DESIGN OF AN AUTOMATED INKLESS

WAFERMAP SYSTEM

by

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ABSTRACT

This project deals with developing a fully automated inkless wafermap system to implement inkless process for Texas Instruments (TI) foundry wafers. In the process, TI to TSMC (Taiwan Semiconductor Manufacturing Company) automated inkless wafermap system has been designed in accordance with TI computer integrated manufacturing inkless standards. The system developed here also can be used for other foundries and subcons. The results will be evaluated as successful when a fully automatic process of uploading Wafermaps from TSMC server to TI WISH (Wafermap Inkless System Host) system is completed. The conclusions and recommendations for future work are discussed.

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CHAPTER I

INTRODUCTION

1.1 Introduction

The integrated circuit (IC) is one of the greatest accomplishments of the twentieth century. No invention in history has so quickly spread throughout the world or so deeply touched so many aspects of human existence. In the past thirty years, the complexity of the IC has increased more than a thousand fold. The modern microprocessor contains as many as 20 million transistors, and each finished chip or die is the product of an extraordinarily sophisticated manufacturing process. Before a functioning chip is released to the market, each chip is tested throughout the entire process — both while part of a wafer containing many chips and after separation. During a procedure known as "wafer sort," an electrical test is conducted to eliminate defective chips from the wafer. Needle-like probes conduct over 10,000 checks per second on the wafer. A chip that fails a test for any reason in this automated process is marked with a dot of red ink that indicates it will not be packaged. This traditional inking process has been used for more than thirty years in the semiconductor industry.

In the inking process, after wafers are probed and the data is collected, the wafers go to the inking station. Binary data files on the host computer system are used by the inkers to place red ink dots on the bad and partial die. If a wafer is inked incorrectly, the ink must be removed by using a cleanup process that could damage the wafer. The ink process itself is messy, and sometimes the ink splatters on good die. This means manufacturing and Quality Control (QC) personnel must check the wafers for ink defects using an inspection station. The inspection station displays a map on the screen of how the wafer should look, and the operator compares the actual wafer with this map. If an ink defect is found, the data must be updated to change the die from good to bad. The inspection station is also used to update the data to reflect other visual defects. After QC has checked the wafers they are ready to be shipped. At the assembly/test (A/T) site, the wafers are mounted to a flex frame, the die is sawed, and the good chips (the ones with no ink dots) are picked using a die sorter. The good die are then packaged and tested. Figure 1.1 shows the flow of the inking process.

With the development of computer technology, wafermap files can be easily stored in a database, uploaded and downloaded to any computer or machine throughout a network. An ASCII format wafermap file can also be converted to an image file, which can be loaded onto an assembly mounter machine. The mounter machine can pick the good die based on the image file instead of the old method of stepping through every die to look for good die, and the inking process can be skipped. Figure 1.2 is the flow of the inkless wafermap process. It is a method whereby die mounting is done using the electronic wafermap data received from the wafer fab. When an inkless wafermap is used, the inking and baking processes are skipped, and the die sorter picks the good die based on the wafermap data stored in the wafermap system. When speed sorting is used, the wafermaps can have chips that are not as good as the "best" chips picked by the die sorter on a second or third pass, resulting in more saleable material.

Inking Process Flow

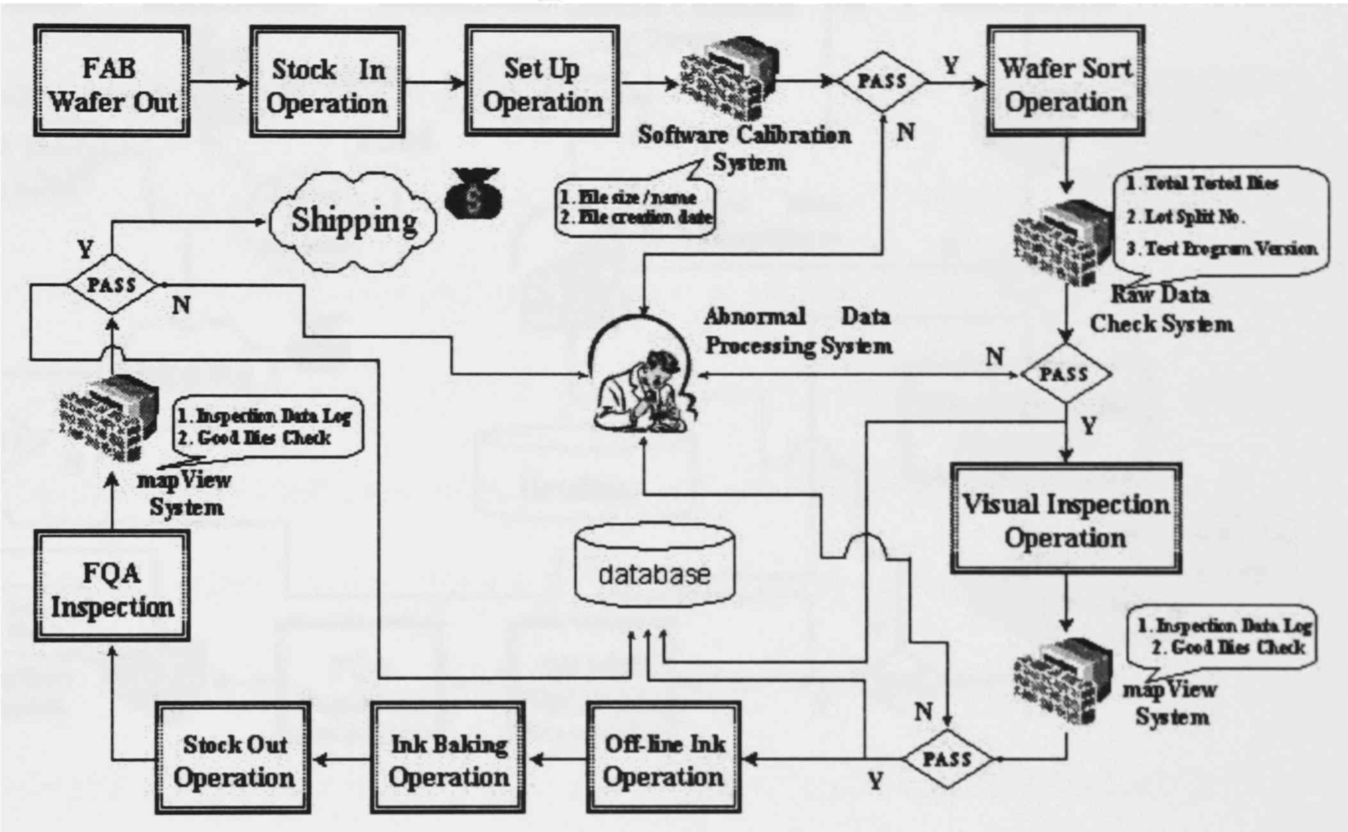


Figure 1.1 Inking Process Flow

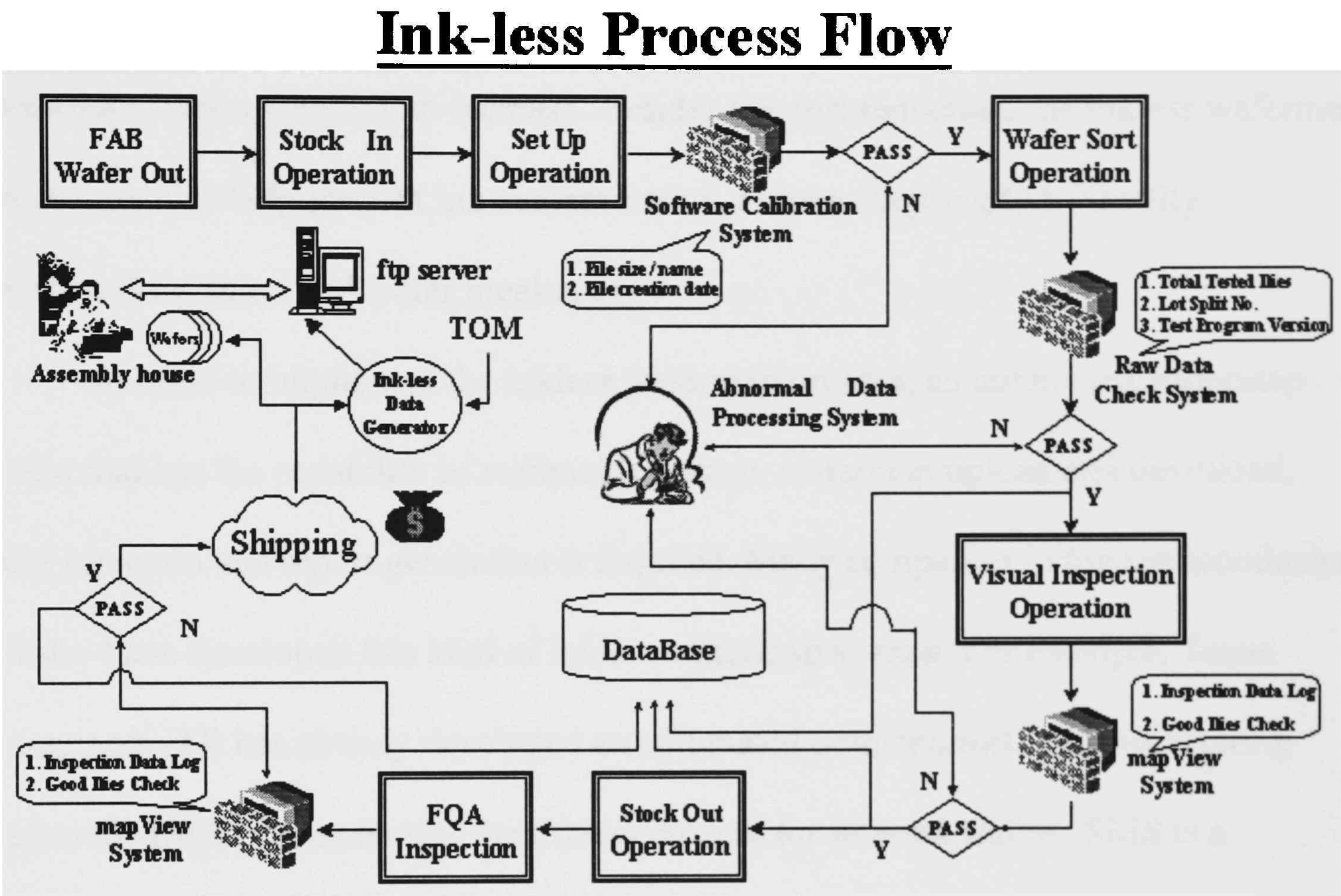


Figure 1.2 Inkless Wafermap Process Flow

In the past five years, the inking process has been gradually replaced by the inkless wafermap process in the semiconductor industry. It is expected to save millions of dollars per year for each semiconductor company. The cost savings is mainly due to eliminating the inking and baking processes, reducing cycle time, and increasing speed sort capability. Although nearly all the cost savings occur in the fabs, the assembly sites have noticed some throughput increase. Besides the cost reduction, the inkless wafermap process can also help prevent ink contamination, reduce outgoing QA (Quality Assurance) rejection and wafer breakage rate.

In order to implement the inkless wafermap process, an automated wafermap system that has the capability of wafermap storage, wafermap upload and download, wafer selection and report generation is required. Many companies in the semiconductor industry have developed this kind of inkless wafermap system. For example, Texas Instruments (TI) has already developed an automated Semiconductor Manufacturing System (SMS)[1] to implement the inkless process for internal wafers. SMS is a mainframe-based system utilized by Texas Instruments wafer fabs and Assembly/Test (A/T) facilities as a central repository for electronic wafer map data. It is housed on an IBM DB2 database on TI's Universal Manufacturing (UM) mainframe. The maps can be kept on-line for up to five years and SMS provides backup and archival service. SMS provided transactions allow for upload and download of maps and selection of wafers within a lot to be sent to a particular A/T site through File Transfer protocol (FTP). The TI worldwide format wafermaps uploaded to the database are also downloaded to the A/T site in the same worldwide format.

After an A/T site receives wafermap data, the TI Wafermap Inkless System Host (WISH) on each site processes the wafermap data and converts an ASCII format (Worldwide Format) wafermap file into an image format. As soon as the wafer ID is read and correlated, the corresponding wafer is sent to the die mounter; the mounter can download the wafermap data for the wafer from the WISH system, and then the die sorter picks the good die based on the wafermap data.

1.2 Statement of the Problem and Objective

In recent years, more and more companies, like TI, build their wafers in different wafer fabs or other wafer fab foundries. To implement an inkless process, an inkless standard is required to design an automated inkless wafermap system. An inkless standard includes a wafermap file standard, a wafer truncation standard, a lot ID and wafermap file-naming standard. So far, there are still no inkless standard in the semiconductor industry. Each company has their own wafermap format, wafer truncation format, lot ID and file naming rules. This causes difficulty in implementing an inkless process for wafers with different inkless standards.

For example, some companies create mirror areas on their wafers for alignment while processing the wafers, and others build the wafers without any mirror areas since the new lithographic machine can align the wafers without the mirror areas. This causes difficulty for the A/T site mounters in locating the reference die on different truncation wafers. Locating the reference-die accurately is very important for processing the wafers using the wafermap file. This locating is done either manually (with operator assistance) or automatically (with machine vision). Each A/T site has different types of mounters, and each of them uses different types of vision systems. To give freedom to the A/T site to choose any mounter to process the wafers, it is necessary to standardize the reference die location for the mounter with low-level capability. To make it easy for the operator to locate the reference-die, a mirror die is required for wafers. A mirror area is defined as the bare metal area to the right next to the reference-die.

Many companies have already developed the automated inkless wafermap systems to implement an inkless process. Since many of these wafermap systems are developed based on the company's own inkless standard, only wafers that meet their inkless standard can be accepted by the system; and thus the usage of the wafermap system is limited to their internal wafers. For example, TI has already developed a SMS wafermap system. It was developed five years ago as a central repository for TI electronic wafermap data. The SMS system only accepts TI worldwide wafermap files and the TI standard 7-digit lot id. Since SMS is housed on an IBM DB2 database, it takes a lot of effort and time to change the system to accept a lot ID other than TI standard 7-digit lot id. Therefore, a new wafermap system must be designed to implement an inkless process for the wafers with other inkless standards.

Inkless process is an industry trend. This project is to aid in the development of a fully automated inkless wafermap system to implement an inkless wafermap process for those foundry wafers with different inkless standards. The system should be able to translate/download wafermap files from the foundry wafer fab ftp server to the TI foundry wafermap server, convert the wafermaps to the TI worldwide wafermap format, and download the wafermaps to the TI A/T site or a subcon A/T site. This system will achieve a computer integrated manufacturing A/T inkless standards. In this thesis, an ink to inkless conversion between Taiwan Semiconductor Manufacturing Company (TSMC) and TI is used as an example to develop an automated inkless wafermap system.

Chapter II introduces the inkless standards that include the TI worldwide wafermap standard and the TI wafer truncation standard. Chapter III describes how to convert the TSMC inkless standards to the TI inkless standards. Chapter IV provides an insight into how to design an automated inkless wafermap system. The final chapter provides results and conclusions, and also suggestions for further improvements.

CHAPTER II

INKLESS STANDARDS

2.1 Introduction

The key to implementing an inkless process is the standardization of the wafermap format, wafer truncation format, lot id and file naming rules. Unfortunately. there are still no inkless standards in the semiconductor industry. Each company defines their own specifications for the wafermap format, wafer truncation format, lot ID and file naming rules. In this project, TI inkless standards are used as the inkless standards to design an automated inkless wafermap system.

2.2 TI Worldwide Wafermap Standard

The TI standard wafermap format is commonly referred to as the worldwide wafermap format [2]. It is an improvement on the MOS-memory format. The MOS-memory format is so named because it was originally developed in the late 1980's to handle inkless mounting of memory devices. It contains a header with information such as lot number, device and reference die position. The rest of the file contains each wafer ID and the good chip locations for each. High volume fabs found that they could not use the MOS-memory format because the files became too large and the two byte X, Y coordinates being used were not unique for wafers with high chip counts. Modifications of the MOS-memory format were needed. Keyword identifiers for all fields were added to the wafermap file and the data was compressed using a "range" identifier for the chip locations. A 14000 chip/wafer in a 48-wafer lot at 90% yield resulted in a file size of 3.5 MB using the MOS-memory format and only 210 KB when using the worldwide format. Another advantage to the worldwide format maps is that they contain the shotmap within the map. A shotmap is a layout of all chips on the wafer. For the MOS-memory format, a shotmap must be sent to the A/T site so they can set up their system the inkless process can be used for a particular device. For the high chip count wafers, shotmaps cannot be used, and all dies must be included in the wafermap. This is due to the reticle pattern sometimes running off the edge of the wafer on either side, so the shotmap varies from wafer to wafer.

The physical records of the worldwide file are character formats and the size of each physical record is 80 bytes per record. Each record in the wafermap file begins with a keyword to identify the type of data being defined. It is possible for some wafermap data records to span several physical records. Once a wafermap data record has multiple physical records, only the first data record will contain the keyword field.

The worldwide wafermap format is used by wafer fabs to load the complete wafermap data into the SMS Wafer Map Database. It also serves as the format used to distribute wafermaps to assembly/test facilities.

The worldwide wafermap format includes an orientation standard, a bin standard, file naming rules and a data record format. They are described later in this chapter.

2.2.1 Wafermap Orientation Standard

Wafermaps are always oriented with FLAT or NOTCH down and the reference die is always coordinate (0,0).

2.2.2 Wafermap Bin Standard

Dies are classified by bins. The wafermap bin standard clarifies the requirements for the wafermap binning in worldwide format wafermaps. It defines die types (such as Good Electrical Die, Rejected Die, Plug Die and Edge Die) and identifies die that can or cannot be placed in a particular bin. Guidelines are provided on when to use particular bins. A maximum of 20 bins can be defined in a wafermap file. Table 2.1 is the wafermap bin standard, which describes the definitions and bin restrictions. The TI wafermap bin standard document has more detailed information [3].

2.2.3 Wafermap Naming Rules

The worldwide wafermap file (ASCII format) is kept in the SMS system and can be downloaded to the A/T site in the same format. The file name must follow the TI wafermap file naming rules. The format of the wafermap file is:

wlllllll.ss

"w" represents the wafer fab code, "lllllll" is the wafer fab lot number and "ss" is the serial number. The serial number is used to distinguish different transmissions of the same lot.

Table 2.1 Wafermap Bin Standard

BIN NUMBER	CATEGORY	IS	IS NOT	NOTES
1	GED	Whole die Patterned die Probed OR Unprobed Inward of EEZ	Partial die Alignment marker OR Test structure OR Ghost die OR Mirror surface Partially in EEZ OR Totally in EEZ	Can be a Reference die "G" required Unprobed only if sample probing
2-6	Multi-bin or Outlier GED	Whole die Patterned die Probed Inward of EEZ	Partial die Alignment marker OR Test structure OR Ghost die OR Mirror surface Unprobed Partially in EEZ OR Totally in EEZ	Can be a Reference die "G" required
7	Reserved for future use			
8	Plug die	Whole die Alignment marker OR Test structure Probed OR Unprobed Inward of the EEZ	Partial die Patterned die Ghost die OR Mirror surface Reference die Totally in EEZ OR Partially in EEZ	
9	Reject die	Whole die Patterned die Probed OR Unprobed Inward of the EEZ	Partial die Alignment marker OR Test structure OR Ghost die OR Mirror surface Totally in EEZ OR Partially in EEZ	Can be a Reference die Unprobed only if visually inspected bad
10	Edge die	Whole die OR Partial die # Patterned die	Reference die Probed Inward of EEZ	

Table 2.1 Continued

BIN NUMBER	CATEGORY	IS	IS NOT	NOTES
		OR Alignment marker OR Test structure OR Ghost die OR Mirror surface Unprobed Partially in EEZ OR Totally in EEZ		
11-15	SWR die	Whole die Patterned die Probed Inward of EEZ	Partial die Alignment marker OR Test structure OR Ghost die OR Mirror surface Partially in EEZ OR Totally in EEZ	Can be a Reference die
16-17	Reserved for future use			
18	Mirror die	Mirror surface Totally in EEZ OR Partially in EEZ	Patterned die Alignment marker OR Test structure OR Ghost die	Cannot be a Reference die
19	Ghost die	Ghost die Totally in EEZ OR Partially in EEZ	Patterned die Alignment marker OR Test structure OR Mirror surface	Cannot be a Reference die
20	Unbuildable die	Whole die Patterned die Probed Inward of EEZ	Partial die Alignment marker OR Test structure OR Ghost die OR Mirror surface Partially in EEZ OR Totally in EEZ	Can be a Reference die "G" required

2.2.4 Wafermap Data Records

Wafermap data records begin with a keyword to identify the type of data being defined. Keywords are classified at the LOT and the WAFER level.

Table 2.2 lists LOT level keywords. LOT level keywords are defined only one time in the wafermap file and apply to all wafers.

Table 2.2 Lot Level Keywords

FACILITY	LOT	DEVICE
PROBE_FACILITY	PROBE_LOT	WAFERS
WAFER_SIZE	X_SIZE	Y_SIZE
UOM	LAYOUT	SHOT_MAP
PLUG_MAP	PARTIAL_MAP	DIE_DESIGNATOR
STATUS	SCRIBE	USER
BIN_NAME	PIN_ONE	END.

Table 2.3 shows the WAFER level keywords. WAFER level keywords must be defined for each wafer in the wafermap file and apply only to the designated wafer.

Table 2.3 Wafer Level Keywords

WAFERID	FABID	NUM_BINS
BIN_COUNT	MAP_XY	

Table 2.4 describes the Worldwide (WW) format of the ASCII wafermap file sent from the wafer fab.

In the Field Types of Table 2.4, “A” represents the alpha field, 4 digits are required in this field. “AN” stands for the alphanumeric field, no embedded blanks are allowed in this field. “ANS” is the alphanumeric string, the string in this field must be enclosed in double quotes and embedded blanks are allowed. “N” symbolizes the integer numeric field, it must be right justified with the leading zeroes. “F” is the floating-point numeric field, it must include the decimal point.

The “xx” field in the above keywords represents the wafer number. It is a two digit, right justified value with leading zeroes. The “bb” field in the above keywords is the bin number. It is also a two digit, right justified value with leading zeroes ranging from 01 to 20.

The keyword “LOT=nnnnnnn” defines the fab lot number. The fab lot number must be a 7 digit, right justified, leading zeroes value. Fab Lot # 123456 would appear as: “LOT=0123456”. This is because the SMS database system can only accept this format.

The keyword "SCRIBE" in the wafermap file defines the location of the scribe relative to the flat or notch of the wafer, the syntax is:

SCRIBE="llllll,cc,rrrr,sss"

The “llllll” field describes the location of the scribe on the wafer with the flat or notch at the bottom. LEFT, RIGHT, TOP and BOTTOM are four valid values. For 125 and 150 mm wafers, LEFT and RIGHT are valid. For 200mm and 300mm wafers, BOTTOM and TOP are used.

The “cc” field represents the number of characters in the wafer identification field. A value of 15 is valid when using the fab scribed wafer id. For vendor scribed wafer id, a value of 14 is valid .

Table 2.4 Keyword/Record Syntax Table

Keyword	Data Description	Field Type	Field Size	Require Record	Note
FACILITY=cccccccc	Fab Facility Id	AN	1-8	Yes	
LOT=nnnnnnn	Fab Lot Number	N	7	Yes	
DEVICE=cccccccccccccc	Fab Device Type	AN	1-14	Yes	
WAFERS=nn	# Wafers	N	2	No	4
USER="cccccccccccccccccccc"	User Defined String	ANS	1-20	No	
PROBE_FACILITY=cccccccc	Fab Facility Id	AN	1-14	No	
PROBE_LOT=nnnnnnnn	Fab Lot Number	N	7	No	
X_SIZE=fffffff	Die X Dimension	F	1-7	Yes	
Y_SIZE=fffffff	Die Y Dimension	F	1-7	Yes	
UOM=cccc	Unit of Measure	A	2-4	No	5
PIN_ONE=nnn	Pin One Orientation	N	3	No	
BIN_NAME.bb="t,ssssssssssssss"	Bin bb Type and Name	ANS	1-16	Yes	
STATUS="ssss"	Status of Map	AN	1-4	Yes	
SCRIBE="llllll,cc,rrrr,sss"	Wafer Id Information	AN	1-18	Yes	
DIE_DESIGNATOR="cccccccccccccccccccc"	Die Designator	AN	1-20	No	
WAFER_SIZE=nnn	Wafer Size in mm	N	3	Yes	
LAYOUT=cccccccccccccc	Wafer Layout Name	AN	1-14	No	1
SHOT_MAP="sssss....ssss"	Shot Map Coordinates	ANS	1-?	No	2
PLUG_MAP="sssss....ssss"	Plug Map Coordinates	ANS	1-?	No	2

Table 2.4 Continued

Keyword	**Data Description**	**Field Type**	**Field Size**	**Require Record**	**Note**
PARTIAL_MAP="sssss....ssss"	Partial Map Coordinates	ANS	1-?	No	2
WAFERID.xx=cccccccccccccccccc	Wafer xx Id	AN	1-18	Yes	
FABID.xx=cccccccccccccccccc	Wafer xx Optional Id	AN	1-18	No	
NUM_BINS.xx=nn	# Bins for Wafer xx	N	2	Yes	
BIN_COUNT.xx.bb=nnnnnn	Wafer xx Bin bb Qty	N	5-6	Yes	
MAP_XY.xx.bb="sssss....ssss"	Wafer xx Bin bb Map	ANS	1-?	Yes	6
END.	End of Wafer Map File	Yes			3

The "rrrr" field describes the method to be used to locate the reference die (coordinates 0,0). Valid field entries are: ROW1, PLUG, NTRL, NONE[4]; the detailed descriptions of these entries can be found later in this chapter. The "sss" field is the type of wafer scribe ID being used. "FAB" is valid when the fab scribed wafer ID format is used and "VEN" is valid when the vendor scribed ID format is used. For a ROW1 truncation fab scribed wafer ID, the keyword can be described as:

SCRIBE="BOTTOM,15,ROW1,FAB"

For a Natural truncation vendor scribed wafer ID, the keyword can be described as:

SCRIBE="BOTTOM,15,NTRL,VEN"

The Map Coordinates String is used to define the X and Y coordinate positions of dies on a wafer. It is used on the SHOT_MAP, PLUG_MAP, PARTIAL_MAP and MAP_XY keyword records. The coordinates specification syntax is :

Ynnn xxx xxx/xxx xxx

In the above syntax, "Ynnn" represents the Y position. It will remain in effect until the Y value changes. Y coordinates are always expressed in ascending order. "xxx" represents the X coordinates; it can be expressed either in ascending or descending order. The "/" indicates a range of X coordinates. X coordinates cannot cross the physical record boundary. A space character is used to separate the coordinate positions. The following expressions are all valid representations of the X,Y coordinates:

"Y1 -1/11 16 20 Y2 -2 1 3/4 99"
"Y1 20 16 11/-1 Y2 99 4/3 1 -2"
"Y1 -1 0 1 2 3 4 6 7 8 9 10 11 16 20 Y2 -2 1 3 4 99"

From the above expression, it is clear that the range indicator "/" can dramatically reduced the file size for wafers with high chip counts.

2.2.5 Example of Worldwide Wafermap File

The following example demonstrates all possible keywords that are defined in the wafermap file.

Figure 2.1 represents a wafer. The die marked with a "P" is the plug die. "B" represents the bad die. The die marked with a "1" and "3"is bin 1 die and bin3 die. "X" is the incomplete or partial die.

The scribe for this wafer is located on the right side of the flat. and the reference die is in Row 1. The wafer size is 200mm with fab scribed wafer ID. Table 2.5 shows all the other information of this wafer.

Table 2.5 Keyword Information of Sample Wafer

KEYWORD	INFORMATION	KEYWORD	INFORMATION
FACILITY	DMOS4	LOT	4000200
DEVICE	5406FIN	WAFERS	01
WAFER_SIZE	200	USER	HIGHBETA
X_SIZE	150	Y_SIZE	100
UOM	MILS	LAYOUT	5406-A
DIE_DESIGNATOR	06F	STATUS	TEST
WAFERID	E-4000200-01-A6		

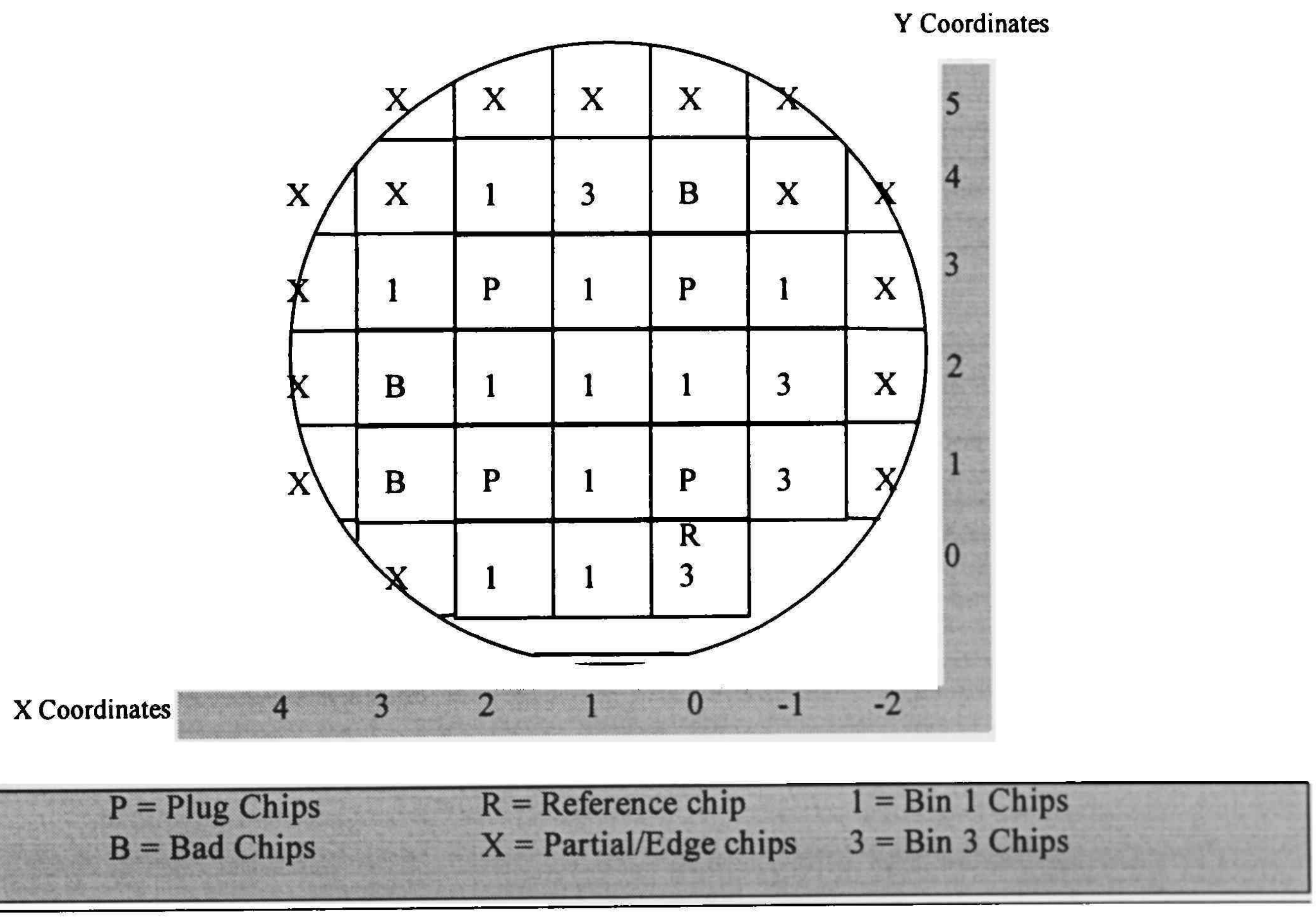


Figure 2.1 Sample wafer coordinates

Figure 2.2 is the worldwide wafermap file of the above sample wafer. The bins would be totaled as follows:

Bin 1 Prime = 10, Bin 3 Industrial = 04, Total Good Quantity = 14

```
FACILITY=DMOS4
LOT=4000200
DEVICE=5406FIN
WAFERS=01
USER="HIGHBETA"
X_SIZE=150.000
Y_SIZE=100.000
UOM=MILS
PIN_ONE=180
LAYOUT=5406-A
SHOT_MAP="Y0 0/2 Y1 -1/3 Y2 -1/3 Y3 -1/3 Y4 0/2"
PLUG_MAP="Y1 0 2 Y3 0 2"
PARTIAL_MAP="Y0 3 Y1 -2 4 Y2 -2 4 Y3 -2 4 Y4 -2/-1 3/4 Y5 -1/3
BIN_NAME.01="G,PRIME"
BIN_NAME.02="G,PRIME"
BIN_NAME.03="G,INDUSTRIAL"
BIN_NAME.04="TYPE B"
BIN_NAME.05="TYPE C"
STATUS="TEST"
SCRIBE="RIGHT,15,ROW1,FAB"
WAFER_SIZE=150
DIE_DESIGNATOR="06F"
WAFERID.01=E-4000200-01-A6
NUM_BINS.01=02
BIN_COUNT.01.01=00010
MAP_XY.01.01="Y0 1/2 Y1 1 Y2 0/2 Y3 -1 1 3 Y4 2"
BIN_COUNT.01.03=00004
MAP_XY.01.03="Y0 0 Y1 -1 Y2 -1 Y4 1"
END.
```

Figure 2.2 Example of Worldwide Wafer Map File

2.3 TI Wafer Truncation Format

A wafer truncation area is a mirror area located next to a reference die. It is the bare metal area to the right of the reference chip. Many fabs or devices within a fab using multi-reticle masks have chips printed out to the edges of the wafer. New masks have to be created to make the blank area and the loss of chips results in a small yield loss. Since the mirror die waste Good Electrical Die (GED) space, the need for the mirror area comes into question. This is particularly true when the devices in question are expensive.

Locating the reference-die accurately is very important for processing the wafer using the map. This locating is done either manually or automatically. Each A/T site has different types of mounters and each of them uses different types of vision systems. Some of them are primitive in technology and some of them are advanced. So to give freedom to the A/T site to choose any mounter to process the wafers, it is necessary to standardize the reference-die location for the mounter with low-level capability. To make it easy for the operator to locate the reference-die, a mirror die is required for all the wafers. A mirror area is defined as the bare metal area to the right next to the reference-die. Those mounters with the capability of "auto reference die search" can make use of this mirror die and locate the reference die. This solves the problem for stepper material as well as non-stepper material.

A mirror die has to be at least 100x100 mils. This is because the old generation mounters have a physical limitation of 6" of table travel (usually varies between 5.8" to 5.9"). Further the wafers are loaded by the operator, and hence the wafer center is not at the same position as table center. Usually there is a margin on the table and wafer forms overlapping circles. The mounter does not allow the table to move beyond the table circle. It restricts the table movement to the circumference of the wafer. It is proposed that there should not be any good die within 100 mils from the circumference. As the reference die is a good full die, it should be at least 100 mils away from the circumference. The gap would be filled up by the mirror-die's presence. If the die size is smaller than 100x100, then there will be more than one mirror die and if more, a partial mirror die of size 100x100 is sufficient.

Detailed information on the reference die, the nature truncation standard and the row1 truncation standard is given later in this chapter.

2.3.1 Reference Die

The reference die is always coordinate (0,0). It must be a whole patterned die located inward of the Edge Exclusion Zone (EEZ). The reference die also must be adjacent to a truncation area. It may be probed or unprobed.

2.3.2 Nature Truncation Standard

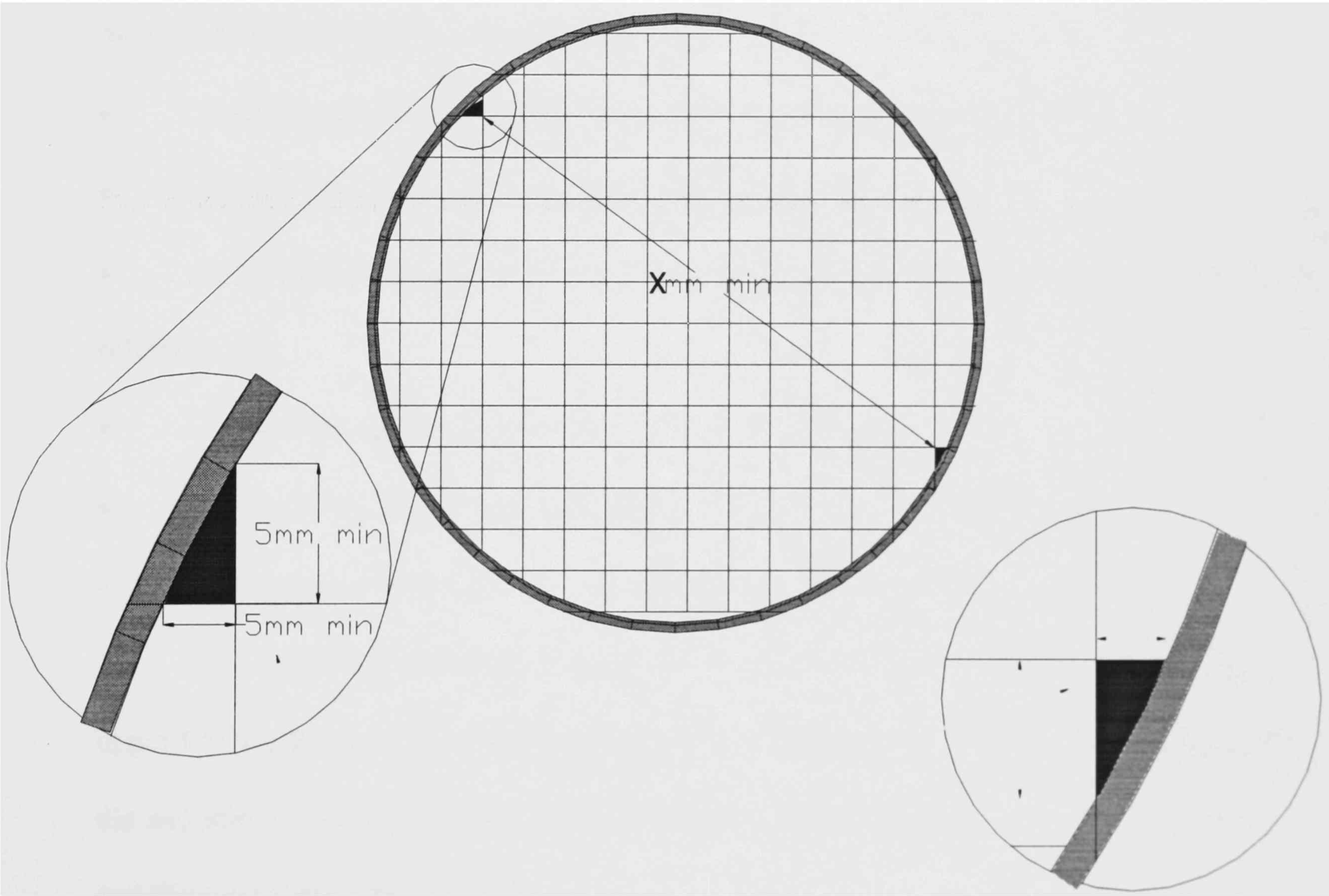
Figure 2.3 shows the nature truncation standard [4]. This format is accepted by most of the wafer fabs. In the nature truncation standard, two mirror areas are required. One is the primary mirror area, it is located at the lower right quadrant of the wafer with the flat down. The minimum X distance of the primary mirror area is 5mm and the minimum Y distance is 5mm minimum or full chip size (whichever is largest). The secondary mirror area is not allowed in the same quadrant as the primary mirror area. The minimum distance between the corners of each mirror area is shown in Table 2.6.

■ = Mirror areas

▒ = Wafer Edge Exclusion zone (dark band)

Note:

1. Wafer is shown with the notch/flat down



Secondary Mirror Area

Primary Mirror Area

Figure 2.3 Nature Truncation Standard

Table 2.6 Distance Between Two Mirror Areas

Wafer Diameter	X dimensions
300mm	150mm
200mm	100mm
150mm	75mm
125mm	65mm
100mm	50mm

The primary reference die position is defined as

- With the flat/notch/reference position to the bottom of the wafer, the reference die is in the lower right quadrant of the wafer.
- A fully patterned, physically whole die lies above the reference die.
- Mirror area is located to the right of the reference die.
- A fully patterned, physically whole or partial die lies above and to the right of the reference die.
- A complete or partial die is required below the reference die.
- No die below the reference die will extend to the right of the reference die.
- No partial or whole die between the reference die and mirror area are allowed.

The secondary reference die position can be located in the upper right quadrant, upper left quadrant, or lower left quadrant. No partial or whole die between the reference die and mirror area are allowed. Figure 2.4 shows the location of the secondary mirrors and the secondary reference dies.

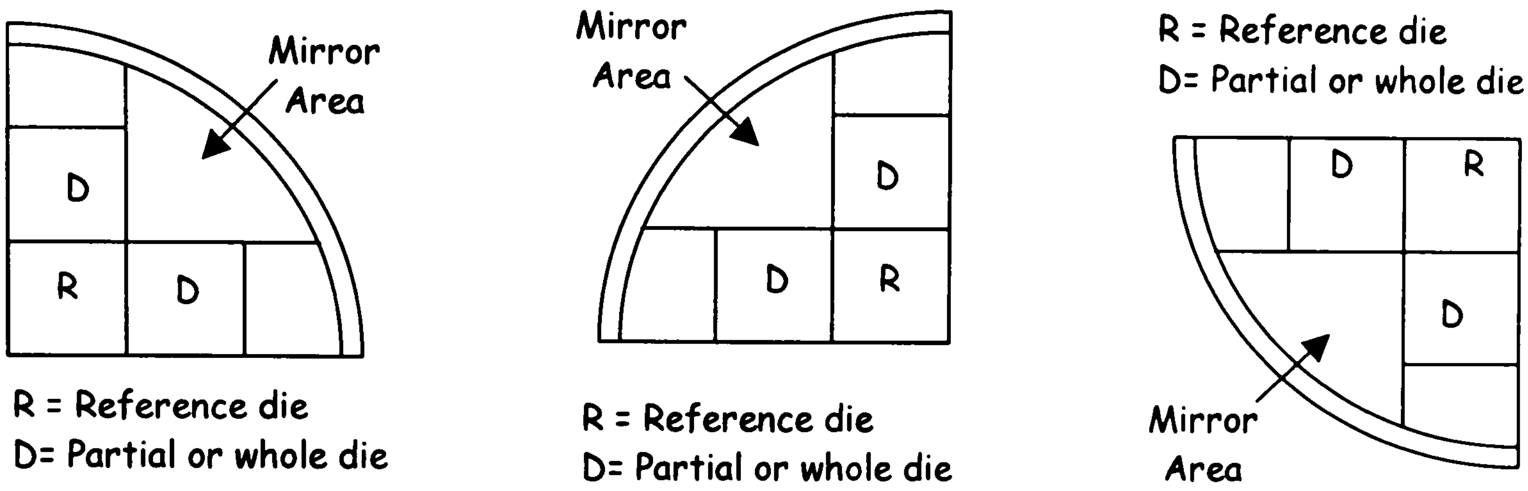


Figure 2.4 Secondary Reference Die Positions

2.3.3 Row1 Truncation Standard

Another popular wafer truncation format is the row1 truncation standard. Figure 2.5 shows the format of the row1 truncation standard. For ROW1 truncation, the reference die is the bottom most right-hand chip next to the notch. It is defined as

- With the flat/notch/reference position to the bottom of wafer the reference die is in lower right quadrant of wafer
- A fully patterned, physically whole die lies above the reference die.
- Mirror area is located to the right of the reference die.
- No partial or whole die between the reference die and mirror area are allowed.
- No die extends below and to the left of the reference die.
- No die extends below and to the right of the reference die.

The minimum X distance of mirror area is 2.50mm (measured from the bottom right-most point of the reference die to the Wafer Edge Etch area or wafer edge).

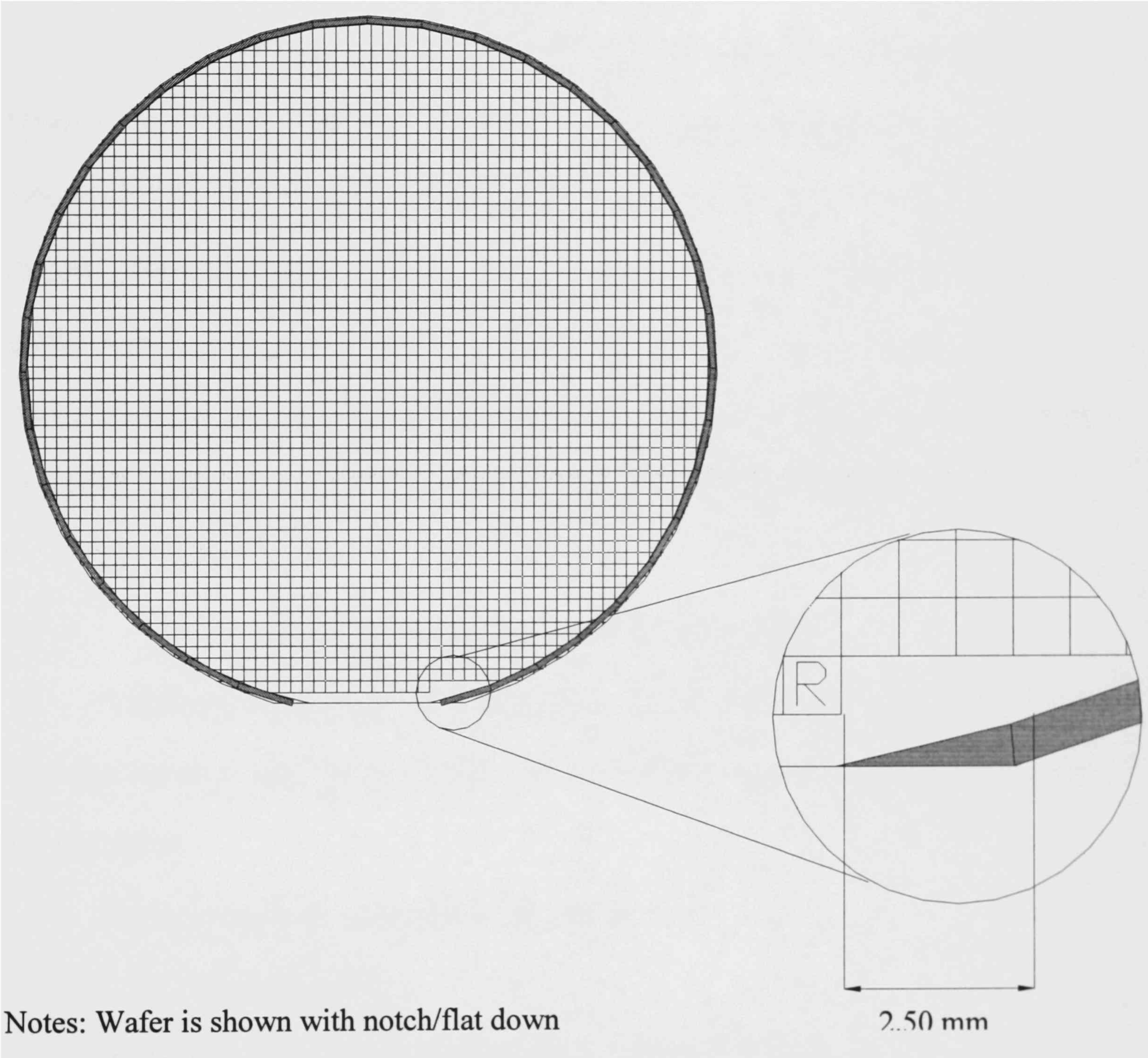


Figure 2.5 Row1 Truncation Standard

CHAPTER III

WAFERMAPPING CONVERSION

3.1 Introduction

Chapter II introduced the TI inkless standard to implement the inkless process. However, these standard have not been accepted as industry standards in the semiconductor industry. Others foundries have their own standard in wafermap file format, wafer truncation format and file naming rules. In order to design an automated inkless wafermap system, a foundry's inkless standard must be converted to the TI inkless standard. In this chapter, TSMC inkless standard [5] is introduced as an example of how to convert a foundry inkless standard to the TI inkless standard.

3.2 TSMC Wafermap File Naming Rules

There are two kinds of files generated in TSMC to implement the inkless process. One is a summary file; it is one file for one lot. Another is a wafermap file; it is one file for one wafer.

The summary file naming rules are defined as:

xxxxxLs.TSM

In the above definition, "xxxxx" represents the TSMC lot number; "s" is the shipping serial number. The summary file is distinguished from the wafermap file by the letter "L" in the file name.

The wafermap file name rules are defined as:

xxxxxww.TSM

"xxxxx" in the above definition represents the TSMC lot number, and "ww" is the wafer ID number.

For example, lot ID D12345.00 has 24 wafers and the shipping serial number is 0. There is one summary file and 24 wafermap files for this lot. The summary file name is D12345L0.TSM, and the wafermap file names are as follows:

D1234501.TSM (#01)
D1234502.TSM (#02)
D1234503.TSM (#03)

.

D1234524.TSM (#24)

If this lot is split into two sub lots C12345.00 and C12345.01, each sub lot has 12 wafers, and the shipping serial number is 0 and 1. There are two summary files and 24 wafermap files. The summary file names are as follows:

C12345L0.TSM C12345L1.TSM

The wafermap files names are as follows:

C1234501.TSM (#01) C1234513.TSM (#13)
C1234502.TSM (#02) C1234514.TSM (#14)
C1234503.TSM (#03) C1234515.TSM (#15)

C1234512.TSM (#12) C1234524.TSM (#24)

3.3 Data Records of TSMC Files

Figure 3.1 shows an example of the summary file format. The summary file format is given by:

row 1 : company name
row 2 : tsmc product name
row 3 : dummy (default is tsmc product name)
row 4 : tsmc lot no.
row 5 : shipping wafer count
row 6 ~ second to last row : summary table
last row: X, Y information of die size

```
TSMC
TM7020A
TM7020A (PPCI4451)
DA8115.00
25
MAPPING   WAFER_ID  BIN 1
DA811501.TSM  DA8115-01    722
DA811502.TSM  DA8115-02    750
DA811503.TSM  DA8115-03    704
DA811504.TSM  DA8115-04    735
DA811505.TSM  DA8115-05    731
DA811506.TSM  DA8115-06    703
DA811507.TSM  DA8115-07    705
DA811508.TSM  DA8115-08    744
DA811509.TSM  DA8115-09    737
DA811510.TSM  DA8115-10    777
DA811511.TSM  DA8115-11    682
DA811512.TSM  DA8115-12    563
DA811513.TSM  DA8115-13    594
DA811514.TSM  DA8115-14    459
DA811515.TSM  DA8115-15    718
DA811516.TSM  DA8115-16    744
DA811517.TSM  DA8115-17    734
DA811518.TSM  DA8115-18    682
DA811519.TSM  DA8115-19    696
DA811520.TSM  DA8115-20    713
DA811521.TSM  DA8115-21    696
DA811522.TSM  DA8115-22    731
DA811523.TSM  DA8115-23    675
DA811524.TSM  DA8115-24    680
DA811525.TSM  DA8115-25    708
                   Total  17383
226.668 x 224.552
```

Figure 3.1 TSMC Summary File Format

Figure 3.2 is the example of the wafermap file format. The contents of the wafermap file should be:

row 1 : company name
row 2 : tsmc product name
row 3 : wafer ID.
row 4 : map file name
row 5 ~ last row : map matrix

```
TSMC
TM7020A
DA8115-01
DA811501.TSM
...........11111111111X...........
.........1X11111X11X1X1XX.........
.......1X111111111111111XX1X.......
......X11111111111111111111XX......
.....1X111X1111X1111111X1111X.....
....X1111111111111111X111111XX....
...XX11111111111X111111X1111XX...
...X1111111111111111X11111111X...
..X1X11111111111X1X1111111111X..
..X11111111111111111111111111111..
.X111X11X11X11X111111X1111111111X.
.X1111111111111X1X1111111111111.
.111111111XX1XX11111X111X1111111.
X11111111111X11111111111111111XX
X1111111111111111111X111X1X1111X1
1XXX11X11111111111111111111111XXX
XXXX11111111XX1X11111111111111XXX
XXXX11111111X111111111X111111XXX
X11X11111111X111X111X111X11111111&
X11X111111111111111111111111111.
.1111111X11XX11111X1111111111111.
.X11111111111111111111111111XX1X.
.X1111111X111111111111111111111X.
..1X11111111111XX11111111111X1X..
..XXX11X11111X1111111111111111XX..
...1111X111X111111X11111111X1X1...
....1X11X11X11X11111111111XX1X....
....XX11X11X11X11111111X111X1X....
.....X1X11111111111111X11X1X......
.......1XX1111111111111111X.......
........X1X111111X11111XXX........
..........X111111X11111X..........
```

Figure 3.2 TSMC Wafermap File Format

In the wafermap file, "X" represents a bad die; "@" means a good die failed visual inspection, so it represents a bad die; "."is a non-tested die or non-exposure area; "&" represents a reference good die and "?" stands for a reference bad die. Other symbols such as "0", "1", ... "9", "A", "B", ..."Z" represent good dies. The notch is always at the 6 o'clock position.

3.4 TSMC Lot ID Naming Rules

Figure 3.3 shows the format for the TSMC lot ID naming rules. Fab ID represents where this lot is produced. For example, "D" represents Fab4; "R" is Fab7A.

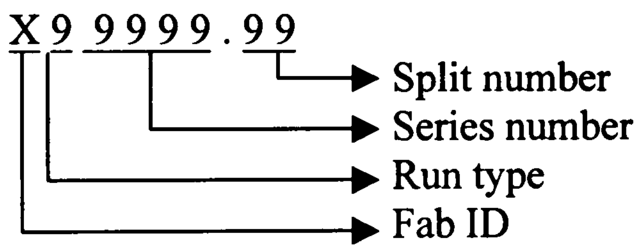


Figure 3.3 TSMC Lot ID Definition

Run type is intended to represent a production run, pilot run, development run or loop test. For example, 5-9 is for a loop test, pilot run and development run; A-Z (excluding D,E,I,J,L,O,Q) is for production runs. The series number is to represent the product sequence, which is from 0000-9999. The split number is to record the number of lot to be split.

3.5 TSMC Wafer Truncation Format

TSMC wafers do not meet any standard wafer truncations mentioned in Chapter II; they do not even have their own standard truncations. Some of their wafers have mirror areas, while other wafers do not have any mirror areas. To standardize the TSMC wafer truncation format, mirror areas must be implemented on all TSMC wafers. Figure 3.4 shows the wafer truncation format after implementing the mirror areas. The reference die is the rightmost die below the right mirror area when the notch is down. The location of reference die must be marked with a special letter; "&" represents the good reference die and "?" represents the bad reference die. The SCRIBE format for a TSMC wafer can be described as:

SCRIBE="BOTTOM,15,NONE,FAB"

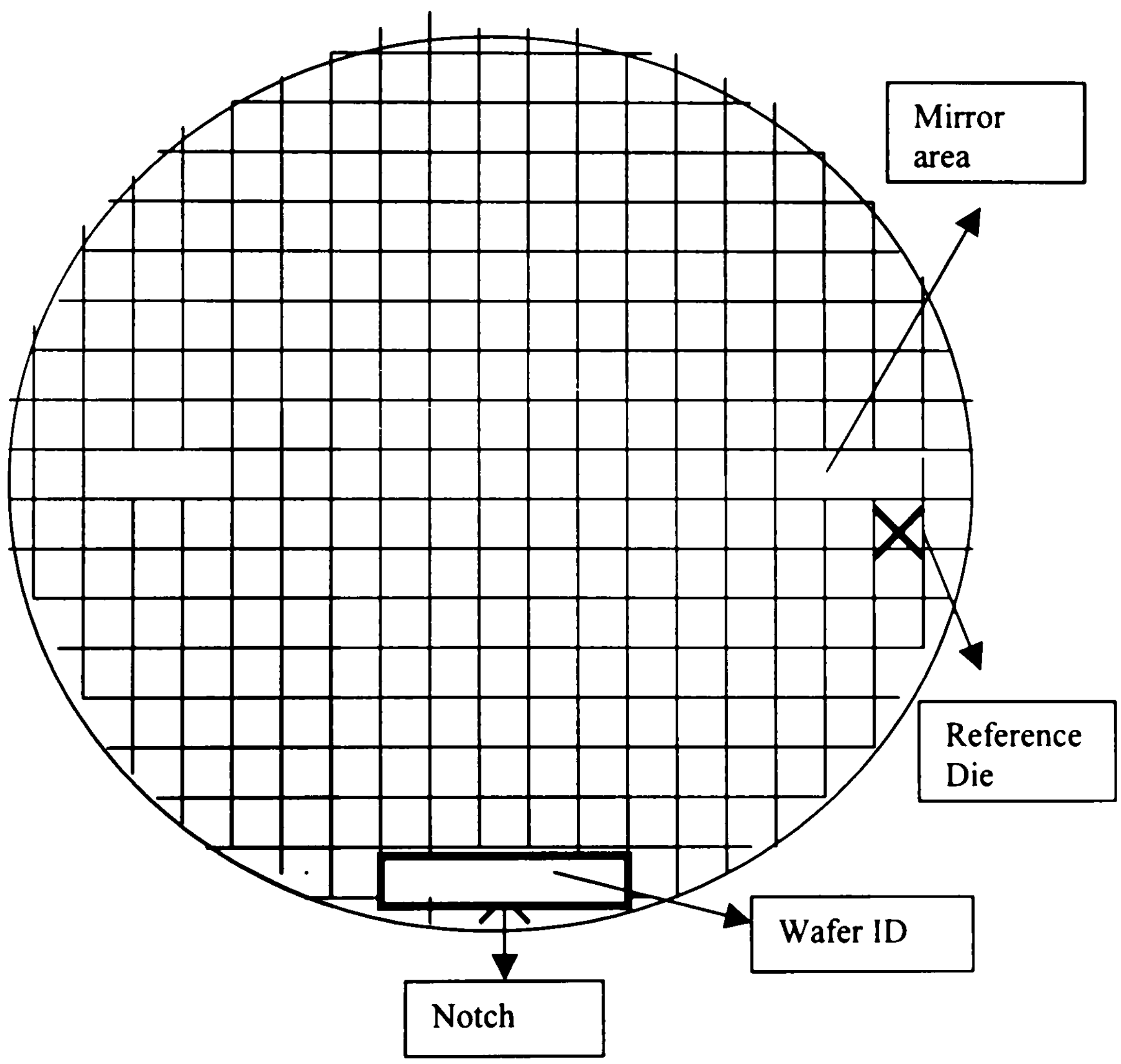


Figure 3.4 TSMC Wafer Truncation

3.6 Converting TSMC Inkless Standard to TI Inkless Standard

In order to design an automated inkless wafermap system to implement inkless processing for all foundry wafers, it is necessary to convert individual foundry inkless standards to the TI inkless standard. The conversion from the TSMC inkless standard to the TI inkless standard is introduced below.

First, mirror areas must be created on all wafers to meet the worldwide Nature Truncation format or Row1 Truncation format. The importance of mirror areas has been discussed in chapter II. It is required to give freedom to the A/T site to choose any mounter to process the wafers. Figure 3.4 shows the TSMC wafer truncation format after implementing mirror areas. There is a small difference between this format and the Nature Truncation format. In the Nature Truncation format, the mirror areas must be located at the lower right quadrant of the wafer with the flat down. The format of Figure 3.4 is selected because some of the TSMC wafers already have this truncation format, and other format wafers can be easily changed to this format without changing the reticles.

Second, if the wafermap file is different from the worldwide wafermap format discussed in chapter II, a conversion program is required to convert the foundry wafermap file to the TI worldwide wafermap format. The detailed information of the conversion program will be described in the next chapter.

Next, all the foundry wafermap file names must be renamed to follow TI file naming rules. For example, a TSMC summary file name C12345L0.TSM must be changed to T0C12345.00, “T” represents the company name TSMC; “0C12345” is the lot ID and “00” is the shipping serial number.

In Chapter II and Chapter III, the TI inkless standard and the TSMC inkless standard are presented. Also, a method of converting the TSMC inkless standard to the TI inkless standard is displayed. The next chapter will discuss how to design an automated inkless wafermapping system based on the TI inkless standard.

CHAPTER IV

DESIGN OF AN AUTOMATED INKLESS WAFERMAPPING SYSTEM

4.1 Introduction

In order to implement an inkless wafermap process, a system that can convert from one wafermap system to another is required. This chapter introduces the development of a fully automated inkless wafermapping system, which can transfer/download the wafermap files from a TSMC wafermap ftp server to the TI foundry wafermap database, convert the TSMC wafermap format to the TI worldwide wafermap format and download the wafermaps to the TI A/T site or subcon A/T site to achieve a computer integrated manufacturing A/T inkless standard. In the design procedure, the TI inkless standard must be followed, and current available resources are utilized to expedite the design process. This chapter will concentrate on the short-term solution of TSMC to TI wafermapping conversion. The long-term solution will be discussed in the last chapter.

4.2 System Overview

This automated inkless wafermapping system is a central repository for the electronic wafermap data utilized by the TSMC wafer fabs (or other foundry fabs) and the TI A/T facilities or the other subcon A/T facilities. It runs on a Sun workstation with the Solaris operating system on TI's Universal Manufacturing (UM) mainframe. The system consists of wafermap transfer/download, wafermap conversion, wafer and wafermap selections, and reporting programs.

4.3 System Process

After a lot is probed in a TSMC wafer fab, the TSMC formatted wafermap files are generated and uploaded to the TI directory of the TSMC FTP wafermap server. This process may be automated and customized to meet the wafer fab's output (i.e.- run the upload once per hour or once per day).

Next, a cron script runs on the TI foundry wafermap server everyday to check whether there are any new wafermaps generated at the TI directory of the TSMC FTP wafermap server. If new wafermaps are found, the script file automatically FTPs the wafermap files to the TI wafermap server and stores the wafermap files in their corresponding directory (such as /tsmc). If the wafermap file format is different from the worldwide wafermap format, a conversion program converts the TSMC wafermap format to the worldwide wafermap format, and then the wafermaps are downloaded to a particular TI A/T site or subcon A/T site through FTP in the same worldwide format. Any errors and messages of the wafermap conversion and transfer are logged and messages are sent out to the corresponding group.

After the WISH system [6] on each site receives wafermap data by FTP, one of the wafermap host tasks "wmspool" spools the wafermap data and converts the ASCII format files into image format files that can be used by the mounter. Once the wafer ID is read and correlated with the frame ID of each wafer at the ID station, another task "idserver" is submitted to match the corresponding wafer to the frame, The wafer is sent to be mounted and the mounter can download the wafermap data from the WISH host by just reading the frame ID. Figure 4.1 shows the process of the automated inkless wafermapping system.

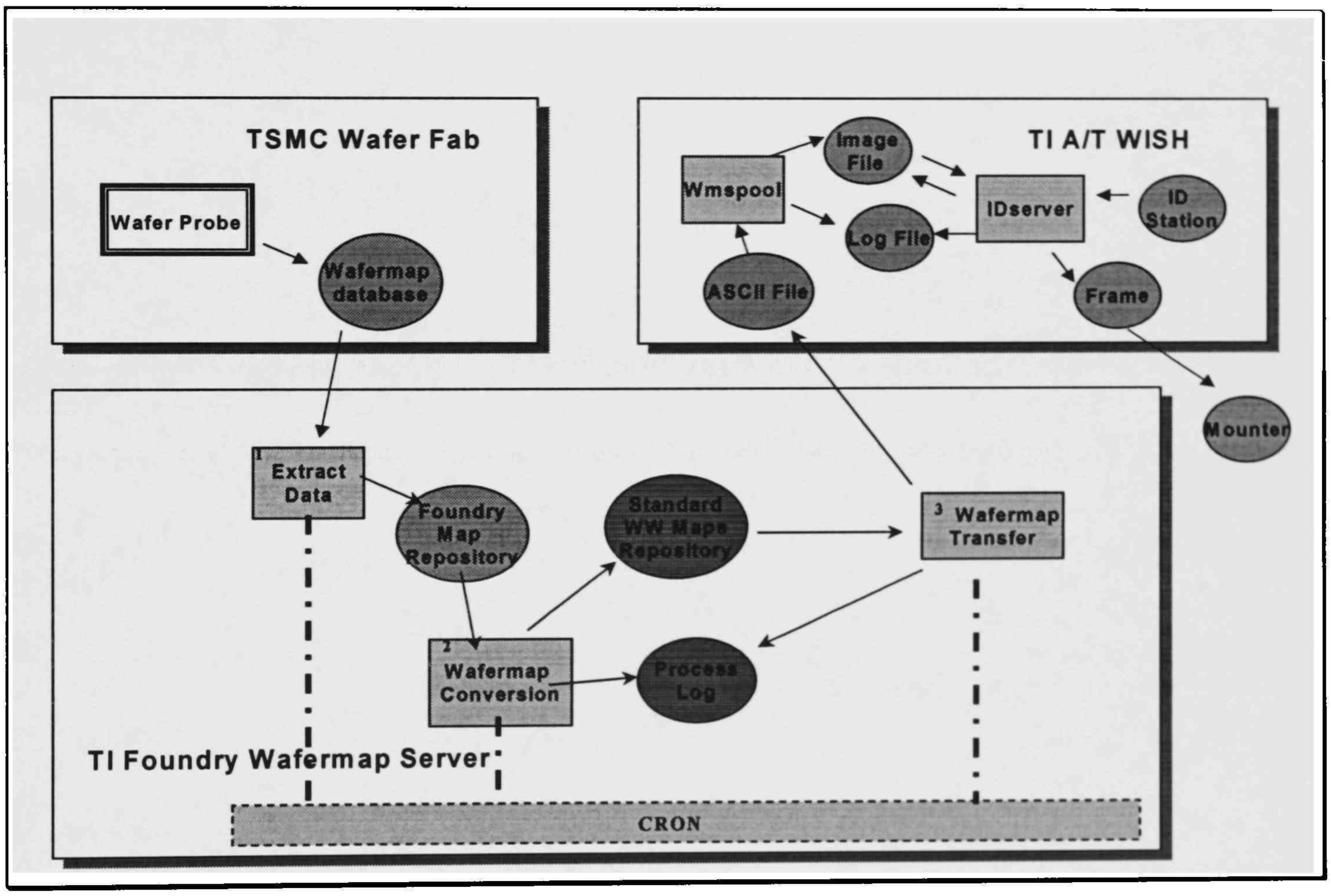


Figure 4.1 System Process of the Automated Wafermapping System

4.4 Design of Automated Inkless Wafermapping System

This wafermap system is divided into several subsystems that have the capability of wafermap storage, wafermap transfer/download, wafer and wafermap selection, and reporting programs. The detailed design procedure for each subsystem is described later in this chapter.

4.4.1 Electronic Wafermap Transfer

The objective of this project is to develop a system to implement a safe mechanism for transferring wafermap data between TI and its business partners to guarantee the delivery of the wafermaps from/to their partners and standardize the process for long-term maintenance and operations.

To design a secure networking system, a firewall is the most commonly used technology [7]. A firewall is a system (either hardware or software or both) that enforces an access control policy between two networks. It can block all unwanted communication between networks while allowing acceptable communication to pass back and forth. To obtain security access, user authentication is required.

In this project, TI Inter Corporate Gateway (ICG) is used as the firewall. Figure 4.2 shows the ICG diagram. It is a combination of host computer systems, hardware encryption devices, communication links and other networking hardware and software that allow TI to communicate with its business partners in a secure fashion. It has the ability to prevent unauthorized logins through the firewall to the TI internal networks.

The router in the ICG controls the IP addresses that can access the system from the outside. The encryptor will only talk with host systems it has been configured to talk to.

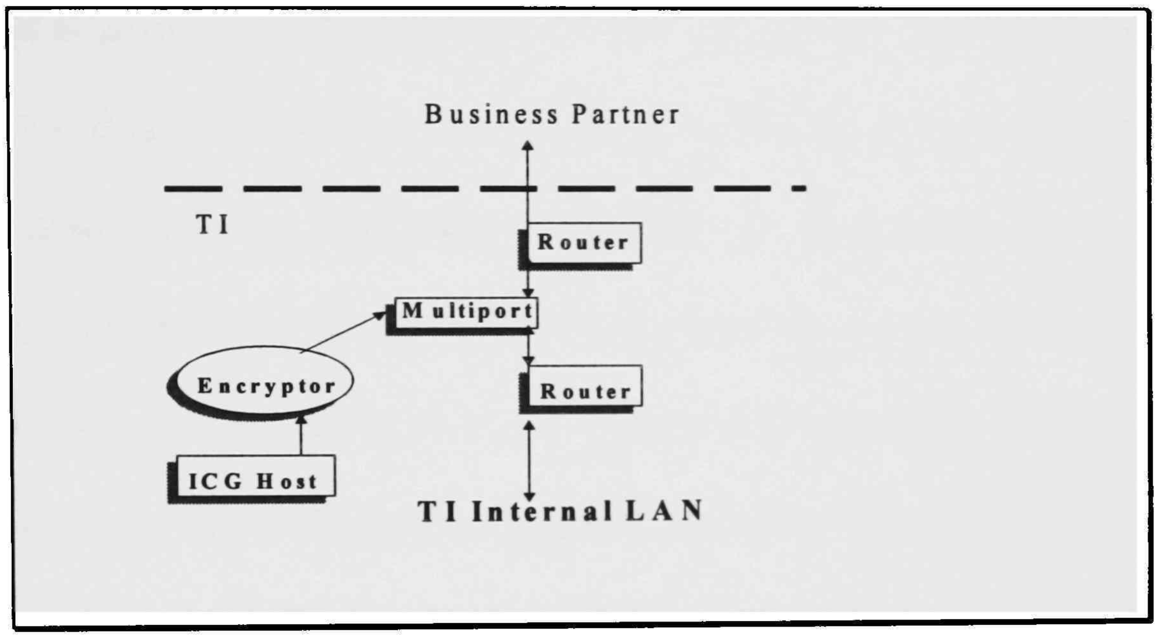


Figure 4.2 Diagram of The Inter Corporate Gateway

The network communication protocol of this project is TCP/IP protocol (Transmission Control Protocol/ Internet Protocol) [8]. TCP/IP is the suite of protocols that governs communications on the network. TCP controls the flow of data over the network, while IP controls how data packets are properly routed through the addressing system. It is used on a variety of computer systems and network types.

The wafermap transfer protocol of the wafermapping system is FTP (File Transfer Protocol). FTP is the standard application provided by TCP/IP for copying a file from one host to another. It uses TCP as a transport protocol to provide reliable end-to-end connections.

FTP is selected because of its three advantages. First, FTP can copy any files, no matter whether they are "ASCII" text files or "binary files". Next, FTP can copy to and from different kinds of computer systems; no matter whether they are UNIX, DOS or Windows systems. Last but not least, FTP can copy files in a fast and simple way. Although transferring files from one system to another seems simple and straightforward, some problems must be dealt with first. For example, two systems may use different file name conventions; two systems may have different directory structures All of these problems have been solved by FTP with a very simple and elegant approach.

FTP differs from other client-server applications in that it establishes two connections between the hosts. One connection is used for data transfer, and the other for control information (commands and login). Separation of commands and data transfer makes FTP more efficient. The control connection uses very simple rules of communication. Only a line of command or a line of response needs to be transferred at a time. For example, the "cd" command is used to navigate the directories and the "ls" command or "dir" command is used to examine directory listings. With these commands, navigation through the directory structure to find a specific file is possible . Once the file is found, the file can be obtained with the command "get filename". As it is necessary to log into the remote host, the user must have a user name and a password to access files and directories to guarantee a secure file transfer. For data transfer, it is easy to switch from ASCII mode to BINARY mode or vice versa by simply entering the " ascii" command or the "binary" command for different file types. Figure 4.3 shows the basic model of FTP.

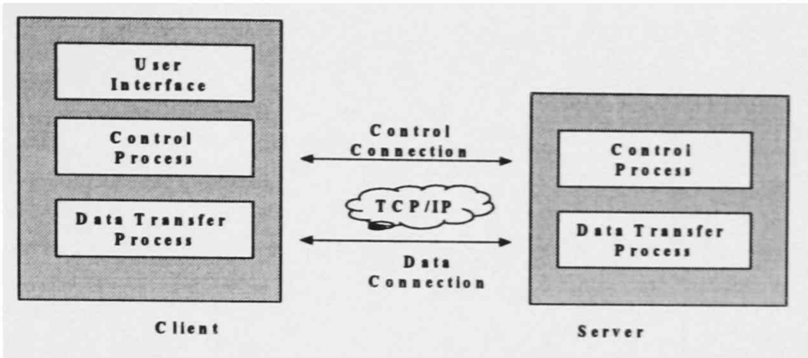


Figure 4.3 Basic Model of FTP

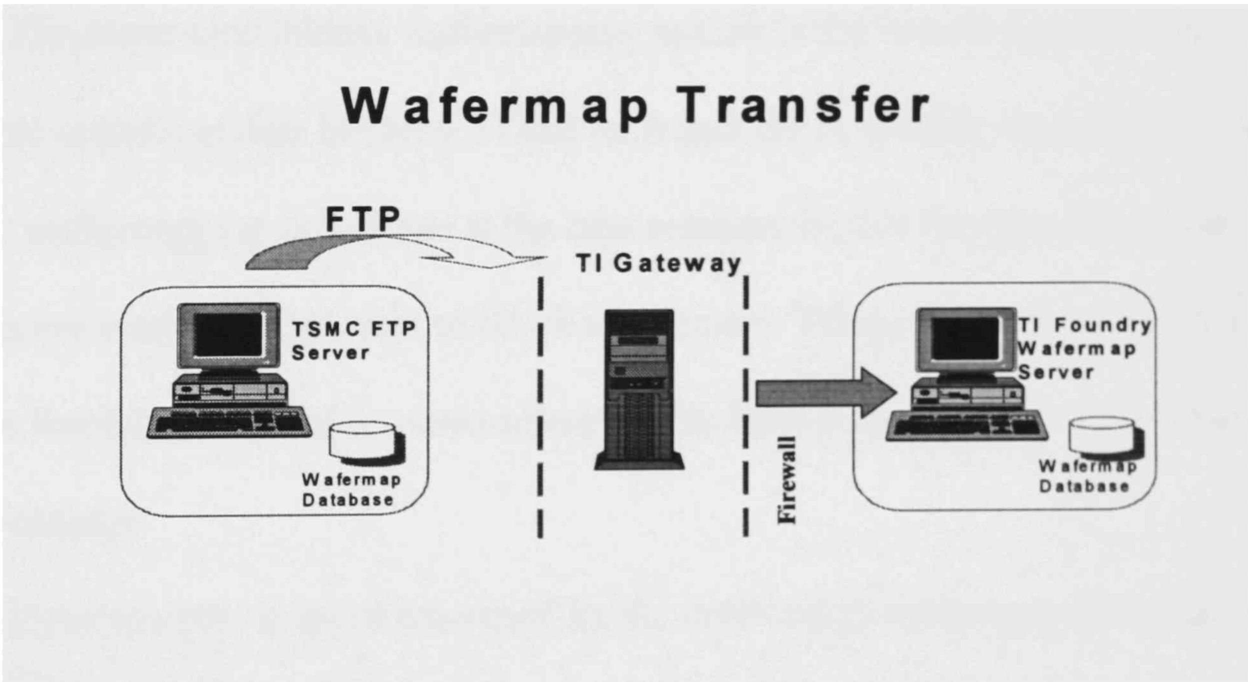


Figure 4.4 Architecture of the Wafermap Transfer

Figure 4.4 is the hardware architecture of the wafermap transfer system between TI and TSMC. The wafermap files at the TSMC FTP server are transferred to the TI foundry wafermap server through the TI ICG gateway via FTP. The software solution to the file transfer is :

```
`ftp -nv gate.ti.com <<EOF
user aaa/@ftpxxxx passwdl
quot auth  bbb
quot response passwd2
prompt
hash
mget *
bye
EOF`;
```

In the above script, "aaa" is the user name on the TSMC server; "@ftpxxx" is the TSMC ftp server name; "passwd1" is the password on the TSMC server; "bbb" is the user name of the TI gateway and "passwd2" is the password on the TI gateway.

4.4.2 Wafermap Repository

The automated inkless wafermapping system is the central repository for electronic wafermap data between TI and its foundries. A specific server belonging to foundry wafermapping operations is the best solution for this function. However, this server is not available right now to finish this project. Temporary disk space on a TI server is furnished as the short-term solution. The long-term solution will be discussed in the last chapter.

There are two types of files used by the wafermapping system. One type of file is an ASCII file, which is the file sent from one of the foundries or internal wafermap files. Each file can consist of data for one or more wafers. The file size may vary with the number of dies per wafer and the number of wafers per file. Another type of file is an IMAGE File, which is the binary file that is used by the mounters. The file size is usually smaller than the ASCII files since one wafer has only one image file.

Because the two types of files vary greatly in their size, it is not necessary to create different file systems for the different types of files; it is recommended to put them on different partitions. Partitions can keep data separate, providing improved recovery options, faster backup and recovery times, and better organization of programs and files on the disk drive. Using partitions can also improve the drive performance by reducing fragmentation. Fragmentation occurs when files are not stored in a single piece but are broken up and distributed. With heavy usage, the drive can eventually become very fragmented. Fragmentation can become a serious issue on many computer systems, partitioning can help to alleviate this problem.

The estimation of how much disk space to use for each partition of each file type is:

Based upon an ASCII file with 25 wafers, with an average of 700 dies per wafer.

ASCII Files (ask-bytes, worldwide format) = 32000 bytes

ASCII Files (bytes-bytes, TSMC format) = 2000 x25=50000bytes

IMAGE Files (imp-bytes)= 73000 (ATCS format)

The total disk space depends on how many lots are processed in a month and how many months of data is to be kept on-line. The disk space is calculated as:

ASCII Files = n * bytes-bytes * m where bytes-bytes = 82000 (4.1)

IMAGE Files = n * bytes-bytes * m where bytes-bytes = 73000 (4.2)

Where n = number of lots processed per month
m = number of months to keep data

For example, if about 200 lots are processed in a month and the data is to be kept on-line for one year. The total disk space required is as:

Total disk space of ASCII files = 200x12x82k = 196.8M

Total disk space of IMAGE files =200x12x73k=175.2M.

4.4.3 Wafer and Wafermap Selection

The function of the wafer and wafermap selection is achieved by the WISH system. The WISH system was developed by TI to support the wafermapping project. It runs on a Sun workstation with Solaris 2.6 or higher as the operating system. The two main functions of the WISH system are called the "wmspool" task and the "idserver" task.

The "wmspool" task is designed to receive and process wafermap data from the wafer fabs. The main function of the "wmspool" task is to convert the worldwide (ASCII) wafermap files to Image (Binary) wafermap files that can be used by a mounter. The "wmspool" task is a real time process running at predefined intervals to check the destination directory as to whether there are any new wafermaps sent from wafer fabs. Once the task detects any new wafermaps, it converts the ASCII wafermap files to image wafermap files that can be used by a mounter. At the same time, it also checks the wafermap data as to whether the data sent is correct or not. First, "wmspool" checks and verifies the checksum of the wafermap data to ensure that data was not changed or lost during transmission. Next, a few validity checks are performed by the "wmspool" task. The "wafer-boundary check" ensures that all the xy locations fall within the wafer boundary. The " xy locations check" ensures that no invalid xy values are in the wafermap data. The "device name check" and the "file pathname check" are performed to check the validity of the device name and the file pathname. The correct pathname of the ASCII file and image file are given by:

/ascii/wlllllll.ss

/image/wlllllll/pppqqq

Where "w" represents the waferfab file code; "lllllll" is the waferfab lot number, and "ss" is the serial number . This is used to distinguish different transmissions of the same lot. "ppp" means sequence number and "qqq" is wafer number.

The "IDSERVER" task is designed to map the physical wafers of a lot at an ID station and take the corresponding image file from the host. The ID station is at a wafer mount process where the wafer is stuck onto a film with a flex frame ring. Once the frame-id and the wafer ID(OCR) are read and correlated, this information is sent to the ID directory in the WISH system to perform the corresponding wafer to frame matching. As in "wmspool", the "IDSERVER" task is also a real time process running at the predefined intervals to check the ID directory as to whether there are any data sent up from the ID Station. When the "IDSERVER" task finds that there is a file from the ID Station, it searches for the corresponding image file in the image directories by wafer fab lot and wafer number and then renames it to a file with the frame-id number. In this process, the wafer to frame matching is finished. Once the physical wafer is sent to the mounter, the mounter can then download the image file for the wafer from the host by just reading the frame-id of the flex frame.

Figure 4.5 is the data flow diagram that gives a brief illustration of the different files created and used by the WMSPOOL and IDSERVER tasks.

4.4.4 Wafermap Conversion

This wafermapping system is designed only to accept worldwide wafermap format. All other wafermap formats must be converted to the worldwide wafermap

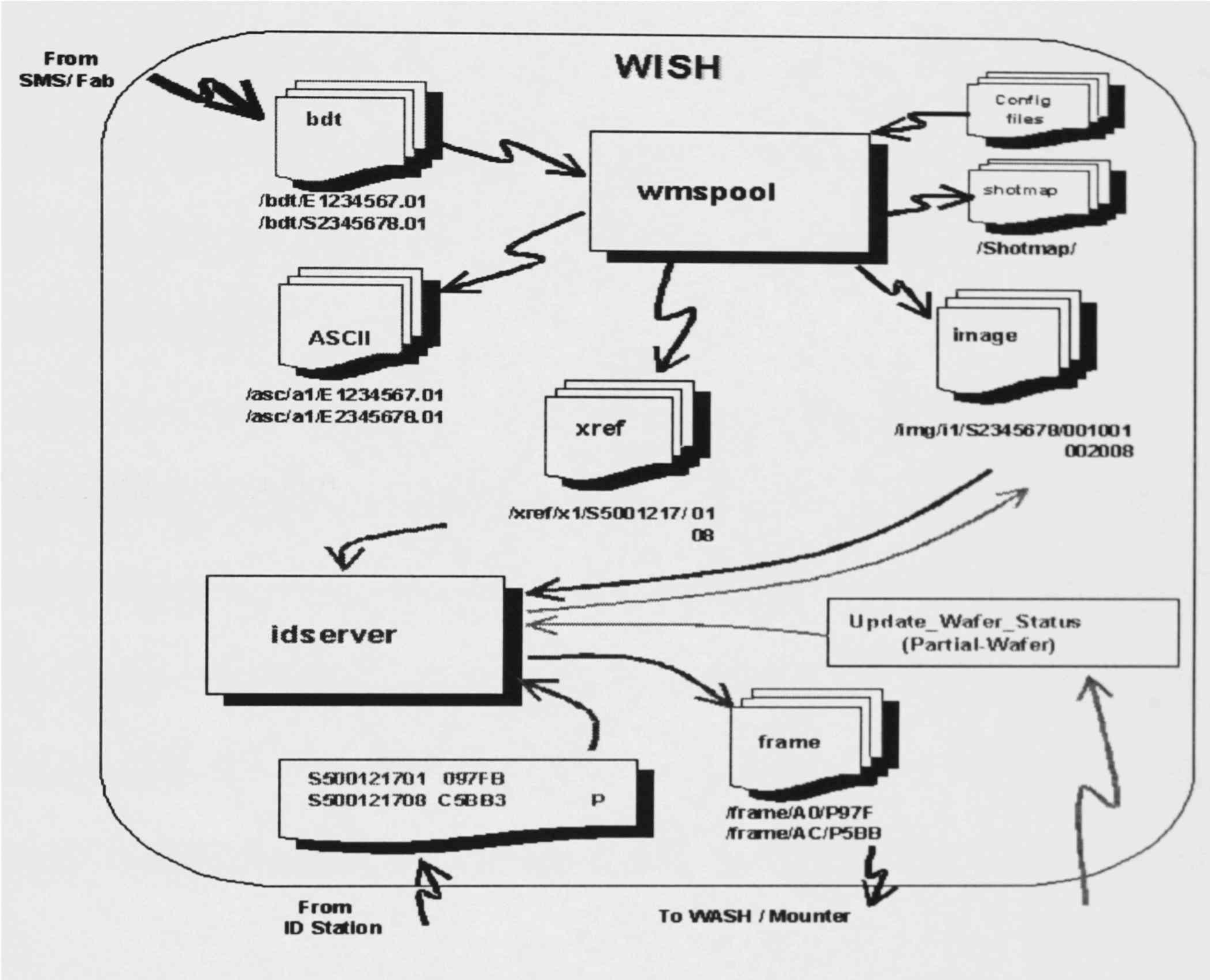


Figure 4.5 Data Flow Diagram of WISH System

format. Chapter II and Chapter III already introduced the worldwide wafermap format and the TSMC wafermap format. A conversion script achieves the conversion from the TSMC wafermap format to the worldwide wafermap format.

In order to write an efficient conversion script, it is important to choose a programming language that suits the needs of the conversion as easily as possible. In this project, a language that was good at text processing was the best type desired. Perl is this kind of language [9]. It is designed to make the easy job easy, without making the hard job impossible. In many programming languages, it is necessary to declare the types, variables and subroutines that are going to be used before writing the first statement of executable code. For complex problems demanding complex data structures, this is a good idea. But for many simple, everyday problems, a more direct approach is better. Perl is such a language.

Perl is also one of the most portable programming languages. It can run on numerous operating systems, including UNIX, MS-DOS, VMS,OS/2, Macintosh and any variety of Windows. To program C portably, it is necessary to put in all those strange #ifdef markings for different operating systems. To program a shell portably, the syntax for each operating system's version of each command must be remembered. Perl, happily avoids both of these problems, while retaining many of the benefits of both C and shell scripts.

There are many reasons to choose Perl as the programming language. The most important reason for choosing Perl as the programming language of this project is that Perl has the strong ability of text processing by easily moving from one file to the next. It was also chosen because of its methods for reading and writing to files. Perl uses a line-by-line reading technique when reading in a file. This is one of the features that simplified the writing of a large portion of the script. Another is the ease in searching for certain strings or patterns on a line.

Once the programming language is chosen, a flow chart is necessary to get an idea on the overall focus of the conversion script. Figure 4.6 is the flow chart of the conversion script. Once the script is running, it will search the TSMC FTP wafermap server first to find the new summary wafermap files. I f the new summary files are not found, the script will report the information with " no summary file existing" and stop the script. Otherwise, the script will ftp all the new files to the TI foundry wafermap server and store the new files at the designated directory (/tsmc) of the foundry wafermap repository. As introduced in Chapter III, TSMC provides two kinds of files. One type is the summary file, which contains some of the keyword values required by the worldwide format as well as the wafermap file names of the shipment. Normally, one lot has one summary file, although some times one lot can have several summary files because of different shipments of the lot.

Another type of file is the wafermap file. This file contains the map data information of the wafer. One wafer has one wafermap file. Once the script opens one summary file , it reads all keyword values from the file and writes the information to the output file in the worldwide format. Next, the script finds the wafermap file name from the summary file and checks whether the corresponding wafermap file is available in the current directory. If not, the script reports the information as " Wafermap of Wafer ID xxxx is not available" and tries to find the next wafermap file in the summary file. If the wafermap file is found, the script opens the wafermap file and converts the TSMC

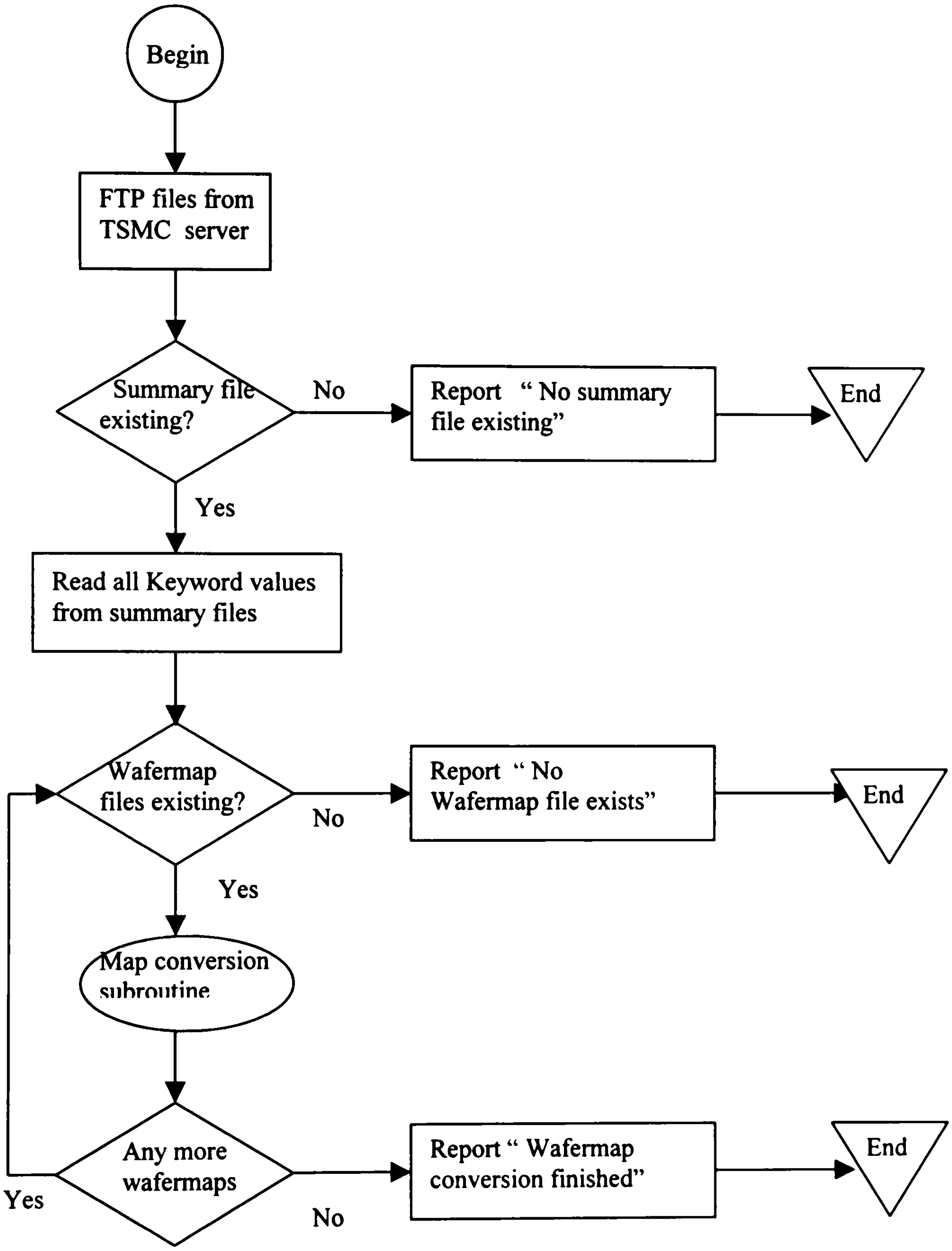


Figure 4.6 Flow Chart of the Conversion Script

wafermap file to the worldwide wafermap file with the map conversion subroutine. After the current wafermap file is converted, the script keeps on looking for the next wafermap file and converts it to the worldwide format until all the wafermap files in the current summary file are converted The script generates an output file with the worldwide wafermap format for each summary file. Once the conversion is finished for one summary file, the script continues looking for other summary files in the current directory. If more summary files are found, the script repeats the conversion procedure discussed before. If no more summary files are found, the script stops the conversion.

The main part of the conversion script is the map conversion subroutine. It is used to convert the TSMC wafermap with matrix format to the worldwide format with X, Y coordinates for each die. The flow chart of the subroutine is shown in Figure 4.7. Once a wafermap file is opened, the subroutine verifies the checksum of the wafer ID first. Next, the subroutine looks for the reference die. A good reference die is represented by the specific symbol "&" and a bad reference die is represented by "?". If the reference die is not found, the subroutine reports the information with " No Reference Die Exists". If the reference die is found, the subroutine finds the row number and column number of the reference die. Since the reference chip is defined to be coordinates (0,0), the X,Y coordinates of the other chips on the map file can be found by subtracting the row and column number of the reference die from the row and column number of the chips. Once all the locations of the chips on the map are found, the subroutine finds the total bins that occur on this map and the total bin counts of each bin. Then, the subroutine

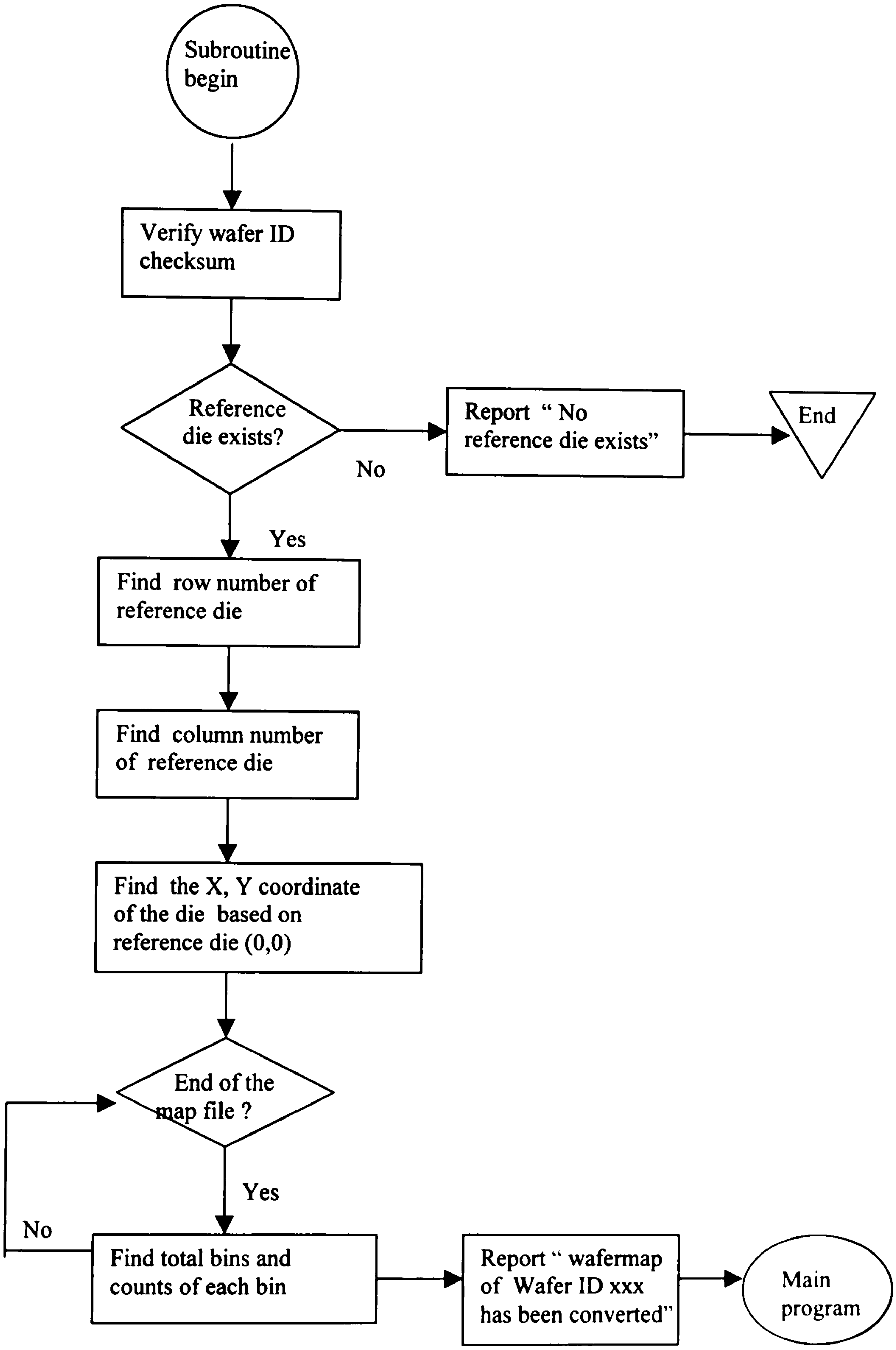


Figure 4.7 Flow Chart of Map Conversion Subroutine

reports the information with " Wafer ID xxx is converted" and goes back to the main script.

The method used to convert the matrix wafermap format to the worldwide format with X, Y coordinates for each die is to break the line up into an array. This is done by using the 'split' command [10] line described is as:

@Char = split(/ */, $Line($J);

The "@Char" is the name of a temporary array that is set up to hold the data that is split up from the line. "$Line($J)" tells the conversion script to look at the line "$J" and split the line up on every character in the line. When it splits the line, it places the first character into the first array element. The second character goes into the second array element and so on. After using the split command to separate the line, the element needed is the @Char [$I] that tells the script which bin this character is. "$I" in the @Char[$I] represents the column number of the die. Once the row and column number of each die is known , the X,Y coordinates of each die is simply calculated by subtracting the row and column number of the reference die from the row number $J and column number $I of the die.

As simple as this subroutine seems it covers nearly the entire spectrum of Perl commands used to do the conversion. This conversion script is also a good example of converting a matrix data format to a format with X,Y coordinates Any other similar wafermap conversion can use this script as a stepping-stone to build other conversion scripts or to get an idea of some of the changes that are needed to make a conversion from one format to the next. The source code of the conversion script is shown in Appendix A.

4.4.5 Reporting Programs

This wafermapping system also needs to report the status and results of each process of the system. There are three major reports generated by the wafermapping system.

The first kind of report is generated in the process of file transfer and the wafermap conversion. The report is sent to the corresponding group or people to tell them whether there are any new wafermap files in the fabs; which wafermap file is successfully converted; which wafermap has no reference die; and which wafermap is missing. Once the corresponding people received the information, they can find and solve the problem immediately.

The status and errors of the wafermap conversion in the "wmspool" task are logged in a file and a message is sent out to warn the appropriate parties that an error has occurred. If there are errors in the wafermap conversion, the ASCII data is copied to a designated directory that is defined in the process config file.

In the “idserver” task, a status file is generated for that batch of wafers while performing the wafer to frame matching. This status file contains the results of each of the wafers mapped. The status code and its representations are described in a file that is read at the ID station. The ID Station retrieves this status file to get the status of each wafer. This information is shown to the operator at the ID Station.

4.4.6 Architecture of the Automated Wafermapping System

Figure 4.8 shows the architecture of the automated wafermapping system for the short-term solution. In this architecture, a temporary server is used as the central repository for the wafermaps sent from foundries (TSMC) and the worldwide format wafermaps. This server is designed to translate/download the wafermap files from the TSMC wafer fab ftp server (or other foundries), convert the wafermaps to the worldwide wafermap format and download the wafermaps to the TI A/T site or other subcon A/T site. The size of each partition is calculated by formulas (4.1) and (4.2). In order to safely deliver the wafermaps between TI and its business partners, the firewall technology is used. All the wafermaps from/to foundries or subcons are transmitted via FTP through the TI Inter Corporate Gateway. The wafer and wafermap selection is achieved by making use of the current TI WISH system. The WISH system can convert the worldwide wafermaps to the image files that can be accepted by the mounters. Once the wafer ID and the frame ID are read and correlated at the ID station, the WISH system can download the corresponding image file to the mounter by just reading the frame ID of the wafer. Each IDSERVER has the capability to support up to a maximum of 5 destination hosts

Although this architecture is just a short-term solution for TSMC to TI wafermapping conversion, it still can be used as an example to design an automated

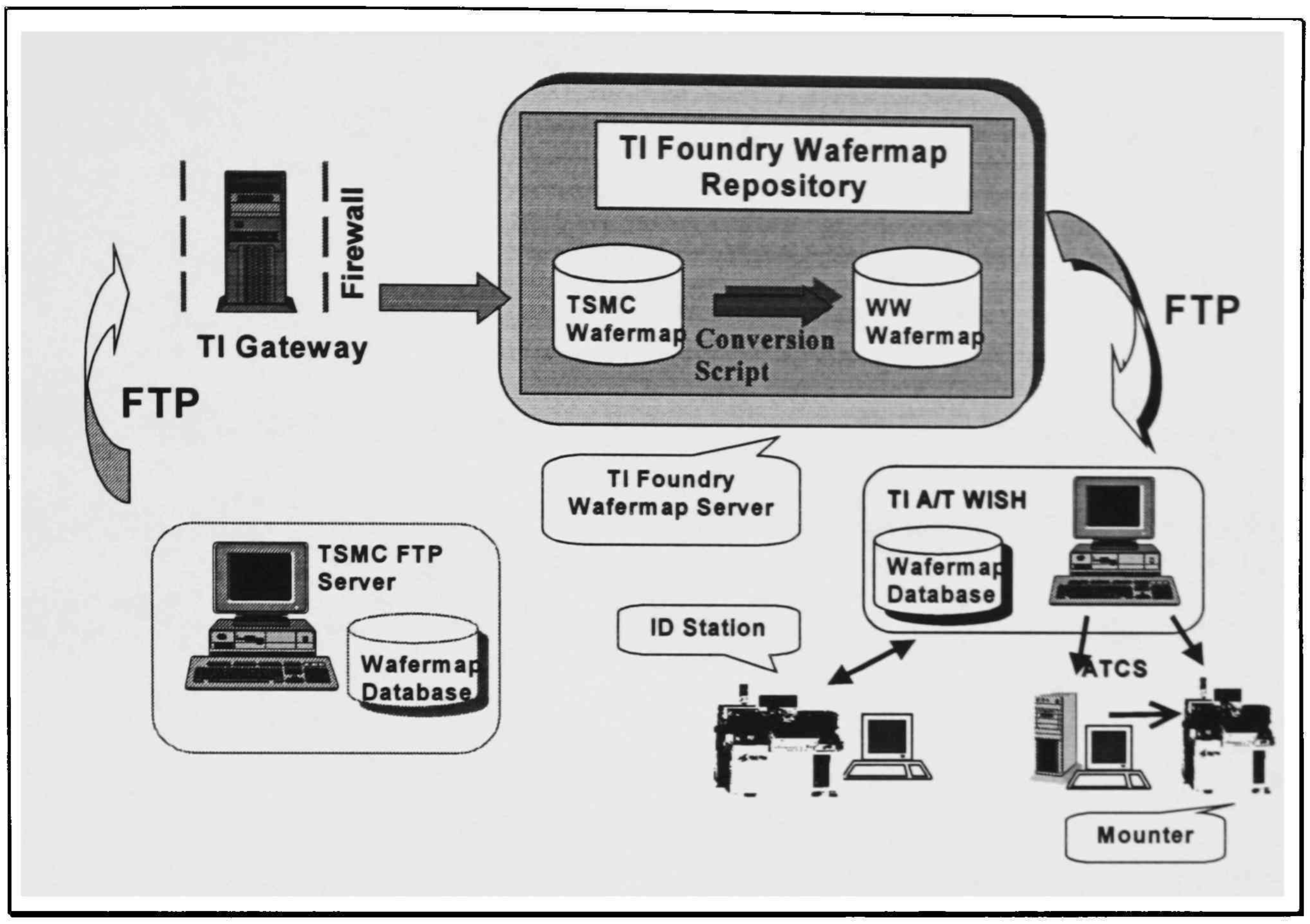


Figure 4.8 Architecture of the Automated Wafermapping System

wafermapping system between two business partners. The last chapter will discuss the long-term solution of the wafermapping system between TI and its business partners.

CHAPTER V

RESULTS AND CONCLUSIONS

5.1 Introduction

The previous chapters detailed the development of the automated inkless wafermap system and the inkless standards it uses. This chapter summarizes the results and gives some future directions of the automated inkless wafermap system.

5.2 Results of the Wafermap Conversion

One of the most important objectives of this project was to convert the TSMC wafermap format to the TI worldwide wafermap format. Once the script detects a new summary and wafermap files at the TSMC wafermap server, all the new files are transferred to the TI wafermap server via FTP. Then, the TSMC wafermap files are converted to the worldwide wafermap format by the Perl conversion program.

Figure 5.1 is the summary file "DA8115L00.TSM". It is distinguished from the wafermap files by the "L" character in the filename. "00" in the file name represents the first shipment of this lot. The lot ID is "DA8115.00". The device type is "TM7020A". This lot contains twenty-five wafers. All these wafers are built in the fab facility "TSMC". The wafer size is 200mm. Dies are 226.668um in the X dimension and 224.552um in the Y dimension. The scribe format is `"BOTTOM,15,NONE,FAB"`. The status of this map is for production purposes only.

Figure 5.2 shows the TSMC wafermap file of DA811501.TSM. The reference die is represented by "&". After the wafermap files are converted, the worldwide format file

```
TSMC
TM7020A
TM7020A (PPCI4451)
DA8115.00
25
     MAPPING     WAFER_ID   BIN 1
DA811501.TSM  DA8115-01    722
DA811502.TSM  DA8115-02    750
DA811503.TSM  DA8115-03    704
DA811504.TSM  DA8115-04    735
DA811505.TSM  DA8115-05    731
DA811506.TSM  DA8115-06    703
DA811507.TSM  DA8115-07    705
DA811508.TSM  DA8115-08    744
DA811509.TSM  DA8115-09    737
DA811510.TSM  DA8115-10    777
DA811511.TSM  DA8115-11    682
DA811512.TSM  DA8115-12    563
DA811513.TSM  DA8115-13    594
DA811514.TSM  DA8115-14    459
DA811515.TSM  DA8115-15    718
DA811516.TSM  DA8115-16    744
DA811517.TSM  DA8115-17    734
DA811518.TSM  DA8115-18    682
DA811519.TSM  DA8115-19    696
DA811520.TSM  DA8115-20    713
DA811521.TSM  DA8115-21    696
DA811522.TSM  DA8115-22    731
DA811523.TSM  DA8115-23    675
DA811524.TSM  DA8115-24    680
DA811525.TSM  DA8115-25    708
                   Total  17383
226.668 x 224.552
```

Figure 5.1 Summary File DA8115L.TSM

```
TSMC
TM7020A
DA8115-01
DA811501.TSM
..........1111111111X...........
........1X11111X11X1X1XX........
.......1X1111111111111XX1X......
.....X1111111111111111111XX.....
.....1X111X1111X1111111X1111X....
....X11111111111111111X111111XX....
...XX1111111111111X111111X1111XX...
...X1111111111111111X11111111X...
..X1X111111111111X1X11111111111X..
..X11111111111111111111111111111..
.X111X11X11X11X111111X1111111111X.
.X1111111111111X1X1111111111111.
.1111111111XX1XX11111X111X1111111.
X111111111111X111111111111111111XX
X111111111111111111X111X1X1111X1
1XXX11X11111111111111111111111XXX
XXXX111111111XX1X1111111111111XXX
XXXX111111111X111111111X111111XXX
X11X11111111X111X111X111X11111111&
X11X11111111111111111111111111111.
.1111111X11XX11111X1111111111111.
.X11111111111111111111111111XX1X.
.X1111111X1111111111111111111111X.
..1X11111111111XX11111111111X1X..
..XXX11X11111X111111111111111XX..
...1111X111X111111X111111111X1X1...
....1X11X11X11X111111111111XX1X....
....XX11X11X11X11111111X111X1X....
.....X1X11111111111111X11X1X......
.......1XX111111111111111X.......
........X1X111111X11111XXX........
..........X111111X11111X..........
```

Figure 5.2 TSMC Wafermap of Wafer DA811501.TSM

“t0DA8115.00” is generated. Figure 5.3 shows the result of the wafermap conversion for the first wafer. There are a total of two bins for this wafer. Bin8 has a total of 157 dies and Bin1 has 723 dies. Bin1 have one more die than the total dies in the summary file because the reference die"&" is consider a good die while in conversion. Figure 5.3 just shows the result of the first wafer, the entire results of the wafermap conversion are placed in APPENDIX B.

```
FACILITY=TSMC
LOT=DA8115
DEVICE=TM7020A
X_SIZE=226.668
Y_SIZE=224.552
WAFER_SIZE=200
SCRIBE="BOTTOM,15,NONE,FAB"
STATUS="PROD"
LAYOUT=TM7020A
USER="NONE"
DIE_DESIGNATOR="NONE"
BIN_NAME.01="G,GOOD"
BIN_NAME.02="G,GOOD2"
BIN_NAME.03="G,GOOD3"
BIN_NAME.08="REJECTS"
WAFERS=25
WAFERID.01=DA8115-01B6
NUM_BINS.01=02
BIN_COUNT.01.08=00157
MAP_XY.01.08="Y-13 10 16 23 Y-12 8/10 16 23 25 Y-11 7 24/25 Y-10 6 8 11
26 28
 Y-9 4 6 10 19 22 25 28/29 Y-8 4 6/7 19 22 25 28 Y-7 4 6 15 22 26 Y-6
2/3 20 26 29/31 Y-5 2 4 16/17 30 Y-4 1 23 32/33 Y-3 1 3/4 32/33 Y-2 15
21/22 25 Y-1 30 Y0 9 13 17 21 30 Y1 0/2 9 20 30/33 Y2 0/2 17 19/20
30/33 Y3 0/2 27 30/33 Y4 1 6 8 12 Y5 0/1 20 Y6 8 12 18/19 21/22 Y7 15
17 32/33 Y8 1 12 19 22 25 28 32/33 Y9 31 Y10 2 14 16 29 31 Y11 3 12 30
Y12 3/4 9 16 29/30 Y13 4/5 12 29 Y14 5 10 18 23 27 Y15 6/7 27 Y16 7
9/10 25 Y17 9/10 12 14 17 23 Y18 11"
BIN_COUNT.01.01=00723
MAP_XY.01.01="Y-13 11/15 17/22 Y-12 11/15 17/22 24 Y-11 8/23 26 Y-10 7
9/10
 12/25 27 Y-9 5 7/9 11/18 20/21 23/24 26/27 Y-8 5 8/18 20/21 23/24
26/27 29 Y-7 3 5 7/14 16/21 23/25 27/30 Y-6 4/19 21/25 27/28 Y-5 3 5/15
18/29 31 Y-4 2/22 24/31 Y-3 2 5/31 Y-2 1/14 16/20 23/24 26/33 Y-1 1/29
31/33 Y0 0/8 10/12 14/16 18/20 22/29 31/33 Y1 3/8 10/19 21/29 Y2 3/16
18 21/29 Y3 3/26 28/29 Y4 0 2/5 7 9/11 13/33 Y5 2/19 21/33 Y6 1/7 [illegible]/11
13/17 20 23/33 Y7 1/14 16 18/31 Y8 2/11 13/18 20/21 23/24 26/27 29/31
Y9 2/30 Y10 3/13 15 17/28 30 Y11 4/11 13/29 Y12 5/8 10/15 17/28 Y13
6/11 13/28 Y14 6/9 11/17 19/22 24/26 28 Y15 8/26 Y16 8 11/24 26 Y17 11
13 15/16 18/22 24 Y18 12/22"
END.
```

Figure 5.3 Worldwide Format of t0DA8115.00

5.3 Results of Converting ASCII File to Image File

Once the TSMC wafermap file is converted to the worldwide wafermap format, the worldwide wafermap file is transferred to the WISH system located at TI A/T site or subcon A/T site. The "wmspool" task on the WISH system checks the worldwide wafermap format and converts the ASCII wafermap file to the image file that can be

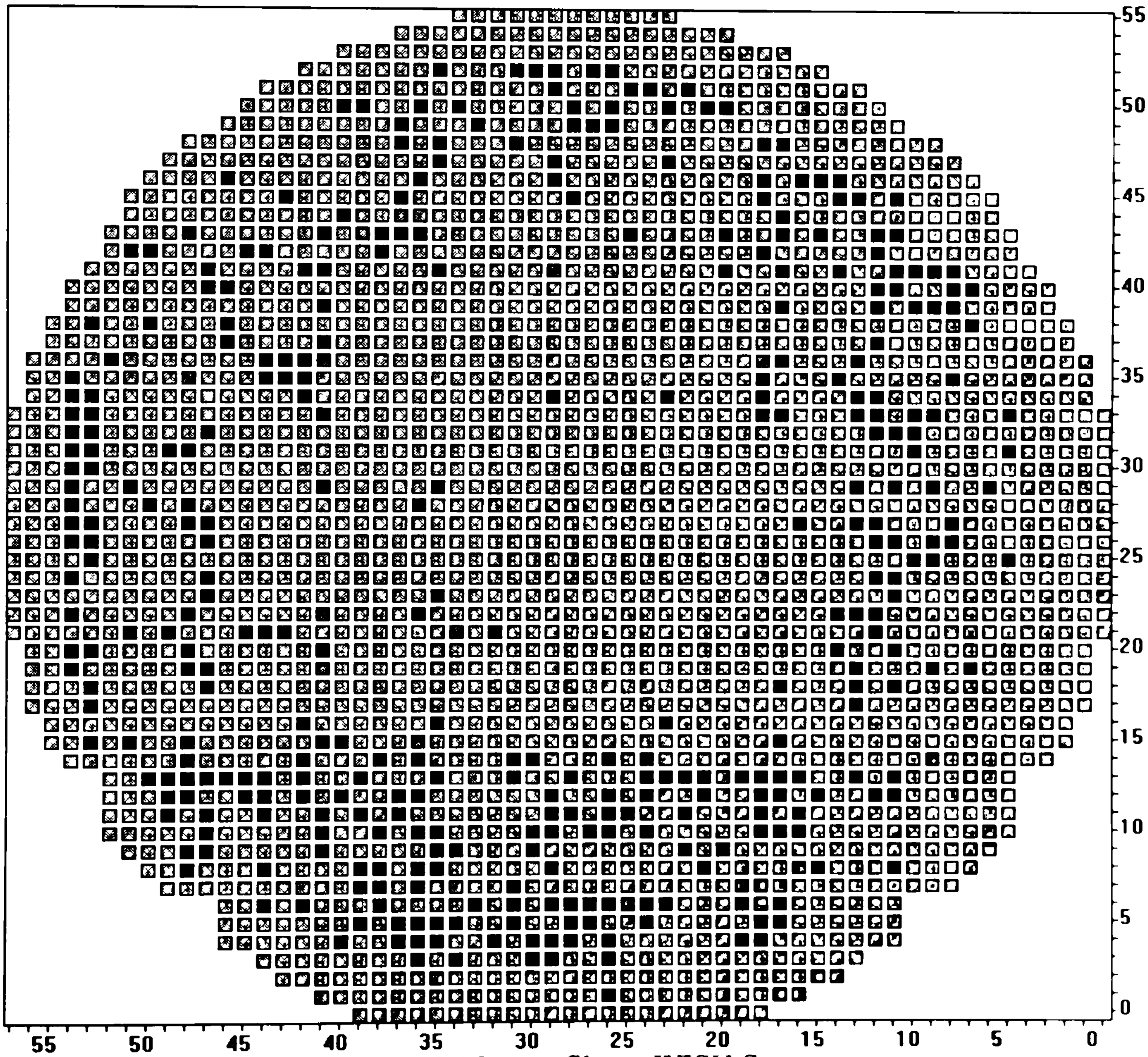


Figure 5.4 Image file on WISH System

loaded by the mounter. Figure 5.4 shows the image file that is converted from worldwide format in Figure 5.3.

5.4 Conclusions and Future Work

Before a functioning integrated circuit(IC) is released to the customer, it must go through the process of IC design, wafer fabrication, wafer sort , inking and baking , IC assembly and final test. Companies always try to find the new technology to replace the old one to reduce the cost and increase the profit margin of their products. With the development of computer technology, an inkless process becomes possible. In an inkless process, the mounter machine can pick the good die based on the wafermap data instead of the old method of stepping through every die to look for good dies, and the inking process can be skipped.

In order to implement the inkless process, an inkless standard is required to design the automated inkless wafermap system. Since there are still no inkless standards in the semiconductor industry, it is necessary to select an inkless standard for the wafermap system. In this thesis, the TI inkless standard is used as the inkless standard of the automated inkless wafermap system, all the wafers and wafermap files with other inkless standards must be converted to meet the TI inkless standards.

The objective of this project is to develop an automated wafermap system to implement the inkless process for TSMC wafers, a fully automatic process of transferring the wafermaps from the TSMC server to the TI foundry wafermap system, converting the TSMC wafermap files to the TI worldwide wafermap format and downloading the wafermap files to the TI WISH system in the same format.

There were three main goals to this project and they were achieved in a manner that will be very beneficial for further improvements. The first goal was to write a conversion script using the Perl programming language that would convert the TSMC wafermaps to the TI worldwide wafermap format. The second goal was to change the TSMC wafer truncation format to meet the TI wafer truncation format. This was achieved by creating the mirror areas on their wafers. The third goal was to design an automated inkless wafermap system that is a fully automatic process of transferring the TSMC wafermaps to the TI WISH system.

The results shown before show that this project was successful in accomplishing most of the goals set at the beginning. The only problem is that this wafermap system has not been tested by the inkless process. Some problems may occur while implementing the inkless process, which include bugs in the conversion script, wafer truncations not meeting with the TI wafer truncation standard, and wafermap files transferring incorrectly. This leaves a lot of room for making improvements on the wafermap system not only making it more efficient but also taking into account possible future changes to the system.

Although this project mostly focused on TSMC to TI wafermapping conversion, it is a project that can be done for any two-business partners to implement the inkless process. Figure 5.5 is the long-term solution of the automated inkless wafermap system between TI and any other foundries and subcons. In this architecture, a TI CIM

(Computer Integrated Manufacturing) server is used as the central wafermap repository to store all the wafermap files from the other foundries; each foundry has its own directory. A couple of conversion scripts are used to convert the corresponding wafermap files to the TI worldwide wafermap format. The daily shipping lists will tell the script file where to transfer the wafermap files, either to the TI internal A/T site or the outside subcon A/T site.

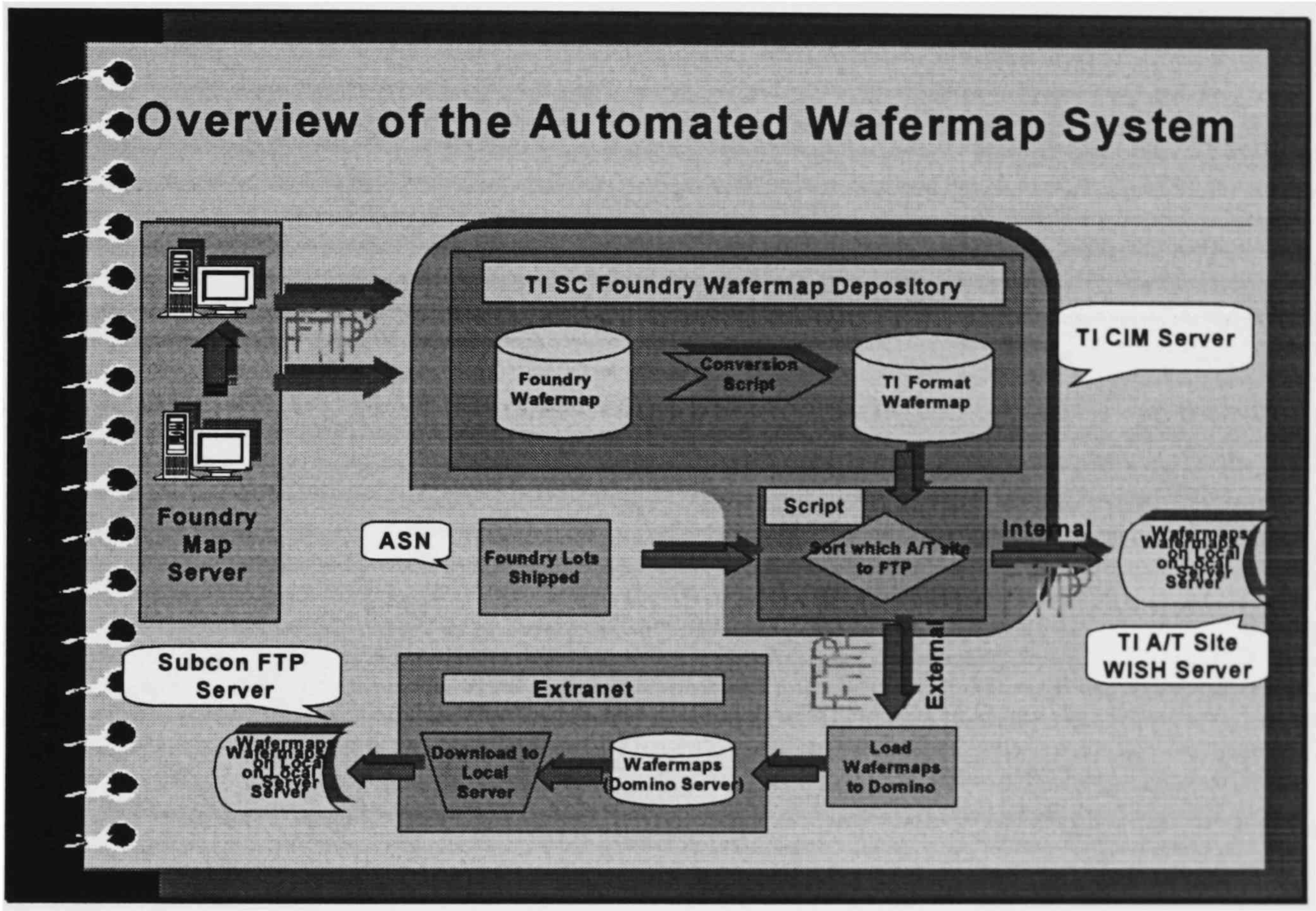


Figure 5.5 Long-Term Solution of Automated Inkless Wafermap System

REFERENCES

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3: *TI Wafermap Bin Standard Version 2.1,* Texas Instruments, 2000

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APPENDIX A

SOURCE CODE FOR THE CONVERSION PROGRAM

```
######################################################################
#      NAME                                                          #
#                                                                    #
#             wafermap_tsmc.pl                                       #
#                                                                    #
#                                                                    #
#                                                                    #
#      DESCRIPTION                                                   #
#                                                                    #
#      This script is developed to convert TSMC wafer map to an ascii#
#      file in World-Wide Wafermap format.                           #
######################################################################

#!/usr/local/bin/perl


`ftp -nv gate.ti.com <<EOF
user ti_noink\@ftp.tsmc.com.tw ultra
quot auth  noink
quot response ultral
prompt
hash
mget *
bye
EOF`;
print " FTP has completed! Starting Map conversion . \n";



$_=localtime;
s/ /_/g;
$time=$_;
$logfile="conv\_$time\.log\n";#print $logfile,"\n";
open (LOG,">$logfile");
printf LOG " \t\t\t TSMC Wafermap Conversion Status Report \n";
printf LOG "\t\t\t= = = = = = = = = = = = = = = = = = = = =\n";
printf LOG "\n";
printf LOG "DATE : $time \n";

@allfile= <*.*>;
@sumfile=grep(/l.*tsm$/i,@allfile); # search for summary file case-
#insensitive
#print "@sumfile \n";
$FILENUM=$#sumfile+1;         # get numbers of summary files
#print $FILENUM ,"\n";

if ( $FILENUM==0 )
   {    printf LOG "\n";
```

```
      printf LOG " There are no wafermap file today!! \n";}

 foreach $SUMFILE ( @sumfile )

{

open(FILE,$SUMFILE) or printf LOG "  summary file $SUMFILE can not be
#opened\n";

@READ=<FILE>;                   #read summary into array
$FACILITY=$READ[0];
$DEVICE=$READ[1];
$LOT=$READ[3];
$WAFERS=$READ[4];
$DIE_SIZE=pop@READ;
chomp $DIE_SIZE;
#print $DIE_SIZE,"\n";
chomp $FACILITY;
chomp $DEVICE;
chomp $LOT;

# get X, Y size of Die
($X_SIZE,$Y_SIZE) = split(/ x /,$DIE_SIZE);
#print $X_SIZE, "\n";
#print $Y_SIZE, "\n";

printf LOG "\n";
printf LOG "DEVICE : $DEVICE \n";
printf LOG "= = = = = = = = =\n";

($LOTID,$SERIALNUM)=split (/\./,$LOT);#print $LOTID,"\n";


$SERIAL=sprintf("%02d",$SERIALNUM);


$OUTPUT="t0$LOTID.$SERIAL";   # get output filename
open (TEMP,">$OUTPUT")or printf LOG " output file can not be opened\n";


select (TEMP);                  # set OUTPUT as default output


      printf ("FACILITY=$FACILITY\n");
      printf ("LOT=$LOTID\n");
      printf ("DEVICE=$DEVICE\n");
      printf ("X_SIZE=$X_SIZE\n");
      printf ("Y_SIZE=$Y_SIZE\n");
      printf ("WAFER_SIZE=200\n");
      printf (qq/SCRIBE="BOTTOM,15,NONE,FAB"\n/);
      printf (qq/STATUS="PROD"\n/);
      printf ("LAYOUT=$DEVICE\n");
      printf (qq/USER="NONE"\n/);
      printf (qq/DIE_DESIGNATOR="NONE"\n/);
```

```
      printf (qq/BIN_NAME.01="G,GOOD"\n/);
      printf (qq/BIN_NAME.02="G,GOOD2"\n/);
      printf (qq/BIN_NAME.03="G,GOOD3"\n/);
      printf (qq/BIN_NAME.08="REJECTS"\n/);



seek(FILE,0,0);         # point to the beginning of the summary file


while(<FILE>) {

      chomp;

      if(m/.*\.\d\d$/i) {
                        $Wafers = <FILE>;
                        $Wafers =~ chomp;
                        printf("WAFERS=%02d\n", $Wafers); # get number
#of wafers
                     }

      if(m/\d+\.TSM/i) {

            # Find the wafermap file name like "R1234567.TSM"
            #--------------------------------------------------

            @Tmp = split;

            # check whether the mapfile is existing
            #--------------------------------------------

            @MAPCHECK=grep(/\d..tsm$/i,@allfile);  #get mapfile

                for($I=0;$I<=$#MAPCHECK;$I++)

                  { if ( lc($MAPCHECK[$I]) eq lc($Tmp[0]) )

                        { MapConv($MAPCHECK[$I]); # Converting map
                          last; }
                    elsif ( $I == $#MAPCHECK )

                        { print LOG "$Tmp[0] is not existing!\n" }
                  }
      }
}

printf ("END\.\n");
close (FILE);
close (TEMP);

}

close (LOG);
```

```
system ' mv *TSM old';
system ' mv t*.* conversion';

`/usr/bin/mailx -s "Wafermap conversion report" x-zhoul\@ti.com  <
conv\_$time\.log`;

exit; # end of main


#####################################################################
#          Map Converting    Subroutines                           #
#                                                                   #
#####################################################################

# start subroutine

sub MapConv {

      my $MapFile = shift(@_);
      open(MAPFILE, "<$MapFile") or  print LOG "Cannot open map file
$MapFile\n" ;

      $InMap = 0;
      $NumRow = 0;
      $RefRow = 0;
      $totalsum=0;

      #Read Map into @Line
      #----------------------

      while(<MAPFILE>) {

            chomp;

            # find waferid checksum
            # 1: $waferid concatenate A0
            # 2: get ASCII value of each char
            # 3: get $totalsum= An+8*(An-1+8*(....+(A1+8*A0)..)
            # 4: get remainder $cs when $totalsum is devided by 59
            # 5: the first data of checksum is int of (59-$cs)/8 plus A
            # 6; the second data of checksum is  remainder of(59-$cs)/8

            if(m/\-\d\d$/i) {

                  ($Waferlot, $WaferNum) = split(/\-/);
                  $WaferID = $Waferlot.$WaferNum.'A0';
                  @IDARRAY = split ( / */, $WaferID );

                  foreach $IDARRAY (@IDARRAY) {

                              $IDARRAY = ord("$IDARRAY")-32; # get
#ASCII value of each char and then reduce 32
                              #print $IDARRAY, "\n";
```

```
                        }

                for ($i=0;$i<length($WaferID);$i++)    {


                #print $IDARRAY[$i],"\n";
                $totalsum=$IDARRAY[$i]+8*$totalsum;


                 }



                $cs = $totalsum - 1 - int($totalsum / 59)*59;
                $first= int((59-$cs)/8);
                $second=(59-$cs)%8;

                $first= chr($first + 65 ); # $first + A
                #print $cs,"\n";
                #print $first,"\n";
                #print $second,"\n";

                $WaferID = $Waferlot."-".$WaferNum.$first.$second;
          printf("WAFERID.%02d=$WaferID\n", $WaferNum); # get waferID

          }

          s/X/8/g;#substitute X & @ with 8
          s/@/8/g;

          if(($InMap == 1) && ($_ ne ""))

                      { $Line[$NumRow] = $_;
                            if(m/\&/) { $RefRow =$NumRow;
                                     #get row number of reference die
                                    }
                            elsif (m/\?/) { $RefRow =$NumRow;
                                     #get row number of reference die
                                    }

                       $NumRow++; }

          elsif(m/^\.+/) { $Line[$NumRow] = $_;
                            $NumRow++; $InMap = 1; }
    }

    close(MAPFILE);

    if ($RefRow == 0) { print LOG "Reference die can not be found in
$MapFile \n";
                          goto  End; }

    # Start processing ...
```

```
# Find ref die Col.
@Char = split(/ */, $Line[$RefRow]);
$NumCol = @Char;

for($I=0;$I<=$NumCol-1;$I++)
      { if($Char[$I] eq "\&") { $RefCol = $I; #get Col of
reference die
                              $I = $NumCol;

substr($Line[$RefRow],$RefCol,1)='1';  }
       elsif ($Char[$I] eq "\?") { $RefCol = $I; #get Col of
reference die
                              $I = $NumCol;

substr($Line[$RefRow],$RefCol,1)='8';  }
       }

  #print $Line[$RefRow],"\n";


# convert wafermap into X,Y coordinate
#----------------------------------------

my %BinCount = {}; # number of each binning
my %BinString = {};
my %FirstLine = {};

for($J=$NumRow-1;$J>=0;$J--) {

      $RowNumAct = $RefRow-$J; # get Y0 Y1 ...
      %FirstLine = {};
      $BinLast = "";
      $StartPos = $NumCol-1;
      $CurrPos = $NumCol-1;
      @Char = split(/ */, $Line[$J]);

      for($I=$NumCol-1;$I>=0;$I--) {

            $BinCount{$Char[$I]}++;

            if(($Char[$I] ne $BinLast) || ($I == 0)) {

                  $OldBin = 0; # new binning

                  foreach(keys(%BinString)){ if($Char[$I] eq $_)
                                    { $OldBin = 1; goto BinFound;
} }

            BinFound:
                  if($I != $NumCol-1) {

                        if($I == 0) { $CurrPos = $RefCol - 0; }
                        else { $CurrPos = $RefCol - ($I+1); }
```

```
                              if($FirstLine{$Char[$I+1]} != 1) {
            if($BinString{$Char[$I+1]} =~ m/\"$/)
                  { $BinString{$Char[$I+1]} .= "Y" . $RowNumAct; }
                  else { $BinString{$Char[$I+1]} .= " Y" . $RowNumAct;
}
                                    $FirstLine{$Char[$I+1]} = 1;
                              }

                              if($CurrPos == $StartPos) {
$BinString{$Char[$I+1]} .= " $CurrPos"; }
                              else { $BinString{$Char[$I+1]} .= "
$StartPos/$CurrPos"; }
                        }
                  if($OldBin == 0) { $BinString{$Char[$I]} =
"MAP_XY.$WaferNum.0" . $Char[$I] . "=\""; }
                  $BinLast = $Char[$I];
                  $StartPos = $RefCol - $I;
                  }
            }
      }

      # get total bins and Bin counts
      #------------------------------
      $TotBin = 0;
      foreach(keys(%BinString))
            { if(($_ ne "\.") && ($BinString{$_} ne ""))
             { $TotBin++; } }
      printf("NUM_BINS.%02d=%02d\n", $WaferNum, $TotBin);

      foreach(keys(%BinString)) {
            if(($_ ne "\.") && ($BinString{$_} ne ""))
                  {
                  printf("BIN_COUNT.%02d.%02d=%05d\n",
$WaferNum,$_,$BinCount{$_});

            # print each line not exceed 80 characters
            #-------------------------------------------
                  use Text::Wrap;
                  $string=$BinString{$_}."\"\n";
                        $Text::Wrap::columns = 80;  #80 characters per
line
                  print wrap ("","  ",$string);
            }
      }
     print LOG "$MapFile is converted \n";
End:
}
#end subroutine
```

APPENDIX B

WORLDWIDE WAFERMAP FORMAT OF t0DA8115

```
FACILITY=TSMC
LOT=DA8115
DEVICE=TM7020A
X_SIZE=226.668
Y_SIZE=224.552
WAFER_SIZE=200
SCRIBE="BOTTOM,15,NONE,FAB"
STATUS="PROD"
LAYOUT=TM7020A
USER="NONE"
DIE_DESIGNATOR="NONE"
BIN_NAME.01="G,GOOD"
BIN_NAME.02="G,GOOD2"
BIN_NAME.03="G,GOOD3"
BIN_NAME.08="REJECTS"
WAFERS=25
WAFERID.01=DA8115-01B6
NUM_BINS.01=02
BIN_COUNT.01.08=00157
MAP_XY.01.08="Y-13 10 16 23 Y-12 8/10 16 23 25 Y-11 7 24/25 Y-10 6 8 11
26 28
 Y-9 4 6 10 19 22 25 28/29 Y-8 4 6/7 19 22 25 28 Y-7 4 6 15 22 26 Y-6
2/3 20 26
 29/31 Y-5 2 4 16/17 30 Y-4 1 23 32/33 Y-3 1 3/4 32/33 Y-2 15 21/22 25
Y-1 30
 Y0 9 13 17 21 30 Y1 0/2 9 20 30/33 Y2 0/2 17 19/20 30/33 Y3 0/2 27
30/33 Y4 1
 6 8 12 Y5 0/1 20 Y6 8 12 18/19 21/22 Y7 15 17 32/33 Y8 1 12 19 22 25
28 32/33
 Y9 31 Y10 2 14 16 29 31 Y11 3 12 30 Y12 3/4 9 16 29/30 Y13 4/5 12 29
Y14 5 10
 18 23 27 Y15 6/7 27 Y16 7 9/10 25 Y17 9/10 12 14 17 23 Y18 11"
BIN_COUNT.01.01=00723
MAP_XY.01.01="Y-13 11/15 17/22 Y-12 11/15 17/22 24 Y-11 8/23 26 Y-10 7
9/10
 12/25 27 Y-9 5 7/9 11/18 20/21 23/24 26/27 Y-8 5 8/18 20/21 23/24
26/27 29 Y-7
 3 5 7/14 16/21 23/25 27/30 Y-6 4/19 21/25 27/28 Y-5 3 5/15 18/29 31 Y-
4 2/22
 24/31 Y-3 2 5/31 Y-2 1/14 16/20 23/24 26/33 Y-1 1/29 31/33 Y0 0/8
10/12 14/16
 18/20 22/29 31/33 Y1 3/8 10/19 21/29 Y2 3/16 18 21/29 Y3 3/26 28/29 Y4
0 2/5 7
 9/11 13/33 Y5 2/19 21/33 Y6 1/7 9/11 13/17 20 23/33 Y7 1/14 16 18/31
Y8 2/11
 13/18 20/21 23/24 26/27 29/31 Y9 2/30 Y10 3/13 15 17/28 30 Y11 4/11
13/29 Y12
 5/8 10/15 17/28 Y13 6/11 13/28 Y14 6/9 11/17 19/22 24/26 28 Y15 8/2[illegible]
Y16 8
```

```
 11/24 26 Y17 11 13 15/16 18/22 24 Y18 12/22"
WAFERID.02=DA8115-02B1
NUM_BINS.02=02
BIN_COUNT.02.08=00129
MAP_XY.02.08="Y-13 10 21 23 Y-12 8 25 Y-11 8 25/26 Y-10 28 Y-9 4 29 Y-8
4 18
 Y-7 6 9 Y-6 2/3 17 23 31 Y-5 15 Y-4 1/2 7 23 32/33 Y-3 15 30/31 Y-2 8
12 26/27
 32/33 Y-1 14 22 Y0 1 10 17 19 25 29 31 Y1 0/2 4/5 30/33 Y2 0/2 5 26
30/33 Y3
 0/2 12 18 26 30/33 Y4 20 31 Y5 0/1 9 12/14 Y6 18/20 Y7 9 11 Y8 1 4 19
27 Y9 4
 Y10 2 7 13 Y11 3 7 Y12 3/4 6 18 30 Y13 4/5 7 14 29 Y14 5 11 28 Y15 6/7
26/27
 Y16 7/11 Y17 9/11 13 15 24 Y18 11/12 17 21/22"
BIN_COUNT.02.01=00751
MAP_XY.02.01="Y-13 11/20 22 Y-12 9/24 Y-11 7 9/24 Y-10 6/27 Y-9 5/28 Y-
8 5/17
 19/29 Y-7 3/5 7/8 10/30 Y-6 4/16 18/22 24/30 Y-5 2/14 16/31 Y-4 3/6
8/22 24/31
 Y-3 1/14 16/29 32/33 Y-2 1/7 9/11 13/25 28/31 Y-1 1/13 15/21 23/33 Y0
0 2/9
 11/16 18 20/24 26/28 30 32/33 Y1 3 6/29 Y2 3/4 6/25 27/29 Y3 3/11
13/17 19/25
 27/29 Y4 0/19 21/30 32/33 Y5 2/8 10/11 15/33 Y6 1/17 21/33 Y7 1/8 10
12/33 Y8
 2/3 5/18 20/26 28/33 Y9 2/3 5/31 Y10 3/6 8/12 14/31 Y11 4/6 8/30 Y12 5
7/17
 19/29 Y13 6 8/13 15/28 Y14 6/10 12/27 Y15 8/25 Y16 12/26 Y17 12 14
16/23 Y18
 13/16 18/20"
WAFERID.03=DA8115-03A4
NUM_BINS.03=02
BIN_COUNT.03.08=00175
MAP_XY.03.08="Y-13 10 14 16 18 20 23 Y-12 8/9 14 19 25 Y-11 7 21 Y-10
8/9 23/24
 28 Y-9 4 14 20/21 23/24 28/29 Y-8 4 6 Y-7 4 9 23 Y-6 2 6 31 Y-5 2 4
7/8 28/29
 31 Y-4 1 21 30 32/33 Y-3 1 4 7 29 31/33 Y-2 5 13 18 32/33 Y-1 3 6 26
Y0 6 27
 Y1 0/2 4 12 25/26 30/33 Y2 0/2 24/25 29/33 Y3 0/2 30/33 Y4 1 26 Y5 0 2
16/17
 26 Y6 2 19 22 Y7 1/2 12 20 31/33 Y8 8/9 21 25 32/33 Y9 4 7 13 28 31
Y10 2/3 12
 14 16 30/31 Y11 9 16 19 27 29 Y12 3/5 10 30 Y13 4/5 26 28/29 Y14 5/6
16 19
 27/28 Y15 6/7 11 19/20 22 27 Y16 7 10 13 20 22 24 26 Y17 9/12 15/16 20
22/24
 Y18 11/12 15/16 18 22"
BIN_COUNT.03.01=00705
MAP_XY.03.01="Y-13 11/13 15 17 19 21/22 Y-12 10/13 15/18 20/24 Y-11
8/20 22/26
 Y-10 6/7 10/22 25/27 Y-9 5/13 15/19 22 25/27 Y-8 5 7/29 Y-7 3 5/8
10/22 24/30
```

```
 Y-6 3/5 7/30 Y-5 3 5/6 9/27 30 Y-4 2/20 22/29 31 Y-3 2/3 5/6 8/28 30
Y-2 1/4
 6/12 14/17 19/31 Y-1 1/2 4/5 7/25 27/33 Y0 0/5 7/26 28/33 Y1 3 5/11
13/24
 27/29 Y2 3/23 26/28 Y3 3/29 Y4 0 2/25 27/33 Y5 1 3/15 18/25 27/33 Y6 1
3/18
 20/21 23/33 Y7 3/11 13/19 21/30 Y8 1/7 10/20 22/24 26/31 Y9 2/3 5/6
8/12 14/27
 29/30 Y10 4/11 13 15 17/29 Y11 3/8 10/15 17/18 20/26 28 30 Y12 6/9
11/29 Y13
 6/25 27 Y14 7/15 17/18 20/26 Y15 8/10 12/18 21 23/26 Y16 8/9 11/12
14/19 21 23
 25 Y17 13/14 17/19 21 Y18 13/14 17 19/21"
WAFERID.04=DA8115-04H2
NUM_BINS.04=02
BIN_COUNT.04.08=00144
MAP_XY.04.08="Y-13 10 22/23 Y-12 8 18 25 Y-11 7 15 25/26 Y-10 6 28 Y-9
4 9 14
 23 29 Y-8 4 9 13 15 20 25 Y-7 3 25 30 Y-6 2/3 5 31 Y-5 29 31 Y-4 1 25
30/33
 Y-3 1/2 19 Y-2 9 Y-1 15 23 26 32/33 Y0 1/2 8 22 Y1 0/2 16 30/33 Y2 0/2
21
 30/33 Y3 0/3 19 30/33 Y4 0 8 14 Y5 0/1 22 31 Y6 2 5 10 18 Y7 1 20
25/26 32/33
 Y8 1 14 32/33 Y9 2 10 20 31 Y10 2/3 16 31 Y11 15 18 24 27 Y12 3/4 30
Y13 4/5
 21 28/29 Y14 5/6 17 21 27/28 Y15 7 15 18 25 27 Y16 7 9/10 23 25/26 Y17
9/10 13
 16 21 24 Y18 11 13 15 22"
BIN_COUNT.04.01=00736
MAP_XY.04.01="Y-13 11/21 Y-12 9/17 19/24 Y-11 8/14 16/24 Y-10 7/27 Y-9
5/8
 10/13 15/22 24/28 Y-8 5/8 10/12 14 16/19 21/24 26/29 Y-7 4/24 26/29 Y-
6 4 6/30
 Y-5 2/28 30 Y-4 2/24 26/29 Y-3 3/18 20/33 Y-2 1/8 10/33 Y-1 1/14 16/22
24/25
 27/31 Y0 0 3/7 9/21 23/33 Y1 3/15 17/29 Y2 3/20 22/29 Y3 4/18 20/29 Y4
1/7
 9/13 15/33 Y5 2/21 23/30 32/33 Y6 1 3/4 6/9 11/17 19/33 Y7 2/19 21/24
27/31 Y8
 2/13 15/31 Y9 3/9 11/19 21/30 Y10 4/15 17/30 Y11 3/14 16/17 19/23
25/26 28/30
 Y12 5/29 Y13 6/20 22/27 Y14 7/16 18/20 22/26 Y15 6 8/14 16/17 19/24 26
Y16 8
 11/22 24 Y17 11/12 14/15 17/20 22/23 Y18 12 14 16/21"
WAFERID.05=DA8115-05G5
NUM_BINS.05=02
BIN_COUNT.05.08=00148
MAP_XY.05.08="Y-13 11 15 17 21 23 Y-12 25 Y-11 8 12 17 20 Y-10 6 1[illegible]
25/26 28
 Y-9 4 16 21 29 Y-8 4 26/27 29 Y-7 17 Y-6 2/3 31 Y-5 2 18 29 Y-4 1 4 9
Y-3 1/2
 30 32/33 Y-2 1 Y-1 7 Y0 1 18 Y1 0/2 5 16 28 30/33 Y2 0/2 4 6 21/22 27
30/33 Y3
```

```
 0/2 4 23 30/33 Y4 0 6 Y5 0 17 Y6 1 17/18 27 Y7 1/4 14 18 32/33 Y8 1/2
12 16
 32/33 Y9 2/3 17 31 Y10 2/4 18 26 30/31 Y11 24 Y12 3/4 7 30 Y13 4/5 7
12/13 29
 Y14 5 8 10 16 19 28 Y15 6/8 11 18 20 Y16 7/8 10/11 19 Y17 9/10 12 17
23/24 Y18
 11/12 14 16 18 20 22"
BIN_COUNT.05.01=00732
MAP_XY.05.01="Y-13 10 12/14 16 18/20 22 Y-12 8/24 Y-11 7 9/11 13/16
18/19 21/26
 Y-10 7/18 20/24 27 Y-9 5/15 17/20 22/28 Y-8 5/25 28 Y-7 3/16 18/30 Y-6
4/30
 Y-5 3/17 19/28 30/31 Y-4 2/3 5/8 10/33 Y-3 3/29 31 Y-2 2/33 Y-1 1/6
8/33 Y0 0
 2/17 19/33 Y1 3/4 6/15 17/27 29 Y2 3 5 7/20 23/26 28/29 Y3 3 5/22
24/29 Y4 1/5
 7/33 Y5 1/16 18/33 Y6 2/16 19/26 28/33 Y7 5/13 15/17 19/31 Y8 3/11
13/15 17/31
 Y9 4/16 18/30 Y10 5/17 19/25 27/29 Y11 3/23 25/30 Y12 5/6 8/29 Y13 6
8/11
 14/28 Y14 6/7 9 11/15 17/18 20/27 Y15 9/10 12/17 19 21/27 Y16 9 12/18
20/26
 Y17 11 13/16 18/22 Y18 13 15 17 19 21"
WAFERID.06=DA8115-06G0
NUM_BINS.06=02
BIN_COUNT.06.08=00176
MAP_XY.06.08="Y-13 10/11 13 18/19 23 Y-12 8/9 15/16 19 22/23 25 Y-11 7
18/19 23
 26 Y-10 6/8 17 22 28 Y-9 4 16/17 20 22 27 29 Y-8 4 20 29 Y-7 14 16
28/30 Y-6
 2/3 10 21 25 30/31 Y-5 2 4 23 28 Y-4 1 4 8 14 26 28 31 Y-3 1 16 20 24
31 Y-2 2
 16 22 27/28 Y-1 12 31 Y0 1 7/8 28 30 32/33 Y1 0/2 11 20/21 27 30/33 Y2
0/2 9
 18 27 30/33 Y3 0/2 6 25 30/33 Y4 1 4 17/18 Y5 0/1 15/16 Y6 7 29 Y7 5
Y8 1/2 5
 14 17 24 30 32/33 Y9 12 25 29 31 Y10 2/3 21 23 26 31 Y11 4 14 30 Y12
3/4 24/25
 28 30 Y13 4 7 15 18 26 29 Y14 5/6 Y15 6/8 10 13 27 Y16 7/10 21 24/26
Y17 9/10
 22 Y18 11 17 22"
BIN_COUNT.06.01=00704
MAP_XY.06.01="Y-13 12 14/17 20/22 Y-12 10/14 17/18 20/21 24 Y-11 8/17
20/22
 24/25 Y-10 9/16 18/21 23/27 Y-9 5/15 18/19 21 23/26 28 Y-8 5/19 21/28
Y-7 3/13
 15 17/27 Y-6 4/9 11/20 22/24 26/29 Y-5 3 5/22 24/27 29/31 Y-4 2/3 5/7
9/13
 15/25 27 29/30 32/33 Y-3 2/15 17/19 21/23 25/30 32/33 Y-2 1 3/15 17/21
23/26
 29/33 Y-1 1/11 13/30 32/33 Y0 0 2/6 9/27 29 31 Y1 3/10 12/19 22/26
28/29 Y2
 3/8 10/17 19/26 28/29 Y3 3/5 7/24 26/29 Y4 0 2/3 5/16 19/33 Y5 2/14
17/33 Y6
```

```
 1/6 8/28 30/33 Y7 1/4 6/33 Y8 3/4 6/13 15/16 18/23 25/29 31 Y9 2/11
13/24
 26/28 30 Y10 4/20 22 24/25 27/30 Y11 3 5/13 15/29 Y12 5/23 26/27 29
Y13 5/6
 8/14 16/17 19/25 27/28 Y14 7/28 Y15 9 11/12 14/26 Y16 11/20 22/23 Y17
11/21
 23/24 Y18 12/16 18/21"
WAFERID.07=DA8115-07F3
NUM_BINS.07=02
BIN_COUNT.07.08=00174
MAP_XY.07.08="Y-13 10/12 20 23 Y-12 8 10/11 21 23 25 Y-11 7 13/15 22
24/25 Y-10
 10 12 14/15 19 22/26 28 Y-9 4 8 11 22/23 27 29 Y-8 7 12 21 Y-7 5 14 26
30 Y-6
 2 17 31 Y-5 7 16 Y-4 1 Y-3 1 17 29 32/33 Y-2 5 8 28/29 32/33 Y-1 5 9
21 Y0 1
 15/16 Y1 0/2 8 16 20 23 30/33 Y2 0/2 12 30/33 Y3 0/2 30/33 Y4 0/1 4 15
Y5 0/1
 4 13 Y6 1 4 9 29 Y7 9 14 30 32/33 Y8 1/2 14 32/33 Y9 8 21 24/25 31 Y10
2/3 7
 19 31 Y11 3/4 18 30 Y12 3/4 16 22 30 Y13 4/5 14 29 Y14 5 14 21 28 Y15
6/7 14
 19 25 27 Y16 7/8 12/13 15 18 22/24 26 Y17 9/11 19/20 23 Y18 11/19
21/22"
BIN_COUNT.07.01=00706
MAP_XY.07.01="Y-13 13/19 21/22 Y-12 9 12/20 22 24 Y-11 8/12 16/21 23 26
Y-10
 6/9 11 13 16/18 20/21 27 Y-9 5/7 9/10 12/21 24/26 28 Y-8 4/6 8/11
13/20 22/29
 Y-7 3/4 6/13 15/25 27/29 Y-6 3/16 18/30 Y-5 2/6 8/15 17/31 Y-4 2/33 Y-
3 2/16
 18/28 30/31 Y-2 1/4 6/7 9/27 30/31 Y-1 1/4 6/8 10/20 22/33 Y0 0 2/14
17/33 Y1
 3/7 9/15 17/19 21/22 24/29 Y2 3/11 13/29 Y3 3/29 Y4 2/3 5/14 16/33 Y5
2/3 5/12
 14/33 Y6 2/3 5/8 10/28 30/33 Y7 1/8 10/13 15/29 31 Y8 3/13 15/31 Y9
2/7 9/20
 22/23 26/30 Y10 4/6 8/18 20/30 Y11 5/17 19/29 Y12 5/15 17/21 23/29 Y13
6/13
 15/28 Y14 6/13 15/20 22/27 Y15 8/13 15/18 20/24 26 Y16 9/11 14 16/17
19/21 25
 Y17 12/18 21/22 24 Y18 20"
WAFERID.08=DA8115-08E6
NUM_BINS.08=02
BIN_COUNT.08.08=00135
MAP_XY.08.08="Y-13 10 14 23 Y-12 8 17 25 Y-11 7 12 17 20 24 26 Y-10 8/9
12 22
 27/28 Y-9 4 6 18 25 27 29 Y-8 4 8 10 27 Y-7 12 30 Y-6 2 31 Y-5 8 10/11
27 31
 Y-4 1 3 20 22 26 28 Y-3 1 Y-2 27 Y-1 14 17 23 29 Y0 5 23 Y1 0/2 6
30/33 Y2 0/2
 30/33 Y3 0/2 24 27 30/33 Y4 18 25 31 Y5 0 11/12 20 23 27 Y6 4/5 10 14
Y7 1 29
```

31 Y8 1 4 32/33 Y9 2 6 11 29 Y10 2/3 25 29 Y11 3 29 Y12 3/4 11 14 16
28 Y13 4
28/29 Y14 5/6 13 Y15 6/7 11 14 25 27 Y16 7/10 26 Y17 9/10 14 19 Y18
11/12"
BIN_COUNT.08.01=00745
MAP_XY.08.01="Y-13 11/13 15/22 Y-12 9/16 18/24 Y-11 8/11 13/16 18/19
21/23 25
Y-10 6/7 10/11 13/21 23/26 Y-9 5 7/17 19/24 26 28 Y-8 5/7 9 11/26
28/29 Y-7
3/11 13/29 Y-6 3/30 Y-5 2/7 9 12/26 28/30 Y-4 2 4/19 21 23/25 27 29/33
Y-3
2/33 Y-2 1/26 28/33 Y-1 1/13 15/16 18/22 24/28 30/33 Y0 0/4 6/22 24/33
Y1 3/5
7/29 Y2 3/29 Y3 3/23 25/26 28/29 Y4 0/17 19/24 26/30 32/33 Y5 1/10
13/19 21/22
24/26 28/33 Y6 1/3 6/9 11/13 15/33 Y7 2/28 30 32/33 Y8 2/3 5/31 Y9 3/5
7/10
12/28 30/31 Y10 4/24 26/28 30/31 Y11 4/28 30 Y12 5/10 12/13 15 17/27
29/30 Y13
5/27 Y14 7/12 14/28 Y15 8/10 12/13 15/24 26 Y16 11/25 Y17 11/13 15/18
20/24
Y18 13/22"
WAFERID.09=DA8115-09E1
NUM_BINS.09=02
BIN_COUNT.09.08=00142
MAP_XY.09.08="Y-13 10 23 Y-12 8 12 23 25 Y-11 23 Y-10 27/28 Y-9 4 7 15
20 27 29
Y-8 17/18 28/29 Y-7 3 8 19 23 30 Y-6 2 10 12 15 18 31 Y-4 1 3 21 25 Y-
3 1 26
Y-2 2 9 17 24/25 32/33 Y-1 1 14/15 31 Y0 1 4 31 Y1 0/2 6 30/33 Y2 0/2
6 14/15
17 30/33 Y3 0/2 11 14 30/33 Y4 1 Y5 0 6 14 23 25 Y6 2 29 Y7 1/2 31 Y8
1/2 8 19
32/33 Y9 3 31 Y10 2 6 10 31 Y11 5 12 23 26 Y12 3/5 7 15 30 Y13 4/6 Y14
5 7 14
22 26 28 Y15 6/7 27 Y16 7/9 11 25/26 Y17 9/11 13 18 23/24 Y18 11/12 17
22"
BIN_COUNT.09.01=00738
MAP_XY.09.01="Y-13 11/22 Y-12 9/11 13/22 24 Y-11 7/22 24/26 Y-10 6/26
Y-9 5/6
8/14 16/19 21/26 28 Y-8 4/16 19/27 Y-7 4/7 9/18 20/22 24/29 Y-6 3/9 11
13/14
16/17 19/30 Y-5 2/31 Y-4 2 4/20 22/24 26/33 Y-3 2/25 27/33 Y-2 1 3/8
10/16
18/23 26/31 Y-1 2/13 16/30 32/33 Y0 0 2/3 5/30 32/33 Y1 3/5 7/29 Y2
3/5 7/13
16 18/29 Y3 3/10 12/13 15/29 Y4 0 2/33 Y5 1/5 7/13 15/22 24 26/33 Y6 1
3/28
30/33 Y7 3/30 32/33 Y8 3/7 9/18 20/31 Y9 2 4/30 Y10 3/5 7/9 11/30 Y11
3/4 6/11
13/22 24/25 27/30 Y12 6 8/14 16/29 Y13 7/29 Y14 6 8/13 15/21 23/25 27
Y15 8/26
Y16 10 12/24 Y17 12 14/17 19/22 Y18 13/16 18/21"
WAFERID.10=DA8115-10E6

```
NUM_BINS.10=02
BIN_COUNT.10.08=00102
MAP_XY.10.08="Y-13 10 23 Y-12 8 22 25 Y-11 7 Y-10 6 9 28 Y-9 4 28/29 Y-
8 4 8 21
 28 Y-7 8 Y-6 2 10 12 14 18 30/31 Y-5 25 28 Y-4 1 Y-3 7 9 20 Y-2 12 Y-1
10 18
 20 24 Y0 5 10 16 Y1 0/3 30/33 Y2 0/2 30/33 Y3 0/2 4 9 26 30/33 Y4 5 22
25
 32/33 Y5 0 2 11 Y7 3 Y8 1 24 Y10 2 21 28/29 Y11 6 29 Y12 3/4 7 Y13 4/5
23 29
 Y14 10 27 Y15 6 24 27 Y16 7 10 17 Y17 9 14 Y18 11/12 18"
BIN_COUNT.10.01=00778
MAP_XY.10.01="Y-13 11/22 Y-12 9/21 23/24 Y-11 8/26 Y-10 7/8 10/27 Y-9
5/27 Y-8
 5/7 9/20 22/27 29 Y-7 3/7 9/30 Y-6 3/9 11 13 15/17 19/29 Y-5 2/24
26/27 29/31
 Y-4 2/33 Y-3 1/6 8 10/19 21/33 Y-2 1/11 13/33 Y-1 1/9 11/17 19 21/23
25/33 Y0
 0/4 6/9 11/15 17/33 Y1 4/29 Y2 3/29 Y3 3 5/8 10/25 27/29 Y4 0/4 6/21
23/24
 26/31 Y5 1 3/10 12/33 Y6 1/33 Y7 1/2 4/33 Y8 2/23 25/33 Y9 2/31 Y10
3/20 22/27
 30/31 Y11 3/5 7/28 30 Y12 5/6 8/30 Y13 6/22 24/28 Y14 5/9 11/26 28 Y15
7/23
 25/26 Y16 8/9 11/16 18/26 Y17 10/13 15/24 Y18 13/17 19/22"
WAFERID.11=DA8115-11E1
NUM_BINS.11=02
BIN_COUNT.11.08=00197
MAP_XY.11.08="Y-13 10/11 17 19 23 Y-12 8 13 17/19 21/22 25 Y-11 7/8
10/11 13
 17/18 20/21 23/26 Y-10 6/7 9 13/14 18/19 21/26 28 Y-9 4/6 8 14 17/18
21/23
 25/29 Y-8 4/5 10/11 15 17/18 24/25 Y-7 3 5 20 23/24 29 Y-6 2/3 6 11 14
19 25
 28 31 Y-5 2 7 15 20 Y-4 1 12 20 27 32/33 Y-3 1 5 22 32/33 Y-2 1 4 8 14
16 25
 30/31 Y-1 11/12 29 Y0 1 10 21 24 31 Y1 0/3 16 26 30/33 Y2 0/2 5 9
30/33 Y3 0/2
 14 23 30/33 Y4 24 Y5 0 3 12 20/21 28 Y6 1 3 31 Y7 1 9 14 18 20 32/33
Y8 1/2 23
 32/33 Y9 22 Y10 2 10 12 21 24 Y11 4 15 19 Y12 3/4 12 19 24 29/30 Y13
4/5 24 29
 Y14 5/6 13 21 Y15 6/8 Y16 7/8 12 18 26 Y17 9 24 Y18 11/13 19"
BIN_COUNT.11.01=00683
MAP_XY.11.01="Y-13 12/16 18 20/22 Y-12 9/12 14/16 20 23/24 Y-11 9 12
14/16 19
 22 Y-10 8 10/12 15/17 20 27 Y-9 7 9/13 15/16 19/20 24 Y-8 6/9 12/14 16
19/23
 26/29 Y-7 4 6/19 21/22 25/28 30 Y-6 4/5 7/10 12/13 15/18 20/24 26/27
29/30 Y-5
 3/6 8/14 16/19 21/31 Y-4 2/11 13/19 21/26 28/31 Y-3 2/4 6/21 23/31 Y-2
2/3 5/7
 9/13 15 17/24 26/29 32/33 Y-1 1/10 13/28 30/33 Y0 0 2/9 11/20 22/23
25/30
```

32/33 Y1 4/15 17/25 27/29 Y2 3/4 6/8 10/29 Y3 3/13 15/22 24/29 Y4 0/23
25/33
Y5 1/2 4/11 13/19 22/27 29/33 Y6 2 4/30 32/33 Y7 2/8 10/13 15/17 19
21/31 Y8
3/22 24/31 Y9 2/21 23/31 Y10 3/9 11 13/20 22/23 25/31 Y11 3 5/14 16/18
20/30
Y12 5/11 13/18 20/23 25/28 Y13 6/23 25/28 Y14 7/12 14/20 22/28 Y15
9/27 Y16
9/11 13/17 19/25 Y17 10/23 Y18 14/18 20/22"
WAFERID.12=DA8115-12D4
NUM_BINS.12=02
BIN_COUNT.12.08=00316
MAP_XY.12.08="Y-13 10/23 Y-12 8/25 Y-11 7/26 Y-10 6/17 20 22/28 Y-9 4
6/7 9/12
14/15 17/20 22/29 Y-8 4/13 15 17 20/22 24/25 27/29 Y-7 3/6 8/9 15 20
23 25/26
28 Y-6 2/3 7 11 13 23 26 29 31 Y-5 3 10 17 Y-4 1 18 Y-3 1 3 18 21 28
Y-2 2/3
11 Y-1 11 Y0 1 3 11 32/33 Y1 0/3 30/33 Y2 0/2 4 8 11 16 20 22 26 30/33
Y3 0/3
11 30/33 Y4 3 9 26 30 Y5 0 Y6 1 27 31 Y7 7/8 12 14 20 31/33 Y8 1 3 17
32/33 Y9
2 31 Y10 3 5 7 9 26 31 Y11 9 14 16 21 25 Y12 3/5 7 14 18 26 30 Y13 4/6
12
15/16 19 23 26 28/29 Y14 5/9 11/15 17 19/21 23/24 27/28 Y15 6 8/12
14/23 25 27
Y16 7 9/13 15/18 20/22 24/26 Y17 9/17 19/20 22/24 Y18 11/22"
BIN_COUNT.12.01=00564
MAP_XY.12.01="Y-10 18/19 21 Y-9 5 8 13 16 21 Y-8 14 16 18/19 23 26 Y-7
7 10/14
16/19 21/22 24 27 29/30 Y-6 4/6 8/10 12 14/22 24/25 27/28 30 Y-5 2 4/9
11/16
18/31 Y-4 2/17 19/33 Y-3 2 4/17 19/20 22/27 29/33 Y-2 1 4/10 12/33 Y-1
1/10
12/33 Y0 0 2 4/10 12/31 Y1 4/29 Y2 3 5/7 9/10 12/15 17/19 21 23/25
27/29 Y3
4/10 12/29 Y4 0/2 4/8 10/25 27/29 31/33 Y5 1/33 Y6 2/26 28/30 32/33 Y7
1/6
9/11 13 15/19 21/30 Y8 2 4/16 18/31 Y9 3/30 Y10 2 4 6 8 10/25 27/30
Y11 3/8
10/13 15 17/20 22/24 26/30 Y12 6 8/13 15/17 19/25 27/29 Y13 7/11 13/14
17/18
20/22 24/25 27 Y14 10 16 18 22 25/26 Y15 7 13 24 26 Y16 8 14 19 23 Y17
18 21"
WAFERID.13=DA8115-13C7
NUM_BINS.13=02
BIN_COUNT.13.08=00285
MAP_XY.13.08="Y-13 10/14 17/23 Y-12 8/25 Y-11 7/26 Y-10 6/28 Y-9 4/29
Y-8 4 6
9/11 13/15 17/18 20 22 24/25 27 29 Y-7 3/6 11/18 20/21 23/26 28/30 Y-6
2 11 16
20 22 31 Y-5 11 18/20 22 28 Y-4 1 6 10 20 29 32/33 Y-3 1/2 20 25 31 Y-
2 2 4/6

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 21/22 28 30/31 Y-1 3 9 11 15 19 23 31/33 Y0 15 23 27 29 Y1 0/2 19
30/33 Y2 0/2
 11 19 30/33 Y3 0/2 4/5 30/33 Y4 11 18 Y5 0/1 3 25 Y6 4 13 29 Y7 1 3
32/33 Y8
 1/3 10 32/33 Y9 4 24 Y10 2/3 25/26 31 Y11 3 9/11 15/16 29 Y12 3/4 7
29/30 Y13
 4/5 11 20 25/26 Y14 5 14 28 Y15 6/9 16 18 26/27 Y16 7 9 11 14 23 25/26
Y17
 9/11 14 20/21 23/24 Y18 11/15 17 22"
BIN_COUNT.13.01=00595
MAP_XY.13.01="Y-13 15/16 Y-8 5 7/8 12 16 19 21 23 26 28 Y-7 7/10 19 22
27 Y-6
 3/10 12/15 17/19 21 23/30 Y-5 2/10 12/17 21 23/27 29/31 Y-4 2/5 7/9
11/19
 21/28 30/31 Y-3 3/19 21/24 26/30 32/33 Y-2 1 3 7/20 23/27 29 32/33 Y-1
1/2 4/8
 10 12/14 16/18 20/22 24/30 Y0 0/14 16/22 24/26 28 30/33 Y1 3/18 20/29
Y2 3/10
 12/18 20/29 Y3 3 6/29 Y4 0/10 12/17 19/33 Y5 2 4/24 26/33 Y6 1/3 5/12
14/28
 30/33 Y7 2 4/31 Y8 4/9 11/31 Y9 2/3 5/23 25/31 Y10 4/24 27/30 Y11 4/8
12/14
 17/28 30 Y12 5/6 8/28 Y13 6/10 12/19 21/24 27/29 Y14 6/13 15/27 Y15
10/15 17
 19/25 Y16 8 10 12/13 15/22 24 Y17 12/13 15/19 22 Y18 16 18/21"
WAFERID.14=DA8115-14C2
NUM_BINS.14=02
BIN_COUNT.14.08=00420
MAP_XY.14.08="Y-13 10/23 Y-12 9/25 Y-11 7/26 Y-10 6/28 Y-9 4/24 26
28/29 Y-8
 4/13 15/29 Y-7 3 5 7 9/15 17/30 Y-6 2 5 9 17 20 22 24/27 29 31 Y-5 3
11/14
 17/24 26 29/31 Y-4 1 5/6 8 12/14 18/20 22 24/30 32/33 Y-3 1 10/13
15/33 Y-2 6
 8 11 18 22/23 27 29/30 32/33 Y-1 1 5 9 13/14 18/19 22 24 27/30 32/33
Y0 2 20
 31/33 Y1 0/4 8 19/20 24 30/33 Y2 0/2 9 26 30/33 Y3 0/2 30/33 Y4 1/3 18
Y5 1 20
 31 Y6 1/2 28 31 Y7 4 6 12 18 20 23 28/29 Y8 1/2 7 17 26 28 32/33 Y9 2
9/10 26
 28 Y10 2 11 21 31 Y11 4/5 13 15 23 27 29/30 Y12 3/4 6 12 22/23 25/26
28 30 Y13
 4/6 12 14 18 20/21 23 26 29 Y14 5/6 9 11 14 16/18 20/22 24/28 Y15 6/11
14/26
 Y16 7/15 17/21 23/26 Y17 9/20 22/24 Y18 11/12 14/16 18/22"
BIN_COUNT.14.01=00460
MAP_XY.14.01="Y-12 8 Y-9 25 27 Y-8 14 Y-7 4 6 8 16 Y-6 3/4 6/8 10/16
18/19 21
 23 28 30 Y-5 2 4/10 15/16 25 27/28 Y-4 2/4 7 9/11 15/17 21 23 31 Y-3
2/9 14
 Y-2 1/5 7 9/10 12/17 19/21 24/26 28 31 Y-1 2/4 6/8 10/12 15/17 20/21
23 25/26
 31 Y0 0/1 3/19 21/30 Y1 5/7 9/18 21/23 25/29 Y2 3/8 10/25 27/29 Y3
3/29 Y4 0
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 4/17 19/33 Y5 0 2/19 21/30 32/33 Y6 3/27 29/30 32/33 Y7 1/3 5 7/11
13/17 19
 21/22 24/27 30/33 Y8 3/6 8/16 18/25 27 29/31 Y9 3/8 11/25 27 29/31 Y10
3/10
 12/20 22/30 Y11 3 6/12 14 16/22 24/26 28 Y12 5 7/11 13/21 24 27 29 Y13
7/11 13
 15/17 19 22 24/25 27/28 Y14 7/8 10 12/13 15 19 23 Y15 12/13 27 Y16 16
22 Y17
 21 Y18 13 17"
WAFERID.15=DA8115-15B5
NUM_BINS.15=02
BIN_COUNT.15.08=00161
MAP_XY.15.08="Y-13 10 12 19 23 Y-12 8 13 25 Y-11 7 19 26 Y-10 6 13
27/28 Y-9 4
 11 19/21 24 29 Y-8 4 29 Y-7 3 21 29/30 Y-6 2 5 22 31 Y-5 3 6 14 23
29/31 Y-4
 1/3 6 9 15 24 28 31 Y-3 1/2 8 Y-2 1 23 27/28 Y-1 3 5 14 17 23 26 31/33
Y0 1 5
 24 31 Y1 0/3 5 9 11 14 22 30/33 Y2 0/2 12 17 21 24/25 28 30/33 Y3 0/2
9/10
 18/19 28 30/33 Y4 1 3 12 Y5 0 4/5 9 30 Y6 1/2 4 8 10 Y7 28 31/33 Y8
1/2 8
 32/33 Y9 19 22 31 Y10 17 31 Y11 3 13 29 Y12 3/4 30 Y13 4 6 9 Y14 5 24
Y15 6/7
 9 20 27 Y16 7/10 21 Y17 9/10 Y18 11/12 15 19 22"
BIN_COUNT.15.01=00719
MAP_XY.15.01="Y-13 11 13/18 20/22 Y-12 9/12 14/24 Y-11 8/18 20/25 Y-10
7/12
 14/26 Y-9 5/10 12/18 22/23 25/28 Y-8 5/28 Y-7 4/20 22/28 Y-6 3/4 6/21
23/30
 Y-5 2 4/5 7/13 15/22 24/28 Y-4 4/5 7/8 10/14 16/23 25/27 29/30 32/33
Y-3 3/7
 9/33 Y-2 2/22 24/26 29/33 Y-1 1/2 4 6/13 15/16 18/22 24/25 27/30 Y0 0
2/4 6/23
 25/30 32/33 Y1 4 6/8 10 12/13 15/21 23/29 Y2 3/11 13/16 18/20 22/23
26/27 29
 Y3 3/8 11/17 20/27 29 Y4 0 2 4/11 13/33 Y5 1/3 6/8 10/29 31/33 Y6 3
5/7 9
 11/33 Y7 1/27 29/30 Y8 3/7 9/31 Y9 2/18 20/21 23/30 Y10 2/16 18/30 Y11
4/12
 14/28 30 Y12 5/29 Y13 5 7/8 10/29 Y14 6/23 25/28 Y15 8 10/19 21/26 Y16
11/20
 22/26 Y17 11/24 Y18 13/14 16/18 20/21"
WAFERID.16=DA8115-16B0
NUM_BINS.16=02
BIN_COUNT.16.08=00135
MAP_XY.16.08="Y-13 10 21 Y-12 8 18 21 Y-11 26 Y-10 19 24 27/28 Y-9 4 11
24 29
 Y-7 5 14 25 30 Y-6 2 16 25 31 Y-5 25 Y-4 1 25/26 28 32/33 Y-3 13 17 26
30 Y-2
 8 17 Y-1 9 Y0 1 5 Y1 0/2 11 13 30/33 Y2 0/2 27 30/33 Y3 0/2 9 30/33 Y4
0 2 16
 Y5 16 21 31 Y6 5 7 Y7 18 31 Y8 1 Y9 2 6 22 28 31 Y10 2 25 31 Y11 4/6
17 22 24
```

29/30 Y12 3/4 6 24 27 30 Y13 4/6 28/29 Y14 5 23/25 28 Y15 6/9 11 13
15/16
26/27 Y16 7 9/10 15 20 24/26 Y17 9 12 17 19 23 Y18 11/14"
BIN_COUNT.16.01=00745
MAP_XY.16.01="Y-13 11/20 22/23 Y-12 9/17 19/20 22/25 Y-11 7/25 Y-10
6/18 20/23
25/26 Y-9 5/10 12/23 25/28 Y-8 4/29 Y-7 3/4 6/13 15/24 26/29 Y-6 3/15
17/24
26/30 Y-5 2/24 26/31 Y-4 2/24 27 29/31 Y-3 1/12 14/16 18/25 27/29
31/33 Y-2
1/7 9/16 18/33 Y-1 1/8 10/33 Y0 0 2/4 6/33 Y1 3/10 12 14/29 Y2 3/26
28/29 Y3
3/8 10/29 Y4 1 3/15 17/33 Y5 0/15 17/20 22/30 32/33 Y6 1/4 6 8/33 Y7
1/17
19/30 32/33 Y8 2/33 Y9 3/5 7/21 23/27 29/30 Y10 3/24 26/30 Y11 3 7/16
18/21 23
25/28 Y12 5 7/23 25/26 28/29 Y13 7/27 Y14 6/22 26/27 Y15 10 12 14
17/25 Y16 8
11/14 16/19 21/23 Y17 10/11 13/16 18 20/22 24 Y18 15/22"
WAFERID.17=DA8115-17A3
NUM_BINS.17=02
BIN_COUNT.17.08=00145
MAP_XY.17.08="Y-12 8 11 15 18 20 22/23 25 Y-11 7 11 15/16 18/19 25 Y-10
7 19 28
Y-9 4 17 27/29 Y-8 4 12 Y-6 2 31 Y-5 4 15 28 Y-4 1/2 7 31/33 Y-3 1 8
19 Y-2
32/33 Y-1 3 10 24 27 30 32/33 Y0 1 15 Y1 0/2 5 25 29/33 Y2 0/2 4 18/19
29/33
Y3 0/2 6/7 12 18 30/33 Y4 5 23 Y5 0/1 Y6 5 14 25 Y7 3 9 14 25 30 Y8 1
16 32/33
Y9 2 24/25 31 Y10 2 18 21 25 28 31 Y11 3 13/14 Y12 3/4 9 12 14 28 Y13
4/5 7/8
29 Y14 5 19 22 24 Y15 6/7 17 27 Y16 7 9 17/18 25/26 Y17 9/12 21 24 Y18
11 13
16"
BIN_COUNT.17.01=00735
MAP_XY.17.01="Y-13 10/23 Y-12 9/10 12/14 16/17 19 21 24 Y-11 8/10 12/14
17
20/24 26 Y-10 6 8/18 20/27 Y-9 5/16 18/26 Y-8 5/11 13/29 Y-7 3/30 Y-6
3/30 Y-5
2/3 5/14 16/27 29/31 Y-4 3/6 8/30 Y-3 2/7 9/18 20/33 Y-2 1/31 Y-1 1/2
4/9
11/23 25/26 28/29 31 Y0 0 2/14 16/33 Y1 3/4 6/24 26/28 Y2 3 5/17 20/28
Y3 3/5
8/11 13/17 19/29 Y4 0/4 6/22 24/33 Y5 2/33 Y6 1/4 6/13 15/24 26/33 Y7
1/2 4/8
10/13 15/24 26/29 31/33 Y8 2/15 17/31 Y9 3/23 26/30 Y10 3/17 19/20
22/24 26/27
29/30 Y11 4/12 15/30 Y12 5/8 10/11 13 15/27 29/30 Y13 6 9/28 Y14 6/18
20/21 23
25/28 Y15 8/16 18/26 Y16 8 10/16 19/24 Y17 13/20 22/23 Y18 12 14/15
17/22"
WAFERID.18=DA8115-18H1
NUM_BINS.18=02

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BIN_COUNT.18.08=00197
MAP_XY.18.08="Y-13 10 18 23 Y-12 8 13 21 25 Y-11 25 Y-10 7 20 22/23 26
28 Y-9 4
 6 9 22/24 27/29 Y-8 4 8 15 24 27/28 Y-7 3/5 14 18 26 Y-6 2/3 5 20 23
30/31 Y-5
 2 4 19 21 24 26 28 31 Y-4 1 3 8 12 32/33 Y-3 1/2 8 13 22/23 Y-2 1 7 16
25 Y-1
 12/13 26 29 Y0 5 7 16 21 25 Y1 0/3 6 13 30/33 Y2 0/2 6 16 30/33 Y3 0/2
14
 20/21 30/33 Y4 1 6 10 14 21 28/30 Y5 0/1 7 9 Y6 8 12 17 21 26 29 32/33
Y7 1/3
 8 16/17 24 32/33 Y8 1 6 15 32/33 Y9 2 14 18/20 29 31 Y10 2 20 31 Y11 3
5 15 22
 26 30 Y12 3/4 9 14 23 25/27 29/30 Y13 4 24 28/29 Y14 5 9 17 27/28 Y15
6/7 9 12
 21 25/27 Y16 7/9 12 22 26 Y17 9 11 16 20 23 Y18 11/12 14 21/22"
BIN_COUNT.18.01=00683
MAP_XY.18.01="Y-13 11/17 19/22 Y-12 9/12 14/20 22/24 Y-11 7/24 26 Y-10
6 8/19
 21 24/25 27 Y-9 5 7/8 10/21 25/26 Y-8 5/7 9/14 16/23 25/26 29 Y-7 6/13
15/17
 19/25 27/30 Y-6 4 6/19 21/22 24/29 Y-5 3 5/18 20 22/23 25 27 29/30 Y-4
2 4/7
 9/11 13/31 Y-3 3/7 9/12 14/21 24/33 Y-2 2/6 8/15 17/24 26/33 Y-1 1/11
14/25
 27/28 30/33 Y0 0/4 6 8/15 17/20 22/24 26/33 Y1 4/5 7/12 14/29 Y2 3/5
7/15
 17/29 Y3 3/13 15/19 22/29 Y4 0 2/5 7/9 11/13 15/20 22/27 31/33 Y5 2/6
8 10/33
 Y6 1/7 9/11 13/16 18/20 22/25 27/28 30/31 Y7 4/7 9/15 18/23 25/31 Y8
2/5 7/14
 16/31 Y9 3/13 15/17 21/28 30 Y10 3/19 21/30 Y11 4 6/14 16/21 23/25
27/29 Y12
 5/8 10/13 15/22 24 28 Y13 5/23 25/27 Y14 6/8 10/16 18/26 Y15 8 10/11
13/20
 22/24 Y16 10/11 13/21 23/25 Y17 10 12/15 17/19 21/22 24 Y18 13 15/20"
WAFERID.19=DA8115-19G4
NUM_BINS.19=02
BIN_COUNT.19.08=00183
MAP_XY.19.08="Y-13 10 23 Y-12 8 10 16/18 21 23 25 Y-11 7/8 10 12 14 16
18/22
 24/26 Y-10 8 10 12/14 16/17 19/20 23/25 28 Y-9 4 8/10 12 14/16 20/24
26/27 29
 Y-8 4 11/12 29 Y-7 5 8 14 24 30 Y-6 2 5 7 9 24 28 31 Y-5 13 18 22 25
27 30/31
 Y-4 1 5 21 28 31/33 Y-3 1 12 31 Y-2 15 Y-1 8 12 30/31 Y0 1 17/19 22
32/33 Y1
 0/2 29/33 Y2 0/2 13 29/33 Y3 0/2 25 30/33 Y4 0 12 Y5 0/1 15 26 31 Y6 5
13 18
 22 25 Y7 2 12 Y8 1 5 7 31/33 Y9 9 31 Y10 2 9 19 28 31 Y11 3 25/26 30
Y12 3/4
 15 30 Y13 4/5 13 17/18 23 29 Y14 5 12 21 28 Y15 6 12 19 27 Y16 7 18
Y17 9/10
 Y18 11/13 21/22"
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BIN_COUNT.19.01=00697
MAP_XY.19.01="Y-13 11/22 Y-12 9 11/15 19/20 22 24 Y-11 9 11 13 15 17 23
Y-10
 6/7 9 11 15 18 21/22 26/27 Y-9 5/7 11 13 17/19 25 28 Y-8 5/10 13/28 Y-
7 3/4
 6/7 9/13 15/23 25/29 Y-6 3/4 6 8 10/23 25/27 29/30 Y-5 2/12 14/17
19/21 23/24
 26 28/29 Y-4 2/4 6/20 22/27 29/30 Y-3 2/11 13/30 32/33 Y-2 1/14 16/33
Y-1 1/7
 9/11 13/29 32/33 Y0 0 2/16 20/21 23/31 Y1 3/28 Y2 3/12 14/28 Y3 3/24
26/29 Y4
 1/11 13/33 Y5 2/14 16/25 27/30 32/33 Y6 1/4 6/12 14/17 19/21 23/24
26/33 Y7 1
 3/11 13/33 Y8 2/4 6 8/30 Y9 2/8 10/30 Y10 3/8 10/18 20/27 29/30 Y11
4/24 27/29
 Y12 5/14 16/29 Y13 6/12 14/16 19/22 24/28 Y14 6/11 13/20 22/27 Y15
7/11 13/18
 20/26 Y16 8/17 19/26 Y17 11/24 Y18 14/20"
WAFERID.20=DA8115-20H1
NUM_BINS.20=02
BIN_COUNT.20.08=00166
MAP_XY.20.08="Y-13 19 21 Y-12 15 23 25 Y-11 7/8 15 20 Y-10 13 17 21 23
26 28
 Y-9 4 6 16 23 26/29 Y-8 4 24 28 Y-7 29 Y-6 2 5 11 18/19 25 30/31 Y-5 2
6 15 25
 30/31 Y-4 1 6 17 32/33 Y-3 3 12 15 21 Y-2 7 22 25 Y-1 10 16 19/20 Y1
0/2 16/17
 20 23 26/27 29/33 Y2 0/2 10 30/33 Y3 0/2 30/33 Y4 1 23 Y5 10 25/26 Y6
13 15 20
 30 Y7 1 3/4 15 21 25 Y8 1/2 16 26 32/33 Y9 2 4 6 19 29 31 Y10 3 21 25
31 Y11
 3/4 7 10 23 30 Y12 3/4 22 25 30 Y13 4/5 16 29 Y14 5/6 18 27/28 Y15 6/9
23 27
 Y16 7/10 14 18 20 26 Y17 9/11 22/24 Y18 11/12 15 18/20 22"
BIN_COUNT.20.01=00714
MAP_XY.20.01="Y-13 10/18 20 22/23 Y-12 8/14 16/22 24 Y-11 9/14 16/19
21/26 Y-10
 6/12 14/16 18/20 22 24/25 27 Y-9 5 7/15 17/22 24/25 Y-8 5/23 25/27 29
Y-7 3/28
 30 Y-6 3/4 6/10 12/17 20/24 26/29 Y-5 3/5 7/14 16/24 26/29 Y-4 2/5
7/16 18/31
 Y-3 1/2 4/11 13/14 16/20 22/33 Y-2 1/6 8/21 23/24 26/33 Y-1 1/9 11/15
17/18
 21/33 Y0 0/33 Y1 3/15 18/19 21/22 24/25 28 Y2 3/9 11/29 Y3 3/29 Y4 0
2/22
 24/33 Y5 0/9 11/24 27/33 Y6 1/12 14 16/19 21/29 31/33 Y7 2 5/14 16/20
22/24
 26/33 Y8 3/15 17/25 27/31 Y9 3 5 7/18 20/28 30 Y10 2 4/20 22/24 26/30
Y11 5/6
 8/9 11/22 24/29 Y12 5/21 23/24 26/29 Y13 6/15 17/28 Y14 7/17 19/26 Y15
10/22
 24/26 Y16 11/13 15/17 19 21/25 Y17 12/21 Y18 13/14 16/17 21"
WAFERID.21=DA8115-21G4
NUM_BINS.21=02
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BIN_COUNT.21.08=00183
MAP_XY.21.08="Y-13 10 14/15 Y-12 8 10 13 15 17 21 23/25 Y-11 19 22 24
Y-10 6
 8/9 15/17 20/21 23/24 26/28 Y-9 4 8/9 12 17/19 21 25 27/29 Y-8 4 7 15
18 22
 24/25 Y-7 4 10 20/21 26 30 Y-6 2 28 31 Y-5 2 5/6 30 Y-4 1 29 31/33 Y-3
1/2 21
 23 Y-2 5 15 25 27/28 Y-1 5 32/33 Y0 1 18 20 32/33 Y1 0/2 19 30/33 Y2
0/2 30/33
 Y3 0/2 10 21 30/33 Y4 0/1 25 Y5 0 4 12 29 Y6 1/2 5 9 16 21 25 27 30 Y7
1/2 5
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8/14
 16/17 19/21 23 26/29 Y-7 3 5/9 11/19 22/25 27/29 Y-6 3/27 29/30 Y-5
3/4 7/29
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Y5 1/3
 5/11 13/28 30/33 Y6 3/4 6/8 10/15 17/20 22/24 26 28/29 31/33 Y7 3/4
6/33 Y8
 3/19 21/29 31 Y9 3 5/25 27/30 Y10 4/19 22/27 30 Y11 4/15 17/29 Y12
5/10 12/25
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Y13 4/5
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2 1/19
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Y12
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28 Y-7 4
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21/23

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24 27
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18/19
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28/29 Y7
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18 21 23 25/26 Y12 3/4 11 30 Y13 4 17 19 28/29 Y14 5 17 21/22 26/28
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18/20
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Y-7 3
20 22 28 Y-6 2 11 20 27/28 31 Y-5 4 6 8 24 31 Y-4 1 15 22 26 28 31 Y-3
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Y-2 3 21 29 Y-1 2 5 Y0 20 22 30 Y1 0/2 15 19 23 27 30/33 Y2 0/2 20 23
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Student Signature Date