17-Aug-2015 Official Response

The Oeko-Institut Request Dated 16-July-2015

1st Questionnaire (Clarification Questionnaire) Exemption No. 7a (renewal request)

RoHS Exemption for *„Lead in high melting temperature type solders (i.e. lead-based alloys containing 85 % by weight or more lead)“*

Abbreviations and Definitions

HMP high melting point solder(s)

LHMP lead-containing high melting point solder(s)

Background

The Oeko-Institut and Fraunhofer IZM have been appointed within a framework contract[1] for the evaluation of applications for the renewal of exemptions currently listed in Annexes III of the new RoHS Directive 2011/65/EU (RoHS 2) by the European Commission.[1]

Freescale et.al. submitted a request for the renewal of the above mentioned exemption, which has been subject to a first evaluation. The information you have referred has been reviewed and as a result we have identified that there is some information missing and have formulated a few questions to clarify some aspects concerning your request before we can start the online consultation.

Please answer the below questions until 30 July 2015 latest or otherwise let us know until when you can provide the requested information.

Questions

1) Please be so kind to resubmit your dossier including a slide explaining all the various acronyms used like on, for example, but not limited to, page 47.

2) Annex III of the RoHS Directive was reviewed in 2008/2009. It was assessed that at that time LHMP solders were used in the following applications[2]:
    I. Internal electrical interconnections within an electronic component
    II. Die attach
    III. Plastic overmoulding
    IV. Ceramic BGAs
    V. High power applications
    VI. Solders for mounting electronic components onto sub-assembled modules or sub-circuit boards
    VII. Solders used as a hermetic sealing material between a ceramic package or plug and a metal case
    VIII. Others (please specify)

[1] Contract is implemented through Framework Contract No. ENV.C.2/FRA/2011/0020 led by Eunomia

[2] For details see report of (Carl-Otto Gensch, Öko-Institut e. V., et al.), with the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Öko-Institut e. V., and Otmar Deubzer, Fraunhofer IZM (19 February 2009), page 99 t o106

Please indicate for which of the above applications you request the continued use of lead HMP solders and give product examples.

3) You provided broad information about the use of LHMP in die attach and in hermetic sealings.
   a) Please provide information on the status and justification of use of LHMP in the other applications specified in point 2) above.
   b) Please also describe the efforts undertaken in the past years since 2008 to substitute or eliminate lead in the above applications and the results.
   c) Please include a roadmap towards RoHS-compliance for each of the above applications.

Please note that answers to these questions are to be published as part of the available information relevant for the stakeholder consultation to be carried out in the course of the evaluation of this request. If your answers contain confidential information, please provide a version that can be made public along with a confidential version, in which proprietary information is clearly marked. Please take into account that any recommendation on the continuation or revocation of exemptions can only be based on publicly available information.

References

(Carl-Otto Gensch, Öko-Institut e. V., et al. 19 February 2009) *Adaptation to scientific and technical progress under Directive 2002/95/EC: Final Report*. With the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Öko-Institut e. V. and Otmar Deubzer, Fraunhofer IZM. Freiburg: . Accessed July 14, 2015. http://ec.europa.eu/environment/waste/weee/pdf/final_reportl_rohs1_en.pdf; http://ec.europa.eu/environment/waste/weee/pdf/report_2009.pdf.

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Response to Oeko-Institut 1st Questionnaire

Name and contact details of responsible person for this application & response:

Company:	Freescale Semiconductor	Tel.:	1-512-895-2519
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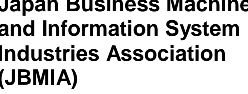
This response to the 16-July-2015 Oeko-Institut questionnaire is submitted on behalf of myself and the participating industry associations and companies listed below.

European Passive Components Industry Association (EPCIA) ID number: 22092908193-23	**European Semiconductor Industry Association (ESIA) is part of the European Electronic Component Manufacturers Association** ID Number: 22092908193-23	**Japan Electronics and Information Technology Industries Association (JEITA)** ID number: 519590015267-92	**Avago Technologies**
Communications and Information network Association of Japan (CIAJ)	**Information Technology Industry Council (ITI)** ID number: 061601915428-87	**LIGHTINGEUROPE** ID number: 29789243712-03	**Diodes Incorporated**
DIGITALEUROPE ID number: 64270747023-20	**IPC – Association Connecting Electronics Industries**	**Japan Electrical Manufacturers´ Association (JEMA)**	**Knowles (UK) Ltd**
European Committee of Domestic Equipment Manufacturers (CECED) ID number: 04201463642-88	**Japan Business Council in Europe (JBCE)** ID number: 68368571120-55	**ZVEI is the German Electrical and Electronics Manufacturers' Association** ID number: 94770746469-09	**Linear Technology Corp.**

European Garden Machinery Industry Federation (EGMF) ID number: 82669082072-33 	**Japan Business Machine and Information System Industries Association (JBMIA)** ID number: 246330915180-10 	**European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry (COCIR)** ID number: 05366537746-69 	**ON SEMICONDUCTOR**

Existing wording as requested for extension:

> "Lead in high melting temperature type solders (i.e. lead-based alloys containing 85 % by weight or more lead)"

Oeko-Institut Question 1:

Please be so kind to resubmit your dossier including a slide explaining all the various acronyms used like on, for example, but not limited to, page 47.

Reply: Acronyms and Abbreviations

The paper employs the following elemental symbols, acronyms and abbreviations:

Acronyms and Abbreviations:

Acronym	Meaning
AC	Autoclave
ACEA	European Automobile Manufacturer's Association
BVDSS	Drain-Source Breakdown Voltage
CAS	Chemical Abstracts Service
CDAF	Conductive Die Attach Film
CFL	Compact Florescent Light
CPU	Central Processing Unit
Cr-VI	Hexavalent Chromium
C-SAM	Confocal Scanning Acoustic Microscopy
CTE	Coefficient of Thermal Expansion
D/A	Die Attach
DA5	Die Attach 5 Consortium
DSS	Die Shear Strength
EEE	Electrical and Electronic Equipment
EMI	ElectroMagnetic Interference
EPP	Environmentally Preferred Products
ESR	Equivalent Series Resistance
FA	Failure Analysis
FET	Field-Effect Transistor
GNSS	Global Navigation Satellite System
GPa	Giga Pascal
HAST	Highly Accelerated Temperature/ Humidity Stress Test
HID	High Intensity Discharge
HMP	High Melting Point solder (any type)
IC	Integrated Circuit
IDSS	Zero Gate Voltage Drain Current
IGBTs	Insulated Gate Bipolar Transistor
IOL	Intermittent Operational Life
IR	International Rectifier
KPI	Key Performance Indicators

Acronym	Meaning
LED	Light Emitting Diode
LF	Leadframe
LSI	Large Scale Integration
MOSFET	Metal Oxide Semiconductor Field-Effect Transistor
MSL	Moisture Sensitivity Level
NDA	Non-Disclosure Agreement
N/mm^2	Newtons / square millimeter
PBB	PolyBrominated Biphenyl
PCB	Printed Circuit Board
PBDE	PolyBrominated Diphenyl Ether
POR	Point of Reference
PQFN	Power Quad Flat No-Lead package (Lead means termination, not Pb)
Q1	Name of a FET device
Q2	Name of a FET device
Rds(on)	MOSFET "On-state" Drain-Source Resistance
RTC	Real Time Clock
S/m	Siemens per meter
SAC	SnAgCu or tin silver copper
SMD	Surface Mount Device
TC	Temperature Cycle
TCXOs	Temperature Compensated Oscillators
T_g	Glass Transition Temperature
THB	Temperature Humidity Bias
T_j	Junction Temperature
TLPS	Transient Liquid Phase Sintering
U1	Name of an IC device
VSD	Voltage Source Drain
W/mK	Watt per meter Kelvin

Elemental Symbols:

Ac	Actinium
Al	Aluminum
Ar	Argon
As	Arsenic
At	Astatine
B	Boron
Ba	Barium
Be	Beryllium
Bh	Bohrium
Bi	Bismuth
Br	Bromine
C	Carbon
Ca	Calcium
Ce	Cerium
Cl	Chlorine
Co	Cobalt
Cr	Chromium
Cs	Caesium
Cu	Copper
Db	Dubnium
F	Fluorine
Fe	Iron
Fr	Francium
Ga	Gallium
Ge	Germanium
H	Hydrogen
He	Helium
Hf	Hafnium
Hs	Hassium

In	Indium
K	Potassium
Kr	Krypton
La	Lanthanum
Li	Lithium
Mg	Magnesium
Mn	Manganese
Mo	Molybdenum
N	Nitrogen
Na	Sodium
Nb	Niobium
Nd	Neodymium
Ne	Neon
Ni	Nickel
Np	Neptunium
O	Oxygen
Os	Osmium
P	Phosphorus
Pa	Protactinium
Pb	Lead
Pm	Promethium
Po	Polonium
Pr	Praseodymium
Pu	Plutonium
Ra	Radium
Rb	Rubidium
Re	Rhenium
Rf	Rutherfordium
Rn	Radon

Ru	Ruthenium
S	Sulfur
Sb	Antimony
Sc	Scandium
Se	Selenium
Sg	Seaborgium
Si	Silicon
Sm	Samarium
Sn	Tin
Sr	Strontium
Ta	Tantalum
Tc	Technetium
Te	Tellurium
Th	Thorium
Ti	Titanium
Tl	Thallium
U	Uranium
V	Vanadium
W	Tungsten
Xe	Xenon
Y	Yttrium
Zn	Zinc
Zr	Zirconium
Ag	Silver
Am	Americium
Au	Gold
Bk	Berkelium
Cd	Cadmium
Cf	Californium
Cm	Curium

Cn	Copernicium
Ds	Darmstadtium
Dy	Dysprosium
Er	Erbium
Es	Einsteinium
Eu	Europium
Fm	Fermium
Gd	Gadolinium
Hg	Mercury
Ho	Holmium
I	Iodine
Ir	Iridium
Lr	Lawrencium
Lu	Lutetium
Md	Mendelevium
Mt	Meitnerium
No	Nobelium
Pd	Palladium
Pt	Platinum
Rg	Roentgenium
Rh	Rhodium
Tb	Terbium
Tm	Thulium
Uuh	Ununhexium
Uuo	Ununoctium
Uup	Ununpentium
Uuq	Ununquadium
Uus	Ununseptium
Uut	Ununtrium
Yb	Ytterbium

This list of elemental symbols, acronyms and abbreviations will be incorporated into a revised copy of the January 2015 dossier.

Oeko-Institut Question 2:

Annex III of the RoHS Directive was reviewed in 2008/2009. It was assessed that at that time LHMP solders were used in the following applications[3]:

I. Internal electrical interconnections within an electronic component
II. Die attach
III. Plastic overmoulding
IV. Ceramic BGAs
V. High power applications
VI. Solders for mounting electronic components onto sub-assembled modules or sub-circuit boards
VII. Solders used as a hermetic sealing material between a ceramic package or plug and a metal case
VIII. Others (please specify)

Please indicate for which of the above applications you request the continued use of lead HMP solders and give product examples.

Reply to Oeko-Institut:

We request renewal for the existing RoHS exemption 7a wording: “Lead in high melting temperature type solders (i.e. lead-based alloys containing 85 % by weight or more lead)”, including all below “Intended LHMP solder use” categories and any associated applications, for categories 1 to 7, 10 and 11 of Annex I for an additional validity period of 5 years. For these categories, the validity of this exemption may be required beyond this timeframe.

The following table has been modified from Table 2 in Section 4B of the January 2015 RoHS 7A renewal request. That table lists ‘intended uses and related products in which high melting point (HMP) lead (Pb) solders under RoHS exemption 7a are utilized.’ The table has been modified to provide a rough correlation between the intended LHMP uses in the renewal dossier (with the associated / non-exhaustive list of examples for related products and reasons for continued use) and the 2008/2009 Oeko-Institut application list.

[3] For details see report of (Carl-Otto Gensch, Öko-Institut e. V., et al.), with the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Öko-Institut e. V., and Otmar Deubzer, Fraunhofer IZM (19 February 2009), page 99 t o106

Intended LHMP solder use	Examples of related LHMP products	2008/2009 Oeko-Institut Defined Applications	Reasons for Necessity of LHMP
– For combining elements integral to an electrical or electronic component: - a functional element with a functional element; or, - a functional element with wire/ terminal/ heat sink/ substrate, etc.	– Resistors, capacitors, chip coil, resistor networks, capacitor networks, power semiconductors, discrete semiconductors, microcomputers, ICs, LSIs, chip EMI, chip beads, chip inductors, chip transformers, power transformers, lamps, etc.	I. Internal electrical interconnections within an electronic component: This term (or application example) comprises all related products listed in the Example column to the left, because it bears almost the same meaning as the "Intended LHMP solder use" mentioned in the first left column. II. Die attach: This term (or application example) comprises power semiconductors, microcomputers, ICs, LSIs, etc. IV. Ceramic BGAs: This term (or application example) comprises LSIs, etc. V. High power applications: This term (or application example) comprises power semiconductors, power transformers, etc.	– Stress relaxation characteristic with materials and metal materials at the time of assembly is needed. - When it is incorporated in products, it needs heatproof characteristics to temperatures higher than 250 to 260°C. - It is needed to achieve electrical characteristic and thermal characteristic during operation, due to electric conductivity, heat conductivity / high thermal dissipation, etc. - It is needed to gain high reliability for temperature cycles, power cycles, etc.
– For mounting electronic components onto sub-assembled modules or sub-circuit boards	– Hybrid IC, modules, optical modules, etc.	III. Plastic overmoulding: This term (or application example) comprises hybrid IC, modules, optical modules, etc. VI. Solders for mounting electronic components onto sub-assembled modules or sub-circuit boards: This term (or application example) bears the same meaning as the "Intended LHMP solder use" mentioned in the first left column.	
– As a sealing material between a ceramic package or plug and a metal case	– SAW (Surface Acoustic Wave) filter, crystal resonators, crystal oscillators, crystal filters, etc.	VII. Solders used as a hermetic sealing material between a ceramic package or plug and a metal case: This term (or application example) bears the same meaning as the "Intended LHMP solder use" mentioned in the first left column.	

The original Table 2 in the January 2015 renewal request provides links to figures and details for each intended use.

Oeko-Institut Question 3:

You provided broad information about the use of LHMP in die attach and in hermetic sealings.

a) Please provide information on the status and justification of use of LHMP in the other applications specified in point 2) above.
b) Please also describe the efforts undertaken in the past years since 2008 to substitute or eliminate lead in the above applications and the results.
c) Please include a roadmap towards RoHS-compliance for each of the above applications.

Reply to Question 3:

We believe the information presented in the January 2015 RoHS exemption 7A renewal request addresses most of these questions. The information provided about the use of LHMP in die attach and in hermetic sealings is applicable to all identified LHMP applications within the 2008/2009 paper* by Oeko Institut.

** (Carl-Otto Gensch, Öko-Institut e. V., et al.), with the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Öko-Institut e. V., and Otmar Deubzer, Fraunhofer IZM (19 February 2009), page 99 to106.*

a) Please provide information on the status and justification of use of LHMP in the other applications specified in point 2) above.

Please see Section 4(B) and 4(C) of the RoHS 7A renewal request, especially Table 2. Table 2 (as explained in the question above) addresses the justification for renewal. Section 4(C) also explains the characteristics of the LHMP that are essential for the defined applications.

> „4(C) The most important property for HMP lead (Pb) solders is high melting points, which are solely managed by the lead composition. Other practical properties, such as electrical conductivity, thermal conductivity, ductility, corrosion-resistivity, appropriate oxidation nature, and wettability are also inherent in lead. Lead is the only known element which gives all these properties. ... Some combinations of elements (e.g. AuSn) will meet some criteria, but the essential requirement is the unique combination of essential properties of HMP solders with lead, not any single property.“

Section 4(C) Table 3 lists the primary performance requirements that can only be met with LHMP.

- High melting point
- Electrical connection
- Thermal conduction
- Ductility
- Corrosion resistivity
- Oxidation nature

b) Please also describe the efforts undertaken in the past years since 2008 to substitute or eliminate lead in the above applications and the results.

As explained in Section 6 of the RoHS 7A renewal request, LHMP solder is an essential element of EEE. No suitable substitute for LHMP has yet been proven to meet the unique combination of essential properties.

Section 7(A) of the RoHS 7A renewal request describes research efforts since 2008 to identify and characterize alternative materials. These documented efforts were driven by the Die Attach 5 (DA5), International Rectifier (IR) and key material suppliers. None have been successful. This basic research and development into raw materials should apply to all LHMP applications.

c) Please include a roadmap towards RoHS-compliance for each of the above applications.

Section 7(B) in the RoHS 7A renewal request states:

> "The electronics industry will continuously research for alternatives, however currently no lead-free alternative technology can be predicted for the future."

The above statement is applicable across the entire spectrum of applications. Section 8(C)d) of the RoHS 7A renewal request explains the industry dilemma in trying to define a roadmap toward alternative Pb-free HMP material conversions.

> "There is no functionally equivalent alternative, so not able to provide availability assessment data. Solder manufacturers continue to modify the formulations for proposed alternatives in order to improve the thermal/mechanical/electrical performance, reliability and manufacturability. Solder manufacturers are only providing samples of these materials under a strict NDA until patents are complete. No single solution has emerged from this development/evaluation process."

Section 7(B) expands upon the requirements for a conversion roadmap.

> "If a possible substitute is identified for evaluation, widespread conversion from use of high temperature type lead-containing solders in related applications will require time for the appropriate EEE qualifications based on the long term reliability requirements. Conversions cannot begin until lead-free alternatives are developed and perfected by solder manufacturers; processes and equipment are installed and implemented within component manufacturing lines; components are qualified, and those components are made available to EEE manufacturers for:
>
> - development of
> - assessment of, and
> - replacement with alternative products."

Section 8(C)d) concludes with this view of a transition roadmap.

> "Once a solder material is available with supplier commitment for at least 15 years of stable production, the electronics industry must develop and install compatible manufacturing processes and equipment before qualifying and ramping production. This process will take many years to complete. Based upon the history from lead terminations, the conversion process could extend for up to 10 years."