



---

*The Institute for  
Interconnecting  
and Packaging  
Electronic Circuits*

# IPC-A-311

## Process Controls for Phototool Generation and Use

**IPC-A-311**

March 1996

A standard developed by the Institute for Interconnecting  
and Packaging Electronic Circuits

---

*2215 Sanders Road  
Northbrook, Illinois  
60062-6135*

*Tel 847 509.9700  
Fax 847 509.9798  
URL: <http://www.ipc.org>*

# Table of Contents

<b>1.0 Introduction</b> .....	1
1.1 Scope and Purpose.....	1
1.2 General Considerations.....	1
<b>2.0 Applicable Documents</b> .....	1
2.1 The Institute for Interconnecting and Packaging Electronic Circuits .....	1
2.2 Department of Defense.....	1
2.2.1 Federal.....	1
2.3 American National Standards Institute <sup>3</sup> .....	1
<b>3.0 Environmental Controls</b> .....	1
3.1 General Requirements.....	1
3.2 The Role of Facilities Engineering .....	2
3.3 Temperature and Humidity Measurement and Control .....	2
3.3.1 Location of Measuring Devices .....	2
3.3.2 Record Retention .....	2
3.3.3 Temperature Monitoring .....	2
3.3.4 Humidity Measurements.....	2
3.4 Cleanliness Requirements.....	2
<b>4.0 Preconditioning Films</b> .....	3
<b>5.0 Traceability of Light-Sensitive Films</b> .....	3
<b>6.0 Plotted Films</b> .....	3
6.1 Plotter Settings.....	3
6.2 Processing Conditions for Silver Films .....	3
6.2.1 Silver Film Developing .....	3
6.2.1.1 Rapid Access Developers .....	3
6.2.1.2 Litho Developers.....	3
6.2.1.3 Hybrid Developers.....	3
6.2.2 The Fixing Step .....	4
6.2.3 The Wash Step.....	4
6.2.4 Sources of Particulates .....	4
6.2.5 The Importance of Filtration.....	4
<b>7.0 Diazo Films</b> .....	4
7.1 Control of Diazo Exposures .....	4
7.2 Control of Diazo Processing .....	4
7.3 Test for Completeness of Diazo Processing .....	4
<b>8.0 Density Measurement</b> .....	5
<b>9.0 Image Registration and Distortion</b> .....	5
9.1 Phototool Alignment.....	5
9.2 Phototool Registration .....	5
<b>Appendix</b> .....	6

# Process Controls for Phototool Generation and Use

## 1.0 Introduction

**1.1 Scope and Purpose** This publication sets forth the information and data which can be collected during the generation and use of phototools with the following objectives and potential benefits:

- improve artwork quality and thereby improve yields downstream;
- help establish and maintain ISO 9000 certification;
- help to establish an SPC program;
- facilitate trouble-shooting;
- standardize the process for the benefit of both experienced and inexperienced operators;
- identify process improvements for ultimate elimination of inspection and touchup of artwork.

**1.2 General Considerations** Quality artwork requires careful attention to the working environment. This encompasses:

- temperature control;
- humidity control;
- elimination of airborne dirt particles;
- elimination of particulates from processing solutions and wash water.

Artwork should be handled as little as possible. Every time a piece of film is picked up, dirt, scratches, kinks, and other defects can be introduced. Automatic conveyor systems eliminate many problems. Where silver phototools are required, the use of first generation phototooling can ensure higher quality.

The controls outlined in this document will not by themselves eliminate inspection and touchup. That can be achieved only by systematic identification and elimination of the causes of artifacts. The relative importance of each such source will vary from one facility to another and are best determined by Pareto analysis. This requires a team effort with the full support of all levels of management.

## 2.0 Applicable Documents

### 2.1 The Institute for Interconnecting and Packaging Electronic Circuits<sup>1</sup>

IPC-A-310 Guidelines for Phototool Generation and Measurement Techniques

### 2.2 Department of Defense

#### 2.2.1 Federal<sup>2</sup>

Federal Standard 209 Clean Room and Work Station Requirements, Controlled Environment

#### 2.3 American National Standards Institute<sup>3</sup>

ANSI IT2.18 Photography (Sensitometry)—Density Measurements—Spectral Conditions

ANSI IT2.19 Photography—Density Measurements—Geometric Conditions for Transmission Density

## 3.0 Environmental Controls

**3.1 General Requirements** Requirements for temperature and relative humidity control are dictated by the physical properties of phototooling films, including how they respond to changes in their environment, and the need to limit changes in film size. For example, a typical size requirement for phototools used in the manufacture of multilayer boards is  $\pm 1$  part in 20,000 ( $\pm 0.025$  mm per 50 cm) [ $\pm 0.001$  inch per 20 inches]. To achieve these tolerances with most silver-gelatin and diazo phototooling films requires control of temperature to  $\pm 0.6^\circ\text{C}$  [ $\pm 1^\circ\text{F}$ ] and relative humidity to  $\pm 3\%$  in all areas where the phototools are created and used, including the resist imaging area. The aim points for temperature and relative humidity are inconsequential to film size and can be set to provide an environment comfortable for the employees, provided they are the same in all areas where the films are handled and used. When artwork is shipped to another location, care must be taken to ensure the environments of the two locations are the same if changes in film size are to be avoided. Temperature and humidity measuring devices appropriate to these requirements must be chosen and properly calibrated.

Additional information on these topics can be found in IPC-D-310.

Room cleanliness requirements vary. Artwork with 0.08mm [0.003 in] lines and spaces obviously calls for tighter standards than artwork with 0.40 mm [0.015 in] lines and spaces. There are also differences in the amount of time and money a facility is willing to spend for touchup. Federal Standard 209 provides guidelines for the design and operation of clean facilities, and measuring the

1. Institute for Interconnecting and Packaging Electronic Circuits, 2215 Sanders Road, Northbrook, IL 60062-6135.

2. Naval Publications and Form Control, 5801 Tabor Road, Philadelphia, PA 19120.

3. American National Standards Institute, 11 West 42nd Street, New York, NY 10036.