

Selective Soldering

Vitronics Soltec Oosterhout

Design rules for selective soldering assemblies

TOOLING AND APPLICATION

Recommendations for a robust selective soldering process

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General

This document describes general guidelines and attention points for PCB design regarding selective soldering. The guidelines can be applied for Select Wave and/or Multi Wave soldering process in both leaded and lead-free alloy.

When a PCB is designed according to these guidelines, a stable and solid solder-process can be guaranteed.

In case these Guidelines seem to restrict your specific application please contact the Vitronics Soltec Tooling group (tooling@vsww.com) to find the right solution for your application.

General PCB Dimensions & Specifications

2.1 Solderability

The solderability of the PCB and the components must be in accordance with the general demands for (machine) soldering. The solderability demands and tests are defined in the IPC/EIA J-STD-002.

2.2 Board dimensions

See machine specification.

2.3 Tolerances on board flatness

Bow and twist should not exceed 1% see IPC-TM-650, 2.4.22.

This is the maximum twist that the conveyor can handle. For a robust process it is recommended to have a minimum twist since this will affect the contact time and cause a potential risk. For assemblies that are not flat board warpage compensation is recommended.

2.4 Board weight

The maximum total board weight including SecureGrip and carrier is 15 kg (33 lbs.).

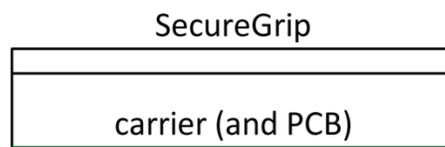


Figure 1: weight



Max.15 kg

The acceleration speed and maximum speed for robot movement in x, y, and z-direction see machine specification. For the stability of the components a component position/Hold down unit can be provided.

2.5 Board weight distribution

The maximum weight concentration for a particular board area of 1 dm² on a larger board must be limited to approximately 0.5 – 1 kg/dm². (1.1 – 2.2 lbs/dm²).



Figure 2: Board weight distribution.

On a board there might be one area where the weight exceeds the average weight expressed in weight/dm². The total weight must not exceed the specified value (see 2.4)

2.6 Edge clearance

2.6.1. Edge clearance for PCB

The edge clearance on top and bottom of PCB must be ≥ 3 mm. This clearance is necessary for supporting the product on the chain/roller conveyor, the clamping fingers on the PCB gripper (*mySelective*) or the clamping unit of the shuttle (*ZEVA*).

Edge components, like connectors, can be applied as long as there is enough space left to support the product. Dedicated pallets may be an alternative.

(*mySelective*) The width, required to place one of the clamping fingers of a PCB SecureGrip (*mySelective*) is 28 mm. There should be a sufficient amount of fingers to prevent the product from bending during handling. Cut-outs in the area of the supporting edges may affect the PCB handling on the pin chain of the conveyor. It is recommended to avoid such cut-outs or if possible use break-out parts for such areas that can be removed after soldering.

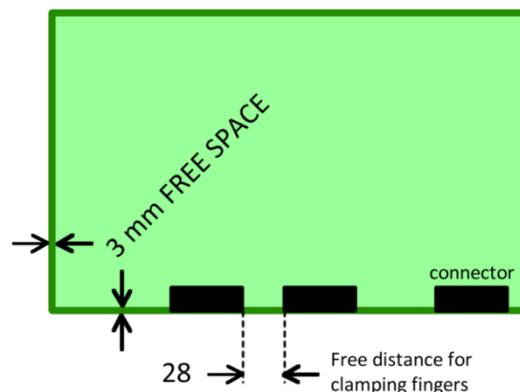


Figure 3: Free space required for gripper.

Free edges are required for board support during soldering, either by a pallet or by a PCB SecureGrip.

(*ZEVA*) The clamping in the shuttle or on the solder conveyor requires 3 mm free space over the whole width. Eventually these clamping systems can be modified for dedicated assemblies.

2.6.2. Board positioning holes in PCB's

(*mySelective*) Two product positioning holes are preferred for precise positioning of the PCB in the SecureGrip or in a pallet. Preferable one round hole and one slotted on the fixed rail side of the PCB, diameter holes 3 mm (according to IPC-2221).

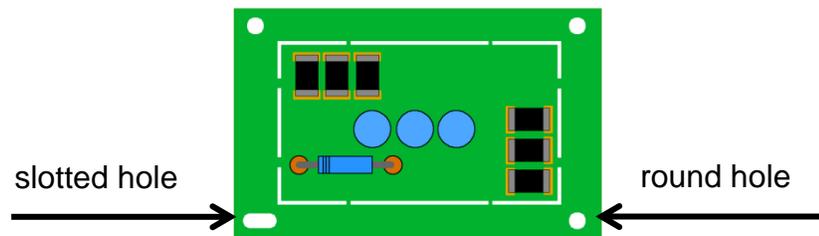


Figure 4: Holes in PCB for positioning

Board positioning holes should be accessible for positioning pins. In case the PCB design is different, please contact the tooling group (tooling@vsww.com) to find the best alternative for your application.

(ZEVA) The shuttle doesn't require these positioning holes, but in case of PCB multi wave dipping these holes are ideal for position the PCB on the nozzle plate.

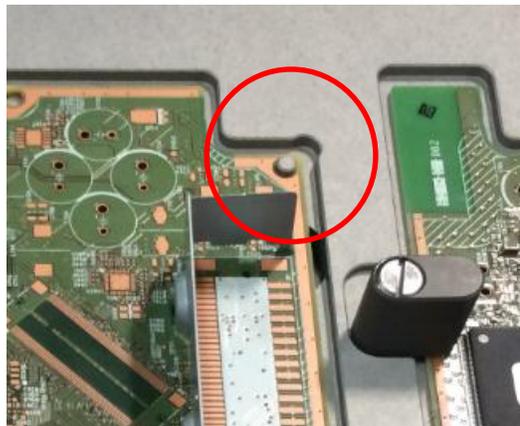


Figure 5: The hole used for PCB positioning in pallet.

2.6.3. Areas for PCB lifting support pins

(mySelective) At the bottom of the PCB in the length of the conveyor direction, at least 4 areas of 6 mm diameter free space are required for lifting the PCB out of the pin-chain conveyor system. These supporting areas are typically within a zone of 10 mm, measured from the PCB edges. A sufficient number of lifting support pins must be selected to guarantee a straight and stable board handling.

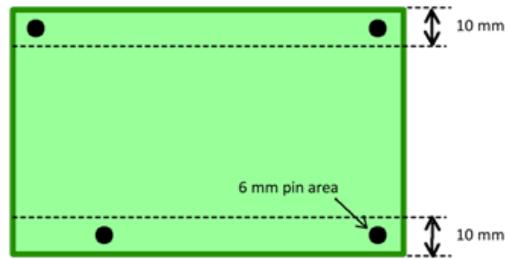


Figure 6: Free areas for PCB lifting on bottom side of the PCB.

These areas are needed for PCB support during lifting from the pin chain conveyor, before the PCB is picked up by the SecureGrip.

PCB joint and component layout

3.1 Component height on top and bottom side

The general specification of component height on the topside of the PCB is 120 mm (*mySelective*/*ZEVA*) in both select and multi wave soldering. Hold down units may affect the maximum height.

Component height on the solder side of the PCB is for multi wave 25 mm (*mySelective*)/16 mm (*ZEVA*). For select wave the height depends on the position of the component in relation to the soldering area and angle.

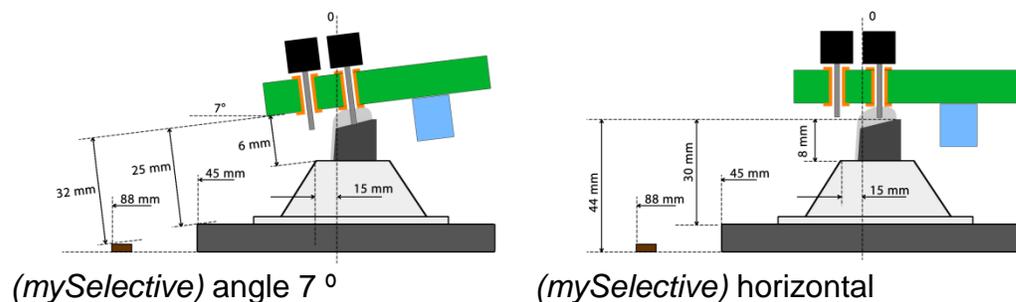


Figure 7: component height at solder side for *mySelective*

The maximum component height on bottom is limited by the conveyor. Special modifications can be made to meet 40 mm height on bottom.

3.2 Joint design

3.2.1 Clearance between component and PCB

Parts and components should be mounted such that there is no obstruction in the solder flow to the solder destination side. A sufficient gap between top side board and component should guarantee a good hole fill.

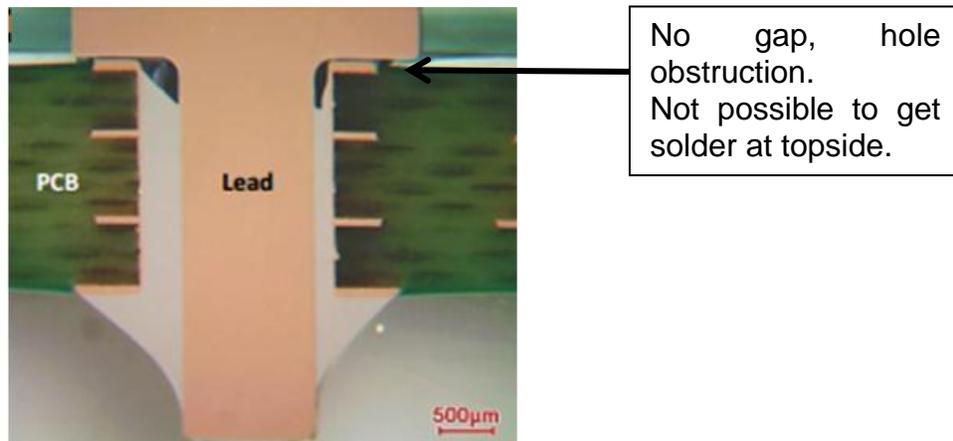


Figure 8: Cross section of joint with no space for outgassing.

3.2.2. Joint dimensions and lead protrusion length

The general minimum lead protruding length is defined in the IPC-A-610 chapter Through-Hole Technology. For double sided boards (supported holes) the end should be discernible in the solder. For single sided boards (unsupported holes) the end should be discernible in the solder additional for class 3 assemblies it should be sufficient to clinch.

For supported holes class 2 the maximum is 2,5 mm and for class 3 it is 1,5 mm. Exempted are leads >1,3 mm diameter provided they don't violate minimum electrical clearance.

The maximum protrusion length for single sided boards is not defined, as long as there is no danger for shorts or violation of minimum electrical clearance.

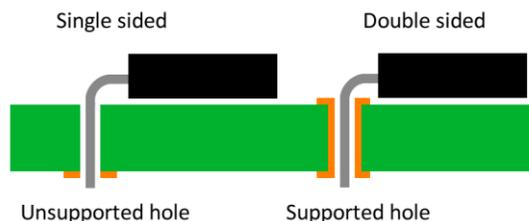


Figure 9: Protrusion length supported and unsupported holes.

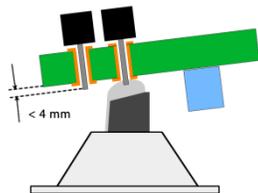
Select wave: to minimize risk for bridging short protrusion lengths are preferred.

Multi wave: to minimize bridging short protrusion length is better, but if screens are used a longer lead length will help the solder to wet the barrels and there is a lower potential for shorts.

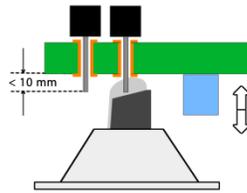
3.3 Lead length limitations

For 'dip' soldering in both, SelectWave or MultiWave process, leads may have a length of 10 mm. For drag soldering on a select wave the lead length is limited to 4 mm. In general shorter leads will give less risk for bridging but longer leads have a better heat transfer to achieve good hole filling.

Select Wave
Drag soldering
< 4 mm



Select Wave
Dip soldering
0,7 - 10 mm



Multi Wave
Dip soldering
0,7 - 10 mm

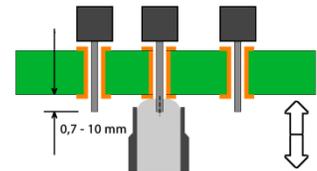


Figure 10: Lead length limitations

A straight protruding length of more than 1 mm will in general not collect more solder in the joint in machine soldering and therefore will not add more strength to the joint.

3.4 Restrictions for SMD components inside the solder area

In general inside the area to be soldered by the MultiWave, no SMD components can be allowed, unless the SMD's are glued and already soldered and can withstand the selective soldering process without interfering with the leads of the solder joint.

To reduce solder bridging between SMD components and/or leads, the PCB design guidelines for wave or dip soldering should be applied.

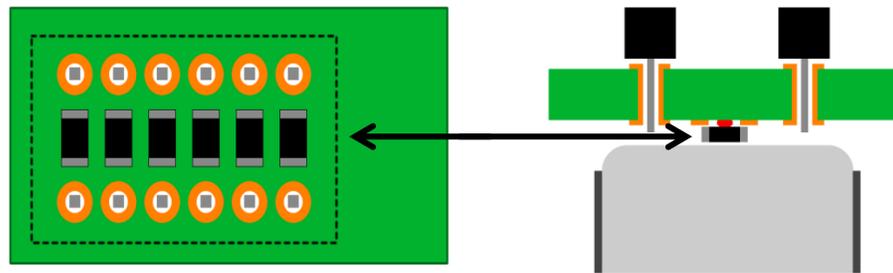


Figure 11: Restricted area for SMD components. SMD components are not recommended in the soldering area.

Free space requirements for selective soldering multi wave:

4.1 General non-wettable nozzles

Free space around a selective solder point is necessary for having free access of the nozzle to the joint and reduce thermal load to surrounding components during soldering. Additional free space might be required to address product tolerances. In general a robust process is guaranteed for select and multi wave processes when there is a free space of 1 mm or more from the edge of the nozzle to a surrounded component or SMD pad.

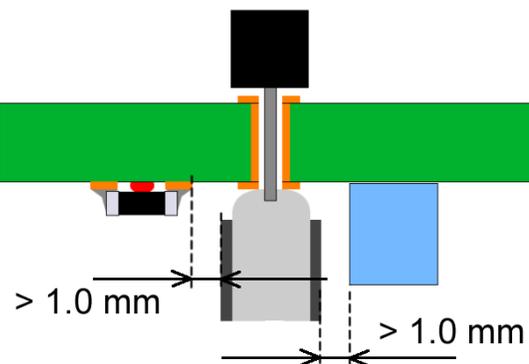


Figure 12: Minimum free spacing for non-wettable nozzles.

4.2 General wettable nozzles

Using a wettable nozzle the solder overflows over the complete nozzles diameter. This allows a small distance to surrounded components. For the smallest standard nozzle diameter (ID 4 mm) the minimum required free space will be > 3mm on all sides of the nozzle measured to the center.

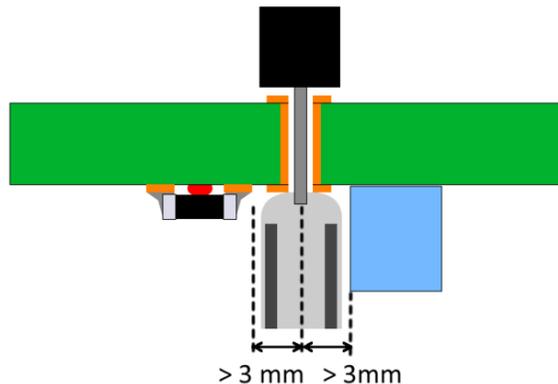


Figure 13: Minimum free spacing for 4 mm wettable nozzles.

4.3 Dimensions available nozzles

General dimensions of Select wave and multi wave non-wettable nozzles:

- Minimum outer diameter Select Wave nozzle 6 mm
- Maximum outer diameter Select Wave nozzle 30 mm
- Minimum dimension Multi wave nozzles outside 6 mm*

* For nozzle plates that have all small and similar nozzles the minimum of 4 mm is possible.

- Maximum dimensions Multi wave are defined by solder pot dimensions

Dimensions for Select Wave wettable nozzles:

- Minimum outer diameter Select Wave 4 mm
- Maximum outer diameter Select Wave 15 mm

4.4 Free space requirements for multi wave soldering

Due to the spherical shape of the solder surface on the static wave in a stainless steel multi wave nozzle the 'net area' that can be used for soldering is reduced.

The inside nozzle dimension must be 1.5 mm more than the solder area in all directions (due to meniscus of solder and nozzle rim). There must be a clearance of 1 mm between the outside edge of the nozzle and surrounded components and the pads of SMDs.

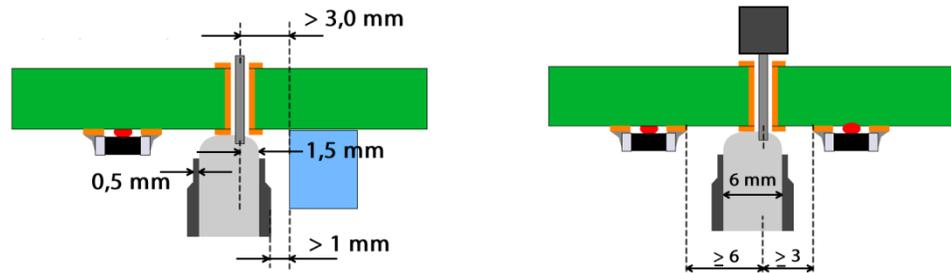


Figure 14: Free space requirements 6 mm nozzles.

4.5 Distance multi wave nozzle to product

MultiWave nozzleplates are provided with 'stand-off' pins. The pins are made to keep the gap between the topside of the nozzle fixed at 0.3 mm from the bottom side of the board during soldering. 0.3 mm is the standard gap; optional are 0 and 1.5 mm.

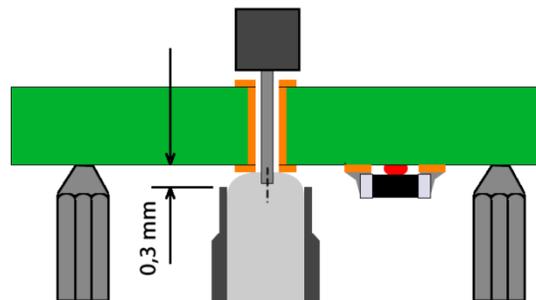


Figure 15: Distance topside nozzle to bottom side board.

For special requests contact the tooling group (tooling@vsww.com).

Free space requirements for selective soldering select wave:

4.6 Free space requirements for select wave soldering

Selectwave soldering can be used for "dip" (= horizontal solder dip) and "drag" (= under an angle or horizontal continuously soldering) solder process. For both processes the minimum standard outside diameter is 4 mm for a wettable nozzle. The nozzle rim is typical 0.5 mm thick.

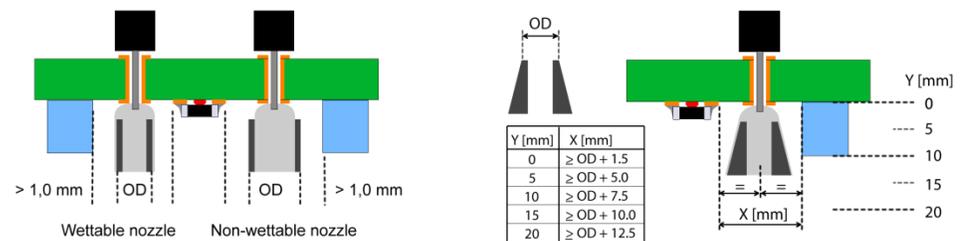


Figure 16: different select wave nozzles and their required free space.

Conical nozzles (right) require more free space, but have a better heat transfer.

4.7 Additional free space for drag soldering

The 'upstream' and 'downstream' free space is necessary to avoid solder contact with joints and surrounded (SMD) components. Depending on the soldering angle and/or height of the component, the down stream distance may need to be enlarged. With this free space wettable surfaces should be avoided since solder may wet it.

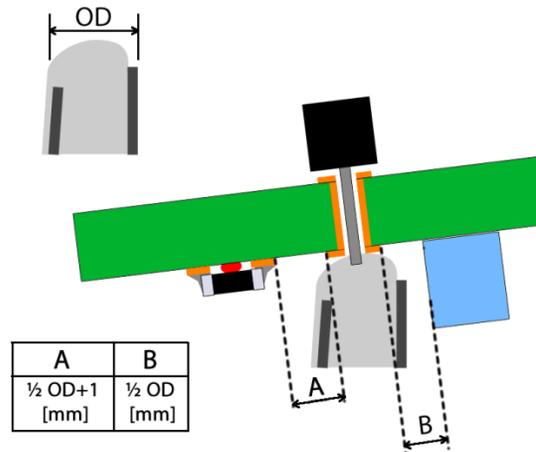


Figure 17: *A = Distance between joint to solder and wettable surface/component, not intended to be soldered, in direction of drag.*

B = Distance between joint to solder and wettable surface/component, not intended to be soldered at the back side of the drag. OD = Outside diameter.

For a robust process in selective soldering, the distance of the centre of the joints to the surrounding components should be ≥ 4 mm. However, using the select wave process the distance be ≥ 1 mm, provided that - placing the minimum admissible diameter select wave nozzle.

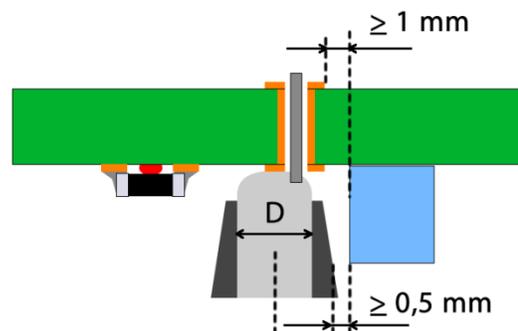


Figure 18: *smallest free space for wettable nozzle*

4.8 Additional free space dip soldering select wave

A dipping process on a select wave nozzle requires less space. Since the dip is made in z-direction only the free area around the nozzles is limited to the outside diameter + 1 mm. For the non-wettable nozzles an additional free area is required to let the solder flow back into the solderbath without toughing surrounded components.

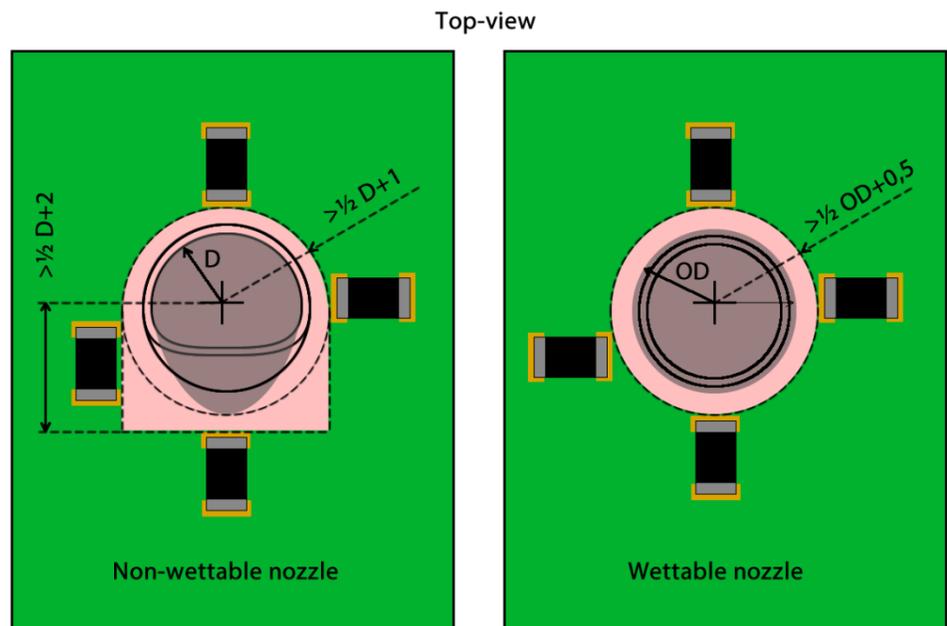


Figure 19: Topside view select wave nozzles. Minimum required space for dipping. (D = Inner diameter and OD = outer diameter)

4.9 Required free space pin conveyor

The ZEVA m can have a pin chain conveyor at the soldering station. Since there is a double pin chain the best method to solder pin connectors at the conveyor side is using a long small wettable nozzle. The closest distance of board edge is 5 mm when using this configuration.

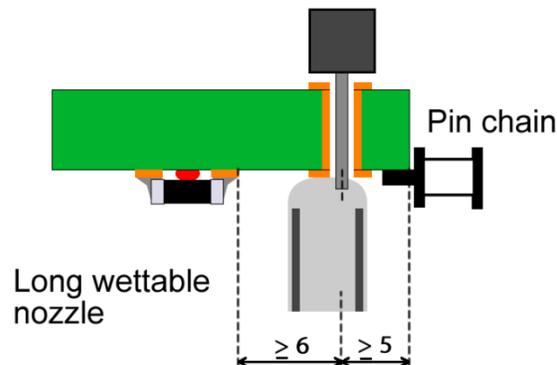


Figure 20: Small toll wettable nozzles are the preferred option for pin chain conveyors at solder unit.

For a non-wettable nozzle with pin chain conveyor more space is required for the nitrogen cover and SDC (solder drainage conditioner) unit.

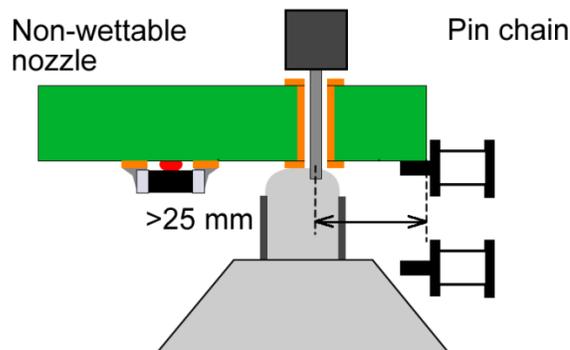


Figure 21: Pin chain and non-wettable nozzle configuration needs 25 mm free space front and rear conveyor side.

The disc conveyor doesn't have free space requirements.