Lead (Pb) Free RoHS Compatibility/Compliance Status and Plans - Analog Devices, Inc.

Revision 15 - July 2005

Objective

Satisfy customer and governmental requirements for eliminating Pb from our product in a time frame consistent with the market and well in advance of the Euro "WEEE" and other legislation.

Issues

1. Materials Set. Re-engineer a material set (molding compound and die attach epoxy) so devices can withstand a +255°C (+5/-0°C) reflow temperature necessary for some Pb free solder paste/ terminal finish systems. The material set has been chosen for maximizing the moisture sensitivity level performance of the devices, ensuring RoHS compliance of the package, and minimally impacting our product cost structure, while progressing at a pace ahead of the industry. This conversion is nearing completion for packages listed in PCN #02_0011. Conversion of remaining packages listed in PCN 04_0065 will occur during 2005.

2. Terminal Finish. Choose terminal finish that does not contain Pb, does not result in degraded device performance or reliability, and meets industry soldering requirements. Given the current needs of our customers, we have decided to offer matte tin (Sn) Pb Free plating and tin/silver/copper (Sn/Ag/Cu) solder spheres for volume applications in addition to continuing to offer SnPb plating for all device types. RoHS compliant devices with a Pb Free finish will be designated with a "Z" suffix in the part number.

3. Transition. Implement a plan to move from Pb product to Pb free RoHS compliant product in a time frame consistent with customer requirements. For leadframe based devices, we do not see backward compatibility issues as we convert to Pb Free terminal finishes and materials. BGA devices with Pb Free solder spheres are not backward compatible when reflowed at low temperatures. Please refer to the following charts for implications:

Leaded Parts:

Reflow Profile	Package Plating	Package Materials	Implications
SnPb Profile/ Traditional Solder Paste	SnPb	Existing Materials	None
SnPb Profile/ Traditional Solder Paste	Sn	High Temp Materials Set	None
255°C (+5/-0° C)/ Pb Free Solder Paste	SnPb	Existing Materials	If Bi in Solder Paste, Potential Reaction With Pb may Cause Weak Joints. Potential Delamination Due to High Temperature
255°C (+5/-0° C)/ Pb Free Solder Paste	Sn	High Temp Materials Set	None

BGA:

Reflow Profile	Ball Composition	Package Materials	Implications
SnPb Profile/ Traditional Solder Paste	SnPb	Existing Materials	None
SnPb Profile/		High	

Traditional Solder Paste	SnAgCu	Temp Materials Set	Reflow Temp Needs to be Sufficient to Melt Balls > 240°C
255°C (+5/-0° C)/Pb Free Solder Paste	SnPb	Existing Materials	Possibility of Delamination or Solder Paste Out Gassing into Balls which may cause Voiding
255°C (+5/-0° C)/ Pb Free Solder Paste	SnAgCu	High Temp Materials Set	None

Position

A number of FAQ's are on a separate web page within this site. They may be very helpful for providing specific information and are referenced with regard to some of the topics below.

Analog Devices continues the characterization and qualification of Pb Free RoHS compliant devices. We conclude from customer surveys that the majority of customers plan to switch to Pb Free RoHS compliant product in 2004 and 2005. We are now offering over 5500 catalogue device types that are RoHS compliant and have a Pb Free terminal finish. The number of requests for high temperature reflow compatible products remains quite large and we continue adding Pb Free RoHS compliant versions.

1. Materials Set. Our initial group of high volume plastic packages has completed qualification for high temp reflow compatibility. These packages are now constructed so they can withstand the +255 °C (+5/-0°C) peak reflow temperature. Mechanical samples are available for customers. (See the FAQ sheet for "How do I obtain Pb Free RoHS Compliant Samples?" for more information.) Analog Devices has issued PCN (Process Change Notification) #02_0011 (Original issue: November 2, 2001, Revision 8: May 15, 2004) to change to materials compatible with higher peak reflow temperatures. The conversion to the new materials for production of packages included in this PCN started in February 2002 and is complete. The remaining packages listed in PCN #04_0065 (Original issue: April 2004, Revision 4: July 8, 2005) will be converted during 2005.

2. Terminal Finish. Based on input from our customer base, ADI is offering Pb Free plating (Sn), as well as SnPb plating concurrently for volume applications. A post Sn plating ("anneal") bake - one hour at 150'C within 24 hours of plating - has been implemented on some assembly lines since inception of Sn plating. To standardize process flows and satisfy customer requests, this post plating bake has now been implemented across ADI assembly sites starting with EIA date code 0522 (May 29-Jun 4, 2005). Implementation has been supported by no change in fit, form, or function of ADI devices and no degradation in solderability.

Sn whisker test data using NEMI/JEDEC proposed test conditions (published in Fall 2004) indicates no whiskers greater than 50 um. ADI has selected 50 um as the whisker length criteria in lieu of an industry standard since it is the generally accepted maximum length. Once an industry consensus on maximum length criteria has been determined, we intend to apply this standard to our product. With the release of JESD22A121 in May 2005 (modifications in pre-storage, pre-conditioning and durations as compared with proposed test conditions), additional testing will be done over the next 6-12 months, taking into consideration the long durations of these tests. We are monitoring the progress of industry task forces and the recommendations of other industry organizations and will make any updates through this web site.

ADI is also selectively adding a Sn3.0Ag0.5Cu solder ball device type for BGA product. Because of concerns about the forward/backward compatibility of SnPb and Sn/Ag/Cu solder spheres under high and low reflow temperatures, we will continue to offer SnPb solder spheres as well. We have qualified Pb Free solder spheres on mini-BGA and PBGA packages and have converted several customer specific specials.

3. Transition. We have developed a detailed plan per a structured TQM methodology that will allow smooth transition to Pb free RoHS compliant devices for our customers.

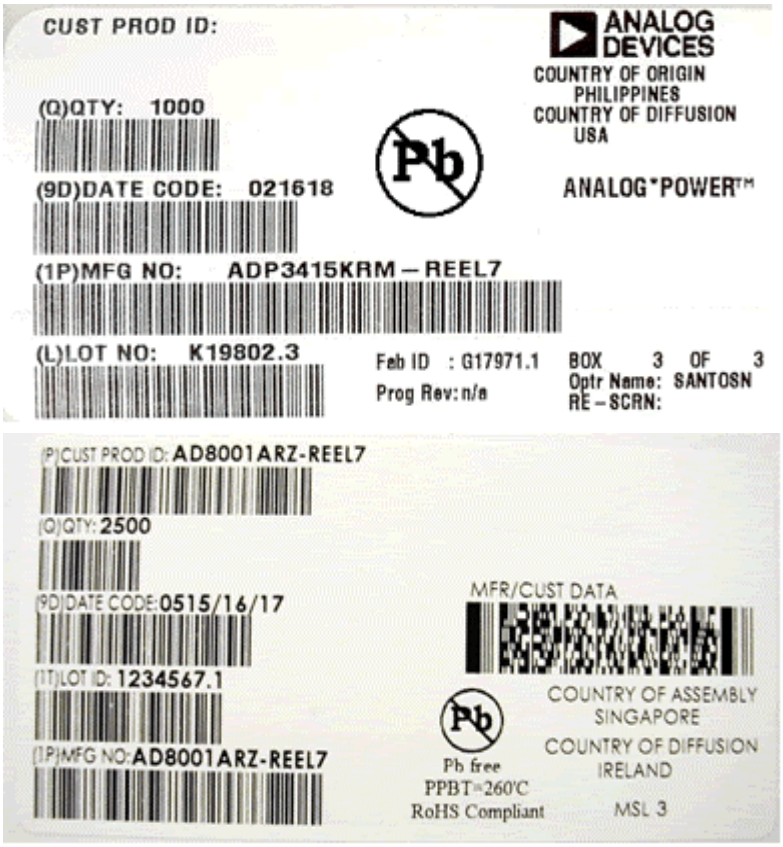
Customers have been notified by PCN (Process Change Notification) #02_0011 (Original issue: November 2, 2001, Revision 8 : May 15, 2004) and PCN #04_0065 (Original issue: April 2004, Revision 4 : July 8, 2005). These PCNs have provided over 90 days notice as we change material sets to meet a +255°C (+5/-0°C) reflow temperature. These PCNs have also tracked our progress on qualification of our Pb Free RoHS compliant option for a number of packages. Our motivation for issuing the PCNs has been to obtain customer input. We have received valuable input from our customers on the development of our strategy which we greatly appreciate. We look forward to continued customer input.

We continue to emphasize converting material sets so our high volume plastic leaded products can be used with Pb Free solder paste and a +255°C (+5/-0°C) temperature reflow, whether with an SnPb or Pb Free finish.

We ask for our customers' cooperation as we work through inventory issues on a few of our device types.

For most of the 5500 catalogue device types that are RoHS compliant and have a Pb Free finish, the device part numbers will contain the letter "Z". (See the FAQ sheet for "Do all Pb Free RoHS compliant parts have a "Z" at the end of the part number?")

Devices that are Pb Free and RoHS compliant will be marked as such on the packaging box label as shown below. "Pb free", Peak Package Body Temperature, and "RoHS Compliant" have been added to the label as of Dec 2004.



Pb Free RoHS compliant devices will also have a "#" marked on the device to denote Pb Free RoHS compliance, except in cases where there is not room for an additional character such as SOT23, SC70 and TSOT. (See the FAQ sheet for "What is the standard naming convention for Pb Free RoHS compliant parts?" and "How will the parts be marked?") We will adopt an industry standard marking and eliminate the "#" as our Pb Free marking if an acceptable industry standard is developed. If we adopt an industry standard we will announce conversion to the new standard via a PCN.

Changes in MSL rating will be listed at www.analog.com/corporate/quality/leadfree/MSL Page.htm. We intend to have our Pb Free RoHS compliant solutions in place early enough that our factory output will be Pb free RoHS compliant on a package-by-package basis by the time the majority of our customers are converting to Pb Free processes and reflow temperatures. We are targeting the end of Dec 2005 to complete this effort.

The status of our qualification effort is as follows

Package	High Temp Material Set	Pb Free Finish	PCN
CSP BGA	Qualified	Qualified	04_0065
LFCSP (9x9 and Below)	Qualified	Qualified	02_0011

LGA	Dec-05	Qualified	04_0065
LQFP (Body Size 14x14 and Below)	Qualified	Qualified	02_0011
LQFP (Body Size 14x20 and 20x20)	Qualified	Qualified	02_0011
LQFP(Body Size 24x24)	Jul-05	Qualified	04_0065
LQFP Integrated Heat Sink (Body Size 7x7-14x14 ED Quad)	Qualified	Qualified	04_0065
LQFP Integrated Heat Sink (body Size 20x20-24x24 ED Quad)	Dec-05	Qualified	04_0065
LQFP Integrated Heat Sink (Power Quad)	Aug-05	Qualified	04_0065
LQFP Integrated Heat Sink			

(INT HS)	Aug-05	Qualified	04_0065
MQFP (Body Size 28x28 and Below)	Qualified	Qualified	02_0011
MQFP (Body Size 32x32)	Qualified	Qualified	04_0065
MQFP Integrated Heat Sink (ED Quad)	Dec-05	Qualified	04_0065
MQFP Integrated Heat Sink (Power Quad)	Dec-05	Qualified	04_0065
Mini SO	Qualified	Qualified	02_0011
PBGA (Body Size 19X19, 27x27)	Qualified	Qualified	04_0065
PDIP	Qualified	Qualified	02_0011
PLCC 20 and 44 Lead	Qualified	Qualified	04_0065
PLCC 28 Lead	Aug-05	Qualified	04_0065
PLCC 68 Lead	Sep-05	Qualified	04_0065
PSOP2	Dec-05	Qualified	04_0065
PSOP3 *	Aug-05	Qualified	04_0065
QSOP	Qualified	Qualified	02_0011
QSOP Exposed Pad	Qualified	Qualified	04_0065

SBGA (Body Size 27x27)	Qualified	Qualified	04_0065
SC70	Qualified	Qualified	04_0065
SOIC	Qualified	Qualified	02_0011
SOIC Exposed Pad	Qualified	Qualified	04_0065
SOT-143	Qualified	Qualified	04_0065
SOT-223	Qualified	Qualified	04_0065
SOT-23	Qualified	Qualified	02_0011
SSOP	Qualified	Qualified	02_0011
TO92	Qualified	Qualified	04_0065
TQFP	Qualified	Qualified	02_0011
TQFP Exposed Pad	Qualified	Qualified	04_0065
TSSOP	Qualified	Qualified	02_0011
TSSOP Exposed Pad	Qualified	Qualified	04_0065
TSOT	Qualified	Qualified	04_0065
WLCSP	Not Applicable	Qualified	04_0065

"Qualified" means the higher volume lead counts within a package family are qualified. In some cases we are continuing work to obtain data on additional lead counts within a package family.

* Packages are Qualified per the exemptions in the RoHS on Pb in glass and 85+% high Pb solder.
A "Solder Joint Reliability" report is now available on request.

We will continue to update our Customers and Sales Force on a quarterly (or more frequent) basis as to our progress and schedule for conversion. Customer comments and questions on our "Lead Free RoHS compliance Program" are welcome and should be directed to:

Lead Free Product Change Notification (PCN)

PCN #02-0011

Date of Original PCN: November 2, 2001
Date of Revision 8 (Final Revision): May 15, 2004

Proposed Change:

Analog Devices is changing molding compounds and, in some cases, die attach materials on high volume plastic package families. The purpose of the change is to provide material sets that demonstrate capability to meet elevated reflow conditions (+255°C (+5/-0°C) peak) for Pb Free reflow.

volume leaded plastic packages from 85Sn/15Pb to 100Sn (tin plating) to eliminate Pb from these package types.

outer packaging label, and if space permits, a "#" sign will be marked on converted devices. If developed, we will replace the "#" with an industry standing marking.

Changes From Original Version of PCN - Customer Input

As a result of issuing the original PCN on November 2, 2001, a number of customers communicated their plans to ADI for Pb Free conversion. There was strong support from customers for converting mold compounds to more robust versions so that packages are compatible with a higher temp reflow as many customers are targeting conversion to Pb Free processes in 2004 or 2005. In preparation for conversion, many customers are conducting their own qualifications of new lead finishes including tin plating. We will continue to poll our customers as to their plans and needs, but will defer a general conversion to Sn finish until an industry consensus is reached. At that time, we will provide

plating for volume applications in addition to continuing to offer SnPb plating for all device types. Devices with Sn plating will be designated with a "Z" suffix in the part number and a Pb Free label will be placed on the shipping container.

Also, with each revision, we have continued to update our schedule for offering these new Pb Free versions. With revision 8 we have completed our qualifications with the package families included in this PCN.

Implementation Plan:

Customers who have not requested Pb Free devices will not receive converted products earlier than the dates in the original PCN. We have already converted the material sets for some LQFP, TSSOP, SSOP, SOIC, TQFP, MQFP, MSOP, QSOP, SOT, and LFCSP products to +255?C (+ 5/-0?C) peak compatible. The dates in the table reflect the information on "the first date material may be received". We have also separated the implementation dates for Mold Compound/Die Attach Material and Plating Material. The exact date of customer receipt of the new materials will depend on materials and inventory

We will continue to advise customers of our overall Pb free program via our Pb Free Updates which can be found at ADI Lead (Pb) Free

Affected Leaded Packages:

Package Family	Mold Compound Change	Die Attach Change	Plating Change
LQFP 14x14 Body Size and below	Yes	Yes	Yes
LQFP 14x20 and 20x20	Yes	Yes	Yes
TQFP	Yes	Yes	Yes
TSSOP	Yes	No	Yes
SOIC	Yes	No	Yes
Mini SO	Yes	No	Yes
SSOP	Yes	No	Yes
SOT-23	Yes	No	Yes
MQFP 28x28 Body Size and below	Yes	Yes	Yes

LFCSP 9x9 Body Size and below	Yes	Yes	Yes
QSOP	Yes	No	Yes
PDIP	No	No	Yes

** Most but not all part types are converted within a package family. Consult the Contact listed at the end of the PCN for more information. Customers should contact their Local Sales and Distributors with Pb Free requests. Analog Customer Service is available to assist Local Sales and Distributors with these Pb Free requests.

*** Not qualified to +255°C (+5/-0°C).

slug and exposed pad packages, power and specialty QFP, BGA/PBGA, SC70, and eventually hermetics.

+255°C (+5/-0°C) reflow. As 'halide-free' mold compounds become available, Analog Devices will characterize, qualify and implement these compounds in order to meet Pb-Free and halide-free requests. Halide-free changes will be covered on a separate PCN.

Where products and/or package/body sizes required a change in MSL, the Moisture Barrier Bags have been labeled accordingly. MSL downgrades or upgrades are listed here.

Package Codes:
See following URL: Lead Free Package Designators

Reason for Change:
driven Analog Device's Pb Free program. Conversion to Sn plating will satisfy customer Pb Free requests. The materials change will allow customers to convert to a higher peak reflow temperature of +255°C (+5/-0°C). In setting reflow profiles, customers must take precautions to ensure that time near peak reflow temperature is not excessive. We assume Pb Free profiles do not put a device in an environment exceeding +250°C for more than 20 seconds.

Summary of Supporting Information:
Analog Devices is following our standard qualification program. Qualification reports are available per the address in the Contact Section.

Date Change Effective:
Conversion was completed per the "Affected Leaded Packages" section of this

(PCN), Including BGA and Thermally Enhanced, and other lead frame packages not covered in PCN # 02-0011

PCN #04_0065
Date of Original PCN: April, 2004
Date of Revision 3: July 8, 2005

Proposed Change:

attach materials on several package families. The purpose of the change is to provide material sets that are RoHS compliant and that demonstrate capability to meet elevated Pb Free reflow conditions (+255°C (+5/–0°C) peak). The PCN for high volume leadframe plastic packages has been issued in November, 2001 (PCN # 02-0011). This PCN covers laminate packages, thermally enhanced packages (i.e. heat slug, exposed pad packages…), and other packages not included in PCN # 02-0011.

packages. For leadframe plastic packages, 85Sn/15Pb plating is changing to 100Sn (matte tin plating). For laminate BGA packages, 62Sn36Pb2Ag or 63Sn37Pb solder ball composition is changing to Sn3.0Ag0.5Cu. The implementation of these new plating and ball compositions will be a result of customer choice.

the part number and will be identified with a Pb Free RoHS compliant label on the outer shipping container. If space permits, a "#" sign will also be marked on the Pb Free RoHS compliant devices. We will replace the "#" sign with an industry standard marking as required.

Customer Input:

plans to ADI for Pb Free RoHS compliant conversion. There has been strong support from customers for converting mold compounds to more robust versions so that packages are compatible with a higher temperature. In preparation for conversion to Pb Free processes, many customers are conducting their own qualifications of new finishes, including Sn plating and SnAgCu solder spheres. We continue to poll our customers on their plans and needs but have deferred a general conversion to Sn plating and SnAgCu solder spheres until an industry consensus is reached.

Given the current needs of our customers, we will offer Pb Free solder balls and plating on request and will continue to offer SnPb solder ball and plating for products currently available with SnPb finishes. SnPb solder finishes might also be offered for some new products.

With this revision we have updated our schedule for the Pb Free RoHS compliant versions included in this PCN.

Implementation Plan:

Customers who have requested Pb Free RoHS compliant devices will not receive converted products earlier than the dates in this PCN. The dates in the table reflect the latest information on "the first date material may be received". For leadframe packages, we have also separated the implementation dates for Mold Compound/Die Attach Material and Plating Material. The exact date of customer receipt of the new materials will depend on materials and inventory depletion. For BGA packages, we will only move to the new mold compound and die attach material in parallel with the move to Pb Free solder spheres.

We will continue to advise customers of our progress via our Pb-Free Updates at ADI Lead (Pb) Free RoHS compliance.

Affected Packages:

Package Family	Mold Compound Change	Die Attach Change	Plating / Solder Sphere Change
CSPBGA	Yes	Yes	Yes
LGA	Yes	Yes	Yes
LQFP 24x24 Body Size	Yes	Yes	Yes

Integrated Heat Sink LQFP (7x7-14x14 Body Size, ED Quad)	Yes	Yes	Yes
Integrated Heat Sink LQFP (20x20-24x24 Body Size, ED Quad)	Yes	Yes	Yes
Integrated Heat Sink LQFP (Power Quad)	Yes	Yes	Yes
Integrated Heat Sink LQFP (INT HS)	Yes	Yes	Yes
MQFP 32x32 Body Size	Yes	Yes	Yes
Integrated Heat Sink MQFP (ED Quad)	Yes	Yes	Yes
Integrated Heat Sink MQFP (Power Quad)	Yes	Yes	Yes

PBGA	Yes	Yes	Yes
PLCC (20 and 44 Lead)	Yes	Yes	Yes
PLCC (28 Lead)	Yes	Yes	Yes
PLCC (68 Lead)	Yes	Yes	Yes
PSOP-2	Yes	Yes	Yes
PSOP-3	Yes	No	Yes
QSOP Exposed Paddle	No	No	Yes
SGBA	Yes	Yes	Yes
SC70	No	No	Yes
SOIC Exposed Paddle	No	No	Yes
SOT143	No	No	Yes
SOT-223	No	No	Yes
TO-92	No	No	Yes
TQFP Exposed Paddle	No	No	Yes
TSSOP Exposed Paddle	Yes	Yes	Yes
TSOT	No	No	Yes
WLCSP	--	--	Yes

* First Material Dates will be updated after qualification completion in a subsequent revision of this PCN.

** Only selective part types are converted within a package family. Consult the Contact listed at the end of the PCN for more information. Customers should contact their Local Sales and Distributors with Pb Free requests. Analog Customer Service is available to assist Local Sales and Distributors with these Pb Free requests.

At present, Analog Devices is focusing on package materials which are RoHS and high temperature (+255°C (+5/-0°C)) reflow compatible.

Where products and/or package body sizes require a change in MSL, the Moisture Barrier Bags will be labeled accordingly. If there are any MSL downgrades or upgrades, they will be listed here.

Package Codes:
See following URL: Lead Free Package Designators

Reason for Change:
driven Analog Devices' Pb Free RoHS compatible program. Conversion to Sn plating and Sn/Ag/Cu solder spheres will satisfy customer Pb Free requests. The materials change will meet RoHS requirements and allow customers to convert to a higher peak reflow temperature of +255°C (+5/–0°C). ADI qualifies Pb Free RoHS compatible packages using reflow profiles per J-STD-020. In setting reflow profiles, customers must take precautions to ensure that time near peak reflow temperature is not excessive.

Summary of Supporting Information:
Analog Devices is following our standard qualification program. Qualification reports are available per the address in the Contact Section.

Date Change Effective:
Conversion will commence per the "Affected Packages" section of this PCN. Conversion will be on a package-by-package basis. Pb Free RoHS compliant shipments may be gated by inventory positions of non-Pb Free units.

ADI Pb-Free Group:
World Wide Manufacturing, Analog Devices
804 Woburn St.
M/S 611
Wilmington, MA 01887
Fax: 781-937-1741
Email: ADI.PbFree@analog.com
Rev. 15 - 07/15/05