5DT Data Glove Ultra Series

User's Manual

5DT

Fifth Dimension Technologies

www.5DT.com

5DT Data Glove Ultra

User’s Manual

Version 1.1 *October 2004*

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1. Introduction

The 5DT Data Glove Ultra is a hand data motion capturing solution for animation and virtual reality.

The 5DT Data Glove Ultra is the second generation of 5DT's high-end data glove and has been completely redesigned and optimized for the best performance and ease of use. This glove measures finger flexure as well as the abduction between the fingers. Finger flexure is measured at two places (1st joint (knuckle), 2nd joint) on each finger.

Among the features of this kit are:

- The glove is comfortable with an improved design for differently-sized hands.
- The accurate and sensitive sensors give a clean signal, minimizing the need for additional filtering.
- Diagnostic software is included with the capability to record hand data.
- The package includes a plug-in for Kaydara MOCAP™.
- The gloves' functions and data are accessible via the 5DT Data Glove SDK.
- The glove data stream from the optional serial kit is an RS-232 data stream with an open protocol allowing for various platform implementations.

2. Setup and Installation

2.1. Package Contents

When first unpacking your glove, please ensure that all the parts are there. If you are missing anything please contact 5DT or your reseller immediately.

The 5DT Data Glove Ultra consists of the following:

1. 5DT Data Glove Ultra (5 or 14 Sensor)
2. 5DT Data Glove Ultra Series USB cable
3. 5DT Data Glove CD

2.2. Connecting the Glove

Connect the glove to the PC as shown in Figure 1.

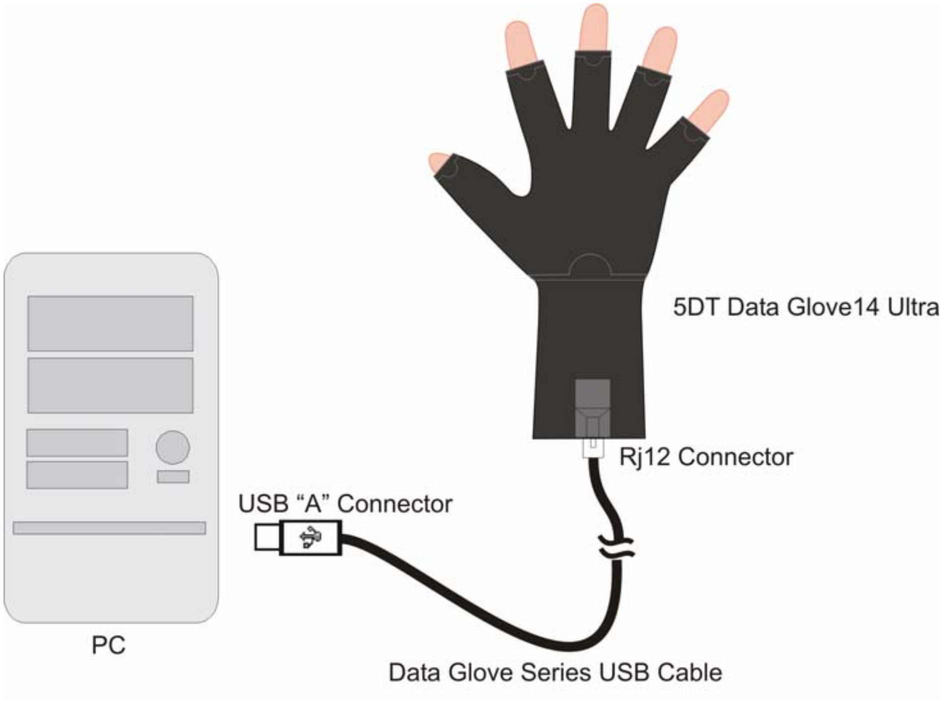


Figure 1 – Connecting the Glove to the PC.

You can use GloveManager to test the operation of the glove. Detail on this is given in Section 4 of this manual.

3. Software Installation

Your package comes with a CD that contains documentation and utilities to help you get up and running with the gloves as quickly as possible.

Most of the supplied programs and software are intended for 32-bit Windows, and require Windows 98, ME, 2000, or XP.

The setup program should run when you insert the CD, but if it doesn't, run the program **setup.exe** in the **install** directory and follow the on-screen instructions.

When prompted, check the 5DT Data Glove Ultra box to install the software for this product.

3.1. CD Contents

The CD contains the following directories:

…\Acrobat

This copy of Adobe® Acrobat® Reader will allow you to read the documentation.

…\DirectX

The CD-ROM also contains the redistributable version of DirectX 9.0. You will need this if you want to run the DirectX implementations of the Glove Demos (DirectX and OpenGL demos are supplied). To install DirectX 9.0, open the folder and run **dxsetup.exe**.

…\Install

This contains the software installation files.

3.2. Installed Software

By default the setup program will install your files to the following directory:

C:\Program Files\5DT\Data Glove Ultra

The installation contains the following directories:

…\Demo

This folder contains the 3D glove demo. Click on **GloveDemo.exe** to start the demo[1].

…\Documents

This directory contains the electronic copy of this manual in pdf format and application notes as they become available.

…\GloveManager

GloveManager is a program that allows you to test your gloves and access advanced glove functions which may not be available in the plug-ins. More detail on this is given in Section 4.

…\Plugins

This directory contains the plug-in for Kaydara MOCAP™ which replaces the built-in Kaydara glove plug-in. More detail on this is given in Section 5.

…\SDK

This directory contains the 5DT Glove SDK files. These are described in detail in Section 6.

[1] The 3D glove demo will not function with the Data Glove Ultra USB.

4. Using GloveManager

The 5DT GloveManager is a useful tool accompanying the Data Glove which may be used for the following:

- Testing the 5DT Data Glove
- Obtaining good calibrated values for the 5DT Data Glove
- Logging data obtained from the 5DT Data Glove

Note: All images are shown for the Data Glove 14 Ultra. Images will differ slightly for the Data Glove 5 Ultra.

4.1. Starting GloveManager

Start the program by running GloveManager.exe, which is installed in the **\Data Glove Ultra\GloveManager\** folder by default. The setup tab window will appear (see below).

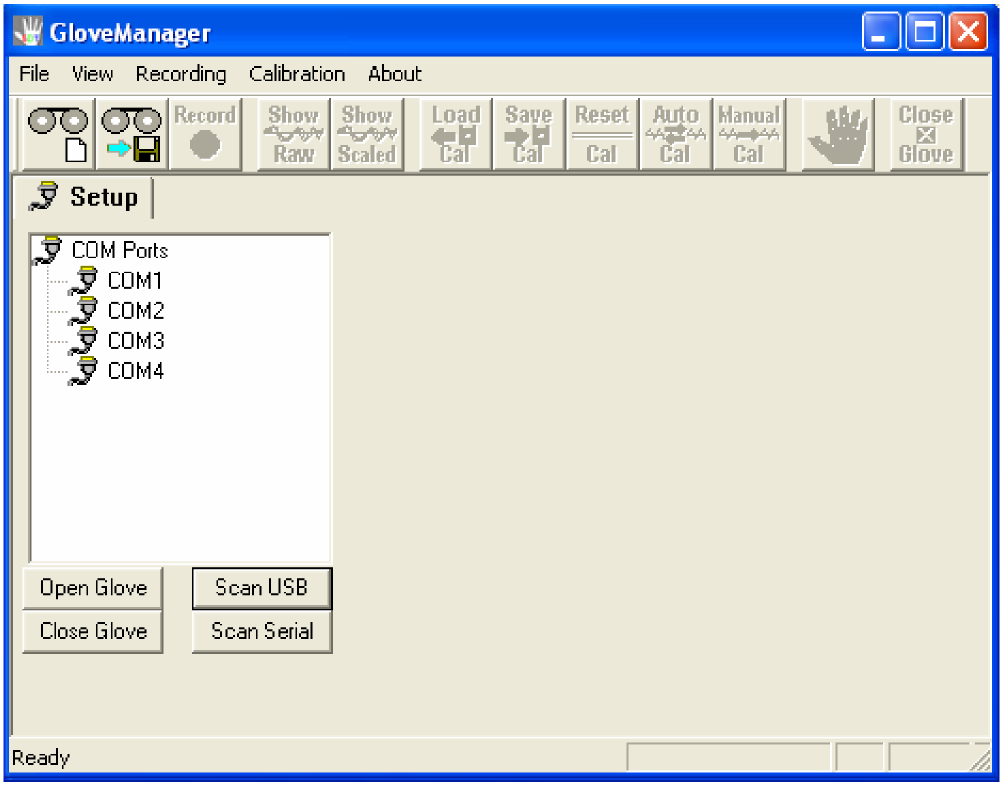
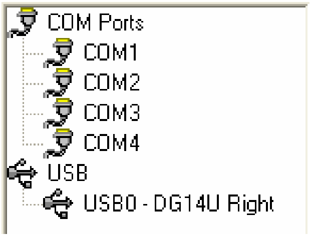


Figure 2 – The Setup Tab Window

4.2. Opening USB Gloves

4.2.1 Scanning for Gloves

Clicking the Scan USB button in the setup tab window causes GloveManager to scan the USB for available gloves. This is useful if you have plugged in the glove after starting GloveManager. Once the USB scan is complete the USB device tree will be updated to show available gloves.



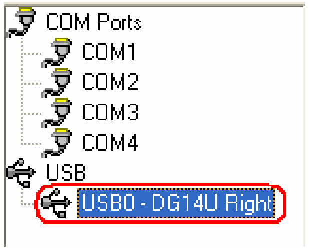
COM Ports
COM1
COM2
COM3
COM4
USB
USB0 - DG14U Right

Figure 3 – Result of the USB Scan

As can be seen in Figure 3, the Port Scan has found two wireless gloves on COM1. The right hand glove is plugged into Port A of the wireless transmitter unit. The left hand glove is plugged into Port B.

4.2.2 Opening Gloves

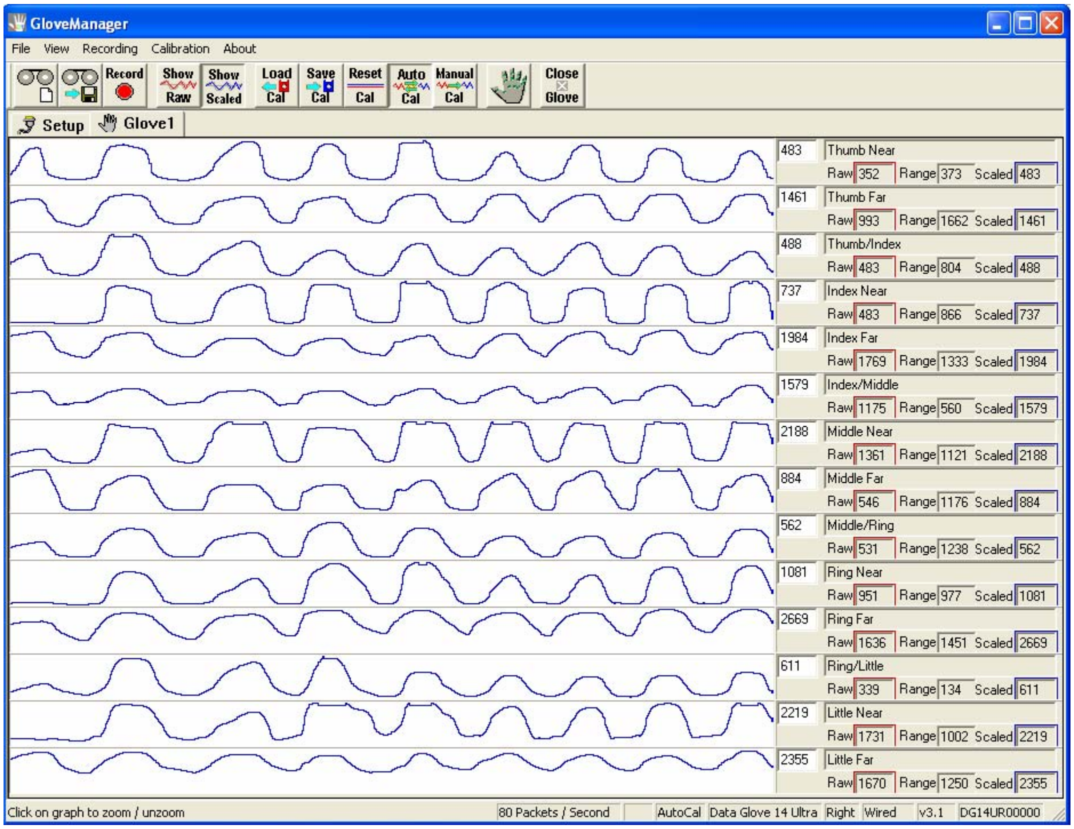
A glove may by opened by clicking the Open Glove button after a USB glove has been selected in the device tree.



COM Ports
COM1
COM2
COM3
COM4
USB
USB0 - DG14U Right

Figure 4 – Selecting the Glove to be Opened

If the glove has been successfully opened the tab window will automatically switch to the newly opened glove, as shown in Figure 5. Double-clicking on a USB glove will also cause GloveManager to attempt to open the glove.



483 Thumb Near Raw 352 Range 373 Scaled 483
1461 Thumb Far Raw 993 Range 1662 Scaled 1461
488 Thumb/Index Raw 483 Range 804 Scaled 488
737 Index Near Raw 483 Range 866 Scaled 737
1984 Index Far Raw 1769 Range 1333 Scaled 1984
1579 Index/Middle Raw 1175 Range 560 Scaled 1579
2188 Middle Near Raw 1361 Range 1121 Scaled 2188
884 Middle Far Raw 546 Range 1176 Scaled 884
562 Middle/Ring Raw 531 Range 1238 Scaled 562
1081 Ring Near Raw 951 Range 977 Scaled 1081
2669 Ring Far Raw 1636 Range 1451 Scaled 2669
611 Ring/Little Raw 339 Range 134 Scaled 611
2219 Little Near Raw 1731 Range 1002 Scaled 2219
2355 Little Far Raw 1670 Range 1250 Scaled 2355

Click on graph to zoom / unzoom | 80 Packets / Second | AutoCal | Data Glove 14 Ultra | Right | Wired | v3.1 | DG14UR00000

Figure 5 – GloveManager after the USB Glove is Successfully Opened

Clicking on the Setup tab will cause GloveManager to display the setup tab window again. To open the second wireless glove, select it from the COM port tree.

4.3. Opening Serial and Wireless Gloves

4.3.1 Scanning for Gloves

Clicking the Scan Serial button in the setup tab window causes GloveManager to scan the COM ports for available gloves. This is useful if you do not know on which COM port your glove is connected to, or you simply want to scan for available gloves. Once the COM port scan is complete the COM port tree will be updated to show available gloves.

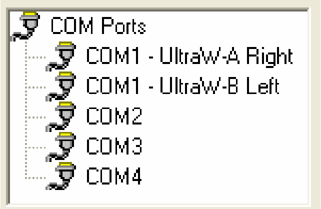


Figure 6 – Result of the Port Scan

As can be seen in Figure 6, the Port Scan has found two wireless gloves on COM1. The right hand glove is plugged into Port A of the wireless transmitter unit. The left hand glove is plugged into Port B.

4.3.2 Opening Gloves

A glove may by opened by clicking the Open Glove button after a COM port has been selected in the COM port tree.

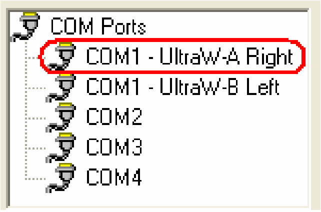
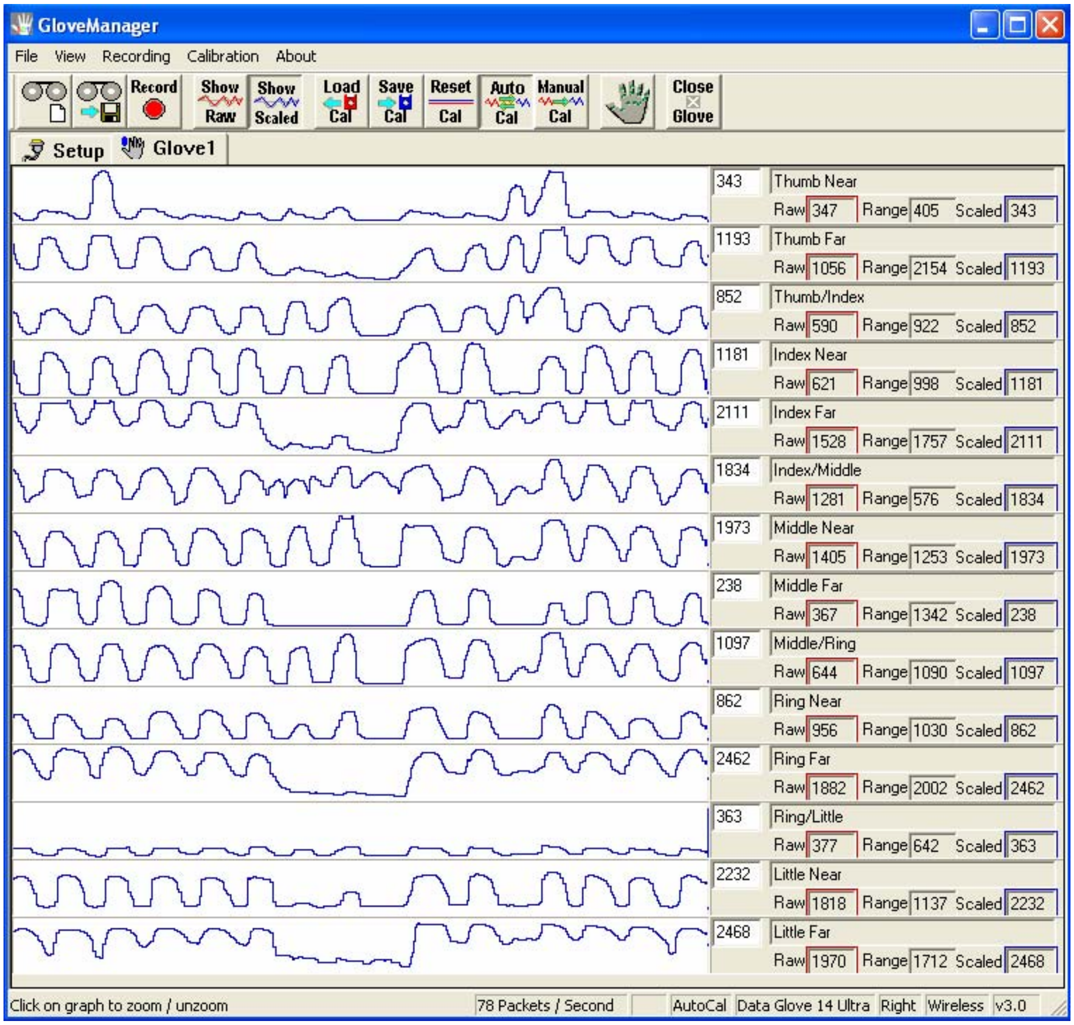


Figure 7 – Selecting the First Glove to be Opened

If the glove has been successfully opened the tab window will automatically switch to the newly opened glove, as shown in Figure 8. Double-clicking on a COM port will also cause GloveManager to attempt to open a glove on that COM port.



343 Thumb Near
Raw 347 Range 405 Scaled 343

1193 Thumb Far
Raw 1056 Range 2154 Scaled 1193

852 Thumb/Index
Raw 590 Range 922 Scaled 852

1181 Index Near
Raw 621 Range 998 Scaled 1181

2111 Index Far
Raw 1528 Range 1757 Scaled 2111

1834 Index/Middle
Raw 1281 Range 576 Scaled 1834

1973 Middle Near
Raw 1405 Range 1253 Scaled 1973

238 Middle Far
Raw 367 Range 1342 Scaled 238

1097 Middle/Ring
Raw 644 Range 1090 Scaled 1097

862 Ring Near
Raw 956 Range 1030 Scaled 862

2462 Ring Far
Raw 1882 Range 2002 Scaled 2462

363 Ring/Little
Raw 377 Range 642 Scaled 363

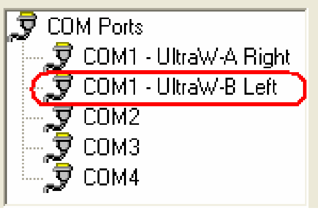
2232 Little Near
Raw 1818 Range 1137 Scaled 2232

2468 Little Far
Raw 1970 Range 1712 Scaled 2468

Click on graph to zoom / unzoom | 78 Packets / Second | AutoCal | Data Glove 14 Ultra | Right | Wireless | v3.0

Figure 8 – GloveManager after the First Glove is Successfully Opened

Clicking on the Setup tab will cause GloveManager to display the setup tab window again. To open the second wireless glove, select it from the COM port tree.



COM Ports
- COM1 - UltraW-A Right
- COM1 - UltraW-B Left
- COM2
- COM3
- COM4

Figure 9 – Selecting the Second Glove to be Opened

Click on the Open Glove button again to open the second glove. If GloveManager was successful in opening the second glove, a new glove tab window will appear.

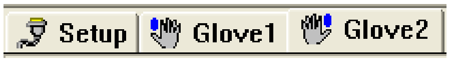


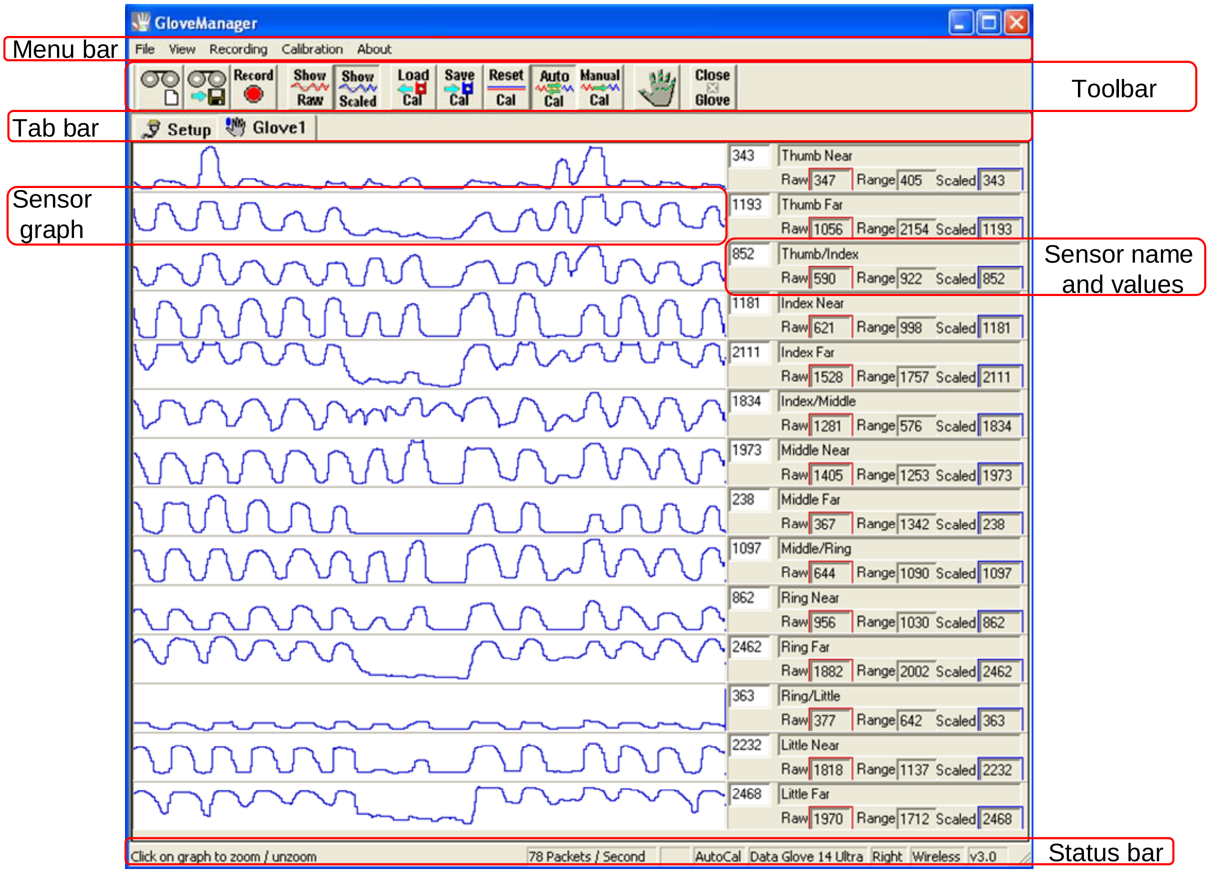
Figure 10 – The Tab Bar with Two Gloves Open

You may switch between open gloves by clicking on either of the Glove Tabs.

4.4. The Graph View

The following information fields are available in Graph View:

- Menu bar
- Toolbar
- Tab bar – Allows you to tab between gloves
- Sensor graph – A real-time graph of the glove sensor
- Sensor name and values – Displays the sensor name and the following real-time values (the amount of information displayed is dependent on the resolution available):
    - Raw sensor value [Value between 0 and 4095]
    - Sensor dynamic range [Value between 0 and 4095]
    - Scaled sensor value [*Scaled* value from 0 to 4095]
    - Lower calibrated value [Value between 0 and 4095]
    - Upper calibrated value [Value between 0 and 4095]
    - Graph top value [Value between 0 and 4095]
    - Current graph value [Value between 0 and 4095]
    - Graph bottom value [Value between 0 and 4095]
- Status bar – Displays status information, such as:
    - Program status and information messages
    - The packet rate
    - An indication if recording is currently on
    - An indication if auto calibration is currently on
    - The model of the current glove
    - The handedness of the current glove
    - An indication if the current glove is wired or wireless
    - The firmware version of the current glove



343 Thumb Near Raw 347 Range 405 Scaled 343
1193 Thumb Far Raw 1056 Range 2154 Scaled 1193
852 Thumb/Index Raw 590 Range 922 Scaled 852
1181 Index Near Raw 621 Range 998 Scaled 1181
2111 Index Far Raw 1528 Range 1757 Scaled 2111
1834 Index/Middle Raw 1281 Range 576 Scaled 1834
1973 Middle Near Raw 1405 Range 1253 Scaled 1973
238 Middle Far Raw 367 Range 1342 Scaled 238
1097 Middle/Ring Raw 644 Range 1090 Scaled 1097
862 Ring Near Raw 956 Range 1030 Scaled 862
2462 Ring Far Raw 1882 Range 2002 Scaled 2462
363 Ring/Little Raw 377 Range 642 Scaled 363
2232 Little Near Raw 1818 Range 1137 Scaled 2232
2468 Little Far Raw 1970 Range 1712 Scaled 2468

Click on graph to zoom / unzoom | 78 Packets / Second | AutoCal | Data Glove 14 Ultra | Right | Wireless | v3.0

Figure 11 – Available Fields in Graph View

4.4.1 The Menu Bar

The following commands are available from the menu:

Item	Shortcut	Description
File | New Recording	Ctrl+N	Creates a new recording file
File | Save Recording	Ctrl+S	Saves the current recording
File | Save Recording As…		Saves the current recording as a new file name
File | Close Current Glove	Alt+C	Closes the currently visible glove
File | Exit		Exits GloveManager
View | Toolbar		Shows/Hides the Toolbar
View | Status Bar		Shows/Hides the Status Bar
View | Show View Setup	V	Toggles between the sensor selection and the graph view
View | Show Scaled Graphs	S	Shows/Hides the Scaled Graphs
View | Show Raw Graphs	X	Shows/Hides the Raw Graphs
Recording | Record	Ctrl+R	Toggles recording of glove data on or off

Item	Shortcut	Description
Calibration | Auto Calibration	A	Toggles between auto and manual calibration
Calibration | Manual Calibration	M	Toggles between auto and manual calibration
Calibration | Reset Calibration	R	Resets the auto calibration values, and turns auto calibration on
Calibration | Load Calibration Values	Alt+O	Load the calibration values from file, turns auto calibration off
Calibration | Save Calibration Values	Alt+S	Save the current calibration values to file
About | About GloveManager…		Displays information about GloveManager

Table 1 – Menu Commands Available in GloveManager

4.4.2 Toolbar

The following buttons are available on the toolbar:

Icon	Shortcut	Description
🗋	Ctrl+N	Creates a new recording file
💾	Ctrl+S	Saves the current recording
Record ●	Ctrl+R	Toggles recording of glove data on or off
Show Raw	X	Shows/Hides the raw graphs
Show Scaled	S	Shows/Hides the scaled graphs
Reset Cal	R	Resets the auto calibration values, and turns auto calibration on
Load Cal	Alt+O	Load the calibration values from file, turns auto calibration off
Save Cal	Alt+S	Save the current calibration values to file
Auto Cal	A	Toggles between auto and manual calibration
Manual Cal	M	Toggles between auto and manual calibration
✋	V	Toggles between the sensor view setup and the graph view
Close ☒ Glove	Alt+C	Closes the currently visible glove

Table 2 – Buttons Available on the GloveManager Toolbar

Some items may me disabled when no glove is open.

4.4.3 Tab Bar

The tab bar allows you to switch between the Setup view and the currently open gloves. The blue dot on the tab icon indicates a wireless glove.

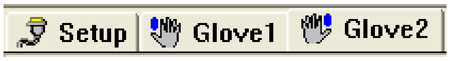


Figure 12 – The Tab Bar

4.4.4 The Sensor Graphs

The sensor graph is a graphical representation of the data from the sensors as it arrives. Two graph representations can be shown:

The scaled graph (showing the values scaled between 0 and 4095)

The raw graph (showing the raw values between 0 and 4095)

4.4.4.1 Scaled Graph

The scaled graph shows the scaled version of the sensor value, normalized between 0 and 1. The default color for this graph is blue.

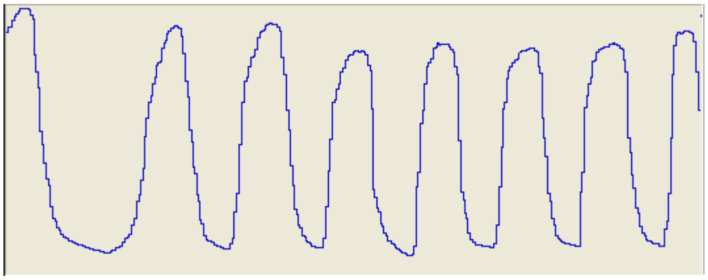


Figure 13 – The Scaled Graph

4.4.4.2 Raw Graph

The raw graph represents the raw sensor value coming from the glove. Additional to the actual graph of the raw values (drawn in red by default), the upper (drawn in green by default) and lower calibration (drawn in orange by default) values are also plotted, as shown in Figure 14.

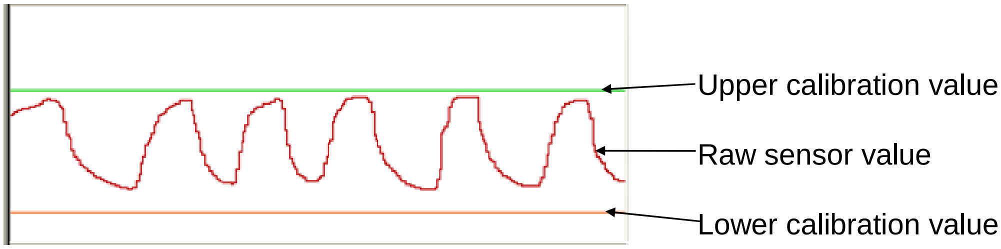
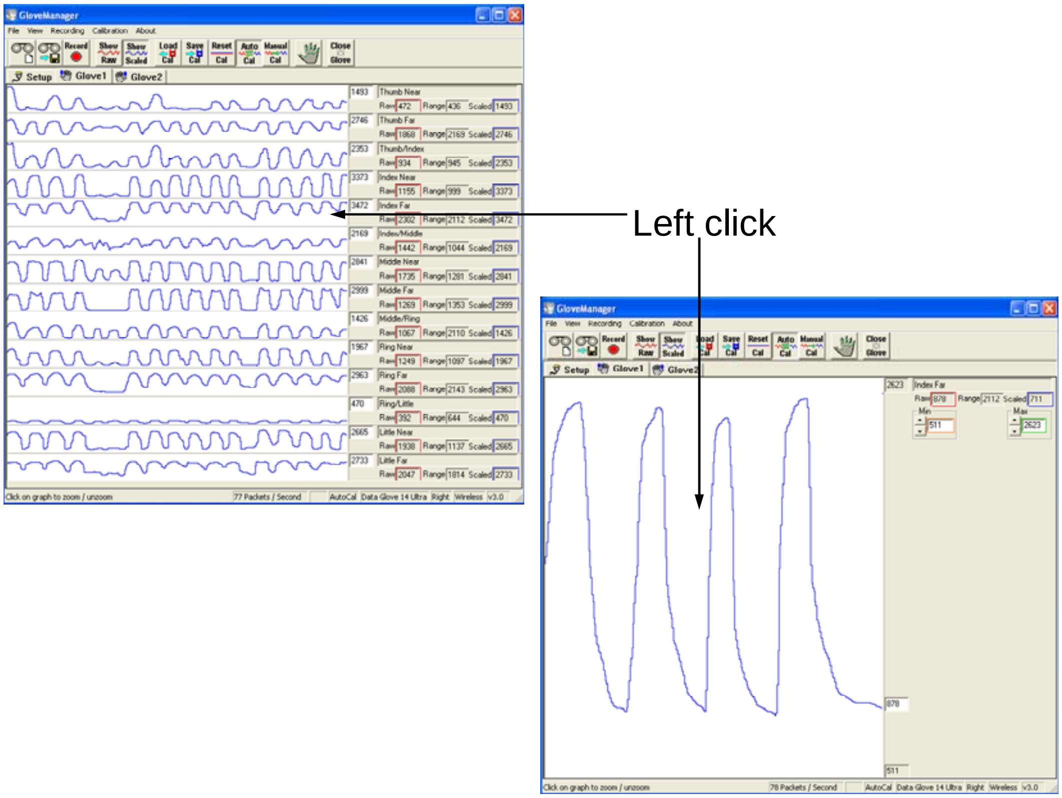


Figure 14 – The Raw Graph

4.4.4.3 Graph Zooming

You may zoom into a graph by simply clicking on it, as illustrated below:



1493 Thumb Near Raw 472 Range 436 Scaled 1493

2746 Thumb Far Raw 1868 Range 2169 Scaled 2746

2353 Thumb/Index Raw 934 Range 945 Scaled 2353

3373 Index Near Raw 1155 Range 999 Scaled 3373

3472 Index Far Raw 2302 Range 2112 Scaled 3472

2169 Index/Middle Raw 1442 Range 1044 Scaled 2169

2841 Middle Near Raw 1735 Range 1281 Scaled 2841

2999 Middle Far Raw 1269 Range 1353 Scaled 2999

1426 Middle/Ring Raw 1067 Range 2110 Scaled 1426

1967 Ring Near Raw 1249 Range 1097 Scaled 1967

2963 Ring Far Raw 2088 Range 2143 Scaled 2963

470 Ring/Little Raw 392 Range 644 Scaled 470

2665 Little Near Raw 1938 Range 1137 Scaled 2665

2733 Little Far Raw 2047 Range 1814 Scaled 2733

Click on graph to zoom / unzoom | 77 Packets / Second | AutoCal | Data Glove 14 Ultra | Right | Wireless | v3.0

2623 Index Far Raw 878 Range 2112 Scaled 711

Min 511 Max 2623

878

511

Click on graph to zoom / unzoom | 78 Packets / Second | AutoCal | Data Glove 14 Ultra | Right | Wireless | v3.0

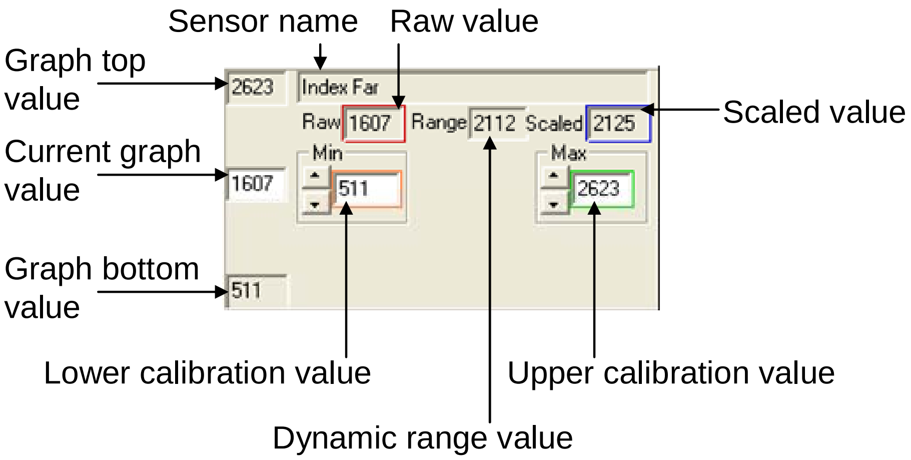
Figure 15 – An Illustration of the Zoom Procedure

The zoomed view gives you a more detailed view of the graph, and allows you to do fine-tuning of the calibration value.

4.4.5 The Sensor Info Box

The sensor info box provides the following information (see Figure 16):

- Raw sensor value [Value between 0 and 4095]
- Sensor dynamic range [Value between 0 and 4095]
- Scaled sensor value [*Scaled* value from 0 to 4095]
- Lower calibrated value [Value between 0 and 4095]
- Upper calibrated value [Value between 0 and 4095]
- Graph top value [Value between 0 and 4095]
- Current graph value [Value between 0 and 4095]
- Graph bottom value [Value between 0 and 4095]



2623 Index Far

Raw 1607 Range 2112 Scaled 2125

1607

Min 511

Max 2623

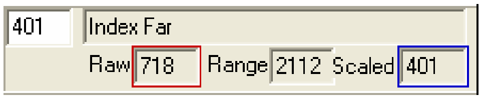
511

Figure 16 – The Sensor Info Box

The upper and lower calibration values may be fine-tuned by adjusting the minimum and maximum values of the dynamic range. These values are automatically adjusted during auto calibration. Please note that the calibration mode is automatically switched to manual calibration during fine-tuning.

The sensor info box has three levels of detail, depending on the pixel resolution available to GloveManager. The highest level of detail is shown in Figure 16. As the pixel resolution decreases, the second level of detail is switched to, as in Figure 17. The value shown next to the sensor name is:

- the current scaled value (when scaled graphs are visible)
- the current raw value (when raw graphs are visible)

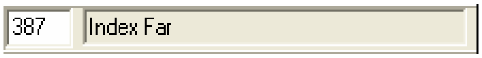


401 Index Far

Raw 718 Range 2112 Scaled 401

Figure 17 – The Second Level of Detail of the Sensor Info Box.

If the pixel resolution is decreased more, only the sensor name and current graph value are shown.



387 Index Far

Figure 18 – The Lowest Level of Detail of the Sensor Info Box.

4.4.6 The Status Bar

The status bar displays various program and glove related information, including:

- Program status and information messages
- The packet rate
- An indication if recording is currently on
- An indication if auto calibration is currently on
- The model of the current glove
- The handedness of the current glove
- An indication if the current glove is wired or wireless
- The firmware version of the current glove

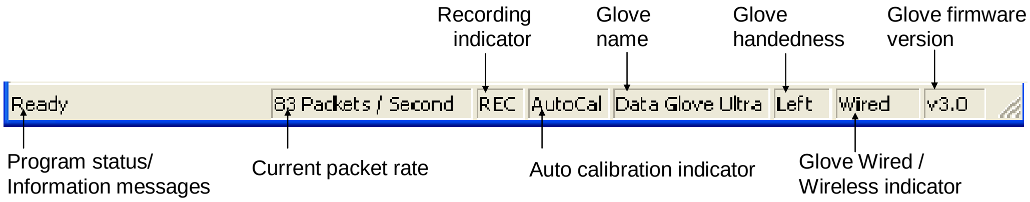


Figure 19 - The Status Bar

4.5. The Sensor Selection View

The sensor selection view may be obtained by clicking the button on the toolbar, by selecting the **View | Show View Setup** option from the menu or by pressing the **V** shortcut key. The view is shown in Figure 20.

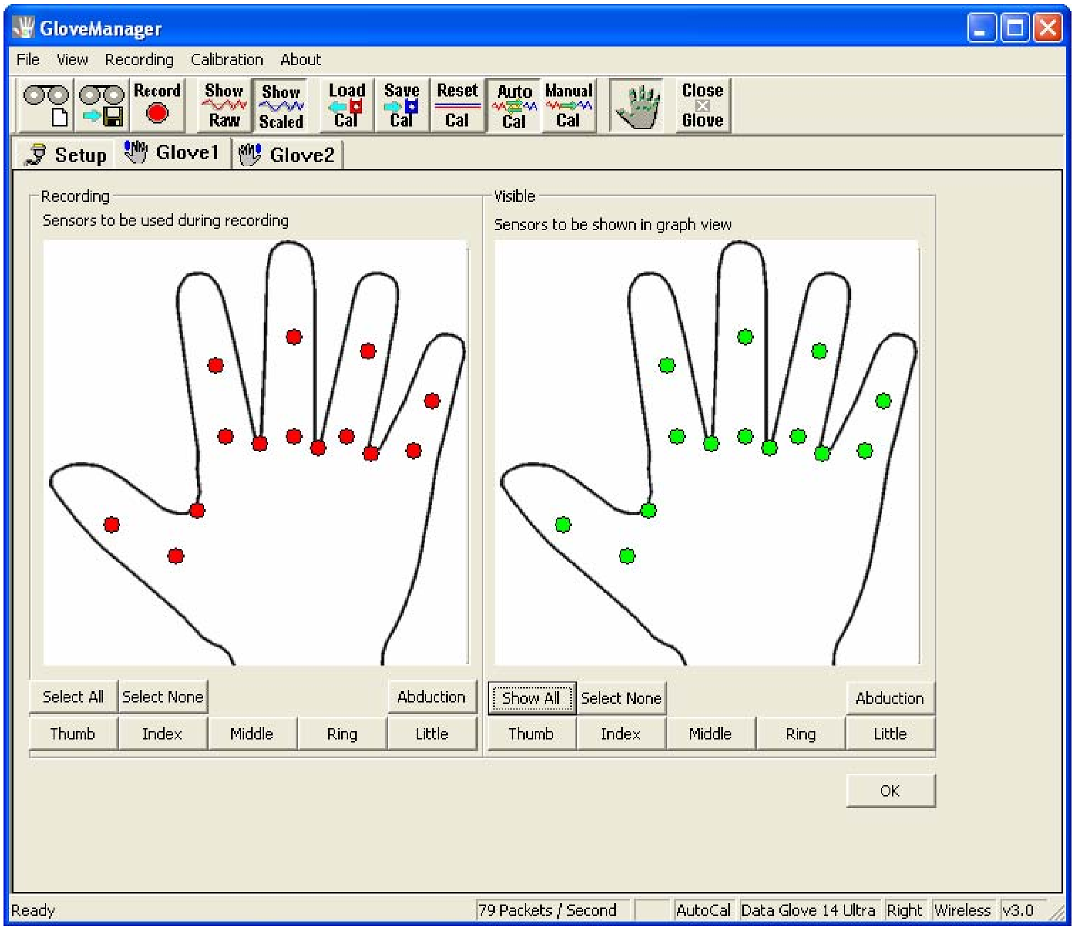
The hand and sensor image on the left allows you to select sensors to be used during recording. Selecting none means that this glove will not be used during the recording process.

The hand and sensor image on the right allows you to select specific sensors to be shown in graph view. Please note that the program will not allow you to display zero sensors.

Clicking the Thumb, Index, Middle, Ring, Little, or Abduction buttons causes the corresponding sensors to be selected or deselected. You may also select or deselect a sensor by clicking on it (🔴 or 🟢).

You may go back to graph view by clicking on the OK or ✋ buttons, by selecting the **View | Show View Setup** option from the menu or by pressing the **V** shortcut key.

4.6. Glove Calibration



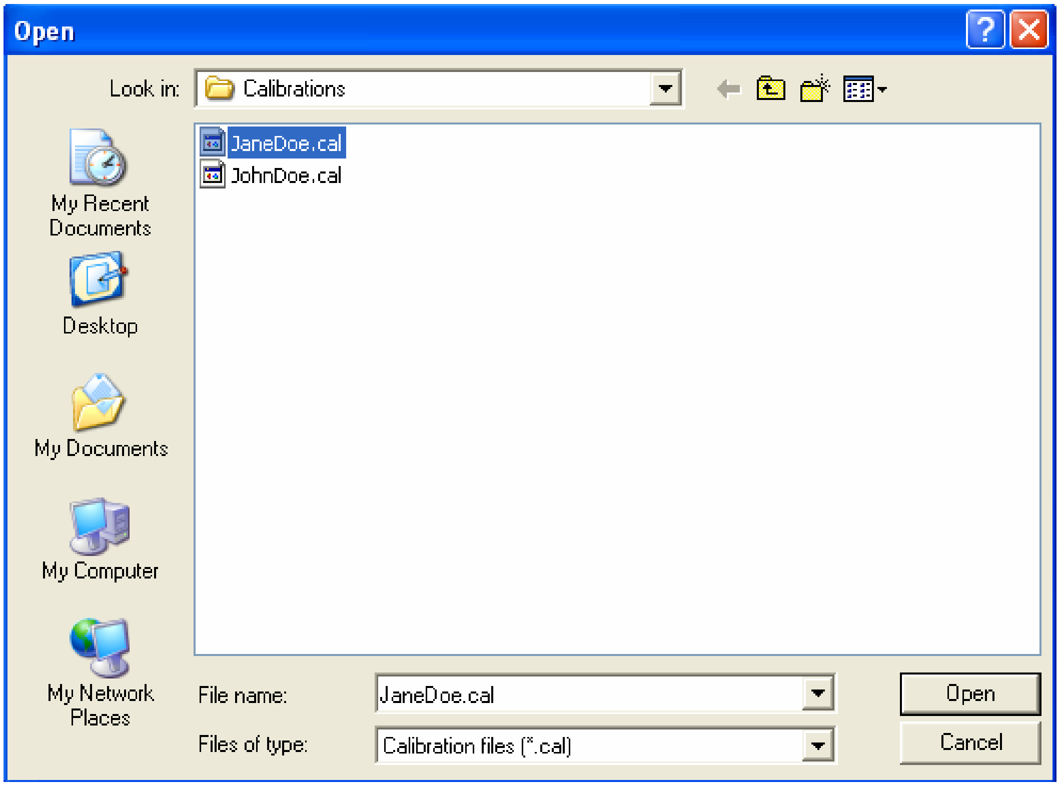
Sensors to be used during recording

Sensors to be shown in graph view

Ready | 79 Packets / Second | AutoCal | Data Glove 14 Ultra | Right | Wireless | v3.0

Figure 20 – The Sensor Selection View

Glove calibration values may be loaded from file by clicking the Load Cal button, by selecting the **Calibration | Load Calibration Values** menu option, or by using the **Alt+O** shortcut key. The file open dialog box will appear.



Look in: Calibrations

JaneDoe.cal
JohnDoe.cal

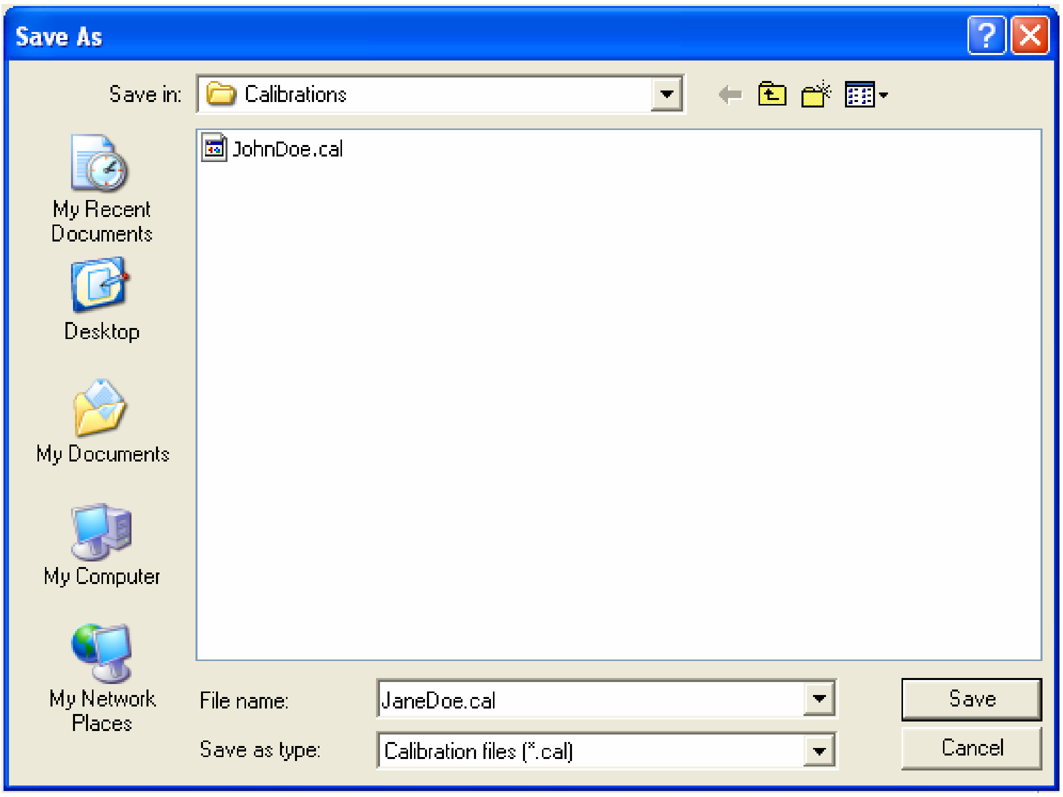
File name: JaneDoe.cal

Files of type: Calibration files (*.cal)

Figure 21 – The File Open Dialog for Calibration Files

Select a calibration file (extension **.**cal) and click on the Open button to open the file.

Glove calibration values may be saved to file by clicking the Save Cal button, by selecting the **Calibration | Save Calibration Values** menu option, or by using the **Alt+S** shortcut key. The file save dialog box will appear.



Save As

Save in: Calibrations

JohnDoe.cal

File name: JaneDoe.cal

Save as type: Calibration files (*.cal)

Figure 22 – The File Save Dialog for Calibration Files

Type in your file name and click the Save button to save the calibration values to file. The file format is also compatible with the 5DT Data Glove SDK.

4.7. Recording

The incoming glove data may be recorded by clicking the Record ● button, by selecting the **Recording | Record** menu option, or by using the **Ctrl+R** shortcut key. This will cause GloveManager to record the latest raw and scaled values at a fixed rate of 60 Hz. Only the sensors selected for recording in the sensor setup view (see section 4.5) will be recorded. These values are recorded in memory and will be lost unless saved to file.

The values may be saved to file, by clicking the 💾 button, by selecting the **File | Save** or **File | Save As…** menu option, or by using the **Ctrl+S** shortcut key. Currently only the CSV (Comma Separated Values) file format is supported.

5. Using the Gloves in Kaydara MOCAP™

5.1. Installation

To install the driver, follow the steps given below.

1. Copy the file **ordevice5dt.dll** to the [MOCAP]\bin\plugins directory.
2. Make sure that the 5DT Glove driver is installed – specifically fglove.dll should be installed in the Windows\System folder.
3. Run MOCAP.
4. Verify that the driver is installed by clicking on the Devices tab in the asset browser. The installed driver should be visible as shown in the red rectangle as shown in Figure 23 below.

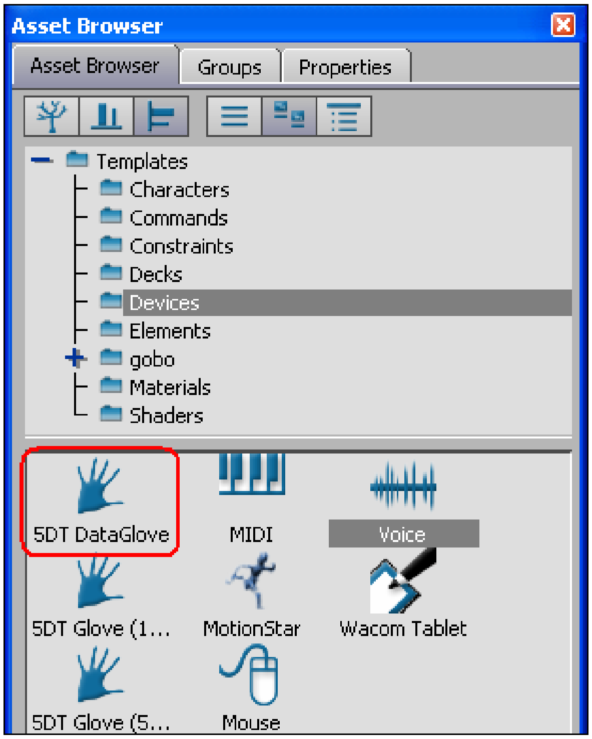


Figure 23 - Verifying that the 5DT Data Glove Plugin has been Installed

5.2. Opening the Glove

From the device pane of the Asset Browser, create a glove in Kaydara by clicking and dragging the 5DT DataGlove icon to the viewer window (see Figure 24).

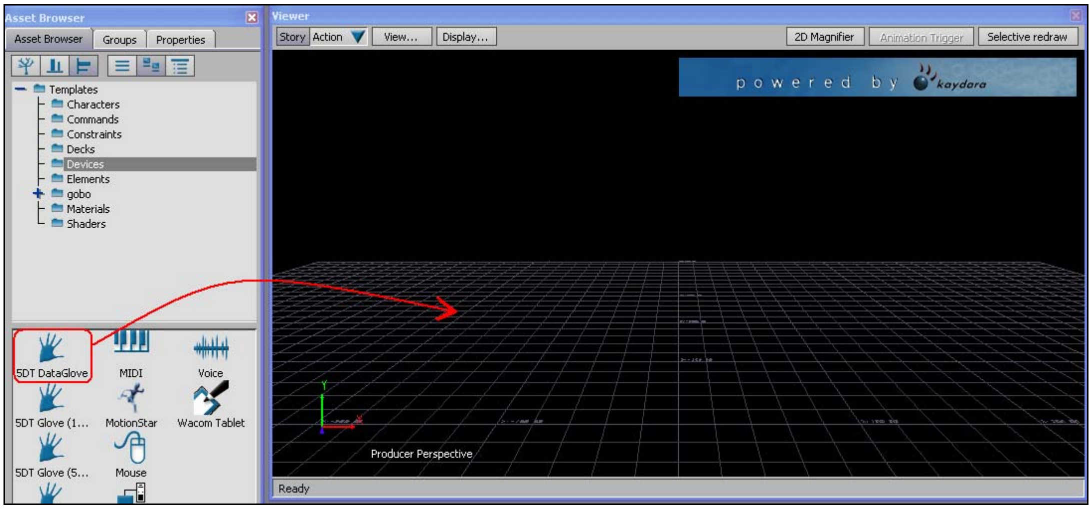
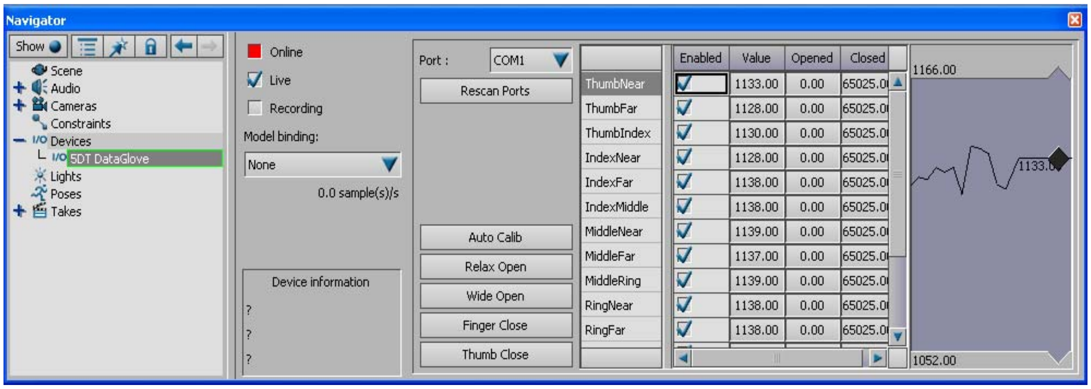


Figure 24 - Clicking and Dragging the 5DT DataGlove Icon to Create a New Glove

In the navigator pane, click on the newly created glove. The following window will appear:



	Enabled	Value	Opened	Closed
ThumbNear	☑	1133.00	0.00	65025.0
ThumbFar	☑	1128.00	0.00	65025.0
ThumbIndex	☑	1130.00	0.00	65025.0
IndexNear	☑	1128.00	0.00	65025.0
IndexFar	☑	1138.00	0.00	65025.0
IndexMiddle	☑	1138.00	0.00	65025.0
MiddleNear	☑	1139.00	0.00	65025.0
MiddleFar	☑	1137.00	0.00	65025.0
MiddleRing	☑	1139.00	0.00	65025.0
RingNear	☑	1138.00	0.00	65025.0
RingFar	☑	1138.00	0.00	65025.0

Figure 25 - The Glove Control Pane

If you know which port the glove is connected to, select it from the ports drop-down list.

If you are unsure as to which port your glove is connected to you may click on the **Rescan Ports** button. The driver will then scan the USB and all COM ports for available gloves and update the Ports drop-down list. The progress of the scan process is shown in the status bar in the Viewer window. Please note that the scan process may take a while.

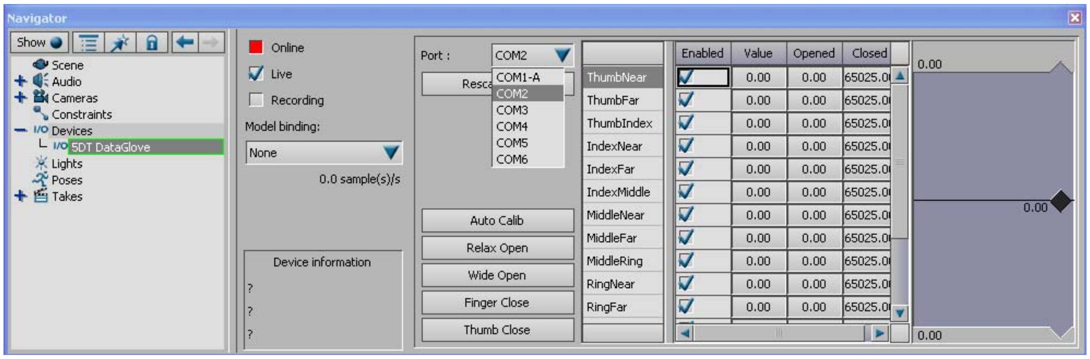
Once the correct port has been selected, click on the **Online** button. If the red button turns green, a successful connection has been made.

5.3. Opening Wireless Gloves

The new 5DT Data Glove Ultra Wireless Kit uses one COM port for receiving data from both gloves connected to the transmitter unit. The driver handles this transparently by allowing you to open two gloves on the same port. Only once the first glove is opened will the second one be opened by the driver. You may open and close either of these gloves any time you wish.

The process of opening two wireless gloves is illustrated next:

1. The first glove is created (by dragging the 5DT DataGlove icon from the device pane into the viewer window) and a port scan is performed. We can see that there is a glove present on COM1-A.

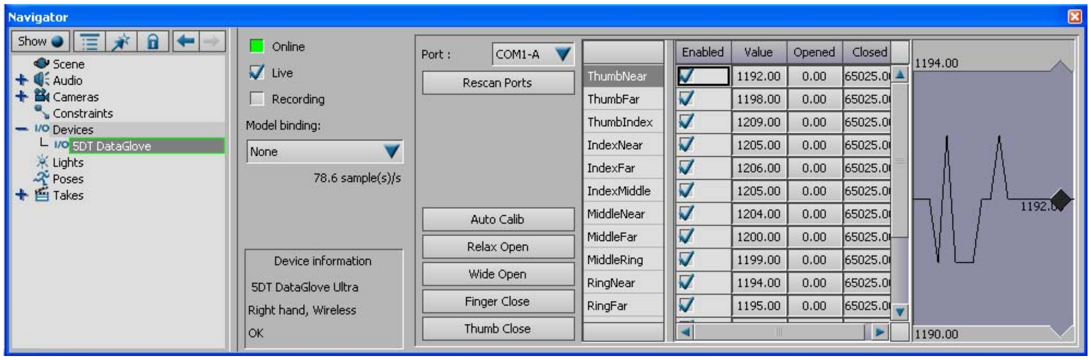


🟥 Online
☑ Live
☐ Recording
Model binding: None
0.0 sample(s)/s
Device information
?
?
?
Port : COM2

	Enabled	Value	Opened	Closed
ThumbNear	☑	0.00	0.00	65025.0
ThumbFar	☑	0.00	0.00	65025.0
ThumbIndex	☑	0.00	0.00	65025.0
IndexNear	☑	0.00	0.00	65025.0
IndexFar	☑	0.00	0.00	65025.0
IndexMiddle	☑	0.00	0.00	65025.0
MiddleNear	☑	0.00	0.00	65025.0
MiddleFar	☑	0.00	0.00	65025.0
MiddleRing	☑	0.00	0.00	65025.0
RingNear	☑	0.00	0.00	65025.0
RingFar	☑	0.00	0.00	65025.0

Figure 26 – Result of the First Port Scan

2. The first glove is opened by selecting the correct port and clicking on the **Online** check box.

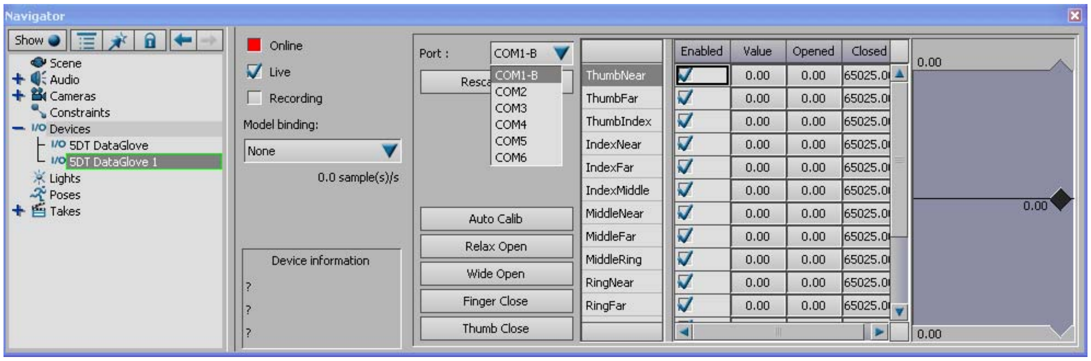


🟩 Online
☑ Live
☐ Recording
Model binding: None
78.6 sample(s)/s
Device information
5DT DataGlove Ultra
Right hand, Wireless
OK
Port : COM1-A

	Enabled	Value	Opened	Closed
ThumbNear	☑	1192.00	0.00	65025.0
ThumbFar	☑	1198.00	0.00	65025.0
ThumbIndex	☑	1209.00	0.00	65025.0
IndexNear	☑	1205.00	0.00	65025.0
IndexFar	☑	1206.00	0.00	65025.0
IndexMiddle	☑	1205.00	0.00	65025.0
MiddleNear	☑	1204.00	0.00	65025.0
MiddleFar	☑	1200.00	0.00	65025.0
MiddleRing	☑	1199.00	0.00	65025.0
RingNear	☑	1194.00	0.00	65025.0
RingFar	☑	1195.00	0.00	65025.0

Figure 27 – Glove A has been opened

3. The second glove is created by dragging the 5DT DataGlove icon from the device pane into the viewer window. The driver automatically picks up that another wireless glove may be opened on COM1-B and adds this to the ports list.



🟥 Online
☑ Live
☐ Recording

Model binding: None

0.0 sample(s)/s

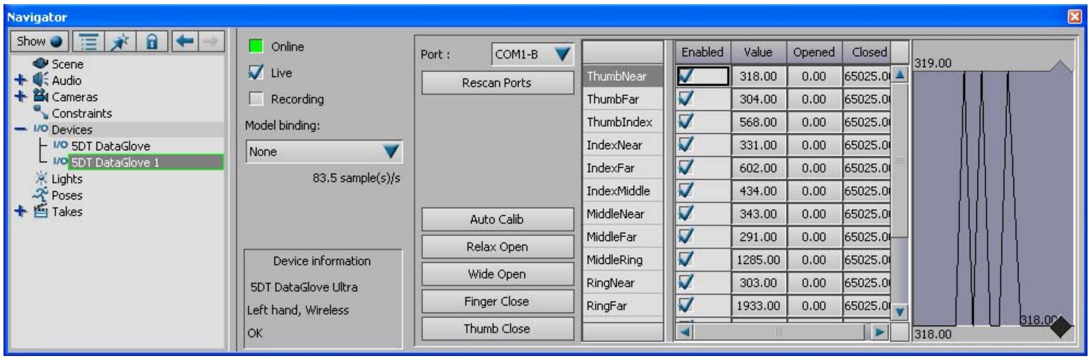
Device information
?
?
?

Port : COM1-B

	Enabled	Value	Opened	Closed
ThumbNear	☑	0.00	0.00	65025.0
ThumbFar	☑	0.00	0.00	65025.0
ThumbIndex	☑	0.00	0.00	65025.0
IndexNear	☑	0.00	0.00	65025.0
IndexFar	☑	0.00	0.00	65025.0
IndexMiddle	☑	0.00	0.00	65025.0
MiddleNear	☑	0.00	0.00	65025.0
MiddleFar	☑	0.00	0.00	65025.0
MiddleRing	☑	0.00	0.00	65025.0
RingNear	☑	0.00	0.00	65025.0
RingFar	☑	0.00	0.00	65025.0

Figure 28 - Result of the Second Port Scan

4. The second glove is opened by selecting the correct port and clicking on the **Online** check box.



🟩 Online
☑ Live
☐ Recording

Model binding: None

83.5 sample(s)/s

Device information
5DT DataGlove Ultra
Left hand, Wireless
OK

Port : COM1-B

	Enabled	Value	Opened	Closed
ThumbNear	☑	318.00	0.00	65025.0
ThumbFar	☑	304.00	0.00	65025.0
ThumbIndex	☑	568.00	0.00	65025.0
IndexNear	☑	331.00	0.00	65025.0
IndexFar	☑	602.00	0.00	65025.0
IndexMiddle	☑	434.00	0.00	65025.0
MiddleNear	☑	343.00	0.00	65025.0
MiddleFar	☑	291.00	0.00	65025.0
MiddleRing	☑	1285.00	0.00	65025.0
RingNear	☑	303.00	0.00	65025.0
RingFar	☑	1933.00	0.00	65025.0

Figure 29 - Glove B has been Opened

5.4. Calibration

You may use auto calibration to calibrate the glove, but it is recommended that you use the pre-defined calibration steps.

To use auto calibration, click on the **Auto Calib** button. The button text will change to **Click to Stop**. Once you are satisfied with the calibration values, click the button again to stop calibrating.

The following calibration process is recommended.

1. Hold your hand in a relaxed, open position, and click on the **Relax Open** button.
2. Open all of your fingers as wide as possible and click on the **Wide Open** button.
3. Close all of your fingers (except your thumb) and click on the **Finger Close** button.
4. Close your thumb and click on the **Thumb Close** button.
5. Calibration is now complete.

5.5. Model Binding

To create a model binding, select Create… from the Model binding drop-drown menu as in Figure 30.

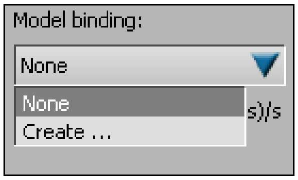


Figure 30 - The Model Binding Drop-down List

After the Create command has been issued the wire frame hand model is created in the viewer and the model's name is added to the Model binding drop-down list.

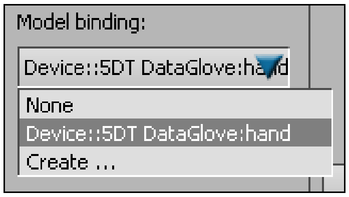


Figure 31 - The Model Binding Drop-down List with Hand

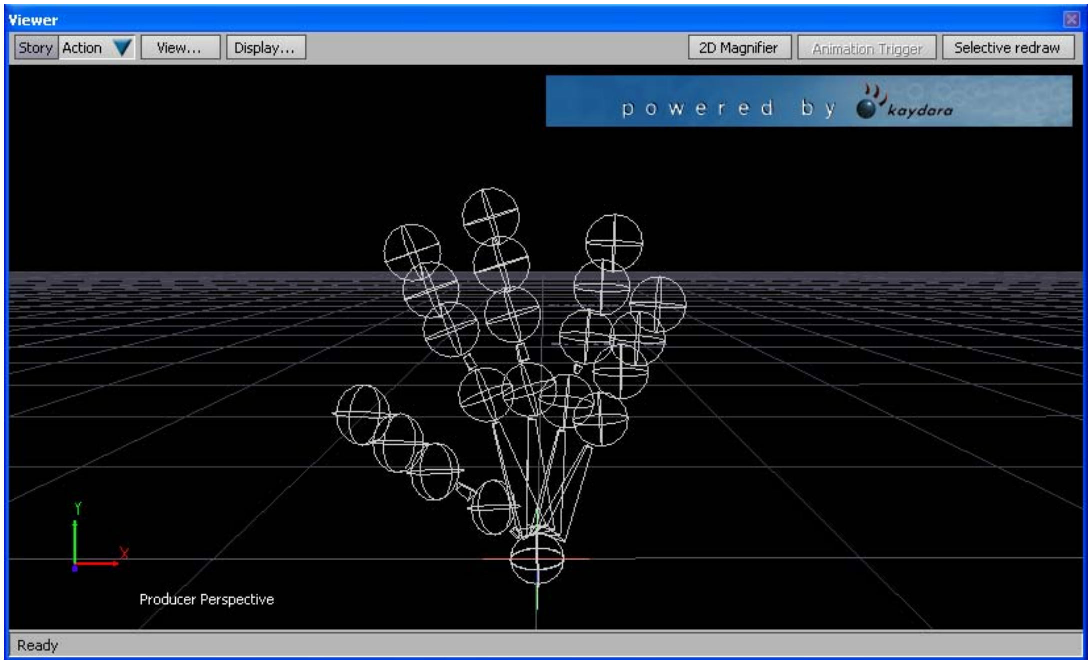


Figure 32 – The Glove Model as Shown in the Viewer Window

This glove can now be automatically connected to an actor. To create an actor, click and drag the Actor icon from the Characters pane in the Asset Browser.

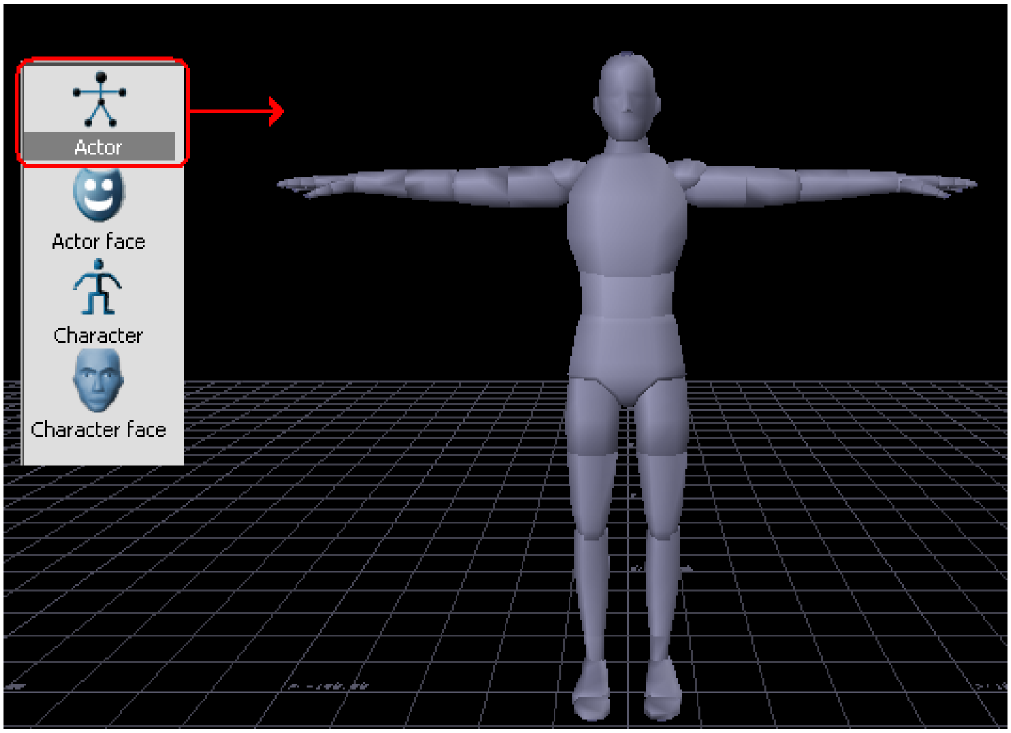
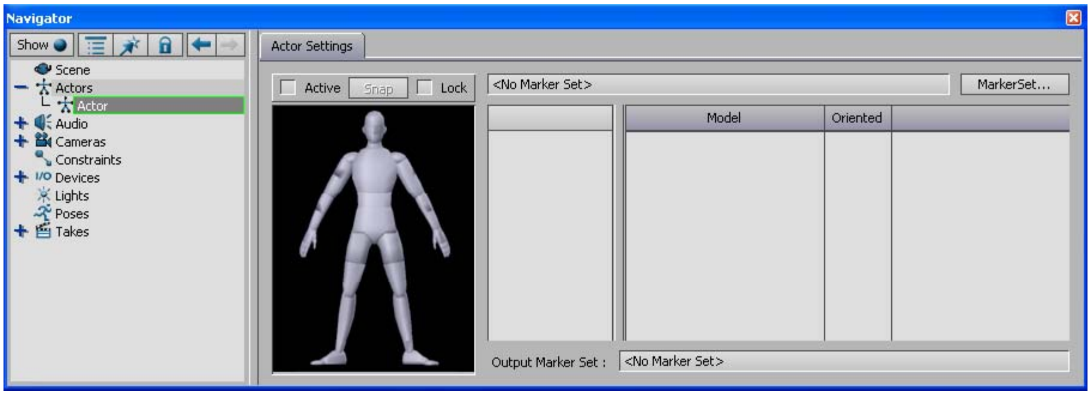


Figure 33 – Creating an Actor

If the actor asset is selected in the Navigator window, the Actor Settings window will appear.



<No Marker Set>

Output Marker Set : <No Marker Set>

Figure 34 – The Actor Settings Window

If no Marker Set exists for this actor create one by clicking on the MarkerSet… button. A popup menu will appear. Select the Create option.

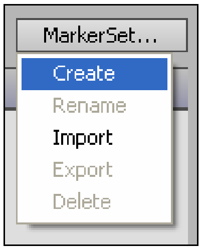
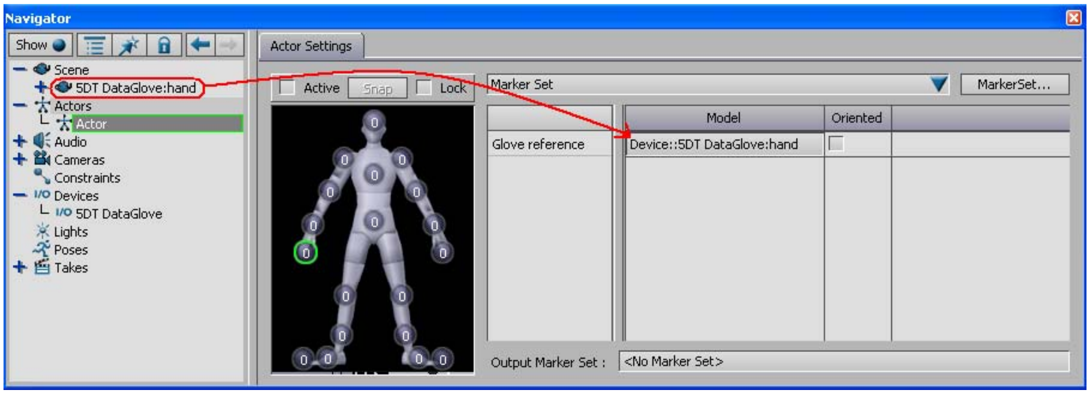


Figure 35 – Creating a Marker Set

Once a Marker Set has been selected, select the hand marker to which the glove should be referenced. Drop the root of the glove device (under the Scene branch) into the Glove Reference in the Model column. Click on the Active checkbox to make the actor active (real-time animations are shown).



	Model	Oriented
Glove reference	Device::5DT DataGlove:hand	□

Output Marker Set : <No Marker Set>

Figure 36 – Assigning a Glove Reference to a Marker Set

6. Using the SDK

6.1. Introduction

The 5DT Data Glove SDK provides access to the 5DT range of data gloves at an intermediate level.

The Windows 98/NT/Me/XP version is provided in the form of a C/C++ header (.h) file, a Microsoft Visual C++ library (.lib) file and a dynamic link library (.dll) file.

The SDK functionality includes:

- Multiple instances
- Easy initialization and shutdown
- Basic (raw) sensor values
- Scaled (auto-calibrated) sensor values
- Calibration functions
- Basic gesture recognition
- Cross-Platform Application Programming Interface

The SDK functions are described in detail in Appendix C.

6.2. Using the SDK

The 5DT Data Glove Driver is easy to implement using the following guidelines:

1. Make sure that the header file `fglove.h`, the library file `fglove.lib` and the dynamic link library file `fglove.dll` reside in the current (application) directory, or somewhere that they can be found. The file `fglove.dll` may be copied into your Windows system directory.
2. Include the header file `fglove.h` in the application where necessary.
3. Add the library file `fglove.lib` to the link process.

There is also a debug version of the driver (`fgloved.lib`, `fgloved.dll`) which outputs debug messages to the debugger.

6.3. Sample Source Code

In the samples directory, there is sample source code that makes use of the glove SDK. Both a console application as well as a Microsoft® Visual Studio® 6 project is included.

6.4. Supported Gloves

The glove SDK supports all 5DT Data Gloves. The current version implements 18 possible sensors, and includes the roll and pitch sensors of the 5DT Data Glove 5. The driver attempts to map values to all sensor outputs. If it is unable to do so the sensor value defaults to a sensible value. This value can be adjusted by forcing a specific value. To the application programmer the driver therefore appears the same regardless of the type of glove that is connected.

6.5. Sensor Mappings for the 5DT Data Glove 5

The sensors on the 5DT Data Glove 5 are positioned as in Figure 37.

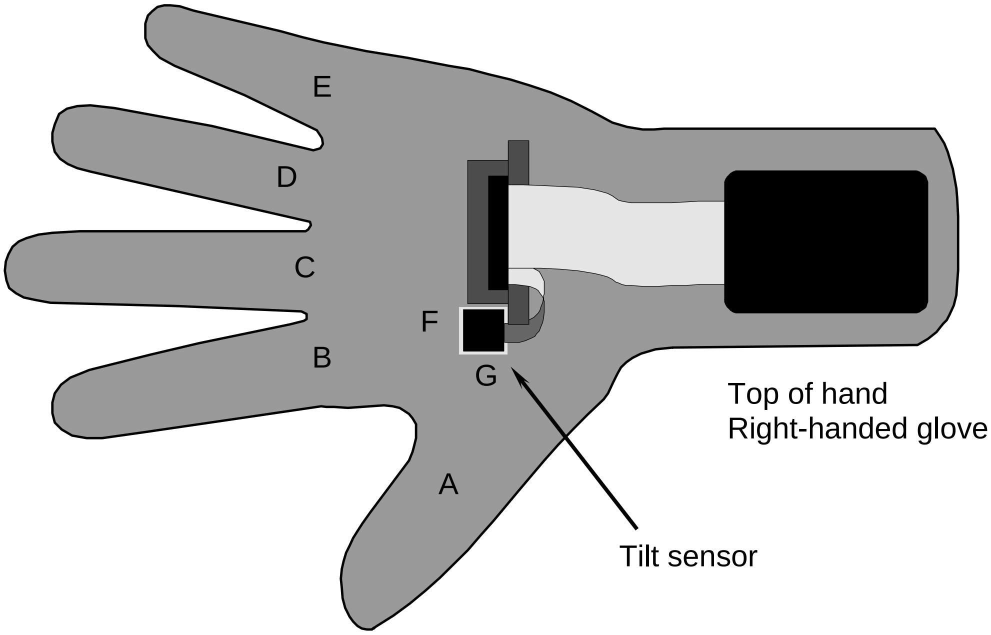


Figure 37 - Sensor Positions for the 5DT Data Glove 5

Sensor	*Driver Sensor Index*	*Description*
A	0,1*	Thumb flexure
B	3,4*	Index finger flexure
C	6,7*	Middle finger flexure
D	9,10*	Ring finger flexure
E	12,13*	Little finger flexure
F	16+	Pitch angle of tilt sensor
G	17+	Roll angle of tilt sensor

Table 3 - Sensor Mappings for the 5DT Data Glove 5 and 5DT Data Glove 5 Ultra

* Both these driver sensor indices will return the same value when the 5DT Data Glove 5 or Data Glove 5 Ultra is used.

+ Not available on the Data Glove 5 Ultra.

6.6. Sensor Mappings for the 5DT Data Glove 16 and 14 Ultra

The sensors on the 5DT Data Glove 16 are positioned as in Figure 38.

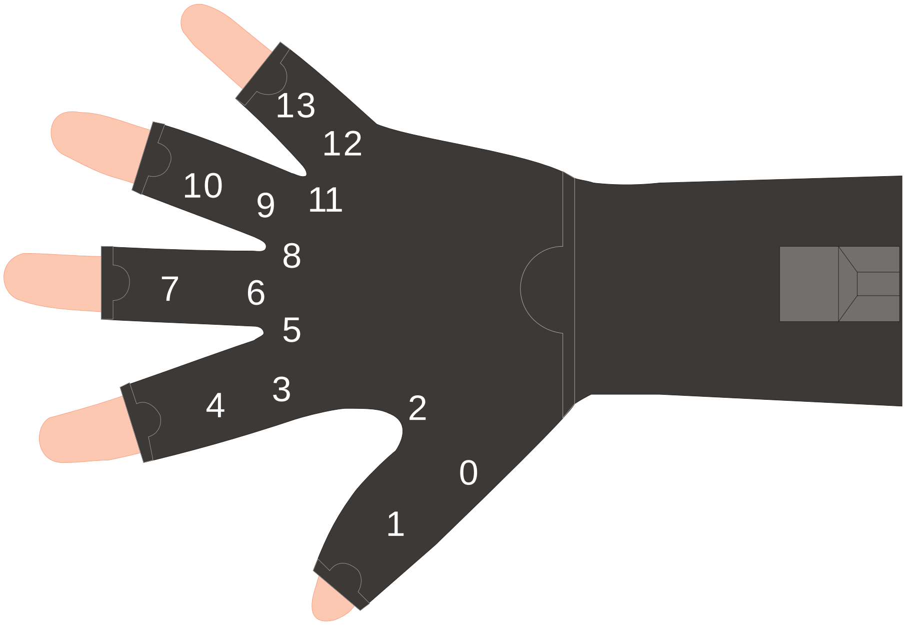


Figure 38 – Sensor Mappings for the 5DT Data Glove 16 and 5DT Data Glove 14 Ultra

Sensor	*Driver Sensor Index*	*Description*
0	0	Thumb flexure (lower joint)
1	1	Thumb flexure (second joint)
2	2	Thumb-index finger abduction
3	3	Index finger flexure (at knuckle)
4	4	Index finger flexure (second joint)
5	5	Index-middle finger abduction
6	6	Middle finger flexure (at knuckle)
7	7	Middle finger flexure (second joint)
8	8	Middle-ring finger abduction
9	9	Ring finger flexure (at knuckle)
10	10	Ring finger flexure (second joint)
11	11	Ring-little finger abduction
12	12	Little finger flexure (at knuckle)
13	13	Little finger flexure (second joint)

Table 4 – Sensor Mappings for the 5DT Data Glove 16 and 5DT Data Glove 14 Ultra

6.7. Gesture Definitions

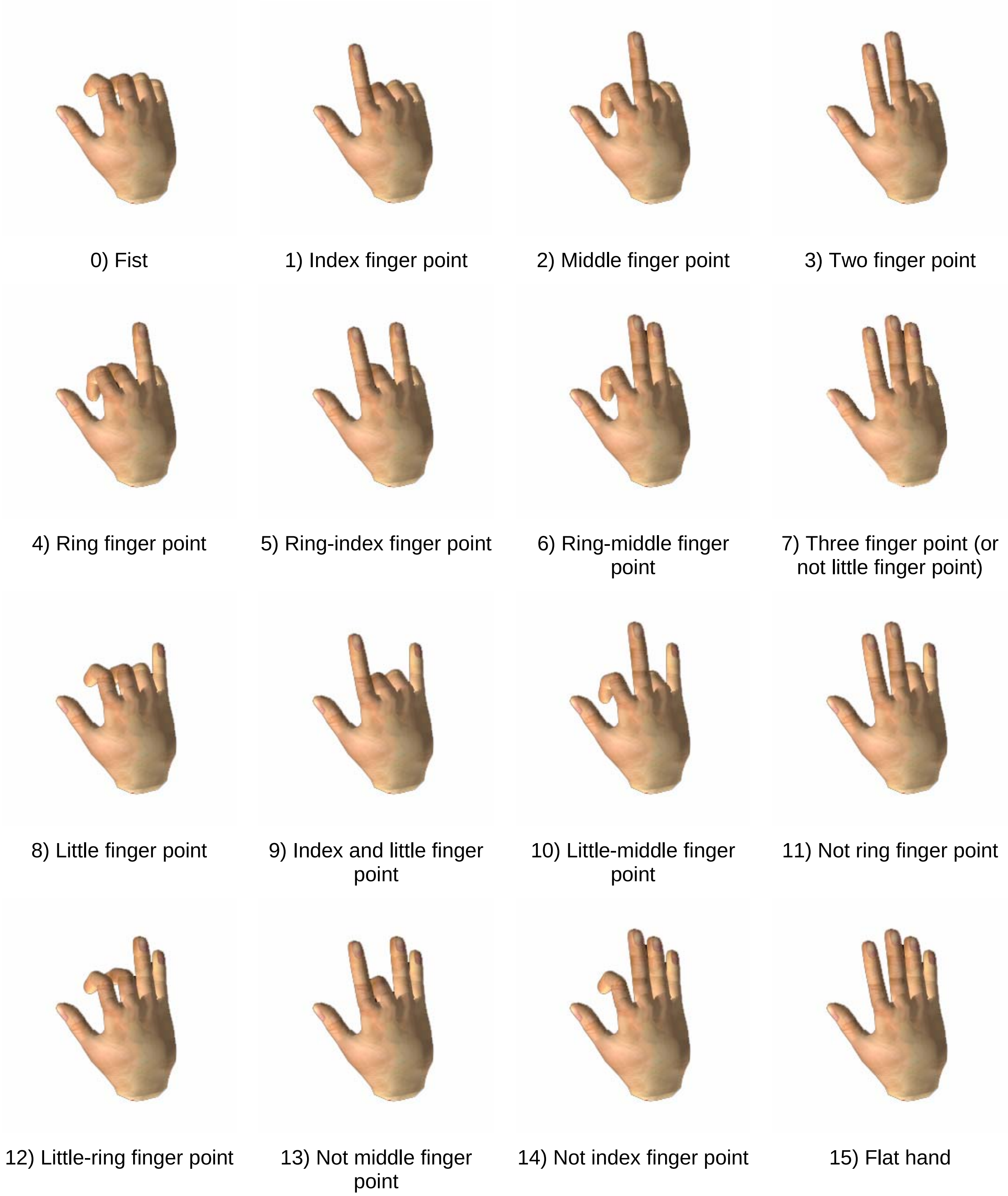
The currently defined set of gestures is comprised of binary open/close configurations of the fingers excluding the thumb. There are $2^4 = 16$ such possible combinations. Gesture number 0 is defined as all the fingers (excluding the thumb) being closed, and gesture number 15 as all the fingers open. The index finger indicates the least significant bit. For example, the index finger point gesture will therefore be number 1, and the little finger point gesture number will be 8. An invalid (unrecognizable) gesture is defined as the value -1.

A scaled sensor value of higher than the upper threshold setting will indicate a closed finger, while a scaled sensor value of lower than the lower threshold setting will indicate an open finger. A value in-between is invalid and will result in an invalid gesture. In the case of multiple finger joint angle measurements, the maximum of the individual joint sensor values is taken to obtain a closed gesture and the minimum to obtain an open gesture. Closed gestures take precedence, in other words, bending only one joint of a finger will count as a closed gesture.

Finger:	**Little**	**Ring**	**Middle**	**Index**		
5DT Data Glove 5 sensor:	E	D	C	B		
5DT Data Glove 16 & 14 Ultra sensor:	12,13	9,10	6,7	3,4		
Driver sensor index:	12,13#	9,10#	6,7#	3,4#		
Gesture Number	Flexure (0=flexed, 1=unflexed)				Gesture Description	Fig.
0	0	0	0	0	Fist	16.0
1	0	0	0	1	Index finger point	16.1
2	0	0	1	0	Middle finger point	16.2
3	0	0	1	1	Two finger point	16.3
4	0	1	0	0	Ring finger point	16.4
5	0	1	0	1	Ring index point	16.5
6	0	1	1	0	Ring middle point	16.6
7	0	1	1	1	Three finger point	16.7
8	1	0	0	0	Little finger point	16.8
9	1	0	0	1	Index and little finger	16.9
10	1	0	1	0	Little middle point	16.1
11	1	0	1	1	Not ring finger point	16.1
12	1	1	0	0	Little ring point	16.1
13	1	1	0	1	Not middle finger point	16.1
14	1	1	1	0	Not index finger point	16.1
15	1	1	1	1	Flat hand	16.1

Table 4 - Gesture Definition Scheme as Implemented for the 5DT Data Glove SDK

# When the 5DT Data Glove 5 is used, both these driver sensor indices will return the same value.



0) Fist

1) Index finger point

2) Middle finger point

3) Two finger point

4) Ring finger point

5) Ring-index finger point

6) Ring-middle finger point

7) Three finger point (or not little finger point)

8) Little finger point

9) Index and little finger point

10) Little-middle finger point

11) Not ring finger point

12) Little-ring finger point

13) Not middle finger point

14) Not index finger point

15) Flat hand

Figure 16 - Gesture Illustrations

When the 5DT Data Glove 16 or 5DT Data Glove 14 Ultra is used, the driver sensor indices will return different values. The maximum of the two values will be used to test for a flexed (closed) gesture, and the minimum value of the two will be used to test for an unflexed (open) gesture.

6.8. Auto-Calibration

The driver can provide sensor outputs in an automatic, linearly calibrated fashion. During every update, the raw value read from the sensor is compared to the current minimum and maximum raw values (raw$_{min}$ and raw$_{max}$) as set by the functions `fdSetCalibrationAll()`, `fdSetCalibration()`or `fdResetCalibration()`. If the current minimum and maximum values are exceeded, they are overwritten. The upper and lower calibration values are therefore continuously pushed "outwards". The normalized output is given by the first order equation

$$out = \frac{raw_{val} - raw_{\min}}{raw_{\max} - raw_{\min}}.Max, \qquad \text{(F-1)}$$

which is in [0...Max]. The value of Max is set by the functions `fdSetSensorMaxAll()`and `fdSetSensorMax()`. Doing a few flexing movements with the hand quickly sets the operating values for *raw$_{min}$* and *raw$_{max}$*, and calibrates the glove.

The auto-calibration process can be ignored by simply regarding only the raw sensor outputs. It would be up to the application developer to provide a suitable calibration process.

Note that calibration is mandatory, especially with the high-end gloves which contain no hardware calibration possibilities.

7. Troubleshooting and Support

The following information is provided to help you diagnose any problems that may be encountered with your 5DT Data Glove Ultra or 5DT Data Glove Ultra Wireless Kit. Please consult this section before contacting your supplier.

7.1. General Troubleshooting

If the glove is not working at all, please work through the **physical connection problems** section of the troubleshooting procedure to identify the source of the problem.

7.1.1 Physical Connection Problems

1. Check that power is connected to the receiver as well as to the wireless data transmitter. There should be a green light on the transmitter when power is applied.
2. Check that the glove is connected to the right port. Try to connect the glove to another port and try again.
3. Check all the connections. Section 2.2 has information on how to correctly connect the system.
4. Check that the port is working. Try connecting another device, for example an external modem.

If the 5DT Data Glove is recognized by your computer but not connecting properly, proceed directly to the **software connection problems** section.

7.1.2 Software Connection Problems

Run **GloveManager** from the start menu. Check which COM ports are available by looking at the list in Figure 3. Remember that not all available ports will be physically connected to a socket on the back of your computer. Some ports may be unavailable because other programs have already taken control of the ports. Examples are mouse drivers and fax or communication programs.

7.2. Frequently Asked Questions (FAQ)

Q My gloves are connected to COM2, but Glove Manager reports that this port is not available.

A There may be a mouse driver, or other program that has already opened that port. Once a program or driver has opened a COM port, no other program will be able to access that port until the first one closes.

Q Is it possible to use the 5DT Data Glove Ultra in a LINUX environment?

A No, the Linux version of the SDK does not support the 5DT Data Glove Ultra, but check our website regularly for updates.

Q Can I use four (or more) serial gloves on one machine at the same time?

A 5DT just loves people like you! The number of gloves is limited by the number of serial ports on your computer. Multiport cards are available that have up to eight serial ports on them and you only need one serial port per wireless pair. It is also possible to obtain a USB (Universal Serial Bus) device that has many RS 232 serial ports on it.

Q When I flex a finger, the output does not change but stays at the maximum value. What is the problem?

A In this case it is possible that one of the fibers has failed. The glove will then have to be returned to the supplier (or 5DT) for repairs.

7.3. Support

If you experience problems or have complaints, suggestions or other comments, please feel free to contact your supplier (preferably via e-mail). Please have the following information available, or include it in your written correspondence:

1. Computer processor make and model (e.g. Pentium IV 3.2GHz)
2. Operating system and version
3. The symptoms of the problem and what was happening when the problem occurred
4. Can you reproduce the problem easily? Describe how
5. Actions taken by yourself to solve the problem

Please feel free to contact 5DT directly. Our contact details are available in Section 9.

Your feedback helps make this a truly great product.

8. Warranty Information

8.1. Thirty (30) Day Customer Satisfaction Guarantee

If, for any reason, you are disappointed with this product, please contact your supplier. If you are not completely satisfied, you will be granted a full refund once the product is returned undamaged. Unfortunately, shipping costs cannot be refunded.

8.2. One (1) Year Product Warranty

5DT warrants to the original purchaser of the 5DT Data Glove 14 Ultra Wireless Kit that it will be free of defects in materials and workmanship for a period of one year from the original date of purchase. During the warranty period, 5DT will repair or replace (with a reconditioned unit) components that are defective.

8.3. Exclusions

The above warranty is provided for private use only and shall not apply to any commercial use of the product, including (but not limited to):

- Location based entertainment (LBE) applications
- Trade show demonstrations

This warranty shall not apply to defects resulting from the following:

- Misuse
- Improper or inadequate maintenance
- Unauthorized modification

8.4. Warranty Claim Instructions

Please use the following procedure if you require warranty service:

1. Contact your supplier to determine if you need to return the product. If your supplier is unable to determine this, contact 5DT directly. Do not return a product to your supplier or to 5DT **without first contacting them**.
2. Your supplier (or 5DT) will issue you with a Return Material Authorization (RMA) number. Do not return a product to your supplier or to 5DT without an RMA number.
3. Pack the items to be returned securely using the original packaging material (if possible).
4. Please enclose the following:

- Your original sales bill
- Name, address, contact telephone/fax numbers
- E-mail address
- Reason for returning the item
- RMA number

5. Mark your shipping container with the RMA number to expedite handling at your supplier or at 5DT.
6. Ship prepaid to your supplier or to 5DT.
7. When completing customs or courier documentation, please clearly indicate: "Unit returned for repairs under warranty".

5DT is not responsible for any damage that may occur during shipping. Shipping charges to 5DT are your responsibility. COD shipments will not be accepted by 5DT.

9. About 5DT

5DT <Fifth Dimension Technologies> is a high technology company specializing in Virtual Reality (VR). 5DT develops, produces and distributes affordable virtual reality hardware, software and systems. 5DT can also develop custom systems for all your VR needs.

5DT's focus is Virtual Reality Training Systems and Virtual Reality Peripherals.

The Virtual Reality hardware currently produced by 5DT includes:

- 5DT Data Glove 5 (Right and left)
- 5DT Data Glove 5-W (Wireless, right and left)
- 5DT Data Glove 5 Ultra
- 5DT Data Glove 16 (Right and left)
- 5DT Data Glove 16-W (Wireless, right and left)
- 5DT Data Glove 14 Ultra
- 5DT Data Glove 14 Ultra Wireless Kit
- 5DT Data Glove MRI
- 5DT Virtual Binoculars
- 5DT Head Mounted Display (HMD)
- 5DT Virtual Binoculars
- 5DT Motion Base

VR Software Systems developed by 5DT include:

- Automotive
  - Driving Training Simulator Series
  - Road Safety Training System
- Aviation
  - Airspace Visualizer
  - Air Traffic Control (ATC) Training Simulator
  - Experimental Avionics Testbed
  - Unmanned Aerial Vehicle (UAV) Training Simulator
- Defense
  - Air Defense Training Simulator
  - Fiber Optic Guided Missile Training System and Training Simulator
  - Rocket Launcher Training Simulator
  - Stand-Off Weapon Training Simulator and Visualizer
- High Voltage
  - High Voltage Line Inspection Logging System
  - High Voltage Line Inspection Training Simulator
  - High Voltage Line Inspection Training System (CBT)
  - High Voltage Line Repair Training System
  - High Voltage Line Visualization System
  - High Voltage Yard Training Simulator
- Medical
  - Bronchoscope Training Simulator

    - Exposure Treatment Phobia Simulator
    - Gastroscope Training Simulator
    - Tele-Rehabilitation (TR) System
    - Virtual Reality Pain Distraction System
- Mining
    - Underground Mining
        - Continuous Miner Training Simulator
        - Long Wall Training Simulator
        - Roof Bolter Training Simulator
    - Surface Mining
        - Haul Truck Training Simulator
        - Shovel Training Simulator
        - Wheeled Loader Training Simulator
        - Dragline Training Simulator
- Visualization
    - Flight Visualization System
    - Flow Visualization System
    - High Voltage Line Visualization System
- Other
    - Virtual Landscape Generation Technology

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Appendix A – Hardware Specifications

MATERIAL:	Black stretch lycra
FLEXURE RESOLUTION:	12-bit A/D for each sensor
	Minimum dynamic range is 8-bits
BEND SENSORS:	Data Glove 14 Ultra:
	Proprietary fiber optic based flexor technology. 2 sensors per finger, 1 sensor between each finger
	Data Glove 5 Ultra:
	Proprietary fiber optic based flexor technology. 1 sensor per finger, measures average of knuckle and first joint.
COMPUTER INTERFACE:	Full-speed USB *or*
	RS 232 (3-wire) GND, TX, RX 115kbps 8 data bits, 1 stop bit, no parity
POWER SUPPLY:	Maximum 5 V DC Center positive DC power connector
SAMPLING RATE:	The full hand (all available sensors) may be sampled at least 60 times per second.

At 5DT we constantly try to improve our products As a result, these specifications are subject to change without prior notice.

Appendix B – Serial Protocol

The data glove is connected to the RS-232 port of the computer. The 5DT Data Glove Ultra Wireless Kit is a transmit-only device, as it does not respond to any commands sent to it.

The 5DT Data Glove Ultra has the following serial settings:

- 115200 bits per second
- 8 data bits, 1 stop bit, no parity
- Hardware handshaking: none

The glove data arrives in packets. If two gloves' data is present on the data stream, then the packets will alternate from one glove then the other. It is possible to distinguish the two by identifying the glove type from the type byte.

The data packet sent by the glove is structured as follows:

Byte No.	Byte	Byte No.	Byte
1	Start	**17**	10Lu | 10Ll
2	Type Byte	**18**	11Hl |11Lu
3	Version	**19**	11Ll |12Hl
4	1Ll | 2Hl	**20**	12Lu |12Ll
5	2Lu | 2Ll	**21**	13Hl |13Lu
6	3Hl | 3Lu	**22**	13Ll |14Hl
7	3Ll | 4Hl	**23**	14Lu |14Ll
8	4Lu | 4Ll	**24**	15Hl |15Lu
9	5Hl | 5Lu	**25**	15Ll |16Hl
10	5Ll | 6Hl	**26**	16Lu |16Ll
11	6Lu | 6Ll	**27**	Checksum
12	7Hl | 7Lu	**28**	Footer
13	7Ll | 8Hl		
14	8Lu | 8Ll		
15	9Hl | 9Lu		
16	9Ll | 10Hl		

Table 5 - 5DT Data Glove 14 Ultra Packet Description

The bytes of the packet are defined as follows:

Header

Packet start byte defined as the '**<**' character. Hex value: **0x3c**

Glove Type

The glove type identifier byte. The following values are defined:

0x00 – Data Glove14 Ultra wired right hand glove

0x01 – Data Glove14 Ultra wired left hand glove

0x02 – Data Glove14 Ultra wireless right hand glove (Port A)

0x03 – Data Glove14 Ultra wireless left hand glove (Port A)

0x06 – Data Glove14 Ultra wireless right hand glove (Port B)

0x07 – Data Glove14 Ultra wireless left hand glove (Port B)

0x10 – Data Glove 5 Ultra wired right hand glove

0x11 – Data Glove 5 Ultra wired left hand glove

0x12 – Data Glove 5 Ultra wireless right hand glove (Port A)

0x13 – Data Glove 5 Ultra wireless left hand glove (Port A)

0x16 – Data Glove 5 Ultra wireless right hand glove (Port B)

0x17 – Data Glove 5 Ultra wireless left hand glove (Port B)

Version

The firmware version byte. The upper nibble (Vmaj) represents the version major, the lower nibble (Vmin) represents the version minor.

xHl

The upper four bits of the 12-bit sensor value, or the lower nibble of the MSB of the 12-bit sensor value.

xLh

The middle four bits of the 12-bit sensor value, or the upper nibble of the LSB of the 12-bit sensor value.

xLl

The lower four bits of the 12-bit sensor value, or the lower nibble of the LSB of the 12-bit sensor value.

Checksum

The 8-bit checksum is computed by adding all the data bytes.

Footer

Packet stop byte defined as the '>' character. Hex value: **0x3e**

Appendix C – SDK Function Descriptions

The following functions are available in the SDK:

```
fdGlove *fdOpen(char *pPort)
```

Initializes the glove device on the specified port.

Return value
Returns a pointer to the glove device (`fdGlove *`). NULL is returned if an error occurred.

Parameter
`pPort`
Pointer to a zero terminated ASCII string containing the name of the communication port. Valid values on Windows range from "COM1" to "COM8". Unix/Linux port names will differ.

Remarks
Do not attempt to alter the contents of the returned pointer directly, use the functions provided instead.

```
int fdClose(fdGlove *pFG)
```

Frees the glove device and communications port.

Return value
Returns nonzero if successful, zero if an error occurred.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks
It is important to call this function when you are finished using the glove.

```
int fdScanUSB(unsigend short *aPID, int &nNumMax)
```

Scans the USB for available gloves.

Return value
Returns the number of gloves found during the scan.

Parameters
`aPID`
Pointer an unsigned short array of length `nNumMax`. The USB Product IDs (PIDs) of the gloves found are returned in this array. The following PIDs are defined:
`DG14U_R` – Data Glove 14 Ultra Right-hand
`DG14U_L` – Data Glove 14 Ultra Left-hand
`DG5U_R` – Data Glove 5 Ultra Right-hand
`DG5U_L` – Data Glove 5 Ultra Left-hand

nNumMax
The length of the aPID array. The number of gloves found is also returned in this parameter.

Remarks
None.

int fdGetGloveHand(fdGlove *pFG)

Obtains the handedness (left or right handed) of the glove.

Return value
Returns either FD_HAND_LEFT or FD_HAND_RIGHT, as defined by the enumerated type EfdGloveHand.

Parameters
pFG
Pointer to a glove device. This is the value returned by fdOpen().

Remarks
None.

int fdGetGloveType(fdGlove *pFG)

Obtains the type of the currently connected glove.

Return value
Returns one of FD_GLOVENONE, FD_GLOVE7, FD_GLOVE7W, FD_GLOVE16 FD_GLOVE16W, FD_GLOVE14U, FD_GLOVE14UW, or FD_GLOVE14U_USB, as defined by the enumerated type EfdGloveTypes.

Parameters
pFG
Pointer to a glove device. This is the value returned by fdOpen().

Remarks
FD_GLOVE7 and FD_GLOVE7W refer to the original 5+2 (tilt angles) sensor glove (5DT Data Glove 5). The W suffix indicates a wireless model. FD_GLOVE16 and FD_GLOVE16W refer to the Data Glove 16. FD_GLOVE14, FD_GLOVE14W, and FD_GLOVE14_USB refer to the Data Glove 14 Ultra. The USB suffix refers to the Universal Serial Bus interface. In order to accommodate all glove types the fdGetNumSensors() function currently returns 18 sensors. The additional two sensors are defined as the original tilt angles that are not present in the 16-sensor glove. See the description of fdGetNumSensors()for more details.

int fdGetNumSensors(fdGlove *pFG)

Obtains the number of available sensors values the driver can make available.

Return value

Returns the number of sensors. Currently it is fixed at 18, but future driver releases may differ.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks
Although the 5-sensor glove can measure only average flexure, the driver will attempt to fill in missing values. The number of sensors returned can therefore be of a higher dimension. The enumerated type `EfdSensors` defines the finger mapping for each sensor.

```
void fdGetSensorRawAll(fdGlove *pFG, unsigned short *pData)
```

Obtains the most recent raw sensor values from the currently connected glove.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pData`
Pointer to an array of 16-bit integers that will contain the raw sensor values. The size of the array must always match the value returned by `fdGetNumSensors()`.

Remarks
Currently the raw sensor samples are all 12 bit unsigned values. The range is therefore from 0 to 4095. Note that this is not the dynamic range of the sensors. There can be severe offset values associated with each sensor. The enumerated type `EfdSensors` defines the finger mapping for each sensor.

```
unsigned short fdGetSensorRaw(fdGlove *pFG, int nSensor)
```

Obtains the most recent raw sensor value for a specific sensor from the currently connected glove.

Return value
Returns a 16-bit integer. See `fdGetSensorRawAll()` for details.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`
Index of the sensor that is being set. The value must lie in the range given by the enumerated type `EfdSensors`, or alternatively from zero to the value returned by `fdGetNumSensors()` minus one.

Remarks

The enumerated type `EfdSensors` defines the finger mapping for each sensor.

```
void fdSetSensorRawAll(fdGlove *pFG, unsigned short *pData)
```

Forces the raw value for all the sensors.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pData`
Pointer to an array of 16-bit integers that will contain the raw sensor values. The size of the array must always match the value returned by `fdGetNumSensors()`.

Remarks
Currently the raw sensor samples are all 12 bit unsigned values. The range is therefore from 0 to 4095. The enumerated type `EfdSensors` defines the finger mapping for each sensor. Forcing a sensor value will result in a raw and scaled output other than the default zero. Values that can be mapped will be overwritten, rendering the forced value void.

```
void fdSetSensorRaw(fdGlove *pFG, int nSensor, unsigned
short nRaw)
```

Forces the raw value for a specific sensor.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`
Index of the sensor that is being set. The value must lie in the range given by the enumerated type `EfdSensors`, or alternatively from zero to the value returned by `fdGetNumSensors()` minus one.
`nRaw`
16 bit raw value of the sensor. If the sensor is unmapped, the scaling calculations will proceed as normal.

Remarks
The enumerated type `EfdSensors` defines the finger mapping for each sensor. This function is only useful for sensors that cannot be mapped by a specific hardware device. Forcing a sensor value will result in a raw and scaled output other than the default zero. Values that can be mapped will be overwritten, rendering the forced value void.

```
void fdGetSensorScaledAll(fdGlove *pFG, float *pData)
```

Obtains the most recent scaled (auto-calibrated) sensor values from the currently connected glove.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pData`
Pointer to an array of floating point numbers that will contain the scaled sensor values. The size of the array must always match the value returned by `fdGetNumSensors()`.

Remarks
The sensor range is a value from zero to the value defined by the `fdSetSensorMax()` and `fdSetSensorMaxAll()` functions. The glove driver defaults to a range of [0...1]. The automatic calibration process is described in section 6. The enumerated type `EfdSensors` defines the finger mapping for each sensor.

```
float fdGetSensorScaled(fdGlove *pFG, int nSensor)
```

Obtains the most recent scaled (auto-calibrated) value for a specific sensor from the currently connected glove.

Return value
Returns a floating point sensor value.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`
Index of the sensor that is being set. The value must lie in the range given by the enumerated type `EfdSensors`, or alternatively from zero to the value returned by `fdGetNumSensors()` minus one.

Remarks
The sensor range is a value from zero to the value defined by the `fdSetSensorMax()` and `fdSetSensorMaxAll()` functions. The glove driver defaults to a range of [0...1]. The automatic calibration process is described in section 6. The enumerated type `EfdSensors` defines the finger mapping for each sensor.

```
int fdGetNumGestures(fdGlove *pFG)
```

Obtains the number of available gestures that can be recognized by the glove driver.

Return value
Returns the number of available gestures. Currently 16 different gestures are supported. Refer to section 5 for details.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks
None.

```
int fdGetGesture(fdGlove *pFG)
```

Obtains the current gesture being performed.

Return value
Returns the current gesture being performed. Refer to section 5 for details.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks
None.

```
void fdGetCalibrationAll(fdGlove *pFG, unsigned short
*pUpper, unsigned short *pLower)
```

Obtains the current auto-calibration settings of the driver.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pUpper` and `pLower`
Arrays of 16 bit unsigned integers that will contain the maximum and minimum raw sensor values. The size of each array must always match the value returned by `fdGetNumSensors()`. Refer to section 6 for details.

Remarks
None.

```
void fdGetCalibration(fdGlove *pFG, int nSensor, unsigned
short *pUpper, unsigned short *pLower)
```

Obtains the current auto-calibration settings of the driver for a specific sensor.

Return value
None.

Parameters
`pFG`

Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`
Index of the sensor that is being set. The value must lie in the range given by the enumerated type `EfdSensors`, or alternatively from zero to the value returned by `fdGetNumSensors()` minus one.
`pUpper` and `pLower`
Pointers to 16 bit unsigned integers containing the maximum and minimum raw sensor values. Refer to section 6 for details.

Remarks
None.

```
void fdSetCalibrationAll(fdGlove *pFG, unsigned short *pUpper, unsigned short *pLower)
```

Resets the current auto-calibration settings of the driver to user defined values.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.

`pUpper` and `pLower`
Arrays of 16 bit unsigned integers containing the maximum and minimum raw sensor values. The size of each array must always match the value returned by `fdGetNumSensors()`. Refer to section 6 for details.

Remarks
For unmapped sensors it would be sensible to set the upper and lower calibration settings above and below the raw value forced with `fdSetSensorRaw()`and `fdSetSensorRawAll()`.

```
void fdSetCalibration(fdGlove *pFG, int nSensor, unsigned short nUpper, unsigned short nLower)
```

Resets the current auto-calibration settings of the driver for a specific sensor to user defined values.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`
Index of the sensor that is being set. The value must lie in the range given by the enumerated type `EfdSensors`, or alternatively from zero to the value returned by `fdGetNumSensors()` minus one.

`nUpper` and `nLower`
16 bit unsigned integers containing the maximum and minimum raw sensor values. Refer to section 6 for details.

Remarks
For unmapped sensors it would be sensible to set the upper and lower calibration settings above and below the raw value forced with `fdSetSensorRaw()`and `fdSetSensorRawAll()`.

```
void fdResetCalibration(fdGlove *pFG)
```

Resets the internal auto-calibration settings of the driver to appropriate default values (for all the sensors).

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks
This function is similar to the `fdSetCalibrationAll()` function with each of the upper and lower calibration array values set to 0 and 4095 respectively. This function, or any of the other calibration functions, should be called whenever the application starts up or the glove changes users during run-time. For unmapped sensors the upper and lower calibration values are set to 4095 and 0 respectively, which is the *inverse* of the auto-calibration settings. If auto calibration was turned off, it is turned on again.

```
void fdResetCalibration(fdGlove *pFG, int nSensor)
```

Resets the internal auto-calibration settings of the driver to appropriate default values (for a specific sensor).

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`
Index of the sensor whose calibration values are to be reset.

Remarks
This function is similar to the `fdSetCalibrationAll()` function with each of the upper and lower calibration array values set to 0 and 4095 respectively. This function, or any of the other calibration functions, should be called whenever the application starts up or the glove changes users during run-time. For unmapped sensors the upper and lower calibration values are set to 4095 and 0

respectively, which is the *inverse* of the auto-calibration settings. If auto calibration was turned off, it is turned on again.

```
void fdGetSensorMaxAll(fdGlove *pFG, float *pMax)
```

Obtains the maximum scaled value for each sensor.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pMax`
Array of floating point values that will contain the maximum scaled sensor values. The size of the array must always match the value returned by `fdGetNumSensors()`.

Remarks
The glove driver defaults to a maximum scaled value of 1 for each sensor.

```
float fdGetSensorMax(fdGlove *pFG, int nSensor)
```

Obtains the maximum scaled value for a specific sensor.

Return value
Returns the maximum scaled values of the sensor.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`
Index of the sensor that is being queried. The value must lie in the range given by the enumerated type `EfdSensors`, or alternatively from zero to the value returned by `fdGetNumSensors()` minus one.

Remarks
The glove driver defaults to a maximum scaled value of 1 for each sensor.

```
void fdSetSensorMaxAll(fdGlove *pFG, float *pMax)
```

Sets the maximum scaled value for each sensor.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pMax`

Array of floating point values that contains the maximum scaled sensor values. The size of the array must always match the value returned by `fdGetNumSensors()`.

Remarks
The glove driver defaults to a maximum scaled value of 1 for each sensor.

```
void fdSetSensorMax(fdGlove *pFG, int nSensor, float fMax)
```

Sets the maximum scaled value for a specific sensor.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`
Index of the sensor that is being set. The value must lie in the range given by the enumerated type `EfdSensors`, or alternatively from zero to the value returned by `fdGetNumSensors()` minus one.
`fMax`
A floating point value that contains the maximum scaled sensor value.

Remarks
The glove driver defaults to a maximum scaled value of 1 for each sensor.

```
void fdGetThresholdAll(fdGlove *pFG, float *pUpper, float
*pLower)
```

Obtains the current gesture recognition threshold settings of the driver.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pUpper` and `pLower`
Arrays of floating point numbers that will contain the maximum and minimum threshold values. The size of each array must always match the value returned by `fdGetNumSensors()`. Refer to section 6 for details.

Remarks
None.

```
void fdGetThreshold(fdGlove *pFG, int nSensor, float
*pUpper, float *pLower)
```

Obtains the current gesture recognition threshold settings of the driver for a specific sensor.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`
Index of the sensor that is being queried. The value must lie in the range given by the enumerated type `EfdSensors`, or alternatively from zero to the value returned by `fdGetNumSensors()` minus one.
`pUpper` and `pLower`
Pointers to floating point numbers that will contain the maximum and minimum threshold values. Refer to section 6 for details.

Remarks
None.

```
void fdSetThresholdAll(fdGlove *pFG, float *pUpper, float
*pLower)
```

Sets the current gesture recognition threshold settings of the driver.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pUpper` and `pLower`
Arrays of floating point numbers that contains the maximum and minimum threshold values. The size of each array must always match the value returned by `fdGetNumSensors()`. Refer to section 6 for details.

Remarks
None.

```
void fdSetThreshold(fdGlove *pFG, int nSensor, float
fUpper, float fLower)
```

Sets the current gesture recognition threshold settings of the driver for a specific sensor.

Return value
None.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`nSensor`

Index of the sensor that is being set. The value must lie in the range given by the enumerated type `EfdSensors`, or alternatively from zero to the value returned by `fdGetNumSensors()` minus one.

`fUpper` and `fLower`

Floating point numbers that contain the maximum and minimum threshold values. Refer to section 6 for details.

Remarks

None.

```
void fdGetGloveInfo(fdGlove *pFG, unsigned char *pData)
```

Obtains the information data block of the currently connected glove.

Return value

None.

Parameters

`pFG`

Pointer to a glove device. This is the value returned by `fdOpen()`.

`pData`

Array of 32 bytes that will contain the information data.

Remarks

The information data is specified in the glove user's manual. The size of the information block is always 32 bytes.

```
void fdGetDriverInfo(fdGlove *pFG, unsigned char *pData)
```

Obtains the information data block of the driver.

Return value

None.

Parameters

`pFG`

Pointer to a glove device. This is the value returned by `fdOpen()`.

`pData`

Array of 32 bytes that will contain the information data.

Remarks

The information data is a zero terminated string that contains driver information. The size of the information block is always 32 bytes.

```
void fdSetCallback(fdGlove *pFG, void *pFunc, LPVOID param)
```

Sets the Callback function and associated parameters.

Return value

None.

Parameters

`pFG`

Pointer to a glove device. This is the value returned by `fdOpen()`.

`pFunc`

Pointer to the callback function. This should be cast to void.

`param`

The parameter to be given to the callback function.

Remarks

This callback function is called every time a new packet is received by the driver. Example:

```
fdSetCallback(pGlove,(void *)&(DriverUpdate),this);
```

`int fdGetPacketRate(fdGlove *pFG)`

Obtains the latest packet rate.

Return value

Returns the latest available packet rate as an integer.

Parameters

`pFG`

Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks

None.

`bool fdNewData(fdGlove *pFG)`

Indicates if the driver has received new data since this function was last called.

Return value

Returns **`true`** if new data is available.

Parameters

`pFG`

Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks

This function may be used as an alternative to using the callback function to trigger events upon the arrival of new glove data.

`bool fdNewData(fdGlove *pFG)`

Indicates if the driver has received new data since this function was last called.

Return value

Returns **`true`** if new data is available.

Parameters

`pFG`

Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks

This function may be used as an alternative to using the callback function to trigger events upon the arrival of new glove data.

```
int fdGetFWVersionMajor(fdGlove *pFG)
```

Obtains the major version of the glove’s firmware.

Return value
Returns the major version of the glove’s firmware as an integer.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks
This function has currently only been implemented for the Data Glove 14 Ultra. It will return 0 if the glove type isn’t a Data Glove 14 Ultra variant. Example: if the firmware version is 3.2 then 3 is returned.

```
int fdGetFWVersionMinor(fdGlove *pFG)
```

Obtains the minor version of the glove’s firmware.

Return value
Returns the minor version of the glove’s firmware as an integer.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks
This function has currently only been implemented for the Data Glove 14 Ultra. It will return 0 if the glove type isn’t a Data Glove 14 Ultra variant. Example: if the firmware version is 3.2 then 2 is returned.

```
bool fdGetAutoCalibrate(fdGlove *pFG)
```

Indicates if the driver is currently auto calibrating.

Return value
Returns **`true`** if the driver is currently auto calibrating.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.

Remarks
None.

```
bool fdSetAutoCalibrate(fdGlove *pFG, bool bAutoCalibrate)
```

Turns auto calibration **on** or **off**.

Return value
Returns **`true`** if the driver is currently auto calibrating.

Parameters
`pFG`

Pointer to a glove device. This is the value returned by `fdOpen()`.
`bAutoCalibrate`
Boolean value indicating if auto calibration should be turned **on** (**`true`**) or **off** (**`false`**).

Remarks
Turn auto calibration off after calibrating to prevent the calibration values from being too extreme, thus causing scaled values of poor quality.

```
bool fdSaveCalibration(fdGlove *pFG, const char *pFileName)
```

Saves the current calibration values to file.

Return value
Returns **`true`** if the save operation completed successfully.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pFileName`
A null-terminated string containing the path and filename.

Remarks
Save your calibration values to file to prevent you from having to calibrate the glove every time you start your application.

```
bool fdLoadCalibration(fdGlove *pFG, const char *pFileName)
```

Loads calibration values from file. Current calibration values are discarded.

Return value
Returns **`true`** if the load operation completed successfully.

Parameters
`pFG`
Pointer to a glove device. This is the value returned by `fdOpen()`.
`pFileName`
A null-terminated string containing the path and filename.

Remarks
None.