Table of content

1. General

The XZ Color sensor can detect the color of objects that are held against or placed upon the sensor. This document provides explanation of the available functionalities and instructions on how to install and integrate the sensor into your digital signage installation.

The information in this document is created for users who are familiar with the Nexmosphere API and are able to control a basic setup with a Nexmosphere API controller. If this is not the case yet, please read the general documentation on the Nexmosphere serial API first.

2. Product overview
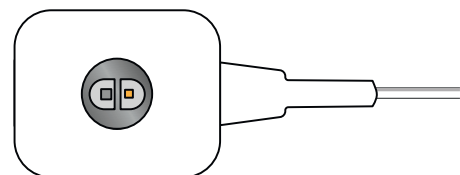
The XZ Color sensor is available in 1 models: **XZ-H60**

	XZ-H60
Hue measurement	✔
Saturation measurement	✔
Lightness measurement	✔
Auto object placement detection	✔
Calibration controls	✔

XZ-H60

The XZ Color sensors utilizes and array of photodiodes and filters which can measure the light intensity within different wavelength ranges. By doing so, it can sense the amount of red, green, blue and white in the light reflected from an object, coming from the embedded LED. These raw measurement values are used by the XZ-H60 to calculate the Hue, Saturation and Lightness of the object which is held against the sensor.

In order for the sensor to function, the sensor needs to be installed behind a cut-out of a front panel. This way, there is room for the light coming from the on-board LED to reflect back into the sensor. Please see page 5 for more detailed information.
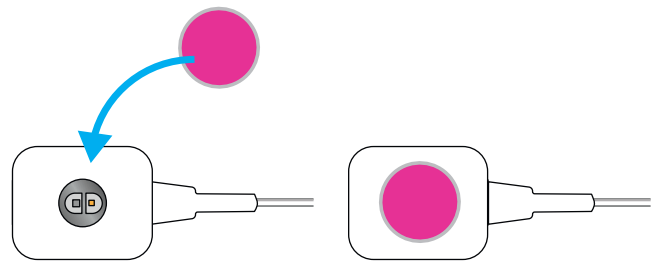
3. Functionalities and API commands

The XZ Color sensor provides the following functionalities:

1. **Color measurement** - measures the HSL values from the object held against the sensor
2. **Reflection measurement** - measured the amount of light reflected from the object held against the sensor
3. **Calibration** - provides features for fine-tuning and calibrating the sensor to its environment and applied materials
4. **Adjust LED intensity and measurement duration** - parameters which influence the color measurement

The following sections will cover each of these functionalities in detail. Please note that for each API example in this document, X-talk interface address 001 is used (X001). When the sensor is connected to another X-talk channel, replace the "001" with the applicable X-talk address.

3.1 - Color measurement

The XZ Color sensor measures the Hue, Saturation and Brightness of the object which is placed against the sensor. When an object is placed against the sensor, the measurement LED immediately starts to blink and the color measurement starts. When the color measurement is completed, an API command is triggered. This API message has the following format:

X001B[Cv=*hhh,sss,lll*]

hhh = Hue	**000-360** or **XXX**
sss = Saturation	**000-100** or **XXX**
lll = Lightness	**000-100** or **XXX**

When implementing color measurements, consider the following:

- For optimal accuracy, make sure the sensor is calibrated. See page 3 for more info
- The measurement duration can be adjusted. See page 4 for more info.
- The sensor is not designed for applications in which highly accurate color measurements are required (e.g. mixing paint colors).
- The sensor can also be set to only output the Hue, Saturation or Lightness. To do so please see page 6 "Settings" In this case the output will have the following formats:

X001B[Hv=*hhh*]	*hhh = Hue*	**000-360** or **XXX**

X001B[Sv=*sss*]	*sss = Saturation*	**000-100** or **XXX**

X001B[Lv=*lll*]	*lll = Lightness*	**000-100** or **XXX**

Example API messages

Color measured with Hue 327, Sat 87 and Lightness 92
X001B[Cv=327,087,092]

Color measured with Hue 213, Sat 66 and Lightness 89
X001B[Cv=213,066,089]

Object removed from sensor
X001B[Cv=XXX,XXX,XXX]

A color measurement can also always be requested by sending one of the following API command:

X001B[HSL?]	Request HSL values
X001B[HUE?]	Request Hue value
X001B[SAT?]	Request Saturation value
X001B[LIGHT?]	Request Lightness value
X001B[ALL?]	Request HSL values with separate replies

The reply will be identical to the triggered API messages such as the examples listed on this page.

Example API messages

Color measured with Hue 120
X001B[Hv=120]

Color measured with Saturation 90
X001B[Sv=090]

Color measured with Lightness 60
X001B[Lv=060]

3.2 - Reflection measurement

Per default, the measurement LED in the XZ color sensor is off. When an object is placed against the sensor, the sensor automatically detects this and the measurement LED will start to blink. The light is reflected from the object back into the sensor to confirm that an object is present and determine if a color measurement should be started. The sensor can measure the level of light reflection to give an indication on how close the object is placed to the sensor. This value can be requested by sending the following API command:

`X001B[REFL?]`   Request current Reflection value

The reply has the following format:

X001B[Rv=***]   ***= *Reflection value* **000-999** *or* **XXX**

The reflection level is also used to determine when a Color measurement trigger is send. This can be adjusted using setting 11. For more information please see page 6.

Example commands

Measured reflection value of object is 410
X001B[Rv=410]

No object is detected (measurement LED is not blinking)
X001B[Rv=XXX]

3.3 - Calibration

The color sensor can be calibrated to its environment to maximize accuracy. The two main procedures are "background" calibration and "white" calibration.

For background calibration, make sure the sensor has a clear view into the void of the environment in which it will be placed. Then, send the following command:

`X001B[CALI=BG]`   Start Background calibration

Once background calibration is done, the sensor will send the following reply:
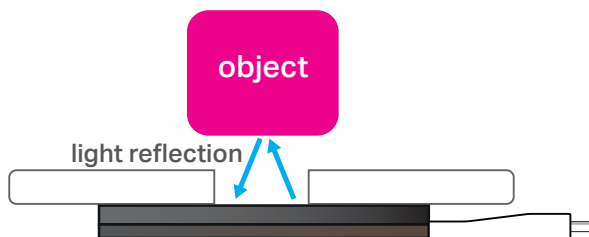
X001B[CALI=DONE]

For white calibration, make sure a white object is placed on the sensor, preferably in the same material as the colored objects which are used in your application. Subsequently, send the following command:

`X001B[CALI=WH]`   Start White calibration

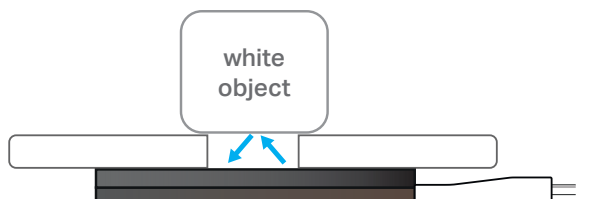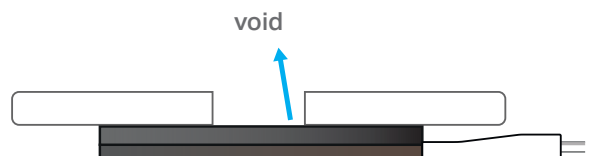Once white calibration is done, the sensor will send the following reply:

X001B[CALI=DONE]

Both calibrations are stored in the sensor's memory. So after a power cycle there is no need to calibrate again.

3.4 - LED intensity and measurement duration

Both the intensity of the measurement LED as well as the duration of a color measurement can be adjusted. The accuracy of the color measurement is - amongst others - dependent on the correlation between these two parameters. The more light, the less time the sensor needs to measure the colors. Vice versa, the less light there is, the more time is needed. Typically it is recommended to leave both parameters to their default value. However, in scenarios where it is desirable to have a less bright LED light or shorter measurement duration, it is possible to adjust accordingly.

After the LED intensity and/or measurement duration have changed, both calibrations need to be performed again. Please see page 3 for the calibration procedures.

Factory reset

The calibrations, LED intensity and measurement duration can be set back to their default factory values by performing a factory reset.

The intensity of the measurement LED can be adjusted by sending the following API command:

`X001B[LED=***]`   ***= *value* **001-100**

Default, the LED value is 100.
Lower is darker, higher is brighter.

The duration of the color measurement can be adjusted by sending the following API command:
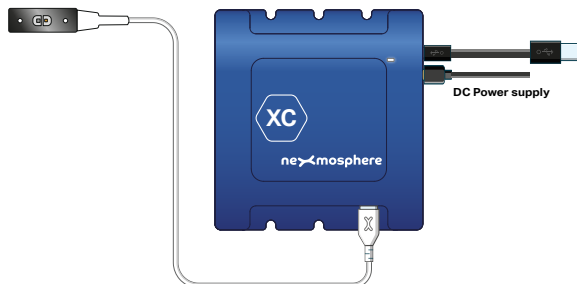
`X001B[MEASURE=*]`   *= *value* **1-5**

Default, the measurement duration is set to 3.
Higher is longer, lower is shorter.

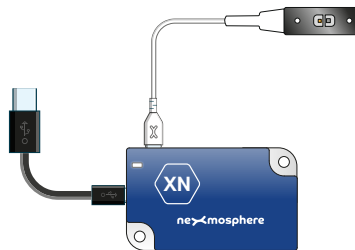A factory reset can be initiated by sending the following API command:

`X001B[FACTORYRESET]`

4.1 Connection Diagrams

The XZ Color sensor can be connected to any X-talk interface and is therefore compatible with all Xperience controllers. Make sure the sensor is connected to the X-talk interface before powering the Xperience controller. Otherwise, it will not be recognized by the Xperience controller and no sensor output will be provided.
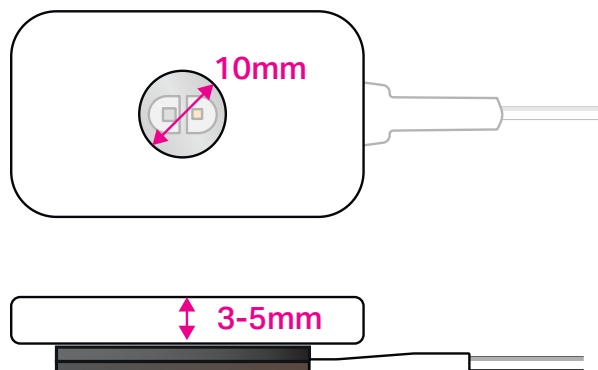

Example connection to XC Controller

Example connection to XN Controller

4.2 Hardware integration guidelines

Installation behind front panel

The XZ Color sensor needs to be installed behind a front panel with a cut-out. We recommend to make a circular cut-out of **10mm diameter** in the front panel behind which the sensor can be placed. For optimal performance, the thickness of the front panel should be between **3-5mm**

Background light

Although the sensor continuously auto-compensates to the ambient background light, the best results are obtained when the sensor is installed in such a way that when placing the object, the cut-out in the front-panel is a completely closed room to which no outside light can reach.

Color perception

Color and light values are complex phenomena which are heavily influenced by the perception and correction of the human eye. As a result, a printed color can for example be perceived differently than the same color values on a digital screen or LED.

5.1 - Settings

The XZ Color sensor has multiple settings which determine the behaviour and output of the sensor. The settings can be adjusted by sending X-talk setting commands via the API. After a power cycle, the settings always return back to default.

Setting 1: Status LED behaviour

1. LED on `X001S[1:1]`
2. LED off `X001S[1:2]`
3. LED on, blink at trigger (default) `X001S[1:3]`
4. LED off, blink at trigger `X001S[1:4]`

Setting 4: Trigger mode

1. Trigger on object detection (def) `X001S[4:1]`
2. No triggers, use data requests `X001S[4:2]`

When set to 1. Trigger on object detection, the sensor will start a measurement as soon as an object is placed on the sensor and the Reflection trigger level is reached. See Setting 11 for more info.

Setting 5: Output format

1. Output Hue value only `X001S[5:1]`
2. Output Saturation value only `X001S[5:2]`
3. Output Lightness value only `X001S[5:3]`
4. Output all values `X001S[5:4]`
5. Output HSL value (def) `X001S[5:5]`

Setting 11: Reflection trigger - threshold level

Set reflection trigger threshold `X001S[11:X]`

X is a value between **1-100** and its default value is **15**. It indicates how high the Reflection level needs to be (x10) for a color measurement to start. So the default reflection trigger level is 150. **The lower this value, the further away the object needs to be from the sensor for a color measurement to start. The higher this value, the closer away the object needs to be from the sensor for a color measurement to start.** When an object is placed on the sensor, the reflection level can be requested. For more information on how to do so please see page 3. Please note that the reflection trigger level does not influence when the measurement LED starts to blink. Object detection in itself is handled automatically by the sensor itself. Instead the reflection level determines when a color measures starts *after an object is detected*. In practice, this determines how close an object needs to be before an actual color measurement starts.

Setting 12: Reflection trigger - number of valid reads

Set required number of valid reads `X001S[12:X]`

X is a value between **1-8** and its default value is **3**. It indicates how many consecutive read cycles the reflection level needs to be above the threshold for a color measurement to start. The lower this value, the faster a color measurement will start, but also the higher the chance of a "ghost trigger" will be. Vice versa, the higher this value, the slower a new measurement will start, but the more stable the sensor will be.

Setting 13: Reflection trigger - delta for valid reads

Set delta for valid reads `X001S[13:X]`

X is a value between **1-100** and its default value is **20**. It determines the maximum allowed delta between valid reads (above the Reflection trigger threshold) for a color measurement to start. The lower this value, the more steady and longer an objects needs to be placed on the sensor for a color measurement to start. Vice versa, the higher this value, the shorter and less steady an objects needs to be placed on the sensor before a color measurement starts.

Setting 16: Saturation correction

1. No saturation correction `X001S[16:1]`
2. Correction for humen eye (def) `X001S[16:2]`

Color and saturation values are complex phenomenons which are heavily influenced by the perception of the human eye and interpretation by the human brain. As a result, the saturation of a physical objects is typically perceived much higher then the actual objective saturation value. Per default (setting 16:2) the sensor compensated for the perception of the human eye.
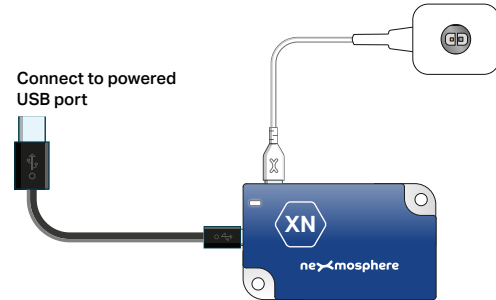
6. Quick test
In order to test if the XZ Color sensor is installed correctly, please follow the test procedure below:

Step 1 - Setup
First, connect the Color sensor to an Xperience controller and place the sensor behind a front panel with cut-out. Secondly, power the Xperience controller.
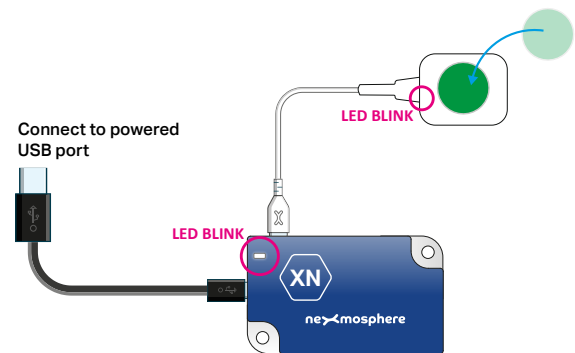
The green status LED of the XZ Color sensor should go on. The status LED of the controller will start to blink and once power-up is completed will be lit continuously.

Connect to powered USB port
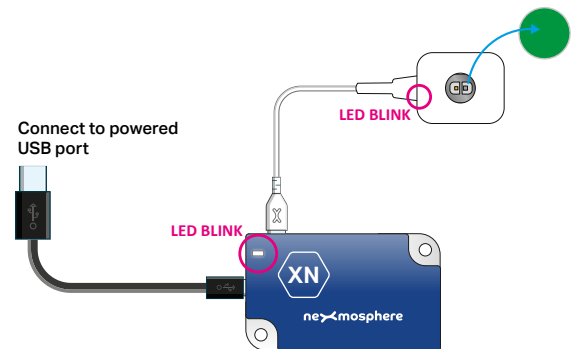
Step 2 - Color measurement
Place a colored object on the sensor.

The measurement LED of the sensor should start to blink. Within +/- 1 to 2 seconds, the sensor should have completed the color measurement and both the green status LED of the sensor and the status LED of the controller should blink.

Connect to powered USB port

LED BLINK

LED BLINK

Remove the colored object from the sensor.

Both the green status LED of the sensor and the status LED of the controller should blink again.

Connect to powered USB port

LED BLINK

LED BLINK

In case any of the steps above does not provide the expected result, please check the installation guidelines in this document.

For a full test we recommend to connect the setup to a mediaplayer or PC and test all API commands listed in this document (see section 3, page 2-4). For more information on how to setup a test for your controller, please see the Quick Start Guide of the Xperience controller you are using. These are available on nexmosphere.com/support-documentation

Please contact support@nexmosphere.com for any support questions you may have.