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# CATC™ Inspector™

## Advanced USB Bus & Protocol Analyzer

# User's Manual

**Version 2.31**

1 October 1998

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# 1. INTRODUCTION

The CATC **INSPECTOR** Advanced USB Bus & Protocol Analyzer is an invaluable development and test tool for Universal Serial Bus designers. When connected to any point in a USB network, the Inspector USB analyzer, like the CATC Detective USB analyzer, continuously monitors all bus activities and alerts the user to any abnormal bus conditions in an easy to use, menu driven, Windows software environment.

Inspector Features:

- advanced USB bus & protocol analyzer, compatible with the CATC Detective™ USB analyzer and the CATC Traffic Generator™
- operates with portable and desktop PCs, controlled through the parallel port
- enhanced triggering—data recording can be triggered by real-time USB events:
    - any possible data field error (PID, CRC, stuff bits)
    - any user defined PID or PID combination
    - any data pattern (DATA0, DATA1, or DATA0/DATA1)
    - any address and endpoint combination with any PID combination
    - any frame number
    - any static bus event (Reset, Suspend, Resume)
- user defined trigger position allows specification of the pre/post-trigger recording ratio
- provides real time USB event decoding signals on an external interface connector
- records four external signals along with the USB traffic, enabling recording of user-provided data or timing information along with USB bus traffic
- built-in, high impedance probe connects non-intrusively to any branch of a USB system
- captures both full- and low-speed USB traffic
- sophisticated software analyzes all bus transactions, identifies & highlights abnormal bus conditions, and decodes generic device class, hub class, and other standard device class messages
- easy to use Windows environment (Win 3.1, Win 95, and Win NT)
- tested for compliance with the USB specification
- one year warranty and hot-line customer support
- non-recording, view-only version of software available (no hardware required)

This document explains how to install the CATC Inspector hardware and software in your PC. It also explains how to connect and activate the analyzer in a USB system environment.

## 1.1 USB Overview

The Universal Serial Bus (USB) is an open industry standard, providing a simple and inexpensive way to connect up to 127 devices to a single computer port. Keyboards, mice, tablets, digitizers, scanners, bar-code readers, modems, printers, and more can all run at the same time. USB devices plug into any platform that supports the standard, from notebooks to desktop PCs to workstations.

The USB is a dynamically reconfigurable serial bus with an elementary data rate of 12,000,000 bits/sec, based on off the shelf, low cost micro-controller technology. Its modular layered software protocol supports sophisticated device drivers and application programs.

Please refer to the USB Specifications for details on the USB protocol. The USB specifications are available from the USB Implementers Forum at:

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M/S JF2-51
2111 NE 25th Avenue
Hillsboro, OR 97124

Tel: +1/ 503 264 0590
Fax: +1/ 503 693 7975
Web: http://www.usb.org/

# 2. CATC INSPECTOR ADVANCED USB BUS & PROTOCOL ANALYZER

## 2.1 General

The CATC Inspector Advanced USB Bus & Protocol Analyzer builds on the success of the CATC Detective USB Bus & Protocol Analyzer; it incorporates the functionality of this earlier product, and adds four major features:

- operation with both portable and desktop PCs
- enhanced triggering—data recording can be triggered by real-time USB events
- provision of real time USB event decoding signals
- recording of four user-provided external signals along with the USB traffic

The Inspector USB analyzer is a stand-alone unit configured and controlled through the PC bi-directional parallel port. It can be used with portable PCs for field service and maintenance, as well as with desktop units in a development lab environment. The analyzer is easily installed, without opening up the PC, by connecting a cable to the parallel port.

The Inspector analyzer includes provisions for on-the-fly detection of, and triggering on, numerous USB events. Such events include specific user-defined PIDs or PID combinations, data patterns, address + endpoint, special USB signaling, and many USB abnormal (error) bus conditions. The Inspector analyzer continuously records the USB data in a wrap-around mode. Upon detection of a triggering event, the analyzer continues to record data (post-trigger) up to a point specified by the user. Real-time event detectors can be individually enabled or disabled to allow triggering on USB events as they happen. This includes pre-defined exception or error

conditions, and a user-defined set of search conditions. The unit can also be triggered by an externally supplied signal. On-board memory provides a path for externally supplied data or timing information to be recorded along with bus traffic.

Real-time USB event detection information is available via an external DB37 connector, making many control, timing, and recovered signals available externally. These signals can be probed and used by other circuitry.

The Inspector USB analyzer is designed to turn any 386/486 or Pentium class PC (including laptop and notebook as well as desktop PCs) into a USB test station. The PC itself does not need to have a USB interface. The Inspector package includes the stand-alone Inspector box, an External Interface Breakout Board with a 37-pin ribbon cable, USB and parallel port cables, an AC to DC power converter, a sophisticated software program running under Microsoft Windows (3.1, 95, and NT versions), and comprehensive product documentation (including on-line help).

The Inspector analyzer has a built-in high impedance USB probe and several status LEDs. The analyzer monitors the two USB wires (D+ and D-) and translates the raw differential data into a single NRZI bit stream. It samples the data with the recovered synchronized clock, and stores the resulting bit stream on disk. The analyzer also detects and reports the static bus conditions Suspend, Resume, Reset, and Idle.

The Inspector software scans the collected data and displays it in several meaningful formats. The user can view the data as a continuous stream, or as complete transactions. In continuous mode, the analyzer fills the entire display line with data; in transaction mode, each line is dedicated to one bus transaction, such as token, data, or handshake.

The Inspector software provides a powerful search function that enables investigation of particular bus events, with the software identifying and highlighting specific events such as Bad PID, Undefined PID, Bad CRC, Bad Stuffing Bits, Missing Frames, etc.

In addition to immediate analysis, the user can print any part of the data and save all or selected portions of the data on disk for later viewing. The program also provides a variety of timing information.

The Inspector USB analyzer comes with a one year warranty and hot-line customer support.

## 2.2 CATC Inspector System Components

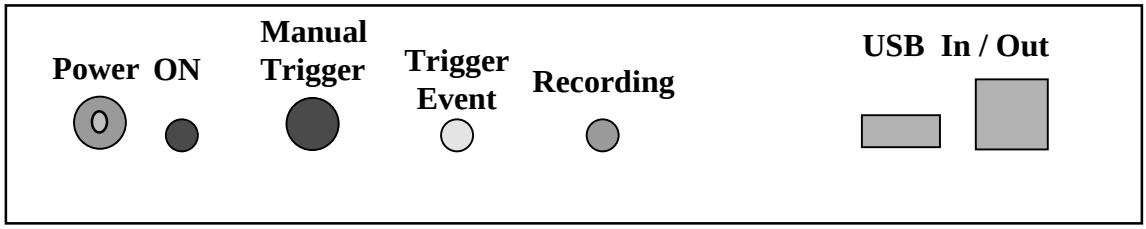
The CATC Inspector package includes the following components:

- the stand-alone Inspector USB box
- an External Interface Breakout Board with a 37 pin ribbon cable
- USB and parallel port cables
- an AC to DC power converter
- two diskettes with the associated application software program, for operation under Microsoft Windows 95, Windows 3.1, or Windows NT
- comprehensive product documentation, including on-line help

## 2.3 The Inspector USB Box

The Inspector USB box has several user-accessible controls on its front and back panels.

### 2.3.1 Front Panel Description

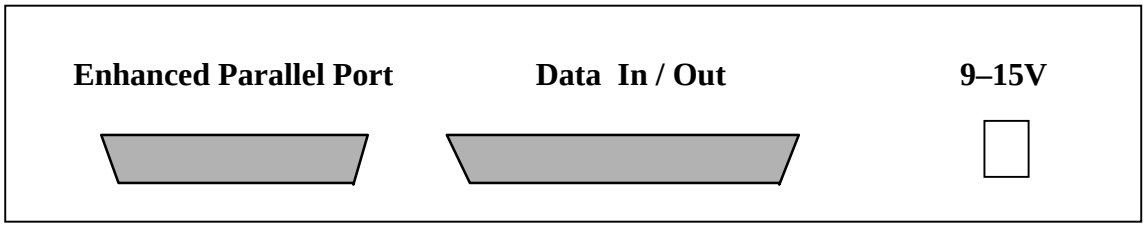



The front panel, viewed above, has two USB connectors, three LEDs, and two switches:

- The four-pin A-type and four-pin B-type USB connectors are marked "USB In/Out".
- The red "ON" LED lights when the box is powered by an external 12V DC @ 1A power source and the power switch is turned on.
- The yellow "Trigger Event" LED lights when a trigger event has occurred.
- The green "Recording" LED lights when the Inspector analyzer is recording USB traffic.
- The "Manual Trigger" push button can be used to manually start and/or end recording sessions (when enabled in the Recording Options dialog box).

### 2.3.2 Back Panel Description

The back panel has three connectors:




- The +12V DC @ 1A input power connector, marked "9–15V DC" (Earlier versions of this product are marked "9V DC", but are equivalent in capability).
- A 25-pin parallel port connector, marked "Enhanced Parallel Port".
- A 37-pin external interface connector, marked "Data In/Out".

### 2.3.3 External Triggers

The CATC Inspector box offers two ways to generate an external trigger to control a recording session: the "Manual Trigger" push-button, and the "EXT TRG" pin on the External Interface Breakout Board.

#### 2.3.3.1 The Manual Trigger Push-Button

The simplest way to generate an external trigger (when enabled in the Recording Options dialog box) is by manually activating the Manual Trigger push button located on the front panel of the Inspector box.

#### 2.3.3.2 EXT TRG Signal Generation

In order to view a particular USB event (to determine—for example—how a particular device behaves during the initialization phase), it is necessary to activate the CATC Inspector analyzer to record the bus activities during a specific time period. If the USB host allows manual control of the bus traffic, then in theory the CATC Inspector recording could be started manually at the same time. Because of USB speed, correspondingly slow human reaction time, and buffer memory limitations (1 Mbytes), however, manually coordinating the host actions with the Inspector recording is generally impractical.

A simple solution is to generate a signal in the USB host PC, or in the USB hub or device under observation, that will be synchronized to the particular event to be recorded. Such a signal can be generated on the PC by calling a small software routine (see sample code below) that uses a standard I/O Write command to a specific pin on an available serial or parallel port.

Alternatively, the EXT TRG signal might be generated by programming one of the general I/O ports on the USB controller in the hub or device.

A short cable connects this (active low) signal to the EXT TRG pin of the External Interface Breakout Board.

**TRIG Signal Sample software Routine**

```
case IOCTL_START_TRIGGER_RTS:

     switch (gTriggerDongle) {
          case SERIAL_PORT_TRIGGER_DONGLE:
               outp (0x3fc, 00);
          break;

          case PARALLEL_PORT_TRIGGER_DONGLE:
               outp (0x378, 00);
          break;
     }//switch
     break;
```

```
case IOCTL_STOP_TRIGGER_RTS:

     switch (gTriggerDongle) {
          case SERIAL_PORT_TRIGGER_DONGLE:
               outp (0x3fc, 02);
          break;

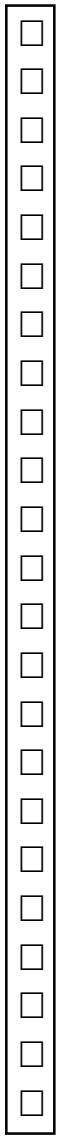
          case PARALLEL_PORT_TRIGGER_DONGLE:
               outp (0x378, 0xFF);
          break;
     }//switch
     break;
```

The CATC Inspector analyzer has two basic recording modes, timed and event driven. Both may be used with external triggering. With timed recording, the analyzer can be set to start or stop recording based on its EXT TRG (input) signal. This mode of operation is the same as the CATC Detective USB Bus & Protocol Analyzer.

With the event driven mode of operation, it is possible to combine other triggering events with the EXT TRG signal. For example, if some external device (such as a logic analyzer) is set up to trigger the CATC Inspector tool, it is still possible to enable USB error checks or PID checks as well. In this situation the first detected event, internal or external, will trigger the analyzer.

## 2.4 The External Interface Breakout Board

The breakout board is an Inspector accessory that allows convenient access to twelve potentially useful output signals. It also provides a means to supply up to five inputs: one to act as an (externally supplied) trigger, and four to sample user signals for display purposes. All signals use TTL levels (0–5V). The following diagram illustrates the breakout board connector:



| | |
|---|---|
| GND | Signal Ground |
| GND | Signal Ground |
| –SUSPEND | Suspend condition—Active Low Output |
| –RESUME | Resume condition—Active Low Output |
| –RESET | Reset condition—Active Low Output |
| –BAD CRC | Bad CRC condition—Active Low Output |
| –BAD PID | Bad PID condition—Active Low Output |
| –STUFF ERR | Stuff Error condition—Active Low Output |
| –TRIGGER | Trigger event detected—Active Low Output |
| –TRIGGERED | Inspector triggered and saved data—Active Low Output |
| DRCLK | Recovered USB clock [output] |
| RDATA | Recovered USB data [binary output] |
| RSE0 | Recovered SE0 signal [output] |
| –IDLE | Bus Idle condition—Active Low Output |
| SPARE | (unused) |
| SPARE | (unused) |
| –EXT TRG | External Trigger—Active Low Input |
| DX0 | User Signal Data input #0—Normally Pulled High |
| DX1 | User Signal Data input #1—Normally Pulled High |
| DX2 | User Signal Data input #2—Normally Pulled High |
| DX3 | User Signal Data input #3—Normally Pulled High |
| GND | Signal Ground |
| GND | Signal Ground |

## 2.5 System setup

The Inspector is designed to work with either desktop or portable PCs. The PC does not have to be equipped with a USB interface in order to work with the Inspector analyzer. Three steps are involved in the setup of the system hardware: connecting to the parallel port, connecting to the USB system under test, and connecting to electrical power.

### 2.5.1 Parallel Port Connection

**Turn off the PC power**, and connect the 25-pin cable between the CATC Inspector "Parallel Port" connector and the PC parallel port. It is suggested that the length of the interface cable be kept as short as possible and a high quality cable be used. PC power may then be restored.

A PC's parallel port can be configured for up to four different operational modes:

1) Standard mode (sometimes called Compatible mode or Compatibility mode)
2) Bi-directional mode (sometimes called Standard/Bi-directional mode)
3) Enhanced Parallel Port mode, or EPP (sometimes called simply Enhanced mode)
4) Extended Capabilities Port mode, or ECP

The parallel port mode is selected using one of the following approaches:

1) BIOS settings (for most computers having a parallel port I/O controller on the motherboard)
2) PC manufacturer-provided hardware setup utility (on some laptop and desktop PCs)
3) jumper settings (for most add-on I/O cards with a parallel port)

CATC Inspector analyzer models that have "Enhanced Parallel Port" written by the parallel port connector are capable of operating in both EPP and bi-directional modes; Earlier Inspector models that have simply "Parallel Port" written by the connector are designed for bi-directional mode only. The current parallel port connection mode is shown in the program's "About" display, available via the Help menu.

Whenever EPP mode is available, it should be used, as the data transfers using this mode are at least twice as fast as bi-directional mode.

ECP mode is supposed to implement the bi-directional mode as a subset. If it does so correctly, the Inspector will function properly (in bi-directional mode). Note, however, that it is fairly common (especially in portable systems, concerned with power-saving shortcuts) to implement non-standard versions of ECP, which can cause the Inspector analyzer to malfunction.

If, at startup, the software finds that the PC has ports running only in standard mode, it displays an information box with the following message:

*The CATC Inspector software could not detect the Inspector USB box. The Inspector box must be powered and connected to the system's Parallel Port (configured to support bi-directional data transfers) to enable the capture and recording of USB traffic. The software found that none of the parallel ports in this system currently supports a bi-directional mode. Use the BIOS setting to set the parallel port to EPP (preferred, for enhanced performance), ECP, or bi-directional mode. If EPP mode has been attempted and the Inspector box still can't be found, try using ECP or bi-directional mode.*

If, at startup, the application finds that the PC has ports running in a mode other than standard, but it still cannot communicate with the Inspector USB box, it displays an information box with the following message:

*The CATC Inspector software could not detect the Inspector USB box. The Inspector box must be powered and connected to the system's Parallel Port (configured to support bi-directional data transfers) to enable the capture and recording of USB traffic. The software found that this system has parallel ports capable of bi-directional data transfers. Ensure that the Inspector USB box is*

*both connected properly and powered, then select the OK button. If this message appears again, select the Help button for more information, or the Cancel button to quit the Inspector application.*

### 2.5.2 USB Connection

Locate the CATC Inspector Box near the USB system under test.

In the USB system, at a point where USB bus traffic is to be analyzed, open a connection and reconnect the open link through the CATC Inspector box as follows:

- Connect a USB cable between one side of the open connection and one of the two USB receptacles on the front panel of the CATC Inspector box (the two receptacles are functionally identical).
- Connect another USB cable between the other side of the open USB connection and the other USB receptacle of the CATC Inspector box.

*Note: CATC recommends the use of USB cables shorter than 2 meters (6 feet) for all connections to the Inspector USB box.*

*Note: The B-type USB connector on the Inspector box is normally connected to the upstream USB port, while the A-type connector is connected to the downstream port.*

To use the external interface signals provided by the Inspector hardware, connect the 37-pin ribbon cable between the External Interface Breakout Board and the "Data In/Out" connector at the back of the Inspector box. To enable external triggering, connect the trigger signal to the EXT TRG pin on the breakout board. To record user input data, connect the user data signals to the DX0–3 pins on the breakout board.

### 2.5.3 Power Connection

Connect the DC plug of the AC to +12V DC @ 1A converter to the "9–15V DC" receptacle on the CATC Inspector back panel.

To activate the Inspector, plug the AC to DC converter into a 110V or 220V power outlet and turn on the "Power" switch on the front panel.

The CATC Inspector Bus & Protocol Analyzer hardware is now ready for operation.

# 3. SOFTWARE INSTALLATION (ALL VERSIONS)

## 3.1 General

The CATC Inspector software is available in three different versions:

- standard version for Windows 3.1 and Windows 95
- standard version for Windows NT

- view-only version (the "CATC USB Trace Viewer") for Windows 3.1, Windows 95, and Windows NT (This version does not require the Inspector USB hardware; it is used only for viewing and analyzing previously created USB traffic files. It also serves as a product demonstration vehicle.)

The software diskette label identifies the program version. To install the CATC Inspector software, run the installation program from the Inspector software diskette, and follow the instructions on the screen.

- For the standard version on Windows NT systems, run the '*setup.exe*' installation program. *Note that correct installation requires logging in as administrator.*
- For all other versions/systems, run the '*install.exe*' installation program.

The installation program creates a program group for the Inspector application once it has finished copying all the files. The icon for an *Uninstall* program is also placed in the program group. This *Uninstall* program can be run later, if desired, to remove the CATC Inspector software from the system.

To run the software, double-click on the Inspector icon in the program group created during installation. Section 4 describes the software in detail.

### 3.1.1 Standard Version (Win 3.1 & Win 95)

The installation program copies the following files to the PC's hard drive.

To the \USBINSPR directory (or that otherwise specified by the user):

- USBINSPR.EXE executable code of the CATC Inspector program
- USBINSPR.DLL DLL for the CATC Inspector program
- CLS_HID.DLL DLL for HID Class device decoding
- USBINSPR.HLP CATC Inspector help file
- DEFAULT.OPT default DISPLAY function settings
- DEMO.USB sample USB traffic file

to the \WINDOWS\SYSTEM directory:

- USBINSPR.386 Windows CATC Inspector virtual device driver
- CTL3D.DLL Windows 3D Control Library
- CTL3DV2.DLL Windows 3D Control Library

to the \WINDOWS directory:

- CLSDECOD.INI USB Device Class decoding initialization

In the \WINDOWS\SYSTEM.INI file, the installation program adds a reference to the CATC Inspector driver in the [386Enh] section.

```
device=usbinspr.386
```

### 3.1.2 Standard Version (Win NT)

The installation program copies the following files to the PC's hard drive.

To \Program Files\CATC\Inspector directory (or that otherwise specified by the user):

- USBINSPR.EXE executable code of the CATC Inspector program
- USBINSPR.DLL DLL for the CATC Inspector program
- CLS_HID.DLL DLL for HID Class device decoding
- USBINSPR.HLP CATC Inspector help file
- DEFAULT.OPT default DISPLAY function settings
- DEMO.USB sample USB traffic file

to the \WINDOWS\SYSTEM32 directory:

- CTL3D32.DLL Windows 3D Control Library

to the \WINDOWS directory:

- CLSDECOD.INI USB Device Class decoding initialization

to the \WINDOWS\SYSTEM32\DRIVERS directory:

- USBINSPR.SYS Windows NT CATC Inspector device driver

The installation program modifies the system registry to install the CATC Inspector driver. *Thus, in order to install this version on Windows NT systems, it is necessary to log in as administrator*.

### 3.1.3 "CATC USB Trace Viewer" Version (Win 3.1, Win 95, & Win NT)

The installation program copies the following files to the PC's hard drive.

To the \CATCVIEW directory (or that otherwise specified by the user):

- CATCVIEW.EXE executable code of the CATC USB Trace Viewer program
- CLS_HID.DLL DLL for HID Class device decoding
- USBINSPR.HLP CATC Inspector help file
- DEFAULT.OPT default DISPLAY function settings
- TRIGUSER.USB full-speed USB trace file (illustrates event trigger, user data)
- HID.USB low-speed USB trace file (illustrates HID class decoding)
- SOF.USB full-speed USB trace file (illustrates many SOF packets)
- ISO.USB full-speed USB trace file (illustrates isochronous traffic)
- NAK.USB full-speed USB trace file (illustrates many NAKed transactions)
- REPORT.USB full-speed USB trace file (illustrates statistics report, view by device)
- ERROR.USB full-speed USB trace file (illustrates field & transaction errors)

to the \WINDOWS\SYSTEM directory:

- CTL3D.DLL Windows 3D Control Library
- CTL3DV2.DLL Windows 3D Control Library

to the \WINDOWS directory:

- CLSDECOD.INI USB Device Class decoding initialization

## 3.2 Running The Software

The CATC Inspector software is a Windows application, and can be run under Windows 3.1, Windows 95, and Windows NT. To start the program, double-click on the file name (located with the Explorer or equivalent service), or on the CATC Inspector icon created during the software installation.

The program will start with the main window active.

# 4. THE CATC INSPECTOR SOFTWARE

## 4.1 Getting Started

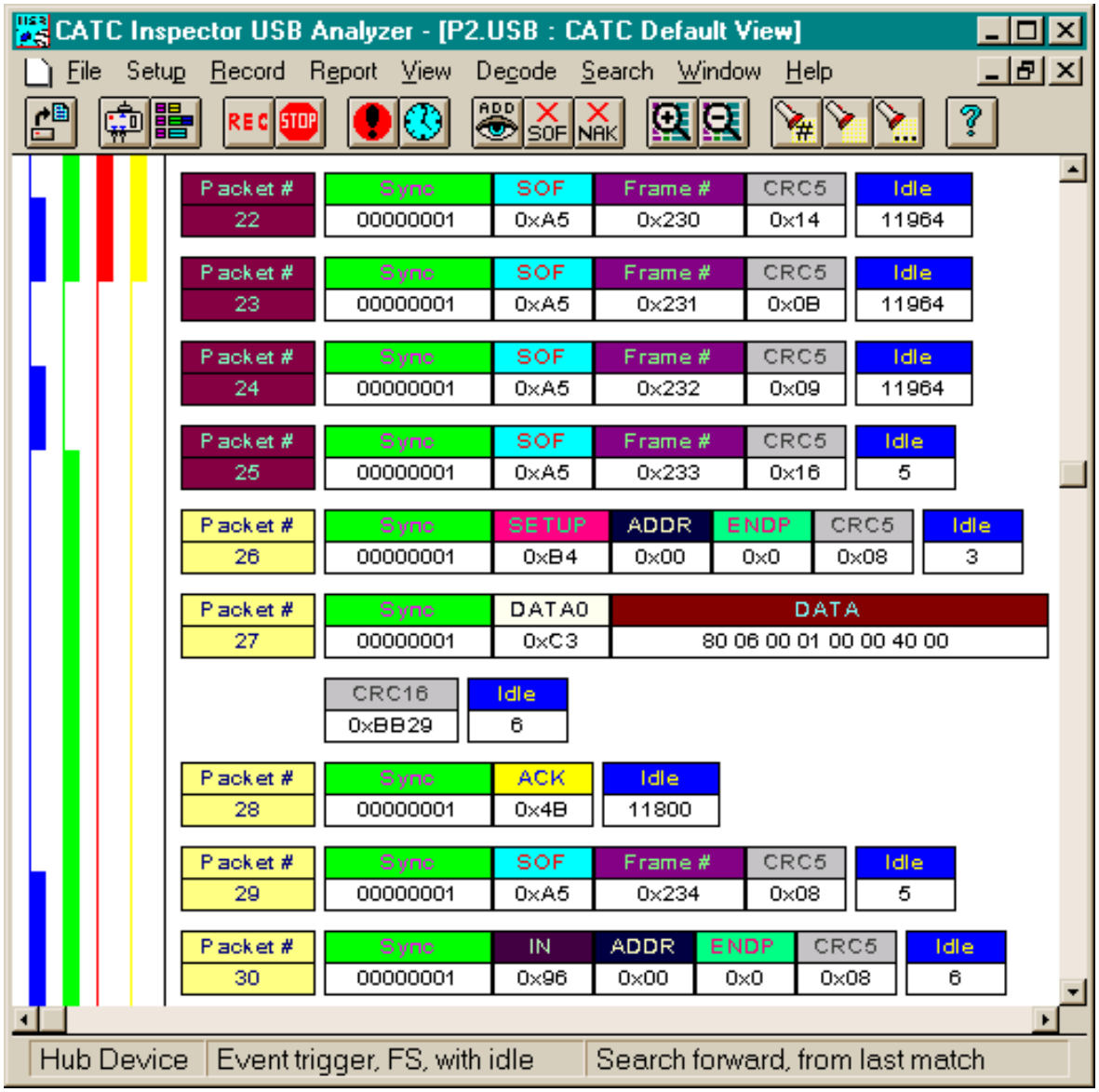
The CATC Inspector Bus & Protocol Analyzer continuously monitors all USB activity. At the operator's discretion, the analyzer will record a snap shot view of the bus traffic. It will store the data in a file (initially named "data.usb") on the system hard drive and then display the information on the screen. Once the information is captured and displayed, it can be viewed and analyzed using a variety of tools. The data can be stored permanently, and conveniently viewed on any PC equipped with the CATC Inspector software. A view-only version of the software permits subsequent viewing without the need for any Inspector hardware.

## 4.2 The Main Display Window

The CATC Inspector analyzer's main display incorporates the following set of Windows pull-down menus:

- File
- Setup
- Record
- Report
- View
- Decode
- Search
- Window
- Help

Clicking on any of these menus will expand it, offering various function selections. Subsequent sections of this document describe the operation of each menu item.




Additionally, several of the most frequently used functions can be activated by specific icons located on the toolbar immediately below the pull-down menus. Each icon's functionality is identified in the left portion of the status bar (at the bottom of the window) when the pointing device cursor moves over the icon. Finally, several operations can be invoked by clicking directly on the affected packet fields (using pop-up menus).

### 4.2.1 The Status Bar

The status bar is located at the bottom of the Inspector main display window. The functionality of each icon and menu item is briefly described in the bar when the pointing device cursor moves over the icon/item. At other times, the bar is divided into three segments, used to display the following:

#### 4.2.1.1 Device Class Status

The center segment displays the currently selected USB Device Class, used when displaying decoded Device Class requests. As described under Recording Status, below, this information will be temporarily overwritten during recording activity.

#### 4.2.1.2 Recording Options Status

The center segment displays the current Recording Options, consisting of trigger state ("Event", "Manual", "ExtStart", or "ExtStop"), idle recording state ("with idle" or "no idle"), and connection speed ("FS" or "LS", for full- and low-speed respectively). As described under Recording Status, below, this information will be temporarily overwritten during data-saving operations.

#### 4.2.1.3 Search Status

The rightmost segment displays the current search direction (forward or backward) and start position (from start/end of file, or from last match).

#### 4.2.1.4 Recording Status

During recording activity, the leftmost segment temporarily displays the current recording status. When the user activates the Record function, this segment will flash one of the following messages (depending on the selected Recording Options):

Recording...

Awaiting trigger to start recording...

Recording; awaiting trigger to stop...

Recording... awaiting event

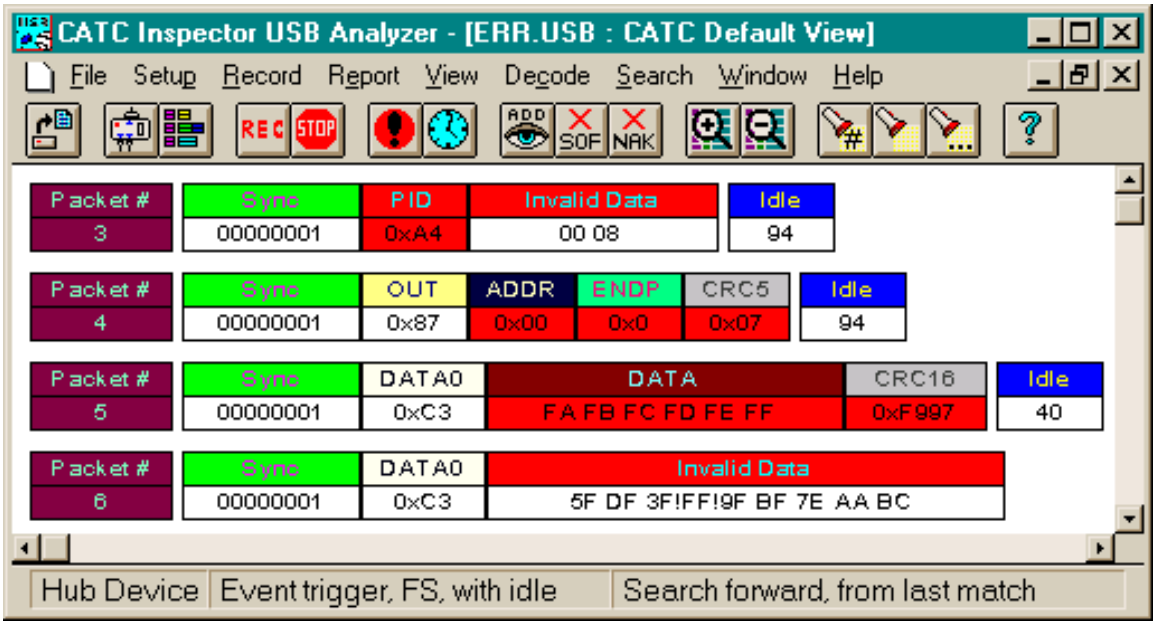
Recording... event occurred

After the Inspector stops recording, the flashing message changes to "Saving data...", which is a multiphase operation. In the first phase, the software scans the recorded data stream, computing the packet boundaries; during this phase, the center segment of the status bar displays the packet number currently being processed by the software. In the second phase, the traffic data is copied to disk, using the default file name "data.usb" (overwriting any previous version of this file). If user input data has been recorded, it will also be copied to disk (as part of the same file); the display will flash "Saving user data..." during this third phase.

When the software has finished saving the data, the recorded data file appears in the main display window and the recording status window is cleared. If the recording was the result of an Event Trigger, the first packet following the trigger (or the packet that caused the trigger) will initially be positioned second from the top of the display; otherwise, the display will begin with the first packet in the traffic file.

### 4.2.2 USB Packet Error Displays

The analyzer detects a variety of USB packet errors, and displays them as follows:




Packet #3 above has an invalid PID value; the PID value field is colored red, and the rest of the packet is marked as "Invalid Data". Packets #4 and #5 have incorrect CRCs; the CRC value field is colored red, as are the preceding fields associated with the CRC value. Packet #6 has bit stuffing errors; the affected field is marked as "Invalid Data", with any byte containing a bit stuffing error bracketed with exclamation marks ("!"). *When a bit stuffing error occurs, it is no longer possible to determine the correct data byte boundaries; thus all affected data (through the end of the packet) are collected into a field labeled "Invalid Data", displaying the raw data received, from left to right (regardless of the order specified in the Field Format Display Options).*

A related situation is the special case of Sync fields. Occasionally, the analyzer does not synchronize with the data stream until part way through the Sync token; such situations are marked by replacing the missed leading zero bits with underscore ("_") characters. This situation is not considered an error, but the analyzer reports only bits it has actually acquired.

In addition to packet errors, the Inspector analyzer also detects a wide variety of transaction errors. Reporting of these and other errors is discussed in section 4.6 ("The Report Menu").

## 4.3 The File Menu

The file menu behaves as a standard Windows File menu, allowing the operator to open existing analyzer traffic data files from previous sessions, save the data file from the current session, create/edit data file comments, and print all or selected portions of the selected data file.

The File menu includes the following functions:

### 4.3.1 Open...

Open an existing, previously recorded "*.usb" file (i.e., a CATC Bus & Protocol analyzer USB traffic file).

### 4.3.2 Close

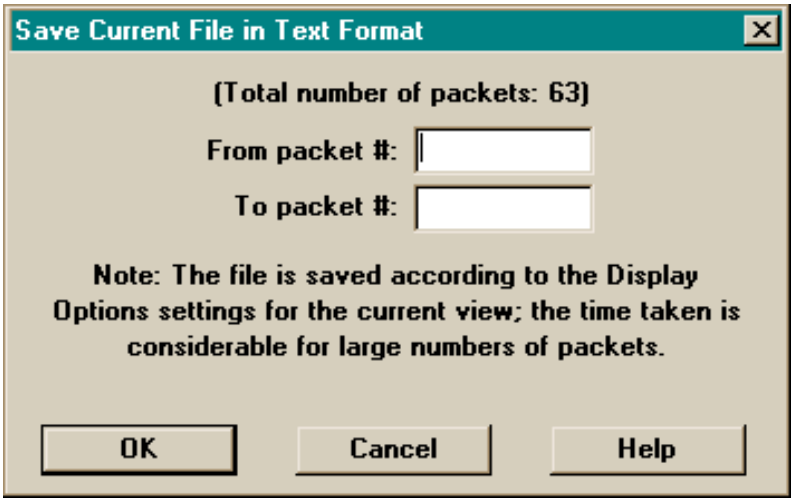
Close an open traffic data file.

### 4.3.3 Save As...

Save the currently displayed USB traffic data file with a newly-specified file name (more correctly, **Rename...** the file). If this function is not used following the capture of new data (which is recorded in the default file "data.usb"), the next recording will overwrite it. Any file name can be specified, though use of the ".usb" extension is recommended (see "Open", above); if no extension is specified, ".usb" will be added by default.

### 4.3.4 Save As Text...

Save all or a selected range of the current USB traffic data file in a text format for further viewing, analysis, and/or printing. Activating this function opens up the following selection box:




Data are saved according to the Display Options settings for the current view. The saved file can be opened with any standard text editor.

### 4.3.5 Edit Comment

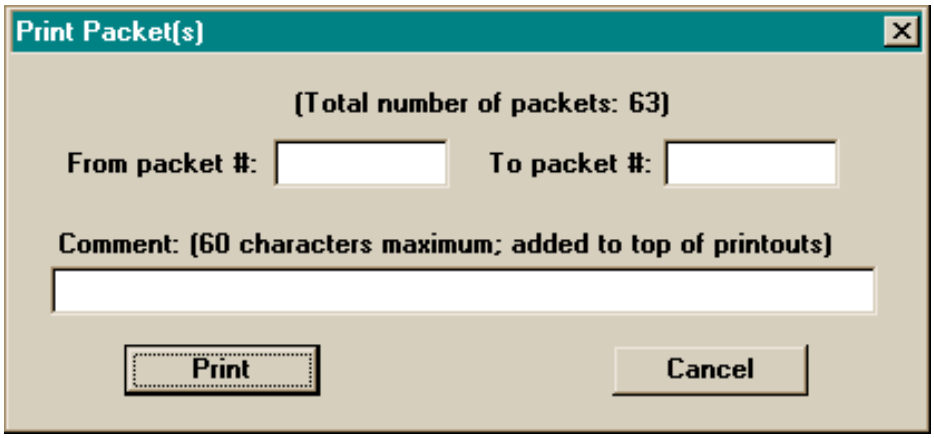
Create, view, and/or edit the 50-character comment field associated with each USB traffic data file.

### 4.3.6 Printer Setup...

The "Printer Setup..." menu item is a standard Windows function that allows configuring of the printer (paper size, source, orientation, etc.).

### 4.3.7 Print...

Print all or a selected range of the current USB traffic data file. Activating this function opens up the following selection box:




The specified traffic information will be printed as currently displayed, in color or grayscale as supported by the destination printer. Any supplied comment (up to 60 characters in length) will be printed following the current document name at the top of each page.

### 4.3.8 Exit

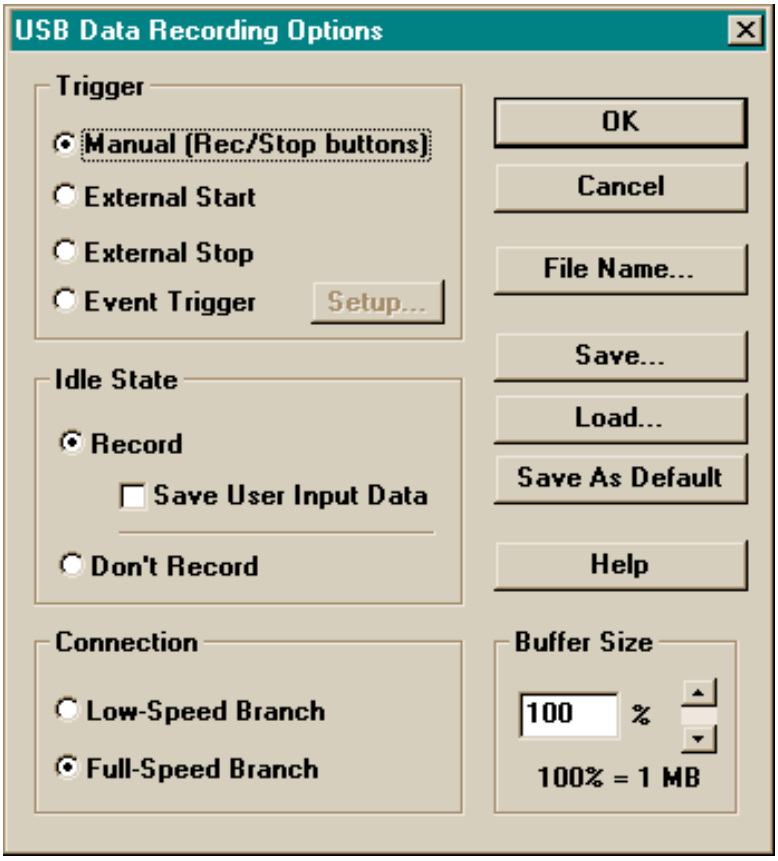
Terminate the CATC Inspector Windows application.

## 4.4 The Setup Menu

The CATC Inspector software offers many choices for recording, viewing, and analyzing USB traffic. The Setup menu includes "Recording Options" and "Display Options" functions that allow customization of these choices. Both functions are additionally available as individual icons on the toolbar in the main display window.

### 4.4.1 Recording Options...

The "Recording Options..." menu item enables customization of the recording criteria, using the following dialog box:




This box includes controls for trigger selection, idle state recording, bus speed selection, constraining the memory buffer size, and a variety of file-related functions. Once the desired recording options are specified (by activating the "OK" button), they remain valid until changed again by the Recording Options function.

*Note: Selecting the OK button to confirm record option selections does not start recording. To actually record USB traffic, either the "REC" icon or the Record menu's "Start" item must be activated.*

#### 4.4.1.1 Trigger Selection

The CATC Inspector supports four modes of data recording triggering:

- Manual
- External Start
- External Stop
- Event Trigger

The external trigger modes work in conjunction with the trigger (active low) input on the External Interface Breakout Board, as previously described under "External Triggers".

##### 4.4.1.1.1 Manual Trigger

In this mode, the analyzer will start to record when the user activates the "REC" icon or "Start" in the Record Menu, and stop when the CATC Inspector on-board buffer memory is full or when the "STOP" icon (or menu function) is activated, whichever comes first.

##### 4.4.1.1.2 External Start Trigger

In this mode, the analyzer **starts** recording when an external trigger signal is detected. This permits recording following a specific point of interest (aided by external decoding).

It is still necessary to "arm" the Inspector software by activating the "REC" icon or "Start" in the Record Menu. Actual recording will begin following detection of an external trigger signal, and stop when the CATC Inspector on-board buffer memory is full or when the "STOP" icon (or menu function) is activated, whichever comes first.

##### 4.4.1.1.3 External Stop Trigger

In this mode the analyzer **stops** recording when an external trigger signal is detected. This permits recording up to a specific point of interest (aided by external decoding).

The operation is initialized by activating the "REC" icon or "Start" in the Record Menu. At which time the analyzer will start recording immediately, and continuously, until it detects the external trigger signal, or when the "STOP" icon (or menu function) is activated, whichever comes first. The system's buffer memory is filled cyclically until the stop trigger occurs, and thus will hold (a maximum of) the last megabyte of USB data that appeared on the bus prior to the trigger.

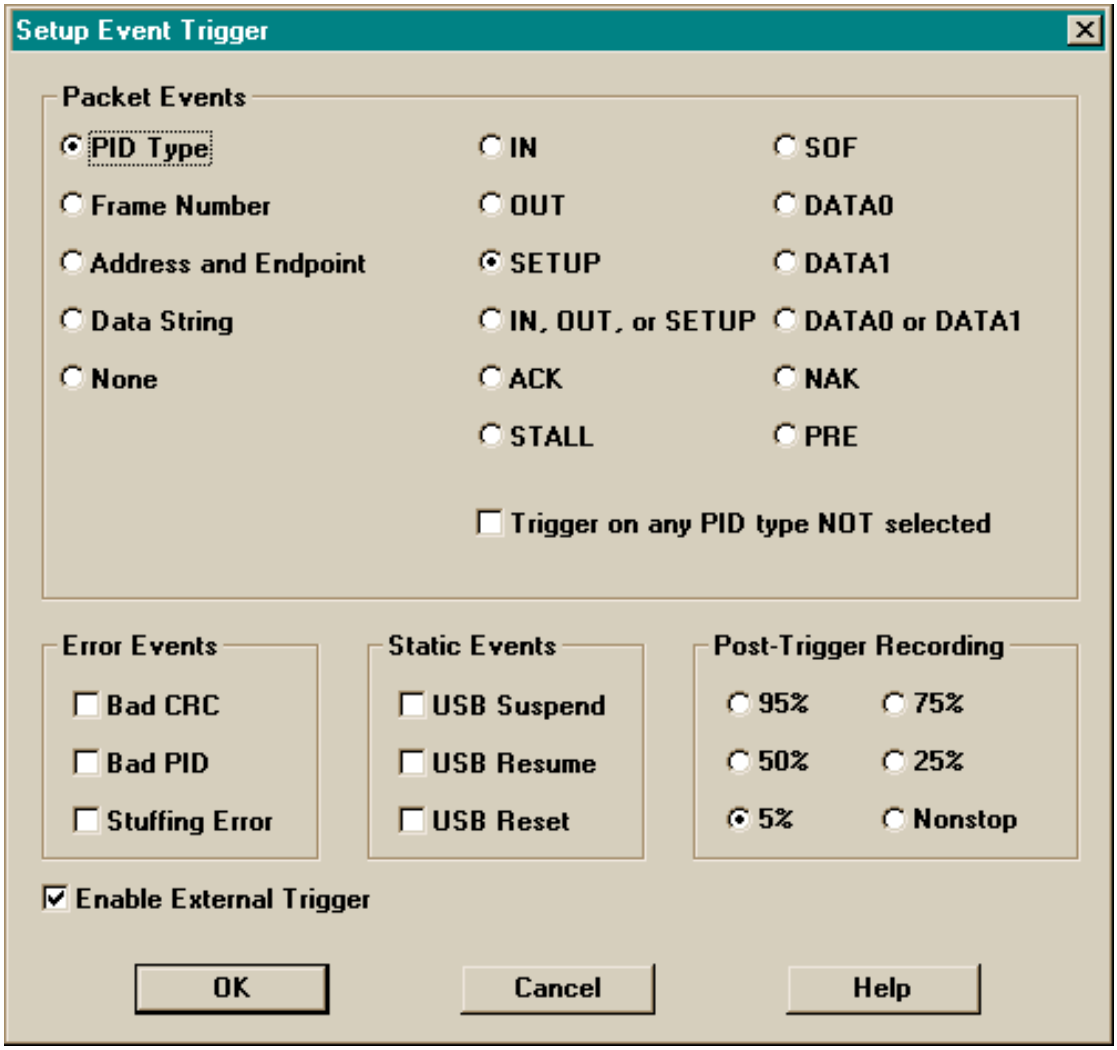
##### 4.4.1.1.4 Event Trigger

In this mode, the analyzer will record the USB traffic stream surrounding the detection of one or more specific **events**. These events are selected by the user, and include:

- a packet of a particular type
- a specific frame number
- a reference (Setup, In, or Out) to a particular address/endpoint
- a distinctive value in a data packet
- a protocol error condition (bad CRC, invalid PID, bit stuffing error)

- a static bus event (Suspend, Resume, Reset)
- an external trigger signal input
- various combinations of the above

Selection of the "Event Trigger" recording mode will enable the "Setup..." button immediately to its right; clicking on the button will bring up the following dialog:



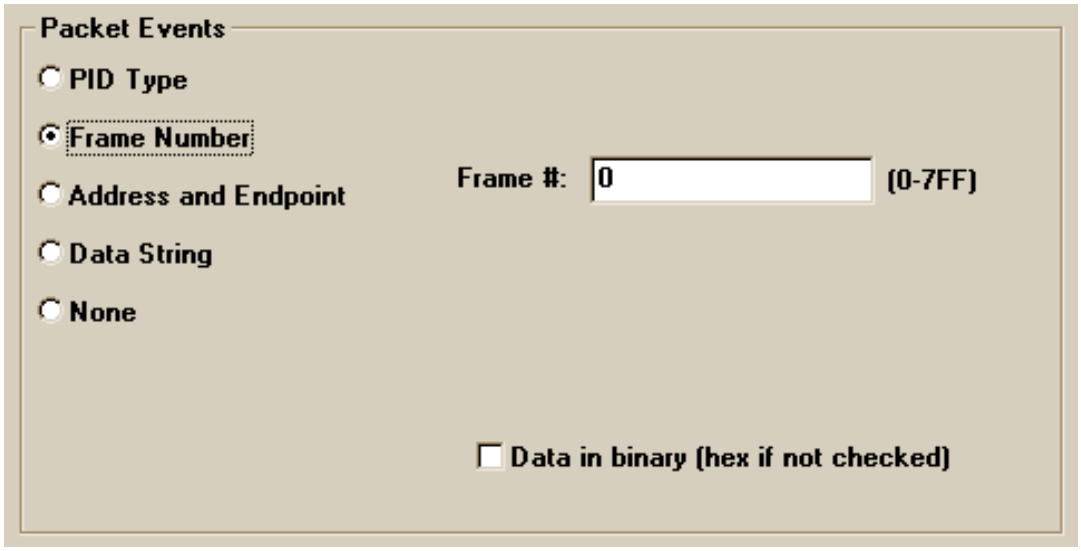

This dialog box contains four panels and a checkbox; the following examines each of these in turn...

#### 4.4.1.1.4.1 Packet Events

This panel allows for the selection of a variety of packet types (and, in some cases, contents). The detection of a packet matching the specified criteria will be interpreted as a trigger event.

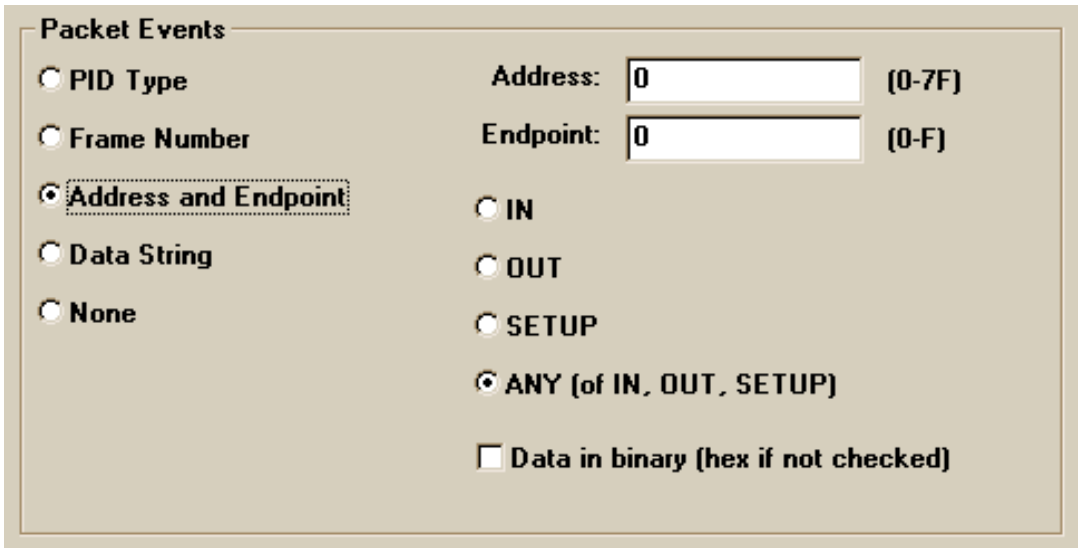
*PID Type:* This is the default event selection (using the dialog box shown above); it permits the operator to select a particular PID type to act as the Event Trigger. Two of the permitted options ("IN, OUT, or SETUP" and "DATA0 or DATA1") combine multiple PID types into one selection. A checkbox ("Trigger on any PID type NOT selected") inverts the meaning of the PID selection: the chosen item will be the only one **not** interpreted as a trigger event.

*Frame Number:* This option permits the definition of a trigger event as a specified frame number, using the following dialog box:



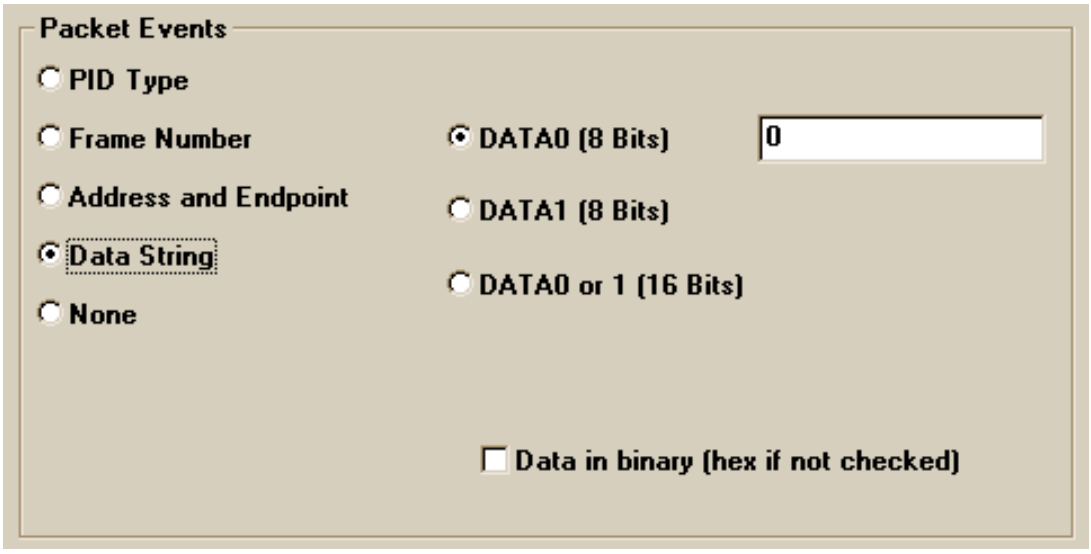

The frame number can be entered in hexadecimal (the default), or—by marking the checkbox—in binary.

*Address and Endpoint:* This option permits the definition of a trigger event as a specified address/endpoint number, found in either or any of an In, Out, or Setup packet, using the following dialog box:



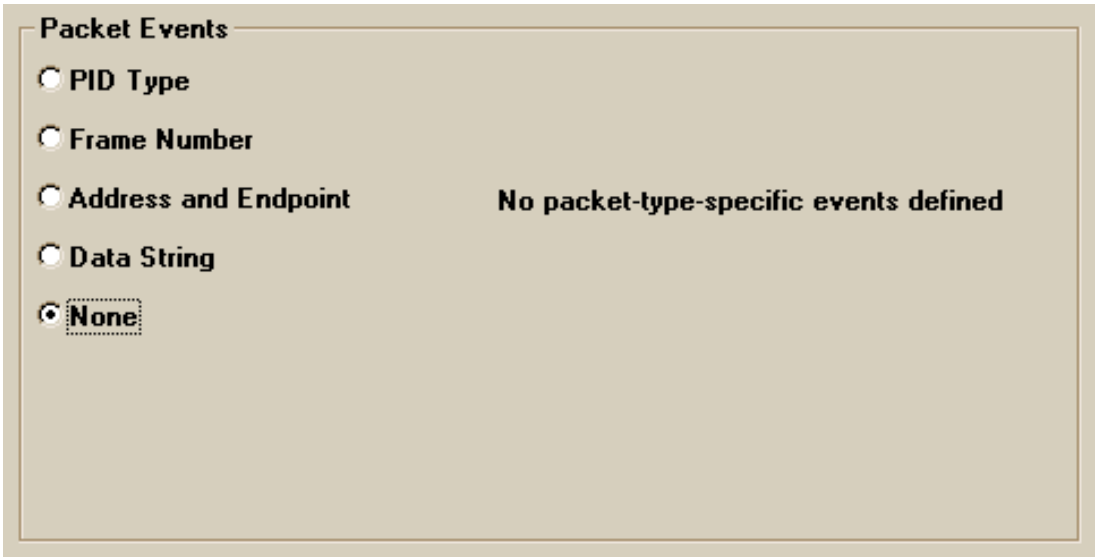

The address and endpoint values can be entered in hexadecimal (the default), or—by marking the checkbox—in binary.

*Data String:* This option permits the definition of a trigger event as a specified bit sequence, using the following dialog box:




When searching specifically within a DATA0 or DATA1 packet, the Inspector hardware restricts the length of the bit string to 8 bits; if both DATA0 and DATA1 packets are included in the search target, the string can be 16 bits. The search makes no assumptions as to bit alignment; the specified string will match any such sequence in the specified type(s) of data packets. Data values can be entered in hexadecimal (the default), or—by marking the checkbox, as illustrated above—in binary.

*None:* Selecting this option is appropriate when trigger events are to be chosen only from among Error Events, Static Events, and an External Event (i.e., no packet-type-specific event is required). It displays the following panel in the dialog box:

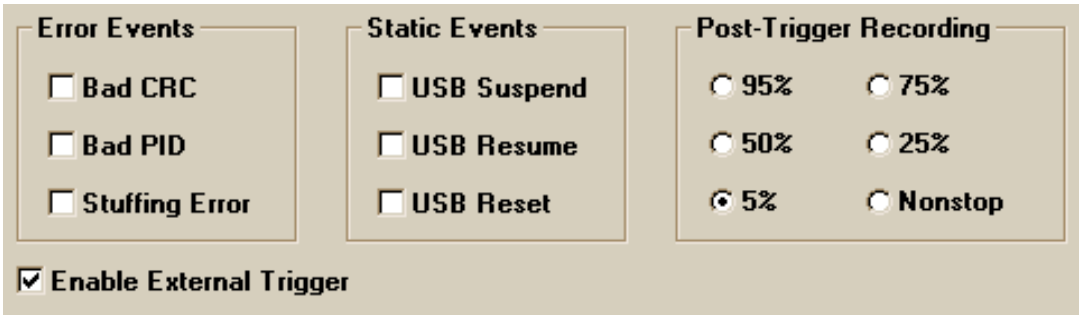



#### 4.4.1.1.4.2 Error Events

Any combination of bad PID value, bad CRC value, and bit stuffing errors can be detected and used as a trigger event, by marking the appropriate checkboxes.

#### 4.4.1.1.4.3 Static Events

Any combination of USB Reset, Resume, and Suspend signals can be detected and defined as a trigger event, by marking the appropriate checkboxes.




#### 4.4.1.1.4.4 Post-Trigger Recording

The user can select the percentage of buffer memory assigned to post-trigger data recording; available selections are: 95%, 75%, 50%, 25%, 5% and nonstop.

The software uses the analyzer's full one megabyte memory to capture event-triggered USB traffic (regardless of any buffer size specified by the user). Following the trigger event, recording continues until the selected percentage of the total memory contains post-trigger data, and then stops recording. When recording ceases, the program saves and displays the complete recorded data stream, or the final megabyte of recording, whichever is less.

*Note: The specified percentage is always that of the total memory; if the trigger event occurs quickly, only a small portion of the buffer might be used for pre-trigger traffic, but the post-trigger data will always occupy the specified amount of memory.*

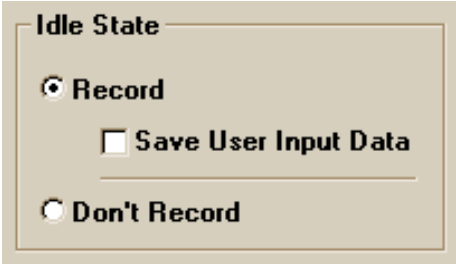
In nonstop mode, the analyzer continues to record indefinitely. This feature can be used to generate USB event-decoding signals on the External Interface Breakout Board's "Data In/Out" connector for external circuitry.

#### 4.4.1.1.4.5 External Event Trigger

To enable an external trigger, mark the Enable External Trigger checkbox in the Data Recording Options dialog box.

#### 4.4.1.2 Idle State Recording Selection

"Idle" is a valid state of the USB physical layer between packets. By default, the CATC Inspector analyzer records all bus activity, including the Idle state; in this mode, the available buffer space permits the recording of just under 0.67 second of full-speed (5.36s of low-speed) traffic.




Idle state recording can be disabled by selecting the "Don't Record" option (in the Idle State panel of the Data Recording Options dialog box, shown above); this will increase the recording time to just under 4 minutes of full-speed traffic (low-speed recording time is traffic-dependent, and could be hours). In this mode the analyzer suspends recording upon detection of the Idle, and resumes upon detection of the start of the next packet (SOP), which is a transition from the J to the K state.

Although this permits greatly increased recording times, there are two associated drawbacks:

1. When bus traffic is at a minimum, it can take a long time to fill the analyzer's recording memory. This is especially true if event detection mode is selected (and thus the memory size cannot be reduced below one megabyte). Once a triggering event has been detected it may still take several minutes before recording stops, due to limited bus traffic filling the memory. Two things can be done to help alleviate this problem: setting the amount of post trigger memory to a minimum, and stopping manually once the trigger has been detected. The analyzer provides both LED and on-screen "triggered" indicators for this purpose.
2. Recording without Idle state eliminates the real-time information, so the CATC Inspector software will not be able to support any of the timing related features.

##### 4.4.1.2.1 User Input Data Recording

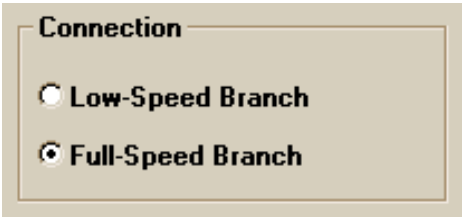
Whenever the Idle state is being recorded, it is also possible to simultaneously record up to four externally supplied User Input Data signals (from the External Interface Breakout Board) along with USB traffic. To select this option, mark the "Save User Input Data" checkbox in the Idle State panel.

This can be quite useful for recording state or timing information from external devices, or for extending the event detection capability of the analyzer. For example, it is possible to "jumper" output signals from the breakout board back to the user data inputs, in order that selected events can be viewed in the display while not selected as triggers. External timing signals (which should be TTL levels to be recorded properly) are sampled once for each byte of USB traffic.

Recording, saving (in USB data files), and displaying this external timing and state data adds notably to the processing time of the Inspector software (and the size of the traffic files); thus it is recommended that this only be enabled as required.

#### 4.4.1.3 Connection Speed Selection

This panel of the Data Recording Options dialog box allows specification of the USB branch where the analyzer is connected. If Low-Speed is specified, the analyzer views the bus traffic as would a low-speed device, switching its internal clock (from the full-speed 12 MHz) to 1.5 MHz clock. Additionally, it inverts the data polarity to provide the software with the correct binary information.




*Note: To use the analyzer's full event triggering capability with USB low-speed bus transactions, it should be connected directly to the low-speed bus branch under test. If the unit is connected to a full-speed branch containing low-speed traffic, the data content of the low-speed packets will not be evaluated for triggering events. The PRE PIDs remain valid triggering events, however, and all displays of USB traffic show complete full- and low-speed packets.*

#### 4.4.1.4 File Name...

Use the specified file name when saving the recorded traffic data file; the default name is "data.usb". Any file name can be specified, though use of the ".usb" extension is recommended (see "Open", under "The File Menu", above); if no extension is specified, ".usb" will be added by default.

#### 4.4.1.5 Save... (Recording Options)

Save the currently specified Recording Options for use in future recording sessions. Any file name can be specified, though use of the ".rec" recommended is suggested (see "Load...", following); if no extension is specified, ".rec" will be added by default.

#### 4.4.1.6 Load... (Recording Options)

Load a previously saved "*.rec" file, thus restoring a previous set of Recording Options.

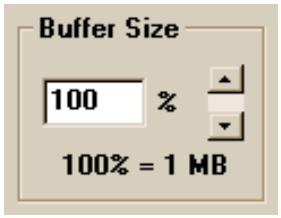
#### 4.4.1.7 Save As Default (Recording Options)

The "Save As Default" function is equivalent to the "Save..." function, specifying the file name "default.rec". Whenever the CATC Inspector software begins execution, it automatically loads the "default.rec" file, if one exists.

#### 4.4.1.8 Buffer Size

When recording without Idle, or from a low-speed branch, it is often useful to use less than the full buffer space of the Inspector analyzer (to save recording time, or reduce the amount of

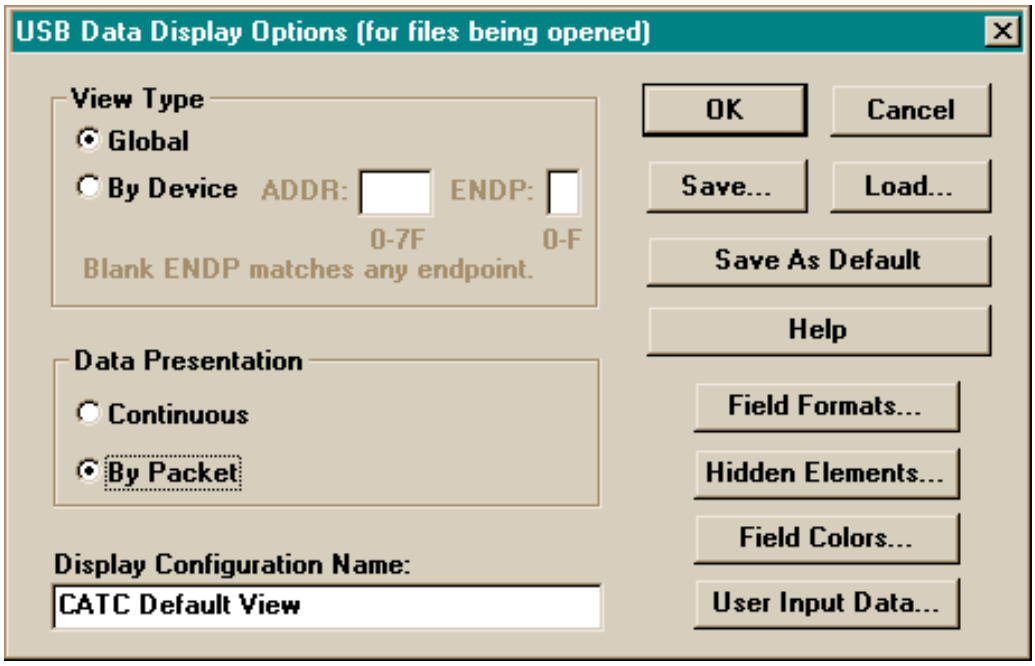
captured data). The "Buffer Size" panel of the Data Recording Options dialog box allows selection of the desired portion (from 10% to 100%) of the buffer memory.




*Note: This option has no effect when an Event Trigger is selected, in which case the entire buffer memory is used.*

## 4.4.2 Display Options...

The "Display Options..." menu item allows customization of the way that the recorded USB traffic data files are presented on the screen. The USB Data Display Options dialog box includes control buttons for the selection of data presentation and screen formatting options, plus the ability to save and restore custom display option configurations. The Inspector software will display the recorded data as specified, highlighting any packet fields that violate USB specifications (e.g., missing stuff bits, invalid PID type, bad CRC, etc.).




Once the desired options are established (by selecting the OK button), they will remain valid until the Display Options function (which can also be invoked from the Add View function in the Display menu) is used again.

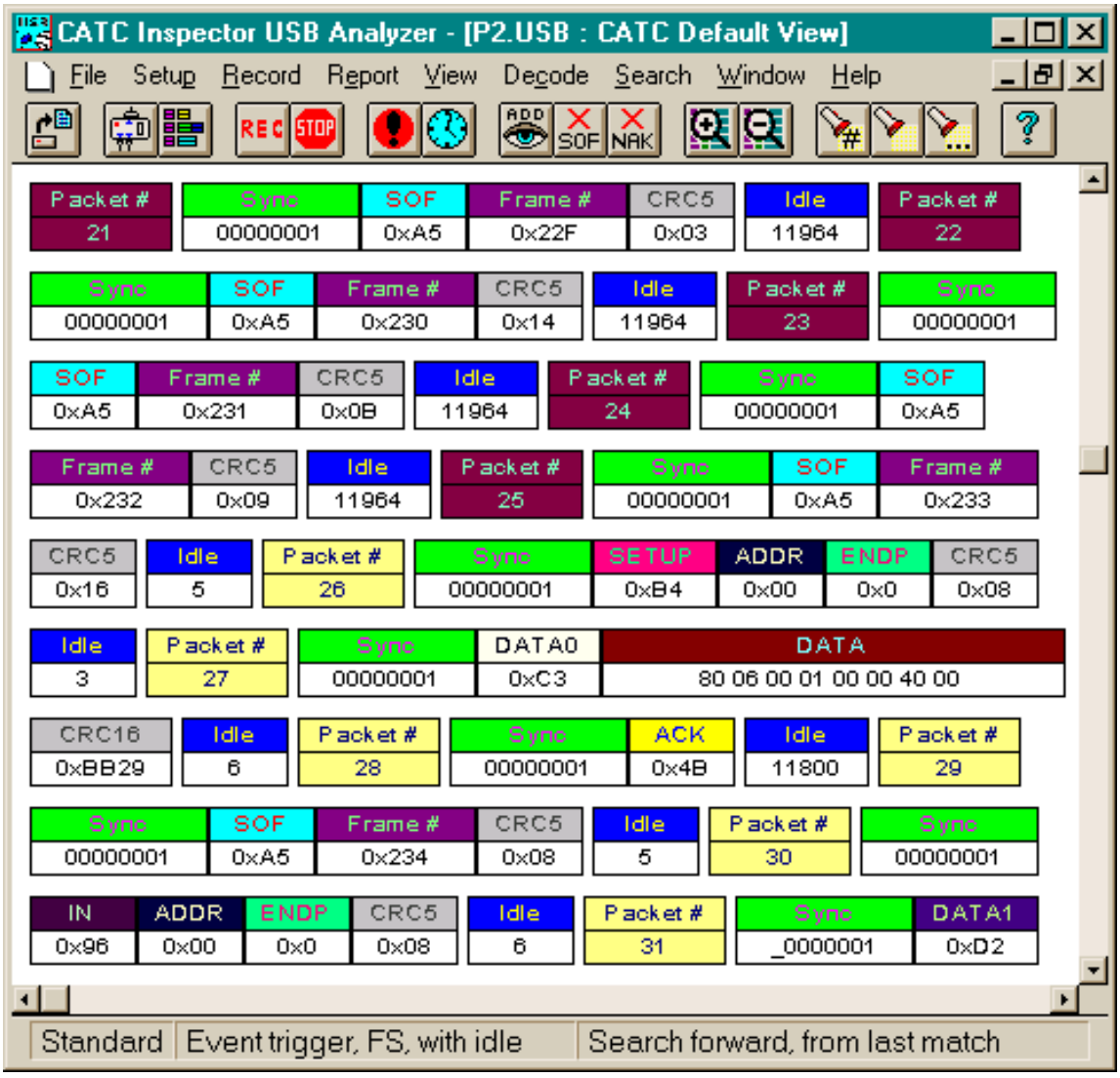
*Note: Selecting the "OK" button to confirm the display options selection does not change the current data view. Only newly created views are affected.*

### 4.4.2.1 View Type

The user can choose whether to view recorded data in a "global" fashion (i.e., displaying all of the data) or "by device". In the latter case, a device is specified by entering its address and, optionally, an endpoint number (if no ENDP is specified, all endpoints are included); subsequently, only SOF (start of frame) packets, and those pertaining to transactions with the specified device will be displayed. Note that the display of SOF and NAKed transaction packets can be independently suppressed (see "Hidden Elements", below).

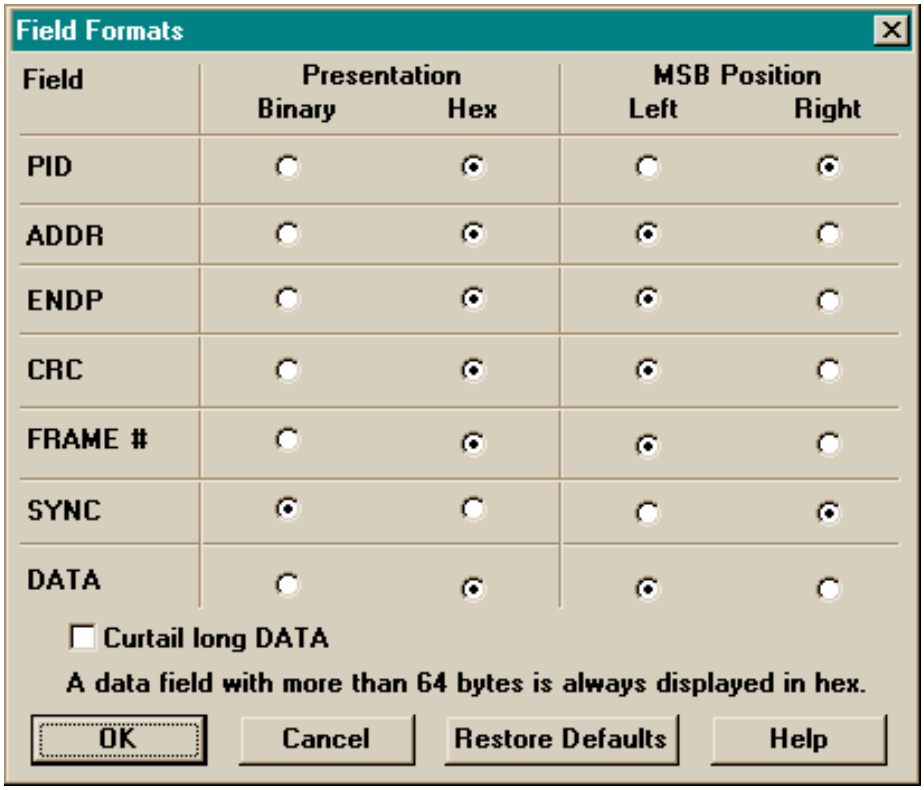
### 4.4.2.2 Data Presentation

Recorded data is displayed either as a "Continuous" stream, or separated "By Packet", as selected. The following screen duplicates the USB traffic information of the screen shown in section 4.2 ("The Main Display Window"), but uses a continuous mode display:



### 4.4.2.3 Field Formats

The CATC Inspector software supports several different formats in which the USB traffic data can be displayed. When the 'Field Formats' button is selected, the following dialog box opens, enabling a choice of viewing mode (either binary or hexadecimal format) for each of the special message fields (Sync, PID, CRC, etc.). In addition, each field can be viewed with the most significant bit (MSB) positioned on its left or right side.




Data fields can sometimes be quite lengthy. To reduce screen clutter, data fields longer than 64 bytes are always displayed in hexadecimal, regardless of the field format specification. In addition, if the "Curtail long DATA" checkbox is marked, data fields longer than 16 bytes will be displayed as their initial two bytes (one byte when in binary mode) plus a remaining byte count. Thus a field that might otherwise occupy several lines of display will be shown as:

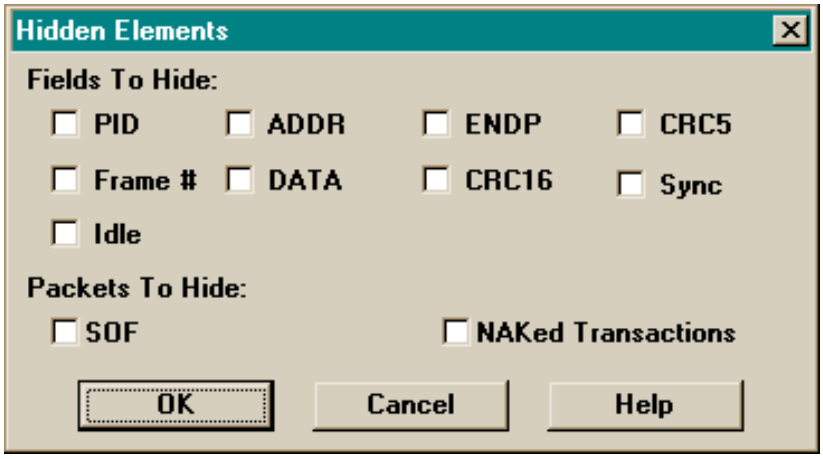



It is possible to revert back to the default setting at any time by selecting the 'Set to Defaults' button. After making the desired selections, selecting the OK button will close this dialog box and return to the Display Options dialog box for additional selections.

### 4.4.2.4 Hidden Elements

It is occasionally convenient to display only some of the different USB packet fields. For example, eliminating the display of Sync and Idle state fields (in situations where they are not significant) can often simplify, and thus clarify, the traffic display. The Hidden Elements button,

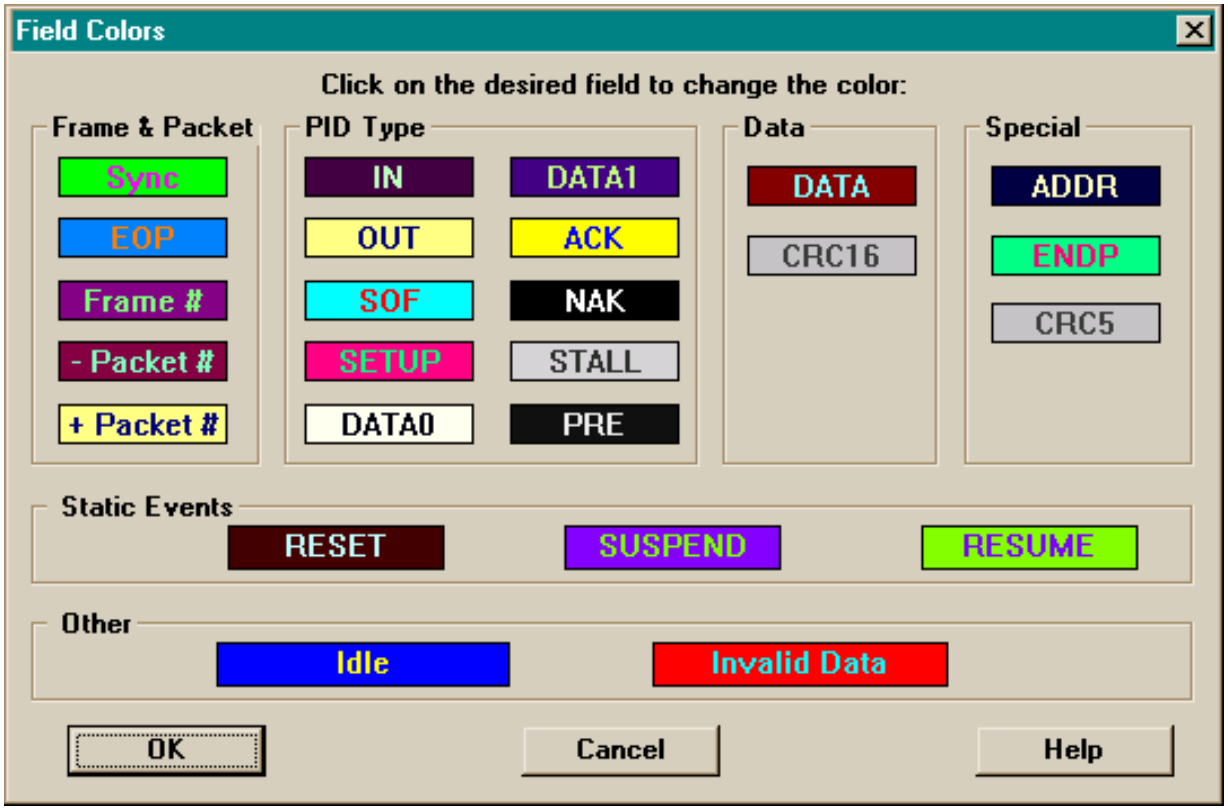
which brings up the following dialog box, allows customization of the message fields to be included in the display.




The suppression of certain entire packets may additionally be of benefit; the CATC Inspector analyzer enables the removal of all SOF packets, and also those pertaining to any NAKed transaction, from the traffic display. Note that the hiding of SOF and NAKed transaction packets can also be controlled specifically for the current view (see section 4.7, "The View Menu").

### 4.4.2.5 Field Colors

The Field Colors button allows customization of the color associated with each field in the message, using the following dialog box:

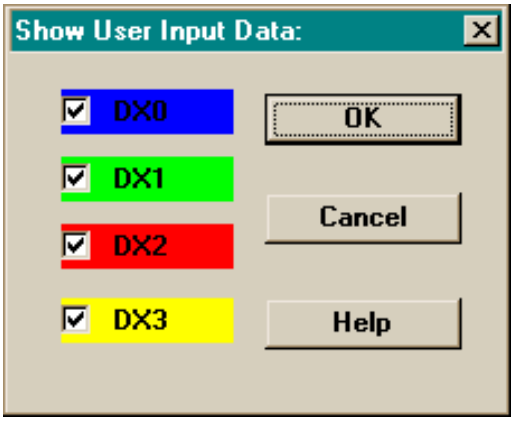


Users may choose to experiment with this option to achieve a color combination that is best suited to a particular graphic system. A brighter color might be appropriate for a specific field that should stand out in the display (e.g. the Setup PID field). Note that the color of an Invalid Data (packet error) field cannot be changed; it is permanently set to red.

Two color fields are provided for packet number displays. The first ("- Packet #") is used to define the color for packets prior to an Event Trigger; the second ("+ Packet #") defines the color for packets following the trigger. If the packet itself was the trigger-causing event, it will be colored in the second color. In traffic streams that were recorded without an Event Trigger, all packet number displays use the first color.

#### 4.4.2.6 User Input Data

Selecting the User Input Data button brings up the following menu, with checkboxes for each of the four channels of user input data that can be recorded by the CATC Inspector analyzer:




This merely chooses which of the user input data channels will be displayed; actual recording of the input data is controlled by the "Save User Input Data" checkbox, located in the Idle State panel of the Recording Options dialog box.

User input data is displayed to the left of—and time correlated with—the USB packet traffic, in much the fashion of a traditional logic analyzer display. It is only shown in packet (i.e., not continuous presentation) display mode. Note that the display colors for these items is fixed, and cannot be altered by the user.

The displayed resolution of the USB traffic is on a per-packet basis, thus user input data that is changing at a frequency greater than the packet rate will not be properly represented.

#### 4.4.2.7 Save... (Display Options)

Save the currently specified Display Options for use in future sessions. Any file name can be specified, though use of the ".opt" extension is recommended (see "Load...", following); if no extension is specified, ".opt" will be added by default.

#### 4.4.2.8 Load... (Display Options)

Load a previously saved "*.opt" file, thus restoring a previous set of Display Options.

#### 4.4.2.9 Save As Default (Display Options)

The "Save As Default" function is equivalent to the "Save..." function, specifying the file name "default.opt". Whenever the CATC Inspector software begins execution, it automatically loads the "default.opt" file, if one exists.

#### 4.4.2.10 Display Configuration Name

This field is used to enter a text string (30 characters maximum) to be associated with the current set of Display Options. This name will be saved with the option set, and appear as part of the title of the view window that is created using this set of options.

## 4.5 The Record Menu

The Record menu has two items ("Start" and "Stop", described below), used to activate recording activity. When the record function is active, the current recording status is displayed in the status bar.

### 4.5.1 Start

Selecting the Start function instructs the CATC Inspector analyzer to begin recording USB traffic data, as specified by the Recording Options.

### 4.5.2 Stop

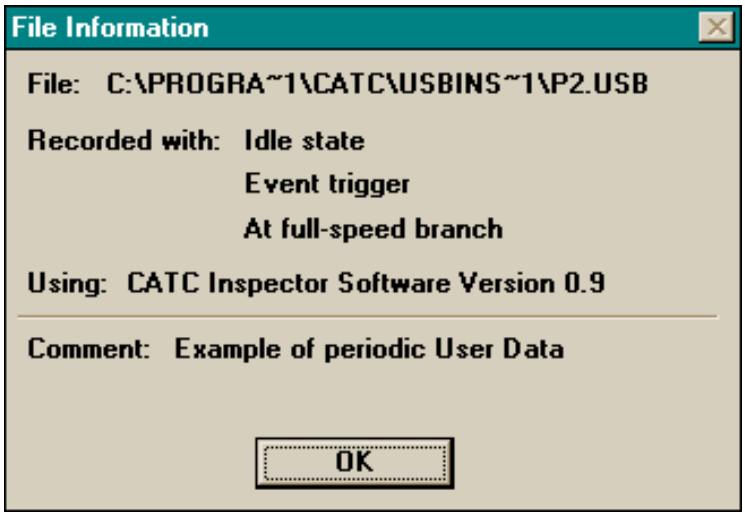
Selecting the Stop function instructs the analyzer to stop the data recording process. This feature is primarily of use when recording low-speed traffic, or not recording Idle states, which could take a long time to fill the recording buffer.

## 4.6 The Report Menu

The Report Menu contains five items, used to generate information displays concerning the current traffic data view.

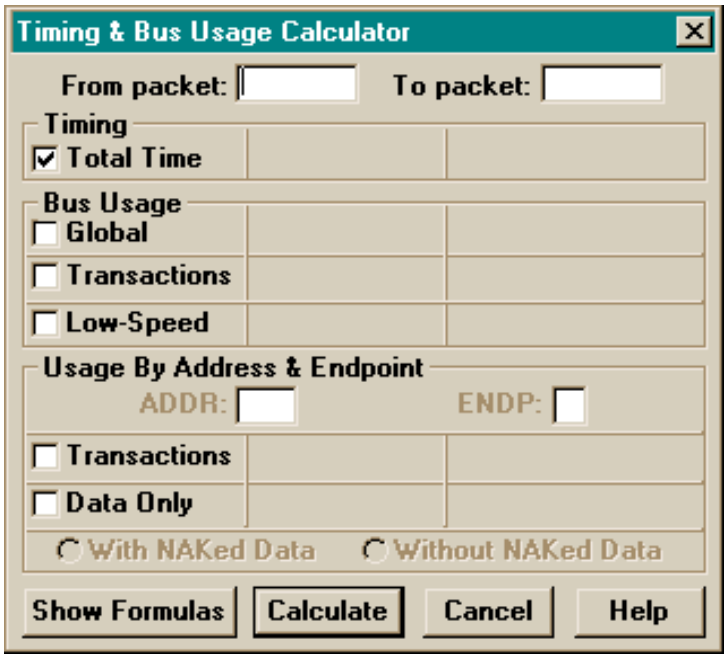
### 4.6.1 File Information

The File Information menu item displays information about the traffic file currently being viewed, including the recording time and conditions, and any comment line that may have been added to the file.



### 4.6.2 Timing Calculations

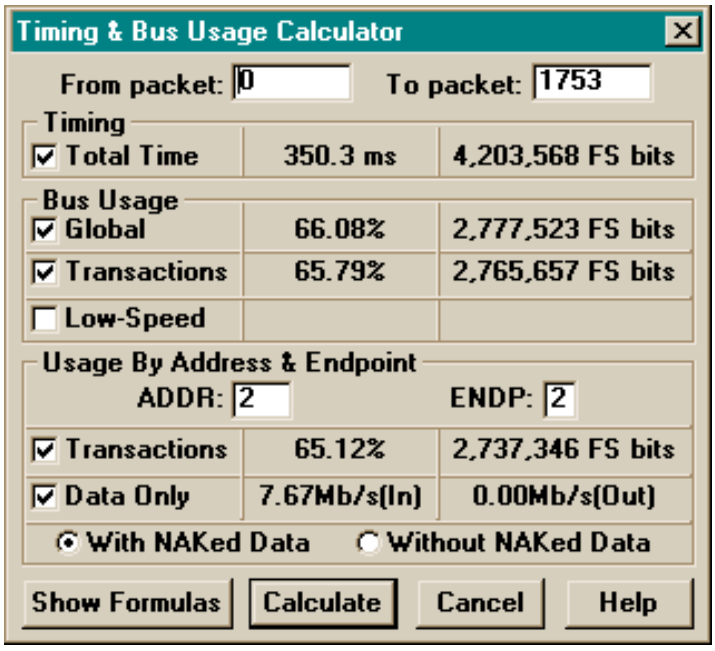
This menu item (enabled only for files recorded with Idle state) opens the following "calculator" display, permitting computation of the time difference between any two packets in the file:



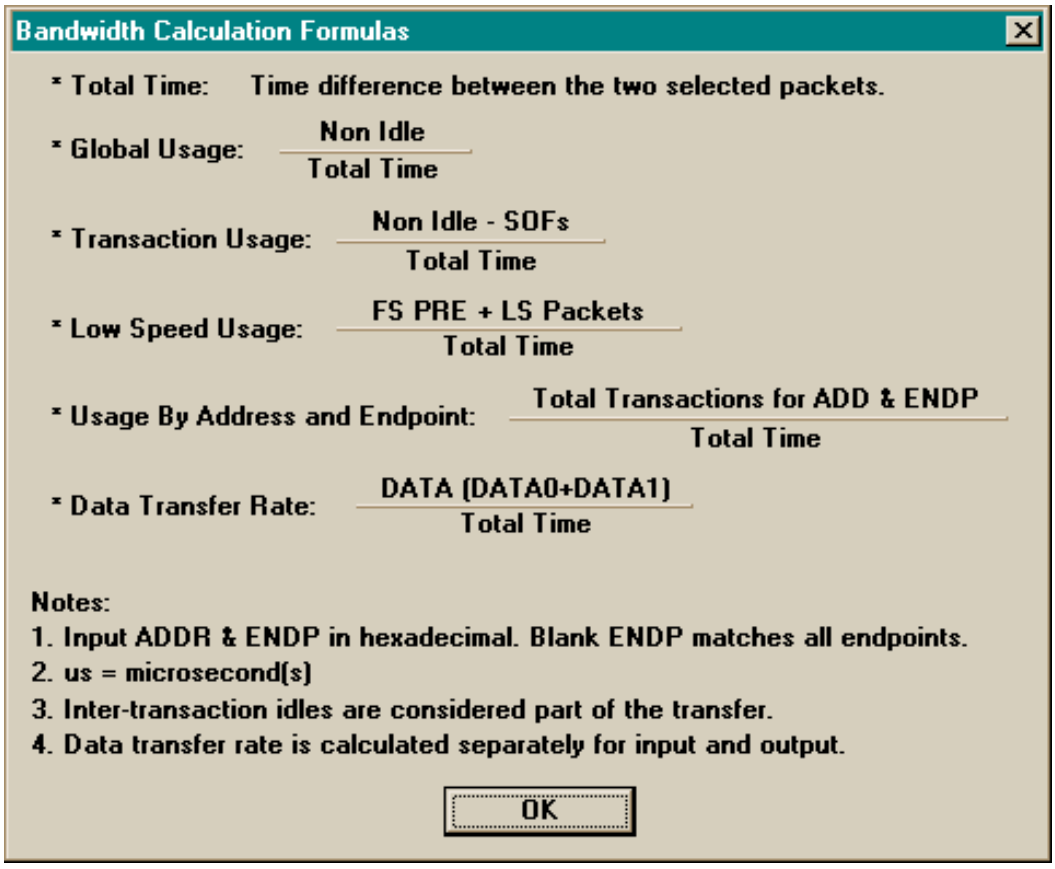

Entering relevant packet numbers and selecting the "Calculate" button results in a display of the packet-to-packet time (measured from start of Sync to start of Sync) in both microseconds (or milliseconds), and bit times. If no packet numbers are entered, the computation is performed over the entire range of packets in the currently displayed file. An appropriate error message is provided if either of the selected packets does not contain a Sync field (i.e., SUSPEND or RESET sequences).

If additional check boxes are marked, further information will be calculated and displayed (note that bus usage computation can take a noticeable amount of time, depending on the range of packets selected). Usage will also be computed for specific addresses (and optionally, endpoints; if ENDP is left blank, all endpoints for the specified address will be included).

The following example shows such a display for a data capture of USB traffic, using isochronous data transfers (the nature of the device—a camera—accounts for the high percentage of bus utilization):



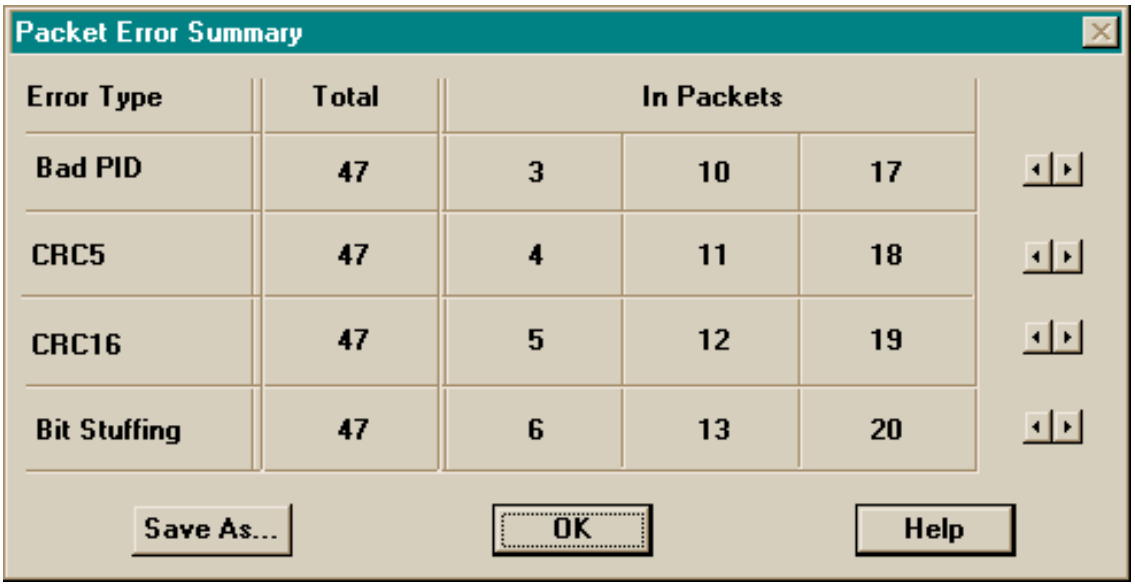

Selecting the "Show Formulas" button presents the following display, summarizing the formulas used to compute bandwidth utilization.



*Note: The active file display can be scrolled, and other files opened; the calculator dialog box remains open (and frontmost) until "Cancel" is selected, or all files closed. Computations are always performed on the currently active file.*

### 4.6.3 Packet Error Summary

The Packet Error Summary menu item displays a summary table of abnormal bus conditions detected in the current recorded file, as follows:

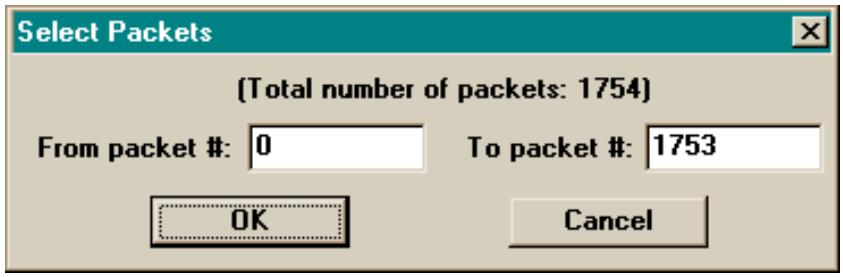



For each error type, the summary lists the packet number(s) in which these errors occur. The dialog box remains open (and frontmost) even if the window is no longer active, allowing manipulation of the open data file view while the error summary is visible (for example, scroll or go to an error packet listed in the error summary). Packet error summary data can be saved (with the "Save As..." button) for future use. See "Saving Summaries as Text Files", below.

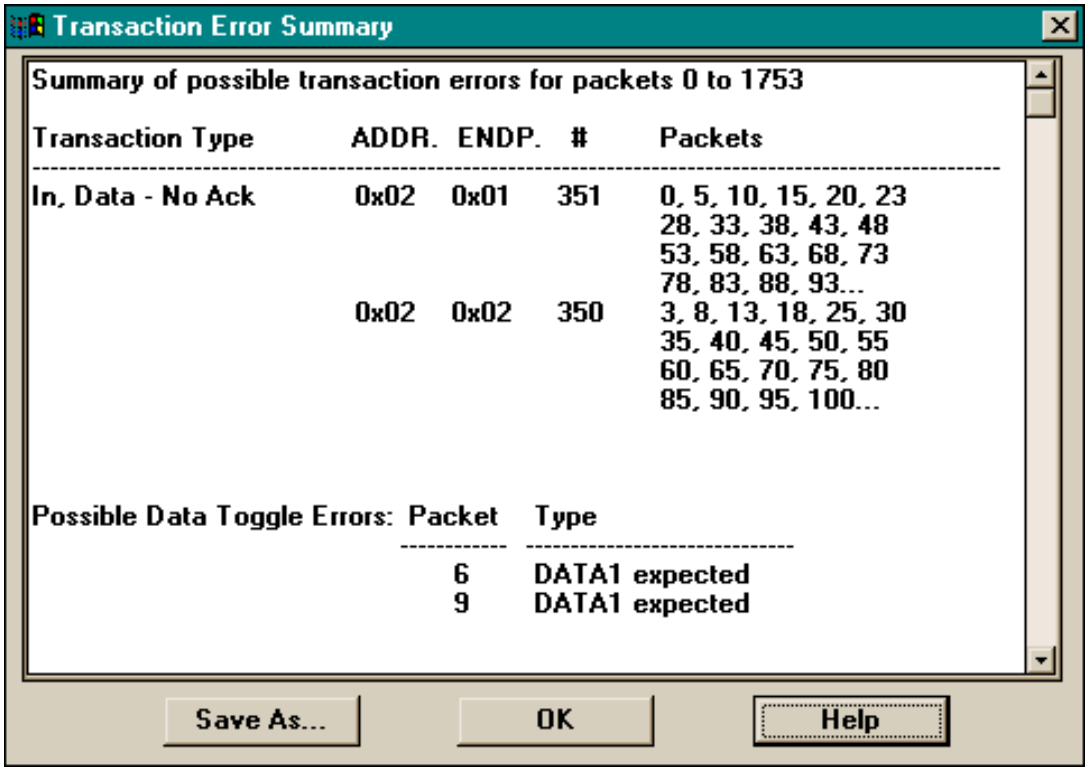
*Note: The number of error packets listed in the error summary is limited to a maximum of 200 for each error type.*

### 4.6.4 Transaction Error Summary

Selecting the Transaction Error Summary menu item brings up a dialog box enabling the specification of a range of packets to search for transaction errors (initialized to the complete set of packets in the file), as follows:



Selecting "OK" in this dialog will subsequently display a listing of possible transaction errors detected in the specified range of packets, such as:



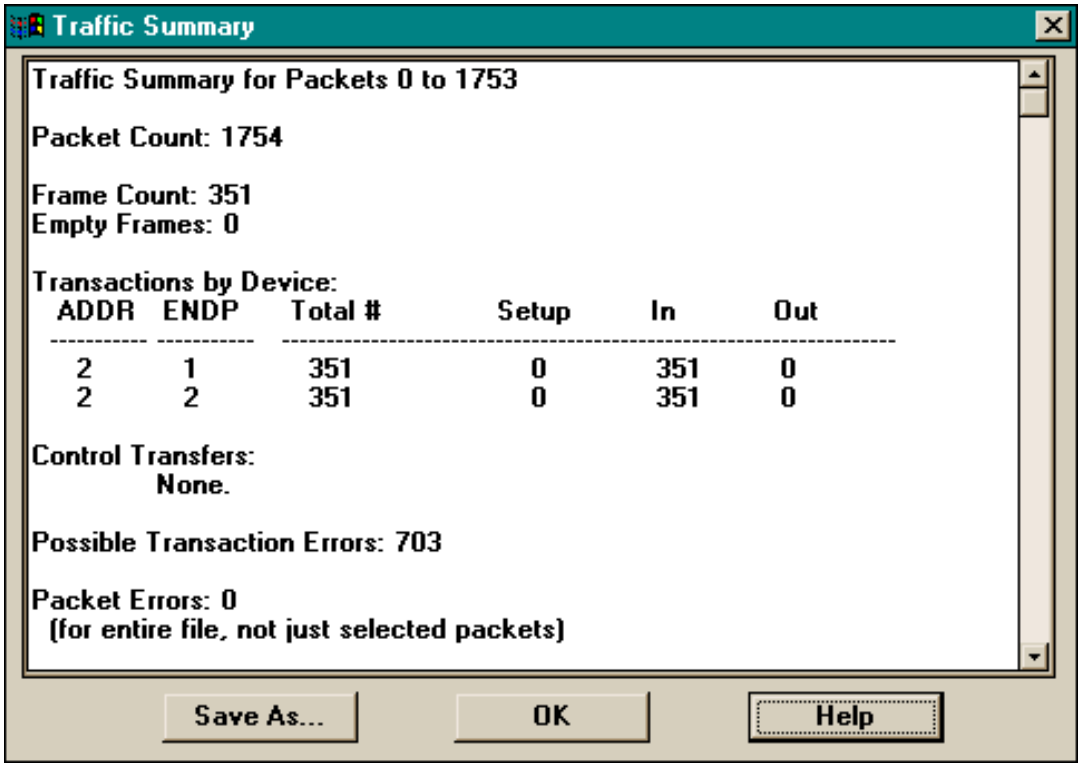

When there are long lists of packets containing the same transaction error (as in the above example), only the first 20 will be shown, followed by an ellipsis (...).

Note that it is not always possible to precisely determine the existence (or lack thereof) of transaction errors, particularly in the presence of isochronous traffic; all suspect occurrences should thus be interpreted as "potential" errors. The above example, for instance, is actually the result of sampled isochronous traffic, and the reported "errors" are merely artifacts of the isochronous data streams.

Transaction error summary data can be saved (with the "Save As..." button) for future use. See "Saving Summaries as Text Files", below.

### 4.6.5 Traffic Summary

Selecting this menu item brings up a dialog box enabling the specification of a range of packets over which to accumulate traffic statistics (initialized to the complete set of packets in the file), as with the Transaction Error Summary. Selecting "OK" then generates a summary of a variety of traffic statistics for the currently selected file, including counts of packets, frames, empty frames, transaction errors, and packet errors, plus listings of transactions (ordered by device) and control transfers, such as the following:




Note that—unlike the other statistics—the packet error count is computed for the entire data file, not just for the range of packets selected in the earlier dialog box.

Traffic statistics data can be saved (with the "Save As..." button) for future use. See "Saving Summaries as Text Files", below.

### 4.6.6 Saving Summaries as Text Files

Results of the three summary items in the Report Menu (as well as exported I/O data; see "The I/O Operation Pop-Up Menu", below) can be saved as text files. Any file name can be specified, though use of the ".txt" extension is recommended; if no extension is specified, ".txt" will be added by default.

If the saved file is opened with a text editor using a monospaced type font, the text will not be aligned in the same fashion as it appears in the analyzer's display window. To most closely approximate this display use the **MS Sans Serif** font in an **8 point** size.

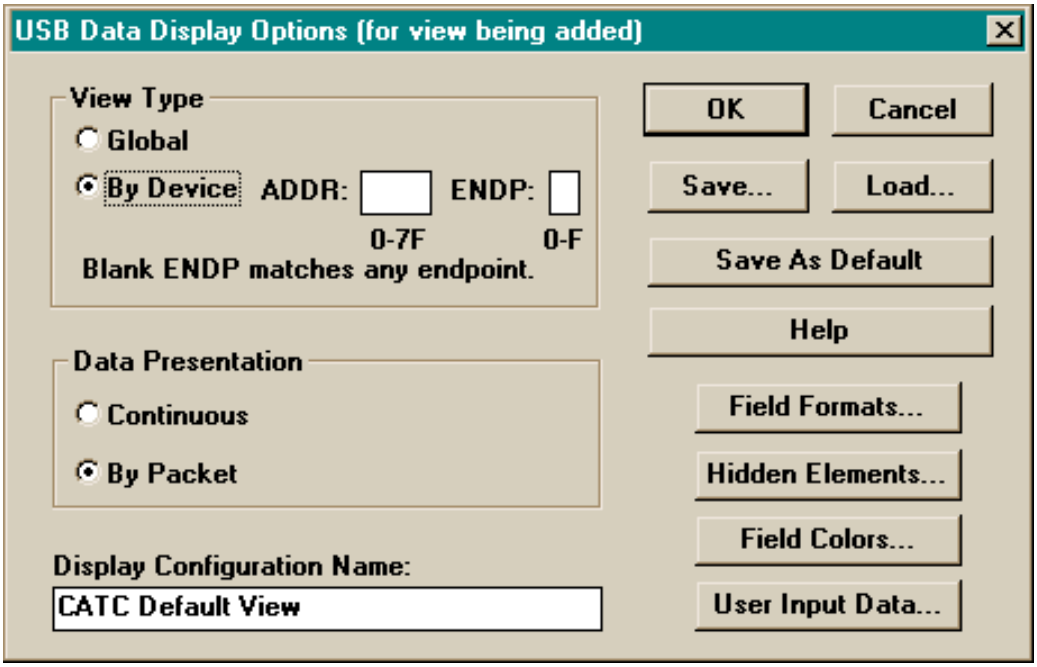
# 4.7 The View Menu

## 4.7.1 Add View

The Add View function is used to open a new window with an additional view of the currently selected USB data file. This is useful to:

- view the recorded data in a different format, or
- view (in conjunction with the "Tile Windows" function) two portions of the data file simultaneously.

As the former is the more common usage, the following dialog box is automatically opened to allow modification of the current viewing format.




Note that this is identical to the default Display Options dialog box, except for the title bar (which is intended to remind the user that the options about to be specified are for this particular view only, and will not be retained for subsequent use). The newly specified view of the data file will then be displayed.

*Note: The previous display window remains open; the user can switch among display windows, or arrange them for simultaneous viewing, by using the Window menu.*

## 4.7.2 Hide SOF

In order to reduce display "clutter", this menu item removes the display of all Start of Frame packets from the current view (a new view is not created; the current view is redrawn). The action takes place immediately, unlike the otherwise equivalent operation in the Display Options selection, where it affects *subsequent* presentations.

As with several of the more frequently-used Inspector options, the Hide SOF feature is accorded its own toolbar icon; this particular button indicates its current state by appearing depressed (or not, as appropriate) in the toolbar display.

### 4.7.3 Hide NAKed Transactions

This menu item functions identically to the Hide SOF operation, except that it is used to suppress the display of any packets pertaining to NAKed transactions.

### 4.7.4 Zoom In

The zoom entries in the View Menu provide an ability to adjust the size of the displayed elements in a USB traffic file, in order to represent more (or less) information on the screen (or printed output). Nine levels of zoom are implemented.

"Zoom In" increases the size of the displayed elements, allowing fewer (but larger) packet fields per screen. This function is also available as an icon in the toolbar.

### 4.7.5 Zoom Out

This function decreases the size of the displayed elements, allowing more (but smaller) packet fields per screen. This function is also available as an icon in the toolbar.

### 4.7.6 Set Current Zoom Value as Default

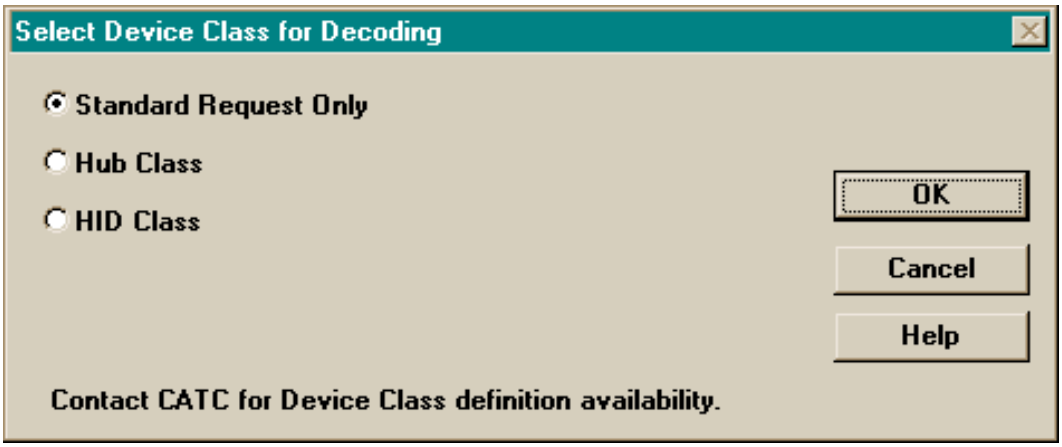
This function causes the current element size to be used as the default value upon subsequent invocations of the CATC Inspector analyzer.

## 4.8 The Decode Menu

If the current file contains class-specific USB device requests, the CATC Inspector software can decode the contained information according to the appropriate Device Class specifications.

### 4.8.1 Select Device Class...

The "Select Device Class..." menu item brings up the following dialog box, allowing selection of a USB Device Class:



Selecting a Device Class will cause future Decode Device Requests to interpret the protocol information according to the specification for the selected class.

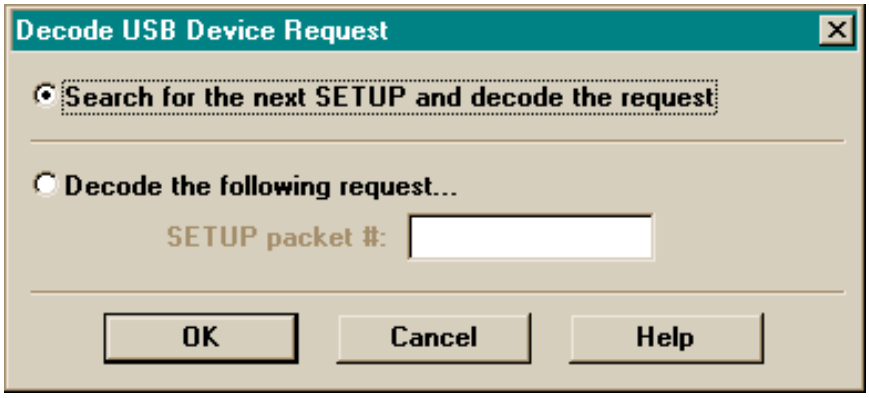
**IMPORTANT:** If the appropriate Device Class is not supported by the Inspector software, the user should select the Standard Request Only option. Applying an improper Device Class specification to class-specific commands will display undefined results!

*Note: A Device Class can also be selected by clicking with the **right** mouse button on the title of any SETUP field on the screen. See "The Device Decoding Pop-Up Menus".*

*Note: The Inspector software incorporates support for standard and Hub Class operations directly in the application code. Other classes are added at system startup time, by reading a set of library files (e.g., "CLS_HID.DLL" for the Human Interface Device Class); these additional classes will automatically show up as options on the above dialog box (which here shows an added "HID Class"). Contact CATC for information on the availability of these additional Device Class files.*

## 4.8.2 Decode Device Request...

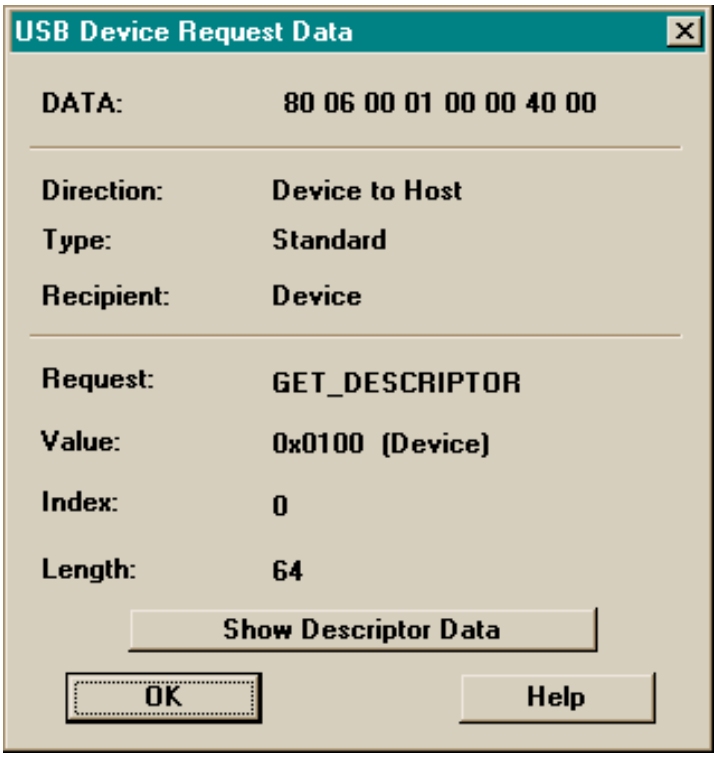
Control Transfers from the USB host to Endpoint 0 of a specific device are defined by the USB specification as USB Device Requests. The "Decode Device Request..." menu item displays a decoding of such requests (including the naming of the standard requests and descriptor types) according to USB Specification 1.0, using the following dialog box:




Two options are available: letting the software automatically search for the next SETUP and perform the decoding of the associated request, and providing the packet number for the SETUP token that begins the setup stage of the desired request. Selecting the OK button then decodes the specified Device Request.

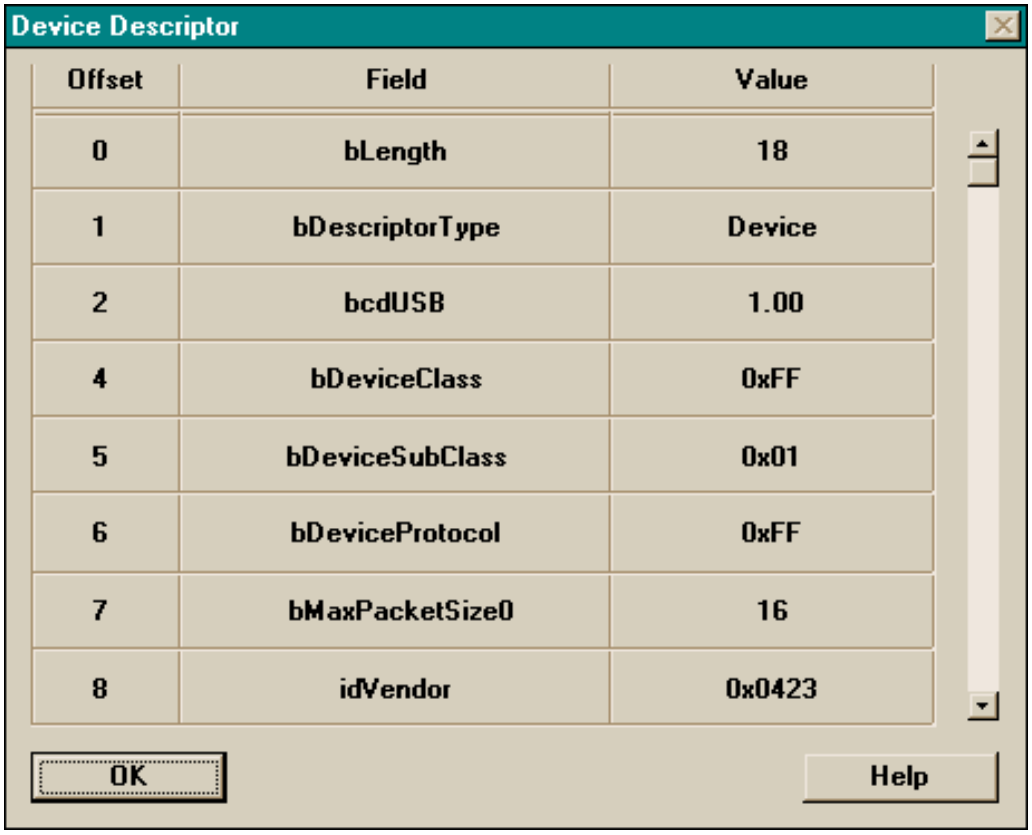
*Note: A specific Device Request can also be decoded by clicking with the **left** mouse button on the title of its SETUP field on the screen. See "The Device Decoding Pop-Up Menus".*

The following dialog box is displayed following a Decode Device Request operation (The contents of the decoded display depend somewhat upon the Device Class and the specific Device Request):



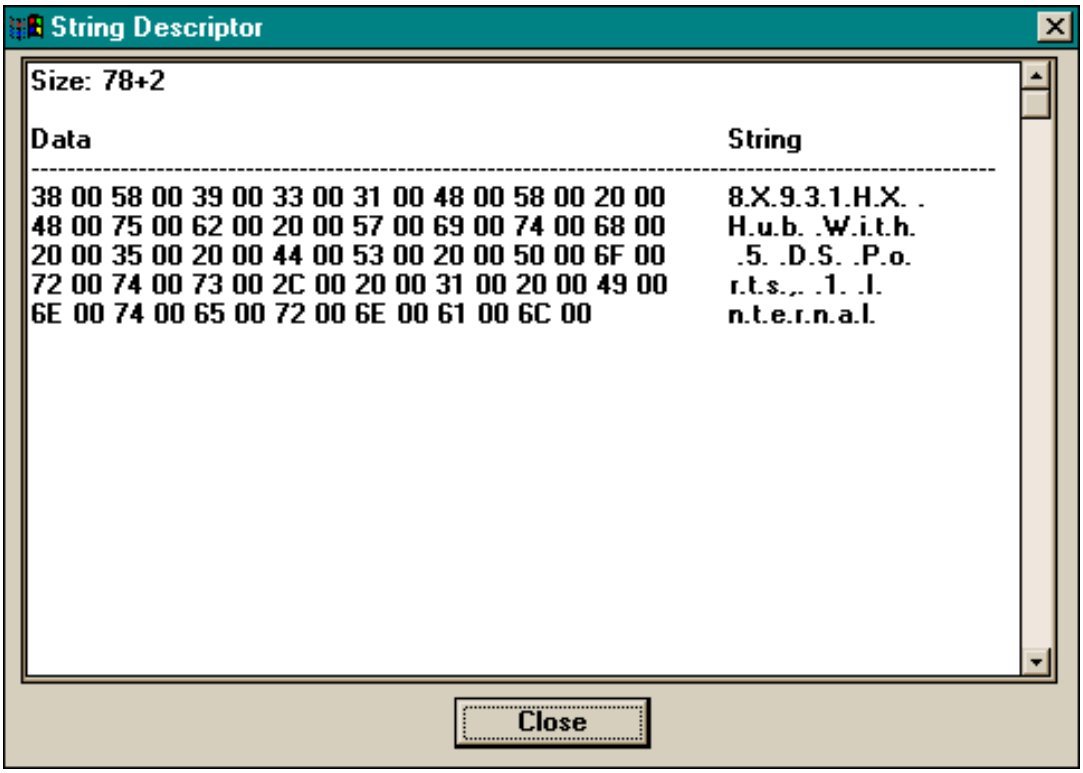
#### 4.8.2.1 Decoded Standard Requests

If the decoded standard request is GET_DESCRIPTOR and the requested descriptor is DEVICE or CONFIGURATION, or the request is SET_DESCRIPTOR, a button called "Show Descriptor Data" appears in the USB Device Request Data dialog box (as in the above example). Selecting this button brings up a form similar to the following, displaying the descriptor(s) returned by (or sent to) the device, decoded according to USB Specification 1.0:



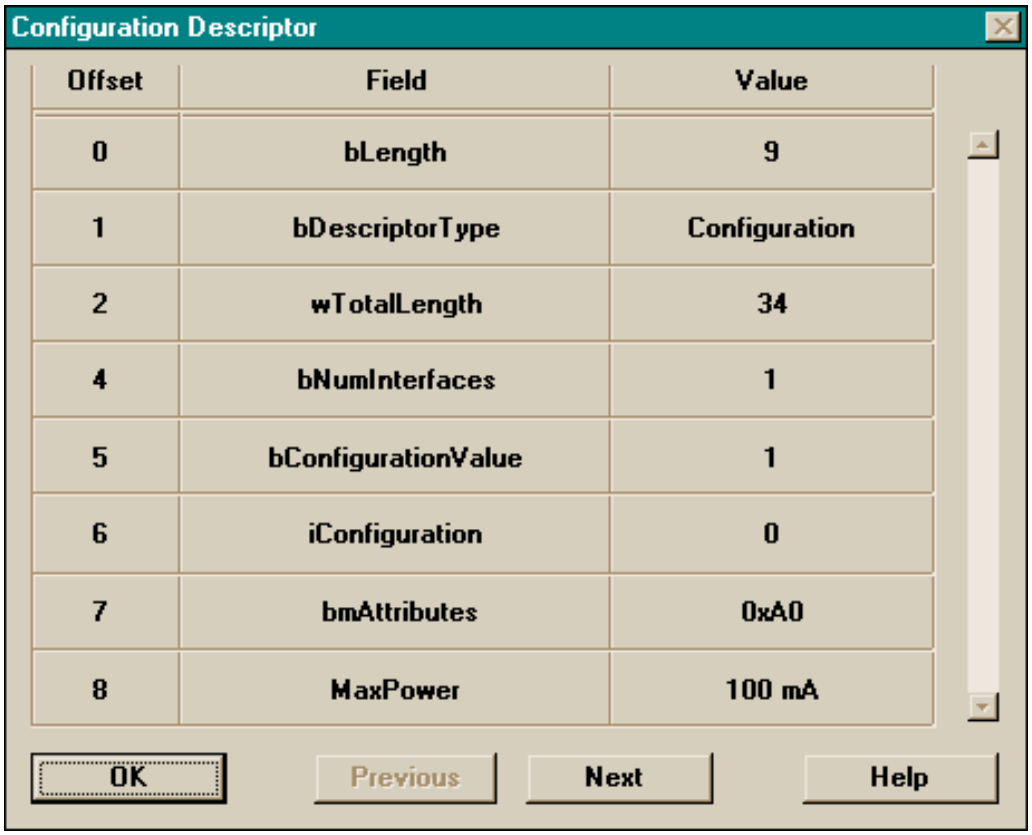

The scrollbar at the right side of the form permits viewing of all descriptor fields. If the device only sends a portion of a descriptor, the Inspector software marks missing fields with "N/A".

If the decoded standard request is GET_DESCRIPTOR and the requested descriptor is STRING, the "Show Descriptor Data" button displays a form similar to the following, showing the string decoded according to USB Specification 1.0:



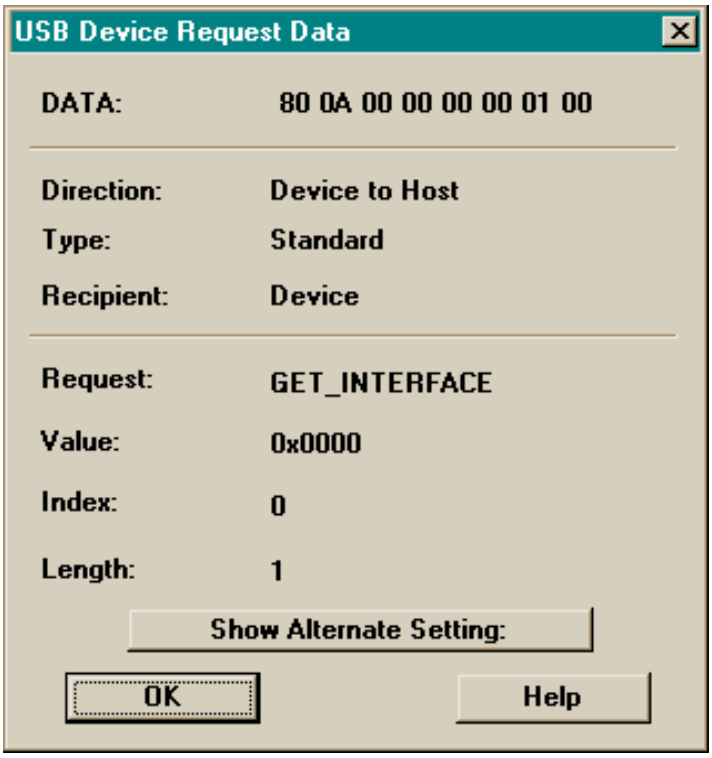

In the above example, the representation of the string size as "78+2" is intended to remind the user that the total length of the string is comprised of the data portion (78 bytes in this instance) plus two bytes used to store the data length.

If a Configuration request is made, the device is expected to return a configuration descriptor and all interface and endpoint descriptors. In this case, Next and Previous buttons will appear at the bottom of the form, allowing viewing of all the returned descriptors in the order in which they were sent by the device.



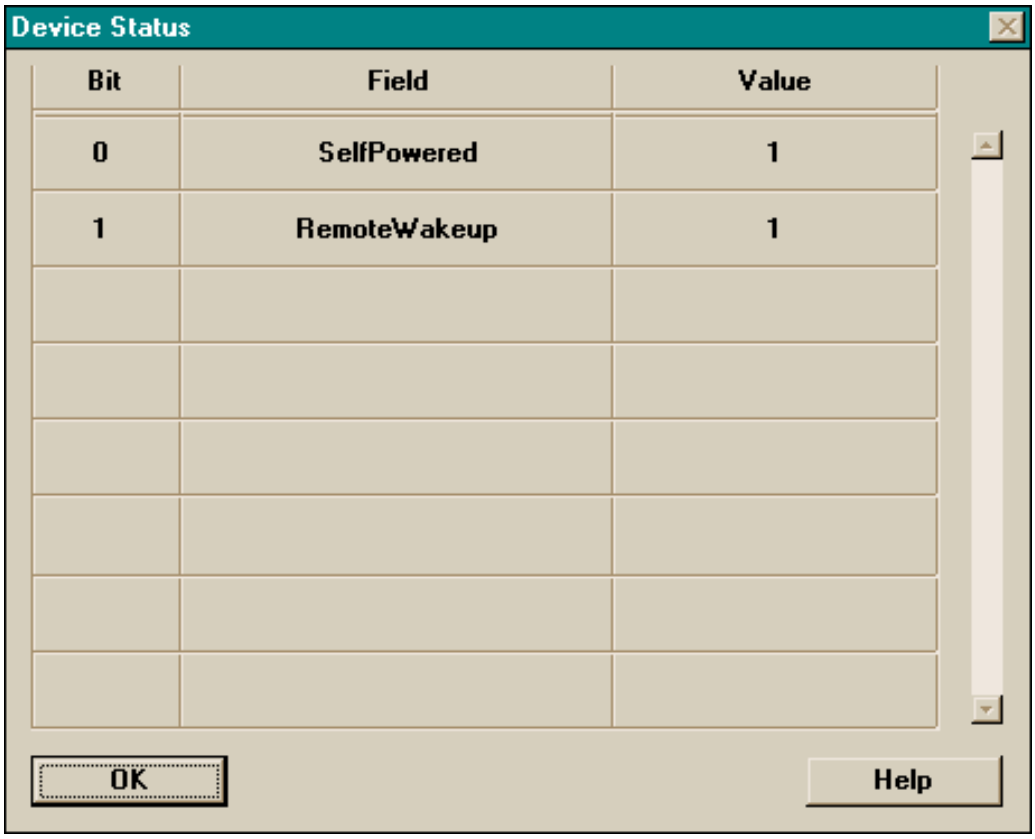

The scrollbar at the right side of the form permits viewing of all the entries. If the device only sends a portion of the data, the Inspector software marks missing entries with "N/A".

If the decoded standard request is GET_INTERFACE (or GET_CONFIGURATION), a button called "Show Alternate Setting:" (or "Show Configuration:") appears in the USB Device Request Data dialog box, as follows:




Selecting this button displays the value that was returned by the device (on the same form, in a small window immediately below the button).

If the decoded standard request is GET_STATUS), a button called "Show Status" appears in the USB Device Request Data dialog box; selecting this button brings up a form similar to the following, displaying the status information returned by the device, decoded according to USB Specification 1.0:

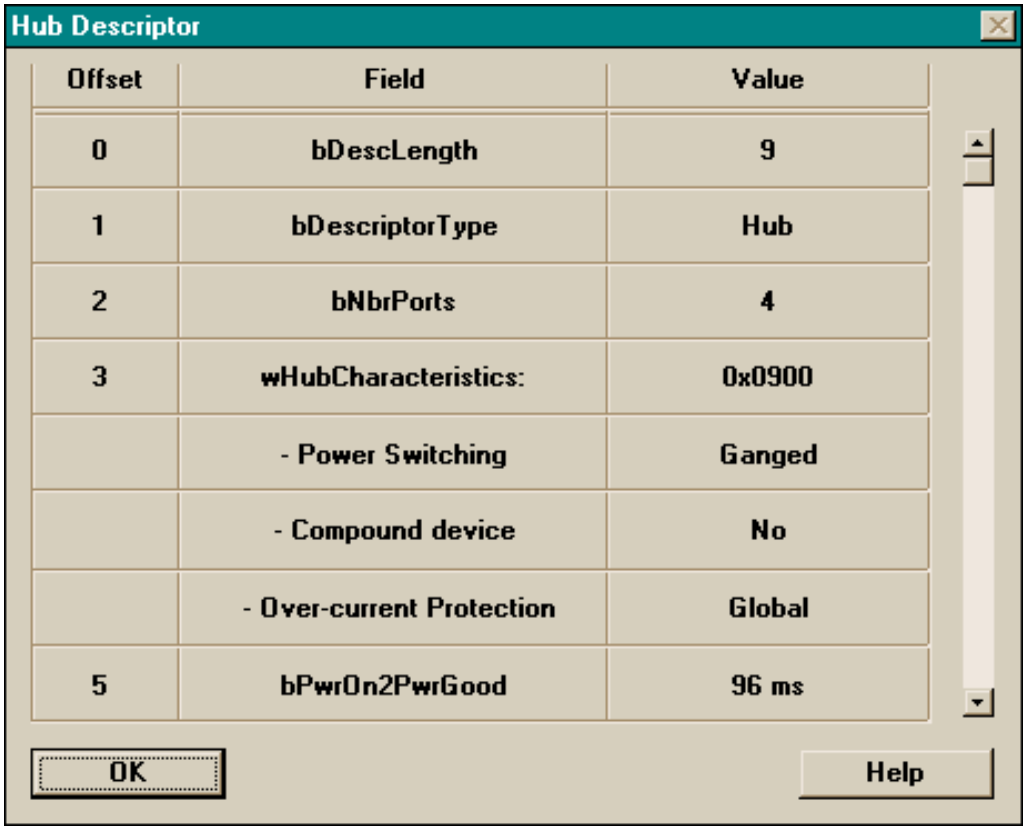



The form displays the recipient of the request (device, interface, or endpoint) as part of its title. For interface and endpoint recipients, it also displays the corresponding number. The scrollbar at the right side of the form permits viewing of all the entries. If the device only sends a portion of the data, the Inspector software marks missing entries with "N/A".

### 4.8.2.2 Decoded Hub Class Requests

**Decoded USB Hub Descriptor**

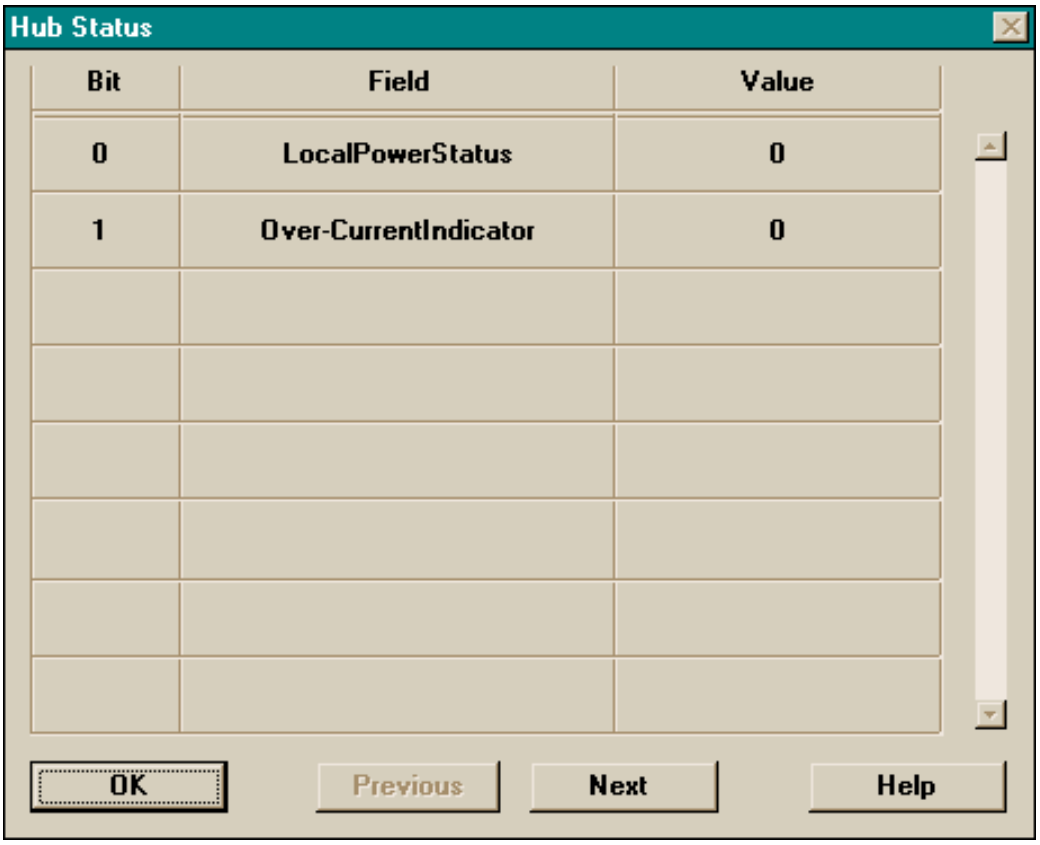
If the decoded standard request is GET_DESCRIPTOR, a button called "Show Descriptor Data" appears in the USB Device Request Data dialog box (as in the earlier example). Selecting this button brings up a form similar to the following, displaying the returned Hub descriptor, decoded according to USB Specification 1.0:




The scrollbar at the right side of the form permits viewing of all the entries. If the device only sends a portion of the data, the Inspector software marks missing entries with "N/A".

**Decoded Hub Status/Change for Hub Device**

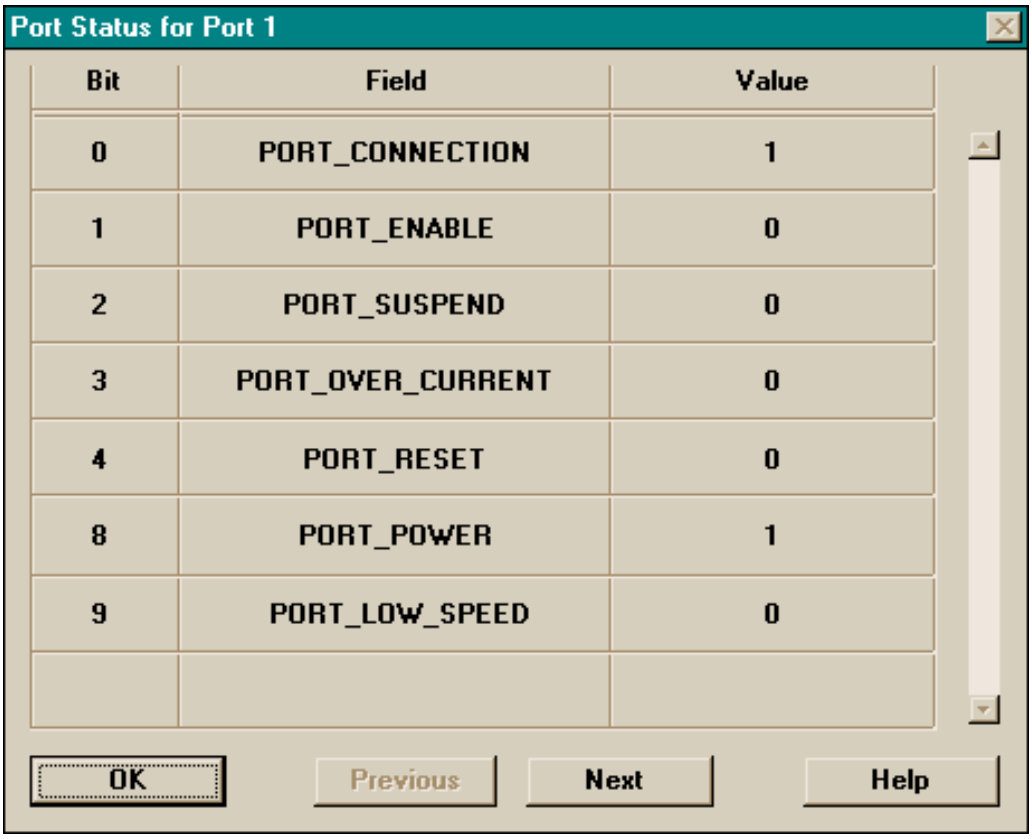
The following form displays the hub status information that was returned by the USB Hub on a hub-class-specific GET_STATUS (GetHubStatus) request, decoded according to USB Specification 1.0:




Corresponding change information can be viewed using the Next button at the bottom of the form. The scrollbar at the right side of the form permits viewing of all the entries. If the device only sends a portion of the data, the Inspector software marks missing entries with "N/A".

**Decoded Port Status/Change for Hub Device**

The following form displays the port status information returned by the Hub on a hub-class-specific GET_STATUS (GetPortStatus) request, decoded according to USB Specification 1.0:




The form displays the number of the port for which status information was requested in its title. Corresponding change information can be viewed using the Next button at the bottom of the form. The scrollbar at the right side of the form permits viewing of all the entries. If the device only sends a portion of the data, the Inspector software marks missing entries with "N/A".

### 4.8.2.3 Decoded Requests for Other Device Classes

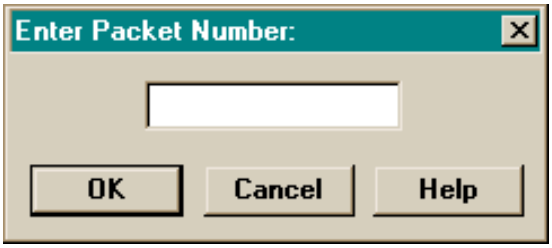
The Inspector software incorporates support for standard and Hub Class operations directly in the application code. Other classes are added at system startup time, by reading a set of library files (e.g., "CLS_HID.DLL" for the Human Interface Device Class); these additional classes will automatically show up as options on the "Select Device Class..." dialog box. Contact CATC for information on the availability of these additional Device Class files.

## 4.9 The Search Menu

The CATC Inspector software provides several options for searching through the recorded USB traffic, allowing the user to find specific packets, based on triggering status, or packet number, marking, or content. The three most common actions (Go to Packet, Find, and Next) also have their own individual icons on the toolbar.

### 4.9.1 Go to Packet...

When the "Go to Packet..." menu item (or the associated toolbar icon) is selected, the following dialog box opens. To move quickly to a view of a specific packet, enter the packet number and select OK; the display will be repositioned with the specified packet at the top.




### 4.9.2 Go to Trigger

The "Go to Trigger" menu item is only enabled when the traffic file is the result of an Event Trigger. When the item is selected, the display will be repositioned with the first packet following the trigger event (or the packet that caused the trigger) at the top.

### 4.9.3 Go To Marker

The "Go to Marker" menu item is only enabled when one of the packets in the traffic data file has been marked (using the Packet Marker & Timing pop-up menu, described below). When the item is selected, the display will be repositioned with the marked packet at the top.

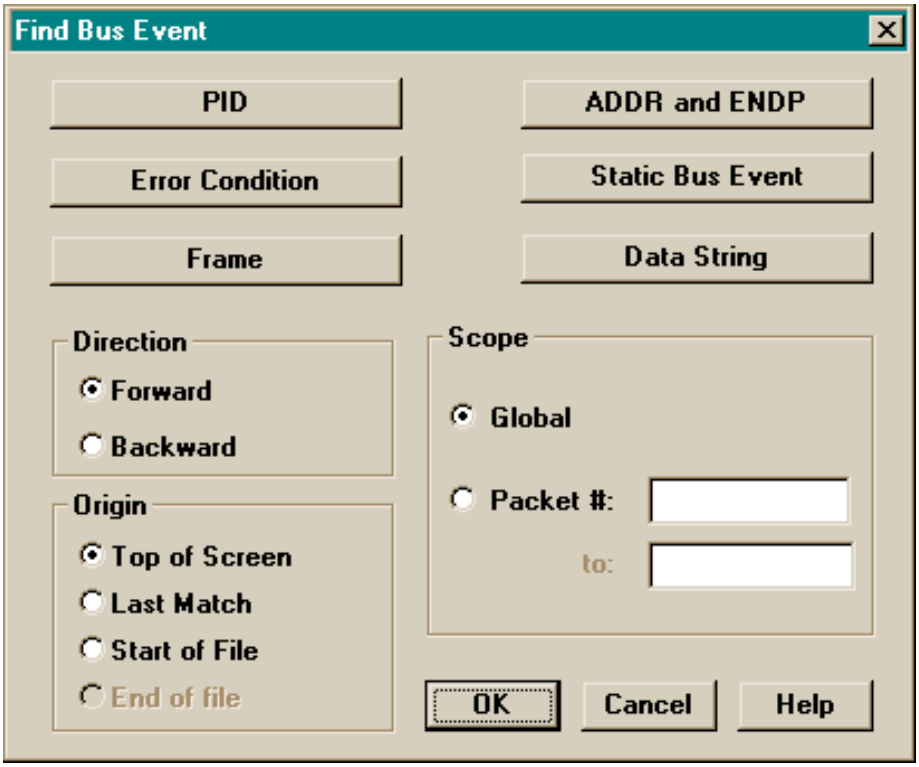
### 4.9.4 Find...

The "Find..." menu item enables searching for specific bus events within the recorded data file. The CATC analyzer will search for:

1. protocol violations:
    - bad PID (check field)
    - undefined PID
    - bad CRC5
    - bad CRC16
    - missing stuff bits
2. packets with specific PIDs (e.g., Setup)
3. bus transactions with specific device Ids

4. specific frame numbers
5. empty frames (with SOF token only)
6. non-empty frames (including one or more non-SOF fields)
7. specific bit strings in data fields
8. transactions with low speed devices (PRE)
9. reset conditions (SE0)
10. suspend & resume conditions

Selecting "Find..." (or the associated toolbar icon) brings up the following dialog box:




As a rule, the **general** search parameters (Direction, Origin, and Scope of search) should be selected prior to the **specific** ones (PID, Error Condition, Frame, ADDR & ENDP, Static Bus Event, and Data String), as selecting the "OK" button in the specific event dialogs will launch the search immediately, without returning to this initial setup screen.

*Note: The "Start of File" and "End of File" origins are considered temporary in nature; immediately following a search from either location, the origin will be changed to "Last Match". This convention provides intuitive behavior when the "Search Next" feature is employed.*

The following keyboard shortcuts can also be used (at any time) to change the direction and origin of searches:

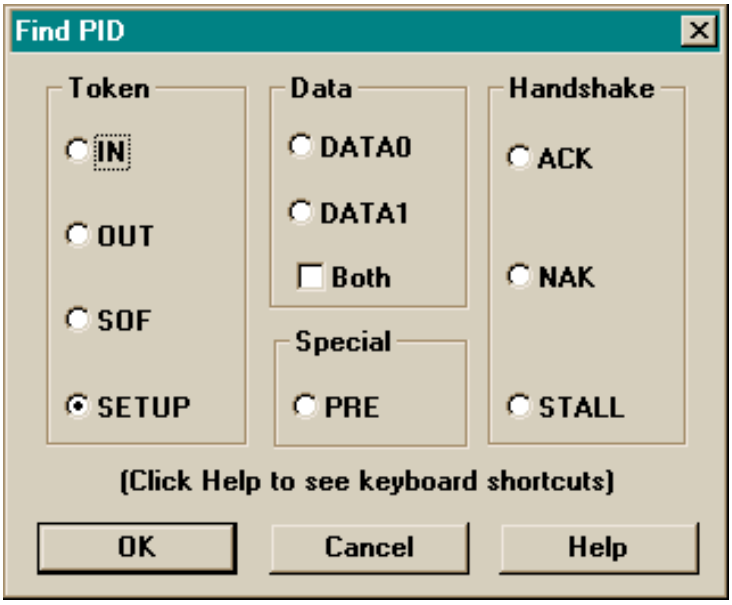
| | |
|---|---|
| Ctrl-**f** | direction: forward |
| Ctrl-**b** | direction: backward |

| | |
|---|---|
| Ctrl-**t** | origin: top of screen |
| Ctrl-**m** | origin: last match |

The current settings for the search direction and origin are always displayed in the right segment of the status bar.

#### 4.9.4.1 Find PID

Selecting the PID button brings up the following dialog box, to allow selection of a specific PID type:



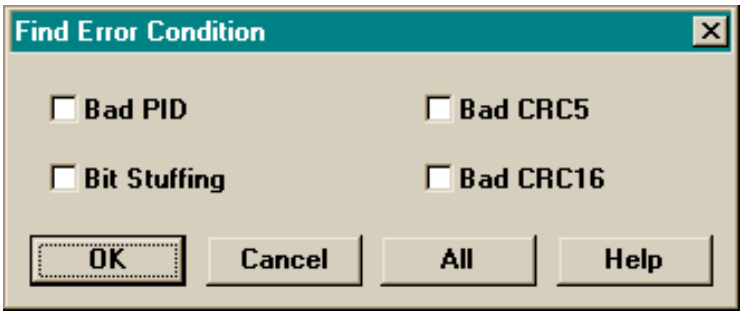

Selecting the "OK" button will then launch the search for the selected PID, using the search direction, origin, and scope previously specified.

The following keyboard shortcuts can also be used (at any time) to search for a specific PID:

| | |
|---|---|
| Shift-**s** | SETUP |
| Shift-**o** | OUT |
| Shift-**i** | IN |
| Shift-**f** | SOF |
| Shift-**0** | DATA0 |
| Shift-**1** | DATA1 |
| Shift-**a** | ACK |
| Shift-**n** | NAK |
| Shift-**l** | STALL |
| Shift-**p** | PRE |

#### 4.9.4.2 Find Error Condition

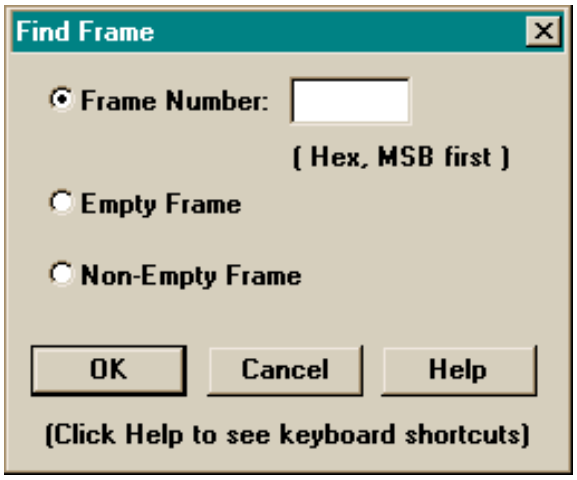
Selecting the Error Condition button brings up the following dialog box, to allow specification of particular error conditions (or, by selecting "All", any error condition):




Selecting the "OK" button will then launch the search for the selected error condition, using the search direction, origin, and scope previously specified.

#### 4.9.4.3 Find Frame

Selecting the Find Frame button brings up the following dialog box, to allow selection of a specific frame (by Frame ID number), an empty frame (containing only an SOF token), or a non-empty frame (containing one or more fields other than SOF):



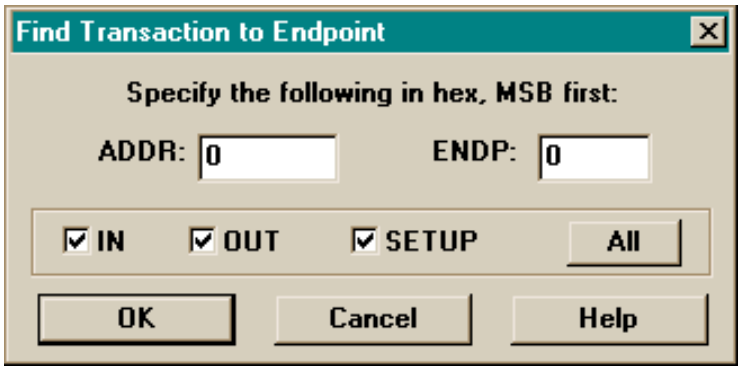

Selecting the "OK" button will then launch the search for the selected frame, using the search direction, origin, and scope previously specified.

The following keyboard shortcuts can also be used (at any time) to search for empty or non-empty frames:

| | |
|---|---|
| < (Shift-comma) | empty frame |
| > (Shift-period) | non-empty frame |

#### 4.9.4.4 Find ADDR and ENDP

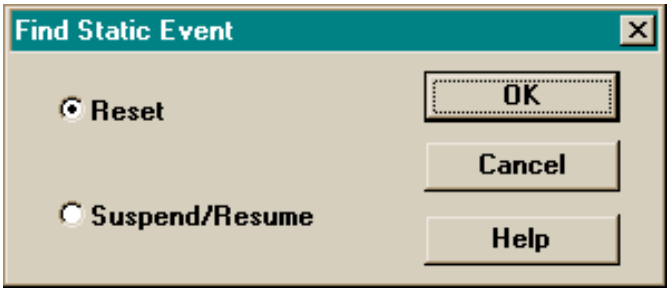
Selecting the ADDR and ENDP button brings up the following dialog box, to allow selection of a specific device address and endpoint:




The search can be restricted to any combination of In, Out, and Setup packets by marking the appropriate checkboxes. Selecting the "OK" button will then launch the search for a packet with the selected device address and endpoint, using the search direction, origin, and scope previously specified.

#### 4.9.4.5 Find Static Bus Event

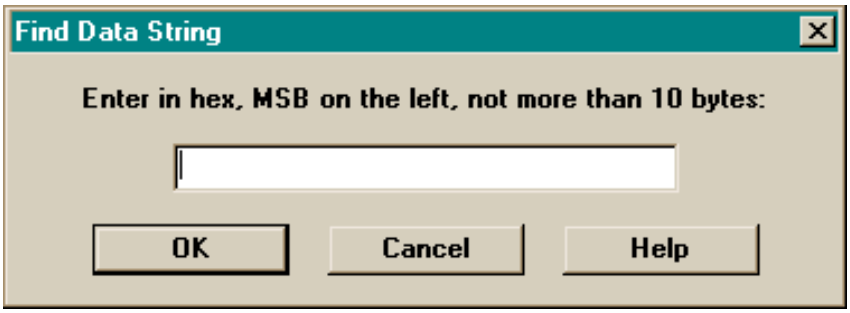
The Static Bus Event button is only enabled when the traffic file was recorded with Idle state; it permits searching for the static bus events Reset and Suspend/Resume. Selecting this button brings up the following dialog box, to allow specification of a particular event:




Selecting the "OK" button will then launch the search for a packet with the specified static bus event, using the search direction, origin, and scope previously specified.

#### 4.9.4.6 Find Data String

Selecting the Data String button brings up the following dialog box, to allow selection of a specific data pattern within the DATA fields of the traffic file:




Up to 10 bytes of data (hexadecimal notation, MSB of each byte on the left) can be specified. Selecting the "OK" button will then launch the search for a packet with the selected data string, using the search direction, origin, and scope previously specified.

An example: to search for the standard device request "Get Device Descriptor", specify the data string '`80060001`'.

*Note: Data string searches are performed on a strict bit-by-bit basis; thus, if the specified bit string appears **anywhere** within a data field (whether or not its position-based hexadecimal representation is identical to that entered) it will produce a match.*

### 4.9.5 Next

Selecting the "Next" menu item (or the associated toolbar icon) will repeat the previous search; that is, it will initiate another search using the previously selected parameters (recall that "start/end of file" origins are automatically converted to "last match"). In keeping with Windows tradition, function key F3 also invokes this function.

## 4.10 The Window Menu

The Window menu is a standard Windows function that allows the open windows to be viewed and arranged in different ways.

## 4.11 The Help Menu

The Help menu is a standard Windows function that supplies additional information on the various functions of the CATC Inspector program when it is in use.

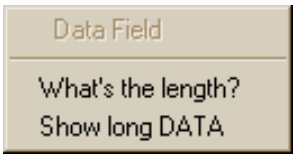
## 4.12 The Data Field View Pop-Up Menu

Clicking on the title of any DATA field will bring up the following Data Field menu for short data fields:

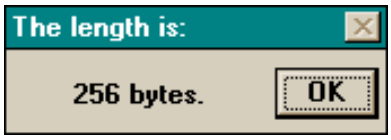



or one of the following menus for data fields containing more than 16 bytes:




Selecting the single "What's the length?" menu item will display the length of the associated data field, using the following display box:




The second menu item enables toggling of the current data display format, between full and curtailed display modes, as previously described under Field Formats. When invoked by the pop-up menu, the display change will take place immediately.

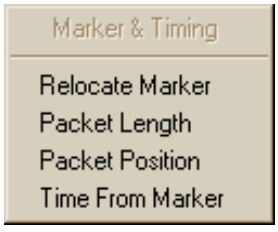
## 4.13 The Packet Marker & Timing Pop-Up Menus

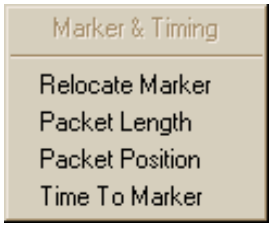
Clicking on the "Packet #" title of any packet display will bring up the following menu (files recorded without Idle state will not show the timing-related items):




The first menu item is associated with the concept of "marking" a particular packet in the traffic data file (only one packet can be marked at any given time). This marked packet (displayed with a distinctive red outline) can be the target of a Search operation (see above), and also a point of reference for timing measurements. If any packet is marked, subsequent invocation of this pop-up menu will produce one of the following displays:



Selecting the relevant menu item will then either clear the marker or relocate it to the current packet (that which spawned the pop-up menu).

The remaining menu items (displayed only for files recorded with Idle state) are used to compute timing information for the associated packet. Selecting "Packet Length" will display the time taken by the packet, from start of Sync to the end of EOP signaling. Selecting "Packet Position" will display the frame-related position of the packet (the time from the closest previous Start of Frame/keep-alive and the time to the closest following SOF/keep-alive). Both durations are displayed as equivalent bit times and in microseconds, as in the following example:




Appropriate error messages are displayed if the selected packet contains a RESET or SUSPEND/ RESUME, or if the lack of an SOF/keep-alive makes the computation of the associated time impossible.

Finally, selecting the "Time From Marker" (or "Time To Marker", as appropriate) menu item will display the elapsed time from the marked packet, using the "Timing & Bus Usage Calculator" display.

## 4.14 The Device Decoding Pop-Up Menus

Clicking on the title of any SETUP field with the **right** mouse button will bring up the following menu, allowing the selection of a USB Device Class to be used in subsequent decoding:

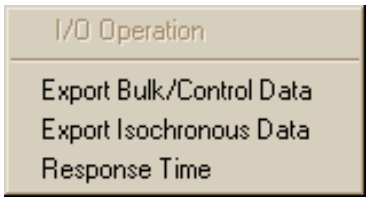



Clicking on the title of any SETUP field with the **left** mouse button will bring up the following single item menu, allowing decoding of its device-specific information, according to the currently selected Device Class:

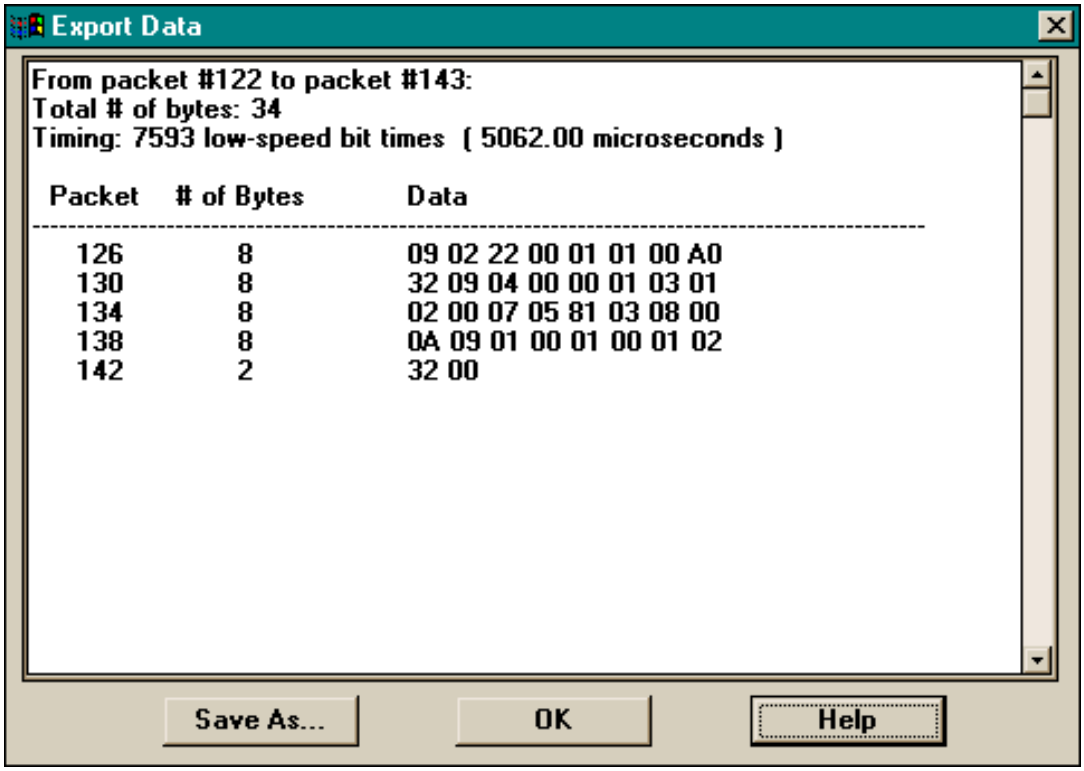


## 4.15 The I/O Operation Pop-Up Menu

Clicking on the title of any IN or OUT field will bring up the following menu:

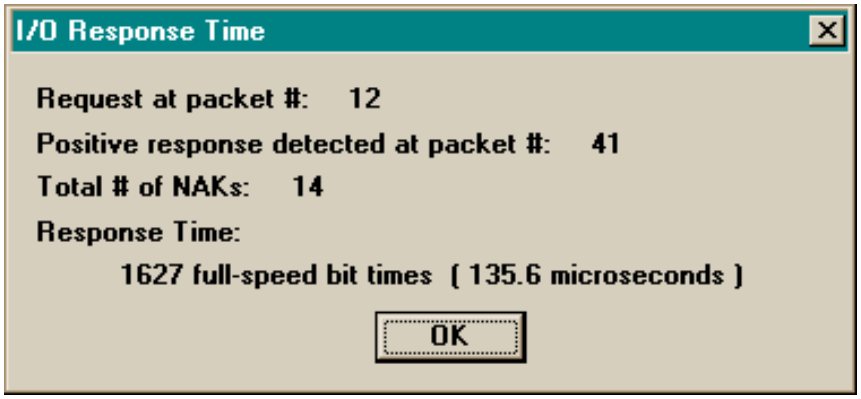



The "Export Bulk/Control Data" and "Export Isochronous Data" menu items are intended for the output of data to a file. The analyzer is not able to determine with certainty the type of data transfer involved, so uses the user's specification of the associated transfer type (bulk/control or isochronous) to guide its "best effort" attempt to isolate the chosen data transfer. Any NAKed data is not included. The collected data is first displayed in a form such as the following:




The extracted data can now be saved (with the "Save As..." button) for future use. See "Saving Summaries as Text Files", above.

Selecting the "Response Time" menu item brings up the following display, showing the elapsed time from the selected I/O request and the closest following positive response to same:




# 5. TRIGGERING LOGIC ANALYZERS AND OSCILLOSCOPES BASED ON USB TRAFFIC

It is sometimes desirable to capture the internal state of some USB device at the time of a specific Bus event. This might be something like "one-shot" tracing of a control program with a logic analyzer upon some error condition, or looking for a logic error by triggering an oscilloscope every time a specific device or endpoint is addressed. The CATC Inspector tool can easily be used to produce triggering signals for these operations.

This is facilitated by the External Interface Breakout Board, which provides output pins for (and thus convenient access to) the configurable trigger signal and those representing pre-determined USB events, error conditions, and clocking information. All such signals are TTL/CMOS compatible, low level true.

For the Logic analyzer example above, the analyzer's Recording Options are set to Event Trigger, and the desired triggering event(s) specified. These might include a specific Address and Endpoint or Data String value. When recording is initiated, the CATC Inspector tool will monitor USB traffic and produce a TRIGGER (out) signal when the desired event occurs. This signal can be used to start or stop logic analyzers and digital storage oscilloscopes. Traditional analog oscilloscopes can benefit from a slightly different analyzer setup. Recording Options and Trigger Selection are as above, but the Post-Trigger Recording selection should be set to Nonstop. This prevents the analyzer itself from stopping on the selected event, thereby providing TRIGGER signals upon each occurrence.

# 6. HOW TO CONTACT CATC

| Type of Service | Contact |
|---|---|
| Call for technical support... | US and Canada: +1/ 800 909 2282<br>Worldwide: +1/ 408 727 6600 |
| Fax your questions... | Worldwide: +1/ 408 727 6622 |
| Write a letter... | Computer Access Technology Corp.<br>Customer Support<br>2403 Walsh Avenue<br>Santa Clara, CA 95051-1302 |
| Send e-mail... | `support@catc.com` |
| Visit CATC's Website... | `http://www.catc.com/` |

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