SC3 and SC3-OEM Touch Screen Controllers

User's Guide

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Material in this manual is for informational purposes only. The contents and the product it describes are subject to change without notice.

Important user information

Because of the variety of uses for the product described in this publication, those responsible for application and use of this product must satisfy themselves that all necessary steps have been taken to ensure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes, and standards.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, 3M Touch Systems cannot assume responsibility or liability, including intellectual property liability, for actual use based on the examples in this publication.

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Preface
About this manual

What's in this manual?

Use this manual to help you install, configure, and customize your SC3 serial touch screen controller or SC3-OEM touch screen controller.

The manual describes how to:

- Install the touch screen hardware for the SC3 and SC3-OEM touch screen controllers.
- Install software drivers and utilities needed to use the touch screen with the operating system installed on your computer.
- Define buttons on the TouchSurround and link them to computer commands or to standard IBM-compatible keyboard keys and key sequences.
- Customize the operation of the two controllers.

Who should use this manual?

This manual is for

- People using the SC3 or SC3-OEM touch screen controller and software for the first time.
- Engineers and technicians using the SC3 or SC3-OEM touch screen controller who need to customize its operations.

Terms

The following terms, which relate to the use of the SC3 and SC3-OEM touch screen controllers, may be unfamiliar.

This Term	Refers to:
Analog resistive	A form of touch screen that consists of two opposing layers, each coated with a transparent resistive material called indium tin oxide. For more information, see Appendix A.
Bezel	The front rim of the computer's display containing the touch screen and the faceplate.
Controller	A device that allows a touch screen to respond to the user's touches.

Display area	The part of the touch screen that is positioned over the display of the computer. Touches in this area emulate the movements and actions of a mouse.
Touch screen	A panel that is placed in front of a computer's display and allows the user to control the computer by touching the screen.
TouchSurround	An area of the touch screen (not defined as the display area) for defining buttons that perform keyboard emulation instead of mouse emulation.

Abbreviations and acronyms

These abbreviations and acronyms appear regularly in the manual.

AC	Alternating Current
ADC	Analog to Digital Convertor
API	Application Programmer's Interface
ASCII	American Standard Code for Information Interchange
COM port	Communications Port
CRT	Cathode Ray Tube
EEPROM	Electrically Erasable Programmable Read-Only Memory
EL	Electroluminescent
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
I/O	Input Output
IRQ	Interrupt Request Channels
ISA	Industry Standard Architecture
ITO	Indium Tin Oxide
LCD	Liquid Crystal Display
LED	Light Emitting Diode
OEM	Original Equipment Manufacturer
PC	Personal Computer
PCI	Peripheral Component Interconnect
RFI	Radio Frequency Interference

SC3	(3M Touch Systems Touch Screen) Serial Controller, Version 3
UART	Universal Asynchronous Receiver/Transmitter
VGA	Video Graphics Array

Related publication

Microsoft Mouse Programmer's Reference, Microsoft Press, Redmond, WA

Customer service and technical information

Before contacting 3M Touch Systems

Before contacting 3M Touch Systems for technical support, please have the following information available:

- Part number and version of your SC3 or SC3-OEM touch screen controller.
- Part number of your Dynaclear touch screen.
- Name and version of the 3M Touch Systems software (found on the disk label).
- Name and version of your operating system.
- Edition of this *User's Guide* (found on the inside front cover).

How to contact 3M Touch Systems

For customer service and technical information, contact 3M Touch Systems at:

Telephone:	888-222-9214 or 414-365-3555
Fax:	414-365-1133 Attn: Technical Support
E-mail:	dtftech@dynapro.com Subject: Technical support
Mailing addres	3M Touch Systems 7025 W. Marcia Road Milwaukee, WI 53223 U.S.A. Attn: Technical Support

Staff are available Monday to Friday (except holidays) from 8:00 a.m. to 4:00 p.m., Central Standard Time.

Chapter 1
Introducing the SC3 and SC3-OEM touch screen controllers

What's in this chapter?

This chapter provides

- An overview of the SC3 serial touch screen controller and the SC3-OEM touch screen controller.
- Information on caring for your touch screen.

What are the components?

There are three major components of 3M Touch Systems touch screen systems :

- An SC3 or an SC3-OEM touch screen controller that allows a touch screen to communicate with the hardware of an IBM-compatible host computer.
- A Dynaclear analog resistive touch screen that is placed over a computer display.
- Software for emulating a Microsoft mouse.

Touch screen controllers

The SC3 and SC3-OEM touch screen controllers connect to a host computer's communications port. The controllers can be used with four-wire or eight-wire resistive touch screens and feature user-selectable options for customizing touch processing.

Both the SC3 and SC3-OEM controllers allow a Dynaclear touch screen to respond to touches.

SC3

3M Touch Systems designed the SC3 touch screen controller to be quick to set up and for low-volume prototyping and proof-of-concept applications. Its features include:

- Intelligent filtering software.
- Three-byte data format for fast processing.

These and other features contribute to the production of quick and accurate touch responses for users of SC3 controllers.

SC3-OEM

3M Touch Systems designed the SC3-OEM touch screen controller so that Original Equipment Manufacturers (OEMs) and system integrators would be able to quickly and easily integrate the controller into other products. The controller's features include:

- Practical mounting holes so that it is easily integrated.
- Locking connectors so that all cables are securely fastened.
- In-line flat cable connections, allowing cost-effective cable design.

Touch screen

Dynaclear touch screens are state-of-the-art input devices for many applications. They are easy to use because of their intuitive nature: you touch the visual image and the computer responds with an input selection. Several types of Dynaclear touch screens are available and can be used with most liquid crystal, electroluminescent, or cathode ray tube displays.

Analog resistive touch screens provide high resolution, quick response times, and are not affected by dust and dirt.

Software

The 3M Touch Systems software provides drivers for the touch screen system as well as utility functions.

After installation, use the software for configuring the touch screen, calibrating the touch screen, and configuring the TouchSurround.

The software emulates much of the functionality of a standard mouse device. Mouse motion, which is based on relative movement, is translated into a count of discrete movement steps for both the horizontal and vertical axis. The touch screen mouse emulation is based on absolute movement. A touch will initiate both a cursor absolute movement and a mouse-click event.

Use and care

3M Touch Systems uses a UV-cured, acrylate, custom-coated polyester (PET) for the front surface of most touch screens. This specially hardcoated material is substantially harder and more abrasion- and chemical-resistant than non-coated material, making it the toughest in the industry.

Regular cleaning of the front surface of the touch screen will keep it free of dirt, dust, fingerprints, and other materials that could degrade optical properties. For best results, use a clean, damp, non-abrasive cloth and any commercially available window cleaner.

Long-term contact with abrasive or sharp materials will scratch the front surface, decreasing image quality.

Important To calibrate the touch screen with greatest accuracy, instead of using your finger, use a blunt instrument such as a stylus. Do not use anything sharp that will damage the screen.

Chapter 2
Connecting an SC3 controller Evaluation Kit

System requirements

To use a 3M Touch Systems touch screen with an SC3 controller, you need an IBM-compatible host computer with a:

- 3.5-inch diskette drive.
- Serial communications port.

Components supplied with SC3 Evaluation Kit

The SC3 evaulation kit includes all of the following components:

- SC3 touch screen controller.
- Power supply for SC3 controller.
- Controller-to-touch screen interconnect cable for SC3 controller.
- Dynaclear analog resistive touch screen.

Connecting SC3 components

To install and set up your touch screen:

1. Turn off the power to the computer and monitor.
2. Mount the touch screen to the computer display.
3. Attach the touch screen to the display using tape or velcro, or mount it inside the bezel.
4. Connect the SC3 controller to the computer in one of two ways:
   - Connect the controller serial plug (RS-232) directly into a nine-pin serial COM port on the back of the computer.

     If the selected computer serial COM port is a DB-25 type, use a 9-to-25 pin serial port adapter.
   - Connect the controller to the computer's COM port using a serial cable (not supplied).

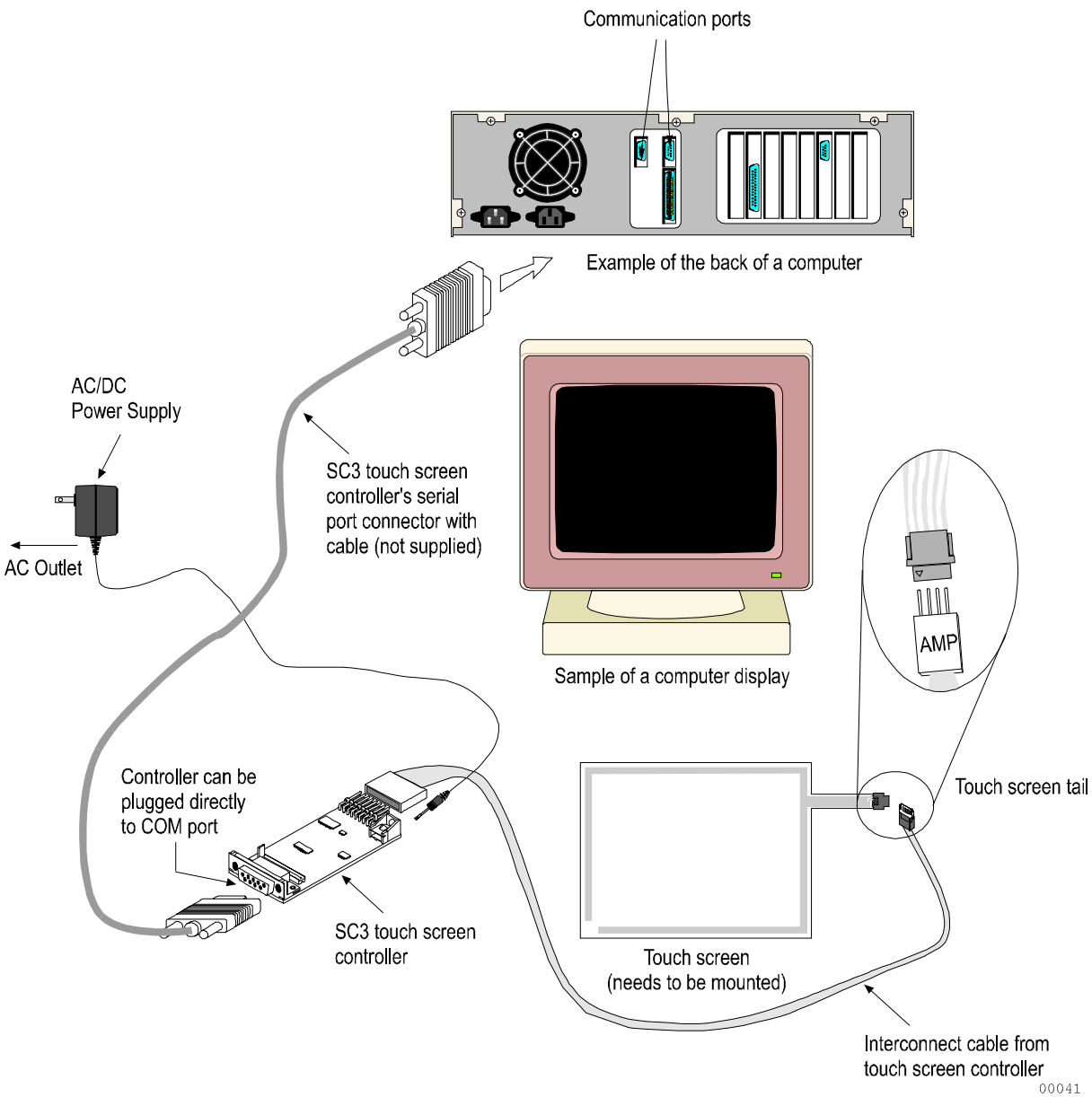


Figure 1: The SC3 touch screen system

5. Connect the touch screen to the controller using the interconnect cable as follows:

   a) Connect the male end of the cable to the touch screen tail.

   b) Connect the female end to the controller.

   In most cases, the four- or eight-wire cable connector is keyed for proper connection (the orientation of the cable connection at the touch screen is not important). For non-standard connections, see "What do I do if I have a touch screen with a non-standard pin-out?"

6. Insert a 9 Vdc power plug into the 3.5-mm power connector on the SC3 controller.

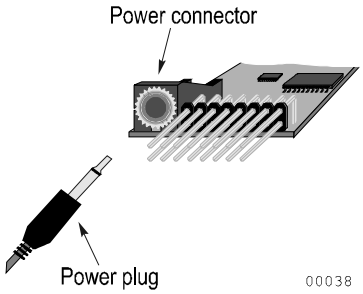


Figure 2: Connecting power to the SC3 touch screen controller

7. Turn on both the computer and the monitor and plug in the 9 Vdc power plug for the SC3 controller.

SC3-OEM hardware

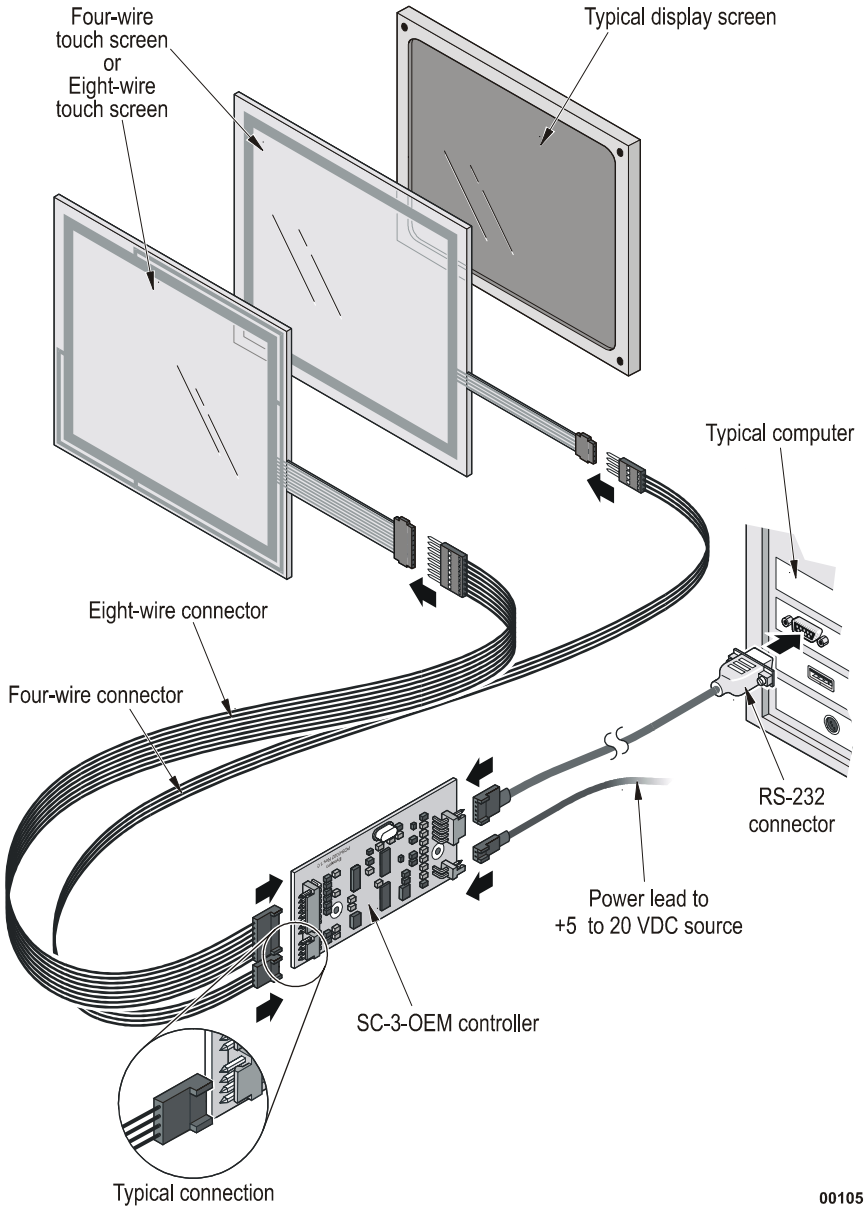


Figure 3: SC3-OEM touch screen system

For details on mounting the SC3-OEM controller, see “Mechanical mounting” in Chapter 9, beginning on page 71.

Chapter 3
Installing and configuring software for Windows 95, 98, and NT

What's in this chapter?

This chapter provides an overview of how to:

- Install the touch screen software for Windows 95, 98, and NT.
- Use the Configuration and Mouse Button Swap utilities.

About the touch screen software

Your touch screen driver software has the following utilities:

- Configuration

  Use this utility for configuring the touch screen controller, calibrating the touch screen, configuring the touch screen, and configuring the TouchSurround.

- Mouse Button Swap

  Use this utility to specify whether a touch will emulate the right or left mouse button.

This software is described in more detail on the following pages.

Installing the software

To install the software:

1. Close all open Windows programs.
2. Insert into the diskette drive the 3M Touch Systems driver that is appropriate for your operating system.
3. From the Start menu, select Run.
4. Type a:\install.exe in the Run window (where 'a' is the drive containing the diskette) and press OK.

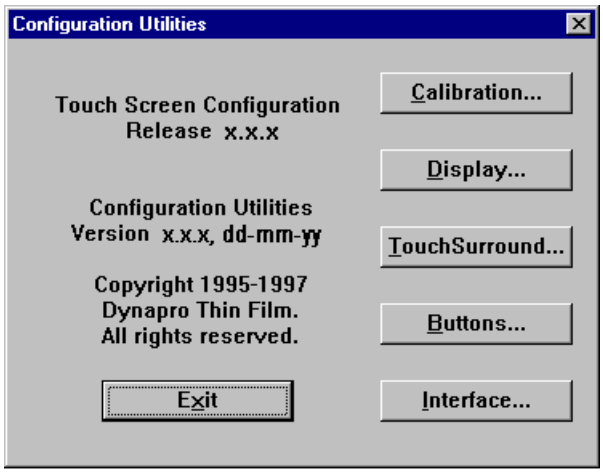
   The software automatically determines your operating system, driver, and destination directory and folder.
5. Press Next.

   The software allows you to change your port, interrupt, and I/O address values.
6. Press Install.
7. Exit the Touch Screen Installation window and then restart the computer.

Starting the configuration utility

To start the configuration utility, select the Windows Start button, point to Programs, Touch Screen Utilities, and then select Configuration.

The Configuration Utilities window appears. Choose from the window the option you want to confiugre.



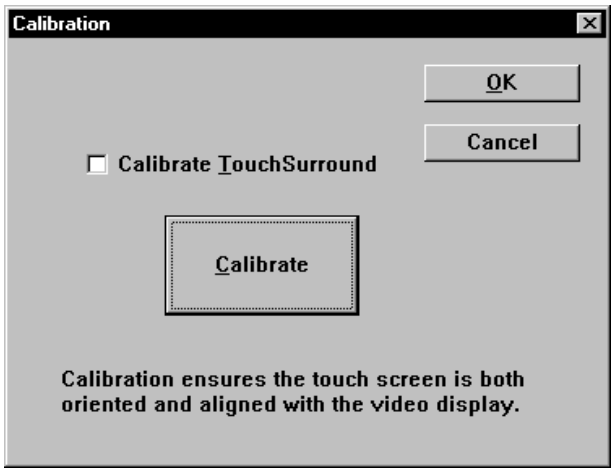
The rest of this chapter will discuss each of the five options in the window:

- **Calibration**: Calibrating the touch screen.
- **Display**: Configuring the display area of the touch screen.
- **TouchSurround**: Configuring the TouchSurround.
- **Buttons**: Configuring the TouchSurround button definitions.
- **Interface**: Configuring the controller (including advanced controller configuration options).

Calibrating the touch screen

Calibration orients and aligns the touch screen with the video display. This step is necessary for all touch screens.

1. In the Configuration Utilities window, select Calibration. The Calibration window appears (see below).
2. To use the TouchSurround buttons, select the Calibrate TouchSurround checkbox. See “Calibrating the TouchSurround” on page 33.
3. Select Calibrate.



4. To calibrate, follow the on-screen prompts. To cancel calibration without any changes, press Esc any time.

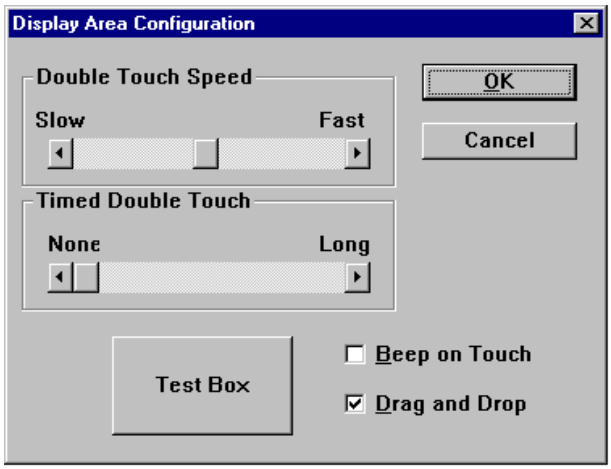
   When finished, the new calibration takes effect immediately and the Calibration window reappears.

5. If the calibration is satisfactory (test it by moving the cursor around the screen with your finger), select OK to save the calibration and close the window. Otherwise, select Cancel to discard the calibration and revert to the old calibration, or select Calibrate and complete the procedure again.

Configuring the touch screen

Use the Display Area Configuration window to configure touch emulation options. This step is necessary only if you want to change how the touch screen operates:

1. In the Configuration Utilities window, select Display. The Display Area Configuration window appears.
2. Fill in the fields as described below.
3. After you've configured the settings, select OK to save them.



Double Touch Speed

Touching the screen twice can produce either a double touch or two individual touches. Use the slider to increase or decrease the time the touch screen allows between touches to distinguish between two touches and a double touch. The default is mid-range.

If you increase the speed too much, it may become difficult to generate a double touch; you will need to touch the screen twice very quickly. If you decrease the speed too much, you may find that what you intended to be two separate touches is interpreted by the touch screen as a double touch.

The Test Box area inverts its black/white color when you successfully double-touch the button.

Timed Double Touch

A double-click mouse event is generated if a touch is held at the same location for a specific time. The time is determined by the Timed Double Touch setting. The default is none.

Adjust the setting from None to Long. Moving just off None sets a time of about 0.2 seconds. Long sets a time of about two seconds. Lengthening the setting increases the touch hold time required to generate a double-touch event. Setting any position except for None automatically sets the Double Touch Speed setting to Fast with a disabled slider. This prevents undesired interaction of the two features.

A Timed Double Touch is generated on the initial touch only. It is not generated after dragging. The Test Box inverts its black/white color when you successfully generate a timed double-touch on the button.

Beep on Touch

Select this option to have the computer beep on each first touch. The default is disabled.

Drag and Drop

This option provides touch dragging functionality. The default is enabled.

If disabled, only the initial touch down will be acted upon. To act on a new or same-position touch, a subsequent touch release is required.

Configuring theTouchSurround

In the Configuration Utilities window, press the TouchSurround button to configure the TouchSurround. The TouchSurround Configuration window appears.

This step is necessary only if you wish to define programmable keys around the video area. For details, see “Configuring the TouchSurround” on page 35.

Configuring the buttons

Select Buttons in the Configuration Utilities window to define TouchSurround buttons. The TouchSurround Button Definitions window appears.

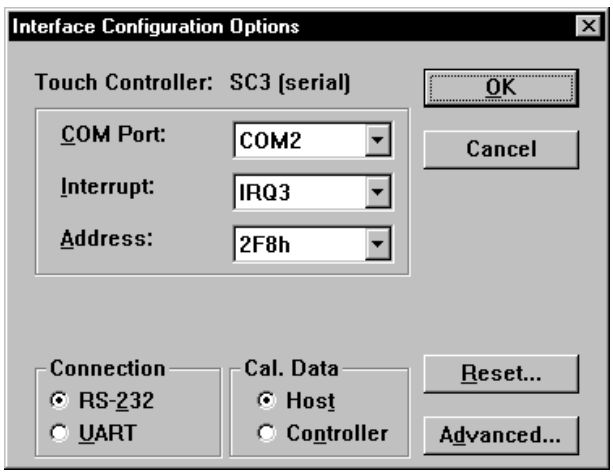
This step is necessary only if you wish to define programmable keys around the video area. For details, see "Defining TouchSurround button functions" on page 36.

Configuring the controller

Use the Interface Configuration Options window to define the parameters required to communicate with the touch screen controller.

This step is necessary only if you want to change the default settings for driver-to-controller communication. For example, if you want the touch screen to use a COM port other than COM Port 1, change that setting here.

1. In the Configuration Utilities window, select Interface. The Interface Configuration Options window appears.
2. Fill in the fields as described below.
3. After you've configured the fields, select OK to save the settings.



COM Port

Sets the serial communication port. Selecting a port will automatically fill the Address and Interrupt fields with the default values for the port. To use custom combinations, select the interrupt and address individually.

Interrupt

Sets the interrupt request number used by the touch screen controller to interrupt the operating system.

Address

Sets the I/O base address used by the touch screen controller. If you are using a standard COM port, you should need to use only the COM port field.

Connection

Sets the driver to the proper communication protocol, depending on the connection of the SC3 controller to the host computer. The SC3 is configured to use the RS-232 protocol to interface with a standard serial communication port.

Cal. Data

Sets the storage location of the calibration data. The driver will store the calibration data either on the host computer or on the SC3 controller's EEPROM. The driver reads the calibration data during start up and uses it to adjust the touch screen coordinates for proper cursor tracking.

If the storage location is set to Controller, Low Power Mode cannot be selected because the controller will not respond when the driver requests the calibration data. Selecting Controller grays out the Low Power Mode check box on the Advanced Controller Options window.

Reset

Reset provides a method for the host computer to re-establish basic communication with the controller. Use the Reset feature only as a recovery tool when the controller and the host are not communicating.

A mouse or keyboard is required to activate the Start button in Windows because touches are not being acknowledged. The host attempts to communicate with the controller at each of 1200, 2400, 4800, and 9600 baud until the controller responds. The baud rate scan will be initiated on the COM port selected in the Interface window. After the host establishes basic communication, it will download the default Control Words to the controller.

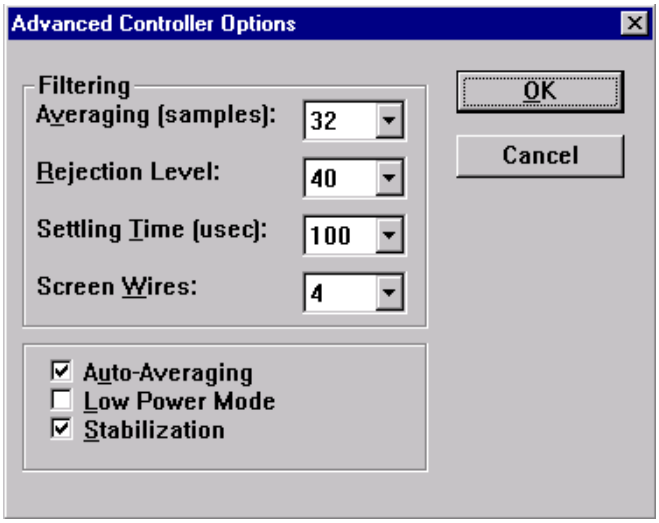
Configuring the controller: Advanced options

Use the Advanced Controller Options window to change parameters that affect the behavior of the controller's touch point processing.

The parameters stored in the controller and those displayed in the window are independent. The values displayed represent the last ones downloaded.

1. In the Configuration Utilities window, select Interface, and then select Advanced. The Advanced Controller Options window appears (see below).
2. Fill in the fields as described below.
3. After you've configured the fields, select OK to save the settings. The changes are then downloaded to the controller.

   To discard the changes, select Cancel.



Averaging (samples)

Sets the number of samples the controller will collect for averaging into a touch point location. The averaging required by an application is based on electrical noise in the system and desired speed of touch point reporting. A higher number produces smoother lines when drawing, at the expense of touch report rate (points/sec). The default is 32.

Rejection Level

Sets the sensitivity of the controller to reject “noisy” touch inputs. Lower settings will reject touch inputs when a small amount of noise is present. Higher settings will allow touch inputs when there is more noise. The default is 40.

Settling Time (usec)

Sets a time delay between the excitation of the touch screen and touch screen measurement. The time allows the system to settle before the controller takes a position measurement. Higher values can compensate for screen resistance. The default is 100.

Screen Wires

Sets the number of wires used for touch screen decoding. Be sure to select the option that matches the type of touch screen you are using.

Auto-averaging

Provides automatic switching between two levels of averaging based on touch movement speed. Slow touch movements invoke the user-set averaging. Fast touch movements invoke a reduced fixed averaging of eight samples per point. This gives better filtering when touch movement is slow, while offering higher speed sampling when touch movement is fast. If you set the Averaging field to 8 or less, this option has no effect. The default is enabled.

Low Power Mode

Provides the enabling of low power mode. When Lower Power Mode is selected, the controller enters low power mode if a touch is not detected for 255 consecutive touch screen scan cycles (approximately three seconds). When Low Power Mode is not selected, the controller enters Run Mode and continuously scans the touch screen and reports X-Y location information for valid touches. After a simple touch occurs, the controller will change from Low Power Mode to Run Mode in approximately 28 milliseconds. The default is disabled.

Stabilization

Sets the stabilization feature, which eliminates any jittering in the cursor or pointer that is caused by system noise. The default is enabled.

3M Touch Systems recommends you use this feature for most applications. For drawing applications, however, 3M Touch Systems recommends you disable the stabilization feature.

Using the Mouse Button Swap utility

Use the Mouse Button Swap utility to select either right- or left-mouse-button click emulation in response to a touch.

To start the utility, select the Windows Start button, point to Programs, Touch Screen Utilities, and then select Mouse Button Swap.

The Mouse Button Swap utility window displays a picture of a mouse. You can move the window anywhere on the screen. The currently active mouse button, left or right, is highlighted in black.
If you select the window, the highlight changes positions. This allows you to emulate both mouse buttons by providing a way to switch between them.

If you want the Mouse Button Swap program to automatically start when Windows starts, add the program to the Startup folder. For details, see the documentation that came with Windows.

Chapter 4
Installing and configuring software for Windows 3.1

What's in this chapter?

This chapter provides an overview of how to:

- Install the touch screen software for Windows 3.1.
- Use the Touch Screen Utility.

About the software

Use the Touch Screen Utility to calibrate and configure the touch screen. This software is described on the following pages.

Installing the software

Follow the instructions below to install the touch screen software from the disk to the computer you're using.

Once you've installed the software for Windows 3.1, the touch screen will not be operational until you calibrate it. Use the Touch Screen Utility to calibrate the touch screen and configure settings (the double-touch speed setting, for example).

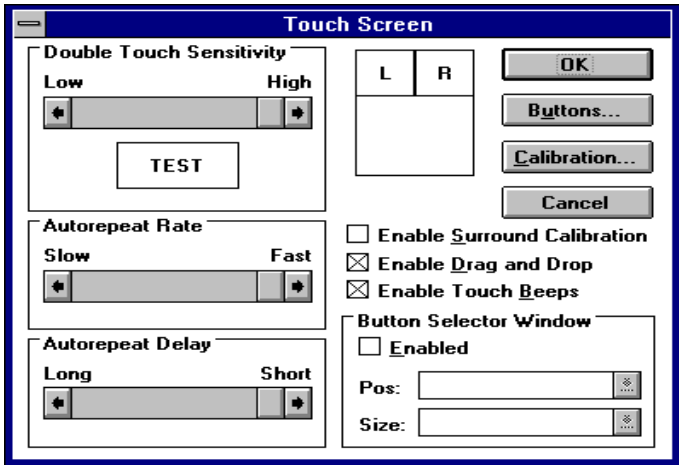
1. Close all open Windows programs.
2. Insert the 3M Touch Systems driver for Windows 3.1/DOS diskette into a diskette drive.
3. Under the File menu, select Run. Type a:\install in the Command Line (where 'a' is the drive containing the diskette). Press Enter.
4. Follow the on-screen instructions. You will be prompted to select a standard COM port. COM port 1 is the default.

   If you wish to use a non-standard COM port, you must edit the autoexec.bat file after the software is installed. For more information, contact 3M Touch Systems.
5. When installation is complete, remove the disk from the diskette drive.
6. Restart the computer.

Starting the Touch Screen Utility

To start the Touch Screen Utility:

1. In the Windows Program Manager, open the Main group.
2. Inside Main, open the Control Panel.
3. Inside Control Panel, open Touch Screen. The Touch Screen Utility window appears.



Calibrating the touch screen

Calibration orients and aligns the touch screen with the video display.

When calibrating the touch screen, be sure you are directly in front of the unit.

1. In the Touch Screen window, select Calibration.
2. To calibrate, follow the on-screen prompts.

After you have completed all the required touches, the calibration is saved and takes effect immediately.

Configuring the touch screen

Use the Touch Screen window to change the touch screen characteristics.

1. Fill in the fields as described below.
2. After you have configured the fields, select OK to save the settings.

To return all parameters to their last configured values, select the Cancel button. The Cancel button does not undo any calibration that was performed from the Calibration button.

Double Touch Sensitivity

Touching the screen twice can produce either a double touch or two individual touches. Use the slider to increase or decrease the time the touch screen allows between touches to distinguish between two touches and a double touch.

The default is mid-range. If you increase the speed too much, it may become difficult to generate a double touch; you will need to touch the screen twice very quickly. If you decrease the speed too much, you may find that what you intended to be two separate touches is interpreted by the touch screen as a double touch.

The Test box area inverts its black/white color when you successfully double-touch the button.

Autorepeat Rate

Use the slider to set the auto repeat rate for buttons on the touch screen. If you set the rate Fast, holding a touch will produce rapid repeat events. If you set the rate Slow, the same touch will generate fewer repeat events in the same length of time.

Autorepeat affects only events generated by button presses. It does not affect events generated by button releases.

Autorepeat Delay

Use the slider to set the time required for a touch to be held before autorepeat mode begins. A short delay means you don't need to hold a touch very long before autorepeat touches are generated. A long delay means that you must hold a touch longer to begin generating autorepeat touches.

Enable Surround Calibration

Use the check box to indicate that you wish to calibrate the TouchSurround.

Enable Drag and Drop

Use this option to provide touch dragging functionality. The default is enabled.

If disabled, only the initial touch down will be acted upon. To act on a new or same position touch, a subsequent touch release is required.

Enable Touch Beeps

Select this option to have the computer beep on each first touch. The default is disabled.

Button Selector Window

Use the Button Selector window to select either right- or left-mouse-button click emulation in response to a touch. When enabled, this window appears displaying the picture of a mouse. The currently active button, left or right, is highlighted in black. When you select this window, the cursor does not appear inside the window, but remains in its last position. This reminds you where you were last touching. The Button Selector window appears on top of other windows.

To enable this window, select the Enabled box. The Position (Pos) and Size fields display the current position and size of the Button Selector window.

Defining TouchSurround buttons

Select Buttons in the Touch Screen window to define the TouchSurround buttons. This step is necessary only if you wish to define programmable keys around the video area.

Configuring the controller

See “SC3SETUP program” and “SC3CAL program” in Appendix B.

Chapter 5
Installing and configuring software for MS-DOS

What's in this chapter?

This chapter provides an overview of how to:

- Install the touch screen software for MS-DOS.
- Use the touch screen software for MS-DOS.

About the software

Use the Touch Screen Driver & Utilities software for calibrating the touch screen, configuring the touch screen, and configuring the touch screen controller.

The software is described in more detail on the following pages.

Installing the software

1. Insert the 3M Touch Systems driver for MS-DOS disk into a diskette drive.
2. At the MS-DOS prompt, type a:\install (where a is the drive containing the disk) and press Enter.
3. Follow the on-screen instructions.
4. When installation is complete, remove the disk from the diskette drive.
5. Restart the computer.

Starting the software

At the MS-DOS prompt, type TOUCHCFG.

Using the software

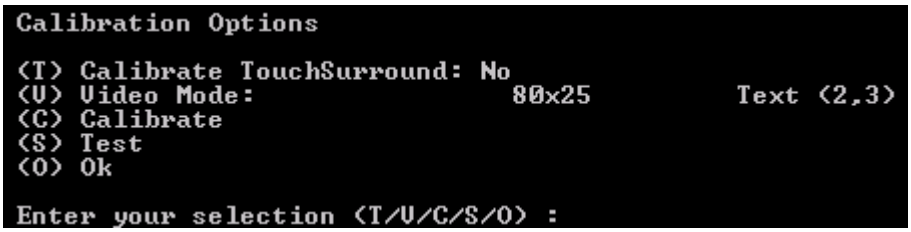
In the Touch Screen Driver & Utilities menu, select the option you want to configure: Calibration, Display, TouchSurround, Buttons, or Interface.

Calibrating the touch screen

Use the Calibration Options menu to orient and align the touch screen with the video display. Calibration is necessary for all touch screens.

1. In the Touch Screen Driver & Utilities menu, press C to select Calibration.

   The software detects the computer's video modes and the Calibration Options menu appears.



Calibrate TouchSurround

The TouchSurround allows you to use part of the touch screen to define keys, such as the ones on a keyboard.

In the Calibration Options menu, press T to turn on or off the Calibrate TouchSurround setting.

Video Mode

In the Calibration Options menu, press V to display the available video modes on your system. This setting is optional.

Calibrate

This procedure is necessary for all touch screens.

To calibrate the touch screen:

1. In the Calibration Options menu, press C to calibrate the touch screen.
2. To calibrate, follow the on-screen prompts. To cancel calibration without any changes, press Esc at any time.

When finished, the new calibration takes effect immediately and the Calibration Options menu reappears.

Test

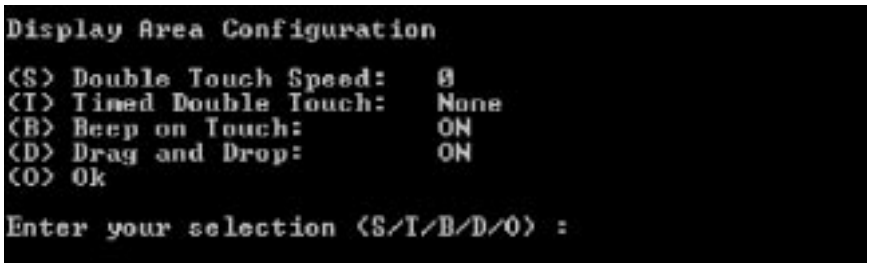
Press S to test the new calibration.

Ok

If the changes you made are satisfactory, press O for okay to save the changes and close the Calibration Options menu. Otherwise, press Esc to discard the calibration and revert to the old calibration, or select Calibrate and complete the procedure again.

Configuring the touch screen

Use the Display Area Configuration menu to configure the touch screen. This section is necessary only if you want to change how the touch screen operates.



1. In the Touch Screen Driver & Utilities menu, press D to select the Display settings. The Display Area Configuration menu appears.

Double Touch Speed and Timed Double Touch

The touch screen can detect a double touch, which is the same as double-clicking the mouse. To generate two separate touches, touch the screen twice slowly.

To use the double touch feature, do one of the following:

- Touch the touch screen twice quickly as if you were double-clicking the mouse (this is the default option).

  Press S to adjust the Double Touch Speed setting. Type 0 and press Enter to select the slowest setting; type 100 and press Enter to select the fastest setting.

  If you increase the speed too much, it may become difficult to generate a double touch; the touches will instead be recognized as two separate touches.

  If you decrease the speed too much, what you intend to be two separate touches might instead be recognized as a double touch.

- Touch the touch screen and hold it.

  Press T to adjust the Timed Double Touch setting. Type 0 and press Enter to select None; type 100 and press Enter to select Long.

  If you decrease the setting to None, the Timed Double Touch setting is inactive.

If you increase the setting to Long, it takes about two seconds to generate a double touch.

A timed double touch is generated on the initial touch only, not after dragging.

Beep on Touch

Press B to turn on or off the Beep on Touch setting. When this option is selected, the computer beeps on each first touch.

Drag and Drop

Press D to turn on or off the Drag and Drop setting, which enables the cursor to follow your finger around the screen until you release it. This allows you to select an object on the screen, drag it across the screen to a new location, and then drop it in its new position by releasing the touch.

Ok

If the changes you made are satisfactory, press O for okay to save the changes and close the Display Area Configuration menu. Otherwise, press Esc to discard the changes and revert to the old settings.

Configuring the TouchSurround

In the Touch Screen Driver & Utilities menu, press T to select TouchSurround. The TouchSurround Configuration menu appears.

Use the TouchSurround Configuration menu to configure the basic operating characteristics of the TouchSurround. The TouchSurround allows you to use part of the touch screen to define keys, such as the ones on a keyboard.

Configuring the buttons

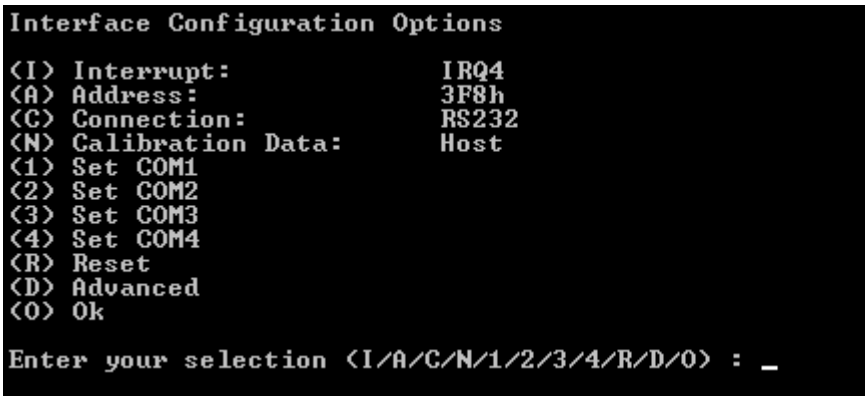
In the Touch Screen Driver & Utilities menu, press B to select Buttons. The TouchSurround Button Definition menu appears.

Use the TouchSurround Button Definition menu to configure the basic operating characteristics of the TouchSurround buttons. You can define the size, position, activation, and function of the buttons on the TouchSurround, and you can define buttons as function keys, command keys, calculator keys, screen change controls, or whatever other format you require.

Configuring the controller

Use the Interface Configuration Options menu to change the communications parameters needed to communicate with the touch screen controller.

This section is necessary only if you want to change the communication settings you selected during installation. For advanced options for controller configuration, see “Configuring the controller: Advanced options” on page 28.



1. In the Touch Screen Driver & Utilities menu, press I to select Interface. The Interface Configuration Options menu appears.

Interrupt

Sets the interrupt request number used by the touch screen controller to interrupt the operating system.

Press I to change the interrupt request number. To cancel without any changes, press Esc at any time.

Address

Sets the I/O base address used by the touch screen controller. If you are using a standard COM port, you should need to use only the COM port setting.

Press A to change the I/O base address. To cancel without any changes, press Esc at any time.

Connection

Sets the driver to the proper communication protocol, depending on the connection of the touch screen controller to the host computer. The default setting is RS-232.

Calibration Data

Sets the storage location of the calibration data. The driver will store the calibration data either on the host computer or on the touch screen controller's EEPROM.

If the storage location is set to Controller, the Low Power Mode setting in the Advanced Controller Options menu cannot be selected. This is because the touch screen controller will not respond when the driver requests the calibration data.

Press N to choose between Host and Controller. For more information about Low Power Mode, see "Low Power Mode" on page 29.

Set COM1, COM2, COM3, COM4

Sets the serial communication port. Selecting a port automatically adjusts the Interrupt and Address settings with the default values for the port. To use custom combinations, select Interrupt and Address individually.

Press 1,2,3, or 4 to choose COM1, COM2, COM3, or COM4.

Reset

Provides a method for the host computer to re-establish basic communication with the controller. Use the Reset feature only as a recovery tool when the controller and the host are not communicating.

Press R to select Reset.

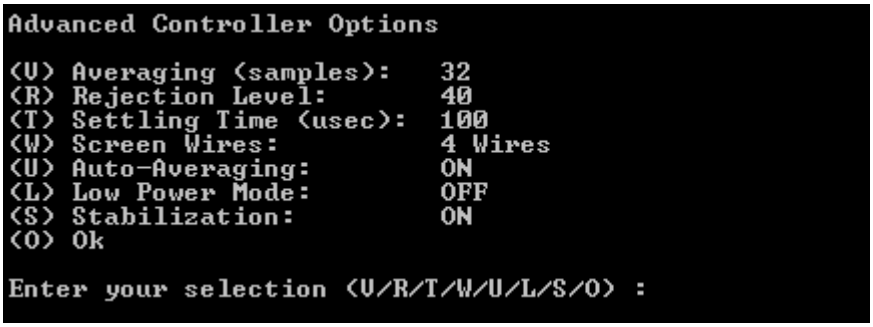
Configuring the controller: Advanced options

Use the Advanced Controller Options menu to change parameters that affect the way the controller processes touches.

This section is necessary only if you want to change how the touch screen operates.

The parameters stored in the controller and those displayed in the window are independent. The values displayed represent the last ones downloaded.

1. In the Touch Screen Driver & Utilities menu, press I to select Interface.
2. In the Interface Configuration Options menu, press D to select Advanced.



Averaging (samples)

Sets the number of samples the controller will collect for averaging into a touch point location. The averaging required by an application is based on electrical noise in the system and the desired speed of touch point reporting. A higher number produces smoother lines when drawing, at the expense of touch report rate (points/sec).

Press V to change the number of averaging samples (4, 8, 16, 32). The default is 32. Follow the on-screen prompts. To cancel, press Esc at any time.

Rejection Level

Sets the sensitivity of the controller to reject “noisy” touch inputs. Lower settings reject touch inputs when a small amount of noise is present. Higher settings allow touch inputs when more noise is present.

Press R to change the rejection level (10, 20, 40, 60). The default is 40. Follow the on-screen prompts. To cancel, press Esc at any time.

Settling Time (usec)

Sets a time delay in microseconds between the excitation of the touch screen and touch screen measurement. The time allows the system to settle before the controller takes a position measurement. Higher values can compensate for screen resistance.

Press T to change the Settling Time (100, 200, 300, 400). The default is 100. Follow the on-screen prompts. To cancel, press Esc at any time.

Screen Wires

Sets the number of wires used for touch screen decoding.

Press W to select the number of screen wires (4, 8). Follow the on-screen prompts. To cancel, press Esc at any time.

Auto-averaging

Provides automatic switching between two levels of averaging based on touch movement speed. Slow touch movements use the user-set averaging. Fast touch movements use a reduced fixed averaging of eight samples per point. This gives better filtering when touch movement is slow, while offering higher speed sampling when touch movement is fast.

Press U to change Auto Averaging. The default is enabled.

Low Power Mode

Provides the enabling of low power mode. When Low Power Mode is selected, the controller enters Low Power Mode if a touch is not detected for 255 consecutive touch screen scan cycles (approximately three seconds). When Low Power Mode is not selected, the controller enters Run Mode and continuously scans the touch screen and reports X-Y location information for valid touches.

Press L to change the Low Power Mode. The default is disabled.

Stabilization

Sets the Stabilization feature, which eliminates any jittering in the cursor or pointer that is caused by system noise.

3M Touch Systems recommends you use this feature for most applications. For drawing applications, however, 3M Touch Systems recommends you turn off Stabilization.

Press S to turn Stabilization on or off.

Ok

If the changes you made are satisfactory, press O for okay to save the changes and close the Advanced Controller Options menu. Otherwise, press Esc to discard the changes and revert to the old settings.

Section 2

Advanced Features

Chapter 6
Configuring the TouchSurround and buttons

What's in this chapter?

Most of this chapter explains how to configure the TouchSurround in Windows 95, 98, and NT.

The same features are available for Windows 3.1 and MS-DOS, although Windows 3.1 users will notice minor visual differences in the software. MS-DOS users should refer to information at the end of this chapter, beginning at page 46.

When the touch screen is larger than the display, the area surrounding the display is the TouchSurround. This area can be used to define buttons that perform keyboard emulation (that is, insert key strokes) instead of mouse emulation.

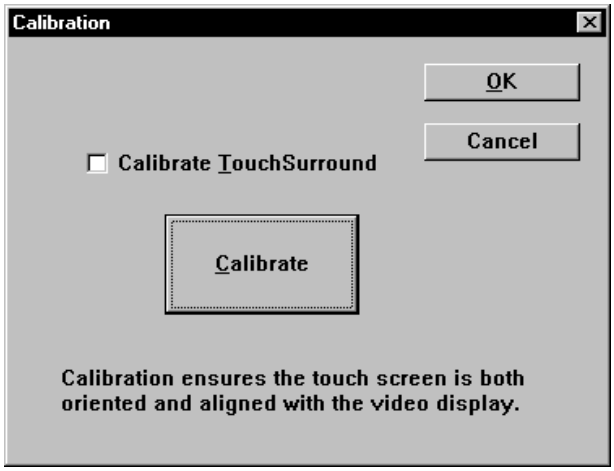
Calibrating the TouchSurround

Most applications do not require this option. Do not calibrate the TouchSurround unless a specific application calls for its use.

Windows 95, 98, and NT

To calibrate the TouchSurround in Windows 95, 98 and NT:

1. Select the Windows Start button, point to Programs, then Touch Screen Utilities, and then Configuration.
2. Select the Calibration in the Configuration Utilities window.
3. Select the Calibrate TouchSurround check box in the Calibration window.



4. Press Calibrate.
5. To calibrate, follow the on-screen prompts. To cancel calibration without any changes, press ESC any time.

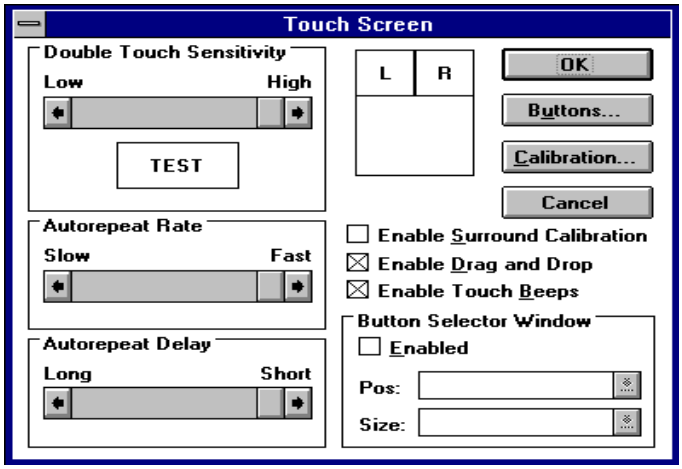
   When finished, the new calibration takes effect immediately and the Calibration window reappears.
6. Test the calibration by moving the cursor around the screen with your finger.

   If it is satisfactory, select OK to save the calibration and close the window. Otherwise, select Cancel to discard the calibration and revert to the old calibration, or select Calibrate and complete the procedure again.

Windows 3.1

To calibrate the TouchSurround in Windows 3.1:

1. In the Windows Program Manager, open the Main Group.
2. Open the Control Panel.
3. Open Touch Screen in the Control Panel.
4. Click the Enable Surround Calibration check box in the Touch Screen window.



5. Select the Calibration button.
6. Follow the on-screen prompts. You can cancel the calibration process any time by pressing ESC.

   After you have completed all the required touches, calibration takes effect immediately and the Touch Screen window appears.
7. Test the calibration by moving the cursor around the screen with your finger.

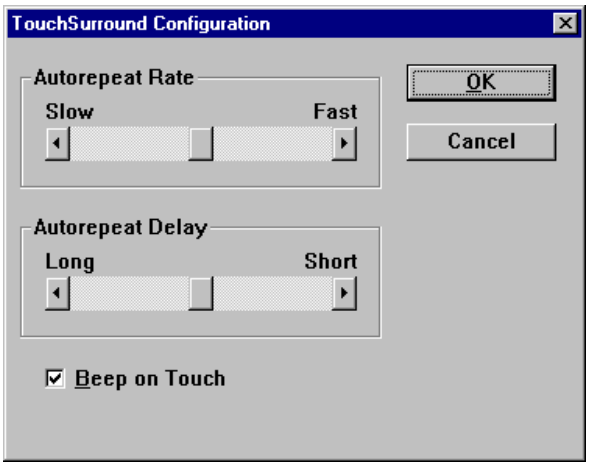
   If it is satisfactory, select OK. Otherwise select Calibration and complete the procedure again.

Configuring the TouchSurround

Use the TouchSurround Configuration window to configure the basic operating characteristics of the TouchSurround's keyboard emulation.

This step is necessary only if you wish to define programmable keys around the video area.

1. In the Configuration Utilities window, select TouchSurround. The TouchSurround Configuration window appears.



2. Configure the TouchSurround as described below.
3. When finished, select OK to save the settings and return to the Configuration Utilities window, or select Cancel to discard the changes and revert to the previous settings.

   The new settings take effect immediately.

Autorepeat Rate

Use the slider to set the autorepeat rate for buttons on the TouchSurround. If you set the rate Fast, holding a touch will produce rapid repeat events. If you set the rate Slow, the same touch will generate fewer repeat events in the same length of time.

Autorepeat affects only events generated by button presses. It does not affect events generated by button releases.

Autorepeat Delay

Use the slider to set the time required for a touch to be held before autorepeat mode begins. A Short delay means you don't need to hold a touch very long before autorepeat touches are generated. A Long delay means that you must hold a touch longer to begin generating autorepeat touches.

Beep on Touch

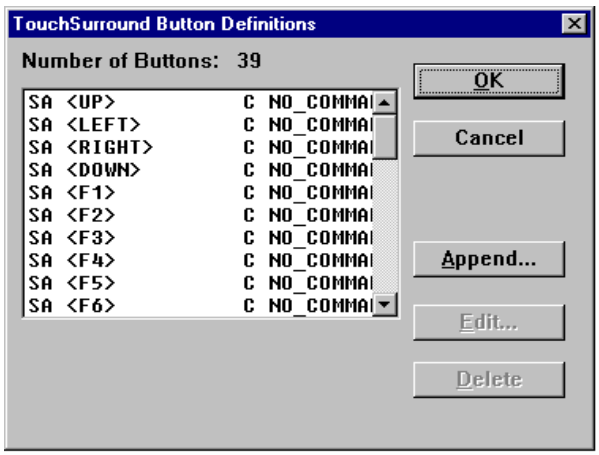
Select this box if you want the computer to beep whenever a TouchSurround button is activated by a touch or release.

Defining TouchSurround button functions

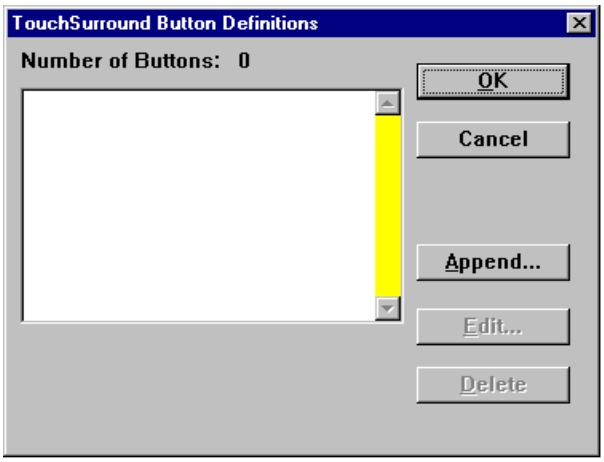
You can define the size, position, activation, and function of the buttons, and you can define buttons as function keys, command keys, calculator keys, screen change controls, or whatever other format you require.

TouchSurround buttons are inactive while you are defining buttons. They become active when you save the definitions and exit the Utilities.

1. In the Configuration Utilities window, select Buttons. The TouchSurround Button Definitions window appears.



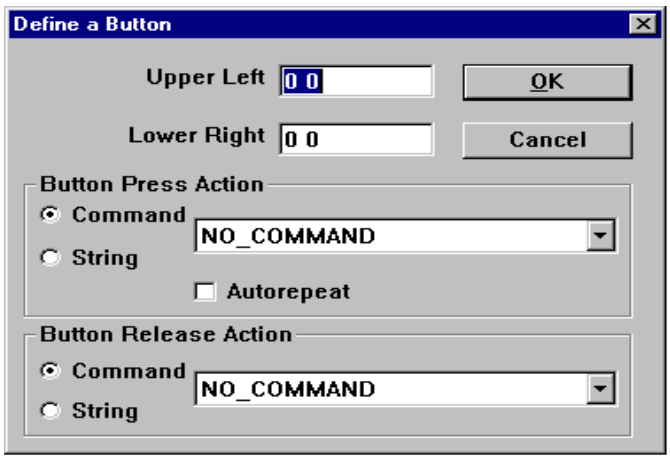
If buttons have not been defined, the list is blank.



2. To display options for defining button location and press/release action, do one of the following:
   - Select Append to add the button definition to the end of the list.

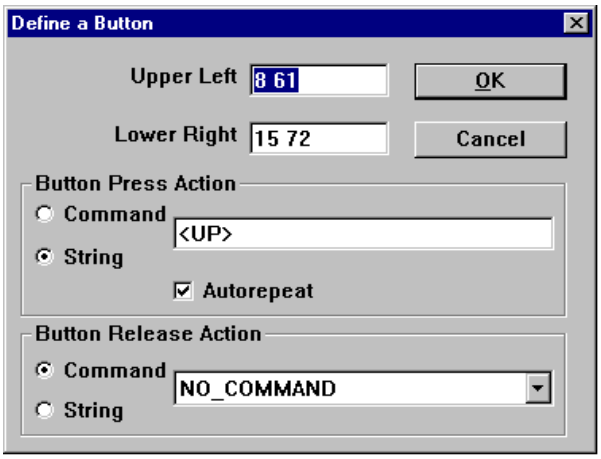
     The Define a Button window appears.
   - Select a button definition in the list: the Append button changes to Insert. Select Insert to add a new button definition above the selected button.

     The Define a Button window appears.



Position the new button on the TouchSurround by defining the upper left and lower right coordinates of the button. See “Defining upper left and lower right coordinates” on page 39.

3. Define whether the button will be activated on press or release or both, then define the button action. See “Defining button press and release actions,” in this chapter.
   - If you choose Command, select a button command from the drop down list. See Table B (page 40).
   - If you choose String, type an ASCII string in the text box. See Table C (page 41) and Table D (page 42).
4. Select the Autorepeat check box to enable the autorepeat function for the button press action. This step is optional.



5. When finished, do one of the following:
   - Select OK to start an automatic diagnostic test of the button definition.

     If the definition is valid, it is added to the button definition list. If the button definition is incorrect, an error message is displayed. See “Fixing overlapping buttons,” in this chapter.
   - Select Cancel to discard the button definition.
6. Repeat steps 2 to 6 for each button definition.
7. When finished defining buttons, select OK in the TouchSurround Button Definitions window to save the button definition(s).

Defining upper left and lower right coordinates

Table A: Descriptions of upper left and lower right buttons

Option	Description
Upper left	Defines the touch screen coordinates of the upper left corner of the button. The first number is the horizontal (x) coordinate and the second is the vertical (y) coordinate. For example, in the Define a Button window, 8 is the x coordinate and 61 is the y coordinate.
Lower right	Defines the touch screen coordinates of the lower right corner of the button. The first number is the horizontal (x) coordinate, and the second is the vertical (y) coordinate. For example, in the Define a Button window, 15 is the x coordinate and 72 is the y coordinate.

To enter coordinates automatically, touch the screen at the desired location. To enter the coordinates manually, type them. However, it is better to enter the coordinates by touching the screen because it is difficult to relate button coordinates to screen position if you type the coordinates.

Defining button press and release actions

A button can carry out a command or insert an ASCII string when activated by a button press or a button release. Only one type of button action can be defined.

- **Commands** control what operations are performed when a button is activated. See “Button Commands” below.
- **ASCII strings** are inserted at the current cursor position when the button to which the ASCII string is assigned is activated. See “ASCII Strings” below.

Button commands

Use the Command option in the Define a Button window to define a command for a button press or release action. Button command codes are described in Table B. When you choose the Command option, the String option becomes disabled.

Table B: Button commands

This command	Does this on the display area
NO_COMMAND	No command defined for this button. This function is useful for disabling a button temporarily (for example, when the button doesn't work as intended).
TOUCH	Enables/disables the touch screen. When the touch screen is disabled, only this button responds to touches, allowing you to re-enable the screen. This function is useful for cleaning the touch screen. Cleaning the touch screen without disabling it could cause touch events that alter your process. To prevent this from happening, you could create a button called CLEAN and define its function as TOUCH. When cleaning the touch screen, you could then press the CLEAN button before cleaning the screen, and press it again after cleaning to enable regular touches.

ASCII strings

Use the String option in the Define a Button window to insert an ASCII string at the current cursor position when the button is activated. For example, you can define a button to behave like the Tab key on a computer keyboard by inserting the string <tab>.

ASCII strings can be any combination of the following:

- **Normal ASCII characters**, which represent keyboard keys, including alpha, numeric, and special characters (see Table C).
- **Special codes**, which represent non-printable keyboard keys, such as Tab (see Table D).
- **Modified keys**, which are created by combining any ASCII character or special code with a Shift, Alt, or Ctrl key modifier.
- **Sticky keys**, which are keys defined as the Shift, Ctrl, or Alt modifier. This applies the modifier to the next character inserted.

An ASCII string can be up to 40 characters. The string consists of the first non-white-space character you type (leading spaces are ignored) and all remaining characters to the end of the line (including embedded white space).

Normal ASCII characters

Table C lists the normal ASCII characters that are supported.

Table C: ASCII characters

A	N	a	n	0	!	.	_
B	O	b	o	1	"	/	`
C	P	c	p	2	#	:	{
D	Q	d	q	3	$	;	|
E	R	e	r	4	%	<	}
F	S	f	s	5	&	=	~
G	T	g	t	6	'	>	
H	U	h	u	7	(	?	
I	V	i	v	8	)	@	
J	W	j	w	9	*	[	
K	X	k	x		+	\	
L	Y	l	y		,	]	
M	Z	m	z		-	^	

Special codes

Special codes represent non-printable keyboard keys. A special code is delimited by angle brackets < > and is translated into the appropriate keyboard character. To put a normal < or > into a string, use double angle brackets like this: << or >>.

Table D lists all the special codes that can be included in the button definition strings.

- Keys preceded by the # character represent number pad keys. Use the number pad keys for arithmetical functions as well — multiply (*), divide (/), subtract (-) and add (+).
- Some codes, such as, SHIFTU, SHIFTD, CTRLU, CTRLD, ALTU and ALTD have no actual keyboard equivalents. They represent Shift key Up, Shift key Down, Control key Up, Control key Down, Alt key Up, and Alt key Down.
- The SHIFTLOCK, ALTLOCK, AND CTRLLOCK codes represent toggle functions on each of the Shift, Alt, and Ctrl keys. For example, one insertion of SHIFTLOCK is equivalent to Shift key Down, while the next insertion is equivalent to Shift key Up.

  CAPSLOCK applies to alphabetical keys only. SHIFTLOCK applies to all keys.

Important Use SHIFTLOCK, ALTLOCK, and CTRLLOCK carefully. The operating system may react differently to a mouse click plus these keys than it would to a mouse click alone.

Table D: Special codes (Windows 95, 98, and NT)

Description	Key	Description	Key
Function key F1	<F1>	Shift Lock	<SHIFTLOCK>
Function key F2	<F2>	Shift key down	<SHIFTD>
Function key F3	<F3>	Shift key up	<SHIFTU>
Function key F4	<F4>	Ctrl Lock	<CTRLLOCK>
Function key F5	<F5>	Ctrl key down	<CTRLD>
Function key F6	<F6>	Ctrl key up	<CTRLU>
Function key F7	<F7>	Alt Lock	<ALTLOCK>
Function key F8	<F8>	Alt key down	<ALTD>
Function key F9	<F9>	Alt key up	<ALTU>
Function key F10	<F10>	Scroll key	<SCROLL>
Function key F11	<F11>	Number pad * key	<MULT>
Function key F12	<F12>	Number pad / key	<DIV>
Escape	<ESC>	Number pad + key	<ADD>
Tab	<TAB>	Number pad - key	<SUB>
Backspace	<BKSP>	Num Lock	<NUM>
Enter	<ENTER>	Print Screen	<PRTSCR>
Spacebar	<SPACE>	Number pad 0 key	<#0>
Up arrow	<UP>	Number pad 1 key	<#1>
Down arrow	<DOWN>	Number pad 2 key	<#2>
Left arrow	<LEFT>	Number pad 3 key	<#3>
Right arrow	<RIGHT>	Number pad 4 key	<#4>
Page Up	<PGUP>	Number pad 5 key	<#5>
Page Down	<PGDN>	Number pad 6 key	<#6>
Insert	<INS>	Number pad 7 key	<#7>
Delete	<DEL>	Number pad 8 key	<#8>
Pause	<PAUSE>	Number pad 9 key	<#9>
Caps Lock	<CAPS>	Number pad . key	<#.>
Home	<HOME>	Number pad Enter key	<#Enter>
End	<END>		

For special codes that apply to Windows 3.1 and DOS, see Appendix C, "*Special codes for Windows 3.1 and MS-DOS*."

Modified key combinations

Create Shift, Alt, or Ctrl key combinations by combining any ASCII character or special code with a Shift, Alt, or Ctrl modifier.

The modifier is added by prefacing the selected key with one of the following prefixes, and delimiting the result with < >:

- S- (for Shift)
- C- (for Ctrl)
- A- (for Alt)
- any combination of these (up to a maximum of three)

Examples:

This code	Generates this key combination
<C-X>	Ctrl+X
<A-Tab>	Alt+Tab
<C-A-DEL>	Ctrl+Alt+Delete

The following procedures show a practical use for modified key combinations for Windows 95 and 98. Key combinations can be used to define TouchSurround buttons that can start Windows applications.

First, create a shortcut to your application, then define a button on the TouchSurround to open or start the application.

To create a shortcut to your application:

1. Select an application icon and drag it to the desktop.
2. Right mouse click on the icon to display options for defining properties.
3. Select the Shortcut tab.
4. Tab to, or click the Shortcut key text box.
5. Type a shortcut key sequence, for example CTRL-ALT-A.
6. Select OK.

Pressing this key combination on the keyboard opens or starts the application pointed to by the shortcut.

To define a TouchSurround button to launch the application:

1. Open the Configuration Utilities window.
2. Select Buttons.
3. Do one of the following:
   - Select Append, then define the button co-ordinates.
   - Select a currently defined button, and then press Edit.
4. Choose String as the button press action.
5. Enter the string to match what was previously entered as the shortcut key sequence, example <C-A-A>, meaning CTRL-ALT-A.
6. Select OK.
7. Select Exit.

Sticky keys

You can also define a button to be the Shift, Ctrl, or Alt modifier that applies to the inserted character that follows the modifier. A button defined to insert this special code is called a sticky key. Inserting such a code has no effect in itself — it modifies the character inserted after it. For example, touching a button defined as <A-> and then touching one defined as <F4> is equivalent to typing Alt+F4.

Generally, you need sticky key codes only if your TouchSurround has buttons called Shift, Ctrl, and Alt, in which case they should be defined as <S->, <C->, and <A->.

Activating a button defined as <S-> and then activating one defined to insert the ASCII character string h-e-l-l-o results in the key sequence H-e-l-l-o. That is, the sticky key is applied only to the first character in the ASCII character string.

Fixing overlapping buttons

Buttons cannot overlap. If you define a button that overlaps an existing button, an error message is displayed and the button definition is not saved.

TIP: To help find the button with the conflicting coordinates, touch the TouchSurround where you encountered the overlap. This will display the button definition information for any button defined in that area. Then you can either modify the original button coordinates or define your new button with new coordinates so they won't conflict.

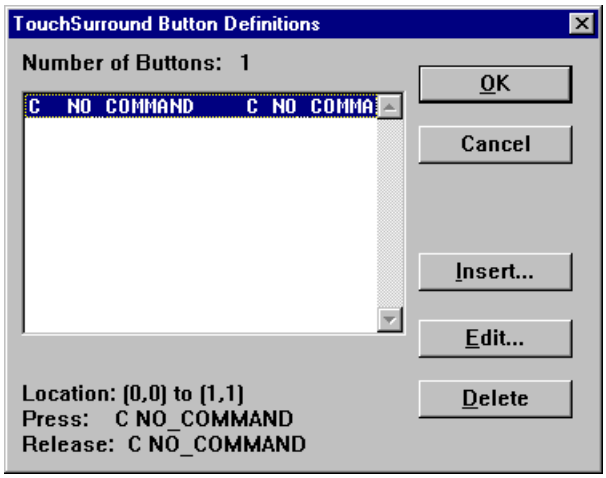
To correct the problem, do one of the following:

- Choose Cancel from the TouchSurround Button Definitions window to clear your button definition.
- Define new coordinates for the button in the Define a Button window.

Reviewing TouchSurround button definitions

The TouchSurround Button Definitions window shows a list of button definitions. The number of defined buttons is shown at the top of the list. When you select a button definition from the list, the following information is displayed in the lower left corner:

- Button position coordinates for a selected button in the list.
- Button press and release actions for a selected button in the list.



The list displays any currently defined buttons. Scroll up and down to see more definitions. Each line in the list shows a button definition.

Editing and deleting TouchSurround button definitions

To edit a button definition:

1. Display the list of button definitions (see the TouchSurround Button Definitions window).
2. Choose a button definition using one of these methods:
   - Double touch a button definition.
   - Touch a button definition to select it and the Edit button becomes visible. Select the Edit button.
3. Change the button definition as required and touch OK to go back to the list of button definitions.
4. To save your changes, touch OK. To restore the button definition, touch Cancel.

To delete a button definition:

1. Display the list of button definitions (see the TouchSurround Button Definitions window).
2. Choose a button definition from the list, and the Delete button becomes visible. Touch Delete to remove the button definition from the list.
3. To save your changes, touch OK. To restore the button definition, touch Cancel.

Calibrating the TouchSurround in MS-DOS

Most applications do not require this option. Do not calibrate the TouchSurround unless a specific application calls for its use.

To calibrate the TouchSurround:

1. Type ecal \s
2. Follow the on-screen prompts.

Using the TouchSurround in MS-DOS

1. At the DOS prompt, type SURROUND and press Enter.

   Buttons on your TouchSurround are temporarily suspended while you run SURROUND.

2. The following screen will be displayed:

```
C:\> surround

Touch Screen Driver Surround Utility  Version 1.0.0  02-Dec-95
Copyright (C) Dynapro Technologies Inc. 1995-1996. All rights reserved.

  Button definitions successfully read in.

  Current button definition file = 'C:\TOUCH\DOS\SURROUND.DEF'
  Number of buttons defined     =  36

  1) Displays current button definitions
  2) Define a new button
  3) Redefine an existing button
  4) Delete an existing button
  5) Save current button definitions
  6) Read in button definition file
  7) Start a new button definition file
  8) Exit

  Enter your selection (1 - 8) :
```

72108

Defining a new button

1. To define a new button, type 2 at the main menu.
2. Enter a button identifier (0 to 65534) or press Enter to use the default.

   The SURROUND utility prompts you for the coordinates of the new button.

3. Touch the upper left and lower right corners of the button. The rectangular area between these two spots becomes your button. See “Defining upper left and lower right coordinates,” in this chapter for more information.

If you press the ESC key on your keyboard, SURROUND stops the button definition procedure and returns to the main menu.

Choosing button behavior

This determines how the button will react to a press or release.

Select one of the following button options:

1) Activate on Press. The button will activate once when it is touched.

2) Activate on Release. The button will activate when you remove your finger from the screen.

3) Activate on Press and Autorepeat. The defined button will activate the first time you touch it and will repeat whatever action you define for it for as long as you hold your finger on the button. It will stop when you release.

Defining button action

This defines what action the button will carry out when activated.

Select one of the following button actions:

1) Button command

2) Inject ASCII string

3) No action

Once you have assigned the position, behavior, and action, the new button is completely defined and you are returned to the main SURROUND menu.

Assigning button commands

The button command option controls what operations are performed if a button is activated.

Injecting ASCII strings

The String option allows you to specify an ASCII string to insert into the active application at your current cursor position when the button is activated. For more information, see “ASCII strings,” in this chapter.

Special codes

For general information on special codes, see “Special codes,” in this chapter. For a listing of the special codes in DOS, see “*Special codes for Windows 3.1 and MS-DOS*” in Appendix C.

Saving your button definition file

When you have defined all the required buttons, save their definitions in a button definition file. To do this:

1. At the main menu prompt, type 5 and press Enter.
2. Type in the name of your button definition file. The default file name is C:\TOUCH\DOS\SURROUND.DEF. Press Enter to use the default file name, or type the full path and file name for your file.
3. If the button definition file already exists, its previous contents are overwritten by the new definitions.

Other SURROUND menu options

Viewing button definition files

To view your current button definitions during a SURROUND session:

1. Type 1.
2. At the main menu prompt, press Enter.

   The button definitions will be displayed by increasing order of button identifier.

Redefining a button

To redefine a button:

1. Type 3 and press Enter at the main menu prompt.
2. Type the button's identifier. If there is more than one button with the identifier you enter, the list of matching buttons will be displayed, and you will be prompted to select which one to redefine.

   You can change only the type and action of the button. Entry for these fields is the same as for defining a new button.

Deleting buttons

To delete a button definition:

1. Type 4 and press Enter at the main menu prompt.
2. Type the button's identifier. If there is more than one button with this identifier, you will be asked to choose from the matching list. Once chosen, the button definition is removed from the defined list.

Chapter 7
Controller configurable parameters

What's in this chapter?

This chapter explains some of the ways the controller can be configured. For details on configuring controllers on:

- Windows NT, Windows 98, Windows 95, see "Configuring the controller: Advanced options" on page 16.
- MS-DOS 2.0.x, see "Configuring the controller: Advanced options" on page 28.
- Windows 3.1 and MS-DOS 1.5.x, see "SC3SETUP program" on page 79.

Configurable parameters

Averaging

Sets the number of samples the controller will collect for averaging into a touch point location. The averaging required by an application is based on electrical noise in the system and desired speed of touch point reporting. The options are 4, 8, 16, and 32. The default is 32.

Auto-averaging

Provides automatic switching between two different levels of averaging based on touch-movement speed. Slow touch movements invoke the user-set averaging. Fast touch movements invoke a reduced fixed averaging of 8 samples per point. This gives better filtering when touch movement is slow, while offering higher speed sampling when touch movement is fast. The option has no effect if the user-set averaging is 8 or less. The default is enabled.

Rejection level

Sets the sensitivity of the controller to reject "noisy" touch inputs. The options are 10, 20, 40, and 60. A low setting rejects touch inputs with a small amount of noise present. Higher settings allow the touch input to have more noise without being rejected. The default is 40.

Screen wires

Sets the number of wires used for touch screen decoding.

Settling time

Sets a time delay between the excitation of the touch screen and touch screen measurement. The time allows the system to settle before the controller takes a position measurement. The options are 100 microseconds, 200 microseconds, 300 microseconds, and 400 microseconds. The default is 100.

Touch mode

Sets the type of touch considered valid for reporting. The options are Continuous, Down, Up, and Down-Up. The default is Continuous.

Table E: Touch mode options

Continuous	The controller reports touch coordinates as a continuous stream whenever, and for however long, the touch screen is touched.
Down	The controller reports one set of touch and release coordinates (two communication packets) when a touch first occurs. Reporting will not occur again until the touch is removed, and then followed by a new touch.
Up	The controller reports one set of touch and release coordinates (two communication packets) when a touch release first occurs. Reporting will not occur again until a new touch is followed by a touch release.
Down-Up	The controller reports touch coordinates only twice per touch session—at first touch and a release packet when the touch is removed.

Baud rate

Sets the serial communication baud rate. The options are 1200, 2400, 4800, and 9600. The default is 2400.

Protocol

Sets the communication protocol used to report touches to the host. The setting is fixed to New 3-byte packet.

Low Power Mode

Provides the enabling of a controller to Low Power Mode. The default is disabled.

Report rate

The touch report rate defines how quickly x-y touch location coordinates (points) are sent to the host. Touch reporting rate depends on Baud Rate, Averaging, and Settling Time parameter settings. The report rate (points/s) increases with higher Baud Rate, lower Averaging, and lower Settling Time settings.

Maximum (Baud Rate=9600, Averaging=4, Settling Time= 100) = ~180 points/s
Minimum (Baud Rate=2400, Averaging=32, Settling Time= 400) = ~40 points/s

A typical mouse produces a report rate of approximately 60 points per second. Simple “button actuation only” applications require fewer than 60 points per second. Handwriting recognition often requires a minimum of 100 points per second.

Parameter default values

For additional information on Control Words, see “Overview of the data encoded commands” on page 56.

If the EEPROM is detected as blank (all ones), the firmware uses hard-coded parameter default values. The default values are:

Control Word 00: 1Fh

Control Word 01: 57h

Control Word 10: 9Fh

Stabilization

Sets the stabilization feature, which eliminates any jittering in the cursor or pointer that is caused by system noise. The default is enabled.

3M Touch Systems recommends you use this feature for most applications. For drawing applications, however, 3M Touch Systems recommends you turn off the stabilization feature.

Chapter 8
Controller/host communication

What's in this chapter?

This chapter provides details of the communication between the SC3 touch screen controller and the host, including touch reporting and controller configuration.

Communication for the SC3

Format

The serial communications are fixed at 8 data bits, no parity, and 1 stop bit (8, N, 1).

Controller-to-host

The SC3 touch screen controller will send unsolicited touch reports to the host in 3-byte data packets. The host can send commands to the SC3 touch screen controller while the controller is transmitting, but the commands will be ignored until the controller has finished sending the touch report.

The 3-byte data packet is coded with pen down/up status, 10 bit x-axis position coordinate, and 10 bit y-axis position coordinate.

Table F: Touch report data protocol for the SC3 controller

Packet / Bit #	7	6	5	4	3	2	1	0
# 1 (sync)	1	P	x9	x8	x7	y9	y8	y7
# 2 (data)	0	x6	x5	x4	x3	x2	x1	x0
# 3 (data)	0	y6	y5	y4	y3	y2	y1	y0

where:

bit 7 = logic 1 indicates the first byte of the data packet.
P = pen status, 1 for pen down, 0 for pen up.
x9 = Most Significant bit (MSb) of x-axis position.
x0 = Least Significant bit (LSb) of x-axis position.
y9 = Most Significant bit (MSb) of y-axis position.
y0 = Least Significant bit (LSb) of y-axis position.

Example: Continuous Touch Mode

At pen down:

```
1 1  x9 x8 x7 y9 y8 y7
0 x6 x5 x4 x3 x2 x1 x0
0 y6 y5 y4 y3 y2 y1 y0

.
.
.

1 1  x9 x8 x7 y9 y8 y7
0 x6 x5 x4 x3 x2 x1 x0
0 y6 y5 y4 y3 y2 y1 y0
```

At pen up:

```
1 0  x9 x8 x7 y9 y8 y7
0 x6 x5 x4 x3 x2 x1 x0
0 y6 y5 y4 y3 y2 y1 y0
```

Example: Down Touch Mode

At pen down:

```
1 1  x9 x8 x7 y9 y8 y7
0 x6 x5 x4 x3 x2 x1 x0
0 y6 y5 y4 y3 y2 y1 y0

1 0  x9 x8 x7 y9 y8 y7
0 x6 x5 x4 x3 x2 x1 x0
0 y6 y5 y4 y3 y2 y1 y0
```

At pen up: nothing

Example: Up Touch Mode

At pen down: nothing

At pen up:

```
1 1  x9 x8 x7 y9 y8 y7
0 x6 x5 x4 x3 x2 x1 x0
0 y6 y5 y4 y3 y2 y1 y0

1 0  x9 x8 x7 y9 y8 y7
0 x6 x5 x4 x3 x2 x1 x0
0 y6 y5 y4 y3 y2 y1 y0
```

Example: Down-Up Touch Mode

At pen down:

```
1 1  x9 x8 x7 y9 y8 y7
0 x6 x5 x4 x3 x2 x1 x0
0 y6 y5 y4 y3 y2 y1 y0
```

At pen up:

```
1 0  x9 x8 x7 y9 y8 y7
0 x6 x5 x4 x3 x2 x1 x0
0 y6 y5 y4 y3 y2 y1 y0
```

Host-to-controller

The SC3 touch screen controller accepts two command types: Data Encoded and Standard Commands.

In either case, the general communication sequence is

1. Host initiates communications <SOH>. (<SOH>is ASCII Start-of-Header (01h))
   Controller sends <ACK>. (<ACK> is ASCII Acknowledge (06h))

2. Host sends <CMD> byte. (<CMD> is a one-byte command)
   Controller sends <ACK>

3. Host sends additional bytes
   Controller sends <ACK> for each byte received

4. Host sends Terminator byte <CR>. (<CR> is ASCII Carriage Return (0Dh))
   Controller sends <ACK>

The SC3 touch screen controller must be wakened from a Low Power Mode, if enabled, before the host can attempt communication. The best way to do this is to start communications after a touch has been detected.

The SC3 touch screen controller will not attempt to send touch reports to the host during a communication sequence.

Serial data sent to the touch screen controller is hardware-echoed back to the host on RS-232 interfaces. Serial data sent to the SC3 touch screen controller is not hardware-echoed back to the host on direct UART interfaces.

The SC3 hardware resistively couples the RS-232 RXD and TXD lines. This is because the SC3 touch screen controller uses host supplied negative voltage on the TXD line to bias the controller's RXD line transmitted data. The resistive coupling of RXD and TXD produces a near instantaneous hardware echo of data back to the host's RXD line when the host transmits data to the controller on the TXD line.

After the controller responds to the <SOH> with an <ACK>, each successive "host sent byte" of the communication sequence must be sent within a 200-millisecond interval from the previous controller <ACK>.

The controller writes data to the EEPROM device for certain Command <CMD> bytes. The process of writing data to EEPROM takes approximately four milliseconds per memory byte written. This limits how quickly the host can send back-to-back communication sequences.

The approximate delay from a "host sent byte" to a controller <ACK> is:

t=[(10/Baud Rate)+(# EEPROM Writes*4ms)+2.5ms]

Overview of the data encoded commands

"Data encoded commands", or "control words", are defined from 00h to BFh. The command itself is encoded with control word (CW) data. The two MSb's of the command identify the control word as CW00, CW01, or CW10. The remaining six LSb's of a control word hold the encoded data.

If a control word that will change the baud rate is sent, the current communication sequence will be at the old baud rate. The new baud rate will take effect immediately after the current communication sequence is complete.

Sending CW00 will overwrite the previous data for CW10. The previous information held in CW10 is replaced with:
Rejection Level = 60, Settling Time = 200, and Low Power Mode = On. This was implemented to maintain backward compatibility with older SC3 touch screen controllers and can be corrected by always sending a desired CW10 command after sending a CW00 command.

The format is: <SOH> <CMD> <CR>.

The recommended order for sending control words is CW00, CW10, CW01.

The tables below show how to combine feature bits to create data encoded commands or control words.

Table G: Command 00-bbbbbb

Feature	Variable	Command Word Bits							
		7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Averaging	4 sample	0	0					0	0
	8 sample	0	0					0	1
	16 sample	0	0					1	0
	32 sample*	0	0					1	1
Auto-Averaging	Off	0	0				0		
	On*	0	0				1		
Screen Wires	8	0	0			0			
	4*	0	0			1			
Rejection Level	60 (high)	0	0		0				
	20 (low)*	0	0		1				
Stabilization	On	0	0	0					
	Off	0	0	1					

* = default
b is a marker for 0 or 1 valued bit data
x implies a don't care state

Table H: Command 01-bbbbbb

Feature	Variable	Command Word Bits							
		7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Touch Mode	Down-Up	0	1					0	0
	Down	0	1					0	1
	Up	0	1					1	0
	Continuous*	0	1					1	1
Baud Rate	1200	0	1			0	0		
	2400*	0	1			0	1		
	4800	0	1			1	0		
	9600	0	1			1	1		
Protocol	New 3-byte packet*	0	1	0	1				

* = default
b is a marker for 0 or 1 valued bit data
x implies a don't care state

Table I: Command 10-bbbbbb

Feature	Variable	Command Word Bits							
		7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Rejection Level	60	1	0	x				0	0
	10	1	0	x				0	1
	20	1	0	x				1	0
	40*	1	0	x				1	1
Settling Time	400	1	0	x		0	0		
	300	1	0	x		0	1		
	200	1	0	x		1	0		
	100*	1	0	x		1	1		
Low Power Mode	On	1	0	x	0				
	Off*	1	0	x	1				

* = default
b is a marker for 0 or 1 valued bit data
x implies a don't care state

Detailed communication sequence

The steps are:

1. Host sends a Start-of-Header <SOH> up to 25 times, expecting to receive a controller Acknowledge <ACK>.
2. Controller responds to received <SOH> by sending an Acknowledge <ACK>.
3. Host sends a Command <CMD> byte, expecting to receive a controller acknowledge <ACK>.
4. Controller responds to received <CMD> by sending an Acknowledge <ACK>.
5. Host sends a Terminator <CR> byte, expecting to receive a controller Acknowledge <ACK>.
6. Controller responds to received <CR> by sending an Acknowledge <ACK>.

Communication pseudo code

The SC3 touch screen controller checks for incoming communications by a 'polling' method. This method requires special considerations. Shown below is an example of pseudo code to help ensure proper communications.

```
send_SOH
        FOR 25 attempts to send <SOH>
        {
        send <SOH>
        delay ~ 4ms
                FOR 50 received <ACK> ? checks
                {
                delay ~ 4ms
                IF <ACK> received
                        GOTO send_CMD
                }
        }
        GOTO bad_COMM



send_CMD
        send <CMD>
        delay ~ 4ms
        FOR 50 received <ACK> ? checks
                {
                delay ~ 4ms
                IF <ACK> received
                        GOTO send_CR
                }
        }
        GOTO bad_COMM

send_CR
        send <CR>
        delay ~ 4ms
        FOR 50 received <ACK> ? checks
                {
                delay ~ 4ms
                IF <ACK> received
                        GOTO good_COMM
                }
        }
        GOTO bad_COMM

good_COMM  (communication success)

bad_COMM   (communications failure)
```

Standard commands

Certain firmware versions support a set of Standard Commands, which are defined from C0h to FFh. The commands are instruction based instead of data based (Data Encoded Commands). The format is:

<SOH> <CMD> <# of data bytes> <Data byte 1> <Data byte 2>
..... <Data byte n> <CR>

where <data byte 1> through <data byte n> are included only when required by a given command.

Table J: Standard command <CMD> set

Command	Hex	Bit							
		7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Write EEPROM	C0	1	1	0	0	0	0	0	0
Read EEPROM	C1	1	1	0	0	0	0	0	1
not used	C2	1	1	0	0	0	0	1	0
.	.	1	1	-	-	-	-	-	-
.	.	1	1	-	-	-	-	-	-
.	.	1	1	-	-	-	-	-	-
not used	FF	1	1	1	1	1	1	1	1

Detailed communication sequence

The following illustrates a sequence of events that occur during host communication.

1. Host sends a Start-of-Header <SOH> up to 25 times, expecting to receive a controller Acknowledge <ACK>.
2. Controller responds to received <SOH> by sending an Acknowledge <ACK>.
3. Host sends a Command <CMD> byte, expecting to receive a controller Acknowledge <ACK>.
4. Controller responds to a received <CMD> by sending an Acknowledge <ACK>.
5. Host sends a <# of data bytes> byte, expecting to receive a controller Acknowledge <ACK>.
6. Controller responds to a received <# of data bytes> by sending an Acknowledge <ACK>.
7. Host sends <Data byte 1>.
8. Controller response is command dependent.
9. Repeat steps 7 and 8 for all data bytes to <Data byte n>.
10. Host sends a Terminator <CR> byte, expecting to receive a controller Acknowledge <ACK>.
11. Controller responds to a received <CR> by sending an Acknowledge <ACK>.

EEPROM

The EEPROM device provides a means to store and retrieve custom information. The device is non-volatile, meaning the stored information will be maintained even if power is removed. The device used has 128 x 8-bit serially accessible memory locations. Controller configurable parameters are stored on the device. Some firmware versions also store touch screen calibration data on the device.

Table K: EEPROM memory map (128 x 8)

Address	Description
00	Control Word 00 (cw00)
01	duplicate cw00
02	duplicate cw00
03	Control Word 01 (cw01)
04	duplicate cw01
05	duplicate cw01
06	Control Word 10 (cw10)
07	duplicate cw10
08	duplicate cw10
09 - 22	reserved for calibration data
23	not used
•	not used
•	not used
•	not used
7F	not used

Write EEPROM (C0h)

Write data to the SC3 touch screen controller's non-volatile memory (EEPROM). The command must contain at least two data bytes: the address to write, and a value to write. Multiple memory location *writes* are possible by specifying additional addresses and values. The format is:

<SOH> <C0h> <2*n> <address 1> <value 1> ... <address n> <value n> <CR>

where n equals the total number of desired write locations (1 to 128).

Example:

Write 4Fh to address 22h.

<SOH> <C0h> <02h> <22h> <4Fh> <CR>

Example:

Write 4Fh to address 22h and a value of 15h to address 6Ah.

<SOH> <C0h> <04h> <22h> <4Fh> <6Ah> <15h> <CR>

Read EEPROM (C1h)

Read data from the SC3 touch screen controller's non-volatile memory (EEPROM). The command must contain at least one data byte: the address to read. Multiple memory location *reads* are possible by specifying additional addresses. The controller will respond with the <value> read (not an <ACK>), after receiving an <address>. The format is:

<SOH> <C1h> <n> <address 1> ... <address n> <CR>

where n equals the total number of desired read locations (1 to 128).

Example:

Read a value from address 2Eh.

<SOH> <C1h> <01h> <2Eh> <CR>

Example:

Read values from address 11h and address 3Eh.

<SOH> <C1h> <02h> <11h> <3Eh> <CR>

Chapter 9
Specifications and integration

What's in this chapter?

This chapter provides the following information on SC3 and SC3-OEM touch screen controllers:

- Specifications summary
- Board block diagram
- Components and schematics
- Connectors
- Mechanical mounting
- Microcontroller dimensions

Specifications summary

Table L: Specifications: SC3 and SC3-OEM controllers

Supply	5.0 to 20.0 VDC
Voltage regulation	3.3 VDC ± 5%
Supply current	Active current (no sensor) ~ 2mA typical Active current (typical sensor load) 20mA typical Sleep mode less than 500µA typical
Sensor support	4-wire and 8-wire analog resistive
Resolution	10-bit (1024 points)
Communication interface	Serial RS-232
Report rate	60–180 reports/second
Report packet	3-byte
Temperature range (microcontroller chip only)	Storage: Commercial -65° to +150°C, Industrial -65° to +150°C Operating: Commercial 0° to +70°C, Industrial -40° to +85°C
Software options	MS-DOS, Windows 9x, Windows NT, OS/2, DOS utilities

Board block

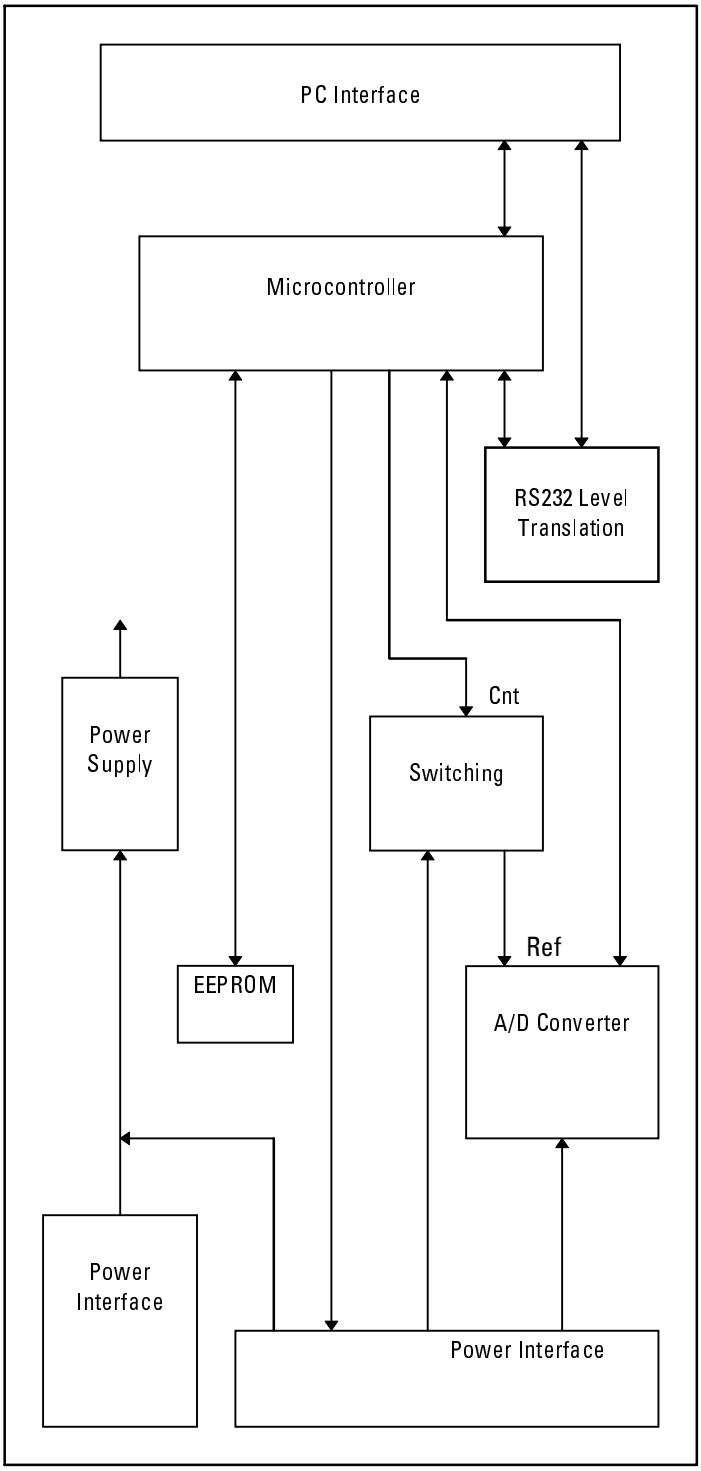


Figure 4: Board block diagram of SC3 and SC3-OEM

Components of SC3 and SC3-OEM

2N3906 PNP small signal transistor

Provides level shifting and RS-232 serial communication. RS-232 communications typically requires positive and negative voltages. Connecting the RXD and TXD together through the 5.6K ohm resistor provides a means of generating these voltages. Turning on transistor Q1 (for SC3) or Q2 (for SC3-OEM), produces positive voltages on RXD while switching it off, yields negative voltages. Transistor Q2 (for SC3) or Q3 (for SC3-OEM) provides level shifting from negative to positive voltages for the RS-232 receive function.

2N3904 NPN small signal transistor

Serves as a wake-up transistor and is enabled when the controller enters sleep mode. Any touch on the touch screen will draw pin 4 (MCLR), normally held high through a pull-up resistor, on the PIC16C58A low, which triggers the startup cycle on the microcontroller and brings it out of sleep mode. After pin 4 on the PIC16C58A is toggled low, all pins on the PIC16C58A go into a tri-state mode.

U1, Microchip PIC16C58A custom microcontroller

The intelligence or “brain” of the controller. Functions include touch screen layer voltage driving, touch screen measurement, processing of measured data, transmission of valid touch coordinates to the host computer, and receiving of input parameters sent by the host computer.

U2, 74HC4052 4-channel analog multiplexer

Switches the drive voltages from the touch screen to the +/- references on the A/D converter. This allows for maximum resolution on the A/D converter even when the PIC16C58A is driving a low-resistance touch screen. Additional inputs allow for eight-wire applications where the drive voltages are referenced directly at the touch screen.

U3, Texas Instruments TLV1543 10-bit analog-to-digital converter

A serial 10-bit analog-to-digital converter serial control with 11 analog inputs. It converts the analog voltages from the touch screen into digital signals processed by the PIC16C58A.

U4, Microchip 93AA46 128 x 8-bit EEPROM

A non-volatile serial Electrically Erasable Programmable Read Only Memory device: It stores user-set parameters used by the firmware inside the PIC16C58A.

U5, Linear Technology LT1121 3.3 volt low dropout voltage regulator

Regulates the input dc supply voltage to 3.3 volt dc to power to the circuit.

Schematic: SC3 controller

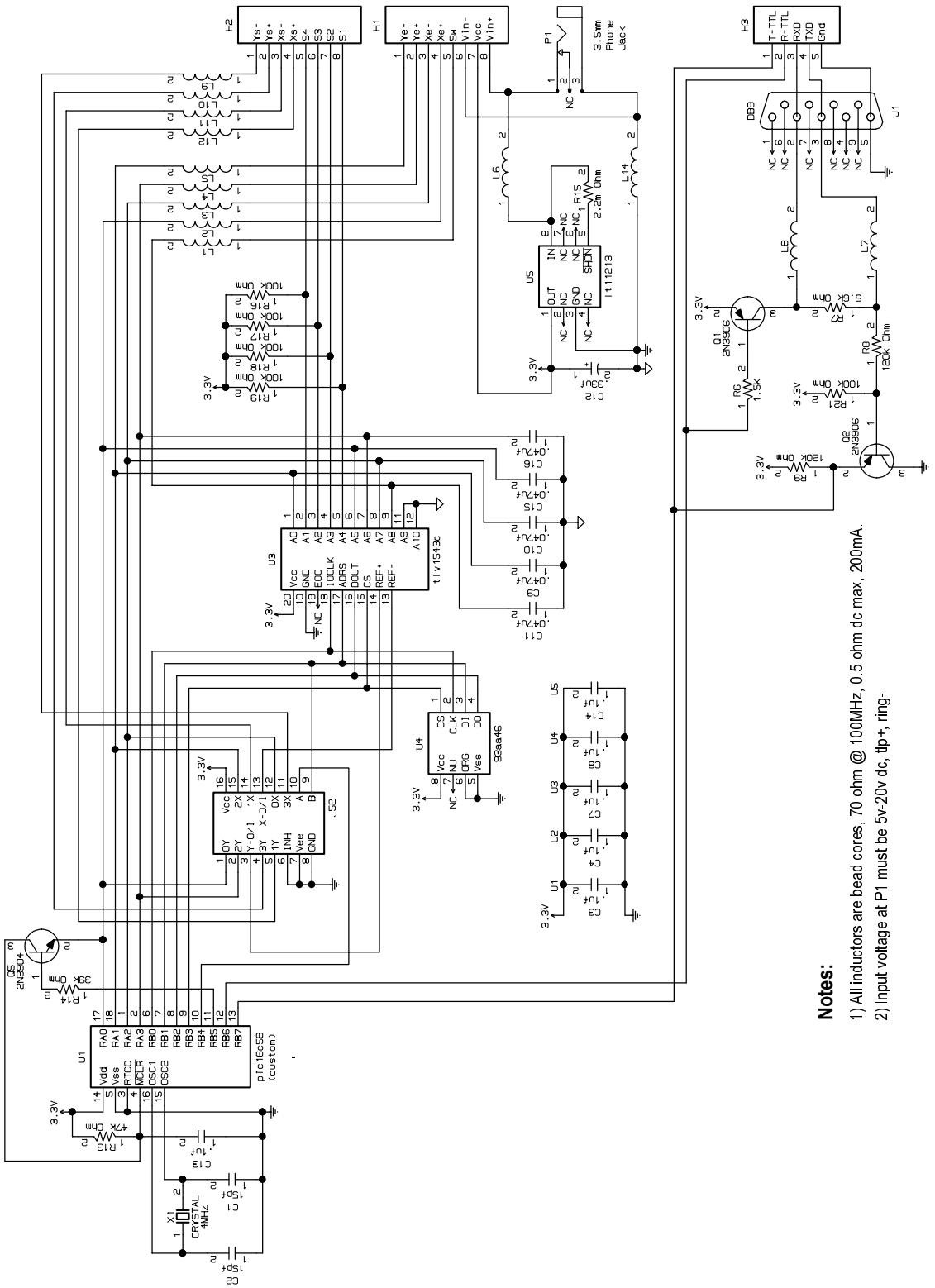


Figure 5: Schematic of SC3 controller

Schematic: SC3-OEM controller

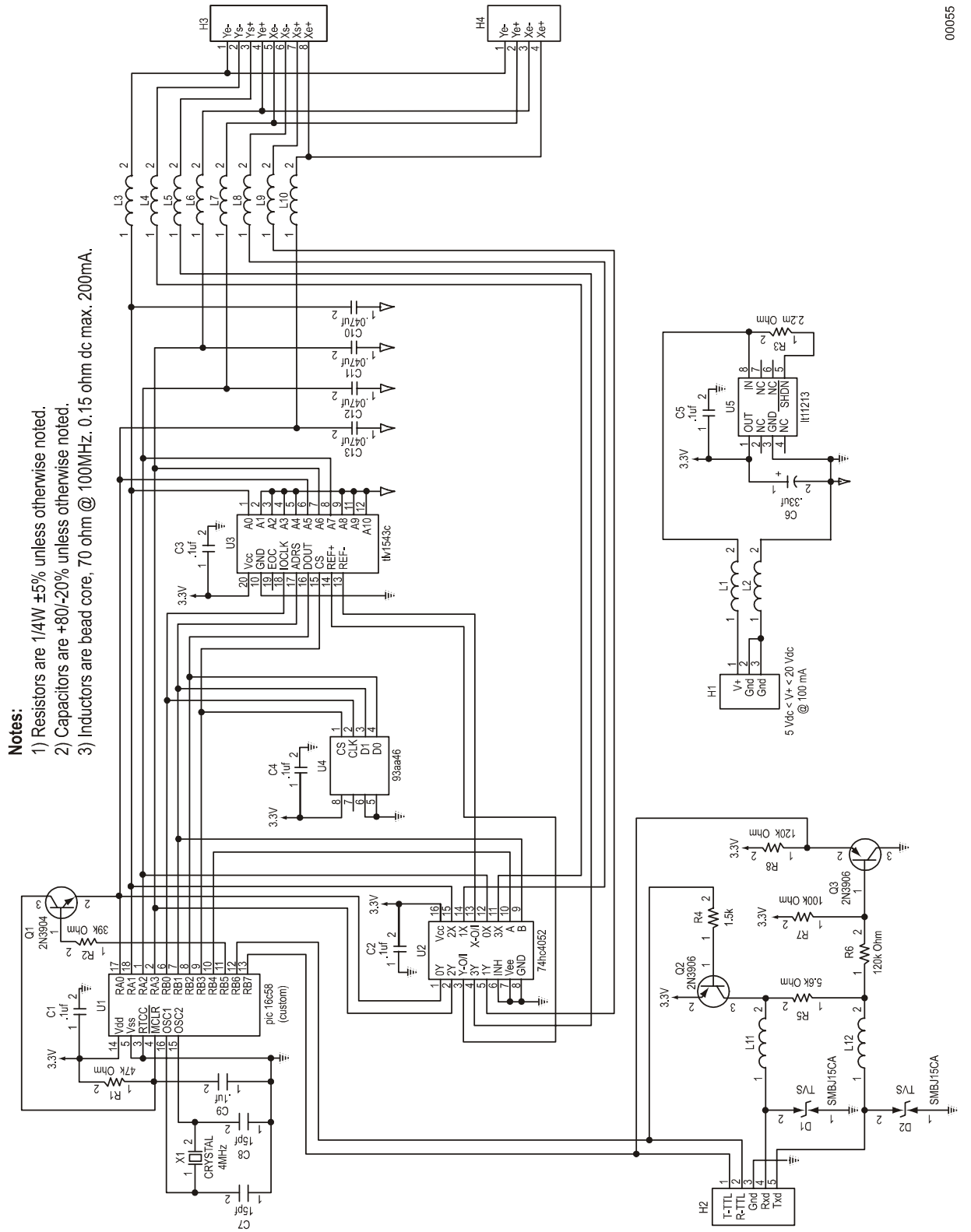


Figure 6: Schematic of SC3-OEM controller

Connections

The controllers have been designed to operate at 3.3 volts for low power consumption and portable applications, or five volts for less power-critical applications. Listed below are brief descriptions of components and/or systems found on the controller schematics.

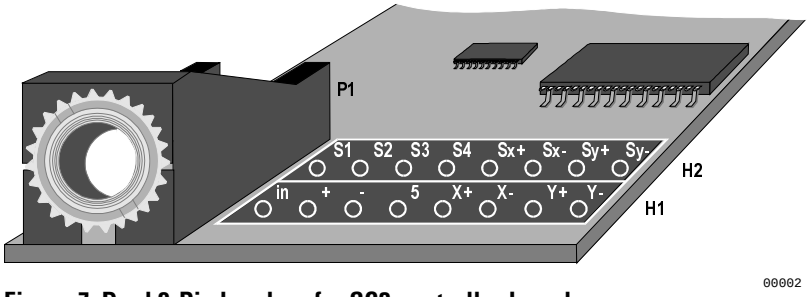


Figure 7: Dual 8-Pin headers for SC3 controller board

Table M: Power connection

Header/Pin # SC3[1]	Header/Pin # SC3-OEM	Pin name	Pin function
H1-8	H1-1	V+	Unregulated (+5V to +20V) DC input voltage
H1-6	H1-2	Gnd	Ground or common voltage bus.

[1]On the SC3 board, H1 is the bottom half of the 2x8 pin header.

Table N: Communication connection

Header/Pin # SC3[1]	Header/Pin # SC3-OEM	Pin name	Pin function	Signal levels
H3-1	H2-1	T-TTL	Host transmit	2.0 Vdc ≤ Space (logic 0) ≤ 3.3 Vdc 0 Vdc ≤ Mark (logic 1) ≤ 0.6 Vdc
H3-2	H2-2	R-TTL	Host receive	2.8 Vdc ≤ Space (logic 0) ≤ 3.5 Vdc @ $I_{source} \leq 1$ mA 0 Vdc ≤ Mark (logic 1) ≤ 0.5 Vdc @ $I_{sink} \leq 1$ mA
H3-5 DB9-5	H2-3	Gnd	Ground	
H3-3 DB9-2	H2-4	RXD	Host receive	2.7 Vdc ≤ Space (logic 0) ≤ 3.5 Vdc Mark (logic 1) = V (TXD from host) ± 5%
H3-4 DB9-3	H2-5	TXD	Host transmit	-15.0Vdc ≤ Mark (logic 1) ≤ -3.5Vdc +3.3Vdc ≤ Space (logic 0) ≤ +15.0Vdc

[1]On the SC3 board, H1 is the bottom half of the 2x8 pin header. H2 is the upper half of the 2x8 pin header.

Table 0: Eight-wire touch screen connection

Header/Pin # SC3[1]	Header/Pin # SC3-OEM	Pin name	Pin function
H1-1	H3-1	Ye-	Negative y-axis excitation line (typically connected to the top touch screen bus bar).
H2-1	H3-2	Ys-	Negative y-axis sense line (typically connected to the top touch screen bus bar).
H2-2	H3-3	Ys+	Positive y-axis sense line (typically connected to the bottom touch screen bus bar).
H1-2	H3-4	Ye+	Positive y-axis excitation line (typically connected to the bottom touch screen bus bar).
H1-3	H3-5	Xe-	Negative x-axis excitation line (typically connected to the left touch screen bus bar).
H2-3	H3-6	Xs-	Negative x-axis sense line (typically connected to the left touch screen bus bar).
H2-4	H3-7	Xs+	Positive x-axis sense line (typically connected to the right touch screen bus bar).
H1-4	H3-8	Xe+	Positive x-axis excitation line (typically connected to the right touch screen bus bar).

[1] On the SC3 board, H1 is the bottom half of the 2x8 pin header. H2 is the upper half of the 2x8 pin header.

Table P: Four-wire touch screen connection

Header/Pin # SC3[1]	Header/Pin # SC3-OEM	Pin name	Pin function
H1-1	H4-1	Ye-	Negative y-axis excitation line (typically connected to the top touch screen bus bar).
H1-2	H4-2	Ye+	Positive y-axis excitation line (typically connected to the bottom touch screen bus bar).
H1-3	H4-3	Xe-	Negative x-axis excitation line (typically connected to the left touch screen bus bar).
H1-4	H4-4	Xe+	Positive x-axis excitation line (typically connected to the right touch screen bus bar).

[1] On the SC3 board, H1 is the bottom half of the 2x8 pin header. H2 is the upper half of the 2x8 pin header.

Power supply ramp up

The controller will stay in RESET as long as U1 pin 4 (MCLR) is logic low. There is an RC network and switching circuitry added to the MCLR line in order to generate a device wake up via touch screen contact. The time it takes MCLR to come out of RESET is given by:

t = -(R13) * (C13) * ln[(Vdd - V MCLR, IH min)/Vdd]

For: Vdd = 3.3V, V MCLR, IH min = 0.85* Vdd = 2.8V, R13=47KΩ, C13=0.1uF

t = 8.9ms

Recommendation: The 3.3 volt supply V_{dd} rate of rise should be greater than 0.05 volts/millisecond.

Modifications

UART interface

The controller can interface directly to a 16450 type UART. This requires special firmware and hardware modifications. The special firmware performs an inversion of the signal read on SC3 header H3, pin 1 (T-TTL). This signal is sent from the UART pin 11 (Sout).

The need for special firmware is eliminated if a hardware inverter is inserted in the connection from the SC3 header H3, pin 1 (T-TTL) to SC3 U1, pin (RB7).

- **Required hardware modifications:**

  Remove transistors: Q1, Q2 (for SC3-OEM Q2, Q3)
  Remove DB9 connector: J1 (not required for SC3-OEM)
  Add pin header: H3 (not required for SC3-OEM)

- **Recommended hardware modifications:**

  Add a pull-up resistor on the UART pin 10 (Sin) or the SC3 controller board R-TTL line.

Table Q: UART interface for SC3 controller (refer to Table N)

	UART 16450	
Name	**Pin**	**Name**
T-TTL	11	Sout
R-TTL	10	Sin
Gnd	20	Vss

Mechanical mounting

Controller dimensions

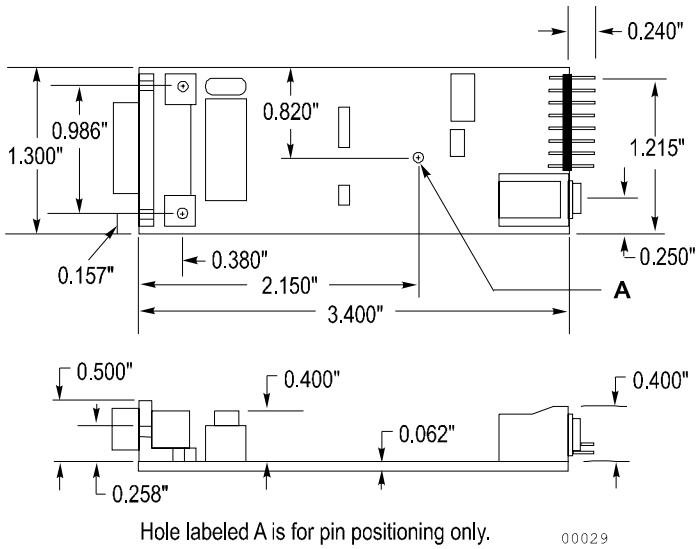


Figure 8: Dimensions of SC3

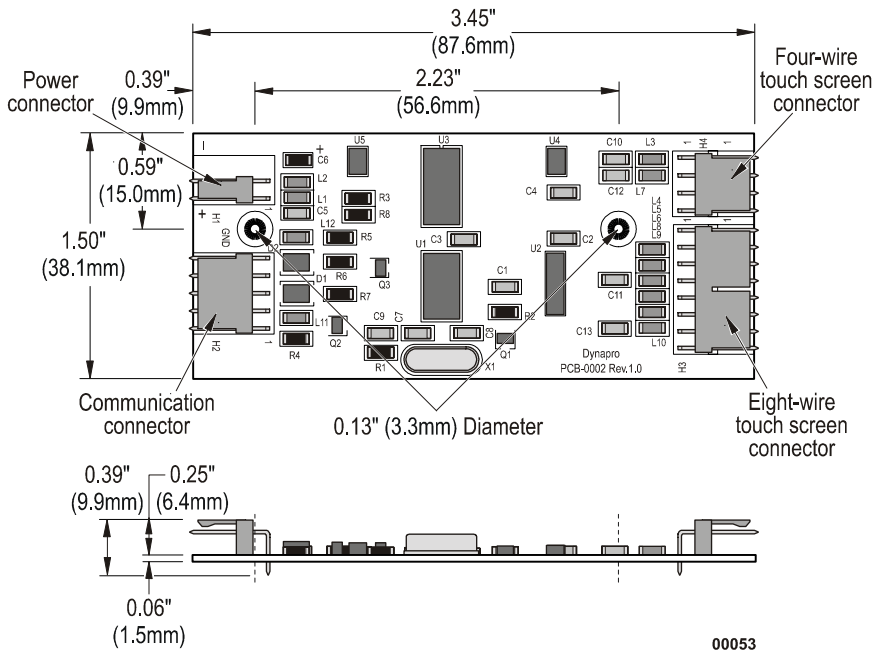


Figure 9: Dimensions of SC3-OEM

Electrical Noise

The controller can resolve voltages down to approximately 3 millivolts. At this resolution level, electrical noise can adversely affect the performance of the touch screen system. For example, CRT, LCD, and EL displays generate noise that could interfere with touch screen controller performance due to the close mechanical coupling of the display to the touch screen.

Table R: SC3-OEM on-board and mating connectors

Connector name	Connector function	On-board connector	Mating connector*
H1	Power supply	1 x 2 locking M pin header Molex model 7478 p/n 22-05-3021	Molex p/n 22-01-3027 housing Molex p/n 08-55-0101 crimp pin
H2	RS232/TTL	1 x 5 locking M pin header Molex model 7478 p/n 22-05-3051	Molex p/n 22-01-3057 housing Molex p/n 08-55-0101 crimp pin
H3	8-wire touch screen	1 x 8 locking M pin header Molex model 7478 p/n 22-05-3081	Molex p/n 22-01-3087 housing Molex p/n 08-55-0101 crimp pin

Table R: SC3-OEM on-board and mating connectors

Connector name	Connector function	On-board connector	Mating connector*
H4	4-wire touch screen	1 x 4 locking M pin header Molex model 7478 p/n 22-05-3041	Molex p/n 22-01-3047 housing Molex p/n 08-55-0101 crimp pin

*These are the friction locking connectors that mate with the on-board connectors by Molex. Other connector brands (AMP, Berg, etc.) can also be used.

Mounting suggestions

To help achieve optimum performance from the touch screen system:

- Mount the controller close to the touch screen.
- Mount the controller away from transformers, AC sources, and high voltage switching noise.
- Route the Controller-to-Touch Screen cable such that it will not pass near any sources of AC or high voltage switching noise. If the connecting cable must be routed near this type of noise, try shielding it with a piece of grounded aluminum or copper foil.
- If the supplied wall mounted power transformer is not used, it may be necessary to isolate the power and ground lines by using a ferrite core. A couple of wraps around a bead core with a minimum of 100 ohms at 100 MHz may offer a solution.
- Ground the metal frame of the display device.
- Add an EMI shield. The EMI shield consists of a transparent conductor placed between the display device and the touch screen. Consult your 3M Touch Systems sales representative for more information on shielding options.
- The SC3-OEM controller has two mounting holes that will accept 4-40 or M3 hardware.
- 3M Touch Systems offers cables for the serial connection and the touch screen connection. For part numbers, see our web site <http://www.dynapro.com/HTML/download/ts_specifications.html>.

Microcontroller dimensions

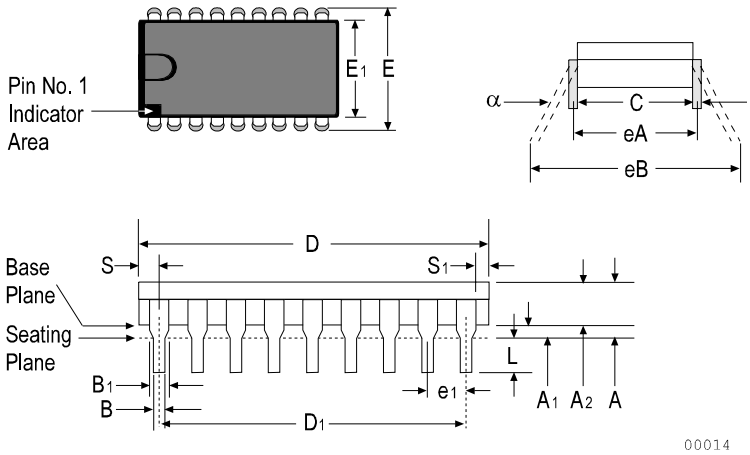


Figure 10: PIC16C58A DIP

Table S: DIP dimensions (Package group: Plastic Dual In-Line (PLA))

	Millimeters			Inches		
Symbol	**Min.**	**Max.**	**Notes**	**Min.**	**Max.**	**Notes**
α	0.00°	10.00°		0.00°	10.00°	
A		4.064			0.160	
A_1	0.381			0.015		
A_2	3.048	3.810		0.120	0.150	
B	0.356	0.559		0.014	0.022	
B_1	1.524	1.524	Reference	0.060	0.060	Reference
C	0.203	0.381	Typical	0.008	0.015	Typical
D_1	22.479	23.495		0.885	0.925	
D	20.320	20.32	Reference	0.800	0.800	Reference
E	7.620	8.255		0.300	0.325	
E_1	6.096	7.112		0.240	0.280	
e1	2.489	2.591	Typical	0.098	0.102	Typical
eA	7.620	7.620	Reference	0.300	0.300	Reference
e8	7.874	9.906		0.310	0.390	
L	3.048	3.556		0.120	0.140	

Table S: DIP dimensions (Package group: Plastic Dual In-Line (PLA))

	Millimeters			Inches		
Symbol	**Min.**	**Max.**	**Notes**	**Min.**	**Max.**	**Notes**
N	18.00	18.00		18.00	18.00	
S	0.889			0.035		
S_1	0.127			0.005		

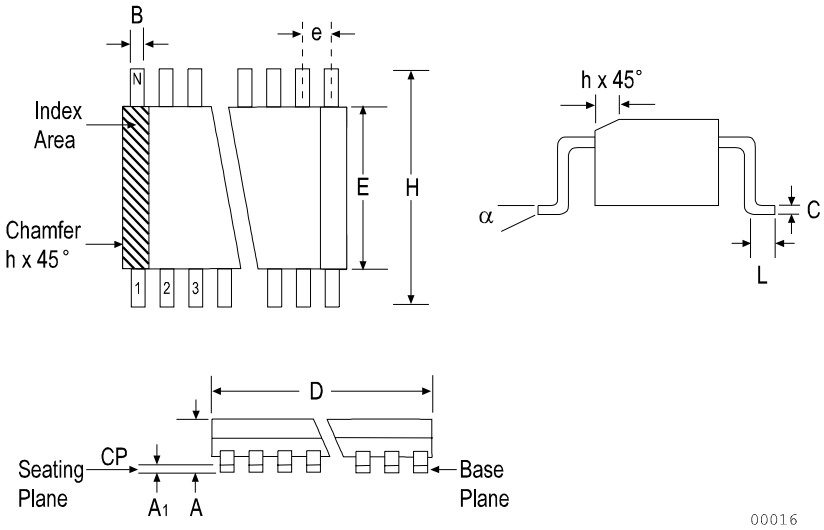


Figure 11: PIC16C58A SOIC

Table T: SOIC dimensions (Package group: Plastic SOIC (SO))

	Millimeters			Inches		
Symbol	**Min.**	**Max.**	**Notes**	**Min.**	**Max.**	**Notes**
α	0.00°	8.00°		0.00°	8.00°	
A	2.3622	2.6416		0.093	0.104	
A_1	0.1016	0.2997		0.004	0.0118	
B	0.3556	0.4826		0.014	0.019	
C	0.2413	0.3175		0.0095	0.0125	
D	11.3538	11.7348		0.447	0.462	
E	7.4168	7.5946		0.292	0.299	
e	1.270	1.270	Reference	0.050	0.050	Reference
H	10.0076	10.6426		0.394	0.419	

Table T: SOIC dimensions (Package group: Plastic SOIC (SO))

	Millimeters			Inches		
Symbol	**Min.**	**Max.**	**Notes**	**Min.**	**Max.**	**Notes**
h	0.381	0.762		0.015	0.030	
L	0.4064	1.143		0.016	0.045	
N	18.00	18.00		18.00	18.00	
CP		0.1016			0.004	

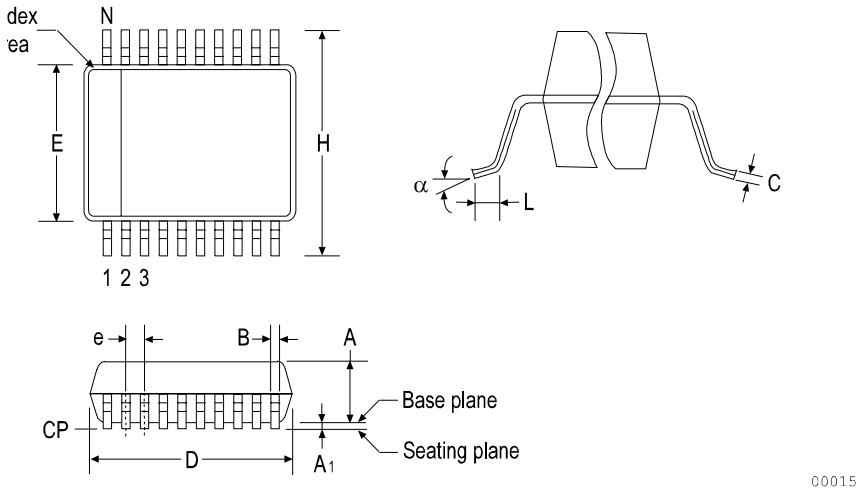


Figure 12: PIC16C58A SSOP

Table U: SSOP dimensions (Package group: Plastic SSOP)

	Millimeters			Inches		
Symbol	**Min.**	**Max.**	**Notes**	**Min.**	**Max.**	**Notes**
α	0.00°	8.00°		0.00°	8.00°	
A	1.73	1.99		0.068	0.078	
A_1	0.05	0.21		0.002	0.008	
B	0.25	0.38		0.010	0.015	
C	0.13	0.22		0.005	0.009	
D	7.07	7.33		0.278	0.289	
E	5.20	5.38		0.205	0.212	
e	0.65	0.65	Reference	0.0256	0.0256	Reference

Table U: SSOP dimensions (Package group: Plastic SSOP)

	Millimeters			Inches		
Symbol	**Min.**	**Max.**	**Notes**	**Min.**	**Max.**	**Notes**
H	7.65	7.90		0.301	0.311	
L	0.55	0.95		0.022	0.037	
N	20.00	20.00		20.00	20.00	
CP		0.1016			0.004	

Chapter 10
MS-DOS software utilities for SC3 hardware setup

What's in this chapter?

This chapter explains how to use various utilities for controller configuration and diagnostics. The utilities are based on direct-to-hardware interface and are not intended for use with 3M Touch Systems touch screen drivers. The utilities require MS-DOS to be the running operating system.

The source code was written using Borland Turbo C and does not support a large memory model.

Installing the software

The utilities are on the Touch Screen Utilities disk. Follow the instructions below to install the software from the disk to your computer. During installation, you can exit at any time by pressing the ESC key on your keyboard.

1. Insert the DTF Touch Screen DOS Utilities disk into a diskette drive.
2. At the DOS prompt, type a:\install, where a is the drive containing the disk. Press Enter.
3. Answer the questions that appear on your screen as the installation proceeds.
4. Remove the installation disk from the diskette drive.

SC3SETUP program

The controller has a number of user configurable options. The option settings are stored in a non-volatile memory device (EEPROM) located on the controller. The controller uses the following default values if the EEPROM device is blank.

Averaging	= 32
Auto Averaging	= On
Wires	= 4
Touch Mode	= Continuous
Baud Rate	= 2400
Rejection Level	= 40
Settling Time	= 100
Low Power Mode	= Off
Stabilization	= On

The SC3SETUP program allows the user to change controller options and test how the new options work:

1. Get to a DOS prompt at the drive/directory holding the SC3SETUP program.
2. Type SC3SETUP <Comport> <Baud Rate>. Press Enter.

   Default values are Comport = 1 and Baud Rate = 2400.

   Example for Comport COM1 and Baud Rate 2400:
   Type SC3SETUP and then press Enter.

   Example for Comport COM2 and Baud Rate 9600:
   Type SC3SETUP 2 9600 and then press Enter.

   When the Comport and Baud Rate are not known, type SC3SETUP and press Enter. Then proceed to step 5.
3. Your monitor displays a screen with buttons (see example screen below). If the host computer does not have a VGA or higher video mode, a default text screen will appear.

The SC3SETUP program attempts to read the operating parameters stored in the SC3 circuit EEPROM.

- If it is successful, it will display these values in the boxes on the left edge of the screen and the word EEPROM will appear in the lowest box.
- If it is unsuccessful, the default operating parameters appear and the word DEFAULT appears in the lowest box.
  - A touch to the screen (with a functioning controller connected) will cause X,Y coordinates to appear in the lowest box. If the touch results in DEFAULT appearing in the box, the controller

may not be functioning and a hardware reset should be initiated by pressing the 'R' key.

4. Touch the screen in the large drawing area box to the right of the buttons. If active coordinates are displayed in the lower left box, but line drawing is not tracking directly with the touch location, exit by pressing Esc and run the SC3CAL program. See "SC3CAL program"in this chapter for more information.

   If there is no response to a touch (no coordinates displayed in box), then see "Resetting the controller" below.

5. Select controller options by touching the option box or by using the arrow keys to move to the box. To scroll through the choices for an option box, repeatedly touch the option box or press Enter.
6. Download the information to the controller using the Down Load button. If the download is successful, the Down Load button will display Sent OK. If the download is not successful, Error is displayed. If an error occurs, see Appendix B, Troubleshooting.

   After each download, the new controller options can be tested using the drawing portion of the SC3SETUP screen. Pressing the spacebar will clear the drawing portion of the screen.
7. Press Esc to exit the SC3SETUP program.

Resetting the controller

This step is only to be used as an attempt to recover a controller that is not responding. Reset will overwrite all previous EEPROM user options settings to default values.

1. Reset the EEPROM device by pressing R on the keyboard. The following message will be displayed:

   TOUCH ANY PLACE ON THE SCREEN NOW
   HOLD THE TOUCH UNTIL THE SCAN IS COMPLETED
   PRESS ANY KEY WHEN READY
2. Touch the screen and hold the touch, then press any keyboard key. The SC3SETUP program scans different Communication Ports at 1200, 2400, 4800, and 9600 baud rates attempting to communicate with the controller. Once communication has been established, the SC3SETUP program will initiate the download of all three default control words to the controller.
3. Press any key to return to the SC3SETUP screen. Touching the screen should now show a response.
4. Press Esc to exit the SC3SETUP program.

SC3CAL program

The touch screen must be calibrated in order to orient and calibrate the touch screen with the video display.

Although some hardware variations support storing the calibration data in the controller's EEPROM device, the DOS SC3CAL utility only supports storing the data in a disk file on the host system. The SC3CAL program creates a touch screen calibration file based on user input to touch prompts on the video display. The calibration data file created by this program is used by the SC3SETUP program to map

touch points to the video display. This program should not be used until there is some type of touch screen response in the SC3SETUP program. The SC3CAL program can be run multiple times, but only needs to be run once.

1. Get to a DOS prompt at the drive/directory holding the SC3CAL program.
2. Type SC3CAL <Comport> <Baud Rate>. Press Enter.

   The default values are Comport = 1 and Baud Rate = 2400.
   Example for Comport COM1 and Baud Rate 2400:
   Type SC3CAL and then press Enter.

   Example for Comport COM2 and Baud Rate 9600:
   Type SC3CAL 2 9600 and then press Enter.
3. Follow the display prompts to touch different locations on the touch screen.
4. To test the calibration for accuracy, run the SC3SETUP program.

SC3PACK program

The SC3PACK program will actively display the current sent touch report data in the 3-byte packet format.

1. Get to a DOS prompt at the drive/directory holding the SC3PACK program.
2. Type SC3PACK and then press Enter.
3. Enter the Comport and Baud Rate when prompted.

   Example for Comport COM1 and Baud Rate 2400:
   Type INPUT COMPORT:1 and then press Enter.
   Type INPUT BAUDRATE: 2400 and then press Enter.
4. Touch the screen to view 3-byte packet touch reports.
5. Press Esc to exit the SC3PACK program.

SC3EEQ program

The SC3EEQ program provides quick downloading of user configurable Control Word parameters to the EEPROM device on the controller. The user configured Control Word values are stored in a file named CNTWRD.DAT.

1. Get to a DOS prompt at the drive/directory holding the SC3EEQ program.
2. Type SC3EEQ <Comport> <Baud Rate>. Then press Enter.

   The default values are Comport = 1 and Baud Rate = 2400.

   Example for Comport COM1 and Baud Rate 2400:
   Type SC3EEQ and then press Enter.

   Example for Comport COM2 and Baud Rate 9600:
   Type SC3EEQ 2 9600 and then press Enter.
3. Select one of the menu options.

   (S)ave new parameter data will show the current control word value read from CNTWRD.DAT in parenthesis, and prompt the user to enter a value. There is an option to write the data or escape after entering all three Control Word values.

(D)own Load will attempt to download Control Word data read from CNTWRD.DAT to the controller EEPROM. The following default Control Word values are used if a CNTWRD.DAT file does not exist.

CW 00 = 27d: Averaging = 32, Auto-Averaging = Off, #Wires = 4, Rejection Level = 20

CW 01 = 87d: Touch Mode = Continuous, Baud Rate = 2400, Protocol = 10-bit 3-byte

CW 10 = 159d: Low Power Mode = Off, Rejection Level = 20, Settling Time = 100 us

(H)elp provides some assistance in using the program.

4. Touch the touch screen to view video scaled touch reports formatted as: X Y PEN STATUS.
5. Press Esc to exit the SC3EEQ program.

SC3RW program

The SC3RW program provides reading and writing to any controller EEPROM device address. The user configured Control Word values are stored in a file named CNTWRD.DAT.

1. Get to a DOS prompt at the drive/directory holding the SC3RW program.
2. Type SC3RW <Comport> <Baud Rate> then press Enter.

   The default values are Comport = 1 and Baud Rate = 2400.

   Example for Comport COM1 and Baud Rate 2400:
   Type SC3RW and then press Enter.

   Example for Comport COM2 and Baud Rate 9600:
   Type SC3RW 2 9600 and then press Enter.
3. Select one of the menu options.

- **Read EEPROM—**(R)ead EEPROM will show options to read data from the EEPROM device.

  Address range

  (A)ddress range will read and display a single address or a range of addresses:

  Addr1 Addr2>
  Type Enter to return to the main menu.

  Example to read all data from address 0 to 127d (7Fh):
  Type Addr1 Addr2> 0 127 and then press Enter.

  Example to read data from address 12d (0Ch):
  Type Addr1 Addr2> 12 and then press Enter.

  Calibration data

  (C)alibration data will read and display the calibration data.

  Parameters

  (P)arameters will read and display the operating parameters (CW00, CW01, CW10).

  Press Esc to return to the main menu.

- **Write EEPROM**—(W)rite EEPROM will write data to a single address or to a range of addresses in the EEPROM device:

  Addr1 Addr2>
  Value>
  Type Enter to return to the main menu.

  Example to write 255d (FFh) to address 15d (0Fh) through 30d (1Eh):

  Type Addr1 Addr2> 15 30 and then press Enter.
  Type Value> 255 and then press Enter.

  Press Esc to return to the main menu.

  Touch Coordinates

  Touch Coordinates (,) will display the controller reported touch location upon a touch.

4. Press Esc from the main menu to exit the SC3RW program.

SC3MON program

The SC3MON program allows the active stream monitoring/viewing of sent touch report data in a hexadecimal format.

1. Get to a DOS prompt at the drive/directory holding the SC3MON program.
2. Type SC3MON <Comport> <Baud Rate> and then press Enter.

The default values are Comport = 1 and Baud Rate = 2400.

Example for Comport COM1 and Baud Rate 2400:
Type SC3MON and then press Enter.

Example for Comport COM2 and Baud Rate 9600:
Type SC3MON 2 9600 and then press Enter.

3. Touch the touch screen to view a stream of hexadecimal touch report data.
4. Press Esc to exit the SC3MON program.

SC3EXP program

The SC3EXP program will actively display the current sent touch report data in a hexadecimal format. The scaled video touch location will be displayed as: X Y PEN STATUS.

1. Get to a DOS prompt at the drive/directory holding the SC3EXP program.
2. Type SC3EXP and then press Enter.
3. Enter the Comport and Baud Rate when prompted.

   Example for Comport COM1 and Baud Rate 2400:
   INPUT COMPORT: 1 and then press Enter.
   INPUT BAUDRATE: 2400 and then press Enter.
4. Touch the touch screen to view video scaled touch reports formatted as: X Y PEN STATUS.
5. Press Esc to exit the SC3EXP program.

Chapter 11
Software for MS-DOS Application Programmers Interface (API)

What's in this chapter?

This chapter explains MS-DOS-based Application Programmers Interface (API) tools used to interface an application program with the 3M Touch Systems touch screen drivers. The tools are written in the C language and have been tested with Turbo C and MSVC++ 1.52c.

The touch screen driver emulates (where applicable) a standard Microsoft mouse. A reference for mouse programming is the *Microsoft Mouse Programmer's Reference* (Microsoft Press).

Installing the software

The API tools are contained on the Touch Screen Utilities disk. Follow the instructions below to install the software from the disk to your computer. During installation you can exit at any time by pressing the Esc key on your keyboard.

1. Insert the DTF Touch Screen DOS Utilities disk into a diskette drive.
2. At the DOS prompt, type a:\install, where a is the drive containing the disk. Press Enter.
3. Answer the questions that appear on your screen as the installation proceeds.
4. Remove the installation disk from the diskette drive when the installation is complete.

For additional information, see the Readme file and other source files on the Touch Screen Utilities disk.

InitMouse

Resets the mouse driver. Checks to see if the mouse driver is loaded and the mouse is reset.

Prototype	:	int InitMouse(void)
Inputs	:	none
Outputs	:	none
Returns	:	1 if mouse (driver) found and reset, 0 if not

MousePos

Returns the immediate position and left button status of the mouse or touch screen. It does not matter what operational mode is set. All outputs are passed by reference.

Prototype	:	void MousePos(int *ButtonStatus, int *x, int *y)
Inputs	:	none
Outputs	:	ButtonStatus: Returns 1 if touch is occurring, 0 if not x is X coordinate of touch event in pixels y is Y coordinate of touch event in pixels
Returns	:	none

GetTouch

This function returns data according to the operating mode set by the SetMode() function. These modes simulate the firmware modes of the SC3 serial touch screen controller.

- CONT is the default mode (will be forced if SetMode() is not called with proper value). Returns a 1 continuously as long as a touch event (pen down) is occurring, along with the x/y coordinates.
- UP returns a 1 only if an untouch (pen up) has occurred since the last time this function was called. Returns a zero if not. Position data reflects the point the untouch occurred at.
- DOWN returns a 1 if a touch (pen down) has occurred since the last time this function was called. Returns a zero if not. Position data reflects the point the touch occurred at.

  DOWN_UP returns a 1 continuously as long as the touch event (pen down) is occurring. The coordinates returned, however, are that of the initial touch.

These functions will only act properly if the SC3 touch screen controller is in "Continuous" touch mode. These routines use mouse functions 5 and 6, thereby yielding unpredictable results if the application program also makes direct calls to these functions.

Prototype	:	int GetTouch(int *x, int *y, int *t);
Inputs	:	none
Outputs	:	x is X coordinate in pixels y is Y coordinate in pixels t is the touch flag, returns current touch (pen) status as the function is called, will be 1 when touch occurs and 0 if not.
Returns	:	1 if data is legitimate (according to mode set), 0 if not

SetMode

Sets the operational mode used by the GetTouch function. For details, see GetTouch on page 86.

Prototype : void SetMode(CONT||UP||DOWN||DOWN_UP)

Inputs : acceptable constants are listed in above prototype

Outputs : none

Returns : none

ShowCursor

Displays the graphics cursor. HideCursor or InitMouse functions will cancel cursor display.

Prototype : void ShowCursor(void)

Inputs : none

Outputs : none

Returns : none

HideCursor

Turns the graphics cursor off.

Prototype : void HideCursor(void)

Inputs : none

Outputs : none

Returns : none

Sample source code

See the “SC3TEST.C” file on the DTF Touch Screen DOS Utilities disk.

Appendix A
Touch screen system

What's in this appendix?

This appendix provides:

- An overview of the analog resistive touch screen and its options.
- A description of the differences between four-wire and eight-wire touch screens.

Analog resistive touch screen

The analog resistive touch screen is a sensor consisting of two opposing layers, each coated with a transparent resistive material called indium tin oxide (ITO). The ITO used has a typical sheet resistivity between 100 and 500 ohms per square (Ω/sq).

The layers are separated by a pattern of very small transparent insulating dots. Silver ink bus bars (~50mΩ/sq) make an electrical connection to the surface of the ITO at the outside edges, spanning the desired axis of the given layer. Silver ink traces (~50mΩ/sq) connect the bus bars to an electromechanical connector used for interfacing to the sensor.

Functional description

Touching the top surface compresses the flexible top layer to the supported bottom layer causing electrical contact of the two layers between the span of insulating dots. Determining a touch location requires two measurements, one to obtain an X-axis coordinate and one to obtain a Y-axis coordinate. A single axis measurement is taken by applying a drive voltage across the ITO of one layer via the silver ink bus bar and trace connections. The voltage applied to this layer produces a voltage gradient across the ITO. The voltage linearly changes from the minimum drive voltage at one end to the maximum drive voltage at the other end. The opposing layer, via a path through its ITO and silver ink connections, is used to measure the voltage at the point of contact on the voltage driven layer. This process is repeated, alternating functions of the two layers to obtain a measurement on the other axis.

Measurements are made using a 10-bit analog to digital convertor (ADC). A 10-bit ADC can resolve 2-to-the-10th power or 1024 different input values in the horizontal and vertical directions. The four-wire system resolution is, however, less than 1024 due to losses in the drive voltage that occur before it reaches the touch screen ITO.

Typical minimum and maximum ADC values will be 50 and 950, respectively. This yields a dynamic range of approximately 900 ADC values.

Touch point coordinates are reported to the host computer through a serial communications port.

Touch screen options

3M Touch Systems touch screens are available off-the-shelf in several sizes to match your choice of display. 3M Touch Systems also designs custom touch screens to meet product requirements. Most 3M Touch Systems touch screens can be supplied with options that can enhance optical properties, increase durability, and improve electrical performance for the entire touch system. Some of these options include:

- Anti-glare and high gloss surface finishes
- Optical filters
- EMI and RFI shields
- Integrated membrane switches
- Gaskets
- Differing activation forces
- Color graphics

Consult a local 3M Touch Systems representative for more information on standard and custom touch screens.

Four-wire and eight-wire touch screens

The SC3 and SC3-OEM controllers support four-wire and eight-wire touch screens.

Four-wire touch screen decoding

The 3M Touch Systems four-wire construction consists of two opposing layers, each coated with a transparent resistive material. The layers are separated by a pattern of transparent insulating dots. Conductive bus bars make electrical connection to the transparent resistive material of a given layer.

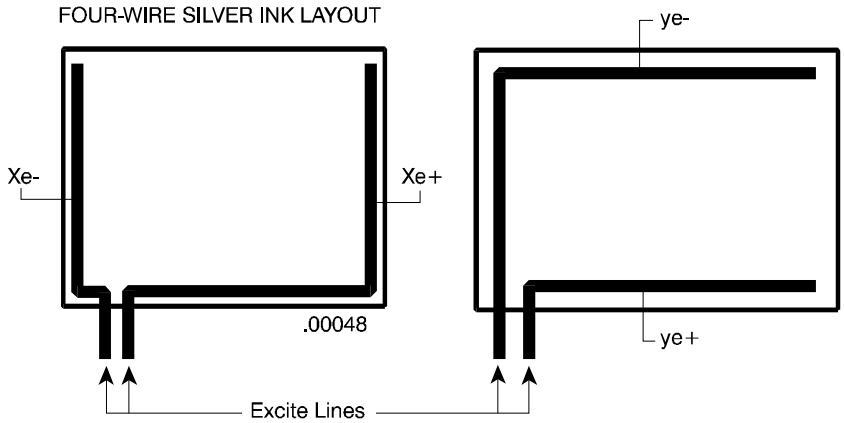


Figure 13: Four-wire resistive touch screen silver ink layout

One layer has bus bars on the left and right edges, and the opposing layer has bus bars on the top and bottom edges. A touch causes the two layers to come into contact with each other between the span of insulating dots. The touch screen is decoded by developing a voltage across the horizontal layer's resistive material, and reading the vertical touch location voltage with the opposing layer. A voltage is then developed across the vertical layer's resistive material, and a horizontal touch location voltage is read from the opposing layer.

Table V: Four-wire touch screen scanning

Axis	Xe+	Xe-	Ye+	Ye-
X Axis	5 V Drive	Gnd Drive	NC	Read
Y Axis	NC	Read	5 V Drive	Gnd Drive

Eight-wire touch screen decoding

The 3M Touch Systems eight-wire design references the measured touch location voltage to the drive (excite) voltage out at the touch screen, rather than at the controller. This requires four additional lines (called sense wires) attached to the four bus bars.

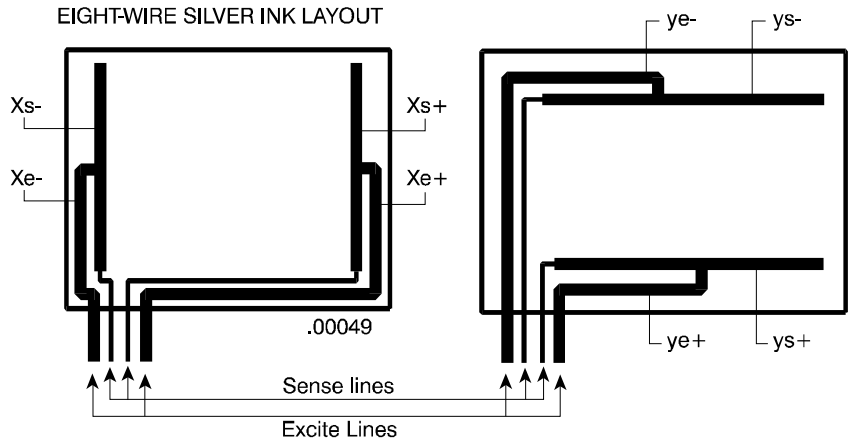


Figure 14: Eight-wire resistive touch screen silver ink layout

Allowing the reference voltage to track the actual voltage out on the touch screen offers a significant advantage — it compensates for resistance changes inherent to any touch system. Resistance changes are caused by aging, use, temperature, and humidity.

The eight-wire design stabilizes the system's accuracy, eliminating touch point drift. The four additional lines (Xs+, Xs-, Ys+, and Ys-) are the sense lines. These lines are individually multiplexed into the references of the A/D converter to yield a ratio-metric conversion.

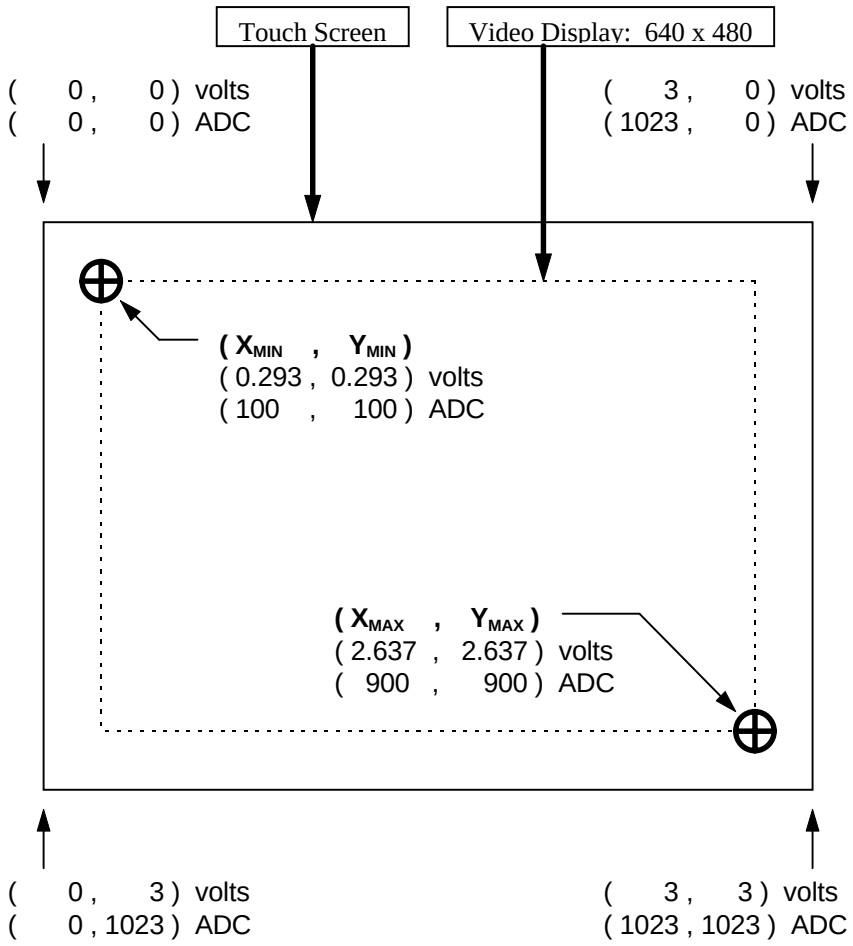
Table W: Eight-wire touch screen scanning

Axis	Xe+	Xe-	Ye+	Ye-	Xs+	Xs-	Ys+	Ys-
X	5 V Drive	Gnd Drive	NC	Read	Ref+[1]	Ref-[1]	NC	NC
Y	NC	Read	5 V Drive	Gnd Drive	NC	NC	Ref+[1]	Ref-[1]

[1]In this table, Ref+ and Ref- are the plus and minus references to the ratio-metric A/D converter.

Touch position to video decoding

Here's an example of touch position to video decoding.



Known values:

$X_{MAX\ PIXELS}$ = 640
$Y_{MAX\ PIXELS}$ = 480
X_{MIN} = 100
X_{MAX} = 900
Y_{MIN} = 100
Y_{MAX} = 900

Conversion formulas:

$$X_{PIXEL} = \frac{(X_{TOUCH} - X_{MIN})}{(X_{MAX} - X_{MIN})} \cdot X_{MAXPIXELS}$$

$$Y_{PIXEL} = \frac{(Y_{TOUCH} - Y_{MIN})}{(Y_{MAX} - Y_{MIN})} \cdot Y_{MAXPIXELS}$$

reduced with known values become:

$$X_{PIXEL} = \frac{(X_{TOUCH} - 100)}{800} \cdot 640$$

$$Y_{PIXEL} = \frac{(Y_{TOUCH} - 100)}{800} \cdot 480$$

Simulated touch:

ADC Reference:
$V_{ADC\ REF+} = 3v,\ V_{ADC\ REF-} = 0v$
$V_{ADC\ REF\Delta} = (V_{ADC\ REF+} - V_{ADC\ REF-}) = 3v - 0v = 3v$

$V_{TOUCH}, X = 0.75v$
$V_{TOUCH}, Y = 1.50v$

$$ADC_{RAW,X} = \frac{V_{TOUCH,X}}{V_{ADCREF\Delta}} \cdot 1024 = \frac{0.75v}{3v} \cdot 1024 = 256ADC$$

$$ADC_{RAW,Y} = \frac{V_{TOUCH,Y}}{V_{ADCREF\Delta}} \cdot 1024 = \frac{1.50v}{3v} \cdot 1024 = 512ADC$$

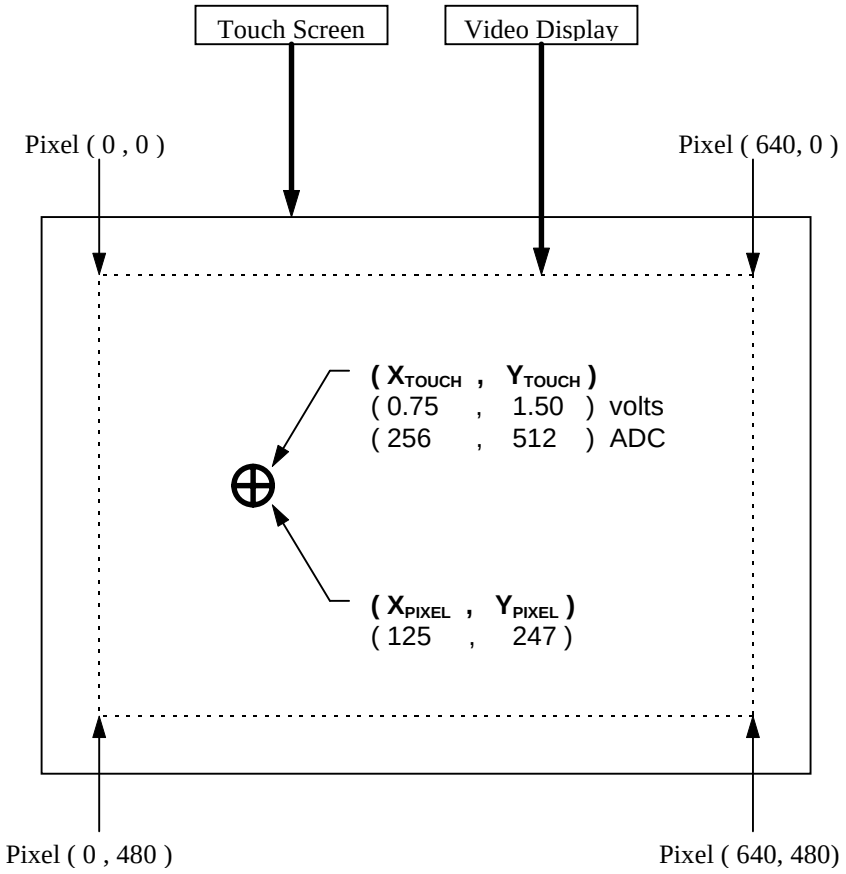
$(X_{TOUCH}, Y_{TOUCH}) = (0.75, 1.50)\ volts = (256, 512)\ ADC$

Converted to coordinates becomes:

$$X_{PIXEL} = \frac{(256 - 100)}{800} \cdot 640 = 125$$

$$Y_{PIXEL} = \frac{(512 - 100)}{800} \cdot 480 = 247$$

$$(X_{PIXEL} , Y_{PIXEL}) = (125, 247)$$



Appendix B
Troubleshooting

Questions & answers

Question	Answer
Will I be able to use the touch screen and a mouse on the same system?	Yes. See the Concurrent Mouse And Touch Screen Operation section in the Readme file for details.
Is it possible to turn off the cursor?	Yes. To turn off the cursor in Windows 95 and NT, you need to select a blank cursor. See your operating system manual to perform the procedure. If needed, 3M Touch Systems can provide a blank cursor file for NT & 95. In Windows 3.1, see the appropriate Software Development Kit. In MS-DOS, the cursor is off by default. Applications must explicitly turn it on using Int 33h function 1. To turn it off again, use Int 33h function 2. These are standard Microsoft Mouse API capabilities (as described in the Microsoft Mouse Programmer's Reference).
When I am using Windows NT and try to change the touch screen configuration I get the error "Can't write configuration data" after I select "OK." What should I do?	The touch screen configuration changes must be written to the registry. You should run the Programs/ Administrative Tools/ User Manager and check your user rights. Ensure that you are logged in as the Administrator or belong to the Administrator group. Only Administrators have rights to access the registry.

Question	Answer
I cannot get any response from the touch screen.	Check your connections to the controller and touch screen. Disconnect and then re-connect the power to the controller. See the reset instructions for Windows 95 and NT. For DOS, see “Resetting the controller,” on page 81. If you’re still experiencing difficulties, call 3M Touch Systems for assistance.
I am using DOS and when I run my application the cursor appears to be stuck in the upper left corner of the screen. What should I do?	Your application uses a non-standard method of communicating with the mouse. Add /NOBOUNDS to the emouse line in your AUTOEXEC.BAT file. For example, EMOUSE /NOBOUNDS
I am having trouble calibrating my touch screen. The software will not accept the confirmation point. What should I do?	Note the numbers displayed on the calibration points then call 3M Touch Systems for assistance. Your touch screen or controller may have been damaged during shipping or installation.
During calibration, the message appears "Display Area exceeds Touch Screen boundary, Please re-calibrate." What should I do?	This may mean that you have not touched the touch screen's calibration points accurately. Re-calibrate more accurately. If this does not work, re-mount your touch screen or adjust your video display area to be the same size as the touch screen area.
After installing the touch screen drivers in Windows 95, my touch screen works but my mouse does not function. What should I do?	1. Select Control Panel and choose Add New Hardware. 2. Choose "yes" to have Windows95 detect new hardware, when prompted. It will find the mouse and correctly configure it for concurrent use with your touch screen.

Question	Answer
I am having trouble downloading configurable option information to the controller.	Ensure your power cord is plugged in and the controller and all cables are properly connected. Ensure the software is correctly configured regarding the IRQ and Base addresses that it is using for communication. Make sure to touch the screen when downloading in case the Low Power Mode is selected. If the controller is in Low Power Mode, it cannot respond to the host commands. See "Host-to-controller," on page 55. If you're still experiencing difficulties, call 3M Touch Systems for assistance.
I am using a small touch screen. The touch is working, but it does not follow my finger after calibration.	Try recalibrating the software. Check the pin-out of the touch screen. Some Dynaclear touch screens have a non-standard pin-out. Pin-out codes are printed on the label on the tail of the part. See the non-standard pin-outs question in this appendix.
I am having trouble calibrating the screen to match the display when working in DOS.	Some video displays in DOS are sensitive to the video mode that your application uses. Try the following suggestions: 1. Determine the video mode you're using. 2. Run ecal using the /VXX option where XX is the standard video mode between 0 and 16, as described in the Microsoft Mouse Programmer's Reference. 3. If you must, use a non-standard video mode. See information below. 4. If you're still experiencing difficulties, call 3M Touch Systems for assistance.
I want to run DOS using a non-standard video mode.	Run ecal using the /VU option to calibrate the touch screen. This option will not present any calibration targets, but will simply prompt for calibration around the edges of the touch screen.

Question	Answer
I'm using a quarter VGA display. How do I configure the software?	In Windows 3.1, change the screen parameters as follows in the TOUCH.INI file: ScreenResX=32768 ScreenResY=32768 ScreenOffX=0 ScreenOffY=0 For DOS, run ecal using the /VR=XXX,YYY option. It allows you to configure the driver so that the coordinates it reports are scaled for the video mode in use. The x and y values specified become the largest coordinates the driver will report (i.e. the coordinate value of a touch at the lower-right corner of the touch screen). In DOS, edit the emouse line in the autoexec.bat file as follows: emouse.com /VR=XXX,YYY where XXX=320 and YYY=100
After exiting the Windows program, the controller often locks up.	Try resetting the communication port using the DOS mode command. mode <comport>:<baudrate>, <parity>,<data bits>, <stop bit> **Example**: MODE com1:2400,N,8,1
Do any mouse functions have to be issued after setting the graphics mode in a custom DOS mouse driver application?	Yes. Issue a mouse function 0 after setting the graphic mode.
What do I do if I have a touch screen with a non-standard pin-out?	For pin-out codes T or U, you must change the standard four-wire touch screen cable as follows: 1. Using a paper clip, press in the barb that holds the pins for the two middle wires (pins 2 and 3). 2. Pull the wires and pins out of the housing. 3. Bend the barbs back up so the wires stay in the housing when re-inserted. 4. Insert the wire that was pin 3 into the pin 2 position, and insert the wire that was pin 2 into the pin 3 position. The connector's pin-out should now be 1,3,2,4.

Question	Answer
The cursor is 'stuck' at a point near the edge of the screen, and the mouse will move the cursor only slightly.	The touch screen may be pressed together (activated) by your bezel at a point near the edge of the screen. Loosen the bezel and reposition it so that less pressure is applied to the edges of the touch screen. If possible, run the touch screen without the bezel to see if it works properly.
I am using third-party software drivers (which support the SC3 controller) and the cursor moves up when I move down, or right when I move left. I have tried re-calibrating many times.	The orientation of the touch panel cables does not affect the operation of the 3M Touch Systems software drivers, but other software drivers may not be as tolerant of how the touch screen is connected. Check the touch screen for correct wiring. See schematics in Chapter 9.

Check our web site for additional troubleshooting information:
www.dynapro.com

Appendix C
Special codes for Windows 3.1 and MS-DOS

This appendix lists the special codes, the non-printable keyboard keys that can be used for the TouchSurround in Windows 3.1 and MS-DOS.

Table X: Special codes (Windows 3.1)

Description	Normal code	Shift code	Ctrl code	Alt code
Backspace key	<BKSP>	<S-BKSP>	<C-BKSP>	<A-BKSP>
Tab key	<TAB>	<S-TAB>	<C-TAB>	<A-TAB>
Carriage Return or Enter	<ENTER>	<S-ENTER>	<C-ENTER>	<A-ENTER>
ESC key	<ESC>	<S-ESC>	<C-ESC>	<A-ESC>
Page Up key	<PGUP>	<S-PGUP>	<C-PGUP>	<A-PGUP>
Page Down key	<PGDN>	<S-PGDN>	<C-PGDN>	<A-PGDN>
End key	<END>	<S-END>	<C-END>	<A-END>
Home key	<HOME>	<S-HOME>	<C-HOME>	<A-HOME>
Left key	<LEFT>	<S-LEFT>	<C-LEFT>	<A-LEFT>
Up key	<UP>	<S-UP>	<C-UP>	<A-UP>
Right key	<RIGHT>	<S-RIGHT>	<C-RIGHT>	<A-RIGHT>
Down key	<DOWN>	<S-DOWN>	<C-DOWN>	<A-DOWN>
Insert key	<INS>	<S-INS>	<C-INS>	<A-INS>
Delete key	<DEL>	<S-DEL>	<C-DEL>	<A-DEL>
Function key F1	<F1>	<S-F1>	<C-F1>	<A-F1>
Function key F2	<F2>	<S-F2>	<C-F2>	<A-F2>
Function key F3	<F3>	<S-F3>	<C-F3>	<A-F3>
Function key F4	<F4>	<S-F4>	<C-F4>	<A-F4>
Function key F5	<F5>	<S-F5>	<C-F5>	<A-F5>

Table X: Special codes (Windows 3.1)

Description	Normal code	Shift code	Ctrl code	Alt code
Function key F6	<F6>	<S-F6>	<C-F6>	<A-F6>
Function key F7	<F7>	<S-F7>	<C-F7>	<A-F7>
Function key F8	<F8>	<S-F8>	<C-F8>	<A-F8>
Function key F9	<F9>	<S-F9>	<C-F9>	<A-F9>
Function key F10	<F10>	<S-F10>	<C-F10>	<A-F10>
Function key F11	<F11>	<S-F11>	<C-F11>	<A-F11>
Function key F12	<F12>	<S-F12>	<C-F12>	<A-F12>
Break key			<C-BREAK>	
A key	a	A	<C-A>	<A-A>
B key	b	B	<C-B>	<A-B>
C key	c	C	<C-C>	<A-C>
D key	d	D	<C-D>	<A-D>
E key	e	E	<C-E>	<A-E>
F key	f	F	<C-F>	<A-F>
G key	g	G	<C-G>	<A-G>
H key	h	H	<C-H>	<A-H>
I key	i	I	<C-I>	<A-I>
J key	j	J	<C-J>	<A-J>
K key	k	K	<C-K>	<A-K>
L key	l	L	<C-L>	<A-L>
M key	m	M	<C-M>	<A-M>
N key	n	N	<C-N>	<A-N>
O key	o	O	<C-O>	<A-O>
P key	p	P	<C-P>	<A-P>
Q key	q	Q	<C-Q>	<A-Q>
R key	r	R	<C-R>	<A-R>
S key	s	S	<C-S>	<A-S>
T key	t	T	<C-T>	<A-T>
U key	u	U	<C-U>	<A-U>
V key	v	V	<C-V>	<A-V>
W key	w	W	<C-W>	<A-W>

Table X: Special codes (Windows 3.1)

Description	Normal code	Shift code	Ctrl code	Alt code
X key	x	X	<C-X>	<A-X>
Y key	y	Y	<C-Y>	<A-Y>
Z key	z	Z	<C-Z>	<A-Z>
Print Screen key	<PRTSCR>			
Spacebar	<SPACE>			
Pause key	<PAUSE>			
Caps Lock key	<CAPS>			
Scroll Lock key	<SCROLL>			
Num Lock key	<NUM>			
Shift key down	<SHIFTD>			
Shift key up	<SHIFTU>			
Shift lock	<SHIFTLOCK>			
Ctrl key down	<CTRLD>			
Ctrl key up	<CTRLU>			
Ctrl lock	<CTRLLOCK>			
Alt key down	<ALTD>			
Alt key up	<ALTU>			
Alt lock	<ALTLOCK>			
Number pad * key	<MULT>			
Number pad + key	<ADD>			
Number pad - key	<SUB>			
Number pad / key	<DIV>			
Number pad 0 key	<#0>			
Number pad 1 key	<#1>			
Number pad 2 key	<#2>			
Number pad 3 key	<#3>			

Table X: Special codes (Windows 3.1)

Description	Normal code	Shift code	Ctrl code	Alt code
Number pad 4 key	<#4>			
Number pad 5 key	<#5>			
Number pad 6 key	<#6>			
Number pad 7 key	<#7>			
Number pad 8 key	<#8>			
Number pad 9 key	<#9>			
Number pad . key	<#.>			
Start application	<RUN>			

Table Y: Special codes (MS-DOS)

Description	Normal code	Shift code	Control code	Alt code
Backspace	<BKSP>		<C-BKSP>	
Tab	<TAB>	<S-TAB>		
Carriage Return or Enter	<ENTER>			
Space Bar	<SPACE>			
Escape	<ESC>			
Function Key F1	<F1>	<S-F1>	<C-F1>	<A-F1>
Function Key F2	<F2>	<S-F2>	<C-F2>	<A-F2>
Function Key F3	<F3>	<S-F3>	<C-F3>	<A-F3>
Function Key F4	<F4>	<S-F4>	<C-F4>	<A-F4>
Function Key F5	<F5>	<S-F5>	<C-F5>	<A-F5>
Function Key F6	<F6>	<S-F6>	<C-F6>	<A-F6>

Table Y: Special codes (MS-DOS)

Description	Normal code	Shift code	Control code	Alt code
Function Key F7	<F7>	<S-F7>	<C-F7>	<A-F7>
Function Key F8	<F8>	<S-F8>	<C-F8>	<A-F8>
Function Key F9	<F9>	<S-F9>	<C-F9>	<A-F9>
Function Key F10	<F10>	<S-F10>	<C-F10>	<A-F10>
Function Key F11	<F11>	<S-F11>	<C-F11>	<A-F11>
Function Key F12	<F12>	<S-F12>	<C-F12>	<A-F12>
Insert	<INS>			
Delete	<DEL>			
Home	<HOME>		<C-HOME>	
End	<END>		<C-END>	
Page Up	<PGUP>		<C-PGUP>	
Page Down	<PGDN>		<C-PGDN>	
Up Arrow	<UP>			
Down Arrow	<DOWN>			
Left Arrow	<LEFT>		<C-LEFT>	
Right Arrow	<RIGHT>		<C-RIGHT>	
A Key	a	A	<C-A>	<A-A>
B Key	b	B	<C-B>	<A-B>
C Key	c	C	<C-C>	<A-C>
D Key	d	D	<C-D>	<A-D>
E Key	e	E	<C-E>	<A-E>
F Key	f	F	<C-F>	<A-F>
G Key	g	G	<C-G>	<A-G>
H Key	h	H		<A-H>

Table Y: Special codes (MS-DOS)

Description	Normal code	Shift code	Control code	Alt code
I Key	i	I		<A-I>
J Key	j	J	<C-J>	<A-J>
K Key	k	K	<C-K>	<A-K>
L Key	l	L	<C-L>	<A-L>
M Key	m	M		<A-M>
N Key	n	N	<C-N>	<A-N>
O Key	o	O	<C-O>	<A-O>
P Key	p	P	<C-P>	<A-P>
Q Key	q	Q	<C-Q>	<A-Q>
R Key	r	R	<C-R>	<A-R>
S Key	s	S	<C-S>	<A-S>
T Key	t	T	<C-T>	<A-T>
U Key	u	U	<C-U>	<A-U>
V Key	v	V	<C-V>	<A-V>
W Key	w	W	<C-W>	<A-W>
X Key	x	X	<C-X>	<A-X>
Y Key	y	Y	<C-Y>	<A-Y>
Z Key	z	Y	<C-Z>	<A-Z>
\ Key			<C-\>	
] Key			<C-]>	
^ Key			<C-^>	
_ Key			<C-_>	
- Key				<A-->
= Key				<A-=>

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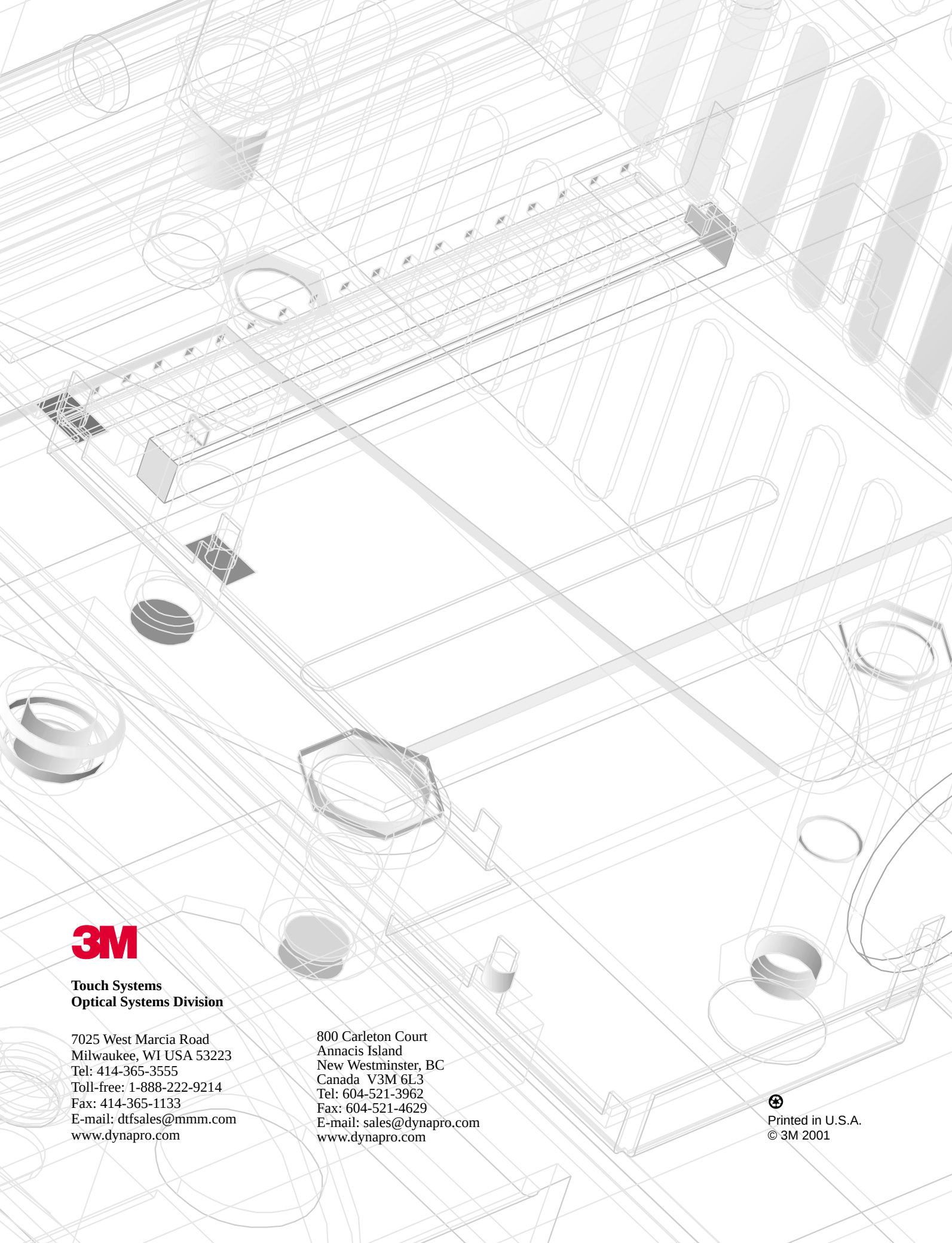

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