

3M™ Electrically Conductive Adhesive Transfer Tape 9704

Product Description

3M™ Electrically Conductive Adhesive Transfer Tape (ECATT) 9704 is a pressure sensitive adhesive (PSA) transfer tape with anisotropic electrical conductivity. The PSA matrix is filled with conductive particles which allow interconnection between substrates through the adhesive thickness (the “Z-axis”) but are spaced far enough apart for the product to be electrically insulating in the plane of the adhesive. The PSA tack properties and lack of any thermal curing make Tape 9704 easy to use in assembly operations.

Tape 9704 is designed to have lower typical outgassing residuals as compared to a similar type conductive adhesive product, such as 3M™ Electrically Conductive Adhesive Transfer Tape 9705.

Tape 9704 electrically connects and adhesively bonds medium pitch flexible circuits with other flexible circuits (flex), rigid printed circuit boards (PCB) or LCD screens. Tape 9704 offers good adhesion to common PCB substrates such as gold, FR-4 epoxy, Kapton™ polyimide and polyester films. Stable electrical performance in any flexible circuit interconnection application may require added mechanical reinforcement (clamping or compressing) in the bond area.

Tape 9704 also electrically connects and adhesively bonds EMI/RFI shield and gaskets to metal frames and enclosures. The low contact resistance and tape construction result in good EMI performance. Tape 9704 can be applied as die cut parts or in roll form and has good adhesion to common EMI/RFI substrates such as, plated surfaces, stainless steel, and smooth gasket materials.

Tape 9704 is a more surface aggressive ECATT on many substrates which will allow a higher level of adhesion build as measured via a peel adhesion test method and as compared to the 3M™ Electrically Conductive Adhesive Transfer Tapes 9703 or 9705. As Tape 9704 is a more aggressive ECATT tape, it is generally not compatible with Indium Tin Oxide (ITO) coatings or other easily corroded surfaces.

Construction

Property	Value
Adhesive Type	Filled Acrylic Pressure Sensitive
Release Liner	Silicone Treated Polyester liner (PET)
Approximate Thickness	
Adhesive	2 mil (50 µm)
Liner	PET = 2 mil (50 µm)

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Typical Physical Properties and Performance Characteristics

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

Adhesive Properties:

Peel Adhesion to Stainless Steel:

(Test Method is based on a modified ASTM D3330, 12 ipm peel rate, 1 in. width, 2 mil PET backing, 180 degree)

Dwell Time @ Room Temperature

23°C

1 Hour

36 oz./in. (3.9 N/cm)

24 Hours

51 oz./in. (5.6 N/cm)

Note: Peel values will often be higher than noted above when using a non-PET backing. Different backing types effect the backing modulus, thickness and stiffness and these differences directly effect the peel test result value. As an example, a 2 mil aluminum backing will change the test value of the peel adhesion as the peel back angle at the interface will change due to the backing stiffness. A 2 mil aluminum backing would generally increase the peel values.

Temperature Performance¹

Application Use Temperatures:

-40 to +85°C in a properly designed end use application. See Note 1.

Application Storage Temperatures:

See “Shelf Life and Storage” comments. End user needs to qualify converted material for a broader storage environmental range.

See also the Application section of this document

Shelf Life and Storage

Tape in roll form: Shelf life 24 months from the date of manufacture when stored in original cartons at 21°C (70°F) and 50% relative humidity.

Outgassing:

The outgassing test for the 3M™ Electrically Conductive Adhesive Transfer Tape 9704 is based on a 3M Test Method that measures the Total Mass Loss (TML) via outgassing excluding water, that can be referred to as the Collected Volatile Condensable Material (CVCN) based on a Head Space (HS) Temperature and Time as is commonly applied in a GC-HS analysis. The Head Space Time, Temperature, sample preparation, etc. can vary with specifics of test methods and so results can vary between test methods. The CVCN of the Tape 9704 is typically < 50% of the CVCN of the standard ECATT product 9705 based on the 3M TM.

Electrical Properties:

Contact Resistance ¹	< 0.3 ohms (3M Test Method, Gold PI Flex onto Gold PCB, RT Initial R, 6 mm ²)
Minimum Gap ²	15 mil (0.4 mm)
Minimum Overlap Area ³	5000 mil ² (3.2 mm ²)

1. The final assembly must be tested to verify that the 3M™ Electrically Conductive Adhesive Transfer Tape 9704 can achieve the desired performance in the assembly's end use application environmental conditions (temperature, humidity, temperature cycling, shock, application assembly design, assembly variation, etc.). Tape 9704 may achieve the -40 to +85°C temperature range (or broader temperature range excursions) in an end use application if the final assembly design is designed so that the conductive particles remain in sufficient mechanical contact between surfaces to achieve the desired contact resistance. Some type of mechanical bond line compression design as determined by the end use customer (clip, clamp, screw, compressed foam, etc.) that will apply a constant minimum pressure across the bond line may be required to meet the desired end use environmental ranges and contact resistance specification. The temperature use range is dictated by two primary items: Temperature performance of the acrylic adhesive (generally in the range of -40°C to about 95°C depending on other environmental conditions) as it supports the conductive particles in the adhesive/ particle matrix and the potential movement of the conductive fillers in the adhesive system in an end use application design. Items contributing to the performance of the Tape 9704 for resistance level performance include, but are not limited to: assembled bond line force (constant force present across the bond line after assembly and over the life of the product), types of substrates bonding, surface features in bonded area, environmental conditions, (temperature, humidity, CTE, shock, environmental cycling, etc.), assembly surfaces and Tape 9704 compatibility, Tape 9704 filler and assembly surfaces galvanic potential compatibility, etc. (See section on mechanical clamping for added information).
2. Minimum free space between adjacent conductors suggested to ensure electrical isolation. Customers may qualify finer pitch performance in their applications.
3. Minimum recommended conductor overlap area (pad area) in the interconnection of individual circuit lines to ensure Z-Axis conduction.

Available Sizes

Slit Tape Width 0.25 to 0.5 inch (6.9 to 13 mm)	Standard Length 36 yds. (32.9 m)	Maximum Length 36 yds. (32.9 m)
0.5 to 24 inch (13 to 609 mm)	36 yds. (32.9 m)	108 yds. (98.8 m)
Normal Slitting Tolerance	0.03125 in. (0.8 mm)	

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Application Techniques

Bonding

- To obtain maximum adhesion, the bonding surfaces must be clean and dry.
- Pressure must be applied to the bond line after assembly to wet the substrates with 3M™ Electrically Conductive Adhesive Transfer Tape 9704 and to engage the conductive particles with the substrates to make electrical connection. Mechanical pressure (roller, metal bar) or finger pressure at 5 to 15 psi (0.03 to 0.10 Mpa) is suggested at 20°C (68°F) to 25°C (77°F). The end user may find through testing that a higher pressure could be more effective in their end use design to meet their specific design criteria. Heat may be applied simultaneously to improve wetting and final bond strength. **See Note A.**
- Tape 9704 is suggested to be applied at a maximum temperature range not to exceed 60°F - 158°F (15°C - 70°C). Tape application below 50°F (10°C) is not suggested because the adhesive will be too firm to wet the surface of the substrate, resulting in low adhesion. **See Note A.**
- Adhesion builds with time, up to 24 to 72 hours may be required to reach final adhesion values.

Note A) Regarding the application of Temperature, Pressure and Time (T-P-T) during assembly and/or lamination: Care must be taken by the end user during assembly as the modulus of the tape will be reduced with the application of heat.

- An application method with ranges of not more than: 5-15 psi @ 15-70°C for 2-30 seconds is suggested as a set of initial evaluation ranges. An example of initial T-P-T that may be evaluated is: 8 psi applied via an assembly fixture using an air actuated pressure pad (pad is a medium firm elastomer) for 5 seconds @ 23°C. The end user may find assembly T-P-T outside these limits works well in their unique application. The noted T-P-T is a suggested starting point of tape bonding criteria and will be influenced by Tape 9704 part size, substrate types, substrate modulus, surface features, flatness, assembly fixtures, etc.
- Final bond strength and conductive performance will be impacted by how Temperature-Pressure-Time interact in an end use assembly method to the desired substrates.
- Care must be used to minimize excessive “Temperature-Pressure-Time” assembly methods as they are applied to the tape during assembly so that the conductive filler/acrylic adhesive matrix is not damaged leading to poor performance (ie: excessive squeeze-out of tape, filler-interface damage, minimize over compression and conductive filler/adhesive matrix damage.)
- A Design of Experiments (DOE) is suggested to establish the optimum bonding conditions for each application assembly.

Mechanical Clamping

To assure electrical resistance stability of Tape 9704 in any flexible circuit interconnection application, or grounding application between various types of substrates, a mechanical clamp or other compressive force (i.e. foam strip held in compression over bond area.) should be considered in the design of the application. Any stress inherent in the assembly design (i.e. tensile, shear, cleavage) or temperature excursions (encountered through normal product use) applied to the bond area could result in an electrical open in the bonded circuit over time when no clamp or mechanism for maintaining a constant compressive forces is used. A well designed mechanical clamp will reduce the environmental stress on the bond line and improve the electrical reliability of the bond. In addition, the temperature operating range for the adhesive can be improved with a properly designed mechanical clamping system to ensure the conducting particles in the Tape 9704 maintain electrical contact. Several types of mechanical clamps have been used successfully including foam strips attached to lids or cases and screw-attached plastic clamps. Contact your 3M Technical Service Engineer for further information about mechanical clamping.

Temperature Performance

The electrical performance of Tape 9704 is more sensitive to environmental changes than is the peel adhesion performance. Contact resistance performance may be compromised, even if holding power is not significantly affected. See note 1 in “Electrical Properties” section. The user is responsible for the environmental performance qualification of Tape 9704 in their design.

Rework

Mechanically separate the parts using torque (for rigid parts) and peel (for flexible parts). Remove the adhesive by rubbing it off with a Scotch-Brite® Hand Pad, clean up the site, and apply new adhesive. The force needed to separate the parts and/or remove the adhesive can be reduced by softening the adhesive by heating 158°F - 212°F (70°C - 100°C) or using solvents.*

***Note:** When using solvents, be sure to follow the manufacturer’s precautions and directions for use when handling such materials.

3M™ Electrically Conductive Adhesive Transfer Tape 9704

General Application Guide

3M has a broad line of Electrically Conductive Adhesive Transfer Tapes (9703, 9704, 9705, 9707, 9709, 9709S, 9709SL, 9712, 9713, 9719, 9723, 7805) that vary in conductive filler types, filler loading design, adhesive chemistry, storage modulus of the conductive tape, adhesion to various surface types, thickness, conformability, etc. The reason that 3M provides a variety of tape products is that the multiple products provide for a range of product attributes that allow end users more options to optimize grounding, EMI shielding and interconnect solutions.

As each end use application has many variables unique to the design, it is suggested that 2 or more products be tested in a Design of Experiments (DOE) to identify the best performing product for the application along with the optimum assembly means (pressure, time, temperature, assembly fixtures, etc.) and final design configuration for desired end use performance.

End use substrate surfaces will vary for many unique characteristics as will the final assembly design specification, design configuration, assembly methods and end use environmental conditions. For example:

- a) End use design substrates to be evaluated with the 3M™ Tapes will vary in surface energy that can impact the adhesion strength of the tape to the surfaces (Stainless Steel vs. Polyimide vs. Gold vs. Nickel plating, etc.).
- b) Substrate surface hardness and inherent conductivity can affect potential filler/surface contact resistance (Stainless Steel vs. Gold vs. Silver Epoxy Ink vs. plated surfaces, etc.)
- c) Modulus or flexibility of the substrates can affect substrate interaction with the 3M™ Tape and environmental aging performance (Rigid PCB vs. Flex circuit vs. Metals vs. substrate thickness)
- d) Contact area for grounding on a substrate can impact the effective contact resistance level achieved in a design (Total contact area [3mm², 25mm², 100mm², etc.) and discrete sizes of individual contact areas (3mm², 10mm², 30mm², etc.)
- e) Substrate surface topography or surface features can impact how the tape can “gap fill or conform to irregularities” and provide adhesion and conductivity between substrates.
- f) Bond line stress in the form of a tensile, cleavage, compression and shear can all affect 3M™ Tape performance in an application (Rigid to Rigid substrates, Multi-layer Flex to Rigid, Thin Flex to Rigid, etc.).
- g) Method of assembly & size of finished parts can affect tape selection (ease of converting and assembly based on die cut part shape and final assembly)
- h) Desired contact resistance level. For example, various applications specification may indicate a contact $R < 100\text{ohms}$ or $R < 10\text{ohms}$ or $R < 1.0\text{ohms}$ target. Each design has its own resistance specification, and within a design, each area can have a different resistance level need.
- i) Environmental conditions (minimum and maximum temperatures, cycling, humidity, etc.)
- j) Assembly methods affect on final performance of the tape with the given substrates (tooling, fixtures, assembly pressure-temperature-time)
- k) Final Assembly configuration: Inherent bond line compression, clamping, stand-alone assembly, etc.

The above end use application variables make it difficult to predict which 3M™ Tape may work “best” to a desired level of performance in an application. Thus, 3M has a broad and unique line of conductive tapes to provide a blend of performance characteristics to evaluate for each application.

3M™ Electrically Conductive Adhesive Transfer Tape 9704

General Application Guide (continued)

Following are some general, basic, comparative tape attributes that might influence end use performance and suggest what products are potential options to be tested for an application:

Product: Adhesive Type, Thickness, Conductive Filler type, Conductivity attributes

3M™ Electrically Conductive Adhesive Transfer Tapes 9703 & 9705: Acrylic Adhesive Type 1A, 50um, Silver Coated Particles Type A, Z-Axis Design

- Tape 9703 is a lower out-gassing version of the Tape 9705. Tape 9703 is typically used in aerospace type applications or where lower out-gassing is a benefit. Tapes 9703/9705 are particle based products that can be evaluated for modest pitch type Z-axis (anisotropic) interconnection. Tape 9705 may provide good contact resistance to hard surfaces (Stainless Steel, Nickel plated surfaces) or medium soft surfaces (gold) for grounding of EMI shields.

3M™ Electrically Conductive Adhesive Transfer Tape 9707: Acrylic Adhesive Type 1SS, 50um, Silver Coated Particles Type C, Z-Axis with variable path length XYZ plus inherent EMI Shielding

- Tape 9707 is a more surface aggressive ECATT on many substrates which will allow a higher level of adhesion build as measured via a peel adhesion test method as compared to the Tape 9709S. As Tape 9707 is a more aggressive ECATT tape, it is generally not compatible with Indium Oxide (ITO) coatings or other easily corroded surfaces. Tape 9707 is designed to have improved contact resistance vs. the Tape 9709 to hard surfaces, such as stainless steel. Tape 9707 has excellent inherent EMI shielding and also good contact resistance to soft surfaces (gold, etc.). The inherent EMI shielding of these products provide for improved EMI shields and shielding effectiveness in an end use design.

3M™ Electrically Conductive Adhesive Transfer Tape 9709: Acrylic Adhesive Type 2A, 50um, Silver Coated Particles Type B, Z-Axis with variable path length XYZ plus inherent EMI Shielding

- Tape 9709 works well on soft surfaces (gold to gold, certain plated surfaces, etc.), but will provide higher contact resistance levels on harder surfaces, such as stainless steel. The inherent EMI shielding of these products provide for improved EMI shields and shielding effectiveness in an end use design as compared to many other types of conductive adhesives tapes.

3M™ Electrically Conductive Adhesive Transfer Tapes 9709S and 9709SL: Acrylic Adhesive Type 2A, 50um, Silver Coated Particles Type C, Z-Axis with variable path length XYZ plus inherent EMI Shielding

- Tapes 9709S and 9709SL are similar with the exception of the release liners used. The Tape 9709SL has premium, low force release liners for applications that require very low liner release. Tapes 9709S/9709SL are designed to have improved contact resistance vs. the Tape 9709 to hard surfaces, such as stainless steel. Tapes 9709S/ 9709SL have excellent inherent EMI shielding and also good contact resistance to soft surfaces (gold, etc.). The inherent EMI shielding of these products provide for improved EMI shields and shielding effectiveness in an end use design. Tapes 9709S/9709SL can be used in a laminate format (Tape 9709S/metal layer/Tape 9709S) to bridge wider gaps or have very robust EMI shielding performance.

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General Application Guide (continued)

3M™ Electrically Conductive Adhesive Transfer Tapes 9712 and 9713: Acrylic Adhesive Type 3A, 89um to 125um, Carbon Scrim Type 1 or Nickel Plated Carbon Scrim Type 2, XYZ-Axis

- Tapes 9712 and 9713 use the same type 3A acrylic adhesive. The key differences are: Tape 9712 is slightly thicker than the Tape 9713 and uses a carbon scrim that generally leads to a higher surface contact resistance vs. the Tape 9713's Nickel plated carbon scrim (a more conductive scrim). As the Tape 9712 is thicker, adhesion can be higher. The Tapes 9712 and 9713 can provide good contact resistance to hard and soft surfaces. But in general, both Tapes 9712 and 9713 will have resistances that are somewhat higher than found with a particle based 3M tape. Tapes 9712 and 9713 also provide excellent die cutting and converting capability as the scrim adds to adhesive support and ease of use.

3M™ Electrically Conductive Adhesive Transfer Tape 9719: Silicone Adhesive Type 1S, 100um, Nickel Plated Carbon scrim Type 2, XYZ-Axis

- Tape 9719 is a silicone version of the Tape 9713 product. The benefits of the silicone based Tape 9719 are: Higher temperature performance, improved adhesion to very low surface energy materials vs. the Tape 9713 (such as silicone based EMI shielding gaskets, etc.)

3M™ Electrically Conductive Adhesive Transfer Tape 9723: Acrylic Adhesive Type 3SS, 60um, Nickel/Copper Plated PET Scrim, XYZ-Axis Design

- Tape 9723 is a more surface aggressive ECATT on many substrates which will allow a higher level of adhesion build as measured via a peel adhesion test method and as compared to the 3M™ Electrically Conductive Adhesive Transfer Tape 9713. As Tape 9723 is a more aggressive ECATT tape, it is generally not compatible with Indium Tin Oxide (ITO) coatings or other easily corroded surfaces. Tape 9723 is a conductive scrim based product that can be evaluated for EMI shielding and grounding. Tape 9723 may provide good contact resistance to hard surfaces (stainless steel, nickel plated surfaces) or medium soft surfaces (gold) for grounding of EMI shields.

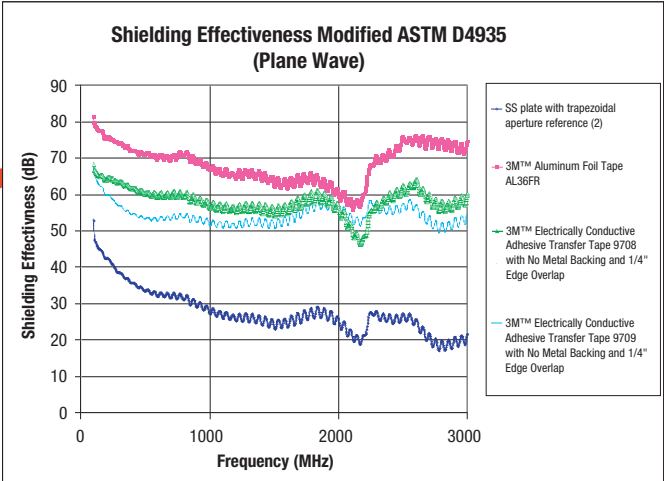
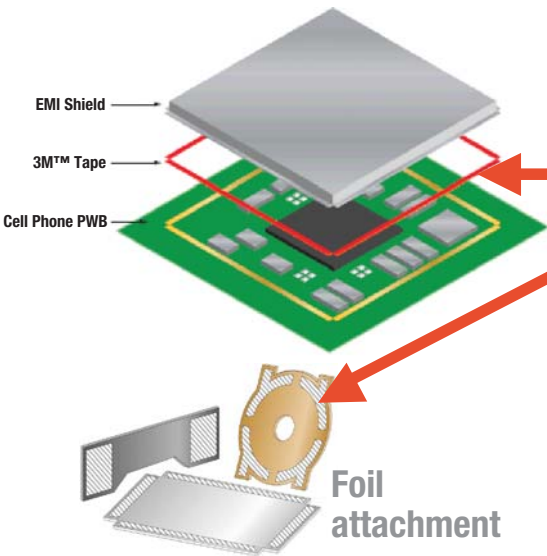
3M™ Electrically Conductive Adhesive Transfer Tape 7805: Acrylic Adhesive Type 4A, 150um, Silver Coated Particles Type D, Z-Axis and XYZ.

- Tape 7805 has been designed to provide a thicker conductive tape. The increased Tape 7805 thickness is achieved through a unique particle concentration design that may allow good resistance levels in a thicker product. The added thickness allows improved conformability, bridging wider gaps, increased tolerance stack-up, etc. Tape 7805 has a degree of inherent EMI shielding that will depend on the end use design. Tape 7805 may work well on soft surfaces (gold to gold, certain plated surfaces, etc.), but will provide higher contact resistance on harder surfaces, such as stainless steel.

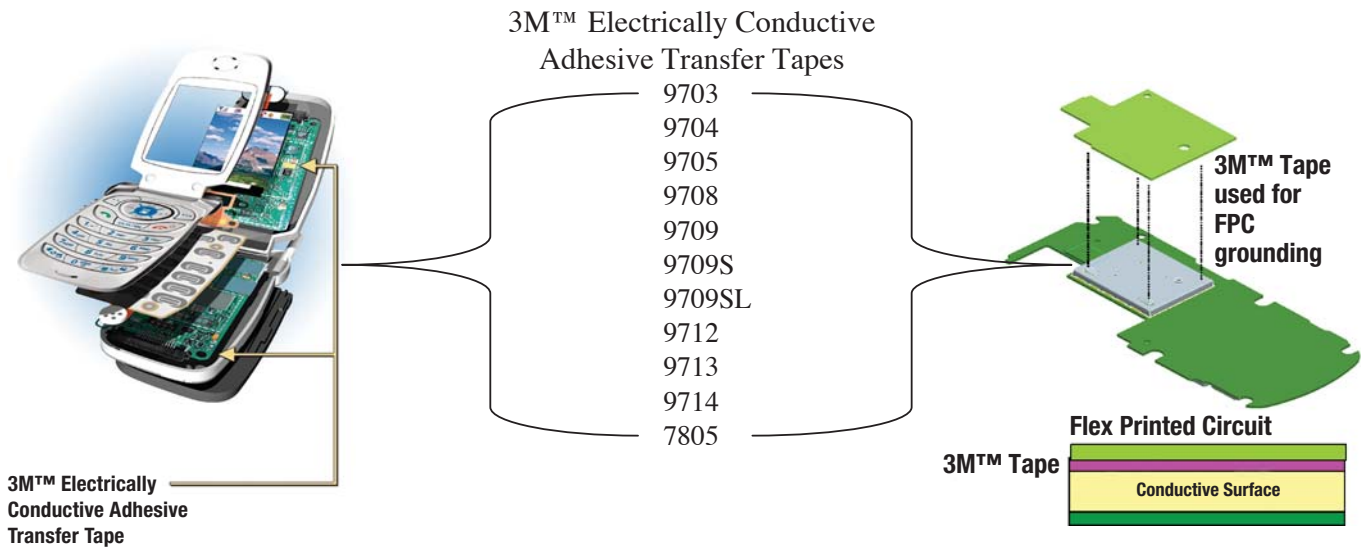
3M™ Electrically Conductive Adhesive Transfer Tape 9704

3M™ Tape Application Benefits

3M™ Electrically Conductive Adhesive Transfer Tapes 9707, 9709, 9709S and 9709SL provide grounding and EMI Shielding through the bond line thickness leading to improved product EMI Shielding performance. 3M™ Electrically Conductive Adhesive Transfer Tape 7805 may provide EMI shielding in the bond line, but actual performance depends on the final design tape width.



3M™ Electrically Conductive Adhesive Transfer Tapes 9703, 9704, 9705, 9709, 9709S, 9709SL, 9712, 9713, 9723 and 7805 can provide FPC grounding and tapes 9707, 9709, 9709S, 9709SL and 7805 can increase the effective EMI Shielding through the bond line thickness leading to improved product EMI Shielding performance of the FPC.



3M™ Electrically Conductive Adhesive Transfer Tape 9704

General Information

3M™ Electrically Conductive Adhesive Transfer Tapes 9703, 9704 and 9705 are part of a family of anisotropic (Z-Axis) conductive tapes and thermoset films. For applications where mechanical clamping is not desired, or where improved electrical, thermal and mechanical performance is required, these alternative thermoset products should be considered.

Product Selection Guide

Product No.	Flex Type			Connection Type			
	Silver Ink on Polyester	Gold/Copper on Polyester	Gold/Copper on Polyimide	Flex to Glass	Flex to Plastic Device	Flex to PCB	Flex to Flex
ACF 5653			X			X	X
ACF 7303	X	X	X	X ¹	X ²	X	X
ACF 7371	X	X	X	X	X		X
ACF 7378		X	X			X	X
ACF 7371-20	X	X	X	X	X		X
ACF 7376-10	X	X	X	X	X	X	X
ACF 7376-30	X	X	X	X	X	X	X
ACF 7379	X	X	X	X			

¹Tested only for silver frit; not suitable for ITO traces.

²Suitable for silver ink traces only, not suitable for ITPO traces.

Application Ideas

3M™ Electrically Conductive Adhesive Transfer Tape 9704 is ideal for interconnection of flexible circuits with other flexible circuits (flex), rigid printed circuit boards (PCB) or LCD screens. Applications include polyester flex circuit splicing, keyboard manufacturing, LCD assembly and many others. Tape 9704 is also ideal for EMI/RFI shield and gasket attachment applications. Applications include EMI shields for displays and gasket attachment to EMI/RFI cabinets and enclosures.

3M™ Electrically Conductive Adhesive Transfer Tape 9704

Certification/Recognition

MSDS: 3M has not prepared a MSDS for this product which is not subject to the MSDS requirements of the Occupational Safety and Health Administration's Hazard Communication Standard, 29 C.F.R. 1910.1200(b)(6)(v). When used under reasonable conditions or in accordance with the 3M directions for use, the product should not present a health and safety hazard. However, use or processing of the product in a manner not in accordance with the directions for use may affect its performance and present potential health and safety hazards.

TSCA: This product is defined as an article under the Toxic Substances Control Act and therefore, it is exempt from inventory listing requirements.

RoHs Complaint/REACH Compliant: This product complies with the European Union's "Restriction of Hazardous Substances" (RoHs) initiative and with European REACH regulations 2002/95/EC and 2005/618/EC.

For Additional Information

To request additional product information or to arrange for sales assistance, call toll free 1-800-251-8634. Address correspondence to: 3M, Electronics Markets Materials Division, 3M Center, Building 225-3S-06, St. Paul, MN 55144-1000. Our fax number is 651-778-4244 or 1-877-369-2923. In Canada, phone: 1-800-364-3577. In Puerto Rico, phone: 1-787-750-3000. In Mexico, phone: 52-70-04-00.

Important Notice

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