Globisens

USER GUIDE

Xploris and XploriLab

REV: 1.0

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Contents

1. Introduction

Globisens' Xploris is a comprehensive STEAM device, offering elementary school students the opportunity to conduct science experiments, create animations, compose music, and write code using Blockly and Python.

This guide will teach you how to use the Xploris sensors to conduct science experiments, utilize its full-color pixel-art display to create art, and use its control outputs and ports to turn on lamps, operate small robots, and control other accessories through coding.

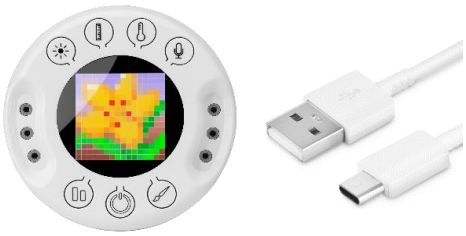
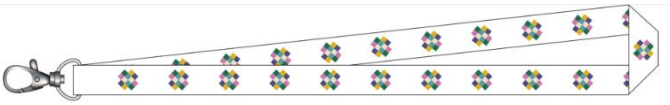
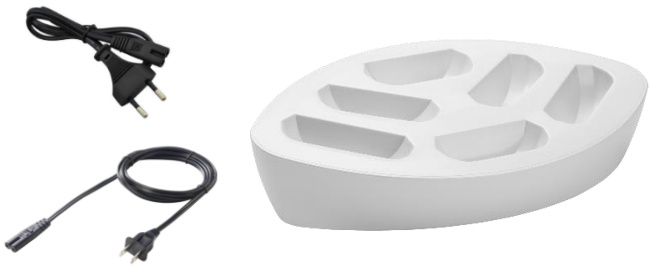
The sensors included on this device are listed below.

- Light (Lx)
- Distance (cm or in)
- Ambient Temperature (°C or °F)
- External Temperature (°C or °F)
- Sound Level (dB)
- Voltage (V)
- Heart Rate (optional add-on, bpm)

2. The Xploris Device

2.1 What's in the Box

The Xploris is delivered as a class set of 6 units, along with 1 charging station. The set includes the following items:

x6	Xploris Units & USB-C to USB-A cables	
x6	Lanyards	
x6	Pairs of banana cables with crocodile clips	
x6	Sensors: • Temperature probe (***included***) • Heart rate probe (***optional - sold separately***)	
x1	Charging station for 6 Xploris units & C7 power cable (US or EUR plug)	

2.2 Xploris Ports, Sensors, and Controls

① Light sensor button

② Distance sensor button

③ Temperature/heart rate sensor button

④ Sound level sensor button

⑤ Control/voltage outputs (left)

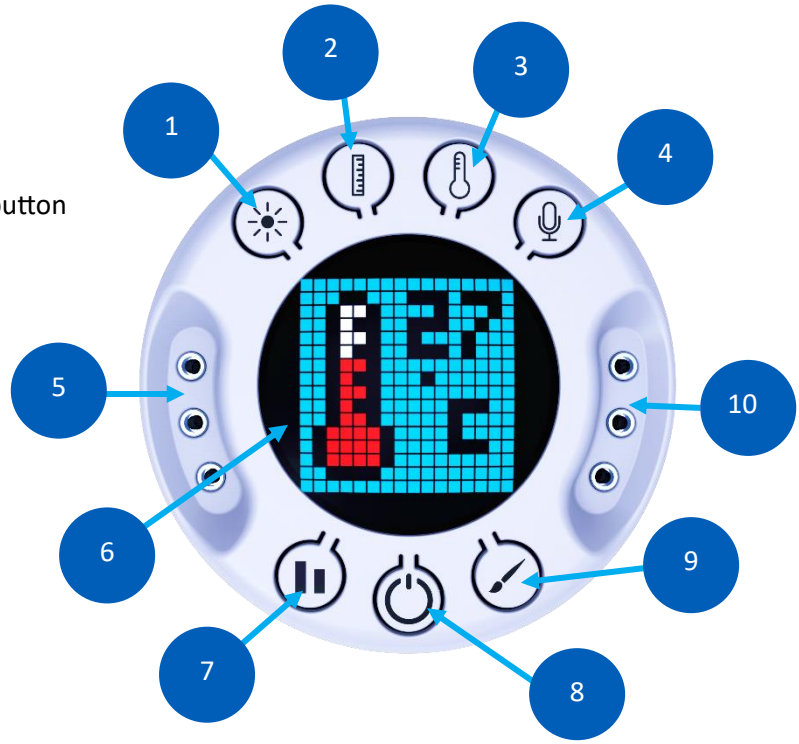
⑥ 16x16 full color LED display

⑦ Bar/brightness button

⑧ ON/OFF button

⑨ Animation button

⑩ Control/voltage outputs (right)



⑪ Distance sensor (Receive/Transmit)

⑫ USB C port (charging or connecting)

⑬ Sound level sensor

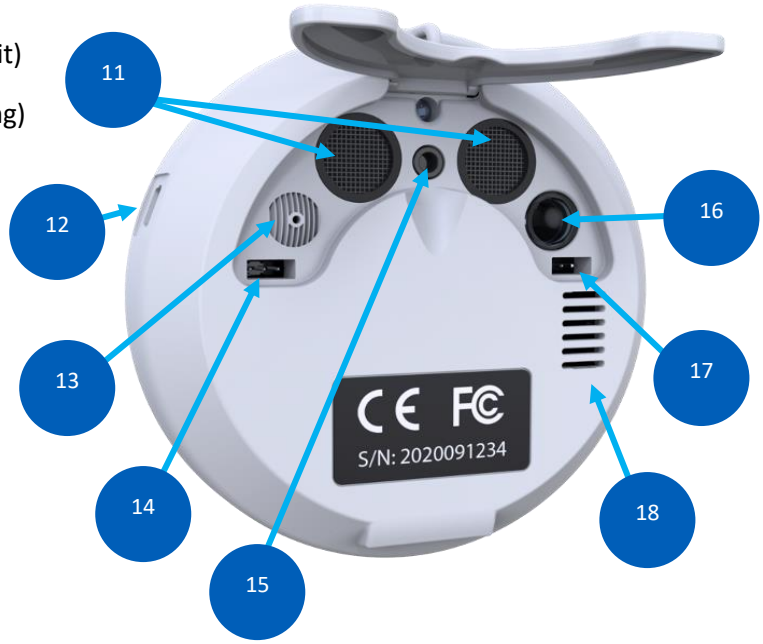
⑭ Servo engine output (**right**)

⑮ Temperature/Heart rate port

⑯ Light sensor

⑰ Servo engine output (**left**)

⑱ Speaker



Sensor Type	Max. Range	Accuracy
Ext. Temperature	-25 to 125 °C	±1 °C
Amb. Temperature	-10 to 50 °C	±2 °C
Distance	40 to 400 cm	±2 mm
Light	0 to 60,000 lx	±10 %
Sound Level	25 to 90 dB	±4 dB
Voltage	0 – 5V	±2 %

2.3 Xploris Rechargeable Battery

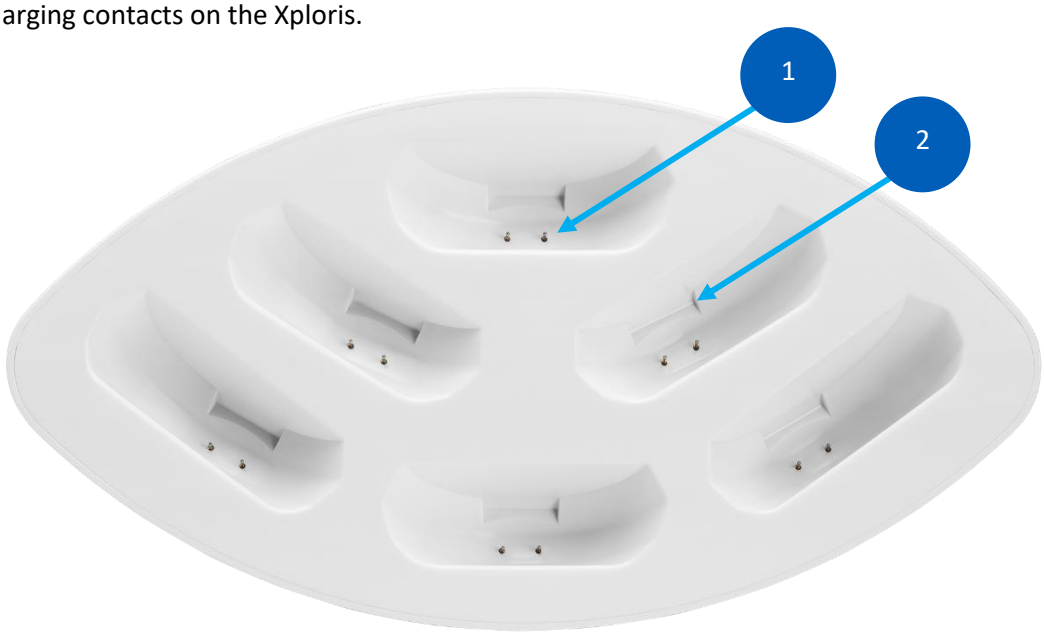
We recommend charging the Xploris before using it for the first time. The Xploris rechargeable battery requires 2-3 hours of charging, depending on its screen brightness and current use.

Charging can be done by placing the Xploris in one of the charging station chambers or by connecting it to any USB source, such as a computer or wall charger, using a USB-C cable.

Do not use force when placing the Xploris in the charging station. The rectangular cavity in each of the six chambers will position the Xploris at the correct angle.

NOTE: The two Xploris units on the left side should be placed with a slight leftward rotation, while the two on the right side should be placed with a slight rightward rotation.

Charging is made possible when the two pins in each chamber make contact with the two charging contacts on the Xploris.

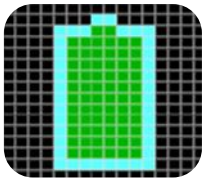


① Charging pins

② Rectangle cavity

2.4 Xploris Charging Indication

While charging, the Xploris displays an icon of a battery being filled on its screen. If the Xploris is turned on while connected to the charger, this icon will only appear for 10 seconds before the screen reverts to what was shown prior to connecting to the charger.



When the battery is fully charged, the Xploris will display a fully green battery icon.

If the Xploris is in use when the battery becomes fully charged, a small green blinking battery icon will appear in the top left corner of the screen. This icon will turn off when the Xploris is disconnected from the charger (or USB).

Similarly, when the Xploris battery is nearly drained (e.g., the battery voltage drops below 3.6V), a small red blinking battery icon will appear in the top left corner of the screen.

2.5 Using Xploris Buttons

2.5.1 Control Buttons

Control Buttons	Operation
 On/Off	Pressing this button when Xploris is off will turn it on. Pressing and holding this button for 2 seconds while Xploris is on will turn it off. When turned on, the Xploris screen shows: • Xploris splash screen. • A loop of Xploris animations. • User animations (if any are loaded on Xploris).
 Paint Brush	Pressing this button activates Animation mode. Use this button to scroll and select your preferred image or animation. When recording data from multiple sensors, use this button to scroll through and display all recorded sensors.

Bar

Bar Display:

Pressing this button while displaying a sensor value will toggle between the numeric value of the sensor and the last 5 measurements of that sensor.

Each Bar column is normalized according to the sensor values below:

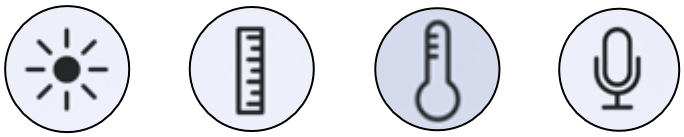
Sensor	***Min Bar***	***Max Bar***
Temperature	-25°C (external) -10°C (ambient)	125°C (external) 50°C (ambient)
Light	0 lux	1000 (Light<1000 lx) 60,000 (Light >1000 lx)
Sound	25dB	95dB
Distance	40cm	400cm

The Bar update rate is set through the XploriLab configuration menu. The default update rate is every 0.5 seconds.

Brightness Control:

Pressing this button while Xploris is displaying animations will change the display brightness to one of three levels: Low, Mid, or High.

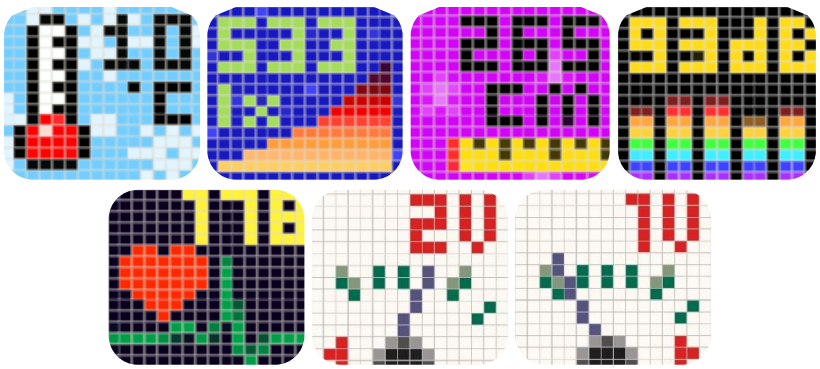
2.5.2 Sensor Buttons



The sensor buttons can do a variety of operations including viewing data and running experiments.

Sensor Display:

Pressing any sensor button will display its value. The graphics on the screen will also adjust according to the readings of the sensor to provide a visual indicator of the value. Temperature, Light, Sound level, Distance, and Heart Rate (Thermometer button).



NOTE: The thermometer button will display ambient temperature if no probe is inserted. If a temperature probe is inserted, it will display the external temperature. If a heart rate probe is inserted, it will display the heart rate in beats per minute.

*Sensor Value Range **as Seen on Xploris Screen**:*

Sensor	*Range*	*Unit*	*Remarks*
Temperature	0 to 99	°C	Outside this range, "Lo" or "Hi" will be displayed.
Light	0 to 9999	lx	Above 9999, "Hi" will be displayed.
Sound	25 to 95	dB	
Distance	0 to 400	cm	
Heart Rate	0 to 200	bpm	
Voltage	0.0 to 5.0	V	

NOTE: Some sensors have larger ranges than what is listed above. To see values outside that range, you must use the XploriLab software rather than the Xploris screen. Due to the limited screen size, the Xploris device can only display values up to a certain amount.

To see the technical details on the sensors' capabilities, refer to section 2.2 Xploris Ports, Sensors, and Controls.

Data Logging:

Start experiment – Press and hold a sensor button for 1 second to begin recording that sensor's data.
Stop experiment – Press and hold the same sensor button, or the on/off button for 1 second to stop recording the data.

NOTE: When starting an experiment using the buttons on the Xploris, you can only use a *single* sensor at a time. To run an experiment with multiple sensors simultaneously, you must set it up in the XploriLab software.

Data Recording Parameters:

- Sensor: selected by the sensor button pressed.
- Sample rate:
    - 10 per sec for Distance.
    - 1 per sec (all other sensors).
- Number of samples: 1000.

During Recording:

- Xploris displays a blinking red rectangle in the corner of the screen.
- Xploris shows only the sensor(s) being recorded. All other buttons, except the sensor buttons, bar button, paint brush button, and on/off button, are disabled.
- Remember, when recording multiple sensors you can use the paint brush button to scroll which sensor is being displayed.

2.6 Useful Shortcuts

Xploris offers the following functionality through shortcuts.

To use these,

1. Turn the Xploris off.
2. Then, press and hold one of the following buttons.
3. While holding it down, press the power button to turn on the Xploris.

Toggle Xploris Speaker on/off.

Puts Xploris in Firmware Update mode.

Turn off Xploris Auto-Off timer (see section 3.4 Configuration Menu).

Start Xploris self-test.

Toggle Temperature between °C/°F and Distance between cm/inch.

2.7 Using the Control Outputs

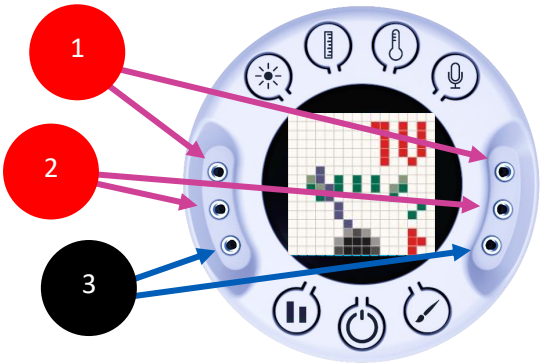
Xploris' six banana sockets (2mm) provide access to its voltage inputs, electronic switches, and voltage outputs. These are found on the front of the unit.

The sockets are in the same order on both sides of the device.

① Voltage Out (top)

② Voltage In / Switch (middle)

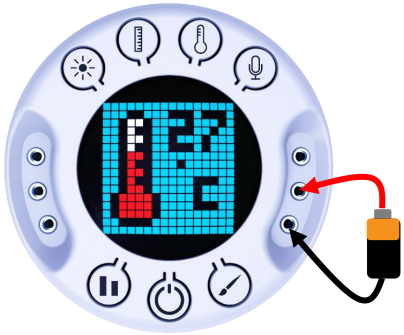
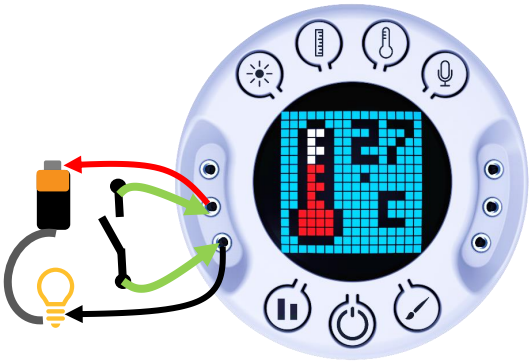
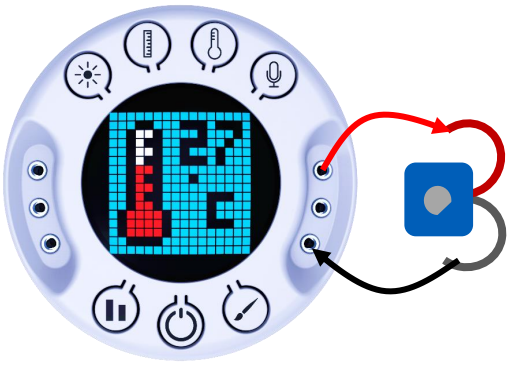
③ Ground (bottom)



- **Voltage Out** is used when you want to power something. Voltage will flow out of the device here and into your circuit.
- **Voltage In** allows you to read how much voltage is in a given system or battery.
- A **Switch** is a device that can turn the flow of electricity on or off, such as a light switch. The Xploris Code and Control menus allow you to flip virtual switches using this port.
- The **Ground** wire completes the circuit and is a safety path for excess electricity to feed.

In general, the **red** banana cable will be using either of the top two sockets while the **black** banana cable will use the bottom socket.

NOTE: the sockets are designed for mini banana cables, or 2.5mm cables. Standard 4mm banana cables will not fit.

Example Experiments	Diagram/Photo
Testing batteries' or circuits' voltage: Hook up the red banana cable to voltage in (middle) on one end and the + side of the battery on the other. Attach the black banana cable to the – side of the battery on one end and then plug in to ground to complete the circuit. These inputs measure voltage from 0 to 5V so if you attach a battery or circuit that is generating more voltage than 5, the sensor will cap at 5V.	
Control a Switch: Use a virtual switch to control a circuit such as turning on or off a light bulb. An external power source must be part of the circuit if not also using Voltage Out. Each switch can handle currents up to 1A.	
Powering a Motor: If you would like to power something like a motor for a fan blade, an LED, etc, connect the red banana cable from the red wire on the motor to the voltage out (top) socket. Run the black banana cable from the dark wire on the motor to the ground (bottom) socket. Colors may vary based on the motor. The voltage out will be 5V. Each voltage output can drive loads up to 100mA.	 **NOTE:** If what you are powering cannot handle 5V, you will need to add a resistor on the red voltage out line between the Xploris and the motor, LED, etc.

On the back of the device, after you open the sensor cover, you will also find two additional outputs. These are the left and right servo motor drivers. These drivers allow you to attach small motors.

NOTE: Right vs Left is determined by looking at the motors from the FRONT of the Xploris.

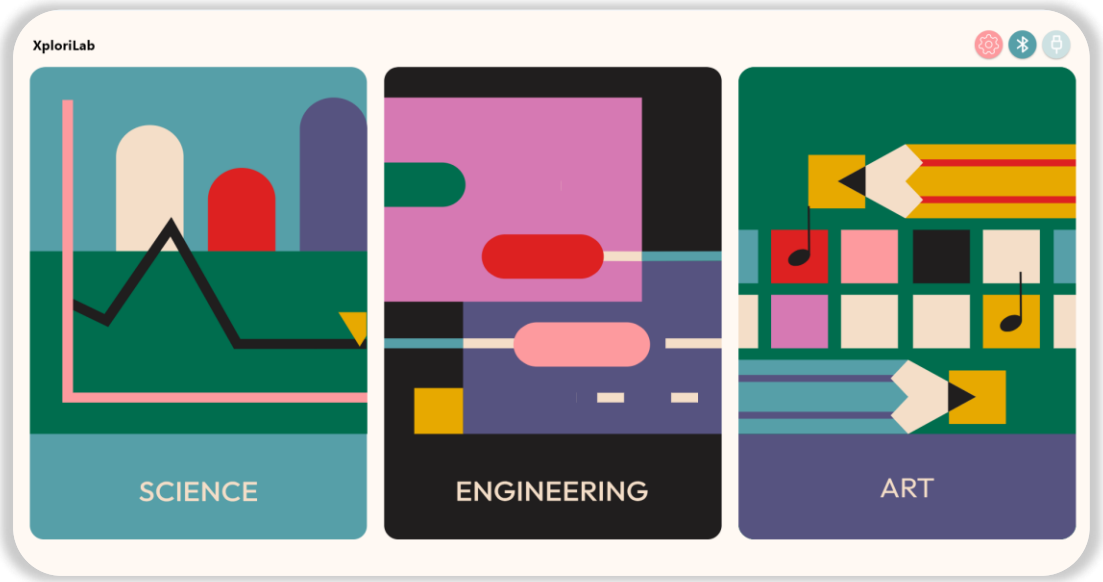
Ensure that the darkest cable (often brown or black) of the servo motor is facing away from center of the Xploris. The lightest color (often white or yellow) will be the most interior wire color for these ports to function.

Example Experiments	Diagram/Photo
Turning your Xploris into a Robot: For this, you will need two continuous rotation servos/motors with wheels. Plug one wheel into each port with the darkest wires on the outside edge. The Xploris should be attached to some sort of body that can hold both it and the wheels. We recommend using a rolling ball at the front of the robot to keep it level and roll smoothly.	

3. XploriLab Software

3.1 Overview

Designed with the Google Flutter platform – XploriLab integrates six different software modules to provide a comprehensive STEAM experience for K-6 students. The modules are sorted into three main categories.



The **Science** section provides the foundation for collecting and analyzing real-time data. It provides gauges and graphs to visualize the readings coming from any of the onboard sensors.

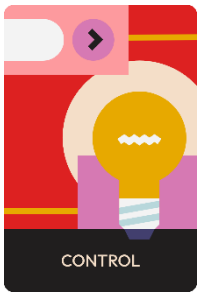
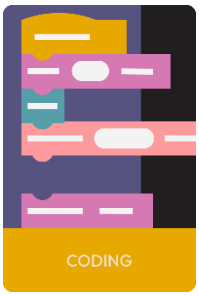
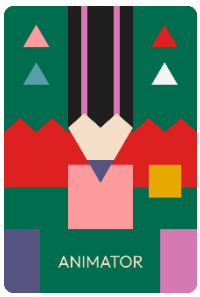
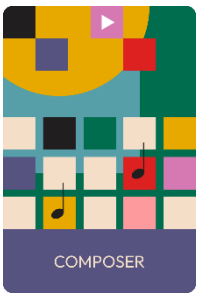
The **Engineering** section provides students with foundational skills in programming. These coding interfaces allow students to control various output devices using sensor readings.

The **Art** section allows students to express creativity by creating colorful still images, animations, and even composing music.

Together, these sections combine to create interdisciplinary, interactive learning experiences for all subject-areas!

Continue on to the next page to learn more about each.

Navigation to the six different modules is made possible through a set of animated posters:

Science		**Sensing** Designed for early learners, this module displays sensor values using various visual formats, including gauges, pictographs, and bar graphs. Data can be displayed in color gradients, visual percentages, standard units, or non-standard units.		**Data Logger** Data can be displayed as graphs, tables, or bar graphs. Users can apply markers, annotations, and mathematical functions to analyze their findings. Data is displayed in standard units.
Engineering		**Control** This module allows users to create IF/THEN conditions using Xploris' sensors as inputs to control outputs such as the display, speaker, voltage output ports, switches, and servo motor drivers.		**Coding** The coding platform supports both Blockly (Scratch) and Python. Set up advanced codes to control outputs such as the display, speaker, voltage output ports, switches, and servo motor drivers.
Art		**Animator** A versatile art and animation editor with a full set of drawing tools and an easy-to-use interface for creating animations with up to 60 frames and 3 layers each. All drawings and animations can be sent to the Xploris pixel screen. Animations can be paired with music or sounds from the Composer interface.		**Composer** A music composer module that allows users to create music with up to 126 notes. These compositions can be uploaded to Xploris and played by its speaker, either individually or accompanying any animation.

We will go into more detail on each module in the following sections.

3.2 Software Installation

WINDOWS OS and MAC OS: Download the relevant XploriLab installation file from https://globisens.net/support/downloads/ and run XPLORILAB.EXE

Android and Chrome OS: Go to the Google Play store, search for "XploriLab", and install it on your Android tablet or Chromebook.

iOS: Go to the App Store search for "XploriLab" and install it on your iPad.

At the end of the installation, you'll see the XploriLab icon on your main screen. Double click or tap the icon to run the XploriLab software.

3.3 Connecting to Xploris

XploriLab can connect to Xploris via a USB-C cable or Bluetooth.

3.3.1 Using the USB Cable

1. Turn on the Xploris.
2. Connect the Xploris to your computer using the USB C cable.

3. Open XploriLab software and click the USB icon on the top right of the screen.
4. The icon will turn green, indicating that the XploriLab software is connected to the Xploris.

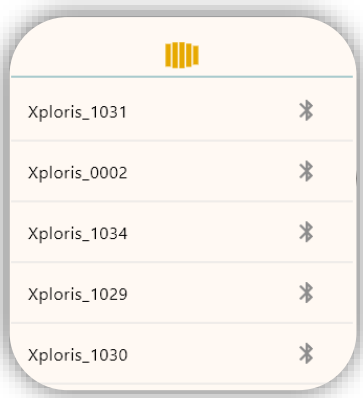
3.3.2 Using Bluetooth Communication

1. Turn on the Xploris.
2. Open XploriLab software and click the Bluetooth icon at the top right of the screen.

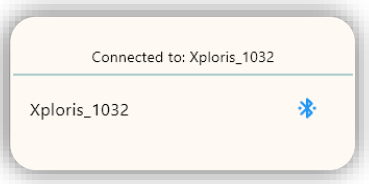
3. XploriLab will open a dialog and start searching for nearby Xploris units. Xploris units are displayed as: "***Xploris_XXXX***", where XXXX represents the last 4 digits of the Xploris serial number located on the back of the unit.

   NOTE: Xploris devices will not show up if they are sitting in the charging tray.

4. Scroll through the list if necessary to find your Xploris unit.



5. Click on the Xploris you want to connect and in few seconds XploriLab will indicate "***Connected to: Xploris_XXXX***" as seen below, and will change the top right icon color to green.



6. To Disconnect the Xploris from the XploriLab software, either close XploriLab, or click the Bluetooth icon.

7. A dialog box will open, displaying the Xploris unit currently connected. Click on that unit and it will disconnect.

If bluetooth connection does not work on the first try, simply close XploriLab and reopen.

3.4 Configuration Menu

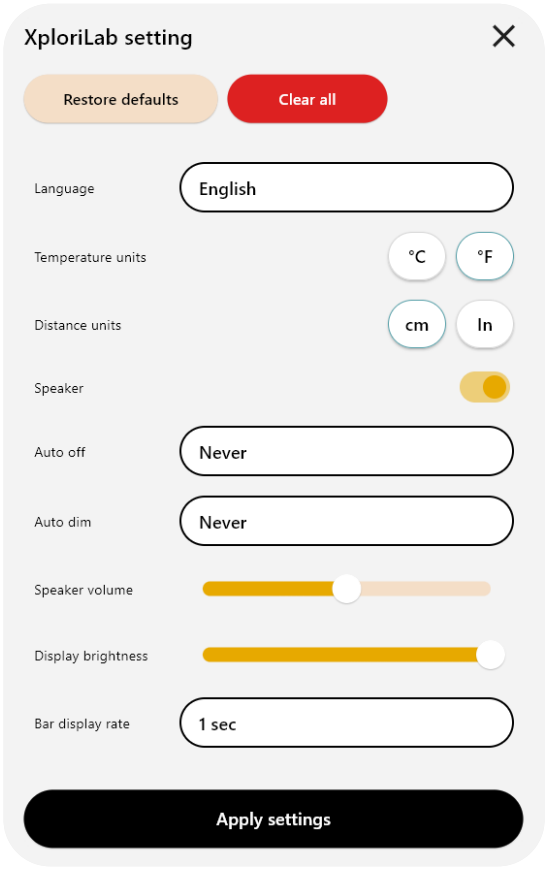
The configuration icon on XploriLab main screen allows you to configure both Xploris and XploriLab. Click the icon and the below dialog box opens.

Here you can:

- Restore settings to our default values:
  a) Auto-off = 10 minutes
  b) Auto-dim = Never
  c) Speaker = ON
  d) Temperature/Distance = °C, cm
  e) Speaker level = 1 out of 8
  f) Display brightness = Medium
  g) Xploris Bar display rate: 1/sec

- Clear all Xploris memory: images, animations, music, and sensor recordings.

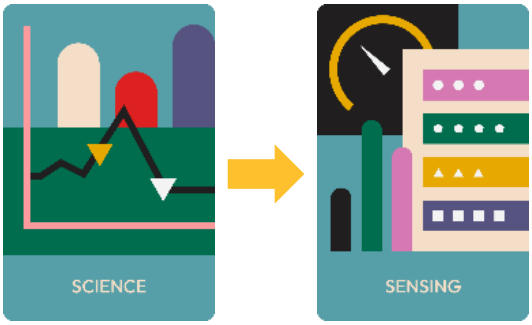
- Select XploriLab language.
- Set Temperature units to Celsius or Fahrenheit in both Xploris and XploriLab.
- Set Distance units to Centimeters or Inches, again in both software and hardware.
- Turn Xploris Speaker on/off and set its volume.
- Set Xploris Auto-off timer.
- Set Xploris display Auto-Dim timer.
- Set Xploris display brightness in 3 levels: Low-Mid-High.
- Set Xploris Bar display update rate from every second to every 15 seconds.



- Scroll down to the bottom of the Configuration Menu to view XploriLab software and Xploris embedded software versions.

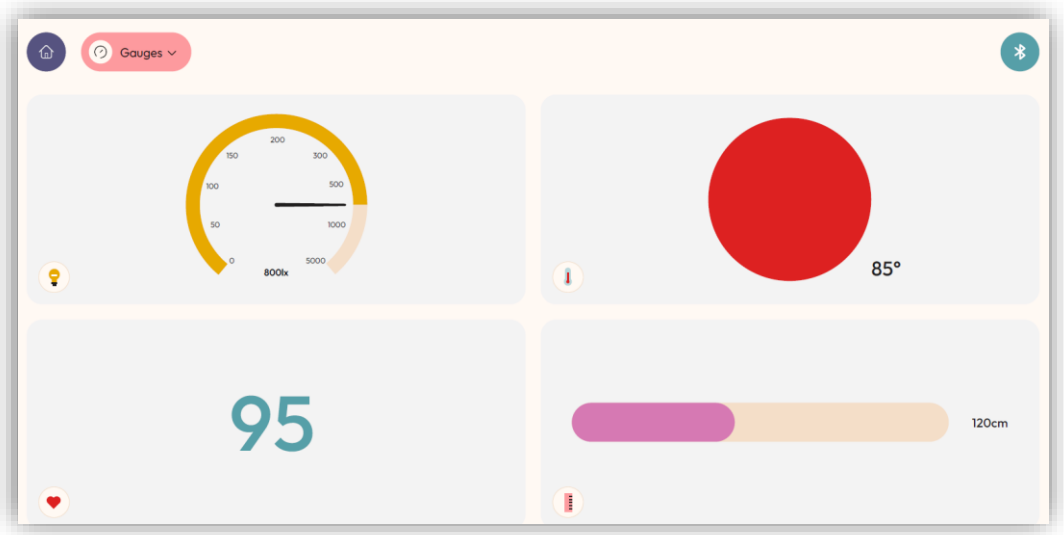
4. XploriLab Science: Sensing Module

From the main screen select the SCIENCE Poster and then tap the SENSING poster.



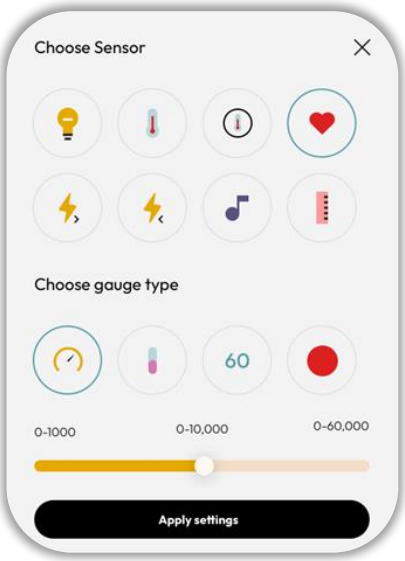
4.1 Gauges Display

The Sensing module opens with a colorful Gauges display, delivering the current sensors' values in up to 4 different display types: digital gauge, color-changing gauge, analog gauge, and bar gauge.



Clicking on any of the gauges will open the dialog box on the right. Here you can:

- Select different sensor for this gauge.
- Select different type of gauge display.
- Use a slider to select the range for the gauge. This is useful in cases where the sensor reading is low.

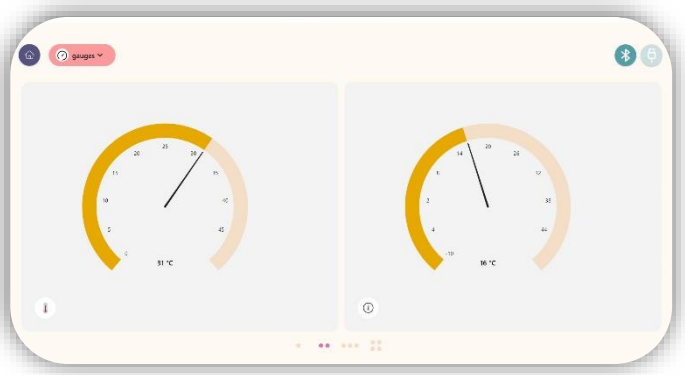


Example: let's consider a Light sensor measuring the classroom ambient light level of ~400 lux. Selecting a full range of 0 – 60,000 lux for this gauge will show a reading very close to zero, making it hard to notice any changes in the ambient light level. However, selecting a range of 0 – 1000 lux will clearly show the sensor value and any changes of the ambient light level in the classroom.

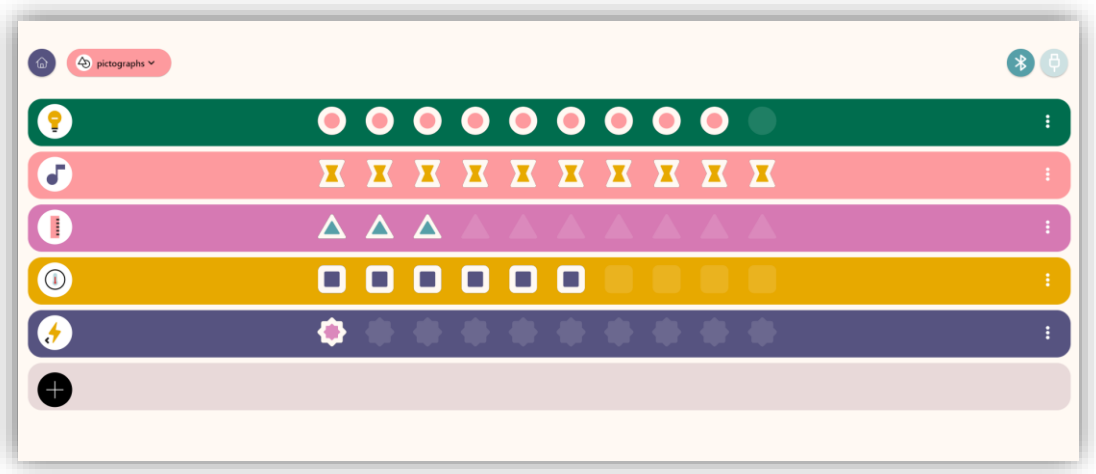
Finally, you may use the bottom set of dots to select the number of gauges on the screen: 1, 2, 3 or 4 gauges.

These buttons allow you to focus your students' attention on what you want them to pay attention to.

You can use them to highlight relationships between sensors or comparisons, for instance the ambient vs external temperature probes as shown here.



4.2 Using the Pictograph Display



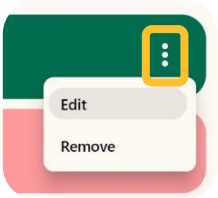
Click the display selection icon at the top of the screen and select Pictograph.

The Pictograph display uses various icons to represent the level of each sensor. 10 icons indicates that the sensor level has reached its maximum range, while no icon indicates that the sensor is at its minimum range.

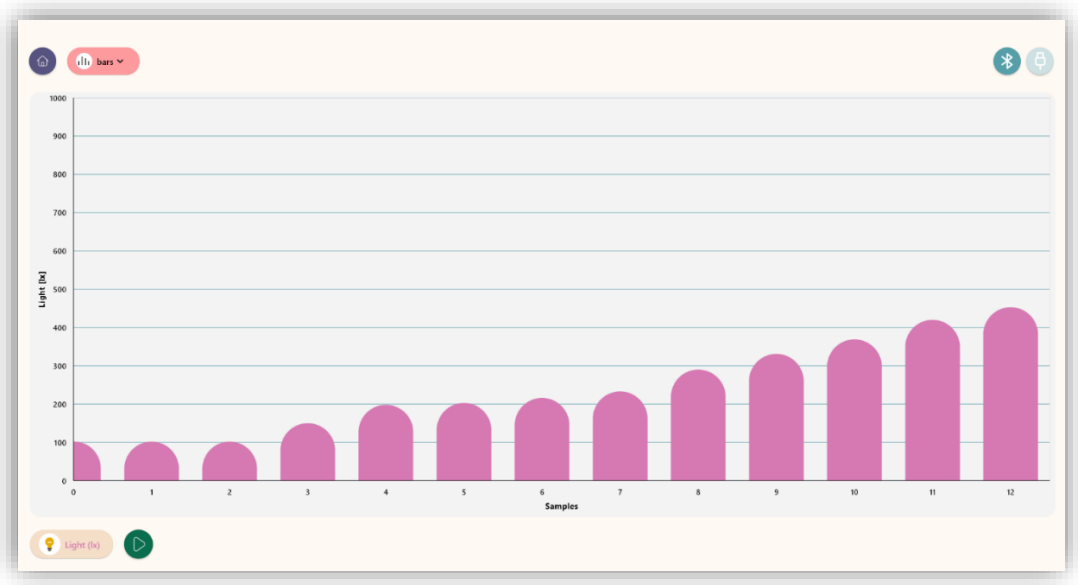
This environment is good for practicing fractions, decimals, and percentages for older students and counting for younger students.

You may add more rows to the Pictograph display using the last row marked by a (+) sign.

Using the 3 dots to the right of each row allows you to change the sensor, change the range of the sensor, or simply remove the entire row from the Pictograph display.



4.3 Bar Graph Display



Unlike the Gauges and Pictograph display types – that only show the current level of the sensors – the Bar graph shows the sensor level history, providing another important indication on how for example the light level is changing.

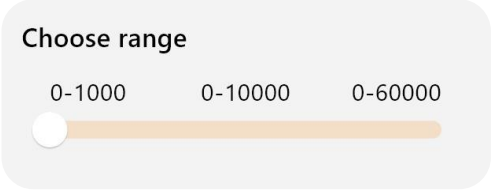
Click the display selection icon and select Bar.

Select the sensor you would like to view using the sensor selection icon at the bottom left corner.

Press Play and view the sensor readings as vertical bars on the screen. A new reading will be taken every 1 second and the graph will update.

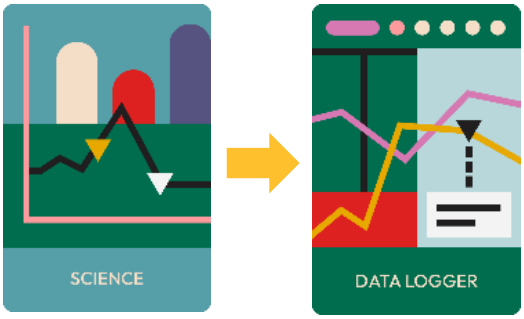
It will only display from 0 to 12 samples and older samples will cycle off the left side of the screen. If you are looking for more samples or more control on how often the samples are taken, use the Data Logger module instead of the Sensing module.

Clicking the sensor name to the left of the Y axis will allow you to change the range of the Bar display.

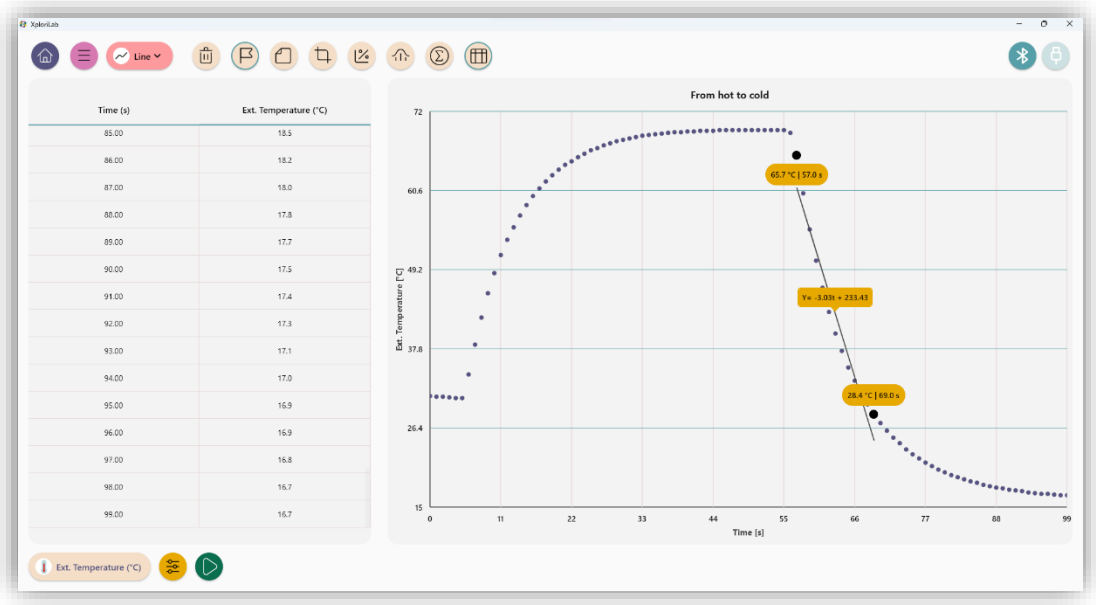


5. XploriLab Science: Data Logger Module

From the main screen select the SCIENCE Poster and then tap the DATA LOGGER poster.



5.1 Recording Xploris Sensors



XploriLab Data Logger module incorporates sophisticated data analysis, lab reporting, plus wireless communication for full setup and control of the Xploris built-in sensors. It offers multi-media rich data visualization through line graphs, tables, and bar graphs.

Graph analysis is made easy using markers, annotations and mathematical functions such as averaging, linear regression, and more.

5.1.1 Start Recording an Experiment

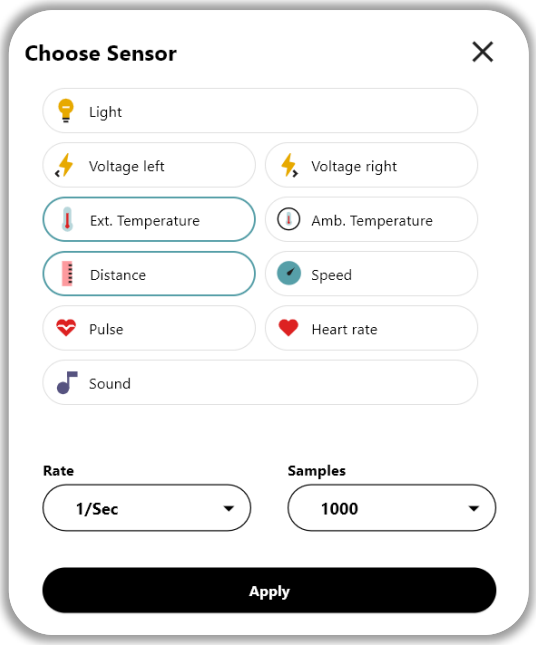
Follow these steps to start recording:

- Turn on the Xploris.
- Connect to XploriLab, either through USB or Bluetooth. See section 3.3 for Connecting to Xploris.
- Select your sensors, sample rate, and total samples by clicking on the SETUP icon. The below dialog box opens, allowing you to setup the parameters for the next recording.

There is no limitation on the number of **sensors** selected for the next recording. All sensors you have selected will be recorded simultaneously.

You may select **sampling rate** as high as 100 samples per second for the Voltage sensors, and 25 samples per second for the Distance sensor. The highest sampling rate for the other sensors is 10 samples per second.

Using XploriLab, you can set the Xploris to Manual recording.
See below.



You can also select the total number of **samples**. This value determines when the Xploris will stop collecting data automatically. You can manually stop an experiment anytime by clicking on the stop button after an experiment has started.

- To start your experiment, click the PLAY icon at the bottom of the screen.
- Xploris will start recording and you'll be able to view the graph on the screen as it happens.

5.1.2 Manual Sampling

If you would like to do an experiment where you are using Manual sampling instead of X/sec samples, you must only select a single sensor to do so. Note, not all sensors are compatible with manual sampling.

- With your single sensor selected, Manual will appear in the sample rate dropdown. Select it.
- Click apply and then play to start your experiment.
- To collect each manual data point, click on the sensor button of your selected sensor when you are ready to collect that data.
- Each time you click on the sensor button, a new value will be added to your graph.

Click on the Stop button when you are ready to stop your experiment.

5.1.3 Sensor-Specific Information

Speed

Speed recording is based on the Distance sensor. Thus, selecting speed will automatically select distance.

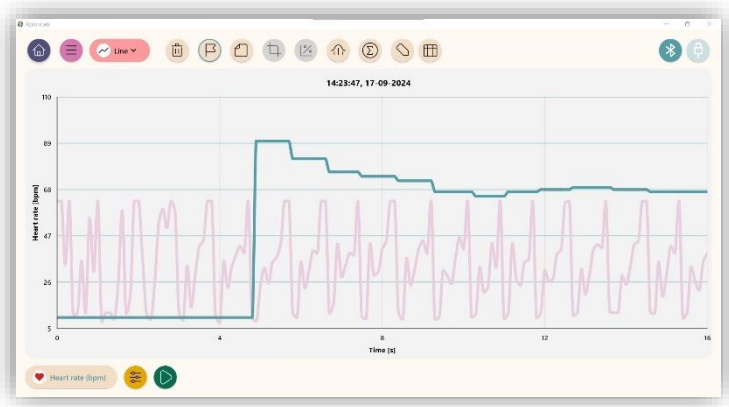
NOTE: Because speed is calculating based on the Distance sensor, it will only be accurate for movement in the axis that the distance sensor is facing. If you move the Xploris perpendicular to a surface while running the speed sensor, it will not provide accurate readings.

Pulse and Heart Rate

Pulse sensor shows the heart rate pulses on a voltage scale. This is shown in pink in the sample image below.

The Heart Rate sensor calculates the number of pulses per minute and displays a graph in bpm (beats per minute). This is shown in blue in the sample image.

Both Pulse and Heart Rate take a few seconds to acclimate. The Heart Rate sensor will start giving an accurate reading after around 8 seconds. The Pulse sensor should start looking accurate after about 5 seconds.



Temperature

External Temperature is collected when the temperature probe is plugged into the Xploris port on the back of the device. The icon for External Temperature is a thermometer.

Ambient Temperature is an internal sensor inside the Xploris. The icon for Ambient Temperature is a thermometer inside a circle, representing the sensor inside the Xploris.

When to use External vs Ambient Temperature:

Often, you will want to use the External Temperature probe as it is more accurate and updates more quickly to changes in the environment because it is not in an insulated device. The External Temperature probe can also be inserted into materials such as soil or liquids to gain readings in those environments.

NOTE: Make sure you do not submerge the probe into anything deep enough that the substance reaches the end of the metal probe near the cord. This could cause serious damage to the probe. If using liquids, make sure the containers do not have so much liquid in them that the probe could accidentally be dropped in and submerged.

Because both battery charging and high brightness Xploris display may raise the internal temperature of the Xploris, the Ambient Temperature is impacted by factors unrelated to the environment outside of the device. If recording Ambient Temperature, we recommend setting the screen to low brightness and disconnecting from a charging cord or station.

If you are unsure whether to use ambient or external temperature, always choose the external temperature probe.

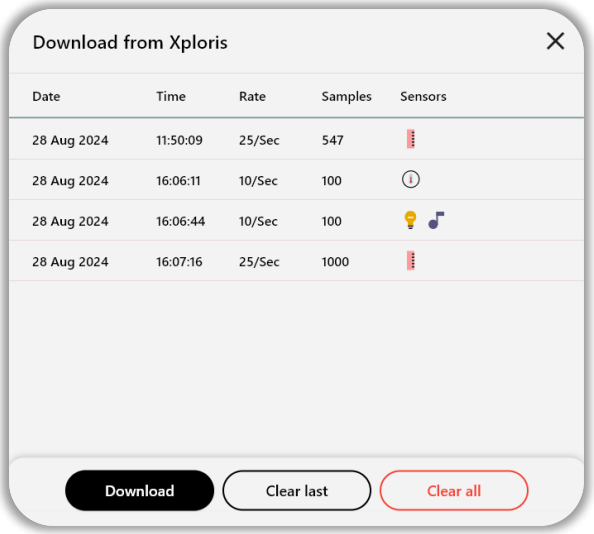
5.2 Download a Recording from Xploris Memory

Clicking the Play icon starts a new sensor recording. Every sensor measurement is simultaneously stored on the Xploris memory. The data is stored on the Xploris device even if you start your experiment without connecting to XploriLab (see Section 2.5.2 on Sensor Buttons to learn how to start an experiment without XploriLab.)

If you are connected to XploriLab, the data will update in real time on the connected device.

If you would like to open any previous experiment, either run on the Xploris directly or in XploriLab previously, follow the below steps:

Click on the Pancakes menu and select "***Download from Xploris.***"



- A dialog box will open, displaying all recordings in that Xploris' memory.
- Each recording indicates the recording start time and date, the sample rate, number of samples collected for each sensor, and the sensor types used for this recording.
- Select one of the lines and click the Download button.

NOTE: Xploris' memory can hold up to either 80,000 samples, or 40 different recordings.

Trying to start a new sensor recording when there is no available space in the memory will have the XploriLab display "***Memory full***" on the screen. You may use the above dialog box to clear the most recent (last) recording or clear all recordings in the memory.

If you would like to save a recording but remove it from your Xploris, you can download it to your device. Then, use the same Pancakes menu to save a local copy on your tablet or computer. Afterwards, you can delete it from the Xploris to free up memory.

5.3 Using the Various Display Types

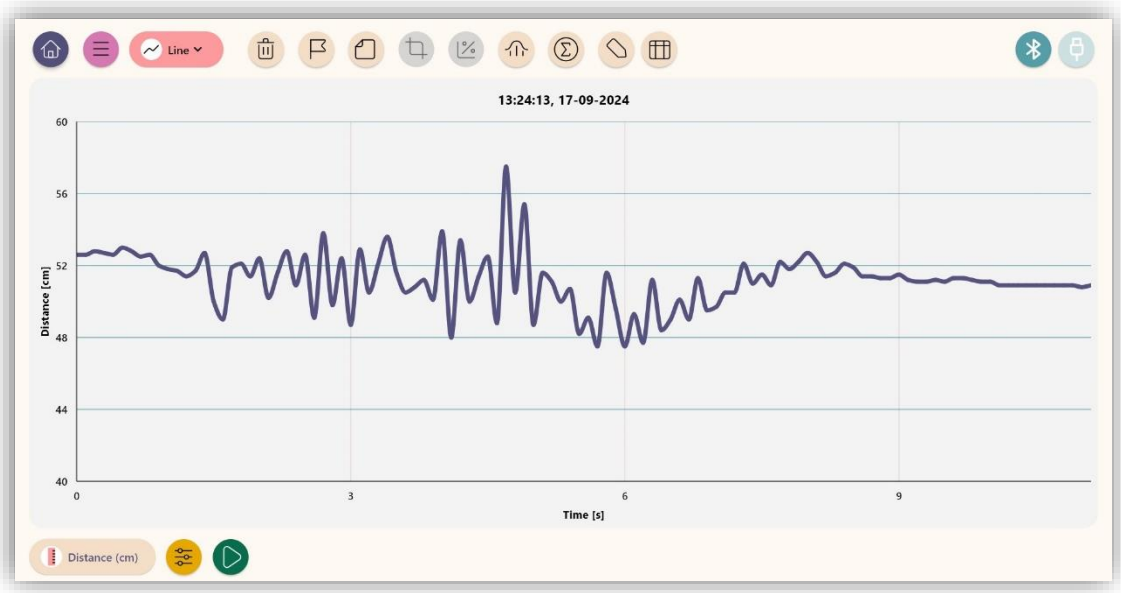
XploriLab displays the collected data in line graphs, bar graphs, or as a data table. Click the display selection icon on the top of the screen. A dialog box opens allowing you to select one of the 3 display options.

5.3.1 Line Graphs

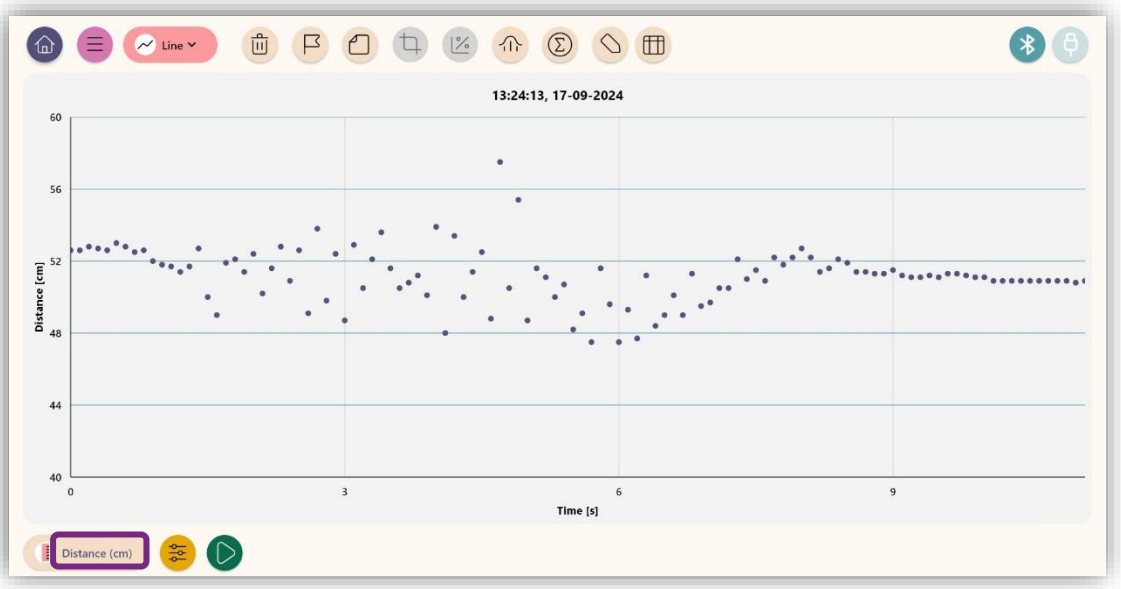
The default display is a line graph for most sample rates.

Line graphs can show multiple sensor readings simultaneously. Each reading will be shown in a specific color and the selected sensor will be a darker line than the others.

Each data point will be added to the graph and a line will be drawn between each point.



If you click on the selected sensor in the bottom left corner of the screen, you can change it from line to dots so you can see exactly the data points creating the line. The graph from above is also shown below so you can see the difference.

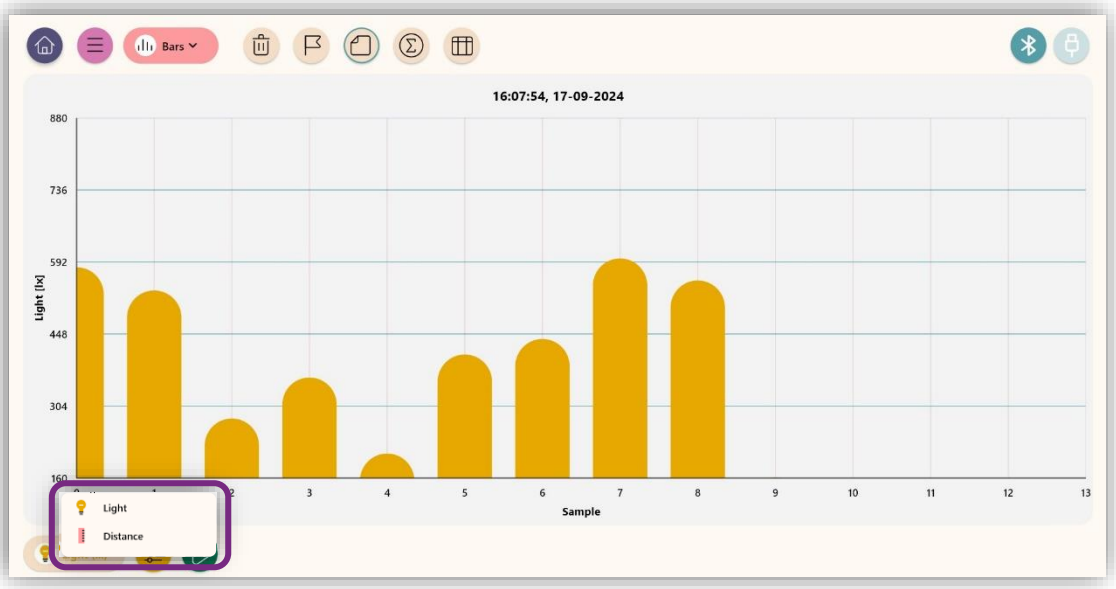


You can also adjust the visibility of each sensor reading using the Graph Settings menu. If multiple sensors were running during the experiment, you can click on the eye icon to toggle visibility on or off for each individual sensor.

Lastly, you are able to change the display color of each sensor, if desired. We go into this in more detail in section 5.4.1, Changing the Graph Settings.

5.3.2 Bar Graphs

The bar graph display will present your data as a bar graph. This is the default view mode selected if you choose “Manual” sampling.



The bar graph will only show a single sensor’s data at a time. If you would like to switch which sensor’s data you are viewing, click on the name of the sensor in the bottom left corner.

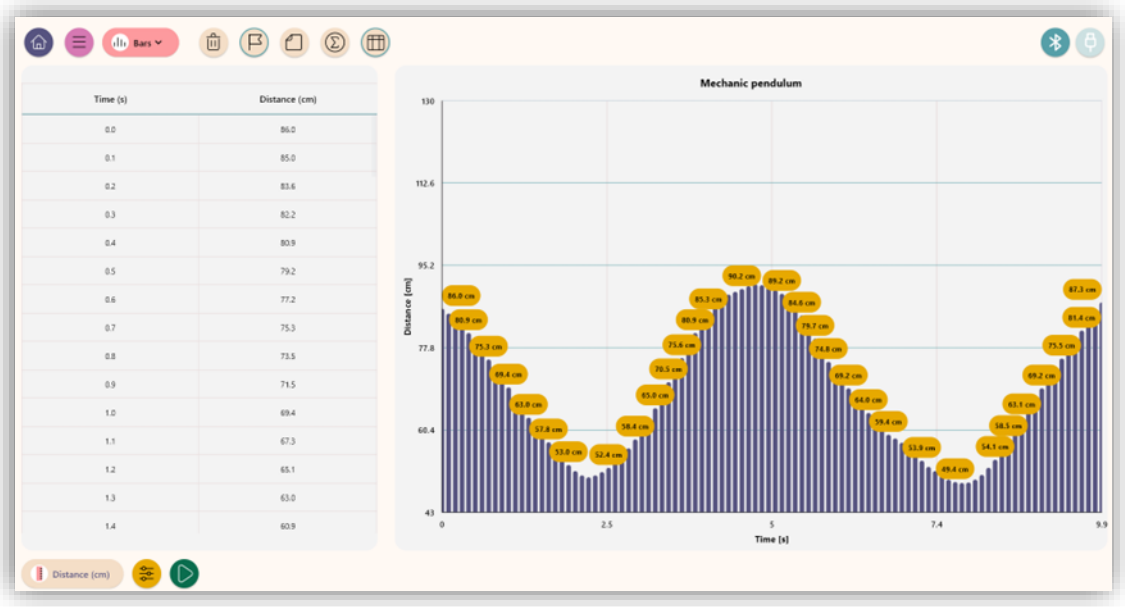
5.3.3 Data Table

When you select “Table” from the dropdown, a data table will display of the collected data. Scroll down to see all the data collected. If you place your mouse on the right side of the screen, a scroll bar will appear.

Time (s)	Light (lx)	Distance (cm)
3.00	53	90.2
3.00	53	90.2
3.00	53	90.2
4.00	120	82.2
4.00	120	82.2
4.00	120	82.2
5.00	178	74.0
5.00	178	74.0
5.00	178	74.0
6.00	276	63.9

When selecting Line or Bar graph display, you may add a table to the left of the graph by clicking the table icon from the buttons at the top of the screen.

Below is an example of a combined Table/Bar graph display.



5.4 Graphical Analysis Tools

Once recording has ended, or you finish downloading it from the Xploris' memory, you may use various graphical tools to analyze the measurements.

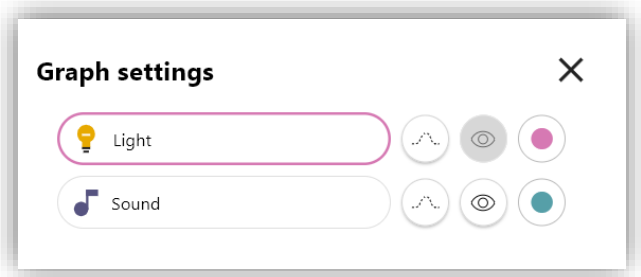
This includes:

- Changing graphs settings.
- Placing and moving markers on the graphs.
- Annotating the graphs with text and images.
- Cropping a sub-set of data.
- Zooming in or out of the graph.

5.4.1 Changing the Graph Settings

Click the graph setting icon at the bottom left of the screen. The graph settings icon will show the name of the currently-selected sensor.

A Graph Settings dialog box opens. When viewing a recording of more than one sensor, clicking on any of the sensors in the dialog box will make it the active sensor and have the Y axis scale showing its name, unit, and values.



You can also:

- Click the color circle on the right to change each sensors' display color.
- Click on "eye" icon to display or hide this sensor.
- Click the dashed graph icon to toggle between line or samples graph.

Graph Settings is available in Line Graph display only.

In Bar graph display, clicking on that button in the bottom left corner will only allow you to select the active sensor.

Graph Settings are not relevant and therefore not available in Table view.

5.4.2 Adding and Using Markers

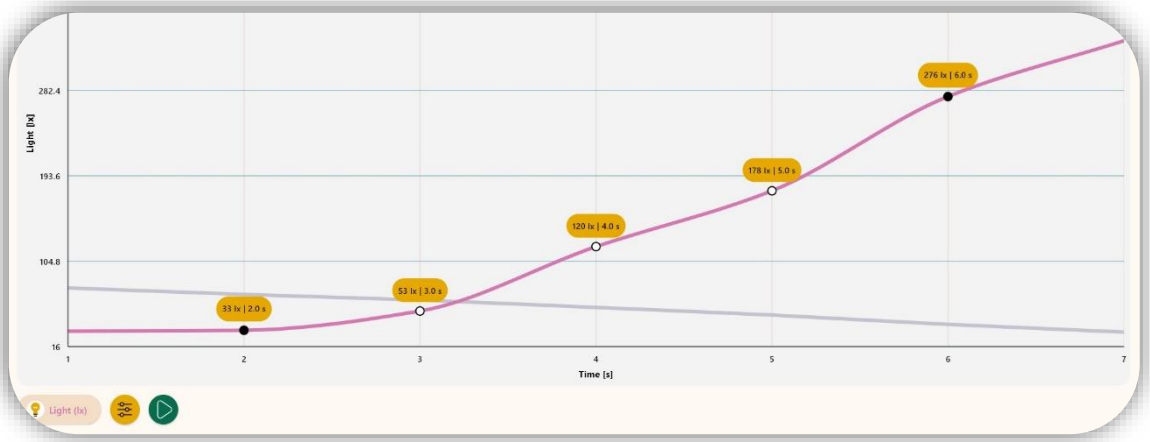
Graph markers are a great tool for viewing sensor level and time for any point on the graph.

Click the Marker icon on the top bar. It looks like a flag.

Markers on Line Graphs

To **add** a marker, click any point on the graph. A marker is displayed, showing the point coordinates (Sensor value, Time).

The markers are always placed on the active sensor graph. When viewing a recording of more than one sensor you may change the active sensor to view the markers on the other graphs on the screen. See section 5.4.1 on Changing the Graph Settings for information on how to do so.



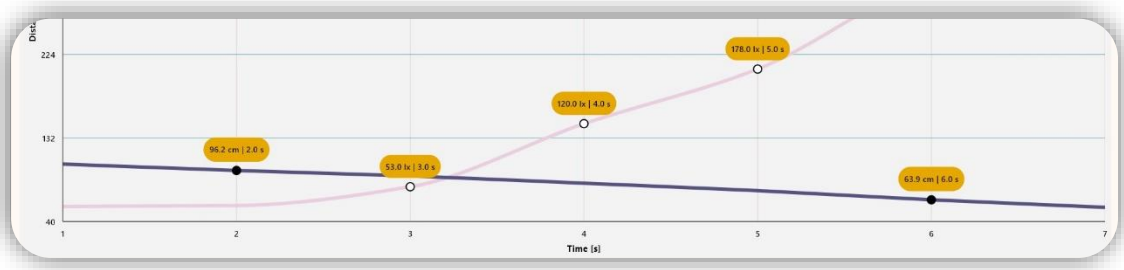
To **move** a marker click and hold the black dot under the marker text balloon and drag it to any point on the graph.

You may place up to two moveable markers on the graph and move them independently.

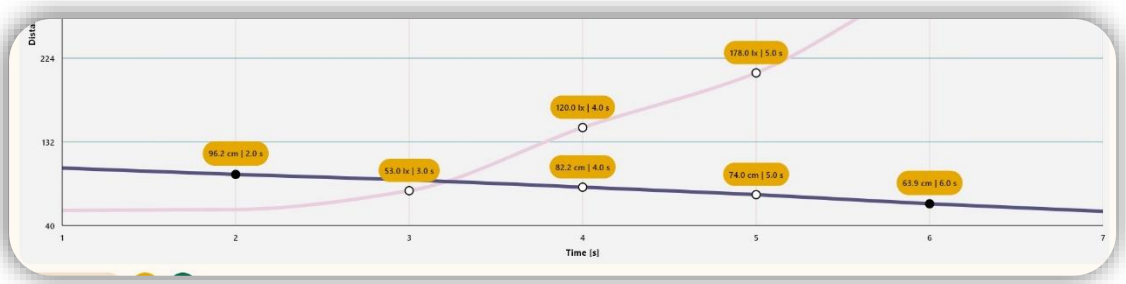
If you want to mark **more than two** interesting points on the graph – you can do that by "locking" markers. Simply click the marker text balloon and select the **lock** on the Dialog box. The black circle indicating the marker's location will turn white. This indicates that this marker cannot be moved on the graph. Once locked, a marker cannot be unlocked. It can, however, be deleted.

You can always have only two moveable markers on a graph at the same time. Any additional markers desired will have to be locked.

NOTE: When you change which graph is the active sensor graph, any unlocked markers will automatically switch over to the active graph. Any locked markers will stay on their original graph.

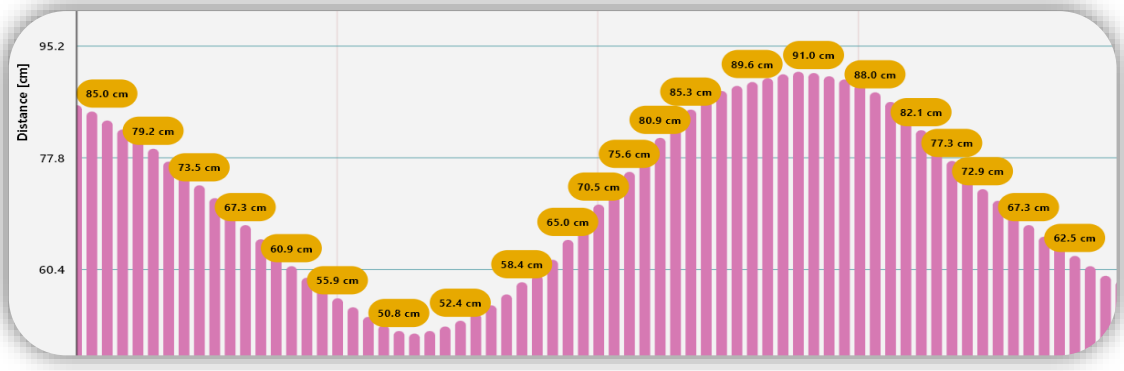


This allows you to mark multiple points of data across different sensors simultaneously.



Markers on Bar Graphs

Using Markers in Bar graph mode will mark all bars on the screen, or as many as will fit, as seen in the next screenshot.



5.4.3 Cropping your Graph

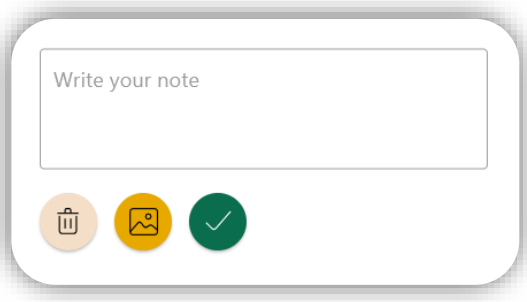
If you would like to permanently delete sensor data from your graph, you may remove data using the Crop tool. First, add two **unlocked** markers to your graph. Any data outside those markers will be deleted when you click on the crop button.

If you do not want to permanently delete data, use the Zoom functionality instead. See section 5.4.5 Zoom.

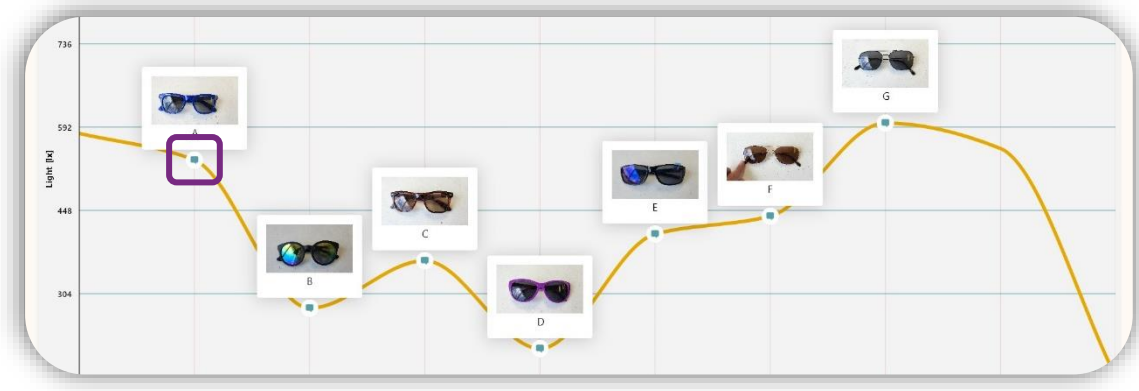
If you accidentally deleted data you did not mean to, you can re-download the data from the Xploris. The crop button only impacts the data in XploriLab.

5.4.4 Adding Annotations

Xplorilab enables users to annotate the line graph and Bar graphs.



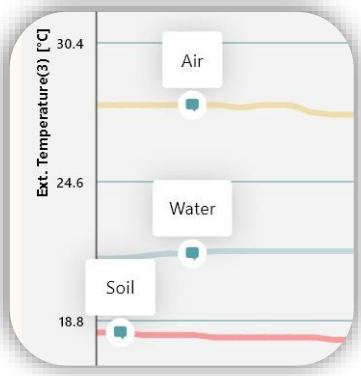
To **add** an annotation, click the annotation icon and then a point on the graph or bar. A dialog box opens allowing you to add text, images and .gif files to provide more information about the graph and your research. When you have added all the information you would like to, click on the green check mark. The image will not appear until you do so.



Annotations can be minimized or opened by clicking on the small word bubble symbol located on the graph itself.

Annotations can be edited by clicking anywhere on the annotation itself.

Annotations will only be added to the active graph. If you would like to add annotations to multiple sensors, you must change the active graph by clicking on the Graph Settings button in the bottom left. See 5.4.1 on Changing the Graph Settings.



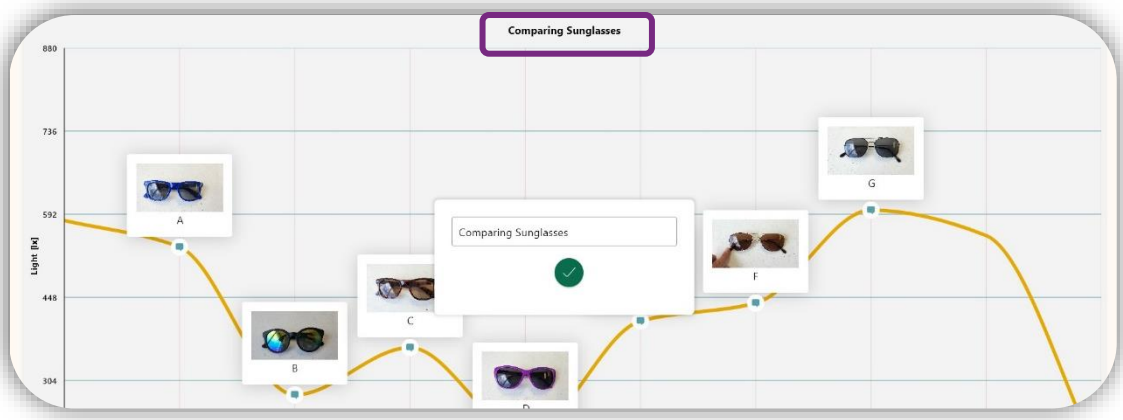
5.4.5 Zoom

If you have a scroll wheel on your mouse, you can zoom in and out of your graph. A right mouse click will take you back to the full graph view.

While zoomed in, you can click and drag the graph around to adjust your view.

5.4.6 Graph Title

The default graph title is the time and date of the current recording. You may change that by clicking on the graph title. That will open a dialog box where you can change the text of the title. Once you've renamed it, click on the green check mark to close the dialog box.



5.4.7 Adjusting the Y-Axis Scale

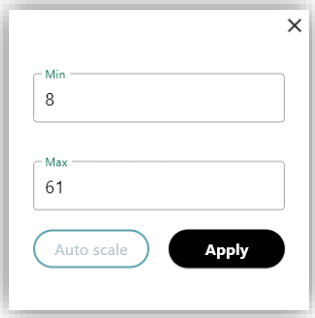
The graph Y axis uses a dynamic scale, adjusting to the graph minimum and maximum values. You may set a fixed scale by clicking the sensor name on the Y axis and selecting the minimum and maximum values for this sensor.

5.4.8 Adding a Prediction Line

Before running an experiment, you can add a prediction line to your graph in Line Graph mode. To do so, click on the pencil icon.

This will clear your graph of any previous experiments.

- Check your Y-Axis to make sure it is at a range you would expect.

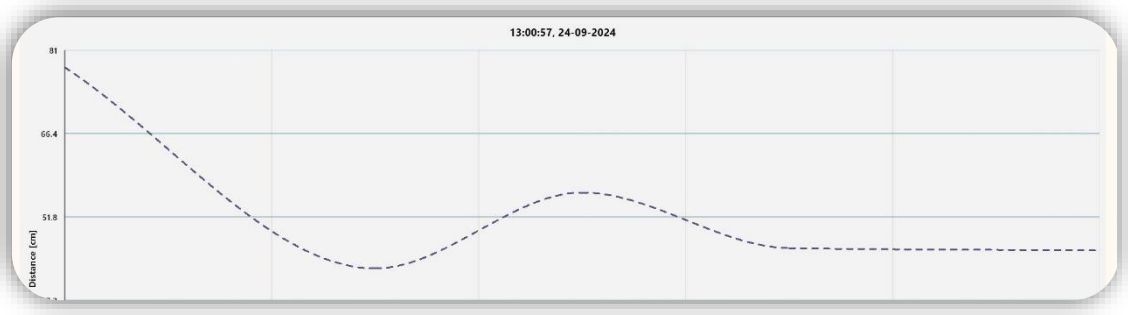


- Go into your Experiment Setup and choose a number of samples corresponding to the length you want for the X-Axis.

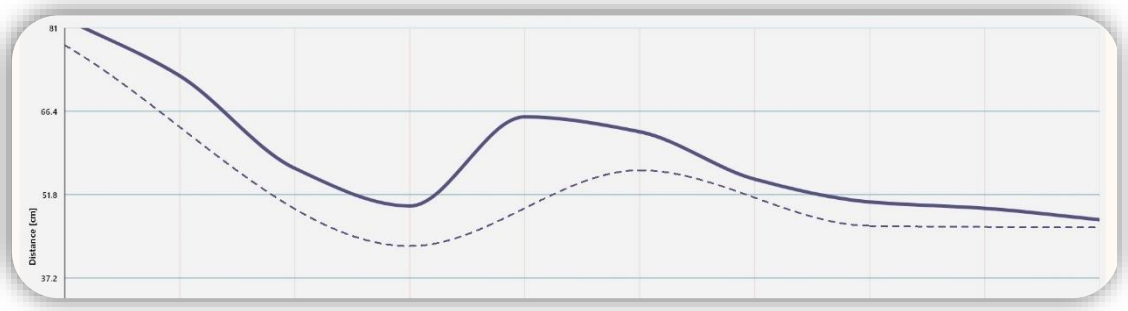
Then, select a point on the graph. **NOTE:** Nothing will show up with the first point you select.

Click a second point on the graph and a straight line will be drawn between them.

As you add additional points, the line with smooth between all provided points.

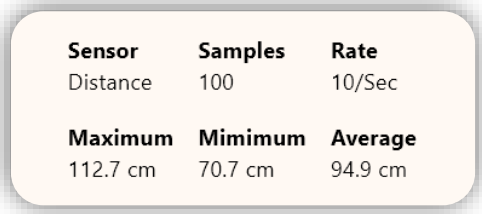


When you click play, your sensor readings will be added to the same screen so you can see your prediction and your actual data on the same graph.



5.5 Mathematical Analysis Tools

The Line graph display offers a set of mathematical functions for analysis.

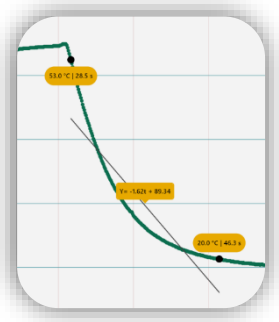


5.5.1 Statistics

Use the Statistics icon to get information on the active graph. This includes:

- Sensor type
- Samples (how many were collected)
- Sampling Rate
- Maximum
- Minimum
- Average

5.5.2 Regression

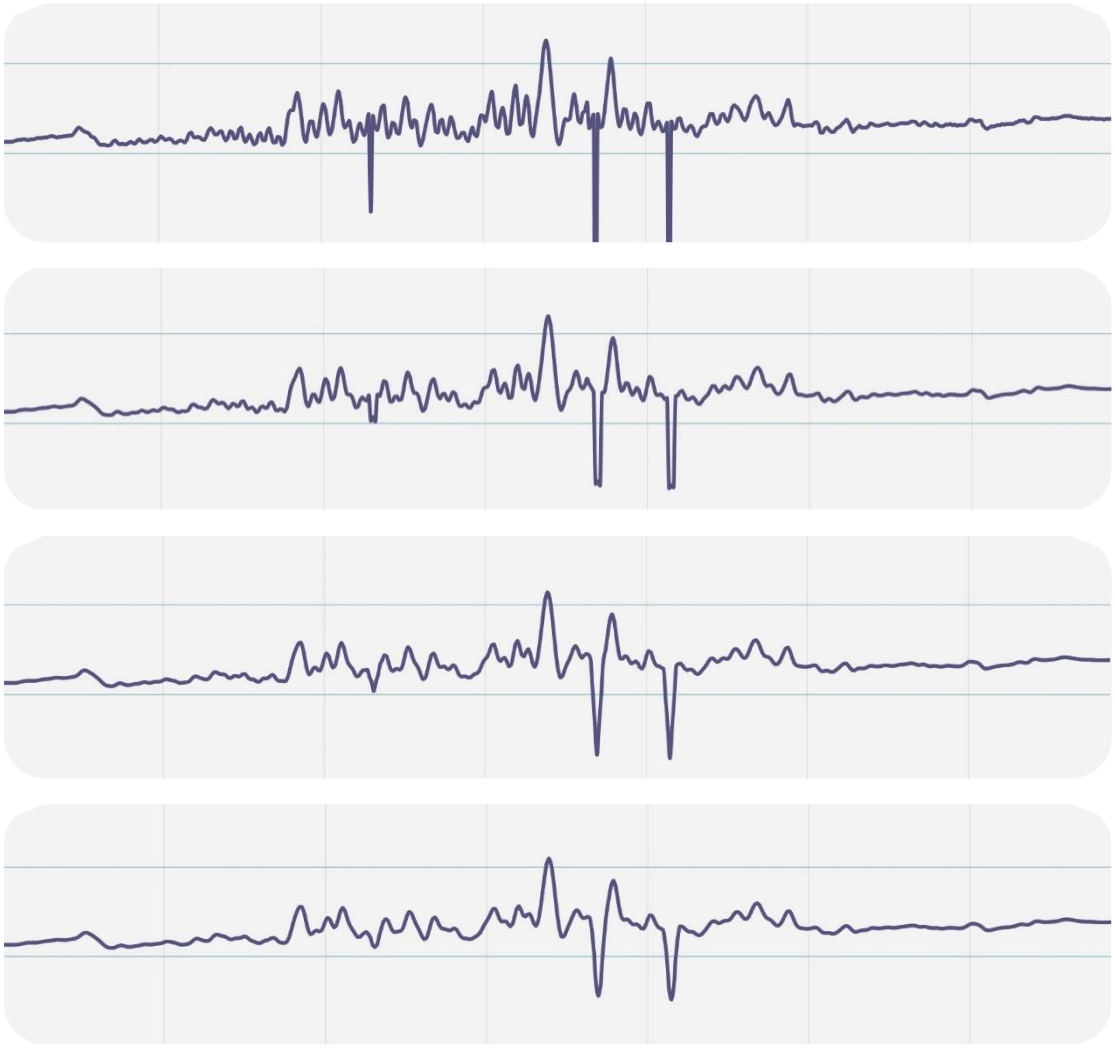


The regression function works between two unlocked markers and displays the best straight line matching the collected measurements. This is accompanied by a linear equation.

5.5.1 Average

The average function is very useful to “smooth” noisy line graphs. Clicking the average icon opens a dialog box where you can select the number of samples for the average window. E.g. for a 3 samples window - each new point on the graph will be the average of 3 graph points: the previous point, current point and the next one.

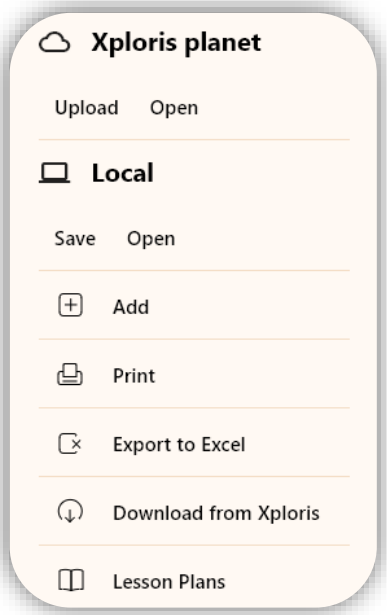
You can do this multiple times. The below images show the same graph run through multiple “Average” operations set to a sample window of 3.



5.6 Files and Data Management

Clicking the files and data management icon, also called the Pancakes menu, opens a dialog box. This box has multiple useful functions.

5.6.1 Saving or Opening Experiments



Any open experiment can be saved either locally or to Xploris Planet. These save files include any markers, annotations, or edits made to the file.

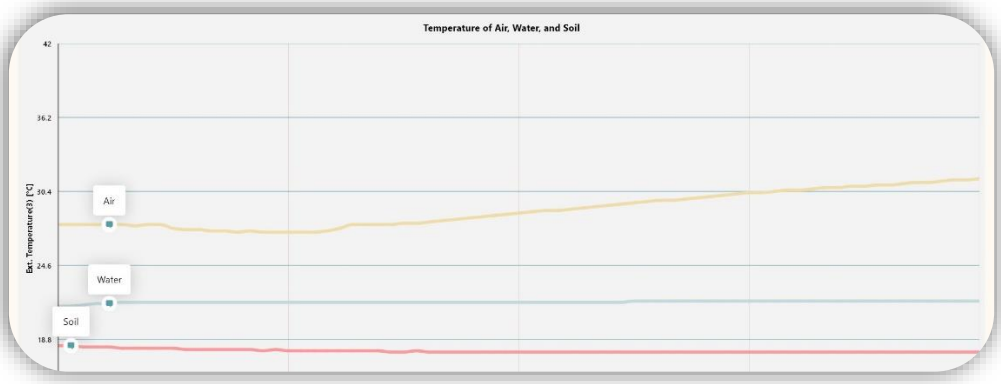
You can also use this to open previously-saved experiments.

5.6.2 Add (Combining Data from Multiple Experiments)

Use the “Add” option in cases where you like to compare graphs from different recordings or from different Xploris units.

For example – when you like to compare two temperature graphs each collected during the same hours, but in different location in the school (e.g. classroom, school garden).

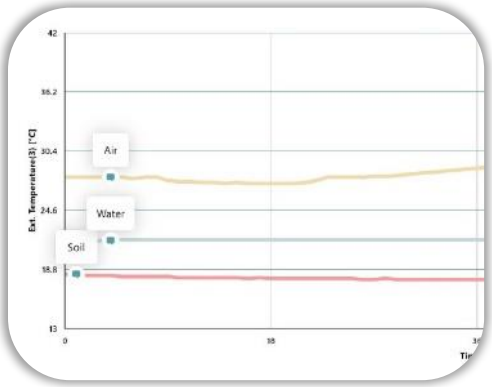
Use *Open* or *Download from Xploris* and select the first graph, then use *Add* to select the second (or third, etc.) graph. All selected graphs will be displayed in the same window allowing you to compare their measurements.



NOTE: This will only work if all graphs are done at the **same sample rate**. The quantity of samples will be determined by the *shortest* of the experiments.

You can compare external temperature to ambient temperature. If comparing temperature values, make sure you are using the same temperature settings when running the experiment.

Important! Make sure the Y-Axis Scale is the same for all graphs to get an accurate comparison. See section 5.4.7 on Adjusting the Y-Axis Scale.



5.6.3 Print

The print button allows you to save the graph of your experiment as a PDF file or send it to a 2D printer. It will only export the graph, markers, annotations, and axes.

5.6.4 Export to Excel

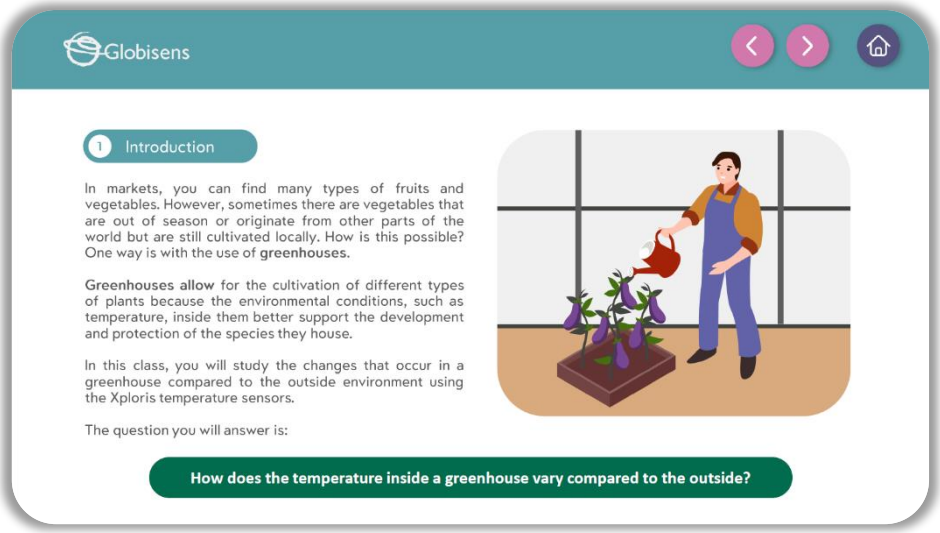
You may export all your measurements to EXCEL in CSV format. This will automatically open EXCEL and fill in all sensors' data in different columns, with the most left column being Time.

5.6.5 Download from Xploris

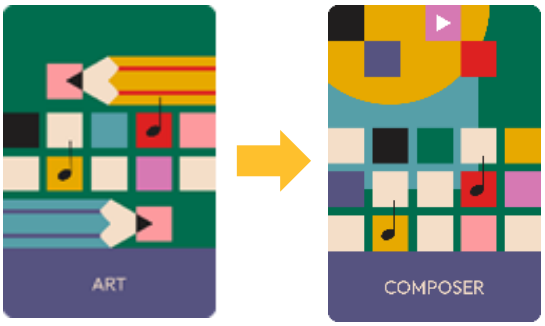
This feature allows you to access a previously-recorded experiment from a connected Xploris. It also allows you to delete experiments off your Xploris to free up memory. For more information, see section 5.2 Download a Recording from Xploris Memory.

5.6.6 Lesson Plans

Last but not least – you may get ideas for science experiments from our lesson plans. Simply click the "Lesson plans" at the bottom of the Dialog box and open any of the PDF files.

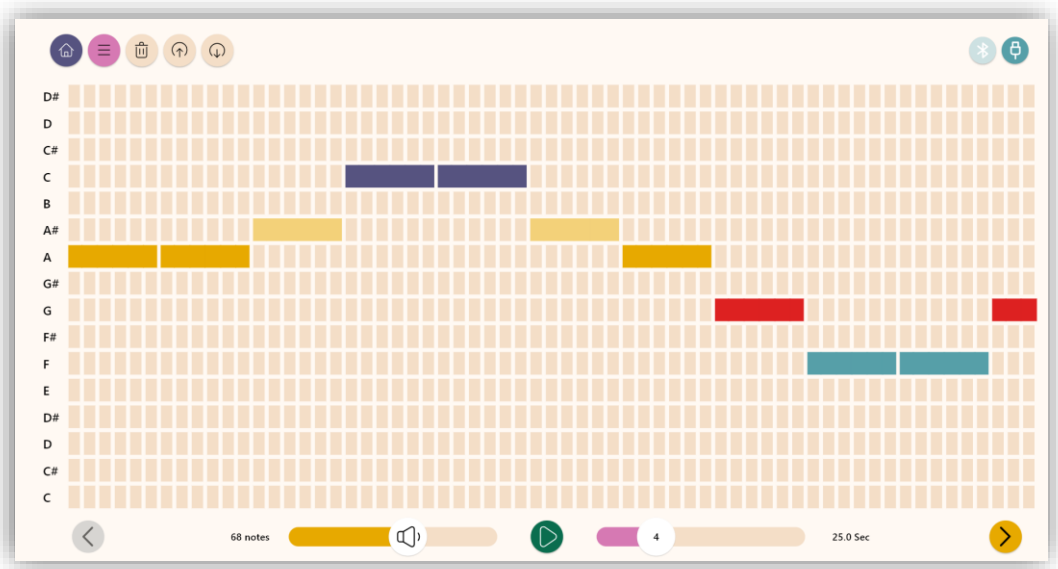


6. XploriLab Art: Composer Module



From the main screen select the ART Poster and then tap the COMPOSER poster.

6.1 Composing Music



The Composer interface offers a set of 16 different notes (one and a half octaves) for music composing. You can play the music in XploriLab or upload it to your Xploris and have the Xploris play it on its speaker.

- **Add** a note to your composition by clicking on one of the light tan note rectangles. This will add a note on the composer page.
- **Note duration** is set by the slider on the bottom right. The maximum composition length is 126 notes, and you can set each note duration from 2/16 of a second to a full second. See the following section for more information on this topic.
- To **delete** a note, simply click on it to remove the note.
- To **edit** a note, select a different note in the same column and it will replace the original note. This method will also allow you to change the **duration** of the given note, moving all other notes over to adjust. However, you must select a *different* note than the current note to edit. You can then re-select the original note, if desired.

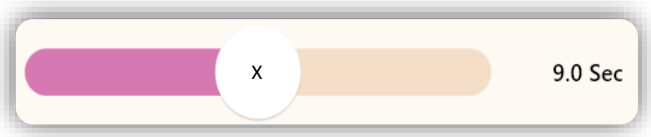
In cases where the number of notes selected for the composition is greater than the XploriLab page size – use the arrow icon to flip to the next page.

6.2 Setting Notes Duration

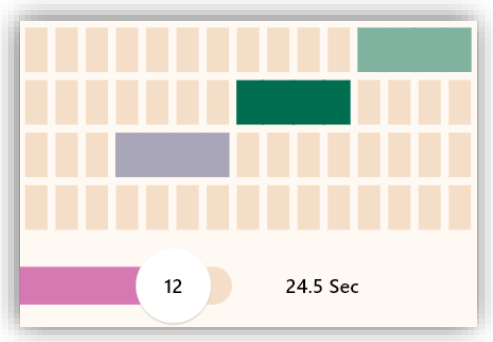
The basic note duration is 1/16” (1/16 of a second), represented by a single rectangle. Using the slider below you can extend a note duration by x2 to x16 – to create a duration of 1/8” to 1” respectively.

Slider options are:

- x2 - duration of 1/8”
- x3 - duration of 3/16”
- x4 - duration of 1/4”
- x5 - duration of 5/16”
- x6 - duration of 3/8”
- x8 - duration of 1/2"
- x12 - duration of 3/4”
- x16 - duration of 1”



With these duration options you'll be able to compose any melody.



An extended note duration is represented by a set of up to 16 concatenated rectangles. E.g. the note on the right has a duration of ¼" represented by 4 linked rectangles.

XploriLab calculates your total composition time - based on the number of notes and the notes duration. This information is displayed on the right side of the slider. In the sample image, you can see the total duration is 24.5 seconds.

Once you are happy with your composition – hit the play button and listen as XploriLab plays it.

6.3 Uploading and Downloading Music to/from Xploris

Use the upload icon to send your composition to your Xploris. Xploris will play it while showing a default note animation on its display.

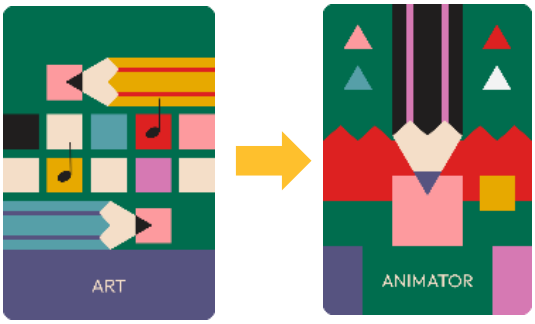
Alternatively, you can have your music piece uploaded as a music track for any animation you create. To do that, simply keep your last music composition on the Composer module, then, open the Animator module. Create or select any animation and upload it to your Xploris. This will upload both the animation and the music. See section 7 for information on the Animator module.

The Download icon sends a copy of an Xploris music file to the Composer module. In this way you can reopen a music file you've previously sent to your device.

Use the pancakes menu icon to save your music. You may reopen it either in the Composer or Animator interfaces by clicking "Choose sound" icon. Then use upload to send both the animation and its music track to your Xploris.

7. XploriLab Art: Animator Module

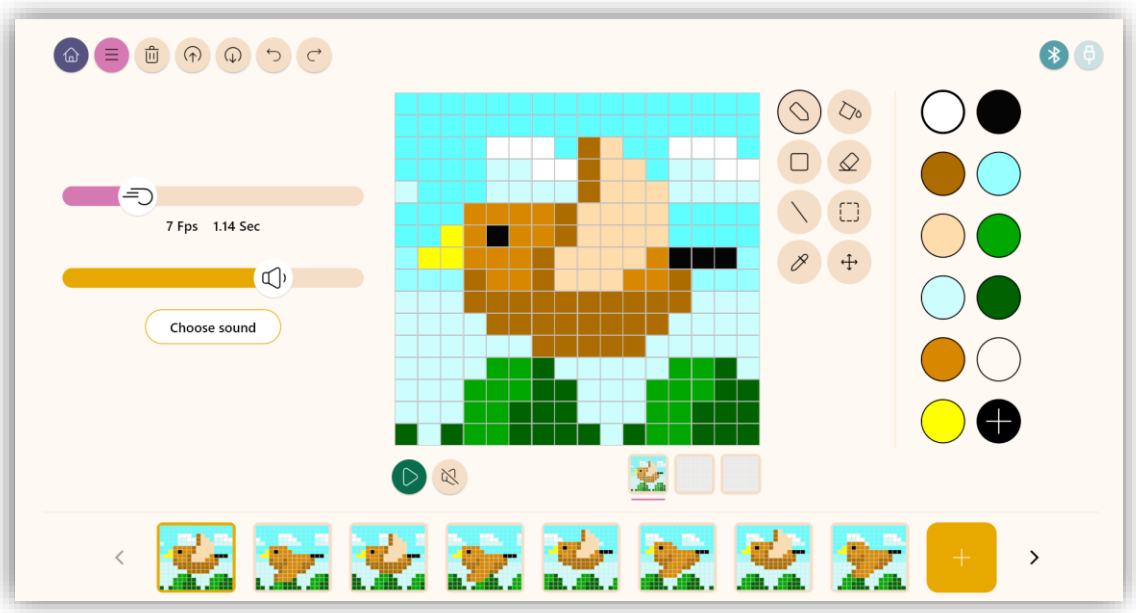
From the main screen select the ART Poster and then tap the ANIMATOR poster.



7.1 Drawing Tools

XploriLab offers a module for creating still images and animations. These can be uploaded and played on the Xploris 16x16 full-color LED pixel-art display.

The Animator interface is a virtual design platform where users create these still images and animations.



7.1.1 Toolbox

The tools are located just to the right of the main pixel grid.

Pencil: Draw a single point (pixel) or a series of points. Anywhere the mouse overlaps will fill with the given color.

Paint Bucket: Fill any closed shape on the canvas with the selected color. Can also be used to replace the canvas background color.

Rectangle: Drag and hold the mouse to create a rectangle on the canvas.

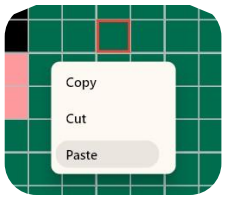
Eraser: Click the pixel you like to erase. Drag and hold the mouse to erase a line of

pixels. Erased pixels will appear black on layer 1 and transparent on layers 2 and 3.

Line: Use this tool to draw either a straight line or a 45° diagonal line.

Selection Tool: Drag and hold the mouse to to select an area of the canvas. Right click will allow you to Cut, Copy and Paste the selected area.

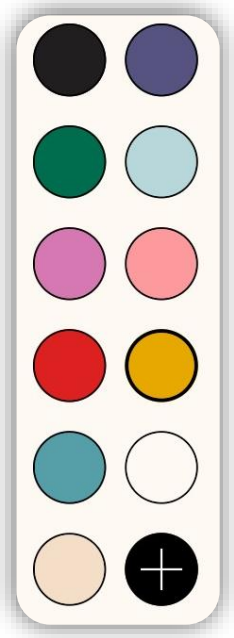
To paste a selected area, click the top left pixel of where you want the design to copy to. It will show up with a red outline. Right click and select paste.



Eyedropper: Select a color from the canvas. Replace the selected color from the palette with this color.

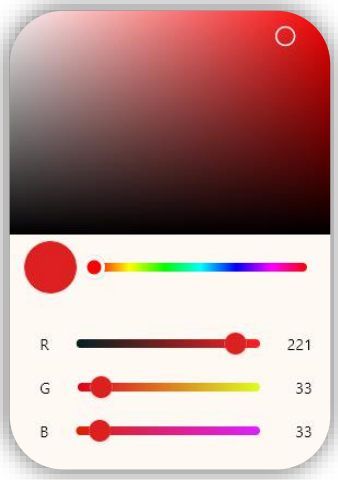
Move: Use this tool to move the entire canvas.
If used together with the Selection Tool it will move the selected area only.

7.1.2 The Palette



The palette of colors, located on the right side of the screen, allows you to select a color for use with any of the above tools. The selected color is marked with a thicker outline.

You may change this color using the plus icon at the bottom right side of the palette. Click the icon to open a color selection dialog box. Here you can dynamically select the desired color by moving the small white circle frame, or by setting the Red, Green, and Blue values (RGB).



7.2 Uploading and Downloading Images to/from Xploris

To send your still image or animation from your computing device to your Xploris, first make sure the Xploris is connected to XploriLab via USB cable or Bluetooth. Then, click the **Upload** icon.

This will transfer all animation frames and music (if selected) to the Xploris. Once the transmission is complete – you will have the image or animation running on the Xploris' screen.

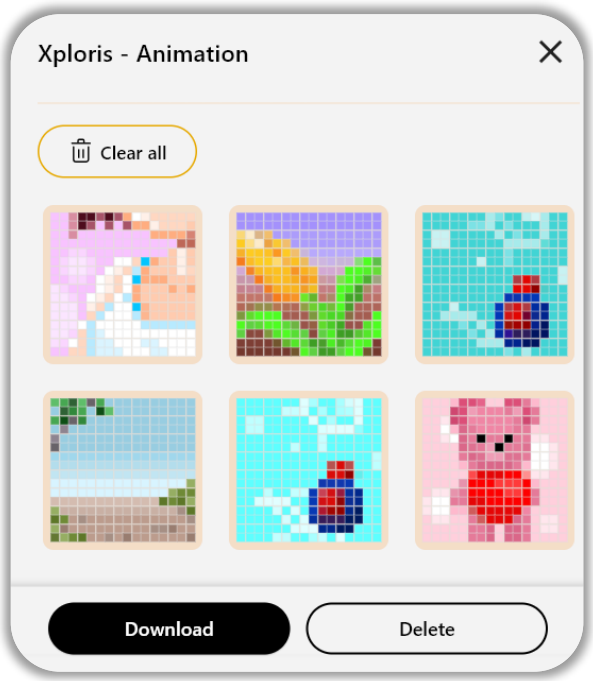
The Xploris' memory can store up to 30 animations, each with up to 60 frames and music.

Click the **Download** icon to download a stored animation from your Xploris' memory.

A dialog box will open, showing thumbnails of the first frame of every animation or image stored in the Xploris' memory.

Selecting one of the thumbnails and clicking "*Download*" will bring the animation from Xploris to XploriLab.

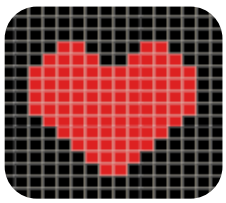
Downloading an animation does not erase it from the Xploris' memory. To erase an animation, click on its thumbnail and then select *"Delete."*



To delete all animations – go to XploriLab main screen. Click the Configuration icon and then "Clear all." This will erase all data stored on the Xploris memory: animations, images, music files and sensor recordings.

7.3 From a Still Image to an Animation

To create an animation, you must start with a single still image, or frame. Use the drawing tools and palette to design an image.

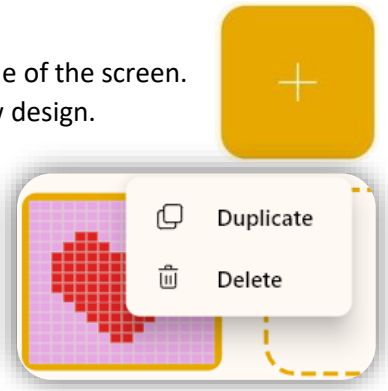


You can follow along with this example to practice.

- Create the red heart as shown here.
- Use the Paint Bucket tool to change the background color to pink.
- Click the Upload icon to view the heart on the Xploris' display as a still image.

An animation is a series of still images displayed one after the other. Each image is called a "frame." In XploriLab, as well as on the Xploris, the animation will automatically loop, starting back at the first frame after it finishes the last frame.

To create an animation, you need to create multiple frames. You have two options to do this.



- One option is to select the yellow + sign on the right side of the screen. This will **create a blank canvas** for you to draw any new design.
- The second option is to **duplicate your existing image**. For most animations, this will be the preferred option for quickly creating an animation.

  Right click on the farthest right image from the bottom image strip. A dialog box will open, allowing you to duplicate (or delete) this frame.

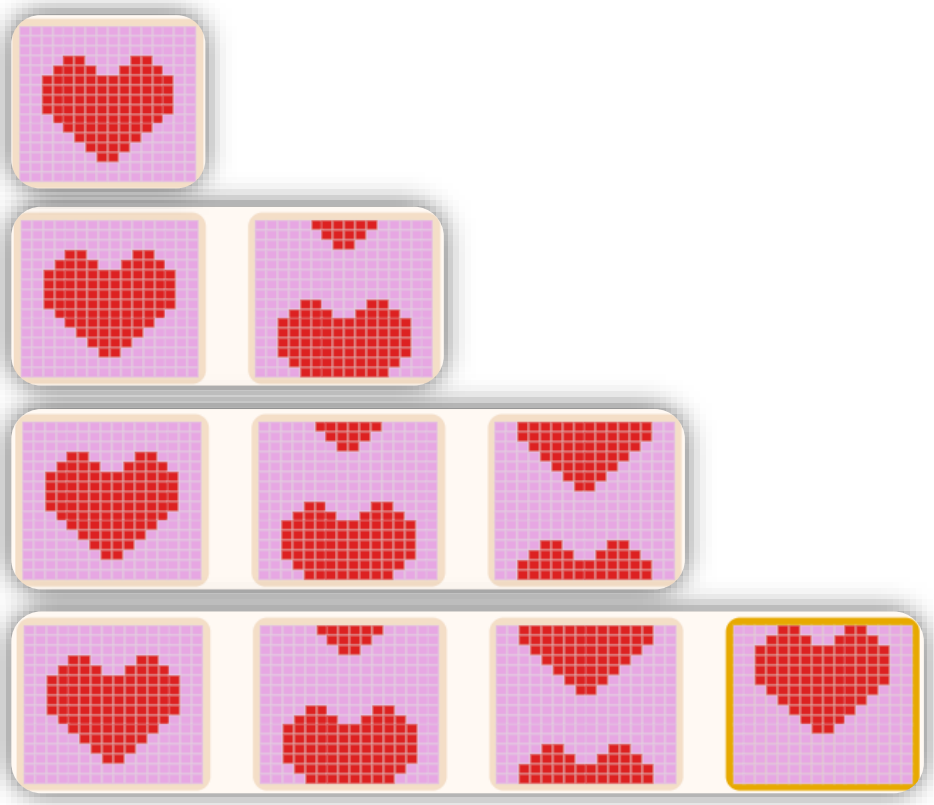
Duplicate it to create the 2nd image.

For our example animation, use the **Move** tool to scroll the entire image 4 pixels down. You will notice that as you slide the image off any edge, it will reappear on the opposite edge of the frame.

Duplicate this new image to create a 3rd image and repeat the 4-pixel scroll down.

Do it once more for the 4th image.

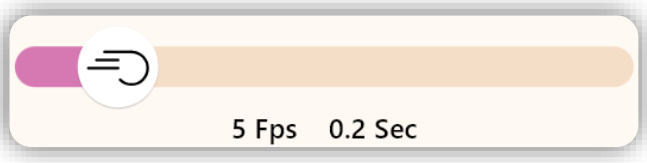
At the end of this process, you'll have a set of 4 images, or 4 animation frames, as seen below.



To **play** the animation, click the play icon. As each of the images is 16 pixels tall – scrolling 4 pixels down over 3 frames, brings us back to the exact first image.

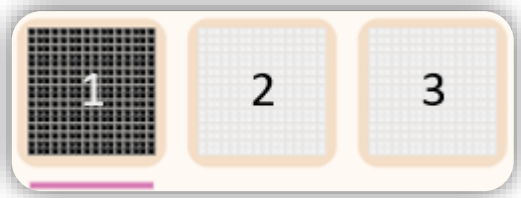
Because XploriLab will automatically loop the animation, this example animation will be a smooth movement of the heart on a loop.

Use this slider to control the speed of the animation. i.e. how many frames it displays in each second. The slider runs from 1 FPS (frames per second) to 25 FPS.



Each animation you create can hold up to 60 frames.

7.4 Using the Layers

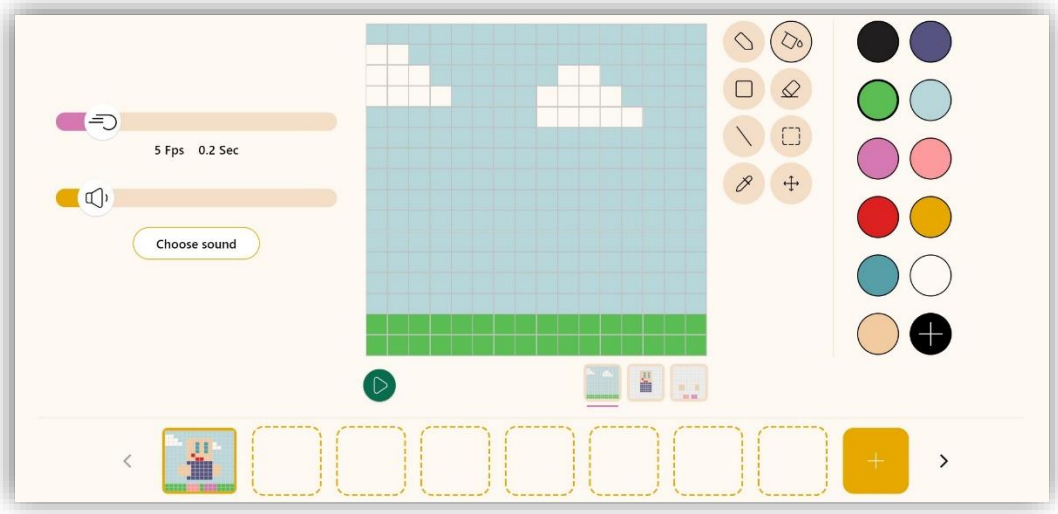


Animation layers let you create more advanced animations easily. XploriLab offers a set of 3 layers for each frame. These layers are located at the bottom right side of the main canvas area.

The bottom layer is marked “1” and typically used for the background of the animation. Layer 2 is displayed on top of layer 1 and layer 3 is displayed on top of layer 2. These top layers are dedicated to the figures or objects moving above the background.

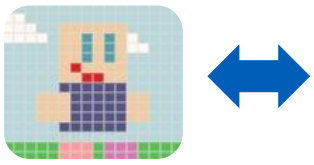
Select a layer by clicking on one of the 3 layers. A pink line will mark the selected layer and allow you to design it on the main canvas. Initially all pixels of layers 2 and 3 are transparent. Painting any of the pixel will make it visible on the animation.

The main 16x16 grid will only display the current layer. Each frame will combine all 3 layers to create one animation image. To see how all three layers overlap, look at the frame strip along the bottom.



In this example, we have divided each image into 3 layers.

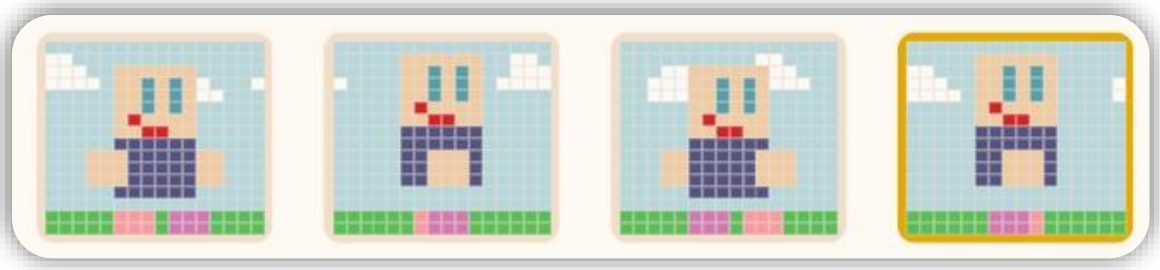
Layer 1 – Background.
Layer 2 – Figure body.
Layer 3 – Arms and legs.



Using layers to divide the scene into 3 separate moving images simplifies our work. We can create the illusion of a walking figure in only 4 frames.

We simply:

- Scroll entire Layer-1 to the left, creating the feeling of moving to the right.
- Scroll entire Layer-2 up and down, creating the up and down motion of walking.
- Adjust arms and legs in Layer 3 to make the figure walk.



Clicking the play icon will play the entire animation as combined frames.

While playing, all three layers will show on the large grid at the same time.

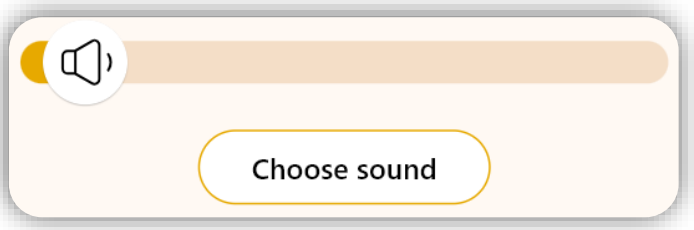
If you would like to view only a single layer's animation, you can select that layer from the layer menu below the 16x16 grid. Clicking on the layer again will return to viewing all three layers' animations stacked on top of each other.

7.5 Adding Music to Your Animation

You may add music to an image or an animation and play them together both in XploriLab and on the Xploris device itself.

Use the XploriLab Composer module to compose your music. See Chapter 6 for more details on how to use the Composer. If you leave the Composer module open with a song on it, it will automatically attach it to your animation when you send it to your Xploris.

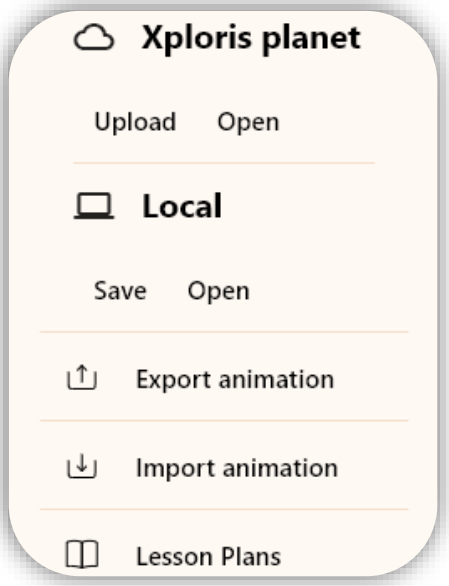
You may also upload a saved music composition using the "Choose sound" button. Click this to open the file manager where you can select the music file you wish to use with the current animation. The volume slider sets the volume of the music.



7.6 Miscellaneous and Data Management

The **Undo** and **Redo** functions cancel or redo the last action you took. They can only undo or redo a *single* action. They cannot undo more than that. The Trash can will **delete** the entire animation.

Use the pancakes menu to manage images and animation files, export your design in GIF format and go over our lesson plans, to get ideas on creating pixel-art.



Click the pancakes button to open the menu dialog box.

Here you can:

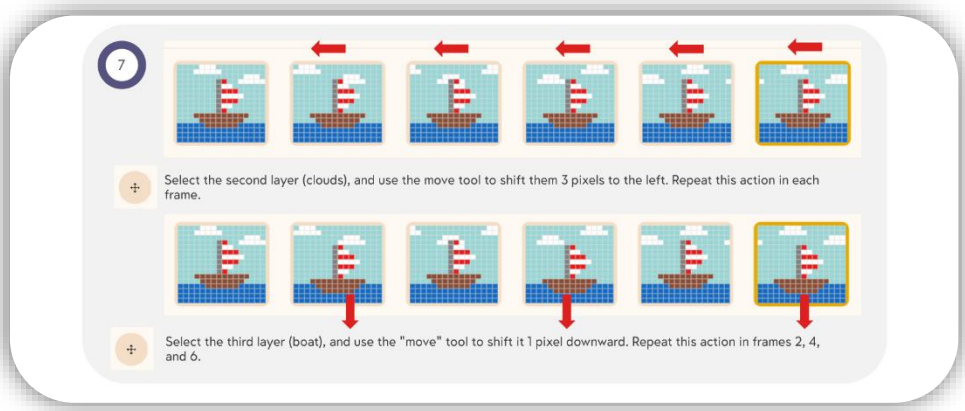
- **Open** and **Save** your project files in *.SRC format
- **Export** your work as *.GIF files
- **Import** .GIF files into the Animator module.

File Types

.SRC files hold all your project design details including frames, layers, and music.

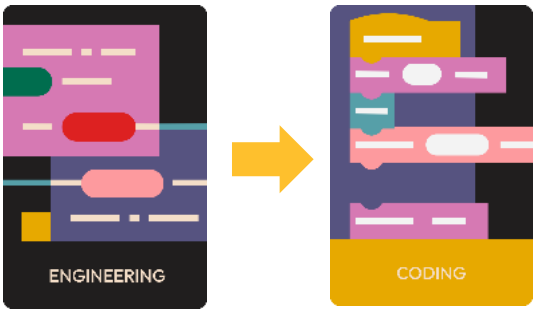
.GIF files only store the animation frames. Gif files can be then imported into the Data Logger module as an annotation. See Section 5.4.4 for details.

Last but not least you may click the **Lesson Plans** and open any of the PDF files providing more information on creating beautiful pixel art stills and animations.

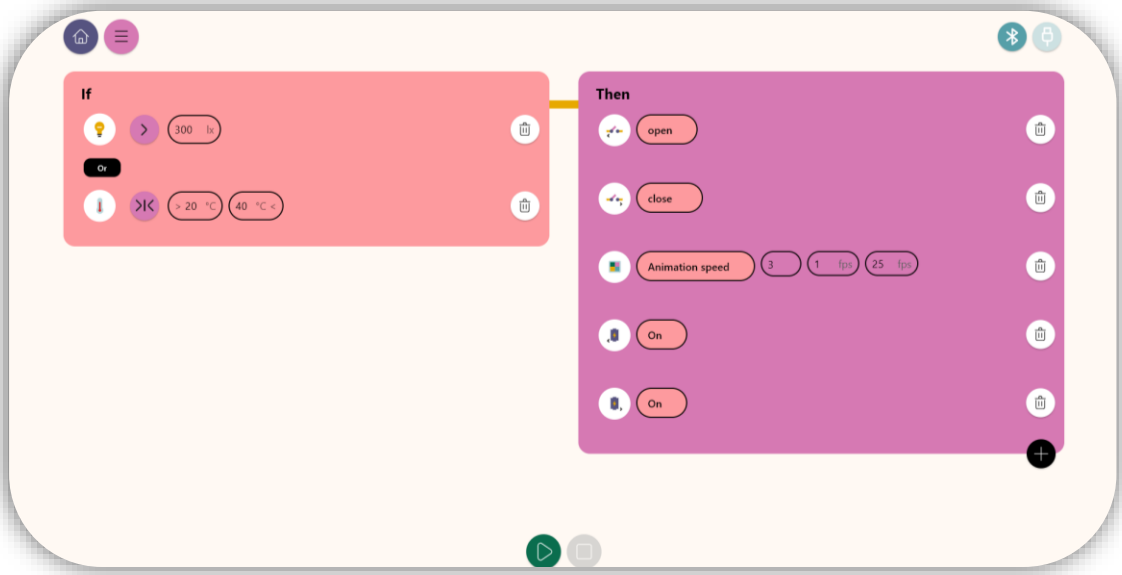


8. XploriLab Engineering: Control Module

From the main screen select the ENGINEERING Poster and then tap the CONTROL poster.



8.1 Using the IF/THEN Condition



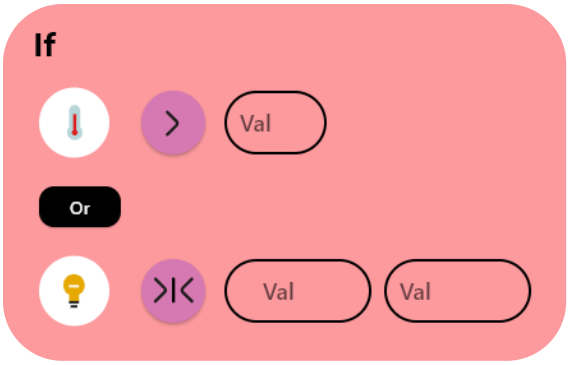
The Control module helps you to control a set of Xploris outputs based on Xploris sensor levels. This is performed by using the basic coding IF/THEN condition. The inputs to the “IF”

conditions are Xploris sensors and the “THEN” can control any of the Xploris outputs: display, speaker, 2 switches, 2 voltage outputs, and 2 servo engine drivers.

You can use up to 2 Xploris sensors as inputs for the IF/THEN condition, while simultaneously controlling all 8 Xploris outputs.

8.2 IF Input Conditions

Any of the following sensors can be used as inputs: Light, Sound level, External Temperature, Distance, left Voltage input and right Voltage input.



VAL is the sensor level value that when crossed activates the output. Fill the VAL on the IF side of the Control IF/THEN condition.

If conditions are:

Activate output when sensor level is greater than VAL. Deactivate the output when the sensor level <= VALUE.

Activate output when sensor level is less than VAL. Deactivate the output when the sensor level >= VALUE.

Activate output when sensor level is between MIN and MAX VAL. Deactivate the output when the sensor level is outside this range.

You may also use this condition to **linearly change** the output level, when the input sensor is changing between the MIN and MAX values.

Activate output when sensor rises above VAL. Output stays active after activation regardless of the sensor level. If you are playing a sound, the note will only sound once.

Activate output when sensor level falls below VAL. Output stays active after activation regardless of the sensor level. If you are playing a sound, the note will only sound once.

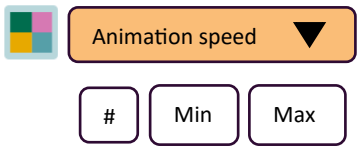
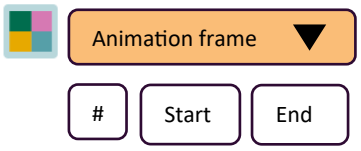
You may set up to 2 conditions, using 2 input sensors.

- If you wish to activate the output when **either one** of the conditions is met – use **OR** between these two conditions.
- If you would like to activate the output only when **both** conditions are met – use **AND** between them.

8.3 THEN Outputs

There are 8 types of outputs:

8.3.1 Display

Control	Description	XploriLab
Animation Speed	Change the speed of the animation number # between MIN and MAX frames per second, based on input sensor value. Relevant only for the X < Sensor < Y input condition. Change the animation speed linearly between Min and Max, according to the Sensor value: If Sensor = X, Then frame rate = Min If Sensor = Y, Then frame rate = Max	
Animation Frame	Change the displayed frame of animation number # between the START frame to END frame, based on input sensor value. Relevant only for the X < Sensor < Y input condition. Change which frame of the animation is showing. It will adjust linearly from the start frame to the end frame, according to the Sensor value: If Sensor = X, Then frame number = Start If Sensor = Y, Then frame number = End	

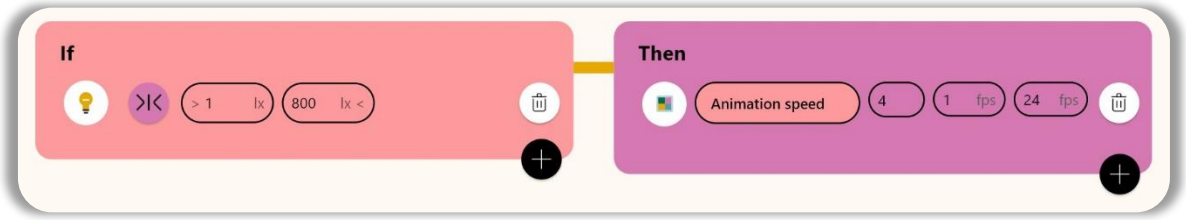
For each section, we will provide simple examples you can recreate on your device to easily test the capabilities of the Control module.

Use the **Play** button to start running your If/Then statement and the **Stop** button to stop running each test. See section 8.4 for more details.

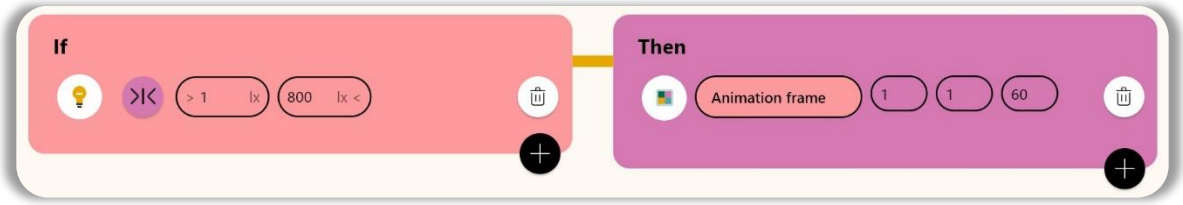
We use **light** as the input as it is the easiest to quickly test things with. Simply use a window or a flashlight to change the sensor readings. Adjust the values if necessary based on your environment. You can use the light sensor to understand what readings you are getting as you move your Xploris around. Remember, the light sensor is located on the back of the Xploris, beneath the flap.

Examples:

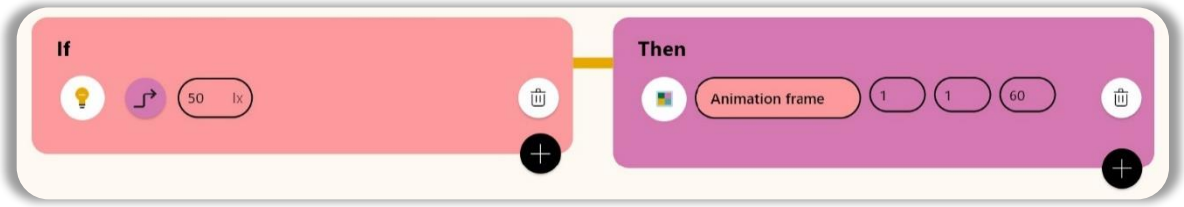
Example 1: As the brightness increases, animation #4 will increase in speed.



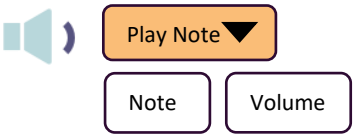
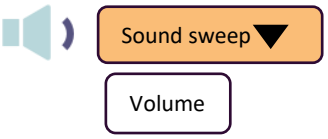
Example 2: As the brightness increases, the displayed frame of animation #1 will move from frame 1 to frame 60.



Example 3: This example code will NOT work, because controlling the display of your Xploris will not work with this format of If condition. It will also not work with simple greater than or less than statements.

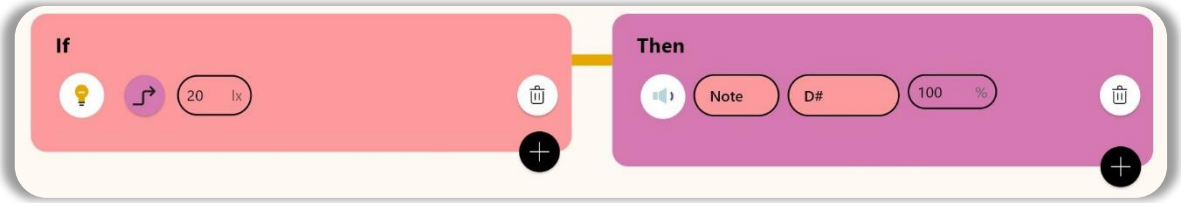


8.3.2 Sound

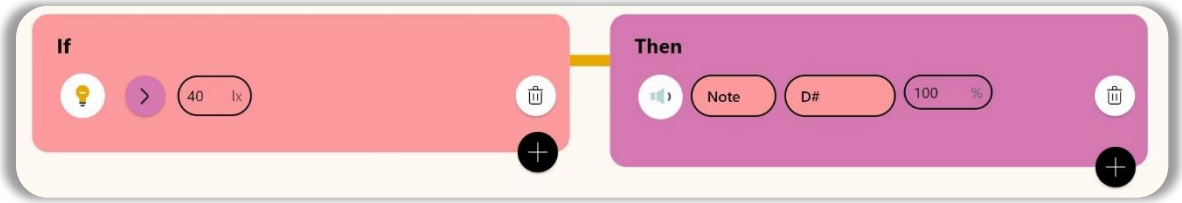
Control	Description	XploriLab
Play note	Play one of the 15 notes from C to D# when input condition is met.	
Sweep sound	Sweep all 15 notes from C to D# based on input sensor level.  Relevant only for the X < Sensor < Y input condition. Change the note played linearly according to the sensor value: If Sensor = X, Then play low note C If Sensor = Y, Then play high note D#	

Examples:

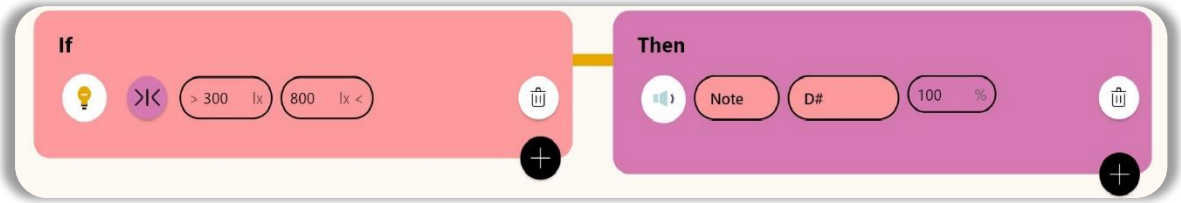
Example 4: If the light goes above 20 lux at any point, play note D# at 100% volume. This will only play the note once, the first time that threshold is reached.



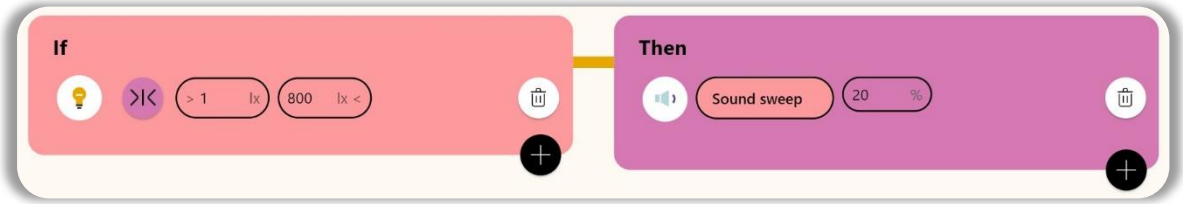
Example 5: Any time the light goes above 40 lux, play note D# at 100% volume. This will play the note any time the value of the light sensor crosses the designated value. It will play in 1-second increments. You can move the sensor from a dark to a bright area to hear it play the note repeatedly.



Example 6: If the light value reads between 300 and 800 lux, play note D# at 100% volume. This will play the note anytime the value of the light sensor enters this range. It will play in 1-second increments. If you leave the range and come back into it, the Xploris will sound the note again.



Example 7: As the light value increases from 1 to 800, make the note being played switch to a higher value. The brighter the light, the higher the note.



8.3.3 Physical Outputs

The following outputs all relate to physical ports on the Xploris, which can be connected to switches, motors, circuits, and more. Refer to section 2.7 for more information on the various Xploris outputs.

For each of the following ports, there are both Right and Left port options. Look for the small black arrow next to the icon to identify which side of the Xploris the output is referring to. The detailed tables below show the right ports but either side can be selected.

Left Ports

Right Ports

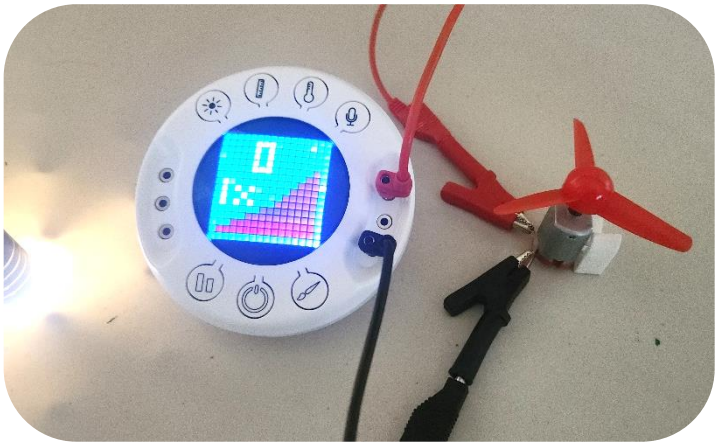
8.3.4 Voltage

You can control the Voltage Out ports. Remember, these are the ports located on the front of the Xploris. The Voltage Out ports are the topmost ports on either side of the Xploris.

Voltage Out	Description	XploriLab
Off – 5V output off	IF condition is met, voltage is off. IF condition is unmet, voltage is on.	
On – 5V output on	IF condition is met, voltage is on. IF condition is unmet, voltage is off.	

Example:

For this, set up your Xploris in the following manner if you have the available materials:

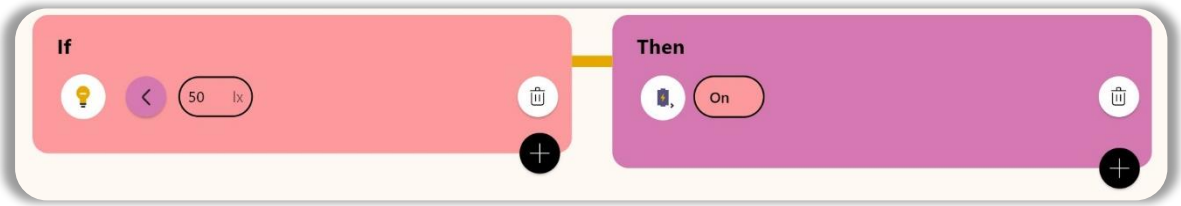


- Plug the red banana cable into the top right port and the black banana cable into the bottom right port.
- Attach the other ends of the cables to a motor with a fan blade. Make sure the motor is rated for a 5V output.*
- Have a flashlight nearby to easily adjust the amount of light hitting the sensor.

This setup will allow you to visually see whether your voltage is on or off, as the voltage out will be activated by certain Control conditions. When voltage is on, the fan blade should spin.

*You can also wire a series circuit that goes from Voltage Out to a 1K Ohm resistor and then to an LED.

Example 8: When the light is below 50 lux, activate the voltage out on the right side of the Xploris to send power to whatever device you have connected to your circuit.



8.3.5 Switches/Contacts

You can control the Switch ports. Remember, these are the ports located on the front of the Xploris. The Switch ports are the middle ports on either side of the Xploris.

Switch	Description	XploriLab Screen
Open – switch open	IF condition is met, switch is open. IF condition is unmet, switch is closed.	Open
Close – switch closed	IF condition is met, switch is closed. IF condition is unmet, switch is open.	Close

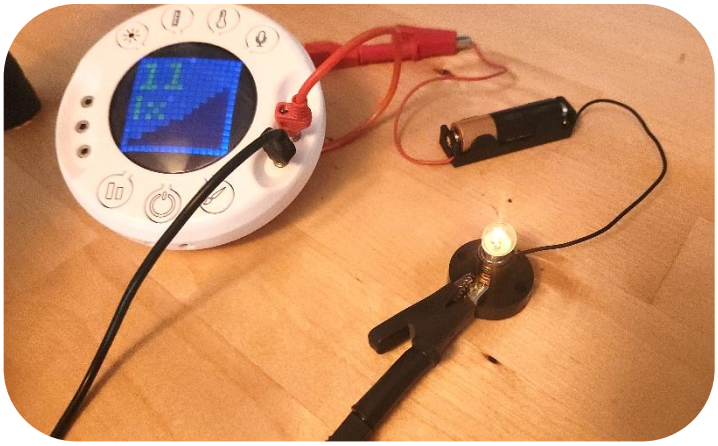
The switches/contacts will allow you to open or close a switch inside the Xploris. An open switch will break the circuit whereas a closed switch will complete the circuit.

Example:

Using the Control module, you cannot control both Voltage Out and Switches. Therefore, in order for this to work, you will need your circuit to include its own power source such as one AA battery.

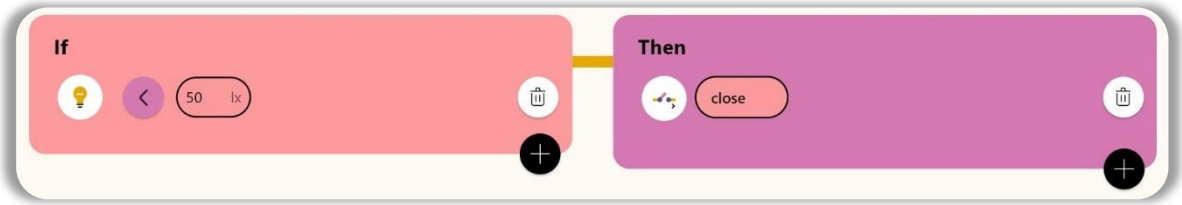
For this example, set up your Xploris in the following manner if you have the available materials:

- Plug the red banana cable into the middle right port and the black banana cable into the bottom right port.
- Run your red banana cable to the red line / + side of a AA battery.
- Connect the black line / - side of the battery to a small light bulb.



- Then, connect the other end of the light to the black banana cable.
- Have a flashlight nearby to easily adjust the amount of light hitting the sensor.

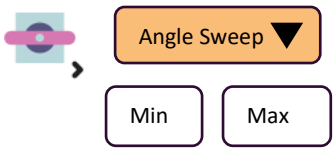
Example 9: When the light is below 50 lux, close the switch on the right side of the Xploris to complete the circuit. This should turn on your light bulb when the light gets low as shown in the picture.



8.3.6 Servos

You can control the Servo ports. These are the rectangular ports located on the back of the Xploris.

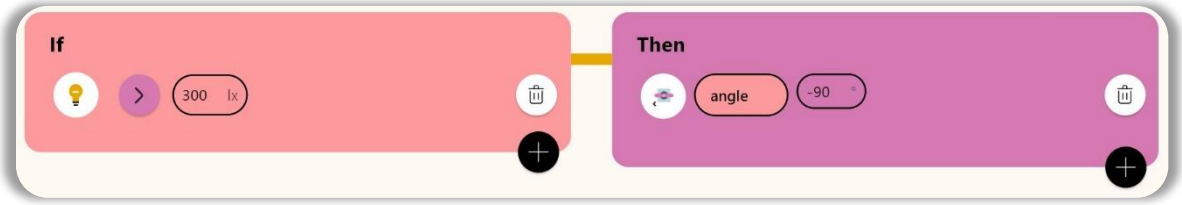
Remember: Right vs Left is determined by looking at the motors from the FRONT of the Xploris, not the back.

Servo	Description	XploriLab
Set Servo Angle	Move the servo arm to a set angle when input condition is met. Set angle back to zero when input condition is unmet. Angle value is between -90˚ to +90˚ Servo arm will always be either the set value or 0°.	
Sweep Servo Angle	Change servo arm angle from minimum defined angle to maximum defined angle, and according to sensor input values.  Relevant only for the X < Sensor < Y input condition.	

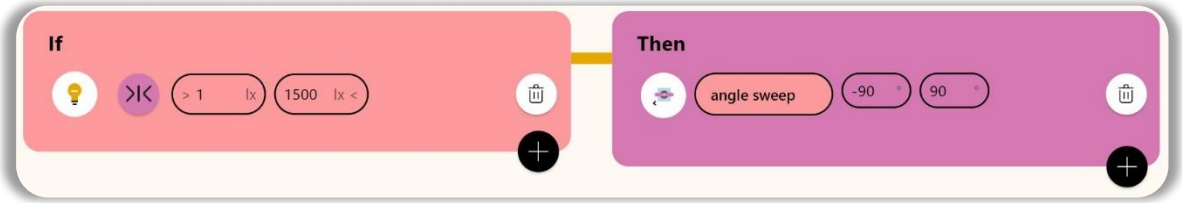
	Change the servo arm angle linearly according to the sensor value: If Sensor = X, Then arm angle = Min angle If Sensor = Y, Then arm angle = Max angle Servo arm will rotate according to the sensor value and could be anywhere in the range of min or max angles.	

Examples:

Example 10: In this example, once the light exceeds 300 lux, the servo plugged into the motor on the left-hand side as you face the screen will turn -90°. If the light drops below that angle, the motor will return to 0°. It will do so as often as the light exceeds 300 lux.



Example 11: This If/Then statement says that as the brightness increases, the angle of the servo motor will increase from -90° to positive 90°. The motor position will continually update based on the newest data.



NOTE: When you stop a control program controlling the angle of a servo motor, the motor will return to 0° automatically.

8.4 Start or Stop your Control Statements

Click the **Play** icon to send the IF/THEN condition to your Xploris.

Once received, your Xploris device will start scanning the relevant sensors and producing the relevant outputs. Scanning is performed at a rate of 5 times per second and outputs will update at that same rate.

If you selected the Xploris Display as an output, it will update according to the program.

If you did not select Xploris Display as an output – the Xploris will show the first sensor level on its display, together with a blinking red rectangle on the corner of the screen indicating that Xploris is in Control mode.

To leave the Control mode simply press and hold the Xploris ON/OFF button for 1 second. Alternately, you can click the **Stop** icon in XploriLab.

8.5 Disconnecting from XploriLab during a Control Statement

Xploris doesn't have to remain connected to XploriLab to perform the If/Then condition. Thus, once you click the Play icon, you may disconnect your Xploris from XploriLab.

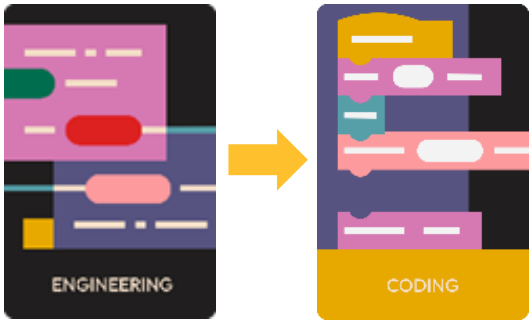
8.6 File Management

Samples are not being saved while working in the Control module. As such, there is no storage limitation on how long you can keep the Xploris in this mode.

Use the Pancakes menu to save and open IF/THEN condition files on your device.

9. Xploris Engineering: Coding Module

From the main screen select the ENGINEERING Poster and then tap the CODING poster.



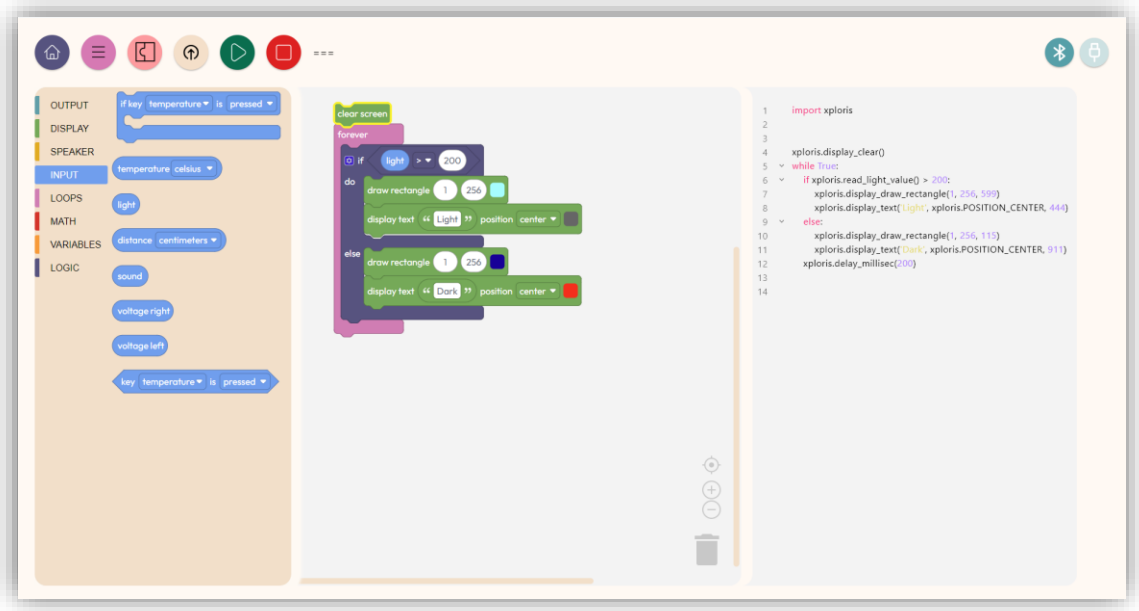
9.1 Coding Overview

XploriLab software incorporates a coding editor allowing users to apply visual programming principles via an intuitive graphical interface. In addition to the "Blockly" interface for coding, XploriLab also supports Python programming for higher learning grades.

This includes Data Types, Variables, Logical operators, If-Else conditions, Loops, and Math Functions. In addition, the Coding module provides you with full access to all Xploris sensors and full control of all its outputs, to create a true physical coding project.

Once you've completed your code you can upload it to your Xploris.

9.2 Selecting Your Coding Interface

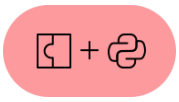


The Blockly mode provides users with a series of pre-made blocks that can be combined to create in-depth codes without needing to know a programming language. The other coding interface available is Python, in which students use the Python coding language to create their programs.

Use the Code Interface Button to switch between Blockly Mode, Python Mode, and Both Mode.

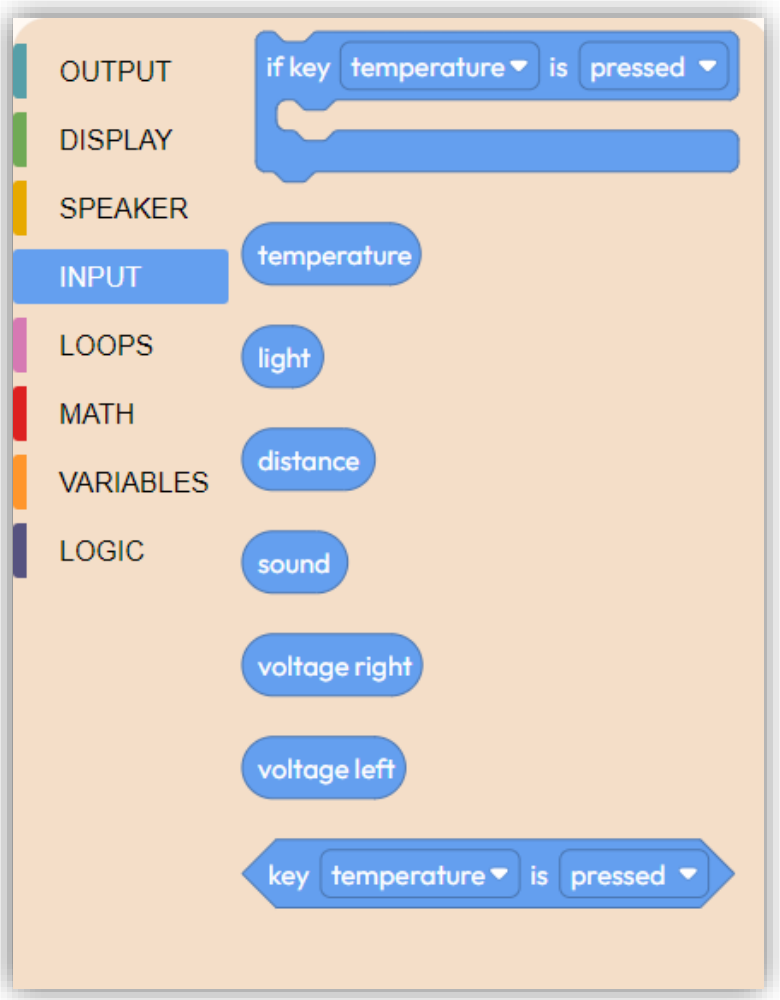
Clicking the code interface button when it shows this icon – switch to Blockly mode.

Clicking the code interface button when it shows this icon – switch to Python mode.



Clicking the code interface button when it shows this icon – will switch to Blockly + Python mode.

9.3 The Block editor

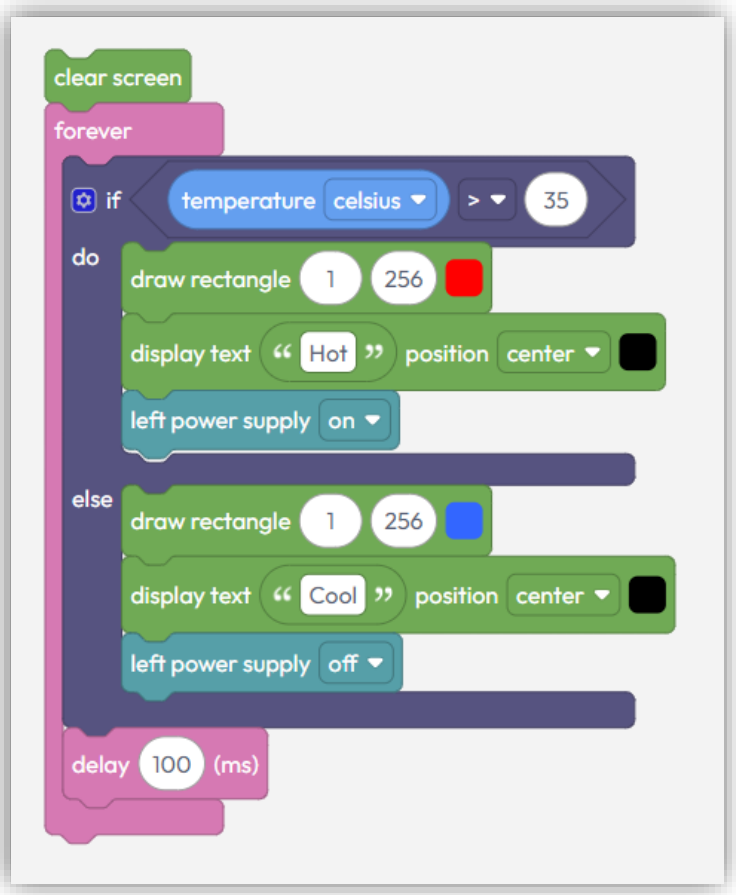


This Blockly editor contains 8 groups of blocks, with a total of 50+ different blocks. From the standard Loops, IF/Then logic, Math and Variables, to the specific Xploris groups such as Display, Input, Output and Speaker.

With full control on Xploris inputs and outputs – users can create an unlimited and rich code.

In the next page you may find an example of a simple Block coding, using the Temperature probe measuring the ambient temperature and turning the left voltage output on when the Temperature is above 35 degrees.

In addition it changes the display background from blue to red and replaces the “Cool” text with “Hot”.



The Blocks are automatically translated to Python and can be viewed in Python when user set the editor to Python mode or Blockly + Python mode. Below is the Python code generated automatically for the above Block example:

```
import xploris


xploris.display_clear()
while True:
    if xploris.read_temperature_value(xploris.TEMPERATURE_CELSIUS) > 35:
        xploris.display_draw_rectangle(1, 256, 911)
        xploris.display_text('Hot', xploris.POSITION_CENTER, 111)
        xploris.power_supply_left_set(xploris.SUPPLY_ON)
    else:
        xploris.display_draw_rectangle(1, 256, 249)
        xploris.display_text('Cool', xploris.POSITION_CENTER, 111)
        xploris.power_supply_left_set(xploris.SUPPLY_OFF)
    xploris.delay_millisec(100)
    xploris.delay_millisec(200)

```

9.4 The Python editor

The Python editor give users full access to the entire Python commands library. In addition to Python, Math and other useful libraries – we have created the Python Xploris Library.

This library holds a set of Python routines called methods - allowing users to read Xploris sensors, control and operate all Xploris outputs and use both the Xploris display and speaker.

Running the below example will turn Xploris 16x16 screen blue and show a scrolling white text of “Hello Xploris!”

import xploris

xploris.display_draw_rectangle(1, 256, 468)
xploris.display_text('Hello Xploris!', xploris.POSITION_CENTER, 999)

9.5 Save, upload and execute you code

Use the Pancakes menu to save and open Coding files. All files are saved with both their Blocks and Python information.

Use the Upload icon to enter Coding Mode and send all code you have created to the Xploris.

Use the Play icon to run (execute) the code sent to Xploris.

Stop code execution and leave Coding mode.

While communicating with the Xploris, it will report back Coding status and Error messages. These messages are displayed at the top bar to the left of the STOP icon:

>>>	Xploris is in Coding mode and is ready to receive code.
===	Code was successfully sent to Xploris.
Running code	Code is being executed.
msh >	Xploris exit coding mode.

An example for Python error message: ***line 7 syntaxError: invalid syntax***.

9.6 Coding – important to know!

9.6.1 Adding Delays in Loops and Infinite Loops

When programming with Xploris, accidental halts or resets can occur if delays are not included in your code. To prevent this, it is essential to add a Delay Block or a Delay command (in Python) to loops, especially long or infinite loops.

Recommendation: Add a minimum delay of 20 milliseconds to ensure smooth execution and prevent the device from halting or resetting.

9.6.2 Entering and Exiting Coding Mode

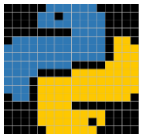
Switching to and from Coding Mode involves multiple steps managed by the Xploris operating system. As a result, both the UPLOAD and STOP commands take approximately 4 seconds to complete when entering or exiting Coding Mode.

9.6.3 Adding Delays Between Consecutive Display Variable Commands

When using consecutive Display Variable commands, ensure there is sufficient delay between them to allow proper display of the variables.

Recommendation: Add a minimum delay of 1000 milliseconds between two consecutive Display Variable commands, or 150ms for Xploris Ver 1.05 and up.

9.6.4 Communication in Coding Mode



When you click the Upload icon, Xploris enters Coding Mode and displays the Python logo – shown on the left side of the screen.

While in Coding Mode, Xploris only communicates with the Coding module in the XploriLab software.

To exit Coding Mode, click the STOP icon in the Coding module, or turn OFF and ON the Xploris.

Connecting a USB cable during code execution switches the Xploris to battery charging mode.

Recommendation: You may use either Bluetooth or USB communication for uploading your Code. For smooth code execution – DO NOT connect the USB cable during code execution.

9.7 Open-Source Licenses

This software includes components from the Blockly library, an open-source project developed by Google, and licensed under the **Apache License, Version 2.0**.

Attribution

Blockly © Google. Licensed under the Apache License, Version 2.0.

License Terms

You can view the full text of the **Apache License, Version 2.0** at:
http://www.apache.org/licenses/LICENSE-2.0

Modifications

This software may include modifications to the original Blockly library. Any modifications made to Blockly's original source code are documented in the source code repository.

10. Technical Specifications

Xploris Hardware	
Parameter	**Description**
SCIENCE DATA LOGGING	
Built-in Accessible Sensors	5 built in sensors: temperature, light, distance, sound, voltage
Max. Sampling Speed	100/s
Sampling Resolution	12-bit
Measurement Memory Size	40 recordings or 80,000 samples
Display Type	Numeric data, bar graph
Remote Data Collection	Yes
Automatic Sensor Testing & Calibration	Yes
CONTROL OUTPUTS	
Open Collector Switches	2 x Open Collectors outputs able to switch up to 1A
Voltage Output	2 x 5V @ 100mA
Servo Engine Drivers	2 x PWM servo engine drivers
ART	
Image Memory Size	30 animations or 1800 images
Display Type	16x16 pixels images and animations
Music Composing	Up to 126 notes
GENERAL	
Display	Full color LED dot Matrix 16x16 pixels
Communication	USB 2.0, Bluetooth 4.2 (BLE)
Speaker	0.7W 8 ohm
Keypad / Buttons	7 keys/buttons
Internal Rechargeable Battery	LiPO 3.7V
Battery Life	11+ hours (low LED brightness) 7 hours (mid LED brightness) 4 hours (high LED brightness) 2 hours charging time
Size	ϕ= 104, H = 30 mm
Weight	140gr.
Temperature Range	-10 to 50 °C
Standard Compliance	CE, FCC

Built-in Sensors		
Sensor Type	**Max. Range**	**Accuracy**
External Temperature	-25 to 125 °C	±1 °C
Ambient Temperature	-10 to 50 °C	±5 °C
Distance	40 to 400 cm	±2 mm
Light	0 to 60,000 lx	±10 %
Sound Level	25 to 90 dB	±4 dB
Voltage	0 – 5V	±2 %

XploriLab Software	
Parameter	**Description**
CODING	
BLOCKLY/SCRATCH Editor	Data types, variables, logical operators, if else conditions, loops, input and output, operations
Python Editor	Python editor, Blockly to Python
Code Flashing	Flash the created code to the XPLORIS via USB-C/BT
SENSING & DATA LOGGING	
Data Retrieval	Real time up to 100 samples per second, or download Xploris stored data
Display for K-6	Real time gauges and pictographs
Data Display	Line graphs, bar graphs, tables
Data Logging Configuration	Sensor selection, sampling rate, sampling points
Graph Manipulation	Placing and moving up to two markers on the graphs, zoom in/out, graph cropping, graph color changing
Graph Annotation	Adding text, images, and GIFs to the graph
Functions	Average, Linear regression
CONTROL	
Inputs	light, distance, temperature, sound, voltage
Conditions	Sensor level: greater than, less than, between, rising above, falling below a user defined value
Outputs	Sound tones, animation speed, animation frame, servo angle, left contact on/off, right contact on/off, left 5V on/off, right 5V on/off
ANIMATIONS	
Drawing Tools	Pencil, color selection, color duplicator, line, rectangle, color fill, area selection, move
Animation Tools	Duplicate image, image speed change, adding sound track
Animation Layers	Supports 3 layers per animation frame

Pixel Art Library	Download from a cloud based library of images and animation
Image Flashing	Flash an image or animation via USB-C/BT, to be displayed on XPLORIS display
MUSIC COMPOSING	
Available Notes	1.5 octave, 16 notes
Composing Tools	Composition of up to 126 notes, controlling notes' duration
Composition Flashing	Flash via USB-C/BT, to be played by XPLORIS speaker
OS	Windows, iOS, Android, Chrome OS

Annex – A Xploris Python Methods

Input methods

Check if key is pressed method

xploris.is_key_pressed(arg)

Arg options: xploris.KEY_LIGHT, xploris.KEY_DISTANCE, xploris.KEY_TEMPERATURE, xploris.KEY_SOUND, xploris.KEY_BAR, xploris.KEY_BRUSH

Returns '1' if the correspondent button is pressed, otherwise returns '0'

Examples:

```
if xploris.is_key_pressed(xploris.KEY_DISTANCE)==True:
        # perform code


if xploris.is_key_pressed(xploris.KEY_TEMPERATURE)==False:
        # perform code
```

Read light sensor value

xploris.read_light_value()

Returns integer light value in lux. Range 0 to 64000 lx.

Example:

```
if xploris.read_light_value()>1000:
        # perform code
```

Read distance sensor value

xploris.read_distance_value(arg)

Arg options: xploris.DISTANCE_CENTIMETERS, xploris.DISTANCE_INCHES

Returns integer distance value in cm/inch.

Example:

```
if xploris.read_distance_value(xploris.DISTANCE_CENTIMETERS)>100:
        # perform code
```

Read temperature sensor value

xploris.read_temperature_value(arg)

Arg options: xploris.TEMPERATURE_CELCIUS, xploris.TEMPERATURE_FAHRENHEIT

Returns integer temperature value in °C/°F.

Example:

```
if xploris.read_temperature_value(xploris.TEMPERATURE_CELCIUS)>64:
        # perform code
```

Read sound sensor value

xploris.read_sound_value()

Returns integer sound value in dB. Range 25 to 95 dB.

Example:

```
if xploris.read_sound_value()<64:
        # perform code
```

Read voltage left sensor value

xploris.read_voltage_left_value()

Returns integer voltage left value in Volts. Range 0 to 5.000 V.

Example:

```
if xploris.read_voltage_left_value()<2.4:
        # perform code
```

Read voltage right sensor value

xploris.read_voltage_right_value()

Returns integer voltage right value in Volts. Range 0 to 5.000 V.

Example:

```
if xploris.read_voltage_right_value()<2.4:
        # perform code
```

Output methods

Power supply left set

xploris.power_supply_left_set(arg)

Turn left 5V supply on/off

Arg options: xploris.SUPPLY_ON, xploris.SUPPLY_OFF

Power supply right set

xploris.power_supply_right_set(arg)

Turn right 5V supply on/off
Arg options: xploris.SUPPLY_ON, xploris.SUPPLY_OFF

Switch left set

xploris.switch_left_set(arg)

Left switch – open/close

Arg options: xploris.SWITCH_OPEN, xploris.SWITCH_CLOSED

Switch right set

xploris.switch_left_set(arg)

Right switch – open/close

Arg options: xploris.SWITCH_OPEN, xploris.SWITCH_CLOSED

Servo motor left angle set

xploris.servo_left_angle_set(arg)

Set left servo to an angle between -90 to +90 degrees

Arg options: integer from -90 to 90

Servo motor left speed set

xploris.servo_left_speed_set(arg1,arg2)

Set left servo rotation speed. Users may define the rotation direction and speed 0 to 90 rpm

Arg1 options: xploris.CLOCKWISE, xploris.COUNTERCLOCKWISE
Arg2 options: integer from 0 to 90

Servo motor right angle set

xploris.servo_right_angle_set(arg)

Set Right servo to an angle between -90 to +90 degrees

Arg options: integer from -90 to 90

Servo motor right speed set

xploris.servo_right_speed_set(arg1,arg2)

Set right servo rotation speed. Users may define the rotation direction and speed 0 to 90 rpm

Arg1 options: xploris.CLOCKWISE, xploris.COUNTERCLOCKWISE
Arg2 options: integer from 0 to 90

Display methods

Clear display

xploris.display_clear()

Clear the Xploris display

Display animation

xploris.display_animation(arg)

Play a stored animation

Arg options: integer from 1 to 30

Display still picture

xploris.display_picture(arg)

Display a stored still image

Arg options: xploris.PICTURE_FROG, xploris.PICTURE_HEART, xploris.PICTURE_CAT …- (each static picture has his own unique name)

Display text or digital variable

xploris.display_text(arg1,arg2,arg3)

Display a string of text on the Xploris display. If text is longer than 2 charecters, the Xploris will scroll it on its display. Users can select the text position – top, center and bottom, as well as the text color.

Arg1 character string (maximum length 32)
Arg2 xploris.POSITION_TOP, xploris.POSITION_CENTER, xploris.POSITION_BOTTOM

Arg3: integer that describes RGB color of the text. Range 111 (black color – the default) to 999 (white color), total 888 colors.

Examples:
xploris.display_text('I am Xploris', xploris.POSITION_CENTER,114)

a=12.34
xploris.display_text(str(a), xploris.POSITION_CENTER,114)

Stop displaying text

xploris.display_text_stop()

Stop displaying text

Plot

xploris.display_plot(arg1,arg2,arg3)

Turn on one of the 16x16 pixels of the display. Users will define the pixel x,y position and its color.

Arg1 is a column number, range 1 to 16
Arg2 is a row number, range 1 to 16
Arg3: integer that describes RGB color of the text. Range 111 (black color – the default) to 999 (white color), total 888 colors.

Unplot (turn off a single dot on the display)

xploris.display_unplot(arg1,arg2)

Turn off one of the 16x16 pixels of the display. Users will define the pixel x,y position and its color.

Arg1 is a column number, range 1 to 16
Arg2 is a row number, range 1 to 16

Draw a rectangle on the display

xploris.display_draw_rectangle(arg1,arg2,arg3)

Draw a rectangle. User define the top left corner and bottom right corner of the rectangle, as well as the rectangle color.

Where:
1 is the display top left LED
256 is the display bottom right LED

Arg1: integer describes top left corner of the rectangle. Range 1 to 256.
Arg2: integer describes bottom right corner of the rectangle. Range 1 to 256.
Arg3: integer that describes RGB color of the rectangle. Range 111 (black color) to 999 (white color), total 888 colors.

Display scroll

xploris.display_scroll(arg1,arg2)

Scroll the display. Users define the number of pixels for the scroll as well as the scroll direction – up, down, left and right.

Arg1 options: xploris.SCROLL_UP, xploris.SCROLL_DOWN, xploris.SCROLL_LEFT, xploris.SCROLL_RIGHT
Arg2: integer that defines number of pixels to scroll. Range from 1 to 16.

Stop scroll display

xploris.display_scroll_stop()

Display the original image, before it was scrolled.

Set display brightness

xploris.display_brightness_set(arg)

Set Xploris display brightness to one of 3 levels – High, Medium and Low.

Arg options: xploris.BRIGHTNESS_HIGH, xploris.BRIGHTNESS_MIDDLE, xploris.BRIGHTNESS_LOW

Display Python animation

xploris.display_animation_python()

Display a Python built-in animation  indicating that the unit is in Coding/Python mode

Speaker methods

Play music

xploris.speaker_play_music(arg)

Play Xploris sound track.

Arg: integer from 0 to 9.

Where:
0 – default music pattern or music created by the user.
1 - 9 hardcoded music patterns.

Play a single note

Xploris is able to play 16 notes (1.5 octave) with duration up to 1000 mSec.

xploris.speaker_play_note (arg1,arg2)

Arg1: xploris.C1, xploris.C1_SHARP, xploris.D1, xploris.D1_SHARP, xploris.E1, xploris.F1, xploris.F1_SHARP, xploris.G1, xploris.G1_SHARP, xploris.A1, xploris.A1_SHARP, xploris.H1, xploris.C2, xploris.C2_SHARP, xploris.D2, xploris.D2_SHARP
Arg2: 125, 188, 250, 313, 375, 500, 750, 1000 all in millisecond

Stop playing

xploris.speaker_stop()

Stop speaker sound.

Set speaker volume

xploris.speaker_volume_set(arg)

Set speaker volume

Arg: integer from 10 to 100 – defines the speaker volume in %.

Increase speaker volume

xploris.speaker_volume_increase(arg)

Increase speaker volume in %

Arg: integer from 10 to 90

Decrease speaker volume

xploris.speaker_volume_decrease(arg)

Decrease speaker volume in %

Arg: integer from 10 to 90

Miscellaneous methods

Common system delay

xploris.delay_millisec(arg)

Arg: integer from 20 to 10000 – defines the system delay in milliseconds

Random integer

xploris.randint(arg1, arg2)

Returns a random integer between Arg1 to Arg2

Arg1: integer from 0 – 254.
Arg2: integer from 1 – 255.

Note: always arg1<arg2

Exit Coding/Python mode

xploris.python_exit()

Returns 1234
Exit coding mode.

Performing the following:

1. Stop music
2. Stop display text or variable
3. Shut down 5V
4. Shut down servo
5. Open both switches
6. Make a 50ms beep
7. Show animation (1)
8. Send “Exit” on the serial port
9. Switch UART to non-coding mode