Typical Physical Properties

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

3M™ VHB™ Tapes				Adhesive and Foam			Release Liner		
Family	Number	Color	Tape Thickness Inches (mm) Tolerance	Adhesive Type	Foam Type	Density lb/ft³ (kg/m³)	Type	Thickness Inches (mm)	Color
4950	4914	White	0.010 (0.25) ± 15%	Gen Purp	Firm	50 (800)	DK Paper	0.003 (0.08)	White (printed)
	4920	White	0.015 (0.4) ± 15%	Gen Purp	Firm	50 (800)	DK Paper	0.003 (0.08)	White (printed)
	4929	Black	0.025 (0.6) ± 15%	Gen Purp	Firm	50 (800)	Polyester	0.002 (0.05)	Clear
	4930	White	0.025 (0.6) ± 15%	Gen Purp	Firm	50 (800)	DK Paper	0.003 (0.08)	White (printed)
	4930F	White	0.025 (0.6) ± 15%	Gen Purp	Firm	50 (800)	PE Film	0.005 (0.13)	Red
	4949	Black	0.045 (1.1) ± 10%	Gen Purp	Firm	50 (800)	Polyester	0.002 (0.05)	Clear
	4950	White	0.045 (1.1) ± 10%	Gen Purp	Firm	50 (800)	DK Paper	0.003 (0.08)	White (printed)
	4955	White	0.080 (2.0) ± 10%	Gen Purp	Firm	50 (800)	Polyester	0.002 (0.05)	Clear
	4959	White	0.120 (3.0) ± 10%	Gen Purp	Firm	50 (800)	Polyester	0.002 (0.05)	Clear
	4959F	White	0.120 (3.0) ± 10%	Gen Purp	Firm	50 (800)	PE Film	0.005 (0.13)	Red
4945	4945	White	0.045 (1.1) ± 10%	Multi-Purp	Firm	50 (800)	DK Paper	0.003 (0.08)	White (printed)
	4946	White	0.045 (1.1) ± 10%	Multi-Purp	Firm	50 (800)	PE Film	0.005 (0.13)	Red (printed)
4910	4905	Clear	0.020 (0.5) ± 15%	Gen Purp	Solid	60 (960)	PE Film	0.005 (0.13)	Red (printed)
	4910	Clear	0.040 (1.0) ± 10%	Gen Purp	Solid	60 (960)	PE Film	0.005 (0.13)	Red (printed)
4951	4951	White	0.045 (1.1) ± 10%	Low TempAppl	Firm	50 (800)	Polyester	0.002 (0.05)	Clear
	4943F	Gray	0.045 (1.1) ± 10%	Low TempAppl	Conform	45 (720)	Polyester	0.002 (0.05)	Clear
	4957F	Gray	0.062 (1.6) ± 10%	Low TempAppl	Conform	45 (720)	Polyester	0.002 (0.05)	Clear
LSE	LSE-060	White	0.025 (0.6) ± 15%	LSE	Very Conf	45 (710)	PE Film	0.005 (0.13)	Red
	LSE-110	White	0.045 (1.1) ± 10%	LSE	Very Conf	45 (710)	PE Film	0.005 (0.13)	Red
	LSE-160	White	0.062 (1.6) ± 10%	LSE	Very Conf	45 (710)	PE Film	0.005 (0.13)	Red
GPH	GPH-060	Gray	0.025 (0.6) ± 15%	High Temp	Conform	45 (710)	PE Film	0.005 (0.13)	Red
	GPH-110	Gray	0.045 (1.1) ± 10%	High Temp	Conform	45 (710)	PE Film	0.005 (0.13)	Red
	GPH-160	Gray	0.062 (1.6) ± 10%	High Temp	Conform	45 (710)	PE Film	0.005 (0.13)	Red
4622	4618	White	0.025 (0.6) ± 15%	Gen/Multi Purp	Conform	45 (720)	PE Film	0.004 (0.10)	Green
	4622	White	0.045 (1.1) ± 10%	Gen/Multi Purp	Conform	45 (720)	PE Film	0.004 (0.10)	Green
	4624	White	0.062 (1.6) ± 10%	Gen/Multi Purp	Conform	45 (720)	PE Film	0.004 (0.10)	Green

Available Sizes

Tape Thickness inches (mm)	Standard Length yards (meters)	Minimum Width inches (mm)	Maximum Width inches (mm)	Maximum Roll Length		
				Width 1/4"up to 3/8" (6.4mm up to 9.5mm) yards (meters)	Width >3/8" up to 1/2" (>9.5mm up to 12.7mm) yards (meters)	Width 1/2" and wider (12.7mm and wider) yards (meters)
0.010 (0.25)	72 (65.8)	0.25 (6)	48 (1219)	72 (65.8)	144 (131.7)	360 (329.2)
0.015 (0.4)	72 (65.8)	0.25 (6)	48 (1219)	144 (131.7)	175 (160.0)	360 (329.2)
0.020 (0.5)	72 (65.8)	0.25 (6)	48 (1219)	72 (65.8)	108 (98.8)	175 (160.0)
0.025 (0.6)	72 (65.8)	0.25 (6)	48 (1219)	72 (65.8)	108 (98.8)	175 (160.0)
0.040 (1.0)	36 (32.9)	0.25 (6)	48 (1219)	72 (65.8)	108 (98.8)	144 (131.7)
0.045 (1.1)	36 (32.9)	0.25 (6)	48 (1219)	72 (65.8)	108 (98.8)	144 (131.7)
0.062 (1.6)	36 (32.9)	0.25 (6)	46 (1168)	72 (65.8)	72 (65.8)	108 (98.8)
0.080 (2.3)	36 (32.9)	0.25 (6)	46 (1168)	36 (32.9)	36 (32.9)	72 (65.8)
0120 (3.0) (4959)	36 (32.9)	0.5 (13)	46 (1168)	N/A N/A	N/A N/A	36 (32.9)
0120 (3.0) (4959F)	36 (32.9)	0.25 (6)	46 (1168)	36 (32.9)	36 (32.9)	36 (32.9)

Slitting Tolerance

Standard slitting tolerance ± 1/32 inch (± 0.031 inch, ± 0.79 mm).

Precision slitting with slitting tolerance of ± 1/64 inch (± 0.016 in., ± 0.41 mm) is available on select products with minimum order of full web increments.

Core Size

All products are provided on a 3 inch ID Core (76.2 mm)

Converted Parts

In addition to standard and custom roll sizes available from 3M through the distribution network, 3M™ VHB™ Tapes are also available in limitless shapes and sizes through the 3M Converter network. For additional information, contact 3M Converter Markets at 1-800-223-7427 or on the web at www.3M.com/converter.

Shelf Life

All 3M™ VHB™ Tapes have a shelf life of 24 months from date of manufacture when stored at 40°F to 100°F (4°C to 38°C) and 0-95% relative humidity. The optimum storage conditions are 72°F (22°C) and 50% relative humidity.

Performance of tapes is not projected to change even after shelf life expires; however, 3M does suggest that 3M™ VHB™ Tapes are used prior to the shelf life date whenever possible.

The manufacturing date is available on all 3M™ VHB™ Tape cores as the lot number. The lot number, typically a 4 digit code, is a Julian date (Y D D D). The first digit refers to the year of manufacture, the last 3 digits refer to the days after January 1. Example: A lot number of 9266 would translate to a date of manufacture of Sept. 22 (266th day of year) in 2009. On most products this is found as the 4 digits after the "9" following the product number. For tapes printed continuously around the core (e.g. 3M™ VHB™ Tape 5952 family) the lot number typically will be the string of 4 digits preceding the product number.

Special Cases:

Plasticized Vinyl – Plasticizers compounded in soft vinyl can migrate into adhesives and significantly change their performance characteristics. 3M™ VHB™ Tapes 4945 family has very good plasticizer resistance and adhesion to many vinyl formulations. Because of the wide variation in vinyl formulations, however, evaluation by the user must be conducted with the specific vinyl used to ensure that performance will be satisfactory over time. Problems related to plasticizer migration can often be predicted by accelerated aging of assembled parts at 150°F (66°C) for one week).

Typical Performance Characteristics

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

3M™ VHB™ Tapes				Dynamic Adhesion Performance		
Family	Product Number	Color	Thickness Inches	90° Peel Adhesion lb/in N/cm	Normal Tensile lb/in² kPa	Dynamic Overlap Shear lb/in² kPa
4950	4914	White	0.010	13 (23)	130 (900)	130 (900)
	4920	White	0.015	15 (26)	160 (1100)	100 (690)
	4929	Black	0.025	20 (35)	160 (1100)	100 (690)
	4930(F)	White	0.025	20 (35)	160 (1100)	100 (690)
	4949	Black	0.045	25 (44)	140 (970)	80 (550)
	4950	White	0.045	25 (44)	140 (970)	80 (550)
	4955	White	0.080	20 (35)	95 (660)	70 (480)
	4959(F)	White	0.062	20 (35)	75 (520)	55 (380)
4945	4945	White	0.045	25 (44)	140 (970)	80 (550)
	4946	White	0.045	25 (44)	140 (970)	80 (550)
4910	4905	Clear	0.020	12 (21)	100 (690)	70 (480)
	4910	Clear	0.040	15 (26)	100 (690)	70 (480)
4951	4951	White	0.045	18 (32)	110 (760)	80 (550)
	4943F	Gray	0.045	20 (35)	85 (590)	70 (480)
	4957F	Gray	0.062	20 (35)	75 (520)	70 (480)
LSE	LSE-060	White	0.025	17 (30)	80 (550)	110 (810)
	LSE-110	White	0.045	25 (44)	70 (470)	85 (590)
	LSE-160	White	0.062	30 (54)	65 (450)	75 (530)
GPH	GPH-060	Gray	0.025	14 (25)	90 (630)	120 (840)
	GPH-110	Gray	0.045	21 (37)	95 (670)	105 (730)
	GPH-160	Gray	0.062	19 (34)	105 (720)	80 (570)
4622	4916	White	0.025	17 (30)	85 (590)	80 (550)
	4622	White	0.045	20 (35)	70 (480)	65 (450)
	4624	White	0.062	20 (35)	55 (380)	60 (410)

90° Peel Adhesion - Based on ASTM D3330 - To stainless steel, room temperature, jaw speed 12 in/min (304.8 mm/min). Average force to remove is measured. 72 hour dwell.

Normal Tensile (T-Block Tensile) - ASTM D-897 - To aluminum, room temperature, 1 in² (6.45 cm²), jaw speed 2 in/min (50.8 mm/min) Peak force to separate is measured. 72 hour dwell.

Dynamic Overlap Shear - ASTM D-1002 - To stainless steel, room temperature, 1 in² (6.45 cm²), jaw speed 0.5 in/min (12.7 mm/min) Peak force to separate is measured. 72 hour dwell.

Typical Performance Characteristics

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

3M™ VHB™ Tapes				Static Shear					Temperature Tolerance	
Family	Product Number	Color	Thickness Inches	72°F (22°C)	150°F (66°C)	200°F (93°C)	250°F (121°C)	350°F (177°C)	Short Term (Minutes, Hours) °F (°C)	Long Term (Days, Weeks) °F (°C)
4950	4914	White	0.010	1500	500	500			300 (149)	200 (93)
	4920	White	0.015	1500	500	500			300 (149)	200 (93)
	4929	Black	0.025	1500	500	500			300 (149)	200 (93)
	4930(F)	White	0.025	1500	500	500			300 (149)	200 (93)
	4949	Black	0.045	1500	500	500			300 (149)	200 (93)
	4950	White	0.045	1500	500	500			300 (149)	200 (93)
	4955	White	0.080	1500	1000	750	750	750	400 (204)	300 (149)
	4959(F)	White	0.120	1500	1000	750	750	750	400 (204)	300 (149)
4945	4945	White	0.045	1500	500	500			300 (149)	200 (93)
	4946	White	0.045	1500	500	500			300 (149)	200 (93)
4910	4905	Clear	0.020	1000	500	500			300 (149)	200 (93)
	4910	Clear	0.040	1000	500	500			300 (149)	200 (93)
4951	4951	White	0.045	1250	500	500			300 (149)	200 (93)
	4943F	Gray	0.045	1000	500	500			300 (149)	200 (93)
	4957F	Gray	0.062	1000	500	500			300 (149)	200 (93)
LSE	LSE-060	White	0.025	1000	500	250			300 (149)	200 (93)
	LSE-110	White	0.045	1000	500	250			300 (149)	200 (93)
	LSE-160	White	0.062	1000	500	250			300 (149)	200 (93)
GPH	GPH-060	Gray	0.025	1000				500	450 (230)	300 (150)
	GPH-110	Gray	0.045	1000				500	450 (230)	300 (150)
	GPH-160	Gray	0.062	1000				500	450 (230)	300 (150)
4622	4616	White	0.025	1000	250	250			250 (121)	200 (93)
	4622	White	0.045	1000	250	250			250 (121)	200 (93)
	4624	White	0.062	1000	250	250			250 (121)	200 (93)

Static Shear - ASTM D3654 - To stainless steel, tested at various temperatures and gram loadings. 0.5 in^2 (3.23 cm^2). Will hold listed weight for 10,000 minutes (approximately 7 days). Conversion: 1500 g/0.5 in^2 equals 6.6 lb/in^2; 500 g/0.5 in^2 = 2.2 lb/in^2.

Short Term Temperature Tolerance - No change in room temperature dynamic shear properties following 4 hours conditioning at indicated temperature with 100 g/static load. (Represents minutes, hours in a process type temperature exposure).

Long Term Temperature Tolerance - Maximum temperature where tape supports at least 250 g load per 0.5 in^2 in static shear for 10,000 minutes. (Represents continuous exposure for days or weeks).

Additional Typical Performance Characteristics

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

	3M™ VHB™ Tape 4950	3M™ VHB™ Tape 4910	Units	Test Standard
Dielectric Constant	2.28 1.99	3.21 2.68	at 1 kHz at 1MHz	ASTM D150 ASTM D150
Dissipation Factor	0.0227 0.0370	0.0214 0.0595	at 1 kHz at 1MHz	ASTM D150 ASTM D150
Dielectric Breakdown Strength	18 (460)	25 (630)	V/µm (V/mil)	ASTM D140
Thermal Conductivity (k value)	0.09 (0.6)	0.16 (1.1)	W/mK (BTU•in/hr•ft²•°F)	
Volume Resisitivity	1.5×10^{15}	3.1×10^{15}	Ω-cm	ASTM D257
Surface Resisitivity	$>10^{16}$	$>10^{16}$	Ω/sq	ASTM D257
Water Vapor Transmission Rate	14.0		g/m^2•day	ASTM F1249 at 38°C/1000% RH
Thermal Properties of Modeling				
Thermal Coefficient of Expansion		180 (100)	10^{-6}m/m/°C (10^{-6}in/in/°F)	
Shear Modulus (at 25°C, 1 Hz)		6×10^5	Pa	
Poisson's Ratio		0.49		

3M™ VHB™ Tapes/ Product Families	Substrates	Temperature Rating Minimum	Temperature Rating Maximum
4914, 4920, 4930, 4950	Aluminum, Galvanized Steel, Enameled Steel, Stainless Steel, Ceramic, Glass/Epoxy	-35°C	110°C
	PBT	-35°C	90°C
	ABS, Polycarbonate, Rigid PVC	-35°C	75°C
4920, 4930, 4950,	Acrylic	-35°C	90°C
4955, 4959, 4959F	Glass / Galvanized Steel*, Glass / Glass*, Galvanized Steel / Aluminum*, Aluminum / Aluminum*	-35°C	120°C
4945	Phenolic, Aluminum, Galvanized Steel, Alkyd Enamel, Enameled Steel	-35°C	110°C
	ABS, Polycarbonate, Polyamide, Stainless Steel, Acrylic/Polyurethane Paint, Polyester Paint	-35°C	90°C
	Unplasticized PVC	-35°C	75°C
4905, 4910	Polycarbonate, Aluminum, Acrylic/Polyurethane Paint	-35°C	90°C
GPH, 4646, 4655	Stainless Steel, Aluminum, Galvanized Steel, Glass, Glass/Epoxy, Phenolic	-35°C	110°C
	Nylon, Polycarbonate	-35°C	90°C
	ABS, Rigid PVC	-35°C	75°C

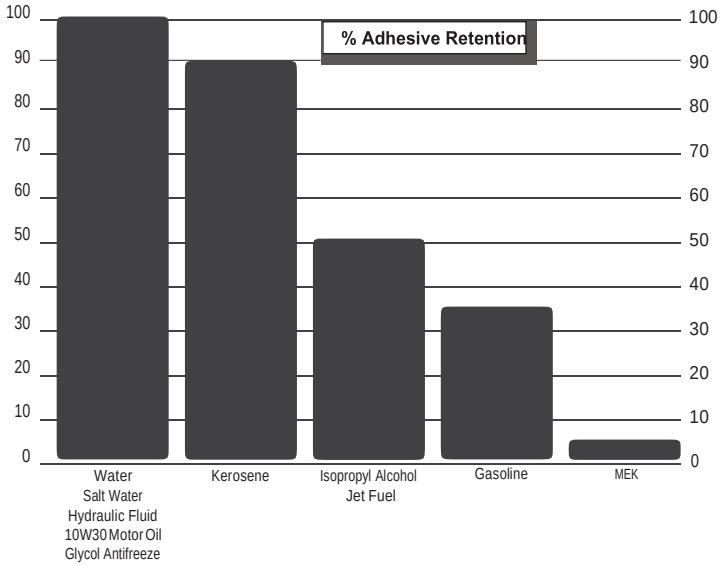
*Substrates can be used with or without primer(s)/Coating. 3M Silane Coating, 3M Adhesion Promoter 4298UV and 3M Tape Primer 94 are used with glass substrate. 3M Primer AP111, 3M Adhesion Promoter 4298UV and 3M Tape Primer 94 are used with aluminum and galvanized steel substrates.

Outgassing

3M™ VHB™ Tapes	% TML	%VCM	%WVR
4930	0.77	0.01	0.21
4932	2.41	0.66	0.23
4945	1.24	0.01	0.19

TML - Total Mass Loss
VCM - Volatile Condensible Materials
WVR - Water Vapor Regained
NASA Reference Publication, "Outgassing Data for Selecting Spacecraft Materials", (11/18/2004)
Available online at http://outgassing.nasa.gov

Solvent and Fuel Resistance



Test Method

- Tape between stainless steel and aluminum foil
- 72 hours dwell at room temperature
- Solvent immersion for 72 hours
- Test within 45 minutes after removing from solvent
- 90° peel angle
- 12 in/min rate of peel
- Peel adhesion compared to control

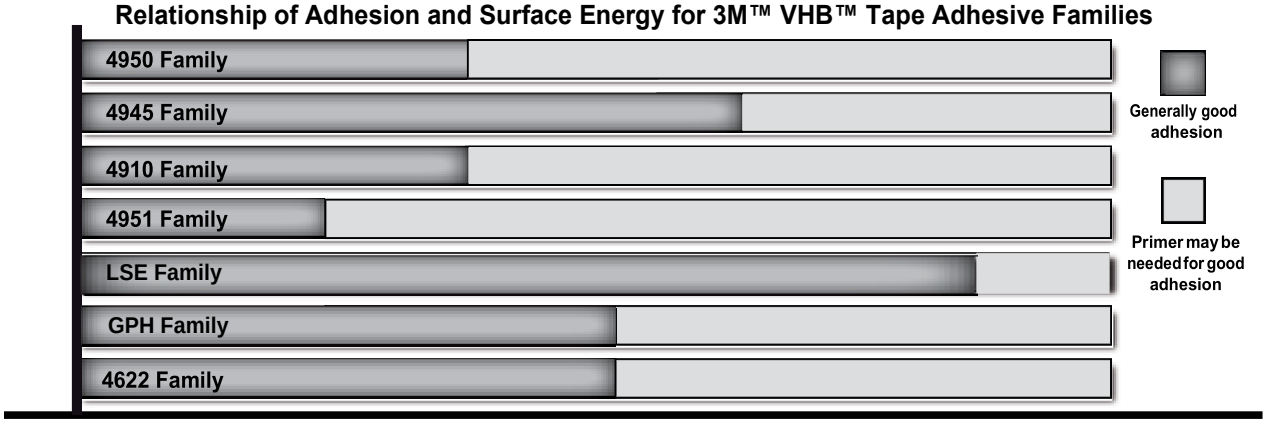
Note: Continuous submersion in chemical solutions is not recommended. The above information is presented to show that occasional chemical contact should not be detrimental to tape performance in most applications in ordinary use.

Design and Tape Selection Considerations

► **Choose the right tape for the substrate:** Adhesives must flow onto the substrate surfaces in order to achieve intimate contact area and allow the molecular force of attraction to develop. The degree of flow of the adhesive on the substrate is largely determined by the surface energy of the substrate.

This illustration demonstrates the effect of surface energy on adhesive interfacial contact. High surface energy materials draw the adhesive closer for high bond strength.

Relationship of Adhesion and Surface Energy for 3M™ VHB™ Tape Adhesive Families



1100-400 (High)	50-42	39-38 (Medium)	37-36	33-18 (Low)

Surface Energy (Dynes/cm)

Aluminum	Polyimide	ABS	PVA	EVA
Stainless Steel	Phenolic	Polycarbonate	Polystyrene	Polyethylene
Copper	Nylon	PVC	Acetal	PVF
Zinc	Alkyd Enamel	PPE	PVDF Paint	Silicone
Tin	Polyester	Acrylic	Powder Paint	PTFE
Lead	Epoxy Paint	PU Enamel	Polypropylene	
Anodized Aluminum	Polyurethane	Powder Paint		
Glass				

NOTES: There are a wide variety of formulations, surfaces finishes and surface treatments available on substrate materials which can affect adhesion. This chart is intended to provide only a rough estimate of the adhesion levels which can be expected on some common materials relative to a reference surface such as aluminum.
Foam type can affect and/or limit maximum adhesive strength.

► **Use the right tape thickness:** The necessary thickness of tape depends on the rigidity of substrates and their flatness irregularity. While the 3M™ VHB™ Tapes will conform to a certain amount of irregularity, they will not flow to fill gaps between the materials. For bonding rigid materials with normal flatness, consider use of tapes with thickness of 45 mils (1.1 mm) or greater. As the substrate flexibility increases thinner tapes can be considered.

► **Use the right amount of tape:** Because 3M™ VHB™ Tapes are viscoelastic by nature their strength and stiffness is a function of the rate at which they are stressed. They behave stronger with relatively faster rate of stress load (dynamic stresses) and will tend to show creep behavior with stress load acting over a long period of time (static stresses). As a general rule, for **static loads,** approximately four square inches of tape should be used for each pound (57 cm^2 of tape per kg) of weight to be supported in order to prevent excessive creep. For **dynamic loads,** the dynamic performance characteristics provided on page 4 should be useful, factoring in the appropriate safety factors.

► **Allow for thermal expansion/contraction:** 3M™ VHB™ Tapes can perform well in applications where two bonded surfaces may expand and contract differentially. Assuming good adhesion to the substrates, the tapes can typically tolerate differential movement in the shear plane up to 3 times their thickness.

► **Bond Flexibility:** While an advantage for many applications where allowing differential movement is a benefit, the tape bonds are typically more flexible than alternative bonding methods. Suitable design modifications or periodic use of rigid fasteners or adhesives may be needed if additional stiffness is required.

► **Severe Cold Temperature:** Applications which require performance at severe cold temperatures must be thoroughly evaluated by the user if the intended use will subject the tape product to high impact stresses. A technical bulletin "3M™ VHB™ Tape Cold Temperature Performance" (70-0707-3991-0) is available for additional information.

Application Techniques

► **Clean:** Most substrates are best prepared by cleaning with a 50:50 mixture of isopropyl alcohol (IPA*) and water prior to applying 3M™ VHB™ Tapes.

Exceptions to the general procedure that may require additional surface preparation include:

- **Heavy Oils:** A degreaser or solvent-based cleaner may be required to remove heavy oil or grease from a surface and should be followed by cleaning with IPA/water.
- **Abrasion:** Abrading a surface, followed by cleaning with IPA/water, can remove heavy dirt or oxidation and can increase surface area to improve adhesion. Abrasion is not suggested with 3M™ VHB™ Tapes 4932 and 4952.
- **Adhesion Promoters:** Priming a surface can significantly improve initial and ultimate adhesion to many materials such as plastics and paints.
- **Porous surfaces:** Most porous and fibered materials such as wood, particleboard, concrete, etc. need to be sealed to provide a unified surface.
- **Unique Materials:** Special surface preparation may be needed for glass and glass-like materials, copper and copper containing metals, and plastics or rubber that contain components that migrate (e.g. plasticizers).

Refer to 3M Technical Bulletin "Surface Preparation for 3M™ VHB™ Tape Applications" for additional details and suggestions. (70-0704-8701-5)

***Note:** These cleaner solutions contain greater than 250 g/l of volatile organic compounds (VOC). Please consult your local Air Quality Regulations to be sure the cleaner is compliant. When using solvents, be sure to follow the manufacturer's precautions and directions for use when handling such materials.

► **Pressure:** Bond strength is dependent upon the amount of adhesive-to-surface contact developed. Firm application pressure develops better adhesive contact and helps improve bond strength. Typically, good surface contact can be attained by applying enough pressure to insure that the tape experiences approximately 15 psi (100 kPa) pressure. Either roller or platen pressure can be used. Note that rigid surfaces may require 2 or 3 times that much pressure to make the tape experience 15 psi.

► **Temperature:** Ideal application temperature range is 70°F to 100°F (21°C to 38°C). Pressure sensitive adhesives use viscous flow to achieve substrate contact area. Minimum suggested application temperatures:

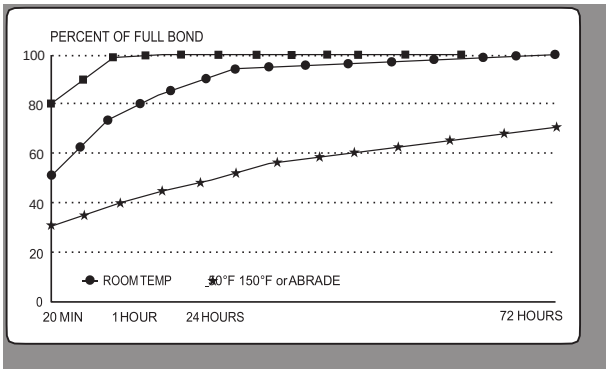
- 50°F (10°C): 3M™ VHB™ Tapes 4950, 4910, 4611, 4622 families.
- 60°F (15°C): 3M™ VHB™ Tape 4945 family.
- 32°F (0°C): 3M™ VHB™ Tape LSE or 4951 family (Note: Surface must be frost free).

Note: Initial tape application to surfaces at temperatures below these suggested minimums is not recommended because the adhesive becomes too firm to adhere readily. However, once properly applied, low temperature holding is generally satisfactory.

To obtain good performance with all 3M™ VHB™ Tapes, it is important to ensure that the surfaces are dry and free of condensed moisture.

► **Time:** After application, the bond strength will increase as the adhesive flows onto the surface (also referred to as "wet out"). At room temperature approximately 50% of ultimate bond strength will be achieved after 20 minutes, 90% after 24 hours and 100% after 72 hours. This flow is faster at higher temperatures and slower at lower temperatures. Ultimate bond strength can be achieved more quickly (and in some cases bond strength can be increased) by exposure of the bond to elevated temperatures (e.g. 150°F [66°C] for 1 hour). This can provide better adhesive wetout onto the substrates. Abrasion of the surfaces or the use of primers/ adhesion promoters can also have the effect of increasing bond strength and achieving ultimate bond strength more quickly.

Bond Typical Build vs. Time



Technical Information

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Product Selection and Use

Many factors beyond 3M's control and uniquely within user's knowledge and control can affect the use and performance of a 3M product in a particular application. As a result, customer is solely responsible for evaluating the product and determining whether it is appropriate and suitable for customer's application, including conducting a workplace hazard assessment and reviewing all applicable regulations and standards (e.g., OSHA, ANSI, etc.). Failure to properly evaluate, select, and use a 3M product and appropriate safety products, or to meet all applicable safety regulations, may result in injury, sickness, death, and/or harm to property.

Warranty, Limited Remedy, and Disclaimer

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ISO 9001

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