

SEMI PV2-0709^E

GUIDE FOR PV EQUIPMENT COMMUNICATION INTERFACES (PVECI)

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^E This Standard was editorially modified in November 2009 to correct an error. All occurrences of 'Vsss.ss' and 'Esss.ss' were changed to 'PV02.00'.

NOTICE: This Standard or Safety Guideline has an Inactive Status because the conditions to maintain Current Status have not been met. Inactive Standards or Safety Guidelines are available from SEMI and continue to be valid for use.

1 Purpose

1.1 The purpose of this Guide is to define the IT equipment automation/integration interface of process, automation and metrology equipment used in photovoltaic (PV) manufacturing. It intends to produce economic benefits for both manufacturers and equipment suppliers. On the one hand the standard is expected to release PV manufacturers from the burden to specify the interface with each equipment supplier and to facilitate an increased level of functionality across all manufacturing equipment. On the other hand, it will reduce the effort equipment suppliers currently have to spend to develop and maintain a variety of equipment interfaces. Altogether, it is expected to reduce both costs and time required for the ramp-up of new production lines and thus supports the industry's ability to grow.

1.2 This Guide references a collection of SEMI and other standards, and gives hints how to apply them in PV manufacturing environment in order to establish a reliable and extensible framework for the IT integration of equipment.

2 Scope

2.1 This Guide for PV equipment communication interfaces applies to equipment used in PV manufacturing lines; independent of the base technology used (such as crystalline or thin film). It is mainly intended to be applied to cell manufacturing, module manufacturing or frontend/backend manufacturing—however it is not limited to these areas of application.

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

2.3 This Guide can be applied to inline equipment as well as batch equipment. Basically, a piece of equipment can be seen as a mechanical entity in the factory which plays a role in the manufacturing process. It can be used to transport, store or process material and can have a modular structure. Figure 1 is an example structure of a piece of equipment. A host is a computer or a network of computers which exchange information with the equipment in order to fulfill manufacturing tasks.

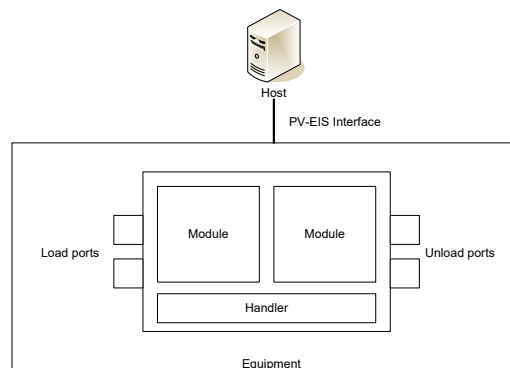


Figure 1
Example of PV Equipment Structure

2.4 This Guide intends to lay the foundation for a reliable and extensible IT integration framework for PV manufacturing based on proven standards using a multi-layered approach. As far as possible this Guide references existing SEMI standards to realize these layers. The resulting framework is referred to as PVECI.

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

2.4.2 It utilizes SEMI E37/SEMI E37.1 for message transfer.

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

2.4.4 This Guide defines the behavior of PV equipment as seen through a SEMI E30 based communications link.

2.4.5 This Guide specifies an infrastructure for time synchronization derived from SEMI E148 which does not require GEM 300 Standards for their implementation.

2.5 As far as possible the SEMI Standards named before are used as known from semiconductor industry. However, a small set of restrictions has been defined to simplify their application in PV industry and thereby to improve the level of acceptance. This Guide contains one subsection for each layer that describes the restrictions that apply for PV manufacturing. Nevertheless, it should be easy to adjust interface implementations 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 Guide is not an all-inclusive list of applicable standards. Additional standards may be used as needed.

3.2 When referring to other SEMI Standards used in this Guide, the reader should allow for some editorial exceptions in order to apply these standards to PV equipment. For example, if another SEMI Standard uses the term wafer, the reader can assume that this also applies to substrates in thin film frontends. These minor differences do not impact the interpretation or usage of those standards in PV manufacturing.

3.3 The approach for single substrate tracking needs to be looked at in more detail in the future. In order to realize single substrate tracking with linked equipment, an additional interface might be required, that provides a facility for equipment to equipment communication, which means the transfer of logistics information from between different pieces of equipment, such as the substrate ID. The GEM-based host interface is not suitable for this purpose, as real-time capabilities are required and as the equipment shall be able to run in offline mode (host down, etc.). The idea is to define the equipment-to-equipment communication itself in some additional standard.

3.4 The PVEC-Interface Guide does not intend to express requirements for data preprocessing (computation of mean-values, etc.).

4 Referenced Standards and Documents

4.1 SEMI Standards

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

SEMI E10 — Specification for Definition and Measurement of Equipment Reliability, Availability, and Maintainability (RAM)

SEMI E30 — 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 Service Single Selected-Session Mode (HSMS-SS or HSMS-SSS)

4.2 IEEE Standards¹

IEEE/IEC 61588 — Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems

4.3 ISO Standards²

ISO 8601:2004 — Internet Standard for Date/Time Format

ISO/IEC 11578:1996 — Information Technology

4.4 Other Documents

RFC 1305 — Network Time Protocol, NTP Version 3³

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

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 *GEM* — Generic Equipment Model

5.1.2 *HSMS* — High Speed SECS Message Service

5.1.3 *SECS* — SEMI Equipment Communication Standard

5.1.4 *PV* — photovoltaic

5.1.5 *PVECI* — Photovoltaic Equipment Communication Interface

5.2 Definitions

5.2.1 *PVEC-Interface* — the Photovoltaic Equipment Communication Interface (PVEC-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 defined in this Document.

6 Conventions

6.1 Requirements Identification

6.1.1 The following notation specifies the structure of requirement identifiers (see Table 1).

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

- [PV02.00-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

<i>Format Notation</i>	<i>Purpose</i>
PV02.00	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.

¹ Institute of Electrical and Electronics Engineers, 3 Park Avenue, 17th Floor, New York, NY 10016-5997, USA; Telephone: +1.212.419.7900, Fax: +1.212.752.4929, <http://www.ieee.org>

² International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland; Telephone: +41.22.749.01.11, Fax: +41.22.733.34.30, <http://www.iso.org>

³ Network Time Protocol; <http://www.ntp.org>

<i>Format Notation</i>	<i>Purpose</i>
-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 Physical Layer

- 7.1 [PV02.00-RQ-00001-00] PV equipment shall provide an Ethernet (per IEEE 802®) port that allows the equipment to connect to the factory network. PV-Equipment shall support state of the art communication data rates. The capabilities of the PVEC-Interface described in this Guide shall be exposed through this port. [/RQ]

8 Application Layer

- 8.1 [PV02.00-RQ-00002-00] PV equipment shall provide an implementation of the application layer compliant to SEMI E37.1 (HSMS-SS). [/RQ]

9 Behavior of PV Equipment as Seen Through the PVEC-Interface

- 9.1 [PV02.00-RQ-00003-00] PV equipment shall comply with fundamental GEM requirements and additional capabilities as defined in SEMI E30. PV equipment supplier shall provide the GEM Compliance Statement (SEMI E30, Table 11). [/RQ]
- 9.2 [PV02.00-RQ-00004-00] In order to comply with this Guide, PV equipment shall provide a PVEC-Interface as defined by SEMI E30 with the restrictions and additions outlined in the following sections. [/RQ]

9.3 PVEC-Interface Documentation Requirements

9.3.1 Besides other criteria, the effort for equipment integration is highly dependent on an equipment supplier's documentation quality. The following requirements are defined in addition to the SEMI E30, GEM documentation requirements.

9.3.2 Format

- 9.3.2.1 [PV02.00-RQ-00005-00] The documentation shall be electronically readable and shall allow for copy/paste actions. This is especially relevant for lists of variable data items, parameters, events, and alarms. [/RQ]
- 9.3.2.2 [PV02.00-RQ-00006-00] Variable Data Items, Alarms, Events, including description and characteristics, shall be provided in electronic format (comma separated values, XML, or any standard office format) in a data dictionary. [/RQ]

9.3.3 Content

- 9.3.3.1 [PV02.00-RQ-00007-00] The supplier shall document when data values (DVVALs) are current and valid. A comma-separated list of DVNAMEs is required for each CEID to show what DVVALs are current and valid at the occurrence of the event. [/RQ]

9.4 Remote Control

- 9.4.1 [PV02.00-RQ-00008-00] Remote commands shall be utilized with the Enhanced Remote Command S2F49/F50 only. [/RQ]

9.5 Alarm Management

- 9.5.1 [PV02.00-RQ-00009-00] One generic event 'AlarmDetected' and one generic event 'AlarmCleared' is required for all alarms. [/RQ]

9.5.2 If possible, the generic events 'AlarmDetected' and 'AlarmCleared' shall not be sent if the events are enabled but the alarm itself is disabled.

9.5.3 Software packages, which provide the 'AlarmDetected' and 'AlarmCleared' events for each single alarm are acceptable.