

Model JI-216

I2C Bus Monitor - USB

User's Manual



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Preliminary

1. INTRODUCTION

The JI-216 I2C Bus Monitor is a low cost, easy-to-use PC hosted instrument specifically designed for troubleshooting and debugging I2C networks. The JI-216's FPGA based architecture provides for capture and display of all valid or invalid messages and I2C bus events. Captured I2C messages are available for display in two modes: real-time streaming, or triggered circular buffer. These modes provide optimized data display for either hardware or software development. The SDA/SCL timing display aids in tracking down and solving hardware timing problems. JI-216's broad bandwidth (DC – 3.4Mbits/s), wide input signal range (0 – 15.0V), and variable signal filtering provides flexibility in monitoring a variety of I2C bus systems. An intuitive, Windows application manages instrument setup and control. Communications and unit power is provided via a USB2.0 link.

Features

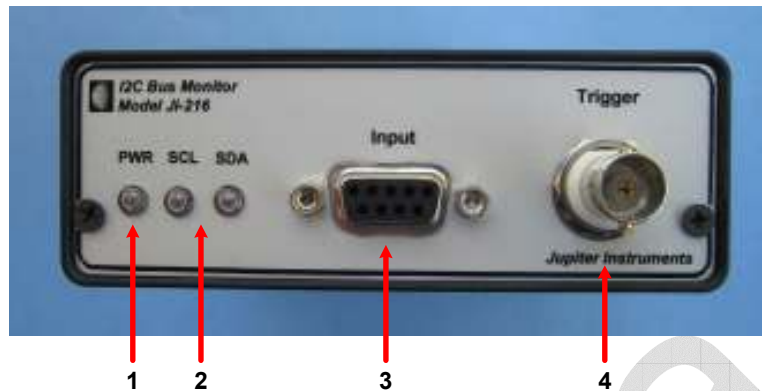
- Passive bus traffic monitoring
- Compatible with Standard-mode (100kbit/s), Fast-mode (400kbit/s), Fast-mode Plus (1.00Mbits/s), and High-Speed mode (3.4Mbit/s)
- Input signal range from 1.50V to 15.0V via programmable V_{IH} and V_{IL} thresholds (10mV steps)
- Timing waveform display with 20nS resolution
- Time stamping and message period timer
- I2C messages displayed in either Real-time Streaming* or Trigger mode
- Trigger signal available at BNC connector - used to trigger external test equipment
- USB 2.0 host interface – No external power required
- Easy-to-use Graphical User Interface (GUI) software included

* Real-time streaming mode limited to a maximum, sustained throughput rate of 1.0Mbits/s

Applications

- Hardware troubleshooting and test
- Software development and debugging
- Production line testing

1.1 Front Panel Description



1. **Power** – Power on LED
2. **Activity** – **SCL, SDA** – I2C bus activity indicators.
3. **Input** – I2C cable jack. 9-pin, Female, D-Sub connector (AMP 745781-4)

Pin-outs: Pin 1 = SDA
 Pin 5 = GND
 Pin 6 = SCL
 Pin 7 = D0
 Pin 3 = D1
 Pin 2, 4, 8, 9 = No Connection

4. **Trigger Output** – Trigger event signal (Trigger Mode only). Selectable positive/negative polarity and 1us/10us pulse width. Standard BNC connector.

1.2 Rear Panel Description



1. **USB** – Type 'B' connector (Molex 67068-0000)

1.3 I2C Cable Description



Details

- Length: 34"
- Signals:
 1. SDA
 2. SCL
 3. D1
 4. D0
 5. GND
- Capacitance: Pin-to-pin < 35pF
- Connector #1: 9-Pin, D-Sub, Male (AMP 1-745492-8)
- Connector #2: Flying-Lead (fits 0.025 sq. post)

2. GETTING STARTED

2.1 Software Installation

The JI-216 I2C Bus Monitor requires the installation of both application software and a USB driver. See appendix C for step-by-step instructions on installing both.

2.2 USB Driver/HW Check

1. Connect the JI-216 to the host PC using the 6' USB cable.
2. After a few seconds, confirm that the JI-216 is powered by verifying that the front panel PWR LED is on.
3. The USB Drive/HW Check has passed.

2.3 Software Check

1. Ensure that the JI-216 unit is connected to the host PC and power is on.
2. Go to the folder where the application software is installed (ex. C:/JI216/)
3. Launch the I2C Bus Monitor application by clicking I2C_Bus_Monitor.exe.
4. Verify that the I2C Bus Monitor main window is displayed as shown in figure 1.

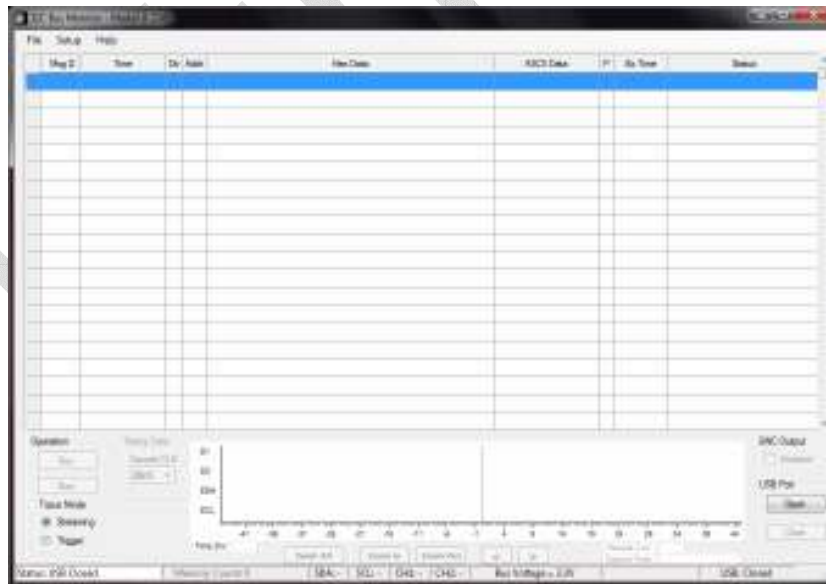


Figure 1. I2C Bus Monitor Main Window

If an error occurs and the window does not appear, begin by verifying that the .NET Framework is installed. To do this, click **Start** on your windows desktop, select **Control Panel**, and then double-click the **Add or Remove Programs** icon. When the window appears, scroll through the list of installed programs. Verify that the .NET Framework 3.0 (or higher) is listed.

If not, go to <http://msdn2.microsoft.com/en-us/netframework/aa569263.aspx> for instructions on downloading and installing the latest .NET Framework version.

5. At the main window, open a USB port by clicking the **Open** button in the USB Connection group.
6. Ensure an open USB port by confirming an open port status.
7. At the menu bar, open the About message box by clicking **Help** then **About**.
8. Verify that the version numbers for the **HW Version** and **VHDL Version** are valid (i.e. HW Version: 1.0, VHDL Version: 2.1, etc.) If a question mark (HW Version: ?, or VHDL Version: ?) or some other character appears, an error has occurred.
9. If no errors have occurred (or if errors have been resolved) the Software Check has passed.

2.4 I2C Message Capture – Streaming Mode

This mode provides real-time capture and display of low bandwidth I2C bus traffic (<5K messages per second at any SCL rate). I2C messages and bus events are logged for later review.

For this exercise, an active I2C test bus is needed with the following requirements:

1. One slave device (minimum)
 2. An I2C test bus running a standard bus voltage (i.e. 5.0V, 3.3V, 2.5V, or 1.8V)
 3. Low bandwidth message stream (preferably 50 messages per second or less at any SCL rate)
 4. Error free I2C message transmissions
1. Ensure power to I2C test bus is off.
 2. Connect the I2C probe cable to the D-sub connector on the I2C Monitor front panel.
 3. Connect the three flying-leads (SDA, SCL, and GND) to the I2C test bus.
 4. Connect the I2C Monitor to the PC and verify that power is on. (See section 2.2)
 5. Apply power to I2C test bus and begin I2C message transmissions.
 6. Launch the I2C Bus Monitor application and open the USB port. (See section 2.3)
 7. At the menu bar, click **Setup**, then **Input Setup** to open the Input Setup menu (See figure 2).



Figure 2. Input Setup Menu

8. Select the appropriate threshold voltages for the test bus, and then click **OK** to save.
9. At the JI-216 front panel, verify test bus activity by observing SDA and SCL LED activity.
10. At the main window, select **Streaming** in the Trace Mode group.
11. Now, begin a session by clicking **Run**.
12. Verify the following action:
 - I2C messages are scrolling in the Message Log.
 - The word "Ok" appears in the comment column for each I2C message.
 - No error messages appear.
13. Allow the session to run until approximately 3K - 4K messages have been collected.
14. Click **Stop** to stop the session.
15. Use the vertical scroll bar on Message Log pane to examine collected message and verify accuracy.
16. The I2C message capture via Streaming Mode exercise is now complete.

2.5 Message Capture – Trigger Mode

The Trigger mode is ideal for capturing and later displaying high bandwidth I2C bus traffic (>5K messages per second at any SCL rate). I2C messages are captured and stored via a 128K circular buffer arrangement. At the occurrence of a trigger, new data continues to over write old until 50% of the buffer length is filled. The result is a Message Log filled with pre and post trigger I2C messages.

For this exercise, an active I2C test bus is needed with the following requirements:

1. One slave device (minimum)
2. An I2C test bus running a standard bus voltage (i.e. 5.0V, 3.3V, 2.5V, or 1.8V)
3. High bandwidth message stream (preferably 2K messages per second or more at any SCL rate)
4. Error free I2C message transmissions

1. If section 2.4, "Message Capture – Streaming Mode", was previously run, go to step 2. Otherwise, execute steps 1 – 10 in section 2.4.
2. At the menu bar, open the Trigger Menu by selecting **Setup**, then **Trigger**. The Trigger Menu is now displayed. (See Figure 3)

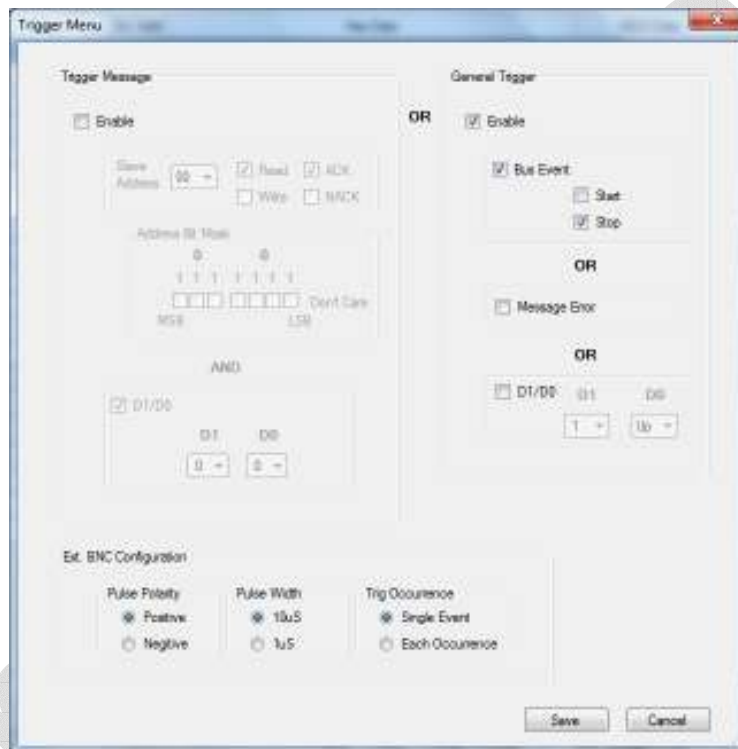


Figure 3. Trigger Menu

3. At the Trigger Menu, make the following selections:
 - General Trigger: Enable
 - Bus Event: Enable
 - Stop: Enable
4. Click **OK** to save the setup.
5. Next, select a Timing Waveform sampling clock rate appropriate for the I2C test message. Choose a sampling rate that is approximately 20x faster than the I2C clock frequency to ensure adequate waveform resolution. Click the **Sampling Clock** combo box and then use the pull-down selector to choose a sample rate.

6. At the main window, select **Trigger** in the Trace Mode group.
7. Now, begin a session by clicking **Run**.
8. Verify the following action:
 - I2C messages are being recorded: increasing byte count in the Record Memory box.
 - A yellow “Trigger” message displayed in the status box.
9. Capture is complete when new data is displayed in the Message Log and the Timing Waveform has been updated (check the time stamp).
10. At the Message Log, scroll through the captured messages and locate the trigger message: a yellow highlighted message.
11. At the Timing Waveform, use the zoom and scroll controls to locate the trigger message. This message’s location is indicated by the blue vertical bar. This bar marks the point in time where the trigger condition was satisfied. Zoom in to a point where SCL and SDA signals are clearly visible and data values can be
12. Visually decode the timing signals and verify a match with the triggered message in the Message Log.
13. The I2C message capture via Trigger Mode exercise is now complete.

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3. MAIN WINDOW AND MENU DESCRIPTIONS

3.1 Main window

The I2C Bus Monitor main window is shown in Figure 4. The Message Log pane is located at the top 3/4ths of the window, and the Timing Waveform display and associated control options are located towards the bottom.

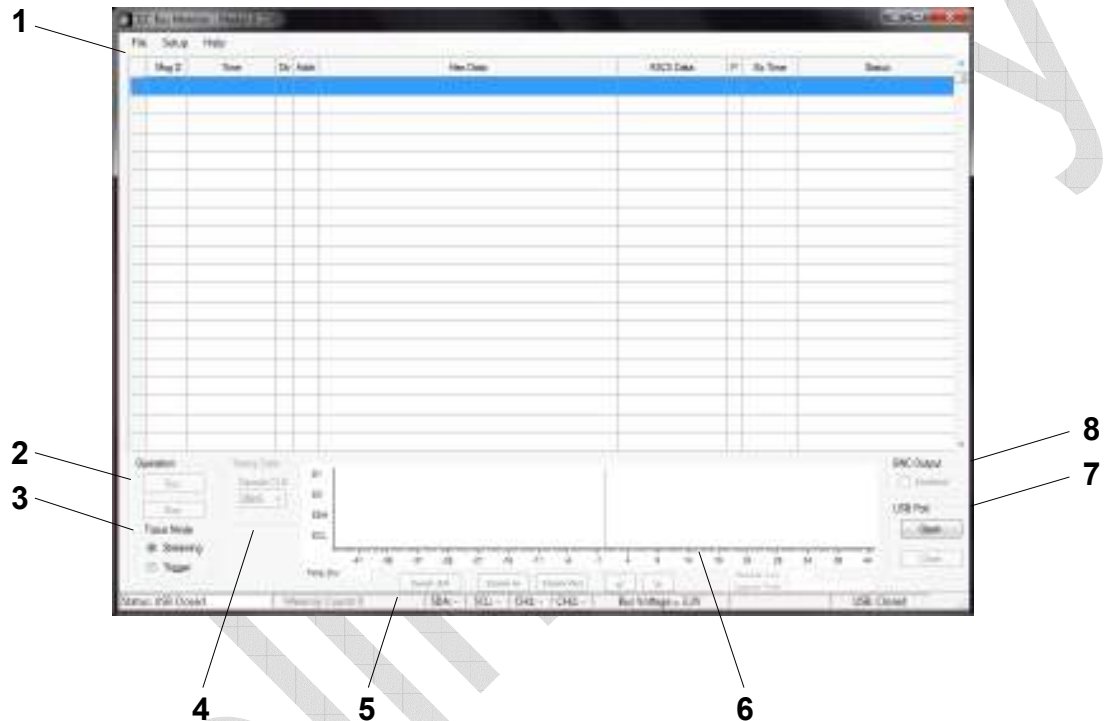


Figure 4. I2C Bus Monitor Main Window

1. **Message Log** – Captured I2C messages are logged and displayed in this component.
2. **Run/Stop** – These buttons control the capture session.
3. **Capture Mode** – I2C messages can be captured via two modes: **Streaming** and **Trigger**. In Streaming mode, I2C messages are captured, logged and displayed in real-time. This mode is ideal for low bandwidth I2C bus traffic. Trigger mode, captured messages are written to memory using a fixed length, circular buffer arrangement where by new data endlessly overwrites old. When a trigger occurs, data is tagged and new data continues to overwrite old until 50% of the buffer length is filled. The result is a Message Log with pre and post trigger I2C messages.
4. **Sampling Clock** – The sampling rate for the Timing display is selected here.
5. **Timing Display Controls** – These controls are used to manipulate the position and time base of the displayed timing signals.
6. **Timing Display** – SDA, SCL, D1, and D0 are displayed here. Timing data is only available during Trigger mode. A blue vertical bar in the timing data indicates the time where the trigger condition was satisfied.

- 7. **USB Port** – Open/close USB port.
- 8. **BNC Enable** – Enable BNC trigger output

3.2 Trigger Menu

The Trigger Menu provides a simplified and convenient means of entering and maintaining a trigger setup.

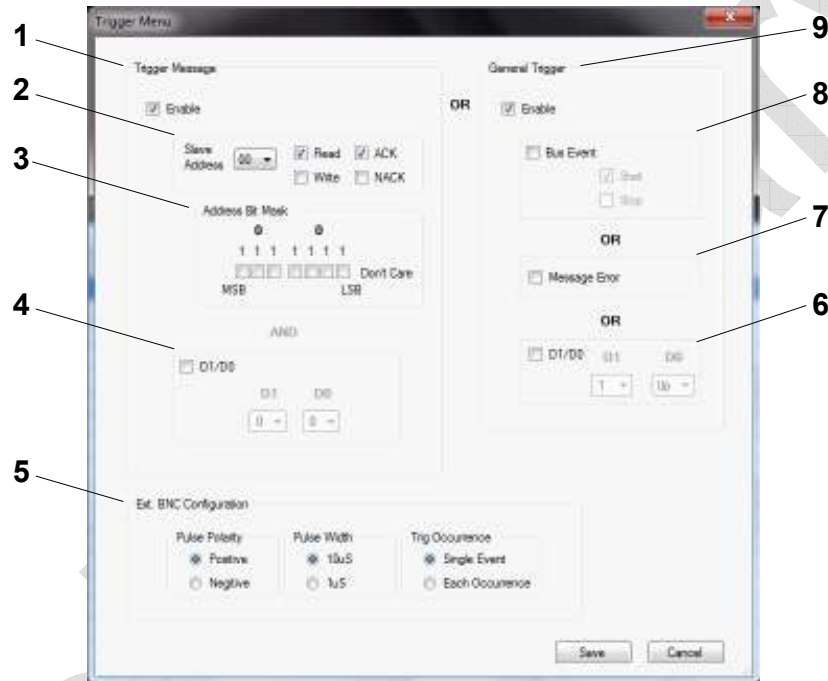


Figure 5. Trigger Menu

1. **Trigger Message** – A trigger event is generated on a 7-bit Slave Address. Click the check box to enable/disable.
2. **Slave Address** – A 7-bit Slave Address is selected via a drop-down list box. Associated check boxes select message direction (Read/Write) and acknowledgement response (ACK/NACK)
3. **Address Bit Mask** – Individual Slave Address bits can be selected as “don’t care.”
4. **D1/D0** – Enabling this option allows qualifying The Slave Address (with bit mask) with the state of GPIOs, D1 and D0. D1 and D0 are evaluated on the SCL falling edge at the Slave Address acknowledgement bit time.
5. **BNC Trigger Signal** – This option configures the behavior of the external trigger signal available at the BNC connector. Choices include signal polarity, pulse width, and occurrence (single event or each event)

6. **Trigger D1/D0** – A trigger event can also be generated by matching patterns on the D1 and D0 lines. A trigger is generated by either a rising (Up) or falling (Dn) edge of either D1 or D0, and qualified by the state (0, 1, or X) of either D1 or D0.
7. **Message Error** – This option generates a trigger event on the occurrence of a message error.
8. **Bus Event** – This option selects a trigger event on the occurrence of either an I2C Stop or Start condition.
9. **General Trigger** – A trigger event can also be generated on the occurrence of a bus event, such as a Stop/Start condition or message error, or on the action of the two GPIs, D1 or D2.

3.3 Input Setup Menu

Values for SDA/SCL voltage thresholds and signal filtering are selected at this menu.

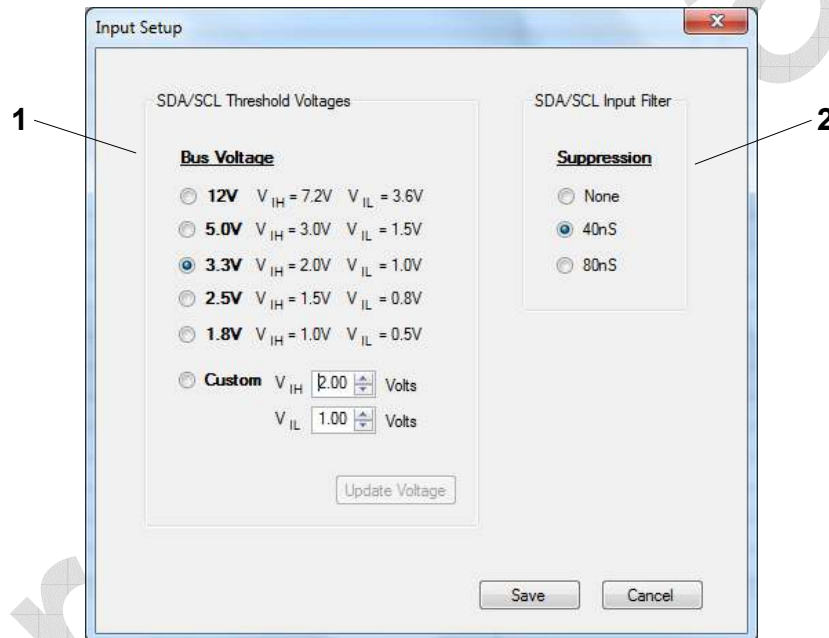


Figure 6. Input Setup Menu

1. **Input Threshold Voltages** – The high (V_{IH}) and low (V_{IL}) threshold voltages for the SDA and SCL lines are set here. The selection includes 5 preset threshold voltages, based on I2C bus voltage, and a custom setting option.
2. **SDA/SCL Input Filter** – This selects the pulse width of the spike that will be suppressed on both SDA and SCL lines.

APPENDIX A

1.0 Specifications**I2C Bus Monitor – USB****Model JI-216**Jupiter
Instruments

Ver 1.0

12/9/2009 Edition

Electrical Specifications

I2C Interface & GPI	
Channels	SDA, SCL, CH1, & CH2
Input Threshold	V _{IH} : 0.01 to 7.20 V (variable, 10mV steps) V _{IL} : 0.00 to 7.19 V (variable, 10mV steps)
Voltage Range	-0.5 to 15V (operational) -30 to 30V (maximum rating)
Bus Speed	DC to 3.7M bits/s
Input Filter (SDA & SCL only)	Selectable: 0, 40ns, or 80ns pulse suppression
Input Resistance	250K
Input Capacitance	< 40pF
Connector Type and Pin-outs	Standard 9-Pin, D-sub, Female Pin 1 = SDA Pin 3 = CH2 Pin 4, 5 = GND Pin 6 = SCL Pin 7 = CH1 Pin 2, 8, 9 = No Connection
Trigger Output (BNC)	
Connector type	BNC
Output	TTL/CMOS (V _{OH} = 2.4V min, V _{OL} = 0.45V min.)
Pulse Width	Selectable: 1uS or 10uS
Pulse Polarity	Selectable: Positive or Negative
Behavior	Selectable: Single event pulse or pulse each trigger event
I2C Message Monitoring	
Mode	Selectable: Real-Time Streaming or Trigger

Time Stamp	Format: Day Hr/Min/Sec/Millisec 10ms resolution
Message Duration Timer	Range: 0 to 1024ms, 20ns resolution
Message Memory (Trigger Mode)	128K Bytes (equivalent to 2.5k, 8 byte messages)
Trigger (Trigger Mode)	Combination: Slave Address, R/W, ACK/NACK, Start/Stop, CH1 & CH2, and Bus Error
Signal Timing	
Signals Displayed	SDA, SCL, CH1, & CH2
Sampling Rates	Selectable: 20ns, 50ns, 100ns, 200ns, 500ns, 1us, 2us 5us, 10us, 20us, 50us, 100us, 200us, 500us
Sampling Capacity	4K/channel

Electrical Specifications (continued)

LEDs	
Power	Power-On
SDA	Bus Activity - Data
SCL	Bus Activity - Clock
PC Interface	
Communication	USB 2.0 Full Speed
Connector	Standard type B socket
Power	5V @ 300mA (max), USB supplied

Mechanical and Environmental Specifications

Mechanical	
Dimension	12.0" x 12.0" x 6.0" (WxHxL)
Weight	1.0lbs
Environmental	
Operating Temperature	0C to 50C
Storage Temperature	-20C to 70C

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APPENDIX B

1.1 PC System Requirements

- Microsoft Windows 2000/XP/Vista or Windows 7
- Pentium 4 or equivalent processor (600 MHz minimum)
- USB 2.0 port
- CD-ROM drive
- 25 MB Free hard disk space
- 256 MB Memory

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APPENDIX C

1. Installing USB Device Driver

Two types of drivers will be installed: Virtual COM Port (VCP) and Direct Drive (D2XX). The VCP driver allows control of the JI-216 Bus Monitor via ASCII serial commands sent using a terminal emulation program such as Windows Hyper Terminal. The D2XX driver allows direct access to a USB device via a DLL interface. For complete driver information, please visit (<http://www.ftdichip.com/FTDrivers.htm>)

Instructions below assist with the installation of JI-216 drivers for the following Windows Operating systems: Windows 2000/XP/Vista or Windows 7

1.1 Windows 7

To install drivers for the JI-216 under Windows 7, follow the instructions below:

Internet Connection

1. Connect the JI-216 to a spare USB port on your PC.
2. Windows 7 will silently connect to Windows Update website and install the required driver(s).
3. At the conclusion of the installation, verify that the JI-216 front panel PWR LED is on. Installation is now complete.
4. If the drivers were not automatically found or the PWR LED did not illuminate, continue to the "No Internet Connection" steps below.

No Internet Connection

1. Please refer to the FTDI Drivers Installation Guide for Windows 7 for detailed instructions.
(http://www.ftdichip.com/Documents/AppNotes/AN_119_FTDI_Drivers_Installation_Guide_for_Windows7.pdf)

1.2 Windows Vista

To install drivers for the JI-216 under Windows Vista, follow the instructions below:

Internet Connection

1. Connect the JI-216 to a spare USB port on your PC.
2. Vista will silently connect to Windows Update website and install the required driver(s).
3. At the conclusion of the installation, verify that the JI-216 front panel PWR LED is on. Installation is now complete.
4. If the drivers were not automatically found or the PWR LED did not illuminate, continue to the "No Internet Connection" steps below.

No Internet Connection

1. Please refer to the FTDI Drivers Installation Guide for Windows Vista for detailed instructions.
([http://www.ftdichip.com/Documents/AppNotes/AN_103_FTDI_Drivers_Installation_Guide_for_VISTA\(FT_000080\).pdf](http://www.ftdichip.com/Documents/AppNotes/AN_103_FTDI_Drivers_Installation_Guide_for_VISTA(FT_000080).pdf))

1.3 Windows XP

To install drivers for the JI-216 under Windows XP, follow the instructions below. For additional installation information, please refer to the FTDI Drivers Installation Guide for Windows XP
([http://www.ftdichip.com/Documents/AppNotes/AN_104_FTDI_Driver_Installation_Guide_for_WindowsXP\(FT_000093\).pdf](http://www.ftdichip.com/Documents/AppNotes/AN_104_FTDI_Driver_Installation_Guide_for_WindowsXP(FT_000093).pdf))

1. Temporarily disconnect the host PC from the Internet. (Simply remove the network cable from the PC)
2. Insert the JI-216 CD-ROM into the computer's CD drive.
3. Connect the JI-216 unit to a spare USB port.
4. Now, verify that the "Found New Hardware Wizard" window is displayed as shown in Figure 1.



Figure 1. Found New Hardware Wizard Window

5. Select "No, not at this time" from the options, and then click "Next".

- At the “Found New Hardware Wizard” window (Figure 2), select “Install from a specific list or location (Advanced)”, and then click “Next”.

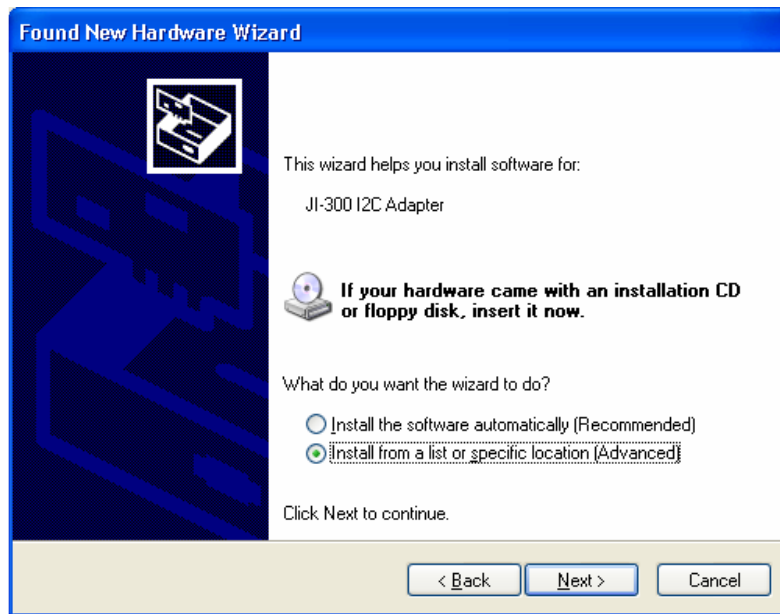


Figure 2. Found New Hardware Wizard Window #2

- At the “Found New Hardware Wizard” window (Figure 3), select “Search for the best driver in these locations” followed by “Search removable media (floppy, CD-ROM...)”. Click Next.

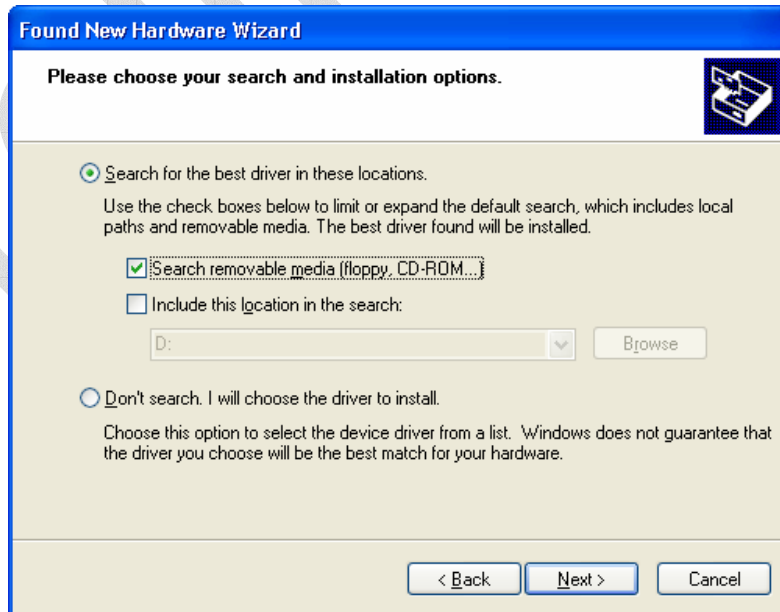


Figure 3. Found New Hardware Wizard Window #3

8. A window is now displayed showing the driver software being located and then copied (Figure 4).

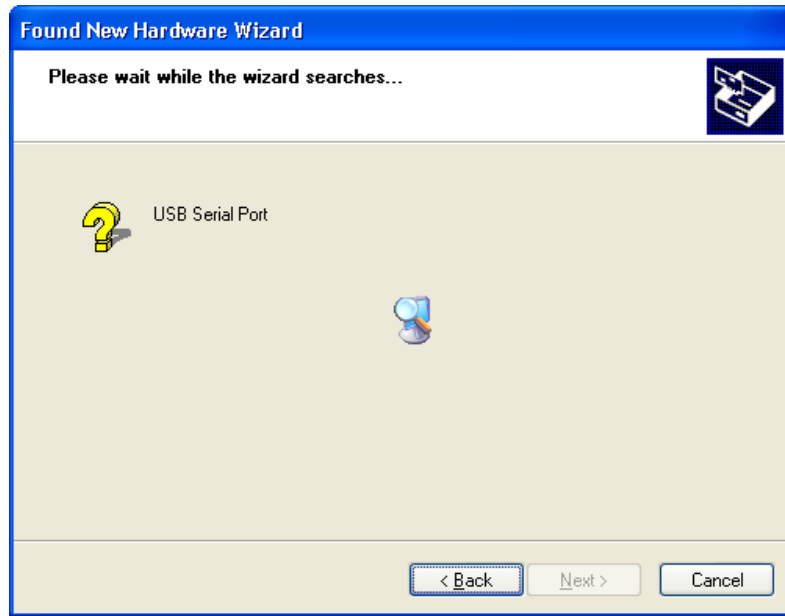


Figure 4. Driver Coping Window

9. A window indicating that the installation was successful should now be displayed (Figure 5).



Figure 5. Installation Success Window

10. The D2XX driver is now installed. Click Finish.

11. Repeat steps 5 through 11 to install the VCP driver.
12. The installation is now complete.

1.4 Windows 2000

To install drivers for the JI-216 under Windows 2000, follow the instructions below. For additional installation information, please refer to the Windows 2000 Installation Guide (http://www.ftdchip.com/Documents/InstallGuides/Windows_2000_Installation_Guide.pdf)

1. Temporarily disconnect the host PC from the Internet. (Simply remove the network cable from the PC)
2. Insert the JI-216 CD-ROM into the computer's CD drive
3. Connect the JI-216 unit to a spare USB port.
4. Now, verify that the "Found New Hardware Wizard" window is displayed as shown in Figure 1.



Figure 1. Found New Hardware Wizard Window

5. Click "Next", to continue.
6. At the next "Found New Hardware Wizard" window (Figure 3), select "Search for a suitable driver for my device (recommended)" as shown below, then click next.



Figure 1. Found New Hardware Wizard Window #2

7. At the next "Found New Hardware Wizard" window (Figure 4), check the box next to "CD-ROM drives" and uncheck all others. Click next.

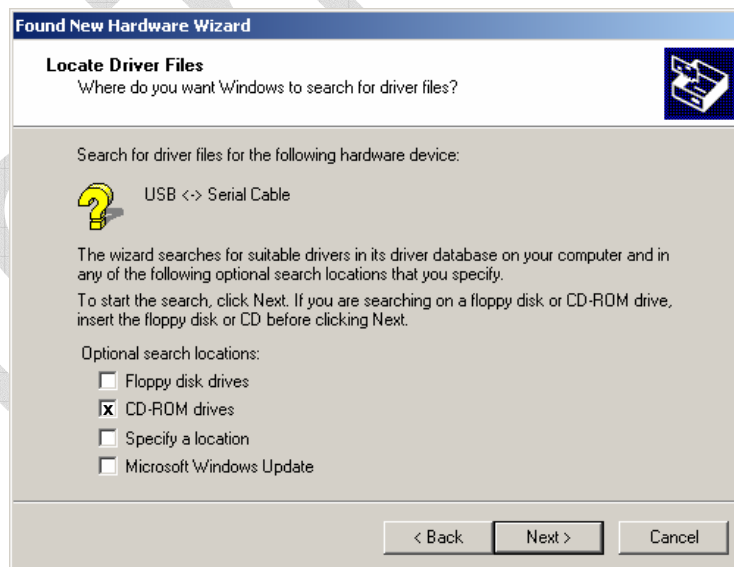


Figure 1. Found New Hardware Wizard Window #3

- Once Windows has found the required .INF driver file (Figure 4), click next to proceed.

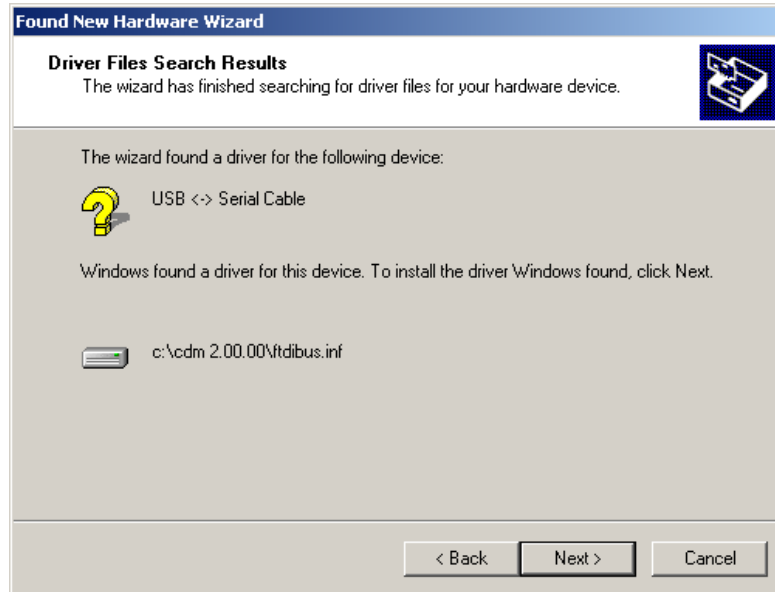


Figure 4. Driver Found Window

- A window indicating that the installation was successful should now be displayed (Figure 5). Click Next.



Figure 5. Installation Success Window

- The installation is now complete.

2.0 Installing Application Software

The JI-216 application software can be installed locally on the host PC's hard drive (C:) or executed directly from CD-ROM. To install:

3. Insert the CD-ROM into the host PC's CD/DVD drive.
4. Using Windows Explorer, find the file "setup.exe" on the CD drive. Double click on the file to begin the installation.
5. Follow the instructions on the screen until the installation is complete.
6. Software installation is now complete.

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APPENDIX D

1.0 General Information

1.1 Warranty

The equipment is warranted for one year from date of purchase against defects in materials or workmanship. Jupiter Instruments reserves the right to repair or replace products at its own and complete discretion. Customer must obtain from Jupiter Instruments a Return Authorization Number (RMA) prior to returning any products to Jupiter Instruments. Products returned under this Warranty must be unmodified and in original packaging. Jupiter Instruments reserves the right to refuse warranty repairs or replacements for any products that are damaged or not in original form.

The customer is responsible for the shipping and insurance cost arising from the return of products to Jupiter Instruments. Jupiter Instruments will return all in-warranty products with shipping cost prepaid.

1.2 Thirty-Day Return Policy

Customers may return Jupiter Instruments products for a full refund if Jupiter Instruments is contacted within thirty days of the customer's receipt of the product. Customer may return Jupiter Instruments products for credit, exchange, or a refund. Customer must obtain from Jupiter Instruments a Return Authorization Number (RMA) prior to returning any products to Jupiter Instruments. Products must be returned unmodified and in original packaging. Jupiter Instruments reserves the right to refuse return rights for any products that are damaged or not in original form. Volume orders may be subject to a significant restocking fee.

1.3 Limitation of Liability

Jupiter Instruments' liability shall be limited to the repair or replacement of defective products in accordance with the Jupiter Instruments limited warranty.

Jupiter Instruments shall not be liable for any incidental, special or consequential damages for breach of any warranty, expressed or implied, directly or indirectly arising out of Jupiter Instruments' sale of merchandise, including any failure to deliver any merchandise, or arising out of customer's installation or use, whether proper or improper, of the product, separately or in combination with other equipment, or from any other cause. Use all Jupiter Instruments products and accessories at your own risk.

Products sold by Jupiter Instruments are not authorized for use as critical components in life support devices or systems.

1.4 Contact Us

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