SEMI HB4-0913 (Reapproved 0419)
SPECIFICATION OF COMMUNICATION INTERFACES FOR HIGH BRIGHTNESS LED MANUFACTURING EQUIPMENT (HB-LED ECI)

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1 Purpose

1.1 The purpose of this Standard is to define the equipment automation interface for communication and control of process, automation and metrology equipment used in HB-LED manufacturing. It intends to produce economic benefits for both manufacturers and equipment suppliers by identifying a subset of relevant functionalities out of the existing SEMI Communications Standards for the application in HB-LED manufacturing facilities. On one hand this Standard should reduce the effort of manufacturers to integrate equipment in their IT factory automation system. On the other hand equipment suppliers could reduce their effort for developing and maintaining a variety of equipment communication interfaces. It is expected to provide a proven set of communication functionality to reduce both costs and time for ramp-up of new equipment in the manufacturing production environment.

1.2 This Specification references a collection of SEMI and other standards and should give guidance on how to apply them in the HB-LED manufacturing environment in order to establish a reliable and extensible communication framework for the IT integration of equipment.

2 Scope

2.1 This Specification for HB-LED equipment communication interface applies to all HB-LED manufacturing equipment including process, automation and metrology systems used in the Front-End and Back-End production area. However, it is not limited to these areas of application.

2.2 The scope of this Standard is limited to the communication interface used to integrate equipment within factory automation systems.

2.3 This Standard can be applied to single wafer equipment as well as batch equipment.

2.4 This Standard intends to lay the foundation for a reliable and extensible IT integration framework for HB-LED manufacturing based on proven standards using a multilayered approach. The Standard references existing SEMI Communication Standards to realize these layers as much as possible. The resulting framework is referred to as HB-LED ECI.

2.4.1 This Standard defines a physical/data link layer based on Ethernet.

2.4.2 This Standard utilizes SEMI E37/SEMI E37.1 for message transfer.

2.4.3 This Standard defines a message and data item set based on SEMI E5.

2.4.4 This Standard defines the behavior of HB-LED equipment communication interface based on SEMI E30.

2.5 The SEMI Standards named in this Scope are used essentially in the same manner as in the semiconductor industry. However, a small set of restrictions and new features have been defined to simplify their application in the HB-LED industry and thereby to improve the level of acceptance and consistency. This Standard contains one subsection for each layer that describes the restrictions that apply for HB-LED manufacturing. Nevertheless, it should be easy to adjust interface implementation developed for semiconductor industry to fulfill these restrictions.

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 This Standard is not an all-inclusive list of applicable standards. Additional standards may be applicable and used as needed.

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3.2 This Standard is focused on the abilities of the equipment. How a host system uses the equipment communication interface is beyond the scope of this Specification.

3.3 This Standard does not intend to express requirements for data processing (e.g., computation of mean-values, etc.).

3.4 This Standard does not specify the implementation of material management, process job management or control job management between equipment and a host system in the HB-LED industry. Such features will be outlined in an additional specification.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI E5 — Specification for SEMI Equipment Communications Standard 2 Message Content (SECS-II)

SEMI E30 — Specification for the Generic Model for Communications and Control of Manufacturing Equipment (GEM)

SEMI E37 — High-Speed SECS Message Services (HSMS) Generic Services

SEMI E37.1 — High-Speed SECS Message Services Single Selected-Session Mode (HSMS-SS)

SEMI E40 — Specification for Processing Management

SEMI E87 — Specification for Carrier Management (CMS)

SEMI E94 — Specification for Control Job Management

SEMI E148 — Specification for Time Synchronization and Definition of the TS-Clock Object

4.2 *IEEE Standards*[1]

IEEE 802 — IEEE Standard for Local and Metropolitan Area Networks

4.3 *ISO Standards*[2]

ISO 8601 — Internet standard for date/time format

ISO/IEC 11578 — Information Technology

ISO 19005-1 — PDF/A-1

ISO 19005-2 — PDF/A-2

4.4 *Other Documents*

NTP Version 3 (RFC 1305) — Network Time Protocol[3]

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

5 Terminology

5.1 Refer to the SEMI Standards Compilation of Terms (COTs) for a list of the current Abbreviations, Acronyms, Definitions, and Symbols.

5.2 *Abbreviations and Acronyms*

5.2.1 *GEM* — generic model for communications and control of manufacturing equipment

5.2.2 *HB-LED* — high brightness light emitting diode

5.2.3 *HB-LED ECI* — HB-LED equipment communication interface

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[2] International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland; Telephone: +41.22.749.01.11, http://www.iso.org

[3] Network Time Protocol (NTP); http://www.ntp.org

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5.2.4 *HSMS* — high speed SECS message service

5.2.5 *SECS* — SEMI Equipment Communications Standard

5.3 *Definitions*

5.3.1 *HB-LED equipment communication interface (HB-LED ECI)* — the HB-LED equipment communication interface is a SECS-II compliant interface. Messages are transmitted via an Ethernet network using HSMS protocol. The functionality is based on SEMI E30 with the restrictions and additions as defined in this Specification.

5.3.2 *HB-LED equipment* — a manufacturing equipment that implements the HB-LED ECI Specification.

6 Conventions

6.1 *Requirements Identification*

6.1.1 The following notation specifies the structure of requirement identifiers.

6.1.1.1 The following requirements prefix format shall be used at the beginning of the requirement text:

- [HBxx.00-RQ-nnnnn-nn]

6.1.1.2 To mark the end of the requirement text the following suffix format must be used:

- [/RQ]

6.1.2 Requirement IDs apply across the row (left to right) of a table unless otherwise specified.

Table 1 Requirement Identifiers

Format Notation	*Purpose*
HBxx.00	SEMI Standards specification identifier. Examples: E087.00, E087.01, E134.00.
RQ	Indicates this is a requirement identifier.
nnnnn	Unique five digit number within this Specification. 90000–99999 are reserved for use by SEMI.
-nn	Two-digit number that indicates version level of the requirement (-00 is used for the first version of a requirement).
/RQ	Indicates the end of a requirement.

7 Summary of Practice

7.1 *Compliance*

7.1.1 [HB4.00-RQ-00001-00] In order to comply with this Specification, HB-LED equipment shall implement each of the SEMI Standards listed below as dictated in each respective section. All requirements in the listed Standard are required except when explicitly excluded in the respective section or when conditional requirement cannot be applied to the equipment. [/RQ]

7.1.2 This Specification references other SEMI Standards. Some of the features or requirements of these referenced Standards are not applicable to the HB-LED industry; therefore this Specification identifies when specific requirements are not required. In some cases, additional requirements are also specified either to make implementations more consistent or to add new features essential to HB-LED manufacturing.

7.2 *Implementation of Physical Layer*

7.2.1 [HB4.00-RQ-00002-00] The equipment shall provide an Ethernet (per IEEE 802®) port that allows the equipment to connect to the factory network. HB-LED equipment shall support state of the art communication data rates. The capabilities of the HB-LED ECI described in this Specification shall be available through this port. [/RQ]

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7.3 *Implementation of HSMS*

7.3.1 *Details on How HB-LED Equipment Shall Implement SEMI Standards E37 and E37.1*

7.3.1.1 [HB4.00-RQ-00003-00] The equipment shall provide an implementation of the application layer compliant to SEMI E37.1 (HSMS-SS). [/RQ]

7.4 *Implementation of SECS-II*

7.4.1 *Details on How HB-LED Equipment Shall Implement SEMI Standard E5*

7.4.1.1 [HB4.00-RQ-00004-00] Messages and data items in the messages shall be based on SEMI E5. [/RQ] The SEMI E5 Standard is essentially a library for use by other standards. Equipment are not required or expected to support all messages defined in SEMI E5. Instead only a subset of SEMI E5 messages is required as defined in other Standards like this Specification and SEMI E30.

7.4.1.2 [HB4.00-RQ-00005-00] All SECS-II messages shall be sent as Single-Block Messages (see SEMI E5 section 'Blocking Requirements'). [/RQ] Multi-Block Messages are for compatibility with the SECS-I standard but are inefficient when used with the HSMS standard.

7.4.1.3 [HB4.00-RQ-00006-00] Equipment initiated inquire/grant/send/acknowledge conversations shall not be used (see SEMI E5 section 'Types of Conversations'). Instead the inquire/grant/send/acknowledge conversations shall be replaced by send/acknowledge conversations where the inquire/grant portion of the conversation is skipped. [/RQ] The inquire/grant conversation is used for granting permission to send multi-block messages. For example, GEM uses an S6, F5/F6 exchange to precede multi-blocked S6, F11/F12 exchanges. Multi-block messages are inefficient when using E37.1 HSMS-SS.

7.4.1.4 [RQ] If the host sends an inquire/grant conversation and the corresponding send/acknowledge is supported, then equipment shall grant permission. [/RQ] Allow the host to use multi-block messages.

7.4.1.5 [HB4.00-RQ-00007-00] SECS-II Message S1, F3 shall use the newer list structure (see SEMI E5 message S1,F3). [/RQ]

7.4.1.6 [HB4.00-RQ-00008-00] SECS-II Message S2, F13 shall use the newer list structure (See SEMI E5 message S2,F13). [/RQ]

7.4.1.7 [HB4.00-RQ-00009-00] SECS-II Message S2, F23 shall use the newer list structure (See SEMI E5 message S2,F23). [/RQ]

7.4.1.8 [HB4.00-RQ-00010-00] SECS-II Messages shall use the allowed format listed below in table 'Allowed Data Item Format' where applicable. [/RQ] These format restrictions make implementations more consistent and therefore easier to integrate with host communication solutions.

Table 2 SEMI E5 Allowed Data Item Format

SEMI E5 Data Item[#1]	*Allowed Format(s)*[#2]
ALID	54
CEID	54
CPNAME	20
DATAID	54
DATALENGTH	54
DVID	54
ECID	54
PPBODY	10, 20
PPID	20
RCMD	20
REPGSZ	54
RPTID	54

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SEMI E5 Data Item[#1]	*Allowed Format(s)*[#2]
SMPLN	54
TOTSMP	54
TRID	54
VID	54

#1 See SEMI E5 § 9.6 Table 'Data Item Dictionary'.

#2 See SEMI E5 § 9.3.1 Table 'Item Format Codes' and § 9.6 Table 'Data Item Dictionary'.

7.4.1.9 [HB4.00-RQ-00011-00] Custom SECS-II Messages shall not be used to implement HB-LED standard functionality. Only SECS-II Messages defined in SEMI E5 and SEMI E30 shall be used to support HB-LED standard features. [/RQ] For example, an S1,F13/F14 exchange and only an S1,F13/F14 exchange shall be used to establish communication.

7.5 *Implementation of GEM*

7.5.1 *Details on How HB-LED Equipment Shall Implement SEMI Standard E30*

7.5.1.1 [HB4.00-RQ-00012-00] The equipment shall comply with the 'Fundamental GEM Requirements' as defined in SEMI E30. [/RQ] Simple example Equipment Processing State Models are provided as Related Information at the end of this Specification. HB-LED equipment are encouraged to implement a similarly simple Equipment Processing State Model in order to facilitate later adoption of the SEMI E40 and SEMI E94 Standards.

7.5.1.2 [HB4.00-RQ-00013-00] The equipment shall comply with the following 'Additional Capabilities' as defined in SEMI E30:

- Establish Communications
- Dynamic Event Report Configuration
- Variable Data Collection
- Trace Data Collection
- Status Data Collection
- Alarm Management
- Equipment Constants
- Material Movement
- Clock
- Control (Host-Initiated). [/RQ]

7.5.1.3 The GEM Additional Capabilities which are not listed are not required for HB-LED ECI compliance. Communication.

7.5.1.3.1 [HB4.00-RQ-00014-00] Equipment-initiated heartbeat functionality shall be implemented using message S1,F1/F2. [/RQ]

7.5.1.3.2 The preferred heartbeat frequency is 0.1 Hertz.

7.5.1.4 *Remote Control*

7.5.1.4.1 [HB4.00-RQ-00015-00] When the optional Remote Control functionality is supported, the PP-SELECT, START, STOP, PAUSE, RESUME, and ABORT remote commands specified in SEMI E30 shall be supported only when process job management and control job management are not implemented according to SEMI E40 and SEMI E94. [/RQ] SEMI E40 and SEMI E94 have remote control features that supersede these specific GEM remote commands.

7.5.1.4.2 The equipment can also support custom remote commands to implement equipment-specific control.

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