



## SEMI M18-96

# FORMAT FOR SILICON WAFER SPECIFICATION FORM FOR ORDER ENTRY

### 1 Scope

1.1 This format provides a standard form for specifying several classifications of silicon wafers, as follows:

1.1.1 Polished Silicon Wafers.

1.1.2 Epitaxial Silicon Wafers.

1.1.3 Epitaxial Silicon Wafers with Buried Layer.

1.2 The form is designed to be used in conjunction with other SEMI specifications where details of the dimensional, physical, electrical, and chemical properties are defined or specified. However, the form includes many items that are not currently included in the SEMI specifications. Also, many items are not now commonly specified, but may find increased importance in the future. The intention is to provide for flexibility and expansion of the technology.

1.3 This format provides for specifying and ordering silicon wafers with varying levels of complexity. The minimum level of completeness is shown in each case, with additional options included to allow for customization of the wafer to the specific processing requirements of the user. If a particular item is not of interest, no entry is required. The only required entries are those marked as such for the purpose of minimal specification (diameter, orientation, dopant, resistivity, etc.).

1.4 Values for many items are listed either in the polished silicon wafer standards in SEMI M1 or in the defect limits tables in SEMI M1, SEMI M2, or SEMI M11. If these standard specifications are sufficient for defining the wafers, only a single entry is required in each section of the form.

1.5 For referee purposes, U.S. Customary units shall be used for wafers of 2- and 3-inch diameters, and SI (System International, commonly called metric) units for 100 mm and larger diameter wafers.

### 2 Applicable Documents

#### 2.1 SEMI Specifications

*SEMI M1* — Specifications for Polished Monocrystalline Silicon Wafers

*SEMI M2* — Specifications for Silicon Epitaxial Wafers

*SEMI M11* — Specifications for Silicon Epitaxial Wafers for Advanced Applications

*SEMI M12* — Specification for Serial Alphanumeric Marking of the Front Surface of Wafers

*SEMI M13* — Specifications for Alphanumeric Marking of Silicon Wafers

*SEMI M20* — Specification for Establishing a Wafer Coordinate System

2.2 Test methods referenced in Table 1 are cited in SEMI M1, SEMI M2, or SEMI M11.

### 3 Definitions

3.1 The items listed in the form are referenced and defined in various documents. A reference for most items in Parts 2 and 3 of the form is listed in Table 1. The entries in the table are keyed to the form by item number. Because terms related to epitaxial wafers with buried layer are defined in this standard and because no standardized test methods for the buried layer parameters exist, Table 1 does not include line items from Part 4 of the form.

3.2 General term used in this standard:

*required (req. or req'd)* — When applied to a parameter listed in the order form, a user-supplied value is necessary to minimally define the material for manufacture.

3.3 Terms related to epitaxial wafers with buried layers:

*buried layer* — A diffused region in a substrate that is, or is intended to be, covered with an epitaxial layer.

*alignment precision* — Pattern displacement in first mask photolithography process.

NOTE 1 — Alignment precision is specified by maximum values of X and Y, the displacement of the center of the pattern from a reference position defined in the wafer specification in terms of the wafer coordinate system defined in SEMI M20, and the maximum value of  $\theta$ , the angle between the x-axis of the pattern and the primary orientation flat (see Figure 1).



*pattern distortion ratio* — Absolute magnitude of the quotient of the (1) difference between the width of the pattern on the substrate and the width of the pattern on the top surface of the epitaxial layer and (2) the thickness of the epitaxial layer.

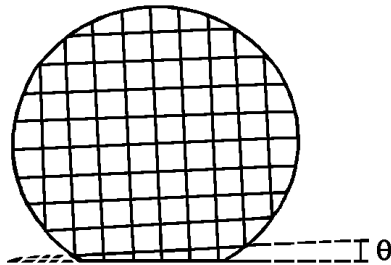


**Figure 1**  
**First Mask Pattern Showing Angular Displacement,  $\Theta$**

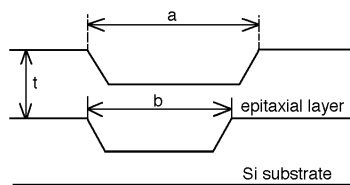


**Figure 2**  
**Cross-Sectional View of Epitaxial Layer Showing the Pattern Widths,  $a$ , at the Epi Surface, and  $b$ , at the Layer-Substrate Interface**

*pattern shift ratio* — Lateral distance between the center point of the pattern on the surface of the substrate and the center point of the pattern on the surface of the epitaxial layer divided by the epitaxial layer thickness.

NOTE 4 — Pattern shift ratio,  $d/t$  (see Figure 4), is specified in terms of a nominal value,  $X$ , and a tolerance,  $\pm Y$ , both of which are dimensionless because both  $d$  and  $t$  are in  $\mu\text{m}$ .

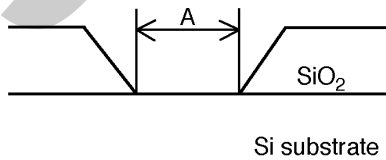


**Figure 3**  
**Schematic Diagram Showing Line Width,  $A$ , of Pattern on Substrate Wafer**

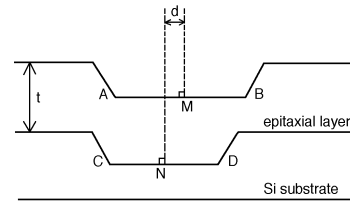


**Figure 4**  
**Cross-Sectional View of Epitaxial Wafer Showing the Pattern Shift,  $d$ . Not to scale:  $AM = MB$  and  $CN = ND$**

*pattern step height* — Difference in vertical position of the diffused (buried layer) surface and the original substrate surface, after removal of oxide.

NOTE 5 — Pattern step height,  $A$ , is specified as a nominal value,  $X$ , and a tolerance  $\pm Y$ , both in nm. See Figure 5.

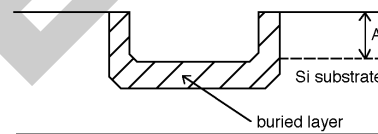


**Figure 5**  
**Cross-Sectional View of Epitaxial Substrate After Oxide Removal but Before Deposition of the Epitaxial Layer Showing the Pattern Step Height,  $A$**

## 4 Use of the Form

4.1 If this form is used in conjunction with purchase orders for silicon wafers, Parts 1 and 2 shall be completed. For epitaxial wafers, Parts 1, 2, and 3 shall be completed. For epitaxial wafers with buried layer, Parts 1, 2, 3, and 4 shall be completed.

4.2 In all cases, items listed as required must have a value or choice indicated to minimally specify the material.

4.3 Certain required dimensional items may be specified as a group according to the standard values presented in the applicable SEMI specification, or they may be specified individually.

4.4 Visual inspection criteria may be specified as a group according to the standard values listed in the applicable SEMI specification, or they may be specified individually.



4.5 For either dimensional values or visual inspection criteria, the appropriate SEMI specification may be marked and an optional line item (or items) marked as well. In this case, the value marked on each individual line item takes precedence over the standard value.

4.6 If the suggested form included in this format is not reproduced and used as a fill-out form, the items and responses must be adequately identified so that the information and requirements are clear to all parties.

## 5 Test Methods

5.1 Measurements shall be made or certifiable to the ASTM, JEIDA, JIS, or DIN standard test method as cited in Table 1.

5.2 When standard test methods from different geographic regions are available, the default method shall be the method in common usage for the region of the purchaser of the wafer.

5.3 If several different standard test methods for an item are commonly used within a region, a specific entry must be made to identify which method of test is applicable.

5.4 If no standard test method for an item is available, the test procedure must be specified.

## 6 Testing Level and Certification

6.1 Material ordered using this format shall be tested and/or certified to the limits set forth in the individual criteria.

6.2 The actual testing level, whether the test is performed on all wafers, a sample of the wafers, special test pieces representing all portions of the material, or a sample of the test pieces, may be specified using this format.

6.3 In some cases, the material may be certified as “capable of meeting” certain requirements. In this context, the supplier is not required to perform the tests outlined in this format. However, if the purchaser performs the test and the material fails to meet the requirement, the material may be subject to rejection.



## SEMI SILICON WAFER SPECIFICATION FORM FOR ORDER ENTRY (Page 1)

## PART 1. GENERAL INFORMATION

| ITEMS                        | INFORMATION | Date: |
|------------------------------|-------------|-------|
| Customer Name                |             |       |
| Purchase Order Number        |             |       |
| Line Number                  |             |       |
| Item Number                  |             |       |
| General Specification Number |             |       |
| Revision Level               |             |       |
| Part Number/Revision         |             |       |

## PART 2. POLISHED WAFER

| CUSTOMER:                     |      | PART NUMBER:                                           | REVISION                                                                                                                                                                                                                                                                            | DATE:  |            |        |  |
|-------------------------------|------|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|--------|--|
| REQ                           | ITEM | SPECIFICATION                                          | TESTING LEVEL                                                                                                                                                                                                                                                                       |        |            |        |  |
|                               |      |                                                        | WAFER                                                                                                                                                                                                                                                                               |        | TEST PIECE |        |  |
|                               |      |                                                        | 100%                                                                                                                                                                                                                                                                                | SAMPLE | 100%       | SAMPLE |  |
| 1. GENERAL CHARACTERISTICS    |      |                                                        |                                                                                                                                                                                                                                                                                     |        |            |        |  |
| ◆                             | 1.1  | Growth Method                                          | <input type="checkbox"/> Cz <input type="checkbox"/> FZ <input type="checkbox"/> MCz                                                                                                                                                                                                |        |            |        |  |
| ◆                             | 1.2  | Crystal Orientation                                    | <input type="checkbox"/> (100) <input type="checkbox"/> (111) <input type="checkbox"/> ( )                                                                                                                                                                                          |        |            |        |  |
| ◆                             | 1.3  | Conductivity Type                                      | <input type="checkbox"/> p <input type="checkbox"/> n                                                                                                                                                                                                                               |        |            |        |  |
| ◆                             | 1.4  | Dopant                                                 | <input type="checkbox"/> B <input type="checkbox"/> Phos <input type="checkbox"/> Sb <input type="checkbox"/> As <input type="checkbox"/> NTD                                                                                                                                       |        |            |        |  |
|                               | 1.5  | Nominal Edge Exclusion Distance for Fixed Quality Area | 6.10 - 6.14; 11 <input type="checkbox"/> 3 mm <input type="checkbox"/> 5 mm <input type="checkbox"/> 5 mm <input type="checkbox"/> other__mm<br>7, 8, 12, 13 <input type="checkbox"/> 3mm <input type="checkbox"/> 5 mm <input type="checkbox"/> other__mm<br>(except edge defects) |        |            |        |  |
| 2. ELECTRICAL CHARACTERISTICS |      |                                                        |                                                                                                                                                                                                                                                                                     |        |            |        |  |
| ◆                             | 2.1  | Resistivity                                            | Nominal <input type="checkbox"/> ± Tolerance <input type="checkbox"/> Ω-cm                                                                                                                                                                                                          |        |            |        |  |
|                               |      | Measurement Position                                   | <input type="checkbox"/> Center Point <input type="checkbox"/> Other:                                                                                                                                                                                                               |        |            |        |  |
|                               | 2.2  | Radial Resistivity Variation (RRG)                     | Not greater than <input type="checkbox"/> %                                                                                                                                                                                                                                         |        |            |        |  |
|                               |      | Measurement Position                                   | ASTM F 81 Fig. 1 - <input type="checkbox"/> A, <input type="checkbox"/> B, <input type="checkbox"/> C, <input type="checkbox"/> D; <input type="checkbox"/> JEIDA                                                                                                                   |        |            |        |  |
|                               |      | Calculation Method                                     | <input type="checkbox"/> ASTM F 81 <input type="checkbox"/> JEIDA <input type="checkbox"/> Other:                                                                                                                                                                                   |        |            |        |  |
|                               | 2.3  | Resistivity Striations                                 | Not greater than <input type="checkbox"/> %                                                                                                                                                                                                                                         |        |            |        |  |
|                               | 2.4  | Minority Carrier Lifetime                              | Greater than <input type="checkbox"/> μs                                                                                                                                                                                                                                            |        |            |        |  |
|                               |      | Test Method                                            | ASTM F28 <input type="checkbox"/> A, <input type="checkbox"/> B; ASTM F391 <input type="checkbox"/> A, <input type="checkbox"/> B;<br><input type="checkbox"/> other                                                                                                                |        |            |        |  |



|                                      |      |                                                                         |                                                                          |        |            |        |  |  |
|--------------------------------------|------|-------------------------------------------------------------------------|--------------------------------------------------------------------------|--------|------------|--------|--|--|
| CUSTOMER:                            |      | PART NUMBER:                                                            | REVISION                                                                 | DATE:  |            |        |  |  |
| REQ                                  | ITEM | SPECIFICATION                                                           | TESTING LEVEL                                                            |        |            |        |  |  |
|                                      |      |                                                                         | WAFER                                                                    |        | TEST PIECE |        |  |  |
|                                      |      |                                                                         | 100%                                                                     | SAMPLE | 100%       | SAMPLE |  |  |
| 3. CHEMICAL CHARACTERISTICS          |      |                                                                         |                                                                          |        |            |        |  |  |
|                                      | 3.1  | Oxygen Concentration                                                    | Nominal [ ] $\pm$ Tolerance [ ] $\times 10^{18} \text{ cm}^{-3}$ or ppma |        |            |        |  |  |
|                                      |      | Calibration Factor                                                      | [ ] IOC-88 [ ] old ASTM [ ] Other ____                                   |        |            |        |  |  |
|                                      |      | Measurement Method                                                      | [ ] IR [ ] SIMS [ ] GFA                                                  |        |            |        |  |  |
|                                      | 3.2  | Radial Oxygen Variation                                                 | Not greater than [ ] %                                                   |        |            |        |  |  |
|                                      |      | Measurement Position                                                    | ASTM F 951 Plan [ ] A [ ] B [ ] B1 [ ] C [ ] D [ ] Other: ____           |        |            |        |  |  |
|                                      |      | Calculation Method                                                      | ASTM F 951 Plan [ ] A [ ] B [ ] B1 [ ] C [ ] D [ ] Other: ____           |        |            |        |  |  |
|                                      | 3.3  | Carbon Concentration                                                    | Not greater than [ ] ppma                                                |        |            |        |  |  |
|                                      | 3.4  | Boron Concentration in Heavily Doped n-type Si                          | Not greater than [ ] ppba                                                |        |            |        |  |  |
| 4. STRUCTURAL CHARACTERISTICS        |      |                                                                         |                                                                          |        |            |        |  |  |
|                                      | 4.1  | Dislocation Etch Pit Density                                            | [ ] Not greater than [ ] / $\text{cm}^2$                                 |        |            |        |  |  |
|                                      | 4.2  | Slip                                                                    | [ ] None [ ] Other ____                                                  |        |            |        |  |  |
|                                      | 4.3  | Lineage                                                                 | [ ] None [ ] Other ____                                                  |        |            |        |  |  |
|                                      | 4.4  | Twin                                                                    | [ ] None [ ] Other ____                                                  |        |            |        |  |  |
|                                      | 4.5  | Swirl                                                                   | [ ] Not greater than [ ] % of wafer area                                 |        |            |        |  |  |
|                                      | 4.6  | Shallow Pits                                                            | Not greater than [ ] / $\text{cm}^2$                                     |        |            |        |  |  |
|                                      | 4.7  | Oxidation Induced Stacking Faults (OSF)                                 | Not greater than [ ] / $\text{cm}^2$                                     |        |            |        |  |  |
|                                      |      | Test Cycle                                                              | ASTM F 416 Cycle-[ ] 1 [ ] 2 [ ] 3 [ ] Other: ____                       |        |            |        |  |  |
|                                      | 4.8  | Oxide Precipitates (BMD) Interstitial Oxygen Reduction ( $\Delta O_i$ ) | Range: [ ] to [ ] / $\text{cm}^2$ [ ] ppma                               |        |            |        |  |  |
|                                      |      | Test Cycle                                                              | ASTM F1239 [ ] A, [ ] B; Other: ____                                     |        |            |        |  |  |
| 5. WAFER PREPARATION CHARACTERISTICS |      |                                                                         |                                                                          |        |            |        |  |  |
|                                      | 5.1  | Wafer ID Marking                                                        | [ ] None [ ] SEMI M12 [ ] SEMI M13 [ ] Other: ____                       |        |            |        |  |  |
|                                      | 5.2  | Front Surface Thin Film(s) Appl                                         | [ ] None [ ] Description: ____                                           |        |            |        |  |  |
|                                      | 5.3  | Denuded Zone                                                            | [ ] None [ ] Description: ____                                           |        |            |        |  |  |
|                                      | 5.4  | Extrinsic Gettering Treatment                                           | [ ] None [ ] Description: ____                                           |        |            |        |  |  |
|                                      | 5.5  | Backseal                                                                | [ ] None [ ] Description: ____                                           |        |            |        |  |  |
|                                      | 5.6  | Annealing                                                               | [ ] None [ ] Description: ____                                           |        |            |        |  |  |