

Semiconductor Wafer Manufacturing Data Format Specification

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1 Introduction

This document describes the format for the semiconductor manufacturing line data as well as relevant comments and information about the data. For each data set, there are 5 data files (or tables) as well as a sixth comments file. The name of each file for a given data set should have a prefix common to all the files for this data set followed by a unique suffix to identify the file. For example, if the data set were `ibm`, then the the files corresponding to this data set would have the names `ibm.<suffix>`.

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Below is a list of the six files, along with their suffixes and a brief description of the data they contain.

<i>File</i>	<i>Suffix ID</i>	<i>Description</i>
Process Route	pr	Process route information for all processes
Rework Sequences	rw	Information on rework sequences
Tool Set	ts	Information on tools
Operator Set	os	Information on operators
Volume/release	vr	Release rate information
Comment File	cf	General comments and sample run results

2 File descriptions

In this section, a detailed description is given of the format for each of the files described in the previous section. For each of the 5 data files, a list of all the fields for each record is given, and for each field, its type (e.g. integer, float, etc.), its width, and a brief description of its contents are specified. A description of the comments file is also provided.

2.1 Process Route File

<i>Field Name</i>	<i>Type</i>	<i>Width</i>	<i>Remarks</i>
Process Flow ID	String	10	Unique process flow ID
Step ID	String	10	Process step ID
Operation Description	String	25	A brief operation description
Tool Set ID	String	10	Assume 1 tool needed from this tool group for this operation
Operator Set ID	String	15	Assume 1 operator needed for this operation (see operator set file for more info)
Load Time	Float	10	Time to load wafers/lot/batch into tool
Unload Time	Float	10	Time to unload wafers/lot/batch from tool
Time per Wafer in Process	Float	10	Processing time per wafer (excluding travel time within tool) (as appropriate)
Wafer Travel Time	Float	10	Travel time within tool (as appropriate)
Time per Lot	Float	10	Lot processing time (as appropriate)
Time per Batch	Float	10	Batch processing time (as appropriate)
Min Batch Size	Integer	5	Minimum batch size (in wafers)
Max Batch Size	Integer	5	Maximum batch size (in wafers)
Batch ID	String	10	Used to identify which operations can be batched together
Time per Spec. Setup	Float	10	Setup time required for changing from one process flow step (recipe spec.) to another
Time per Group Setup	Float	10	Setup time required for changing from one "group" to another where group is specified by the Setup Group ID
Setup Group ID	String	15	See above
Lot Scrap Probability	Float	10	Prob. an entire lot is scrapped after this operation
Wafer Scrap Probability	Float	10	Prob. a wafer in a lot is scrapped after this operation
Lot Rework Probability	Float	10	Prob. an entire lot is sent for rework after this operation given it has not been scrapped
Wafer Rework Probability	Float	10	Prob. a wafer in a lot is sent for rework given it is has not been scrapped
Rework Sequence ID	String	10	Rework sequence to follow
Rework Return Step ID	String	10	Step to which wafers return after rework
Travel Time	Float	10	Time to travel to next operation process step
Travel Time Operator ID	String	15	Operator set needed for travel

2.2 Rework Sequences File

The format for a rework sequence record is almost identical to the corresponding format given for the process route. The difference is that instead of a Process ID, there is a rework sequence ID.

<i>Field Name</i>	<i>Type</i>	<i>Width</i>	<i>Remarks</i>
Rework Sequence ID	String	10	Unique product family ID
Step ID	String	10	Process step ID
Operation Description	String	25	A brief operation description
Tool Set ID	String	10	Assume 1 tool needed from this tool set for this operation
Operator Set ID	String	15	Assume 1 operator needed for this operation (see operator set file for more info)
Load Time	Float	10	Time to load wafers/lot/batch into tool
Unload Time	Float	10	Time to unload wafers/lot/batch from tool
Time per Wafer in Process	Float	10	Processing time per wafer (excluding travel time within tool) (as appropriate)
Wafer Travel Time	Float	10	Travel time within tool (as appropriate)
Time per Lot	Float	10	Lot processing time (as appropriate)
Time per Batch	Float	10	Batch processing time (as appropriate)
Min Batch Size	Integer	5	Minimum batch size (in wafers)
Max Batch Size	Integer	5	Maximum batch size (in wafers)
Batch ID	String	10	Used to identify which operations can be batched together
Time per Spec. Setup	Float	10	Setup time required for changing from one process flow step (recipe spec.) to another
Time per Group Setup	Float	10	Setup time required for changing from one "group" to another where group is specified by the Setup Group ID
Setup Group ID	String	15	See above
Lot Scrap Probability	Float	10	Prob. an entire lot is scrapped after this operation
Wafer Scrap Probability	Float	10	Prob. a wafer in a lot is scrapped after this operation
Lot Rework Probability	Float	10	Prob. an entire lot is sent for rework after this operation given it has not been scrapped
Wafer Rework Probability	Float	10	Prob. a wafer in a lot is sent for rework given it is has not been scrapped
Rework Sequence ID	String	10	Rework sequence to follow
Rework Return Step ID	String	10	Step to which wafers return after rework
Travel Time	Float	10	Time to travel to next operation process step
Travel Time Operator ID	String	15	Operator set needed for travel

2.3 Tool Set File

<i>Field Name</i>	<i>Type</i>	<i>Width</i>	<i>Remarks</i>
Tool Set ID	String	10	Tool set identifier
Tool Description	String	25	Name or description of tool
Quantity	Integer	5	Number of (identical) tools in tool set
Operator Load Fraction	Float	10	Fraction of time operator is needed for lot loading
Operator Unload Fraction	Float	10	Fraction of time operator is needed for lot unloading
Operator Process Fraction	Float	10	Fraction of time operator is needed for lot processing
Down Time #1 Description	String	25	Description of tool down time type 1
Down Time #1 Type	Integer	5	0 = time based; 1 = run based
Time or Runs Between #1	Float	15	Mean time (runs) between this down time event
Duration #1	Float	10	Duration of this down time event
Down Time #1 Operator Set ID	String	15	Operator needed from this set during this down time event
Down Time #2 Description	String	25	Description of tool down time type 2
Down Time #2 Type	Integer	5	0 = time based; 1 = run based
Time or Runs Between #2	Float	15	Mean time (runs) between this down time event
Duration #2	Float	10	Duration of this down time event
Down Time #2 Operator Set ID	String	15	Operator needed from this set during this down time event
Down Time #3 Description	String	25	Description of tool down time type 3
Down Time #3 Type	Integer	5	0 = time based; 1 = run based
Time or Runs Between #3	Float	15	Mean time (runs) between this down time event
Duration #3	Float	10	Duration of this down time event
Down Time #3 Operator Set ID	String	15	Operator needed from this set during this down time event
Down Time #4 Description	String	25	Description of tool down time type 4
Down Time #4 Type	Integer	5	0 = time based; 1 = run based
Time or Runs Between #4	Float	15	Mean time (runs) between events
Duration #4	Float	10	Duration of this down time event
Down Time #4 Operator Set ID	String	15	Operator needed from this set during this down time event
Down Time #5 Description	String	25	Description of tool down time type 5
Down Time #5 Type	Integer	5	0 = time based; 1 = run based
Time or Runs Between #5	Float	15	Mean time (runs) between events
Duration #5	Float	10	Duration of this down time event
Down Time #5 Operator Set ID	String	15	Operator needed from this set during this down time event

2.4 Operator Set File

The format for operator set records is similar to the format for the tool set.

<i>Field Name</i>	<i>Type</i>	<i>Width</i>	<i>Remarks</i>
Operator Set ID	String	15	Operator set identifier
Operator Description	String	25	Operator Set Name
Quantity	Integer	5	Number of operators in this set
Break #1 Description	String	25	Description of break type
Time Between #1	Float	15	Time between breaks of this type
Duration #1	Float	10	Duration of breaks of this type
Break #2 Description	String	25	Description of break type
Time Between #2	Float	15	Time between breaks of this type
Duration #2	Float	10	Duration of breaks of this type
Break #3 Description	String	25	Description of break type
Time Between #3	Float	15	Time between breaks of this type
Duration #3	Float	10	Duration of breaks of this type

2.5 Volume/Release File

<i>Field Name</i>	<i>Type</i>	<i>Width</i>	<i>Remarks</i>
Process Flow	String	10	Process Flow ID
Product ID	String	10	Unique product family ID
Product Name	String	25	Name of Product (optional)
Start Rate	Float	10	Number of wafers per day released into line based on 7 day/week operation
Lot Size	Integer	10	Number of wafers in a released lot

2.6 Comments File

The comments file contains information about the factory represented by the dataset, including the type of product manufactured, number of process flows in the dataset, number of equipment groups, and approximate wafer starts per month. The file also contains sample simulation output, including assumptions, simulation run conditions, and results (cycle times and number of outs).

3 Additional Information

In this section, we list, in no particular order, relevant issues and clarifying points relating to the data sets.

1. All times are specified in minutes except if stated explicitly otherwise.
2. All tools in a tool set and all operators in a operator set are considered identical. In particular, all tools in a tool set are considered qualified to perform all operations coming to that tool set. The same holds true for operators.
3. An operation is uniquely specified by its Process ID (or Rework ID) and Step ID. However, we allow multiple entries for the same Product ID, Step ID pair. The resolution of such multiple entries should be made in the description field. Multiple entries might be used to specify alternative tool sets or operator sets that can be used to perform an operation.
4. The following formulas can be used to calculate processing time per lot (pt), time until tool becomes free (tf), and total lot cycle time through an operation (ct):
$$\begin{aligned} \text{pt} &= \text{Time per Batch} * \text{Number of batches required for the lot} \\ &+ \text{Time per Lot} + \text{Time per Wafer in Process} * \text{Number of wafers in lot} \\ &+ \text{Product Setup (if appropriate)} + \text{Group Setup (if appropriate)} \\ \text{tf} &= \text{Load Time} + \text{pt} + \text{Unload Time} \\ \text{ct} &= \text{Load Time} + \text{pt} + \text{Wafer Travel Time} + \text{Unload Time} \end{aligned}$$
5. No distributional information is included in the data sets beyond first moment (mean) information. Fields with names like `Load Time` have the implicit prefix qualifier `Mean`.
6. The wafer start rates given in the Volume/release file are intended as guidelines. The exact method by which lots are released is to be determined by the users of the data.
7. Information on process holds, engineering holds and send aheads is not included.
8. Time bound sequences cannot be specified explicitly.
9. The following types of tools typically found in a semiconductor wafer manufacturing line can be modeled by making appropriate use of the processing time parameters:
 - (a) Single wafer tools. Set `Time per Wafer in Process` field to wafer processing time and all other process time parameters to 0.

- (b) Batch tools. Set `Min Batch Size` and `Max Batch Size` fields appropriately. Set `Time per Batch` field to batch processing time and all other process time parameters to 0. Lots with the same batch ID may be batched together (up to the max batch size). Where batch IDs are left blank only lots at the same step of the same process flow may be batched together.
 - (c) Multi-Sequence tools. Set `Min Batch Size` and `Max Batch Size` fields appropriately. Set `Time per Batch` field to the largest single tank time and set `Wafer Travel Time` field to the remaining tank time. Set other process time parameters to 0.
 - (d) Conveyor tools. Set `Time per Wafer in Process` field to wafer processing time and `Wafer Travel Time` field to the wafer travel time. Set other process time parameters to 0.
 - (e) Inspect tools. Set `Time per Lot` field to inspect time. Set other process time parameters to 0.
 - (f) Certain cluster tools. Model as batch tools.
 - (g) Linked track/ linked lithography tools. Model as conveyor tools.
10. Group and spec. setups are assumed to be done whenever the group or process flow step ID changes from one operation to another. However, the duration of the setup does not vary as a function of the specific group or product preceding the operation.
 11. An Operator Set ID or Tool Set ID field that is blank indicates that no resource is needed for that step.