

**tobii**

Tobii Pro Spectrum  
User Manual

## Tobii Pro Spectrum User Manual

v 2.9

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# 1 Introduction

## 1.1 Overview

Tobii 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. It supports research investigating blinks and eye closure dynamics, based on raw pupil and eye openness signal data (for example, constriction/dilation velocity, lid closure rate and acceleration).

The eye tracker's design enables the subject to move naturally during recording while still achieving high accuracy and precision. In 2022, Tobii introduced Eye Tracking modes so that researchers can choose between human and nonhuman primate modes. Read more about [Nonhuman primate modes](#).

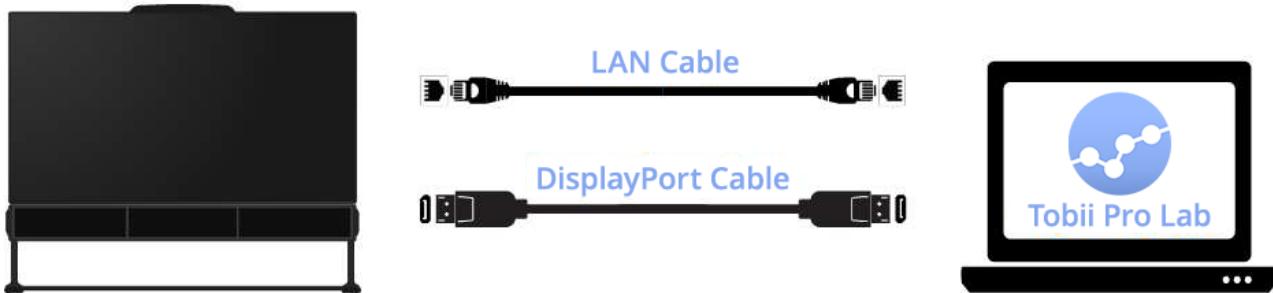


Figure 1. The typical setup is using Tobii Pro Spectrum connected to a PC that is running Tobii Pro Lab.

## 1.2 Basic operating principles

Tobii 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

Tobii Pro Spectrum is available in three product versions: 1200 Hz, 600 Hz, and 300 Hz. The values denote the eye tracker's maximum sampling frequency, but it can be used at lower settings as well. The 600 Hz and 300 Hz versions can be upgraded to a faster version. For more information, contact your sales representative or visit Tobii [online](#).

## 1.4 Additional software options

<a href="#"><u>Tobii Pro Lab</u></a>	Tobii 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.
<a href="#"><u>Tobii Pro SDK</u></a>	Tobii 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.
Third-party software	This term refers to any application built on Tobii Pro SDK.

## 2 What's in the Tobii Pro Spectrum box

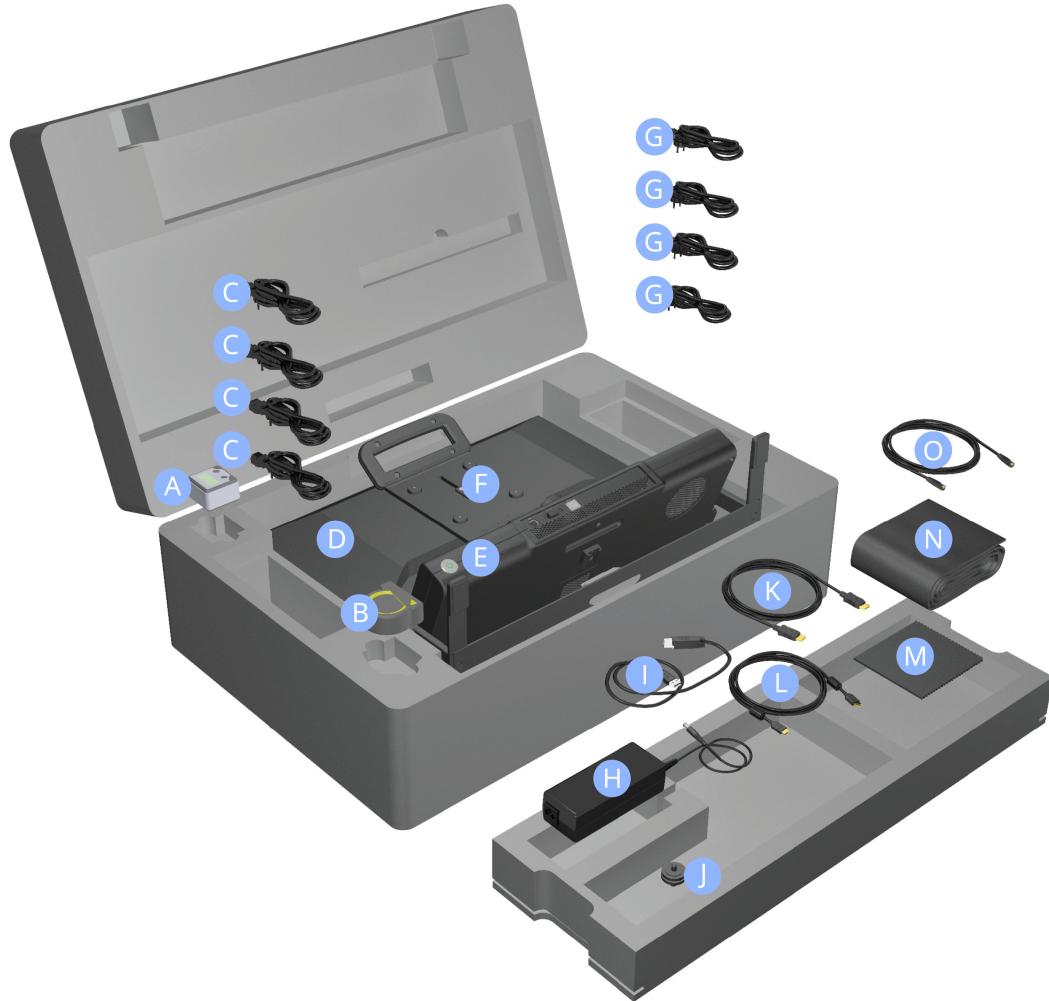


Figure 2. The contents of the Tobii Pro Spectrum box.

A. Angle meter	I. USB cable for connection between the PC and the monitor's integrated USB hub
B. Measuring tape	J. Cold shoe for mounting of a user camera
C. Power cables for monitor *	K. DisplayPort cable
D. Monitor	L. HDMI cable
E. Eye tracker	M. Cleaning cloth
F. Monitor mounting bracket	N. Fabric cord sleeve for collecting the cables
G. Power cables for eye tracker *	O. Ethernet cable
H. Power adaptor for eye tracker	

\* UK, US, EU, and Aus/China

# 3 Safety

## 3.1 Mounting warning



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

## 3.2 Emergency warning



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

## 3.3 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.

## 3.4 Infrared warning



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

### 3.5 Child safety



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.

### 3.6 Do not open Tobii Pro Spectrum



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

### 3.7 Environment



Tobii Pro Spectrum 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.

# 4 Compliance Information

## 4.1 EU Compliance

### 4.1.1 CE statement



Tobii Pro Spectrum is CE-marked, certifying compliance with the essential requirements for health, safety, and environmental protection requirements for the European Single Market. Tobii Pro Spectrum complies with the following directives:

- 2014/35/EU (LVD) – Low Voltage Directive.
- 2014/30/EU (EMC) – Electromagnetic Compatibility Directive.
- 2011/65/EU (RoHS) – Restriction of Hazardous Substances Directive.

### 4.1.2 Other EU directives and regulations

Tobii AB and Tobii Pro Spectrum comply with the essential requirements of the following EU directives and regulations:

- 2012/19/EU (WEEE) – Waste Electrical and Electronic Equipment Directive.
- 1907/2006 EC (REACH) – Registration, Evaluation, Authorization and Restriction of Chemicals.

Furthermore, Tobii AB complies with applicable parts of the Directive 94/62/EC on packaging and packaging waste.

## Manufacturer Contact Information

Tobii AB

Karlsrovägen 2D

S-182 53 Danderyd, Sweden

## 4.2 UKCA Statement



Tobii Pro Spectrum is UKCA-marked, certifying compliance with the essential requirements for health, safety, and environmental protection requirements for the GB market. Tobii Pro Spectrum complies with the following statutory instruments:

- The Electrical Equipment (Safety) Regulations 2016. UK Statutory Instruments 2016 No. 1101.
- The Electromagnetic Compatibility Regulations 2016. UK Statutory Instruments 2016 No. 1091.
- The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012. UK Statutory Instruments 2012 No. 3032.

#### 4.2.1 Other UK Legislation

Tobii AB and Tobii Pro Spectrum comply with the essential requirements of the UK regulations regarding WEEE, REACH, packaging and packaging waste.

#### UK Importer Contact Information

Tobii UK Limited

1st Floor, Advantage House, 87 Castle Street  
RG1 7SN Reading, United Kingdom

### 4.3 FCC interference statement

Tobii Pro Spectrum has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. Tobii Pro Spectrum generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If Tobii Pro Spectrum does cause harmful interference to radio or television reception, which can be determined by turning Tobii Pro Spectrum off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between Tobii Pro Spectrum and receiver.
- Connect Tobii Pro Spectrum into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Modifications not expressly approved by Tobii AB could void the user's authority to operate Tobii Pro Spectrum under FCC rules.

#### U.S. Responsible Party Contact Information

Tobii Technology, Inc.

12007 Sunrise Valley Dr # 400

Reston, VA 20191, USA

### 4.4 ISED statement

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

## 4.5 NRTL listed



Tobii Pro Spectrum head unit is ETL Listed. Control number 5001591.

## 4.6 Australia and New Zealand compliance



Tobii Pro Spectrum is registered in the Australian National Equipment Registration System.

Tobii Pro Spectrum is RCM-marked which signifies compliance with the Australian and New Zealand product safety requirement for electrical and electronic equipment according to EESS and radio communication and electromagnetic compatibility according to ACMA.

## 4.7 Korea compliance



Tobii Pro Spectrum is KC-marked which signifies compliance with Korea's product safety requirements for electrical and electronic equipment.

Certificate number:

R-REI-TBI-ProSpec

## 4.8 Safety compliance

Tobii Pro Spectrum complies with the following standards:

- EN IEC 62471:2008, Photobiological safety of lamps and lamp systems.
- EN 62368-1:2014 +A11, Audio/video, information and communication technology equipment - Part 1: Safety requirements.
- IEC 62368-1:2018, Audio/video, information and communication technology equipment - Part 1: Safety requirements.

Including national deviations for European Group, Australia, New Zealand, China, Japan, USA, and Canada.

- UL 62368-1: 2019 Ed.3+R:22Oct2021, CSA C22.2#62368-1:2019 Ed.3 + U1, Audio/video, information and communication technology equipment - Part 1: Safety requirements.

## 4.9 EMC compliance

Tobii Pro Spectrum complies with the following standards:

- EN 55032:2015/A11, Electromagnetic compatibility of multimedia equipment - Emission requirements.

- EN 55035:2017/A11, Electromagnetic compatibility of multimedia equipment - Immunity requirements.
- FCC 47 CFR Part 15, Subpart B, Class B.
- ICES-003 Issue 7 Class B, Information Technology Equipment (including Digital Apparatus).
- CISPR32:2015, Electromagnetic compatibility of multimedia equipment - Emission requirements (International standard accepted in AS/NZS and Japan).
- KN32, Electromagnetic interference prevention test for multimedia equipment.
- KN35, Electromagnetic wave immunity test for multimedia devices.
- EN 61000-3-2:2014, Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current  $\leq$  16 A per phase).
- EN 61000-3-3:2013, Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current  $\leq$  16 A per phase and not subject to conditional connection.

## 4.10 RoHS compliance

RoHS compliance for Tobii Pro Spectrum is achieved by following the standard:

- EN IEC 63000: 2018, Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.

## 4.11 Waste disposal and recycling

Tobii AB is committed to reducing the environmental impact of our products throughout their life-cycle, from manufacturing to use and disposal. We are a member of various compliance schemes for collection, recycling and re-using of electronic waste, batteries, and packaging of our products.



Tobii Pro Spectrum is marked with the crossed-out wheeled bin symbol, which indicates that it must not be disposed of with household waste. You can return your used Tobii Pro Spectrum to one of the municipality's recycling centers free of charge.

Due to the size of the eye tracker, Tobii Pro Spectrum is eligible for Tobii's Take-back program. We encourage our Tobii Pro Spectrum customers to arrange recycling with a local recycling partner, to avoid emission from transport.

For more information about the WEEE directive and recycling at Tobii AB, please visit: [How we run our business](#)

or



# 5 Set up Tobii Pro Spectrum

## 5.1 Ventilation

As with most electronic devices, Tobii 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.

## 5.2 Test environment

Tobii 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)

## 5.3 Mount the monitor to the eye tracker

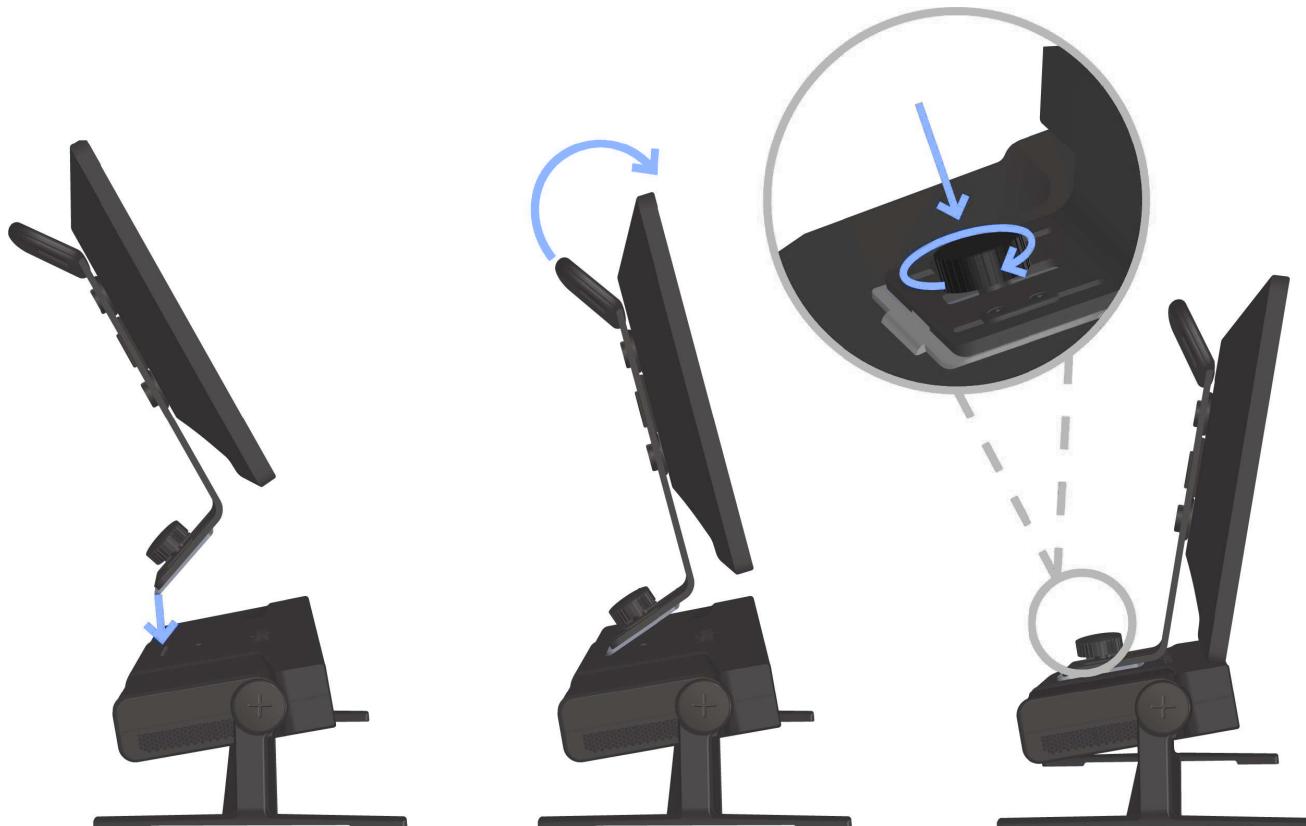


Figure 3. Mount the monitor to the eye tracker unit.

Tobii 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.

#### How to attach 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.

#### 5.4 Connect the eye tracker

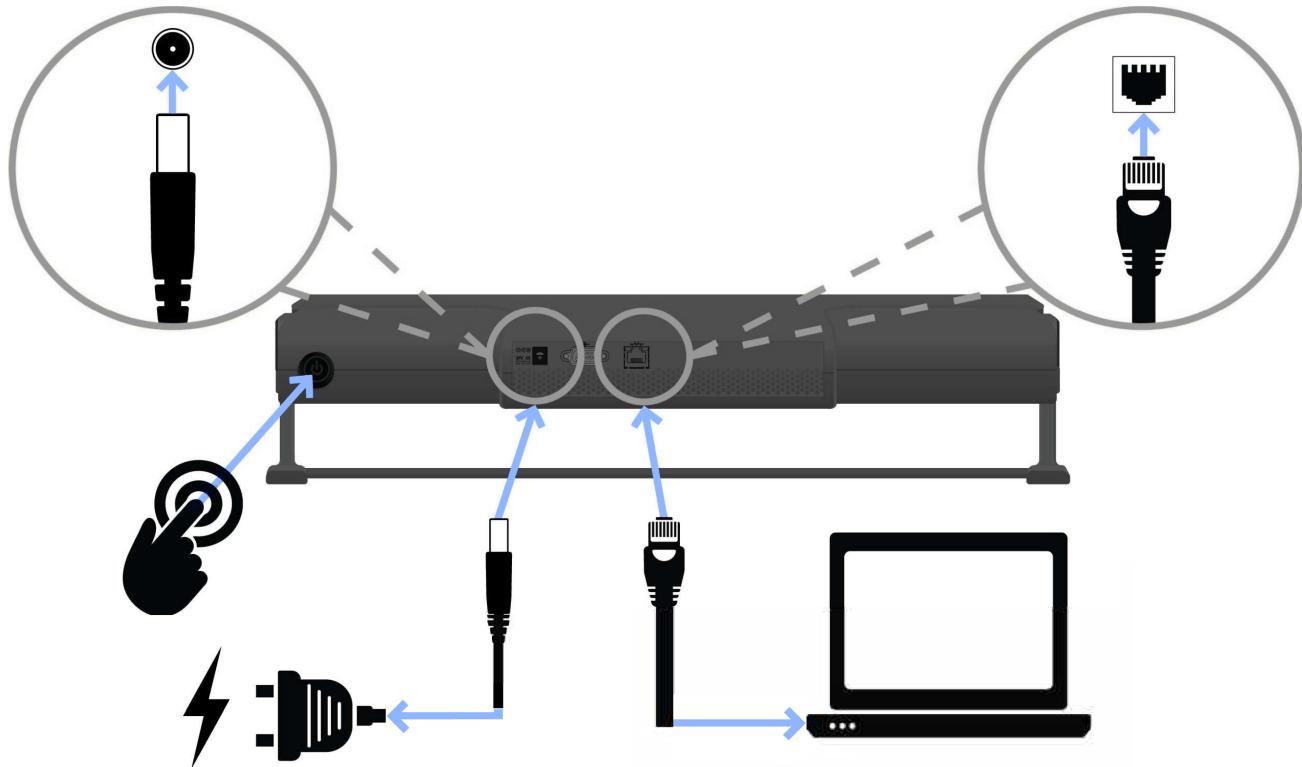


Figure 4. Tobii Pro Spectrum is connected to a standard Ethernet network with a RJ-45 connector.

## How to attach 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 cord 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 cord plug to a mains power outlet.

### 5.4.1 Power on Tobii Pro Spectrum

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

## 5.5 Monitor settings

Tobii 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.

*Figure 5. Monitor settings for power ON/OFF Tobii Pro Spectrum.*

1. Attach the supplied Display Port 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 Display Port 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 work with your power outlet, please contact your sales representative or Tobii Pro Support for assistance.

# 6 Display settings



Figure 6. Display options for Tobii Pro Spectrum.

1. Tobii Pro Spectrum shown as delivered with the monitor mounted on the eye tracker.
2. Tobii Pro Spectrum as a standalone eye tracker without the monitor.
3. Eye tracker and monitor together on a VESA 100x100 mount.
4. Standalone with monitor.



You can use the eye tracker with another monitor, but it is not recommended.  
For more information, read [Recommended monitor](#).

## 6.1 User coordinate system

User Coordinate System (UCS): a coordinate system used to communicate 3D positions for gaze calculations. The origin of the UCS is located at the top (center) of the eye tracker. This is also the external reference point for physical measurements for standalone setups.



For more information, read [Coordinate Systems](#).

## 6.2 VESA mount

Tobii Pro Spectrum can be mounted on a standard VESA 100 x 100 mount. For more information, read [Display settings](#).

**Here's what to do:**

Remove the stand by unscrewing the two screws from the underside.

Figure 7. How to attach the VESA mount.

1. Fold the two legs upwards so they lie neat against the eye tracker's side panels. Make sure they don't cover the ventilation holes on the side panel.
2. Attach the VESA mount to the bracket with four screws.

### 6.3 Scene camera mount

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

**Here's what to do:**

1. Attach the enclosed mounting bracket to your camera unit.
2. Slide the assembly into the scene camera mount and tighten the screw.

# 7 Tobii Pro Spectrum configuration

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

## 7.1 Tobii Pro Eye Tracker Manager

Tobii Pro Eye Tracker Manager is free software available on [Tobii Connect](#).

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

- Drivers and Firmware installation or updates
- Display setup
- Eye tracker frequency
- Eye tracking mode selection
- Positioning guide
- User calibration
- Gaze visualization<sup>1</sup>
- Eye images<sup>2</sup>
- Get diagnostics<sup>3</sup>



References in product documentation to Tobii Pro Eye Tracker Manager refer to the latest version available on Tobii's website.

## 7.2 Keep your eye tracker software updated

From time to time, Tobii 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 website regularly for news and information about updates about your eye tracker. We recommend that you leave updates and notifications in Tobii Pro Eye Tracker Manager activated. (They are activated by default and the sliders are colored blue.)

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

---

<sup>1</sup>Gaze visualization in Tobii Pro Eye Tracker Manager lets you quickly evaluate the quality of the eye tracking data. The Gaze visualization overlaps data only on the Tobii Pro Eye Tracker Manager screen while Tobii Pro Eye Tracker Manager is open.

<sup>2</sup>Applicable when Tobii Pro Eye Tracker Manager is used with eye trackers that support eye images (Tobii Pro Spectrum and Tobii Pro Fusion).

<sup>3</sup>Get diagnostics button enables you to collect an encrypted blob file with full frame images and eye tracker logs to send to Customer Care for assistance with troubleshooting.

1. Expand the dropdown list at the top of Tobii Pro Eye Tracker Manager.
2. Toggle the switches for notifications. Blue means they are activated.
3. If a software update is available, the available update has a clickable link.
4. Select an interface language. The default is English.

### 7.3 Keep your display setup updated

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



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

### 7.4 Upgrade and downgrade the eye tracker's firmware

You can determine which firmware version your connected Tobii Pro Spectrum uses by reading the details on the displayed card with your eye tracker's name in Tobii 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.

#### Downgrade:

1. Turn on the eye tracker and confirm that it appears in Tobii Pro Eye Tracker Manager.
2. Restart Tobii 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. Tobii Pro Spectrum eye tracker restarts one or more times. This is not an error. After a while, your eye tracker appears in Tobii Pro Eye Tracker Manager again.
4. On the Drivers & Firmware tab in Tobii Pro Eye Tracker Manager, select the desired firmware version from the list and click the Install button.

#### Upgrade:

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

### 7.5 Configure your eye tracker in Tobii Pro Eye Tracker Manager

In Tobii Pro Eye Tracker Manager you can change some settings for your eye tracker. For example, you can create and recall setups for using the eye tracker in standalone mode, select the eye tracking mode, and change the eye tracker's frequency.

### 7.5.1 Change Tobii Pro Spectrum frequency and mode

1. Start Tobii Pro Eye Tracker Manager. Tobii Pro Spectrum will display as a “card” in the list of available eye trackers at the top.
2. Select Tobii Pro Spectrum.
3. Select the desired frequency setting from the dropdown list on the first tab.



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.

4. Select the desired eye tracker mode from the dropdown list. See more information in [Eye tracking specifications](#).

### 7.5.2 Configure Tobii Pro Spectrum for standalone use

1. Start Tobii Pro Eye Tracker Manager on your computer. All available eye trackers appear in the “Connected Eye Trackers” pane.
2. Select Tobii Pro Spectrum by clicking on it.
3. On the Overview tab, locate Display Setup and click the ellipsis button to the right. On the dropdown 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 dropdown list of display setups.
6. To confirm that Tobii Pro Spectrum can detect the participant’s eyes, enable the Position Guide at the bottom left of Tobii Pro Eye Tracker Manager. Once activated, you should be able to see two circles in a face contour.

# 8 Additional features

## 8.1 User calibration for Tobii Pro Spectrum

Tobii 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.

Tobii Pro Spectrum supports:

- Binocular calibration
- Monocular calibration

### 8.1.1 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

### 8.1.2 Monocular calibration

Tobii Pro Spectrum's monocular calibration functionality lets you to collect eye tracking data optimized for each of the eyes of the participant. Tobii 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, Tobii Pro Spectrum will continue to search for both eyes because it is less likely to find data for the uncalibrated eye. Nevertheless, Tobii Pro Spectrum will report the data for the uncalibrated eye when available.

**Tobii 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 the 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 information on how to calibrate Tobii Pro Spectrum using Tobii Pro Eye Tracker Manager, read the Learn article, [Performing a monocular calibration with the Tobii Pro Spectrum](#).

For more information on the Binocular and Monocular calibration using Tobii Pro SDK, visit the [Tobii developer site](#).

## **8.2 Use the TTL input port for external event recording**

Tobii 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 timestamp accuracy better than 50 µs. The detected events are available in decimal format (0-255) through either Pro Lab or 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: Vin <0,8 V=>; Vin > 2 V => Logical 1

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

Input voltage interval: 0-5 V

Connector shielding: connect to system chassis ground

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

### 8.3 Eye images

Eye images are available in 5 Hz from Tobii Pro Spectrum eye tracker. Each eye tracking camera provides a 5 Hz image stream. During tracking mode (i.e., when the eye tracker detects eyes), the image resolution is 496 x 175 px, except for 1200 Hz when the resolution is 384 x 105 px. During gaze recovery (i.e., when the eye tracker does not detect eyes), the image resolution is 640 x 512 px.

The eye images are accessed via Tobii Pro SDK. They are also visible in Tobii Pro Eye Tracker Manager.

### 8.4 Eye openness

Tobii Pro Spectrum provides a raw, unprocessed eye openness signal. The eye openness data is provided in mm, for the left and the right eye individually, at the same frequency as the gaze. (For example, in 1200 Hz when the eye tracker's frequency is set to 1200 Hz and 600 Hz when the frequency is set to 600 Hz.)

The eye openness signal can be used independently of the other signals. The timestamp of the eye openness signal will match those in the gaze stream, as they are based on the same eye images.



The eye openness signal is available in firmware (FW) version 2.6.1 or later. It also requires Tobii Pro SDK version 1.10 or later.

### 8.5 Eye tracking mode

Tobii Pro Spectrum provides modes for different groups of nonhuman primate species, due to variations in facial and eye features. Available modes are human, great ape, monkey, and small monkey. Each nonhuman primate mode is described in the Appendix [Nonhuman primate modes](#).



The eye tracking modes monkey and great ape are available in FW version 2.6.1 or later and requires Tobii Pro SDK version 1.10 or later. Eye tracking mode small monkey is available in FW version 2.9.0 or later and requires Tobii Pro SDK version 1.11 or later.

# 9 Product care and liability

## 9.1 Transportation and storage

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

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)



Tobii 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.

## 9.2 Cleaning

Before cleaning Tobii 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.



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

## 9.3 Disinfection

The surfaces of 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.

## 9.4 Disposal of the eye tracker

Do not dispose of your Tobii Pro eye tracker in general household or office garbage receptacles. Follow your local regulations for the proper disposal of electrical and electronic equipment.

## 9.5 Limitation of liability

Except where prohibited by law, Tobii AB is not liable for any loss or damage arising from the use or misuse of a Tobii eye tracker or the mounting plate, whether direct, indirect, special, incidental or consequential, regardless of the legal theory asserted, including warranty, contract, negligence, or strict liability.

# 10 Technical specifications

For definitions of terms used in the tables below, see the [eye tracker glossary](#) on Tobii Connect.

## 10.1 Eye tracking specifications

The characteristics of the gaze data from an eye tracker are described in terms of accuracy and precision. For more details, take the *Accuracy and precision* course in [Tobii Academy](#). See notes below.



For more information about output data and the supplementary data stream, please read the [Tobii Pro SDK documentation](#).

Eye tracking technique	Video-based pupil and corneal reflection eye tracking with dark and bright pupil illumination modes. Two cameras capture stereo images of both eyes for robust, accurate measurement of eye gaze and eye position in 3D space, as well as pupil diameter.
Eye tracking mode	Tobii Pro Spectrum has four different eye tracking modes for different groups of primate species: <ul style="list-style-type: none"><li>• Human</li><li>• Great ape</li><li>• Monkey</li><li>• Small monkey</li></ul> For details, see <a href="#">Nonhuman primate modes</a> .
Sampling frequency	60 Hz, 120 Hz, 150 Hz, 300 Hz, 600 Hz, or 1200 Hz (max. frequency depends on hardware version)
Precision <sup>1</sup>	<b>Head supported<sup>2</sup></b> 0.01° RMS in optimal conditions (applying Savitzky-Golay filtering, settings listed in the <a href="#">test report</a> ) 0.06° RMS in optimal conditions (raw signal) <b>Head free-to-move<sup>3</sup></b> 0.02° RMS (applying Savitzky-Golay filtering, settings listed in the <a href="#">test report</a> ) 0.08° RMS (raw signal)
Accuracy <sup>1</sup>	<b>Head supported<sup>2</sup></b> Down to 0.15° $P_{50}$ : 0.30° ( $P_{25}$ : 0.23° - $P_{75}$ : 0.41°) <b>Head free-to-move<sup>3</sup></b> Down to 0.17° $P_{50}$ : 0.43° ( $P_{25}$ : 0.32° - $P_{75}$ : 0.6°)
Binocular eye tracking	Yes

Eye tracker latency	Mean latency < 2 ms at 1200Hz (SD < 0.2 ms) <sup>4</sup>
Blink recovery time	1 frame (immediate)
Gaze recovery time	Less than 150 ms
Data sample output	Timestamp, Gaze origin, Gaze point, Pupil diameter
Eye openness data stream	Eye openness stream has the same frequency as frequency selected for the gaze stream and will have the same timestamps. Eye openness data is provided in millimeters, for each eye individually.
Eye image data stream	Eye image stream frequency is approximately 10 Hz (one image with both eyes). Zoomed-in eye images available in tracking mode. Full-frame camera images are available in gaze recovery mode.
TTL input stream	8-bit timestamped data (256 event codes) Event driven detection with a timestamp accuracy of 50 µs
Tracker and client time synchronization	Integrated between the eye tracker time domain and the client computer time domain with an accuracy of 100 µs
User calibration	Binocular, Monocular

<sup>1</sup> Tobii uses an extensive test method to measure and report performance and quality of data with human participants. Please download the [test report](#) for more detailed information. To learn more about nonhuman primate data quality, please contact your Sales representative.

<sup>2</sup> Head supported specs are measured with 20 participants under optimal conditions and chinrest. Values represent the average for the entire screen area. Download [Tobii Pro Spectrum Laboratory Metrics Test Report](#) to read the full report.

<sup>3</sup> Head free-to-move specs are measured with a sample of 400+ participants without any head restriction. The setup and test environment are selected to represent normal usage and illustrate the performance of the eye tracker with a variety of participants and for the entire screen area.

<sup>4</sup> Visit [Tobii Connect](#) for more information on how to optimize your Tobii Pro Spectrum setup.

Note: FW v.2.2.3 and Pro SDK v.1.9 or later are required to obtain the stated performance.

## 10.2 Setup

For definitions, see the [Tobii eye tracker glossary](#) on Tobii Connect.

Head movement tolerance	Excellent; Dual-camera system, with more images than a one camera system, gives a more accurate data calculation and the best level of precision and robustness for head movement.
Operating distance (mounted on screen)	55 cm to 75 cm (22" to 30") from the eye tracker
Freedom of head movement (width × height)	<i>Freedom of head movement at 65 cm distance</i> 34 cm × 26 cm (13.5" × 10")
	<i>Freedom of head movement at 75 cm distance</i> 42 cm × 26 cm (16.5"× 10")
Optimal screen size	Up to 24" (16:9 aspect ratio)

Recommended monitor	Supplied 23.8" monitor
Tracker setup options	 <p>Eye tracker mounted on a tripod, allows for even larger screens or physical objects to be tracked.</p>
Participant setup	Very simple and easy. Typically, less than 1 minute.

### 10.3 Software and framework compatibility

Software and framework compatibility	Tobii Pro Lab Tobii Pro Eye Tracker Manager Tobii Pro SDK Any application built on the Tobii Pro SDK
Operating system	Windows, macOS, Linux

### 10.4 Hardware versions

300 Hz

600 Hz

1200 Hz

### 10.5 Tobii Pro Spectrum eye tracker specifications

Tobii 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

Dimensions (L × H × W)	55 × 18 × 6 (22" × 7" × 2") The eye tracker is mounted on a stand, which raises it from the surface by 9 cm (approximately 4").
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Weight	5.1 kg (11.4 lbs.) With the power supply unit, the weight is 5.7 kg (12.9 lbs.)
Connectors	TTL input: 8-bit (DB-9 connector) Communication: Ethernet (RJ-45 connector) Power supply: 24 VDC (5.5 mm connector)
Data processing	Fully embedded data processing
Eye tracking cameras	2
Illuminators	Dark pupil illumination modules Bright pupil illumination modules
User camera mount	Standard 1/4" thread
Power Consumption	Typical power consumption: 60 W Max. rated power consumption: 96 W
Power Options	Input: 100-240 VAC 50/60 Hz Max. rated power consumption: 120 W No load power consumption: <0.15 W Energy efficient level: VI Complies with EISA 2007/DoE, NRCan, AU/NZ MEPS, EU ErP and CoC Version 5

## Monitor

Monitor model name	EIZO FlexScan EV2451
Panel type	IPS, LED backlight
Screen size (diagonal)	23.8"
Weight	3.8 kg (8.4 lbs), incl. mounting
Aspect ratio	16:9
Resolution	1920 × 1080 pixels
Screen response time	5 ms (gray-to-gray)
Connectors	DVI VGA HDMI Display port 1 port for monitor control (USB 3.0) 2-port USB hub (USB 3.0) C13 power connector Audio input connector: 3.5 mm Headphone jack: 3.5 mm
Built in speakers	1.0 W + 1.0 W

Power supply	100-240 VAC 50/60 Hz
Power	<p>Maximum rated power consumption: 42 W</p> <p>Typical power consumption: 13 W</p> <p>Power save Mode: 0.5 W</p> <p>Power Management: Power Save (VESA DPM, Display Port- Rev 1.1a, and DVI DMPM)</p>

# Appendix A Nonhuman primate modes

Tobii worked closely with primate labs around the world to develop new image collections to train our systems and continually develop our software. By capturing eye movements while untrained and with naturalistic head movement, primates can choose for themselves whether to interact with the screen or not during an eye tracking study. The improved calibration process makes it easier to calibrate energetic participants.

Tobii Pro Spectrum has different eye tracking modes for different groups of nonhuman primate species, due to differences in physical appearance (facial and eye features). Each eye tracking mode was developed using data from the respective species or group of species.

## A1 Great ape

The following species are currently supported by Tobii Pro Spectrum:

- **Chimpanzee** (*Pan troglodytes*) - adults
- **Bonobo** (*Pan paniscus*) - adults
- **Gorilla** (*Gorilla gorilla*) - adults
- **Orangutang** (*Pongo abelii*) - adults

## A2 Monkey

The following species are currently supported by Tobii Pro Spectrum:

- **Rhesus macaque** (*Macaca mulatta*) - adults and infants
- **Long-tail macaque** (*Macaca fascicularis*) - adults

## A3 Small monkey

Tobii Pro Spectrum is tailored for the following species:

- **Common marmoset** (*Callithrix jacchus*) - adults
- **Rhesus macaque** (*Macaca mulatta*) - infants

## Appendix B     Recommended monitor

Tobii 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, Tobii cannot guarantee the safety of such a combination and you will use it at your own risk.

# Appendix C Customer Care, training, and warranty

## C1 Customer Care

For technical issues, please contact Tobii Customer Care via [Tobii Connect](#). To receive assistance as quickly as possible, make sure you have access to your eye tracker and, if possible, to an internet connection. You should also be able to supply the serial number of the eye tracker, which you can find on the back or bottom of the device.

### C1.1 Get help

Many questions can be answered by visiting Tobii Connect. It contains the latest information about contacting Customer Care, helpful articles and FAQs, links to downloads, and much more. Log in or register to see information about your account and to reach Customer Care on [Tobii Connect](#).

## C2 Training and education services

If you are new to eye tracking, or want to extend your knowledge about eye tracking research, sign up for one of our online sessions, onsite trainings, Tobii Academy, and more on [Training and education services](#).

## C3 Warranty information

Read more online about [Tobii limited warranty and Tobii Care](#) (PDF download).

# Appendix D      Limitations and considerations

## D1    Intended use



Tobii Pro eye trackers are 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 this User Manual. Please read the User Manual and other supplied documentation thoroughly before using the product.

## D2    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. This 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.

## D3    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.

## D4    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.

# Appendix E      Glossary

For definitions of eye tracking terms used in this manual, see the [Tobii eye tracker glossary](#) on Tobii Connect.



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## Support for your Tobii product

### Get help

Visit [Tobii Connect](#) for help with your Tobii device. It contains the latest information about contacting Customer Care, documentation, courses, articles, and more.

### Contact your solution consultant or reseller

For questions or issues with your product, contact your Tobii sales representative or authorized reseller for assistance. They are most familiar with your personal setup and can help you with tips and product training.