# IPC-7621

## 2018 - January

# Guideline for Design, Material Selection and General Application of Encapsulation of Electronic Circuit Assembly by Low Pressure Molding with Thermoplastics

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# Guideline for Design, Material Selection and General Application of Encapsulation of Electronic Circuit Assembly by Low Pressure Molding with Thermoplastics

Developed by the Low Pressure Molding Task Group (5-33g) of the Cleaning and Coating Committee (5-30) of IPC

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

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**PREFACE**

As addressed in this document, encapsulation by the process of Low Pressure Molding (LPM) with Thermoplastics is used to encapsulate electronic assemblies into a desired form or shape. The process involves injection molding of a full or partial circuit assembly, thus encapsulating the desired circuitry and components. This can be done in a way so as to surround all or a select portion of the board assembly to achieve design goals. LPM forms a thick plastic coating which provides a sealed protective barrier. Results of LPM are not entirely dissimilar to results from a traditional potting process.

Typically, potting vessels are filled with potting compound which hardens in the vessel, causing the vessel to become part of the potted assembly. LPM requires no such vessel and can be molded into a desired form. LPM does require mold tooling.

The goal of the LPM encasement is to produce a physical protective layer in a desired shape. This layer protects the board and components from the environment and can provide mechanical attributes for handling and mounting and in some designs, the final product enclosure.

LPM is commonly done with polyamide (PA) polymer, a thermoplastic. Other thermoplastic materials such as polyolefins, polyesters and various copolymers may also be used. Thermoplastics are solid until elevated to melting temperature. During the molding process, material temperature is increased to become molten (liquid state) and remains molten until temperature returns to below the melt point. Further, thermoplastics by nature, never take a permanent set. There is no transformation or transition temperature as there is with thermoset plastics. Thermoplastics remain capable of returning to a liquid state, given enough temperature elevation.

Please note that thermoset and other polymer materials can also be used for electronics encasement or encapsulation purposes (see IPC-HDBK-850, ''Guidelines for Design, Selection and Application of Potting Materials and Encapsulation Processes Used for Electronics Printed Circuit Board Assemblies.'' However, the majority of LPM materials currently used are thermoplastics. Accordingly, this document will focus on thermoplastics, realizing there will be some overlap with thermoset polymers.

Traditional injection molding is generally comprised of high speed injection of solid plastic in pellet form. Using high pressures, pellets are forced into a molten state and into a mold cavity, evacuating the air and packing the cavity. Forces of velocity and high pressure rapidly fill an otherwise vacant mold cavity. While this can be suitable for molding metals or other rigid items, the very nature of the high pressures and heats involved are much too high to be suitable for circuit board assembly molding.

Results obtained by LPM are unlike traditional injection molding as LPM is not intended to create a hollow enclosure or shell, rather the goal is to protect the circuit. The electronic content being molded is itself a barrier to LPM material flow, so the mold cavity forms the exterior shape with the electronic content consuming the balance of volume within the mold.

There are numerous applications for low pressure molding that may include high voltage and high reliability components. However, the user must validate the application, as incorporation of LPM with the device, the device design and the device's intended use vary widely.

When protection from shock, vibration, physical contact of the circuit assembly, corrosive, damp or wet environments is sought, LPM could be considered. In high vibration environments, the mechanical adhesion and resonance dampening properties of LPM materials mitigate the force seen on component bodies and lead attachment. Without additional mechanical means, there is only a solder joint producing the mechanical bond of the component to the board. The area within any encapsulation, is fully supported.

LPM can be considered to be used where conformal coatings and potting applications have traditionally been applied. Likewise, no guideline to date has been established to define clear differences where potting, coating, or LPM best apply.

This document is intended to provide insight as to uses for LPM and allowing the user to decide if and where LPM is appropriate. This document covers terminology associated with the LPM process as related to electronic board assembly. Designers of encapsulation for electronics applications must consider the encapsulation process and the properties of the materials.

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# Acknowledgment

Any document involving a complex technology draws material from a vast number of sources across many continents. While the principal members of the Low Pressure Molding Task Group (5-33g) of the Cleaning and Coating Committee (5-30) 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.

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# Guideline for Design, Material Selection and General Application of Encapsulation of Electronic Circuit Assembly by Low Pressure Molding with Thermoplastics

## 1 SCOPE

Encapsulation, for the purpose of this document, is defined as a low pressure molded thermoplastic, e.g., polyamide, which is brought to a liquid state and injection molded and (rather quickly) returned to a temperature below its melting point, forming a durable yet pliable (rubbery-like) form. The desired performance characteristics of LPM encapsulation depend on the application and must be considered when selecting material. Users are urged to consult material suppliers for detailed technical data. This guide will aid the user in understanding the capabilities and limits of LPM using thermoplastics. It is the responsibility of the user to determine the suitability, via appropriate testing, of the selected encapsulation and if the application method is suitable for a particular end use application, including but not limited to:

a. Inhibit current leakage and short circuit due to humidity and contamination from service environment.
b. Inhibit corrosion, tarnish.
c. Encapsulation may help in reducing the stresses due to CTE mismatches.
d. Inhibit arcing and corona, in particular, for high voltage applications.
e. Provide mechanical support and to prevent damages due to mechanical shock and vibration.
f. Provide a mitigation method limiting the growth of tin-whiskers.
g. Promote longer battery life in battery operated devices by limiting parasitic voltage leaching.
h. Inhibit ability of dendritic element formation.
i. Prevent damage of circuit by assemblers, installers and end users.

The acceptability criteria listed in this document were chosen with the intent that the printed board assemblies would not be seen by the end user. If the LPM is to be used as the final housing, more restrictions may be set on aesthetics. The acceptability criteria for any one project may be unique and should considered by the design team and consensus reached between designer, tool makers and part manufacturers prior to engaging in a tooling process. The resulting quality and workmanship acceptability may fall beyond the limits called for in this document. If so, those requirements will be AABUS.

**1.1 Purpose** The purpose of this handbook is to assist the individuals who must either make choices regarding encapsulation or who must work with LPM encapsulation. IPC-7621 is to provide guidelines for design, material selection, and application specifically as it pertains to electronic components and printed board assembly by Low Pressure Molding with Thermoplastics.

## 2 APPLICABLE DOCUMENTS AND TERMS AND DEFINITIONS

### 2.1 Applicable Documents

#### 2.1.1 IPC

**IPC-T-50** Terms and Definitions for Interconnecting and Packaging Electronic Circuits

**IPC J-STD-001** Requirements for Soldered Electrical and Electronic Assemblies

**IPC-HDBK-001** Handbook and Guide to Supplement J-STD-001

**IPC-A-610** Acceptability of Electronic Assemblies

**IPC-HDBK-850** Guidelines for Design, Selection and Application of Potting Materials and Encapsulation Processes Used for Electronics Printed Circuit Board Assemblies

#### 2.1.2 United States Food and Drug Administration (FDA)

**21CFR 175.105** Code of Federal Regulations (CFR) Indirect Additives in Food Contact Substances