Instructions, Mounting a Bare Chip

CAUTION: This chip is sensitive to electrostatic discharge (ESD). Use ESD precautionary procedures when handling, or making mechanical or electrical connections to this device in order to avoid performance degradation or loss of functionality.

GENERAL COMMENTS

All of the possible permutations for mounting the chips have not been thoroughly tested. The chips also are not protected by a coating over the active film, in order to avoid possible adverse effects on stability. The customer must therefore assume some risk of damaging the chips during installation. The material presented below includes the best techniques we know to help assure the successful application of unencapsulated chips.

1. Use good fine-point tweezers. Grasp the chip by the edges at one end (at a contact pad end, if possible). This way, if the tweezers should scrape across the chip, the resistor will not be damaged. Alternately, the wires may be grasped with fingers or tweezers. In the latter case, the operator must develop a very light touch so the wires are not cut or damaged.

2. If it is necessary to apply pressure to the chip, do so with a cotton swab over the contact area, or with harder objects only outside the patterned area. Do not rub the chip.

3. Some dirt particles will not hurt the sensor reading, but conducting particles and moisture may. If it is deemed necessary to clean the chips, place a few into a watch glass and rinse with appropriate solvents. (A watch glass is used because it has a curved surface and the sensor will touch only at its corners. It also has a shallow sloped surface, and the rinse liquids can be easily decanted.) Finish with a rinse of pure isopropyl alcohol. Decant the liquid and dry under a light bulb (≈50 °C). For chips with leads, hold the sensor by the leads and immerse it in isopropyl alcohol for a few seconds.

ATTACHING LEADS

There are several potential ways to apply electrical leads to the contact pads, which are gold over molybdenum or platinum. In all cases, clamp the sensor chip by the edges and if possible do not rely on hand control to position and attach the wires. A clamp can be made from a small, smooth-jawed alligator clip (Figure 1) by cutting off the jaw to which the wire is normally soldered and then fastening that side of the clip to a plate. Another method uses tape to hold the sensors (Figure 2). Kapton tape and adhesive will withstand epoxy cure temperatures (165 °C) and the adhesive will not come off on the chip. Do *not* use Scotch tape.

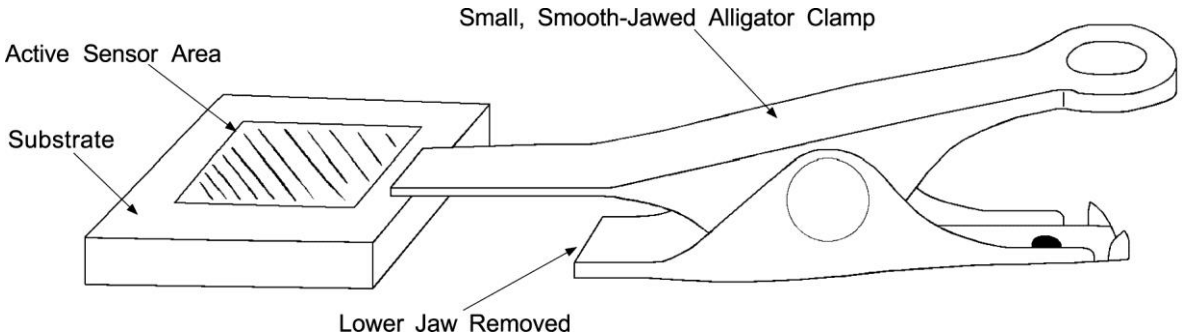

Figure 1. Smooth-Jawed Alligator Clip

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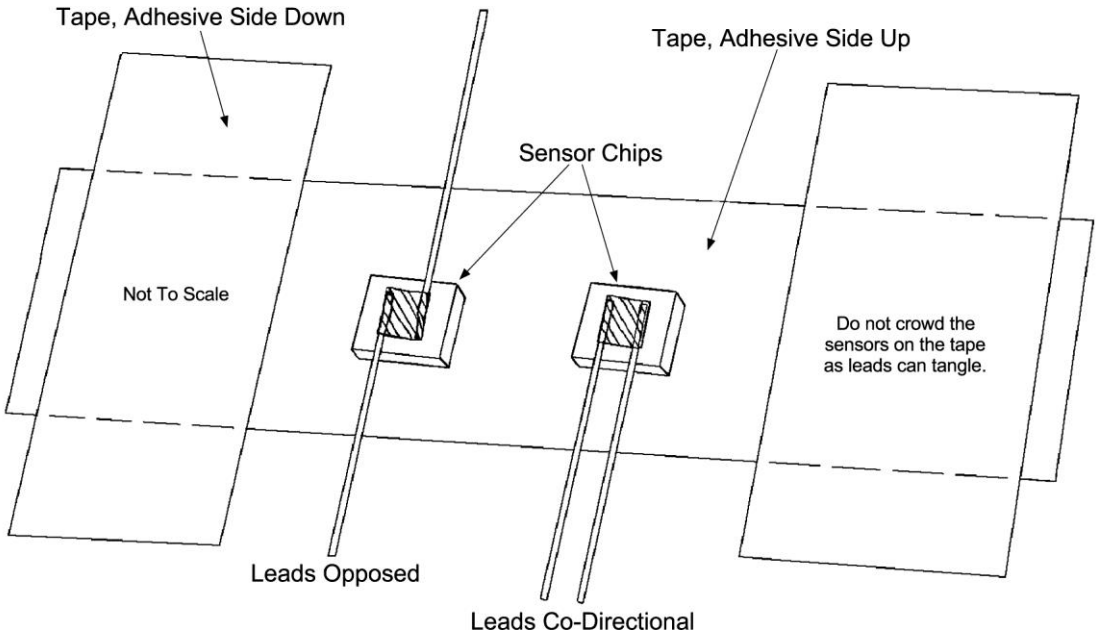

Figure 2. Sensor Tape Mounting

By far the best way to connect the chip is to use a standard ultrasonic lead bonder equipped to apply heat during the bonding operation. The bonding is clean, uses no flux, and can be done at or near room temperature. The ball attachment at the pad also provides a robust way of making a flying lead that can be attached at the other end later (50 µm diameter gold wire).

Another way is to use silver-loaded epoxy. Make sure the wire and the pads are clean. Use a flexible wire, 40 AWG or smaller, so undue stress will not be applied to the pads. Use a needle to apply small amounts of epoxy to the pads and on to the ceramic substrate as well. If the epoxy must be heated in order to cure, a temperature of up to 200 °C could be tolerated by the chip. This should be done before calibrating, however, since the calibration may shift a little (shift may amount to 0.05% of reading at temperatures above 50 K and 1% at 4.2 K and below).

The contact pads of our thin-film bare devices (diodes, RhFe, and Cernox) do not withstand soldering or welding. Soldering on thick-film ruthenium oxide can be accomplished using a minimum 99% pure Indium.

MOUNTING SENSOR CHIPS

There are several means of attaching the chip to a substrate. Not enough data has been taken on these sensors to quantify whether strain-induced shifts in calibration can occur. Therefore, keep in mind that the greater the expansion difference between the sensor substrate, the bonding substance and the mating piece, the more likely a strain-induced shift in the calibration may occur. If the joint is stable, this shift probably will be reproducible, and an in-situ calibration may remove the uncertainty. The only substance we have found capable of removing stress during use is pure indium. This will only work with metalized substrates and in systems that can be heated if the joint is to be soldered.

If it is deemed advisable to use an indium solder joint for reasons of strain, and the mating piece cannot be soldered, a “buffer” layer of metalized BeO or sapphire can be used. Solder the chip to the buffer with In, and use Stycast 2850FT/catalyst 9 or equivalent epoxy to attach the buffer to the mating piece.

Stycast 2850FT or another low expansion, non-conducting epoxy can be used for direct mounting as well. It is not known what would happen if epoxy were used to completely encapsulate the chip, so you will have to do your own experimenting.

If a greased mounting is desired (Apiezon N or equivalent), the sensor could be inserted into a hole lined with cigarette paper or tied to a greased surface with thread, with paper over it to avoid abrasion. The leads must be insulated with spaghetti, fiberglass sleeving, epoxy or other technique.

GE 7031 varnish is also a good mounting adhesive, and is more easily removed than epoxy. It can be soaked into cigarette paper for a more reliable insulating layer for the leads. The substrate of the sensor is already insulating.

ATTACHING CABLE WIRES TO THE SENSOR LEADS

The lead wires on a chip sensor are necessarily small in diameter. 50 µm diameter gold wire has a break strength of about 25 g, and 62 µm (42 AWG) copper wire has a rated tensile strength of about 150 g, but the actual break strength is lower because the weak point is usually at the point of attachment or damage from handling (e.g., tweezer marks). The copper wire will only withstand two or three sharp 90 degree bends with a 10 g weight attached. The wire will also peel out of silver-loaded epoxy at a smaller force than the rated break strength. However, with reasonable care, loss from damaged leads will be negligible.

Soldering

Both gold and copper wires will dissolve in In and Pb/Sn solders, but gold dissolves much faster. Gold can be successfully soldered by using a **temperature controlled iron set just above the solder's melting point**. The wire or other attachment point is tinned and the gold wire **stuck** into the solder as the iron is removed. If the gold alloys any length beyond the solder bead, the joint will be greatly weakened, but it is not difficult to repeatedly make successful joints.

Copper wire does not require the precautions above, but repeated soldering will gradually shorten the wire. Keep in mind that heat sinking may be necessary in some situations, but that the solder joints on the chip, if any, will usually be well heat sunk through the chip.

Attachment

The two most important requirements are that the attachment points of the fine sensor wires should be **immobile** under all operating conditions, and the sensor leads should have some **slack** to take up contraction upon cooling. If the leads are connected to a cable, the cable should be attached so it cannot twist at the end. Four wire (Kelvin) cabling schemes down to the sensor leads are preferred for resistance sensors. The lower the resistance, the more necessary this becomes.

The following sequence is usually the best:

1. Fix the end of the wire or cable in place, with the ends pretinned.
2. Apply an insulating layer on the mounting surface if it is a conductor. The uninsulated sensor leads can be kept separate using small Teflon spaghetti or by making channels out of the cigarette paper, Kapton film, etc. used for the insulator. See Figure 3.
3. Mount the sensor as desired.
4. Adjust the sensor leads into contact with the proper cable wire, and solder the joint. It is best to do this by **pushing or training** the leads into place. See Figure 4. Grasping the wire while trying to solder it is inviting wire damage. It is unnecessary to twist the sensor leads around the cable wires. Slack can be built into the leads by using two pairs of tweezers to put an “S-curve” into the wire before soldering.

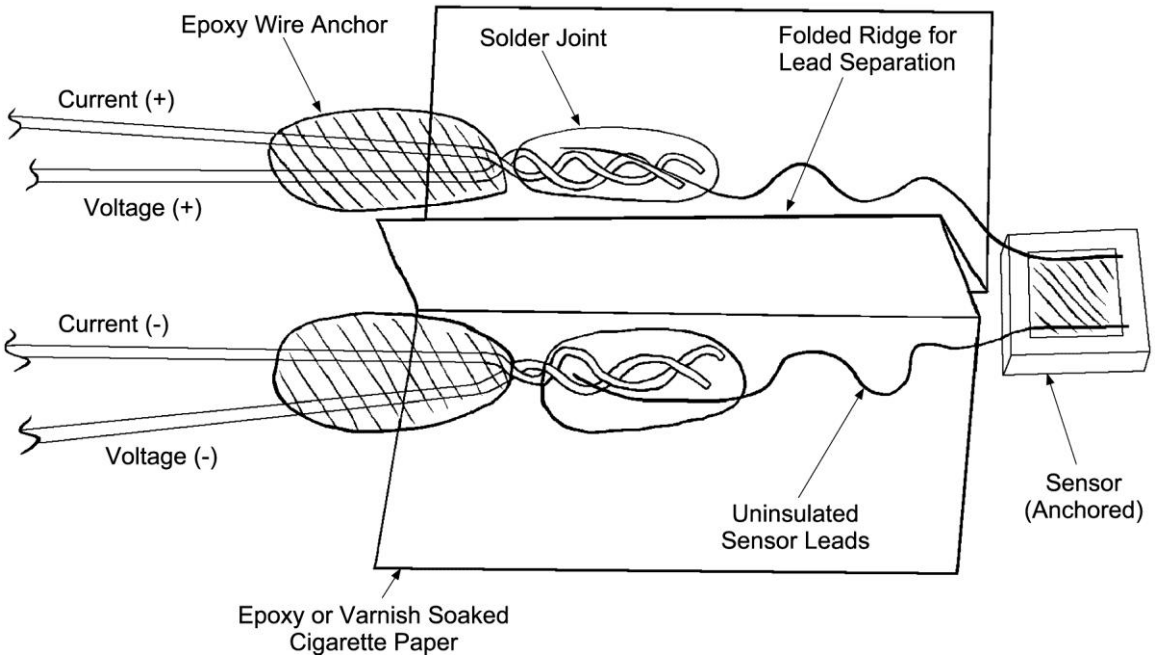

Figure 3. Cigarette Paper Insulator

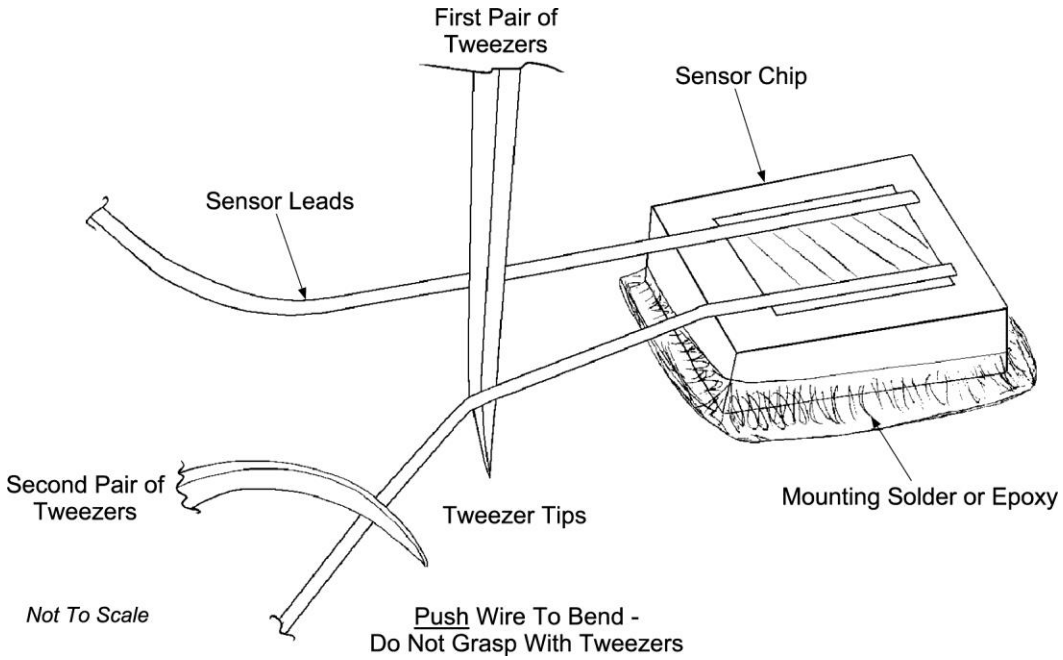

Figure 4. Push Sensor Leads To Form