SEMI A1 PESCI Production Equipment Smart Connection Interface
- A general-purpose equipment connection interface for smart production line -

As of Feb. 12, 2020

Flow Manufacturing Forum / Automation Technology Committee, SEMI
Homepage: http://www1.semi.org/jp/SEMI_A1_PESCI
Introduction

Position of This Document

This document introduces the concept and functions of

**SEMI A1 PESCI**

*Production Equipment Smart Connection Interface*

that makes production line smarter

For up-to-date information, please visit:

http://www1.semi.org/jp/SEMI_A1_PESCI

For Standards document and further information, please contact:

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Email: jcollins@semi.org
Introduction

Application of SEMI A1 to SEMI SMT-ELS

• Demonstrations Done
  • JISSO PROTEC  |  Tokyo  |  June  |  2019
  • NEPCON ASIA  |  Shenzhen |  August |  2019
  • Productronica |  München  |  November  |  2019
  • APEX  |  San Diego  |  February  |  2020

• Watch the demo videos on: http://www1.semi.org/jp/SEMI_SMT-ELS

JISSO PROTEC / Tokyo
June 2019

NEPCON ASIA / Shenzhen
August 2019

Productronica / München
November 2019
Introduction

Pizza Factory Analogy of SEMI A1 Application

Manufacturing Management:
- I am the host.
- I preset all work orders to my workers.
- I start material and take all working log.

General Data: Work Order Setting and Log by the Host

Material Data:
- My name is #132
- I am going to be Pizza Type A
- 13:20.15 Started

Work Order:
- If Type A comes, I make it t=5mm
- If Type B comes, I make it t=4mm

Material Data: Hey, getting thick! Ok, I adjust!

Work Order:
- If Type A comes, I put cheese and tomatoes
- If Type B comes, I put four different cheeses

Material Data: I’m getting sick Ok, I halt.

Work Order:
- If Type A comes, I bake it for 3 minutes
- If Type B comes, I bake it for 2 minutes

General Data: Work Order Setting and Log by the Host

Material Data:
- My name is #132
- I am going to be Pizza Type A
- 13:20.15 Started
- 13:20.45 12in. t=5mm @E1
- 13:21.30 Cheese and tomatoes are put @E2

Material Data: Object Oriented “Material and Material Data” Transfer throughout Equipment Chain

Material Data: Autonomous Process Execution and Line Management by Equipment Chain

General Data: Hey, getting thick! Ok, I adjust!

General Data: I’m getting sick Ok, I halt.

General Data: Work Order Setting and Log by the Host

Material Data:
- My name is #132
- I am going to be Pizza Type A
- 13:20.15 Started
- 13:20.45 12in. t=5mm @E1
- 13:21.30 Cheese and tomatoes are put @E2
- 13:24.55 3 minutes @E3

Material Data: Object Oriented “Material and Material Data” Transfer throughout Equipment Chain

Material Data: Autonomous Process Execution and Line Management by Equipment Chain

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Concept of SEMI A1 PESCI

The General-Purpose Equipment Interface
What is SEMI A1 PESCI?

- A general-purpose Production Equipment Smart Connection Interface

- SEMI A1 provides connections between:
  - An upper tier host and local hosts
  - An upper tier host and equipment (via a local host or direct)
  - A local host and equipment
  - Equipment and equipment
What is SEMI A1 PESCI?

- **A general-purpose Production Equipment Smart Connection Interface**
  - General-purpose Data communication channel (GD)
    - Tiered Host connection
      - Equipment Group ➔ Local Host ➔ Upper Tier Host
    - Various addressing modes
      - Equipment to equipment, equipment to the local host, equipment to upper tier host, inter host
    - Message definitions are open to upper tier Standard per application area
  - Up to ten Material and Material Data transfer channels (Tracks)
    - Object Oriented simultaneous transfer of Material and its Material Data
      - Material Data definition is open to the upper tier Standard per application area
    - Compatible with various transfer means such as conveyors, AGVs, robots
    - Support Uni-direction, Alternate-direction, and Bi-direction transfer operation
Orthogonal “Line Management” and “Execution Control”

Production Line Management in Vertical and Production Execution Control in Horizontal

• Production Line Management:
  • Through Host-equipment communication (Point to Point)
  • Equipment settings and observations
  • Material tracking

• Production Execution Control:
  • By equipment-equipment communication (Daisy chain)
  • Autonomous Production Execution:
    • By equipment-equipment collaboration
    • Through General Data communication
  • Object Oriented Material and Material Data transfer
    • Simultaneous handoff of Material and Material Data
    • Direct reference of attached Material Data
    • Exception handlings of handoff (Pause – Recovery)

Industry Network free
PLC conformance
Concept of SEMI A1 PESCI

Segment and Tiered Host Operation Capability

- Tiered Host operation
- Localization of equipment dependent detail control in a Segment
- Easy to change per Segment
Application of SEMI A1 PESCI

- Host and Equipment connection (point to point) for:
  - Equipment management
  - WIP tracing
- Equipment and Equipment connection (daisy chain) for:
  - Generic communication between equipment via the adjacent equipment
  - Simultaneous handoff of Material and its Material Data
Definition Overview of SEMI A1/1.1

• SEMI A1 defines communication channels for equipment
  • Material and Material Data (MD) (Material Handshake)
    • Performs simultaneous handoff of Material and its Data
  • General Data (GD) (Data Handshake)
    • Performs generic data communication
    • Both for host-equipment and equipment-equipment communications
  • Simple “Memory Image Exchange” type of messaging
    • Better conformance even with low-end PLC

• SEMI A1.1 defines TCP/IP interface for SEMI A1
  • TCP/IP interface for both MD and GD Handshakes
  • “Memory Image Exchange” messaging scheme
    • for better conformance with low cost control components such as PLC
  • Direct mapping on TCP/IP
    • for higher compatibility among various control components
• Connections for production line (SEMI A1)
  • General Data between the host and equipment
  • General Data between adjacent equipment
  • Material and Material Data handoff between equipment

• Communication Protocol for SEMI A1 (SEMI A1.1)
  • Direct mapping on TCP/IP
    • Connectivity between PLCs based on different Fieldbus
      (Intra equipment communication may be done by own Fieldbus)

• PLC conformance (SEMI A1/1.1)
  • Messaging to exchange Memory Mapped Data

VC: Vertical Communication
HC: Horizontal Communication
Concept of SEMI A1 PESCI

Equipment Model of SEMI A1 PESCI

- **Production Line Management in Vertical**
  - Preset of Recipe, Route, etc.
  - Start Event
  - Exception Handling
  - Completion Event Log (for analysis)

- **Production Execution Control in Horizontal (Multiple Tracks)**
  - Inter-Equipment Collaboration
  - Material Data + Material
  - Autonomous Execution by Equipment
    - Refer Material Data and follow to the preset recipes
    - Reduction of load and cost of the host

- **Standardized communication specification**
  - Direct use of TCP/IP
  - Memory Block transfer for PLC conformance
  - Connectivity, quick launch

- **Inter Equipment Communication**
  - Autonomous coordination along with the line
  - Reduction of Host load/cost

- **Simultaneous handoff of Material and Material Data**
  - Instance ID, Product ID, Log
  - Material require equipment to process according to the Material Data
  - Object Oriented

- **Line Management by the Host**
  - Equipment setting, watch, log
  - Material Data creation, trace, log
  - Information aggregation to the host

- **Equipment setting, watch, log**
- **Material Data creation, trace, log**

- **Inter-Equipment Collaboration**
  - Equipment setting, watch, log
  - Material Data creation, trace, log
  - Information aggregation to the host

- **VC**: Vertical Communication
- **HC**: Horizontal Communication

VC: Vertical Communication
HC: Horizontal Communication
"Line" a Connection between Equipment

**Concept of SEMI A1 PESCI**

One “Line” Consists of
- One Line Information channel
- Up to ten Track Information channels

**Line Information**
- Full duplex data channel
- For “General Data”
- By “Data Handshake”

**Track Information 1 .. n**
- n tracks of half duplex transportation channels
- For “Material and Material Data”
- By “Material Handshake”
General Data Communication

For message exchange.
General Data Communication

SEMI A1 supports various Addressing Modes for Vertical Communication
General Data Communication (Horizontal)

SEMI A1 supports various Addressing Modes for Horizontal Communication

- Full Duplex
- Broadcasting
- Thread Management
- Interleaving Management
Material and Material Data Transfer
For message exchange.
Material and Material Data Transfer

SEMI A1 supports simultaneous handoff of Material and Material Data
Multiple Tracks are controlled independently

- Object Oriented way
- Material carries its characteristics as Material Data
- Equipment refers Material Data and executes prespecified operation

Object Oriented “Material and Material Data” Transfer throughout Equipment Chain

Material Data → Material
Material and Material Data Transfer

Typical Example of Material Data (MD)

- Material Data is an identification tag of the WIP

- Consists of the following three sections
  - **Instance ID**: Identifier of the individual material
  - **Class ID**: Identifier of the product class, the material belongs to
  - **Log**: Result record at each equipment
    - Applied parameters or measured results (value or classification)
    - To be used as process log
    - May also be used for notifications for process/route changes to the equipment after

<table>
<thead>
<tr>
<th>Field</th>
<th>Mnemonic</th>
<th>Definition</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instance ID</td>
<td>Material ID</td>
<td>Identifier of this individual material</td>
<td>To be used to identify this individual material</td>
</tr>
<tr>
<td>Class ID</td>
<td>Product ID</td>
<td>Identifier of Product this material to be</td>
<td>To be used to select recipe or route</td>
</tr>
<tr>
<td></td>
<td>Version ID</td>
<td>Identifier of Version of the product</td>
<td>May be used for modification of recipe or route</td>
</tr>
<tr>
<td>Log</td>
<td>Result E0</td>
<td>Result record at equipment 0</td>
<td>Control of process or branch in the equipment after</td>
</tr>
<tr>
<td></td>
<td>Result E1</td>
<td>Result record at equipment 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result E2</td>
<td>Result record at equipment 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.........</td>
<td>.........</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result En</td>
<td>Result record at equipment n</td>
<td></td>
</tr>
</tbody>
</table>
Material and Material Data Transfer

Track Types

• Three Track Types
  • Uni-Direction  Material flows to one direction
  • Alternate-Direction  Material flows both directions alternatively
  • Bi-Direction  Materials are swapped in one cycle

• Multiple Tracks per one Line

<table>
<thead>
<tr>
<th>Single set</th>
<th>&quot;Uni-Direction&quot;</th>
<th>Equipment A</th>
<th>Equipment B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Multiple set</th>
<th>&quot;Alternate-Direction&quot;</th>
<th>Equipment A</th>
<th>Equipment B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A(S/R) ←→ A(S/R)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>&quot;Bi-Direction&quot;</th>
<th>Equipment A</th>
<th>Equipment B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X(S+R) ←→ X(S+R)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Line Topology

- Supports line topology that includes:
  - Branch
  - Merge
  - Loop
  - Turn back
Handoff Function

• Handoff Step function
  • Compatible with handoff mechanisms that require multiple handoff steps
  • Conveyor, Robot, Isolation doors, etc.

• Operator assistance and recovery
  • Pause – Recovery functions
    • Operator or equipment initiated upon handoff exception
    • Restart, Resume, Forward, Abort can be selected for recovery
SEMI A1 PESCI Activities
Organization and Activities
Technology Community that consists of the members who have the same Business Interest

The forum for Flow shop type manufacturing line

SEMI Tech. Community

SEMI Standards

Flow Manufacturing (FM) Forum

Automation Technology (AT) Committee

A1 WG
(SEMI A1)
Responsible to SEMI A1/A1.1 PESCI

SMT WG
(Surface Mount Technology)
Responsible to SEMI A1/A1.1 PESCI

A1 TF
(SEMI A1)
Responsible to SEMI A1/A1.1 PESCI

SMT TF
(Surface Mount Technology)
Responsible to SEMI A2 SMASH

Application knowhow sharing
Hosting of Interoperability Testing
Industry interactions (promotion, feedback)

Development and improvement of Standards
Ballot actions and adjudications

Global Standardization organization that is open for those who have the same Technical Interest

The technical committee that is responsible to flow shop type manufacturing line

Responsible Working Groups

Responsible Task Forces
Relationship between FM Forum and AT Committee

SEMI Technology Community

Industry

SEMI

FM Forum

Factory Requirements

PDCA Cycle

Interoperability Testing

Prototyping

Standard Requirements

SEMI Standards

AT Committee

Standard Proposal

PDCA Cycle

Standard Publication

Standard Voting / Review

Standard Development

SEMI A1 PESCI Activities

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Interoperability Testing Support

• Flow Manufacturing Forum hosts interoperability testing
  • Interoperability should be managed by the forum members since SEMI should
    be neutral and is not in the position to test or certificate

• Participants who appropriately performed the testing with multiple
  proven members are posted to SEMI A1 PESCI homepage

• Please visit SEMI A1 PESCI homepage for up-to-date information
Thank you!

SEMI A1 PESCI