RoHS-Compliant Through-Hole V•I Chip Soldering Recommendations

By Ankur Patel, *Associate Product Line Engineer*

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Introduction

RoHS compliant, through-hole full size V•I Chips are intended for wave soldering assembly. The information contained in this document defines the processing conditions required for mounting a full size V•I Chip to the PCB using wave soldering or hand soldering. Failure to follow the recommendations provided can result in visual and functional failure of the module. In addition to soldering procedures, common soldering defects will be discussed and direction will be provided for detecting, handling and preventing these defects. For surface mount V•I Chip reflow soldering guidelines, please see AN:009 (vicorpower.com/applications-information).

Note: Solder and related soldering equipment may be hot and/or emit noxious gases. Industry standard health and safety procedures must be followed when soldering V•I Chips.

Wave Soldering

Storage

The full size through-hole V•I Chip is qualified to withstand an equivalent of MSL level 1 pre-condition using a 3-zone wave soldering oven. A recommended oven temperature profile is available upon request. MSL 1 indicates that the product has an unlimited life in conditions of ≤ 30°C / 85% RH according to JEDEC-STD-020C for SMD components.

Pick & Place

The V•I Chip should be placed such that each lead rests in its appropriate hole without damage, distension, or bending. The appropriate hole spacing as recommended on the data sheet should be maintained to avoid improper seating of the V•I Chip leads within the PCB. 3D models of all V•I Chips and recommended pad spacings are available on the web (vicorpower.com/mechanical_drawings/VI_Chip). All persons and equipment in contact with V•I Chips should have proper ESD protection to avoid damaging the units during the mounting process.

Fluxing

Fluxes are available in no-clean and water washable varieties. Alpha EF 2202 is recommended for use in wave soldering through-hole V•I Chips. Ultra-sonic spray is the recommended method for applying flux in wave soldering process. Flux should be applied to underside of the board (solder side). Precise control of flux quantities is required. Too little flux will cause poor joints, while too much flux may cause cosmetic or other problems.

Preheating

The preheating procedure must be carefully selected to ensure that temperature and time cycles used do not degrade the product.

Recommended board preheat lead free temperature profile:

Zone 1 Upper = 400°F (convection zone) closest to wave
Zone 1 Lower = 400°F (convection zone) closest to wave
Zone 2 Lower = 375°F (middle convection zone)
Zone 3 Lower = 725°F (IR zone) farthest from wave

Wave Soldering

No-clean or water washable 96.5 Sn 3.0 Ag 0.5 Cu solder should be used for wave-soldering V•I Chips. Other types of solder (including leaded solders) may be used if the module can be safely wave soldered without exceeding its maximum case temperature, as noted on the V•I Chip data sheet.

As with any process, control of process variables will have a direct effect on the quality of the final product. The following guidelines are provided for wave soldering of full size through-hole V•I Chips.

Table 1
General Guidelines for Machine Settings

Operating Parameter	Typical	Recommended
Amount of Flux Applied	< 1200 µg/in² using Spray method	Ultra Sonic Spray Method
Top side Preheat Temperature	—	400°F
Bottom side Preheat Temperature	—	Zone 1 = 400°F, Zone 2 = 375°F, Zone 3 = 725°F
Recommended Preheat Profile	Straight ramp to desired top side temperature	—
Maximum Ramp Rate of Topside Temperature (to avoid the component damage)	2°C / seconds Maximum	—
Conveyor (wave) Angle	5 – 8°	6°
Conveyor (wave) Speed	2.75 – 6.5 feet / minute	2.75 feet / minute
Contact Time in Solder (Dwell Time)	1.5 – 4.0 seconds	3 to 4 seconds
Solder Pot (wave) Temperature: Lead Free Alloys (99.3 Sn / 0.7 Cu, 96.5 Sn / 3.5 Ag, 96.5 Sn / 3.0 Ag / 0.5 Cu)	490 – 510°F (255 – 265°C)	510°F

Hand Soldering

Before soldering, make sure that PCB is clean. The pins on the V•I Chip are optimized to provide a low resistance electrical connection. The final mounting scheme for any V•I Chip should be designed to minimize any potential mechanical stress on the pins and solder joints. The maximum clamp pressure for the through-hole V•I Chip is 6 lbs. If additional force is required, please contact Applications Engineering.

The time required to create a good solder connection will vary depending on several parameters such as PCB thickness, copper trace area, copper trace thickness, soldering iron power, tip temperature, type of solder, tip size etc.

The following typical guidelines apply to hand soldering through-hole V•I Chips.
(1) Tip size: recommended tip diameter of 5 mm
(2) Tip temperature: 850°F
(3) Soldering time: 5 to 10 seconds
(4) Type of solder: No clean, 96.5 Sn 3.0 Ag 0.5 Cu
(5) Type of flux: None

Soldering multiple pins of the same potential simultaneously is acceptable. Care should be taken not to short pins of different potentials.

Wire can be soldered directly to the V•I Chip leads. However, any wires soldered to the V•I Chip should have appropriate strain relief to insure that no stress is applied to the lead frame. The V•I Chip itself should be mechanically secured appropriately so that it will not move in the application and stress the solder connection. Caution should be taken not to cause solder bridging and shorts. Direct wire soldering to the V•I Chip leads is not recommended for production applications and should only be used in initial prototyping exercises when a PCB is not available.

Pin/Lead Protrusion

Pin/Lead protrusion guidelines, defined in IPC-A-610D, are necessary to enable a good solder connection. Minimum criteria require the lead end to be discernible in the solder, while the maximum criteria require enough clearance to avoid danger of shorting between leads. Figures 1-3 and Table 2 show length (L) and the maximum and minimum criteria.

Figure 1
Length of leads considered without clinch (left) and with clinch (right).

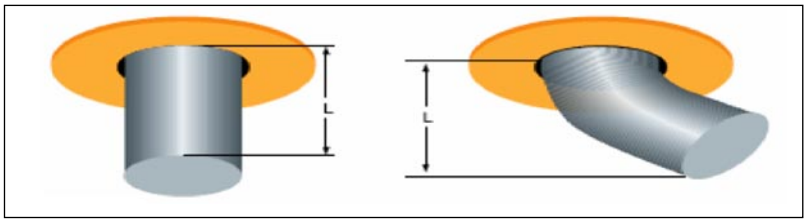


Figure 2
Maximum (left image) and minimum criteria (right image).

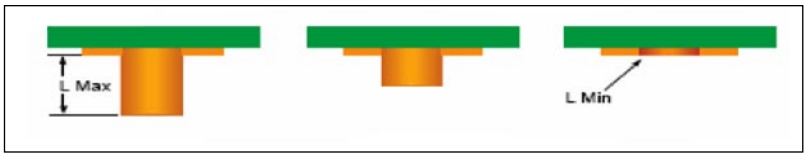


Figure 3
Example of acceptable protrusion of soldered lead.

Table 2
Maximum and minimum recommended lead protrusion lengths

	Class 1*	Class 2*	Class 3*
(L) Min	End is visible in the solder joint (see Figure 3)		
(L) Max	No danger of shorts	2.5 mm [0.0984 in]	1.5 mm [0.0591 in]

- Class 1 – General electronic products as defined in IPC-A-610 D
- Class 2 – Dedicated service electronic products as defined in IPC-A-610D
- Class 3 – High performance electronic products as defined in IPC-A-610D

Board Cleaning

If water-soluble solder is used, the board can be water washed using deionized water. No-clean solders do not require cleaning but will leave residues on the board surface. If this is a concern, cleaning can be performed using isopropyl alcohol.

Solder Joint Inspection Procedure

A magnifying glass or optical microscope of 10x magnification should be used to look for solder shorts, and solder voiding. Electrical inspection should be conducted to verify any shorting that may not be visible.

Figures 4 – 7 illustrate good solder joints with views from both the bottom and the top sides of the PCB.

Figure 4
Good joint-board bottom side

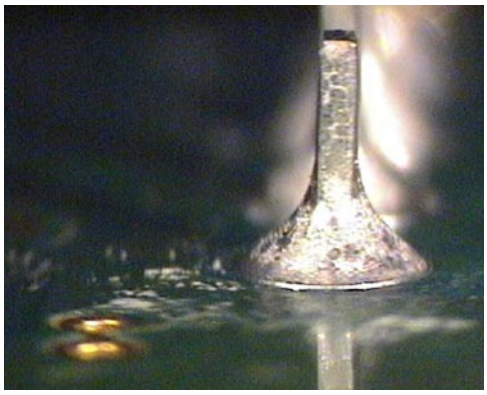


Figure 5
Good joints-board bottom side

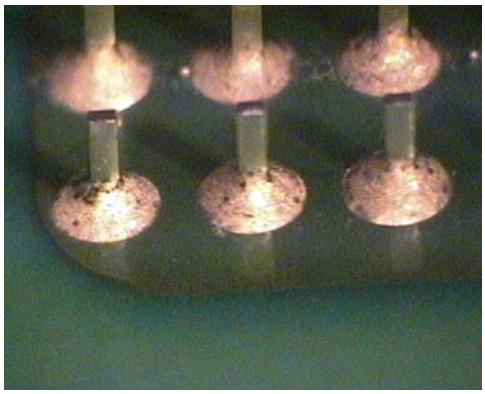


Figure 6
Good joints-board top side

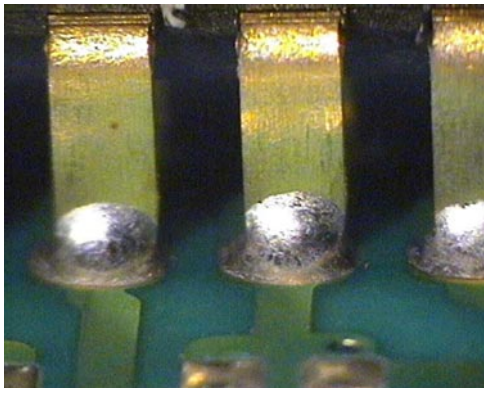
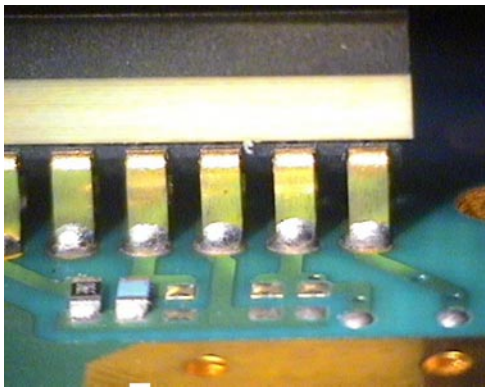


Figure 7
Good joints on board top side



Potential Defects

Some common defects of soldering through-hole V•I Chips are described below, and illustrated in figures 8 – 14.

(1) Solder voiding is caused by outgassing of substances from the solder. To prevent this, a correct soldering profile should be selected and enough preheat should be provided.

(2) Non-wetting is caused by improper chemical characteristics between the solder and the pad surface metallization. Surface plating should be compatible with the solder in order to eliminate non-wetting defects.

(3) Fillet lifting is a defect in which solder joints lifts off from the pad. Fillet lifting has been associated with Pb contamination which leads to difference in solder solidification rate at the interface. The use of Bismuth and Lead with lead-free solders should be avoided in order to avoid fillet lifting.

(4) Shrink hole and hot tearing defect is related to the appearance of tearing in the soldered joints. According to IPC 610 standard this defect is acceptable provided the shrink hole does not contact the lead, land or barrel wall.

(5) Solder balling is related to the presence of solder balls after the soldering operation. Adjusting the reflow profile and allowing enough time for soldering can avoid this.

(6) Insufficient solder is related to solder not filling the through-hole during the soldering process. Less than 75% solder fill is not acceptable according to IPC 610 rev D.

(7) Solder bridging is related to solder improperly connecting two or more adjacent pads and leads that come into contact to form a conductive path during the wave soldering process. Solder bridging between joints of same potential is acceptable but should not be expected.

Figure 8
Solder voiding

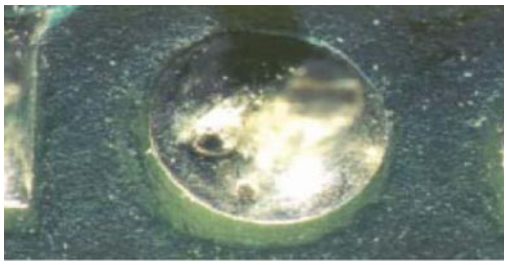


Figure 9
Non wetting

Figure 10
Fillet lifting

Figure 11
Shrink hole/Hot tear

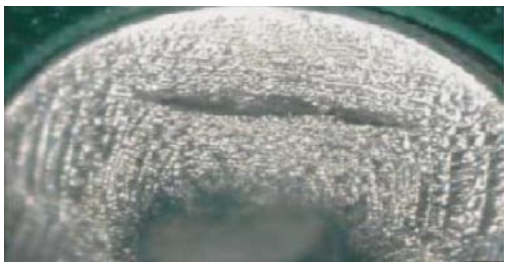


Figure 12
Insufficient solder

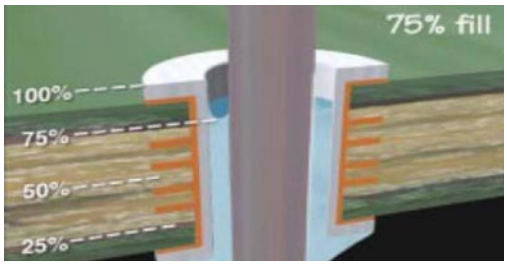


Figure 13
Solder balling

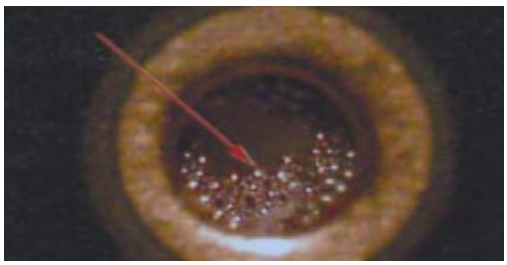
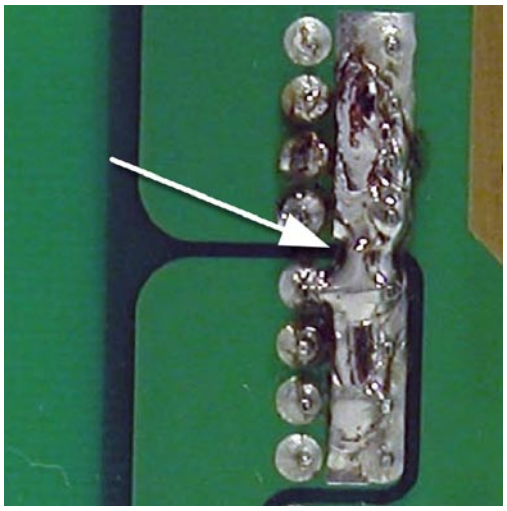


Figure 14
Solder bridging



Removal

Through-hole V•I Chip components may be removed from a PCB using a vacuum method:

(1) Preheat assembly or component if required.
(2) Heat each individual joint one at a time in a rapid, controllable fashion to achieve complete solder reflow.
(3) Avoid thermal and mechanical damage to component, board, adjacent components and their joints. Do not exceed 150°C on the top side (case) of the V•I Chip.
(4) Apply vacuum during lead movement to cool joint and free lead.

Through-hole V•I Chips may also be removed using a solder fountain method:

(1) Reflow all joints in solder fountain.
(2) Remove old component and either immediately replace with new components or clear through-holes for component replacement later.

Disclaimer

This document provides general guidelines, which have proven to yield excellent results. However, depending upon equipment, components and circuit boards, the optimal settings may be different. In order to optimize the soldering process, it is recommended that soldering process experimentation be performed, optimizing the most important soldering process variables (amount of flux applied, topside preheat temperature, bottom side preheat temperature, recommended preheat profile, maximum ramp rate of topside temperature, conveyor angle, conveyor speed, contact time in the solder, solder pot temperature and board orientation.) Mechanical samples of V•I Chips are available to enable optimization of the soldering process.

Please contact Applications Engineering for further assistance or inquiries regarding the soldering of through-hole V•I Chip components not covered in this document.

Reference

Further information can be obtained from the following web sites and documents:

IPC-A-610 Revision D Acceptability of Electronic Assemblies

http://www.ipc.org

http://www.jedec.org