The Hermes Standard:

The new backbone for board-flow data management in Smart SMT Factories

www.the-hermes-standard.info
Welcome to The Hermes Standard for M2M communication.
The Hermes Standard for vendor independent machine-to-machine communication in SMT Assembly.

Welcome to The Hermes Standard for M 2 M communication

Everything Gets Connected.
Innovation in Communication
“Every Day Life”

All the way from manual switch boards... ... to instant global connections.
From „One line – Two wires each“…

… to multi channel glass fibre.

Innovation in Communication
“Telecommunications Infrastructure”

Images: Licensed by Fotolia.de for use by ASM AS
From IPC-SMEMA 9851…

… to The Hermes Standard
for vendor independent Machine to Machine communication
Innovation in Communication
“Along the SMT Line”

From IPC-SMEMA 9851…

… to The Hermes Standard
for vendor independent
Machine to Machine communication
Innovation in Communication

“Welcome to The Hermes Standard”

IPC-HERMES-9852
The global standard for "M2M" in SMT assembly
Challenges: The Situation before The Hermes Standard

How does SMEMA* work?

E.g.: Communication for board transfer

Source: IPC SMEMA 9851
Mechanical Equipment Interface Standard, IPC, Rev. 2007
Challenges: The Situation before The Hermes Standard

How does SMEMA* work?

SMEMA reflects the state-of-the-art in automation... of the early 1990s.

Source: IPC SMEMA 9851
Mechanical Equipment Interface Standard, IPC, Rev. 2007

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*IPC-SMEMA Standard 9851

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The Hermes Standard for vendor independent machine-to-machine communication in SMT Assembly.
Challenges: The Situation before The Hermes Standard

How does SMEMA* work?

E.g.: PCB identification

In mixed vendor lines, ID readers were required before each machine

- Board ID Scanning required

*IPC-SMEMA Standard 9851
Challenges: The Situation before The Hermes Standard

High level line control was burdened with additional load and complexity

- Board ID Scanning required
Challenges: The Situation before The Hermes Standard

High level line control was burdened with additional load and complexity

“The Old World”: Complex and Faulty

No data available, no closed loop handover.

- Board ID Scanning required
“Old” versus “New”
SMEMA cannot be upgraded to unleash the options of latest technology

IPC-SMEMA-9851

- Multiple cable types. At least 4 different types of cables: Plug – Pin, Plug – socket, Plug – plug and Pin – pin
- Rather expensive due to dedicated HW requirements.
- Need to check each machine to connect for getting the right cable
- Additional information needs to be modulated on the hardware signals
- There is no general system to keep additional information through several machines

SMEMA was leading edge process technology when defined, but it offers no option for “the future”
Why is The Hermes Standard the better solution?

- **Protocol based** instead of “signal based”: Easy to adjust and easy to expand for integrating further information.

- **Standard components** instead of “special needs”: Cables, plugs and interfaces inexpensive and easily available.

- **Integrated data management** versus separation: Consistent board and data assignment.
The Hermes Standard (IPC-HERMES-9852)
Full Process data availability, maximum line throughput & traceability.

- Standardized M to M Interface via The Hermes Standard
- Need for board identification (Barcode scanning / RFID reading, etc) only once per line and typically at the beginning:
The Hermes Standard (IPC-HERMES-9852)
Full Process data availability, maximum line throughput & traceability.

The product drives the change!
The Hermes Standard
Designed to meet the requirements – today and in future

The Hermes Standard (IPC-HERMES-9852)
Full Process data availability, maximum line throughput & traceability.

1) Generic communication back bone to work even in mixed-brand equipment lines.
2) Product centric approach, keeping complexity under control.
3) Board tracking along the entire line with single board ID reading possible.
4) Open protocol, adaptable to further and future requirements.
5) Standard Interfaces (Ethernet) reduce cost and effort for installation.
The Hermes Standard protocol: “step by step”
Signalling MachineReady (downstream) and BoardAvailable (upstream)
The Hermes Standard protocol: “step by step”

What kind of data can be transmitted?

<table>
<thead>
<tr>
<th>BoardAvailable</th>
<th>Type</th>
<th>Range</th>
<th>Optional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BoardId</td>
<td>string</td>
<td>GUID</td>
<td>no</td>
<td>Indicating the ID of the available board</td>
</tr>
<tr>
<td>BoardIdCreatedBy</td>
<td>string</td>
<td>non-empty string</td>
<td>no</td>
<td>MachineId of the machine which created the BoardId (the first machine in a consecutive row of machines implementing this protocol). The MachineId is part of the Hermes configuration.</td>
</tr>
<tr>
<td>FailedBoard</td>
<td>int</td>
<td>0 .. 2</td>
<td>no</td>
<td>A value of the list below</td>
</tr>
<tr>
<td>ProductTypeId</td>
<td>string</td>
<td>any string</td>
<td>yes</td>
<td>Identifies a collection of PCBs sharing common properties</td>
</tr>
<tr>
<td>FlippedBoard</td>
<td>int</td>
<td>0 .. 2</td>
<td>no</td>
<td>A value of the list below</td>
</tr>
<tr>
<td>TopBarcode</td>
<td>string</td>
<td>any string</td>
<td>no</td>
<td>The barcode of the top side of the PCB</td>
</tr>
<tr>
<td>BottomBarcode</td>
<td>string</td>
<td>any string</td>
<td>yes</td>
<td>The barcode of the bottom side of the PCB</td>
</tr>
<tr>
<td>Length</td>
<td>float</td>
<td>positive numbers</td>
<td>yes</td>
<td>The length of the PCB in millimeter.</td>
</tr>
<tr>
<td>Width</td>
<td>float</td>
<td>positive numbers</td>
<td>yes</td>
<td>The width of the PCB in millimeter.</td>
</tr>
<tr>
<td>Thickness</td>
<td>float</td>
<td>positive numbers</td>
<td>yes</td>
<td>The thickness of the PCB in millimeter.</td>
</tr>
<tr>
<td>ConveyorSpeed</td>
<td>float</td>
<td>positive numbers</td>
<td>yes</td>
<td>The conveyor speed preferred by the upstream machine in millimeter per second</td>
</tr>
</tbody>
</table>

FailedBoard may be one of the following values:
- 0  Board of unknown quality available
- 1  Good board available
- 2  Failed board available

FlippedBoard may be one of the following values:
- 0  Side up is unknown
- 1  Board top side is up
- 2  Board bottom side is up
Globally Unique Identifier

eg. 123e4567-e89b-12d3-a456-426655440000

Chances of collision are negligible

5.3x10^{36} randomly generatable GUIDs exist

Need to generate 2.7x10^{18} for a 50% collision chance

Hermes uses GUIDs as a handle to uniquely identify and track boards
The Hermes Standard protocol: “step by step”

Board Handover

![Diagram of board handover process]

- **Upstream Machine**
- **Downstream Machine**

**TransportFinished**
- **TransferState BoardId**

**StartTransport(BeltSpeed)**
- **Conveyor on**
- **Conveyor off**

**Board is being transferred**

**TransportFinished(Complete)**
- **StartTransport**
  - BoardId
  - ConveyorSpeed
- **StopTransport(Complete)**
  - **Conveyor off**
  - **StopTransport**
    - TransferState
    - BoardId
The Hermes Standard protocol: “step by step”
… and so on …
Standing on the shoulders of giants: TCP/IP and XML

TCP/IP
Reliable connection-oriented communication protocol
Provides time-out handling

XML
Tagged data to ensure compatibility with future versions of Hermes
Predefined W3C standards for date, time, representation of floating point numbers etc.
For simplicity, restricted to UTF-8 (for Hermes 1.0, this effectively amounts to ASCII).
Overhead in size irrelevant for Hermes messages
Welcome to The Hermes Standard
IPC-HERMES-9852 for M 2 M communication

The Hermes Standard gets everything connected.
Connectivity Needs Cooperation
The Hermes Standard Initiative is a joint project of leading vendors of electronics assembly equipment.

Active participation is open to all vendors of electronics assembly equipment.

All members are equally important in a fair and open decision making process.
# The Hermes Standard time line

**Impressively fast growth of members base**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early 2016</td>
<td>First Discussions</td>
<td></td>
</tr>
<tr>
<td>March 2017</td>
<td>Foundation Meeting (First “Members’ Meeting”)</td>
<td>16 members</td>
</tr>
<tr>
<td></td>
<td>Agreement on Release Vso.1.0</td>
<td></td>
</tr>
<tr>
<td>April 2017</td>
<td>Public Website Online</td>
<td></td>
</tr>
<tr>
<td>June 2017</td>
<td>“Members’ Forum” website online</td>
<td></td>
</tr>
<tr>
<td>November 2017</td>
<td>Second “Members Meeting”, official Go Live!” and exhibiting at Productronica in Munich; Release of Vso 1.0 Rev1</td>
<td>27 members</td>
</tr>
<tr>
<td>February 2018</td>
<td>Joint activity with ipc cfx and exhibiting at APEX in San Diego</td>
<td></td>
</tr>
<tr>
<td>April 2018</td>
<td>Third “Members’ Meeting” and exhibiting at Nepcon China</td>
<td>~ 45 members</td>
</tr>
<tr>
<td>August 2018</td>
<td>Announcement of IPC-HERMES-9852</td>
<td>&gt; 50 members</td>
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<tr>
<td>January 2019</td>
<td>Fourth “Members Meeting” at APEX Expo in San Diego, CA, USA</td>
<td></td>
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<tr>
<td>March 2019</td>
<td>Release version 1.2</td>
<td></td>
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<tr>
<td>November 2019</td>
<td>Fifth “Members Meeting” at Productronica in Munich, joint Demo Line “Hermes/CFX”</td>
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</table>

**Next Event:**

- November 2019: Fifth “Members Meeting” at Productronica in Munich, joint Demo Line “Hermes/CFX”
The Hermes Standard Initiative

A global footprint defines a global standard

All vendors of equipment or integration solutions are invited to join!

- All vendors of SMT equipment are invited to join.
- Participation is free of charge.
- All results are published via [www.the-Hermes-standard.info](http://www.the-Hermes-standard.info)
- Committed to open standard principles as published at [www.open-stand.org](http://www.open-stand.org)

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Country</th>
<th>Language</th>
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<tbody>
<tr>
<td>Achat Engineering GmbH</td>
<td>ILJN</td>
<td>Reprint</td>
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<tr>
<td>atSMT</td>
<td>IPE</td>
<td>RG Eлектротехнологии</td>
</tr>
<tr>
<td>ASM Assembly Systems GmbH</td>
<td>ITW EAE</td>
<td>SAKI Corp</td>
</tr>
<tr>
<td>ASYS Automationssysteme GmbH</td>
<td>JAPAN UNIC CO., LTD.</td>
<td>SEIKO Systems</td>
</tr>
<tr>
<td>BESI</td>
<td>Keylight Technologies</td>
<td>S.E.I.C.A. S.p.A.</td>
</tr>
<tr>
<td>BITU</td>
<td>KIC</td>
<td>SEICA AUTOMATION s.r.l.</td>
</tr>
<tr>
<td>CTI Systems</td>
<td>KOH YOUNG Technology Inc.</td>
<td>SICK AG</td>
</tr>
<tr>
<td>CTS</td>
<td>Kolb Cleaning Technology GmbH</td>
<td>SMT Thermal Discoveries</td>
</tr>
<tr>
<td>CYBEROPTICS</td>
<td>Kulicke &amp; Soffa</td>
<td>SolderStar</td>
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<tr>
<td>ECD</td>
<td>Kurzenta</td>
<td>Sonic Technology</td>
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<tr>
<td>Eurol Co., Ltd.</td>
<td>Magic Ray Technology</td>
<td>SPEA S.p.A.</td>
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<tr>
<td>Exellos</td>
<td>MRTec</td>
<td>SYNO</td>
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<tr>
<td>Fanuc Automation Srl</td>
<td>MYCRONIC AB</td>
<td>SYSTech Europe GmbH</td>
</tr>
<tr>
<td>FlexLink</td>
<td>Nordson ASYMTEK</td>
<td>Test Research, Inc. (TRI)</td>
</tr>
<tr>
<td>GES</td>
<td>Nuinek Europe B.V.</td>
<td>Universal Instruments</td>
</tr>
<tr>
<td>Göpel electronic GmbH</td>
<td>OMRON Corporation</td>
<td>VI TECHNOLOGY (Myronic)</td>
</tr>
<tr>
<td>Hamachi</td>
<td>OSAI</td>
<td>VISCOM AG</td>
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<tr>
<td>Heller industries</td>
<td>PARMI</td>
<td>VITRON</td>
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<tr>
<td>Hayashi</td>
<td>Pennonian</td>
<td>VITRON Co., Ltd.</td>
</tr>
<tr>
<td>HR Automation</td>
<td>Rehm Thermal Systems GmbH</td>
<td>VXLON</td>
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<tr>
<td>Holly</td>
<td></td>
<td>6TL Engineering</td>
</tr>
</tbody>
</table>

In addition to the companies listed above, there are more companies in the internal decision making process.

When will YOU join?

*Members and applicants; status per Jan 2019

*A notable comment because at “JARA” meetings, you need to understand Japanese. If you are invited at all…
The Hermes Standard Initiative
Digitalization needs cooperation

The Hermes Standard Initiative Public Website

- Global Info
- Download of Specification
- Joint Marketing Communication

The Hermes Standard Initiative "Members Meeting"
- Welcoming and introduction of new members
- Discussion of proposals
- Decisions about new releases

About 6 months

The Hermes Standard Initiative Members Online Forum

Members Area
- Discussion Forum
- Joint development of The Hermes Standard protocol
- Download of internal documents

Next “Members Meeting”

The Hermes Standard Initiative "Member Companies"

Joint Activities
- "Organization & Admin"
- Joint projects
- Field Tests
- Joint Marketing Activities & Com'cation

Individual Activities
- "Chair Functions"
- Own product development
- Individual Sales & Marketing activities

The Hermes Standard Public Website

- Global Info
- Download of Specification
- Joint Marketing Communication

15.08.2019
The Hermes Standard Initiative

Digitalization needs cooperation

The Hermes Standard for vendor independent machine-to-machine communication in SMT Assembly.
The Hermes Standard: “Better By Design“

▪ The Hermes Standard will replace the current “SMEMA” Standard.
▪ There is only need for one board ID reader for a whole line.
▪ Based on well established technologies such as TCP/IP and XML, the protocol is easy to adapt to future requirements.
▪ Utilizing Standard components makes it inexpensive and ultimately flexible.
▪ Data Management and Traceability features are fully integrated.

The Hermes Standard Initiative: Open, transparent, agile.

▪ The Hermes Standard Initiative is open for all vendors of assembly equipment.
▪ Cooperation is based on clear processes and procedures.
▪ After only one year, about fifty companies are supporting the standard.
   And the initiative keeps growing
The Hermes Standard for vendor independent machine-to-machine communication in SMT Assembly.

IPC-HERMES-9852
The global standard for "M2M" in SMT Assembly

The new backbone for board-flow data management in Smart SMT Factories.
The new backbone for board-flow data management in Smart SMT Factories.

Thank You!

www.the-hermes-standard.info
The Hermes Standard for vendor independent machine-to-machine communication in SMT Assembly.

<table>
<thead>
<tr>
<th>Tag</th>
<th>Source</th>
<th>Courtesy of</th>
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<tbody>
<tr>
<td>SMEMA Schematics</td>
<td>ipc.org</td>
<td></td>
</tr>
<tr>
<td>The Hermes Standard</td>
<td>the-hermes-standard.info</td>
<td>The Hermes Standard</td>
</tr>
<tr>
<td>SMEMA Plugs</td>
<td><a href="http://www.enlishaobao.net">www.enlishaobao.net</a></td>
<td>LinHao Inc</td>
</tr>
</tbody>
</table>
### The Issue

<table>
<thead>
<tr>
<th></th>
<th>At SMEMA</th>
<th>At The Hermes Standard (1.0)</th>
</tr>
</thead>
</table>
| 1) Scenario definitions in the protocol | ▪ Several error scenarios undefined: e.g. PCB is signalled to be handed over but has not arrived because the signal “PCB arrived” is missing | ▪ Most error scenarios already defined  
▪ Easily expandable in future versions                                                                 |
| 2) Dealing with defective Cables | ▪ Variety of specified cable set makes it hard to bring the exact replacement to the site or requires broad stock. | ▪ Only one standard cable type, which is easily and inexpensively available: Ethernet cables. |
| 3) Hardware installation effort | ▪ Cables are “hand made” w/o standard lengths.  
▪ Installation of SMEMA box & adapter  
▪ Separate cables for LAN and SMEMA  
▪ “Dual Lane” requires second set of entire hardware | ▪ Only Ethernet port necessary  
▪ No separate SMEMA cable necessary  
▪ “Dual lane” required no (!) additional hardware, it is fully covered by the protocol |
| 4) Synchronizing PCB data and hand-over message | ▪ Data is transfer requires separate Ethernet interface  
▪ Data must be synchronized with SMEMA signals assigned to PCB  
▪ Timing must match all vendors to ensure correct assignment | ▪ No synchronization is necessary and no timing issues exist as data is transferred together with handover message.  
▪ Implementation of transferring data between different vendors very easy. |
| 5) Flexibility at changing line configurations | ▪ Specific cable length is necessary, therefore any change in the line configuration leads to new cabling | ▪ Standard Ethernet cables: Easily available and specific length is not required. |
The naïve approach to data transfer
Hermes transfers keys (unique ID, barcode), not data

Out of scope of Hermes 1.0 (but enabled!)
The Hermes Standard facilitates a Server („Man in the Middle“) in order to

- route through different network segments
- track the board flow
- intercept the board flow
Hermes step by step
I: Establishing the connection from down- to upstream

Upstream Machine

Downstream Machine

Open connection (TCP three-way handshake)

ServiceDescriptionDownstream()

ServiceDescriptionUpstream()

ServiceDescription
MachinId
LaneId
HermesVersion
SupportedFeatures
Hermes step by step
II: Exchanging CheckAlive messages

Upstream Machine

Downstream Machine

loop

CheckAlive()

CheckAlive()

CheckAlive
TimeStamp
The Hermes Standard for vendor independent machine-to-machine communication in SMT Assembly.

Hermes step by step
III: Signalling MachineReady (downstream) and BoardAvailable (upstream)
Hermes step by step
IV: Board handover

Upstream Machine

Conveyor on

StartTransport(BeltSpeed)

Conveyor off

Board is being transferred

TransportFinished(Complete)

StopTransport(Complete)

Downstream Machine

Conveyor on

StartTransport

BoardId

ConveyorSpeed

StopTransport

TransferState

BoardId

TransferFinished

BoardId
Hermes step by step
V: and so on ...

Upstream Machine

BoardAvailable

Downstream Machine

MachineReady
Hermes step by step
VI: Graceful shutdown

Notification
NotificationCode
Severity
Description

Upstream Machine
Notification(Info, MachineShutdown)
Close TCP connection

Downstream Machine
The Hermes Standard

for vendor independent machine-to-machine communication in SMT Assembly.

The Hermes Standard state chart
Hermes Configuration (I)
To ensure easy and fast configuration, The Hermes Standard protocol defines configuration messages

**SetConfiguration**
Used to configure the Hermes interfaces of a machine

**GetConfiguration**
Used to read out the configuration of the Hermes interfaces

**CurrentConfiguration**
Response to a GetConfiguration-Message
Hermes Configuration (III)

SetConfiguration

<Hermes Timestamp="2017-03-22T13:20:30.452">
  <SetConfiguration MachineId="TRM01">
    <UpstreamConfigurations>
      <UpstreamConfiguration UpstreamLaneId="1" HostAddress="192.168.1.2" Port="50101" />
      <UpstreamConfiguration UpstreamLaneId="2" HostAddress="192.168.1.2" Port="50102" />
    </UpstreamConfigurations>
    <DownstreamConfigurations>
      <DownstreamConfiguration DownstreamLaneId="1" Port="50101" />
      <DownstreamConfiguration DownstreamLaneId="2" ClientAddress="192.168.1.4" Port="50102" />
    </DownstreamConfigurations>
  </SetConfiguration>
</Hermes>
Removing and re-inserting a board in an SMT assembly line

a) The repair station creates a new BoardId and attaches the scanned barcode to it. An MES correlates the old and new BoardId and merges the various pieces of information.

b) The repair station queries the MES via barcode for the associated BoardId. Board handover continues using the old BoardId.

c) The repair station prompts the user to confirm that the inserted board is the one that was removed.