



## IPC-9716

# Requirements for Automated Optical Inspection (AOI) Process Control for Printed Board Assemblies

If a conflict occurs between the English language and translated versions of this document, the English version will take precedence.

Developed by the Automated Optical Inspection Process Control Standard Task Group (7-25a) of the Process Control Management Committee (7-20) of IPC

### **IPC Standards and Artificial Intelligence (AI) Statement – 2024**

IPC explicitly prohibits:

- The integration or transfer of any data whether in the form of IPC books, standards, metadata, or other formats – into AI engines or algorithms by any person or entity, including authorized distributors and their end users.
- Activities involving data harvesting, text and data mining, enrichment, or the creation of derivative works based on this data, including the use of automated data collection methods or artificial intelligence.

Any breach of these provisions is considered a copyright infringement unless expressly and formally authorized by IPC.

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

Contact:

IPC  
3000 Lakeside Drive, Suite 105N  
Bannockburn, Illinois  
60015-1249  
Tel 847 615.7100  
Fax 847 615.7105

## Table of Contents

<b>1</b>	<b>SCOPE</b> ..... 1	1.10	AOI-Specific Personnel Proficiency ..... 4
1.1	Purpose..... 1	1.11	Acceptance Requirements ..... 4
1.2	Classification..... 1	<b>2</b>	<b>APPLICABLE DOCUMENTS</b> ..... 4
1.3	Definition of Requirements ..... 1	2.1	IPC ..... 4
1.3.1	Hardware Defects and Process Indicators .... 2	2.2	Joint Industry Standards ..... 4
1.3.2	Process Nonconformance ..... 2	2.3	JEDEC ..... 4
1.4	Process Control Requirements..... 2	<b>3</b>	<b>INSPECTION STRATEGY</b> ..... 5
1.4.1	Artificial Intelligence (AI) ..... 2	3.1	AOI Classification Strategies ..... 5
1.5	Order of Precedence ..... 2	3.1.2	Reliability Strategy..... 6
1.5.1	Conflict..... 2	3.1.3	Cycle Time Strategy ..... 6
1.5.2	Clause References..... 2	3.1.4	Feedback Loops with Other Tests..... 6
1.5.3	Appendices..... 2	<b>4</b>	<b>AOI SYSTEM USE REQUIREMENTS AND CAPABILITIES</b> ..... 6
1.6	Use of “Lead”..... 2	4.1	AOI System Performance..... 6
1.7	Abbreviations and Acronyms ..... 2	4.1.1	Accuracy, Repeatability and Reproducibility..... 6
1.8	Terms and Definitions..... 3	4.1.1.1	Accuracy ..... 6
1.8.1	AOI Classification ..... 3	4.1.1.2	Repeatability ..... 6
1.8.2	AOI Recipe..... 3	4.1.1.3	Reproducibility..... 6
1.8.3	Call..... 3	4.1.2	Defect Detectability..... 6
1.8.4	Confusion Matrix ..... 3	4.1.3	Resolution and Imaging Capabilities ..... 7
1.8.5	Control Printed Board Assembly ..... 3	4.2	Software..... 7
1.8.6	Disposition ..... 3	4.3	Networks and Communication..... 7
1.8.7	Electrical Clearance..... 3	4.3.1	Data Collection for Analytics ..... 7
1.8.8	Engineering Documentation ..... 3	<b>5</b>	<b>AOI RECIPE ALGORITHM SETUP REQUIREMENTS</b> ..... 7
1.8.9	Escape..... 3	5.1	Programming Inputs ..... 7
1.8.10	Excess Solder ..... 3	5.2	Programming Outputs..... 7
1.8.11	False Call..... 3	5.2.1	Program Files ..... 7
1.8.12	Field of View (FOV)..... 3	5.2.2	Traceability Data..... 7
1.8.13	Insufficient solder ..... 3	5.2.3	Log Files ..... 7
1.8.14	Manufacturer..... 3	5.2.4	Audit Trail..... 8
1.8.15	Manufacturing Execution System (MES)..... 3	5.2.5	Quality Metrics..... 8
1.8.16	Objective Evidence ..... 3	<b>6</b>	<b>NEW SYSTEM SETUP</b> ..... 8
1.8.17	Open Circuit ..... 3	6.1	Data Provided by Manufacturer ..... 8
1.8.18	Part Shift/Displacement/Alignment..... 4	6.2	Data and Support Provided by the Supplier .. 8
1.8.19	Poor Wetting ..... 4	6.3	Data and Preparation at Installation Site (at the Manufacturer)..... 8
1.8.20	Process Control ..... 4		
1.8.21	Solder Sample Board..... 4		
1.8.22	Supplier ..... 4		
1.8.23	User ..... 4		
1.9	Facilities Cleanliness..... 4		

6.4	Installation .....	9	<b>APPENDIX A Examples of Anomalies/Defects Picked Up by AOI Systems .....</b>	<b>14</b>
<b>7</b>	<b>AOI SYSTEM QUALIFICATION AND MAINTENANCE .....</b>	<b>9</b>	<b>APPENDIX B Best Practices for Criteria Thresholds for an AOI Strategy .....</b>	<b>16</b>
7.1	AOI System Qualification .....	9	B.1 Key Performance Indicators (KPI).....	16
7.2	Qualification Measurements .....	9	B.2 False Call Reduction .....	17
7.3	Qualification (Gage) Parts and Their Monitoring .....	9	<b>APPENDIX C Index of Acronyms and Abbreviations .....</b>	<b>18</b>
7.4	Qualification Measurement Volume (Depth) .....	10		
7.5	Qualification Acceptance Criteria .....	10	<b>Tables</b>	
7.5.1	Parametric Feature Acceptance Criteria ....	10	Table B-1 Escape Rate by Class .....	17
7.5.2	Attribute Feature Acceptance Criteria .....	10		
7.6	Reference Value and Tolerance Range.....	10	<b>Figures</b>	
7.7	Requalification Parameters.....	10	Figure 3-1 Inline Classification Strategy .....	5
7.8	Documentation.....	10	Figure 3-2 Offline Classification Strategy .....	5
7.9	Calibration .....	11	Figure A-1 Black and White Images.....	14
7.9.1	Calibration Intervals .....	11	Figure A-2 Color Images.....	15
7.9.2	Repeatability and Reliability Analysis.....	11		
7.10	AOI-to-AOI Matching .....	12		
7.11	Ongoing Maintenance.....	12		
7.12	AOI System Reliability .....	12		
<b>8</b>	<b>PROCESS CONTROL .....</b>	<b>12</b>		
8.1	Inspection Parameters.....	12		
8.2	Strategy Based on Defined Standard Inspection Methods .....	12		
8.3	Key Defects to Monitor .....	12		
8.4	Algorithm Settings.....	13		
8.4.1	Inspection Criteria .....	13		
8.4.2	Threshold Values.....	13		
8.4.3	Sample Boards .....	13		
8.5	Statistical Process Control .....	13		
8.6	Accept/Reject Criteria .....	13		
8.7	False Call Reduction .....	13		
8.8	Escape Rate .....	13		

# IPC-9716

## Requirements for Automated Optical Inspection (AOI) Process Control for Printed Board Assemblies

---

### 1 SCOPE

This standard provides requirements for automated optical inspection (AOI) systems to define, set up, establish and apply process control for manufacturing printed board assemblies, including general and specific process and AOI system conditions. Requirements include inspection parameters, lighting conditions, calibration, detectability, resolution, threshold limits and program setups, measurement system analysis (MSA), maintenance and verification protocols.

**1.1 Purpose** The purpose of this standard is to set industry-defined requirements for AOI systems to reduce false calls to ensure quality and reliability of printed board assemblies, with improved throughput and shortened cycle times. This standard also supports electronics manufacturers to enable advanced manufacturing, real-time data analytics and control capabilities.

**1.2 Classification** This standard recognizes that electrical and electronic assemblies are subject to classifications by intended end-item use. Three general end-product classes have been established to reflect differences in manufacturability, complexity, functional performance requirements, quality and reliability requirement, and verification (inspection/test) frequency.

#### **CLASS 1 General Electronic Products**

Includes products suitable for applications where the major requirement is function of the completed assembly.

#### **CLASS 2 Dedicated Service Electronic Products**

Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically, the end-use environment would not cause failures.

#### **CLASS 3 High Performance Electronic Products**

Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

**1.3 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.

Where the words **shall** or **shall not** are used in this standard, the requirements for each class are in brackets next to the requirement.

N = No requirement has been established for this Class but may require separate criteria as agreed between the Manufacturer and User.

A = Acceptable

P = Process Indicator

D = Defect

#### **Examples:**

[A1P2D3] is Acceptable Class 1, Process Indicator Class 2 and Defect Class 3

[N1D2D3] is No requirement has been established Class 1, Defect Classes 2 and 3

[A1A2D3] is Acceptable Classes 1 and 2, Defect Class 3

[D1D2D3] is Defect for all Classes

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.