



European
Automobile
Manufacturers
Association



et al.

Automotive Industry Interpretation Guide for ELV Annex II (2016/774/EU)

with

IMDS Information added by the IMDS Steering Committee

This guiding principles are common Automotive Industry understanding

Based upon the ACEA / JAMA / KAMA / CLEPA / JAPIA et al. documentation.

--not legally binding--

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IMDS REPORTING Preface

The electrical/electronic applications detailed in exemptions 8a to 8j and 10a to 10d of EU ELV Annex II and corresponding demands in other regions, require the OEMs to gather additional information (via IMDS) on the uses of lead in electronic modules for new vehicle types, in order to satisfy their legal obligations.

To enable information on these applications, Application Codes have been made available in IMDS (see Table 1).

Some of the Application Codes are linked to exemptions with a reference to a vehicle Type Approval date.

In case new Application Codes need to be made available in IMDS (caused by a change of Annex II), the following change management rules apply:

- All newly created MDS must use the new Application Codes
- Application Codes that have been deactivated because of a further diversification of an ELV Annex II exemption (e.g. for exemption 8f) will remain valid for parts in current production and already sent MDS.
- An update is necessary in case the part is identified for vehicles with Type Approval date later than an exemption is granted ("New Vehicle Type") or because of material compliance demands from regulations in other markets (carry over parts).
- A request to update all MDS using previous (deactivated) Application Codes, not meeting above mentioned criteria, must be avoided.

PLEASE REFER TO TABLE 2 FOR ADDITIONAL GUIDANCE.

The applications must be entered accurately with care as legal compliance is derived from them.

It is the OEMs' responsibility to inform their Tier 1 Suppliers and Directed Suppliers if the intended part is for use in a "New Vehicle Type".

In general, the OEM should provide a list of affected parts to the Tier 1 supplier at least 6 months before the IMDS record is required (a late request may result in a late submission, due to the time taken to gather this data). Specifically short termed new legislation may require reduced timelines.

It is the Tier 1 Suppliers' responsibility to manage this requirement within their supply chain to ensure that they provide the required information.

Application Code	OLD / NEW	Date of inclusion or deactivation	Expiry date of exemption
Solder in electronic circuit boards and other electric applications	OLD	2010	-
8(a) - Lead in solder used in electronic circuit board applications	NEW	2010	2016-01-01
8(b) - Lead in solders in electrical applications other than soldering on electronic circuit boards or on glass	NEW	2010	2011-01-01
8(c) - Lead in finishes on terminals of electrolyte aluminum capacitors	NEW	2010	2013-01-01
8(d) - Lead used in soldering on glass in mass airflow sensors	NEW	2010	2015-01-01
8(e) - Lead in high melting temperature type solders (i.e. lead-based alloys containing 85 % by weight or more lead)	NEW	2010	-
8(f) - Lead in compliant pin connector systems	OLD	2010	-
8(f) (a) - Lead in compliant pin connector systems	NEW	2016	2017-01-01
8(f) (b) - Lead in compliant pin connector systems other than the mating area of vehicle harness connectors	NEW	2016	-
8(g) - Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages	NEW	2010	-
8(h) - Lead in solder to attach heat spreaders to the heat sink in power semiconductor assemblies	NEW	2010	2016-01-01
8(i) - Lead in solders in electrical glazing applications on glass except for soldering in laminated glazing	NEW	2010	2016-01-01
8(j) - Lead in solders for soldering on laminated glazing	NEW	2010	2020-01-01
Electrical components which contain lead in a glass or ceramic matrix compound except glass in bulbs and glaze of spark plugs	OLD	2011	-
10 (a) - Electrical and electronic components which contain lead in a glass or ceramic, in a glass or ceramic matrix compound, in a glass-ceramic material, or in a glass-ceramic matrix compound. This exemption does not cover the use of lead in: - glass in bulbs and glaze of spark plugs, - dielectric ceramic materials of components listed under 10(b), 10(c) and 10(d)	NEW	2011	-
10 (b) - Lead in PZT based dielectric ceramic materials of capacitors being part of integrated circuits or discrete semiconductors	NEW	2011	-
10 (c) - Lead in dielectric ceramic materials of capacitors with a rated voltage of less than 125 V AC or 250 V DC	NEW	2011	2016-01-01
10 (d) - Lead in the dielectric ceramic materials of capacitors compensating the temperature-related deviations of sensors in ultrasonic sonar systems	NEW	2011	2017-01-01

Table 1: Active IMDS Application Codes for electronic modules

Case #	Submission Type	IMDS INITIALLY CREATED	Electronic components and PCB's	Comments
	Initial			
A1	Newly created IMDS Module	Any time	1) Use UPDATED REC019 and NEW Application Codes 2) ZVEI semi components to be used for REC019 declaration 3) in general NEW Application Codes to be used	As the information becomes available, suppliers must identify remaining application codes.
A2	Tier 1 ASSEMBLY NOT PRESENT in New Type Approval	Any time	1) Use REC019 applicable for scenario A1. 2) May contain OLD Declarations and NEW Application Codes according to A1	Example: This scenario covers a new seat assembly for a current model that does not need a new Type Approval. The newly created MDS Modules will comply with A1. The carry over MDS modules will still be permitted.
A3	Tier 1 ASSEMBLY - PRESENT in New Type Approval.	Any time	1) Use current REC019 applicable for scenario A1. 2) Must NOT contain OLD Application codes 3) OLD MDS's be revised according to A1	OEMs to communicate list of Part Numbers to Tier 1 Suppliers. OLD Application codes NOT PERMITTED Example: For the seat assembly -old MDS's with the above application code will need to be redefined according to A1.
	re-submissions			
B1	Carry over MDS Module - PRESENT in New Type Approval	Any Time	Resubmission needed to A1 requirements	Tier 1's to cascade requirement through their responsible supply chain to enable the Tier 1 resubmission. OLD Application codes NOT PERMITTED
B2	Carry over MDS Module - NOT PRESENT in New Type Approval	Any Time	1) No general re submission required for application update 2) It will still be allowed to use IMDS SC PCB existing, even after revision of Rec019 has been released	OLD Application codes ARE PERMITTED
B3	Carry over MDS Module - PRESENT in New Type Approval.	Any Time	This is scenario A1	

Table 2: Supplier guidance on the handling on new electronic application codes.

Definition/interpretation of -Exemption (8a)

8(a).Lead in solders to attach **electrical and electronic components**¹⁾ to **electronic circuit boards**⁵⁾ and **lead in finishes on terminations of components**²⁾ other than electrolyte aluminum capacitors, (finishes) **on component pins**³⁾ and (finishes) **on electronic circuit boards**⁴⁾

DUE DATE: Vehicles type approved before 1 January 2016 and spare parts for these vehicles

IMDS APPLICATION CODE: 8(a) - Lead in solder used in electronic circuit board applications

To better understand what is meant here and what is in scope, the single elements of this exemption are defined separately.

1)... electrical and electronic components

... in this context are all components (elements) which are soldered to the ECB and which cannot be removed mechanically without destroying the board or unsoldering the components.

Examples of such components are:

a) passive elements

like inductors, magnetics, ferrite, resistors, thermistors, varistors, polyswitches, capacitors (ceramic, tantalum, electrolytic, film), quartz, resonators, etc.



Fig. 1: Passive Electronic Components

b) active elements

like discrete circuits (diodes, thyristors, transistors, MOS-FET, etc.), integrated circuits, power semiconductors (thyristors, IGBT's, MOS-FET's) any other performance module, etc.



Fig. 2: Active electronic Components

c) and others

like terminals, heat sinks, relays, pins, sockets, plugs, and sensors as well as other electromechanical components /devices suitable to be used on a board.

Components in themselves can have ECB's with components like IC's, resistors, capacitors. Examples of such components are actuators and sensors.

2) ... lead in finishes on terminations of components

... are all kind of lead containing coatings/finishes on terminations of these components (e.g. the "legs" of a performance module)

3) ... (lead in finishes) on component pins

... are coatings on the pins of these components (e.g. the thin wire "wire legs" of resistors, diodes)

4)... (lead in finishes) on electronic circuit boards

... are all kind of lead containing coatings on the ECB/PWB itself.

5) Electronic Circuit Board (ECB) is the main term for both Printed Circuit Board (PCB) and Printed wiring Board (PWB)

See pictures as examples for:

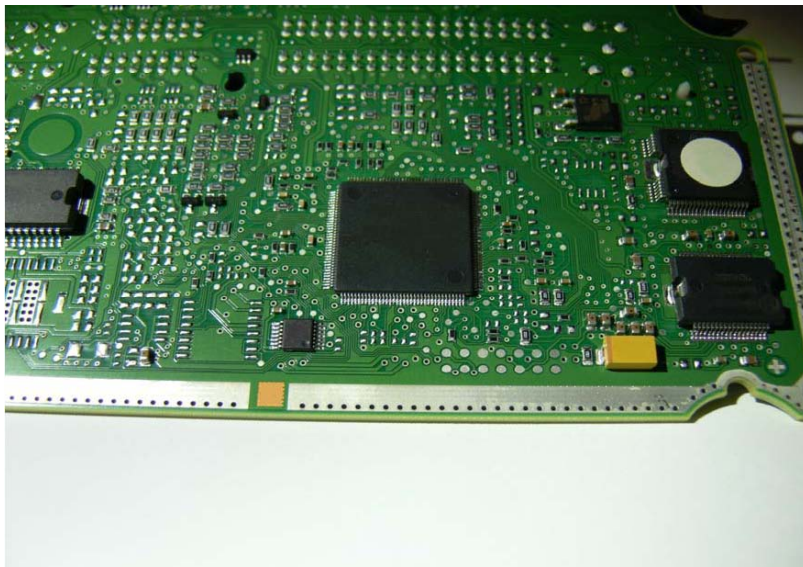


Fig. 3: Typical ECB (separated)

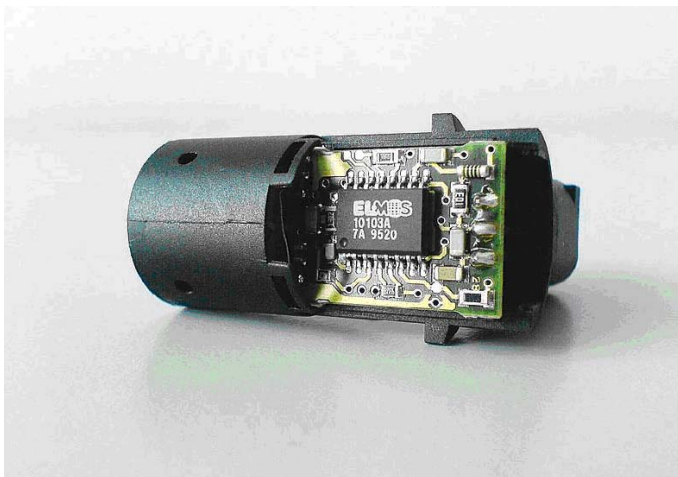


Fig. 4: Small ECB in a part

A **Printed Circuit Board (PCB)** is a printed board used to **mechanically support** and providing both, electrical point to point connections **and printed components** in a predetermined arrangement, using **conductive pathways, or traces**, e.g. etched from copper sheets **laminated onto a non-conductive substrate**.

A **PCB** populated with electronic components (mounted and/or interconnected) is also known as a **Printed Circuit Board Assembly (PCBA)**.

The main **elements of a PCB** as defined as follows:

Printed Board (PB) is the general term for completely processed printed circuit and printed wiring configurations. This includes single-sided, double-sided and multilayer boards with rigid, flexible, and rigid-flex base materials. **The geometry may be flat or 3D.**

The material used is not a relevant distinguishing criterion.

Printed Circuit is a conductive pattern that is composed of printed components, printed wiring, discrete wiring, or a combination thereof, that is formed in a predetermined arrangement on a common base.

Printed Component is a part (such as an inductor, resistor, capacitor, or transmission line) that is formed as part of the conductive pattern of a printed board.

The following variants belong to the group of ECB's

- FPC (flexible printed Circuits)
- Ceramics:
 - LTCC (low temperature co-fired ceramics)
 - DCB / DBC (direct copper bonding / direct bonding copper)
 - thick film circuits
 - thin film circuits
- leadframes

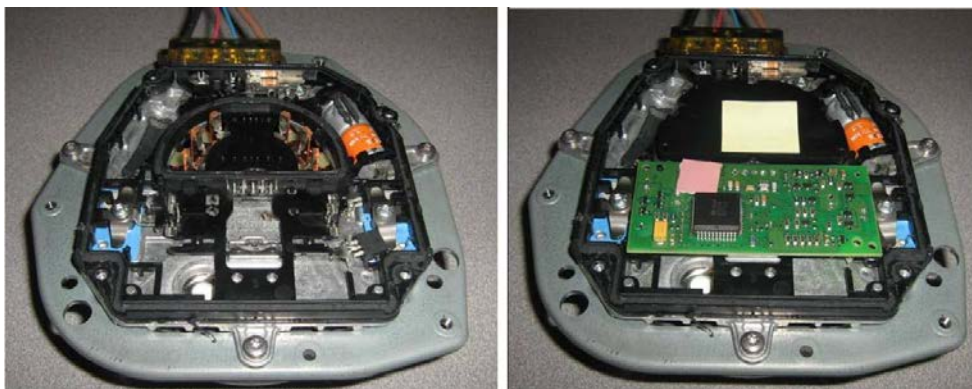


Fig. 5: Lead frame for a brushless motor left: without the PCB right: with the PCB



Fig. 6: Lead frame for a control knob to adjust the headlight height left: topside right: downside

A **Printed Wiring Board (PWB)** is a printed board used to **mechanically support** and providing electrical point to point connections **but not printed components** in a predetermined arrangement, using **conductive pathways, or traces**, etched from copper sheets **laminated onto a non-conductive substrate**.

A **PWB** populated with electronic components (mounted and/or interconnected) is also known as a **Printed Wiring Board Assembly (PWBA)**.

The main **elements of a PCB** as defined as follows.

Printed Wiring is a conductive pattern that provides point-to-point connections but not printed components in a predetermined arrangement on a common base.

Printed Contacts (portion of a conductive pattern that serves as one part of a contact system) and **Conductive Inks** can be used on both, **PWB** and **PCB** and are therefore covered by the definition of **Electronic Circuit Board (ECB)**.

All components (see description, examples and pictures above) as well as **terminals and sockets** for plug in cables which are soldered to the ECB and which cannot be removed mechanically without destroying the board are also included in the definition of **Electronic Circuit Board (ECB)**.

Housings, detachable connections (e.g. wires, connectors) or flexible flat wirings however, are not covered by the definition of Electronic Circuit Board

Definition/interpretation of -Exemption (8b)

8(b). Lead in solders in **electrical applications other than soldering on electronic circuit boards or on glass**

DUE DATE: Vehicles type approved before 1 January 2011 and spare parts for these vehicles

IMDS APPLICATION CODE: 8(b) - Lead in solders in electrical applications other than soldering on electronic circuit boards or on glass

This exemption is related to electrical/ electronic applications which are not covered by 8a) or any other exemption 8c) to 8j).

It is basically the remaining “rest” for which no exemption has been granted.

It covers at least all discrete electrical/electronic components which are not directly soldered to the ECB. (See definition for 8a).

Roughly spoken, it are “normal” or even simple solder joints, mostly a single or just a few solder joints (most of them hand soldered) whereas a ECB has numerous of solder joints.

Those typical applications are as follows: E.g., wire sets, (pre soldering of) wire ends, actuators (solenoid valves, motors, valves) loudspeakers, Illuminations, switches*), sockets, contacts*), sensors*), transmitters, relays, pushbuttons, solder for attachments, etc. ... unless none of the exemptions 8c) to 8j) could be applied.

*) if on a board then 8a)

Following example may help to explain the difference between 8a) and 8b).

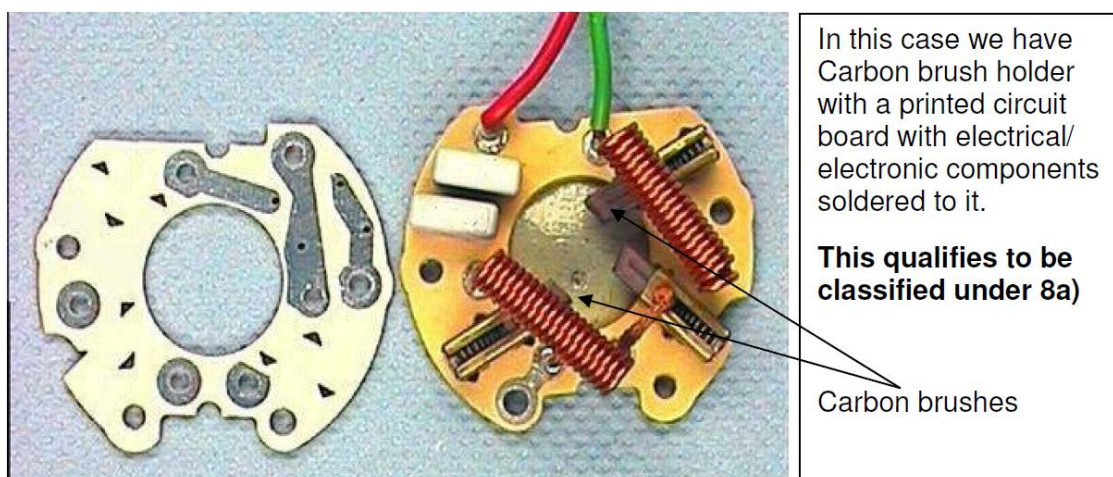


Fig. 7: Carbon Brush holder with a printed Circuit Board

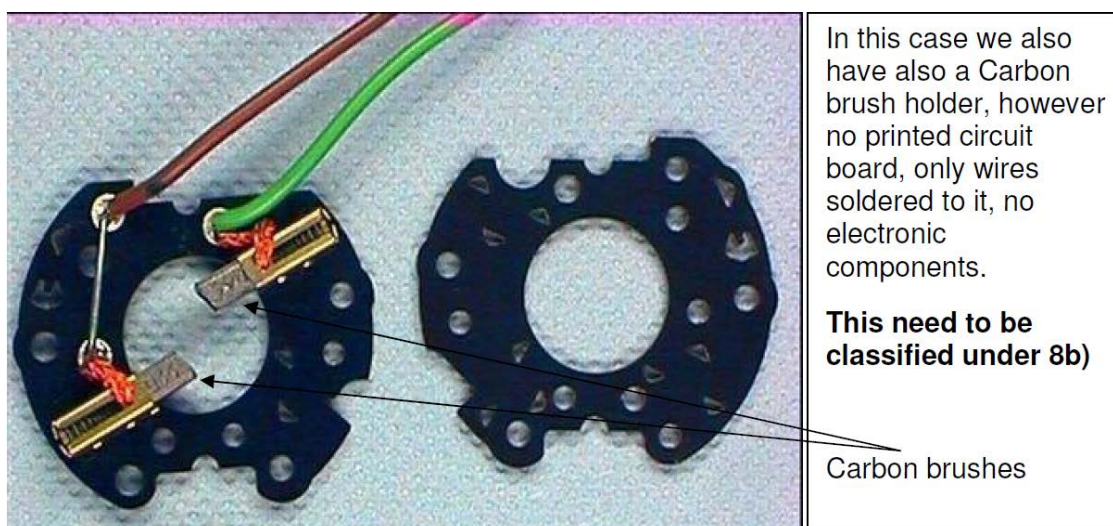


Fig. 8: Carbon Brush holder without a printed Circuit Board

Another example is shown below where the solder joint -pin to the ECB/PCB -falls under exemption 8a) but the simple solder joint -wire to the pin -(most hand soldered) and all other solder joints along the wire fall under exemption 8b).

👉 If a pin is soldered on a ECB, and e.g. a wire or a component is soldered to the pin

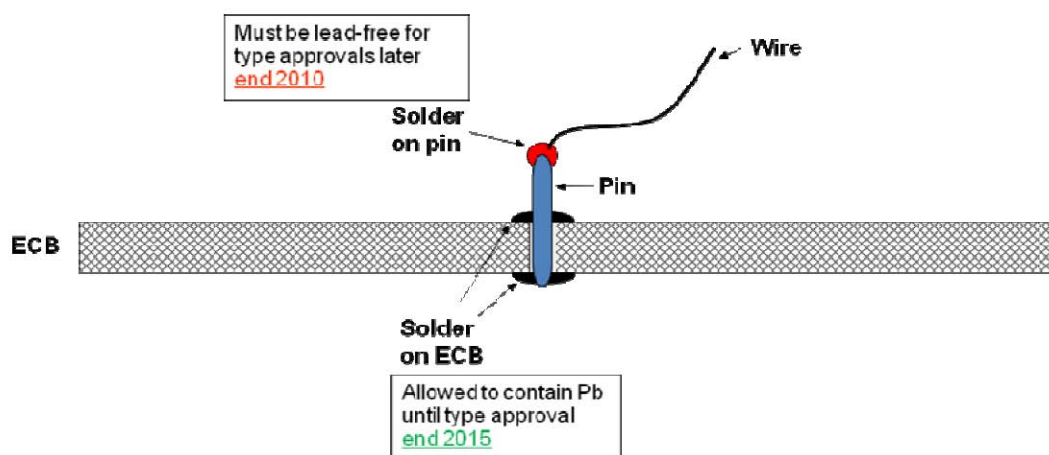


Fig. 9: Pin soldered to an ECB, and wire soldered to a pin

Definition/interpretation of -Exemption (8c)**8(c).** Lead in finishes on terminals of electrolyte aluminum capacitors**DUE DATE:** Vehicles type approved before 1 January 2013 and spare parts for these vehicles**IMDS APPLICATION CODE:** 8(c) - Lead in finishes on terminals of electrolyte aluminum capacitors

This is a very specific application and is self-explaining. These Al-capacitors do also qualify to be covered under the “(lead in finishes) on component pins” of exemption 8a), however as there are lead free Al-capacitors out in the market, mainly for the consumer electronic, and they are not exempted under RoHS, just two more years implementation time have been granted.

See picture

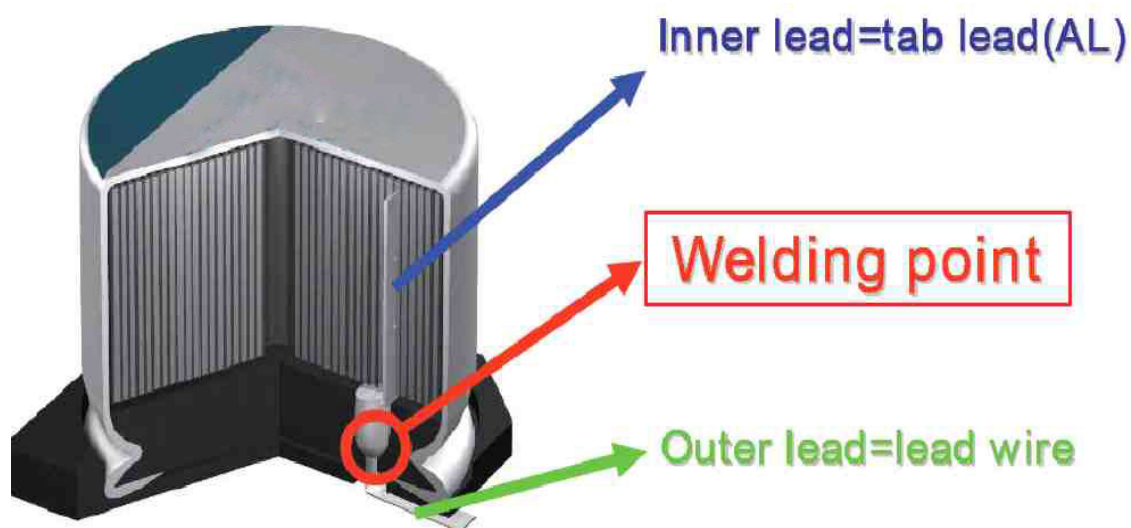


Fig. 10: Typical electrolyte capacitor

Definition/interpretation of -Exemption (8d)

8(d). Lead used in soldering on glass in mass airflow sensors

DUE DATE: Vehicles type approved before 1 January 2015 and spare parts for these vehicles

IMDS APPLICATION CODE: 8(d) - Lead used in soldering on glass in mass airflow sensors

This is a very specific application and is obviously not self-explaining.

The Mass Airflow Sensor is used to measure the mass quantity of air entering an internal combustion engine. This information is used by the engine management system to optimize the combustion process in an engine with regard to fuel efficiency and emissions.

A flow sensing element consisting of an electrically heated hot film or hot-wire is heated to a defined offset temperature relative to the ambient temperature (determined by a separate temperature sensor). The power needed to keep the sensing element at the offset temperature is a measure of the mass air flow passing the sensor

The base material of the flow and temperature sensing elements must fulfill certain requirements. Among other requirements, a low thermal conductivity and the capability of thin film application is of critical importance for thin-film elements.

Glass is the ideal material to meet these requirements.

Due to the mechanical sensitivity of glass, the mechanical connection of the sensing element to a carrier must be chosen carefully, so that the glass is not damaged during processing and in use.

With the soldering process both the mechanical fixation of the element and the electrical connection to the thin-film can be achieved.

A typical application for solder on glass for non-glazing application is a mass airflow sensor.

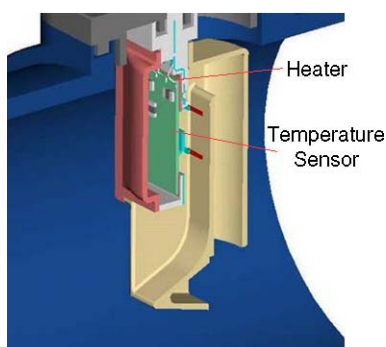
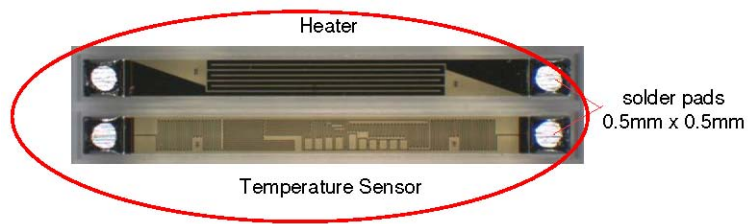


Fig.11: Cross-Section of a Mass Airflow Sensor in a tube

The solder reservoir is applied to the glass chips via solder-paste screen-printing & reflow soldering



The glass chips are soldered onto a carrier via stamp soldering

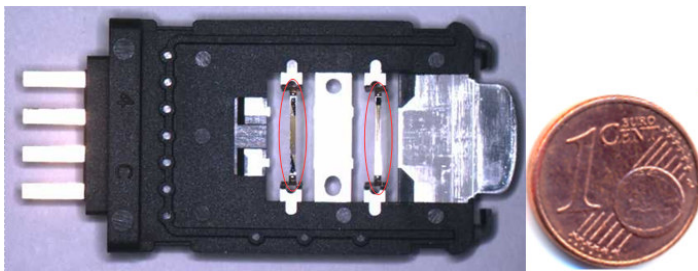


Fig.12: Solder joint on glass

Definition/interpretation of -Exemption (8e)

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

This exemption shall be reviewed in 2019

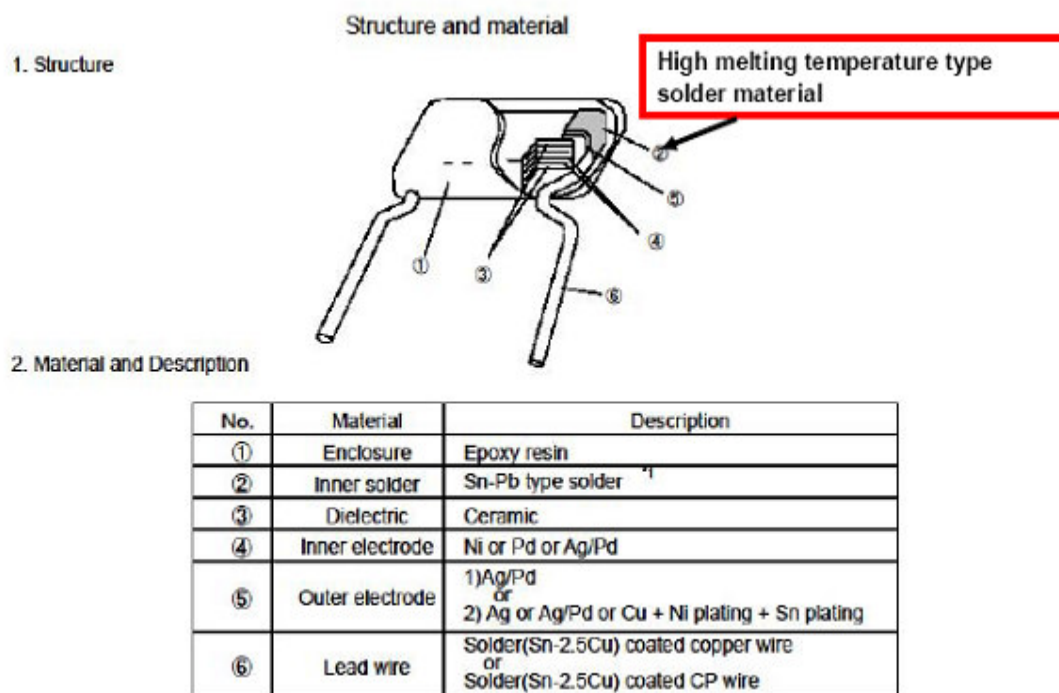
IMDS APPLICATION CODE: 8(e) - Lead in high melting temperature type solders (i.e. lead-based alloys containing 85 % by weight or more lead)

This is a broad scope for all “high melting temperature type solder” with a melting point $>250^{\circ}\text{C}$. As the 85% lead content is mentioned as a minimum, any other, little lower lead containing solder alloy (e.g. around 80%) would not be covered under this exemption.

Remark: Composition of the solder material is the important, not the lead concentration in the solder joint. The latter one can be lower.

Typical applications are as follows: (As explained in our justifications)

1. Component Internal Connections



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

Fig.13: Leaded Capacitor – representative example component

2. Die Attach

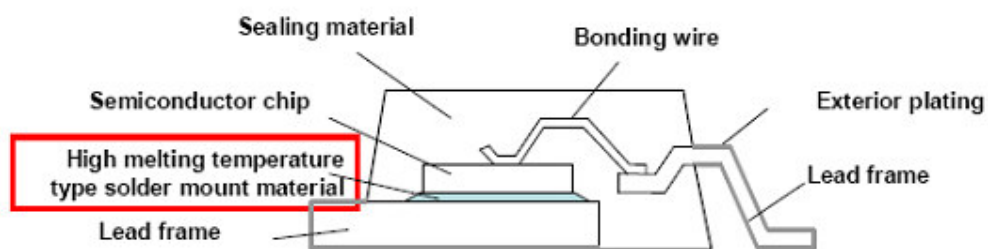


Fig.14: Power Semiconductor -representative example component

3. Hermetic sealing

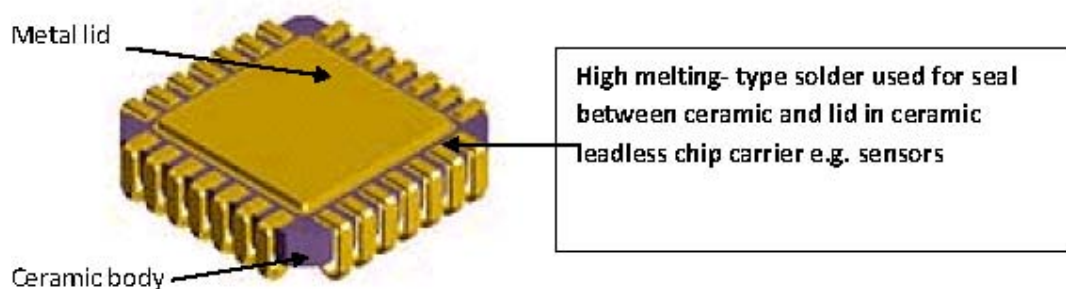


Fig.15: Ceramic Leadless Chip Carrier – representative example component

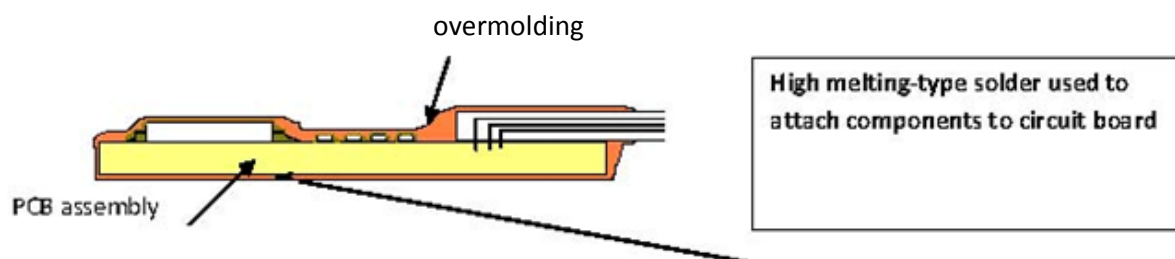


Fig.16: Example of an over molded component

5. Ceramic Ball Grid Array (CBGA)

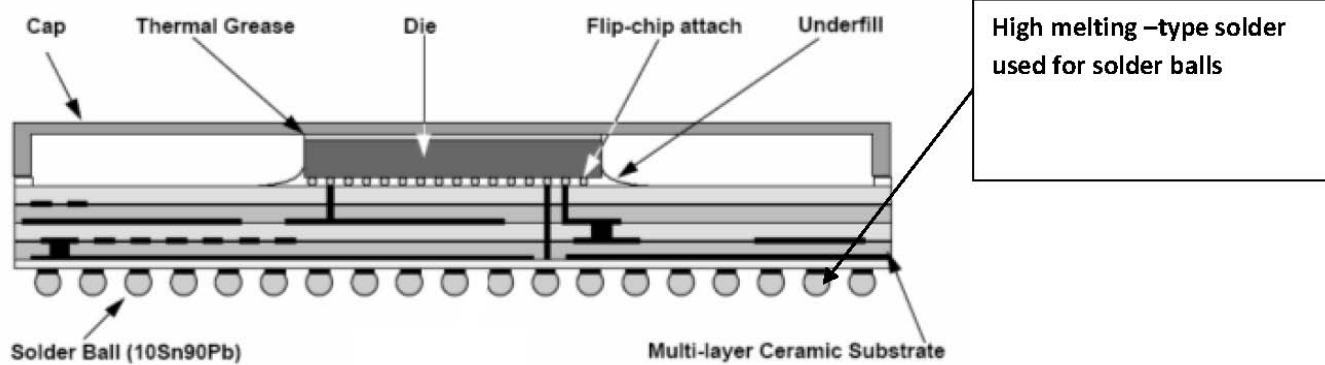


Fig.17: Ceramic Ball Grid Array -representative example component

6. High Power Applications

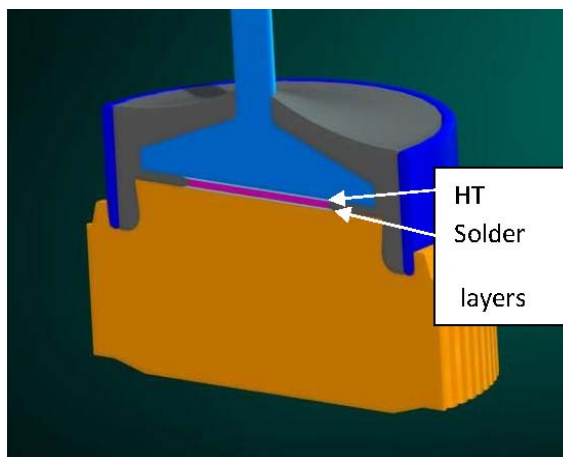


Fig.18: Generator Diode

7. Some other examples

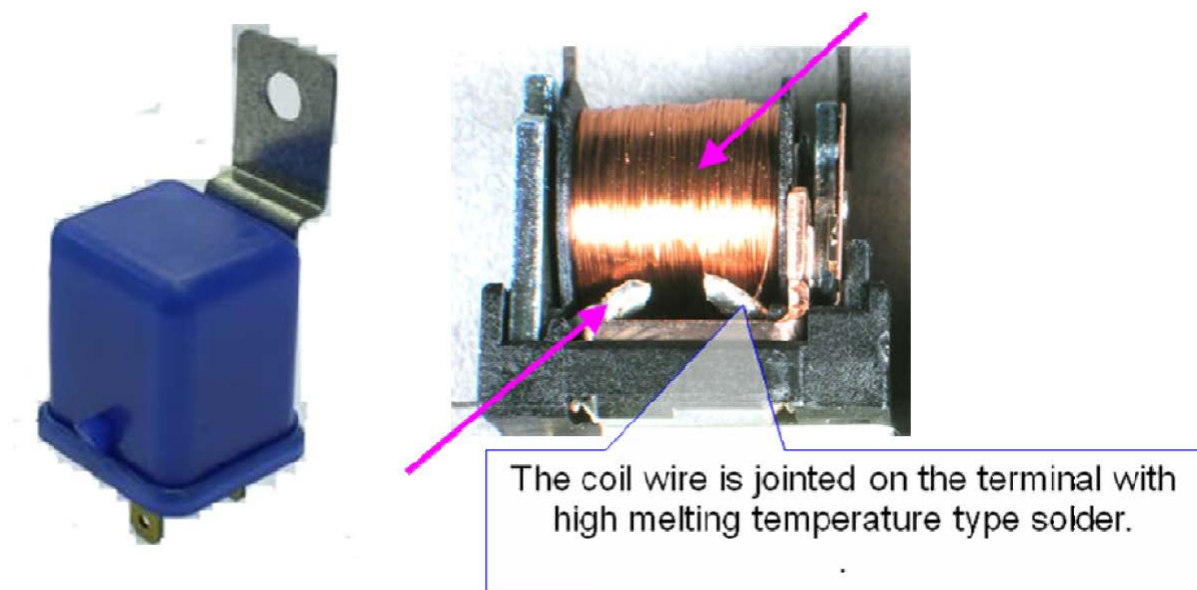


Fig. 19: Connection of the coil wire with the terminal in a relay

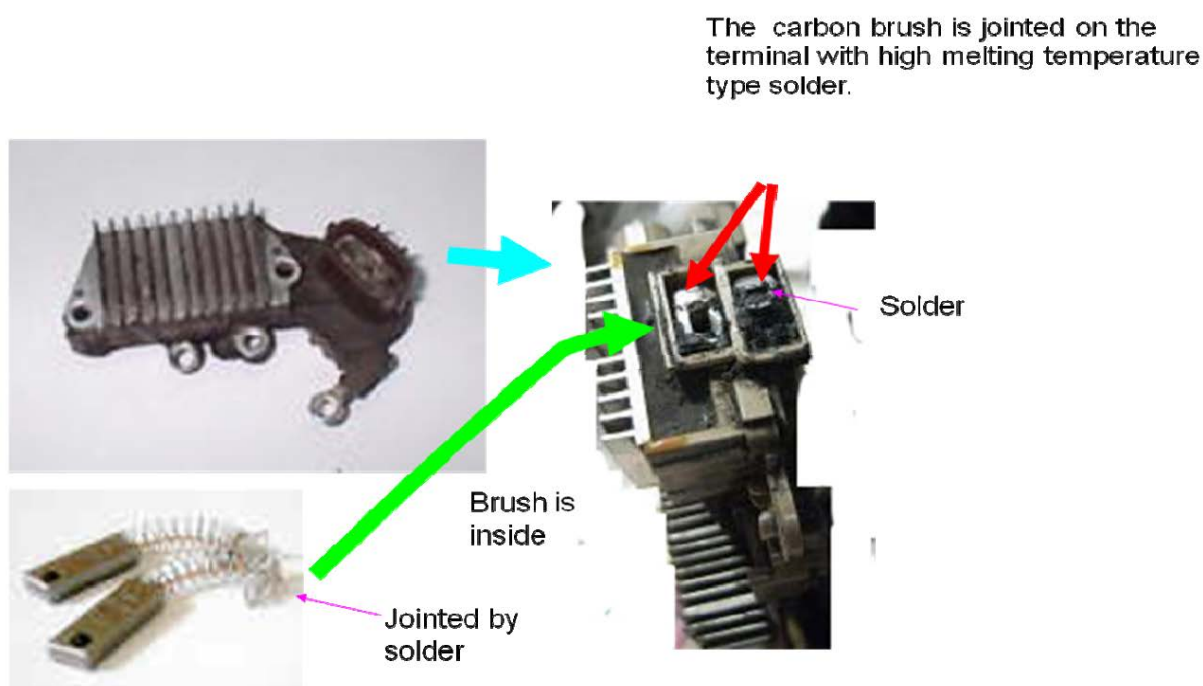


Fig. 20: Joint of carbon brushes in a motor or alternator

Other, not shown applications using HT solder are also covered by this exemption.

Definition/interpretation of - Exemption 8f) resp. 8f (a) and 8f (b)

8f (a). Lead in compliant pin connector systems
DUE DATE: Vehicles type approved before 1 January 2017 and spare parts for these vehicles
IMDS APPLICATION CODE: 8(f) (a) - Lead in compliant pin connector systems

8f (b). Lead in compliant pin connector systems other than the mating area of vehicle harness connectors
This exemption shall be reviewed in 2019
IMDS APPLICATION CODE: 8(f) (b) - Lead in compliant pin connector systems other than the mating area of vehicle harness connectors

History

2003 -02/2010: Until the 4th revision of the annex II in Febr.2010 there was no specific exemption for the use of lead in compliant pin connector systems. So this use case for lead was included before in the exemption entry 8a existing at that time (Solder in electronic circuit boards and other electrical applications except on glass) being valid until 25.02.2010.

02/2010 – 04/2016: With the 4th amendment of annex II the entries 8 had been reconfigured and more detailed. As a spin off from the RoHS I directive, for automotive applications the new entry 8(f) for press fits was introduced in 2010. This version was free of any reference to any type approval date.

New Situation

On May 19th 2016 the 7th revision of annex II was published with directive 2016/744. Therein the scope of the exemption 8(f) was amended. The previous exemption 8(f) is now split up into the two subentries 8(f) (a) and 8(f) (b).

Entry 8(f) (a) has the same scope as the previous exemption 8(f) as defined in 2010, but is now limited in use to vehicles (and their spare parts) being type approved before 1.1.2017 only.

Entry 8f (b) is valid for all vehicles with a type approval date after 31.12.2016. Entry 8(f) (b) prohibits the use of lead containing solders or coatings in the mating area of vehicle harness connectors. So 8(f) (b) has a narrowed scope of application compared to the previous exemption 8(f). Entry 8f (b) shall be reviewed in 2019.

Application code 8(f) has been de-activated (will not be available for new applications) and replaced with 8(f) (a) and 8(f) (b).

Please review the following examples to determine the correct IMDS Application code for your pin connector system.

Old definition (valid only for vehicles type approved until 31.12.2016)

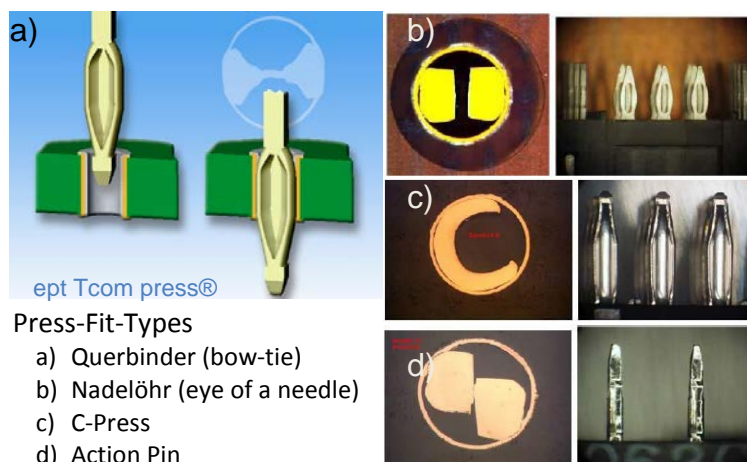
This previous “old” definition for exemption 8(f) is also good for explaining the scope of the new entry 8(f) (a) but it is not applicable for the new entry 8(f) (b). If a car manufacturer is using a connector with this application code on a vehicle that will be Type Approved after January 1st, 2017 you will be requested to update your IMDS entry to identify if it falls into the 8(f) (a) or 8(f) (b) application.

The following text originates from the previous version of the interpretation guide.

“Connectors are pressed into a PCB without soldering it. This application however, has a limited scope applicable e.g. it is impossible for high power electronics.

For such applications lead is needed to suppress formation and growth of whiskers, which may occur if pure tin layers are used.”

Press in terminals (with flex zone) are included in this exemption.



Press-Fit-Types

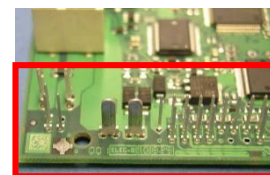


Fig. 21: Compliant pin connector types (press fit)

Fig. 22: Press fit assemblies

The following example was also covered by the “compliant pin connector systems” exemption, meaning the whole pin can have a lead-containing surface.

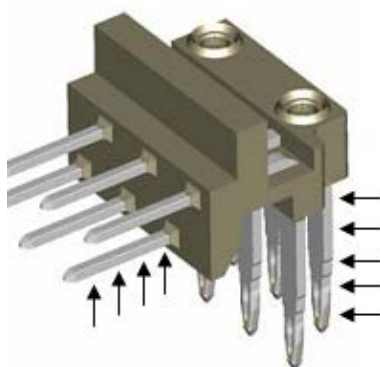


Fig 23: Compliant pin connector system with leaded pins (arrows)

New: Definition of entry 8(f) (b) for vehicles with a type approval after 31.12.16

(taken from OEKO institute report for 7th revision; 01/07/2015 chapter 5 page 40ff)

The scope of entry 8(f) (b) is outlined in the consultant report as following:

“...ACEA et al. differentiates between harness connectors (standard CoPiCS) and complex stamping grids. Unlike harness connectors, complex stamping grids, besides compliant pin zones, use other assembly and interconnection technologies like welding, “Schneid-Klemm,” etc. on the same stamping grid.

Typically, these stamping grids have no simple point-to-point connection but more the function of a printed circuit board combined with a complex three-dimensional form. For these kinds of complex parts, the surface needs to suffice the highest technical requirements of the interconnection technology. The application of different surfaces, for example lead and lead-free ones, is technically not feasible because of the complexity of the 3D-form. Therefore, if they use compliant pin zones, leaded tin could be used on the stamping grid.

ACEA et al. defines the “mating area” as the “customer” side of the standard CoPiCS. The connection is here typically done with a harness connector. Figure 5-4 illustrates the situation. According to ACEA et al.128, the definition “Lead in compliant pin connector systems other than the mating area of a vehicle harness connector” will reduce the use of lead for most of the CoPiCS, but keep the door open for the use of lead on complex stamping grids where it is still required. ...”

The following explanation shall make more clear what it is meant, resp. which of the application codes 8(f) (a) or 8(f) (b) need to be applied.

The definition is illustrated in the following figure 24:

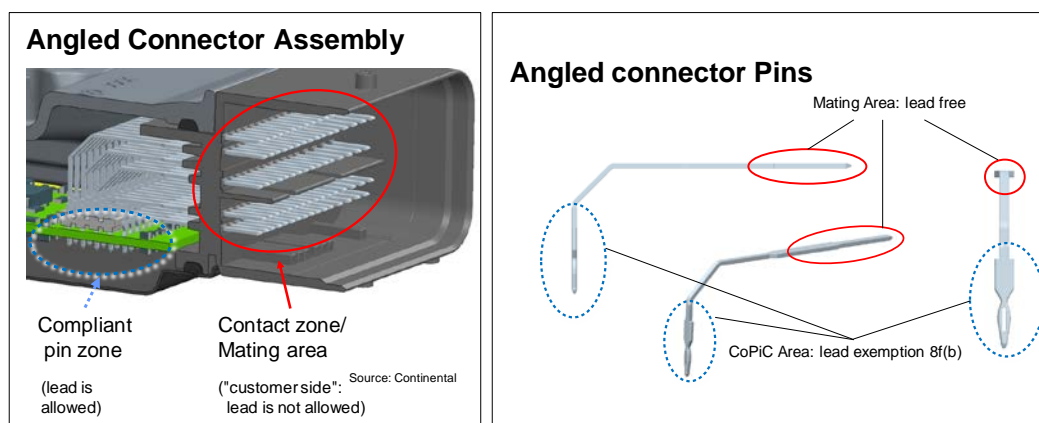


Fig 24: Compliant pin connector zone and definition of mating area (graphics used with permission of Continental)

Based on industry expert discussions, the following two additional figures 25 and 26 have been drafted:

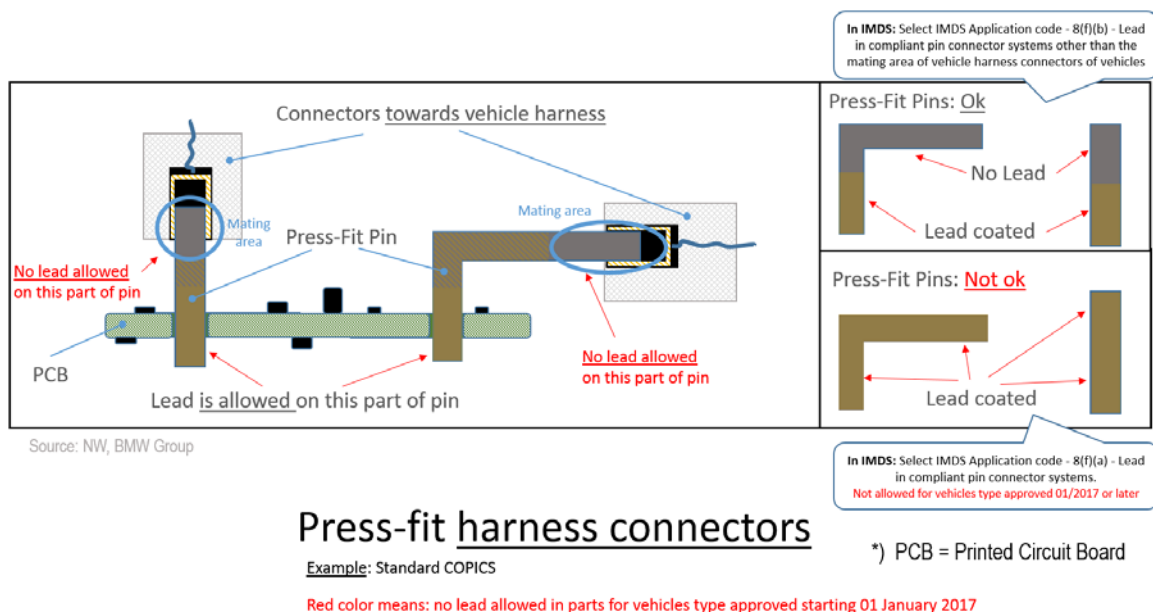


Fig 25: Compliant pin connector zone and definition of mating area for harness connectors

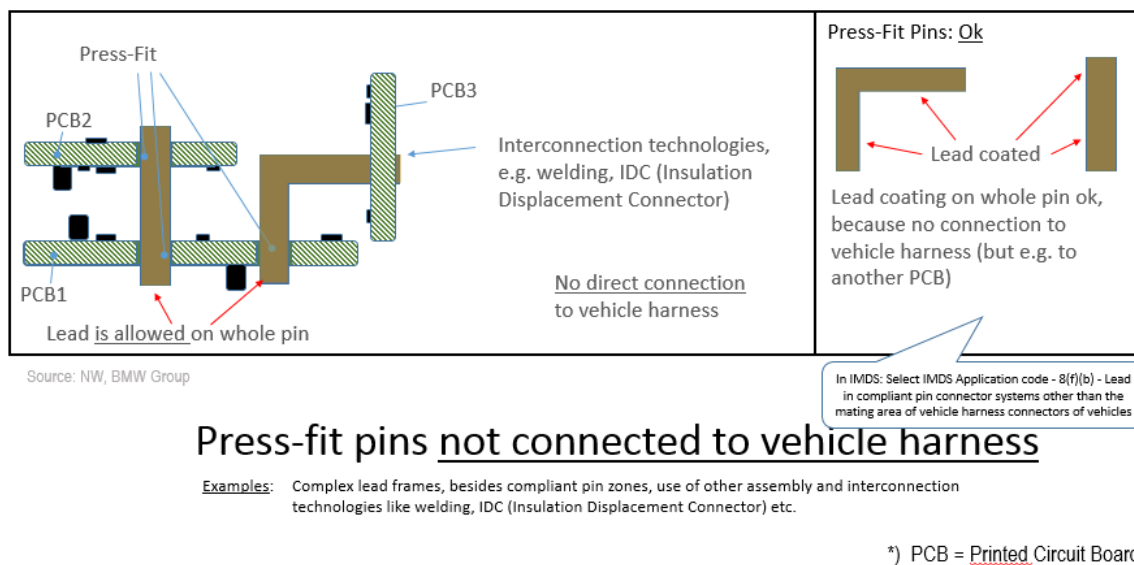


Fig 26: Compliant pin connector without mating area

Figure 25 outlines that the scope of entry 8(f) (b), is focussed to the area fitting in the printed circuit board but not to the area where the connection with the harness happens. And figure 26 makes clear that if pin connectors are used to establish the junction between different boards or board level, a lead containing plating is allowed.

In a nutshell: Under 8(f) (b) for the pin area connected to the board, the use of lead in the pin coating is OK, whereas in the opposite pin area resp. the other end of the pin enabling the harness connection no lead coating is allowed.

Background information

The exemptions reflect specific needs of automotive applications and the problem of tin whisker formation which may occur if pure tin layers are used.

By using this defined exemptions for the use of lead, it is enabled that potential tin whisker formation especially in combination with mechanical stress is suppressed and potential fatal failures occurrence is reduced to very low levels.

The allowed lead content in the coating or presoldering of the press fits is not specified. Typical concentrations applied often are below 10 % wt Pb.

Definition/interpretation of -Exemption (8g)

8(g). Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages

This exemption shall be reviewed in 2019

IMDS APPLICATION CODE: 8(g) - Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages

Flip chip packages is a well proven technology that solves a wide range of microelectronics packaging problems by mounting the semiconductors with the active side down. Another feature of flip-chip technology is that it eliminates wire-bonding.

Flip Chips are the heart of new technology solutions that can significantly improve vehicle safety and environmental performance of vehicles. These systems process digital information from sources like digital cameras, lasers, radar and other sensors to perform the tasks as described below. The processed information can be displayed on screens or announced via acoustic warning signals.

Typical applications are e.g.

Electronic Stability Control Systems, Advance Emergency Braking Systems, Distance Control, Lane Departure Warning Systems, Frontal Protection Systems, Pedestrian Protection, TPMS, Hydrogen and Hybrid Vehicles, Vision Systems, Traffic Sign Recognition, Navigation, Head-up Displays, ...

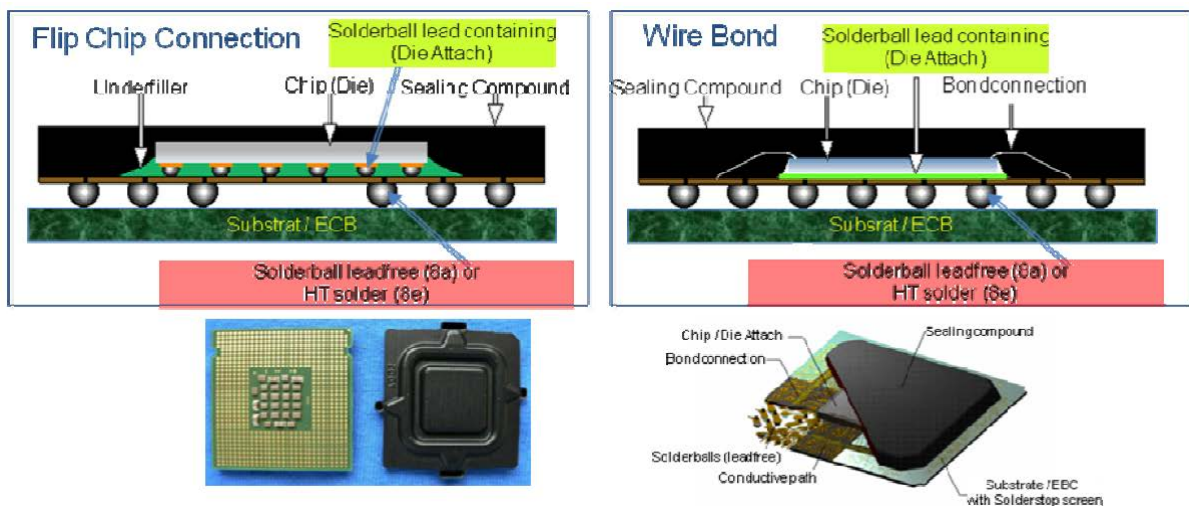


Fig. 27: Cross section and examples of flip chip packages

Definition/interpretation of -Exemption (8h)

8(h). Lead in solder to attach heat spreaders to the heat sink in power semiconductor assemblies with a chip size of at least 1 cm² of projection area and a nominal current density of at least 1 A/mm² of silicon chip area

DUE DATE: Vehicles type approved before 1 January 2016 and spare parts for these vehicles

IMDS APPLICATION CODE: 8(h) - Lead in solder to attach heat spreaders to the heat sink in power semiconductor assemblies

The application is the die soldering of Silicon chips (Si chips) of large size, having about 1 cm² of surface area or more, to lead frames. Insulated Gate Bipolar Transistors (IGBT) are Silicone semiconductor chips; they are the main active component in power modules for Hybrid Electric Vehicles (HEV) and Electric Vehicles (EV). The semiconductor chips are converters that control the electric voltage and current between battery and the electric drive motor / alternator of a vehicle. The solder used to join the Silicon chip to the lead frame is containing Lead. The Lead containing Tin-Lead solder (SnPb solder) provides thermal conductivity from the semiconductor chip, over the heat spreader, to the metal lead frame. The design can involve an intermediate heat spreader, as seen in the figure 28.

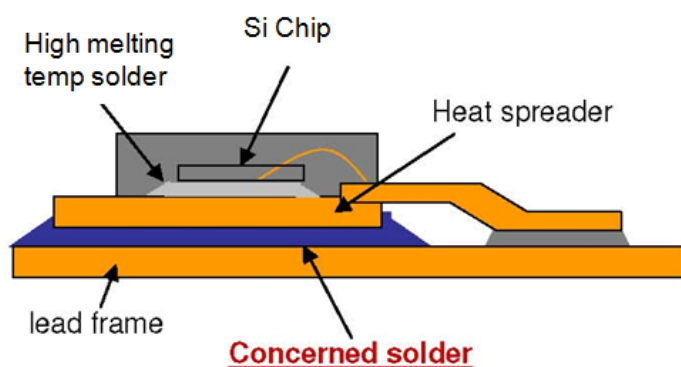


Fig. 28: Semiconductor attachment principle



Fig. 29: Power Semiconductors

Definition/interpretation of -Exemption (8i)

8(i). Lead in solders in electrical glazing applications on glass except for soldering in laminated glazing

DUE DATE: Vehicles type approved before 1 January 2016 and spare parts for these vehicles

IMDS APPLICATION CODE: 8(i) - lead in solders in electrical glazing applications on glass except for soldering in laminated glazing

The solder is used to solder electrical connections to automotive non laminated glass products (for instance conductive printed design on an exposed surface). E.g. single side toughened glass.

The soldered connection provides both an electrical contact and a mechanical contact between the glass product and the wiring harness in the vehicle. The product is used for heating the glass (to aid vision), for alarm systems (for security) and for antennae (communication). It is expected that the soldered connection will remain attached to the glass for the life of the vehicle and that it will not fail in service.

The lead in the solder is a vital component for relieving the stresses in the junction between glass and connector that occur as a consequence of the different expansion coefficients of the metal connector and the glass substrate. The lead containing solders have sufficiently high melting points to meet the high temperature storage and operating conditions required by the vehicle manufacturers.

The automotive glass products are usually easily identifiable. The types of connectors are manifold and may vary from vehicle brands and types.

See some examples below (Fig 30 to 33).

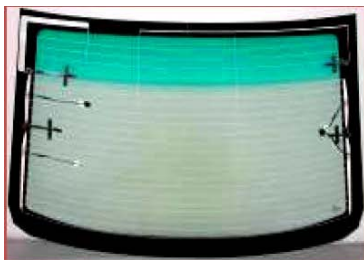


Fig. 30: Location of connectors



Fig. 31: Connector types with different footprints



Fig. 32: Soldered braids are another type of connectors



Fig. 33: Antenna connectors

In the following an application example for non laminated glass is showing the printing of a silver containing paste (in a wire-like pattern) to the surface of a glazing -here a rear window- followed by firing of the paste and contacting by soldering of pre-soldered connectors to the silver print.



Fig. 34 and 35: Area of connectors on the glazing and pre-soldered connectors

Definition/interpretation of -Exemption (8j)

8(j). Lead in solders for soldering of laminated glazing

DUE DATE: Vehicles type approved before 1 January 2020 and spare parts for these vehicles

IMDS APPLICATION CODE: 8(j) - Lead in solders for soldering of laminated glazing

Figure 36 shows a laminated glazing structure. Between two thinner panes of glass a polymer layer is embedded.

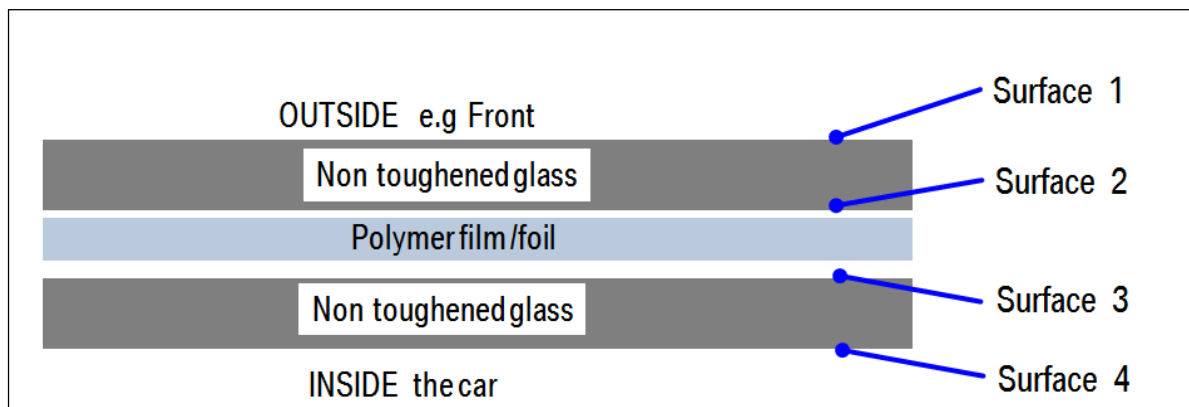


Fig. 36: Structure of a laminated glass

This exemption covers all applications (for instance: antenna or defrosting) with soldering procedures of laminated glazing structures (for instance: windscreen, quarter glass or roof glass). It does not apply to single side non –laminated glass, which is covered by entry 8i.

Typical uses are:

- Wire heated windscreens with wires embedded into/on the foil between the two glass plies
- Wire heated wiper rest area windscreens (wires embedded into/on foil)
- Printed heated device circuit on the inner surfaces of the windscreen (surface 2 or surface 3)
- Antenna or sensors wire products (wires embedded into/on the foil)
- Printed antenna device circuit on laminated glass surface 4
- Printed heated circuits on laminated glass surface 4 Connection joints to electrically conductive films within the laminate

Wires may be made of tungsten or copper.

Lead based solders are applied to compensate the mechanical stress resulting of different coefficients of thermal expansion of the components of laminated glazing.

The technology for these product groups is different to that used for the products that are covered by exemption 8i). E.g. there is mostly an additional autoclave procedure, where foil and glass plies are assembled to a laminated glazing structure under application of mechanical pressure and heat.

Whereas for rear screens or side screens mainly toughened glass is used, panes of front screens are normally not toughened. This is to enable that visibility through the screen is maintained if there is a highway stone defect. And whereas a toughened glass is crumbling in small particles the screen of a laminated front screen will show a crack.

Laminated glass is more stress sensitive than toughened glass. In addition laminated glazing is a complex material composite and thinner glass panes – mainly of annealed glass- are used.

- a) For laminated wire heated glazing (see Figure 33) there are fine tungsten wires embedded onto the surface of the polymeric interlayer material (normally polyvinyl-butylal (PVB)) with solder connections to copper strip bus bars, all of which is assembled between two plies of glass. Electrical contacts are also made to both ends of all the heating wires in the array that is embedded onto the PVB.
- b) For wire antenna or sensor requirements, there is a metal wire (usually made of copper) applied on the surface of the PVB that is between the two plies of glass.

Soldering to the metal wire is usually done via a connector. That is inserted between or at the edge of two plies of glass during the assembly process or by leaving a small cut back in the glass at the edge of the screen (see fig. 37 & 38 for an example of a connector to a wire between laminated glass). This special design enables the challenging control of the thermal stress between the non tempered laminated glass of windscreens and attached contacts.



Fig. 37: Example for a lead solder application at laminated glazing structure

- c) For printed de-ice circuits on surface 2 of the laminated glass the connector is soldered to a silver print on the glass or on black enamel print on glass. However this is very different to soldering to a toughened glass and there are significant complications compared with toughened glass. Figure 37 shows a typical construction of this type of product soldering on the glass.

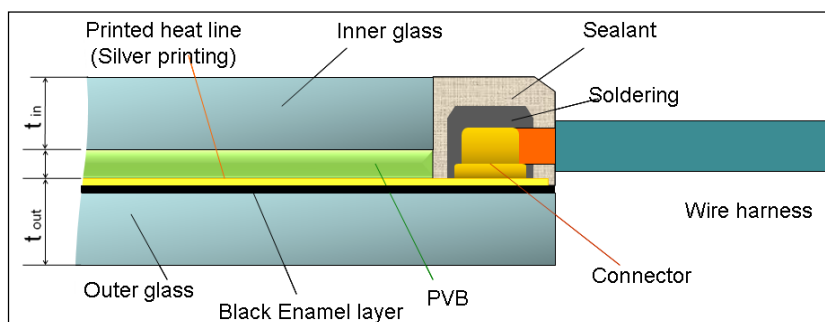


Fig. 38: soldering to silver print on surface 2 of laminated glass



Fig. 39: windscreen wiper heating on laminated glass

Figure 39 is showing a heating wiper area with silver print on glass (printed heating device circuit).

Definition/interpretation of -Exemption (10a)

10(a). Electrical and electronic components which contain lead in a glass or ceramic, in a glass or ceramic matrix compound, in a glass-ceramic material, or in a glass-ceramic matrix compound. This exemption does not cover the use of lead in:

- glass in bulbs and glaze of spark plugs,
- dielectric ceramic materials of components listed under 10(b), 10(c) and 10(d)

DUE DATE: none

IMDS APPLICATION CODE: 10(a) - Electrical and electronic components which contain lead in a glass or ceramic, in a glass or ceramic matrix compound, in a glass-ceramic material, or in a glass-ceramic matrix compound. This exemption does not cover the use of lead in: - glass in bulbs and glaze of spark plugs, - dielectric ceramic materials of components listed under 10(b), 10(c) and 10(d).

This exemption is related to electrical/ electronic applications in general, which are not covered by 10b -d). Exemptions 10b-d subsume specific applications of lead in glass and ceramic of electric and electronic components.

To better understand what is meant here and what is in scope, the single elements of this exemption are defined separately.

For definitions on electrical and electronic components please see guide section for entry 8a.

1) ...definition of Lead in a glass or ceramic, in a glass or ceramic matrix compound, in a glass-ceramic material, or in a glass-ceramic matrix compound...:

Ceramics are defined as crystalline structures, whereas a glass is characterised through an amorphous structure. In some cases lead containing ceramics or glasses are bonded or mixed together with other materials. This overlap is then covered through the above wording. Some examples are given below:

a) ...lead in a glass or ceramic

Lead is a constituent of a glass or ceramic material.

Examples:

- Ceramic: bulk material in knock-sensor, PZT-actuators or PZT-sensors....
- Glass: housing of diodes, cover layer in thick film applications

b) ... Lead ... in a glass or ceramic matrix compound, ...

Lead is a constituent of a matrix compound (of glass or ceramic) with other materials (inorganic, metal or organic compounds).

Examples:

- Ceramic matrix compound: Lead-Ceramic (Nano-) Composites for Acid Battery Grids
- Glass matrix compound: thick film pastes, metallisation of ceramic capacitors

c) ... lead ... in a glass-ceramic material...

Lead is a constituent of a glass-ceramic material, which is a combination of amorphous and crystalline phases of glass and ceramic.

Example:

- Cooking field (no automotive application)

d) ... lead ... in a glass-ceramic matrix compound

Lead is a constituent of a glass-ceramic matrix, which is a combination between amorphous and crystalline phases of glass and ceramic and other material (metal or organic).

Example:

- thick film resistor, which is a combination of metal and glass sintered onto a ceramic substrate

2) Examples for components covered by 10 a)**a) Piezoceramics**

Piezoceramics are characterised through their ability to transform mechanical energy in electrical energy and reciprocal. They fulfil technical functions as actuators, sensors, generators and motors. They are used for instance in Actuators for diesel and gasoline injection valves, knock sensors, resonator and filter, ultrasonic sensor and transmitter, bending actuators for pneumatic valves, tire pressure sensors, ceramic sensors (like ABS, air bag, pressure, car navigation sensors), piezo ceramic buzzers, actuators.

The lead content in the piezoceramics ceramics is around 50 to 70% by weight, depending on the content of dopants, required functional properties and on the proportion of zirconium (Zr) and titanium (Ti).



Fig. 40: 10a) products using piezoceramics

b) PTC:

Positive Temperature Coefficient (PTC) thermistors are temperature-dependent resistors with a positive temperature coefficient. PTC ceramics increase their electrical resistance with increasing temperature. Examples of Material compositions are Barium-Strontium-Lead-Titanate, Barium Titanate and Lead Zirconate Titanate with dopants. Lead is used in the solid solution of Barium titanate and Lead titanate. Substituting of Barium atoms of Barium titanate to lead enables to raise the Curie temperature and realizes high high-temperature operation. The lead content within these materials varies within a range of typically about 4% -15% by weight.

In particular within the automotive industry, PTC are used as overheating detector (Temp.-Sensor), and for over current protection in all engine section parts and all car electronic circuits. PTC as self regulated heater are in use for cabin heating, fuel and fuel filter preheating, nozzle heating (e.g. washer and crankcase ventilation)



Fig. 41: 10a) PTC examples

c) Various components with Pb in ceramic:

e.g. Multilayer Ceramic Varistors (MLV):

Material used in MLV is hexagonal Zinc oxide (ZnO), doped with Bismuth, Cobalt, Manganese and Antimony oxides. Lead is contained in a ~ 20µm thick passivation layer in the form of a ceramic Lead Zirconate Titanate (PZT) (Perovskite type crystallites within the ceramic grains).

Similar applications of lead in passivation layers or as a dopant may become necessary in other components as well.

d) as metallisation of components:

A special case of metallic thick film paste is the metallisation (called “termination”, see drawing below) of several ceramic capacitor types. Thick film paste is used in this application to contact the internal electrodes of the capacitor. It contains a leaded glass in a low portion to promote

adhesion to the ceramic body of the component. Leaded glasses enable for sufficient wetting and sintering activities at much lower temperatures as the component body has been fired to prevent it from changing its characteristics when the firing the metallisation. So the safe contacting is assured.

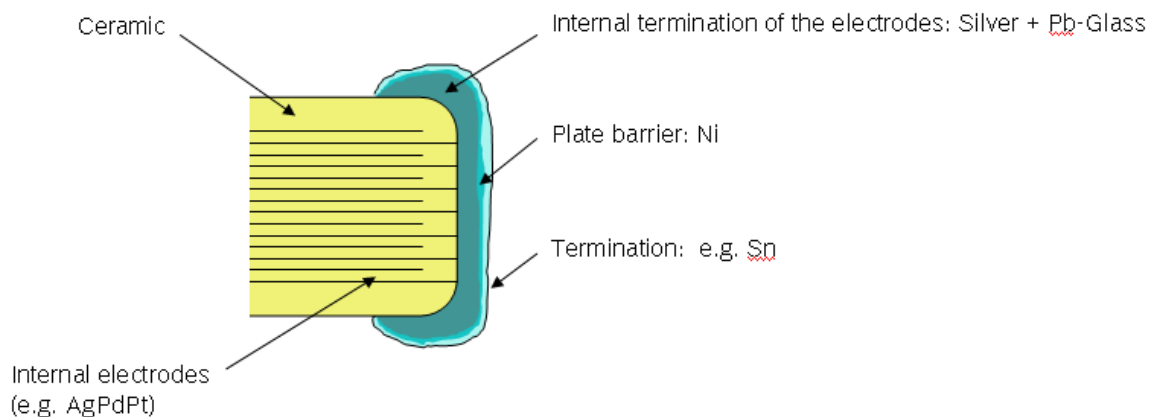


Fig. 42: Simplified cross section of a ceramic capacitor

e) Glass / Thick Film:

on ceramic carriers:

Electronic circuit boards based on ceramic carriers use thick film pastes to form the conductors, insulating layers (dielectric, overglaze) and passive components (resistor).

Pastes for conductors are based on metals e.g. silver, copper as well as gold, platinum and palladium. Pastes for resistor applications consist of compositions of lead containing metal oxides, metals and polymers. Pastes for dielectrics and overglazes comprise leaded earth alkaline or alkaline silicates enabling for utmost hermeticity and adhesion.

Typical technologies for ceramic carriers are:

- Thick and thin-film circuits
- LTCC (Low Temperature Co-fired Ceramic)
- DCB / DBC (direct copper bonding / direct bonding copper) for power applications

Thick film pastes contain leaded glass to ensure a good adhesion and to reduce the firing temperature.

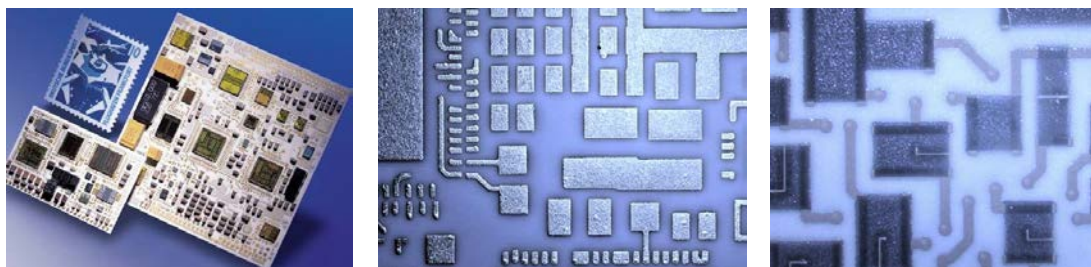


Fig. 43:
ceramic based assembly using LTCC

Conductors

Printed passive components
(resistor)

f) Glass / protection:

Lead containing low melting type glass frit is used in glass paste for protection (such as hermetic seals) and bonding applications (such as sensor components).

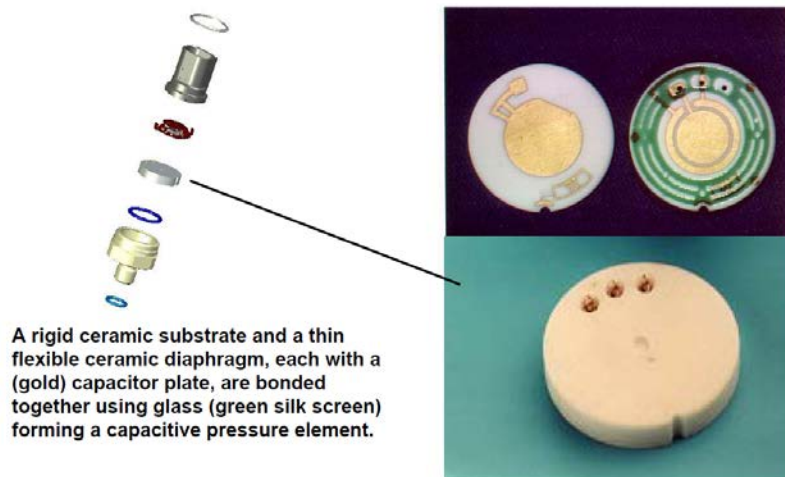
Examples:

Fig. 44: Glass bonding

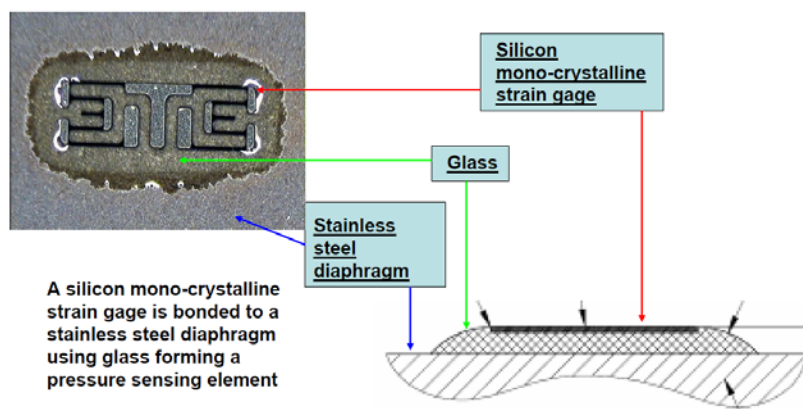
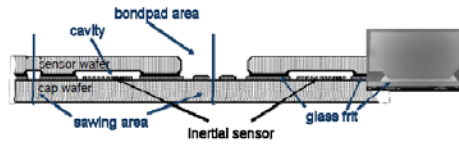


Fig. 45: Glass bonding

Glass frit bonding for micromechanical sensors

→ Low temperature process mandatory for micro sensors in safety relevant applications

- Screen printing on cap wafer
- Wafer bonding of sensor and cap wafer
- Process requires low melting glass frit (lead glass) for compatibility with sensor materials (Al-spiking) and sensor functionality



- lead content $\leq 0,5 \text{ mg per sensor}$
- typical sensor size $\leq 2 - 10 \text{ mm}^2$

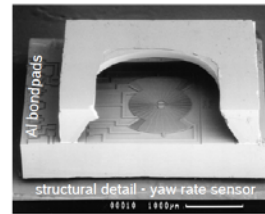
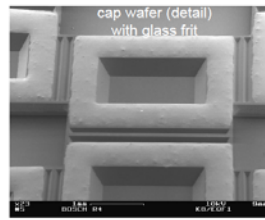
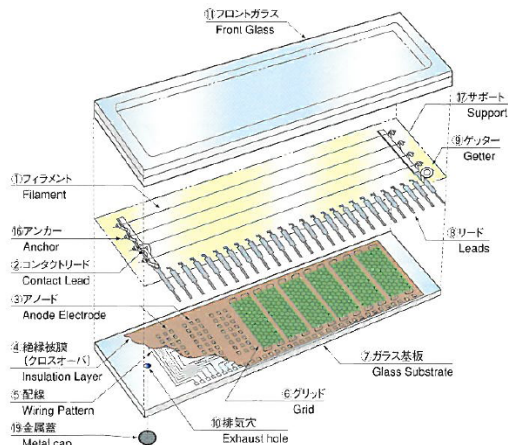


Fig. 46: Glass frit bonding for micromechanical sensors

蛍光表示管の分解斜視図 Stranbismal Figure of VFD



蛍光表示管の断面図 Cross sectional view of VFD

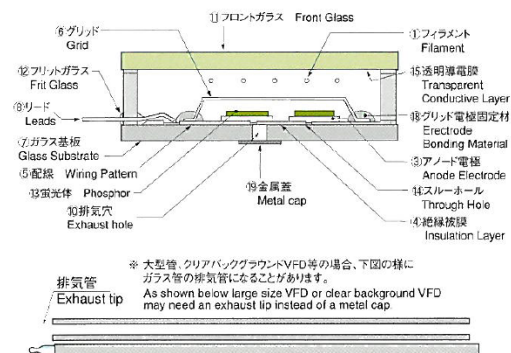


Fig. 47: VFD

g) Glass / encapsulation:

Lead containing low melting type glass is used for protection / hermetical seals, e.g. Crystal Units, Crystal Oscillators, Glass diodes, VFD Displays and thermistors.

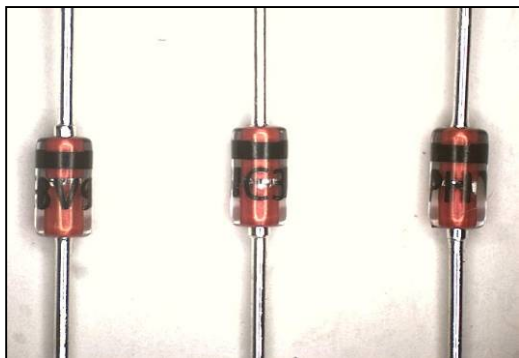


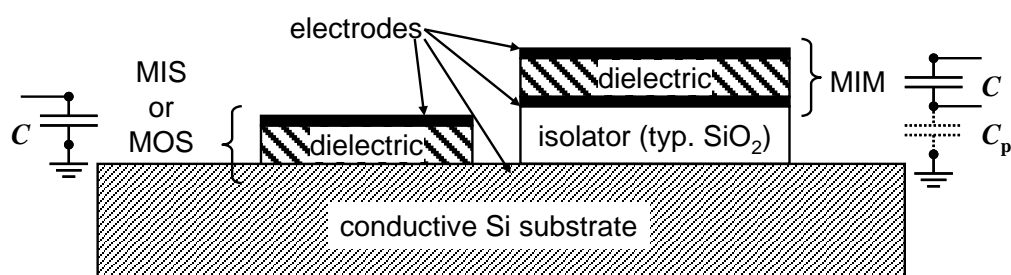
Fig. 48: Visual samples of glass diodes with Standard Glass

Definition/interpretation of -Exemption (10b)

10(b) Lead in PZT based dielectric ceramic materials of capacitors being part of integrated circuits or discrete semiconductors

DUE DATE: none

IMDS APPLICATION CODE: 10(b) - Lead in PZT based dielectric ceramic materials of capacitors being part of integrated circuits or discrete semiconductors



Application is defined by picture above.

Fig. 49:

Typical thin-film capacitor configurations: MIM (metal insulator metal) and MIS (metal insulator semiconductor) or MOS (metal oxide silicon).

Definition/interpretation of -Exemption (10c)

10(c) Lead in dielectric ceramic materials of capacitors with a rated voltage of less than 125 V AC or 250 V DC

DUE DATE: Vehicles type approved before 1 January 2016 and spare parts for these vehicles

IMDS APPLICATION CODE: 10(c) - Lead in dielectric ceramic materials of capacitors with a rated voltage of less than 125 V AC or 250 V DC

Lead-containing dielectric ceramic material of capacitors is essential for electronics components called high- voltage capacitors which require the capability to withstand DC rated voltage of 250V or more and AC rated voltage of 125V or more with the function to accumulate large amounts of electricity.

For capacitors with rated voltages lower than the above, lead free ceramics are available, thus the exemption is time constrained. A longer transition period is necessary, since a drop in solution is not viable.

Definition/interpretation of -Exemption (10d)

10(d) Lead in the dielectric ceramic materials of capacitors compensating the temperature-related deviations of sensors in ultrasonic sonar systems

DUE DATE: Vehicles type approved before 1 January 2017 and spare parts for these vehicles

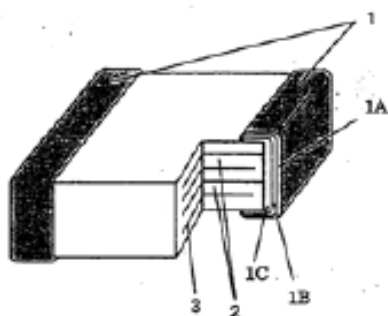
IMDS APPLICATION CODE: 10(d) - Lead in the dielectric ceramic materials of capacitors compensating the temperature-related deviations of sensors in ultrasonic sonar systems

Ultrasonic sensors in vehicles are used as sonars to detect obstacles e. g. when driving backwards and for parking assistance systems. They measure the distance between the car and an obstacle and warn the driver to avoid accidents and damages. Picture of ultrasonic sensor is referred to Fig. 50.



Fig. 50: Ultrasonic sensor

Lead is used in the ceramic of compensation capacitors in ultrasonic sonars. Picture of sample is referred to Fig. 51.



No	Part		Material
1	External electrode	1A	Tin plating layer
		1B	Nickel plating layer
		1C	Silver-Palladium
2	Dielectric device		Strontium titanate (Lead content: 20w/w%)
3	Internal electrode		Platinum + Gold + Palladium

Fig. 51: Capacitors compensating the temperature-related deviations (Internal structure)

The sensor's precision of distance measurement depends on the capacitance of the sensor ceramic that changes with the outside temperature to which the car – and the sensor – is exposed. Exact distance measurements over a wider outside temperature range thus are impossible. To compensate for the temperature-related shift of capacitance in the ultrasonic ceramic, a compensating ceramic capacitor is used.

Release history:

Release 1: first publication 2010 (exemptions 8a – 8j)

Release 2 (2013):

- Revision of info for application 8i and 8j
- Addition of info for exemptions 10a – 10d
- Adoption to current wording of annex II

Release 3 (2016): Adoption to current wording of annex II