VRC 4000

Software Driver Manual

Click on red text at any location in the manual to jump to the specified chapter, topic, or reference.

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Revision A

February 1997

symbol®

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About This Manual

This manual provides information for the software developer writing programs for use with the VRC 4000. This manual describes the installation and use of the TWdriver for Windows and the TBdriver for DOS with the VRC 4000 terminal. Included are sections on the required switch settings and hardware notes, programming guidelines, tips on using multiple touchscreens, and instructions on using the TWdriver Application Programming Interface.

The following are the specific chapter / appendix titles along with brief descriptions of the contents of each:

Chapter 1, *TWDriver Touchscreen Driver for Windows*, describes the installation methods for installing the TWDriver, and provides additional information on calibration and troubleshooting.

Chapter 2, *TBDriver Touchscreen Driver for DOS*, provides similar information for installing and configuring TBDriver for DOS, including instructions on unloading the driver and calibration.

Appendix A, *TWDriver Switch Settings and Hardware Notes*, describes required switch settings for use with various controllers, as well as some additional hardware notes.

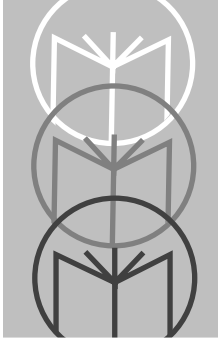
Appendix B, *TBDriver Switch Settings and Hardware Notes*, provides similar information for use with TBDriver.

Appendix C, *Using Multiple Touchscreens*, provides information on using multiple touchscreens, including instructions on using a matrix touchscreen.

Appendix D, *Programming Guidelines*, describes some techniques commonly employed in touchscreen programming.

Appendix E, *TWDriver Application Programming Interface*, describes the use of the API, and includes explanations of each of the function calls.

Contents



Chapter 1 TWDriver Touchscreen Driver for Windows

Contents

Introduction

A touchscreen is one of the most technically sophisticated yet easiest to use input devices available today. Many different types are available, but the end result is the same: you touch the visual images you see, and the computer responds. A touchscreen is a hardware device which is physically attached to the computer's monitor and can accurately sense the position of a touch.

TWdriver is a device driver which enables you to use a touchscreen with Microsoft Windows and any Windows application program. TWdriver interfaces the touchscreen to Windows as though it were a mouse, and allows the touchscreen to perform all the normal functions of a mouse, the only difference being that while a real mouse has two or more buttons, a touchscreen emulates just one.

Touchscreens are the most practical input device for Windows applications operating in physical environments where a mouse is unsuitable, for example in public places, points of sale, factory floors and dealing rooms, to name but a few. They are also ideal for use by people with little or no computer experience, for whom there is nothing more intuitive than touching what they see. The combination of a touchscreen with the Windows Graphical User Interface is ideal for these purposes.

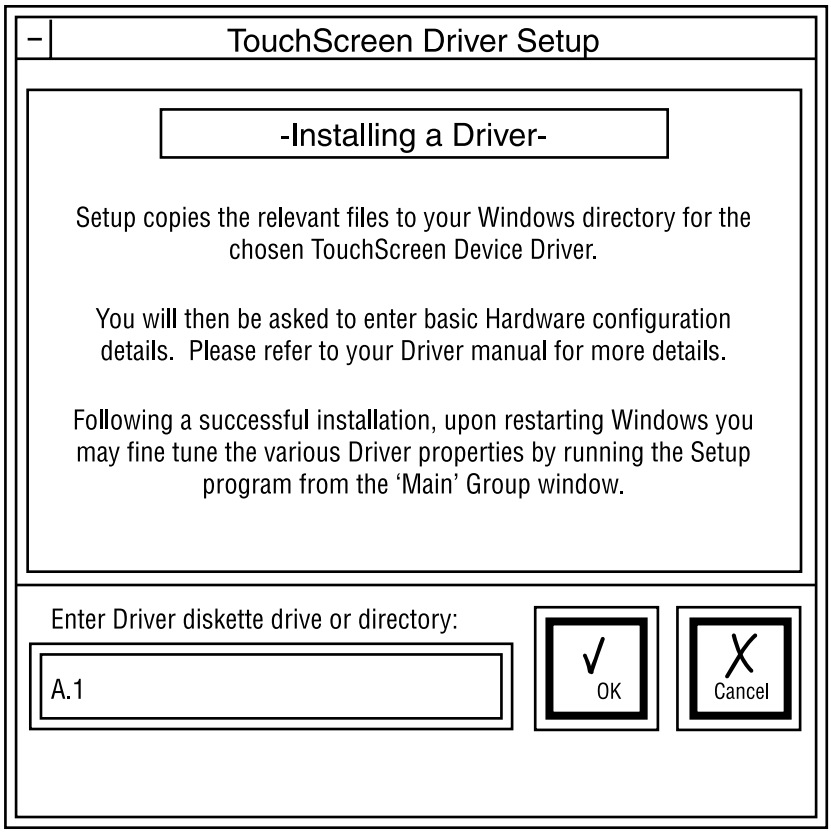
For program developers, TWdriver exports an Application Programming Interface (API). This enables application programs to directly interact with TWdriver and to control it's configuration and behavior. The technical specification of the API is available on request from Touch-Base Ltd.

Getting Started

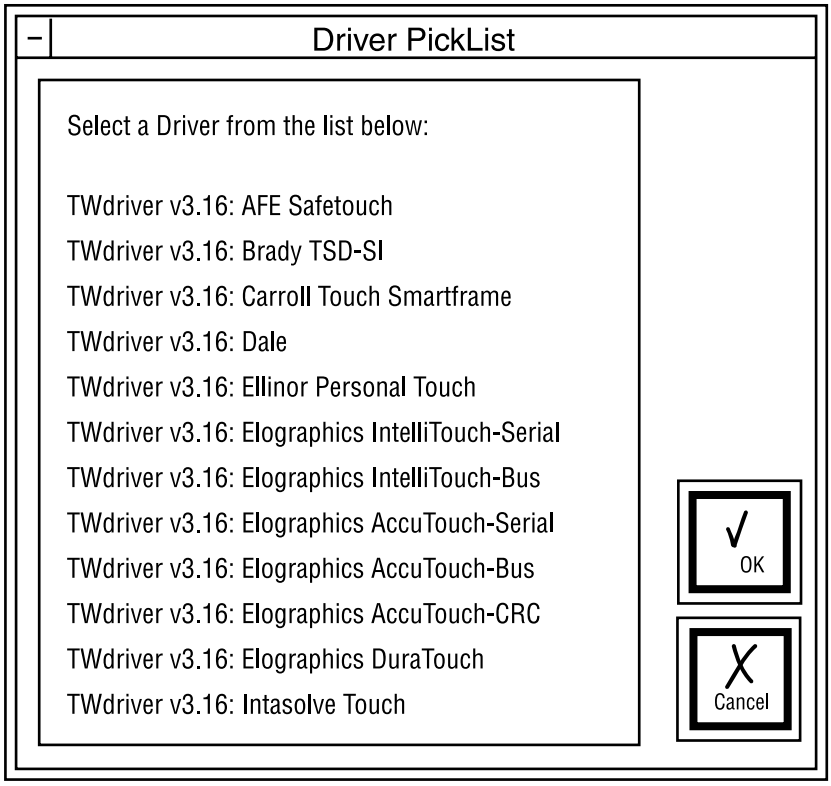
Installation

The easy way to install TWdriver is to run the TWsetup program from the TWdriver release diskette:

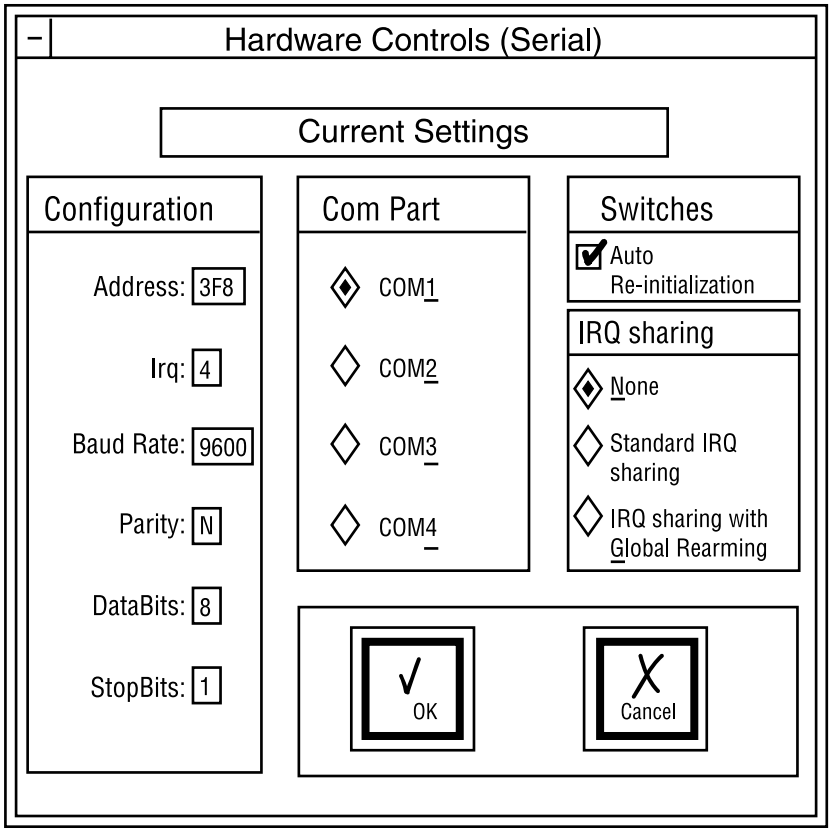
1. Pull down the Windows Program Manager File menu and select the Run option.
2. Enter d:TWsetup as the command line, where d: is the diskette drive id. Click OK. The following screen will be displayed:



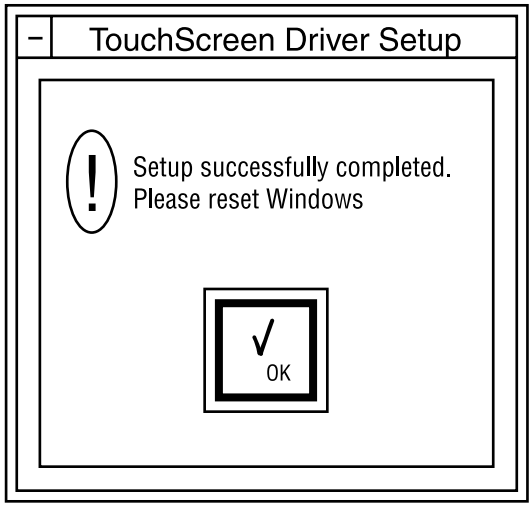
3. Enter the diskette drive id, and click OK.
4. If your TWdriver diskette contains drivers for several different touchscreens, the following screen will be displayed:



5. Scroll the list down, if necessary, to locate your touchscreen type, and select it by clicking on it. Then click OK.
6. Wait while TWsetup copies files to your hard disk.
7. For serial touchscreens, the following screen is now displayed. A slightly different screen is displayed for bus touchscreens:



8. In most cases, you simply have to select COM1 or COM2. For more advanced hardware configurations, refer to the section 'Hardware Configuration'. Click OK.
9. Windows only loads device drivers when it starts. The following screen is displayed. Click OK, then close down Windows and re-start it.



10. When you have re-started Windows, the touchscreen driver will be active but will require calibration. Start TWsetup by double clicking its icon in the Main program group, and select the calibrate option. Touch the two points as requested. See the 'Calibration' section for further details.

Alternative Installation Methods

There are several alternative methods of installing TWdriver, which are now briefly described for the benefit of advanced users. We recommend that you use the easy method described above where at all possible. You may need to refer to this section if you use a shell other than Program Manager.

The easiest alternative method of installing the touchscreen device driver is to use the DOS version of the Windows Setup program to install an 'other' mouse driver, by selecting the last option on the mouse configuration picklist.

You can also copy the appropriate driver to the system directory and edit the 'mouse=' command in the SYSTEM.INI file to load the new mouse driver. You can determine the correct driver from the oemsetup.ini file on the TWdriver release diskette.

The TWsetup program must be used to perform touchscreen calibration, so you need to copy the TWSETUP.EXE and BWCC.DLL files onto your hard disk. It is usually convenient to have TWsetup as an icon in one of the program groups. In Program Manager groups this is done with the New option of the File menu. You must specify the command line as 'TWSETUP CONTROL'. If TWsetup is run without the CONTROL parameter, it starts in 'install' mode.

The TWdriver default configuration settings are chosen to be appropriate in most cases, although if your touchscreen is connected to a serial port other than COM1, you will need to alter the hardware configuration as described in 'Hardware Configuration'.

Windows Double Click Speed

Sometimes you cannot achieve double clicks as quickly using a touchscreen as you can with a mouse, so you may need to adjust Windows' mouse double click time threshold. This setting controls the length of time during which Windows will recognize two clicks as a double click as opposed to two separate single clicks.

An easy way to adjust this setting is to select the 'Main' program group window, then 'Control Panel', then 'Mouse', and then set the Double Click Speed to Slow.

The same effect can also be achieved by editing WIN.INI and setting DoubleClickSpeed=900 in the [Windows] section.

The User Controls section of TWsetup also contains the same DoubleClickSpeed control.

Windows Border Width

You may wish to increase the Windows' border width in order to make them easier to touch. To do this, select the 'Main' program group window, then 'Control Panel', then 'Desktop'. Increase the Border Width to approximately 12.

The same effect can also be achieved by editing WIN.INI and setting BorderWidth=12 in the [Windows] section.

Hardware Installation

For some types of touchscreen, TWdriver has specific requirements for the controller switch settings, and where specified these must be set accordingly. If the touchscreen is connected to a serial port other than COM1, or a bus controller touchscreen is set to a port address or IRQ other than the defaults given in the 'Switch Settings and Hardware Notes' section, the TWdriver hardware configuration settings must match the settings on the hardware itself. Refer to this section for touchscreen-specific details.

Calibration

Calibration enables the software to accurately align touches with the mouse cursor. This procedure usually only needs to be performed once, as part of the initial software installation, and only needs to be repeated if the alignment of the touchscreen with the visual image should change for any reason, or if the calibration data file is deleted for any reason. The procedure involves touching two displayed points, which the software then stores in a file known as the calibration file.

To perform calibration, run the TWsetup program by double clicking its icon and select the calibration option. Touch the first point, then the second point, as requested. Calibration is now complete, and a file called TWcalib will have been created in the Windows directory.

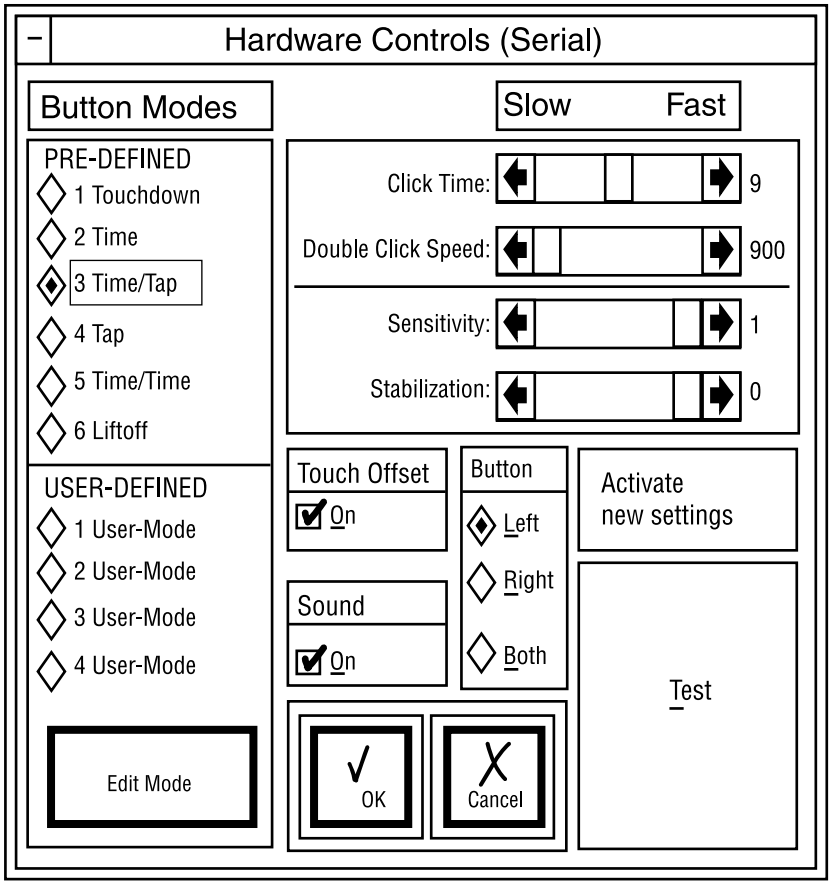
If you do not have a mouse, you can start the control program using the keyboard. Use Control-Tab to switch between program group windows and icons, then use the cursor keys to highlight the TWsetup icon, then Enter to start it. Once in TWsetup, press Alt-C to run the Calibrate option.

With the touchscreen working and correctly calibrated, touching the screen should move the mouse cursor immediately to the point of the touch, and the cursor should follow your finger as you slide it around the screen.

Configuration

A number of configuration options affect the operational characteristics of the touchscreen, and enable you to tailor it to your precise needs. All the configuration options can be established or amended using the supplied control program, TWsetup.

Most of the options are to be found in the 'User Controls' section of the program:



Whenever you make any changes to the configuration, you can press the 'Activate new settings' button to bring your changes into immediate effect, and press the 'Test' button to test how the button responds to touches. Pressing the 'OK' button activates your changes, saves them, and exits the User Controls screen. Pressing the 'Cancel' button cancels any changes you have made, and exits the User Controls screen.

Button Modes - Pre-Defined

The method used to simulate button presses and releases depends on the Button Mode configured. The default after initial installation is Button Mode three (Time / Tap mode).

There are six pre-defined modes, which are quick and easy to configure, and four 'User Defined' modes which offer great flexibility, but require slightly more setting up.

The pre-defined modes operate as follows:

Button Mode 1 - Touchdown mode

The mouse cursor is moved to the point of the touch, then the button is immediately pressed. You can then slide around with the button held down. The button is released when you remove your finger from the screen.

Button Mode 2 - Time mode

The mouse cursor is moved to the point of the touch, but the button is not pressed. You can then slide around with the button not pressed. Any time you hold your finger stationary for about half a second, the button is pressed, and a beep sounds. Once pressed, you can slide around with the button pressed, and the button is only released when you remove your finger from the screen.

Button Mode 3 - Time/Tap mode

Mode 3 is similar to mode 2, but double clicks are possible. After holding stationary to generate a button press, you quickly lift your finger off the screen and then immediately touch it again. A second button press is generated immediately at the same location as the first one, and another beep sounds.

Button Mode 4 - Tap mode

The mouse cursor is moved to the point of the touch, but the button is not pressed. Button presses are generated by quickly lifting your finger off the screen and then touching it again within a short time. Double clicks are achieved by doing this twice.

Button Mode 5 - Time/Time mode

Mode 5 is similar to mode 3, except the second press is achieved by holding your finger stationary for a further half second after the first beep.

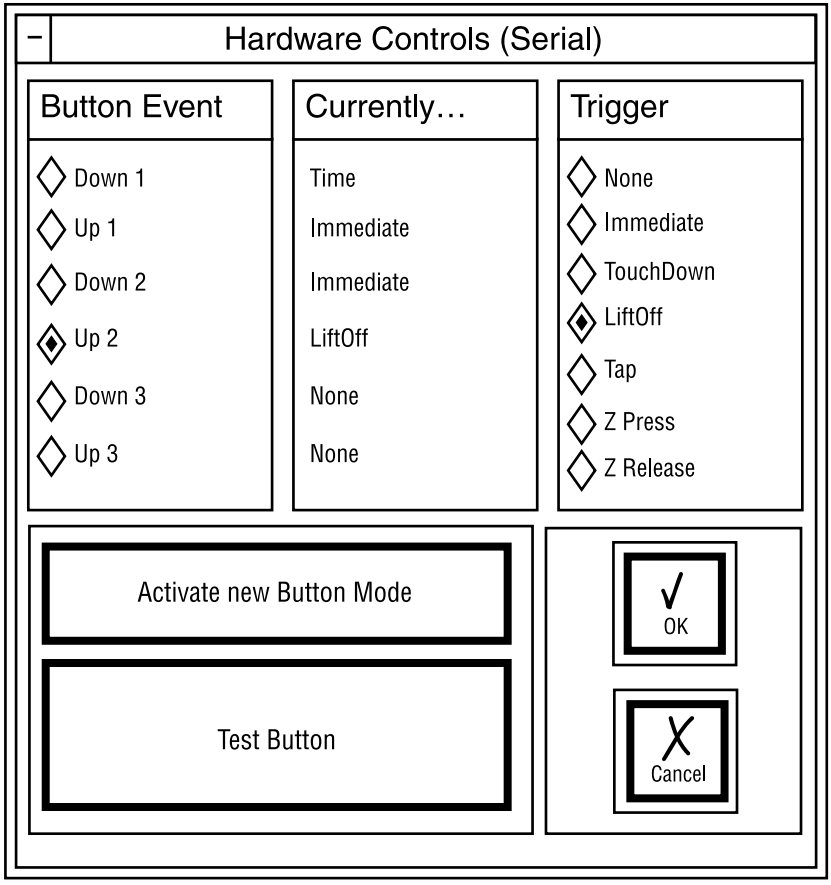
Button Mode 6 - Liftoff mode

The mouse cursor is moved to the point of the touch, but the button is not pressed. When you lift your finger off the screen, the button is pressed and then immediately released again. Double clicks can be achieved by quickly touching the screen and lifting off again.

Button Modes - User-Defined

TWsetup allows you to define, save and recall up to four User Defined Button Modes, each with their own characteristics and behavior. These Button Modes allow you to specify the touch triggers which cause simulated mouse button events in a very flexible and powerful way.

Initially, the four User Defined Button Modes are undefined. To define one, you select one, and press the 'Edit Mode' button. This displays the 'Set User Defined Mode' screen.



You must now define the touch triggers which cause each of six possible button events. The six button events are:

1. Down1 The first mouse button press
2. Up1 The first mouse button release
3. Down2 The second mouse button press (for double clicks)

4. Up2 The second mouse button release
5. Down3 Subsequent mouse button presses
6. Up3 Subsequent mouse button releases

Down1 defines the touch triggers required to simulate a first button press, and Up1 defines the touch event required to simulate releasing the button.

Down2 and Up2 define the touch trigger, if any, which will simulate another button press, if that trigger occurs within the time specified by the ClickTime option, in other words the actions required to generate a double click.

Down3 and Up3 define the touch trigger, if any, which will simulate subsequent button presses.

The description of ClickTime, later in this section, further describes the significance of first, second and subsequent clicks.

The touch triggers which can be assigned to each of the six mouse events are:

1. None ie The mouse event will never occur
2. Immediate ie The mouse event will occur immediately
3. Touchdown ie The mouse event will occur on touchdown
4. Liftoff ie The mouse event will occur on liftoff
5. Time ie The mouse event will occur on stationary touch
6. Tap ie The mouse event will occur on tapping the screen
7. Z press ie The mouse event will occur on increasing pressure
8. Z release ie The mouse event will occur on decreasing pressure

The None option is used to prevent double clicks or subsequent clicks.

The **Immediate** option is used to generate the mouse event immediately it becomes possible.

The **Touchdown** option is triggered whenever a finger makes initial contact with the screen.

The **Liftoff** option is triggered whenever a finger breaks contact with the screen. A finger lift always causes the mouse button to be released if it is pressed.

The **Time** option is triggered by holding a touch stationary for an amount of time defined by the ClickTime option, which is described later in this section.

A **Tap** is defined as a finger lift followed by a re-touch within the amount of time also defined by ClickTime. Note that a click generated by a tap will occur at the point of the liftoff, not at the point of the re-touch.

The **Z** options are only supported on touchscreens with a Z (pressure) axis.

To assign a touch trigger to a mouse event, select the button event in the left hand column, then the touch trigger you want to assign to it from the right hand column. The centre column shows the trigger currently assigned to each button event. As a bare minimum, you need to assign triggers to the Down1 and Up1 events. Press the 'Activate new Button Mode' button to immediately activate the new mode, and press the 'Test' button to test how the button responds to touches. Press the 'OK' button to activate your changes, save them, and exit back to the User Controls screen. Press the 'Cancel' button to cancel any changes you have made, and exit to the User Controls screen.

The use of User Defined Button Modes is best explained by examples. In the notation that follows, a Button Mode is defined by specifying the six button events Down1, Up1, Down2, Up2, Down3, Up3.

The pre-defined Button Modes 1 to 6 are defined as follows:

1. Mode 1: Touchdown, liftoff, touchdown, liftoff, touchdown, liftoff.
2. Mode 2: Time, liftoff, none, none, none, none.
3. Mode 3: Time, liftoff, tap, liftoff, none, none.
4. Mode 4: Tap, liftoff, tap, liftoff, tap, liftoff.
5. Mode 5: Time, time, immediate, liftoff, none, none.
6. Mode 6: Liftoff, immediate, liftoff, immediate, liftoff, immediate

The following examples give an idea of the many other modes which can be created:

- Touchdown, immediate, none, none, none, none.

  This will generate an instantaneous single click (down and up) when the screen is touched. It will not be possible to drag the mouse cursor with the button pressed.

- Touchdown, immediate, immediate, immediate, none, none.

  This will generate two instantaneous clicks (down, up, down, up) when the screen is touched. It will not be possible to drag the mouse cursor with the button pressed.

- Time, immediate, immediate, liftoff, none, none.

  This will generate a double click when a touch is held stationary for ClickTime, and the button will remain down until the finger is lifted off the screen, so it will be possible to drag the cursor with the button down.

- Liftoff, immediate, tap, liftoff, none, none.

  This will generate a single click (down and up) when the finger is lifted off the screen, and a second click if the screen is re-touched within ClickTime. Then the button will remain down until the finger is again lifted off the screen.

- Time, time, immediate, time, immediate, time.

  This will generate a continuous sequence of button presses as long as the finger is held stationary.

- Zpress, Zrelease, Zpress, liftoff, none, none.

  This will allow you to move the cursor around, then press hard to generate a button press, and release it by reducing the pressure. Double clicks will be possible by pressing hard again.

- Touchdown, immediate, immediate, immediate, immediate.

  Not recommended! Continuous, never ending, button presses will be generated on first touching the screen. In fact TWdriver will go into a tight loop continuously pressing and releasing the button, and no other processing will be able to occur.

Touch Offset

Normally, the cursor is directly underneath your finger, which is desirable in most circumstances, but inconvenient in others. With Touch Offset On, the cursor is offset directly above your finger by 10% of the height of the screen, except at the top and bottom, where it converges with your finger as you approach the edge. This can be very useful in applications where you need to be able to see the precise position of the cursor clearly.

Button

Normally, the left button is simulated, although a configuration option allows the right button, or both buttons at once, to be simulated instead.

ClickTime

ClickTime is a time interval which TWdriver uses for a number of purposes. It is defined as a number of system clock ticks, there being 18.2 ticks to each second. The default value of ClickTime is 9, which corresponds to about half a second. Smaller values correspond to a shorter time, and larger values correspond to a longer time.

ClickTime has three functions:

A Time touch event is generated by holding your finger stationary in contact with the screen for ClickTime. So in Button Mode 2 (Time mode), for example, ClickTime controls the length of time you need to hold your finger stationary for to generate a button press.

A Tap touch event is defined as a finger lift and re-touch within ClickTime. So in mode 4 (Tap mode), for example, ClickTime defines the length of time within which you must re-touch the screen after lifting off in order to generate a button press.

ClickTime is also used to distinguish between first, second, and subsequent clicks, allowing each to be assigned to different types of touch event. For example, after the first click has been generated in Button Mode 3 (Time / Tap mode), TWdriver is expecting a tap event to generate a second click, but only if it occurs within ClickTime. After ClickTime, a tap will be ignored since TWdriver will then be expecting a first press again, and will only respond to a time event. Similarly, after a second click and within ClickTime, TWdriver will be expecting the event defined for a subsequent button press, if any. After ClickTime, it will again start looking for the event defined for a first button press.

Note that second button presses - the second click of a double click, are forced by TWdriver to occur at exactly the same location as the first click. This has an interesting, and sometimes confusing, implication in Button Mode 1 (Touchdown mode). In an application such as the Windows calculator, Touchdown mode is ideal for simulating the buttons of a real calculator. However, two successive clicks on two different buttons within ClickTime would be treated by TWdriver as a double click on the first button, which is incorrect in this situation. The solution here is to reduce ClickTime to, say, 1, since it serves no purpose in this case.

DoubleClickSpeed

This option actually belongs to the Windows mouse control panel, but is duplicated here for convenience. It changes the speed at which Windows will register a double click. For touchscreens, this normally needs to be set to the high end of the scale.

Sensitivity

The Sensitivity option specifies the time interval required to register a finger lift, and uses the same units as the ClickTime option. The default varies depending on the touchscreen model, but is the smallest value required to make the touchscreen usable, typically 1, 2, or 3. In some cases you may wish to increase this time, so that any momentary loss of contact when sliding around is ignored.

Stabilization

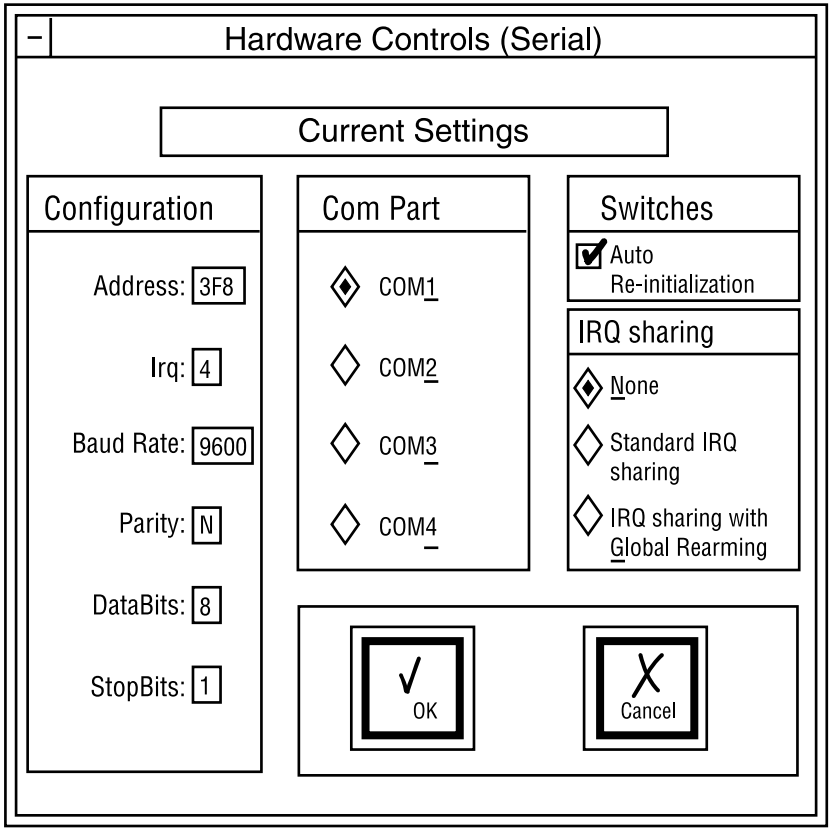
The Stabilization option sets the number of touch coordinates from the hardware which are averaged to produce stabilized values. The default varies depending on the touchscreen model, but is commonly 0, ie no stabilization, 2, or 3. This value may be increased if the cursor appears jittery. Specifying a higher than necessary value causes the cursor to be unnecessarily delayed in following your finger around the screen.

Sound

The Sound on / off option enables or disables the beep which accompanies simulated button presses.

Hardware Configuration

Selecting the 'Hardware Controls' option of TWsetup displays the Hardware Controls screen:



These options control the configuration of the software to work with the touchscreen hardware, and must be set correctly for your hardware configuration or the touchscreen will not work.

Standard COM Port Configurations

In most cases, the touchscreen will be connected to either a standard COM1 port or a standard COM2 port. In these cases, all that is required is to select the appropriate port. The correct port address and IRQ will be assigned automatically.

Non-Standard COM Port Configurations

The default port addresses and IRQs assumed for the COM ports are:

Table 1-1. Com Port Addresses and IRQs

ComPort	Address	IRQ
1	3F8	4
2	2F8	3
3	3E8	5
4	2E8	2

Other configurations can also be configured by specifying the port address and IRQ explicitly. IRQ 2 cannot be used in Enhanced mode, since Windows uses it for vertical retrace handling, and interrupts do not reach the touchscreen driver. The port address is specified in hexadecimal.

In order for COM ports to work properly in 386 enhanced mode, the Windows Virtual COM Driver (VCD) must also know the configuration of the COM ports. Windows takes the COM port configuration from the [386enh] section of the SYSTEM.INI file, and assumes the following defaults:

```
COM1base=3F8
COM1irq=4
COM2base=2F8
COM2irq=3
COM3base=2E8
COM3irq=4
COM4base=2E0
COM4irq=3
```

The defaults for COM1 and COM2 do not normally require overriding, but the defaults for COM3 and COM4 usually do. When you use TWsetup to select a non-standard COM port configuration, TWsetup updates SYSTEM.INI for you.

However, in order to handle the port correctly in 386 enhanced mode, Windows also needs to find the port address listed in the BIOS COM port table. In many cases, non-standard COM ports will not be detected by the system BIOS at boot time, so the port address will not be automatically listed in the BIOS COM port table. A small DOS utility, TBbios, is provided with TWdriver, to force port addresses into the BIOS COM port table, and this should be run in your AUTOEXEC.BAT file. For example, “TBbios 3 3E8” will force the port address 3E8 into the entry for COM3 in the BIOS COM port table. TWsetup ***does not*** amend your AUTOEXEC.BAT file for you.

Automatic Re-initialization

Some touchscreen controllers require a software initialization sequence to set them into the required operating mode, and TWdriver always performs this when Windows loads. When the controller is serially connected and external to the PC, there is always the possibility that the user will power the touchscreen controller off and on, particularly if the controller is located inside the monitor. The controller will then power up uninitialized and will not work. TWdriver attempts to detect this situation and automatically re-initialize the controller when required. Automatic re-initialization is triggered by a positive going change in the state of the CTS signal on the RS232 interface. Note, however, that if the CTS connection is omitted from the RS232 cable the touchscreen will still work, but the automatic re-initialization function can not, and in some cases will be falsely triggered by the floating CTS. While TWdriver is attempting to re-initialize the touchscreen, it can cause the computer to slow down considerably. Automatic re-initialized can be disabled here if required.

Communications Parameters

TWdriver chooses defaults for Baud Rate, Parity, Databits and Stopbits which are either the only ones supported by the touchscreen, or which will be automatically recognized by the touchscreen, or which can be used with the switch settings defined in the 'Switch Settings and Hardware Notes' section. You may wish to change the communications parameters to support different switch settings, or to reduce the communications overhead.

Shared IRQ's and Global Rearming

For serial touchscreens only, TWdriver supports the ability for more than one COM port to share the same IRQ. For hardware reasons, this only works when the hardware is designed to support IRQ sharing, for example on multiport serial adapter cards. IRQ sharing cannot be made to work by simply switching two ordinary COM ports to the same IRQ.

The Global Rearm IRQ-sharing mechanism found on an increasing number of machines is also supported.

Bus Touchscreens

A different Hardware Controls screen is displayed for touchscreen controllers which plug directly into the PC bus. In these cases, only the port address and IRQ need be specified if the jumper or switch settings do not match the defaults given in the 'Switch Settings and Hardware Notes' section.

Activating the New Configuration

Press 'OK' to save the changes and exit, or 'Cancel' to cancel your changes and exit. Changes to the hardware configuration cannot be activated immediately. You must restart Windows for them to take effect.

WIN.INI

All the TWdriver configuration options are stored in the Windows configuration file WIN.INI, and you may alter the TWdriver configuration by editing this file using a text editor. The syntax of the entries follows. All entries are shown with their default values, followed by the valid range of values:

[Touch-Base]	
ButtonMode=3	0 - 6
ButtonDown1=0	0,1,2,4,8,16,32,64
ButtonUp1=0	0,1,2,4,8,16,32,64
ButtonDown2=0	0,1,2,4,8,16,32,64
ButtonUp2=0	0,1,2,4,8,16,32,64
ButtonDown3=0	0,1,2,4,8,16,32,64
ButtonUp3=0	0,1,2,4,8,16,32,64
ClickTime=9	1 - 20
Sensitivity=1	1 - 20
Stabilisation=0	0 - 20
Offset=Off	On, Off
Button=Left	Left, Right, Both
Sound=On	On, Off
ComPort=1	1, 2, 3, 4
Address=3F8	0 - FFFF
Interrupt=4	1 - 15
Baud=9600	1200,2400,4800,9600
Parity=N	N, O, E

DataBits=8	7, 8
StopBits=1	1, 2
IRQshare=Off	On, Off
IRQreArm=Off	On, Off
AutoReInit=On	On, Off
Path=.	A DOS directory pathname
PacketsToIgnore=0	1 - 20

UserMode1=n n n n n n	0,1,2,4,8,16,32,64 (x6)
UserMode2=n n n n n n	0,1,2,4,8,16,32,64 (x6)
UserMode3=n n n n n n	0,1,2,4,8,16,32,64 (x6)
UserMode4=n n n n n n	0,1,2,4,8,16,32,64 (x6)
CurrentUserMode=n	1 - 4

ButtonDown1 - ButtonUp3 are only processed if **ButtonMode** is 0.

Path specifies the pathname of the calibration file. If this option is not used, the TWcalib file will reside in the Windows directory. This option may be used to locate it elsewhere.

PacketsToIgnore specifies a number of coordinate packets to ignore before sensing a touchdown. The default value is zero. This can be useful in touchdown mode, where the touchdown position is the position of the button click. If the touchscreen takes a few packets to stabilize on the correct position, this parameter can be used to ignore the first few inaccurate packets. This feature is not supported by the configuration control program.

The touch triggers for the User Defined Button Modes are defined by numbers, as follows:

0	None	ie The mouse event will never occur
1	Immediate	ie The mouse event will occur immediately
2	Touchdown	ie The mouse event will occur on touchdown
4	Liftoff	ie The mouse event will occur on liftoff

8	Time	ie The mouse event will occur on stationary touch
16	Tap	ie The mouse event will occur on tapping the screen
32	Z press	ie The mouse event will occur on increasing pressure
64	Z release	ie The mouse event will occur on decreasing pressure

An even further range of possibilities is available here than in the control program: Touch events can be OR'ed by adding their configuration numbers together. So, for example, the value 24 would define a trigger of Time OR Tap.

The default BaudRate, Parity, DataBits and StopBits are touchscreen dependent. IRQshare and IRQreArm are mutually exclusive. That is, they should not both be On.

Co-existence with Mice

TWdriver operates with a touchscreen alone if no mouse hardware is present, or with a mouse alone if no touchscreen is present, or with both together if both are present.

TWdriver supports all types of Microsoft and IBM PS/2 mice, and 100% hardware compatibles. However, since Windows can only load one mouse driver at a time, it is not possible to provide simultaneous support for mice which require their own special Windows driver.

Co-existence with DOS TBdriver

In Windows Real and Standard modes, TBdriver (and TBmouse, if required) may be left resident while Windows runs if desired. They will be disabled while Windows is running, but restored to operation when Windows terminates or executes a Dos shell.

However, in Windows Enhanced mode, each virtual machine is a perfect copy of the machine environment which Windows finds when it starts up, including any TSR's. Windows continues to reflect serial interrupts into TBdriver, as well as TWdriver, with the result that the Windows driver loses data and performance of the touchscreen is severely degraded. For this reason, TBdriver must not be loaded when Windows is started in Enhanced mode.

Troubleshooting and Technical Support

The control program 'TWsetup' displays an 'About' box which amongst other things, shows the initialization status and whether calibration is valid for the installed TWdriver.

If the initialization status is anything other than 'Ok' read on... if the calibration status is anything other than 'Ok', this represents the DOS error encountered when TWdriver attempted to access the calibration data - try re-calibrating. If the communications errors are anything other than zero read on....

In case of difficulty, the following checks should be made before calling technical support:

No cursor movement when touchscreen touched

- Check that the touchscreen has power, and that its communication cable is connected to the computer.
- Check that the switch settings, if any, are set as specified in 'Switch Settings and Hardware Notes'.
- Check that you selected the correct driver for your touchscreen in the Windows Setup program.
- Check that the TWdriver hardware configuration is set up correctly. For serial touchscreens check that TWdriver is configured for the correct serial port number. For COM3, COM4, and bus controller touchscreens, check that the port address and IRQ are configured to match the hardware switch or jumper settings. Also check for port address or IRQ conflicts with other cards in the system.

Cursor moves but incorrectly

- Check that you have calibrated, and that TWdriver still has access to the

TWcalib calibration file, either in the Windows directory, or via the Path setting in WIN.INI.

- If you have re-installed TWdriver for a different type of touchscreen, you will need to re-calibrate.

Difficulties with double clicks

- Ensure that Windows' mouse double click speed is set to slow, as described in the 'Getting Started' section.
- You may have set the TWdriver settings for ClickTime or Sensitivity to time intervals so great that two clicks take longer than the time allowed by the Windows DoubleClickSpeed setting. If you have set high values for ClickTime or Sensitivity, try reducing them.

System performance

- If your touchscreen requires software initialization, and is powered off, TWdriver will attempt to re-initialize it every ten seconds, which may degrade system performance. This can be prevented by specifying AutoReInit=Off in WIN.INI, or using the TWsetup program.
- If you are running Windows in 386 enhanced mode, and you left a DOS touchscreen driver running when you started Windows, Windows will reflect serial interrupts into that as well as TWdriver, which will severely degrade touch responses.

TBdiag - The Touchscreen Diagnostic Program

The TBdiag program is provided on the distribution diskette for the more technically minded user, to help identify communication problems with serial touchscreens, or simply to observe the raw data from the touchscreen. TBdiag is a DOS program, and is invoked from the DOS command line by typing TBdiag.

Its monitor screen shows data sent to and received from the touchscreen, allowing you to see if it is responding to the initialization sequence, and if it is sending any coordinate data at all. You can re-try the initialization sequence at any time by pressing 'I', switch to hex display mode by pressing 'H', and exit by pressing 'X'. TBdiag takes several optional parameters:

The TBdiag Command Line

```
TBdiag [Port] [/C:bbbb,p,d,s] [/A:address] [/I:irq] [/NI] [/G]
```

Port	Specifies a serial port (1 .. 8)
/C:bbbb,p,d,s	Communications parameters:
bbbb	Baud rate (1200, 2400, 4800, 9600)
p	Parity (N, O, E)
d	Databits (7, 8)
s	Stopbits (1, 2)
/A:address	Port address (hexadecimal)
/I:irq	Interrupt request number (0 .. 15)
/NI	No initialization. Do not initialize touchscreen.
/G	Perform Global rearming
TBdiag /?	Prints the above summary

Most of these options are only rarely required. In most cases all that is required is simply:

TBdiag 1	For a touchscreen on COM1, or:
TBdiag 2	For a touchscreen on COM2.

Example

```
TBdiag /C:4800,e,7,2 /A:748 /I:10 /NI
```

Load TBdiag on a COM port at address 748 hex, using irq 10, at 4800 baud, even parity, 7 data bits, 2 stop bits. Do not perform touchscreen initialization.

A large window shows data sent to and received from the touchscreen, while the lower window shows the status, mainly of the serial port.

Interpretation of much of the information given by TBdiag requires specialist knowledge of serial ports and the touchscreen data stream. However, a working touchscreen should always show a data stream of some kind when touched.

Before Calling Technical Support

Please have the following information available (most can be found in TWsetup's 'About' box) before calling Technical Support:

- TWdriver version number
- Touchscreen manufacturer and type
- Touchscreen communications hardware configuration
- Windows version number, and modes affected
- DOS manufacturer and version number

Please also have the TWdriver distribution diskette to hand, as we may ask you to load and run TBdiag.

Service Information

If you have a problem with your equipment, contact the Symbol Support Center.

Call the Support Center from a phone near the equipment so that the service person can try to talk you through your problem.

If your problem cannot be solved over the phone, you may need to return your equipment for servicing. If that is necessary, you will be given specific directions.

> ***Note:*** *Symbol Technologies is not responsible for any damages incurred during shipment if the approved shipping container is not used. Shipping the units improperly can possibly void the warranty. If the original shipping container was not kept, contact Symbol to have another sent to you.*

Symbol Support Center

For service information, warranty information or technical assistance, call:

USA

SYMBOL SUPPORT CENTER
1-800-653-5350

Canada

Mississauga, Ontario
Canadian Headquarters
(905) 629-7226

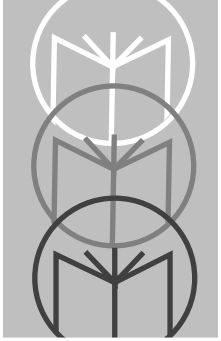
Europe

Wokingham, England
European Headquarters
0734-771-222 (Inside UK)
+44-1734-771222 (Outside UK)

Asia

Singapore
Symbol Technologies Asia, Inc.
337-6588 (Inside Singapore)
+65-337-6588 (Outside Singapore)

If you purchased your Symbol product from a Symbol Business Partner, contact that Business Partner for service.



Chapter 2 TBDriver Touchscreen Driver for DOS

Contents

Introduction

A touchscreen is one of the most technically sophisticated yet easiest to use input devices available today. Many different types are available, but the end result is the same: you touch the visual images you see, and the computer responds. A touchscreen is a hardware device which is physically attached to the computer's monitor and can accurately sense the position of a touch.

Traditionally, touchscreens were sold as a purely hardware product, and applications tended to interface directly with the hardware, sometimes with unsatisfactory results. Recognizing the disadvantages of this approach, most manufacturers do now provide drivers with their touchscreens, and virtually all modern touchscreen applications use a driver of some sort to insulate the application programmer from the worst of the low level programming. Some touchscreen drivers are relatively simple data capture and packet interpretation utilities, and do little to provide real performance, resilience and flexibility. TBdriver is at the other end of the scale, providing an extensive range of facilities and a rich Application Programming Interface. TBdriver also offers an important advantage over any other touchscreen driver. Each of the growing number of touchscreens on the market uses a different interface protocol, but TBdriver maps them all to an identical API. An application written to the TBdriver API will automatically work with any of the touchscreens TBdriver supports. That gives you, your application, and your users a valuable edge in today's tough commercial world.

TBdriver takes care of all the complexities of touchscreen initialization, interrupt handling, touch buffering, calibration, orientation, scaling and more. It presents all its functions as a logical, fully documented and consistent API, saving the application programmer a great deal of time and effort.

The major features of TBdriver are summarized below.

- Supports all touchscreens with an identical API
- Low memory overhead (around 6K)
- Written in Assembler and interrupt driven for performance
- Logical touch buffering for touch-ahead capability
- Well defined logical data stream presented to the API

- Resolves touches to application defined rectangular 'pads' if required
- Variable off-touch sensitivity
- Optional coordinate stabilization to control jitter
- Variable X, Y, Z scales and origin
- Hard and soft calibration
- Automatic re-calibration on change of video mode
- Application defined and user defined calibrations
- Automatic screen orientation adjustment
- Automatic re-initialization of touchscreen after power off / on
- Time axis - timing of stationary touches
- Applications can poll for touches, or be event driven
- Extensive API, accessible from any programming language
- Configurable API interrupt vector
- Handles COM1 - COM8 or non-standard serial port configurations
- Handles IRQ sharing and 'Global Rearming'
- Takes advantage of buffered serial port chips (16550A)
- Fully configurable communications parameters
- Touchscreen data packet validation protects against errors caused by lost interrupts and transmission errors
- Unloads from memory by command argument or API call
- Mouse emulation utility for driving DOS mouse applications
- Keyboard emulation utility for driving DOS keyboard applications
- Demonstration and calibration utility programs
- Serial data diagnostic program
- Example application source code in several languages
- Full documentation
- Support and advice from independent experts in touch

Welcome to the world of real touchscreen programming!

Getting Started

TBdriver is intended for use on IBM PC, XT, AT, PS/2 or compatibles running DOS 2.x or greater. The TBdriver distribution diskette contains the following files:

- Readme.dvr The latest information on TBdriver
- Install.exe Installation program
- TBdriver.lzh Compressed drivers and utility programs
- Extras.lzh Compressed paint drawing and prototyping tool

We recommend that you make a backup copy of the distribution diskette as soon as you receive it. To install the driver, simply insert the diskette and type:

```
driveid: install
```

where driveid is the diskette drive id. First, you will be asked to select the type of touchscreen you are using from a picklist of supported types. You are then presented with another picklist which allows you to select the pathname of the directory you wish the software to be installed and the level of installation you require. The return key toggles the selection on or off. Default installation options are as follows:

Base directory	C:\TOUCH	Base Directory
Install driver	Yes	TBdriver
Install utilities	Yes	TBdriver Utilities
Install examples	Yes	Example Applications
Install TBpad	Yes	Keyboard Emulation Utility
Professional Touch	Yes	Prototyping Tool
Install TBpaint	Yes	Paint Package

Start Installation

Select the last entry of the picklist to being installation.

The following files are installed by a full installation:

Readme.dvr	Text file containing additional information
TBdriver.exe	The DOS touchscreen driver program
TBmouse.exe	The DOS mouse emulator
TBcal.exe	The TBdriver calibration program
TBddemo.exe	The TBdriver demonstration program
TBdiag.exe	The serial data diagnostic program

In subdirectory Examples:

TBdex.pas	Pascal example source program
TBdex.exe	Compiled Pascal example
TBdex2.pas	Event driven Pascal example
TBdex3.pas	Example of driving two touchscreens
TBdex.c	C example source program
TBdex2.c	Event driven C example
TBdex.bas	Basic example source program
TBdex.cbl	Cobol example source program
Intr.obj	Software interrupt interface for Cobol
Intr.doc	Documentation for Intr.obj

In subdirectory TBpad:

TBpad.exe	The keystroke emulator
TBpad.dem	Example pad definition file
TBkey.exe	Utility to identify keyboard scan codes
Paddemo.bat	Batch file to run TBpad demonstration

In subdirectory Protouch:

Protouch.*	Professional Touch is a touchscreen application
Proedit.*	prototyping tool. See the file protouch.doc
TBgrab.exe	for full product details.
TBmousec.exe	
*.bgi	
*.chr	

In subdirectory TBpaint:

TBpaint.exe	TBpaint is a touch painting package. See
TBpaint.doc	TBpaint.doc for full product details.
*.bgi	
*.chr	

Please read the readme.dvr file as it may contain important information concerning the software which was not available in time to be included in this manual.

The 'Hardware Configuration' section contains full details on loading TBdriver, but for most purposes you simply type:

```
TBdriver c
```

where c is the number of the COM port which the touchscreen is connected to.

You must then hard calibrate the system using TBcal, option H. If you wish, you can then run TBddemo and explore the features of TBdriver by trying them.

Concepts

Application Programming Interface

TBdriver is a Terminate Stay Resident program. You load it by running it before your application, and it remains in low memory until you unload it or reboot the machine. Your application program interfaces to TBdriver by calling a software interrupt specifying the function code and parameters in the processor registers. On return from the call, the registers contain the results of the function. This is a very common type of interface mechanism under DOS, and most programming languages offer good facilities for using it. The default software interrupt used is 66 hex, but this can be altered by means of environment variable TBdint, as described in 'Hardware Configuration'.

Touch Input Data

At the most basic level, a touchscreen application needs to know the horizontal and vertical position of a finger touching the screen, and this information takes the form of a pair of X and Y coordinates, where the origin is arbitrarily pre-defined as the top left hand corner.

Experience soon shows, however, that it is useful to know a little more, such as the location of the initial point of contact, the final point of contact, or that the finger is not presently touching. TBdriver handles this by reporting a touch type with every pair of X and Y coordinates. There are four touch types:

A *First touch* is reported for the initial point of contact with the screen. Only one of these is reported for each touch.

A *Repeat touch* is reported every time the application reads the driver while the finger remains on the screen. The coordinates associated with the touch may change, of course, as the finger slides around the screen.

A *Last touch* is reported for the point at which the finger breaks its contact with the screen. Again, there can only be one of these for each touch.

A *No touch* is reported whenever the application reads the driver and the screen is not being touched. The X,Y coordinates are irrelevant to this type of response.

One of the TBdriver API calls allows the application to read the touchscreen, and this operation returns the following data:

- A touch type
- The X coordinate (left to right)
- The Y coordinate (top to bottom)
- The Z coordinate (pressure), if supported by the hardware
- The Time coordinate (see later)
- The Pad number (see later)
- The Raw coordinates

Scales and the Origin

It is useful for the application to be able to define the X and Y scales of the touch coordinates returned by the driver, for example to match the pixel resolution of the current graphics mode, or the number of lines and columns in a text mode. By default, TBdriver uses a scale of 1000 x 1000 and an origin of 0, which means that the top left hand corner is defined by coordinates 0,0 and the bottom right hand corner is defined by coordinates 999,999.

One of the TBdriver API calls allows the application to specify the scales and origin to be used. After this call, all subsequent touch coordinates will automatically be mapped to the new scales. A text mode application might, for example, define a scale of 80 x 25 with an origin of 1,1, so that TBdriver returns the line and column numbers of the character touched. A graphics application might define a scale of 640 x 350 with an origin of 0,0, in which case the driver would return the pixel coordinates touched.

Touch Buffering

Just as you sometimes want to 'type ahead' of a program on a keyboard, you sometimes want to 'touch ahead' of a program on a touch screen. The absence of this facility can be a source of extreme frustration for an experienced user who frequently inputs a lot of data.

TBdriver buffers up to 25 touches, after which the buffer wraps around, overwriting the oldest touch.

Touch buffering affects the touch types reported to the application. For example, it would make no sense to buffer repeat touches, since these are only relevant when an application is responding to them in real time. Similarly, there is no point in buffering no touches, since it makes no sense for an application to do nothing for the time it takes to read the next packet from the buffer. TBdriver only buffers first and last touches. Repeat and no conditions are only reported if they exist at the moment the application reads the driver.

The application can remain completely unaware that buffering is taking place. It simply has to know how to handle all four types of packet, and TBdriver takes care of the buffering. There are times, of course, when buffered touches would be meaningless or undesirable, so one of the API calls allows the application to flush out the touch buffer.

Calibration

A calibration procedure must be carried out to enable the driver to map the touch coordinate onto the visual image. In order for this to be done accurately at all times, two types of calibration are needed: hard calibration and soft calibration.

Hard Calibration

Hard calibration must always be performed on a newly assembled system. Hard calibration gives TBdriver vital reference information about the orientation of the touchscreen and the extents of its raw coordinates.

Hard calibration involves touching the bottom left hand corner, followed by the top right hand corner of the visual image, which gives the system sufficient information to determine the position of the four edges. TBdriver can also deduce from these two touches whether the coordinates of either axis need to be inverted in order to make the origin the top left hand corner. Some touchscreens are capable of being installed either way up on the monitor face, and TBdriver is able to compensate for this after hard calibration. After hard calibration, any touches outside the calibrated edges are assigned the appropriate edge coordinates.

In an ideal world, such a simple calibration scheme would be all that was required to ensure that the touch coordinates correctly reflected the position on the visual image at all times. Unfortunately however, when driven in different modes, many monitors display images of considerably different size, and/or in different positions on the CRT. Normally of course this doesn't matter very much, but it is very inconvenient for a touchscreen user.

Soft Calibration

Imagine a hypothetical application which uses a graphics mode in some parts, and a text mode in others. Also suppose that your monitor displays graphics images half an inch smaller than text images, and that you hard calibrated the touchscreen in graphics mode. Everything works perfectly in graphics mode, with the program responding to touches exactly as the user expects. However, when the screen is switched to text mode, things start to go wrong. The touchscreen system thinks that the edges of the screen are a quarter of an inch away from where the user sees them, and the program starts responding to areas a quarter of an inch away from where the user is touching. Fortunately, a technique called soft calibration comes to the rescue.

Soft calibration is a means of defining different calibrations for different video modes. Again, two touches are used to define the edges of the image. The resulting coordinates are used to re-map the raw coordinates to the new edges. TBdriver provides a number of facilities for managing the different soft calibrations required in various video modes. Most cases are handled fully automatically.

Automatic Soft Calibration

The TBcal utility program supplied allows you to soft calibrate in most of the commonly used video modes, as well as any two other modes of your choice. The calibration coordinates are stored in a file called TBcalib. TBdriver reads TBcalib when it loads, and remembers all the soft calibrations stored in it. It then monitors changes in the current video mode and automatically switches to the most appropriate soft calibration if it exists in the file. If no calibration is defined for a particular mode, then the hard calibration is used.

This automatic mode is the default, and can handle virtually all situations. All you have to do is run TBcal and provide two touches for each mode. TBdriver does the rest.

User Defined Calibrations

The calibration utility program allows you to specify the video modes which are used to calibrate in the two user defined calibration modes, and also to edit the mappings of system video modes to calibration modes used by the driver. This provides a complete solution to the problem of calibration for non-standard video modes and non-standard video hardware.

API Call Soft Calibration

In order to cater for the unlikely event that an application needs to use more video modes than are handled by automatic calibration, TBdriver provides a set of API calls which allow an application to capture its own soft calibrations, store them, and activate them at any time. A pair of calls return the raw coordinates of the bottom left and top right corners of the image, based on two touches. The application can then store these coordinates, and can issue another call to activate any set of previously stored calibration coordinates. The application can therefore arrange to capture calibrations for any number of modes, store them in a file, and activate them when it puts the video system into those modes. While such user defined calibrations are active, TBdriver's automatic re-calibration is disabled, since the application is assumed to want to manage soft calibration itself. Another API call allows the application to de-activate its own soft calibrations, and return to automatic mode.

Calibration Summary

Always use TBcal to perform hard calibration when you first assemble a new system, and soft calibrate in all the video resolutions you might use. Allow TBdriver to handle soft calibration automatically unless you have a good reason for doing otherwise.

Note that the soft calibrated area cannot be larger than the hard calibrated area, so the hard calibration must be to the extreme edge of the monitor bezel.

Sensitivity

TBdriver allows you to control the amount of time it takes to register that a finger has been lifted off the screen. A setting of 1 corresponds to the shortest possible amount of time, which means the lift is recognized immediately, giving maximum sensitivity. As the sensitivity value is increased, the finger lift is detected more slowly, decreasing sensitivity. Usually, maximum sensitivity (1) is used, where areas of the screen are simply being touched, like keys on a keyboard, in a data-entry type manner.

A touchscreen can offer data entry techniques which a keyboard cannot, in particular using the ability to sense that a stylus is sliding around on the screen. For example a graphical picture of a sliding scale can be a rapid way of scanning through a list of values or items. Pieces of text or graphics can be dragged around the screen, or lines can be drawn.

When sliding on some types of touchscreen, the user's finger can accidentally lose contact with the screen, invoking an undesired response from the application. This problem can be alleviated by the application temporarily reducing sensitivity, say to a value of 3. This will cause finger lifts of very short duration to go undetected, while intentional finger lifts will still be detected reasonably quickly.

Pads

It is very common to want to match incoming touch coordinates to rectangles or other shapes displayed on the screen. For example, a touch menu screen might consist of a number of boxes inviting the user to touch one of the options. The menu program would then have to determine, from the X and Y coordinates and the current scale, which box had been touched and act accordingly. This can easily be done by the application, but it is easier and more efficient to have TBdriver do it.

An API call allows you to define the coordinates of up to 99 rectangular areas on the screen, and subsequently refer to these areas, or pads, by number. Once defined, pads can be activated and de-activated. That is, they can be made touch sensitive, or not touch sensitive. When you read the driver, you always receive a touch type and a pair of X and Y coordinates. In addition, if the coordinates fall within the bounds of a currently active pad, you also receive the pad number in one of the other registers. If the coordinates do not fall within the bounds of an active pad, you receive a pad number of zero.

So in our menu example above, you would define the option 1 box as pad 1, option 2 as pad 2, and so on, and then activate all or some of the pads. Then you read TBdriver and examine the pad number. If it is zero you might just make a rude noise and try again, but if it is non-zero, you just execute that particular option.

There is nothing to stop two active pads from having coordinates which overlap each other on the screen. If a touch falls inside the bounds of more than one active pad definition, TBdriver assigns the lowest numbered active pad number to the touch. Overlapped pads will occur in, for example, applications which make use of popup windows. The simplest way of handling this from a pad point of view is to de-activate pads which are partially or fully obscured. If you must leave overlapped pads active, you will have to assign pad numbers carefully. Pads are numbered 1 to 99, and their coordinates are defined in the current scale.

Stability

On some touchscreens, if you keep your finger stationary in contact with the screen, the reported coordinates are subject to continual slight variations, known as 'jitter'. In certain types of application, you may need to dampen this effect in order to provide a more stable visual response. An API call allows you to specify a number of coordinates which are historically averaged to dampen the effect of these slight variations. The penalty for setting this value high is of course that it takes longer for movements to be reported, since stabilized coordinates are affected by the values of a number of previous coordinates.

Stabilization is not implemented for infra-red touchscreens, which never suffer from jitter.

The Time Axis

TBdriver internally monitors the length of time that your finger remains stationary in contact with the screen, and returns it with the X, Y and Z coordinates. The Time axis adds a useful extra dimension to touch screen programming. While your finger slides around on the screen, the time axis is zero, or a small value. As soon as you hold your finger stationary, the Time axis begins to increase, at the rate of one unit per clock tick (the clock ticks 18.2 times per second). The Time axis can be used, for example, to perform some special action when the user's finger has remained stationary on a pad for a period of time.

Event Driven Applications

TBdriver allows your application to drive the touchscreen in two ways. You can 'poll' the driver to read the touch state through the Read Touches API call, or you can set TBdriver to interrupt you when a touch event occurs. This is done by giving TBdriver the address of a 'User Interrupt Service Routine' - a procedure within your application which will be called when an event occurs. An event is defined as:

- The touch buffer is not empty
- A Repeat touch and either the X or Y coordinates have changed, i.e. the finger is sliding around.
- A Repeat touch and the Z axis threshold is crossed by the rising Z coordinate.
- A Repeat touch and the Time axis threshold is crossed by the rising Time coordinate.

TBdriver handles all the tricky bits of this for you by saving all the CPU registers, swapping stacks to one provided by the application, and setting up the data segment register to point to your data space. TBdriver continues to operate normally, for example buffering touches, while the User Interrupt Service Routine executes.

Application Programming Interface

Before Calling The API

Before you make any calls to TBdriver, you must make sure that it is loaded. One very simple check you can make is to examine the address in the chosen interrupt vector. If it is zero, then TBdriver is definitely not loaded, and if you were to call this null interrupt, you would certainly crash the machine. If the address is non-zero, you can be sure that some API is loaded, although you can't be sure it is TBdriver. Usually your system will be set up such that this simple check will be quite adequate, but to be really certain, you can check the 8 bytes preceding the address pointed to by the interrupt vector. If it is truly TBdriver, then these 8 bytes will contain the string 'TBDRIVER'.

The default API interrupt vector is 66 hex, but if some other API in your system is already using this, you may change it as described in 'Hardware Configuration'. In this case your application should call the new vector.

TBdriver saves the DS register on entry to the API and restores it on exit. All other registers are destroyed.

Function: **Activate Pad**

Calling Sequence: AL=13 hex

AH=Pad number

Call API interrupt

Return Values: None

Description: Makes a pad touch sensitive. Subsequent touches within the pad are reported as such. There is no harm in activating an already active pad, but it makes no sense to activate a pad which has not yet been defined.

See Also: De-activate Pad
Define Pad
Get Pad Definition

Function: **Activate Soft Calibration Coordinates**

Calling Sequence:

AL =9

BX=X1 (Left edge)
CX=Y1 (Bottom edge)
DX=X2 (Right edge)
ES=Y2 (Top edge)
Call API interrupt

Return Values:

None

Description:

Activates soft calibration for the area defined. Subsequent coordinates are relative to this new area. The coordinates must have been obtained using the Read Soft Calibration Coordinates function.

Note that while such API call soft calibration is active, TBdriver's normal function of automatically loading soft calibrations appropriate to the current video mode is disabled.

For most purposes, the usage of this call has been superseded by the Soft Calibrate API call.

See Also:

Read Soft Calibration Coordinates
De-activate Soft Calibration
Get Current Calibration

Function: **De-Activate Soft Calibration**

Calling Sequence:
AL =10 hex
Call API interrupt

Return Values: None

Description: De-activates the soft calibration which was defined using the Activate Soft Calibration Coordinates function. Automatic calibration is resumed.

For most purposes, the usage of this call has been superseded by the Soft Calibrate API call.

See Also:
Activate Soft Calibration Coordinates
Read Soft Calibration Coordinates
Get Current Calibration

Function: **De-Activate Pad**

Calling Sequence: AL = 14 hex

AH = Pad number, or zero to de-activate all pads

Call API interrupt

Return Values: None

Description: Stops a pad from being touch sensitive, but retains its coordinates. Subsequent touches within the pad are not reported as being within the pad. Any touched area not within an active pad is reported as pad zero. An inactive pad may later be re-activated.

See Also: Activate Pad
Define Pad
Get Pad Definition

Function: **Define Pad**

Calling Sequence:
AL = 12 hex
AH = Pad number
BX = X1 (Top left)
CX = Y1
DX = X2 (Bottom right)
ES = Y2
Call API interrupt

Return Values: None

Description: Defines the coordinates of a pad, but does not activate it. The coordinates must be defined in the current scale. An already defined pad can be re-defined at any time, whether it is currently active or inactive. Pad numbers other than 1 to 99 are ignored.

See Also:
Activate Pad
De-activate Pad
Get Pad Definition

Function: **Disable Touches**

Calling Sequence: AL = 19 hex

Call API interrupt

Return Values: None

Description: Prevents further coordinates from being returned via a Read Touches API call. In the case of the Carroll Touch and Intasolve infra-red touchscreens, a command is sent to the touchscreen controller which disables touch scanning and preserves the lifetime of the infra-red LED's.

See Also: Enable Touches
Get Parameters

Function: **Enable Touches**

Calling Sequence: AL = 20 hex

Call API interrupt

Return Values: None

Description: Re-enables touches disabled by Disable Touches. In the case of the Carroll Touch and Intasolve infra-red touchscreens, a command is sent to the touchscreen controller which re-enables touch scanning.

See Also: Disable Touches
Get Parameters

Function: **Flush Buffer**

Calling Sequence: AL = 7

Call API interrupt

Return Values: None

Description: Flushes the touch storage buffer, discarding all stored touches.

Function: **Get Current Calibration**

Calling Sequence: AL=11 hex

Call API interrupt

Return Values:

AH= Current calibration mode (see below)
BX = X1 (Left edge)
CX = Y1 (Bottom edge)
DX = X2 (Right edge)
ES = Y2 (Top edge)
DI = Segment address
SI = Offset address of TBcalib file pathname as an asciiz string

Description: Returns the current state of calibration in the driver. The calibration modes are:

0	Hard	7	640 x 350
1	40 x 25	8	640 x 480
2	80 x 25	9	640 x 400
3	User defined (1)	10	800 x 600
4	User defined (2)	11	1024 x 768
5	320 x 200	255	API defined
6	640 x 200		

API defined calibration is set by the Activate Soft Calibration Coordinates function.

See Also: Read Soft Calibration Coordinates
De-activate Soft Calibration
Activate Soft Calibration Coordinates

Function: **Get Pad Definition**

Calling Sequence:

AL = 15 hex
AH = Pad number

Call API interrupt

Return Values:

AH = 1 if pad is currently active
0 if not
BX = X1
CX = Y1
DX = X2
ES = Y2

Description: Returns information about the pad.

See Also:

Activate Pad
De-activate Pad
Define Pad

Function: **Get Parameters**

Calling Sequence: AL = 3

Call API interrupt

Return Values:

AL = Stabilization factor
AH = Current origin, 0 or 1
BL = Touchscreen hardware type

- 08 AFE Safetouch (AFE protocol)
- 17 AFE Safetouch (Carroll protocol)
- 29 Brady TSD-SI
- 04 Carroll Touch Smart-Frame
- 34 Carroll Touch HBC bus controller
- 35 Carroll Touch SBC bus controller
- 19 Dale
- 33 Dynapro - Serial, not SC3
- 43 Dynapro - Serial, SC3
- 37 Dynapro - Bus, pre version J2LB5
- 42 Dynapro - Bus, post version J2LB5
- 02 Ellinor Personal Touch
- 14 Elographics Accutouch, CRC
- 11 Elographics Accutouch, Bus
- 05 Elographics AccuTouch, Serial
- 20 Elographics DuraTouch
- 12 Elographics Intellitouch, Bus
- 03 Elographics Intellitouch, Serial
- 28 ExZec SureTouch
- 07 Intasolve Touch
- 22 ISI Crystal Clear
- 10 Gunze/TST, Bus
- 09 Gunze/TST, Serial

39 Keytec Magic Touch
01 MicroTouch
06 Microvitec Touchtech
16 Mors matrix Capacitive
21 Quick Analogue Resistive
27 Quick Analogue Resistive Rev 1.2
38 Simple Matrix
36 SwacTouch 3D
41 Thomson Tubes Electronique
13 Touch Technology TekTouch
18 Touch Technology AR5000/Digitouch
25 Touch Technology PC2000 Bus
26 Touch Technology RS2000 Serial
32 Touch Technology PC5000 Bus
30 Vivid TST2900
15 Wasp TSI 5000/3
24 Wasp TSI 5000/4 BC (Bus Controller)

BH = COM port number
0 = COM1, 1 = COM2, etc.
CL = Driver major version number
CH = Driver minor version number
SI = Current X scale
DI = Current Y scale
DL = Current Z scale
ES = Current sensitivity
DH = Touch state
1 = Touches currently disabled
0 = Touches currently enabled

Description: Returns miscellaneous parameters currently in use by the driver.

See Also: Set Scale and Origin
Set Sensitivity
Set Stabilization

Function: **Hard Calibrate**

Calling Sequence:

AL=4
Call API interrupt
AL=5

Call API interrupt

Return Values: (after second call)

AH = 0 means success, any other value means failure

Note: These two calls must be used as a pair and in the correct order.

Description:

After the first call has been issued, the screen should be touched in the bottom left hand corner. The first call will wait for this, and will only return when it has been performed.

After the second call has been issued, the screen should be touched in the top right hand corner. The second call will wait for this, and will only return when it has been performed.

Note that no coordinates are returned to the application, since hard calibration is entirely the domain of the driver. The new hard calibration will be permanently stored by TBdriver.

Function: **Non-Destructive Read**

Calling Sequence: AL = 27 hex

Call API Interrupt

Return Values: As for Read Touches

Description: Identical to Read Touches, but does not de-queue touch states from the internal buffer.

See Also: Read Touches

Function: **Packet Counts**

Calling Sequence:

AL = 21 hex
AH= 1 to reset the packet count to zero
0 to preserve the packet count

Call API interrupt

Return Values:

BX = Number of packets received

Description:

Provides a count of the number of physical touch packets received from the touchscreen. This may be used to determine the relative performance of various different types of touchscreen.

Function: **Read Soft Calibration Coordinates**

Calling Sequence:
AL = 8
Call API interrupt
AL = 8
Call API interrupt

Return Values: (After each call)

BX =X coordinate
CX =Y coordinate

Description: After the first call has been issued, the screen should be touched in the bottom left hand corner. The first call will wait for this, and will only return when it has been performed.

After the second call has been issued, the screen should be touched in the top right hand corner. The second call will wait for this, and will only return when it has been performed.

The touches should be at the extreme edges of a full screen image. The two pairs of coordinates obtained may be stored in a file by the application, and activated when required by calling Activate Soft Calibration Coordinates.

For most purposes, the usage of this call has been superseded by the Soft Calibrate API call.

See Also:
Activate Soft Calibration Coordinates
De-Activate Soft Calibration
Get Current Calibration

Function: **Read Touches**

Calling Sequence: AL = 1

Call API interrupt

Return Values:

AH = Touch type F,L,R, or N
AL = Z coordinate, if applicable
BX = X coordinate
CX = Y coordinate
DX = Pad number
SI = Time coordinate
DI = Raw X coordinate
ES = Raw Y coordinate

Description: This function immediately returns one of the touch types specified. If the application is lagging behind the touches, either an F or an L will be returned from the buffer. If the application is keeping up with the touches, any of the four types are possible. The X and Y coordinates are always returned, scaled to the current scale.

If the coordinates fall within the bounds of an active pad, the pad number is returned, otherwise a pad number of zero is returned. The Z coordinate is always zero for touchscreens which do not have a Z axis. The Time coordinate is the number of clock ticks that a stylus has remained stationary in contact with the screen. The X,Y,Z values and pad number are undefined and irrelevant for 'N' touch types.

Function: **Reset Touchscreen**

Calling Sequence: AL=23 hex
Call API interrupt

Return Values: AL=1 if successful

0 if unsuccessful

Description: Performs initialization of the touchscreen controller, in the same way as is automatically performed when TBdriver loads. The actions performed depend on the hardware in use. In some cases no initialization is necessary, so none is performed.

Function: **Set Scale and Origin**

Calling Sequence:

AL = 2
AH = New origin
BX = New X scale
CX = New Y scale
DL = New Z scale

Call API interrupt

Return Values: None

Description: The new scales and origin are stored in the driver, and will be effective for as long as the driver remains in memory, or until they are changed again. The new origin will be applied to the X and the Y axis. Any existing pad definitions will not be re-mapped to the new scales, and so would probably become meaningless.

The Z axis may be scaled in the range 1 to 15, but always has an origin of 1. If a Z scale greater than 15 is specified, it is set to 15.

Any scale specified as zero retains its previous value.

See Also: Get Parameters

Function: **Set Sensitivity**

Calling Sequence: AL = 6

BX = Sensitivity value

Call API interrupt

Return Values: None

Description: Sets the number of clock ticks required to register a finger lift. By default, this is initially set to the most appropriate value for the hardware in use. There is no maximum value, but greater than about 5 makes the screen noticeably unresponsive. A value of 3 improves 'sliding'.

Setting sensitivity to zero returns the setting to the default value for the touchscreen installed.

See Also: Get Parameters

Function: **Set Stabilization**

Calling Sequence: AL = 18 hex

AH = Stabilization factor

Call API interrupt

Return Values: None

Description: Sets the number of touch coordinates from the hardware which are averaged to produce stabilized values. By default, this is initially set to the most appropriate value for the hardware in use. A value of 0 implies no stabilization is to be performed. The maximum value is 10, which means that every coordinate is the average of the preceding 10 coordinates received. Values above 10 are taken as 10.

See Also: Get Parameters

Function: **Set Event User ISR**

Calling Sequence:

AL	=	22 hex
AH	=	0
CH	=	Z axis threshold
CL	=	Time axis threshold
ES	=	Segment address of user ISR
BX	=	Offset address of user ISR
DI	=	Segment address of user stack
SI	=	Offset address of user stack
DX	=	Segment address of user data segment

Return Values: None

Description: Sets the address of a User Interrupt Service Routine to be called when a touch event occurs. There are four types of touch event:

- The touch buffer is not empty
- A Repeat touch and either the X or Y coordinates have changed, i.e. the stylus is sliding around.
- A Repeat touch and the Z axis threshold is crossed by the rising Z coordinate.
- A Repeat touch and the Time axis threshold is crossed by the rising Time coordinate.

Note that the user ISR is never called in a No touch situation, and is only called in a Repeat touch situation when the X or Y coordinates have changed, or if the Z or T axis thresholds are reached. The application is thus truly event driven.

If the Time axis threshold is zero, no Time axis events will occur. The same applies to the Z axis threshold. The Z axis threshold must be supplied in the scale 1 to 15.

If a user stack is specified, TBdriver will switch to the user stack prior to calling the user ISR. If DI is zero, no stack switch will occur. It is highly recommended to specify a user stack, especially if the user ISR is written in a high level language.

Prior to calling the user ISR, TBdriver will automatically load the DS register with the user data segment address specified here in register DX. The application will therefore have access to its variables immediately upon invocation.

TBdriver saves all registers prior to calling the user ISR, and restores them after the call. The ISR is called with interrupts enabled. It must exit with a far return.

The user ISR is simply called when a touch event occurs, and no details of the event are passed to it. The ISR must therefore call Read Touches to determine the touch event. It may also make any other TBdriver API calls, since the API is fully reentrant. However, it must not make any DOS or BIOS calls, and care must be taken not to re-enter any non-reentrant parts of the application. TBdriver will not re-enter the user ISR.

The user ISR is not called if its segment address is zero. The application must reset the user ISR address to zero before terminating.

The example program TBdex2.pas uses this feature.

Function: **Set Pre-Processing User ISR**

Calling Sequence:

AL	=	29 hex
AH	=	Call mask
00000001	for First touches	
00000010	for Last touches	
00000011	for both First and Last touches	
ES	=	Segment address of user ISR
BX	=	Offset address of user ISR
DI	=	Segment address of user stack
SI	=	Offset address of user stack
DX	=	Segment address of user data segment

Call API Interrupt

Return Values: None

Description: Sets the address of a User Interrupt Service Routine to be called immediately a First or Last touch occurs.

The Pre-processing User ISR has a different function from the event processing user ISR setup by function call hex 22. It is immediately called once for each First and Last touch as it occurs, regardless of the state of the touch event buffer. The application can therefore be aware of whether the screen is being touched, or provide audio feedback, ahead of the actual de-queuing and processing of touches.

If a user stack is specified, TBdriver will switch to the user stack prior to calling the user ISR. If DI is zero, no stack switch will occur. It is highly recommended to specify a user stack, especially if the user ISR is written in a high level language. If the event user ISR facility is also used, the two ISR's may specify the same stack, since they will never be inter-called.

Prior to calling the user ISR, TBdriver will automatically load the DS register with the user data segment address specified here in register DX. The application will therefore have access to its variables immediately upon invocation.

TBdriver saves all registers prior to calling the user ISR, and restores them after the call. The ISR is called with interrupts enabled. It must exit with a far return.

The user ISR is called with the AL register equal to 'F' for a First touch, or 'L' for a Last touch. BX and CX are the X and Y coordinates of the touch. The user ISR may make any TBdriver API calls, since the API is fully reentrant, although it would be illogical to de-queue touches. It must not make any DOS or BIOS calls, and care must be taken not to re-enter any non-reentrant parts of the application. TBdriver will not re-enter the user ISR, or inter-call the Pre-processing user ISR and the Event user ISR.

The user ISR is not called if its segment address is zero. The application must reset the user ISR address to zero before terminating.

TBddemo has two options which demonstrate this feature. Option 'K' sets a pre-processing user ISR which beeps and displays the touch event in the bottom right hand corner of the screen. Option 'L' disables the ISR, as does exiting the program.

Function: **Soft Calibrate**

Calling Sequence:
AL = 0A hex
Call API interrupt
<First touch>
AL = 0B hex
AH = 0 for calibration using extreme corners
1 for calibration using points 20% in
BL = 0 (reserved for future use)
Call API interrupt
<Second touch>

Return Values:
(Both calls)
AH = 0 if successful
1 if BL not 0 on entry
2 if current video mode unsupported
3 if AH not 0 or 1 on entry
4 if not hard calibrated yet
5 if touches too close
6 if user aborted by pressing a key
7 if no touch after 30 seconds

Description:
These two calls simplify the implementation of soft calibration routines in applications. The Read Soft Calibration Coordinates, Activate Soft Calibration Coordinates, De-Activate Soft Calibration, and Update Soft Calibration Coordinates API calls are no longer required as these new, simpler calls should be used instead.

The first call waits for a touch either at the bottom left corner of the screen or 20% away from it, returning when the touch is removed. The second call waits for a touch either at the top right of the screen or 20% away. If the touches are acceptable, TBdriver updates the TBcalib file and activates the new calibration. The calibration mode updated is defined by the video mode mapping table described in the 'Co-existence with Mice' section.

Before the first call, the application should direct the user to touch a point displayed at the bottom left of the screen, or 20% away from it. On return from the first call, the application should clear the point drawn at the bottom left and draw a new one at the top right. On return from the second call, calibration is complete. It is usually more accurate to use calibration points 20% away from the edges of the extreme corners, the location of the points being:

First point (20% from bottom left): Xmax * 20 / 100, Ymax * 80 / 100

Second point (20% from top right): Xmax * 80 / 100, Ymax * 20 / 100

Function: **Unload**

Calling Sequence: AL = 16 hex

Call API interrupt

Return Values: AH = 1 if successfully unloaded
0 if unable to unload

Description: Restores interrupt vectors and returns TBdriver's memory to DOS. Unloading is not possible if any of TBdriver's interrupt vectors have been 'hooked' by another program.

Function: **Update Soft Calibration**

Calling Sequence:

AL = 24 hex
AH = Calibration mode
BX = X1 (Left edge)
CX = Y1 (Bottom edge)
DX = X2 (Right edge)
ES = Y2 (Top edge)

Call API interrupt

Return Values: None

Description: Updates the soft calibration held in memory within TBdriver for the calibration mode specified, replacing the values loaded from the TBcalib file. If the specified mode matches the current video mode of the system, the new calibration takes effect immediately. The calibration mode numbers are the same as those defined for the Get Current Calibration call.

For most purposes, the usage of this call has been superseded by the Soft Calibrate API call.

Notes: The application is responsible for updating the TBdriver calibration file, TBcalib, if the new calibration co-ordinates are to be preserved for the next loading of TBdriver.

Loading and Unloading TBDRIVER

The TBdriver Command Line

```
TBdriver[Port] [/A:addr] [/C:bbbb,p,d,s] [/D] [/H] [/G]
[/I:irq] [/S:nn] [/T:nn] [/E:hhhhh...] [/V] [/NI]
```

Port	Specifies a serial port (1 .. 8)	
	/A:addr	Port address (0000 - FFFF hexadecimal)
	/C:bbbb,p,d,s	Communications parameters. Can be used to override the default baud, parity, databits and stopbits:
	bbbb	Baud rate (1200, 2400, 4800, 9600)
	p	Parity (N, O, E)
	d	Databits (7, 8)
	s	Stopbits (1, 2)
	/D	Disable automatic re-initialization
	/H	Standard IRQ sHaring
	/G	IRQ sharing with Global rearming
	/I:irq	Interrupt request number (0 .. 15)
	/S:nn	Sensitivity value (1 .. 20)
	/T:nn	Stabilization factor (0 .. 20)
	/E:hhhhhh...	Extra initialization. Specifies additional hex characters to be sent to the touchscreen after normal initialization. Serial touchscreens only.
	/V	Use clock vector 1C instead of 8.
	/NI	No touchscreen initialization to be performed.

TBdriver /? Prints the above summary

TBdriver U Unloads TBdriver from memory

Most of these options are only rarely required. In most cases all that is required is simply:

TBdriver 1 For a touchscreen on COM1, or:

TBdriver 2 For a touchscreen on COM2.

Non-Standard Serial Port Configurations

TBdriver also supports COM3 to COM8, although these are not as well defined as COM1 and COM2. By default, TBdriver defines the COM ports as follows:

COM1:	Port Address 3F8	IRQ 4
COM2:	Port Address 2F8	IRQ 3
COM3:	Port Address 3E8	IRQ 5
COM4:	Port Address 2E8	IRQ 2
COM5:	Port Address 4220	IRQ 3
COM6:	Port Address 4228	IRQ 3
COM7:	Port Address 5220	IRQ 3
COM8:	Port Address 5228	IRQ 3

In order to provide complete flexibility of serial port configurations, TBdriver allows the port address and IRQ number to be overridden explicitly using the /a and /i parameters. For example:

```
TBDRIVER 5 /A:748 /I:10
```

Defines a COM port at address 748 on IRQ 10

In practice, usage of COM3 to 8 will often require explicit specification of the port address and IRQ.

BIOS COM Port Base Address Table

Normally, when TBdriver loads, it zeros out the entry in this table for the COM port in use, and restores it when it unloads. However, it only does this for COM1 to COM4, and then only if the address in the BIOS table matches the actual port address in use. So if, for some reason, you wanted to load TBdriver on COM1 without zeroing out the BIOS COM table, you could do so by loading "TBdriver 5 /a:3F8 /i:4".

Bus Controller Configurations

For bus controller touchscreens, the COM port parameter is ignored, and TBdriver will default to the factory settings of port address and IRQ. Again, the /a and /i parameters may be used to specify unusual configurations.

Automatic Re-initialization

Some touchscreen controllers require a software initialization sequence to set them into the required operating mode, and TBdriver always performs this when it loads. When the controller is serially connected and external to the PC, there is always the possibility that the user will power the touchscreen controller off and on, particularly if the controller is located inside the monitor. The controller will then power up uninitialized and will not work.

For certain touchscreens then, TBdriver monitors the Clear To Send RS232 signal in an attempt to detect if the controller is powered off and on. On a low to high transition of CTS, TBdriver automatically initiates the controller initialization process. This usually has the effect of recovering from a touchscreen controller power off/on within a few seconds. However, certain conditions can cause this process to be falsely triggered, and hence this feature can be switched off by specifying the /D parameter when loading TBdriver. Please note that while TBdriver is attempting to re-initialize the touchscreen, it can cause the system to slow down considerably.

Communications Parameters

TBdriver chooses default communications parameters which are either the only ones supported by the touchscreen, or which will be automatically recognized by the touchscreen, or which can be used with the switch settings defined in Appendix B. The TBdriver Install program displays the default communications parameters after completing installation. You may wish to change the communications parameters to support different switch settings, or even to reduce the communications overhead. This can be done using the /C parameter. For example:

`TBDRIVER /C:4800,o,7,1` Use 4800 baud, odd parity, 7 data bits, 1 stop bit.

Note that all elements of the /C parameter must be specified.

Sensitivity and Stabilization

TBdriver chooses default stabilization and sensitivity values to give optimum performance for the touchscreen in use. You can determine the default values by loading TBdriver and running TBddemo, which displays the current stabilization and sensitivity settings. If required the /S and /T parameters can be used to override the default initial settings. This has no effect on subsequent **Set Sensitivity** or **Set Stabilization** API calls.

Shared IRQ's and Global Rearming

For serial touchscreens only, TBdriver supports the ability for more than one COM port to share the same IRQ. For hardware reasons, this only works when the hardware is designed to support IRQ sharing, for example on multiport serial adapter cards. IRQ sharing cannot be made to work by simply switching two ordinary COM ports to the same IRQ.

When TBdriver is loaded with /H, it processes any data available at its serial port, if any, and then calls any other interrupt service routines which were loaded before it on the same IRQ. It does not send an EOI to the PIC. When loading multiple TBdrivers on the same IRQ, the first should be loaded without /H, so that it performs an EOI and a simple IRET. Subsequent TBdrivers should be loaded with /H. For example:

```
TBdriver /a:740 /i:10       Load first TBdriver on irq 10

set TBdint=65               Change the TBdriver API vector

set TBdpath=c:\touch2       Change the calibration file path

TBdriver /a:748 /i:10 /h    Load second TBdriver on irq 10
```

The example program TBDEX3.PAS shows an example of using two TBdrivers.

Interrupts may be shared with non-sharing-aware applications, by loading the non-sharing-aware application before TBdriver, and then loading TBdriver with /H.

The Global Rearm IRQ-sharing mechanism found on an increasing number of machines is also supported, using the /G parameter. If Global Rearm IRQ-sharing is required, /G should be specified instead of /H. /G and /H are mutually exclusive.

Location of the Calibration Data File

TBdriver maintains a calibration data file called TBcalib, which it must be able to locate when it loads. If TBcalib does not exist when TBdriver loads, it is created, with null calibration data. It will then be necessary to recalibrate.

Unless the environment variable TBdpath is used, the file is located in the directory which is current when TBdriver loads. Unless you use the TBdpath environment variable, you must always load TBdriver from the same current directory, in order that TBdriver can locate the TBcalib file.

If an invalid TBcalib file is detected when TBdriver loads, it is automatically deleted, and a message displayed. This happens when you change touchscreen type, or when the TBcalib file format changes due to an upgrade.

Environment Variables

If TBdriver is loaded with no parameters, the default COM port number is 1, but this can be changed by means of environment variable TBdcom, for example, the DOS command:

```
SET TBdcom=2
```

would change the default COM port number to 2. Note that a value specified on the TBdriver command line takes precedence, if specified.

The default software interrupt vector number of 66 hex may be changed by environment variable TBdint, for example, the DOS command:

```
SET TBdint=63
```

would change the software interrupt vector number to 63 hex. There is no command line argument to override this. Values of 60 to 66 hex are allowed.

The location of the calibration data file can be specified by environment variable TBdpath, for example, the DOS command:

```
SET TBdpath=c:\
```

would cause TBdriver to always locate the TBcalib file in the root directory.

If any of the environment variables are set to invalid values, they are ignored, and the normal defaults apply.

Unloading TBdriver

To unload TBdriver from memory, type:

```
TBdriver u
```

TBdriver Messages

TBdriver made resident

TBdriver loaded successfully.

TBdriver Unloaded

TBdriver is being unloaded from memory at your request.

Invalid COM port number

You specified a value other than 1 to 8 as a command line argument when you attempted to load TBdriver.

Hard calibration is required

TBdriver loads successfully, but cannot find file TBcalib. No hard calibration will be active. The touchscreen will work, but the coordinates will not match the display. Use TBcal to perform hard calibration.

Can't unload - not loaded

You requested TBdriver to unload, but it is not loaded, or is loaded for an API interrupt vector which is not the current value of TBdint.

Can't unload - vectors have been hooked

You requested TBdriver to unload, but another Terminate Stay Resident program has been loaded after TBdriver, and has hooked interrupt vectors used by TBdriver. Unload the second TSR first, then you can unload TBdriver.

Can't load - already loaded

You tried to load TBdriver when it is already loaded. Use environment variable TBdint to specify a different API vector if you wish to load a second TBdriver.

API interrupt vector already in use

The interrupt vector you are asking TBdriver to use is already in use by another program. You will have to use environment variable TBdint to specify a different vector.

Touchscreen controller not responding

The driver is unable to communicate with the touchscreen controller hardware. Check that it is properly connected and powered on.

Invalid TBcalib file deleted

The TBcalib file was created for a different type of touchscreen, or was created by an old version of TBdriver. It has been deleted and a new one created with null calibration data. Re-calibrate using TBcal.

Unable to create calibration file

Could be caused by insufficient disk space, or an invalid TBdpath environment variable.

Touchscreen controller reports bad status

Some touchscreens report possible hardware problems when they are initialized. TBdriver attempts to continue.

Invalid address parameter

The address specified with the /a control argument was not a valid hexadecimal address in the range 0 - FFFF.

Invalid IRQ parameter

The IRQ specified with the /i control argument was not a valid decimal number in the range 0 to 15.

Invalid /S value

The value specified for the /S parameter was not a valid decimal number in the range 1 to 20.

Invalid /T value

The value specified for the /T parameter was not a valid decimal number in the range 0 to 20.

Invalid /C parameters

You did not correctly specify all the components of the /C parameter. All components must be specified in the form /C:bbbb,p,d,s where bbbb is 1200, 2400, 4800 or 9600, p is N, O or E, d is 7 or 8, and s is 1 or 2.

/H and /G are mutually exclusive

You specified both the /G and the /H parameters. /H is for normal IRQ-sharing, and /G is for IRQ-sharing with Global Rearming. You do not need to specify both parameters.

TBdriver Return Codes

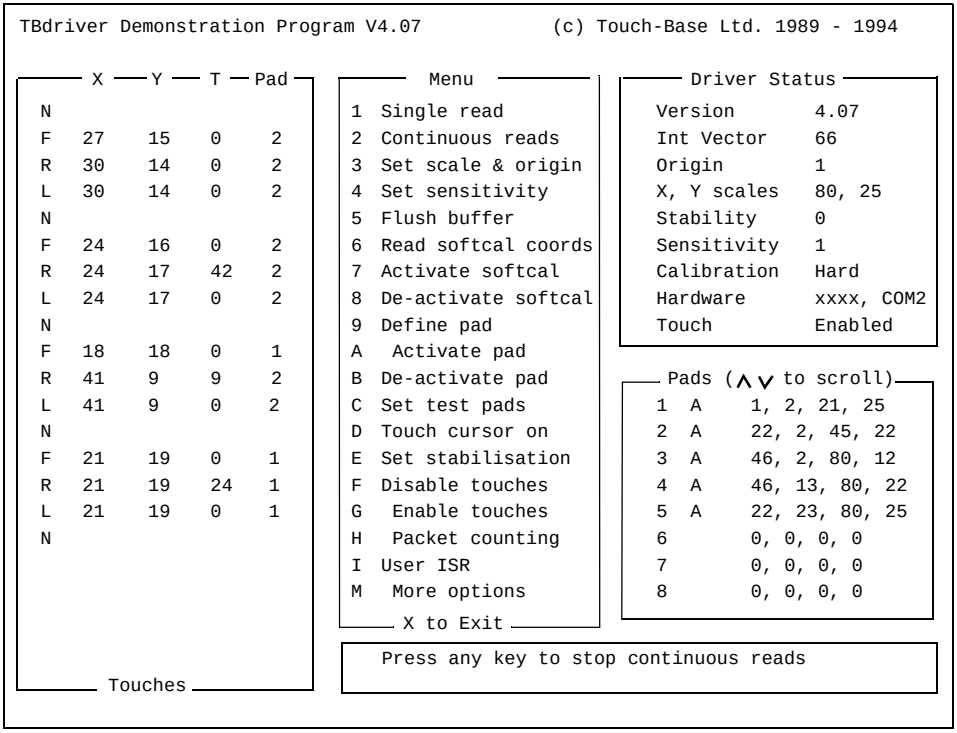
If the driver fails to load an error code is returned so that batch files can determine the driver status with an IF ERRORLEVEL statement.

Returned error codes are as follows:

0 - Loaded/Unloaded OK
1 - Driver already loaded
2 - Can't unload, not loaded
3 - Can't unload, vectors hooked
4 - API vector in use
5 - Invalid COM port number
6 - Controller not responding
8 - Unable to create calibration file
9 - Invalid address parameter
10 - Invalid IRQ parameter
11 - Invalid /S parameter
12 - Invalid /T parameter
13 - Invalid /C parameter

The TBdriver Demonstration Program

The supplied utility program, TBddemo, can demonstrate almost all the features of TBdriver. To run TBddemo, first load TBdriver, then TBddemo. The following screen is displayed:



Selecting 'M' for more options reveals four further options. 'J' performs a touchscreen Reset, 'N' performs a Non-Destructive Read, 'K' sets up a built in Pre-Processing User ISR, and 'L' disables the built in Pre-Processing User ISR.

When the program loads, it makes use of the **Get Parameters**, **Get Pad Definition**, and **Get Current Calibration** functions to display the current state of the driver in the status and pads windows.

Single Read

This option performs a single Read Touches function, and displays the resulting information in the touches window. A new line is only written to the touches window when the touch type changes, otherwise the current line is overwritten.

Continuous Reads

This option performs the **Read Touches** function continuously until a key is pressed on the keyboard. The information returned from each read is displayed in the touches window. This function provides a good example of the type of touch data stream handled by a polling application.

Set Scale and Origin

Allows you to enter the X and Y values for a new scale, and 0 or 1 for the new origin, then calls the **Set Scale and Origin** function. If the touchscreen supports a Z axis, the new Z scale may also be entered.

Set Sensitivity

Allows you to enter the new sensitivity value, then performs the **Set Sensitivity** function.

Flush Buffer

Performs the **Flush Buffer** function.

Read Soft Calibration Coordinates

Invites you to touch the bottom left, then the top right corners of the area to be soft calibrated, in order to perform a pair of **Read Soft Calibration Coordinates** functions. The resulting coordinates are then displayed for you to write down (just as an application would have to store them in a file). You may wish to soft calibrate a small subset of the screen in order to see an exaggerated example of soft calibration.

Activate Soft Calibration

Invites you to enter the soft calibration coordinates you wish to activate, then performs the **Activate Soft Calibration Coordinates** function. For convenience, the coordinates last obtained using the previous option are defaulted, but you may change them if you wish.

Deactivate Soft Calibration

Performs the **De-activate Soft Calibration Coordinates** function.

Define Pad

Allows you to enter a pad number and the coordinates which apply to the pad, then performs the **Define Pad** function.

Activate Pad

Allows you to enter a pad number then performs the **Activate Pad** function.

Deactivate Pad

Allows you to enter a pad number then performs the **De-activate Pad** function.

Set Test Pads

Forces the scale to 80 x 25, then defines and activates five pads to fit the five windows of TBddemo. If you then select the *continuous reads* option, you can see the pad number being returned as you touch or slide around the screen. Better still, switch on the *touch cursor* first.

Touch Cursor On

Forces the scale to 80 x 25, then enables a cursor which follows the current X and Y coordinates. When the cursor is on, this option changes to Touch cursor off, so repeated selection of this option toggles the cursor on and off. Note that the cursor is a function of TBddemo, not TBdriver.

Set Stabilization

Allows you to enter a new value for stability averaging in the range 0 to 10, then calls the *Set Stabilization* function.

Disable Touches

Performs the *Disable Touches* function.

Enable Touches

Performs the *Enable Touches* function.

Packet Counting

Like the continuous reads option, this option performs the **Read Touches** function until a key is pressed on the keyboard. After each call to **Read Touches**, it calls the **Packet Counting** function and updates the packet count, elapsed seconds, and packets per second in the Packet Counts window.

User ISR

This option calls the **Set Event User ISR** function, passing the address of a built-in user ISR routine, then simply waits for a key to be pressed on the keyboard. When a key is pressed, Set **Event User ISR** is called again with a null ISR address. The built-in user ISR performs the **Read Touches** function and displays the result in the Touches window, and moves the cursor if it is switched on. Unlike the continuous reads option though, the user ISR always writes a new line for each event. This demonstration conveys the event driven nature of the user ISR - notice that No-touch states are not reported, nor are Repeat-touch states when there has been no movement. Also remember that the foreground application could be doing some useful work here, whereas in this demonstration it is simply looping waiting for a key to be pressed.

Reset Touchscreen

Performs the **Reset Touchscreen** function

Scroll pads

The up and down arrow keys allow you to scroll the pads window, so that you can examine all presently defined pads.

Non-Destructive Read

Performs the **Non-Destructive Read** API Call.

Set Pre-Processing User ISR

This option calls the **Set Pre-Processing User ISR** function, passing the address of a built-in user ISR routine, then returns to normal menu processing. The built-in user ISR simply beeps and displays the touch event in the bottom right hand corner of the screen

Disable Pre-Processing User ISR

This option calls the **Set Pre-Processing User ISR** function, passing a null address.

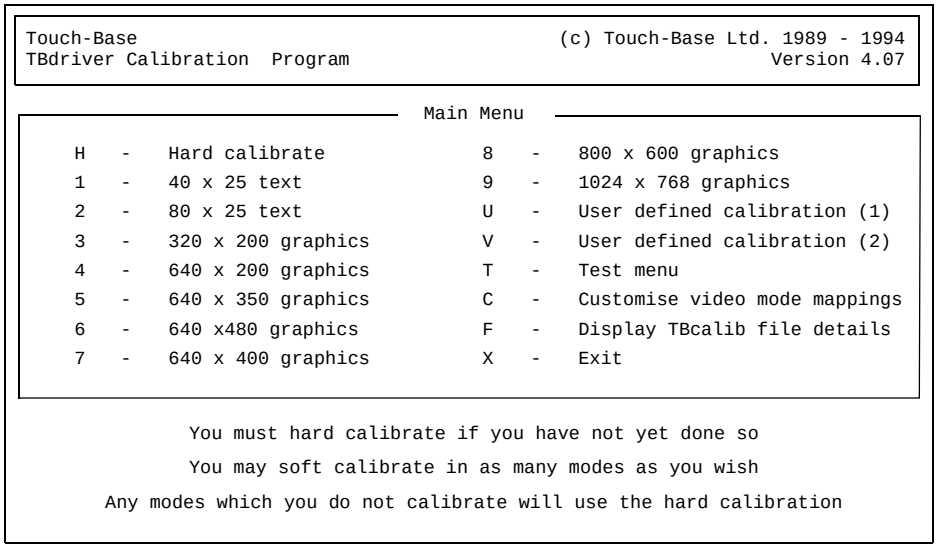
Exit

Terminates TBddemo.

The TBdriver Calibration Program

The supplied utility program, **TBcal**, should be used to perform hard calibration and, optionally, soft calibration for various video resolutions. The 'Concepts' section describes the need for soft calibration. Soft calibrations defined using TBcal are automatically loaded by TBdriver when the system changes into the appropriate video modes. To calibrate matrix touchscreens refer to the 'Matrix Touchscreens' section.

To run TBcal, first load TBdriver, then TBcal. The following menu screen is displayed:



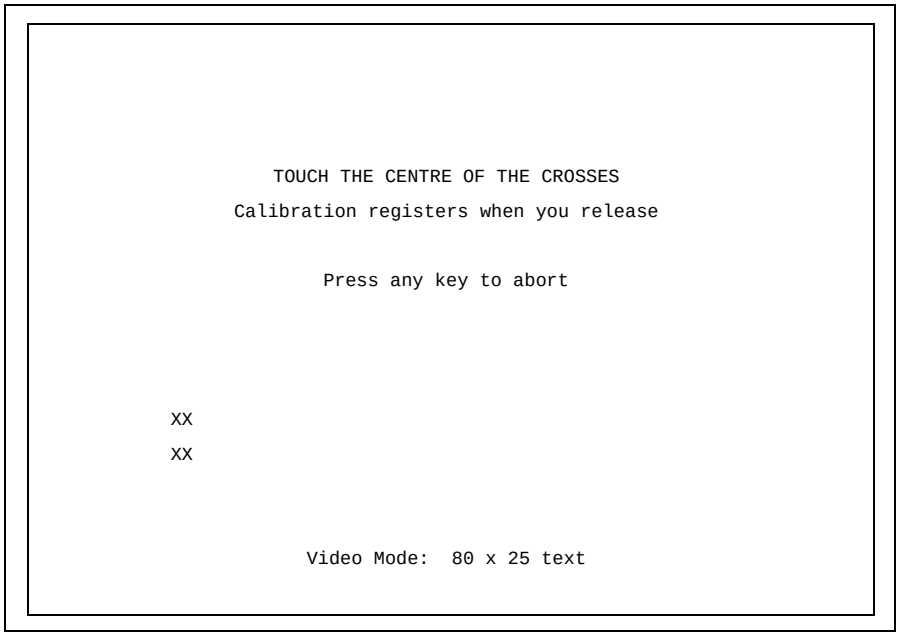
You must always hard calibrate after installation, and may optionally soft calibrate in any video modes you may be going to use. Any new calibrations take immediate effect and are also stored in the TBcalib file. All standard resolutions are supported, as are Super VGA modes up to 1024 x 768, as well as two "user defined" resolutions.

Hard Calibrate

Invites you to touch the bottom left, then the top right corners of the screen, in order to perform hard calibration. Note that whenever you hard calibrate you should also perform the soft calibration procedure(s), because the soft calibrations are relative to the hard calibration.

Options 1 - 9

Sets the system into a video mode with the resolution shown, then invites you to touch a point near the bottom left corner of the screen, followed by a point near the top right corner of the screen. These points are actually 20% in from the true edges, in order to obtain the best linearity. For example:



Options U and V

These options allow you to calibrate in any two other resolutions not shown on the menu. Before using either of these options, you must define the video mode to be used using the **Customize video mode mappings** option.

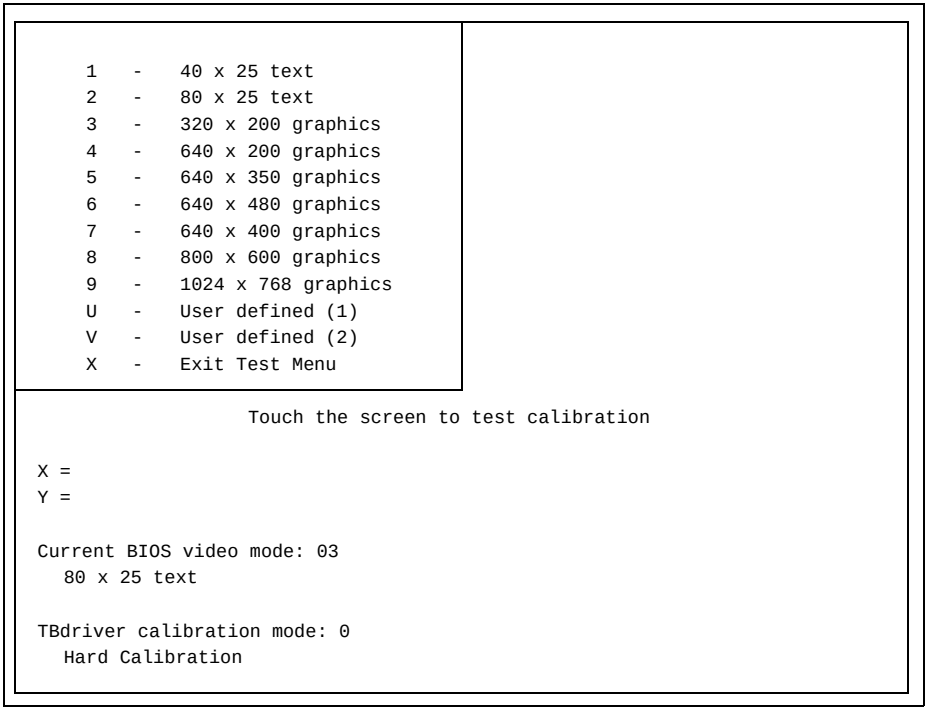
Option X

Option X terminates TBcal, and updates TBdriver and the TBcalib file.

Option F

Option F displays the contents of the TBcalib file. This may be used to see which resolutions have been calibrated.

Test Menu



In this example, the system is currently in an 80 x 25 text mode, but TBdriver is using its hard calibration because no soft calibration has been defined for 80 x 25 text. You can now test how accurately your touches match the video image by observing the touch cursor as you touch the screen.

The menu options allow you to do the same for the other resolutions. Advanced users may also press M to enter a hexadecimal BIOS mode number.

Note that if the visual image is larger than the touch sensitive area, you may not be able to invoke a response right up to the edges of the image.

Customize Video Mode Mappings

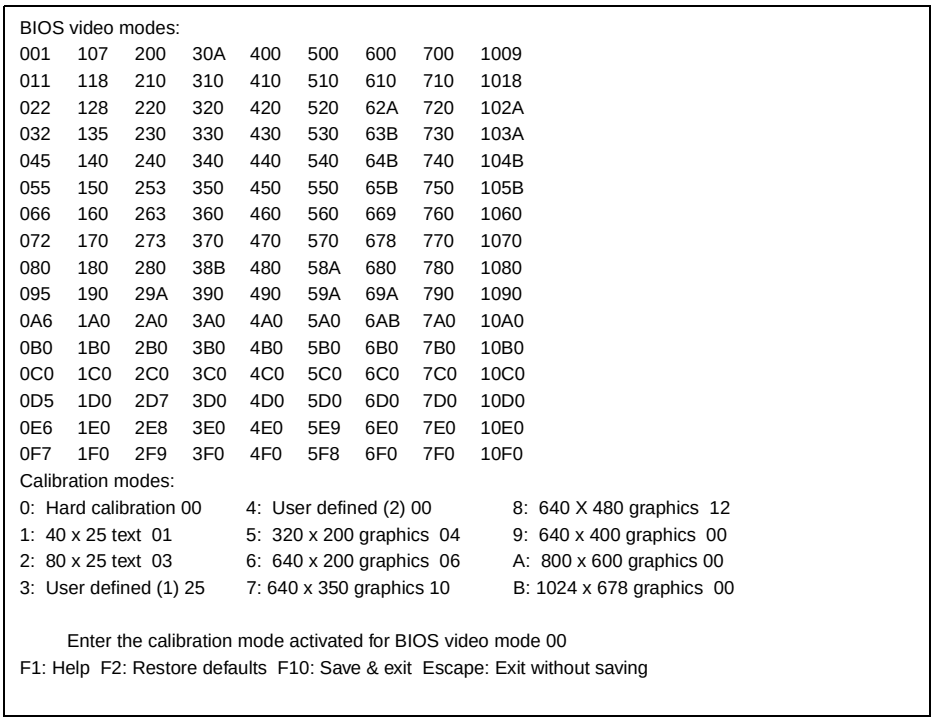
TBdriver constantly monitors the system for video mode changes. When a mode change occurs, TBdriver switches over to using the most appropriate calibration coordinates for the new mode. The mapping of video mode numbers to TBcalib modes is straightforward for the standard IBM defined video modes, but less well defined for higher resolution modes.

On the Customize Video Mode Mappings screen, the top table controls TBdriver's mapping of BIOS video modes to calibrations for every BIOS video mode from 0 through 7F and 100 through 10F (the VESA modes). Modes 0 to 13h are IBM defined standards, but for higher resolutions each video card manufacturer uses different BIOS mode numbers. The default settings correctly handle VESA modes and non-VESA modes for Paradise, Tseng, Video-7, and Trident chip-sets up to 1024 x 768. If you are using high resolution graphics modes on video cards other than these, you may need to alter the mapping of BIOS video modes to calibration modes.

The lower table controls the video modes used by TBcal to perform and test calibration for each resolution. Again, the IBM standards are used for resolutions up to 640 x 480. The zero values for the Super VGA modes invoke TBcal's auto-detection of VESA, Paradise, Tseng, Video-7, and Trident, for which suitable video modes are defaulted at run-time. The zero value for hard calibration causes TBcal not to change video modes when hard calibrating.

The user defined calibration modes may be used to handle any two other resolutions you may be using. In this case, you must define the video mode to be used for calibration / testing, and the BIOS video modes which TBdriver should map to the user defined calibrations.

Changes to the mode mapping table take effect the next time TBdriver is unloaded and reloaded. Changes to the calibration mode table are effected by TBcal immediately.



In the example screen above, BIOS video modes 25, 26 and 27 have been mapped to User defined calibration mode 1, which performs and tests calibration in BIOS video mode 25.

The Arrow keys, Tab, and Enter move the cursor around the table.

Home moves to the first field. End moves to the last field. F1 displays a help screen. F10 updates the tables in the TBcalib file, and exits back to the main menu. F2 restores the default values. Escape exits back to the main menu without updating TBcalib.

Application Controlled Calibration

The **Hard Calibrate** and **Soft Calibrate** API calls should be used by applications requiring their own calibration routines. Using these calls, there is no requirement for applications to update the TBcalib file directly. However, the format of the TBcalib file is available on request.

Troubleshooting and Technical Support

In case of difficulty, the following checks should be made before calling technical support:

No cursor movement when touchscreen touched

- Check that the touchscreen has power, and that its communication cable is connected to the computer.
- Check that the switch settings, if any, are set as specified in Appendix B.
- Check that you selected the correct driver for your touchscreen during installation.
- Check that the TBdriver hardware configuration is set up correctly. For serial touchscreens check that TBdriver is configured for the correct serial port number. For COM3, COM4, and bus controller touchscreens, check that the port address and IRQ are configured to match the hardware switch or jumper settings. Also check for port address or IRQ conflicts with other cards in the system.

Cursor moves but incorrectly

- Check that you have calibrated, and that TBdriver still has access to the TBcalib calibration file, either in the current directory, or via the environment variable TBdpath.
- If you have re-installed TBdriver for a different type of touchscreen, you will need to re-calibrate.

System performance

- If your touchscreen requires software initialization, and is powered off, TBdriver will attempt to re-initialise it every ten seconds, which may degrade system performance. This can be prevented by specifying /D when loading the driver.

TBDIAG - The Touchscreen Diagnostic Program

TBdiag is designed to assist in locating communications problems with serially connected touchscreens. If, on loading TBdriver, no data is received from the touchscreen, or if TBdriver refuses to load, try running TBdiag. Its monitor screen shows data sent to and received from the touchscreen, allowing you to see if it is responding to the initialization sequence, and if it is sending any coordinate data at all. You can re-try the initialization sequence at any time by pressing 'I', switch to hex display mode by pressing 'H', and exit by pressing 'X'. TBdiag takes several optional parameters:

The TBdiag Command Line

```
TBdiag    [Port] [/C:bbbb,p,d,s] [/A:address] [/I:irq] [/NI] [/G]
```

Port	Specifies a serial port (1 .. 8)	
/C:bbbb,p,d,s	Communications parameters:	
	bbbb	Baud rate (1200, 2400, 4800, 9600)
	p	Parity (N, O, E)
	d	Databits (7, 8)
	s	Stopbits (1, 2)
/A:address	Port address (hexadecimal)	
/I:irq	Interrupt request number (0 .. 15)	
/NI	No initialization. Do not initialize touchscreen.	
/G	Perform Global rearming	
TBdiag /?	Prints the above summary	

Most of these options are only rarely required. In most cases all that is required is simply:

TBdiag 1	For a touchscreen on COM1, or:
TBdiag 2	For a touchscreen on COM2.

Example.

`TBdiag /C:4800,e,7,2 /A:748 /I:10 /NI`

Load TBdiag on a COM port at address 748 hex, using irq 10, at 4800 baud, even parity, 7 data bits, 2 stop bits. Do not perform touchscreen initialization.

A large window shows data sent to and received from the touchscreen, while the lower window shows the status, mainly of the serial port. For example:

```
Touchscreen Diagnostic Program V4.07          (c) Touch-Base Ltd. 1989 - 1994

Send
Recv 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F
Send
Recv 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F
Send
Recv 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F 41 26 0F
Send
Recv 41 26 0F 41 26 10 41 20 1C 41 20 1C 41 20 1C 41 22 1A 41 22 1C 41 22 1C
Send
Recv 41 22 1C 41 22 1C 41 22 1C 41 22 1C 41 22 1C 41 22 1C 41 22 1C 41 22 1C
Send
Recv 41 22 1C 41 22 1C 41 23 1C 41 23 1C 41 22 1C 41 22 1E 41 22 1E 41 24 1B
Send
Recv 41 24 1C 41 24 1C 41 24 1C 41 24 1C 41 24 1C 41 24 1C 41 24 1C 41 24 1C
Send
Recv 41 24 1C 41 24 1C 41 24 1C

Touchscreen: xxxx                              Initialisation:  Unknown

COM2, Base 02F8, Irq 3, Type 8250A/16450:9600, N, 8, 1  Bytes/second: 0.0

CTS: ┘  DSR: ┌  DCD: ┌   RI: ┌   Breaks: 0   Send Timeouts: 0     Hex mode
Overrun errors:0    Parity errors:0    Framing errors:0    FIFO errs:0
I:Initialise   H:Toggle Hex mode   S:Send   C:Clear   P:Prnt    Esc:Exit
```

Interpretation of much of the information given by TBdiag requires specialist knowledge of serial ports and the touchscreen data stream. However, a working touchscreen should always show a data stream of some kind when touched, and no errors should be reported.

How To Contact Technical Support

If you are still unable to resolve your problem, please collect together the following information, and FAX it to us.

- Your name, company name, telephone number and fax number
- Where you purchased the software from
- TBdriver version number
- Touchscreen manufacturer and type
- Touchscreen switch or jumper settings, if any
- DOS version number
- Description of computer (make, model, architecture, processor, speed, adapters, peripherals etc.)
- Detailed description of the problem
- The exact text of any error messages

A support engineer will contact you.

TBMOUSE - The Mouse Emulator

TBmouse enables a touchscreen to drive programs which normally use a mouse. TBmouse interfaces with the touchscreen through TBdriver, and emulates the interrupt 33 mouse function calls.

Programs vary as to how well they lend themselves to being adapted to a touchscreen in this way. There can be no doubt that a true touchscreen user interface differs fundamentally in design from one designed for a mouse. Nevertheless, in some cases, mouse emulation through touch can be effective.

Experience has shown that success is only feasible for applications which make use of a single button. Techniques which attempt to simulate both buttons are impractical, so TBmouse supports only the left button.

Please be aware that there is a significant difference between the positional data reported by a mouse and a touchscreen: A touchscreen reports the absolute position of a touch on the video screen, whereas a mouse reports horizontal and vertical motion relative to its previous position. Mouse software therefore, at some stage, converts the relative motion of the mouse to an absolute screen position. At this point, applications divide into two types, those which perform their own conversion from mouse motion to absolute screen position, and those which allow the mouse driver to do it for them and read absolute coordinates from the mouse driver. The latter of these two are the straightforward cases - since they expect absolute coordinates they are ideally suited to work with a touchscreen. It is those applications which work with mouse motion which often present difficulties, sometimes insurmountable.

The TBmouse Command Line

You must load TBdriver before loading TBmouse. You may optionally also load a standard mouse driver before loading TBmouse. If you do, you will be able to use the mouse as well as the touchscreen. If you don't, there will be no mouse cursor, unless the application generates its own.

```
TBmouseMode [/R] [/Z] [/Q] [/C] [/I] [/L] [/O] [/N]
[/S:xxxx,yyyy] [/P:xxxx,yyyy] [/M:xx,yy]
[/K:size]
```

Mode	Specifies a button mode: 1, 2, 3, 4 or 6
/R	Relative cursor movement
/Z	Use Z axis
/Q	Quiet mode, no sound
/C	Suppress Cursor
/I	Incremental motion
/L	Treat x,y Limits as scales
/O	Ignore touches outside x,y limits
/N	No stack swap when calling user ISR
/S:xxxx,yyyy	Set initial virtual screen Size
/P:xxxx,yyyy	Set initial cursor Position
/M:xx,yy	Set initial Mickey to pixel ratios
/K:size	size of User ISR stack. Default 500 bytes

TBmouse /?	Displays the above summary
TBmouse U	Unloads TBmouse from memory

Again, most of these options are only required in special circumstances. TBmouse is normally loaded by typing:

TBmouse 1	for button mode 1
or	
TBmouse 2	for button mode 2, etc.

Button Emulation Modes

TBmouse provides several different modes of mouse button usage. Experimentation quickly determines the most appropriate mode for a particular application.

In mode 1, when you touch the screen, the mouse cursor is moved to the point of the touch, and the left button is immediately pressed down. You can then slide around with the left button held down. The button is released when you remove your finger from the screen.

In mode 2, when you touch the screen, the mouse cursor is moved to the point of the touch, but the button is not pressed. You can then slide around with the left button not pressed. Any time you hold your finger stationary for about half a second, the left button is pressed, and two short beeps are sounded. Once pressed, you can slide around with the button pressed, and the button is only released when you remove your finger from the screen.

Mode 3 is similar to mode 2, but rapid double clicks are possible. After holding stationary to generate a button press, you quickly lift your finger off the screen and then immediately touch it again. A single beep sounds, and a second button press is generated immediately at the same location as the first one.

In mode 4, button presses are generated by quickly lifting your finger off the screen and putting it back on again.

Mode 5 is reserved for future use.

In mode 6, button presses are generated when you lift your finger off the screen.

The Mouse Cursor

In some applications the mouse cursor may no longer be relevant when using a touchscreen, so the /C parameter can be used to disable it. TBmouse can only disable the mouse cursor if the application allows the mouse driver to handle cursor display. Some applications generate their own cursor internally, in which case TBmouse cannot suppress it.

If you don't disable it, TBmouse allows the normal mouse driver to handle the cursor. Therefore if you use TBmouse without a mouse driver loaded, no cursor will be displayed unless the application generates its own.

Absolute Mode

By default, TBmouse operates in absolute mode, and attempts to maintain the mouse cursor at the exact position of your touch. When you touch the screen, the mouse cursor immediately jumps to a position directly under your finger, and follows your finger as you slide around. Unfortunately, this is not possible with some applications, especially sophisticated ones which have their own internal algorithms for translating relative mouse movement to cursor movement. You can experiment with various scales and mickey to pixel ratios, but some applications will resolutely refuse to cooperate. For such cases, relative mode is the solution.

Relative Mode

If you specify the /R switch when you load TBmouse, you can “pick up” the cursor anywhere on the screen, and it will move relative to your finger. In other words, if you move your finger to the left, the cursor moves to the left, even though it may be nowhere near your finger. This has the advantage that you can see the cursor clearly, just as you can when using a mouse. Also in this mode, the relative motion of the cursor is reduced when you move your finger slowly, which considerably improves precision.

The Mickey to Pixel Ratio

The unit of mouse motion is the Mickey: Older mice had about 200 mickeys to the inch, whereas newer mice have about 400 mickeys to the inch. A real mouse driver converts mouse motion in mickeys to movement in screen pixels using the “mickey to pixel ratio”.

The interrupt 33 mouse API is very rich and applications can use numerous different techniques to obtain mouse position information. Fundamentally though, the choice is between reading relative motion in Mickeys, or absolute coordinates on the mouse “virtual screen”. Applications which read Mickeys are the most difficult to accommodate via a touchscreen, yet they are all too common.

When an application reads relative mouse motion in mickeys, it must perform its own internal conversion of the motion to absolute screen coordinates, and draw its cursor or activate functions accordingly. In order to provide mouse emulation for such applications, TBmouse must convert the absolute position of touches to relative motion in mickeys, and supply the correct number of mickeys, with the correct polarity, to the application. In order to provide accurate calibration, TBmouse's conversion of absolute coordinates to mickeys must be exactly identical to the application's conversion of mickeys back to absolute coordinates.

Although this may seem simple enough, unfortunately, TBmouse does not always know what “Mickey to Pixel” ratio the application is using internally. TBmouse's /M switch is provided to supply this to TBmouse, and in many cases the correct values must be determined by trial and error. The mickey to pixel ratio is expressed as the number of mickeys required to move 8 pixels. The default is 8 mickeys to 8 pixels horizontally (ie 1 to 1), and 16 mickeys to 8 pixels vertically (ie 2 to 1). The default /M parameter is therefore /M:8,16. Increasing the numerical values increases the movement of the cursor for a given touch offset. For example, specifying /M:16,32 means that any given relative touch movement will generate twice as many mickeys as the default, which in turn will generate twice as much motion of the application cursor.

Initial Virtual Screen Size

The mickey to pixel ratio defines the ratio of motion in mickeys to movement in pixels. The “pixels” referred to here are not physical screen pixels, but pixels on a “virtual screen”. The mouse virtual screen size is officially defined for each video mode in the Microsoft Mouse documentation, and does not always correspond with the number of physical pixels on the screen. To make matters worse, applications reading mouse motion in mickeys are not concerned with the mouse driver's internal virtual screen size, and might use a virtual screen which corresponds with neither the official mouse virtual screen size, nor the number of pixels on the physical screen! TBmouse's /S parameter allows you to override the default virtual screen size, and has a corresponding effect on the mickey to pixel conversion. For example, if the virtual screen size is 640 x 200 (/S:640,200) and the mickey to pixel ratio is 8,16 (/M:8,16), touching two points at opposite sides of the screen will generate 640 mickeys of horizontal motion. With a virtual screen size of 800 x 600 and the same mickey to pixel ratio, touching the same two points would generate 800 mickeys of horizontal motion.

Using the /M and /S parameters, an infinite variety of mickey to pixel conversion ratios are achievable, although it can be very time-consuming to experiment with them all.

Initial cursor position

The /P switch enables you to specify the initial cursor position following a mouse reset function. The default position is the centre of the screen, but this is not correct for all applications. The x and y values must be specified in terms of the virtual screen size in use for the video mode used by the application.

Incremental Motion

The /I switch causes TBmouse to limit the emulated mouse motion to a maximum of 127 mickeys at a time. This switch is required when running applications written using older versions of MetaWindows.

Alternate Interpretation of x,y Limits

The /L switch causes TBmouse to interpret mouse functions 7 and 8 (Set Minimum and Maximum Cursor Position) differently. By default, these are interpreted (correctly) as restricting the movement of the cursor to a sub-area of the screen. However, some applications use these calls to effect a scaling of incoming mouse coordinates and then apply these to the full screen. Using /L will emulate this quirk.

Ignoring Touches Outside x,y Limits

Normally, TBmouse interprets touches outside the x,y limits specified by mouse calls 7 and 8 as touches on the extreme edge of the defined area. The /O switch causes TBmouse to ignore such touches instead. This may be desirable for some applications.

Stack Switching

Normally, TBmouse switches to its own internal stack prior to calling a mouse user ISR. The /N switch enables you to prevent TBmouse from switching to its internal stack before calling an application user ISR, in which case the application will have whatever stack happened to be current when the ISR needed to be called. Do not use this switch unless you have good reason.

The /K switch allows you to specify the size of the user ISR stack. The default is 500 bytes.

The Z Axis

For touchscreens which have a Z axis, the /Z switch causes TBmouse to look for a hard press instead of a stationary touch in button modes 2 and 3.

Acceleration and Other Problems

Unfortunately, there are some applications which cannot successfully work with a touchscreen mouse emulator. This occurs in the following circumstances:

1. The mickey to pixel ratio used by applications is sometimes not linear: Acceleration is often implemented so that the mouse cursor moves a greater distance when the mouse is moved quickly than when it is moved

slowly. If the application implements acceleration, the touchscreen driver has little chance of calculating the correct number of mickeys required to simulate the correct movement, since touches any distance apart represent extremely rapid movement and will always invoke maximum acceleration.

2. Sometimes, applications move their internal mouse pointer without informing the mouse driver, for example when changing screens or entering a different sub-program from a menu. In such cases, TBmouse will then calculate the wrong mouse motion for the next touch, and the cursor will get out of calibration with the touchscreen. Calibration can usually be regained by pushing the mouse cursor into a corner, but this is not really satisfactory.
3. Sometimes, applications use different mickey to pixel ratios or different virtual screen sizes in different sub-programs. This is especially true of large systems (for example some Executive Information Systems) where presumably different programming teams handled each sub-program.

Unloading TBmouse

TBmouse can be unloaded from memory by typing:

```
TBmouse u
```

TBdriver can then be unloaded if required.

TBmouse Messages

TBmouse displays the following messages:

- Warning - no mouse driver loaded

  There will be no mouse cursor.

- Can't load - TBdriver not loaded

  TBmouse cannot be used without the touch screen driver.

- Can't load - already loaded

  You tried to load TBmouse, but it is already loaded.

- Invalid mode number

  You specified an unsupported button mode number.

- Can't unload - not loaded

  You requested TBmouse to unload, but it was not loaded.

- Can't unload - vectors have been hooked

  You requested TBmouse to unload, but another program has loaded after TBmouse and hooked interrupt vector 33. Unload the second program first, then you can unload TBmouse.

- /Z ignored - no Z axis

  The /z switch is only used if TBdriver reports that it is driving a touchscreen with a Z axis.

- Invalid virtual screen size

  The values specified with the /s switch are invalid. They must be in the range 1 to 9999, and must both be specified.

- Invalid mickey to pixel values

  The values specified with the /m switch are invalid. They must be in the range 1 to 99, and must both be specified.

- Invalid initial cursor position

  The values specified with the /P switch are invalid. They must be in the range 0 to 9999, and must both be specified.

- Invalid stack size

  The value specified with the /K switch is invalid. It must be in the range 0 to 9999.

- TBmouse unloaded from memory

  TBmouse has been removed from memory at your request.

- TBmouse made resident

  TBmouse has been successfully loaded into memory, and is ready for use.

Return Codes

The commands to load and unload TBmouse will often be placed in batch files. To facilitate this, TBmouse returns the following error levels:

0 - Loaded or unloaded successfully
1 - Can't load - already loaded
2 - Can't unload - not loaded
3 - Can't unload - vectors have been hooked
4 - Can't load - TBdriver not loaded
5 - Invalid mode number
6 - No parameters
7 - Invalid initial scales
8 - Invalid mickey to pixel values
10 - Invalid initial cursor position
11 - Invalid stack size

TBmouse Extended Application Program Interface

As well as emulating the normal mouse API functions on interrupt 33, TBmouse provides additional functions.

Function: **Disable TBmouse**

Calling Sequence: AX =F4 hex
Call interrupt 33 hex

Return Values: None

Description: Disconnects TBmouse from TBdriver, so that touches will not be reported as mouse movements. If a real mouse driver is loaded, it will continue to work.

Function: **Enable TBmouse**

Calling Sequence: AX =F5 hex

Call interrupt 33 hex

Return Values: None

Description: Re-connects TBmouse to TBdriver, so that touches will be reported as mouse movements.

Function: **Get TBmouse Configuration**

Calling Sequence:
AX =F1 hex
Call interrupt 33 hex

Return Values:

AX =	'TB', if TBmouse is loaded
BL =	Button mode, 1, 2, or 3
BH =	Control bits:
	00000001 / Q
	00000010 / C
	00000100 / R
	00001000 / Z
	00010000 / I
	00100000 / L
	01000000 / N
	10000000 / O
CL =	Major version number
CH =	Minor version number
DL =	1 if currently enabled
	0 if currently disabled

Description:
Provides a means of finding out if TBmouse is loaded, and if it is, how it is configured.

Function: **Set TBmouse Configuration**

Calling Sequence: AX = F3 hex

BL = Button mode, 1, 2, or 3

BH = Control bits as for Get TBmouse Configuration

Call interrupt 33 hex

Return Values: None

Description: Allows TBmouse to be reconfigured without unloading and reloading from the command line. This call must only be used with TBmouse disabled, so you must call Disable TBmouse first, then call Enable TBmouse afterwards. You may also wish to perform a Get TBmouse Configuration call to setup the current values of the control flags and mode prior to using this call.

Function: **Unload TBmouse**

Calling Sequence: AX = F2 hex

Call interrupt 33 hex

Return Values: AH = 1 if successful
0 if unsuccessful

Description: Restores vectors and returns TBmouse's memory to DOS, Unloading is not possible if interrupt 33 has been 'hooked' by another program.

TBmouse Application Support

Touch-Base have experience of using TBmouse with many commercial applications. A few of the more common ones are noted here:

- LabWindows, from National Instruments

  [Requires version 2.2 or above of LabWindows]
  TBdriver
  TBmouse n /M:8,8

- Iconics Genesis real time control system

  [Requires Gn_timer.sys (from Iconics) in config.sys]
  TBdriver /V
  TBmouse n

- Dinosaur Adventure

  set TBdint=65
  TBdriver
  TBmouse n /L

TBPAD - The Keyboard Emulator

TBpad is a utility which extends the function of TBdriver to enable emulation of keystrokes by touch. The idea is to convert a keyboard application to touch without re-programming it. Very few keyboard applications lend themselves well to this type of conversion as a permanent solution, but the facility can nevertheless be useful in some cases.

TBpad is a small Terminate Stay Resident program which allows you to supply a simple ascii file describing the coordinates of up to 99 pads, and the corresponding keystrokes to be stuffed into the keyboard buffer when each pad is touched.

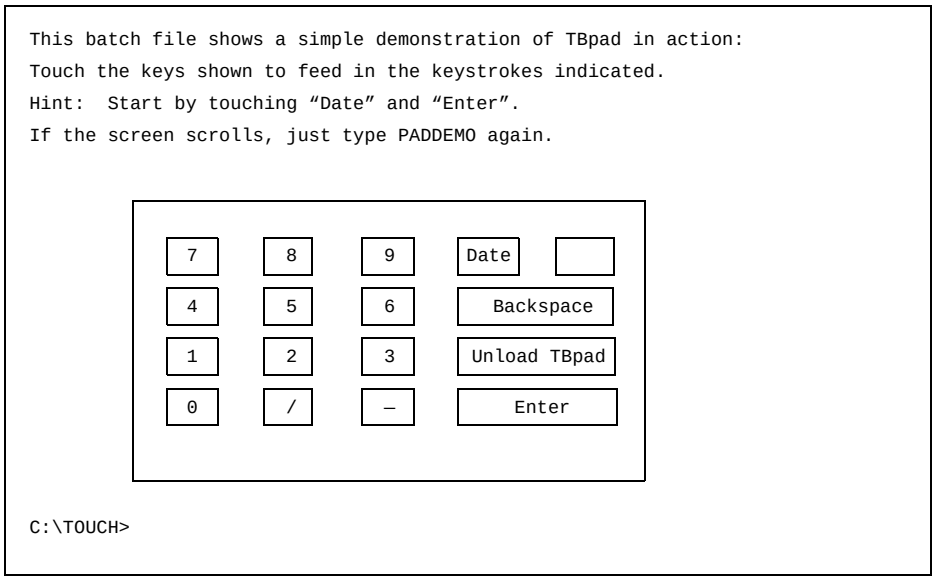
The set of active pad and key definitions can be changed at any time in one of two ways, either by calling TBpad via the command line and supplying a new filename, or via TBpad's Application Programming Interface.

TBpad can be unloaded from memory via the command line or via the API.

The TBpad Demonstration

The best way to understand what TBpad does is to run the demonstration. First ensure that TBdriver is installed and working. Get to the directory containing the TBpad software (the install program puts it in a subdirectory called TBpad), and then type “paddemo” to start the demonstration.

The paddemo.bat file will simply invoke TBpad specifying the pad definition file “tbpad.dem”, and then display the instructions for you to read, and the keypad for you to touch, and then it terminates, returning you to the DOS prompt. TBpad is now resident in memory and will react to touches as defined by the “tbpad.dem” file.



First touch “Date”. The characters “Date” will be stuffed into the keyboard buffer, and so DOS echoes them on the screen. Now touch “Enter”. An Enter key will be stuffed, so DOS will execute the date command. You can now enter a date by touching the various characters on the screen. When you have entered the correct date, touch “Enter” again, and the date will be set. When you have finished, touch “Unload TBpad”, and TBpad will be unloaded from memory (or you can type “TBpad U”).

The interesting thing about this demonstration is that it shows a touchscreen being used with no application programming whatsoever. The touch actions are entirely defined in the “tbpad.dem” file, and TBpad simply feeds the specified keystrokes into the keyboard buffer, where DOS or an application program will receive them exactly as if they had come from the real keyboard.

Here's the pad definition file which made all that happen:

```
*

* TBPAD.DEM: An example pad definition file for TBpad
*
Scale 1,80,25
Mode F
Pad 11,6,18,8,”7”
Pad 20,6,27,8,”8”
Pad 29,6,36,8,”9”
Pad 38,6,45,8,”Date”
Pad 11,9,18,11,”4”
Pad 20,9,27,11,”5”
Pad 29,9,36,11,”6”
Pad 38,9,54,11,0E08
Pad 11,12,18,14,”1”
Pad 20,12,27,14,”2”
Pad 29,12,36,14,”3”
Pad 38,12,54,14,”TBpad u” 1c0d
Pad 11,15,18,17,”0”
Pad 20,15,27,17,”/”
Pad 29,15,36,17,”-”
Pad 38,15,54,17,1c0d
```

Pad Definition File Syntax

There are three commands which may be used in pad definition files: *Scale*, *Mode* and *Pad*. Lines with a * in the first column are comment lines and are ignored. Lines beginning with anything else are rejected as errors.

- The *Scale* Command

  The Scale command defines the origin and X,Y scales in which the pad definitions for the current file are defined. There may be more than one scale command, but only the last one in the file is used. The syntax is:

  ```
  Scale<Origin>,<Xscale>,<Yscale>
  ```

  Some examples are:

  Scale 1,80,25

  Scale 0,639,349

  Scale 0,639,479

- The *Mode* Command

  The Mode command defines the touch mode by which the pads are activated. It may have a value of “F” for First touch activation, or “L” for Last touch activation. In First touch activation, a pad is activated once as soon as you touch onto it. Sliding onto other pads will not activate them - pads will only be activated by touching down onto them. In Last touch activation, a pad is only activated when your finger breaks contact with the screen at the pad. Touching down or sliding has no effect.

  There may be more than one Mode command, but again, only the last one is used.

  Examples:

  Mode F

  Mode L

- The *Pad* Command

The Pad command defines the coordinates of a pad, and the sequence of keystrokes to be stuffed into the keyboard buffer if the pad is touched. The syntax is:

```
Pad<X1>,<Y1>,<X2>,<Y2>,<Keystroke definitions>
```

where:

X1 is the top row of the pad
Y1 is the left column of the pad
X2 is the bottom row of the pad
Y2 is the right column of the pad

The coordinates must be defined in the scale defined by the active Scale command. The file may contain any number of Pad commands, but only the first 99 are used.

Keystroke Definitions

Keystroke definitions can be defined as either simple characters or hexadecimal scancode definitions, or any combination of both. Simple characters must be surrounded by double quotes, as in the following example:

```
Pad 38,6,45,8,"Date"
```

More complex keystrokes must be defined as hexadecimal scancodes, consisting of four characters, for example the backspace key as follows:

```
Pad 38,9,54,11,0E08
```

The two types can be combined, for example "TBpad u" followed by the Enter key:

```
Pad 38,12,54,14,"TBpad u" 1c0d
```

Spaces and tabs are ignored when they occur outside quotes, and may be used to make the file more easily readable, but spaces are treated as normal characters when they occur inside quotes. The double quote character cannot be used literally, so it must always be defined using its scancode (0322). Up to 16 keystrokes may be defined for each pad. Here are some more examples:

```
Pad 11,15,18,17,0322 “HELLO” 0322(“HELLO”, with quotes)
Pad 20,15,27,17,”HD” 0E08 “ELLO” 1C0D(HD, backspace, ELLO, Enter)
Pad 29,15,36,17,4800 4800 4100 1C0D(Up, Up, F7, Enter)
```

A small utility program, TBkey is provided for you to find out what the scancodes are for the various keystrokes you might want to generate. Run it by typing TBkey, and press any key, or combination of Alt-keys, Shift-keys, etc., and TBkey will display the scancode. Press Escape to exit TBkey.

The TBpad Command Line

TBpad can be invoked at the command line in one of three ways:

- TBpad
- TBpad U
- TBpad <filename>

Invoking “TBpad” on its own will make it resident in memory if it is not already resident. If it is already resident, it will do nothing.

Invoking “TBpad U” unloads TBpad from memory.

Invoking “TBpad <filename>” will make the program resident if it is not already resident, and load and activate the specified pad definition file. If TBpad is already resident, it will load and activate the specified pad definition file, replacing any previously active file - A convenient way of swapping pad definitions.

When loading a pad definition file from the command line like this, TBpad might display the following error messages:

- Error, line xx - Line too long
- Error, line xx - Syntax error
- Error, line xx - Code yy

The first message occurs if a line in the pad definition file is more than 80 characters long. The second occurs if a syntax error is discovered while parsing a line, and the third reports errors reading the file, in which case the code yy is the DOS error code.

The TBpad Application Programming Interface

TBpad uses software interrupt vector 68hex to export its Application Programming Interface. There are four callable functions:

- Identify TBpad
- Load Pad Definition File (Pascal string)
- Load Pad Definition File (C string)
- Unload TBpad

The Identify TBpad Function

Calling sequence:

AL = 1

Interrupt 68hex

Return Values.

AX ='TB'

BH =Major version number

BL =Minor version number

The Load Pad Definition File Function (Pascal string)

Calling sequence:

AL =2

BX =Segment of file pathname (Pascal string)

CX =Offset of file pathname

Interrupt 68hex

Return Values:

AX = 0 if load successful

5001 = Line too long error

5002 = Syntax error

Or any DOS file error code

BX = Line number in error, if AX <> 0

The Load Pad Definition File Function (C string)

Calling sequence:

AL =4

BX =Segment of file pathname (C string)

CX =Offset of file pathname

Interrupt 68hex

Return Values:

AX = 0 if load successful

5001 = Line too long error

5002 = Syntax error

Or any DOS file error code

BX = Line number in error, if AX <> 0

The Unload TBpad Function

Calling sequence:

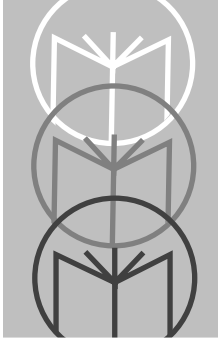
AL =3

Interrupt 68hex

Return Values:

AH = 0 if unload possible

1 if unload not possible



Appendix A TWDriver Switch Settings and Hardware Notes

Contents

Introduction

Some touchscreen controllers use on-board switches to control touch modes and communications parameters, while others do not. Where TWdriver requires specific switch settings, these are listed in this section.

For PC bus type controllers, the manufacturers factory settings of I/O address and IRQ are the default, and these are listed here. Alternative settings may be used, so long as TWdriver is notified using TWsetup or the WIN.INI file.

Brady TSD-SI Touchscreen

E6,E7,E8	Out,Out,Out	9600 baud
E9	In	10-bit mode
E10	In	Binary mode
E11	In	Continuous mode
E12	In	Flag untouches
E13	Don't care	X inversion
E14	Don't care	Y inversion
E15	In	Standard filtering
E16	In	Brady protocol

This touchscreen is unusual in that it does not transmit packets while a stationary touch is held in place, and a special 'untouch' packet is transmitted when the touch is released. While this is efficient in terms of host CPU usage, it suffers from some slight drawbacks. On a heavily loaded CPU, incoming data is occasionally lost due to serial port overruns, especially in Windows and Multimedia environments. Touch-Base drivers recover from such situations by discarding incomplete touch packets and re-synchronizing. However, with this touchscreen, if an 'untouch' packet gets lost, the driver will maintain the stationary touch condition while it waits for the lost untouch packet. If you experience this problem, a serial port containing a buffered UART chip (16550A) should help. Further, since there is no coordinate stream for a stationary touch, stabilization is not implemented for this touchscreen.

Carroll Touch HBC bus controller

Default Base I/O Port = 300 hex
Default IRQ = 7

CompuAdd POS Terminal

This is fitted with a Touch Technology AR5000 touchscreen controller, connected to one of four serial ports on the “Integrated Terminal Board”. The addresses and IRQs of the serial port are soft configurable and their power on default state is disabled. Consequently the touchscreen will not work until the ITB is appropriately configured as described in the hardware specification available from CompuAdd.

Dale Touchscreen

May be setup for auto-baud or fixed 9600 baud operation.

Dynapro

J1	Touch
J2	9600

Ellinor Touchscreen

J1	Don't care	Continuous/transmit on touch
J2	1-2	Binary mode

Elographics Accutouch - CRC Controller

SW1-1,2,3	On,On,On	(9600 baud)
SW1-4,5	Off,On	(Continuous mode)
SW1-6,7,8	Off,Off,On	(Binary mode)
SW2-1	Off	(Run mode)
SW2-2,3	Off,Off	
SW2-4,5	Don't care	(Identifier Tag)
SW2-6	Off	

The setup procedure for this controller must be performed before it is used with TWdriver.

Elographics Accutouch - PC Bus Controller

Default Base I/O Port = 280 hex
Default IRQ = 5

SW1	On	(12 bit mode)
SW2	On	(No calibration)
SW3	Off	(Stream mode)
SW4	On	(Filtered mode)

Elographics AccuTouch - RS232 Controller

SW1,2	Off,Off	(9600 baud)
SW3	Off	(8 bits)
SW4	On	(Binary mode)
SW5	On	(Filtered)
SW6	Off	(Stream mode)

Elographics DuraTouch

TBdriver overrides the jumper settings by software control, although the following jumper settings are preferred:

E1,E2	No,Yes	(Binary / stream / untouch mode)
E3,E4	No,No	(No axis inversion)
E5,E6	Yes,No	(9600 baud)

Elographics E271-2201 PC-Bus Touchscreen Controller

Touch-Base drivers support this device as an Elographics Accutouch Bus controller. The default jumper settings are as follows:

J0,J1	No,No	(Base address 280)
J2,J3	Yes,No	(IRQ 5)
J4	No	(Stream mode)
J5	Yes	(For Accutouch)
J5	No	(For Duratouch)
J6	No	(Reserved)
J7	Yes	(Default from jumpers)
J8	No	(Reserved)
J9	No	(Reserved)
J10	Yes	(E271-141 emulation mode)
J11	No	(12-bit mode)

Elographics IntelliTouch - PC Bus Controller

Default Base I / O Port = 280 hex
Default IRQ = 5

SW1	On	(12 bit mode)
SW2	Not used	
SW3	Off	(Stream mode)
SW4	Not used	
SW5	On	(Z-axis enabled)
SW6	Off	(Point mode)
SW6,7	Not used	

Elographics IntelliTouch - RS232 Controller

SW0	Off	(Stream mode)
SW1	Off	(Binary data)
SW2	On	(Z-axis enabled)
SW3,4,5	Off,Off,Off or	
	On,On,On	(9600 baud)
SW6,7	Don't care	

Elographics E271-2201 PC Bus Controller

TWdriver supports this device as an Elographics Accutouch Bus controller. The required jumper settings are as follows:

Default Base I/O Port = 280 hex

Default IRQ = 5

J0,J1	No,No	(Base address 280)
J2,J3	Yes,No	(IRQ 5)
J4	No	(Stream mode)
J5	Yes	(For Accutouch)
J5	No	(For Duratouch)
J6	No	(Reserved)
J7	Yes	(Default from jumpers)
J8	No	(Reserved)
J9	No	(Reserved)
J10	Yes	(E271-141 emulation mode)
J11	No	(12-bit mode)

IBM 4655 POS Terminal

This is fitted with a Carroll Touch touchscreen. Individual 4655's may vary, but a typical hardware configuration for TWdriver would be:

COM4
Address: 83E8
Irq: 7
Baud Rate: 4800
Parity: Odd
DataBits: 8
StopBits: 1
IRQ sharing with Global Rearming

Intasolve Touch

(Formerly known as Mellordata Taxan Touch)

SW1-1,2,3,4	Off,Off,Off,On	(9600 baud receive)
SW1-5,6,7,8	Off,Off,Off,On	(9600 baud transmit)
SW2-3	Don't care	(Status command on power up)
SW3-1	Off	(No parity)
SW3-2	Don't care	(Odd/even parity)
SW3-3	On	(RTS/CTS flow control)
SW3-4	Off	(1 stop bit)
SW3-5,6,7	On,On,Off	(Continuous mode)
SW3-8	Off	(8 data bits)

ISI Crystal Clear

(Formerly known as Mors analogue capacitive touchscreen)

JP20	On	(9600 baud) (8 data bits) (1 stop bit) (No Parity)

MA Systems & Design - Serial Controller

(Formerly known as Gunze / TST Serial)

SW1,2	Off,Off	(9600 baud)
SW3,4	On,Off	(Touch driver format)
or		
	Off,Off	(Simple format)
SW5-8	All Off	(Reserved)

Note that the factory setting of these controllers is SW1-4 On,On,On,Off, ie 1200 baud, 5 byte mode, although we prefer the improved responsiveness of 9600 baud operation.

Quick Analogue Resistive, Firmware Rev 1.2

Revision 1.2 of the firmware for this touchscreen supports a mode which does not stream zero coordinates when the touchscreen is not being touched. If your touchscreen has this revision of firmware, you should select this option from the TWdriver installation menu, as it places a lower overhead on the system. Note that the initial factory calibration must be performed prior to running TWdriver.

Touch Technology AR5000/Digitouch

SW1,2	Off,Off	(9600 baud)
SW3	Off	(Continuous mode)
SW4	Off	(Auto-calibration off)

Touch Technology PC2000 Bus Controller

Default Base I / O Port = 23C hex
Default IRQ = 2

Touch Technology PC5000 Bus Controller

J6,J7	Dependent on sensor type	
J8 - J13	Interrupt select (2 - 7)	
SW2	Off	(Standard speed)
SW1,3,4	Off	(Not used)

Touch Technology RS2000 Serial Controller

SW1	Off	(Normal)
SW2	On	(Headers On)
SW3	On	(Continuous mode)
SW4,5	On,On	(Binary data)
SW6,7	Off,Off	(9600 baud)
SW8	On	(1024x1024 resolution)

Touch Technology TekTouch

(Also known as Tektronix TekTouch)

This controller can be set for either continuous or delta mode. Delta mode is preferred as the overhead on the PC processor is reduced and the controller's internal filtering is better in this mode.

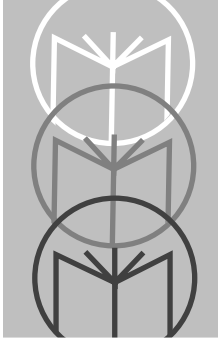
SW1,2	Off,Off	(Continuous mode)
or		
SW1,2	On,On	(Delta mode)
SW3,4	Off,On	(9600 baud, 1 stop bit)
SW5,6	Off,On	(No parity)
SW7	Off	(Ascii format)

Wasp TSI 5000/4 BC - PC Bus Controller

Default Base I/O Port = 220 hex
Default IRQ = 3

Automatic Re-initialization

Automatic re-initialization is currently implemented on MicroTouch, Microvitec, Carroll Touch and Elographics DuraTouch touchscreens. 'Hardware Configuration' contains more information on automatic re-initialisation.



Appendix B TBDriver Switch Settings and Hardware Notes

Contents

Introduction

Some touchscreen controllers use on-board switches to control touch modes and communications parameters, while others do not. Where TBdriver requires specific switch settings, these are listed in this section.

PC-Bus Touchscreens Controllers

For PC bus type controllers, the manufacturers factory settings of I/O address and IRQ are the default, and these are listed here. Alternative settings may be used, so long as TBdriver is notified using the /a and /i parameters, as described in section 5.

Automatic Re-initialisation

Automatic re-initialisation is currently implemented on MicroTouch, Microvitec, Carroll Touch and Elographics DuraTouch touchscreens. Section 5 contains more information on automatic re-initialisation.

Delta Mode Touchscreens

Most touchscreens send a continuous stream of coordinate data packets while they are being touched, even while a touch is held stationary. A few touchscreens work only in “delta” mode, meaning that they do not send data while a touch is held stationary in contact, and a special 'untouch' packet is transmitted when the touch is released. While this is efficient in terms of host CPU usage, it suffers from some slight drawbacks. On a heavily loaded CPU, incoming data is occasionally lost due to serial port overruns, especially in Windows and Multimedia environments. Touch-Base drivers recover from such situations by discarding incomplete touch packets and re-synchronizing. However, if a delta mode untouch packet gets lost, the driver will maintain the stationary touch condition while it waits for the lost untouch packet. If you experience this problem, a serial port containing a buffered UART chip (16550A) should help.

Brady TSD-SI Touchscreen

E6,E7,E8	Out,Out,Out	9600 baud
E9	In	10-bit mode
E10	In	Binary mode
E11	In	Continuous mode
E12	In	Flag untouches
E13	Don't care	X inversion
E14	Don't care	Y inversion
E15	In	Standard filtering
E16	In	Brady protocol

This is a delta mode touchscreen.

Carroll Touch HBC bus controller

Default Base I/O Port = 300 hex

Default IRQ = 7

Carroll Touch SBC bus controller

This controller requires the Carroll Touch TAPI driver (SBC) to be loaded on software interrupt 55 hex before TBdriver is loaded.

CompuAdd POS Terminal

This is fitted with a Touch Technology AR5000 touchscreen controller, connected to one of four serial ports on the “Integrated Terminal Board”. The addresses and IRQ's of the serial port are soft configurable and their power on default state is disabled. Consequently the touchscreen will not work until the ITB is appropriately configured as described in the hardware specification available from CompuAdd.

Dale Touchscreen

May be setup for auto-baud or fixed 9600 baud operation.

Dynapro - Serial, not SC3

J1	Touch mode
J2	9600

Dynapro - Bus

J2Touch mode

Ellinor Touchscreen

J1	Don't care	Continuous / transmit on touch
J2	1-2	Binary Mode

Elographics Accutouch - CRC Controller

SW1-1,2,3	On,On,On	(9600 baud)
SW1-4,5	Off,On	(Continuous mode)
SW1-6,7,8	Off,Off,On	(Binary mode)
SW2-1	Off	(Run mode)
SW2-2,3	Off,Off	
SW2-4,5	Don't care	(Identifier Tag)
SW2-6	Off	

The setup procedure for this controller must be performed before it is used with TBdriver.

Elographics Accutouch E271-141 PC Bus Controller

Default Base I / O Port = 280 hex

Default IRQ = 5

SW1On(12 bit mode)
SW2On(No calibration)
SW3Off(Stream mode)
SW4On(Filtered mode)

Elographics AccuTouch E271-140 Serial Controller

SW1,2	Off,Off	(9600 baud)
SW3	Off	(8 bits)
SW4	On	(Binary mode)
SW5	On	(Filtered)
SW6	Off	(Stream mode)

Elographics DuraTouch E261-280 Serial Controller

TBdriver overrides the jumper settings by software control, although the following jumper settings are preferred:

E1,E2	No,Yes	(Binary / stream / untouch mode)
E3,E4	No,No	(No axis inversion)
E5,E6	Yes,No	(9600 baud)

Elographics E271-2201 PC-Bus Controller

J0,J1	No,No	(Base address 280)
J2,J3	Yes,No	(IRQ 5)
J4	No	(Stream mode)
J5	Yes	(For Accutouch)
J5	No	(For Duratouch)
J6	No	(Reserved)
J7	Yes	(Default from jumpers)
J8	No	(Reserved)
J9	No	(Reserved)
J10	Yes	(E271-141 emulation mode)
J11	No	(12-bit mode)

Elographics E271-2202 Micro Channel Bus Controller

J0	No	(Reserved)
J1	No	(Reserved)
J2	No	(Reserved)
J3	No	(Reserved)

J4	No	(Stream mode)
J5	Yes	(Accutouch)
J6	No	(Reserved)
J7	Yes	(Settings from jumpers)

Elographics E281-2300 Serial Controller

J0,J1	No,No	(9600)
J2	No	(Binary)
J3	Yes	(Disable handshaking)
J4	No	(Stream mode)
J5	No	(Reserved)
J6	No	(Reserved)
J7	Yes	(Settings from jumpers)
J8	No	(Reserved)
J9	No	(Reserved)
J10,J11	Yes,No	(E271-140 emulation mode)

Elographics IntelliTouch E281-4025 PC Bus Controller

Default Base I/O Port = 280 hex
Default IRQ = 5

SW1	On	(12 bit mode)
SW2	Not used	
SW3	Off	(Stream mode)
SW4	Not used	
SW5	On	(Z-axis enabled)
SW6	Off	(Point mode)
SW6,7	Not used	

Elographics IntelliTouch E281-4001/4002 Serial Controllers

SW0	Off (Stream mode)
SW1	Off (Binary data)
SW2	On (Z-axis enabled)
SW3,4,5	Off,Off,Off or On,On,On(9600 baud)
SW6,7	Don't care

ExZec Guided Acoustic Wave Touchscreen

This touchscreen requires the driver supplied with it, Surtch, to be loaded on software interrupt 60 hex before TBdriver is loaded. We recommend “Surtch -t 1000".

IBM 4655 POS Terminal

This is fitted with a Carroll Touch touchscreen. Individual 4655's may vary, but a typical command line for TBdriver would be:

TBdriver /a:83E8 /i:7 /c:4800,o,8,1 /g

Intasolve Touch - Series 100

(Formerly known as Mellordata Taxan Touch)

SW1-1,2,3,4	Off,Off,Off,On	(9600 baud receive)
SW1-5,6,7,8	Off,Off,Off,On	(9600 baud transmit)
SW2-3	Don't care	(Status command on power up)
SW3-1	Off	(No parity)
SW3-2	Don't care	(Odd / even parity)
SW3-3	On	(RTS / CTS flow control)
SW3-4	Off	(1 stop bit)
SW3-5,6,7	On,On,Off	(Continuous mode)
SW3-8	Off	(8 data bits)

Intasolve Touch - Series 200

SW1-1,2	As required for touch matrix size	
SW1-3	Off	(CTS handshaking)
SW1-4	Either	
SW1-5,6	On,On	(Continuous Mode)
SW1-7,8	On,Off	(9600 baud)

ISI Crystal Clear

(Also known as Mors analogue capacitive touchscreen)

JP20	On	(9600, 8, 1, N)

Keytec Magic Touch TS-232-B

E4	No	Normal Mode
E5	No	1200 baud
E6	Don't care	Data format
E7	Don't care	Untouch selection
E8	Don't care	Stream / point selection

MA Systems & Design - PC Bus Controller

(Formerly known as Gunze/TST PC Bus Controller

Default Address Location = CF00 hex

Default IRQ = 3

Beware that the interface to this touchscreen is through main memory, not through the I/O channel, and clashes with other adapter cards may occur.

MA Systems & Design - Serial Controller

(Formerly known as Gunze/TST Serial)

SW1,2	Off,Off	(9600 baud)
SW3,4	On,Off	(Touch driver format)
or	Off,Off	(Simple format)
SW5-8	All Off	(Reserved)

Note that the factory setting of these controllers is SW1-4 On,On,On,Off, ie 1200 baud, 5 byte mode, although we prefer the improved responsiveness of 9600 baud operation. The factory switch settings can be used by loading TBdriver with "/C:1200,n,8,1 /S:2".

Quick Analogue Resistive, Firmware Rev 1.2

Revision 1.2 of the firmware for this touchscreen supports a mode which does not stream zero coordinates when the touchscreen is not being touched. If your touchscreen has this revision of firmware, you should select this option from the TBdriver installation menu, as it places a lower overhead on the system. Note that the initial factory calibration must be performed prior to running TBdriver.

RGB Dynamics Matrix Capacitive

(Also known as Mors matrix capacitive touchscreen)

SW1,2,3	On,On,On	(9600 baud)
SW4	On	(Off touch recognition)
SW5	Off	(No leading character)
SW6	Off	(No trailing character)
SW7	Off	(No parity)
SW8	Off	(Send each pad code)
SW9	Off	(Test mode off)
SW10	Off	(not used)

TBdriver makes this matrix touchscreen appear to be an analogue touchscreen of low resolution. See Appendix C for further information.

The default TBcalib file installed for this touchscreen is defined for the standard 80 pad layout. TBcal may be used to define other layouts.

Simple Matrix

This install option refers to a generic driver for matrix type devices which return a single byte for each pad touched. See Appendix C for further information.

Thomson Tubes Electroniques

SMH0,1	No,Yes	1200 Baud
SMH2,3,4	No,Yes,No	No parity, 8 data, 1 stop

Touch Technology AR5000 and Digitouch

SW1,2	Off,Off	(9600 baud)
SW3	Off	(Continuous mode)
SW4	Off	(Auto-calibration off)

Touch Technology PC2000 PC Bus Controller

Default Base I/O Port = 23C hex
Default IRQ = 2

Touch Technology PC5000 PC Bus Controller

J6,J7	Dependent on sensor type	
J8 - J13	Interrupt select (2 - 7)	
SW2	Off	(Standard Speed
SW1,3,4	Off	(Not used)

Touch Technology RS2000 Serial Controller

SW1	Off	(Normal)
SW2	On	(Headers On)
SW3	On	(Continuous mode)
SW4,5	On,On	(Binary data)
SW6,7	Off,Off	(9600 baud)
SW8	On	(1024x1024 resolution)

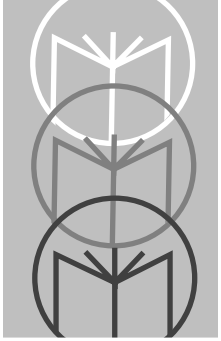
Touch Technology Analogue Capacitive and TekTouch

(Also known as Tektronix TekTouch)

This controller is available in several different versions and configurations, and we no longer specify switch settings for it. In many cases TBdriver's default communications parameters will be incorrect and you will need to use the /c parameters to specify the correct parameters. TBdriver now works with this controller in either delta mode or continuous mode, and in most cases we would recommend using delta mode. Please contact your supplier for details of switch settings and communications parameters for your particular unit.

Wasp TSI 5000/4 BC - PC Bus Controller

Default Base I/O Port = 220 hex
Default IRQ = 3



Appendix C Using Multiple Touchscreens

Contents

Introduction

Many video adapters are available which enable a PC to drive two or more monitors. In order to support multiple touchscreens, multiple copies of TBdriver can be loaded into memory, provided they each use a separate API interrupt vector and a separate calibration data file, and provided the touchscreens use separate port addresses.

For touchscreens of the same type, a single copy of TBdriver on disk may be used, and the environment variables TBdint and TBdpath may be used to control the API vector and calibration data file directory. For touchscreens of different types, multiple copies of TBdriver must be installed in separate directories. Note that the calibration data file is always called TBcalib, so multiple copies must always be located in separate directories.

TBdriver only refers to environment variable TBdpath when it loads, so changing it after loading does not affect the resident TBdriver. TBdpath may then be changed to control the TBcalib directory of another copy of TBdriver. Similarly, environment variable TBdint is only used when TBdriver loads or unloads, and so can be used to load and unload multiple drivers to and from different API vectors. Note that drivers must be unloaded on a last in first out basis.

The supplied programs TBcal and TBddemo both use the environment variable TBdint to determine the software interrupt vector to use. Access to several resident TBdrivers can therefore be achieved by setting TBdint appropriately before running either program. In the same way, your application would access either driver simply by calling the appropriate software interrupt vector.

For example, the following DOS commands would load two TBdrivers to drive two touchscreens of the same type. Touchscreen 1 could then be driven by making calls to interrupt 65, and touchscreen 2 by making calls to interrupt 66:

- Set TBdpath=c:\driver1
- Set TBdint=65
- TBdriver 1
- Set TBdint=66

- Set TBdpath=c:\driver2
- TBdriver 2

The following commands would be required to calibrate touchscreen 1:

- Set TBdint=65
- TBcal

The following commands would be required to calibrate touchscreen 2:

- Set TBdint=66
- TBcal

Matrix Touchscreens

TBdriver is primarily designed to provide comprehensive support of analogue touchscreens, although matrix touchscreens are also supported where possible. Matrix touchscreens return pad identification numbers instead of coordinates, and in order to provide compatibility at the API, TBdriver maps these pad numbers to coordinates.

Pad to Coordinate Mapping

The pad to coordinate mapping is held in file TBcalib and defined by program TBcal. TBcal behaves entirely differently for matrix touchscreens, displaying the following screen when invoked:

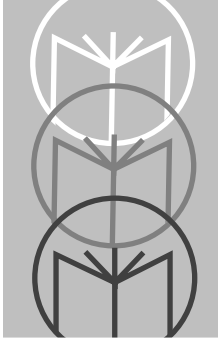
```
TBcal V4.07                                    (c) Touch-Base Ltd. 1989 - 1994

Press Enter to proceed to the main calibration screen.

You must calibrate every pad on the screen, as follows:

    1) Touch and release a pad to select it.  The pad ID will flash.

    2) Move the pad ID around the screen using the cursor keys, until
       it is roughly in the centre of the pad.  The insert key
       toggles between fast and slow movement.

    3) When you are satisfied with the pad's position, press Enter.
       The pad ID will stop flashing.

    4) When you have calibrated every pad, press Escape to quit.  You
       may quit at any time - the file will always be updated.
```

TBddemo

When TBddemo runs on matrix touchscreens, the options which are no longer relevant are displayed in low intensity. These options may still be used, although the resulting API calls are ignored by matrix versions of TBdriver.

Read Touches API Call

For matrix touchscreens the read touches API call returns the TBdriver pad number in DX and the hardware pad number is returned in DI.



Appendix D Programming Guidelines

Introduction

This section describes some techniques commonly employed in touchscreen programming, but is by no means an exhaustive guide. One of the joys of touchscreen programming is the scope for devising innovative and effective methods of user interaction.

Audio and Video Feedback

When an active pad is touched, it is very helpful to see visual feedback immediately on touching the screen, and this can take several forms. The whole pad may change color, or just the text within it, or just its border if it has one. The pad might revert to its original color when released, or might stay highlighted for some reason.

Activation

Unlike a keyboard, a pad need not necessarily invoke action within the application when it is first touched. Activation can be on first, repeat or last touch. If the touchscreen has a Z axis, it might also be on a 'heavy' touch. One of the most popular and effective forms of activation is last touch, with visual feedback on first touch. This enables the user to confirm he has touched the correct area before lifting his finger to action the area.

Typematic Activation

Just like a key on keyboard, a pad may begin to invoke continuous responses after it has been touched for a period of time. If the touchscreen has a Z axis, the repeat rate could be made to increase with increasing pressure.

Allow Entry of Valid options Only

One of the key advantages of touch screens is that only valid options need be presented for selection, minimizing input errors. Entry of calendar dates serves as a thought provoking example. In a touch screen application, it is quite feasible, yet quite wrong, to pop up a calculator-style number pad for the user to punch in a numeric date. Much better to construct a graphical calendar for a chosen month, with only the valid days touch sensitive. In this solution, invalid dates such as the 30th of February would never even appear on the screen, and bank holidays could be in a different color, insensitive to touches.

Timeout

If the screen is not touched for a time, you may want to perform some action. For example, return to a password screen, or display a help message.

Keyboard Sharing

In some parts of an application it can be convenient for the user to be able to use the touchscreen or the keyboard interchangeably, with the same effect. For example, even short items of text input are easier on a keyboard, and this would often be preferred if the keyboard is close at hand. Touchscreens are most unsuitable for even moderate amounts of text input.

Sliding Scales

The unique ability of a touchscreen to continuously return coordinates when a finger slides around it may be used in a number of ways. A visual image of a sliding scale, with a moveable cursor bar is a most effective way of increasing or decreasing numeric quantities, or scrolling through a list.

“Pop-Up” Pads

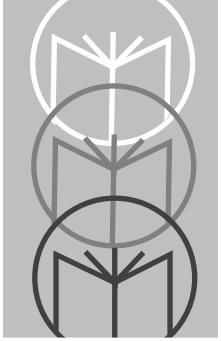
If, for some reason, a window is popped-up, or promoted, on top of some others, partially or wholly obscuring some of them, you might wish to promote its touch attributes in a similar manner, ie making it exclusively touch sensitive, and de-sensitizing all other pads.

Toggle Buttons

Instead of displaying a pair of buttons for Yes / No, Buy / Sell etc., it can be more effective to display a button which toggles between two or more values when it is touched. In other words touching the word “Buy” makes it change to “Sell” etc. This technique is most effective in “form fill-in” type screens.

TouchBox

When you start to design your application, possibly making use of some of the techniques just described, you may well decide to front-end it with a set of routines to manage the touchscreen in close harmony with the visual images. We believe this to be a very sound approach, and have done just that ourselves. Call Touch-Base now and ask us about TouchBox.



Appendix E TWDriver Application Programming Interface

Contents

Introduction

TWdriver is a Windows 3.0/3.1 mouse driver. A Windows device driver is actually a dynamic-link library (DLL) that programs call to interact with a piece of hardware.

Like all Windows DLL's, functions are exported which Windows application programs can dynamically link to and call. TWdriver is linked with the following .DEF file:

```
LIBRARY MOUSE
EXETYPE WINDOWS
DESCRIPTION 'TWdriver V3.xx:  Touchscreen name'
STUB 'WINSTUB.EXE'
CODE PRELOAD DISCARDABLE
DATA PRELOAD FIXED SINGLE
EXPORTS
        Inquire         @1
        Enable          @2
        Disable         @3
        MouseGetIntVect@4

        WEP
        TWGetInfo

        TWSetClickTime
        TWSetSensitivity
        TWSetStabilisation
        TWSetButtonMode
        TWSetButton
        TWSetTouchOffset
        TWSetSound
        TWReadCalibration1
        TWReadCalibration2
        TWUpdateCalibration
        TWSendData
        TWReceiveData
```

The first five functions are required by Windows for the mouse interface, the rest are exported mainly for use by TWsetup, although they may also be called by user applications.

PASCAL & C Declarations

TWdriver exports 13 API functions, which can be called from high-level language programs, using the normal Windows calling conventions, i.e. Pascal style.

The declarations required are as follows:

PASCAL:

procedure **TWGetInfo**(lpTWInfo : LPvoid); far; external 'mouse';

procedure **TWSetButtonMode**(arg : Word;
down1,up1,down2,up2,down3,up3: byte);

far; external 'mouse';

procedure **TWSetTouchOffset**(arg : Byte); far; external 'mouse';

procedure **TWSetButton**(arg : Byte); far; external 'mouse';

procedure **TWSetClickTime**(arg : Word); far; external 'mouse';

procedure **TWSetSensitivity**(arg : Word); far; external 'mouse';

procedure **TWSetSound**(arg : byte); far; external 'mouse';

procedure **TWSetStabilisation**(arg : Word); far; external 'mouse';

procedure **TWReadCalibration1**(lpTWXy : LPvoid); far; external 'mouse';

procedure **TWReadCalibration2**(lpTWXy : LPvoid); far; external 'mouse';

procedure **TWUpdateCalibration**(bCalibMode : byte; wX1,wY1,wX2,wY2 : Word;

bInvertX,bInvertY : byte); far; external 'mouse';

procedure **TWSendData**(lpDataBuff : LPvoid; wDataLength : Word); far; external 'mouse';

procedure **TWReceiveData**(lpDataBuff : LPvoid; wDataLength : Word); far; external 'mouse';

'C'

VOID FAR PASCAL **TWGetInfo**(LPVOID lpTWInfo);

VOID FAR PASCAL **TWSetButtonMode**(WORD arg, BYTE down1,BYTE up1,

BYTE down2,BYTE up2,BYTE down3,BYTE up3);

VOID FAR PASCAL **TWSetTouchOffset**(BYTE arg);

VOID FAR PASCAL **TWSetButton**(BYTE arg);

VOID FAR PASCAL **TWSetClickTime**(WORD arg);

VOID FAR PASCAL **TWSetSensitivity**(WORD arg);

VOID FAR PASCAL **TWSetSound**(BYTE arg);

VOID FAR PASCAL **TWSetStabilisation**(WORD arg);

VOID FAR PASCAL **TWReadCalibration1**(LPVOID lpTWXy);

VOID FAR PASCAL **TWReadCalibration2**(LPVOID lpTWXy);

VOID FAR PASCAL **TWUpdateCalibration**(BYTE bCalibMode, WORD wX1,

WORD wY1,WORD wX2,WORD wY2, BYTE bInvertX, BYTE bInvertY);

VOID FAR PASCAL **TWSendData**(LPVOID lpDataBuff, WORD wDataLength);

VOID FAR PASCAL **TWReceiveData**(LPVOID lpDataBuff, WORD wDataLength);

Before Calling the API

Before attempting to call the TWdriver API, your application must determine if TWdriver is loaded.

This can be achieved using one of the following functions:

BORLAND TURBO PASCAL for WINDOWS

```
function CheckTWPresent : TFarProc;
const
  Module_Name: PChar = 'MOUSE';
  Proc_Name: PChar = 'TWGetInfo';
begin
  CheckTWPresent := GetProcAddress(GetModuleHandle(Module_Name), Proc_Name);
end;
```

MICROSOFT 'C'

```
FARPROC CheckTWPresent()
{
 PSTR Module_Name = “MOUSE”;
 PSTR Proc_Name   = “TWGetInfo”;
 return (GetProcAddress (GetModuleHandle (Module_Name), Proc_Name));
}
```

THE API

Function: **TWGetInfo**

Syntax: TWGetInfo(lpTWInfo)

Description: This function fills the supplied structure with all the current configuration parameters of TWdriver. Note that the calibration file pathname is an asciiz string and requires conversion for use in Pascal.

Parameter: lpTWInfo. Far Pointer to a TWInfo structure.

Structure: PASCAL:

```
TWInfo = Record

VerMajor:       byte;                  { major version number }
VerMinor:       byte;                  { minor version number }
Touchscreen:    byte;                  { touchscreen number, see 'Touchscreen
                                         Type Numbers}
CalibFilePath:  array[1..80] of char;  { calibration file pathname, Asciiz }
CalibMode:      byte;                  { current TWcalib mode. Always 0 }
ComPort:        byte;                  { 0=bus card ; 1=COM1 ; 2=COM2 .. }
Address:        word;                  { port base address }
Irq:            byte;                  { IRQ number }
ClickTime:      word;                  { clicktime }
Sensitivity:    word;                  { sensitivity }
ButtonMode:     word;                  { current button mode }

Stabilization:  word;                  { stabilization factor }
Offset:         byte;                  { 0 = Off ; 1 = On }
Button:         byte;                  { 0 = Left ; 1 = Right ; 2 = Both }
CalFileOK:      byte;                  { 0 = OK, or a DOS file error }
AutoInit:       byte;                  { 0 = Disabled ; 1 = Enabled }
TSname:         array[1..60] of char;  { Touchscreen name, $ terminated }
InitStatus      byte;                  { Initialisation status, 1 = OK }
EvalVersion:    byte;                  { 0 = Production ; 1 = Eval }
Zsupport:       byte;                  { 1 = Z supported ; 0 = not }
```

```
ARIsupport:     byte;                 { 1 = ARI supported ; 0 = not }
Down1:          byte;                 { ButtonDown1 setting }
Up1:            byte;                 { ButtonUp1 setting }
Down2:          byte;                 { ButtonDown2 setting }
Up2:            byte;                 { ButtonUp2 setting }
Down3:          byte;                 { ButtonDown3 setting }
Up3:            byte;                 { ButtonUp3 setting }
SoundOff:       byte;                 { 1 = Sound Off ; 0 = On }
NumScreens:     byte;                 { Number of touchscreens }
PortType:       byte;                 { 1 = Serial ; 2 = Bus ; 3 = Other }
Baud:           word;                 { 1200, 2400, 4800, or 9600 }
Parity:         byte;                 { 'N', 'O', 'E' }
Databits:       byte;                 { '7' or '8' }
Stopbits:       byte;                 { '1' or '2' }
IRQshare:       byte;                 { 1 = On ; 0 = Off }
ReArm:          byte;                 { 1 = On ; 0 = Off }
OverrunErrs:    word;                 { Count of overrun errors }
ParityErrs:     word;                 { count of parity errors }
FramingErrs:    word;                 { count of framing errors }
RFU:            array[1..100] of byte; { reserved for future use }
end;
'C'
typedef struct
{
BYTE            VerMajor;             /* major version number */
BYTE            VerMinor;             /* minor version number */
BYTE            TouchScreens;         /* touchscreen number, see 'Touchscreen
                                      Type Numbers'*/
BYTE            CalibFilePath[80];    /* calibration file pathname, Asciiz */
BYTE            CalibMode;            /* current TWcalib mode active */
BYTE            ComPort;              /* 0 = bus card, 1 = Com1, 2 = Com2 */
WORD            Address;              /* port base address */

BYTE        Irq;                  /* Irq number */
WORD        ClickTime;            /* click time */
WORD        Sensitivity;          /* sensitivity */
WORD        ButtonMode;           /* current button mode, User defined if zero */
WORD        Stabilization;        /* stabilization */
BYTE        Offset;               /* 0 = Off, 1 = On */
BYTE        Button;               /* 0 = Left ; 1 = Right ; 2 = Both */
```

```
BYTE      CalFileOK;      /* 0 = OK or a DOS file error */
BYTE      AutoReInit;     /* 0 = Disabled, 1 = Enabled */
BYTE      TSname[60];     /* touchScreen name, $ terminated */
BYTE      InitStatus;     /* initialisation status, 1 = OK */
BYTE      EvalVersion;    /* 0=Production, 1=Evaluation */
BYTE      Zsupport;       /* 1 = Z supported ; 0 = not */
BYTE      ARIsupport;     /* 1 = ARI supported ; 0 = not */
BYTE      Down1;          /* ButtonDown1 setting */
BYTE      Up1;            /* ButtonUp1 setting */
BYTE      Down2;          /* ButtonDown2 setting */
BYTE      Up2;            /* ButtonUp2 setting */
BYTE      Down3;          /* ButtonDown3 setting */
BYTE      Up3;            /* ButtonUp3 setting */
BYTE      SoundOff;       /* 1 = Sound Off ; 0 = On */
BYTE      NumScreens;     /* Number of touchscreens */
BYTE      PortType:       /* 1 = Serial ; 2 = Bus ; 3 = Other */
WORD      Baud:           /* 1200, 2400, 4800, or 9600 */
BYTE      Parity:         /* 'N', 'O', 'E' */
BYTE      Databits:       /* '7' or '8' */
BYTE      Stopbits:       /* '1' or '2' */
BYTE      IRQshare:       /* 1 = On ; 0 = Off */
BYTE      ReArm:          /* 1 = On ; 0 = Off */
WORD      OverrunErrs:    /* Count of overrun errors */
WORD      ParityErrs:     /* count of parity errors */
WORD      FramingErrs:    /* count of framing errors */
BYTE      RFU[100];       /* Reserved for future use */
} TTWInfo;
```

Note: **CalibFilePath** is actually the Windows directory pathname, with the calibration filename (TWcalib) appended. There will always be a pathname here, whether or not the file actually exists.

CalFileOK is set to 0 if the file is found, if the correct number of bytes were read from it, the file version number was correct, and the hardware type matched the current touchscreen. Otherwise

it is set to the DOS error code returned on opening or reading the file, or:

E1: File length wrong
E2: Incorrect file version ID
E3: Incorrect hardware type

AutoInit is false if AutoReInit=No in WIN.INI, otherwise it is set true.

Function: TWSetButtonMode

Syntax: **TWSetButtonMode(wTWButtonMode,bDown1,bUp1,bDown2,bUp2,bDown3,bUp3)**

Description: This function sets the ButtonMode used by TWdriver. See the TWdriver User documentation for a description of ButtonModes.

Parameters: wTWButtonMode. Must be 0, 1, 2, 3, 4, 5, or 6.

bDown1 defines the event for first button press.
bUp1 defines the event for first button release.
bDown2 defines the event for second button press.
bUp2 defines the event for second button release.
bDown3 defines the event for subsequent button presses.
bUp3 defines the event for subsequent button releases.

The values for bDown1 .. bUp3 are:
0 = None
1 = Immediate
2 = Touchdown
4 = Liftoff
8 = Time
16 = Tap
32 = Zpress
64 = Zrelease

ButtonMode 0 means “User Defined Button Mode”, in which case bDown1 .. bUp3 may take any set of legal values. ButtonModes 1 - 6 have pre-defined configurations, which the caller must specify when calling this function:

ButtonMode 1:	2,4,2,4,2,4
ButtonMode 2:	8,4,0,0,0,0
ButtonMode 3:	8,4,16,4,0,0
ButtonMode 4:	16,4,16,4,16,4
ButtonMode 5:	8,8,1,4,0,0
ButtonMode 6:	4,1,4,1,4,1

Function: TWSetClickTime

Syntax: TWSetClickTime(wTWClickTime)

Description: This function sets the ClickTime used by TWdriver. See the TWdriver User documentation for a description of ClickTime.

Parameter: wTWClickTime

Function: **TWSetSensitivity**

Syntax: TWSetSensitivity(wTWSensitivity)

Description: This function sets the Sensitivity used by TWdriver. See the TWdriver User documentation for a description of Sensitivity.

Parameter: wTWSensitivity. A value of zero restores the default value for the touchscreen in use.

Function: TWSetStabilisation

Syntax: TWSetStabilisation(wTWStabilisation)

Description: This function sets the Stabilization used by TWdriver. See the TWdriver User documentation for a description of Stabilization.

Parameter: wTWStabilisation. A value of zero restores the default value for the touchscreen in use.

Function: **TWSetButton**

Syntax: TWSetButton(bTWButton)

Description: This function sets the Button to be emulated by TWdriver.

Parameter: bTWButton. 0 for Left, 1 for Right, 2 for Both. Any other value is ignored.

Function: **TWSetTouchOffset**

Syntax: TWSetTouchOffset(bTWTouchOffset)

Description: This function sets the TouchOffset used by TWdriver. See the TWdriver User documentation for a description of TouchOffset.

Parameter: bTWTouchOffset. 0 = Touch offset off. 1 = Touch offset on.

Function: **TWSetSound**

Syntax: TWSetSound(bTWSound)

Description: This function sets Sound On or Off.

Parameter: bTWSound. 0 = Sound On. 1 = Sound Off.

Function: **TWReadCalibration1 and 2**

Syntax: **TWReadCalibration1(lpTWXY)**

Description: For all touchscreens EXCEPT MicroTouch:

This function disables the normal function of TWdriver for the next touch. The next touch will not activate Windows in the normal way, ie, as a mouse. TWdriver waits for the next touch to complete, ie waits for a finger lift, then returns the RAW coordinates in the TWXY structure. It is then the callers's responsibility to adjust the coordinates if necessary and update the TWcalib file, if required. After this call returns, TWdriver returns to its normal functionality.

For MicroTouch touchscreens:

This function puts the controller into hard calibration mode, when it will wait for two touches. The first must be at the extreme bottom left corner of the video image and the second at the extreme top right corner of the image. For TWReadCalibration1, the X and Y coordinates returned are 0 and 0. For TWReadCalibration2, the X and Y coordinates returned are 999 and 999. These values should be stored as the soft calibration for the relevant video mode as normal, and will effectively cause TWdriver to map to the hard calibration.

In either case, status returned is zero for successful calibration, or any other value if more than thirty seconds elapsed without a touch. If calibration times out on a MicroTouch controller, the calibration program should display the message “Calibration aborted - you may need to power the touchscreen controller off and on”.

Parameter: lpTWXY. Far pointer to a TWXY structure.

Structure:

Pascal:

```
TWxy = Record

status:     byte;   { return status }
X:          word;   { raw X coordinate }
Y:          word;   { raw Y coordinate }
end;
```

C:

```
typedef struct
{
BYTE      status;  /* return status */
WORD      X;       /* raw X coordinate */
WORD      Y;       /* raw Y coordinate */
} TWxy;
```

Function: **TWUpdateCalibration**

Syntax: **TWUpdateCalibration(brfu,wX1,wY1,wX2,wY2,bInvertX,bInvertY)**

Description: This function updates the calibration coordinates in TWdriver's internal calibration coordinate buffer, replacing the values loaded from the TWcalib file.

Parameter	Type	Description
brfu	byte	Must be zero
wX1	word	Raw coordinates of left edge
wY1	word	Raw coordinates of bottom edge
wX2	word	Raw coordinates of right edge
wY2	word	Raw coordinates of top edge
bInvertX	byte	1 = X axis inversion required ; 0 = no
bInvertY	byte	1 = Y axis inversion required ; 0 = no

Function: **TWSendData**

Syntax: **TWSendData(lpDataBuff : LPvoid; wDataLength : Word)**

Description: This function is available for all touchscreens, but is only functional with certain serial touchscreens. The raw data pointed to by lpDataBuff is sent to the touchscreen. The function returns immediately, without waiting for any response.

Parameters: wDataLength is the number of bytes to send to the touchscreen, starting at the address given by lpDataBuff.

Function: TWReceiveData

Syntax: **TWReceiveData(lpDataBuff : LPvoid; wDataLength : Word)**

Description: This function is available for all touchscreens, but is only functional with certain serial touchscreens. Any data received from the touchscreen which is not recognized as touch coordinates or other data relevant to TWdriver is placed in an internal buffer, 255 bytes in length. This API call transfers any data in that internal buffer to the buffer pointed to by lpDataBuff, and the internal buffer is reset. Note that the responsibility for synchronizing with incoming non-touch data lies with the application, not with TWdriver.

wDataLength specifies the maximum length of the buffer pointed to by lpDataBuff, which TWdriver will not exceed. However, the value returned in wDataLength specifies the amount of data which was available for transfer, even if this was greater than the buffer length given. In this case, the additional data is lost, as the internal buffer is still reset, even if not all the data could be transferred.

Parameters: wDataLength is the length of the buffer pointed to by lpDataBuff.

The Calibration Data File

Calibration data for the touchscreen is held in a file called TWcalib which by default resides in the Windows directory, but can reside elsewhere as defined by the PATH= command in the [Touch-Base] section of Win.ini. The format of the file is:

Pascal:

```
CalFileRec = RECORD
FileVersion:      BYTE;          { $A4 }
HardwareType:     BYTE;          { Touchscreen type }
InvertX:          BOOLEAN;       { True if X coordinates need to be inverted }
InvertY:          BOOLEAN;       { True if Y coordinates need to be inverted }
X1:               integer;       { bottom left X coordinate }
Y1:               integer;       { bottom left Y coordinate }
X2:               integer;       { top right X coordinate }
Y2:               integer;       { top right Y coordinate }
reserved:         array[0..99] of byte;
END;
```

'C':

```
typedef struct

{

BYTE        FileVersion;        /* 0xA4 */
BYTE        HardwareType;       /* Touchscreen type */
BYTE        InvertX;            /* 1 if X coordinates need to be inverted, else 0 */
BYTE        InvertY;            /* 1 if Y coordinates need to be inverted, else 0 */
INT         X1;                 /* bottom left X coordinate */
INT         Y1;                 /* bottom left Y coordinate */
INT         X2;                 /* top right X coordinate */
INT         Y2;                 /* top right Y coordinate */
BYTE        reserved[100];
} CalFileRec;
```

Note: **FileVersion** is used to identify the file as a TWcalib file, and must have the value A4 hex.

Hardware Type is the Touch-Base defined hardware type number for the touchscreen in use. See section 'Touchscreen Type Numbers'.

InvertX and **InvertY** should be set to 1 if touch coordinates need to be inverted in order to restore the origin to the top left of the screen, as required by Windows.

X1, Y1 are the RAW coordinates returned by the touchscreen for the bottom left hand corner of the screen.

X2, Y2 are the RAW coordinates returned by the touchscreen for the top right hand corner of the screen.

Calibration Procedure

The following minimum logic is required for a calibration procedure to be built into an application:

1. Check for the presence of TWdriver (see section “Before calling the API”)
2. Perform TWGetInfo call to determine touchscreen type and calibration file pathname.
3. Display prompt for user to touch extreme bottom left hand corner of physical screen.
4. Perform TWReadCalibration1 call to get raw coordinates touched. If timeout occurs, display message and quit.
5. Display prompt for user to touch extreme top right hand corner of physical screen.
6. Perform TWReadCalibration2 call to get raw coordinates touched. If timeout occurs, display message and quit.
7. Calculate invertX and invertY as follows:
   If X1 (bottom edge) > X2 (top edge) then
   touchscreen's X origin is its bottom edge, so X inversion is needed
   If Y2 (right edge) > Y1 (left edge) then
   touchscreen's Y origin is its right edge, so Y inversion is needed
8. Call TWUpdateCalibration to make the new coordinates active in TWdriver.
9. Re-create the TWcalib file using the new data, so that it will be used the next time TWdriver loads.

Calibration Points 20% From True Edges

In some cases the active video area may extend slightly beyond the active touch area, and a few touchscreens suffer from poor linearity at their extreme corners. In order to alleviate these problems TWsetup displays its calibration reference points 20% away from the true edges of the physical screen. The TWReadCalibration calls still return the actual coordinates touched, and so TWsetup must interpolate the coordinates of the true edges to pass back to the TWUpdateCalibration call and to store in the TWcalib file. The algorithm for this is as follows:

- If invertX is set, then the left edge is high, so X1 is the high value edge and X2 is the low value edge.
- If invertX is not set, then the right edge is high, so X2 is the high edge and X1 is the low edge.
- DECREASE the value of the low value edge X coordinate by 1/3 of the difference between the returned X1 and X2.
- INCREASE the value of the high value edge X coordinate by 1/3 of the difference between the returned X1 and X2.
- If invertY is set, then the top edge is high, so Y2 is the high value edge and Y1 is the low value edge.
- If invertY is not set, then the bottom edge is high, so Y1 is the high edge and Y2 is the low edge.
- DECREASE the value of the low value edge Y coordinate by 1/3 of the difference between the returned Y1 and Y2.
- INCREASE the value of the high value edge Y coordinate by 1/3 of the difference between the returned Y1 and Y2.

MicroTouch Touchscreens

For MicroTouch touchscreens, the TWReadCalibration procedures perform the hardware calibration procedure, storing the calibration coordinates in the touchscreen controller hardware. For this to work properly, the points touched must be at the extreme corners of the video image. Calibration programs using a “20% in” strategy must not do so if the touchscreen type is MicroTouch.

Touchscreen Type Numbers

08	AFE Safetouch (AFE protocol)
17	AFE Safetouch (Carroll protocol)
29	Brady TSD-SI
04	Carroll Touch Smart-Frame
34	Carroll Touch HBC bus controller
35	Carroll Touch SBC bus controller
19	Dale
33	Dynapro
02	Ellinor Personal Touch
14	Elographics Accutouch, CRC
11	Elographics Accutouch, Bus
05	Elographics AccuTouch, Serial
20	Elographics DuraTouch
12	Elographics Intellitouch, Bus
03	Elographics Intellitouch, Serial
28	ExZec SureTouch
07	Intasolve Touch
22	ISI Crystal Clear
10	Gunze / TST, Bus
09	Gunze / TST, Serial
01	MicroTouch
06	Microvitec Touchtech
16	Mors matrix Capacitive
21	Quick Analogue Resistive
27	Quick Analogue Resistive Rev 1.2
36	SwacTouch 3D
13	Touch Technology TekTouch
18	Touch Technology AR5000 / Digitouch
25	Touch Technology PC2000 Bus
26	Touch Technology RS2000 Serial
32	Touch Technology PC5000 Bus
30	Vivid TST2900
15	Wasp TSI 5000 / 3
24	Wasp TSI 5000 / 4 BC (Bus Controller)

Multiple Touchscreens

Versions of TWdriver are available to drive multiple touchscreens attached to the same PC, for use with video cards which are capable of dividing the Windows desktop across multiple monitors. A full API set is available for each touchscreen independently.

In a multi-screen TWdriver, the standard API calls apply to the first (primary) screen. The TWGetInfo call returns the number of screens configured, in the NumScreens byte. When NumScreens is greater than one, a set of API calls is available for each additional touchscreen, with the touchscreen number appended to the call names.

So, for example, in a three screen configuration, there are three TWGetInfo calls available as follows:

TWGetInfo	For the primary screen
TWGetInfo2	For the second screen
TWGetInfo3	For the third screen

Similarly, there are three TWcalib calibration files:

TWcalib	For the primary screen
TWcalib2	For the second screen
TWcalib3	For the third screen

Index

L

M

N

O

P

Q

R

S

T

Index

U

V

W

Z

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