# AMPHENOL TCS

TB-2241

InfinX™

# DFM and SMT Assembly Guideline

Revision “G“

### Specification Revision Status

| Revision | SCR No. | Description | Initial | Date |
|---|---|---|---|---|
| “A“ | S1647 | Initial Release | J. Proulx | 1/27/11 |
| “B” | S1884 | Implemented 6-Pr changes<br>Updated PN Tree and connector weight table | J. Proulx | 12/15/11 |
| “C” | S2248 | Updated 6-Pr images, 4-pr & 6-pr weight table, stack heights, PN Tree and JEDEC Tray Info | J. Proulx | 2/19/13 |
| “D” | S2412 | Updated section 9.0 to recommend using a secondary method of attachment for bottom side reflow<br>Updated Addendum A – Connector Weights Table to remove testing results | J. Proulx | 8/20/13 |
| “E” | S2652 | Added Section 3.5.1 Allowable mating angles and mating forces and suggested mechanical structure for heavier assemblies. Revised connector weight table to reflect metal caps on 6-pr plugs | J. Proulx | 1/16/14 |
| “F” | S3138 | Updated Section 3.7, changed minimum recommended standoff length and clarified DFM impact | M. Chareth | 9/29/14 |
| “G” | S3260 | Updated PN Trees. Added info for new part #’s – 4pr 15.5 and 17.5mm – 6pr 16mm. Added PCB hole info and hardware assembly order to section 3.7 | J. Proulx | 1/08/15 |

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## Table of Contents

## 1.0 DFM Guideline Introduction

This document is intended to provide design criteria and process information that will promote automation, cost and cycle time reduction, and help to produce designs that will yield high quality for the solder attach of InfinX connectors. The InfinX connector will be used in many assembly processes, and because all processes are different, this document provides a starting point, or “baseline” criteria for application process development. **This document is not intended to be the final process definition, nor is it intended to constrain designs.** If customers cannot meet/follow all of the recommendations, they should contact TCS to discuss the best alternatives.

## 1.1 Scope

This document has been prepared to communicate the application guidelines for the InfinX Surface Mount Connector. It provides Printed Circuit Board (PCB) footprint and layout criteria, and “starting-point” process recommendations for SMT assembly. Updates and revisions will be issued on a continuous basis to expand the guidelines, address changes in technology and manufacturing capabilities, and cover modifications and/or additions to current criteria.

## 1.2 Purpose

DFM is the sharing of manufacturing guidelines developed from industry standards and the knowledge gained from design and production. Applying these guidelines concurrently, in new product development with the design and application of Amphenol TCS’s InfinX connector, can positively impact cost, time to market, and quality of the end product.

## 1.3 Reference Documents

Located at: http://www.amphenol-tcs.com/search.php?n=infinx&srt=rel&p=1

**1.3.1** TB2240 InfinX Routing Guideline

**1.3.2** Customer Use Drawings

| | |
|---|---|
| C379-XXXX-XXX | Plug |
| C380-XXXX-XXX | Receptacle |

## 1.4 Levels of Requirement

For each requirement, an impact and benefit statement is included to quantify the requirement. Some requirements are stated as being recommended or preferred per the following:

**Recommended:** The minimum processing requirement – a deviation **will** most likely impact manufacturability and cost.

**Preferred:** Should be done when possible – a deviation **could** impact manufacturability and cost.

## 2.0 Design Introduction – InfinX Connector

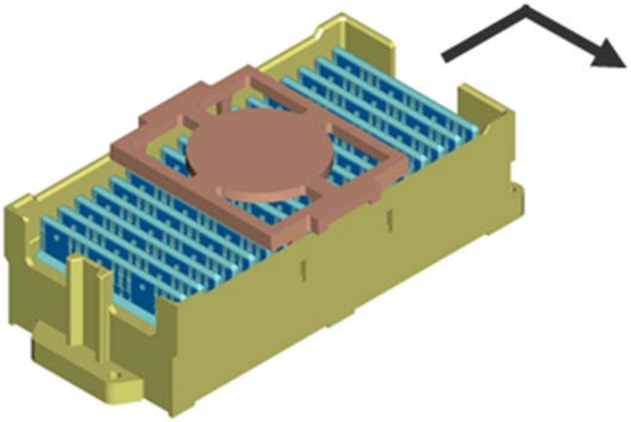
The InfinX connector is wafer constructed and organized in 10 and 18 wafer configurations. There are 4 Pair and 6-Pair versions available. Each 4-Pair wafer has 18 connections – 8 signals and 10 grounds. The 6-Pair wafer has a total of 26 connections - 12 Signals and 14 Grounds.

The wafer construction allows for the contacts to be spaced on a 1.15mm x 2.3mm interstitial grid. The connector can be specified in multiple separation heights – see section 2.1.

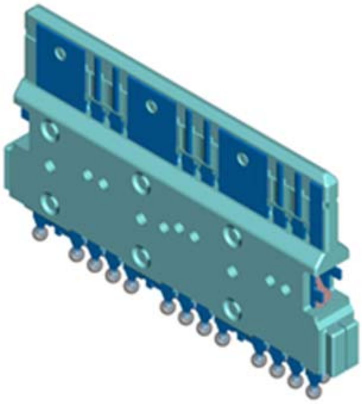
The connector is completely SMT attach, utilizing ball grid technology for termination to the board, and is readily applied using standard SMT processes.

The solder ball used is a SAC305 Alloy with a diameter of 28 mils (0.71mm), re-flowed on the end of a lead – “Blade in Ball”. (Tin-Lead is also available)

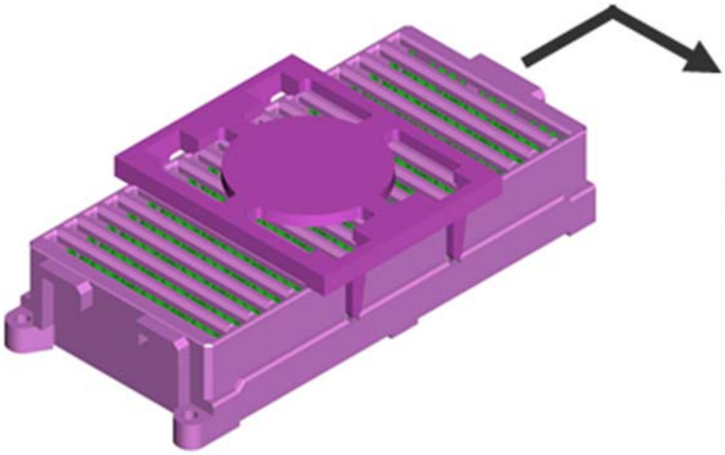
### 18 Wafer 6-Pair Plug Assembly – 8mm



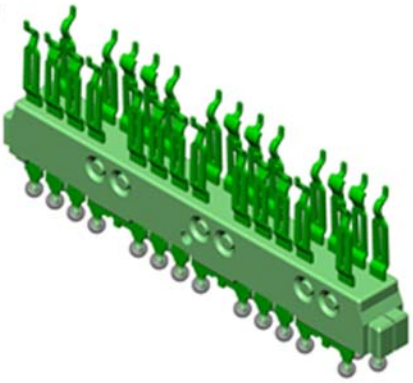
**8mm Plug Wafer**



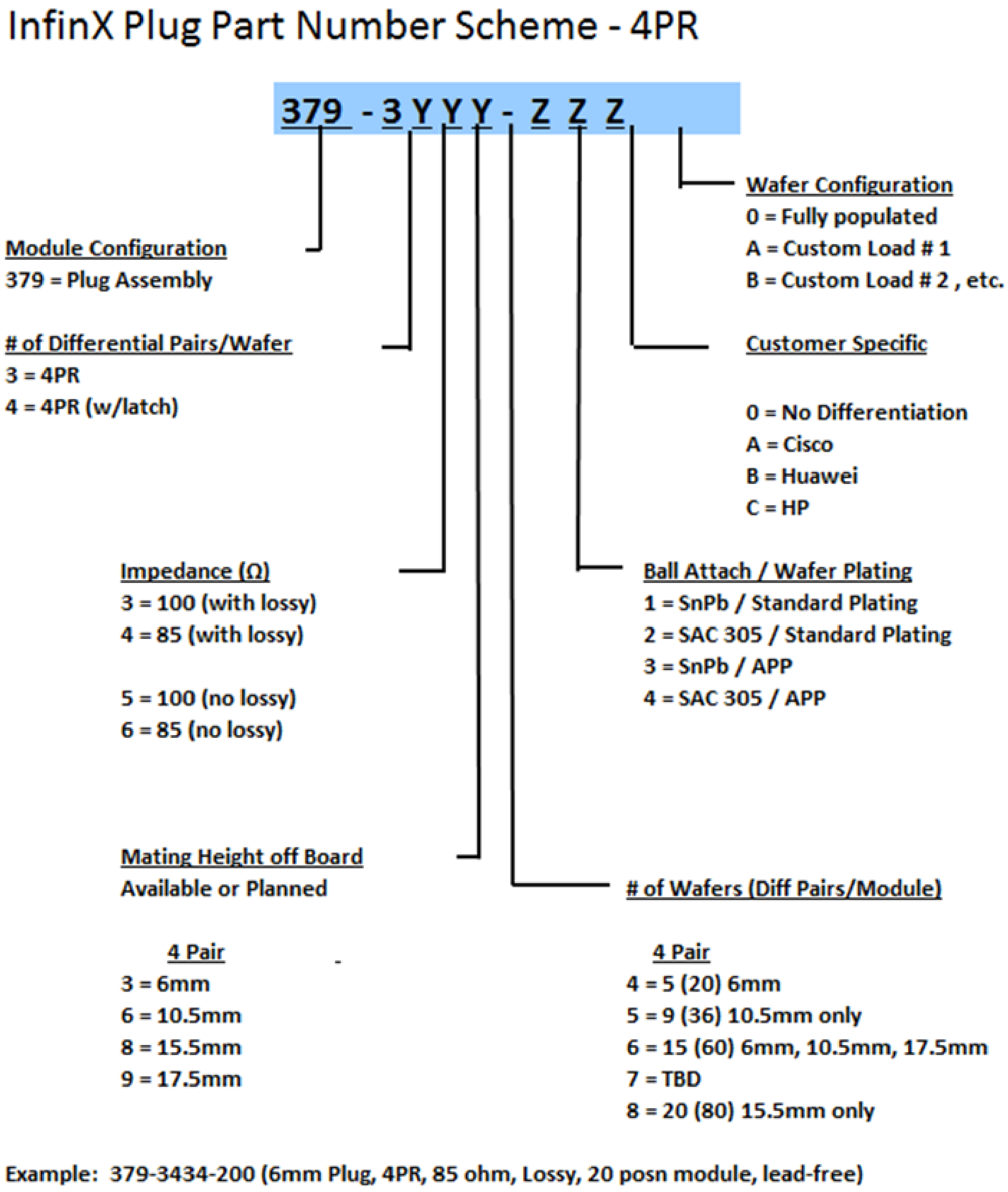
### 18 Wafer 6-Pair Receptacle Assembly – 9mm



**9mm Receptacle Wafer**



## 2.1 Part Numbering Matrix: 4-Pair - Plug



InfinX Plug Part Number Scheme - 4PR

379 - 3 Y Y Y - Z Z Z

**Module Configuration**
379 = Plug Assembly

**# of Differential Pairs/Wafer**
3 = 4PR
4 = 4PR (w/latch)

**Impedance (Ω)**
3 = 100 (with lossy)
4 = 85 (with lossy)

5 = 100 (no lossy)
6 = 85 (no lossy)

**Mating Height off Board**
Available or Planned

**4 Pair**
3 = 6mm
6 = 10.5mm
8 = 15.5mm
9 = 17.5mm

**# of Wafers (Diff Pairs/Module)**

**4 Pair**
4 = 5 (20) 6mm
5 = 9 (36) 10.5mm only
6 = 15 (60) 6mm, 10.5mm, 17.5mm
7 = TBD
8 = 20 (80) 15.5mm only

**Ball Attach / Wafer Plating**
1 = SnPb / Standard Plating
2 = SAC 305 / Standard Plating
3 = SnPb / APP
4 = SAC 305 / APP

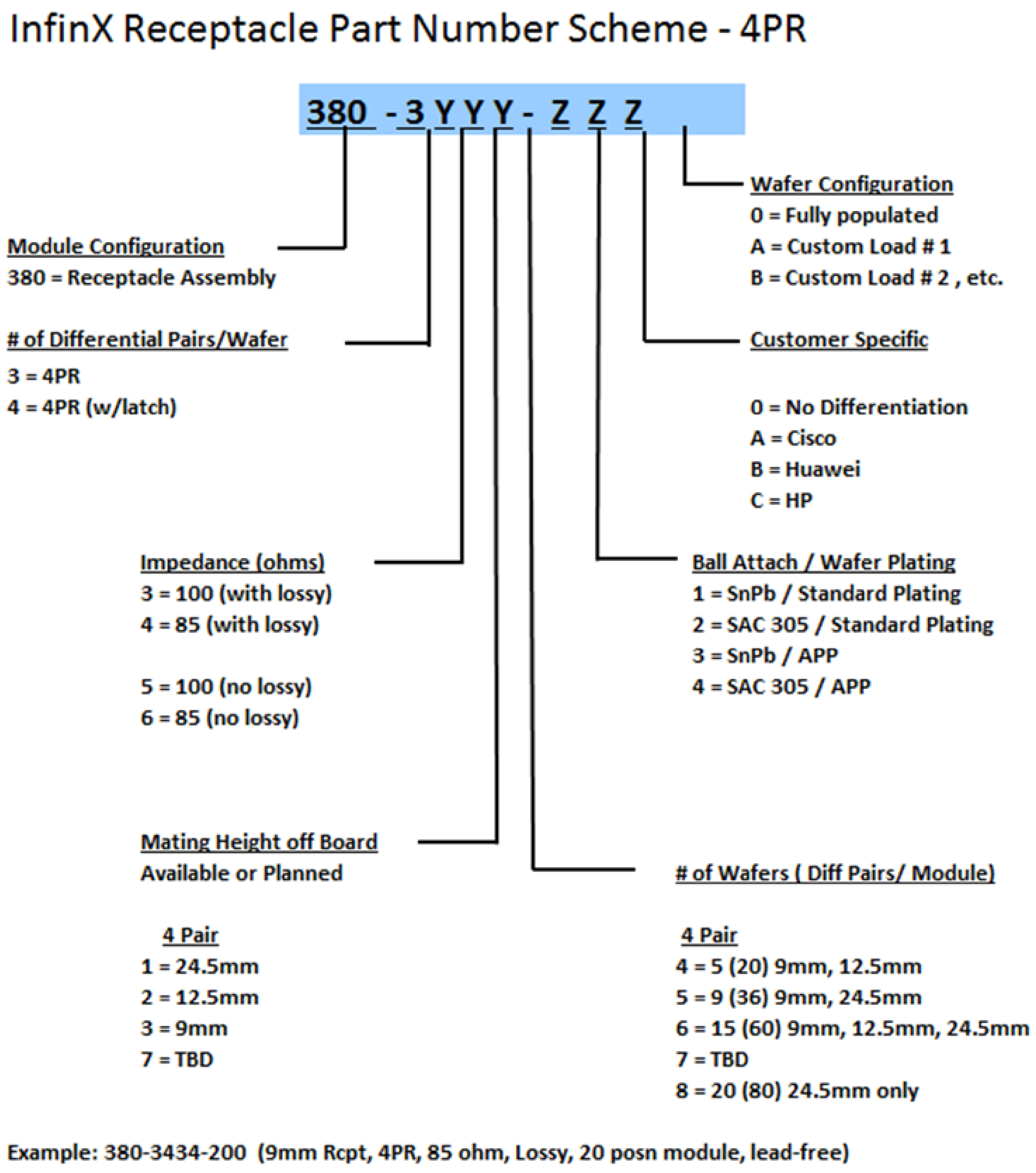
**Customer Specific**

0 = No Differentiation
A = Cisco
B = Huawei
C = HP

**Wafer Configuration**
0 = Fully populated
A = Custom Load # 1
B = Custom Load # 2 , etc.

Example: 379-3434-200 (6mm Plug, 4PR, 85 ohm, Lossy, 20 posn module, lead-free)

## 2.2 Part Numbering Matrix: 4-Pair - Receptacle



### InfinX Receptacle Part Number Scheme - 4PR

**380 - 3 Y Y Y - Z Z Z**

**Module Configuration**
380 = Receptacle Assembly

**# of Differential Pairs/Wafer**
3 = 4PR
4 = 4PR (w/latch)

**Impedance (ohms)**
3 = 100 (with lossy)
4 = 85 (with lossy)

5 = 100 (no lossy)
6 = 85 (no lossy)

**Mating Height off Board**
Available or Planned

**4 Pair**
1 = 24.5mm
2 = 12.5mm
3 = 9mm
7 = TBD

**Wafer Configuration**
0 = Fully populated
A = Custom Load # 1
B = Custom Load # 2 , etc.

**Customer Specific**

0 = No Differentiation
A = Cisco
B = Huawei
C = HP

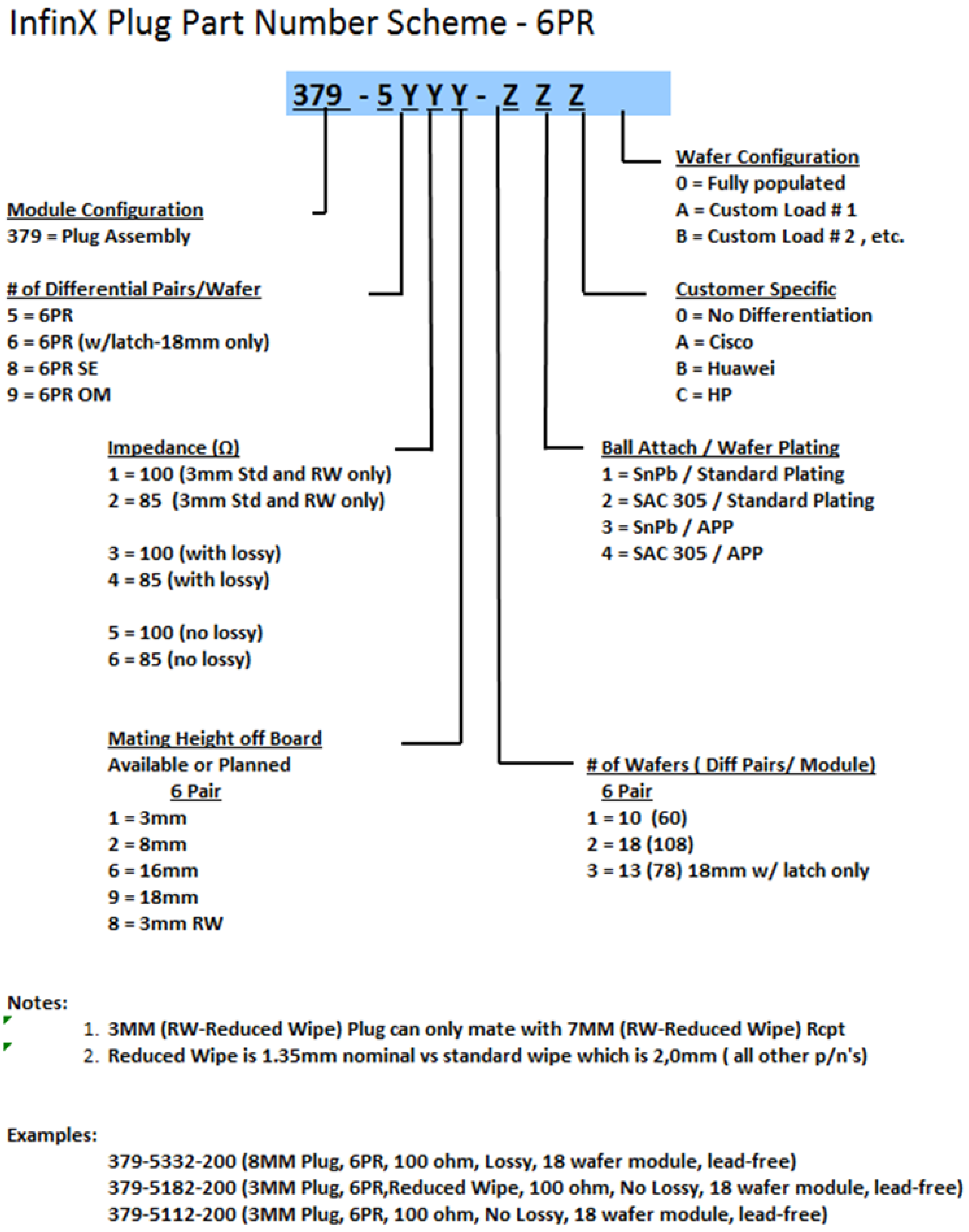
**Ball Attach / Wafer Plating**
1 = SnPb / Standard Plating
2 = SAC 305 / Standard Plating
3 = SnPb / APP
4 = SAC 305 / APP

**# of Wafers ( Diff Pairs/ Module)**

**4 Pair**
4 = 5 (20) 9mm, 12.5mm
5 = 9 (36) 9mm, 24.5mm
6 = 15 (60) 9mm, 12.5mm, 24.5mm
7 = TBD
8 = 20 (80) 24.5mm only

Example: 380-3434-200 (9mm Rcpt, 4PR, 85 ohm, Lossy, 20 posn module, lead-free)

## 2.3 Part Numbering Matrix: <u>6-Pair - Plug</u>



InfinX Plug Part Number Scheme - 6PR

379 - 5 Y Y Y - Z Z Z

**Module Configuration**
379 = Plug Assembly

**# of Differential Pairs/Wafer**
5 = 6PR
6 = 6PR (w/latch-18mm only)
8 = 6PR SE
9 = 6PR OM

**Impedance (Ω)**
1 = 100 (3mm Std and RW only)
2 = 85 (3mm Std and RW only)

3 = 100 (with lossy)
4 = 85 (with lossy)

5 = 100 (no lossy)
6 = 85 (no lossy)

**Mating Height off Board**
Available or Planned
6 Pair
1 = 3mm
2 = 8mm
6 = 16mm
9 = 18mm
8 = 3mm RW

**# of Wafers ( Diff Pairs/ Module)**
6 Pair
1 = 10 (60)
2 = 18 (108)
3 = 13 (78) 18mm w/ latch only

**Ball Attach / Wafer Plating**
1 = SnPb / Standard Plating
2 = SAC 305 / Standard Plating
3 = SnPb / APP
4 = SAC 305 / APP

**Customer Specific**
0 = No Differentiation
A = Cisco
B = Huawei
C = HP

**Wafer Configuration**
0 = Fully populated
A = Custom Load # 1
B = Custom Load # 2 , etc.

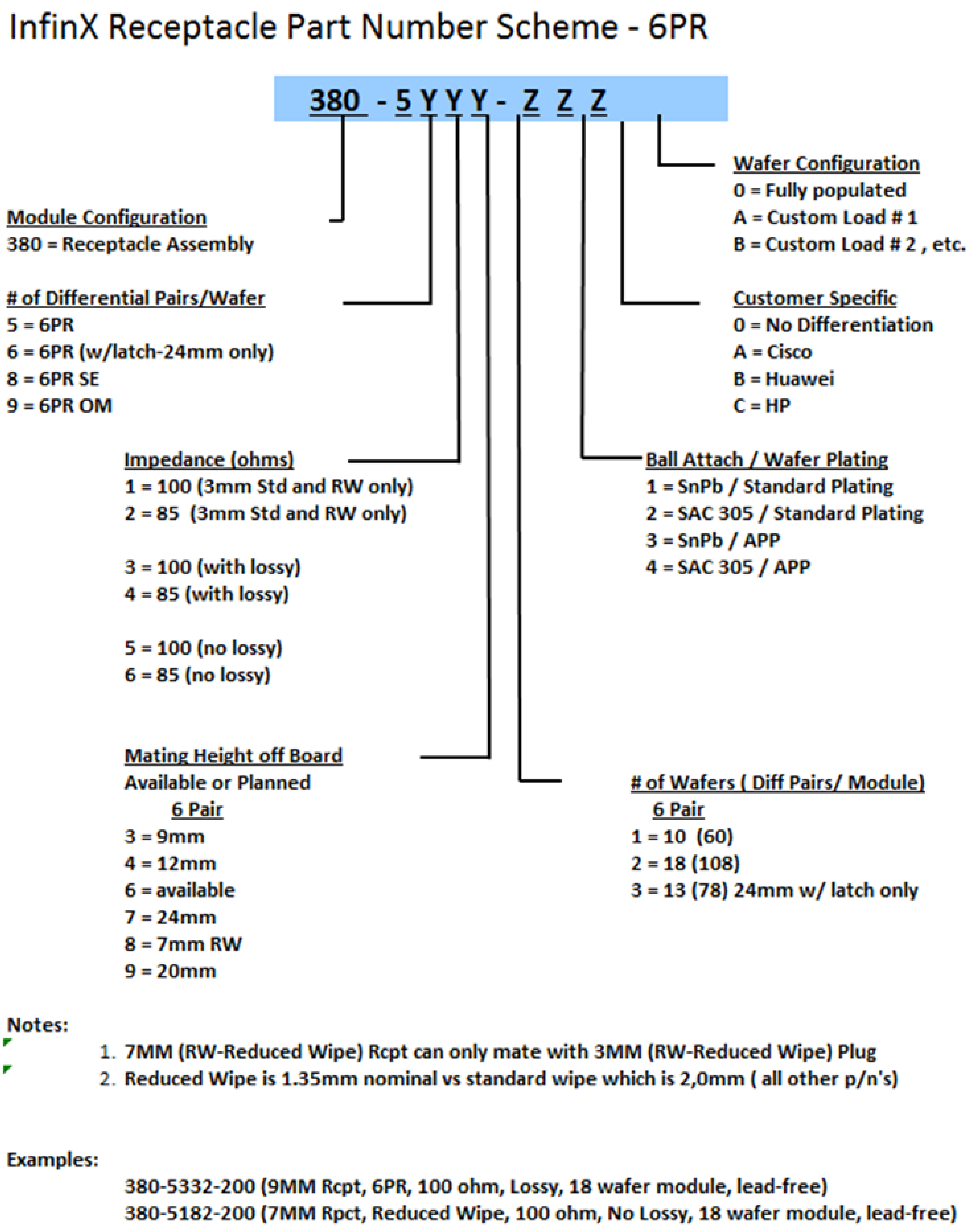
Notes:

1. 3MM (RW-Reduced Wipe) Plug can only mate with 7MM (RW-Reduced Wipe) Rcpt
2. Reduced Wipe is 1.35mm nominal vs standard wipe which is 2,0mm ( all other p/n's)

Examples:

379-5332-200 (8MM Plug, 6PR, 100 ohm, Lossy, 18 wafer module, lead-free)
379-5182-200 (3MM Plug, 6PR,Reduced Wipe, 100 ohm, No Lossy, 18 wafer module, lead-free)
379-5112-200 (3MM Plug, 6PR, 100 ohm, No Lossy, 18 wafer module, lead-free)

## 2.4 Part Numbering Matrix: 6-Pair - Receptacle



### InfinX Receptacle Part Number Scheme - 6PR

**380 - 5 Y Y Y - Z Z Z**

**Module Configuration**
380 = Receptacle Assembly

**# of Differential Pairs/Wafer**
5 = 6PR
6 = 6PR (w/latch-24mm only)
8 = 6PR SE
9 = 6PR OM

**Impedance (ohms)**
1 = 100 (3mm Std and RW only)
2 = 85 (3mm Std and RW only)

3 = 100 (with lossy)
4 = 85 (with lossy)

5 = 100 (no lossy)
6 = 85 (no lossy)

**Mating Height off Board**
Available or Planned
6 Pair
3 = 9mm
4 = 12mm
6 = available
7 = 24mm
8 = 7mm RW
9 = 20mm

**Wafer Configuration**
0 = Fully populated
A = Custom Load # 1
B = Custom Load # 2 , etc.

**Customer Specific**
0 = No Differentiation
A = Cisco
B = Huawei
C = HP

**Ball Attach / Wafer Plating**
1 = SnPb / Standard Plating
2 = SAC 305 / Standard Plating
3 = SnPb / APP
4 = SAC 305 / APP

**# of Wafers ( Diff Pairs/ Module)**
6 Pair
1 = 10 (60)
2 = 18 (108)
3 = 13 (78) 24mm w/ latch only

Notes:

1. 7MM (RW-Reduced Wipe) Rcpt can only mate with 3MM (RW-Reduced Wipe) Plug
2. Reduced Wipe is 1.35mm nominal vs standard wipe which is 2,0mm ( all other p/n's)

Examples:

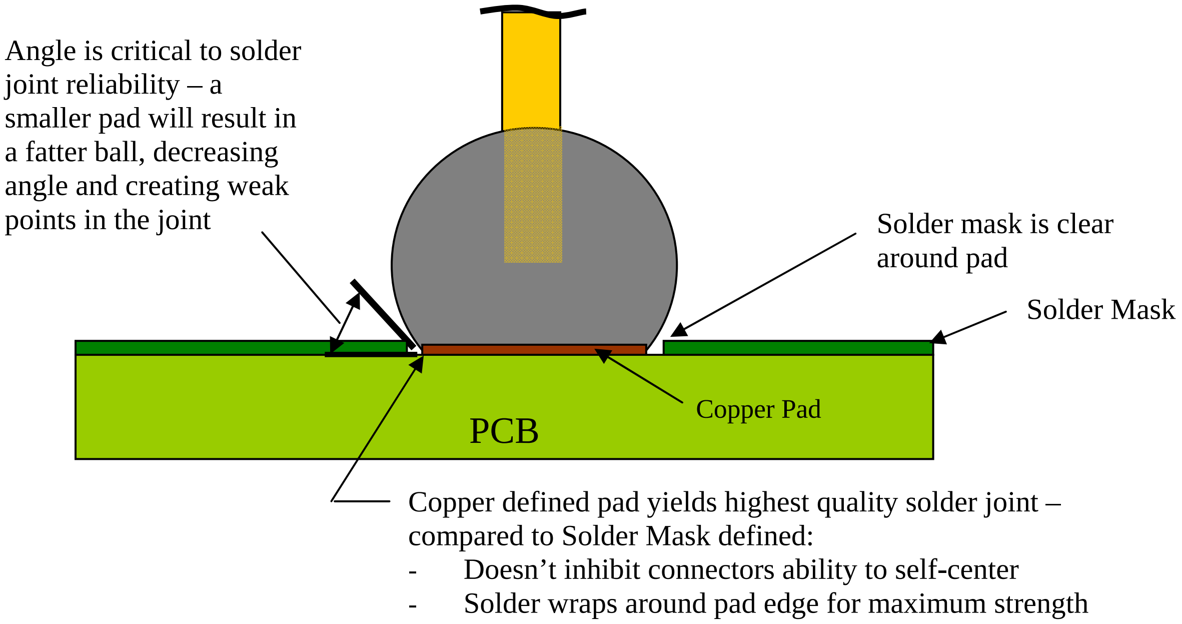
380-5332-200 (9MM Rcpt, 6PR, 100 ohm, Lossy, 18 wafer module, lead-free)
380-5182-200 (7MM Rpct, Reduced Wipe, 100 ohm, No Lossy, 18 wafer module, lead-free)

## 3.0 Design Requirements

### 3.1 InfinX Solder Joint Definition – Reliability Factors

The recommendations made below have a direct impact on the reliability of the connector solder joint, and play an important role in facilitating the connectors' ability to self-center and achieve the best possible location tolerances. This is especially important when multiple connectors are being used.

| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| • Recommend using a “Copper Defined” landing pad as opposed to a “Solder-Mask Defined” pad. | • “Copper defined” better insures a round, accurately located pad – critical to part location tolerance.<br>• “Copper defined” pad produces a more reliable solder joint – allowing solder to wrap around the pad edge. |
| • Pad Size = .60mm (.024”) | • Smaller pad will result in decreased ball-to-pad angle, based on solder volume – increasing the risk of solder fracture.<br>• Larger pads will increase the risk of shorting. |
| • Solder mask should be clear around pad | • In-accurate registration will result in solder mask encroaching onto copper pad. |



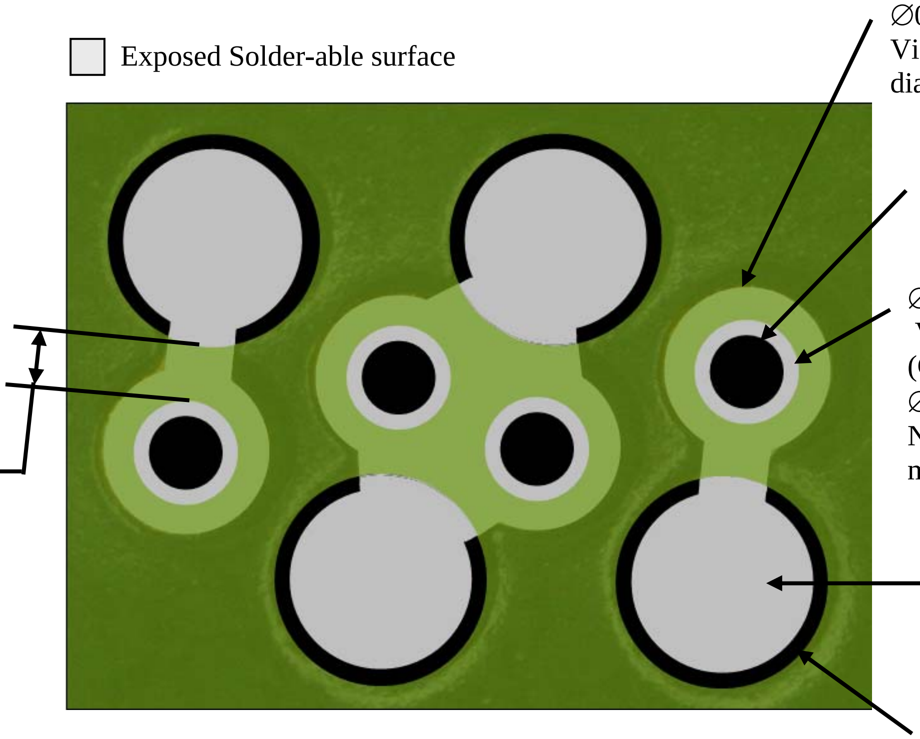
## 3.2 Landing Pad Footprint

Refer to next page (Figure 3.2.1) for overall landing pad layout. See below for pad and via design details. The exact design will depend on several factors including design goals, route-ability, customer specific design for manufacturability (DFM) guidelines, and PCB fabricator capabilities. The diagram below offers a starting point, with the critical parameters in bold.

| **Requirements** | **DFM Impact/Benefit/Alternatives** |
|---|---|
| • Amphenol TCS recommends a .60mm (.024”) “Copper Defined” landing pad over a “Solder-Mask Defined” pad. | • See previous section for impact |
| • Minimum .13mm (.005”) Solder Mask Dam between pad and via. | • Prevents solder from wicking away from pad and into via, causing insufficient solder joints. |
| • It’s preferred to mask the vias if design allows, or if a .13mm min dam can’t be held. | • Via drill sizes can be changed based on PCB fabricators board thickness aspect ratio, but must insure a minimum solder mask dam. |

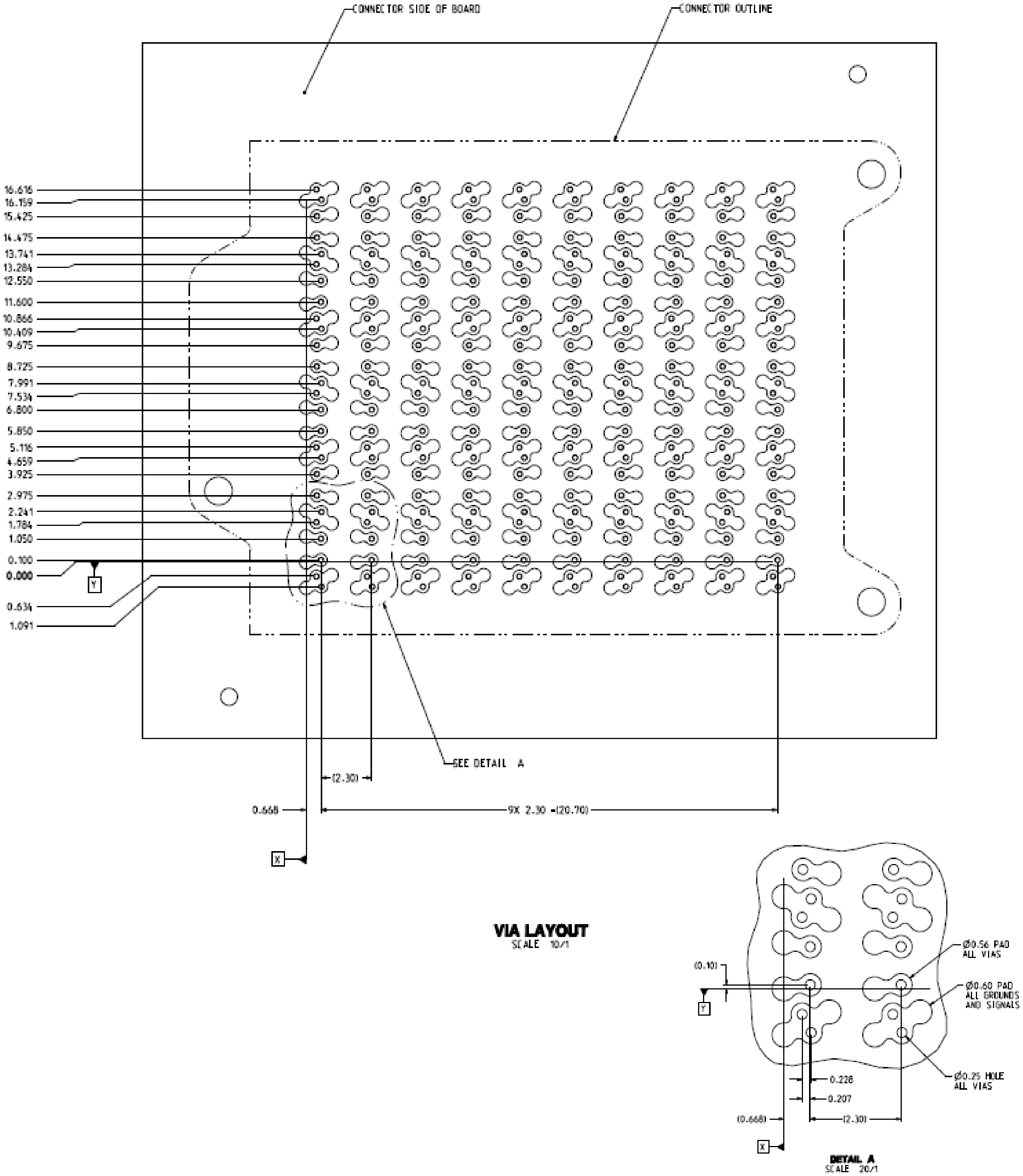
**Board Pad and Via Detailed Footprint – Differential Pair**

☐ Exposed Solder-able surface



***Note: Insure PCB Fabricators solder mask registration capabilities**

## Figure 3.2.1 InfinX Detailed Board Layout – (4-Pair Plug is shown)

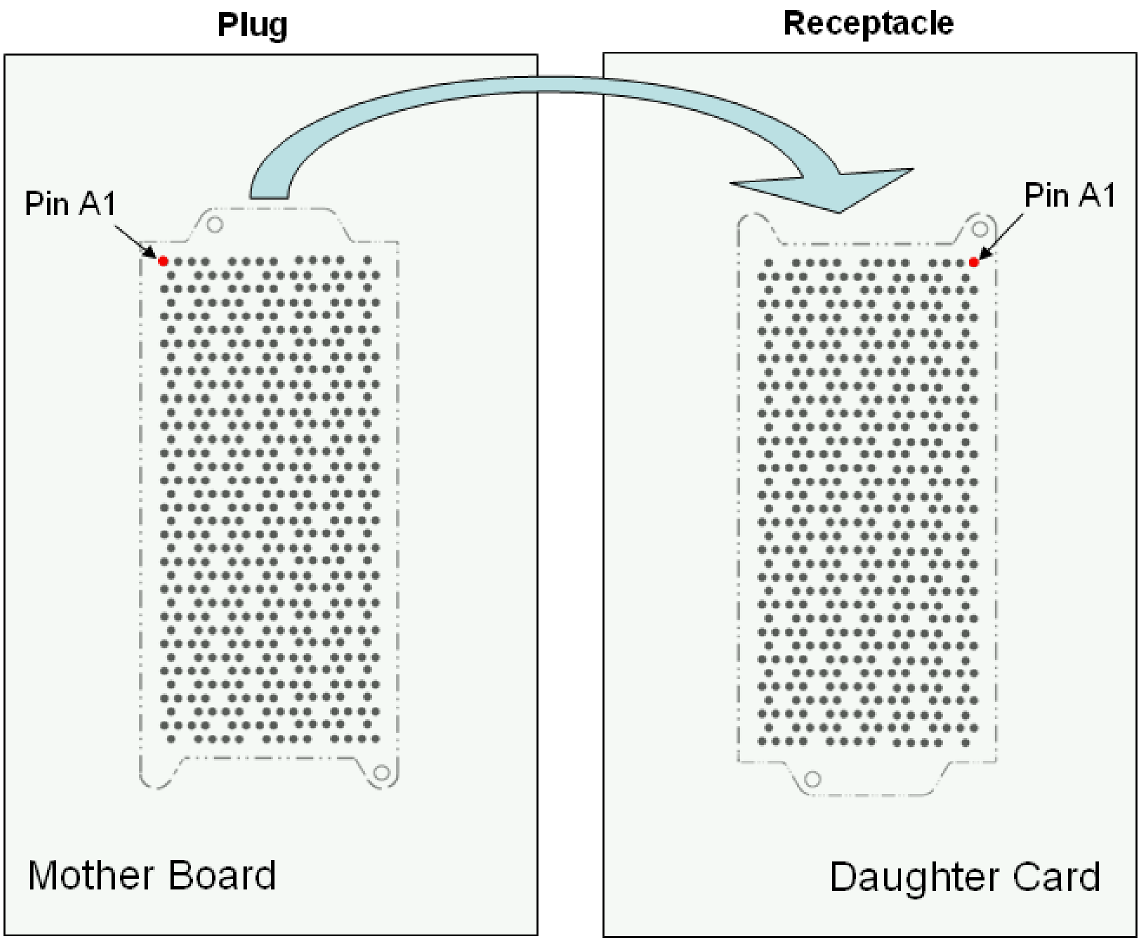


### 3.3 PCB General Requirements and Routing

**3.3.1** Refer to TB2240 – InfinX Routing Guideline

| Requirements | DFM Impact/Benefit |
|---|---|
| • Maximum recommended board warp – 7 mils/inch*****. (Sufficient for surface finishes that have less than .001” thickness variation such as OSP, ENIG, Immersion Tin and Silver.) | • Minimizes the risk of opens |
| • The Pin 1 pad for the plug should align with the pin 1 pad of the receptacle when the mother and daughter card are mated – see below | • Ensures correct board alignment |

***Note: The recommended board warp is also based on the assembly process stencil thickness used. For more detail, see selection matrix in section 6.0 – “Solder Paste Process”**



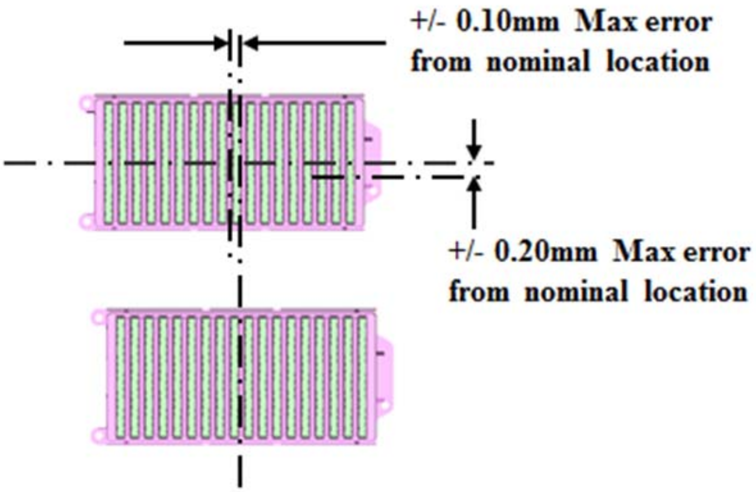
**Board Footprint View**

(6-Pair Shown)

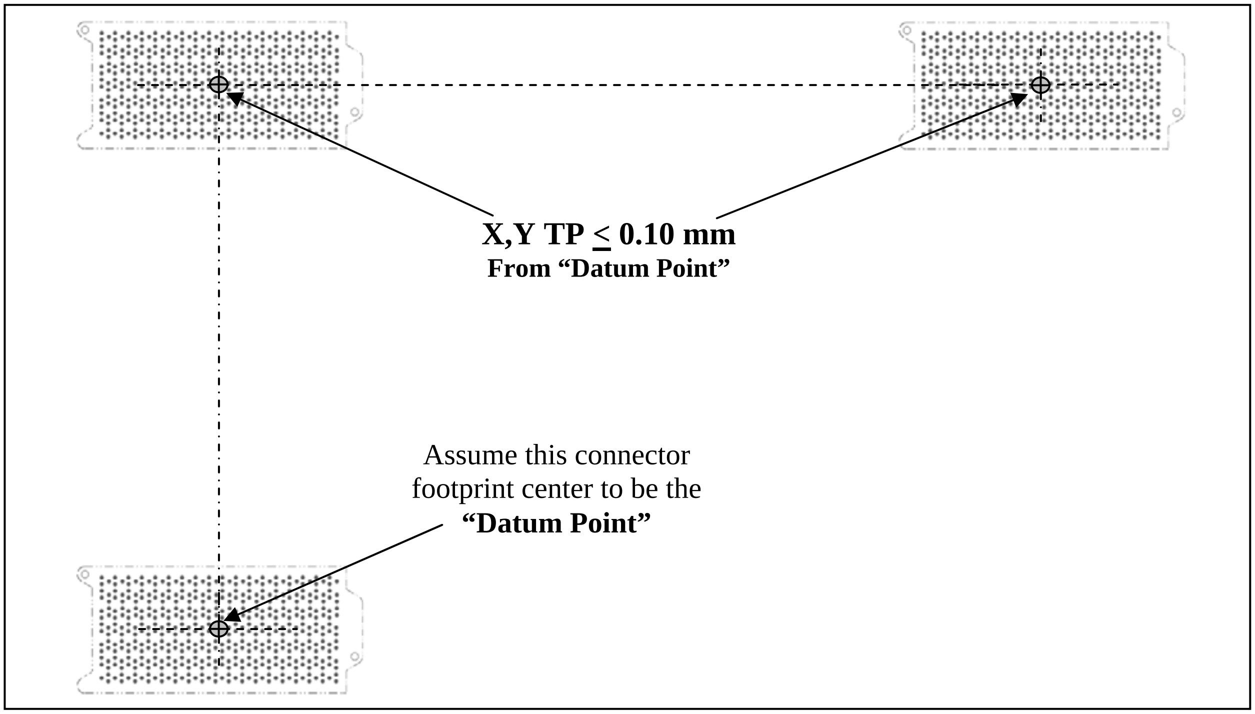
### 3.4 Connector Float Allowance and PCB Fabrication Tolerances

The InfinX connector is designed to accommodate SMT assembly and PCB fabrication tolerances. Below are the total allowances for the connector design, and the recommended PCB fabrication tolerances.

**Total Connector Float Allowance (6-Pair 18 Wafer part is shown)**



**Recommended PCB Footprint True Position Tolerance**

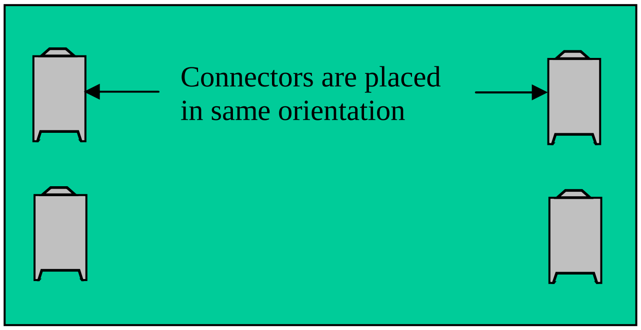


### 3.5 Layout and Orientation for Multi-Connector Applications

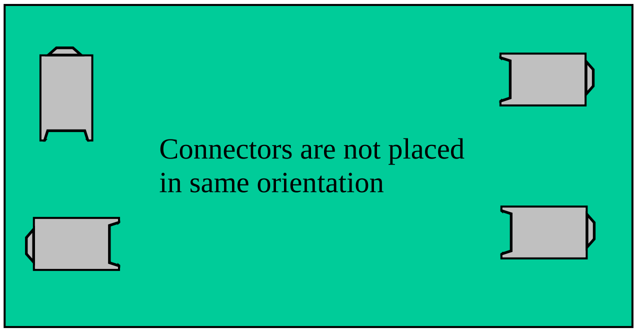
**Layout:**

| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| • Preferred to align connectors in the same direction | • Ease of multi-board mating alignment |
| • Connectors are parallel across the larger span, and in series on shorter spans. | • Maximizes designed-in “float” tolerances |
| • Max span is dependant on board fabrication tolerances – reference section 3.4. | • Board tolerance exceeds connector max alignment tolerance. |
| • Layout should include a slightly larger silkscreen outline of the component housing. | • Silkscreen is visible after connector placement, and allows for “first-piece” visual inspection of polarity/orientation. |

* InfinX un-mating forces are generally 20% less than mating forces. (Forces will decrease as mating cycles increase)

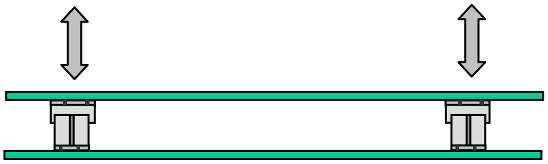


**Preferred**

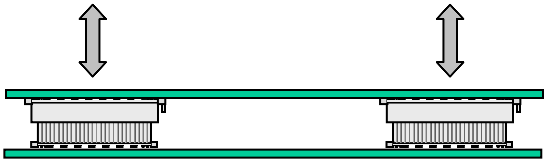


**Not preferred**

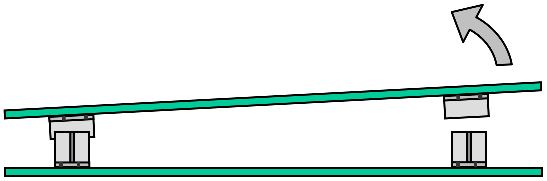
**Mating and Un-Mating:**



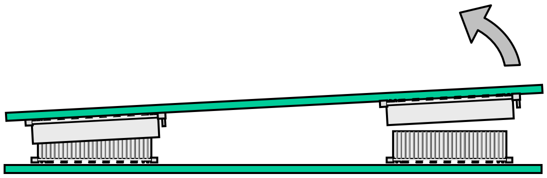
**Preferred**



**Preferred**



**Acceptable**

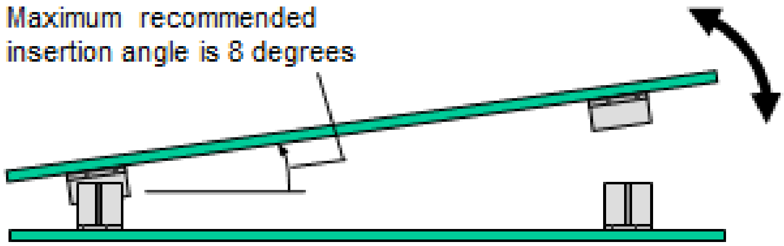


**Not Recommended**

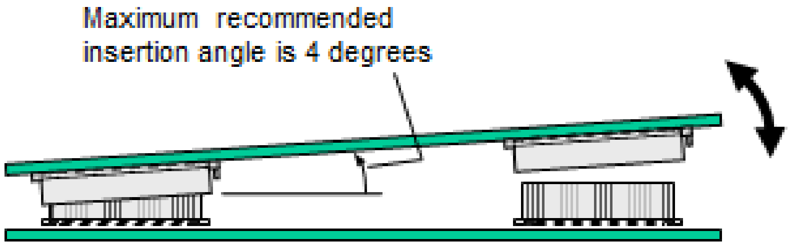
### 3.5.1 Allowable Mating and Un-mating Angles

| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| • Figure 1 - When mating/un-mating connectors where you rotate on connector width – max angle is 8 degrees | • Prevents connector damage |
| • Figure 2 - When mating/un-mating connectors where you rotate on connector length – max angle is 4 degrees | • Prevents connector damage |

**1. Rotating on connector width**



**2. Rotating on connector length**



### 3.6 Connector Mating Forces and Polarizing Features

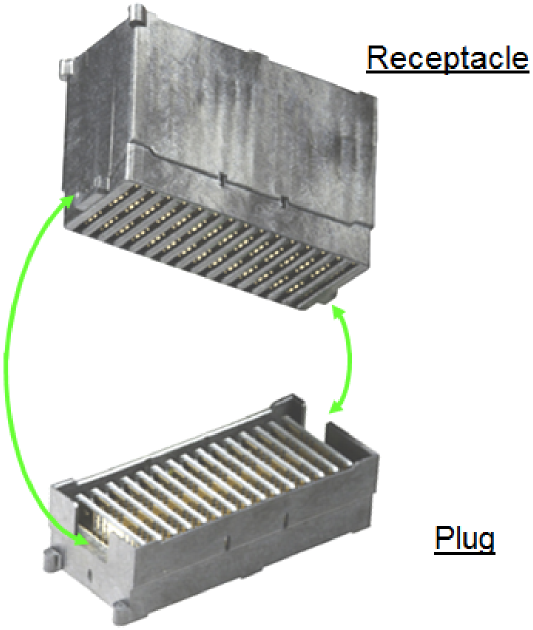
| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| • Mating should be performed using the polarizing features as shown below | • Prevents mis-mating and damage to the connector |
| • Blind mates should include standoffs or mechanical alignment hardware (guide pin) to assist. (See section 3.7 for details) | • Completes gross alignment allowing connector housings to begin next level of align. |

## Connector Mating and Un-Mating Forces

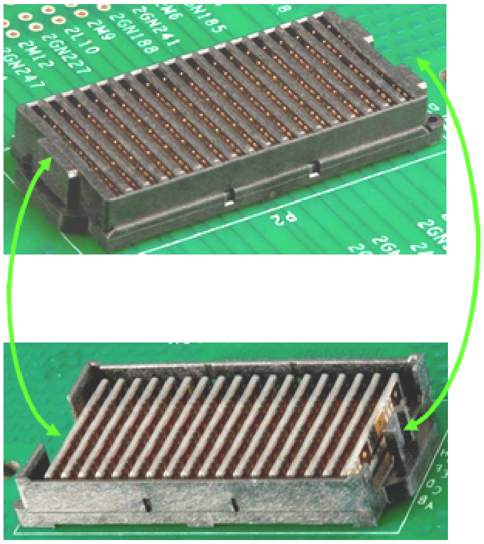
| Connector Type | Wafer Count | Mating Force (lbs) | Un-Mating Force (lbs) |
|---|---|---|---|
| 4-Pair | 5 | 3.5 | 2.5 |
| | 9 | 6.3 | 4.5 |
| | 15 | 10.5 | 7.5 |
| | 20 | 14.0 | 10.0 |
| 6-Pair | 10 | 10.0 | 7.0 |
| | 18 | 18.0 | 12.6 |

## Polarizing Features

**4-Pair**



**6-Pair**



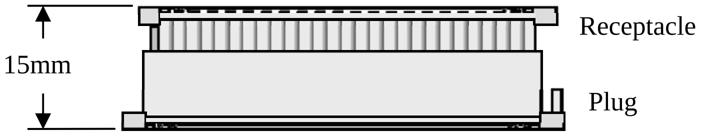
## 3.7 Mechanical Requirements

The InfinX connector should **NOT** be used as the mechanical structure of two mated boards within a system. Board assembly weight and shock and vibration forces should be supported by other mechanical means such as standoffs or structural hardware.

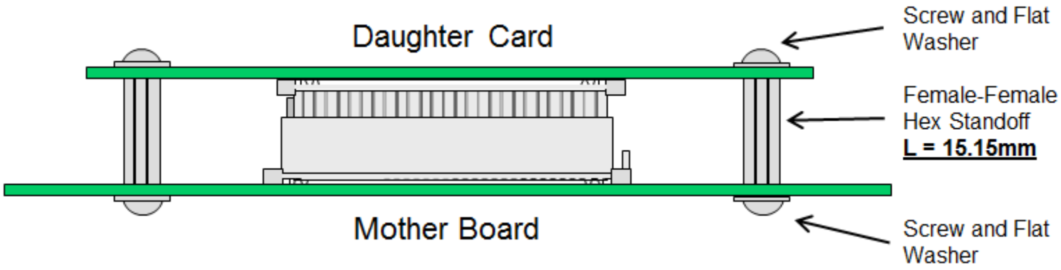
The following describes minimum requirements for mechanical packaging.

| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| Provide sufficient hold down forces to retain mated cards. | Insure connectors stay mated during shipment, vibration and other static and dynamic forces |
| Standoffs between boards are required for all applications.<br>Rigid mechanical structures should be used for heavier assemblies and/or higher stack heights. See next sections | Maintain minimum wipe regardless of shock, vibration and board warp tolerances.<br>Support the mated boards and protect the BGA solder joints.<br>Minimizes mechanical stresses on the solder joints |
| Nominal stand-off lengths should be 0.15mm greater than connector stack height. Insure a **minimum** height of "stack height" + 0.05mm – see below | Minimize board or connector stresses. |
| Stand-offs should be placed outside the connector keep-out zones. | Allows for connector rework without having to remove stand-offs<br>Allow the board to absorb some of the stresses if over-mating occurs. |
| Number of stand-offs and pattern of placement should prevent all mechanical stresses to the solder joint. | Insures no solder joint failures due to shock and vibration. |

Example:
Nominal Connector Stack Height = 15mm



Nominal standoff length = Stack-height + 0.15mm = **15.15mm**

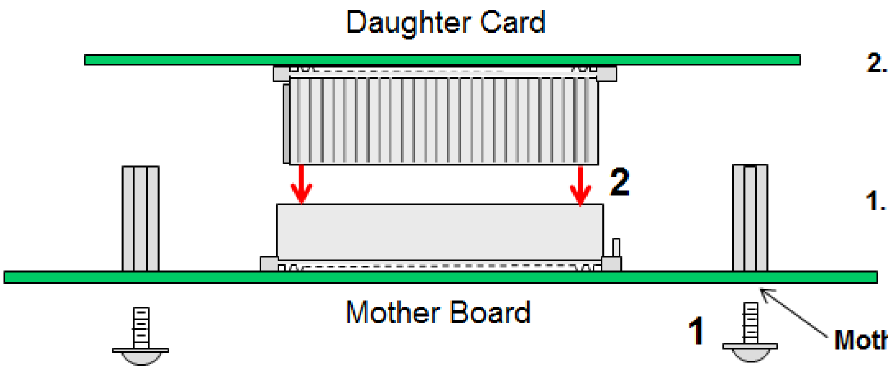


**Accounting for stand-off tolerances –**

**Minimum recommended standoff length = Stack-height + 0.05mm = 15.05mm**

### 3.7.1 Mechanical Requirements – PCB Holes

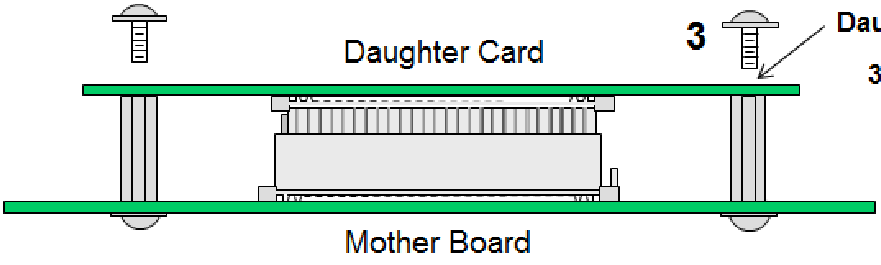
| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| • PCB holes for standoff fasteners must permit a true position misalignment of .20mm and an angular displacement of .05 degrees minimum (Board-to-board fastening must comply to the connector alignment) | • Prevents stresses to connector and/or printed circuit board |
| • Tighter tolerance holes recommended on the mother (primary) board<br>• Looser tolerance holes on the mating board | • Allows connector to act as the primary alignment feature of mated boards<br>• Hardware alignment does not bind against mated connectors. |



**2.** Mate daughter card connector to mother board connector.
- Connectors mate freely

**1.** Assemble hardware to mother board
- Tighter screw/hole tolerance – slip fit

**Mother board – tight hole tolerance**

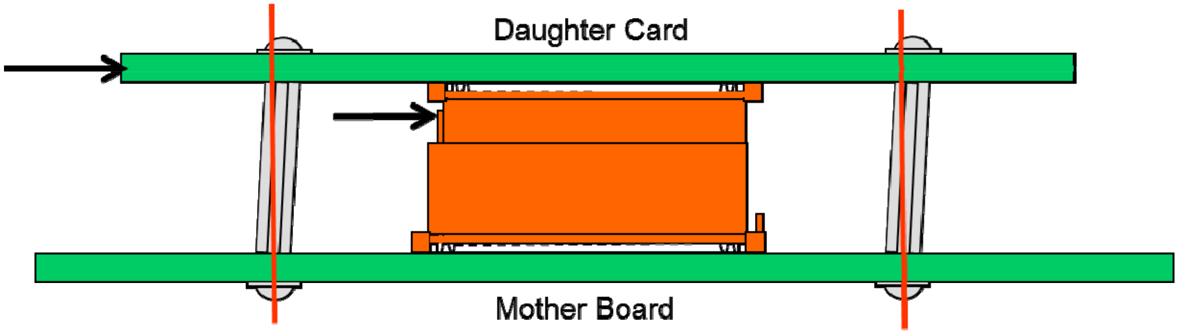


**Daughter card – loose hole tolerance**

**3.** Assemble daughter card hardware
- Loose screw/hole tolerance – loose fit
- Allows for a true position misalignment of .20mm and an angular displacement of .05 degrees
- Should not bind against connector mate

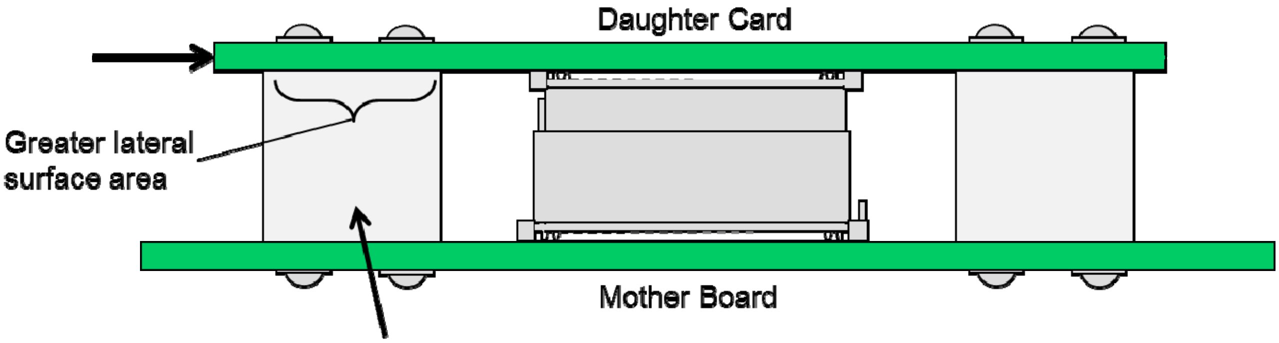
### 3.7.2 Suggested Mechanical Structure for Heavier Assemblies

**Standoff weakness with greater weight and stack height**



- Standoffs may not provide enough lateral support with heavier assemblies and taller stack heights.
- Board and standoff flexing can result in high stresses to the connector and solder joints.
- Support is poor without lateral surface area between the board and standoff

## Preferred Rigid Mechanical Structure

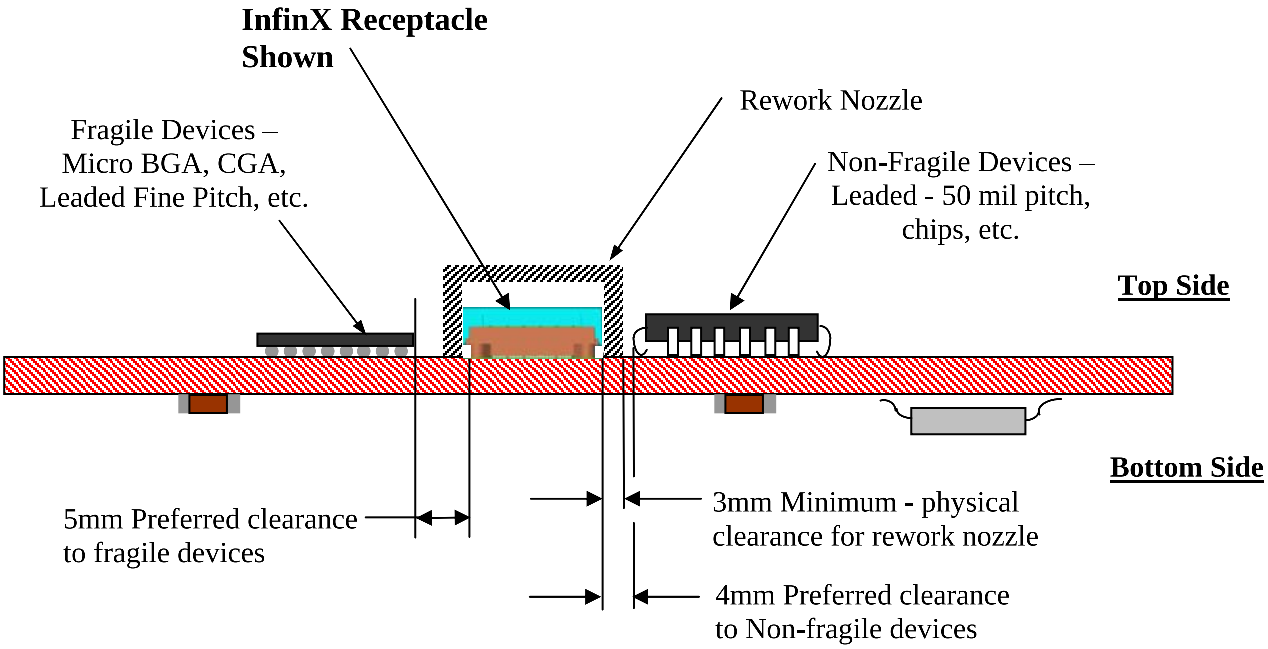


- Recommend a mechanical structure that provides more lateral surface area at the connection interface to prevent excess stresses on the connector and solder joints.
- Rigidity of this component is also greater than a standoff

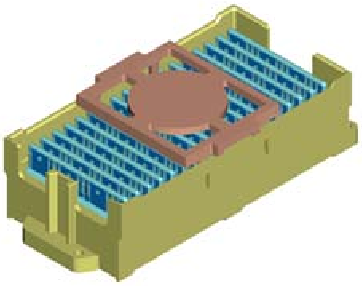
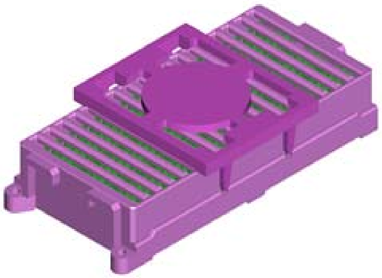
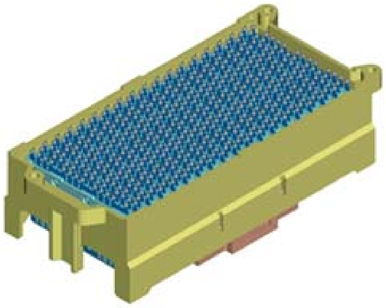
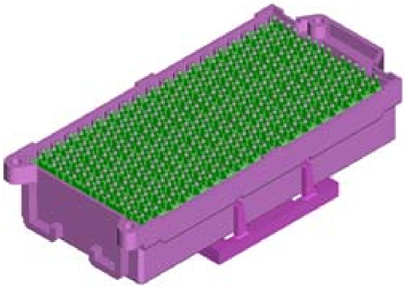
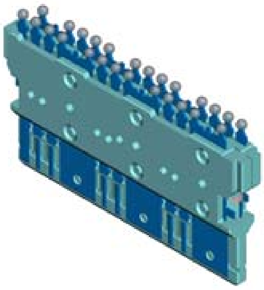
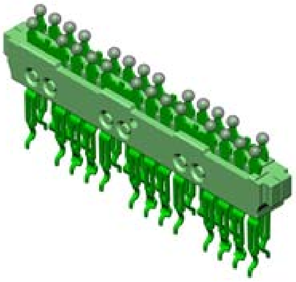
### 3.8 Keep-out Zone and Clearances

The InfinX connector keep-out zone is required for re-work capability. This allows clearance around the connector housing for rework tooling and nozzles.

| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| • The recommended minimum clearance required is 3mm – preferred clearance is 4mm to non-fragile adjacent components. | • Rework nozzle - physical clearance |
| • It’s preferred to have 5mm clearance to adjacent devices that are very fine pitch with small thermal mass, and could re-reflow – this is dependent on board thickness, copper weight and connector height | • Prevents re-reflow of adjacent device, which could cause shorts/defects on that device. |



## 4.0 Manufacturing Introduction – InfinX Connector

| | **Plug** | **Receptacle** |
|---|---|---|
| **Solder Ball Alloy** | **Standard - SAC305 Alloy (Sn96.5 Ag3.0 Cu0.5)** | |
| **Solder Ball Diameter** | **28 Mils (0.71mm)** | |
| **Connector Heights (mm)** | **See Section 2** | **See Section 2** |
| **Separable Side**<br>**(18 Wafer 6-Pair Part Shown)** |  |  |
| **Solder Ball Side** |  |  |
| **Wafer** |  |  |

## 5.0 Connector Handling

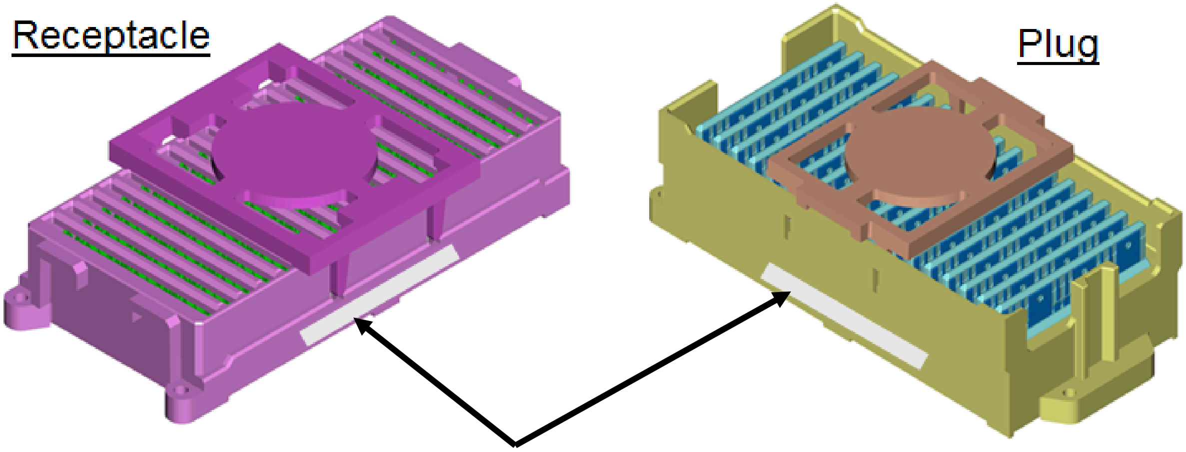
InfinX connectors are 100% laser inspected before leaving Amphenol TCS. Each ball is laser scanned and checked for radial true position (RTP), co-planarity and ball protrusion from the housing (BH). This is done using an automated 3-D laser inspection system.

The solder balls are attached to straight leads using a reflow process. The leads are robust and not easily susceptible to damage. Standard SMT device care should be taken when handling the connectors through the process.

Outer box and foam packaging can be removed in the stockroom prior to transferring the parts to the SMT area.

**InfinX connector materials are NOT moisture sensitive per J-STD-020. This standard does not apply to connectors**.

| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| • Connectors should be kept in the strapped JEDEC tray and cover with the vacuum bag sealed for transfer and storage in the SMT process. | • Protects the ball field until it can be loaded into the placement machine |
| • The vacuum bag, straps and tray cover are removed for loading onto the placement machine. | |
| • Once the assembly run is complete, tray should be removed from machine, top cover replaced, and Velcro strap together. | • Protection of ball field. |
| • It is recommended to bag and re-vacuum seal the tray if the parts are not going to be used within a reasonable time frame - shelf life is dependent on factory/stockroom environmental conditions. | • Re-bagging is to protect solderability<br>• InfinX Connector materials are not moisture sensitive, and do not require pre-bake. |
| • Each connector is laser marked with the part # followed by serial # in the location shown below. | • Provides date/lot code info and specific ball position data for each connector |



**Part # and Serial # location**
**(6-Pr shown – 4-Pr is in the same location)**

## 6.0 Solder Paste Process

| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| - Liquid Photo-Imageable (LPI) solder mask over bare copper is preferred. | - Most common – provides best adhesion for solder mask - preventing peeling and flaking of mask during assembly processes. |
| - Recommended stencil thickness 5 - 6 mils (0.127 - 0.152mm) | - Minimizes the risk of opens |
| - Recommended aperture is 24 mils (0.61mm) | - Minimizes the risk of solder bridging |

**Board Warp Matrix** - The following matrix defines the board warp spec required for each of the listed variables – Stencil Thickness and Pad Finish Co-planarity

| | | **Pad Finish Co-planarity** | |
|---|---|---|---|
| | | **<.001”** | **<.002”** |
| **Stencil Thickness and Paste Process Variation** | 5 mil +2/-0 mil | **.007”** | **.005”** |
| | 5 mil +2/-.5 mil | **.005”** | **Not Recommended** |
| | 6 mil +2/-0 mils | **.007”** | **.007”** |
| | 6 mil +2/-.5 mil | **.007”** | **.005”** |

## 7.0 Placement Process

| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| • “All-ball” field best-fit alignment is preferred | • Most accurate placement |
| • Housing align, back-lit black-body align, or mechanical align is not preferred | • Plastic housing to ball field tolerance stack-up will result in less than optimal placement accuracy |
| • Connector should be **pre-oriented** for machine vision system alignment. | • Prevents nozzle slip/skew, between camera and placement, due to connector weight. |
| • Full circular side lighting is preferred – see below | • Ability to most accurately find the ball, without background lighting issues. |
| • Nozzle selection should be based on connector weight and height.<br>Note: Refer to Placement equipment specs to verify capability | • Heavier connectors require larger bore nozzles to allow for sufficient vacuum and pick-up force and prevent part slip or skew.<br>• Taller connectors may require custom length nozzles for correct focal length to vision system |
| • Placement location/centroid of the part should be based on the ball locations. | • Minimizes the percentage of ball that is off-pad. |

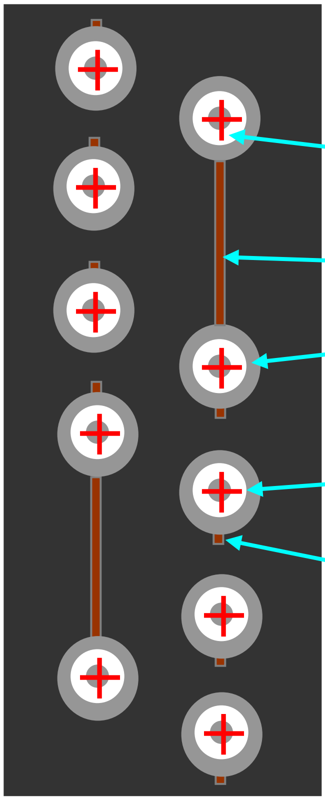
***Note: Set-up can be verified for placement repeatability and accuracy.**
**Contact Amphenol TCS for information on verification tools.**

## Side Lighting

- Not affected by background
- Found to be more accurate/robust
- Better suited for InfinX

## Camera Resolution

- Less than 3 mil/pixel finer resolution cameras are recommended to better filter-out background issues



**Sample image showing a portion of one wafer**

White shows reflection back to the camera when light is flashed on

Lead Frame – white light flashback is reduced on lead frame

Gray indicates no reflection

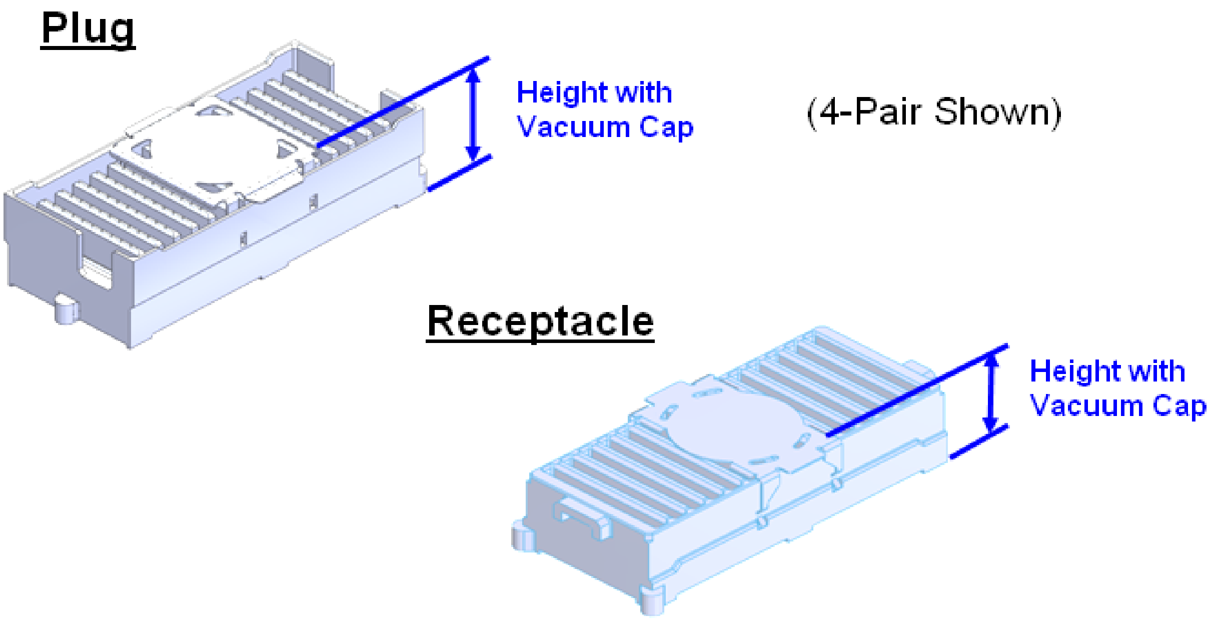
Crosshair is placed where machine finds ball center

Background lead frame is washed out and not picked up by the camera – causing placement error

## 7.1 Placement Process – 4 and 6 Pair Part Setup

| Type | Part Number | Diff Pairs/Wafer | Design Height (mm) | Overall Height w/o Vacuum Cap (mm) | Overall Height with Vacuum Cap (mm) |
|---|---|---|---|---|---|
| Plug | 379 - 3X3X | 4 | 6 | 11.20 | 11.40 |
| | 379 - 3X6X | 4 | 10.5 | 15.70 | 15.90 |
| | 379 - 3X8X | 4 | 15.5 | 20.70 | 20.90 |
| | 379 - 3X9X | 4 | 17.5 | 22.70 | 22.90 |
| | 379 - 5X8X | 6 | 3 (RW) | 7.35 | 8.40 |
| | 379 - 5X1X | 6 | 3 | 8.20 | 9.25 |
| | 379 - 5X2X | 6 | 8 | 13.20 | 14.25 |
| | 379 - 5X6X | 6 | 16 | 21.20 | 22.25 |
| | 379 - 5X9X | 6 | 18 | 23.2 | 24.25 |
| | | | | | |
| Receptacle | 380 - 3X3X | 4 | 9 | 9.00 | 9.20 |
| | 380 - 3X2X | 4 | 12.5 | 12.50 | 12.70 |
| | 380 - 3X1X | 4 | 24.5 | 24.50 | 24.70 |
| | 380 - 5X8X | 6 | 7 (RW) | 7.00 | 8.95 |
| | 380 - 5X3X | 6 | 9 | 9.00 | 10.95 |
| | 380 - 5X4X | 6 | 12 | 12.00 | 13.95 |
| | 380 - 5X9X | 6 | 20 | 20.00 | 21.95 |
| | 380 - 5X7X | 6 | 24 | 24.00 | 25.95 |

**Note: Connector heights that exceed 12.7mm may require shorter “custom” nozzles for placement. (Refer to your specific placement machine specs for more information)**



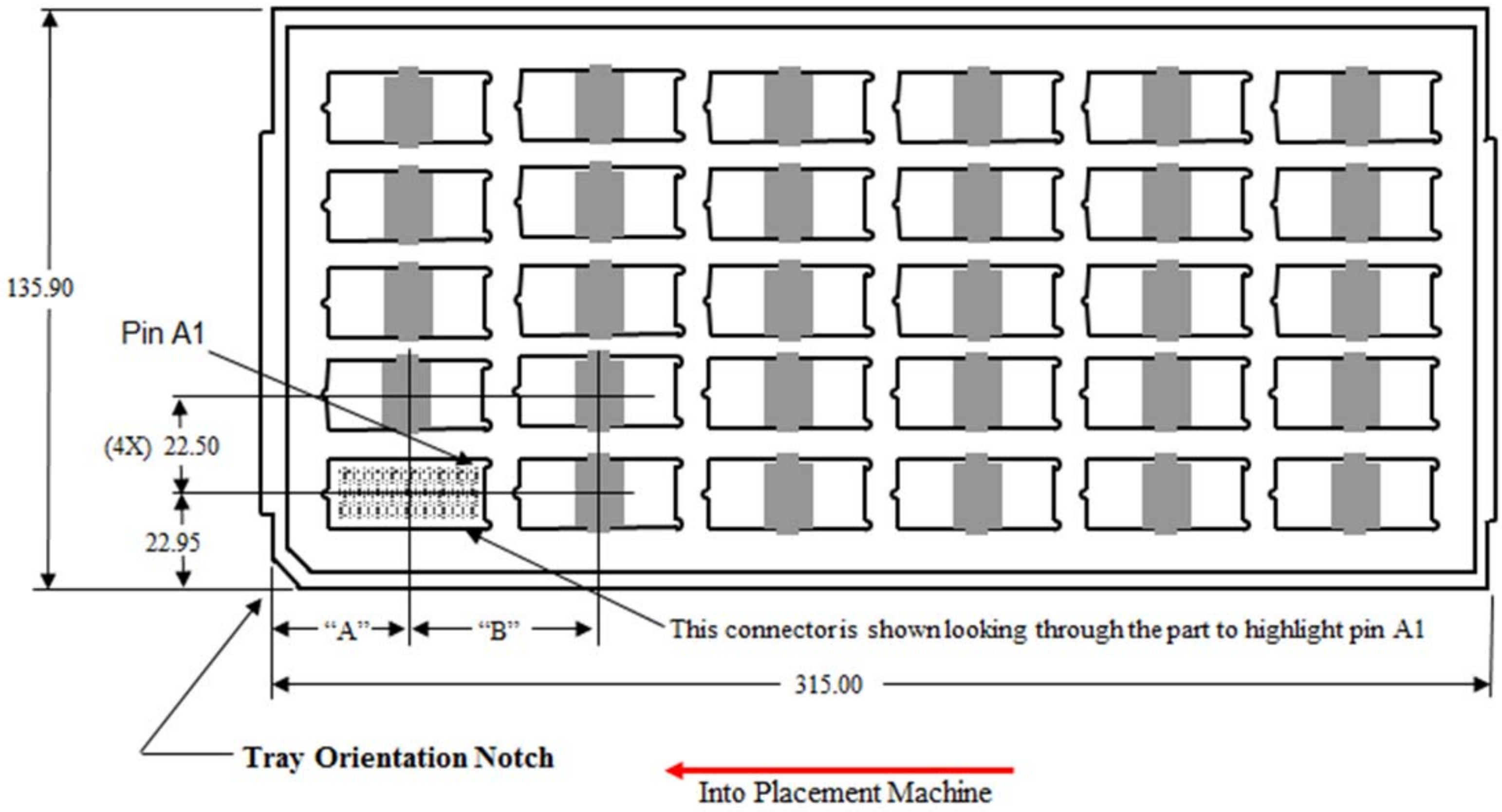
## 7.2 Placement Process – Feeders

| **Requirements** | **DFM Impact/Benefit** |
|---|---|
| • Connectors are shipped in standard JEDEC outline trays and are equipped with a cap that provides a flat vacuum surface – see below and next page. | • Meets the requirements of industry standard placement equipment |
| • The vacuum caps can be removed by hand after reflow | • See reflow process section for more info |
| • There are multiple tray configurations depending on part width and length, and whether it's a Plug or Receptacle. | • The only size variation in the trays are the pockets that hold the connector. Overall tray length and width are standard. See next page. |
| • Trays should be loaded into the machine with the "tray-notch" in the upper left hand corner - for both the plug and receptacles. See diagram next page. | • Allows for part set-up standardization across the product line.<br>• Consistent loading of all parts minimizes the risk of reversed loading of the tray into the placement machine. |
| • Both Plug and Receptacle are oriented the same in the tray | • Provide consistent placement set-ups |
| • Plug trays are blue, Receptacle trays are black | • Minimizes the risk of reversed loading of the part into the tray.<br>• Minimizes the risk of putting the wrong part in the wrong tray. |

### 7.3 Placement Process – 4-Pair Plug JEDEC Tray Set-up

| Type | Part # | # of Wafers | Dimension "A" | Dimension "B" | "C" | Tray Height | Tray Part # |
|---|---|---|---|---|---|---|---|
| Plug | 379-3XX4-XXX | 5 | 18.53 | 21.38 | 13 | 4.5 | 801-4116-000 |
|  | 379-3XX5-XXX | 9 | 22.5 | 33.75 | 8 | 4.5 | 801-4118-000 |
|  | 379-3XX6-XXX | 15 | 35.5 | 48.8 | 5 | 4.5 | 801-4120-000 |

* To calculate the height from the bottom of the tray to the top of the vacuum "pick-up" cap - add tray height to overall connector height shown in Section 7.1.

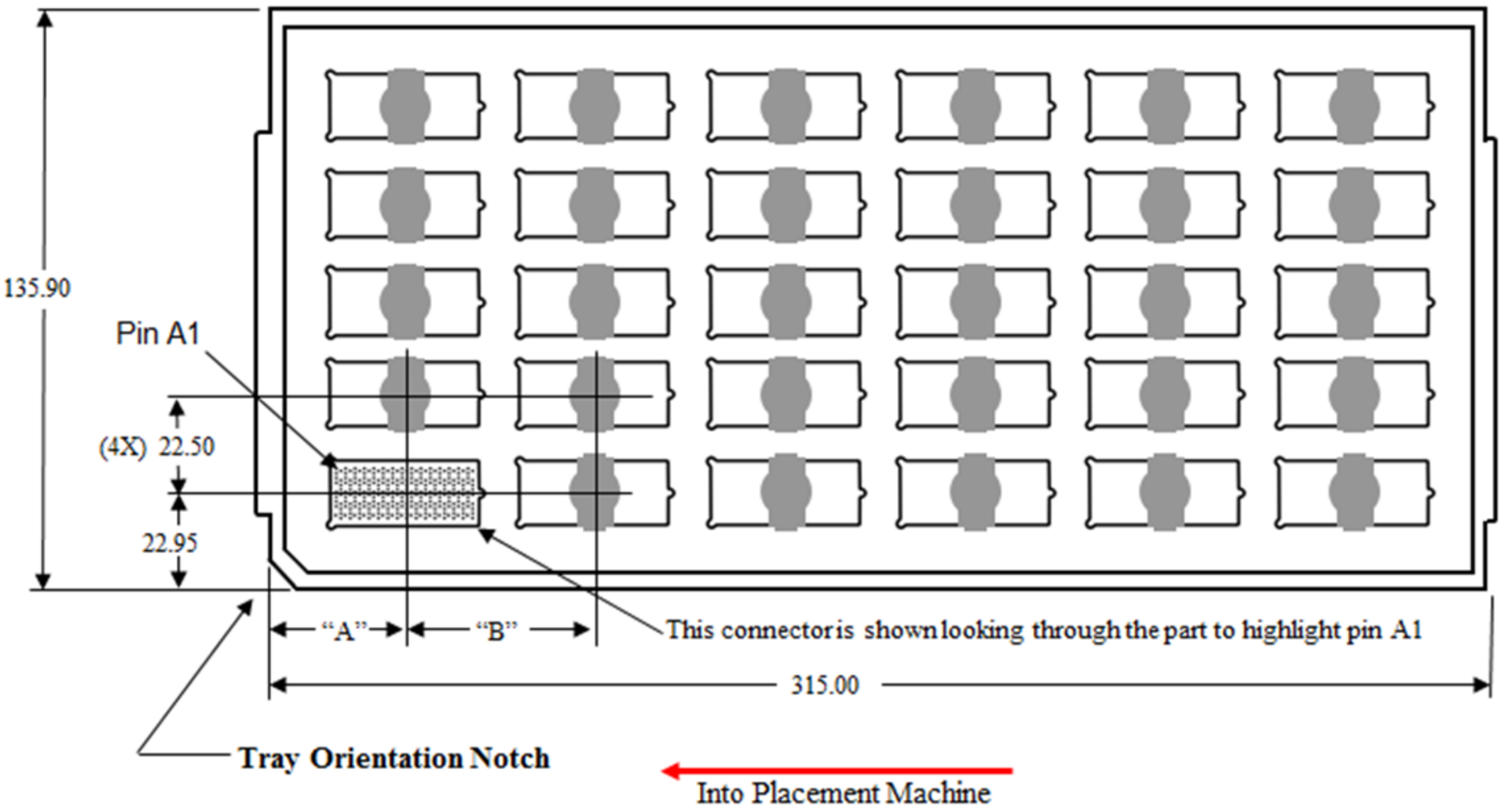


JEDEC Tray With 15-Wafer Plug Connectors – shown for reference
(Part # 379-3XX6-XXX) (Dimensions are in mm)

## 7.4 Placement Process – 4-Pair Receptacle JEDEC Tray Set-up

| Type | Part # | # of Wafers | Dimension "A" | Dimension "B" | "C" | Tray Height | Tray Part # |
|---|---|---|---|---|---|---|---|
| Receptacle | 380-3XX4-XXX | 5 | 18.53 | 21.38 | 13 | 4.85 | 801-4110-000 |
| | 380-3XX5-XXX | 9 | 22.5 | 33.75 | 8 | 4.85 | 801-4112-000 |
| | 380-3XX6-XXX | 15 | 35.5 | 48.8 | 5 | 4.85 | 801-4114-000 |

***** To calculate the height from the bottom of the tray to the top of the vacuum "pick-up" cap - add tray height to overall connector height shown in Section 7.1.



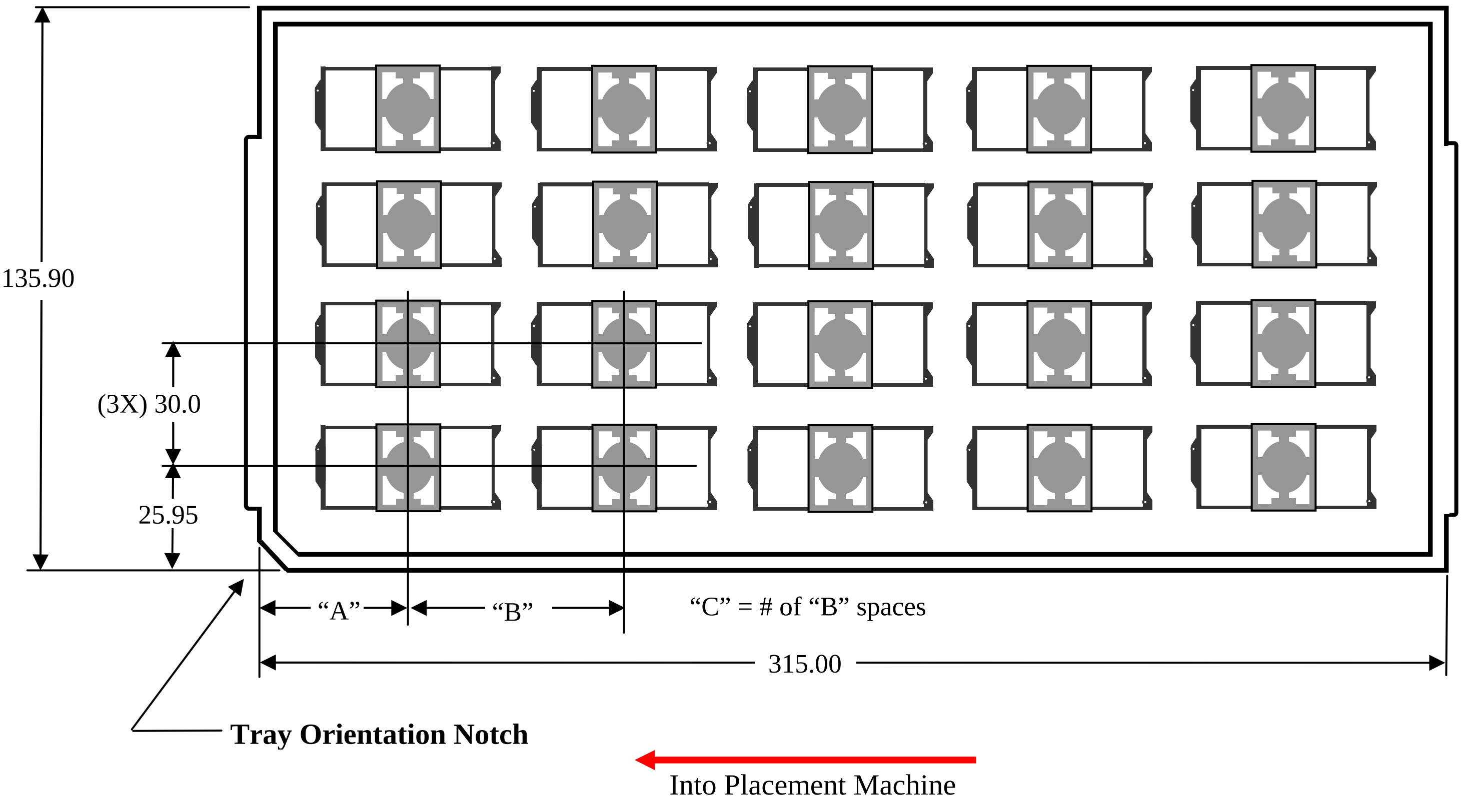
**JEDEC Tray With 15-Wafer Receptacle Connectors – shown for reference**
(Part # 380-3XX6-XXX) (Dimensions are in mm)

## 7.5 Placement Process – 6-Pair Plug and Receptacle JEDEC Tray Set-up

| Type | Part # | # of Wafers | Dimension “A” | Dimension “B” | "C" | Tray Height | Tray Part # |
|---|---|---|---|---|---|---|---|
| Plug | 379-5XX1-XXX | 10 | 24.5 | 38.0 | 7 | 6.42 | 801-4031-000 |
|  | 379-5XX2-XXX | 18 | 37.5 | 60.0 | 4 | 6.42 | 801-4034-000 |
|  |  |  |  |  |  |  |  |
| Receptacle | 380-5X81-XXX | 10 | 24.5 | 38.0 | 7 | 5.02 | 801-4032-000 |
|  | 380-5X82-XXX | 18 | 37.5 | 60.0 | 4 | 5.02 | 801-4035-000 |

* To calculate the height from the bottom of the tray to the top of the vacuum “pick-up” cap - add tray height to overall connector height shown in Section 7.1.

**Note: Both Plug and Receptacle are oriented the same in the tray**

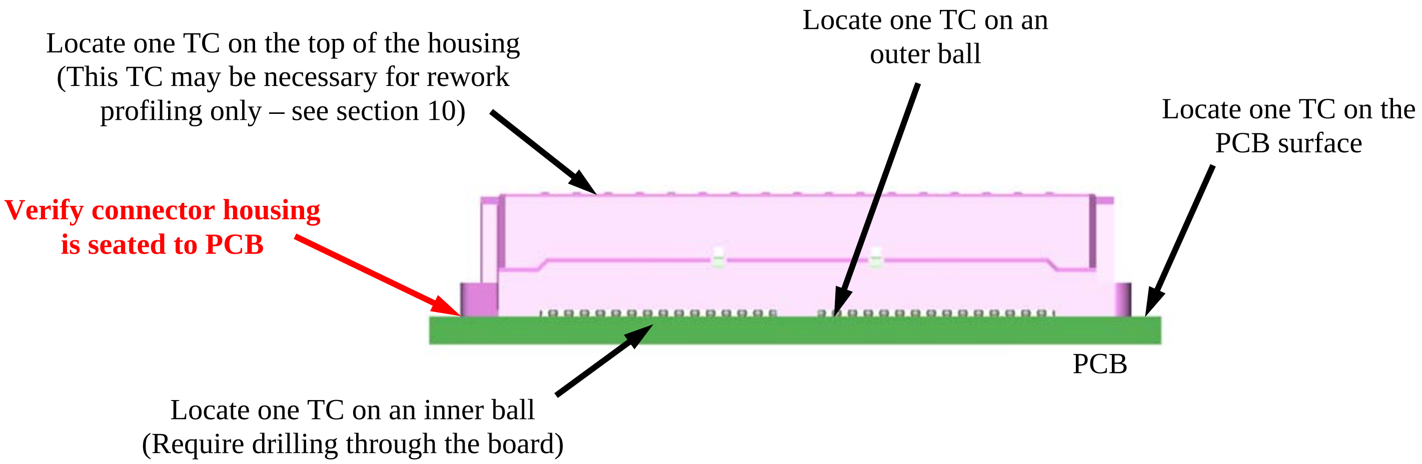


**JEDEC Tray With 18-Wafer Receptacle Connectors – shown for reference**
(Part # 380-6XX2-XXX) (Dimensions are in mm)

## 8.0 Reflow Process – Set-up and Recommended Thermocouple Locations

| Requirements | DFM Impact/Benefit |
|---|---|
| • To determine correct oven settings, follow standard reflow profile processes for set-up and placement of thermocouples (TC). | • Insure even heat distribution across the part.<br>• Insure profile matches solder paste supplier recommendations. |
| • Locate one thermocouple (TC) on PCB surface (same side as connector). | • Insures against PCB over-heating and damage. |
| • Locate one thermocouple (TC) on top of the connector housing during reflow profiling – It’s preferred to keep the plastic below 260°C with a max allowable temperature of 280°C. | • Insures against plastic over-heating and damage. |
| • Locate at least (2) thermocouple (TC) – one on an outer ball, and one on an inner ball – may require drilling through the board. | • Insures balanced reflow profile definition for all of the solder joints. |
| • Verify the solder balls have completely reflowed with good wetting and solder ball collapse, and no cold solder exists.<br>Check connector to insure that housing is seated to the board surface – see below. | • This insures good reflow and balls have completely collapsed. Unseated connectors are due to improperly reflowed balls, and could result in long-term reliability failures. |

**Note: This thermal differential may require the lower oven heaters to be set hotter than the upper heaters, providing thermal balance between the board and connector.**



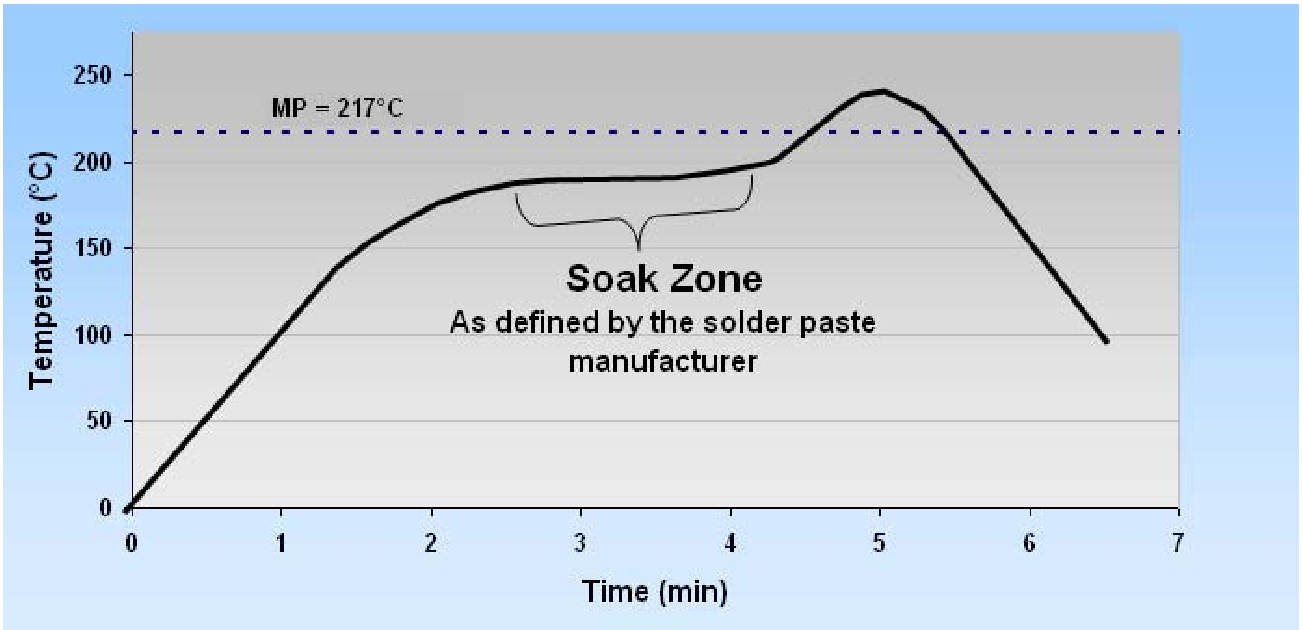
**InfinX Assembled to PCB After First Reflow**

**(6-Pair Shown)**

## 8.1 Reflow Process – Reflow Profile Recommendations

| Requirements | DFM Impact/Benefit |
|---|---|
| • Set process to the solder paste supplier's recommended profile. | • This varies by supplier and specific flux chemistry |
| • Recommend using a Soak Profile over a straight ramp to peak.<br>The soak time and temperature is defined by the paste manufacturer based on optimal flux chemistry activation temperatures. | • Minimizes void formation and risk of pillow head defects<br>• Minimizes delta T's across thermally heavier parts |

**Note: Melting Point of the SAC305 Solder ball is 217ºC**



### 8.2 Reflow Process – Vacuum Cap Removal

| Requirements | DFM Impact/Benefit |
|---|---|
| • Post reflow vacuum cap removal | • Vacuum cap can be removed after reflow/inspection. (Note: A new vacuum cap is required for connector rework) |
| • Remove cap in the steps shown in Figure 1 for the Plug, and Figure 2 for the receptacle. | • Ease of cap removal |

**Note: Vacuum cap disassembly is the same for both 4 and 6-Pr. 4-Pr is shown below.**

**Figure 1**
**4-Pr Plug**

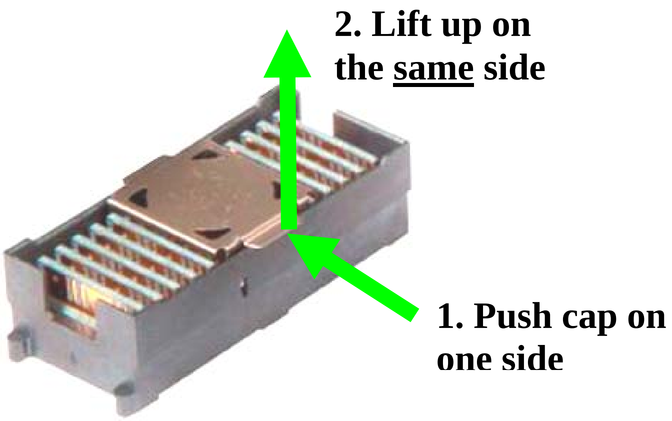
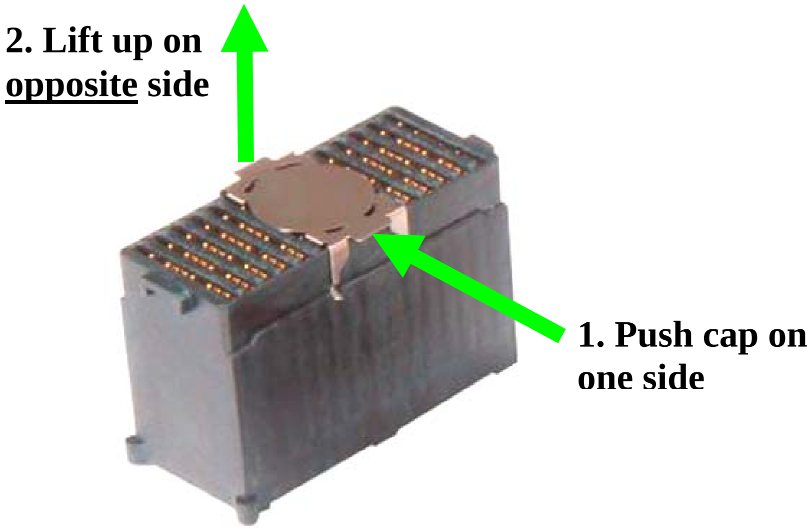


**Figure 2**
**4-Pr Receptacle**

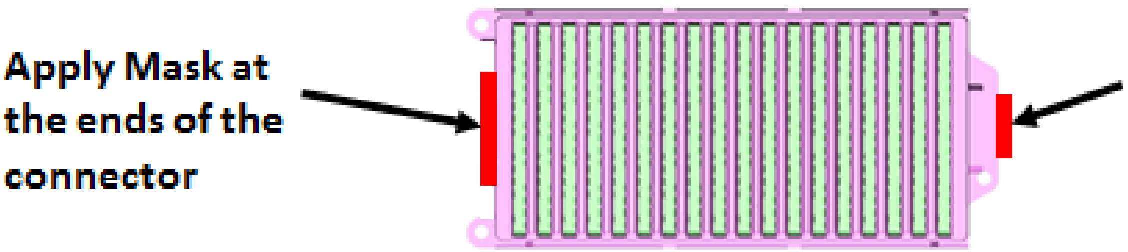


## 9.0 Double Sided Reflow Process

| Requirements | DFM Impact/Benefit |
|---|---|
| • InfinX is compatible with double-sided reflow soldering.<br>• **ATCS recommends a secondary method of retention (such as peel-able solder mask) when running InfinX connectors upside down in the reflow process.** | • Prevents excessive solder ball elongation or connectors falling off the board. |
| • Before applying the secondary retention and running connectors upside down in reflow - inspect the connector to insure the solder balls have reflowed and the housing is seated to the board surface – see Reflow Process section for more info. | • Improperly reflowed connectors and possible cold and/or insufficient solder joints will result in problems with the secondary method of attachment |
| • Remove the vacuum cap after the 1st reflow cycle. | • Reduces the weight of the connector and the risk of the connector dropping off the board. |
| • One method is to apply RTV or peel-able solder mask to the base of the housing AFTER the 1st reflow cycle | • Holds connector on the board<br>• Should be tested and verified in the customer’s specific process |
| • The method of retention and material used is the decision of the customer.<br>ATCS can provide input and technical support during the development phases. | • Each customer will have different process and design restrictions or requirements for their specific application. |

* Refer to Addendum “A” for more detailed information on connector weights and weight/ball data by part number.

One example of peelable solder mask is Kester TC-530. It will cure in the first 2-3 zones of the reflow oven and hold the part on the board in the peak zones. It should be peeled off after the reflow process.



## 10.0 Rework Process

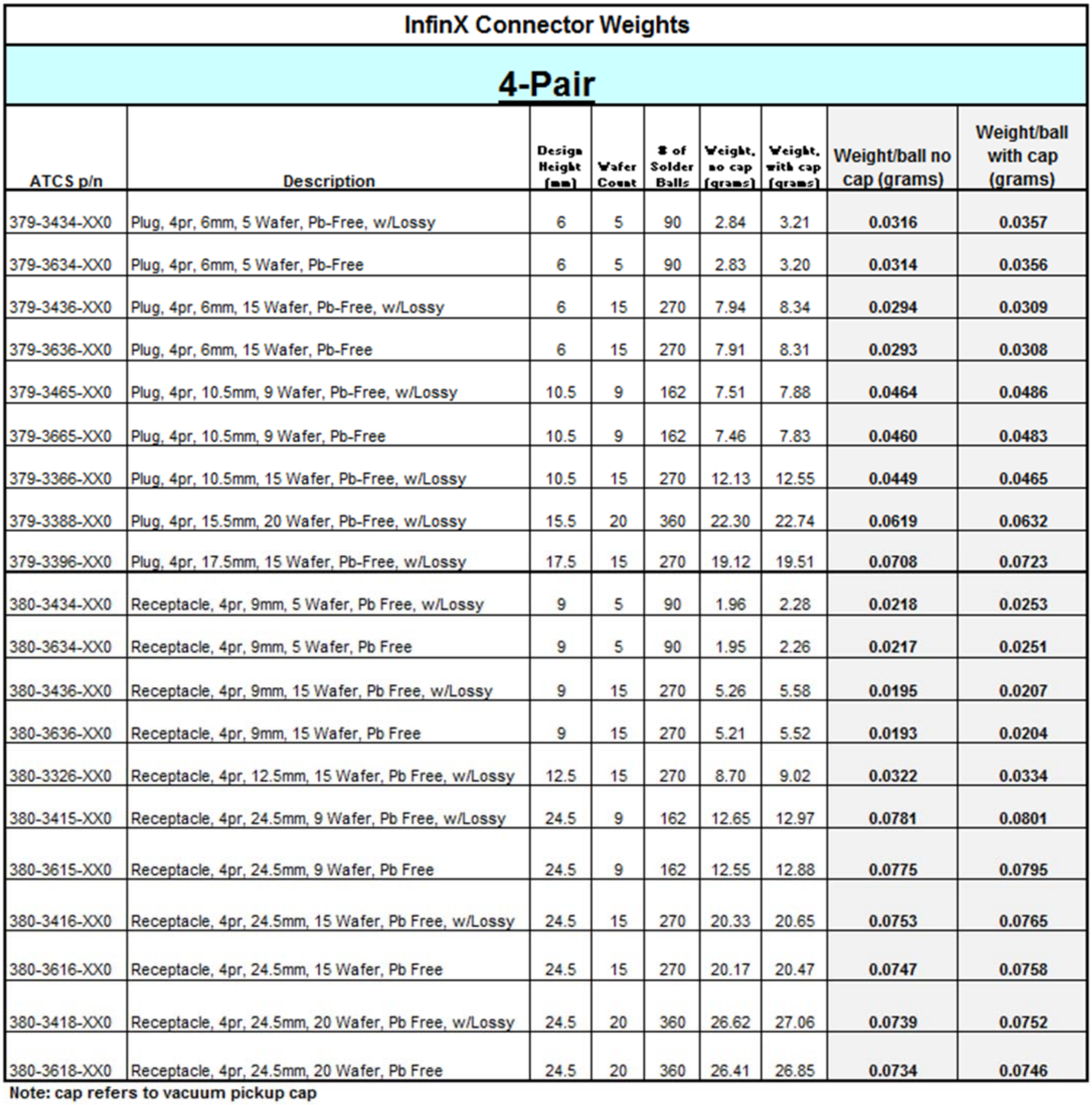
The rework of a InfinX connector, for solder shorts and opens, requires that the connector be completely removed and replaced with a new connector.

| Requirements | DFM Impact/Benefit |
|---|---|
| • Use specialized BGA rework equipment for connector removal and replacement, and should include thermal profiling and temperature measurement capability. | • Achieves an all-ball reflow at point of removal without excessive heat to the connector and PCB, or insufficient heat causing lifted pads. |
| • Follow reflow profiling guidelines in section 8 and make sure to include a thermocouple on **top of the connector housing** during reflow profiling – It is preferred to keep the plastic below 260°C with a max allowable temperature of 280°C. | • Insures against plastic over-heating and damage. (See reflow section for more detail.) |
| • Placement location of the part should be based on the ball locations using a best-fit alignment | • Minimizes the percentage of ball that is off-pad. |
| • Semi-Automated placement capability is preferred – including vacuum pick-up and placement. | • This will provide consistent placements. |
| • Split Vision alignment systems are required to allow a ball-field best-fit alignment to PCB footprint. | • Allows blind alignment of ball to pad - minimizing placement error. |
| • Hand/Manual placement is not recommended. | • Manual placement is inconsistent, and blind/housing align does not provide the required placement accuracy. |
| • Using custom InfinX nozzles is preferred for the taller connectors | • Because of the higher thermal masses, more consistent/even heat distribution is required. |
| • Follow normal rework processes for PCB site cleaning and prep, and reflow profile development. | • Improves rework yield and insures reliable solder joints |
| • "Flux-only" processing is not recommended. | • Inconsistent amount of metal left on pad during site prep, resulting in excessive pad co-planarity variation – increased risk of solder opens. |
| • Paste deposition is recommended using either an automated dispensing system or manual micro stencils – resulting in a 6 mil tall x 24 mil diameter deposit. | • Prevents opens/shorts with high reliability solder joints. |
| • Re-balling of InfinX connectors is not recommended. | • Re-balling processes not available for InfinX. |

Air-Vac and VJ Electronix have developed custom rework nozzles for InfinX, and will assist in any process development work related to InfinX. For more info go to the following Web Sites:

| | |
|---|---|
| **Air-Vac** | http://www.air-vac-eng.com/ |
| **VJ Electronix** | http://vjelectronix.com/ |

## Addendum “A”



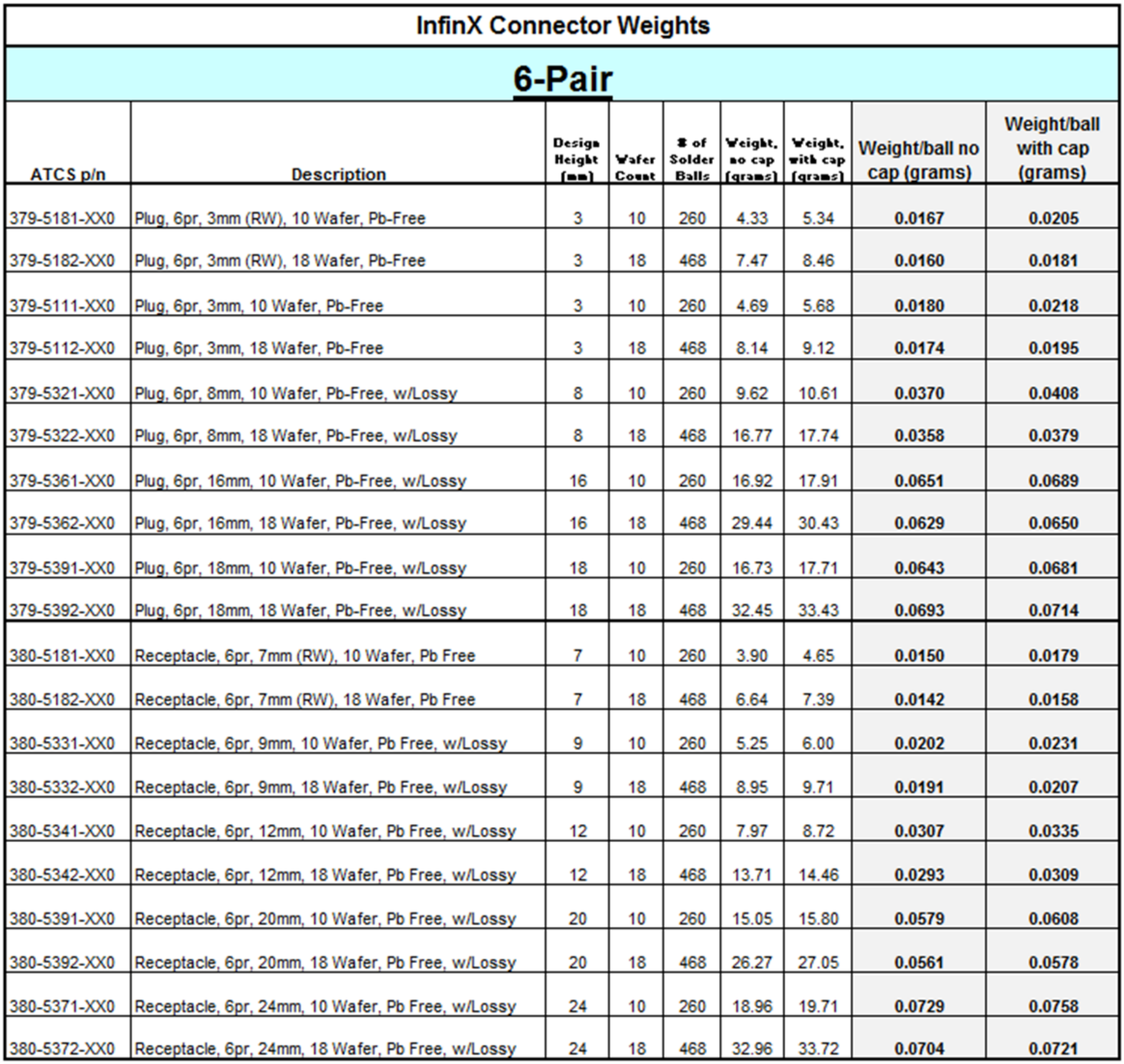
**InfinX Connector Weights**

**4-Pair**

| ATCS p/n | Description | Design Height (mm) | Wafer Count | # of Solder Balls | Weight, no cap (grams) | Weight, with cap (grams) | Weight/ball no cap (grams) | Weight/ball with cap (grams) |
|---|---|---|---|---|---|---|---|---|
| 379-3434-XX0 | Plug, 4pr, 6mm, 5 Wafer, Pb-Free, w/Lossy | 6 | 5 | 90 | 2.84 | 3.21 | **0.0316** | **0.0357** |
| 379-3634-XX0 | Plug, 4pr, 6mm, 5 Wafer, Pb-Free | 6 | 5 | 90 | 2.83 | 3.20 | **0.0314** | **0.0356** |
| 379-3436-XX0 | Plug, 4pr, 6mm, 15 Wafer, Pb-Free, w/Lossy | 6 | 15 | 270 | 7.94 | 8.34 | **0.0294** | **0.0309** |
| 379-3636-XX0 | Plug, 4pr, 6mm, 15 Wafer, Pb-Free | 6 | 15 | 270 | 7.91 | 8.31 | **0.0293** | **0.0308** |
| 379-3465-XX0 | Plug, 4pr, 10.5mm, 9 Wafer, Pb-Free, w/Lossy | 10.5 | 9 | 162 | 7.51 | 7.88 | **0.0464** | **0.0486** |
| 379-3665-XX0 | Plug, 4pr, 10.5mm, 9 Wafer, Pb-Free | 10.5 | 9 | 162 | 7.46 | 7.83 | **0.0460** | **0.0483** |
| 379-3366-XX0 | Plug, 4pr, 10.5mm, 15 Wafer, Pb-Free, w/Lossy | 10.5 | 15 | 270 | 12.13 | 12.55 | **0.0449** | **0.0465** |
| 379-3388-XX0 | Plug, 4pr, 15.5mm, 20 Wafer, Pb-Free, w/Lossy | 15.5 | 20 | 360 | 22.30 | 22.74 | **0.0619** | **0.0632** |
| 379-3396-XX0 | Plug, 4pr, 17.5mm, 15 Wafer, Pb-Free, w/Lossy | 17.5 | 15 | 270 | 19.12 | 19.51 | **0.0708** | **0.0723** |
| 380-3434-XX0 | Receptacle, 4pr, 9mm, 5 Wafer, Pb Free, w/Lossy | 9 | 5 | 90 | 1.96 | 2.28 | **0.0218** | **0.0253** |
| 380-3634-XX0 | Receptacle, 4pr, 9mm, 5 Wafer, Pb Free | 9 | 5 | 90 | 1.95 | 2.26 | **0.0217** | **0.0251** |
| 380-3436-XX0 | Receptacle, 4pr, 9mm, 15 Wafer, Pb Free, w/Lossy | 9 | 15 | 270 | 5.26 | 5.58 | **0.0195** | **0.0207** |
| 380-3636-XX0 | Receptacle, 4pr, 9mm, 15 Wafer, Pb Free | 9 | 15 | 270 | 5.21 | 5.52 | **0.0193** | **0.0204** |
| 380-3326-XX0 | Receptacle, 4pr, 12.5mm, 15 Wafer, Pb Free, w/Lossy | 12.5 | 15 | 270 | 8.70 | 9.02 | **0.0322** | **0.0334** |
| 380-3415-XX0 | Receptacle, 4pr, 24.5mm, 9 Wafer, Pb Free, w/Lossy | 24.5 | 9 | 162 | 12.65 | 12.97 | **0.0781** | **0.0801** |
| 380-3615-XX0 | Receptacle, 4pr, 24.5mm, 9 Wafer, Pb Free | 24.5 | 9 | 162 | 12.55 | 12.88 | **0.0775** | **0.0795** |
| 380-3416-XX0 | Receptacle, 4pr, 24.5mm, 15 Wafer, Pb Free, w/Lossy | 24.5 | 15 | 270 | 20.33 | 20.65 | **0.0753** | **0.0765** |
| 380-3616-XX0 | Receptacle, 4pr, 24.5mm, 15 Wafer, Pb Free | 24.5 | 15 | 270 | 20.17 | 20.47 | **0.0747** | **0.0758** |
| 380-3418-XX0 | Receptacle, 4pr, 24.5mm, 20 Wafer, Pb Free, w/Lossy | 24.5 | 20 | 360 | 26.62 | 27.06 | **0.0739** | **0.0752** |
| 380-3618-XX0 | Receptacle, 4pr, 24.5mm, 20 Wafer, Pb Free | 24.5 | 20 | 360 | 26.41 | 26.85 | **0.0734** | **0.0746** |

**Note: cap refers to vacuum pickup cap**

## Addendum “A” (Cont’d)



### InfinX Connector Weights

### 6-Pair

| ATCS p/n | Description | Design Height (mm) | Wafer Count | # of Solder Balls | Weight, no cap (grams) | Weight, with cap (grams) | Weight/ball no cap (grams) | Weight/ball with cap (grams) |
|---|---|---|---|---|---|---|---|---|
| 379-5181-XX0 | Plug, 6pr, 3mm (RW), 10 Wafer, Pb-Free | 3 | 10 | 260 | 4.33 | 5.34 | **0.0167** | **0.0205** |
| 379-5182-XX0 | Plug, 6pr, 3mm (RW), 18 Wafer, Pb-Free | 3 | 18 | 468 | 7.47 | 8.46 | **0.0160** | **0.0181** |
| 379-5111-XX0 | Plug, 6pr, 3mm, 10 Wafer, Pb-Free | 3 | 10 | 260 | 4.69 | 5.68 | **0.0180** | **0.0218** |
| 379-5112-XX0 | Plug, 6pr, 3mm, 18 Wafer, Pb-Free | 3 | 18 | 468 | 8.14 | 9.12 | **0.0174** | **0.0195** |
| 379-5321-XX0 | Plug, 6pr, 8mm, 10 Wafer, Pb-Free, w/Lossy | 8 | 10 | 260 | 9.62 | 10.61 | **0.0370** | **0.0408** |
| 379-5322-XX0 | Plug, 6pr, 8mm, 18 Wafer, Pb-Free, w/Lossy | 8 | 18 | 468 | 16.77 | 17.74 | **0.0358** | **0.0379** |
| 379-5361-XX0 | Plug, 6pr, 16mm, 10 Wafer, Pb-Free, w/Lossy | 16 | 10 | 260 | 16.92 | 17.91 | **0.0651** | **0.0689** |
| 379-5362-XX0 | Plug, 6pr, 16mm, 18 Wafer, Pb-Free, w/Lossy | 16 | 18 | 468 | 29.44 | 30.43 | **0.0629** | **0.0650** |
| 379-5391-XX0 | Plug, 6pr, 18mm, 10 Wafer, Pb-Free, w/Lossy | 18 | 10 | 260 | 16.73 | 17.71 | **0.0643** | **0.0681** |
| 379-5392-XX0 | Plug, 6pr, 18mm, 18 Wafer, Pb-Free, w/Lossy | 18 | 18 | 468 | 32.45 | 33.43 | **0.0693** | **0.0714** |
| 380-5181-XX0 | Receptacle, 6pr, 7mm (RW), 10 Wafer, Pb Free | 7 | 10 | 260 | 3.90 | 4.65 | **0.0150** | **0.0179** |
| 380-5182-XX0 | Receptacle, 6pr, 7mm (RW), 18 Wafer, Pb Free | 7 | 18 | 468 | 6.64 | 7.39 | **0.0142** | **0.0158** |
| 380-5331-XX0 | Receptacle, 6pr, 9mm, 10 Wafer, Pb Free, w/Lossy | 9 | 10 | 260 | 5.25 | 6.00 | **0.0202** | **0.0231** |
| 380-5332-XX0 | Receptacle, 6pr, 9mm, 18 Wafer, Pb Free, w/Lossy | 9 | 18 | 468 | 8.95 | 9.71 | **0.0191** | **0.0207** |
| 380-5341-XX0 | Receptacle, 6pr, 12mm, 10 Wafer, Pb Free, w/Lossy | 12 | 10 | 260 | 7.97 | 8.72 | **0.0307** | **0.0335** |
| 380-5342-XX0 | Receptacle, 6pr, 12mm, 18 Wafer, Pb Free, w/Lossy | 12 | 18 | 468 | 13.71 | 14.46 | **0.0293** | **0.0309** |
| 380-5391-XX0 | Receptacle, 6pr, 20mm, 10 Wafer, Pb Free, w/Lossy | 20 | 10 | 260 | 15.05 | 15.80 | **0.0579** | **0.0608** |
| 380-5392-XX0 | Receptacle, 6pr, 20mm, 18 Wafer, Pb Free, w/Lossy | 20 | 18 | 468 | 26.27 | 27.05 | **0.0561** | **0.0578** |
| 380-5371-XX0 | Receptacle, 6pr, 24mm, 10 Wafer, Pb Free, w/Lossy | 24 | 10 | 260 | 18.96 | 19.71 | **0.0729** | **0.0758** |
| 380-5372-XX0 | Receptacle, 6pr, 24mm, 18 Wafer, Pb Free, w/Lossy | 24 | 18 | 468 | 32.96 | 33.72 | **0.0704** | **0.0721** |

**Note: cap refers to vacuum pickup cap**

# Addendum “B”: DFM and Assembly Readiness Check Sheet

| Item | Sect | Check | Change/Comments | Who | Status |
|---|---|---|---|---|---|
| PCB Design | 3.1 | • Copper defined .60mm (024”) pad – clear of solder mask | | | |
| | 3.2 | • Minimum .13mm (.005”) Solder Mask dam to Via, or via masking | | | |
| | 3.3/6.0 | • Specify board warp spec per process variables | | | |
| | 3.4/ 3.5 | • Multi connector orientation is the same<br>• Long side of connector is parallel across the larger spans<br>• Layout includes slightly oversized silkscreen outline of connector. | | | |
| Mech. Req’ments | 3.6 | • Stand-offs or mechanical spacers are required to secure the mezzanine cards. | | | |
| Handling | 4.0/ 5.0 | • Removal/replacement from JEDEC tray is not recommended – minimize manual handling<br>• Handling process should include re-packaging and handling pre-cautions. | | | |
| Solder Paste | 6.0 | • Stencil thickness is 5-6 mil.<br>• Stencil aperture should be 24 mils | | | |
| Placement | 7.0 | • Set-up should include ball-field align, full circular side lighting, and pre-orient align. | | | |
| | 7.1 | • Custom programming and nozzles may be required for the taller connectors. | | | |
| Reflow | 8.0 | • Follow solder paste manufacturer’s recommended profile. | | | |
| | 8.1 | • Recommend using a soak profile in reflow. | | | |
| | 8.2 | • Follow recommended process for vacuum cap removal. | | | |
| Double Sided Reflow | 9.0 | • ATCS recommends a secondary method of retention (such as peel-able solder mask) when running InfinX connectors upside down in the reflow process. | | | |
| Rework | 10.0 | • When profiling, include thermal probe attachment to the top of housing, to insure against plastic over-heating.<br>• Placement with ball-field align and best-fit<br>• Manual placement not recommended<br>• Use custom dedicated nozzles for the taller connectors.<br>• Paste deposition should be 5-6 mils high and 24 mil diameter<br>• “Flux-only” processing not recommended | | | |