

SEMI A2-0419

SPECIFICATION FOR SURFACE MOUNT ASSEMBLER SMART HOOKUP (SMASH)

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Table of Contents

1 Purpose	2
2 Scope	2
3 Limitations	2
4 Referenced Standards and Documents	2
5 Terminology	2
6 Conventions	3
7 Conceptual Description	5
8 Requirements	8
9 Parameter Definitions	13
10 Vertical Communication (VC) Message Requirements	16
11 Horizontal Communication (HC) Message Requirements	19
12 Panel and Panel Data Transfer Requirements	20
13 Requirements for Compliance	24
14 Related Documents	25
Related Information 1 Use of Smema Compliant Equipment	26
Related information 2 Applicable Equipment	27

1 Purpose

1.1 The purpose of this Standard is to provide a standardized automation interface specification to be used for the equipment control in an assembly line for printed circuit board (PCB) that uses surface mount technology (SMT).

1.2 The purpose of this Standard is to provide an interface specification that replaces conventional electrical interface with a network connection and adds data communication capability.

2 Scope

2.1 The scope of this Standard is to define an automation interface specification to be used for SMT assembly line, which includes:

- A control interface between the host and equipment.
- A control interface between equipment via the adjacent equipment.
- A logistics control interface between adjacent equipment, which transfers a PCB and its data as a set.

2.2 The scope of this Standard is to define an automation interface specification that is based on SEMI A1 and SEMI A1.1.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 *SEMI A1/A1.1 Compliant Equipment Only* — This Standard is intended to be applied to the equipment that is capable to be compliant with the required part of SEMI A1 and SEMI A1.1 specified in this Standard.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI A1 — Specification for Horizontal Communication (HC) Between Equipment for Factory Automation System

SEMI A1.1 — Specification for Media Interface for a Horizontal Communication (HC) Between Equipment

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *E2E* — equipment-to-equipment

5.1.2 *ID* — Identifier

5.1.3 *M2M* — machine-to-machine

5.1.4 *PCB* — printed circuit board

5.1.5 *PLC* — programmable logic controller

5.1.6 *SMT* — surface mount technology

5.1.7 *TCP* — Transmission Control Protocol

5.1.8 *TCP/IP* — Transmission Control Protocol/Internet Protocol

5.2 *Definitions*

5.2.1 *downstream equipment* — Equipment that is in the position to receive Material in an equipment-to-equipment interface in manufacturing line.

5.2.2 *host* — the factory computer system or an intermediate system that represents the factory and the user to the equipment.

5.2.3 *Panel* — a printed circuit board under production and assembly that may contain multiple products not cut out as products yet.

5.2.4 *Route* — a logical path of Panels that have the commonality in production condition such as the same width of conveyor or the use of same assembly parts, etc. Multiple Routes may be set on the same Track.

5.2.5 *user* — a human who represent the factory and enforce the factory operation model to the factory resources. A user is considered to be responsible for many setup and configuration activities that cause the equipment to best conform to factory operations practices.

5.2.6 *upstream equipment* — Equipment that is in the position to send Material in an equipment-to-equipment interface in manufacturing line.

5.3 *Abbreviations, Acronyms, and Definitions from SEMI A1*

5.3.1 *GD* — General Data

5.3.2 *HC* — Horizontal Communication

5.3.3 *MD* — Material Data

5.3.4 *VC* — Vertical Communication

5.3.5 *Data Handshake*

5.3.6 *Equipment ID*

5.3.7 *General Data*

5.3.8 *Horizontal Communication*

5.3.9 *Line*

5.3.10 *Master Port*

5.3.11 *Material*

5.3.12 *Material Data*

5.3.13 *Material Handshake*

5.3.14 *Port*

5.3.15 *Receive Port*

5.3.16 *Slave Port*

5.3.17 *Starter Port*

5.3.18 *Send Port*

5.3.19 *Terminator Port*

5.3.20 *Track*

5.3.21 *Vertical Communication*

5.4 *Abbreviations, Acronyms, and Definitions from SEMI A1.1*

5.4.1 None.

6 Conventions

6.1 *Definitions* — This Standard uses the following definitions.

6.1.1 *Data Type Definition* — This Standard uses the following data type definitions.

Table 1 Data Type Definition

<i>Data Type</i>	<i>Definition</i>
BOOL	1-bit Boolean: TRUE (Signal On) = 1, FALSE (Signal Off) = 0
BYTE	8-bit binary data
CHAR	Single-byte ASCII character
STRING	ASCII character string. Fixed length with null terminated content unless otherwise noted.
STRUCT	Structured data
UINT8	8-bit unsigned integer
UINT16	16-bit unsigned integer
UINT32	32-bit unsigned integer

6.1.2 *Requirement Level Definition* — This Standard uses the following requirement levels in the ‘Req.’ column of tables.

Table 2 Requirement Level Definition

<i>Mnemonic</i>	<i>Name</i>	<i>Implementation</i>	<i>Use</i>	<i>Description</i>
R	Required	Mandatory	Mandatory	An item that shall be implemented and used. For parameters, the item shall be implemented and given a valid value for use.
C	Conditional	Mandatory	Not a mandatory	An item that shall be implemented but may not be used in some cases. For parameters, the item shall be implemented but may not be given a valid value for use in some cases.
O	Optional	Not a mandatory	Not a mandatory	An item that may be implemented and used in some cases.

6.2 *Table Formats* — This Standard uses the following table formats.

6.2.1 *Parameter Definition Table* — This Standard uses the following table format for parameter definitions.

Table 3 Parameter Definition Table

<i>Parameter Name</i>	<i>Form/Type^{#1}</i>	<i>Range/Multiplicity</i>	<i>Description</i>

#1 See the section ‘Data Type Definition’ for Type expressions.

- *Parameter Name* — This column defines the name of the parameter.
- *Form/Type* — This column defines the format or type of the parameter.
- *Range/Multiplicity* — This column defines the range or multiplicity of the value for the parameter.
- *Description* — This column is used to describe the parameter.

6.2.2 *Message Description Table* — This Standard uses the following table format for message descriptions.

Table 4 Message Description Table

<i>Message</i>	<i>GD_ID</i> ^{#1}			<i>Addressing ID</i> ^{#1}		<i>Req.</i> ^{#2}	<i>Description</i>
	<i>AC</i>	<i>CC</i>	<i>FC</i>	<i>ORIG_ID</i>	<i>RESP_ID</i>		

#1 See definitions in SEMI A1.

#2 See the section 'Requirement Level Definition'.

6.2.2.1 *Message* — This column defines the name of the message.

6.2.2.2 *GD_ID* — This column and sub-columns define the values to be used for General Data ID defined in SEMI A1.

- *GD_ID* — General Data ID
- *AC* — Application Code
- *CC* — Category Code
- *FC* — Function Code

6.2.2.3 *Addressing ID* — This column and sub-columns define the values to be used for Addressing ID defined in SEMI A1.

- *ORIG_ID* — Originator ID
- *RESP_ID* — Responder ID

6.2.2.4 *Req.* — This column defines the requirement level. 'R' is 'Requirement', 'O' is Optional.

6.2.2.5 *Description* — This column is used to describe the message.

6.2.3 *Message Parameter Definition Table* — This Standard uses the following table format to define the parameters used in a message.

- *Ordered List in GD_CONTENT* — Message parameters are put as an ordered list into GD_CONTENT defined in SEMI A1.

Table 5 Message Parameter Definition Table

<i>Parameter Name</i>	<i>Req.</i> ^{#1}	<i>Description</i>

#1 See the section 'Requirement Level Definition'.

- *Parameter Name* — This column defines the name of the used parameter.
- *Req.* — This column defines the requirement level. See the section 'Requirement Level Definition'.
- *Description* — This column is used to describe the message parameter.

7 Conceptual Description

7.1 *Conceptual Description* — This section describes the concept of this Standard and includes no requirement.

7.2 *Image of the Production Line* — The image of typical SMT assembly line is as shown below.

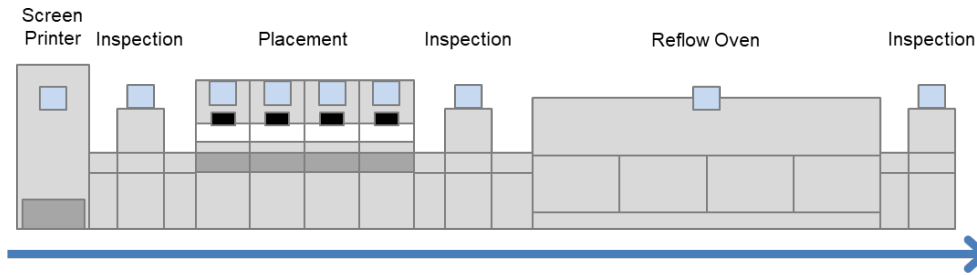


Figure 1
Image of Typical SMT Assembly Line

7.3 *Background* — This Standard is developed to meet industry expectations such as:

- *Next Generation M2M Interface* — Introduction of the next generation M2M (E2E) interface that is a superset of the conventional electrical interface and has data communication capability.
- *Standardized M2M Interface* — Standardized M2M (E2E) interface for Panel handoff between various equipment from various suppliers.
- *Transfer Panel Data with the Panel* — Communication capability to transfer a Panel and the Panel Data that belongs to the Panel as a set: PanelID that specifies the Panel individually and uniquely, ProductID that identifies the product to which the Panel belongs, Process Log of the Panel such as an inspection result, etc.
- *Standardized Product Change Scheme* — Automated setup change of the equipment in the assembly line for the change of the products to be assembled.
- *PLC Conformance* — Introduction of the next generation equipment interface that can be dealt with PLC.

7.4 *Prerequisites and Restrictions* — This Standard is designed based on the following prerequisites and restrictions.

- *Communication Capability* — Equipment shall have a network communication capability.
- *Panel ID Management* — The PanelID should be transferred starting from the equipment that has a PanelID reader to downstream equipment.
- *Product ID Management* — The relationship between ProductID and PanelID should be defined beforehand.
- *Virtual AI Controller* — A simple Panel transport equipment (such as a conveyor) that does not have a communication capability should be controlled by SEMI A1 capable additional controller that interprets the conventional interface the equipment uses or by the adjacent upstream or downstream equipment.

7.5 *Position of This Standard* — This Standard is in the upper tier of SEMI A1 and provides SMT assembly line specific specifications to be used by the user code for host-equipment and equipment-to-equipment (E2E, also called M2M) interfaces.

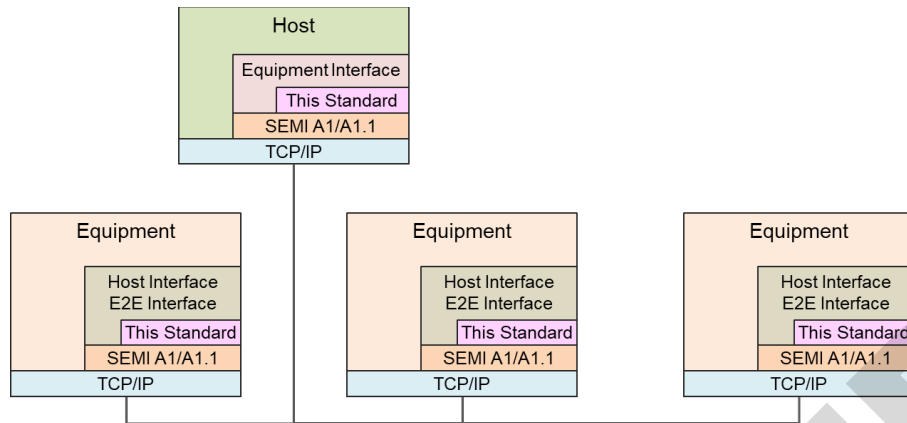


Figure 2
Position of This Standard

7.6 *Line Topology and Control Scheme* — The SMT assembly line that this Standard controls has the following topology.

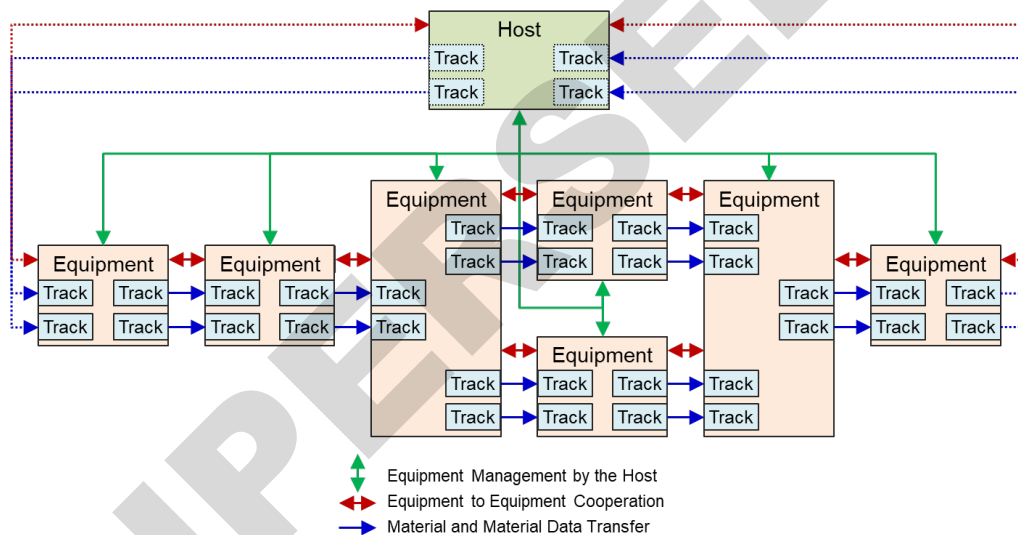


Figure 3
Line Topology and Control Scheme

7.6.1 *Assembly Line Topology* — This Standard presupposes the following characteristics.

- *Direct Panel Handoff Between Adjacent Equipment* — Equipment directly passes a Panel between adjacent equipment without separate Panel handling system.
- *Multiple Panel Tracks Between Adjacent Equipment* — Equipment may have multiple Tracks that transfer Panels between adjacent equipment.
- *Branch and Merge of Tracks* — Equipment may branch a Track to multiple Tracks or may merge multiple Tracks into one Track.
- *The Host as the First or Last Equipment* — The host may play the role of the first equipment or the last equipment to generate or gather Panel Data.

7.6.2 Assembly Line Control Scheme — This Standard provides the assembly line control scheme that uses the peer to peer communication channel called ‘Line’ defined in SEMI A1 for Vertical Communication (VC) and Horizontal Communication (HC).

7.6.2.1 VC (Connection between the Host and Equipment) — The connection between the host (or upstream controller that may be deemed as the host) and equipment uses the following scheme.

- *Peer to Peer Connection* — Each equipment is connected by one ‘Line’ with the host.
- *Host-to-Equipment Coordination* — One full-duplex ‘Line Information’ channel in the ‘Line’, which communicates General Data (GD), is used.

7.6.2.2 HC (Connection between Adjacent Equipment) — The connection between adjacent equipment uses the following scheme.

- *Direct Connection* — Adjacent equipment are directly connected by one ‘Line’.
- *Equipment-to-Equipment Coordination* — One full-duplex ‘Line Information’ channel in the ‘Line’, which communicates General Data (GD), is used for equipment-to-equipment coordination via the adjacent equipment.
- *Transfer of Panel and Panel Data* — A ‘Track Information’ channel in the ‘Line’ is used to transfer a Panel and its data (MD). One ‘Track Information’ channel is used for one Track.
- *The Host as the First or Last Equipment* — The host may logically act as the first or the last equipment in the production line and may originate or terminate GD or MD.

7.6.3 Information Structure — The following figure shows the image of the information structure of this Standard.

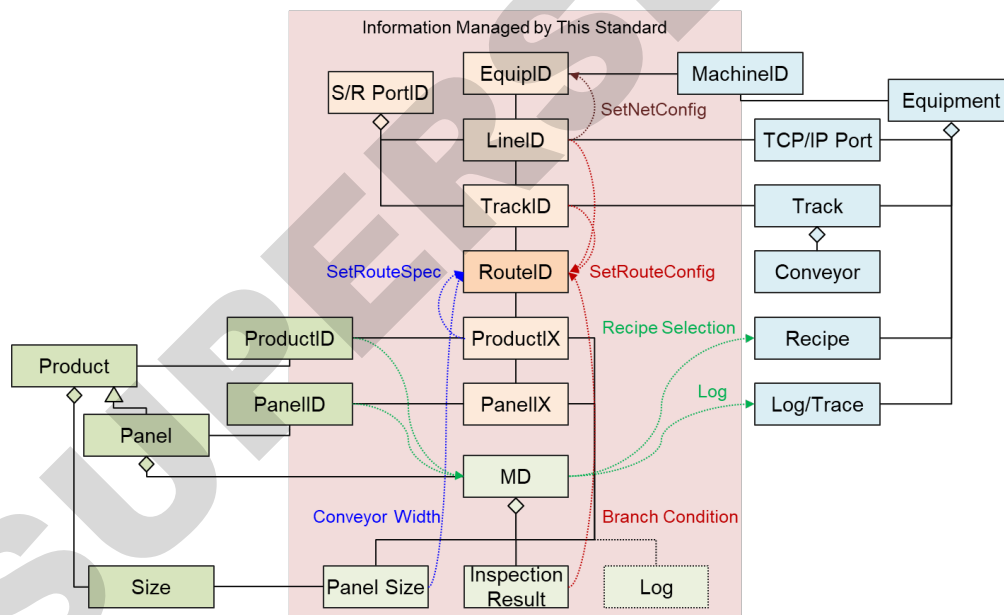


Figure 4
Image of the Information Structure

8 Requirements

8.1 Line Number and Track Number — Lines and Tracks of each equipment shall be numbered as defined below.

- *Line Number* — Lines are numbered from left front to right back starting with L0 per equipment.
- *Track Number* — Tracks are numbered from front to back starting with T0 per Line.

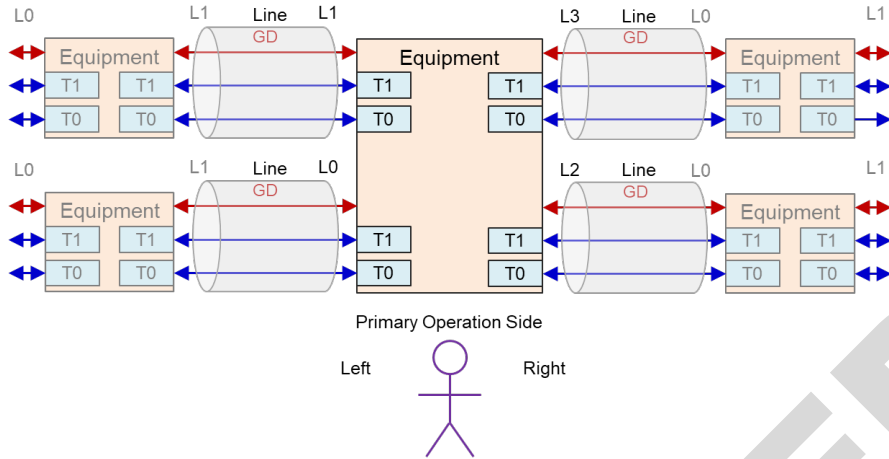


Figure 5
Line Number and Track Number

8.2 *Network Connection Setup* — SEMI A1.1 compliant network connection is used for both Vertical (host-equipment) and Horizontal (equipment-equipment) connections.

8.2.1 *Vertical Connection* — The parameters required for host-equipment communication shall be set manually.

- *Items to be Set* — EquipID, MachineID, IPAddress, and PortNumber of the equipment shall be set.
- *Parameter Definitions* — See the table ‘Equipment Parameter Definition’ for required parameters.
- *When to Enable VC* — VC shall be enabled just after above setups are done.
- *Server/Client Setting* — Server/Client Setting shall be done per the definition in SEMI A1.1.

8.2.2 *Horizontal Connection* — The parameters required for equipment-equipment communication may be set manually or by the host.

- *Items to be Set* — EquipID, MachineID, IPAddress, and PortNumber of every adjacent equipment shall be set.
- *Parameter Definitions* — See the table ‘Equipment Parameter Definition’ for required parameters.
- *Message to be Used* — The host uses SetNetConfig message to set network configuration of the equipment. The host uses GetNetConfig message to get network configuration of the equipment, and the equipment responds with CurrentNetConfig message.
- *When to Enable HC* — HC shall be enabled just after SetNetConfig is done.
- *Server/Client Setting* — Server/Client Setting shall be done per the definition in SEMI A1.1.