



**PapillArray Tactile Sensor  
Visualisation Software  
(v2.0)**

**Installation and Operation Manual**

**Document #:** PTSVIS\_2.0\_MAN\_NOV21

November, 2021

## **Foreword**

Information contained in this document is the property of Contactile Pty Ltd. and shall not be reproduced in whole or in part without prior written approval of Contactile Pty Ltd. The information herein is subject to change without notice and should not be construed as a commitment on Contactile Pty Ltd. This manual is periodically revised to reflect and incorporate changes made to the PapillArray Tactile Sensor Development Kit.

Contactile Pty Ltd assumes no responsibility for any errors or omissions in this document. Users' critical evaluation is welcome to assist in the preparation of future documentation.

Copyright © by Contactile Pty Ltd, Sydney, Australia. All Rights Reserved.  
Published in Australia.

All trademarks belong to their respective owners.

## **Conditions of Sale**

Contactile's conditions of sale apply to all products sold by Contactile to the Distributor under this Agreement. The conditions of sale that apply are provided on the USB flash drive shipped with the product in the folder 'LEGAL' in the root directory.

## **End User Licence Agreement**

Contactile's end user license agreement applies to all software and algorithms included with the products sold by Contactile. The end user license agreement that applies is provided on the USB flash drive shipped with the product in the folder 'LEGAL' in the root directory.

## **Compliance**

The devices are sold as is.

The devices are specifically designed solely for the purposes of research and development only made available on a business-to-business basis.

The devices are not for resale.

## Table of Contents

1	Introduction .....	4
2	Safety .....	5
2.1	General.....	5
2.2	Explanation of warnings .....	5
2.3	Precautions.....	5
3	Getting started .....	6
3.1	Hardware installation.....	6
3.2	End user licence agreement licence.....	6
3.3	Software installation .....	6
4	Operation.....	7
4.1	Configuration .....	<b>Error! Bookmark not defined.</b>
4.2	Microsoft Windows display settings.....	7
4.3	Starting the software .....	7
4.4	Start-up sequence.....	7
5	GUI components.....	8
5.1	Visual representation of pillar displacement .....	9
5.2	Internal temperature display .....	10
5.3	Displacement or force values .....	10
5.4	Force plots .....	10
6	GUI controls.....	11
6.1	Changing the COM port .....	11
6.2	Biasing the sensor data.....	11
6.3	Rotating a sensor.....	11
6.4	Display controls.....	12
6.5	Log file controls.....	13
6.6	Keyboard shortcuts .....	13
7	Log file .....	14
7.1	Overview.....	14
7.2	Log file location .....	14
7.3	Log file name .....	14
7.4	Log file format .....	14

## 1 Introduction

The PapillArray Tactile Sensor Development Kit (v2.0) is a system of (up to) two PapillArray Tactile Sensor arrays and a Controller. Each PapillArray Tactile Sensor array can measure 3D displacement, 3D force, and vibration on each sensing element, as well as global 3D force, global 3D torque, the onset of slip, and friction. The Controller supplies power for (up to) two sensors and coordinates the simultaneous data acquisition from up to two PapillArray Tactile Sensors; i.e., coordinates sampling of the 9 pillars if one sensor is connected to the Controller, 18 pillars if two sensors are connected to the Controller. The Development Kit is shipped with visualisation software and (optional) C++ libraries for Windows and Linux environments and a ROS node for developing software control algorithms using the sensor signals.

The main components of the PapillArray Tactile Sensor Development Kit (v2.0) are shown in Figure 1.1, connected to a laptop running the visualisation software.



Figure 1.1 – The PapillArray Tactile Sensor Development Kit (v2.0). Laptop not included.

This document contains an operation and installation manual for the Visualisation Software. Figure 1.2 shows a screenshot of the Visualisation Software.

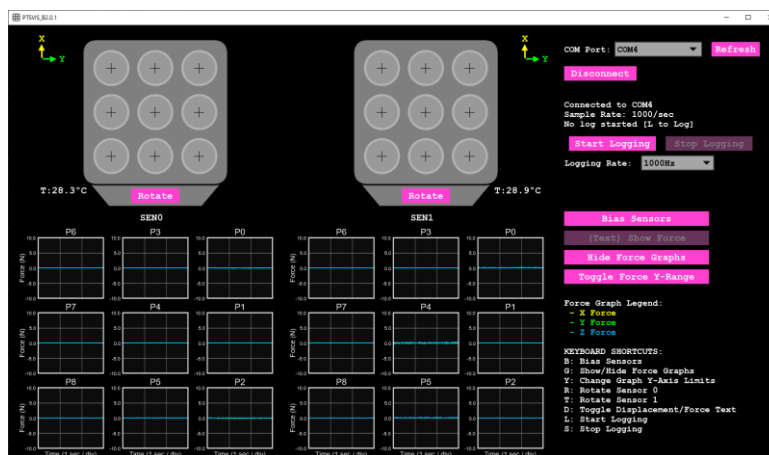


Figure 1.2 – The PapillArray Tactile Sensor Visualisation Software (v2.0).

## 2 Safety

### 2.1 General

The customer should verify that the maximum loads and moments expected during operation fall within the sensing range of the sensor as outside this range, sensor reading accuracy is not guaranteed (refer to Document #PTS\_2.0\_SPEC\_NOV21). Particular attention should be paid to dynamic loads caused by robot acceleration and deceleration if the sensors are mounted on robotic equipment. These forces can be many multiples of the value of static forces in high acceleration or deceleration situations.

### 2.2 Explanation of warnings

The warnings included here are specific to the product(s) covered by this manual. It is expected that the user heed all warnings from the manufacturers of other components used in the installation.



Danger indicates that a situation could result in potentially serious injury or damage to equipment.



Caution indicates that a situation could result in damage to the product and/or the other system components.

### 2.3 Precautions



**DANGER:** Do not attempt to disassemble the sensor. This could damage the sensor and will invalidate the calibration.



**DANGER:** Do not attempt to drill, tap, machine, or otherwise modify the sensor casing. This could damage the sensor and will void any warranty.



**DANGER:** Do not use the sensor on abrasive surfaces or surfaces with sharp points/edges. This could damage the silicone surface of the sensor.



**CAUTION:** Sensors may exhibit a small offset in readings when exposed to intense light sources.



**CAUTION:** Exceptionally strong and changing electromagnetic fields, such as those produced by magnetic resonance imaging (MRI) machines, constitute a possible source of interference with the operation of the sensor and Controller.



**CAUTION:** Temperature variations can cause drift in sensor readings. Some temperature compensation is included in Development Kit version of the PapillArray. However, bias removal in software prior to operation is necessary, and it is recommended that biasing is performed each time the sensor is known to be unloaded.

### 3 Getting started

This section contains instructions for setting up and using PapillArray Tactile Sensor Visualisation Software (v2.0). It is recommended that first time users first read the preceding Safety section, then read through this section to get more familiar with the system.

#### 3.1 Hardware installation

The visualisation software is used with the PapillArray Tactile Sensor Development Kit (v2.0). The Controller should first be connected to the sensors and then to a PC via the micro-USB port on the Controller before you can use the visualisation software. For more information about connecting the sensors and powering on the Controller, refer to Document #PTSDK\_2.0\_MAN\_NOV21.

The micro-USB port is shown in Figure 3.1.



Figure 3.1 – Micro-USB port of the PapillArray Tactile Sensor Controller (v2.0)

#### 3.2 End user licence agreement licence

Contactile's end user license agreement applies to all software and algorithms included with the products sold by Contactile. The end user license agreement that applies is provided on the USB flash drive shipped with the product in the folder 'LEGAL' in the root directory.

#### 3.3 Software installation

The visualisation software is provided on the Contactile USB flash drive that was shipped with the development kit. Copy the entire contents of the Contactile USB flash drive to a location on the PC running Microsoft Windows.

## **4 Operation**

### **4.1 COM Port**

The data transmission protocol between the Controller device and the PC is a serial connection emulated on the USB connection, visible as a COM port on the PC. After connecting the Controller to the PC, use the PC's device manager to determine the COM port number of the connection.

### **4.2 Microsoft Windows display settings**

Before starting the software, for the GUI to display in full screen, it is recommended to change the Windows display settings.

In Windows 7:

1. Type "Display" in the windows search bar
2. Open "Display"
3. In the section "Make it easier to read what's on your screen", select "Smaller – 100%"

In Windows 10:

1. Type "Display Settings" in the windows search bar
2. Open the "Display Settings"
3. In the section "Scale and layout", change the "size of text, apps and other items" to "100%"

### **4.3 Starting the software**

Run the executable file "PTSVIS\_2.0.exe".

### **4.4 Start-up sequence**

Once the software is launched, the GUI will appear. A serial connection will need to be made before the software begins sampling and displaying the data. To select a COM port and make a serial connections, see *6.1 Changing the COM port*.

## 5 GUI components

The top left area of the GUI window is a visual representation of the sensor connected to the SEN0 port of the Controller, and the top right is a visual representation of the sensor connected to the SEN1 port. Directly below each sensor visual representation is an area which can be toggled between 3D force plots for each pillar, or a text-based representation of the photodiode values, calibrated displacement or calibrated force of each of the sensors. There are also numerous controls for changing the display options, connecting to the Controller, logging data, and biasing the sensors - these are highlighted in Figure 5.1.

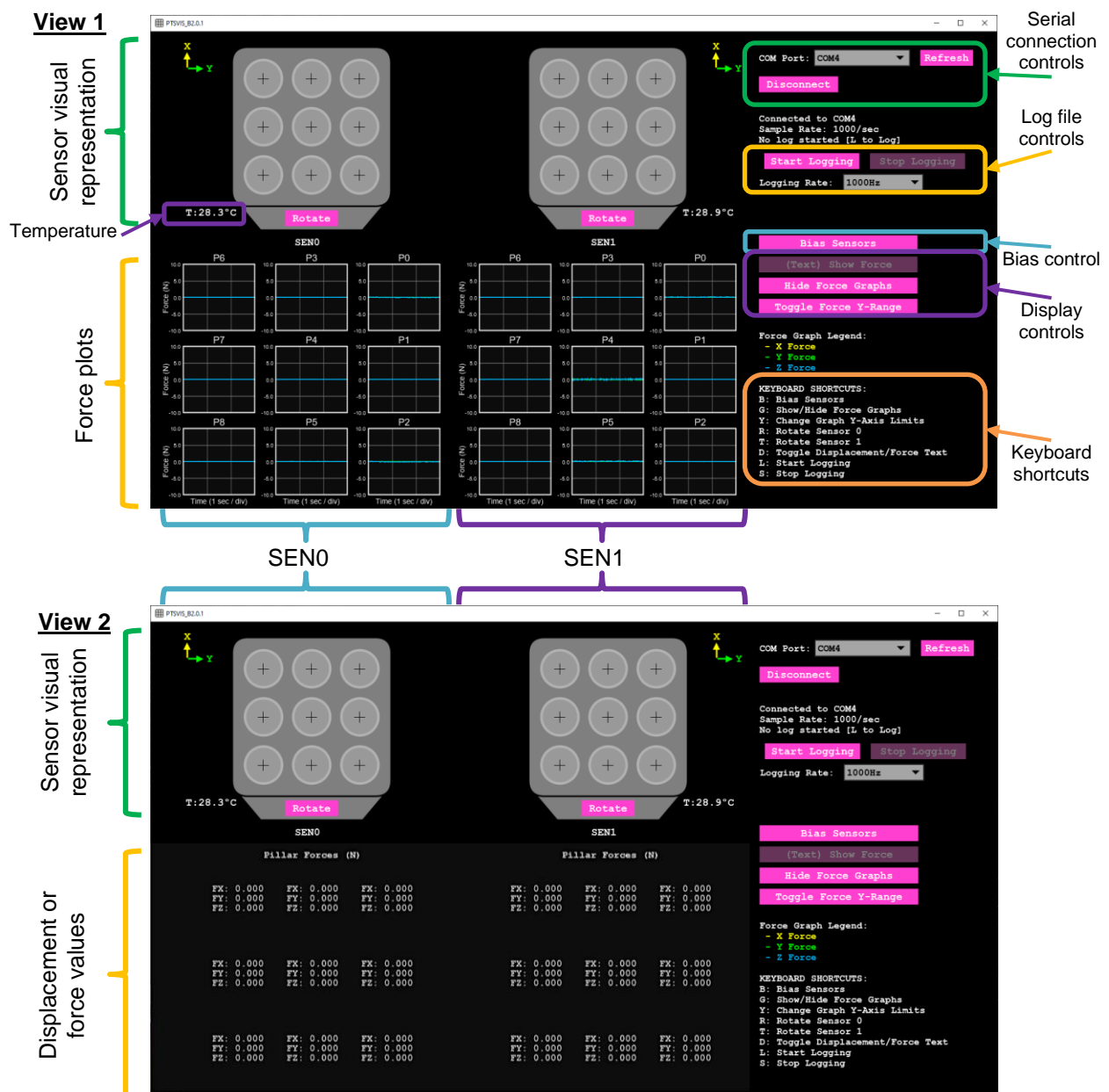


Figure 5.1 – GUI components of the visualisation software. The bottom half of the window can be toggled to display displacement or force values, or force plots (see Section 6.4 *Display controls*).



## 5.1 Visual representation of pillar displacement

The visual representation of the sensor takes a top view of the sensor pillars. Each pillar of the sensor is represented as a 2-D grey (when unloaded) or white (when loaded) shape with a cross hair representing the tip of the pillar. The representation of an unloaded sensor is shown alongside the physical sensor is shown in Figure 5.1.

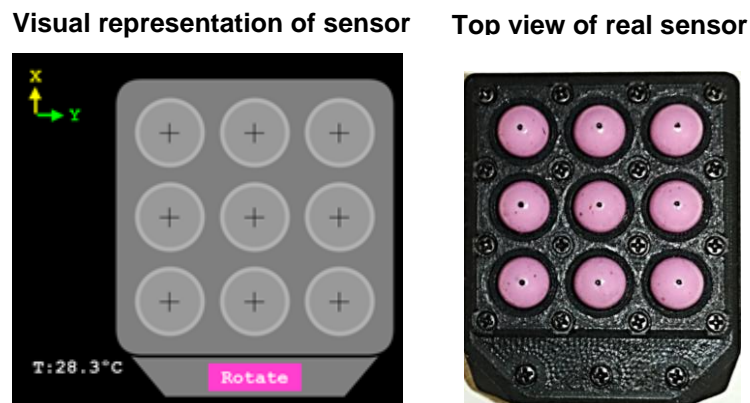


Figure 5.2 – Visual representation of sensor in GUI, including the X and Y axis orientation and internal temperature measurement; and corresponding physical sensor.

The cross hair moves left and right, and up and down to indicate positive and negative displacement of the pillar, in the X- and Y-axis depending upon the orientation of the visual representation (see Section 6.3 *Rotating a sensor* and Section 6.4 *Display controls*). The shape of the pillar representation deforms as a result of displacement in the X- and Y- axis. Additionally, Z displacement of the pillar is represented by a grey circle centred at the cross-hair – larger positive Z displacement results in a larger grey circle. Contact is represented by a change in the colour of the pillar – when the pillar is not in contact, it is grey, and when contact is made, the pillar becomes white. For visual purposes, the default threshold for a pillar to be considered in contact is 0.2 N in any one axis. Figure 5.3 shows an unloaded pillar, a pillar that is compressed to 1.5 N in the Z-axis, a pillar compressed to 5 N in the Z-axis, and a pillar compressed to 6 N in the Z-axis and also displaced in the positive X-axis.

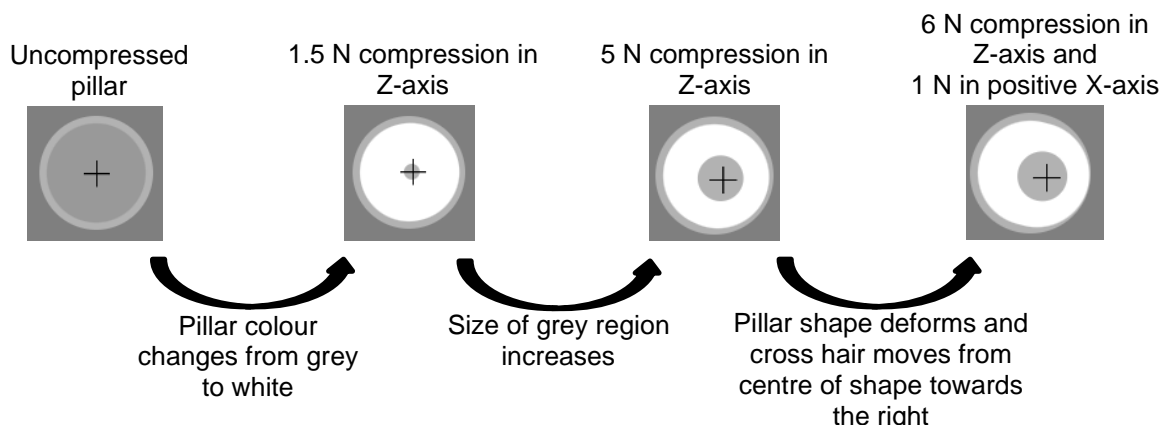


Figure 5.3 – Visual representation of a pillar when uncompressed, compressed to different z-forces, and displaced in X-axis.

## 5.2 Internal temperature display

The internal temperature of the sensor is displayed as text in the bottom left corner of the visual representation of the sensor (see Figure 5.2).

## 5.3 Displacement or force values

For each pillar, the calibrated displacement or force values (in the X-, Y- and Z-axis) are displayed as text. The relative locations of a block of values for one pillar corresponds to the pillar location in the sensor visualisation. The X-, Y- and Z-axis displacements or forces are arranged in separate rows – for more information on toggling between displacement and force values, see Section. Figure 5.4 shows the displacement and force values for a single pillar.

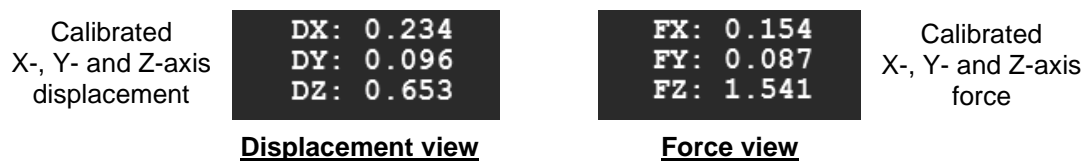


Figure 5.4 – In the displacement view, arranged vertically as DX, DY, DZ are the three calibrated XYZ displacements; in the force view, arranged vertically as FX, FY, FZ are the three calibrated XYZ forces.

## 5.4 Force plots

For each pillar, the calibrated X-, Y- and Z-axis forces vs. time are displayed in a single plot. The relative locations of the force vs. time plots correspond to the pillar location in the sensor visualisation. The X-axis force is displayed as a yellow trace, the Y-axis force is displayed as a green trace, and the Z-axis force is displayed as a blue trace. Figure 5.5 shows a force vs. time plot for a single pillar.

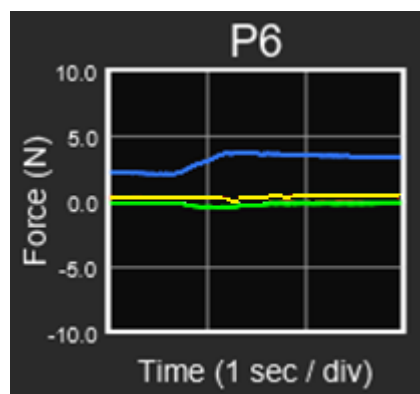


Figure 5.5 – Force vs. time plot of a pillar 6. The X-axis force is displayed in yellow, the Y-axis force is displayed in green, and the Z-axis force is displayed in blue.

## 6 GUI controls

### 6.1 Changing the COM port

The GUI controls related to the serial connection are shown in Figure 6.1. To change the COM port number of the serial connection to the Controller:

1. If the GUI is already connected to a COM port, click the Disconnect button.
2. Click on the Refresh button to refresh the list of available COM ports.
3. Select the appropriate COM port number from the COM Port drop down list.
4. Click on the Connect button.



Figure 6.1 – Changing the COM port in the GUI and connecting

### 6.2 Biasing the sensor data

To bias the data (i.e., remove any offset in the calibrated displacement and force data), ensure that the sensor is unloaded and the signals are in a steady state, click on the Bias Sensors button (Figure 6.2). The bias operation takes approximately 2 s. Ensure that the sensor remains unloaded throughout this time. The sensor calibrated displacement and force signals should become zero after this point.



Figure 6.2 – Biasing the sensors

If a bias is initiated in one instance of the visualisation software (connected to the MAIN or MNTR micro-USB port), it will be processed in all running instances of the visualisation software as well as any program using the C++ library that is also reading from the same Controller (and *vice versa*).

### 6.3 Rotating a sensor

To rotate the orientation of a sensor by 90° in a clockwise direction, click on the Rotate button in the visual representation of the sensor (see Figure 6.3). This will rotate the sensor visualisation as well as the force graphs and calibrated values.



Figure 6.3 – Rotating a sensor

## 6.4 Display controls

The display controls are shown in Figure 6.4.

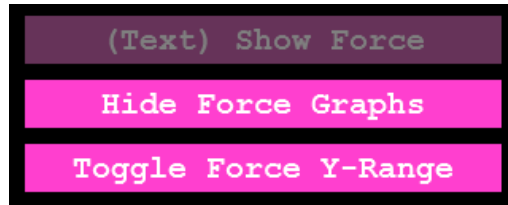


Figure 6.4 – Display controls

### 6.4.1 Show force/displacement text values

To display the displacement values as text, click on the (Text) Show Displacement button. To display the force values as text, click on the (Text) Show Force button (see view 2 in Figure 5.1).

### 6.4.2 Show/hide force graphs

If the force graphs are not displayed, then click on the Show Force Graphs button to show the force graphs (see view 1 in Figure 5.1). If the force graphs are already displayed click on the Hide Force Graphs button to hide the force graphs and instead display the calibrated values of the pillars of both sensors as text (see view 2 in Figure 5.1).

### 6.4.3 Change graph Y-axis limits

To increase the force-axis resolution (i.e., reduce the limits of the force-axis) of the force vs. time plots, click on the Toggle Force Y-Range button. Each time the Toggle Force Y-Range button is pressed, the force-axis limits will reduce, until the minimum limit of  $\pm 0.5$  N. If the force-axis limits are  $\pm 0.5$  N and the Toggle Force Y-Range button is pressed, then the force-axis limits will reset to the maximum limit of  $\pm 10$  N.

## 6.5 Log file controls

The log file controls are shown in Figure 6.5.

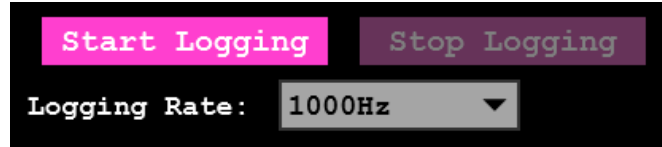


Figure 6.5 – Log file controls

### 6.5.1 Changing the log file rate

To change the log file sampling rate, select the appropriate rate from the drop down list next to Logging Rate. The log file sampling rate can only be changed when the GUI is not logging data.

### 6.5.2 Start/stop logging

To start logging data, click on the Start Logging button. If data logging had previously been started, click on the Stop Logging button to stop logging and save the log file – see Section 7 *Log file* for more information about the log file.

## 6.6 Keyboard shortcuts

A list of keyboard shortcuts is displayed in the GUI. These are shown in Figure 6.6.

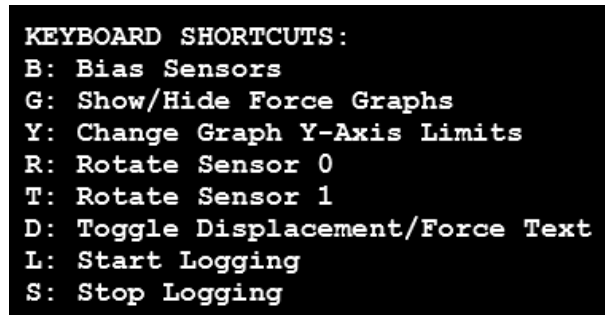


Figure 6.6 – List of keyboard shortcuts displayed in the GUI

## 7 Log file

### 7.1 Overview

The visualisation software also generates a log file of the sensor data, including raw photodiode values, calibrated X-, Y- and Z-axis displacement values, calibrated X-, Y- and Z-axis force values, slip detection and friction estimates.

### 7.2 Log file location

The log file that is generated is stored in the Logs subfolder in the same location as the Visualisation Software executable file (PTSVIS\_2.0.exe) which was run to launch the GUI.

### 7.3 Log file name

The name of the log file that is generated is LOG\_YYMMDD\_hhmmss.csv where YY is the two digit year, MM is the two digit month, DD is the two digit day, hh is the two digit hour, mm is the two digit minute and ss is the two digit second from the system clock at the time that the log file was created.

### 7.4 Log file format

The log file is saved as comma-separated values (CSV) in ASCII text format. The order of the values and a description is shown in Table 7.1

Table 7.1 – Data in log file

Data Order	Data Name	Data Description	
1	T_us	Timestamp in $\mu$ s	Timestamps
2	S0_P0_DX	Sensor 0, pillar 0, X-axis displacement	Sensor 0, pillar 0, displacements
3	S0_P0_DY	Sensor 0, pillar 0, Y-axis displacement	
4	S0_P0_DZ	Sensor 0, pillar 0, Z-axis displacement	
5	S0_P0_FX	Sensor 0, pillar 0, X-axis force	Sensor 0, pillar 0, forces
6	S0_P0_FY	Sensor 0, pillar 0, Y-axis force	
7	S0_P0_FZ	Sensor 0, pillar 0, Z-axis force	
8	S0_P1_DX	Sensor 0, pillar 1, X-axis displacement	Sensor 0, pillar 1, displacements
9	S0_P1_DY	Sensor 0, pillar 1, Y-axis displacement	
10	S0_P1_DZ	Sensor 0, pillar 1, Z-axis displacement	
11	S0_P1_FX	Sensor 0, pillar 1, X-axis force	Sensor 0, pillar 1, forces
12	S0_P1_FY	Sensor 0, pillar 1, Y-axis force	
13	S0_P1_FZ	Sensor 0, pillar 1, Z-axis force	
⋮			
50	S0_P8_DX	Sensor 0, pillar 8, X-axis displacement	Sensor 0, pillar 8, displacements
51	S0_P8_DY	Sensor 0, pillar 8, Y-axis displacement	
52	S0_P8_DZ	Sensor 0, pillar 8, Z-axis displacement	

Data Order	Data Name	Data Description	
53	S0_P8_FX	Sensor 0, pillar 8, X-axis force	Sensor 0, pillar 8, forces
54	S0_P8_FY	Sensor 0, pillar 8, Y-axis force	
55	S0_P8_FZ	Sensor 0, pillar 8, Z-axis force	
56	S0_GG_FX	Sensor 0, global X-axis force	Sensor 0, global force
57	S0_GG_FY	Sensor 0, global Y-axis force	
58	S0_GG_FZ	Sensor 0, global Z-axis force	
59	S0_GG_TX	Sensor 0, global X-axis torque	Sensor 0, global torque
60	S0_GG_TY	Sensor 0, global Y-axis torque	
61	S0_GG_TZ	Sensor 0, global Z-axis torque	
62	S0_isSDActive	Sensor 0, is slip detection activated	Sensor 0 slip detection and friction estimate
63	S0_isRefLoad	Sensor 0, is the reference pillar tangentially loaded	
64	S0_P0_isInContact	Sensor 0, pillar 0, is in contact	
65	S0_P0_slipState	Sensor 0, pillar 0, slip state	
66	S0_P1_isInContact	Sensor 0, pillar 1, is in contact	
67	S0_P1_slipState	Sensor 0, pillar 1, slip state	
⋮			
80	S0_P8_isInContact	Sensor 0, pillar 8, is in contact	
81	S0_P8_slipState	Sensor 0, pillar 8, slip state	
82	S0_FrictionEst	Sensor 0, friction estimate	
83	S1_P0_DX	Sensor 1, pillar 0, X-axis displacement	Sensor 1, pillar 0, displacements
84	S1_P0_DY	Sensor 1, pillar 0, Y-axis displacement	
85	S1_P0_DZ	Sensor 1, pillar 0, Z-axis displacement	
86	S1_P0_FX	Sensor 1, pillar 0, X-axis force	Sensor 1, pillar 0, forces
87	S1_P0_FY	Sensor 1, pillar 0, Y-axis force	
88	S1_P0_FZ	Sensor 1, pillar 0, Z-axis force	
89	S1_P1_DX	Sensor 1, pillar 1, X-axis displacement	Sensor 1, pillar 1, displacements
90	S1_P1_DY	Sensor 1, pillar 1, Y-axis displacement	
91	S1_P1_DZ	Sensor 1, pillar 1, Z-axis displacement	
92	S1_P1_FX	Sensor 1, pillar 1, X-axis force	Sensor 1, pillar 1, forces
93	S1_P1_FY	Sensor 1, pillar 1, Y-axis force	
94	S1_P1_FZ	Sensor 1, pillar 1, Z-axis force	
...			
131	S1_P8_DX	Sensor 1, pillar 8, X-axis displacement	Sensor 1, pillar 8, displacements
132	S1_P8_DY	Sensor 1, pillar 8, Y-axis displacement	
133	S1_P8_DZ	Sensor 1, pillar 8, Z-axis displacement	
134	S1_P8_FX	Sensor 1, pillar 8, X-axis force	Sensor 1, pillar 8, forces
135	S1_P8_FY	Sensor 1, pillar 8, Y-axis force	
136	S1_P8_FZ	Sensor 1, pillar 8, Z-axis force	

Data Order	Data Name	Data Description	
137	S1_GG_FX	Sensor 1, global X-axis force	Sensor 1, global force
138	S1_GG_FY	Sensor 1, global y-axis force	
139	S1_GG_FZ	Sensor 1, global Z-axis force	
140	S1_GG_TX	Sensor 1, global X-axis torque	Sensor 1, global torque
141	S1_GG_TY	Sensor 1, global Y-axis torque	
142	S1_GG_TZ	Sensor 1, global Z-axis torque	
143	S0_isSDActive	Sensor 1, is slip detection activated	Sensor 1 slip detection and friction estimate
144	S0_isRefLoad	Sensor 1, is the reference pillar tangentially loaded	
145	S0_P0_isInContact	Sensor 1, pillar 0, is in contact	
146	S0_P0_slipState	Sensor 1, pillar 0, slip state	
147	S0_P1_isInContact	Sensor 1, pillar 1, is in contact	
148	S0_P1_slipState	Sensor 1, pillar 1, slip state	
		⋮	
161	S0_P8_isInContact	Sensor 1, pillar 8, is in contact	
162	S0_P8_slipState	Sensor 1, pillar 8, slip state	
163	S0_FrictionEst	Sensor 1, friction estimate	