Use of Surftape® Carrier Tape to Ship TI Bare Die and Small Packages

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ABSTRACT

Surftape® cross-functional carrier tape is a new product being used to ship bare-die integrated circuits to automotive customers. This tape is punched carrier tape, with an adhesive tape applied to the bottom of the cavity to hold components in place. The tape allows for a single-size cavity to hold various die or package sizes. This reduces tape inventory because one tape can be used for multiple die. Also, the bottom adhesive tape eliminates the need for a top cover tape to constrain the components. This tape has been qualified by and is currently in production use by the Texas Instruments (TI) Automotive Products Group (APG).

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Surftape is a trademark of Tempo Electronics.

1 Introduction

Packing is the final step in getting a good product to the customer. At Texas Instruments (TI), various packing media and methods are used, including magazines, trays, waffle packs, gel packs, and tape and reel. These materials are extremely important because they ensure that the product gets to the customer free of mechanical and/or electrical damage. The primary TI shipping method is tape and reel for dual in-line, BGA, chip-scale, and wafer-scale packages. The new Surftape® carrier tape is being used for some shipments. This tape has many advantages over conventional carrier tape and is being used to ship bare die to customers. Because Surftape is new to TI and to its customers, this application report characterizes and defines the current application.

Today, all TI groups cannot use Surftape because a special feeder is needed to extract the die or packages from the tape. This feeder is offered by several manufacturers that are listed on the Surftape website (www.surftape.com). Some TI product groups sell via distribution and, as a result, many unknown customers purchase TI products. Customers receiving a tape they cannot process with their standard machines without buying a special feeder are not likely to purchase TI products again. Thus, Surftape is allowed to be used only by TI businesses that have a customer base that can use the tape without any issues. Currently, only the Automotive Products Group uses this tape for automotive applications.

2 Industry Requirements

The consumer-electronics, automotive, and defense industries are focused on product or component miniaturization in order to provide more efficient products. This miniaturization is attained by using smaller packages (area and height) that allow reduced board size, less product volume, and less weight. Package volume and weight are extremely important for various reasons in each industry. In the automotive world, lightweight cars, for the most part, are more economical. Product performance comes from three areas: increased functions, increased heat dissipation, and improved electrical parasitics. The number of functions per circuit board can be increased because devices are smaller, and more devices can be added to the board. Heat dissipation is important because the package with the best thermal dissipation typically can run at faster speeds. Finally, packages with better electrical parasitics generally have lower signal noise. This is important because high-end processors require logic devices for a stable, clean signal output. All of these advantages are complicated by the fact that consumers do not want to pay more for new technology. Thus, manufacturers must develop processes that do not increase cost significantly. This is a challenge because smaller packages often need new, more-accurate equipment for processing. The current trend is toward bare-die sales or wafer-scale packages, which presents another challenge—how to deliver these new products. For bare-die sales, the problem lies in how to deliver small (less than 1 mm) die to the customer effectively. TI has chosen Surftape as one solution to this problem for the automotive industry.

3   Surftape Defined

3.1   What is Surftape?

Surftape is punched carrier tape, with two strips of adhesive tape on the bottom of the cavity to constrain the component (see Figure 1). The carrier tape is modified polystyrene or ABS/polyethylene, combined with carbon black to produce surface conductivity of 10^4 to 10^6 Q/square and a halogen content not exceeding 0.3 ppm. The two strips of adhesive tape are the standard adhesive-film carrier for IC wafers to which wafers are affixed prior to dicing. The tape holds the component in place and does not allow lateral, vertical, or rotational movement until the component is picked up by a vacuum tip. Because the adhesive tape constrains the components, a top cover tape is not needed, making the components accessible for inspection, testing, marking, and other processing by automated means. Surftape can be used for any die or package as long as a single plane on the package can be used as an interface with the adhesive tape. However, this carrier tape has many advantages over other tapes when used with small, lightweight components.

The most common use for Surftape is for automotive-customer bare-die applications. The automotive customers use the bare die on Surftape in their current assembly placement machines for board-level attachment, along with packaged devices. The die are stored on the shelf with other surface-mount devices until assembly is required. After the assembly process is completed, remaining die are returned to the shelf for future use.
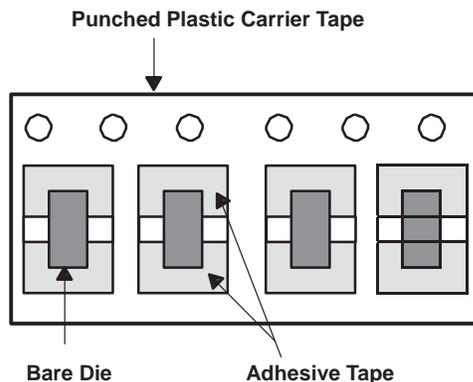

Figure 1. Surftape® **Carrier Tape**

3.2   Surftape Dimensions and Tolerances

Surftape is an industry-standard carrier tape and conforms to IEC 60286-3, EIA/IS-747, EIA 481, and JIS C 0806 standards. With Surftape, the fixed positioning of the components is secured by use of sticky tapes. Therefore, the standardized compartment sizes A0 $\times$ B0 can be used for a wide spectrum of component sizes (see Figure 2).
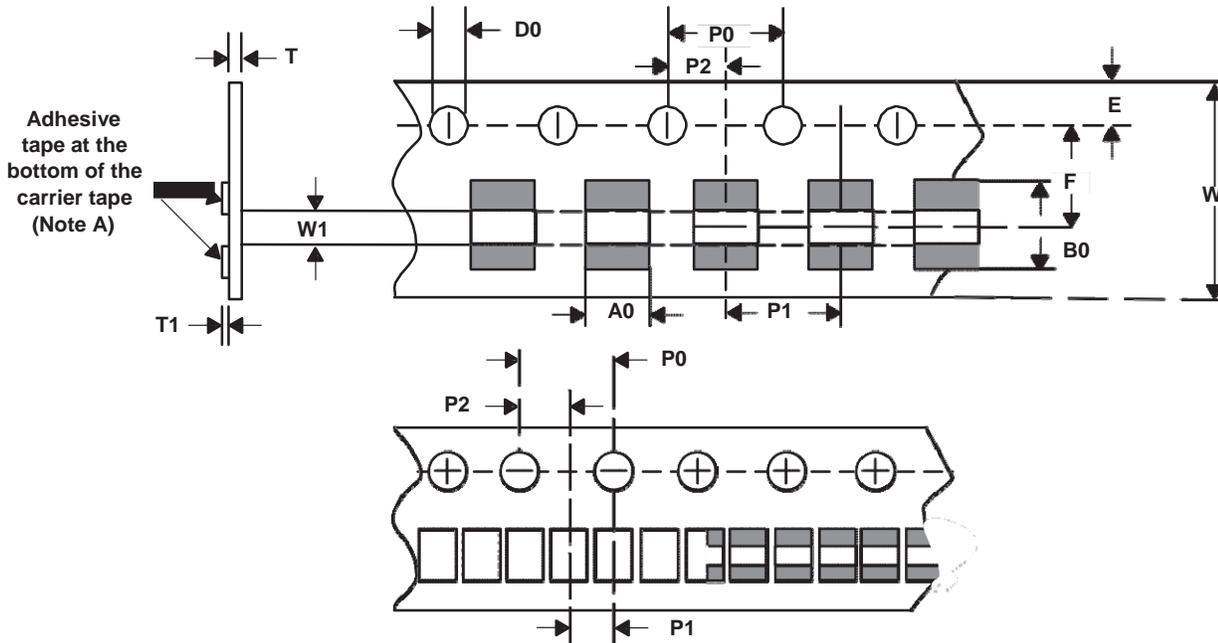
Illustration of 2-mm Cavity Pitch (P1)

FIXED DIMENSIONS (all dimensions in mm)

Tape Size	D0	E	P0 (Note D)	P2	T1 (MAX)	W1
8–44	1.50 (+0.05, -0.00)	1.75 (±0.05)	4.00 (±0.025)	2.0 (basic)	0.10	Note A

VARIABLE DIMENSIONS (all dimensions in mm)

Tape Size	P1 (Basic)	F (Basic)	W (+0.05, −0.00)	T	A0 (NOM)	B0 (NOM)
8	2.00	3.50	8.00		1.5	3.1
8	4.00	3.50	8.00		3.1	3.1
12	4.00	5.50	12.00		3.1	6.35
12	8.00	5.50	12.00	1.1 (MAX) (Note B)	6.35	6.35
16	12.00	7.50	16.00		10.2	10.2
24	16.00	11.50	24.00		14.0	17.3
32 (Note C)	24.00	14.50	32.00		22.0	24.4
44 (Note C)	24.00	19.50	44.00		22.0	36.4

NOTES: A. W1 is determined from the component specifications (dimension B and surface terrain) to achieve:
   1. Secure retention of component in Surftape® compartment during reeling/unreeling
   2. Ready removal using vacuum to pick components from Surftape® in de-reeler equipped with push-up pin; typically, W1 ≤ (1/2 ⋈ component dimension B)
   B. Surftape® is available in standard nominal thickness dimensions (T) of 0.30, 0.45, 0.60, 0.70, 0.75, 0.85, and 1.00 mm. To prevent component contact with adjacent layers when spooled, Surftape® thickness (T) should be ≥ (1.1 ⋈ component thickness).
   C. Surftape® widths of 32 mm and 44 mm have a second set of sprocket drive holes not shown on the drawing above. The location, dimensions, and tolerances of these holes conform to the requirements of IEC 60286-3, EIA 481-3, and JIS C 0806 for 32-mm and 44-mm carrier tapes.
   D. The cumulative tolerance for 40 consecutive pitches is ±0.1 mm.

Figure 2. Surftape® Carrier Tape Dimensions

4 Pin 1 Orientation Rules

Pin or bond-pad 1 location is defined by industry standard EIA-481-B. Pin 1 is closest to the sprocket holes (see Figures 3, 4, and 5). EIA-481 rules dictate that, for rectangular packages, the long axis should be perpendicular to the sprocket holes and pin 1 should be closest to the sprocket holes. For square packages, the side of the package with pin 1 should be parallel to the sprocket holes. For packages where pin 1 is in the corner, pin 1 goes in quadrant 1. Thus, unless directed otherwise by a customer, pin 1 will be in either quadrant 1 or 2.
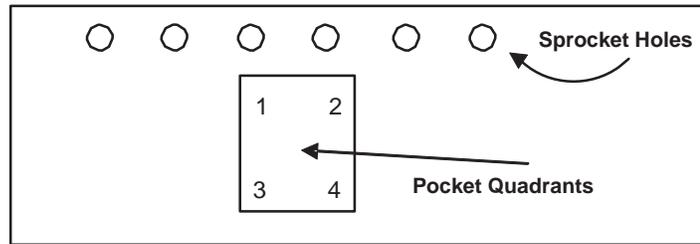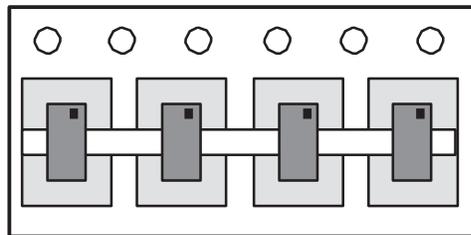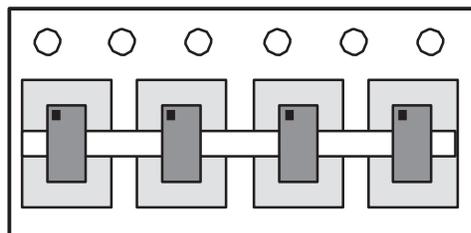
Figure 3. Carrier Tape Cavity Quadrants

■ = Pin 1 Quadrant (die on Surftape®)

Figure 4. Bond Pad 1 in Quadrant 2

■ = Pin 1 Quadrant (die on Surftape®)

Figure 5. Bond Pad 1 in Quadrant 1
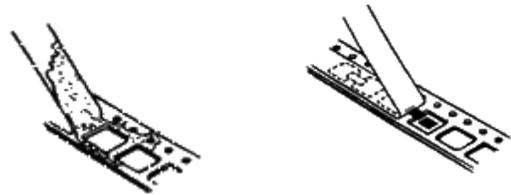
5   Advantages of Surftape

Surftape has several advantages over conventional carrier tape:

1. In certain applications, this carrier tape is faster and more reliable in production because there is no cover tape to break, tear, delaminate the carrier, or spike during peelback. Fewer materials make the process simpler.

2. The tape can be used for multiple packages, ranging from large SOIC packages down to QFN and wafer-scale packages. In addition to bare die, Surftape can be used for bumped bare die. For bumped die, the orientation rules still apply and the back of the die is still attached to the adhesive tape. Because component manufacturers normally want bumped or leaded packages "live bug", Surftape can be installed into the special feeder upside down so that the pick-and-place machine can come through the adhesive tape and extract the component. This can be done because the adhesive tape is split. This is by design.

3. Large and small surface-mount components remain secure on the adhesive tape, exactly as placed, until picked by vacuum. The adhesive tape does not allow any lateral or rotational movement under normal processing and shipping. This is beneficial for bare die and other small components because machine vibration can affect these packages more severely and cause pick-and-place issues.

4. The sticky tape is compatible with current surface-mount processing. The tape contains no halogens, contaminants, or residue that can affect the quality of the surface mounting. Surftape works with existing taping machines, with the addition of an inexpensive tape feeder available from Tempo Electronics or assembly placement-machine manufacturer. This is the one disadvantage to Surftape and the reason the tape cannot be used by all groups within TI. Not all commodity customers have the required feeders or want to purchase them for this type of tape.

5. As noted previously, one pocket size fits many packages, which can reduce the number of tapes to be stocked. If there is sufficient inventory reduction, the increased cost of Surftape, per linear foot, can be justified. Three sizes of Surftape can accommodate the majority of current bare-die sizes (see Figure 2).

6. The contact area between the package and adhesive tape can be adjusted to change the adhesion level, optimizing secure retention during handling and ease of removal during pick and place.

7. Additional advantages are shown in Figure 6 (courtesy of Tempo Electronics).

No tombstoning or flipping-out during cover-tape peelback due to carrier-tape vibration
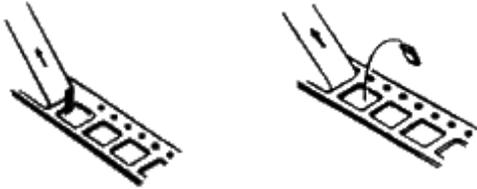
No delamination of carrier-tape or slippage of thin components between cavities
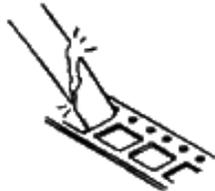
Components do not cling to cover tape during peelback.

With no cover tape, components can be inspected and tested after being inserted in Surftape®.

No breakage or tearing of cover tape during cover-tape peelback

Figure 6. Advantages of Surftape®

6 Qualification Requirements

Surftape has met TI's qualification requirements for carrier tape:

1. First article inspection: This test ensures that the carrier tape conforms to the supplier's drawings and industry standard EIA-763. Additionally, the tape is checked for any visible damage such as pinholes and scratches. This test is performed by incoming QC.

2. Manufacturability: This test ensures that the carrier tape can be used in the manufacturing equipment without any problems, and that the tape is of sufficient quality to allow for problem-free shipping to our customers.

3. Surface resistivity test: This test ensures that the carrier tape falls within the EIA-625 guidelines for static dissipative materials. The static dissipative range has a surface resistivity between 10^4 and 10^{11} Q/square. This range is chosen for TI material to help control tribocharging and ESD discharges, if present.

4. Camber: This test ensures that the carrier tape is straight and not bowed. The tape must have less than 1 mm of camber per 250-mm length to meet qualification requirements.

5. Fit analysis: This test ensures that the package fits within the cavity according to industry-standard guidelines. For traditional packages, such as SOIC, if the pocket is too large, there can be excessive rotation that can cause many machine stops during pick and place. Additionally, an excessively large cavity can cause more bent leads. Because Surftape uses an adhesive tape to hold the package, rotational and bent-lead concerns are not an issue. This test is not performed, other than to ensure that the package fits in the tape cavity.

6. Drop test: TI final packaged reels are dropped six times on a concrete surface from a height of 30 inches to ensure that no damage occurs if the box is dropped during shipping or handling. The drop height is normal tabletop height and hand-carrying height. No units were dislodged when dropped.

7. Shelf Life: TI product has a two-year shelf life. Product must remain usable for this period. The tape used to hold the packages does not lose its adhesiveness over this time. Storage of die on Surftape for a period longer than 2 years is not recommended due to increased adhesion. The increased adhesion can lead to pick-and-place issues and, possibly, die damage.

8. Ionics and outgassing: The plastic used for this carrier tape meets TI ionics and outgassing requirements (see Table 1). One concern customers have is the outgassing of the adhesive tape, leading to contaminated bond pads on the die surface. The adhesive tape has been used in expanded-wafer sales and has not caused any contamination issues. Die stored in Surftape have been analyzed, and contamination has not been observed. Another concern customers have with Surftape is the possibility of contamination. The absence of a cover tape leaves the die open to environmental contamination if not handled correctly. At TI, the die is placed on the Surftape in a controlled environment and shipped in a moisture-barrier bag with desiccant to prevent any contamination during shipment or while sitting on the customer's shelf. Customer handling of the die must prevent contact with a hazardous environment. It is recommended that the customer store excess die for future production in a moisture-barrier bag for protection.

Table 1. TI Ionic and Outgassing Requirements

Compound	TI Specification Limits[†] (μ-g/cm^2)
Fluoride	0.02
Chloride	0.28
Nitrate	0.01
Phosphate	0.01
Sulphate	0.01
Sodium	0.1
Potassium	0.02

[†] Specification limits reflect TI specifications for plastic wafer shipping boxes.

7   Additional Product Information

For more information regarding Surftape, contact the manufacturer using the contact information below. Surftape is covered by U.S. Patent 5,203,143. Additional patents may be in progress.

Tempo Electronics Corporate Offices
12925 Riverside Dr., Second Floor
Sherman Oaks, CA 91423
Tel: 818-763-9444/Fax: 9411
Email: info@surftape.net

8   Conclusion

Surftape is an extremely versatile carrier tape because one cavity size can hold many different die or package sizes without concern about the effect of machine vibration. The large cavity with the adhesive bottom facilitates inventory reduction. The end user is allowed to pick the package, either live bug or dead bug and, generally, the process is more reliable because no cover tape is used. Also, the tape meets industry-standard requirements for bare-die packing and has met all TI qualification requirements. Surftape is being used in mass production by the TI Automotive Products Group to satisfy the needs of its automotive customers. Surftape has limited use by other groups because the end user needs special feeders. TI commodity businesses cannot assume that end users buying via distributors will have the necessary feeder.

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TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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