SPI^2 Monitor

User Manual

Written by
Jonathan R. Bynum

NILSEN CONSULTING

Experts in Hardware
&
Embedded Software Development

NILSEN CONSULTING, INC.

7115 W. Tidwell, #102
Houston, Texas 77092
Voice: (713) 690-8120
Fax: (281) 552-9566
Email: nilsen@ncon.com

October 27, 1998

Purpose of Document

The purpose of this document is to provide information necessary to utilize the SPI^2 Monitor.

SPI ^{2} Monitor Features

- **SPI Buss speeds up to 8 MHz Supported**
- **Data Through-put of 750K Bytes per second in Windows 95/98**
- **Data Through-put of 650K Bytes per second in Windows NT**
- **Digital O-Scope Function for viewing real-time data**
- **Raw Data Monitor for monitoring all data on the SPI buss**
- **Raw Data File Save Feature**
- **Windows 95/98 NT 4.0 Compatible**

Hardware Requirements

The SPI Monitor program requires at least a Pentium computer, a display and adapter that will support at least 1024 x 768 resolution and an ECP parallel port.

Package Contents

Software

A Windows 95/98/NT based Program is included with the SPI^2 Monitor. This program allows the operator to configure and run the SPI^2 Monitor. Once configured the program will then allow the user to plot data graphically, monitor raw data, and save data to a file for later viewing.

Hardware

The hardware consists of the SPI^2 Monitor, SPI^2 Monitor Harness, a power supply, and a shielded parallel cable.

SPI ^{2} Monitor Software Installation

To Install the SPI^2 Monitor software insert Program Disk 1 into drive A. From the Windows Start Menu select run. Type in A: Setup. The Installation program will guide you through the rest of the software installation. After installing the PC program make sure that the PC's parallel port is configured for ECP mode. This can be done through the PC's CMOS setup.

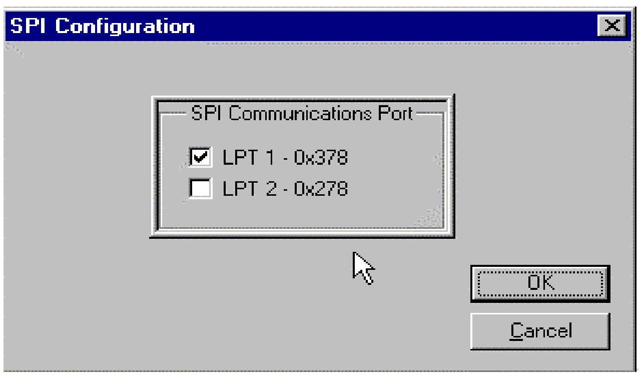
SPI ^{2} Monitor Hardware Setup

The SPI^2 Monitor plugs into the parallel port. Use the parallel cable provided. The cable harness then plugs into the other end of the monitor. The cable harness is color-coded for ease of use. The **Black wire** is ground and must be connected to a suitable ground on the target circuit. The **Orange wire** is the Chip Select and is connected to the Chip Select pin of the device that you want to monitor. The **White wire** is the Serial Clock line and is connected to the serial clock of the device. The **Green wire** is the data in and is connected to the serial data line of the device to be monitored.

SPI 2 Configuration

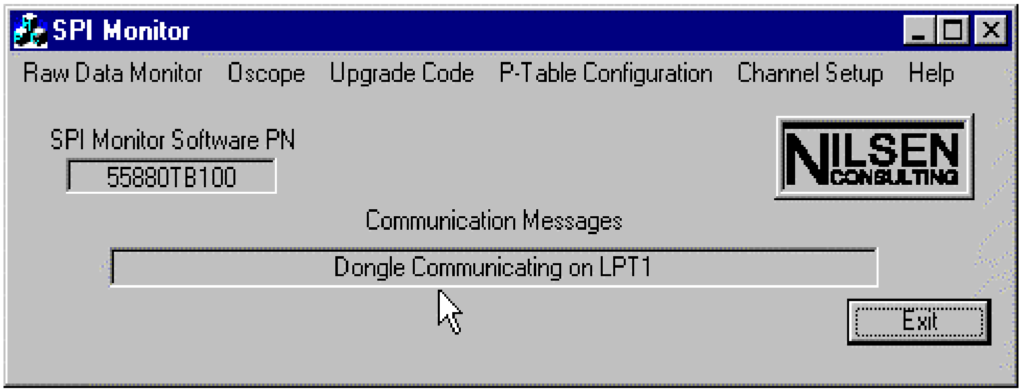
The SPI² Monitor Configuration requires knowledge of the operation of the SPI Buss. How you configure the software will determine how the monitor syncs up with the buss and the data that can be captured and displayed. The Data Scope program, which controls the SPI² Monitor, will attempt to locate the SPI² Monitor on a specific parallel port selected by the user.

FIGURE 1. SPI Configuration Dialog Box



Once the SPI^2 Monitor is found the main dialog screen will be displayed.

FIGURE 2. Main Dialog Box



Parameter Table Setup

In order for the Monitor to sync up with an SPI bus the Parameter Table (P-Table) MUST be configured correctly. The P-Table consists of several parameters.

CS Active

Chip Select Active is the state at which the SPI device is the active device on the bus (high or low).

Bit Order

Bit Order is the order in which the bits are transmitted on the bus. Selects either MSB or LSB bit order.

S Clock phase

The S clock phase is the edge at which data is valid on the bus. Selects either falling or rising edge.

Normal/Alternate Framing

Selects Normal or alternate framing method.

Normal framing would be SCLK = 0, CPOL = 0, CPHS = 1 or, SCLK = 1, CPOL = 1, CPHS = 1.

Alternate framing would be SCLK = 0, CPOL = 1, CPHS = 0 or, SCLK = 1, CPOL = 0, CPHS = 0.

Framing Method

Framing method is either continuous or framed every word.

Checksum

The checksum is the code checksum of the monitor. It cannot be modified.

Packet Size

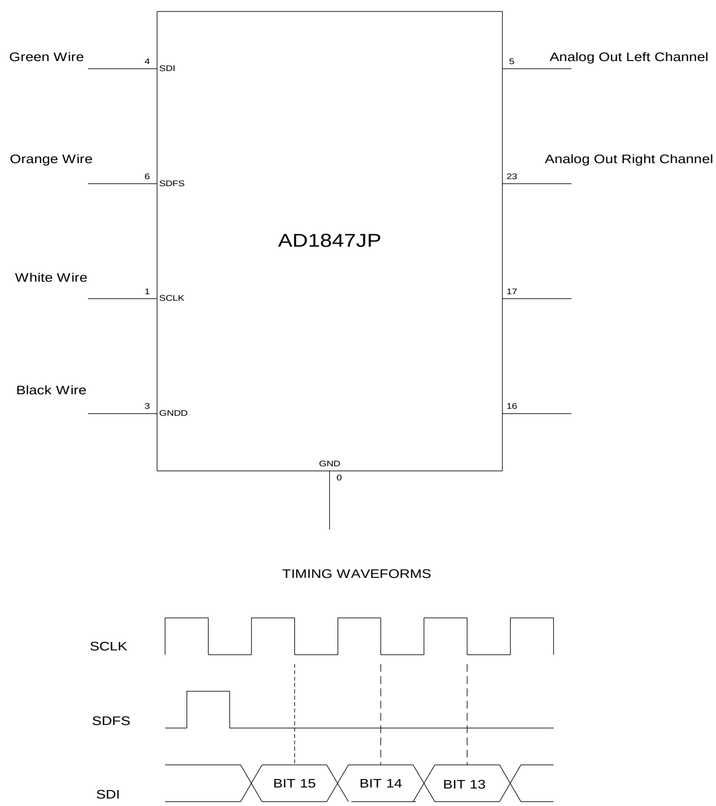
Packet size is the size of the transfer buffer of the monitor. It's the number of bytes accumulated before being transmitted to the PC. For fast data this buffer size would be a large number up to 6K. For slower data the number would be lower. The Packet Size is auto configured by the channel setup dialog box. The packets per second will configure this parameter to the closest buffer size based upon the number of bytes transferred per second. For example a if you have a 1 Hz sample rate you wouldn't want the buffer size to be 6K. Then it would take 6000 seconds before any data was transferred to the PC! A more typical buffer size for a 1 Hz sample rate would be 1 byte. That way you would get a one-second-update rate.

Pre-Set Configuration

The pre-set configuration check boxes allow you to configure the SPI monitor with either the standard Motorola configuration or the Analog Devices configuration. These configurations should work for most Analog Devices or Motorola processors.

The best way to describe the functionality of the SPI^2 Monitor is to use an example. In Figure 3 the monitor is connected to an analog devices AD1847 Codec chip. The chip is controlled by a ADSP2181 Digital Signal Processor. The chip is configured to send data via a 1-wire format. Data is 16 bits wide. With control, left channel playback, right channel playback, status, left channel capture, right channel capture sent in that order.

FIGURE 3. AD1847 Serial Codec Chip Hardware Setup

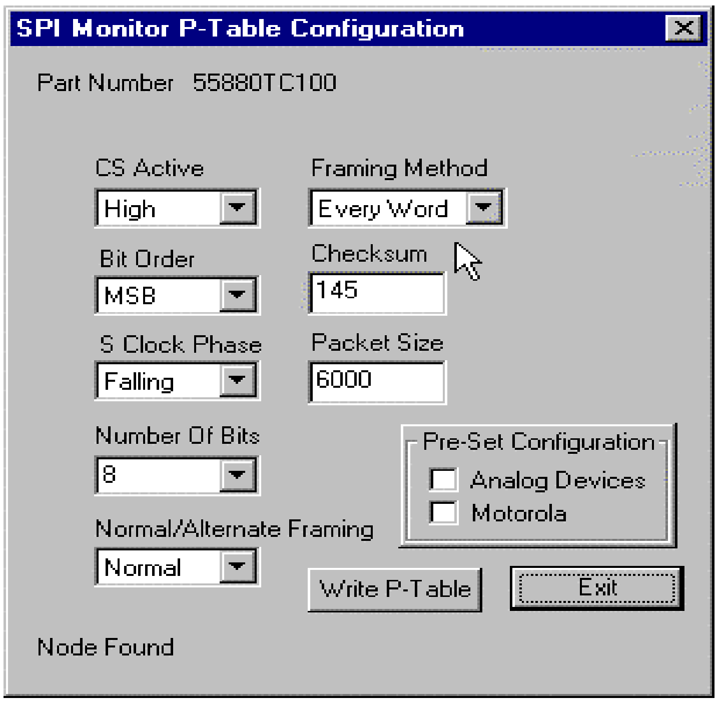


Serial Data Format

Control	Left Playback	Right Playback	Status	Left Capture	Right Capture

In order for the Monitor to sync up with the codec chip the P-Table would be configured as follows. Click on the P-Table menu item and change the fields to match Figure 4.

FIGURE 4. P-Table Dialog Configuration Screen



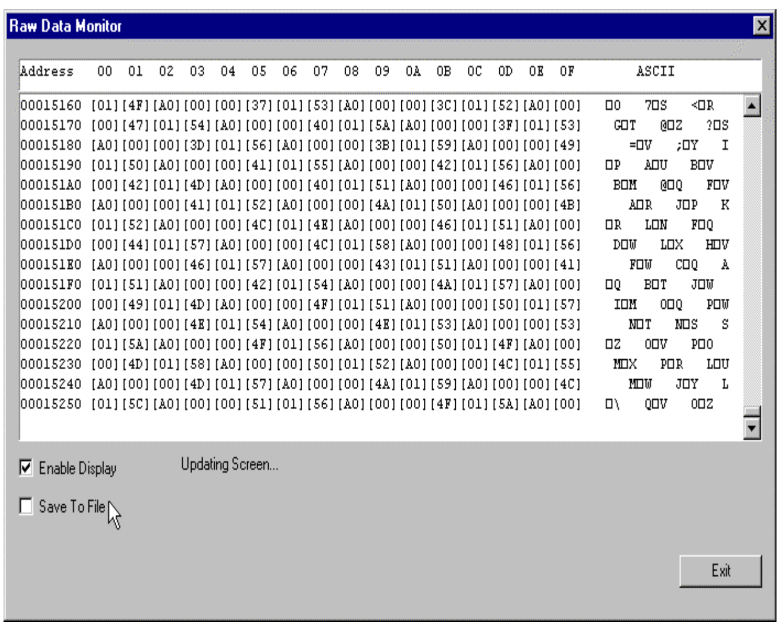
Once the P-Table parameters are configured correctly the monitor will sync up with the SPI device and spew SPI data to the PC via the parallel port. The Data can then be viewed with the Raw Data Monitor.

Raw Data Monitor

The Raw Data monitor shows all raw data coming across the SPI bus. The data can be saved to a file and viewed at a later time using the Read from File Menu Item. The Enable Display check box is used to turn the displaying of data on or off. This will allow you to increase the data through put when saving data to a file to decrease the chance for data loss.

NOTE: when saving data to a file the file sizes can become quite large depending on the data through put.

FIGURE 5. Raw Data Monitor.



Reading saved Data from a file

The read from file menu item looks just like the raw data monitor. However, Instead of reading from the SPI device data is read from a saved file. The **HOME** key will take you to the beginning of the file. The **PAGE DOWN** key will take you to the end of the file. The **PAGE UP** and **PAGE DOWN** keys traverse through the file up or down one screen worth of data at a time. The **ARROW** keys can be used to move through the data on the screen.

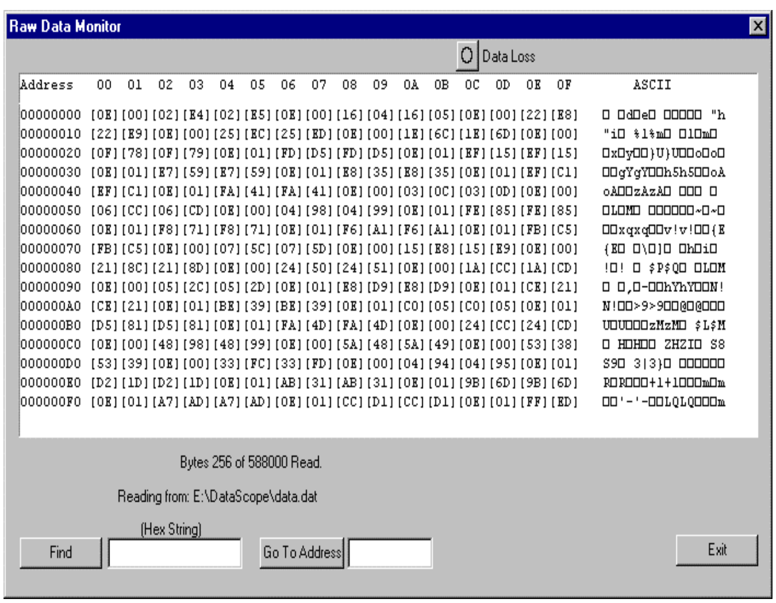
Find Box

The Find Box will find the first occurrence of a HEX string in the file. This is useful if there is a known data pattern that you are searching for.

Go to Address Box

The Go to Address Box will go to a specific address in the file.

FIGURE 6. Read From File Dialog Box



Channel Configuration Setup

The channel configuration dialog screen is the key to displaying data correctly using the O-Scope Dialog Box. A through understanding of the data stream on the SPI buss is required. This Dialog Box parses the SPI data stream into channels that you can view using the O-Scope Dialog Box.

On/Off

Enables the channel for configuring. Up to ten channels can be configured at once.

Number of Bytes

The Number of Bytes associated with this channel. Up to 4 bytes can be specified.

Signed/Unsigned

The Data is either signed or unsigned data.

Big Endian/Little Endian

The Big Endian/Little Endian check- boxes are used to byte-swap the data from Intel to Motorola format or visa versa.

FFT

The FFT check box will perform a FFT on the parsed data. The FFT will be performed on the nearest 2^n points of data.

Scale and Offset

The scale and offset edit boxes allow the data to be scaled and an offset applied. They are used for scaling data from raw A to D counts to a voltage or some other transform.

Display On/Off

Enables the channel for display on the O-Scope display. Only four channels can be displayed on the O-Scope at one time.

Number of Packets Per Second

The number of packets per second is the total number of bytes transferred over the SPI in one second. This is used to compute the transfer buffer size and the amount of data plotted in the O-Scope Dialog box.

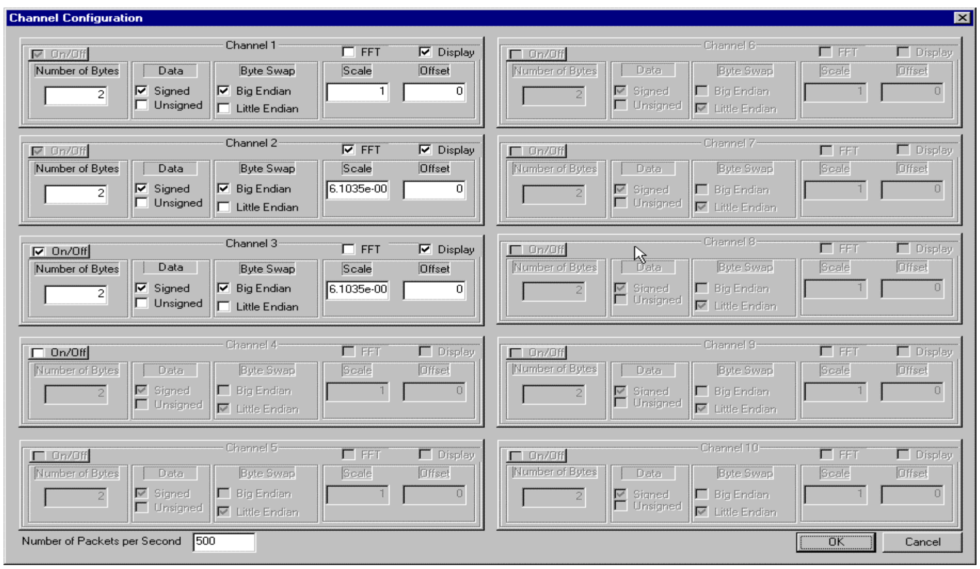
Channel Configuration Example

In the codec example the channel configuration could be setup as follows. Since the AD1847 is configured for three channels of 16 bit data three channels are used.

Channel 1 - 2 bytes – signed data – Big Endian – Selected for display-
Channel 2 - 2 bytes – signed data – Big Endian – Selected for display-
Channel 3 - 2 bytes – signed data – Big Endian – Selected for display-
All other channels off.

In this example all three channels are selected for display.

FIGURE 7. Channel Configuration Dialog Box

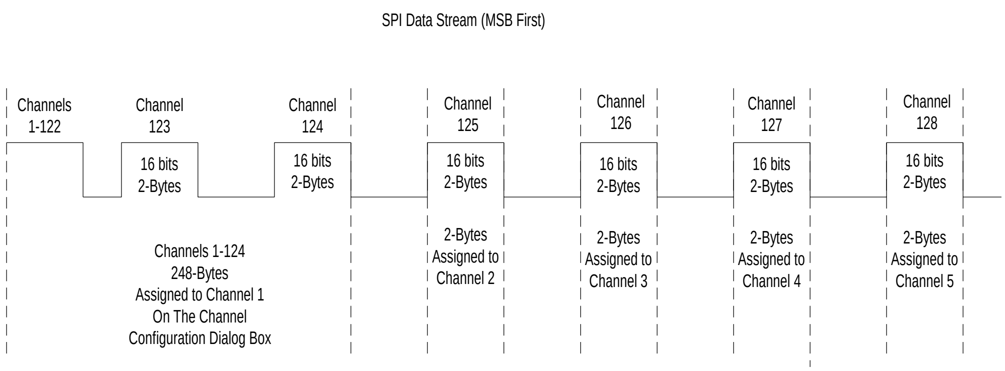


Using the channel configuration screen it is possible to parse up to ten channels of data from a data stream.

Another example of using the channel setup screen would be:

Suppose you have 128 channels of 16 bit signed data on the SPI bus and you want to examine the last 4 channels. Each channel is transferred at a 1K Hz rate. You would configure channel 1 for 248 bytes but leave the **display check box** off. You would then configure channels 2-5 for two bytes each and turn the **display check boxes** on. Since it is signed data the signed data check box would be checked. The **packets per seconded** would be set to 1000. See figure 8.

FIGURE 8. Channel Configuration Example



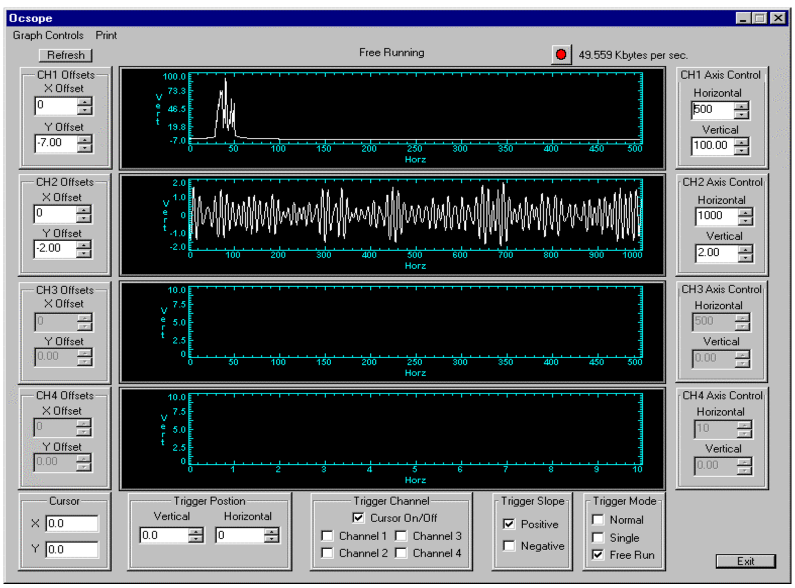
Channel 125 would be assigned to channel 1 in the O-Scope Dialog Box. Channel 126 would be assigned to channel 2 in the O-Scope Dialog Box. Channel 127 would be assigned to channel 3 in the O-Scope dialog box. And Channel 128 would be assigned to channel 4 in the O-Scope Dialog Box.

Once the channel setup is completed you can then monitor SPI data using the O-Scope dialog box.

O-Scope Display

The O-Scope display allows you to view up to 4 channels of data. It works in conjunction with the Channel Configuration setup. Using the O-Scope is very similar to using a digital O-Scope. Data displayed on the O-scope is first parsed according to the channel setup. The channels selected for display in the channel setup are then displayed on the O-Scope. Any channel that is displayed on the O-scope can be used for triggering. Figure 8 shows an example of the O-Scope display utilizing the Channel Setup from the Codec Example in Figure 3.

FIGURE 9. O-Scope Display Dialog Box



Axis Controls

The Channel Axis controls on the right hand side of the O-Scope Dialog Box allow the user to change the horizontal and vertical scaling of each channel.

Offset Controls

The Channel Offset controls on the left side of the O-Scope Dialog Box allow the user to change the X and Y offsets of each channel.

Trigger Position

The Trigger Position adjusts the vertical and horizontal position of the trigger channel.

Trigger Channel

The Trigger Channel selects the channel that will be used for triggering the O-Scope. Trigger position cursors can be turned on or off by selecting Cursor On/Off.

Trigger Slope

The Trigger Slope selects either a positive or negative trigger slope used when triggering on a channel.

Trigger Mode

The Trigger Mode selects the O-Scope mode of operation.

Normal – O-Scope is triggered based upon the trigger configuration.
Single – O-Scope is triggered ONCE each time the check box is clicked.
Free Run – O-Scope is in free run mode. (Not Triggered)

Graph Controls

The Graph Controls Menu item allows the user to change the properties of each channel. Color of trace, axis on/off, frame on/off, etc.

Print Menu Item

The Print Menu item allows the user to print each channel.

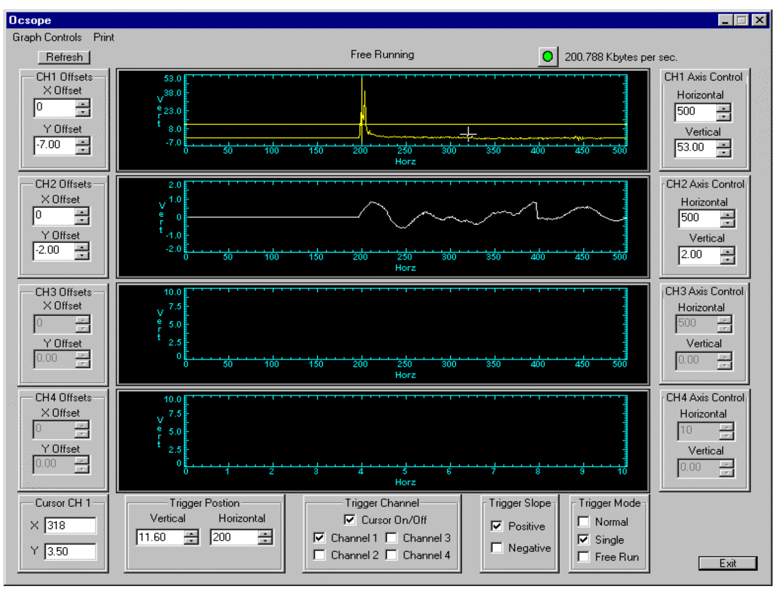
Data Loss Led

The Data Loss LED is an indication that data loss is occurring. This is because the PC is not fast enough to keep up with the Data throughput from the monitor. If the LED is RED then there is data loss occurring. If this happens it might be possible to change the Number of packets per second parameter on the Channel Configuration screen to a higher number. The number of kilobytes per second is displayed to the right of the LED.

Cursor X and Y

The cursor X and Y boxes show the data point position on the selected channel. By right clicking on the channel trace and holding the right button down the user can position the crosshairs on the channel trace. The X and Y positions are then displayed. See Figure 10.

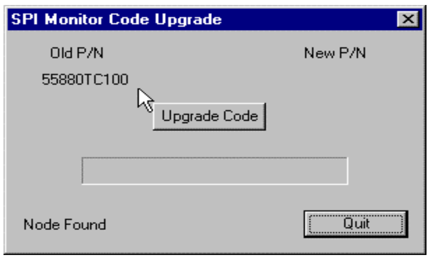
FIGURE 10. O-Scope Cursor X and Y



Upgrade Code Function

The upgrade code function allows the user to upgrade the code in the Monitor, as new versions of code become available. Or for specialized versions of code. The Upgrade Code button is initially disabled. If a code upgrade is required an installation disk can be obtained by Nilsen Consulting. This disk will install the new code to your PC and enable this button.

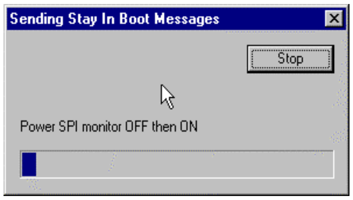
FIGURE 11. Upgrade-code Dialog Box



Pressing the Upgrade Code button will upgrade the Embedded code in the SPI monitor. The New Part Number will be reflected in the New Part number Text Box.

If the SPI monitor cannot be found a Stay In Boot Dialog box will be displayed. At this time power to the SPI monitor should be cycled.

FIGURE 12. Stay-In-Boot Dialog Box



The SPI monitor should then be found and the code will be automatically upgraded.

SPI Monitor Theory of Operation

The SPI monitor is used to monitor devices on the SPI buss. It monitors the SPI buss and then sends buffered data to the PC via the PC's Parallel port. Data through put varies depending upon the speed of the data on the SPI buss and the speed of the PC. Obviously the faster the PC the higher the data through put. A PCI parallel port card will improve performance.

Synchronization

The SPI monitor syncs up with the SPI bus using the P-Table parameters. Since an SPI bus can be configured differently depending on the hardware application a thorough understanding of how the SPI hardware is configured is required. The P-Table configuration along with the color-coded wire harness allows a user to configure the monitor for almost all types of SPI configurations.

CS Active

The P-Table parameter CS active is used to determine the state at which the device on the SPI buss is active. The **Orange wire** on the SPI monitor harness is connected to the CS line of the device to be monitored. The P-Table parameter CS Active state is then configured to the state in which the device is active (high or low).

Bit Order

Since devices on an SPI buss can be configured to send data in either LSB or MSB format the P-Table Parameter Bit Order must be configured correctly (MSB or LSB).

S Clock phase

The S clock phase is the phase of the S clock at which data is valid on the buss (rising or falling). The **white wire** on the SPI monitor harness is connected to the SCLK line of the SPI buss. The P-Table parameter S clock phase is then configured to the correct phase of the SCLK.

Normal/Alternate Framing

Data on the SPI buss can be synchronized using either a Normal or Alternate framing method. Normal framing is usually defined by the following conditions:

SCLK = 0, CPOL = 0, CPHS = 1 or, SCLK = 1, CPOL = 1, CPHS = 1.

Alternate framing is usually defined by the following conditions:

SCLK = 0, CPOL = 1, CPHS = 0 or, SCLK = 1, CPOL = 0, CPHS = 0.

You must determine which of the conditions the hardware is using and select the appropriate one in the P-Table setup.

Framing Method

The framing method used by the Hardware can either be continuous or framed every word. A Continuous framing method assumes a continuous SCLK framing every word assumes a SCLK that is active only during the CS active state.

Data Connection

The **Green wire** on the SPI monitor harness is connected to the SDI pin of the SPI buss on the target hardware. Be sure the **Black Wire** is connected to a suitable ground on the target hardware.

SPI Monitor Quick Start Instructions

To start using the SPI Monitor immediately.

1. Install the software.
2. Make sure the SPI monitor is plugged into the parallel port.
3. Connect the harness to the target circuit using the color-coded chart. **Green wire** – Connect to SDI pin of target hardware. **Black Wire** – Connect to GND of target hardware. **Orange wire** – Connect to Chip Select of the device on the target hardware you wish to monitor. **White wire – Connect** to the S-CLK of the SPI.
4. Apply power to the SPI monitor.
5. Run the SPI Monitor program.
6. Configure the P-Table parameters according to the type of SPI buss to be monitored.
7. If the O-Scope Dialog Box is used configure the channels to the type of data that will be monitored using the Channel Configuration Dialog Box.
8. Run the Raw Data Monitor Dialog Box or the O-Scope Dialog Box.

SPI Monitor Troubleshooting

Hardware Power-up Problems

If the SPI Monitor is not found make sure that the SPI Monitor is powered up and plugged into the correct Parallel Port.

Make sure that the PC's parallel port is configured for ECP mode. This can be done through the CMOS settings.

If it is then try and disconnect the SPI Monitor from the target circuit and see if the Monitor is found. If it is then there is either a problem with the target circuit or the monitor is connected to the target circuit incorrectly.

Try the Monitor on another PC if one is available. If it works then there is a problem with the parallel port.

Data is not what you expected

Make sure that the Monitor is configured properly. The SPI Monitor P-Table parameters, channel configuration, etc must be configured correctly. If its not then erroneous data capture will occur.

Is the target circuit performing as expected? After all the purpose of the SPI Monitor is to troubleshoot the SPI buss. There could be a problem with the target circuit.

Try the binary approach. Change the P-Table parameters one at a time until the SPI Monitor synchronizes and the data looks okay.

Technical Support

Technical support for the SPI monitor can be obtained by calling Nilsen Consulting at 713-690 –8120. Business hours are from 8:00 – 5:00(CST) Monday through Friday. We may also be reached via e-mail at nilsen@ncon.com.

Document Revision History

Revision A (JRB). *January 19, 1999)* *Document created*