Comments related to Specific questions exemption 7(a)
Lead in high melting temperature type solders
(i.e. lead-based alloys containing 85 % by weight or more lead)

Japan Business Council in Europe

We would like to express our opinion concerning consultation on exemption 7(a) of Directive 2002/95/EC (RoHS Directive) to the effect that the exemption should be continued and substitution would be difficult.

<The Specific questions exemption 7(a)>

*1. Which **types of solders** (composition and melting points) are currently used in applications falling under this exemption? Specify what type of **applications** these solders are used in.*

＜Answer.1＞

- Table 1 lists types and melting temperatures of solders currently (as of March 2008) used in applications falling under this exemption. For your reference, it also lists types and melting temperatures of solders containing 85% or less lead, use of which is prohibited under RoHS Directive.

Table 1 Composition and Melting Temperature of Lead-Containing Solders

Category	Solder Type	Alloy Composition (wt%)	Melting Temperatures [Solidus Line – Liquidus Line] (°C)
Lead-containing solder	High temperature type lead-containing solder (Falling under exemption under RoHS Directive)	Sn-85Pb	226～290°C
		Sn-90Pb	268～302°C
		Sn-95Pb	300～314°C
	＜Reference＞ Lead-containing solder Use thereof prohibited under RoHS Directive	Sn-37Pb (Conventionally used)	183°C
		Sn-60Pb	183～238°C
		Sn-70Pb	183～255°C
		Sn-80Pb	183～280°C

- Table 2 lists applications and related products in which high temperature type lead-containing solders under the exemption are used. The table also includes reasons why they are needed.

Table 2. Applications and Related Products in which High Temperature Type Lead- Containing Solders are Used

Intended Use	Related Products	Reasons for Necessity
Solders used for internally combining a functional element and a functional element, and a functional element with wire/terminal/heat sink/substrate, etc. within an electronic component.	Resistors, capacitors, chip coil, resistor networks, capacitor networks, power semiconductors, discrete semiconductors, microcomputers, ICs, LSIs, chip EMI, chip beads, chip inductors, chip transformers, etc. (Annex : Fig.1 to 3)	・ 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, etc. ・ It is needed to gain high reliability for temperature cycles, power cycles, etc.
Solders for mounting electronic components onto sub-assembled module or sub-circuit boards.	Hybrid IC, modules, optical modules, etc. (Annex : Fig.4)	
Solders used as a sealing material between a ceramic package or plug and a metal case	SAW (Surface Acoustic Wave) filter, crystal unit, crystal oscillators, crystal filters, etc. (Annex : Fig.5)	

2. Is the exemption still required for all of these applications? In which applications can the use of these leaded solders not yet be avoided? Please present a ***roadmap*** *or similar evidence for the elimination of lead. If possible, please provide a roadmap with activities, milestones and timelines towards the* ***replacement of lead in High Melting Point (HMP) solders*** *used in these applications.*

<<**Answer.2**>>
<<**Conclusion**>>

Both lead-free solders of metallic system and electrically conductive adhesive system that have solidus line temperature of 250°C or higher have problems and thus cannot substitute high temperature type lead-containing solders.

・ Table 3 lists types and melting temperatures of lead-free solders that are currently (as of March 2008) in use and commercial viability of which is currently under study.

Table 3 Composition and Melting Temperatures of Main Lead-free Solders

Category	Solder Type	Alloy Composition (wt%)	Melting Temperatures [Solidus Line − Liquidus Line] (°C)
Lead-free solders (Solidus Line 250°C or lower)	Sn-Zn (-Bi)	Sn-8.0Zn-3.0Bi	190～197°C
	Sn-Bi	Sn-58Bi	139°C
	Sn-Ag-Bi-In	Sn-3.5Ag-0.5Bi-8.0In	196～206°C
	Sn-Ag-Cu-Bi	Sn96Ag2.5Bi1Cu0.5	213～218°C
	Sn-Ag-Cu	Sn-3.0Ag-0.5Cu	217～220°C
		Sn-3.5Ag-0.7Cu	217～218°C
		Sn-4Ag-0.5Cu	217～229°C
	Sn-Cu	Sn-0.7Cu	227°C
	Sn-low Sb	Sn-5.0Sb	235～240°C
Lead-free solders (Solidus Line more than 250°C)	Bi system	Bi-2.5Ag	263°C
	Au-Sn system	Au-20Sn	280°C
	Sn-high Sb	Sn->43Sb	325～>420°C
	Zn-Al system	Zn-(4-6)Al(Ga,Ge,Mg)	About 350～380°C
	Sn system + high melting temperature type metal	Sn + (Cu,Ni,etc.)	≥ about 230～ >400°C

- Fig. 6 shows a relationship of types and melting temperatures of lead-containing solder and lead-free solders, based on the data shown in Table.1 and 3.

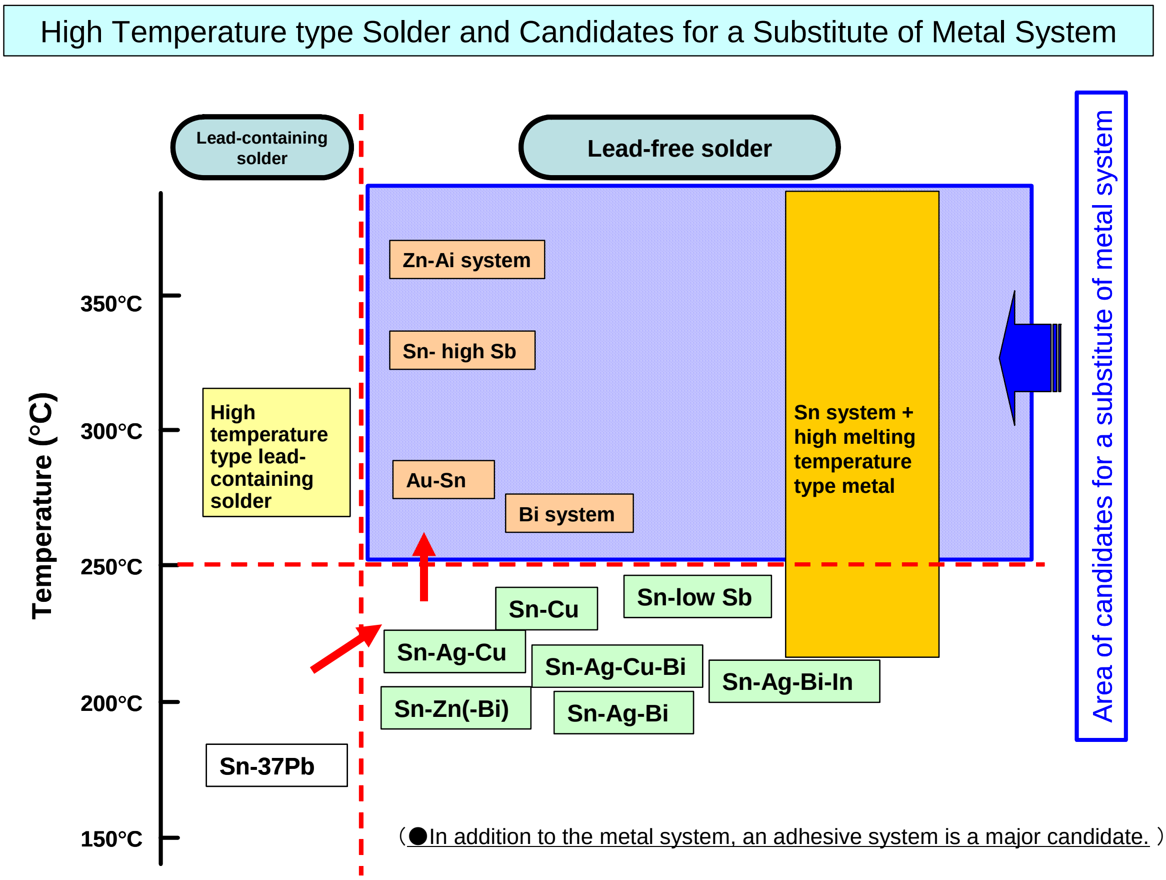


Fig. 6 Relationship Diagram of Solders and Melting Temperatures

- As seen in Fig. 6, before enforcement of RoHS Directive (2006), Sn-37Pb was widely used as lead-containing solder for the reason of convenience. However, after the enforcement of RoHS Directive, it was replaced by lead-free solders mainly composed of Sn-Ag-Cu.
- However, soldering temperatures to be set in production processes have risen to 250 to 260°C in lead-free solders mainly composed of Sn-Ag-Cu, while soldering temperatures to be set in production processes for solder joint were 230 to 250°C in conventional lead-containing solders. Thus, availability of high melting temperatures of more than 85% of lead that falls under the exemption of RoHS Directive has gained in importance.
- In the following, Table 4 shows advantages and disadvantages of lead-free solders and electrically conductive adhesive systems having solidus line temperature of 250°C or higher that are candidates for replacement of high temperature type lead-containing solders as listed in Fig.6.

Table 4 Advantages and Disadvantages of High Temperature Lead-free Solders

Candidate for Substitution		**Advantages**	**Disadvantages**
Metal System	Bi system	･Solidus line is high. ･ Joint operating temperature is comparable with conventional high temperature type solders. ･Relatively low-cost	･Low ductility ･Low strength
	Au-Sn	･Solidus line is high. ･ Joint operating temperature is comparable with conventional high temperature type solders. ･Strength is high.	･Low ductility ･High cost due to being Au-based.
	Sn-high Sb	･Solidus line is high.	･Low ductility ･Concern of Sb toxicity ･ Joint operating temperature rises higher than conventional high temperature type solders.
	Zn-Al system	･Solidus line is high.	･Fragile or low ductility ･Concern of corrosion ･ Joint operating temperature rises higher than conventional high temperature type solders.
	Sn system＋High melting temperature type metal	･It is still retentive even if it is remelted. The joint operating temperature is comparable with that of conventional high temperature type solder, depending on a combination of remelting. ･Solidus line is high if all can be made inter-metal compounds.	･For a resin mold, there is fear that a molten part may exude to outside of a component. ･Joint operating temperature is high, extending duration. ･Fragile or low ductility because joint is mainly made by inter-metal compounds.
Electrically conductive adhesive system		･No concern of remelting due to thermal hardening.	･Poor heat conductivity ･Susceptible to humidity ･Difficult to repair

- As shown in Table 4, both lead-free solders of metallic system and electrically conductive adhesive system that have solidus line temperature of 250°C or higher have problems and thus cannot substitute high temperature type lead-containing solders.

- In addition, the following report（Refer to "Efficient Use of Resources and Effects on the Environment throughout All Lifecycle of Substance/Material Circulation" published by: Eco-material Research Center of Independent Administrative Agency, National Institute for Materials Science, 26 pages, URL for reference http://www.lifecycle.jp/manual/coefficient_of_resources.pdf) quantifies and assesses environment load of various metals by an index named "Total Materials Requirement (TMR)".

  Total Materials Requirement（TMR）: "Efficient Use of Resources and Effects on the Environment throughout All Lifecycle of Substance/Material Circulation": Total amount of earth resource involved in production

- According to this report, candidates as a substitute for high temperature type lead-containing solders such as Au, Ag, Bi and Nb are considered to have greater environment load than lead, due to its scarcity. In addition, as Bi is obtained as by-product of lead ore, an attempt to obtain Bi inevitably would generate Pb, while non-use of this would require considerable energy in disposal.

Comparison of TMR

Pb	95（Comparative criterion）
Au	1,800,000（Approx.19000 times）
Ag	160,000（Approx. 1700 times）
Bi	150,000（Approx.1500 times）
Nb	1,400（Approx. 14 times）

<<**Roadmap**>>

- Fig. 7 shows a roadmap in substituting high temperature type lead-free solders. As earlier discussed, as substitution of high temperature type lead-containing solders is currently (in 2008) not possible, research and development of substitute materials will continue till 2012. Even if any high temperature type lead-free solder capable of substitution could be supplied in a mass-producible manner at the review assessment in 2012, it is expected that quite a few years more from then would be necessary for development into practical applications, adoption in all electronic/electric components, and thus completion of substitution.

- Even if development of/assessment of/replacement by substitute products progress, widespread use of high temperature type lead-containing solders and a large number of those solders in use might confuse the market unless an appropriate transitional period is provided. We thus expect that the EU Commission conduct survey on setting of a transitional period and that an appropriate deadline be set. JEITA is prepared to actively cooperate in the survey.

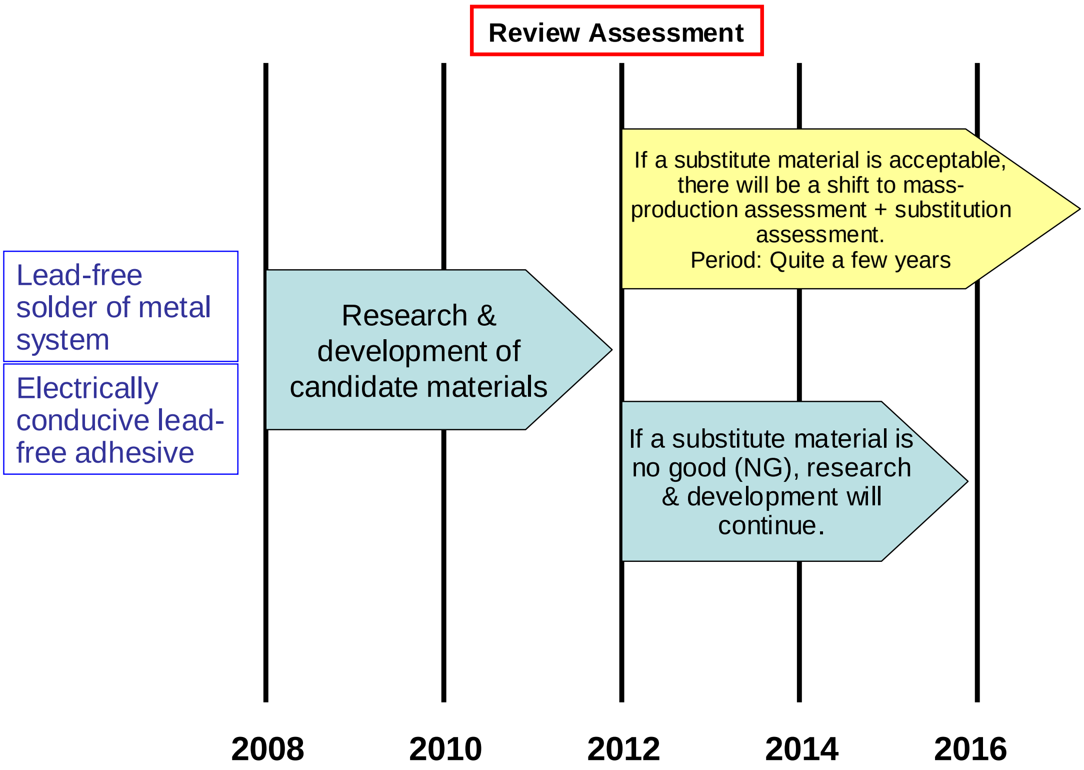


Fig. 7 Roadmap in substituting high temperature lead-free solders

3. What is the **amount of lead** per application, the lead content in the homogeneous material, the annual production volume as well as the number of applications related to exemption 7(a) put on the EU market annually.

- Since numerous lead-containing solders are used in end products including various products that do not fall under exemptions of RoHS Directive (production facilities, medical equipment, analytical equipment, etc.), it is impossible to actually measure the amount of lead that is shifted into EU. This time, we herein introduce the result of estimation by JEITA based on a ratio of the lead production amount as a metal to intended usage thereof. Thus, we would like to ask for your understanding that this is simply an estimated figure to the extent possible, and not a numeric value that can be responsible for actual amount of shifted lead.

Table 5 Lead Production Amount on a Global Basis and Ratio by Region（Years 2001-2003）Unit：1,000 t

Country (Region)	2001	2002	2003	Mean	Ratio
World-wide	6,730	6,686	6,939	6,785	100.0%
Asia	2,128	2,222	2,456	2,269	33.4%
North America	1,853	1,863	1,874	1,863	27.5%
South America	246	254	286	262	3.9%
EU	***1,553***	***1,485***	***1,432***	***1,490***	***22.0%***
Africa	181	159	193	178	2.6%
Oceania	769	704	698	724	10.7%
Japan(for your reference)	236	213	226	225	3.3%

Source：UN, *Industrial Commodity Statistics Yearbook 2003*

Table 6 Quantities and Ratio of Lead Consumed in Japan by Application (Years 1997-2001)（Unit: t/yr）
Source: Annual Statistical Report of Resources

Calendar Year / Demanding Field	1997	1998	1999	2000	2001	Mean	Ratio
Accumulator batteries	248,321	236,056	221,408	229,435	223,227	231,689	71.2%
Inorganic chemicals	38,418	32,325	33,139	38,302	29,325	34,302	10.5%
Solders	***13,041***	***10,580***	***11,260***	***11,996***	***10,104***	***11,396***	***3.5%***
Lead pipe plates	12,085	11,491	-	3,248	3,121	7,486	2.3%
Electric wire cables	4,079	2,871	2,378	4,588	6,440	4,071	1.3%
Plating	657	664	766	—	—	696	0.2%
Tubes	337	309	305	—	—	317	0.1%
Antifriction alloy	59	72	—	—	—	66	0.0%
Others	30,704	31,721	69,588	27,654	25,996	37,133	11.4%
Total	347,701	326,089	338,844	315,259	298,213	325,221	100.0%

Table 7 Production Amount of High Temperature Type Lead-containing Solders (85% or higher) Manufactured in Japan（Year 2007）

Production amount of high temperature type lead-containing (85% or higher) solders（*）
930 t/yr（Year 2007）

*Data summarized from the questionnaire collected from Japanese major solder manufacturers

- Table 5 shows the lead production amount on a global basis and a ratio by region. Table 6 shows the quantities and ratio of lead consumed in Japan by application. Table 7 shows the production amount of high temperature type lead-containing solder of lead manufacturers in Japan.
- According to Table 5, the mean of the worldwide lead production in years 2001 to 2003 was approximately 6.8Mt/yr, to which ratio of production in EU was 22.0%, i.e., approximately 1.5 Mt/yr. For your information, the production ratio of Japan was 3.3%, i.e., approximately 0.23 Mt/yr.
- According to Table 6, among the quantities of lead consumed in Japan in 1997 to 2001, accumulator batteries stood first, accounting for 71.2% and the average use ratio as a solder being 3.5%. Note that the total lead consumed quantities in 2001 are greater than the production amount in Fig. 4 because the former includes imported lead.
- According to Table 7, the production amount of high temperature type lead-containing solder in 2007 was 930t/year. The proportion of the "amount of lead used in high temperature type lead-containing solders" to the "amount of lead used in all solders" is estimated to be 6.9%, compared with lead to be used in solders in Fig. 5. (Refer to the following expression.)

Proportion of "amount of lead used in high temperature type lead-containing solders" to the "amount of lead used in all solders"(%)

= ((0.85 × Production amount of high temperature type lead-containing solders) ÷ Amount of lead used in solders) × 100

= ((0.85 × 930) ÷ 11,396) × 100

= 6.9%

- Based on the above results, we estimate amount of lead in high temperature type lead-containing solders to be put on the EU market, with the following expression:

Amount of Lead in High Temperature Type Lead-containing Solders Put on the European Market in a Year (t/yr)

= Lead production amount in Europe (t/year)

× Ratio (%) of lead used in solders in applications using lead (%)

× Ratio of high temperature type lead-containing solders to the amount of lead used in all solders

= 1,500,000 (t/yr)

× 3.5%

× 6.9%

= **3,600 (t/yr)**

- In this figure, we cannot consider the amount of high temperature type lead-containing solders contained in products to be imported into EU as a final product.

*4. What has changed compared to the **last evaluation** in 2004?*

- Before enforcement of RoHS Directive (2006), Sn-37Pb was widely used as lead-containing solder for the reason of convenience. However, after the enforcement of RoHS Directive, it was replaced by lead-free solders mainly composed of Sn-Ag-Cu.
- However, there is the actual status of the usage that lead-containing solders used in solder joint of any equipment or application not covered by RoHS Directive still exceeds the production amount of high temperature lead-containing solders.

<<General Questionnaire>>

1. For which substance(s) or compound(s) should the requested exemption be valid?

Lead in high melting temperature type solders (Exemption 7(a))

2. What is the application in which the substance/compound is used for and what is its specific technical function?)

See the attached file, Table.1 and Table.3.

3. What is the specific (technical) function of the substance/compound in this application?)

See the attached file, Table.3 and Fig.6.

4. Please justify why this application falls under the scope of the RoHS Directive (e.g. is it a finished product? is it a fixed installation? What category of the WEEE Directive does it belong to?).

Lead in high melting temperature type solders (Exemption 7(a)) See the attached file.

5. What is the amount (in absolute number and in percentage by weight) of the substance/compound in: i) the homogeneous material[1], ii) the application and iii) total EU annually for RoHS relevant applications?

See the attached file, Answer.3.

6. Please check and justify why the application you request an exemption for does not overlap with already existing exemptions respectively does not overlap with exemption requests covered by previous consultations.)

Not applicable – this is only for new exemption requests

7. Please provide an unambiguous wording for the (requested) exemption.)

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

Annex (1/3)

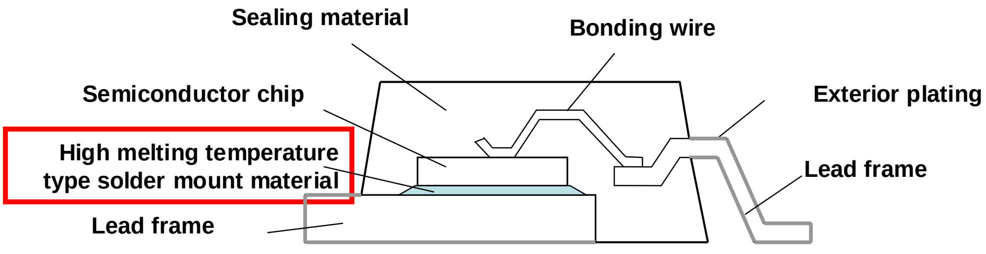


Fig. 1 Schematic Cross Sectional View of Power Semiconductor

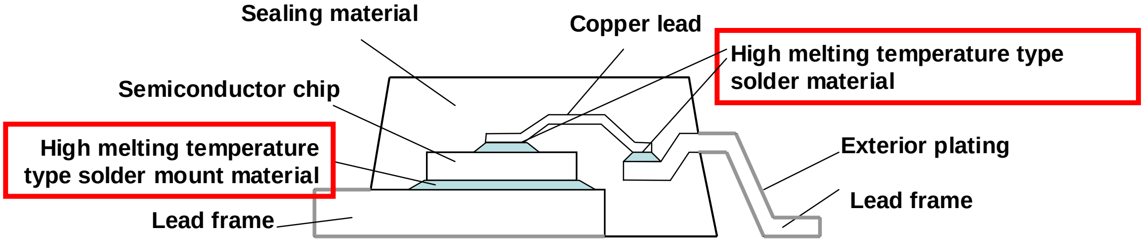
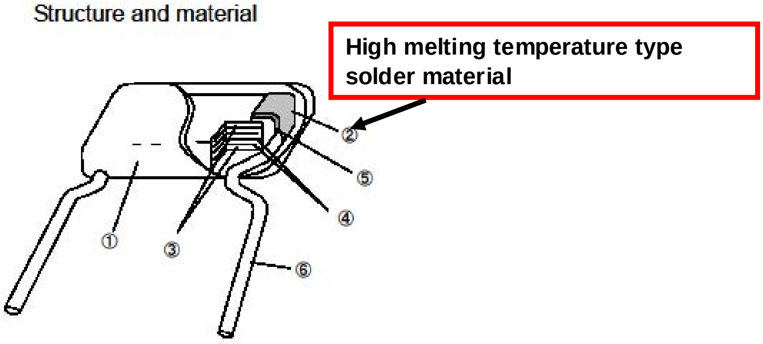


Fig. 2 Schematic Cross Sectional View of Internal Connection of Semiconductor

Annex (2/3)

Structure and material

1. Structure



2. Material and Description

No.	Material	Description
①	Enclosure	Epoxy resin
②	Inner solder	Sn-Pb type solder *1
③	Dielectric	Ceramic
④	Inner electrode	Ni or Pd or Ag/Pd
⑤	Outer electrode	1)Ag/Pd or 2) Ag or Ag/Pd or Cu + Ni plating + Sn plating
⑥	Lead wire	Solder(Sn-2.5Cu) coated copper wire or Solder(Sn-2.5Cu) coated CP wire

*1 Lead in high melting temperature type solders (Pb;85% or more) are exempted from the requirements of RoHS.

Fig. 3 Schematic View of Capacitor with Lead

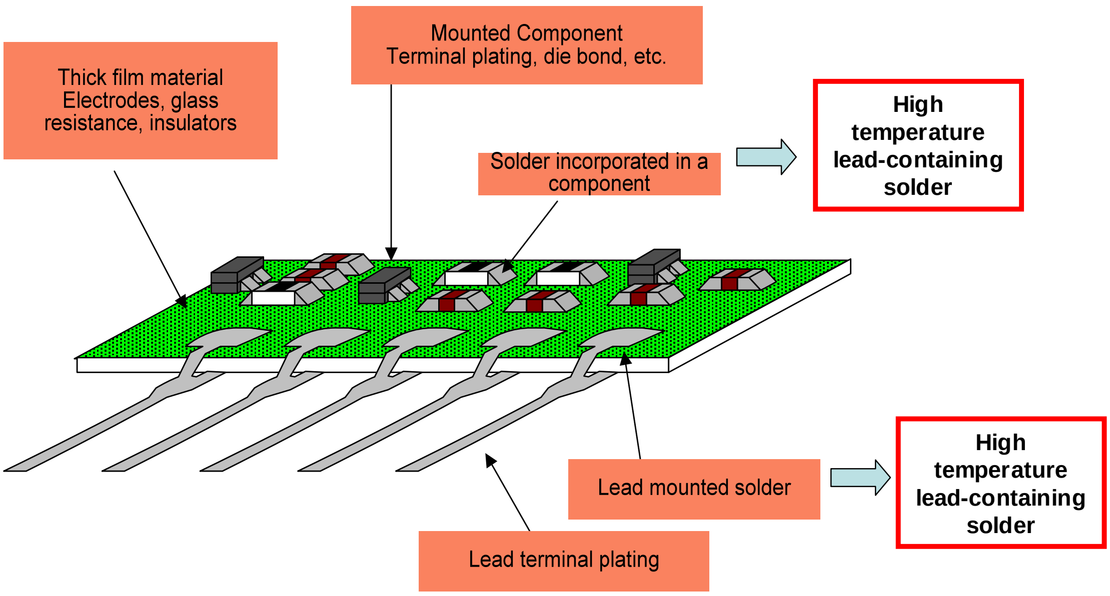


Fig. 4 Schematic View of Circuit Module Component

Annex (3/3)

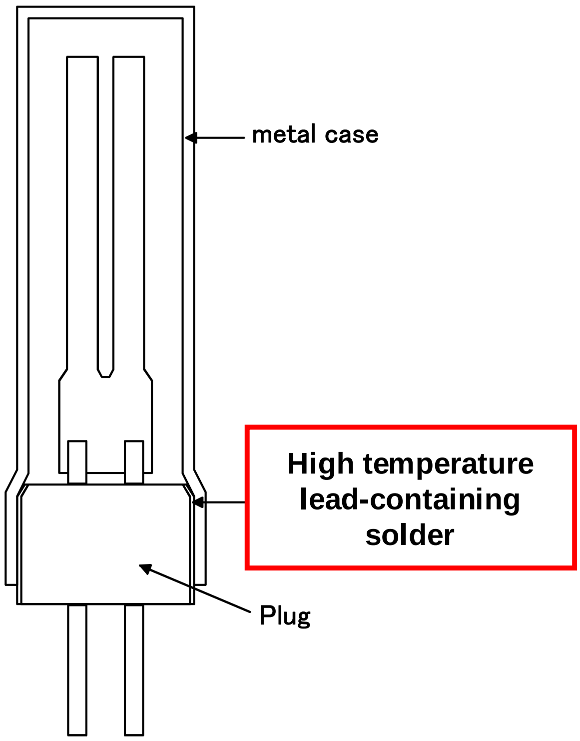


Fig. 5 Schematic View of Crystal Unit