

The background of the slide is a close-up photograph of semiconductor manufacturing components. It features several strips of tape, likely used for transporting and placing chips. One strip is dark with visible gold-colored contacts. Another strip is lighter, possibly clear or light grey, with small, colorful components (chips) mounted on it. A few loose, small, colorful components are scattered on a dark surface in the lower right. The overall lighting is dramatic, highlighting the textures and colors of the materials.

**3M** Science.  
Applied to Life.™

# 3M Chip Transport Solutions for Semiconductors

# Introduction

Market trends toward smaller, lighter, and more efficient electronic devices continue to drive the need for increasingly compact and sophisticated component packaging. Advanced packaging technologies, including wafer-level chip scale packages (WLCSPs) and other next-generation form factors, allow for size and weight advantages to meet these market demands. These solutions often require more stringent carrier tape and cover tape performance to help ensure proper component protection during transport, storage, and the pick-and-place process.

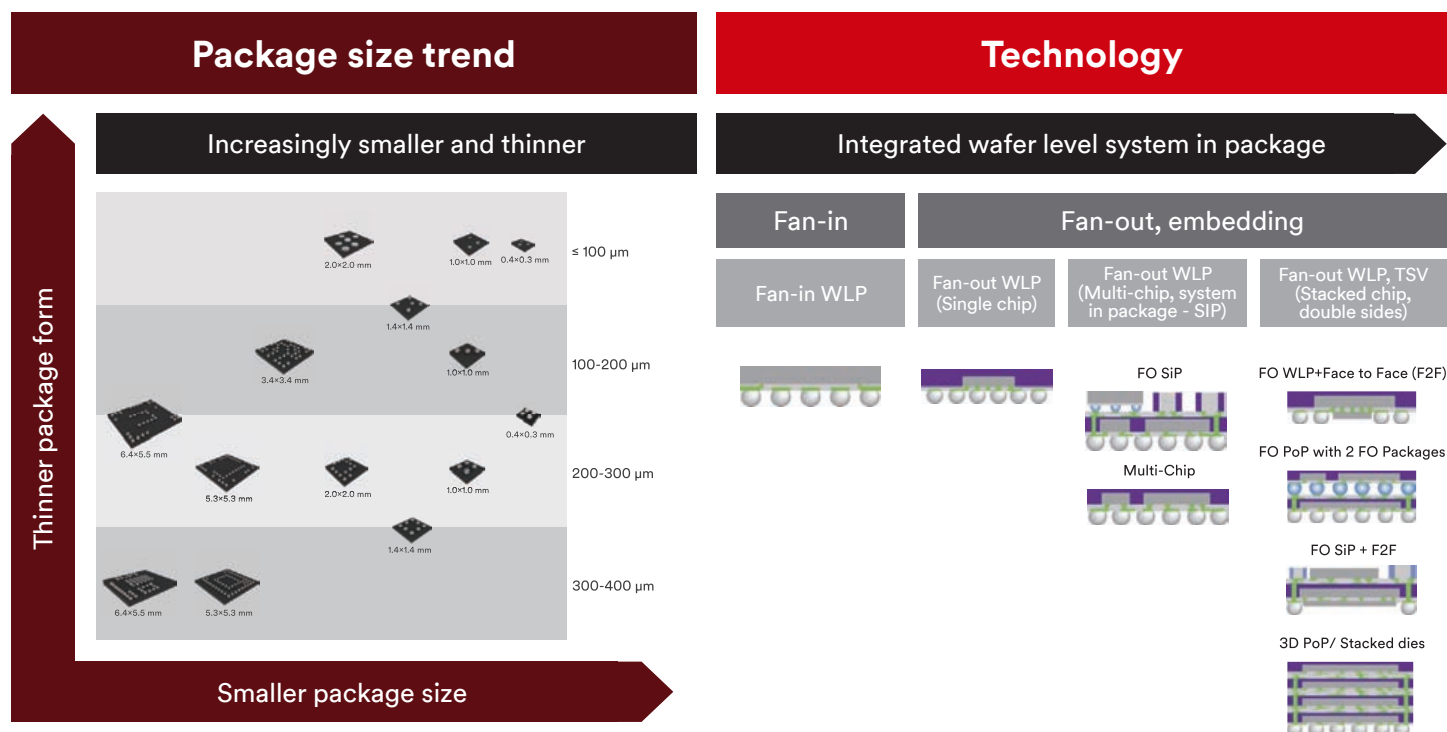


## What are the common concerns about tape-and-reel packaging for advanced packaging components?

Many package types continue to shrink in thickness, footprint, and overall mass. In some applications, such as WLCSPs, thicknesses are reaching below 0.2 mm or under 1 mm × 1 mm in size. At such minute scales, components may be more prone to flipping, tilting, or rotating within the carrier, migrating out of pocket, or sticking and wetting-out onto the cover tape. These challenges can increase vulnerability to particle contamination and other handling-related risks.



# Wafer level packaging size and technology trends



As semiconductor manufacturers increasingly adopt low-(k) dielectric materials to help improve device performance, chip packages can become more mechanically fragile. These softer materials may provide less structural support to components, potentially increasing the risk of damage during handling and transport, particularly at vulnerable parts of the chip such as corners and edges.

With extensive expertise in design, tool fabrication, and manufacturing, 3M provides high-precision carrier and cover tape solutions with advanced protection features, consistent performance, and cleanroom compatibility to help reduce these risks.

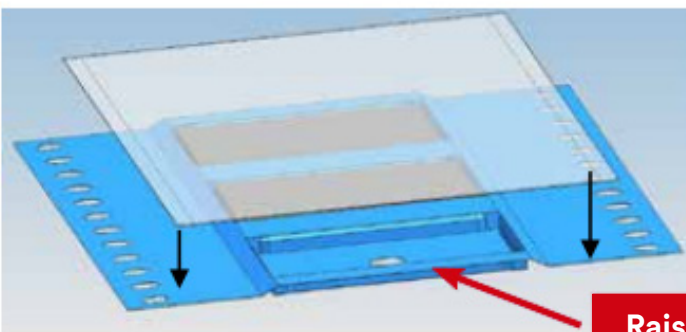
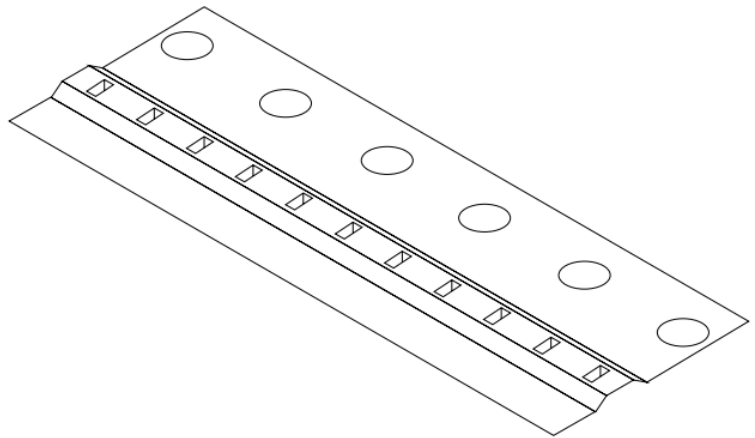
# 3M Carrier Tape Designs

Effective carrier design plays a significant role in device protection and tape-and-reel performance. At 3M, our extensive industrial expertise and outstanding manufacturing capabilities make available a variety of carrier designs to help protect your advanced packages and WLCSP.

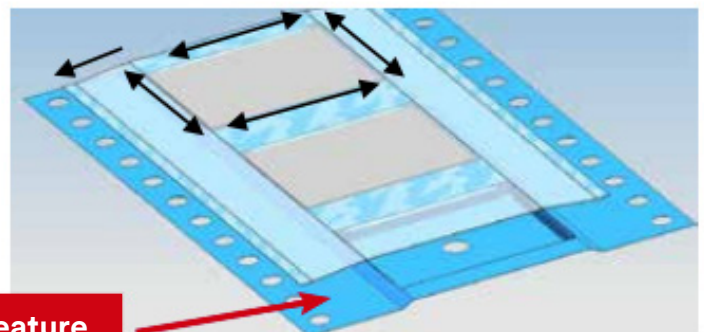
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## 3M raised platform design

The 3M proprietary raised platform design creates cover tape tension around the top pocket edge, helping reduce the gap between cover tape and carrier tape. This can minimize component migration out of pocket and/or tilt or rotation within the pocket.



Applying cover tape onto carrier tape with raised feature design.



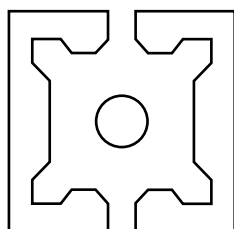
Raised feature creates cover tape tension around top pocket edges.

## 3M raised platform with groove design

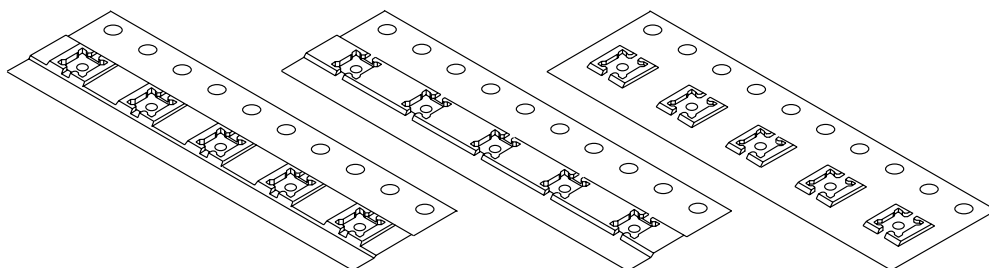
The raised platform with groove design provides additional support to help prevent thin dies from migrating out-of-pocket during shipping and storage. It also helps reduce chip movement while the taped reel is feeding into board production equipment for improved chip line-up during the pick-and-place process.

After sealing, the cover tape curves towards the groove in the pocket center, keeping dies securely in place.

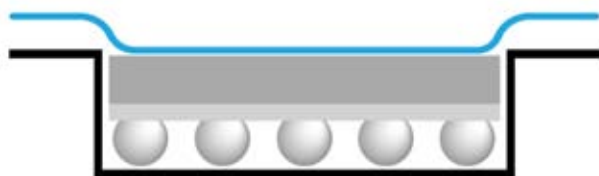
## Examples of 3M raised platform carrier with groove design



Top view



3M groove design of the pocket



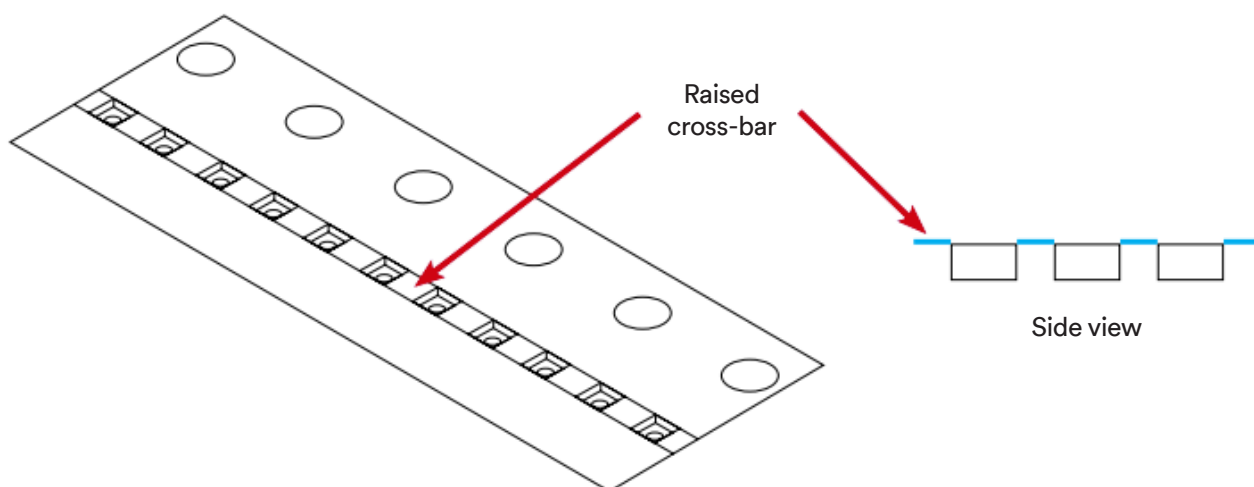
Side view



When the 3M™ Carrier Tape is bent or wound inward, the 3M™ Cover Tape bends in to help capture components securely in the pockets.

## 3M cross-bar design

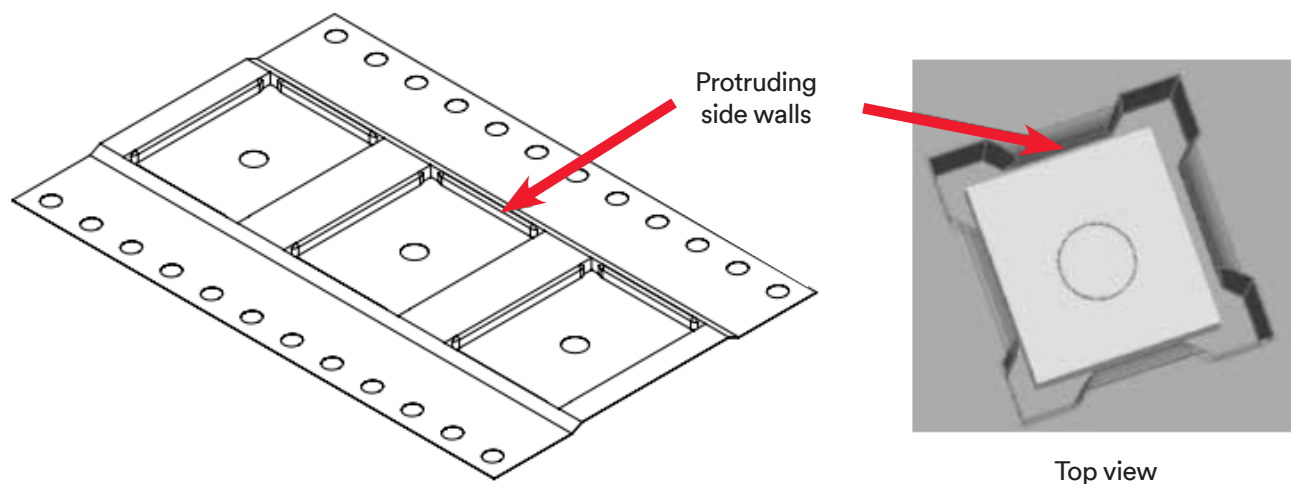
The raised cross-bar between the pockets serves as an impediment to die migration. The increased distance between the cover tape and die surface can also help reduce adhesive contamination in pocket nesting.



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## 3M corner protection design

This smart design helps prevent damage to the die corners and edges during shipping and storage. The middle portions of side walls protrude out to hold the chips securely in place, helping protect the die from chipping or cracking and ultimately helping improve production yield.



The protruding side walls help prevent the component corners from crashing into the side walls.

# Features and Benefits of 3M™ Polycarbonate Precision Carrier Tapes

3M innovative engineering capabilities help produce highly precise and accurate pockets conforming to and helping protect your chips. Moreover, with a broad selection of pocket designs and dimensions, 3M™ polycarbonate precision carrier tapes can effectively fit and help protect your electronic components during shipping or storage.

## 3M™ Polycarbonate Precision Carrier 3000BD

For bare dies and other devices that require high cleanliness and precision, 3M carrier 3000BD is recommended.

3M carrier 3000BD works well with 3M™ Pressure Sensitive Cover Tapes and 3M™ Heat Activated Cover Tapes. It is available in widths of 8 mm to 44 mm in planetary and level-winding format. Customized designs and dimensions may also be available upon request.

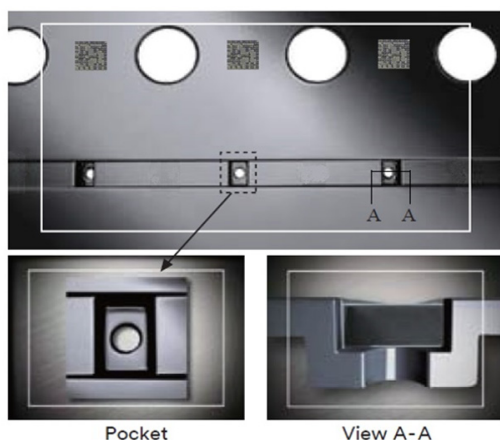


3M carrier 3000BD is cleaned and packaged in a class 10,000 cleanroom environment with particle size controlled below 100µm. Each reel is sealed individually into a static shielding bag for protection from particulate matter that can contaminate bare dies and potentially reduce product yields.

## 3M™ Polycarbonate Extreme Precision Carrier 3000XP

3M carrier (UPC) 3000XP uses the same materials and has the same physical characteristics as 3M™ Polycarbonate Precision Carrier 3000R. However, it has an even tighter pocket dimensional tolerance at  $\pm 0.03$  mm, and the pocket hole (D1) can be as small as 0.15 mm. It is highly recommended for small (size  $< 1$  mm x 1 mm), static-sensitive components.

3M carrier 3000XP works well with 3M™ Pressure Sensitive Cover Tapes and 3M™ Heat Activated Cover Tapes. It is available in width of 8 mm in planetary or level winding format. Customized designs and dimensions may be available upon request.



A pocket with a narrow side wall draft angle ( $< 3^\circ$ ) and flat bottom helps keep components flat in place for more reliable picks.

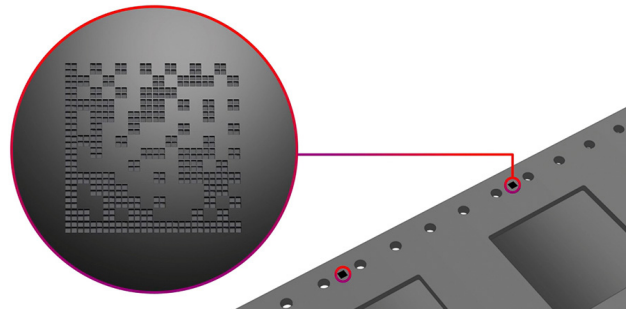


The curved bottom and "bathtub corner" in the typical traditional pocket allows chip movement which can cause problems at the pick-up point.

## 3M™ Polycarbonate Ultra Precision Carrier 3002 2D Barcode Series

3M carrier tape 3002 2D barcode series delivers the precision, performance, reliability and consistency needed for customers to identify each die module in the final package and provide traceability during manufacturing processes.

When the growing popularity of heterogeneous integration, there is a requirement to trace individual modules after being integrated. Marking every module is challenging due to the small die size. Additionally, in 3D stacking, any markings would not be visible after integration, but the need for traceability does not go away. A logical and economic way to achieve traceability is to move the marking onto the carrier tape. A 2D Barcode can be used to encode traceable information for each individual module before integration into a system. Thus, the individual module can be traced by linking 2D Barcodes to the final package in the system. 3M has the process for 2D Barcode marking with laser technology.

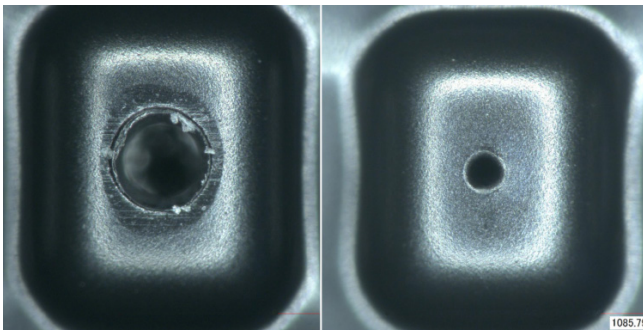


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## 3M™ Polycarbonate Precision Carrier Tape 3200 Series

3M carrier tape 3200 series uses optical precision process to deliver an ultra-small pocket hole. 3M has improved on current conventional mechanical punch method and can deliver small pocket holes. 3M can make pocket hole diameters that are less than 0.1mm. This is necessary because this helps prevent the die bump from being trapped inside the pocket hole. Making small pocket holes with diameters less than 0.1 mm using mechanical punch is not possible, whereas 3M has the technology to make small pocket holes that meet the required criteria.

This capability enables the carrier to sustain vacuum pressure and helps prevent solder balls from adhering to the pocket holes, which would otherwise cause line stoppages in downstream processes. It also helps eliminate burr debris that may contaminate carrier tapes.



# Recommended Applications

## 3M™ Polycarbonate Carrier 3000 Series

### Application recommendation:

Primarily functions for devices that are very sensitive to ESD effects.

### Product recommendations depend on:

- Component size
- Tolerance required
- Cleanroom requirement

### Example component types:

- Active devices
- Middle-size QFN & DFN
- Discrete / passives / LED
- RF, PA die / Integrated passive devices (IPD)
- CoWoS top die / HBM cube

| 3M™ Carrier Tape               | Grade | Grade Meaning                     | Process Enhancement                                                    |
|--------------------------------|-------|-----------------------------------|------------------------------------------------------------------------|
| 3M™ Polycarbonate Carrier 3000 | BD    | Bare die                          | Product is cleaned & packaged in a class 10,000 cleanroom environment* |
|                                | UP    | Ultra precision                   | ±0.03mm tolerance                                                      |
|                                | XP    | Extreme precision                 | ±0.02mm tolerance                                                      |
|                                | UB    | Bare die + ultra precision        | Product is cleaned & packaged in a class 10,000 cleanroom environment* |
|                                | R     | Open radius control               | Open R ≤ 0.10mm                                                        |
| 3M™ Polycarbonate Carrier 3200 | OPPC  | Optical Precision Process Carrier | Small hole for precise pick up                                         |
| 3M™ Polycarbonate Carrier 3002 | 2DID  | QR code (2D barcode)              | High precision readability                                             |

\*Particle Control: 3M™ Polycarbonate Carrier Tape 3000BD and 3M™ Polycarbonate Carrier Tape 3000UB features enhanced cleaning processes for protection from particulate matter that can contaminate bare dies and potentially reduce product yields.

# Features and Benefits of 3M™ Cover Tapes

## 3M Cover Tape Capability Comparison

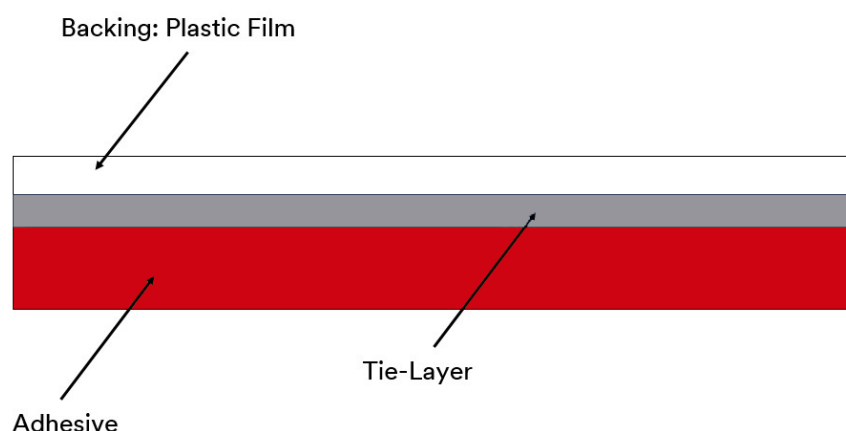
| Attribute           | 3M™ Heat Activated Adhesive Cover Tapes | 3M™ Pressure Sensitive Adhesive Cover Tapes | 3M™ Universal Cover Tapes      |
|---------------------|-----------------------------------------|---------------------------------------------|--------------------------------|
|                     | HAA                                     | PSA                                         | UCT                            |
| Peel force          | >30 grams per inch                      | <30 grams per inch                          | <20 grams per inch             |
| Process window      | Tight; operator-dependent               | Wide; simple pressure/alignment             | Wide; controlled by UCT design |
| Surface resistivity | Non-conductive/static dissipative       | Non-conductive or conductive                | Static dissipative             |
| Tensile strength    | Medium                                  | Highest                                     | High (50% > traditional HAA)   |
| Transparency        | Medium                                  | High                                        | High                           |
| Clarity             | Medium                                  | High                                        | High                           |

**Note:** The above technical information and data should be considered representative or typical only and should not be used for specification purposes.

## 3M™ Static Dissipative Heat Activated Cover Tape 2671A, 3M™ Static Dissipative Heat Activated Cover Tape 2690

3M cover tape 2671A and 3M cover tape 2690 provide reliable sealing performance for a wide range of advanced packaging components. These polyester-based, heat-activated adhesive cover tapes bond securely to polycarbonate carrier tapes and help ensure stable pocket retention for small, thin, and sensitive semiconductor devices throughout transport, storage, and automated handling processes.

Both cover tapes feature controlled surface resistivity to support applications where electrostatic performance is important. The transparent film construction helps enable visual inspection of pocketed components, while the consistent sealing performance helps reduce concerns of device shifting, popping, or loss of retention during high-speed pick-and-place or de-taping operations. Together, these attributes support improved process consistency and help maintain component integrity across demanding production flows.



**3M™ Heat Activated Adhesive (HAA) Cover Tape Construction**

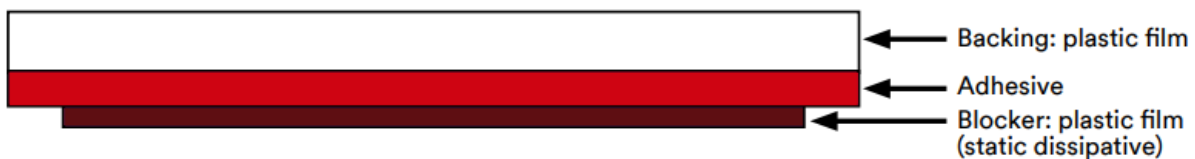
3M cover tape 2671A and 3M cover tape 2690 work well with 3M's family of polycarbonate carrier tapes. They are supplied in splice-free rolls and available in standard widths of 5.4 mm, 9.3 mm, 13.3 mm, 21.3 mm, 25.5 mm, 37.4 mm, and 49.4 mm. Roll length is typically 480 meters.

## 3M™ High Shear Pressure Sensitive Cover Tape (PSA) 2668

3M cover tape 2668 is a transparent, conductive polyester tape equipped with a static-dissipative blocker film on the component side, and synthetic, room-temperature PSA zone along each edge. It is reworkable and bakeable.

This cover tape is a good option for various components — particularly WLCSP — because blocker film and the adhesive zones can effectively reduce the risk of adhesive contamination or contact with devices during shipping and storage.

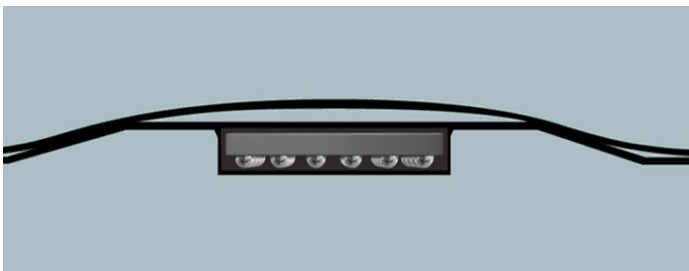
3M cover tape 2668 works well with the 3M family of polycarbonate carrier tapes. It is supplied in 300-meter splice-free rolls and available in standard widths of 5.4 mm, 9.3 mm, 13.3 mm, 21.3 mm, 25.5 mm, 37.4 mm and 49.4 mm.



3M™ Pressure Sensitive Adhesive (PSA) Cover Tape Construction

Due to the following advantages, 3M pressure sensitive adhesive (PSA) cover tapes are a good option to heat activated adhesive (HAA) for maintaining die stability and helping prevent migration out of the pocket.

1. 3M PSA cover tapes usually create a flat seal surface, which helps reduce domes on top of the pockets and help prevent dies from tilting, flipping, disorientation and migration out-of-pocket.
2. 3M PSA cover tapes have more consistent peeling performance than HAA cover tapes and help keep chips from bouncing out of the carrier during the de-taping process.



Typical HAA cover tape can create domes after sealing. The extra headspace may cause the components to migrate out-of-pocket during the de-taping process.

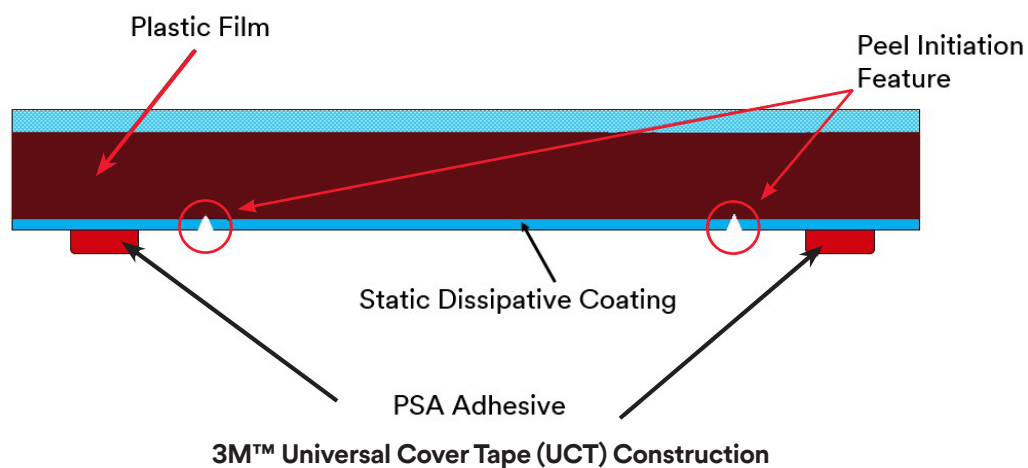


3M™ Pressure Sensitive Adhesive (PSA) Cover Tape creates flat seal surface that helps minimize die migration.

## 3M™ Static Dissipative Universal Cover Tape (UCT) 2688A

3M cover tape (UCT) 2688A has the best peeling performance among our 3M cover tapes and is highly recommended for WLCSP, bare dies, ultra-small and ultra-thin packages. 3M cover tape 2688A is a transparent film tape with synthetic, room temperature PSA zones along the edges.

3M cover tape 2688A has a simple process window. The stable removal force is obtained by peel initiation and removal of the medial section of cover tape. Smooth peeling helps effectively reduce vibration and minimize component movement in the pockets or slipping out during the de-taping process.



3M cover tape 2688A works well with the 3M family of polycarbonate carrier tapes. It is supplied in 300-meter splice-free rolls and available in standard widths of 5.4 mm, 9.3 mm, 13.3 mm and 21.3 mm.



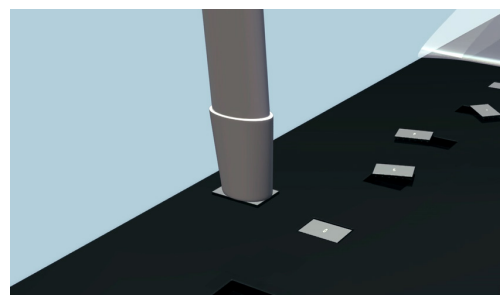
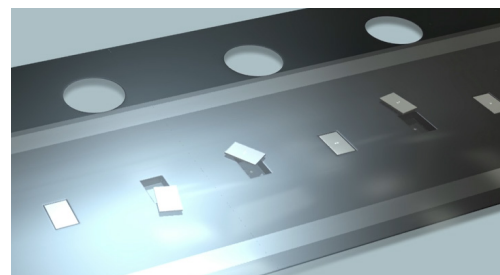
3M™ Universal Cover Tape 2688A is unique in peeling process that removes only the center of the cover tape, creating consistent peeling with tight range.

# Recommended 3M System Solutions to Common Advanced Packaging Problems

## Issue

❌ Thin chips can slip out-of-pocket.

When the carrier pockets are too deep, the side wall draft angle is too wide or the heat-sealed cover tape creates domes (i.e. extra headspace) on the pocket top. This can cause the thin components to easily slip out-of-pocket or migrate to the adjacent cavity, causing mis-picks during the pick-and-place process.



Out-of-pocket migration of thin chips may disrupt the pick-and-place operation.

## Solution

✅ 3M recommends the following system solutions that can reduce room and headspace in the pockets to help securely capture the chips in place:

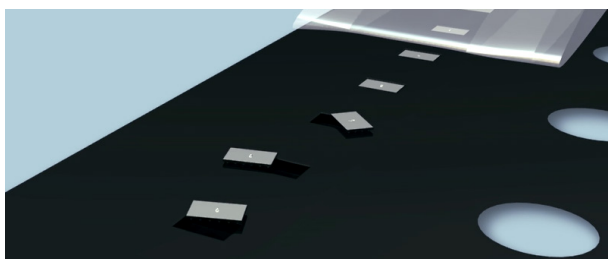
| With raised cross bar |                                                                         |
|-----------------------|-------------------------------------------------------------------------|
| Carrier Tape          | 3M™ Polycarbonate Precision Carrier 3000UP                              |
|                       | 3M™ Polycarbonate Ultra Precision Carrier 3000UPR                       |
| Cover Tape            | 3M™ Pressure Sensitive Cover Tape 2668 / 3M™ Universal Cover Tape 2688A |

| With raised platform and groove design |                                                                         |
|----------------------------------------|-------------------------------------------------------------------------|
| Carrier Tape                           | 3M™ Polycarbonate Precision Carrier 3000UP                              |
|                                        | 3M™ Polycarbonate Ultra Precision Carrier 3000UPR                       |
| Cover Tape                             | 3M™ Pressure Sensitive Cover Tape 2668 / 3M™ Universal Cover Tape 2688A |

## Issue

❌ **Small chips tilt, flip and rotate in the pockets.**

When the carrier tapes with unfit pocket dimensions (A0/B0/K0), wide sidewall draft angles, or heat-sealed cover tapes that may create domes on top of the pockets, the small chips may tilt, flip or rotate in the pockets, leading to chip damage and downtime in the pick-and-place operation.



## Solution

✅ **To help prevent small chips from tilting, flipping and rotating in the pockets, 3M recommends the following system solutions with highly precise pockets to firmly capture the chips in place:**

| With raised platform |                                                                          |
|----------------------|--------------------------------------------------------------------------|
| Carrier Tape         | 3M™ Polycarbonate Ultra Precision Carrier 3000UP                         |
|                      | 3M™ Polycarbonate Ultra Precision Carrier 3000XP                         |
| Cover Tape           | 3M™ Pressure Sensitive Cover Tape 2668<br>3M™ Universal Cover Tape 2688A |

| With raised cross bar |                                                                          |
|-----------------------|--------------------------------------------------------------------------|
| Carrier Tape          | 3M™ Polycarbonate Ultra Precision Carrier 3000UP                         |
|                       | 3M™ Polycarbonate Ultra Precision Carrier 3000XP                         |
| Cover Tape            | 3M™ Pressure Sensitive Cover Tape 2668<br>3M™ Universal Cover Tape 2688A |

## Issue

### ⊗ Chips stick or wet out onto the cover tape.

When cover tape is pressed down in pocket nesting, adhesive contamination, die contact and chip stick can occur. If the surface resistivity of the cover tape is poor, static charges may cause chip damage and lead to yield loss.



## Solution

✓ **3M™ Cover Tapes** have stable surface resistivity and a high performance blocker layer designed to help reduce the chip stick concern. The following solutions are recommended to help prevent cover tape indentation in pocket nesting:

| With raised platform |                                                                          |
|----------------------|--------------------------------------------------------------------------|
| Carrier Tape         | 3M™ Polycarbonate Ultra Precision Carrier 3000UP                         |
| Cover Tape           | 3M™ Pressure Sensitive Cover Tape 2668<br>3M™ Universal Cover Tape 2688A |

| With raised cross bar |                                                                          |
|-----------------------|--------------------------------------------------------------------------|
| Carrier Tape          | 3M™ Polycarbonate Ultra Precision Carrier 3000UP                         |
| Cover Tape            | 3M™ Pressure Sensitive Cover Tape 2668<br>3M™ Universal Cover Tape 2688A |

## Issue

❌ **Tiny chips are easily contaminated by dust and burr.**

Packing in soiled cavities of a carrier tape, the tiny chips will be contaminated by dust or burr, leading to yield loss.



D1 hole with burr from mechanical punch



D1 hole without burr using 3M™ Optical Precision Process Carrier (OPPC)



## Solution

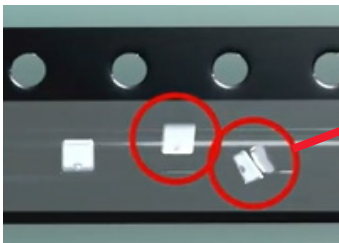
✅ **3M recommends the following system solution to address particle contamination. The recommended carrier tape is cleaned and packed in a class 10,000 cleanroom environment. The planetary or level winding plastic reel is then sealed individually into a static shielding bag for protection:**

|              |                                                  |
|--------------|--------------------------------------------------|
| Carrier Tape | 3M™ Polycarbonate Precision Carrier 3000BD       |
|              | 3M™ Polycarbonate Ultra Precision Carrier 3000UB |
| Cover Tape   | 3M™ Pressure Sensitive Cover Tape 2668           |
|              | 3M™ Universal Cover Tape 2688A                   |
|              | 3M™ Heat Activated Cover Tape 2671A              |

## Issue

❌ **Dies can easily crack or become damaged.**

When the pressure at the contact points of chip corners, edges and side walls is too strong, the chip can crack and break.



## Solution

✅ **To help avoid chip damage and yield loss, 3M recommends the following system solution. 3M™ Carrier Tapes are designed to keep the chips firmly in place with their corner protection design.**

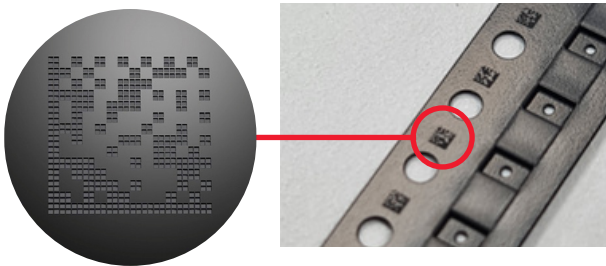
| With corner design |                                                  |
|--------------------|--------------------------------------------------|
| Carrier Tape       | 3M™ Polycarbonate Precision Carrier 3000BD       |
|                    | 3M™ Polycarbonate Ultra Precision Carrier 3000UB |
| Cover Tape         | 3M™ Pressure Sensitive Cover Tape 2668           |
|                    | 3M™ Universal Cover Tape 2688A                   |

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## Issue

❌ Chips are too small to have marking on surface.

When multiple modules are integrated into one WLCSP package, traceability for each module is still required. Due to the small size, marking becomes invisible after integration, so physical marking is impractical, but traceability remains essential.



## Solution

✅ 3M recommends shifting traceability marking to the carrier tape. A 2D barcode on the tape captures module-level data before integration and can be linked to the final package. 3M provides a reliable laser process for precise 2D barcode marking.

|              |                                                                                                                 |
|--------------|-----------------------------------------------------------------------------------------------------------------|
| Carrier Tape | 3M™ Polycarbonate Carrier 3002, 2D Barcode series                                                               |
| Cover Tape   | 3M™ Pressure Sensitive Cover Tape 2668<br>3M™ Universal Cover Tape 2688A<br>3M™ Heat Activated Cover Tape 2671A |

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## Issue

❌ Solder balls on chips get stuck in the pocket hole.

The use of very small pocket holes is an industry requirement as die and pocket dimensions continue to shrink. With these reduced sizes, die bumps can become trapped in the pocket.



## Solution

✅ 3M delivers ultra-small pocket holes for advanced packaging needs that provide reliable performance in high-density applications.

|              |                                                                          |
|--------------|--------------------------------------------------------------------------|
| Carrier Tape | 3M™ Polycarbonate Carrier 3200, OPFC series                              |
| Cover Tape   | 3M™ Pressure Sensitive Cover Tape 2668<br>3M™ Universal Cover Tape 2688A |

# Why 3M for Semiconductor Carrier and Cover Tapes?

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## Deep materials and process expertise

- 3M uses expertise in materials science and precision engineering to design and manufacture carrier and cover tape solutions for demanding WLCSP and advanced packaging applications.
- 3M delivers end-to-end chip transport solutions with enhanced carrier tapes and cover tapes designed to meet the evolving complexity of advanced packaging.

## Customizable, application-focused design

- 3M teams work directly with customers to develop features such as precision formed pockets, dust particle control, and traceability elements tailored to specific device and process requirements.
- 3M™ Cover Tape portfolio offering (HAA, PSA, UCT) offers optimized sealing, clarity, ESD control, and process flexibility for diverse applications.

## Global manufacturing presence

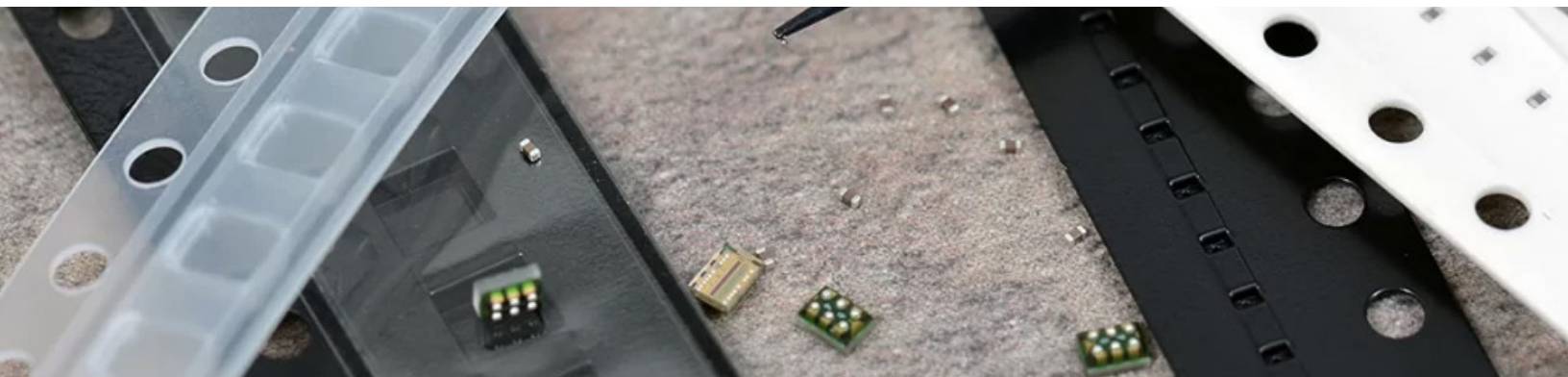
- Production sites in Japan, Singapore, China, and Taiwan support supply continuity, timely delivery, and regional manufacturing requirements.

## Consistent performance supported by quality systems

- Polycarbonate carrier platforms support a wide range of device sizes, tolerances, cleanroom needs, and traceability requirements.
- Innovations such as open radius control, ultra precision pockets, OPPC hole technology, and 2D ID barcodes enhance transport security and process performance.

## Support across the packaging flow

- 3M provides technical guidance, troubleshooting support, and access to global sales, engineering, and R&D resources from initial design through final end-user application.



# Important Notice and Disclaimer

**Safety Data Sheet:** Consult Safety Data Sheet before use.

**Regulatory:** For regulatory information about this product, contact your 3M representative.

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**3M Display and Electronics**  
3M Center, Building 223-3S-32  
St. Paul, MN 55144-1000

Phone 1-800-362-3550  
[www.3M.com/semiconductor](http://www.3M.com/semiconductor)

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