Soldering Process

When assembling IrDC transceivers on a printed circuit board (PCB), it is useful to have an understanding of the properties of the materials used during manufacturing.

While IrDC transceivers use semiconductor dice and other constituents processed in the semiconductor industry, there are considerable differences between transceivers and other semiconductor devices. One of the most important differences is the molding material that is used for its manufacture.

Packaging material used for transceivers must be transparent to infrared radiation in order to emit and receive optical signals. However, visible light might disturb the proper performance of the transceiver ASIC. A special dye is mixed into the encapsulant to block visible light. This results in the transceiver appearing black. The need for good optical performance requires the use of pure resin. No other ingredients can be added.

The encapsulant used for standard integrated circuits (IC), however, is a mixture of resin (typically 30 %) and other ingredients (e.g. nearly 70% silica sand). This mixture results in more uniform mechanical properties of semiconductor die, leadframe and encapsulant.

Figure 1 and figure 2 show the difference between filled and unfilled epoxy resin.

The following table 1 shows the main differences between the two types of mold compound

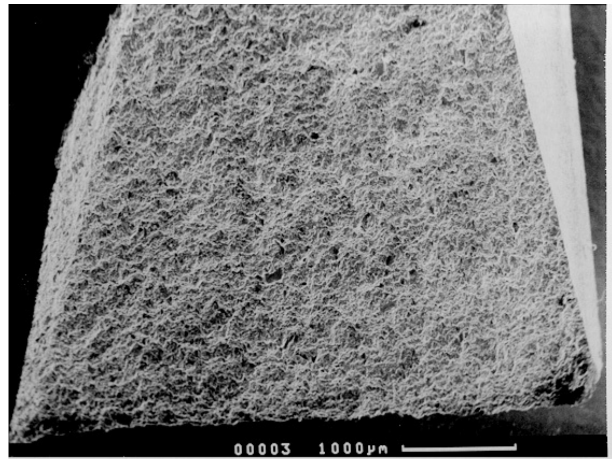

Figure 1. IC molding compound (30 % resin)

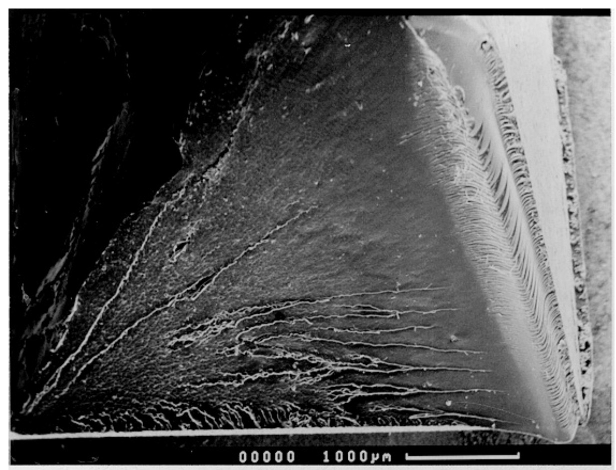

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Figure 2. Clear molding compound (100 % resin)

Table 1

Characteristics	IC Mold Compound	IrDC Mold Compound
Optical Properties	Light Blocking	Transparent
Hardness	High	Low (brittle)
Coefficient of thermal expansion	Low (matched to leadframe & die)	High
Glass transition temperature	High (160 °C)	Low (120 °C to 140 °C)
Thermal conductivity	High	Low
Moisture ingress	Low	High

A standard molded integrated circuit will have its constituents nicely matched to each other in terms of thermal expansion. The typical IC package is rather free of mechanical stress compared to an IrDC transceiver, which experience more mechanical stresses during manufacturing.

Moisture Sensitivity

The high rate of moisture ingress is another property of the optical clear molding compound. The saturation value for room temperature of moisture intake is roughly a factor of ten larger than for filled molding compound. Due to this high rate of moisture ingress transceivers are more prone to the "popcorn effect".

Any possible void (delamination, bubble) inside the package will be filled very quickly with moisture. Even the whole package can soak up a considerable amount of moisture. Whenever the package is heated up above the boiling point of water, a very high vapor pressure builds up inside the voids. This pressure can cause the package to crack or creates severe delamination.

The amount of moisture absorbed by the package is determined by the exposure time to humid air. The exposure time allowed for a particular package is defined by a moisture sensitivity level (MSL) according to JEDEC standards J-STD-020 and JESD22-A113.

Vishay transceivers are designed to withstand three subsequent passes through a reflow soldering oven using our recommended reflow temperature-time profile when the package has been exposed not longer than 72 hours to environmental conditions of ≤ 30 °C/60 % RH. This correlates to MSL 4.

The parts will be delivered in a moisture barrier bag containing desiccant and a humidity indicator card. As long as the parts are stored in the sealed bag, the performance will not degrade. As soon as the bag is opened, the material should be consumed within 72 hours or must be stored in a dry place (chamber which is purged with a dry gas like air or nitrogen) or baked according to the sticker on the reel.

Reflow Soldering

Vishay Semiconductor transceivers are surface mount devices and are designed to be assembled to printed circuit boards (PCB) using reflow soldering.

State of the art for reflow soldering is the use of a so-called convection reflow oven.
Recommendations for reflow conditions can only be given in general terms since each PCB should be considered individually depending on the size and distribution of components. Because IrDA transceivers are more sensitive to thermal stress than most other components, it is recommended that these be used to determine the optimum soldering conditions. If the subsequent recommendations are followed excellent results can be achieved despite the limitations of the materials used.

Reflow Solder Profile

There are two distinct tasks for the temperature-time profile of the solder process:

- Prepare the components for the stress at the soldering temperature.
- Solder the components to the PCB.

The main idea behind this pre-soldering preparation (neglecting the solder paste activation and the like) is to have a very small temperature difference between all components. This allows for a low peak temperature and damage free soldering.

There are two different profile types used in industry nowadays. The most often used type in the past and still today is the ramp-soak-spike profile (RSS).

The convection oven allows for a ramp-to-spike profile (RTS), and the application of this type is increasing.

A solder profile consists roughly of three distinct phases.

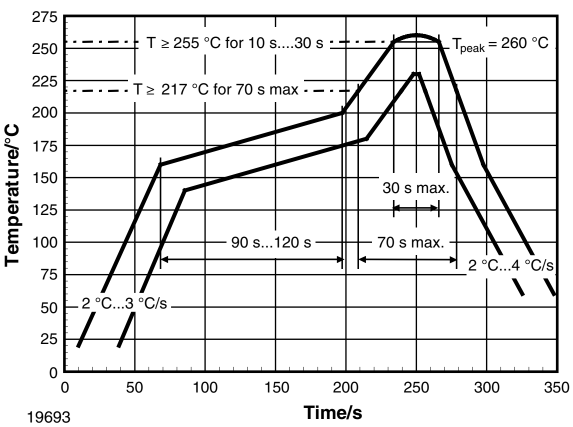
- Pre-heating or Soak Phase: For standard components, this is the phase where all parts should come roughly to the same temperature. This is achieved either by keeping the PCB for a certain time at a specific temperature (RSS) or ramp-up the temperature at a certain speed (RTS) to have all parts at all times of the profile at the same temperature.
- Soldering: During this phase, the actual soldering takes place. We recommend not to exceed 260 °C peak temperature and the device should not be exposed to higher temperatures than 255 °C for more than 30 s (TFDUxxxx) or 20 s (TFBSxxxx) depending on the type of transceiver
- Cool Down: The PCB should be cooled down rather quickly to have a fine grain solder joint.

As outlined previously a transceiver package has built-in mechanical stress, which should be reduced before submitting the part to the actual solder temperature. This stress is relieved during the soak phase.

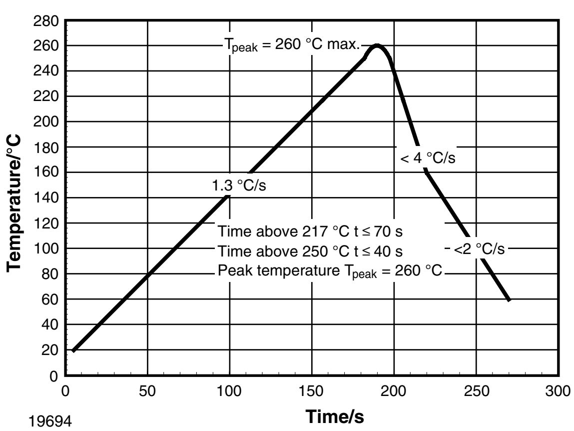
Depending on the encapsulant material used for packaging, the best soak temperature is in the range of 140 °C to 160 °C and the time interval is 120 s to 180 s. As a rule of thumb, the temperature should be slightly above the glass transition temperature and the dwell time must be long enough to allow for stress relief. This is most conveniently realized with an RSS profile.

For RTS profiles, the low thermal conductivity compared to standard components should be considered. To get the transceiver into thermal equilibrium with the PCB and allow for internal stress relief the thermal ramp-up rate normally must be lower than for standard components.

Vishay Semiconductor recommended RSS Profile



Vishay Semiconductor recommended RTS Profile



Wave Soldering

For TFDUxxxx and TFBSxxxx transceiver devices wave soldering is not recommended.

Manual Soldering

Manual soldering is the standard method for lab use. However, for a production process it cannot be recommended because the risk of damage is quite highly depending on the experience of the operator. Nevertheless, we added a chapter, describing manual soldering and desoldering. Before soldering or desoldering be sure that the devices (or boards) are correctly dried corresponding to given MSL-condition. See the equivalent standard JEDEC J-STD-033A, "Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices".

Storage

The storage and drying processes for all VISHAY transceivers (TFDUxxxx and TFBSxxx) are equivalent to MSL4 if not otherwise specified in the data sheet.

The data for the drying procedure is given on labels on the packing and also in the application note "Taping, Labeling, Storage and Packing" (http://www.vishay.com/docs/82601/82601.pdf).

Pick & Place

For reliable pick and place operation an adequate flat area on the topside of the module is important. Vishay Semiconductors always design transceivers to have a flat surface on the topside for pick and place.

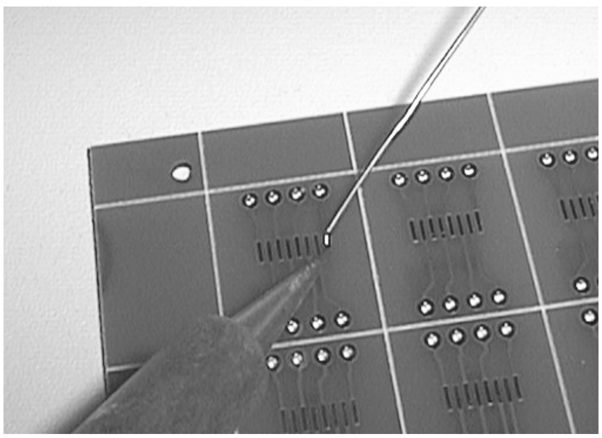
Due to the non-symmetric package - very common for opto-electronic parts - the pick-up position can not be expected in any case at the center of the package.

The best pick-up location is indicated in the data sheet drawings as "mounting center". It coincides with the center of the hole in the pocket of the carrier tape.

Manual Soldering

Although IrDC transceivers are surface mount components and therefore designed for reflow soldering, it is possible to solder these manually using soldering irons. Be sure that the devices are correctly dried corresponding to the MSL4 conditions. Based on long-standing experience of some of Vishay Semiconductors customers the following rules should be observed:

- Use standard Pb-Sn or Sn solder
- Use a high power (at least 25 W) temperature controlled soldering iron
- Soldering iron temperature 345 °C ± 5 °C
- Soldering time 1 second maximum per lead
- Avoid any mechanical stress to the leads during soldering or cool down



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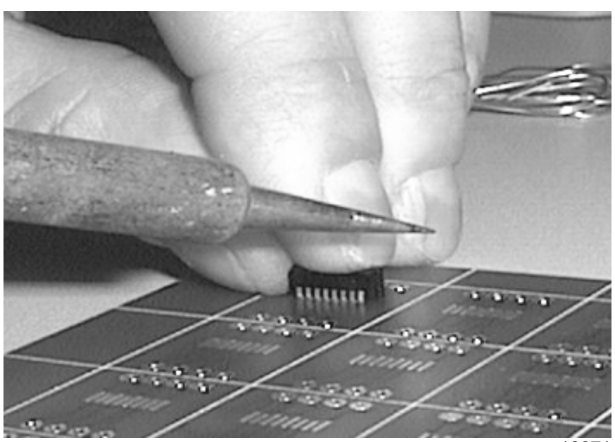
Step 1:
Start with one pad only and get some solder on it.



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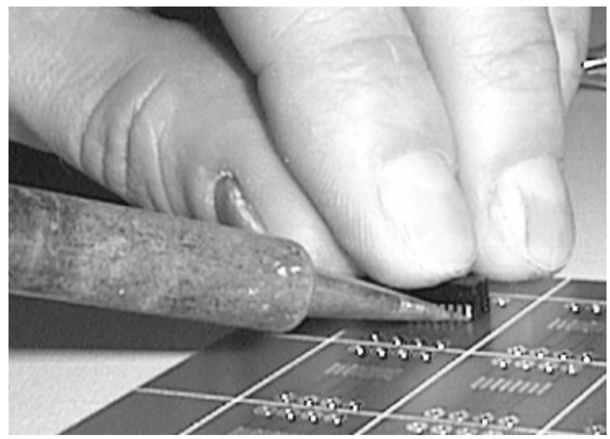
Step 2:
Place the transceiver at its appropriate position



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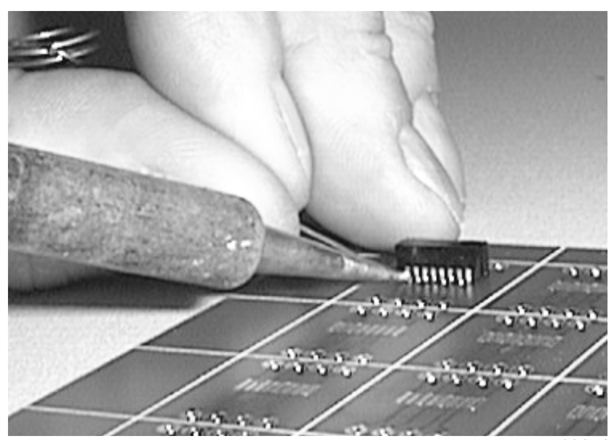
Step 3:
Solder the lead to lead pad prepared in step 1



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Step 4:
Solder quickly and skillfully the remaining leads

Desoldering

If it is necessary to remove a transceiver from a PCB for replacement or investigation without damage the same constraints apply as for soldering. Excessive heat or mechanical strain (e.g. usage of pliers) could result in cracks or damaged wire bonds. Bake the whole board according to MSL4 before removing the part to avoid moisture effects. Vishay recommends two procedures which have been found to give the most consistent results:

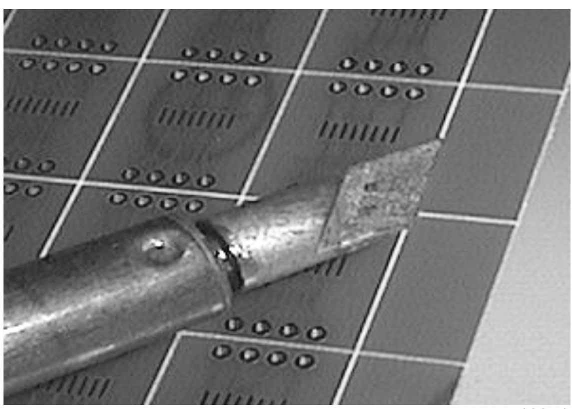
Soldering iron method

- Use a high thermal capacity soldering iron (> 25 W) at 360 °C ± 10 °C
- Use a solder iron with a very broad tip
- Hold device with long nose tweezers
- Heat leads
- Do not apply force until the solder melts
- Push the unit away without force

Hot air method

- Nozzle temperature 400 °C ± 10 °C
- Lead temperature (nozzle 5 cm from the device) 270 °C ± 10 °C
- Hold device with long tweezers
- Apply air at an angle of 45° to the lead moving the nozzle to heat all of the leads or apply the heat from the back side when no components are mounted on the back under the transceiver
- When the solder melts (< 4 s) push gently or lift device to lift off the leads

It is important that as little mechanical force as possible is applied to the leads when the package is hot and softened by the heat. Any excessive force can tear off the leads causing internal damage to the wire bonds.



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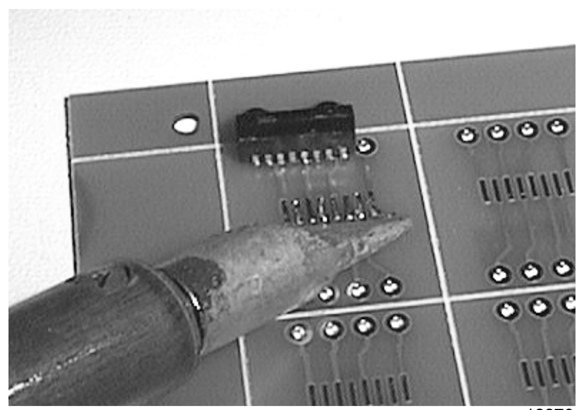
Use a broad tip for desoldering with a solder iron



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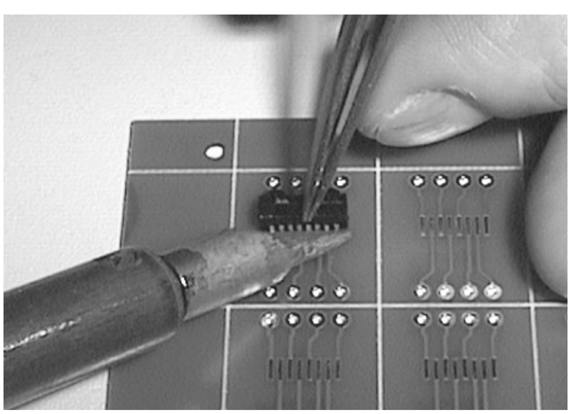
When the solder is completely molten (< 2 s) push the transceiver gently off the solder pads on the PCB



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Apply heat uniformly to the whole set of leads