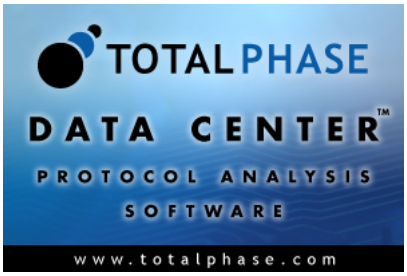
Total Phase Data Center Software



TOTAL PHASE

Supported products:

BEAGLE™ PROTOCOL ANALYZER

Data Center Software
Manual v4.10
February 3, 2010

Features

- Non-intrusive High-speed USB Monitoring (480 Mbps)
- Non-intrusive Full-speed USB Monitoring (12 Mbps)
- Non-intrusive Low-speed USB Monitoring (1.5 Mbps)
- Non-intrusive I^2C Monitoring (up to 4 MHz)
- Non-intrusive SPI Monitoring (up to 24 MHz)
- Monitor transmissions in real time as they appear on the bus
- Extensive real-time filters
- Repetitive packet compression
- Bit-level timing from 100 to 20 ns resolution
- Windows, Linux, and Mac OS X compatible

Summary

The Total Phase Data Center™ software package is a graphical user interface to the Beagle series of protocol analyzers. The Data Center application provides access to all the features of the Beagle analyzers. Developers can capture, display and filter USB, I^2C, and SPI serial bus data in real time.

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1 Overview

The Total Phase Data Center application is a graphical user interface for the Beagle series of protocol analyzers. Data Center software provides access to all the features of the Beagle analyzers. Developers can capture, display and filter USB, I^2C, and SPI serial bus data in real-time.

This software manual will introduce and explain how to use the Data Center application. For specific or technical information about the Beagle protocol analyzers, please refer to the Beagle Protocol Analyzer Data Sheet which can be downloaded from the Total Phase website - www.totalphase.com.

1.1 Changes in version 4.10

The following features have been added to the Total Phase Data Center software.

General

- Added the ability to configure the timestamp precision of the Transaction Window.
- Added support for Japanese.
- Minor bug fixes.

USB

- The following Communications Device Class (CDC) subclasses have been added:
  - Network Control Model (NCM)
  - Mobile Direct Line Model (MDLM) Semantic Models:
    - Early Network Control Model (ENCM)

1.2 Changes in version 4.00

The following features have been added to the Total Phase Data Center software.

General

- Added the ability to insert comments.
- Added the ability to be notified when updates to the software are available.
- Reinstated the instantaneous and inter-transaction bandwidth reporting.
- Removed the 4 billion record limit.
- Added support for German.
- Minor bug fixes.

USB

- The following classes have been added:
  - Printer
  - Video
  - Still Image
  - Communications Device Class (CDC)
    - Public Switched Telephone Network (PSTN)
    - Ethernet Control Module (ECM)

    - Wireless Mobile Communications Devices (WMC)
  - Device Firmware Upgrade (DFU)

1.3 Changes in version 3.50

The following new features have been added to the Total Phase Data Center software.

General

- Added support for French.
- Minor bug fixes.

USB

- Added support for class-level decoding. The following classes are supported:
  - Audio v1.00
  - Hub
  - Human Interface Devices (HID)
  - Mass Storage (Bulk Only)
  - Standard Device Requests

1.4 Changes in version 3.10

The following new features have been added to the Total Phase Data Center software.

General

- Added support for circular capture buffer.
- Added support for exporting in CSV format.
- Added support for additional languages.
- Minor bug fixes.

1.5 Changes in version 3.00

The Total Phase Data Center application has been migrated to a new platform. Many features have been added to make the interface more informative and easier to navigate.

Notable New Features

- USB packets are now grouped into transactions in a hierarchical view in real-time.
- The Info pane displays detailed information about the selected record, including parsed packet information displayed in multiple formats.
- The Bus pane lists devices that have been detected on the bus being monitored. For USB captures, any enumeration information that was seen during the capture is also represented in detail.
- A command line console, with built-in history, logs all actions performed in the software. The user can then repeat or modify previous actions and create batch scripts that are loaded on startup.

MDIO support is no longer available in version 3.00 of the Data Center software. Additionally, a few features from the previous version of the Data Center application will be temporarily

unavailable as they are migrated to the new platform. If you require these features, download version 2.20 of the Data Center application from the Total Phase website, www.totalphase.com.

1.6 Changes in version 2.20

The following new features have been added to Total Phase Data Center software.

General

- Added support for 64-bit Windows. Note that Data Center will run on 64-bit systems as a 32-bit application.

1.7 Changes in version 2.19

The following new features have been added to Total Phase Data Center software.

General

- Added support for Intel versions of Mac OS X 10.4 Tiger and 10.5 Leopard.

USB

- Made improvements to OTG event detection.
- Resume bus events are now displayed with a duration.
- Fixed the timing of high-speed suspend events.
- Fixed a bug with the Setup Data Details.
- Minor bug fixes.

1.8 Changes in version 2.10

The following new features have been added to Total Phase Data Center software.

General

- Added the ability to insert comments during a capture.
- Native file format (.bgl) updated to store comments. Old files can be opened but new files will not open in previous versions of the software.
- New bandwidth and data payload measurement between packets.
- Instantaneous bandwidth displayed during capture.
- On Windows systems, the saturation dialog now stays accessible even if application is minimized and later unminimized.
- Fixed an issue with save and export dialogs affecting certain Linux systems.

I^2C

- A parsing issue with 10-bit I^2C transactions has been resolved.

USB

- Beagle USB 12 Analyzer now displays bit-stuff errors.
- USB descriptors are now properly parsed when requested by the OS X operating system.
- Improved display of Setup packets.

- BOS and OTG descriptors are now parsed
- Beagle USB 480 Analyzer reports OTG events

1.9 Changes in version 2.00

The following new features have been added to Total Phase Data Center software.

General

- Delta time displayed between the selected transaction and the transaction under the mouse pointer.
- **Find** tool can search for text in info, event, and collapsed transactions.
- Option to increase incoming data buffer size to reduce possibility of losing capture data.
- Beagle analyzer hardware and firmware version displayed in status bar.
- Native file format (.bgl) updated to store additional information. Old files can be opened but new files will not open in previous versions of the software.

I^2C

- Added parsing support for I^2C combined format transactions.
- XML batch support export option added to replay I^2C transactions using an Aardvark I^2C/SPI Host Adapter and the Aardvark Control Center software.

SPI

- XML batch support export option added to replay SPI transactions using an Aardvark I^2C/SPI Host Adapter and the Aardvark Control Center software.

USB

- CRC and SOF frame number errors reported in error column.
- Find can search for specific PIDs by name.
- USB packet group filtering option layout improved.
- Filter option added to filter out event transactions.
- Details mode replaces Descriptor mode to display information about collapsed packets and events, in addition to the descriptor display.
- Support for Beagle USB 480 protocol analyzer added with the following features:
  - Real-time capture of High-speed, Full-speed, and Low-speed USB traffic.
  - Displays the chirp events in the High-speed negotiation process, including identification of potential “Tiny J/K” events.
  - Option to lock capture speed or to allow the Beagle USB 480 Protocol Analyzer to automatically detect the bus speed.
  - Capture USB traffic in real-time with or without hardware buffer overflow protection, or run a delayed-download capture to minimize traffic on the bus while capture is occurring.
  - Option to suppress common packet groups, such as SOF, IN+NAK, and PING+NAK in the hardware.
  - Support for up to 4 digital input lines in the capture.
  - Configure the 4 digital output lines to toggle on capture start, active packet, on specific PIDs and device and endpoint address, and on specific data patterns.
  - Ability to disable packet collapsing.

  - Option to filter out packets generated by the Beagle USB 480 Protocol Analyzer.

1.10 Changes in version 1.30

The following new features have been added to Total Phase Data Center software.

General

- On Windows systems, requires version 1.1.0.0 of the Beagle analyzer USB driver. Refer to the Beagle analyzer datasheet for instructions on upgrading the USB driver.
- Native file format (.bgl) updated to include status information. Old files can be opened but new files will not open in previous versions of the software.
- Abridged transaction timestamp is displayed in transaction tables.
- Abridged transaction duration is displayed in transaction tables.
- Full transaction timestamps and full duration times displayed in timing detailed views.
- Filtering based on transaction duration added.
- Partial byte information and other errors displayed in transaction windows.
- Clear command asks for confirmation of command.
- Progress bar appears when loading .bgl files.
- Saturation dialog in Windows platforms always stays on top of main window.
- Export while in protocol specific tab now only exports transactions of that protocol.
- Informational headers added to text and CSV export formats.
- CSV formats updated with new columns in transaction tables.

I^2C

- Start and stop conditions displayed in the transaction table.
- Packet detailed view added with start and stop conditions.
- Asterisk will be displayed in the address field of the transaction window if the address byte was NACK'ed.

SPI

- Combined MOSI/MISO detailed view added.
- Text export now displays MOSI data properly in timing table.

MDIO

- MDIO capture and filtering support added.

USB

- Parsing of setup packets improved.

1.11 Changes in version 1.20

The following new features have been added to Total Phase Data Center software.

General

- Clear added to the menu to clear the capture contents while preserving the file path.
- Data pattern filter added to allow for filtering of transactions based upon transaction data content.

- Open, Save, and Export dialogs remember the directory of the last file worked upon.

I²C

- Target power is no longer enabled upon connection to a Beagle I²C/SPI/MDIO analyzer.
- Ability to filter on more than one device address.

USB

- Ability to filter on more than one device address.
- Ability to filter on more than one endpoint address.

1.12 Changes in version 1.10

The following new features have been added to Total Phase Data Center software.

Bug Fixes

- Libpango has been updated and fixed for International versions of Windows.
- Selected index is preserved when applying new filter settings.
- Empty USB configuration and empty USB interface descriptors are properly parsed.
- Consistent time scale is used across all bytes of a given transaction.

General

- Maximum and minimum index numbers can be set in the filters to see a particular range of transactions.
- Filtering by length no longer requires a default value and can be left blank.
- Find arbitrary hex value or ASCII data patterns in a transaction. Matching data patterns are highlights in the Data view.
- Application saturation dialog window now includes a bar graph that indicates the application load.
- The Connection Dialog window can be refreshed by clicking the refresh button.
- Beagle analyzers that are in use by other applications are listed as unavailable in the Connection Dialog window.
- When exporting “-export” is added to exported file name by default.
- Comma separated values (*.csv) file added as an export option.

I²C

- Filter transactions based on the read/write bit.

USB

- Grouped IN, OUT and SETUP packets are color coded.
- Added a CRC column in the transaction window. The CRC can be viewed in standard bit order or in reversed bit order (for CATC compatibility).

2 Quick Start

2.1 Capturing traffic

The general flow for capturing traffic with any Beagle analyzer is the same, whether it be the USB 480, USB 12, or I^2C/SPI analyzers with the following caveats.

When monitoring USB, it is best to attach the Beagle analyzer's analysis port and start the capture before the attaching target device port. This allows the Beagle Analyzer to capture the descriptor information that is communicated at device connection.

For all other protocols, the capture can be started before or during the presence of traffic on the target bus. If traffic is already present on the bus, the first packet may appear corrupted or incomplete since the Beagle analyzer may start monitoring traffic midway into a transmission.

These are the basic steps for capturing data with a Beagle analyzer. For more detailed information, please refer to the specific sections in this manual.

1. Install the Beagle analyzer USB driver and Total Phase Data Center software.
2. Plug in the Beagle analyzer into the analysis computer.
3. Attach the Beagle analyzer to the bus under test. (For USB, do not attach the target device until the capture been started. The target host port, however, can be connected now.)
4. Launch the Data Center application.
5. Click the  (**Connect to Analyzer**) button in the toolbar and connect to an available Beagle analyzer.
6. Click on the  (**Device Settings**) button in the toolbar and make sure the correct capture protocol is selected in the pull-down list. Set any other device settings as appropriate.
7. Click on the  (**Capture Settings**) button in the toolbar. Set the capture settings as appropriate.
8. Ensure the Protocol Lens is set to the appropriate protocol (I^2C, SPI, or USB).
9. Click the  (**Run Capture**) button in the toolbar to start the capture.
10. For USB, connect the target device to the Beagle USB 12/480 analyzer. Some spurious events may appear. There is no need to be alarmed since these events correspond to electrical noise created during the physical connection event.
11. As traffic is seen on the bus, it will be displayed in real-time in the Transaction window.

The capture can be stopped at any time by clicking the  (**Stop**) button. The captured data can be filtered during or after the capture. The captured data or a filtered view can be saved as a binary *.tdc file for future analysis.

3 Getting Started

3.1 Requirements

Overview

The following sections describe the system requirements to run the Data Center software. Be sure the device driver has been installed before plugging in the Beagle analyzer. Refer to the Beagle Protocol Analyzer Datasheet for additional information regarding the driver and compatibility.

Hardware

- Intel or AMD processor running at a minimum speed of 2.0 GHz
- 512 MB of physical RAM
- 1 GB of hard disk space
- High-speed USB port

Windows

Data Center software is compatible with Windows XP (SP2 or later, 32-bit only), Windows Vista (32-bit and 64-bit), and Windows 7 (32-bit and 64-bit). The software will run on 64-bit systems as a 32-bit application. Windows 2000 and legacy 16-bit Windows 95/98/ME operating systems are not supported.

Linux

Data Center software has been designed for Red Hat Enterprise Linux 5 with integrated USB support. Kernel 2.6 is required. The software will run on 64-bit systems as a 32-bit application, provided that 32-bit system libraries are available.

Mac OS X

Data Center software is compatible with Intel versions of Mac OS X 10.4 Tiger, 10.5 Leopard, and 10.6 Snow Leopard. The software will run on 64-bit systems as a 32-bit application.

3.2 USB Driver

Please refer to the Beagle analyzer datasheet for instructions regarding installing and uninstalling the Beagle analyzer USB driver.

3.3 Installing Data Center Software

The Data Center software package is a self-contained application. All DLLs and support files that are required to run the Data Center software are bundled into a single directory hierarchy. No additional DLLs need to be installed into the core operating system directories (e.g. `c:\Windows\`).

This makes installing the software as easy as unarchiving the software zip package into the directory of your choice.

To install the Data Center application:

1. Download the latest version of the software from the Total Phase website.
2. Unzip the zip archive to your desired location.

   Please make sure that the directory structure is preserved when unzipping the zip archive. The application will fail to launch if the directory structure is not preserved.

3.4 Uninstalling Data Center Software

Since the Data Center application is self-contained, there is no need to "Uninstall" it. To remove the application from your machine, you need only delete the directory where the application resides. There is no further action required to remove the software from the system.

3.5 Overview of the Beagle Protocol Analyzers

This is a brief introduction to the Beagle Protocol Analyzers. More detailed information can be found in the Beagle Protocol Analyzer Datasheet.

Beagle USB 480 Protocol Analyzer

The Beagle USB 480 analyzer is a compact device for monitoring high-, full-, and low-speed USB traffic.

On one side of the Beagle USB 480 monitor is a single USB-B receptacle. This is the **Analysis** side (Figure 1). This port connects to the analysis computer that is running the Beagle Data Center application or custom application.

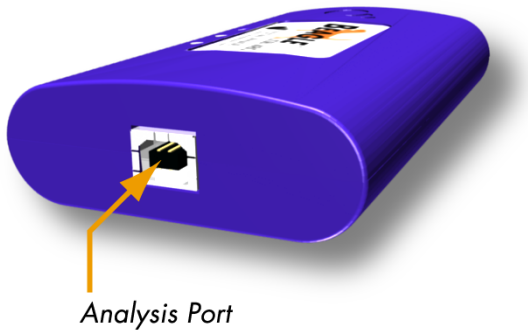


Figure 1: *Beagle USB 480 Protocol Analyzer - Analysis Side*

Please note the following performance issues:

- Use of USB ports that are mounted directly onto the motherboard is highly recommended. Ports that are not mounted directly can cause noise and sync errors due to poor quality of cables and connections.
- For best performance, it is recommended that the Beagle USB 480 analyzer be connected to its own USB host controller. All other USB devices should be connected to separate controllers.
- If only one USB host controller is available, it is still possible to use the Beagle analyzer effectively. Please refer to the Beagle Protocol Analyzer Datasheet (Device Operation section) and later sections of this manual for information on those operating modes.

The opposite side is the **Capture** side (Figure 2), and it contains a USB-A and USB-B receptacle. These are used to connect the target host computer to the target device. The target host computer can be the same computer as the analysis computer. However, for more performance critical applications, separate target host and analysis computers may be necessary.

Figure 2: *Beagle USB 480 Protocol Analyzer - Capture Side*

The **Capture** side acts as a USB pass-through. In order to remain within the USB 2.0 specifications, no more than 5 meters of USB cable should be used in total between the target host computer and the target device.

The **Capture** side also includes a mini-DIN 9 connector which serves as a connection to the digital inputs and outputs. The pinout of the connector is documented in the Beagle protocol analyzer datasheet.

The top of the Beagle USB 480 Protocol Analyzer has three LED indicators as shown in Figure 3. The green LED serves as an Analysis Port connection indicator. The green LED will be illuminated when the Beagle analyzer has been correctly connected to the analysis computer and is receiving power from USB. The amber LED serves as a Target Host connection indicator. The amber LED will be illuminated when the target host computer is connected to the analyzer. Finally, the red LED is an activity LED. Its blink rate is proportional to the amount of data being sent across the monitored bus. If no data is seen on the bus, but the capture is active, the activity LED will simply remain on.

Please check all the connections if the either of the connection LEDs fail to illuminate after

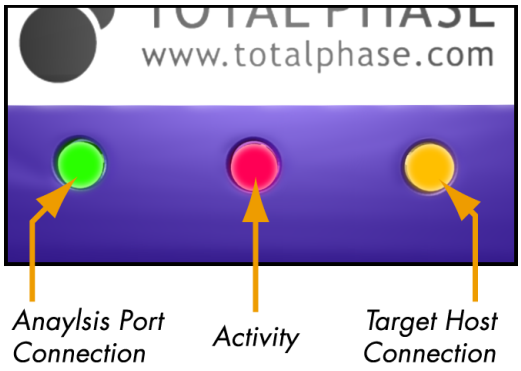


Figure 3: *Beagle USB 480 Protocol Analyzer - LED Indicators*

the Beagle USB 480 analyzer has been connected to the analysis computer or the target host computer.

Beagle USB 12 Protocol Analyzer

The Beagle USB 12 analyzer is a compact device for monitoring full and low-speed USB traffic.

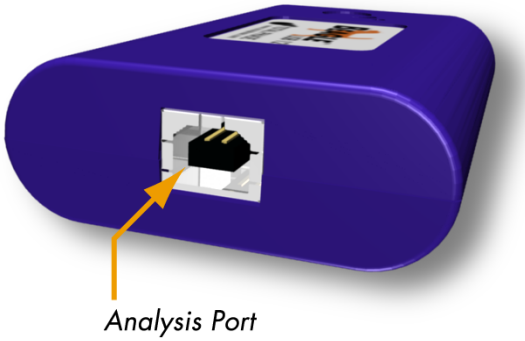


Figure 4: *Beagle USB 12 Protocol Analyzer - Analysis Side*

On one side of the Beagle USB 12 analyzer is a single USB-B receptacle. This is the **Analysis** side (Figure 4). This port connects to the analysis computer that is running the Beagle Data Center application.

Please note the following performance issues:

- Use of USB ports that are mounted directly onto the motherboard is highly recommended. Ports that are not mounted directly can cause noise and sync errors due to poor quality of cables and connections.
- For best performance, it is recommended that the Beagle USB 12 analyzer be connected to its own USB host controller. All other USB devices should be connected to separate controllers.

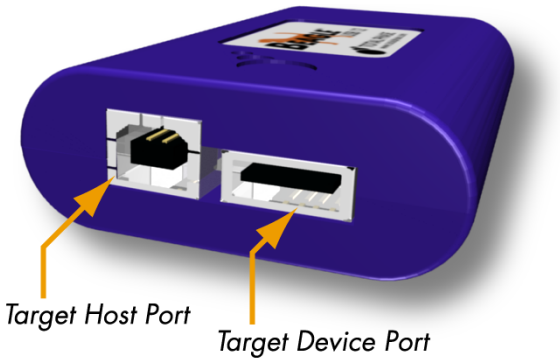


Figure 5: *Beagle USB 12 Protocol Analyzer - Capture Side*

On the opposite side is the **Capture** side (Figure 5), are a USB-A and USB-B receptacle. These are used to connect the target host computer to the target device. The target host computer can be the same computer as the analysis computer, though for more performance critical applications, separate target host and analysis computers may be necessary.

The **Capture** side acts as a USB pass-through. The Beagle USB 12 analyzer is galvanically isolated from the USB bus to ensure the signal integrity. In order to remain within the USB 2.0 specifications, no more than 5 meters of USB cable should be used in total between the target host computer and the target device. For best performance, it is recommended that the absolute minimum amount of cable be used.

Please note, that on the **Capture** side, there is a small gap between the two receptacles. In this gap, two LED indicators are visible, a green one and an amber one, as shown in Figure 6. When the Beagle USB 12 analyzer has been correctly connected to the analysis computer, the green LED will illuminate. When the Beagle USB 12 analyzer is correctly connected to the target host computer, the amber LED will illuminate.

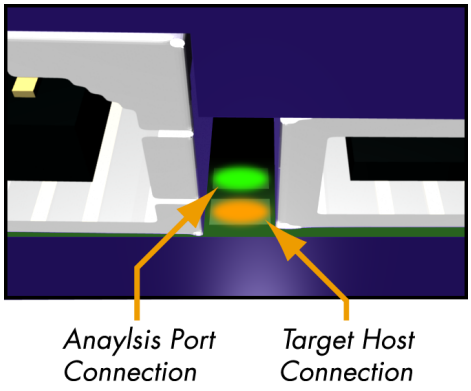


Figure 6: *Beagle USB 12 Protocol Analyzer - LED Indicators*

Please check all the connections if the one or both LEDs fail to illuminate after the Beagle USB 12 analyzer has been connected to the analysis computer or the target host computer.

Beagle I²C/SPI Protocol Analyzer

The Beagle I²C/SPI analyzer is physically similar to the Aardvark I²C/SPI Host Adapter.

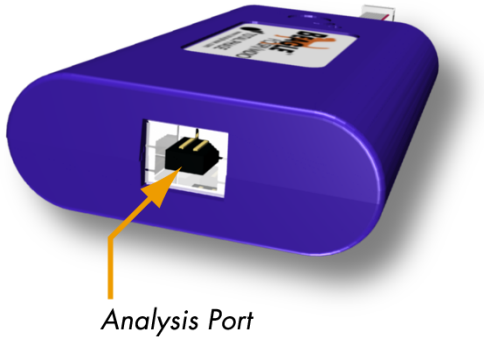


Figure 7: *Beagle I²C/SPI Protocol Analyzer - Analysis Side*

On one side of the Beagle I²C/SPI analyzer is a single USB-B receptacle. This is the **Analysis** side (Figure 4). This port connects to the analysis computer that is running the Beagle Data Center application.

Please note the following performance issue:

- Use of USB ports that are mounted directly onto the motherboard is highly recommended. Ports that are not mounted directly can cause noise and sync errors due to poor quality of cables and connections.

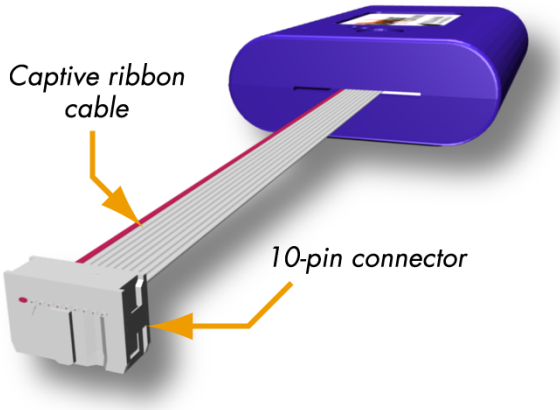


Figure 8: *Beagle I²C/SPI Protocol Analyzer - Capture Side*

On the opposite side is the **Capture** side (Figure 8, is a captive 10-pin ribbon cable. This cable is used to connect to the serial bus. The ribbon cable connector is a standard 0.100” (2.54mm) pitch IDC type connector. This connector will mate with a standard keyed boxed header.

Alternatively, Total Phase sells a 10-pin split cable with and without grabber clips which connects to the Beagle I^2C/SPI analyzer and provides individual flying leads for each pin which can be connected to the serial bus.

This 10-pin connector has the same pinout as the Aardvark I^2C/SPI Host Adapter. This pinout is documented in the Beagle Protocol Analyzer Datasheet.

4 Using the Total Phase Data Center Application

4.1 Starting Data Center Software

Windows

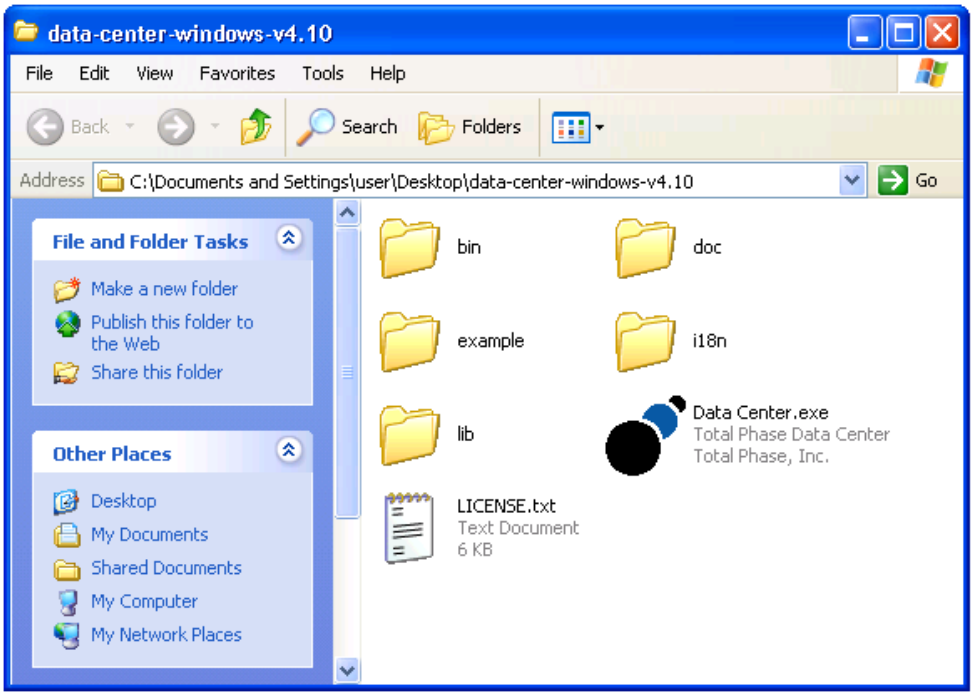


Figure 9: *Total Phase Data Center Software Directory Contents*

1. Go to the folder (Figure 9) where the software package was extracted.
2. Double-click on **Data Center.exe**.

Linux

1. Go to the installation directory where the software package was unzipped.
2. Execute `Data Center`.

Mac OS X

1. Go to the installation directory where the software package was unzipped.
2. Double click **Data Center**.

Windows File Associations

When Total Phase Data Center software is executed on a Windows machine, it will check to see if the correct file associations have been set for Data Center files (*.tdc files). This file association will allow users to double click on TDC files and have them automatically open in Data Center. It will also provide an icon for the TDC files to make them easier to distinguish.

Click **OK** to set the association, or **Cancel** to leave the file type unassociated.

Please note that only users with write permissions to the Windows registry will be able to set the file association for TDC files.

Command Line Options

To launch the Data Center application from the command line, use the script located in the `bin` directory in the software package. Note that the `bin` directory is located inside the app bundle on Mac OS X.

The following option are available when running the Data Center application from the command line:

- **-b FILE**, Run the given file in batch mode.
- **-c**, Create a command line interface.
- **-r PORT**, Create a remote console on the given TCP port.

Batch Mode

The **-b FILE** option allows for the specified file to be run in batch mode when the Data Center application is launched. The file can contain commands in the same format as those entered in the command line window (Section 5.3).

Command Line Console

Using the **-c** option will create a command line console on the command line where the Data Center application was launched. Commands that can be entered in the command line window (Section 5.3) can also be entered in the console.

Remote Console

The **-r PORT** option will create a remote console on the given port. Connecting to this port via Telnet will give the user a command line console similar to the one found in the command line window. This allows users to control the Data Center application when they can't physically be in front of the machine running the application.

Certain commands that require a graphical interface will not be permitted. Additional arguments may be required in order to execute these commands from the remote console. Refer to a command's help output for more details on the required arguments (Section 5.3).

4.2 Exiting Data Center Software

To exit the application, select **File** | **Quit** from the menu or use the keyboard shortcut **Ctrl+Q**.

Upon quitting, Data Center software will verify that the current capture session has been saved. If it has not been saved, the user will be prompted to save or discard the file before exiting (Figure 10).

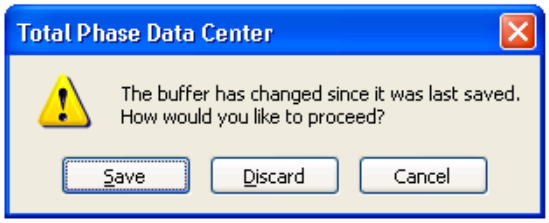


Figure 10: *Unsaved Warning Dialog*

4.3 Getting Around the Total Phase Data Center Application

The Data Center application is a powerful, yet easy-to-use, graphical interface to the Beagle analyzers. The general interface of this application is shown in Figure 11.

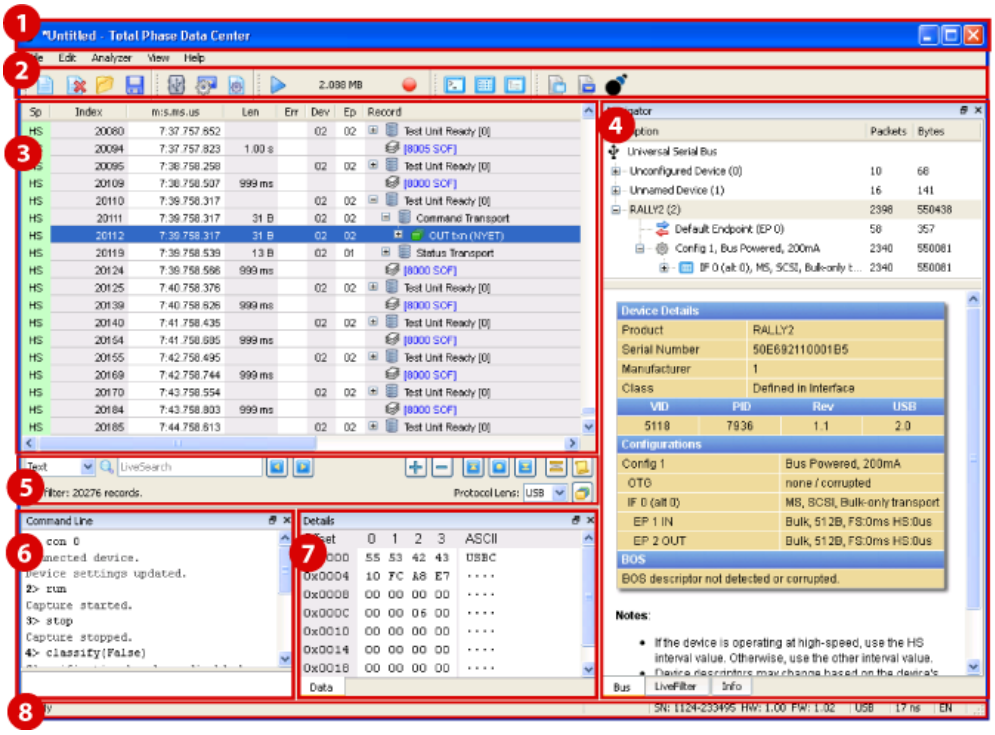


Figure 11: *Beagle Data Center Software Interface*

Title Bar (1)

The title bar provides the status of the current capture file. A name of “Untitled” will be used when a new capture buffer is created and the data has not been saved to a file.

An asterisk (*) preceding the filename indicates that the capture buffer contains new data that has not been saved. Figure 12 shows this situation with a filename of “usb_capture”.

Figure 12: *Unsaved data exists in the capture buffer*

A plus (+) preceding the filename indicates that the data in the capture buffer has been saved, but reduced save settings have been used. For additional information on reduced save settings see the Save Settings section below. Figure 13 shows an example of this notation.

Figure 13: *Capture buffer has been saved with reduced save settings*

Toolbar (2)
The toolbar provides single click access to the majority of the Data Center application’s functionality.

Transaction Window (3)
The Transaction window displays all the raw data from the bus capture. When capturing packets over the USB protocol, the application will group related packets under a single transaction entry in the Transaction window. The user may expand or collapse the entries in a transaction by double-clicking the record, or by single-clicking the icon preceding the record’s description in the **Record** column.

Navigator Window (4)
The Navigator window contains three tools that allow the user to quickly find relevant data.

- The **Bus Pane** shows all devices that the Beagle Analyzer has detected on the bus during a capture, as well as the address(es), endpoint(s), and/or enumeration information corresponding to that device.
- The **Filter Pane** allows the user to filter the captured data based on selected parameters.
- The **Info Pane** gives a detailed description of the information and fields, if any, contained in a packet.

The specific operation of each panel depends on the protocol being analyzed. For more specific information, see the relevant protocol sections below.

Transaction Window Controls (5)
These controls allow the user to navigate the Transaction window and alter the way records are displayed.

Command Line Console (6)
The command line console provides a command line interface to the application and logs all actions performed. The user can then repeat or modify previous actions and create batch scripts

that are loaded on startup. For a list of commands, type **help** into the console. Command-specific documentation can also be accessed using help with the **help COMMAND** syntax.

Details Window (7)
The raw bytes from the selected record are displayed in the Details window. Timing information will also be displayed if the protocol supports it. Each protocol type may have a different set of panels that are specific to that protocol.

Status Bar (8)

The status bar provides the user with information about the current status of the software and the Beagle analyzer. It displays information from the search, delta-time, data payload, and instantaneous bandwidth functions. The status bar also displays the hardware and firmware versions of the connected Beagle analyzer.

Toolbar

The Toolbar (Figure 14) is the primary means of operating the Data Center application. It is comprised of the following functions:

Figure 14: *Beagle Data Center Toolbar*

File New 
Use the **File New** button to discard the current capture and create a new, unnamed file.

The File New command can also be issued through **File** | **New** or with the keyboard shortcut **<Ctrl>+N**.

File Clear 
Use the **File Clear** button to discard the current capture and keep the current file active.

The File Clear command can also be issued through **File** | **Clear** or with the keyboard shortcut **<Ctrl>+L**.

File Open 
Use the **File Open** button to open a previously saved capture file.

The File Open command can also be issued through **File** | **Open** or with the keyboard shortcut **<Ctrl>+O**.

File Save 
Use the **File Save** button to save the current capture to disk.

The File Save command can also be issued through **File** | **Save** or with the keyboard shortcut **<Ctrl>+S**.

Connect to Analyzer... 
The **Connect to Analyzer...** button launches the Connection dialog, which is the primary means of connecting and disconnecting Beagle protocol analyzers to the Data Center software.

The Connection dialog can also be accessed through **Analyzer** | **Connect to Analyzer...**.

Device Settings... 
The **Device Settings...** button launches the Device Settings dialog, which allows the user to configure device-specific settings.

The Device Settings dialog can also be accessed through **Analyzer** | **Device Settings...**.

Capture Settings... 
The **Capture Settings...** button launches the Capture Settings dialog, which allows the user to configure capture-specific settings.

The Capture Settings dialog can also be accessed through **Analyzer** | **Capture Settings...**.

Start Capture/Stop Capture 
To start a capture, simply press the **Start Capture** button. When a capture is running, the **Start Capture** button becomes the **Stop Capture** button. To stop a capture, press the **Stop Capture** button.

The capture can also be started by selecting the menu item **Analyzer** | **Run Capture** or using the keyboard shortcut **<Ctrl>+R**. The capture can be stopped by selecting the menu item **Analyzer** | **Stop Capture** or by using the same keyboard shortcut **<Ctrl>+R**.

Capture Size
Indicates the amount of data that has been captured and displays this amount in the appropriate format (either kilobytes or megabytes).

Capture Indicator 
Indicates if a capture has been started or stopped. A red indicator means that the capture is currently stopped. A green indicator means that the capture is currently active.

Command Line 
Toggle the visibility of the Command Line window.

Details 
Toggle the visibility of the Details window.

Navigator 
Toggle the visibility of the Navigator window.

Manual 
Opens a PDF copy of the Data Center Software Manual.

Datasheet 
Opens a PDF copy of the Beagle Analyzer Datasheet.

Website 
Launches a web browser and opens the Total Phase website, http://www.totalphase.com.

Transaction Window

The Transaction window displays the transactions captured on a serial bus in real-time. When a transaction is selected, detailed information about that transaction is displayed in the Details window, the Info pane, and the Bus pane.

The Transaction window has additional protocol specific parsing, providing high level information about the data as is appropriate to the protocol. Specific information about these protocol-dependent features can be found in the sections in this manual pertaining to the respective protocols.

Transaction Window Controls

These tools allow the user to have more control over the display and navigation of the Transaction window.

Search Tool 

Run an instantaneous search for text or data across all records. Clicking the magnifying glass reveals a menu allowing the user to choose what type of data to search for. The **Find Next** and **Find Previous** buttons allow the user to quickly navigate the matching records. The input format required by the search tool is the same as required by the text and data filtering. Please refer to the filtering sections below for additional details.

Expand/Collapse All 
The **Expand All** button (plus sign) expands all the transactions that have been captured, while the **Collapse All** button (minus sign) collapses all transactions that have been captured. Please note that the **Incoming Expand/Collapse** button will also be toggled, if needed, to reflect a similar state to either button that was clicked. That is, using the **Expand All** button will also ensure that new transactions are expanded when added to the Transaction Window. Similarly, using the **Collapse All** button will ensure that new transactions are collapsed when added to the Transaction window.

Buffer Navigation 
The **Beginning of Buffer** and **End of Buffer** buttons move the scrollbar in the Transaction window to the top or bottom of the capture, respectively. The **Selected Record** button moves the scrolling position of the Transaction window such that the selected record is visible. The **Selected Record** button has no affect if there is no record selected. Please note that any time the scrollbar is moved using any of these buttons, scrolling will be disabled.

Incoming Expand/Collapse 
When the **Incoming Expand/Collapse** button is in the expanded state, all new transactions added to the Transaction window are expanded. Similarly, if the button is in the collapsed state, all new transactions are collapsed.

Scrolling 

The **Scrolling** button has three states: enabled, locked, and disabled. When enabled, the Transaction window will automatically scroll to the most recently captured transaction. Moving the scrollbar or clicking in the Transaction window will cause the automatic scrolling to be disabled. When the button is in the locked state, the automatic scrolling is enabled, and won't be disabled when clicking in the transaction window or moving the scrollbar. When disabled, the Transaction window will remain at the position the user indicates.

Filter Status

When a filter is not applied, the filter status displays the total number of records that have been captured. When a filter is applied, the number of matched records is displayed along with the total number of records.

Protocol Lens

The **Protocol Lens** choice box displays the protocol lens that is being applied to the Transaction window. When captured data from multiple protocols are present in the Transaction window, only those transactions from the selected protocol will be shown. Transactions from other protocols will be collapsed to a single record per capture.

Please note that this setting does not affect the capture protocol setting of the current device. To view or change the capture protocol, open the Device Settings dialog.

Classification 

When enabled, the captured data will be parsed with class-level decoding. Otherwise, the captured data will be parsed with only the protocol-level decoding. This option is only available for the USB protocol (see section 6.5).

Filter Pane of Navigator Window

The Filter pane provides a useful and powerful set of tools to filter the transactions in the transaction window. Filters can be applied at any time, even in real-time during a capture. The use of filters can help developers quickly identify and locate data of interest in a large data set.

Details Window

The Details window provides actual byte content of a specific transaction. The Beagle Data Center supports capturing bit-timing for the SPI and I2C protocols. When the capture protocol is configured as I2C and SPI, the Details window will have an extra tab that displays the bit-timing of the transaction selected in the transaction window.

Additional protocol specific viewing modes may be available and are documented in their respective sections.

4.4 Connecting to a Beagle Analyzer

The Data Center application must connect to a Beagle analyzer before it can start a capture. To start the connection process, click on the **Connect to Analyzer...** button in the toolbar, or select **Analyzer** | **Connect to Analyzer ...** from the menu to open the Connection Dialog.

Connection Dialog

The Connection Dialog (Figure 15) displays all the Beagle analyzers that are connected to the computer. If the user connects or disconnects a device after the dialog has been opened, click the **Refresh** button in the top right corner to update the list of analyzers in the dialog.

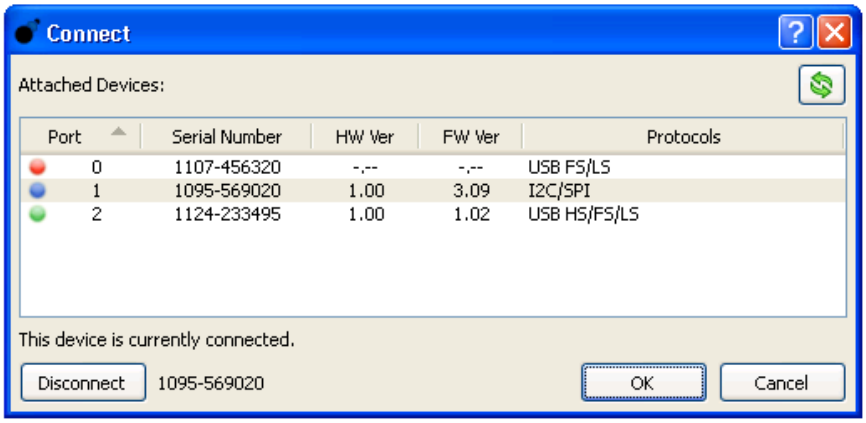


Figure 15: *Connection Dialog*

The list of available devices provides the following information:

Port
The port number of the Beagle analyzer.

Availability
The icon preceding the port number indicates the availability of the device. A green icon indicates an available device, and a red icon indicates a device that is being used by another application. A blue icon indicates the device that is currently connected to this instance of the application.

Serial Number
The serial number of the Beagle analyzer. This is a convenience to allow developers to easily identify the physical unit that is being connected to Data Center.

HW Ver
The hardware version of the Beagle analyzer.

FW Ver
The firmware version of the Beagle analyzer.

Protocols
The protocols that can be captured by the Beagle analyzer.

Connecting to a Beagle Analyzer

To connect to a Beagle analyzer:

1. Click on **Connect to Analyzer...** in the toolbar to open the Connection dialog.

2. Select a Beagle analyzer from the list of available devices.
3. Click on the **OK** button at the bottom of the dialog.

If the Beagle analyzer is being used by another process, you will not be able to connect to it.

Disconnecting a Beagle Analyzer

To disconnect a Beagle analyzer:

1. Click on **Connect to Analyzer...** in the toolbar to open the Connection dialog.
2. Click on the **Disconnect** button at the bottom of the dialog.

Figure 16: *Beagle Analyzer Connection Error*

Errors can occur If the Beagle analyzer is physically disconnected before it is disconnected via the software. In these cases, the Data Center application will automatically close the analyzer and display an error message (Figure 16).

4.5 Starting a Capture

The application must be connected to a Beagle analyzer in order to start a capture. If a Beagle analyzer is not connected, any attempts to configure a device or run a capture will not succeed.

To start a capture:

1. Connect to a Beagle analyzer
2. Click on the **Run Capture** button in the toolbar, select **Analyzer** | **Run Capture** from the menu, or use the keyboard shortcut **Ctrl+R**.

Once the capture has been started, the capture indicator will flash green and a record indicating the capture start time will appear in the transaction window.

While the application is capturing data, it is not possible to reconfigure the device, change the capture settings, or connect to a different Beagle analyzer. To access these options, you must first stop the capture.

The current capture data will be appended to any data that has already been captured. Data Center software can only capture to a single file at a time. To capture to a new file, go to **File | New**, or use the keyboard shortcut **Ctrl+N**. If the current data is unsaved, the application will issue a warning (Figure 10). The user has the option to save the data before continuing.

To clear the capture data while keeping the current file open, go to **File | Clear**, or use the keyboard shortcut **Ctrl+L**. If you are discarding data that has not yet been saved, Data Center provides a warning (Figure 17). Any subsequent data captured will be saved to the same file.

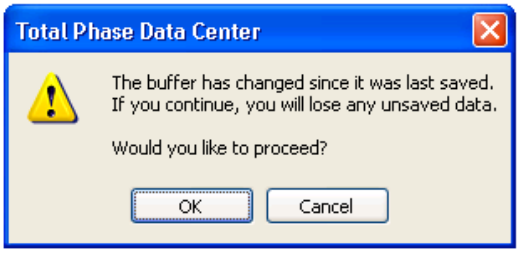


Figure 17: *Clear Capture Data Warning Dialog*

Maximum Capture Size

The data captured by Data Center software is stored in memory. The total amount of memory used by the capture is displayed in the toolbar.

The Data Center application will automatically stop the capture after it has captured a finite amount of data. The initial stop point is set at 256 MB. When the limit is reached, a Capture Limit Dialog (Figure 18) will appear.

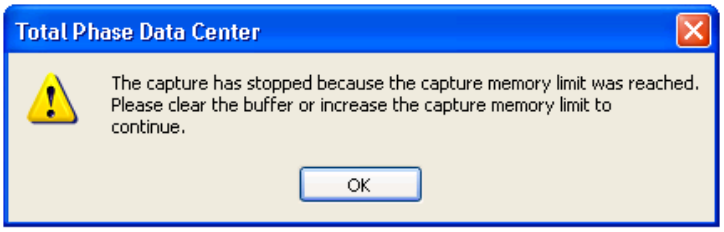


Figure 18: *Capture Limit Dialog*

It is possible to change the maximum size of a capture. Please refer to the Changing Settings section for more information.

4.6 Stopping a Capture

To stop a data capture: click the **Stop Capture** button, go to **Analyzer | Stop Capture**, or use the keyboard shortcut **Ctrl+R**.

The capture indicator will turn red and a record indicating the capture stop time will be inserted

into the transaction window.

4.7 Filtering a Capture

A capture can be filtered at any point during or after a capture.

Applying Filters

Filters are constructed and applied to the capture through the Filter tab of the Navigator pane. Click on the **Filter** tab at the bottom of the Navigator pane to reveal the Filter options. To apply a filter, click on the **Apply** button in the Filter tab. The results will be immediately displayed in the transaction window.

All filter parameters are applied at the same time. A transaction must meet all the filter requirements in order to appear in the transaction window.

Specific protocols may have additional filtering options available. Information about these options can be found in their respective sections.

Disabling Filters

If a filter is enabled, the **Enabled** checkbox at the bottom of the Filter tab will be checked. To disable the filter, un-check the **Enabled** checkbox. Any hidden transactions will immediately become visible. You may re-enable the filter by re-checking the **Enabled** checkbox.

Editing Filters

You may edit filter settings without applying them by editing the fields of the Filter tab. Clicking the **Revert** button will update the Filter fields with the options from the last filter that was applied, regardless of whether it is currently enabled or disabled.

Restoring Filter Defaults

The default filter state matches all packets and does not filter any data from the capture. To restore the default filter state to the Filter tab, click the **Default** button at the bottom of the Filter tab window. Note that the **Default** button only affects the state of the Filter pane and will not apply any settings to the filter.

4.8 Searching a Capture

A capture can be searched for arbitrary patterns in the text fields of the Transaction window and in the data payload of each record. The user can choose which fields to search with the drop down menu to the left of the LiveSearch box (Figure 19).

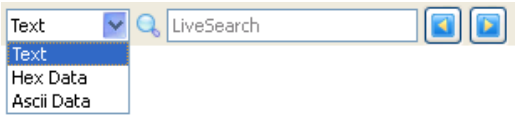


Figure 19: *Search options*

- **Text**
  Search the textual information in the Record and Data columns. Any raw data that is shown in the Data column will not be searched when **Text** is selected. Use **Hex Data** or **Ascii Data** to search the data values.

- **Hex Data**
  Search the payload data of each record and transaction for the hexadecimal data specified in the search pattern. The requirements for the search pattern format are the same as the requirements for the data fields in the filter options. Refer to the filtering sections below for more information.

- **Ascii Data**
  Search the payload data of each record and transaction for the ASCII data specified in the search pattern. As with the **Hex Data**, refer to the filtering sections below for more information regarding the search pattern format.

4.9 Saving a Capture

Captures can be saved to a binary file for later analysis. By default, all the data that was captured will be saved to file, regardless of how the data is being filtered. This is to ensure that no information is lost. However, the save settings can be modified to save only the filtered view. See the **Save Settings** section for more details.

To save a capture, go to **File** | **Save**, or use the keyboard shortcut **Ctrl+S**. If the capture(s) have not yet been saved, the application will open a file save dialog to determine the name and location of the save file.

After the user supplies a valid file location, the application will open another dialog to allow the user to set the file's Save Settings (Figure 20). The Save Settings dialog offers several options for discarding data from the capture in order to reduce the size of the binary file. To preserve all of the captured data, leave all settings unchecked.

The data will be saved into a Total Phase Data Center file (*.tdc).

Save Settings

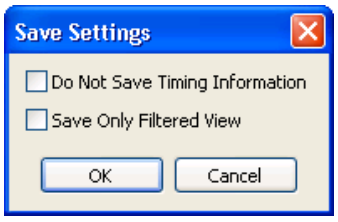


Figure 20: *The Save Settings Dialog*

The save settings must be configured the first time a capture is saved to a file. Excluding data will reduce the size of the saved binary file.

Do Not Save Timing Information

In SPI and I^2C capture modes, the Data Center application extracts and displays the timing between bits in a single transaction. While this information can be quite useful, it significantly increases the size of the binary capture file. If this option is selected, none of the bit level timing information will be saved.

Save Only Filtered View If selected, only the filtered transactions of the current protocol will be saved. Please note that significant amounts of information may be lost. Because transactions may be missing, the saved file is marked as incomplete. If the user reopens this file with Data Center software, it will be marked as a "**(Filtered File)**" in the title bar and appending additional captures to this file will be disallowed. To resume capturing, the user will need to clear the current capture, create a new file, or open another file.

Also note that any transaction or record that is a soft match (denoted by the faded color) will be saved when saving only the filtered view.

Furthermore, please note that when saving a filtered view of a USB capture, you may lose the ability to do class-level parsing of your capture. This can happen if you filter out certain transactions that are necessary for class-level parsing when in the protocol-level view. If you would like to have the option of class-level parsing for subsequent loading of the saved file, save your filtered view while classification (i.e., class-level parsing) is enabled.

4.10 Opening a Saved Capture

To open a previous capture, go to **File** | **Open...**. This will open a dialog the user can use to navigate the file system and select a Data Center file. Data Center files have the extension *.tdc.

When opening a file, the current capture data will be overwritten. If the current capture data has not been saved, the user will be prompted (Figure 10) to save their data. Click **Save** to save the capture data, or **Discard** to ignore it.

It is possible to append additional capture data to an existing file. Information rows in the data set will indicate when the separate captures were performed.

There is one exception, however. Additional data cannot be captured to a file that was previously saved with a Filtered View.

4.11 Exporting a Capture

It is possible to export an entire capture or a subset of a capture for future analysis. A capture can only be exported as a comma delimited file (*.csv).

To export a capture, go to **File** | **Export**, or use the keyboard shortcut **Ctrl+E**. The application will open a file dialog to determine the name and location of the export file.

After the user supplies a valid file location, the application will allow the user to set the file's Export Settings (Figure 21).

Figure 21: *Export Settings Dialog*

Export Settings

The export settings must be configured each time a capture is exported, unless the **Re-Export** option is being used. See the **Re-Exporting a Capture** section below for more details.

Please note that the current state of the filter is used when exporting. This means that the filter must be enabled in order to export a filtered view.

Export Only Full Matches

If selected, only the records that are full matches will be exported. Any record that is a soft match (denoted by the faded color) will not be exported when this option is enabled.

Export Only Visible Records

If selected, only the records that are visible will be exported. Any record that is hidden, such as a record whose parent is collapsed, will not be exported when this option is enabled.

Re-Exporting a Capture

After an export has been performed, the **File** | **Re-Export** option can be used to re-export the capture to the same file, with the same export settings. The user is not prompted for any additional information.

If an export has not previously been performed, the user will be prompted for a file name and export settings as if the **File** | **Export** option was selected.

Please note that it is the current state of the filter that is used when exporting, and not the state when the initial export was performed.

4.12 Preferences

The Preferences dialog (Fig. 22) allows the user to configure the Data Center software. The Language section provides a list of available languages to choose from. Selecting the preferred language will translate all the strings used throughout the application. The Updates section allows the user to configure when to be notified that a newer version of Data Center software is available.

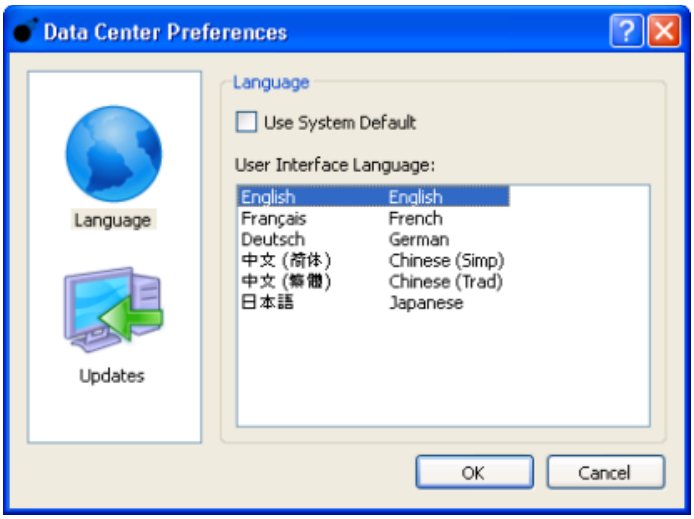


Figure 22: *Preferences Dialog*

4.13 Changing Settings

The Capture Settings and Device Settings dialogs allow the user to change the parameters of a capture. Capture options that are common to all protocols are available in the Capture Settings dialog. In addition, each protocol has device settings which are discussed in the protocol-specific sections of this manual.

To change the capture settings, Click on **Capture Settings...** in the toolbar, or go to **Analyzer | Capture Settings...**.

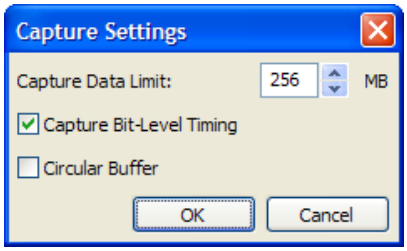


Figure 23: *Default Capture Settings*

Capture Data Limit

The capture data limit setting limits the amount of memory that captured data can occupy on the analysis computer. Once this limit is reached, the capture will either automatically stop or records will begin to be deleted, depending on the circular buffer setting.

Total Phase recommends that the maximum size allowed for a capture should be set to no more than half the available memory on a system. On an extremely busy computer, the capture limit should be set even lower to prevent problems. If the application starts swapping memory, incoming capture data may be lost.

Note that the capture buffer limit is intended to be an approximate, as it is difficult to keep exact under real-time capture constraints. As such, the actual capture size may fluctuate around this setting when the circular capture buffer is enabled, or go slightly over when it is not.

Bit-Level Timing

The capture of bit-level timing is optional. By not capturing bit-level timing data, the Data Center software will have improved performance, reduced memory usage and will be able to capture data for a longer period of time before running into the capture data limit.

The bit-level timing option is only available when capturing SPI and I^2C data.

Circular Buffer

The circular buffer option allows the Data Center application to discard past records during a capture in order to keep the capture size below the capture data limit. The removing of records will begin at the start of the first index of the transaction table, regardless of whether or not that record is visible.

Please note that when using circular buffer for USB captures, you may lose the ability to see your capture with class-level parsing. This is because certain records necessary for class-level parsing may be discarded. These required records are usually sent when the device is initially plugged in, and are therefore the first to be dumped when the circular buffer rolls over. If you would like to preserve the ability to use class-level parsing, enable the classification option before starting the capture. This activates a special feature that preserves the records necessary for class-level parsing.

4.14 Getting Help

Help files are available to assist the user. To open the manual, go to **Help** | **Manual**, or use the keyboard shortcut **F1**. To open the datasheet, go to **Help** | **Datasheet**, or use the keyboard shortcut **F2**. To visit the Total Phase website, select the menu item **Help** | **Website**, or use the keyboard shortcut **F3**. Each of these commands are also available from the toolbar. See Section 4.3 for details.

4.15 Example Captures

Examples of common types of captures are available in all supported protocols for the user to peruse. To access the Examples dialog (Figure 24), either select the **File** | **Examples...** menu item, select the **Help** | **Examples...** menu item, or use the keyboard shortcut **F4**.

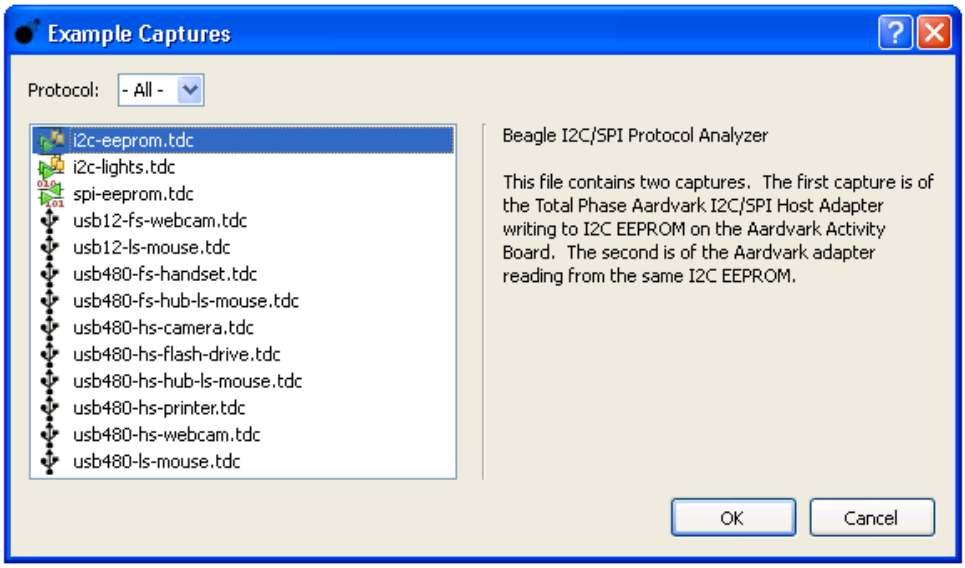


Figure 24: *Example Captures Dialog*

5 General Monitoring

The Data Center application has a common interface regardless of what protocol is being captured. This section describes those common features. Details that are specific to each protocol can be found in the protocol-specific sections below.

5.1 Transaction Window

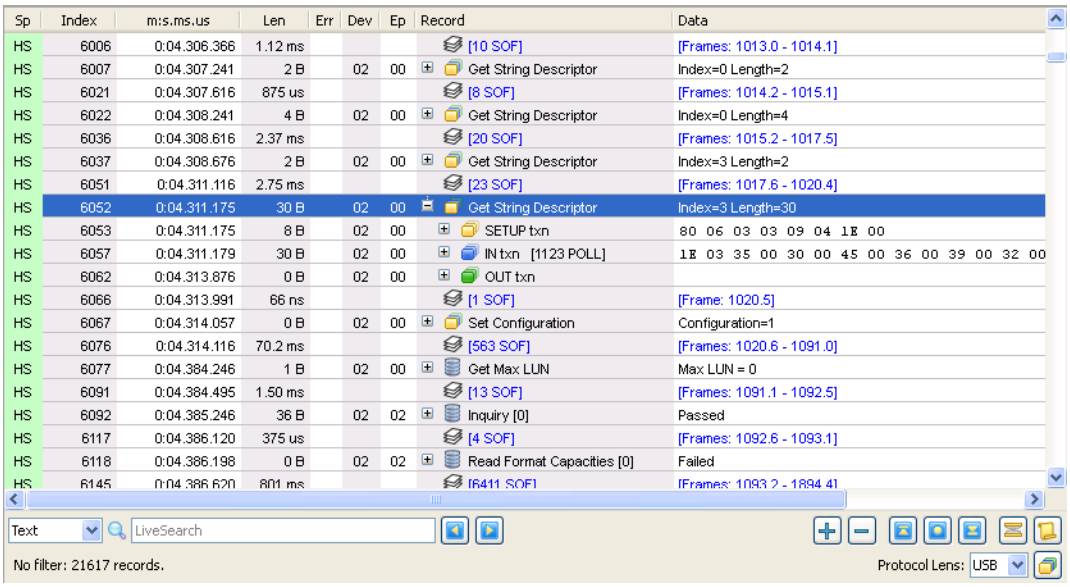


Figure 25: *The Transaction window with Protocol Lens set to USB*

The Transaction window (Figure 25) displays all the transactions that were captured on a serial bus in real time, as well as bus events or capture meta-information such as when the capture began or ended. Each discrete message on the bus will appear as a single record, or transaction, in the Transaction window. When a transaction is selected in the Transaction window, the byte content and/or timing data of that transaction is displayed in the Details window. Packet meta-information such as originating device and time stamp will be displayed in the Navigator window.

The transaction table provides the following information that is common among all protocols:

Index
The transaction index number. The first record of the first capture is considered index 0.

Timestamp
The time that the transaction was captured. The time counter starts at 0 when a capture is started. Every time a new capture is started, the time is reset to zero.

The timestamp column can be configured to display timestamps at millisecond (min:sec.ms), microsecond (min:sec.ms.µs), or nanosecond (min:sec.ms.µs:ns) resolution. To change the timestamp precision of the Transaction window, open the context menu over the table and select

the desired precision from the **Timestamp Resolution** menu. The timestamp of the transaction is displayed in nanosecond precision in the Info pane.

Duration (Dur)
The elapsed time that the transaction was in the bus. The duration value displayed is shown in an abridged format. The full duration to nanosecond precision is displayed in the Info pane.

Length (Len)
The number of bytes in the transaction.

Error codes (Err)
Error codes listing abnormal conditions that occurred while capturing the transaction. See Table 1 for the possible error codes.

Table 1: *Error code values*

Code	Meaning	Description
U	Unexpected	A packet or event occurred outside of the expected context.
T	Time out	Capture for transaction timed out while waiting for additional data.
M	Middle of packet	Data collection was started in the middle of a packet.
S	Short buffer	Transaction was too long to fit in capture buffer.
P	Partial last byte	The last byte in the buffer is incomplete. The number following the error code indicates how many bits were received for the last byte.

In addition, there are error code values specific to USB transactions listed in Table 2.

Record
A description of the transaction.

Data
The bytes in the transaction.

There are also additional protocol specific features for the Transaction window which provide high level information about the data captured. Specific information about these features can be found in their respective sections in this manual.

Each column in the Transaction window can be hidden by right clicking the column's header and selecting the appropriate option in the context menu. Additionally, columns can be resized and reordered to create a custom layout for each lens.

Right clicking in the Transaction window will bring up a context menu with the following options.

Time Reference
By default, each capture session starts at time 0 and the timestamp displayed for each transaction is relative to the Capture started event. The user can select any transaction in a session to be the time reference and the timestamps of the other transactions will be adjusted accordingly. To denote that a transaction other than the Capture started event is set as the time reference, the timestamps for the entire session are colored. Also, the time reference is set on a capture session basis since the timestamps for each session are independent.

Table 2: *USB-specific error code values*

Code	Meaning	Description
0	Bad bit-stuff	The Beagle USB 12 analyzer has detected a bit-stuff error.
B	Bad signals	Invalid signal observed on the bus. With the Beagle USB 480, this could be caused by a misaligned bit-stuff error.
C	Bad CRC	The CRC of the packet is invalid.
F	SOF frame number error	Unexpected frame number encountered. This could be caused by a discontinuity in the frame number sequence, a repeated frame number in full-speed, or greater or fewer than 8 repeated frame numbers in high-speed.
H	Invalid SPLIT bits	Certain bit patterns of the SPLIT packet are not allowed by the USB 2.0 Specification. Please refer to the USB 2.0 Specification section 8.4.2.2 for more information.
I	Invalid PID sequence	An invalid sequence of packets has been observed.
K	Classification error	An error occurred during class-level parsing.
L	Improper packet length	The packet has a length that is too large or too small for the packet's PID type.
Y	Unexpected PING	A PING token was seen but is unexpected. A PING token is expected to be seen only after one of these transactions: a OUT-DATA-NYET, a OUT-DATA-NAK, or a PING-NAK.
Z	Frame timing jitter	The frame was observed outside of the acceptable timing specification. Please refer to USB 2.0 Specification section 7.1.12 for the particular timing specifications.

Expand/Collapse All
Expand or collapse all the transactions in the Transaction window.

Fully Expand/Collapse Branch
Expand or collapse the entire branch below the selected record. This does not affect any record in other branches or records that are parents of the selected record. Holding the Ctrl key while double clicking a record has the same effect.

Expand All to Level
Expand all transactions to the level of the selected record.

Comments
Comments allow the user to insert a record into the capture stream that contains arbitrary text. When a capture is running, comments can only be appended to the end of the capture buffer. When a capture is not running, comments can be inserted into the capture buffer as a top level record. This means that comments cannot be inserted in the middle of a transaction tree. Once a comment has been inserted, it can be modified or removed only when the capture is not running.

Delta Time and Data Payload Display

When moving the mouse over the Transaction window, the transaction that the mouse pointer is over will be highlighted. The time difference between this transaction and the currently selected transaction will be displayed as “Delta time” in the status bar at the bottom of the application window. The time displayed will be the time difference between the start times of the two transactions.

Next to the “Delta time”, the “Transferred length” will be shown along with the bandwidth. The “Transferred length” is the number of data bytes (i.e. the summation of the length field inclusively) between the selected transaction and the hovered transaction. The corresponding data bandwidth for this range is displayed in parenthesis. Be aware that due to the way transactions may be ordered, the reported bandwidth is an approximate value. Also note that the data payload information is only displayed when the selected and hovered transactions are at the same level in the same branch.

The delta time and data payload will only be displayed when the two transactions are from the same capture session. So if you start then stop a capture, then start another capture, these statistics will only be displayed when both the selected transaction and the one the mouse is over are from the same capture session.

5.2 Details Window

The Details window provides lower level detailed information about a specific transaction. There are two types of panes available. A Data pane is available for all protocols, and a Timing pane is available for SPI and I^2C captures. The way the data is displayed in these modes will depend on the protocol type.

Additional protocol specific viewing modes may be available and are documented in their respective sections.

Data Pane

The Data pane (Figure 26) provides a way for the user to examine the raw bytes of a transaction, regardless of the protocol specific structure of the data. By default, the Data pane is configured to show the data in hexadecimal and ASCII format. Right clicking in the Data pane will bring up a context menu that allows the user to configure the view by adding additional panes and adjusting the size, grouping, and radix of each pane.

When a pane is configured to display the data in ASCII format, a “.” is used if the equivalent ASCII character is a non-printing character. Also, when a sequence of bytes is highlighted in one pane, the corresponding byte representation of the same data in the other panes is also highlighted. This allows the user to easily translate between the different representations of the data.

Please see the protocol specific sections later in this document for more protocol-related features.

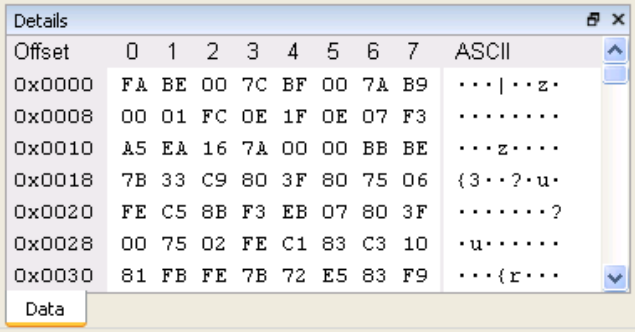


Figure 26: *Details Window - Data Pane*

Timing Pane

The Timing pane of the Details window (Figure 27) provides bit-level timing for the data of I^2C and SPI transactions. Each byte of the transaction appears as a row in this pane. All the bytes from the transaction will be displayed in this pane, including start and stop conditions.

The first line of the table displays the transaction timestamp as well as the transaction duration, both to nanosecond precision.

Each row contains the following information:

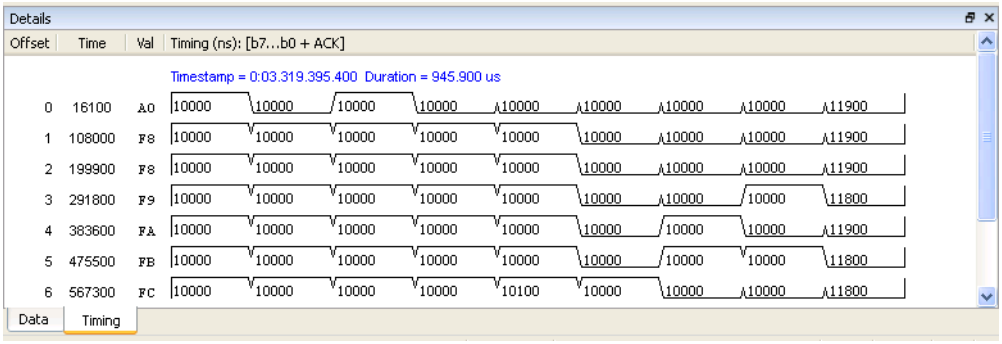


Figure 27: *Details Window - Timing Pane*

Offset
The offset position of the byte.

Time
The time in nanoseconds from the start of the transaction to the start of the byte.

Value
The hexadecimal value of the byte.

Timing
A graphic display of each individual bit of a byte. Each bit is displayed as being either high or low with the time in nanoseconds from the start of the current bit to the start of the subsequent bit.

The lengths of the timing blocks in the graph are not drawn to scale and are intended merely to provide a hint to the relative time scale of one bit time to the next.

Please note that depending on the protocol, the bit order may be MSB or LSB. You can determine the bit order by looking at the column label. The text in the label will indicate if the data is MSB (b7...b0) or LSB (b0...b7).

In the case of the I^2C protocol, the timing mode displays 9 bits per line. The ninth bit is the ACK/NACK bit.

In the case of the SPI protocol, the timing mode displays both MOSI and MISO. The MOSI line is displayed in red and the MISO line is blue.

Please see the protocol specific sections later in this document for more details.

5.3 Command Line Window

The Command Line window gives the user another method to interact with the Data Center application. All operations that can be done by pointing and clicking throughout the application can also be done via the command line. When an operation is performed in the application, its corresponding command line command is echoed in the command line output and added to the command line history. The user can use the arrow keys in the command line input box to scroll back through the command line history and edit or repeat previous commands.

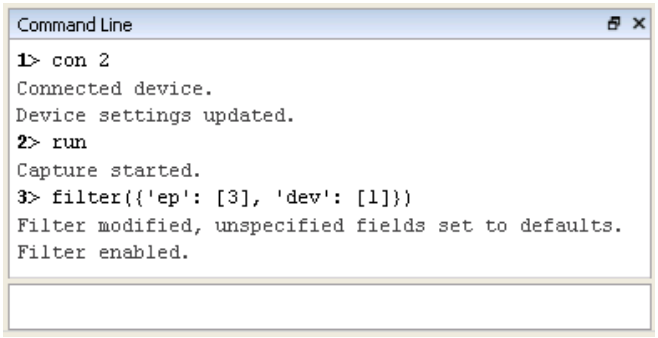


Figure 28: *Command Line Window*

To view all available commands, type **help** into the command line. Type **help COMMAND** to see help specific to a particular command.

When the command line input is in focus, pressing the escape key once will clear the command line input box, and double pressing the escape key will clear the command line output and history.

The command line uses the Python syntax and behaves similarly to the command line found in the Python interpreter. This means that local variables can be defined and control structures can be used as well. The arguments passed to the Data Center application commands are generally singleton values (such as integers, strings, or True/False), lists, or dictionaries. For more information on Python syntax and data structures, see http://www.python.org.

5.4 Bus Pane

The Bus pane of the Navigator window shows the devices that have been detected on the serial bus being monitored. For I^2C and USB, the devices are distinguished by the addresses. When an SPI bus is monitored, all the traffic is lumped into one device per capture since the Beagle can only monitor one slave select at a time. Clicking on a device in the bus tree will reveal more detailed information regarding that device. For additional information on what is displayed for each protocol, see the protocol specific sections later in this document.

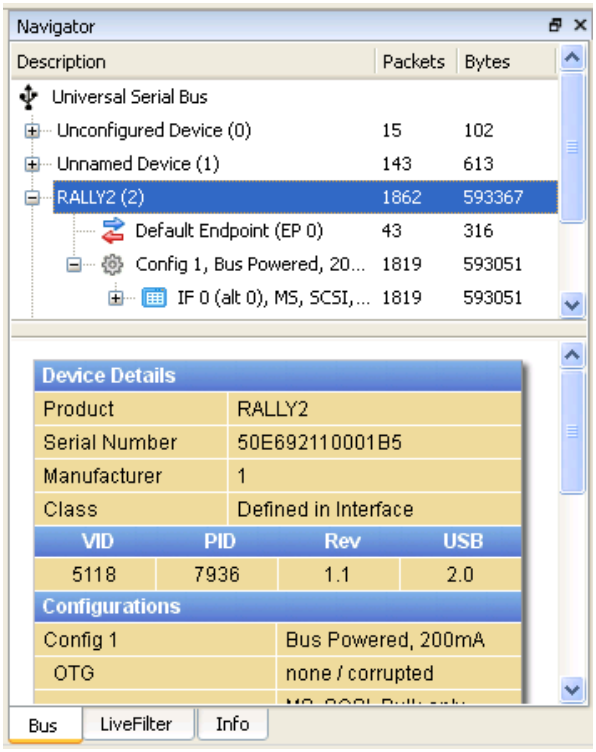


Figure 29: *Bus Pane*

5.5 Filtering

The Filter pane (Figure 30) in the Navigator window allows the user to non-destructively filter the data shown in the Transaction window.

The general filter fields are described below. Information on applying filters can be found in Section 4.7.

Filter Fields

The general set of filters available (Figure 30) for the all the protocols include:

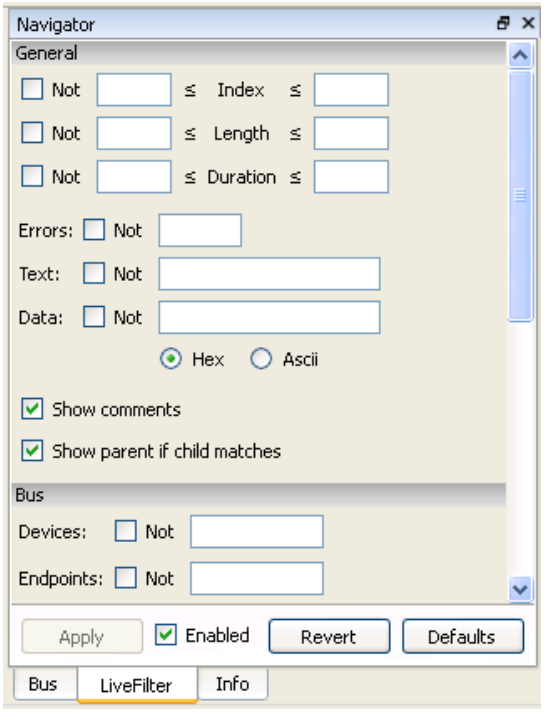


Figure 30: *Filter Pane*

Index

An integer range that filters the transactions based on a minimum and maximum index number.

Length

An integer range that filters the transactions based on a minimum and maximum length.

Duration

An integer range that filters the transactions based on a minimum and maximum duration in nanoseconds.

Errors

A list of codes (as defined in Tables 1 and 2) that filters the transactions based on whether the transaction contains any of the codes.

The codes must be in a list with no characters between each codes. For example, filtering for transactions that are unexpected or that have timed out would require the Errors field to contain “UT”.

Using an asterisk (*) by itself will cause the filter to match any transaction that has an error.

Text

A case-insensitive string pattern that filters the transactions based on the text in the Record or Data column. Any raw data that is shown in the Data column will not be examined when running this filter. Use the data filter to filter the raw data.

Syntax

There are 4 special characters defined in Table 3 that may be used in the pattern.

Table 3: *Special values for text and data pattern filters*

Value	Name	Meaning
?	Placeholder	One character of any value.
*	Wildcard	Zero or more characters of any value.
^	Start Anchor	Pattern must match at the beginning of the string. Only valid when put at the beginning of a pattern.
$	End Anchor	Pattern must match at the end of the string. Only valid when put at the end of a pattern.

See Table 4 for examples of text patterns.

Table 4: *Example text pattern filter entries*

Example	Result
`in`	Matches “IN” Matches “PING”
`^in`	Matches “IN” Does not match “PING”
`config*n`	Matches “Set Configuration” Matches “Get Configuration Descriptor”
`config*n$`	Matches “Set Configuration” Does not match “Get Configuration Descriptor”
`get*descriptor`	Matches “Get String Descriptor” Matches “Get Device Descriptor”
`s???t`	Matches “Start” Matches “SPLIT”

Data

A data pattern that filters the transactions based on the data contained in the transaction. The pattern may be specified as either a hexadecimal pattern or an ASCII pattern. Data patterns may contain the same special characters used in text patterns described in Table 3.

Syntax

When an ASCII pattern is used, the pattern is case-insensitive and applied to the raw data as it is shown in the ASCII portion of the hex editor found in the Details window. The syntax of ASCII patterns is the same as text patterns (Table 4).

When a hexadecimal pattern is used, each byte, or special character, must be separated with spaces. See Table 5 for examples of hexadecimal data patterns.

Table 5: *Example hexadecimal data pattern filter entries*

Example	Meaning
`1 2 3`	Must contain the sequence of `01 02 03` somewhere in data.
`^ 1 ? 2 FF`	Must have `01`, `02`, and `FF` in the first, third and fourth byte positions, respectively.
`0 ff $`	Must end with `00 FF`.
`^ ? c0 ? $`	Must be exactly three bytes long and have the value `C0` as the second byte.
`^ ? ? a5 * 20 $`	Must have `A5` in the third byte and end with 20.

Show parent if child matches

Checking this box will force any non-matching parents of a matching record to show as a soft match (Section 5.5).

Figure 31 shows what the Transaction window would look like after filtering for just DATA packets in a USB capture when the **Show parent if child matches** option is enabled. The parent of each of the DATA packets is shown as a soft match.

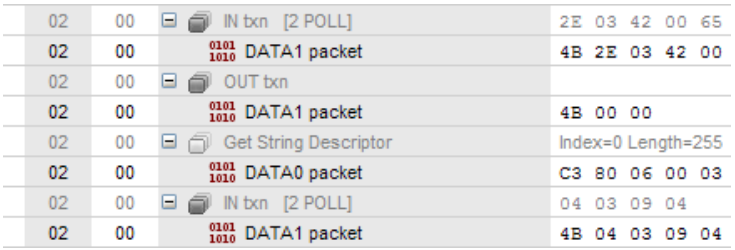


Figure 31: *"Show parent if child matches" is checked*

Unchecking the **Show parent if child matches** option hides the non-matching parents. Any record that no longer has a visible parent will have a dot placed to the left of the icon in the Record column. Figure 32 shows an example of this situation.

Soft Matches

A soft match is a record that doesn't match the applied filter, but one of its children, or its parent, matches. A soft match is displayed with its icon and text grayed out to distinguish it from records

02	00	▪	DATA1 packet	4B 1C 03 54 00
02	00	▪	DATA1 packet	4B 00 00
02	00	▪	DATA0 packet	C3 80 06 00 02
02	00	▪	DATA1 packet	4B 09 02 27 00
02	00	▪	DATA1 packet	4B 00 00
02	00	▪	DATA0 packet	C3 80 06 00 03
02	00	▪	DATA1 packet	4B 04 03 09 04
02	00	▪	DATA1 packet	4B 00 00

Figure 32: *"Show parent if child matches" is not checked*

that are full matches.

Be definition, all children of a matched record will be shown. If a child also matches the filter, it is a full match, otherwise it is a soft match. Similarly, the parents (up to the top level) of a matched record are soft matches if they don't match the filter, or they are full matches if they do. The user can disable the parents from showing using the **Show parent if child matches** filter (Section 5.5).

5.6 Info Pane

The Info pane (Figure 33), located in the Navigator window, shows detailed information about the record that is selected. The information may include:

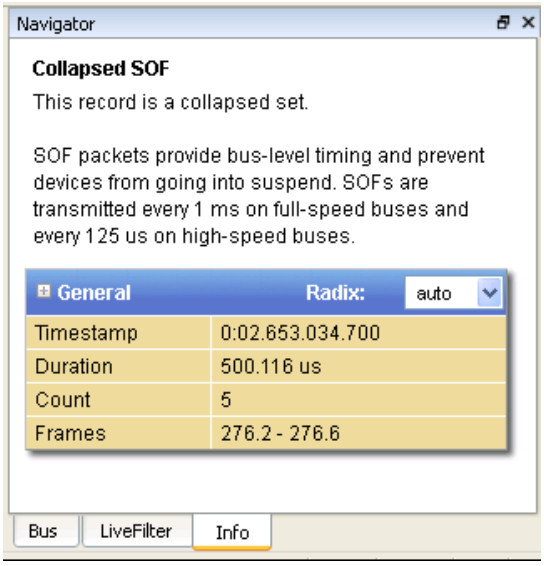


Figure 33: *Info Pane*

- A description of the type of record and how it used in the protocol.
- The data represented in tabular form with fields parsed for convenience. There may be rows in a table that are hidden. To reveal hidden rows, use the +/- button to the left of the table title. The user may also change the format of the data shown with the radix button

in the upper right corner of each table. The radix options are: decimal, hexadecimal, binary, and auto. “Auto” indicates that the format was chosen to be the most common or natural radix of the expressed field. It may be any one of the other modes based on what is appropriate for the data in that table row.

- A description of the error codes.

6 USB Monitoring

The Beagle USB 480 Protocol Analyzer is capable of monitoring high-speed, full-speed, and low-speed USB devices in real time.

The Beagle USB 12 Protocol Analyzer is capable of monitoring full-Speed and low-Speed USB devices in real time.

The Data Center software is able to parse the USB packets and provides the user with several powerful tools for filtering the captured data.

6.1 Performing a USB Capture

Here are the steps for starting a capture with the Beagle USB 480 analyzer or the Beagle USB 12 analyzer.

1. Start the Data Center application.
2. Connect the Beagle USB analyzer to the analysis computer. Make sure that the green indicator LED has illuminated. **Be sure the analyzer is powered before plugging in any devices on the capture side to ensure the target device can function properly.**
3. Click the **Connect to Analyzer...** button in the toolbar and connect to the analyzer.
4. Ensure the Protocol Lens is set to **USB**.
5. Connect the Beagle USB analyzer to the target host computer. This can be the same computer. Make sure that the amber indicator LED has illuminated.
6. Click the **Run Capture** button to start the data capture. Once the capture has started, the capture indicator will turn green and an informational transaction will appear in the Transaction window which notes when the capture was started.
7. Connect the target device.

   With the Beagle USB 480 analyzer, any high-speed, full-speed, or low-speed USB device can be connected directly.

   With the Beagle USB 12 analyzer, full-speed and low-speed devices can be connected directly to the Beagle USB 12 analyzer. High-speed devices can also be monitored, but they must be connected through an in-line full-speed hub.
8. To stop the capture, click on the **Stop Capture** button.

The Bus pane will only display a device's descriptors if the device's entire enumeration sequence was captured. If the target device connects to the host before the capture is started, the device enumeration will not be captured and the descriptors cannot be displayed.

6.2 Beagle USB 480 Device Settings

There are several USB capture settings that can be set by the user when using a Beagle USB 480 Protocol Analyzer. Please note that there are no user controlled device settings when using the Data Center application with the Beagle USB 12 Protocol Analyzer. The device settings in this section only apply when using the Beagle USB 480 Protocol Analyzer.

The USB device settings can be changed in the Device Settings dialog (Figure 34). To open this dialog, click on the **Device Settings...** button or go to **Analyzer** | **Device Settings...**.

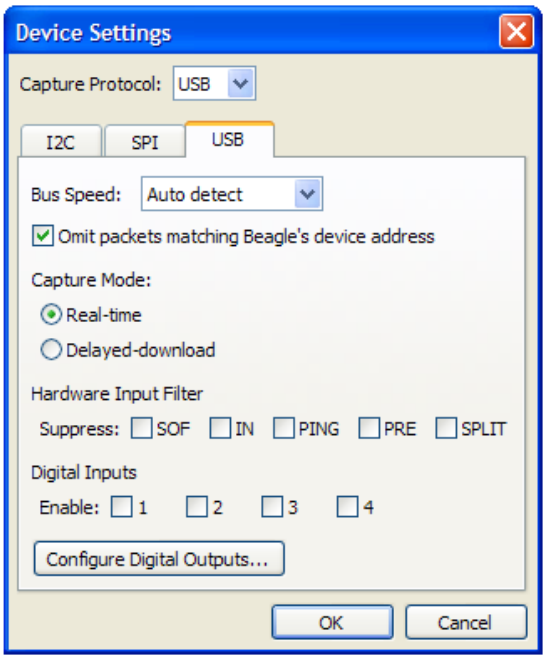


Figure 34: *USB Device Settings Dialog*

Omit Packets Matching Beagle Analyzer's Device Address

When the analysis port of the Beagle USB 480 analyzer is connected to the same USB host controller as the traffic being monitored, the Beagle analyzer may observe its own USB traffic. This is because all downstream packets from the host are broadcast to all USB links. Therefore, packets from the host to the Beagle analyzer may appear on the capture side of the Beagle USB 480 analyzer.

One method to avoid flooding the capture with traffic for the Beagle analyzer is to enable the **Omit packets matching Beagle's device address** option. This option instructs the Beagle USB 480 analyzer to discard any packets directed to its own device address. Further information about this option may be found in Device Operation section of the Beagle datasheet.

Do not enable this option if the Beagle USB 480 analyzer is not on the same host controller or if it is not on the same computer as the traffic being monitored. This may cause the Beagle analyzer to discard USB packets intended for another device since device addresses across

different USB buses can overlap. Furthermore, do this only if you are monitoring a High-speed device with the Beagle 480 Analyzer, as High-speed devices and Full-speed or Low-speed devices on the same host may also have overlapping addresses.

Bus Speed

The Beagle USB 480 analyzer has the ability to automatically detect the speed at which the USB-under-test is operating. However, there may be a situation where the user wishes to explicitly lock it to a specific USB bus speed. This control allows the user to switch between the Beagle analyzer automatically detecting the bus speed to locking the hardware to a specific speed.

If the user knows that the traffic on a bus will always be a certain speed, there can be at least one minor advantage to locking the target speed in the capture settings. Specifically for low-speed and full-speed devices, by locking the bus speed, the Beagle analyzer will not attempt to detect high-speed signaling levels. This will help mitigate the appearance of Chirp J/K and Tiny J/K events which are not of great importance for low-speed- and full-speed-only devices, and these events would otherwise only serve to clutter the display.

Capture Mode

The Beagle USB 480 analyzer has two modes of operation during capture.

- **Real-time** – The capture is streamed from the Beagle USB 480 analyzer to the Data Center software as it is received. If the hardware is monitoring traffic faster than it can stream data to the analysis PC, it will cache the data in the analyzer's hardware buffer. If the hardware buffer should fill completely, the capture will be stopped.
- **Delayed-download** – The Beagle analyzer hardware will not stream the capture data to the analysis PC until the capture is concluded. The capture will be stored in the analyzer's hardware buffer until it is filled or the user stops the capture to download the results. This feature is useful if the Beagle analyzer is connected to the same host controller as the traffic being monitored, as this greatly reduces the amount of USB traffic generated by the Beagle analyzer while the capture is taking place. More information about the utility of a delayed-download capture can be found in the Beagle datasheet (Device Operation section). More details on running a delayed-download capture can be found in Section 6.3.

Hardware Input Filter

These options will enable the Beagle USB 480 analyzer hardware to discard some common packet groups to reduce the amount of capture data received. Some of these packet groups correspond to polling operations and so these sequences do not contain any actual data transfer.

Note: If there is a change in the digital input lines in the middle of one of the packet groups that is being filtered, that group will not be discarded. In this way, the context for the digital input line change is preserved.

The hardware filter options are:

- **SOF** – Discard Start-of-Frame packets.
- **IN** – Discard IN+ACK and IN+NAK packet groups.
- **PING** – Discard PING+NAK packet groups.
- **PRE** – Discard all PRE tokens.
- **SPLIT** – Enabling this option will cause the hardware to discard many polling split packet groups. The split groups that will be discarded are:
  - SSPLIT+IN
  - SSPLIT+IN+ACK
  - CSPLIT+IN+NAK
  - CSPLIT+IN+NYET
  - CSPLIT+OUT+NYET
  - CSPLIT+SETUP+NYET

Digital Inputs

This option enables the user to individually enable the four digital input lines on the Beagle USB 480 analyzer hardware. During the capture, if there is a change on one of the enabled input lines, an event transaction will be displayed in the Transaction window with the new input line state.

Digital Output

The **Configure Digital Outputs...** button opens the digital output settings dialog (Figure 35) to configure the digital output lines on the Beagle USB 480 analyzer hardware. See the **Device Operation** section of the Beagle analyzer datasheet for information on the timing of the digital output pins.

The following sections describe the tabs of the digital output settings dialog.

Pin 1

When enabled, digital output pin 1 (Figure 35) will switch to its active state at the beginning of capture and will stay at the active level until the capture is stopped. The options available on this tab are to set pin 1 to be active high, active low, or to disable the pin.

Pin 2

When enabled, digital output pin 2 (Figure 36) will switch to its active state whenever there is a USB packet being transmitted on the bus. The options available on this tab are to set pin 2 to be active high, active low, or to disable the pin.

Pin 3

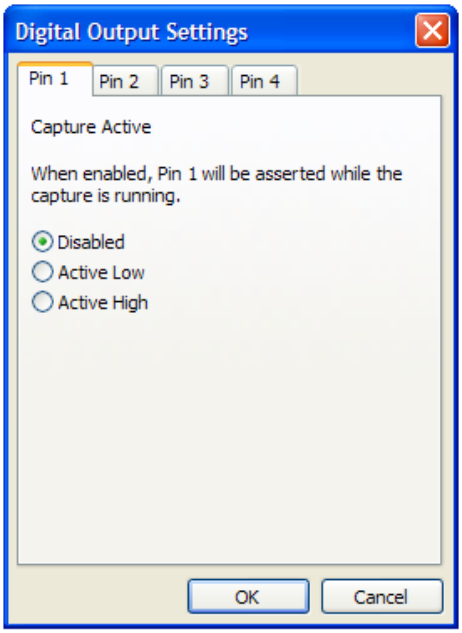


Figure 35: *Digital Output Pin 1 Tab*

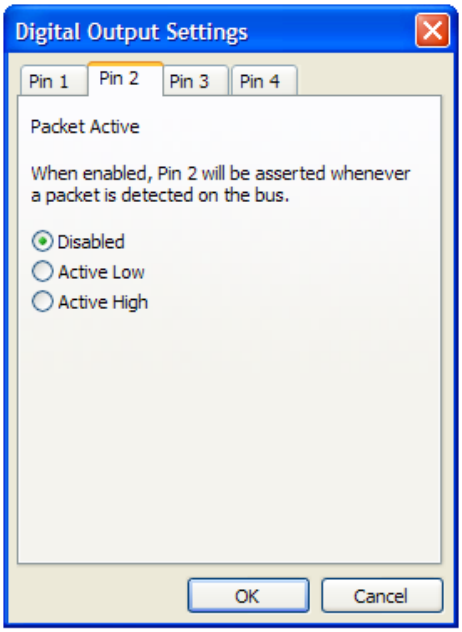


Figure 36: *Digital Output Pin 2 Tab*

Digital output pin 3 (Figure 37) can be set to match a PID, a device address, and an endpoint address. For example, pin 3 can go active when it observes a DATA0 packet to any device but 0x01 on any endpoint address. Each of the match settings can be set to match if the packet equals the parameter (**=**), does not equal the parameter (**!=**), or it can disregard the parameter (**X**). Pin 3 can also be set to be active high, active low, or to be disabled.

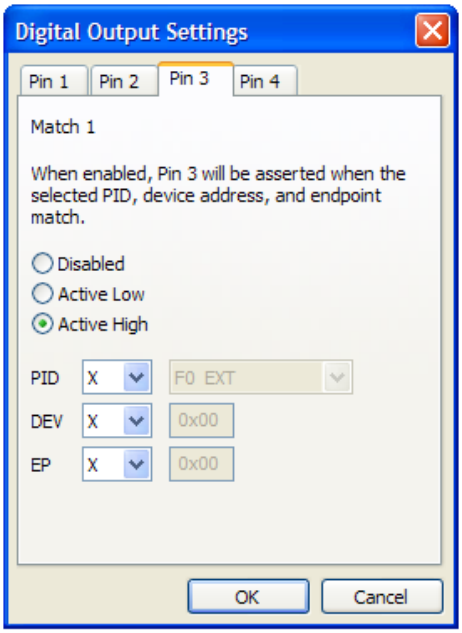


Figure 37: *Digital Output Pin 3 Tab*

Pin 4

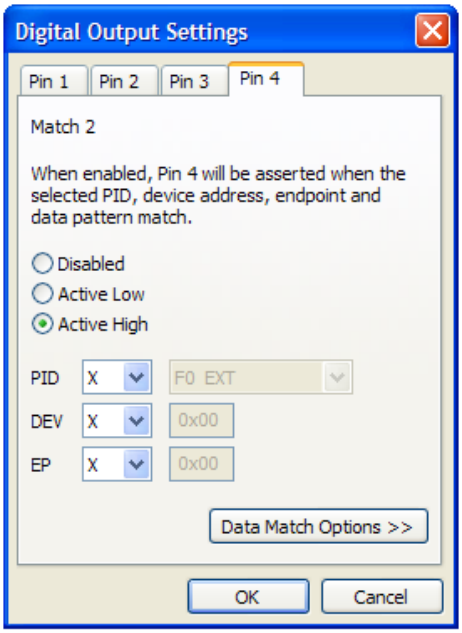


Figure 38: *Digital Output Pin 4 Tab*

Digital output pin 4 (Figure 38) can be set to match a PID, a device address, an endpoint address, and a data payload pattern. As with Pin 3, the PID, device, and endpoint settings can be set to match if the packet equals the parameter (**=**), does not equal the parameter (**!=**), or it

can disregard the parameter (**X**). The data pattern to match can be set in the **Data Matching Options** once data matching is enabled. Pin 4 can also be set to be active high, active low, or to be disabled.

Data Matching Options

Clicking the **Data Match Options** button in the Pin 4 tab of the Digital Output Settings dialog will reveal the data match options (Figure 39). Checking the **Enable Data Matching** option will enable the data match functionality.

Note: PID matching will be disabled when data pattern matching is enabled. The data PIDs selected in the **PIDs to match** section will be used instead.

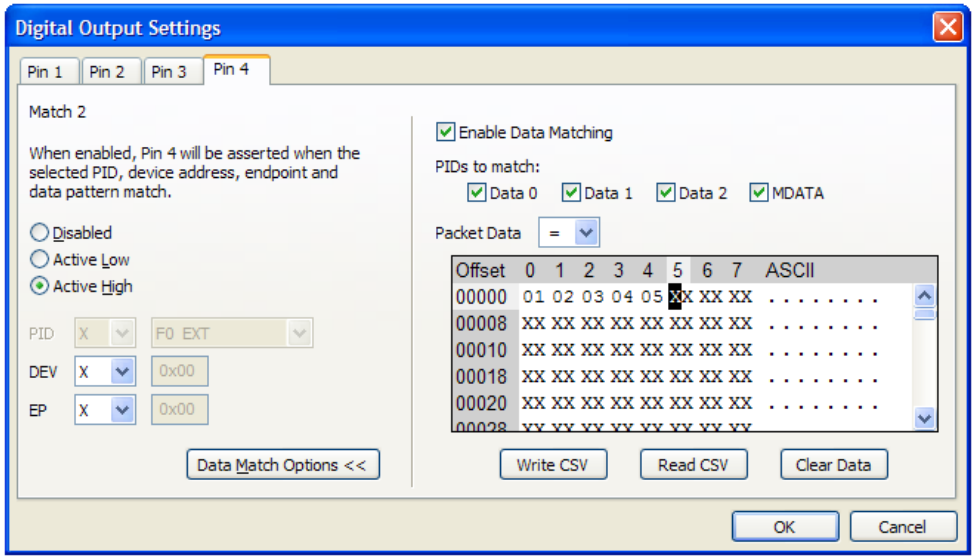


Figure 39: *Digital Output Pin 4 Data Tab*

The data match pattern for output pin 4 can be specified in the hex editor. **XX** can be used anywhere in the pattern as a wildcard to match any 1-byte datum at that location. The data match pattern can be up to 1024 bytes in length.

When data pattern matching is enabled, every data packet with the specified PID will have its data payload (not including the PID or the CRC field) matched against as much of the pattern as the data payload size. So a data packet with an 8-byte data payload will be compared against the first 8 bytes of the data match pattern. And a data packet with a 64-byte payload will be compared against the first 64 bytes of the data pattern.

Using the pulldown box above the hex editor, the packet can be set to match if the payload equals the pattern (**=**) or does not equal (**!=**) the pattern.

The **Write CSV** button allows the contents of the data match hex editor to be written to a comma-separated values (*.csv) file. The CSV file can be loaded into the data match table by clicking the **Read CSV** button. The **Clear Data** button will clear the contents of the data match table.

6.3 Delayed-Download Capture

In this capture mode, the capture data is not streamed out of the analysis port of the Beagle analyzer until after the analyzer has stopped monitoring the bus. This greatly reduces the amount of USB traffic going to the Beagle USB 480 analyzer while the capture is active, and thus is primarily useful when the Beagle analyzer and the test device share the same host controller. Please refer to the **Device Operation** section of the Beagle datasheet for more information regarding the delayed-download mode of the Beagle analyzer.

Performing a Delayed-Download Capture

To run a delayed-download capture, select the Delayed-Download Capture Mode option in the Device Settings dialog. During the delayed-download capture, there will still be a small amount of Beagle USB 480 analyzer traffic on the capture bus since the software pings the analyzer to retrieve capture statistics. Therefore, if the monitored device is High-speed and shares its host controller with the Beagle Analyzer, it is advisable to enable the **Omit packets matching Beagle's device address** option to filter out the few Beagle packets that will remain during the delayed-download capture. In addition, because the capture will be stored in the Beagle analyzer's hardware buffer during the capture, enabling the **Hardware input filter** options may be useful to allow for a longer capture by preventing non-essential traffic from being saved in the hardware buffer.

Once the capture settings have been set, click the **Run Capture** button to open the **Delayed-Download Capture** dialog (Figure 40).

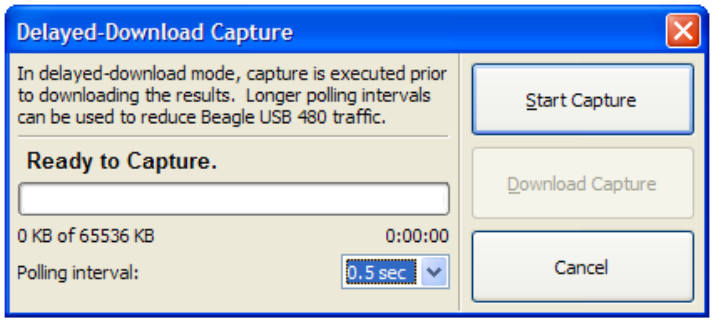


Figure 40: *Delayed-Download Capture dialog*

Set the polling interval for the capture. When polling during the capture, the Data Center software will check the hardware buffer usage and display it in the progress bar. The polling will generate traffic on the bus, so polling can be disabled to eliminate this traffic by choosing **Never** for the polling interval.

Click the **Start Capture** button to start the capture. If polling is enabled, the progress bar will show the portion of the hardware buffer that has been filled with capture data. The progress bar will be updated every time the Data Center software polls the Beagle USB 480 analyzer. When the hardware buffer is full, the capture will stop and the dialog will say that it is ready to download the capture from the hardware.

If polling is disabled, the only way to know that the hardware buffer has filled and capture has stopped is by observing that the red activity LED on the Beagle Analyzer is no longer blinking and has turned off.

You may click the **Download Capture** button at any point to download the results. This will stop the capture if it had not already stopped. Once the download begins, the Delayed-Download Capture dialog will automatically close.

The **Cancel** button may be clicked at any time to exit the delayed-download process and close the dialog. This will completely discard any data that has been captured.

6.4 Transaction Window

The Transaction window (Figure 41) displays all the transactions as they were captured on the USB bus in real time.

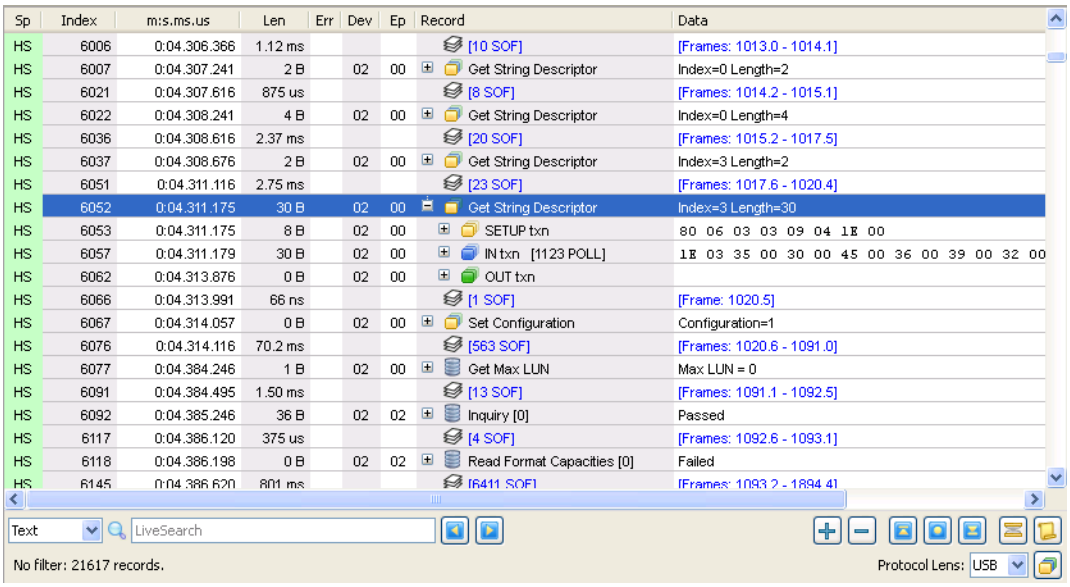


Figure 41: *USB Transaction Window*

For a general description of the Transaction window, see Section 5.1. The following describes the specifics of the USB Transaction window.

Speed (Sp)
The bus speed of the transaction (Beagle USB 480 analyzer only). The background color of the column will also indicate the bus speed. The possible values displayed are shown in Table 6.

Length (Len)
The length of the transaction in bytes is shown if the transaction has a byte value. If the transaction doesn't have a byte value, such as bus events, the duration is shown instead.

Error codes (Err)
Error codes listing abnormal conditions that occurred while capturing the transaction. See Table 1 for the possible error codes. In addition, there are several USB specific error codes as

Table 6: *USB speed column values*

Value	Meaning	Background color
HS	High-speed	Green
FS	Full-speed	Yellow
LS	Low-speed	Red
LF	Low-speed over full-speed	Yellow

described in Table 2.

Dev
The device being addressed represented as a decimal value.

Ep
The endpoint being addressed represented as a decimal value.

Data
For individual packets, the **Data** column will show the raw data bytes including the PID and CRC. For some transactions, such as SETUP transactions, the **Data** column may show a parsed representation of its corresponding packet data. For other transactions, such as IN transactions, the **Data** column will show its internal packet data without any PID or CRC.

Transaction Groups

USB packets are grouped into transactions when they are detected on the USB bus. The four transaction groups are IN, OUT, SETUP, and LPM. Each transaction group is denoted with a unique icon and can be expanded to reveal the individual packets. The timestamp of the group will match the timestamp of the first item in the group to appear on the bus.

Polling transactions that do not have a data payload, such as IN/NAK or PING/NAK, will also be included in the related transaction group. Figure 42 shows an example of this where the IN/NAKs associated with the IN transaction have been included in the IN group.

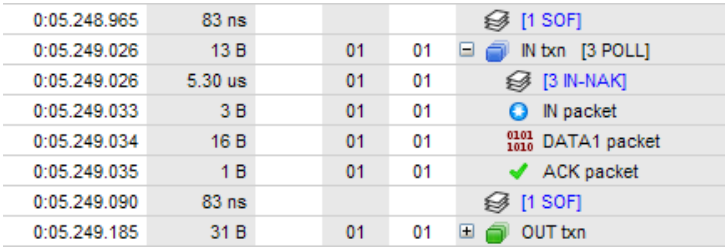


Figure 42: *IN/NAK collapsed packets included in IN transaction*

As a result of grouping the polling transactions into higher level transaction groups, there may be situations where packets are shown out of chronological order. Figure 43 shows an example of this. The collapsed PING/NAK group at index 5604 has an earlier timestamp than the collapsed SOF group at index 5602. Digital input transactions may also appear out of order since they are not included in any transaction group.

5598	0:05.364.175	512 B		01	01	OUT txn (NAK)
5602	0:05.364.231	125 us				[2 SOF]
5603	0:05.364.187	512 B		01	01	OUT txn [83 POLL]
5604	0:05.364.187	193 us		01	01	[83 PING-NAK]
5605	0:05.364.381			01	01	PING-ACK
5608	0:05.364.385	3 B		01	01	OUT packet
5609	0:05.364.386	515 B		01	01	DATA0 packet
5610	0:05.364.395	1 B		01	01	ACK packet
5611	0:05.364.395	512 B		01	01	OUT txn (NAK)

Figure 43: *PING/NAK out of order grouping*

Consecutive isochronous, or interrupt, transactions that are related may be grouped together as shown in Figure 44.

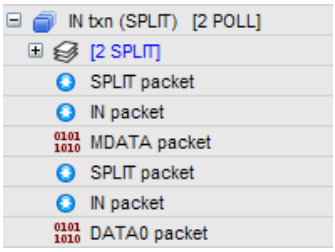


Figure 44: *Grouped isochronous SPLIT transactions*

Special Transaction Types

Besides the four main transaction groups, there are several different types of transactions which can appear in the Transaction window.

Information

Start/Stop informational transactions indicate when a capture was started or stopped. These transactions appear in blue text.

Events

Event transactions represent non-packet bus activity, such as host connect, target device connect, bus reset, or bus speed events. These transactions are displayed as a text description of the event that occurred with further information available in the Info pane. These transactions appear in the Transaction window in green text. Please refer to the **Device Operation** section of the Beagle datasheet for more information on specifics of bus events and their timings.

The types of event transactions are:

- **Host connected** – USB cable connected to upstream port.
- **Host disconnected** – USB cable disconnected from upstream port or voltage level dropped below detection threshold.

- **Target connected** – USB cable connected to downstream port.
- **Target disconnected** – USB cable disconnected from downstream port or voltage level dropped below detection threshold.
- **Reset** – Bus put into reset state.
- **Sync error** – Bad sync observed on packet. (Beagle USB 12 only)
- **Low-speed** – The bus is operating at low-speed. (Beagle USB 480 analyzer only)
- **Full-speed** – The bus is operating at full-speed. (Beagle USB 480 analyzer only)
- **High-speed** – The bus is operating at high-speed. (Beagle USB 480 analyzer only)
- **Suspend** – The bus has entered suspend state. (Beagle USB 480 analyzer only)
- **Resume** – The bus has left suspend state. (Beagle USB 480 analyzer only)
- **Keep-alive** – Low-speed keep-alive strobe detected. This signal is used by the host to keep low-speed devices from going into suspend mode. (Beagle USB 480 analyzer only)
- **Chirp J** – A high-speed chirp J was observed. This signal is part of the High-speed Detection Handshake used by high-speed devices to transition from full-speed to high-speed. (Beagle USB 480 analyzer only)
- **Chirp K** – A high-speed chirp K was observed. This signal is part of the High-speed Detection Handshake used by high-speed devices to transition from full-speed to high-speed. (Beagle USB 480 analyzer only)
- **Tiny J** – A false J caused by a voltage divider effect between the device pulling up the D+ line with a 1.5K resistor and the host not driving the data line to ground with a sufficiently low enough output resistance. (Beagle USB 480 analyzer only)
- **Tiny K** – A false K caused by a voltage divider effect between the device pulling up the D- line with a 1.5K resistor and the host not driving the data line to ground with a sufficiently low enough output resistance. (Beagle USB 480 analyzer only)
- **Input line change** – Voltage change on one or more of the input lines detected. (Beagle USB 480 analyzer only)
- **OTG HNP** – An On-The-Go Host Negotiation Protocol was detected. (Beagle USB 480 analyzer only)
- **OTG SRP data-line pulse** – A data-line pulse of the On-The-Go Session Request Protocol was detected. (Beagle USB 480 analyzer only)
- **OTG SRP Vbus pulse** – A Vbus pulse of the On-The-Go Session Request Protocol was detected. (Beagle USB 480 analyzer only)

Collapsed

There are common packet sequences that are repeated frequently on the USB bus which can quickly fill up a capture and make it difficult to find the data of interest. In order to reduce this

problem, the Data Center software will automatically “collapse” these sequence of packets into a single row. Packets will only be collapsed together if they share the same device and endpoint. Some of these collapsed transactions may appear in transaction groups.

These collapsed packets will collapse the following types of data.

SOF

Start-of-Frame. These packets are issued once every millisecond in full-speed and every 125 microseconds in high-speed to keep devices synchronized with the host.

Keep-alive

Low-speed keep-alive strobe. This signal is used by the host to keep low-speed devices from going into suspend mode. (Beagle USB 480 analyzer only)

IN/NAK

Some USB devices require the host to periodically poll the device to see if any changes occurred. The host will issue an IN packet and if the device has no changes, it will send a NAK. This sequence of packets can quickly eat up capture space when a device is idle and is therefore collapsed.

IN/ACK

When an IN/DATA/ACK occurs on a parallel USB link, only the IN and the ACK will be observed by the Beagle analyzer. Therefore, this packet group is collapsed.

PRE/IN, PRE/IN/NAK, PRE/IN/PRE/ACK

When a host communicates to a low-speed device through a full-speed hub, the host must send the hub a PRE packet before every packet to the low-speed device. This alerts the hub that the packet that follows the PRE will be transmitted at the low-speed data rate. This is called low-speed over full-speed.

These packet groups are similar to IN/NAK and IN/ACK, so are similarly collapsed.

PING/NAK

PING packets are used in high-speed traffic to poll if a device is ready to receive data. The NAK packet indicates that the device is not yet ready to receive more data.

SPLIT transactions

Split transactions are used by the host to communicate with a full- or low-speed device through a high-speed hub. (Beagle USB 480 analyzer only)

In a typical situation, the host will send a START-SPLIT packet (SSPLIT) to the hub. The split packet will contain flags indicating which port to send the following packets to and what speed to send them at. Then the host will send the token packet (IN, OUT, or SETUP) to send to the full- or low-speed device. For OUT and SETUP transactions, a data packet will follow. Then the hub may or may not send an ACK to the host, depending on the transfer type.

The hub will then transmit the packets to the downstream device at the requested bus speed. The host will then periodically poll the hub to see if the hub has completed the transaction

and to get the response of the device. The host does this by sending the hub a complete-split (CSPLIT) packet followed by the same token packet it sent earlier. The hub will then either respond with a NYET to indicate that it is not yet done sending the transaction, or it will respond with the device's response (data or NAK for IN tokens, a handshake packet for OUT and SETUP tokens).

Since there can be a good deal of polling with split transactions, including using IN packets to poll the downstream device, the following packet groups are collapsed into SPLIT groups:

- SSPLIT/IN will be shown as [START]
- SSPLIT/IN/ACK will be shown as [START]
- CSPLIT/IN/NYET will be shown as [NYET]
- CSPLIT/IN/NAK will be shown as [NAK]

The following packets groups are collapsed inline with their associated transaction group:

- CSPLIT/OUT/NYET
- CSPLIT/SETUP/NYET

6.5 Class-Level Parsing

Some USB hosts and devices may communicate with one another using device classes. The Data Center software supports parsing of these device classes. Further information about device classes may be found in the USB Background section of the Beagle datasheet.

General Use

Class-level parsing may be either enabled or disabled by clicking the classification button in the Transaction Window Controls section of the application. For class-level parsing to work correctly, it is necessary for the Data Center software to capture the enumeration of the USB device. The easiest way to ensure that the enumeration is captured is to first start the capture and then to plug in the device into the analyzer. It is not possible to enable or disable classification while the capture is running. The enumeration is preserved across capture sessions. This may lead to unintended behavior if different devices share the same device address across the capture sessions.

Note that when using circular buffer or saving a filtered view the class-level parsing ability may be lost. For more information please see the section on circular buffer (section 4.13) and saving a capture (section 4.9).

Also, note that the Beagle USB 12 Analyzer supports parsing of the Standard Device Requests only. Class specific parsing is not supported with the Beagle USB 12 Analyzer.

Class-Level Transactions

The benefit of enabling classification is that class-level fields are visible for each transfer. One or more protocol-level transactions will be grouped into a class-level transaction. Additionally, for some classes, a class-level transaction may contain one or more other class-level transactions. The transaction will display information that is relevant to the device class. For instance, with a mass storage device, a class-level transaction may be named “Read”, and the Data column will show the logical block address and length of the transfer. Additional information can be obtained by clicking on the class-level transaction and looking at the Info pane. The Info pane will show the parsed fields of the selected class transaction. See Figure 45 for an example.

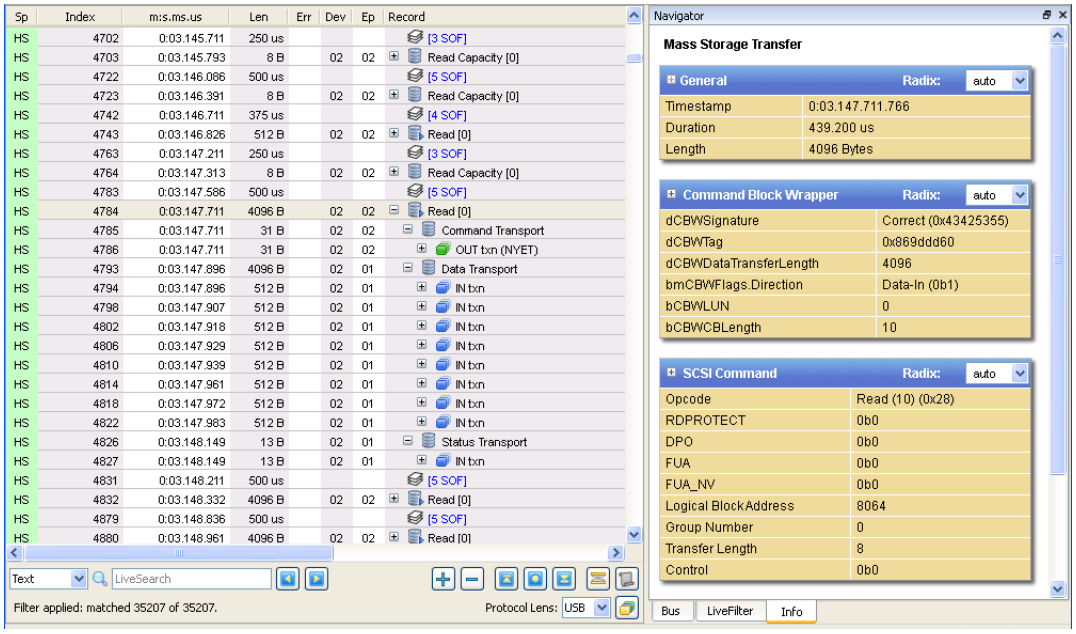


Figure 45: *A parsed mass storage class transaction.*

Control Transfers

An additional benefit of enabling classification is that the protocol-level transactions that make up a control transfer are grouped into a single class-level transaction (Figure 46). If the control transfer can be parsed, the transaction will be named accordingly. Otherwise, the transaction will show up as “Control Transfer.”

6.6 Bus Pane

The USB Bus pane (Figure 47) provides detailed information about each device on the bus. Clicking on a packet in the Transaction window will highlight the related device in the Bus pane.

The Bus pane will only display descriptor information for devices whose enumeration was captured. It is possible to have missing or incomplete descriptor information if a capture is stopped prematurely or is interrupted.

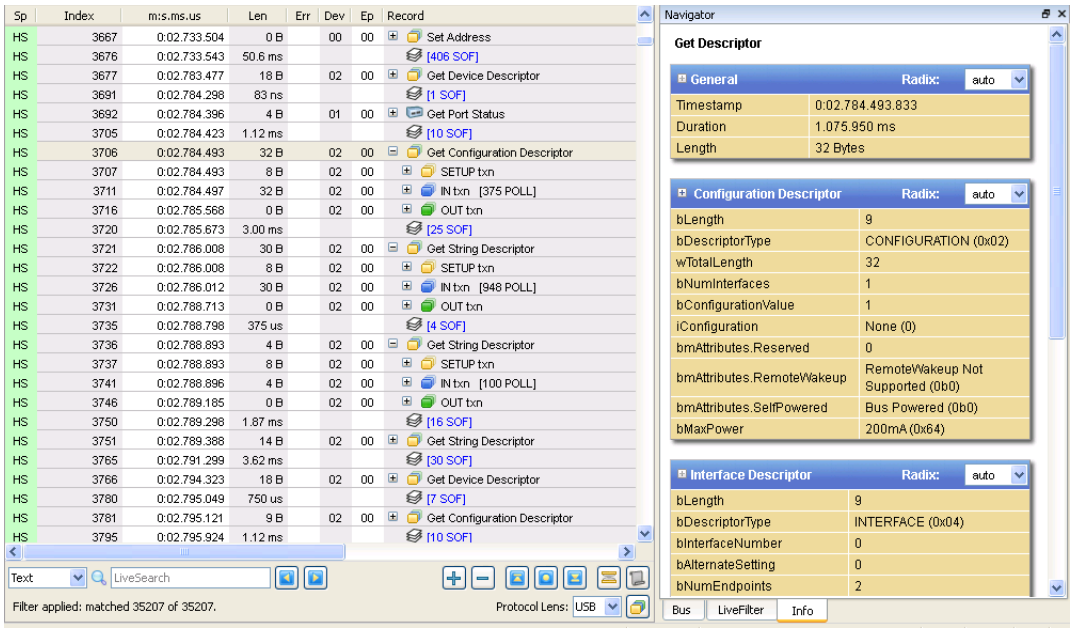


Figure 46: *A parsed control transfer.*

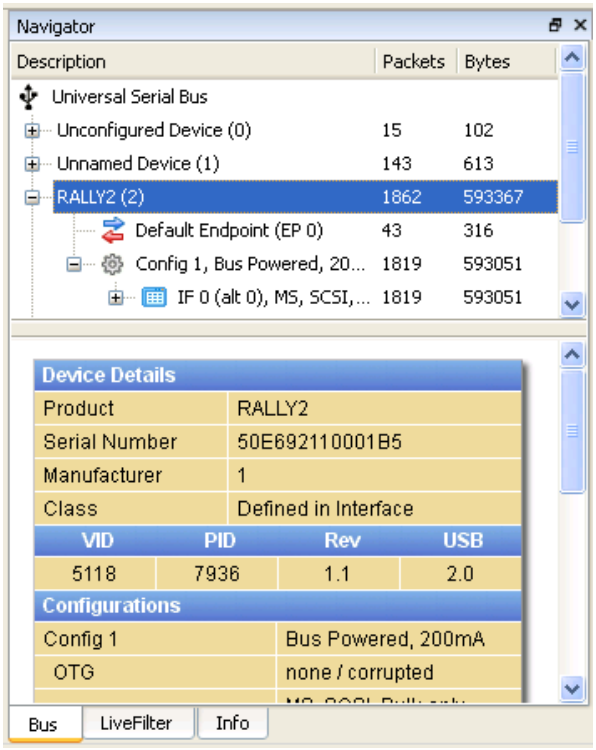


Figure 47: *USB Bus Pane*

Descriptor information is stored in a cache for an entire capture session. The descriptor information associated to a device is based on the device's address. Therefore all packets that are sent or received to the same address are considered to be interacting with the same device.

However, if the USB control message "SET ADDRESS" is seen, the software will parse all new descriptor information as corresponding to a different target device, even if that device has the same USB address as a previously connected target device.

Please note that this feature can cause some strange behaviors. When appending to an older capture file, different devices may share the same address. The Data Center software may become confused and display the wrong descriptor information if a SET ADDRESS is not seen.

Based on how the operating system assigns device addresses, there may be duplicate addresses for different devices when devices are disconnected and plugged in.

Clicking on a device will show a summary of the descriptor information below the tree. Expanding a device will reveal a hierarchy of descriptor information from the device, configuration, interface, and endpoint descriptors. Clicking on any level of the tree will show a parsed view of those descriptors and any child descriptors.

The packets and bytes columns list the number of each that have been sent or received from each endpoint, interface, configuration, and entire device. The byte count includes only the size of the data payload, excluding PIDs, CRCs, etc.

Right clicking in the Bus tree will reveal a popup menu that gives the user the option to apply a filter so that specific devices can be shown or hidden in the Transaction window.

Details Window

Refer to section 5.2 for an overview of the Details View. Note that for USB captures, a bit-level timing view of the data is not available.

6.7 Filtering a USB Capture

A USB capture can be filtered in real time or after it has been completed. The Data Center software offers an extensive list of filters (Figure 48) to help developers filter out extraneous data. All filters are non-destructive and users are free to apply filters multiple times without losing data.

For a description of the General filters and how filtering works, refer to Section 5.5.

Bus Filters

Devices

An integer value, or list of values, that filters transactions based on their device address. This filter only applies to transactions that have a device address. Addresses should be expressed as decimal values as they are shown in the **Dev** column. Multiple addresses can be listed separated by commas or spaces.

Endpoints

An integer value, or list of values, that filters transactions based on their endpoint address. This filter only applies to transactions that have an endpoint address. Addresses should be

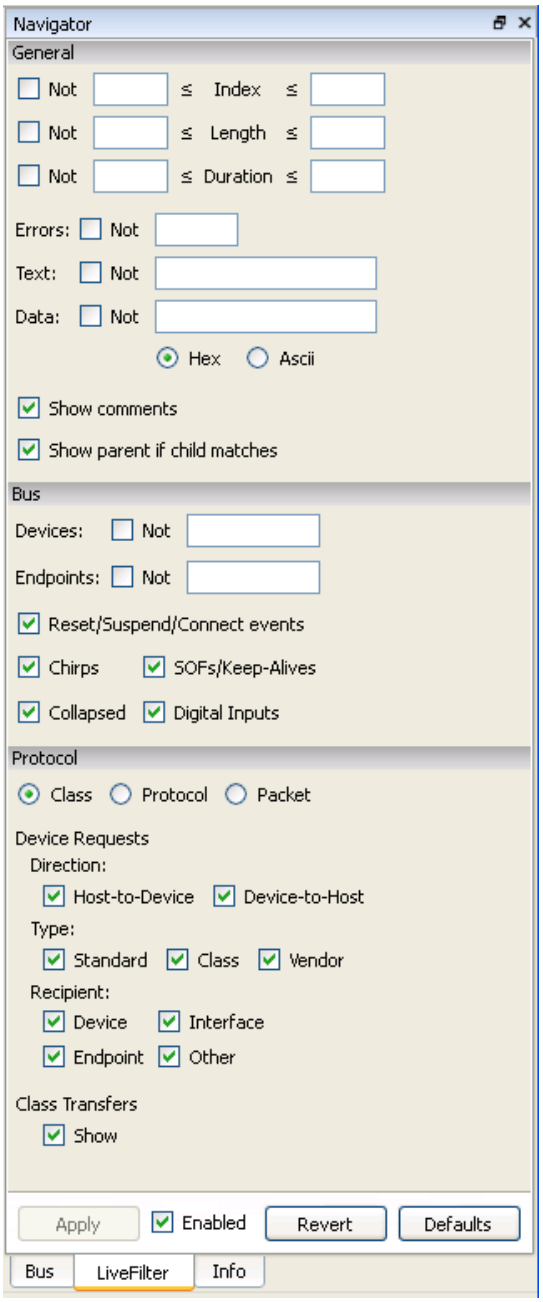


Figure 48: *USB Filters*

expressed as decimal values as they are shown in the **Ep** column. Multiple addresses can be listed separated by commas or spaces.

Reset/Suspend/Connect Events

Unchecking this option will hide all bus events.

Chirps

Unchecking this option will hide all chirp J and chirp K events.

SOFs/Keep-Alives

Unchecking this option will hide all SOF and keep-alive events.

Collapsed

Unchecking this option will hide all collapsed transactions. Note that this setting will not affect collapsed SOFs and keep-alives, as they are bus events and not transactions.

Digital Inputs

Unchecking this option will hide all digital input events.

Protocol Filters

The Protocol filters are broken into three types: class filtering, transaction filtering, and packet filtering.

Class

When Class is selected, the Device Requests and the Class Transfers options apply only to class-level transactions, not to the protocol-level transactions or the packets inside the class-level transactions.

The Device Requests options filter class-level transactions on the Default Control Pipe based on the `bmRequestType` field of the transfer. For example, unchecking the Host-To-Device option would hide all the Set device requests such as the Set Configuration request.

The Class Transfer option decides whether to show all of the class transactions which are not on the Default Control Pipe. For example, unchecking this option will hide all of the class transactions that occur on endpoints other than 0.

When all of the options under the Device Requests and the Class Transfers are selected, all transactions packets are matched. None of the protocol-level transactions, or individual packets will match unless all of the options under the Device Requests and the Class Transfers are selected.

Transactions

When Transactions is selected, the Token and Handshake options apply only to the protocol-level transactions as a whole, and not to the class-level transactions, or the individual packets inside the transactions.

Any protocol-level transaction that has BOTH a selected Token and a selected Handshake will match. None of the individual packets will match, unless all the Token and Handshake options are selected.

For example, selecting only IN, SETUP, ACK and NAK will show all IN/ACK, IN/NAK, SETUP/ACK and SETUP/NAK transactions. All other transaction groups will not be shown.

The Token and Handshake options are also applied to collapsed transactions. For example, unchecking the NAK handshake will hide all IN/NAK collapsed transactions.

Packets

When Packets is selected, only the selected packets match, and all of the class-level transactions and the protocol-level transactions do not match. This means that even with all the individual packet options checked, every transaction will appear in the Transaction window as a soft match. This is helpful for isolating specific packet types apart from transactions when used in conjunction with the **Show parent if child matches** option (Section 5.5).

7 I²C Monitoring

The Beagle I²C/SPI Protocol Analyzer is capable of non-intrusively monitoring I²C at up to 4 MHz.

Please note that captured I²C data is 9 bits wide because the ninth bit is the ACK/NACK bit to indicate whether the data was received properly. For this reason, I²C data will appear differently in the General views.

7.1 Performing an I²C Capture

Here are the steps for starting an I²C capture.

1. Start the Data Center application.
2. Connect the Beagle I²C/SPI analyzer to the analysis computer. Make sure that the green indicator LED has illuminated.
3. Connect the Beagle I²C/SPI analyzer to the I²C bus. The 10-pin ribbon cable can be connected directly, or the 10-pin split cable can be used to provide individual flying leads.
4. Click the **Connect to Analyzer...** button in the toolbar and connect to a Beagle I²C/SPI analyzer.
5. Make sure **I²C** is selected in the Protocol Lens pull-down menu under the Transaction window.
6. Click **Device Settings** in the toolbar and set the I²C capture settings. Make sure **I²C** is selected in the Capture Protocol pull-down menu.
7. Connect the Beagle I²C/SPI analyzer to the target device.
8. Click the **Run Capture** button to start the data capture. Once the capture has started, the capture indicator will turn green and an informational transaction will appear in the Transaction window which notes when the capture was started.
9. To stop the capture, click on the **Stop Capture** button.

7.2 I²C Device Settings

The I²C device settings described below can be configured in the Device Settings dialog (Figure 49). To open this dialog, click on the **Device Settings...** button.

The Device Settings dialog can also be accessed through **Analyzer** | **Device Settings...**.

Sampling Rate

There are three different sampling rates which can be used to monitor the I²C bus. As a rule of thumb, it is recommended that the sampling rate should be at least 4 times faster than the data rate of the monitored bus. For a 400 kHz I²C bus, a sampling rate of 10 MHz would suffice.

To select a sampling rate, simply select the desired rate from the pull-down menu.

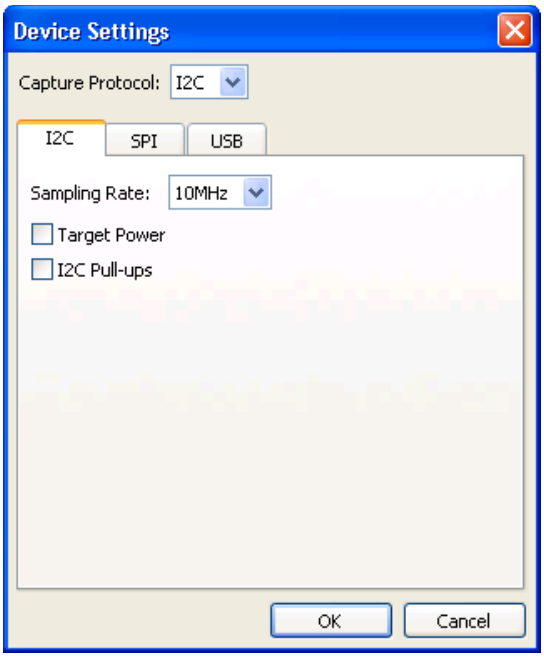


Figure 49: *I²C Tab of the Device Settings Dialog*

Target Power

It is possible to power a downstream target, such as an I²C or SPI EEPROM with the Beagle analyzer's power (which is provided by the USB port). It is ideal if the downstream device does not consume more than 20-30 mA.

To enable or disable target power, check or uncheck the box in the Settings window.

I²C Pull-ups

There is a 2.2K resistor on each I²C line (SCL, SDA). The lines are effectively pulled up to 3.3V, so that results in approximately 1.5 mA of pull-up current. For more information about the pull-up resistors, please consult the Beagle I²C/SPI Protocol Analyzer datasheet.

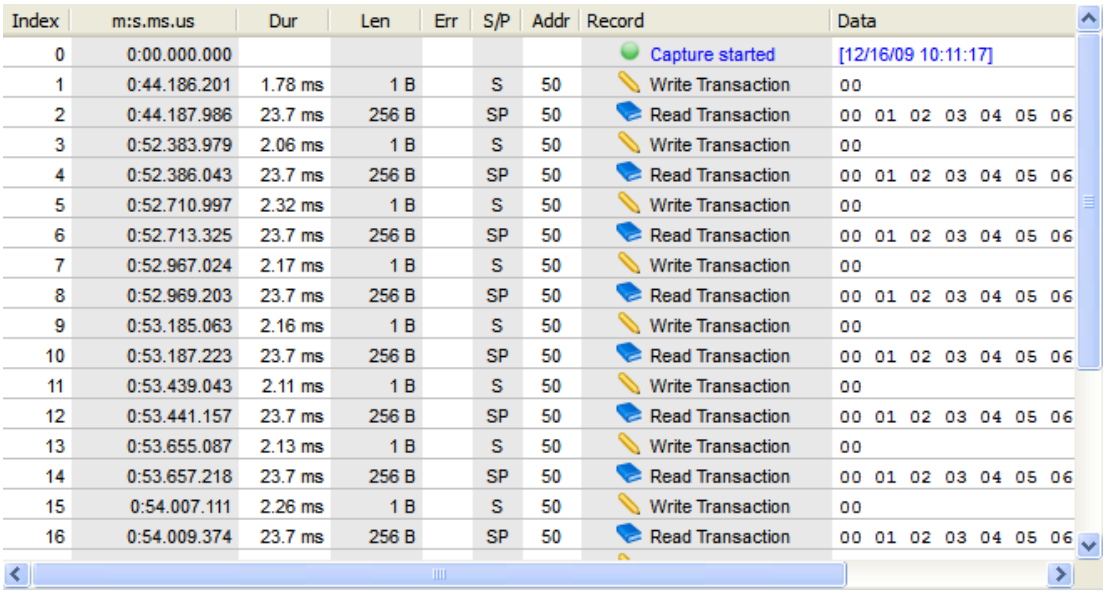
To enable or disable the I²C pull-ups, check or uncheck the box in the Settings window.

7.3 Transaction Window

The I²C Transaction window (Figure 50) displays all the transactions that were captured on the I²C bus in real time. When a transaction is selected in the Transaction window, detailed information about that transaction is displayed in the Info pane.

For a general description of the Transaction window, see Section 5.1. The general description encompasses the behavior of the I²C Transaction window, with the following modifications:

Start/Stop (S/P)
This column is unique to the I²C Transaction window. It indicates whether the start and stop conditions were observed for each record. S indicates the start condition; P indicates the stop



Index	m:s.ms.us	Dur	Len	Err	S/P	Addr	Record	Data
0	0:00.000.000						Capture started	[12/16/09 10:11:17]
1	0:44.186.201	1.78 ms	1 B		S	50	Write Transaction	00
2	0:44.187.986	23.7 ms	256 B		SP	50	Read Transaction	00 01 02 03 04 05 06
3	0:52.383.979	2.06 ms	1 B		S	50	Write Transaction	00
4	0:52.386.043	23.7 ms	256 B		SP	50	Read Transaction	00 01 02 03 04 05 06
5	0:52.710.997	2.32 ms	1 B		S	50	Write Transaction	00
6	0:52.713.325	23.7 ms	256 B		SP	50	Read Transaction	00 01 02 03 04 05 06
7	0:52.967.024	2.17 ms	1 B		S	50	Write Transaction	00
8	0:52.969.203	23.7 ms	256 B		SP	50	Read Transaction	00 01 02 03 04 05 06
9	0:53.185.063	2.16 ms	1 B		S	50	Write Transaction	00
10	0:53.187.223	23.7 ms	256 B		SP	50	Read Transaction	00 01 02 03 04 05 06
11	0:53.439.043	2.11 ms	1 B		S	50	Write Transaction	00
12	0:53.441.157	23.7 ms	256 B		SP	50	Read Transaction	00 01 02 03 04 05 06
13	0:53.655.087	2.13 ms	1 B		S	50	Write Transaction	00
14	0:53.657.218	23.7 ms	256 B		SP	50	Read Transaction	00 01 02 03 04 05 06
15	0:54.007.111	2.26 ms	1 B		S	50	Write Transaction	00
16	0:54.009.374	23.7 ms	256 B		SP	50	Read Transaction	00 01 02 03 04 05 06

Figure 50: *I²C Transaction Window*

condition. Transactions that have no stop condition (in the case of repeated start conditions) will have only S displayed.

Address (Addr)
The I²C address of the slave device that was the target of the transaction. This number is in hexadecimal. "None" is displayed for transactions that are zero bytes long, and thus have no address field. An asterisk (*) following the address indicates that the address byte was NACK'ed. In certain situations, an I²C transaction may not specify the lowest 8 bits of a 10-bit slave address. In these situations, the **Address (Addr)** column will render the incomplete addresses as 0XX, 1XX, 2XX, or 3XX, depending on the value of the first two address bits.

Data
In the I²C **Data** column, NACK'ed bytes are followed by an asterisk (*) to differentiate them from ACK'ed bytes.

7.4 Details Window

The Details window has some extra features to accommodate the I²C protocol. Refer to section 5.2 for an overview of the Details View, including the Data and Timing panes.

Data Pane

The I²C Data pane (Figure 51) provides a hexadecimal and ASCII dump of the contents of the transaction. Please note that it does not include the byte(s) which are composed of the slave address and read/write bit. In the I²C Data pane, NACK'ed bytes are rendered in red text to differentiate them from ACK'ed bytes.

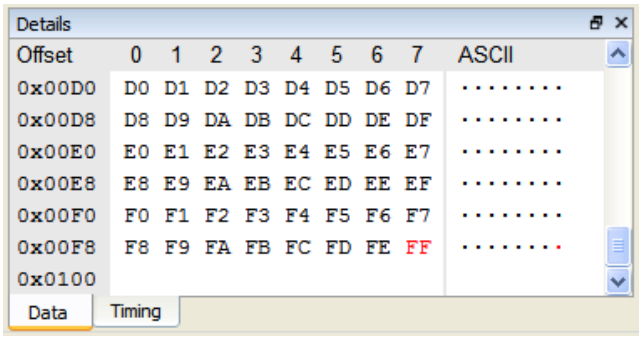


Figure 51: *I²C Details Window - Data Pane*

Timing Pane

In the I²C Timing pane (Figure 52), all the bytes from the transaction will be displayed in the pane, including start and stop conditions.

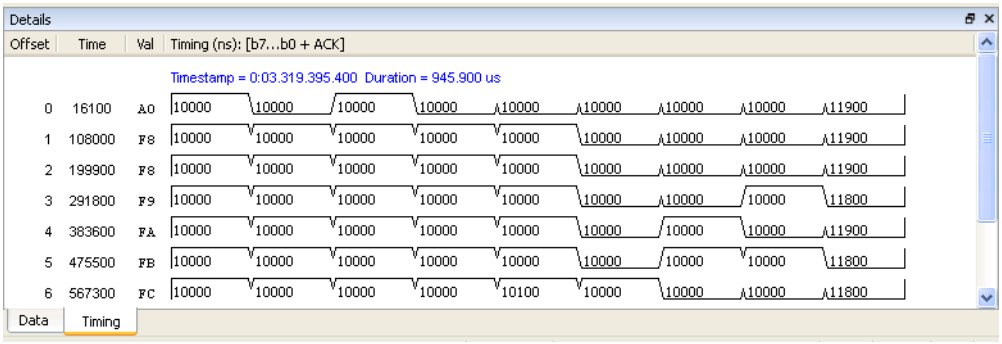


Figure 52: *I²C Details Window - Timing Pane*

There are a few additional things to note:

- I²C data is sent MSB first and LSB last. In the column header for the Timing column, the bit order is indicated to be b7 . . . b0.
- The timing display for I²C actually shows 9 bits. The last bit is the ACK/NACK bit.

7.5 Filtering an I²C Capture

The following is a description of the parameters that are specific to the I²C protocol. For a description of the General parameters, or for information on how to operate the Filter pane, refer to Section 5.5. The I²C Filter pane (Figure 53) has protocol-specific filtering options under the **Bus** caption in the pane.

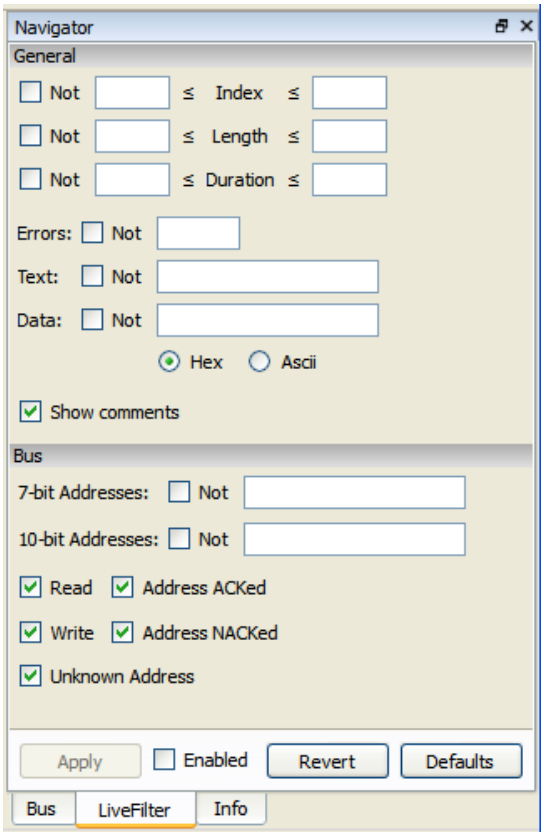


Figure 53: *I²C Filter Pane*

7-bit Addresses

Filter the transactions based on the I²C slave address of the message. The addresses should be specified in hexadecimal format. Multiple device addresses should be separated by commas or spaces. Note that this parameter only filters transactions that were addressed to slaves with 7-bit addresses.

10-bit Addresses

Filter the transactions based on the I²C slave address of the message. The addresses should be specified in hexadecimal format. Multiple device addresses should be separated by commas or spaces. Note that this parameter only filters transactions that were addressed to slaves with 10-bit addresses.

Partial 10-bit addresses can be specified as well using the 0XX, 1XX, 2XX, or 3XX notation as seen in the Transaction window.

Read

Unchecking this option will hide all Read transactions.

Write

Unchecking this option will hide all Write transactions.

Address ACKed

Unchecking this option will hide all transactions in which the address was ACK'ed.

Address NACKed

Unchecking this option will hide all transactions in which the address was NACK'ed.

Unknown Address

Unchecking this option will hide all transactions that have an unknown address. An unknown address can occur when a transaction did not contain any data or encountered an error while transmitting the address.

8 SPI Monitoring

The Beagle I^{2}C/SPI Protocol Analyzer is capable of non-intrusively monitoring SPI at up to 24 MHz. However, the Beagle analyzer may have difficulty monitoring continuous transactions at a sustained rate of 24 MHz. Please see the Beagle Analyzer datasheet for more details.

Please note that SPI is a full duplex protocol. For this reason, two bytes are recorded by the Data Center application during every 1-byte clock period. When the Data Center application displays these two bytes together, the first byte will be the MOSI byte and the second byte will be the MISO byte. There is no standard higher level protocol for SPI data.

8.1 Performing an SPI Capture

Here are the steps for starting an SPI capture.

1. Start the Total Phase Data Center application.
2. Connect the Beagle I^{2}C/SPI analyzer to the analysis computer. Make sure that the green indicator LED has illuminated.
3. Connect the Beagle I^{2}C/SPI analyzer to the SPI bus. The 10-pin ribbon cable can be connected directly, or the 10-pin split cable can be used to provide individual flying leads.
4. Click **Connect to Analyzer...** in the toolbar and connect to a Beagle I^{2}C/SPI analyzer.
5. Select **SPI** from the Protocol Lens pull-down menu under the Transaction Window.
6. Click **Device Settings...** in the toolbar and set the SPI capture settings. Make sure **SPI** is selected in the Capture Protocol pull-down menu.
7. Connect the Beagle I^{2}C/SPI analyzer to the target device.
8. Click the **Run Capture** button to start the data capture. Once the capture has started, the capture indicator will turn green and an informational transaction will appear in the Transaction window which notes when the capture was started.
9. To stop the capture, click on the **Stop** button.

8.2 SPI Device Settings

The SPI device settings described below can be configured in the Device Settings dialog (Figure 54). To open this dialog, click on the **Device Settings...** button.

Sampling Rate

There are three different sampling rates which can be used to monitor the SPI bus. As a rule of thumb, it is recommended that the sampling rate should be at least 4 times faster than the data rate of the monitored bus. For a 1000 kHz SPI bus, a sampling rate of 10 MHz would suffice.

To select a sampling rate, simply select the desired rate from the pull-down menu.

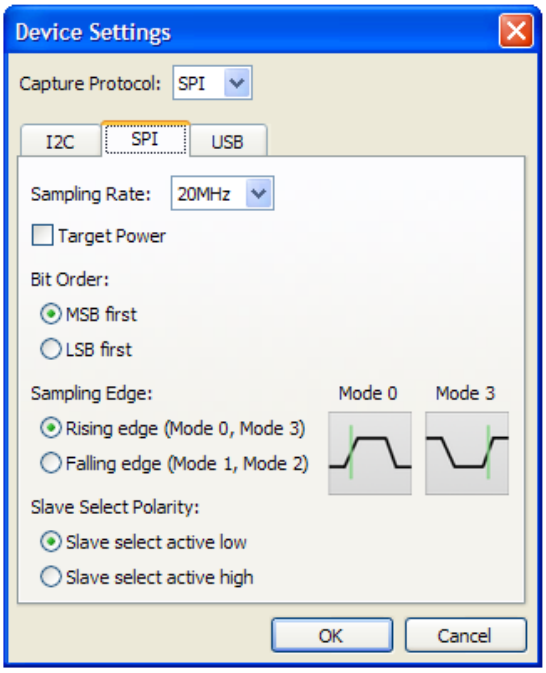


Figure 54: *SPI Tab of the Device Settings Dialog*

Target Power

It is possible to power a downstream target, such as an SPI flash or SPI EEPROM with the Beagle analyzer's power (which is provided by the USB port). It is ideal if the downstream device does not consume more than 20-30 mA.

To enable or disable target power, check or uncheck the box in the Settings window.

Bit Order

Since SPI does not have a high level protocol, it is necessary for the user to specify the bit order of the data bytes in order to have the Data Center software properly parse the captured data.

MSB first means that the Most Significant Bit (MSB) is transmitted first. The byte order would be b7 . . . b0.

LSB first means that the Least Significant Bit (LSB) is transmitted first. The byte order would be b0 . . . b7.

Sampling Edge

SPI has multiple modes (0, 1, 2, 3) which define the data frame for data transmission. In order for the Data Center software to correctly parse the captured data, the sampling edge of the data frame must be specified.

Mode 0 and 3 are sampled on the **Rising edge** of the clock and Mode 1 and 2 are sampled on the **Falling edge** of the clock.

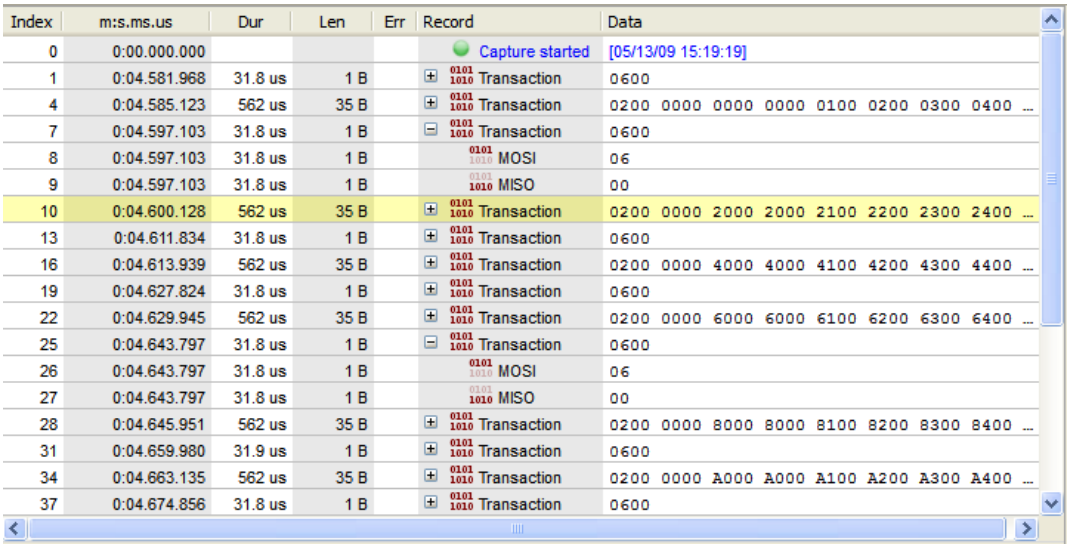
For more information about SPI modes, please refer to the SPI Background section of the Beagle Protocol Analyzer datasheet.

Slave Select Polarity

Different SPI devices use different polarities on Slave Select to activate an SPI slave device. Slave select can be pulled low to activate the SPI slave or it can be pulled high to activate the SPI slave.

8.3 Transaction Window

The SPI Transaction window (Figure 55) displays all the transactions that were captured on the SPI bus in real time. When an transaction is selected in the Transaction window, detailed information about that transaction is displayed in the Info pane.



Index	m:s.ms.us	Dur	Len	Err	Record	Data
0	0:00.000.000				Capture started	[05/13/09 15:19:19]
1	0:04.581.968	31.8 us	1 B		Transaction	0600
4	0:04.585.123	562 us	35 B		Transaction	0200 0000 0000 0000 0100 0200 0300 0400 ...
7	0:04.597.103	31.8 us	1 B		Transaction	0600
8	0:04.597.103	31.8 us	1 B		MOSI	06
9	0:04.597.103	31.8 us	1 B		MISO	00
10	0:04.600.128	562 us	35 B		Transaction	0200 0000 2000 2000 2100 2200 2300 2400 ...
13	0:04.611.834	31.8 us	1 B		Transaction	0600
16	0:04.613.939	562 us	35 B		Transaction	0200 0000 4000 4000 4100 4200 4300 4400 ...
19	0:04.627.824	31.8 us	1 B		Transaction	0600
22	0:04.629.945	562 us	35 B		Transaction	0200 0000 6000 6000 6100 6200 6300 6400 ...
25	0:04.643.797	31.8 us	1 B		Transaction	0600
26	0:04.643.797	31.8 us	1 B		MOSI	06
27	0:04.643.797	31.8 us	1 B		MISO	00
28	0:04.645.951	562 us	35 B		Transaction	0200 0000 8000 8000 8100 8200 8300 8400 ...
31	0:04.659.980	31.9 us	1 B		Transaction	0600
34	0:04.663.135	562 us	35 B		Transaction	0200 0000 A000 A000 A100 A200 A300 A400 ...
37	0:04.674.856	31.8 us	1 B		Transaction	0600

Figure 55: *SPI Transaction Window*

For a general description of the Transaction window, see Section 5.1. The general description encompasses the behavior of the SPI Transaction window, with the following caveats for each column:

Data

For the top level SPI Transactions, data is displayed as a sequence of 2-byte words. The first byte of the word is the MOSI data and the second byte is the MISO data. The data is paired because SPI is a bidirectional protocol and the MOSI and MISO bytes appear on the bus at the same time. SPI transactions can be expanded into separate MISO and MOSI records, both of which contain the normal sequence of 1-byte words.

8.4 Details Window

The Details window has some extra features to accommodate the SPI protocol. Refer to section 5.2 for an overview of the Details window, including the Data and Timing panes.

MOSI and MISO Data Panes

The SPI Details window separates the transaction data into the MOSI Data Pane (Figure 56) and the MISO Data Pane (Figure 57).

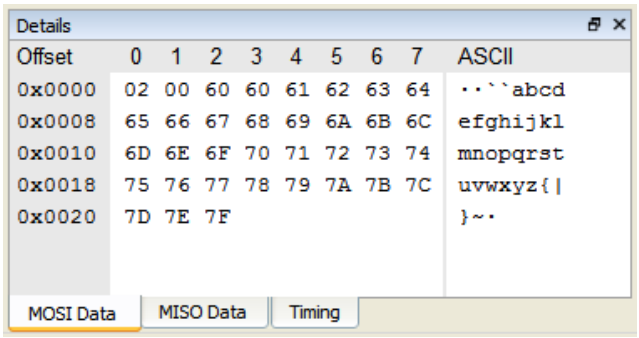


Figure 56: *MOSI Data Pane of the SPI Details Window*

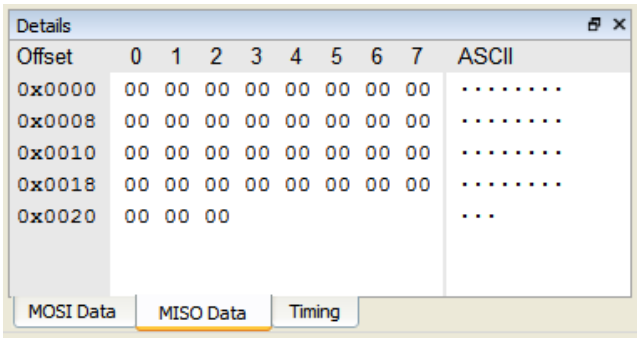


Figure 57: *MISO Data Pane of the SPI Details Window*

Each of these Data panes behaves as the Data pane described in Section 5.2.

Timing Pane

The SPI Timing Pane (Figure 58) overlays the bit timing diagram of the MOSI line with the MISO line. The MOSI line is displayed in red and the MISO line in blue. If a **Transaction** record is selected, the red and blue MOSI and MISO timing lines will overlap in the diagram. If either a **MOSI** or a **MISO** record is selected, only the MISO or MOSI line will be drawn in the Timing pane.

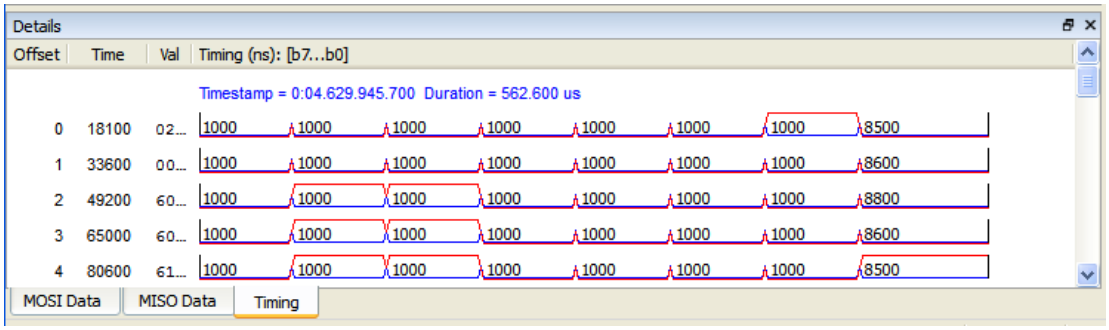


Figure 58: *Timing Pane of the SPI Details Window*

8.5 Filtering an SPI Capture

The following is a description of the parameters that are specific to the SPI protocol. For a description of the General parameters, or for information on how to operate the Filter Pane, refer to Section 5.5. The SPI Filter Pane (Figure 59) has protocol-specific filtering options under the **Bus** caption in the pane.

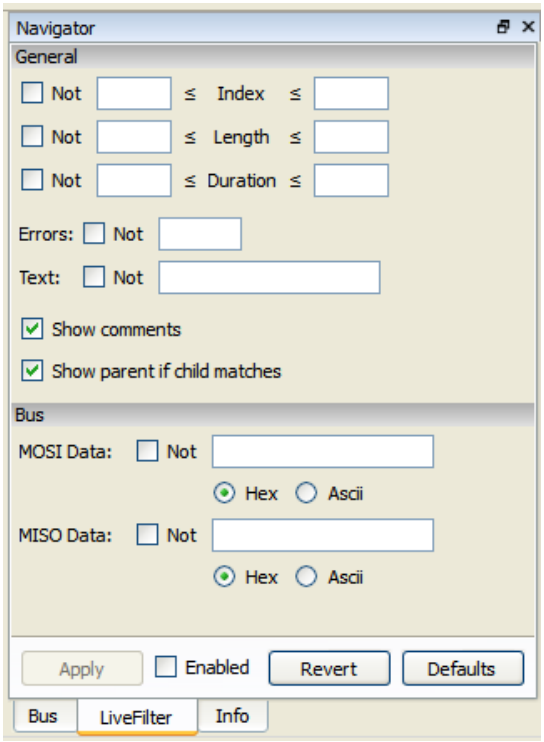


Figure 59: *Filter Pane located in the SPI Navigator Window*

MOSI Data and MISO Data

In the SPI Filter pane, there is no **Data** field in the General parameters section. It is replaced by two Data fields, one that matches only MOSI Data and one that matches only MISO Data.

These Data parameters accept the same syntax described in Section 5.5.

9 Troubleshooting

9.1 General

When attempting to open the Connection Dialog, I receive the following error message: "Could not detect the attached Beagle analyzers for the following reason: Incompatible driver- Please check your CD or the Total Phase website for an updated driver."

A driver newer than the version installed is required. Please refer to the Beagle analyzer datasheet for instructions on upgrading the Beagle analyzer USB driver.

I've connected my device to a Beagle analyzer. When I try to capture data, no packets are shown.

Please try the following:

- Make sure that you are viewing the correct protocol. To change the Protocol Lens, select the correct protocol from the Protocol Lens pull-down menu under the Transaction window.
- Disable the filter to make sure you are seeing all the packets.
- For I^2C and SPI, make sure that you have selected the correct protocol from the Device Settings Dialog, as either protocol may be used with the Beagle I^2C/SPI Analyzer. You will have to stop your capture in order to change this setting.
- For I^2C, make sure that the I^2C pullups are set correctly for your target device.
- For SPI, make sure that your capture settings are set to the correct sampling edge, bit order and slave select polarity.
- If the downstream target requires power from the Beagle I^2C/SPI analyzer, please make sure that target power has been turned on in the settings.
- For USB, if you are testing a high-speed device, make sure you connect the device to the Beagle USB 12 analyzer through a full-speed USB hub or you are using a Beagle USB 480 analyzer.

I've set some filters, but the contents of the transaction window have not changed.

Filters are not applied to the transaction window until the **Apply** button has been pressed. After settings all your filters, make sure you click on the **Apply** button.

9.2 USB

I've plugged in a device into the Beagle USB 480 analyzer and it is acting strangely.

Be sure that the analysis end of the Beagle USB 480 analyzer is plugged in prior to plugging in any devices on the target end. This ensures that the devices in the analyzer hardware that isolate the USB bus on the target end are functioning and the target device can communicate properly.

The descriptor information does not appear for my device even though I am able to capture data from the device and it works fine on the host computer.

In order for the Data Center software to correctly parse and display the descriptor data for a target device, the entire enumeration process must be captured. In order to ensure that this entire sequenced is captured, we recommend that the user start the capture before connecting the target device.

I'm running a capture with the Beagle USB 480 analyzer and I'm seeing a lot of IN packets with no data or handshake response.

Because the USB protocol is broadcast in the downstream direction, it is possible to see packets from parallel USB links. But only the downstream packets from the host to other USB devices will be observed; upstream packets from other devices to the host will not be seen.

It is possible that the IN packets observed may be directed to the Beagle USB 480 analyzer itself. Methods for dealing with these packets are described in Section 6.3.

I've plugged in my target device into the target device port of the Beagle USB 12 analyzer. When I try to capture data, no packets are shown.

The Beagle USB 12 protocol analyzer can only capture full-speed and low-speed USB and cannot capture high-speed USB directly. Please make sure that the target device is not a high-speed USB device.

If you would like to capture the USB data of a High-speed device with the Beagle USB 12 analyzer, connect the device to the Beagle Analyzer through a full-speed hyb in order to downgrade the speed of the data.

I get a lot of sync errors when capturing USB data with the Beagle USB 12 analyzer.

Sync errors can be caused by a poor USB connection or an analysis computer that has insufficient resources available for the Beagle Data Center application.

Here are some possible ways to eliminate sync errors:

- Use only USB ports that are mounted directly on the computer's motherboard. USB ports that are not mounted directly may perform poorly due to cable or connector quality.
- For best performance, it is recommended that a Beagle analyzer does not share its USB host controller. All other USB devices should be connected to separate controllers.
- Make sure that your computer has adequate physical memory. The Data Center software can become unstable if your computer starts to swap into virtual memory.
- Make sure that your computer is not running any other performance or resource hungry applications.
- You may want to consider using one computer as the analysis computer and a separate computer as the target host computer.
- It may be possible that the USB signals between the target host and the target device are at the very edge of compliance. If this is the case, the Beagle analyzer may encounter

errors when trying to capture the data. One way to test this is to use a USB hub in-line between the Beagle analyzer and the target device. The hub will retransmit the USB data. If this resolves the problem, the electrical signals of the target device should be examined in further detail.

- If the error is due to USB signals on the edge of compliance, you may be able to mitigate this issue by using shorter USB cables.

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