



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES®

IPC-2546 with Amendment 1

Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Assembly



Endorsed by the National
Electronics Manufacturing
Initiative (NEMI)

IPC-2546 with Amendment 1

January 2003

A standard developed by IPC

Supersedes IPC-2546
October 2001

3000 Lakeside Drive, Suite 309S, Bannockburn, IL 60015-1219
Tel. 847.615.7100 Fax 847.615.7101

AVA Documents
Document Sharing Hub
www.ipc.org

The Principles of Standardization

In May 1995 the IPC's Technical Activities Executive Committee adopted Principles of Standardization as a guiding principle of IPC's standardization efforts.

Standards Should:

- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

Standards Should Not:

- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

Notice

IPC Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards and Publications shall not in any respect preclude any member or nonmember of IPC from manufacturing or selling products not conforming to such Standards and Publication, nor shall the existence of such Standards and Publications preclude their voluntary use by those other than IPC members, whether the standard is to be used either domestically or internationally.

Recommended Standards and Publications are adopted by IPC without regard to whether their adoption may involve patents on articles, materials, or processes. By such action, IPC does not assume any liability to any patent owner, nor do they assume any obligation whatever to parties adopting the Recommended Standard or Publication. Users are also wholly responsible for protecting themselves against all claims of liabilities for patent infringement.

IPC Position Statement on Specification Revision Change

It is the position of IPC's Technical Activities Executive Committee (TAEC) that the use and implementation of IPC publications is voluntary and is part of a relationship entered into by customer and supplier. When an IPC standard/guideline is updated and a new revision is published, it is the opinion of the TAEC that the use of the new revision as part of an existing relationship is not automatic unless required by the contract. The TAEC recommends the use of the latest revision.
Adopted October 6, 1998

Why is there a charge for this standard?

Your purchase of this document contributes to the ongoing development of new and updated industry standards. Standards allow manufacturers, customers, and suppliers to understand one another better. Standards allow manufacturers greater efficiencies when they can set up their processes to meet industry standards, allowing them to offer their customers lower costs.

IPC spends hundreds of thousands of dollars annually to support IPC's volunteers in the standards development process. There are many rounds of drafts sent out for review and the committees spend hundreds of hours in review and development. IPC's staff attends and participates in committee activities, typesets and circulates document drafts, and follows all necessary procedures to qualify for ANSI approval.

IPC's membership dues have been kept low in order to allow as many companies as possible to participate. Therefore, the standards revenue is necessary to complement dues revenue. The price schedule offers a 50% discount to IPC members. If your company buys IPC standards, why not take advantage of this and the many other benefits of IPC membership as well? For more information on membership in IPC, please visit www.ipc.org or call 847/597-2872.

Thank you for your continued support.



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES®

IPC-2546

CAMX

– ASSEMBLY

Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Assembly

A standard developed by the Assembly XML Schema Formatting Task Group (2-13b) of the Shop Floor Communications Subcommittee (2-13) of IPC.

The IPC-2546 standard defines an XML encoding schema, specific to printed circuit board assembly equipment, which enables a detailed definition of electronics assembly equipment messages to be encoded at a level appropriate to facilitate plug-and-play characteristics in a factory's shop-floor information system.

This project was initiated by the NEMI Plug-and-Play Factory Project which established proof of concept. After completion, the project leaders recommended standardization by IPC under the ANSI rules and procedures.



Supersedes:

IPC-2546 - October 2001

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

Contact:

IPC
3000 Lakeside Drive, Suite 309S
Bannockburn, Illinois
60015-1219
Tel 847 615.7100
Fax 847 615.7105

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the Assembly XML Schema Formatting Task Group (2-13b) of the Shop Floor Communications Subcommittee (2-13) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

Shop Floor Communications Subcommittee	Assembly XML Schema Formatting Task Group	Technical Liaison of the IPC Board of Directors
Chair Allan Fraser GenRad Inc.	Chair Tom Dinnel Universal Instruments	Stan Plzak SMTC Manufacturing Corp.

Assembly XML Schema Formatting Task Group

Tom Baggio, Panasonic Factory Automation Company	Mike Hamblin, GenRad Inc.	Jim Perilli, MPM Division, Speedline Technologies
Cord Burmeister, Siemens Dematic AG	Nam Hoang, KIC	Jari Pirkola, JOT Automation
Tom Dinnel, Universal Instruments	Dave Kerem, Camalot Division, Speedline Technologies	Mike Rogers, DEK Printing Machines Ltd.
Andrew D. Dugenske, Georgia Institute of Technology	Miles Moreau, KIC	Hannu Ronkainen, JOT Automation
Allan Fraser, GenRad Inc.	Dave J. Morris, Nortel Networks	Bob Voitus, Celestica Inc.
Frank Gearhart, Assembleon	Hitoshi Nakamura, Matsushita Electric Industrial Co. Ltd.	Mark Williams, Motorola
Yoshiyuki Hattori, Matsushita Electric Industrial Co. Ltd.	Bob Neal, Agilent Technologies	
	Andy Oughton, DEK Printing Machines Ltd.	

A special note of thanks goes to the following individuals for their dedication to bringing this project to fruition. We would also like to highlight those individuals who were involved with the initial NEMI program concept and made major contributions to the development of the standard.

Allan Fraser, GenRad, Incorporated	Andy Dugenske, Georgia Institute of Technology	Bob Voitus, Celestica, Inc.
Tom Dinnel, Universal Instruments		Robert E. Neal, Agilent Technologies
Mark Williams, Motorola	David Kerem, Speedline Technologies	

Table of Contents

1	SCOPE	1
1.1	Interpretation	1
2	Applicable documents	2
3	General Requirements.....	2
3.1	Date and Time Notation.....	2
3.2	CAMX Compliance	2
4	Generic Assembly Equipment Events and Message Formats	3
4.1	Dictionary of Common Terms.....	3
4.2	Model of Equipment	4
4.3	Dictionary of Attributes	4
4.4	Dictionary of Nested Elements.....	5
4.4.1	Element: BadBoardMark	6
4.4.2	Element: Fiducial	6
4.4.3	Element: MachineError	7
4.4.4	Element: Parameter	7
4.4.5	Element: Recipe	8
4.4.6	Element: Subsystem	8
4.5	Extensions to IPC-2541 Mandatory Messages.....	8
4.5.1	IPC-2541 <EquipmentInformation> Message	9
4.5.2	IPC-2541 <EquipmentParameterModified> Message	10
4.5.3	IPC-2541 <WaitingforOperatorAction> Message	10
4.6	New Events.....	11
4.6.1	Event: EquipmentPoweringUp	11
5	Specific Assembly Equipment Events and Message Formats.....	12
5.1	Specific Screen Printing Equipment Events and Message Formats (Print).....	12
5.1.1	Dictionary of Screen Printing Terms	12
5.1.2	Abstract Model of Screen Printer Item(s), Lane(s) and Zone(s)	14
5.1.3	Abstract Model of Screen Printer Subsystems (Single Lane, Single Zone)	14
5.1.4	Dictionary of Screen Printing Specific Attributes and Parameters	15
5.1.5	Screen Printing Dictionary of Nested Elements.....	19
5.1.6	Extension to <IPC-2541 EquipmentAlarm> Messages	20
5.1.7	Screen Printing Specific Extensions to <IPC-2541 EquipmentError> Messages.....	21
5.1.8	Extensions to <IPC-2541 EquipmentWarning> Messages	24
5.1.9	Extension to <IPC-2541 EquipmentInformation> Messages	27
5.1.10	Extension to <IPC-2541 ItemInformation> Messages	31
5.2	Specific Adhesive Dispensing Equipment Events and Message Formats (Dispense)	34
5.3	Specific Manual Placement Equipment Events and Message Formats (Manual)	34
5.4	Specific Reflow Equipment Events and Message Formats (Reflow)	34

5.5	Specific Pick and Place Equipment Events and Message Formats (Place)	34
5.5.1	Dictionary of Common Terms	34
5.5.2	Model of Equipment	35
5.5.3	Dictionary of Attributes	37
5.5.4	Dictionary of Nested Elements	38
5.5.5	Extensions to IPC-2541 Mandatory Messages	40
5.5.6	IPC-2541 <EquipmentWarning> Messages	42
5.5.7	IPC-2541 <EquipmentInformation> Messages	47
5.6	Plated Through Hole Placement	53
5.7	Solder Reflowing	53
5.8	Wave Soldering	53
5.9	Final Assembly and Packaging	53
6	The Specific PCB-Assembly Equipment XML-Message Format	54
7	Equipment Flow Event Scenarios – Single Lane Equipment	55
7.1	Scenario 1, Version 1	55
8	2546 XML Schema	69
8.1	BadBoardMarkReport	70
8.2	ProcessDataReport	71
8.3	EquipmentParameterModifiedExtension	72
8.4	EquipmentOutOfComponent	73
8.5	EquipmentErrorSubsystem	74
8.6	ItemRecognitionFailure	75
8.7	ItemDidNotTransferSuccessfully	77
8.8	MaterialHandlerLow	78
8.9	MaterialHandlerInstalled	80
8.10	MaterialHandlerUnInstalled	82
8.11	MaterialHandlerDivisionDown	84
8.12	MaterialHandlerTrouble	86
8.13	MaterialHandlerOutOfComponent	88
8.14	ComponentMisPick	90
8.15	ComponentNotPlaced	92
8.16	MaterialHandlerChanged	94
8.17	ComponentNotRecognized	96
8.18	MaterialHandlerTableInstalled	98
8.19	MaterialHandlerTableUnInstalled	100
8.20	MaterialHandlerDivisionUp	102
8.21	MaterialHandlerRefilled	104
8.22	ComponentReject	106

Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Assembly

Introduction

Factory Information Systems (FIS) form the nervous system of an enterprise, analysing data and delivering information to the machines and people who need to make information-based decisions. These systems provide a bi-directional flow of information between the factory floor and the rest of the enterprise. The National Electronics Manufacturing Initiative's (NEMI) Plug & Play Factory project addressed some critical problems involving factory information system deployment on the electronics manufacturing factory floor. The Plug & Play Factory project focused on the development of standards necessary to achieve interoperability – or, plug-and-play capability – on the factory floor. Activities were comprised of three areas:

- Definition of standards for a software framework that will allow interoperability among software and equipment produced by different vendors.
- Development of process-specific, machine communication interface standards for surface mount equipment. These standards will leverage the Generic Equipment Model (GEM) specification developed for semiconductor equipment and web-based standards for data transmission.
- Establishment of a test-bed manufacturing line to prove the concepts developed by the project.

1 SCOPE

IPC-2546 describes the event message content specific to assembly equipment. This standard **shall** be used together with the IPC-2541 standard entitled "Generic Requirements for Electronics Manufacturing Shop Floor Equipment Communication (CAMX)", which defines the set of messages and key attributes of the generic equipment class used in electronics manufacturing.

The types of processes covered by IPC-2546 include material movement systems like conveyors and buffers, manual placement, automated screen printing, automated adhesive dispensing, automated surface mount placement, automated plated through hole placement, forced convection and infrared reflow ovens, and wave soldering.

1.1 Interpretation

"**Shall**", the emphatic form of the verb, is used throughout this standard whenever a requirement is intended to express a provision that is mandatory. Deviation from a **shall** requirement is not permitted, and compliance with the XML syntax and semantics **shall** be followed without ambiguity, or the insertion of superfluous information.

The words "should" and "may" are used whenever it is necessary to express non-mandatory provisions.

"Will" is used to express a declaration of purpose.

To assist the reader, the word **shall** is presented in bold characters.

2 Applicable documents

The following documents contain provisions, which, through reference in this text, constitute provisions of this standard. All documents are subject to revision. Parties who make agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below.

IPC-T-50	Terms and Definitions for Interconnecting and Packaging Electronic Circuits
IPC 2500	Generic Computer Aided Manufacturing (CAMX) Framework definitions
IPC 2511	Generic Computer Aided Manufacturing (GenCAM) descriptions for Printed Circuit Boards and Printed Board Assemblies
IPC 2541	Generic Requirements for Electronics Manufacturing Shop Floor Equipment Communication (CAMX)
IPC 2547	Sectional Requirements for Specific Printed Circuit Board Inspection and Test Equipment

3 General Requirements

The requirements of IPC-2541 are a mandatory part of this standard. That document describes the generic requirements for the CAMX format.

3.1 Date and Time Notation

All 2540 standards **shall** use the World Wide Web consortium (W3C) date time standard. This standard **shall** use the Complete Date plus Hours, Minutes, Seconds, and a decimal fraction of a second and Time Zone Designator. Two decimal places will be used in order to represent time down to a hundredth of a second. For additional information on date and time, see web page:

<http://www.w3.org/TR/1998/NOTE-datetime-19980827>

3.2 CAMX Compliance

The IPC-2501 document defines a message packet structure. The IPC-2541 document defines a set of Equipment, Recipe, Item, and Operator events and related message formats. All screen printers, adhesive dispensers, surface mount placement machines, through hole placement machines, forced convection and infrared reflow ovens, final assembly and packaging equipment that comply with the IPC-2546 standards **shall** also comply with the event messages contained in the IPC-2541 standard as well as those events that are described in this document. All event messages **shall** be formatted in compliance with the IPC-2501 message packet structure.

4 Generic Assembly Equipment Events and Message Formats

4.1 Dictionary of Common Terms

AirSupply

The source of the air supplied to operate the machine elements. One of possibly many sources of energy used to run the machine.

Controller

The device that directs the operation of a part of the machine. Some examples are motion or vision or sequence controllers.

Environmental Control Unit (ECU)

A subsystem that monitors and controls the overall temperature and humidity of the machine.

Inspection

The technique used to analyse the quality of the process.

ItemRecognition/Vision System

A subsystem that captures images of the items being processed. The ItemRecognition/Vision System is typically used for alignment, locating features, and inspection.

MaterialSupplyArea

The area in the machine where material is supplied to the machine. This could be a feeder area, tray area, glue area, adhesive area etc.

Network

Any software or hardware related to a network connect.

OperatingSystem

This is the software environment used by the controllers.

PowerSupply

The source of the voltage and current to operate the machine elements. One of possibly many sources of energy used to run the machine.

Process

The sequence of events required to locate and align the product and perform a specific machine operation.

Safety

The protection mechanism to keep a human from harm or injury.

Scanner

This is used to scan: items, components, feeders, material. Some examples of are specific id tags are: i.e. barcode, 2D barcode, linear barcode, touch memory cell, RF tag.

Software

Any software that is used on the machine.

Tooling

The mechanism used to support the product during the machine operation.

Transport

The mechanism required to implement the following:

- To load the product into the machine before a process begins.
- To secure the product in the machine during the machines operation.
- To unload the product after the machine operation is complete.
- Protocol (messages or signals) between this machine and the upstream and downstream machines.

VacuumGenerator

A system used to generate the vacuum in the machine.

Verification

This is a system that validates a process. It can be a camera, electrical probe etc.

4.2 Model of Equipment

Under Consideration*

4.3 Dictionary of Attributes

Attribute Name	Attribute Type	Description
command	string	A Specific action associated with a recipe step
designator	string	Identifies a unique location on the board.
description	string	Human readable description of the error
errorType	string	Describes the type of error message.
fromParameterValue	string	Value of parameter before change
imageId	string	The IPC-2510 Image. This is typically a single circuit in the panel array
imageShape	string	Shape of the image. Some types are Disc, Rectangle, Swiss Cross, Donut, Diamond, etc.
imageType	enumerated string	LOCAL GLOBAL
increment	double	Resolution of a parameter
informationType	string	Describes the type of information message.
laneList	string list	Identifies the lane(s) executing a recipe
maximum	double	Maximum value of a parameter
messageInitiator	enumerated string	A description of how this message was initiated. OPERATOR HOST AUTOMATIC.
minimum	double	Minimum value of a parameter
nameId	string	The name of a parameter
nominal	double	Expected value of a parameter

Attribute Name	Attribute Type	Description
parameterId	string	Identifies a parameter. Something like LaneOneBoardSpeedSetting or ZoneOneTemperatureSetting
recipeId	string	Identifies the Recipe
revision	string	Identifies the revision
recipeStep	string	Recipe step associated with the element
recognitionReference	string	Reference name used by the recognition system and/or the recipe.
scannedLot	string	Scanned Identification of the unit of component delivery, like a tape or bulk
scannerId	string	Identifies Scanner
score	positiveInteger	Identifies confidence level
subsystemId	string	Identification of a Subsystem like "Network Interface Card"
subsystemType	string	Type of subsystem, this might be ItemRecognition ComponentRecognition Transport Nozzlechanger Head Headgroup Cutting ComponentsApplyArea Controller Network Software Scanner Applicator Cleaner Inspection MotionControl OperatingSystem PowerSupply AirSupply PrintMedium PrintStencil Tooling Transport Verification Communications Safety ECU
toParameterValue	string	Value of parameter after change
units	string	Units of a parameter
value	double	Value of a parameter
vendorErrorCode	string	Vendor specific Error Code
warningType	string	This describes the type of warning.
zoneList	string list	Identifies the zone(s) executing a recipe

4.4 Dictionary of Nested Elements

The following tables define the attributes of nested elements that are appropriate for assembly functions. These elements are necessary for tracking product and process quality. The right-most column indicates the expected number of occurrences (cardinality) of each attribute or element. 0-1 indicates an optional field. 1-1 indicates a single mandatory field. 0-n indicates any number, including zero. 1-n indicates at least one.

4.4.1 Element: BadBoardMark

Description: Information about a specific bad board mark.

Attribute Name	Attribute Type	Description	Occurrence
imageId	string	The IPC-2510 Image. Typically a single circuit in the panel array	1-1
designator	string	Identifies a unique location on the board.	0-1
imageType	enumerated string	LOCAL GLOBAL	0-1

```
<BadBoardMark
  imageId="2"
  designator="B1"
  imageType="LOCAL"
/>
```

4.4.2 Element: Fiducial

Description: Information about a specific fiducial.

Attribute Name	Attribute Type	Description	Occurrence
designator	string	Identifies a unique location on the board.	1-1
imageId	string	The IPC-2510 Image. Typically a single circuit in the panel array	0-1
imageType	Enumerated string	LOCAL GLOBAL	0-1
imageShape	string	Shape of the image. Some types are Disc, Rectangle, Swiss Cross, Donut, Diamond, etc.	0-1
recognitionReference	String	Reference name used by the recognition system and/or the recipe.	0-1
score	positiveInteger	Identifies confidence level	0-1

```
<Fiducial
  designator="F1"
  imageId="2"
  imageType="GLOBAL"
  imageShape="Rectangle"
  recognitionReference="123.gf"
  score=90
/>
```

4.4.3 Element: MachineError

Description: Information about an error in the machine. This element shall have the element *Subsystem* imbedded as a part of the Machine Error message

Attribute Name	Attribute Type	Description	Occurrence
<i>Subsystem</i>	See 4.4.6	Information about a specific subsystem	1-1
vendorErrorCode	string	Vendor specific Error Code	0-1
description	string	Human readable description of the error	0-1

```

<MachineError
  vendorErrorCode="NW1002139123"
  description="Network not reachable">
  <Subsystem
    subsystemType="Network"
    subsystemId="Ethernet Adapter:1"
  />
</MachineError>

```

4.4.4 Element: Parameter

Description: A record of the name, value and units for an equipment parameter. Optional constraints can also be applied to the parameter.

Attribute Name	Attribute Type	Description	Occurrence
nameId	string	The name of a Parameter	1-1
value	double	Value of a parameter	1-1
units	string	Units of parameter	1-1
nominal	double	Expected value of a parameter	0-1
minimum	double	Minimum value of a parameter	0-1
maximum	double	Maximum value of a parameter	0-1
increment	double	Resolution of a parameter	0-1

```

<Parameter
  nameId = "PrintSpeed"
  value = "100.0"
  units = "mm/s"
  nominal = "100.0"
  minimum = "0.0"
  maximum = "200.0"
  increment = "1.0"
/>

```

4.4.5 Element: Recipe

Description: The Recipe element uniquely identifies the recipe, program or algorithm set that is being applied at the station.

Attribute Name	Attribute Type	Description	Occurrence
recipeId	string	Identifies the name of the recipe	1-1
revision	string	Identifies the revision of the recipe	0-1
zoneList	string list	Identifies the zone(s) executing this recipe	0-1
laneList	string list	Identifies the lane(s) executing this recipe	0-1
recipeStep	string	Identifies the step of the executing recipe	0-1
command	string	Command in the recipe such as line number or process step.	0-1

```
<Recipe
  recipeId="VCR-2912"
  revision="4"
  zoneRange="1,2"
  laneRange="1,2"
/>
```

4.4.6 Element: Subsystem

Description: Information about a specific Subsystem.

Attribute Name	Attribute Type	Description	Occurrence
subsystemType	string	Unique area found on the machine	1-1
subsystemId	string	Unique location on the machine	1-1
revision	string	Identifies the revision of the subsystem	0-1

```
<Subsystem
  subsystemType="Scanner"
  subsystemId="Zone 1: Lane 1:top"
/>
```

4.5 Extensions to IPC-2541 Mandatory Messages

The following tables define the event message attributes or elements that are appropriate for assembly functions. These events are necessary for tracking product and process quality. The right-most column indicates the expected number of occurrences (cardinality) of each attribute or element. 0-1 indicates an optional field. 1-1 indicates a single mandatory field. 0-n indicates any number, including zero. 1-n indicates at least one.

4.5.1 IPC-2541 <EquipmentInformation> Message

4.5.1.1 informationId: BadBoardMarkReport

Definition: This is an indication that one or more Bad Board Marks were found on the item. For every found Bad Board Mark the equipment must send one Fiducial element.

Attribute/Element Name	Attribute / Element Type	Description	Occurrence
nameId	string	Name of bad board mark report	1-1
BadBoardMarkReport	See 4.4.1	Information about a specific bad board mark	1-n
Subsystem	See 4.4.6	Information about a specific Subsystem	0-1
Recipe	See 4.4.5	Identifies the recipe, program or algorithm	0-1

```

<BadBoardMarkReport
  nameId = "BadBoardMarkReport1">
  <BadBoardMark
    imageId="2"
    designator="B1"
    imageType="LOCAL"
  />
  <Subsystem
    subsystemType="Scanner"
    subsystemId="Zone 1: Lane 1:top"
  />
  <Recipe
    recipeId="VCR-2912"
    revision="4"
    zoneRange="1,2"
    laneRange="1,2"
  />
</BadBoardDataReport>

```

4.5.1.2 informationId: StartSession

Under Consideration

4.5.1.3 informationId: EndSession

Under Consideration

4.5.1.4 informationId: SessionManagement

Under Consideration

4.5.1.5 informationId: ManagementData

Under Consideration

4.5.1.6 informationId: ProcessDataReport

Description: A report containing process data in order to permit SPC (Statistical Process Control) analysis

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
nameId	string	Name of process data report	1-1
parameter	See 4.4.4	process data report parameter(s)	1-n

```

<ProcessDataReport
  nameId = "ProcessDataReport1">
  <Parameter
    nameId = "XError"
    value = "0.05"
    units = "mm"
    minimum = "-0.0"
    maximum = "0.1"
    increment = "0.01"
  />
  <Parameter
    nameId = "YError"
    value = "0.02"
    units = "mm"
    minimum = "-0.0"
    maximum = "0.1"
    increment = "0.01"
  />
</ProcessDataReport>

```

4.5.2 IPC-2541 <EquipmentParameterModified> Message

Definition: This is an extension to the IPC-2541 message

Attribute Name	Attribute Type	Description	Occurrence
ParameterId	string	Identifies a parameter. Something like LaneOneBoardSpeedSetting or ZoneOneTemperatureSetting	1-1
FromParameterValue	string	Value of parameter before change	0-1
ToParameterValue	string	Value of parameter after change	0-1

4.5.3 IPC-2541 <WaitingforOperatorAction> Message

Under Consideration

4.6 New Events

4.6.1 Event: EquipmentPoweringUp

Description: This event is sent when the machine is in the process of powering up. This is not mandatory but is helpful when the machine has knowledge that is in the process of powering up. It should occur before the Equipment is initialized.

Attribute Name	Attribute Type	Description	Occurrence
dateTime	dateTime	Date and time of the event	1-1
revision	string	Software or Firmware revision code	0-1

```
<EquipmentPoweringUp
  dateTime="2000-02-02T11:13:12.00-05:00"
  revision="Rev 3.2.0"
/>
```

5 Specific Assembly Equipment Events and Message Formats.

5.1 Specific Screen Printing Equipment Events and Message Formats (Print)

5.1.1 Dictionary of Screen Printing Terms

The objective of this model is to define a common naming convention for the subsystem categories used in screen printing machines.

5.1.1.1 Screen Printer Subsystems

PrintApplicator

The mechanism used to fix the medium to the product, e.g. a squeegee in stencil printer application.

StencilCleaner

The device used to clean the print medium off the stencil, e.g. Paper Roll.

PrintDispenser

A subsystem that supplies the medium to the stencil.

PrintMedium

The material applied to the product as a result of the printing process, e.g. Solder Paste.

PrintStencil

The mask used when applying the print medium to the product.

Table

This provides a support base for the tooling mechanism.

5.1.1.2 Limits Monitoring

Monitoring Limit

A monitoring limit divides the possible range of a parameter's value into two parts, the upper zone and the lower zone. At any time the monitored parameter is considered to be in one and only one of these zones. If the value of a parameter crosses the zone boundary in either direction a MonitoringLimitZoneTransition event is generated (see Figure 1).

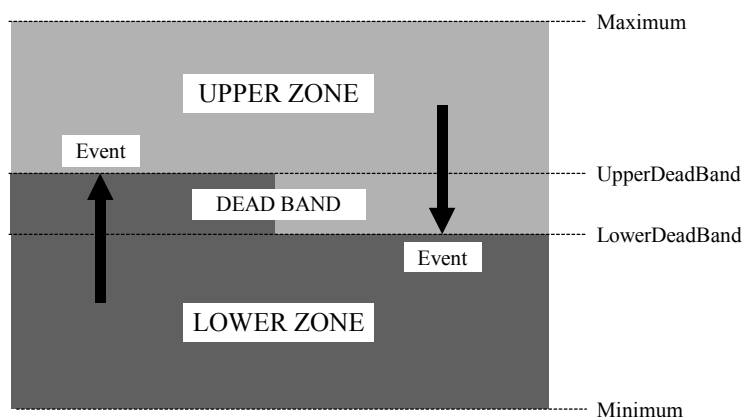


Figure 1 Zone Boundary Transition – Monitoring Limits

There is an area of overlap between the two zones called the dead band. The dead band is a key concept of limits monitoring, especially for floating point variables. Its purpose is to prevent a phenomenon known as chattering (the repeated changing of zones due to small, rapid fluctuations in a parameter's value while near the zone boundary).

In practice the value of a parameter must reach the opposite boundary of the dead band before a zone transition can occur. Thus, if a parameter's value reaches the UpperDeadBand and moves into the upper zone it will not return to the lower zone until the value falls back to the LowerDeadBand.

The difference between UpperDeadBand and LowerDeadBand should normally be greater than the typical amplitude of those fluctuations deemed insignificant. In some cases the width of the dead band may be set to zero. The range of values of UpperDeadBand and LowerDeadBand are limited by the following:

$$\text{Maximum} > \text{UpperDeadBand} \geq \text{LowerDeadBand} > \text{Minimum}$$

Figure 2 illustrates the operation of the dead band when the following limit is used:

$$\text{UpperDeadBand} = 102, \text{LowerDeadBand} = 98, \text{width of dead band} = 4$$

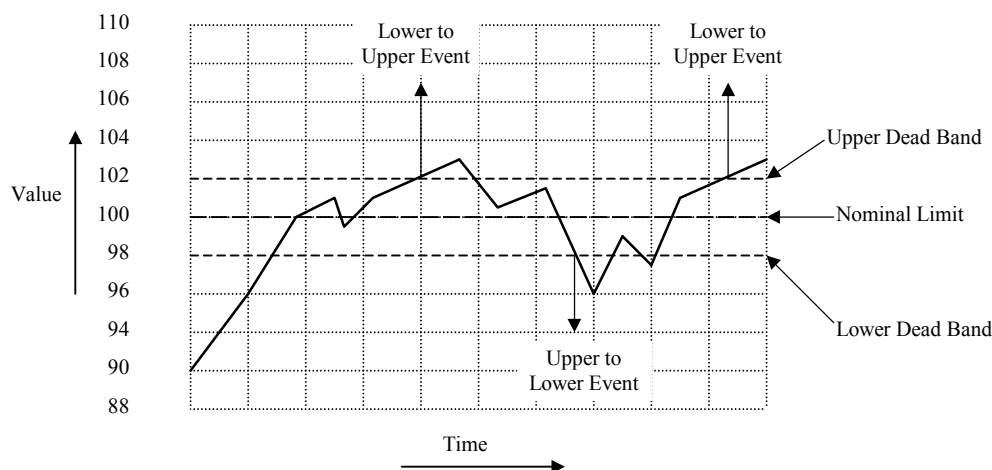


Figure 2 Example Graphing DeadBand Operation

5.1.2 Abstract Model of Screen Printer Item(s), Lane(s) and Zone(s)

Figure 3 shows an example comparing a two lane operation each having three separate Zones that must be monitored.

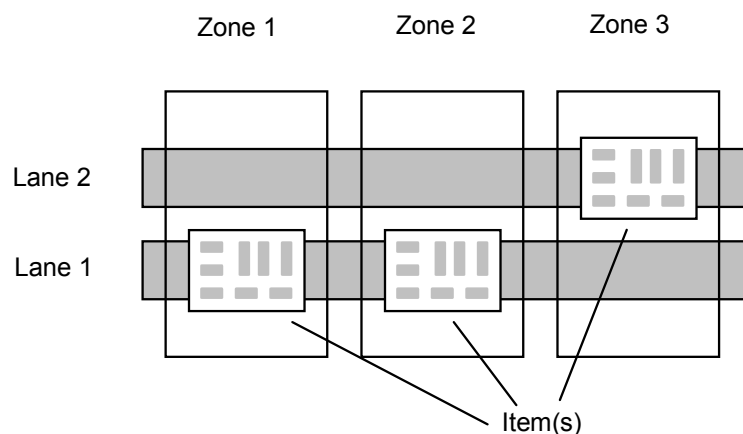


Figure 3 Multiple Lane, Multiple Zone Example

5.1.3 Abstract Model of Screen Printer Subsystems (Single Lane, Single Zone)

Figures 4 and Figure 5 show the conditions of the screen printer system for a single lane, having a single zone. Figure 4 is an exploded view; Figure 5 shows the details of the print operation.

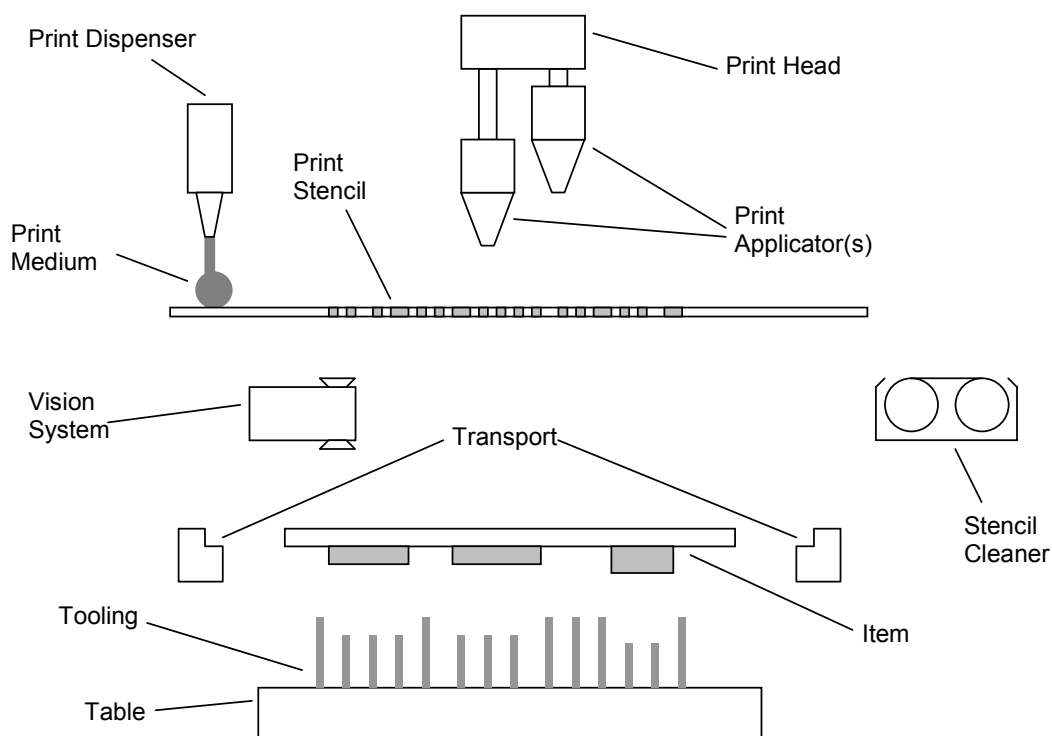


Figure 4 Exploded View

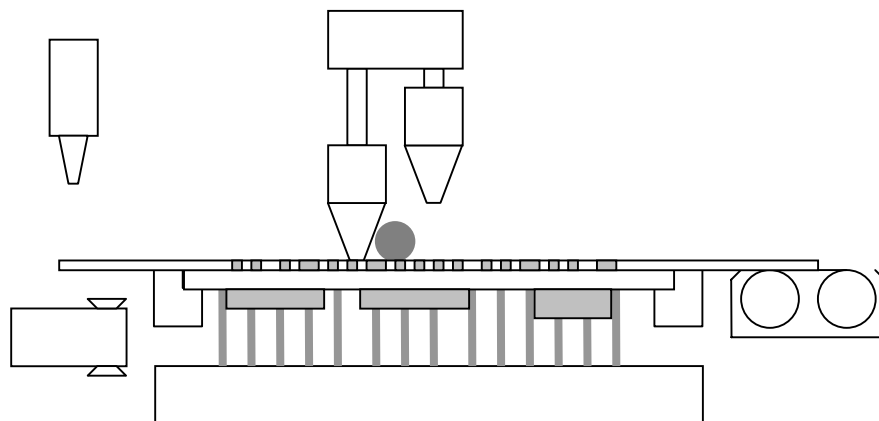


Figure 5 Print Operation View

5.1.4 Dictionary of Screen Printing Specific Attributes and Parameters

5.1.4.1 Screen Printing Recipe Parameters

The following table specifies the screen printing recipe parameters that may be adjusted during screen printer operation. Parameter adjustments will be reported via the EquipmentParameterModified event's Extensions element.

All parameters in the following table are defined using the Parameter element type.

nameId	Value Type	Description
BatchLimit	double	The number of items to print in one batch
CleaningFrequency	integer	The number of items to be printed between each cleaning cycle
InspectionFrequency	integer	The number of items to be printed between each inspection cycle
PrintMediumConditioningFrequency	integer	The number of items to be printed between each print medium conditioning cycle
PrintMediumDispenseFrequency	integer	The number of items to be printed between each print medium dispense cycle
PrintMediumDispenseSpeed	double	The linear speed of the print dispenser
FrontApplicatorPressureRecipe	double	The required force to be applied by the front applicator
FrontApplicatorSpeedRecipe	double	The required linear speed of the front applicator
FrontApplicatorAccelerationRecipe	double	The required acceleration of the front applicator
RearApplicatorPressureRecipe	double	The required force to be applied by the rear applicator
RearApplicatorSpeedRecipe	double	The required linear speed of the rear applicator

RearApplicatorAccelerationRecipe	double	The required acceleration of the rear applicator
FrontApplicatorSeparationDistanceRecipe	double	The required separation distance between the front applicator and stencil
FrontApplicatorSeparationSpeedRecipe	double	The required separation speed of the front applicator from the stencil
FrontApplicatorSeparationAccelerationRecipe	double	The required separation acceleration of the front applicator from the stencil
RearApplicatorSeparationDistanceRecipe	double	The required separation distance between the rear applicator and stencil
RearApplicatorSeparationSpeedRecipe	double	The required separation speed of the rear applicator from the stencil
RearApplicatorSeparationAccelerationRecipe	double	The required separation acceleration of the rear applicator from the stencil
ItemSeparationDistanceRecipe	double	The required separation distance between the item and stencil
ItemSeparationSpeedRecipe	double	The required separation speed of the item from the stencil
ItemSeparationAccelerationRecipe	double	The required separation acceleration of the item from the stencil
SeparationMode	String (enumeration)	The order in which the Applicator and Item separate after the print cycle is complete ITEMTHENAPPLICATOR APPLICATORTHENITEM SIMULTANEOUS
XOffset	double	The fixed offset in the X direction required to align the item with the print stencil
YOffset	double	The fixed offset in the Y direction required to align the item with the print stencil
ThetaOffset	double	The fixed offset rotation required to align the item with the print stencil

5.1.4.2 Screen Printing Process Data Parameters

The following table specifies Screen Printing Process Data parameters. All parameters are defined using the Parameter element type.

Parameter	Value Type	Description
XAlignment	double	The linear movement required in the X direction to align the item with the print stencil
YAlignment	double	The linear movement required in the Y direction to align the item with the print stencil
ThetaAlignment	double	The rotational movement required in the Theta direction to align the item with the print stencil
BoardStretch	double	The difference in fiducial separation on the item versus the difference in fiducial separation on the print stencil
MaxPrintMediumPresent	double	The maximum print medium present reported by the inspection system
MinPrintMediumPresent	double	The minimum print medium present reported by the inspection system
AvgPrintMediumPresent	double	The average print medium present reported by the inspection system
FrontApplicatorPressureActual	double	The actual force applied by the front applicator
FrontApplicatorSpeedActual	double	The actual linear speed of the front applicator
FrontApplicatorAccelerationActual	double	The actual acceleration of the front applicator
RearApplicatorPressureActual	double	The actual force applied by the rear applicator
RearApplicatorSpeedActual	double	The actual linear speed of the rear applicator
RearApplicatorAccelerationActual	double	The actual acceleration of the rear applicator
FrontApplicatorSeparationDistanceActual	double	The actual separation distance between the front applicator and stencil
FrontApplicatorSeparationSpeedActual	double	The actual separation speed of the front applicator from the stencil
FrontApplicatorSeparationAccelerationActual	double	The actual separation acceleration of the front applicator from the stencil
RearApplicatorSeparationDistanceActual	double	The actual separation distance between the rear applicator and stencil
RearApplicatorSeparationSpeedActual	double	The actual separation speed of the rear applicator from the stencil
RearApplicatorSeparationAccelerationActual	double	The actual separation acceleration of the rear applicator from the stencil

ItemSeparationDistanceActual	double	The actual separation distance between the item and stencil
ItemSeparationSpeedActual	double	The actual separation speed of the item from the stencil
ItemSeparationAccelerationActual	double	The actual separation acceleration of the item from the stencil
ItemFiducial1Score	double	The score for item fiducial 1
ItemFiducial2Score	double	The score for item fiducial 2
ItemFiducial3Score	double	The score for item fiducial 3
StencilFiducial1Score	double	The score for stencil fiducial 1
StencilFiducial2Score	double	The score for stencil fiducial 2
StencilFiducial3Score	double	The score for stencil fiducial 3
Temperature	double	The internal temperature of the screen printer
Humidity	double	The internal humidity of the screen printer
CycleTime	double	The time elapsed from a item being received from up-line to the same item being released to down-line.

5.1.4.3 Screen Printing Attributes

Attribute Name	Attribute Type	Description
vendorWarningCode	string	Vendor specific warning code
transitionType	String (enumeration)	Indicates the direction in which a monitoring limit was crossed. LOWERTOUPPER UPPERTOLOWER
upperDeadBand	double	The upper boundary of the dead band for a monitoring limit
lowerDeadBand	double	The lower boundary of the dead band for a monitoring limit

5.1.5 Screen Printing Dictionary of Nested Elements

5.1.5.1 Element: MonitoringLimitZoneTransition

Description: An element containing the details of a monitoring limit zone transition.

Attribute Name	Attribute Type	Description	Occurrence
nameId	string	Name of the parameter that has crossed the monitoring limit	1-1
transitionType	String (enumeration)	Indicates the direction in which the monitoring limit was crossed. LOWERTOUPPER UPPERTOLOWER	1-1
upperDeadBand	double	The upper boundary of the dead band for the monitoring limit	0-1
lowerDeadBand	double	The lower boundary of the dead band for the monitoring limit	0-1
Parameter	See 4.4.4	Details of the parameter that has crossed the monitoring limit	0-1

```

<MonitoringLimitZoneTransition
  nameId = "Temperature"
  transitionType = "LOWERTOUPPER"
  upperDeadBand = "51.0"
  lowerDeadBand = "49.0">
  <Parameter
    nameId = "Temperature"
    value = "51.1"
    units = "Celsius"
    minimum = "0.0"
    maximum = "110.0"
  />
</MonitoringLimitZoneTransition>

```

5.1.5.1.1 Monitoring Limit Ids for MonitoringLimitZoneTransition Message

The following table lists the MonitoringLimitZoneTransition name Ids that are applicable to screen printing

nameId	Attribute Type
XAlignment	string
YAlignment	string
ThetaAlignment	string
BoardStretch	string
MaxPrintMediumPresent	string
MinPrintMediumPresent	string
AvgPrintMediumPresent	string
FrontApplicatorPressureActual	string
FrontApplicatorSpeedActual	string

FrontApplicatorAccelerationActual	string
RearApplicatorPressureActual	string
RearApplicatorSpeedActual	string
RearApplicatorAccelerationActual	string
FrontApplicatorSeparationDistanceActual	string
FrontApplicatorSeparationSpeedActual	string
FrontApplicatorSeparationAccelerationActual	string
RearApplicatorSeparationDistanceActual	string
RearApplicatorSeparationSpeedActual	string
RearApplicatorSeparationAccelerationActual	string
ItemSeparationDistanceActual	string
ItemSeparationSpeedActual	string
ItemSeparationAccelerationActual	string
ItemFiducial1Score	string
ItemFiducial2Score	string
ItemFiducial3Score	string
StencilFiducial1Score	string
StencilFiducial2Score	string
StencilFiducial3Score	string
Temperature	string
Humidity	string

5.1.6 Extension to <IPC-2541 EquipmentAlarm> Messages

5.1.6.1 alarmId: SafetyCoverOpen

Description: An alarm generated when the equipment safety covers are opened.

```
<EquipmentAlarm
  dateTime = "2000-02-02T11:33:22.00-05:00"
  alarmId = "SafetyCoverOpen"
  alarmInstanceId = "12345"
  alarmType = "PERSONALSAFETY"
  laneRange = "1"
  zoneRange = "1"
/>
```

5.1.7 Screen Printing Specific Extensions to <IPC-2541 EquipmentError> Messages

5.1.7.1 errorId: EquipmentErrorSubsystem

Screen printer errors that are not process specific will be reported using the 2546 generic EquipmentErrorSubsystem message.

Example of Screen Printing specific EquipmentErrorSubsystem message:

```
<EquipmentError
  dateTime = "2000-02-02T11:39:22.00-05:00"
  errorId = "EquipmentErrorSubsystem"
  errorInstanceId = "12345"
  laneRange = "1"
  zoneRange = "1">
  <Extensions>
    <EquipmentErrorSubsystem>
      <MachineError
        vendorErrorCode = "FSPE1234"
        description = "Pressure error">
        <Subsystem
          subsystemType = "PrintApplicator"
          subsystemId = "FrontApplicator"
        />
      </MachineError>
    </EquipmentErrorSubsystem>
  </Extensions>
</EquipmentError>
```

5.1.7.1.1 Printer Subsystem Ids for EquipmentErrorSubsystem Message

subsystemId	Attribute Type
AirSupply	string
Inspection	string
MotionControl	string
PowerSupply	string
PrintApplicator	string
PrintDispenser	string
PrintHead	string
PrintStencil	string
StencilCleaner	string
Table	string
Tooling	string
Transport	string
VacuumGenerator	string

5.1.7.2 errorId: ItemLocationFailure

Description: The printer has failed to align the item with the print stencil.

Attribute Name	Attribute Type	Description	Occurrence
description	string	Human readable description of the failure	1-1
vendorErrorCode	string	Vendor specific error code	0-1
Subsystem	See 4.4.6	Information about a specific subsystem	0-1
Fiducial	See 4.4.2	Information about the specific fiducial	0-1
Parameter nameId = FiducialScore	See 4.4.4	The fiducial score	0-1

```

<EquipmentError
  dateTime = "2000-02-02T11:39:22.00-05:00"
  errorId = "ItemLocationFailure"
  errorInstanceId = "12345"
  laneRange = "1"
  zoneRange = "1">
  <Extensions>
    <ItemLocationFailure
      description = "Fiducial location failure">
      <Fiducial
        designator = "F1"
        shape = "Circle"
      />
      <Parameter
        nameId = "FiducialScore"
        value = "50"
        Minimum = "0"
        Maximum = "1000"
        Increment = "1"
      />
    </ItemLocationFailure>
  </Extensions>
</EquipmentError>

```

5.1.7.3 errorId: InspectionError

Description: An error generated by the inspection process. This may contain a single inspection error, reported during the inspection cycle, or a number of inspection errors listed upon completion of the inspection process.

Attribute Name	Attribute Type	Description	Occurrence
ProcessStepStatus	See IPC2547 Section 4.5	An inspection or measurement step has been executed and a resulting status for the individual step has been determined.	1-n

```

<EquipmentError
  dateTime = "2000-02-02T11:39:22.00-05:00"
  errorId = "InspectionError"
  errorInstanceId = "12345"
  laneRange = "1"
  zoneRange = "1">
  <Extensions>
    <InspectionError>
      <ProcessStepStatus
        dateTime = "2000-02-02T11:39:22.00-05:00"
        itemInstanceId = "1234"
        sessionRef = "Batch1"
        itemProcessRef = "2DInspection"
        processStepId = "1234"
        status = "FAILED">
        <RegionOfInterest
          regionId = "PCB1234-Site-1">
          <Component designator = "FPGA-1"/>
        </RegionOfInterest>
        <Indictment
          indictmentId
            = "PCB1234-Site1-MediumOnPad"
          indictmentKey = "MEDIUM ON PAD ERROR">
          <MeasurmentRef
            PCB1234-Site1-MediumOnPad>
          </MeasurmentRef>
        </Indictment>
        <Measurement
          measurementId
            = "PCB1234-Site1-MediumOnPad"
          measurementType = "MediumOnPad">
          <MeasuredNumeric
            value = "50.0"
            units = "Percent"
          />
          <ExpectedNumeric
            minimum = "70.0"
            units = "Percent"
          />
        </Measurement>
      </ProcessStepStatus>
    </InspectionError>
  </Extensions>
</EquipmentError>

```

5.1.7.4 errorId: MonitoringLimitZoneTransition

Description: Error event to indicate when the value of an equipment parameter crosses a pre-defined error limit.

```
<EquipmentError
  dateTime = "2000-02-02T11:51:22.00-05:00"
  errorId = "MonitoringLimitZoneTransition"
  errorInstanceId = "12345"
  laneRange = "1"
  zoneRange = "1">
  <Extensions>
    <MonitoringLimitZoneTransition
      nameId = "Temperature"
      transitionType = "LowerToUpper"
      upperDeadBand = "51.0"
      lowerDeadBand = "49.0">
      <Parameter
        nameId = "Temperature"
        value = "51.1"
        units = "Celsius"
        minimum = "0.0"
        maximum = "110.0"
      />
    </MonitoringLimitZoneTransition>
  </Extensions>
</EquipmentError>
```

5.1.8 Extensions to <IPC-2541 EquipmentWarning> Messages

Unless otherwise specified all of the Screen Printing specific EquipmentWarning messages use the following structure.

Attribute Name	Attribute Type	Description	Occurrence
description	string	Human readable description of the warning	1-1
vendorWarningCode	string	Vendor specific warning code	0-1
Subsystem	See 4.4.6	Information about the specific subsystem	0-1

Any EquipmentWarning messages that deviate from the above structure will be explicitly defined in the relevant message section.

Example of Screen Printing specific EquipmentWarning message:

```
<EquipmentWarning
  dateTime = "2000-02-02T11:39:22.00-05:00"
  warningId = "PrinterConsumableExpired"
  warningInstanceId = "12345"
  laneRange = "1"
  zoneRange = "1">
  <Extensions>
    <PrinterConsumableExpired
      description = "Solder paste cartridge empty"
      vendorWarningCode = "SPCE">
```

```

        <Subsystem
            subsystemType = "PrintDispenser"
            subsystemId = "Dispenser1"
        />
    </PrinterConsumableExpired>
</Extensions>
</EquipmentWarning>

```

5.1.8.1 warningId: PrinterConsumableExpired

Description: A warning specific to printer consumables.

5.1.8.2 warningId: PrinterConsumableLow

Description: A warning specific to printer consumables.

5.1.8.3 warningId: MonitoringLimitZoneTransition

Description: Warning event to indicate when the value of an equipment parameter crosses a pre-defined warning limit.

```

<EquipmentWarning
    dateTime = "2000-02-02T11:51:22.00-05:00"
    warningId = "MonitoringLimitZoneTransition"
    warningInstanceId = "12345"
    laneRange = "1"
    zoneRange = "1">
    <Extensions>
        <MonitoringLimitZoneTransition
            nameId = "Temperature"
            transitionType = "LowerToUpper"
            upperDeadBand = "51.0"
            lowerDeadBand = "49.0">
            <Parameter
                nameId = "Temperature"
                value = "51.1"
                units = "Celsius"
                minimum = "0.0"
                maximum = "110.0"
            />
        </MonitoringLimitZoneTransition>
    </Extensions>
</EquipmentWarning>

```

5.1.8.4 warningId: InspectionWarning

Description: A warning generated by the Screen Printer inspection system. This may contain a single inspection warning reported during the inspection process or a series of inspection warnings listed once the inspection process is complete.

Attribute Name	Attribute Type	Description	Occurrence
ProcessStepStatus	See IPC-2547 Section 4.5	An inspection or measurement step has been executed and a resulting status for the individual step has been determined.	1-n

```

<EquipmentWarning
  dateTime = "2000-02-02T11:39:22.00-05:00"
  warningId = "InspectionWarning"
  warningInstanceId = "12345"
  laneRange = "1"
  zoneRange = "1">
  <Extensions>
    <InspectionWarning>
      <ProcessStepStatus
        dateTime = "2000-02-02T11:39:22.00-05:00"
        itemId = "1234"
        sessionRef = "1234"
        itemProcessRef = "2DInspection"
        processStepId = "1234"
        status = "PASSED">
        <RegionOfInterest
          regionId = "PCB1234-Site-1">
          <Component designator = "FPGA-1"/>
        </RegionOfInterest>
        <Indictment
          indictmentId
            = "PCB1234-Site1-MediumOnPad"
          indictmentKey
            = "MEDIUM ON PAD WARNING">
          <MeasurmentRef>
            PCB1234-Site1-MediumOnPad
          </MeasurmentRef>
        </Indictment>
        <Measurement
          measurementId
            = "PCB1234-Site1-MediumOnPad"
          measurementType = "MediumOnPad">
          <MeasuredNumeric
            value = "50.0"
            units = "Percent"
          />
          <ExpectedNumeric
            minimum = "70.0"
            units = "Percent"
          />
        </Measurement>
      </ProcessStepStatus>
    </InspectionWarning>
  </Extensions>
</EquipmentWarning>

```

```

    </Extensions>
</EquipmentWarning>

```

5.1.9 Extension to <IPC-2541 EquipmentInformation> Messages

Unless otherwise specified all of the Screen Printing specific EquipmentInformation messages use the following structure.

Attribute Name	Attribute Type	Description	Occurrence
description	string	Human readable description of the information	1-1
Subsystem	See 4.4.6	Information about the specific subsystem	0-1

Any EquipmentInformation messages that deviate from the above structure will be explicitly defined in the relevant message section.

Example of Screen Printing specific EquipmentInformation message:

```

<EquipmentInformation
  dateTime = "2000-02-02T11:51:22.00-05:00"
  informationId = "AlignmentStart"
  laneRange = "1"
  zoneRange = "1">
  <Extensions>
    <AlignmentStart
      description = "Stencil item alignment started">
      <Subsystem
        subsystemType = "PrintStencil"
        subsystemId = "Stencill1"
      />
    </AlignmentStart>
  </Extensions>
</EquipmentInformation>

```

5.1.9.1 informationId: AlignmentStart

Description: Information event to indicate that alignment has started.

5.1.9.2 informationId: AlignmentComplete

Description: Information event to indicate that alignment is complete.

Attribute Name	Attribute Type	Description	Occurrence
description	string	Human readable description of the information	1-1
Subsystem	See 4.4.6	Information about the specific subsystem	0-1
Parameter nameId = XAlignment	See 4.4.4	The linear movement required in the X direction to align the item with the print stencil	0-1
Parameter nameId = YAlignment	See 4.4.4	The linear movement required in the Y direction to align the item with the print stencil	0-1
Parameter nameId = ThetaAlignment	See 4.4.4	The rotational movement required in the Theta direction to align the item with the print stencil	0-1

```

<EquipmentInformation
  dateTime = "2000-02-02T11:51:22.00-05:00"
  informationId = "AlignmentComplete"
  laneRange = "1"
  zoneRange = "1">
  <Extensions>
    <AlignmentComplete
      description = "Stencil item alignment complete">
      <Subsystem
        subsystemType = "PrintStencil"
        subsystemId = "Stencill1"
      />
      <Parameter
        nameId = "XAlignment"
        value = "0.1"
        units = "mm"
      />
      <Parameter
        nameId = "YAlignment"
        value = "0.1"
        units = "mm"
      />
      <Parameter
        nameId = "ThetaAlignment"
        value = "1.0"
        units = "ArcSeconds"
      />
    </AlignmentComplete>
  </Extensions>
</EquipmentInformation>

```

5.1.9.3 informationId: CleaningCycleStart

Description: Information event to indicate that the cleaning cycle has started.

5.1.9.4 informationId: CleaningCycleComplete

Description: Information event to indicate that the cleaning cycle is complete.

5.1.9.5 informationId: InspectionStart

Description: Information event to indicate that the inspection cycle has started.

5.1.9.6 informationId: InspectionComplete

Description: Information event to indicate that the inspection cycle is complete.

Attribute Name	Attribute Type	Description	Occurrence
ItemProcessStatus	See IPC-2547 Section 4.4	Processing of an item has completed, and the process task issues an overall status for the processed item	1-1

```

<EquipmentInformation
  dateTime = "2000-02-02T11:51:22.00-05:00"
  informationId = "InspectionComplete"
  laneRange = "1"
  zoneRange = "1">
  <Extensions>
    <InspectionComplete>
      <ItemProcessStatus
        dateTime = "2000-02-02T11:51:22.00-05:00"
        itemInstanceId = "1234"
        sessionRef = "Batch1"
        itemProcessId = "2DInspection"
        status = "PASSED"
        comment = "Inspection complete with warnings"
      />
    </InspectionComplete>
  </Extensions>
</EquipmentInformation>

```

5.1.9.7 informationId: PrintCycleStart

Description: Information event to indicate that the print cycle has started.

5.1.9.8 informationId: PrintCycleComplete

Description: Information event to indicate that the print cycle is complete.

5.1.9.9 informationId: PrintMediumConditioningStart

Description: Information event to indicate that the print medium conditioning has started.