



SC400 Serial Resistive Controller Reference Guide

3M Touch Systems

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

The information in this document is subject to change without notice. No part of this document may be reproduced or transmitted in any form or by any means, electronic or mechanical, for any purpose, without the express written permission of 3M Touch Systems. 3M may have patents or pending patent applications, trademarks, copyrights, or other intellectual property rights covering subject matter in this document. The furnishing of this document does not give you license to these patents, trademarks, copyrights, or other intellectual property except as expressly provided in any written license agreement from 3M Touch Systems.

The information provided in this document is intended only as a guide. For the latest detailed engineering specifications, please contact your 3M Touch Systems Application Engineer. 3M Touch Systems is committed to continually improving product designs, as a result, product specifications may be subject to change without notification.

NOTICE: Given the variety of factors that can affect the use and performance of a 3M Touch Systems Product (the “Product”), including that solid state equipment has operation characteristics different from electromechanical equipment, some of which factors are uniquely within User’s knowledge and control, it is essential that User evaluate the 3M Touch Systems Product and software to determine whether it is suitable for User’s particular purpose and suitable for User’s method of application. 3M Touch Systems’ statements, engineering/technical information, and recommendations are provided for User’s convenience, but their accuracy or completeness is not warranted. 3M Touch Systems products and software are not specifically designed for use in medical devices as defined by United States federal law. 3M Touch Systems products and software should not be used in such applications without 3M Touch Systems’ express written consent. User should contact its sales representative if User’s opportunity involves a medical device application.

IMPORTANT NOTICE TO PURCHASER: Specifications are subject to change without notice. These 3M Touch Systems’ Products and software are warranted to meet their published specifications from the date of shipment and for the period stated in the specification. **3M Touch Systems makes no additional warranties, express or implied, including but not limited to any implied warranties of merchantability or fitness for a particular purpose.** User is responsible for determining whether the 3M Touch Systems Products and software are fit for User’s particular purpose and suitable for its method of production, including intellectual property liability for User’s application. If the Product, software or software media is proven not to have met 3M Touch Systems’ warranty, then 3M Touch Systems’ sole obligation and User’s and Purchaser’s **exclusive remedy**, will be, at 3M Touch Systems’ option, to repair or replace that Product quantity or software media or to refund its purchase price. 3M Touch Systems has no obligation under 3M Touch Systems’ warranty for any Product, software or software media that has been modified or damaged through misuse, accident, neglect, or subsequent manufacturing operations or assemblies by anyone other than 3M Touch Systems. **3M Touch Systems shall not be liable in any action against it in any way related to the Products or software for any loss or damages, whether non-specified direct, indirect, special, incidental or consequential (including downtime, loss of profits or goodwill) regardless of the legal theory asserted.**

© 2004 3M All rights reserved.
Printed in the United States

Document Title: *SC400 Serial Resistive Controller Reference Guide*
Document Number: 19-270, Version 1.0

MicroTouch, the MicroTouch logo, and ClearTek are either registered trademarks or trademarks of 3M in the United States and/or other countries.

IBM is a registered trademark of International Business Machines Incorporated.

Microsoft, Windows, and Windows NT are registered trademarks or trademarks of Microsoft Corporation.

All other trademarks are the property of their respective owners.

Contents

Introduction

- What You Need to Know 5
- Important Safety Information 5
- 3M Touch Systems Support Services..... 6
- 3M Touch Systems Worldwide Offices 7

Chapter 1

Integrating the SC400 Controller

- Overview of the SC400 Touch Screen Controller..... 9
- Handling and ESD Protection 10
- Establishing the Data Connection 10
- Mounting the Controller..... 11
- Supplying Power to the Controller..... 12
- Mounting the Touch Screen 13
- Touch Screen Cable Connector..... 13
- Turning On Your System 13
- Status Light (LED) Diagnostics 14
- What's Next? 14

Chapter 2

SC400 Controller Communications

- Controller Default Settings..... 15
- Communicating with the Controller 16
- Firmware Commands 18
- Calibrate 3 Point..... 19
- Guidelines for the C3 Commands 19
- Enter Sleep 20
- Format Tablet 21
- Get Controller Number..... 22
- Mode Stream 22
- Null Command 22
- Output Identity 22
- Reset..... 23
- Restore Defaults 23

	Set Controller Number	23
	Unit Type.....	24
Appendix A	SC400 Controller Specifications	
	Technical Specifications.....	26

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 manual, directed to developers of touch screen systems, provides installation and configuration information for the small outline 3M Touch Systems SC400 serial resistive touch screen controller. This document includes information on integrating the SC400 controller into your design, communicating with the controller, installing MicroTouch™ Software, and troubleshooting setup problems. It also includes a complete description of the firmware commands, a guide to interpreting status LED conditions, and 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 SC400 controller was designed to enable touch in conjunction with other 3M Touch Systems products and was tested to replace an existing small format serial controller. This controller is intended for internal mounting 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:
<ul style="list-style-type: none">• Do not install or use this product in a hazardous location.• Do not use this product in any outdoor environment unless NEMA standards are followed.

⚠ CAUTION

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

- Dispose of the controller board in accordance with local, state, and federal regulations.

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 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 (if applicable):

- Part number and serial number from your touch system
- 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 call back service Saturdays and Sundays.

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

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

3M Touch Systems Worldwide Offices

All offices can be reached through the website: <http://www.3Mtouch.com/>.

- United States 978-659-9000
- United Kingdom +44 (0) 1235-444400
- Australia +61 3 9582 4799
- Canada 604-521-3962
- France +33 (1) 30 31 68 32
- Germany +49 (0) 2131 14-4003
- Hong Kong/China (852) 2333-6138
- Italy +39 0 39-230 2230
- Japan +81 (44) 811-1133
- Korea +822 552 3198
- Singapore +65-6450 8851
- Spain +34 934 15 6285
- Taiwan +886-2-2704 9011

CHAPTER 1

Integrating the SC400 Controller

The MicroTouch™ SC400 serial resistive controller is an accurate, small outline, low cost, temperature stable controller capable of supporting a wide range of 3M Touch Systems resistive touch screens. It was designed for internal mounting in OEM applications.

This chapter covers the following SC400 controller specifications:

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

Overview of the SC400 Touch Screen Controller

The SC400 controller is an uncased device using an RS-232 serial interface. The communication parameters for the SC400 are N81 -- no parity, 8 data bits, and 1 stop bit.

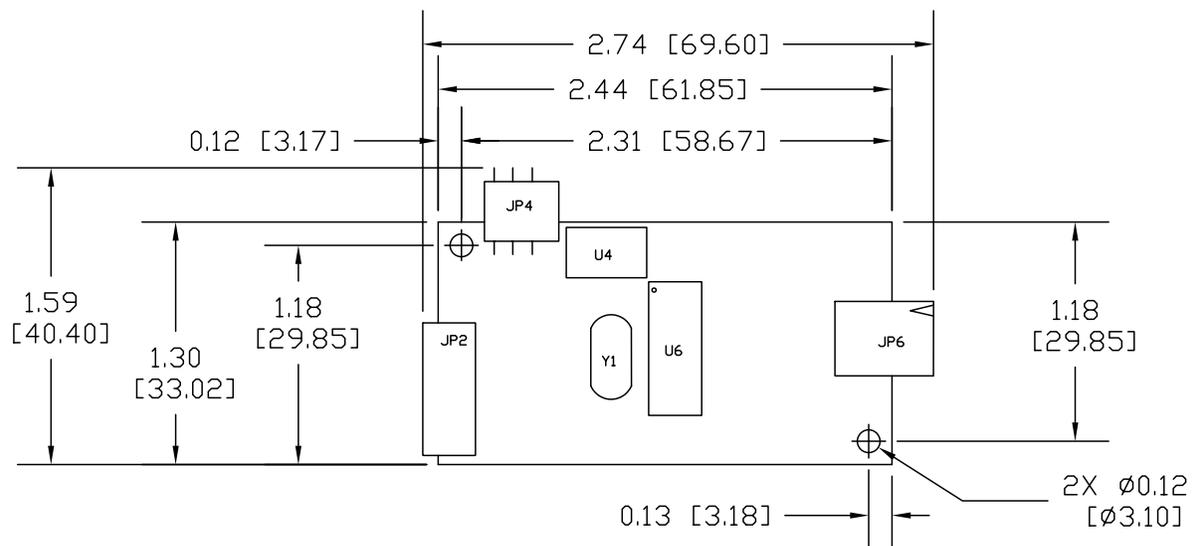
To integrate and test the SC400 controller, you need the following items:

- A 3M Touch Systems 4-wire resistive touch screen. These touch screens are available in a variety of sizes.
- A method of establishing the serial data communication between the controller and your system. The standard 3M Touch Systems RS-232 plug and play serial cable (P/N 7319630) is recommended. This cable is PC99 compliant.
- A power source.
- A touch screen utility or driver with a calibration routine.

Note: You can use MicroTouch™ Software, which includes the touch screen device driver and utilities software.

The controller measures 1.3 x 2.4 inches, or 1.6 x 2.7 inches total profile over the connectors. Allow additional clearance for the mating connectors. The total height profile is 0.40 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 SC400 has a 4-pin touch screen connector (JP6), an 8-pin serial plug and play cable connector (JP2), and a 3-pin power connector for selectable input voltages.

Figure 1. SC400 Overall Dimensions



Handling and ESD Protection

When mounting the touch screen and controller, use normal precautions for handling electrostatic sensitive devices. The SC400 has internal protection to ± 20 kV for ESD air discharges to the touch screen (not to the controller directly) that may occur during normal operation of the touch screen. Refer to Appendix A for further specifications.

Establishing the Data Connection

The SC400 controller requires that an RS-232 serial plug and play communication cable be attached to connector JP2.

You can use a standard 3M Touch Systems RS-232 plug and play cable (P/N 7319630) or an equivalent interconnect. One end of this cable plugs into the RS-232 connector (JP2) on the SC400 controller. The other end, which has a 9-pin D connector, plugs directly into a serial COM port on your PC. The 9-pin D connector also has an input in the connector body for an external 5V power supply. Table 1 describes the interconnections for the 3M Touch Systems RS-232 cable.

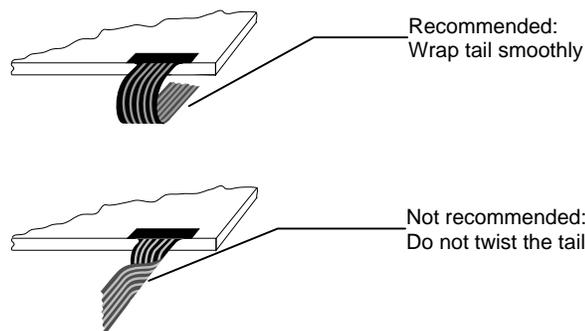
Table 1 COM Cable for SC400Controller

PC Side (9-Pin D)			Controller Side (8-Pin Molex)	
Pin	RS-232 Assigned	Jumpered to:	Pin	Description
1	Data Carrier Detect (DCD)	4 and 6 DTR and DSR	8	DCD, DTR, DSR
2	Receive Data (RXD)		2	Transmit Data (TXD)
3	Transmit Data (TXD)		3	Receive Data (RXD)
4	Data Terminal Ready (DTR)	1 and 6 DCD and DSR	8	DCD, DTR, DSR
5	Signal Ground		5	Power supply ground
6	Data Set Ready (DSR)	1 and 4 DCD and DSR	8	DCD, DTR, DSR
7	Request to Send (RTS)		1	Request to Send (RTS)
8	Clear to Send (CTS)		4	Clear to Send (CTS)
9	Not Used			Do not ground
Sleeve			6	DC power jack (+5 VDC)
Pin			7	Cable shield connected to ground. DC power jack ground
Shell			7	Chassis (earth) ground

Mounting the Controller

The controller is designed for internal mounting only. Choose a convenient spot away from high-voltage, high power cables and electronics. Use 4-40 metal screws to mount the controller using the two diagonal mounting holes in the board. The controller should be mounted in line with the touch screen cable exit point to minimize cable flexing. The controller should be mounted internally behind or on the side of the display on stand offs to allow room for the touch screen cable connector.

Ensure that the tail and controller are aligned such that the tail remains straight (90°), not pulled or twisted in an odd angle from the touch screen. Good engineering design avoids awkward electrical connections.



Supplying Power to the Controller

You must supply the SC400 controller with power. The source must deliver (for 5 VDC) 16 mA typical, 27 mA touching; $\pm 5\%$ regulation or (for 12 VDC) 19 mA typical, 30 mA touching; $\pm 5\%$ regulation, with a maximum ripple and noise of 50 mV peak-to-peak.

You can supply power to the SC400 controller using any of the following methods. The voltage input can be either +5VDC or +12VDC. In Sleep Mode the controller draws less than 5 mA.



CAUTION

To avoid possible damage to the controller, you must provide a path for electrostatic discharge (ESD). The controller mounting hole near the touch screen connector should be used to connect to chassis safety ground and must be attached by the shortest possible route to a good earth return (chassis) in all applications.

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 to JP4

Provide power directly to the controller using JP4 (Molex 22-05-3031). Use a mating 3-pin connector (Molex 22-0 and Pins 08-50-011X) and connect Pin 1 to 5VDC power and Pin 2 to the return or (alternately) 12VDC to Pin 3 and Pin 2 to the return.

Using an Internal Power Supply with a Custom Serial Cable Design

When creating a custom serial cable connection, you can provide power to the controller through the mating Molex connector. Refer to Table 1 for more information on actual cable connections. Unlike using JP4 of the controller to supply power, you can only use 5VDC at the serial interface.

1. Obtain an 8-pin Molex connector 51004-0800.
2. Attach power and ground to the connector, (Pin 6: +5V, Pin 7: Ground).

Using an External Wall-Mount Power Supply

If you are using a standard 3M Touch Systems RS-232 serial cable (P/N 7319630), you can use a 120-volt wall-mount power supply (P/N 19-408). Typically, this option is utilized by developers for prototyping purposes only.

To connect an external wall-mount power supply:

1. Remove the plastic plug covering the power jack of the 9-pin D connector on the serial cable.
2. Connect the DC power plug to the power jack built into the 9-pin D connector. Note that power is applied to the shield and ground to the center pin.
3. Plug the power supply into a grounded outlet. The power plug supplies +5V and return to the controller.

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 design, refer to the *MicroTouch Resistive Integration Guide* (P/N 19-441). 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).

It is critical for you to understand the tail orientation of your touch screen prior to connecting the controller. This will affect how the controller interprets your touch on the screen. Refer to the Chapter on controller communications for additional details.

Touch Screen Cable Connector

The touch screen cable has a 4-pin single row locking female connector that plugs into the controller. The controller is compatible with the “XYXY” latched connector pinout, not the “XXYY” style, non-latched connector pinout. Here, X or Y refers to one or the other sheet, and + or – refers one or the other side of a sheet. The calibration process sorts out left/right and up/down.

Connector pins 1 & 3 must be connected to one sheet and pins 2 & 4 must be connected to the other sheet.

1. Y-
2. X+
3. Y+
4. X-

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.

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 SC400 controller provides diagnostic feedback with a light emitting diode (LED) on the component side of the board that indicates the status of the touch screen unit. During normal operation, when you touch the touch screen the LED becomes bright as long as the controller detects a touch. 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 SC400 Controllers

Flashes	Self Test Condition	Self Test Bit	Description	What to do...
1	Reserved.	0	Reserved	
2	ROM Error	1	Firmware EPROM checksum verification error	No recovery. Replace the controller.
3	Reserved.	2	Reserved	
4	Block 1 checksum Error	3	Operating parameters invalid (using defaults).	Cycle power off and on.
5	Hardware error	4	Power up touch screen connector voltages out of range	Check connections to touch screen
6	Reserved.	5	Reserved	
7	Reserved.	6	Reserved	

What's Next?

Installing and Using MicroTouch™ Software

The MicroTouch™ Software Suite includes a driver and tools that enable your touch screen to work with your computer. 3M Touch Systems has touch screen drivers for many operating systems, including Microsoft® Windows® XP, 2000, 9X, Windows Me, and Windows NT 4.0. Be sure to install the touch screen software for your operating system.

TouchWare 5.64 SR4 supports the SCxxx family of controllers. Please check the corporate website for the latest releases of software and documentation.

For more information on connecting your cables and installing and using the touch screen, refer to the *TouchWare™ for Windows 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).

CHAPTER 2

SC400 Controller Communications

This chapter discusses the fundamentals of communicating with the SC400 controller. The firmware commands, which are usually issued by a driver or utility program on the host system, control the operation of the touch screen controller, however developers can enter these commands directly. This chapter:

- Describes the controller default settings.
- Lists the recommended firmware commands.
- 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.

Controller Default Settings

Communication Parameters

The SC400 controller communication parameters are N81 (no parity, 8 data bits, and 1 stop bit) at 9600 baud.

Data Format

Data format refers to the type of packet the controller uses to send the X/Y touch coordinates to the host system. Format Tablet is the format for the SC400 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 Touch Systems touch screen controllers.
- It 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.

Refer to the Format Tablet command in the firmware reference section.

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 operating mode for the SC400 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 touch screen.

Mode Stream provides the best response time and overall feel.

3M Touch Systems recommends that the touch screen driver generate an interrupt as each packet in the data stream arrives. Because touchdown and liftoff events are specially coded, provided that the interrupts are sent as recommended, your software always knows exactly 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 responses.

The commands listed in Table 3 are those that 3M Touch Systems currently uses for development and recommends that you use only these commands.

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 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>
```

Controller Initialization

To initialize the SC400 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 screen users do *not* have to use firmware commands to use their touch systems. For example, users can use MicroTouch™ software or equivalent software 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 may alter the performance of your touch screen and render it inoperable. You should be aware of the results before executing any firmware commands.

To optimize the performance of the SC400 touch screen controller and simplify the development of custom drivers, 3M Touch Systems recommends you use only the commands listed in Table 3 for current development.

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 SC400 Development

Command	Code	Description
Calibrate 3 Point	C3	Initiates a 3-point calibration routine.
Enter Sleep	ES	Controller enters low power mode.
Format Tablet	FT	Outputs the X/Y touch coordinate data in a five-byte packet.
Get Controller Number	Q002	Used to determine a controller ID number for multiple monitor applications.
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.
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 calibration data is lost.
Set Controller Number	W002	Used to determine a controller ID number for multiple monitor applications.

Command	Code	Description
Unit Type	UT	Returns controller unit type string and status.

Calibrate 3 Point

Syntax: <SOH>C3<CR>

Response: <SOH>0<CR> Positive response to initializing the command.

<SOH>1<CR> Positive touch response.

A valid touch coordinate (point) response ('1') signifies that a touch coordinate was detected and is in range of the expected screen target area. Three valid point responses indicate successful calibration.

<SOH>0<CR> Negative touch response.

An invalid touch coordinate (point) response ('0') is returned if the touch coordinate is out of range. If either calibration point is invalid, the touch coordinates are discarded and the calibration points remain unchanged from their previous values. If you receive a negative response, you must start over again.

<SOH>2<CR> Negative touch response.

An invalid touch coordinate (point) response ('2') is returned if the user did not touch the target long enough to provide an accurate calibration point.

Description: Initiates an interactive 3-point calibration.

In addition to scaling the Format Tablet output to the display, this command corrects for touch screen display orientation and touch screen pinout variations. This information will be maintained by the controller. The Calibrate 3 Point command initiates an interactive calibration procedure which defines the active area of the touch screen by mapping locations to an absolute X,Y coordinate system. Touch points generated subsequent to a successful calibration operation are calculated based upon these calibration points. Calibrate 3 Point utilizes inset calibration points located 12½ percent inboard from the screen corners (at touch X,Y locations 128,128, 895,895 and 128,895) for accuracy and ease of operation.

Guidelines for the C3 Commands

Here are several guidelines for using the C3 commands:

- The controller uses the data immediately before liftoff to register a calibration touch. Therefore, you can touch the coordinate target, hold for a few seconds, and then lift off. Instructing users to touch this way results in a more accurate calibration.
- The controller stores the data in non-volatile memory. 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 area changes physical size.
- You can restart calibration at any time during this sequence by issuing a Reset command and reissuing a C3 command.

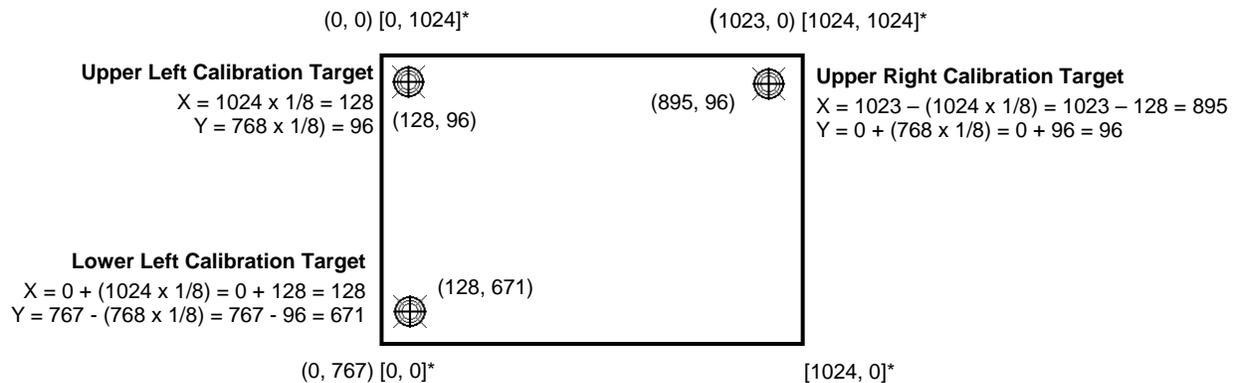
Determining Target Areas

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 C3 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 C3 command then positions the first calibration target inward from the lower left corner and the second calibration target inward from the upper right corner. Figure 2 shows how the calibration targets are calculated.

Figure 2 Calibration Target Locations



* 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 for both axes, regardless of display resolution.

Enter Sleep

Syntax: <SOH>ES<CR>

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

Description: This command is a power management feature that lets you put the controller into a low power mode (4-5 mA) when not in use. Send this command to put the controller in a low power state. The controller returns to a normal power level on touch. If you need to send a command to the controller when it is in a low power state, first raise CTS.

Format Tablet

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

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

The controller will respond with ACK for compatibility with older controllers. This format is the only format supported by this controller.

With the controller 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 4.

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

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

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.

Table 4 Data Sequence

	Most Significant Bit							Least Significant Bit
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

Table 5 defines the status bits (Byte 1) for the Format Tablet data.

Table 5 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.

Get Controller Number

Syntax: <SOH>**Q002**<CR>

Response: <SOH>**XXXXXXXX**<CR> Where each X is a hexadecimal digit, most significant digit first.

Description: This command is used to get a controller number for applications use. The controller does not use this value. This is useful for identifying individual controllers in a multiple controller system.

Mode Stream

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

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

The controller will respond with ACK for compatibility with older controllers. This format is the only format supported by this controller.

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.

Null Command

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

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

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.

Output Identity

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

Response: <SOH>**CcXxxx**<CR>

where:

Cc = Two ASCII characters that describe the type of 3M Touch Systems controller.
Xxxx = This is a unique identifier not necessarily the actual firmware revision number.

Description: Returns a 6-character identifier, which describes the controller type and the firmware version number. The output identity for the SC400 controller is SCXxxx.

Reset

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

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

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.

Restore Defaults

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

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

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 6 lists the factory defaults for the SC400 controller. The Restore Defaults command is useful in situations where inadvertent commands to the controller have rendered the touch screen inoperative.

Table 6 SC400 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

Note: After you issue a Restore Defaults command, you must recalibrate your touch screen.

Set Controller Number

Syntax: <SOH>**W002xxxxxx**<CR> Where each x is a hexadecimal digit, most significant digit first.

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

Description: This command is used to set a controller number for applications use. The controller does not use this value. This is useful for identifying individual controllers in a multiple controller system.

Unit Type

<SOH>**UT**<CR>

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).

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.

SC Indicates the SC series of controllers

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

R Indicates a resistive controller

4 Indicates either 4 wire controller (SC400) or an 8 wire controller (SC800)

Indicates no additional features configured

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

Table 2 defines the meaning of each bit in the status byte. Each bit can be set to 1 or 0, where **1** = an error and **0** = no error. So a response of:

00 = No diagnostic errors (normal response)

The SC400 running with no errors returns the following string:

<SOH> **SCR4**00** <CR>

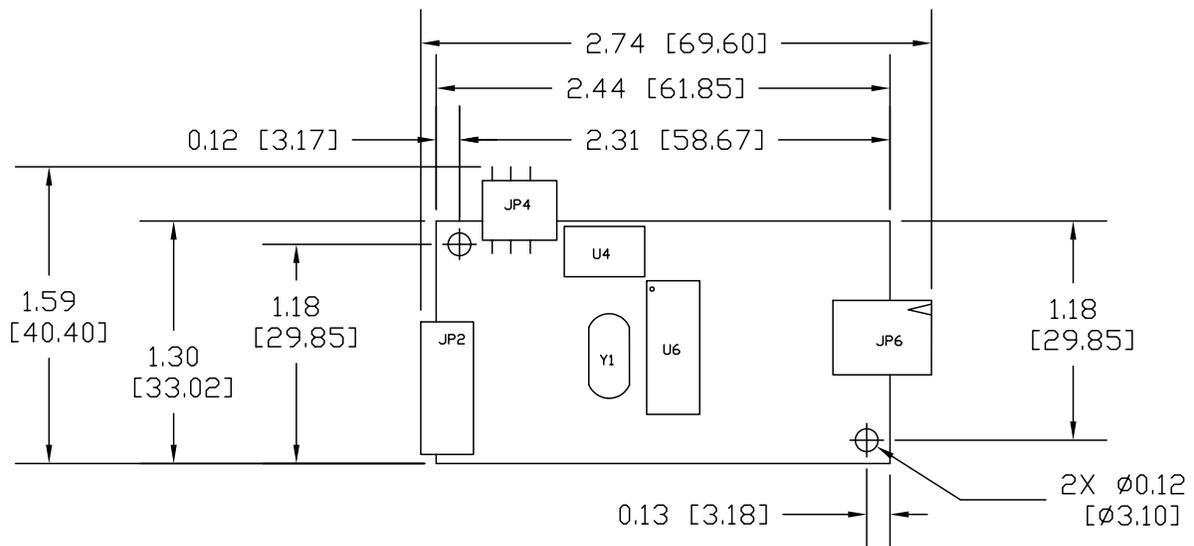
APPENDIX A

SC400 Controller Specifications

This section provides controller specifications such as power requirements, environmental requirements, and cable connectors. The SC400 controller is a compact RS-232 serial controller. This controller was designed to be mounted inside your monitor.

The following figures show the overall dimensions of the SC400 controller and the locations of the mounting holes and connectors.

Figure 3 SC400 Touch Screen Controller



Technical Specifications

Physical Dimensions

Uncased 2.72 in. x 1.59 in. x 0.45 in. (69.1 mm x 40.4 mm x 11.4 mm)

Board Level Functions

Power 5 VDC (16 mA typical, 27 mA touching); $\pm 5\%$ regulation
 12 VDC (19 mA typical, 30 mA touching); $\pm 5\%$ 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

Ambient Operating and Storage Environmental Conditions

Note: All humidity is non-condensing

Operating Temperature Range	0°C to +65°C
Operating Humidity Range (0 to 95% RH up to +36°C; above 36°C refer to Figure below)	
Storage Temperature Range	-20°C to +75°C
Storage Humidity Range (0 to 80% RH up to +36°C; above 36°C refer to Figure below)	

Performance and Reliability

Minimum Touch Duration	14 \pm 1 ms
Touch Resolution (Maximum number of addressable coordinates generated by the controller)	1024 x 1024
ESD Susceptibility ¹	

¹ ESD discharges to a 3M Touch Systems touch screen connected to the controller

±8KV Contact Discharge– Class 2 per section 9 of IEC 61000-4-2 1 false touch allowed	Compliant
±20KV Air Discharge – Class 1 per section 9 of IEC 61000-4-2 Normal Operation – No false touches	Compliant
MTBF (by MIL Std. 217F Calculation)	>400,000 Hours

3M Touch Systems Parameters

Accuracy vs. Dynamic Temperature Change Maintains 1% Accuracy
 (tested at 0° C to 65° C with a 0.5° C/minute temperature ramp)

Touch Screen Compatibility 3M Touch Systems Resistive Touch Screens
 Communications Protocol Serial RS-232

Figure 5. Storage and Operating Temperature and Humidity Conditions

