# Touch Screen Selection Guide

## General

A touch screen is an assembly that is mounted in front of a video display. It is activated by touching, with a stylus or finger, the selected area on the display that indicates the desired function. The touch screen or frame has an independent X-Y coordinate system that is calibrated to the display matrix. The X-Y coordinates of the position of the stylus are communicated to the host computer causing the desired action.

Other than voice recognition, touch input is probably the most natural human interface to any computing device. It is particularly useful and popular in those applications where the user is relatively unskilled in the operation of a computer. For that group of users, keyboards tend to be intimidating devices.

Touch screens have been used for many years, mainly in applications such as point of sale, public information kiosks, industrial and process control, military displays, medical displays and interactive video systems.

## Touch Screens for the Factory Floor

As computer based graphic displays and workstations replace switch and indicator banks as the primary man-machine interface for machine and process control, touch screens are becoming increasingly popular as the input device of choice There are several reasons for this increased popularity.

- Using touch screens, pop-up alpha and numeric keypads replace fixed, expensive industrial keyboards.
- Since video switch banks are software programmable, making changes is significantly less costly than modifying a control panel that contains mechanical switches and indicators.
- Using touch input an unskilled user can operate a complex computing device by interacting directly with the video display with relative ease.
- Touch targets can be any shape size or color which makes screen design more flexible.
- Touch input can provide instant audio and/or visual feedback to tile user to confirm his choice.
- Touch active menus can help guide tile user through complex sequences of commands or actions.
- Complicated control panels can be simplified by only displaying valid options for any control sequence.

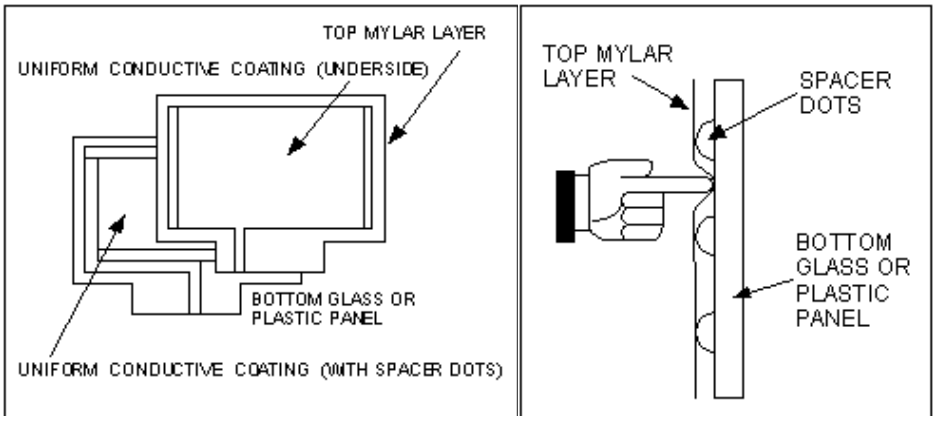
This guide is intended to provide a designer with basic tools and selection criteria to allow the most appropriate touch technology and controller configuration to be chosen for their industrial control application.

## Present Touch Technologies

- Ideally a touch screen would have the following characteristics:
- It would not overlay the display and would, therefore, not degrade the display image.
- It would have resolution equivalent to that of the video display.
- It would be activated by 1) any size stylus 2) conducting or non-conducting styli or 3) a gloved or non-gloved finger.
- It would provide a positive, tactile feedback to the operator.
- It would be modular and capable of being added to a display and computer in the same manner that other input devices are added.
- It would be impervious to dust, grease, moisture chemical or oil vapors or pressure hose down that may be present in a hostile environment.

Unfortunately, none of the touch screens currently manufactured have all of those characteristics. Accordingly, the selection of any touch technology is a compromise that will depend on the particular application and environment.

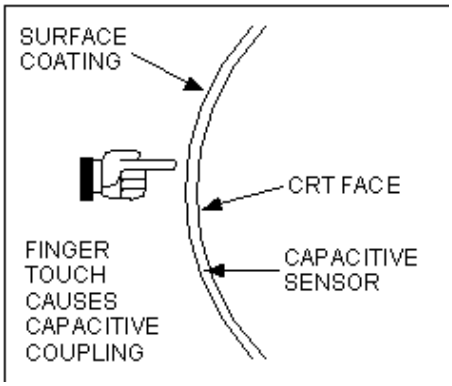
There are four major touch technologies--analog resistive, capacitive, scanning infrared (IR) and surface acoustic wave (SAW). All of these technologies provide an assembly consisting of a touch screen overlay or touch frame and a separate controller. The controller is a printed circuit board assembly that must be mounted in either the display device or the computer.




## Analog Resistive

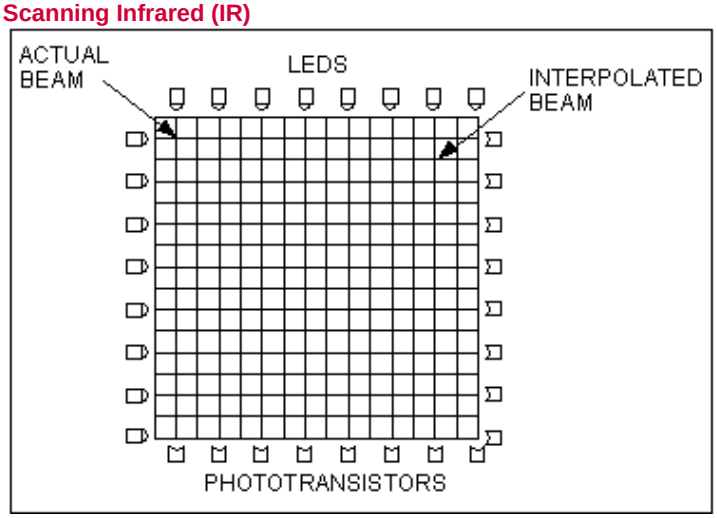
Analog resistive screens consist of a sandwich of Mylar and plastic or glass. Usually the Mylar overlay is hard coated to resist abrasion. The two layers are separated from each other by transparent elastic spacer dots. The inside surfaces of the sandwich are coated with a uniform transparent thin film conductive coating, usually indium-tin-oxide (ITO). In operation, a voltage is alternately applied along the horizontal and vertical axes. When the Mylar overlay is depressed and its conductive layer makes contact with the energized layer, that voltage is sensed and transmitted to a controller containing an analog-to-digital converter. The voltage is converted to a digital X or Y touch location. Although the basic analog resistive technology has infinite resolution, the actual system resolution is limited to the resolution of the A-D converter and is generally greater than 1,000x1,000 points.

## Capacitive




A cross section of a capacitive screen is shown. A glass panel is coated with a conductive coating (usually ITO) that is fused into the glass. The coating is connected to four electrodes at the edges of the screen. Each electrode is connected to an oscillator circuit. When an operator touches the screen, the body capacitance of the operator causes a change in the impedance of the screen. The impedance change causes the oscillator frequencies to vary, and the frequency differentials are converted into X-Y coordinates by an A-D converter. As with the analog resistive screen, the basic capacitive screen has infinite resolution but the system resolution is limited by the signal-to-noise ratio which puts a practical upper limit on the A-D converter resolution--typically 1,000x 1,000 points.

## Scanning Infrared (IR)

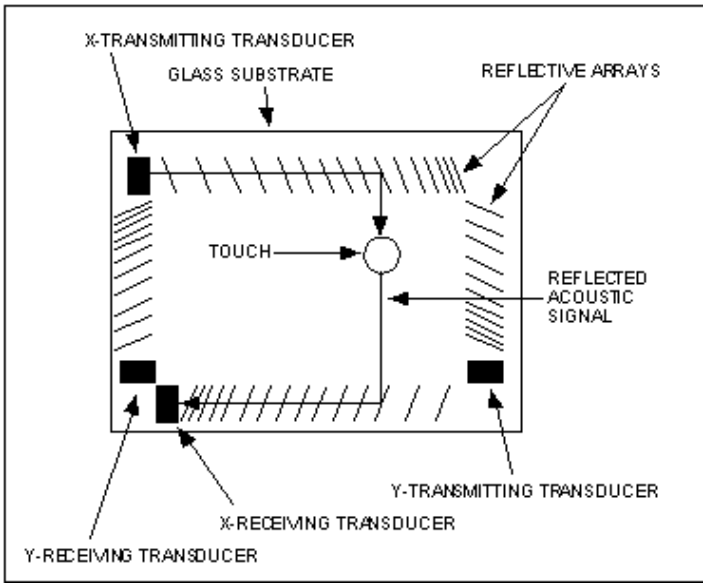



The IR technology is the only technology that does not overlay the display with an additional screen or screen sandwich. An array of infrared (IR) light emitting diode (LED)/photo detector pairs are mounted in a plastic frame. Using the IR spectrum allows ambient light to be filtered out and makes possible the use of opaque (to the visible spectrum) plastic frames to hide the photo devices. Thus, the array frame simply looks like a bezel. In operation, the LED/photo detector array is continuously and sequentially scanned horizontally and then vertically When an operator touches the display breaking one or more of the light beams, the X-Y position of the touch stylus is transmitted to the host computer. The maximum resolution using an interpolation technique is approximately double the number of LED/photo detector pairs in the array. Using interpolation, when an odd number of beams is broken along either axis, the X or Y coordinate of the center beam is transmitted, but when an even number of beams is broken, the coordinates of the interpolated beam are calculated and transmitted to the host computer.

## Surface Acoustic Wave (SAW)

The surface acoustic wave technology is the latest of the touch input technologies and uses inaudible acoustic waves traveling over the surface of

a glass panel at precise speeds in straight lines. X and Y transmitting transducers are located along the horizontal and vertical edges of a glass plate. Corresponding X and Y receiving transducers are located at the opposite edges of the glass plate. A reflective array made of powdered glass is printed along the edges of the glass plate. The array consists of .2 mil thick by 1/2 inch wide diagonal, parallel lines. In operation, the transducer generates a surface acoustic wave which travels along the axis of the reflector array. At each reflector element, a small amount of the energy in the wave is deflected orthogonally to the direction of the wave, travels over the surface of the glass and is again deflected orthogonally toward the receiving transducer by a mirror image reflector. Since the energy in the wave is reduced as it travels the length of the reflective array, the reflector elements are placed increasingly closer together to compensate for the decreasing energy level. When an operator touches the screen, a portion of the energy is absorbed by the touch stylus. This reduced energy level is detected and, by comparing the speed of the received signal with the known speed of the SAW on glass, an X or Y coordinate location is registered. As with capacitive screens, the basic SAW technology has infinite resolution but is limited by the signal-to-noise ratio which puts a practical limit on the A-D converter--typically 900x900 coordinate locations.




## Touch Screen Controllers

Most manufacturers offer two controller configurations--ISA Bus and Serial-RS232.

- ISA bus controllers are contained on a standard printed circuit plug-in board and can only be used on ISA or EISA PCs. Depending on the manufacturer they may be interrupt driven, polled or be configured as another serial port.
- Serial controllers are contained on a small printed circuit board and are usually mounted in the video monitor cabinet. They are then cabled to a standard RS232 serial port on the host computer.

## Software

Most touch screen manufacturers offer some level of software support which include mouse emulators, software drivers, screen generators and development tools for Windows, OS/2, Macintosh and DOS.

Most of the supervisory control and data acquisition (SCADA) software packages now available contain support for one or more touch technologies.

## Selection Process

Generally there four factors that must must considered for any touch screen application:

- The basic touch technology
- The touch controller configuration
- The screen surface treatment (not applicable to IR touch screens)
- Compatibility with the applications software

## Touch Technology Evaluation Factors

- *Resolution*-- The smallest detectable increment of stylus movement establishes the touch resolution. Low resolution may be adequate to activate large targets but for mouse tracking or small target activation, resolution equivalent to that of the monitor is desirable.
- *Parallax*-- If a significant variance exists between the target position on the CRT and the point on the touch screen matrix that, when activated by a stylus, causes a touch to be registered the operator could select a different target area than the desired target.
- *Environment*-- The buildup of a layer of dust, oil, grease or any foreign substance on fingers, harsh chemical vapors and hose-down by pressure hoses may cause improper touch operation.
- *Stylus*-- Types of styli typically used with touch screens are bare finger and gloved finger. Occasionally other types of styli including pencil erasers, tips of a pen, may be pointed at the screen and the user expects a response
- *Transmissivity*-- Overlay touch screens act as a neutral density filter and, therefore attenuate the light from the CRT.
- *Abrasion*-- Touch screen abrasion is experienced in one of three ways. 1) Cleaning of screen with an abrasive 2) Impacting the screen with a sharp object 3) Gradual wearing of the screen from repeated use

## Touch Technology Selection Criteria

Analog Resistive

Advantages

- Highest resolution (better than 1 K x 1 K), smooth mouse tracking and small target activation
- Will operate with virtually any stylus including gloved/ungloved fingers
- Low parallax with spherical screen that conforms to CRT faceplate
- Impervious to dust, oils, grease, moisture
- Touch has some tactile feedback

Disadvantages

- Although Mylar overlay has a hard coat and is somewhat abrasion resistant, it can be damaged by gouging from a sharp instrument
- Hose down can cause unwanted activation of target areas
- Lowest transmissivity of all touch technologies - 55%-65%

Capacitive

Advantages

- High resolution - 1 K x 1 K, smooth mouse tracking and small target activation
- Low parallax with spherical screen that conforms to CRT faceplate
- Impervious to dust, oils, grease, moisture
- Hose-down does not cause unwanted activation of targets
- Impervious to scratching by all but the hardest materials
- High transmissivity - >85%

Disadvantages

- Will not respond to gloved finger or any non-conductive stylus

Scanning Infrared (IR)

Advantages

- Best image quality as there is no overlay
- Impervious to scratching
- Activates with gloved or ungloved finger and any stylus that is large enough to break IR light beam (typically >.25")

Disadvantages

- Low resolution
- Exhibits worst parallax problem of all technologies for CRT use since light beams do not follow curvature of CRT faceplate
- May cause unintended activation of target prior to finger contact with CRT caused by IR light beam location above surface of CRT
- Pressure hose down may cause unwanted target selection
- Dust, oil or grease buildup on frame that impedes light beam may cause malfunction

Surface Acoustic Wave (SAW)

Advantages

- High transmissivity - >92%
- High resolution - 900 x 900, smooth mouse tracking and small target activation
- Low parallax with spherical screen that conforms to CRT faceplate
- Impervious to scratching by all but the hardest materials
- Only technology with Z axis control

Disadvantages

- Pressure hose down may cause unwanted target selection
- Dust, oil or grease on surface of touch screen may cause malfunction or unwanted target selection

## Touch Controller Selection Criteria

Bus Controller

- Bus controllers are available for ISA/EISA and Micro channel. For any other bus, a serial controller must be used
- Bus controllers usually take a half-length slot
- Bus controllers can only be driven a few feet. Therefore the distance between the video monitor and computer must be relatively short
- Certain designs are interrupt driven and require the assignment of an IRQ line. Others have a serial port format and require the assignment of a COM port.
- Bus controllers are mechanically easier to install.

Serial Controllers

Serial Controllers are necessary if:

- A computer bus other than ISA/EISA or Micro channel is used
- A computer slot is not available but a serial port is available
- There is a separation between the computer and monitor of several feet or more
- No IRQ line is available

## Surface Treatment Selection Criteria

Two types of surface treatment are offered for most overlay screens - clear and anti-glare

- Anti-glare screens use an etched surface to diffuse reflected light thus scattering specular reflected light and reducing glare. Unfortunately, this also causes some diffusion of the image. The diffusion is limited if the screen is close to the display surface, but some diffusion remains.
- Clear screens have no diffusion of the display image but the screen is highly reflective

The choice of clear or anti-glare may be somewhat affected by the intensity and direction of ambient light in the viewing area, but in the final analysis, it is usually a subjective decision

## Software Compatibility

After the touch screen technology and controller have been selected:

- It is necessary to determine that the software drivers supplied with the touch screen are compatible with tile latest version of the user's operating system
- If standard application software is being considered. it is necessary to determine that the software is compatible with the drivers and touch hardware
- If software is being developed, it is necessary to ascertain that adequate software drivers and development tools are available

## Summary

We have shown that there are many factors to consider in the proper selection of a touch screen, primarily focused on the application and the environment in which it will be used. We have attempted to provide the designer with adequate information to make an informed choice of a touch screen technology that best suits the application.

Nortech offers a complete line of touch input workstations, control stations and video monitors. Analog resistive and capacitive touch screens are offered as standard products, since one or the other will best satisfy most industrial control applications for use with CRTs. For generally clean environments, surface acoustic wave (SAW) touch screens may be substituted, if desirable. Nortech does not support scanning infrared (IR) touch screens for use with CRTs.