



*Resistive Design
and Integration Guide*

Copyright

This manual is © 3M 2003. All rights reserved.

Reproduction of the contents of this copyrighted manual in whole or in part, by any means, electronic or mechanical, for any purpose, without written permission of 3M Touch Systems, a subsidiary of 3M, is prohibited.

Notice

Given the variety of factors that can affect the use and performance of a 3M Touch Systems Product (the “Product”), including that solid state equipment has operation characteristics different from electromechanical equipment, some of which factors are uniquely within User’s knowledge and control, it is essential that User evaluate the 3M Touch Systems Product and software to determine whether it is suitable for User’s particular purpose and suitable for User’s method of application. 3M Touch Systems’ statements, engineering/technical information, and recommendations are provided for User’s convenience, but their accuracy or completeness is not warranted. 3M Touch Systems products and software are not specifically designed for use in medical devices as defined by United States federal law. 3M Touch Systems products and software should not be used in such applications without 3M Touch Systems’ express written consent. User should contact its sales representative if User’s opportunity involves a medical device application.

Important notice to purchaser

Specifications are subject to change without notice. These 3M Touch Systems’ Products and software are warranted to meet their published specifications from the date of shipment and for the period stated in the specification. **3M Touch Systems makes no additional warranties, express or implied, including but not limited to any implied warranties of merchantability or fitness for a particular purpose.**

User is responsible for determining whether the 3M Touch Systems Products and software are fit for User’s particular purpose and suitable for its method of production, including intellectual property liability for User’s application. If the Product, software or software media is proven not to have met 3M Touch Systems’ warranty, then 3M Touch Systems’ sole obligation and User’s and Purchaser’s **exclusive remedy**, will be, at 3M Touch Systems’ option, to repair or replace that Product quantity or software media or to refund its purchase price. 3M Touch Systems has no obligation under 3M Touch Systems’ warranty for any Product, software or software media that has been modified or damaged through misuse, accident, neglect, or subsequent manufacturing operations or assemblies by anyone other than 3M Touch Systems. **3M Touch Systems shall not be liable in any action against it in any way related to the Products or software for any loss or damages, whether non-specified direct, indirect, special, incidental or consequential (including downtime, loss of profits or goodwill) regardless of the legal theory asserted.**

Edition

April 2003
Document Number: 19441 (Rev. 1.1)
[Supersedes 19441 Rev. 1.0]

Trademarks

MicroTouch and TouchSurround are trademarks of 3M.

Clincher is a trademark of FCI. AMP is a trademark AMP Incorporated. Molex is a trademark of Molex Incorporated.

Contents

Preface	Before you start	1
	About the manual	1
	Your choices.....	1
	About 3M Touch Systems.....	2
Chapter 1	Introducing resistive touch by 3M Touch Systems	5
	Resistive touch	5
	Design types	6
	Standard and custom	6
	Size	7
Chapter 2	Construction.....	9
	Common features	9
	FG construction.....	9
	PL construction	9
	Backing panels	9
Chapter 3	Tail and connector	13
	Tail	13
	Connector	14
Chapter 4	Surface finish and activation force	17
	Surface finishes	17
	Activation force of the touch screen	18
Chapter 5	Mounting.....	19
	Positioning the touch screen inside a bezel.....	19
	Rear mounting or front mounting?.....	20
	Rear mounting	20
	Front mounting.....	25
	Designing to meet NEMA sealing standards	27
Chapter 6	Graphics and switches.....	29
	Custom touch screen graphics.....	29
	Switches	31
Chapter 7	Gaskets	33
	Options	33
	Comparing gaskets	33
	Ordering gaskets.....	35
Chapter 8	Shields	37
	About shields.....	37
	Choosing.....	37
	Grounding.....	38
Appendix A	Matrix touch screens	43
Appendix B	Glossary	45

PREFACE

Before you start

About the manual

Who should read this guide

This manual is written for electrical and mechanical engineers, design engineers, and system integrators who are responsible for designing, positioning, installing, and/or maintaining MicroTouch™ resistive touch screen products.

How the guide is organized

The manual provides guidelines for:

- **Selecting a standard resistive touch screen system** for your application. If we do not have a standard touch screen to fit your needs, you can request a custom product quotation from your sales representative. To search our Sensor Selection Database, see www.3Mtouch.com.
- **Requesting a custom product.** A completed checklist is required by 3M Touch Systems so we can efficiently quote on the touch solution that is right for your application. Your sales representative will work with you to complete the Quotation Checklist (see “Contacting your regional touch specialist” on page 2).
- **Integrating your touch screen into your application.** Detailed information is included to equip the integrator with the information necessary to integrate the touch screen as smoothly as possible. The single most important chapter for integrators is Chapter 5.

Your choices

There are many choices available to you when designing and integrating your resistive touch screen system.

There are basic choices that need to be made, whatever your application, and there are also options that may make for an even better fit between the touch screen and your application.

The basics

The basic decisions you need to make regarding the touch screen include:

- **Type of screen:** 4-wire, 5-wire, or 8-wire.
- **Size:** Size of screen, overall thickness required for application.
- **Construction type:** PL (Polyester Laminated) or FG (Film-on-Glass), including choices about backing panel material.

- **Tail:** Location and length.
- **Connector:** Type and size.
- **Mounting technique:** Front-mounting or rear-mounting.
- **Surface finish:** Antiglare, for example.
- **Activation force of touch screen:** Responds to finger/pen, for example.
- **Controlling electronics:** 3M Touch Systems offers a variety of controllers to accompany our 4-, 5-, and 8-wire touch screen configurations. For details, contact your 3M Touch Systems sales representative.

The Options

There are several options available to further customize your resistive touch screen system for your application.

- **Graphics.** An optional graphic layer can be added to both PL and FG constructions. The graphic layer can incorporate software switches, referred to as TouchSurround™, which may be placed outside the touch screen's clear window.
- **Switches.** There are options for discrete switches. They use their own traces and operate independently of the rest of the touch screen).
- **Gaskets.** There are options for gaskets made of various materials, thicknesses, and adhesion levels for applications running in an environment that requires the touch screen to be sealed or to be able to withstand shock and/or vibration.
- **Shields.** Various optional shield configurations are available if your application is running in an environment where there is significant electromagnetic interference.

About 3M Touch Systems

Contacting your regional touch specialist

To find the name of your 3M Touch Systems sales representative, refer to the www.3Mtouch.com.

Work with your regional sales representative to complete the quotation checklist.

3M Touch Systems Support Services

3M Touch Systems provides extensive support services through our website and technical support organization. Visit the 3M Touch Systems website at www.3Mtouch.com, where you can download touch screen software and drivers, obtain regularly updated technical documentation on 3M Touch Systems products, and learn more about our company.

Whenever you contact Technical Support, please provide the following information:

- Part number and serial number
- Current driver version
- Operating system used
- Information on peripherals

Technical Support is available Monday through Friday 8 a.m. to 8 p.m. US Eastern Standard Time – 9 a.m. to 5 p.m. throughout Europe. Limited call back service Saturdays and Sundays.

You can contact 3M Touch Systems Technical Support (US only -- Eastern Standard Time) by calling the hot line or sending a fax.

- Technical Support Hot Line: 978-659-9200
- Technical Support Fax: 978-659-9400
- Toll Free: 1-866-407-6666
- Email: US-TS-techsupport@mmm.com

3M Touch Systems Worldwide Offices

All offices can be reached through the website: www.3Mtouch.com.

Country	Telephone
United Kingdom	+ 44 (0) 1235-444400
United States	978-659-9000
Australia	+61 395-82-4799
Canada	604-521-3962
France	+33 (1) 45-13-90-30
Germany	+49 (0) 2131-14-0
Hong Kong/China	(852) 2333-6138
Italy	+39 (0) 39-230-2230
Japan	+81 (4) 4811-1133
Korea	+822 552 3198
Singapore	+65-96279173
Spain	+34 934-15-6285

CHAPTER 1

Introducing resistive touch by 3M Touch Systems

About the chapter

This chapter describes:

- how resistive touch screens work
- main types of resistive touch screens available from 3M Touch Systems
- size options available for our resistive touch screens

Resistive touch

Resistive technology is versatile and economical for applications such as food service and retail point-of-sale, industrial process control and instrumentation, portable and handheld products, and communication devices.

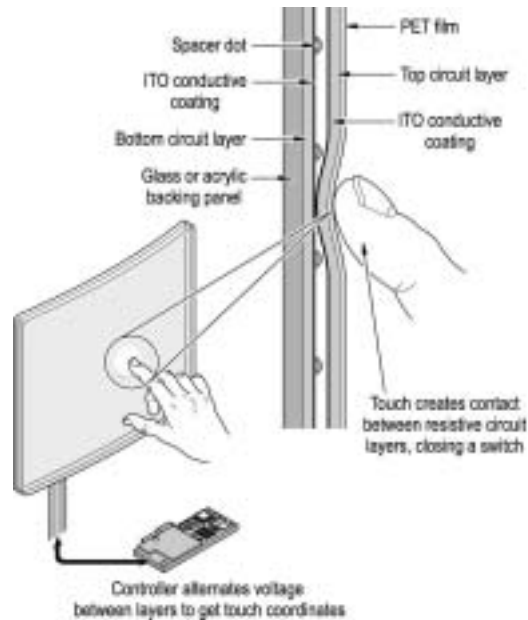


Figure 1: Resistive touch screen technology

Resistive touch screens have a flexible top layer and a rigid bottom layer separated by insulating spacer dots, with the inside surface of each layer coated with a transparent conductive coating. Voltage applied to the layers produces a gradient across each layer. Pressing the flexible top sheet creates electrical contact between the resistive layers, essentially closing a switch in the circuit. Depending on the controller electronics you use, they either alternate voltage gradient horizontally and vertically to get x then y touch coordinates or they simultaneously measure the current at each corner (Figure 1).

Design types

3M Touch Systems offers a wide range of resistive touch screen designs to fit a range of application requirements. We offer three types of resistive products in two different constructions:

- 5-wire, offered in FG (Film-on-Glass). FG construction consists of a flexible layer of film on a glass backing panel.
- 8-wire, offered in FG and PL (Polyester Laminated). PL construction consists of two polyester layers. One layer remains flexible while the other is typically bonded to a chemically strengthened glass backing panel.
- 4-wire, offered in FG and PL.

The design and type of touch screen construction you choose will depend upon how and where your touch product will be used. Table A is a guide to help you select the type of touch screen you will need for your project. For more information on construction types, see Chapter 2.

Table A: Range of resistive products available from 3M Touch Systems

	4-wire/8-wire FG	4-wire/8-wire PL	5-wire FG
Range of applications	<ul style="list-style-type: none"> ■ Portable devices ■ Consumer devices ■ Web pads ■ Thin clients ■ Remote controls 	<ul style="list-style-type: none"> ■ Rugged portables ■ Industrial controls ■ Instrumentation ■ Harsh environments 	<ul style="list-style-type: none"> ■ Point-of-sale ■ Retail ■ Hospitality ■ Voting machines ■ Financial
Product features	<ul style="list-style-type: none"> ■ Film on glass ■ Lower power consumption ■ Smaller sizes ■ 1-year warranty 	<ul style="list-style-type: none"> ■ Polyester laminated ■ Chemically strengthened glass ■ Impact strength ■ 3-year warranty 	<ul style="list-style-type: none"> ■ Film on glass ■ Physically robust ■ Environmentally robust ■ 5-year warranty

Standard and custom

3M Touch Systems has an extensive selection of standard touch screen sizes to fit most flat panel and curved displays. These are available quickly without costly art and design charges and are ideal for samples, prototyping, and pre-production.

For current size options, visit the Sensor Selection Database on our website at www.3Mtouch.com. If you cannot find the touch screen size and construction that you need, contact your sales representative.

Size

When deciding on the overall dimensions of your touch screen, consider the following:

- **Location of mounting holes.** To mount the touch screen most simply, the display's mounting holes should be outside the perimeter of the touch screen. If this is not an option, you can consider mounting the touch screen with a mounting plate (see Figure 13 on page 25).
- **Active area.** The active area of the touch screen should match the active area of the display (Figure 2).
- **Viewing area.** The viewing area of the touch screen is typically designed to match the viewing area of the display (Figure 2).
- **Size of bezel opening.** 3M Touch Systems recommends that the bezel be placed between the viewing area and active area. For details, see Table H on page 23.

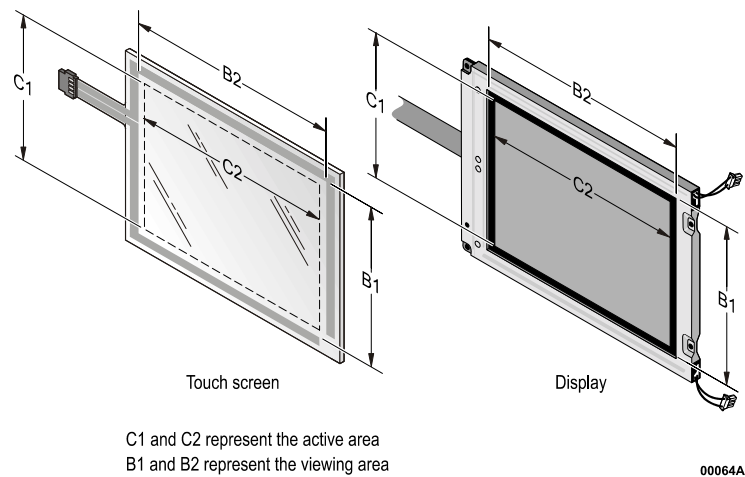


Figure 2: Active area and viewing area

- **Registration tolerance.** 3M Touch Systems uses the backing panel of the touch screen for registration of the other layers. The backing panel is cut to an overall size tolerance (length and width) of ± 0.015 inches (0.4 mm). Keep this in mind when designing your assembly.

CHAPTER 2

Construction

About the chapter

This chapter describes:

- features common to all of our resistive constructions
- construction choices: PL and FG
- backing panel choices

Common features

Resistive touch screens from 3M Touch Systems are either Polyester Laminated (PL) or Film-on-Glass (FG) constructions. All constructions are:

- scratch-resistant
- chemical-resistant
- capable of being sealed (NEMA, IP)
- provide reliable and accurate touch input, even when users are wearing gloves
- come with Anti-Newton Ring (ANR) technology which eliminates undesirable interference patterns that occur when two or more clear surfaces are close together

FG construction

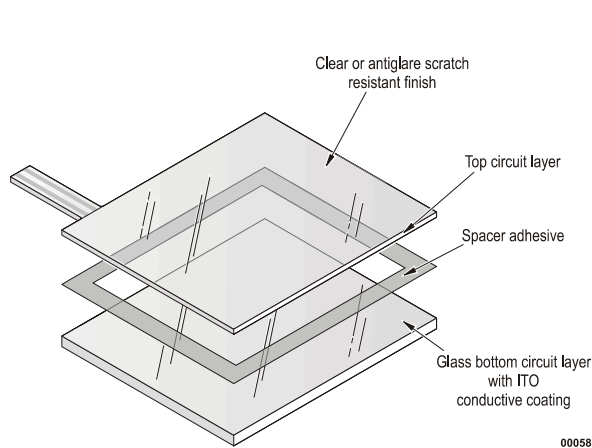
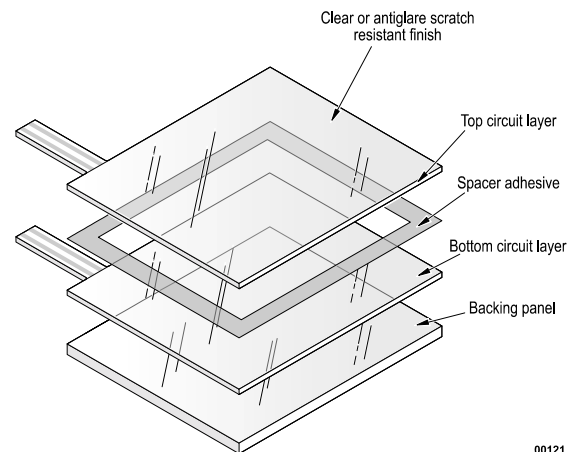
FG construction consists of a flexible layer of film on a conductive coated glass backing panel. FG construction offers greater transmissivity than PL touch screens, but less impact resistance.

PL construction

PL construction consists of two polyester layers. One layer remains flexible while the other is typically bonded to a non-conductive, chemically strengthened glass backing panel.

Backing panels

All resistive touch screens from 3M Touch Systems have a backing panel that provides strength and durability.

Table B:**Figure 3: FG construction****Figure 4: PL construction**

For custom products, you can select the material and thickness of the backing panel.

Material

For PL touch screens, backing panels are available in glass, acrylic, and polycarbonate. For FG constructions, the backing panel material is always glass.

Glass

A glass backing panel is a good choice if flatness is required and if the touch screen will be located where there are temperature and humidity fluctuations.

A glass backing panel is cut to an overall size tolerance of ± 0.015 inches (0.4 mm).

Acrylic

Acrylic backing panels are typically chosen for custom applications that need a lighter, more shatter-resistant product (for example, in food industries and educational environments).

Polycarbonate

3M Touch Systems offers 0.020" (0.5 mm) polycarbonate backing panels for custom applications that require a light, thin, break-resistant touch screen. A hardcoated, scratch-resistant surface is applied to the rear of the polycarbonate backing panel to protect it during manufacturing and handling.

Thickness

The choice of backing panel thicknesses should be based on:

- material of the backing panel
- size of the touch screen
- coefficient of thermal expansion (CTE) of the backing panel

The co-efficient of thermal expansion (CTE) for backing panel materials (Table C) is vital in choosing the backing panel. The CTE measures the rate at which the material of a backing panel expands and contracts.

Table C: CTE for backing panel materials

Backing panel material	Coefficient of thermal expansion (CTE)*
Glass	5×10^{-6} inches/inches °F
Acrylic	34×10^{-6} inches/inches °F
Polycarbonate	39×10^{-6} inches/inches °F
Polyester	17×10^{-6} inches/inches °F

*Typical CTE for backing panel materials tested by 3M Touch Systems.

The closer the CTE of the materials are to one another, the less prone the touch screen will be to distortion (e.g., bagging, pillowing, warping, stretching) from environmental changes over time.

Important

It is important to follow the recommendations of 3M Touch Systems for backing panel thickness. It is also important to follow recommended operating and storage conditions related to humidity as stated in the Resistive Touch Screen Specifications. Doing so will help ensure that touch screen layers expand and contract at the same rate as the backing panel and so prevent bagging, pillowing, and stretching. For a copy of the Resistive Touch Screen Specifications, contact your sales representative.

Recommended backing panel thicknesses for panels constructed of different materials and having different touch screen sizes are shown in Table D (acrylic) and Table E (glass).

Table D: Recommended backing panel thicknesses: Acrylic

Use this backing panel thickness	For this size of touch screen
0.060" (1.5 mm)	5" and smaller
0.080" (2 mm)	7" and smaller
0.100" (2.5 mm)	9" and smaller
0.125" (3.2 mm)	11" and smaller
0.187" (4.8 mm)	14" and smaller

Table E: Recommended backing panel thicknesses: Glass

Use this backing panel thickness	For this size of touch screen
PL construction	
0.028" (0.7 mm)	3" and smaller
0.043" (1.1 mm)	6" and smaller
0.062" (1.6 mm)	12" and smaller
0.079" (2.0 mm)	13" and smaller
0.093" (2.4 mm)	14" and smaller
0.125" (3.2 mm)	16" and smaller
FG construction	
0.043" (1.1 mm)	6" and smaller
0.062" (1.6 mm)	10" and smaller
0.075" (1.9 mm)	14" and smaller
0.114" (2.9 mm)	Larger than 14"

CHAPTER 3

Tail and connector

About the chapter

This chapter provides guidelines for choosing tails and connectors for your custom application and indicates some of the features and constraints of each. You can specify:

- location of the tail
- length of the tail
- type of connector
- special pin-outs (if required)

Tail

Location

The location of the touch screen tail must be specified. It is recommended that the tail be located:

- On a shorter edge of the touch screen, if possible (Figure 5).
- So that it is not routed past unshielded, high-voltage sources (e.g., backlights).
- For 5-wire touch screens, center the tail if possible. If centering is not possible, place the tail a minimum of 1" (25 mm) from a corner.

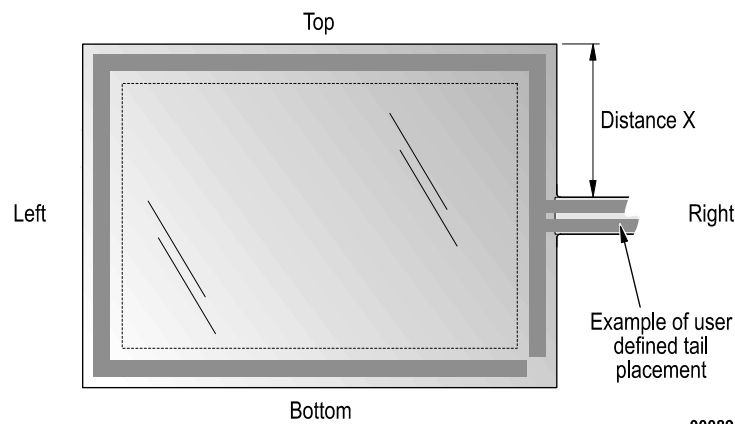


Figure 5: Location of the touch screen tail

Length

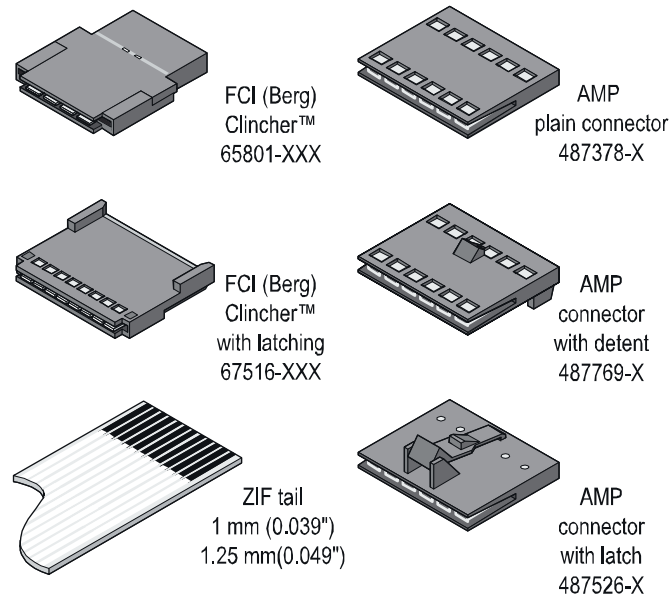
It is recommended that the tail length be:

- Between 2 to 3 inches (50 to 75 mm), with the combined length of the tail and touch screen not exceeding 20 inches (508 mm).
- When using an FCI (Berg) connector, minimum 1 inch (25.4 mm).
- When using an AMP™ connector, minimum 2 inches (50.8 mm).

Typically, long tails are more expensive than short tails.

Connector

3M Touch Systems offers FCI (formerly Berg) and AMP connectors as well as touch screen tails designed for ZIF connectors (Figure 6).



00115

Figure 6: Examples of connectors and a ZIF tail

For a summary of connectors recommended by 3M Touch Systems, see Table F.

Important

When choosing a connector, make sure to select mating connector contacts of the same material.

Touch screen pin-outs

Be sure that your touch screen pin-outs match your chosen controller.

If you have special pin-out requirements, specify them when working through the *Quotation Checklist* with your 3M Touch Systems sales representative.

Table F: Summary of connectors recommended by 3M Touch Systems

Connector type and size	Constraints	Features	More information
FCI (formerly Berg) <ul style="list-style-type: none"> Clincher™ Latching Receptacle 0.100" (2.5 mm) Clincher Receptacle 0.100" (2.5 mm) 	<ul style="list-style-type: none"> Tail length must be minimum 1" (25.4 mm) 	<ul style="list-style-type: none"> Easy to extend tail length Easy to connect to the MicroTouch™ SC4 controller Tin or gold contacts available 	www.fciconnect.com
AMP™ Three housing options (all for four-pin and eight-pin connectors) 0.100" (2.5 mm). <ul style="list-style-type: none"> Plain Latch Detent 	<ul style="list-style-type: none"> Tail length must be minimum 2" (50.8 mm) Must specify appropriate housing and receptacle 	<ul style="list-style-type: none"> Locking feature available so that connector doesn't work loose; makes AMP the best choice for shock-prone and vibration-prone environments. Easy to connect to the MicroTouch MT410 or MT510. Easy to extend tail with additional cabling. Three housing options (see "Connector type" column). 	www.tycoelectronics.com
ZIF 3M Touch Systems offers two pitch tails that are designed for ZIF connectors: <ul style="list-style-type: none"> 1 mm (0.039") pitch tail. Recommended connectors: <i>For 4-wire, 5-wire, and 8-wire:</i> <ul style="list-style-type: none"> Molex™ 52043, 52089, 52207, 71220, 71226 AMP 487951, 487952 <i>For 8-wire only:</i> <ul style="list-style-type: none"> Molex 52030, 52271, 52610 1.25 mm (0.049") pitch tail <ul style="list-style-type: none"> Molex 5597 	<ul style="list-style-type: none"> When using ZIF connector with touch screens, tail traces must face down. Must specify a connector that is compatible with a tail design of carbon/silver ink. Difficult to extend tail. More difficult to connect to a MicroTouch controller. Not available for 5-wire resistive. 	<ul style="list-style-type: none"> Minimum tail length not a major concern. Suited to small designs with a small connector and a narrow tail. Surface mount connectors are available. 	www.avxcorp.com

CHAPTER 4

Surface finish and activation force

About this chapter

This chapter discusses two types of custom resistive choices:

- surface finish (for abrasion protection and enhanced viewing quality)
- activation force

Surface finishes

Abrasion protection

All resistive touch screens from 3M Touch Systems include a proprietary hardcoated polyester on the front surface of the screen that is substantially harder and more abrasion-resistant than uncoated touch screens.

Viewing quality

High-gloss and anti-glare finishes can be applied to the touch screen surface. Consider the optical values of each type of finish when choosing whether one of these would be appropriate for your application (Table G).

Antiglare

Antiglare finishes reduce glare, are scratch resistant, do not show fingerprints easily, and provide a smoother feel for drag-and-drop and stylus applications. Two antiglare finishes are available for our resistive touch screens:

- Anti-glare finish HCG12 offers high clarity and is well suited for indoor applications.
- Anti-glare finish HCG10 provides superior antiglare qualities and is often used in outdoor settings.

High-gloss

The high-gloss finish, HCC01, delivers superior image quality. This finish is reflective, however, so it may not be suitable for a touch screen that will be used outdoors or in a setting with high ambient light.

Table G: Optical characteristics of assembled touch screen (does not apply to buffer designs)

Touch screen type	Front surface hardcoat	Haze* (values are typical)	Clarity* (values are typical)
FG	HCC01	2%	90%
	HCG12	5%	80%
	HCG10	11%	64%
PL	HCC01	3%	93%
	HCG12	5%	77%
	HCG10	13%	65%

*Values derived using BYK Gardner hazegard plus

Activation force of the touch screen

The activation force of a touch screen affects its touch sensitivity.

The standard activation force of our resistive touch screens is optimized for finger and stylus use. However, 3M Touch Systems can manufacture a touch screen with customized activation force, such as palm rejection.

If you think your application may require customized activation force, contact 3M Touch Systems technical support.

CHAPTER 5

Mounting

About the chapter

This chapter provides guidelines to help you to make the best mounting choices for your application as you discuss mounting options with your sales representative and as you integrate the touch screen with your application.

Specifically, the chapter includes guidelines on:

- Rear mounting, including:
 - Special guidelines for rear mounting PL and FG touch screens.
 - Steps for rear mounting directly.
 - Steps for rear mounting using a mounting plate.
- Front mounting.
- Positioning the touch screen inside a bezel.
- Mounting to achieve NEMA sealing standards.

Positioning the touch screen inside a bezel

Guidelines

- **As a general rule**, your product's bezel should be 0.030 inches to 0.060 inches (0.8 mm to 1.5 mm) away from the touch screen's active area and 0.030 inches to 0.060 inches (0.8 mm to 1.5 mm) inside the screen's viewing area.
- **For touch screens less than 12 inches (300 mm)**, the layer-to-layer assembly tolerance of the screen is 0.030 inches (0.8 mm).
- **For touch screens 12 inches (300 mm) and larger**, the layer-to-layer assembly tolerance of the screen is 0.050 inches (1.3 mm).

- **When mounting the touch screen in environments where there are temperature and humidity fluctuations**, 3M Touch Systems recommends that a glass backing panel be used because it expands and contracts at approximately the same rate as the rest of the touch screen. If you cannot use a glass backing panel for some reason, consider the coefficient of thermal expansion (CTE) of your backing panel material. For more information on the CTE for different backing panel materials, refer to Chapter 2.
- **If you're going to be mounting the touch screen in an environment with a high sulfur concentration**, contact 3M Touch Systems technical support.

Important

High sulfur concentrations can cause a reaction with the exposed silver in the tail, causing tarnish or failures. To prevent this, 3M Touch Systems can recommend a custom tail configuration.

Rear mounting or front mounting?

Our resistive touch screens can be mounted from the rear or the front. Rear mounting is the most convenient method for most applications.

Front mounting works well if you need a uniformly smooth surface on the front of your product. Front mounting requires that the bezel be specially designed to accommodate a resistive touch screen produced by 3M Touch Systems.

Rear mounting

Guidelines

To rear mount a touch screen is to position it behind the bezel. Rear mounting can be done using the display or a mounting plate.

Before rear mounting your touch screen, consider the following guidelines to help ensure optimal performance. Unless otherwise noted, these guidelines apply to all resistive constructions.

Mounting environment

Mount the touch screen in a clean environment so that dust is not trapped between the touch screen and the display.

Aligning

Align the touch screen and display so that the active area of the touch screen is centered on the active area of the display.

Mounting holes

To mount the touch screen in the simplest way, make sure that the display's mounting holes are outside the perimeter of the touch screen. If this is not an option and the touch screen covers the display's mounting holes, then use a mounting plate (see "Mounting with a mounting plate" on page 24).

Avoid bonding touch screen to the back of the bezel

Mount the touch screen so that it is supported from the rear instead of using an adhesive that bonds the touch screen to the back of your bezel.

Important

Attaching the touch screen to the bezel makes the polyester adhere to the bezel and prevents the polyester from expanding and contracting in response to fluctuations in temperature and humidity. This can damage the polyester by making it bag, stretch, pillow, or otherwise be distorted.

Assembly tolerance

For touch screens with outer dimensions less than 12 inches (300 mm), the layer-to-layer assembly tolerance of the screen is 0.030 inches (0.8 mm). For touch screens with outer dimensions that are 12 inches (300 mm) or larger, the layer-to-layer assembly tolerance of the screen is 0.050 inches (1.3 mm). These tolerances are factored into the dimensions shown in Table H.

Bezel clearances

The bezel clearances recommended in Table H and illustrated in Figure 7, Figure 8, and Figure 9 are intended to prevent accidental activation of or damage to the touch screen when clamping force is applied. The recommended clearances depend on three factors:

- Type of touch screen design (4/8-wire or 5-wire).
 - In 5-wire designs, clamping force is optimal over the spacer adhesive, but allowed anywhere outside the active area of the touch screen.
- Whether the touch screen has a buffer layer. The mechanical drawing will indicate if there is a buffer layer.
- Size of the touch screen.

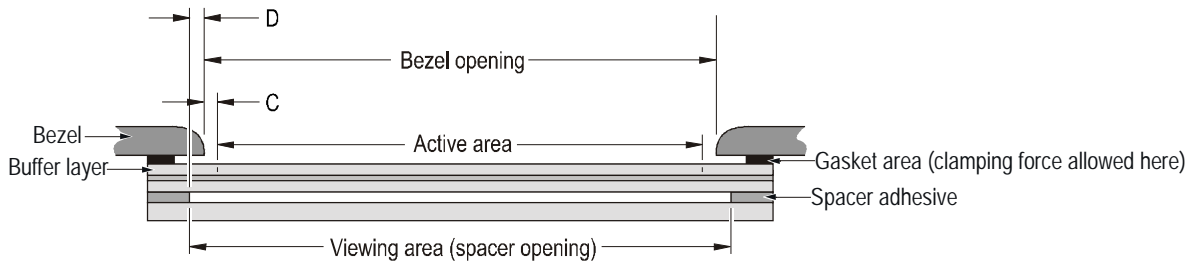


Figure 7: Recommended bezel clearances for 4-Wire and 8-wire touch screens *with Buffer Layer* (see Table H)

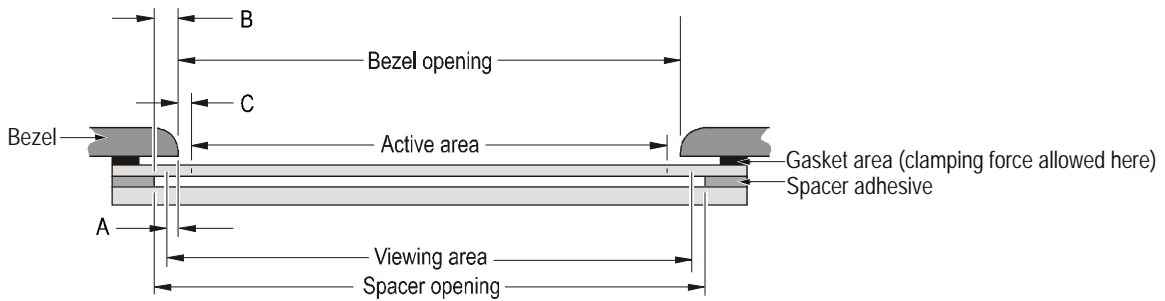


Figure 8: Recommended bezel clearances for 4-Wire and 8-wire touch screens *without buffer layer* (see Table H)

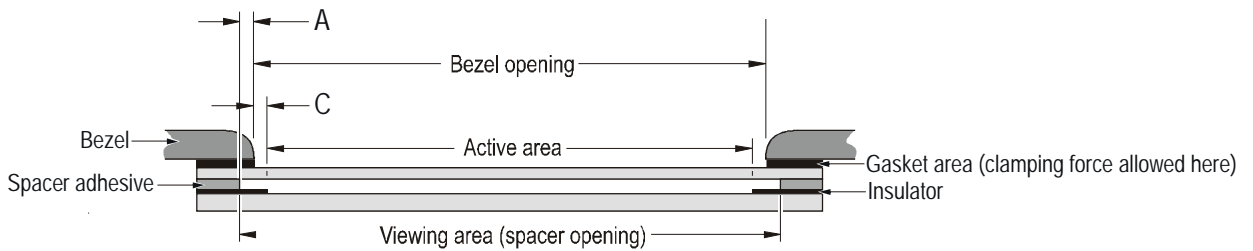


Figure 9: Recommended bezel clearances for 5-Wire touch screens (see Table H)

Table H: Recommended bezel clearances

Clearance areas (Refer to Figure 7, Figure 8, or Figure 9) ^{2, 3}	A Between edge of viewing area and bezel	B Between edge of spacer and bezel (For non-buffer- layer touch screens)	C Between edge of active area and bezel	D Between edge of spacer and bezel (For buffer layer touch screens) ¹
Small Screens (Outer dimensions less than 12 inches)	0.03" 0.8 mm	0.09" 1.3 mm	0.03" 0.08 mm	0.03" 0.08 mm
Large Screens (Outer dimensions 12 inches or greater)	0.05" 1.3 mm	0.11" 2.8 mm	0.05" 1.3 mm	0.05" 1.3 mm

¹The mechanical drawing of the part will indicate whether it includes a buffer layer.

²For *non-buffer* touch screens, two edges have the same dimensions for the spacer opening and the viewing area and two edges have different dimensions. Different bezel clearances apply as shown above. The mechanical drawing will indicate to which edge each dimension applies.

³For *buffer layer* touch screens, the dimensions of the spacer opening and the viewing area are the same on all edges.

Rear mounting guidelines exclusively for non-buffer-layer constructions

Backing panel and registration

Mount the touch screen so that the backing panel is used for registration within the bezel. The backing panel is cut to an overall size (length and width) tolerance of ± 0.015 inches (0.4 mm).

Smooth bezel underside

Use a gasket in combination with a bezel that has a continuous boss, ridge, or groove so that the underside of the bezel is smooth and does not contact the touch screen surface inside the spacer opening.

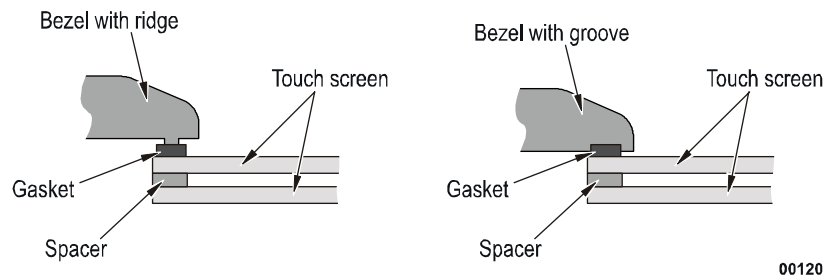


Figure 10: Achieving smooth bezel underside

Tail position

In noisy environments, 3M Touch Systems recommends that you avoid routing the touch screen tail past unshielded, high-voltage sources (such as backlights).

Position the touch screen tail so that its bend radius is greater than 0.125 inches (3.3 mm). The tail can be damaged and the product warranty voided if the tail is severely creased. Also avoid having multiple bends in the tail.

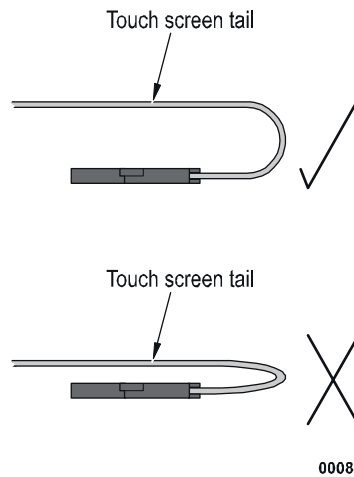


Figure 11: Recommended (and not recommended) bend radius for tail

Hiding the circuitry

Enhance the appearance of the touch screen and your application.

Mounting directly

The easiest and most affordable way to rear mount the touch screen is by screwing the display to the rear of your product's bezel. Here are the steps:

1. Align and adhere the touch screen to the display, using a gasket (Figure 12). For information about gasket options, see Chapter 7.
2. Secure the display to the bezel using the display's mounting holes.

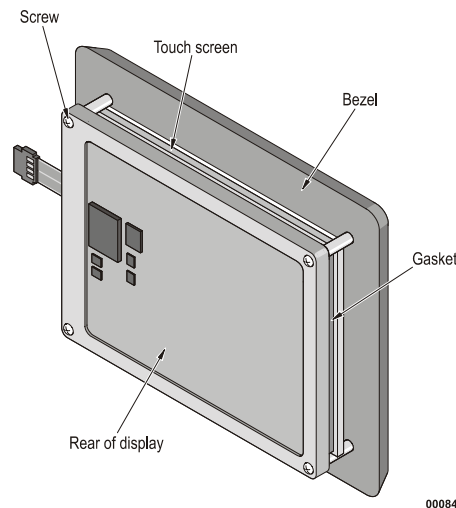


Figure 12: Example of rear mounting a touch screen directly

Mounting with a mounting plate

The other way to rear mount the touch screen is by using a mounting plate. This method is recommended if:

- Your touch screen covers the display's mounting holes.

- You need a versatile mounting method that will allow several holes to be made to accommodate various displays.
- You need good shock absorption.

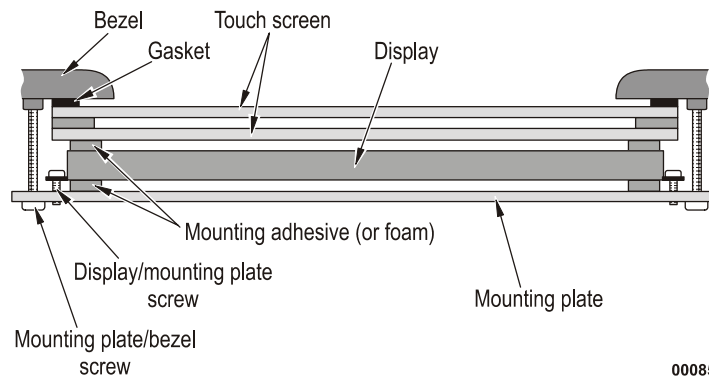


Figure 13: Example of rear mounting a touch screen with a mounting plate

Here are the steps for rear mounting with a mounting plate:

1. Attach the display to the mounting plate.
2. Align and adhere the touch screen to the display by using mounting adhesive (see Figure 13).
3. Secure the assembly to your product's bezel.

Front mounting

Guidelines

When deciding whether front mounting is appropriate for your application, there are some constraints that you need to bear in mind.

If you choose to design for front mounting:

- The touch screen will need to be integrated into a bezel specifically designed to accommodate it.
- If a graphic layer is used, it should be optically bonded to the entire touch screen surface. Using a graphic with a cutout window will cause problems.
- The gap between the touch screen and display will be larger than it would be with the rear mounting method.
- There will be a height difference between the bezel and the touch screen, so that void will need to be filled. Options include:
 - Designing an embossed edge around the entire perimeter, as in Figure 15 (recommended by 3M Touch Systems), *or*
 - Heat staking the plastic bezel to the touch screen.

Important

The touch screen must have rigid support from the back so that it can withstand recurrent touches. One option for achieving this is to place adhesive on the back of the touch screen and attach it to the bezel.

- If an overhanging graphic area is too large, it can be damaged during handling and shipping.

- The touch screen tail must be designed to fold back gently. If the tail is sharply bent, it will create a bulge in the graphic layer.
- In most cases, the active area of the touch screen should match the active area of the display.
- Include an overhanging graphic area with a rear mounting adhesive (Figure 14).

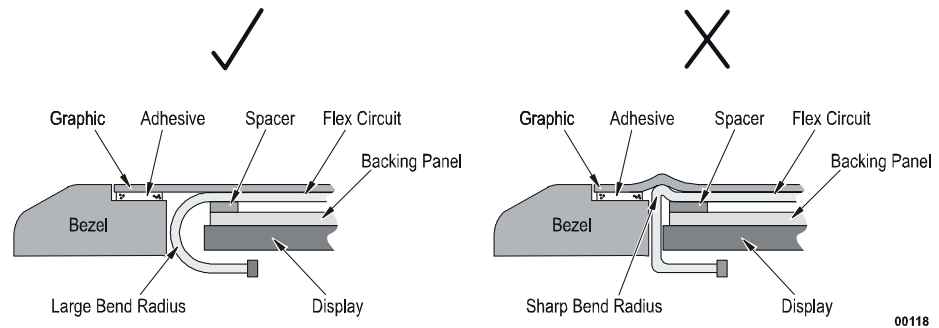


Figure 14: Cross section of front mounting method

- Include ledges on the bezel to hold the overhanging graphic and the touch screen backing panel. Make sure the ledges are strong enough to withstand recurrent touches.
- Position the touch screen tail so that its bend radius does not cause delamination of the touch screen area.

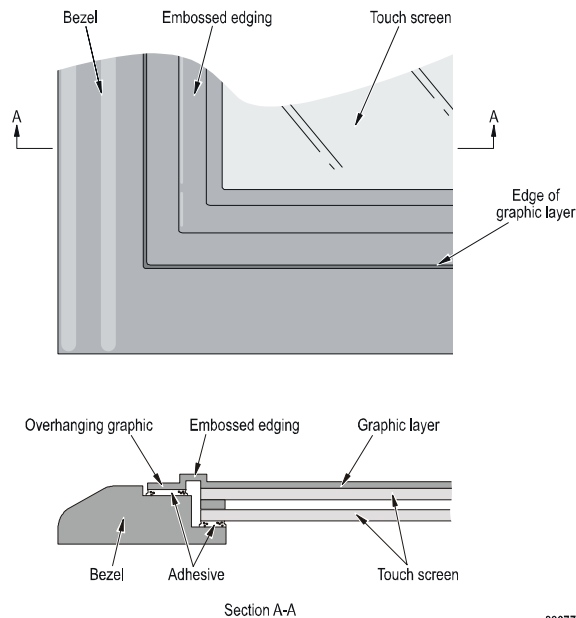


Figure 15: Embossed edge around the bezel

Designing to meet NEMA sealing standards

With the touch screen properly mounted, your product can be sealable to NEMA 12, NEMA 4, and NEMA 4X.

Important

When your product meets one of the specified NEMA standards, it also meets the IP standard (a European designation). However, if your product meets a specified IP standard, it does not necessarily meet a NEMA standard.

- **NEMA 12.** For indoor applications, NEMA 12 enclosures provide a degree of protection against dust, falling dirt, and dripping non-corrosive liquids. NEMA 12 enclosures are not intended to provide protection against internal condensation.
- **NEMA 4.** For indoor and outdoor applications, NEMA 4 enclosures provide a degree of protection against wind-blown dust and rain, splashing water, and water directed by a hose. NEMA 4 enclosures are undamaged by the formation of ice on them, but NEMA 4 enclosures are not intended to provide protection against conditions such as internal condensation or internal icing.
- **NEMA 4X.** NEMA 4X enclosures provide the same level of protection for indoor and outdoor applications as the NEMA 4 standard plus protection against corrosion.

NEMA standard	IP standard
4 and 4X	IP56
12	IP52

Source: *NEMA Standards Publication 250-1997. Enclosures for Electrical Equipment (1000 Volts Maximum)*. National Electrical Manufacturers Association. 1998.

When using resistive touch screens to meet a certain standard, consider such factors as your product's working environment, temperature and humidity, type of bezel, and method of mounting. For more information about standards, please contact 3M Touch Systems technical support.

CHAPTER 6

Graphics and switches

About this chapter

This chapter provides information on custom resistive options for:

- a graphic layer
- discrete and software switches

Custom touch screen graphics

You can enhance the user interface by creating a border with touch-sensitive graphics (e.g., touchable buttons, icons, pictures, logos) around the display.

You can do this by using a touch screen that is larger than the display and adding an optional graphic layer to the top circuit layer of FG and PL touch screens (Figure 16 and Figure 17). The graphic layer is affixed with optical adhesive.

3M Touch Systems accepts film or electronic files to produce custom graphics that can be incorporated into many of our custom resistive touch screens.

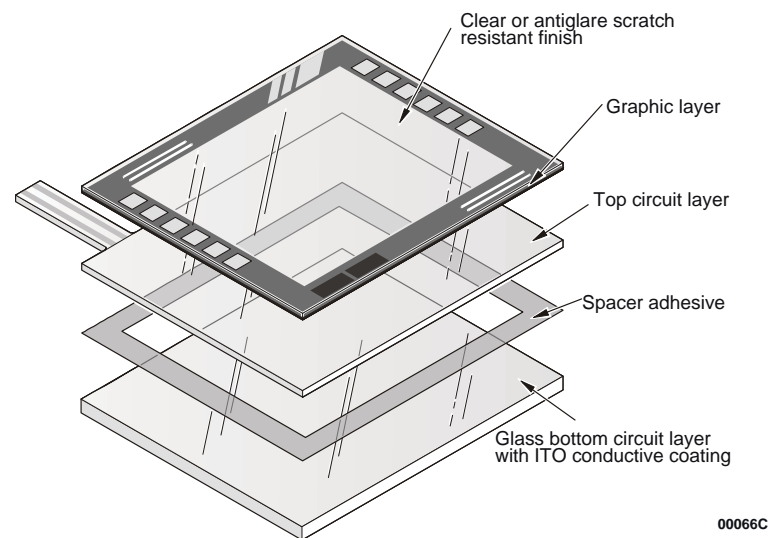


Figure 16: FG construction (with graphic layer)

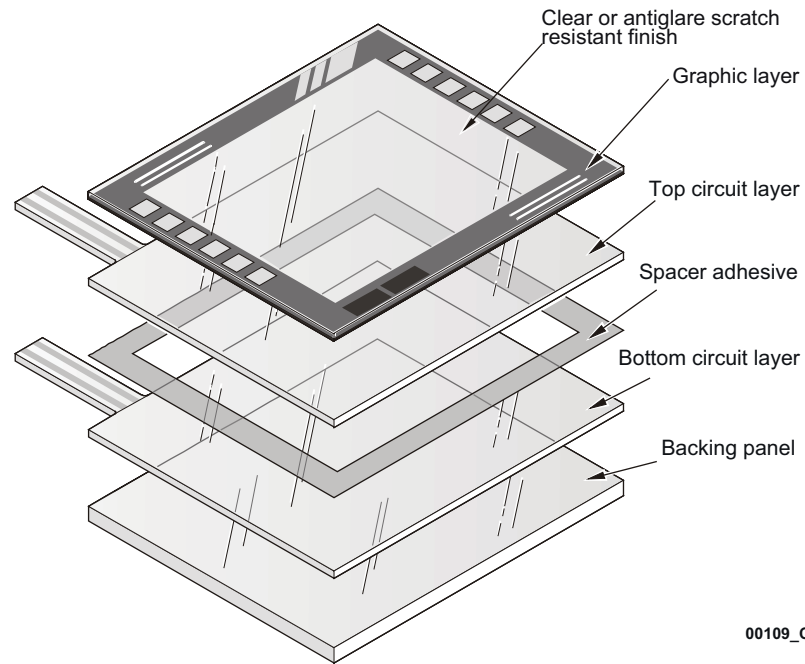


Figure 17: PL construction (with graphic layer)

Guidelines

When choosing graphic features for your custom resistive touch screen system, bear these points in mind:

- Only one color may be used around the inner edge of the touch screen's clear window. Secondary colors should be 0.075 inches (1.9 mm) from the edge of the clear window.
- With each color added to a graphic, the cost increases.

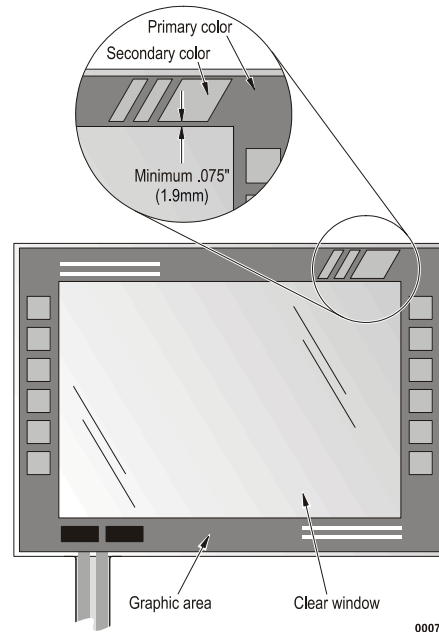


Figure 18: Example of a touch screen with graphics

Switches

Discrete switches or software (programmable) switches can be included in your custom resistive touch screen. You can also customize the sensitivity of your screen.

Discrete

Discrete switches are buttons that use their own traces. In other words, the switches work independently of the rest of the touch screen. That may be a useful option when the switch is used for power or for another safety-related function. Discrete switches can be used with analog resistive or matrix touch screens. (For information on matrix touch screens, see Appendix A, starting on page 43.)

Table I: Advantages and disadvantages of discrete switches

Advantages	Disadvantages
<ul style="list-style-type: none"> ■ Use their own traces, ensuring that the switches work independently of the touch screen. 	<ul style="list-style-type: none"> ■ Reduce flexibility because the switch cannot easily be moved.
<ul style="list-style-type: none"> ■ Do not require re-calibration. 	<ul style="list-style-type: none"> ■ Add cost to the design of the touch screen. ■ Increase the number of pins on the touch screen tail connector.

Software switches

Software switches are buttons that are outside the touch screen’s clear window and use 3M Touch Systems software to detect touches. Software switches suit applications where the function or location of a button may change at a later date

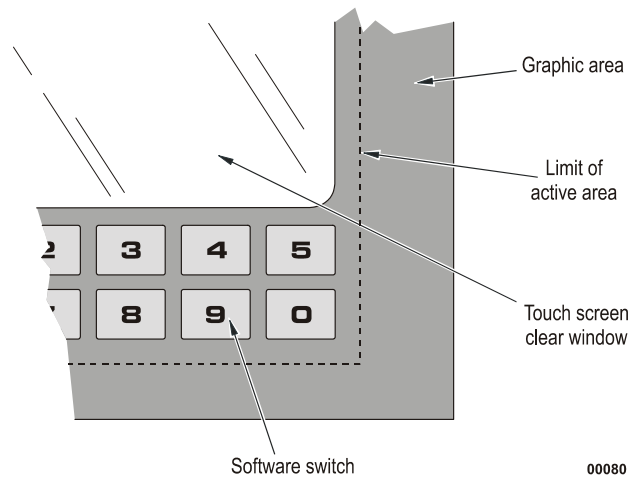


Figure 19: Example of a software switch

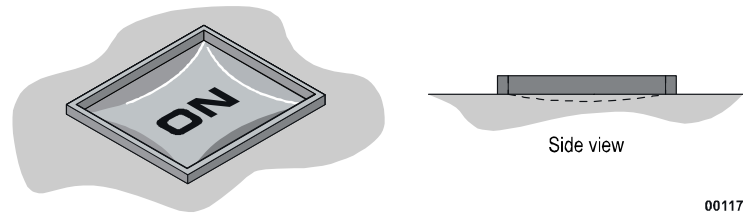
Table J: Advantages and disadvantages of the software switches

Advantages	Disadvantages
<ul style="list-style-type: none"> Provide flexibility because the switch can be moved and functionality can change. 	<ul style="list-style-type: none"> Extra time to configure the switches (using the software) may be necessary.
<ul style="list-style-type: none"> Require no additional pins on the touch screen tail connector. 	

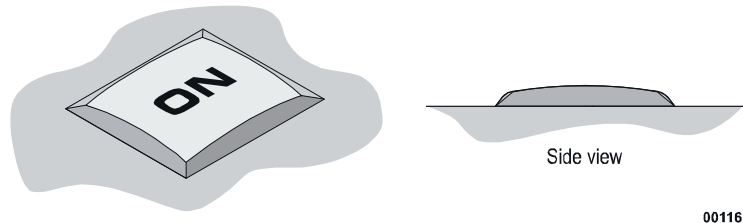
Embossing

The most cost-effective way to add switches is with a flat, non-embossed icon. However, if you need embossing, 3M Touch Systems can provide two types: rim embossed and pillow embossed switches.

A rim embossed switch is one that is raised just around the button's perimeter (Figure 20). It is available as either a discrete switch or a software switch.

**Figure 20: Rim embossed switch**

A pillow embossed switch has a raised button that emits a click when pressed. Tactile switches are available only as discrete switches. All tactile switches use pillow embossing (Figure 21).

**Figure 21: Pillow embossed switch**

CHAPTER 7

Gaskets

About this chapter

Gaskets are available for resistive touch screens to keep dust and moisture out, reduce the effects of shock and vibration, and seal the touch screen to a flat panel display.

This chapter presents:

- Gasket options available and a comparison of when different gasket types are most suitable.
- How to order gaskets from 3M Touch Systems.

Options

You have a number of options when choosing a gasket. You may choose a gasket:

- for different sides of the touch screen, specifically:
 - rear
 - front
 - on both sides
- with foam
- with double-sided (rear only) or single-sided (front side) adhesive

Comparing gaskets

Your application will dictate the most appropriate gasket(s) to use with your resistive touch screen. The advantages of various gasket types are described below. For a complete specification list of gaskets available for resistive touch screens from 3M Touch Systems, see Table K.

Rear gasket

Choose a rear gasket to secure the touch screen to the display, keep dust away from the display, and minimize the impact of shock and vibration.

Front gasket

Choose a front gasket to keep moisture and dust away from the display and to minimize the effects of shock and vibration.

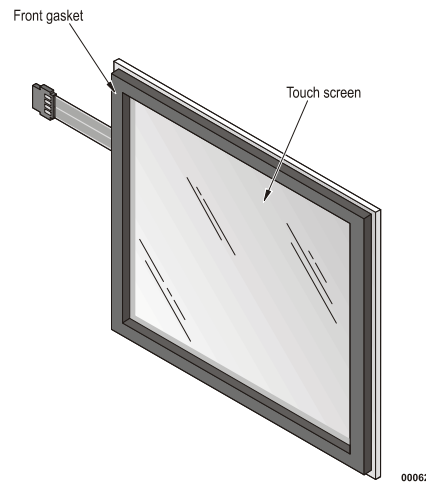


Figure 22: Example of a touch screen gasket (front gasket shown here)

Important

Do not use a front gasket with an adhesive that adheres to your product's bezel. Mounting the touch screen this way may damage it if there are temperature and humidity fluctuations.

Gasket with foam

If you need an exceptional seal, choose a gasket with foam when your product will:

- be in an environment with excessive dust or moisture or
- operate in an environment with a lot of shock and vibration

Double-sided and single-sided adhesive gaskets

For rear gaskets, choose a double-sided adhesive gasket to securely attach the touch screen to a display, keep moisture and dust out, and minimize shock and vibration.

If you want to easily disassemble your product, choose a single-sided adhesive gasket to adhere the rear gasket to the touch screen but not adhere the touch screen to the display.

For front gaskets, 3M Touch Systems recommends a single-sided adhesive so that the adhesive attaches to the bezel, but not to the gasket.

The potential problem with attaching the gasket to the bezel is that the polyester tends to adhere to the bezel and prevent the polyester from expanding and contracting in response to fluctuations in temperature and humidity. This, in turn, can damage the polyester by causing it to bag, stretch, pillow, or otherwise distort.

Table K: Recommend gasket materials

Gasket number	Base material	Type	Adhesion level	Thickness	Cost	Example of application
Double-sided adhesive gaskets						
01	Supported adhesive	Rear	Medium — ideal for most applications	0.003" (0.08 mm)	Low	<ul style="list-style-type: none"> Secure touch screen to display
02	Supported adhesive	Rear	Medium	0.008" (0.2 mm)	Low	<ul style="list-style-type: none"> Secure touch screen to display
03	3M 9871	Rear	Low	0.0025" (0.06 mm)	Moderate	<ul style="list-style-type: none"> Secure touch screen to display Allows disassembly
04	3M 9495MP	Rear	Very high	0.005" (0.13 mm)	High	<ul style="list-style-type: none"> Strongly secure touch screen to display
Double-sided adhesive gaskets with foam						
05	Foam 6 with adhesive 3	Rear	Low	0.035" (0.89 mm)	Moderate	<ul style="list-style-type: none"> Secure touch screen to display Allows disassembly
Single-sided adhesive gaskets with foam						
06	Black closed cell polyethylene	Front or rear	Medium	0.031" (0.79 mm)	Low	<ul style="list-style-type: none"> Seal touch screen to bezel Allows disassembly
07	Black closed cell polyethylene	Front or rear	Medium	0.064" (1.63 mm)	Moderate	<ul style="list-style-type: none"> Seal touch screen to bezel Allows disassembly
08	Black closed cell polyethylene	Front or rear	Medium	0.033" (0.84 mm)	High	<ul style="list-style-type: none"> Seal touch screen to bezel Allows disassembly

Ordering gaskets

Add a gasket to your touch screen

Gaskets can be added to a custom designed resistive touch screen by request or by working with your sales representative to complete the Resistive Quotation Checklist. Gaskets may also be added to standard 4-, 5-, and 8-wire resistive touch screens.

The following conditions apply to adding a gasket to a standard product:

- Gaskets are not sold separately.
- 3M Touch Systems will mount recommended gaskets to our sensors with a 50-piece minimum order quantity.
- Due to the high number of possible gasket and size combinations, please contact your sales representative for a quotation and part number.
- Applying a gasket could add up to 3 weeks to your quoted touch screen lead time.
- One standard gasket size is available per part number and no cancellations or returns will be accepted on touch screens with gaskets.
- Drawings showing gasket placement may be obtained from 3M Touch Systems.

Ordering gaskets: Two easy steps

Follow these steps to order gaskets from 3M Touch Systems:

1. Using Table K, determine which gasket material you need for your application.
2. Contact your regional sales representative to complete a Resistive Quotation Checklist and to obtain pricing and a part number.

CHAPTER 8

Shields

About this chapter

This chapter offers guidelines on:

- choosing an appropriate shield
- deciding where to locate a shield and how to ground it

About shields

To protect the touch screen from electromagnetic interference, an EMI shield (a transparent conductor) may be placed between the touch screen and the device emitting the interference.

Although electrical noise is generally not a problem for MicroTouch™ resistive touch screens, noisy electroluminescent displays and some applications (e.g., medical and instrumentation) require touch screen shields or extra design considerations in order to pass FCC or CE emissions testing.

Important

3M Touch Systems recommends that, in noisy environments, you avoid routing the touch screen tail past unshielded, high-voltage sources, such as backlights. For more information about positioning the touch screen system, refer to Chapter 5 in this guide.

Choosing

To choose a shield for a PL touch screen, consider the ohms/square desired, optical quality desired, and the cost of the shield (Table L).

Before deciding to include a shield in the touch screen design for your application, bear in mind that a shield adds layers to a touch screen assembly and will degrade the screen's optical properties.

If you are using a film-on-glass touch screen, 3M Touch Systems does not recommend incorporating a shield into the design. A shield on an FG touch screen significantly degrades optical quality.

Table L: Guidelines for choosing a PL shield

Ohms/sq.	Shielding	Optics	Cost
350	Good	Best	Low
100	Better	Better	Moderate
60	Best	Good	High

Table M: Guidelines for choosing a shield on the backing panel

Ohms/sq.	Shielding	Optics	Cost
Less than 15	Better	Better	Low
Less than 10	Best	Good	High

Grounding

3M Touch Systems recommends four possible locations for shields (pages 39 through 42). Grounding varies depending on the location of the shield:

For shield locations 1, 2, and 3, grounding of the touch screen EMI shield is accomplished with polyester tabs that protrude from the touch screen or from a touch screen tail that has a connector.

For shield location 4, grounding is accomplished with a conductive mechanical connector (e.g., a metal clamp, copper tape, or conductive gasket).

Shield location 1

This is a common shielding method and one that helps ensure superior optics (Figure 23):

- Bottom circuit layer is optically laminated to the backing panel by applying indium tin oxide (ITO) to both sides of the layer.
- Perimeter of silver ink is applied to the bottom circuit layer.
- Shield is grounded by using either an additional tail or polyester tabs.

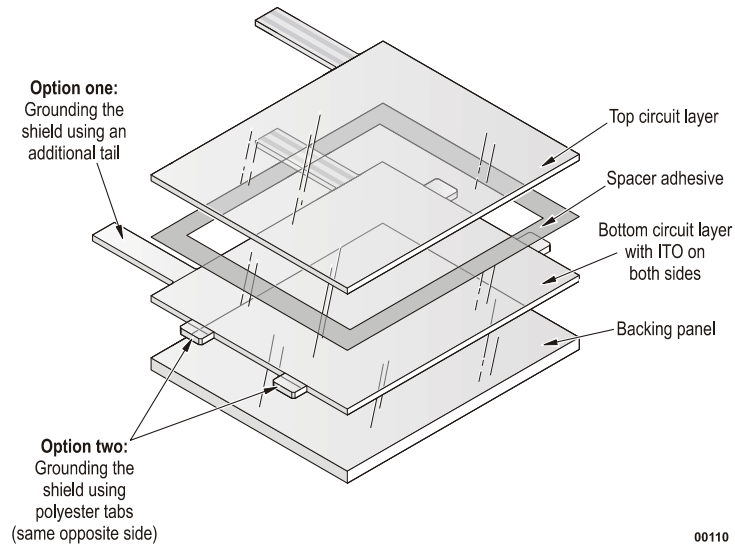


Figure 23: Shield Location 1 - ITO on the bottom circuit layer

Shield location 2

This location (Figure 24) includes:

- Extra layer of polyester (PL “buffer layer”) is optically laminated to the top circuit layer using ITO applied to the top side of the top circuit layer. The PL buffer layer adds about 0.01 inches (0.3 mm) to the thickness of the touch screen.
- Bottom circuit layer is optically laminated to the backing panel.
- Shield is grounded by using either an additional tail or polyester tabs.

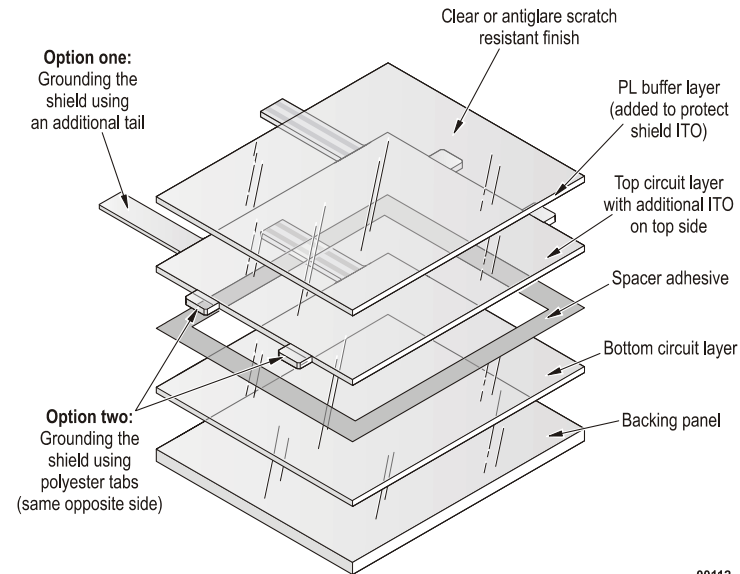


Figure 24: Location 2 - ITO on top of the top circuit layer

3M Touch Systems recommends Shield Location 2 when:

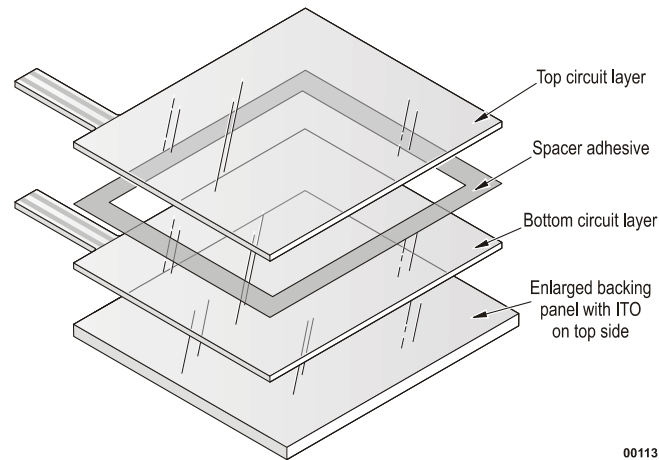
- You need to shield electrical noise that may emit from the touch screen.
- The touch screen needs to be included in the overall product shielding.

Shield Location 3

This location (Figure 25) includes:

- Bottom circuit layer laminated to the backing panel with a layer of ITO is added to the top of the backing panel,
- Backing panel larger than bottom circuit layer (on at least one side) by 0.12 inches (3 mm) to 0.4 inches (10 mm). A larger backing panel is necessary so that it can be grounded.

Bottom circuit layer is optically laminated to the backing panel.



00113

Figure 25: Location 3 - ITO on an enlarged backing panel

3M Touch Systems recommends Shield Location 3 when:

- you need the best possible shielding
- the ITO needs to be protected
- you need superior optics

For shielding guidelines, see Table M on page 38.

Shield Location 4

This location (Figure 26) includes ITO on the bottom side of a glass backing panel.

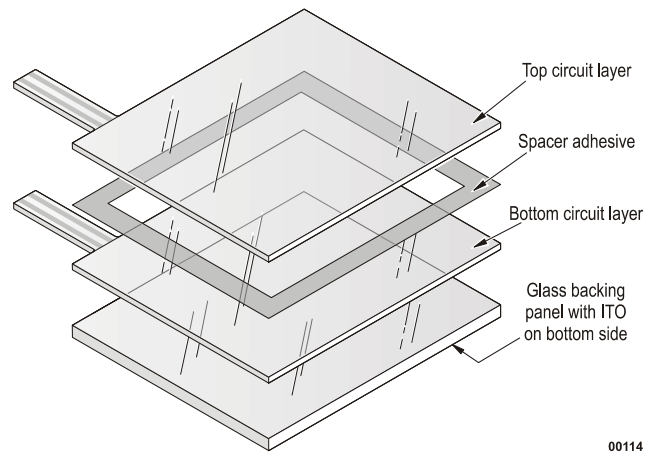


Figure 26: Location 4 - ITO on the bottom side of the backing panel

3M Touch Systems recommends this option when:

- you need superior optics
- you need the best possible shielding
- you need touch screen construction that is easily grounded

For guidelines on mounting a shield on the backing panel, see Table M on page 38.

APPENDIX A

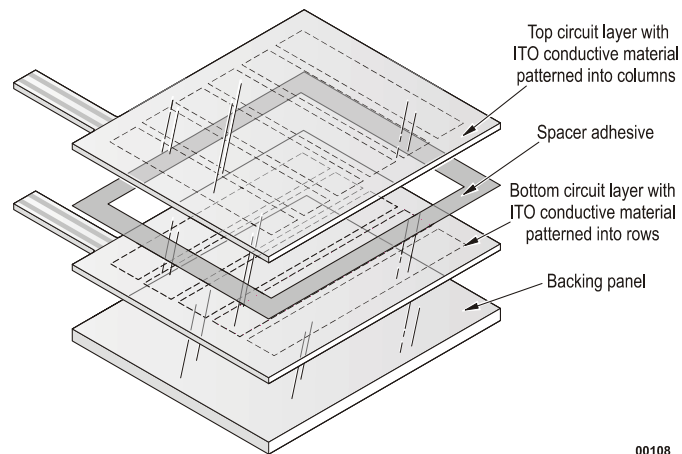
Matrix touch screens

About matrix touch screens

Although most custom resistive touch screens are analog, matrix touch screens are available from 3M Touch Systems.

Matrix touch screens are most suitable for simple applications that require buttons with a fixed size. Matrix touch screens are available in both PL and FG constructions.

Matrix touch screens consist of a transparent conductive material (indium tin oxide) that is patterned into rows and columns (of any size or width) to make up discrete switches (Figure 27).



00108

Figure 27: Example of a matrix touch screen

Features

The major features of matrix touch screens include:

- No re-calibration is necessary.
- Capable of being sealed (NEMA, IP).
- Easily controlled with a keyboard controller or other off-the-shelf components. 3M Touch Systems does not offer controlling electronics for matrix touch screens.
- Most matrix touch screens do not require software drivers; they are constructed to scan for switch (button) closures.

Defining

In choosing the right matrix touch screen for your application, you will need to determine:

1. The number of rows and columns on the screen.
2. The maximum loop resistance value. The resistance value is affected by the screen's sheet resistance and configuration.

More information

For more information on matrix touch screens, contact your 3M Touch Systems regional sales representative or 3M Touch Systems technical support.

APPENDIX B

Glossary

Below are some of the terms used in this manual to refer to resistive touch screen technology and to resistive touch screen products from 3M Touch Systems.

Term	Meaning
Activation force	Force required to make the layers of a touch screen close together and register a touch in the electronics.
Active area	Area on a touch screen where a touch will be registered. It is usually an area smaller than the viewing area.
Anti-Newton Rings (ANR) technology	3M Touch Systems proprietary touch screen construction that eliminates unsightly Newton Rings (see Newton Rings).
Backing panel	Rigid substrate for a touch screen. Usually glass (chemically strengthened or non-strengthened), but also can be made of acrylic or polycarbonate.
Buffer layer	Additional layer of polyester that is laminated to the top circuit layer with optically clear adhesive.
Bus bar	Silver traces that are connected to the indium tin oxide (ITO) patterning along opposing edges.
CTE	Coefficient of thermal expansion. A measure of expansion and contraction. In this guide, refers to backing panel materials.
Delamination	Where touch screen adhesive is not adhering properly. Often appears as a bubble.

Term	Meaning
FG	Film-on-Glass. A resistive touch screen construction. The conductive layer of the touch screen is printed on a glass backing panel.
Gasket	A die-cut layer that is made of polyester, adhesive, foam, or combinations of these materials. A gasket typically used to seal a touch screen to a bezel or display.
Heat staking	Deformation of a Thermoplastic material through the use of heat to secure two or more parts together
ITO	Indium tin oxide. A transparent, conductive, vacuum-deposited coating applied to the inside surface of touch screen layers.
Linearity	A measure of how well a touch screen reproduces a straight line which has been drawn on it.
Matrix touch screen	A type of resistive touch screen that is patterned into rows and columns to make up discrete switches.
Newton Rings	Optical effects that typically resemble a mixture of oil and water. Caused by light interference that occurs when two or more clear surfaces are close together.
Ohm	Unit of electrical resistance.
PET (polyester)	Polyethylene Terephthalate (PET), also called "polyester" is a standard material used for the flex and stable layers in touch screen construction. PET may also be used as the substrate for shields, graphic layers, overlays, and buffer layers.
Pillowing	A puffiness or bagginess between touch screen layers. Caused by excessive air trapped between layers.
PL	Polyester Laminated. A resistive touch screen construction consisting of two polyester layers, one of which is allowed to be flexible while the other is bonded to a chemically strengthened glass backing panel.
Polyester (see PET)	
Shield	A conductive layer used to prevent electromagnetic interference (EMI) from entering or leaving the product.

Term	Meaning
Spacer dots	Small, round dots of transparent insulating material that are used to separate the conductive layers in a touch screen except when pressed together by a finger or stylus.
Viewing area	Area of a touch screen that is clear and can be viewed through. Usually larger than the active area.
ZIF (Zero Insertion Force)	A type of connector housing that is mounted on a device into which a bare touch screen tail may be plugged with little force.
