APPLICATION NOTE

Diode Chips, Beam-Lead Diodes, Capacitors: Bonding Methods and Packaging

Diode Chips

Handling

Skyworks chips are shipped in plastic chip trays containing up to 400 individual devices. The chips may be removed from the tray and positioned for inspection or bonding using tweezers or a vacuum pickup. Particular care must be exercised to avoid any mechanical damage to the active junction area when handling chips. In addition, if tweezers are used, care must be taken to avoid excessive force which might result in nicks or cracks.

Special handling precautions are also required to avoid electrical damage by static discharge. For package opening instructions see Figure 4.

Die Attach

The recommended method for attaching Skyworks semiconductor chips to substrates is by means of a solder preform or silver epoxy. Basically this method involves the use of the preform or epoxy to form a joint between the gold metalized base of the chip and the metalized area of the substrate. Recommended preform materials are: Gold (80%) – Tin (20%); Gold (89.5% – Gallium (0.5%) – Germanium (10%); or Gold (90%) – Germanium (10%). These are available from Alpha Metals, Jersey City, New Jersey. Recommended silver epoxy is Epo-Tek H31D Single Component from Epoxy Technology, Inc.

Procedure

The substrate may be heated directly by placement on a heater strip or hot plate. Resistance heating may also be used, in which case the localized heat is supplied by passing current through the appropriate metalized portion of the substrate by use of two contact electrodes. Hot gas heating may also be used, in which case the localized heat is supplied by a jet flow of heated forming gas or nitrogen.

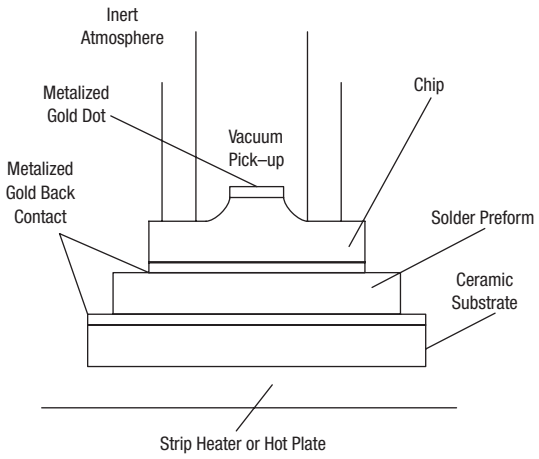


Figure 1. Die Attach Procedure

Temperatures of approximately 280 °C for gold-tin, 350 °C for gold-gallium-germanium and 380 °C for gold-germanium are recommended. A 100 °C bake for 1 hour is recommended for silver epoxy. Exact temperatures should be determined empirically for the particular conditions at hand. The bonding should be done in an atmosphere of nitrogen or forming gas. Both solder preform and chip may best be handled by means of a vacuum pickup. A preform is placed on the desired location of the substrate followed by the chip. Appropriate force is maintained between substrate and chip while the preform melts and wets both substrate metalization and chip. The force, approximately 50 grams, is maintained until the preform solidifies. Cooling may be accelerated through use of a blast of inert gas.

Lead Bonding

Wire or ribbon leads should be attached to the chip and the substrate by use of thermocompression bonding. As with the beam-lead devices, this method involves pressing the gold lead against the gold metalized area on the chip or substrate under proper conditions of heat pressure and scrub to effect a bond.

Procedure (See Figure 2)

Gold should be used for the lead wire or ribbon. Though either ball bonding or wedge bonding may be used, the latter is generally preferred since smaller bond areas are possible with consequent less parasitic capacitance. The bonding tool is tungsten carbide, and the detail tip design is dependent upon the dimensions of the lead material to be bonded. A tip temperature of 350 °C to 400 °C with approximately 50 grams pressure is recommended. This temperature may be reduced by heating the substrate to 325 °C or using ultrasonics for a scrub. Generally, a satisfactory bond is attained with a bonding time of 2–3 seconds. Optimum conditions should be determined by trial and error to adjust for differences in chip configurations, substrate condition and other variables.

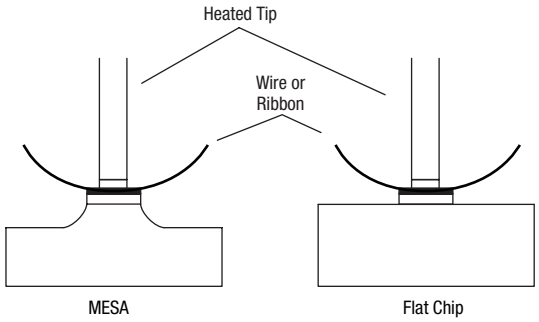


Figure 2. Lead Bonding Procedure

Equipment

Equipment for die attachment and lead bonding is commercially available from several manufacturers and varies in sophistication from laboratory setups to automated machines.

Beam-Lead Diodes and Capacitors

Due to their small size, beam-lead devices are fragile and should be handled with extreme care. The individual plastic packages should be handled and opened carefully, so that no undue mechanical strain is applied to the packaged device. It is recommended that the beam-lead devices be handled through use of a vacuum pencil using an appropriate size vacuum needle or a pointed wooden stick such as a sharpened Q-tip or match stick. The device will adhere to the point and can easily be removed from the container and positioned accurately for bonding without damage. Such handling should be done under a binocular microscope with magnification in the range of 20X to 30X.

Special handling precautions are also required to avoid electrical damage, such as static discharge. For waffle pack package opening instructions see Figure 4.

Bonding

Skyworks beam-lead devices can best be bonded to substrates by means of thermocompression bonding. Essentially this type of bonding involves pressing the gold beam of the device against the gold plated metalized substrate under proper conditions of heat and pressure so that a metallurgical bond joint between the two occurs.

Procedure

The beam-lead devices to be bonded should be placed on a clean, hard surface such as a microscope slide. It is recommended that the beam side of the device be down so that this side will be toward the substrate when bonded. The device can be picked up by pressing lightly against one beam with the heated tip. The substrate can then be appropriately positioned under the tip and the device brought down against the substrate, with proper pressure applied by means of the weld head.

A bonding tip temperature in the 350 °C to 450 °C range is recommended along with a bonding force of 50 to 70 grams. The bonding time is in the range of 2–3 seconds. Optimum bonding conditions should be determined by trial and error to compensate for slight variations in the condition of the substrate,bonding tip, and the type of device being bonded.

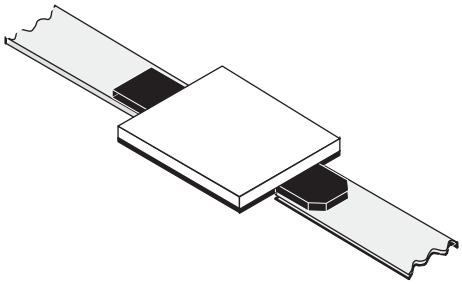


Figure 3. Beam Lead Cap Mounted

Equipment

The heat and pressure are obtained through use of a silicon carbide bonding tip with a radius of two to three mils. Such an item is available from several commercial sources. In order to supply the required tip-travel and apply proper pressure, a standard miniature weld head can be used. Also available is a heated wedge shank which is held by the weld head and in turn holds the tip and supplies heat to it. The wedge shank is heated by means of a simple AC power supply or a pulse type heated tool.

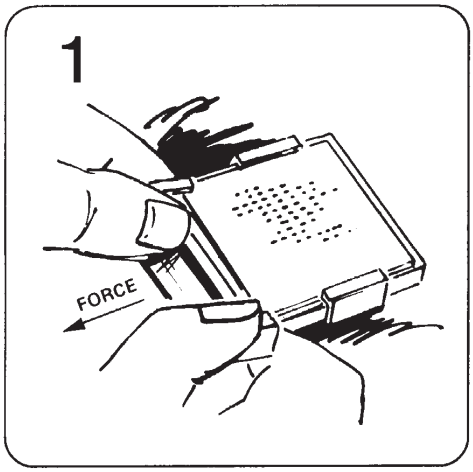
Substrate

For optimum bonding a gold plated surface at least 100 microinches thick is necessary. Although it is possible to bond to relatively soft metalized substrate material such as epoxy-fiberglass, etc., optimum bonding occurs when a hard material such as ceramic can be used.

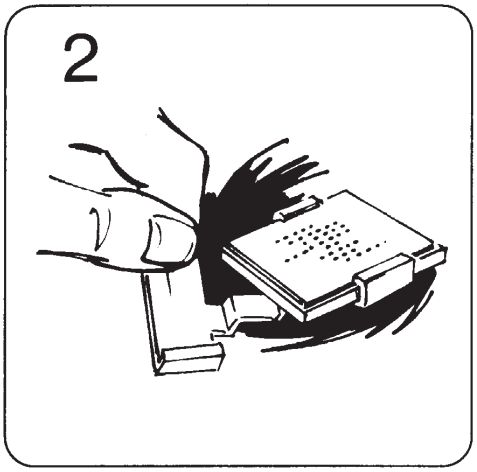
Quality

If a good bond has been obtained, it is impossible to separate the beam-lead device from the metalized substrate without damage. If the device is destructively removed, the beam will tear away, leaving the bonded portion attached to the substrate. In bonding the high value capacitors, it is important that the bond be made at the ends of the beams.

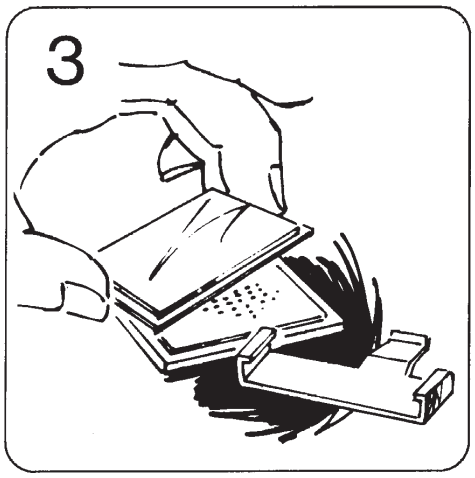
Chip Packaging



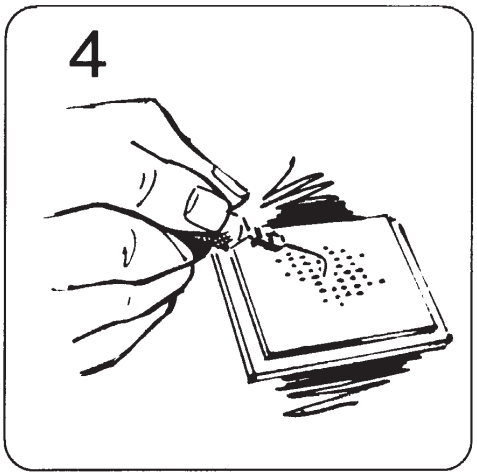
1. Place package on table top. There are two interlocking fasteners. Turn package so that interlocking side is facing down.
2. Grip one section of the plastic fasteners with thumbs hold package when applying force.
3. Pull one plastic fastener from package



Remove both plastic fasteners.



Remove lid from waffle.



Remove chip from waffle at work station with vacuum pickup.

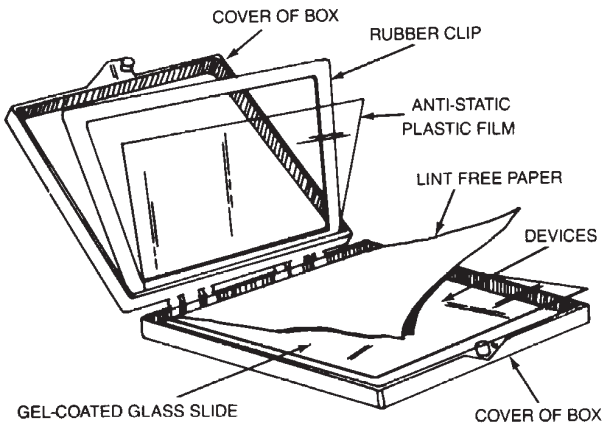
Figure 4. Diode Chip Waffle Package Opening Instructions

Beam-Lead Packaging

Skyworks beam-lead diodes and capacitors are shipped in various package styles depending upon the customer's preference. See Beam-Lead Diodes and Capacitors Bonding Procedure for proper device handling.

Type 1 (Gel-pak)

This is a 2" x 2" black plastic conductive box. The beam-leads are mounted on a gel-coated glass slide. The devices are covered with a piece of lint-free release paper, on top of which is placed a piece of anti-static plastic film. The glass slide and paper are held down by a rubber clip which runs along the perimeter of the box. The cover of the box is snapped shut and taped to prevent opening during shipment.



Drawing #1

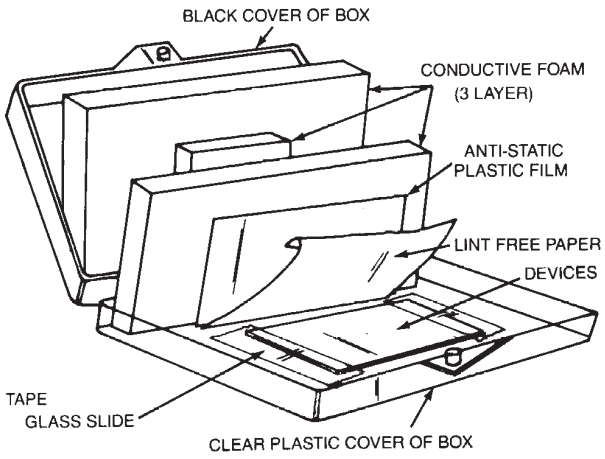
Caution: *Care must be taken in removing foam, film, and lint-free release paper, because if units fall off the glass slide, they may get stuck to tape. One advantage of this packaging is that the devices can be transferred directly from the glass slide to the circuit.*

Type 2 (Gel-pak)

For larger beam-leads, a piece of foam is substituted for the rubber clips to ensure that devices will not be released from the gel during shipment.

Type 3

Some customers prefer shipment of beam-leads on glass slides without gel. In this case, a glass slide is taped to the bottom of a 2" x 3" plastic box, and the units are placed on the glass slide. Pieces of lint-free release paper and antistatic plastic film are placed on top of the glass slides. Three pieces of antistatic foam are placed within the box as a filler to prevent the devices from moving. The box is snapped shut and taped to prevent movement during shipment. The lower part of the box is clear to allow the incoming inspection groups to count the units without opening the box. The upper part of the box is black conductive plastic material.



Drawing #2

The sequence is as follows:

1. Open the box.
2. Carefully remove the foam, plastic and release paper.
3. Use an X-acto knife to cut the tape holding the glass slide and beam-lead devices.
4. A hot bonding tool may then be used to pick up the beam-lead from the glass slide and place it directly across the gap in the circuit.