IPC-2591-Version 1.4

Connected Factory Exchange (CFX)

Developed by the Connected Factory Initiative Subcommittee (2-17) of the Electronic Product Data Description Committee (2-10) of IPC

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Users of this publication are encouraged to participate in the development of future revisions.

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1 SCOPE

This standard establishes the requirements for the omnidirectional exchange of information between manufacturing processes and associated host systems for assembly manufacturing. This standard applies to communication between all executable processes in the manufacture of printed board assemblies – automated, semiautomated and manual – and is applicable to related mechanical assembly and transactional processes.

1.1 Purpose With the growth and acceptance of digital modeling and practices in manufacturing, the lack of a holistic Industrial Internet of Things (IIoT) standard for the transfer of information between machines, systems and processes has become a severe limitation to the growth of digitization and computerization in the electronics manufacturing industry, inhibiting technology innovations such as Industry 4.0 and Smart Factories being available to all companies in the industry, regardless of size, sector and location.

This Connected Factory Exchange (CFX) standard provides a true ''plug and play'' Internet of Things (IoT) communication environment throughout manufacturing, where all equipment, manufacturing processes and transactional stations can communicate with each other without the need for the development and use of bespoke interfaces. CFX-enabled equipment and solutions from different vendors work seamlessly together.

There are many types of users of this CFX standard, including equipment vendors, solution providers, in-house information technology (IT) groups, etc. The many types of data included in CFX are used in different ways depending on the application; for example, closed-loop feedback systems, live production dashboards, traceability (IPC-1782), manufacturing execution systems (MES) control, lean supply chain management, active quality management, production control, etc.

As CFX data is fully omnidirectional, any CFX endpoint connection can consume data as well as create it. As an illustration, consider the scenario in which a single machine from a certain vendor is connected in-line with other machines from different vendors. CFX messages are sent from the single machine to other machines in the line, and to host systems such as MES. The single machine can also receive CFX messages from all other machines in the line, as well as from the host systems in order to optimize the machine operation and enable the vendor of the machines to create added-value functionality, such as to support machine-specific Industry 4.0. In this way, a smart, digital, Industry 4.0 factory will be comprised of many different Industry 4.0 computerization applications, each of which can be provided by different suppliers, at the machine, line, site and even enterprise levels, all working together, sharing data seamlessly through CFX.

This CFX standard supports the concept of big data by including data of different types from across the factory, including performance, materials, resources, users, quality events, product tracking, etc., all of which can be combined to create a big-data environment. CFX, therefore, provides many kinds of added value opportunities to the whole manufacturing operation, including, for example, improving operational efficiency and productivity, quality and reliability, agility and responsiveness. This CFX standard helps organizations ensure that end users/consumers will receive products and services that meet or exceed their expectations and in the timeliest and most economically viable method.

1.2 Application of This Standard This standard defines the communication protocol and content across all assembly production processes, irrespective of type or method of operation. It can also be applied to transactional operations. There are no restrictions in terms of product classification sector, size of operation or location. Surface-mount technology (SMT) production is not required to be a part of the factory. Though intended to support all aspects of printed board production, the use of CFX can be extended downstream to include, for example, mechanical assembly, personalization, packing and shipping, as well as upstream to include, for example, electrical and mechanical subassemblies.

1.3 CFX and the Hermes Standard This CFX standard is complementary to IPC-HERMES-9852. The Hermes Standard, as an advanced, intelligent Surface Mount Equipment Manufacturers Association (SMEMA) standard replacement, provides near-instant line control, passing information about production units as they pass down the line. CFX provides vertical messaging that is complementary to Hermes.

1.4 Updates to This Standard The IPC Connected Factory Exchange Initiative Subcommittee intends to make frequent incremental revisions to this standard to support additional machines and processes. Version updates are identified by version number and the change (added, removed, etc.), so the reader can easily identify changes in each version. See Figure 1-1 for an example of this version change tracking using a portion of the CFX.Maintenance table of this standard as an example.

Appendix A also provides an itemized version history.

All messages in this standard apply to IPC-2591, Version 1.0 and subsequent versions, unless otherwise stated.

Table 8-5 CFX.Materials.Management Messages

Name	Type	Description
BlockMaterial	RR	Specify that a particular material should not be used for any reason.
GetMaterialInformation	RR	A request (typically, to a factory-level software system) to obtain detailed information about a particular material package (or collection of material packages). – *Added v1.1*
MaterialsChainSplit	E	Sent when a certain material package chain has been modified by opening the splice plate and therefore creates two material chains out of one. No new material ID will be created during this use case. This use case is operated on the station. – *Added v1.1*

Figure 1-1 Version Change Tracking Example

1.5 Definition of Requirements The words **shall** or **shall not** are used in the text of this document wherever there is a requirement for materials, preparation, process control or acceptance.

The word ''should'' reflects recommendations and is used to reflect general industry practices and procedures for guidance only.

Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this Standard. The text takes precedence over the figures.

1.6 Order of Precedence The contract **shall** take precedence over this standard, referenced standards and drawings.

In the event of conflict, the following order of precedence applies:

1) Procurement as agreed and documented between user and supplier.
2) Master drawing, design brief or tech pack reflecting the user's detailed requirements.
3) When invoked by the customer or per contractual agreement, this standard.

When documents other than this standard are cited, the order of precedence **shall** be defined in the procurement documents. The user can specify alternate acceptance criteria.

1.6.1 Conflict In the event of conflict between the requirements of this standard and the applicable drawing(s) and documentation, the applicable user-approved drawing(s) and documentation govern.

Some examples of documentation include the contract, purchase order, technical data package, engineering specification or performance specification. In the event of a conflict between the text of this standard and the applicable documents cited herein, the text of this standard takes precedence. In the event of conflict between the requirements of this standard and drawing(s) and documentation that has not been user approved, this standard governs.

1.6.2 Clause References When a clause in this document is referenced, its subordinate clauses apply, unless the requirement references specific subordinate clauses.

1.7 Acronyms See Appendix B for a list of acronyms used in this standard.

1.8 Terms and Definitions Other than those terms listed below, the definitions of terms used in this standard are in accordance with IPC-T-50.

1.8.1 Activity An action performed by an endpoint in the course of performing its function. There are many different types of activities that may be performed, depending on the specific function of the endpoint. Activities may be value added (such as placing components on a printed board), or non-value added (such as a tool change by a pick-and-place machine).

1.8.2 Component The component is a single instance of a bulk material, such as a resistor, capacitor, integrated circuit (IC), etc. Bulk components are normally supplied in material packages.

1.8.3 Dashboard An information management tool used to track key performance indicators (KPIs), metrics and other key data points relevant to a business, department or specific process. Through the use of data visualizations, dashboards simplify complex data sets to provide users with at-a-glance awareness of current performance.