

Intel Design Specifications for
Supplier Provided or Supplier Specified Ladders, Stair Ladders,
Platform Stands, Platforms, and Stairs

Scope and Application:

This design specification applies to all supplier provided or supplier specified ladders, stair ladders, platform stands, platforms and stairs; whether affixed or detachable to Semiconductor Manufacturing Equipment (SME) for use during service and maintenance activities as defined by SEMI S2 including equipment installation activity.

Effective Date: 1 March 2013

Revision 1.0

Definitions:

Elevated location: a walking or working surface 500mm or more above an adjacent surface intended by the supplier to be used as a work surface or platform.

Guardrail: physical structure positioned at a prescribed height to prevent a fall from an elevated location, consisting of vertical supports (posts), a top rail, a midrail, and in some cases a toe board.

Handrail: a horizontal or inclined structure intended to be grasped by hand for support.

Horizontal guardrail system: a physical structure erected along exposed sides and ends of platforms, where the top rail, midrail, and toe board are approximately horizontal.

Inclined guardrail system: a physical structure erected along exposed sides of stairs, where the top rail, midrail, and toe board are approximately parallel to the direction of travel.

Live load: force exerted on a structure as a consequence of its anticipated environment and normal use (e.g., load from personnel and transient materials such as toolboxes).

Midrail: the linear element of a guardrail that is approximately midway between the top rail and the walking or working surface.

Pitch: angle between the plane passing through the front edge of consecutive steps or rungs and the horizontal surface. Pitch can be defined as $(\text{Pitch} = \arctangent(\text{rise/run}))$.

Platform: a horizontal elevated location intended by the supplier to support the weight of personnel during operation, service, and maintenance where the work duration exceeds 2 minutes.

Platform stand: a fixed-height, self-supporting, movable structure consisting of one or more platforms on a rigid base (with or without wheels or casters) having a means of ascending or descending between levels.

Rise: vertical distance between the treads of successive steps or rungs.

Run: horizontal distance between the front edge of successive steps or rungs.

Rung: horizontal crosspiece of a ladder, intended to support the feet of personnel and to be grasped by hand.

Span: usable width (right to left) of a step or rung perpendicular to the direction of travel.

Step: horizontal surface, other than a rung, landing, or platform intended to support the ascent or descent of people.

Toe board: vertical structure erected along the edge of a walking or working surface to restrict falls of material.

Tread: walking surface of a step.

Walking or working surface: surface on which supplier intends personnel to walk, stand, squat, kneel, sit, or lie to perform work.

A. General Requirements:

1. Ladders, stair ladders, platform stands, platforms and stairs shall be of non-combustible construction and appropriate for their intended use. Consideration of intended use may include use during energized electrical work, use with extreme temperatures, etc.
2. Ladders, stair ladders, Platform stands, platforms and stairs where joints comprised of threaded fasteners shall be designed to be vibration tolerant (e.g., lock-nut, thread locking compound).
3. Ladders, stair ladders, platform stands, platforms and stairs shall be of reliable construction. The design of which shall take into account the area required to conduct the intended work, and support loads presented by personnel, their tools, and materials required for tasks as intended or specified by supplier.
4. The minimum rated live load of ladders, stair ladders, platform stands, and stairs shall be the greater of 1.3 kN (300 lbf) and the loads intended by the supplier.
5. Ladders, stair ladders, platform stands, and stairs shall be designed to support a minimum of 4 times the rated live load.
6. Platforms or walking and working surfaces shall be designed to support at least 3.6 kN/m^2 (75 lbf/ft^2) evenly distributed over the entire surface.
7. Walking and working surfaces or platforms where a person could stand or work shall support at least 1.3 kN (300 lbf) concentrated load placed in each position that would cause maximum stress to one or more structural members.
8. Platforms or walking or working surfaces shall be made of material either solid or with openings such that openings in material cannot allow a 10mm (.38 inch) sphere to pass through at a height of 3 meters or greater above a walking or

working surface, and such that a 25mm (1.0 inch) sphere cannot pass through regardless of height.

9. The walking, stepping, standing or working surface of stairs, treads, and rungs shall be slip-resistant utilizing corrugated, serrated, knurled, textured or dimpled construction methods.
10. All exposed surfaces that personnel may be exposed to shall be free from burrs or sharp edges per SEMI S2 ¶18.2.
11. The height difference between a loaded and an adjoining unloaded surface of platforms or walking or working surface shall not exceed 4mm.
12. A suitable means of ascent and descent to platforms or walking and working surfaces 500mm (19.7 inches) or above shall be specified or provided with a fixed or portable means of ascent and descent (e.g., steps, stairs, ladders).
13. Platforms or walking or working surface only requiring a single step up shall not exceed a maximum height of 380mm (15 inches).
14. Ladders, stair ladders, platform stands, platforms, and stairs shall be marked with its maximum rated live load and the maximum number of personnel intended by the supplier.
15. The use of guardrails, inclined guardrails, shall be incorporated when work as intended by the supplier is to be performed at elevated locations.
16. Manual handling of portable means of ascent and descent and Platform Stands shall meet the manually handling requirements defined in Appendix 1 of SEMI S8.

B. Guardrails

1. Vertical post of guardrails shall not be spaced further than 2.4m (8 ft) center to center.
2. Vertical posts, top rails, and midrails shall be 38mm (1.5 inches) in its minimum outside dimension.
3. The height of the top edge of the top rail shall not be less than 1.09m (43 inches) and not higher than 1.15m (45 inches) above the platform or walking or working surface.
4. Midrails or functionally equivalent structures shall be provided such that a two vertical gaps are of equal distance between elements of guardrail systems.
5. Structural components of guardrails shall support without permanent deformation exceeding 3mm (0.12 inch) a force equal to 890 N (200 lbf) applied in any direction at the least favorable points along the top rail.
6. Structural components of midrails or functionally equivalent structures shall support without permanent deformation exceeding 3mm (0.12 inches) a force equal to 667 N (150 lbf) applied in any downward or outward direction at any point along the midrail.
7. The maximum loaded deflection for any guardrail component shall not exceed 30mm (1.2 inches).

8. Toe boards shall be made of materials either solid or with openings such that a 10mm sphere cannot pass through.
9. Toe boards shall be at least 102mm (4 inches) in height and placed not more than 6.35mm (0.25 inch) above a tread, platform, or walking or working surface.
10. Toe boards should be incorporated into incline and horizontal guardrail systems if they would reduce the risk to Low or Very Low (per SEMI S10) of falling objects striking personnel in areas where personnel are expected to perform work as intended by the supplier.

C. Access through horizontal guardrail systems

1. Where access through a guardrail system is required, passage through it shall be either by a self-closing gate or be offset such that personnel cannot walk directly through the opening. Gates shall have its top rail, and midrail positioned at the same level as the guardrail system.
2. Gates shall close against a firm stop to prevent personnel from pushing outwards against the gate and falling through.
3. Gates shall be subject to the same strength requirements as guardrails, when closed.
4. Gates shall be sized to provide a minimum passage width of 610mm (24 inches) when opened.
5. Swinging gates shall be designed to open onto the platform.
6. Obstruction of the area behind the gate, when opened, is acceptable as long as sufficient space is available to allow personnel to pass through and allow the gate to close under its own power.
7. Swinging gates shall not require a force greater than 44.5 N (10lbf) as measured at the end of the gate farthest away from the hinge, to operate.
8. Sliding gates shall not require a force greater than 31 N (7lbf) to operate.

D. Handrails

1. Handrails shall be continuous the full length of stairs and Platforms.
2. Handrails ends shall have rounded terminations and bend inward toward a wall, or downwards to reduce risks due to bodily contact to the end of the handrail.
3. Handrails shall be clear of obstacles within a distance of 100mm (3.9 inches), except on the underside of the handrail at its support locations.
4. The height of handrails shall be 900mm (35.5 inches) to 1m (39.4 inches) from the upper surface to the surface of the stair, tread or step.
5. Portions of handrails intended to be grasped shall have horizontal and vertical cross-sectional dimensions of not less than 33mm (1.3 inches) or more than 56mm (2.2 inches).
6. Handrails shall support without permanent deformation exceeding 3mm (0.12 inches) a load equal to 890 N (200 lbf) applied in each direction (upwards,

downwards, and horizontally (perpendicular to the rail, toward and away from the walking surface)) at the least favorable point(s) along the rail.

7. The maximum loaded deflection for any handrail component shall not exceed 30mm (1.2 inches).

E. Stairs, Specific Requirements

1. Stairs are defined as having a pitch of not more than 45 degrees.
2. The minimum span of each step or tread of a stair shall be not less than 559mm (22 inches).
3. Steps or treads of stairs shall not have a slope greater than 6mm in 300mm (0.25 inch in 1ft) from the horizontal.
4. Horizontal overlap of steps to steps and steps to landings shall be at least 10mm (0.38 inches).
5. Rise and run of stairs shall be uniform throughout any set of consecutive steps.
6. The variation of rise and run shall not exceed 6mm (0.25 inches).
7. The maximum rise (step to step) shall be 229mm (9 inches). The minimum run (step to step) shall be 229mm (9 inches).
8. Deflection of stair treads under the anticipated live load shall not exceed 1/300 of the span or 6mm (0.25 inch), whichever is less.
9. Landings that occur between a series of steps shall be at least as wide as the narrowest step or tread of a stair and have a minimum depth (in direction of travel) of not less than 559mm (22 inches).
10. Stairs shall have handrails on each side enclosed by a wall.
11. Stairs that ascend more than 500mm (19.7 inches) above the adjacent floor or standing surface shall have inclined guardrail system fitted on open sides or where there is a lateral space exceeding 50mm (2 inches) to a wall or other fixed vertical obstruction (equipment, equipment enclosure, or similar fixed structure).
12. Vertical distance (headroom) above stairs treads to an overhead obstruction shall be at least 2134mm (7 ft) as measured from surface of the tread nearest the obstruction.

F. Stair Ladder, Specific Requirements

1. Stair ladders are defined as having a pitch of more than 45 degrees but less than 75 degrees.
2. The minimum span of each step or rung of stair ladders shall be not less than 559mm (22 inches).
3. Stair ladders shall have a run of not less than 76mm (3 inches) nor more than 190mm (7.5 inches).
4. Stair ladders shall have a rise of not less than 190mm (7.5 inches) nor more than 279mm (11 inches).

5. Stair ladders reaching 500mm or more above the floor shall have handrails where the line through the front edge of the steps (Pitch) on a stair ladder to the underside (bottom) of the handrail are as defined in the following table (Table 1), with the handrail beginning at a vertical height not greater than 1 m (39.4 inches) from the floor or walking surface.

Table 1 Distances from the Pitch-line on a Stair Ladder to bottom of handrail.

Θ (degrees)	Linear dimension perpendicular to the pitch-line (mm)
46	625 ± 10
50	500 ± 10
55	375 ± 10
60	250 ± 10
65	200 ± 10
70	150 ± 10
75	100 ± 10

6. Handrails of stair ladders shall connect to guardrail systems (if present) at the top and bottom of the handrail. Where a gap is unavoidable, the clear space between the two rail system segments shall not be less than 75 mm (3 inches) (to prevent hand entrapment) nor greater than 120mm (4.7 inches).

G. Platform Stands, Specific Requirements

1. Where the pitch of steps or treads of platform stands is not more than 45 degrees, the steps or treads shall conform to the criteria for stairs (see D. Stairs above).
2. Where the pitch of steps or treads of platform stands is greater than 45 degree but not more than 75 degrees, the steps or treads shall conform to the criteria for stair ladders (see E. Stair Ladders above).
3. Ladder criteria shall be used for when the pitch of steps, treads or rungs exceeds 75 degrees.
4. Platform stands fitted with wheels or casters shall be equipped with a braking system to stop horizontal movement while occupied.
5. Each wheel or caster shall be sized to support four times its anticipated live load.
6. Platform stands shall be stable under all anticipated load conditions with their rated live load uniformly distributed on the top step or platform.
7. Platform stands shall have a base width of 508mm (20 inches) or the width of the top step or platform whichever is greater.
8. The width of a platform of a platform stand shall not be less than 508mm (20 inches).
9. The upper most flat surface of a platform stand shall have a depth of not less than 241mm (9.5 inches).

10. Platforms of platform stands, intended by the supplier for use by more than a single person at a time, shall have a depth (dimension in the direction of travel) of more than 813mm (32 inches) or a surface area of more than 0.62m² (6.7 ft²).
11. Platforms of platform stands shall allow work to be performed in orientations as intended by the supplier and meet the minimum dimensional criteria of section seven (in particular ¶7.2) within Appendix 1 of SEMI S8.
12. The maximum working level of a platform stand shall not exceed four (4) times its minimum base dimension. Outriggers can be used to increase the minimum base dimension.

H. Ladders, Specific Requirements

1. Ladders are defined as having a pitch greater than 75 degrees but not more than 90 degrees.
2. Rungs and steps of ladders shall have a spacing of not less than 178mm (7 inches) apart, nor more than 304.8mm (12 inches) apart, as measured between consecutive treads of rungs or steps, the spacing of which shall be uniformed throughout the length of the ladder.
3. Rung or step variation shall not exceed 6mm (0.25 inch).
4. Portable ladders shall have a minimum span of not less than 304.8mm (12 inches).
5. Fixed ladders shall have a minimum span of not less than 406.4mm (16 inches).
6. Rungs, if used, shall have a cross-sectional dimension between 19mm (0.75 inch) and 40mm (1.5 inches).
7. Steps of ladders shall have a depth of not less than 76mm (3 inches) nor more than 190mm (7.5 inches).
8. Perpendicular clear distance from the centerline of the rung of a fixed ladder to the nearest permanent object or obstruction on the climbing side of the ladder shall be at least 915mm (36 inches) for a pitch of 76 degrees, and 762mm (30 inches) for a pitch of 90 degrees. Clearances for intermediate pitches between these two limits will vary in proportion to slope.
9. Clearance from the centerline of the fixed ladder sideways to any permanent object or obstruction shall be a minimum of 381mm (15 inches).
10. Clearance from the centerline of rung of a fixed ladder to a permanent object or obstruction, below a rung, opposite the climbing side of the ladder shall be not less than 40mm (1.5 inches).
11. Clearance from the centerline of rung of a fixed ladder to a permanent object or obstruction, above a rung, opposite the climbing side of the ladder shall be not less than 114mm (4.5 inches).
12. Clearance from the centerline of rung of a fixed ladder to a platform shall not exceed 305mm (12 inches).
13. Step-across distance (nearest edge a fixed ladder to nearest edge of equipment or structure) shall not be greater than 305mm (12 inches).

14. On platforms being accessed by a fixed ladder, one rung of the fixed ladder should be located at the level of the platform.
15. Horizontal clearance between the side rail of a fixed ladder and a guardrail system shall be at least 610mm (24 inches).
16. Clearance between the inside surfaces of side rails of the step-through portion of a fixed ladder shall have a minimum clearance of 610mm (24 inches) and a maximum clearance of 762mm (30 inches).
17. Side rail extensions of the step-through portion of a fixed ladder shall extend 1.1 m (3.5 ft) above a platform or obstruction.
18. Height of a fixed ladder intended to access a platform or walking or working surface where personnel will leave the ladder in a side-step fashion, the fixed ladder shall extend above the height of the platform or walking or working surface by at least 1.1 m (3.5 ft).

I. Grab bars

1. Grab bars shall maintain the same linear spacing as that of ladder rungs.
2. Width of grab bars shall be the same as the span of a fixed ladder 406.4mm (16 inches).
3. Grab bars shall have a diameter of not less than 19mm (0.75 inch), nor more than 40mm (1.5 inches).
4. Clearance from the centerline of grab bars to the nearest permanent object or obstruction in back of the grab bar shall not be less than 102mm (4 inches)
5. Grab bars shall not protrude on the climbing side beyond the rails of the fixed ladder for which they serve.

References:

American National Standards Institute (ANSI)

ANSI A14.2-2000, Portable Metal Ladders, Safety Requirements for
ANSI A14.7-2006, Mobile Ladder Stands and Ladder Stand Platforms

California Code of Regulations

Title 8, Section 3622 General
Title 8, Section 3621 Definitions
Title 8, Section 3234 Fixed Industrial Stairs
Title 8, Section 3214 Stair Rails and Handrails
Title 8, Section 3209 Standard Guardrails
Title 8, Section 3627 Mobile Ladder Stands

Humanscale, Vol 7/8/9 Body Access

EN Standards

EN 131-1-2003 Ladders – Part 1 Specifications for terms, types, functional sizes
EN 131-2-2003 Ladders – Part 2 Requirements, Testing, Marking
IBC 2003 Section 1009 Stairways and Handrails

International Standards Organization (ISO)

ISO 14 122-1 Safety of machinery – Permanent means of access to machinery Part 1:
Choice of fixed means of access between two levels
ISO 14 122-2 Safety of machinery – Permanent means of access to machinery Part 2:
Working platforms and walkways
ISO 14 122-3 Safety of machinery – Permanent means of access to machinery Part 3:
Stairs, stepladders, and guardrails
ISO 14 122-3 Safety of machinery – Permanent means of access to machinery Part 4:
Fixed ladder

Occupational Safety Health Administration (OSHA)

OSHA 29 CFR 1910.23 Guarding floors and wall openings and holes
OSHA 29 CFR 1910.26 Portable metal ladders
OSHA 29 CFR 1910.29 Manually propelled mobile ladder stands and scaffolds (towers)

SEMI Standards

S02-0712 Environmental, Health and Safety Guideline for Semiconductor Manufacturing
Equipment
S08-0712 Safety Guidelines for Ergonomics Engineering of Semiconductor
Manufacturing Equipment
S10 Safety Guideline for Risk Assessment and Risk Evaluation Process
S26-0308 Environmental, Health and Safety Guidelines for FPD Manufacturing System

Other References

Mil-STD 1472D, Human Engineering Design Criteria for Military Systems, Equipment and
Facilities

Irvine, C. H, Snook, S. H., & Sparshatt, J. H. (1990), Stairways risers and treads;
acceptable and preferred dimensions. *Applied Ergonomics*, 21(3), p215-225

Templer, J. A. (1992), *The staircase: studies of hazards, falls, and safer design*.
Cambridge, Mass: MIT Press