TDK SEMICONDUCTOR CORP.

Banned and Restricted Material Declaration of I.C. Packages and RoHS Compliance

TDK Semiconductor Corporation (TSC) manufactures a wide range of products that are assembled in various I.C. packages. Being a fabless semiconductor company, our products are fabricated and assembled by subcontract manufacturers to our strict quality, reliability, and environmental/safety requirements.

Along with our parent company TDK Corporation, TSC goes to great lengths to ensure that our products meet applicable environmental/safety legal requirement. We have surveyed our products, and to the best of our knowledge, TSC is in compliance with the RoHS Directive that prohibits the use of six materials on new electrical and electronic equipment.

TSC offers two types of products:

a) **Standard Product**
These products are manufactured with Sn-Pb plating on its leads. Except for the use of Pb in the plating of the leads, all other materials used on this product are RoHS compliant.

b) **Lead-Free Product**
These products are full RoHS compliant. These products are manufactured with 100% Sn plating on its leads.

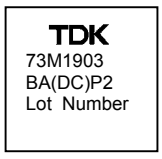
Using currently acceptable analytical methods and through our active involvement with our subcontract manufacturers, the following materials are not intentionally added on our lead-free product, and have not shown to have impurities that exceed the maximum allowed by RoHS.

Name of restricted material	RoHS maximum allowed content
Cd (Cadmium)	100 ppm
Cr+6 (Hexavalent chromium)	1000 ppm
Pb (Lead)	1000 ppm
Hg (Mercury)	1000 ppm
PBB (Polybrominated biphenyl)	1000 ppm
PBDE (Polybrominated diphenyl ether)	1000 ppm

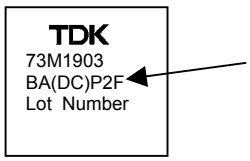
NOTES:

1. TDK Semiconductor Corporation defines product as an I.C package. Certain packages with various lead count but with the same body size (L x W x H) are classified as a package family.
2. An I.C. package family can have several TDK part numbers. Since each part number is associated to a specific I.C. package, a separate declaration for each TDK part number is deemed unnecessary.
3. Lead-Free products are identified with the letter “F” on the last digit of the second line marking of the top marking of the package. Below are examples of the top marking of each product type.

Standard Product:



Lead-Free Product:



4. Lead-Free products per JESD 97 will be identified with this label affixed to the dry pack/ESD bag or lowest level shipping container.

Certified by:

3/18/2005

Val Irlanda – Q.A. Manager
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Lead-Free Product Additional Information

Lead Finish Composition and Thickness

Package Type	Standard Product Composition	Lead-Free Product Composition	Plating Thickness
Lead-frame Packages	85Sn / 15Pb	Matte Sn (100% Sn)	8 microns, minimum 12 microns, nominal

Lead-Free packages are annealed within 24 hours after Sn plating. The annealing is done for 1 hour at 150°C. This is the industry-accepted method for mitigating tin whisker growth on matte tin plated copper alloy lead-frames.

Tin Whiskers Testing

Our Lead-Free Products are tested to NEMI/JEDEC Test Method for Evaluating Tin Whisker Growth. These tests include:

a) Temperature Cycling
b) High Temperature Humidity Storage, and
c) Ambient Temperature Humidity Storage.

Parts tested to-date have not exhibited whiskers growth after completing 1000 Temp Cycles, 1000 hours High Temp Humidity, and 1000 hours of Ambient Temp Humidity Storage. Today, parts are continuing additional hours of tin whiskers testing.

Other Included Testing of Lead-Free Packages

- Moisture sensitivity level (MSL) was tested to 260°C for all affected packages per the requirements of J-STD-020C.
- Solderability tests were done on steam aged parts using Tin-Silver-Copper (SAC) lead-free solder.
- The following reliability tests were run:
  - Preconditioning + Autoclave (168 hours)
  - Preconditioning + Temperature Cycle (-65/150°C for 500 cycles)
  - Preconditioning + Temperature Humidity Bias (85°C/85% RH for 1000 hours)
  - High Temperature Storage Life (150°C for 1000 hours)

Compatibility of Lead-Free Products with Sn-Pb Soldering Process.

TSC's lead-free leadframe packages are backward compatible with Sn-Pb solder. This means that leadframe-based components with matte tin (100% Sn) finish can be soldered to a PCB using tin/lead solder paste with a tin/lead solder profile (typical peak reflow temperatures ranging from 220°C to 235°C).

Lead-Free Recommended Reflow Soldering Profile

(See adjoining page)

Pb-Free IR/Convection Reflow Profile Recommendation
(Per IPC/JEDEC J-STD-020C)

Reflow Parameter	Pb-Free Assembly
Average Ramp-Up Rate (Ts_{max} to Tp)	3^0C/second max.
Preheat - Temperature Min (Ts_{min}) - Temperature Max (Ts_{max}) - Time (ts_{min} to ts_{max})	 150^0C 200^0C 60-180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	 217^0C 60-150 seconds
Peak Temperature (Tp)	See Table 1 below
Time within 5^0C of actual Peak Temperature (tp)	20-40 seconds
Ramp-Down Rate	6^0C/second max.
Time 25^0C to Peak Temperature	8 minutes max.

Note: All temperatures refer to topside of the package, measured on the package body surface.

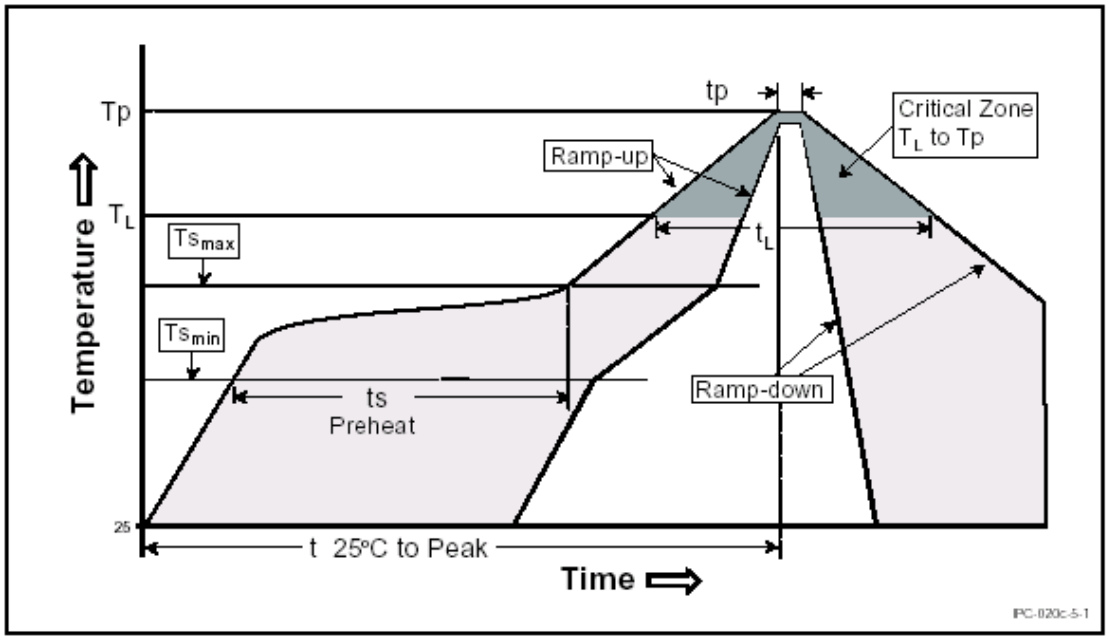

Table 1 Pb-Free Process – Peak Reflow Temperature (Tp)

Package Thickness	Volume mm^3 < 350	Volume mm^3 350 - 2000	Volume mm^3 > 2000
<1.6 mm	260 $+0^0$C	260 $+0^0$C	260 $+0^0$C
1.6mm – 2.5 mm	260 $+0^0$C	250 $+0^0$C	245 $+0^0$C
≥2.5 mm	250 $+0^0$C	245 $+0^0$C	245 $+0^0$C