# Touch System Programmer's Guide

**CARROLL TOUCH**

TOUCH PRODUCTS

an **AMP** company

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# *Welcome*

As computers become a part of daily life, a technology that makes them easier to use has become a necessity. Carroll Touch provides the solution through the power of touch.

Thank you for your purchase of a Carroll Touch product and welcome to Carroll Touch.

## Purpose

This Programmer's Guide is designed to:

- Give an overview of the touch technologies used by Carroll Touch, with a particular emphasis on hardware and software information (such as calibration and initialization) needed by programmers.
- Define the use and functions of the Smart-Frame Protocol, the Smart-Frame Protocol II, the Touch Application Program Interface (TAPI) driver, the CTKERN application interface, and the Windows driver dynamic link libraries (DLLs).

## Audience

This guide is designed for the programmer or software engineer who integrates Carroll Touch touch systems with host computer systems.

## Organization

Chapter 1, "Introduction to Infrared Touch Systems," is an overview of Carroll Touch infrared touch system hardware and operating principles.

Chapter 2, “Introduction to Guided Wave Touch Systems,” is an overview of Carroll Touch guided wave touch system hardware and operating principles.

Chapter 3, “General Programming Issues,” includes information on programming topics that apply to all Carroll Touch touch systems, such as calibration and HBC I/O registers.

Chapter 4, “Smart-Frame Protocol,” gives an overview of the SFP firmware protocol, including a discussion of command and report types, initialization, timing, and programming tips and examples.

Chapter 5, “Smart-Frame Protocol II,” gives an overview of the SFP-II firmware protocol, which extends the capabilities of SFP by offering support of z-axes and higher resolution. Explanations of command and report formats are included.

Chapter 6, “Touch Application Program Interface (TAPI),” includes an overview of the TAPI software functions, and TAPI driver installation and initialization information.

Chapter 7, “CTKERN,” includes an overview of the CTKERN software functions, CTKERN driver installation, and parameters. It also discusses the operation of the CTKERN calibration program (`CALIB.EXE`).

Chapter 8, “Dynamic Link Library (DLL) Functions,” describes how to use the DLL function calls to the Carroll Touch Windows driver.

Appendix A, “Smart-Frame Protocol Command Reference,” gives the specifications for each SFP command and report.

Appendix B, “Smart-Frame Protocol II Function Reference,” gives the specifications for each SFP-II function.

Appendix C, “TAPI Function Reference,” gives the specifications for each TAPI function.

Appendix D, “CTKERN Function Reference,” gives the specifications for each CTKERN function.

Appendix E, “Dynamic Link Library (DLL) Function Reference,” gives the specifications for each Windows driver DLL.

## Conventions

For clarity, this guide uses certain conventions to visually distinguish different types of information. The conventions are:

- **Bold** is used to emphasize a word or phrase, including definitions of important concepts.
- SMALL CAPITAL LETTERS (such as SPACE or ENTER) indicates a key on the keyboard.
- `Courier` font indicates file names, directory names, messages displayed by the computer, parameters in command lines, and information to be typed by the user.
- *Italics* indicate a command, function name, or mode (such as *Debug Mode*).
- Reports (such as the Touch Coordinate Report) and menus (such as the Configuration Menu) use initial capital letters.
- *`Courier italic`* font indicates a variable in a command line for which you must substitute a value.
- Hexadecimal numbers in text are identified with capital H; for example, 1BH is the hexadecimal value 1B. Command and report formats and examples reproduce numbers as they appear on the screen and thus do not use the H convention.
- Information of particular importance or actions that may have undesirable results if performed improperly are included under the headings ***Note*** and ***Caution***.

# 1 *Introduction to Infrared Touch Systems*

This chapter gives an overview of Carroll Touch scanning infrared touch systems, and covers the following topics:

- Overview.
- Touch Frames.
- Touch Controllers.
- Interpolating Touch Coordinates.
- Reporting Touch Coordinates.
- Failed Beams.

## Overview

A Carroll Touch infrared touch system consists of a touch controller and touch frame or a combined touch frame and controller. The touch system uses scanning infrared (IR) beam technology to detect operator input. Generating an invisible grid of IR light beams in front of the host video display screen, the touch system reports touch input when the IR light field is interrupted by a stylus (typically a finger). This input can be used by a touch application just as similar applications use input from pointing devices such as a mouse, light pen or trackball.

## Touch Frames

The typical Carroll Touch touch frame is a thin, flat rectangle comprised of four joined printed circuit boards (PCBs). Two adjacent PCBs contain arrays of IR light emitting diodes (LEDs), while the other two PCBs contain arrays of phototransistor/receivers. Each IR LED and the phototransistor opposite it is called an **opto-pair**. The IR LED of each opto-pair emits an IR light beam that is detected by the phototransistor. The x-axis and y-axis arrays of opto-pairs are pulsed sequentially to create a grid of IR beams, as shown in Figure 1-1.

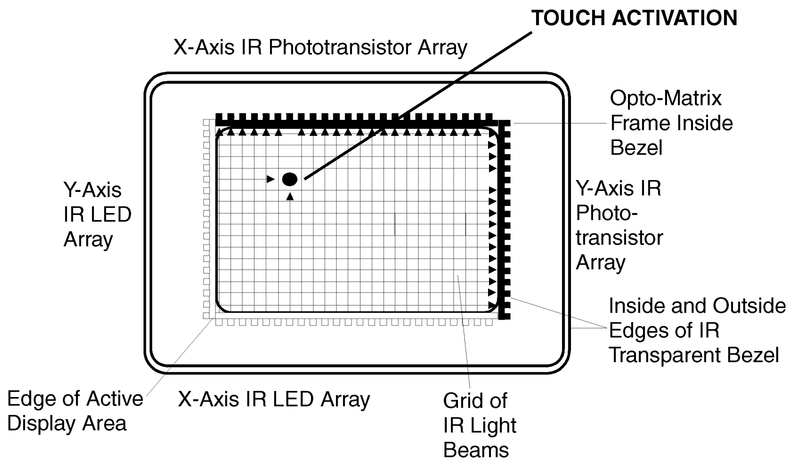

TOUCH ACTIVATION
X-Axis IR Phototransistor Array
Opto-Matrix Frame Inside Bezel
Y-Axis IR LED Array
Y-Axis IR Photo-transistor Array
Inside and Outside Edges of IR Transparent Bezel
Edge of Active Display Area
X-Axis IR LED Array
Grid of IR Light Beams

Figure 1-1. Infrared Touch Frame

A **beam**, or a **beam pair**, consists of an IR LED and phototransistor directly across from each other in the touch frame.

## Touch Controller

The touch controller is the circuitry required to create and monitor the IR grid. A sequence of electrical pulses is sent to the LEDs to create the grid of IR beams in front of the video display surface. This grid of IR beams is the **touch active area**.

When a stylus enters the touch active area, light beams are obstructed at a particular location on the grid. The touch frame then transmits to the controller a list that indicates which beams have been interrupted. The controller converts this list into an x, y coordinate that identifies the location of the touch. The x, y coordinate data is transmitted to the host processor via the PC bus or the RS-232 serial port and is then processed and used by the application program.

## Interpolating Touch Coordinates

To achieve finer resolution than the physical IR beam grid provides, Carroll Touch IR touch systems interpolate a virtual beam between each pair of physical beams. The physical beams are assigned even numbers (0, 2, 4, and so on). The virtual beams are assigned odd numbers (1, 3, 5, and so on). The combination of physical beams and virtual beams results in a set of **logical beams**.

The coordinate system formed by the logical beams is called the **logical coordinate system**. The origin of the logical coordinate system (0, 0) is located in the upper left corner of the display. When multiple beams are interrupted, the touch system averages them and reports one x, y logical coordinate pair to the host, a process known as **beam averaging**. Examples of beam averaging are shown in Figures 1-2 and 1-3.

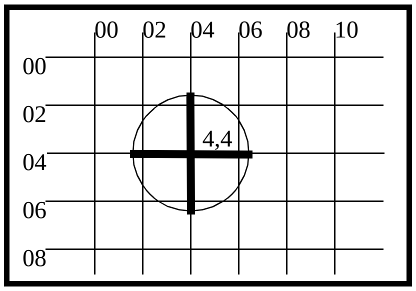


Figure 1-2. Beam Averaging - Example 1

In Figure 1-2, beams 2, 4, and 6 are interrupted on both the x- and y-axes. The logical coordinate pair reported to the host is 4, 4.

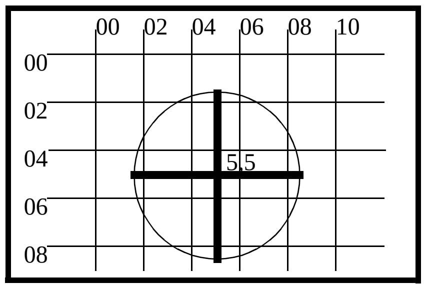


Figure 1-3.  Beam Averaging - Example 2

In Figure 1-3, beams 2, 4, 6, and 8 are interrupted on both the x- and y-axes. The logical coordinate pair reported to the host is 5, 5.

## Reporting Touch Coordinates

For a touch to be reported, at least one x beam and one y beam must be interrupted. If no beams are interrupted in either the x- or y-axis, the touch is ignored.

The lowest logical coordinate reported for any axis on any touch frame is zero. The maximum logical coordinate that may be reported for a given touch frame axis may be determined from the number of physical beams on that touch frame axis as follows:

Maximum logical coordinate = 2 x (number of physical beams - 1)

For example, on a frame that has 40 x-axis beams and 30 y-axis beams, the maximum logical coordinates for the frame are:

Maximum logical x coordinate = 2 x (40 - 1) = 78
Maximum logical y coordinate = 2 x (30 - 1) = 58

Therefore, the reported coordinates would range from 0 to 78 on the x-axis and from 0 - 58 on the y-axis.

## Failed Beams

Carroll Touch touch systems have incorporated into their firmware a mechanism for detecting defective beam pairs and removing them from consideration when determining the location of a stylus within the touch frame. This failed beam mechanism provides a measure of fault tolerance for the touch system so that, in the event of an opto-component failure, the touch system simply suffers a localized loss of resolution in one coordinate axis, rather than being completely inoperable.

## Criteria for Failing a Beam

The touch system considers a beam to be interrupted if the IR light level at the phototransistor is below a threshold level. A beam is considered **failed** if it appears to be interrupted for a given period of time.

The touch system detects failed beams:

- During power up.
- When the touch system is reset using the SFP *Reset (45H)* command or BREAK.
- When the touch system diagnostics are run using the SFP *Run_Diagnostics (3AH)* command.
- While the touch system is scanning the beams during normal operation.

In the first three cases, the time required to fail a beam is less than one second. In the last case, the time required to fail a beam is determined by the failed beam timing parameters.

The touch system maintains a table of beams that have been determined to have failed.

## Failed Beam Timing Parameters

The values for the various failed beam timing parameters are different for ASIC-based touch systems and non-ASIC-based touch systems, as shown in Table 1-1.

Table 1-1. Failed Beam Timing Parameters

| **Parameter** | **ASIC-Based** | **Non-ASIC-Based** |
|---|---|---|
| Valid Touch Fail Time | 59 - 62 sec. | 225 - 270 sec. |
| Non-Contiguous Touch Fail Time | 2.2 - 4.4 sec. | 10 - 20 sec. |
| Single Axis Touch Fail Time | 2.2 - 4.4 sec. | 10 - 20 sec. |
| Unfail Time | 2.2 - 4.4 sec. | 10 - 20 sec. |

A touch system is probably ASIC-based if it is a modular touch system, or an invasively integrated Smart-Frame with a five switch Communication Parameters jumper block on the frame. If you are unsure whether your system is ASIC-based and if you need to know the values of the failed beam timing parameters, use the touch system diagnostics software (CTDIAG) to observe the amount of time required to fail beams that are interrupted by a valid touch.

Table 1-1 gives a range of values rather than a specific value because the touch system firmware checks for failed beams at a regular interval (2.2 seconds or 10 seconds). A beam that appears to be interrupted just after the firmware checks takes longer to fail than a beam that appears to be interrupted just before the firmware checks.

**_Note_**

Custom touch systems may have different values for the failed beam timing parameters from those given in Table 1-1.

During normal operation, with the touch system scanning the beams, a beam is considered failed if it is interrupted for the amount of time specified by the Valid Touch Fail Time parameter and if the pattern of interrupted beams appears to indicate a valid touch with a single stylus. (A touch is considered valid if there appears to be one and only one region of contiguous interrupted beams in each coordinate axis.) Thus, a single stylus that remains stationary within the touch screen for the Valid Touch Fail Time causes beams to be failed.

If beams are interrupted on only one axis of the touch frame, the interrupted beams are failed in the amount of time specified by the Single Axis Touch Fail Time parameter.

For any other pattern of interrupted beams, such as more than one region of interrupted beams in an axis, the interrupted beams are failed in the amount of time specified by the Non-Contiguous Touch Fail Time parameter. Thus, multiple styli that remain stationary for longer than the Non-Contiguous Touch Fail Time result in beams being failed, as do non-contiguous touches.

For example, if you place a piece of tape over the opto-devices in one axis of the touch screen, the beams obstructed by the tape are determined by the touch system firmware to be failed and are added to the failed beam table only after the amount of time specified by the Invalid Touch Fail Time parameter has elapsed. If you then remove the tape, the time specified in the Unfail Time parameter must elapse before the beams are considered unfailed by the touch system firmware.

## Criteria for Unfailing a Beam

If a failed beam appears not to be interrupted for the amount of time specified by the Unfail Time parameter, it is unfailed and removed from the failed beam table by the touch system firmware.

## Failed Beam Reports

Two SFP commands can be used to generate reports related to the failed beam status of the touch system: *Get_Error_Report (32H)* and *Get_Failed_Beam_Report (36H)*. See Appendix A, “Smart-Frame Protocol Command Reference,” for details on these commands.

# 2 Introduction to Guided Wave Touch Systems

This chapter gives an overview of Carroll Touch guided wave touch systems and covers the following topics:

- Overview.
- Touch Screens.
- Touch Controllers.
- EEPROM File and Parameters.

## Overview

A Carroll Touch guided wave touch system consists of a touch controller and touch screen. The touch system uses guided acoustic wave (GW) technology to detect operator input for a variety of applications. Generating invisible acoustic waves, the touch system reports touch input when the wave motion is attenuated by a stylus (typically a finger). This input can be used by a touch application just as similar applications use input from pointing devices such as a mouse, light pen or trackball.

## Touch Screens

Guided acoustic wave technology is based on transmitting acoustic waves through a glass overlay placed over the display surface. A transducer mounted on the edge of the glass emits an acoustic wave. The wave travels along the reflector array, is redirected across the overlay to the reflecting edge, and returns to the array where it is reflected back to the transducer. The first reflector will send a signal back first, then the second, and so on, as shown in Figure 2-1.

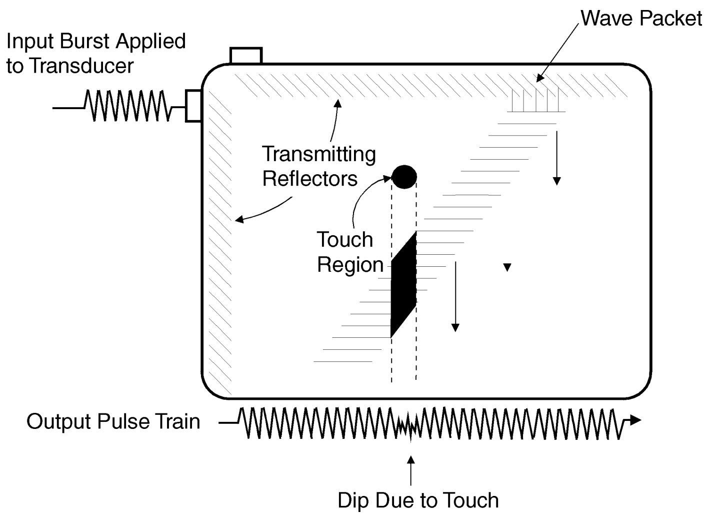


Figure 2-1. Guided Wave Touch Screen

## Touch Controllers

The touch controller is the circuitry required to create and monitor the acoustic waves. A sequence of electrical pulses is sent to the transducer located in the upper left of the glass overlay to generate the acoustic waves. The area covered by the acoustic waves is the **touch active area**.

When a stylus enters the touch active area, acoustic waves are attenuated at that location on the overlay. The touch screen then transmits to the controller information indicating the location of the attenuated waves. The controller converts this information to an x, y coordinate that identifies the location of the touch. The x, y coordinate data is transmitted to the host processor via the controller and is then processed and used by the application program.

## EEPROM File and Parameters

Guided wave touch screens use an electrically erasable programmable read-only memory (EEPROM) chip. An associated file stores the values of the EEPROM parameters that control many features of the touch screen. The following EEPROM values may be displayed, modified, saved, and restored:

- Touch sensitivity.
- Touch active region.
- Transducer corner.
- Coordinate origin corner.
- Transducer orientation.
- Touch refresh time.
- No touch refresh time.
- Temporal filter space.
- Temporal filter time.

# 3 General Programming Issues

This chapter includes information that may apply to any Carroll Touch touch system. It discusses the following topics:

- Hardware Configurations.
- Calibration.
- HBC I/O Registers.

## Hardware Configurations

There are two major types of Carroll Touch controller configurations: built-in controllers (used in infrared Smart-Frames) and external controllers (used in modular infrared and guided wave touch systems).

### *Built-In Controllers*

An **infrared Smart-Frame touch system** has controller electronics built onto the touch frame itself. The Smart-Frame touch system communicates directly with the host computer through the host serial port. Figure 3-1 illustrates the built-in Smart-Frame controller hardware.

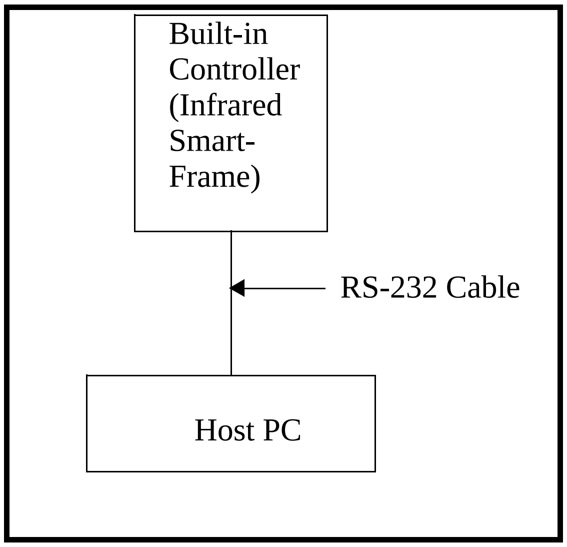


Figure 3-1. Built-In Smart-Frame Controller Hardware

The Smart-Frame communicates serially with the host computer using a selectable baud rate (300, 600, 1200, 2400, 4800, 9600, 19,200 or autobaud) and parity (odd, even, none, autoparity). Default values for the standard Smart-Frame are autobaud and autoparity.

### *External Controllers*

External controllers connect to the touch system via the Modular Digital Interface (MDI) cable in modular infrared touch systems or an 8-pin mini-DIN sensor cable in guided wave systems. The MDI cable carries digital signals, while the mini-DIN sensor cable carries analog signals.

A **modular infrared touch system** consists of any one of a number of IR-transparent protective bezels that house and protect a touch frame, matched with any one of three modular touch controllers: the software-based controller (SBC), hardware-based controller (HBC), and RS-232 controller. A **guided wave touch system** uses HBCs or RS-232 controllers. Figure 3-2 illustrates the RS-232 controller hardware.

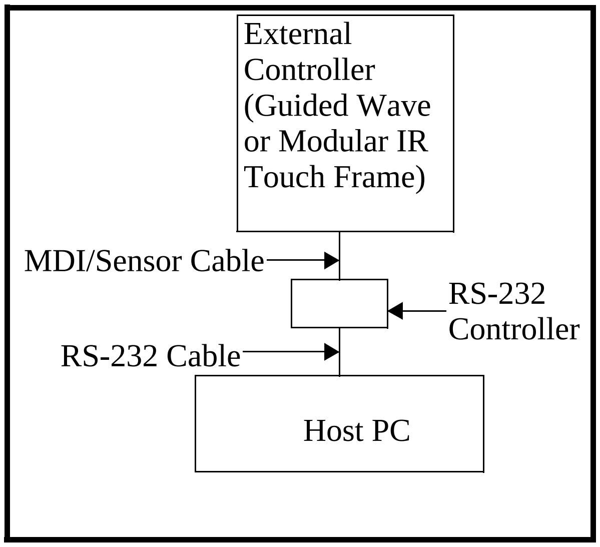


Figure 3-2. RS-232 Controller Hardware (Modular IR Touch Systems)

The RS-232 controller is a PCB that has its own protective housing and requires an external power supply. The RS-232 controller communicates with the modular touch frame via the MDI cable and with the host computer through the host serial port.

The RS-232 controller communicates serially with the host computer using a selectable baud rate (300, 600, 1200, 2400, 4800, 9600, 19,200 or autobaud) and parity (odd, even, none, autoparity). Default values for the RS-232 controller are autobaud and autoparity.

Figure 3-3 illustrates the SBC and HBC controller hardware. The SBC and HBC are PCBs that fit into an expansion slot of an IBM-compatible PC, communicating with and drawing power for the touch system directly from the host through the PC bus. Both controllers communicate with the modular touch frame via the MDI cable.

The SBC and HBC communicate with the host via several I/O registers. The SBC and HBC also support interrupt-driven communications.

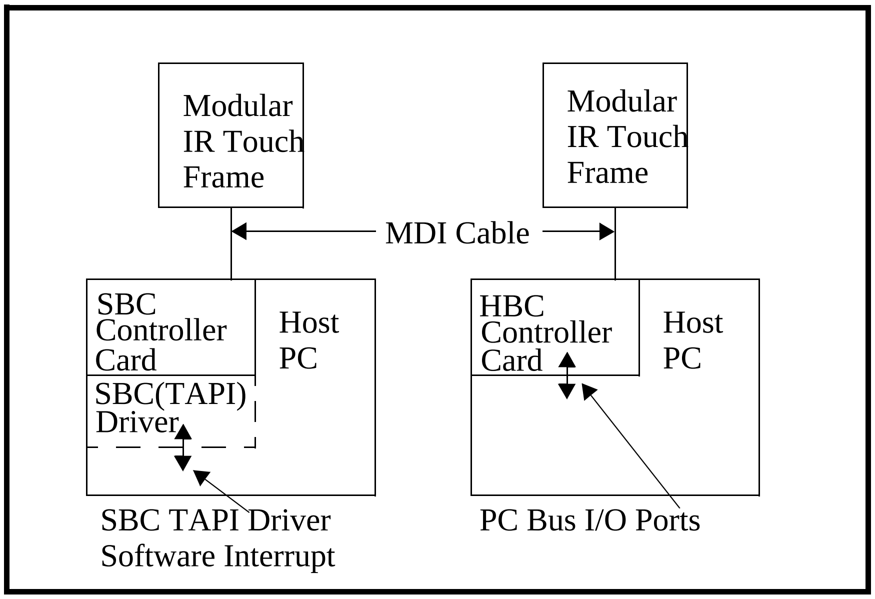


Figure 3-3. SBC and HBC Hardware (Modular IR Touch Systems)

## Application Program Interface

As shown in Figure 3-4, application programs may interface with Smart-Frame systems and systems using the HBC or RS-232 controller directly via the Smart-Frame Protocol. Smart-Frame systems and systems using the RS-232 controller are identical in terms of software. Both communicate using the Smart-Frame Protocol via the RS-232 serial interface. Systems using the HBC communicate with the application program using the Smart-Frame Protocol via the HBC I/O registers. For more details about the I/O registers, see “HBC I/O Registers” later in this chapter. The SBC cannot use the Smart-Frame Protocol directly because the SBC has no processor on board. The Smart-Frame Protocol is discussed in Chapter 4, “Smart-Frame Protocol.”

As also shown in Figure 3-4, application programs may interface with Smart-Frame systems and systems using the SBC, HBC, or RS-232 controller using the Smart-Frame Protocol via a Touch Application Program Interface (TAPI) driver. This is the same Smart-Frame Protocol used when interfacing directly to the touch system hardware.

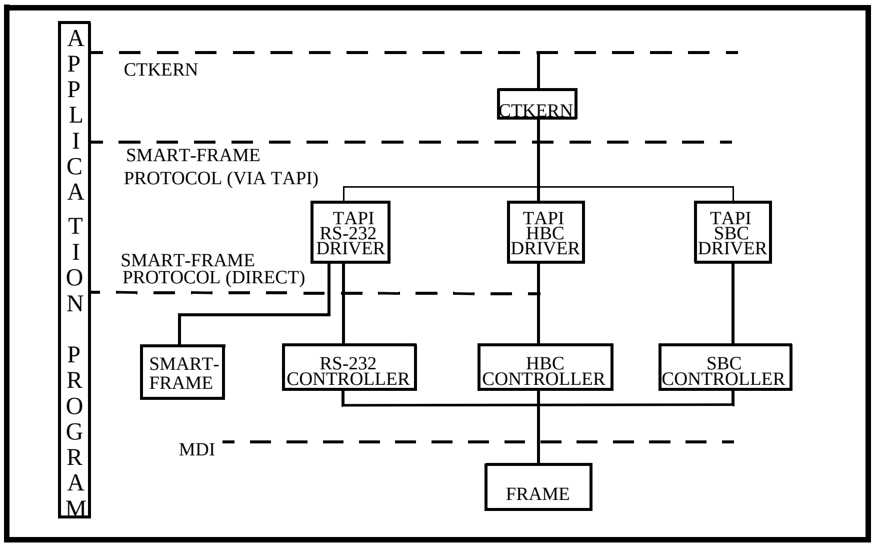


Figure 3-4. Touch Control Software

There are three TAPI drivers: the SBC driver, the HBC driver, and the RS-232 driver. The RS-232 driver works with Smart-Frames as well. Each TAPI driver communicates with the touch system using the hardware interface appropriate for the touch system, and with the application program using the TAPI functions that are accessed via a software interrupt. The TAPI interface is the same regardless of which TAPI driver is used. This means that you may make an application touch system hardware-independent by interfacing at the TAPI driver level rather than directly to the touch system hardware. The TAPI software functions are discussed in Chapter 6.

Figure 3-4 also shows that application programs may interface with Smart-Frame systems and systems using the SBC, HBC, or RS-232 controller via the CTKERN driver. The CTKERN driver communicates with the touch system using the TAPI driver appropriate for the touch system, and with the application program using the CTKERN functions, which are accessed via a software interrupt. CTKERN is a DOS driver that provides calibration and scaling support, as well as easy-to-use touch state reporting. CTKERN also features an installable user event handler that allows interrupt-driven communication with the application program. The CTKERN functions are discussed in Chapter 7.

## Calibration

The size of the display area of the video monitor frequently does not match the size of the touch active area of the touch frame. The touch active area is usually larger than the display area. The relationship of touch and video coordinates is shown in Figure 3-5. In addition, the display area on most video monitors may actually shift position or drift, while the touch active area remains constant. To establish and maintain alignment of the touch active area with the active display area, the touch screen must be calibrated. A calibration procedure such as the one that follows identifies the touch coordinates of the extreme outside corners of the video image displayed on the monitor and derives calibration parameters that may then be used to convert touch coordinates into video coordinates.

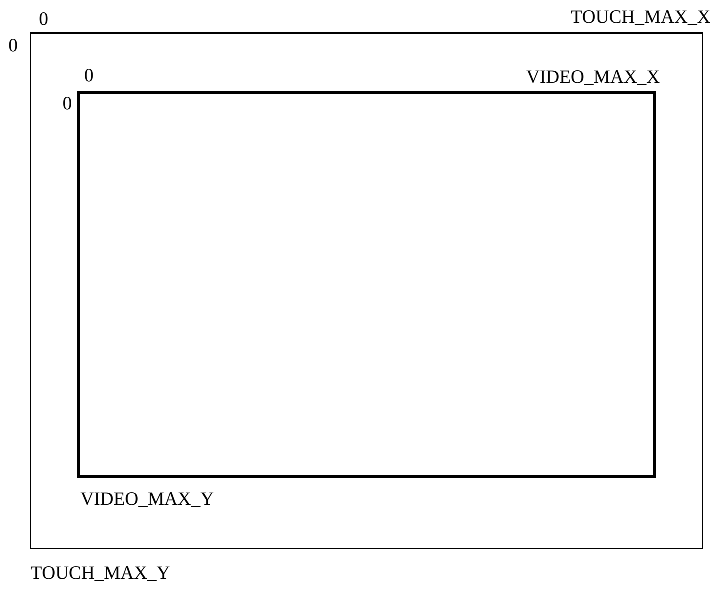


Figure 3-5.  Touch Calibration Screen

It is strongly recommended that a calibration program be included in any touch application or driver. Touch applications or drivers should not use hard-wired values that are specific to a particular touch frame and monitor. Use of a calibration program takes care of variations in monitor image size and location and allows touch applications to be used on different sizes of monitors and/or touch systems without modifying the touch application or driver.

This calibration must be performed at least once for each physical touch screen/video monitor pair. This procedure produces four calibration parameters that should be stored by the host computer in some form of nonvolatile storage, which lets the calibration be performed only once.

Once calibration is completed, the host software may use the calibration parameters to convert touch coordinates into video coordinates (pixel coordinates). These may then be used in the remainder of the host software.

Some monitors do not maintain a constant video image size and placement for all of the video modes that they support. For this reason, the calibration should be performed using the same video mode as the touch application in order to assure an accurate calibration.

## Floating Point Calibration Program Design

When designing a program to calibrate the touch screen, include the following steps:

1. Prompt the user to touch the upper left corner of the video screen.
2. Save the coordinates returned as TOUCH_UL_X and TOUCH_UL_Y.
3. Prompt the user to touch the lower right corner of the video screen.
4. Save the coordinates returned as TOUCH_LR_X and TOUCH_LR_Y.

   A good way to prompt the user to touch the corners is to draw a border around the edge of the screen and prompt the user to touch each point using a target in the respective corner and text centered on the screen.
5. Calculate the four calibration parameters as follows:

   ```
   OFFSET_X = TOUCH_UL_X
   OFFSET_Y = TOUCH_UL_Y

   SCALE_X = VIDEO_MAX_X / (TOUCH_LR_X -
                            TOUCH_UL_X)
   SCALE_Y = VIDEO_MAX_Y / (TOUCH_LR_Y -
                            TOUCH_UL_Y)
   ```
6. Save the four calibration parameters to a nonvolatile storage area, if available. If none is available, the calibration procedure must be followed each time the system is powered up.

The floating point calibration procedure is now complete. In your application program, convert the touch coordinates reported by the touch system into the equivalent video coordinates with these equations:

```
VIDEO_X = SCALE_X * (TOUCH_X - OFFSET_X)
VIDEO_Y = SCALE_Y * (TOUCH_Y - OFFSET_Y)
```

You may also want to limit VIDEO_X and VIDEO_Y to the ranges defined by VIDEO_MAX_X and VIDEO_MAX_Y. It is recommended that the touch coordinates be converted to video coordinates immediately upon their receipt from the touch system, and that video coordinates be used in the remainder of the application program.

## *Floating Point Calibration Examples*

If the coordinates resulting from calibration of a system with 640 x 480 resolution are:

| | |
|---|---|
| TOUCH_UL_X | = 10 |
| TOUCH_UL_Y | = 7 |
| | |
| TOUCH_LR_X | = 150 |
| TOUCH_LR_Y | = 110 |

and the system has a resolution of 640 x 480:

| | |
|---|---|
| VIDEO_MAX_X | = 639 |
| VIDEO_MAX_Y | = 479 |

the four calculated calibration parameters are:

| | | | |
|---|---|---|---|
| OFFSET_X | = 10 | | |
| OFFSET_Y | = 7 | | |
| | | | |
| SCALE_X | = 639 / (150 - 10) | = | 4.5643 |
| SCALE_Y | = 479 / (110 - 7) | = | 4.65 |

Following are three examples of how to solve for different values of VIDEO_X and VIDEO_Y:

If TOUCH_X = 7 and TOUCH_Y = 10, then:
   VIDEO_X = 4.5643 * (10 - 10) = 0
   VIDEO_Y = 4.65 * (7 - 7) = 0

If TOUCH_X = 60, and TOUCH_Y= 80, then:
   VIDEO_X = 4.5643 * (60 - 10) = 228
   VIDEO_Y = 4.65 * (80 - 7) = 339

If TOUCH_X = 150, and TOUCH_Y= 110, then:
   VIDEO_X = 4.5643 * (150 - 10) = 639
   VIDEO_Y = 4.65 * (110 - 7) = 479

## HBC I/O Registers

### Overview

The HBC communicates with the PC through the PC bus via three consecutive I/O registers. The base address of these I/O registers is set by the I/O address jumpers on the HBC board, and may be set in increments of 16 to any I/O address between 200H and 3F0H inclusive. The three I/O registers are defined in Table 3-1.

Table 3-1. HBC I/O Registers

| I/O Address | Name | Read/ Write | Description |
|---|---|---|---|
| I/O Base Address | Data Register | R/W | Used to send commands to and receive reports from the touch controller. |
| I/O Base Address + 1 | Status Register | R | Used to check the touch controller communications status (i.e. ready to receive commands, reports available). |
| I/O Base Address +2 | Hardware Reset Register | W | Used to reset the touch controller. |

The touch controller may be used in polling mode or in interrupt mode. In **polling mode**, the application software must check the Status Register before sending or receiving data. In **interrupt mode**, the application software must check the Status Register when sending data to the touch controller, but may install an interrupt handler to receive data from the touch controller. The interrupt number used is set by the interrupt number jumpers on the HBC board, as described in the HBC installation instructions. When using polling mode, set these jumpers to none to prevent the HBC from generating any interrupts.

### Sending a Touch Command to the HBC

The procedure used to send a touch command to the HBC is the same for both interrupt mode and polling mode.

Before sending a command to the touch controller, you must first perform an I/O read of the Status Register (Base Address + 1). Bit 0 of the Status Register indicates whether the touch controller is ready to receive a command or whether it is busy. Table 3-2 shows the values of Bit 0 of the Status Register.

Table 3-2. Status Register Bit 0 Values

| Bit 0 | Description |
|---|---|
| 0 | Touch controller ready to receive command. |
| 1 | Touch controller busy. |

If Bit 0 of the Status Register is 0, you may send a command to the touch controller by performing an I/O write to the Data Register (Base Address). If Bit 0 of the Status Register is 1, do not send a touch command to the touch controller.

## Receiving Touch Data from the HBC

The procedure used to receive data from the HBC differs depending on which communication mode you are using.

### Polling Mode

When using polling mode, the application software polls the Status Register (Base Address + 1) to check if touch data is available in the Data Register (Base Address).

Before reading the Data Register, you must first perform an I/O read of the Status Register. Bit 1 of the Status Register indicates whether there is touch data available in the Data Register. Table 3-3 shows the values of Bit 1 of the Status Register.

Table 3-3. Status Register Bit 1 Values

| Bit 1 | Description |
|---|---|
| 0 | Touch data available. |
| 1 | No touch data available. |

If Bit 1 of the Status Register is 0, you may receive a byte of touch data by performing an I/O read of the Data Register. If Bit 1 of the Status Register is 1, there is no data available in the Data Register.

### Interrupt Mode

When using interrupt mode, the touch controller uses a PC hardware interrupt to notify the application software that touch data is available in the Data Register (Base Address). When the display is touched with touch enabled, or an information request command is received by the touch system, the touch system sends touch data to the Data Register.

The HBC then interrupts the host computer, indicating that data is available in the Data Register. The application software's interrupt handler should perform an I/O read of the Data Register to receive a byte of touch data from the touch system.

## *Resetting the HBC*

The procedure to perform a hardware reset on the HBC is the same for both interrupt and polling communication modes. To cause a hardware reset of the touch controller, perform an I/O write to the Hardware Reset Register (Base Address + 2).

Note that the value of the data byte written to the Hardware Reset Register does not matter.

# 4 Smart-Frame Protocol

This chapter gives an overview of the SFP firmware protocol, including a discussion of command and report types, initialization, timing, and programming tips and examples.

The chapter discusses the following topics:

- Overview.
- SFP and SFP-II.
- Types of SFP Commands.
- Reports.
- Touch System Initialization.
- Touch System Initialization Examples.
- Using an SBC.
- Compatibility Issues/Programming Tips.
- SFP Timing.
- SFP Programming Examples.

See Appendix A, “Smart-Frame Protocol Command Reference,” for the specifications of each Smart-Frame Protocol command.

## Overview

The Smart-Frame Protocol (SFP) regulates communication between the touch system and the application program.

Smart-Frame Protocol commands are used to:

- Initialize the touch system.
- Establish host-to-touch communications.
- Select the touch system reporting and operating modes.
- Request special reports.
- Manage report transfer.
- Execute diagnostic functions.

## SFP and SFP-II

The SFP, defined in 1985, is currently used by most Carroll Touch touch systems, but will eventually be supplanted by Smart-Frame Protocol II (SFP-II) on newer touch systems.

The SFP is implemented as a modal protocol, meaning that, even if a touch system supports both the SFP and SFP-II, it can only support one protocol at a time and, during that time, cannot accept commands from the other protocol. To switch between protocols, use the *SwitchToSFP-II (65H)* SFP command and the *SwitchToClassicSFP (64H)* SFP-II function.

## Types of SFP Commands

Smart-Frame Protocol commands are grouped into five logical categories:

- Communication commands.
- Reporting method commands.
- Touch mode commands.
- Information request commands.
- System commands.

SFP commands may be invoked with either a hexadecimal code or an ASCII code, and many of the commands have associated reports. To issue a command under the Smart-Frame Protocol, simply type its function number. An SFP command example is `32`, the hexadecimal code for the *Get_Error_Report (32H)* command.

## Communication Commands

Communication between the touch system and the host computer can be regulated by hardware or software flow control. Communication commands are shown in Table 4-1.

Table 4-1. SFP Communication Commands

| **Command Name** | **Hex Code** | **ASCII Code** | **Associated Report** |
|---|---|---|---|
| *Hardware_Flow_Control_On* | 41H | A | None |
| *Hardware_Flow_Control_Off* | 42H | B | None |
| *Report_Transfer_Off* | 43H | C | None |
| *Report_Transfer_On* | 44H | D | None |
| *Get_One_Report* | 46H | F | varies |

Hardware flow control regulates the transmission of data from the touch system to the host and from the host to the touch system by using RS-232 control signals. To enable and disable this type of data flow control, use the *Hardware_Flow_Control_On (41H)* and *Hardware_Flow_Control_Off (42H)* commands.

Software flow control regulates transmission of data from the touch system to the host on a report-by-report basis. To implement this type of data flow control, use the *Report_Transfer_On (44H)* command, *Report_Transfer_Off (43H)* command, or the *Get_One_Report (46H)* command.

The default flow control method is software flow control.

## Reporting Method Commands

Reporting methods determine the form in which data is sent from the touch system to the host. Both the desired reporting method and touch mode should be selected before turning touch system scanning on, although they may also be changed with scanning on. The commands used to select the reporting method are shown in Table 4-2.

Table 4-2. SFP Reporting Method Commands

| **Command Name** | **Hex Code** | **ASCII Code** | **Associated Report** |
|---|---|---|---|
| *Scan_Reporting* | 22H | “ | Scan Report |
| *Coordinate_Reporting* | 23H | # | Touch Coordinate Report<br>Add Exit Coordinate Point Report<br>Non-Contiguous Coordinate Report |

Scan reports present interrupt beam data with no software interpretation and are used for diagnostic and testing purposes. Coordinate reports present interrupt beam data in the form of x, y (x-axis, y-axis) coordinate pairs for application processing.

## *Touch Mode Commands*

Touch mode commands select the conditions under which touch coordinates are reported when the reporting method is set to coordinate reporting. Touch mode commands are shown in Table 4-3.

Table 4-3. SFP Touch Mode Commands

| **Command Name** | **Hex Code** | **ASCII Code** | **Associated Report** |
|---|---|---|---|
| *Enter_Point_Mode* | 25H | % | Touch Coordinate Report |
| *Tracking_Mode* | 26H | & | Touch Coordinate Report |
| *Continuous_Mode* | 27H | ‘ | Touch Coordinate Report |
| *Exit_Point_Mode* | 28H | ( | Touch Coordinate Report |
| *Add_Exit_Point_ Modifier** | 29H | ) | Touch Coordinate Report |

*Add Exit Point is a modifier that is used with other touch modes. It is not a stand-alone touch mode.

To change the touch mode, simply send the touch mode command that selects the new touch mode. For example, to change from *Enter Point Mode* to *Tracking Mode*, send the *Tracking_Mode (26H)* command.

Changing the touch mode clears the Add Exit Point modifier. To disable the Add Exit Point modifier without changing the current touch mode, simply send the desired touch mode command again.

For example, to select *Tracking Mode* with Add Exit Point, send the *Tracking_Mode (26H)* command followed by the *Add_Exit_Point_Modifier (29H)* command. To deselect Add Exit Point and remain in *Tracking Mode*, send the *Tracking_Mode (26H)* command again.

## Information Request Commands

Information request commands query the touch system for system status reports, such as error, configuration, firmware version, failed beam, frame size, and state reports. Information request commands are shown in Table 4-4.

Table 4-4. SFP Information Request Commands

| **Command Name** | **Hex Code** | **ASCII Code** | **Associated Report** |
|---|---|---|---|
| *Get_Error_Report* | 32H | 2 | Error Report |
| *Get_Configuration_Report* | 33H | 3 | Configuration Report |
| *Get_Firmware_Version_ Report* | 34H | 4 | Firmware Version Report |
| *Get_Failed_Beam_Report* | 36H | 6 | Failed Beam Report |
| *Get_Frame_Size_Report* | 37H | 7 | Frame Size Report |
| *Get_State_Report* | 47H | G | State Report |

## System Commands

System commands control all touch system functions such as initialization, software reset, diagnostics, and scanning. The system commands are shown in Table 4-5.

Table 4-5. SFP System Commands

| **Command Name** | **Hex Code** | **ASCII Code** | **Associated Report** |
|---|---|---|---|
| *Echo_On* | 20H | Space | None |
| *Echo_Off* | 21H | ! | None |
| *Touch_Scanning_On* | 2AH | * | None |
| *Touch_Scanning_Off* | 2BH | + | None |
| *Run_Diagnostics* | 3AH | : | Error Report |
| *Software_Reset* | 3CH | < | None |
| *Clear_Touch_Report_Buffer* | 3DH | = | None |
| *Reset* | 45H | E | None |
| *SwitchToSFP-II* | 65H | | SFP-II Protocol Version Report or Error Report |

## Reports

An SFP report has the following format:

*`header reportbytes trailer`*

The trailer is always `FF`. An example of a report returned from the *Get_Error_Report (32H)* command is:

```
F8 00 FF
```

`F8` is the header, `00` indicates no errors, and `FF` is the trailer. An example of a touch coordinate report is:

```
FE 35 2D FF
```

`FE` is the header; `35` and `2D` are the x, y touch coordinates; and `FF` is the trailer.

## Touch System Initialization

To initialize a touch system that uses the Smart-Frame Protocol, take the following steps:

1. Reset the touch system.
2. Perform the autobaud/autoparity sequence, if appropriate, then the software reset command.
3. Check for any errors that may have been detected.
4. Set the desired reporting method and touch mode.

Details on each step are in the following sections.

### *Resetting the Touch System*

The following methods may be used to reset the touch system. Be sure to use a method that is appropriate for the touch system being used.

#### Power Cycle

This method resets everything. For touch systems that communicate serially, Clear To Send (`CTS`) is deasserted (negative voltage) to indicate that the touch system is busy until the touch system is ready to accept commands. For serial touch systems that have their communication parameters set to autobaud/autoparity, this occurs when the touch system enters the autobaud sequence by sending breaks.

#### Dedicated Reset Signal

On some Smart-Frame systems, a dedicated reset signal line is present. If present, this signal is on pin 8 of the 2 x 5 pin communication connector that is on the frame. To reset the touch system, deassert this pin by applying negative voltage for a minimum of 10 ms. This type of reset is equivalent to cycling the power to the touch system. This signal is not present on the modular RS-232 controller.

#### Break (Hardware Detected)

For touch systems that use the modular RS-232 controller, a break of at least 400 ms resets the touch system. To send a break of 400 ms, set the Transmit Data (`TD`) signal to the “space” condition (positive voltage), wait 400 ms, and set the `TD` signal back to the “mark” condition (negative voltage). For PC systems, the “Set Break” bit in the Line Control Register of the 8250 USART chip is used to set and/or clear the break condition. This type of reset is equivalent to cycling the power to the touch system.

### HBC Hardware Reset Register

For touch systems that use the modular HBC, writing any value to the HBC Hardware Reset Register (Base Address +2) resets the touch system. This type of reset is equivalent to cycling the power to the touch system.

### Break (Firmware Detected)

For all touch systems that communicate serially, a break of at least 150ms resets the touch system. To send a break of 150ms, set the Transmit Data (`TD`) signal to the “space” condition (positive voltage), wait 150ms, and set the `TD` signal back to the “mark” condition (negative voltage). For PC systems, the “Set Break” bit in the Line Control Register of the 8250 USART chip is used to set and/or clear the break condition. This type of reset is equivalent to cycling the power to the touch system, except that Clear To Send (`CTS`) is not affected if hardware flow control was not enabled before the reset.

### Reset (45H)

This Smart-Frame Protocol command resets everything. If the touch system communicates serially and hardware flow control is enabled, `CTS` is deasserted (negative voltage) to indicate that the touch system is busy until the touch system is ready to accept commands. For serial touch systems that have their communication parameters set to autobaud/autoparity, this occurs when the touch system enters the autobaud/autoparity sequence by sending breaks. If hardware flow control is disabled, Clear To Send (`CTS`) is not affected. This type of reset is equivalent to cycling the power to the touch system, except that the Clear To Send (`CTS`) is not affected if hardware flow control was not enabled before the reset. Also, if the touch system communicates serially but is set to use a fixed baud rate and parity (not autobaud/autoparity), or if the touch system uses the HBC, the touch system sends a Power Up Report (`F1 FF`) when it is ready to receive commands.

In all cases, the touch system is ready to receive commands within one second after the reset occurs. Touch applications must delay for one second after resetting the touch system. In cases where a break is sent, the one second time does not begin until the break is released.

## *Performing the Autobaud/Autoparity Sequence*

If you are using a touch system that communicates serially and is set to use autobaud/autoparity, you must perform the autobaud/autoparity sequence to allow the touch system to establish baud rate and parity that is used by the host.

To perform the autobaud/autoparity sequence, the host must send five ASCII carriage returns (CR - 0DH) followed by a delay of at least 100ms after each carriage return. The touch system uses these carriage returns to determine the baud rate used by the host. When the touch system has determined the baud rate of the host, it stops sending breaks to the host; the host need not send additional carriage returns after this occurs. The simplest method, however, is for the host to send five carriage returns with delays and ignore the breaks sent by the touch system. This is the recommended method.

Regardless of whether or not the touch system uses autobaud/autoparity, the host must send a *Software_Reset (3CH)* command followed by a delay of at least 100ms. This clears the touch system buffers and resets the touch system parameters listed in Table 4-6 to their defaults. If autobaud/autoparity is being used, this also establishes the parity being used by the host.

Table 4-6. SFP Default Settings

| **System Parameters** | **Default Setting** |
|---|---|
| Touch Scanning | Off |
| Reporting Method | Coordinate reporting |
| Touch Mode | *Tracking Mode* |
| Add Exit Point Modifier | Off |
| Report Transfer | Off |
| Hardware Flow Control | Off |

## Checking for Touch System Errors

To confirm that the initialization sequence was successful, determine the status of the touch system by sending the *Get_Error_Report (32H)* command. The Error Report that is returned lists any errors detected by the touch system. Since report transfer has not been enabled yet, the host must enable it so that the touch system can transmit the Error Report. This is accomplished by sending the *Report_Transfer_On (44H)* command to the touch system before sending the *Get_Error_Report (32H)* command.

The contents of the Error Report vary according to whether the touch system has a single processor or dual processors.

If the touch system did not detect any errors, the Error Report appears as follows:

| | |
|---|---|
| `F8 00 FF` | Reports no errors for single processor systems. |
| `F8 00 00 FF` | Reports no errors for dual processor systems. |

If the touch system detects errors, the `00` byte is replaced by an error code count, followed by error codes. These error codes are identified in the *Get_Error_Report (32H)* documentation in Appendix A.

If the Error Report is not received by the host, there is a communication error. Run the initialization sequence again or send the *Echo_On (20H)* command to determine the source of the communication problem.

### Setting the Reporting Method and Touch Mode

The host may now complete the initialization sequence and enable touch system scanning. It should send the appropriate Smart-Frame Protocol commands to set the desired reporting method and touch mode, send any other parameters (such as hardware flow control, and so forth), then send the *Touch_Scanning_On (2AH)* command.

## Touch System Initialization Examples

The following examples represent the recommended initialization sequences for various touch system hardware configurations.

### Using Autobaud/Autoparity

To initialize a touch system that communicates serially and uses autobaud/autoparity, use the following initialization sequence:

1. Send a 400ms break. You may send a *Reset (45H)* command instead, but this only works if the touch system has previously been set to receive commands at the current baud rate and parity and is not recommended.
2. Wait one second for the touch system to complete its power-on testing.

3. Send five carriage returns (CRs - 0DH) with a 100ms delay after each CR.
4. Send the *Software_Reset (3CH)* and delay 100ms.
5. Send the *Report_Transfer_On (44H)* command, followed by the *Get_Error_Report (32H)* command.
6. Read the Error Report sent by the touch system. If the report is received correctly and indicates no errors, the touch system is ready to use. If the report is not received correctly, or contains errors, take the appropriate action.
7. Send the *Get_Frame_Size_Report (37H)* command.
8. Read the Frame Size Report sent by the touch system. If the frame size is 223 x 223 (DFH x DFH), you can assume that the touch system is a guided acoustic wave system. If the frame size is reported as any other value, you can assume that the touch system is a scanning infrared system.

## Using a Fixed Baud Rate

To initialize a touch system that communicates serially and used a fixed baud rate, use the following initialization sequence:

1. Send a 400ms break. You may send a *Reset (45H)* command instead, but this only works if the touch system has previously been set to receive commands at the current baud rate and parity and is not recommended.
2. Wait one second for the touch system to complete its power-on testing.
3. Send the *Software_Reset (3CH)* command and delay 100ms.
4. Send the *Report_Transfer_On (44H)* command, followed by the *Get_Error_Report (32H)* command.
5. Read the Error Report sent by the touch system. If the report is received correctly and indicates no errors, the touch system is ready to use. If the report is not received correctly, or contains errors, take the appropriate action.

## Using the HBC

To initialize a touch system that uses the modular hardware-based controller (HBC), use the following initialization sequence:

1. Write to the HBC Hardware Reset Register (Base Address +2).
2. Wait one second for the touch system to complete its power-on testing.
3. Send the *Software_Reset (3CH)* command and delay 100ms.

4. Send the *Report_Transfer_On (44H)* command, followed by the *Get_Error_Report (32H)* command.
5. Read the Error Report sent by the touch system. If the report is received correctly and indicates no errors, the touch system is ready to use. If the report is not received correctly, or contains errors, take the appropriate action.

## Using an SBC

Touch systems that include the SBC are unique because they use the CPU of the host PC to manage the scanning of the frame and reporting of touch coordinates instead of using a dedicated microprocessor.

The following exceptions to the standard Smart-Frame Protocol exist for SBC-based touch systems:

- The scan reporting method is not supported by the SBC. Sending the *Scan_Reporting (22H)* command to the SBC has no effect.
- Sending the *Echo_On (20H)* command, the *Echo_Off (21H)* command, or the *Reset (45H)* command to the SBC has no effect, and causes the Invalid Command error to occur.
- The *Hardware_Flow_Control_On (41H)* and the *Hardware_ Flow_Control_Off (42H)* commands apply only to touch systems that communicate serially, and have no effect when sent to the SBC.

When using an SBC-based touch system, turning touch scanning on via the *Touch_Scanning_On (2AH)* command causes the SBC hardware to begin issuing hardware interrupts. Turning touch scanning off via the *Touch_Scanning_Off (2BH)* command causes the SBC hardware to stop issuing hardware interrupts. Since the SBC TAPI driver only uses host CPU time when an interrupt is issued by the SBC hardware, turning touch scanning off whenever possible releases host CPU time that would otherwise be used by the SBC TAPI driver for other uses.

## Compatibility Issues/Programming Tips

An application or driver that is hard-wired to a typical size or model of CT touch system may require modification if a different touch system is used. Applications and drivers that use the Smart-Frame Protocol to interface to the touch system should be designed to work with all types and sizes of touch systems that use the Smart-Frame Protocol. This lets you continue to use the application or driver without modification if a different size and/or model of CT touch system is used. The following design rules should be followed.

## Number of Processors Independence

*Get_Error_Report (32H)* causes an Error Report to be returned that details the errors for each processor in the touch system. Use the *Get_Configuration_Report (33H)* command to get a Configuration Report that includes the number of processors in the touch system to properly interpret this report. Do not hard wire the code that interprets the Error Report to work with a specific number of processors.

## Firmware Version Independence

*Get_Firmware_Version_Report (34H)* causes a Firmware Version Report to be returned that lists firmware versions for various touch system components. Do not hard wire the code that interprets the Firmware Version Report to only work with a specific number of version reports or a specific firmware version.

## Frame Size Independence

If a software calibration and scaling program, as described in this guide, is used, a change to a touch system with a different size frame simply requires that the calibration program be run on the new touch system. The frame size difference is reflected in the calibration parameters, and the touch application or driver code itself does not need to be modified. Do not hard wire the touch application or driver to a specific frame size, since this requires the touch application or driver to be modified if a different size frame is used.

## Touch System Response Time Independence

The amount of time required for a touch system to process a command may vary, depending upon the model of the touch system. This, coupled with the fact that there is no provision for software flow control in the host-to-touch system direction, means that the input queue of the touch system could overflow, causing commands to be missed if the touch system is bombarded with commands at a faster rate than it can process them. This usually occurs only when a long sequence of initialization commands is issued at a high baud rate.

To prevent this overrun and loss of command characters:

1. Use a delay of approximately 10 milliseconds between commands to allow the touch system time to process each command before the next is sent.
2. Use a lower baud rate.

Using a baud rate above 2400 baud does not produce any increase in apparent touch responsiveness. This is due to the fact that the communication bandwidth required to transmit the four-byte touch coordinate reports at the typical rate of 30 scans per second is slightly above 1200 baud. Therefore, using a baud rate above 2400 baud is unnecessary and merely reduces the noise immunity of the communication channel while producing no increase in apparent touch responsiveness.

## SFP Timing

The following timing parameters apply to touch systems that use the Smart-Frame Protocol.

### *Autobaud/Autoparity Delay Time*

During the autobaud/autoparity initialization sequence, a delay of at least 100 milliseconds must be present between the carriage returns and after the *Software_Reset (3CH)* command. This delay is required in order for the autobaud/autoparity algorithms to work properly.

### *Maximum Command Completion Time*

The maximum amount of time required for a Smart-Frame Protocol command to be processed and a corresponding report (if any) to be generated is one second. Touch applications should use at least this amount of time as their time-out value when awaiting a Smart-Frame report.

### *Reset Time/Diagnostics Completion Time*

The maximum amount of time required for a touch system that uses the Smart-Frame Protocol to become ready to begin the autobaud/ autoparity sequence or to receive commands is one second. Touch applications should either wait at least this amount of time or wait for some other signal that the touch system is ready to receive commands (such as the assertion of the Clear To Send (`CTS`) signal if serial hardware flow control is used) before beginning the autobaud/ autoparity sequence or sending commands to the touch system.

## SFP Programming Examples

The Carroll Touch Driver/Demo Disk contains five short example programs under the heading of “Programmer’s Guide Programming Examples.” They demonstrate how to interface directly to RS-232-based and HBC-based touch systems using the Smart-Frame

Protocol. Both a polling method and an interrupt-driven method are shown for each type of touch system. All of these programs were developed using Borland C. Minor modifications may be required for other compilers.

The example files are:

| | | |
|---|---|---|
| `CT.H` | - | Contains a CT header file. |
| `UART8250.H` | - | Contains a 8250 serial UART header file. |
| `RS232POL.C` | - | Contains an RS-232 polling example. |
| `RS232INT.C` | - | Contains an RS-232 interrupt example. |
| `HBCPOL.C` | - | Contains an HBC polling example. |
| `HBCINT.C` | - | Contains an HBC interrupt example. |

# 5 Smart-Frame Protocol II

This chapter gives an overview of the Smart-Frame Protocol-II, a firmware protocol that extends the capabilities of the SFP by offering support for higher resolution and a z-axis. Explanations of command formats and report formats are included.

This chapter discusses the following topics:

- Overview.
- Types of SFP-II Functions.
- Functions.
- Commands.
- Reports.
- Error Reporting.
- Overloaded Functions.
- Shared Parameters between SFP and SFP-II.

See Appendix B, “Smart-Frame Protocol II Function Reference,” for the specifications of each Smart-Frame Protocol II function.

## Overview

The Smart-Frame Protocol II (SFP-II) is a firmware protocol intended to be the successor to the existing Smart-Frame Protocol firmware protocol, which was defined in 1985. Driving factors behind the development of the SFP-II protocol are:

- The introduction of touch systems using guided acoustic wave technology, which supports high resolution touch coordinates as well as z-axis touch coordinates - features not supported by the existing Smart-Frame Protocol.
- The need for general and architectural enhancements to the SFP.

SFP-II has been initially implemented on guided acoustic wave systems, but is designed for and will be implemented on all Carroll Touch systems.

### *Extensibility*

SFP-II is designed to support true extensibility, allowing features to be added or removed over time. It does this by providing a standard mechanism whereby applications or drivers that interface with the touch system can determine which features the touch system supports.

This mechanism consists of two parts: the touch system can report the protocol version (not to be confused with the firmware version) to an application or driver via the Protocol Version Report, and the application or driver can use the *SetReportProperties (21H)* command to request that a Report Properties Report be sent. This report includes a parameter called FunctionVersion that can be used to determine if a particular function is supported.

The protocol version number reflects the unique set of features supported by that version of the protocol. Any time that a feature is added, removed, or changed in such a way that it would be visible to the user using the published SFP-II functions, the protocol version number is incremented.

The protocol version number of the SFP is (retroactively) defined to be 1.0. Note, however, that because the SFP contains no mechanism for reporting the protocol version number, SFP touch systems do not actually respond with a Protocol Version Report. Instead, if an application or driver receives no response when attempting to switch to SFP-II mode using the *SwitchToSFP-II (65H)* SFP command, it should timeout waiting for the command, and then assume that the touch system only supports SFP (SFP 1.0).

Protocol version numbers greater than 1.0 but less than 2.0 will be used during the development of the SFP-II protocol. When the SFP-II protocol is complete, that is, when it incorporates the initial set of desired features, that version of the protocol will be given a version number of 2.0. Subsequent changes to the protocol will result in changes to the subminor, minor, or major portions of the protocol version number, depending upon the extent of the changes.

One of the main purposes for extensibility is to allow properly written applications and drivers to work with touch systems that support SFP and touch systems that support SFP-II. A “properly written” application or driver uses the following sequence of steps during touch system initialization to determine the protocol version and act accordingly:

1. Initialize the touch system using the common initialization sequence.
2. Attempt to switch to SFP-II mode by issuing the *SwitchToSFP-II (65H)* SFP command.
3. If the touch system does not respond with a Protocol Version Report within the SFP timeout time (one second), the application or driver should assume that the touch system supports only the SFP (SFP 1.0), and use only SFP commands and expect only SFP reports.
4. If the touch system responds with a protocol version report that indicates a protocol version number of 2.0 or above, the application or driver may use all of the standard SFP-II commands and reports. The application or driver may also (optionally) use *SetReportProperties (21H)* command to request Report Properties Reports to ensure that each command that it uses is supported. This optional step is recommended if the application uses commands or reports that were not included in the original SFP-II protocol (SFP 2.0).

In summary, applications or drivers can use the Protocol Version Report to determine the firmware protocol version. The protocol version can be used to determine whether the touch system supports only SFP or SFP and SFP-II. The application or driver may also use the Protocol Version Report in conjunction with the protocol version revision history to determine the exact features that the firmware supports. Finally, for maximum protection against protocol changes, the application or driver can use the *SetReportProperties (21H)* function to ensure that each command that it intends to use is supported.

## Modal Protocols

The SFP-II is implemented as a modal protocol, meaning that, even if a touch system supports both the SFP and SFP-II, it can only support one protocol at a time and, during that time, cannot accept commands from the other protocol. To switch between protocols, use the *SwitchToSFP-II (65H)* SFP command and the *SwitchToClassicSFP (64H)* SFP-II function.

### Note

The SFP-II protocol currently lacks many necessary features that are supported in SFP, so it is necessary for the host to switch between the SFP and SFP-II to access these features. When the SFP-II protocol specification is complete, it will include all necessary features, eliminating the need to switch protocols.

## Backward Compatibility

Touch systems that implement SFP-II (known as SFP-II aware touch systems) also implement the existing SFP to ensure backward compatibility with existing touch systems and to avoid obsoleting the installed base of touch applications. Backward compatibility means that:

1. SFP-II aware touch systems may be used with existing applications that use the SFP without requiring the application to be modified.

   This is possible because the initialization sequence is identical for both SFP-II aware and non SFP-II aware touch systems, and because SFP-II aware touch systems power up under SFP and remain in SFP until explicitly commanded to switch to SFP-II.
2. Applications and drivers may be written to use both SFP-II aware touch systems and non SFP-II aware touch systems (albeit with reduced functionality).

   This is possible because a mechanism exists whereby applications and drivers can interrogate the touch system to determine whether the touch system supports SFP-II. The application or driver may choose to use the advanced functions of SFP-II or to use only the SFP.

## Types of SFP-II Functions

SFP-II functions are currently grouped into four logical categories. The logical categories are reserved in groups of 16 (10H), with each group containing functions that have similar purposes.

- Reset and touch reporting:
  *GetTouchState (01H)*
- Status reporting:
  *GetCoordinateRanges (10H)*
  *GetConfiguration (11H)*
- Parameter setting and reporting:
  *SetTouchModes (20H)*
  *SetReportProperties (21H)*
  *SetReportTransferMode (22H)*
- Mode switching:
  *SwitchToClassicSFP (64H)*
  *GetProtocolVersion (65H)*

## Functions

Touch systems that support SFP-II communicate with applications and drivers via the use of SFP-II functions. Each function consists of a command and a corresponding report, even if that report is simply a null report that only returns the report number and the command error status. The report number is the same as the command number for each command/report pair.

Each command/report pair may be thought of as corresponding to a function call in a language such as C, with the command parameters (if any) representing the parameters that are passed into the function, and the report parameters (if any) representing the parameters that are returned by the function.

The host computer sends SFP-II commands to the touch system, and the touch system responds by sending SFP-II reports to the host. The touch system must respond with the corresponding SFP-II report packet for each and every SFP-II command packet that it receives. The host, in turn, must wait until it receives the corresponding SFP-II report packet after sending an SFP-II command packet before it can send another SFP-II command packet.

The host should use a one second timeout when waiting for the report packet. If the report packet has not arrived after that time, the host should retry sending the command. If the touch system still does not respond after another timeout period, the host should send enough FFH bytes to ensure that the touch system's input buffer overflows, and then retry the command again. Note that the host could certainly send the FFH bytes without retrying the command if it so chose. Refer to "Error Reporting," later in this chapter, for more details on error handling.

This design greatly simplifies the handling of command and report packets for the touch system and the host. The touch system cannot queue up command packets from the host, thus preventing many potential overrun and timing problems.

## Commands

An SFP-II command has the format:

*`header packetbytecount commandnumber optionalparameters trailer`*

*`header`* = Defined to be 66H.

*`packetbytecount`*
= Length of the command number + the command parameters (if any) in bytes. For example, a command with two bytes of parameters has a byte count of 3 (one byte for the command number and two bytes for the parameters).

*`commandnumber`*
= One byte opcode that identifies the SFP-II command. Valid opcodes are 00H through BFH.

*`optionalparameters`*
= Parameters for the SFP-II command. The maximum number of parameter bytes is 252 (FCH).

*`trailer`*
= Defined to be FFH.

The maximum length of an SFP-II command packet is 256 bytes.

The format for SFP-II commands reflects the fact that SFP-II is a layered protocol. There are two layers, the validation layer and the interpretation layer.

## Validation Layer

The format for SFP-II commands at the validation layer is:

*`header packetbytecount interpretationlayer trailer`*

The validation layer consists of the outer portions of the command format and "wraps" around the inner portions of the command format, or the interpretation layer. To detect a valid SFP-II command in the incoming stream of bytes, the touch system firmware detects the header, reads the byte count that follows the header, reads the number of bytes specified by the byte count (the command packet), and verifies that the following byte is a trailer byte. If the segment of the incoming byte stream under consideration fits this format, the segment is deemed to be a valid SFP-II command packet and the command number and parameters are forwarded to the interpretation layer.

## Interpretation Layer

The format for SFP-II commands at the interpretation layer is:

*`commandnumber optionalparameters`*

To interpret the command, the touch system firmware first jumps to the appropriate command handler using a jump table. If the command number does not correspond to a defined SFP-II command, the command is deemed invalid and a report is sent to the host with the command error parameter set to the Invalid Command value.

If the command handler determines that the appropriate number of parameter bytes for the command is not present, or that one or more of the parameter bytes are otherwise invalid for the command (parameter is out of range, not set to a valid value for this particular touch system, and so forth), the corresponding SFP-II report is sent to the host with the command error parameter set to indicate the missing or invalid parameter byte. The parameters that the host sent in the command are echoed to the host in this report.

If the command handler determines that the appropriate number of parameter bytes for the command is present and that all of the parameter bytes are valid for that command, the touch system processes the command and sends the corresponding SFP-II report back to the host. The command error parameter is set to the "valid command and parameters" value to indicate that both the command and parameters were valid.

The bytes within the command packet are indexed beginning at 0 for the SFP-II command number, and ending at (command packet byte count - 1) for the last parameter byte. The length of the command packet is given by the packet byte count from the validation layer.

### *Example*

A simple example of an SFP-II command is the *GetTouchState (01)* command, which has one byte of data and no optional command parameters, is:

```
66 01 01 FF
```

A more complex example of a SFP-II command is the imaginary *Fubar* command, which expects a one byte parameter (bip) and a two byte parameter (flap):

```
66 04 <Fubar> <Bip> <FlapHi> <FlapLo> FF
```

If the command opcode for *Fubar* is 27H, and the values of the Bip and Flap parameters are 18H and 8923H, respectively, the command packet is as follows:

```
66 04 27 18 89 23 FF
```

## Reports

An SFP-II report has the format:

*`header packetbytecount commanderrorstatus reportnumber optionalreportparameters trailer`*

*`header`* = Defined to be EOH.

*`packetbytecount`*
= Length of the report number + the command error status + the report parameters (if any) in bytes. For example, a report with two bytes of parameters would have a byte count of 4 (one byte for the command number, one byte for the command error status, and two bytes for the parameters).

*`commanderrorstatus`*
= A one byte parameter that indicates whether the SFP-II command number and/or the SFP-II command

parameters of the SFP-II command packet that solicited the report were valid.

If the command number and parameters were all valid, this parameter is 0.

If there was an error associated with one of the command parameters, this parameter contains a number that points to the first byte of the parameter that was in error. If there are multiple parameters with errors, only the first one is indicated.

If the command number is invalid, this parameter is FFH.

If no SFP-II command packet was associated with this report (i.e, the report is an unsolicited report), this parameter is 0. Refer to “Error Reporting,” later in this chapter, for more information on this parameter.

`reportnumber`
= One byte opcode that identifies the SFP-II report. Valid opcodes are 00H through BFH.

`optionalreportparameters`
= Parameters for the SFP-II report. The maximum number of parameter bytes is 251 (FBH).

`trailer`= Defined to be FFH.

The maximum length of an SFP-II report packet is 256 bytes.

The generic report format for SFP-II reports reflects the fact that SFP-II is a layered protocol. There are two layers, the validation layer and the interpretation layer.

## Validation Layer

The format for SFP-II reports at the validation layer is as follows:

```
header packetbytecount interpretationlayer
trailer
```

Note that the validation layer consists of the outer portions of the report format and “wraps” around the inner portions of the format, or the interpretation layer. To detect a valid SFP-II report in the incoming stream of bytes, the host must detect the header, read the byte count that follows the header, read the number of bytes specified by the byte count (the report packet), and verify that the following byte is a trailer byte. If the segment of the incoming byte stream under consideration fits this format, the segment is deemed to be a valid SFP-II report packet and the command error status, report number, and parameters are forwarded to the interpretation layer.

## Interpretation Layer

The format for SFP-II reports at the interpretation layer is as follows:

*`commanderrorstatus reportnumber`*
*`optionalreportparameters`*

To interpret the report, the host should first examine the command error status parameter. If the command error status parameter indicates an error, the host should take the appropriate action.

The host should then examine the report number. If the report number does not correspond to a defined SFP-II report, the host should deem the report invalid.

Finally, the host should examine the report to determine that the appropriate number of parameter bytes for the report is present. If the appropriate number is not present, or one or more of the parameter bytes are otherwise invalid for the report (parameter is out of range and so forth), the host should deem the report invalid.

If the host determines that all information in the interpretation layer is valid, the host should process the command.

The bytes within the report packet are indexed beginning at 0 for the SFP-II report number, and ending at (report packet byte count - 1) for the last parameter byte. The length of the report packet is given by the packet byte count that was read during the validation layer.

## Example

An example of a report issued in response to a valid SFP-II command, *GetProtocolVersion* (command 65), is:

```
E0 04 00 65 02 12 FF
```

`E0` and `FF` are the header and footer, respectively. `04` indicates the report contains four bytes. `00` is the command error status (Cmderr) and indicates the report is valid. `65` is the report number, which is the command number. The parameters `02` and `12` represent the ProtocolVersionHi and ProtocolVersionLo bits, indicating protocol version 2.12.

## Reporting Modes

Each SFP-II report has a reporting mode associated with it that specifies when the report is to be sent. The available reporting modes are:

| | | |
|---|---|---|
| *Solicited Only Mode* | - | The touch system sends the selected report after receiving the corresponding command. |
| *Parameter Change Mode* | - | The touch system sends the selected report after receiving the corresponding command and whenever any of the parameters contained in the report changes. |
| *Continuous Mode* | - | The touch system sends the selected report after receiving the corresponding command and each time that it executes its main executive loop. |

*Parameter Change Mode* and *Continuous Mode* produce “unsolicited reports,” because reports are sent by the touch system even though it has not received a corresponding SFP-II command. The default reporting mode of most reports is *Parameter Change Mode*. The exceptions to this are the Multi Touch State and Raw Touch State Reports, which are solicited only.

Use the *SetReportProperties (21H)* function to set the reporting mode of reports.

## Report Transfer Mode

When report transfer is disabled, unsolicited reports are not transferred from the touch system to the host. Solicited reports continue to be transferred from the touch system to the host.

When report transfer is enabled, both solicited and unsolicited reports are transferred.

Use the *SetReportTransferMode (22H)* function to set the reporting mode of reports.

## Error Reporting

SFP-II uses a command error status parameter (Cmderr) to report errors in commands sent to the touch system. The one-byte parameter is part of every SFP-II report and indicates whether the SFP-II command number and/or command parameters were valid.

### *Note*

The use of the Cmderr parameter to indicate unsupported features is especially useful during the period that the SFP-II specification is being developed. Features that have been specified but not yet implemented will be indicated in this manner. **The host should check Cmderr in all reports returned from the touch system to recognize these unsupported features.**

Cmderr has a value of 0 if the command number and parameters are all valid, or if the report is an unsolicited report.

When an error occurs, the command number and parameter bytes (if any) that were sent by the host are echoed to the host in the corresponding report. The touch system does not take any of the actions and/or change the values of any of the parameters in the command.

### *Invalid Command Number*

When an invalid command number is detected, an SFP-II report packet is sent with Cmderr set to `FF`.

For example, if function 93H is undefined and the host sends the following command:

```
66 01 93 FF
```

The touch system responds with the following report:

```
E0 02 FF 93 FF
```

The first `FF` byte is Cmderr and indicates that there is no command defined with an opcode value of 93H.

If function 94H is undefined and the host sends the following command:

```
66 04 94 01 02 03 FF
```

The touch system responds with the following report:

```
E0 05 FF 94 01 02 03 FF
```

The first `FF` byte is Cmderr and indicates that there is no command defined with an opcode value of 94H. Note that the parameters that were sent with the invalid command packet (`01 02 03`) are returned along with the invalid command number.

## Invalid Parameter Value

When the parameter number is out of range, an SFP-II report packet is sent with Cmderr containing a number that points to the first byte of the parameter that was in error. If there were multiple parameters with errors, only the first one is indicated.

If the host sends the *SetTouchModes (20H)* command as follows:

```
66 04 20 01 04 03 FF
```

The touch system responds with the following report:

```
E0 05 02 20 01 04 03 FF
```

The `02` byte is Cmderr and indicates that the second parameter is out of range. (The value of `04` for TouchStateReportType is not among the valid values of 01, 02, or 03.) Since the `04` byte is out of range, the error results and is reported in Cmderr. The third parameter is also out of range. This parameter is the TouchReportingMode parameter, which has valid values of 00, 01, and 02. The `03` byte is out of range. However, this is not reported to the host because Cmderr only reports the first invalid parameter if multiple parameters are invalid.

## Unsupported Feature

When a parameter value requests an option that the particular firmware implementation does not support, an SFP-II report packet is sent with Cmderr containing a number that points to the first byte of the parameter that was in error. If there were multiple parameters with errors, only the first one is indicated.

Suppose the host sends the *SetTouchModes (20H)* command as follows to (1) enable touch detection; (2) set the TouchStateReportType to the Multi Touch State Report; and (3) set the *Touch Reporting Mode* to Continuous:

```
66 04 20 01 02 02 FF
```

If the particular firmware implementation in the touch system does not support the MultiTouchState value of the TouchStateReportType parameter (the first `02H` byte in the command), the touch system responds with the following report:

```
E0 05 02 20 01 02 02 FF
```

The `02` byte is Cmderr and indicates that the second parameter is in error. This parameter is the TouchStateReportType parameter. The value of 02H is a valid value for this parameter and represents a request by the host that the touch data be returned using the Multi Touch State Report. However, since this particular firmware does not support the MultiTouchState reporting method, the touch system returns the error in Cmderr to indicate this to the host.

## Invalid Byte Count

The touch system reports an invalid byte count if it reads the number of bytes specified by the byte count and the next byte received is not a command packet trailer byte.

Note that this means that if the number of bytes received after the byte count is less than the byte count, no error is generated until enough additional bytes are received to match the byte count or the touch system’s input buffer overflows. The touch system does not use any sort of timeout technique if it receives fewer bytes than expected.

This error also occurs if the touch system’s input buffer overflows while it is attempting to read the number of bytes specified by the byte count.

When an invalid byte count is detected, an SFP-II report packet is sent with the Cmderr parameter set to FEH and the SFP-II report number set to the command number.

For example, suppose the host sends the following command:

```
66 04 20 01 04 03 FF
```

Due to noise on the serial line, the touch system actually receives an extra byte after the first parameter as follows:

```
66 04 20 01 86 04 03 FF
```

The touch system responds with the following report:

```
E0 06 FE 20 01 86 04 03 FF
```

`FE` is the Cmderr parameter and indicates that a byte count mismatch error occurred. `20` is the ReportNumber parameter, and the following four bytes echo the parameters that the touch system received.

As a second example, suppose the touch system has an input buffer size of 32 bytes and the host sends the following, lengthy, incorrect command:

```
66 50 FA 01 02 03 ... 4F FF
```

The touch system reads bytes until its input buffer overflows, then responds with the following report:

```
E0 06 FE FA 01 02 03 ... 1D FF
```

`FE` is the Cmderr parameter and indicates that a byte count mismatch error occurred. The following 30 bytes echo the command number and parameters that the touch system received before the input buffer overflowed.

For a complex example, suppose the touch system has an input buffer size of 32 bytes and the host sends the command as follows:

```
66 04 20 01 04 03 FF
```

Due to noise on the serial line, the touch system actually receives a value of 40H (64 decimal) for the byte count instead of 04H as follows:

```
66 40 20 01 04 03 FF
```

The touch system reads all seven bytes of the command and places them in its input buffer. No report is sent because the touch system is expecting a command that is 64 bytes in length (not counting the header, byte count and trailer), but only 5 of the 64 bytes have arrived (the command number, the three parameter bytes, and the trailer, which the touch system interprets as byte 5 of the 64 bytes that it expects to receive).

The host can then wait until the command completion timeout time of one second has elapsed, and then re-send the command. The seven bytes contained in the command are interpreted by the touch system as bytes 6 through 12 of the 64 bytes that it is expecting, and it again sends no report. At this point, there are 14 bytes in the input buffer, with 18 bytes remaining.

If the host repeats the timeout and re-send cycle three more times, the input buffer overflows when the third command is sent, and the touch system responds with the following report:

```
E0 06 FE 20 01 04 03 FF 66 04 20 01 04 03 FF 66
04 20 01 04 03 FF 66 04 20 01 04 03 FF 66 04 20
01 FF
```

`FE` is the Cmderr parameter and indicates that a byte count mismatch error occurred. The following 30 bytes echo the command number and parameters that the touch system received before the input buffer overflowed. The touch system is now looking for a new command, and if the host sent the command once more, the touch system would receive it, process it, and return a report (presuming no error occurred in sending this latest command).

The time to re-synchronize this entire sequence would be a little over four seconds - the original command timeout (one second) plus three retry timeouts (one second each). The fourth retry would not result in a timeout because the touch system would send the report that contained the bytes read.

The host need not wait for enough timeout and re-send cycles to fill the input buffer, however. The host can accelerate re-synchronization by issuing enough FFH bytes to flush the touch system's input buffer. This forces the input buffer to overflow and causes the touch system to begin looking for a new command. For example, if the host had used this method after the first report timeout had occurred, the touch system would have responded with the following report:

```
E0 06 FE 20 01 04 03 FF FF FF FF FF FF FF FF FF
FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
FF FF
```

`FE` is Cmderr and indicates that a byte count mismatch error occurred. The following 30 bytes echo the command number and parameters, as well as the flushing `FFH`s that the touch system received before the input buffer overflowed. The touch system is now looking for a new command, and if the host sent the command once more, the touch system would receive and process it, and return a report (presuming no error occurred in sending this latest command). With this approach, the time to re-sync is a little over one second (the timeout for only the original command).

## Not Enough Parameters

If the number of command parameters is less than the number of command parameters expected for the command, an SFP-II report packet is sent with Cmderr pointing to the location of the first missing parameter (the trailer).

Note that this case differs from the invalid byte count case. In this case, the command packet byte count is consistent with the total number of bytes in the command number and parameters, there just weren't enough parameters.

If the host sends the *SetTouchModes* (20H) command as follows to enable touch detection and set the TouchStateReportType to the Multi Touch State Report, but leaves off the required third parameter (the TouchReportingMode parameter):

```
66 03 20 01 02 FF
```

The touch system responds with the following report:

```
E0 04 03 20 01 02 FF
```

The `03` byte is Cmderr and indicates that a third parameter was expected but not present.

## Too Many Parameters

If the number of command parameters is greater than the number of command parameters expected for the command, an SFP-II report packet is sent with Cmderr pointing to the location of the first extra parameter.

Suppose the host sends the *SetTouchModes (20H)* command as follows. The first three parameters correctly enable touch detection (`01`), set the TouchStateReportType to the Multi Touch State Report (`02`), and set the TouchReportingMode to Continuous (`02`). However, an erroneous fourth parameter (`04`) is also included:

```
66 05 20 01 02 02 04 FF
```

The touch system responds with the following report:

```
E0 06 04 20 01 02 02 04 FF
```

The `04` byte is Cmderr and indicates that an extra parameter (the fourth parameter) was present but not expected.

## Overloaded Functions

Some SFP-II functions are overloaded in a manner similar to the way that C++ supports overloaded functions.

An overloaded function is a function that is normally used to set the values of some parameters, but can also be used to get the values of the same parameters.

- To set the parameter values, the host sends the complete command including all parameters. The touch system sets the parameters using the values sent by the host, and returns a report that contains the resulting values for the parameters.
- To get the parameter values, the host sends only the command number with none of the parameter values present or a subset of the parameter values present, depending on the function definition. The touch system returns a report that contains the parameter values.

If the host sends a command that includes the command number and a partial list of parameters, it is an illegal action and an invalid parameter error is returned in Cmderr.

For example, to get the current touch values using the *SetTouchModes (20H)* command, the host sends the command as follows:

```
66 01 20 FF
```

The touch system responds with the following report:

```
E0 05 00 20 01 01 00 FF
```

This report indicates no errors in Cmderr and reports the values for the three parameters defined for the function that were in effect when the command was sent (`01`, `01`, and `00`). No parameter values were changed.

However, to set the touch values using the *SetTouchModes (20H)* command, the host sends the command as follows:

```
66 04 20 01 01 01 FF
```

The touch system responds with the following report:

```
E0 05 00 20 01 01 01 FF
```

This report indicates no errors in Cmderr and reports the values for the three parameters defined for the function after the parameter values were changed as a result of the host sending the command (three `01` values).

If the host sends a partial list of parameters for the *SetTouchModes (20H)* command as follows:

```
66 02 20 00 FF
```

The touch system responds with the following report:

```
E0 03 02 20 00 FF
```

This report indicates that the second parameter byte was erroneous via Cmderr (the `02` byte) and echoes the parameters that the host sent. A Cmderr value of 02H indicates that the touch system expected more parameters than were actually received.

## Shared Parameters between SFP and SFP-II

Most global parameters (that is, parameters that are not associated with a particular function) in SFP and SFP-II are independent of one another. However, some global parameters are shared between SFP and SFP-II and maintain their value when the protocol changes.

Because touch systems that support SFP and SFP-II power up in the SFP, shared parameters have an SFP default value but no SFP-II default value. The initial value of shared parameters at the time that the touch system is switched to the SFP-II is equivalent to the value of the corresponding SFP parameter at that time.

The global parameters that are currently shared include Touch Detection and Report Transfer.

### *Touch Detection*

In the SFP, the Touch Scanning parameter is enabled and disabled via the *Touch_Scanning_On (2AH)* and *Touch_Scanning_Off (2BH)* SFP commands and is reported in the Touch Scanning parameter of the *Get_State_Report (47H)* SFP command.

In SFP-II, the Touch Detection parameter is set and reported via the TouchDetection parameter of the SFP-II function.

## Report Transfer

The method of transferring reports differs slightly between SFP and SFP-II. In SFP, turning Report Transfer off disables all reports, both solicited and unsolicited. In SFP-II, setting the ReportTransferMode parameter to disabled inhibits unsolicited reports but does not inhibit solicited reports.

In the SFP, the Report Transfer parameter is enabled and disabled via the *Report_Transfer_On (44H)* and *Report_Transfer_Off (43H)* SFP commands and is reported in the Report Transfer parameter of the *Get_State_Report (47H)* SFP command.

In SFP-II, the ReportTransferMode parameter is set and reported via the ReportTransferMode parameter of the *SetTouchModes (20H)* SFP-II function.

If Report Transfer is disabled when the touch system is switched to SFP-II, any SFP reports that are pending at that time are sent before the SFP-II Protocol Version Report is sent. The Report Transfer parameter remains set to disabled.

### Note

The Report Transfer shared parameter is implemented in the GW DSP Serial Controller in a different manner from that described here because the *SetReportTransferMode (22H)* SFP-II function is not implemented on this controller. The ReportTransfer parameter is shared as described, but when the controller is switched from SFP mode to SFP-II mode, the ReportTransfer shared parameter is set to enabled. When the controller is switched from SFP-II back to SFP, the ReportTransfer shared parameter does not change value.

# 6 *Touch Application Program Interface (TAPI)*

This chapter includes an overview of the TAPI software functions, the specifications for each function, TAPI driver installation and initialization, and programming examples.

The chapter discusses the following topics:

- Overview.
- Installing a TAPI Driver.
- Determining if a TAPI Driver Is Installed.
- Calling TAPI Functions.
- Touch System Initialization Using a TAPI Driver.
- TAPI Programming Examples.

See Appendix C, “TAPI Function Reference,” for the specifications of each TAPI function.

## Overview

The Touch Application Program Interface (TAPI) is a set of software functions that lets an application communicate with a Carroll Touch touch system using the Smart-Frame Protocol without interfacing directly to the hardware. Using the TAPI interface protocol yields the following benefits:

- An application that interfaces to a TAPI driver is independent of the touch system hardware. Each touch system hardware configuration has a TAPI driver, and all of these TAPI drivers share a common interface (the TAPI interface). As a result, an application that uses TAPI may be used with various touch system hardware configurations without modification by simply loading the appropriate TAPI driver.
- It is generally easier to write an application that uses TAPI software interrupt calls to communicate with the touch system than to write an application that interfaces directly to the touch system hardware.

The TAPI interface does not include support for calibration or touch coordinate scaling. These two functions must be performed by the touch application itself, just as in touch applications that interface directly to the touch system hardware.

There are three TAPI drivers:

- Software-based controller (SBC) driver.
- Hardware-based controller (HBC) driver.
- RS-232 controller driver.

TAPI driver is a generic term used to describe all three drivers. Each TAPI driver is a terminate-and-stay-resident (TSR) program that makes it possible to use the touch system via a software interrupt rather than by directly accessing the touch system hardware.

The SBC driver must be loaded to use a touch system that uses the SBC. The SBC is unable to use the Smart-Frame Protocol directly because the SBC has no processor on board. Use of the HBC or RS-232 drivers with touch systems that use the HBC or RS-232 controller is optional, since the application may interface directly to the HBC or RS-232 controller using the Smart-Frame Protocol.

The TAPI drivers run on an IBM or IBM-compatible PC. Each TAPI driver communicates with any Carroll Touch touch system or controller that recognizes the Smart-Frame Protocol and communicates either serially through a comm port or directly through the PC bus.

## Installing a TAPI Driver

To install a TAPI driver, simply run the executable driver file with additional command line parameters, if appropriate, from the DOS command line. This loads the driver into memory as a TSR program.

### *SBC Driver*

If you have set the I/O address or the interrupt number parameter of the SBC to values other than the default parameters, or if you are using a touch frame that has a different number of x-axis or y-axis beams than the default, you must provide the correct values for these parameters on the command line when installing the SBC driver.

The SBC driver command line has the following syntax:

`SBC` *`options`*

The available *`options`* are:

| | | |
|---|---|---|
| `U` | = | Uninstalls the driver. |
| `A`*`n`* | = | I/O address. *`n`* may range from 200H to 3F0H. The default is 300H. |
| `I`*`n`* | = | Interrupt number override. *`n`* may be 2, 3, 4, 5, or 7. The default is 7. |
| `X`*`n`* | = | Number of x beams on frame. The default is 40. |
| `Y`*`n`* | = | Number of y beams on frame. The default is 30. |
| `S`*`n`* | = | TAPI software interrupt. *`n`* may be the number of any unused software interrupt. The default is 55H. |

The command line is case insensitive and the command line parameters may be arranged in any order. For example, to install an SBC driver using an I/O address of 320H, interrupt 5, and 30 x-beams and 20 y-beams, you can type either:

```
SBC A320 I5 X30 Y20
```
or
```
sbc i5 x30 a320 y20
```

## HBC Driver

If you have set the I/O address or the interrupt number parameters of the HBC to values other than the default parameters, you must provide the correct values for these parameters on the command line when installing the HBC driver.

The HBC driver command line has the following syntax:

`HBC` *`options`*

The available *`options`* are:

| | | |
|---|---|---|
| `U` | = | Uninstalls the driver. |
| `A`*`n`* | = | I/O address. *`n`* may range from 200H to 3F0H. The default is 300H. |
| `I`*`n`* | = | Interrupt number. *`n`* may be 2, 3, 4, 5, or 7. The default is 7. |
| `S`*`n`* | = | TAPI software interrupt. *`n`* may be the number of any unused software interrupt. The default is 55H. |

The command line is case insensitive and the command line parameters may be arranged in any order. For example, to install an HBC driver using an I/O address of 340H, hardware interrupt 2, and software interrupt 57H, you can type either:

```
HBC A340 I2 S57
```
or
```
hbc i2 a340 s57
```

## RS-232 Driver

If you have set the baud rate or parity parameters of the RS-232 controller board to values other than the default values of autobaud/autoparity, or if you are using an RS-232 port other than the default value of COM1, you must provide the correct values for these parameters on the command line when installing the RS-232 driver.

The RS-232 driver command line has the following syntax:

`RS232` *`options`*

The available *`options`* are:

| | | |
|---|---|---|
| `U` | = | Uninstalls the driver. |
| `C`*n* | = | Serial port. *n* may be 1 or 2. The default is 1. If the `A` and `I` parameters are used, the `C` parameter is ignored. |
| `B`*n* | = | Baud rate. *n* may be 3, 12, 24, 48, or 96. The default is 48. |
| `P`*n* | = | Parity. *n* may be E (even), O (odd) or N (none). The default is N. |
| `S`*n* | = | TAPI software interrupt. *n* may be any unused software interrupt. The default is 55H. |
| `A`*n* | = | I/O address override. *n* may range from 0H to FFFFH. The `A` and `I` parameters must be used together. An error condition occurs if one override parameter is used without the other being present. |
| `I`*n* | = | Interrupt number override. *n* may be 2, 3, 4, 5, 6, or 7. The `A` and `I` parameters must be used together. An error condition occurs if one override parameter is used without the other being present. |

The command line is case insensitive and the command line parameters may be arranged in any order. For example, to operate the RS-232 controller at a baud rate of 4800 with no parity through serial communication port 1, you can type either:

```
RS232 C1 B48 PN
```
or
```
rs232 b48 c1 pn
```

If you wish to use the RS-232 driver with a serial port that uses a base I/O address and/or interrupt number other than the standard values of 3F8H and 4 for COM1 or 2F8H and 3 for COM2, you may use the `A` and `I` parameters to override the default values.

## Error Messages

Table 6-1 defines the error messages and meanings for the TAPI drivers.

Table 6-1. TAPI Error Messages and Explanations

| | |
|---|---|
| Message: | `Invalid command line parameter.`<br>`Valid command line parameters are:` |
| Meaning: | The command line syntax is invalid. The installation process is aborted. |
| Message: | `A CT driver is already installed at software interrupt xxH`. |
| Meaning: | A CT driver has been previously installed on the same software interrupt. `xxH` denotes the software interrupt. The TAPI driver looks only for the string `CT DRIVER -`. It does not look for a specific type of driver. |
| Message: | `Communication error - unable to send command.`<br>`Check that the touch system is properly connected.` |
| Meaning: | The TAPI driver could not initialize the touch system because the driver could not send commands to the touch system. A timeout occurred while attempting to transmit the command. |
| Message: | `Communication error - report expected but not received.`<br>`Check that the touch system is properly connected.` |
| Meaning: | The TAPI driver could not initialize the touch system because a report that was expected was not received. A timeout occurred while waiting for the report. |
| Message: | `The selected RS-232 serial port was not found.` |
| Meaning: | The RS-232 driver could not initialize the touch system because the driver could not find the specified serial port. |

Table 6-1. TAPI Error Messages and Explanations (Continued)

| | |
|---|---|
| Message: | `TAPI driver installation failed.` |
| Meaning: | This error message accompanies other error messages and indicates that installation was aborted due to the stated condition. |
| Message: | `Communication error - report expected but not received. Check that the touch system is properly connected.` |
| Meaning: | The TAPI driver could not initialize the touch system because a report that was expected was not received. A timeout occurred while waiting for the report. |
| Message: | `No TAPI driver resident at software interrupt XXH. Uninstall aborted.` |
| Meaning: | An attempt is made to uninstall a TAPI driver at software interrupt `XXH`, but no TAPI signature is detected at that software interrupt. |
| Message: | `The I/O Address Override (a) and Interrupt Number override (i) parameters must both be present in order to override the I/O address and interrupt number.` |
| Meaning: | One override parameter is present without the other. |

## Determining if a TAPI Driver Is Installed

An application program may determine if a TAPI driver is installed by performing a string compare starting at the address pointed to by the TAPI software interrupt vector +2. For all TAPI drivers, the first 9 characters read `CT DRIVER`. The type of driver is identified by an additional string:

| | |
|---|---|
| `CT DRIVER - SBC` | Identifies an SBC driver. |
| `CT DRIVER - HBC` | Identifies an HBC driver. |
| `CT DRIVER - 232` | Identifies an RS-232 driver. |

## Calling TAPI Functions

To call a TAPI function, load the registers as described in the “Call with” sections for the TAPI functions described in Appendix C. Then, call the TAPI driver software interrupt and read the registers as described in the “Returns” section for that function.

The following example illustrates how to call TAPI functions:

```
int SendSmartFrameCommand (char command, int
TAPI_sw_int)
{
  union REGS regs;

  regs.x.ax = 1;
  regs.h.bh = 0;
  regs.h.bl = 0x32;
  int86 (0x55, &regs, &regs);

  if (regs.x.cx)
   return (1);

  return (0);

} /*  SendSmartFrameCommand  */
```

## Touch System Initialization Using a TAPI Driver

To initialize the touch system using a TAPI driver, send the following functions and commands in this order:

1. Call *Reset (0)*.
2. Call *SendCommand (1)*, with the *Software_Reset (3CH)* as the Smart-Frame command (`BL` = 3CH). If *SendCommand* returns a nonzero value in `CX`, abort the routine.
3. Wait at least 100 ms.
4. Call *SendCommand (1)*, with *Report_Transfer_On (44H)* as the Smart-Frame command (`BL` = 44H).
5. Call *SendCommand (1)*, using *Get_Error_Report (32H)*.
6. Call *GetReports (2)*, which loads the report into the report buffer pointed to by `BX` and `DX`.
7. Read the Error Report out of the buffer. If there are no errors, the report reads `F8 00 FF`.

At this point you may set the desired touch mode using *SendCommand (1)* with the appropriate Smart-Frame Protocol command, then turn on scanning by using *SendCommand (1)* with a *Touch_Scanning_On (2AH)* command. The touch system is now initialized.

## TAPI Programming Examples

The CT Driver/Demo Disk contains three short example programs under the heading of “Programmer’s Guide Programming Examples.” They demonstrate how to interface to RS-232-based and HBC-based touch systems via a TAPI driver using the Smart-Frame Protocol. Both a polling method and an interrupt-driven method are shown for each type of touch system. All of these programs were developed using Borland C. Minor modifications may be required for other compilers.

The example files are:

| | |
|---|---|
| `CT.H` | Contains a Carroll Touch header file. |
| `TAPIPOL.C` | Contains a TAPI polling example. |
| `TAPIINT.C` | Contains a TAPI interrupt example. |

# 7 CTKERN

This chapter describes the features and capabilities of the CTKERN driver, as well as its installation procedures and parameters. It also discusses the operation of the CTKERN calibration program (`CALIB.EXE`).

This chapter discusses the following topics:

- Overview.
- Calibration.
- Scaling.
- Touch Reporting.
- Calibration and Scaling Examples.
- Temporal Filter.
- Methods for Interfacing CTKERN and an Application Program.
- Loading the CTKERN Driver.
- Determining if the CTKERN Driver Is Installed.
- Calling CTKERN Functions.
- CALIB.EXE.
- CALIB.DAT.
- CTKERN Programming Examples.

See Appendix D, “CTKERN Function Reference,” for the specifications of each CTKERN function.

## Overview

The CTKERN driver communicates with the touch system using the TAPI driver appropriate for the touch system, and with the application program using the CTKERN functions, which are accessed via a software interrupt.

CTKERN is a DOS driver that offers the following features:

- Calibration support, including multiple calibrations to allow for monitors that do not maintain a constant image size when displaying multiple video modes.
- Touch coordinate scaling support, including multiple sets of scaling parameters to automatically support multiple video modes.
- Easy-to-use touch state reporting.
- Support for user-installable touch event handlers for interrupt-driven applications.
- Uninstall capability.

The application software may not issue TAPI function calls while CTKERN is loaded. In fact, when CTKERN loads, it reads the TAPI software interrupt vector, saves it, and uses it to call the TAPI driver instead of the software interrupt. The TAPI software interrupt is replaced by a pointer to a return from interrupt instruction within CTKERN, blocking any calls to TAPI. The return from interrupt instruction is followed by a `NOP` and the `CT DRIVER -` string, so that the driver detection mechanism continues to indicate an installed TAPI driver at the TAPI software interrupt. When CTKERN is unloaded, it replaces the TAPI software interrupt vector with the value that was saved, re-enabling calls to TAPI.

The overall relationship between the touch hardware, the TAPI drivers, the CTKERN driver, and the application software is illustrated in Figure 7-1.

## Calibration

CTKERN allows up to ten sets of video mode specific calibration parameters. By using multiple calibrations, CTKERN can allow for monitors that do not maintain a constant image size when displaying multiple video modes. One of these sets is designated as the default calibration.

There are three options for calibration: disabled, fixed, and automatic. If calibration is disabled, the touch coordinates reported by CTKERN

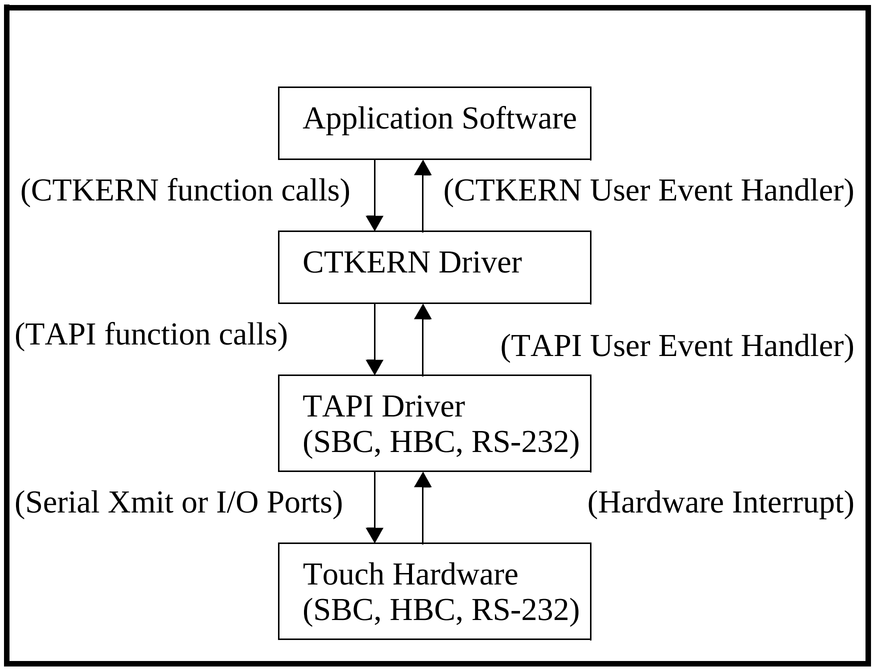


Figure 7-1. Touch System to Application Communication

are not calibrated. If fixed calibration is selected, the default calibration is always used, regardless of the BIOS video mode being used. If automatic calibration is selected, CTKERN intercepts BIOS Int 10H and watches for *SetVideoMode (0)*. When a *SetVideoMode* function occurs, CTKERN switches to the calibration parameters for that video mode if they exist. If no calibration exists for that video mode, CTKERN switches to the default calibration parameters.

*SetCalibrationParameters (4)* may also be used to set the calibration parameters to arbitrary values that are not related to any calibration table entry.

CTKERN attempts to read a file of calibration parameters (stored, by default, in `CALIB.DAT`) when it is loaded. This file is created by `CALIB.EXE`, the CTKERN calibration program, described later in this chapter. If no calibration file is present or if the calibration file contains multiple default calibrations, CTKERN does not load, but instead prints an appropriate error message.

The CTKERN internal table of calibration parameters may be read or modified while CTKERN is loaded by calling *GetCalibrationTableEntry (7)* or *SetCalibrationTableEntry (6)*, respectively.

## Scaling

CTKERN has the ability to scale the touch coordinates to a user-defined coordinate system. There are three options for scaling: disabled, fixed, and automatic.

If scaling is disabled, the touch coordinates reported by CTKERN are not scaled.

If fixed scaling is selected, the touch coordinates reported by CTKERN are scaled using 0, 0 for the upper left x and y scaling parameters and (Xres - 1, Yres - 1) from the calibration parameters of the default calibration entry for the lower right x and y scaling parameters, then are passed on to the application program. If no calibration entry is marked as the default, the Xres, Yres values of the first calibration entry (calibration table index 0) are used.

If automatic scaling is selected, the touch coordinates reported by CTKERN are scaled using 0, 0 for the upper left x and y scaling parameters and (Xres - 1, Yres - 1) from the calibration parameters for the currently selected BIOS video mode for the lower right x and y scaling parameters, then are passed on to the application program. The driver determines the video mode by intercepting calls to BIOS mode 10H function 0 (*Set Video Mode*). If an entry in the table of calibration parameters that corresponds to that video mode exists, the Xres, Yres values of those calibration parameters are used. If no such entry exists, the Xres, Yres values of the default calibration parameters are used. If no calibration entry is marked as the default, the Xres, Yres values of the first calibration entry (calibration table index 0) are used.

*SetScalingParameters (9)* may also be used to set the scaling parameters to arbitrary values that are not related to the Xres and Yres parameters in any calibration table entry.

CTKERN has the ability to scale the z-axis pressure parameter returned by touch systems that support z-axis pressure detection. There are only two options for z-axis scaling: disabled and enabled. When z-axis scaling is disabled, the raw z-axis parameter reported by the touch system is reported by CTKERN. If z-axis scaling is enabled, the z-axis parameter reported by the touch system is scaled linearly within the range defined by user-definable minimum and maximum pressure values.

## Touch Reporting

The application program may get touch reporting information from CTKERN either by calling *GetTouchState (1)* that returns the current touch state, or by setting up a user event handler that is called whenever the touch state changes by using *SetUserEventHandlerMode (23)*.

Possible touch states are:

| | |
|---|---|
| NT | Not touched, with scaled (if enabled), calibrated (if enabled) coordinates of the last place the screen was touched. If the screen has not been touched since the driver was last loaded or reset, the coordinates returned are 0, 0. |
| TO | Touched, with scaled (if enabled), calibrated (if enabled) coordinates of where the screen is currently being touched. |
| NC | Non-contiguous. |

The touch state is automatically maintained by CTKERN using an interrupt-driven background process.

CTKERN also includes *SetTouchState (2)* to manually set the touch state to a user-specified state. This can be useful for debugging and so forth.

## Calibration and Scaling Examples

Because the calibration and scaling modes of CTKERN may be independently set, there are four possible combinations of calibration and scaling modes, as shown in Figure 7-2 through 7-5:

| | | |
|---|---|---|
| Figure 7-2: | Calibration mode | = Fixed or automatic |
| | Scaling mode | = Fixed or automatic |
| Figure 7-3: | Calibration mode | = Fixed or automatic |
| | Scaling mode | = Disabled |
| Figure 7-4: | Calibration mode | = Disabled |
| | Scaling mode | = Fixed or automatic |
| Figure 7-5: | Calibration mode | = Disabled |
| | Scaling mode | = Disabled |

Each figure illustrates the touch coordinates that are returned for that particular combination of calibration and scaling modes. The touch active area is indicated by the striped area. The range of touch coordinates that are returned by a touch within the touch active area is indicated by the coordinate pairs at the upper left and lower right corners of either the touch active area defined during calibration (the inner rectangle) or the touch active area of the touch system (the outer rectangle).

The examples all assume the following:

- A touch frame with 80 logical x-axis coordinates numbered 0 - 79, and 60 logical y-axis coordinates numbered 0 - 59.
- Scaling parameters set to match a 640 x 480 VGA display.

| | |
|---|---|
| Upper left x | = 0 |
| Upper left y | = 0 |
| Lower right x | = 639 |
| Lower right y | = 479 |

- Touches at (5, 4) and (74, 55) for the upper left and lower right corners, respectively, during calibration.

The numbers on the outside of the outer rectangle indicate the logical touch coordinates along each axis.

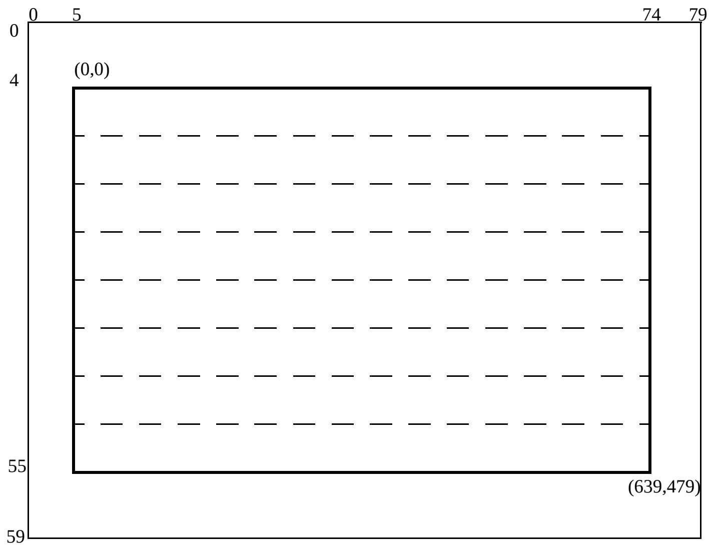


Figure 7-2. Calibration Mode Fixed or Automatic and Scaling Mode Fixed or Automatic

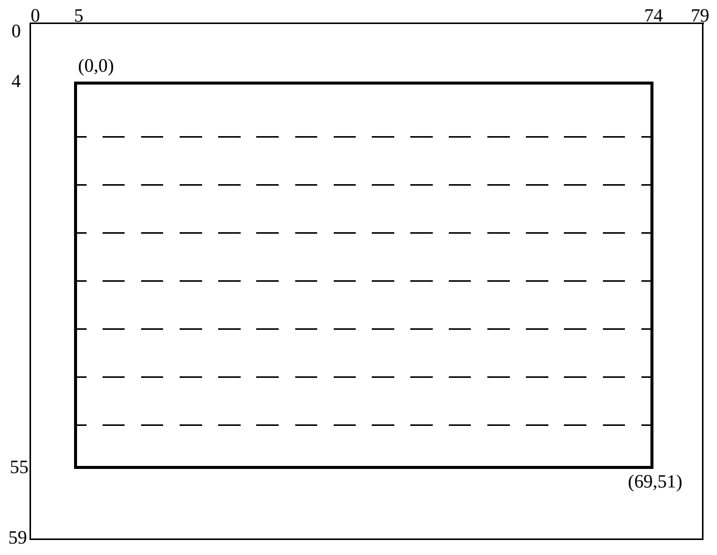


Figure 7-3. Calibration Mode Fixed or Automatic and Scaling Mode Disabled

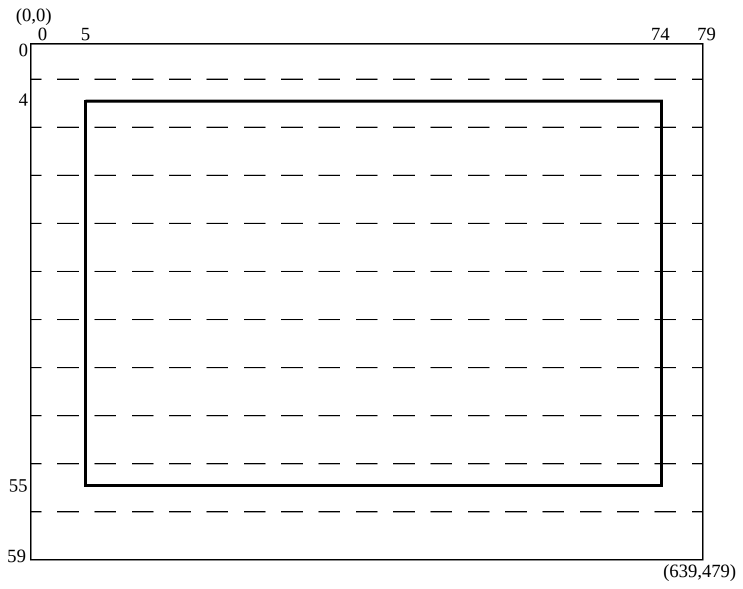


Figure 7-4. Calibration Mode Disabled and Scaling Mode Fixed or Automatic

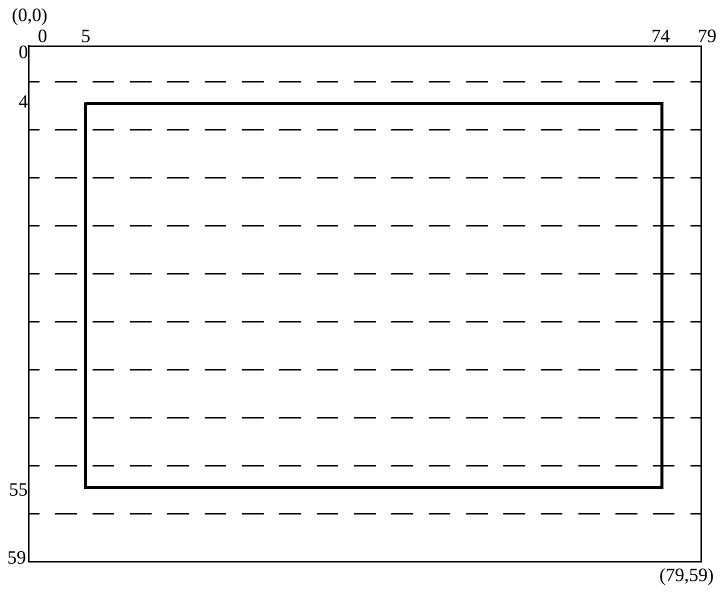


Figure 7-5. Calibration Mode Disabled and Scaling Mode Disabled

## Temporal Filter

When enabled, the temporal filter acts much like a low pass filter in the time domain for all touch state transitions. You must define two parameters, Spatial Filter Box Size and Temporal Filter Time.

When the stylus touches the screen, the center of the spatial filter box is set to the coordinates where the screen was first touched. The touch state is set to “touched” only after the stylus has remained in the spatial filter box for the length of time specified by the Temporal Filter Time parameter.

If the stylus moves beyond the spatial filter box, the Temporal Filter Time and the center of the spatial filter box are reset. The coordinates are not updated until the stylus has once again remained in the spatial filter box for the Temporal Filter Time. The coordinates associated with the “not touched” state are still the exit point, but the touch state becomes “not touched” only after the stylus is out of the screen for the Temporal Filter Time. The touch state is set to “non-contiguous” only after a non-contiguous stylus has been in the touch screen for the Temporal Filter Time.

## Methods for Interfacing CTKERN and an Application Program

Application programs generally use either an interrupt mode or a polling mode to retrieve touch information.

### Polling Mode

Using the polling mode, the application program periodically checks the touch state using *GetTouchState (1)*. If the application does this at a comparatively rapid rate, touch state information is current. If the application polls at a slower rate, there is danger of missing transitions in the touch state during the time between polls.

### Interrupt Mode

In the interrupt mode, the application program installs a CTKERN user event handler (UEH) using *SetUserEventHandler (7)*. Whenever the touch state changes, CTKERN places the touch state parameters in the CPU registers and calls the application's UEH. The application's UEH then reads the parameters from the registers and copies them into variables within the application. The application program should keep the CTKERN UEH as short as possible, as touch information may be lost if the screen is touched while the hardware interrupts are turned off. If the CTKERN UEH is disabled for a period of time then re-enabled, touch state changes that occurred while the UEH was disabled are lost.

## Loading the CTKERN Driver

### Command Line

The CTKERN driver command line has the following syntax:

`ctkern` *`options`*

The available *`options`* follow.

| | | |
|---|---|---|
| `U` | = | Uninstalls the driver. |
| `T`*`n`* | = | TAPI software interrupt. *n* may be any unused software interrupt. The default is 55H. |
| `K`*`n`* | = | CTKERN software interrupt. *n* may be any unused software interrupt. The default is 56H. |

| | | |
|---|---|---|
| D*x* | = | Pathname to calibration data file. *x* may be any valid pathname. The default is `CALIB.DAT` in the current DOS drive and directory. |

The command line is case-insensitive and the command line parameters may be arranged in any order. An example command line is:

```
CTKERN K59 t57
```

If you use the uninstall command line parameter (`U`) to uninstall a CTKERN driver that is installed on an interrupt other than the default, you must also specify the CTKERN software interrupt on the command line by using the `K` parameter. For example, to uninstall a copy of CTKERN that was installed on software interrupt 59, use the following command line:

```
CTKERN U K59
```

## Error Messages

Table 7-1 defines the error messages and meanings for the CTKERN driver.

Table 7-1. CTKERN Error Messages

| | |
|---|---|
| Message: | `A CT driver is already installed at software interrupt xxH.` |
| Meaning: | A CT driver has been previously installed on S/W interrupt `xxH`. CTKERN looks only for the string `CT DRIVER -`. It does not look for a specific type of driver. |
| Message: | `Bad calibration entry in CALIB.DAT as follows:` <br><br> <the text line in CALIB.DAT that has the problem> |
| Meaning: | A calibration entry in `CALIB.DAT` has bad syntax. |
| Message: | `CTKERN installation failed.` |
| Meaning: | This error message accompanies other error messages and indicates that installation was aborted. |

Table 7-1.  CTKERN Error Messages (Continued)

| | |
|---|---|
| Message: | `Invalid command line parameter.`<br>`Valid CTKERN command line parameters are:`<br><br>(followed by a list of valid command line parameters) |
| Meaning: | The CTKERN command line syntax is invalid. |
| Message: | `No CALIB.DAT file found.` |
| Meaning: | The calibration data file could not be found. |
| Message: | `No TAPI driver loaded at software interrupt xxH.` |
| Meaning: | CTKERN could not find a TAPI driver at S/W interrupt `xxH`. |
| Message: | `TAPI driver communication error - invalid report received.`<br>`Check that the touch system is properly connected.` |
| Meaning: | CTKERN could not initialize the touch system because an invalid SFP report was received. |
| Message: | `TAPI driver communication error - report expected but not received.`<br>`Check that touch system is properly connected.` |
| Meaning: | CTKERN could not initialize the touch system because an SFP report that was expected was not received. (The TAPI *CheckForReports* function returned a report length of 0 in `CX` and CTKERN timed out waiting for the report.) |
| Message: | `TAPI driver communication error - unable to send command.`<br>`Check that the touch system is properly connected.` |
| Meaning: | The CTKERN driver could not initialize the touch system because the TAPI driver reported that it could not send SFP commands to the touch system. (The TAPI *SendCommand* function returned an error code in `CX`.) |

Table 7-1. CTKERN Error Messages (Continued)

| | |
|---|---|
| Message: | `The CALIB.DAT file contains multiple default calibrations.` |
| Meaning: | `CALIB.DAT` contains more than one default calibration. |
| Message: | `The CALIB.DAT file does not contain a default calibration.` |
| Meaning: | The calibration data file contains no default calibration. |
| Message: | `The CALIB.DAT file is invalid.` |
| Meaning: | The calibration data file does not contain the string `Carroll Touch Calibration Data File` as its first line of text. |
| Message: | `The calibration parameters of the following calibration entry in CALIB.DAT are too large for the touch system currently being used (the sum of the offset value and span value is greater or equal to the frame size in one or both axes):`<br><br>(followed by the bad calibration entry)<br><br>`Enter a Y to truncate the X and/or Y span values to the frame size so that this entry is valid for the touch system being used and continue loading CTKERN. Press any other key to abort CTKERN installation.` |
| Meaning: | A calibration entry has parameters too large for the touch system being used.<br><br>Press the Y key to truncate the value and continue to load. You must truncate all out of range calibration entries for CTKERN to load. The truncation applies only to the CTKERN driver resident in memory; the `CALIB.DAT` file is not modified. Run `CALIB.EXE` to modify the `CALIB.DAT` file so it contains calibration entries that are correct for the touch system in use.<br><br>Press any key other than Y to abort CTKERN and display the bad calibration entry. |

## Determining If the CTKERN Driver Is Installed

An application program may determine if the CTKERN driver is installed by performing a string compare starting at the address pointed to by the CTKERN software interrupt vector + 2. For all CT drivers, the first nine characters will be `CT DRIVER`. The type of driver (CTKERN in this case) is identified by an additional string:

```
CT DRIVER - CTKERN
```

## Calling CTKERN Functions

The CTKERN functions may be accessed via the CTKERN driver software interrupt (default 56H).

To call a CTKERN function, load the registers as described in the “Call with” section for the CTKERN functions described in Appendix D. Then call the CTKERN driver software interrupt (default 56H) and read the registers as described in the “Returns” section for that function.

An example of a CTKERN function call is:

```
int GetTouchState (int ctkern_sw_int,
int *x_coordinate, int *y_coordinate)
{
union REGS regs;
int touch_state;

regs.x.ax =1;
int86(ctkern_sw_int, &regs, &regs);

touch_state = (int) regs.h.bl;
*x_coordinate = regs.x.cx;
*y_coordinate = regs.x.dx;

return(touch_state);

} /* GetTouchState */
```

## CALIB.EXE

Note that both a TAPI driver and the CTKERN driver must be installed to run `CALIB.EXE`, the CTKERN calibration program.

## Command Line

The command line for `CALIB.EXE` has the following syntax:

```
calib options
```

The available *`options`* are:

| | | |
|---|---|---|
| K*n* | = | CTKERN software interrupt. *n* may be any unused software interrupt. The default is 56H. |
| `I` | = | Load calibration parameters from an installed CTKERN driver. |
| D*x* | = | Pathname to calibration data file. *x* may be any valid pathname. The default is `CALIB.DAT` in the current DOS drive and directory. When `CALIB.EXE` exits, the calibration data is saved in this file. |

The command line is case-insensitive and the command line parameters may be arranged in any order.

At startup, `CALIB.EXE` reads calibration data from either a calibration data file (the default) or from an installed CTKERN driver if specified on the command line. If the `I` and `D` command line parameters are both specified, the `I` parameter takes precedence and `CALIB.EXE` loads the calibration data from the installed CTKERN driver.

To run `CALIB.EXE` using the default values for the CTKERN software interrupt and read the calibration data from `CALIB.EXE` in the current DOS drive and directory, use the following command line:

```
calib
```

To run `CALIB.EXE` when the CTKERN driver is installed on software interrupt 62H, and the calibration parameters are to be loaded from and saved to a calibration data file named `CARROLL.CAL` in the `\CALIB` directory of drive `E`:, use the following command line:

```
calib K62 de:\calib\carroll.cal
```

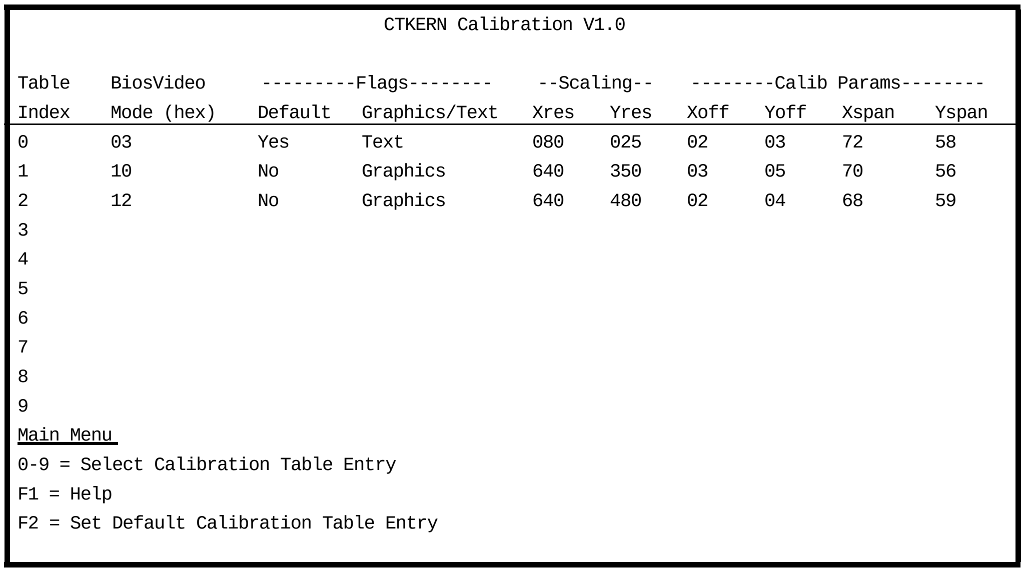
To run `CALIB.EXE` using the default value for the CTKERN software interrupt and load the calibration data from the installed CTKERN driver, use the following command line:

```
calib I
```

## Operation

You may create, edit, and delete calibration parameter sets for up to ten video modes.

When `CALIB.EXE` is started, a message is displayed that indicates where the calibration data is being read from, followed by the Main Menu screen, shown in Figure 7-6. The Main Menu screen displays the parameters for each of the ten calibration table entries, along with the Main Menu options. See *SetCalibrationTableEntry (6)* in Appendix D for a definition of the flags.

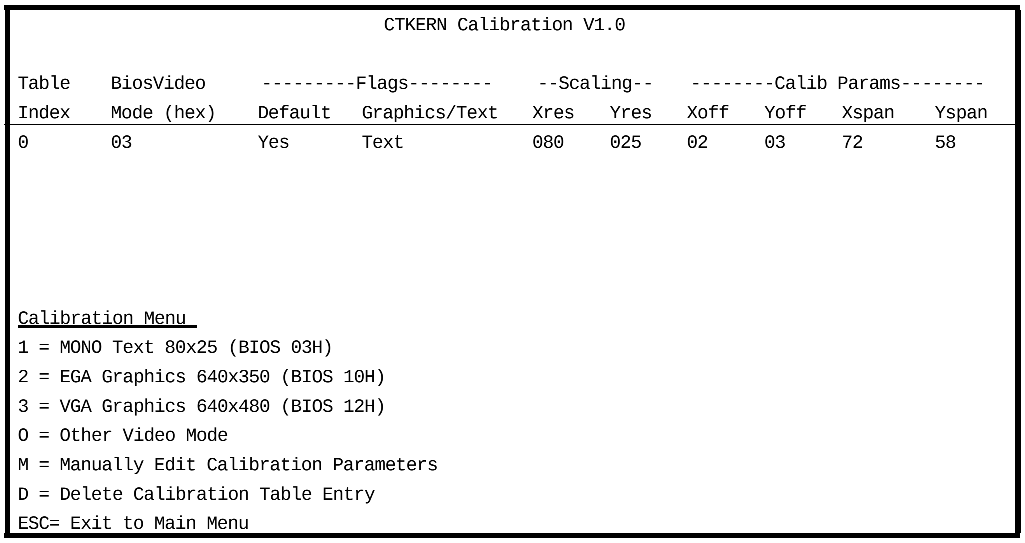


```
                                   CTKERN Calibration V1.0

Table    BiosVideo     ---------Flags--------    --Scaling--    --------Calib Params--------
Index    Mode (hex)    Default   Graphics/Text   Xres    Yres   Xoff    Yoff    Xspan    Yspan
0        03            Yes       Text            080     025    02      03      72       58
1        10            No        Graphics        640     350    03      05      70       56
2        12            No        Graphics        640     480    02      04      68       59
3
4
5
6
7
8
9
Main Menu
0-9 = Select Calibration Table Entry
F1 = Help
F2 = Set Default Calibration Table Entry
```

Figure 7-6. Calibration Main Menu Screen

Press F2 to designate the default calibration table entry. You are prompted to enter the calibration table index number for the default. The default calibration table entry holds the calibration parameters that are used when the calibration and/or scaling modes are set to “fixed.” A default calibration table entry must be specified before exiting calibration.

Press 0 through 9 to display the calibration parameters for the selected calibration table entry, along with the Calibration Menu. (See Figure 7-7.)

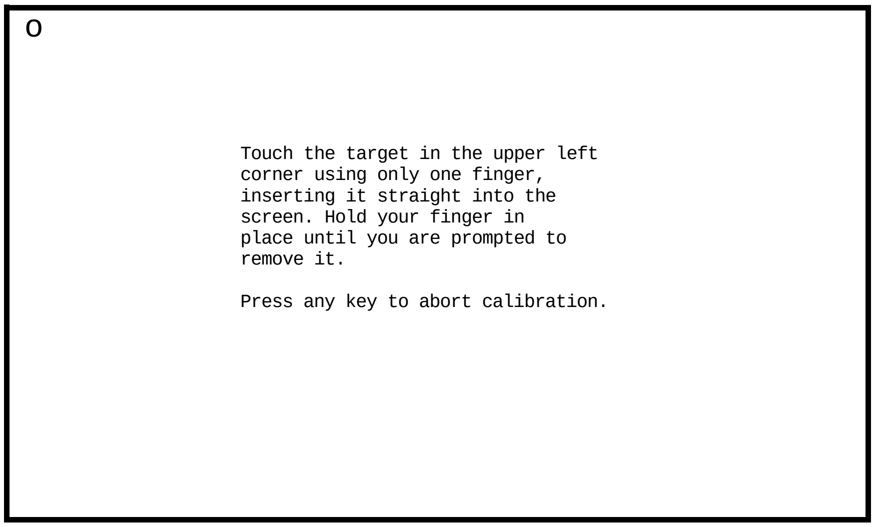


```
                                CTKERN Calibration V1.0

Table    BiosVideo     ---------Flags--------    --Scaling--    --------Calib Params--------
Index    Mode (hex)    Default   Graphics/Text   Xres    Yres   Xoff    Yoff    Xspan    Yspan
0        03            Yes       Text            080     025    02      03      72       58




Calibration Menu
1 = MONO Text 80x25 (BIOS 03H)
2 = EGA Graphics 640x350 (BIOS 10H)
3 = VGA Graphics 640x480 (BIOS 12H)
O = Other Video Mode
M = Manually Edit Calibration Parameters
D = Delete Calibration Table Entry
ESC= Exit to Main Menu
```

Figure 7-7. Calibration Menu Screen

## Calibrate Mono, EGA, VGA Video Modes

Calibration Menu options include entries for all of the video modes that `CALIB.EXE` can display calibration target screens for. Press the key corresponding to one of these options to display a calibration target screen, as shown in Figure 7-8. You are prompted to touch the target in the upper left corner. When the target is touched, the number displayed above the prompt counts down until it reaches 0. You are then prompted to remove your finger. This process is repeated for the lower right corner, and the main menu screen reappears.

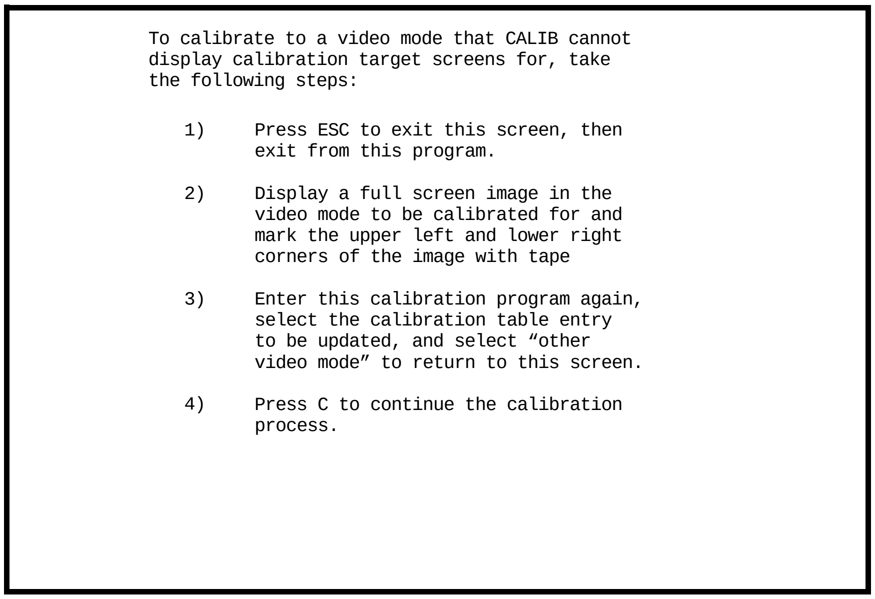


```
O


                    Touch the target in the upper left
                    corner using only one finger,
                    inserting it straight into the
                    screen. Hold your finger in
                    place until you are prompted to
                    remove it.

                    Press any key to abort calibration.
```

Figure 7-8. Calibration Target Screen

## Calibrate Other Video Modes

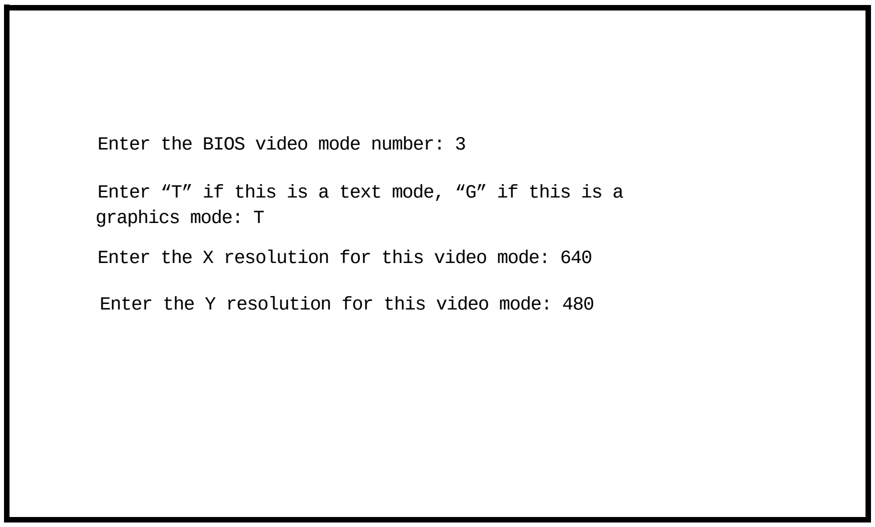
Press the O key to perform a calibration for a video mode for which `CALIB.EXE` cannot display calibration target screens. The first Other Video Mode screen appears, as shown in Figure 7-9, and prompts you to take several steps.



```
To calibrate to a video mode that CALIB cannot
display calibration target screens for, take
the following steps:

   1)     Press ESC to exit this screen, then
          exit from this program.

   2)     Display a full screen image in the
          video mode to be calibrated for and
          mark the upper left and lower right
          corners of the image with tape

   3)     Enter this calibration program again,
          select the calibration table entry
          to be updated, and select “other
          video mode” to return to this screen.

   4)     Press C to continue the calibration
          process.
```

Figure 7-9. Calibration Other Video Mode Screen #1

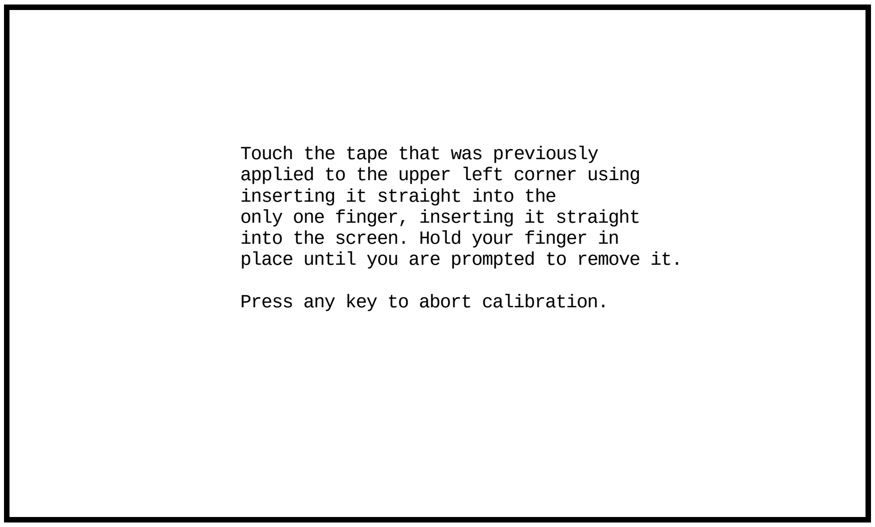
After completing these four steps, the second Other Video Mode screen appears, as shown in Figure 7-10, and prompts you to take several steps.



```
Enter the BIOS video mode number: 3

Enter “T” if this is a text mode, “G” if this is a
graphics mode: T

Enter the X resolution for this video mode: 640

Enter the Y resolution for this video mode: 480
```

Figure 7-10. Calibration Other Video Mode Screen #2

After completing these four steps, the third Other Video Mode screen appears as shown in Figure 7-11.



```
Touch the tape that was previously
applied to the upper left corner using
inserting it straight into the
only one finger, inserting it straight
into the screen. Hold your finger in
place until you are prompted to remove it.

Press any key to abort calibration.
```

Figure 7-11. Calibration Other Video Mode Screen #3

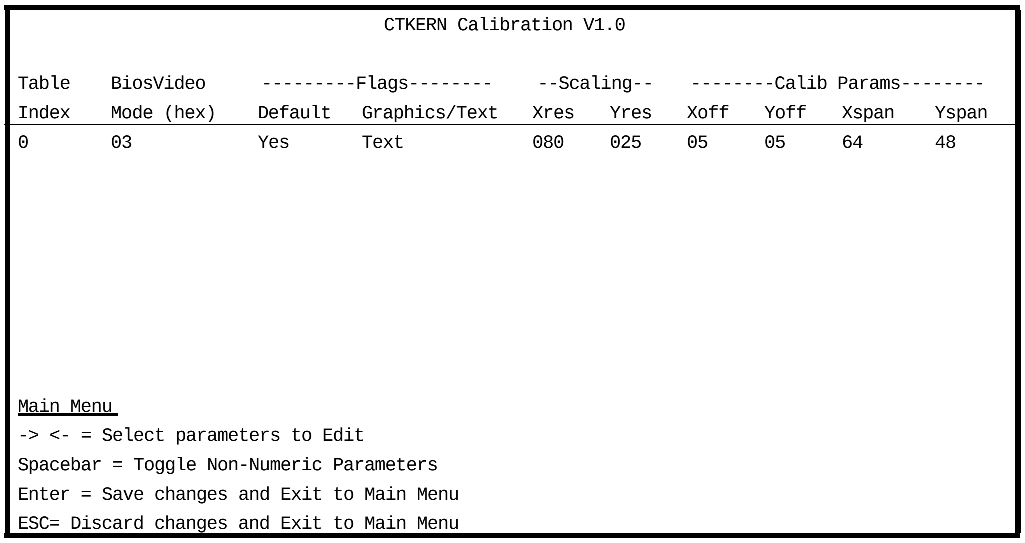
When the target is touched, the number displayed above the prompt counts down until it reaches 0. You are then prompted to remove your finger. This process is repeated for the lower right corner, and the Main Menu screen reappears.

## Edit Entry

Press the M key to display the Manual Edit Menu screen, as shown in Figure 7-12. The screen displays the calibration parameters for the selected calibration table entry, along with the list of menu options. You may use the keys listed in the Manual Edit Menu to edit the calibration table entry parameters. When the parameters are edited as desired, and you exit the manual edit menu screen, the Main Menu screen reappears.

## Delete Entry

Press the D key to set all calibration parameters for the selected calibration table entry to 0. The Main Menu screen reappears.

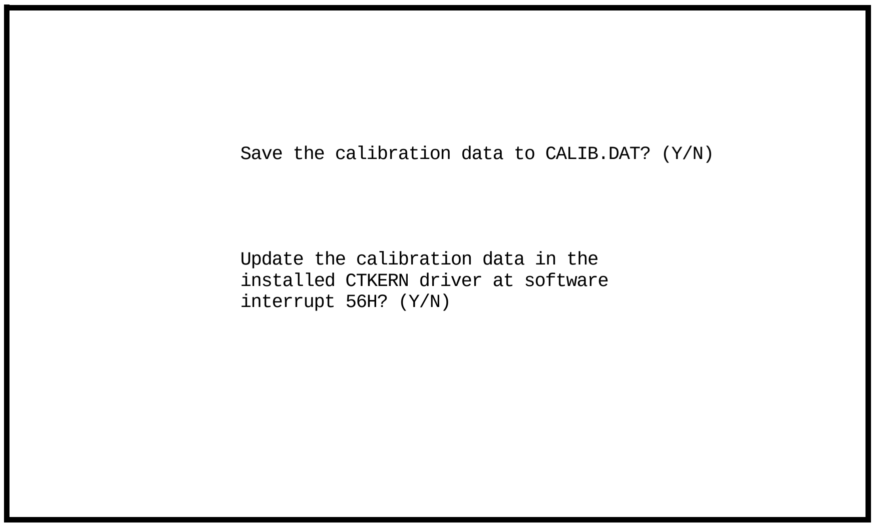


```
                                CTKERN Calibration V1.0

Table    BiosVideo     ---------Flags--------    --Scaling--   --------Calib Params--------
Index    Mode (hex)    Default   Graphics/Text   Xres    Yres    Xoff    Yoff    Xspan    Yspan
0        03            Yes       Text            080     025     05      05      64       48









Main Menu
-> <- = Select parameters to Edit
Spacebar = Toggle Non-Numeric Parameters
Enter = Save changes and Exit to Main Menu
ESC= Discard changes and Exit to Main Menu
```

Figure 7-12. Calibration Manual Edit Menu Screen

## Exit

After you complete all desired calibrations and press the ESC key from the main menu screen to exit CALIB, you are prompted to save the calibration data to the specified calibration data file and/or the installed CTKERN driver, as shown in Figure 7-13. If you attempt to exit without specifying a default calibration, or if multiple default calibrations are specified, a message appears and you are given the option of either returning to the Main Menu or exiting CALIB without saving any calibration data.



```
Save the calibration data to CALIB.DAT? (Y/N)


Update the calibration data in the
installed CTKERN driver at software
interrupt 56H? (Y/N)
```

Figure 7-13. Calibration Exit Prompt Screen

## CALIB.DAT

The calibration data file (default `CALIB.DAT`) has the following format:

```
Carroll Touch Calibration Data File
<video mode> <flags> <xres> <yres> <xoff> <yoff> <xspan> <yspan>
<video mode> <flags> <xres> <yres> <xoff> <yoff> <xspan> <yspan>
<video mode> <flags> <xres> <yres> <xoff> <yoff> <xspan> <yspan>
. . .
```

All of the parameters except for the video mode and the flags are saved in decimal. The video mode and the flags are saved in hexadecimal. An example of a calibration data file is:

```
Carroll Touch Calibration Data File
0003 8001 00080 00025 00002 00003 00072 00058
0010 0000 00640 00350 00003 00005 00070 00056
0012 0000 00640 00480 00002 00004 00068 00059
```

Decimal entries are five characters long, and hexadecimal entries are four characters long. The spacing between entries serves to organize them into groups. CTKERN and `CALIB.EXE` read `CALIB.DAT` with any spacing (white space independent), but `CALIB.EXE` writes the file in this format so it is more readable.

## CTKERN Programming Examples

The CT Driver/Demo Disk contains three short example programs under the heading of “Programmer’s Guide Programming Examples.” They demonstrate how to interface to CT touch systems via the CTKERN driver. Both a polling mode and an interrupt-driven mode are shown. All of these programs were developed using Borland C. Minor modifications may be required for other compilers.

The example files are:

| | |
|---|---|
| `CT.H` | Contains a CT header file. |
| `CTKRNPOL.C` | Contains a CTKERN polling example. |
| `CTKRNINT.C` | Contains a CTKERN interrupt example. |

8

# Dynamic Link Library (DLL) Functions

The Carroll Touch Windows driver is controlled through the use of dynamic link library (DLL) function calls. The DLLs are used by the Carroll Touch Control Panel, but may also be used by an application, which can then control the driver directly from within the application itself. This chapter presents the information you need to use the DLLs for the Windows 3.x driver and covers the following topic:

- Calling Windows Driver DLL Functions

See Appendix E, “Dynamic Link Library (DLL) Function Reference,” for the specifications of each DLL.

## Calling Windows Driver DLL Functions

All Windows driver functions are exported by ordinal value. To access these functions, you must:

1. Include a statement similar to the following in the IMPORTS section of your application's definitions (`.DEF`) file:

   ```
   SetTouchEvents = MOUSE.8
   ```

2. Specify a function prototype similar to the following in your application:

   ```
   void FAR PASCAL SetTouchEvents (LPSTR);
   ```

3. Define a data structure similar to the following for the function parameter:

   ```
   typedef struct tagTOUCHEVENTS     {

         char user_touch_event;
         char user_untouch_event;
         char user_noncontig_event;

   }     TOUCHEVENTS_TYPE;
   ```

4. Create a variable using the data structure for a function similar to the following:

   ```
   static TOUCHEVENTS_TYPE touchevents;
   ```

5. Populate the data structure and call the function. All CT Windows driver functions have either no parameters or a single LPSTR parameter. Your application must supply an LPSTR type pointer to a variable that uses the data structure that corresponds to the function called.

   ```
   touchevents.user_touch_event= 2;
   touchevents.user_untouch_event= 3;
   touchevents.user_noncontig_event= 0;

   SetTouchEvents (&touchevents);
   ```

# A Smart-Frame Protocol Command Reference

This appendix lists each SFP command in alphabetic and numeric order, respectively, and subsequently gives the details of each SFP command.

- Add_Exit_Point_Modifier (29H).
- Clear_Touch_Report_Buffer (3DH).
- Continuous_Mode (27H).
- Coordinate_Reporting (23H).
- Echo_Off (21H).
- Echo_On (20H).
- Enter_Point_Mode (25H).
- Exit_Point_Mode (28H).
- Get_Configuration_Report (33H).
- Get_Error_Report (32H).
- Get_Failed_Beam_Report (36H).
- Get_Firmware_Version_Report (34H).
- Get_Frame_Size_Report (37H).
- Get_One_Report (46H).
- Get_State_Report (47H).
- Hardware_Flow_Control_Off (42H).
- Hardware_Flow_Control_On (41H).
- Report_Transfer_Off (43H).
- Report_Transfer_On (44H).
- Reset (45H).

- Run_Diagnostics (3AH).
- Scan_Reporting (22H).
- Software_Reset (3CH).
- SwitchToSFP-II (65H).
- Touch_Scanning_Off (2BH).
- Touch_Scanning_On (2AH).
- Tracking_Mode (26H).

Table A-1. SFP Commands in Alphabetical Order

| Command Name | Hex Code | ASCII Code | Associated Report (in Hex) |
|---|---|---|---|
| *Add_Exit_Point_Modifier* | 29H | ) | `FD X Y FF` |
| *Clear_Touch_Report_Buffer* | 3DH | = | – |
| *Continuous_Mode* | 27H | ’ | `FE X Y FF` |
| *Coordinate_Reporting* | 23H | # | `FE X Y FF` |
| *Echo_Off* | 21H | ! | – |
| *Echo_On* | 20H | Space | – |
| *Enter_Point_Mode* | 25H | % | `FE X Y FF` |
| *Exit_Point_Mode* | 28H | ( | `FE X Y FF` |
| *Get_Configuration_Report* | 33H | 3 | `F7 Nt T1...Tn FF` |
| *Get_Error_Report* | 32H | 2 | `F8 Na A1...An Nb B1...Bn FF` |
| *Get_Failed_Beam_Report* | 36H | 6 | `FA Nx X1 T1...Xn Tn` `Ny Y1 S1...Yn Sn FF` |
| *Get_Firmware_Version_Report* | 34H | 4 | `F6 Nv V1...Vn FF` |
| *Get_Frame_Size_Report* | 37H | 7 | `F4 Nx Ny FF` |
| *Get_One_Report* | 46H | F | `F5 FF` or any other report |
| *Get_State_Report* | 47H | G | `F2 Nx S1...Sn FF` |
| *Hardware_Flow_Control_Off* | 42H | B | – |
| *Hardware_Flow_Control_On* | 41H | A | – |
| *Report_Transfer_Off* | 43H | C | – |
| *Report_Transfer_On* | 44H | D | – |
| *Reset* | 45H | E | – |
| *Run_Diagnostics* | 3AH | : | `F8 Na A1...An Nb B1...Bn FF` |
| *Scan_Reporting* | 22H | ” | `FB Nx Xa...Xn Ny Ya...Yn FF` |
| *Software_Reset* | 3CH | < | – |
| *SwitchToSFP-II* | 65H | | Protocol Version Report (SFP-II) or Error Report (SFP) |
| *Touch_Scanning_Off* | 2BH | + | – |
| *Touch_Scanning_On* | 2AH | * | – |
| *Tracking_Mode* | 26H | & | `FE X Y FF` |

Table A-2. SFP Commands in Numerical Order

| **Hex Code** | **ASCII Code** | **Command Name** | **Associated Report (in Hex)** |
|---|---|---|---|
| 20H | Space | *Echo_On* | – |
| 21H | ! | *Echo_Off* | – |
| 22H | ” | *Scan_Reporting* | `FB Nx Xa...Xn Ny Ya...Yn FF` |
| 23H | # | *Coordinate_Reporting* | `FE X Y FF` |
| 25H | % | *Enter_Point_Mode* | `FE X Y FF` |
| 26H | & | *Tracking_Mode* | `FE X Y FF` |
| 27H | ’ | *Continuous_Mode* | `FE X Y FF` |
| 28H | ( | *Exit_Point_Mode* | `FE X Y FF` |
| 29H | ) | *Add_Exit_Point_Modifier* | `FD X Y FF` |
| 2AH | * | *Touch_Scanning_On* | – |
| 2BH | + | *Touch_Scanning_Off* | – |
| 32H | 2 | *Get_Error_Report* | `F8 Na A1...An Nb B1...Bn FF` |
| 33H | 3 | *Get_Configuration_Report* | `F7 Nt T1...Tn FF` |
| 34H | 4 | *Get_Firmware_Version_Report* | `F6 Nv V1...Vn FF` |
| 36H | 6 | *Get_Failed_Beam_Report* | `FA Nx X1 T1...Xn Tn` `Ny Y1 S1...Yn Sn FF` |
| 37H | 7 | *Get_Frame_Size_Report* | `F4 Nx Ny FF` |
| 3AH | : | *Run_Diagnostics* | `F8 Na A1...An Nb B1...Bn FF` |
| 3CH | < | *Software_Reset* | – |
| 3DH | = | *Clear_Touch_Report_Buffer* | – |
| 41H | A | *Hardware_Flow_Control_On* | – |
| 42H | B | *Hardware_Flow_Control_Off* | – |
| 43H | C | *Report_Transfer_Off* | – |
| 44H | D | *Report_Transfer_On* | – |
| 45H | E | *Reset* | – |
| 46H | F | *Get_One_Report* | `F5 FF` or any other report |
| 47H | G | *Get_State_Report* | `F2 Nx S1...Sn FF` |
| 65H | | *SwitchToSFP-II* | Protocol Version Report (SFP-II) or Error Report (SFP) |

## *Add_Exit_Point_Modifier (29H) ()*

### Command Description

When the Add Exit Point modifier is enabled by sending the *Add_Exit_Point_Modifier (29H)* command, the touch system sends an Add Exit Point Coordinate Report when the stylus exits the touch active area. This report is in addition to the Touch Coordinate Reports that are sent for the currently selected touch mode. For example, if the touch mode is sent to *Enter Point Mode* and the Add Exit Point modifier is set, a Touch Coordinate Report is sent when the stylus enters the touch active area and an Add Exit Point Coordinate Report is sent when the stylus is removed from the touch active area. The touch system default is Add Exit Point modifier disabled.

### Report Format

The Add Exit Point Coordinate Report has the following format:

```
FD X Y FF
```

| | | |
|---|---|---|
| `FD` | = | Start of Add Exit Point Coordinate report. |
| `X` | = | X-axis logical touch coordinate. |
| `Y` | = | Y-axis logical touch coordinate. |
| `FF` | = | End of report. |

### Example

An example of an Add Exit Point Coordinate Report is:

```
FD 10 00 FF
```

It indicates that the center of the stylus exited at x coordinate 16 and at y coordinate 0.

### See Also

*Coordinate_Reporting (23H)*

## *Clear_Touch_Report_Buffer (3DH) (=)*

### Command Description

The *Clear_Touch_Report_Buffer (3DH)* command clears any pending Touch Coordinate, Add Exit Point Coordinate, or Non-Contiguous Coordinate Report from the touch report buffer. This command is useful when the host does not need old touch data, such as when it is moving from one menu page to the next. The command does not stop a report in the process of being transmitted. Once transmission has begun the entire report is transmitted. Reports requested by the host cannot be cleared from the touch report buffer, and therefore are not affected by this command.

## *Continuous_Mode (27H) (')*

### Command Description

When the touch mode is set to *Continuous Mode* by sending the *Continuous_Mode (27H)* command, the touch system sends Touch Coordinate Reports to the host as long as the stylus is in the touch active area. Touch Coordinate Reports are continuously sent whether the stylus is moving or stationary. Process control applications use *Continuous Mode* to control specific functions such as filling a tank.

### Report Format

When the touch mode is set to *Continuous Mode*, the touch system reports the coordinates of the stylus using the Touch Coordinate Report. See *Coordinate Reporting (23H)* in this appendix for the format of the Touch Coordinate Report and Non-Contiguous Coordinate Report.

### Example

See *Coordinate Reporting (23H)* in this appendix for examples of the Touch Coordinate Report and Non-Contiguous Coordinate Report.

### See Also

*Coordinate_Reporting (23H)*

## Coordinate_Reporting (23H) (#)

### Command Description

When the reporting method is set to coordinate reporting by sending the *Coordinate_Reporting (23H)* command, the touch system uses software interpolation to interpret the interrupted physical beam data and find the center of the stylus.

The three types of coordinate reports are:

- Touch Coordinate Report.
- Add Exit Point Coordinate Report.
- Non-Contiguous Coordinate Report.

Touch modes are recognized when the reporting method is set to coordinate reporting. The system default reporting method is coordinate reporting.

### Report Format

The current touch mode determines the type of report that is sent and when it is sent.

The Touch Coordinate Report has the following format:

```
FE X Y FF
```

| | | |
|---|---|---|
| FE | = | Start of Touch Coordinate Report. |
| X | = | X-axis logical touch coordinate. |
| Y | = | Y-axis logical touch coordinate. |
| FF | = | End of report. |

Non-Contiguous Coordinate Reports are issued whenever interrupted beams are non-contiguous (not adjacent). Non-contiguous touches can be caused by the presence of more than one stylus in the touch active area at the same time; this occurs, for example, if you accidentally break the touch active area with another portion of the stylus. The Non-Contiguous Coordinate Report has the following format:

```
FC T FF
```

| | | |
|---|---|---|
| FC | = | Start of Non-Contiguous Coordinate Report. |

| | | |
|---|---|---|
| `T` | = | Identifying number.<br>1 = Non-contiguous x-stylus.<br>2 = Non-contiguous y-stylus.<br>3 = Non-contiguous x- and y-styli. |
| `FF` | = | End of report. |

### *Caution*

Because non-contiguous touches can occur accidentally, do not use Non-Contiguous Coordinate Reports to indicate a specific selection or trigger a critical function.

See *Add_Exit_Point_Modifier (29H)* in this appendix for details of the Add Exit Point Coordinate Report.

## Example

An example of a Touch Coordinate Report is:

```
FE 04 10 FF
```

It indicates that the center of the stylus at logical coordinate x is 4, and the center of the stylus at logical coordinate y is 16.

## See Also

*Scan_Reporting (22H)*
*Enter_Point_Mode (25H)*
*Tracking_Mode (26H)*
*Continuous_Mode (27H)*
*Exit_Point_Mode (28H)*
*Add_Exit_Point_Modifier (29H)*
“Interpolating Touch Coordinates” in Chapter 1

## *Echo_Off (21H) (!)*

### Command Description

The *Echo_Off (21H)* command turns off *Echo Mode*. The *Echo_Off* character is not sent back to the host. *Echo_Off* is the system default.

### Example

The example below sends the *Echo_On (20H)* command, followed by a test sequence that checks every bit position, and ends with the *Echo_Off (21H)* command.

```
20 01 02 04 08 10 20 40 80 21
```

#### *Note*

While *Echo Mode* is on, wait for each byte to be echoed back before sending the next byte to the touch system.

### See Also

*Echo_On (20H)*

## *Echo_On (20H) (SPACE)*

### Command Description

The *Echo_On (20H)* command places the touch system in *Echo Mode*. In this mode, the touch system transmits back to the host all data bytes it receives except for the *Echo_Off* character. To check whether serial communications are operating correctly, send the *Echo_On (20H)* command, a test sequence, and the *Echo_Off (21H)* command. The touch system should return the *Echo_On* character and the test sequence exactly as it was transmitted from the host.

### Example

The example below sends the *Echo_On (20H)* command, followed by a test sequence that checks every bit position, and ends with the *Echo_Off (21H)* command.

```
20 01 02 04 08 10 20 40 80 21
```

#### *Note*

While *Echo Mode* is on, wait for each byte to be echoed back before sending the next byte to the touch system.

### See Also

*Echo_Off (21H)*

## *Enter_Point_Mode (25H) (%)*

### Command Description

When the touch mode is set to *Enter Point Mode* by sending the *Enter_Point_Mode (25H)* command, the touch system sends a Touch Coordinate Report to the host when the stylus enters the touch active area. No additional Touch Coordinate Reports are transmitted until an empty scan (no stylus located within the touch active area) is detected, indicating that the stylus has left the touch active area. *Enter Point Mode* is most commonly used to select a sequence of items on a single menu or when an immediate response is required.

### Report Format

See *Coordinate Reporting (23H)* in this appendix for the format of the Touch Coordinate Report and Non-Contiguous Coordinate Report.

### Example

See *Coordinate Reporting (23H)* in this appendix for examples of the Touch Coordinate Report and Non-Contiguous Coordinate Report.

### See Also

*Coordinate_Reporting (23H)*

## *Exit_Point_Mode (28H) (()*

### Command Description

When the touch mode is set to *Exit Point Mode* by sending the *Exit_Point_Mode (28H)* command, the touch system sends a Touch Coordinate Report to the host when the stylus leaves the touch active area. The stylus must have already entered the touch active area before the Exit Point touch can be detected.

*Exit Point Mode* is used for menu selection. It lets the stylus enter the touch active area and move to the desired target without activating a selection until the stylus leaves the touch active area. This can be advantageous for small or very complex screen designs, or for educational purposes when the user is not familiar with the selections.

### Report Format

See *Coordinate Reporting (23H)* in this appendix for the format of the Touch Coordinate Report and Non-Contiguous Coordinate Report.

### Example

See *Coordinate Reporting (23H)* in this appendix for examples of the Touch Coordinate Report and Non-Contiguous Coordinate Report.

### See Also

*Coordinate_Reporting (23H)*

## *Get_Configuration_Report (33H) (3)*

### Command Description

When the host sends the *Get_Configuration_Report (33H)* command, the touch system returns a Configuration Report that includes the number of processors that are included in the touch system. The Configuration Report is necessary to interpret the Error Report.

### Report Format

The Configuration Report has the following format:

```
F7 Na Aa, ..., An FF
```

| | | |
|---|---|---|
| `F7` | = | Start of Configuration Report. |
| `Na` | = | Number of processors in the touch system. |
| `Aa` | = | Identifier of first processor. |
| `An` | = | Identifier of last processor. |
| `FF` | = | End of report. |

#### *Note*

The identifiers for each processor no longer have any meaning associated with them, but are included for historical reasons. The *Get_Configuration_Report (33H)* command has been retained so that the number of processors in the touch system may be determined.

### Example

Examples of two Configuration Reports are:

| | |
|---|---|
| `F7 01 00 FF` | Reports configuration for single-processor touch systems. |
| `F7 02 01 02 FF` | Reports configuration for dual-processor touch systems. |

The example for the dual-processor touch system reports two processors; the identifier of the first is 01H and of the second is 02H.

## *Get_Error_Report (32H) (2)*

### Command Description

When the host sends the *Get_Error_Report (32H)* command, the touch system returns an Error Report, which identifies the current error conditions.

### Report Format

For single-processor systems, the Error Report has the following format:

```
F8 Na Aa, ..., An FF
```

For dual-processor systems, the Error Report has the following format:

```
F8 Na Aa, ..., An Nb Ba, ..., Bn FF
```

| | | |
|---|---|---|
| `F8` | = | Start of Error Report. |
| `Na` | = | Number of first processor errors to follow. |
| `Aa, ..., An` | = | Error codes (defined in Table A-3). |
| `Nb` | = | Number of second processor errors to follow. |
| `Ba, ..., Bn` | = | Error codes (defined in Table A-3). |
| `FF` | = | End of report. |

If the touch system does not detect any errors, the following report is sent:

| | |
|---|---|
| `F8 00 FF` | Reports no errors for single-processor systems. |
| `F8 00 00 FF` | Reports no errors for dual-processor systems. |

The Error Report contains a list of error codes for each processor in the touch system. Use the *Get_Configuration_Report (33H)* command to get a Configuration Report that includes the number of processors in the touch system in order to properly interpret this report.

## Caution

Do not hard wire the code that interprets the Error Report to work with a specific number of processors. To do so results in code that may not be portable from one touch system to another.

Table A-3 describes the error codes that appear in the Error Report.

Table A-3. Smart-Frame Protocol Error Report Error Codes

| **Error Code** | **Description/Affected Touch System Component** |
|---|---|
| 01H | ROM (Read Only Memory) checksum verification error.<br>The ROM has an error and must be repaired.<br>68705 Smart-Frame: Frame<br>8031 Pre-modular separate controller (UFP III): Controller<br>8031 Smart-Frame (SDSF): Frame<br>Modular: Controller |
| 02H | RAM (Random Access Memory) verification error.<br>The processor RAM has an error and must be repaired.<br>68705 Smart-Frame: Frame<br>8031 Pre-modular separate controller (UFP III): Controller<br>8031 Smart-Frame (SDSF): Frame<br>Modular: Controller |
| 03H | A/D converter error.<br>An error has been detected in the analog/digital circuitry and must be repaired.<br>68705 Smart-Frame: Frame<br>8031 Pre-modular separate controller (UFP III): Controller<br>8031 Smart-Frame (SDSF): Frame<br>Modular: Frame |
| 04H | Failed beam(s) detected.<br>One or more beams have failed. The system should be repaired, but will continue to function, treating the failed beam as interrupted if it is surrounded by interrupted beams. Use the Failed Beam report to determine the location of the failed beam.<br>68705 Smart-Frame: Frame<br>8031 Pre-modular separate controller (UFP III): Frame<br>8031 Smart-Frame (SDSF): Frame<br>Modular: Frame |

Table A-3. Smart-Frame Protocol Error Report Error Codes (Con't)

| Error Code | Description/Affected Touch System Component |
|---|---|
| 05H* | Communication error.<br>A communications error has been detected between the frame and controller (NOT between the controller and the host).<br>68705 Smart-Frame: Interprocessor comm error<br>8031 Pre-modular separate controller (UFP III): Comm error over the frame to controller interface.<br>8031 Smart-Frame (SDSF): All beams on at least one axis appear to be broken.<br>Modular: All beams on at least one axis appear to be broken - may be caused by having no frame attached to the controller. |
| 06H & 07H | Reserved. |
| 08H* | UART (Universal Asynchronous Receiver/Transmitter) error.<br>A parity or framing error was detected on data received from the host. Perform initialization procedures to reset the touch system. |
| 09H* | Serial overrun error on data received from the host.<br>Commands were received by the touch system faster than it could process them. Increase the timing delay between commands. |
| 0AH* | Invalid command received. A command that is not recognized as valid was received from the host. Note that a 0DH will be treated as valid command during the autobaud phase, but as an invalid command after the autobaud phase. |
| 0BH | External RAM (Random Access Memory) checksum verification error.<br>68705 Smart-Frame: N/A (No external RAM)<br>8031 Pre-modular separate controller (UFP III): Controller (External RAM)<br>8031 Smart-Frame (SDSF): Frame (ASIC RAM)<br>Modular: Frame (ASIC RAM) |
| 0CH - 0DH | Reserved. |
| 0EH* | Power-On Reset (POR) Detected.<br>The touch system has been reset (usually due to a power cycle) and the touch system has not yet been reinitialized. |
| 0FH - 10H | Reserved. |
| 11H* | High Ambient Detected.<br>One or more beams are being treated as failed beams when determining the coordinates of touches due to excessive ambient light.<br>The beams are not failed, however, and when the excessive ambient light is removed, the beams recover immediately. |

Table A-3. Smart-Frame Protocol Error Report Error Codes (Con't)

| Error Code | Description/Affected Touch System Component |
|---|---|
| 12H - 18H | Reserved. |
| 19H | External Read Only memory (ROM) checksum verification error.<br>68705 Smart-Frame: N/A (No external ROM)<br>8031 Pre-modular separate controller (UFP III): Frame (EEPROM)<br>8031 Smart-Frame (SDSF): Frame (EEPROM)<br>Modular: Frame (EEPROM) |
| 1AH & up | Reserved. |

* Error is cleared by sending the *Software_Reset (3CH)* command. All other error codes, once detected, are reported for each subsequent error report.

## Example

An example of an Error Report is:

```
F8 01 04 FF
```

It indicates that one "failed beam(s) detected" error was found.

## See Also

*Get_Configuration_Report (33H)*
*Get_Firmware_Version_Report (34H)*
*Software_Reset (3CH)*
*Run_Diagnostics (3AH)*

## *Get_Failed_Beam_Report (36H) (6)*

### Command Description

When the host sends the *Get_Failed_Beam_Report (36H)* command, the touch system analyzes the beams that are listed in the failed beam table at the time the command is processed. It does not examine any beams other than those listed in the table and does not add beams to or remove beams from the table.

When a beam fails, the touch system firmware attempts to determine which opto-device is not functioning, if the touch system hardware allows this. If the touch system hardware does not allow such an analysis, the status indicator is set to “firmware could not determine problem” (0) for all failed beams specified in the Failed Beam Report.

### Report Format

The Failed Beam Report has the following format:

```
FA Nx Xa, Ta, ..., Xn, Tn Ny Ya, Sa, ..., Yn, Sn
FF
```

`FA` = Start of Failed Beam Report.

`Nx` = Number of x-beam reports to follow.

`Xa, ..., Xn`
= X-beam numbers.

`Ta, ..., Tn`
= Status of failed x-beams.

| | | |
|---|---|---|
| 0 | = | Firmware could not determine problem. |
| 1 | = | Failed phototransistor. |
| 2 | = | Failed LED. |
| 3 | = | Failed phototransistor and LED. |
| 4 | = | Individual components appear to work separately, but not together. Failure cannot be isolated. |

`Ny` = Number of y-beam reports to follow.

`Ya, ..., Yn`
= Y-beam numbers.

`Sa, ..., Sn`
= Status of failed y-beams; has the same values (0-4) and definitions as status of failed x-beams.

`FF` = End of report.

## Example

An example of a Failed Beam Report is:

```
FA 01 03 02 00 FF
```

It indicates that there is one failed x-beam (beam number 3), that its LED failed, and that there are no failed y-beams.

## See Also

“Failed Beams” in Chapter 2

## *Get_Firmware_Version_Report (34H) (4)*

### Command Description

When the host sends the *Get_Firmware_Version_Report (34H)* command, the touch system returns a list of the firmware version for various touch system components. Each firmware version is represented as a 10-byte ASCII-encoded string.

### Report Format

The Firmware Version Report has the following format:

```
F6 Nv Va Vb, ..., Vn FF
```

| | | |
|---|---|---|
| `F6` | = | Start of Firmware Version Report. |
| `Nv` | = | Number of firmware versions to follow. |
| `Va` | = | Firmware version of first component. |
| `Vb` | = | Firmware version of second component. |
| `Vn` | = | Firmware version of last component. |
| `FF` | = | End of report. |

### Example

A Firmware Version Report for a touch system with one firmware version to report follows:

```
F6 01 2D 30 30 30 34 2D 30 30 2D 2D FF
```

The `2D`...`2D` parameters indicate one firmware version report (ASCII ‘-0004-00--’).

#### *Caution*

Do not hard wire the code that interprets the Firmware Version Report so that it only works with a specific number of version reports or a specific firmware version. To do so results in code that may not be portable from one touch system to another.

It is generally sufficient for an application to simply report the firmware version strings without interpretation. Also, variations over the years in the configurations of firmware versions reported makes interpretation difficult. As a general rule, however, for the standard products specified below, the configurations of the reported firmware versions are as follows:

68705 Smart-Frame:

| | | |
|---|---|---|
| Firmware version #1 | - | Slave processor EPROM. |
| Firmware version #2 | - | Master processor EPROM. |

8031 Pre-Modular (UFP III)

| | | |
|---|---|---|
| Firmware version #1 | - | EPROM. |
| Firmware version #2 | - | EEROM if present, otherwise EPROM firmware version is repeated. |

8031 Smart-Frame (SDSF) and Modular:

| | | |
|---|---|---|
| Firmware version #1 | - | EPROM. |
| Firmware version #2 | - | EEROM. |

## *Get_Frame_Size_Report (37H) (7)*

### Command Description

When the host sends the *Get_Frame_Size_Report (37H)* command, the touch system returns a Frame Size Report that specifies the size of the touch frame, expressed as the number of logical coordinates on each axis.

### Report Format

The Frame Size Report has the following format:

```
F4 X Y FF
```

| | | |
|---|---|---|
| F4 | = | Start of Frame Size Report. |
| X | = | Number of x-axis logical coordinates. |
| Y | = | Number of y-axis logical coordinates. |
| FF | = | End of report. |

### Example

An example Frame Size Report is:

```
F4 4F 3B FF
```

It indicates that the coordinate ranges are 0-78 x-axis logical coordinates (4FH = 79) and 0-58 y-axis logical coordinates (3BH = 59).

## Get_One_Report (46H) (F)

### Command Description

The *Get_One_Report (46H)* command requests that a single report be sent to the host. Report transfer is turned on temporarily to transfer one report then turned off.

#### *Note*

When using the *Get_One_Report (46H)* command with hardware flow control off, wait until the full report sequence is received before sending the next command to the touch system.

### Report Format

If no reports are available to be transmitted when the *Get_One_Report (46H)* command is sent, the touch system returns a Null Report to the host. The report has the following format:

```
F5  FF
```

| | | |
|---|---|---|
| F5 | = | Start of Null Report. |
| FF | = | End of report. |

### See Also

*Run_Diagnostics (3AH)*
*Report_Transfer_Off (43H)*
*Report_Transfer_On (44H)*

## Get_State_Report (47H) (G)

### Command Description

When the host sends a *Get_State_Report (47H)* command, the touch system returns a State Report that indicates the current state of the touch system. The report lists the values of various internal flags, allowing the host to determine whether its commands were correctly received.

### Report Format

The State Report has the following format:

```
F2 NS SRM SOM STS SUE SRT SHF FF
```

| | | | | |
|---|---|---|---|---|
| F2 | = | Start of State Report. | | |
| NS | = | Number of state bytes returned. | | |
| SRM | = | Reporting method. | | |
| | | 1 | = | Coordinate method. |
| | | 2 | = | Scan method. |
| SOM | = | Touch Mode. | | |
| | | 1 | = | *Tracking Mode*, Add Exit Point modifier off. |
| | | 2 | = | *Enter Point Mode*, Add Exit Point modifier off. |
| | | 3 | = | *Continuous Mode*, Add Exit Point modifier off. |
| | | 4 | = | *Exit Point Mode*, Add Exit Point modifier off. |
| | | 5 | = | *Tracking Mode*, Add Exit Point modifier on. |
| | | 6 | = | *Enter Point Mode*, Add Exit Point modifier on. |
| | | 7 | = | *Continuous Mode*, Add Exit Point modifier on. |
| | | 8 | = | *Exit Point Mode*, Add Exit Point modifier on. |
| STS | = | Touch scanning. | | |
| | | 1 | = | Off. |
| | | 2 | = | On. |
| SUE | = | Reserved (always returns 1). | | |
| SRT | = | Report transfer. | | |
| | | 1 | = | Off. |
| | | 2 | = | On. |
| SHF | = | Hardware flow control. | | |
| | | 1 | = | Off. |
| | | 2 | = | On. |

| | | |
|---|---|---|
| `FF` | = | End of report. |

### *Note*

The `SOM` byte is not valid under scan reporting.

## Example

An example of a State Report is:

```
F2 06 01 03 02 01 02 01 FF
```

The six state bytes indicate the reporting method is coordinate, the touch mode is continuous, touch scanning is on, (reserved bit), report transfer is on, and hardware flow control is off.

## *Hardware_Flow_Control_Off (42H) (B)*

### Command Description

When the host sends the *Hardware_Flow_Control_Off (42H)* command, the touch system stops using hardware handshaking to regulate serial communication with the host.

Data Terminal Ready (`DTR`) is ignored by the touch system, and Smart-Frame Protocol reports are always transmitted.

For touch systems that use the modular RS-232 controller, Clear To Send (`CTS`) is always asserted, indicating that the touch system is ready to receive commands (even when it is not).

For Smart-Frame type touch systems, `CTS` follows the state of Request To Send (`RTS`) signal from the host and is asserted if `RTS` is asserted and deasserted if RTS is deasserted.

### See Also

*Hardware_Flow_Control_On (41H)*

## *Hardware_Flow_Control_On (41H) (A)*

### Command Description

When the host sends the *Hardware_Flow_Control_On (41H)* command, the touch system uses hardware handshaking to regulate serial communications with the host. Carroll Touch touch systems use one of two hardware flow control methods, depending on the type of touch system.

*Modular RS-232 Controller*

The Clear To Send (`CTS`) signal is used to regulate data transmission from the host to the touch system. The touch system controls the state of the `CTS` signal and asserts `CTS` by applying a positive voltage and deasserts `CTS` by applying a negative voltage. If `CTS` is asserted, the touch system is ready to receive commands. If `CTS` is deasserted, the touch system is processing a command or performing some other activity, and is not ready to receive commands.

The Data Terminal Ready (`DTR`) signal is used to regulate data transmission from the touch system to the host. The host controls the state of the `DTR` signal and should assert `DTR` by applying a positive voltage and deassert `DTR` by applying a negative voltage. If the host asserts `DTR,` the touch system transmits Smart-Frame Protocol reports to the host. If the host deasserts `DTR`, no reports are transmitted from the touch system to the host.

*Smart-Frame Type Touch Systems*

The hardware flow control method is the same as for the modular RS-232 controller with one exception. If the Request To Send (`RTS`) signal is deasserted, the Clear To Send (`CTS`) signal is always deasserted, regardless of whether or not the touch system is ready to receive commands. If `RTS` is asserted, the `CTS` signal reflects the ready state of the touch system. If `CTS` is asserted, the touch system is ready to receive commands; if not, the touch system is not ready.

### See Also

*Hardware_Flow_Control_Off (42H)*

## *Report_Transfer_Off (43H) (C)*

### Command Description

The *Report_Transfer_Off (43H)* command stops the transmission of touch data to the host. If the transfer of a report is in process, it is completed. The touch system continues to scan until another report is generated and stored in the touch report buffer. The touch system then stops scanning and waits for the host to send either the *Report_Transfer_On (44H)*, *Get_One_Report (46H)*, or *Clear_Touch_Report_Buffer (3DH)* command. When the host sends *Report_Transfer_On (44H)*, the touch system sends the coordinates in the touch report buffer (if any) or scans until another report is ready for transfer. The system default setting for report transfer is off.

### See Also

*Report_Transfer_On (44H)*
*Get_One_Report (46H)*

## *Report_Transfer_On (44H) (D)*

### Command Description

The *Report_Transfer_On (44H)* command allows the Smart-Frame to send reports to the host computer. Use this command when the host processor is fast enough to receive touch data at the rate at which it is sent. The system default setting for report transfer is off.

### See Also

*Report_Transfer_Off (43H)*
*Get_One_Report (46H)*

## *Reset (45H) (E)*

### Command Description

When the touch system receives the *Reset (45H)* command, the touch system reenters initialization mode. Use this command for resetting the touch system to initialization mode at the end of an application.

### See Also

“Touch System Initialization” in Chapter 4

## *Run_Diagnostics (3AH) (:)*

### Command Description

When the host sends the *Run_Diagnostics (3AH)* command, the touch system executes all of the diagnostics tests that occur at power-up (such as the RAM test, ROM test, and so forth) and generates an Error Report. The touch system then resets the system defaults, just as if the power had been turned off and then on again. The performance of these diagnostics routines may take up to one second to complete.

Since the touch system defaults are reset, the host must send either the *Report_Transfer_On (44H)* command or the *Get_One_Report (46H)* command to the touch system so that the host can receive the Error Report.

### Report Format

See *Get_Error_Report (32H)* in this appendix for details of the Error Report.

### See Also

*Get_Error_Report (32H)*
*Software_Reset (3CH)*

## *Scan_Reporting (22H) (")*

### Command Description

When the reporting method is set to scan reporting by sending the *Scan_Reporting (22H)* command, a list of the physical beams that are interrupted in each axis is reported to the host. Scan reporting is primarily used for testing and diagnostic purposes, or to obtain raw beam interruption data for custom touch recognition algorithms. The first physical beam on each axis is numbered zero (0) with the origin located in the upper left corner. Touch modes are not recognized when the reporting method is set to scan reporting. The scan reporting method is not supported by the software-based controller (SBC).

### Report Format

The Scan Report has the following format:

```
FB Nx Xa, Xb, Xc, ..., Xn Ny Ya, Yb, Yc, ..., Yn
FF
```

| | | |
|---|---|---|
| `FB` | = | Start of Scan Report. |
| `Nx` | = | Number of x-axis physical beams interrupted. |
| `Xa, ..., Xn` | = | List of x-axis physical beams interrupted. |
| `Ny` | = | Number of y-axis beams physical beams interrupted. |
| `Ya, ..., Yn` | = | List of y-axis physical beams interrupted. |
| `FF` | = | End of report. |

### Example

An example of a Scan Report is:

```
FB 02 04 05 04 07 08 09 0A FF
```

It indicates that two x-axis physical beams (beams 4 and 5) are interrupted and that four y-axis physical beams (beams 7, 8, 9 and A) are interrupted.

### See Also

*Coordinate_Reporting (23H)*

## Software_Reset (3CH) (<)

### Command Description

The *Software_Reset (3CH)* command clears all touch system internal buffers and resets the touch system parameters to the default conditions as shown in Table A-4.

Table A-4. Touch System Default Settings

| **System Parameter** | **Default Setting** |
|---|---|
| Touch Scanning | Off |
| Reporting Method | Coordinate reporting |
| Touch Mode | *Tracking Mode* |
| Add Exit Point Modifier | Off |
| Report Transfer | Off |
| Hardware Flow Control | Off |

The *Software_Reset (3CH)* command is used to determine the parity during the autobaud/autoparity sequence and must be followed by a delay of at least 100 milliseconds to allow time for the initialization sequence to finish if autobaud/autoparity is being used. It is recommended, but not required, that a 100 millisecond delay be included even if autobaud/autoparity is not being used.

### See Also

*Get_Error_Report (32H)*

## *SwitchToSFP-II (65H)*

### Command Description

The *SwitchToSFP-II (65H)* command instructs a touch system that is using the Smart-Frame Protocol to switch to Smart-Frame Protocol II. If successful, the touch system returns the SFP-II Protocol Version Report and subsequently accepts only SFP-II commands. If the touch system does not support SFP-II or cannot switch to SFP-II, the touch system returns an error code.

To return to the SFP from SFP-II, the host must send the *SwitchToClassicSFP (64H)* SFP-II command. (Within the Smart-Frame Protocol II, the original Smart-Frame Protocol is referred to as the “classic” SFP.)

### Report Format

If the touch system supports SFP-II and is able to switch to SFP-II, the touch system returns the SFP-II Protocol Version Report. (Note that the command number for the SFP-II *GetProtocolVersion* command is also 65H.) The version report is structured such that it is also a legal SFP report - that is, none of the bytes between the header and the trailer are larger than DFH. This means that an application that uses a layered protocol for validating SFP reports can continue to use its SFP report validation layer until after this report is received. Refer to the *GetProtocolVersion (65H)* SFP-II command in Appendix B for additional information on this report.

If the touch system does not support SFP-II or cannot switch to SFP-II, it does not respond to the command. The host should timeout waiting for the command, then assume that the touch system only supports SFP. The error code for an invalid command (0AH) is returned in the error report that is sent the next time the host sends the *Get_Error_Report (32H)* SFP command.

If report transfer is disabled when the touch system is switched to SFP-II, any SFP reports that are pending at that time are sent before the SFP-II Protocol Version Report is sent. The state of the Report Transfer parameter remains set to disabled.

### Examples

While in the SFP, the host sends the *SwitchToSFP-II* command as follows:

```
65
```

When the touch system successfully switches to SFP-II, it responds with an SFP-II Protocol Version Report similar to the following:

```
E0 04 00 65 02 20 FF
```

As a second example, assume the touch system is using SFP, report transfer is disabled and an SFP Error Report (that indicates no errors for a one processor touch system) is pending. The host sends the *SwitchToSFP-II* SFP command as follows:

```
65
```

Once the touch system successfully switches to SFP-II, it responds first with the pending SFP Error Report, then the Protocol Version Report as follows:

```
F8 00 FF

E0 04 00 65 02 20 FF
```

## *Touch_Scanning_Off (2BH) (+)*

### Command Description

The *Touch_Scanning_Off (2BH)* command causes the touch system to stop scanning the infrared beams. Use this command when the touch system is not currently being used as an input device. The touch system default is touch scanning off.

### See Also

*Touch_Scanning_On (2AH)*

## *Touch_Scanning_On (2AH) (*)*

### Command Description

The *Touch_Scanning_On (2AH)* command causes the touch system to begin scanning the infrared beams. When Report Transfer is also on, the touch system sends interrupted beam data to the host in the formats defined by the currently selected reporting method. Both the desired reporting method and touch mode should be selected before touch scanning is turned on, although they may also be changed with touch scanning on. The touch system default setting is touch scanning off.

### See Also

*Touch_Scanning_Off (2BH)*

## *Tracking_Mode (26H) (&)*

### Command Description

When the touch mode is set to *Tracking Mode* by sending the *Tracking_Mode (26H)* command, the touch system sends Touch Coordinate Reports to the host as long as the stylus is moving in the touch active area. The touch system tracks the stylus, sending Touch Coordinate Reports to indicate the current stylus position as it moves through the touch active area. The touch system stops sending Touch Coordinate Reports when the stylus is stationary, and resumes sending Touch Coordinate Reports if the stylus begins to move again.

*Tracking Mode* is fundamentally identical to *Continuous Mode* except that the touch system does not send redundant Touch Coordinate Reports when the stylus is stationary. *Tracking Mode* is used in applications where cursor positioning is required, such as graphics applications. *Tracking Mode* is the system default touch mode.

### Report Format

See *Coordinate Reporting (23H)* in this appendix for the format of the Touch Coordinate Report and Non-Contiguous Coordinate Report.

### Example

See *Coordinate Reporting (23H)* in this appendix for examples of the Touch Coordinate Report and Non-Contiguous Coordinate Report.

### See Also

*Coordinate_Reporting (23H)*

# B Smart-Frame Protocol II Function Reference

This appendix lists each SFP-II function in alphabetic and numeric order, respectively, and subsequently gives the details of each SFP-II function.

- GetConfiguration (11H).
- GetCoordinateRanges (10H).
- GetProtocolVersion (65H).
- GetTouchState (01H).
- SetReportProperties (21H).
- SetReportTransferMode (22H).
- SetTouchModes (20H).
- SwitchToClassicSFP (64H).

Table B-1. SFP-II Functions in Alphabetical Order

| **Function Name** | **Hexadecimal Function #** |
|---|---|
| *GetConfiguration* | 11H |
| *GetCoordinateRanges* | 10H |
| *GetProtocolVersion* | 65H |
| *GetTouchState* | 01H |
| *SetReportProperties* | 21H |
| *SetReportTransferMode* | 22H |
| *SetTouchModes* | 20H |
| *SwitchToClassicSFP* | 64H |

Table B-2. SFP-II Functions in Numerical Order

| **Hexadecimal Function #** | **Function Name** |
|---|---|
| 01H | *GetTouchState* |
| 10H | *GetCoordinateRanges* |
| 11H | *GetConfiguration* |
| 20H | *SetTouchModes* |
| 21H | *SetReportProperties* |
| 22H | *SetReportTransferMode* |
| 64H | *SwitchToClassicSFP* |
| 65H | *GetProtocolVersion* |

## *GetConfiguration (11H)*

### Command Description

The *GetConfiguration (11H)* command instructs the touch system to return the Get Configuration Report, which describes each component of the touch system.

A **component** is a portion of the touch system hardware such as a sensor/frame or a controller. The information for each component is contained in its attributes. An **attribute** is a single piece of information that applies to that component. Each attribute consists of two parts: a **tag** that indicates the attribute's meaning, and a **value** that indicates its value.

For example, a guided wave touch system consists of a sensor/frame component and a controller component. The sensor/frame has one attribute - touch technology - with a value of guided wave. The controller component has two attributes - a touch technology attribute with a value of guided wave and an interface attribute with a value of RS-232.

Because the *GetConfiguration (11H)* command is extensible, new component types, attribute types, and attribute values may be added as needed.

Application or driver software that seeks to list the entire configuration of a touch system should maintain a table of strings that match the defined component types, attribute types, and attribute values, and should display those strings if the numeric values for the types and values correspond to a string in the table. If a numeric value for a type or value does not correspond to any of the strings in the table, the numeric value should be displayed.

Application or driver software that seeks to determine the value of a specific attribute should use the value supplied by the Get Configuration Report if an attribute tag and value pair is returned that corresponds to that specific attribute. If no attribute tag and value pair is returned, the application or driver software should use the default value for that specific attribute, if a default is defined. (Note that not all attributes have default values defined; in that case, the application or driver software will be unable to determine via software means the value of the attribute.) If the touch system does not support the *GetConfiguration (11H)* function (as indicated by Cmderr), the application or driver software should act as if no attribute tag and value pair is returned that corresponds to that specific attribute; that is, the application or driver software should use the default value for that specific attribute, if a default is defined.

### Command Format

```
11
```

### Report Format

The Get Configuration Report details the configuration of the touch system.

### Report Format

```
11 ComponentCount
     ComponentType
        AttributeCount
           AttributeTag AttributeValue
           AttributeTag AttributeValue...
     ComponentType...FF
```

*ComponentCount*

= Number of components in the touch system.

*ComponentType*

= Type of component:

| | | |
|---|---|---|
| 0 | = | Unknown. The component exists and has attributes, but its type could not be determined. |
| 1 | = | Sensor/frame. This is the touch sensing portion of the touch system, such as a GW sensor or IR frame. |
| 2 | = | Controller. This is the portion of the touch system that controls one or more touch sensing portions of the touch system. |
| 3 | = | Processor. This is the portion of the touch system that executes the operating firmware. |

No ComponentType value is defined for Smart-Frames; Smart-Frames are treated as the combination of a sensor/frame and a controller.

*AttributeCount*

= Number of attribute tag/value pairs in the component.

*AttributeTag*

= Indicates the meaning of the attribute. Values for AttributeTag depend upon the value of ComponentType. Refer to Table B-3 for the possible values.

`AttributeValue`

= Indicates the value of the attribute. Values for AttributeValue depend upon the value of the corresponding AttributeTag. Refer to Table B-3 for the possible values.

Table B-3. ComponentTypes, AttributeTags and AttributeValues

| ComponentType | AttributeTag | AttributeValue |
|---|---|---|
| 00 = Unknown. | | |
| 01 = Sensor/Frame. | 00 = Reserved. | |
| | 01 = Touch Technology. Specifies the type of touch technology that the sensor or frame uses to detect touches. | 00 = Unknown.<br>01 = Infrared.<br>02 = Guided Wave (default). |
| 02 = Controller. | 00 = Reserved. | |
| | 01 = Touch Technology. Specifies the type of touch technology that the sensor or frame that this controller can control uses to detect touches. | 00 = Unknown.<br>01 = Infrared.<br>02 = Guided Wave (default). |
| | 02 = Interface. Specifies the interface method used by the controller. | 00 = Unknown.<br>01 = RS-232 (default).<br>02 = Smart ISA Bus Controller (HBC-style).<br>03 = Dumb ISA Bus Controller (SBC-style). |
| | 03 = GW Dual Sensitivity. Specifies whether the controller supports the dual sensitivity feature, i.e., it supports two sensitivity parameters, the Entry Sensitivity and Tracking Sensitivity parameters, as opposed to one sensitivity parameter, the Touch Sensitivity parameter. | 00 = Dual sensitivity is not supported (default).<br>01 = Dual sensitivity is supported. |
| 03 = Processor. | 00 = Reserved. | |
| | 01 = Processor family. Specifies the type of microprocessor used by the controller. Note that the type of processor is not generally of direct interest to software, but often serves to help identify the exact controller being used. | 00 = Unknown.<br>01 = DSP (320c26) (default).<br>02 = 805x (8051, 8052, etc...).<br>03 = 6805 (6805, 68705, ...). |

## Examples

The host sends the following *GetConfiguration (11H)* command string:

```
66 01 11 FF
```

If the touch system is a guided wave sensor with a guided wave serial DSP touch system, the returned report may be:

```
E0 13 00 11 03 01 01 01 02 02 03 01 02 02 01 03
00 03 01 01 01 FF
```

The above report indicates that the system has three components (`03`). The first component is a sensor (`01`), with one attribute (`01`) of touch technology (`01`) of guided wave (`02`). The second component is a controller (`02`) with three attributes (`03`): a touch technology attribute (`01`) of guided wave (`02`), an interface attribute (`02`) of RS-232 (`01`), and a sensitivity attribute (`03`) which does not support dual sensitivity (`00`). The last component is the processor (`03`), with one attribute (`01`) of processor family (`01`) of DSP (`01`).

A guided wave sensor with a guided wave serial 8051 touch system may report:

```
E0 13 00 11 03 01 01 01 02 02 03 01 02 02 01 03
01 03 01 01 02 FF
```

The above report is the same as the previous report, except that the controller supports dual sensitivity (`01`) and the processor is of the 8051 family (`02`).

A guided wave sensor with a guided wave dumb ISA bus controller (GWSBC) may issue the following report:

```
E0 0F 00 11 02 01 01 01 02 02 03 01 02 02 03 03
00 FF
```

The above report indicates that the system has two components (`02`). The first component is a sensor (`01`), with one attribute (`01`) of touch technology (`01`) of guided wave (`02`). The second component is a controller (`02`) with three attributes (`03`): a touch technology attribute (`01`) of guided wave (`02`), an interface attribute (`02`) of dumb ISA bus controller (`03`), and a sensitivity attribute (`03`) which does not support dual sensitivity (`00`). No processor component is reported, since the controller has no processor.

Either an infrared modular frame with RS-232 controller or an infrared Smart-Frame with a single 8051 processor would report:

```
E0 13 00 11 03 01 01 01 01 02 03 01 01 02 01 03
00 03 01 01 02 FF
```

An infrared Smart-Frame with dual 68705 processors may report:

```
E0 17 00 11 04 01 01 01 01 02 03 01 01 02 01 03
00 03 01 01 03 03 01 01 03 FF
```

The above report indicates that the system has four components (`04`). The first component is a frame (`01`), with one attribute (`01`) of touch technology (`01`) of IR (`01`). The second component is a controller (`02`) (which happens to be integrated with the frame) with three attributes (`03`): a touch technology attribute (`01`) of IR (`01`), an interface attribute (`02`) of RS-232 (`01`), and a sensitivity attribute (`03`) which does not support dual sensitivity (`00`). The third component of the controller is a processor (`03`), with one attribute (`01`) of processor family (`01`) of 6805 family (`03`). The last component is also a processor (`03`), with one attribute (`01`) of processor family (`01`) of 6805 family (`03`).

An infrared modular frame with ISA bus controller (HBC) with 8052 processor may report:

```
E0 13 00 11 03 01 01 01 01 02 03 01 01 02 02 03
00 03 01 01 02 FF
```

## *GetCoordinateRanges (10H)*

### Command Description

The *GetCoordinateRanges (10H)* command instructs the touch system to report the minimum and maximum values for the x-, y-, and z-axes.

### Command Format

```
10
```

### Report Description

The Coordinate Ranges Report contains the minimum and maximum coordinate values that the touch system will report for each coordinate axis.

### Report Format

```
10 XMinHi XMinLo XMaxHi XMaxLo YMinHi YMinLo
YMaxHi YMaxLo ZMinHi ZMinLo ZMaxHi ZMaxLo
```

*XMinHi XMinLo*
= Minimum x-axis coordinate (16-bit)

*XMaxHi XMaxLo*
= Maximum x-axis coordinate (16-bit)

*YMinHi YMinLo*
= Minimum y-axis coordinate (16-bit)

*YMaxHi YMaxLo*
= Maximum y-axis coordinate (16-bit)

*ZMinHi ZMinLo*
= Minimum z-axis coordinate (16-bit)

*ZMaxHi ZMaxLo*
= Maximum z-axis coordinate (16-bit)

### Example

To obtain the minimum and maximum coordinate values that the touch system will report for each coordinate axis, the host sends the *GetCoordinateRanges (10H)* command as follows:

```
66 01 10 FF
```

The touch system responds with a Coordinate Ranges Report similar to the following:

```
E0 0E 00 10 00 00 07 AA 00 00 0B AB 00 01 00 0F FF
```

In this example, the x-axis coordinates range from 0 to 1962 (00H to 07AAH), the y-axis coordinates range from 0 to 2987 (00H to 0BABH), and the z-axis coordinates range from 1 to 15 (01H to 000FH).

## *GetProtocolVersion (65H)*

### Command Description

The *GetProtocolVersion (65H)* command instructs the touch system to return the version number of the interface protocol that the touch system firmware uses to communicate with the host.

Note that this is not the same as the *GetFirmwareVersion (34H)* SFP command, which instructs the touch system to return the Firmware Version Report containing the version number of the firmware that implements the interface protocol.

### Command Format

```
65
```

### Report Description

The Protocol Version Report returns the version number of the firmware protocol in an xx.yz format using Binary Coded Decimal (BCD) encoding.

This report is also sent in response to the *SwitchToSFP-II (65H)* SFP command if a touch system that supports SFP-II receives that command while it is in SFP mode. This mechanism can used by an application to determine if the touch system supports SFP-II.

### Report Format

`65` *`ProtocolVersionHi ProtocolVersionLo`*

*`ProtocolVersionHi`*

= Two-digit major version number encoded in BCD with the most significant BCD digit in the most significant nibble.

*`ProtocolVersionLo`*

= Two-digit minor version number encoded in BCD with the most significant BCD digit in the most significant nibble.

### Example

To obtain the protocol version, the host sends the *GetProtocolVersion* command as follows:

```
66 01 65 FF
```

The touch system responds with a Protocol Version Report similar to the following:

```
E0 04 00 65 02 13 FF
```

In this example, the protocol version is 2.13.

## See Also

*SwitchToSFP-II (65H)* in Appendix A
*SwitchToClassicSFP (64H)*

## *GetTouchState (01H)*

### Command Description

The *GetTouchState (01H)* command instructs the touch system to return the current touch state and coordinates.

### Command Format

`01`

### Report Description

The Touch State Report contains the touch state and x, y, and z coordinates that together describe the current state of the touch system.

The touch state parameter is a single byte that reports whether the touch system is currently being touched. The x, y, and z coordinates are all 16-bit parameters that report the location and pressure of the touch. If the touch system does not support the z-axis, the z-axis parameter is 0.

The host should use either the TouchReportingMode parameter in the *SetTouchModes (20H)* command (the preferred method) or the ReportingMode parameter in the *SetReportProperties (21H)* command to indicate under what conditions the Touch State Report should be sent.

- To send Touch State Reports to the host only when requested, set the *Reporting Mode* to solicited only.
- To send Touch State Reports continuously or whenever a parameter changes, set the *Reporting Mode* to continuous or parameter change, respectively.

### Report Format

*`01 TouchState XCoordHi XCoordLo YCoordHi YCoordLo ZCoordHi ZCoordLo`*

*`TouchState`*

= Value for the TouchState parameter:

| | | |
|---|---|---|
| 00 | = | Not touched. The x, y, and z parameters report where and how hard the screen was last touched. |
| 01 | = | Touched. The x, y, and z parameters report where and how hard the screen is currently being touched. |
| 02 | = | Non-contiguous. The x, y, and z parameters are undefined if the screen is being touched with more than one finger. |

*XCoordHi XCoordLo*
= 16-bit x coordinate.

*YCoordHi YCoordLo*
= 16-bit y coordinate.

*ZCoordHi ZCoordLo*
= 16-bit z coordinate.

## Example

To determine the location of a touch, the host sends the *GetTouchState (01H)* command as follows:

```
66 01 01 FF
```

The touch system responds with a Touch State Report similar to the following:

```
E0 09 00 01 01 00 0C 07 D3 00 00 FF
```

In this example, the screen is being touched at x=12 (000CH) and y=2003 (07D3H). The z-axis is not supported.

## See Also

*SetTouchModes (20H)*
*SetReportProperties (21H)*

## *SetReportProperties (21H)*

### Command Description

The *SetReportProperties (21H)* command acts in conjunction with the *SetReportTransferMode (22H)* command to control under what conditions the touch system generates reports.

#### *Note*

This command is not implemented in the GW DSP Serial Controller firmware. The reporting mode for all SFP-II functions except *GetTouchState (01H)* is set to *Solicited Only Mode* and cannot be changed. The reporting mode for *GetTouchState (01H)* can be set to *Solicited Only Mode*, *Parameter Change Mode*, or *Continuous Mode* using *SetTouchModes (20H)*.

The *SetReportProperties (21H)* command sets the reporting mode for individual SFP-II functions via the ReportingMode parameter. The available reporting modes are:

| | | |
|---|---|---|
| *Solicited Only Mode* | - | The touch system only sends the selected report in response to having received the corresponding command. |
| *Parameter Change Mode* | - | The touch system sends the selected report both in response to having received the corresponding command and whenever any of the parameters contained in the report changes. |
| *Continuous Mode* | - | The touch system sends the selected report in response to having received the corresponding command and each time that it executes its main executive loop. |

*Parameter Change Mode* and *Continuous Mode* produce “unsolicited reports,” because reports are sent by the touch system when other conditions occur, without the corresponding SFP-II command having been received.

The *SetReportProperties (21H)* command is an overloaded command.

- If the host sends only the *SetReportProperties (24H)* command number and the report number for a report, the report properties of that report are not modified and the Report Properties Report is sent to report the current report properties of the selected report.

- If the host sends the entire *SetReportProperties (21H)* command with all parameters, the report properties of that report are modified and the Report Properties Report are sent to report the current report properties of the selected report.
- If the host sends the *SetReportProperties (21H)* command number with any other combination of parameters, an invalid parameter error is returned in Cmderr.

In general, the touch system firmware should allow all reports to be set to any reporting mode, even if it does not seem sensible. For example, the reporting mode of the *GetProtocolVersion (65H)* function can be set to either *Parameter Change Mode* or *Continuous Mode*, but the protocol version is not likely to change.

If the firmware is implemented so that there is one place in the code that decides when to send a report for all reports, then no extra development effort is required to allow the report to be set to all modes, even though it doesn't make sense to do so. In fact, extra development effort would be required to prevent the report from being able to be set to all reporting modes.

If, however, a situation arises where it is deemed necessary to prohibit a particular report from being set to a particular reporting mode, *SetReportProperties (21H)* should use the Cmderr parameter to report an invalid parameter for the ReportingMode parameter to indicate that the desired reporting mode is not supported by that particular report.

## Command Format

`21` *`ReportNumber`*
or
`21` *`ReportNumber ReportingMode`*

*`ReportNumber`*
= Specifies the report that is to have its properties modified or reported.

*`ReportingMode`*
= Value for the reporting mode parameter:

| | | |
|---|---|---|
| 00 | = | Solicited only. |
| 01 | = | Parameter change. |
| 02 | = | Continuous. |

## Report Description

The Report Properties Report returns the current report properties for the specified report.

## Report Format

`21 ReportNumber ReportingMode FunctionVersion`

*`ReportNumber`*

= Specifies the report for which properties are being reported.

*`ReportingMode`*

= Returns the reporting mode parameter for the selected report.
00 = Solicited only.
01 = Parameter change.
02 = Continuous.

*`FunctionVersion`*

= Reports the protocol version number of the selected SFP-II function.

| | | |
|---|---|---|
| 00 | = | Function is not defined. |
| 01 or greater | = | Function is defined. |

At this time, no firmware implementation supports the assignment of a version number of 02 or greater to a function. The ability to assign version numbers of 02 or greater is reserved for future firmware implementations. Refer to "Extensibility" in Chapter 5 for more information regarding the use of this parameter.

## Examples

If the host sends the *SetReportProperties (21H)* command as follows:

```
66 02 21 01 FF
```

The touch system responds with the following report (assuming that function 01 is defined and is currently set to *Parameter Change Mode*):

```
E0 05 00 21 01 01 01 FF
```

This report indicates that there are no errors in Cmderr, that the reporting mode for report number `01` is currently set to parameter change (`01`), and that the version number for function 01 is `01`. No parameter values were changed.

If the host sends the *SetReportProperties (21H)* command as follows:

```
66 01 21 FF
```

The touch system responds with the following report:

```
E0 02 01 21 FF
```

This report indicates that fewer parameters byte were received than expected via Cmderr (the `01` byte).

If function 09 is not defined and the host sends the *SetReportProperties (21H)* command as follows:

```
66 02 21 09 FF
```

The touch system responds with the following report:

```
E0 05 00 21 09 00 00 FF
```

This report indicates no errors in Cmderr and indicates that function 09 is not defined (that is, has a version number of 00) in the last `00`. The reporting mode parameter is undefined and reported as `00` in the next to last `00`.

If function 01 is defined and the continuous reporting mode (02) is valid for that particular function and the host sends the *SetReportProperties (21H)* command as follows:

```
66 03 21 01 02 FF
```

The touch system responds with the following report:

```
E0 05 00 21 01 02 01 FF
```

This report indicates no errors in Cmderr and reports that the reporting mode for function 01 is now continuous (`02`). It also reports that the version number for function 01 is `01`.

If function 05 is defined and the continuous reporting mode (02) is invalid for that particular function and the host sends the *SetReportProperties (21H)* command as follows:

```
66 03 21 05 02 FF
```

The touch system responds with the following report:

```
E0 05 02 21 05 01 01 FF
```

This report indicates that the second parameter byte was erroneous via Cmderr (the `02` byte). This indicates that the reporting mode property could not be set to continuous (`02`) for this particular function.

## See Also

*SetReportTransferMode (22H)*

## *SetReportTransferMode (22H)*

### Command Description

The *SetReportTransferMode (22H)* command acts in conjunction with the *SetReportProperties (21H)* command to control under what conditions the touch system generates reports.

#### *Note*

This command is not implemented in the GW DSP Serial Controller firmware. The reporting mode for all SFP-II functions except *GetTouchState (01H)* is set to *Solicited Only Mode* and cannot be changed. The reporting mode for *GetTouchState (01H)* can be set to *Solicited Only Mode*, *Parameter Change Mode*, or *Continuous Mode* using *SetTouchModes (20H)*.

The *SetReportTransferMode (22H)* command sets the ReportTransferMode SFP-II global parameter via the ReportTransferMode function parameter. When ReportTransferMode is set to disabled, the transfer of unsolicited reports from the touch system to the host is inhibited. The transfer of solicited reports from the touch system to the host is unaffected. When ReportTransferMode is set to enabled, the transfer of both solicited and unsolicited reports from the touch system to the host is unaffected. The use of the ReportTransferMode parameter to regulate the transfer of unsolicited reports is illustrated in Figure B-1.

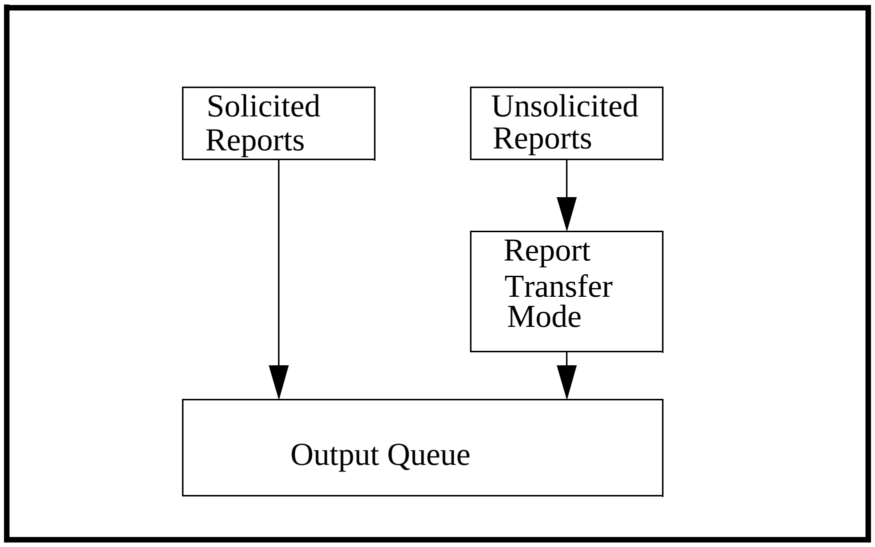


Figure B-1. Flow Diagram for Report Transfer Mode

The *SetReportTransferMode (22H)* command is an overloaded command.

- If the host sends only the *SetReportTransferMode (22H)* command number, the ReportTransferMode SFP-II global parameter is not modified and the ReportTransferMode report is sent to report the current state of the ReportTransferMode SFP-II global parameter.
- If the host sends the entire *SetReportTransferMode* command including the ReportTransferMode parameter, the ReportTransferMode SFP-II global parameter is modified and the Report Transfer Mode Report is sent to report the current state of the ReportTransferMode SFP-II global parameter.
- If the host sends the *SetReportTransferMode (22H)* command number with any other combination of parameters, an invalid parameter error is returned in Cmderr.

If the *SetReportProperties (21H)* command attempts to set the ReportTransferMode SFP-II global parameter to a value other than enabled or disabled, an invalid parameter error is returned in Cmderr.

The primary purpose of the *SetReportTransferMode (22H)* command is to provide the host computer with the means to implement software flow control in the touch system-to-host direction. The host may use the *SetReportTransferMode (22H)* command to inhibit report transfer from the touch system when necessary, as in the case where the host's input buffer is about to overflow. The host must allow for the SetReportTransferMode report packet that is sent by the touch system in response to the *SetReportTransferMode (22H)* command.

## Command Format

`22`
or
`22` *`ReportTransferMode`*

*`ReportTransferMode`*

= Specifies the value to which the ReportTransferMode SFP-II global parameter is to be set. Legal values for the report transfer mode parameter are:

| | |
|---|---|
| 00 = | Disabled. The transfer of unsolicited reports from the touch system to the host is inhibited. |
| 01 = | Enabled. The transfer of both solicited and unsolicited reports from the touch system to the host is unaffected. |

The ReportTransferMode SFP-II global parameter is a shared parameter and corresponds to the Report Transfer SFP global parameter. As with all shared parameters, there is no SFP-II default for this parameter. The initial value of this parameter is equivalent to the value of the corresponding SFP parameter at the time that the touch system is switched to the SFP-II protocol. The SFP default for this parameter is report transfer disabled. Refer to Chapter 5 for more details concerning shared parameters.

## Report Description

The Set Report Transfer Mode Report returns the current state of the ReportTransferMode SFP-II global parameter.

## Report Format

`22` *`ReportTransferMode`*

*`ReportTransferMode`*

= Returns the value to which the ReportTransferMode SFP-II global parameter is currently set. Legal values for the report transfer mode parameter are:

| | | |
|---|---|---|
| 00 | = | Disabled. The transfer of unsolicited reports from the touch system to the host is inhibited. |
| 01 | = | Enabled. The transfer of both solicited and unsolicited reports from the touch system to the host is unaffected. |

## Examples

If the host sends the SFP *Report_Transfer_On (44H)* command before switching to SFP-II, the state of the ReportTransferMode SFP-II global parameter upon entry to SFP-II mode is enabled.

If, after switching to SFP-II mode, the host sends the *SetReportTransferMode (22H)* command as follows to read the state of the ReportTransferMode SFP-II global parameter:

```
66 01 22 FF
```

The touch system responds with a Report Transfer Mode Report to indicate that the current state of the ReportTransferMode parameter is enabled as follows:

```
E0 03 00 22 01 FF
```

If the host subsequently sets the reporting mode of the function to *Parameter Change Mode* and the screen is touched, the touch system sends TouchState reports similar to the following to report the movements of the stylus within the active area of the touch screen:

```
E0 09 00 01 01 00 0C 07 D3 00 00 FF
E0 09 00 01 01 00 0D 07 D2 00 00 FF
E0 09 00 01 00 00 0D 07 D2 00 00 FF
```

If the host then sends the *GetProtocolVersion (65H)* command as follows:

```
66 01 65 FF
```

The touch system responds with a Protocol Version Report similar to the following:

```
E0 04 00 65 01 15 FF
```

If the host then sends the *SetReportTransferMode (22H)* command as follows to set the state of the ReportTransferMode SFP-II global parameter to disabled and inhibits unsolicited reports:

```
66 02 22 00 FF
```

The touch system responds with a Report Transfer Mode Report to indicate the new state of the ReportTransferMode parameter:

```
E0 03 00 22 00 FF
```

If the screen is touched again, the touch system does not send any Touch State Reports because all unsolicited reports have been inhibited due to the fact that the ReportTransferMode global parameter is set to disabled.

However, if the host sends a *GetTouchState (01H)* command, the touch system responds with a Touch State Report similar to the following to report the current touch state:

```
E0 09 00 01 00 00 0D 07 D2 00 00 FF
```

The Touch State Report is sent even though the ReportTransferMode global parameter is set to disabled because it is a solicited report; that is, it was generated in response to a corresponding SFP-II command.

If the host then sends another command as follows:

```
66 01 65 FF
```

The touch system again responds with a Protocol Version Report similar to the following:

```
E0 04 00 65 01 15 FF
```

Again, this report is sent even though the ReportTransferMode global parameter is set to disabled because it is a solicited report.

## See Also

*SetReportProperties (21H)*

## SetTouchModes (20H)

### Command Description

The *SetTouchModes (20H)* command sets the parameters that control how the touch system detects and reports touch information.

#### Note

The only legal value for the TouchStateReportType parameter at this time is Touch State Report. The Multi Touch State and Raw Touch State Reports have yet to be defined.

The *SetTouchModes (20H)* command is an overloaded command.

- If the host sends only the command number, no touch mode parameters are modified and the Set Touch Modes Report is sent to report the current state of the touch mode parameters.
- If the host sends the entire command with all parameters, the touch mode parameters are modified and the Set Touch Modes Report is sent to report the current state of the touch mode parameters.
- If the host sends the *SetTouchModes (20H)* command number with any other combination of parameters, an invalid parameter error is returned in Cmderr.

The *SetTouchModes (20H)* command sets the report properties of each of the Touch State Reports to implement the functionality specified by the TouchStateReportType and TouchReportingMode parameters. For example, if the TouchStateReportType parameter was set to Touch State Report and the TouchReportingMode parameter was set to *Parameter Change Mode*, the *SetTouchModes (20H)* command would set the TouchState reporting mode to *Parameter Change Mode* and the MultiTouchState and RawTouchState reporting modes to *Solicited Only Mode*. If the TouchStateReportType parameter was set to RawTouchState and the TouchReportingMode parameter was set to *Continuous Mode*, the *SetTouchModes (20H)* command would set the TouchState and MultiTouchState reporting modes to *Solicited Only Mode* and the RawTouchState reporting mode to *Continuous Mode*.

The *SetTouchModes (20H)* command enables or disables touch detection explicitly. Even if the reporting mode of all TouchState reports are set to solicited only, the touch detection state is unaffected.

## Command Format

`20`

or

`20` *`TouchDetection TouchStateReportType TouchReportingMode`*

*`TouchDetection`*

= Specifies the value to which the TouchDetection SFP-II global parameter is to be set. The TouchDetection global parameter enables or disables the touch system hardware that detects touches. For example, disabling touch detection on an IR touch system would cause the touch system to stop scanning the IR beams to detect touches. Legal values for the touch detection parameter are:
00 = Touch detection disabled
01 = Touch detection enabled

Note that the TouchDetection SFP-II global parameter is a shared parameter and corresponds to the Touch Scanning SFP global parameter. As with all shared parameters, there is no SFP-II default for this parameter. The initial value of this parameter is equivalent to the value of the corresponding SFP parameter at the time that the touch system is switched to the SFP-II protocol. Refer to Chapter 5 for more details on shared parameters.

*`TouchStateReportType`*

= Selects the type of touch state report that is to be sent when the touch system detects a change in the touch state. Legal values for the touch state report type parameter are:

| | | |
|---|---|---|
| 01 | = | Touch State Report (default) |
| 02 | = | Multi Touch State Report |
| 03 | = | Raw Touch State Report |

Note that the values for the touch state report type parameter match the function numbers for the various types of touch state reports. For example, the value of 03 for the Raw Touch State Report matches the function number of 03 for the *GetRawTouchState* function.

*`TouchReportingMode`*

= Determines under what conditions TouchState reports should be sent. Legal values for the touch reporting mode parameter are:

| | |
|---|---|
| 00 = | Solicited only. The touch system only sends the touch state report in response to having received the corresponding command. |
| 01 = | Parameter change (default). The touch system sends the touch state report both in response to having received the corresponding command and whenever the touch state changes (including coordinate changes). |
| 02 = | Continuous. The touch system sends the touch state report both in response to having received the corresponding command and each time that it executes its main executive loop. This should mean that the touch system reports the touch state after every scan. |

Note that the values for the touch reporting mode parameter match the values for the ReportingMode parameter in *SetReportProperties (21H)*.

## Report Description

The Set Touch Modes Report returns the current values of the parameters that control how the touch system detects and reports touch information.

## Report Format

`20` *`TouchDetection TouchStateReportType TouchReportingMode`*

*`TouchDetection`*

= Reports the enable status of the touch system hardware that detects touches. Legal values for the touch detection parameter are:

| | |
|---|---|
| 00 = | Touch detection disabled. |
| 01 = | Touch detection enabled. |

*`TouchStateReportType`*

= Reports the type of touch state report that is sent when the touch system detects a change in the touch state. Legal values for the touch state report type parameter are:

| | |
|---|---|
| 01 = | Touch State Report. |
| 02 = | Multi Touch State Report. |
| 03 = | Raw Touch State Report. |

Note that the values for the touch state report type parameter match the function numbers for the various types of touch state reports. For example, the value of 03 for the Raw Touch State Report matches the function number of 03 for the *GetRawTouchState* function.

`TouchReportingMode`

= Reports the conditions under which TouchState reports are sent. Legal values for the touch reporting mode parameter are:

| | |
|---|---|
| 00 = | Solicited only. The touch system only sends the touch state report in response to having received the corresponding command. |
| 01 = | Parameter change. The touch system sends the touch state report both in response to having received the corresponding command and whenever the touch state changes (including coordinate changes). |
| 02 = | Continuous. The touch system sends the touch state report both in response to having received the corresponding command and each time that it executes its main executive loop. This should mean that the touch system reports the touch state after every scan. |

Note that the values for the touch reporting mode parameter match the values for the ReportingMode parameter in *SetReportProperties (21H)*.

## Examples

If the host sends the *SetTouchModes (20H)* command as follows:

```
66 01 20 FF
```

The touch system responds with the following report:

```
E0 05 00 20 01 01 00 FF
```

This report indicates no errors in Cmderr and reports the values for the three parameters defined for the function that were in effect when the command was sent (the `01`, `01`, and `00` values in the report). No parameter values were changed.

If the host sends the *SetTouchModes (20H)* command as follows:

```
66 02 20 00 FF
```

The touch system responds with the following report:

```
E0 03 02 20 00 FF
```

This report indicates that the second parameter byte was erroneous via Cmderr (the `02` byte), and echoes back the parameters that the host sent. The fact that Cmderr is set to 02 reflects the fact that the touch system expected more parameters than were actually received.

If the host sends the *SetTouchModes (20H)* command as follows:

```
66 04 20 01 01 01 FF
```

The touch system responds with the following report:

```
E0 05 00 20 01 01 01 FF
```

This report indicates no errors in Cmderr and reports the values for the three parameters defined for the function after the parameter values were changed as a result of the host sending the command (the three `01` values in the report).

## See Also

*GetTouchState (01H)*
*SetReportProperties (21H)*

## *SwitchToClassicSFP (64H)*

### Command Description

The *SwitchToClassicSFP (64H)* command instructs the touch system to return to the classic Smart-Frame Protocol. (Within SFP-II, the original Smart-Frame Protocol is referred to as the “classic” SFP.) After the associated report is returned, the touch system accepts only SFP commands and does not accept SFP-II commands. To return to SFP-II, the host must send the *SwitchToSFP-II (65H)* SFP command.

### Command Format

```
64
```

### Report Description

The Switch To Classic SFP Report reports to the host the result of the touch system's attempt to return to the classic SFP.

### Report Format

`64` *`SwitchResult`*

*`SwitchResult`*

= Indicates whether the switch to SFP mode was successful.

| | |
|---|---|
| 00H= | Switch successful. |
| 01H= | Switch failed; touch system still in SFP-II. |

### Examples

While in SFP-II mode, the host sends the *SwitchToClassicSFP (64H)* command as follows:

```
66 01 64 FF
```

If the touch system was able to successfully switch to Classic SFP mode, it responds with the following report:

```
E0 03 00 64 00 FF
```

If the touch system could not switch to Classic SFP mode, it responds with the following report:

```
E0 03 00 64 01 FF
```

### See Also

*GetProtocolVersion* (65H)

# C

# *TAPI Function Reference*

This appendix lists each TAPI function in alphabetic and numeric order respectively and subsequently gives the details of each function.

- CheckForReports (3).
- GetCommunicationParameters (4).
- GetReports (2).
- GetTAPIDriverConfiguration (6).
- GetUserEventHandlerParameters (8).
- Reset (0).
- SendCommand (1).
- SetCommunicationParameters (5).
- SetSBCFrameSize (40H).
- SetUserEventHandler (7).

Table C-1. TAPI Functions in Alphabetical Order

| **Function Name** | **Function # (AX = )** |
|---|---|
| *CheckForReports* | 3 |
| *GetCommunicationParameters* | 4 |
| *GetReports* | 2 |
| *GetTAPIDriverConfiguration* | 6 |
| *GetUserEventHandlerParameters* | 8 |
| *Reset* | 0 |
| *SendCommand* | 1 |
| *SetCommunicationParameters* | 5 |
| *SetSBCFrameSize* | 40H |
| *SetUserEventHandler* | 7 |

Table C-2. TAPI Functions in Numerical Order

| **Function # (AX = )** | **Function Name** |
|---|---|
| 0 | *Reset* |
| 1 | *SendCommand* |
| 2 | *GetReports* |
| 3 | *CheckForReports* |
| 4 | *GetCommunicationParameters* |
| 5 | *SetCommunicationParameters* |
| 6 | *GetTAPIDriverConfiguration* |
| 7 | *SetUserEventHandler* |
| 8 | *GetUserEventHandlerParameters* |
| 40H | *SetSBCFrameSize* |

## *CheckForReports (3)*

### Description

If any reports are available from the touch system, the number of bytes available for transfer to the report buffer is returned in `CX`. This function is similar to *GetReports (2)*, but does not transfer any reports.

### Call with

| | | |
|---|---|---|
| `AX` | = | 3 (function number). |

### Returns

| | | |
|---|---|---|
| `AX` | = | 3 (function number). |
| `CX` | = | Number of bytes available for transfer to the report buffer.<br>0 = No reports available - no bytes transferred.<br>nonzero = Reports were available - number of bytes available for transfer to the buffer. |

### Notes

The application program may use this function to poll the driver to determine if any reports are available.

The SBC driver does not return the number of bytes available in `CX`. If no report bytes are available, `CX` is 0. If report bytes are available, `CX` is FFH.

## GetCommunicationParameters (4)

### Description

This function returns the communication parameters that the driver uses to communicate with the touch system. The application program should read the `BH` register to determine how to interpret the remaining registers.

Touch applications that use these TAPI functions must use the register that defines the driver type in order to interpret the driver-specific parameters. If this is not done (that is, the application is hard-wired to a specific driver type), the resulting touch application may not be compatible with other TAPI drivers.

### Call with

| | | |
|---|---|---|
| `AX` | = | 4 (function number). |

### Returns

| | | |
|---|---|---|
| `AX` | = | 4 (function number). |
| `BH` | = | Driver type.<br>0 = SBC driver.<br>1 = HBC driver.<br>2 = RS-232 driver. |

If `BH` = 0 (SBC) or 1 (HBC), the additional returns are:

| | | |
|---|---|---|
| `BL` | = | Interrupt number. Valid values are 2, 3, 4, 5 and 7. |
| `CX` | = | I/O address. Valid values are from 200H through 3F0H in 10H increments (200H, 210H, 220H, ..., 3F0H). |

If `BH` = 2 (RS-232), the additional returns are:

| | | |
|---|---|---|
| `BL` | = | Comm port.<br>1 = COM1.<br>2 = COM2. |
| `CH` | = | Parity.<br>0 = None.<br>1 = Odd.<br>2 = Even. |

|  |  |  |
|---|---|---|
| `CL` | = | Baud rate.<br>0 = 300.<br>1 = 600.<br>2 = 1200.<br>3 = 2400.<br>4 = 4800.<br>5 = 9600. |

## GetReports (2)

### Description

If any reports are available from the touch system, this function transfers them to the report buffer. The length (in bytes) of the reports transferred to the report buffer is returned in `CX`.

### Call with

| | | |
|---|---|---|
| `AX` | = | 2 (function number). |
| `BX` | = | Segment of report buffer. |
| `CX` | = | Size of report buffer (in bytes). |
| `DX` | = | Offset of report buffer. |

### Returns

| | | |
|---|---|---|
| `AX` | = | 2 (function number). |
| `CX` | = | Number of bytes transferred to the report buffer. |

| | | |
|---|---|---|
| 0 | = | No reports available - no bytes transferred. |
| nonzero | = | Reports were available - number of bytes transferred to the report buffer. |

### Notes

The report buffer is an area of memory in the application program that is dedicated to receiving Smart-Frame Protocol reports. One or several reports may be sent to the report buffer. Only complete reports are sent to the report buffer. No partial reports are sent.

The buffer size value passed in `CX` is the maximum number of bytes that the TAPI driver writes to the report buffer. If the number of bytes that the TAPI driver has available to write to this buffer is greater than this value, the excess bytes are discarded.

It is recommended that the report buffer be at least 64 bytes long. Since the TAPI driver transfers a maximum of 512 bytes to the report buffer, the maximum report buffer size necessary is 512 bytes.

## GetTAPIDriverConfiguration (6)

### Description

This function returns the configuration information for the TAPI driver.

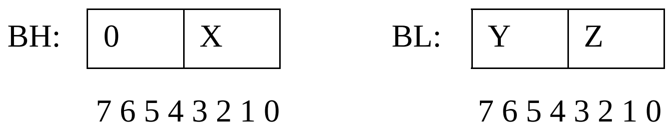
### Call with

| | | |
|---|---|---|
| AX | = | 6 (function number). |

### Returns

| | | |
|---|---|---|
| AX | = | 6 (function number). |
| BX | = | TAPI driver version number. |
| CX | = | Protocol version number.<br>01 00 = Indicates SFP.<br>all other = Indicates the specific version number of SFP-II. |

If the driver version is represented as X.YZ, then the version number in register BX is in the following format:



### Notes

Table C-3 gives examples of how version numbers are represented in BX.

Table C-3. Typical BL/BH Register Contents

| **Version Number** | **Register BL Contents** | **Register BH Contents** |
|---|---|---|
| 1.0 | 01 | 00 |
| 2.1 | 02 | 10 |
| 2.13 | 02 | 13 |

## GetUserEventHandlerParameters (8)

### Description

This function returns the parameters associated with the user event handler.

### Call with

AX = 8 (function number).

### Returns

AX = 8 (function number).

BH = Event mask.
Bit 0= If 1, handler is called on all coordinate reports.
Bit 1= If 1, handler is called on all non-coordinate reports.

| BH: | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | X | X |

The Touch Coordinate Report (report header = FEH), Add Exit Point Coordinate Report (report header = FDH), Non-Contiguous Coordinate Report (report header = FCH), and Scan Report (report header = FBH) are all classified as coordinate reports, and are enabled if bit 0 of the event mask is set. All other reports are classified as non-coordinate reports, and are enabled if bit 1 of the event mask is set. If the user event handler is enabled for all reports, both event mask bits are set.

BL = Enable bits.
Bit 0= If 1, event handler calls are enabled.
If 0, event handler calls are disabled.

| BH: | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | X |

CX = Segment address of user event handler.

DX = Offset address of user event handler.

## *Reset (0)*

### Description

This function resets the driver and/or touch system, using the hardware reset feature that is appropriate for the touch controller used. The driver is reset by performing the following steps:

1. Reinstalling the hardware interrupt vector.
2. Clearing the report buffer.
3. Clearing the user event handler event mask and enable bits.

A driver reset does NOT affect any communication parameters or the address of the user event handler.

Resetting the report buffer only clears the TAPI report buffer. It does not send a *Clear_Touch_Report_Buffer (3DH)* command to the touch system.

### Call with

| | | |
|---|---|---|
| AX | = | 0 (function number). |
| BH | = | 0. |
| BL | = | Select driver / touch system reset.<br>0 = Reset touch system and driver.<br>1 = Reset driver only.<br>2 = Reset touch system only.<br>3 = Reset report buffer only. |

### Returns

| | | |
|---|---|---|
| AX | = | 0 (function number). |
| CX | = | Reset result.<br>0 = Reset OK.<br>1 = TAPI driver could not send commands to touch system.<br>2 = TAPI driver received an error report from the touch system that contained error codes.<br>3 = TAPI driver did not receive the expected error report from the touch system. |

### Notes

For the SBC driver, there is no difference between resetting the driver and resetting the touch system. Therefore, the SBC driver resets the driver and the touch system if BL = 0, 1, or 2.

## SendCommand (1)

### Description

This function sends the specified Smart-Frame Protocol command to the touch system.

### Call with

| | | |
|---|---|---|
| AX | = | 1 (function number). |
| BH | = | 0. |
| BL | = | Smart-Frame Protocol command. |

### Returns

AX = 1 (function number).

CX = Command status.

| | | |
|---|---|---|
| 0 | = | Command accepted. |
| 1 | = | Command could not be transmitted to the touch system because a time out occurred. The TAPI driver has a time out value of approximately 150 ms. |
| 2 | = | Command not supported by TAPI driver. The SBC driver does not support the full Smart-Frame command set. If a valid SFP command is sent, but is not supported by the SBC driver, CX is set to 2. |

### Notes

For more specific information concerning the Smart-Frame Protocol commands, see Chapter 4, “Smart-Frame Protocol.”

## *SetCommunicationParameters (5)*

### Description

This function is used to set the communication parameters that the driver uses to communicate with the touch system. The application program should set register `BH` to the appropriate driver type for the driver loaded.

Touch applications that use these TAPI functions must use the register that defines the driver type in order to interpret the driver-specific parameters. If this is not done (that is, the application is hard-wired to a specific driver type), the resulting touch application may not be compatible with other TAPI drivers.

### Call with

| | | |
|---|---|---|
| `AX` | = | 5 (function number). |
| `BH` | = | Driver type.<br>0 = SBC driver.<br>1 = HBC driver.<br>2 = RS-232 driver. |

If `BH` = 0 (SBC) or 1 (HBC), the additional calls are:

| | | |
|---|---|---|
| `BL` | = | Interrupt number. Valid values are 2, 3, 4, 5 and 7. |
| `CX` | = | I/O address. Valid values are from 200H through 3F0H in 10H increments (200H, 210H, 220H, ..., 3F0H). |

If `BH` = 2 (RS-232), the additional calls are:

| | | |
|---|---|---|
| `CH` | = | Parity.<br>0 = None.<br>1 = Odd.<br>2 = Even. |
| `CL` | = | Baud rate.<br>0 = 300.<br>1 = 600.<br>2 = 1200.<br>3 = 2400.<br>4 = 4800.<br>5 = 9600. |

## Returns

| | | |
|---|---|---|
| AX | = | 5 (function number). |
| CX | = | Status.<br>00H = Communication parameters accepted.<br>01H = Invalid driver type.<br>02H = Invalid interrupt number.<br>04H = Invalid I/O address.<br>08H = Invalid parity.<br>10H = Invalid baud rate. |

### *Note*

Multiple invalid parameter status codes may be returned in the CX register. For example, if both the baud rate and parity parameters were invalid, 18H would be returned in register CX. This is equivalent to the "Invalid Baud Rate" and "Invalid Parity" status codes or'ed together. The application should interpret these codes on a bitwise basis.

## Notes

This function is very similar to *GetCommunicationParameters*, except that register BL does not contain a value representing the RS-232 comm port being used.

Note that sending the *SetCommunicationParameters* function only changes the communication parameters for commands that are subsequently sent to the touch system by the TAPI driver. The touch system communication parameters must also be set to the same communication parameters for proper communication to take place. If an SBC or HBC is being used, for example, the jumpers on the SBC or HBC circuit board that control the interrupt number and I/O address must be changed to match the new interrupt number and I/O address.

If an RS-232-based touch system is being used with a fixed baud rate and parity, the jumpers on the touch system would have to be changed to match the new baud rate and parity. If an RS-232-based touch system is being used that uses autobaud/autoparity, the touch system must be reset using *Reset (0)* for proper communication to take place.

## *SetSBCFrameSize (40H)*

### Description

This function sets the frame size parameters for the SBC driver. Setting these parameters is equivalent to passing the parameters on the command line when loading the SBC driver.

This function is supported by the SBC driver only.

### Call with

| | | |
|---|---|---|
| AX | = | 40H (function number). |
| BX | = | Number of physical beams on the x-axis. |
| CX | = | Number of physical beams on the y-axis. |

### Returns

| | | |
|---|---|---|
| AX | = | 40H (function number). |

### Notes

It is best to set the frame size parameters by passing them on the command line when loading the SBC driver. Avoid using this command, since it violates the philosophy of interchangeability between the TAPI drivers.

The frame size may be read by using the *Get_Frame_Size_Report (37H)* SFP command.

## *SetUserEventHandler (7)*

### Description

This function lets you install a user event handler (UEH) subroutine that is called whenever a report is available from the driver. This lets a user application receive reports from the TAPI driver using an interrupt method rather than a polling method. The UEH subroutine should end with a normal return instruction, not a return from interrupt instruction.

Once a UEH has been installed and enabled, execution of the user program is halted and the event handler subroutine is called whenever the TAPI driver has a report to be sent to the user, as long as the bit in the event mask that corresponds to the type of report is set.

When the UEH is called, the CPU registers contain the following:

| | | |
|---|---|---|
| BX | = | Segment of the TAPI driver's internal report buffer. |
| CX | = | Number of report bytes available for transfer. |
| DX | = | Offset of the TAPI driver's internal report buffer. |

The UEH may then read report bytes from the buffer, up to the number of bytes in CX. Any bytes read from the buffer beyond the value passed in CX are invalid. The UEH must not write to the buffer.

When the event handler subroutine returns, it must load AX as follows:

| | | | | |
|---|---|---|---|---|
| AX | = | 0 | = | Leave the TAPI driver's internal report buffer intact. |
| AX | = | Nonzero | = | Clear the TAPI driver's internal report buffer. |

The execution of the user program then continues at the point at which it was interrupted.

### Call with

AX = 7 (function number).

BH = Event mask.
Bit 0= If 1, call handler on all coordinate reports.
Bit 1= If 1, call handler on all non-coordinate reports.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BH: | | | | | | | X | X |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

The Touch Coordinate Report (report header = FEH), Add Exit Point Coordinate Report (report header = FDH), Non-Contiguous Coordinate Report (report header = FCH), and Scan Report (report header = FBH) are all classified as coordinate reports, and are enabled by setting bit 0 of the event mask. All other reports are classified as non-coordinate reports, and are enabled by setting bit 1 of the event mask. To enable the user event handler for all reports, set both event mask bits.

`BL` = Enable Bits
Bit 0= If 1, enable calls to event handler.
If 0, disable calls to event handler.
Bit 7= If 1, set user event handler address from `CX:DX.`
If 0, do not set user event handler address.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BL: | X | | | | | | | X |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

`CX` = Segment address of user event handler.

`DX` = Offset address of user event handler.

## Returns

`AX` = 7 (function number).

## Notes

Hardware interrupts are disabled during the user event handler. The interrupt enable flag is cleared with a `CLI` instruction.

Use of reentrant function calls such as BIOS calls in the user event handler is acceptable, as is the use of TAPI function calls in the user event handler. However, use of non reentrant function calls such as DOS function calls is not acceptable.

The UEH should execute as quickly as possible to let the TAPI driver continue to process hardware interrupts from the touch system. If the UEH takes too long to return, the TAPI driver may miss hardware interrupts from the touch system.

The UEH is called once and only once for each report. If reports were pending when the UEH was installed, multiple reports could be in the buffer the first time the UEH is called. If this condition is undesirable, clear the report buffer using *Reset* (function 0) immediately before enabling the UEH.

The usual method for using the UEH is for the user program to clear the report buffer (using *Reset (0)*), install the handler (using *SetUserEventHandler (7)*), read one report per event in the user event handler, and exit the UEH with an AX = nonzero, causing the report buffer to be cleared.

Before terminating the user program, be sure to disable the UEH, either by using *SetUserEventHandler (7)* or *Reset (0)*. Otherwise, when the TAPI driver calls the address of where the user program's event handler was, it will now be an invalid address.

The SBC driver does not support calling the UEH on non-coordinate reports. Therefore, the SBC driver ignores bit 1 of BH.

D

# *CTKERN Function Reference*

This appendix lists each CTKERN function in alphabetic and numeric order and subsequently gives the details of each function.

- GetCalibrationTableEntry (7).
- GetCommunicationParameters (22).
- GetCTKERNDriverConfiguration (20).
- GetCurrentCalibrationModeAndParameters (5).
- GetCurrentScalingModeAndParameters (10).
- GetTemporalFilterModeAndParameters (16).
- GetTAPIDriverConfiguration (19).
- GetTouchState (1).
- GetTouchSystemStatus/Configuration (17).
- GetUserEventHandlerModeAndParameters (25).
- GetZ-AxisScalingModeAndParameters (13).
- Reset (0).
- SendSmartFrameProtocolCommandAndGetReport (18).
- SetCalibrationMode (3).
- SetCalibrationParameters (4).
- SetCalibrationTableEntry (6).
- SetCommunicationParameters (21).
- SetScalingMode (8).
- SetScalingParameters (9).
- SetTemporalFilterMode (14).
- SetTemporalFilterParameters (15).

- SetTouchState (2).
- SetUserEventHandlerMode (23).
- SetUserEventHandlerParameters (24).
- SetZ-AxisScalingMode (11).
- SetZ-AxisScalingParameters (12).

Table D-1. CTKERN Functions in Alphabetical Order

| **Function Name** | **Function # (AL = )** |
|---|---|
| *GetCalibrationTableEntry* | 7 |
| *GetCommunicationParameters* | 22 |
| *GetCTKERNDriverConfiguration* | 20 |
| *GetCurrentCalibrationModeAndParameters* | 5 |
| *GetCurrentScalingModeAndParameters* | 10 |
| *GetTemporalFilterModeAndParameters* | 16 |
| *GetTAPIDriverConfiguration* | 19 |
| *GetTouchState* | 1 |
| *GetTouchSystemStatus/Configuration* | 17 |
| *GetUserEventHandlerModeAndParameters* | 25 |
| *GetZ-AxisScalingModeAndParameters* | 13 |
| *Reset* | 0 |
| *SendSmartFrameProtocolCommandAndGetReport* | 18 |
| *SetCalibrationMode* | 3 |
| *SetCalibrationParameters* | 4 |
| *SetCalibrationTableEntry* | 6 |
| *SetCommunicationParameters* | 21 |
| *SetScalingMode* | 8 |
| *SetScalingParameters* | 9 |
| *SetTemporalFilterMode* | 14 |
| *SetTemporalFilterParameters* | 15 |
| *SetTouchState* | 2 |
| *SetUserEventHandlerMode* | 23 |
| *SetUserEventHandlerParameters* | 24 |
| *SetZ-AxisScalingMode* | 11 |
| *SetZ-AxisScalingParameters* | 12 |

Table D-2. CTKERN Functions in Numerical Order

| **Function # (AL = )** | **Function Name** |
|---|---|
| 0 | *Reset* |
| 1 | *GetTouchState* |
| 2 | *SetTouchState* |
| 3 | *SetCalibrationMode* |
| 4 | *SetCalibrationParameters* |
| 5 | *GetCurrentCalibrationModeAndParameters* |
| 6 | *SetCalibrationTableEntry* |
| 7 | *GetCalibrationTableEntry* |
| 8 | *SetScalingMode* |
| 9 | *SetScalingParameters* |
| 10 | *GetCurrentScalingModeAndParameters* |
| 11 | *SetZ-AxisScalingMode* |
| 12 | *SetZ-AxisScalingParameters* |
| 13 | *GetZ-AxisScalingModeAndParameters* |
| 14 | *SetTemporalFilterMode* |
| 15 | *SetTemporalFilterParameters* |
| 16 | *GetTemporalFilterModeAndParameters* |
| 17 | *GetTouchSystemStatus/Configuration* |
| 18 | *SendSmartFrameProtocolCommandAndGetReport* |
| 19 | *GetTAPIDriverConfiguration* |
| 20 | *GetCTKERNDriverConfiguration* |
| 21 | *SetCommunicationParameters* |
| 22 | *GetCommunicationParameters* |
| 23 | *SetUserEventHandlerMode* |
| 24 | *SetUserEventHandlerParameters* |
| 25 | *GetUserEventHandlerModeAndParameters* |

## GetCalibrationTableEntry (7)Description

This function gets the calibration parameters for one entry in the internal calibration table. There are two retrieval methods, using either a calibration table index, or a search for a BIOS video mode. If a BIOS video mode is searched for, and no entry is found in the table that corresponds to the BIOS video mode, the default calibration entry is returned. If no calibration entry is marked as the default, the first calibration entry (calibration table index 0) is returned.

### Call with

| | | |
|---|---|---|
| AL | = | 7 (function number). |
| BH | = | Calibration table entry retrieval method.<br>00 = Retrieve by calibration table index.<br>01 = Retrieve by searching for a video mode. |
| BL | = | Calibration table index (if BH = 00). |
| BL | = | BIOS video mode to search for (if BH = 01). |
| CX | = | Segment of eight-word buffer to hold the calibration data structure. |
| DX | = | Offset of eight-word buffer to hold the calibration data structure. |

### Returns

| | | |
|---|---|---|
| AL | = | Calibration status.<br>00 = Calibration table entry returned successfully.<br>01 = Calibration table index out of range.<br>02 = Calibration table entry returned is not the BIOS video mode that was searched for. |
| BL | = | Calibration table index of the calibration table entry that was returned. |

Calibration data structure in the buffer pointed to by CX and DX:

WORD VideoMode
WORD Flags
WORD Xres
WORD Yres
WORD Xoff
WORD Yoff
WORD Xspan

WORD Yspan

The bits of the WORD Flags are set as follows:

| | | | | |
|---|---|---|---|---|
| Bit 0 | = | Video mode text/graphics flag. | | |
| | | 0 | = | Graphics video mode. |
| | | 1 | = | Text video mode. |
| Bits 1-14 | = | Reserved and must be 0. | | |
| Bit 15 | = | Default calibration flag. | | |
| | | 0 | = | This entry is not the default calibration. |
| | | 1 | = | This entry is the default calibration. |

## Notes

The internal calibration table consists of ten sets of calibration parameters. The valid range for the calibration table index parameter is 0 through 9. If this function is called with a calibration table index outside this range, the calibration status is set to 01, the calibration table index value in `BL` is undefined, and no calibration data is returned.

## GetCommunicationParameters (22)

### Description

This function returns the communication parameters that the driver uses to communicate with the touch system. The application program should read the BH (driver type) register to determine how to interpret the remaining registers.

### Call with

| | | |
|---|---|---|
| AL | = | 22 (function number). |

### Returns

| | | | | |
|---|---|---|---|---|
| BH | = | Driver type. | | |
| | | 0 | = | SBC driver. |
| | | 1 | = | HBC driver. |
| | | 2 | = | RS-232 driver. |

If BH = 0 (SBC) or 1 (HBC), the additional returns are:

| | | |
|---|---|---|
| BL | = | Interrupt number. |
| CX | = | I/O address. |

If BH = 2 (RS-232), the additional returns are:

| | | | | |
|---|---|---|---|---|
| BL | = | Comm port. | | |
| | | 1 | = | COM1. |
| | | 2 | = | COM2. |
| CH | = | Parity. | | |
| | | 0 | = | None. |
| | | 1 | = | Odd. |
| | | 2 | = | Even. |
| CL | = | Baud rate. | | |
| | | 0 | = | 300. |
| | | 1 | = | 600. |
| | | 2 | = | 1200. |
| | | 3 | = | 2400. |
| | | 4 | = | 4800. |
| | | 5 | = | 9600. |

## GetCTKERNDriverConfiguration (20)

### Description

This function returns configuration information for the CTKERN driver.

### Call with

AL = 20 (function number).

### Returns

BX = CTKERN driver version number.

If the CTKERN driver version is represented as X.YZ, then the version number in register BX is in the following format:

```
BH: | 0    | X    |        BL: | Y    | Z    |

     7 6 5 4 3 2 1 0            7 6 5 4 3 2 1 0
```

### Notes

Table D-3 gives examples of how version numbers are represented in BX.

Table D-3. Typical BX Register Contents

| Version Number | Register BH Contents | Register BL Contents |
|---|---|---|
| 1.0 | 01 | 00 |
| 2.1 | 02 | 10 |
| 2.13 | 02 | 13 |

## *GetCurrentCalibrationModeAndParameters (5)*

### Description

This function gets the current calibration mode and the current calibration parameters. The calibration mode determines how the touch coordinates reported by CTKERN are calibrated.

If the calibration mode is set to disabled, the contents of the calibration data structure returned are undefined.

### Call with

| | | |
|---|---|---|
| `AL` | = | 5 (function number). |
| `CX` | = | Segment of four-word buffer to hold the calibration data structure. |
| `DX` | = | Offset of four-word buffer to hold the calibration data structure. |

### Returns

| | | |
|---|---|---|
| `BL` | = | Calibration mode.<br>00 = Calibration disabled.<br>01 = Fixed calibration.<br>02 = Automatic calibration. |

The calibration data structure that contains the calibration data for the calibration that is in effect at the time that this function is called is placed in the buffer that was pointed to by `CX` and `DX`. The calibration data structure is:

WORD Xoff
WORD Yoff
WORD Xspan
WORD Yspan

## *GetCurrentScalingModeAndParameters (10)*

### Description

This function gets the current scaling mode and the current scaling parameters. The scaling mode determines how the touch coordinates reported by CTKERN are scaled.

If the scaling mode is set to disabled, the contents of the scaling data structure are undefined.

### Call with

| | | |
|---|---|---|
| `AL` | = | 10 (function number). |
| `CX` | = | Segment of four-word buffer to hold the scaling data structure. |
| `DX` | = | Offset of four-word buffer to hold the scaling data structure. |

### Returns

`BL` = Scaling mode.

| | | |
|---|---|---|
| 00 | = | Scaling disabled. |
| 01 | = | Fixed scaling. |
| 02 | = | Automatic scaling. |

The scaling data structure that contains the scaling data for the scaling that is in effect at the time that this function is called is placed in the buffer that was pointed to by `CX` and `DX`. The scaling data structure is:

WORD Upper Left X
WORD Upper Left Y
WORD Lower Right X
WORD Lower Right Y

## GetTAPIDriverConfiguration (19)

### Description

This function returns configuration information for the TAPI driver.

### Call with

AL = 19 (function number).

### Returns

BX = TAPI driver version number.

If the driver version is represented as X.YZ, then the version number in register BX is in the following format:

| | | | | | |
|---|---|---|---|---|---|
| BH: | 0 | X | BL: | Y | Z |
| | 7 6 5 4 | 3 2 1 0 | | 7 6 5 4 | 3 2 1 0 |

### Notes

Table D-4 gives examples of how version numbers are represented in BX.

Table D-4. Typical BL/BH Register Contents

| Version Number | Register BH Contents | Register BL Contents |
|---|---|---|
| 1.0 | 01 | 00 |
| 2.1 | 02 | 10 |
| 2.13 | 02 | 13 |

## *GetTemporalFilterModeAndParameters (16)*

### Description

This function gets the temporal filter parameters.

### Call with

| | | |
|---|---|---|
| `AL` | = | 16 (function number). |
| `BL` | = | Parameter reporting mode.<br>00 = Original parameters.<br>01 = Absolute parameters. |

### Returns

| | | |
|---|---|---|
| `BL` | = | Temporal filter mode.<br>00 = Temporal filter disabled.<br>01 = Temporal filter enabled. |

If `BL` is 00 (original parameters), the additional returns are:

| | | |
|---|---|---|
| `CX` | = | Spatial filter box size expressed as a percentage (%) of the full screen size. |
| `DX` | = | User-specified temporal filter time (ms). This parameter returns the exact number of milliseconds set by the call to *SetTemporalFilterParameters (15)*. |

If `BL` is 01 (absolute parameters), the additional returns are:

| | | |
|---|---|---|
| `CH` | = | Spatial filter box size x (actual size of the box in pixels). |
| `CL` | = | Spatial filter box size y (actual size of the box in pixels). |
| `DX` | = | Actual temporal filter time used (ms). This parameter returns the number of milliseconds that the driver actually uses for the wait (modulo 55 ms). Note that the actual time waited may still vary by +/- 55ms. |

## GetTouchState (1)

### Description

This function returns the instantaneous touch state of the touch system.

### Call with

| | | |
|---|---|---|
| AL | = | 1 (function number). |

### Returns

| | | |
|---|---|---|
| BH | = | Z-axis touch pressure. |
| BL | = | Touch state.<br>0 = Not touched (x, y set to last place screen was touched).<br>1 = Touched (x, y set to where the screen is touched).<br>2 = Non-contiguous (x, y undefined). |
| CX | = | X coordinate. |
| DX | = | Y coordinate. |

### Notes

The x and y coordinates may be scaled and/or calibrated as defined by the calibration and scaling parameters.

The default origin for the touch coordinate reports is the upper left corner. This default origin may be changed by setting the scaling parameters appropriately. See *SetScalingParameters (9)* for more information about setting the default origin.

All touch coordinates reported are scaled and calibrated according to the scaling and calibration modes and parameters that are in effect at the time that the touch event occurred, not at the time that the coordinates are reported. For example, if the scaling mode was set to fixed with Xres, Yres set to 640, 200 and the screen was touched at the point corresponding to 200, 100 and released, subsequent calls to *GetTouchState (1)* report the touch state as not touched, x=200, y=100, even if the scaling or calibration modes or parameters were changed.

If the touch screen has not been touched since CTKERN was loaded or reset, the touch state is Not Touched (0), and the x and y coordinates are both set to 0.

If z-axis scaling is disabled, the raw z-axis parameter reported by the touch system is reported in BH. If z-axis scaling is enabled, the z-axis parameter reported in BH is determined by linearly scanning the raw z-axis parameter reported by the touch system within the range defined by the minimum and maximum z-axis pressure values.

If the touch system hardware does not support the z-axis, BH is set to 0 if z-axis scaling is disabled. If z-axis scaling is enabled, BH is set to the minimum pressure value.

If the calibration mode is set to fixed or auto and the screen is touched outside of the calibrated area, the coordinates of the point inside the calibrated area closest to the location of the touch are reported.

## GetTouchSystemStatus/Configuration (17)

### Description

This function returns the status and configuration information for the touch system.

### Call with

| | | |
|---|---|---|
| `AL` | = | 17 (function number). |
| `CX` | = | Segment of 64-byte buffer to hold the touch system status/configuration data structure. |
| `DX` | = | Offset of 64-byte buffer to hold the touch system status/configuration data structure. |

### Returns

`AL` = Touch system error status.

| | | |
|---|---|---|
| 00 | = | The touch system reported no errors. |
| 01 | = | The touch system reported some errors (see status/configuration data structure for details), the host received unexpected data from the touch system, or expected data was missing. |
| 02 | = | Unable to communicate with the touch system. |

Touch system status/configuration data structure in the buffer pointed to by `CX` and `DX` is:

| | | |
|---|---|---|
| | BYTE | Number of processors |
| | BYTE | Number of processor 1 errors |
| 8 | BYTES | Processor 1 errors |
| | BYTE | Number of processor 2 errors |
| 8 | BYTES | Processor 2 errors |
| | WORD | X frame size |
| | WORD | Y frame size |
| | WORD | Z-axis resolution |
| 10 | BYTES | Firmware version report #1 |
| 10 | BYTES | Firmware version report #2 |

### Notes

See the explanations for the Smart-Frame Protocol configuration, Error Report, frame size, z-axis resolution and Firmware Version Report in Appendix A, “Smart-Frame Protocol Command Reference.”

If the touch system has no z-axis, the z-axis resolution is reported as 0.

## *GetUserEventHandlerModeAndParameters (25)*

### Description

This function returns the parameters associated with the user event handler.

### Call with

| | | |
|---|---|---|
| `AL` | = | 25 (function number). |

### Returns

| | | |
|---|---|---|
| `BL` | = | User event handler mode.<br>00 = User event handler disabled.<br>01 = User event handler enabled. |
| `CX` | = | Segment address of user event handler. |
| `DX` | = | Offset address of user event handler. |

## GetZ-AxisScalingModeAndParameters (13)

### Description

This function gets the z-axis scaling parameters.

### Call with

| | | |
|---|---|---|
| AL | = | 13 (function number). |

### Returns

| | | |
|---|---|---|
| BL | = | Z-axis scaling mode.<br>00 = Z-axis scaling disabled.<br>01 = Z-axis scaling enabled. |
| CL | = | Minimum z-axis pressure value. |
| DL | = | Maximum z-axis pressure value. |

## Reset (0)

### Description

This function resets the CTKERN driver and/or touch system. The CTKERN driver is reset by reinitializing the driver queues, status bits, interrupt masks, and so forth. The TAPI driver and/or touch system is reset by calling the TAPI *Reset (0)* function with the select driver/touch system reset value from BL in BL.

### Call with

| | | |
|---|---|---|
| AL | = | 0 (function number). |
| BH | = | 0. |
| BL | = | Select driver / touch system reset.<br>0 = Reset touch system and driver.<br>1 = Reset driver only.<br>2 = Reset touch system only. |

### Returns

| | | |
|---|---|---|
| AL | = | Reset result.<br>0 = Reset OK.<br>1 = The TAPI driver indicated that it could not send commands to the touch system.<br>2 = The TAPI driver indicated that it received an error report from the touch system that contained error codes.<br>3 = The TAPI driver indicated that it did not receive the expected error report from the touch system. |

### Notes

If BL = 0 (Reset touch system and driver):

1. Reset CTKERN variables.
2. Call TAPI with BL = 0 (Reset the touch system and the driver).
3. Send init string via TAPI to set the touch system to the tracking with add exit touch mode and enable scanning.

If BL = 1 (Reset driver only):

1. Reset CTKERN variables.
2. Call TAPI with BL = 1 (Reset driver only).

If BL = 2 (Reset touch system only):

1. Do not reset CTKERN variables.

2. Call TAPI with `BL` = 2 (Reset touch system only).
3. Send init string via TAPI to set the touch system to the tracking with add exit touch mode and enable scanning.

## *SendSmart-FrameProtocolCommandAnd GetReport (18)*

### Description

This function sends one Smart-Frame Protocol command to the touch system; the Smart-Frame Protocol report that the touch system sends back is returned in the report buffer. The length (in bytes) of the report transferred to the report buffer is also returned.

### Call with

| | | |
|---|---|---|
| AL | = | 18 (function number). |
| BH | = | Smart-Frame Protocol command byte. The only SFP commands valid for use with this function are *Get_Failed_Beam_Report (36H)* and *State_Report (47H)*. |
| BL | = | Size of report buffer (in bytes). |
| CX | = | Segment of report buffer that holds the Smart-Frame Protocol report received from the touch system. |
| DX | = | Offset of report buffer that holds the Smart-Frame Protocol report received from the touch system. |

### Returns

| | | |
|---|---|---|
| AL | = | Smart-Frame Protocol command status.<br>00 = Smart-Frame Protocol command accepted.<br>01 = Invalid SFP command. An SFP command other than *Get_Failed_Beam_Report (36H)* and *State_Report (47H)* was sent. |
| CX | = | Number of bytes transferred to the report buffer.<br>0 = No bytes transferred (time out).<br>nonzero = Report was returned - number of bytes transferred to the report buffer. |

### Notes

This function is normally not needed to create a touch application using CTKERN. However, it does allow you to obtain touch screen information that would otherwise be unobtainable because the touch application is unable to make TAPI driver calls while using CTKERN.

The buffer size value passed in `CX` is the maximum number of bytes that the CTKERN driver writes to the report buffer. If the number of report bytes is greater than this value, the excess bytes are discarded. If the touch system does not respond to the command with a report within a set time, the function returns with 00 in `CX`, indicating that a timeout occurred and no report bytes were transferred.

The report buffer should be at least 64 bytes long. Since the CTKERN driver can transfer a maximum of 512 bytes to the report buffer, the maximum report buffer size necessary is 512 bytes.

No touch data is processed while this command is processed. The actual algorithm used in this command is:

1. Disable TAPI driver event handler.
2. Send command.
3. Start timeout counter.
4. If the report comes back, transfer it to the report buffer and enable the TAPI driver event handler.

   If the report does not come back (timeout), indicate timeout and enable the TAPI driver event handler.

## SetCalibrationMode (3)

### Description

This function sets the calibration mode, which determines how the touch coordinates reported by CTKERN are calibrated.

### Call with

| | | |
|---|---|---|
| AL | = | 3 (function number). |
| BL | = | Calibration mode. |
| | | 00 = Calibration disabled. |
| | | 01 = Fixed calibration. This is the default. |
| | | 02 = Automatic calibration. |

### Notes

In calibration mode 00 (disabled), the raw touch coordinates are not calibrated before being passed on to the scaling function within the driver.

In calibration mode 01 (fixed), the raw touch coordinates are always calibrated using the calibration parameters of the default calibration entry before being passed on to the scaling function within the driver. If no calibration entry is marked as the default, the first calibration entry (calibration table index 0) is used.

In calibration mode 02 (automatic), the raw touch coordinates are calibrated using the calibration parameters for the currently selected BIOS video mode. The driver determines the video mode by intercepting calls to BIOS mode 10H function 0 (*SetVideoMode*). If an entry in the table of calibration parameters that corresponds to that video modes exists, those calibration parameters are used. If no such entry exists, the default calibration parameters are used. If no calibration entry is marked as the default, the first calibration entry (calibration table index 0) is used. The calibrated coordinates are then passed on to the scaling function within the driver.

At the time that the calibration mode is set to automatic (02), CTKERN does a *GetVideoMode* BIOS call, and looks in the calibration table for an entry that matches the currently selected video mode. If a matching entry is found, it is used. If there is no matching entry, the default entry is used. CTKERN then hooks the BIOS Video Interrupt (Int 10H). If the calibration mode is subsequently changed to other than automatic, the BIOS Video Interrupt is unhooked.

## *SetCalibrationParameters (4)*

### Description

This function sets the calibration parameters that CTKERN uses to calibrate the raw touch coordinates, overriding the parameters that are in effect at the time that this function is called.

### Call with

| | | |
|---|---|---|
| AL | = | 4 (function number). |
| CX | = | Segment of four-word buffer that holds the calibration data structure. |
| DX | = | Offset of four-word buffer that holds the calibration data structure. |

### Returns

| | | |
|---|---|---|
| AL | = | Calibration status. |
| | | 00 = Calibration parameters set successfully. |
| | | 01 = Calibration offset and/or span out of range. |

Calibration data structure in the buffer pointed to by CX and DX:

WORD Xoff
WORD Yoff
WORD Xspan
WORD Yspan

### Notes

This function lets you set the calibration parameters to arbitrary values that are not related to the calibration parameters in any calibration table entry. The calibration mode should be set to fixed when this function is used. If the calibration mode is set to automatic, the next video mode change causes the calibration parameters to be overwritten by the calibration parameters that correspond to the calibration table entry for that video mode. If the calibration mode is set to disabled, the parameter change has no effect, and the calibration parameters are overwritten by calibration parameters from a calibration table entry when the calibration mode is changed to fixed or automatic.

The sum of the offset value and the span value must be less than or equal to the frame size in both the x- and y-axes. If this is not the case, the calibration status is set to 01, and the function call has no effect. The current calibration parameters are not changed.

## SetCalibrationTableEntry (6)

### Description

This function sets the calibration parameters for one entry in the internal calibration table.

### Call with

| | | |
|---|---|---|
| AL | = | 6 (function number). |
| BL | = | Calibration table index. |
| CX | = | Segment of eight-word buffer that holds the calibration data structure. |
| DX | = | Offset of eight-word buffer that holds the calibration data structure. |

### Returns

AL = Calibration status.

| | | |
|---|---|---|
| 00 | = | Calibration table entry set successfully. |
| 01 | = | Calibration table index out of range. |
| 02 | = | Calibration offset and/or span out of range. |

Calibration data structure in the buffer pointed to by CX and DX:

WORD VideoMode
WORD Flags
WORD Xres
WORD Yres
WORD Xoff
WORD Yoff
WORD Xspan
WORD Yspan

The bits of the WORD Flags are set as follows:

Bit 0 = Video mode text/graphics flag.

| | | |
|---|---|---|
| 0 | = | Graphics video mode. |
| 1 | = | Text video mode. |

Bits 1-14 = Reserved and must be 0.

| | | | | |
|---|---|---|---|---|
| Bit 15 | = | Default calibration flag. | | |
| | | 0 | = | This entry is not the default calibration. |
| | | 1 | = | This entry is the default calibration. |

## Notes

The internal calibration table consists of ten sets of calibration parameters. The valid range for the calibration table index parameter is 0 through 9. If this function is called with a calibration table index outside this range, the calibration status is set to 01, and the function call has no effect.

The sum of the offset value and the span value must be less than or equal to the frame size in both the x- and y-axes. If this is not the case, the calibration status is set to 02, and the function call has no effect.

If the default calibration flag is set, the default calibration flag of all of the other calibration table entries is cleared. This is done in order to help ensure that there is only one default calibration.

Setting the calibration table entry for the calibration that is currently in effect does not immediately affect the current calibration or scaling parameters. For example, if the calibration mode is set to fixed and calibration table entry 0 is the default calibration (Default Calibration Flag =1), changing the calibration parameters for calibration table entry 0 using this function does not cause the current calibration parameters to be changed. The previous calibration remains in effect, which can be verified using *GetCurrentCalibrationModeandParameters (5)*. Sending *SetCalibrationMode (3)* with `BL`=01 (fixed) causes the new calibration parameters to be read from the table and the new parameters to become the current calibration parameters.

## *SetCommunicationParameters (21)*

### Description

This function sets the communication parameters that the driver uses with the touch system. The application program should set register `BH` (driver type) to the appropriate value for the driver loaded.

### Call with

| | | |
|---|---|---|
| `AL` | = | 21 (function number). |

| | | | | |
|---|---|---|---|---|
| `BH` | = | Driver type. | | |
| | | 0 | = | SBC driver. |
| | | 1 | = | HBC driver. |
| | | 2 | = | RS-232 driver. |

If `BH` = 0 (SBC) or 1 (HBC), the additional calls are:

| | | |
|---|---|---|
| `BL` | = | Interrupt number. Valid values are 2, 3, 4, 5 and 7. |
| `CX` | = | I/O address. Valid values are from 200H through 3F0H in 10H increments (200H, 210H, 220H, ..., 3F0H). |

If `BH` = 2 (RS-232), the additional calls are:

| | | | | |
|---|---|---|---|---|
| `CH` | = | Parity. | | |
| | | 0 | = | None. |
| | | 1 | = | Odd. |
| | | 2 | = | Even. |

| | | | | |
|---|---|---|---|---|
| `CL` | = | Baud rate. | | |
| | | 0 | = | 300. |
| | | 1 | = | 600. |
| | | 2 | = | 1200. |
| | | 3 | = | 2400. |
| | | 4 | = | 4800. |
| | | 5 | = | 9600. |

### Returns

| | | | | |
|---|---|---|---|---|
| `CX` | = | Status. | | |
| | | 00 | = | Communication parameters accepted. |
| | | 01 | = | Invalid driver type. |
| | | 02 | = | Invalid interrupt number. |
| | | 04 | = | Invalid I/O address. |
| | | 08 | = | Invalid parity. |
| | | 10H | = | Invalid baud rate. |

#### *Note*

Multiple invalid parameter status codes may be returned in the `CX` (Status) register. For example, if both the baud rate and parity parameters were invalid, 18H would be returned in register `CX`. This is equivalent to the “Invalid Baud Rate” and “Invalid Parity” status codes or’ed together. The application should interpret these codes on a bitwise basis.

### Notes

This function is very similar to *GetCommunicationParameters (22)*, except that register `BL` does not contain a value representing the RS-232 communication port being used.

Sending this function causes CTKERN to modify the communication parameters and then reset the touch system, just as if *Reset (0)* was called. For any touch system other than an RS-232-based touch system using autobaud/autoparity, the communication parameters of the touch system must be changed to the new parameters before this function is called. For RS-232-based touch systems that use autobaud/autoparity, the touch system is simply reset using the new baud rate and parity.

## SetScalingMode (8)

### Description

This function sets the scaling mode, which determines how the touch coordinates reported by CTKERN are scaled.

### Call with

|  |  |  |
|---|---|---|
| AL | = | 8 (function number). |
| BL | = | Scaling mode.<br>00 = Scaling disabled.<br>01 = Fixed scaling. This is the default.<br>02 = Automatic scaling. |

### Notes

If scaling is disabled (00), the calibrated touch coordinates are not scaled before being passed on to the application program.

If scaling is fixed (01), the calibrated touch coordinates are scaled using 0, 0 for the upper left x and y scaling parameters and (Xres - 1, Yres - 1) from the calibration parameters of the default calibration entry for the lower right x and y scaling parameters before being passed on to the application program. If no calibration entry is marked as the default, the first calibration entry (calibration table index 0) is used.

If scaling is automatic (02), the calibrated touch coordinates are scaled using 0, 0 for the upper left x and y scaling parameters and (Xres - 1, Yres - 1) from the calibration parameters for the currently selected BIOS video mode for the lower right x and y scaling parameters before being passed on to the application program. The driver determines the video mode by intercepting calls to BIOS mode 10H function 0 (*SetVideoMode*). If an entry in the table of calibration parameters that corresponds to that video mode exists, the Xres, Yres values of those calibration parameters are used. If no such entry exists, the Xres, Yres values of the default calibration parameters are used. If no calibration entry is marked as the default, the first calibration entry (calibration table index 0) is used.

At the time that the scaling mode is set to automatic, CTKERN does a *GetVideoMode* BIOS call, and looks in the calibration table for an entry that matches the currently selected video mode. If a matching entry is found, it is used. If there is no matching entry, the default entry is used. CTKERN then hooks the BIOS Video Interrupt (Int 10H). If the scaling mode is subsequently changed to other than automatic, the BIOS Video Interrupt is unhooked.

## *SetScalingParameters (9)*

### Description

This function sets the scaling parameters that CTKERN uses to scale the calibrated touch coordinates, overriding the parameters that are in effect at the time that this function is called.

### Call with

| | | |
|---|---|---|
| `AL` | = | 9 (function number). |
| `CX` | = | Segment of four-word buffer that holds the scaling data structure. |
| `DX` | = | Offset of four-word buffer that holds the scaling data structure. |

Scaling data structure:

WORD Upper Left X
WORD Upper Left Y
WORD Lower Right X
WORD Lower Right Y

### Notes

This function lets you set the scaling parameters to arbitrary values that are not related to the Xres and Yres parameters in any calibration table entry. The scaling mode should be set to fixed when using this function. If the scaling mode is set to automatic, the next video mode change causes the scaling parameters to be overwritten by the scaling parameters that correspond to the calibration table entry for that video mode.

The default origin for the Touch Coordinate Reports is the upper left corner. This default origin may be changed by setting the upper left value of an axis to a value greater than that for the lower right value for that axis. For example, if the scaling parameters are set to:

| | | |
|---|---|---|
| Upper left x | = | 0 |
| Upper left y | = | 0 |
| Lower right x | = | 639 |
| Lower right y | = | 479 |

The screen reports 0, 0 when the upper left corner is touched and 639, 479 when the lower right corner is touched, and linearly scaled coordinates in between.

If the scaling parameters are set to:

| | | |
|---|---|---|
| Upper left x | = | 0 |
| Upper left y | = | 479 |
| Lower right x | = | 639 |
| Lower right y | = | 0 |

The screen reports 0, 479 when the upper left corner is touched, 639, 0 when the lower right corner is touched, and 0, 0 when the lower left corner is touched. This places the origin in the lower left corner. By swapping either or both axes, the origin may be placed in any corner.

## SetTemporalFilterMode (14)

### Description

This function sets the temporal filter mode.

### Call with

| | | |
|---|---|---|
| AL | = | 14 (function number). |
| BL | = | Temporal filter mode.<br>00 = Temporal filter disabled.<br>01 = Temporal filter enabled. |

### Notes

When enabled, the temporal filter acts much like a low pass filter in the time domain for all touch state transitions. You must specify a Spatial Filter Box Size and a Temporal Filter Time.

When the stylus touches the screen the center of the spatial filter box is set to the coordinates where the screen was first touched. The touch state is set to “touched” and the touch coordinates set to the current stylus location only after the stylus has remained in the spatial filter box for the length of time specified by the Temporal Filter Time parameter. If the stylus moves beyond the spatial filter box, the temporal filter timer and the center of the spatial filter box are reset. The coordinates are not updated until the stylus has once again remained in the spatial filter box for the Temporal Filter Time. The coordinates associated with the “not touched” state are still the exit point, but the touch state becomes “not touched” only after the stylus is out of the screen for the Temporal Filter Time. The touch state is set to “non-contiguous” only after a non-contiguous stylus has been in the touch screen for the Temporal Filter Time.

The Spatial Filter Box Size is specified as a percentage of the full screen size. The valid range for this parameter is from 0% to 100% and the default is 10%. This parameter specifies the width of the box. The spatial filter box size is specified as a percentage rather than as an absolute touch coordinate value because if it were specified as an absolute value, the absolute size of the spatial filter box would vary if the display resolution changed as a result of a change in the BIOS video mode. Note that while the same percentage is used for both the x- and y-axes, the absolute size of the box is not necessarily square. The box instead has the same aspect ratio as the display. No correction for display aspect ratio is performed.

The absolute pixel value is derived by taking a percentage of either the scaled or raw touch coordinate range, depending on whether scaling is enabled.

Figure D-1 pictures an example of a spatial filter box set to 25%. Note that this is a much larger value than is usually used - this value is usually less than 10%.

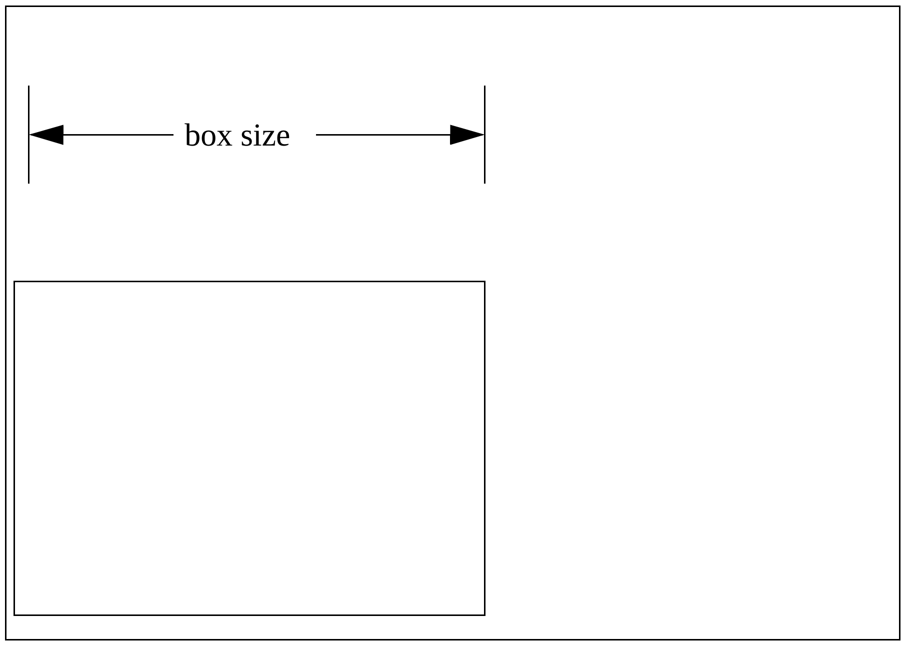


Figure D-1. Temporal Filter Spatial Box Size

This approach ensures that the spatial filter box size remains constant for a given monitor. However, if a touch application that uses the temporal filter is run on several monitors of differing sizes, the absolute size of the spatial filter box will vary and may need to be adjusted.

The Temporal Filter Time is specified in milliseconds. The valid range for this parameter is between 0 ms and 2000 ms, and the default is 500 ms. The actual filter time that is used, however, is restricted to multiples of 55 ms. The actual formula used is as follows:

absolute time = Trunc (specified filter time / 55) * 55

For example, if you specify a time of 50, the time value used is actually set to 0. If you specified a value of 100, the time value is 55. If you specified a value of 500, the time value is 495. The filter time resolution is 55 ms, which means that the actual amount of time that is required to trigger a touch may vary from the actual filter time by +/- 55 ms.

Normally, the time value is set to a value large enough so that entry and exit coordinate transients resulting from the stylus not entering/leaving straight into/out of the screen are eliminated, but small enough so that the delay time is not noticeable. The typical range of values to achieve this is 100ms through 500ms.

## *SetTemporalFilterParameters (15)*

### Description

This function sets the temporal filter parameters.

### Call with

| | | |
|---|---|---|
| `AL` | = | 15 (function number). |
| `CL` | = | Spatial filter box size. |
| `DX` | = | Temporal filter time. |

### Returns

`AL` = Temporal filter status.

| | | |
|---|---|---|
| 00 | = | Temporal filter parameters valid. |
| 01 | = | Spatial filter box size out of range. |
| 02 | = | Temporal filter time out of range. |

### Notes

The Spatial Filter Box Size is specified as a percentage of the full screen size. The valid range for this parameter is from 0% to 100% and the default is 10%. This parameter specifies the width of the box. The spatial filter box size is specified as a percentage rather than as an absolute touch coordinate value because if it were specified as an absolute value, the absolute size of the spatial filter box would vary if the display resolution changed as a result of a change in the BIOS video mode. Note that while the same percentage is used for both the x- and y-axes, the absolute size of the box is not necessarily square. The box instead has the same aspect ratio as the display. No correction for display aspect ratio is performed.

The absolute pixel value is derived by taking a percentage of either the scaled or raw touch coordinate range, depending on whether scaling is enabled.

This approach ensures that the spatial filter box size remains constant for a given monitor. However, if a touch application that uses the temporal filter is run on several monitors of differing sizes, the absolute size of the spatial filter box will vary and may need to be adjusted.

The temporal filter time is specified in milliseconds. The valid range for this parameter is between 0 ms and 2000 ms and the default is 500 ms. The actual filter time that is used, however, is restricted to multiples of 55 ms. The actual formula used is as follows:

absolute time = Trunc (specified filter time / 55) * 55

For example, if you specify a time of 50, the time value used is actually set to 0. If you specified a value of 100, the time value is 55. If you specified a value of 500, the time value is 495. The filter time resolution is 55 ms, which means that the actual amount of time that is required to trigger a touch may vary from the actual filter time by +/- 55 ms.

Normally, the time value is set to a value large enough so that entry and exit coordinate transients resulting from the stylus not entering/leaving straight into/out of the screen are eliminated, but small enough so that the delay time is not noticeable. The typical range of values to achieve this is 100ms through 500ms.

## SetTouchState (2)

### Description

This function sets the touch state that CTKERN reports. It is useful for debugging, or any other situation where it is necessary to force the touch state to be a particular value without a touch actually occurring.

### Call with

| | | |
|---|---|---|
| `AL` | = | 2 (function number). |
| `BH` | = | Touch pressure (z-axis). |
| `BL` | = | Touch state.<br>00 = Not touched (x, y set to last place the screen was touched).<br>01 = Touched (x, y set to where the screen is touched).<br>02 = Non-contiguous (x, y undefined). |
| `CX` | = | X coordinate. |
| `DX` | = | Y coordinate. |

### Notes

If calling this function causes the touch state to change and a CTKERN user event handler is installed and enabled, the user event handler is called just as if the change in touch state had resulted from an actual touch.

You must ensure that the touch coordinates passed in this function are compatible with the scaling mode and parameters that are in effect at the time that this function is called. This function performs no parameter checking.

## SetUserEventHandlerMode (23)

### Description

This function sets the user event handler (UEH) mode, which lets you install an event handler subroutine that is called whenever the touch state changes.

It also allows a user application to receive reports from the CTKERN driver using an interrupt mode rather than a polling mode. The UEH subroutine should end with a normal return instruction, not a return from interrupt instruction.

Once a UEH has been installed and enabled, execution of the user program is halted and the event handler subroutine is called whenever the touch state changes.

When the UEH is called, the CPU registers contain the following:

| | | |
|---|---|---|
| `BH` | = | Z-axis touch pressure. |
| `BL` | = | Touch state.<br>0 = Not touched (x, y set to last place screen was touched).<br>1 = Touched (x, y set to where the screen is touched).<br>2 = Non-contiguous (x, y undefined). |
| `CX` | = | X coordinate. |
| `DX` | = | Y coordinate. |

These parameters are the same as those in the *GetTouchState (1)* function.

When the event handler subroutine returns, the execution of the user program continues at the point at which it was interrupted.

### Call with

| | | |
|---|---|---|
| `AL` | = | 23 (function number). |
| `BL` | = | User event handler mode.<br>00 = User event handler disabled.<br>01 = User event handler enabled. |

## Notes

The UEH is most often used to get the touch state and to update an internal touch state variable in the user program.

Use of reentrant function calls such as BIOS calls in the UEH is acceptable, as is the use of CTKERN function calls. However, use of non reentrant function calls such as DOS calls is not.

Hardware interrupts are disabled while the UEH is executing. The UEH should execute as quickly as possible to allow the TAPI driver to continue to process hardware interrupts from the touch system. If the UEH takes too long to return, the TAPI driver may miss hardware interrupts from the touch system.

The UEH is called once and only once each time the touch state changes.

While the UEH is disabled, CTKERN continues to update the touch state. When re-enabled after being disabled, the UEH is NOT called to notify you of any change in the touch state that may have occurred during the time that the UEH was disabled.

Before terminating the user program, be sure to disable the UEH. Otherwise, when the CTKERN driver calls the address of where the application program’s event handler was, it will now be an invalid address.

## *SetUserEventHandlerParameters (24)*

### Description

This function sets the user event handler parameters.

### Call with

| | | |
|---|---|---|
| `AL` | = | 24 (function number). |
| `CX` | = | Segment address of user event handler. |
| `DX` | = | Offset address of user event handler. |

## SetZ-AxisScalingMode (11)

### Description

This function sets the z-axis scaling mode.

### Call with

| | | |
|---|---|---|
| AL | = | 11 (function number). |
| BL | = | Z-axis scaling mode.<br>00 = Z-axis scaling disabled.<br>01 = Z-axis scaling enabled. |

### Notes

If z-axis scaling is disabled, the raw z-axis parameter reported by the touch system is reported by CTKERN. If z-axis scaling is enabled, the z-axis parameter reported by CTKERN is determined by linearly scaling the raw z-axis parameter reported by the touch system within the range defined by the minimum and maximum z-axis pressure values.

## SetZ-AxisScalingParameters (12)

### Description

This function sets the z-axis scaling parameters.

### Call with

| | | |
|---|---|---|
| `AL` | = | 12 (function number). |
| `CL` | = | Minimum z-axis pressure value. |
| `DL` | = | Maximum z-axis pressure value. |

### Notes

The origin of the z-axis parameter may be changed from the minimum z-axis pressure value to the maximum z-axis pressure value by specifying a larger value for the maximum z-axis pressure value than for the minimum z-axis pressure value.

The default value for the minimum and maximum z-axis pressure values are 0 and 255, respectively.

E

# Dynamic Link Library (DLL) Function Reference

The Windows 3.x driver exports the functions listed at the beginning of this appendix. Subsequent sections give specific details on each function, its data structure, and function call.

- DisableMouse (11).
- DisableTouch (12).
- EnableMouse (9).
- EnableTouch (10).
- GetMouseInfo (13).
- GetTemporalFilterInfo (18).
- GetTouchInfo (14).
- GetTouchStateandCoord (5).
- InitializeTouch (16).
- SetCalibInfo (7).
- SetTemporalFilterInfo (17).
- SetTouchEvents (8).

Table E-1. Windows Driver DLL Functions in Alphabetical Order

| Function Name | Ordinal Export Value |
|---|---|
| DisableMouse | 11 |
| DisableTouch | 12 |
| EnableMouse | 9 |
| EnableTouch | 10 |
| GetMouseInfo | 13 |
| GetTemporalFilterInfo | 18 |
| GetTouchInfo | 14 |
| GetTouchStateandCoord | 5 |
| InitializeTouch | 16 |
| SetCalibInfo | 7 |
| SetTemporalFilterInfo | 17 |
| SetTouchEvents | 8 |

Table E-2. Windows Driver DLL Functions in Numerical Order

| Ordinal Export Value | Function Name |
|---|---|
| 5 | GetTouchStateandCoord |
| 7 | SetCalibInfo |
| 8 | SetTouchEvents |
| 9 | EnableMouse |
| 10 | EnableTouch |
| 11 | DisableMouse |
| 12 | DisableTouch |
| 13 | GetMouseInfo |
| 14 | GetTouchInfo |
| 16 | InitializeTouch |
| 17 | SetTemporalFilterInfo |
| 18 | GetTemporalFilterInfo |

## *DisableMouse (11)*

### Description

This function disables the mouse.

### IMPORTS Statement in the Definition File

```
DisableMouse=MOUSE.11
```

### Functions Prototype

```
void FAR PASCAL DisableMouse();
```

### Function Call

```
DisableMouse();
```

## *DisableTouch (12)*

### Description

This function disables the touch system.

### IMPORTS Statement in the Definition File

```
DisableTouch=MOUSE.12
```

### Functions Prototype

```
void FAR PASCAL DisableTouch();
```

### Function Call

```
DisableTouch();
```

## *EnableMouse (9)*

### Description

This function enables the mouse for user input.

### IMPORTS Statement in the Definition File

```
EnableMouse=MOUSE.9
```

### Functions Prototype

```
void FAR PASCAL EnableMouse();
```

### Function Call

```
EnableMouse();
```

## *EnableTouch (10)*

### Description

This function enables the touch system for user input.

### IMPORTS Statement in the Definition File

```
EnableTouch=MOUSE.10
```

### Functions Prototype

```
void FAR PASCAL EnableTouch();
```

### Function Call

```
EnableTouch();
```

## *GetMouseInfo (13)*

### Description

This function gets the type of mouse being used by the driver, plus a mouse flag byte.

### IMPORTS Statement in the Definition File

```
GetMouseInfo=MOUSE.13
```

### Functions Prototype

```
void FAR PASCAL GetMouseInfo(LPSTR);
```

### Data Structure and Parameter Variable

Definitions of flag bits for the *`mouse_flags`* variable:

```
#define MFLAG_ENABLED0x01 Mouse is enabled
#define MF_INT33H    0x02 Int 33H mouse found
                     0x04
                     0x08
                     0x10
                     0x20
#define MF_ON_SLAVCPIC0x040 Mouse is on slave PIC
#define MF_MOUSE_EXISTS0x080 Mouse was found at boot time
```

Definitions of mouse types for the *`mouse_type`* variable:

```
#define MT_NO_MOUSE  0
#define MT_BUS       1
#define MT_SERIAL    2
#define MT_INPORT    3
#define MT_PS2       4
#define MT_HP        5
#define MT_INT33     6

typedef struct tagMOUSEINFO   {

   char mouse_flags;
   char mouse_type;

}   MOUSE_INF_TYPE;

static MOUSEINFO_TYPE mouseinfo;
```

### Function Call

```
GetMouseInfo (&mouseinfo);

mouse_flags    = mouseinfo.mouse_flags;
mouse_type     = mouseinfo.mouse_type;
```

## *GetTemporalFilterInfo (18)*

### Description

To be determined.

### IMPORTS Statement in the Definition File

To be determined.

### Functions Prototype

To be determined.

### Data Structure and Parameter Variable

To be determined.

### Function Call

To be determined.

## *GetTouchInfo (14)*

### Description

This function gets the type of touch system being used by the driver, plus a touch flag byte.

### IMPORTS Statement in the Definition File

```
GetTouchInfo=MOUSE.14
```

### Functions Prototype

```
void FAR PASCAL GetTouchInfo(LPSTR);
```

### Data Structure and Parameter Variable

Definitions of the flag byte *`touch_flags`*:

```
#define TF_ENABLED   0x01 Touch is enabled
                     0x02
                     0x04
                     0x08
                     0x10
                     0x20
#define TF_ON_SLAVEPIC0x040 Touch is on slave PIC
#define TF_TOUCH_EXISTS   0x080 Touch was found at boot
time
```

Definitions of touch types for the *`touch_type`* variable:

```
#define TT_NO_TOUCH  0
#define TT_TAPI      1
#define TT_HBC       2
#define TT_RS232     3

typedef struct tagTOUCHINFO   {

   char touch_flags;
   char touch_type;

}   TOUCH_INFO_TYPE;

static TOUCHINFO_TYPE touchinfo;
```

### Function Call

```
GetTouchInfo(&touchinfo);

touch_flags    = touchinfo.touch_flags;
touch_type     = touchinfo.touch_type;
```

## GetTouchStateandCoord (5)

### Description

This function gets the touch state and the raw touch coordinates from the touch system. The touch state indicates whether the screen is touched at the time that the call is made. The X and Y coordinates that are returned are the raw touch coordinates from the touch system. The intended purpose for this function is to provide raw touch data to a calibration program.

### IMPORTS Statement in the Definition File

```
GetTouchStateandCoord=Mouse.5
```

### Functions Prototype

```
void FAR PASCAL GetTouchStateandCoord (LPSTR);
```

### Data Structure and Parameter Variable

```
define NOT_TOUCHED   0
define TOUCHED       1

typedef struct tagTOUCHSTATEANDCOORDS   {

   char touch_state;
   char Xcoord;
   char Ycoord;

}   TOUCHSTATEANDCOORDS_TYPE;

static TOUCHSTATEANDCOORDS_TYPE touchstateandcoords;
```

### Function Call

```
GetTouchStateandCOORD (&touchstateandcoords);

touch_state    =     touchstateandcoords.touch_state;
Xcoord         =     touchstateandcoords.Xcoord;
YCoord         =     touchstateandcoords.Ycoord;
```

## *InitializeTouch (16)*

### Description

This function re-initializes the touch system. The touch system type and communication parameters that were in effect when Windows was started are used.

### IMPORTS Statement in the Definition File

```
InitializeTouch=MOUSE.16
```

### Functions Prototype

```
void FAR PASCAL InitializeTouch(LPSTR);
```

### Data Structure and Parameter Variable

```
static char initresult;
```

### Function Call

```
InitializeTouch(&initresult);
```

## SetCalibInfo (7)

### Description

This function sets the calibration parameters that the driver uses to convert raw touch coordinates to touch coordinates that correspond to the 65535 x 65535 Windows virtual display screen. To calculate the correct calibration parameter values, you must first get the raw touch coordinates that correspond to the upper left and lower right corners of the video image. This is typically done by displaying touch targets in the corners and using the GetTouchStateandCoord function to get the raw touch information. You then calculate the calibration parameters as shown in the CalculateCalibInfo function and send them to the driver via SetCalibInfo.

### IMPORTS Statement in the Definition File

```
SetCalibInfo=MOUSE.7
```

### Functions Prototype

```
void FAR PASCAL SetCalibInfo(LPSTR);
```

### Data Structure and Parameter Variable

```
typedef struct tagCALIBINFO   {

   long int Xmag;
   long int Xoff;
   long int Ymag;
   long int Yoff;

}   CALIBINFO_TYPE calibinfo;

static CALIBINFO_TYPE calibinfo;
```

## Function Call

```
void FAR CalculateCalibInfo()

{

   static unsigned int video_max_xy = 65535;

   static float Xmag_float;
   static float Ymag_float;
   static float Xoff_float;
   static float Yoff_float;

   Xmag_float = video_max_xy / (touch_lr_x - touch_ul_x);
   calibinfo.Xmag = Xmag_float;

   Ymag_float = video_max_xy / (touch_lr_y - touch_ul_y);
   calibinfo.Ymag = Ymag_float;

   Xoff_float = Xmag_float * touch_ul_x);
   calibinfo.Xoff = Xoff_float;

   Yoff_float = Ymag_float * touch_ul_y);
   calibinfo.Yoff = Yoff_float;

}  /*  CalculateCalibInfo   */

CalculateCalibInfo();

SetCalibInfo(&calibinfo);
```

## SetTemporalFilterInfo (17)

### Description

To be determined.

### IMPORTS Statement in the Definition File

```
SetTemporalFilter=MOUSE.17
```

### Functions Prototype

```
void FAR PASCAL SetTemporalFilter(LPSTR);
```

### Data Structure and Parameter Variable

Definitions of legal values for the `temporal_filter_time` variable:

```
#define TFTI_disable    0
#define TFTI_142ms      1
#define TFTI_285ms      2
#define TFTI_428ms      3
#define TFTI_571ms      4
#define TFTI_714ms      5
#define TFTI_857ms      6
#define TFTI_1000ms     7
```

Definitions of legal values for the `temporal_filter_space` variable:

```
#define TFSP_0          0
#define TFSP_1          1
#define TFSP_2          2
#define TFSP_3          3
#define TFSP_4          4
#define TFSP_5          5
#define TFSP_6          6
#define TFSP_7          7
#define TFSP_8          8
#define TFSP_9          9
#define TFSP_A          A
#define TFSP_B          B
#define TFSP_C          C
#define TFSP_D          D
#define TFSP_E          E
#define TFSP_F          F

typedef struct tagTEMPORALFILTERPARAMS {

   char TFTime;
   char TFSpace;

}   TEMPORALFILTERPARAMS_TYPE;

static TEMPORALFILTERPARAMS_TYPE temporalfilter_params;
```

## Function Call

```
temporalfilter_params.TFTime= TFTI_142ms;
temporalfilter_params.TFSpace= TFSP_2;

SetTemporalFilter (&temporalfilter_params);
if (temporalfilter_params = FF)
then *T_F_ not supported*
```

## *SetTouchEvents (8)*

### Description

This function sets the mouse/touch event mapping parameters. The mouse events and the associated codes are specified in Table E-3.

Table E-3. Definition of Touch Events

| Event | Definition |
|---|---|
| Touch Event | A finger enters the touch screen. |
| Untouch Event | The finger leaves the touch screen. |
| Non-Contiguous Event | More than one finger is present in the touch screen at the same time. |

### IMPORTS Statement in the Definition File

```
SetTouchEvents=MOUSE.8
```

### Functions Prototype

```
void FAR PASCAL SetTouchEvents (LPSTR);
```

### Data Structure and Parameter Variable

```
typedef struct tagTOUCHEVENTS   {

   char user_touch_event;
   char user_untouch_event;
   char user_noncontig_event;

}   TOUCHEVENT_TYPE

static TOUCHEVENTS_TYPE touchevents;
```

### Function Call

```
touchevents.user_touch_event= 2;
touchevents.user_untouch_event= 3;
touchevents.user_noncontig_event= 0;

SetTouchEvents(&touchevents);
```

# Glossary

| | |
|---|---|
| Add Exit Point Modifier | A modifier that can be added to any of the four touch reporting types (*Continuous Mode*, *Enter Point Mode*, *Exit Point Mode*, *Tracking Mode*) under the SFP and that reports the coordinates at which the stylus exits the screen. |
| axis (x-axis, y-axis, z-axis) | A dimension that makes up the touch coordinate system. The x-axis is the horizontal axis and the y-axis is the vertical axis. The z-axis, available on guided wave systems only, measures the pressure placed on the screen. |
| baud rate | The speed of data transfer between a peripheral and the computer. This is a communication parameter used by the serial (RS-232) controller. |
| beam | An infrared light beam emitted by an infrared light-emitting diode (LED) and received by a phototransistor, which are set opposite each other in the touch frame. *Also called* a physical beam or opto-pair. |
| bezel | The plastic protective housing of the touch frame or touch screen, which either replaces or is fastened over the existing bezel of the monitor. |
| broken beam | A beam in which the infrared light level received by the infrared sensitive phototransistor falls below a threshold value set by the touch system firmware. In normal operation, this is due to a stylus obstructing the beam path from the LED to the phototransistor. Broken beams may also result from a defective LED, phototransistor, or other touch system hardware, and from other obstructions of the beam path. *See* beam. |
| comm port | The serial (RS-232) port on the back of the computer to which a touch frame or touch screen is connected. |
| communication parameters | The variables that control the transfer of information between the controller and the computer. For serial (RS-232) controllers, the variables are comm port, parity, baud rate, data bits, and stop bits. For hardware- and software-based controllers, the variables are I/O address and interrupt number. |
| *Continuous Mode* | A touch reporting type under the SFP that reports touch coordinates at intervals from the time a stylus enters the screen until it exits, even if the stylus is unmoving. Add Exit Point can be added as a modifier. |

| | |
|---|---|
| controller | The interface between the touch system and the computer. The controller may be software-based or hardware-based, or may use the computer's serial (RS-232) port. *See* hardware-based controller, serial (RS-232) controller, and software-based controller. |
| coordinate origin corner | The 0, 0 origin of the video coordinate system. This is usually in the upper left corner of the display. |
| coordinate reporting | One of two methods that determines the form used to send data from the touch system to the host. The touch system reports x, y coordinate values that identify the touch location. The x and y values are reported as logical coordinates. *See also* scan reporting. |
| coordinates | The two-dimensional mathematical representation of a point. For example, 29, 38 represents a value of 29 on the x-axis and a value of 38 on the y-axis. |
| data bits | The number of bits used to represent a character or byte of data, usually 8. This is a communication parameter used by the serial (RS-232) controller. |
| EEPROM | An electrically erasable programmable read-only memory (EEPROM) chip. |
| *Enter Point Mode* | A touch reporting type under the SFP that reports only the coordinates at which a stylus enters the touch screen. Add Exit Point reporting can be added as a modifier. |
| *Exit Point Mode* | A touch reporting type under the SFP that reports only the coordinates at which the stylus exits the touch screen. Add Exit Point reporting can be added as a modifier; if you do this, however, the touch system reports the coordinates at which the stylus exits the screen twice, first as a normal Coordinate Report and then as an Add Exit Point Coordinate Report. |
| frame size | A general term for either logical or physical frame size. *See* logical frame size, physical frame size. |
| guided acoustic wave touch technology | A technology used in touch screens, based upon transmitting acoustic waves through a glass overlay placed over the display surface. |
| hardware-based controller (HBC) | A touch-system-independent, digital controller containing a microprocessor. The HBC is a half-card installed in the computer, drawing its power through the PC bus and communicating through the bus using an I/O address and hardware interrupt. |

| | |
|---|---|
| hardware interrupt | A dedicated hardware line between the touch system and the computer, defining where to search for an SBC or HBC. |
| HBC | *See* hardware-based controller (HBC). |
| HBC driver | A software program that interfaces with the hardware-based controller via a selectable I/O address and optional hardware interrupt and with the application via the touch application program interface (TAPI). |
| host (host system) | The computer system to which a touch system is added. |
| I/O address | A parameter that defines the hardware base address location of an SBC's or HBC's hardware registers on the controller card. |
| infrared touch technology | A technology used in touch systems, based upon superimposing a grid of invisible infrared light in front of the display surface. |
| interrupt number | A parameter that defines where to search for an SBC or HBC controller. |
| logical (virtual) beam | A member of a set of beams that includes both the physical beams and the interpolated virtual beams, which are imaginary beams that occupy the spaces between physical beams. In each axis, the number of logical beams is twice the number of physical beams minus one. |
| logical coordinates | A coordinate system consisting of an x- and y-axis, each made up of logical beams. The origin of the coordinate system is the upper left corner of the display/touch frame. |
| logical frame size | The logical frame size is double the physical frame size minus one, since the space between the opto-pair is considered a virtual beam. *See* beam, physical frame size. |
| MDI | *See* modular digital interface (MDI). |
| modular digital interface (MDI) | The touch-system-to-controller interface created by confining all of the analog functions to the touch system. The MDI makes a standard touch system controller-independent and reduces the touch system cabling requirement to a simple 8-pin standard phone cable up to six feet in length. This extends the allowable distance between the touch system and controller and improves noise immunity. |
| option | A selection, test, or function available on a menu. |
| opto-pair | An infrared light-emitting diode (LED) matched with a phototransistor and set opposite one another in a touch frame (opto-matrix frame) and pulsed sequentially so as to send and receive a single beam of infrared light. *See* beam. |

| | |
|---|---|
| parity | A parameter used for error-checking to ensure that the data that was transmitted by the serial peripheral is identical to that received by the computer, and vice versa. This is a communication parameter used by the RS-232 controller. |
| physical beam | A member of a set of beams that includes only the beams that actually exist as an LED/phototransistor pair. *See* beam. |
| physical coordinates | A coordinate system consisting of an x- and y-axis, each made up of physical beams. The origin of the coordinate system is the upper left corner of the display/touch screen. |
| physical frame size | The actual number of opto-pairs (beams) that make up each axis of the frame. *See* beam, logical frame size. |
| RS-232 controller | *See* serial (RS-232) controller. |
| SBC | *See* software-based controller (SBC). |
| SBC driver | A software program that interfaces with the software-based controller via a selectable I/O address and hardware interrupt and with the application via TAPI. |
| scan reporting | One of two methods that determines the form used to send data from the touch system to the host. The touch system reports a list of physical beams that are interrupted in each axis. *See also* coordinate reporting. |
| scanning infrared technology | *See* infrared touch technology. |
| serial (RS-232) controller | A touch-system-independent, digital controller containing a microprocessor. This controller requires an external +12V power supply and communicates using a standard RS-232 serial port. |
| serial (RS-232) driver | A software program that interfaces with the RS-232 controller, or any other serially communicating CT controller that recognizes the Smart-Frame protocol, via the RS-232 serial port, and with the application program TAPI. |
| Smart-Frame | A Carroll Touch touch frame with built-in serial (RS-232) controller. |
| Smart-Frame Protocol | A Carroll Touch proprietary set of commands and reports used to communicate with Carroll Touch touch systems. This protocol is used by virtually all Carroll Touch infrared touch systems. |
| Smart-Frame Protocol II | A Carroll Touch proprietary set of commands and reports used to communicate with Carroll Touch touch systems. This is an enhancement of the Smart-Frame Protocol and supports both guided acoustic wave and infrared touch systems. |

| | |
|---|---|
| software-based controller (SBC) | A touch-system-independent, digital controller that has no microprocessor, but, instead, shares processor time with the host microprocessor. The SBC is a half-card installed in the computer, drawing its power through the PC bus and communicating through the bus using an I/O address and hardware interrupt. |
| stop bit | The number of bits, usually 1, inserted by the serial (RS-232) controller into the data stream to inform the host computer that the transmission of a byte of data is complete. This is a communication parameter used by the RS-232 controller. |
| sync error | An error that occurs when the beam number provided by the SBC hardware at the time of an SBC hardware interrupt is not one beam greater than the beam number provided by the previous SBC hardware interrupt. |
| TAPI | *See* Touch Application Program Interface (TAPI). |
| TAPI driver | A software program that interfaces with the touch system controller and with TAPI. |
| TAPI interrupt | The software interrupt used to communicate with the TAPI driver. |
| temporal filter space | A parameter that defines a guardband around a touch point, within which other touches are not reported. This reduces demands upon system processing. |
| temporal filter time | A parameter that reduces the frequency of coordinate reporting, which helps differentiate valid touches from noise and other transient events. |
| touch active area | The area inside the touch frame or touch screen that is sensitive to touch. |
| Touch Application Program Interface (TAPI) | A Carroll Touch proprietary series of software function calls within the individual controller driver that interfaces a touch application to a touch system using the Smart-Frame Protocol. TAPI enables a properly-written application to interface with any Carroll Touch controller driver that communicates serially or through the PC bus and recognizes the Smart-Frame Protocol. |
| touch frame | A rectangular assembly of circuit boards. Two adjacent circuit boards contain banks of infrared light-emitting diodes (LEDs), while the opposite two contain banks of complementary phototransistor-receivers. The LEDs and phototransistors create a grid of invisible infrared light. The opto-electronics are concealed behind an IR transparent bezel, which shields the opto-electronics from the operating environment, while allowing the IR beams to pass through. |

| | |
|---|---|
| *Touch Reporting Mode* | A method that determines the form used to send data from the touch system to the host. In scan reporting, the touch system reports a list of physical beams that are interrupted in each axis. In coordinate reporting, the touch system reports x, y coordinate values that identify the touch location. |
| touch reporting type | A touch mode that determines when touch coordinates are reported. *Enter Point Mode* reports only the coordinates at which a finger or stylus enters the touch screen. *Exit Point Mode* reports only the coordinates at which the stylus exits the touch screen. *Tracking Mode* reports the coordinates of the entry of the touch screen and all movement within the screen. *Continuous Mode* generates reports at intervals from the time the screen is entered until it is exited, even though the finger or stylus is unmoving. Exit Point reporting can be added as a modifier to the four basic reporting types. |
| touch screen | A glass overlay containing a transducer and reflectors, placed over the display surface. A transducer mounted on the edge of the glass emits an acoustic wave. The wave travels along the reflector array, is redirected across the overlay to the reflecting edge, and returns to the array where it is reflected back to the transducer. The first reflector will send a signal back first, then the second, and so on. |
| Touch State Report | A touch reporting type under SFP-II that reports touch coordinates at intervals from the time a stylus enters the screen until it exits, even if the stylus is unmoving. |
| touch system | The collection of all the components that are necessary to detect a touch and report it to the host. This collection usually consists of the touch frame or screen, protective bezel, controller, and software. |
| transducer | The device that is mounted on the corner of the glass overlay of a guided wave touch system and emits an acoustic wave. |
| *Tracking Mode* | A touch reporting type under the SFP that reports the coordinates of the initial touch on the touch screen, as well as all movement within the screen. Add Exit Point can be added as a modifier. |
| virtual beam | Imaginary beams that occupy the spaces between physical beam. |

# Index

CONTACTING CARROLL TOUCH:

Carroll Touch
2800 Oakmont Drive
Round Rock, Texas 78664

http://www.carrolltouch.com

| | |
|---|---|
| (512) 244-3500 | Switchboard |
| (800) 386-8241 | Toll Free |
| (512) 388-5643 | Order Assistance |
| (512) 388-5509 | Technical Support |
| (512) 244-7040 | Fax |
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