Product Description

Tobii X2-30 Eye Tracker Tobii X2-60 Eye Tracker



Product Description

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1 Introduction

1.1 Overview

This document describes the features and functionality of the Tobii X2 Eye Trackers. The X2 Eye Tracker is a stand alone eye tracker that can be used in various setups by attaching it to monitors, laptops or for performing eye tracking on physical objects. The eye tracker requires some assembly before first time use and after transport.

The Tobii X2 Eye Tracker is an unobtrusive eye tracker for detailed research of natural behavior. Its large head movement box allows the subject to move during recording while maintaining accuracy and precision. The Tobii X2 Eye Trackers offer maximum flexibility with numerous software and stimuli set-up options.

The eye tracker comes in two different versions: the Tobii X2-30 with a sampling rate of 30 Hz and the Tobii X2-60 with a sampling rate of 60 Hz.

- The Tobii X2–30 and X2–60 Eye Trackers are small eye trackers measuring only 184 mm (7.2") in length. It enables your portable eye tracking lab and studies that require an eye tracker to track even large objects at close distances (up to 36° gaze angle). Use the eye trackers to conduct studies on:
 - Laptops
 - PC monitors up to app. 25" (16:9)
 - Mobile devices
 - Real-world interfaces
 - Projections, simulators
 - TV screens

Tobii X2-30 Eye Tracker mounted on a laptop and a computer monitor (laptop and monitor not included):





1.2 Applications Areas

The modular system can be used both in screen and real-world test scenarios, making way for a very broad spectrum of studies. You can mount the eye tracker on a laptop, a PC monitor, an all-in-one PC, or even a tablet. Present your stimuli using a projection or TV. You can study real-world interfaces like a control panel, an ATM or a store shelf. The supplied mounting solutions support a variety of study designs.

• Tobii X2–30 Eye Tracker — is designed for studies primarily aimed at determining precisely where the participants are looking — the gaze point—rather than studying timing, duration of fixations or eye movements such as saccades, for example.

Tobii X2–60 Eye Tracker — is designed for studies aimed at determining precisely where the participants are looking
and for studying and measuring eye fixations and other eye tracking metrics based on these.

1.3 Basic Operating Principles

During tracking, Tobii Eye Trackers use infrared diodes to generate reflection patterns on the corneas of the subject's eyes. These reflection patterns, together with 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 finally the gaze point on the screen; in other words, where the subject is looking.



Tobii Eye Trackers are designed for use in indoor office environments.

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2 Technical Specifications

The characteristics of an eye tracker can be described in terms of gaze accuracy and gaze precision. Accuracy describes the angular average distance from the actual gaze point to the one measured by the eye tracker. Gaze precision describes the spatial variation between successive samples collected when the subject fixates at a specific point on a stimuli. More information regarding the accuracy and precision measurements can be found in *Appendix B Accuracy and Precision Measurements* and in tests reports available on the Tobii web site. A glossary can be found at *Appendix A Glossary*.

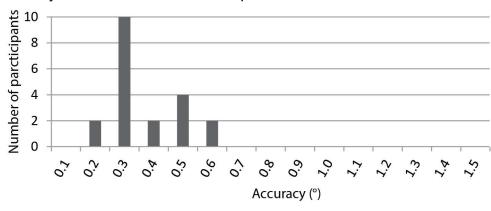
2.1 Tobii X2-30 Eye Tracker Specifications

Table 2.1 Gaze Accuracy

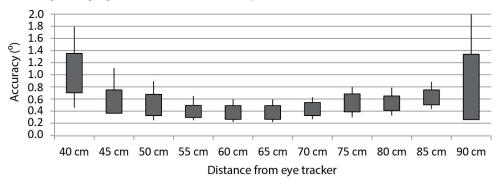
Gozo gogurgoul	Tobii X2-30 Eye Tracker Compact Edition (firmware version 1.0.1)		
Gaze accuracy ¹	Binocular	Monocular	
At ideal conditions	0.4	0.5	
At 25° gaze angle	0.4	0.5	
At 30° gaze angle	0.4	0.5	
At 1 lux	1.0	1.3	
At 300 lux	0.4	0.5	
At 600 lux	0.5	0.7	
At 1000 lux	0.6	0.8	
White stimuli background	0.7	1.0	

Accuracy under ideal conditions is measured in the center of the head movement box with the participant fixed in a chinrest. Data is collected immediately after calibration in a controlled laboratory environment with constant illumination with 9 stimuli points at gaze angles of ≤20°.

Accuracy at ideal conditions - X2-30 Compact Edition



Accuracy at varying distances - X2-30 Compact Edition



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Table 2.2 Gaze Precision

Gaze precision at ideal conditions	Tobii X2-30 Eye Tracker Compact Edition	
Cazo prodicion at lacar contantono	Binocular	Monocular
Artificial Eye	NA	NA
Human Eye	0.32	0.45

Table 2.3 Eye Tracking Specifications

Eye Tracking Specifications		Tobii X2-30 Eye Tracker Compact Edition
Sampling rate ¹		30 Hz
		(std. dev. approx. 2 Hz)
Total system latency		50-70 ms
Time to tracking recovery		For blinks: immediate
Head movement ²	Freedom of head movement at 70 cm (width x height)	50 x 36 cm (20 x 14")
	Operating distance (eye tracker to participant)	40-90 cm (15.7-33.5")
Recommended screen size		up to 25" (16:9)
Data sample output		Timestamp, eye position, gaze point, pupil diameter, validity code

^{1.} As the Tobii X2-30 Eye Trackers have a variable and low sampling rate, they are not suitable for detailed studies of the onset or durations of fixations, saccades or other measures requiring high temporal and stable sampling precision.

Table 2.4 Eye Tracking Unit

Eye Tracking Unit	Tobii X2-30 Eye Tracker Compact Edition
Eye tracker processing unit	Embedded, no external eye tracking host necessary
Connectors	USB 2.0
Weight	200 g (7.1 oz)
Size	184*28*23 mm (7.2 * 1.1* 0.9")
Mounting solutions	Adhesive Mounting brackets for monitors, laptops and tablets. Desk Stand Accessory package for Tripods and desks

Table 2.5 Hardware package content

Tobii X2-30 Eye Tracker Compact Edition Hardware Package	
Tobii X2-30 Eye Tracker Compact Edition	
2 x Adhesive mounting brackets for permanent installation.	
Safety Instructions	
Installation Guide	
USB extension cable	
Zipper bag	
Tobii X2-30 Eye Tracker USB memory stick containing the Tobii Eye Tracker Installer.	
Tobii X2-30 Eye Tracker user manual (pdf)	

4 2 Technical Specifications Product Description v.1.0.2 - en-US

^{2.} Freedom of head movement describes the volume in front of the tracker in which the user must have at least one of the eyes. The numbers are specified parallel/orthogonal to screen surface, assuming the eye tracker is at a 20 degree angle to the screen.

Table 2.6 Accessories

Tobii X2-30 Eye Tracke	Compact Edition
------------------------	-----------------

Tobii X2 Eye Tracker Laptop Case

Tobii Mobile Device Stand for X2

Tobii X2 Additional Mounting Brackets

Tobii X2 Eye Tracker Desk Stand Package:

- Tobii X2 Eye Tracker Desk Stand Kit
- Digital angle gauge
- Measuring tape
- Small tripod
- Tripod screw nut

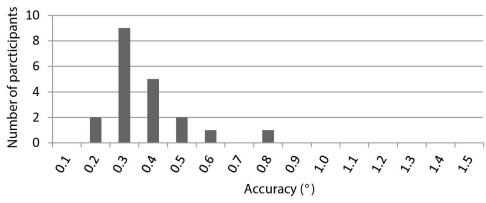
2.2 Tobii X2-60 Eye Tracker Specifications

Table 2.7 Gaze Accuracy

Gaze accuracy ¹	Tobii X2-60 Eye Tracker Compact Edition (firmware version — 1.0.5)		
	Binocular	Monocular	
At ideal conditions	0.4	0.4	
At 25° gaze angle	0.4	0.5	
At 30° gaze angle	0.4	0.5	
At 1 lux	1.2	1.9	
At 300 lux	0.4	0.4	
At 600 lux	0.4	0.6	
At 1000 lux	0.6	0.9	
White stimuli background	1.2	1.9	

Accuracy under ideal conditions is measured in the center of the head movement box with the participant fixed in a chinrest. Data is collected immediately after calibration in a controlled laboratory environment with constant illumination with 9 stimuli points at gaze angles of ≤20°.

Accuracy at ideal conditions — X2-60 Compact Edition



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Accuracy at varying distances — X2-60 Compact Edition

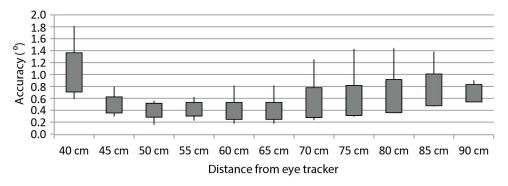


Table 2.8 Gaze Precision

Gaze precision at ideal conditions	Tobii X2-60 Eye Tracker Compact Edition	
daze precision at ideal conditions	Binocular	Monocular
Artificial Eye	NA	NA
Human Eye	0.34	0.45

Table 2.9 Eye Tracking Specifications

Eye Tracking Specifications		Tobii X2-60 Eye Tracker Compact Edition	
Sampling rate		60 Hz	
		(std. dev. approx. 0.1 Hz)	
Total system latency		<35 ms	
Time to tracking recovery		For blinks: immediate	
Head movement ¹	Freedom of head movement at 70 cm (width x height)	50 x 36 cm (20 x 14")	
	Operating distance (eye tracker to participant)	45-90 cm (15.7-33.5")	
Recommended screen size		up to 25" (16:9)	
Data sample output		Timestamp, eye position, gaze point, pupil diameter validity code	

^{1.} Freedom of head movement describes the volume in front of the tracker in which the user must have at least one of the eyes. The numbers are specified parallel/orthogonal to screen surface, assuming the eye tracker is at a 20 degree angle to the screen.

Table 2.10 Eye Tracking Unit

Eye Tracking Unit	Tobii X2-60 Eye Tracker Compact Edition
Eye tracker processing unit	Tobii X2-60 Eye Tracker external processing unit
Connectors	USB 2.0
Weight	200 g (7.1 oz)
Size	184 x 28 x 23 mm (7.2 x 1.1 x 0.9")
Mounting solutions	Adhesive Mounting brackets for monitors, laptops and tablets. Desk Stand Accessory package for Tripods and desks

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Table 2.11 Tobii X2-60 Eye Tracker external processing unit

Connectors	USB 2.0, LAN and power connector
Size	116.6 x 112 x 39 mm (4.6 x 4.4 x 1.55")
Weight	500 g (17.6 oz)

Table 2.12 Hardware package content

Tobii X2-60 Eye Tracker Compact Edition Hardware Package	
Tobii X2-60 Eye Tracker Compact Edition	
Tobii X2-60 Eye Tracker external processing unit	
2 x Adhesive mounting brackets for permanent installation.	
Safety Instructions	
Installation Guide	
USB extension cable	
Zipper bag	
Tobii X2-60 Eye Tracker USB memory stick containing the Tobii Eye Tracker Installer.	
Tobii X2-60 Eye Tracker user manual (pdf)	

Table 2.13 Accessories

Table 2.13 Accessories		
Tobii X2-60 Eye Tracker Compact Edition		
Tobii X2 Eye Tracker Laptop Case		
Tobii Mobile Device Stand for X2		
Additional Mounting Brackets		
Tobii X2 Eye Tracker Desk Stand Package:		
 Tobii X2 Eye Tracker Desk Stand Kit Digital angle gauge Measuring tape Small tripod Tripod screw nut 		

3 Data Output

tracker.

Different applications can be connected as clients to the eye tracker to, e.g., gather eye gaze data in real-time and perform calibrations. Applications that can be used together with the eye tracker include the Tobii Studio software, third party software products, or your own custom software based on the Tobii Software Development Kit. For more information about the supported software products please refer to the product descriptions and documentation for the respective products.

Below is a summary of the data that the eye tracker outputs. Please note that the parameter names, definitions and coordinate systems may differ depending on the software used, please refer to the software documentation for additional information.

Timestamp	Timestamp in microseconds from the eye tracker's internal clock. Additional timestamps are available in Tobii Studio.
Gaze Point Left X, Y	Horizontal (X) and vertical (Y) coordinates of the gaze point for the left eye. Available in different coordinate systems in Tobii Studio and the Tobii Software Development Kit.
Eye Position Left X, Y, Z	The 3D position of the left eye in relation to the eye tracker. Available in different coordinate systems in Tobii Studio and the Tobii Software Development Kit.
Pupil Diameter Left	Estimated diameter of the left eye pupil in millimeters.
Validity Code Left	Indicates the confidence level that the left eye has been correctly identified by the eye tracker.
Gaze Point Right X, Y	Horizontal (X) and vertical (Y) coordinates of the gaze point for the right eye. Available in different coordinate systems in Tobii Studio and the Tobii Software Development Kit.
Eye Position Right X, Y, Z	The 3D position of the right eye in relation to the eye tracker. Available in different coordinate systems in Tobii Studio and the Tobii Software Development Kit.
Pupil Diameter Right	Estimated diameter of the left eye pupil in millimeters.
Validity Code Right	Indicates the confidence level that the right eye has been correctly identified by the eye

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4 Eye Tracking Setups

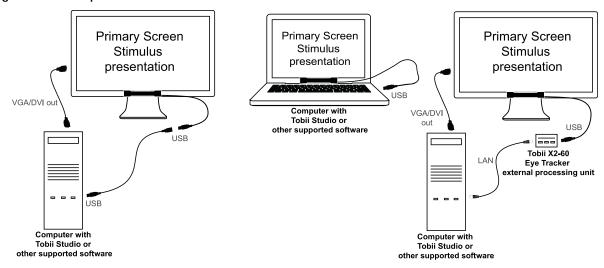
This chapter describes typical setup configurations that can be used with the Tobii X2 Eye Trackers. For specific information about custom configurations or system requirements and recommendation, please contact your Tobii sales representative or Tobii technical support. The System Requirements and Recommendations document can be downloaded at www.tobii.com.

Your particular needs might differ from these typical configurations. More detailed information is available in the Eye Tracker User Manual provided with the product.

4.1 Typical Tobii X2 Eye Tracker Screen Setups

These basic setups are the simplest setups when using on screen stimuli, such as images, movies or web. To record the participant's reactions, the conversation between the test leader and test participant, you need to connect an external user camera and microphone to the computer running Tobii Studio. The setups below do not include the user camera and user sound.

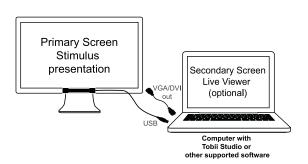
Single Screen Setups

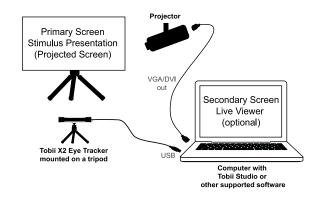


4.1.1 Local Live Viewer

The setup below is used when the test is to be supervised from a separate screen where the test leader can see the eye movements of the subject in real time during testing.

Local Live Viewer Setups



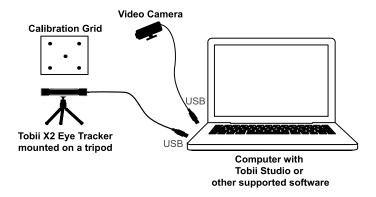


4.2 Typical Tobii X2 Eye Tracker Physical Object Setup

When studying a stimuli that doesn't have a screen or when studying an external device such as a mobile phone, a physical object setup needs to be used where a video or web camera captures the image of the stimuli.

To record the participant's reactions, the conversation between the test leader and test participant, you need to connect an additional camera and microphone to the computer running Tobii Studio. The setups below do not include the user camera and user sound.

Physical Object Setup



4.2.1 External video stimulus recording

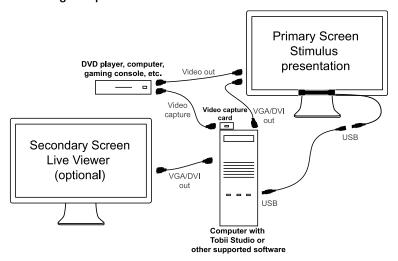
This setup is suitable when using a Tobii Eye Tracking system for eye tracking data analysis when the stimulus is presented from a separate computer or other RGB or VGA sources. This could include a computer game, a DVD player, or when stimulus is presented on a computer running a different operating system. The computer running Tobii Studio must be equipped with an additional video capture card.



Note that if the external application runs on the Windows operating system, and it does not use 3D graphics acceleration or it does not have a high processor load and high memory usage, it may be more suitable and less complex to instead run this on the same computer as Tobii Studio and use the Screen Recording option in Tobii Studio.

For this setup, the image from the Tobii Studio computer has to be displayed on the screen during calibration (to display the calibration points). The external stimulus computer, however, should be shown on the screen during the actual test. Both devices must therefore be connected to the same screen. To switch between the inputs, use a switch or a screen that allows for multiple input sources. The image shown on the screen must be sent to Tobii Studio to record the video stream and synchronize it with the gaze data. If the stimulus is presented from an analogue video source, e.g., a VCR or an analogue video camera, a similar setup with slightly modified components can be used.

External Video Stimulus Recording Setup



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Appendix A Glossary

Monocular/binocular Monocular data shown is based on data from the participant's dominant eye only. Binocular data is

the average of the two eyes.

Gaze precision Describes the spatial angular variation between a set of consecutive gaze samples. Gaze precision

can be measured under various conditions.

Gaze accuracy Describes the angular average distance from the actual gaze point to the one measured by the eye

tracker. Gaze accuracy can be measured under various conditions.

Sampling rate Number of eye tracking data samples per second.

Total system latency The duration from mid-point of the eye image exposure, to when a sample is available via the API on

the client computer. This includes half of the image exposure time plus image read-out and transfer

time, processing time and time to transfer the data sample to a client computer.

Time to tracking
When a participant blinks, the eye tracker loses the ability to track eye gaze because the eye is
covery for blinks
covered by the eyelid. If the pupil is occluded for only a short period, the system will regain tracking

immediately when the pupil becomes visible again, but only if the participant 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 eyelid movement itself or when the eye is closed.

Time to tracking recovery after lost tracking

An eye tracker working in a natural user environment may occasionally lose track of the participant's eyes, e.g., when the participant 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. If the eye tracker is unable to detect the eyes of the participant even after about one minute, the

system will enter a "slow search" mode, leading to larger recovery times.

Freedom of head movement

Describes an area (width x height in cm) where at least one eye is within the eye tracker's field of

view.

Operating distance Describes the range of distances (minimum and maximum) between the participant's eyes and the

surface covering the eye tracker sensors at which eye tracking can be done while maintaining

tracking

Eye tracking processing unit Gaze data calculations are performed by firmware embedded in the eye tracker or in a separate

processing unit.

Appendix B Accuracy and Precision **Measurements**

Gaze accuracy and precision are typically measured in degrees of visual angle. One degree accuracy corresponds to an average error of 12 mm (0.47") on a screen at a distance of 65 cm (27"). Data is presented as monocular or binocular. Monocular data is based on data from the subject's dominant eye only. Binocular data is the average of both eyes.

Gaze Precision

Precision measurements are done using artificial eyes to eliminate artifacts from human eye movements. Tobii specifies precision both with and without noise reduction filters. All measurements are done at the default sampling rate of the eye tracker and at the optimum distance between the eye tracker and the subject. Precision is calculated as root-mean-square (RMS) of successive samples.

As the distance from the eye tracker influences precision, measurements are also taken at various distances. Data from these measurements is binocular.

B2 Gaze Accuracy

Accuracy under ideal conditions is measured in the center of the head movement box with the subject fixed in a chinrest. Data is collected immediately after calibration, in a controlled laboratory environment with constant illumination, with 9 stimuli points at gaze angles ≤20°. Measurements are done on 20 test subjects without lenses, glasses or droopy eyelids. Accuracy for one subject is calculated as the mean of several data samples for several stimuli points across a screen. The accuracy figure presented is the mean accuracy from all subjects.

Good accuracy is difficult to achieve at large gaze angles, but is important when testing large stimuli. For instance, the upper corner of a 23" screen with the test subject at a distance of 65 cm (26") from the eye tracker corresponds to a 32° visual angle from the center of the eye tracker unit. Consequently, measurements are also presented for stimuli presentations at large gaze angles.

When luminance of the stimuli or the illumination in the lab changes, the size and shape of the pupil is affected. Unless compensated for, this may cause a significantly reduced accuracy. Testing the influence of surrounding light and stimuli luminance on accuracy is done in a laboratory environment with controlled light conditions. Stimuli points are presented on a black background so as not to influence ambient light conditions. Testing is also done with ambient light at a level deemed 'normal' office lighting where the background is changed to white with black stimuli points. The results from a test in which the background was changed has been referred to as Drift in previous Tobii product description documents.

As with precision, the distance from the eye tracker influences accuracy. When testing this influence, calibration is done with the subject in the center of the head movement box (i.e. at a distance of 65 cm) and measurements are done thereafter. Measurements are performed with the test subject at precise and specific distances relative to the eye tracker, measured along the axis of the tracking sensors. Data from these measurements is binocular.

Appendix C Compliance Information and **Warnings**

All Tobii X2 Eye Trackers are CE-marked, indicating compliance with the essential health and safety requirements set out in European Directives.

FCC Statement

This device complies with Part 15 of the FCC Rules. 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 could void the user's authority to operate the equipment under FCC

This equipment 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. This equipment 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 this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment 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 the equipment and receiver.
- Connect the equipment into a wall outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or experienced radio/TV technician for assistance.

Industry Canada 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.

Standards

The Tobii X2 Eye Trackers complies with the following standards:

- IEC/EN62471, Photobiological Safety of Lamps and Lamp Systems
- EMC Emission: EN 61000-6-3:2001 including EN 55022:1998/A1/A2 Class B, FCC part 15, Class B
- EMC Immunity: EN 61000-6-1:2007
- FCC part 15, Class B

Mounting Warning



The Tobii X2 Eye Trackers should be mounted according to MANUFACTURER instructions of approved mounts. Tobii or its agents are not liable for damage or injuries to a person or its property due to a Tobii X2 Eye Trackers falling from a mounted configuration. The mounting of a Tobii X2 Eye Trackers is done entirely at the user's own risk.

The double sided tape supplied with the adhesive Magnetic Mounting Plates is designed to permanently attach the bracket to the monitor/laptop. Attempting to remove the bracket after attaching it using the supplied tape can result in damage both to the monitor/laptop and the bracket.

Do not lick the tape or place any part of the tape or Magnetic Mounting Plate in one's mouth.

Do not mount the Tobii X2 Eye Trackers on monitors positioned above the head or face of a users unless using a dedicated "fixed mounting" solution.

Infrared Warning C5



When activated, the Tobii X2 Eye Trackers emits pulsed infrared (IR) light. Certain medical devices are susceptible to disturbance by IR light and/or radiation. Do not use the Tobii X2 Eye Trackers when in the vicinity of such susceptible medical devices as their accuracy or proper functionality could be inhibited.



Tobii Support

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