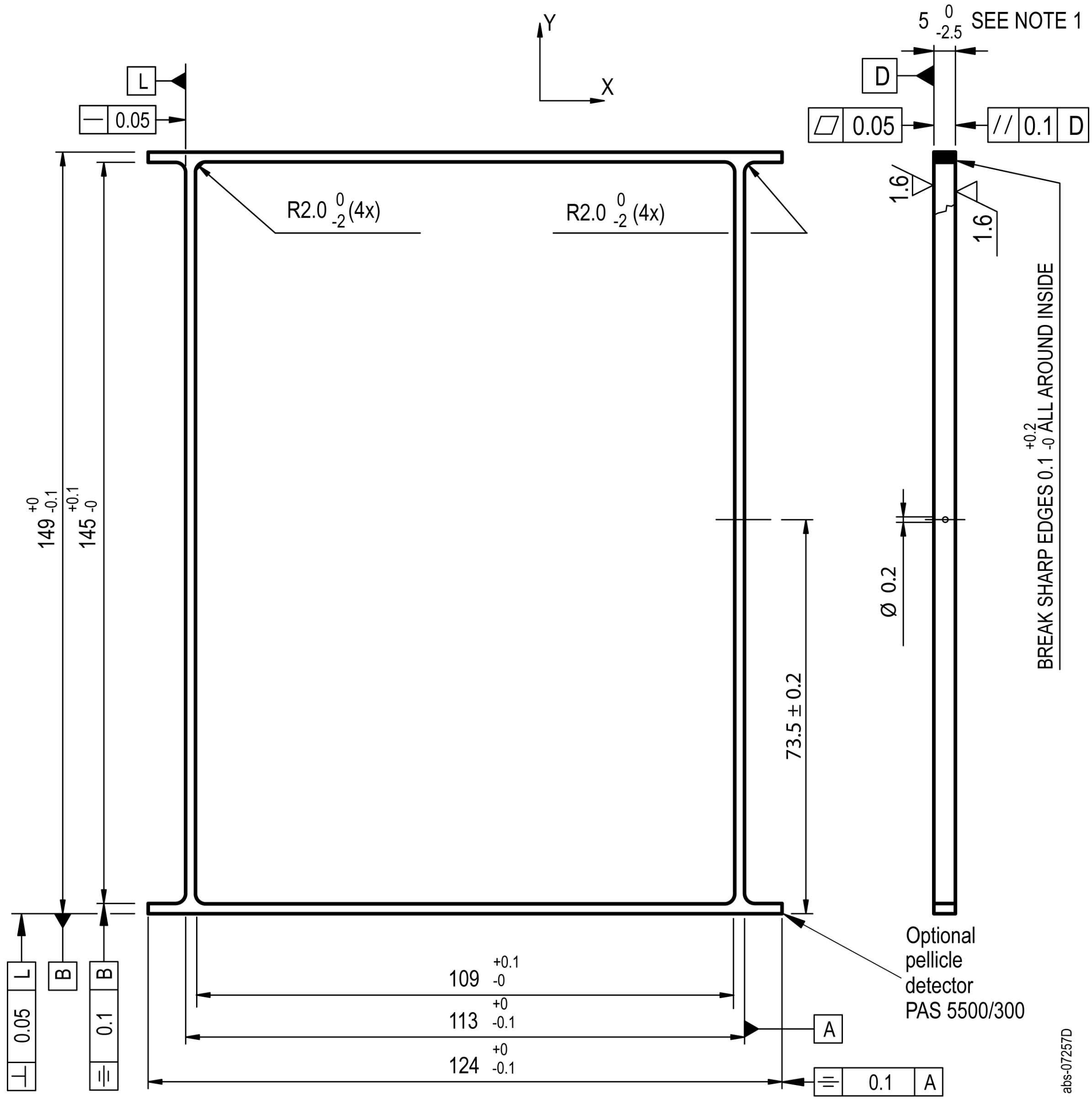
Reticle and pellicle dimensions for PAS 5500 Step & Scan



Notes:

- CLy is the center line perpendicular to line D. The CLy line indicates the middle between both MA marks.
- The recommended flatness for this reticle is less than 1.0 micrometer.
- The pattern is shown with the chromium side down
- All dimensions are in mm.
- All borders are in chromium

Figure 4.3 The reticle layout required for the PAS 5500 Step & Scan systems



Notes:
1. This dimension includes pellicle film and pellicle attachment tape thickness.
2. Pellicle attachment tape not to protrude beyond inner or outer edges of the pellicle frame.
3. Inserts for pellicle handling may be considered.
4. All dimensions are in mm.
5. Ventilation holes are recommended.

Figure 4.4 The recommended pellicle frame for PAS 5500 Step & Scan systems

TWINSCAN

For TWINSCAN systems the maximum field size is dependent on the configuration. For an overview of field sizes and recommended image border see section Image Border (page 35).

Figure 4.5 shows a detailed layout of a standard TWINSCAN reticle, including dimensional tolerances. The dimensions in Figure 4.5 use the center (R) of the reticle layout, as a reference point.
Also refer to section Reticle Layout and Orientation (page 6) for additional details.

The TIS reticle alignment marks should be positioned with respect to the reticle center (R) of the reticle layout, with an accuracy equal to, or better than the accuracy of the image pattern. All four TIS marks (R1, R2, R3 and R4) in the image field are used in the TWINSCAN systems. Refer to section TWINSCAN reticle pattern location (page 61) for more information about the reticle pattern locations.

For the recommended pellicle frame, see Figure 4.6. ASML recommends that a ventilated pellicle frame is used to prevent uncontrolled pellicle variation. The vents must be located on the long side of the pellicle frame to reduce the influence of pressure variations caused by air showers in the machine.

How to use variable TIS-mark locations is shown in Figure 4.6. It can have performance advantages to use TIS marks in variable locations. Before variable TIS mark locations are used it must always be verified first if there is an advantage.

Note

ASML advises that the TIS marks are placed at the maximum specified Y-locations (refer to Figure 4.5 and Table 4.3).

The maximum Y-location in combination with the use of low-quality blank materials can cause problems in achieving TIS mark specifications.

Note

ASML advises that the compatible Step & Scan reticle design (see section RBA and TTL Compatible reticle for Step & Scan systems (page 68)) is used for platform compatibility.

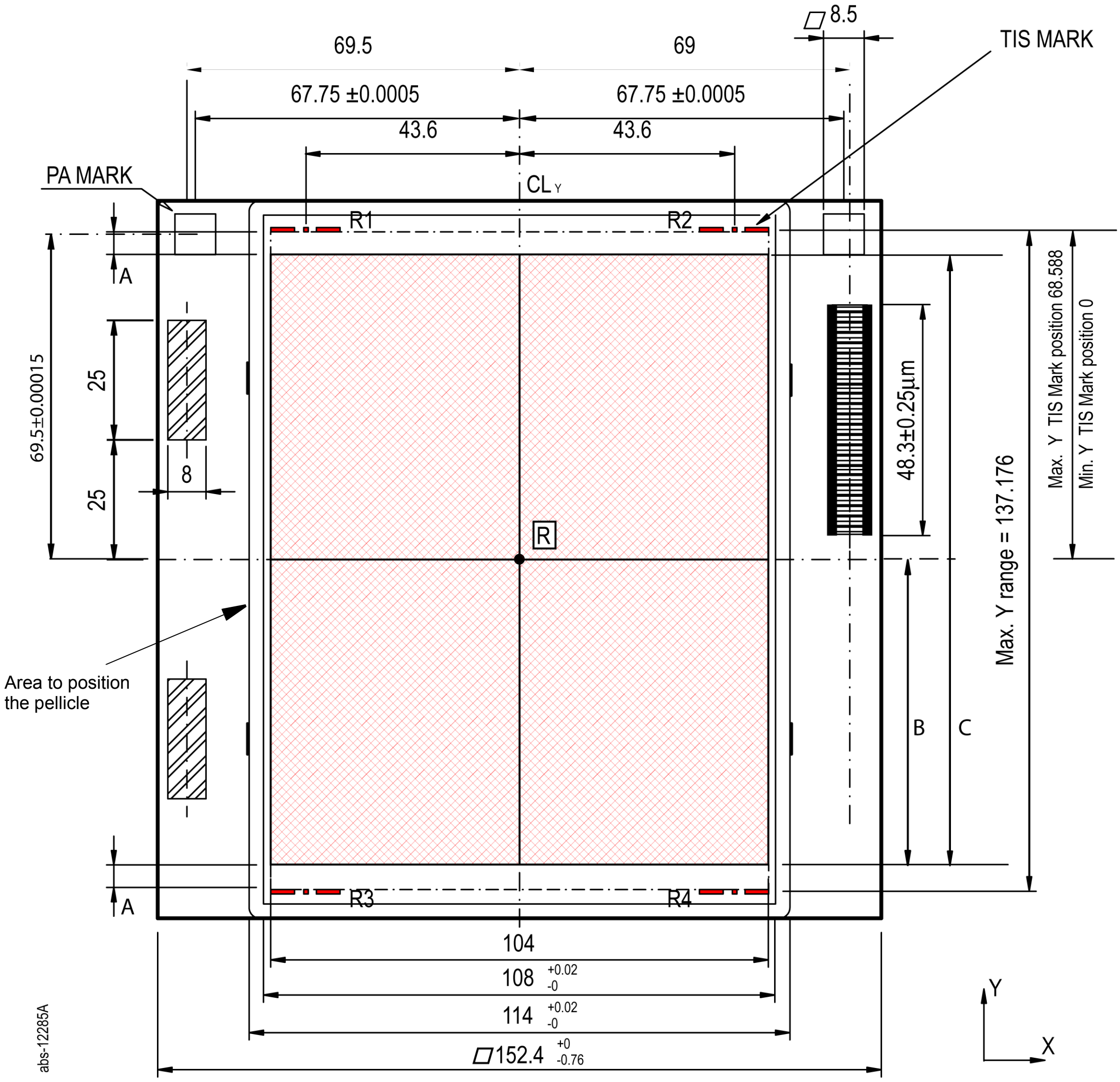
TWINSCAN reticle pattern location

The coordinates in Table 4.3 are referenced to the center of the reticle layout (center of image field). The location of this center is 76 ± 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the location shown in the previous columns. A positive orientation is a counterclockwise rotation, a negative orientation is clockwise.

Table 4.3 TWINSCAN reticle pattern location

Pattern	X size (mm)	Y size (mm)	X pos. (mm)	Y pos. (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
PL	0.30	5.00	57.15	-37.50	90	
			57.15	37.50	90	
			-57.15	37.50	90	
			-57.15	-37.50	90	
B_1	5.00	48.30	69.00	29.15	90	Including quiet zones
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	Including quiet zones
	5.00	48.30				With chromium border
HRC	8.00	25.00	-69.50	37.50	90	
			-69.50	-37.50	90	
TIS R1	note	note	-43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4.
TIS R2	note	note	+43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4. The Y-location of R2 must be the same as the Y-location of R1.
TIS R3	note	note	-43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4.
TIS R4	note	note	+43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4. The Y-location of R4 must be the same as the Y-location of R3.

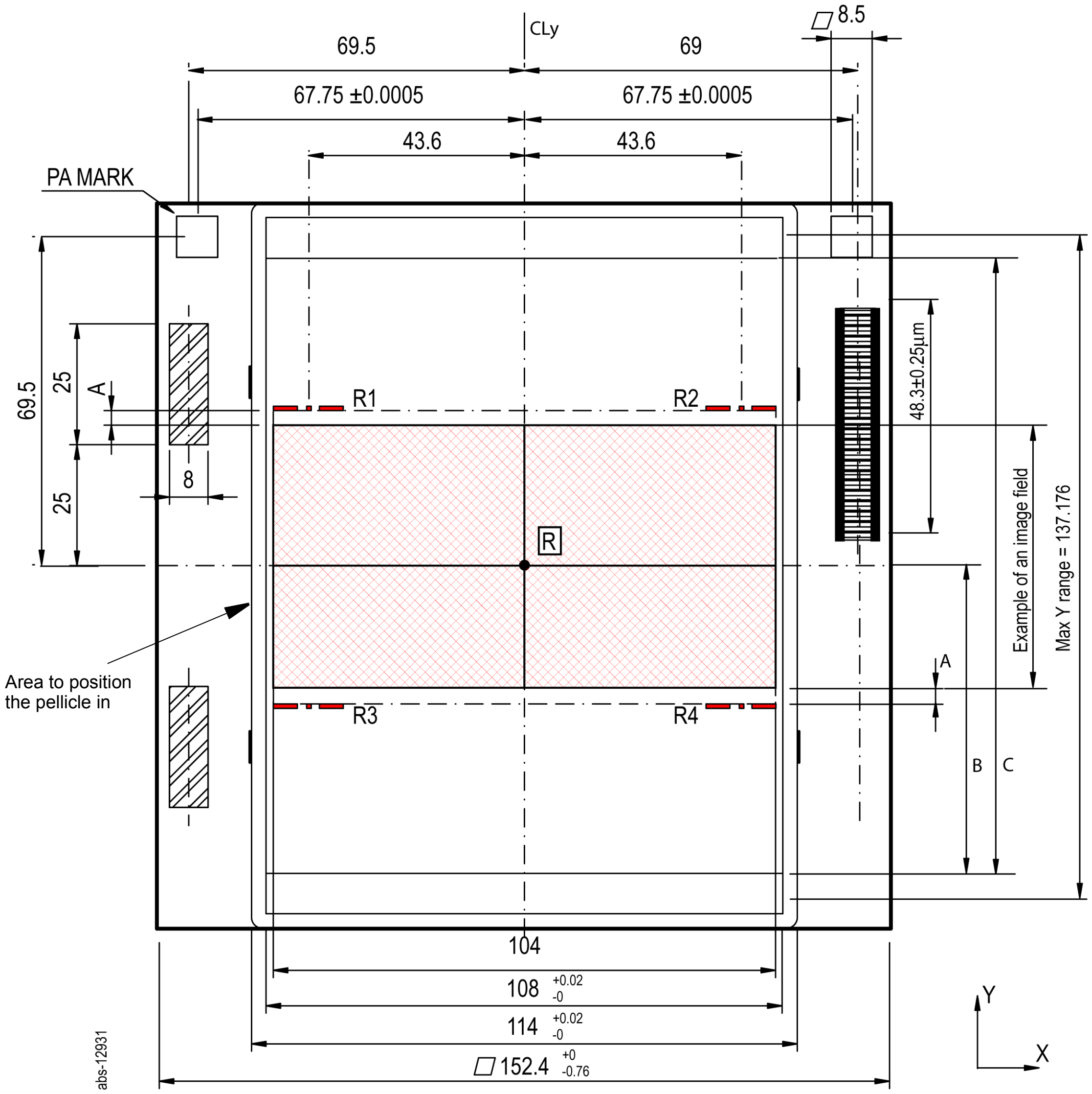
Reticle and pellicle dimensions for TWINSCAN



Legend:
A: Image border size depending on the configuration (see also section: Image Border).
B: Half the maximum image field size (64 mm or 66 mm) depending on the configuration.
C: maximum image field size (128 mm or 132 mm) depending on the configuration

Notes:
- CLy is the center line through R and perpendicular to the line that connects the centers of R1 and R2 TIS marks. This line indicates the middle between both TIS marks.
- The recommended flatness for this reticle is less than 0.5 micrometer.
- The pattern is shown with the chromium side down
- All dimensions are in mm.
- All borders are in chromium

Figure 4.5 An example of a standard TWINSCAN reticle layout



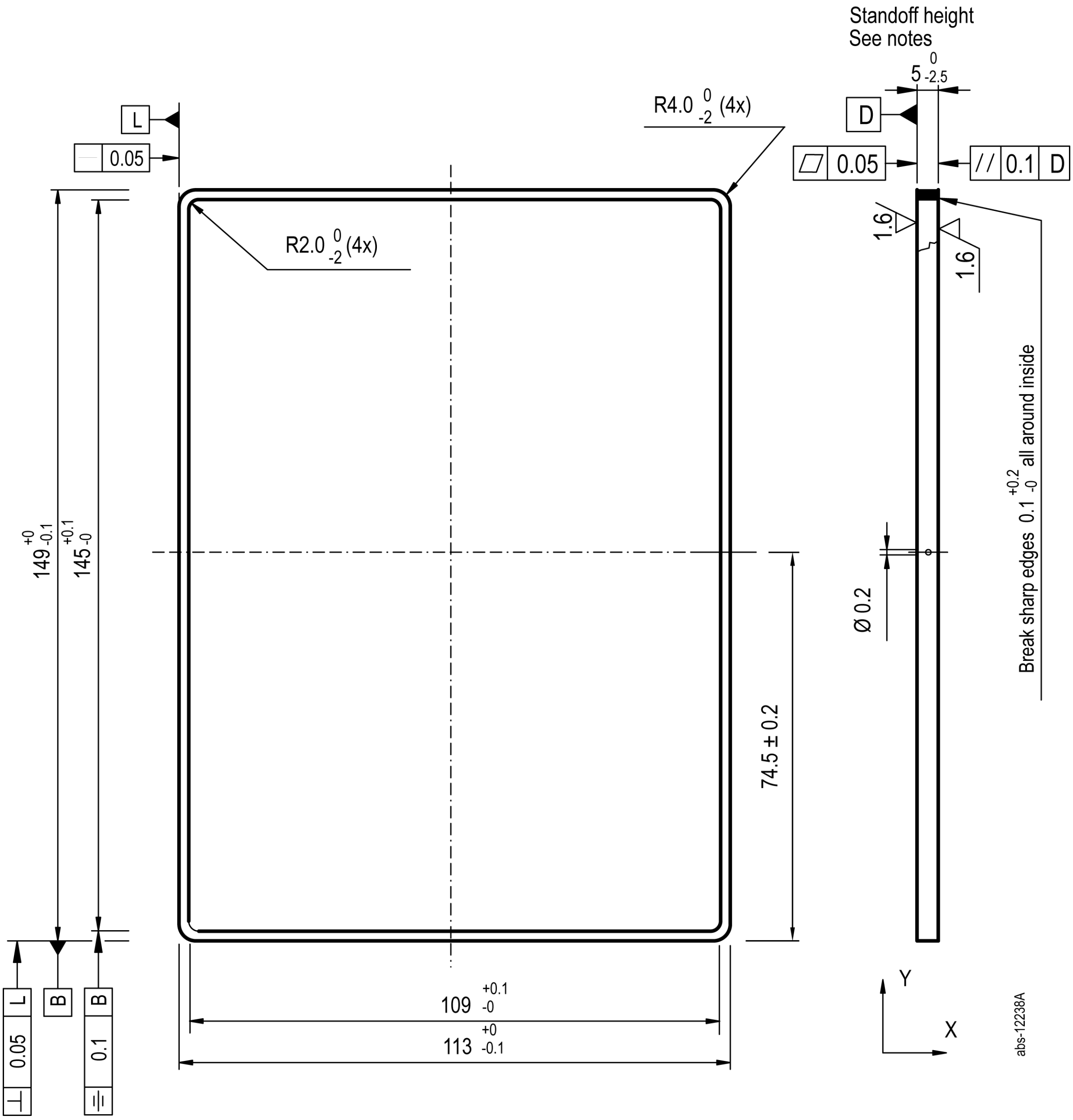
Legend:

A: Image border size depending on the configuration (see also section: Image Border).
B: Half the maximum image field size (64 mm or 66 mm) depending on the configuration.
C: maximum image field size (128 mm or 132 mm) depending on the configuration

Notes:

- CLy is the center line through R and perpendicular to the line that connects the centers of R1 and R2 TIS marks. This line indicates the middle between both TIS marks.
- The recommended flatness for this reticle is less than 0.5 micrometer.
- The pattern is shown with the chromium side down
- All dimensions are in mm.
- All borders are in chromium.

Figure 4.6 An example of variable TIS mark locations



Notes:

- For allowed frame standoff heights see section “General requirements for pellicles” on page 48.
- The pellicle attachment tape must not protrude beyond the inner or outer edges of the pellicle frame.
- Inserts for pellicle handling may be considered.
- All dimensions are in mm.
- Ventilation holes are recommended. On the long side only.

Figure 4.7 Maximum dimensions of the pellicle frame and pellicle on TWINSCAN models

TWINSCAN RETICLE SHAPE CORRECTION

Linear height deviations of the reticle surface are measured by the reticle alignment system. On each corner of the image field a standard TIS mark is used for this alignment.

With the Reticle Shape Correction (RSC) option it is possible to measure nonlinear height deviations of the reticle surface. The RSC option requires additional TIS marks to be added along each side of the image field.

There are additional design requirements for reticles used in combination with the Reticle Shape Correction option.
These requirements affect:

1. Chromium-border and pellicle-frame specifications
2. Default mark layout for RSC
3. Guidelines for modifications on default mark layout.

Chromium-border and pellicle-frame specifications

The additional TIS marks along the horizontal (X) side of the image field have the same specifications as the TIS_RBA marks. The additional TIS marks along the vertical (Y) side of the image field require a modification of the chromium-border size and pellicle frame inner-width in X-direction.

Table 4.4 Changed specifications to enable reticle shape correction

	Current spec	New spec
Chromium border, X	2.5 mm	2.0 mm
Chromium border, Y	2.5 mm	2.5 mm
Distance of vertical marks to pellicle frame	-	1.3 mm
Pellicle frame inner width, X (at maximum field width)	≥ 109 mm	≥ 111.0 mm
Placement accuracy of the pellicle frame	-	0.3 mm
Pellicle frame height	-	≤ 5.0 mm

Note

Reticles with vertical markers placed closer than 2.5 mm to the image field, can only be used on systems where the chromium-border size is set to 2.0 mm.

This is irrespective of whether or not those systems are equipped with the Reticle Shape Correction option.

If the Chromium border is **not** set to 2.0 mm, there is a risk of exposing the vertical TIS marks as ghost images.

The default layout for TIS_RSC marks is outside the regular image field. Figure 4.9 shows the default layout for the additional TIS marks that are used for Reticle Shape Correction. Figure 4.8 also gives an enlarged view of one of the marks for Reticle Shape Correction along the vertical side of the image field. This figure indicates the requirements for pellicle placement and chromium border.

The default locations for the horizontal and vertical marks are given in Table 4.5 and Table 4.5.

Table 4.5 Default locations for the horizontal RSC marks

Nr.	Name	X	Y	Placement tolerance	CD range
1	Y_55_5941_1_A	– 43600	68588	T40 [a]	T1 [b]
2	Y_55_5941_1_A	– 21800	68588	T40	T1
3	Y_55_5941_1_A	0	68588	T40	T1
4	Y_55_5941_1_A	21800	68588	T40	T1
5	Y_55_5941_1_A	43600	68588	T40	T1
6	Y_55_5941_1_A	– 43600	– 68588	T40	T1
7	Y_55_5941_1_A	– 21800	– 68588	T40	T1
8	Y_55_5941_1_A	0	– 68588	T40	T1
9	Y_55_5941_1_A	21800	– 68588	T40	T1
10	Y_55_5941_1_A	43600	– 68588	T40	T1

(a): T40 = 40 nm

(b): T1 = 100 nm

Table 4.6 Default locations for the vertical RSC marks

Nr.	Name	X	Y	Placement tolerance	CD range
1	Y_TIS_TYV_1U0	– 54088	68000	T40 [a]	T1 [b]
2	Y_TIS_TYV_1U0	54088	68000	T40	T1
3	Y_TIS_TYV_1U0	– 54088	38000	T40	T1
4	Y_TIS_TYV_1U0	54088	38000	T40	T1
5	Y_TIS_TYV_1U0	– 54088	8000	T40	T1
6	Y_TIS_TYV_1U0	54088	8000	T40	T1
7	Y_TIS_TYV_1U0	– 54088	– 22000	T40	T1
8	Y_TIS_TYV_1U0	54088	– 22000	T40	T1
9	Y_TIS_TYV_1U0	– 54088	– 52000	T40	T1
10	Y_TIS_TYV_1U0	54088	– 52000	T40	T1

(a): T40 = 40 nm

(b): T1 = 100 nm

Note

For additional information on Reticle Shape Correction please refer to the Application Note on Reticle Shape Correction. This Application Note can be found on CustomerNet.

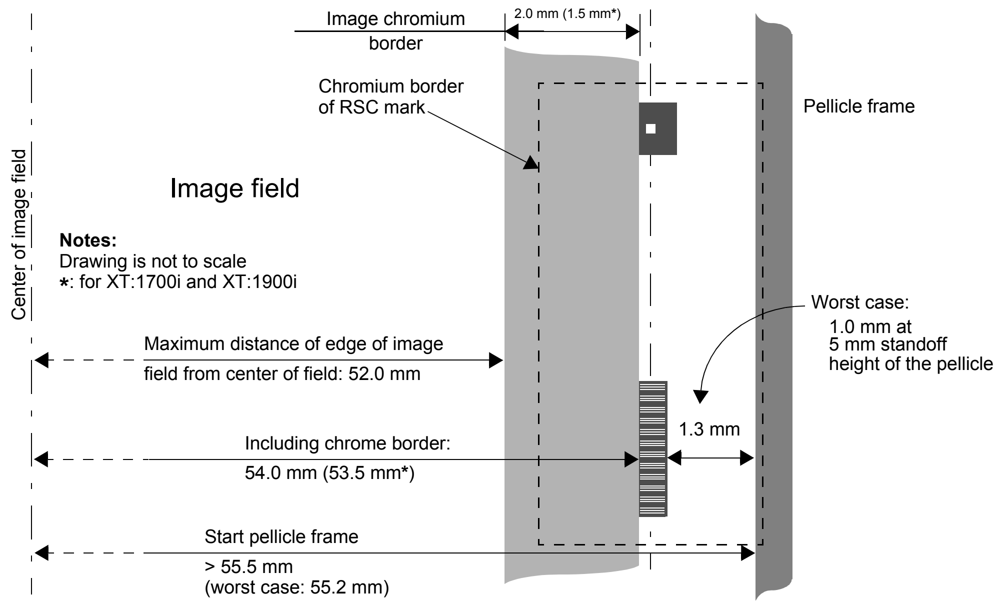
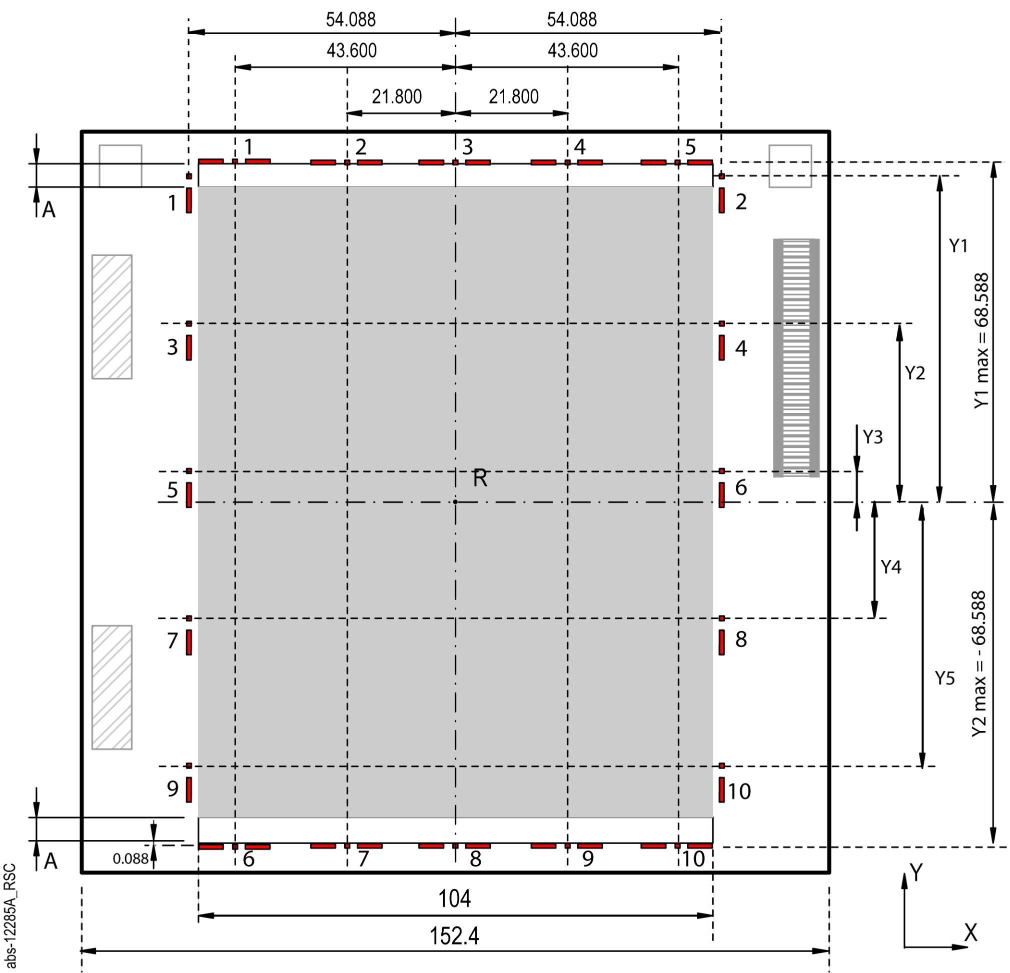


Figure 4.8 Enlarged view of placement of one of the vertical marks



Legend: Y1 = 68.000, Y2 = 38.000, Y3 = 8.000, Y4 = -22.000, y5 = -52.000

Figure 4.9 Default mark layout for RSC marks

RBA AND TTL COMPATIBLE RETICLE FOR STEP & SCAN SYSTEMS

Note that:

- If a reticle is to be used on a system using a different exposure wavelength, the pellicle film must be compatible with the wavelength of that other system.
- If the reticle is to be used for PAS 5500 and TWINSCAN, it must have Reticle Blue Alignment TIS marks (see Figure 4.10).

> **Note**
>
> ASML advises that this design is used for platform compatibility for all Step & Scan systems.

The location and orientation of these reticle patterns are shown in Table 4.7. For dimensional tolerances, refer to Figure 4.10. For the pellicle specifications, see Figure 4.7.

PAS 5500 Step & Scan models, and TWINSCAN reticle pattern location

The coordinates in Table 4.7 on page 68 are referenced to the center of the reticle layout (center of image field). This center should be positioned at 76 ± 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the location shown in the previous columns. A positive orientation is a counterclockwise rotation, a negative orientation is clockwise.

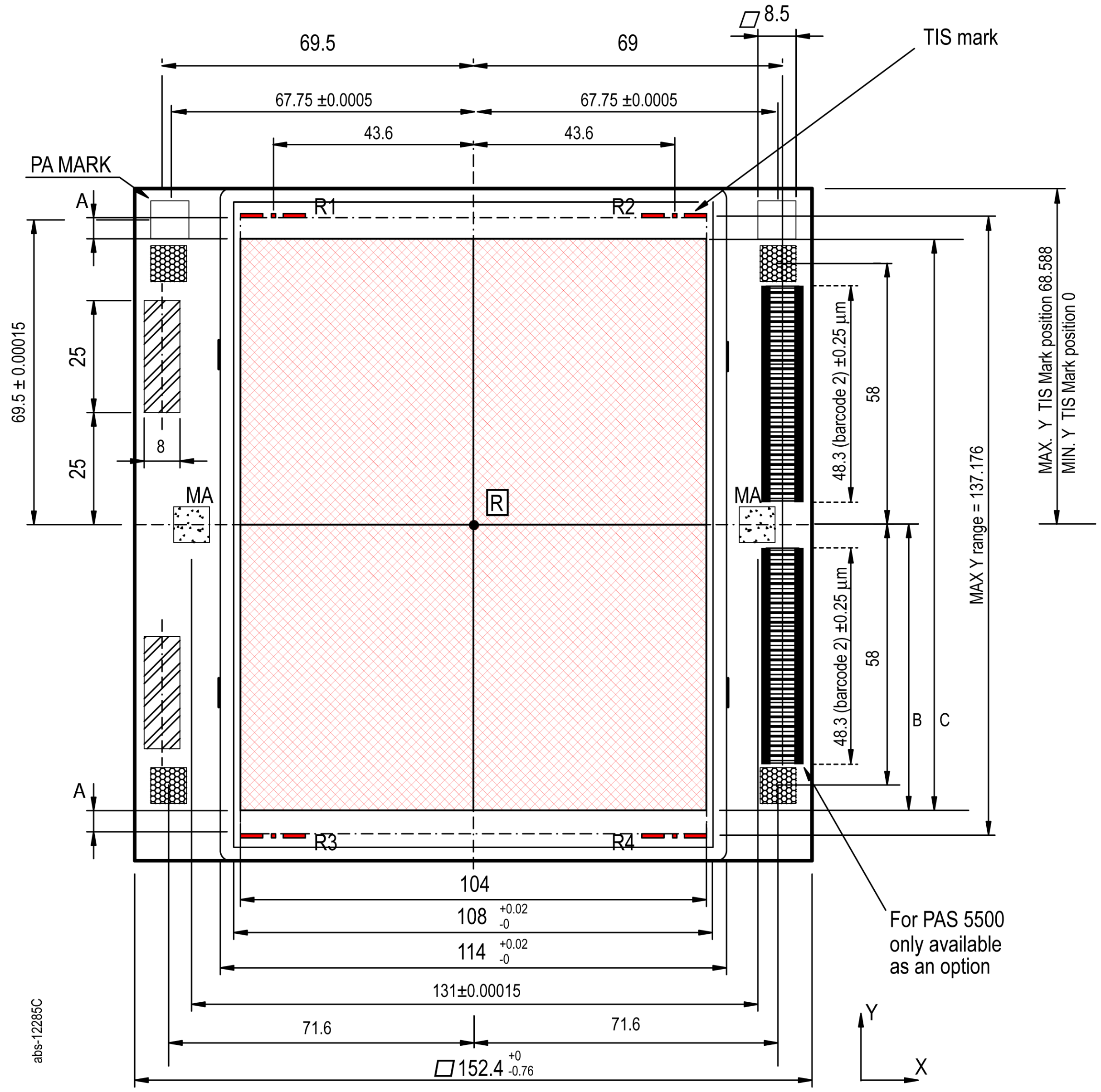
Table 4.7 PAS 5500 and TWINSCAN reticle pattern location

Pattern	X size (mm)	Y size (mm)	X pos. (mm)	Y pos. (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
MA	1.467	1.467	-65.50	0.00	0	
			65.50	0.00	0	
	8.00	8.00				With chromium border
PL	0.30	5.00	57.15	-37.50	90	
			57.15	37.50	90	
			-57.15	37.50	90	
			-57.15	-37.50	90	
B_1	5.00	48.30	69.00	29.15	90	Including quiet zones
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	Including quiet zones
	5.00	48.30				With chromium border
HRC	8.00	25.00	-69.50	37.50	90	

Table 4.7 PAS 5500 and TWINSCAN reticle pattern location (Continued)

Pattern	X size (mm)	Y size (mm)	X pos. (mm)	Y pos. (mm)	Orientation (Degrees)	Remarks
			-69.50	-37.50	90	
R-pin	6.00	6.00	-71.60	58.00	0	
			-71.60	-58.00	0	
			71.60	58.00	0	
			71.60	-58.00	0	
TIS R1	note	note	-43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4.
TIS R2	note	note	+43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4. The Y-location of R2 must be the same as the Y-location of R1.
TIS R3	note	note	-43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4.
TIS R4	note	note	+43.60	-68.588 < Y < +68.588	0	For X and Y size, see TIS mark details in Figure 3.4. The Y-location of R4 must be the same as the Y-location of R3.

Reticle and pellicle dimensions for RBA and TTL compatible reticles



Legend:
A: 2.5 or 4.5 depending on the configuration.
B: 64 or 66 depending on the configuration (see also section: Image Border).
C: 128 or 132 depending on the configuration.

Notes:

- CLy is the center line through R and perpendicular to the line that connects the centers of R1 and R2 TIS marks. This line indicates the middle between both TIS marks.
- The recommended flatness for this reticle is less than 0.5 micrometer.
- The pattern is shown with the chromium side down.
- All dimensions are in mm.
- All borders are in chromium.

Figure 4.10 An example of a reticle that is compatible with both TWINSCAN and PAS 5500 Step & Scan models.

II

RETICLES FOR 5X REDUCTION

A DESCRIPTION OF THE LAYOUT OF 6 INCH RETICLES USED IN:

- **PAS 5500/22**
- **PAS 5500/60 (6 INCH)**
- **PAS 5500/80**
- **PAS 5500/90**
- **PAS 5500/1XX SERIES**
- **PAS 5500/2XX SERIES**

5

DEFINITION OF TERMS AND CONCEPTS

INTRODUCTION

In addition to the product image, the reticle must always have a number of additional patterns to ensure the correct operation of the ASML system. There are patterns to support the:

- Alignment of the reticle to the reticle table
- Alignment of the reticle to the wafer
- Handling of the reticle.

In this part of the manual the locations and dimensions of these patterns are described for 6 inch reticles that support systems with 5x reduction. These systems are:

PAS 5500/22
PAS 5500/60 (6 inch)
PAS 5500/80
PAS 5500/90
PAS 5500/1xx series
PAS 5500/2xx series

Also described within this chapter are:

- The areas which can be used for further identification of the reticle.
- The pellicle specification and the defect specifications for the various reticle patterns.
- Pattern descriptions of the standard wafer marks.

Note

Any deviation from the described positions or dimensions may cause damage to, or malfunctioning of the system.

A Calma GDS2 description, in STREAM format, of all the reticle patterns is available on ASML CustomerNet.

For more help with reticle patterns, please contact your local ASML sales office.

RETICLE LAYOUT AND ORIENTATION

Figure 5.1 shows the relationship between the reticle and wafer coordinate system. There is a five times reduction (5x) from the reticle to the wafer, and the image is inverted over the X and Y axes.

The location of the reticle patterns on the reticle are shown in Figure 5.2.

In this figure point S is the center of the substrate. This center is defined as 76 mm ± 0.5 mm from the left and bottom edge of the substrate.

The point R is the center of the reticle layout. This point is the reference for the reticle patterns, and must be located within an area of 0.5 mm x 0.5 mm around the substrate center (S). The rotation of the reticle layout around the reticle layout center R, with reference to the lower side of the substrate, must be less than 3.3 mrad. The point R is the zero (X and Y) reference for the location of each pattern on the reticle.

The location of each reticle pattern is defined as the center position of this pattern or area, and its location is referenced to the reticle layout center (R).

Note

All figures that show reticle layout and pattern details are viewed through the glass, chromium side down. All dimensions in the figures are in micrometers (μm), unless stated otherwise.

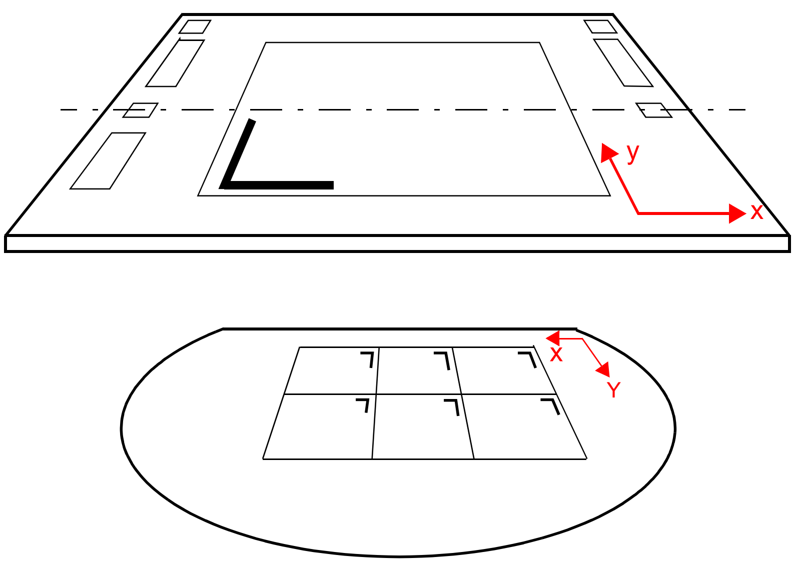
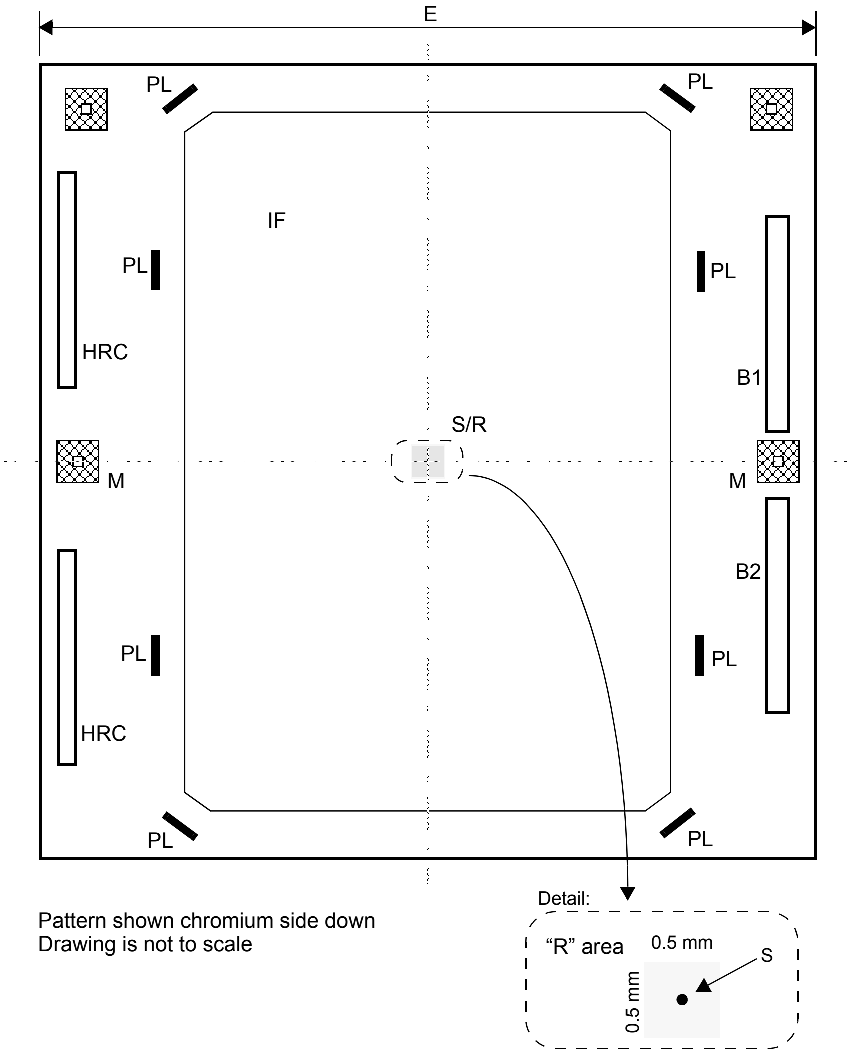


Figure 5.1 Relationship between reticle and wafer coordinate system

Figure 5.2 shows the schematic layout of a PAS 5500 (5x reduction) reticle, and shows all the required reticle patterns.



Pattern shown chromium side down
Drawing is not to scale

B1:	Bar code area	M:	Reticle alignment mark
B2:	24 character barcode area (optional)	P:	Reticle prealignment mark
E:	Edge length = 152 mm (6")	PL:	Pellicle position line
HRC:	Human Readable Code	R:	Center of reticle layout
IF	Image field	S:	Center of substrate

Figure 5.2 Schematic layout of a PAS 5500 5X (6 inch) reticle

6

Generic Information on Reticle Design

RETICLE SUBSTRATE SPECIFICATIONS

The reticle substrate must conform to the SEMI standard P1-83, and P2-86 for Hard Surface Photomask Substrates.

The specifications are:

Nominal edge length:	6 inch square (152.40 mm)
Recommended thickness:	0.250 inch (6.35 mm)
Optional thickness:	0.150 inch (3.81 mm), or 0.120 inch (3.05 mm)
Recommended glass type:	Ultra low thermal expansion quartz
Recommended flatness:	1 μm (total indicated reading over square quality flatness area)
Chromium layer-density:	Optical density OD3 is recommended.

CONTAMINATION AND DEFECTS

The reticle patterns, which are used by the stepper for alignment and identification are not normally inspected for contamination or defects. However, too many defects can affect the accuracy of the alignment system and cause bar code reader errors. It is therefore important that the reticle areas are inspected.

The alignment system and bar code reader are affected by the total defect area. The number of defects is based on what generally can be expected from the maximum number of defects/area in these regions, together with the stepper specifications.

Bar Code

The bar code consists of alternating bright and dark lines 5000 μm long. The width of the lines is either 200 or 450 μm. The only error which can occur due to defects is the bar code reader misinterpreting the actual width. This can cause a wrong or failed reticle identification.

No defects larger than 30 μm can be expected in the bar code area, including the quiet zones at the start and end of the bar code.

Reticle prealignment mark

The registration of this mark is based on the intensity variation between the four quadrants of a quad cell. The mark has a four fold symmetry. A defect in one of the quadrants will result in a intensity difference, and an erroneous shift in position.

No defects larger than 10 μm are allowed in the prealignment mark, including the chromium border.

Reticle alignment mark

The principle of this alignment is scanning the images of two gratings (reticle and wafer) over each other. The sine wave intensity is measured, and is related to a stage position. The reticle grating has a 40 μm period and the lines are 800 μm long for each direction. The scan uses 20 periods in the reticle grating. Defects may cause a shift in the apparent line position, and therefore a shift in the center of gravity of the grating. This will result in a shift in the alignment position.

No defects larger than 3 μm are allowed in the 40 μm period areas including the chromium border.

RETICLE DATA FILES

The possible reticle patterns and layouts for each system are available on ASML Customer Net.

The 5X data is stored in GDS files in STREAM format with these filenames:

- 5500-22.gds
- 5500-60.gds
- 5500-80.gds
- 5500-90.gds
- 5500-1xx.gds
- 5500-2xx.gds

Each GDS file contains five layers:

Layer 0: Prealignment marks (mark design and position)
Layer 1: Reticle alignment marks (mark design and position)
Layer 2: Pellicle position lines (standard design, position and orientation)
Layer 3: Borders of all reticle patterns
Layer 4: Wafer mark layouts (5X) (see Table 6.1).

The combination of layers 0,1 and 2 gives the standard layout. Layer 3 can be used to verify whether, for example, titles and bar codes are within the specified areas.

Table 6.1 Position of wafer marks (5X) in GDS layout

Name in gds file	ASML name	X location	Y location	Rotation	Mag
Y_450_2355_2	XPA-XS	- 14600	29200	0	1
Y_450_2353_2	XPA-YS	14600	29200	0	1
Y_450_2404_1	SPM-XS	- 14600	14600	0	1
Y_454_2017_1	XPA-S	0	14600	0	1
Y_450_2403_1	SPM-YS	14600	14600	0	1
Y_435_7693_1	PM	0	0	0	1
Y_450_2402_1	SPM-X	-14600	- 14600	0	1
Y_454_2016_2	XPA	0	- 14600	0	1
Y_450_2401_1	SPM-Y	14600	- 14600	0	1
Y_450_2354_2	XPA-X	- 14600	- 29200	0	1
Y_450_2352_2	XPA-Y	14600	- 29200	0	1

7

Reticle Patterns (5x reduction)

Summary

This chapter gives a description of the layout requirements for 6 inch reticles used in:

PAS 5500/22
PAS 5500/60 (6 inch)
PAS 5500/80
PAS 5500/90
PAS 5500/1xx series
PAS 5500/2xx series

For correct operation, in addition to the device layout image, the reticle should contain:

- Patterns for pre-aligning the reticle to the reticle table.
- Reticle alignment marks for aligning the reticle to the wafer.
- A bar code for reticle identification.

The required position and dimensions of these are described for each model type. Also described within this chapter are:

- The areas which can be used for further identification of the reticle.
- The pellicle specification and the defect specifications for the various reticle patterns.
- Pattern descriptions of the standard wafer marks.

Note

Any deviation from the described positions or dimensions may cause damage to, or malfunctioning of the system.

A Calma GDS2 description, in STREAM format, of all the reticle patterns is available on ASML Customer Net.

For more help with reticle patterns, please contact your local ASML sales office.

Figure 5.1 shows the relationship between the orientation of the reticle and wafer coordinate system. There is a five times reduction from the reticle to the wafer, and the image is inverted over the X and Y axes.

RETICLE PREALIGNMENT MARK

The reticle prealignment mark (P) is a star shaped pattern that is found twice on the reticle (see Figure 7.1). The marks are used by the reticle handling system to prealign the reticle on the reticle table. The marks should be clear with a dark (chromium) background. The chromium background must have an area of at least 8.5 x 8.5 mm^2 centered around each prealignment mark. The chromium cross in the center of the prealignment mark can be used for inspection with an optical metrology tool.

See “Reticle Layout (5x reduction)” on page 93. for the location of the mark on the reticle.

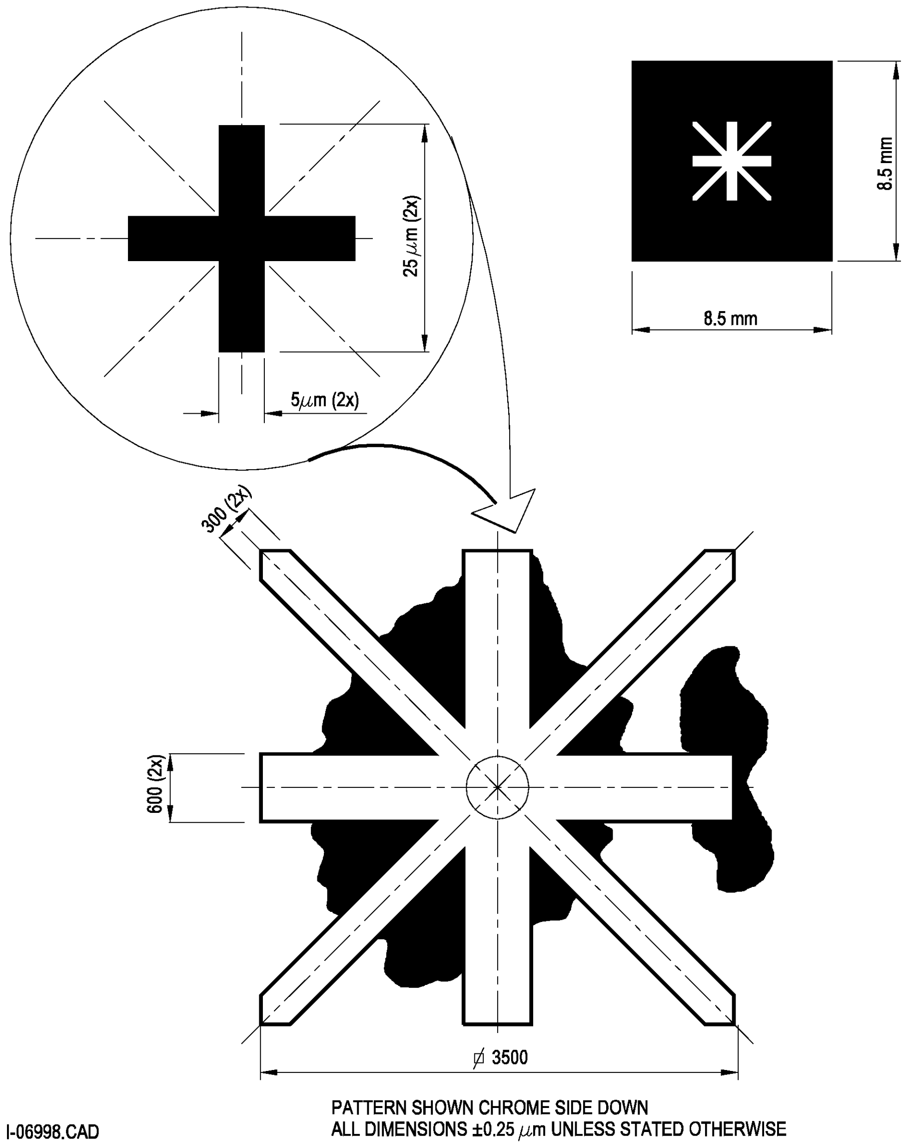


Figure 7.1 The reticle prealignment mark

RETICLE ALIGNMENT MARK

The reticle alignment mark (MA) is a square pattern, subdivided into four quadrants (see Figure 7.2). There are two vertical and two horizontal gratings, with one grating in each quadrant. In two of the gratings (one horizontal and one vertical), the grating period is 40 µm and in the other two the period is 44 µm. The duty cycle of the gratings must be 50%. The chromium cross in the center of the mark can be used for inspection with an optical metrology tool.

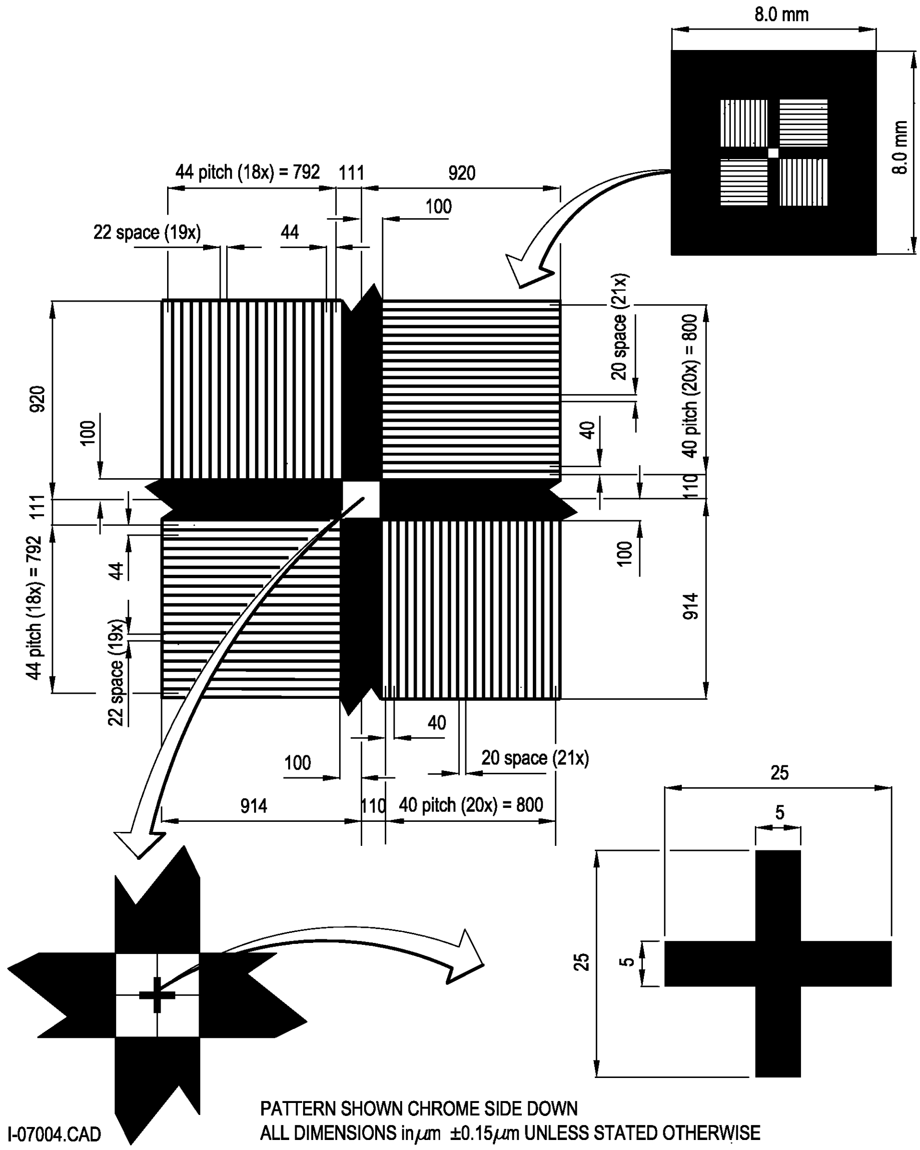


Figure 7.2 ***The reticle alignment mark***

Two reticle alignment marks are used for Through The Lens (TTL) alignment of the reticle to the wafer in global and/or field by field alignment mode. The nominal distance between the marks depends on the distance at reticle level between the alignment branches in the stepper (see Table 7.1).

When a reticle will be used on different PAS 5500 models, the reticle alignment marks for all models should be patterned on the reticle. This results in four or six reticle alignment marks on the reticle.

The mark must have a dark (chromium) background with an area of at least 8.0 x 8.0 mm^2 centered around each alignment mark.

For the location of the marks on the reticle, see "Reticle Layout (5x reduction)" on page 93.

Table 7.1 Alignment mark distances

Stepper type	Alignment mark distance (mm)
PAS 5500/22	126
PAS 5500/60	111
PAS 5500/80	126
PAS 5500/90	126
PAS 5500/1xx series	139
PAS 5500/2xx series	139

BAR CODE

The bar code is used for automatic identification of the reticle. The system uses the Alpha-39 industrial standard bar code which has an alphanumeric character set consisting of the integers 0-9, upper case letters A-Z, and seven special characters: % + / $. - and space (see Figure 7.3).

The code format (see Figure 7.4) consists of:

- A quiet zone
- A start character
- The actual code
- A stop character
- Another quiet zone.

The quiet zone 2 at the beginning consists of an 8 mm x 5 mm chromium area and the quiet zone 1 at the end has a 2 mm x 5 mm chromium area. (The 8 mm x 5 mm quiet zone must be located closest to the prealignment mark (see Figure 7.1).) The actual user defined code may consist of up to 12 characters. The user defined characters are always preceded by the Start/Stop character and the last character of the user defined code is always followed by a Start/Stop character.

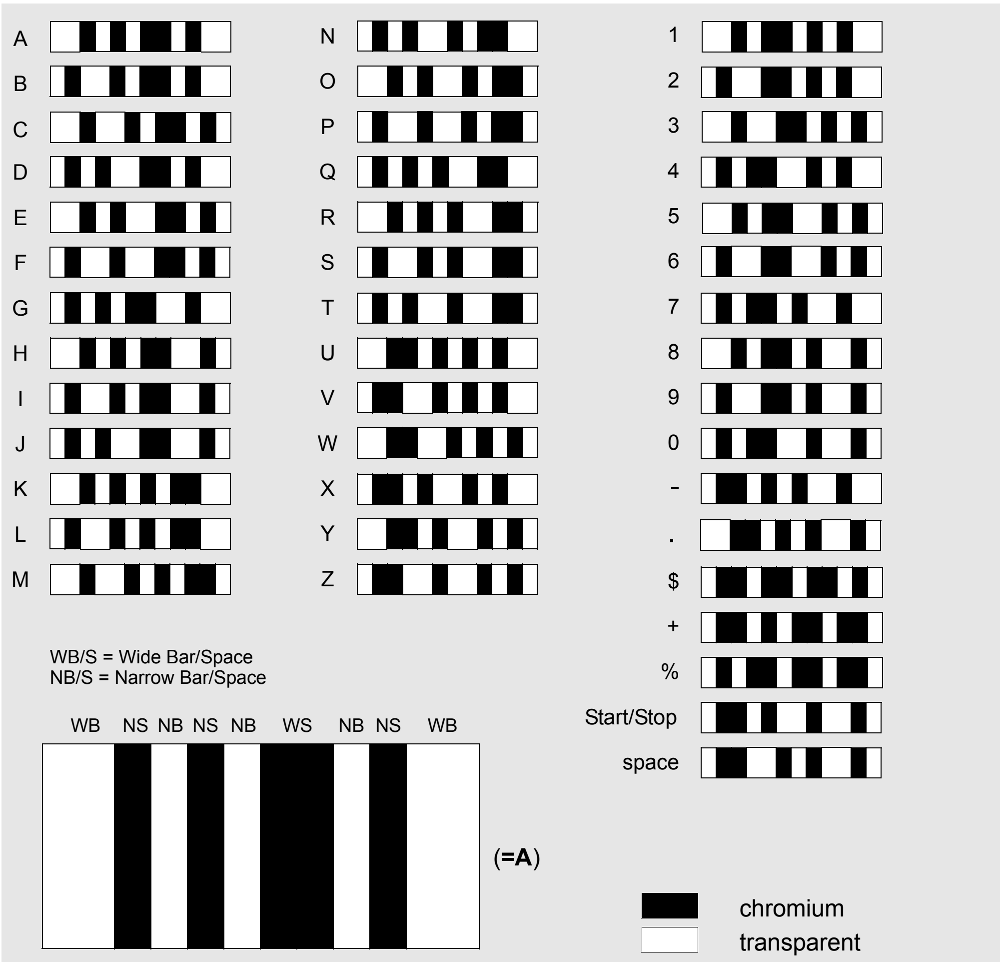


Figure 7.3 The bar code characters

ASML Confidential

Bar Code dimensions

All characters of the bar code, including Start/Stop, consist of nine elements. These elements are five clear rectangles separated by opaque chromium spaces either 0.2 mm or 0.45 mm wide. Every character structure begins and ends with a clear rectangle.

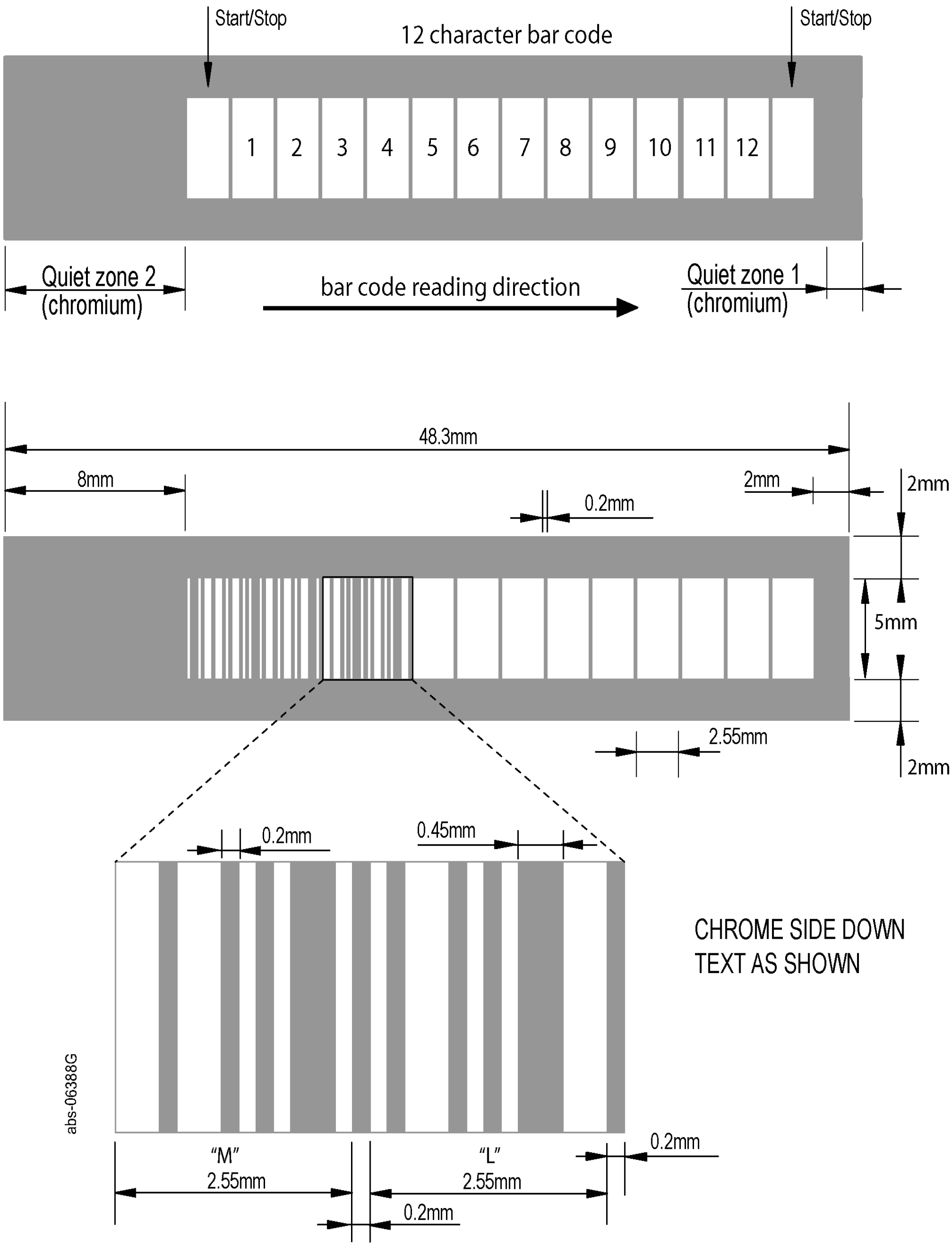


Figure 7.4 The bar code structure and dimensions

The characters must be 2.55 mm wide, and therefore must consist of three wide (0.45 mm) and six narrow (0.2 mm) elements. The height of each element is 5 mm. Between the characters, there is a spacing of 0.2 mm of chromium.

Depending on the number of characters in the user defined code, the size of the bar code varies between 15.3 (2 characters code) and 48.3 mm (12 characters code).

A chromium line, at least 2 mm wide, must be along each side of the bar code, (it is not required before or after the quiet zones).

An area on the reticle is reserved for the location of the bar code. The bar code should be positioned somewhere inside this area. See “Reticle Layout (5x reduction)” on page 93. for the location of this area on different reticles.

The 24-character bar code option

The 24 character bar code option is designed to enable larger logical codes for distinguishing reticles. It allows customers to double the length of the identification bar codes from the standard 12 characters to 24 characters, and allows those who use a large number of reticles to easily distinguish between them by reading the bar code. This option is available on PAS 5500 Steppers and Step & Scan systems with ARMS installed, and with software release 8.5 and higher.

The 24-character bar code option can also be used with old jobs made with the 12 character reticle bar code system and older software releases. New jobs that use the 24-character bar code option can also be read on older software releases, but in this case the reticle bar code will be truncated to the original 12 character bar code. Because of the unique nature of the 24-character bar code option, it will not be possible to downgrade to previous software releases. It is therefore advisable to use 24-character bar codes across the whole fabrication facilitiy.

Figure 7.4 shows the structure and dimensions of a 12-character bar code. The specifications for the second half of the 24 character bar code is identical.

PELLICLE POSITION LINES

A pellicle position line is a rectangle of 5.0 x 0.3 mm (see Figure 7.5). There are eight pellicle position lines positioned around the image field on the reticle.

The size of the pellicle position lines may vary from that shown in Figure 7.5, but the position of the inner edge (closest to the image field) must remain the same.

The pellicle position lines can be used to place the pellicle correctly on the reticle. The outer edge of the pellicle must be within the boundaries indicated by these eight lines.

See “General requirements for Pellicles” on page 91. for more information on using a pellicle. For the location of the pellicle position lines and the dimensions for the various stepper models, See “Reticle Layout (5x reduction)” on page 93.

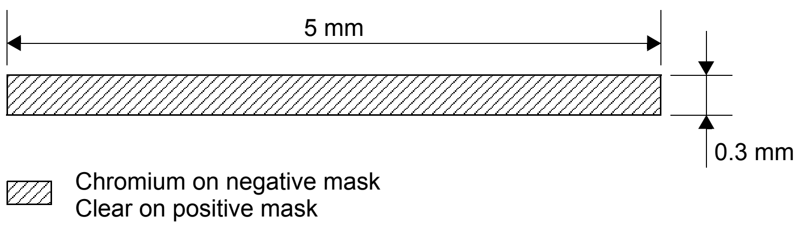


Figure 7.5 The pellicle position line

HUMAN READABLE CODE

On the reticle there are two areas reserved for user defined, human readable codes. The size of each area is 45 x 2.5 mm.

For the location of these areas, See “Reticle Layout (5x reduction)” on page 93.

IMAGE BORDER

To print only the desired part of the image field, the REMA blades of the stepper can put a window over the reticle. Because of the accuracy of the REMA blades and the half shadow effect, each image in the image field should be surrounded by a chromium border.

The recommended width varies, according to stepper type, between 3.0 and 7.2 mm (See “Reticle Layout (5x reduction)” on page 93.). The inner edge of the border defines the area which is printed. This inner edge may be located just on the edge of the image field with the rest of the border outside this field. In this case the width given in Chapter 13 is still required.

When two images are located inside the image field, each image should be surrounded by an image border. The images can be separated by only one border stripe (see Figure 7.6).

The image border required depends on the characteristics of both the illumination system and the resist process. A wider image border will always give greater manufacturing tolerance for printing separate images from one die, but at the cost of increased chromium area. A range of allowed image borders is given in Chapter 13.

The minimum border value is that given for the REMA acceptance testing. The maximum image border is sufficiently large that the penumbra intensity falls well below 1% and no shadow effects can occur on adjacent dies.

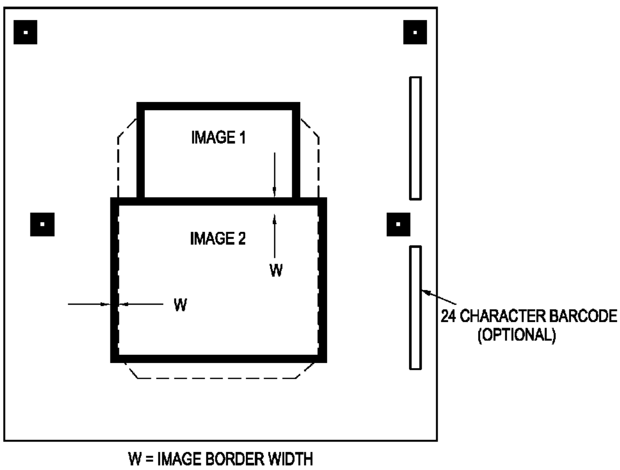


Figure 7.6 The image borders for steppers

Minimum window

The minimum REMA window size for the PAS 5500/2xx series is 5.6 mm (reticle level). When smaller images must be printed the chromium border around these images must be extended to form the required window size. Examples are shown in Figure 7.7, where (A) is the normal image border and (B) is an extended image border.

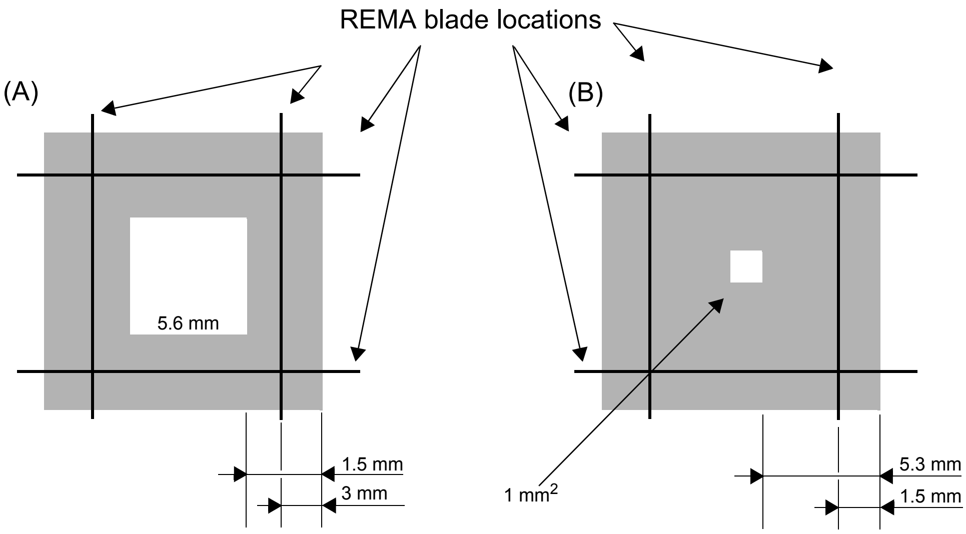


Figure 7.7 Examples of normal and extended image borders

GENERAL REQUIREMENTS FOR PELLICLES

The PAS 5500 steppers can use reticles with pellicles on both sides. The total frame standoff-height including possible film bow, adhesive and film thickness, depends on the substrate thickness and must not be more than the values shown in Figure 7.8. Also a minimum height of 2.5 mm is required for pellicle detection.

Ventilation holes with a diameter of 0.2 mm are recommended, to prevent the pellicle height from increasing (See “Reticle Layout (5x reduction)” on page 93.).

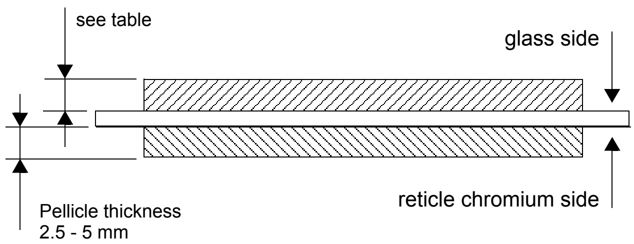
The eight pellicle position lines can be used to place the pellicle correctly on the reticle. The outer edge of the pellicle must be within the boundaries indicated by these eight lines.

The pellicle film type should be optimized for the exposure wavelength.

CAUTION

To prevent pellicle or reticle damage, the pellicle film must not extend more than 100 µm above the frame.

If the pellicle is placed outside the inner edge of the pellicle position lines, a reticle handling error can occur. This may cause damage to the reticle, the reticle management system and the pellicle.



Reticle thickness	Pellicle thickness glass-side (PAS 5500 only)
0.120 **[inch]**	2.5 - 3.0 mm
0.150 **[inch]**	2.5 mm
0.250 **[inch]**	0 mm

Figure 7.8 Pellicle frame standoff height

8

RETICLE LAYOUT (5X REDUCTION)

PAS 5500/22

The PAS 5500/22 uses i-line as the exposure wavelength (365 nm). The maximum field size is:

	Wafer level	Reticle level
Diameter:	31.1 mm	155.5 mm
Maximum Y:	27.4 mm	137.0 mm
Maximum X:	22.0 mm	110.0 mm

The distance between the reticle alignment marks is 126 mm. This makes the reticles compatible with the PAS 5500/80 and the PAS 5500/90. When reticles are also used on the PAS 5500/1xx series or PAS 5500/2xx series systems, additional reticle alignment marks are necessary. The mark spacing for the PAS 5500/1xx series and PAS 5500/2xx series is 139 mm.

> **Note**
>
> The maximum field size of the PAS 5500/60, PAS 5500/80 and PAS 5500/90 is smaller than that of the PAS 5500/22.
>
> Reticle compatibility can only be obtained for the smallest field size and the widest chromium borders of the different steppers.
>
> If the reticle is also to be used on the PAS 5500/60 then the PAS 5500/60 layout must be used (see “PAS 5500/60” on page 98)
>
> **If reticles are to be used on PAS 5500/22 and PAS 5500/90 machines, the pellicle film should be compatible with both i-line and DUV.**

Figure 8.1 shows a detailed layout of a PAS 5500/22 reticle, including dimensional tolerances. The dimensions in Figure 8.1 use the left (chromium side down) reticle alignment mark (M1) as a reference point, and the mid-point between the left and right alignment marks as the center of the image field. The left reticle alignment mark should be positioned with $\pm$ 0.5 mm accuracy relative to the left and bottom edge of the substrate.

Image border The minimum image-border width is 5mm, recommended is 7.2 mm.

Pellicle Frame For the recommended dimensions of the pellicle frame, see Figure 8.2.

Ventilation holes with a diameter of 0.2 mm are recommended, to prevent the pellicle height from increasing. These holes must be located on the side (long edge) of the frame.

Reticle-pattern position

The coordinates in Table 8.1 are referenced to the center of the reticle layout (center of image field). This center should be positioned at 76 ± 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the position shown in the previous columns. A positive orientation is a counter-clockwise rotation, a negative orientation is clockwise. .

Table 8.1 PAS 5500/22 reticle pattern position

Pattern	X size (mm)	Y size (mm)	X pos (mm)	Y pos (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
M	1.834	1.834	-63.00	0.00	0	
			63.00	0.00	0	
	8.00	8.00				With chromium border
PL	0.30	5.00	60.65	-37.50	90	
			60.65	37.50	90	
			48.66	69.49	-30	
			-48.66	69.49	30	
			-60.65	37.50	90	
			-60.65	-37.50	90	
			-48.66	-69.49	-30	
			48.66	-69.49	30	
B_1	5.00	48.30	69.00	29.15	90	
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	
	5.00	48.30				With chromium border
HRC	2.50	45.00	-70.25	27.50	90	
			-70.25	-27.50	90	
For PAS 5500/60 compatibility						
M	1.834	1.834	-55.50	0.00	0	
			55.50	0.00	0	
	8.00	8.00				With chromium border
For PAS 5500/1xx series and PAS 5500/2xx series compatibility						
M	1.834	1.834	-69.50	0.00	0	
			69.50	0.00	0	
	8.00	8.00				With chromium border

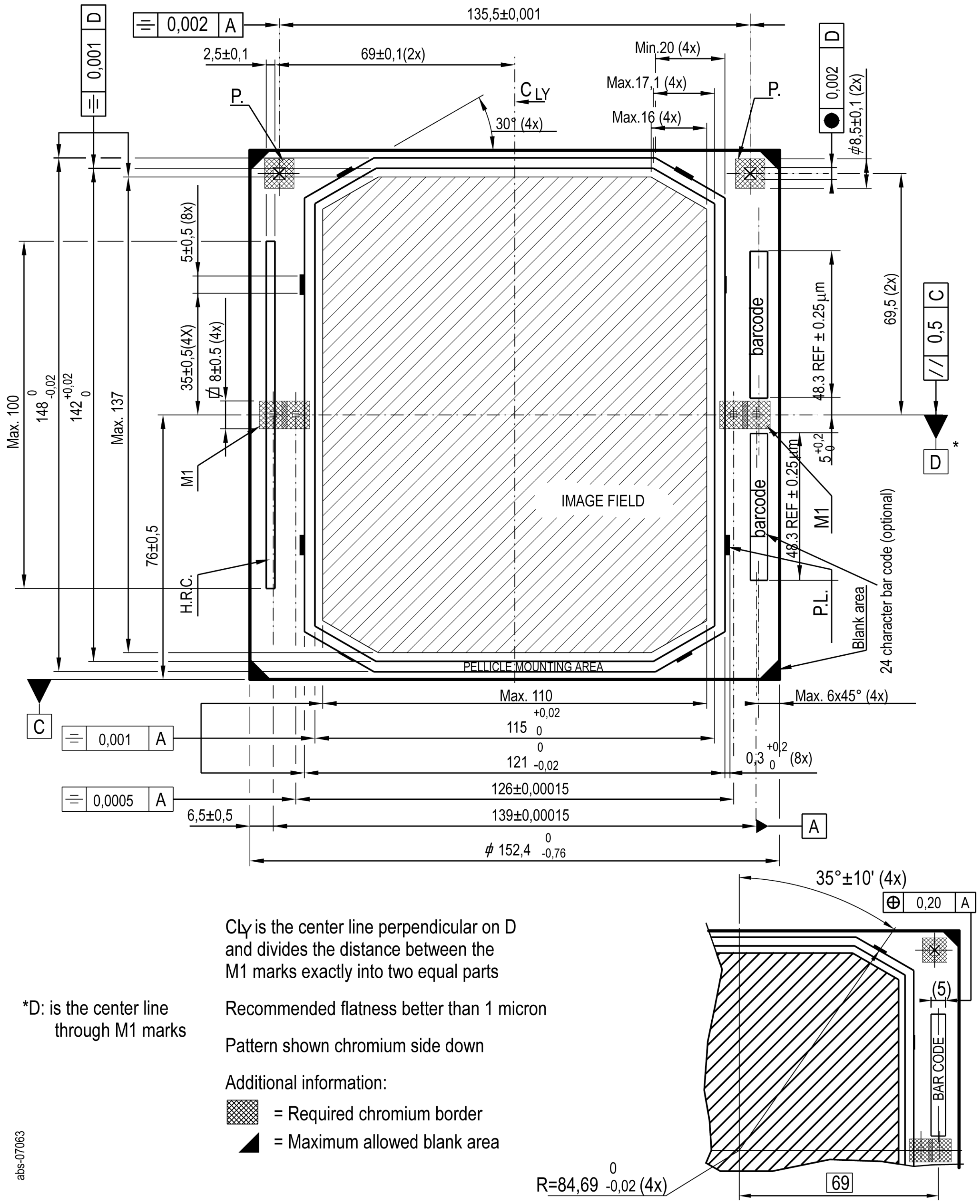
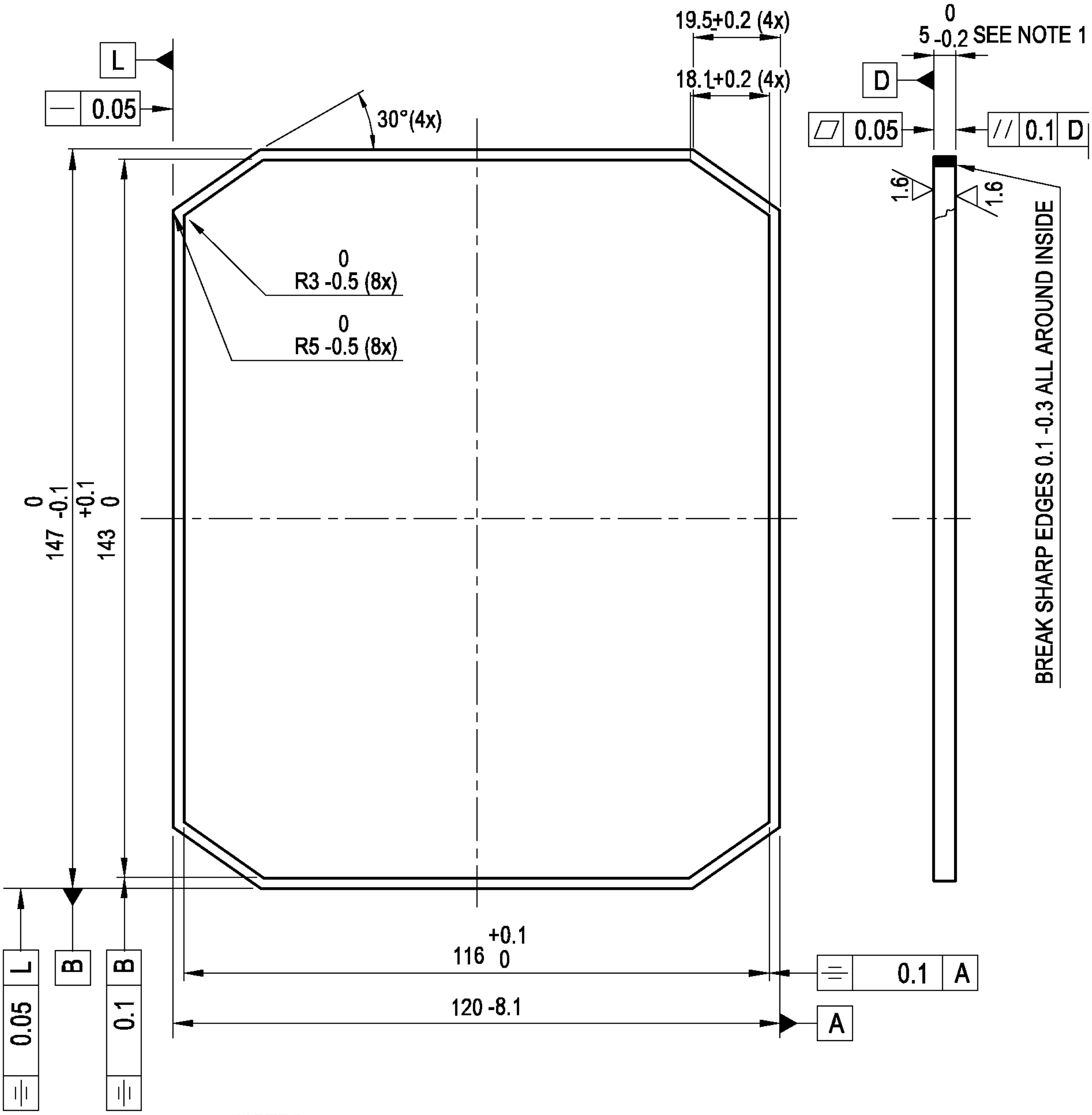


Figure 8.1 ***PAS 5500/22 reticle layout***



NOTES

1 THIS DIMENSION INCLUDES PELLICLE FILM AND PELLICLE ATTACHMENT TAPE THICKNESS.
2 PELLICLE ATTACHMENT TAPE NOT TO PROTRUDE BEYOND INNER OR OUTER EDGES OF PELLICLE FRAME.
3 VENTILATION HOLES AND INSERTS FOR PELLICLE HANDLING MAY BE CONSIDERED.
4 ALL DIMENSIONS ARE IN mm.

Figure 8.2 The recommended pellicle frame for PAS 5500/22 systems

PAS 5500/60

The PAS 5500/60 uses i-line as the exposure wavelength (365 nm). The maximum field size is:

	Wafer level	Reticle level
Diameter:	25.5 mm	127.5 mm
Maximum Y:	24.2 mm	121.0 mm
Maximum X:	18.0 mm	90.0 mm

The distance between the reticle alignment marks is 111 mm. When reticles are also used on the other PAS 5500 systems, additional reticle alignment marks are necessary. The mark spacing for the PAS 5500/22, PAS 5500/80 and PAS 5500/90 is 126 mm, the spacing for the PAS 5500/1xx series and PAS 5500/2xx series is 139 mm.

Note

The maximum field sizes of the PAS 5500/22, PAS 5500/80, PAS 5500/90, PAS 5500/1xx series and PAS 5500/2xx series are larger than that of the PAS 5500/60. Reticle compatibility can only be obtained for the smallest field size and widest chromium border of the different steppers.

If reticles are to be used on PAS 5500/60 and PAS 5500/90 machines, the pellicle film should be compatible with both i-line and DUV.

Figure 8.3 shows a detailed layout of a PAS 5500/60 reticle, including dimensional tolerances. The dimensions in Figure 8.3 uses the left reticle alignment mark (M1) as a reference point, and the midpoint between the left and right alignment marks as the center of the image field. The left reticle alignment mark must be positioned with $\pm$ 0.5 mm accuracy relative to the left and bottom edge of the substrate.

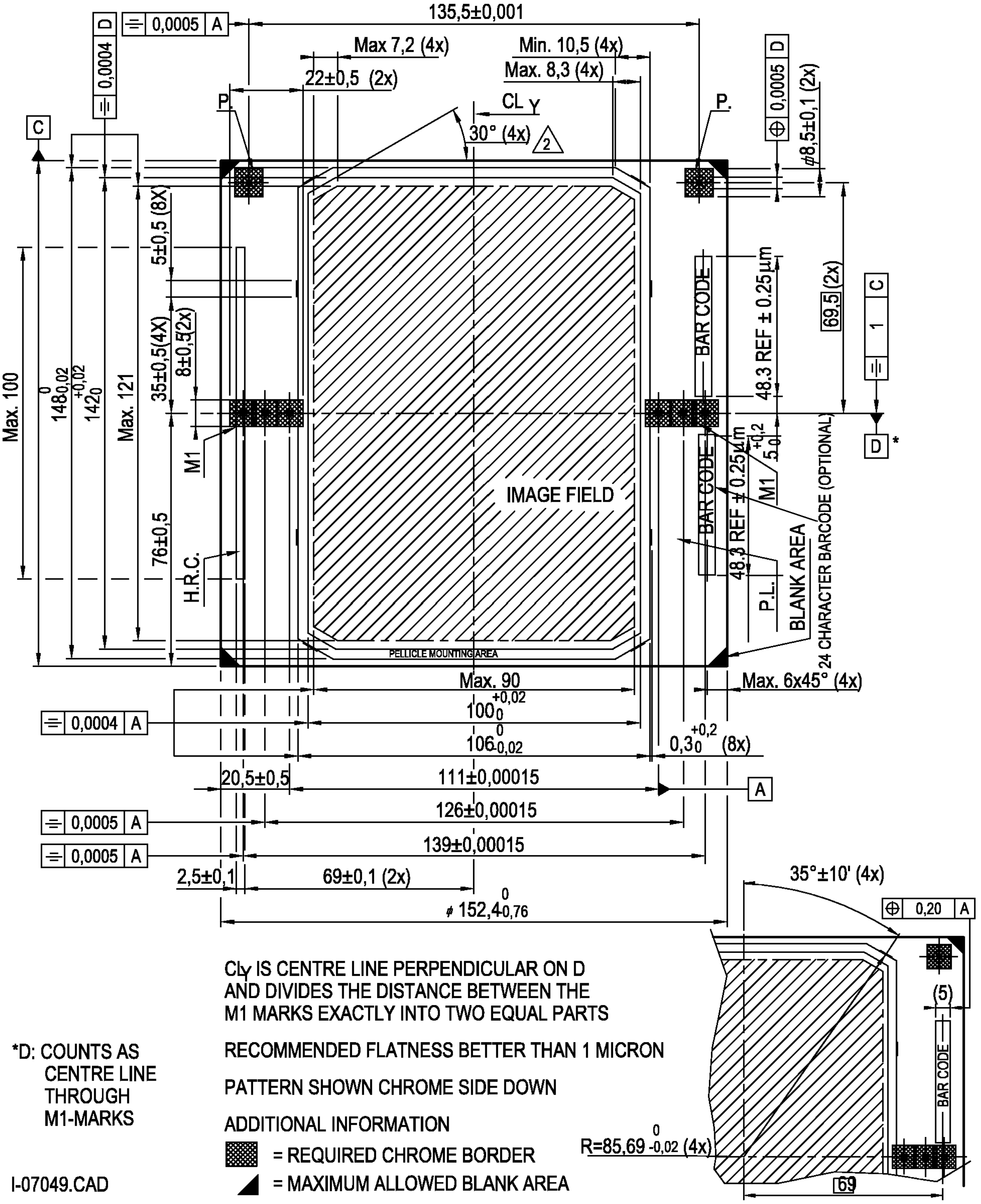
Image border The minimum image-border width is 4 mm, recommended is 6.2 mm.

Pellicle frame For the recommended pellicle frame, see Figure 8.4. Ventilation holes with a diameter of 0.2 mm are recommended, to prevent the pellicle height from increasing. These holes must be located on the side (long edge) of the frame.

Reticle-pattern position The coordinates in Table 8.2 on page 99 are referenced to the center of the reticle layout (center of image field). This center should be positioned at 76 $\pm$ 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the position shown in the previous columns. A positive orientation is a counter-clockwise rotation, a negative orientation is clockwise.

Table 8.2 PAS 5500/60 reticle pattern position

Pattern	X size (mm)	Y size (mm)	X pos (mm)	Y pos (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
M	1.834	1.834	-55.5	0.00	0	
			55.50	0.00	0	
	8.00	8.00				With chromium border
PL	0.30	5.00	53.15	-37.50	90	
			53.15	37.50	90	
			49.23	70.31	-30	
			-49.23	70.31	30	
			-53.15	37.50	90	
			-53.15	-37.50	90	
			-49.23	-70.31	-30	
			49.23	-70.31	30	
B_1	5.00	48.30	69.00	29.15	90	
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	
	5.00	48.30				With chromium border
HRC	2.50	45.00	-70.25	27.50	90	
			-70.25	-27.50	90	
For PAS 5500/22, PAS 5500/80 and PAS 5500/90 compatibility						
M	1.834	1.834	-63.00	0.00	0	
			63.00	0.00	0	
	8.00	8.00				With chromium border
For PAS 5500/1xx series and PAS 5500/2xx series compatibility						
M	1.834	1.834	-69.50	0.00	0	
			69.50	0.00	0	
	8.00	8.00				With chromium border



ClY IS CENTRE LINE PERPENDICULAR ON D AND DIVIDES THE DISTANCE BETWEEN THE M1 MARKS EXACTLY INTO TWO EQUAL PARTS

RECOMMENDED FLATNESS BETTER THAN 1 MICRON

PATTERN SHOWN CHROME SIDE DOWN

ADDITIONAL INFORMATION

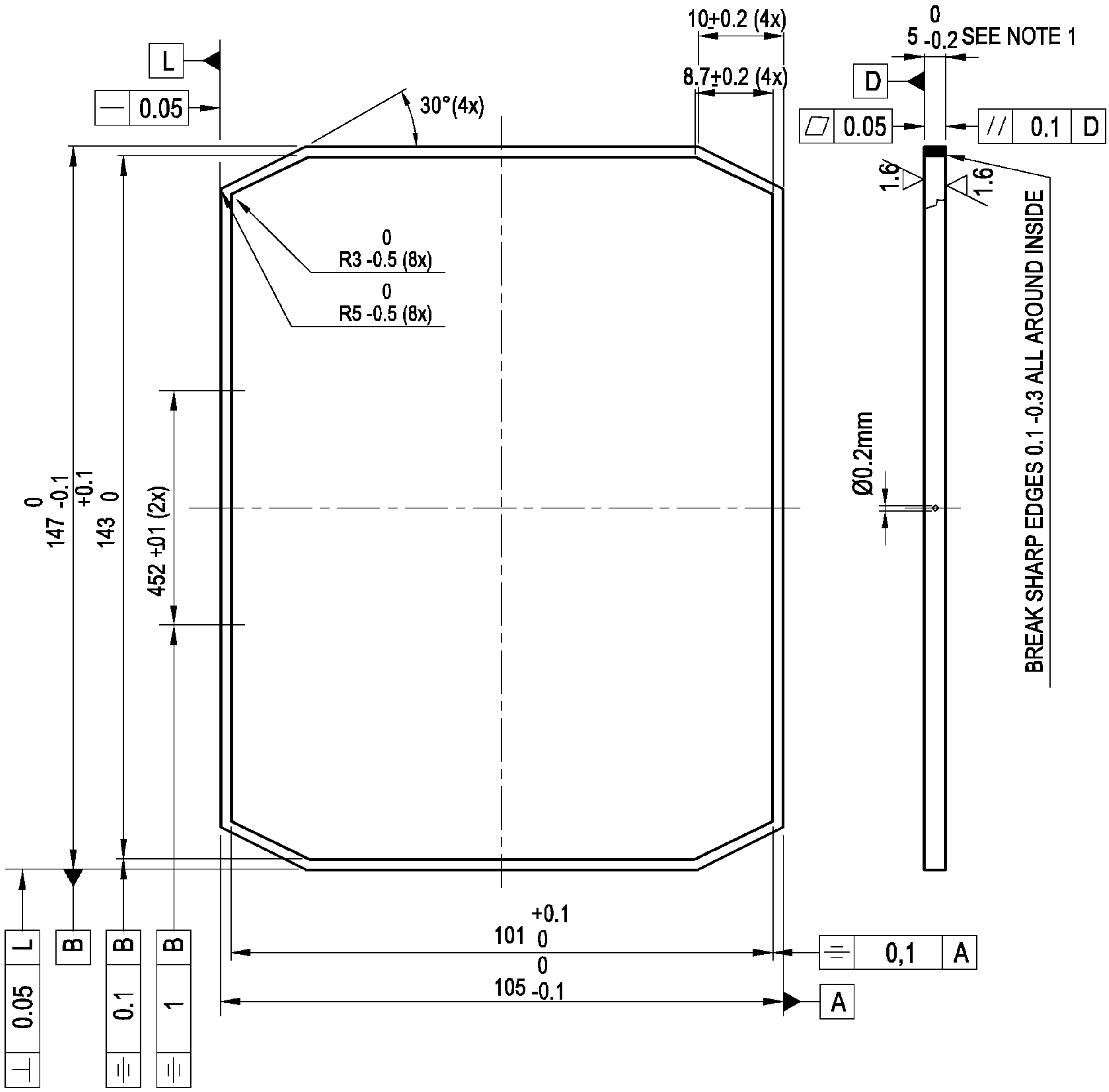
= REQUIRED CHROME BORDER

= MAXIMUM ALLOWED BLANK AREA

*D: COUNTS AS CENTRE LINE THROUGH M1-MARKS

I-07049.CAD

Figure 8.3 PAS 5500/60 reticle layout



NOTES:
1 THIS DIMENSION INCLUDES PELLICLE FILM AND PELLICLE ATTACHMENT TAPE THICKNESS.
2 PELLICLE ATTACHMENT TAPE NOT TO PROTRUDE BEYOND INNER OR OUTER EDGES OF PELLICLE FRAME.
3 INSERTS FOR PELLICLE HANDLING MAY BE CONSIDERED
4 PATTERN SHOWN CHROME SIDE DOWN
5 VENTILATION HOLES ARE RECOMMENDED

X-X
SCALE 2:1

Figure 8.4 The recommended pellicle frame for PAS 5500/60 systems

PAS 5500/80

The PAS 5500/80 uses i-line as exposure wavelength (365 nm). The maximum field size is:

	Wafer level	Reticle level
Diameter:	29.7 mm	148.5 mm
Maximum Y:	27.4 mm	137.0 mm
Maximum X:	21.0 mm	105.0 mm

The distance between the reticle alignment marks is 126 mm. This makes the reticles compatible with the PAS 5500/22 and the PAS 5500/90. When reticles are also used on the PAS 5500/60, PAS 5500/1xx series or/2xx series systems, additional reticle alignment marks are necessary. The mark spacing for the PAS 5500/60 is 111 mm, the spacing for the PAS 5500/1xx series and PAS 5500/2xx series is 139 mm.

Notes

If the reticle is also to be used on the PAS 5500/60 then the PAS 5500/60 layout must be used (See “PAS 5500/60” on page 98.). The maximum field size of the PAS 5500/60 is smaller than that of the PAS 5500/80. Reticle compatibility can only be obtained for the smallest field size and widest chromium border of the different steppers.

If reticles are to be used on PAS 5500/80 and PAS 5500/90 machines, the pellicle film should be compatible with both i-line and DUV.

Figure 8.5 shows a detailed layout of a PAS 5500/80 reticle, including dimensional tolerances. The dimensions in the figure uses the left reticle alignment mark (M1) as a reference point, and the middle between the left and right alignment mark as the center of the image field. The left reticle alignment mark should be positioned with $\pm$ 0.5 mm accuracy relative to the left and bottom edge of the substrate.

Image border The minimum image border width is 4 mm, recommended is 5.6 mm.

Pellicle frame For the recommended pellicle frame, see Figure 8.6. Ventilation holes with a diameter of 0.2 mm are recommended, to prevent the pellicle height from increasing. These holes must be located on the side (long edge) of the frame.

Reticle-pattern position The coordinates in Table 8.3 are referenced to the center of the reticle layout (center of image field). This center should be positioned at 76.2 $\pm$ 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the position shown in the previous columns. A positive orientation is a counter-clockwise rotation, a negative orientation is clockwise.

Table 8.3 PAS 5500/80 reticle pattern position

Pattern	X size (mm)	Y size (mm)	X pos (mm)	Y pos (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
M	1.834	1.834	-63.00	0.00	0	
			63.00	0.00	0	
		8.00	8.00			With chromium border
PL	0.30	5.00	60.65	-37.50	90	
			60.65	37.50	90	
			48.66	69.49	-30	
			-48.66	69.49	30	
			-60.65	37.50	90	
			-60.65	-37.50	90	
			-48.66	-69.49	-30	
			48.66	-69.49	30	
B_1	5.00	48.30	69.00	29.15	90	
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	
	5.00	48.30				With chromium border
HRC	2.50	45.00	-70.25	27.50	90	
			-70.25	-27.50	90	
For PAS 5500/60 compatibility						
M	1.834	1.834	-55.50	0.00	0	
			55.50	0.00	0	
	8.00	8.00				With chromium border
For PAS 5500/1xx series and PAS 5500/2xx series compatibility						
M	1.834	1.834	-69.50	0.00	0	
			69.50	0.00	0	
	8.00	8.00				With chromium border

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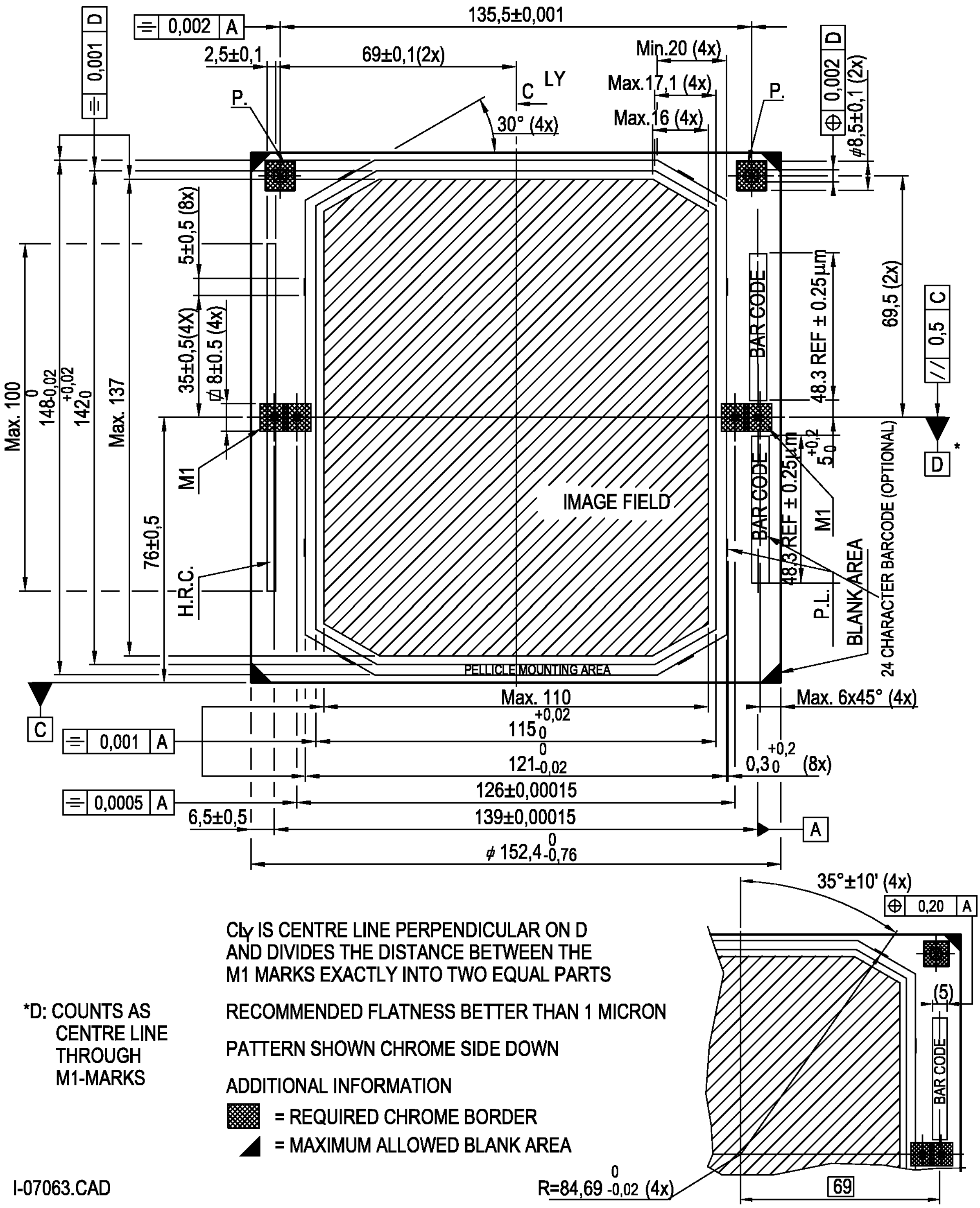
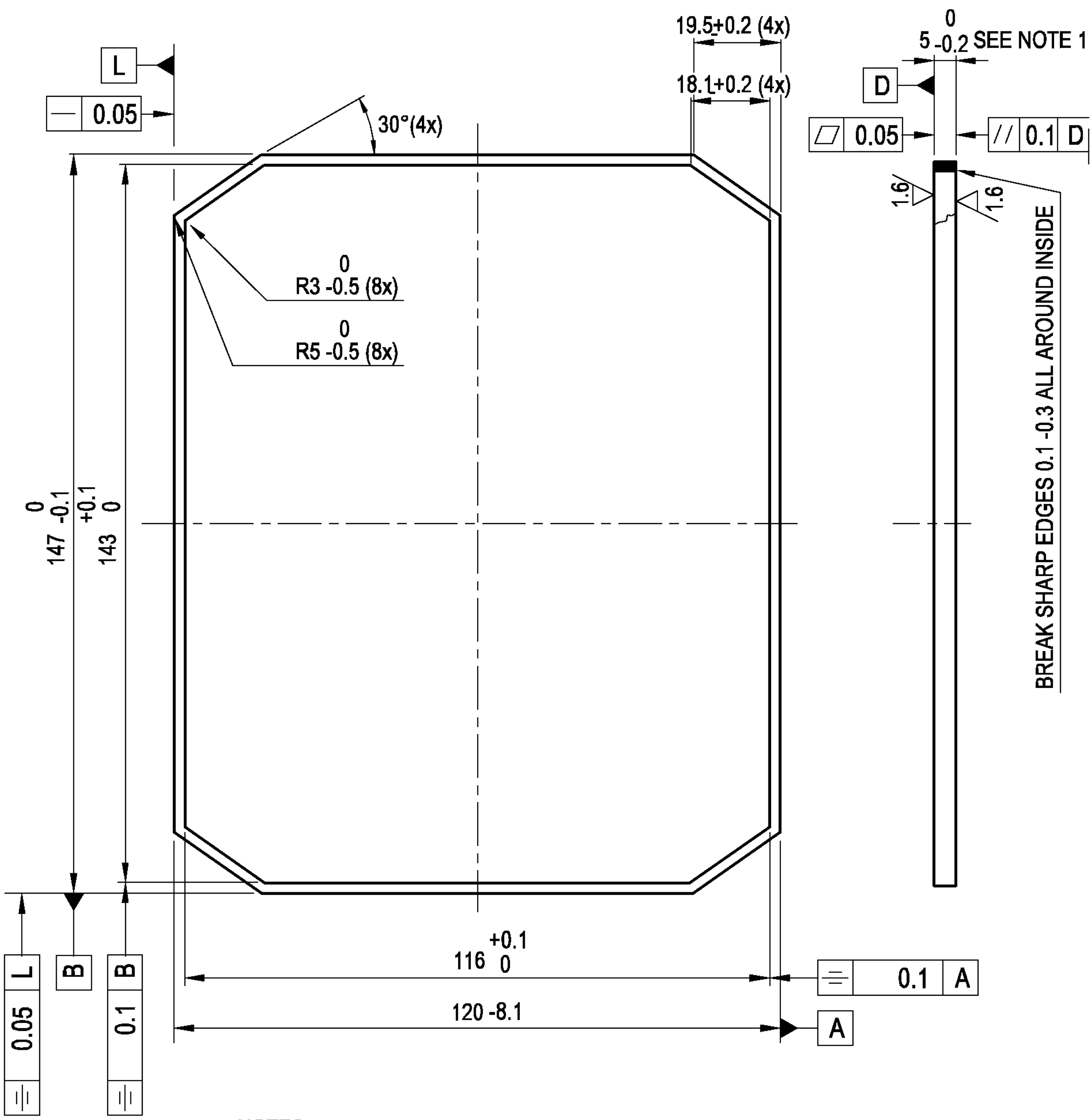


Figure 8.5 PAS 5500/80 reticle layout



NOTES

1 THIS DIMENSION INCLUDES PELLICLE FILM AND PELLICLE ATTACHMENT TAPE THICKNESS.

2 PELLICLE ATTACHMENT TAPE NOT TO PROTRUDE BEYOND INNER OR OUTER EDGES OF PELLICLE FRAME.

3 VENTILATION HOLES AND INSERTS FOR PELLICLE HANDLING MAY BE CONSIDERED.

4 ALL DIMENSIONS ARE IN mm.

Figure 8.6 The recommended pellicle frame for PAS 5500/80 systems

PAS 5500/90

The PAS 5500/90 uses DUV as the exposure wavelength (248 nm). The maximum field size is:

	Wafer level	Reticle level
Diameter:	29.7 mm	148.5 mm
Maximum Y:	27.4 mm	137.0 mm
Maximum X:	21.0 mm	105.0 mm

The distance between the reticle alignment marks is 126 mm. This makes the reticles compatible with the PAS 5500/22 and the PAS 5500/80. When reticles are also used on the PAS 5500/60, PAS 5500/1xx series or PAS 5500/2xx series systems, additional reticle alignment marks are necessary. The mark spacing for the PAS 5500/1xx series and PAS 5500/2xx series is 139 mm.

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Note

If the reticle is also to be used on the PAS 5500/60 then the PAS 5500/60 layout must be used (See “PAS 5500/60” on page 98.). The maximum field size of the PAS 5500/60 is smaller than that of the PAS 5500/90. Reticle compatibility can only be obtained for the smallest field size.

If reticles are to be used on PAS 5500/90 and i-line machines, the pellicle film must be compatible with both i-line and DUV.

Figure 8.7 shows a detailed layout of a PAS 5500/90 reticle, including dimensional tolerances. The dimensions in Figure 8.7 use the left reticle alignment mark (M1) as a reference point, and the midpoint between the left and right alignment marks as the center of the image field. The left reticle alignment mark should be positioned with ± 0.5 mm accuracy relative to the left and bottom edge of the substrate.

Image border The minimum image border width is 4 mm, recommended is 5.8 mm.

Pellicle frame For the recommended pellicle frame, see Figure 8.8. Ventilation holes with a diameter of 0.2 mm are recommended, to prevent the pellicle height from increasing. These holes must be located on the side (long edge) of the frame.

Reticle-pattern position The coordinates in Table 8.4 are referenced to the center of the reticle layout (center of image field). This center should be positioned at 76 ± 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the position shown in the previous columns. A positive orientation is a counter-clockwise rotation, a negative orientation is clockwise.

Table 8.4 PAS 5500/90 reticle pattern position

Pattern	X size (mm)	Y size (mm)	X pos (mm)	Y pos (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
M	1.834	1.834	-63.00	0.00	0	
			63.00	0.00	0	
	8.00	8.00				With chromium border
PL	0.30	5.00	60.65	-37.50	90	
			60.65	37.50	90	
			48.66	69.49	-30	
			-48.66	69.49	30	
			-60.65	37.50	90	
			-60.65	-37.50	90	
			-48.66	-69.49	-30	
			48.66	-69.49	30	
B_1	5.00	48.30	69.00	29.15	90	
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	
	5.00	48.30				With chromium border
HRC	2.50	45.00	-70.25	27.50	90	
			-70.25	-27.50	90	
For PAS 5500/60 compatibility						
M	1.834	1.834	-55.50	0.00	0	
			55.00	0.00	0	
	8.00	8.00				With chromium border
For PAS 5500/1xx series and PAS 5500/2xx series compatibility						
M	1.834	1.834	-69.50	0.00	0	
			69.50	0.00	0	
	8.00	8.00				With chromium border

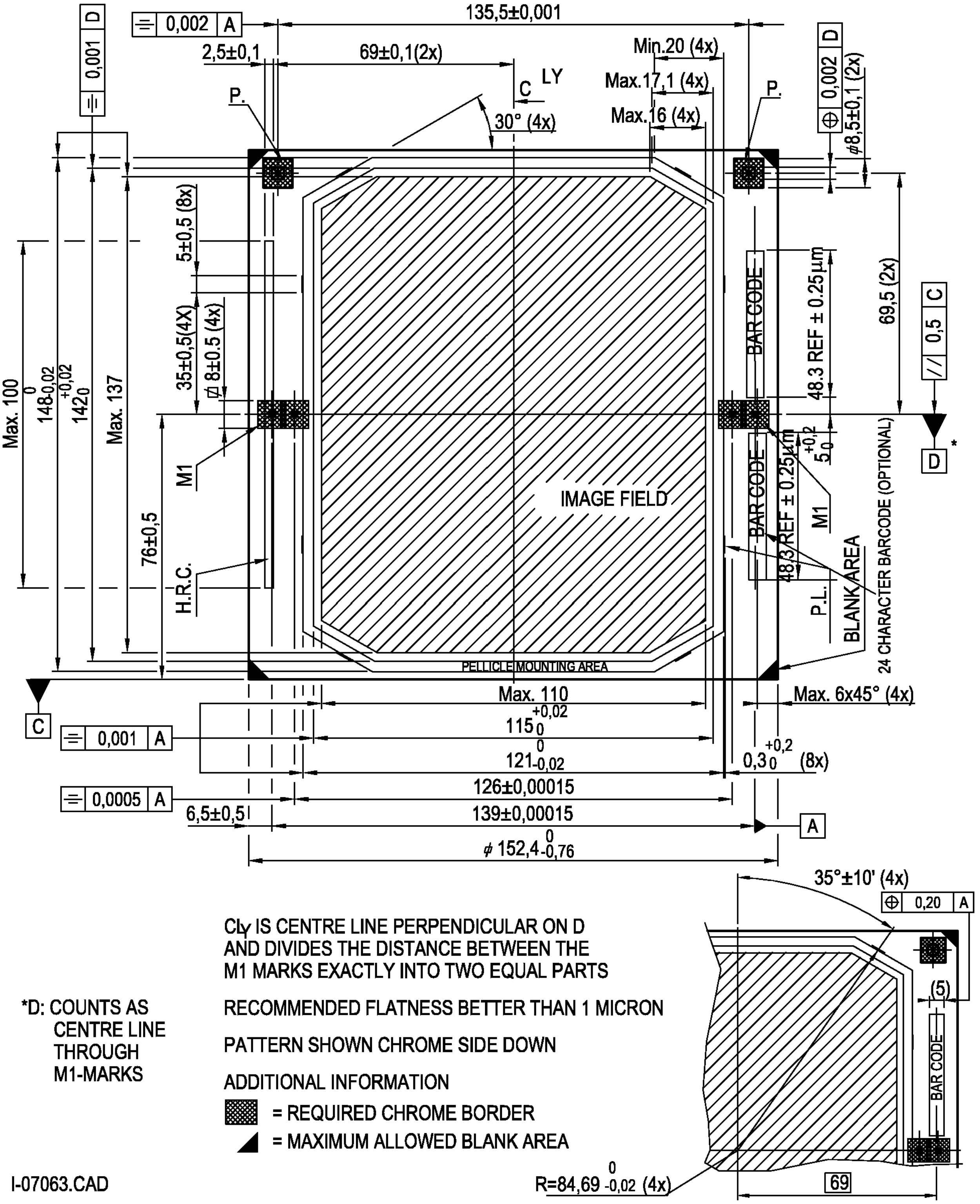
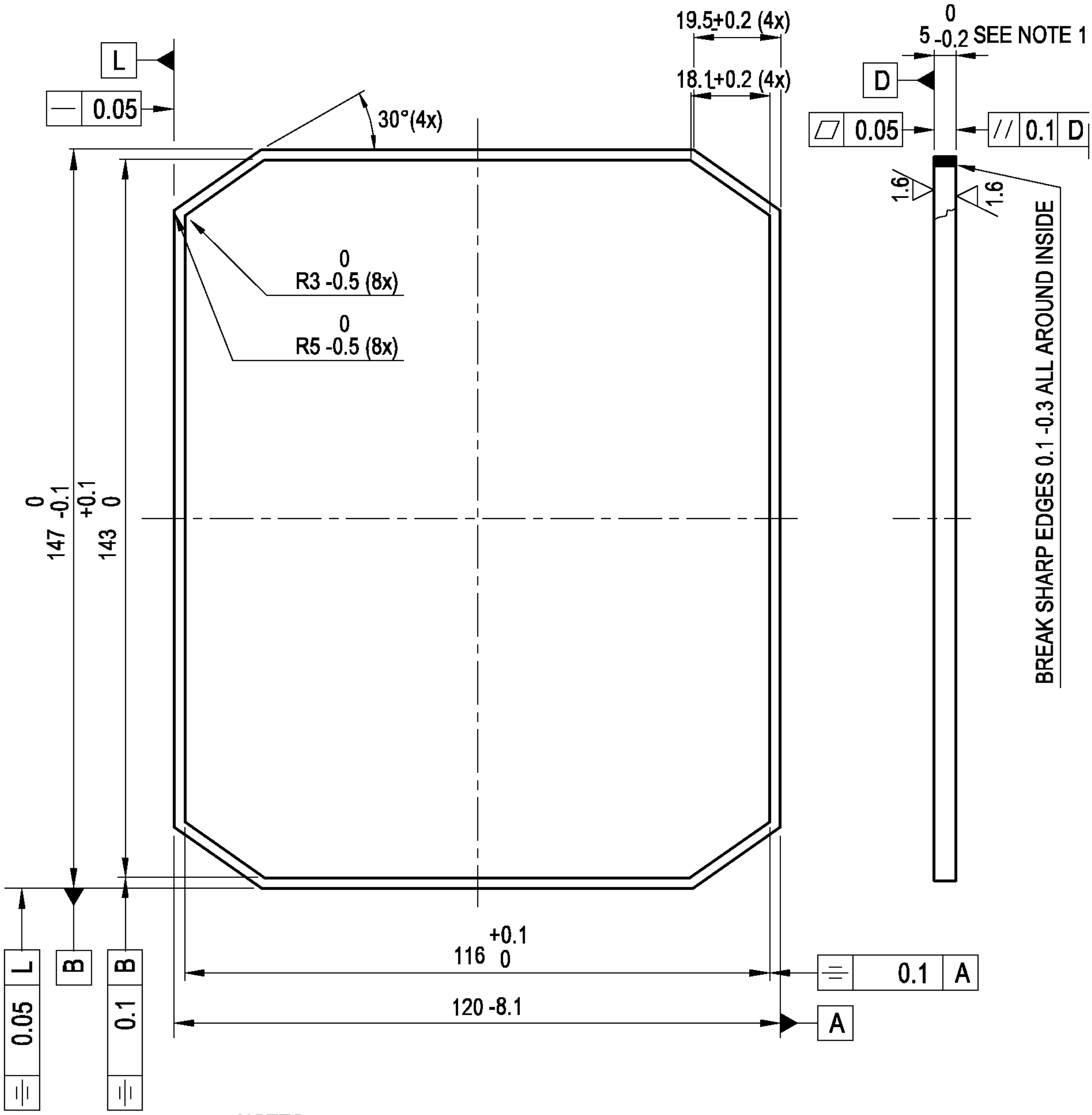


Figure 8.7 PAS 5500/90 reticle layout



NOTES
1 THIS DIMENSION INCLUDES PELLICLE FILM AND PELLICLE ATTACHMENT TAPE THICKNESS.
2 PELLICLE ATTACHMENT TAPE NOT TO PROTRUDE BEYOND INNER OR OUTER EDGES OF PELLICLE FRAME.
3 VENTILATION HOLES AND INSERTS FOR PELLICLE HANDLING MAY BE CONSIDERED.
4 ALL DIMENSIONS ARE IN mm.

Figure 8.8 The recommended pellicle frame for PAS 5500/90 systems

PAS 5500/1XX SERIES

The PAS 5500/1xx series uses i-line as the exposure wavelength (365 nm). The maximum field size is:

	Wafer level	**Reticle level**
Diameter:	31.1 mm	155.5 mm
Maximum Y:	27.4 mm	137.0 mm
Maximum X:	22.0 mm	110.0 mm

The distance between the reticle alignment marks is 139 mm, this is the same as for the PAS 5500/2xx series. When reticles are also used on other PAS 5500 systems, additional reticle alignment marks are necessary. The mark spacing for the PAS 5500/60 is 111 mm. The spacing for the PAS 5500/22, PAS 5500/80 and PAS 5500/90 is 126 mm.

Note

If the reticle is also to be used on the PAS 5500/60 then the PAS 5500/60 layout must be used (See “PAS 5500/60” on page 98.). The maximum field size of the PAS 5500/60, PAS 5500/80 and PAS 5500/90 is smaller than that of the PAS 5500/1xx series. Reticle compatibility can only be obtained for the smallest field size and widest chromium border of the different steppers.

If reticles are to be used on PAS 5500/90 and PAS 5500/1xx series machines, the pellicle film must be compatible with both i-line and DUV.

Figure 8.9 shows a detailed layout of a PAS 5500/1xx series reticle, including dimensional tolerances. The dimensions in Figure 8.9 use the left reticle alignment mark (M1) as a reference point and the midpoint between the left and right alignment marks as the center of the image field. The left reticle alignment mark should be positioned with ± 0.5 mm accuracy relative to the left and bottom edge of the substrate.

Image border The minimum image border width is 5 mm, recommended is 7.2 mm.

Pellicle frame For the recommended pellicle frame, see Figure 8.9. Ventilation holes with a diameter of 0.2 mm are recommended, to prevent the pellicle height from increasing. These holes must be located on the side (long edge) of the frame.

Reticle-pattern position The coordinates in Table 8.5 are referenced to the center of the reticle layout (center of image field). This center should be positioned at 76 ± 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the position shown in the previous columns. A positive orientation is a counter-clockwise rotation, a negative orientation is clockwise.

Table 8.5 PAS 5500/1xx series reticle pattern position

Pattern	X size (mm)	Y size (mm)	X pos (mm)	Y pos (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
M	1.824	1.824	-69.50	0.00	0	
			69.50	0.00	0	
	8.00	8.00				With chromium border
PL	0.30	5.00	63.65	-37.5	90	
			63.65	37.50	90	
			61.83	61.83	-35	
			-61.83	61.83	35	
			-63.65	37.50	90	
			-63.65	-37.50	90	
			-61.83	-61.83	-35	
			61.83	-61.83	35	
B_1	5.00	48.30	69.00	29.15	90	
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	
	5.00	48.30				With chromium border
HRC	2.50	45.00	-70.25	27.50	90	
			-70.25	-27.50	90	
For PAS 5500/60 compatibility						
M	1.834	1.834	-55.50	0.00	0	
			55.50	0.00	0	
	8.00	8.00				With chromium border
For PAS 5500/22, PAS 5500/80 and PAS 5500/90 compatibility						
M	1.834	1.834	-63.00	0.00	0	
			63.00	0.00	0	
	8.00	8.00				With chromium border

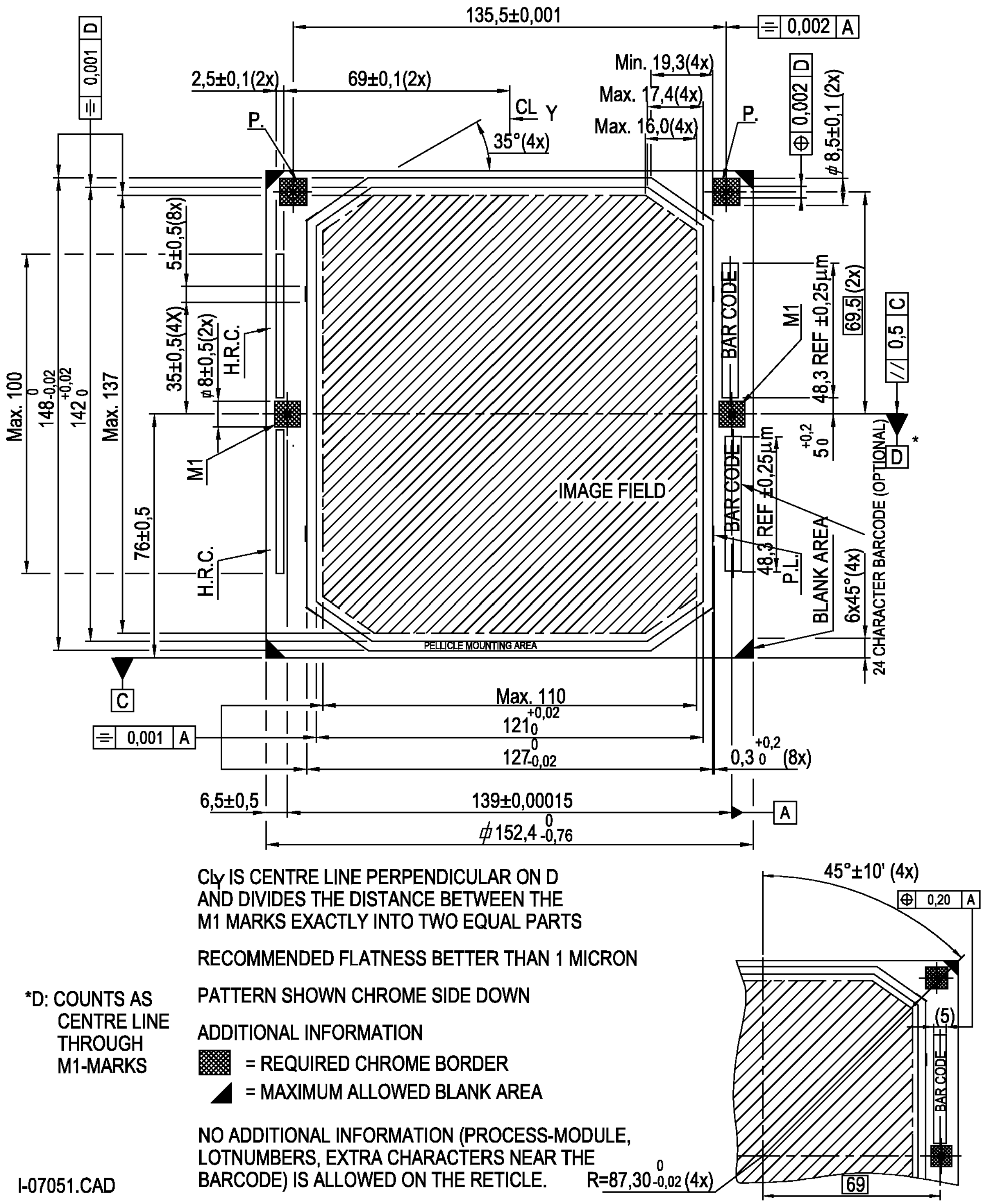
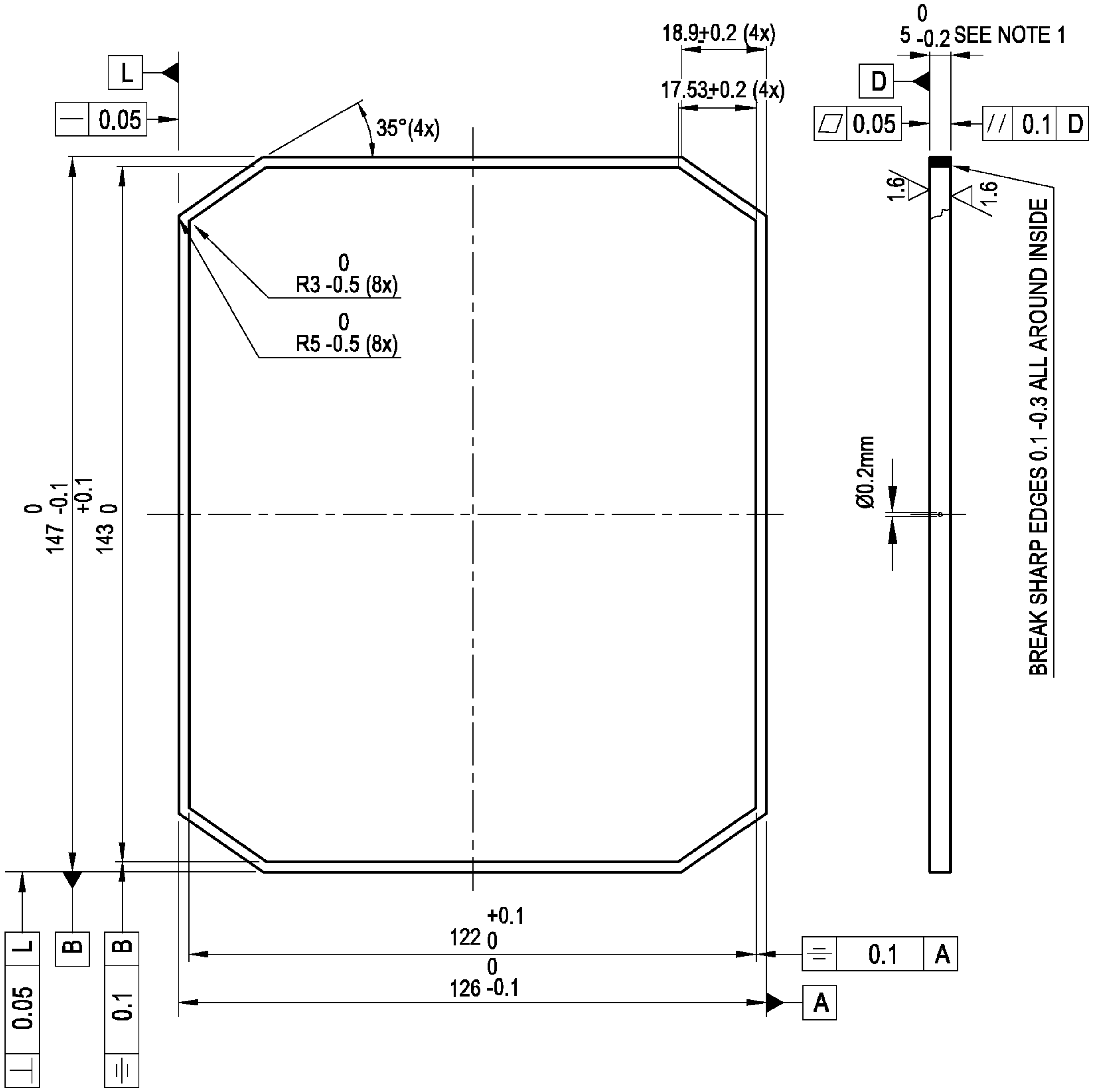


Figure 8.9 PAS 5500/1xx series reticle layout



NOTES:
1 THIS DIMENSION INCLUDES PELLICLE FILM AND PELLICLE ATTACHMENT TAPE THICKNESS.
2 PELLICLE ATTACHMENT TAPE NOT TO PROTRUDE BEYOND INNER OR OUTER EDGES OF PELLICLE FRAME.
3 INSERTS FOR PELLICLE HANDLING MAY BE CONSIDERED
4 PATTERN SHOWN CHROME SIDE DOWN
5 VENTILATION HOLES ARE RECOMMENDED

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Figure 8.10 The recommended pellicle frame for PAS 5500/1xx series systems

PAS 5500/2XX SERIES

The PAS 5500/2xx series use i-line as the exposure wavelength (365 nm). The maximum field size is:

	Wafer level	Reticle level
Diameter:	31.1 mm	155.5 mm
Maximum Y:	27.4 mm	137.0 mm
Maximum X:	22.0 mm	110.0 mm

The distance between the reticle alignment marks is 139 mm, this is the same as for the PAS 5500/1xx series. This makes the reticles compatible with the PAS 5500/1xx series. When the reticles are used on the PAS 5500/22, PAS 5500/60, PAS 5500/80 or PAS 5500/90 systems, additional reticle alignment marks are necessary. The mark spacing for the PAS 5500/60 is 111 mm. The spacing for the PAS 5500/22, PAS 5500/80 and PAS 5500/90 is 126 mm.

Note

If the reticle is also to be used on the PAS 5500/60 then the PAS 5500/60 layout must be used (See “PAS 5500/60” on page 98.). The maximum field size of the PAS 5500/60, PAS 5500/80 and PAS 5500/90 is smaller than that of the PAS 5500/2xx series.

Reticle compatibility can only be obtained for the smallest field size and widest chromium border of the different steppers.

If reticles are to be used on PAS 5500/2xx series and PAS 5500/90 machines, the pellicle film must be compatible with both i-line and DUV.

Figure 8.11 shows a detailed layout of a reticle for the PAS 5500/2xx series, including dimensional tolerances. The dimensions in Figure 8.11 use the left reticle alignment mark (M1) as a reference point, and the midpoint between the left and right alignment marks as the center of the image field. The left reticle alignment mark should be positioned with ± 0.5 mm accuracy relative to the left and bottom edge of the substrate.

Image border The recommended image border width is 3 mm.

Pellicle frame If the reticles have to be compatible with other PAS 5500 systems, the appropriate border width for that system must be used. The 3 mm border can only be used on PAS 5500/2xx systems.

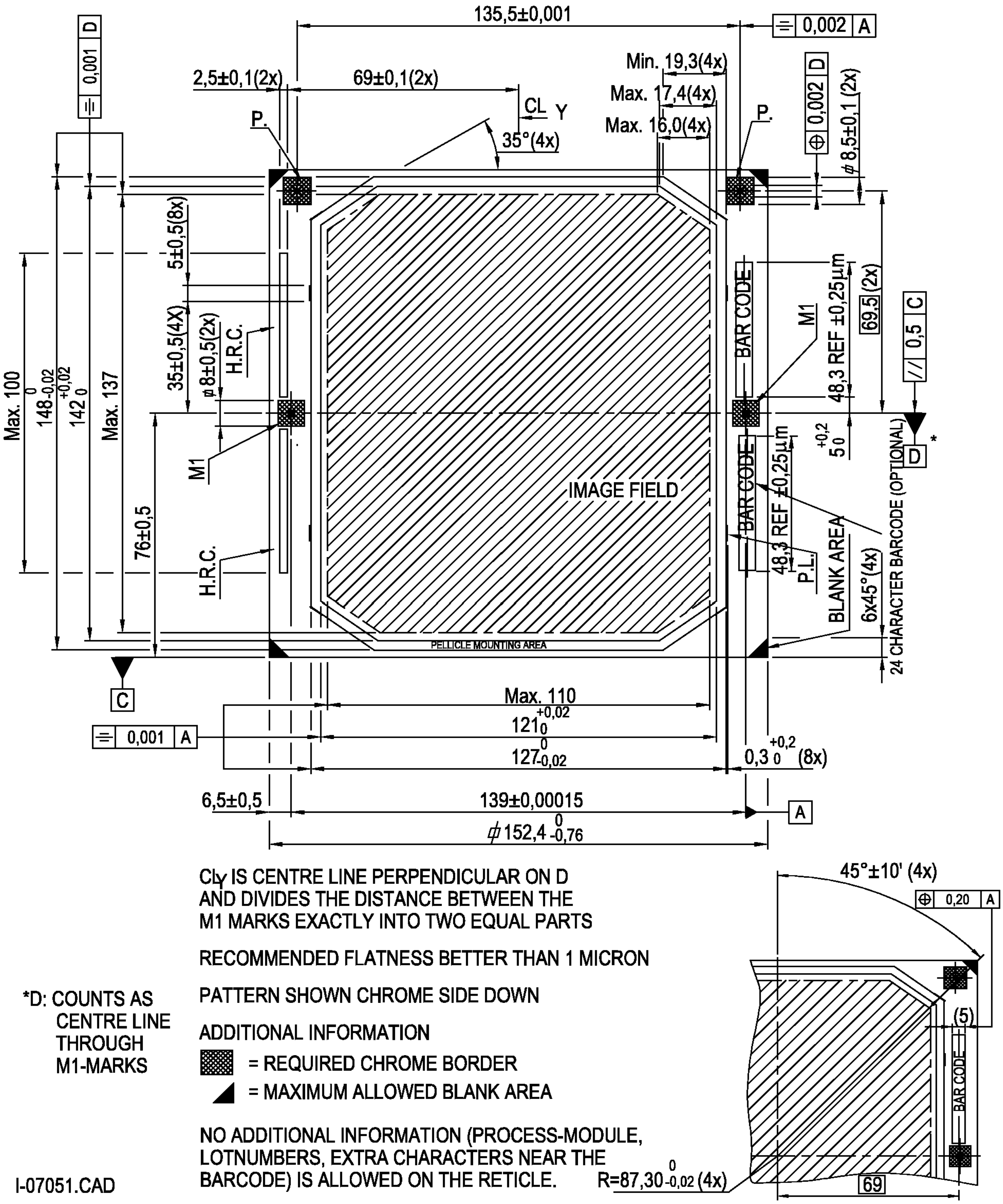
For the recommended pellicle frame, see Figure 8.12. Ventilation holes with a diameter of 0.2 mm are recommended, to prevent the pellicle height from increasing. These holes must be located on the side (long edge) of the frame.

Reticle pattern position

The coordinates in Table 8.6 on page 115are referenced to the center of the reticle layout (center of image field). This center should be positioned at 76 ± 0.5 mm from the left and bottom edge of the substrate. In the table, the orientation is a rotation angle around the position shown in the previous columns. A positive orientation is a counter-clockwise rotation, a negative orientation is clockwise.

Table 8.6 The PAS 5500/2xx series reticle pattern position

Pattern	X size (mm)	Y size (mm)	X pos (mm)	Y pos (mm)	Orientation (Degrees)	Remarks
P	3.50	3.50	-67.75	69.50	0	
			67.75	69.50	0	
	8.50	8.50				With chromium border
M	1.834	1.834	-69.50	0.00	0	
			69.50	0.00	0	
	8.00	8.00				With chromium border
PL	0.30	5.00	63.65	-37.50	90	
			63.65	37.50	90	
			61.83	61.83	-35	
			-61.83	61.83	35	
			-63.65	37.50	90	
			-63.65	-37.50	90	
			-61.83	-61.83	-35	
			61.83	-61.83	35	
B_1	5.00	48.30	69.00	29.15	90	
	9.00	48.30				With chromium border
B_2 (optional)	5.00	48.30	69.00	-29.15	90	
	5.00	48.30				With chromium border
HRC	2.50	45.00	-70.25	27.50	90	
			-70.25	-27.50	90	
For PAS 5500/60 compatibility						
M	1.834	1.834	-55.50	0.00	0	
			55.50	0.00	0	
	8.00	8.00				With chromium border
For PAS 5500/22, PAS 5500/80 and PAS 5500/90 compatibility						
M	1.834	1.834	-63.00	0.00	0	
			63.00	0.00	0	
	8.00	8.00				With chromium border



ClY IS CENTRE LINE PERPENDICULAR ON D AND DIVIDES THE DISTANCE BETWEEN THE M1 MARKS EXACTLY INTO TWO EQUAL PARTS

RECOMMENDED FLATNESS BETTER THAN 1 MICRON

PATTERN SHOWN CHROME SIDE DOWN

ADDITIONAL INFORMATION

= REQUIRED CHROME BORDER

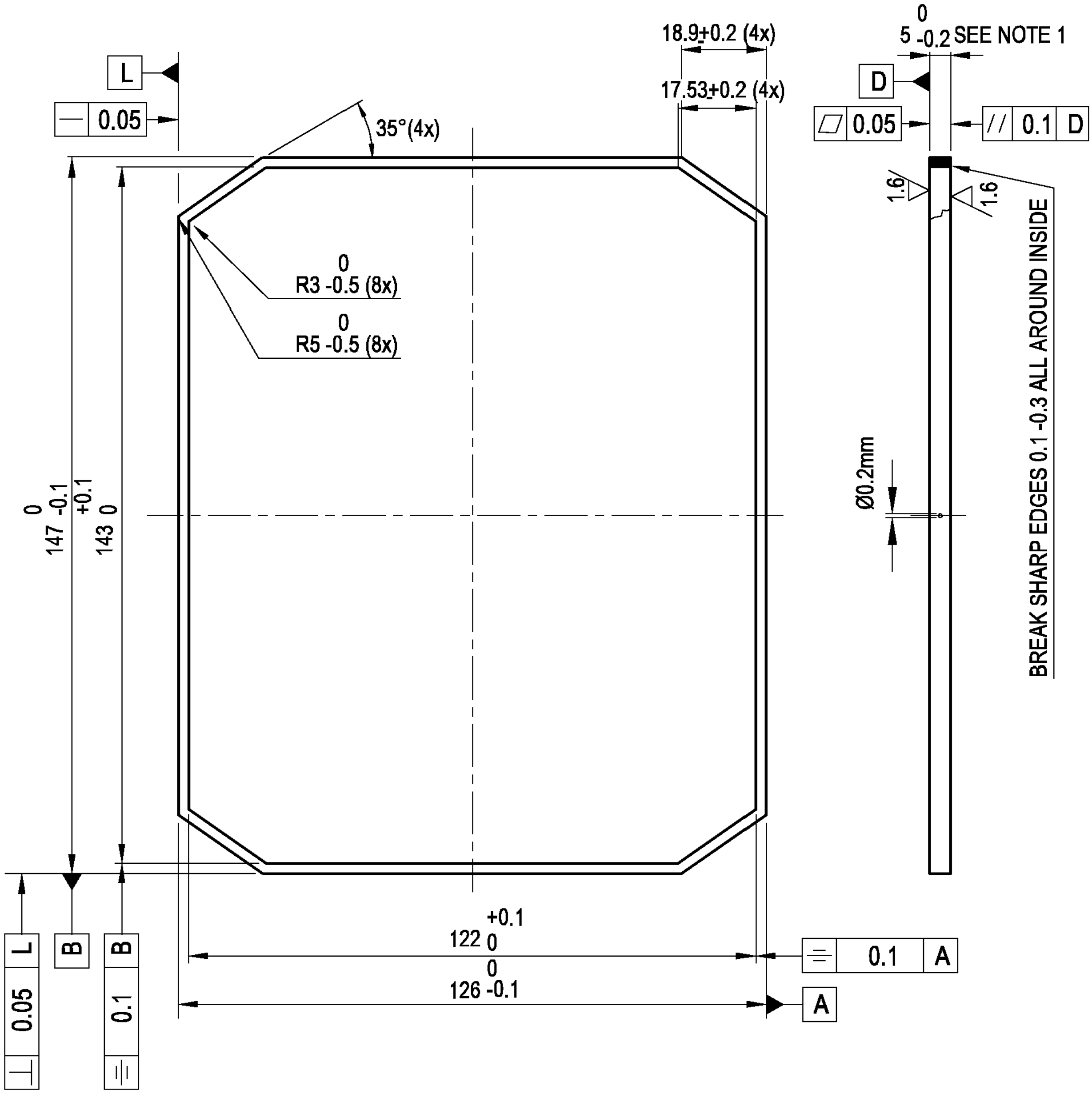
= MAXIMUM ALLOWED BLANK AREA

NO ADDITIONAL INFORMATION (PROCESS-MODULE, LOTNUMBERS, EXTRA CHARACTERS NEAR THE BARCODE) IS ALLOWED ON THE RETICLE. R=87,30 0 -0,02 (4x)

*D: COUNTS AS CENTRE LINE THROUGH M1-MARKS

I-07051.CAD

Figure 8.11 PAS 5500/2xx series reticle layout



NOTES:
1 THIS DIMENSION INCLUDES PELLICLE FILM AND PELLICLE ATTACHMENT TAPE THICKNESS.
2 PELLICLE ATTACHMENT TAPE NOT TO PROTRUDE BEYOND INNER OR OUTER EDGES OF PELLICLE FRAME.
3 INSERTS FOR PELLICLE HANDLING MAY BE CONSIDERED
4 PATTERN SHOWN CHROME SIDE DOWN
5 VENTILATION HOLES ARE RECOMMENDED

Figure 8.12 The recommended pellicle frame for PAS 5500/2xx systems

Conventions used in ASML documents

Text formats

Each chapter contains explanatory text in several building blocks:

- Regular text
  Regular text discusses a multitude of topics. Topics are marked by headers.
- Tables and figures
- Notes, CAUTION, WARNING:

> **Note**
>
> This is an example of a **Note** to emphasize a topic. If this text box is used to emphasize a safety topic there will also be a pictogram on the left side of this gray text box.

- Excursion:

Excursion

This is an example of an excursion. An excursion discusses a topic that is related to the topic in the regular text but can be skipped by the reader.

- Report
  Text from a report is presented in a different format as it is text that is generated by an ASML machine.

Report 1This is the caption of an example of a report

```
A report is a summary of results as obtained from actions that have been done on the system.
```

Font Formats

In an ASML document there can be a number of font formats to make the document easier to read. Some of these formats (various **blue colored** headings) support navigation through the document. Other formats support text emphasis.

All text that is used to show and explain what is visible on a (computer) screen, i.e. the Graphical User Interface of a software product, is indicated in this document by one of the following formats:

- This is an example of text that is **`formatted in a SCREEN font`**.
- The text emphasis to indicate the state (this can be any type of state, but generally it is used for software states) looks **LIKE THIS**.
- A link to another chapter or section in a chpater will by indicted by blue text.

Screen captures

Screen captures are sometimes added to the text. Be aware that these are for reference only. The screen image shown by your software may be different from the examples shown in any document.

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