



# Anisotropic Conductive Film Adhesive

## 7303

Technical Data

January, 2007

### Product Description

3M™ Anisotropic Conductive Film (ACF) Adhesive 7303 is a heat-bondable, electrically conductive adhesive film. It has a slight amount of tack at room temperature and consists of a thermosetting epoxy/acrylate adhesive matrix randomly loaded with conductive particles. These particles allow interconnection of circuit lines through the adhesive thickness after bonding, but are spaced far enough apart for the product to be electrically insulating in the plane of the adhesive. Application of heat and pressure causes the adhesive initially to flow and to bring the circuit pads into contact by trapping the conductive particles. The thermoset rapidly cures and provides mechanical strength. ACF 7303 may be used to bond a flexible printed circuit to another flexible printed circuit or to a printed circuit board.

### Construction

#### General Properties

| Property           | Value                                        |
|--------------------|----------------------------------------------|
| Adhesive Type      | Epoxy / Acrylate Blend                       |
| Particle Type      | Silver-coated glass                          |
| Particle Size      | 43 microns                                   |
| Liner Type         | Polyester-coated Kraft with Silicone Release |
| Adhesive Thickness | 74 microns                                   |
| Liner Thickness    | 100 microns                                  |

### 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.*

#### Design Requirements

| Property                         | Value                     | Units                                  |
|----------------------------------|---------------------------|----------------------------------------|
| Minimum Space Between Conductors | 250<br>(10)               | micron<br>(mil)                        |
| Minimum Overlap Area             | 0.75<br>(1200)            | mm <sup>2</sup><br>(mil <sup>2</sup> ) |
| Temperature Cycling Range*       | -40 to 80<br>(-40 to 177) | °C<br>(°F)                             |

\*Long-term outdoor use may require additional reinforcement.

# 3M™ Anisotropic Conductive Film Adhesive 7303

## Typical Physical Properties and Performance Characteristics (continued)

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

### Ambient Physical Properties

| Property                               | Test Substrates                 | Value               | Units   |
|----------------------------------------|---------------------------------|---------------------|---------|
| Interconnect Resistance <sup>(1)</sup> | Flex to PC board <sup>(2)</sup> | < 0.2               | Ohms    |
| Insulation Resistance                  | Flex to glass <sup>(3)</sup>    | ≥ 10 <sup>10</sup>  | Ohms-cm |
| Peel Strength <sup>(1)</sup>           | Flex to PC board <sup>(2)</sup> | ≥ 500               | gf/cm   |
| Modulus <sup>(4)</sup>                 |                                 | 1 x 10 <sup>6</sup> | Pa      |

(1) For a given application, values may differ depending on particular flex circuit and PC board materials used.

(2) Measured for silver ink/polyester or gold coated copper/polyester flex circuits bonded to solder, tin, or gold coated copper/FR-4 printed circuit boards. Contact overlap area was 0.75 sq. mm. Pad pitch was 500 microns.

(3) The insulation resistance measurement was made using gold-coated copper/polyimide flex circuits bonded to glass. Circuit line spacing was 0.19 mm. Bias voltage was 50V. Circuit line thickness was 0.058 mm.

(4) Storage shear modulus from dynamic mechanical analysis measured at 25°C using 1 rad/sec.

### Reliability Performance

| Test Conditions           | Notes      | Interconnect Resistance <sup>(5)</sup><br>(Ω)<br>IPC 2.5.4 |
|---------------------------|------------|------------------------------------------------------------|
|                           |            |                                                            |
| 80°C x 1000 hrs           | (6-11)     | < 0.2                                                      |
| 25°C x 4 yrs              | (8, 12)    | < 0.2                                                      |
| -40°C x 1000 hrs          | (8, 12)    | < 0.2                                                      |
| 60°C/95% RH x 1000 hrs    | (6, 7, 10) | < 0.2                                                      |
| 70°C/95% RH x 1000 hrs    | (6, 7, 11) | < 0.2                                                      |
| -40 to 80°C x 1000 cycles | (6, 7-11)  | < 0.2                                                      |

(5) For a given application, values may differ depending on particular flex circuit and PC board materials used.

(6) Contact overlap area was 0.75 sq. mm. Pad pitch was 500 microns.

(7) Flex Circuit: Ag ink/PET PC board: Sn-Pb solder-coated Cu/FR-4

(8) Flex Circuit: Au-coated Cu/PET PC board: Sn-Pb solder-coated Cu/FR-4

(9) Flex Circuit: Au-coated Cu/PET PC board: Sn-Ag-Cu solder-coated Cu/FR-4

(10) Flex Circuit: Au-coated Cu/PET PC board: Immersion Sn-coated Cu/FR-4

(11) Flex Circuit: Au-coated Cu/PET PC board: Au-coated Cu/FR-4

(12) Contact overlap area ranged from 0.9 sq. mm to 5.4 sq. mm. Pad pitch varied from 750 microns to 2 mm.

## Assembly Process Techniques

A source of heat and pressure, such as a thermo-compression (hot bar) bonder is required for use of 3M™ Anisotropic Conductive Film Adhesive 7303. Several commercially available models exist; a list of vendors can be obtained by calling the toll free number on the back of this Technical Data Sheet.

Bonding of ACF 7303 requires a three-part procedure:

- tacking the film to one circuit (pre-tacking)
- removal of the release liner
- bonding the first circuit to the second circuit.

A summary of the pre-tacking and bonding conditions is provided in the table on page 3 and further details of the full process are given in the following sections.

# 3M™ Anisotropic Conductive Film Adhesive 7303

## Assembly Process Techniques (continued)

### Assembly Conditions

| Procedure                   | Conditions                              |
|-----------------------------|-----------------------------------------|
| <b>Tacking Conditions</b>   |                                         |
| Temperature <sup>(13)</sup> | 25 - 35°C                               |
| Pressure                    | 1 - 15 Bar (1 - 15 kg/cm <sup>2</sup> ) |
| Time                        | ~1 second                               |
| <b>Bonding Conditions</b>   |                                         |
| Temperature <sup>(13)</sup> | 140°C                                   |
| Pressure <sup>(14)</sup>    | >18 Bar (18.4 kg/cm <sup>2</sup> )      |
| Time <sup>(15)</sup>        | 25 seconds                              |

<sup>(13)</sup> Temperature measured in the adhesive. Thermode set points will be higher and will depend upon the substrate materials and bond equipment. A typical bonding set-up for a flex interconnect bond is a thermode temperature of 200°C and a bonding time of 30 seconds (see also note 15).

<sup>(14)</sup> Bonding pressure setting depends on the type of circuits used. Further details are provided below.

<sup>(15)</sup> Adhesive requires approximately 25 seconds bond time after required adhesive temperature of 135-150°C is reached to make the electrical connection. Also, it may be desirable to hold pressure while cooling for maximum performance. Total bond time includes the time to ramp to required bond temperature (2-3 seconds), the 25 second hold at bond temperature, and cool-down time. The cool-down time will require hold until temperature is lowered to below 90°C which is highly dependent on the type of bonder used.

### Pre-tacking Method

Pre-tacking is required to attach the 3M™ Anisotropic Conductive Film Adhesive 7303 to one of the circuits to be joined. The ACF 7303 may be attached either by hand or using automated equipment. The ACF 7303 has sufficient tack to adhere to the surface after pre-tacking to allow the backing or liner to be easily removed. The ACF 7303 may also be attached with automated equipment that sections the ACF 7303 to the desired length and attaches it to one of the circuits. This process may include the application of a limited heating not to exceed 35°C. The pre-tacking step requires a pre-tacking temperature of 25-35°C under a pressure of 1-15 Bar (1-15 kg/cm<sup>2</sup> or 15-230 psi).

### Release Liner Removal Method

After pre-tacking to one of the circuits, the liner must be removed. If the ACF 7303 was pre-tacked by hand the liner should be removed using a tweezers. If the ACF 7303 was attached to a printed circuit board, then a razor blade may be required to begin to remove the liner. If the ACF 7303 was attached to flex circuitry, then the flex can be bent slightly along the adhesive length to begin the liner removal. In either case the liner can be fully removed using a tweezers.

If ACF 7303 is attached with automated equipment the liner removal is generally removed by the pre-tacking equipment.

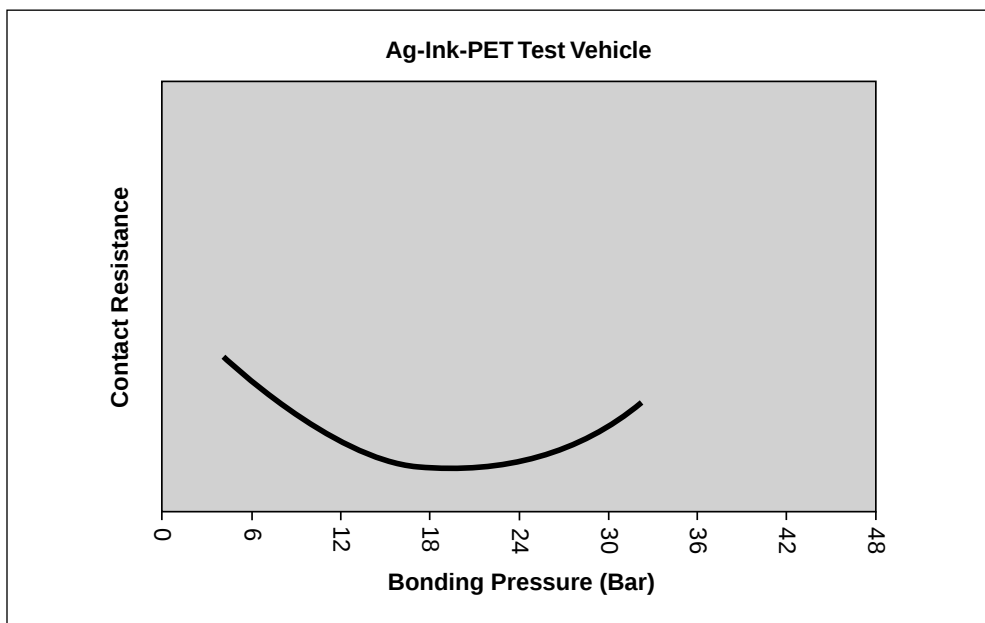
# 3M™ Anisotropic Conductive Film Adhesive 7303

## Assembly Process Techniques (continued)

### Bonding Method

Final bonding must be done under heat and pressure, with a typical desirable bond line temperature of 135-150°C, and a bonding pressure setting that depends on the type of circuitry to be joined. For bonding flex circuitry with silver ink traces a pressure of 18-22 bar (18.4-22.4 kg/cm<sup>2</sup> or 260-320 psi) should be used. An example of the variation in contact resistance found using silver ink circuits bonded to printed circuit boards is shown in Figure 1. A minimum in the contact resistance was found for a bonding pressure of about 20 Bar (20.4 kg/cm<sup>2</sup> or 290 psi). For bonding flex circuitry with gold/nickel/copper traces a pressure greater than 20 Bar (20.4 kg/cm<sup>2</sup> or 290 psi) should be used. An example of the variation in contact resistance found using gold/nickel/copper circuits bonded to printed circuit boards is shown in Figure 2.

Heating the adhesive to the prescribed bonding temperature allows the adhesive to flow and wet over the surface, and enables electrical contact to be made as the circuit pads are pressed together. During bonding, electrical contact is typically achieved after the bond line reaches 135-150°C. Additional time at temperature is necessary to complete the cure of the thermoset in the adhesive. This gives the adhesive high peel strength and reliability. The required bonding time is at least 25 seconds after the adhesive reaches the prescribed bonding temperature.

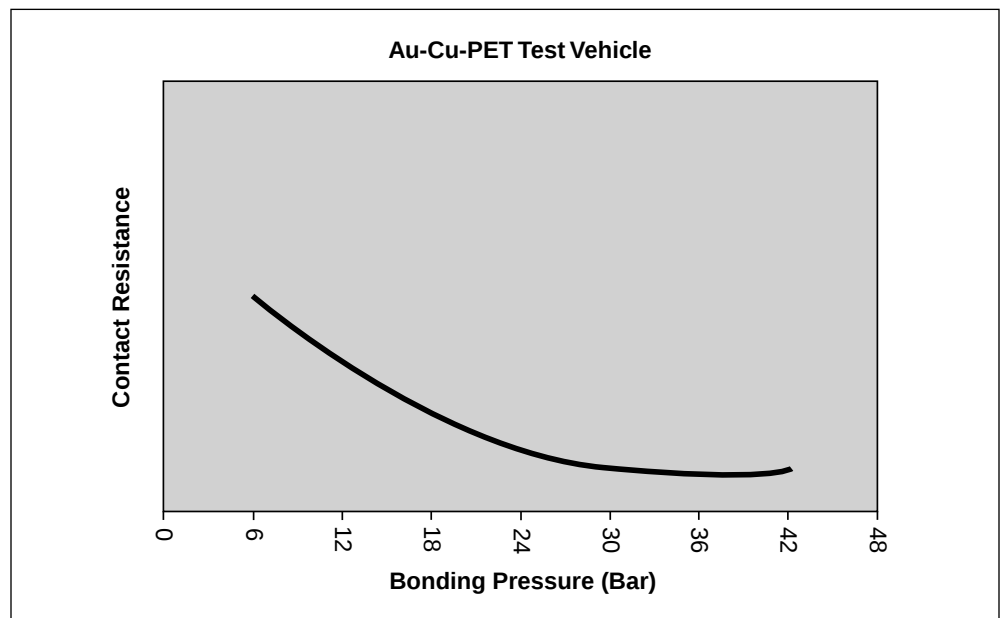


**Figure 1.** Graph of relative contact resistance vs. bonding pressure using polyester flexible printed circuitry with silver ink circuit lines bonded to printed circuit board with gold/nickel/copper circuit lines.

# 3M™ Anisotropic Conductive Film Adhesive 7303

## Assembly Process Techniques (continued)

### Bonding Method (continued)



**Figure 2.** Graph of relative contact resistance vs. bonding pressure using polyester flexible printed circuitry with gold/nickel/copper circuit lines bonded to printed circuit board with gold/nickel/copper circuit lines.

A 30 second bond time, with at least 25 seconds  $>135^{\circ}\text{C}$  may be used as a starting point in developing a bond profile. Bond times may vary depending upon the substrates to be bonded. Pressure may be released after the adhesive reaches full cure but for maximum mechanical and electrical performance, the pressure should be maintained while cooling to below  $90^{\circ}\text{C}$ . This increases the total bond time. The time required to drop adhesive bond-line temperature below  $90^{\circ}\text{C}$  is highly dependent upon the bonding equipment used.

### Repair

Bonds made with 3M™ Anisotropic Conductive Film Adhesive 7303 are repairable by heating the bond-line to above  $100^{\circ}\text{C}$  (e.g. with a hot plate or rework tool) and peeling the circuits apart. The bond site then requires cleaning with a solvent, after which the circuit can be re-bonded using a fresh piece of ACF 7303. Solvents such as 3M™ Novec™ Engineered Fluid HFE-72DA or Acetone may be used.

**Note:** *Carefully read and follow the solvent manufacturer's precautions and directions for use.*

### Storage

ACF 7303 has a shelf life of 18 months from date of manufacture when stored at no more than  $5^{\circ}\text{C}$  ( $40^{\circ}\text{F}$ ) in the original, unopened package. ACF 7303 also has a room temperature shelf life of 9 months from the converting date provided it is stored at no more than  $25^{\circ}\text{C}$  ( $75^{\circ}\text{F}$ ) and is kept sealed and protected from high humidity. ACF 7303 should be stored away from high humidity environments as absorbed water can lead to moisture volatilization producing bubbles during heat bonding.

# 3M™ Anisotropic Conductive Film Adhesive 7303

## Available Sizes

**Rolls:** 2.5 mm (0.1 in.) wide x 35 m (38 yds.) long,  
5.0 mm (0.2 in.) wide x 35 m (38 yds.) long.

## General Information

3M™ Anisotropic Conductive Film Adhesive 7303 mechanical and electrical performance meets or exceeds the performance of silver-ink polyester flexible circuits in environmental testing. ACF 7303 has shown good electrical stability in high humidity testing such as 70°C/95% RH. The data contained in the Typical Physical Properties and Performance Characteristics Tables was obtained on specific flex to printed circuit board interconnections, and the results in a customer application may differ. For specific performance information, please contact your 3M Technical Service Representative.

## Anisotropic Conductive Film Adhesive Produce Selection Guide

| Product   | Flex Type               |                          |                          | Connection Type |             |              | Pitch    |                     |                          |
|-----------|-------------------------|--------------------------|--------------------------|-----------------|-------------|--------------|----------|---------------------|--------------------------|
|           | Silver Ink on Polyester | Gold/Copper on Polyester | Gold/Copper on Polyimide | Flex to Glass   | Flex to PCB | Flex to Flex | Moderate | Fine (≥ 200 micron) | Very Fine (≤ 100 micron) |
| 5363      |                         |                          | x                        |                 | x           | x            |          | x                   |                          |
| 5460R     |                         |                          | x                        |                 | x           | x            |          | x                   |                          |
| 5552R     |                         |                          | x                        | x               |             |              |          |                     | x                        |
| 7303      | x                       | x                        | x                        | x*              | x           | x            | >0.50 mm |                     |                          |
| 7313      | x                       | x                        | x                        | x*              | x           | x            | >0.50 mm |                     |                          |
| 9703/9705 | x                       |                          | x                        |                 | x†          | x†           | >0.76 mm |                     |                          |

\*Tested only for silver frit traces; not suitable for ITO traces.

†Requires mechanical backup for lowest electrical resistance.

## Other Applications

ACF 7303 may be used to connect and bond flex circuits to touch panels for touch screen displays. The conductor traces on the glass panels are made using silver frit. The minimum conductor spacing is 0.25 mm (10 mil) and the minimum pad overlap is 0.75 mm<sup>2</sup> (1200 mil<sup>2</sup>). ACF 7303 is ideal for a wide variety of electronic interconnection applications.

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### 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, Building 21-1W-10, 900 Bush Avenue, 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.

Please examine our entire line of conductive products for electronics at:  
[www.3M.com/electronics](http://www.3M.com/electronics)

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### Product Use

All statements, technical information and recommendations contained in this document are based upon tests or experience that 3M believes are reliable. However, many factors beyond 3M's control can affect the use and performance of a 3M product in a particular application, including the conditions under which the product is used and the time and environmental conditions in which the product is expected to perform. Since these factors are uniquely within the user's knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for the user's method of application.

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### Limitation of Liability

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