

SEMI E125.1-0310

SPECIFICATION FOR SOAP BINDING FOR EQUIPMENT SELF DESCRIPTION (EqSD)

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1 Purpose

1.1 SOAP Implementation Mapping

1.1.1 The purpose of this specification is to provide an implementation mapping of the SEMI E125 specification to the SOAP 1.2 protocol. This document provides a description of the XML Schema data types used to support the UML classes defined in SEMI E125, and also describes the WSDL port type and binding definitions used to support the operations defined by the interfaces specified in SEMI E125.

2 Scope

2.1 The scope of this specification is the representation of the EqSD model in an XML Schema and corresponding WSDL port types and bindings. It will not add new domain information or concepts to the SEMI E125 model. The only additions made are those needed to render useful WSDL or XML Schema.

2.2 This specification requires SEMI E132 authentication, and defines requirements for the application of SEMI E132 concepts to the SEMI E125 specification.

NOTICE: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 None.

4 Referenced Standards and Documents

4.1 SEMI Standards

SEMI E120.1 — XML Schema for the Common Equipment Model

SEMI E121 — Guide for Style & Usage of XML for Semiconductor Manufacturing Applications

SEMI E125 — Specification for Equipment Self Description (EqSD)

SEMI E128 — Specification for XML Messaging

SEMI E132.1 — Specification for SOAP Binding of Equipment Client Authentication and Authorization

SEMI E138 — XML Semiconductor Common Components

SEMI E145 — Classification for Measurement Unit Symbols in XML

4.2 OMG Standards¹

Unified Modeling Language (UML) Specification, Version 1.4, OMG Specification 01-09-67; http://www.omg.org/technology/documents/modeling_spec_catalog.htm

4.3 W3C Standards²

Extensible Markup Language (XML) 1.0 (Fourth Edition) — W3C 16 August 2006; <http://www.w3.org/TR/2006/REC-xml-20060816/>

Namespaces in XML (Second Edition) — W3C 16 August 2006; <http://www.w3.org/TR/2006/REC-xml-names-20060816/>

XML Schema Part 0: Primer (Second Edition) — W3C, 28 October 2004; <http://www.w3.org/TR/2004/REC-xmlschema-0-20041028/>

¹ Object Management Group, Inc., 250 First Ave. Suite 100, Needham, MA 02494, USA. Telephone: 1.781.444.0404; Fax: 1.781.444.0320; <http://www.omg.org>

² World Wide Consortium, Massachusetts Institute of Technology (MIT) Computer Science and Artificial Intelligence Laboratory (CSAIL), 32 Vassar Street Room 32-G515, Cambridge, MA 02139, USA. Telephone: 1.617.253.2613; Fax: 1.617.258.5999; <http://www.w3c.org>

XML Schema Part 1: Structures (Second Edition) — W3C, 28 October 2004; <http://www.w3.org/TR/2004/REC-xmlschema-1-20041028/>

XML Schema Part 2: Datatypes (Second Edition) — W3C, 28 October 2004; <http://www.w3.org/TR/2004/REC-xmlschema-2-20041028/>

SOAP Version 1.2 Part 1: Messaging Framework (Second Edition) — W3C, 27 April 2007; <http://www.w3.org/TR/2007/REC-soap12-part1-20070427/>

SOAP Version 1.2 Part 2: Adjuncts (Second Edition) — W3C, 27 April 2007; <http://www.w3.org/TR/2007/REC-soap12-part2-20070427/>

Web Services Description Language (WSDL) 1.1 — W3C Note; <http://www.w3.org/TR/wsdl>

4.4 Other Standards

Internet Engineering Task Force (IETF) RFC 2616 — Hypertext Transfer Protocol – HTTP/1.1; <http://www.ietf.org/rfc/rfc2616.txt>

Secure Sockets Layer (SSL) Protocol 3.0; available from <http://wp.netscape.com/eng/ssl3/draft302.txt>

Web Services Interoperability (WS-I): Basic Profile Version 1.0a, available from <http://www.ws-i.org/Profiles/Basic/2003-08/BasicProfile-1.0a.html>

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

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 SOAP — Simple Object Access Protocol

5.1.2 UML — Unified Modeling Language

5.1.3 W3C — World Wide Web Consortium

5.1.4 WSDL — Web Service Description Language

5.1.5 XML — eXtensible Markup Language

5.2 Definitions

5.2.1 *Unified Modeling Language (UML)* — a notation for representing object-oriented designs and views created by Booch, Rumbaugh, and Jacobson in order to merge their three popular notations plus aspects of other existing notations into a single object-oriented notation intended to be usable by all.

5.2.2 *eXtensible Markup Language (XML)* — a markup language used for representing data rich with context and content in documents and in communications. XML is an extension of SGML, a document-oriented markup language. It was created by W3C for use on the Internet.

6 Conventions

6.1 Translating UML to XML Schema

6.1.1 The reader is expected to have a working knowledge of the UML, XML, WSDL, SOAP, and Schema specifications (see ¶ 4.2 and ¶ 4.3). This document does not provide tutorial information on these subjects.

6.1.2 This document follows the guidelines for XML as outlined in SEMI E121.

6.1.3 Some of the key guidelines followed in this document are summarized here:

- Attributes of UML classes from SEMI E125 are generally represented as XML attributes, to improve efficiency in transferring metadata descriptions from the equipment. Exceptions to this convention are UML attributes that correspond to data structures or other constructs that cannot be represented as XML attributes, or may include text values that may need to include non-parsed character data (CDATA).
- Composition associations are mapped to a single XML element (or multiple such elements if the specified multiplicity is greater than 1).

- Aggregations are mapped to contained elements or arrays of references to one or more unique attributes of the target type.
- Inheritance is modeled using complexType extension. In cases where a reference to an abstract base class occurs in the UML model, a choice compositor for each of the possible derived types is used in order to restrict instance documents from including arbitrary extension through type substitution.

6.1.4 The translation of a UML class to XML Schema types is documented using a table format illustrated by Table 1. Operations defined for a UML class are translated into WSDL operations.

6.1.5 Translation Table Column Header Description

- *Attribute or Role Name* — If an attribute, the name of the attribute is placed here. If an association (including aggregation or composition), the role name from the UML diagram is placed here. Compositions are often not assigned role names. In that case “none” is placed here.
- *UML Name/Type* — If an attribute, the data type of the UML attribute is placed here. If an association, the type of association is placed here. The possible association types are “Composition”, “Aggregation”, or the basic “Association”. UML defines these three types of association.
- *XML Element or Attribute* — Lists the type of XML construct used to represent the UML attribute or association.
- *XML Name/Type* — Provides the name and data type of the resulting XML construct. The type may be a built-in type (e.g., xsd:string), or a named type defined within the XML Schema.

Table 1 Example Translation Table

<i>Attribute or Role Name</i>	<i>UML Name/Type</i>	<i>XML Element or Attribute</i>	<i>XML Name/Type</i>
friend	association	element	Friend: HumanReferenceArray
employees	aggregation	element	Employees: HumanArray
family	composition	element	Family: HumanArray
name	string	element	Name: xsd:string

6.1.6 Translating Operations to XML Schema

6.1.6.1 The translation of an operation defined for UML interface classes to XML Schema types is documented using a table format illustrated in Table 2. One row is provided for each possible input/output argument for the operation being described.

Table 2 Example Translation Table for Operation Input/Output Arguments

<i>Argument Name</i>	<i>Format</i>	<i>XML Element or Attribute</i>	<i>XML Name/Type</i>
<argument name from abstract specification>	<argument format from abstract specification>	<whether the argument is modeled as an Element or Attribute>	<namespace-qualified name of the attribute/element>

6.2 Documenting XML Schema and WSDL Files

6.2.1 Associated with this document are XML Schema and WSDL files that are core components of the specification. Each such document is described using a table format illustrated by Table 3.

Table 3 Example Schema/WSDL Document Description Table

<i>File Name</i>	<.xsd or .wsdl file name>
<i>Target Namespace</i>	<target namespace defined in the schema or WSDL file>
<i>Imported/Referenced Namespaces</i>	<namespaces imported or used by the schema or WSDL file>
<i>Description</i>	<brief description of the purpose/function of the schema or WSDL file>

6.3 Documenting XML Schema with Diagrams³

6.3.1 This document provides graphical representations of the included XML Schema data type and element definitions. Although no standard graphical notation for XML Schema could be found, various XML tools have their own notation. This document will use the notation provided by XMLSpy from Altova Corporation. Figure 1 shows a sample XML Schema diagram that will be used to provide a basis for explanation of the schema graphical notation used in the rest of the document.

6.3.2 In the diagram, rectangular boxes represent XML element definitions. The owner elements are on the left side while the elements contained within the owner element are on the right side. In the sample diagram, ParentType contains Child1, Child2, Child 3, and Child 4. In turn, Child2 contains Child2a, Child2b, and Child2c. The additional symbols (8-sided boxes) represent sequences or choices. See Table 4 for an explanation of these symbols.

Table 4 Altova XMLSPY Schema Diagram Symbols

	Denotes a required ordered sequence of the right hand elements with a cardinality of one for each element. (sequence)
	Denotes an optional ordered sequence of the right hand elements with a cardinality of one for each element. (sequence)
	Denotes a required, but unordered, sequence of the right hand elements with a cardinality of one for each element. (all)
	Denotes a required choice of the right hand elements. Exactly one or two of the right hand elements must be present. (choice)
	Denotes an element that contains parsed character data.
	Denotes a reference to a group or element defined elsewhere.

6.3.3 A graphic using a solid line is a required element; using a dashed line represents an optional element. Numbers or ranges in the lower right hand corner represent cardinality. The default cardinality is one.

6.3.4 To simplify a diagram or help focus on a particular aspect, detail may be hidden. The 8-sided symbols have a small square on the right end. If a minus sign “-” is in the box, then all detail is shown. If the box contains a plus sign “+”, then all detail to the right of that symbol is hidden. The example has no hidden detail.

6.3.5 The yellow (or grey if printed in monochrome) boxes indicate the use of other defined types. So, Child4 is of type “Child4Type”. Child4Type defines Child4a and Child4b. This detail may be hidden in the diagram. Object oriented inheritance is typically represented in XML as type extension. In Figure 1, ParentType extends Child1and 2Type by adding a sequence that includes Child3 and Child4.

6.3.6 Reading Figure 1 would yield the following additional information:

1. Child1and 2Type is an ordered sequence of two items: Child2 and Child1.
2. Child1 contains an optional ordered sequence of Child1a, one or more Child1b, and (optionally) Child1c.
3. Child2 contains a choice of one or two of the following: Child2a, Child2b, and Child2c.
4. Child3 contains an unordered sequence of Child3a and Child3b.

6.4 XML Schema Sample

6.4.1 The sample XML Schema for the example shown in Figure 1, is presented below. Refer to the XML documentation referenced in ¶ 4.3 for a complete description of the syntax and semantics of XML Schema.

³ All images/graphics were created using Altova’s XMLSPY®. Copyright 2003 Altova GmbH and reprinted with permission of Altova.

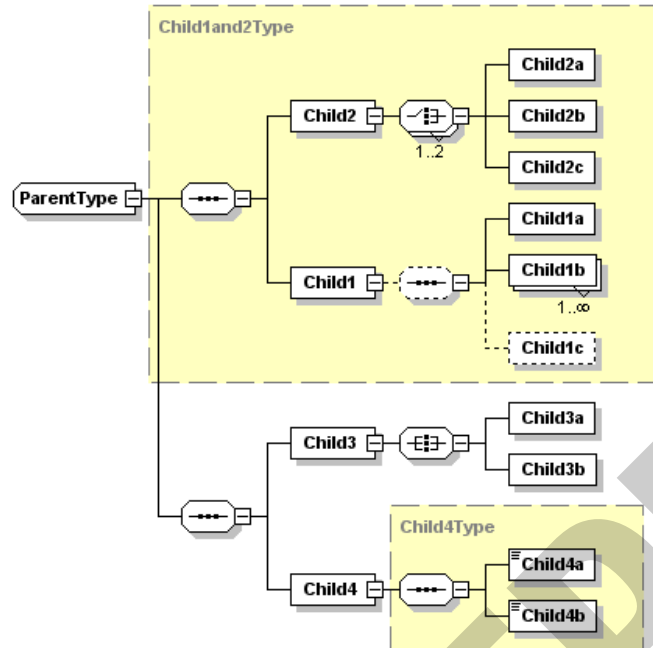


Figure 1
XML Schema Example Diagram

```
<xsd:element name="Parent">
  <xsd:complexType>
    <xsd:sequence>
      <xsd:element name="Child1"/>
      <xsd:complexType>
        <xsd:sequence minOccurs="0">
          <xsd:element name="Child1a"/>
          <xsd:element name="Child1b" maxOccurs="unbounded"/>
          <xsd:element name="Child1c" minOccurs="0"/>
        </xsd:sequence>
      </xsd:complexType>
    </xsd:element>
    <xsd:element name="Child2">
      <xsd:complexType>
        <xsd:choice maxOccurs="2">
          <xsd:element name="Child2a"/>
          <xsd:element name="Child2b"/>
          <xsd:element name="Child2c"/>
        </xsd:choice>
      </xsd:complexType>
    </xsd:element>
    <xsd:element name="Child3">
      <xsd:complexType>
        <xsd:all>
          <xsd:element name="Child3a"/>
          <xsd:element name="Child3b"/>
        </xsd:all>
      </xsd:complexType>
    </xsd:element>
  </xsd:sequence>
</xsd:complexType>
</xsd:element>
```

Figure 2
XML for Sample

6.5 Translating UML to WSDL

6.5.1 In general, UML interface classes defined in the abstract specification are translated into WSDL as portType definitions, and each portType definition has a corresponding WSDL binding definition. The following tables show the convention used for documenting the WSDL port type and binding definitions for a given UML interface class.

Table 5 Example Interface WSDL Port Type Table

<i>Class Name</i>	<UML interface name from abstract specification>
<i>WSDL Port Type Name</i>	<port type name used in WSDL>
<i>SEMI E125 Operation → WSDL Operation</i>	<operation name from UML interface> → <WSDL port type operation name>

Table 6 Example Interface WSDL Binding Table

<i>SEMI E125 Class Name</i>	<UML interface name from abstract specification>
<i>WSDL Binding Name</i>	<binding name used in WSDL>
<i>SOAP Binding Style</i>	<RPC or document>
<i>SOAP Transport</i>	<transport identifying URI>

6.5.2 Each operation defined for a given UML interface class has a corresponding operation definition and binding. Operations are described using a table format illustrated by Table 7 and Table 8.

Table 7 Example Operation Binding Table

<i>SOAPAction</i>	<the Content-Type header “action” value to be used for this operation>
<i>Input Headers (WSDL Message, Required)</i>	<the name of the WSDL message providing input headers, and whether or not the headers are required>
<i>Output Headers (WSDL Message, Required)</i>	<the name of the WSDL message providing output headers, and whether or not the headers are required>

Table 8 Example PortType Operation Table

<i>Input Message Name</i>	<WSDL message name used as input for the WSDL port type operation>
<i>Output Message Name</i>	<WSDL message name used as output for the WSDL port type operation>

7 Mapping of SEMI E125 UML to XML Schema and WSDL

7.1 WSDL Organization

7.1.1 Each interface definition in SEMI E125 is mapped to a WSDL portType and binding definition. WSDL portType definitions are named after the interface and its operations as they appear in SEMI E125. WSDL binding definitions for each portType are used to specify the SOAP 1.2 envelope contents for each operation, and to define the corresponding XML encoding styles and HTTP header usage. All SEMI E125 WSDL interfaces use document/literal encoding, with the complete SOAP header and body contents defined in XML Schema file(s) via global element definitions.

7.1.2 Figure 3 shows the relationship between the WSDL binding and portType definitions and the XML Schema types used for each interface. The portType definition imports XML Schema type definitions used in each operation via the XML Schema “import” statement. The WSDL binding definition imports the portType definition via the WSDL “import” statement. Figure 4 shows the specific XML Schema and WSDL files defined for SEMI E125.

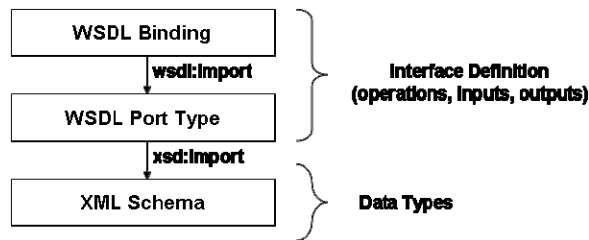


Figure 3
XML Schema and WSDL File Organization

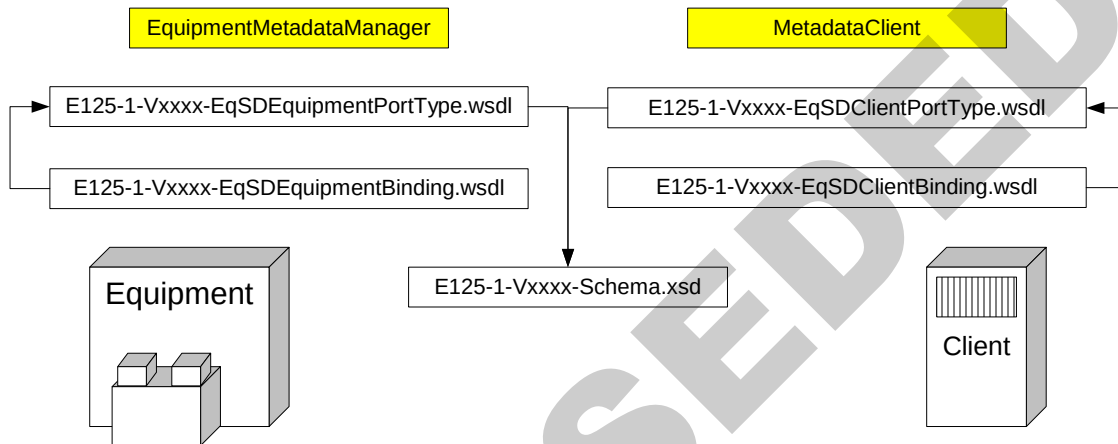


Figure 4
WSDL and XML Schema Files for SEMI E125

7.2 EquipmentMetadataManager

7.2.1 Application of SEMI E132 Sessions

7.2.1.1 Although no special privileges are specified by SEMI E125 in order to access equipment metadata, SEMI E125 information is proprietary to the equipment supplier, and should be protected against unauthorized access within the factory.

7.2.1.2 For this reason, all operations defined by the SEMI E125 EquipmentMetadataManager interface can be exchanged using the HTTPS transport (HTTP 1.1 over SSL 3.0) by enabling SSL authentication as specified in SEMI E132.1. Once enabled via SEMI E132.1, the equipment shall require mutual client-server SSL authentication for all SEMI E125 operations supported by the equipment, and the equipment shall not provide access to any operations except via the HTTPS transport.

7.2.2 There may be some integration, development, and/or test environments in which it is not practical or feasible to install equipment and/or client certificates in order to communicate with the equipment. As a practical consideration for such environments only, the equipment shall support the ability of the user to disable SSL authentication for the SEMI E125 EquipmentMetadataManager interface, using the equipment configuration specified by SEMI E132.1. Users should be aware that disabling SSL authentication opens up complete unrestricted access to SEMI E125 data for any application with network access to the equipment.

7.2.2.1 Regardless of whether or not SSL authentication is enabled, the equipment shall reject all requests from clients that do not provide a valid SEMI E128 session identifier in the SOAP envelope header provided with the request. The SEMI E128 session identifier shall be provided via the SEMI E128 SyncHeader element, as specified by SEMI E128. If a client does not provide a recognized session identifier, the equipment shall immediately reject the request using the SEMI Common Error data type, with an error code of '6005' and a source of 'urn:semi-org:E132' as specified in SEMI E132.1. The equipment shall perform no other processing of a SEMI E125 request if the request is found to include an invalid SEMI E132 session identifier, or if no session identifier is provided.

7.2.3 Use of Common Error Type

7.2.3.1 This specification does not define any SEMI E125-specific error codes, but reserves the common error type “source” name of “urn:semi-org:E125” for future use.

7.2.4 XML Schema and WSDL Files

7.2.4.1 The XML Schema and WSDL defined by this specification for the EquipmentMetadataManager interface is contained in the following documents:

Table 9 XML Schema

<i>File Name</i>	E125-1-V0310-Schema.xsd
<i>Target Namespace</i>	urn:semi-org:xsd:E125-1.V0310.esd
<i>Imported/Referenced Namespaces</i>	urn:semi-org:xsd:E120-1.V0310.CommonEquipmentModel urn:semi-org:xsd:E138.V0709.ccs http://www.w3.org/2001/XMLSchema
<i>Description</i>	This file defines all of the E125 data types and elements used by both the EquipmentMetadataManager and MetadataClient interfaces.

Table 10 EquipmentMetadataManager PortType Definitions

<i>File Name</i>	E125-1-V0709-EqSDEquipmentPortType.wsdl
<i>Target Namespace</i>	urn:semi-org:ws:E125-1.V00310.EqSDEquipmentPortType
<i>Imported/Referenced Namespaces</i>	urn:semi-org:xsd:E128.V0706.xms urn:semi-org:xsd:E125-1.V0310.esd http://schemas.xmlsoap.org/wsdl/ http://www.w3.org/2001/XMLSchema
<i>Description</i>	This file defines all of the input/output messages and operations for the EquipmentMetadataManager interface, based on the data types defined in the SEMI E125 XML Schema.

Table 11 EquipmentMetadataManager Binding Definitions

<i>File Name</i>	E125-1-V0310-EqSDEquipmentBinding.wsdl
<i>Target Namespace</i>	urn:semi-org:ws:E125-1.V0310.EqSDEquipmentBinding
<i>Imported/Referenced Namespaces</i>	urn:semi-org:ws:E125-1.V0310.EqSDEquipmentPortType http://schemas.xmlsoap.org/wsdl/soap12/ http://schemas.xmlsoap.org/wsdl/
<i>Description</i>	This file binds the abstract portType definition to HTTP and SOAP, specifying required SOAP and HTTP headers for each operation and the XML encoding style.

7.2.4.2 These documents are a part of this specification and should accompany this document. The contents of these documents constitute the core part of this specification.

7.2.5 WSDL Port Type Overview

7.2.5.1 The EquipmentMetadataManager WSDL portType definition organizes the SEMI E125.1 XML Schema data types into a collection of named operations with inputs and outputs that correspond to the UML operations that are defined for the EquipmentMetadataManager interface in SEMI E125. The WSDL portType itself is named after the SEMI E125 interface, and each WSDL portType operation is named after the corresponding UML operation defined for the interface. Each WSDL operation consists of two WSDL message definitions corresponding to the input and output (request and response) for the UML operation defined in SEMI E125. Figure 5 illustrates the relationship between the SEMI E125 UML interface and the WSDL portType definition; Table 12 describes this in tabular form. The WSDL message and operation definitions are described in §§ 7.2.8–7.2.16.

7.2.5.2 Detail for the port type operations for the EquipmentMetadataManager are defined in the wsdl files listed in Table 12.

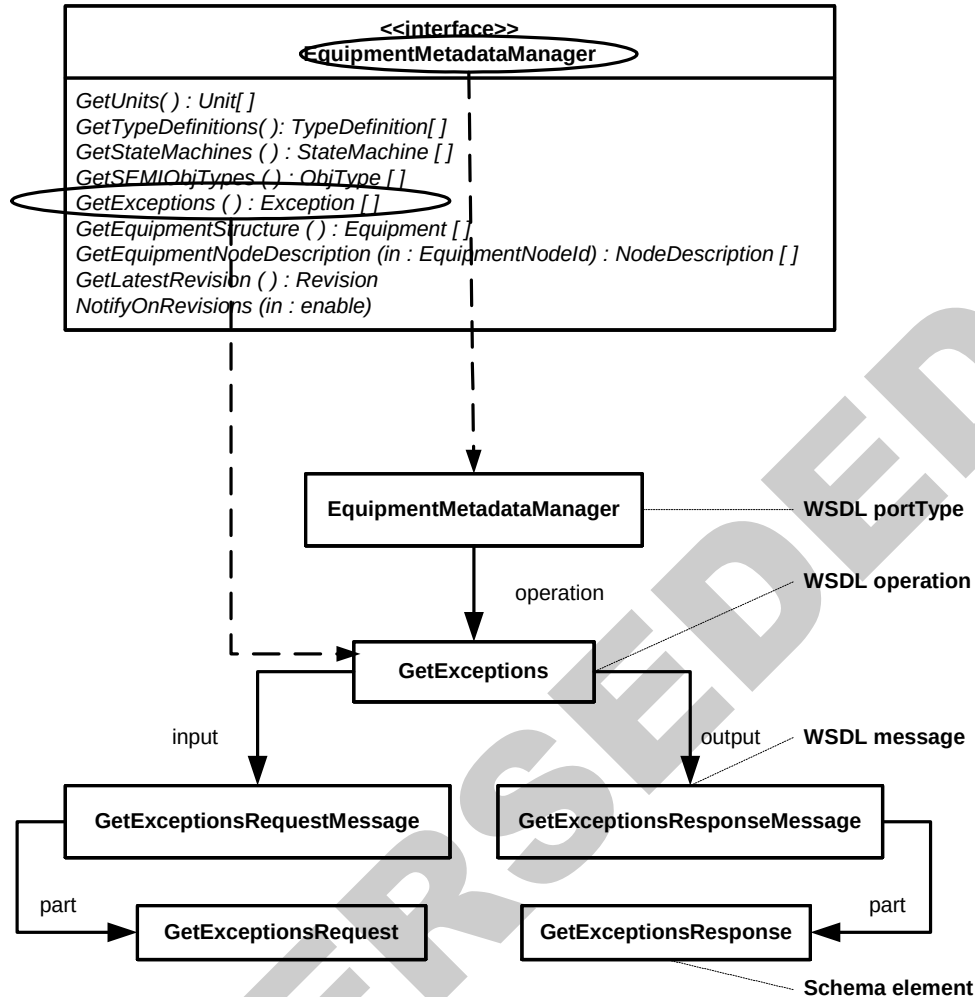


Figure 5
Mapping the EquipmentMetadataManager to a WSDL portType

Table 12 EquipmentMetadataManager Port Type

SEMI E125 Class Name	EquipmentMetadataManager
WSDL Port Type Name	EquipmentMetadataManager
SEMI E125 Operation → WSDL Operation	GetUnits → GetUnits GetTypeDefinitions → GetTypeDefinitions GetStateMachines → GetStateMachines GetSEMIObjTypes → GetSEMIObjTypes GetExceptions → GetExceptions GetEquipmentStructure → GetEquipmentStructure GetEquipmentNodeDescriptions → GetEquipmentNodeDescriptions GetLatestRevision → GetLatestRevision NotifyOnRevisions → NotifyOnRevisions

7.2.6 WSDL Binding Overview

7.2.6.1 The WSDL EquipmentMetadataManager binding definition specifies a message and transport protocol to use for a given portType (SOAP and HTTP for SEMI E125.1), as well as the interface style used (document style

for SEMI E125.1). These settings are shown in Table 13. For each WSDL portType operation, the binding defines any SOAP headers used and whether or not they are required, the Content-Type header “action” value to use for that operation, and the XML encoding to use (literal). The binding definitions for each portType operation are described in §§ 7.2.8–7.2.16.

7.2.6.2 Details for the binding operation for the EquipmentMetadataManager are defined by the wsdl file in Table 11. The SOAP action used in all EquipmentMetadataManager operations uses the binding target namespace from Table 11 followed by a colon and the operation name (i.e., soapAction = <binding target namespace>:<operation-name>).

soapAction = “urn:semi-org:ws.E125.V0310.EqSDEquipmentBinding:<operation-name>”

Table 13 EquipmentMetadataManager Binding

<i>SEMI E125 Class Name</i>	EquipmentMetadataManager
<i>WSDL Binding Name</i>	EquipmentMetadataManagerBinding
<i>SOAP Binding Style</i>	document
<i>SOAP Transport</i>	http://schemas.xmlsoap.org/soap/http

7.2.7 WSDL Service Overview

7.2.7.1 This specification does not provide a WSDL service definition. WSDL service definitions provide one way to define and locate the endpoint(s) at which a given interface can be accessed by a client. Such information cannot be determined until the equipment has been installed on a factory network, and therefore is out of scope for this specification. Users are responsible for defining the mechanisms by which clients locate SEMI E125 equipment services in the factory.

7.2.8 GetUnits

7.2.8.1 WSDL Operation Binding

7.2.8.1.1 See the operation binding for “GetUnits” in the binding wsdl file. Key information for the binding operation is shown for convenience in the following table.

Table 14 GetUnits Operation Binding

<i>SOAPAction</i>	<binding target namespace>:GetUnits
<i>Input Headers (WSDL Message, Required)</i>	SyncHeaderMessage, required
<i>Output Headers (WSDL Message, Required)</i>	SyncHeaderMessage, required

7.2.8.2 WSDL PortType Operation

7.2.8.2.1 See the port type operation definition for “GetUnits” in the port type wsdl file. Key information for the port type operation is shown for convenience in the following table.

Table 15 GetUnits PortType Operation

<i>Input Message Name</i>	GetUnitsRequestMessage
<i>Output Message Name</i>	GetUnitsResponseMessage

7.2.8.3 WSDL Message(s)

7.2.8.3.1 See the message definitions for “SyncHeaderMessage”, “GetUnitsRequestMessage”, and “GetUnitsResponseMessage” in the corresponding port type wsdl file. Key information is shown for convenience in the following table.

Table 16 EquipmentMetadataManager Binding

<i>Message Name → Schema Element Name</i>	SyncHeaderMessage → xmlns:SyncHeader GetUnitsRequestMessage → esd:GetUnitsRequest GetUnitsResponseMessage → esd:GetUnitsResponse
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7.2.8.4 XML Schema Types

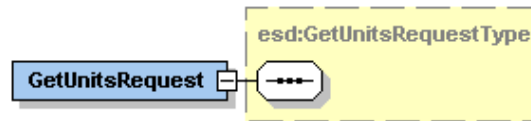


Figure 6
GetUnitsRequest Global Element

7.2.8.4.1 *GetUnitsRequest* — This global element acts as a top-level container entity representing the SOAP body of a GetUnits request. As defined in SEMI E125, this operation has no input arguments, so the element has no contents.

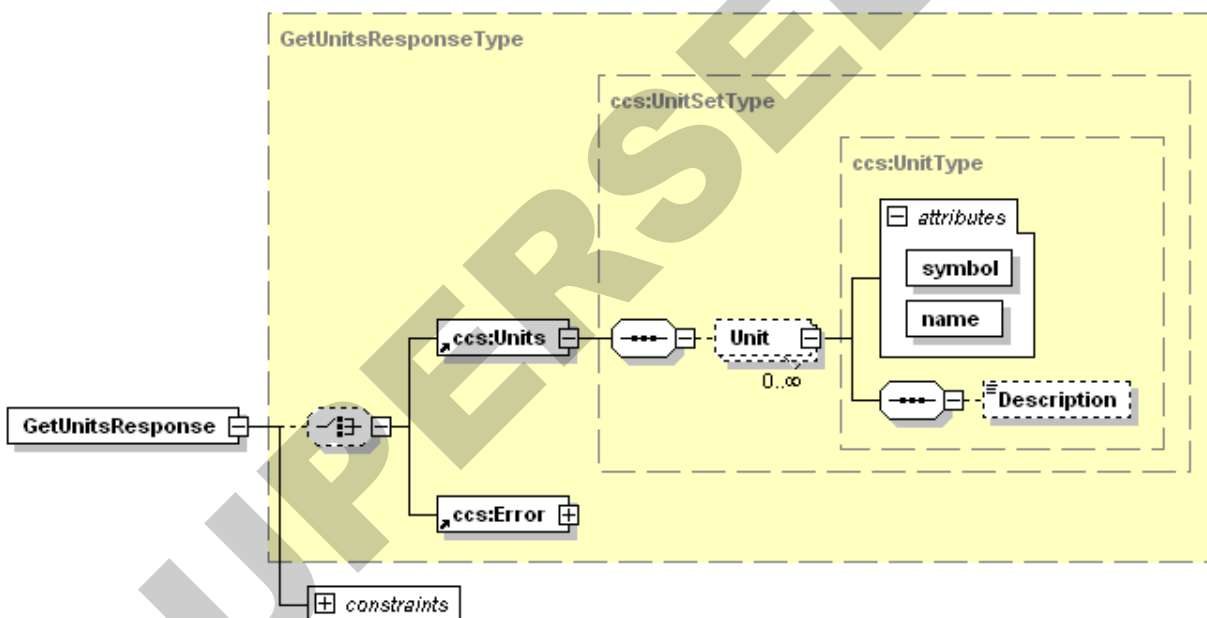


Figure 7
GetUnitsResponse Global Element

7.2.8.4.2 *GetUnitsResponse* — This global element acts as a top-level container entity representing the SOAP body of the response to an SEMI E125 GetUnits request. It contains either zero or more elements named “Units” of complexType “UnitSetType” that represent a collection of “UnitType” or an element named “Error” of complexType “ErrorType”, as defined in SEMI E138.