Application Report
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# Surface Mount Package Removal Application Note

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**ABSTRACT**

This application note will provide guidelines for how to remove a Surface Mount (SMT) package from a Printed Circuit Board (PCB) without damaging the SMT. Rapid increase in temperature of a SMT package to desoldering temperatures while the package is loaded with moisture. Delamination can occur inside the package as the moisture turns to superheated steam, building up pressure inside the component and causing the package to crack. Such delamination during the removal process must be avoided since it will mask the root cause of a package or Silicon chip failure; therefore, following the provided guidelines to remove the failed SMT component can maximize the chances to find and correct the root cause of the failure.

**Contents**

# 1 Repair and Rework of SMT Components

To prevent moisture-induced damage, SMT components require a bake-out prior to removal from the board.

A number of tools can remove components, including hot-air machines for removing active surface mount components. As with any rework tool, a key issue in using hot-air machines is preventing thermal damage to the component or adjacent components.

It is recommended to initially cover the components, adjacent to the component intended for removal, with heat tape. The gas nozzle, used during this process, surrounds the device and seals against the board. The SMT is heated from the top side with hot gas, while residual heat is exhausted up and away from adjacent components. The anti-crushing feature in the nozzle prevents excessive top-side force from being applied to the SMT. The entire assembly is also heated from the bottom side with an underboard heater to help prevent warpage. Preheating the board to a fixed temperature before the component is heated also helps to ensure process repeatability. Once the reflow process is complete, the nozzle vacuum cup is automatically activated and the component is slowly lifted off the pads. The vacuum cup in the nozzle is designed to disengage if the component has not fully reflowed for any reason preventing the potential damage to the SMT.

Regardless of which tool is used, all of the controlling desoldering/soldering variables should be studied, including the number of times a component can be removed, replaced (only once is recommended for TI SMT components), and desoldering temperature and time. It is also helpful to preheat the board assembly to 90°C for 15 to 20 minutes before rework. This will prevent thermal damage such as measling or white spots of the boards, and to avoid pressure on the pads during the rework operation.

# 2 Preparing PCBs and Packages for Rework

Both the PCB and SMT devices can absorb moisture from the ambient air, which can cause internal expansion and damage to the PCB and/or device during heating to the desoldering temperature. Therefore it is strongly recommended to bake the PCBs and devices prior to any rework, especially if the SMT device removed is planned for further failure analysis. The recommended temperature depends on the maximum temperature that the devices and PCB can withstand without damage. Generally, the recommended bake conditions for SMT packages are 8 to 24 hours at 105°C–125°C, see J-STD-033 for more details.

When rework is done on a new IC package for the first time, it is strongly recommended to control the temperature of the package during the rework process. This means either using equipment that can measure the package temperature by infrared thermography or using a small thermocouple attached to the top side of the package.

# 3 Recommended Rework Procedure

Section 4 lists generic guidelines to remove SMT packages assembled on a 0.056-in (1.4mm) FR4 board. It is recommended to modify heating profiles based on different board thicknesses and equipment used. Parts must not exceed the peak temperature as listed on the MSL label located on the shipping box of the parts. It is strongly recommended to bake out parts and boards prior to rework to reduce the risk of delamination. This is important because delamination, caused by the rework process, can mask the true root cause of the failure. (See an example in Section 5.)

## 4 Pb-Free Solder Component Removal

**Note:** This is only an example, the exact procedure will depend on the equipment used, its capabilities, the PCB thermal mass, and the size of the IC package. See an example of the Rework Procedure for Texas Instrument's NanoStar™ and NanoFree™ Packages at the end of this document.

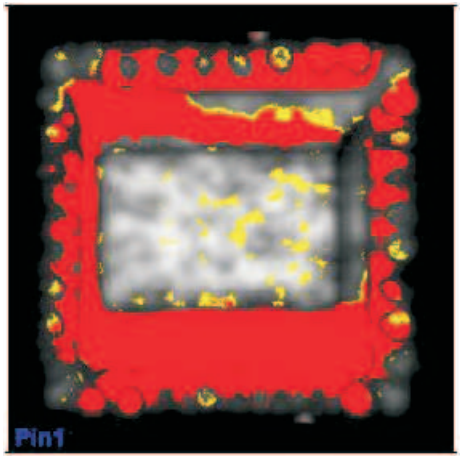
1. Align nozzle over part to be removed
2. Maintain nozzle 0.050-in (1.27 mm) over device or use equipment supplier recommendation
   - Care must be taken to prevent over travel of the vacuum tip, which may damage the part or vacuum tip when measuring this distance
3. Preheat board to 90C, nozzle warming up 20% air flow, 125°C.
4. Soak stage at 20% air flow, 225°C, 90 seconds (the airflow may be dependant on package volume)
5. Ramp stage at 20% air flow, 335°C, 30 seconds
6. Reflow stage at 25% air flow, 370°C, 65 seconds
7. Enable vacuum at the end of the reflow cycle, lower vacuum nozzle, and remove part.
8. Cool down stage at 40% air flow, 25°C, 50 seconds
9. Turn off the vacuum and remove part from nozzle by placing a plate underneath to catch the part
10. Using any metal tweezers or rough handling can damage the part and render it impossible to analyze
11. Do not reuse the part after it is removed

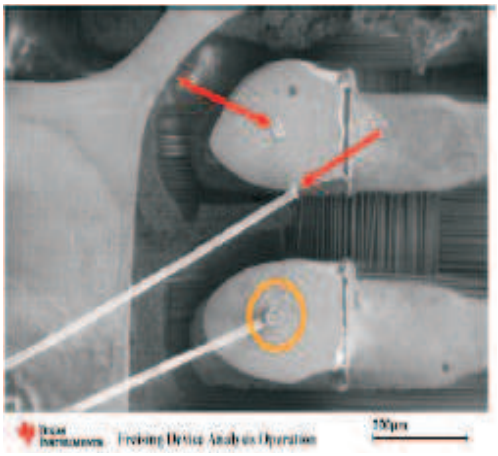
## 5 Example of Component Delamination after Removal from PCB

C-SAM delamination at mount pad and several leads

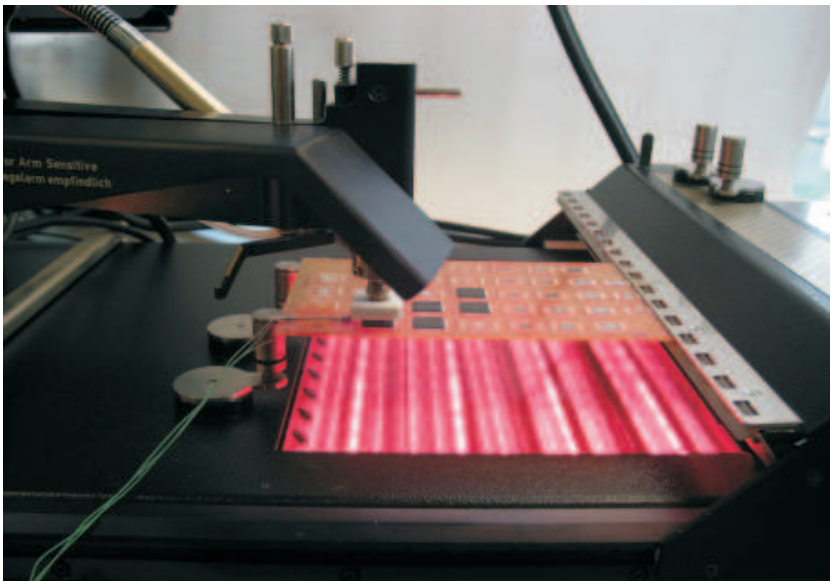
Pin 16 / Pin 15 broken/fractured bond stitches

C-SAM is an ultrasonic wave analysis method used for the detection of delamination of materials inside the IC package.

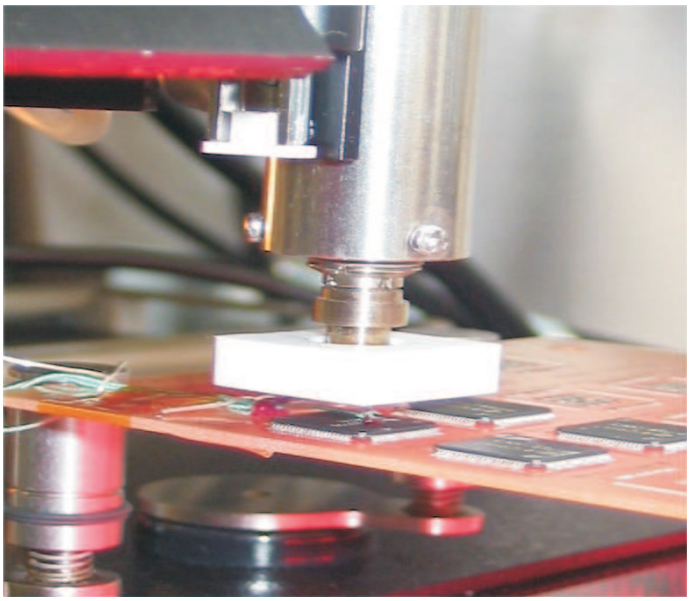


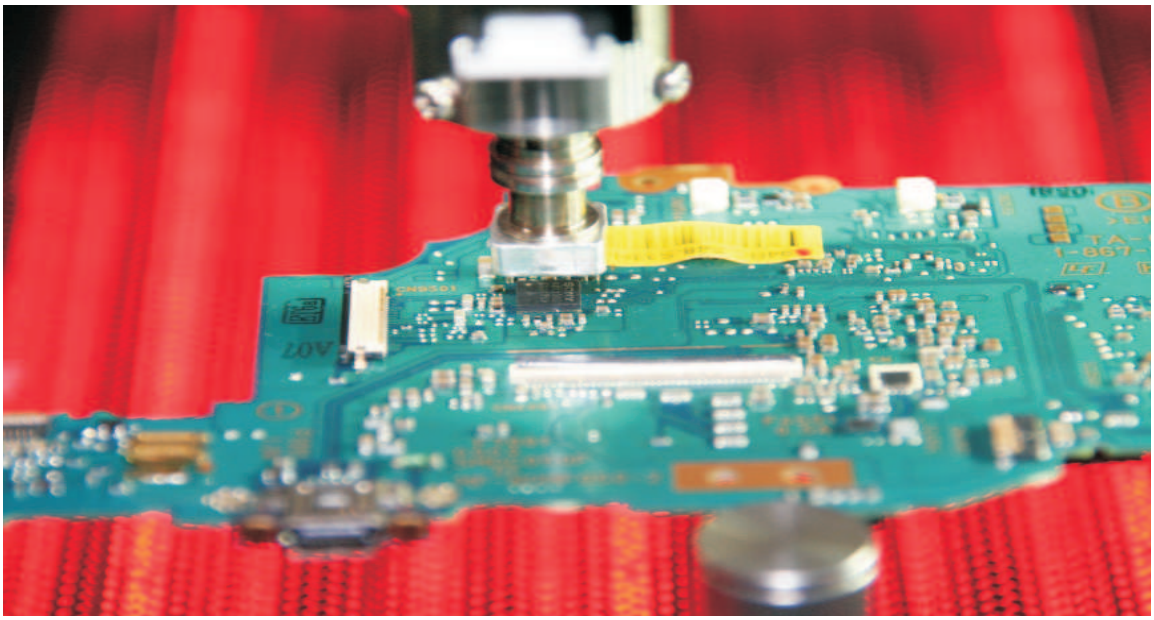
## 6 Example of a Martin Commercial Rework Station



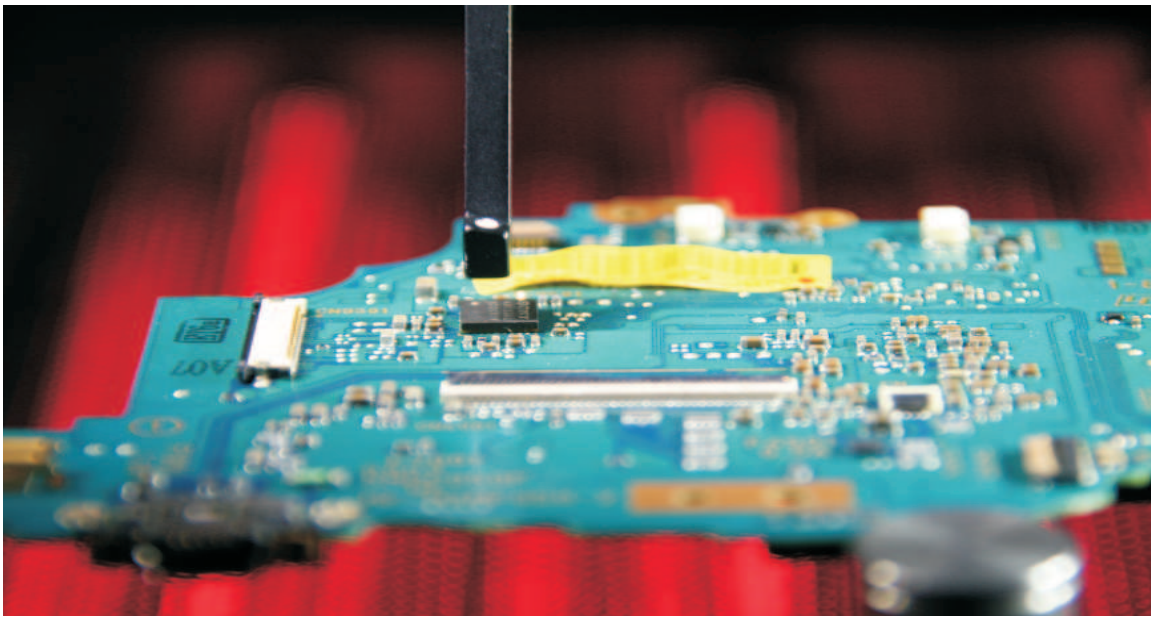
Thermocouples placed on the IC Package for creation of the rework resoldering temperature profile to be used on new IC packages.



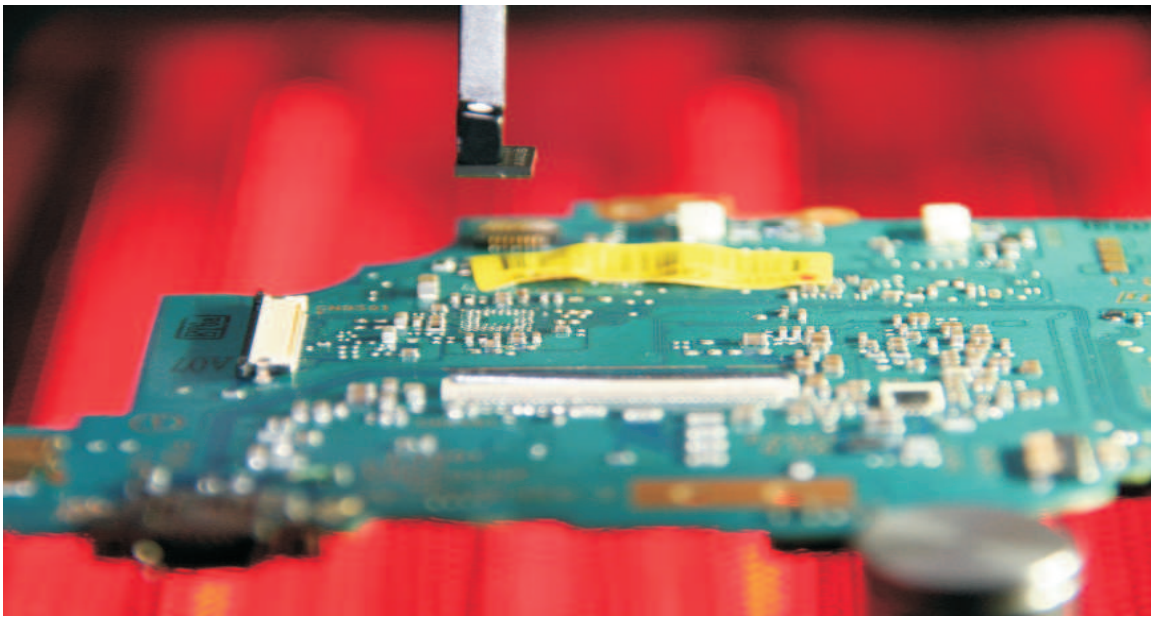
Thermocouples are glued on package top side, lead top side, and adjacent PCB.

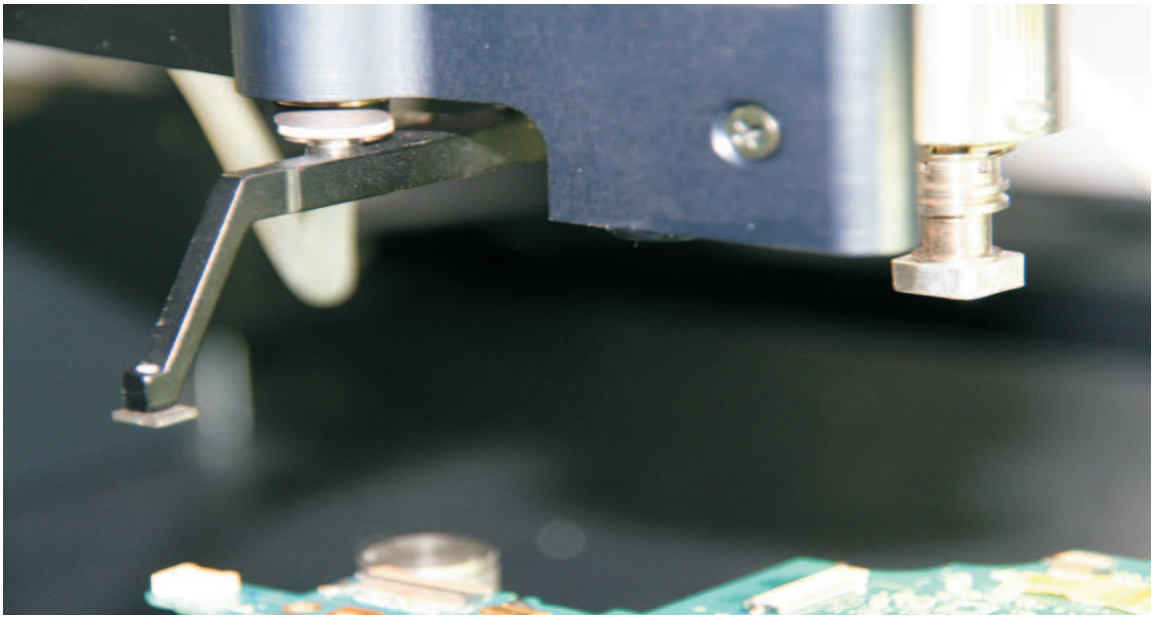


Devices are heated up with hot air from top and IR from the bottom.



After the lead temperature reaches the solder's liquidus temperature, the package picker is moved over the IC package to remove it from the board.





Device can now be removed from the package picker after releasing the vacuum.

# Rework Procedure for Texas Instrument's NanoStar™ and NanoFree™ Packages

## 1 NanoStar™ (SnPb) Rework Procedure

Presented here are generic guidelines to Remove NanoStar™ (SnPb bumps) packages assembled on a 0.056-inch thick FR4 board. It is recommended to modify heating profiles for different board thicknesses and equipment used. Do not reuse the part after it is removed. The assembly process recommended below should be used with a new device.

Note that the temperatures set below are not taken at the component but are "Set Points" on the rework equipment so results and settings may vary due to equipment and differences in the thermal characteristics of the PCB. Characterizing each component using a thermocouple to ensure the peak temperature at both the board and component does not exceed the MSL (Moisture Sensitivity Rating) rating which is typically 260°C for leadfree rework is recommended. Also note that to prevent Polyimide discoloration the temperature must be kept below 275°C.

### *1.1 Eutectic Balls (NanoStar™) Removal*

1. Apply flux paste to component.
2. Align nozzle over part to be removed.
3. Maintain nozzle .050" over device.
   - Care must be taken to prevent over-travel of the vacuum tip which may damage the part or vacuum tip when measuring this distance
4. Preheat board to 90ºC, nozzle warming up 20% air flow, 100ºC
5. Soak Stage—20% air flow, 200ºC, 90 seconds
6. Ramp Stage—20% air flow, 300ºC, 30 seconds
7. Reflow Stage—25% air flow, 325ºC, 55 seconds
8. Enable vacuum at the end of the reflow reflow cycle, lower vacuum nozzle, and remove part.
9. Cool down Stage—40% air flow, 25ºC, 30 seconds
10. Turn off the vacuum and remove part from nozzle.
11. Using any metal tweezers, or rough handling can damage the part and render it un-analyzable.

### *1.2 Eutectic Balls (NanoStar™) Placement*

1. Apply flux paste to component.
2. Align device over the pads.
3. Place device on board
   - Care must be taken to prevent over-travel during placement which may damage the part or vacuum tip.
4. Raise nozzle .050"
5. Preheat board to 90ºC, nozzle warming up 20% air flow, 100ºC
6. Soak Stage—20% air flow, 200ºC, 90 seconds
7. Ramp Stage—20% air flow, 300ºC, 30 seconds
8. Reflow Stage—25% air flow, 325ºC, 55 seconds
9. Cool down Stage—40% air flow, 25ºC, 30 seconds

### 1.3 Pb-Free Balls (NanoFree™) Removal

1. Apply flux paste to component
2. Align nozzle over part to be removed
3. Maintain nozzle .050" over device.
   - Care must be taken to prevent over-travel of the vacuum tip which may damage the part or vacuum tip when measuring this distance
4. Preheat board to 90ºC, nozzle warming up 20% air flow, 125ºC
5. Soak Stage—20% air flow, 225ºC, 90 seconds
6. Ramp Stage—20% air flow, 335ºC, 30 seconds
7. Reflow Stage—25% air flow, 370ºC, 65 seconds
8. Enable Vacuum at the end of the reflow reflow cycle, lower vacuum nozzle, and remove part
9. Cool down Stage—40% air flow, 25ºC, 50 seconds
10. Turn off the vacuum and remove part from nozzle
11. Using any metal tweezers, or rough handling can damage the part and render it un-analyzable

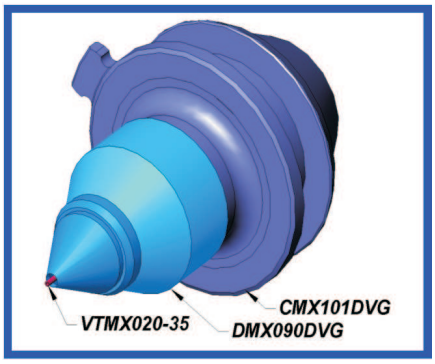
### 1.4 Pb-Free Balls (NanoFree™) Placement

1. Apply flux paste to component
2. Align device over the pads
3. Place device on board
   - Care must be taken to prevent over-travel during placement which may damage the part or vacuum tip
4. Raise nozzle .050"
5. Preheat board to 90ºC, nozzle warming up 20% air flow, 125ºC
6. Soak Stage—20% air flow, 225ºC, 90 seconds
7. Ramp Stage—20% air flow, 335ºC, 30 seconds
8. Reflow Stage—25% air flow, 370ºC, 65 seconds
9. Cool down Stage—40% air flow, 25ºC, 50 seconds

## 2 Air-Vac Engineering

Air-Vac Engineering (www.air-vac-eng.com) has established NanoStar™ reflow profiles for their Hot Gas (convection) rework equipment, DRS-24NC, and also provides tooling recommendations. Customers can use other hot gas (convection) rework equipment and tooling that is comparable.

- **NMX090DVG/DMX090DVG**
  - 0.090" Exhaust Opening
  - Used for Die sizes up to 2.15mm x 2.15mm
  - VTMX020-35 Vacuum Tip
- **NMX188DVG**
  - 0.18" Exhaust Opening
  - Used for Die sizes between 2.15mm to 4.5mm
  - VTMX020-35 Vacuum Tip

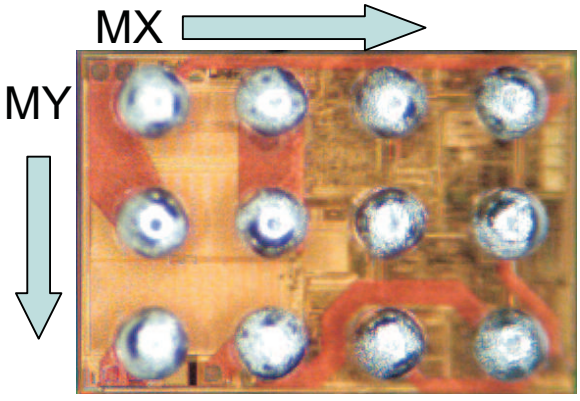



**Hot Gas Convection Nozzle**

**Recommended Nozzle Sizes**[(1)]

| Package Designator | Nozzle | Min X (mm) | Max X (mm) | Min Y (mm) | Max Y (mm) | MX | MY |
|---|---|---|---|---|---|---|---|
| YEB/YZB | NMX090DVG | 0.85 | 1.65 | 0.85 | 1.65 | 2 | 2 |
| YEC/YZC | NMX090DVG | 1.35 | 2.15 | 0.85 | 1.65 | 3 | 2 |
| YED/YZD | NMX090DVG | 1.85 | 2.65 | 0.85 | 1.65 | 4 | 2 |
| YEF/YZF | NMX090DVG | 1.35 | 2.15 | 1.35 | 2.15 | 3 | 3 |
| YEG/YZG | NMX188DVG | 1.85 | 2.65 | 1.35 | 2.15 | 4 | 3 |
| YEH/YZH | NMX188DVG | 1.85 | 2.65 | 1.85 | 2.65 | 4 | 4 |
| YEJ/YZJ | NMX188DVG | 2.35 | 3.15 | 1.85 | 2.65 | 5 | 4 |
| YEK/YZK | NMX188DVG | 2.35 | 3.15 | 2.35 | 3.15 | 5 | 5 |
| YEL/YZL | NMX188DVG | 2.85 | 3.65 | 2.35 | 3.15 | 6 | 5 |
| YEM/YZM | NMX188DVG | 2.85 | 3.65 | 2.85 | 3.65 | 6 | 6 |

(1) All Units in mm



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