

Zetex' RoHS compliance

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This document can be found at www.zetex.com/leadfree

Introduction to lead-free and the RoHS legislation

Zetex' Pb-free definition

Zetex, defines "lead-free" or "Pb-free" to be product that does not contain Pb in the device terminal plating.

Legislation

The European Union (EU) has recently adopted the following new directives which affect the electronics' industry:

2002/95/EC - <u>Restriction of Hazardous Substances (RoHS)</u>, (As amended by <u>2005-618-EC</u>, <u>2005/717/EC</u>, <u>2005/747/EC</u> & <u>2006/310/EC</u>)

2002/96/EC - Waste Electrical and Electronic Equipment (WEEE) (as amended by 2003/108/EC)

These directives restrict the use of certain substances, including lead (Pb), in electrical and electronic products and their component parts. The directives are applicable throughout the EU. In addition to Pb, the directives also control the use of Cadmium (Cd), Mercury (Hg), Hexavalent Chromium (Cr (VI)), Polybrominated Biphenyls (PBB) and Polybrominated diphenyl ethers (PBDE).

There is also <u>2000/53/EC</u> - End of Life Vehicles (ELV) which came into force on July 1, 2003 and <u>2003/11/EC</u> - Pentabromodiphenyl ether and Octabromodiphenyl ether prohibitions, which came into force on August 15, 2004.

In Asia, China has already passed a law, as has Japan. Both have marking requirements and China's has a disclosure requirement. Neither restrict substances, yet. See the DCA "<u>China RoHS</u>" website, and <u>www.designchainassociates.com/japanrohs.html</u> for more info. Korea has legislation pending that would restrict substances. See <u>www.KoreaRoHS.com</u> for more info.

In the US, California has enacted <u>SB20</u>, the Electronic Waste Recycling Act of 2003, their version of the EU directives. Amendment, <u>AB901</u>, was passed that delays the implementation from the original date of July 1, 2004. Material restrictions consistent with the EU directives take effect from January 1, 2007. <u>SB50</u>, a new bill that both amends and clarifies SB20, was signed into law on September 29, 2004.

The United Kingdom Department of Trade and Industry's website has extensive information regarding WEEE, RoHS and ELV. <u>http://www.dti.gov.uk/innovation/sustainability/index.html</u>

The European Community (EC) also has a dedicated RoHS and WEEE web site: http://www.europa.eu.int/comm/environment/waste/weee_index.htm.

Note: This document uses 'Pb' to denote the element Lead, and 'termination' to denote component leads.

Zetex' commitment to the directive

Zetex products comply with the RoHS directive, and through this supports its customers in their compliance with WEEE and ELV directives.

Zetex Pb-free components do not contain Lead, Cadmium, Mercury, Polybrominated biphenyls, Polybrominated diphenyl ethers, Hexavalent Chromium, Pentabromodiphenyl ether or Octabromodiphenyl ether above permitted levels. Product Chemical Content Policy <u>http://www.zetex.com/7.0/pdf/pccp.pdf</u>

Zetex recognizes the hazards associated with the restricted substances, and is in full compliance with the RoHS directive. Conversion to Pb-free was completed in Q2/2005.

Zetex' manufacturing processes and products meet the directives, environmental standards, and 'Green' requirements from our customers.

Zetex is committed to the development of technologies free of hazardous materials and to make a fast conversion to further reduce the impact on our environment.

Zetex continues to evaluate substitute materials to ensure that they are technologically and economically feasible and do not compromise product performance, quality or reliability.

Zetex believes that industry standard solutions to eliminate Pb are the best for everyone. We openly share information regarding alternatives to Pb in electronic components where sharing that information does not violate confidentiality agreements.

Zetex is actively working with its supply chain partners and others in the industry to develop and demonstrate reliable, environmentally responsible alternatives to Pb, including industry consortia, material and component suppliers, subcontract manufacturers, and original equipment manufacturers.

Zetex will offer the same product specification after conversion:

Product performance and characteristics Data sheet & reliability Quality standards Moisture sensitivity level

Technical note

Pb-free specification for terminations

Zetex, in line with other manufacturers, has elected to replace the tin/lead (SnPb) solder finishes on all its components with 100% matter tin without any change to the leadframe material, the thickness of the plating finish, or the performance of the product. Zetex will not introduce any additional layers, such as Nickel, under the tin finish unless already present on the existing component. The grain size of the tin will be a few microns and will be matter in appearance. There is no impact on the bending and the abrasion caused by the change to matter tin. The behaviour is analogous to SnPb finish.

Properties	Plating composition	
	Sn85Pb15 - Sn95Pb5	Pure matte Sn
Melting temperature	215°C (nominal)	232°C
Plating method	Electroplating	Electroplating
Thickness	8-15µm	8-25µm
Hardness, ductility, abrasion & cracking	Similar to SnPb	

Evaluation of the various Pb-free plating options

Pure matte tin	Ease of deposition; Compatible with PbSn & SnAgCu solder pastes; No composition control issues; Properties similar to PbSn; Concerns over "whiskering".
NiPd/Au	Commercially available; Cracking on bending; Not compatible with NiFe42 lead-frames; Expensive; Unsuitable for eutectic die attach.
SnAg	Comparable fatigue life to SnPb; high cost; Tight control required on alloy; complicated waste treatment
SnBi	Very brittle and prone to fracture; Poor wetting and joint characteristics; Bi is a by-product of Pb mining, avoid any applications with Pb containing solder materials.
SnCu	High strength; Brittle alloy; Poor wetting characteristics

Whisker formation

Whisker formation is a well-documented phenomenon of electroplated tin. It is also present on SnPb plated finishes. Whiskering is a diffusion controlled mechanism cause by mechanical stress in the layer. Electrical fields, humidity, and ionic contamination can all influence the growth. They can grow from a few microns up to a few millimetres (worst case) in length.

The Zetex matte tin finish is stress-free plating process that minimizes the risk of whisker growth.

During the soldering process with Pb-free solder paste (e.g. SnAgCu) the matte tin finish alloys with the solder paste further reducing whisker formation.

Zetex Reliability Test Methods:-

- Standard reliability tests
- Pre-conditioning: Minimum of 4 hours storage 15~30°C 30~80%RH (JESD22A121 level B)
- Temperature cycling:
- Temperature/ Humidity Storage:

-40°C ~ +85°C 10minute dwell, 500 & 1000 cycles 60±5°C and 87+3/-2% RH, 3000 hours 30±2°C and 60±3% RH, 3000 hours

Evaluation and assessment (SPC, visual inspection by magnification: 25-40x & SEM) Whisker count, whisker dimensions, preferred appearance on termination, tin thickness. Acceptance criteria: Zetex has defined an acceptable maximum whisker length of 50µm.

Qualification results for Pb-free plating (100% pure matte Sn)

Package	Package
<u>E-line & TO92</u>	SO packages
MSOP	SOT323, SOD323 & SOD523 packages
QSOP & TSSOP	<u>SOT23, SOT23-5/6</u>
<u>SM8 & SOT223</u>	<u>SOT89</u>

Process monitoring

Zetex has implemented the following control measures to minimize the risk of whiskering

- Sn thickness monitoring (SPC)
- Continuous control of the tin electroplating process (process parameters, grain size, surface texture)
- Regular monitoring with temperature cycling at -35°C/ +125°C, 504 cycles

Recommended reflow soldering profile

Figure 1: shows the recommended solder profile for devices that have Pb-free terminal plating, and where a Pb-free solder is used.

Figure 2 shows the recommended solder profile for devices with Pb-free terminal plating used with leaded solder, or for devices with leaded terminal plating used with a leaded solder.



Reflow soldering profile

Profile feature	Sn-Pb system	Pb-Free system
Average ramp-up rate	~3°C/second	~3°C/second
Preheat -Temperature range -Time	150-170°C 60-180 seconds	150-200°C 60-180 seconds
Time maintained above: -Temperature -Time	200°C 30-50 seconds	217°C 60-150 seconds
Peak temperature	235°C	260°C
Time at peak temperature	10 seconds	40 seconds
Ramp-down rate	3°C/second max.	6°C/second max.

Recommended wave soldering profiles



The recommended solder profile for devices with Pb-free terminal plating where a Pb-free solder is used. (Figure 3).

The recommended solder profile for devices with Pb-free terminal plating used with leaded solder, or for devices with leaded terminal plating used with a leaded solder. (Figure 4)

Profile feature	Sn-Pb system	Pb-Free system
Average ramp-up rate	~200°C/second	~200°C/second
Heating rate during preheat	Typical 1-2, max 4°/sec	Typical 1-2, max 4°/sec
Final preheat temperature	Within 125°C of solder temp.	Within 125°C of solder temp
Peak temperature	235°C	260°C
Time within +0 -5°C of actual Peak	10 seconds	10 seconds
Ramp-down rate	5°C/second max.	5°C/second max.

Wave soldering profile

Moisture Sensitivity Level (MSL)

MSL indicates the maximum allowable time period (floor life time) before the soldering process is performed for which a moisture sensitive plastic device, once removed from the dry bag, can be exposed to an environment with a maximum temperature of 30°C and a maximum relative humidity of 60%RH.

Zetex products are qualified to the requirements of JEDEC J-STD-020D, MSL 1.

Please note that MSL 1 classified devices come in standard packaging materials and not in dry bags.

Ordering Instructions

Zetex has now converted all of its active product range to RoHS-compliant (Pb-free). If you buy directly from Zetex you will automatically receive compliant parts.

If you buy via distribution you will need to liaise with them regarding ordering compliant parts as they may have some non-compliant (SnPb plated) stock.

RoHS compliance cannot be guaranteed where parts are bought from unauthorized sources such as brokers or non-franchised distributors.

Frequently asked questions

1. What are the health effects of Pb?

The health effects of exposure to Pb have been well studied. However, whilst there are no known health effects of human exposure to lead from using electronic products, concerns have been raised about Pb in products that are disposed in landfills and incinerators. <u>Click here for more information about the health effects of Pb.</u>

Although there is little data to suggest any link between Pb in electronic products and any environmental or human health impacts, reduction in Pb, or any hazardous material, in products is a positive step and aligns with the Zetex Environmental policy.

2. Are there toxicological effects of tin (Sn)?

Replacing Pb with another hazardous material is a potential issue. The choice of Sn as a replacement for Pb is shown to be a safe alternative material. The toxicological effects of tin.

3. What legislation is in effect?

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4. Is the legislation world-wide?

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5. Do Zetex products contain Pb?

All Zetex Pb-free products will be 100% Pb-free plated. However, certain products will continue to use high-temperature melting point SnPb-based solders for internal die-attach purposes and also some products contain lead (<4%) in the leadframe alloy. These are currently exempted from the legislation.

6. What Pb-free plating finish does Zetex offer?

Zetex has selected 100% matte Sn.

7. What is the Zetex definition Pb-free?

Lead was the only substance that prevented Zetex products being defined as RoHS compliant. Zetex' definition of "Pbfree" has the same meaning as "fully RoHS compliant". Zetex' products do not contain concentration levels of Lead, Mercury, Hexavalent Chromium, PBBs & PBDEs per homogeneous material above 1000ppm (0.1%) by weight, nor do they contain concentration levels of Cadmium per homogeneous material above 100ppm (0.01%) by weight.

8. Are Zetex products WEEE, ROHS and ELV compliant?

Zetex Pb-free products are WEEE, ROHS and ELV compliant.

9. Are Zetex products registered on the IMDS database?

Zetex has a range of products that are registered within the IMDS database with additions being made on an on-going basis. Information on this can be obtained on request.

10. Are Zetex products RoHS 5/6 or RoHS 6/6?

The meaning of RoHS 5/6 (AKA RoHS 5) is open to interpretation. Zetex' understanding of the definition was that there was lead in the termination solder finish which therefore allowed usage in exemption 7b & 7c applications. The meaning now varies from company to company based upon their interpretation, but is basically that a product does not fully comply with the RoHS Directive. Zetex products fully comply with the RoHS directive and are therefore RoHS 6/6 (AKA RoHS 6).

11. Will Zetex only offer Sn-plated devices?

Zetex now only manufactures Sn-plated products.

12. Can Zetex Pb-free products be used with SnPb-based solders?

Zetex Pb-free products have been qualified with both SnPb and SnAgCu solders at a range of temperatures ensuring full forwards- and backwards compatibility.

13. Does Zetex recommend a Pb-free solder / solder paste?

For qualification purposes, Zetex used Sn96.7Ag3.0Cu0.3 solder/solder paste.

14. Will I have to change my assembly equipment and/or assembly process?

Zetex offers Pb-free products. Manufacturers must use Pb-free solders and solder pastes in their manufacturing processes for their products to be compliant with the Directives. Pb-free solders demand higher soldering temperatures, and as such, a different soldering profile will be required to effectively solder Pb-free devices.

15. Does Zetex have a recommended solder profile?

As part of its qualification exercise, Zetex has assembled components using a range of Pb-free solders and has determined a typical soldering profile. <u>Click here</u>

16. Do Zetex Pb-free products whisker?

Zetex has conducted a thorough series of reliability tests over the last 3 years and from the results obtained has introduced the following controls into the production process:

- Application of the proper chemicals
- Tightly controlled, minimum plating thickness

Whisker behaviour has been investigated for all of our products with no significant whisker growth detected.

17. Will the Moisture Sensitivity Level (MSL) rating change?

For Zetex Pb-free products, the MSL rating will remain the same - MSL 1

18. Is the performance of the product affected?

Changing to Pb-free plating has no impact on the performance of Zetex products.

19. Is there any impact on shelf life for Pb-free components?

Shelf life remains the same.

20. Why has Zetex chosen Sn as their plating solution?

Several years of experience with pure Sn platings has shown that they are the logical choice for coating package terminals, enabling cost-effective, ideal drop-in replacements for devices using SnPb platings.

21. Will the product part codes change?

Zetex has now converted all of its active product ranges to Pb-free. Part codes are now as per the datasheet. (see also FAQ 26 **How can I order Pb-free products?**)

22. Will Pb-free product be easily identifiable?

All Pb-free product boxes and reels will have a green "Pb-free plating" label attached.

23. Will there be a date code identifier for product implementation date?

Based on the Zetex change over plan, date codes will be usable to identify Pb-free components.

24. When will the whole portfolio be Pb-free?

The entire Zetex portfolio is available with Pb-free plating. Please note that products denoted "Obsolete" may never have been converted prior to their obsolescence.

25. How can I order Pb-free products?

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26. The answer is not here, what should I do?

E-mail your question directly to: leadfree@zetex.com

References

2002/95/EC - Restriction of Hazardous Substances (RoHS) <u>http://www.zetex.com/7.0/pdf/2002-95-EC.pdf</u> Amendments to RoHS: <u>http://www.zetex.com/7.0/pdf/2005-618-EC.pdf</u>

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This document can be found at <u>www.zetex.com/leadfree</u>

The Company reserves the right to alter without notice the specification, design, price or conditions of supply of any product or service.

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