intersema

AN808

Soldering of sensors

1 Introduction

The European RoHS directive 2002/95/EC (Restriction of the use of certain Hazardous Substances in electrical and electronic equipment) bans the placing on the EU market of new electrical and electronic equipment containing more than the set levels of lead, cadmium, mercury, hexavalent chromium and both polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame retardants from 1 July 2006.
In regard to the RoHS directive, most of Intersema pressure sensors were transferred to RoHS-compatible and hence Pb-free products in 2005. The present application note aims to help users of Intersema pressure sensors to deal with all soldering issues.

RoHS-compatible & Pb-free Intersema pressure sensors are mounted on ceramic substrates. Pb-free SnAgCu solder bumps on AgPt connection pads ensure positioning and soldering of the modules onto diverse customer devices. Soldering of the parts can be done either using Pb-containing or Pb-free solder and the corresponding processes. **To fabricate fully RoHS-compatible products, Intersema pressure modules must be soldered using Pb-free solder (See paragraph 2).** Nevertheless it will still be possible to solder RoHS-compatible pressure modules with Pb-containing solder (See paragraph 3).

2 Soldering of RoHS-compatible & Pb-free pressure sensors with Pb-free solder

Choice of the Pb-free solder alloy
Intersema pressure sensors are fabricated using Pb-free SnAgCu solder. The reliability of SnAgCu solder alloys (see table 1) and their physical properties are at least as good as the current Pb-containing solders. **Intersema suggests to use a solder alloy of the SnAgCu family (Melting point 217-221°C)**. Soldering using the 99.3%Sn0.7%Cu alloy is possible as well.

Metal	Proportion
Sn Ag Cu	95.5 – 96.5 % 3.0 – 4.0 % 0.5 – 0.7 %

Table 1: Pb-free solder alloys of the SnAgCu family

The surface of Pb-free solder alloys is substantially matt if compared to Pb-containing solder (See Figure 1). This is due to an increased volume contraction of the Pb-free alloys when cooled down and the surface becomes rough. In general Pb-free solder joints are slimmer to Pb-containing solder joints. Both effects are of cosmetic nature and have no impact on the reliability of the solder joint.

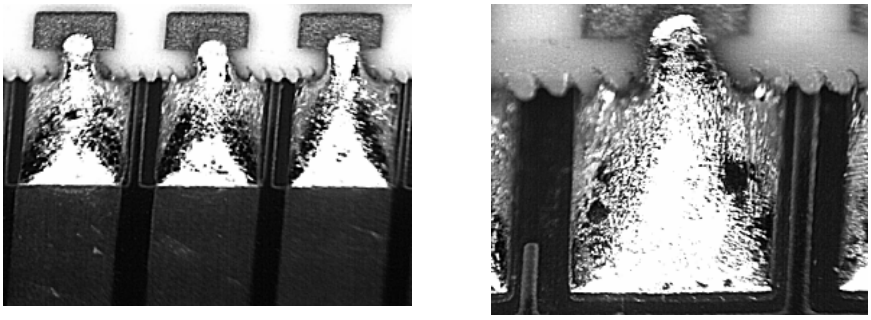

Figure 1: Example of good solder joints (left) and a typical surface of Pb-free solder(right).

Reflow soldering

The increased melting point of Pb-free solder and the new flux types require an adaptation of the current reflow temperature profiles. One of the most important factors for a successful Pb-free reflow soldering is a low temperature difference on the board. This ensures that the minimal temperature on the board required for soldering is achieved but the maximal temperature is not critical to damage of sensitive parts on the board.
The process window for Pb-free soldering is smaller than that of current Pb-containing solders. For this reason, IR-reflow systems are not recommended for Pb-free soldering. It is highly recommended to use forced convection reflow systems for Pb-free soldering.
The best temperature profile is defined by the board and the solder paste used. Most Pb-free solder pastes are designed for linear as well as for ramp profiles. Intersema pressure sensors can be soldered with profiles based on the standard IPC/JEDEC J-STD-020B (July 2002). For every application, however, the best temperature profile has to be evaluated.

Pb-free assembly (IPC/JEDEC J-STD-020B)	**Large body**	**Small body**
	Package thickness >= 2.5 mm or Package volume >= 350 mm^3	Package thickness < 2.5 mm or Package volume < 350 mm^3
Average ramp-up rate (TL to Tp)	3°C/second max.	
Preheat – temperature Min (Tsmin) – temperature Max (Tsmax) – time (min to max) (ts)	150°C 200°C 60-180 seconds	
Tsmax to TL – Ramp-up rate	3°C/second max	
Time maintained above – temperature (TL) – time (tL)	217°C 60-150 seconds	
Peak temperature (Tp)	245 +0/-5°C	250 +0/-5°C
Time within 5°C of actual peak temperature (tp)	10-30 seconds	20-40 seconds
Ramp-down rate	6°C/second max.	
Time 25°C to peak temperature	8 minutes max.	

Table 2: Pb-free reflow parameters (IPC/JEDEC J-STD-020B)

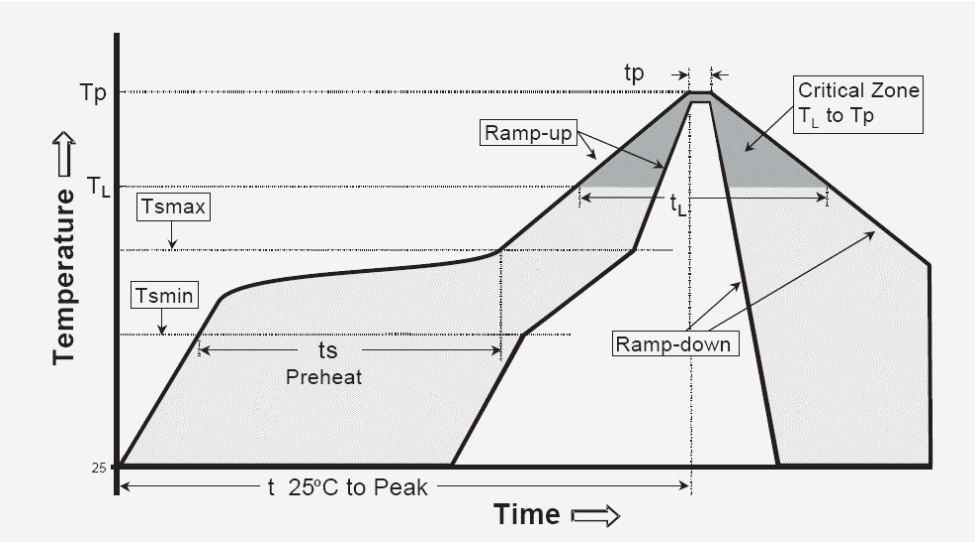

Figure 2: Definitions for reflow profiles

Use of nitrogen
Due to both the increased reflow temperature and the increased oxidation of Pb-free solder alloys it may be necessary to work in nitrogen. The question if working under nitrogen is necessary can be answered only if working in air does not lead to satisfying solder joints. Most of the Pb-free solder pastes can be used in air. Soldering in nitrogen may be useful if a sufficient wetting of the solder joints cannot be achieved in air. Nitrogen improves the wetting of the solder on the solder pads and hence increases the process window.

Hand soldering
Intersema does not recommend hand soldering! Pb-free soldering requires an excess of energy compared to Pb-containing solder alloys. The heat transfer to the solder joint is a critical aspect and an optimal contact area between the tip of the soldering iron and the component is required. Generally, for a sufficient heat transfer a longer solder time and/or an increase of the tip temperature is required. Pb-free solder might be soldered at tip temperatures of 360-390°C. It is important to supply a fast heat transfer to keep the tip temperature constant. It is highly recommended to use solder stations of at least 80 W power.
For prototyping purposes wire wrap cables can be soldered to the solder bumps on the backside of the sensor. The cable should be very thin to avoid lifting off the contact pad from the ceramic. First, some solder is melted to the end of the wire wrap cable. Second, the end of the wire wrap cable is pressed against the solder pad on the backside of the sensor and shortly heated with the solder iron to melt the alloy.

3 Soldering of RoHS-compatible & Pb-free pressure sensors with Pb-containing solder

Using a Pb-containing solder, forced convection or IR reflow processes should not exceed temperatures of 225°C for 30 sec. Like for other ceramic devices the modules must be soldered with 62%Sn36%Pb2%Ag solder paste. The melting point of this paste is 179°C. This solder paste contains 2%Ag which avoids silver migration from the AgPt pad into the solder paste. **Do not use 63%Sn37%Pb solder paste**. To avoid cleaning of the PCB, solder paste of the “no-clean” type shall be used.

SnPb eutectic assembly (IPC/JEDEC J-STD-020B)	Large body	Small body
	Package thickness >= 2.5 mm or Package volume >= 350 mm^3	Package thickness < 2.5 mm or Package volume < 350 mm^3
Average ramp-up rate (TL to Tp)	3°C/second max.	
Preheat – temperature Min (Tsmin) – temperature Max (Tsmax) – time (min to max) (ts)	100°C 150°C 60-120 seconds	
Tsmax to TL – Ramp-up rate		
Time maintained above – temperature (TL) – time (tL)	183°C 60-150 seconds	
Peak temperature (Tp)	225 +0/-5°C	240 +0/-5°C
Time within 5°C of actual peak temperature (tp)	10-30 seconds	10-30 seconds
Ramp-down rate	6°C/second max.	
Time 25°C to peak temperature	6 minutes max.	

Table 3: SnPb reflow parameters (IPC/JEDEC J-STD-020B)

A good solder joint should (See Figure 2) forms a slight angle and fills the via almost to the top**. Do always solder by reflow** using the recommended reflow profile. Soldering by hand will in most cases result in overheating of the device due to the good thermal conductivity of the ceramic. It is recommended to optimise the profile attaching a thermocouple to the sensor. Too low temperature will result in incomplete soldering resulting in a much less strong connection to the PCB as can be seen in Figure 2 (right). For prototyping purposes cables can be soldered to the solder bumps on the backside of the sensor. The cable should be very thin to avoid lifting off the contact pad from the ceramic. Wire wrap cables will normally do a good job.

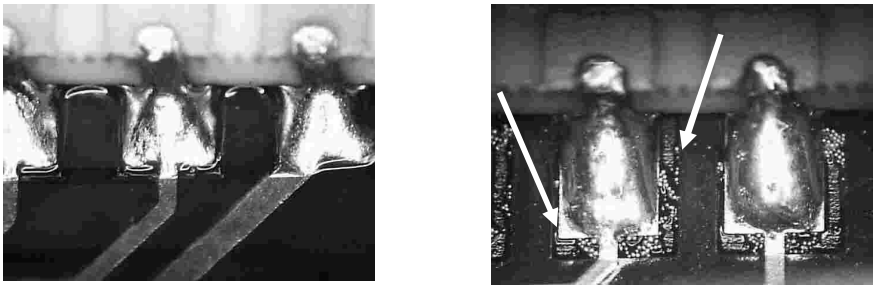

Figure 2: Examples of good solder joints (left) and bad solder joints (right). The right photo shows that the wetting of the pads is not sufficient and that the reflow temperature was to low and leaves solder balls around the pads.

4 Calibration of pressure sensors

For the best calibration of the Intersema pressure sensors mounted in customer devices it is important to let the device repose at least 48 hours at room temperature after the last solder step. This will release most of temperature induced stress in the sensor package and the calibration of the device will be improved.

REVISION HISTORY

Date	Revision	Type of changes	ECN
19.01.2005	00	Initial release	
20.12.2005	01	Update to Jedec J-STD-020C	827

FACTORY CONTACTS

Intersema Sensoric SA
Ch. Chapons-des-Prés 11
CH-2022 BEVAIX

SWITZERLAND

Tel. 032 847 9550
Tel. Int. +41 32 847 9550
Telefax +41 32 847 9569
e-mail: sales@intersema.ch
http://www.intersema.ch