

# 3M™ MicroTouch™ Controller SX112 Reference Guide

(formerly EX II 3700SP)

Read and understand all safety information  
contained in this document before using this product.



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## About This Manual

3M Touch Systems offers several advanced controllers designed for reliability and easy installation. Each controller provides superior performance and delivers excellent stability, sensitivity, accuracy, and fast response.

This reference guide, designed for developers of touch systems, provides installation and configuration information for the 3M™ MicroTouch™ SX112 touch controller. This document includes information on integrating the SX pen controller into your design, communicating with the controller, installing the MT 7 software user interface, and troubleshooting setup problems. It also includes a complete description of the firmware commands and controller specifications.

3M Touch Systems is committed to being a premier supplier in touch systems throughout the world. As a 3M Touch Systems customer, you are aware that we have strong internal programs that meet or exceed environmental regulations of our customers and the regions in which we conduct business.

## What You Need to Know

This document assumes you are familiar with firmware commands and how to use them. Executing some commands may alter the performance of your touch product. You should be aware of the results of using these commands before executing them.

## Important Safety Information

Read, understand and follow all safety information before using this product. Follow all instructions marked on the product and described in this document. Pay close attention to the following installation warnings and safety precautions.

<b>Intended Use</b>
The SX112 pen controller was designed to enable surface capacitive touch in conjunction with other 3M™ MicroTouch™ sensor products and was tested to replace an existing serial controller. This controller is intended for internal mounting only and is not suitable for use in hazardous locations.

### Explanation of Signal Word Consequences

**⚠ WARNING:** Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury and/or property damage.

**⚠ CAUTION:** Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury and/or property damage.

**CAUTION:** Indicates a potentially hazardous situation, which, if not avoided, may result in property damage.

### ⚠ WARNING

**To reduce the risk of fire and/or explosion which could result in serious injury or death:**

Do not install or use this product in a hazardous location.

**To reduce the risk of fire and/or explosion which could result in serious injury or property damage:**

Do not use this product in any outdoor environment unless NEMA standards (or similar standards such as IP rating) are followed.

**To avoid the risk of electric shock which could result in serious injury or death:**

- Do not use a damaged power supply.
- Do not use a power cord that is frayed or otherwise damaged.

### ⚠ CAUTION

**To reduce the risks associated with improper disposal, which if not avoided may result in minor or moderate injury from ground water contamination:**

Dispose of components in accordance with federal, state and local regulations.

**To reduce the risk of possible environmental contamination which may result in minor or moderate injury:**

Dispose of the display in accordance with federal, state and local regulations.

**To avoid the potentially hazardous situations associated with the use of isopropyl alcohol which may result in minor or moderate injury or property damage:**

Follow all instructions and recommendations in the manufacturer's Material Safety Data Sheet and product label.

## Sensor Care and Cleaning

The sensor requires very little maintenance. 3M Touch Systems recommends that you periodically clean the glass surface.

### ⚠ CAUTION

**To reduce the risk of the potentially hazardous situations associated with the use of isopropyl alcohol which may result in minor or moderate injury or property damage:**

Follow all instructions and recommendations in the alcohol manufacturer's Material Safety Data Sheet and product label.

Typically, an isopropyl alcohol and water solution ratio of 50:50 is the best cleaning agent for your touch screen. You can also use straight isopropyl alcohol. Be sure to follow solvent manufacturer's precautions and directions for use when using any solvents.

- It is important to avoid using any caustic chemicals on the sensor.
- Always dampen the cloth and then clean the screen. Be sure to spray the cleaning liquid onto the cloth, not the screen, so that drips do not seep inside the display or stain the bezel.
- Apply the cleaner with a soft, lint-free cloth. Avoid using gritty cloths.
- Always handle the sensor with care. Do not pull on or stress flex tail.

### 3M Touch Systems Support Services

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

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

- Touch display size, part number and serial number
- Current driver version
- Operating system used
- Information on additional peripherals

Technical Support is available Monday through Friday 8:30 a.m. to 5:30 p.m. with limited call back service after 5:30 p.m. until 8:00 p.m. US Eastern Standard Time – 9 a.m. to 5 p.m. throughout Europe.

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

- Technical Support Hot Line: 978-659-9200
- Technical Support Fax: 978-659-9400
- Toll Free: 1-866-407-6666 (Option 3)
- Email: US-TS-techsupport@mmm.com

### Contact 3M Touch Systems

Contact information for all offices can be found on our website at:

<http://www.3M.com/touch/>



## CHAPTER 1

# Integrating the SX112 Controller

The 3M™ MicroTouch™ SX112 controller provides a drop-in replacement for the entire family of pen controllers with all the improved features of the EX II ASIC including wide dynamic range, increased noise immunity, wide operating temperature stability, reprogrammability using software utilities and inherent ungrounded capability.

This chapter covers the following SX112 controller specifications:

- Cable connections
- Mounting requirements
- Power requirements and options
- Status LED codes

## Overview of the SX112 Touch Controller

The SX112 is a form, fit and functional replacement for an existing controller with a standard RS-232 serial interface. The SX112 controller, sensor, stylus and cables are supplied separately.

To effectively integrate and test the SX112 controller, you will need the following items:

- A 3M™ MicroTouch™ pen (P/N 69-502 with 7311420 cable extension to connect to controller). A complete integration kit is also available: P/N 69-901.
- A 3M™ MicroTouch™ surface capacitive touch sensor
- A method of establishing the serial data communication between the controller and your system. The 3M™ MicroTouch™ RS-232 serial cable (P/N 7311273) is recommended.
- A method of supplying +12VDC power to the controller.
- A touch driver with a calibration routine. You can use 3M™ MicroTouch™ MT 7 software which includes the necessary touch driver and utilities software.

## Handling and ESD Protection

When mounting the sensor and controller, use normal precautions for handling electrostatic sensitive devices. The SX serial controllers have internal protection to  $\pm 27$  kV for ESD discharges to the sensor (not to the controller directly) that may occur during normal operation of the sensor. Refer to the appendices for further specifications.

## Establishing the Data Connection

You will need a method of establishing the serial data communication between the controller and your system. You can build your own or purchase the standard 3M™ MicroTouch™ RS-232 serial cable (P/N 7310101). Table 1 describes the pins for this cable, which connects to a serial communication (COM) port on the PC.

**Table 1 Controller Pinouts for JP1, JP2 and JP3 Connectors**

Pin	JP1 (Sensor)	JP2 (Pen)	JP3 (Power)
1	UL	Ground	+12V
2	UR	Pen Tip	Ground
3	Shield	Reserved	Receive data (RXD)
4	LR	Reserved	Transmit date (TXD)
5	LL	Reserved	Reserved
6	Ground	Shield	Reserved
7	N/A	N/A	Reserved

## Mounting the Controller

The controller should be mounted on the chassis inside the monitor. Choose a convenient spot away from high-voltage, high power cables and electronics.

## Supplying Power to the Controller

You must supply the SX112 controller with power (+12 VDC) through a custom serial cable configuration. Exact specifications can be found in Appendix A.

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**Note:** However you supply power, the source must deliver >100 mA @ 12V  $\pm 5\%$  typical with a maximum ripple and noise of 50mV peak-to-peak. Mounting posts should be grounded to the chassis.

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## Using a Custom Serial Cable Design

When creating a custom serial cable connection, you can provide power to the controller through the mating Molex connector:

1. Obtain a 7-pin Molex connector 51004-0700.
2. Attach power and return to the connector (Pin 1: +12V, Pin 2: Ground).

## Mounting the Sensor

There are several methods for mounting the sensor depending on your application. If you need instructions or recommendations from 3M Touch Systems on how to incorporate a sensor into your design, refer to the *3M™ MicroTouch™ System 3250EX Integration Guide* (P/N 19-278). All 3M Touch Systems documentation is available from the corporate website at [www.3Mtouch.com](http://www.3Mtouch.com).

## Turning On Your System

Before you turn on your touch system, ensure that all cables are connected properly and that the controller is properly mounted. Be sure to tighten all cable connector screws.

To start up your system:

1. Turn on your display and computer.
2. Adjust the contrast and brightness to suit your personal preference and working environment.
3. Adjust the horizontal and vertical position controls on the display to center the image on the screen.

If the LED is on, and remains dimly lit, the controller has power and is operating properly. If the LED is off, the controller is not receiving power.

## Status Light (LED) Diagnostics

3M™ MicroTouch™ controllers are highly reliable units; however, there may be occasions when the controller does not perform exactly as you expected. The SX112 controller provides diagnostic feedback with an LED indicator on the controller.

When you power-up the unit, the LED is bright until the controller start-up sequence is completed. Following start-up, the LED becomes dim and remains dim as long as you do not touch the sensor. When you touch the sensor, the LED becomes bright.

A flashing (or blinking) LED during power-up indicates the controller's power-on self-test failed. Refer to Table 2 for a description of each error code.

**Table 2 LED Diagnostic Codes for SX112 Controllers**

LED Flashes	Error Description	What to do...
1	Reserved	
2	Reserved	
3	Setup error. Unable to establish operating range at power-up. Non-recoverable error.	Replace controller. If error reoccurs, might be a touch sensor problem.

LED Flashes	Error Description	What to do...
4	Controller NOVRAM error. The operating parameters in the controller NOVRAM are invalid. Using defaults.	Restore defaults (RD command). If fault persists, replace controller. If error reoccurs, might be a touch sensor or cable problem.
5	HDW error. The controller hardware failed (unable to initialize or load program). Non-recoverable error.	Replace controller.
6	Reserved	
7	Reserved	
8	Reserved	
9	Reserved	
10	Controller EEPROM not formatted	Contact Tech Support or replace controller.
11	Invalid controller block 5	Not applicable to serial controller.
12	Invalid controller block 6	Replace controller.

## Installing 3M™ MicroTouch™ Software

3M™ MicroTouch™ Software includes the driver that enables your sensor to work with your computer. 3M Touch Systems has touch drivers for many operating systems, including Windows Vista, XP, XP embedded, 2000, 9X, Windows Me, Windows CE, and Windows NT 4.0 (refer to the website for a complete listing). You must be sure to install the correct software for your operating system.

3M™ MicroTouch™ Software includes a control panel for setting your sensor preferences and a diagnostic utility. If you are experiencing problems with the sensor, you can use the diagnostic utilities provided to locate the controller and test the sensor.

For more information on connecting your cables and installing and using the sensor control panel and utilities, refer to the 3M™ MicroTouch™ Software User Guides available on the corporate website at [www.3Mtouch.com](http://www.3Mtouch.com).

## Calibrating the Sensor

*Calibration* aligns the sensor with the underlying video. Specifically, calibration defines the dimensions of the image area of the sensor, determines the edges of the screen's video image, and locates the center of the sensor. You must calibrate the sensor by following the instructions on the screen and test the calibration to ensure accurate operation.

Using 3M™ MicroTouch™ Software, you must perform a 25-point linearization with the pen. When complete, you should perform a standard 2-point calibration *TWICE*: once with the pen and once with your finger. This will ensure that both input methods are accurate.

## CHAPTER 2

# SX112 Controller Communications

This chapter discusses the fundamentals of communicating with the 3M™ MicroTouch™ SX112 controller. The firmware commands, which are usually issued by a driver or utility program on the host system, control the operation of the touch controller, however developers can enter these commands directly. This chapter:

- Describes the controller default settings.
- Lists the recommended firmware commands for current development.
- Describes how to use each of these commands.
- References additional commands developers may need to use.

The description of each command includes the command syntax, the default value, how the command works, and the expected response from the controller.

## Overview of Firmware Commands

Developers may use these commands when writing touch applications, developing custom drivers or touch configurations, or testing their touch systems. Developers can issue commands to initialize the controller, select operating modes, and execute diagnostic functions.

Most sensor users do *not* have to use firmware commands to use their touch systems. For example, users can use MT 7 software to calibrate the sensor or to determine the controller type and firmware version.

---

**Note:** This document assumes you are familiar with standards and modes of communication with serial devices, as well as firmware commands and how to use them. Executing some commands may alter the performance of your sensor and render it inoperable. You should be aware of the results before executing any firmware commands.

---

To optimize the performance of the 3M™ MicroTouch™ SX touch controller and simplify the development of custom drivers, 3M Touch Systems recommends you use the commands listed in this chapter for current development. Using these commands ensures compatibility with all 3M™ MicroTouch™ controllers.

## Controller Default Settings

### Communication Parameters

The default operation of the SX112 controller is N81 (no parity, 8 data bits, and 1 stop bits) at 9600 baud.

### Data Format

*Data format* refers to the type of packet the controller uses to send the X/Y touch coordinates to the host system. Format Tablet is the default format for the 3M™ MicroTouch™ SX112 controller. In Format Tablet, the controller sends 5 bytes per point and provides the most rapid response time to a touch.

- Format Tablet is supported by all current 3M™ MicroTouch™ touch controllers.
- It is the standard for current 3M Touch Systems product development and is the format used by all touch drivers written by 3M Touch Systems.

Refer to the Format Tablet command in the firmware reference section. Note that 3M MicroTouch Software automatically sets communications parameters to N81.

### Operating Mode

The *operating mode* specifies the conditions under which the controller sends the X/Y touch coordinates (input data packet) to the host system.

Mode Stream is the default operating mode for the SX112 controller. In Mode Stream, the controller sends a continuous stream of data packets when the sensor is touched. The controller sends the data as long as a touch continues on the sensor.

Because Mode Stream sends touch data continually, it is the most versatile mode, and it provides the best response time and overall feel.

3M Touch Systems recommends that the touch driver generate an interrupt as each packet in the data stream arrives. Because touchdown and liftoff events are specially coded, your software can generate mouse events that correspond to what the user is doing. This enables instant feedback and prevents data loss.

## Communicating with the Controller

This section provides information on sending firmware commands to the controller and interpreting the responses that the controller returns.

The commands listed in the following table are those that 3M Touch Systems currently uses for development. 3M Touch Systems recommends that you use only these commands for 3M™ MicroTouch™ SX112 controller development.

Commands to the controller are sent on the signal **Receive Data** (RXD) line as a serial data stream. For each command it receives, the controller sends a response to the host on the signal **Transmit Data** (TXD) line also as a serial data stream.

## Sending Commands to the Controller

When you send a command to the controller, you must use the correct command format. The general format of a command is as follows:

<Header>Command<Terminator>

---

**Note:** The following descriptions of header, command, and terminator, use 3M Touch Systems terminal emulator key sequences. You may need to enter the sequence in a different format, depending on your emulator.

---

The *header* is the first character in the command string and is the ASCII start-of-header control character SOH. The hexadecimal code for the ASCII SOH control character is 01. To start the command sequence, use the key combination Ctrl A (^A). If you are working with an IBM PC compatible system, the Ctrl A key combination immediately returns an ASCII ☺ character.

The *command*, which always follows the header, consists of ASCII uppercase letters and numbers only (printable characters).

The *terminator* is the last character of each command string and is an ASCII carriage return CR. An ASCII CR control character is 0D hexadecimal. To enter a carriage return, ending the command sequence, use Enter or the key combination Ctrl M (^M).

This chapter lists each command as a string of ASCII control characters and printable characters consisting of a header, the command, and a terminator as follows:

<SOH>Command<CR>

## Receiving Responses from the Controller

After executing a command, the controller returns a response or acknowledgment to the host system. Each controller response consists of a header, the command response, and a terminator in the following format:

<Header>Command Response<Terminator>

---

**Note:** The following descriptions of header, response, and terminator, use 3M Touch Systems terminal emulator key sequences. The format of controller responses varies depending on the terminal emulation mode you are using.

---

The *header* is the first character in the response string and is the ASCII start-of-header control character SOH. The hexadecimal code for the ASCII SOH control character is 01. If you are working with an IBM PC compatible system in terminal mode, the SOH control character returns a ☺ character to the sensor.

The *command response*, which always follows the header, is a range of ASCII characters depending on the type of command sent. Responses can be in many forms. For example, one standard response is **0** (ASCII character ‘zero’ or 30 hexadecimal). This response indicates a successful command completion for most commands, while it indicates a failed completion for other commands. Refer to the firmware reference section for a description of what the response indicates for *each* particular command.

Another standard response is **1** (ASCII character ‘one’ or 31 hexadecimal). In most cases, this response indicates the command failed. The controller received an invalid command that it could not execute.

Some possible reasons for a command failure include:

- The command was not formatted correctly.
- The system parameters were not set up to allow command execution.
- The controller does not support the command.

The *terminator* is the last character of each response string and is an ASCII carriage return CR. The hexadecimal code for the ASCII CR control character is 0D hexadecimal. The value returned in the response will be the ASCII control character for a carriage return, displayed on the screen as the cursor moving to the next line.

In this chapter, responses are shown as a string of ASCII characters consisting of a header, the response, and a terminator as follows:

```
<SOH>Response<CR>
```

## Controller Initialization

To initialize the SX serial controller for new development, 3M Touch Systems recommends that the host system issue a Reset command whenever the host system is powered on and is attempting to establish communication with the controller.

## Firmware Commands

Developers may use this information when writing touch applications, developing custom drivers or touch configurations, or testing their touch systems. Developers can use firmware commands to initialize the controller, select operating modes, specify data formats, and execute diagnostic functions.

Most touch systems users do *not* have to use firmware commands to use their touch systems. For example, users can use 3M™ MicroTouch™ Software to calibrate the sensor or to determine the controller type and firmware version.

---

**Caution:** This document assumes you are familiar with firmware commands and how to use them. Executing some commands may alter the performance of your touch system and render it inoperable. You should be aware of the results before executing any firmware commands.

---

To optimize the performance of the touch controller and simplify the development of custom drivers, 3M Touch Systems recommends you use the commands listed in Table 5 for current development. Using these commands ensures compatibility with all 3M™ MicroTouch™ controllers.

**Note:** When you enter commands in terminal mode, precede each command with <CTRL> A to enter the start of header.

**Table 5 Firmware Commands for SX112 Controller Development**

Command	Code	Description
Calibrate Extended	CX	Initiates an interactive 2-point calibration.
Calibrate Raw	CR	Collects the raw X and Y coordinates before normal scaling, linearization, and filtering process.
Diagnostic Command	DC	Requests that the controller check for sensor failures such as broken corners, broken wires, etc.
Finger Only	FO	The controller disables the pen and only recognizes finger touch on the sensor.
Format Raw	FR	Returns the signal level (amount of touch) of each of the four sensor corners in digital format.
Format Tablet	FT	Outputs the X/Y touch coordinate data in a five-byte packet. Preferred for current development.
Mode Stream	MS	Sends a continuous stream of X/Y coordinate data when you touch the sensor.
Name	NM	Returns a controller identifier string.
Null Command	Z	Queries the controller and waits for a response.
Output Identity	OI	Identifies the controller type and the firmware version.
Parameter Set	<i>Ppds[b]</i>	Lets you adjust the communication parameters (parity, data bits, and stop bits) of the controller.
Pen or Finger	PF	The controller recognizes both pen and finger touch. This is the default setting.
Pen Only	PO	The controller is set to only recognize input from the pen and ignores any finger contact on the touch sensor.
Reset	R	Initializes the hardware and the firmware, causes the controller to stop sending data, and recalculates the environmental conditions.
Restore Defaults	RD	Returns the controller to the factory default operating parameters. Note: the serial port is reset to N81 format tablet and 2-point calibration is lost.
Unit Type	UT	Identifies the touch controller on your system.

## Calibrate Extended

Syntax: <SOH>CX<CR>

---

**Note:** This command should not be used when 3M™ MicroTouch™ Software is being used. The CX command will interfere with the auto orientation algorithm. To calibrate, use the 2- or 4-point calibration in 3M™ MicroTouch™ Software.

---

Description: Initiates an interactive 2-point calibration.

During the calibration process, you define the active area of the sensor by mapping locations to an absolute X/Y coordinate system. You touch two *target areas* on the sensor. Touching the target areas sends the X/Y coordinates for those touch points to the controller. The controller calculates all other touch points based on these two points.

The Calibrate Extended command sets the calibration targets (points) inward from the corner of the video image. Setting the targets inward makes the calibration process easier and more accurate.

### Guidelines for Calibrate Extended

Here are several guidelines for using the Calibrate Extended command:

- The controller uses the data immediately before liftoff to register a calibration touch. Therefore, you can touch the sensor, move your finger to the target, hold for a few seconds, and then lift off. Instructing users to touch this way results in a more accurate calibration.
- The controller stores the data in non-volatile memory (NOVRAM). Therefore, you do not have to calibrate the sensor each time you power on the system. You should, however, recalibrate the sensor any time the video display changes size or resolution.
- You can restart calibration at any time during this sequence by issuing a Reset command and reissuing a CX command.

### Determining Target Areas

The default calibration targets (points) are located 12.5% (1/8) inward from the corners of the video image. For example, suppose the display resolution of your display is 1024 x 768. The Calibrate Extended command calculates the amount to move inward as follows:

- Amount to move inward in the X direction:  $1024 \times 1/8 = 128$
- Amount to move inward in the Y direction:  $768 \times 1/8 = 96$

The Calibrate Extended command then positions the first calibration target inward from the lower left corner and the second calibration target inward from the upper right corner. The following illustration shows how the calibration targets are calculated.



\*The coordinates are in *video* terms, with the origin (0, 0) in the upper left corner of the sensor. Examples from the *controller's* perspective, however, place the origin at the lower left corner of the sensor (numbers in brackets). The controller outputs 0 to 64K on both axes independent of display screen resolution.

## Calibrate Extended Procedure

To use the CX command:

1. Enter the Calibrate Extended (CX) command. The controller sends an initial acknowledgment of <SOH>0<CR>.
2. Touch the sensor at a lower left target, which is located 12.5% (1/8) in from the corner of the video image. The controller returns an acknowledgment of <SOH>1<CR>. This is a positive response. If you receive a negative response <SOH>0<CR>, you can cancel the calibration by issuing a Reset command and then start over again.
3. Touch the sensor at an upper right target, which is located 12.5% (1/8) in from the corner of the video image. The controller returns an acknowledgment of <SOH>1<CR>. This is a positive response. If you receive a negative response, you must start over again.

Touching the two valid calibration points results in a successful calibration. If either calibration point is invalid, the calibration fails. The SX112 controller restores the previous calibration values. If the Calibrate Extended failed, repeat the CX process.

Response: <SOH>1<CR> Positive response.

Indicates that the controller received a valid touch coordinate (point) when the target was touched. Two valid touch points indicate a successful calibration.

<SOH>0<CR> Negative response

Indicates that the touch point is out of range of the expected target area. If you receive a negative response, you must start over again.

No Response

Indicates that you did not touch the target long enough to provide an accurate calibration point.

## Calibrate Raw

Syntax: <SOH>**CR**<CR>

Description: Allows the collection of raw (signed) X and Y coordinates before the normal scaling, linearization, and filtering processes. The controller sends a continuous stream of data in Calibrate Raw mode.

The Calibrate Raw data is a 5-byte packet that includes 1 status byte and 4 bytes of binary X/Y coordinate data. Each X/Y coordinate includes 10 binary bits and 1 sign bit. The 10 bits represent coordinates within a range of -1024 to +1023.

To use the Calibrate Raw command, the controller and host system must be in an 8-bit data communication mode. The Calibrate Raw command returns a negative response if the controller is not using an 8-bit communication mode. To end Calibrate Raw mode, issue a Reset command.

3M Touch Systems uses the Calibrate Raw command during manufacturing and testing, and recommends you only use this command for diagnostics when you want raw data.

Response: <SOH>**0**<CR> Positive response.

After the controller is in Calibrate Raw mode, the controller returns a response in the following format:

SXxYy where:

S = Status byte, first byte of data. Refer to **Error! Reference source not found.6**.

Xx = X (horizontal) coordinate data; second and third bytes of data

Yy = Y (vertical) coordinate data; fourth and fifth bytes of data.

**Table 6 Data Sequence**

Data Sequence	MSB*		Bits					LSB*
	7	6	5	4	3	2	1	0
S- Byte 1	1	S6	Reserved					
X- Byte 2	0	X3	X2	X1	X0	Reserved		
x- Byte 3	0	Xs**	X9	X8	X7	X6	X5	X4
Y- Byte 4	0	Y3	Y2	Y1	Y0	Reserved		
y- Byte 5	0	Ys**	Y9	Y8	Y7	Y6	Y5	Y4

\*MSB = Most Significant Bit, LSB = Least Significant Bit

\*\* s = sign bit

Table 7 describes the meaning of the bits in the status byte (Byte 1).

**Table 7 Calibrate Raw Status Bits**

Bit	Description	Values
S0 – S5	Reserved	—
S6	Proximity (touch state)	1 = Sensor is being touched (a touchdown or a continued touch). 0 = Sensor is not being touched (a touch liftoff or inactive). When the proximity bit changes from 1 to 0 (touch liftoff), the controller outputs one final set of X/Y coordinate data with the bit equal to 0 and the X/Y coordinate data equal to the last touch point.
S7	Packet synchronization	Always 1.

## Diagnostic Command

Syntax: <SOH>**DX**<CR>

Description: This command requests that the controller check for sensor failures such as broken corners, broken wires, etc.

Response: <SOH>**0**<CR> Positive response.  
<SOH>**1**<CR> Command not supported.  
<SOH>**2**<CR> Failure detected.

## Finger Only

Syntax: <SOH>**FO**<CR>

Description: The controller is set to only respond to finger touches and disable the pen.

Response: <SOH>**0**<CR> Positive response

## Format Raw

Syntax: <SOH>**FR**<CR>

Description: Returns the signal level (amount of touch) of each of the four sensor corners in digital format. The returned values are not corrected for stray values.

The Format Raw data is a 41-byte packet that includes 1 status byte and 40 bytes of binary corner data. The first byte of each packet always has its high bit (Bit 7) set to provide synchronization with the host system. Refer to Table 8 for General Packet Formats. Each corner data is composed of a pair of 32-bit I and Q values, which are delivered in 10 bytes.

I and Q are complex touch currents as measured in phase and 90 degrees out of phase with the corner drive signal. Refer to Table 9 for I/Q Corner Components.

To use the Format Raw command, the controller and host system must be in an 8-bit data communication mode. The Format Raw command returns a negative response if the controller is not using an 8-bit communication mode.

To terminate Format Raw, issue a Reset command. The controller may return several bytes of data between the time you issue a Reset command and the controller receives it. You can either scan the data stream for the Reset acknowledgment, or you can ignore the response to the first Reset command and then issue a second Reset after approximately 10 seconds has passed.

Use the Format Raw command for diagnostics. Use Format Tablet for standard sensor operation.

Response: <SOH>0<CR>            Positive response.

After the controller is in Format Raw mode, the controller returns a continuous response in the following format:

*<41-byte-packet><41-byte-packet>...<41-byte-packet>...*

**Table 8 General Packet Formats**

Byte	Bits 0 – 7
1	b0 – b6: Reserved b7: Synchronization bit (Always 1)
2-6	I component of upper left (UL) corner
7-11	Q component of upper left (UL) corner
12-16	I component of upper right (UR) corner
17-21	Q component of upper right (UR) corner
22-26	I component of lower left (LL) corner
27-31	Q component of lower left (LL) corner
32-36	I component of lower right (LR) corner
37-41	Q component of lower right (LR) corner

**Table 9 I/Q Corner Components**

Byte	Bits 0 – 7
N	b0 – b6: bits 0-6 of respective I/Q corner data b7: Always 0
N+1	b0 – b6: bits 7-13 of respective I/Q corner data b7: Always 0
N+2	b0 – b6: bits 14-20 of respective I/Q corner data b7: Always 0
N+3	b0 – b6: bits 21-27 of respective I/Q corner data b7: Always 0
N+4	b0 – b3: bits 28-31 of respective I/Q corner data b4 – b7: Always 0

## Format Tablet

Syntax: <SOH>**FT**<CR>

Description: Outputs the X/Y touch coordinate data in a 5-byte packet. The packet includes 1 status byte and 4 bytes of binary X/Y coordinate data. The protocol also establishes the X and Y coordinate output as 14 binary bits providing a range of 0 to 16,383.

The low order bits (X3 – X0 and Y3 – Y0) are not significant in a 1024 by 1024 sensor because data can fluctuate with each touch, and therefore may not be completely accurate.

To use Format Tablet, the controller and host system must be in an 8-bit data communication mode. The Format Tablet command returns a negative response if the controller is in 7-bit format.

Response: <SOH>**0**<CR> Positive response.

With the controller in Format Tablet mode, touching the sensor causes the controller to return a response in the following format:

*SXxYy*

*S* = Status byte, first byte of data. Refer to Table 10.

*Xx* = X (horizontal) coordinate data; second and third bytes of data.

*Yy* = Y (vertical) coordinate data; fourth and fifth bytes of data.

**Table 10 Data Sequence**

Data Sequence		MSB*		Bits				LSB*	
		7	6	5	4	3	2	1	0
S	Byte 1	1	S6	S5	S4	S3	S2	S1	S0
X	Byte 2	0	X6	X5	X4	X3	X2	X1	X0
x	Byte 3	0	X13	X12	X11	X10	X9	X8	X7
Y	Byte 4	0	Y6	Y5	Y4	Y3	Y2	Y1	Y0
y	Byte 5	0	Y13	Y12	Y11	Y10	Y9	Y8	Y7

\*MSB = Most Significant Bit, LSB = Least Significant Bit

Table 11 defines the status bits (Byte 1) for the Format Tablet data.

**Table 11 Format Tablet Status Bits**

Bit	Description	Values
S0 – S5	Reserved	—
S6	Proximity (touch state)	1 = Sensor is being touched (a touchdown or a continued touch). 0 = Sensor is not being touched (a touch liftoff or inactive). When the proximity bit changes from 1 to 0 (touch liftoff), the controller outputs one final set of X/Y coordinate data with the bit equal to 0 and the X/Y coordinate data equal to the last touch point.
S7	Packet synchronization	Always 1.

## Mode Stream

Syntax: <SOH>**MS**<CR>

Description: Sends a continuous stream of X/Y coordinate data when you touch the sensor. The controller continues to send data as long as you touch the sensor. The controller sends the data even if the touch is stationary and unchanging.

The format of the coordinate data depends on the last format command received by the controller.

Response: <SOH>**0**<CR> Positive response.

## Name Command

Syntax: <SOH>**NM**<CR>

Description: This command returns a string of characters to help identify the controller. The string contains the controller model number and current firmware revision number. The content and format of this command can change and therefore is not intended for normal customer use.

## Null Command

Syntax: <SOH>**Z**<CR>

Description: Queries the controller and waits for a response.

Use Z to determine that you are communicating with the controller or to make sure that a utility is communicating with the controller. Using this command does not affect the controller's current operating parameters.

Response: <SOH>**0**<CR> Positive response.

## Output Identity

Syntax: <SOH>**OI**<CR>

Description: Returns a 6-character random identifier, which describes the controller type and the firmware version number.

Response: <SOH>*CcXxx*<CR>

where:

*Cc* = Two ASCII characters that describe the type of 3M™ MicroTouch™ controller.

*Xxx* = Four ASCII characters that indicate a build identifier.

## Parameter Set

Syntax: <SOH>**P***pds*[*b*]<CR>

where:

*p* = Parity type  
     **N** = No parity  
     **O** = Odd parity  
     **E** = Even parity

*d* = Number of data bits (**7** or **8**).

*s* = Number of stop bits (**1** or **2**)

*b* = Communication rate  
     **1** = 19200 baud      **4** = 2400 baud  
     **2** = 9600 baud      **5** = 1200 baud  
     **3** = 4800 baud

**Description:** Lets you adjust the communication parameters (parity, data bits, and stop bits) of the controller. Optionally, you can change the communication rate by appending an additional character to the command string. Upon execution of the Parameter Set command, the controller automatically stores the new settings, the current operating mode, and the current data format in NOVRAM.

The communication parameters of the host system must match the present settings of the controller when the command is given for it to be accepted and the changes implemented.

The process of changing the parameters takes three steps:

- The host system must first communicate with the controller using a matched set of parameters.
- The Parameter Set command is issued with the new parameters to the controller. The new settings take effect immediately.
- The host system must be changed to the new parameters in order to communicate with the controller again.

**Examples:** <SOH>PN813<CR> Sets the serial line to no parity, eight data bits, one stop bit, and 4800 baud.

<SOH>PN81<CR> Sets the parity, data bits, and stop bits; leaves the baud at its previous value.

---

**Caution:** The settings are immediately written to NOVRAM, and all future communication must occur at the new values. It is possible to set the parameters to values that prevent future communication with the controller.

---

**Response:** <SOH>**0**<CR> Positive response.

## Pen/Finger

Syntax: <SOH>**PF**<CR>

Description: The default setting for the SX112 controller. It will recognize touch from either the pen or finger.

Response: <SOH>**0**<CR> Positive response

## Pen Only

Syntax: <SOH>**PO**<CR>

Description: The controller will disable finger touch and will only respond to the pen.

Response: <SOH>**0**<CR> Positive response

## Reset

Syntax: <SOH>**R**<CR>

Description: Initializes the hardware and the firmware, causes the controller to stop sending data, and recalculates the environmental conditions (for example, stray and offset values). The Reset command also cancels the Format Raw, Calibrate Raw, and Calibrate Extended commands and returns the controller to normal operation.

3M Touch Systems recommends that the host system issue a Reset command whenever the host system is powered on and is attempting to establish communication with the controller.

The amount of time needed to execute a Reset command ranges from 225 milliseconds to 800 milliseconds. Therefore, the application program should wait and be sure it receives the command response before issuing another command to the controller following the reset.

Response: <SOH>**0**<CR> Positive response.

## Restore Defaults

Syntax: <SOH>**RD**<CR>

Description: Returns to the factory default operating parameters. The Restore Defaults command copies the 3M Touch Systems factory default parameters from ROM to the non-volatile memory (NOVRAM) and then executes a Reset command.

Table 12 lists the factory defaults for the SX112 controller. The Restore Defaults command is useful in situations where inadvertent commands to the controller have rendered the sensor inoperative.

**Table 12 SX112 Serial Controller Factory Default Settings**

Operating Parameter	Default
Baud Rate	9600
Serial Communication Settings	N, 8, 1
Data Format	Format Tablet
Operating Mode	Mode Stream
Return to Factory Calibration	Yes

The Restore Defaults command requires approximately 1.8 seconds. Therefore, the application program should wait the maximum amount of time and be sure it receives the command response before issuing another command to the controller.

---

**Note:** After you issue a Restore Defaults command, you must recalibrate your sensor using a 2-point calibration.

---

Response: <SOH>**0**<CR> Positive response.

## Unit Type

Syntax: <SOH>**UT**<CR>

Description: Responds with an 8-character identity string. This string identifies the type of controller currently attached to the system, lists the features supported by the controller, and outputs the status of the controller hardware (a self-test code).

Response: Returns an identification code up to 8 ASCII characters in the following format:

<SOH>*TtFffSs*<CR>

where:

*Tt* = Two ASCII characters that identify the controller type.

**TP** = pen controller

*Ffff* = Four ASCII characters that indicate the features supported by the controller.

\*\*\*\* = Indicates no additional features configured

*Ss* = Two ASCII characters that provide status information about the controller hardware. The two characters represent one byte. Each character is in the range 0 to 9 and A to F.

Table 2 defines the meaning of each bit (LED minus 1) in the status byte. Each bit can be set to 1 or 0, where:

**1** = Error

**0** = No error

**00** = No diagnostic errors (normal response)



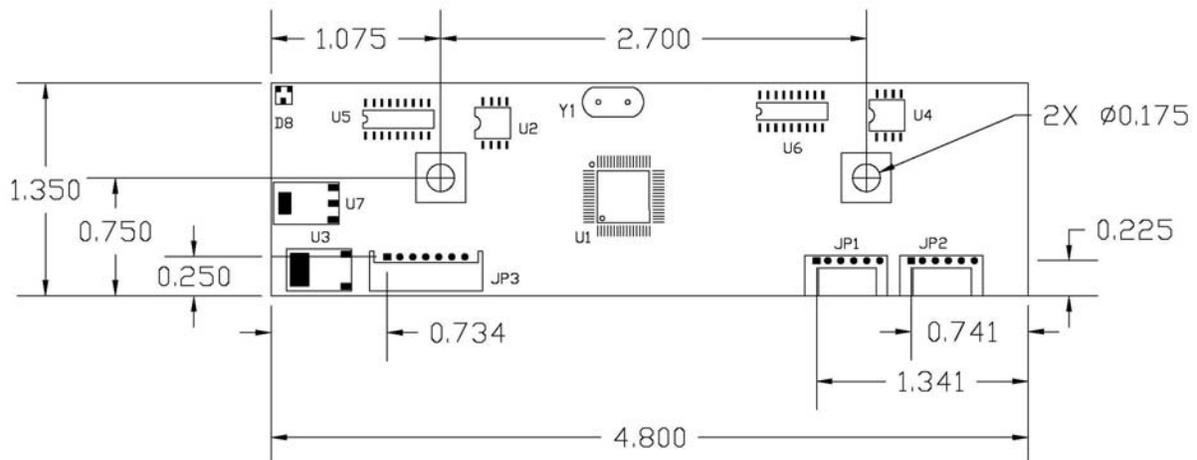
## APPENDIX A

# SX112 Controller Specifications

This section provides controller specifications such as power requirements, environmental requirements, and cable connectors.

The controller measures 1.35 x 4.8 inches with a total height profile of 0.35 inches from the thru hole pins on the trace side of the board to the top of the highest component on the opposite side. The SX112 has a touch sensor connector, a pen connector and a serial cable connector.

**Figure 2 SX112 Overall Dimensions**



## Controller Technical Specifications

### Physical Dimensions

4.80 in. x 1.35 in. x 0.032 in. (121.9 mm x 34.3 mm x 8.2 mm)

### Board Level Functions

#### Power

+12V Input: (100 mA typical, 110 mA maximum),  $\pm 5\%$  regulation, 50 mV maximum ripple and noise.

### Regulatory Requirements

CE		Compliant
Radiated Emissions – EN 55022:1998	Class B	Compliant
AC Mains Conducted Emissions – EN 55022:1998	Class B	Compliant
Telco Lines Conducted Emissions	N/A	N/A
RFI – EN 61000-4-3 / ENV 50140	Class A	Compliant
CRFI – EN 61000-4-6	Cable < 3 meters long	N/A
	Class A < 80% screen area	
	Class C < 80% screen area	
EFT (Burst Immunity) – EN 61000-4-4	Class B	Compliant
ESD Susceptibility – IEC 61000-4-2	Class 1	Compliant
Surge – EN 61000-4-5	Class B	Compliant
Harmonics – EN 61000-3-2	Class A	Compliant
Flicker – EN 61000-3-3		Compliant
Power Frequency Magnetic Field – EN 61000-4-8	Class A	Compliant
Voltage Dips – EN 61000-4-11	Class B < 5% V	
	Class C < 70% V	Compliant
Voltage Interruptions – EN 61000-4-11	Class C	Compliant
UL/cUL	Compliant	
FCC Class B / CISPR22 Class B	Class B	Compliant
VCCI Class B ITE Emissions (Japan)	Class B	Compliant
AS/NZS 3548:1995/CISPR 22 Class B ITE Emissions (Aus.)	Class B	Compliant

### Ambient Operating and Storage Environmental Conditions

(All Humidity is Non-Condensing)

Operating Temperature Range	-40°C to +70°C
Operating Humidity Range	< 36° C 0-95% RH
	$\geq 36$ °C see Figure 1 below

Storage Temperature Range	- 50 °C to +85 °C
Storage Humidity Range	< 36°C 0-80% RH ≥ 36 °C see Figure 1 below

### Performance & Reliability

Minimum Touch Duration	5.4 msec.	
Touch Resolution – (Maximum number of addressable coordinates generated by the controller)	16K x 16K	
ESD Susceptibility		
±8 kV Contact Discharge* – Class 2 per section 9 of IEC 61000-4-2 1 false touch allowed		Compliant
±27 kV Air Discharge* – Class 1 per section 9 of IEC 61000-4-2 Normal Operation – No false touches		Compliant
* ESD discharges to a 3M™ MicroTouch™ touch sensor connected to the controller		
MTBF (by MIL Std. 217F Calculation)	> 600,000 Hours	

### Touch System Parameters

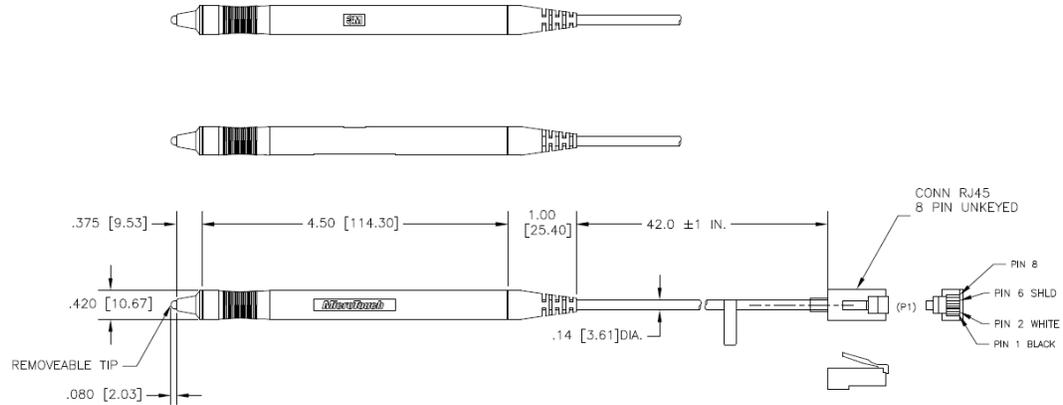
Accuracy vs. Dynamic Temperature Change (tested at 0 deg. C to 60 deg. C with a 0.5 deg. C/minute temperature ramp)	Maintains 1% Accuracy
Communications Protocol	Serial RS 232
Warranty Period	3 Years from Date of Shipment

## Pen Technical Specifications

The product specifications listed below were validated in test systems containing 3M Touch Systems' components – pen, surface capacitive sensor and SX112 controller. These specifications may not be valid if the pen is configured with components from suppliers other than 3M Touch Systems.

All components used in the manufacture of MicroTouch pens are RoHS Directive compliant (2002/95/EC).

## Physical Dimensions



## Pen Construction

Body Material	Lightly Textured ABS Plastic
Body Color	Black
Pen Cable	0.140 Diameter Shielded Cable with Strain Relief; Length = $42.0 \pm 1$ In.
Pen Connector	RJ45 8 pin Connector
Pen Tip – Conductive	Replaceable – 3M Touch Systems P/N 2604634

## Pen Cable Mechanical Specifications

Pen End – Dynamic Pull Force	Minimum 20 lb. pull force
J1 Connector End – Dynamic Pull Force	Minimum 6 lb. pull force
Pen End – Cable Flexing	Minimum of 3000 bends of $\pm 135^\circ$ from normal with an 8 oz. weight applied – bend radius of 1 inch.
J1 Connector End – Cable Flexing	Minimum of 3000 bends of $\pm 135^\circ$ from normal with an 8 oz. weight applied – bend radius of 1 inch.
J1 Connector Mating Insertions	50 Insertions; $\leq 0.2 \Omega$ Resistance Change

## Pen Performance Specifications

Power Supply Requirement	12V DC (sourced from the controller through the J1 connector)
Maximum Current Draw	5 mA (incremental to controller current draw)
Positional Accuracy	99.0% True Position Accuracy
Touch Resolution	2048 X 2048 when mated with an SX112 controller
Minimum Touch Duration	< 14 ms when mated with an SX112 controller
ESD Susceptibility	

±8 kV Contact Discharge\* - 1 “touch” allowed

Compliant with Class 2 operation per section 9 of IEC 61000-4-2

±22 kV Air Discharge\* – Normal Operation – No false touches

Compliant with Class 1 operation per section 9 of IEC 61000-4-2

\* ESD discharges to the tip and tapered end of the pen when connected to an SX112 controller

**Operating and Storage Environmental Conditions**

Operating Temperature Range	- 15 °C to +70 °C
Operating Humidity Range	< 36° C 0-90% RH
(All Humidity is Non-Condensing)	≥ 36 °C see Figure below
Storage Temperature Range	- 30 °C to +70 °C
Storage Humidity Range	< 36°C 0-90% RH
(All Humidity is Non-Condensing)	≥ 36 °C see Figure below
Agency Compliance	UL Recognized Component (UL File No. E155649)
Reliability – Mean Time To Failure	4 Million Hours MTTF -
	Calculated per Mil Handbook 217-F1 @ 35°C

**Storage and Operating Temperature with Humidity Conditions**

