3M Science. Applied to Life.™

ePowertrain Electrical Insulation Solutions

3M™ Electrical Tapes provide electrical insulation between energized and grounded parts in electric vehicle batteries.



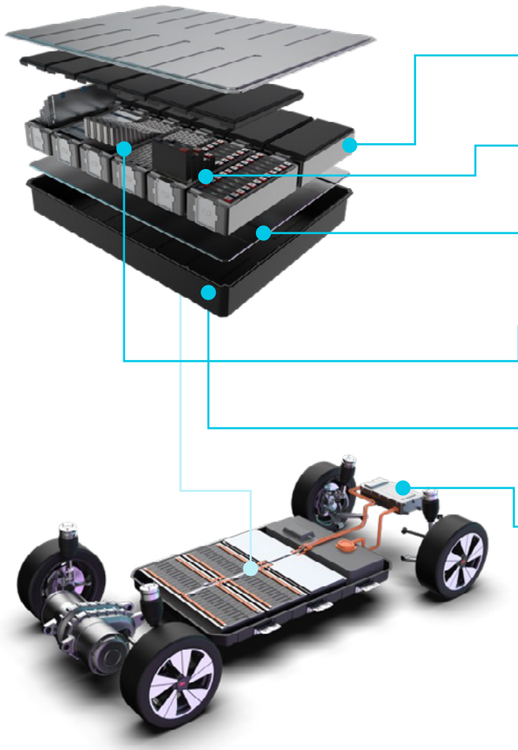
3M™ Electrical Tapes provide electrical insulation between energized parts and ground in electric vehicle batteries.

The correct tape to use will depend on the specific requirements that the customer/application demands:

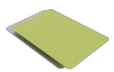
- Cost
- Mechanical strength
- CTI rating
- Halogen free[1]
- Overlap shear bond strength
- Dielectric strength and breakdown voltage

Areas and surfaces where they may be applied include:

- Module side / mid plates
- Cell can
- Cold plate
- Thermal fins
- Busbar
- Pack Retaining Straps



Applications and potential 3M Product Solutions

Potential Applications	Materials for Consideration	Electrical Insulation	High Bonding Strength	High Shear Strength	Flame Barrier
 Module Side / Mid Plate Insulation	3M™ Polyester Film Electrical Tape 1350F-1*	●			
	3M™ Polyester Film Electrical Tape 1350F-2*	●			
	3M™ UV-Initiated Semi-Structural Insulation Tape 1924B-1*	●	●	●	
 Cell Can Wrap, Enclosure Insulation	3M™ Polyester Film Electrical Tape 1350F-1*	●			
	3M™ UV-Initiated Semi-Structural Insulation Tape 1924B-1*	●	●	●	
 Cold Plate Insulation	3M™ Polyester Film Electrical Tape 1350F-1*	●			
	3M™ Polyester Film Electrical Tape 1350F-2*	●			
	3M™ UV-Initiated Semi-Structural Insulation Tape 1924B-1*	●	●	●	
 Cell Spacer Insulation, Thermal Fin Insulation	3M™ Polyester Film Electrical Tape 1351-1*	●			
	3M™ Polyester Film Electrical Tape 1351-1(1.5)*	●			
 Pack Retaining Straps	3M™ Polyester Film Electrical Tape 1350F-2*	●			
	3M™ Polyester Film Electrical Tape 1351-1(1.5)*	●			
	3M™ Insulating Polyester Film Tape 1350T-3*	●			
 Inverter/Power Electronics, Busbar Insulation	3M™ Flame Barrier FRB-NT102 & FRB-NT127**	●			●
	3M™ High-Adhesion Glass Cloth Electrical Tape 91 *, **	●			●
	3M™ Polyester Film Electrical Tape 1350F-1*	●			
	3M™ Polyester Film Electrical Tape 1350F-2*	●			
	3M™ Polyester Film Electrical Tape 1351-1*	●			
	3M™ Polyester Film Electrical Tape 1351-1(1.5)*	●			
	3M™ Polyester Film Tape 1388*	●			
	3M™ Insulating Polyester Film Tape 1350T-1*	●			
	3M™ Insulating Polyester Film Tape 1350T-3*	●			

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** Full Intended and Restricted Use statements https://multimedia.3m.com/mws/media/2148744O/intended-use-statement-vent-path-solutions.pdf

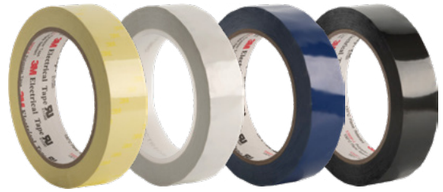
1. Halogen Free defined as i.) no halogen compounds are intentionally added to the product or used in the manufacturing process for the product and ii.) any impurities present are less than 900 ppm bromine, less than 900 ppm chlorine, and/or less than 1500 ppm total bromine and chlorine. The latter are the levels set forth in certain industry standards, such as the International Electrotechnical Commission (IEC) 61249-2-21 standard.

3M™ Polyester Film Electrical Tape 1350F-1, 1350F-2*

3M™ Polyester Film Electrical Tape 1350F series tapes are yellow, white, blue or black, UL recognized flame retardant, 2.5-mils (0.064 mm) or 3.5-mils (0.089 mm) thick tape composed of a 1-mil (0.025 mm) or 2-mils (0.051 mm) polyester film backing coated on one side with a non-corrosive, acrylic pressure-sensitive adhesive. 3M Tapes 1350F-1, 1350F-2 are good options when the only special requirement is flame-retardant dielectric performance.

Product Benefits

- UL Component Recognized: UL510A Standard, Category OANZ2, File No. E17385
- Flame-retardant
- UL temperature rated up to 130°C (266°F)
- Non-corrosive, acrylic pressure-sensitive adhesive
- RoHS Compliant - For Regulatory information including RoHS, REACH, please visit www.3M.com/regs



Product Construction

- Adhesive
- PET film

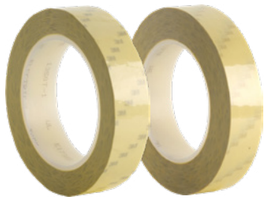
Properties	3M Tape 1350F-1	3M FRB-NT102
Backing thickness	1 mil (0.025 mm)	2 mils (0.051 mm)
Total thickness	2.5 mils, +/-0.5 mils (0.064 mm +/-0.013 mm) per ASTM-D1000	3.5 mils, +/-0.5 mils (0.089 mm +/-0.013mm) per ASTM-D1000
Adhesion to steel	≥ 25 oz/in (2.7 N/cm) per ASTM-D1000	≥ 25 oz/in (2.7 N/cm) per ASTM-D1000
Dielectric breakdown voltage	≥ 5,000 V per ASTM-D1000	≥ 7,000 V per ASTM-D1000

3M™ Polyester Film Electrical Tape 1350T-1, 1350T-3*

3M™ Polyester Film Electrical Tape 1350T series are yellow, UL recognized flame retardant, 3.0-mil (0.076 mm) or 4.5-mils (0.114 mm) thick tapes composed of three bonded polyester film layers of 1.5-mils (0.038 mm) or 3.0-mils (0.025 mm) backing coated on one side with a non-corrosive, acrylic pressure-sensitive adhesive. 3M Tape 1350T-1, 1350T-3 have the added mechanical strength to resist cuts, tears, or burrs.

Product Benefits

- High mechanical strength and dielectric strength
- UL Component Recognized: UL510A Standard, Category OANZ2, File No. E17385
- Flame-retardant
- UL temperature rated up to 130°C (266°F)
- Non-corrosive, acrylic pressure-sensitive adhesive
- UL CTI Rating of Material Group II
- RoHS Compliant - For Regulatory information including RoHS, REACH, please visit www.3M.com/regs



Product Construction

- Adhesive
- PET film

Properties	3M Tape 1350T-1	3M Tape 1350T-3
Backing thickness	1.5 mils (0.038 mm)	3.0 mils (0.076 mm)
Total thickness	3.0 mils (0.076 mm) per ASTM-D1000	4.5 mils (0.114 mm) per ASTM-D1000
Adhesion to steel	≥ 25 oz/in (2.7 N/cm) per ASTM-D1000	≥ 25 oz/in (2.7 N/cm) per ASTM-D1000
Dielectric breakdown voltage	≥ 6,500 V per ASTM-D1000	≥ 10,000 V per ASTM-D1000

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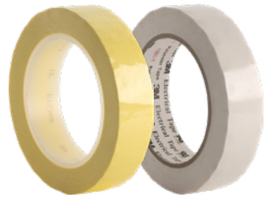
Notes: The technical information and data in the above tables should be considered representative or typical only and should not be used for specification purposes.

3M™ Polyester Film Electrical Tape 1351-1, 1351-1 (1.5) *

3M™ Polyester Film Electrical Tape 1351-1, 1351-1 (1.5) series are yellow and white, UL recognized flame retardant, 2.5-mil (0.064 mm) or 2.8-mil (0.071 mm) thick tape composed of a 1-mil (0.025 mm) or 1.5-mils (0.051 mm) polyester film backing coated on one side with a non-corrosive, acrylic pressure-sensitive adhesive. 3M Tape 1351-1 offers similar performance to the 3M Tape 1350F-1, 1350F-2, but with added benefits of Comparative Tracking Index (CTI) tracking Level 1.

Product Benefits

- Comparative Tracking Index of Material Group I
- UL Component Recognized: UL510A Standard, Category OANZ2, File No. E17385
- Flame-retardant
- UL temperature rated up to 130°C (266°F)
- Non-corrosive, acrylic pressure-sensitive adhesive
- RoHS Compliant - For Regulatory information including RoHS, REACH, please visit www.3M.com/regs



Product Construction

- Adhesive
- PET film

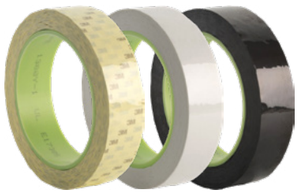
Properties	3M Tape 1351-1	3M Tape 1351-1 (1.5)
Backing thickness	1 mil (0.025 mm)	1.5 mils (0.038 mm)
Total thickness	2.5 mils, +/-0.5 mils (0.064 mm +/-0.013 mm) per ASTM-D1000	2.8 mils, +/-0.4 mils (0.072 mm +/-0.011 mm) per ASTM-D1000
Adhesion to steel	≥ 21 oz/in (2.3 N/cm) per ASTM-D1000	≥ 21 oz/in (2.3 N/cm) per ASTM-D1000
Dielectric breakdown voltage	≥ 5,000 V per ASTM-D1000	≥ 5,500 V per ASTM-D1000

3M™ Polyester Film Electrical Tape 1388*

3M™ Polyester Film Tape 1388 is UL recognized flame retardant, 2.3-mils (0.058 mm) thick tape composed of a 1-mil (0.025 mm) polyester film backing coated on one side with a non-corrosive, non-halogenated flame-retardant acrylic pressure-sensitive adhesive.

Product Benefits

- Halogen Free*
- UL Component Recognized: UL510A Standard, Category OANZ2, File No. E17385
- Flame-retardant
- UL temperature rated up to 130°C (266°F)
- Non-corrosive, acrylic pressure-sensitive adhesive
- UL CTI Rating of Material Group II
- RoHS Compliant - For Regulatory information including RoHS, REACH, please visit www.3M.com/regs



Product Construction

- Adhesive
- PET film

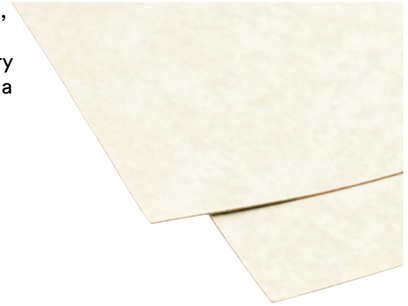
Properties	3M Tape 1388
Backing thickness	1 mil (0.025 mm)
Total thickness	2.3 mils +/-0.15 mils (0.058 mm +/-0.004 mm) per ASTM-D1000
Adhesion to steel	≥ 26.4 oz/in (2.9 N/cm) per ASTM-D1000
Dielectric breakdown voltage (AC)	≥ 5,000 V per ASTM-D1000
Dielectric breakdown voltage (DC)	≥ 10,000 V per ASTM-D3755

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3M™ Flame Barrier FRB-NT102 & FRB-NT127**



3M™ Flame Barrier FRB-NT102, FRB-NT127 is a series of thin inorganic based, halogen free sheet material that has flammability rating, easy to convert and has good compatibility with various adhesives. It provides protection to battery cell areas while allowing venting of high temperature gases/particulates from a battery cell undergoing thermal runaway.

Product Features

- An inorganic-based, halogen-free[1] material
- UL 94 5VA flame rating at low thickness (UL File E65069)
- Excellent ignitability resistance
- Excellent arc/track resistance and good dielectric strength
- Dimensionally stable (low moisture absorption and low shrinkage at high temperature)

Product Construction

- An inorganic-based, halogen free material[1]

Properties	3M FRB-NT127	3M FRB-NT102
Nominal thickness	5 mils (0.127 mm) per ASTM D-645	4 mils (0.102 mm) per ASTM D-645
Basis weight	0.36 lb/yd² (195 g/m²) per ASTM D-202	0.29 lb/yd² (156 g/m²) per ASTM D-202
Tensile strength, MD	31 lb/inch (54 N/cm)	22 lb/inch (39 N/cm)
Dielectric breakdown voltage	2,700 V per ASTM-D149	2,200 V per ASTM-D149
Comparative Tracking Index[2]	PLC 0 per ASTM D3638	PLC 0 per ASTM D3638
Flame rating[2]	V-0, 5 VA per ANSI/UL 94	V-0, 5 VA per ANSI/UL 94

3M™ High-Adhesion Glass Cloth Electrical Tape 91*,**



3M™ High-Adhesion Glass Cloth Electrical Tape 91 is a white, 7-mils (0.178 mm) thick tape composed of a 5.5-mils (0.140 mm) glass cloth backing coated on one side with a non-corrosive, high temperature silicone adhesive, glass cloth backing, and release liner.[3,4]

Product Features

- Thermosetting silicone adhesive, glass cloth backing, and release liner
- Higher adhesion after thermal exposure relative to standard silicone adhesive:
  - Hot Block thermal exposure (550°C for 20 seconds, 3M Internal Test)
  - Torch flame exposure (1200°C for 20 seconds, 3M Internal Test)
- Flame-retardant
- RoHS Compliant - For Regulatory information including RoHS, REACH, please visit www.3M.com/regs

Product Construction

- Liner
- Adhesive
- Glass Cloth

Properties	3M Tape 91
Backing thickness	1 mil (0.025 mm)
Total thickness	7.0 mils +/-1.0 mil (0.178 mm +/-0.025 mm) per ASTM-D1000
Adhesion to steel	≥ 34 oz/in (3.7 N/cm) per ASTM-D1000
Dielectric breakdown voltage (AC)	≥ 2,000 V per ASTM-D1000
Dielectric breakdown voltage (DC)	≥ 4,000 V per ASTM-D3755

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** Full Intended and Restricted Use statements https://multimedia.3m.com/mws/media/2148744O/intended-use-statement-vent-path-solutions.pdf

Notes: The technical information and data in the above tables should be considered representative or typical only and should not be used for specification purposes.

3M™ UV-Initiated Semi-Structural Insulation Tape 1924B-1*

3M™ UV-Initiated Semi-Structural Insulation Tape 1924B-1 consists of a black polyester film and is single side coated with a modified acrylic-based adhesive. This construction provides excellent electrical insulation properties. 3M Tape 1924B-1 has an initial tackiness which is like that of PSA tape. After the adhesive side is initiated with UV light, the bonding strength will gradually increase to semi-structural strength at full cure.

Product Features

- Semi-structural bond strength helps create a more robust electrically insulated surface for bonding additional materials
- UV initiated adhesive system, does not require heat or excessive pressure
- Easy application process, same as PSA tape
- Application at room temperature
- Good initial bonding to help shorten process time
- Excellent aging performance
- Reliable electrical insulation
- Low tack prior to curing for easy positioning



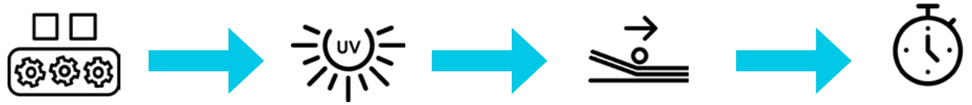
Product Construction



Properties	3M Tape 1924B-1
Backing thickness	3.9 mils (0.10 mm)
Total thickness	5.5 mils (0.14 mm) per ASTM-D1000
Overlap shear strength (to aluminum)	> 4.5 MPa per GB/T 7124-2008
Dielectric breakdown voltage	> 10,000 V per ASTM-D1000

Note: The above technical information and data is based upon limited 3M testing conditions and should not be used for specification purposes. Properties measured at room temperature 73°F (~23) unless otherwise stated.

Application Process



Converting

Converting under yellow light (e.g., Philip TL-D 18W/16) to delay curing. Package with black plastic bag.

UV initiation*

UV light irradiates the adhesive side to initiate cure. The range of energy of the UVA band is 1,500~3,000 mJ/cm2 (365nm LED UV light).

Application/Lamination

After irradiation of UV light, the recommendation is to laminate on substrate within five minutes. The pressure of lamination needs to be above 0.15 Mpa.

Curing

After lamination, it will take 72 hours to reach about 80% bonding strength and about a week to reach maximum bonding strength at room temperature. If it needs to be accelerated, it is recommended to cure at 80° C for 30-60 minutes.

*Note: New developmental UVi insulation tapes are anticipated to have more flexibility in the application process whereby the UV initiation can be done after the application/lamination step.

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2. UL QMFZ2/E65069 assigned rating

3. Intended Use: 3M™ High-Adhesion Glass Cloth Electrical Tape 91 is intended for use in certain automotive and industrial applications requiring thermal resistance, electrical insulation, and flame retardance.

4. Restricted Use: 3M advises against the use of this 3M product in any application other than the stated intended use(s), since other applications have not been evaluated by 3M and may result in an unsafe or unintended condition.

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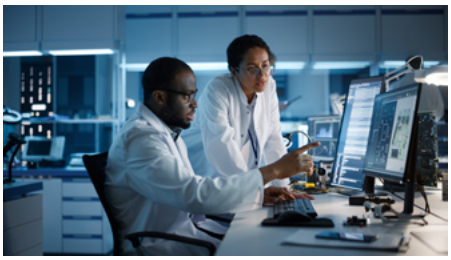
Notes: The technical information and data in the above tables should be considered representative or typical only and should not be used for specification purposes.

3M™ Tape Comparison:

Product	Key Benefit
3M™ Polyester Film Electrical Tape 1350F-1, 1350F-2	Baseline dependable electrical insulating performance
3M™ Polyester Film Electrical Tape 1351-1, 1351-1 (1.5)	Comparative Tracking Index of Material Group I
3M™ Polyester Film Tape 1388	Halogen Free[1]
3M™ Polyester Film Electrical Tape 1350T-1, 1350T-3	High mechanical strength and dielectric strength
3M™ UV-Initiated Semi-Structural Insulation Tape 1924B-1	Applies like a standard tape, then UV-initiated adhesive system increases semi-structural bonding after full cure
3M™ Glass Cloth Automotive Electrical Tape 91	High-temperature survivability

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Our engineers will collaborate bench-to-bench with you to understand your design and manufacturing needs.



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