

3M™ MicroTouch™ EX113 Dual-Mode Controller Reference Guide

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



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Document Title: *3M™ MicroTouch™ EX113 Dual-Mode Controller Reference Guide*
Document Number: TSD-40848A

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CHAPTER 1

Introduction

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™ EX Dual Mode capacitive touch controller. This document includes information on integrating the EX Dual Mode controller into your design, communicating with the controller, 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.

Intended Use
The EX113 Dual Mode controller was designed to enable surface capacitive touch in conjunction with other 3M™ MicroTouch™ sensor products. This controller is intended for internal mounting only and is not suitable for use in hazardous locations.

Explanation of Signal Word Consequences

- ⚠ DANGER:** Indicates a potentially hazardous situation, which, if not avoided, will result in death or serious injury and/or property damage.
- ⚠ 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.
- NOTICE:** 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 sensor. 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 2

Integrating 3M™ MicroTouch™ EX Dual Mode Controllers

The 3M™ MicroTouch™ EX dual mode controller features wide dynamic range, increased noise immunity, wide operating temperature stability, reprogrammability using software utilities and improved capability in ungrounded environments.

The EX113 capacitive controller firmware is optimized for surface capacitive sensors integrated in the latest flat panel displays.

This chapter covers the following EX dual mode controller specifications:

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

Overview of the EX113 Dual Mode Controller

Note: For complete specifications for this EX dual mode controller, refer to the appendix at the end of this manual.

The EX dual mode controller and sensors are supplied separately or as a mated pair. A 25-point linearization procedure has been performed to determine the physical properties of the sensor, and the data is stored in a 2D bar code label attached to the flex tail. The linearization data must be loaded in both serial and USB modes.

The EX113 can operate in either USB or serial mode and is available in N81 Format Tablet without cable for mounting within a custom chassis.

Note: Power must always be supplied to JP3. If a USB cable is connected, the controller is in USB mode – otherwise it defaults to serial mode. Power for the controller is not derived from Vbus.

The EX ASIC has a built-in Universal Serial Bus (USB) full speed interface. A full speed USB interface has a data rate of 12 Mb/s. The USB core in the ASIC was designed to USB specification revision 1.1 but is forward compatible with revision 2.0.

To integrate and test the EX dual mode controller, you need the following items:

- A 3M™ MicroTouch™ surface capacitive sensor. These sensors are available in a variety of sizes.
- A method of establishing the serial data communication between the controller and your system. The standard 3M™ MicroTouch™ RS-232 serial cable (P/N 7310101) or USB communications cable (P/N 7319420) is recommended.
- A method of supplying power to the controller -- either internal or external.
- 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 EX dual mode controllers have internal protection to $\pm 27\text{kV}$ for ESD discharges to the sensor (not to the controller directly) that may occur during normal operation of the sensor. Refer to the appendix for further specifications.

EX Dual Mode Controller Communication Connections

The EX USB controller requires a 3M™ MicroTouch™ USB communication cable (P/N 7319420) or an equivalent interconnect. One end of this cable plugs into the USB connector (JP4) on the EX USB controller. The other end plugs into a USB port on your PC with a Type-A connector. Table 1 describes the interconnections of the 3M™ MicroTouch™ USB cable.

Table 1. USB Cable for EX USB Mode

PC Side (USB Type A)		Wire	Controller Side (5-Pin Molex)	
Pin	USB Assigned	Color	Pin	Description
1	+5VDC	Red	1	+5VDC input power
2	Data (DN)	Gray	2	Data (DN) differential pair
3	Data (DP)	Green	3	Data (DP) differential pair
4	0V	Black	4	Power return
5	Cable Shield Shell	Charcoal Gray	5	Outer cable shield around signal and power lines. Chassis (earth) ground

If you choose serial communications, 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). The following table describes the pins for this cable, which connects to a serial communication (COM) port on the PC.

Table 2. COM Connections for EX Serial Mode

9-pin D	7-pin Molex	Wire Color	Description
1	No connection	————	Data Carrier Detect (DCD). Connected to DTR and DSR.
2	2	Brown	Transmit Data (TXD). Pin 2 is the controller's output to the host.
3	3	Red	Receive Data (RXD). Pin 3 is the controller's receive from the host.
4	No connection	————	Data Terminal Ready (DTR). Connected to DSR and DCD.
5	5	Blue	Power supply ground.
6	No connection	————	Data Set Ready (DSR). Connected to DTR and DCD.
7	1	Black	Request To Send (RTS). Connected to CTS.
8	4	Green	Clear To Send (CTS). Connected to RTS.
9	Not used		
Sleeve	6	White	DC power jack (+5 VDC).
Pin	7	Shield	Cable shield connected to ground DC power jack (ground)
Shell	7	————	Chassis (earth) ground.

EX113 Sensor Cable Connections

The sensor cable has a 5-pin single row locking female connector that plugs into the controller. The following table describes the pins on this connector.

Table 3. Sensor Flex Tail Connector for EX113 dual-mode controllers

Pin	Description
1	Upper left (UL) corner
2	Upper right (UR) corner
3	Connects to the flex tail shield, which must <i>not</i> be grounded because the EX113 drives the flex tail shield with an AC waveform.
4	Lower right (LR) corner
5	Lower left (LL) corner

Mounting the Controller

The controller is mounted internally. Choose a convenient spot away from high-voltage, high power cables and electronics. Use 4-40 metal screws to mount the controller.

The controller should be mounted in line with the sensor flex tail exit point to minimize flexing. Refer to Figure 1 for more details on controller mounting.

Note: To avoid possible damage to one or both of the power supplies, do not supply both internal power and external power to the controller. Power from two sources could cause damage.

Using an Internal Power Supply (+5V to +12V) to JP3

Provide power directly to the controller using JP3 (Molex 22-05-3021). Use a mating 2-pin connector and connect Pin 2 to power (between +5V and +12V) and Pin 1 to the return. (Mating connector is the Molex housing 22-01-3027 with 08-50-0114 contacts).

Using a Custom Serial Cable Design

When creating a custom serial cable connection, you can provide power to the controller through JPI. Refer to Table 1 for more information on actual cable connections.

1. Obtain a 7-pin Molex connector 51004-0700.
2. Attach power and ground to the connector, (Pin 6: +5V to +12V, Pin 7: Ground).

Using an External Wall-Mount Power Supply

If you are using a standard 3M™ MicroTouch™ RS-232 serial cable (P/N 7310101), consult your applications engineer for power supply specifications.

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 3nnnEX Integration Guide* (P/N TSD-19-278). All 3M Touch Systems documentation is available from the corporate website at 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.

Note for USB mode: If the driver has been previously loaded, the controller will enumerate and the PC will beep when hot plugging the controller into a USB port. When disconnecting the controller, the PC will beep again.

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 EX dual mode controller provides diagnostic feedback with a light emitting diode (LED) on the component side of the board that indicates the status of the touch system.

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 as long as a touch is detected.

A flashing (or blinking) LED during power-up indicates the controller's power-on self-test failed. Refer to Table 4 for a description of each error code.

Table 4. LED Diagnostic Codes for the Dual-Mode Controller

Self Test Condition	LED Flashes	Self Test Bit	Description	What to do...
RAM Data Error ²	1	0	Data side checksum error	Reload program code.
RAM Code Error ²	2	1	Firmware EEPROM checksum verification error	Reload program code.
STRAY Error ¹	3	2	Unable to initialize stray cancellation	Replace controller. If error reoccurs, might be a sensor problem.
NOV Error ³	4	3	Parameters invalid (using defaults)	Restore defaults. If fault persists, replace controller. If error reoccurs, might be a sensor or cable problem.
HDW Error ¹	5	4	Controller hardware failure (phase/gain initialization)	Cycle power. If fault persists, replace controller.
Reserved	6	5	Reserved	
Reserved	7	6	Reserved	
NOV2 Error	8	7	Controller NOVDRAM linearization data invalid	Replace sensor or perform a 25-point linearization. Contact Technical Support.
Reserved	9	8	Reserved	
EEPROM Error ²	10	9	EEPROM is not working	Reload program code.
NOV5 Error	11	10	Controller ID is not valid	Restore defaults. If fault persists, replace controller.
NOV6 Error	12	11	Interface configuration values are not valid	Restore defaults. If fault persists, replace controller.
NOV7 Error	13	12	Touch configuration values are not valid	Restore defaults. If fault persists, replace controller.
Reserved	14	13	Reserved	
Resistance Error	15	14	Sensor resistance is out of supported range	Cycle power. If fault persists, replace sensor.

Self Test Condition	LED Flashes	Self Test Bit	Description	What to do...
Backplane Error	16	15	Low resistance path from backplane to sensor	Cycle power. If fault persists, replace sensor.
Corner Error	17	16	Corner drive offset level is too high	Cycle power. If fault persists, replace controller.
Fixed Cal Error	18	17	Fixed 2-point cal error high	Cycle power. If fault persists, replace controller.

Note 1: this is a fatal error.

Note 2: this error is detected by the ROM code

Note 3: indicates that the EEPROM is not formatted when given by the ROM code

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® 7, Windows® Vista, Windows® XP, Windows® XP embedded, Windows® CE, and Linux® (Kernel 2.6) (refer to the website for a complete listing). You must be sure to install the correct software for your operating system.

3M™ MicroTouch™ Touch Solutions include 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.

CHAPTER 3

3M™ MicroTouch™ EX USB Communications

This chapter discusses the fundamentals of communicating with the 3M™ MicroTouch™ EX113 Dual-Mode controller in USB mode. 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 USB Firmware Commands

Developers may use these USB 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 USB standards and modes of communication with USB 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™ EX USB 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.

Communicating with the Controller

This section provides information on sending firmware commands to the controller and interpreting the responses that the controller returns. The default operation of the EX USB controller is USB Rev 1.1 compliant.

The USB command set is implemented by using vendor requests and vendor reports, i.e., vendor specific transactions.

You need to know product ID (1 for normal mode and 2 for special mode) and the vendor ID (0596H) to write your own driver.

The EX USB controller is command set compatible with previous generation MicroTouch™ USB controllers. Modifications of existing software should not be necessary when replacing an older controller.

The following commands are those that 3M Touch Systems currently uses for communications. 3M Touch Systems recommends that you use only these commands for 3M™ MicroTouch™ EX USB controller communications.

Vendor Requests

The following list summarizes the six available vendor requests:

- Request 4 Calibrate
- Request 6 Status
- Request 7 Reset
- Request 8 Restore Defaults
- Request 10 Controller ID
- Request 16 Read Parameter

Sending Commands to the Controller

Table 5. General Format for Vendor Requests

Offset	Field	Size	Value	Description
0	bmRequestType	1	d1000000	Characteristics of request [dir, type, recipient] D7: Data Transfer Direction 0 = Host-to-device 1 = Device-to-host D6... 5 Type 0 = Standard 1 = Class 2 = Vendor 3 = Reserved D4...0 Recipient 0 = Device 1 = Interface 2 = Endpoint 3 = Other 4...31 = Reserved
1	bRequest	1	0xXX	Specific request [our command number]
2	wValue	2	0xFFFF	Used to specify command parameters
4	wIndex	2	0xFFFF	Used to specify command parameters
6	wLength	2	0xFFFF	Number of bytes to transfer

The Type field should be set to Vendor (0x10). The Recipient field should be set to Device. The Direction field depends on the command.

Receiving Reports from the Controller

Four reports can be sent from the controller to the host. These reports fit into two categories: those sent immediately in response to a host request (synchronous) and those sent when updates to the data they contain become available (asynchronous).

Synchronous reports:

- Report 4 Parameter Data
- Report 6 Status
- Report 12 Controller ID

Asynchronous reports:

- Report 1 Coordinate Data

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.

Controller Initialization

To initialize the EX USB controller, 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.

Coordinate Data Report 1

Coordinate Data Report 1 is used to transfer both the raw and adjusted coordinate data to the host. This report, when activated, is sent to the host whenever new data is available. It is an asynchronous report activated by default at power up.

Table 6. Coordinate Data Report

Offset	Field	Size	Value	Description
0	Report ID	1	0x01	USB report ID number
1	Loop Counter	1	0xXX	Report synchronization
2	Status byte	1	0xXX	Pen/finger touch status
3	X Compensated	2	0xFFFF	Compensated X coordinate
5	Y Compensated	2	0xFFFF	Compensated Y coordinate
7	X Raw	2	0xFFFF	Raw X coordinate
9	Y Raw	2	0xFFFF	Raw Y coordinate

The main purpose of the loop counter is to effectively put a time stamp on the output data. Data produced in the same tick will have the same timestamp. This can be used to match the final coordinate data with other data that was used to produce it. This is not a sequential number.

The status byte contains information pertaining to whether the sensor is being touched.

Table 7. Touch Status

Bit	Description
7	Always 1
6	Proximity 1 when touching 0 when not touching
5	Reserved
4	Reserved
3	Reserved
2	Reserved
1	Reserved
0	Reserved

The raw X and Y coordinate data are generated directly from the sensor. The range of values is -8192 to 8191. The X and Y adjusted coordinate data is derived by applying calibration information. The range of values is 0 to 65,535. Coordinate data is sent LSB first.

Operating Mode

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

Report 1 enabled is the default operating mode for the EX USB controller. In Report 1, 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 Report 1 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 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.

Calibration Request 4

This is a request to perform a 2-point calibration. The calibration can be performed at points inset from the lower left and upper right corners (extended calibration) or it can be done at those corners. This is equivalent to the Calibrate Extended (12.5% insets from the lower left and upper right corners) command used by 3M™ MicroTouch™ serial controllers. The 2-point calibration defines the active area of the sensor by mapping two targets displayed on the video image to absolute X and Y coordinates on the sensor.

Table 8. Calibration Request

Offset	Field	Size	Value	Description
0	bmRequestType	1	01000000	Characteristics
1	bRequest	1	4	Command number
2	wValue	2	0xXXXX	Calibration type
4	wIndex	2	0x0000	Not used
6	wLength	2	0	No data phase

The direction bit in bmRequestType has been set to 0 (host-to-device). This request does not require that the device return any data. The byte bRequest is set to 4 to indicate that this is the calibration command.

The wValue field is used to select the type of calibration to be performed. This value can be either 1 for Extended (or Inset) or 2 for Corner.

The controller does not use the wIndex field. This field should be set to zero to ensure future compatibility.

Response

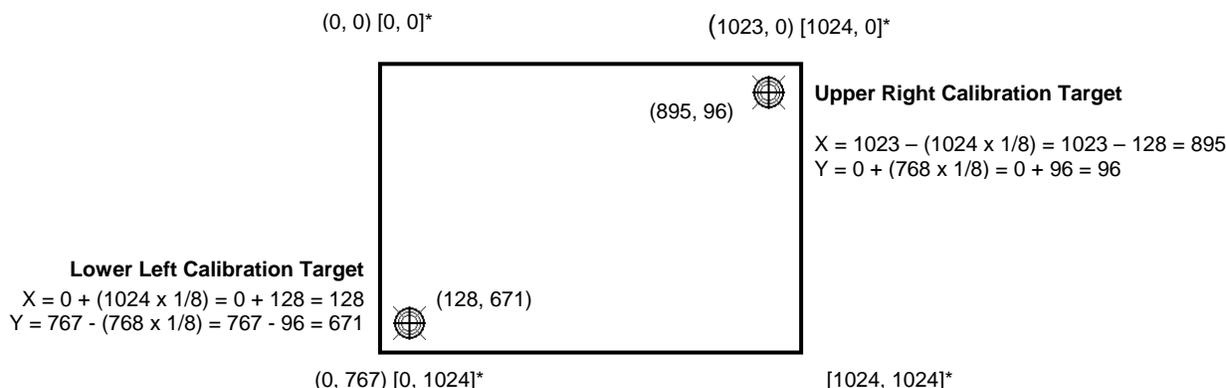
The device stalls endpoint 0 if the request cannot be processed successfully. The host should issue status requests to determine the status of this request. A command status of 1 indicates that the controller is waiting for a touch in the lower left quadrant. A status of 2 indicates that the lower left touch has been completed and the controller is waiting for a touch in the upper right quadrant. A status of 3 indicates that the upper right touch has been completed. A status of 0 indicates that the request has failed. A soft reset command should be sent if the host wishes to terminate calibration.

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 resolution of your Windows-based 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 (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 for a Windows-based system. Your operating system may be different.



*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.

Controller Status Request 6

This is a request to send information that indicates the status of the controller. Use this request to determine whether there were any power on check errors and whether the last request was completed successfully.

The Controller Status Request is used to poll the controller for command completion when a previous USB request involved a controller reset. Refer to the Reset Request 7 for additional details.

Table 9. Controller Status Request

Offset	Field	Size	Value	Description
0	bmRequestType	1	11000000	Characteristics
1	bRequest	1	6	Command number
2	wValue	2	0x0000	Not used
4	wIndex	2	0x0000	Not used
6	wLength	2	0xXXXX	Size of status report

The direction bit in bmRequestType has been set to 1 (device-to-host) to return the status report.

The byte bRequest is set to 6 to indicate that this is a Controller Status request.

The controller does not use the wValue and wIndex fields. These fields should be set to zero to ensure future compatibility.

The wLength field indicates the size of the Controller Status report.

Response

When the request is processed, the device returns a Controller Status report.

The device stalls endpoint 0 if the request cannot be processed successfully. This would happen if the report length requested by wLength does not match the controller status report size.

Controller Status Report 6

This report contains information describing the status of the controller. The report sent is determined by the size specified in the wLength field of the Status Request.

All multi-byte quantities in this report are sent LSB first.

Standard Format Status Report

This version of the Status report will be sent if the EX compatible driver asks for the 8-byte Status report. This version is simply the first 8 bytes of the controller Status report.

EX Controller Status Report

This version of the Status report is only compatible with the EX USB controller. This version is sent when the larger (20-byte) Status report is requested.

Table 10. Expanded Status Report

Offset	Field	Size	Value	Description
0	Report ID	1	0x06	Report ID number
1	POC Status	2	0xXXXX	Power On Check Status
3	Cmd Status	1	0xXX	Status of last command
4	Touch Status	1	0xXX	Finger Up/Down

Offset	Field	Size	Value	Description
5	Asynch Reports	2	0xXXXX	Active asynchronous reports
7	Reserved	2	0xXXXX	Reserved
9	Extended POC Status	2	0xXXXX	Additional Power On Check Status
11	Reserved	9	9 bytes	Reserved

POC Status – The status of the Power On Checks. Various controller systems are checked at power-up. If any failures in these systems are detected, a POC flag is set. The POC status field reports the state of these flags. The POC status information is also flashed on the controller’s LED. The number of flashes generated for a given error is one more than the error’s bit number. Refer to the following table for further details. This is a 2-byte bitmapped field.

Cmd Status – The status for the last command request. This field is used to determine whether the last request was processed successfully. It is also used to track the progress of a multi-stage request, such as 2-point calibration. The Status Request does not affect the contents of this field, i.e., successful or unsuccessful processing of a previous status request does not cause the command status field to be updated.

Table 11. Valid Command Status Field Entries

Response	Description
0	Failure in command processing
1	Command being processed
2	Stage 1 processing complete (for multi-stage commands)
3	Command complete
4	Soft reset occurred
5	Hard reset occurred

Touch Status – Status information for the most recent touch coordinate.

Table 12. Touch Status

Bit Number	Description
0	1 if the sensor is being touched
1 - 7	Reserved

Async reports – the only active asynchronous report is the Touch Coordinate report 1.

Extended POC Status – This is additional power on status information. This is a 2-byte bitmapped field.

Table 13. Extended POC Status

Bit Number	Description
0	Corner drive offset level is too high
1	Fixed 2-point calibration error high
2 - 15	Reserved

Reset Request 7

This is a request to perform a controller reset. The standard hard or soft reset can be requested. Soft resets are generally required for any parameter changes to take effect. A soft reset results in the touch application using its initial (start-up) values.

Table 14. Reset Request

Offset	Field	Size	Value	Description
0	bmRequestType	1	01000000	Characteristics
1	bRequest	1	7	Command number
2	wValue	2	0xXXXX	Reset type
4	wIndex	2	0x0000	Not used
6	wLength	2	0x0000	No data phase

The direction bit in bmRequestType has been set to 0 (host-to-device).

The byte bRequest is set to 7 to indicate that this is a Reset request.

The wValue field is used to select the type of reset to be performed -- 1 for Soft Reset and 2 for Hard Reset.

The wIndex field is not used. This field should be set to zero to ensure future compatibility.

The wLength field is set to zero since there is no data phase for this request.

Response

Since the time to complete the soft reset can be more than 500 ms, the device acknowledges the request before it is completed. The host must issue a status request to determine whether the reset request was completed. The command status field of the status report will be set to “command in progress” while the soft reset is occurring. The field will change to “soft reset occurred” when the reset has completed. Any other request issued while the reset is still in progress will be ignored.

The hard reset is executed immediately upon decoding of this request. The reset sequence begins by simulating a device disconnect from the host. A re-connect is then performed and the device must re-enumerate its connection with the host. Because of this, a response to the request cannot be sent prior to, or even after, the beginning of the reset sequence.

The host should issue status and ID requests after the reset has completed to verify whether this request was handled properly by the device. The status request should be used to determine when the hard reset occurred. The ID request is used to verify that the controller is now in the desired mode by looking at the contents of the controller type field.

The device stalls endpoint 0 if the request cannot be processed successfully. The request cannot be processed if the reset type specified by the wValue field is not valid.

EX Controller Compatibility Issues

The hard reset did not use a device disconnect as part of the reset process for the previous 3M™ MicroTouch™ USB controller. The disconnect causes the driver to unload and will result in any handles to the driver that an application may have becoming invalid. An application should handle an unplug event.

Restore Defaults Request 8

This is a request to restore the default values in the controller. This is used to restore the values to the factory presets.

A soft reset is automatically done after completing the request so that parameter changes will take effect.

Table 15. Restore Defaults Request

Offset	Field	Size	Value	Description
0	bmRequestType	1	01000000	Characteristics
1	bRequest	1	8	Command number
2	wValue	2	0x0000	Reserved
4	wIndex	2	0x0000	Reserved
6	wLength	2	0x0000	No data phase

The direction bit in bmRequestType has been set to 0 (host-to-device). This request does not require that the device return any data.

The byte bRequest is set to 8 to indicate that this is the Restore Defaults request.

The wValue field should be set to 0 for future compatibility.

The wIndex field should be set to 0 for future compatibility.

Response

The device stalls endpoint zero if it cannot process this request. The request will fail if any of the fields are not set correctly.

When the request is processed successfully, a positive USB acknowledge (zero length data packet) is sent.

A soft reset will be done at the completion of this request. Because of this, the controller must be polled to determine when the reset is done (see Reset Request for details).

Controller ID Request 10

This is a request to send various pieces of information that identify the controller, including the controller type and firmware revision level. The key use for this request is in identifying the mode that the controller is running in and the revision level of the ASIC firmware.

Table 16. Controller ID Request

Offset	Field	Size	Value	Description
0	bmRequestType	1	11000000	Characteristics
1	bRequest	1	10	Command number
2	wValue	2	0x0000	Not used
4	wIndex	2	0x0000	Not used
6	wLength	2	0xXXXX	Length of ID report

The direction bit in bmRequestType has been set to 1 (device-to-host) to return the Controller ID report.

The byte bRequest is set to 10 to indicate that this is Controller ID request.

This request does not use the wValue or wIndex fields. These fields should be set to zero to ensure future compatibility.

The wLength field is set to the size (either 18 or 24 bytes) of a Controller ID report.

Response

The controller sends the Controller ID report when the request is processed successfully.

If the request cannot be processed, endpoint 0 will be stalled. The request cannot be processed if the requested report size (wLength) does not match either the size of the backward compatible ID report (18) or the EX report (24).

Controller ID Report 12

This report contains information describing the controller, including its type, firmware revision, special features, and the ROM checksum. This report is sent via the control endpoint.

All multi-byte quantities in this report are sent LSB first.

Standard Format Controller ID Report

This version of the Controller ID report will be sent if the EX compatible driver asks for the 16-byte Controller ID report size. This version contains the first 16 bytes of the EX Controller ID report.

EX Controller ID Report

This version of the Controller ID report is only compatible with the EX USB driver. This version is sent when the larger (24-byte) Controller ID report is requested.

Table 17. Expanded Controller ID Report

Offset	Field	Size	Value	Description
0	Report ID	1	0x0C	Report ID number
1	Controller type	2	0xXXXX	Indicates the type of controller

Offset	Field	Size	Value	Description
3	FW major revision	1	0xXX	Firmware major revision level
4	FW minor revision	1	0xXX	Firmware minor revision level
5	Features	1	0xXX	Special features
6	Constants Checksum	2	0XXXXX	RAM constants checksum
8	Max Param Write	2	0xFFFF	Maximum data for Read Parameter request
10	Reserved	1	0x41	Reserved
11	Reserved	1	0x41	Reserved
12	Reserved	1	0x41	Reserved
13	Reserved	1	0x41	Reserved
14	Reserved	1	0x41	Reserved
15	Reserved	1	0x42	Reserved
16	Reserved	1	0x41	Reserved
17	Reserved	1	0x41	Reserved
18	Code Checksum	4	0XXXXXXXX	RAM Program Code checksum
22	ASIC type	2	0x01XX	ASIC type

Controller Type – The identifier M1 is used. M identifies it as an EX based USB controller. The 1 identifies it as the first model of this type. This value is treated as an integer, not two characters. This means that the 1 will be transmitted first.

Note: If you received an identifier of M0, you must issue a Reset with a wValue of 5. This must be done twice to lock in the values.

FW Major Revision – This can range from 0 to 99. This is a BCD value, i.e., major revision 23 is sent as 0x23.

FW Minor Revision – This can range from 0 to 99. This is a BCD value, i.e., minor revision 23 is sent as 0x23.

Features – This identifies the special features of the controller. This is a bitmapped field.

Constants Checksum – 2-byte checksum for the constants data section.

Max Parameter Write -- The largest transfer that can take place. This only affects the Read Parameter requests.

Code Checksum – 4-byte checksum for the program section of the code.

ASIC Type – this indicates the type and version of the ASIC in the controller. The value 0x0100 indicates the first EX revision. The high byte is used to note major ASIC changes, such as a new ASIC family, and the low byte indicates changes within a family.

Read Parameter Request 16

This is a request to send the contents of a parameter via the control endpoint. This is a one-time transfer of data. The request is used to access data in the controller.

This request provides a means for reading the configuration parameters. The request uses parameter numbers to determine what data is being requested and where that data is located.

Table 18. Read Parameter Request

Offset	Field	Size	Value	Description
0	bmRequestType	1	11000000	Characteristics
1	bRequest	1	16	Command number
2	wValue	2	0xFFFF	Parameter number
4	wIndex	2	0x0000	Not used
6	wLength	2	0xFFFF	Length of Parameter Data report

The direction bit in bmRequestType has been set to 1 (device-to-host) to return the contents of the requested parameter.

The byte bRequest is set to 16 to indicate that this is the Read Parameter request.

The wValue field is set to the number of the parameter being requested.

This request does not use the wIndex field. This field should be set to zero to ensure future compatibility.

The wLength field is the number of bytes being sent by the device to the host. The data is returned to the host in the format of the Parameter Data report, which has a 3-byte header, so 3 must be added to the number of parameter bytes desired. The following table lists the parameters currently supported and the appropriate settings for the request fields.

Table 19. Supported Parameters

Parameter (wValue)	wIndex	wLength (bytes+3)	Range	Description
0	0	0	0	Reserved for future use
1	0	5	0 – 3	Sensor orientation - where the lower left corner of the display maps to the sensor. 0000 – Upper right 0001 – Lower right 0002 – Upper left 0003 – Lower left (standard, not rotated)
2	0	7	0 – 2 ³² -1	Controller serial number

Response

The parameter data is sent to the host in a Parameter Data report. All parameter data is treated as if it were stored as bytes. This means that multi-byte values will be sent MSB first.

If the command cannot be processed, the device stalls endpoint 0. The command cannot be processed if the parameter number is not valid. It cannot be processed if less than 4 bytes (wLength) are requested. It cannot be processed if more data is requested than is contained in the parameter.

Parameter Data Report 4

This report is sent in response to any request for parameter data. All parameter data is treated as if it were stored as bytes in the order that it is stored in memory. This means that multi-byte values will be sent MSB first.

Table 20. Parameter Data Report

Offset	Field	Size	Value	Description
0	Report ID	1	0x04	Report ID number
1	Data size	2	0xFFFF	Amount of data to follow
3	Data bytes	Data Size	0xFF	Data bytes

Data size – the number of data bytes to follow.

Data byte – At least 1 data byte will follow when data size is greater than zero. The number of data bytes returned by this report is limited by the “Max Param Write” value returned by the Controller ID report. The contents of this data section are dependent on which parameter is being accessed.

CHAPTER 4

3M™ MicroTouch™ EX Serial Communications

This chapter discusses the fundamentals of communicating with the 3M™ MicroTouch™ EX serial 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™ EX 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 EX serial controllers is N81 (no parity, 8 data bits, and 1 stop bits) at 9600 baud. Some EX113 dual-mode controllers can be programmed to work with even/odd parity, 7 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 default format for the 3M™ MicroTouch™ EX serial 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 EX serial 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™ EX serial 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 EX 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 the following table 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 21. Firmware Commands for EX Serial 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.
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	Ppds[b]	Lets you adjust the communication parameters (parity, data bits, and stop bits) of the controller.
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 Verify	UV	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 calibration routine 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:

- 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 EX113 dual-mode 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 the following table.

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

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

Table 22. 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

The following table describes the meaning of the bits in the status byte (Byte 1).

Table 23. 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.

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 the following table 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 the following table 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 24. 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 25. I/Q Corner Components

Byte	Bits 0 – 7
N	b0 – b6: bits 25-31 of respective I/Q corner data b7: Always 0
N+1	b0 – b6: bits 18-24 of respective I/Q corner data b7: Always 0
N+2	b0 – b6: bits 11-17 of respective I/Q corner data b7: Always 0
N+3	b0 – b6: bits 4-10 of respective I/Q corner data b7: Always 0
N+4	b0 – b3: bits 0-3 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 the following table.
 Xx = X (horizontal) coordinate data; second and third bytes of data.
 Yy = Y (vertical) coordinate data; fourth and fifth bytes of data.

Table 26. 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

The following table defines the status bits (Byte 1) for the Format Tablet data.

Table 27. 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.

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>*CcXxxx*<CR>

where:

Cc = Two ASCII characters that describe the type of 3M™ MicroTouch™ controller.
Xxxx = Four ASCII characters that indicate a build identifier.

Parameter Set

Syntax: <SOH>**Ppds**[*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

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.

The following table lists the factory defaults for the EX serial controller. The Restore Defaults command is useful in situations where inadvertent commands to the controller have rendered the sensor inoperative.

Table 28. EX 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 Verify

Syntax: <SOH>**UV**<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.

QM = Serial controller

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

R= Indicates a resistive controller

V= Indicates the serial 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 4 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)

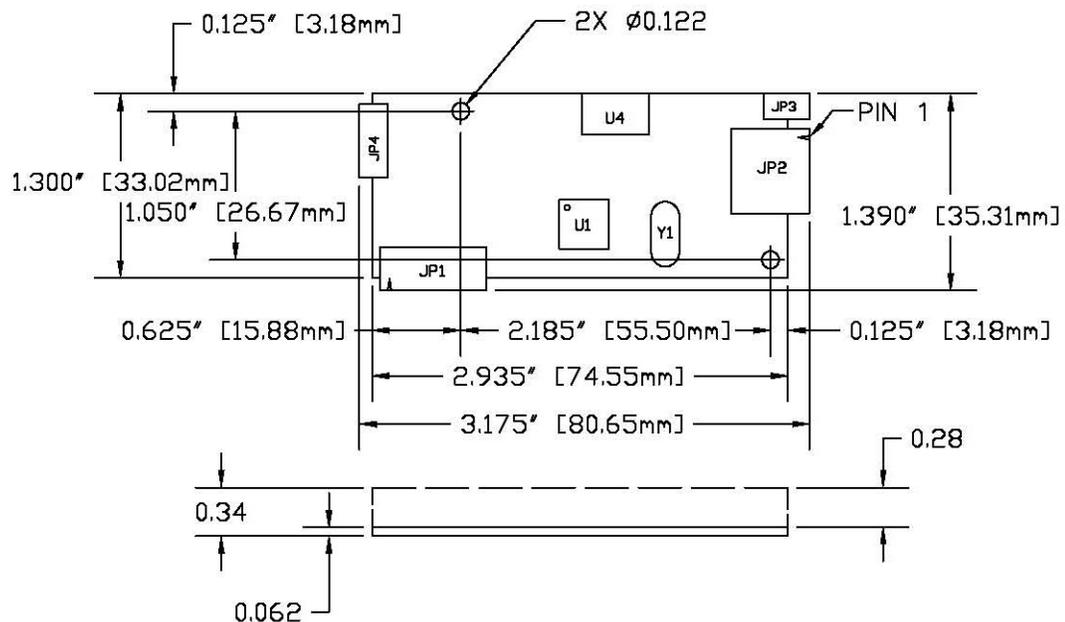
APPENDIX A

EX113 Dual-Mode Controller Specifications

This section provides EX113 dual-mode controller specifications such as power requirements, environmental requirements, and cable connectors.

The EX113 dual-mode controller is a compact (3.175 x 1.30 x 0.45 inches) controller for internal mounting in your display. The following figure shows the overall dimensions of the EX113 dual-mode controller and the locations of the mounting holes and connectors.

Figure 2. EX113 Touch Controller



Technical Specifications

The controller specifications listed below were validated in test systems containing 3M Touch Systems components. These specifications may not be valid if configured with components from suppliers other than 3M Touch Systems. All components in the manufacture of electronic controllers are RoHS Directive compliant (2002/95/EC).

Physical Dimensions

3.175 x 1.30 x 0.45 inches (80.65 mm x 33.02 mm x 11.4 mm)

Board Level Functions

Power

- 5 VDC (80 mA typical, 100 mA maximum); $\pm 5\%$ regulation 50 mV_{pp} maximum ripple and noise
- 12 VDC (85 mA typical, 100 mA maximum); $\pm 10\%$ regulation 50 mV_{pp} 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
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
RFI – EN 61000-4-3 / ENV 50140	Class A		Compliant
CRFI – EN 61000-4-6			
Communications cable < 3 meters long	N/A		N/A
AC Mains	Class A	< 80% Screen Area	Compliant
AC Mains	Class B	$\geq 80\%$ Screen Area	Compliant
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% Voltage	Compliant
	Class C	< 70% Voltage	Compliant
Voltage Interruptions – EN 61000-4-11	Class C		Compliant
TUV			Compliant

Ambient Operating and Storage Environmental Conditions

Note: All humidity is non-condensing

Operating Temperature Range		-40 °C to +70 °C
Operating Humidity Range	< 36° C 0-95% RH	≥ 36 °C (refer to Figure 3)
Storage Temperature Range		-50 °C to +85 °C

Storage Humidity Range < 36°C 0-80% RH ≥ 36 °C (refer to Figure 3)

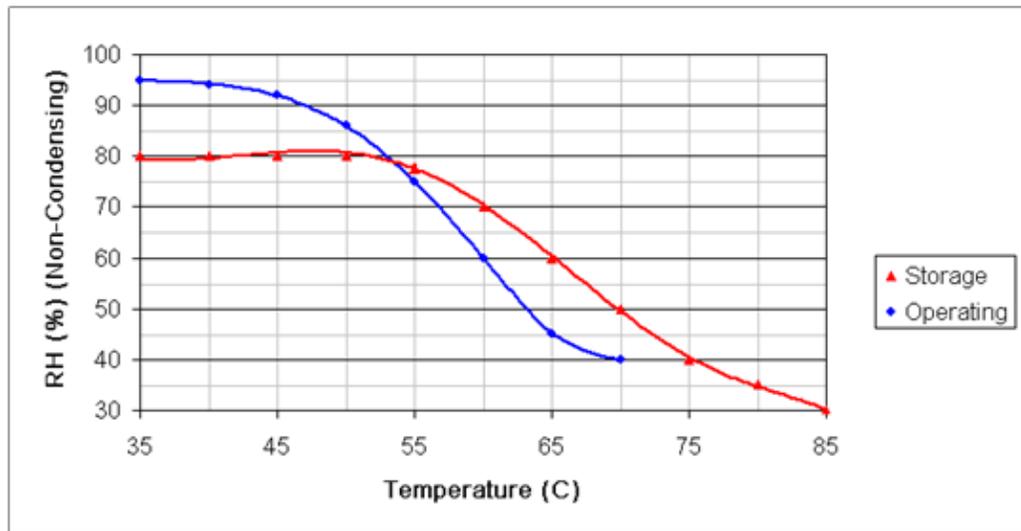
Performance and Reliability

Minimum Touch Duration	5.4 msec.
Touch Resolution – (Maximum addressable coordinates generated by the controller)	16K x 16K
ESD Susceptibility ¹ -	
±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	Compliant
Normal Operation – No false touches	
MTBF (by MIL Std. 217F Calculation)	740,000 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 99.0% Accuracy
Sensor Compatibility	3M™ MicroTouch™ Capacitive Sensors
Communications Protocol	USB or serial RS 232

Figure 3. Storage and Operating Temperature with Humidity Conditions



¹ ESD discharges to a 3M™ MicroTouch™ sensor connected to the controller