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1 Introduction

1.1 Overview

This user manual describes the features and functionalities of the Pro Spectrum eye tracker. The Pro Spectrum can be used in various setups, either with an attached monitor or as a standalone unit, to perform eye tracking with physical objects. The typical setup is having the Pro Spectrum connected to a PC running Pro Lab, see the image below.

The design enables the subject to move naturally during recording while still achieving high accuracy and precision.

1.2 Basic operating principles

The Pro Spectrum use infrared illuminators to generate reflection patterns on the corneas of the subject's eyes. These patterns, plus other visual data about the subject, are collected by image sensors. Sophisticated image-processing algorithms identify relevant features, including the eyes and the corneal reflection patterns. Complex mathematics is used to calculate the 3D position of each eyeball and the gaze point on the screen (or when a screen isn’t used, for the gaze point on the object); in plain words, it tells you where the subject is looking.

Eye trackers from Tobii Pro are designed for use in indoor office environments and for tracking on humans.

1.3 Product versions

The Pro Spectrum is available in four product versions: 1200 Hz, 600 Hz, 300 Hz and 150 Hz. The values denote the eye tracker’s maximum sampling frequency, but it can be used at lower settings as well. The 600 Hz, 300 Hz and 150 Hz versions can be upgraded to a faster version. Contact your sales representative or Tobii Pro for more information.
## 2 Hardware Package Content

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Angle meter</td>
</tr>
<tr>
<td>B.</td>
<td>Measuring tape</td>
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<td>C.</td>
<td>Power cables for monitor (UK, US, EU and Aus/China)</td>
</tr>
<tr>
<td>D.</td>
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</tr>
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<td>E.</td>
<td>Eye tracker</td>
</tr>
<tr>
<td>F.</td>
<td>Monitor mounting bracket</td>
</tr>
<tr>
<td>G.</td>
<td>Power cables for eye tracker (UK, US, EU and Aus/China)</td>
</tr>
<tr>
<td>H.</td>
<td>Power adaptor for eye tracker</td>
</tr>
<tr>
<td>I.</td>
<td>USB cable for connection between the PC and the monitor’s integrated USB hub</td>
</tr>
<tr>
<td>J.</td>
<td>Cold shoe for mounting of a user camera</td>
</tr>
<tr>
<td>K.</td>
<td>DisplayPort cable</td>
</tr>
<tr>
<td>L.</td>
<td>HDMI cable</td>
</tr>
<tr>
<td>M.</td>
<td>Cleaning cloth</td>
</tr>
<tr>
<td>N.</td>
<td>Fabric cord sleeve for collecting the cables</td>
</tr>
<tr>
<td>O.</td>
<td>Ethernet cable</td>
</tr>
</tbody>
</table>
3 Product Care

3.1 Transportation and storage

For transportation and storage, the recommended range for temperature and humidity for the device is as follows:

- **Temperature**: -40°C to 70°C (-40°F to 158°F)
- **Humidity**: 20% to 95% (no condensation on the device)

⚠️ The Pro Spectrum is not waterproof or water resistant. The device should not be kept in excessively humid, damp or wet conditions. Do not submerge the device in water or in any other liquid. Be careful not to spill liquids on the device.

3.2 Cleaning

Before cleaning the Pro Spectrum, unplug all cables. Use a soft, slightly damp, lint-free cloth. Avoid getting moisture in openings on the device. Don’t use window cleaners, household cleaners, aerosol sprays, solvents, alcohol, ammonia, or abrasives to clean the device.

ℹ️ Keep in mind that scratches on the front surface of the eye tracker may cause impaired eye tracking performance.

3.3 Disinfection

The surfaces of the Tobii Pro Spectrum can be cleaned with Isopropyl alcohol using a moist, soft, lint-free, non-scratching cloth. Do not let liquid Isopropyl alcohol enter into the unit. Be careful not to scratch the front filter surface as it is part of the optical system and scratches will reduce the product’s performance.

3.4 Transporting the Pro Spectrum

Before storage or shipping, disconnect all cables and use the travel case and packaging materials provided.

3.5 Disposing of the Pro Spectrum

Do not dispose of Pro Spectrum in general household or office waste. Follow your local regulations for disposal of electronic equipment.
4 Setting up the Pro Spectrum

4.1 Ventilation

As with most electronic devices, the Pro Spectrum generates heat during use and needs adequate ventilation. Allow for free air flow around the unit and never cover it as this will restrict the air flow and lead to overheating.

4.2 Testing environment

The Pro Spectrum is best kept in dry conditions at room temperature. The recommended range for temperature and humidity during operation is as follows:

- **Temperature**: 15°C to 30°C (59°F to 86°F)
- **Humidity**: Max 20% to 95% (no condensation on the device)

4.3 Mounting the monitor to the eye tracker unit

The Pro Spectrum is delivered with the monitor already mounted. If this for any reason is not the case, e.g. someone has been using the unit as a standalone eye tracker, you need to reattach the monitor to the base. You mount and remove the monitor swiftly thanks to its one-screw fastening.

Procedure for affixing the mounting bracket:

1. Make sure the eye tracker is placed on an even and steady surface.
2. Hold the monitor firmly and insert the lower end of the mounting bracket into the slot on the top of the eye tracker.
3. When the lower end of the mounting bracket is fully inserted into the slot, gently tilt the screen forward.
4. When the mounting bracket is in place, secure it by pushing the lock knob downwards and turning it until it is firmly in place.
If you need to remove the monitor, repeat the above steps in the reverse order.

4.4 Connecting the eye tracker

The Pro Spectrum is connected to a standard Ethernet network with a RJ–45 connector.

Procedure for attaching the power supply:

1. Attach the supplied Ethernet cable to the corresponding Ethernet socket on the eye tracker.
2. Attach the other end of the Ethernet cable to the Ethernet socket on your PC. It is also possible to connect the eye tracker to a switch connected to your LAN.
3. Attach the supplied power adapter cable to the corresponding outlet on the eye tracker.
   a. Choose the power cable with the power plug suited for the electrical outlet and connect the other end to the AC adapter.
   b. If neither of the power plugs suits your needs, please contact your sales representative or Tobii Pro Support for assistance.
   c. Insert the power cable plug to a mains power outlet.

4.4.1 Powering on the Pro Spectrum

The Pro Spectrum’s power switch is located on its back side. We recommend that you shut off the unit after the workday or for longer periods of inactivity.

During startup, the illuminators in the front of the Pro Spectrum, lit up one by one to indicate that the LED-hardware is OK. Approximately 20 seconds after you power on, a short beep is heard, indicating that the processor module has loaded the BIOS and now begins to load the operating system.

After another 20 seconds two long beeps are heard, indicating that the system is ready for use.

If anything goes wrong (no matter the cause), you hear three short beeps about 40 to 50 seconds after the powering-on sequence, followed by a short pause and then another three short beeps.
You turn off the eye tracker by pressing the power switch. During shut down, the power switch indicator lamp flashes. Depending on the unit’s internal state, powering down can take up to 20 seconds.

You force a shutdown of the Pro Spectrum by pressing the power switch for at least 5 seconds.

4.5 Monitor settings

The Pro Spectrum is supplied with a pre-mounted 23.8” monitor.

Note that the monitor has two power switches: one main power switch on the backside and one ON/OFF switch on the front. Make sure the main switch is ON before starting the monitor with the ON/OFF switch.

1. Attach the supplied DisplayPort or HDMI cable to the corresponding connector on your computer.

   It is possible to use any of the other display interfaces on the monitor as well. However, for the best performance we recommend DisplayPort or HDMI, depending on what your PC is equipped for.

2. Choose the power cable with the plug suited for the wall outlet and connect the other end to the corresponding outlet on the monitor.
3. Insert the power cable plug to a power outlet.
4. If neither of the plugs works with your power outlet, please contact your sales representative or Tobii Pro Support for assistance.
5  Setup Options

1. The Pro Spectrum as delivered with the monitor mounted on the eye tracker
2. The Pro spectrum as a standalone eye tracker without monitor
3. Eye tracker and monitor together on a VESA 100x100 mount.
   (Instructions of how to remove the stand and mount the eye tracker and monitor on the VESA mount are in the section below.)
4. Standalone with monitor

   You can use the eye tracker with another monitor, but that is not recommended (see Appendix B).
5.1 Mounting the Pro Spectrum on a VESA mount (setup 3 in the image above)

The Pro Spectrum can be mounted on a standard VESA 100x100 mount. Proceed in the following way:

1. Remove the stand by unscrewing the two screws from the underside (see image below).

2. Fold the two legs upwards so they lie neat against the eye tracker’s side panels (as in setup 3 in the Setup Options-image above). Make sure they don’t cover the ventilation holes on the side panel.

3. Attach the VESA mount to the bracket with four screws.

5.2 Mounting a scene camera

Beneath the eye tracker there is a mount used for attaching a scene camera (purchased separately).

Mounting procedure:

1. Attach the enclosed mounting bracket to your camera unit.

2. Slide the assembly into the scene camera mount and tighten the screw.
6 Eye Tracker Configuration

Tobii Pro Spectrum is configured via Tobii Pro Eye Tracker Manager.

6.1 Tobii Pro Eye Tracker Manager

Tobii Pro Eye Tracker Manager is free software available on the Tobii Pro Products webpage.

Pro Eye Tracker Manager helps you manage your screen-based eye tracker. It lets you see which eye tracker firmware and software versions you are running and also facilitates applicable updates where applicable. It provides:

- Drivers and Firmware installation or updates
- Display setup
- Positioning guide
- User calibration
- Gaze visualization*

You can read more about Tobii Pro Eye Tracker Manager and how it works with Tobii Pro eye trackers (specifications) on our Tobii Pro Eye Tracker Manager Product page.

References in the manual to Tobii Pro Eye Tracker Manager refer to the latest version available on Tobii Pro’s website.

*Gaze visualization in Pro Eye Tracker Manager lets you quickly evaluate the quality of the eye tracking data. The Gaze visualization overlaps data only on the Pro Eye Tracker Manager screen while Pro Eye Tracker Manager is open.

6.2 Keeping your eye tracker software and display setup updated

Updates

From time to time, Tobii Pro releases updates for an eye tracker’s applicable driver and firmware in order to improve performance and/or introduce new functionalities. Please check the Tobii Pro website regularly for news and information about updates about your eye tracker. We recommend that you activate updates and notifications in Pro Eye Tracker Manager.

How to activate notifications and updates in Pro Eye Tracker Manager:

1. Click to expand the drop-down list at the top of Pro Eye Tracker Manager.
2. Toggle the switches for notifications. Orange means they are activated.
3. If a software update is available, the available update has a clickable orange link.
4. Select an interface language. The default is English.

Display setup updates

Use Pro Eye Tracker Manager whenever you change computers or display setups.

All references to Pro Eye Tracker Manager assume that you are using the latest version of this free software.

6.3 Upgrading and downgrading the eye tracker’s firmware

You can determine which firmware version your connected Pro Spectrum uses by reading the details on the displayed card with your eye tracker’s name in Pro Eye Tracker Manager. Firmware versions are listed on the Drivers & Firmware tab.

You can upgrade or downgrade the firmware by resetting the eye tracker to factory defaults and then reinstalling the desired firmware version.

Downgrading:

1. Turn on the eye tracker and confirm that it appears in Pro Eye Tracker Manager.
2. Restart Pro Spectrum by inserting a pointy device (i.e. a straightened paper clip) into the recessed reset button hole, located between the power connector and the data port on the connector panel at the back of the eye tracker. Keep pressing the reset button till you hear a beep.
3. The Pro Spectrum eye tracker restarts one or more times. This is not an error. After a while, your eye tracker appears in Pro Eye Tracker Manager again.
4. On the Drivers & Firmware tab in Pro Eye Tracker Manager, select the desired firmware version from the list and click the Install button.

Upgrading:
1. Turn on the eye tracker and confirm that it appears in Pro Eye Tracker Manager.
2. On the Drivers & Firmware tab in Pro Eye Tracker Manager, select the desired firmware version from the list and click the Install button.

6.4 Configuring Pro Spectrum in Tobii Pro Eye Tracker Manager

In Pro Eye Tracker Manager you can change some settings for your Pro Spectrum. For instance, you can create and recall setups for using the eye tracker in standalone mode and change the eye tracker’s frequency.

6.4.1 Changing the Pro Spectrum's frequency setting
1. Start Pro Eye Tracker Manager. Pro Spectrum will displays as a “card” in the list of available eye trackers at the top.
2. Select Pro Spectrum by clicking on it.
3. On the Drivers & Firmware tab, you can select the desired frequency setting from the drop-down list.

Option with reduced infrared light: If you change the sampling frequency to 60 or 120 Hz, you reduce the brightness of the infrared light from the eye tracker. This is useful when you want a highly unobtrusive setup for the participant. This low visibility option is only available for 60 and 120 Hz.

6.4.2 Configuring Pro Spectrum for standalone use
1. Start Pro Eye Tracker Manager on your computer. All available eye trackers appear in the “Connected Eye Trackers” pane.
2. Select Pro Spectrum by clicking on it.
3. On the Overview tab, locate Display Setup and click the ellipsis button to the right. On the drop-down menu, click New.
4. Follow the instructions in each configuration step, including naming your new setup.
5. When finished, your new setup appears in the drop-down list of display setups.
6. To confirm that Pro Spectrum can detect the participant’s eyes, enable the Position Guide at the bottom left of Pro Eye Tracker Manager. Once activated, you should be able to see two circles in a face contour.
7 Specific Features

7.1 User Calibration for Pro Spectrum

The Pro Spectrum calibration procedure allows for robust eye tracking research by facilitating workflows that take into consideration your research questions, as well as the characteristics of your participant.

Pro Spectrum supports:

1. Binocular calibration
2. Monocular calibration

7.1.1 Binocular calibration

The binocular calibration is successful if enough data has been collected to successfully calibrate both eyes. Calibration results are presented for all the points in which data has successfully been collected for both eyes. To improve a calibration, you can redo the entire calibration or recalibrate the points for which data is missing or not good enough for your research. This is an efficient and powerful method to calibrate your participant’s eyes, suitable for most research questions and for most participants.

Available in:

- Tobii Pro Lab, when selecting the Calibration stimuli in the Design Timeline
- Tobii Pro SDK, when using screen-based calibration class/methods

7.1.2 Monocular calibration

Pro Spectrum’s monocular calibration functionality lets you to collect eye tracking data optimized for each of the eyes of the participant. Pro Spectrum can robustly identify the left and right eyes, irrespective if only one eye or both are visible to the eye tracking sensors. For increased confidence in some cases, you could choose to cover the eye that is not tracked, but this is not required.

This functionality is useful if one eye causes the binocular calibration process to fail. This could happen, for example, due to severe strabismus, or if one eye is a prosthetic.

Separate calibration for the two eyes is also useful for research into binocular coordination and fixation disparity, or in situations where you would like the calibration to pass even if only one eye could be tracked.

Note that a default calibration is used for the eye that was not selected for calibration or that has failed to calibrate. During the recording, Pro Spectrum will continue to search for both eyes because it is less likely to find data for the uncalibrated eye. Nevertheless, Pro Spectrum will report the data for the uncalibrated eye when available.

Pro Spectrum allows for two types of monocular calibration:

- Both eyes
- Only one eye – left or right

Depending on how the calibration flow is implemented in the software, you can choose to perform a calibration for both eyes at a time; calibrate only one eye – left or right; or calibrate first one eye, and then the other.

Calibrating both eyes at a time:

Using the Monocular calibration functionality provides more granularity for your calibration results, reporting on whether the participant’s left, right or both eyes have been successfully calibrated. Results will be presented for each point. In this case you can successfully calibrate even if only one eye was correctly calibrated. You can improve a successful calibration by redoing the calibration, or by selecting to calibrate first one eye and then the other. In this case one can successfully calibrate even if only one eye was successfully calibrated. One can improve a successful calibration by redoing the calibration, or by selecting to calibrate only one eye, and then the other.

Calibrating only one eye at a time:

Using the Monocular calibration functionality lets you calibrate only one of your participant’s eyes, while ignoring the other eye. In this case, a calibration is successful if enough data has been collected for the eye of interest and the other eye is ignored. The calibration results report how good the calibration was for the eye of interest. If the data is not good enough
for your research, you can improve a calibration by redoing the entire calibration or recalibrating the points with missing data for the eye of interest. Proceed with calibrating the other eye if desired.

Available in:

- **Tobii Pro Eye Tracker Manager**, when selecting Calibration mode you can choose between: Both eyes, Right eye or Left eye
- **Tobii Pro SDK**, when using Screen based Monocular calibration class/methods

For more details on how to calibrate Tobii Pro Spectrum using Tobii Pro Eye Tracker Manager, read [Performing a monocular calibration with the Tobii Pro Spectrum](#).

For more details on the Binocular and Monocular calibration using Tobii Pro SDK, visit [developer.tobii.com](http://developer.tobii.com)

### 7.2 Using the TTL input port for external event recording

The Pro Spectrum is equipped with a digital data input port that records events in up to eight parallel TTL signals. The events are recorded with a time-stamp accuracy better than 50 µs. The detected events are available in decimal format (0–255) through either Pro Lab or the Pro SDK. The TTL signal can be combined to obtain up to 256 different events.

Any digital signal source fulfilling the electrical specification can be connected to the tracker, for example the Cedrus Stimtracker.

**Interface:** 8–bit parallel TTL input (DBc9)

**TTL levels:** $V_{in} < 0.8 \text{ V} \Rightarrow \text{Logical 0}$; $V_{in} > 2 \text{ V} \Rightarrow \text{Logical 1}$

**Pinning:** pin 1-8: inputs; pin 9: GND

**Input voltage interval:** 0–5 V

**Connector shielding:** connected to system chassis ground

**Input configuration:** inputs (pin 1-8) are connected to pull up resistors and are opto-isolated.

### 7.3 Eye images

Eye images are available in 10Hz from the Spectrum eye tracker. Each eye tracking camera provides 5Hz image stream. During tracking mode (i.e. when the eye tracker detects eyes), the image resolution is 496x175, except when for 1200 Hz when the resolution is 384x105. During gaze recovery (i.e. when the eye tracker doesn’t detect eyes), the image resolution is 640x512.

The eye images are accessed via Pro SDK. They are also visible in Eye Tracker Manager.
## Appendix A  Pro Spectrum – Specifications

### A1  Eye tracking specifications

The characteristics of the gaze data from an eye tracker are described in terms of accuracy and precision. Accuracy indicates the angular average distance from the actual gaze point to the one measured by the eye tracker. Gaze precision indicates the spatial variation between successive samples collected when the subject fixates at a specific point on a stimuli.

| Eye-tracking technique | Binocular bright and dark pupil tracking  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Two cameras capture stereo images of both eyes for the accurate measurement of eye gaze and eye position in 3D space, as well as pupil diameter</td>
</tr>
</tbody>
</table>

| Sampling frequency | 60, 120, 150, 300, 600 or 1200 Hz (max. frequency depends on product version) |

| Accuracy* | 0.3° at optimal conditions (down to 0.16°) |
| Precision* | 0.06° RMS at optimal conditions (down to 0.04°) |
| Precision filtered* | 0.01° RMS at optimal conditions |

| Maximum gaze angle | 30° |

| Freedom of head movement | Width x height: 34 cm x 26 cm (13.5” x 10”) at 65 cm (at least one eye tracked). |

| Operating distance | 55 to 75 cm (22” and 30”) from the eye tracker reference point |

| Total system latency | Less than three frames (eg. <2.5 ms at 1200 Hz) |

| Blink recovery time | One frame (immediate) |

| Gaze recovery time | Less than 150 ms |

| Recommended monitor | Supplied 23.8” monitor (see note below) |

| Data output (for each eye) | Timestamp  
| Gaze origin  
| Gaze point  
| Pupil diameter |

| Eye image data stream | Eye image stream frequency is approx. 2x5 Hz  
| Zoomed-in eye images are available in tracking mode  
| Full-frame camera images available in gaze recovery mode |

| TTL input stream | 8–bit time-stamped data (256 event codes)  
| Event-driven detection with a timestamp accuracy of 50 µs |

| User calibration options | Standard calibration, 1-14 calibration points  
| Additional options to calibrate only one eye (left/right), or one eye at the time. |

| Tracker and client time synchronization | Integrated synchronization between the eye tracker time domain and the client computer time domain, with an accuracy of 100 µs |

---

*Tobii Pro uses an extensive test method to measure and report performance and data quality. Please download the data quality test report for more detailed information: [https://www.tobiipro.com/tobii-pro-spectrum/](https://www.tobiipro.com/tobii-pro-spectrum/).
A2  Unit specifications

The Pro Spectrum is an integrated eye tracker with a removable 23.8” monitor. Removing the monitor transforms the integrated eye tracker into a standalone eye tracker.

**Eye tracker**

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>55 cm x 18 cm x 6 cm (22” x 7” x 2”)</td>
</tr>
<tr>
<td></td>
<td>The eye tracker is mounted on a stand which raises it 9 cm</td>
</tr>
<tr>
<td></td>
<td>(approximately 4”) from the surface.</td>
</tr>
<tr>
<td>Weight</td>
<td>5.1 kg (11.4 lbs.)</td>
</tr>
<tr>
<td></td>
<td>With the power supply unit, the weight is 5.7 kg (12.9 lbs.)</td>
</tr>
<tr>
<td>Eye tracker processing</td>
<td>Integrated in the eye tracker unit</td>
</tr>
<tr>
<td>User camera mount</td>
<td>Standard 1/4” thread</td>
</tr>
<tr>
<td>Connectors</td>
<td>TTL input: 8-bit (DB-9 connector)</td>
</tr>
<tr>
<td></td>
<td>Communication: Ethernet (RJ-45 connector)</td>
</tr>
<tr>
<td></td>
<td>Power supply: 24 VDC (5.5 mm connector)</td>
</tr>
<tr>
<td>Power</td>
<td>Maximum rated power consumption: 96 W</td>
</tr>
<tr>
<td></td>
<td>Typical power consumption: 60 W</td>
</tr>
<tr>
<td>External power supply</td>
<td>Input: 100-240 VAC 50/60 Hz</td>
</tr>
<tr>
<td></td>
<td>Maximum rated power consumption: 120 W</td>
</tr>
<tr>
<td></td>
<td>No load power consumption: &lt;0.15 W</td>
</tr>
<tr>
<td></td>
<td>Energy efficiency level: VI</td>
</tr>
<tr>
<td></td>
<td>Complies with EISA 2007/DoE, NRCan, AU/NZ MEPS, EU ErP and CoC Version 5</td>
</tr>
<tr>
<td>Monitor</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Monitor model name</td>
<td>EIZO FlexScan EV2451</td>
</tr>
<tr>
<td>Panel type</td>
<td>IPS, LED backlight</td>
</tr>
<tr>
<td>Screen size (diagonal)</td>
<td>23.8”</td>
</tr>
<tr>
<td>Weight</td>
<td>3.8 kg (8.4 lbs.) (including mounting materials)</td>
</tr>
<tr>
<td>Aspect ratio</td>
<td>16:9</td>
</tr>
<tr>
<td>Resolution</td>
<td>1920 x 1080 pixels</td>
</tr>
<tr>
<td>Response time</td>
<td>5 ms (Gray-to-gray)</td>
</tr>
<tr>
<td>Connectors</td>
<td>DVI</td>
</tr>
<tr>
<td></td>
<td>VGA</td>
</tr>
<tr>
<td></td>
<td>HDMI</td>
</tr>
<tr>
<td></td>
<td>Display port</td>
</tr>
<tr>
<td></td>
<td>1 port for monitor control (USB 3.0)</td>
</tr>
<tr>
<td></td>
<td>2–port USB hub (USB 3.0)</td>
</tr>
<tr>
<td></td>
<td>C13 power connector</td>
</tr>
<tr>
<td></td>
<td>Audio input connector: 3.5 mm</td>
</tr>
<tr>
<td></td>
<td>Headphone jack: 3.5 mm</td>
</tr>
<tr>
<td>Built in speakers</td>
<td>1.0 W + 1.0 W</td>
</tr>
<tr>
<td>Power supply</td>
<td>100-240 V AC 50/60 Hz</td>
</tr>
<tr>
<td>Power</td>
<td>Maximum rated power consumption: 42 W</td>
</tr>
<tr>
<td></td>
<td>Typical power consumption: 13 W</td>
</tr>
<tr>
<td></td>
<td>Power Save Mode: 0.5 W</td>
</tr>
<tr>
<td></td>
<td>Power Management: Power Save (VESA DPM, DisplayPort Rev 1.1a, and DVI DMPM)</td>
</tr>
</tbody>
</table>
### A3 Compliance and certifications

The certification and compliance statements in this section are only valid for the eye tracker unit. For compliance and certification of the monitor and external power supply, please see the separate compliance documentation of those.

#### Safety

|                  | UL 60950-1 Edition 2 +A1 +A2  
|                  | CSA 60950-1 Edition 2 + A1 + A2  
|                  | J60950-1 (H29)  
|                  | National differences for Australia to IEC 60950-1, 2nd Edition  
|                  | IEC 62471:2006 (First Edition) |

| Certification and declaration of conformance | ETL Listed (US & Canada)  
|                                            | CB Certificate  
|                                            | CE |
EMC

| EMC standards:       | EN 55032: 2015, Class B |
|                     | EN 55024: 2010 + A1     |
|                     | EN 61000-6-1: 2007      |
|                     | EN 61000-6-3: 2007 + A1|
|                     | CISPR 32: 2015, Class B|
|                     | CISPR 35: 2016         |
|                     | KN 32:2015, class A    |
|                     | KN 35:2015             |
|                     | KN 61000-4-2:2013      |
|                     | KN 61000-4-3:2011      |
|                     | KN 61000-4-4:2011      |
|                     | KN 61000-4-5:2008      |
|                     | KN 61000-4-6:2013      |
|                     | KN 61000-4-11:2008     |

| Certification and declaration of conformance: | FCC, CAN ICES-3 (B)/NMB-3(B), ACMA (RCM), CE, KC* |
|                                               | *Test coverage for KC certification doesn’t include use of the TTL Input port. |

See ETL and CB certificates for details.

Sustainability

| Directives:       | RoHS Directive 2011/65/EU |
|                  | REACH Directive EC 1907/2006 |

This product is exempt from CCC.
## A4 Software Options

Software applications can be connected over TCP/IP (Ethernet connector) as clients to the eye tracker (e.g. perform user calibrations and gather eye gaze data in real-time).

<table>
<thead>
<tr>
<th>Software</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pro Lab</strong></td>
<td>Pro Lab is a comprehensive research software platform for eye tracking designed to meet the highest demands on different research scenarios with exact timing accuracy. This software offers an efficient workflow, making it easy to design experiments, record data, analyze and visualize eye tracking data, and to sync this data with other biometric data streams.</td>
</tr>
<tr>
<td><strong>Pro SDK</strong></td>
<td>Pro SDK offers a broad set of tools that makes it simple to develop a variety of niche applications or scripts across multiple platforms, using a wide range of programming languages. This SDK gives the researcher access to the full set of relevant gaze data streams, such as 3D eye coordinates, raw data, pupil data, etc.</td>
</tr>
<tr>
<td><strong>Pro Eye Tracker Manager</strong></td>
<td>Pro Eye Tracker Manager is a tool used to perform firmware upgrades, configure eye tracker settings and more.</td>
</tr>
</tbody>
</table>
| **Third-party software and framework compatibility** | Compatible with any application supporting the Pro SDK, such as:  
  - E-Prime 3  
  - PyGaze  
  - PsychToolbox  
  - Octave  
  - and others |

The Pro Spectrum is not compatible with the Pro Analytics SDK version 3.0 or older or with Pro Studio.
Appendix B  Recommended monitor

The Pro Spectrum is supplied with a thoroughly tested and approved 23.8” 16:9 LCD monitor. Our recommendation is to use this monitor, which has been tested for weight, dimension and center of gravity for the system set up with the eye tracker unit and screen mounting solution. If you need to use a different monitor, we recommend that you choose a black monitor without any colored décor elements and that the screen bezel is as slim/thin as possible. No connections or buttons should be located underneath the monitor as this could interfere with the mounting of the eye tracker. The monitor must be equipped with a standard 100 x 100 mm VESA mounting interface on the back and it should not weigh more than the supplied monitor.

The eye tracker has undergone tipping tests with the supplied monitor attached. If you choose to use a different monitor, we cannot guarantee the safety of such a combination and you will use it at your own risk.
Appendix C Support, Learning Center, and Warranty

C1 Customer Support
If you need help, please contact Customer Support at Tobii Pro AB. In order to receive assistance as quickly as possible, make sure you have access to your Tobii Pro device and, if possible, an Internet connection. You should also be able to supply the serial number of the device, which you will find on a sticker on the back or bottom of the device.

C1.1 Get Help Online
Many questions can be answered by visiting Tobii Pro Connect. It contains the latest information about contacting Support, links to our Learning Center, and much more. Log in or register to see information about your account and to reach Customer Support. Tobii Pro Connect.

C2 Learning Center
If you are new to eye tracking, or want to extend your knowledge about eye tracking research, sign up for one of our learning programs and events, or browse through our extensive article library in our Learning Center.

For further product information and other support resources, please visit www.tobiipro.com.

C3 Warranty information
For detailed information about the Tobii Pro Limited Warranty and Tobii Pro Care, read the complete PDF.
### Appendix D  Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binocular eye tracking</td>
<td>Tracks and reports data for both left and right eye.</td>
</tr>
<tr>
<td>Blink recovery time (time to tracking recovery for blinks)</td>
<td>When a subject blinks, the eye tracker loses the ability to track eye gaze because the eye is covered by the eyelid. If the pupil is occluded for only a short period (a few hundred milliseconds), the system will regain tracking immediately when the pupil becomes visible again, but only if the subject has maintained approximately the same head position during the blink. Data during blinks are only lost when the pupil is occluded, i.e. during the eye lid movement itself or when the eye is closed.</td>
</tr>
<tr>
<td>Eye-tracking technique</td>
<td>Tobii Pro Eye Trackers use two different techniques to determine eye position: 1. Bright pupil eye tracking, where an illuminator is placed close to the optical axis of the imaging device, causing the pupil to appear lit up (the same phenomenon that causes red eyes in photos). 2. Dark pupil eye tracking where the illuminator is placed away from the optical axis, causing the pupil to appear black.</td>
</tr>
<tr>
<td>Freedom of head movement</td>
<td>Describes the region in space where the participant may move his/her head and still have at least one eye within the eye tracker’s field of view.</td>
</tr>
<tr>
<td>Gaze accuracy</td>
<td>Describes the angular average distance from the actual gaze point to the one measured by the eye tracker.</td>
</tr>
<tr>
<td>Gaze data output frequency</td>
<td>The number of data samples per second output for each eye.</td>
</tr>
<tr>
<td>Gaze precision</td>
<td>Describes the spatial angular variation between individual and consecutive gaze samples (Root Mean Square), calculated on raw data.</td>
</tr>
<tr>
<td>Gaze recovery time (time to tracking recovery after lost tracking)</td>
<td>An eye tracker working in a natural user environment may occasionally lose track of the subject's eyes, e.g., when the subject completely turns away from the tracker. If a period of a few hundred milliseconds elapses during which the eye tracker is unable to detect the eyes in close proximity to where they were last detected, the eye tracker will start searching for the eyes within the entire head movement box. The stated measurement is the typical time to tracking recovery in such a situation.</td>
</tr>
<tr>
<td>Max gaze angles</td>
<td>The maximum gaze angle for which the eye tracker can perform robust and accurate tracking on both eyes. The gaze angle is the angle ABC with A = center of the eye tracker (midpoint between the two eye tracking sensors), B = eye position (midpoint between the left and the right eye) and C = stimuli point.</td>
</tr>
<tr>
<td>Max head movement speed</td>
<td>Describes the maximum head movement speed allowed while maintaining robust tracking. The specified number is for sideways head movement.</td>
</tr>
<tr>
<td>Optimal conditions</td>
<td>Please download the data quality test report: <a href="https://www.tobiipro.com/tobii-pro-spectrum/">https://www.tobiipro.com/tobii-pro-spectrum/</a></td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Operating distance</td>
<td>Describes the minimum and maximum distances between the subject’s eyes and the surface covering the eye tracker sensors at which eye tracking can be done while maintaining robust tracking.</td>
</tr>
<tr>
<td>Processing Latency</td>
<td>Describes the time required by the eye tracker processor to perform image processing and eye gaze computations.</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>Number of data samples per second. The Tobii Spectrum eye trackers have a stable data-rate of 60, 120, 150, 300, 600 or 1200 Hz; that is 60, 120, 150, 300, 600 or 1200 data samples per second are collected for each eye.</td>
</tr>
<tr>
<td>Total system latency</td>
<td>The duration from the mid-point of the eye image exposure, to when a sample is available via the API on the client computer (assuming there is a dedicated Gigabit Ethernet connection). This includes half of the image exposure time, image read-out and transfer time, processing time and time to transfer the data sample to a client computer.</td>
</tr>
</tbody>
</table>
Appendix E  Safety and compliance

E1  Safety

The Tobii Pro Spectrum should be mounted according to the instructions of the approved mounts used. Tobii Pro AB or its agents are not liable for damage or injuries to a person or its property due to the Tobii Pro Spectrum falling from a mounted configuration. The mounting of the Tobii Pro Spectrum is done entirely at the user’s own risk.

E1.1 Emergency Warning

The Tobii Pro Spectrum system is to be used for research purposes only. Be aware that due to the low, but possible risk of failure or distraction, the Tobii Pro Spectrum should not be relied upon or used in dangerous or otherwise critical situations.

E1.2 Infrared Warning

When activated, the Tobii Pro Spectrum emits pulsed infrared (IR) light. Certain medical devices are susceptible to disturbance by IR light and/or radiation. Do not use the Tobii Pro Spectrum when in the vicinity of such susceptible medical devices as their accuracy or proper functionality could be inhibited.

E1.3 Epilepsy Warning

Some people with Photosensitive Epilepsy are susceptible to epileptic seizures or loss of consciousness when exposed to certain flashing lights or light patterns in everyday life. This may happen even if the person has no medical history of epilepsy or has never had any epileptic seizures.

A person with Photosensitive Epilepsy would also be likely to have problems with TV screens, some arcade games, and flickering fluorescent bulbs. Such people may have a seizure while watching certain images or patterns on a monitor, or even when exposed to the light sources of an eye tracker. It is estimated that about 3-5% of people with epilepsy have this type of Photosensitive Epilepsy. Many people with Photosensitive Epilepsy experience an “aura” or feel odd sensations before the seizure occurs. If you feel odd during use, move your eyes away from the eye tracker.

E1.4 Child Safety

The Tobii Pro Spectrum is an advanced computer system and electronic device. As such it is composed of numerous separate, assembled parts. In the hands of a child certain of these parts have the possibility of being separated from the device, possibly constituting a choking hazard or another danger to the child.

Young children should not have access to, or use, the device without parental or guardian supervision.

E1.5 Do not open Tobii Pro Spectrum

Non-compliance will result in loss of Warranty! There are no user serviceable components inside. Contact Tobii Pro Support if your Tobii Pro Spectrum is not working properly.
E1.6 Environment

The Tobii Pro Spectrum system is designed for use in dry indoor environments. Avoid any exposure to direct sunlight as this will affect eye tracking quality and longer exposure can overheat the equipment. Avoid exposure to any liquids, gels, moist, rain, sweat or other damp materials or environments. Do not use the eye tracker near water – the device is not water resistant.

Keep the eye tracker in a clean and dust free environment. When using the equipment take adequate precautions against dust and dirt.

Do not place or use the equipment in places subject to extreme temperatures and humidity, such as on top of and or near a heating element, in a hot or damp room, or in a hot automobile in the sun.

E2 Other limitations and considerations

E2.1 Intended use

The Tobii Pro Spectrum is intended to be used in research activities about human behavior including eye movements, in a dry and dust free indoor environment. The product should only be used as described in the User Manual. Please read the User Manual and other supplied documentation thoroughly before using the product.

E2.2 Light conditions

We recommend that eye tracking studies be performed in a controlled environment. Sunlight should be avoided since it contains high levels of infrared light which will interfere with the eye tracker system. Sunlight affects eye tracking performance severely and longer exposure can overheat the eye tracker. The eye tracker is not designed for exposure to (direct) sunlight. Eye tracking generally does not work in strong direct sunlight. Shielding the eye tracker adequately from the sun may prevent sunlight from interfering with eye tracking.

E2.3 Eyelashes

Long eyelashes can be obstructive when the participant’s eyes are less open, especially if the participant is wearing mascara. In rare cases, eyelashes may completely block the view of the participant’s pupils, making eye tracking impossible.

E2.4 Droopy eyelids

Droopy eyelids or otherwise obstructive eyelids can block the view of the participant’s pupils. In rare cases, such eyelids may completely block the view of the participant’s pupils, making eye tracking impossible.