3M

EX II 3000SP Controller Reference Guide

3M Touch Systems

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 touch screen controllers designed for reliability and easy installation. Each controller provides superior performance and delivers excellent stability, sensitivity, accuracy, and fast response.

This reference manual, directed to developers of touch screen systems, provides installation and configuration information for the 3M Touch Systems EX II 3000SP TouchPen touch screen controller.

This document includes information on integrating the EX II 3000SP controller into your design, communicating with the controller, installing the TouchWare user interface software, and troubleshooting setup problems. It also includes a complete description of the firmware commands, a guide to interpreting status LED conditions, and a table of controller specifications.

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 and understand 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.

Intended Use
The EX II 3000SP TouchPen controller was designed to enable touch in conjunction with other 3M Touch Systems products and was tested to replace an existing controller. This controller is intended for indoor use only and is not designed for use in hazardous locations.

⚠ **WARNING**
To avoid the risk of fire and/or explosion which could result in serious injury or property damage: ▪   Do not install or use this product in a hazardous location. ▪   Do not use this product in any outdoor environment.

Explanation of Symbols

⚠ Attention: Read accompanying documentation

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.3mtouch.com/ where you can download touch screen software and drivers, obtain regularly updated technical documentation on 3M Touch Systems products, and learn more about our company.

Whenever you contact Technical Support, please provide the following information:
- Part number and serial number from your monitor
- Current driver version
- Operating system used
- Information on additional peripherals

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

You can contact 3M Touch Systems Technical Support (US only -- Eastern Standard Time) by calling the hot line or sending a fax.
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Integrating the EX II 3000SP Controller

The 3M Touch Systems EX II 3000SP controller provides a drop-in replacement for the entire family of TouchPen controllers with all the improved features of the EX II chipset including wide dynamic range, increased noise immunity, wide operating temperature stability, reprogrammability using software utilities and inherent APAC (ungrounded) capability.

This chapter covers the following EX II 3000SP controller specifications:

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

Overview of the EX II 3000SP Touch Screen Controller

The EX II 3000SP is a form, fit and functional replacement for the TP4+ controller (64-68) with a standard RS-232 serial interface. The EX II 3000SP controller, touch screen, stylus and cables are supplied separately.
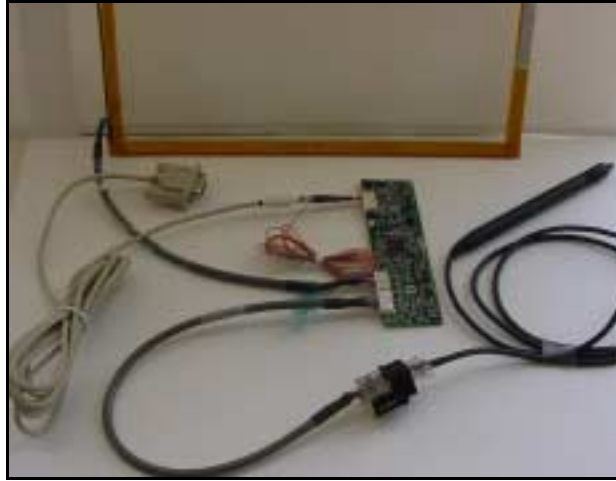
Figure 1   Components of the TouchPen System

To effectively integrate and test the EX II 3000SP controller, you will need the following items:

- A 3M Touch Systems TouchPen (P/N 69-502 with 7311420 cable extension to connect to controller). A complete integration kit is also available: P/N 69-900.

- A 3M Touch Systems touch screen

- A method of establishing the serial data communication between the controller and your system. The 3M Touch Systems RS-232 serial cable (P/N 7311273) is recommended.

- A method of supplying +12VDC internal power to the controller.

- A touch screen driver with an appropriate calibration routine.

  Note: You can use TouchWare, which includes the touch screen device driver and utilities software as the software interface.

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 EX II 3000SP has a touch screen connector, a TouchPen connector and a serial cable connector.
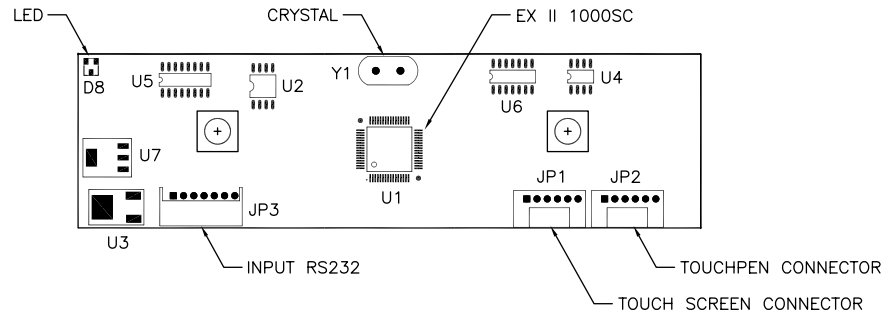
Figure 2 EX II 3000SP Connector Locations
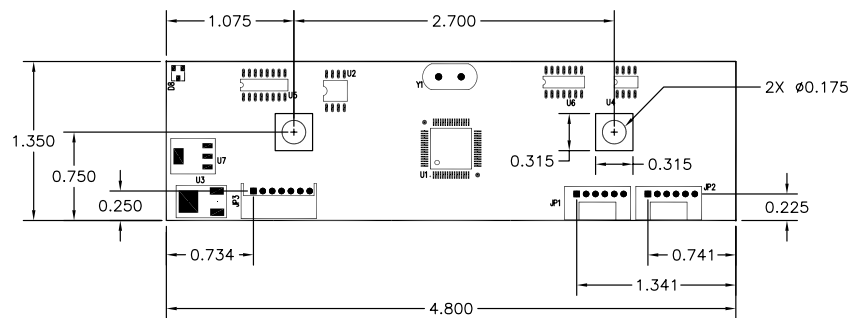
Figure 3 EX II 3000SP Overall Dimensions

Establishing the Data Connection

The EX II 3000SP controller requires that an RS-232 serial communication cable be attached to connector JP3.

You can use a 3M Touch Systems RS-232 cable (P/N 7311273). One end of this cable plugs into the RS-232 connector (JP3) on the EX II 3000SP controller. The other end, which has a 9-pin D connector, plugs into a serial COM port on your PC. Table 1 describes the interconnections for the 3M Touch Systems RS-232 cable.

Table 1 COM Cable for EX II 3000SP Controller

PC Side (9-Pin D)	Wire	Controller Side (7-Pin Molex) JP3	
Pin	Color	Pin	Description
1		NC	
2	White	4	Receive data (RXD)
3	Red	3	Transmit date (TXD)
4		NC	
5	Black	2	Ground (also connects to grey wire)
6		NC	
7		NC	
8		NC	
9		NC	
Shell		NC	
NC		1	+12V to orange wire

Mounting the Controller

The controller should be mounted on the chassis inside the monitor.

Supplying Power to the Controller

You must supply the EX II 3000SP controller with power internally (+12 VDC) through a custom serial cable configuration. Exact specifications can be found in Appendix A.

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

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 Touch Screen

There are several methods for mounting the touch screen depending on your application (CRT displays or flat panel displays, each in a variety of sizes). If you need instructions or recommendations from 3M Touch Systems on how to incorporate a touch screen into your OEM design, refer to the *Touch Screen Kits Installation Guide* (P/N 19-215) or the *Flat Panel Display Integration Reference Guide* (P/N 19-250). All 3M Touch Systems documentation is available from the corporate website at www.3Mtouch.com or from the Touch Solutions CD (P/N 19-640).

Handling and ESD Protection

When mounting the sensor and controller, use normal precautions for handling electrostatic sensitive devices. The EX II 3000SP has internal protection to 27 kV for ESD discharges that may occur during normal operation of the touch screen.

Turning On Your System

Before you turn on your custom 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 monitor 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 monitor to center the image on the screen.

The EX II 3000SP controller has a light emitting diode (LED) on one edge of the board that indicates the status of the touch screen unit.

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 Touch Systems controllers are highly reliable units; however, there may be occasions when the controller does not perform exactly as you expected. The EX II 3000SP 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 EX II 3000SP 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 screen problem.
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 screen 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.

What's Next?

Installing and Using TouchWare

TouchWare includes the software driver that lets your touch screen work with your computer. 3M Touch Systems has touch screen drivers for many operating systems, including Windows XP, 2000, 9*x*, Windows Me, Windows 3.1*x*, and Windows NT. Be sure to install the correct touch screen software for your operating system.

TouchWare also includes a control panel for setting your touch screen preferences and a diagnostic utility. If you are experiencing problems with the touch screen, you can use the diagnostic utilities provided to locate the touch screen controller and test the touch screen.

For more information on connecting your cables and installing and using the touch screen control panel and utilities, refer to the *TouchWare User's Guide (19-224)*. All 3M Touch Systems documentation is available from the corporate website at www.3Mtouch.com or from the Touch Solutions CD (P/N 19-640).

Calibrating the Touch Screen

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

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

EX II 3000SP Controller Communications

This chapter discusses the fundamentals of communicating with the EX II 3000SP controller. Firmware commands are usually issued by a driver or utility program on the host system, 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

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

Controller Default Settings

This section describes the default communications parameters, data format, and operating mode settings for the EX II 3000SP controller.

Communication Parameters

The default operation of the EX II 3000SP controller is N, 8, 1 (no parity, 8 data bits, and 1 stop bits) at 9600 baud. It also can be programmed to work with even/odd parity, 8 data bits, and 1 or 2 stop bits.

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 format for the EX II 3000SP controller operating at 8 data bits only.

- Format Tablet uses only 5 bytes per point and provides a rapid response time.

- Format Tablet includes a status byte. The status byte contains information on whether the X/Y coordinate is generated from a touchdown, a touch continuation (when the finger is resting on the screen), or a touch liftoff.

- Format Tablet is supported by all current 3M Touch Systems touch screen controllers.

- Format Tablet is the standard for current 3M Touch Systems product development and is the format used by all touch screen drivers written by 3M Touch Systems.

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 EX II 3000SP controller. In Mode Stream, the controller sends a continuous stream of data packets when the screen 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 screen driver generate an event 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.

Communicating with the Controller

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

The EX II 3000SP command set is compatible with the TP4+ controller and should not require modifications of existing software when replacing an older controller.

The commands listed in Table 3 are those that 3M Touch Systems currently uses for development. 3M Touch Systems recommends that you use only these commands for EX II 3000SP 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 screen.

The *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. See 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>

Summary of 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 screen users do *not* have to use firmware commands to use their touch systems. For example, users can use TouchWare to calibrate the touch screen 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 alters the performance of your touch screen and can render it inoperable. You should be aware of the results before executing any firmware commands.

To optimize the performance of the EX II 3000SP touch screen controller and simplify the development of custom drivers, 3M Touch Systems recommends you use the commands listed in Table 3 for current development. Using these commands ensures compatibility with all 3M Touch Systems controllers.

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

Table 3 Firmware Commands for EX II 3000SP Development

Command Name	Code	Description
Pen or Finger	PF	The controller recognizes both TouchPen and finger touch. This is the default setting.
Calibrate Extended	CX	Initiates an interactive, two-point calibration.
Calibrate Raw	CR	Collects the raw X and Y coordinates prior to normal scaling, linearization, and filtering process.
Finger Only	FO	The controller disables the TouchPen and only recognizes finger touch on the screen.
Format Raw	FR	Returns the signal level (amount of touch) of each of the four touch screen 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 screen.
Null Command	Z	Queries the controller and waits for a response.
Output Identity	OI	Identifies the controller type and the firmware version.
Pen Only	PO	The controller is set to only recognize input from the TouchPen and ignores any finger contact on the touch screen.
Reset	R	Initializes the hardware and the firmware, causes the controller to stop sending data, and recalculates the environmental conditions. Note: 2-pt calibration data is lost.
Restore Defaults	RD	Returns the controller to the factory default operating parameters. Note: the serial port is reset to N81 data format and 2-pt calibration data is lost.
Unit Type	UT	Identifies the touch screen controller on your system.

Calibrate Extended

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

Description: Initiates an interactive, two-point calibration.

During the calibration process, you define the active area of the touch screen by mapping locations to an absolute X/Y coordinate system. You touch two *target areas* on the screen. 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, users can touch the screen, move their finger to the target, hold for one second, and then lift off their finger. 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 screen each time you power on the system. You should, however, recalibrate the touch screen any time the video display changes size or resolution or gets repositioned.

- 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 monitor 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 x 1/8 = 128

- Amount to move inward in the Y direction: 768 x 1/8 = 96

The Calibrate Extended command then positions the first calibration target inward from the lower left corner (0,767) and the second calibration target inward from the upper right corner (1023,0). The following illustration shows how the calibration targets are calculated.

(0, 0)
(1023, 0) [1024, 1024]*

(895, 96) ⊕ — **Upper Right Calibration Target**
X = 1023 – (1024 x 1/8) = 1023 – 128 = 895
Y = 0 + (768 x 1/8) = 0 + 96 = 96

⊕ (128, 671)

[1024, 0]*

(0, 767) [0,0]*

Lower Left Calibration Target
X = 0 + (1024 x 1/8) = 0 + 128 = 128
Y = 767 - (768 x 1/8) = 767 - 96 = 671
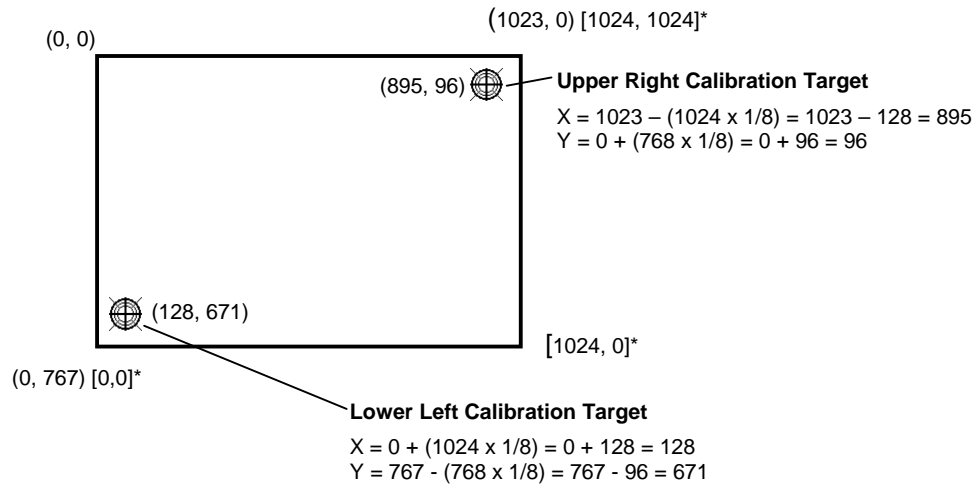
*The coordinates are in *video* terms, with the origin (0, 0) in the upper left corner of the screen. Examples from the *controller's* perspective, however, place the origin at the lower left corner of the screen (numbers in brackets). The controller outputs 0 to 1024 on both axes independent of display 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 screen 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 must start over again.

3. Touch the screen 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 EX II 3000SP controller restores the factory default calibration. 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   <SOH>**2**<CR>

Indicates that the user 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 prior to the normal scaling, linearization, and filtering processes. The controller sends the coordinates whenever a touch is detected and continues to send a stream of data as long as a finger remains in contact with the touch screen.

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, touching the screen causes the controller to return a response in the following format:

SXxYy where:
S   = Status byte, first byte of data. Refer to Table 4.
Xx = X (horizontal) coordinate data; second and third bytes of data
Yy = Y (vertical) coordinate data; fourth and fifth bytes of data.

Table 4 Data Sequence

Data Sequence	MSB* 7	6	5	Bits 4	3	2	1	LSB* 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 5 describes the meaning of the bits in the status byte (Byte 1).

Table 5 Calibrate Raw Status Bits

Bit	Description	Values
S0 – S5	Reserved	—
S6	Proximity (touch state)	1 = Touch screen is being touched (a touchdown or a continued touch). 0 = Touch screen 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.

Finger Only

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

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

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 touch screen 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 6 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 7 for I/Q Corner Components.

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 when 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 touch screen operation.

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

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

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

Table 6 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 7 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 touch screen 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

               After the controller is in Format Tablet mode, touching the screen causes
               the controller to return a response in the following format:

               SXxYy

               S   =   Status byte, first byte of data. Refer to Table 8.

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

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

Table 8 Data Sequence

		MSB*			Bits				LSB*
Data Sequence		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 9 defines the status bits (Byte 1) for the Format Tablet data.

Table 9 Format Tablet Status Bits

Bit	Description	Values
S0 – S5	Reserved	—
S6	Proximity (touch state)	1 = Touch screen is being touched (a touchdown or a continued touch).
		0 = Touch screen 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 screen. The controller continues to send data as long as you touch the screen. 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.
	Format Raw automatically uses Mode Stream to send X/Y coordinate data.
Response:	<SOH>**0**<CR> Positive response

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 identifier, which describes the controller type and the firmware version number.

Response: <SOH>*CcXxxx*<CR>

where:

Cc   =   Two ASCII characters that describe the type of 3M Touch Systems controller.

　　　　　　　P5   =   EX II 3000SP

Xxxx =   Four ASCII characters that indicate the firmware version number in decimal format. The first two characters represent the version number; the last two characters represent the revision level. For example, 0800 means Version 8, Revision 0 (that is, 8.0).

Pen/Finger

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

Description: The default setting for the EX II 3000SP controller. It will recognize touch from either the TouchPen 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 TouchPen.

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 and Calibrate Raw 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 10 lists the factory defaults for the EX II 3000SP controller. The Restore Defaults command is useful in situations where inadvertent commands to the controller have rendered the touch screen inoperative.

Table 10 EX II 3000SP 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 75 to 100 milliseconds, plus the execution time of the Reset command (225 to 800 milliseconds). Therefore, the application program should wait and be sure it receives the command response before issuing another command to the controller.

After you issue a Restore Defaults command, you must recalibrate your touch screen 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>*TtFfffSs*<CR>

                 where:

                 Tt   =   Two ASCII characters that identify the controller type.

                             TP   = TouchPen 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 (page 13) 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

EX II 3000SP Controller Specifications

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

The EX II 3000SP controller is a compact (4.8 x 1.35 x 0.35 inches), RS-232 serial controller. This controller should be internally mounted in your monitor.

The following figures show the overall dimensions of the EX II 3000SP controller and the locations of the mounting holes and connectors.
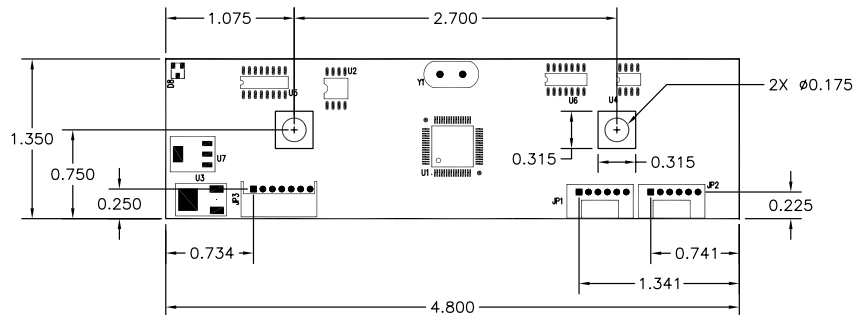
Figure 4 EX II 3000SP Touch Screen Controller

Technical Specifications

Description	Specification
Physical Dimensions	
Size	4.80 in. x 1.35 in. x 0.032 in. 121.9 mm x 34.3 mm x 8.2 mm
Weight	55 grams (1.95 oz.) 20.5 grams (0.72 oz.)
Board Level Functions	
Power:	+12V Input: (100 mA typical, 110 mA maximum), ±5% regulation, 50 mV maximum ripple and noise.
Regulatory Requirements	
CE Compliance	Compliant
EMC Emissions – EN 55022:1998	Compliant
EMC Immunity – EN 55024:1998	Compliant
ESD Susceptibility - IEC 61000-4-2	Compliant
EMI Immunity - IEC 61000-4-3	Compliant
Burst Immunity - IEC 1000-4-4	Compliant
FCC Class B / CISPR22 Class B	Compliant
VCCI Class B ITE Emissions (Japan)	Compliant
AS/NZS 3548:1995/CISPR 22 Class B ITE Emissions (Aus.)	Compliant
UL/cUL	Compliant
Operating and Storage Environmental Conditions	
Operating Temperature Range (max temp. ramp – 0.5° C/min.) (up to 95% RH from 0°C to +36°C; up to 20% RH from +37°C to +70°C)	-40° C to +70° C
Operating Temperature/Humidity	+36° C @ 95% RH
Storage Temperature Range (at up to 20% RH)	-50° C to +85° C
Performance and Reliability	
Minimum Touch Duration	3 ms
Touch Resolution – (Maximum number of addressable coordinates generated by the controller)	16K x 16K
ESD Susceptibility	
8KV Contact Discharge*	1 false touch allowed
27K Air Discharge*	Normal Operation – No false touches
* ESD discharges to a 3M Touch Sensor connected to the controller	
MTBF (by MIL Std. 217F Calculation)	>600,000 Hours
Touch Systems Parameters	
Accuracy vs. Dynamic Temperature Change (tested at 20° C to 60° C with a 0.5° C/minute temperature ramp)	Maintained 1% Accuracy
Touch Screen Compatibility	3M Touch Systems Capacitive Sensors
Communications Protocol	Serial RS 232