# Electronic Component Information Exchange (ECIX)

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## Abstract

A number of industry trends are shaping the requirements for IC and electronic equipment design. The density and complexity of circuit technologies have increased to a point where design cannot be performed without EDA tools. The availability of completely designed and verified reusable design components has become a major impediment to meeting required design productivity goals. Design reuse is moving down the package hierarchy to include chip design in addition to PCA design.

At the same time, the widespread use of Internet and Worldwide Web technologies offer component suppliers global access to customers, and component users access to suppliers, worldwide. To realize the full potential of modern technology, it is necessary that a level of consistency be defined and used to represent component information. Standard formats for datasheets and standard terminology within datasheets aids customers in their analysis and value-comparison of components from multiple suppliers. Additionally, standards are required to facilitate software tools than can help automate current manual processes to populate customer's Component Information System (CIS) databases and generate CAD libraries from this component information.

Electronic Component Information Exchange (ECIX) is a multi-company project that is focused on the development of standards and architecture that supports the flow of component information from suppliers to all potential customers in a manner that improves productivity for:

- Component suppliers
- Information suppliers
- Component engineering
- CAD library development
- Product designers

By working collaboratively, these companies are able to tackle a problem that is too large for any individual company, yet minimizes development cost. Even though they are all business competitors, they are committed to cooperation for the development of ECIX as its success will provide industry-wide benefits to all.

## ECIX Architecture Overview

ECIX has an open-industry, standards-based architecture that supports the creation, distribution, and use of datasheets for components used on printed circuit assemblies, multi-chip modules, and integrated circuit chips. The overall goal of ECIX is to provide a seamless flow of component information from its supplier to the customers and CAD tools that use this information.



The ECIX architecture supports datasheet distribution across the Internet and Worldwide Web as well as conversion to all popular media formats, such as hardcopy and electronic print formats (e.g., Portable Document Format (PDF) and PostScript™). ECIX presents component information in a format that can be directly used by both humans and computers. The content of ECIX

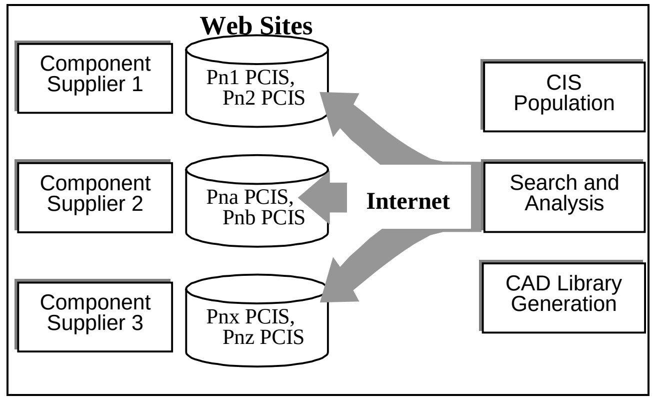


**Figure 1. ECIX Flow**

datasheets is represented in a manner that is unambiguous, which facilitates comparative analysis of components supplied from different vendors.

ECIX accomplishes its goals through the use of three open standards, namely: a datasheet format standard; an electronic dictionary for component terms; and, a standard definition of the basic component characteristics that are required for components based on their classification.

### ECIX Datasheets

The foundation of the ECIX architecture is an SGML (Standard Graphic Markup Language) standard definition for component datasheets. This SGML application is the Pinnacles Component Information Standard (PCIS), which was developed by Hitachi America, Intel Corporation, National Semiconductor, Philips Semiconductors and Texas Instruments.

SGML is an ISO standard (ISO8879) that defines a formal method of structuring and identifying information. Information fragments can then be extracted, operated upon, and formatted, updated, etc., by computer programs. Information fragments are identified with predefined tags that uniquely define the information content meaning and syntax. These tags allow computer automation to parse the document and perform operations on fragments of the information based on their tag. Such operations might include the following:

- Extract information fragments with specific tags (e.g., extract all information tagged as <*package.info*>).
- Convert all fragments contained within selected tags to a specific format (such as, convert the content within <*datasheet.body*> to PostScript).
- Perform special formatting on selected (e.g., <*highlight*>) based on the target media (hardcopy versus display).
- Generate another data format for information fragments with specific tags (e.g. create a schematic editor symbol library from information tagged as <*connections*>).

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PostScript is a registered trademark of Adobe Systems, Inc.

By structuring information in this way, it is possible to perform computer operations on a datasheet without regard to its semantics, but only its structure. This ability to extract or replace specific elements of a datasheet document, via computer automation, is fundamental to the ECIX architecture for improving the productivity for all intended customers.

The formal specification for PCIS is an SGML Document Type Definition (DTD) which provides the information model for each PCIS tag. The DTD is used by SGML editors and readers to create, parse, and interpret information fragments within the PCIS datasheet.

Use of the Internet to distribute datasheets often begs the question of why PCIS is not HTML. HTML can be viewed as an SGML application, though not all variants of HTML are explicitly compliant with SGML. HTML, however, has a limited set of tag definitions that support mainly document formatting. PCIS, on the other hand, is a fully compliant SGML application with a rich set of tags that support not only document formatting but also, identification of data types related to component datasheet information. Further, as an SGML application, document style sheets can be released with the datasheets which allow the supplier to define how the datasheets body is to be rendered in print. In HTML, this is a function of the browser.

There are 271 tags defined in PCIS to represent the comprehensive set of information used in datasheet publication. These tags include:

- Named datasheet divisions for Absolute Maximum, Architectural Functional Description , Features Summary, Instruction Set Information, Memory Map, Package Information, Pinout Information, Product Characterization Information, Register Sets, and Soldering and Mounting
- Product summary data tags
- Level and version management tags
- Product specification tags for characteristic parameters, measurement conditions, connector information, and model references
- Complex table definition tags
- Audiovisual tags which reference encapsulated graphic, audio, video, or custom program objects that can be executed in real-time (e.g., by a browser)

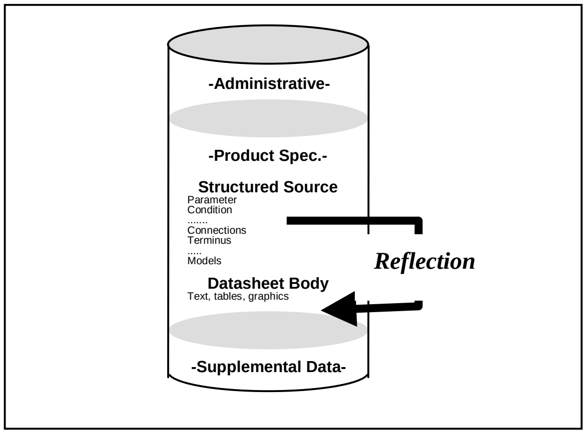


**Figure 2. PCIS Datasheet Structure**

PCIS Version 1.2, which was published in November 1995, documents the ECIX standard method to represent datasheets. PCIS structured datasheets offer their creator many advantages over plain, information-based formatting. For example, templates of required data content can easily be defined using the PCIS DTD and used with an SGML editor to guide the authoring process. This can assure the consistency and maintainability across all datasheets produced by a corporate enterprise.

The PCIS DTDs are modularized, and define the structure for major sections of the datasheet. The major sections include:

- Administrative information
- Structured product specification information (*Source*)
- Datasheet body (prose, tables, lists, graphics)
- Supplemental information, which may include application notes, environmental data, and reliability data

PCIS does not prescribe what the content of a datasheet must be, but does define the structure and the SGML tags for all contextual elements that the author chooses to document for the component.

**Administrative Information**

The Administrative Information section of the PCIS contains:

- Document identification (public identifier, title, literature order number, date, version, and revision history)
- Owner identification (company name, company address, company ISBN prefix)
- Creator identification (name of owner or owners, author name, author address)
- Product identification (product name, part number, ordering information)

**Source**

A significant feature of PCIS is that it provides the capability to define information fragments once and reference them many times throughout the datasheet. This feature, called Source, is used to define the component parameters once and substitute their values wherever needed throughout the entire datasheet. This greatly aids the change management process, and is an essential feature to support the use of PCIS datasheets by software automation.

The Source section provides a highly structured specification of the component. This structuring of the component characteristics provides the basis for PCIS computer sensibility. Source contains:

- Component characteristics measured under specified conditions (i.e., a parameter, one or more values, pointers to conditions under which the parameter was measured, connections that were part of this measurement, testing information, descriptive text, etc.)

  The characteristic's PCIS structure consists of the parameter symbol, the dictionary standard where the parameter is defined, any informal description and its formal definition.

  The parameter value structure contains the number or expression or range, order of magnitude, units, and value type (min, max, typical,...)

- Characteristic conditions, which may be specified for each measured characteristic (i.e., condition parameter, value, pointers to other conditions in effect at the time this condition's value was stated, testing information)

- Connection information for logical placement of the component (i.e., connector name, mnemonic, description, type)

- Terminus information for physical placement of the component
- Model information (model format, file format, publication date, associated model, author information, revision history)

The <*mode.info*> tag provides a standard method to reference any CAD model. This tag specifies the model type e.g., SPICE, Verilog or VHDL and its location (file name). The model itself is not contained within the datasheet, but is instead pointed to from the datasheet through use of this tag. Attributes specified within <*model.info*> provide administrative information about the model and in the future, will describe additional model properties, such as its level of detail based on the "RASSP VHDL Modeling Terminology and Taxonomy".

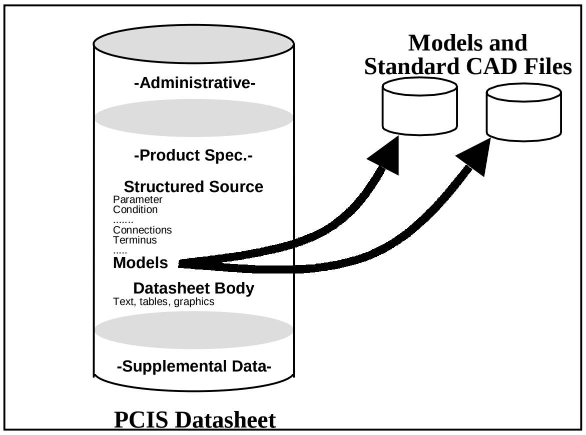


**Figure 3. CAD File Wrapper**

This feature of PCIS is extensible to any standard CAD file. In the future, for example, it will be used to refer to DCL libraries for ASIC delay and power calculation and to the Virtual Sockets Interface Alliance (VSIA) defined standard formats for soft, firm and hard on-chip components (e.g. cores).

### Datasheet Body

The datasheet body contains prose, tables, lists and graphics that are associated with today's datasheets. This is the human sensible product specification and is often rendered into a formatted display as well as hardcopy or some other print file format. In addition, this section may contain hyperlinks to information such as audiovisual objects.

PCIS provides an <*avo*> tag to reference graphic elements that are to be inserted into the datasheet. These may be logic diagrams, schematics, flow charts, graphs, etc., each of which can be defined in a standard manner. Additionally, <*avo*> can be used to insert audio clips, video clips, or even information that is to be viewed with special software browsers. An example of the latter case may be a waveform description for the component that can be viewed with an interactive viewer that provides dynamic formatting of the timing diagram.

### PCIS Features

PCIS contains a formal definition for substitution of component characteristic throughout the datasheet. This feature is referred to as reflection. Measured component characteristics and specified conditions at which the measurements were made are defined within the Source of the datasheet. These parameters may then be reflected into tables or lists within the datasheet body. This is accomplished by referencing a Source characteristic or condition by a unique *id (see Figure 2)*. The *id* is a unique identifier for each Source element (characteristic or condition) which may be referred to by a <*reflection*> tag within the body of the datasheet. This reference may be made from any information fragment within the datasheet body. The <*reflection*> tag triggers a substitution or reflection of the Source element by a parser, browser or other PCIS application when processing the datasheet. In a typical application, these *source* elements are not displayed stand-alone, but are displayed only within the context of the datasheet body. However, PCIS applications that populate CIS databases, or generate CAD libraries, can use these *source* elements directly, without having to parse the datasheet body at all.

Use of reflection offers three distinct advantages for PCIS datasheets. First, it allows component characteristics to be specified or changed in only one place, thereafter automatically substituting into the proper places within the datasheet body. This eliminates time consuming and error-prone manual processes that might otherwise be required when maintaining datasheets (i.e., manually editing a parameter's change every place it appears within the datasheet). Secondly, it offers a single reference to the pertinent component characteristics required by the CAD libraries and CIS databases. Third, by structuring these *source* elements, computer software can extract component characteristics from the datasheet authoring tools in a format that can be directly used by that software. This further enhances the datasheet creation process.

### PCIS Publishing

A common method currently used by semiconductor companies today is to publish overview information about available components on the Worldwide Web via HTML and the detailed datasheet is presented in PDF or PostScript form. Once the customer has analyzed the HTML summary data and selected the component of potential interest, he/she may then order that datasheet or download its PDF or postscript files that contain the actual datasheet. Since viewers and print drivers are readily available for these popular document formats, this methodology works well for human access to the component's information. However, as with HTML, it does not support the computer sensibility goals of ECIX as these formats do not support computer recognition of the information fragments or automated use of the information.

SGML-based PCIS datasheets can be used in the same methodology as that provided today in HTML, but also enable the required computer sensibility. SGML browsers allow the customer to view PCIS datasheets on-line. SGML applications can render the PCIS datasheets into hard-copy based on format style sheets provided with the datasheet. SGML datasheets can be parsed and used by computer applications. And, for those not ready for total change, SGML filters can be developed to produce PDF or PostScript print files from PCIS datasheets with the reflections fully expanded.

## Datasheets from Multiple Suppliers

It is possible for different component suppliers to specify components of a given class (e.g., memory, logic, microprocessors, ASIC cells, etc.) with different terminology for identical characteristic parameters, or with like terminology for characteristics that that are actually defined differently. Use of standard dictionaries for component terms greatly decrease the risk of this problem. However, since multiple terms dictionaries exist (e.g., IEC1360 and JEDEC JEP104A, JESD77A, JEDEC99, JESD100A), it is still possible that ambiguity will result across different datasheets. In addition, since these dictionary standards are in themselves only human sensible, their use is subject to human error.

Another situation that can arise is that characteristics or conditions not defined within any standard dictionary may be needed to support new component products or technologies. In these cases, the component vendor must use non-standard terminology for the component until a standards dictionary has defined them. This increases the possibility that PCIS application software will be presented with ambiguous terminology across multiple component suppliers which will require human interaction to reconcile.

To address the ambiguity problem, PCIS defines a tag used to reference the dictionary where the characteristic terms are defined. Current development is adding tags to refer to a particular entry within that dictionary. For example, the value for $t_f$ might look like the following within a PCIS instance:

```
<PARM ID="k177">
  <PARM.SYMBOL STD="IEC7U8" ID="k178"
ref="a3">t<SUB>f</SUB></PARM.SYMBOL>

  <PARM.DESC ID="k179" ref="a1">fall time </PARM.DESC>
</PARM>

 <CC.VALUE VALUE.TYPE="MIN" ID="k180">
  <NUMBER ID="k181">4.5</NUMBER>
  <ORDER.OF.MAG ID="s27"></ORDER.OF.MAG>
   <UNIT ID="k182" ref="a7">ns</UNIT>
</CC.VALUE>
```

**Example 1. CIDS Reference from PCIS**

In this example, the *<parm.symbol.std>* tag is used to reference the dictionary (IEC7U8) that defines the characteristic ($t_f$) being specified. Ultimately, PCIS datasheets will provide a specific reference to location within the Dictionary where the term is defined (in the example, *ref="a1"* points to a specific term in IEC7U8 Dictionary. This provides the basis for PCIS applications to greatly reconcile terminology used for *source* elements across different supplier datasheets.

In addition to the terms ambiguity problems, there is no standard operating conditions at which characteristics are measured for components. This complicates automating the creation of CIS databases and EDA libraries. Identical parameters for components

```
< PROD.INFO ID="P1843">
< SOURCES>< CN.SOURCE ID="k7">

< CN STATIC="1" ACOUSTIC="0" CHEMICAL="0"
ELECTRIC="0" MAGNETIC="0" MECHANIC
AL="0" OPTICAL="0" RADIATION="0" THERMAL="1"
TIMING="0" ID="k13">

< PARM ID="k14">< PARM.SYMBOL STD="IEC7U7"
ID="k15">T< SUB>amb</SUB></PARM.SYMBOL>

< PARM.DESC ID="s786">ambient temperature range
</PARM.DESC>
</PARM>

< CN.VALUE VALUE.TYPE="SPEC" ID="k16">

< RANGE ID="k17">-40 to +85</RANGE>

< ORDER.OF.MAG ID="s2></ORDER.OF.MAG>

< UNIT ID="k18">deg C</UNIT</CN.VALUE>

</CN>
```

**Example 2. Characteristic Conditions**

from different suppliers may be values measured at different operating temperatures or load conditions. It is desirable that CIS databases have parameters represented for the same operating conditions for similar components. Without this, it is left to the customer to determine the true differences between two components. While PCIS does nothing specific to solve this problem, it does provide standard tags to specify the operating conditions under which parameters are measured. This facilitates the manual process to reconcile specified measurement conditions for component parameters across datasheets from different suppliers.

The structure of characteristic conditions can be seen in an example, such as an ambient temperature of between -40 and +80 degrees.

## Component Information Dictionary Standard (CIDS)

The ECIX architecture provides an SGML based computer sensible terms dictionary called the Component Information Dictionary Standard (CIDS). The CIDS dictionary is based on the IEC1360-2 information model for electronic component data elements. The ECIX standard dictionary is defined by the CIDS DTD and is populated with dictionary terms from both IEC 1360-4 and JEDEC. This dictionary is, therefore, computer sensible, populated with industry standard terminology, and usable by PCIS software applications.

CIDS may be used in both the creation and usage of PCIS datasheets. During datasheet creation, editing tools can look-up a parameter's formal definition and provide the dictionary reference based on user queries. Alternately, the authoring tool may render allowable CIDS terms in a format more in line with its normal SGML capability and user interface. Additionally stand-alone CIDS lookup tools can be written which alleviate the need for datasheet editing tools to be modified.

A PCIS application that updates a CIS database may make use of the CIDS to reconcile vendor terminology to its own unique syntax. Here, the software application may be created with a precise mapping from all CIDS terms to its own.

To support advanced components that use terminology not yet standardized, additional dictionaries using the same CIDS DTD may be created. The ECIX architecture provides for the definition of a search path that is used to direct application look-up of terms across multiple CIDS dictionary instances.

For example, a dictionary for not-yet-standard but widely used parameters may be provided. Terms within this dictionary are destined for industry standardization and once standardization is complete, they may be removed from this dictionary, as they will

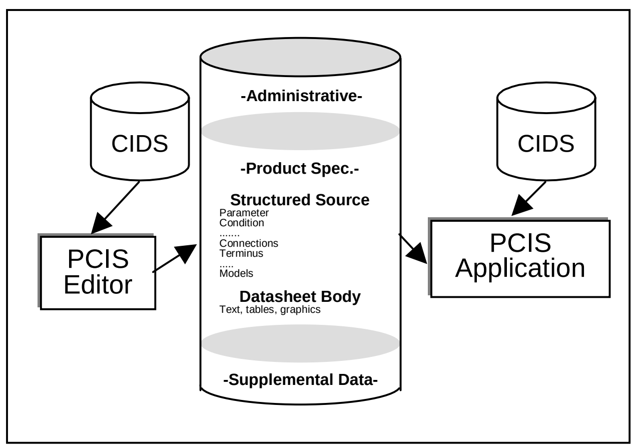


**Figure 4. CIDS**

be added to the ECIX standard dictionary. In this case, the search path would define the ECIX standard dictionary as the first to search, followed by the non-standard dictionary.

Supplier unique dictionaries, for instances where advanced components require company-unique terminology definitions may also be provided. In this case, the CIDS defined dictionary is created by and released from the component vendor. In this case, the search path might define the supplier unique dictionary as the first to search, followed by the ECIX standard dictionary.

### Base Terms Template Standard (BTTS)

To feed automation tools that populate CIS databases and create CAD libraries, it is required that a minimum set of information be present within the PCIS-compliant file. This set of information varies based on the class of component being documented. For EDA libraries, this minimum set must support creation of the complete set of libraries necessary for the full scope of design tools (e.g., for ASICs this would be synthesis, floorplanning, layout, parasitic extraction, simulation, timing analysis, mask generation, etc.).

To support CIS database population from multiple supplier PCIS information, a level of availability and consistency of additional information is also desired. This is necessary for effective analysis of the merits of competing components from different suppliers. Required information to support this analysis may include descriptions of packaging, availability, reliability, etc. This is a more subjective specification (as opposed to the preciseness of information required for EDA libraries) and specification of this information is based on a consensus of component information users (i.e., component engineering, design engineering, etc.).

To define the required PCIS information content, ECIX supplies a specification of required information for unique classes of components (memory, logic, microprocessors, ASICs, etc.), and by EDA tool type (schematic capture, synthesis, simulation, etc.)

The ECIX BTTS is defined by a DTD and is actually a blank PCIS instance of the minimum information content for each component class. It contains the required characteristic parameters and other required datasheet fragments but without any values. In this way, BTTS serves as a template for datasheet creation. With this template, software can be written to guide datasheet authoring and ensure the basic information is contained in the PCIS datasheet. Additionally, software can be written to test any existing PCIS datasheet for compliance, before it is accepted by the customer.

## Status

The ECIX effort is not complete. Except for the PCIS standard, much of the architecture still needs to be proven in industry. ECIX, like all standards, will be measured by its level of adoption. Of particular importance will be the acceptance and adoption of PCIS as a basis to describe component datasheets by a broad set of suppliers. To capture their attention, suppliers will want to have visibility to companies already using PCIS, tools to aid the creation of PCIS datasheets, and assurance that application software and that strong customer pull is present.

Semiconductor companies participating on ECIX are each at various stages of creating and releasing PCIS datasheets. Support tools for PCIS authoring are now becoming commercially available. A small number of companies are beginning to develop PCIS application software. Completion of each of these activities will assure additional supplier adoption.

At the same time, PCIS is being extended to provide even broader coverage and to alleviate certain usability problems. With this, a formal analysis of PCIS usage at customer locations will be carried out to assure that it can achieve the required productivity improvements for its customers.

## Conclusions

There are hundreds of component manufacturers worldwide who produce more than 100,000 unique components. Each day, hundreds of new components are introduced and hundreds are rendered obsolete. Customers need better ways to access the current information for the active components and better methods to translate it into the format they want. Today, design and component engineers spend 25%-50% of their time selecting, qualifying and documenting components. After a component is selected, it costs hundreds to thousands of dollars to enter it into their local CIS database and much more to create and qualify the CAD libraries. Moreover, at the same time, the time-to-market pressures are increasing and the need for reusable components to systems-on-a-chip design.

ECIX promises to provide significant relief on several fronts:

- It will eliminate the proliferation of paper databooks which can save component suppliers millions of dollars in printing, stocking and shipping
- It will assure the customer of the latest and most current component information because the datasheets will be instantly available worldwide for each and every change released
- Customers will have access to worldwide supplier information because of the proliferation of the Internet
- Suppliers will be able to reach customers worldwide because of the proliferation of the Internet
- Time and cost to populate useful information into CIS databases will decrease significantly due to the consistency in datasheets and elimination of ambiguous terminology
- Time and cost to create CAD libraries for new components will decrease significantly due to the computer sensible PCIS datasheets
- Sub-chip level "component" information in support of systems-on-a-chip designs will be released and supported in the same manner as are board-level components due to the extensibility of ECIX.

## References


1. "RASSP VHDL Modeling Terminology and Taxonomy", 9/9/96, C.Hein et. al.
2. "Pinnacles Component Information Standard 1.2", November 1995, Pinnacles Group
3. "Standard Data Element Types With Associated Classification Scheme for Electric Components, IEC 1360-4", International Electrotechnical Commission, 1995
4. "Principles and Methods for Defining Standard Data Element Types With associated Classification Scheme for Electric Components, IEC 1360-2", International Electrotechnical Commission, 1995
5. "Reference Guide to Letter Symbols for Semiconductor Devices, JEP104-A", Electronic Industries Associates, 1992
6. "README .1ST, SGML For Writers and Editors", R.C.Turner et. al., ISBN 0-13-432717-9
7. "Pinnacles Group Creates New Standard for EDBs", T.Jeffery, Integrated System Design, 10/96