1.9 Attachment: Application Form

# Exemption Request Form

Date of Submission: January, 19-2015

## 1. Name and contact details

1) Name and contact details of applicant:

Company: Bourns Inc. Telephone: 951-781-5008
Name: Cathy Godfrey email: cathy.godfrey@bourns.com
Function: Corporate EHS Manager Address: 1200 Columbia Ave., Riverside, CA USA

2) Name and contact details of responsible person for this application (if different from above):

Same as above

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## 2. Reason for application:

Please indicate where relevant:

○ Request for new exemption in:

○ Request for amendment of existing exemption in

● Request for extension of existing exemption:

○ Request for deletion of existing exemption in:

○ Provision of information referring to an existing specific exemption in:

○ Annex III ○Annex IV

No. of exemption in Annex III or IV where applicable: 7a

Proposed or existing wording: N/A

Duration where applicable: standard extension at minimum

○ Other:

## 3. Summary of the exemption request / revocation request

Bourns, Inc. respectively requests to extend the current exemption 7a, lead in high melting temperature type solders. Bourns continues to research and monitor potential alternatives to the high melting temperature solders. With a multitude of applications and specific requirements/specifications of our customers, no single lead-free solution has been identified. Applications where simple substitutions were possible have already occurred. Any potential alternatives require material development, evaluation, internal process and product qualification and reliability testing to guarantee product reliability. Lead-containing solders have been used for over 50 years; the years of experience and data are well documented. More time is needed to understand lead-free solders or other alternatives and their reliability especially in critical safety applications. Many of our customers including aerospace, automotive and military mandate high temperature solders with melting points above 300C in components they use in their products. Reliability is crucial.

Semiconductor products use high-lead solder for a die attach in diodes, transistors, clip bonding of discrete devices and for surface mount and insertion components due to excellent wettability, reliability due to ductility and no re-melting during PCB reflow process. Many of these devices have an essential safety purposes in many applications including the automotive industry. The unique properties such as the high melting point and thermal conductivity of the high-lead alloys are necessary for the level of reliability required. Potential substitute reliability issues include voiding/cracking/disruption after stress, growth of brittle intermetallics at high temperature and disruption during temperature cycling. Some alternative solders such as zinc, bismuth or tin/ antimony-based solder have limited experience on reliability.

A cost friendly and high-melting point solder for semiconductor components has not been identified at this time. One possible option still requiring research is 80Au/20Sn but is cost prohibitive due to the gold content.

Several consortium evaluations and research papers are posted on the internet. Obviously, with the numerous individual applications, it is difficult to find one suitable substitute. Several of these sources are included here for review:

*Lead-Free Die Attach Reliability Assessment for High Temperature Environments*
http://blogs.uprm.edu/pquintero/files/2008/09/p_quintero_lead-free-die-attach_final-rev1.pdf

*Die Attach 5 Project*
http://www.infineon.com/dgdl/DA5_customer_presentation_200813.pdf?folderId=db3a30433162923a013176306140071a&fileId=db3a30433fa9412f013fbd2aed4779a2

Lead in solder comprises less than 1% of the total US lead consumption.
(World Semiconductor Council 2001: Lead-free White Paper)
http://www.semiconductorcouncil.org/wsc/uploads/leadfree.pdf

# 4. Technical description of the exemption request/revocation request

(A) Description of the concerned application:

1. To which EEE is the exemption request/information relevant?

   Name of applications or products: Listed are electronic components used as subcomponents in various categories of EEE. Components include Transient Voltage Suppressor Diodes, Fast Response Rectifier Diodes, High Voltage Rectifier Diodes, Schottky Barrier Rectifier Diodes, Power TVS Diodes, Telecom CPTC Resettable Fuses, Thick Film Molded DIP/SIP, Thin Film Molded SIP, Thin Film Wide Body Gull Wing Resistor Network, Thick Film Surface Mounted Body Wide Resistor Network, Thyristor Surge Protector (SMA and SMB packages). These electronic components are typically used on circuit boards and other internal electronics of the various categories used by our customers.

   a. List of relevant categories: possibly 1-11 depending on EEE manufacturer using electronic components as part of their assembly.

   b. Please specify if application is in use in other categories to which the exemption request does not refer: N/A

   c. Please specify for equipment of category 8 and 9.

      Our company does not manufacture equipment; our components may be used by manufacturers of categories 8 and 9.

2. Which of the six substances is in use in the application/product?

   ●Pb ○Cd ○Hg ○ Cr-VI ○PBB ○PBDE

3. Function of the substance: High temperature Pb-containing (>85%) solder

4. Content of substance in homogeneous material (% weight): 88-95.5%

5. Amount of substance entering the EU market annually through application for which the exemption is requested:

   Name of material/component: High temperature solders used in:

   Passive electronic components Transient Voltage Suppressor Diodes, Fast Response Rectifier Diodes, High Voltage Rectifier Diodes, Schottky Barrier Rectifier Diodes, Power TVS Diodes, Telecom CPTC Resettable Fuses, Thick Film Molded DIP/SIP, Thin Film Molded

SIP, Thin Film Wide Body Gull Wing Resistor Network, Thick Film Surface Mounted Body Wide Resistor Network, Thyristor Surge Protector (SMA and SMB packages).

Since a majority of Bourns components are sold by distribution, it is not known exactly the amount of high temperature Pb solder entering the EU per total components sold. Approximately 117M components containing a high temperature solder were sold in 2014. The total lead content of these 117M parts collectively is approximately 77g. The average weight of the components is 0.37g.

6. Environmental Assessment:

   LCA: Yes

   The LCA used for this review is the EPA document (EPA-744-S-05-001, August 2005) *Solders in Electronics: A Life-Cycle Assessment Summary*. This study evaluated both lead-based and lead-free solder alternatives. Although no high temperature solders were in the evaluation, Sn63Pb37, was included with alternatives SnCu, SnAgCu, BiSnAg and SnAgBiCu. Comparisons of lead-based and lead-free environmental and occupational/health impacts are evaluated. Various impact categories are used including non-renewable resource use, renewable resource use, energy use, global warming, ozone depletion, acidification, water quality, aquatic ecotoxicity, occupational health for both cancer and non-cancer and public human health for cancer and non-cancer. There is no real winner in the environmental or health category as each type of solder has its impacts.

   The complete document, executive summary and various sections can be found at the EPA's website: http://www.epa.gov/opptintr/dfe/pubs/solder/lca/index.htm

   The US Center for Disease Control includes worker exposure to lead as a health impact. Activities such a lead smelting and refining, foundry working, soldering, steel welding and cutting operations, battery manufacturing plants and lead compound manufacturing industries are some occupations that could result in workplace exposure typically by breathing lead particles. The International Agency for Research on Cancer (IARC) has determined that inorganic lead is probably carcinogenic to humans. There is not enough test data for organic lead sources to identify as a probably carcinogen to humans. http://www.atsdr.cdc.gov/sites/toxzine/docs/lead_toxzine.pdf

   Other substances including silver, copper and tin also have hazard characteristics. Silver inhalation can result in breathing issues, lung and throat irritation and digestive issues. Skin contact can cause allergic reactions such as rash, swelling and inflammation. Long term exposure can result in arygria, a blue-gray discoloration of skin and body tissues. http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=539&tid=97

   High copper exposures can cause liver and kidney damage and even death. Other lesser exposures to copper dust can irritate the respiratory system, cause headaches, dizziness,

nausea and diarrhea. Drinking water with high levels of copper may cause vomiting, diarrhea, stomach cramps, and nausea.
http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=206&tid=37

Large amounts of tin can cause digestive issues, anemia, and liver and kidney problems. Breathing or swallowing organotin compounds can cause breathing problems and eye irritation and can interfere with the way the brain and nervous system works. Rats and mice exposed to organotin compounds showed reproduction problems and development issues of young.
http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=543&tid=98

Further, reviewing world reserves of lead and various alternatives, lead reserves are significantly more than the other metals which serve as metals in potential alternatives. Future scarcity of one or more of these alternatives may lead to increased costs or depleted supplies.

| Metal | World Reserves (thousand metric tons) 2014 |
|---|---|
| Antimony | 1800 |
| Bismuth | 320 |
| Tin | 4700 |
| Indium | 7 |
| Silver | 520 |
| Lead | 89000 |

http://minerals.usgs.gov/minerals/pubs/mcs/

To summarize, lead and alternatives all have their environmental/health impacts. Fortunately, worker exposure can be mitigated through safe work practices and engineering controls. Resources are not infinite. There are trade-offs with all choices.

(B) In which material and/or component is the RoHS-regulated substance used, for which you request the exemption or it revocation? What is the function of this material or component?

Lead as in exemption 7a is the regulated substance in question. High temperature solders are used in many applications and equipment. Electronic components for some applications require a solder that can perform well in harsh environments.

(C) What are the particular characteristics and functions of the RoHS-regulated substance that require its use in this material or component?

High temperature solders (>85% Pb) are used in electronic components to maintain the integrity of the joints between the die and leadframe at the board level assembly. The softening temperature must be no lower than 260C; there must be good thermal fatigue resistance; good

wettability and ductility. Other factors include the manufacturability, reliability factors in a harsh environment and cost effectiveness. For lead-containing solders, the historical data of over 50 years of usage provides proven reliability.

## 5. Information on possible preparation for reuse or recycling of waste from EEE and on provisions for appropriate treatment of waste

1) Please indicate if a closed loop system exist for EEE waste of application exists and provide information of its characteristics (method of collection to ensure closed loop, method of treatment, etc.)

   Electronic components alone are not typically listed as EEE. These components are a subassembly part used to build the inner electronics workings of specific EEE. Electronic components at end of life are typically classified as electronic waste. In the US, the EPA classifies electronic waste as universal waste and requires specific handling. It is unknown the methods of handling/treatment globally.

2) Please indicate where relevant: All answers may be applicable for various EEE manufacturers.

   ● Article is collected and sent without dismantling for recycling (example: electronic waste) or

   ● Article is collected and completely refurbished for reuse (components as a part of the EEE article), or

   ● Article is collected and dismantled (components as a part of the EEE article), or:

   ○ The following parts are refurbished for use as spare parts: ___
   ○ The following parts are subsequently recycled: ____

   ● Article cannot be recycled and is therefore (components as a part of an EEE article that is not recyclable)

   ○Sent for energy return
   ○ Landfilled

3) Please provide information concerning the amount (weight) of RoHS substance present in EEE waste accumulates per annum:

   ○ In articles which are refurbished unknown

   ○ In articles which are recycled unknown

   ○ In articles which are send for energy return unknown

   ○ In articles which are landfilled unknown

## 6. Analysis of possible alternative substances

(A) Please provide information if possible alternative applications or alternatives for use of RoHS substances in application exist. Please elaborate analysis on a life-cycle basis, including where available information about independent research, peer-review studies development activities undertaken:

(B) Please provide information and data to establish reliability of possible substitutes of application and or RoHS materials in application

(A)+(B) discussion: High temperature solders are used in many components including aerospace, military and automotive applications. Components must be able to survive in harsh high temperature environments. The automotive engine compartments are more compact increasing the compartment temperature. Modules are now installed near the point of use requiring higher temperature solders. Components containing high lead solder are reflowed up to 260C without melting the inner component solder which will soften at about 300C. Semiconductor-type devices require these high temperature solders to maintain the integrity of the joint between the die and leadframe at board level assembly.

Many research papers and journal articles discussing this issue with many alternatives are available on the internet. These alternatives are compared to lead-based high temperature solders based on reliability, manufacturability, cost and environmental factors. There is no drop-in solution or a one-size-fits-all solution. Any change will take research, testing, final qualification, process changes, etc. for each specific application. Potential substitutes in these articles do not yet meet all the positive characteristics of lead-based high temperature solders that are cost-effective. There may be one or more alternatives to address each individual application. It appears at this time, there may be solutions but, most likely, the solutions will not be identified, tested, qualified and adapted to the process in the mid-2016 time frame.

Reviewed literature includes:

*Review of High-Lead Solder and Lead-Glass RoHS Exemptions*
http://rohs.exemptions.oeko.info/fileadmin/user_upload/Stakeholder_comments/Exemption-7a_5_Pecht_Uni_Maryland_25_March_2008.pdf

*High Temperature Lead-Free Solder for Microelectronics*
http://iweb.tms.org/PbF/JOM-0106-17.pdf

*High Melting Lead-Free Mixed BiAgX Solder Paste System*
http://www.globalspec.com/Indium/ref/high_melting_leadfree_mixed_biagx_solder_paste_system_98747_r0.pdf

## 7. Proposed actions to develop possible substitutes

(A) Please provide information if actions have been taken to develop further possible alternatives for the application or alternatives for the application or alternatives for RoHS substances in application.

The applications where SnPb solders can be converted to a non-leaded solder have already taken place. We are still researching and testing alternative solders or processes to eliminate the high temperature solder in some cases. Component manufacturers still need to supply their customers with parts that work for their applications. If automotive, aerospace, military and other manufacturers require specific materials for their applications, Bourns as a supplier, will find it necessary to continue to meet expectations and requirements. Some actions on the component level will depend on the higher level needs.

(B) Please elaborate what stages are necessary for establishment of possible substitute and respective timeframe needed for completion of such stages.

As a component manufacturer, research and internal testing will continue. We continue to work with our customers to meet their requirements. Some legacy products may be phased out in time as technological advances in certain components occur.

## 8. Justification according to Article 5(1)(a):

(A) Links to REACH: (substance + substitute)

1) Do any of the following provisions apply to the application described under (A) and (C)? N/A

○ Authorisation
- ○ SVHC
- ○ Candidate list
- ○ Proposal inclusion Annex XIV
- ○ Annex XIV

○ Restriction
- ○ Annex XVII
- ○ Registry of intrusions

○ Registration

2) Provide REACH-relevant information received through the supply chain.

Name of document:

(B) Elimination/substitution:

1. Can the substance named under 8(A)1 be eliminated: N/A

   ○ Yes. Consequences? _____

   ○ No. Justification: _____

2. Can the substance named under 8(A)1 be substituted?

   ○ Yes.
   - ○ Design changes:
   - ○ Other materials:
   - ○ Other substance:

   ○ No:

   Justification: _____

3. Give details on the reliability of substitutes (technical date + information): ____

4. Describe environmental assessment of substance from 8(A)1 and possible substitutes with regard to:
   1) Environmental impacts: _____
   2) Health impacts: _____
   3) Consumer safety impacts: _____

→ Do impacts of substitution outweigh benefits thereof?
Please provide third-party verified assessment on this: ____

(C) Availability of substitutes: N/A

a) Describe supply sources for substitutes:
b) Have you encountered problems with the availability? Describe: ___
c) Do you consider the price of the substitute to be a problem for the availability?

   ○ Yes ○ No

d) What conditions need to be fulfilled to ensure the availability? _____

(D) Socio-economic impact of substitution:

→ What kind of economic effects do you consider related to substitution:

- ○ Increase in direct production costs
- ○ Increase in fixed costs
- ○ Increase in overhead
- ○ Possible social impacts within the EU
- ○ Possible social impacts external to the EU
- ○ Other: unknown

→ Provide sufficient evidence (third-party verified) to support your statement: ___

## 9. Other relevant information

Please provide additional relevant information to further establish the necessity of your request:

We believe this exemption may be eventually phased out as legacy parts/products phase out. But in the meantime, this exemption needs to be extended for at least another review period.

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## 10. Information that should be regarded as proprietary

Please state clearly whether any of the above information should be regarded to as proprietary information. If so, please provide verifiable justification: N/A